# DESIGN CAPACITY TABLES

## FOR STRUCTURAL STEEL HOLLOW SECTIONS

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# Design Capacity Tables for Structural Steel Hollow Sections

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**DESIGN CAPACITY TABLES FOR STRUCTURAL STEEL HOLLOW SECTIONS**

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## Relevance of information contained in this Publication

***Material Standards and product qualities:***

*USERS OF THIS PUBLICATION* SHOULD NOTE THAT THE DESIGN CAPACITIES, CALCULATIONS, TABULATIONS AND OTHER INFORMATION PRESENT IN THIS PUBLICATION ARE SPECIFICALLY RELEVANT TO STRUCTURAL STEEL HOLLOW SECTIONS SUPPLIED BY Australian Tube Mills.

Consequently, the information contained in this publication cannot be readily used for hollow sections supplied from other manufacturers as those sections may vary significantly in grade, thickness, size, material Standard compliance (including chemical composition, mechanical properties, tolerances) and quality when compared to structural steel hollow sections supplied from Australian Tube Mills (ATM).

In many instances, the higher strengths and qualities provided by ATM structural steel hollow sections to obtain efficient and economical designs from structural mass reductions cannot be readily provided by hollow sections from other sources.

***Structural steelwork/engineering Standards:***

The maximum design loads and design capacities listed in this publication are based on the limit states design method of AS 4100 and the factored limit states design loads and combinations considered within AS/NZS 1170. Hence, much of the information contained herein will only be of use to persons familiar with the limit states design method and the use of:

- AS 4100 Steel structures
- AS/NZS 1170 Structural design actions

***Product availability & other information:***

As the section, grade and finish of all products are subject to continuous improvement, reference should be made to the ATM *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The current version of the PAG can be found on the ATM website www.austubemills.com.

# Foreword

Australian Tube Mills is one of the world's premier producers of welded steel tube and pipe for structural, mechanical and low pressure reticulation applications. For many years, Australian Tube Mills has been at the industry forefront with numerous innovations delivering significant value to a wide range of key industries. With manufacturing facilities strategically located in Australia (Brisbane, Newcastle, Melbourne and Perth), Australian Tube Mills is effectively placed to supply high quality tubular steel products to markets in Australia, New Zealand, South Pacific and South-East Asia.

Australian Tube Mills' innovative approach to the development of tubular products has been noted by various industries for many years. This has included the introduction and ongoing push of higher strength RHS and Pipe products which reduce weight and cut costs for end-users. Strength enhancements began with Grade C350L0 ("TruBlu"), then Grade C450L0 ("GreensTuf") and DuraGal® and now C450PLUS® (previously DualGrade® C350L0/C450L0) products. Australian Tube Mills were the first to develop and promote these grades into Australian Standards and its market areas and now offer the largest range of C450PLUS® sections – not only in Australia but across the world.

Development of tubular shapes has also been an important strategy for Australian Tube Mills. Specific shapes (some of which carry patents and trademarks) were developed for defined industries and include the SiloTube, UniRail, StockRail and Architectural sections. Limited rollings of other forms of hollow sections can be supplied on a special order basis.

Apart from material improvements, Australian Tube Mills' plants also produce different types of coating systems for tubular products. Revolutionary primer-paint systems were developed with industry participation to protect hollow sections from rust during warehouse storage, transportation and fabrication as well as offer a smooth clean work surface during and after fabrication.

Australian Tube Mills now supplies the largest range of welded tubular steel products in Australia which vary in shape, grade and finish.

Compared to other steel products, the worldwide consumption of welded tubular steel products is significantly increasing. The main reasons for this outcome is due to the aesthetics, engineering efficiencies, cost-effectiveness, increased specifier/end-user awareness and the high value-adding inherent with tubular products. This has now firmly positioned Australian Tube Mills as the preferred tubular supplier within many industries.

Quality products, people and service sets Australian Tube Mills apart from its competitors.

## Acknowledgements

Australian Tube Mills gratefully acknowledges the assistance provided by the Australian Steel Institute (ASI) – previously the Australian Institute of Steel Construction (AISC) – for permitting the use of their "Design Capacity Tables" text and format in the development of various parts of this publication.

Additionally, Australian Tube Mills wishes to acknowledge the detailed contributions from the following:

- Russell Watkins of Australian Tube Mills for writing, generating and checking the text, tables and graphs used in this publication;
- OneSteel's marketing services team for artwork and coordination; and
  Nick van der Kreek at Australian Tube Mills for checking and updating various aspects of this publication.

# Preface

The “Design Capacity Tables for Structural Steel” (DCT) suite of publications from the Australian Steel Institute (ASI) – previously the Australian Institute of Steel Construction (AISC) – has been commonly used by design engineers for at least a decade. The actual origin of these publications goes back to 1969 when the Safe Load Tables (SLT) was published by AISC (at the time) for the then permissible stress based steel structures Standards AS CA-1 and subsequently AS 1250. The SLT was published in six editions (the last edition being in 1987) with both hot-rolled “open” sections (e.g. UB, UC, PFC, etc) and structural steel hollow sections (CHS, RHS and SHS) included in its contents.

The release of AS 4100 Steel Structures in 1990 to supersede AS 1250 saw a change in design philosophy from permissible stress to limit states design principles. Such a change prompted the revision of the SLT to manifest itself as the DCT. The first edition of the DCT had an overall format which was similar to the sixth edition of the SLT and included both open and hollow sections. However, due to the growing popularity, increasing range and innovation of hollow section construction, the DCT was effectively split in 1992 with the release of the “Design Capacity Tables for Structural Steel Hollow Sections” (DCTHS) which only considered tubular members. Thereafter, a second edition of the DCTHS was released in 1999 entitled “Design Capacity Tables for Structural Steel – Volume 2: Hollow Sections” (DCT-v2:HS).

While somewhat of a challenge, the aim of the DCT-v2:HS (and preceding DCTHS/DCT) was to provide current information on hollow sections available from various manufacturers. However, at the time of publication, the consolidated product range listing from each of the manufacturers was disjointed and not reflective of available sections. Even though the DCT-v2:HS listed a large range of hollow sections, this positive aspect was negated by imprecise information on product availability. Various manufacturers also complicated the situation by producing their own versions of the DCTHS even though they had a smaller product/size range. Subsequent market studies by Australian Tube Mills revealed that there was growing specifier and industry frustration from the numerous but fragmented publications available that attempted to describe the total range of hollow sections compliant with Australian Standards. Market feedback also indicated some level of confusion with what sizes were available in various grades. There was no ready answer to this frustration and confusion – unless, of course, a single manufacturer could confidently supply a total consistent range of hollow sections.

As part of its ongoing Sales & Marketing strategies, and after much analysis, Australian Tube Mills are undertaking various initiatives to significantly grow the tubular market with a substantial increase in product range and technical support. Prior to this initiative, one of the limitations with tubular construction was the restricted range of large readily available hollow sections that are fully compliant with Australian Standards. For RHS/SHS this was seen to typically “top out” at 250 x 250 SHS with thickness up to 9 mm thick. The situation with CHS was slightly different with the availability of larger “down-graded” line-pipe though there were some issues reported on the compliance of such products to the structural requirements of AS/NZS 1163 Grade C350L0.

The ability to supply a full range of structural steel hollow sections coupled with the ability to ease industry frustration from the lack of consolidated correct information of such sections also sees Australian Tube Mills providing a large array of technical/marketing media (i.e. literature and software). Part of the media includes this DCTHS which is based on AS 4100–1998.

In order to embrace the acceptance level of the previously published industry document, this

# Preface (continued)

DCTHS follows the same format as the ASI/AISC DCTHS. This means that the Parts of this publication follow the same numeric sequence as those in the ASI/AISC DCTHS and AS 4100. The tabulated data and much of the text in this publication also follows the same format and sequence as the ASI/AISC DCTHS which now makes it a ready companion to the DCT for hot-rolled "open" sections. Hence, if readers are familiar with the current ASI/AISC DCTs they will also be familiar with this publication.

Whilst based on the ASI/AISC DCTHS, some minor revisions, corrections and updates were incorporated in this publication as well as recognition of the changed "loading" Standards to AS/NZS 1170 and other related Standards. Also, readers will note that this publication is produced in "landscape" format – i.e. the width of the page is the longer dimension. The rationale behind this modification followed industry surveys that noted the generally published "portrait" format did not suit publications substantially containing landscape tables. Consequently, this and several other Australian Tube Mills publications have been produced in landscape format. For additional information, readers should also refer to page (ii) for the appropriate use of this DCTHS.

It is interesting to note that after nearly twenty years since the release of the first DCTHS, the same basic team involved in the first document has been brought together to develop this publication. This team includes engineers for computations, content and project management as well as graphic designers. Accordingly, we trust this publication is of value to designers of hollow section construction and would appreciate any feedback on its adequacy or ways to refine it.

May your designs in tubular construction be fruitful ones!

Arun Syam
Editor & Tubular Development Manager
Australian Tube Mills

# Notation & Abbreviations

| | |
|---|---|
| $A_e$ | effective sectional area of a hollow section in shear, or effective area of a compression member |
| $A_g$ | gross area of a cross-section |
| $A_n$ | net area of a cross-section |
| AISC | Australian Institute of Steel Construction (now ASI) |
| ASI | Australian Steel Institute (formerly AISC) |
| $b$ | width of a section |
| $b_b$, $b_{bf}$, $b_{bw}$ | bearing widths |
| $b_f$ | width of a flange |
| $b_s$ | stiff bearing length |
| $C$ | torsional modulus for a cross-section; or Compact section (in bending) |
| C250L0 | cold-formed Grade C250 hollow section to AS/NZS 1163 with L0 properties |
| C350L0 | cold-formed Grade C350 hollow section to AS/NZS 1163 with L0 properties |
| C450L0 | cold-formed Grade C450 hollow section to AS/NZS 1163 with L0 properties |
| C450PLUS™ | RHS/SHS which satisfy the strength and elongation requirements of AS/NZS 1163 Grade C350L0 and C450L0 |
| CHS | Circular Hollow Section(s) |
| $c_m$ | factor for unequal moments |
| $d$ | depth of a section |
| $d_o$ | outside diameter of a Circular Hollow Section (CHS) |
| $d_1$ | clear depth between flanges |
| $d_5$ | flat width of web |
| DN | nominal size OD for Pipe (CHS) sections (as noted in AS 1074) |
| $E$ | Young's modulus of elasticity, 200 x $10^3$ MPa |
| ERW | electric resistance welding |
| FLR | maximum value of (beam) segment length for Full Lateral Restraint |
| $f_u$ | tensile strength used in design, as defined in AS 4100 |
| $f_y$ | yield stress used in design, as defined in AS 4100 |
| $f^*_{va}$ | average design shear stress in a web |
| $f^*_{vm}$ | maximum design shear stress in a web |
| $G$ | shear modulus of elasticity, 80 x $10^3$ MPa; or nominal permanent actions (e.g. dead loads) |
| $G^*$ | design (factored) permanent actions (e.g. dead loads) |
| $h_s$ | storey height |
| $I$ | second moment of area of a cross-section |
| $I_w$ | warping constant for a cross-section (≈0 for hollow sections) |
| $I_x$ | $I$ about the cross-section major principal x-axis |
| $I_y$ | $I$ about the cross-section minor principal y-axis |
| $J$ | torsion constant for a cross-section |
| $k_e$ | member effective length factor |
| $k_f$ | form factor for members subject to axial compression |
| $k_l$ | effective length factor for load height |
| $k_r$ | effective length factor for restraint against lateral rotation |
| $k_{sm}$ | exposed surface area to mass ratio |
| $k_t$ | correction factor for distribution of forces in a tension member; or effective length factor for twist restraints |
| $k_v$ | ratio of flat width of web ($d_5$) to thickness ($t$) of hollow section |
| $L$ | span or member length; or sub-segment length (also see note at end of notation) |
| $L_e$ | effective length of a compression member or laterally unrestrained member (also see note at end of notation) |
| L0 | impact properties (as noted in AS/NZS 1163) |
| $M_b$ | nominal member moment capacity |

# **Notation & Abbreviations** (continued)

| | |
|---|---|
| $M_{bx}$ | $M_b$ about major principal x-axis |
| $M_{cx}$ | lesser of $M_{ix}$ and $M_{ox}$ |
| $M_i$ | nominal in-plane member moment capacity |
| $M_{ix}$ | $M_i$ about major principal x-axis |
| $M_{iy}$ | $M_i$ about minor principal y-axis |
| $M_o$ | reference elastic buckling moment for a member subject to bending; or nominal out-of-plane member moment capacity |
| $M_{oa}$ | amended elastic buckling moment for a member subject to bending |
| $M_{ox}$ | $M_o$ about major principal x-axis |
| $M_{rx}$ | $M_s$ about major principal x-axis reduced by axial force |
| $M_{ry}$ | $M_s$ about minor principal y-axis reduced by axial force |
| $M_s$ | nominal section moment capacity |
| $M_{sx}$ | $M_s$ about major principal x-axis |
| $M_{sy}$ | $M_s$ about minor principal y-axis |
| $M^*$ | design bending moment |
| $M_m^*$ | maximum calculated design bending moment along the length of a member or segment |
| $M_x^*$ | design bending moment about major principal x-axis |
| $M_y^*$ | design bending moment about minor principal y-axis |
| N | Non-compact section (in bending) |
| $N_c$ | nominal member capacity in axial compression |
| $N_{cx}$ | $N_c$ for member buckling about major principal x-axis |
| $N_{cy}$ | $N_c$ for member buckling about minor principal y-axis |
| $N_{om}$ | elastic buckling load |
| $N_{omb}$ | $N_{om}$ for a braced member |
| $N_s$ | nominal section capacity of a concentrically loaded compression member |

| | |
|---|---|
| $N_t$ | nominal section capacity in tension |
| $N^*$ | design axial force, tensile or compressive |
| n | axis through corners of a SHS |
| n/a | not applicable |
| OD | outside diameter (for CHS) |
| ATM | Australian Tube Mills |
| $P$ | applied concentrated load |
| PAG | Product Availability Guide by Australian Tube Mills |
| $Q$ | nominal imposed actions (e.g. live loads) |
| $Q^*$ | design (factored) imposed actions (e.g. live loads) |
| $R_b$ | nominal bearing capacity of a web |
| $R_{bb}$ | nominal bearing buckling capacity of a web |
| $R_{by}$ | nominal bearing yield capacity of a web |
| $R_u$ | nominal capacity |
| $r$ | radius of gyration; or radius |
| $r_{ext}$ | outside radius of hollow section |
| $r_x$ | radius of gyration about major principal x-axis |
| $r_y$ | radius of gyration about minor principal y-axis |
| $R^*$ | design bearing force; or design reaction |
| $øR_u$ | design capacity |
| RHS | Rectangular Hollow Section(s) |
| $S$ | plastic section modulus; or Slender section (in bending) |
| $S_x$ | (plastic) $S$ about major principal x-axis |
| $S_y$ | (plastic) $S$ about minor principal y-axis |
| $S^*$ | design action effect, as defined in AS 4100 |
| SHS | Square Hollow Section(s) |

# Notation & Abbreviations (continued)

| | |
|---|---|
| $t$ | thickness of a section |
| $t_f$ | thickness of a flange |
| $t_w$ | thickness of a web |
| UNO | unless noted otherwise |
| $V_u$ | nominal shear capacity of a web with a uniform shear stress distribution |
| $V_v$ | nominal shear capacity of a web |
| $V_{vm}$ | nominal shear capacity of a web in the presence of bending moment |
| $V^*$ | design shear force |
| $W$ | total uniformly distributed applied load |
| $W^*$ | design action; or design (factored) $W$ |
| $W^*_{EM}$ | equivalent strength Maximum Design Load based on Moment (Table T5.1) |
| $W^*_{ES}$ | equivalent serviceability Maximum Design Load based on Deflection (Table T5.1) |
| $W^*_{EV}$ | equivalent strength Maximum Design Load based on Shear (Table T5.1) |
| $W^*_L$ | strength limit state maximum design load |
| $W^*_{L1}$ | $W^*_L$ based on design moment capacity |
| $W^*_{L2}$ | $W^*_L$ based on design shear capacity |
| $W^*_S$ | serviceability limit state maximum design load |
| $W^*_{S1}$ | $W^*_S$ based on deflection limit |
| $W^*_{YL}$ | $W^*_S$ based on first yield load |
| x | major principal axis coordinate |
| y | minor principal axis coordinate |
| $Z$ | elastic section modulus |
| $Z_e$ | effective section modulus |
| $Z_{ex}$ | $Z_e$ for bending about major principal x-axis |
| $Z_{ey}$ | $Z_e$ for bending about minor principal y-axis |
| $Z_n$ | $Z$ about the n-axis through the corners of an SHS |
| $Z_x$ | $Z$ for bending about major principal x-axis |
| $Z_y$ | $Z$ for bending about minor principal y-axis |

| | |
|---|---|
| $\alpha_a$ | compression member factor |
| $\alpha_b$ | compression member section constant |
| $\alpha_c$ | compression member slenderness reduction factor |
| $\alpha_m$ | moment modification factor for bending |
| $\alpha_s$ | slenderness reduction factor |
| $\alpha_T$ | coefficient of thermal expansion |
| $\beta_m$ | ratio of smaller to larger bending moments at the ends of a member |
| $\gamma$ | ratio for compression member stiffness to end restraint stiffness |
| $\Delta_s$ | deflection |
| $\Delta_b$ | translational displacement of the top relative to the bottom for a storey height |
| $\delta_b$ | moment amplification factor for a braced member |
| $\delta_m$ | moment amplification factor, taken as the greater of $\delta_b$ and $\delta_s$ |
| $\delta_s$ | moment amplification factor for a sway member |
| $\xi$ | compression member factor |
| $\eta$ | compression member imperfection factor |
| $\pi$ | pi ($\approx$ 3.14159) |
| $\lambda$ | slenderness ratio |
| $\lambda_c$ | elastic buckling load factor |
| $\lambda_e$ | plate element slenderness |
| $\lambda_{ep}$ | plate element plasticity slenderness limit |
| $\lambda_{ey}$ | plate element yield slenderness limit |
| $\lambda_n$ | modified compression member slenderness |
| $\nu$ | Poisson's ratio |
| $\rho$ | density of a material |
| $\phi$ | capacity factor |

## Notes:

1. The Tables use $L_e$ and $L$ in lieu of $l_e$ and $l$ respectively (as noted in AS 4100) to avoid confusion with the standard typeface used.

# Standard and Other References

The Australian Standards referred to in this publication are centrally listed in Section 1.1.2. Other references are listed at the end of the initial text portion in each respective Part of the publication (i.e. prior to the main table listings).

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# Part 1

## INTRODUCTION

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**The maximum design loads and design capacities listed in this publication are based on the limit states design method of AS 4100 and the factored limit states design actions and combinations considered within AS/NZS 1170. Hence, much of the information contained herein will only be of use to persons familiar with the limit states design method and the use of:**

- **AS 4100 Steel structures**
- **AS/NZS 1170 Structural design actions**

**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 1

## INTRODUCTION

### 1.1 General

### 1.1.1 Steel Structures Standard

The tables in this publication have been calculated in accordance with the Australian Standard AS 4100–1998 Steel Structures. As far as possible, the notation and terminology used are the same as those adopted in that Standard.

Cold-formed hollow sections manufactured in accordance with Australian Standard AS/NZS 1163:2009 Structural Steel Hollow Sections are included within the scope of AS 4100. Extensive research [1.1,1.2,1.3] undertaken over a number of years has confirmed that cold-formed hollow sections compliant with AS/NZS 1163 meet the inherent requirements of AS 4100. Cold-formed hollow sections may also be designed to AS/NZS 4600:2005 Cold-Formed Steel Structures which is outside of the scope of this publication.

### 1.1.2 Reference Standards

"AS 1074" refers to AS 1074–1989 Steel tubes and tubulars for ordinary service

"AS 4100" refers to AS 4100–1998 Steel structures

"AS/NZS 1163" refers to AS/NZS 1163:2009 Cold-formed structural steel hollow sections

"AS/NZS 1170" refers to AS/NZS 1170:2002 Structural design actions

"AS/NZS 1554.1" refers to AS/NZS 1554.1:2011 Structural steel welding – Welding of steel structures

"AS/NZS 2312" refers to AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings

"AS/NZS 4600" refers to AS/NZS 4600:2005 Cold-formed steel structures

"AS/NZS 4792" refers to AS/NZS 4792:2006 Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

### 1.1.3 Table Format and Usage

Within this publication the terms "Table" and "Tables" refer to information in this edition and volume of the Design Capacity Tables for Structural Steel Hollow Sections by Australian Tube Mills.

A brief list of the Tables' contents is provided in Section 1.5. It should be noted that the main tables listing design capacities and other member information are placed at the end of the initial text portion of each Part of this publication. The main tables will generally be listed within a numerical sequence – e.g. Table 5.1 series (Maximum Design Loads for Simply Supported Beams with Full Lateral Restraint), Table 5.2 series (Design Section Moment and Web Capacities), Table 5.3 series (Design Moment Capacities for Members without Full Lateral Restraint), etc.

Any table listed in the (initial) text portion of each Part of this Publication will have a "T" before the Table number – e.g. Table T2.1 in Section 2.2.

### 1.2 Range of Structural Steel Grades and Sections

The Tables contain information on the currently available (at the time of publication) structural steel hollow sections supplied by Australian Tube Mills (ATM) which fully comply with AS/NZS 1163. Section 2 should be consulted for further details on the structural steel hollow sections considered in the Tables.

Reference should also be made to the Australian Tube Mills Product Availability Guide (PAG) for general information on the **availability** of the **listed sections** and associated **finishes**.

### 1.3 Units

The units in the Tables are consistent with those in the SI (metric) system. The base units utilised in the Tables are newton (N) for force, metre (m) for length, and kilogram (kg) for mass. Where noted, stress is expressed in megapascals (MPa).

With some minor exceptions, all values in the Tables are rounded to three (3) significant figures.

## 1.4 Limit States Design using these Tables

AS 4100 sets out the minimum requirements for the design, fabrication and erection of steelwork in accordance with the limit states design method and follows a semi-probabilistic limit state approach presented in a deterministic format.

*Definition of limit states* – When a structure or part of a structure is rendered unfit for use it reaches a 'limit state'. In this state it ceases to perform the functions or to satisfy the conditions for which it was designed. Relevant limit states for structural steel include strength, serviceability, stability, fatigue, brittle fracture, fire, and earthquake. Only two limit states are considered in the Tables – the strength limit state and, where applicable, the serviceability limit state.

Limit states design requires structural members and connections to be proportioned such that the **design action effect** ($S^*$) resulting from the **design action** ($W^*$), is less than or equal to the **design capacity** ($\phi R_u$) i.e.

$$S^* \leq \phi R_u$$

**Design action** or **design load** ($W^*$) is the combination of the nominal actions or loads imposed upon the structure (e.g. transverse loads on a beam) multiplied by the appropriate load combination factors as specified in AS/NZS 1170 (Structural design actions). These design actions/loads are identified by an asterisk ( * ) after the appropriate action/load (e.g. $W^*_L$ is the maximum design transverse load on a beam).

**Design action effects** ($S^*$) are the actions (e.g. design bending moments, shear forces, axial loads) calculated from the **design actions** or **design loads** using an acceptable method of analysis (Section 4 of AS 4100). These effects are identified by an asterisk ( * ) after the appropriate action effect (e.g. $M^*$ describes the design bending moment).

**Design capacity** ($\phi R_u$) is the product of the nominal capacity ($R_u$) and the appropriate capacity factor ($\phi$) found in Table 3.4 of AS 4100. $R_u$ is determined from the characteristic values and specified parameters found in Sections 5 to 9 of AS 4100.

For example, consider the strength limit state design of a simply supported beam which has full lateral restraint subject to a total transverse **design load** ($W^*$) distributed uniformly along the beam. For flexure, the appropriate **design action effect** ($S^*$) is the **design bending moment** ($M^*$) which is determined by:

$$M^* = \frac{W^* L}{8}$$

where $L$ = span of the beam.

In this case the **design capacity** ($\phi R_u$) is equal to the **design section moment capacity** ($\phi M_s$), given by:

$$\phi M_s = \phi f_y Z_e$$

where $\phi$ = the capacity factor
$f_y$ = yield stress used in design
$Z_e$ = effective section modulus

To satisfy the strength limit state, the following relationship (equivalent to $S^* \leq \phi R_u$) is used:

$$M^* \leq \phi M_s$$

The **maximum design bending moment** ($M^*$) is therefore equal to the **design section moment capacity** ($\phi M_s$), and the **maximum design load** is that **design load** ($W^*$) which corresponds to the maximum $M^*$. (It should be noted that other checks on the beam may be necessary – e.g. shear capacity, bearing capacity, etc).

When considering external loads, in the context of this publication, the **maximum design load** ($W^*_L$) given in the relevant table must be greater than or equal to the imposed **design load** ($W^*$).

Where applicable, the Tables give values of **design capacity** ($\phi R_u$) and **maximum design load** ($W^*_L$) determined in accordance with AS 4100. When using the Tables, the designer must determine the relevant *strength limit state* **design action** ($W^*$) and/or corresponding **design action effect** ($S^*$) to ensure that the strength limit state requirements of AS 4100 are satisfied. Where relevant, other limit states (e.g. serviceability, fatigue, etc) must also be considered by the designer. Some useful information for checking the serviceability limit state is included in the Tables.

# Part 1
## INTRODUCTION

### 1.5 Table Contents

For the range of structural steel grades and sections considered, tables are provided for:

(i) section dimensions and section properties:
  - Dimensions and Properties + Properties for Design to AS 4100 (PART 3)
  - Fire Engineering Design (PART 3)
  - Telescoping Information (PART 3)

(ii) design capacity ($\phi R_u$) for:
  - Members Subject to Bending (PART 5)
  - Members Subject to Axial Compression (PART 6)
  - Members Subject to Axial Tension (PART 7)
  - Members Subject to Combined Actions (PART 8)

(iii) maximum design load ($W^*$) for:
  - Strength Limit State ($W^*_L$) for Beams (PART 5)
  - Serviceability Limit State ($W^*_S$) for Beams (PART 5)

Acceptable methods of analysis for determining the design action effects are defined in Section 4 of AS 4100 and material relevant to some of these methods of analysis is briefly presented in Part 4 of this publication.

### 1.6 References

[1.1] Hasan, S.W. and Hancock, G.J., "Plastic Bending Tests of Cold-Formed Rectangular Hollow Sections", Steel Construction, Vol. 23, No. 4, Australian Institute of Steel Construction, 1989 (Note: AISC is now ASI – Australian Steel Institute).

[1.2] Key, P.W., Hasan, S.W. and Hancock, G.J., "Column Behaviour of Cold-Formed Hollow Sections", Journal of Structural Engineering, American Society of Civil Engineers, Vol. 114, No. 2, 1988.

[1.3] Zhao, X.L. and Hancock, G.J., "Tests to Determine Plate Slenderness Limits for Cold-Formed Rectangular Hollow Sections of Grade C450", Steel Construction, Vol. 25, No. 4, Australian Institute of Steel Construction, 1991 (Note: AISC is now ASI – Australian Steel Institute).

**See Section 1.1.2 for details on reference Standards.**

# Part 2
## MATERIALS

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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 2
## MATERIALS

### 2.1 Range of Structural Steel Grades and Sections

These Tables cover the full range of structural steel hollow sections supplied by Australian Tube Mills manufactured in accordance with AS/NZS 1163.

The section sizes and their respective grades listed in the Tables include:

- AS/NZS 1163 Grade C250L0 Circular Hollow Sections (CHS)
- AS/NZS 1163 Grade C350L0 Circular Hollow Sections (CHS)
- AS/NZS 1163 Grade C350L0 Rectangular Hollow Sections (RHS) ('small' sizes only)
- AS/NZS 1163 Grade C450PLUS® RHS
- AS/NZS 1163 Grade C350L0 Square Hollow Sections (SHS) ('small' sizes only)
- AS/NZS 1163 Grade C450PLUS® SHS

The grade designation (e.g. C450L0) is based on the nominal minimum yield strength of the steel (in MPa). The prefix 'C' is used before the value of the nominal yield strength of the steel to indicate that the section is cold-formed. It should be noted that AS/NZS 1163 only considers cold-formed structural steel hollow sections. The suffix 'L0' denotes impact properties at 0°C as specified in AS/NZS 1163. Hollow sections rated with impact properties such as L0 are not only important in lower temperature environments but also for welded structures subject to dynamic loads. This becomes much more important for hollow sections with larger thickness (i.e. $t \geq 6.0$ mm).

AS/NZS 1163 Grade C450PLUS® RHS/SHS comply with the strength and elongation requirements of both Grade C350L0 and C450L0. The key mechanical properties of C450PLUS® are covered in Section 2.2 and a further description of C450PLUS® is given in Section 2.4. Where relevant, C450PLUS® RHS/SHS are designed as AS/NZS 1163 Grade C450L0 sections in these Tables to capitalise on the higher strength benefits of this steel grade – see Section 2.4.2. C450PLUS® are registered trademarks of Australian Tube Mills.

Further general information on the availability of the sections listed in the Tables is noted in Section 2.7.

### 2.1.1 Specifications

Hollow sections supplied by Australian Tube Mills are manufactured by cold-forming and high-frequency Electric Resistance Welding (ERW). The ERW process allows cold-formed hollow sections to be welded at ambient temperatures without subsequent stress relieving.

However, the Tables only apply to those hollow sections manufactured in accordance with AS/NZS 1163 and supplied by Australian Tube Mills.

Specifiers should also note that hollow sections not complying with AS/NZS 1163 may be required to be down-graded in yield stress, tensile strength and other mechanical properties when designing to AS 4100 and welding to AS/NZS 1554.1 – see Section 2.6.

To ensure the assumptions, product benefits and quality of structural steel hollow sections considered in these Tables, designers should specifically nominate AS/NZS 1163 compliant product in their specifications and general notes. Such wording may be:

*Unless Noted Otherwise* –

- CHS to comply with AS/NZS 1163–C350L0
- RHS/SHS to comply with AS/NZS 1163–C450L0

Note, for SHS with overall dimensions of 50 x 50 and smaller (and equivalent perimeter RHS), ATM typically supplies these sizes in Grade C350L0 to AS/NZS 1163. However, these sizes are available ex-rolling to AS/NZS 1163-C450L0 subject to minimum order requirements.

By specifying AS/NZS 1163–C450L0 RHS/SHS in the general notes and specifications it will also signal the fabricator to use typically available, prequalified higher strength welding consumables (i.e. E49/W50). This is generally reinforced by the welding part of the specification and general notes which flags the welding consumables to be E49/W50 – unless noted otherwise – as this is typical practice. However, should designers not utilise the higher strength benefits of C450PLUS® and only use its C350L0 properties, this can be indicated outside of the general notes and specification at the appropriate drawing arrangement or detail.

It should be noted that Australian Tube Mills also supplies AS/NZS 1163–C250L0 CHS and, if used and specified, they can also be flagged as such in the relevant part of the engineering/workshop drawings, material lists and/or bills of quantities with the default Standard and grade specification as noted above.

The importance of “L0” impact properties cannot be understated (as noted in Section 2.1) and has to be included in the grade designations of general notes, specifications and other points of steel grade reference.

In conjunction with the above structural steel hollow section Standard and grade designations, further information on the appropriate specification of structural steelwork can be found in Ref.[2.1] or by contacting Australian Tube Mills.

## 2.2 Yield Stress and Tensile Strength

Table T2.1 lists the minimum yield stresses and tensile strengths for the structural steel hollow section grades covered by this publication and used for calculating the design capacities.

**TABLE T2.1: Yield Stress and Tensile Strength based on Steel Grade**

| Australian Standard | Section Type | Steel Grade | Yield Stress $f_y$ MPa | Tensile Strength $f_u$ MPa |
|---|---|---|---|---|
| AS/NZS 1163 | CHS | C250L0 | 250 | 320 |
| | CHS | C350L0 | 350 | 430 |
| | RHS/SHS | C450PLUS®<br>(designed as C450L0) | 450 | 500 |

NOTE: See Section 2.4 for a definition of C450PLUS® and its use in these Tables.

More detailed information on the strengths and other mechanical properties of these steels can be found in Table 2.1 of AS 4100, AS/NZS 1163, other ATM product guides or by contacting ATM (by the contact details noted at the bottom of the page).

## 2.3 Properties of Steel

The properties of steel adopted in this publication are shown in Table T2.2. Properties such as Poisson’s Ratio and Coefficient of Thermal Expansion for structural steel are also listed in Table T2.2.

**TABLE T2.2: Properties of Steel**

| Property | Symbol | Value |
|---|---|---|
| Young's Modulus of Elasticity | $E$ | $200 \times 10^3$ MPa |
| Shear Modulus of Elasticity | $G$ | $80 \times 10^3$ MPa |
| Density | $\rho$ | 7850 kg/m$^3$ |
| Poisson's Ratio | $\nu$ | 0.25 |
| Coefficient of Thermal Expansion | $\alpha_T$ | $11.7 \times 10^{-6}$ per $^o$C |

### 2.3.1 Masses

The masses given in these Tables are based on a steel density of 7850 kg/m$^3$, the nominal section size and standard corner radii (see Section 3.2.1.2). In practice the tabulated values are affected by rolling tolerances and actual corner shape. Masses per metre listed are for the sections only, and do not include any allowances for cleats, end plates, weld metal, etc.

## 2.4 Grades

### 2.4.1 Circular Hollow Sections (CHS)

Australian Tube Mills (ATM) offers CHS in two AS/NZS 1163 grades: C250L0 and C350L0. The Grade C350L0 products provide a more comprehensive range of sections for structural applications and should be commonly specified. ATM also provide CHS/Pipe products which comply with AS 1074 and AS/NZS 1163–C250L0 for structural and low pressure piping applications. As the sizes supplied in the C250L0 CHS range are used in structural applications, they are also offered as Structural CHS by ATM.

### 2.4.2 Rectangular/Square Hollow Sections (RHS/SHS) and C450PLUS®

Due to the nature of manufacturing cold-formed hollow sections, RHS/SHS generally have higher strengths and lower elongations (from tensile tests) than CHS manufactured from the same type of feed-coil. This is basically due to the additional cold-working RHS/SHS receive during the sizing and finishing stages of shape formation. Consequently, from the three basic strength grades noted in AS/NZS 1163, CHS are generally supplied in grades C250L0 and C350L0 whereas RHS/SHS are supplied in the higher strengths of grades C350L0 and C450L0.

Australian Tube Mills (ATM) have always been at the forefront in utilising higher strength hollow sections both in Australia and internationally. This was previously seen by ATM's push to use Grade C350L0 for CHS, Grade C450L0 for RHS/SHS (the "GreensTuf" range) and now by offering the C450PLUS® RHS/SHS across a wide range of pre-coated and uncoated products.

The name C450PLUS® is derived from satisfying two key mechanical properties from tensile tests – strength and elongation. These properties undergo opposing effects during manufacturing. As noted above, it is widely known that the cold-forming process increases material strengths of welded cold-formed hollow sections. However, the elongation requirements of the material (a reflection of ductility) generally do not increase with strength. This is best illustrated by the following extract from AS/NZS 1163: Structural Steel Hollow Sections –

**Table T2.3: Tensile test requirements for RHS/SHS from Table 6 of AS/NZS 1163**

| Grade | Minimum yield strength ($f_y$) MPa | Minimum tensile strength ($f_u$) MPa | Minimum elongation as a proportion of the gauge length $5.65\sqrt{S_o}$ | | |
|---|---|---|---|---|---|
| | | | RHS, SHS b/t, d/t | | |
| | | | ≤ 15 | > 15 ≤ 30 | > 30 |
| C350L0 | 350 | 430 | 12% | 14% | 16% |
| C450L0 | 450 | 500 | 10% | 12% | 14% |
| **C450PLUS®** | **450** | **500** | **12%** | **14%** | **16%** |

NOTE: These elongation limits apply to the face from which the tensile test is taken.

The above table shows that higher strengths are developed in Grade C450L0 products and higher elongation is attained with Grade C350L0 products. C450PLUS® satisfies all the higher values of these key mechanical properties (shaded in Table T2.3 and also summarised in bold in the last row of that table).

Apart from higher strength and lighter weight benefits, the reasons for Australian Tube Mills supplying C450PLUS® RHS/SHS include:

- Grade C450L0 by itself may not perform well if the hollow section is bent to a tight radius during fabrication (e.g. corners in gate frames, etc). Excess straining sometimes produces section failures. Experience has shown that Grade C450L0 products which possess the C350L0 elongation requirements can be adequately formed in these situations.
- Structural steelwork drawings sometimes nominate C350/C350L0 as the default (i.e. "unless noted otherwise") grade for RHS/SHS. It is often perceived that C450L0 is a new and less readily available grade. This perception is not true as Australian Tube Mills has been supplying a large range of C450PLUS® RHS/SHS in pre-coated and uncoated finishes for some time. However, there remains some specifiers and end-users who wish to use C350L0 RHS/SHS. C450PLUS® can fulfill their requirements as well as the requirements of those who wish to specify/use higher strength C450L0 and its inherent advantages.
- Dual-stocking of grades for a particular section is costly. If the same section can comply with the requirements of both the commonly specified lower strength grade and the structurally efficient higher strength grade, ***a lower cost product*** will be available to the specifier and end-user.

**In order to capitalise on the benefits of C450PLUS®'s higher strength properties, the Tables contained in this publication consider C450PLUS® RHS/SHS to be designed with the strength properties of AS/NZS 1163 Grade C450L0 – i.e. $f_y$ = 450 MPa and $f_u$ = 500 MPa.**

As noted in Section 2.1, impact properties such as "L0" are not only important for low temperature applications but very important for welded members subject to dynamic loads. This is particularly so for thicker hollow sections. Hence, "L0" impact rated hollow sections, which is satisfied by all of ATM AS/NZS 1163 compliant structural hollow sections, should always be specified.

Further information on AS/NZS 1163 Grades C250L0, C350L0 and C450PLUS® can be found in the Australian Tube Mills' (ATM) Product Manual. These and other publications and software can be obtained freely from www.austubemills.com or by contacting ATM via the details noted at the bottom of the page.

## 2.5 Mill Surface Finishes

It is commonly recognised that pre-primed and pre-coated hollow sections provide considerable benefits and savings for fabrication construction as these sections are coated either prior, during or immediately after the tube forming process. Australian Tube Mills are regarded as being innovative in various mill finishes for many years and offer tubular products in the following surface finishes: DuraGal®, SupaGal®, (semi-continuous) hot-dip galvanized, primer-painted, oiled, and NOP (no oil or paint) coatings. ATM's galvanized coatings comply with AS/NZS 4792.

It should be noted that due to manufacturing limitations, surface finishes can vary with shape and size of hollow section. Further information on Australian Tube Mills' (ATM) surface finishes can be found in the ATM Product Manual. These and other publications and software can be obtained freely from www.austubemills.com or by contacting ATM via the details noted at the bottom of the page.

AS/NZS 2312 also provides useful information on this topic.

## 2.6 Hollow Sections Not Compliant with AS/NZS 1163

A key aspect of design within the provisions of a national steel structures Standard as AS 4100 is the inclusion of cold-formed hollow sections. This situation is highly dependent on the integrity of the supporting material Standards. One such material Standard is AS/NZS 1163 Structural steel hollow sections.

AS/NZS 1163 has been developed to reflect the way cold-formed hollow sections have been manufactured, specified, fabricated and subsequently used in Australia. This includes taking account of the enhancement in strength due to cold-forming, superior product tolerances (including dimensional limits and the supply of minimum cross-section material as assumed in design), ductility, weldability and resistance to impact loads.

Designers and specifiers should be very wary of the substitution of AS/NZS 1163 product by either unidentified product or specific product complying with other inferior international Standards which do not deliver the full range of AS/NZS 1163 product requirements.

AS 4100 states that hollow sections not complying with AS/NZS 1163 must be tested and checked for compliance. Non-conforming or unidentified hollow sections must be down-rated to a design yield stress of 170 MPa and a design ultimate strength of 300 MPa.

Though AS 4100 is a key Standard for the design, fabrication and erection of steelwork, other important Standards are also used to produce the completed structure that is to be eventually fit for purpose. The other important Standards for structural steel hollow sections include welding, painting and galvanizing which, in the case of structural steel hollow sections, are also dependent on compliance with AS/NZS 1163. Additionally, as noted in Sections 1.1, 1.2, 2.1 and 2.2, *the use of these Tables is also based on hollow sections complying with AS/NZS 1163*.

## 2.7 Availability

The sections listed in the Tables are normally readily available from Australian Tube Mills' distributors in standard lengths. However, the availability should be checked for larger sizes, for larger tonnages of individual sections or for non-standard lengths.

The standard lengths for Australian Tube Mills (ATM) range of structural steel hollow sections are summarised in Table T2.4. Sections may be ordered in other lengths ex-mill rolling subject to ATM length limitations and minimum order requirements.

**TABLE T2.4: Standard Length Availability**

| Section Type | Sizes | Standard Lengths (m) |
|---|---|---|
| CHS – Grade C250L0 | 26.9 OD to 165.1 OD | 6.5 |
| CHS – Grade C350L0 | 26.9 OD to 165.1 OD<br>168.3 OD to 508 OD | 6.5<br>12.0 |
| RHS – Grade C350L0 | 50 x 20 to 75 x 25 | 8.0 |
| RHS – Grade C450PLUS® | 50 x 20 to 75 x 25#<br>75 x 50 to 250 x 150<br>300 x 200 to 400 x 300 | 8.0<br>8.0 and/or 12.0*<br>12.0 |
| SHS – Grade C350L0 | 20 x 20 to 25 x 25<br>30 x 30 to 50 x 50 | 6.5<br>8.0 |
| SHS – Grade C450PLUS® | 20 x 20 to 25 x 25#<br>30 x 30 to 65 x 65#<br>75 x 75 to 250 x 250<br>300 x 300 to 400 x 400 | 6.5<br>8.0<br>8.0 and/or 12.0*<br>12.0 |

Notes:

* See ATM Product Manual for further details.

# For small sizes up to 50 x 50 SHS and RHS of equivalent perimeter, the standard grade is AS/NZS 1163 Grade C350L0.

The structural steel hollow sections listed in the Tables are generally available in all Australian Tube Mills' (ATM) market areas, however, reference should also be made to the ATM Product Availability Guide (PAG) for information on the availability of the listed sections, their grades and associated finishes.

The list of Australian Tube Mills' (ATM) distributors can be found in the ATM Product Manual which is freely available from www.austubemills.com or by contacting ATM via the details noted at the bottom of the page.

Standard lengths and Mass & Bundling data on Australian Tube Mills' (ATM) structural steel hollow sections can be found in the ATM Product Manual which is freely available from www.austubemills.com or by contacting ATM via the details noted at the bottom of the page.

*It is highly recommended* that readers always ensure that they are using current information on the ATM product range. This can be done by reference to the ATM Product Availability Guide (PAG) as noted in www.austubemills.com.

## 2.8 References

[2.1] Syam, A.A. (ed), "A Guide to the Requirements for Engineering Drawings of Structural Steelwork", Steel Construction, Vol. 29, No. 3, Australian Institute of Steel Construction, September 1995 (Note: AISC is now ASI – the Australian Steel Institute).

**See Section 1.1.2 for details on reference Standards.**

# Part 3

## SECTION PROPERTIES

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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 3

## SECTION PROPERTIES

### 3.1 General

The section property tables include all relevant section dimensions and properties necessary for assessing steel structures in accordance with AS 4100. The AS/NZS 1163 structural hollow sections included in these tables are:

| | |
|---|---|
| Circular Hollow Sections | Grade C250L0 |
| Circular Hollow Sections | Grade C350L0 |
| Rectangular Hollow Sections | Grade C350L0 (smaller sizes as noted in the Tables) |
| Rectangular Hollow Sections | Grade C450PLUS™ |
| Square Hollow Sections | Grade C350L0 (smaller sizes as noted in the Tables) |
| Square Hollow Sections | Grade C450PLUS™ |

C450PLUS™ RHS/SHS are designed as Grade C450L0 – see Section 2.4.2 for further details.

### 3.2 Section Property Tables

For each group of structural hollow section the Tables include:

- Dimensions, Ratios and Properties
- Properties for Design to AS 4100

These parameters are considered in Tables 3.1-1 to 3.1-6 inclusive.

### 3.2.1 Dimensions, Ratios and Properties

The Tables give standard dimensions and properties for the structural steel hollow sections noted in Sections 2.1, 2.7 and 3.1. These properties, such as gross cross-section area ($A_g$), second moments of area ($I_x$, $I_y$), elastic and plastic section moduli ($Z_x$, $S_x$, $Z_y$, $S_y$) and the torsion constant ($J$) are the fundamental geometric properties required by design Standards. It should be noted that Clause 5.6 of AS 4100 indicates that the warping constant ($I_w$) for hollow sections may be taken as zero.

Additionally, the external surface area of the hollow section – as used in estimating quantities of protective coatings – is also considered within these Tables.

### 3.2.1.1 Torsion Constants

The torsional constant ($J$) and the torsional modulus constant ($C$) for square and rectangular hollow sections are defined as follows:

$$J = \left(t^3\frac{h}{3} + 2kA_h\right)$$

$$C = \left(\frac{t^3\frac{h}{3} + 2kA_h}{t + \frac{k}{t}}\right)$$

where $R_c = \dfrac{R_o + R_i}{2}$

$h = 2[(b-t)+(d-t)] - 2R_c(4-\pi)$

$A_h = (b-t)(d-t) - R_c^2(4-\pi)$

$k = \dfrac{2A_h t}{h}$

and $t$ = specified thickness of section

$b$ = width of section

$d$ = depth of section

$R_o$ = outer corner radius

$R_i$ = inner corner radius

$R_c$ = mean corner radius

$h$ = length of the mid-contour

$A_h$ = area enclosed by $h$

$k$ = integration constant

as shown in Figure 3.1.

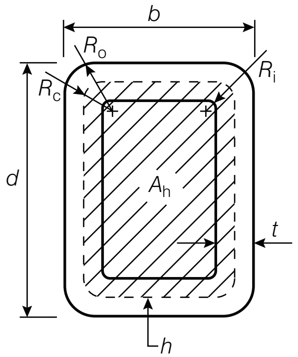


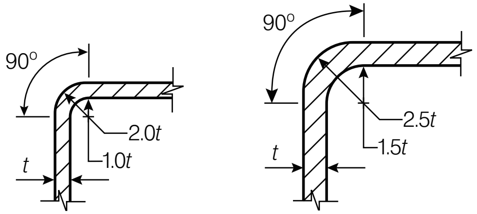
**Figure 3.1: Parameters for Calculation of Torsion Constants**

The above calculation method of $J$ and $C$ is extracted from Ref. [3.1]. For CHS, $J$ and $C$ are calculated by the traditional methods, i.e. $J = \pi/32(d_o^4 - d_i^4)$ and $C = J/(d_o/2)$ where $d_o$ = outside diameter and $d_i$ = inside diameter = $d_o - 2t$.

### 3.2.1.2 Corner Radii

The section properties presented in this publication are calculated in accordance with AS/NZS 1163.

Figure 3.2 shows the corner radii detail used in determining section properties. However, it should be noted that the actual corner geometry may vary from that shown.



a) thickness 3.0 mm and less
b) thickness greater than 3.0 mm

**Figure 3.2: Corner Geometry for Determining Section Properties**

## 3.2.2 Properties for Design to AS 4100

These properties are necessary for calculating the section capacities of hollow sections in accordance with AS 4100. The section form factor ($k_f$), compactness and effective section moduli ($Z_e$, $Z_{ex}$, $Z_{ey}$) are tabulated. These values are dependent on steel grade.

### 3.2.2.1 Compactness

In Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100, sections are described as **compact**, **non-compact** or **slender** (C, N or S respectively). This categorisation provides a measure of the relative importance of yielding and local buckling of the plate elements which make up a section when subject to compression caused by bending.

The “Design to AS 4100” listings include a column(s) headed “Compactness” for a given (principal) axis of bending.

The compactness of a hollow section is also important when selecting the methods of analysis (elastic or plastic) used to determine the design action effects (Clause 4.5 of AS 4100) or in using the higher tier provisions of Section 8 of AS 4100 for designing members subject to combined actions. Clause 4.5 of AS 4100 does not currently permit plastic analysis when designing with hollow sections.

General worked examples for calculating section compactness are provided in Section 3.2.3 and Refs. [3.2, 3.3].

### 3.2.2.2 Effective Section Modulus

Having evaluated the compactness of a hollow section, the effective section modulus ($Z_e$) is then evaluated. This parameter is based on the section moduli ($S$, $Z$) and is used in the determination of the design section moment capacity ($\phi M_s$). $Z_e$ is then calculated using Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100. The equations for determining $Z_e$ reflect the proportion of the hollow section that is effective in resisting compression in the section caused by flexure - that is whether the section is compact, non-compact or slender.

From Table 5.2 of AS 4100, the cold-formed (CF) residual stress category is used in the calculation of $Z_e$ for hollow section complying with AS/NZS 1163. It should be noted that the deformation limit ($\lambda_{ed}$) is not exceeded for hollow sections manufactured in accordance with AS/NZS 1163 and listed in these Tables and therefore noticeable deformations will not occur for such sections. General worked examples for calculating $Z_e$ are provided in Section 3.2.3 and Refs. [3.2, 3.3].

### 3.2.2.3 Form Factor

The form factor ($k_f$) is defined in Clause 6.2.2 of AS 4100. $k_f$ is used to determine the design section capacity of a concentrically loaded compression member ($\phi N_s$). The calculation of $k_f$ indicates the degree to which the plate elements which make up the column section will buckle locally before squashing (i.e. yielding). $k_f$ represents the proportion of the hollow section that is effective in compression and is based on the effective width of each element in the section (i.e. $k_f = 1.0$ signifies a column section which will yield rather than buckle locally in a short or stub column test). The evaluation of $k_f$ is also important when designing to the higher tier provisions for members subject to combined actions as noted in Section 8 of AS 4100.

From Table 6.2.4 of AS 4100, the cold-formed (CF) residual stress category is used in the calculation of $k_f$ for hollow sections complying with AS/NZS 1163. General worked examples for calculating $k_f$ are provided in Section 3.2.3 and Refs. [3.2, 3.3].

## 3.2.3 Example

Determine $Z_{ex}$ and $k_f$ for a 400 x 200 x 8.0 RHS in C450PLUS™ – designed as an AS/NZS 1163 Grade C450L0 structural steel hollow section.

<u>Solution:</u> (All relevant data are obtained from Table 3.1-4(1))

Design Yield Stress $f_y = 450$ MPa

Flange slenderness $$\lambda_{ef} = \frac{b-2t}{t}\sqrt{\frac{f_y}{250}} = 23.0\sqrt{\frac{f_y}{250}} = 30.9$$

Web slenderness $$\lambda_{ew} = \frac{d-2t}{t}\sqrt{\frac{f_y}{250}} = 48.0\sqrt{\frac{f_y}{250}} = 64.4$$

(a) To calculate $Z_{ex}$ the plate element slenderness values are compared with the plate element slenderness limits in Table 5.2 of AS 4100.

Bending about the section x-axis puts the flange in uniform compression. Hence,

$\lambda_{ef} = 30.9$ $\lambda_{ep} = 30$ $\lambda_{ey} = 40$ $\lambda_{ef} / \lambda_{ey} = 0.773$

Bending about the section x-axis places one edge of the web in tension and the other in compression. Hence,

$\lambda_{ew} = 64.4$ $\lambda_{ep} = 82$ $\lambda_{ey} = 115$ $\lambda_{ew} / \lambda_{ey} = 0.560$

The flange has the higher value of $\lambda_e / \lambda_{ey}$ and is the critical element in the section. From Clause 5.2.2 of AS 4100 the section slenderness and slenderness limits are the flange values, i.e.

$\lambda_s = 30.9$ $\lambda_{sp} = 30$ $\lambda_{sy} = 40$

Now $\lambda_{sp} < \lambda_s \leq \lambda_{sy}$ $\therefore$ The section is NON-COMPACT (hence "N" in Table 3.1-4(1)).

$Z_x = 949 \times 10^3$ mm$^3$ $S_x = 1170 \times 10^3$ mm$^3$

$Z_{cx} = \min.\ [S_x\ ,\ 1.5Z_x] = \min.\ [1170,\ 1.5 \times 949] \times 10^3 = 1170 \times 10^3$ mm$^3$

$$Z_{ex} = Z_x + \left[\frac{(\lambda_{sy} - \lambda_s)}{(\lambda_{sy} - \lambda_{sp})}(Z_{cx} - Z_x)\right] = 949 \times 10^3 + \left[\frac{(40-30.9)}{(40-30)}(1170-949)\right] \times 10^3$$

$= 1150 \times 10^3$ mm$^3$

(b) To determine the form factor ($k_f$) the plate element slenderness for both the flange and web are compared with the plate element yield slenderness limits ($\lambda_{ey}$) in Table 6.2.4 of AS 4100.

Flange $\lambda_{ef} = 30.9 < \lambda_{ey} = 40$ – i.e. flange is fully effective

Web $\lambda_{ew} = 64.4 > \lambda_{ey} = 40$ – i.e. web is not fully effective

Effective width of web $= d_{ew} = \lambda_{ey} / \lambda_{ew}\ (d–2t) = 40/64.4 \times (400 – 2 \times 8) = 238.5$ mm

Gross Area $= A_g = 9120$ mm$^2$

Effective Area $= A_e = A_g – 2 \times (d – 2t – d_{ew})\ t$

$= 9120 – 2 \times (400 – 2 \times 8 – 238.5) \times 8 = 6790$ mm$^2$

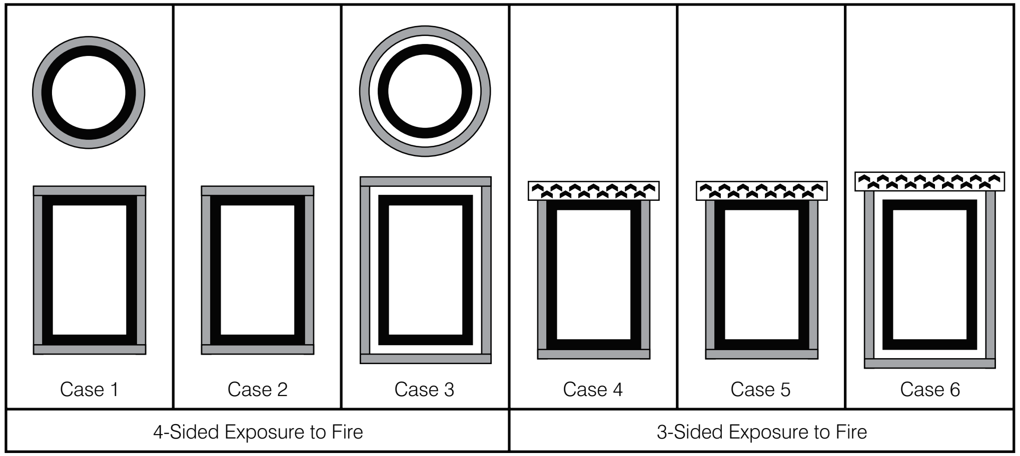
$\therefore k_f = A_e / A_g = 6790/9120 = 0.745$

## 3.3 Properties for Fire Design

To assist with the design of structural steel hollow sections for fire resistance (Section 12 of AS 4100), values of the exposed surface area to mass ratio ($k_{sm}$) are presented in Tables 3.2-1 to 3.2-4 for the various cases shown in Figure 3.3.

For **unprotected steel hollow sections** the values of $k_{sm}$ corresponding to four- and three-sided exposure should be taken as those corresponding to Cases 1 and 4 respectively in Figure 3.3.

For members requiring the addition of fire protection materials, Ref. [3.4] may be used to determine the thickness of proprietary materials required for a given value of $k_{sm}$ and Fire Resistance Level (FRL). It should be noted that $k_{sm}$ is equivalent to $E$ in Ref. [3.4]. Further information and worked examples on fire design to Section 12 of AS 4100 can be found in Refs. [3.5, 3.6, 3.7].



**Cases of fire exposure considered:**

1 = Total Perimeter, Profile-protected
2 = Total Perimeter, Box-protected, No Gap
3 = Total Perimeter, Box-protected, 25 mm Gap
4 = Top Flange Excluded, Profile-protected
5 = Top Flange Excluded, Box-protected, No Gap
6 = Top Flange Excluded, Box-protected, 25 mm Gap

**Figure 3.3: Cases for Calculation of Exposed Surface Area to Mass Ratio**

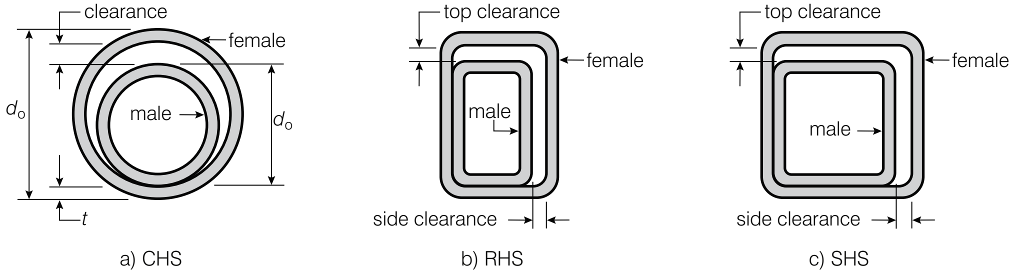
## 3.4 Telescoping Sections

Tables 3.3-1 to 3.3-3 can be used to determine hollow sections which are suitable for telescoping. Within these tables the total available clearance is tabulated to allow designers to select hollow sections with suitable clearance for the type of fit required. Sections with clearances less than 2.0 mm are shown in **bold** in the tables. Figure 3.4 shows the typical telescoping data required to select appropriate sections.

All calculations used in the preparation of the tables are based on the nominal dimensions of hollow sections and manufacturing tolerances specified in AS/NZS 1163. Owing to dimensional tolerances permitted within that Standard actual clearances of sections manufactured to this specification will vary marginally from the values tabulated.

For tight fits, varying corner radii and internal weld heights can affect telescoping of sections and it is recommended that some form of testing is carried out prior to committing material. Where telescoping over some length is required, additional clearance may be needed to allow for straightness of the section.

Telescoping of SHS and RHS where the female (outer) has a larger wall thickness requires careful consideration of corner clearance due to the larger corner radii of the thicker section. Typical corner geometry may differ from that used for the calculation of section properties and reference should be made to Australian Tube Mills for further information (see contact details at the bottom of the page).



a) CHS b) RHS c) SHS

**Figure 3.4: Parameters for Telescoping Tables**

## 3.5 References

[3.1] International Standard Organisation, ISO 657/XIV, "Hot-rolled steel sections – Part XIV: Hot-finished structural hollow sections – Dimensions and sectional properties", International Standards Organisation, 1977.

[3.2] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., "Worked Examples for Steel Structures", third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – the Australian Steel Institute).

[3.3] AISC, "Design Capacity Tables for Structural Steel – Volume 1: Open Sections", fourth edition, Australian Steel Institute, 2009.

[3.4] Proe, D.J., Bennetts, I.D., Thomas, I.R. and Szeto, W.T., "Handbook of Fire Protection Materials for Structural Steel", Australian Institute of Steel Construction, 1990 (Note: AISC is now ASI – the Australian Steel Institute).

[3.5] Thomas, I.R., Bennetts, I.D. and Proe, D.J., "Design of Steel Structures for Fire Resistance in Accordance with AS 4100", Steel Construction, Vol. 26, No. 3, Australian Institute of Steel Construction, 1992 (Note: AISC is now ASI – the Australian Steel Institute).

[3.6] O'Meagher, A.J., Bennetts, I.D., Dayawansa, P.H. and Thomas, I.R., "Design of Single Storey Industrial Buildings for Fire Resistance", Steel Construction, Vol. 26, No. 2, Australian Institute of Steel Construction, 1992 (Note: AISC is now ASI – the Australian Steel Institute).

[3.7] Rakic, J., "Structural Steel Fire Guide - Guide to the Use of Fire Protection Materials", Steel Construction, Vol. 42, No. 1, Australian Steel Institute, 2008.

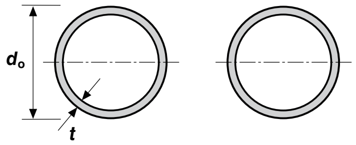
**See Section 1.1.2 for details on reference Standards.**

TABLE 3.1-1

# Circular Hollow Sections
# AS/NZS 1163 Grade C250L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | Properties | | | | | | | Properties for Design to AS 4100 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | Mass per m | External Surface Area | | $\frac{d_o}{t}$ | Gross Section Area | About any axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About any axis | |
| $d_o$ | | t | | | per m | per t | | $A_g$ | I | Z | S | r | J | C | $k_f$ | Compactness | $Z_e$ |
| mm | | mm | | kg/m | $m^2/m$ | $m^2/t$ | | $mm^2$ | $10^6 mm^4$ | $10^3 mm^3$ | $10^3 mm^3$ | mm | $10^6 mm^4$ | $10^3 mm^3$ | | (C,N,S) | $10^3 mm^3$ |
| 165.1 | x | 5.4 | CHS | 21.3 | 0.519 | 24.4 | 30.6 | 2710 | 8.65 | 105 | 138 | 56.5 | 17.3 | 209 | 1.00 | C | 138 |
| | | 5.0 | CHS | 19.7 | 0.519 | 26.3 | 33.0 | 2510 | 8.07 | 97.7 | 128 | 56.6 | 16.1 | 195 | 1.00 | C | 128 |
| 139.7 | x | 5.4 | CHS | 17.9 | 0.439 | 24.5 | 25.9 | 2280 | 5.14 | 73.7 | 97.4 | 47.5 | 10.3 | 147 | 1.00 | C | 97.4 |
| | | 5.0 | CHS | 16.6 | 0.439 | 26.4 | 27.9 | 2120 | 4.81 | 68.8 | 90.8 | 47.7 | 9.61 | 138 | 1.00 | C | 90.8 |
| 114.3 | x | 5.4 | CHS | 14.5 | 0.359 | 24.8 | 21.2 | 1850 | 2.75 | 48.0 | 64.1 | 38.5 | 5.49 | 96.1 | 1.00 | C | 64.1 |
| | | 4.5 | CHS | 12.2 | 0.359 | 29.5 | 25.4 | 1550 | 2.34 | 41.0 | 54.3 | 38.9 | 4.69 | 82.0 | 1.00 | C | 54.3 |
| 101.6 | x | 5.0 | CHS | 11.9 | 0.319 | 26.8 | 20.3 | 1520 | 1.77 | 34.9 | 46.7 | 34.2 | 3.55 | 69.9 | 1.00 | C | 46.7 |
| | | 4.0 | CHS | 9.63 | 0.319 | 33.2 | 25.4 | 1230 | 1.46 | 28.8 | 38.1 | 34.5 | 2.93 | 57.6 | 1.00 | C | 38.1 |
| 88.9 | x | 5.9 | CHS | 12.1 | 0.279 | 23.1 | 15.1 | 1540 | 1.33 | 30.0 | 40.7 | 29.4 | 2.66 | 59.9 | 1.00 | C | 40.7 |
| | | 5.0 | CHS | 10.3 | 0.279 | 27.0 | 17.8 | 1320 | 1.16 | 26.2 | 35.2 | 29.7 | 2.33 | 52.4 | 1.00 | C | 35.2 |
| | | 4.0 | CHS | 8.38 | 0.279 | 33.3 | 22.2 | 1070 | 0.963 | 21.7 | 28.9 | 30.0 | 1.93 | 43.3 | 1.00 | C | 28.9 |
| 76.1 | x | 5.9 | CHS | 10.2 | 0.239 | 23.4 | 12.9 | 1300 | 0.807 | 21.2 | 29.1 | 24.9 | 1.61 | 42.4 | 1.00 | C | 29.1 |
| | | 4.5 | CHS | 7.95 | 0.239 | 30.1 | 16.9 | 1010 | 0.651 | 17.1 | 23.1 | 25.4 | 1.30 | 34.2 | 1.00 | C | 23.1 |
| | | 3.6 | CHS | 6.44 | 0.239 | 37.1 | 21.1 | 820 | 0.540 | 14.2 | 18.9 | 25.7 | 1.08 | 28.4 | 1.00 | C | 18.9 |
| 60.3 | x | 5.4 | CHS | 7.31 | 0.189 | 25.9 | 11.2 | 931 | 0.354 | 11.8 | 16.3 | 19.5 | 0.709 | 23.5 | 1.00 | C | 16.3 |
| | | 4.5 | CHS | 6.19 | 0.189 | 30.6 | 13.4 | 789 | 0.309 | 10.2 | 14.0 | 19.8 | 0.618 | 20.5 | 1.00 | C | 14.0 |
| | | 3.6 | CHS | 5.03 | 0.189 | 37.6 | 16.8 | 641 | 0.259 | 8.58 | 11.6 | 20.1 | 0.517 | 17.2 | 1.00 | C | 11.6 |
| 48.3 | x | 4.0 | CHS | 4.37 | 0.152 | 34.7 | 12.1 | 557 | 0.138 | 5.70 | 7.87 | 15.7 | 0.275 | 11.4 | 1.00 | C | 7.87 |
| | | 3.2 | CHS | 3.56 | 0.152 | 42.6 | 15.1 | 453 | 0.116 | 4.80 | 6.52 | 16.0 | 0.232 | 9.59 | 1.00 | C | 6.52 |
| 42.4 | x | 4.0 | CHS | 3.79 | 0.133 | 35.2 | 10.6 | 483 | 0.0899 | 4.24 | 5.92 | 13.6 | 0.180 | 8.48 | 1.00 | C | 5.92 |
| | | 3.2 | CHS | 3.09 | 0.133 | 43.1 | 13.3 | 394 | 0.0762 | 3.59 | 4.93 | 13.9 | 0.152 | 7.19 | 1.00 | C | 4.93 |
| 33.7 | x | 4.0 | CHS | 2.93 | 0.106 | 36.1 | 8.43 | 373 | 0.0419 | 2.49 | 3.55 | 10.6 | 0.0838 | 4.97 | 1.00 | C | 3.55 |
| | | 3.2 | CHS | 2.41 | 0.106 | 44.0 | 10.5 | 307 | 0.0360 | 2.14 | 2.99 | 10.8 | 0.0721 | 4.28 | 1.00 | C | 2.99 |
| 26.9 | x | 4.0 | CHS | 2.26 | 0.0845 | 37.4 | 6.73 | 288 | 0.0194 | 1.45 | 2.12 | 8.22 | 0.0389 | 2.89 | 1.00 | C | 2.12 |
| | | 3.2 | CHS | 1.87 | 0.0845 | 45.2 | 8.41 | 238 | 0.0170 | 1.27 | 1.81 | 8.46 | 0.0341 | 2.53 | 1.00 | C | 1.81 |
| | | 2.6 | CHS | 1.56 | 0.0845 | 54.2 | 10.3 | 198 | 0.0148 | 1.10 | 1.54 | 8.64 | 0.0296 | 2.20 | 1.00 | C | 1.54 |



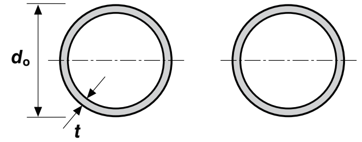
## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C250L0: $f_y$ = 250 MPa and $f_u$ = 320 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C250L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.
5. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 3.1-2(1)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES



| Dimensions and Ratios | | | | | | | | Properties | | | | | | | Properties for Design to AS 4100 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | Mass per m | External Surface Area | | $\frac{d_o}{t}$ | Gross Section Area | About any axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About any axis | |
| $d_o$ | | t | | | per m | per t | | $A_g$ | I | Z | S | r | J | C | $k_f$ | Compactness | $Z_e$ |
| mm | | mm | | kg/m | $m^2/m$ | $m^2/t$ | | $mm^2$ | $10^6mm^4$ | $10^3mm^3$ | $10^3mm^3$ | mm | $10^6mm^4$ | $10^3mm^3$ | | (C,N,S) | $10^3mm^3$ |
| 508.0 | x | 12.7 | CHS | 155 | 1.60 | 10.3 | 40.0 | 19800 | 606 | 2390 | 3120 | 175 | 1210 | 4770 | 1.00 | N | 3050 |
| | | 9.5 | CHS | 117 | 1.60 | 13.7 | 53.5 | 14900 | 462 | 1820 | 2360 | 176 | 925 | 3640 | 1.00 | N | 2170 |
| | | 6.4 | CHS | 79.2 | 1.60 | 20.2 | 79.4 | 10100 | 317 | 1250 | 1610 | 177 | 634 | 2500 | 0.857 | N | 1290 |
| 457.0 | x | 12.7 | CHS | 139 | 1.44 | 10.3 | 36.0 | 17700 | 438 | 1920 | 2510 | 157 | 876 | 3830 | 1.00 | N | 2500 |
| | | 9.5 | CHS | 105 | 1.44 | 13.7 | 48.1 | 13400 | 334 | 1460 | 1900 | 158 | 669 | 2930 | 1.00 | N | 1790 |
| | | 6.4 | CHS | 71.1 | 1.44 | 20.2 | 71.4 | 9060 | 230 | 1010 | 1300 | 159 | 460 | 2010 | 0.904 | N | 1090 |
| 406.4 | x | 12.7 | CHS | 123 | 1.28 | 10.4 | 32.0 | 15700 | 305 | 1500 | 1970 | 139 | 609 | 3000 | 1.00 | C | 1970 |
| | | 9.5 | CHS | 93.0 | 1.28 | 13.7 | 42.8 | 11800 | 233 | 1150 | 1500 | 140 | 467 | 2300 | 1.00 | N | 1450 |
| | | 6.4 | CHS | 63.1 | 1.28 | 20.2 | 63.5 | 8040 | 161 | 792 | 1020 | 141 | 322 | 1580 | 0.960 | N | 895 |
| 355.6 | x | 12.7 | CHS | 107 | 1.12 | 10.4 | 28.0 | 13700 | 201 | 1130 | 1490 | 121 | 403 | 2260 | 1.00 | C | 1490 |
| | | 9.5 | CHS | 81.1 | 1.12 | 13.8 | 37.4 | 10300 | 155 | 871 | 1140 | 122 | 310 | 1740 | 1.00 | N | 1130 |
| | | 6.4 | CHS | 55.1 | 1.12 | 20.3 | 55.6 | 7020 | 107 | 602 | 781 | 123 | 214 | 1200 | 1.00 | N | 710 |
| 323.9 | x | 12.7 | CHS | 97.5 | 1.02 | 10.4 | 25.5 | 12400 | 151 | 930 | 1230 | 110 | 301 | 1860 | 1.00 | C | 1230 |
| | | 9.5 | CHS | 73.7 | 1.02 | 13.8 | 34.1 | 9380 | 116 | 717 | 939 | 111 | 232 | 1430 | 1.00 | C | 939 |
| | | 6.4 | CHS | 50.1 | 1.02 | 20.3 | 50.6 | 6380 | 80.5 | 497 | 645 | 112 | 161 | 994 | 1.00 | N | 601 |
| 273.1 | x | 12.7 | CHS | 81.6 | 0.858 | 10.5 | 21.5 | 10400 | 88.3 | 646 | 862 | 92.2 | 177 | 1290 | 1.00 | C | 862 |
| | | 9.3 | CHS | 60.5 | 0.858 | 14.2 | 29.4 | 7710 | 67.1 | 492 | 647 | 93.3 | 134 | 983 | 1.00 | C | 647 |
| | | 6.4 | CHS | 42.1 | 0.858 | 20.4 | 42.7 | 5360 | 47.7 | 349 | 455 | 94.3 | 95.4 | 699 | 1.00 | N | 441 |
| | | 4.8 | CHS | 31.8 | 0.858 | 27.0 | 56.9 | 4050 | 36.4 | 267 | 346 | 94.9 | 72.8 | 533 | 1.00 | N | 312 |
| 219.1 | x | 8.2 | CHS | 42.6 | 0.688 | 16.1 | 26.7 | 5430 | 30.3 | 276 | 365 | 74.6 | 60.5 | 552 | 1.00 | C | 365 |
| | | 6.4 | CHS | 33.6 | 0.688 | 20.5 | 34.2 | 4280 | 24.2 | 221 | 290 | 75.2 | 48.4 | 442 | 1.00 | C | 290 |
| | | 4.8 | CHS | 25.4 | 0.688 | 27.1 | 45.6 | 3230 | 18.6 | 169 | 220 | 75.8 | 37.1 | 339 | 1.00 | N | 210 |
| 168.3 | x | 7.1 | CHS | 28.2 | 0.529 | 18.7 | 23.7 | 3600 | 11.7 | 139 | 185 | 57.0 | 23.4 | 278 | 1.00 | C | 185 |
| | | 6.4 | CHS | 25.6 | 0.529 | 20.7 | 26.3 | 3260 | 10.7 | 127 | 168 | 57.3 | 21.4 | 254 | 1.00 | C | 168 |
| | | 4.8 | CHS | 19.4 | 0.529 | 27.3 | 35.1 | 2470 | 8.25 | 98.0 | 128 | 57.8 | 16.5 | 196 | 1.00 | C | 128 |

### Notes:

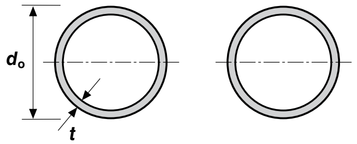
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C350L0: $f_y$ = 350 MPa and $f_u$ = 430 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-2(2)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | Properties | | | | | | | Properties for Design to AS 4100 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | Mass per m | External Surface Area | | $\frac{d_o}{t}$ | Gross Section Area | About any axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About any axis | |
| $d_o$ | | t | | | per m | per t | | $A_g$ | I | Z | S | r | J | C | $k_f$ | Compactness | $Z_e$ |
| mm | | mm | | kg/m | $m^2/m$ | $m^2/t$ | | $mm^2$ | $10^6mm^4$ | $10^3mm^3$ | $10^3mm^3$ | mm | $10^6mm^4$ | $10^3mm^3$ | | (C,N,S) | $10^3mm^3$ |
| 165.1 | x | 3.5 | CHS | 13.9 | 0.519 | 37.2 | 47.2 | 1780 | 5.80 | 70.3 | 91.4 | 57.1 | 11.6 | 141 | 1.00 | N | 86.6 |
| | | 3.0 | CHS | 12.0 | 0.519 | 43.2 | 55.0 | 1530 | 5.02 | 60.8 | 78.8 | 57.3 | 10.0 | 122 | 1.00 | N | 71.9 |
| 139.7 | x | 3.5 | CHS | 11.8 | 0.439 | 37.3 | 39.9 | 1500 | 3.47 | 49.7 | 64.9 | 48.2 | 6.95 | 99.5 | 1.00 | N | 63.7 |
| | | 3.0 | CHS | 10.1 | 0.439 | 43.4 | 46.6 | 1290 | 3.01 | 43.1 | 56.1 | 48.3 | 6.02 | 86.2 | 1.00 | N | 53.3 |
| 114.3 | x | 3.6 | CHS | 9.83 | 0.359 | 36.5 | 31.8 | 1250 | 1.92 | 33.6 | 44.1 | 39.2 | 3.84 | 67.2 | 1.00 | C | 44.1 |
| | | 3.2 | CHS | 8.77 | 0.359 | 41.0 | 35.7 | 1120 | 1.72 | 30.2 | 39.5 | 39.3 | 3.45 | 60.4 | 1.00 | N | 39.5 |
| 101.6 | x | 3.2 | CHS | 7.77 | 0.319 | 41.1 | 31.8 | 989 | 1.20 | 23.6 | 31.0 | 34.8 | 2.40 | 47.2 | 1.00 | C | 31.0 |
| | | 2.6 | CHS | 6.35 | 0.319 | 50.3 | 39.1 | 809 | 0.991 | 19.5 | 25.5 | 35.0 | 1.98 | 39.0 | 1.00 | N | 25.1 |
| 88.9 | x | 3.2 | CHS | 6.76 | 0.279 | 41.3 | 27.8 | 862 | 0.792 | 17.8 | 23.5 | 30.3 | 1.58 | 35.6 | 1.00 | C | 23.5 |
| | | 2.6 | CHS | 5.53 | 0.279 | 50.5 | 34.2 | 705 | 0.657 | 14.8 | 19.4 | 30.5 | 1.31 | 29.6 | 1.00 | C | 19.4 |
| 76.1 | x | 3.2 | CHS | 5.75 | 0.239 | 41.6 | 23.8 | 733 | 0.488 | 12.8 | 17.0 | 25.8 | 0.976 | 25.6 | 1.00 | C | 17.0 |
| | | 2.3 | CHS | 4.19 | 0.239 | 57.1 | 33.1 | 533 | 0.363 | 9.55 | 12.5 | 26.1 | 0.727 | 19.1 | 1.00 | C | 12.5 |
| 60.3 | x | 2.9 | CHS | 4.11 | 0.189 | 46.1 | 20.8 | 523 | 0.216 | 7.16 | 9.56 | 20.3 | 0.432 | 14.3 | 1.00 | C | 9.56 |
| | | 2.3 | CHS | 3.29 | 0.189 | 57.6 | 26.2 | 419 | 0.177 | 5.85 | 7.74 | 20.5 | 0.353 | 11.7 | 1.00 | C | 7.74 |
| 48.3 | x | 2.9 | CHS | 3.25 | 0.152 | 46.7 | 16.7 | 414 | 0.107 | 4.43 | 5.99 | 16.1 | 0.214 | 8.86 | 1.00 | C | 5.99 |
| | | 2.3 | CHS | 2.61 | 0.152 | 58.2 | 21.0 | 332 | 0.0881 | 3.65 | 4.87 | 16.3 | 0.176 | 7.30 | 1.00 | C | 4.87 |
| 42.4 | x | 2.6 | CHS | 2.55 | 0.133 | 52.2 | 16.3 | 325 | 0.0646 | 3.05 | 4.12 | 14.1 | 0.129 | 6.10 | 1.00 | C | 4.12 |
| | | 2.0 | CHS | 1.99 | 0.133 | 66.8 | 21.2 | 254 | 0.0519 | 2.45 | 3.27 | 14.3 | 0.104 | 4.90 | 1.00 | C | 3.27 |
| 33.7 | x | 2.6 | CHS | 1.99 | 0.106 | 53.1 | 13.0 | 254 | 0.0309 | 1.84 | 2.52 | 11.0 | 0.0619 | 3.67 | 1.00 | C | 2.52 |
| | | 2.0 | CHS | 1.56 | 0.106 | 67.7 | 16.9 | 199 | 0.0251 | 1.49 | 2.01 | 11.2 | 0.0502 | 2.98 | 1.00 | C | 2.01 |
| 26.9 | x | 2.3 | CHS | 1.40 | 0.0845 | 60.6 | 11.7 | 178 | 0.0136 | 1.01 | 1.40 | 8.74 | 0.0271 | 2.02 | 1.00 | C | 1.40 |
| | | 2.0 | CHS | 1.23 | 0.0845 | 68.8 | 13.5 | 156 | 0.0122 | 0.907 | 1.24 | 8.83 | 0.0244 | 1.81 | 1.00 | C | 1.24 |



### Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C350L0: $f_y$ = 350 MPa and $f_u$ = 430 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-3

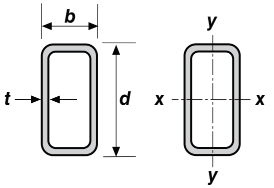
# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

① RHS

② C350L0

③ Finish



| Dimensions and Ratios | | | | | | | | | | | Properties | | | | | | | | | | | Properties for Design to AS 4100 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | | | Mass per m | External Surface Area | | $\frac{b-2t}{t}$ | $\frac{d-2t}{t}$ | Gross Section Area | About x-axis | | | | About y-axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About x-axis | | About y-axis | |
| d | | b | | t | | | per m | per t | | | $A_g$ | $I_x$ | $Z_x$ | $S_x$ | $r_x$ | $I_y$ | $Z_y$ | $S_y$ | $r_y$ | J | C | $k_f$ | Compact-ness | $Z_{ex}$ | Compact-ness | $Z_{ey}$ |
| mm | | mm | | mm | | kg/m | m²/m | m²/t | | | mm² | 10⁶mm⁴ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | | (C,N,S) | 10³mm³ | (C,N,S) | 10³mm³ |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 0.191 | 53.1 | 8.00 | 28.0 | 459 | 0.285 | 7.60 | 10.1 | 24.9 | 0.0487 | 3.89 | 4.53 | 10.3 | 0.144 | 7.14 | 1.00 | C | 10.1 | N | 4.33 |
| | | | | 2.0 | RHS | 2.93 | 0.193 | 65.8 | 10.5 | 35.5 | 374 | 0.238 | 6.36 | 8.31 | 25.3 | 0.0414 | 3.31 | 3.77 | 10.5 | 0.120 | 6.04 | 0.964 | C | 8.31 | S | 3.18 |
| | | | | 1.6 | RHS | 2.38 | 0.195 | 81.7 | 13.6 | 44.9 | 303 | 0.197 | 5.26 | 6.81 | 25.5 | 0.0347 | 2.78 | 3.11 | 10.7 | 0.0993 | 5.05 | 0.813 | C | 6.81 | S | 2.22 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 0.183 | 34.2 | 6.75 | 14.3 | 681 | 0.328 | 10.1 | 13.3 | 22.0 | 0.123 | 7.03 | 8.58 | 13.4 | 0.320 | 12.5 | 1.00 | C | 13.3 | C | 8.58 |
| | | | | 3.0 | RHS | 4.25 | 0.190 | 44.7 | 9.67 | 19.7 | 541 | 0.281 | 8.65 | 11.0 | 22.8 | 0.106 | 6.04 | 7.11 | 14.0 | 0.259 | 10.4 | 1.00 | C | 11.0 | C | 7.11 |
| | | | | 2.5 | RHS | 3.60 | 0.191 | 53.1 | 12.0 | 24.0 | 459 | 0.244 | 7.52 | 9.45 | 23.1 | 0.0926 | 5.29 | 6.13 | 14.2 | 0.223 | 9.10 | 1.00 | C | 9.45 | C | 6.13 |
| | | | | 2.0 | RHS | 2.93 | 0.193 | 65.8 | 15.5 | 30.5 | 374 | 0.204 | 6.28 | 7.80 | 23.4 | 0.0778 | 4.44 | 5.07 | 14.4 | 0.184 | 7.62 | 1.00 | C | 7.80 | N | 4.69 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 0.140 | 45.5 | 6.33 | 14.7 | 391 | 0.112 | 4.47 | 5.86 | 16.9 | 0.0367 | 2.93 | 3.56 | 9.69 | 0.0964 | 5.18 | 1.00 | C | 5.86 | C | 3.56 |
| | | | | 2.5 | RHS | 2.62 | 0.141 | 54.0 | 8.00 | 18.0 | 334 | 0.0989 | 3.95 | 5.11 | 17.2 | 0.0328 | 2.62 | 3.12 | 9.91 | 0.0843 | 4.60 | 1.00 | C | 5.11 | C | 3.12 |
| | | | | 2.0 | RHS | 2.15 | 0.143 | 66.6 | 10.5 | 23.0 | 274 | 0.0838 | 3.35 | 4.26 | 17.5 | 0.0281 | 2.25 | 2.62 | 10.1 | 0.0706 | 3.92 | 1.00 | C | 4.26 | C | 2.62 |
| | | | | 1.6 | RHS | 1.75 | 0.145 | 82.5 | 13.6 | 29.3 | 223 | 0.0702 | 2.81 | 3.53 | 17.7 | 0.0237 | 1.90 | 2.17 | 10.3 | 0.0585 | 3.29 | 1.00 | C | 3.53 | N | 2.05 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 0.130 | 45.8 | 4.67 | 14.7 | 361 | 0.0951 | 3.81 | 5.16 | 16.2 | 0.0212 | 2.12 | 2.63 | 7.67 | 0.0620 | 3.88 | 1.00 | C | 5.16 | C | 2.63 |
| | | | | 2.5 | RHS | 2.42 | 0.131 | 54.2 | 6.00 | 18.0 | 309 | 0.0848 | 3.39 | 4.51 | 16.6 | 0.0192 | 1.92 | 2.32 | 7.89 | 0.0550 | 3.49 | 1.00 | C | 4.51 | C | 2.32 |
| | | | | 2.0 | RHS | 1.99 | 0.133 | 66.8 | 8.00 | 23.0 | 254 | 0.0723 | 2.89 | 3.78 | 16.9 | 0.0167 | 1.67 | 1.96 | 8.11 | 0.0466 | 3.00 | 1.00 | C | 3.78 | C | 1.96 |
| | | | | 1.6 | RHS | 1.63 | 0.135 | 82.7 | 10.5 | 29.3 | 207 | 0.0608 | 2.43 | 3.14 | 17.1 | 0.0142 | 1.42 | 1.63 | 8.29 | 0.0389 | 2.55 | 1.00 | C | 3.14 | N | 1.54 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C350L0: $f_y$ = 350 MPa and $f_u$ = 430 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

**ADDITIONAL NOTES:**

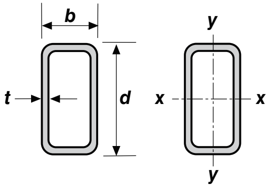
**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS®.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 3.1-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES



| Dimensions and Ratios | | | | | | | | Properties | | | | | | | | | | | Properties for Design to AS 4100 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | Mass per m | External Surface Area | | $\frac{b-2t}{t}$ | $\frac{d-2t}{t}$ | Gross Section Area | About x-axis | | | | About y-axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About x-axis | | About y-axis | |
| d | b | t | | per m | per t | | | $A_g$ | $I_x$ | $Z_x$ | $S_x$ | $r_x$ | $I_y$ | $Z_y$ | $S_y$ | $r_y$ | J | C | $k_f$ | Compact-ness | $Z_{ex}$ | Compact-ness | $Z_{ey}$ |
| mm | mm | mm | kg/m | m²/m | m²/t | | | mm² | 10⁶mm⁴ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | | (C,N,S) | 10³mm³ | (C,N,S) | 10³mm³ |
| 400 x | 300 x | 16.0 RHS | 161 | 1.33 | 8.27 | 16.8 | 23.0 | 20500 | 453 | 2260 | 2750 | 149 | 290 | 1940 | 2260 | 119 | 586 | 3170 | 1.00 | C | 2750 | N | 2230 |
| | | 12.5 RHS | 128 | 1.35 | 10.5 | 22.0 | 30.0 | 16300 | 370 | 1850 | 2230 | 151 | 238 | 1590 | 1830 | 121 | 471 | 2590 | 0.996 | C | 2230 | S | 1580 |
| | | 10.0 RHS | 104 | 1.36 | 13.0 | 28.0 | 38.0 | 13300 | 306 | 1530 | 1820 | 152 | 197 | 1320 | 1500 | 122 | 384 | 2130 | 0.877 | N | 1600 | S | 1120 |
| | | 8.0 RHS | 84.2 | 1.37 | 16.2 | 35.5 | 48.0 | 10700 | 251 | 1260 | 1490 | 153 | 162 | 1080 | 1220 | 123 | 312 | 1750 | 0.715 | S | 1140 | S | 800 |
| 400 x | 200 x | 16.0 RHS | 136 | 1.13 | 8.33 | 10.5 | 23.0 | 17300 | 335 | 1670 | 2140 | 139 | 113 | 1130 | 1320 | 80.8 | 290 | 2000 | 1.00 | C | 2140 | N | 1300 |
| | | 12.5 RHS | 109 | 1.15 | 10.6 | 14.0 | 30.0 | 13800 | 277 | 1380 | 1740 | 141 | 94.0 | 940 | 1080 | 82.4 | 236 | 1650 | 0.996 | C | 1740 | S | 936 |
| | | 10.0 RHS | 88.4 | 1.16 | 13.1 | 18.0 | 38.0 | 11300 | 230 | 1150 | 1430 | 143 | 78.6 | 786 | 888 | 83.6 | 194 | 1370 | 0.855 | C | 1430 | S | 658 |
| | | 8.0 RHS | 71.6 | 1.17 | 16.3 | 23.0 | 48.0 | 9120 | 190 | 949 | 1170 | 144 | 65.2 | 652 | 728 | 84.5 | 158 | 1130 | 0.745 | N | 1150 | S | 464 |
| 350 x | 250 x | 16.0 RHS | 136 | 1.13 | 8.33 | 13.6 | 19.9 | 17300 | 283 | 1620 | 1990 | 128 | 168 | 1340 | 1580 | 98.5 | 355 | 2230 | 1.00 | C | 1990 | C | 1580 |
| | | 12.5 RHS | 109 | 1.15 | 10.6 | 18.0 | 26.0 | 13800 | 233 | 1330 | 1620 | 130 | 139 | 1110 | 1290 | 100 | 287 | 1840 | 1.00 | C | 1620 | N | 1200 |
| | | 10.0 RHS | 88.4 | 1.16 | 13.1 | 23.0 | 33.0 | 11300 | 194 | 1110 | 1330 | 131 | 116 | 927 | 1060 | 101 | 235 | 1520 | 0.943 | N | 1320 | S | 865 |
| | | 8.0 RHS | 71.6 | 1.17 | 16.3 | 29.3 | 41.8 | 9120 | 160 | 914 | 1090 | 132 | 95.7 | 766 | 869 | 102 | 191 | 1250 | 0.833 | N | 928 | S | 614 |
| 300 x | 200 x | 16.0 RHS | 111 | 0.931 | 8.42 | 10.5 | 16.8 | 14100 | 161 | 1080 | 1350 | 107 | 85.7 | 857 | 1020 | 78.0 | 193 | 1450 | 1.00 | C | 1350 | C | 1020 |
| | | 12.5 RHS | 89.0 | 0.946 | 10.6 | 14.0 | 22.0 | 11300 | 135 | 899 | 1110 | 109 | 72.0 | 720 | 842 | 79.7 | 158 | 1210 | 1.00 | C | 1110 | C | 842 |
| | | 10.0 RHS | 72.7 | 0.957 | 13.2 | 18.0 | 28.0 | 9260 | 113 | 754 | 921 | 111 | 60.6 | 606 | 698 | 80.9 | 130 | 1010 | 1.00 | C | 921 | N | 628 |
| | | 8.0 RHS | 59.1 | 0.966 | 16.3 | 23.0 | 35.5 | 7520 | 93.9 | 626 | 757 | 112 | 50.4 | 504 | 574 | 81.9 | 106 | 838 | 0.903 | N | 746 | S | 447 |
| | | 6.0 RHS | 45.0 | 0.974 | 21.7 | 31.3 | 48.0 | 5730 | 73.0 | 487 | 583 | 113 | 39.3 | 393 | 443 | 82.8 | 81.4 | 651 | 0.753 | S | 474 | S | 288 |
| 250 x | 150 x | 16.0 RHS | 85.5 | 0.731 | 8.55 | 7.38 | 13.6 | 10900 | 80.2 | 641 | 834 | 85.8 | 35.8 | 478 | 583 | 57.3 | 88.2 | 836 | 1.00 | C | 834 | C | 583 |
| | | 12.5 RHS | 69.4 | 0.746 | 10.8 | 10.0 | 18.0 | 8840 | 68.5 | 548 | 695 | 88.0 | 30.8 | 411 | 488 | 59.0 | 73.4 | 710 | 1.00 | C | 695 | C | 488 |
| | | 10.0 RHS | 57.0 | 0.757 | 13.3 | 13.0 | 23.0 | 7260 | 58.3 | 466 | 582 | 89.6 | 26.3 | 351 | 409 | 60.2 | 61.2 | 602 | 1.00 | C | 582 | N | 404 |
| | | 9.0 RHS | 51.8 | 0.761 | 14.7 | 14.7 | 25.8 | 6600 | 53.7 | 430 | 533 | 90.2 | 24.3 | 324 | 375 | 60.7 | 56.0 | 554 | 1.00 | C | 533 | N | 352 |
| | | 8.0 RHS | 46.5 | 0.766 | 16.5 | 16.8 | 29.3 | 5920 | 48.9 | 391 | 482 | 90.8 | 22.2 | 296 | 340 | 61.2 | 50.5 | 504 | 1.00 | C | 482 | N | 299 |
| | | 6.0 RHS | 35.6 | 0.774 | 21.8 | 23.0 | 39.7 | 4530 | 38.4 | 307 | 374 | 92.0 | 17.5 | 233 | 264 | 62.2 | 39.0 | 395 | 0.843 | N | 368 | S | 191 |
| | | 5.0 RHS | 29.9 | 0.779 | 26.0 | 28.0 | 48.0 | 3810 | 32.7 | 262 | 317 | 92.6 | 15.0 | 199 | 224 | 62.6 | 33.0 | 337 | 0.762 | N | 275 | S | 144 |

## Notes:

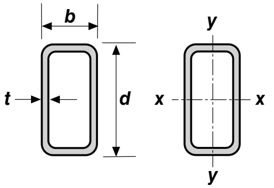
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the <u>availability</u> of <u>listed</u> <u>sections</u> and associated <u>finishes</u>. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) <u>and</u> C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-4(2)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | Properties | | | | | | | | | | | Properties for Design to AS 4100 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | Mass per m | External Surface Area | | $\frac{b-2t}{t}$ | $\frac{d-2t}{t}$ | Gross Section Area | About x-axis | | | | About y-axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About x-axis | | About y-axis | |
| d | b | t | | per m | per t | | | $A_g$ | $I_x$ | $Z_x$ | $S_x$ | $r_x$ | $I_y$ | $Z_y$ | $S_y$ | $r_y$ | J | C | $k_f$ | Compactness | $Z_{ex}$ | Compactness | $Z_{ey}$ |
| mm | mm | mm | kg/m | m$^2$/m | m$^2$/t | | | mm$^2$ | $10^6$mm$^4$ | $10^3$mm$^3$ | $10^3$mm$^3$ | mm | $10^6$mm$^4$ | $10^3$mm$^3$ | $10^3$mm$^3$ | mm | $10^6$mm$^4$ | $10^3$mm$^3$ | | (C,N,S) | $10^3$mm$^3$ | (C,N,S) | $10^3$mm$^3$ |
| 200 x | 100 x | 10.0 RHS | 41.3 | 0.557 | 13.5 | 8.00 | 18.0 | 5260 | 24.4 | 244 | 318 | 68.2 | 8.18 | 164 | 195 | 39.4 | 21.5 | 292 | 1.00 | C | 318 | C | 195 |
| | | 9.0 RHS | 37.7 | 0.561 | 14.9 | 9.11 | 20.2 | 4800 | 22.8 | 228 | 293 | 68.9 | 7.64 | 153 | 180 | 39.9 | 19.9 | 272 | 1.00 | C | 293 | C | 180 |
| | | 8.0 RHS | 33.9 | 0.566 | 16.7 | 10.5 | 23.0 | 4320 | 20.9 | 209 | 267 | 69.5 | 7.05 | 141 | 165 | 40.4 | 18.1 | 250 | 1.00 | C | 267 | N | 163 |
| | | 6.0 RHS | 26.2 | 0.574 | 22.0 | 14.7 | 31.3 | 3330 | 16.7 | 167 | 210 | 70.8 | 5.69 | 114 | 130 | 41.3 | 14.2 | 200 | 0.967 | C | 210 | S | 110 |
| | | 5.0 RHS | 22.1 | 0.579 | 26.2 | 18.0 | 38.0 | 2810 | 14.4 | 144 | 179 | 71.5 | 4.92 | 98.3 | 111 | 41.8 | 12.1 | 172 | 0.855 | C | 179 | S | 82.2 |
| | | 4.0 RHS | 17.9 | 0.583 | 32.5 | 23.0 | 48.0 | 2280 | 11.9 | 119 | 147 | 72.1 | 4.07 | 81.5 | 91.0 | 42.3 | 9.89 | 142 | 0.745 | N | 144 | S | 58.0 |
| 152 x | 76 x | 6.0 RHS | 19.4 | 0.430 | 22.2 | 10.7 | 23.3 | 2470 | 6.91 | 90.9 | 116 | 52.9 | 2.33 | 61.4 | 71.5 | 30.7 | 5.98 | 108 | 1.00 | C | 116 | N | 70.2 |
| | | 5.0 RHS | 16.4 | 0.435 | 26.4 | 13.2 | 28.4 | 2090 | 6.01 | 79.0 | 99.8 | 53.6 | 2.04 | 53.7 | 61.6 | 31.2 | 5.13 | 94.3 | 1.00 | C | 99.8 | N | 55.2 |
| 150 x | 100 x | 10.0 RHS | 33.4 | 0.457 | 13.7 | 8.00 | 13.0 | 4260 | 11.6 | 155 | 199 | 52.2 | 6.14 | 123 | 150 | 38.0 | 14.3 | 211 | 1.00 | C | 199 | C | 150 |
| | | 9.0 RHS | 30.6 | 0.461 | 15.1 | 9.11 | 14.7 | 3900 | 10.9 | 145 | 185 | 52.9 | 5.77 | 115 | 140 | 38.5 | 13.2 | 197 | 1.00 | C | 185 | C | 140 |
| | | 8.0 RHS | 27.7 | 0.466 | 16.8 | 10.5 | 16.8 | 3520 | 10.1 | 134 | 169 | 53.5 | 5.36 | 107 | 128 | 39.0 | 12.1 | 182 | 1.00 | C | 169 | C | 128 |
| | | 6.0 RHS | 21.4 | 0.474 | 22.1 | 14.7 | 23.0 | 2730 | 8.17 | 109 | 134 | 54.7 | 4.36 | 87.3 | 102 | 40.0 | 9.51 | 147 | 1.00 | C | 134 | N | 101 |
| | | 5.0 RHS | 18.2 | 0.479 | 26.3 | 18.0 | 28.0 | 2310 | 7.07 | 94.3 | 115 | 55.3 | 3.79 | 75.7 | 87.3 | 40.4 | 8.12 | 127 | 1.00 | C | 115 | N | 78.5 |
| | | 4.0 RHS | 14.8 | 0.483 | 32.7 | 23.0 | 35.5 | 1880 | 5.87 | 78.2 | 94.6 | 55.9 | 3.15 | 63.0 | 71.8 | 40.9 | 6.64 | 105 | 0.903 | N | 93.2 | S | 55.9 |
| 150 x | 50 x | 6.0 RHS | 16.7 | 0.374 | 22.4 | 6.33 | 23.0 | 2130 | 5.06 | 67.5 | 91.2 | 48.7 | 0.860 | 34.4 | 40.9 | 20.1 | 2.63 | 64.3 | 1.00 | C | 91.2 | N | 40.4 |
| | | 5.0 RHS | 14.2 | 0.379 | 26.6 | 8.00 | 28.0 | 1810 | 4.44 | 59.2 | 78.9 | 49.5 | 0.765 | 30.6 | 35.7 | 20.5 | 2.30 | 56.8 | 1.00 | C | 78.9 | N | 31.8 |
| | | 4.0 RHS | 11.6 | 0.383 | 32.9 | 10.5 | 35.5 | 1480 | 3.74 | 49.8 | 65.4 | 50.2 | 0.653 | 26.1 | 29.8 | 21.0 | 1.93 | 48.2 | 0.877 | C | 65.4 | S | 22.7 |
| | | 3.0 RHS | 8.96 | 0.390 | 43.5 | 14.7 | 48.0 | 1140 | 2.99 | 39.8 | 51.4 | 51.2 | 0.526 | 21.1 | 23.5 | 21.5 | 1.50 | 38.3 | 0.713 | C | 51.4 | S | 14.5 |
| | | 2.5 RHS | 7.53 | 0.391 | 52.0 | 18.0 | 58.0 | 959 | 2.54 | 33.9 | 43.5 | 51.5 | 0.452 | 18.1 | 19.9 | 21.7 | 1.28 | 32.8 | 0.633 | C | 43.5 | S | 10.9 |
| | | 2.0 RHS | 6.07 | 0.393 | 64.7 | 23.0 | 73.0 | 774 | 2.08 | 27.7 | 35.3 | 51.8 | 0.372 | 14.9 | 16.3 | 21.9 | 1.04 | 26.9 | 0.553 | N | 31.6 | S | 7.64 |
| 127 x | 51 x | 6.0 RHS | 14.7 | 0.330 | 22.5 | 6.50 | 19.2 | 1870 | 3.28 | 51.6 | 68.9 | 41.9 | 0.761 | 29.8 | 35.8 | 20.2 | 2.20 | 54.9 | 1.00 | C | 68.9 | C | 35.8 |
| | | 5.0 RHS | 12.5 | 0.335 | 26.7 | 8.20 | 23.4 | 1590 | 2.89 | 45.6 | 59.9 | 42.6 | 0.679 | 26.6 | 31.3 | 20.6 | 1.93 | 48.6 | 1.00 | C | 59.9 | N | 30.6 |
| | | 3.5 RHS | 9.07 | 0.341 | 37.6 | 12.6 | 34.3 | 1150 | 2.20 | 34.7 | 44.6 | 43.7 | 0.526 | 20.6 | 23.4 | 21.3 | 1.44 | 37.2 | 0.905 | C | 44.6 | S | 18.5 |
| 125 x | 75 x | 6.0 RHS | 16.7 | 0.374 | 22.4 | 10.5 | 18.8 | 2130 | 4.16 | 66.6 | 84.2 | 44.2 | 1.87 | 50.0 | 59.1 | 29.6 | 4.44 | 86.2 | 1.00 | C | 84.2 | C | 59.1 |
| | | 5.0 RHS | 14.2 | 0.379 | 26.6 | 13.0 | 23.0 | 1810 | 3.64 | 58.3 | 72.7 | 44.8 | 1.65 | 43.9 | 51.1 | 30.1 | 3.83 | 75.3 | 1.00 | C | 72.7 | N | 50.5 |
| | | 4.0 RHS | 11.6 | 0.383 | 32.9 | 16.8 | 29.3 | 1480 | 3.05 | 48.9 | 60.3 | 45.4 | 1.39 | 37.0 | 42.4 | 30.6 | 3.16 | 63.0 | 1.00 | C | 60.3 | N | 37.4 |
| | | 3.0 RHS | 8.96 | 0.390 | 43.5 | 23.0 | 39.7 | 1140 | 2.43 | 38.9 | 47.3 | 46.1 | 1.11 | 29.5 | 33.3 | 31.1 | 2.43 | 49.5 | 0.845 | N | 46.5 | S | 24.2 |
| | | 2.5 RHS | 7.53 | 0.391 | 52.0 | 28.0 | 48.0 | 959 | 2.07 | 33.0 | 40.0 | 46.4 | 0.942 | 25.1 | 28.2 | 31.4 | 2.05 | 42.1 | 0.763 | N | 34.7 | S | 18.2 |
| | | 2.0 RHS | 6.07 | 0.393 | 64.7 | 35.5 | 60.5 | 774 | 1.69 | 27.0 | 32.5 | 46.7 | 0.771 | 20.6 | 22.9 | 31.6 | 1.67 | 34.4 | 0.624 | S | 24.8 | S | 13.0 |
| 102 x | 76 x | 6.0 RHS | 14.7 | 0.330 | 22.5 | 10.7 | 15.0 | 1870 | 2.52 | 49.4 | 61.9 | 36.7 | 1.59 | 42.0 | 50.5 | 29.2 | 3.38 | 69.8 | 1.00 | C | 61.9 | C | 50.5 |
| | | 5.0 RHS | 12.5 | 0.335 | 26.7 | 13.2 | 18.4 | 1590 | 2.22 | 43.5 | 53.7 | 37.3 | 1.41 | 37.0 | 43.9 | 29.7 | 2.91 | 61.2 | 1.00 | C | 53.7 | C | 43.9 |
| | | 3.5 RHS | 9.07 | 0.341 | 37.6 | 19.7 | 27.1 | 1150 | 1.68 | 33.0 | 39.9 | 38.2 | 1.07 | 28.2 | 32.6 | 30.5 | 2.14 | 46.1 | 1.00 | C | 39.9 | N | 29.8 |



## Notes:

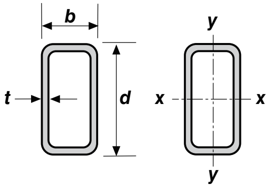
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-4(3)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | Properties | | | | | | | | | | | Properties for Design to AS 4100 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | Mass per m | External Surface Area | | b-2t | d-2t | Gross Section Area | About x-axis | | | | About y-axis | | | | Torsion Constant | Torsion Modulus | Form Factor | About x-axis | | About y-axis | |
| d | b | t | | per m | per t | t | t | $A_g$ | $I_x$ | $Z_x$ | $S_x$ | $r_x$ | $I_y$ | $Z_y$ | $S_y$ | $r_y$ | J | C | $k_f$ | Compact-ness | $Z_{ex}$ | Compact-ness | $Z_{ey}$ |
| mm | mm | mm | kg/m | $m^2/m$ | $m^2/t$ | | | $mm^2$ | $10^6mm^4$ | $10^3mm^3$ | $10^3mm^3$ | mm | $10^6mm^4$ | $10^3mm^3$ | $10^3mm^3$ | mm | $10^6mm^4$ | $10^3mm^3$ | | (C,N,S) | $10^3mm^3$ | (C,N,S) | $10^3mm^3$ |
| 100 x | 50 x | 6.0 RHS | 12.0 | 0.274 | 22.8 | 6.33 | 14.7 | 1530 | 1.71 | 34.2 | 45.3 | 33.4 | 0.567 | 22.7 | 27.7 | 19.2 | 1.53 | 40.9 | 1.00 | C | 45.3 | C | 27.7 |
| | | 5.0 RHS | 10.3 | 0.279 | 27.0 | 8.00 | 18.0 | 1310 | 1.53 | 30.6 | 39.8 | 34.1 | 0.511 | 20.4 | 24.4 | 19.7 | 1.35 | 36.5 | 1.00 | C | 39.8 | C | 24.4 |
| | | 4.0 RHS | 8.49 | 0.283 | 33.3 | 10.5 | 23.0 | 1080 | 1.31 | 26.1 | 33.4 | 34.8 | 0.441 | 17.6 | 20.6 | 20.2 | 1.13 | 31.2 | 1.00 | C | 33.4 | N | 20.3 |
| | | 3.5 RHS | 7.53 | 0.285 | 37.9 | 12.3 | 26.6 | 959 | 1.18 | 23.6 | 29.9 | 35.1 | 0.400 | 16.0 | 18.5 | 20.4 | 1.01 | 28.2 | 1.00 | C | 29.9 | N | 17.1 |
| | | 3.0 RHS | 6.60 | 0.290 | 43.9 | 14.7 | 31.3 | 841 | 1.06 | 21.3 | 26.7 | 35.6 | 0.361 | 14.4 | 16.4 | 20.7 | 0.886 | 25.0 | 0.967 | C | 26.7 | S | 13.9 |
| | | 2.5 RHS | 5.56 | 0.291 | 52.4 | 18.0 | 38.0 | 709 | 0.912 | 18.2 | 22.7 | 35.9 | 0.311 | 12.4 | 14.0 | 20.9 | 0.754 | 21.5 | 0.856 | C | 22.7 | S | 10.4 |
| | | 2.0 RHS | 4.50 | 0.293 | 65.1 | 23.0 | 48.0 | 574 | 0.750 | 15.0 | 18.5 | 36.2 | 0.257 | 10.3 | 11.5 | 21.2 | 0.616 | 17.7 | 0.746 | N | 18.2 | S | 7.33 |
| | | 1.6 RHS | 3.64 | 0.295 | 81.0 | 29.3 | 60.5 | 463 | 0.613 | 12.3 | 15.0 | 36.4 | 0.211 | 8.43 | 9.33 | 21.3 | 0.501 | 14.5 | 0.661 | N | 12.5 | S | 5.19 |
| 76 x | 38 x | 4.0 RHS | 6.23 | 0.211 | 33.9 | 7.50 | 17.0 | 793 | 0.527 | 13.9 | 18.1 | 25.8 | 0.176 | 9.26 | 11.1 | 14.9 | 0.466 | 16.6 | 1.00 | C | 18.1 | C | 11.1 |
| | | 3.0 RHS | 4.90 | 0.218 | 44.4 | 10.7 | 23.3 | 625 | 0.443 | 11.7 | 14.8 | 26.6 | 0.149 | 7.82 | 9.09 | 15.4 | 0.373 | 13.6 | 1.00 | C | 14.8 | N | 8.92 |
| | | 2.5 RHS | 4.15 | 0.219 | 52.8 | 13.2 | 28.4 | 529 | 0.383 | 10.1 | 12.7 | 26.9 | 0.129 | 6.81 | 7.81 | 15.6 | 0.320 | 11.8 | 1.00 | C | 12.7 | N | 7.00 |
| 75 x | 50 x | 6.0 RHS | 9.67 | 0.224 | 23.2 | 6.33 | 10.5 | 1230 | 0.800 | 21.3 | 28.1 | 25.5 | 0.421 | 16.9 | 21.1 | 18.5 | 1.01 | 29.3 | 1.00 | C | 28.1 | C | 21.1 |
| | | 5.0 RHS | 8.35 | 0.229 | 27.4 | 8.00 | 13.0 | 1060 | 0.726 | 19.4 | 24.9 | 26.1 | 0.384 | 15.4 | 18.8 | 19.0 | 0.891 | 26.4 | 1.00 | C | 24.9 | C | 18.8 |
| | | 4.0 RHS | 6.92 | 0.233 | 33.7 | 10.5 | 16.8 | 881 | 0.630 | 16.8 | 21.1 | 26.7 | 0.335 | 13.4 | 16.0 | 19.5 | 0.754 | 22.7 | 1.00 | C | 21.1 | C | 16.0 |
| | | 3.0 RHS | 5.42 | 0.240 | 44.2 | 14.7 | 23.0 | 691 | 0.522 | 13.9 | 17.1 | 27.5 | 0.278 | 11.1 | 12.9 | 20.0 | 0.593 | 18.4 | 1.00 | C | 17.1 | N | 12.8 |
| | | 2.5 RHS | 4.58 | 0.241 | 52.7 | 18.0 | 28.0 | 584 | 0.450 | 12.0 | 14.6 | 27.7 | 0.240 | 9.60 | 11.0 | 20.3 | 0.505 | 15.9 | 1.00 | C | 14.6 | N | 9.95 |
| | | 2.0 RHS | 3.72 | 0.243 | 65.4 | 23.0 | 35.5 | 474 | 0.372 | 9.91 | 12.0 | 28.0 | 0.199 | 7.96 | 9.06 | 20.5 | 0.414 | 13.1 | 0.904 | N | 11.8 | S | 7.07 |
| | | 1.6 RHS | 3.01 | 0.245 | 81.3 | 29.3 | 44.9 | 383 | 0.305 | 8.14 | 9.75 | 28.2 | 0.164 | 6.56 | 7.40 | 20.7 | 0.337 | 10.8 | 0.799 | N | 8.26 | S | 5.01 |
| 75 x | 25 x | 2.5 RHS | 3.60 | 0.191 | 53.1 | 8.00 | 28.0 | 459 | 0.285 | 7.60 | 10.1 | 24.9 | 0.0487 | 3.89 | 4.53 | 10.3 | 0.144 | 7.14 | 1.00 | C | 10.1 | N | 4.05 |
| | | 2.0 RHS | 2.93 | 0.193 | 65.8 | 10.5 | 35.5 | 374 | 0.238 | 6.36 | 8.31 | 25.3 | 0.0414 | 3.31 | 3.77 | 10.5 | 0.120 | 6.04 | 0.878 | C | 8.31 | S | 2.88 |
| | | 1.6 RHS | 2.38 | 0.195 | 81.7 | 13.6 | 44.9 | 303 | 0.197 | 5.26 | 6.81 | 25.5 | 0.0347 | 2.78 | 3.11 | 10.7 | 0.0993 | 5.05 | 0.746 | C | 6.81 | S | 2.02 |
| 65 x | 35 x | 4.0 RHS | 5.35 | 0.183 | 34.2 | 6.75 | 14.3 | 681 | 0.328 | 10.1 | 13.3 | 22.0 | 0.123 | 7.03 | 8.58 | 13.4 | 0.320 | 12.5 | 1.00 | C | 13.3 | C | 8.58 |
| | | 3.0 RHS | 4.25 | 0.190 | 44.7 | 9.67 | 19.7 | 541 | 0.281 | 8.65 | 11.0 | 22.8 | 0.106 | 6.04 | 7.11 | 14.0 | 0.259 | 10.4 | 1.00 | C | 11.0 | C | 7.11 |
| | | 2.5 RHS | 3.60 | 0.191 | 53.1 | 12.0 | 24.0 | 459 | 0.244 | 7.52 | 9.45 | 23.1 | 0.0926 | 5.29 | 6.13 | 14.2 | 0.223 | 9.10 | 1.00 | C | 9.45 | N | 5.95 |
| | | 2.0 RHS | 2.93 | 0.193 | 65.8 | 15.5 | 30.5 | 374 | 0.204 | 6.28 | 7.80 | 23.4 | 0.0778 | 4.44 | 5.07 | 14.4 | 0.184 | 7.62 | 0.985 | C | 7.80 | S | 4.37 |
| 50 x | 25 x | 3.0 RHS | 3.07 | 0.140 | 45.5 | 6.33 | 14.7 | 391 | 0.112 | 4.47 | 5.86 | 16.9 | 0.0367 | 2.93 | 3.56 | 9.69 | 0.0964 | 5.18 | 1.00 | C | 5.86 | C | 3.56 |
| | | 2.5 RHS | 2.62 | 0.141 | 54.0 | 8.00 | 18.0 | 334 | 0.0989 | 3.95 | 5.11 | 17.2 | 0.0328 | 2.62 | 3.12 | 9.91 | 0.0843 | 4.60 | 1.00 | C | 5.11 | C | 3.12 |
| | | 2.0 RHS | 2.15 | 0.143 | 66.6 | 10.5 | 23.0 | 274 | 0.0838 | 3.35 | 4.26 | 17.5 | 0.0281 | 2.25 | 2.62 | 10.1 | 0.0706 | 3.92 | 1.00 | C | 4.26 | N | 2.58 |
| | | 1.6 RHS | 1.75 | 0.145 | 82.5 | 13.6 | 29.3 | 223 | 0.0702 | 2.81 | 3.53 | 17.7 | 0.0237 | 1.90 | 2.17 | 10.3 | 0.0585 | 3.29 | 1.00 | C | 3.53 | N | 1.92 |
| 50 x | 20 x | 3.0 RHS | 2.83 | 0.130 | 45.8 | 4.67 | 14.7 | 361 | 0.0951 | 3.81 | 5.16 | 16.2 | 0.0212 | 2.12 | 2.63 | 7.67 | 0.0620 | 3.88 | 1.00 | C | 5.16 | C | 2.63 |
| | | 2.5 RHS | 2.42 | 0.131 | 54.2 | 6.00 | 18.0 | 309 | 0.0848 | 3.39 | 4.51 | 16.6 | 0.0192 | 1.92 | 2.32 | 7.89 | 0.0550 | 3.49 | 1.00 | C | 4.51 | C | 2.32 |
| | | 2.0 RHS | 1.99 | 0.133 | 66.8 | 8.00 | 23.0 | 254 | 0.0723 | 2.89 | 3.78 | 16.9 | 0.0167 | 1.67 | 1.96 | 8.11 | 0.0466 | 3.00 | 1.00 | C | 3.78 | N | 1.93 |
| | | 1.6 RHS | 1.63 | 0.135 | 82.7 | 10.5 | 29.3 | 207 | 0.0608 | 2.43 | 3.14 | 17.1 | 0.0142 | 1.42 | 1.63 | 8.29 | 0.0389 | 2.55 | 1.00 | C | 3.14 | N | 1.44 |



### Notes:

1. ***REFER** to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE** (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.*

**1. *REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**

2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.
6. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 3.1-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

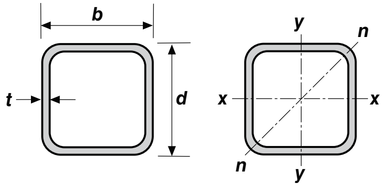
## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | | | Section Properties | | | | | | | | Properties for Design to AS 4100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | | | Mass per m | External Surface Area | | $\frac{b-2t}{t}$ | Gross Section Area | About x-, y- and n-axis | | | | | Torsion Constant | Torsion Modulus | Form Factor | About x and y-axis | | |
| d | | b | | t | | | per m | per t | | $A_g$ | $I_x$ | $Z_x$ | $Z_n$ | $S_x$ | $r_x$ | J | C | $k_f$ | $\lambda_e$ | Compactness | $Z_{ex}$ |
| mm | | mm | | mm | | kg/m | m²/m | m²/t | | mm² | $10^6$mm⁴ | $10^3$mm³ | $10^3$mm³ | $10^3$mm³ | mm | $10^6$mm⁴ | $10^3$mm³ | | | (C,N,S) | $10^3$mm³ |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 0.174 | 23.8 | 6.33 | 932 | 0.275 | 11.0 | 9.45 | 14.5 | 17.2 | 0.518 | 17.7 | 1.00 | 7.49 | C | 14.5 |
| | | | | 5.0 | SHS | 6.39 | 0.179 | 27.9 | 8.00 | 814 | 0.257 | 10.3 | 8.51 | 13.2 | 17.8 | 0.469 | 16.3 | 1.00 | 9.47 | C | 13.2 |
| | | | | 4.0 | SHS | 5.35 | 0.183 | 34.2 | 10.5 | 681 | 0.229 | 9.15 | 7.33 | 11.4 | 18.3 | 0.403 | 14.3 | 1.00 | 12.4 | C | 11.4 |
| | | | | 3.0 | SHS | 4.25 | 0.190 | 44.7 | 14.7 | 541 | 0.195 | 7.79 | 5.92 | 9.39 | 19.0 | 0.321 | 11.8 | 1.00 | 17.4 | C | 9.39 |
| | | | | 2.5 | SHS | 3.60 | 0.191 | 53.1 | 18.0 | 459 | 0.169 | 6.78 | 5.09 | 8.07 | 19.2 | 0.275 | 10.2 | 1.00 | 21.3 | C | 8.07 |
| | | | | 2.0 | SHS | 2.93 | 0.193 | 65.8 | 23.0 | 374 | 0.141 | 5.66 | 4.20 | 6.66 | 19.5 | 0.226 | 8.51 | 1.00 | 27.2 | C | 6.66 |
| | | | | 1.6 | SHS | 2.38 | 0.195 | 81.7 | 29.3 | 303 | 0.117 | 4.68 | 3.44 | 5.46 | 19.6 | 0.185 | 7.03 | 1.00 | 34.6 | N | 5.10 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 0.143 | 34.9 | 8.00 | 521 | 0.105 | 5.26 | 4.36 | 6.74 | 14.2 | 0.192 | 8.33 | 1.00 | 9.47 | C | 6.74 |
| | | | | 3.0 | SHS | 3.30 | 0.150 | 45.3 | 11.3 | 421 | 0.0932 | 4.66 | 3.61 | 5.72 | 14.9 | 0.158 | 7.07 | 1.00 | 13.4 | C | 5.72 |
| | | | | 2.5 | SHS | 2.82 | 0.151 | 53.7 | 14.0 | 359 | 0.0822 | 4.11 | 3.13 | 4.97 | 15.1 | 0.136 | 6.21 | 1.00 | 16.6 | C | 4.97 |
| | | | | 2.0 | SHS | 2.31 | 0.153 | 66.4 | 18.0 | 294 | 0.0694 | 3.47 | 2.61 | 4.13 | 15.4 | 0.113 | 5.23 | 1.00 | 21.3 | C | 4.13 |
| | | | | 1.6 | SHS | 1.88 | 0.155 | 82.3 | 23.0 | 239 | 0.0579 | 2.90 | 2.15 | 3.41 | 15.6 | 0.0927 | 4.36 | 1.00 | 27.2 | C | 3.41 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 0.130 | 45.8 | 9.67 | 361 | 0.0595 | 3.40 | 2.67 | 4.23 | 12.8 | 0.102 | 5.18 | 1.00 | 11.4 | C | 4.23 |
| | | | | 2.5 | SHS | 2.42 | 0.131 | 54.2 | 12.0 | 309 | 0.0529 | 3.02 | 2.33 | 3.69 | 13.1 | 0.0889 | 4.58 | 1.00 | 14.2 | C | 3.69 |
| | | | | 2.0 | SHS | 1.99 | 0.133 | 66.8 | 15.5 | 254 | 0.0451 | 2.58 | 1.95 | 3.09 | 13.3 | 0.0741 | 3.89 | 1.00 | 18.3 | C | 3.09 |
| | | | | 1.6 | SHS | 1.63 | 0.135 | 82.7 | 19.9 | 207 | 0.0379 | 2.16 | 1.62 | 2.57 | 13.5 | 0.0611 | 3.26 | 1.00 | 23.5 | C | 2.57 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 0.110 | 46.5 | 8.00 | 301 | 0.0350 | 2.34 | 1.87 | 2.96 | 10.8 | 0.0615 | 3.58 | 1.00 | 9.47 | C | 2.96 |
| | | | | 2.5 | SHS | 2.03 | 0.111 | 54.8 | 10.0 | 259 | 0.0316 | 2.10 | 1.65 | 2.61 | 11.0 | 0.0540 | 3.20 | 1.00 | 11.8 | C | 2.61 |
| | | | | 2.0 | SHS | 1.68 | 0.113 | 67.4 | 13.0 | 214 | 0.0272 | 1.81 | 1.39 | 2.21 | 11.3 | 0.0454 | 2.75 | 1.00 | 15.4 | C | 2.21 |
| | | | | 1.6 | SHS | 1.38 | 0.115 | 83.3 | 16.8 | 175 | 0.0231 | 1.54 | 1.16 | 1.84 | 11.5 | 0.0377 | 2.32 | 1.00 | 19.8 | C | 1.84 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 0.0897 | 47.4 | 6.33 | 241 | 0.0184 | 1.47 | 1.21 | 1.91 | 8.74 | 0.0333 | 2.27 | 1.00 | 7.49 | C | 1.91 |
| | | | | 2.5 | SHS | 1.64 | 0.0914 | 55.7 | 8.00 | 209 | 0.0169 | 1.35 | 1.08 | 1.71 | 8.99 | 0.0297 | 2.07 | 1.00 | 9.47 | C | 1.71 |
| | | | | 2.0 | SHS | 1.36 | 0.0931 | 68.3 | 10.5 | 174 | 0.0148 | 1.19 | 0.926 | 1.47 | 9.24 | 0.0253 | 1.80 | 1.00 | 12.4 | C | 1.47 |
| | | | | 1.6 | SHS | 1.12 | 0.0945 | 84.1 | 13.6 | 143 | 0.0128 | 1.02 | 0.780 | 1.24 | 9.44 | 0.0212 | 1.54 | 1.00 | 16.1 | C | 1.24 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 0.0731 | 69.7 | 8.00 | 134 | 0.00692 | 0.692 | 0.554 | 0.877 | 7.20 | 0.0121 | 1.06 | 1.00 | 9.47 | C | 0.877 |
| | | | | 1.6 | SHS | 0.873 | 0.0745 | 85.4 | 10.5 | 111 | 0.00608 | 0.608 | 0.474 | 0.751 | 7.39 | 0.0103 | 0.924 | 1.00 | 12.4 | C | 0.751 |

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS™.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS™ PRODUCTS.**



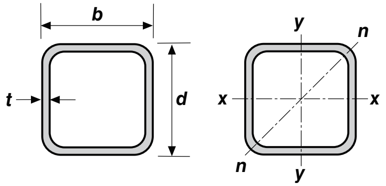
## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C350L0: $f_y$ = 350 MPa and $f_u$ = 430 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-6(1)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES



| Dimensions and Ratios | | | | | | | | | | Section Properties | | | | | | | | Properties for Design to AS 4100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | | | Mass per m | External Surface Area | | b-2t / t | Gross Section Area | About x-, y- and n-axis | | | | | Torsion Constant | Torsion Modulus | Form Factor | About x and y-axis | | |
| d | | b | | t | | | per m | per t | | $A_g$ | $I_x$ | $Z_x$ | $Z_n$ | $S_x$ | $r_x$ | J | C | $k_f$ | $\lambda_e$ | Compactness | $Z_{ex}$ |
| mm | | mm | | mm | | kg/m | m²/m | m²/t | | mm² | 10⁶mm⁴ | 10³mm³ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | | | (C,N,S) | 10³mm³ |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 1.53 | 8.23 | 23.0 | 23700 | 571 | 2850 | 2140 | 3370 | 155 | 930 | 4350 | 1.00 | 30.9 | N | 3320 |
| | | | | 12.5 | SHS | 148 | 1.55 | 10.5 | 30.0 | 18800 | 464 | 2320 | 1720 | 2710 | 157 | 744 | 3520 | 0.994 | 40.2 | S | 2310 |
| | | | | 10.0 | SHS | 120 | 1.56 | 13.0 | 38.0 | 15300 | 382 | 1910 | 1400 | 2210 | 158 | 604 | 2890 | 0.785 | 51.0 | S | 1650 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 1.33 | 8.27 | 19.9 | 20500 | 372 | 2130 | 1610 | 2530 | 135 | 614 | 3250 | 1.00 | 26.7 | C | 2530 |
| | | | | 12.5 | SHS | 128 | 1.35 | 10.5 | 26.0 | 16300 | 305 | 1740 | 1300 | 2040 | 137 | 493 | 2650 | 1.00 | 34.9 | N | 1900 |
| | | | | 10.0 | SHS | 104 | 1.36 | 13.0 | 33.0 | 13300 | 252 | 1440 | 1060 | 1670 | 138 | 401 | 2180 | 0.904 | 44.3 | S | 1350 |
| | | | | 8.0 | SHS | 84.2 | 1.37 | 16.2 | 41.8 | 10700 | 207 | 1180 | 865 | 1370 | 139 | 326 | 1790 | 0.715 | 56.0 | S | 971 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 1.13 | 8.33 | 16.8 | 17300 | 226 | 1510 | 1160 | 1810 | 114 | 378 | 2310 | 1.00 | 22.5 | C | 1810 |
| | | | | 12.5 | SHS | 109 | 1.15 | 10.6 | 22.0 | 13800 | 187 | 1240 | 937 | 1470 | 116 | 305 | 1900 | 1.00 | 29.5 | C | 1470 |
| | | | | 10.0 | SHS | 88.4 | 1.16 | 13.1 | 28.0 | 11300 | 155 | 1030 | 769 | 1210 | 117 | 250 | 1570 | 1.00 | 37.6 | N | 1080 |
| | | | | 8.0 | SHS | 71.6 | 1.17 | 16.3 | 35.5 | 9120 | 128 | 853 | 628 | 991 | 118 | 203 | 1290 | 0.840 | 47.6 | S | 768 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 0.931 | 8.42 | 13.6 | 14100 | 124 | 992 | 774 | 1210 | 93.8 | 212 | 1530 | 1.00 | 18.3 | C | 1210 |
| | | | | 12.5 | SHS | 89.0 | 0.946 | 10.6 | 18.0 | 11300 | 104 | 830 | 634 | 992 | 95.7 | 173 | 1270 | 1.00 | 24.1 | C | 992 |
| | | | | 10.0 | SHS | 72.7 | 0.957 | 13.2 | 23.0 | 9260 | 87.1 | 697 | 523 | 822 | 97.0 | 142 | 1060 | 1.00 | 30.9 | N | 811 |
| | | | | 9.0 | SHS | 65.9 | 0.961 | 14.6 | 25.8 | 8400 | 79.8 | 639 | 477 | 750 | 97.5 | 129 | 972 | 1.00 | 34.6 | N | 699 |
| | | | | 8.0 | SHS | 59.1 | 0.966 | 16.3 | 29.3 | 7520 | 72.3 | 578 | 429 | 676 | 98.0 | 116 | 878 | 1.00 | 39.2 | N | 586 |
| | | | | 6.0 | SHS | 45.0 | 0.974 | 21.7 | 39.7 | 5730 | 56.2 | 450 | 330 | 521 | 99.0 | 88.7 | 681 | 0.753 | 53.2 | S | 380 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 0.731 | 8.55 | 10.5 | 10900 | 58.6 | 586 | 469 | 728 | 73.3 | 103 | 914 | 1.00 | 14.1 | C | 728 |
| | | | | 12.5 | SHS | 69.4 | 0.746 | 10.8 | 14.0 | 8840 | 50.0 | 500 | 389 | 607 | 75.2 | 85.2 | 772 | 1.00 | 18.8 | C | 607 |
| | | | | 10.0 | SHS | 57.0 | 0.757 | 13.3 | 18.0 | 7260 | 42.5 | 425 | 324 | 508 | 76.5 | 70.7 | 651 | 1.00 | 24.1 | C | 508 |
| | | | | 9.0 | SHS | 51.8 | 0.761 | 14.7 | 20.2 | 6600 | 39.2 | 392 | 297 | 465 | 77.1 | 64.5 | 599 | 1.00 | 27.1 | C | 465 |
| | | | | 8.0 | SHS | 46.5 | 0.766 | 16.5 | 23.0 | 5920 | 35.7 | 357 | 268 | 421 | 77.6 | 58.2 | 544 | 1.00 | 30.9 | N | 415 |
| | | | | 6.0 | SHS | 35.6 | 0.774 | 21.8 | 31.3 | 4530 | 28.0 | 280 | 207 | 327 | 78.6 | 44.8 | 425 | 0.952 | 42.0 | S | 272 |
| | | | | 5.0 | SHS | 29.9 | 0.779 | 26.0 | 38.0 | 3810 | 23.9 | 239 | 175 | 277 | 79.1 | 37.8 | 362 | 0.785 | 51.0 | S | 207 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 0.557 | 13.5 | 13.0 | 5260 | 16.5 | 220 | 173 | 269 | 56.1 | 28.4 | 341 | 1.00 | 17.4 | C | 269 |
| | | | | 9.0 | SHS | 37.7 | 0.561 | 14.9 | 14.7 | 4800 | 15.4 | 205 | 159 | 248 | 56.6 | 26.1 | 316 | 1.00 | 19.7 | C | 248 |
| | | | | 8.0 | SHS | 33.9 | 0.566 | 16.7 | 16.8 | 4320 | 14.1 | 188 | 144 | 226 | 57.1 | 23.6 | 289 | 1.00 | 22.5 | C | 226 |
| | | | | 6.0 | SHS | 26.2 | 0.574 | 22.0 | 23.0 | 3330 | 11.3 | 150 | 113 | 178 | 58.2 | 18.4 | 229 | 1.00 | 30.9 | N | 175 |
| | | | | 5.0 | SHS | 22.1 | 0.579 | 26.2 | 28.0 | 2810 | 9.70 | 129 | 96.2 | 151 | 58.7 | 15.6 | 197 | 1.00 | 37.6 | N | 135 |

## Notes:

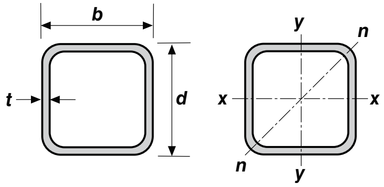
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-6(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | | | Section Properties | | | | | | | | Properties for Design to AS 4100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | | | Mass per m | External Surface Area | | b-2t | Gross Section Area | About x-, y- and n-axis | | | | | Torsion Constant | Torsion Modulus | Form Factor | About x and y-axis | | |
| d | | b | | t | | | per m | per t | t | $A_g$ | $I_x$ | $Z_x$ | $Z_n$ | $S_x$ | $r_x$ | J | C | $k_f$ | $\lambda_e$ | Compactness | $Z_{ex}$ |
| mm | | mm | | mm | | kg/m | $m^2/m$ | $m^2/t$ | | $mm^2$ | $10^6mm^4$ | $10^3mm^3$ | $10^3mm^3$ | $10^3mm^3$ | mm | $10^6mm^4$ | $10^3mm^3$ | | | (C,N,S) | $10^3mm^3$ |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 0.457 | 13.7 | 10.5 | 4260 | 8.93 | 143 | 114 | 178 | 45.8 | 15.7 | 223 | 1.00 | 14.1 | C | 178 |
| | | | | 9.0 | SHS | 30.6 | 0.461 | 15.1 | 11.9 | 3900 | 8.38 | 134 | 106 | 165 | 46.4 | 14.5 | 208 | 1.00 | 16.0 | C | 165 |
| | | | | 8.0 | SHS | 27.7 | 0.466 | 16.8 | 13.6 | 3520 | 7.75 | 124 | 96.8 | 151 | 46.9 | 13.3 | 192 | 1.00 | 18.3 | C | 151 |
| | | | | 6.0 | SHS | 21.4 | 0.474 | 22.1 | 18.8 | 2730 | 6.29 | 101 | 76.5 | 120 | 48.0 | 10.4 | 154 | 1.00 | 25.3 | C | 120 |
| | | | | 5.0 | SHS | 18.2 | 0.479 | 26.3 | 23.0 | 2310 | 5.44 | 87.1 | 65.4 | 103 | 48.5 | 8.87 | 133 | 1.00 | 30.9 | N | 101 |
| | | | | 4.0 | SHS | 14.8 | 0.483 | 32.7 | 29.3 | 1880 | 4.52 | 72.3 | 53.6 | 84.5 | 49.0 | 7.25 | 110 | 1.00 | 39.2 | N | 73.2 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 0.357 | 14.0 | 8.00 | 3260 | 4.11 | 82.2 | 68.1 | 105 | 35.5 | 7.50 | 130 | 1.00 | 10.7 | C | 105 |
| | | | | 9.0 | SHS | 23.5 | 0.361 | 15.4 | 9.11 | 3000 | 3.91 | 78.1 | 63.6 | 98.6 | 36.1 | 7.00 | 123 | 1.00 | 12.2 | C | 98.6 |
| | | | | 8.0 | SHS | 21.4 | 0.366 | 17.1 | 10.5 | 2720 | 3.66 | 73.2 | 58.6 | 91.1 | 36.7 | 6.45 | 114 | 1.00 | 14.1 | C | 91.1 |
| | | | | 6.0 | SHS | 16.7 | 0.374 | 22.4 | 14.7 | 2130 | 3.04 | 60.7 | 47.1 | 73.5 | 37.7 | 5.15 | 93.6 | 1.00 | 19.7 | C | 73.5 |
| | | | | 5.0 | SHS | 14.2 | 0.379 | 26.6 | 18.0 | 1810 | 2.66 | 53.1 | 40.5 | 63.5 | 38.3 | 4.42 | 81.4 | 1.00 | 24.1 | C | 63.5 |
| | | | | 4.0 | SHS | 11.6 | 0.383 | 32.9 | 23.0 | 1480 | 2.23 | 44.6 | 33.5 | 52.6 | 38.8 | 3.63 | 68.0 | 1.00 | 30.9 | N | 51.9 |
| | | | | 3.0 | SHS | 8.96 | 0.390 | 43.5 | 31.3 | 1140 | 1.77 | 35.4 | 26.0 | 41.2 | 39.4 | 2.79 | 53.2 | 0.952 | 42.0 | S | 34.4 |
| | | | | 2.5 | SHS | 7.53 | 0.391 | 52.0 | 38.0 | 959 | 1.51 | 30.1 | 21.9 | 34.9 | 39.6 | 2.35 | 45.2 | 0.787 | 51.0 | S | 26.1 |
| | | | | 2.0 | SHS | 6.07 | 0.393 | 64.7 | 48.0 | 774 | 1.23 | 24.6 | 17.8 | 28.3 | 39.9 | 1.91 | 36.9 | 0.624 | 64.4 | S | 18.8 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 0.351 | 52.1 | 34.0 | 859 | 1.09 | 24.1 | 17.6 | 28.0 | 35.6 | 1.70 | 36.2 | 0.878 | 45.6 | S | 22.3 |
| | | | | 2.0 | SHS | 5.45 | 0.353 | 64.8 | 43.0 | 694 | 0.889 | 19.7 | 14.3 | 22.8 | 35.8 | 1.38 | 29.6 | 0.696 | 57.7 | S | 16.0 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 0.330 | 22.5 | 12.8 | 1870 | 2.06 | 46.4 | 36.4 | 56.7 | 33.2 | 3.55 | 71.8 | 1.00 | 17.2 | C | 56.7 |
| | | | | 5.0 | SHS | 12.5 | 0.335 | 26.7 | 15.8 | 1590 | 1.82 | 40.8 | 31.5 | 49.2 | 33.8 | 3.06 | 62.8 | 1.00 | 21.2 | C | 49.2 |
| | | | | 3.5 | SHS | 9.07 | 0.341 | 37.6 | 23.4 | 1150 | 1.38 | 31.0 | 23.3 | 36.5 | 34.6 | 2.25 | 47.2 | 1.00 | 31.4 | N | 35.8 |
| | | | | 2.0 | SHS | 5.38 | 0.349 | 64.9 | 42.5 | 686 | 0.858 | 19.3 | 14.0 | 22.3 | 35.4 | 1.33 | 29.0 | 0.704 | 57.0 | S | 15.7 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 0.274 | 22.8 | 10.5 | 1530 | 1.16 | 30.9 | 24.7 | 38.4 | 27.5 | 2.04 | 48.2 | 1.00 | 14.1 | C | 38.4 |
| | | | | 5.0 | SHS | 10.3 | 0.279 | 27.0 | 13.0 | 1310 | 1.03 | 27.5 | 21.6 | 33.6 | 28.0 | 1.77 | 42.6 | 1.00 | 17.4 | C | 33.6 |
| | | | | 4.0 | SHS | 8.49 | 0.283 | 33.3 | 16.8 | 1080 | 0.882 | 23.5 | 18.1 | 28.2 | 28.6 | 1.48 | 36.1 | 1.00 | 22.5 | C | 28.2 |
| | | | | 3.5 | SHS | 7.53 | 0.285 | 37.9 | 19.4 | 959 | 0.797 | 21.3 | 16.1 | 25.3 | 28.8 | 1.32 | 32.5 | 1.00 | 26.1 | C | 25.3 |
| | | | | 3.0 | SHS | 6.60 | 0.290 | 43.9 | 23.0 | 841 | 0.716 | 19.1 | 14.2 | 22.5 | 29.2 | 1.15 | 28.7 | 1.00 | 30.9 | N | 22.2 |
| | | | | 2.5 | SHS | 5.56 | 0.291 | 52.4 | 28.0 | 709 | 0.614 | 16.4 | 12.0 | 19.1 | 29.4 | 0.971 | 24.6 | 1.00 | 37.6 | N | 17.0 |
| | | | | 2.0 | SHS | 4.50 | 0.293 | 65.1 | 35.5 | 574 | 0.505 | 13.5 | 9.83 | 15.6 | 29.7 | 0.790 | 20.2 | 0.841 | 47.6 | S | 12.1 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 0.234 | 23.1 | 8.83 | 1290 | 0.706 | 21.7 | 17.8 | 27.5 | 23.4 | 1.27 | 34.2 | 1.00 | 11.9 | C | 27.5 |
| | | | | 5.0 | SHS | 8.75 | 0.239 | 27.3 | 11.0 | 1110 | 0.638 | 19.6 | 15.6 | 24.3 | 23.9 | 1.12 | 30.6 | 1.00 | 14.8 | C | 24.3 |
| | | | | 4.0 | SHS | 7.23 | 0.243 | 33.6 | 14.3 | 921 | 0.552 | 17.0 | 13.2 | 20.6 | 24.5 | 0.939 | 26.2 | 1.00 | 19.1 | C | 20.6 |
| | | | | 3.0 | SHS | 5.66 | 0.250 | 44.1 | 19.7 | 721 | 0.454 | 14.0 | 10.4 | 16.6 | 25.1 | 0.733 | 21.0 | 1.00 | 26.4 | C | 16.6 |
| | | | | 2.5 | SHS | 4.78 | 0.251 | 52.6 | 24.0 | 609 | 0.391 | 12.0 | 8.91 | 14.1 | 25.3 | 0.624 | 18.1 | 1.00 | 32.2 | N | 13.7 |
| | | | | 2.0 | SHS | 3.88 | 0.253 | 65.3 | 30.5 | 494 | 0.323 | 9.94 | 7.29 | 11.6 | 25.6 | 0.509 | 14.9 | 0.978 | 40.9 | S | 9.80 |
| | | | | 1.6 | SHS | 3.13 | 0.255 | 81.2 | 38.6 | 399 | 0.265 | 8.16 | 5.94 | 9.44 | 25.8 | 0.414 | 12.2 | 0.774 | 51.8 | S | 7.01 |



## Notes:

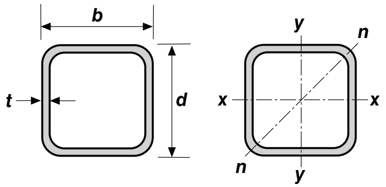
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-6(3)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

| Dimensions and Ratios | | | | | | | | | | Section Properties | | | | | | | | Properties for Design to AS 4100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Designation | | | | | | Mass per m | External Surface Area | | b-2t / t | Gross Section Area | About x-, y- and n-axis | | | | | Torsion Constant | Torsion Modulus | Form Factor | About x and y-axis | | |
| d | | b | | t | | | per m | per t | | $A_g$ | $I_x$ | $Z_x$ | $Z_n$ | $S_x$ | $r_x$ | J | C | $k_f$ | $\lambda_e$ | Compactness | $Z_{ex}$ |
| mm | | mm | | mm | | kg/m | m²/m | m²/t | | mm² | 10⁶mm⁴ | 10³mm³ | 10³mm³ | 10³mm³ | mm | 10⁶mm⁴ | 10³mm³ | | | (C,N,S) | 10³mm³ |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 0.174 | 23.8 | 6.33 | 932 | 0.275 | 11.0 | 9.45 | 14.5 | 17.2 | 0.518 | 17.7 | 1.00 | 8.50 | C | 14.5 |
| | | | | 5.0 | SHS | 6.39 | 0.179 | 27.9 | 8.00 | 814 | 0.257 | 10.3 | 8.51 | 13.2 | 17.8 | 0.469 | 16.3 | 1.00 | 10.7 | C | 13.2 |
| | | | | 4.0 | SHS | 5.35 | 0.183 | 34.2 | 10.5 | 681 | 0.229 | 9.15 | 7.33 | 11.4 | 18.3 | 0.403 | 14.3 | 1.00 | 14.1 | C | 11.4 |
| | | | | 3.0 | SHS | 4.25 | 0.190 | 44.7 | 14.7 | 541 | 0.195 | 7.79 | 5.92 | 9.39 | 19.0 | 0.321 | 11.8 | 1.00 | 19.7 | C | 9.39 |
| | | | | 2.5 | SHS | 3.60 | 0.191 | 53.1 | 18.0 | 459 | 0.169 | 6.78 | 5.09 | 8.07 | 19.2 | 0.275 | 10.2 | 1.00 | 24.1 | C | 8.07 |
| | | | | 2.0 | SHS | 2.93 | 0.193 | 65.8 | 23.0 | 374 | 0.141 | 5.66 | 4.20 | 6.66 | 19.5 | 0.226 | 8.51 | 1.00 | 30.9 | N | 6.58 |
| | | | | 1.6 | SHS | 2.38 | 0.195 | 81.7 | 29.3 | 303 | 0.117 | 4.68 | 3.44 | 5.46 | 19.6 | 0.185 | 7.03 | 1.00 | 39.2 | N | 4.74 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 0.143 | 34.9 | 8.00 | 521 | 0.105 | 5.26 | 4.36 | 6.74 | 14.2 | 0.192 | 8.33 | 1.00 | 10.7 | C | 6.74 |
| | | | | 3.0 | SHS | 3.30 | 0.150 | 45.3 | 11.3 | 421 | 0.0932 | 4.66 | 3.61 | 5.72 | 14.9 | 0.158 | 7.07 | 1.00 | 15.2 | C | 5.72 |
| | | | | 2.5 | SHS | 2.82 | 0.151 | 53.7 | 14.0 | 359 | 0.0822 | 4.11 | 3.13 | 4.97 | 15.1 | 0.136 | 6.21 | 1.00 | 18.8 | C | 4.97 |
| | | | | 2.0 | SHS | 2.31 | 0.153 | 66.4 | 18.0 | 294 | 0.0694 | 3.47 | 2.61 | 4.13 | 15.4 | 0.113 | 5.23 | 1.00 | 24.1 | C | 4.13 |
| | | | | 1.6 | SHS | 1.88 | 0.155 | 82.3 | 23.0 | 239 | 0.0579 | 2.90 | 2.15 | 3.41 | 15.6 | 0.0927 | 4.36 | 1.00 | 30.9 | N | 3.37 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 0.130 | 45.8 | 9.67 | 361 | 0.0595 | 3.40 | 2.67 | 4.23 | 12.8 | 0.102 | 5.18 | 1.00 | 13.0 | C | 4.23 |
| | | | | 2.5 | SHS | 2.42 | 0.131 | 54.2 | 12.0 | 309 | 0.0529 | 3.02 | 2.33 | 3.69 | 13.1 | 0.0889 | 4.58 | 1.00 | 16.1 | C | 3.69 |
| | | | | 2.0 | SHS | 1.99 | 0.133 | 66.8 | 15.5 | 254 | 0.0451 | 2.58 | 1.95 | 3.09 | 13.3 | 0.0741 | 3.89 | 1.00 | 20.8 | C | 3.09 |
| | | | | 1.6 | SHS | 1.63 | 0.135 | 82.7 | 19.9 | 207 | 0.0379 | 2.16 | 1.62 | 2.57 | 13.5 | 0.0611 | 3.26 | 1.00 | 26.7 | C | 2.57 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 0.110 | 46.5 | 8.00 | 301 | 0.0350 | 2.34 | 1.87 | 2.96 | 10.8 | 0.0615 | 3.58 | 1.00 | 10.7 | C | 2.96 |
| | | | | 2.5 | SHS | 2.03 | 0.111 | 54.8 | 10.0 | 259 | 0.0316 | 2.10 | 1.65 | 2.61 | 11.0 | 0.0540 | 3.20 | 1.00 | 13.4 | C | 2.61 |
| | | | | 2.0 | SHS | 1.68 | 0.113 | 67.4 | 13.0 | 214 | 0.0272 | 1.81 | 1.39 | 2.21 | 11.3 | 0.0454 | 2.75 | 1.00 | 17.4 | C | 2.21 |
| | | | | 1.6 | SHS | 1.38 | 0.115 | 83.3 | 16.8 | 175 | 0.0231 | 1.54 | 1.16 | 1.84 | 11.5 | 0.0377 | 2.32 | 1.00 | 22.5 | C | 1.84 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 0.0897 | 47.4 | 6.33 | 241 | 0.0184 | 1.47 | 1.21 | 1.91 | 8.74 | 0.0333 | 2.27 | 1.00 | 8.50 | C | 1.91 |
| | | | | 2.5 | SHS | 1.64 | 0.0914 | 55.7 | 8.00 | 209 | 0.0169 | 1.35 | 1.08 | 1.71 | 8.99 | 0.0297 | 2.07 | 1.00 | 10.7 | C | 1.71 |
| | | | | 2.0 | SHS | 1.36 | 0.0931 | 68.3 | 10.5 | 174 | 0.0148 | 1.19 | 0.926 | 1.47 | 9.24 | 0.0253 | 1.80 | 1.00 | 14.1 | C | 1.47 |
| | | | | 1.6 | SHS | 1.12 | 0.0945 | 84.1 | 13.6 | 143 | 0.0128 | 1.02 | 0.780 | 1.24 | 9.44 | 0.0212 | 1.54 | 1.00 | 18.3 | C | 1.24 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 0.0731 | 69.7 | 8.00 | 134 | 0.00692 | 0.692 | 0.554 | 0.877 | 7.20 | 0.0121 | 1.06 | 1.00 | 10.7 | C | 0.877 |
| | | | | 1.6 | SHS | 0.873 | 0.0745 | 85.4 | 10.5 | 111 | 0.00608 | 0.608 | 0.474 | 0.751 | 7.39 | 0.0103 | 0.924 | 1.00 | 14.1 | C | 0.751 |



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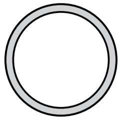
3. For C450PLUS™:
   $f_y$ = 450 MPa and $f_u$ = 500 MPa;
   $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
4. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
5. Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.
6. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 3.2-1

# Circular Hollow Sections
# AS/NZS 1163 Grade C250L0

## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO ($m^2$/tonne)



| Designation | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | |
| mm | | mm | | kg/m | | | | | | |
| 165.1 | x | 5.4 | CHS | 21.3 | 24.4 | - | 31.8 | - | - | - |
| | | 5.0 | CHS | 19.7 | 26.3 | - | 34.2 | - | - | - |
| 139.7 | x | 5.4 | CHS | 17.9 | 24.5 | - | 33.3 | - | - | - |
| | | 5.0 | CHS | 16.6 | 26.4 | - | 35.9 | - | - | - |
| 114.3 | x | 5.4 | CHS | 14.5 | 24.8 | - | 35.6 | - | - | - |
| | | 4.5 | CHS | 12.2 | 29.5 | - | 42.4 | - | - | - |
| 101.6 | x | 5.0 | CHS | 11.9 | 26.8 | - | 40.0 | - | - | - |
| | | 4.0 | CHS | 9.63 | 33.2 | - | 49.5 | - | - | - |
| 88.9 | x | 5.9 | CHS | 12.1 | 23.1 | - | 36.1 | - | - | - |
| | | 5.0 | CHS | 10.3 | 27.0 | - | 42.2 | - | - | - |
| | | 4.0 | CHS | 8.38 | 33.3 | - | 52.1 | - | - | - |
| 76.1 | x | 5.9 | CHS | 10.2 | 23.4 | - | 38.8 | - | - | - |
| | | 4.5 | CHS | 7.95 | 30.1 | - | 49.9 | - | - | - |
| | | 3.6 | CHS | 6.44 | 37.1 | - | 61.5 | - | - | - |
| 60.3 | x | 5.4 | CHS | 7.31 | 25.9 | - | 47.4 | - | - | - |
| | | 4.5 | CHS | 6.19 | 30.6 | - | 56.0 | - | - | - |
| | | 3.6 | CHS | 5.03 | 37.6 | - | 68.8 | - | - | - |
| 48.3 | x | 4.0 | CHS | 4.37 | 34.7 | - | 70.7 | - | - | - |
| | | 3.2 | CHS | 3.56 | 42.6 | - | 86.8 | - | - | - |
| 42.4 | x | 4.0 | CHS | 3.79 | 35.2 | - | 76.6 | - | - | - |
| | | 3.2 | CHS | 3.09 | 43.1 | - | 93.8 | - | - | - |
| 33.7 | x | 4.0 | CHS | 2.93 | 36.1 | - | 89.8 | - | - | - |
| | | 3.2 | CHS | 2.41 | 44.0 | - | 109 | - | - | - |
| 26.9 | x | 4.0 | CHS | 2.26 | 37.4 | - | 107 | - | - | - |
| | | 3.2 | CHS | 1.87 | 45.2 | - | 129 | - | - | - |
| | | 2.6 | CHS | 1.56 | 54.2 | - | 155 | - | - | - |

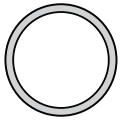
### Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C250L0: $f_y$ = 250 MPa and $f_u$ = 320 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
4. See Section 3.3 for details on cases of fire exposure considered.
5. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 3.2-2

# Circular Hollow Sections
# AS/NZS 1163 Grade C350L0

## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO ($m^2$/tonne)



| Designation | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | |
| mm | | mm | | kg/m | | | | | | |
| 508.0 | x | 12.7 | CHS | 155 | 10.3 | - | 11.3 | - | - | - |
| | | 9.5 | CHS | 117 | 13.7 | - | 15.0 | - | - | - |
| | | 6.4 | CHS | 79.2 | 20.2 | - | 22.1 | - | - | - |
| 457.0 | x | 12.7 | CHS | 139 | 10.3 | - | 11.4 | - | - | - |
| | | 9.5 | CHS | 105 | 13.7 | - | 15.2 | - | - | - |
| | | 6.4 | CHS | 71.1 | 20.2 | - | 22.4 | - | - | - |
| 406.4 | x | 12.7 | CHS | 123 | 10.4 | - | 11.6 | - | - | - |
| | | 9.5 | CHS | 93.0 | 13.7 | - | 15.4 | - | - | - |
| | | 9.4 | CHS | 63.1 | 20.2 | - | 22.7 | - | - | - |
| 355.6 | x | 12.7 | CHS | 107 | 10.4 | - | 11.9 | - | - | - |
| | | 9.5 | CHS | 81.1 | 13.8 | - | 15.7 | - | - | - |
| | | 6.4 | CHS | 55.1 | 20.3 | - | 23.1 | - | - | - |
| 323.9 | x | 12.7 | CHS | 97.5 | 10.4 | - | 12.1 | - | - | - |
| | | 9.5 | CHS | 73.7 | 13.8 | - | 15.9 | - | - | - |
| | | 6.4 | CHS | 50.1 | 20.3 | - | 23.4 | - | - | - |
| 273.1 | x | 12.7 | CHS | 81.6 | 10.5 | - | 12.4 | - | - | - |
| | | 9.3 | CHS | 60.5 | 14.2 | - | 16.8 | - | - | - |
| | | 6.4 | CHS | 42.1 | 20.4 | - | 24.1 | - | - | - |
| | | 4.8 | CHS | 31.8 | 27.0 | - | 32.0 | - | - | - |
| 219.1 | x | 8.2 | CHS | 42.6 | 16.1 | - | 19.8 | - | - | - |
| | | 6.4 | CHS | 33.6 | 20.5 | - | 25.2 | - | - | - |
| | | 4.8 | CHS | 25.4 | 27.1 | - | 33.3 | - | - | - |
| 168.3 | x | 7.1 | CHS | 28.2 | 18.7 | - | 24.3 | - | - | - |
| | | 6.4 | CHS | 25.6 | 20.7 | - | 26.8 | - | - | - |
| | | 4.8 | CHS | 19.4 | 27.3 | - | 35.4 | - | - | - |
| 165.1 | x | 3.5 | CHS | 13.9 | 37.2 | - | 48.4 | - | - | - |
| | | 3.0 | CHS | 12.0 | 43.2 | - | 56.3 | - | - | - |
| 139.7 | x | 3.5 | CHS | 11.8 | 37.3 | - | 50.7 | - | - | - |
| | | 3.0 | CHS | 10.1 | 43.4 | - | 58.9 | - | - | - |
| 114.3 | x | 3.6 | CHS | 9.83 | 36.5 | - | 52.5 | - | - | - |
| | | 3.2 | CHS | 8.77 | 41.0 | - | 58.9 | - | - | - |
| 101.6 | x | 3.2 | CHS | 7.77 | 41.1 | - | 61.3 | - | - | - |
| | | 2.6 | CHS | 6.35 | 50.3 | - | 75.0 | - | - | - |
| 88.9 | x | 3.2 | CHS | 6.76 | 41.3 | - | 64.5 | - | - | - |
| | | 2.6 | CHS | 5.53 | 50.5 | - | 78.9 | - | - | - |
| 76.1 | x | 3.2 | CHS | 5.75 | 41.6 | - | 68.9 | - | - | - |
| | | 2.3 | CHS | 4.19 | 57.1 | - | 94.6 | - | - | - |
| 60.3 | x | 2.9 | CHS | 4.11 | 46.1 | - | 84.4 | - | - | - |
| | | 2.3 | CHS | 3.29 | 57.6 | - | 105 | - | - | - |
| 48.3 | x | 2.9 | CHS | 3.25 | 46.7 | - | 95.1 | - | - | - |
| | | 2.3 | CHS | 2.61 | 58.2 | - | 118 | - | - | - |
| 42.4 | x | 2.6 | CHS | 2.55 | 52.2 | - | 114 | - | - | - |
| | | 2.0 | CHS | 1.99 | 66.8 | - | 146 | - | - | - |
| 33.7 | x | 2.6 | CHS | 1.99 | 53.1 | - | 132 | - | - | - |
| | | 2.0 | CHS | 1.56 | 67.7 | - | 168 | - | - | - |
| 26.9 | x | 2.3 | CHS | 1.40 | 60.6 | - | 173 | - | - | - |
| | | 2.0 | CHS | 1.23 | 68.8 | - | 197 | - | - | - |

### Notes:

1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. For Grade C350L0: $f_y$ = 350 MPa and $f_u$ = 430 MPa; $f_y$ = yield stress used in design; $f_u$ = tensile strength used in design; as defined in AS 4100.
3. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
4. See Section 3.3 for details on cases of fire exposure considered.

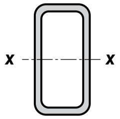
TABLE 3.2-3(1)

# Rectangular Hollow Sections To AS/NZS 1163

## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m²/tonne)

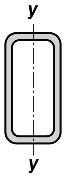
### *slab/wall parallel to x-axis*

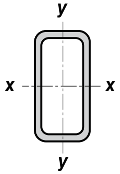
| Designation d | | b | | t | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | | | | | | |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8.27 | 8.70 | 9.94 | 6.91 | 6.84 | 7.46 |
| | | | | 12.5 | RHS | 128 | 10.5 | 10.9 | 12.5 | 8.65 | 8.58 | 9.36 |
| | | | | 10.0 | RHS | 104 | 13.0 | 13.5 | 15.4 | 10.6 | 10.6 | 11.5 |
| | | | | 8.0 | RHS | 84.2 | 16.2 | 16.6 | 19.0 | 13.1 | 13.1 | 14.3 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 8.33 | 8.84 | 10.3 | 7.45 | 7.36 | 8.10 |
| | | | | 12.5 | RHS | 109 | 10.6 | 11.0 | 12.9 | 9.29 | 9.21 | 10.1 |
| | | | | 10.0 | RHS | 88.4 | 13.1 | 13.6 | 15.8 | 11.4 | 11.3 | 12.4 |
| | | | | 8.0 | RHS | 71.6 | 16.3 | 16.8 | 19.5 | 14.0 | 14.0 | 15.4 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 8.33 | 8.84 | 10.3 | 7.08 | 7.00 | 7.73 |
| | | | | 12.5 | RHS | 109 | 10.6 | 11.0 | 12.9 | 8.83 | 8.75 | 9.67 |
| | | | | 10.0 | RHS | 88.4 | 13.1 | 13.6 | 15.8 | 10.8 | 10.8 | 11.9 |
| | | | | 8.0 | RHS | 71.6 | 16.3 | 16.8 | 19.5 | 13.3 | 13.3 | 14.7 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 8.42 | 9.04 | 10.8 | 7.33 | 7.23 | 8.13 |
| | | | | 12.5 | RHS | 89.0 | 10.6 | 11.2 | 13.5 | 9.09 | 8.99 | 10.1 |
| | | | | 10.0 | RHS | 72.7 | 13.2 | 13.8 | 16.5 | 11.1 | 11.0 | 12.4 |
| | | | | 8.0 | RHS | 59.1 | 16.3 | 16.9 | 20.3 | 13.6 | 13.5 | 15.2 |
| | | | | 6.0 | RHS | 45.0 | 21.7 | 22.2 | 26.7 | 17.9 | 17.8 | 20.0 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 8.55 | 9.35 | 11.7 | 7.73 | 7.60 | 8.77 |
| | | | | 12.5 | RHS | 69.4 | 10.8 | 11.5 | 14.4 | 9.50 | 9.37 | 10.8 |
| | | | | 10.0 | RHS | 57.0 | 13.3 | 14.0 | 17.6 | 11.5 | 11.4 | 13.2 |
| | | | | 9.0 | RHS | 51.8 | 14.7 | 15.4 | 19.3 | 12.7 | 12.5 | 14.5 |
| | | | | 8.0 | RHS | 46.5 | 16.5 | 17.2 | 21.5 | 14.1 | 14.0 | 16.1 |
| | | | | 6.0 | RHS | 35.6 | 21.8 | 22.5 | 28.1 | 18.4 | 18.3 | 21.1 |
| | | | | 5.0 | RHS | 29.9 | 26.0 | 26.7 | 33.4 | 21.8 | 21.7 | 25.0 |



### *slab/wall parallel to y-axis*

| Designation d | | b | | t | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | | | | | | |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8.27 | 8.70 | 9.94 | 6.29 | 6.21 | 6.84 |
| | | | | 12.5 | RHS | 128 | 10.5 | 10.9 | 12.5 | 7.87 | 7.80 | 8.58 |
| | | | | 10.0 | RHS | 104 | 13.0 | 13.5 | 15.4 | 9.68 | 9.61 | 10.6 |
| | | | | 8.0 | RHS | 84.2 | 16.2 | 16.6 | 19.0 | 11.9 | 11.9 | 13.1 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 8.33 | 8.84 | 10.3 | 5.98 | 5.89 | 6.63 |
| | | | | 12.5 | RHS | 109 | 10.6 | 11.0 | 12.9 | 7.45 | 7.36 | 8.28 |
| | | | | 10.0 | RHS | 88.4 | 13.1 | 13.6 | 15.8 | 9.13 | 9.05 | 10.2 |
| | | | | 8.0 | RHS | 71.6 | 16.3 | 16.8 | 19.5 | 11.2 | 11.2 | 12.6 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 8.33 | 8.84 | 10.3 | 6.34 | 6.26 | 7.00 |
| | | | | 12.5 | RHS | 109 | 10.6 | 11.0 | 12.9 | 7.91 | 7.82 | 8.75 |
| | | | | 10.0 | RHS | 88.4 | 13.1 | 13.6 | 15.8 | 9.70 | 9.62 | 10.8 |
| | | | | 8.0 | RHS | 71.6 | 16.3 | 16.8 | 19.5 | 11.9 | 11.9 | 13.3 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 8.42 | 9.04 | 10.8 | 6.43 | 6.33 | 7.23 |
| | | | | 12.5 | RHS | 89.0 | 10.6 | 11.2 | 13.5 | 7.96 | 7.86 | 8.99 |
| | | | | 10.0 | RHS | 72.7 | 13.2 | 13.8 | 16.5 | 9.73 | 9.63 | 11.0 |
| | | | | 8.0 | RHS | 59.1 | 16.3 | 16.9 | 20.3 | 11.9 | 11.9 | 13.5 |
| | | | | 6.0 | RHS | 45.0 | 21.7 | 22.2 | 26.7 | 15.7 | 15.6 | 17.8 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 8.55 | 9.35 | 11.7 | 6.56 | 6.43 | 7.60 |
| | | | | 12.5 | RHS | 69.4 | 10.8 | 11.5 | 14.4 | 8.05 | 7.93 | 9.37 |
| | | | | 10.0 | RHS | 57.0 | 13.3 | 14.0 | 17.6 | 9.78 | 9.66 | 11.4 |
| | | | | 9.0 | RHS | 51.8 | 14.7 | 15.4 | 19.3 | 10.7 | 10.6 | 12.5 |
| | | | | 8.0 | RHS | 46.5 | 16.5 | 17.2 | 21.5 | 11.9 | 11.8 | 14.0 |
| | | | | 6.0 | RHS | 35.6 | 21.8 | 22.5 | 28.1 | 15.6 | 15.5 | 18.3 |
| | | | | 5.0 | RHS | 29.9 | 26.0 | 26.7 | 33.4 | 18.5 | 18.4 | 21.7 |





## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.

TABLE 3.2-3(2)

# Rectangular Hollow Sections To AS/NZS 1163

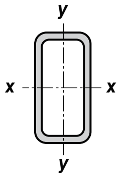
## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m²/tonne)

### *slab/wall parallel to x-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 13.5 | 14.5 | 19.4 | 12.3 | 12.1 | 14.5 |
| | | | | 9.0 | RHS | 37.7 | 14.9 | 15.9 | 21.2 | 13.4 | 13.3 | 15.9 |
| | | | | 8.0 | RHS | 33.9 | 16.7 | 17.7 | 23.6 | 14.9 | 14.7 | 17.7 |
| | | | | 6.0 | RHS | 26.2 | 22.0 | 22.9 | 30.6 | 19.3 | 19.1 | 22.9 |
| | | | | 5.0 | RHS | 22.1 | 26.2 | 27.2 | 36.2 | 22.8 | 22.6 | 27.2 |
| | | | | 4.0 | RHS | 17.9 | 32.5 | 33.5 | 44.7 | 28.1 | 27.9 | 33.5 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 22.2 | 23.5 | 33.9 | 19.8 | 19.6 | 24.8 |
| | | | | 5.0 | RHS | 16.4 | 26.4 | 27.7 | 39.9 | 23.3 | 23.1 | 29.2 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 13.7 | 15.0 | 20.9 | 12.2 | 12.0 | 15.0 |
| | | | | 9.0 | RHS | 30.6 | 15.1 | 16.3 | 22.9 | 13.3 | 13.1 | 16.3 |
| | | | | 8.0 | RHS | 27.7 | 16.8 | 18.1 | 25.3 | 14.7 | 14.5 | 18.1 |
| | | | | 6.0 | RHS | 21.4 | 22.1 | 23.3 | 32.6 | 18.8 | 18.6 | 23.3 |
| | | | | 5.0 | RHS | 18.2 | 26.3 | 27.5 | 38.5 | 22.2 | 22.0 | 27.5 |
| | | | | 4.0 | RHS | 14.8 | 32.7 | 33.9 | 47.4 | 27.3 | 27.1 | 33.9 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 22.4 | 23.9 | 35.8 | 21.2 | 20.9 | 26.9 |
| | | | | 5.0 | RHS | 14.2 | 26.6 | 28.1 | 42.1 | 24.8 | 24.6 | 31.6 |
| | | | | 4.0 | RHS | 11.6 | 32.9 | 34.4 | 51.6 | 30.3 | 30.1 | 38.7 |
| | | | | 3.0 | RHS | 8.96 | 43.5 | 44.7 | 67.0 | 39.3 | 39.1 | 50.2 |
| | | | | 2.5 | RHS | 7.53 | 52.0 | 53.1 | 79.7 | 46.7 | 46.5 | 59.8 |
| | | | | 2.0 | RHS | 6.07 | 64.7 | 65.9 | 98.8 | 57.8 | 57.6 | 74.1 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 22.5 | 24.3 | 37.9 | 21.1 | 20.8 | 27.6 |
| | | | | 5.0 | RHS | 12.5 | 26.7 | 28.4 | 44.4 | 24.7 | 24.4 | 32.4 |
| | | | | 3.5 | RHS | 9.07 | 37.6 | 39.3 | 61.3 | 33.9 | 33.6 | 44.7 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 22.4 | 23.9 | 35.8 | 19.7 | 19.4 | 25.4 |
| | | | | 5.0 | RHS | 14.2 | 26.6 | 28.1 | 42.1 | 23.1 | 22.8 | 29.8 |
| | | | | 4.0 | RHS | 11.6 | 32.9 | 34.4 | 51.6 | 28.2 | 28.0 | 36.6 |
| | | | | 3.0 | RHS | 8.96 | 43.5 | 44.7 | 67.0 | 36.5 | 36.3 | 47.5 |
| | | | | 2.5 | RHS | 7.53 | 52.0 | 53.1 | 79.7 | 43.4 | 43.2 | 56.5 |
| | | | | 2.0 | RHS | 6.07 | 64.7 | 65.9 | 98.8 | 53.7 | 53.5 | 70.0 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 22.5 | 24.3 | 37.9 | 19.4 | 19.1 | 25.9 |
| | | | | 5.0 | RHS | 12.5 | 26.7 | 28.4 | 44.4 | 22.7 | 22.4 | 30.4 |
| | | | | 3.5 | RHS | 9.07 | 37.6 | 39.3 | 61.3 | 31.2 | 30.9 | 41.9 |

### *slab/wall parallel to y-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 13.5 | 14.5 | 19.4 | 9.87 | 9.69 | 12.1 |
| | | | | 9.0 | RHS | 37.7 | 14.9 | 15.9 | 21.2 | 10.8 | 10.6 | 13.3 |
| | | | | 8.0 | RHS | 33.9 | 16.7 | 17.7 | 23.6 | 12.0 | 11.8 | 14.7 |
| | | | | 6.0 | RHS | 26.2 | 22.0 | 22.9 | 30.6 | 15.5 | 15.3 | 19.1 |
| | | | | 5.0 | RHS | 22.1 | 26.2 | 27.2 | 36.2 | 18.3 | 18.1 | 22.6 |
| | | | | 4.0 | RHS | 17.9 | 32.5 | 33.5 | 44.7 | 22.5 | 22.3 | 27.9 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 22.2 | 23.5 | 33.9 | 15.9 | 15.7 | 20.8 |
| | | | | 5.0 | RHS | 16.4 | 26.4 | 27.7 | 39.9 | 18.7 | 18.5 | 24.6 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 13.7 | 15.0 | 20.9 | 10.7 | 10.5 | 13.5 |
| | | | | 9.0 | RHS | 30.6 | 15.1 | 16.3 | 22.9 | 11.6 | 11.4 | 14.7 |
| | | | | 8.0 | RHS | 27.7 | 16.8 | 18.1 | 25.3 | 12.9 | 12.7 | 16.3 |
| | | | | 6.0 | RHS | 21.4 | 22.1 | 23.3 | 32.6 | 16.5 | 16.3 | 21.0 |
| | | | | 5.0 | RHS | 18.2 | 26.3 | 27.5 | 38.5 | 19.5 | 19.3 | 24.8 |
| | | | | 4.0 | RHS | 14.8 | 32.7 | 33.9 | 47.4 | 23.9 | 23.7 | 30.5 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 22.4 | 23.9 | 35.8 | 15.2 | 14.9 | 20.9 |
| | | | | 5.0 | RHS | 14.2 | 26.6 | 28.1 | 42.1 | 17.8 | 17.6 | 24.6 |
| | | | | 4.0 | RHS | 11.6 | 32.9 | 34.4 | 51.6 | 21.7 | 21.5 | 30.1 |
| | | | | 3.0 | RHS | 8.96 | 43.5 | 44.7 | 67.0 | 28.1 | 27.9 | 39.1 |
| | | | | 2.5 | RHS | 7.53 | 52.0 | 53.1 | 79.7 | 33.4 | 33.2 | 46.5 |
| | | | | 2.0 | RHS | 6.07 | 64.7 | 65.9 | 98.8 | 41.3 | 41.2 | 57.6 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 22.5 | 24.3 | 37.9 | 15.9 | 15.6 | 22.4 |
| | | | | 5.0 | RHS | 12.5 | 26.7 | 28.4 | 44.4 | 18.6 | 18.3 | 26.3 |
| | | | | 3.5 | RHS | 9.07 | 37.6 | 39.3 | 61.3 | 25.5 | 25.3 | 36.3 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 22.4 | 23.9 | 35.8 | 16.7 | 16.4 | 22.4 |
| | | | | 5.0 | RHS | 14.2 | 26.6 | 28.1 | 42.1 | 19.6 | 19.3 | 26.3 |
| | | | | 4.0 | RHS | 11.6 | 32.9 | 34.4 | 51.6 | 23.9 | 23.7 | 32.3 |
| | | | | 3.0 | RHS | 8.96 | 43.5 | 44.7 | 67.0 | 30.9 | 30.7 | 41.9 |
| | | | | 2.5 | RHS | 7.53 | 52.0 | 53.1 | 79.7 | 36.7 | 36.5 | 49.8 |
| | | | | 2.0 | RHS | 6.07 | 64.7 | 65.9 | 98.8 | 45.5 | 45.3 | 61.7 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 22.5 | 24.3 | 37.9 | 17.6 | 17.3 | 24.1 |
| | | | | 5.0 | RHS | 12.5 | 26.7 | 28.4 | 44.4 | 20.6 | 20.3 | 28.3 |
| | | | | 3.5 | RHS | 9.07 | 37.6 | 39.3 | 61.3 | 28.3 | 28.0 | 39.0 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.

TABLE 3.2-3(3)

# Rectangular Hollow Sections To AS/NZS 1163

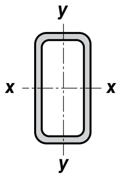
## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m²/tonne)

### *slab/wall parallel to x-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 22.8 | 24.9 | 41.6 | 21.1 | 20.8 | 29.1 |
| | | | | 5.0 | RHS | 10.3 | 27.0 | 29.1 | 48.5 | 24.6 | 24.2 | 33.9 |
| | | | | 4.0 | RHS | 8.49 | 33.3 | 35.4 | 58.9 | 29.8 | 29.5 | 41.2 |
| | | | | 3.5 | RHS | 7.53 | 37.9 | 39.9 | 66.4 | 33.5 | 33.2 | 46.5 |
| | | | | 3.0 | RHS | 6.60 | 43.9 | 45.5 | 75.8 | 38.1 | 37.9 | 53.0 |
| | | | | 2.5 | RHS | 5.56 | 52.4 | 53.9 | 89.8 | 45.2 | 44.9 | 62.9 |
| | | | | 2.0 | RHS | 4.50 | 65.1 | 66.6 | 111 | 55.8 | 55.5 | 77.7 |
| | | | | 1.6 | RHS | 3.64 | 81.0 | 82.5 | 138 | 69.0 | 68.8 | 96.3 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 33.9 | 36.6 | 68.7 | 31.0 | 30.5 | 46.6 |
| | | | | 3.0 | RHS | 4.90 | 44.4 | 46.5 | 87.3 | 39.1 | 38.7 | 59.1 |
| | | | | 2.5 | RHS | 4.15 | 52.8 | 54.9 | 103 | 46.1 | 45.8 | 69.8 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 23.2 | 25.8 | 46.5 | 21.1 | 20.7 | 31.0 |
| | | | | 5.0 | RHS | 8.35 | 27.4 | 29.9 | 53.9 | 24.4 | 23.9 | 35.9 |
| | | | | 4.0 | RHS | 6.92 | 33.7 | 36.1 | 65.1 | 29.3 | 28.9 | 43.4 |
| | | | | 3.0 | RHS | 5.42 | 44.2 | 46.1 | 83.0 | 37.2 | 36.9 | 55.3 |
| | | | | 2.5 | RHS | 4.58 | 52.7 | 54.5 | 98.2 | 43.9 | 43.6 | 65.4 |
| | | | | 2.0 | RHS | 3.72 | 65.4 | 67.2 | 121 | 54.1 | 53.8 | 80.7 |
| | | | | 1.6 | RHS | 3.01 | 81.3 | 83.1 | 150 | 66.8 | 66.5 | 99.7 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 53.1 | 55.5 | 111 | 49.0 | 48.6 | 76.3 |
| | | | | 2.0 | RHS | 2.93 | 65.8 | 68.2 | 136 | 60.0 | 59.7 | 93.7 |
| | | | | 1.6 | RHS | 2.38 | 81.7 | 84.0 | 168 | 73.9 | 73.5 | 116 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 34.2 | 37.4 | 74.8 | 31.4 | 30.9 | 49.6 |
| | | | | 3.0 | RHS | 4.25 | 44.7 | 47.1 | 94.2 | 39.3 | 38.9 | 62.4 |
| | | | | 2.5 | RHS | 3.60 | 53.1 | 55.5 | 111 | 46.2 | 45.8 | 73.6 |
| | | | | 2.0 | RHS | 2.93 | 65.8 | 68.2 | 136 | 56.6 | 56.2 | 90.3 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 45.5 | 48.9 | 114 | 41.3 | 40.7 | 73.3 |
| | | | | 2.5 | RHS | 2.62 | 54.0 | 57.2 | 134 | 48.2 | 47.7 | 85.8 |
| | | | | 2.0 | RHS | 2.15 | 66.6 | 69.8 | 163 | 58.7 | 58.2 | 105 |
| | | | | 1.6 | RHS | 1.75 | 82.5 | 85.6 | 200 | 71.9 | 71.4 | 128 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 45.8 | 49.4 | 120 | 43.0 | 42.4 | 77.7 |
| | | | | 2.5 | RHS | 2.42 | 54.2 | 57.7 | 140 | 50.1 | 49.5 | 90.7 |
| | | | | 2.0 | RHS | 1.99 | 66.8 | 70.3 | 171 | 60.8 | 60.3 | 110 |
| | | | | 1.6 | RHS | 1.63 | 82.7 | 86.1 | 209 | 74.3 | 73.8 | 135 |

### *slab/wall parallel to y-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 22.8 | 24.9 | 41.6 | 17.0 | 16.6 | 24.9 |
| | | | | 5.0 | RHS | 10.3 | 27.0 | 29.1 | 48.5 | 19.7 | 19.4 | 29.1 |
| | | | | 4.0 | RHS | 8.49 | 33.3 | 35.4 | 58.9 | 23.9 | 23.6 | 35.4 |
| | | | | 3.5 | RHS | 7.53 | 37.9 | 39.9 | 66.4 | 26.9 | 26.6 | 39.9 |
| | | | | 3.0 | RHS | 6.60 | 43.9 | 45.5 | 75.8 | 30.6 | 30.3 | 45.5 |
| | | | | 2.5 | RHS | 5.56 | 52.4 | 53.9 | 89.8 | 36.2 | 35.9 | 53.9 |
| | | | | 2.0 | RHS | 4.50 | 65.1 | 66.6 | 111 | 44.7 | 44.4 | 66.6 |
| | | | | 1.6 | RHS | 3.64 | 81.0 | 82.5 | 138 | 55.3 | 55.0 | 82.5 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 33.9 | 36.6 | 68.7 | 24.9 | 24.4 | 40.5 |
| | | | | 3.0 | RHS | 4.90 | 44.4 | 46.5 | 87.3 | 31.3 | 31.0 | 51.4 |
| | | | | 2.5 | RHS | 4.15 | 52.8 | 54.9 | 103 | 37.0 | 36.6 | 60.7 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 23.2 | 25.8 | 46.5 | 18.5 | 18.1 | 28.4 |
| | | | | 5.0 | RHS | 8.35 | 27.4 | 29.9 | 53.9 | 21.4 | 20.9 | 32.9 |
| | | | | 4.0 | RHS | 6.92 | 33.7 | 36.1 | 65.1 | 25.7 | 25.3 | 39.8 |
| | | | | 3.0 | RHS | 5.42 | 44.2 | 46.1 | 83.0 | 32.6 | 32.3 | 50.7 |
| | | | | 2.5 | RHS | 4.58 | 52.7 | 54.5 | 98.2 | 38.5 | 38.2 | 60.0 |
| | | | | 2.0 | RHS | 3.72 | 65.4 | 67.2 | 121 | 47.4 | 47.1 | 74.0 |
| | | | | 1.6 | RHS | 3.01 | 81.3 | 83.1 | 150 | 58.5 | 58.2 | 91.4 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 53.1 | 55.5 | 111 | 35.1 | 34.7 | 62.5 |
| | | | | 2.0 | RHS | 2.93 | 65.8 | 68.2 | 136 | 43.0 | 42.6 | 76.7 |
| | | | | 1.6 | RHS | 2.38 | 81.7 | 84.0 | 168 | 52.9 | 52.5 | 94.5 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 34.2 | 37.4 | 74.8 | 25.8 | 25.3 | 44.0 |
| | | | | 3.0 | RHS | 4.25 | 44.7 | 47.1 | 94.2 | 32.2 | 31.8 | 55.4 |
| | | | | 2.5 | RHS | 3.60 | 53.1 | 55.5 | 111 | 37.9 | 37.5 | 65.2 |
| | | | | 2.0 | RHS | 2.93 | 65.8 | 68.2 | 136 | 46.4 | 46.0 | 80.1 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 45.5 | 48.9 | 114 | 33.1 | 32.6 | 65.2 |
| | | | | 2.5 | RHS | 2.62 | 54.0 | 57.2 | 134 | 38.7 | 38.2 | 76.3 |
| | | | | 2.0 | RHS | 2.15 | 66.6 | 69.8 | 163 | 47.1 | 46.5 | 93.1 |
| | | | | 1.6 | RHS | 1.75 | 82.5 | 85.6 | 200 | 57.6 | 57.1 | 114 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 45.8 | 49.4 | 120 | 32.4 | 31.8 | 67.1 |
| | | | | 2.5 | RHS | 2.42 | 54.2 | 57.7 | 140 | 37.7 | 37.1 | 78.4 |
| | | | | 2.0 | RHS | 1.99 | 66.8 | 70.3 | 171 | 45.8 | 45.2 | 95.4 |
| | | | | 1.6 | RHS | 1.63 | 82.7 | 86.1 | 209 | 55.9 | 55.3 | 117 |



**Notes:**

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.

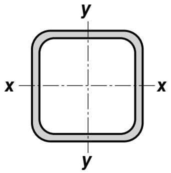
TABLE 3.2-4(1)

# Square Hollow Sections<br>To AS/NZS 1163

## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m$^2$/tonne)

### *slab/wall parallel to x- or y-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 8.23 | 8.60 | 9.68 | 6.51 | 6.45 | 6.99 |
| | | | | 12.5 | SHS | 148 | 10.5 | 10.8 | 12.2 | 8.17 | 8.11 | 8.79 |
| | | | | 10.0 | SHS | 120 | 13.0 | 13.4 | 15.0 | 10.1 | 10.0 | 10.9 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 8.27 | 8.70 | 9.94 | 6.60 | 6.53 | 7.15 |
| | | | | 12.5 | SHS | 128 | 10.5 | 10.9 | 12.5 | 8.26 | 8.19 | 8.97 |
| | | | | 10.0 | SHS | 104 | 13.0 | 13.5 | 15.4 | 10.2 | 10.1 | 11.1 |
| | | | | 8.0 | SHS | 84.2 | 16.2 | 16.6 | 19.0 | 12.5 | 12.5 | 13.7 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 8.33 | 8.84 | 10.3 | 6.71 | 6.63 | 7.36 |
| | | | | 12.5 | SHS | 109 | 10.6 | 11.0 | 12.9 | 8.37 | 8.28 | 9.21 |
| | | | | 10.0 | SHS | 88.4 | 13.1 | 13.6 | 15.8 | 10.3 | 10.2 | 11.3 |
| | | | | 8.0 | SHS | 71.6 | 16.3 | 16.8 | 19.5 | 12.6 | 12.6 | 14.0 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 8.42 | 9.04 | 10.8 | 6.88 | 6.78 | 7.68 |
| | | | | 12.5 | SHS | 89.0 | 10.6 | 11.2 | 13.5 | 8.53 | 8.43 | 9.55 |
| | | | | 10.0 | SHS | 72.7 | 13.2 | 13.8 | 16.5 | 10.4 | 10.3 | 11.7 |
| | | | | 9.0 | SHS | 65.9 | 14.6 | 15.2 | 18.2 | 11.5 | 11.4 | 12.9 |
| | | | | 8.0 | SHS | 59.1 | 16.3 | 16.9 | 20.3 | 12.8 | 12.7 | 14.4 |
| | | | | 6.0 | SHS | 45.0 | 21.7 | 22.2 | 26.7 | 16.8 | 16.7 | 18.9 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 8.55 | 9.35 | 11.7 | 7.15 | 7.01 | 8.18 |
| | | | | 12.5 | SHS | 69.4 | 10.8 | 11.5 | 14.4 | 8.78 | 8.65 | 10.1 |
| | | | | 10.0 | SHS | 57.0 | 13.3 | 14.0 | 17.6 | 10.7 | 10.5 | 12.3 |
| | | | | 9.0 | SHS | 51.8 | 14.7 | 15.4 | 19.3 | 11.7 | 11.6 | 13.5 |
| | | | | 8.0 | SHS | 46.5 | 16.5 | 17.2 | 21.5 | 13.0 | 12.9 | 15.1 |
| | | | | 6.0 | SHS | 35.6 | 21.8 | 22.5 | 28.1 | 17.0 | 16.9 | 19.7 |
| | | | | 5.0 | SHS | 29.9 | 26.0 | 26.7 | 33.4 | 20.2 | 20.0 | 23.4 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 13.5 | 14.5 | 19.4 | 11.1 | 10.9 | 13.3 |
| | | | | 9.0 | SHS | 37.7 | 14.9 | 15.9 | 21.2 | 12.1 | 11.9 | 14.6 |
| | | | | 8.0 | SHS | 33.9 | 16.7 | 17.7 | 23.6 | 13.4 | 13.3 | 16.2 |
| | | | | 6.0 | SHS | 26.2 | 22.0 | 22.9 | 30.6 | 17.4 | 17.2 | 21.0 |
| | | | | 5.0 | SHS | 22.1 | 26.2 | 27.2 | 36.2 | 20.5 | 20.4 | 24.9 |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 13.7 | 15.0 | 20.9 | 11.4 | 11.2 | 14.2 |
| | | | | 9.0 | SHS | 30.6 | 15.1 | 16.3 | 22.9 | 12.5 | 12.3 | 15.5 |
| | | | | 8.0 | SHS | 27.7 | 16.8 | 18.1 | 25.3 | 13.8 | 13.6 | 17.2 |
| | | | | 6.0 | SHS | 21.4 | 22.1 | 23.3 | 32.6 | 17.7 | 17.5 | 22.1 |
| | | | | 5.0 | SHS | 18.2 | 26.3 | 27.5 | 38.5 | 20.8 | 20.6 | 26.1 |
| | | | | 4.0 | SHS | 14.8 | 32.7 | 33.9 | 47.4 | 25.6 | 25.4 | 32.2 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 14.0 | 15.6 | 23.5 | 12.0 | 11.7 | 15.6 |
| | | | | 9.0 | SHS | 23.5 | 15.4 | 17.0 | 25.5 | 13.0 | 12.7 | 17.0 |
| | | | | 8.0 | SHS | 21.4 | 17.1 | 18.7 | 28.1 | 14.3 | 14.0 | 18.7 |
| | | | | 6.0 | SHS | 16.7 | 22.4 | 23.9 | 35.8 | 18.2 | 17.9 | 23.9 |
| | | | | 5.0 | SHS | 14.2 | 26.6 | 28.1 | 42.1 | 21.3 | 21.1 | 28.1 |
| | | | | 4.0 | SHS | 11.6 | 32.9 | 34.4 | 51.6 | 26.0 | 25.8 | 34.4 |
| | | | | 3.0 | SHS | 8.96 | 43.5 | 44.7 | 67.0 | 33.7 | 33.5 | 44.7 |
| | | | | 2.5 | SHS | 7.53 | 52.0 | 53.1 | 79.7 | 40.0 | 39.9 | 53.1 |
| | | | | 2.0 | SHS | 6.07 | 64.7 | 65.9 | 98.8 | 49.6 | 49.4 | 65.9 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 52.1 | 53.4 | 83.1 | 40.3 | 40.0 | 54.9 |
| | | | | 2.0 | SHS | 5.45 | 64.8 | 66.1 | 103 | 49.8 | 49.6 | 67.9 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 22.5 | 24.3 | 37.9 | 18.5 | 18.2 | 25.0 |
| | | | | 5.0 | SHS | 12.5 | 26.7 | 28.4 | 44.4 | 21.6 | 21.3 | 29.3 |
| | | | | 3.5 | SHS | 9.07 | 37.6 | 39.3 | 61.3 | 29.7 | 29.4 | 40.5 |
| | | | | 2.0 | SHS | 5.38 | 64.9 | 66.1 | 103 | 49.8 | 49.6 | 68.2 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 22.8 | 24.9 | 41.6 | 19.1 | 18.7 | 27.0 |
| | | | | 5.0 | SHS | 10.3 | 27.0 | 29.1 | 48.5 | 22.2 | 21.8 | 31.5 |
| | | | | 4.0 | SHS | 8.49 | 33.3 | 35.4 | 58.9 | 26.8 | 26.5 | 38.3 |
| | | | | 3.5 | SHS | 7.53 | 37.9 | 39.9 | 66.4 | 30.2 | 29.9 | 43.2 |
| | | | | 3.0 | SHS | 6.60 | 43.9 | 45.5 | 75.8 | 34.3 | 34.1 | 49.2 |
| | | | | 2.5 | SHS | 5.56 | 52.4 | 53.9 | 89.8 | 40.7 | 40.4 | 58.4 |
| | | | | 2.0 | SHS | 4.50 | 65.1 | 66.6 | 111 | 50.2 | 50.0 | 72.2 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 23.1 | 25.6 | 45.3 | 19.6 | 19.2 | 29.1 |
| | | | | 5.0 | SHS | 8.75 | 27.3 | 29.7 | 52.6 | 22.7 | 22.3 | 33.7 |
| | | | | 4.0 | SHS | 7.23 | 33.6 | 36.0 | 63.6 | 27.4 | 27.0 | 40.8 |
| | | | | 3.0 | SHS | 5.66 | 44.1 | 45.9 | 81.3 | 34.8 | 34.5 | 52.1 |
| | | | | 2.5 | SHS | 4.78 | 52.6 | 54.4 | 96.2 | 41.1 | 40.8 | 61.7 |
| | | | | 2.0 | SHS | 3.88 | 65.3 | 67.1 | 119 | 50.6 | 50.3 | 76.1 |
| | | | | 1.6 | SHS | 3.13 | 81.2 | 83.0 | 147 | 62.5 | 62.2 | 94.1 |



## Notes:

1. ***REFER** to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE** (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.*
2. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-5 and 3.1-6 for Grade allocation of these hollow sections.

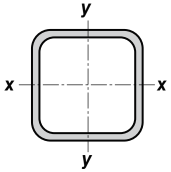
TABLE 3.2-4(2)

# Square Hollow Sections To AS/NZS 1163

## FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m$^2$/tonne)

### *slab/wall parallel to x- or y-axis*

| Designation | | | | | | Mass per m | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | |
| mm | | mm | | mm | | kg/m | | | | | | |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 23.8 | 27.3 | 54.7 | 21.1 | 20.5 | 34.2 |
| | | | | 5.0 | SHS | 6.39 | 27.9 | 31.3 | 62.6 | 24.0 | 23.5 | 39.1 |
| | | | | 4.0 | SHS | 5.35 | 34.2 | 37.4 | 74.8 | 28.6 | 28.1 | 46.8 |
| | | | | 3.0 | SHS | 4.25 | 44.7 | 47.1 | 94.2 | 35.7 | 35.3 | 58.9 |
| | | | | 2.5 | SHS | 3.60 | 53.1 | 55.5 | 111 | 42.0 | 41.6 | 69.4 |
| | | | | 2.0 | SHS | 2.93 | 65.8 | 68.2 | 136 | 51.5 | 51.1 | 85.2 |
| | | | | 1.6 | SHS | 2.38 | 81.7 | 84.0 | 168 | 63.4 | 63.0 | 105 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 34.9 | 39.1 | 88.0 | 30.0 | 29.3 | 53.8 |
| | | | | 3.0 | SHS | 3.30 | 45.3 | 48.4 | 109 | 36.8 | 36.3 | 66.6 |
| | | | | 2.5 | SHS | 2.82 | 53.7 | 56.8 | 128 | 43.1 | 42.6 | 78.1 |
| | | | | 2.0 | SHS | 2.31 | 66.4 | 69.4 | 156 | 52.5 | 52.0 | 95.4 |
| | | | | 1.6 | SHS | 1.88 | 82.3 | 85.2 | 192 | 64.4 | 63.9 | 117 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 45.8 | 49.4 | 120 | 37.7 | 37.1 | 72.4 |
| | | | | 2.5 | SHS | 2.42 | 54.2 | 57.7 | 140 | 43.9 | 43.3 | 84.5 |
| | | | | 2.0 | SHS | 1.99 | 66.8 | 70.3 | 171 | 53.3 | 52.7 | 103 |
| | | | | 1.6 | SHS | 1.63 | 82.7 | 86.1 | 209 | 65.1 | 64.6 | 126 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 46.5 | 50.8 | 136 | 38.8 | 38.1 | 80.5 |
| | | | | 2.5 | SHS | 2.03 | 54.8 | 59.0 | 157 | 45.0 | 44.3 | 93.5 |
| | | | | 2.0 | SHS | 1.68 | 67.4 | 71.5 | 191 | 54.3 | 53.7 | 113 |
| | | | | 1.6 | SHS | 1.38 | 83.3 | 87.3 | 233 | 66.1 | 65.5 | 138 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 47.4 | 52.9 | 159 | 40.6 | 39.7 | 92.6 |
| | | | | 2.5 | SHS | 1.64 | 55.7 | 61.0 | 183 | 46.6 | 45.7 | 107 |
| | | | | 2.0 | SHS | 1.36 | 68.3 | 73.3 | 220 | 55.8 | 55.0 | 128 |
| | | | | 1.6 | SHS | 1.12 | 84.1 | 89.0 | 267 | 67.5 | 66.7 | 156 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 69.7 | 76.2 | 267 | 58.2 | 57.2 | 152 |
| | | | | 1.6 | SHS | 0.873 | 85.4 | 91.7 | 321 | 69.8 | 68.8 | 183 |



**Notes:**

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. 1 = Total Perimeter, Profile-protected
   2 = Total Perimeter, Box-protected, No Gap
   3 = Total Perimeter, Box-protected, 25 mm Gap
   4 = Top Flange Excluded, Profile-protected
   5 = Top Flange Excluded, Box-protected, No Gap
   6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-5 and 3.1-6 for Grade allocation of these hollow sections.

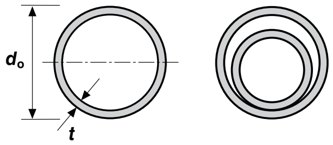
TABLE 3.3-1

# Circular Hollow Sections to AS/NZS 1163

## TELESCOPING INFORMATION

| Female (outer) | | | | Male (inner) | Nominal Clearance |
|---|---|---|---|---|---|
| $d_o$ | | t | | $d_o$ | |
| mm | | mm | | mm | mm |
| 508.0 | x | 12.7 | CHS | 457.0 | 16.0 |
| | | 9.5 | CHS | 457.0 | 22.4 |
| | | 6.4 | CHS | 457.0 | 28.6 |
| 457.0 | x | 12.7 | CHS | 406.4 | 16.6 |
| | | 9.5 | CHS | 406.4 | 23.0 |
| | | 6.4 | CHS | 406.4 | 29.2 |
| 406.4 | x | 12.7 | CHS | 355.6 | 17.8 |
| | | 9.5 | CHS | 355.6 | 24.2 |
| | | 6.4 | CHS | 355.6 | 30.4 |
| 355.6 | x | 12.7 | CHS | 273.1 | 50.8 |
| | | 9.5 | CHS | 323.9 | 5.9 |
| | | 6.4 | CHS | 323.9 | 12.1 |
| 323.9 | x | 12.7 | CHS | 273.1 | 19.4 |
| | | 9.5 | CHS | 273.1 | 25.8 |
| | | 6.4 | CHS | 273.1 | 32.0 |
| 273.1 | x | 12.7 | CHS | 219.1 | 23.7 |
| | | 9.3 | CHS | 219.1 | 30.5 |
| | | 6.4 | CHS | 219.1 | 36.3 |
| | | 4.8 | CHS | 219.1 | 39.5 |
| 219.1 | x | 8.2 | CHS | 168.3 | 30.5 |
| | | 6.4 | CHS | 168.3 | 34.1 |
| | | 4.8 | CHS | 168.3 | 37.3 |
| 168.3 | x | 7.1 | CHS | 139.7 | 11.3 |
| | | 6.4 | CHS | 139.7 | 12.7 |
| | | 4.8 | CHS | 139.7 | 15.9 |
| 165.1 | x | 5.4 | CHS | 139.7 | 11.6 |
| | | 5.0 | CHS | 139.7 | 12.4 |
| | | 3.5 | CHS | 139.7 | 15.4 |
| | | 3.0 | CHS | 139.7 | 16.4 |
| 139.7 | x | 5.4 | CHS | 114.3 | 12.1 |
| | | 5.0 | CHS | 114.3 | 12.9 |
| | | 3.5 | CHS | 114.3 | 15.9 |
| | | 3.0 | CHS | 114.3 | 16.9 |
| 114.3 | x | 5.4 | CHS | 88.9 | 12.6 |
| | | 4.5 | CHS | 101.6 | **1.5** |
| | | 3.6 | CHS | 101.6 | 3.3 |
| | | 3.2 | CHS | 101.6 | 4.1 |

| Female (outer) | | | | Male (inner) | Nominal Clearance |
|---|---|---|---|---|---|
| $d_o$ | | t | | $d_o$ | |
| mm | | mm | | mm | mm |
| 101.6 | x | 5.0 | CHS | 88.9 | **0.8** |
| | | 4.0 | CHS | 88.9 | 2.8 |
| | | 3.2 | CHS | 88.9 | 4.4 |
| | | 2.6 | CHS | 88.9 | 5.6 |
| 88.9 | x | 5.9 | CHS | 60.3 | 15.3 |
| | | 5.0 | CHS | 76.1 | **1.2** |
| | | 4.0 | CHS | 76.1 | 3.2 |
| | | 3.2 | CHS | 76.1 | 4.8 |
| | | 2.6 | CHS | 76.1 | 6.0 |
| 76.1 | x | 5.9 | CHS | 60.3 | 2.6 |
| | | 4.5 | CHS | 60.3 | 5.4 |
| | | 3.6 | CHS | 60.3 | 7.2 |
| | | 3.2 | CHS | 60.3 | 8.0 |
| | | 2.3 | CHS | 60.3 | 9.8 |
| 60.3 | x | 5.4 | CHS | 48.3 | **0.2** |
| | | 4.5 | CHS | 48.3 | **2.0** |
| | | 3.6 | CHS | 48.3 | 3.8 |
| | | 2.9 | CHS | 48.3 | 5.2 |
| | | 2.3 | CHS | 48.3 | 6.4 |
| 48.3 | x | 4.0 | CHS | 33.7 | 5.4 |
| | | 3.2 | CHS | 33.7 | 7.0 |
| | | 2.9 | CHS | 33.7 | 7.6 |
| | | 2.3 | CHS | 42.4 | **0.1** |
| 42.4 | x | 4.0 | CHS | 26.9 | 6.3 |
| | | 3.2 | CHS | 33.7 | **1.1** |
| | | 2.6 | CHS | 33.7 | 2.3 |
| | | 2.0 | CHS | 33.7 | 3.5 |
| 33.7 | x | 4.0 | CHS | n/a | n/a |
| | | 3.2 | CHS | n/a | n/a |
| | | 2.6 | CHS | 26.9 | **0.4** |
| | | 2.0 | CHS | 26.9 | **1.6** |
| 26.9 | x | 4.0 | CHS | n/a | n/a |
| | | 3.2 | CHS | n/a | n/a |
| | | 2.6 | CHS | n/a | n/a |
| | | 2.3 | CHS | n/a | n/a |
| | | 2.0 | CHS | n/a | n/a |



## How to use this chart:

A. Select the size of Female (or Outer) member closest to your requirements from the left hand column.

B. The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.

C. Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.

Note that the clearance is the total available difference between member dimensions, not the gap on both sides.

D. Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.

E. Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used, consideration of both clearance and thickness within the size list available may be required.

F. Pipe may need to be fixed against twisting by welding or bolting.

G. Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Clearance = (AS/NZS 1163 Min. $d_o - 2t$) – (AS/NZS 1163 Max. $d_o$).
3. CHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Internal weld bead may need to be considered when a closer fit is required.
4. Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
5. For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.

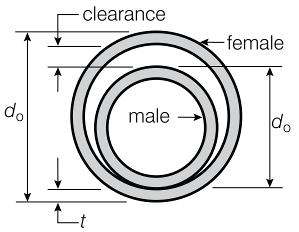


TABLE 3.3-2

# Rectangular Hollow Sections to AS/NZS 1163

## TELESCOPING INFORMATION

| Female (outer) | | | | | | Male (inner) | | Nominal Clearance | |
|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | d | b | top | side |
| mm | | mm | | mm | | mm | mm | mm | mm |
| 400 | x | 300 | x | 16.0 | RHS | 350 | 250 | 18.0 | 18.0 |
| | | | | 12.5 | RHS | 350 | 250 | 25.0 | 25.0 |
| | | | | 10.0 | RHS | 350 | 250 | 30.0 | 30.0 |
| | | | | 8.0 | RHS | 350 | 250 | 34.0 | 34.0 |
| 400 | x | 200 | x | 16.0 | RHS | 250 | 150 | 118.0 | 18.0 |
| | | | | 12.5 | RHS | 250 | 150 | 125.0 | 25.0 |
| | | | | 10.0 | RHS | 250 | 150 | 130.0 | 30.0 |
| | | | | 8.0 | RHS | 250 | 150 | 134.0 | 34.0 |
| 350 | x | 250 | x | 16.0 | RHS | 300 | 200 | 18.0 | 18.0 |
| | | | | 12.5 | RHS | 300 | 200 | 25.0 | 25.0 |
| | | | | 10.0 | RHS | 300 | 200 | 30.0 | 30.0 |
| | | | | 8.0 | RHS | 300 | 200 | 34.0 | 34.0 |
| 300 | x | 200 | x | 16.0 | RHS | 250 | 150 | 18.0 | 18.0 |
| | | | | 12.5 | RHS | 250 | 150 | 25.0 | 25.0 |
| | | | | 10.0 | RHS | 250 | 150 | 30.0 | 30.0 |
| | | | | 8.0 | RHS | 250 | 150 | 34.0 | 34.0 |
| | | | | 6.0 | RHS | 250 | 150 | 38.0 | 38.0 |
| 250 | x | 150 | x | 16.0 | RHS | 200 | 100 | 18.0 | 18.0 |
| | | | | 12.5 | RHS | 200 | 100 | 25.0 | 25.0 |
| | | | | 10.0 | RHS | 200 | 100 | 30.0 | 30.0 |
| | | | | 9.0 | RHS | 200 | 100 | 32.0 | 32.0 |
| | | | | 8.0 | RHS | 200 | 100 | 34.0 | 34.0 |
| | | | | 6.0 | RHS | 200 | 100 | 38.0 | 38.0 |
| | | | | 5.0 | RHS | 200 | 100 | 40.0 | 40.0 |
| 200 | x | 100 | x | 10.0 | RHS | 152 | 76 | 28.0 | 4.0 |
| | | | | 9.0 | RHS | 152 | 76 | 30.0 | 6.0 |
| | | | | 8.0 | RHS | 152 | 76 | 32.0 | 8.0 |
| | | | | 6.0 | RHS | 152 | 76 | 36.0 | 12.0 |
| | | | | 5.0 | RHS | 152 | 76 | 38.0 | 14.0 |
| | | | | 4.0 | RHS | 152 | 76 | 40.0 | 16.0 |
| 152 | x | 76 | x | 6.0 | RHS | 127 | 51 | 13.0 | 13.0 |
| | | | | 5.0 | RHS | 127 | 51 | 15.0 | 15.0 |
| 150 | x | 100 | x | 10.0 | RHS | 127 | 51 | 3.0 | 29.0 |
| | | | | 9.0 | RHS | 127 | 51 | 5.0 | 31.0 |
| | | | | 8.0 | RHS | 127 | 51 | 7.0 | 33.0 |
| | | | | 6.0 | RHS | 127 | 51 | 11.0 | 37.0 |
| | | | | 5.0 | RHS | 127 | 51 | 13.0 | 39.0 |
| | | | | 4.0 | RHS | 127 | 51 | 15.0 | 41.0 |
| 150 | x | 50 | x | 6.0 | RHS | 76 | 38 | 62.0 | **0.0** |
| | | | | 5.0 | RHS | 76 | 38 | 64.0 | 2.0 |
| | | | | 4.0 | RHS | 76 | 38 | 66.0 | 4.0 |
| | | | | 3.0 | RHS | 76 | 38 | 68.0 | 6.0 |
| | | | | 2.5 | RHS | 76 | 38 | 69.0 | 7.0 |
| | | | | 2.0 | RHS | 76 | 38 | 70.0 | 8.0 |
| 127 | x | 51 | x | 6.0 | RHS | 76 | 38 | 39.0 | **1.0** |
| | | | | 5.0 | RHS | 76 | 38 | 41.0 | 3.0 |
| | | | | 3.5 | RHS | 76 | 38 | 44.0 | 6.0 |
| 125 | x | 75 | x | 6.0 | RHS | 100 | 50 | 13.0 | 13.0 |
| | | | | 5.0 | RHS | 100 | 50 | 15.0 | 15.0 |
| | | | | 4.0 | RHS | 100 | 50 | 17.0 | 17.0 |
| | | | | 3.0 | RHS | 100 | 50 | 19.0 | 19.0 |
| | | | | 2.5 | RHS | 100 | 50 | 20.0 | 20.0 |
| | | | | 2.0 | RHS | 100 | 50 | 21.0 | 21.0 |
| 102 | x | 76 | x | 6.0 | RHS | 76 | 38 | 14.0 | 26.0 |
| | | | | 5.0 | RHS | 76 | 38 | 16.0 | 28.0 |
| | | | | 3.5 | RHS | 76 | 38 | 19.0 | 31.0 |
| 100 | x | 50 | x | 6.0 | RHS | 76 | 38 | 12.0 | **0.0** |
| | | | | 5.0 | RHS | 76 | 38 | 14.0 | 2.0 |
| | | | | 4.0 | RHS | 76 | 38 | 16.0 | 4.0 |
| | | | | 3.5 | RHS | 76 | 38 | 17.0 | 5.0 |
| | | | | 3.0 | RHS | 76 | 38 | 18.0 | 6.0 |
| | | | | 2.5 | RHS | 76 | 38 | 19.0 | 7.0 |
| | | | | 2.0 | RHS | 76 | 38 | 20.0 | 8.0 |
| | | | | 1.6 | RHS | 76 | 38 | 20.8 | 8.8 |
| 76 | x | 38 | x | 4.0 | RHS | 50 | 25 | 18.0 | 5.0 |
| | | | | 3.0 | RHS | 50 | 25 | 20.0 | 7.0 |
| | | | | 2.5 | RHS | 50 | 25 | 21.0 | 8.0 |
| 75 | x | 50 | x | 6.0 | RHS | 50 | 25 | 13.0 | 13.0 |
| | | | | 5.0 | RHS | 65 | 35 | **0.0** | 5.0 |
| | | | | 4.0 | RHS | 65 | 35 | 2.0 | 7.0 |
| | | | | 3.0 | RHS | 65 | 35 | 4.0 | 9.0 |
| | | | | 2.5 | RHS | 65 | 35 | 5.0 | 10.0 |
| | | | | 2.0 | RHS | 65 | 35 | 6.0 | 11.0 |
| | | | | 1.6 | RHS | 65 | 35 | 6.8 | 11.8 |
| 75 | x | 25 | x | 2.5 | RHS | n/a | n/a | n/a | n/a |
| | | | | 2.0 | RHS | n/a | n/a | n/a | n/a |
| | | | | 1.6 | RHS | n/a | n/a | n/a | n/a |
| 65 | x | 35 | x | 4.0 | RHS | 50 | 25 | 7.0 | 2.0 |
| | | | | 3.0 | RHS | 50 | 25 | 9.0 | 4.0 |
| | | | | 2.5 | RHS | 50 | 25 | 10.0 | 5.0 |
| | | | | 2.0 | RHS | 50 | 25 | 11.0 | 6.0 |
| 50 | x | 25 | x | 3.0 | RHS | n/a | n/a | n/a | n/a |
| | | | | 2.5 | RHS | n/a | n/a | n/a | n/a |
| | | | | 2.0 | RHS | n/a | n/a | n/a | n/a |
| | | | | 1.6 | RHS | n/a | n/a | n/a | n/a |
| 50 | x | 20 | x | 3.0 | RHS | n/a | n/a | n/a | n/a |
| | | | | 2.5 | RHS | n/a | n/a | n/a | n/a |
| | | | | 2.0 | RHS | n/a | n/a | n/a | n/a |
| | | | | 1.6 | RHS | n/a | n/a | n/a | n/a |

## How to use this chart:

A. Select the size of Female (or Outer) member closest to your requirements from the left hand column.

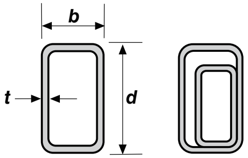
B. The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.

C. Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.

Note that the clearance is the total available difference between member dimensions, not the gap on both sides.

D. Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.

E. Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used consideration of both clearance and thickness within the size list available may be required.



F. RHS has the obvious advantage that its shape prevents rotation of the section.

G. Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

## Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. RHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Varying corner radii and the internal weld bead may need to be considered when a closer fit is required.
3. Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
4. For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.

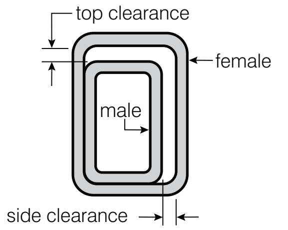


TABLE 3.3-3

# Square Hollow Sections AS/NZS 1163

## TELESCOPING INFORMATION

| Female (outer) | | | | Male (inner) | | Nominal Clearance | |
|---|---|---|---|---|---|---|---|
| d | b | t | | d | b | top | side |
| mm | mm | mm | | mm | mm | mm | mm |
| 400 x | 400 x | 16.0 | SHS | 350 | 350 | 18.0 | 18.0 |
| | | 12.5 | SHS | 350 | 350 | 25.0 | 25.0 |
| | | 10.0 | SHS | 350 | 350 | 30.0 | 30.0 |
| 350 x | 350 x | 16.0 | SHS | 300 | 300 | 18.0 | 18.0 |
| | | 12.5 | SHS | 300 | 300 | 25.0 | 25.0 |
| | | 10.0 | SHS | 300 | 300 | 30.0 | 30.0 |
| | | 8.0 | SHS | 300 | 300 | 34.0 | 34.0 |
| 300 x | 300 x | 16.0 | SHS | 250 | 250 | 18.0 | 18.0 |
| | | 12.5 | SHS | 250 | 250 | 25.0 | 25.0 |
| | | 10.0 | SHS | 250 | 250 | 30.0 | 30.0 |
| | | 8.0 | SHS | 250 | 250 | 34.0 | 34.0 |
| 250 x | 250 x | 16.0 | SHS | 200 | 200 | 18.0 | 18.0 |
| | | 12.5 | SHS | 200 | 200 | 25.0 | 25.0 |
| | | 10.0 | SHS | 200 | 200 | 30.0 | 30.0 |
| | | 9.0 | SHS | 200 | 200 | 32.0 | 32.0 |
| | | 8.0 | SHS | 200 | 200 | 34.0 | 34.0 |
| | | 6.0 | SHS | 200 | 200 | 38.0 | 38.0 |
| 200 x | 200 x | 16.0 | SHS | 150 | 150 | 18.0 | 18.0 |
| | | 12.5 | SHS | 150 | 150 | 25.0 | 25.0 |
| | | 10.0 | SHS | 150 | 150 | 30.0 | 30.0 |
| | | 9.0 | SHS | 150 | 150 | 32.0 | 32.0 |
| | | 8.0 | SHS | 150 | 150 | 34.0 | 34.0 |
| | | 6.0 | SHS | 150 | 150 | 38.0 | 38.0 |
| | | 5.0 | SHS | 150 | 150 | 40.0 | 40.0 |
| 150 x | 150 x | 10.0 | SHS | 125 | 125 | 5.0 | 5.0 |
| | | 9.0 | SHS | 125 | 125 | 7.0 | 7.0 |
| | | 8.0 | SHS | 125 | 125 | 9.0 | 9.0 |
| | | 6.0 | SHS | 125 | 125 | 13.0 | 13.0 |
| | | 5.0 | SHS | 125 | 125 | 15.0 | 15.0 |
| 125 x | 125 x | 10.0 | SHS | 100 | 100 | 5.0 | 5.0 |
| | | 9.0 | SHS | 100 | 100 | 7.0 | 7.0 |
| | | 8.0 | SHS | 100 | 100 | 9.0 | 9.0 |
| | | 6.0 | SHS | 100 | 100 | 13.0 | 13.0 |
| | | 5.0 | SHS | 100 | 100 | 15.0 | 15.0 |
| | | 4.0 | SHS | 100 | 100 | 17.0 | 17.0 |

| Female (outer) | | | | Male (inner) | | Nominal Clearance | |
|---|---|---|---|---|---|---|---|
| d | b | t | | d | b | top | side |
| mm | mm | mm | | mm | mm | mm | mm |
| 100 x | 100 x | 10.0 | SHS | 75 | 75 | 5.0 | 5.0 |
| | | 9.0 | SHS | 75 | 75 | 7.0 | 7.0 |
| | | 8.0 | SHS | 75 | 75 | 9.0 | 9.0 |
| | | 6.0 | SHS | 75 | 75 | 13.0 | 13.0 |
| | | 5.0 | SHS | 90 | 90 | **0.0** | **0.0** |
| | | 4.0 | SHS | 90 | 90 | 2.0 | 2.0 |
| | | 3.0 | SHS | 90 | 90 | 4.0 | 4.0 |
| | | 2.5 | SHS | 90 | 90 | 5.0 | 5.0 |
| | | 2.0 | SHS | 90 | 90 | 6.0 | 6.0 |
| 90 x | 90 x | 2.5 | SHS | 75 | 75 | 10.0 | 10.0 |
| | | 2.0 | SHS | 75 | 75 | 11.0 | 11.0 |
| 89 x | 89 x | 6.0 | SHS | 75 | 75 | 2.0 | 2.0 |
| | | 5.0 | SHS | 75 | 75 | 4.0 | 4.0 |
| | | 3.5 | SHS | 75 | 75 | 7.0 | 7.0 |
| | | 2.0 | SHS | 75 | 75 | 10.0 | 10.0 |
| 75 x | 75 x | 6.0 | SHS | 50 | 50 | 13.0 | 13.0 |
| | | 5.0 | SHS | 65 | 65 | **0.0** | **0.0** |
| | | 4.0 | SHS | 65 | 65 | 2.0 | 2.0 |
| | | 3.5 | SHS | 65 | 65 | 3.0 | 3.0 |
| | | 3.0 | SHS | 65 | 65 | 4.0 | 4.0 |
| | | 2.5 | SHS | 65 | 65 | 5.0 | 5.0 |
| | | 2.0 | SHS | 65 | 65 | 6.0 | 6.0 |
| 65 x | 65 x | 6.0 | SHS | 50 | 50 | 3.0 | 3.0 |
| | | 5.0 | SHS | 50 | 50 | 5.0 | 5.0 |
| | | 4.0 | SHS | 50 | 50 | 7.0 | 7.0 |
| | | 3.0 | SHS | 50 | 50 | 9.0 | 9.0 |
| | | 2.5 | SHS | 50 | 50 | 10.0 | 10.0 |
| | | 2.0 | SHS | 50 | 50 | 11.0 | 11.0 |
| | | 1.6 | SHS | 50 | 50 | 11.8 | 11.8 |
| 50 x | 50 x | 6.0 | SHS | 35 | 35 | 3.0 | 3.0 |
| | | 5.0 | SHS | 40 | 40 | **0.0** | **0.0** |
| | | 4.0 | SHS | 40 | 40 | 2.0 | 2.0 |
| | | 3.0 | SHS | 40 | 40 | 4.0 | 4.0 |
| | | 2.5 | SHS | 40 | 40 | 5.0 | 5.0 |
| | | 2.0 | SHS | 40 | 40 | 6.0 | 6.0 |
| | | 1.6 | SHS | 40 | 40 | 6.8 | 6.8 |

| Female (outer) | | | | Male (inner) | | Nominal Clearance | |
|---|---|---|---|---|---|---|---|
| d | b | t | | d | b | top | side |
| mm | mm | mm | | mm | mm | mm | mm |
| 40 x | 40 x | 4.0 | SHS | 30 | 30 | 2.0 | 2.0 |
| | | 3.0 | SHS | 30 | 30 | 4.0 | 4.0 |
| | | 2.5 | SHS | 35 | 35 | **0.0** | **0.0** |
| | | 2.0 | SHS | 35 | 35 | **1.0** | **1.0** |
| | | 1.6 | SHS | 35 | 35 | **1.8** | **1.8** |
| 35 x | 35 x | 3.0 | SHS | 25 | 25 | 4.0 | 4.0 |
| | | 2.5 | SHS | 30 | 30 | **0.0** | **0.0** |
| | | 2.0 | SHS | 30 | 30 | **1.0** | **1.0** |
| | | 1.6 | SHS | 30 | 30 | **1.8** | **1.8** |
| 30 x | 30 x | 3.0 | SHS | 20 | 20 | 4.0 | 4.0 |
| | | 2.5 | SHS | 25 | 25 | **0.0** | **0.0** |
| | | 2.0 | SHS | 25 | 25 | **1.0** | **1.0** |
| | | 1.6 | SHS | 25 | 25 | **1.8** | **1.8** |
| 25 x | 25 x | 3.0 | SHS | n/a | n/a | n/a | n/a |
| | | 2.5 | SHS | 20 | 20 | **0.0** | **0.0** |
| | | 2.0 | SHS | 20 | 20 | **1.0** | **1.0** |
| | | 1.6 | SHS | 20 | 20 | **1.8** | **1.8** |
| 20 x | 20 x | 2.0 | SHS | n/a | n/a | n/a | n/a |
| | | 1.6 | SHS | n/a | n/a | n/a | n/a |

### How to use this chart:

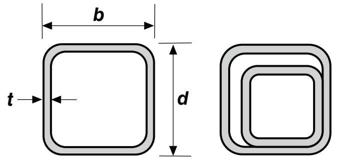
A. Select the size of Female (or Outer) member closest to your requirements from the left hand column.

B. The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.

C. Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.

Note that the clearance is the total available difference between member dimensions, not the gap on both sides.

D. Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.



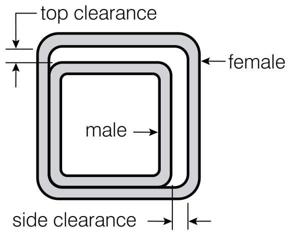
E. Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used consideration of both clearance and thickness within the size list available may be required.

F. SHS has the obvious advantage that its shape prevents rotation of the section.

G. Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. SHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Varying corner radii and the internal weld bead may need to be considered when a closer fit is required.
3. Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
4. For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.



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# Part 4

## METHODS OF STRUCTURAL ANALYSIS

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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 4

## METHODS OF STRUCTURAL ANALYSIS

### 4.1 Methods of Determining Design Action Effects

This section provides guidance on calculating design action effects as required by AS 4100. The methods of analysis recognised by AS 4100 are:

(a) first-order elastic analysis with moment amplification (Clause 4.4.2 of AS 4100)
(b) second-order elastic analysis (Appendix E of AS 4100)
(c) plastic analysis with moment amplification (Clause 4.5 of AS 4100), and
(d) advanced analysis (Appendix D of AS 4100).

These four methods consider the interaction of load and deformation that produce second-order effects. From an AS 4100 perspective, second-order effects (known as $P\Delta$ and $P\delta$ effects) can increase the design bending moment for members subject to bending and axial force.

In first-order analysis, it is assumed that the member remains elastic under the action of the design loads for all strength limit states. As such, method (a) without moment amplification - i.e. first-order elastic analysis - does not consider these second-order effects and may be used for members with bending moments only, axial tension or compression force only and, for braced members, combined bending moments and tension forces.

Second-order effects, which are caused by changes in the geometry of the member, are not accounted for in first-order analysis. Consequently, some modification must be made for second-order effects and AS 4100 includes methods for making a suitable adjustment to the calculated design actions.

Second-order elastic analysis does account for the effects of design loads acting on the structure and its members in their displaced and deformed configuration. With respect to AS 4100, no adjustment is required to the calculated design actions with a second-order analysis. Second-order effects may be substantial in some frames.

All of the methods of analysis are discussed in detail in the commentary to AS 4100 (Ref.[4.2]).

These Design Capacity Tables are intended to be used with first-order and second-elastic analysis, which are currently the most commonly used methods of analysis. For simple structural members, hand methods of analysis are most common, while for frames involving a number of members, analysis is usually by means of a computer program.

Consequently, the tabulated values in Parts 5, 6, 7 and 8 of this publication may be used for design in those cases where second-order effects:

- can be neglected (members with only: tension force; compression force; bending moments, or; for braced members, combined bending moments and tension force)
- are accounted for by using moment amplification factors in conjunction with a first-order elastic analysis
- are accounted for in a second-order elastic analysis.

Some further consideration of hand methods for assessing second-order effects and subsequently design actions are noted in the balance of this part of the publication.

### 4.2 Moment Amplification for First-Order Elastic Analysis

For a member subjected to combined bending moment and axial force, the bending moments are amplified by the presence of axial force. This occurs for both isolated, statically determinate members and members in a statically indeterminate frame. A first-order elastic analysis alone does not consider second-order effects, however, moment amplification can be used to account for second-order effects. The moment amplification factor is calculated differently for braced and sway members as explained in the following sub-section.

### 4.2.1 Braced Members

In a braced member the transverse displacement of one end of the member relative to the other is effectively prevented. The moment amplification factor for a braced member is $\delta_b$.

If a first-order elastic analysis is carried out then $\delta_b$ is used to amplify the bending moments between the ends of the member (Clause 4.4.2.2 of AS 4100). A first-order elastic analysis with moment amplification cannot be used if $\delta_b$ is greater than 1.4. If $\delta_b$ is greater than 1.4, it may be practical to alter the member sizes or connections so that $\delta_b \leq 1.4$. Alternatively a second-order elastic analysis in accordance with Appendix E of AS 4100 may be used.

$\delta_b$ can be calculated from the flow chart in Figure 4.1. The design bending moment ($M^*$) is then given by:

$M^* = M^*_m$ (for braced members subject to axial tension or with zero axial force)
$M^* = \delta_b M^*_m$ (for braced members subject to compression)

where $M^*_m$ is the maximum design bending moment calculated from a first-order analysis.

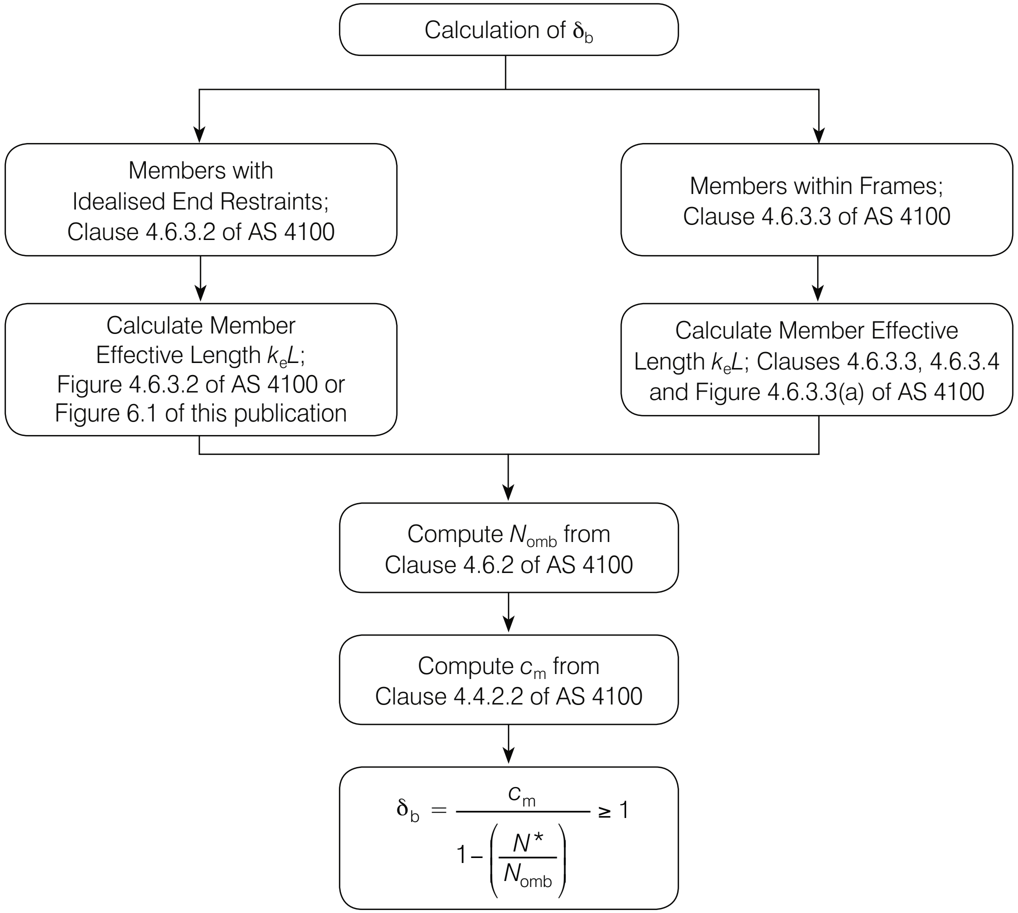

**Figure 4.1: Flow Chart for the calculation of the moment amplification factor for a braced member, $\delta_b$**

### 4.2.1.1 Calculation of $c_m$

The factor for unequal moments ($c_m$) is used in the calculation of $\delta_b$. If a braced member is subject *only to end moments* then the factor $c_m$ is calculated as follows:

$$c_m = 0.6 - 0.4\beta_m \leq 1.0 \qquad \text{(Clause 4.4.2.2 of AS 4100)}$$

where $\beta_m$ is the ratio of the smaller to the larger bending moment at the ends of the member, taken as positive when the member is bent in reverse curvature.

If the member is subjected to transverse loading, the same expression for $c_m$ shall be used provided $\beta_m$ is calculated using one of the following methods:

a) $\beta_m = -1.0$ (conservative) (Clause 4.4.2.2(a) of AS 4100)
b) $\beta_m$ is obtained by matching the moment distribution options shown in Figure 4.4.2.2 of AS 4100 (Clause 4.4.2.2(b) of AS 4100)
c) $\beta_m$ is based on the midspan deflection. (Clause 4.4.2.2(c) of AS 4100)

## 4.2.2 Sway Members

In a sway member the transverse displacement of one end of the member relative to the other is not effectively prevented. The moment amplification factor for a sway member is $\delta_s$.

The bending moments calculated from a first-order elastic analysis are modified by the moment amplification factor ($\delta_m$) which is the greater of $\delta_b$ (see Section 4.2.1) and $\delta_s$ (Clause 4.4.2.3 of AS 4100). If $\delta_m$ is greater than 1.4, a second-order elastic analysis must be used in accordance with Appendix E of AS 4100. A detailed explanation of the procedure for calculating $\delta_s$ may be found in Ref.[4.2].

$\delta_b$ and $\delta_s$ are calculated from the flow charts shown in Figures 4.1 and 4.2. The design bending moment is given by:

$$M^* = \delta_m M_m^*$$

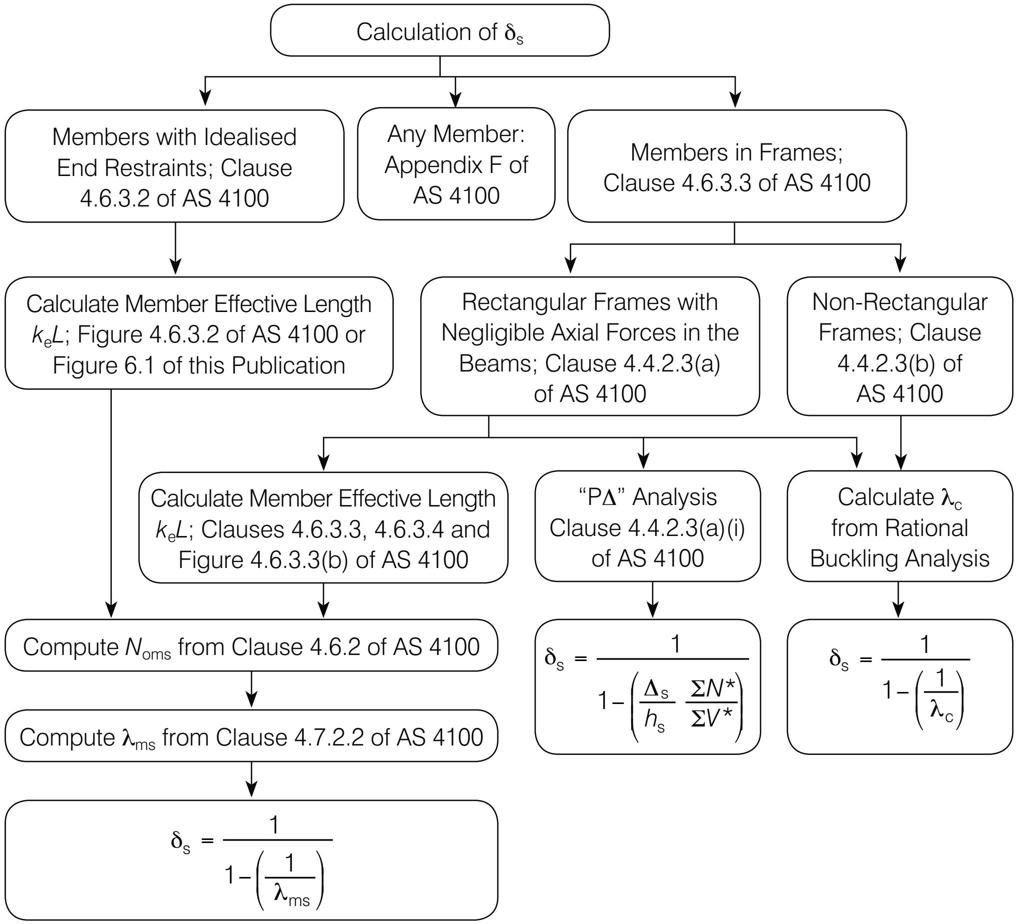

**Figure 4.2: Flow Chart for the calculation of the moment amplification factor for a sway member, $\delta_s$**

### 4.2.3 Elastic Flexural Buckling Loads

Elastic flexural buckling loads ($N_{omx,}$ $N_{omy}$) are required for the calculation of $\delta_b$ and $\delta_m$. Values of $N_{om}$ are determined from Clause 4.6.2 of AS 4100 using the expression:

$$N_{om} = \frac{\pi^2 EI}{(k_e L)^2}$$

where $k_eL = L_e =$ effective length. $k_e$ is given in Figure 6.1 for members with idealised end restraints or Clause 4.6.3 of AS 4100 for other end restraint conditions. For braced or sway members in frames, $k_e$ depends on the ratio ($\gamma$) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Refs. [4.1,4.3] provide worked examples for the calculation of effective lengths, elastic flexural buckling loads and moment amplification factors for members in those instances.

For a specific effective length, reference can be made to the Dimensions and Properties Tables in Part 3 (i.e. Tables 3.1-1 to 3.1-6 as appropriate) to determine $I$ (i.e. $I_x$ or $I_y$ ) and then simply evaluate the above equation for $N_{om}$. No tables relating $N_{om}$ to effective length are provided in this publication.

## 4.3 Examples

### 1. Braced Beam-Column

Determine the design action effects for an isolated braced beam-column which is subject to the design actions from a first-order elastic analysis as noted in Figure 4.3.

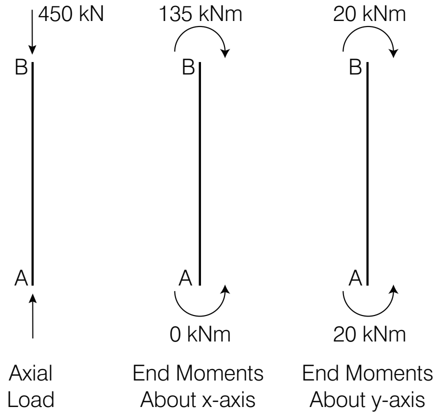

**Figure 4.3: Design action effects on isolated braced beam-column**

Design Data:

Section: 250 x 150 x 12.5 RHS in C450PLUS® – designed as AS/NZS 1163 Grade C450L0

Effective Lengths: Axial compression flexural buckling (x-axis), $L_{ex} = 10.0$ m
Axial compression flexural buckling (y-axis), $L_{ey} = 5.0$ m

Solution:

$N^* = 450$ kN

$$N_{ombx} = \frac{\pi^2 EI_x}{L_{ex}^2} = \frac{\pi^2 \text{ x } 200 \text{ x } 10^3 \text{ x } 68.5 \text{ x } 10^6}{\left(10\,000\right)^2}$$ ($I_x$ obtained from Table 3.1-4 (1))

$= 1350$ kN

$$N_{omby} = \frac{\pi^2 EI_y}{L_{ey}^2} = \frac{\pi^2 \text{ x } 200 \text{ x } 10^3 \text{ x } 30.8 \text{ x } 10^6}{\left(5000\right)^2}$$ ($I_y$ obtained from Table 3.1-4 (1))

$= 2430$ kN

$M^*_{mx} = 135$ kNm maximum at End B

$M^*_{my} = 20$ kNm maximum at Ends A and B

$c_{mx} = 0.60$ from Section 4.2.1.1 for $\beta_{mx} = 0$

$c_{my} = 1.0$ from Section 4.2.1.1 for $\beta_{my} = -1.0$

From Figure 4.1 the moment amplification factor ($\delta_b$ ) is given by:

$$\delta_b = \frac{c_m}{1 - \left(\frac{N^*}{N_{omb}}\right)}$$

Considering flexural buckling about the x-axis: $$\delta_{bx} = \frac{0.6}{1 - \left(\frac{450}{1350}\right)}$$

$= 0.900\ (<1)\ (\Rightarrow \delta_{bx} = 1.0)$

∴ Maximum moment occurs at the ends, i.e. at End A $M^*_x = 135$ kNm

Considering flexural buckling about the y-axis: $\delta_{by} = \dfrac{1.0}{1-\left(\dfrac{450}{2430}\right)}$

$= 1.23$

∴ Maximum moment occurs between ends, i.e. in span $M_y^* = 1.23 \times 20$

$= 24.6$ kNm

It can be seen that there is a 23% increase in the peak moment about the y-axis due to the second-order interaction effects between bending and axial compression.

**2. Sway Beam-Column**

Due to space limitations, general examples of sway beam-columns are considered in Refs. [4.1,4.3].

## 4.4 Miscellaneous

Readers should note that previous editions of this publication by the Australian Steel Institute (previously AISC) listed tables of $N_{om}$ at the end of Part 4. These tables were rarely used and could be readily calculated by manual methods (as noted in the example above). Consequently, the $N_{om}$ tables have been omitted from this part of the Tables and this also aligns with Ref. [4.3] which is a companion publication that considers hot-rolled open sections (UB, UC, etc.)

## 4.5 References

[4.1] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., “Worked Examples for Steel Structures”, third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – the Australian Steel Institute).

[4.2] Standards Australia, AS 4100 Supplement 1-1999: “Steel Structures Commentary” (Supplement to AS 4100-1998), Standards Australia, 1999.

[4.3] ASI, “Design Capacity Tables for Structural Steel – Volume 1: Open Sections”, fourth edition, Australian Steel Institute 2009.

**See Section 1.1.2 for details on reference Standards.**

# Part 5

## MEMBERS SUBJECT TO BENDING

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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

## 5.1 Maximum Design Loads for Beams with Full Lateral Restraint Subject to Uniformly Distributed Loading

Tables 5.1-1 to 5.1-6 give values of the maximum design loads for single-span simply-supported beams with full lateral restraint subject to uniformly distributed loads as shown in Figure 5.1 for both the strength and serviceability limit states.

**Designers should assess maximum design loads for the strength and serviceability limit states separately as different load combinations apply to these cases (AS/NZS 1170 Part 0).**

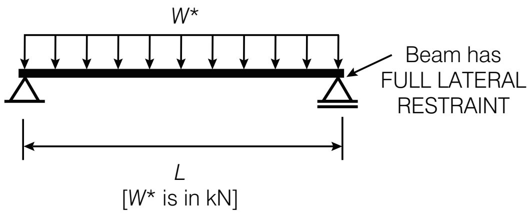


**Figure 5.1: Beam configuration for Tables 5.1-1 to 5.1-6**

***NOTE: BEAM SELF WEIGHT: For Tables 5.1-1 to 5.1-6, the self-weight of the beam has NOT been deducted. The designer must include the self-weight as part of the dead load when determining the maximum design load $W^*_L$ or $W^*_S$.***

Tables 5.1-1 to 5.1-6 also list the maximum segment length for full lateral restraint (FLR) required to be achieved for each section type loaded and configured as noted in Figure 5.1.

Examples of the use of these tables are given in Section 5.1.6.

### 5.1.1 $W^*_L$ – Strength Limit State Design Load

For the beam configuration shown in Figure 5.1, the maximum strength limit state design load ($W^*_L$) is the *lesser* of the maximum design load ($W^*_{L1}$) associated with the design section moment capacity ($\phi M_{sx}$) and the maximum design load ($W^*_{L2}$) associated with the design shear capacity ($\phi V_v$).

The designer must ensure that the strength limit state design load ($W^*$) is less than or equal to the maximum design load $W^*_L$, i.e.

$$W^* \leq W^*_L$$

where $W^*_L$ = min. [$W^*_{L1}$; $W^*_{L2}$].

$W^*_{L1}$ and $W^*_{L2}$ are listed in the (A) series tables of the 5.1 Table Series – i.e. Tables 5.1-1 to 5.1-6. The (A) series tables in this instance consider the **strength** limit state. For a specific group of hollow sections, each respective (A) series table is immediately followed by a (B) series table which considers the **serviceability** limit state – see Section 5.1.2 below.

For the beam configuration shown in Figure 5.1, the strength of the beam is not controlled by the interaction of bending moment and shear force (Clause 5.12 of AS 4100). An example on the use of these tables is given in Section 5.1.6.

### 5.1.1.1 $W^*_{L1}$ – based on Design Moment Capacity

The derivation of the design section moment capacity ($\phi M_s$) is given in Section 5.2.2.1 and listed in Tables 5.2-1 to 5.2-4 for RHS/SHS and Tables 8-1 to 8-6 for all hollow sections (including CHS).

For a single-span simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum design bending moment ($M_{max}$) is given by:

$$M_{max} = \frac{WL}{8}$$

where $W$ = total load on the beam, including beam self weight
$L$ = span of the beam.

The design moment capacity for the beam in Figure 5.1 is $\phi M_{sx}$. Therefore, substituting $\phi M_{sx}$ for $M_{max}$, and rearranging the above equation gives:

$$W^*_{L1} = \frac{8(\phi M_{sx})}{L}$$

where $W^*_{L1}$ is the *Maximum Design Load* based on the design section moment capacity of the beam.

### 5.1.1.2 $W^*_{L2}$ – based on Design Shear Capacity

The derivation of the design shear capacity ($\phi V_v$) is given in Section 5.2.2.4 and listed in Tables 5.2-1 to 5.2-4 for RHS/SHS and Tables 8-1 to 8-6 for all hollow sections (including CHS).

For a single-span, simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum design shear force ($V_{max}$) is given by:

$$V_{max} = \frac{W}{2}$$

Therefore, substituting $\phi V_v$ for $V_{max}$ and rearranging the equation gives:

$$W^*_{L2} = 2(\phi V_v)$$

where $W^*_{L2}$ is the *Maximum Design Load* based on the design shear capacity of the beam.

### 5.1.2 $W^*_S$ – Serviceability Limit State Design Load

For the beam configuration shown in Figure 5.1, the value of maximum serviceability limit state design load ($W^*_S$) given in the tables is the *lesser* of the maximum design load ($W^*_{S1}$) which will achieve a **calculated total elastic deflection** of $L/250$ (where $L$ is the span of the beam) and the load at which first yield occurs ($W^*_{YL}$), i.e.

$$W^*_S = \min.[\, W^*_{S1};\ W^*_{YL}\,]$$

$W^*_S$ is listed in the (B) series tables of the 5.1 Table Series – i.e. Tables 5.1-1 to 5.1-6. The (B) series tables in this instance consider the **serviceability** limit state. For a specific group of hollow sections, each respective (B) series Table is immediately preceded by an (A) series Table which considers the **strength** limit state – see Section 5.1.1 above. An example of the use of these Tables is given in Section 5.1.6.

### 5.1.2.1 $W^*_{S1}$ – based on a Deflection Limit of $L/250$

The maximum *elastic* deflection ($\Delta_{max}$) of the beam shown in Figure 5.1 is given by:

$$\Delta_{max} = \frac{5WL^3}{384EI_x}$$

where $E = 200 \times 10^3$ MPa

$I_x$ = second moment of area about the major principal x-axis.

Therefore, substituting $\Delta_{max} = L/250$ and rearranging the equation gives the maximum design load for serviceability based on deflection ($W^*_{S1}$):

$$W^*_{S1} = \frac{384EI_x}{1250L^2}$$

For deflection limits other than $L/250$, the value of the maximum design load based on another deflection limit ($W^*_{S2}$) may be calculated by using the method given above but using the new limit.

### 5.1.2.2 $W^*_{YL}$ – based on First Yield Load

The load at which first yield occurs in the member is given by:

$$W^*_{YL} = \frac{8Z_x f_y}{L} \quad \text{since} \quad \frac{W^*L}{8Z_x} \leq f_y$$

### 5.1.3 Full Lateral Restraint

Full lateral restraint may be achieved for a beam by: (a) continuous lateral restraint (Clause 5.3.2.2 of AS 4100), or (b) full, partial or lateral restraint provided at sufficient locations along the beam (Clauses 5.3.2.3 and 5.3.2.4 of AS 4100). The distance between the locations in (b) is termed the segment length and the maximum value of segment length to maintain the full lateral restraint condition is generally noted as "FLR" in the Tables.

**FLR values are not shown in the Tables for CHS and SHS as these sections are not considered to be susceptible to flexural-torsional buckling.** However, FLR values are given in the (A) series of Tables 5.1-3 and 5.1-4 as they consider RHS bending about the major principal axis and these sections may, in some instances, be subject to flexural-torsional buckling. As noted in Tables 5.1-3 and 5.1-4, FLR is only listed in the strength (not serviceability) limit state tables (A).

Formulae for calculating FLR are given in Clause 5.3.2.4 of AS 4100 and Section 5.2.2.2. For the beam configuration shown in Figure 5.1, the ratio $\beta_m$ is equal to –0.8 to derive the FLR values in Tables 5.1-3 and 5.1-4.

### 5.1.4 Additional Design Checks

Where loads are transmitted into the webs at supports or at load points, the capacity of the web to resist such forces should be checked in accordance with Section 5.2.2.5, Section 5.2.5 and the values of the web capacities listed in Tables 5.2-1 to 5.2-4.

## 5.1.5 Other Load Conditions

The values given in Tables 5.1-1 to 5.1-6 are for single-span, simply-supported beams subject to uniformly distributed loads (Figure 5.1). However, the information presented in these tables may be used for beams with full lateral restraint and other loading situations using the equivalent uniform design loads given in Table T5.1 and the following procedure:

(1) Calculate the equivalent uniformly distributed maximum design load for moment ($W^*_{EM}$) using Table T5.1.

(2) Based on $W^*_{EM}$ select a section with an adequate maximum design load ($W^*_{L1}$) associated with the design moment capacity from Tables 5.1-1 to 5.1-6.

(3) Calculate the equivalent uniformly distributed maximum design load for shear ($W^*_{EV}$) using Table T5.1.

(4) Check that the section selected in (2) has an adequate maximum design load ($W^*_{L2}$) associated with the design shear capacity to resist $W^*_{EV}$. If not, select a new section size which can resist $W^*_{EV}$.

(5) Check shear and bending interaction in accordance with Section 5.2.4. A check is not necessary if $V^* < 0.6(\phi V_v)$ or $M^* < 0.75(\phi M_s)$.

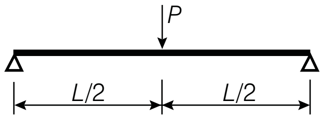
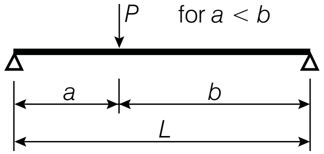
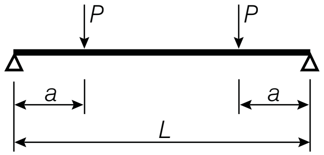
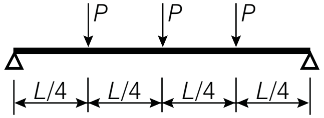
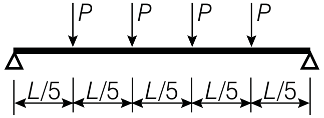
(6) Calculate the equivalent uniformly distributed serviceability maximum design load ($W^*_{ES}$) from Table T5.1.

(7) Check that the section selected in (4) has an adequate maximum serviceability design load ($W^*_{S1}$) to resist $W^*_{ES}$. If not, select a new section size which can resist $W^*_{ES}$.

Steps (6) and (7) only work if first yield does not control. If it does, the analysis for serviceability is invalid.

The above procedure is shown in Example 2 of Section 5.1.6.

**Table T5.1: Table of Equivalent Uniform Design Loads**

| Loading | Equivalent Strength Maximum Design Loads | | Equivalent Serviceability Maximum Design Load $W^*_{ES}$ |
|---|---|---|---|
| | Moment $W^*_{EM}$ | Shear $W^*_{EV}$ | |
|  | $2P$ | $P$ | $\frac{8P}{5}$ |
|  | $\frac{8abP}{L^2}$ | $\frac{2Pb}{L}$ | $\frac{8P}{5}\left[3\left(\frac{a}{L}\right)-4\left(\frac{a}{L}\right)^3\right]$ at midspan |
|  | $\frac{8aP}{L}$ | $2P$ | $\frac{16P}{5}\left[3\left(\frac{a}{L}\right)-4\left(\frac{a}{L}\right)^3\right]$ |
|  | $4P$ | $3P$ | $\frac{19P}{5}$ |
|  | $\frac{24P}{5}$ | $4P$ | $\frac{3024P}{625}$ |

### 5.1.6 Examples

#### 1. Beam with Uniformly Distributed Load

A simply-supported beam of 4 metres span is subjected to the following (unfactored) uniformly distributed loads:

$G$ (Dead Load) = 20 kN (total load including beam self weight)
$Q$ (Live Load) = 60 kN (short term total load, $\Psi_s = 0.7$)

The beam is continuously laterally restrained. The total deflection of the beam under serviceability load must not exceed $L/250$. Select an appropriate Grade C450L0 (C450PLUS®) RHS to resist this loading.

<u>Solution:</u>

(a) Calculation of maximum design loads:

*Strength Limit State* $W^*_L$ = max. [1.35$G$; 1.2$G$ + 1.5$Q$]
= 114 kN
*Serviceability Limit State* $W^*_S$ = $G$ + 0.7$Q$
= 62.0 kN

Note: The above design load calculations are based on the load combinations in AS/NZS 1170.0.

(b) Use of the Tables:

*Strength Limit State* – Select a section from the Tables such that the maximum design loads $W^*_{L1}$ (based on moment capacity) and $W^*_{L2}$ (based on shear capacity) are greater than or equal to $W^*_L$. It can be seen from Table 5.1-4(2)(A) that for a 200 x 100 x 6.0 RHS – C450PLUS® designed as AS/NZS 1163 Grade C450L0 with 4.0 m span, the maximum design loads are:

$W^*_{L1}$ = 170 kN (Tabulated)
$W^*_{L2}$ = 1040 kN (Tabulated)
$\therefore$ $W^*_L$ = min [$W^*_{L1}$; $W^*_{L2}$] (Tabulated)
= 170 kN (Tabulated) (> 114 kN .... COMPLIES)

Therefore, a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®) satisfies the strength limit state. (Note: a 200 x 100 RHS in 4 and 5 mm thickness would also have sufficed though the 6 mm thick was selected in advance of satisfying the serviceability limit state – see below).

*Serviceability Limit State* – From Table 5.1-4(2)(B), it can be seen that for a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®) with 4.0 m span, the serviceability load for a deflection limit of $L/250$ is:

$W^*_S$ = 64.2 kN (Tabulated) (> 62.0 kN .... COMPLIES)

Therefore, a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®), satisfies the serviceability limit state.

#### 2. Beam with Central Concentrated Load

A beam which is simply-supported has a span of 4.0 metres with full lateral restraint. The beam is subjected to nominal, central dead and short term live loads of 10 kN and 30 kN respectively. Design a suitable RHS in Grade C450L0 (C450PLUS®) with a limit on deflection of span / 250.

<u>Solution:</u>

(1) Calculate the equivalent uniformly distributed maximum design load for moment ($W^*_{EM}$).
From Table T5.1, the $W^*_{EM}$ associated with the central load case is:

$W^*_{EM}$ = 2$P$
= 2 x max. [1.35 x 10; 1.2 x 10 + 1.5 x 30]
= 114 kN

Note: The design load calculations in this Example are based on the load combinations in AS/NZS 1170.0.

(2) Based on $W^*_{EM}$ select a section with an adequate maximum design load ($W^*_{L1}$) associated with the design section moment capacity.
From Table 5.1-4(2)(A), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum design load with $W^*_{L1}$ = 145 kN (> 114 kN required).

(3) Calculate the equivalent uniformly distributed maximum design load for shear ($W^*_{EV}$).
From Table T5.1, $W^*_{EV}$ for the central load case is:

$W^*_{EV}$ = $P$
= max. [1.35 x 10; 1.2 x 10 + 1.5 x 30]
= 57 kN

(4) Check that the section selected in Step (2) has an adequate maximum design load ($W^*_{L2}$) based on design shear capacity.
From Table 5.1-4(2)(A), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum design load with $W^*_{L2}$ = 879 kN (> 57 kN required).

(5) See if a shear and bending interaction check is necessary.

$W^*_{L2}$ = 879 kN (Table 5.1-4(2)(A))
$\phi V_v$ = 440 kN (Table 5.2-2(2)(A) or 0.5 $W^*_{L2}$)
$0.6\phi V_v$ = 264 kN
> 28.5 kN (= $V^* = W^*_{EV}/2$ from above)

Therefore no shear and bending check is necessary.

(6) Calculate the equivalent uniformly distributed serviceability load ($W^*_{ES}$).
From Table T5.1, $W^*_{ES}$ for the central load case is (for $\Psi_s$ = 0.7):

$$W^*_{ES} = \frac{8P}{5}$$

$$= \frac{8}{5}(10 + 0.7 \text{ x } 30)$$

$$= 49.6 \text{ kN}$$

(7) From Table 5.1-4(2)(B), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum serviceability design load with $W^*_S$ = 55.2 kN (> 49.6 kN).
∴ Adopt a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) section.

Note: For illustrative purposes, the self-weight of the beam is assumed to be included in the dead load of this example. Nominal beam self weight - 22.1 kg/m x 4.0m = 88.4 kg ⇒ 0.867 kN.

## 5.2 Design Section Moment and Web Capacities

### 5.2.1 General

For RHS and SHS, the 5.2 Table Series – i.e. Tables 5.2-1 to 5.2-4 – contain values of design section moment capacities about the principal x- and y-axes ($\phi M_{sx}$ , $\phi M_{sy}$) and the design shear capacity ($\phi V_v$) for shear forces acting in the principal y-axis direction (i.e. for RHS/SHS bending about the x-axis) and in the principal x-axis direction (for RHS only). These values provide the basic information necessary for checking shear-bending interaction. The Tables also provide listings of the design torsional section moment capacity ($\phi M_z$) for RHS and SHS.

The maximum segment length for full lateral restraint (FLR) for RHS is also listed. FLR values may be used to ensure appropriate spacing of restraints so that the design section moment capacity can be achieved for bending about the x-axis. The Tables also provide values of design web bearing capacities.

Due to there being no specific CHS design provisions for web bearing in AS 4100, **CHS are not considered in the 5.2 Table series** though design section capacities (e.g. $\phi M_{sx}$, $\phi V_v$ and $\phi M_z$) can be found in the 8.1 and 8.2 Table series.

### 5.2.2 Method

### 5.2.2.1 Design Section Moment Capacity

The design section moment capacity ($\phi M_s$) is determined from Clauses 5.1 and 5.2.1 of AS 4100 using:

$$\phi M_s = \phi f_y Z_e$$

where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$f_y$ = yield stress used in design
$Z_e$ = effective section modulus (see Section 3.2.2.2)

For RHS, design section moment capacities are listed for bending about both principal axes. These actions are split into two separate tables – the type (A) table for bending about the x-axis (e.g. Table 5.2-2(1)(A) for Grade C450L0 (C450PLUS®) RHS lists $\phi M_{sx}$) which is immediately followed by the type (B) table for bending about the y-axis (e.g. Table 5.2-2(1)(B) for Grade C450L0 (C450PLUS®) RHS lists $\phi M_{sy}$). Due to SHS being doubly-symmetric, the SHS tables (i.e. Tables 5.2-3 and 5.2-4) only consider design section moment capacities about the x-axis.

For RHS bending about the x-axis, the design member moment capacity ($\phi M_b$) equals the design section moment capacity ($\phi M_s$) for members which have full restraint against flexural-torsional buckling (see Section 5.1.3). For SHS bending about the x-axis and RHS bending about the y-axis, flexural-torsional buckling does not normally occur so $\phi M_b$ equals $\phi M_s$ (refer section 5.1.3).

## 5.2.2.2 Segment Length for Full Lateral Restraint (FLR)

The Tables only consider RHS bending about the major principal x-axis to be susceptible to flexural-torsional buckling. For such sections, a beam segment with full or partial restraint at each end may be considered to have full lateral restraint if its length satisfies Clause 5.3.2.4 of AS 4100, i.e.

$$\text{FLR} \leq r_y\,(1800 + 1500\,\beta_m)\left(\frac{b_f}{b_w}\right)\left(\frac{250}{f_y}\right)$$

where $\text{FLR}$ = maximum segment length for full lateral restraint

$r_y = \sqrt{\left(\frac{I_y}{A_g}\right)}$ (see Tables 3.1-3 and 3.1-4)

The FLR values listed in the (A) series tables of Tables 5.2-1 and 5.2-2 (for RHS) are calculated using $\beta_m = -1.0$ which is the most conservative case. However, $\beta_m = -0.8$ may be used for segments with transverse loads (as in the case of the (A) series tables in Tables 5.1-3 and 5.1-4 for RHS). Alternatively, $\beta_m$ may be taken as the ratio of the smaller to larger end moments in the length (*L*) for segments without transverse loads (positive when the segment is bent in reverse curvature).

## 5.2.2.3 Design Torsional Moment Section Capacity

The design torsional moment section capacity ($\phi M_z$) listed in the 5.2 Table series is determined in accordance with (a) and (b) as noted below.

(a) Although AS 4100 makes no provision for the design of members subject to torsion it is nevertheless considered appropriate to provide torsional capacities for hollow sections in the Tables. Hollow sections perform particularly well in torsion and their behaviour under torsional loading is readily analysed by simple procedures. An explanation of torsional effects is provided in Refs. [5.1, 5.2].

The general theory of torsion established by Saint-Venant is based on uniform torsion. The theory assumes that all cross-sections rotate as a body around the centre of rotation. When the applied torsional moment is non-uniform, such as when the torsional load is applied midspan between rigid supports or when the free warping of the section is restricted, then the torsional load is shared between uniform and non-uniform torsion or warping. However, in the case of hollow sections, the contribution of non-uniform torsion is negligible and sections can be treated as subject to uniform torsion without any significant loss of precision in analysis.

(b) For hollow sections, torsional actions can be considered using the following formulae:

*Strength Limit State*

$$M_z^* \leq \phi M_z$$

$$\phi M_z = \phi 0.6 f_y C$$

where $M_z^*$ = design torsional moment

$\phi$ = 0.9 (based on shearing loads and Table 3.4 of AS 4100)

$\phi M_z$ = design torsional section moment capacity

$f_y$ = yield stress used in design

$C$ = torsional section modulus (see 3.1 Table series)

*Serviceability Limit State*

The angle of twist per unit length $\theta$ (in radians) can be determined from the following formula:

$$\theta = \frac{M_z^*}{GJ}$$

where $G$ = shear modulus of elasticity, 80 x $10^3$ MPa

$J$ = torsional section constant (see 3.1 Table series).

The method for determining the constants *C* and *J* is detailed in Section 3.2.1.1.

### 5.2.2.4 Design Shear Capacity of a Web

Designers must ensure that the design shear force ($V^*$) ≤ $\phi V_v$ along the beam.

RHS and SHS generally have non-uniform shear stress distributions along their webs. Consequently, the design shear capacity of a web ($\phi V_v$) for most RHS/SHS in the Tables are primarily determined from Clauses 5.11.3 and 5.11.4 of AS 4100 and is calculated as the lesser of:

$$\phi V_v = \phi V_w \qquad \text{(Clause 5.11.4 of AS 4100)}$$

and
$$\phi V_v = \frac{2\phi V_u}{0.9 + \left(\dfrac{f^*_{vm}}{f^*_{va}}\right)} \qquad \text{(Clause 5.11.3 of AS 4100)}$$

Also, for CHS:
$$\phi V_v = 0.324 f_y A_e \qquad \text{(Clause 5.11.4 of AS 4100)}$$

Where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$V_w$ = $0.6 f_y (d - 2t)\, 2t$

$$V_u = V_w \quad \text{for} \quad \frac{d_1}{t}\sqrt{\left(\frac{f_y}{250}\right)} \le 82 \text{ and applies for all ATM RHS/SHS in the Tables}$$

$$= \alpha_v V_w \quad \text{for} \quad \frac{d_1}{t}\sqrt{\left(\frac{f_y}{250}\right)} > 82 \text{ and } \alpha_v \text{ is evaluated from Clause 5.11.5 of AS 4100}$$

$f^*_{va}$ = average design shear stress in the web
$f^*_{vm}$ = maximum design shear stress in the web
$f_y$ = yield stress used in design
$A_e$ = effective sectional area of CHS in shear
= $A_g$ (i.e. gross cross-section of CHS provided there are no holes larger than those required for fasteners, or that the net area is greater than 0.9 times the gross area)
$d$ = full depth of section
$t$ = thickness of section
$d_1$ = $d - 2t$

The ratio of maximum to average design shear stress in the web ($f^*_{vm} / f^*_{va}$) for bending about the x-axis is calculated [5.3] using:

$$\frac{f^*_{vm}}{f^*_{va}} = \frac{3(2b + d)}{2(3b + d)}$$

where $d$ = full depth of section
$b$ = full width of section
Note: For bending about the y-axis, $b$ and $d$ are interchanged in the calculation of the maximum to average design web shear stress ratio. Non-uniform shear stress governs when $d / b > 0.75$.

For calculating the web area, the web depth has been taken as $d - 2t$ (or $b - 2t$ when appropriate) for RHS/SHS and 0.6 times the gross cross-section area (0.6 $A_g$) for CHS.

### 5.2.2.5 Design Web Bearing Capacities

Designers must ensure that the design bearing force ($R^*$) ≤$\phi R_b$ at all locations along a beam where bearing forces are present.

The design bearing capacity ($\phi R_b$) is calculated in accordance with Clause 5.13 of AS 4100 and taken as the lesser of:

$$\phi R_{by} = \phi 2 \alpha_p b_b t f_y$$

and
$$\phi R_{bb} = \phi 2 \alpha_c b_b t f_y$$

where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$\phi R_{by}$ = design web bearing yield capacity (Clause 5.13.3 of AS 4100)
$\phi R_{bb}$ = design web bearing buckling capacity (Clause 5.13.4 of AS 4100)
$t$ = thickness of section
$f_y$ = yield stress used in design

(a) For **interior bearing** such that $\boldsymbol{b_d \geq 1.5 d_5}$ (see Figure 5.2(b))

$b_b$ = $b_s + 5r_{ext} + d_5$
$b_s$ = actual length of bearing (see Figure 5.2(b))
$d_5$ = flat width of web (see Figure 5.2(a))
$r_{ext}$ = outside corner radius (see Section 3.2.1.2)

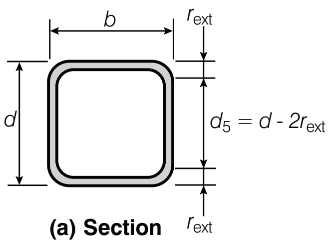
$$\alpha_p = \frac{0.5}{k_s}\left[1+(1-\alpha_{pm}^2)\left(1+\frac{k_s}{k_v}-(1-\alpha_{pm}^2)\frac{0.25}{k_v^2}\right)\right]$$

$$\alpha_{pm} = \frac{1}{k_s}+\frac{0.5}{k_v}$$

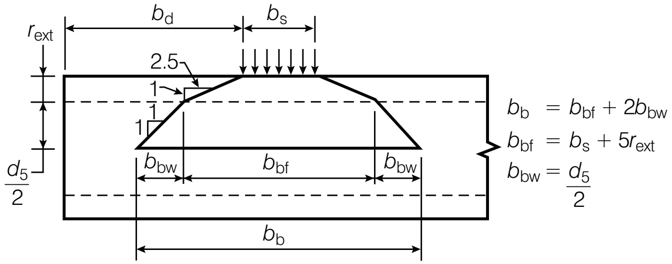
$$k_s = \frac{2r_{ext}}{t}-1$$

$$k_v = \frac{d_5}{t}$$

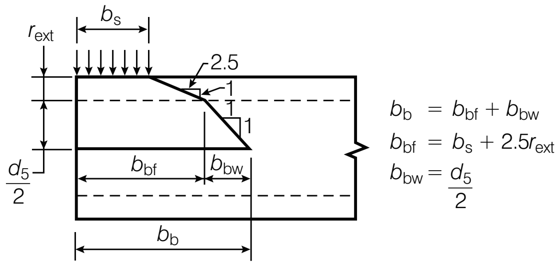
$\alpha_c$ = member slenderness reduction factor determined from Clause 5.13.4 of AS 4100. This is equal to the design axial compression capacity of a member with area $t_w b_b$ with $\alpha_b = 0.5$, $k_f = 1.0$ and slenderness ratio, $L_e/r = 3.5d_5/t$.



(a) Section



(b) Interior Force



(c) End Force

**Figure 5.2: Dispersion of force through flange, radius and web of RHS/SHS**

(b) For **end bearing** such that $\mathbf{b_d < 1.5d_5}$ (see Figure 5.2(c))

$$b_b = b_s + 2.5r_{ext} + \frac{d_5}{2}$$

$$\alpha_p = \sqrt{2 + k_s^2} - k_s$$

$\alpha_c$ = member slenderness reduction factor determined from Clause 5.13.4 of AS 4100. This is equal to the design axial compression capacity of a member with area $t_w b_b$ with $\alpha_b = 0.5$, $k_f = 1.0$ and slenderness ratio, $L_e/r = 3.8d_5/t$.

Tables 5.2-1 to 5.2-4 list values $\phi R_{by}$ and $\phi R_{bb}$ in terms of $\phi R_{by}/b_b$ and $\phi R_{bb}/b_b$ respectively for RHS/SHS. In both the interior and end bearing cases, the critical web bearing failure mode (i.e. web bearing yield design capacity or web bearing buckling design capacity) is shown in **bold**. Additionally, the terms $5r_{ext}$ (=2 x $2.5r_{ext}$ for interior bearing), $2.5r_{ext}$ (for end bearing), $b_{bw}$ (see Figures 5.2 (b) and (c)) and $L_e/r$ are also listed in these tables. For the same section range, the RHS listings in this table series consider shear and bearing forces for flexure about the x-axis (the (A) series tables) which is then immediately followed by the (B) series tables for flexure about the y-axis.

## 5.2.3 Example – Web Bearing

For an interior bearing location, a 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) section has a central design concentrated force of 150 kN bearing over the full width of the RHS for a length of 100 mm along the RHS (see Figure 5.3). Check the bearing capacity of the beam which is bending about the x-axis.

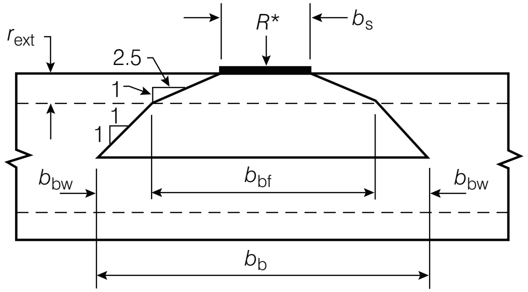


**Figure 5.3: Web bearing design example**

Design Data:

| | | | |
|---|---|---|---|
| Design bearing force | $R^*$ | = | 150 kN |
| Design shear force | $V^*$ | = | 75 kN |
| Stiff bearing length | $b_s$ | = | 100 mm |
| From Table 5.2-2(2)(A) | $5r_{ext}$ | = | 50.0 mm |
| From Table 5.2-2(2)(A) | $b_{bw}$ | = | 65.0 mm |

Solution:

(1) Check shear capacity

$V^*$ = 75 kN (assuming $R^*$ provides the total shearing action)

$\phi V_v$ = 267 kN (Table 5.2-2(2)(A))

$> V^*$ ∴ O.K.

(2) Check bearing capacity

Bearing length at the edge of the corner radius

$$\begin{aligned} b_{bf} &= b_s + 5r_{ext} \\ &= 100 + 50.0 \\ &= 150 \text{ mm} \end{aligned}$$

Bearing length at the centre of the web

$$\begin{aligned} b_b &= b_{bf} + 2b_{bw} \\ &= 150 + (2 \text{ x } 65.0) \\ &= 280 \text{ mm} \end{aligned}$$

From Table 5.2-2(2)(A):

(a) Design web yield capacity

$$\frac{\phi R_{by}}{b_b} = 0.828 \text{ kN/mm}$$

(b) Design web buckling capacity

$$\frac{\phi R_{bb}}{b_b} = 0.860 \text{ kN/mm}$$

∴ web yielding will govern (as it is the **bold** entry in the table).

Design web bearing capacity ($\phi R_b$)

$$\begin{aligned} \phi R_b &= \phi R_{by} \\ &= 0.828 \text{ x } 280 \\ &= 232 \text{ kN} \\ &> R^* \end{aligned}$$

∴ the 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) is satisfactory.

## 5.2.4 Shear and Bending Interaction

### 5.2.4.1 Method

The design web shear capacity determined in Section 5.2.2.4 may be significantly reduced when the section is subject to a large design bending moment at the same location. The reduced design shear capacity ($\phi V_{vm}$) is determined in accordance with Clause 5.12.3 of AS 4100 as:

$$\phi V_{vm} = \phi V_v \qquad \text{for } M^* \leq 0.75\phi M_s$$

or

$$= \phi V_v \left[ 2.2 - \left( \frac{1.6M^*}{\phi M_s} \right) \right] \qquad \text{for } 0.75\phi M_s < M^* \leq \phi M_s$$

where

$\phi V_v$ = design web shear capacity (see Sections 5.2.1 and 5.2.2.4)
$M^*$ = design bending moment
$\phi M_s$ = design section moment capacity (see Sections 5.2.1 and 5.2.2.1)

Designers must ensure that $V^* \leq \phi V_{vm}$.

**Note: If $V^* \leq 0.6(\phi V_v)$ or if $M^* \leq 0.75(\phi M_s)$ then no check on the interaction of shear and bending is necessary.**

### 5.2.4.2 Example

An example of a check on shear and bending interaction is given in Section 5.3.6.

## 5.2.5 Bending and Bearing Interaction

### 5.2.5.1 Method

The design web bearing capacity determined in Section 5.2.2.5 of the Tables may be significantly reduced when the section is subject to a large bending moment at the same location. The effect of this interaction of bending and bearing force in RHS and SHS is considered in AS 4100.

The bending and bearing interaction is dependent on the ratio of bearing length to the width of bearing ($b_s/b$) and web slenderness ($d_1/t$). Clause 5.13.5 of AS 4100 considers the following interaction to apply to RHS and SHS:

$$1.2\left(\frac{R^*}{\phi R_b}\right)+\left(\frac{M^*}{\phi M_s}\right)\le 1.5 \qquad \text{for } \frac{b_s}{b}\ge 1.0 \text{ and } \frac{d_1}{t}\le 30$$

or

$$0.8\left(\frac{R^*}{\phi R_b}\right)+\left(\frac{M^*}{\phi\, M_s}\right)\le 1.0 \qquad \text{otherwise}$$

where

$b_s$ = stiff bearing length (see Figure 5.2)
$b$ = width of section
$d_1$ = clear depth between flanges
$t$ = thickness of section
$R^*$ = maximum design bearing force
$\phi$ = capacity factor = 0.9 (Table 3.4 of AS 4100)
$\phi R_b$ = design web bearing capacity (see Section 5.2.2.5)
$M^*$ = maximum design bending moment
$\phi M_s$ = design section moment capacity (see Sections 5.2.1 and 5.2.2.1)

**Note: These formulae only apply to bearing across the full width of section.**

### 5.2.5.2 Example

Assuming a design bending moment of 15.0 kNm is present at the bearing load shown in the example of Section 5.2.3, check the adequacy of the beam under the interaction of bending and bearing.

Design Data:

| | | | | |
|---|---|---|---|---|
| Design bearing force | $R^*$ | = | 150 kN | (Section 5.2.3) |
| Design web bearing capacity | $\phi R_b$ | = | 232 kN | (Section 5.2.3) |
| Design bending moment | $M^*$ | = | 15.0 kNm | |
| Design section moment capacity | $\phi M_s$ | = | 37.8 kNm | (Table 5.2-2(2)(A)) |
| Stiff bearing length | $b_s$ | = | 100 mm | (Section 5.2.3) |
| Web slenderness | $d_1/t$ | = | 35.5 | (Table 3.1-4(2) or = $(d-2t)/t$) |

Solution:

$$\frac{b_s}{b} = \frac{100}{100} \ge 1.0$$

and $$\frac{d_1}{t} = 35.5 > 30$$

$\therefore$ the interaction equation is $$0.8\left(\frac{R^*}{\phi R_b}\right)+\left(\frac{M^*}{\phi M_s}\right)\le 1.0$$

Substituting values $$0.8\left(\frac{150}{232}\right)+\left(\frac{15.0}{37.8}\right) = 0.914 \le 1.0$$

$\therefore$ the 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) is satisfactory.

# Part 5
## MEMBERS SUBJECT TO BENDING

## 5.3 Design Moment Capacities for Members Without Full Lateral Restraint

### 5.3.1 General

Values of design member moment capacity ($\phi M_b$) are given in Tables 5.3-1 and 5.3-2 for various values of effective length ($L_e$) based on the uniform moment case ($\alpha_m = 1.0$) for RHS bending about the x-axis *without full lateral restraint*. The design section moment capacity ($\phi M_{sx}$ – see Section 5.2.2.1) is also listed to allow easy calculation of $\phi M_b$ for other moment distributions, as well as the design shear capacity ($\phi V_v$ – see Section 5.2.2.4) for checking the interaction of shear force and bending. Additionally, the segment length for full lateral restraint (FLR) is also listed in these Tables.

**CHS and SHS are not included in these tables as they are generally not susceptible to flexural-torsional buckling.** For these sections, the design member moment capacity ($\phi M_b$) always equals the design section moment capacity ($\phi M_s$) except for the extreme case when the load acts far above the shear centre (Clause 5.6.1.4 of the Commentary to AS 4100 – Ref.[5.1]). Values of $\phi M_s$ (and $\phi V_v$) are given in Tables 8-1 to 8-2 for CHS and Tables 5.2-3 and 5.2-4 and/or Tables 8-5 and 8-6 for SHS.

### 5.3.2 Design Member Moment Capacity

Designers must ensure that the design bending moment ($M^* \leq \phi M_b$ for all beam segments. The tabulated values of design member moment capacity ($\phi M_b$) are determined in accordance with Clause 5.6.1.4 of AS 4100 as:

$\phi M_b = \phi \alpha_m \alpha_s M_s \leq \phi M_s$

where $\phi = 0.9$ (Table 3.4 of AS 4100)

$\alpha_m$ = moment modification factor (Clause 5.6.1.1 of AS 4100)

$= 1.0$ **(Assumed for all entries in the 5.3 series tables based on the uniform bending moment case)**

$\alpha_s$ = slenderness reduction modification factor (Clause 5.6.1.1 of AS 4100)

$$= 0.6\left\{\sqrt{\left[\left(\frac{M_s}{M_{oa}}\right)^2 + 3\right]} - \left(\frac{M_s}{M_{oa}}\right)\right\}$$ (Equation 5.6.1.1(2) of AS 4100)

$M_{oa} = M_o$ – the reference buckling moment (Clause 5.6.1.1(a)(iv)(A) of AS 4100)

$$= \sqrt{\left(\frac{\pi^2 E I_y}{L_e}\right) GJ}$$ (equation 5.6.1.1(3) of AS 4100 with $I_w = 0$ as required by Clause 5.6.1.4 of AS 4100)

$L_e$ = effective length of beam segment.

### 5.3.3 Beam Effective Length

The value of $\phi M_b$ depends on the effective length ($L_e$) of the flexural member. $L_e$ is determined by:

$L_e = k_t k_l k_r L$ (Clause 5.6.3 of AS 4100)

where $k_t$ = twist restraint factor (Table 5.6.3(1) of AS 4100)

$k_l$ = load height factor (Table 5.6.3(2) of AS 4100)

$k_r$ = lateral rotation restraint factor (Table 5.6.3(3) of AS 4100)

$L$ = length of segment

Ref. [5.4] provides guidance on the restraint conditions on flexural members provided by many common structural steelwork connections. Additionally, Ref. [5.5] considers further guidance on unbraced cantilevers.

### 5.3.4 Other Loading and Restraint Conditions

The design member moment capacities presented in the 5.3 series tables can be used for other loading conditions. For these situations the effective length ($L_e$) corresponding to the actual length and restraint conditions must be assessed and the appropriate value of $\alpha_m$ determined in accordance with Clause 5.6.1.1(a) of AS 4100. The design member moment capacity can then be determined as the *lesser* of:

$\phi M_{sx} = \phi f_y Z_{ex}$

and $\phi M_b = \phi \alpha_m \alpha_s f_y Z_{ex}$

where $\phi = 0.9$ (Table 3.4 of AS 4100)

$\phi M_b = \alpha_m$ times the value of $\phi M_b$ ($= \phi \alpha_s f_y Z_{ex}$) given in the 5.3 series tables.

**The 5.3 series tables are based on the most critical moment distribution – i.e. uniform moment over the entire beam segment ($\alpha_m = 1.0$). For other values of $\alpha_m$, designers should use the lesser of $\phi M_{sx}$ and $\alpha_m$ ($\phi M_b$) where $\phi M_b$ is the value given in the appropriate Table for the same effective length.**

## 5.3.5 Segment Length for Full Lateral Restraint (FLR)

Section 5.2.2.2 provides information for the calculation of FLR for RHS. The tabulated values of FLR in the 5.3 series tables are based on the conservative value of $\beta_m = -1.0$. Higher values of FLR may be obtained if transverse loads are present on the beam segment or if the end moments of the beam segment cause other than uniform bending moment – Clause 5.3.2.4 of AS 4100 should be consulted in these situations.

## 5.3.6 Examples

### 1. Beam with Restraint at Load Points and Ends

A simply supported beam as shown in Figure 5.4 has two concentrated loads applied to the top flange. Full lateral restraint is provided at the load points and the supports. The calculated design load at each point is 60 kN and includes an allowance for self weight. What thickness 200 x 100 RHS – Grade C450L0 (C450PLUS®) is required to support these loads for the strength limit state?

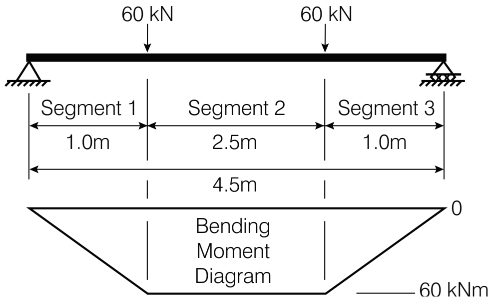


**Figure 5.4: Beam and loading configuration for Example 1**

<u>Design Data:</u>

Design bending moment $M^* = 60$ kNm
Design shear force $V^* = 60$ kN

<u>Solution – Moment and shear:</u>

For beam segment 2: the critical segment by inspection and using Clause 5.3.3 of AS 4100
End restraint condition = FF (i.e. fully restrained at both ends of the segment)
Twist restraint factor $k_t = 1.0$ (Table 5.6.3(1) of AS 4100)
Load height factor $k_l = 1.0$ (Table 5.6.3(2) of AS 4100)
Lateral rotation restraint factor $k_r = 0.7$ (Table 5.6.3(3) of AS 4100)

$\therefore$ Effective length $L_e = k_t \, k_l \, k_r \, L$
$= 1.0 \times 1.0 \times 0.7 \times 2.5$
$= 1.75$ m
$\cong 2.0$ m (say, for this example)

As a uniform bending moment is applied to beam segment 2, then $\alpha_m = 1.0$ (Table 5.6.1 of AS 4100). Thus the required section can be read directly from Table 5.3-2(2) for a uniform design bending moment of 60 kNm on segment 2 with an effective length ($L_e$) of 2.0 m.

$\therefore$ Choose a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) with:

$\phi M_b = 72.6 \text{ kNm} > M^*$
and $\phi V_v = 440 \text{ kN} > V^*$ (Note also $0.6\phi V_v \geq V^*$ and no shear – bending interaction check is required. See Section 5.2.4.)

It should also be noted that when looking at Table 5.3-2(2) from the “bottom-up” for the entries of $\phi M_b > 60.0$ kN in the $L_e = 2.0$ m column, the 150 x 100 RHS with 8.0, 9.0 and 10.0 mm thickness in C450PLUS® initially satisfy this inequality. However, the 200 x 100 x 5.0 RHS in C450PLUS® was selected as it satisfies the above inequality and is lower in mass (by at least 20%) and has greater stiffness (by at least 24%) than the above listed 150 x 100 RHS.

In terms of design member moment capacity, beam segments 1 and 3 do not have to be checked because they have the same design bending moment (i.e. the maximum segment moment) and end restraints but a shorter effective length when compared with the middle segment. Additionally, the bending moment distribution is less adverse in the end segments (with $\alpha_m = 1.75$ as noted in Table 5.6.1 of AS 4100). As the end segments have a smaller effective length and larger moment modification factor, the design member moment capacity of these segments cannot be less than that of the central (critical) segment.

This example specifically illustrates the use of the Tables for bending moment and shear design of unrestrained RHS beam sections possibly subject to flexural-torsional buckling (CHS and SHS do not generally experience this instability). However, due to the length, bending moment and restraint conditions, beam segment 2 has full lateral restraint (see Note 4 in Table 5.3-2(2)). The next example considers the above case but without full lateral restraint at the load points (making the RHS subject to flexural-torsional buckling). In all such situations, designers should also undertake checks on bearing (Section 5.2.2.5) and bending-bearing interaction (Section 5.2.5) for the strength limit state and deflections (Sections 5.1 and 5.4) for the serviceability limit state.

### 2. Beam with Restraints at Ends Only

Consider the simply supported beam in Example 1 above, check the beam assuming that full lateral restraint is **not** provided at the load points.

Design Data:

Design bending moment $M^* = 60$ kNm
Design shear force $V^* = 60$ kN

Solution – Moment and shear:

For entire beam:
End restraint condition = FF (i.e. fully restrained at both ends of the segment)
Twist restraint factor $k_t = 1.0$ (Table 5.6.3(1) of AS 4100)
Load height factor $k_l = 1.4$ (Table 5.6.3(2) of AS 4100 with top flange loading within segment)
Lateral rotation restraint factor $k_r = 1.0$ (Table 5.6.3(3) of AS 4100)
∴ Effective length $L_e = k_t\, k_l\, k_r\, L$
$= 1.0 \times 1.4 \times 1.0 \times 4.5$
$= 6.3$ m
Moment modification factor $\alpha_m = 1.07$ (Second listing in Table 5.6.1 of AS 4100)
To satisfy the strength limit state $M^* \leq \phi M_b = \phi\alpha_m\, \alpha_s\, M_{sx}\ (\leq \phi M_{sx})$
This can be rewritten as $M^*/\alpha_m = 60/1.07 = 56.1$ kNm
$\leq \phi(1.0)\alpha_s\, M_{sx}$

The right hand side of the last inequality is the value of $\phi M_b$ (based on $\alpha_m = 1.0$) that is found in Table 5.3-2(2).

To design this beam from these Tables
$M^*/\alpha_m = 56.1 \text{ kNm} < \phi M_b$ (listed in Table 5.3-2(2))

Therefore the appropriate section can then be read directly from the table using the adjusted design bending moment of $M^*/\alpha_m$.

From Table 5.3-2(2), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has:

$\phi M_b = 68.6$ kNm (for $L_e = 6.3$ m and $\alpha_m = 1.0$ by linear interpolation)
$> M^*/\alpha_m$ (= 56.1 kNm)

Alternatively, the listed value of $\phi M_b$ from Table 5.3-2(2) may be multiplied by $\alpha_m$ (=1.07) and limited if necessary to $\phi M_{sx}$. The resulting value then should be greater than or equal to $M^*$.

Hence, in terms of design member moment capacity, the 5.0 mm thick section is adequate – that is the same as in Example 1. The reason for this is due to the effect of the (more favourable) non-uniform moment distribution offsetting the negative effects of increased effective length. (An analysis of the effect of increasing effective length on RHS design member moment capacity sees the level of moment capacity reduction being only gradual).

Additionally, from Table 5.3-2(2), for the 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) section:

$\phi V_v = 440 \text{ kN} > V^*$ (Note also $0.6\phi V_v \geq V^*$ and no shear – bending interaction check is required. See Section 5.2.4.)

This example specifically illustrates the use of the Tables for bending moment and shear design of unrestrained RHS beam sections subject to flexural-torsional buckling (CHS and SHS do not generally experience this instability). In such situations, designers should also undertake checks on bearing (Section 5.2.2.5) and bending-bearing interaction (Section 5.2.5) for the strength limit state and deflections (Sections 5.1 and 5.4) for the serviceability limit state.

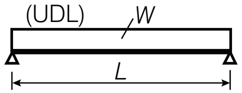
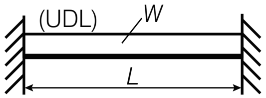
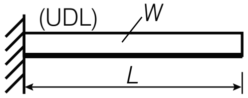
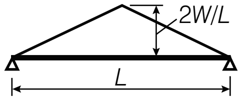
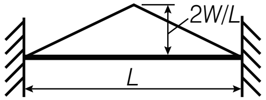
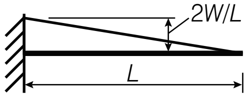
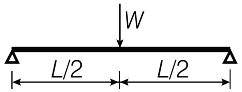
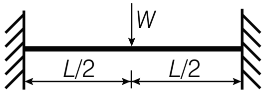
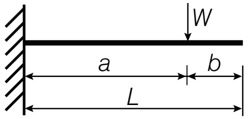
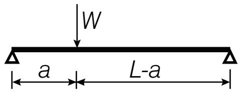
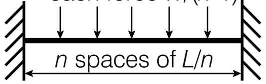
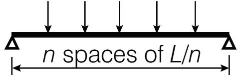
## 5.4 Calculation of Beam Deflections

Some methods for calculating the elastic deflection of a beam include:

(i) integration of *M/EI* diagram
(ii) moment area
(iii) slope deflection
(iv) published solutions for particular cases
(v) approximate or numerical methods (e.g. finite elements).

Table T5.2 gives the more commonly used beam deflection formulae. Due to the large range of loading configurations and support conditions considered for beams in design, a comprehensive set of beam deflection formulae is provided in Ref. [5.6].

**Table T5.2: Beam Deflection Formulae**

| Simple supported beams | | Built in beams | | Cantilevers | |
|---|---|---|---|---|---|
|  | $\Delta = \frac{5}{384} \frac{WL^3}{EI}$ |  | $\Delta = \frac{1}{384} \frac{WL^3}{EI}$ |  | $\Delta = \frac{1}{8} \frac{WL^3}{EI}$ |
|  | $\Delta = \frac{1}{60} \frac{WL^3}{EI}$ |  | $\Delta = \frac{1.4}{384} \frac{WL^3}{EI}$ |  | $\Delta = \frac{1}{15} \frac{WL^3}{EI}$ |
|  | $\Delta = \frac{1}{48} \frac{WL^3}{EI}$ |  | $\Delta = \frac{1}{192} \frac{WL^3}{EI}$ |  | $\Delta = \frac{Wa^3}{EI} \frac{1}{3} \left[1 + \frac{3b}{2a}\right]$ |
|  | $\Delta = \frac{WL^3}{48EI} \left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$ | each force $W/(n\text{-}1)$<br> | $\Delta = \frac{k}{192\left(n-1\right)} \frac{WL^3}{EI}$ | | |
| each force $W/(n\text{-}1)$<br> | $\Delta = \frac{k}{192\left(n-1\right)} \frac{WL^3}{EI}$ | | | | |
| $n$ odd, $k = \left[n - \frac{1}{n}\right]\left[3 - \frac{1}{2}\left(1 - \frac{1}{n^2}\right)\right]$<br>$n$ even, $k = n\left[3 - \frac{1}{2}\left(1 + \frac{4}{n^2}\right)\right]$ | | $n$ odd, $k = \left[n - \frac{1}{n}\right]\left[1 - \frac{1}{2}\left(1 - \frac{1}{n^2}\right)\right]$<br>$n$ even, $k = \left[3 - \frac{1}{2}\left(1 + \frac{4}{n^2}\right)\right] \times n - \left[2\left(n - \frac{1}{n}\right)\right]$ | | | |

Where:
$\Delta$ = maximum deflection
$W$ = total load on beam
$L$ = span of beam
$E$ = Young's modulus of elasticity
$I$ = second moment of area of cross-section

## 5.5 References

[5.1] Standards Australia, AS 4100 Supplement 1-1999: “Steel Structures Commentary” (Supplement to AS 4100–1998), Standards Australia, 1999.

[5.2] Trahair, N.S. and Bradford, M.A., “The Behaviour and Design of Steel Structures to AS 4100”, third edition – Australian, E & FN Spon, 1998.

[5.3] Bridge, R.Q. and Trahair, N.S., “Thin-Walled Beams”, Steel Construction, Vol. 15, No. 1, Australian Institute of Steel Construction, 1981 (Note: AISC is now ASI – the Australian Steel Institute).

[5.4] Trahair, N.S., Hogan, T.J. and Syam, A.A., “Design of Unbraced Beams”, Steel Construction, Vol. 27, No. 1, Australian Institute of Steel Construction, March 1993 (Note: AISC is now ASI – the Australian Steel Institute).

[5.5] Trahair, N.S., “Design of Unbraced Cantilevers”, Steel Construction, Vol. 27, No. 3, Australian Institute of Steel Construction, September 1993 (Note: AISC is now ASI – the Australian Steel Institute).

[5.6] Syam, A.A., “Beam Formulae”, Steel Construction, Vol. 26, No. 1, Australian Institute of Steel Construction, March 1992 (Note: AISC is now ASI – the Australian Steel Institute).

**See Section 1.1.2 for details on reference Standards.**

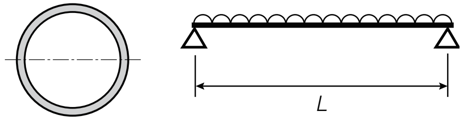
TABLE 5.1-1(A)

# Circular Hollow Sections
# AS/NZS 1163 Grade C250L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***bending about any axis***

| Designation | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | | | | | | | | | | |
| mm | | mm | | kg/m | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | kN |
| 165.1 | x | 5.4 | CHS | 21.3 | 496 | 248 | 165 | 124 | 99.2 | 82.7 | 70.9 | 62.0 | 55.1 | 49.6 | 41.3 | 35.4 | 31.0 | 27.6 | 439 |
| | | 5.0 | CHS | 19.7 | 462 | 231 | 154 | 115 | 92.3 | 76.9 | 65.9 | 57.7 | 51.3 | 46.2 | 38.5 | 33.0 | 28.8 | 25.6 | 407 |
| 139.7 | x | 5.4 | CHS | 17.9 | 351 | 175 | 117 | 87.7 | 70.2 | 58.5 | 50.1 | 43.9 | 39.0 | 35.1 | 29.2 | 25.1 | 21.9 | 19.5 | 369 |
| | | 5.0 | CHS | 16.6 | 327 | 163 | 109 | 81.7 | 65.3 | 54.5 | 46.7 | 40.8 | 36.3 | 32.7 | 27.2 | 23.3 | 20.4 | 18.2 | 343 |
| 114.3 | x | 5.4 | CHS | 14.5 | 231 | 115 | 76.9 | 57.7 | 46.1 | 38.5 | 33.0 | 28.8 | 25.6 | 23.1 | 19.2 | 16.5 | 14.4 | 12.8 | 299 |
| | | 4.5 | CHS | 12.2 | 195 | 97.7 | 65.1 | 48.9 | 39.1 | 32.6 | 27.9 | 24.4 | 21.7 | 19.5 | 16.3 | 14.0 | 12.2 | 10.9 | 251 |
| 101.6 | x | 5.0 | CHS | 11.9 | 168 | 84.1 | 56.0 | 42.0 | 33.6 | 28.0 | 24.0 | 21.0 | 18.7 | 16.8 | 14.0 | 12.0 | 10.5 | 9.34 | 246 |
| | | 4.0 | CHS | 9.63 | 137 | 68.6 | 45.7 | 34.3 | 27.4 | 22.9 | 19.6 | 17.2 | 15.2 | 13.7 | 11.4 | 9.80 | 8.58 | 7.62 | 199 |
| 88.9 | x | 5.9 | CHS | 12.1 | 147 | 73.3 | 48.9 | 36.6 | 29.3 | 24.4 | 20.9 | 18.3 | 16.3 | 14.7 | 12.2 | 10.5 | 9.16 | 8.14 | 249 |
| | | 5.0 | CHS | 10.3 | 127 | 63.4 | 42.3 | 31.7 | 25.4 | 21.1 | 18.1 | 15.9 | 14.1 | 12.7 | 10.6 | 9.06 | 7.93 | 7.05 | 213 |
| | | 4.0 | CHS | 8.38 | 104 | 51.9 | 34.6 | 26.0 | 20.8 | 17.3 | 14.8 | 13.0 | 11.5 | 10.4 | 8.66 | 7.42 | 6.49 | 5.77 | 173 |
| 76.1 | x | 5.9 | CHS | 10.2 | 105 | 52.5 | 35.0 | 26.2 | 21.0 | 17.5 | 15.0 | 13.1 | 11.7 | 10.5 | 8.74 | 7.49 | 6.56 | 5.83 | 211 |
| | | 4.5 | CHS | 7.95 | 83.2 | 41.6 | 27.7 | 20.8 | 16.6 | 13.9 | 11.9 | 10.4 | 9.24 | 8.32 | 6.93 | 5.94 | 5.20 | 4.62 | 164 |
| | | 3.6 | CHS | 6.44 | 68.2 | 34.1 | 22.7 | 17.0 | 13.6 | 11.4 | 9.74 | 8.52 | 7.58 | 6.82 | 5.68 | 4.87 | 4.26 | 3.79 | 133 |
| 60.3 | x | 5.4 | CHS | 7.31 | 58.8 | 29.4 | 19.6 | 14.7 | 11.8 | 9.80 | 8.40 | 7.35 | 6.53 | 5.88 | 4.90 | 4.20 | 3.67 | 3.27 | 151 |
| | | 4.5 | CHS | 6.19 | 50.6 | 25.3 | 16.9 | 12.6 | 10.1 | 8.43 | 7.22 | 6.32 | 5.62 | 5.06 | 4.21 | 3.61 | 3.16 | 2.81 | 128 |
| | | 3.6 | CHS | 5.03 | 41.7 | 20.9 | 13.9 | 10.4 | 8.34 | 6.95 | 5.96 | 5.22 | 4.64 | 4.17 | 3.48 | 2.98 | 2.61 | 2.32 | 104 |
| 48.3 | x | 4.0 | CHS | 4.37 | 28.3 | 14.2 | 9.45 | 7.08 | 5.67 | 4.72 | 4.05 | 3.54 | 3.15 | 2.83 | 2.36 | 2.02 | 1.77 | 1.57 | 90.2 |
| | | 3.2 | CHS | 3.56 | 23.5 | 11.7 | 7.82 | 5.87 | 4.69 | 3.91 | 3.35 | 2.93 | 2.61 | 2.35 | 1.96 | 1.68 | 1.47 | 1.30 | 73.4 |
| 42.4 | x | 4.0 | CHS | 3.79 | 21.3 | 10.7 | 7.10 | 5.33 | 4.26 | 3.55 | 3.04 | 2.66 | 2.37 | 2.13 | 1.78 | 1.52 | 1.33 | 1.18 | 78.2 |
| | | 3.2 | CHS | 3.09 | 17.7 | 8.87 | 5.91 | 4.44 | 3.55 | 2.96 | 2.53 | 2.22 | 1.97 | 1.77 | 1.48 | 1.27 | 1.11 | 0.986 | 63.8 |
| 33.7 | x | 4.0 | CHS | 2.93 | 12.8 | 6.39 | 4.26 | 3.19 | 2.56 | 2.13 | 1.83 | 1.60 | 1.42 | 1.28 | 1.06 | 0.913 | 0.799 | 0.710 | 60.5 |
| | | 3.2 | CHS | 2.41 | 10.8 | 5.38 | 3.59 | 2.69 | 2.15 | 1.79 | 1.54 | 1.34 | 1.20 | 1.08 | 0.896 | 0.768 | 0.672 | 0.598 | 49.7 |
| 26.9 | x | 4.0 | CHS | 2.26 | 7.63 | 3.81 | 2.54 | 1.91 | 1.53 | 1.27 | 1.09 | 0.954 | 0.848 | 0.763 | 0.636 | 0.545 | 0.477 | 0.424 | 46.6 |
| | | 3.2 | CHS | 1.87 | 6.51 | 3.25 | 2.17 | 1.63 | 1.30 | 1.08 | 0.930 | 0.814 | 0.723 | 0.651 | 0.542 | 0.465 | 0.407 | 0.362 | 38.6 |
| | | 2.6 | CHS | 1.56 | 5.55 | 2.77 | 1.85 | 1.39 | 1.11 | 0.925 | 0.793 | 0.694 | 0.616 | 0.555 | 0.462 | 0.396 | 0.347 | 0.308 | 32.2 |



## Notes:

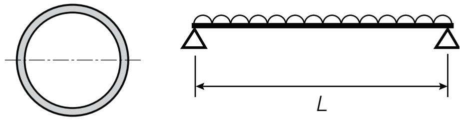
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
3. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load $W^*_{L}$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
5. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 5.1-1(B)

# Circular Hollow Sections
# AS/NZS 1163 Grade C250L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

***bending about any axis***



| Designation<br>$d_o$ | | t | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 |
| 165.1 | x | 5.4 | CHS | 21.3 | 419 | 209 | 140 | 105 | 83.8 | 59.0 | 43.4 | 33.2 | 26.2 | 21.3 | 14.8 | 10.8 | 8.30 | 6.56 |
| | | 5.0 | CHS | 19.7 | 391 | 195 | 130 | 97.7 | 78.2 | 55.1 | 40.5 | 31.0 | 24.5 | 19.8 | 13.8 | 10.1 | 7.74 | 6.12 |
| 139.7 | x | 5.4 | CHS | 17.9 | 295 | 147 | 98.2 | 73.7 | 50.6 | 35.1 | 25.8 | 19.8 | 15.6 | 12.6 | 8.78 | 6.45 | 4.94 | 3.90 |
| | | 5.0 | CHS | 16.6 | 275 | 138 | 91.7 | 68.8 | 47.2 | 32.8 | 24.1 | 18.5 | 14.6 | 11.8 | 8.20 | 6.03 | 4.61 | 3.64 |
| 114.3 | x | 5.4 | CHS | 14.5 | 192 | 96.1 | 64.1 | 42.2 | 27.0 | 18.7 | 13.8 | 10.5 | 8.33 | 6.75 | 4.69 | 3.44 | 2.64 | 2.08 |
| | | 4.5 | CHS | 12.2 | 164 | 82.0 | 54.7 | 36.0 | 23.0 | 16.0 | 11.8 | 9.00 | 7.11 | 5.76 | 4.00 | 2.94 | 2.25 | 1.78 |
| 101.6 | x | 5.0 | CHS | 11.9 | 140 | 69.9 | 46.6 | 27.3 | 17.4 | 12.1 | 8.90 | 6.81 | 5.38 | 4.36 | 3.03 | 2.23 | 1.70 | 1.35 |
| | | 4.0 | CHS | 9.63 | 115 | 57.6 | 38.4 | 22.5 | 14.4 | 9.99 | 7.34 | 5.62 | 4.44 | 3.60 | 2.50 | 1.83 | 1.40 | 1.11 |
| 88.9 | x | 5.9 | CHS | 12.1 | 120 | 59.9 | 36.4 | 20.5 | 13.1 | 9.09 | 6.68 | 5.11 | 4.04 | 3.27 | 2.27 | 1.67 | 1.28 | 1.01 |
| | | 5.0 | CHS | 10.3 | 105 | 52.4 | 31.8 | 17.9 | 11.4 | 7.94 | 5.84 | 4.47 | 3.53 | 2.86 | 1.99 | 1.46 | 1.12 | 0.883 |
| | | 4.0 | CHS | 8.38 | 86.7 | 43.3 | 26.3 | 14.8 | 9.47 | 6.58 | 4.83 | 3.70 | 2.92 | 2.37 | 1.64 | 1.21 | 0.925 | 0.731 |
| 76.1 | x | 5.9 | CHS | 10.2 | 84.9 | 42.4 | 22.0 | 12.4 | 7.94 | 5.51 | 4.05 | 3.10 | 2.45 | 1.98 | 1.38 | 1.01 | 0.775 | 0.612 |
| | | 4.5 | CHS | 7.95 | 68.5 | 34.2 | 17.8 | 10.0 | 6.40 | 4.45 | 3.27 | 2.50 | 1.98 | 1.60 | 1.11 | 0.817 | 0.625 | 0.494 |
| | | 3.6 | CHS | 6.44 | 56.8 | 28.4 | 14.7 | 8.30 | 5.31 | 3.69 | 2.71 | 2.07 | 1.64 | 1.33 | 0.922 | 0.677 | 0.518 | 0.410 |
| 60.3 | x | 5.4 | CHS | 7.31 | 47.0 | 21.8 | 9.67 | 5.44 | 3.48 | 2.42 | 1.78 | 1.36 | 1.07 | 0.871 | 0.605 | 0.444 | 0.340 | 0.269 |
| | | 4.5 | CHS | 6.19 | 41.0 | 19.0 | 8.44 | 4.75 | 3.04 | 2.11 | 1.55 | 1.19 | 0.938 | 0.759 | 0.527 | 0.387 | 0.297 | 0.234 |
| | | 3.6 | CHS | 5.03 | 34.3 | 15.9 | 7.07 | 3.97 | 2.54 | 1.77 | 1.30 | 0.994 | 0.785 | 0.636 | 0.442 | 0.324 | 0.248 | 0.196 |
| 48.3 | x | 4.0 | CHS | 4.37 | 22.8 | 8.46 | 3.76 | 2.11 | 1.35 | 0.940 | 0.691 | 0.529 | 0.418 | 0.338 | 0.235 | 0.173 | 0.132 | 0.104 |
| | | 3.2 | CHS | 3.56 | 19.2 | 7.12 | 3.16 | 1.78 | 1.14 | 0.791 | 0.581 | 0.445 | 0.352 | 0.285 | 0.198 | 0.145 | 0.111 | 0.0879 |
| 42.4 | x | 4.0 | CHS | 3.79 | 17.0 | 5.52 | 2.46 | 1.38 | 0.884 | 0.614 | 0.451 | 0.345 | 0.273 | 0.221 | 0.153 | 0.113 | 0.0863 | 0.0682 |
| | | 3.2 | CHS | 3.09 | 14.4 | 4.68 | 2.08 | 1.17 | 0.749 | 0.520 | 0.382 | 0.293 | 0.231 | 0.187 | 0.130 | 0.0955 | 0.0732 | 0.0578 |
| 33.7 | x | 4.0 | CHS | 2.93 | 9.95 | 2.57 | 1.14 | 0.644 | 0.412 | 0.286 | 0.210 | 0.161 | 0.127 | 0.103 | 0.0715 | 0.0525 | 0.0402 | 0.0318 |
| | | 3.2 | CHS | 2.41 | 8.56 | 2.21 | 0.984 | 0.554 | 0.354 | 0.246 | 0.181 | 0.138 | 0.109 | 0.0886 | 0.0615 | 0.0452 | 0.0346 | 0.0273 |
| 26.9 | x | 4.0 | CHS | 2.26 | 4.78 | 1.19 | 0.531 | 0.299 | 0.191 | 0.133 | 0.0975 | 0.0746 | 0.0590 | 0.0478 | 0.0332 | 0.0244 | | |
| | | 3.2 | CHS | 1.87 | 4.19 | 1.05 | 0.465 | 0.262 | 0.167 | 0.116 | 0.0854 | 0.0654 | 0.0517 | 0.0419 | 0.0291 | 0.0214 | | |
| | | 2.6 | CHS | 1.56 | 3.64 | 0.910 | 0.405 | 0.228 | 0.146 | 0.101 | 0.0743 | 0.0569 | 0.0450 | 0.0364 | 0.0253 | | | |

## Notes:

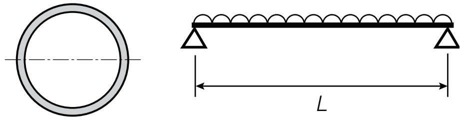
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.
4. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 5.1-2(1)(A)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***bending about any axis***



| Designation | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | | | | | | | | | | |
| mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | kN |
| 508.0 | x | 12.7 | CHS | 155 | 7700 | 3850 | 2570 | 1920 | 1540 | 1280 | 1100 | 962 | 855 | 770 | 700 | 641 | 592 | 550 | 4480 |
| | | 9.5 | CHS | 117 | 5470 | 2730 | 1820 | 1370 | 1090 | 911 | 781 | 683 | 607 | 547 | 497 | 455 | 420 | 390 | 3370 |
| | | 6.4 | CHS | 79.2 | 3260 | 1630 | 1090 | 816 | 653 | 544 | 466 | 408 | 363 | 326 | 297 | 272 | 251 | 233 | 2290 |
| 457.0 | x | 12.7 | CHS | 139 | 6310 | 3160 | 2100 | 1580 | 1260 | 1050 | 902 | 789 | 701 | 631 | 574 | 526 | 485 | 451 | 4020 |
| | | 9.5 | CHS | 105 | 4520 | 2260 | 1510 | 1130 | 904 | 753 | 646 | 565 | 502 | 452 | 411 | 377 | 348 | 323 | 3030 |
| | | 6.4 | CHS | 71.1 | 2750 | 1370 | 916 | 687 | 550 | 458 | 393 | 343 | 305 | 275 | 250 | 229 | 211 | 196 | 2050 |
| 406.4 | x | 12.7 | CHS | 123 | 4960 | 2480 | 1650 | 1240 | 992 | 827 | 709 | 620 | 551 | 496 | 451 | 414 | 382 | 354 | 3560 |
| | | 9.5 | CHS | 93.0 | 3650 | 1820 | 1220 | 912 | 730 | 608 | 521 | 456 | 405 | 365 | 332 | 304 | 281 | 261 | 2690 |
| | | 6.4 | CHS | 63.1 | 2260 | 1130 | 752 | 564 | 451 | 376 | 322 | 282 | 251 | 226 | 205 | 188 | 173 | 161 | 1820 |
| 355.6 | x | 12.7 | CHS | 107 | 3760 | 1880 | 1250 | 941 | 753 | 627 | 538 | 471 | 418 | 376 | 342 | 314 | 290 | 269 | 3100 |
| | | 9.5 | CHS | 81.1 | 2850 | 1420 | 948 | 711 | 569 | 474 | 406 | 356 | 316 | 285 | 259 | 237 | 219 | 203 | 2340 |
| | | 6.4 | CHS | 55.1 | 1790 | 894 | 596 | 447 | 358 | 298 | 255 | 224 | 199 | 179 | 163 | 149 | 138 | 128 | 1590 |
| 323.9 | x | 12.7 | CHS | 97.5 | 3100 | 1550 | 1030 | 775 | 620 | 517 | 443 | 388 | 345 | 310 | 282 | 258 | 239 | 222 | 2820 |
| | | 9.5 | CHS | 73.7 | 2370 | 1180 | 789 | 592 | 473 | 395 | 338 | 296 | 263 | 237 | 215 | 197 | 182 | 169 | 2130 |
| | | 6.4 | CHS | 50.1 | 1510 | 757 | 505 | 379 | 303 | 252 | 216 | 189 | 168 | 151 | 138 | 126 | 117 | 108 | 1450 |
| 273.1 | x | 12.7 | CHS | 81.6 | 2170 | 1090 | 724 | 543 | 434 | 362 | 310 | 271 | 241 | 217 | 197 | 181 | 167 | 155 | 2360 |
| | | 9.3 | CHS | 60.5 | 1630 | 816 | 544 | 408 | 326 | 272 | 233 | 204 | 181 | 163 | 148 | 136 | 126 | 117 | 1750 |
| | | 6.4 | CHS | 42.1 | 1110 | 555 | 370 | 278 | 222 | 185 | 159 | 139 | 123 | 111 | 101 | 92.5 | 85.4 | 79.3 | 1220 |
| | | 4.8 | CHS | 31.8 | 787 | 393 | 262 | 197 | 157 | 131 | 112 | 98.3 | 87.4 | 78.7 | 71.5 | 65.6 | 60.5 | 56.2 | 918 |
| 219.1 | x | 8.2 | CHS | 42.6 | 920 | 460 | 307 | 230 | 184 | 153 | 131 | 115 | 102 | 92.0 | 83.6 | 76.6 | 70.7 | 65.7 | 1230 |
| | | 6.4 | CHS | 33.6 | 730 | 365 | 243 | 182 | 146 | 122 | 104 | 91.2 | 81.1 | 73.0 | 66.4 | 60.8 | 56.1 | 52.1 | 970 |
| | | 4.8 | CHS | 25.4 | 530 | 265 | 177 | 133 | 106 | 88.3 | 75.7 | 66.3 | 58.9 | 53.0 | 48.2 | 44.2 | 40.8 | 37.9 | 733 |
| 168.3 | x | 7.1 | CHS | 28.2 | 465 | 233 | 155 | 116 | 93.0 | 77.5 | 66.5 | 58.2 | 51.7 | 46.5 | 42.3 | 38.8 | 35.8 | 33.2 | 815 |
| | | 6.4 | CHS | 25.6 | 423 | 211 | 141 | 106 | 84.6 | 70.5 | 60.4 | 52.9 | 47.0 | 42.3 | 38.5 | 35.2 | 32.5 | 30.2 | 738 |
| | | 4.8 | CHS | 19.4 | 323 | 162 | 108 | 80.9 | 64.7 | 53.9 | 46.2 | 40.4 | 35.9 | 32.3 | 29.4 | 27.0 | 24.9 | 23.1 | 559 |

### Notes:

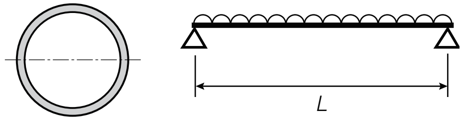
1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
3. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.

## TABLE 5.1-2(1)(B)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about any axis*



| Designation | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 |
| 508.0 | x | 12.7 | CHS | 155 | 6680 | 3340 | 2230 | 1670 | 1340 | 1030 | 760 | 582 | 460 | 373 | 308 | 259 | 220 | 190 |
| | | 9.5 | CHS | 117 | 5100 | 2550 | 1700 | 1270 | 1020 | 789 | 580 | 444 | 351 | 284 | 235 | 197 | 168 | 145 |
| | | 6.4 | CHS | 79.2 | 3500 | 1750 | 1170 | 874 | 699 | 541 | 398 | 305 | 241 | 195 | 161 | 135 | 115 | 99.4 |
| 457.0 | x | 12.7 | CHS | 139 | 5360 | 2680 | 1790 | 1340 | 1070 | 747 | 549 | 420 | 332 | 269 | 222 | 187 | 159 | 137 |
| | | 9.5 | CHS | 105 | 4100 | 2050 | 1370 | 1020 | 820 | 571 | 419 | 321 | 254 | 205 | 170 | 143 | 122 | 105 |
| | | 6.4 | CHS | 71.1 | 2820 | 1410 | 939 | 705 | 564 | 393 | 288 | 221 | 174 | 141 | 117 | 98.1 | 83.6 | 72.1 |
| 406.4 | x | 12.7 | CHS | 123 | 4200 | 2100 | 1400 | 1050 | 749 | 520 | 382 | 292 | 231 | 187 | 155 | 130 | 111 | 95.5 |
| | | 9.5 | CHS | 93.0 | 3220 | 1610 | 1070 | 804 | 574 | 398 | 293 | 224 | 177 | 143 | 119 | 99.6 | 84.8 | 73.2 |
| | | 6.4 | CHS | 63.1 | 2220 | 1110 | 739 | 554 | 395 | 275 | 202 | 154 | 122 | 98.9 | 81.7 | 68.6 | 58.5 | 50.4 |
| 355.6 | x | 12.7 | CHS | 107 | 3170 | 1590 | 1060 | 773 | 495 | 344 | 252 | 193 | 153 | 124 | 102 | 85.9 | 73.2 | 63.1 |
| | | 9.5 | CHS | 81.1 | 2440 | 1220 | 812 | 594 | 380 | 264 | 194 | 149 | 117 | 95.1 | 78.6 | 66.0 | 56.3 | 48.5 |
| | | 6.4 | CHS | 55.1 | 1690 | 843 | 562 | 411 | 263 | 183 | 134 | 103 | 81.2 | 65.8 | 54.4 | 45.7 | 38.9 | 33.6 |
| 323.9 | x | 12.7 | CHS | 97.5 | 2600 | 1300 | 868 | 578 | 370 | 257 | 189 | 145 | 114 | 92.5 | 76.4 | 64.2 | 54.7 | 47.2 |
| | | 9.5 | CHS | 73.7 | 2010 | 1000 | 669 | 446 | 285 | 198 | 146 | 111 | 88.0 | 71.3 | 58.9 | 49.5 | 42.2 | 36.4 |
| | | 6.4 | CHS | 50.1 | 1390 | 696 | 464 | 309 | 198 | 137 | 101 | 77.3 | 61.0 | 49.4 | 40.9 | 34.3 | 29.3 | 25.2 |
| 273.1 | x | 12.7 | CHS | 81.6 | 1810 | 905 | 603 | 339 | 217 | 151 | 111 | 84.7 | 67.0 | 54.2 | 44.8 | 37.7 | 32.1 | 27.7 |
| | | 9.3 | CHS | 60.5 | 1380 | 688 | 458 | 258 | 165 | 115 | 84.2 | 64.4 | 50.9 | 41.2 | 34.1 | 28.6 | 24.4 | 21.0 |
| | | 6.4 | CHS | 42.1 | 978 | 489 | 326 | 183 | 117 | 81.4 | 59.8 | 45.8 | 36.2 | 29.3 | 24.2 | 20.4 | 17.3 | 15.0 |
| | | 4.8 | CHS | 31.8 | 747 | 373 | 249 | 140 | 89.5 | 62.2 | 45.7 | 35.0 | 27.6 | 22.4 | 18.5 | 15.5 | 13.2 | 11.4 |
| 219.1 | x | 8.2 | CHS | 42.6 | 773 | 387 | 207 | 116 | 74.3 | 51.6 | 37.9 | 29.0 | 22.9 | 18.6 | 15.4 | 12.9 | 11.0 | 9.48 |
| | | 6.4 | CHS | 33.6 | 619 | 309 | 165 | 93.0 | 59.5 | 41.3 | 30.4 | 23.2 | 18.4 | 14.9 | 12.3 | 10.3 | 8.80 | 7.59 |
| | | 4.8 | CHS | 25.4 | 474 | 237 | 127 | 71.3 | 45.6 | 31.7 | 23.3 | 17.8 | 14.1 | 11.4 | 9.42 | 7.92 | 6.75 | 5.82 |
| 168.3 | x | 7.1 | CHS | 28.2 | 389 | 180 | 79.9 | 44.9 | 28.8 | 20.0 | 14.7 | 11.2 | 8.88 | 7.19 | 5.94 | 4.99 | 4.25 | 3.67 |
| | | 6.4 | CHS | 25.6 | 355 | 164 | 72.9 | 41.0 | 26.3 | 18.2 | 13.4 | 10.3 | 8.10 | 6.56 | 5.42 | 4.56 | 3.88 | 3.35 |
| | | 4.8 | CHS | 19.4 | 274 | 127 | 56.3 | 31.7 | 20.3 | 14.1 | 10.3 | 7.92 | 6.25 | 5.07 | 4.19 | 3.52 | 3.00 | 2.58 |

## Notes:

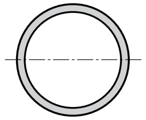
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.

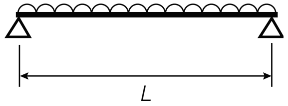
TABLE 5.1-2(2)(A)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## **STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***bending about any axis***





| Designation $d_o$ | | t | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | kN |
| 165.1 | x | 3.5 | CHS | 13.9 | 436 | 218 | 145 | 109 | 87.3 | 72.7 | 62.3 | 54.5 | 48.5 | 43.6 | 36.4 | 31.2 | 27.3 | 24.2 | 403 |
| | | 3.0 | CHS | 12.0 | 362 | 181 | 121 | 90.6 | 72.4 | 60.4 | 51.7 | 45.3 | 40.2 | 36.2 | 30.2 | 25.9 | 22.6 | 20.1 | 346 |
| 139.7 | x | 3.5 | CHS | 11.8 | 321 | 160 | 107 | 80.2 | 64.2 | 53.5 | 45.8 | 40.1 | 35.7 | 32.1 | 26.7 | 22.9 | 20.1 | 17.8 | 340 |
| | | 3.0 | CHS | 10.1 | 268 | 134 | 89.5 | 67.1 | 53.7 | 44.7 | 38.3 | 33.6 | 29.8 | 26.8 | 22.4 | 19.2 | 16.8 | 14.9 | 292 |
| 114.3 | x | 3.6 | CHS | 9.83 | 222 | 111 | 74.1 | 55.6 | 44.5 | 37.1 | 31.8 | 27.8 | 24.7 | 22.2 | 18.5 | 15.9 | 13.9 | 12.4 | 284 |
| | | 3.2 | CHS | 8.77 | 199 | 99.6 | 66.4 | 49.8 | 39.8 | 33.2 | 28.4 | 24.9 | 22.1 | 19.9 | 16.6 | 14.2 | 12.4 | 11.1 | 253 |
| 101.6 | x | 3.2 | CHS | 7.77 | 156 | 78.1 | 52.1 | 39.1 | 31.2 | 26.0 | 22.3 | 19.5 | 17.4 | 15.6 | 13.0 | 11.2 | 9.76 | 8.68 | 224 |
| | | 2.6 | CHS | 6.35 | 126 | 63.2 | 42.1 | 31.6 | 25.3 | 21.1 | 18.1 | 15.8 | 14.0 | 12.6 | 10.5 | 9.03 | 7.90 | 7.02 | 183 |
| 88.9 | x | 3.2 | CHS | 6.76 | 119 | 59.3 | 39.5 | 29.6 | 23.7 | 19.8 | 16.9 | 14.8 | 13.2 | 11.9 | 9.88 | 8.46 | 7.41 | 6.58 | 195 |
| | | 2.6 | CHS | 5.53 | 97.6 | 48.8 | 32.5 | 24.4 | 19.5 | 16.3 | 13.9 | 12.2 | 10.8 | 9.76 | 8.14 | 6.97 | 6.10 | 5.42 | 160 |
| 76.1 | x | 3.2 | CHS | 5.75 | 85.8 | 42.9 | 28.6 | 21.4 | 17.2 | 14.3 | 12.3 | 10.7 | 9.53 | 8.58 | 7.15 | 6.13 | 5.36 | 4.76 | 166 |
| | | 2.3 | CHS | 4.19 | 63.2 | 31.6 | 21.1 | 15.8 | 12.6 | 10.5 | 9.02 | 7.89 | 7.02 | 6.32 | 5.26 | 4.51 | 3.95 | 3.51 | 121 |
| 60.3 | x | 2.9 | CHS | 4.11 | 48.2 | 24.1 | 16.1 | 12.0 | 9.64 | 8.03 | 6.89 | 6.02 | 5.36 | 4.82 | 4.02 | 3.44 | 3.01 | 2.68 | 119 |
| | | 2.3 | CHS | 3.29 | 39.0 | 19.5 | 13.0 | 9.75 | 7.80 | 6.50 | 5.57 | 4.88 | 4.34 | 3.90 | 3.25 | 2.79 | 2.44 | 2.17 | 95.0 |
| 48.3 | x | 2.9 | CHS | 3.25 | 30.2 | 15.1 | 10.1 | 7.54 | 6.03 | 5.03 | 4.31 | 3.77 | 3.35 | 3.02 | 2.51 | 2.15 | 1.89 | 1.68 | 93.8 |
| | | 2.3 | CHS | 2.61 | 24.5 | 12.3 | 8.18 | 6.14 | 4.91 | 4.09 | 3.51 | 3.07 | 2.73 | 2.45 | 2.05 | 1.75 | 1.53 | 1.36 | 75.4 |
| 42.4 | x | 2.6 | CHS | 2.55 | 20.8 | 10.4 | 6.93 | 5.20 | 4.16 | 3.46 | 2.97 | 2.60 | 2.31 | 2.08 | 1.73 | 1.48 | 1.30 | 1.15 | 73.7 |
| | | 2.0 | CHS | 1.99 | 16.5 | 8.23 | 5.49 | 4.12 | 3.29 | 2.74 | 2.35 | 2.06 | 1.83 | 1.65 | 1.37 | 1.18 | 1.03 | 0.915 | 57.6 |
| 33.7 | x | 2.6 | CHS | 1.99 | 12.7 | 6.35 | 4.23 | 3.18 | 2.54 | 2.12 | 1.81 | 1.59 | 1.41 | 1.27 | 1.06 | 0.907 | 0.794 | 0.706 | 57.6 |
| | | 2.0 | CHS | 1.56 | 10.1 | 5.07 | 3.38 | 2.54 | 2.03 | 1.69 | 1.45 | 1.27 | 1.13 | 1.01 | 0.845 | 0.724 | 0.634 | 0.563 | 45.2 |
| 26.9 | x | 2.3 | CHS | 1.40 | 7.04 | 3.52 | 2.35 | 1.76 | 1.41 | 1.17 | 1.01 | 0.879 | 0.782 | 0.704 | 0.586 | 0.503 | 0.440 | 0.391 | 40.3 |
| | | 2.0 | CHS | 1.23 | 6.26 | 3.13 | 2.09 | 1.57 | 1.25 | 1.04 | 0.895 | 0.783 | 0.696 | 0.626 | 0.522 | 0.447 | 0.391 | 0.348 | 35.5 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
3. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.

TABLE 5.1-2(2)(B)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

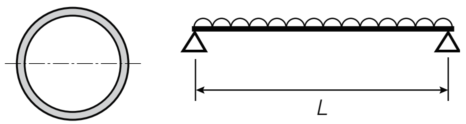
## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about any axis*

1 CHS

2 C350L0

3 Finish



| Designation $d_o$ | | t | | Mass per m | $W_S^*$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 |
| 165.1 | x | 3.5 | CHS | 13.9 | 394 | 197 | 131 | 89.1 | 57.0 | 39.6 | 29.1 | 22.3 | 17.6 | 14.3 | 9.90 | 7.28 | 5.57 | 4.40 |
| | | 3.0 | CHS | 12.0 | 341 | 170 | 114 | 77.1 | 49.3 | 34.3 | 25.2 | 19.3 | 15.2 | 12.3 | 8.57 | 6.29 | 4.82 | 3.81 |
| 139.7 | x | 3.5 | CHS | 11.8 | 279 | 139 | 92.9 | 53.4 | 34.2 | 23.7 | 17.4 | 13.3 | 10.5 | 8.54 | 5.93 | 4.36 | 3.34 | 2.64 |
| | | 3.0 | CHS | 10.1 | 241 | 121 | 80.5 | 46.2 | 29.6 | 20.6 | 15.1 | 11.6 | 9.14 | 7.40 | 5.14 | 3.78 | 2.89 | 2.28 |
| 114.3 | x | 3.6 | CHS | 9.83 | 188 | 94.1 | 52.4 | 29.5 | 18.9 | 13.1 | 9.63 | 7.37 | 5.82 | 4.72 | 3.28 | 2.41 | 1.84 | 1.46 |
| | | 3.2 | CHS | 8.77 | 169 | 84.5 | 47.1 | 26.5 | 17.0 | 11.8 | 8.65 | 6.62 | 5.23 | 4.24 | 2.94 | 2.16 | 1.66 | 1.31 |
| 101.6 | x | 3.2 | CHS | 7.77 | 132 | 66.1 | 32.7 | 18.4 | 11.8 | 8.18 | 6.01 | 4.60 | 3.64 | 2.95 | 2.05 | 1.50 | 1.15 | 0.909 |
| | | 2.6 | CHS | 6.35 | 109 | 54.6 | 27.1 | 15.2 | 9.75 | 6.77 | 4.97 | 3.81 | 3.01 | 2.44 | 1.69 | 1.24 | 0.952 | 0.752 |
| 88.9 | x | 3.2 | CHS | 6.76 | 99.8 | 48.7 | 21.6 | 12.2 | 7.79 | 5.41 | 3.97 | 3.04 | 2.40 | 1.95 | 1.35 | 0.993 | 0.760 | 0.601 |
| | | 2.6 | CHS | 5.53 | 82.8 | 40.4 | 17.9 | 10.1 | 6.46 | 4.48 | 3.29 | 2.52 | 1.99 | 1.61 | 1.12 | 0.824 | 0.631 | 0.498 |
| 76.1 | x | 3.2 | CHS | 5.75 | 71.8 | 30.0 | 13.3 | 7.49 | 4.80 | 3.33 | 2.45 | 1.87 | 1.48 | 1.20 | 0.832 | 0.612 | 0.468 | 0.370 |
| | | 2.3 | CHS | 4.19 | 53.5 | 22.3 | 9.92 | 5.58 | 3.57 | 2.48 | 1.82 | 1.40 | 1.10 | 0.893 | 0.620 | 0.456 | 0.349 | 0.276 |
| 60.3 | x | 2.9 | CHS | 4.11 | 40.1 | 13.3 | 5.90 | 3.32 | 2.12 | 1.47 | 1.08 | 0.829 | 0.655 | 0.531 | 0.369 | 0.271 | 0.207 | 0.164 |
| | | 2.3 | CHS | 3.29 | 32.8 | 10.8 | 4.82 | 2.71 | 1.74 | 1.20 | 0.885 | 0.678 | 0.536 | 0.434 | 0.301 | 0.221 | 0.169 | 0.134 |
| 48.3 | x | 2.9 | CHS | 3.25 | 24.8 | 6.57 | 2.92 | 1.64 | 1.05 | 0.730 | 0.537 | 0.411 | 0.325 | 0.263 | 0.183 | 0.134 | 0.103 | 0.0812 |
| | | 2.3 | CHS | 2.61 | 20.4 | 5.41 | 2.41 | 1.35 | 0.866 | 0.602 | 0.442 | 0.338 | 0.267 | 0.217 | 0.150 | 0.111 | 0.0846 | 0.0669 |
| 42.4 | x | 2.6 | CHS | 2.55 | 15.9 | 3.97 | 1.77 | 0.993 | 0.635 | 0.441 | 0.324 | 0.248 | 0.196 | 0.159 | 0.110 | 0.0811 | 0.0621 | 0.0490 |
| | | 2.0 | CHS | 1.99 | 12.8 | 3.19 | 1.42 | 0.797 | 0.510 | 0.354 | 0.260 | 0.199 | 0.158 | 0.128 | 0.0886 | 0.0651 | 0.0498 | 0.0394 |
| 33.7 | x | 2.6 | CHS | 1.99 | 7.60 | 1.90 | 0.845 | 0.475 | 0.304 | 0.211 | 0.155 | 0.119 | 0.0938 | 0.0760 | 0.0528 | 0.0388 | 0.0297 | 0.0235 |
| | | 2.0 | CHS | 1.56 | 6.17 | 1.54 | 0.686 | 0.386 | 0.247 | 0.171 | 0.126 | 0.0965 | 0.0762 | 0.0617 | 0.0429 | 0.0315 | 0.0241 | |
| 26.9 | x | 2.3 | CHS | 1.40 | 3.33 | 0.833 | 0.370 | 0.208 | 0.133 | 0.0926 | 0.0680 | 0.0521 | 0.0412 | 0.0333 | 0.0231 | | | |
| | | 2.0 | CHS | 1.23 | 3.00 | 0.750 | 0.333 | 0.187 | 0.120 | 0.0833 | 0.0612 | 0.0469 | 0.0370 | 0.0300 | 0.0208 | | | |

## Notes:

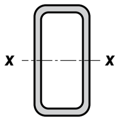
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W_S^*$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.

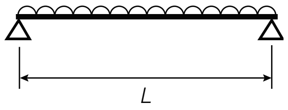
TABLE 5.1-3(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## **STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*





| Designation d | | b | | t | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | kN | m |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 50.7 | 33.8 | 25.4 | 20.3 | 16.9 | 14.5 | 12.7 | 10.1 | 8.45 | 7.24 | 6.34 | 5.63 | 5.07 | 4.23 | 123 | 1.47 |
| | | | | 2.0 | RHS | 2.93 | 41.9 | 27.9 | 20.9 | 16.8 | 14.0 | 12.0 | 10.5 | 8.38 | 6.98 | 5.98 | 5.23 | 4.65 | 4.19 | 3.49 | 99.9 | 1.50 |
| | | | | 1.6 | RHS | 2.38 | 34.3 | 22.9 | 17.2 | 13.7 | 11.4 | 9.81 | 8.59 | 6.87 | 5.72 | 4.91 | 4.29 | 3.82 | 3.43 | 2.86 | 80.8 | 1.53 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 66.9 | 44.6 | 33.5 | 26.8 | 22.3 | 19.1 | 16.7 | 13.4 | 11.2 | 9.56 | 8.37 | 7.44 | 6.69 | 5.58 | 165 | 3.10 |
| | | | | 3.0 | RHS | 4.25 | 55.4 | 36.9 | 27.7 | 22.2 | 18.5 | 15.8 | 13.8 | 11.1 | 9.23 | 7.91 | 6.92 | 6.16 | 5.54 | 4.62 | 128 | 3.23 |
| | | | | 2.5 | RHS | 3.60 | 47.6 | 31.8 | 23.8 | 19.1 | 15.9 | 13.6 | 11.9 | 9.53 | 7.94 | 6.81 | 5.96 | 5.29 | 4.76 | 3.97 | 108 | 3.28 |
| | | | | 2.0 | RHS | 2.93 | 39.3 | 26.2 | 19.7 | 15.7 | 13.1 | 11.2 | 9.83 | 7.86 | 6.55 | 5.62 | 4.91 | 4.37 | 3.93 | 3.28 | 88.2 | 3.33 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 29.5 | 19.7 | 14.8 | 11.8 | 9.85 | 8.44 | 7.39 | 5.91 | 4.92 | 4.22 | 3.69 | 3.28 | 2.95 | 2.46 | 95.0 | 2.08 |
| | | | | 2.5 | RHS | 2.62 | 25.7 | 17.2 | 12.9 | 10.3 | 8.58 | 7.35 | 6.43 | 5.15 | 4.29 | 3.68 | 3.22 | 2.86 | 2.57 | 2.14 | 81.0 | 2.12 |
| | | | | 2.0 | RHS | 2.15 | 21.5 | 14.3 | 10.7 | 8.59 | 7.16 | 6.14 | 5.37 | 4.30 | 3.58 | 3.07 | 2.69 | 2.39 | 2.15 | 1.79 | 66.2 | 2.17 |
| | | | | 1.6 | RHS | 1.75 | 17.8 | 11.8 | 8.88 | 7.11 | 5.92 | 5.08 | 4.44 | 3.55 | 2.96 | 2.54 | 2.22 | 1.97 | 1.78 | 1.48 | 53.9 | 2.21 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 26.0 | 17.3 | 13.0 | 10.4 | 8.66 | 7.43 | 6.50 | 5.20 | 4.33 | 3.71 | 3.25 | 2.89 | 2.60 | 2.17 | 93.8 | 1.31 |
| | | | | 2.5 | RHS | 2.42 | 22.7 | 15.2 | 11.4 | 9.10 | 7.58 | 6.50 | 5.68 | 4.55 | 3.79 | 3.25 | 2.84 | 2.53 | 2.27 | 1.89 | 80.0 | 1.35 |
| | | | | 2.0 | RHS | 1.99 | 19.1 | 12.7 | 9.53 | 7.63 | 6.35 | 5.45 | 4.77 | 3.81 | 3.18 | 2.72 | 2.38 | 2.12 | 1.91 | 1.59 | 65.4 | 1.39 |
| | | | | 1.6 | RHS | 1.63 | 15.8 | 10.5 | 7.91 | 6.33 | 5.27 | 4.52 | 3.95 | 3.16 | 2.64 | 2.26 | 1.98 | 1.76 | 1.58 | 1.32 | 53.2 | 1.42 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
3. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load $W_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
5. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with $\beta_m$ = -0.8.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

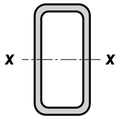
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

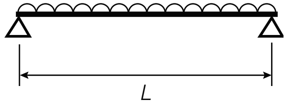
TABLE 5.1-3(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## ***SERVICEABILITY*** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*





| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 42.6 | 28.4 | 17.5 | 11.2 | 7.79 | 5.72 | 4.38 | 2.80 | 1.95 | 1.43 | 1.10 | 0.865 | 0.701 | 0.487 |
| | | | | 2.0 | RHS | 2.93 | 35.6 | 23.7 | 14.6 | 9.37 | 6.51 | 4.78 | 3.66 | 2.34 | 1.63 | 1.20 | 0.915 | 0.723 | 0.586 | 0.407 |
| | | | | 1.6 | RHS | 2.38 | 29.5 | 19.6 | 12.1 | 7.76 | 5.39 | 3.96 | 3.03 | 1.94 | 1.35 | 0.990 | 0.758 | 0.599 | 0.485 | 0.337 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 56.6 | 35.8 | 20.2 | 12.9 | 8.96 | 6.58 | 5.04 | 3.23 | 2.24 | 1.65 | 1.26 | 0.996 | 0.807 | 0.560 |
| | | | | 3.0 | RHS | 4.25 | 48.4 | 30.7 | 17.3 | 11.1 | 7.67 | 5.64 | 4.32 | 2.76 | 1.92 | 1.41 | 1.08 | 0.853 | 0.691 | 0.480 |
| | | | | 2.5 | RHS | 3.60 | 42.1 | 26.7 | 15.0 | 9.61 | 6.68 | 4.90 | 3.76 | 2.40 | 1.67 | 1.23 | 0.939 | 0.742 | 0.601 | 0.417 |
| | | | | 2.0 | RHS | 2.93 | 35.2 | 22.3 | 12.5 | 8.02 | 5.57 | 4.09 | 3.13 | 2.01 | 1.39 | 1.02 | 0.783 | 0.619 | 0.501 | 0.348 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 25.0 | 12.2 | 6.86 | 4.39 | 3.05 | 2.24 | 1.72 | 1.10 | 0.763 | 0.560 | 0.429 | 0.339 | 0.275 | 0.191 |
| | | | | 2.5 | RHS | 2.62 | 22.1 | 10.8 | 6.07 | 3.89 | 2.70 | 1.98 | 1.52 | 0.972 | 0.675 | 0.496 | 0.380 | 0.300 | 0.243 | 0.169 |
| | | | | 2.0 | RHS | 2.15 | 18.8 | 9.16 | 5.15 | 3.30 | 2.29 | 1.68 | 1.29 | 0.824 | 0.572 | 0.420 | 0.322 | 0.254 | 0.206 | 0.143 |
| | | | | 1.6 | RHS | 1.75 | 15.7 | 7.67 | 4.31 | 2.76 | 1.92 | 1.41 | 1.08 | 0.690 | 0.479 | 0.352 | 0.269 | 0.213 | 0.172 | 0.120 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 21.3 | 10.4 | 5.84 | 3.74 | 2.60 | 1.91 | 1.46 | 0.935 | 0.649 | 0.477 | 0.365 | 0.289 | 0.234 | 0.162 |
| | | | | 2.5 | RHS | 2.42 | 19.0 | 9.26 | 5.21 | 3.33 | 2.31 | 1.70 | 1.30 | 0.833 | 0.579 | 0.425 | 0.325 | 0.257 | 0.208 | 0.145 |
| | | | | 2.0 | RHS | 1.99 | 16.2 | 7.90 | 4.44 | 2.84 | 1.97 | 1.45 | 1.11 | 0.711 | 0.494 | 0.363 | 0.278 | 0.219 | 0.178 | 0.123 |
| | | | | 1.6 | RHS | 1.63 | 13.6 | 6.64 | 3.74 | 2.39 | 1.66 | 1.22 | 0.934 | 0.598 | 0.415 | 0.305 | 0.234 | 0.184 | 0.149 | 0.104 |

## Notes:

1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.

## ADDITIONAL NOTES:

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

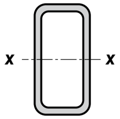
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

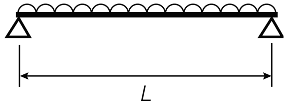
TABLE 5.1-4(1)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*





| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN)<br>Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | kN | m |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8920 | 4460 | 2970 | 2230 | 1780 | 1490 | 1270 | 1110 | 991 | 892 | 811 | 743 | 686 | 637 | 5570 | 29.8 |
| | | | | 12.5 | RHS | 128 | 7210 | 3610 | 2400 | 1800 | 1440 | 1200 | 1030 | 901 | 801 | 721 | 656 | 601 | 555 | 515 | 4440 | 30.2 |
| | | | | 10.0 | RHS | 104 | 5190 | 2590 | 1730 | 1300 | 1040 | 865 | 741 | 649 | 577 | 519 | 472 | 432 | 399 | 371 | 3600 | 30.5 |
| | | | | 8.0 | RHS | 84.2 | 3710 | 1850 | 1240 | 927 | 742 | 618 | 530 | 463 | 412 | 371 | 337 | 309 | 285 | 265 | 2910 | 30.7 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 6930 | 3460 | 2310 | 1730 | 1390 | 1150 | 990 | 866 | 770 | 693 | 630 | 577 | 533 | 495 | 5450 | 13.5 |
| | | | | 12.5 | RHS | 109 | 5640 | 2820 | 1880 | 1410 | 1130 | 940 | 806 | 705 | 627 | 564 | 513 | 470 | 434 | 403 | 4340 | 13.7 |
| | | | | 10.0 | RHS | 88.4 | 4650 | 2320 | 1550 | 1160 | 929 | 774 | 664 | 581 | 516 | 465 | 422 | 387 | 357 | 332 | 3520 | 13.9 |
| | | | | 8.0 | RHS | 71.6 | 3740 | 1870 | 1250 | 935 | 748 | 623 | 534 | 467 | 415 | 374 | 340 | 312 | 288 | 267 | 2840 | 14.1 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 6460 | 3230 | 2150 | 1610 | 1290 | 1080 | 922 | 807 | 717 | 646 | 587 | 538 | 497 | 461 | 4800 | 23.5 |
| | | | | 12.5 | RHS | 109 | 5250 | 2630 | 1750 | 1310 | 1050 | 876 | 751 | 657 | 584 | 525 | 478 | 438 | 404 | 375 | 3840 | 23.9 |
| | | | | 10.0 | RHS | 88.4 | 4260 | 2130 | 1420 | 1070 | 852 | 710 | 609 | 533 | 474 | 426 | 387 | 355 | 328 | 304 | 3120 | 24.2 |
| | | | | 8.0 | RHS | 71.6 | 3010 | 1500 | 1000 | 752 | 601 | 501 | 429 | 376 | 334 | 301 | 273 | 251 | 231 | 215 | 2520 | 24.4 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 4380 | 2190 | 1460 | 1100 | 877 | 731 | 626 | 548 | 487 | 438 | 399 | 365 | 337 | 313 | 4030 | 17.3 |
| | | | | 12.5 | RHS | 89.0 | 3600 | 1800 | 1200 | 901 | 720 | 600 | 515 | 450 | 400 | 360 | 327 | 300 | 277 | 257 | 3230 | 17.7 |
| | | | | 10.0 | RHS | 72.7 | 2980 | 1490 | 995 | 746 | 597 | 497 | 426 | 373 | 332 | 298 | 271 | 249 | 230 | 213 | 2630 | 18.0 |
| | | | | 8.0 | RHS | 59.1 | 2420 | 1210 | 805 | 604 | 483 | 403 | 345 | 302 | 268 | 242 | 220 | 201 | 186 | 173 | 2140 | 18.2 |
| | | | | 6.0 | RHS | 45.0 | 1540 | 768 | 512 | 384 | 307 | 256 | 220 | 192 | 171 | 154 | 140 | 128 | 118 | 110 | 1630 | 18.4 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 2700 | 1350 | 900 | 675 | 540 | 450 | 386 | 338 | 300 | 270 | 246 | 225 | 208 | 193 | 3260 | 11.5 |
| | | | | 12.5 | RHS | 69.4 | 2250 | 1130 | 751 | 563 | 451 | 376 | 322 | 282 | 250 | 225 | 205 | 188 | 173 | 161 | 2630 | 11.8 |
| | | | | 10.0 | RHS | 57.0 | 1890 | 943 | 629 | 471 | 377 | 314 | 269 | 236 | 210 | 189 | 171 | 157 | 145 | 135 | 2150 | 12.0 |
| | | | | 9.0 | RHS | 51.8 | 1730 | 864 | 576 | 432 | 345 | 288 | 247 | 216 | 192 | 173 | 157 | 144 | 133 | 123 | 1950 | 12.1 |
| | | | | 8.0 | RHS | 46.5 | 1560 | 781 | 521 | 391 | 312 | 260 | 223 | 195 | 174 | 156 | 142 | 130 | 120 | 112 | 1750 | 12.2 |
| | | | | 6.0 | RHS | 35.6 | 1190 | 597 | 398 | 298 | 239 | 199 | 171 | 149 | 133 | 119 | 109 | 99.5 | 91.8 | 85.3 | 1340 | 12.4 |
| | | | | 5.0 | RHS | 29.9 | 891 | 446 | 297 | 223 | 178 | 149 | 127 | 111 | 99.0 | 89.1 | 81.0 | 74.3 | 68.6 | 63.7 | 1120 | 12.5 |

## Notes:

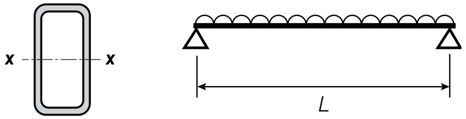
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
6. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with $\beta_m$ = -0.8.

TABLE 5.1-4(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8150 | 4070 | 2720 | 1740 | 1110 | 772 | 567 | 434 | 343 | 278 | 230 | 193 | 165 | 142 |
| | | | | 12.5 | RHS | 128 | 6670 | 3330 | 2220 | 1420 | 910 | 632 | 464 | 356 | 281 | 228 | 188 | 158 | 135 | 116 |
| | | | | 10.0 | RHS | 104 | 5510 | 2750 | 1840 | 1180 | 752 | 522 | 384 | 294 | 232 | 188 | 155 | 131 | 111 | 96.0 |
| | | | | 8.0 | RHS | 84.2 | 4520 | 2260 | 1510 | 965 | 617 | 429 | 315 | 241 | 191 | 154 | 128 | 107 | 91.3 | 78.7 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 6020 | 3010 | 2010 | 1280 | 822 | 571 | 419 | 321 | 254 | 206 | 170 | 143 | 122 | 105 |
| | | | | 12.5 | RHS | 109 | 4980 | 2490 | 1660 | 1060 | 680 | 472 | 347 | 265 | 210 | 170 | 140 | 118 | 101 | 86.7 |
| | | | | 10.0 | RHS | 88.4 | 4140 | 2070 | 1380 | 883 | 565 | 393 | 288 | 221 | 174 | 141 | 117 | 98.1 | 83.6 | 72.1 |
| | | | | 8.0 | RHS | 71.6 | 3420 | 1710 | 1140 | 729 | 466 | 324 | 238 | 182 | 144 | 117 | 96.3 | 81.0 | 69.0 | 59.5 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 5820 | 2910 | 1930 | 1090 | 695 | 483 | 355 | 271 | 214 | 174 | 144 | 121 | 103 | 88.6 |
| | | | | 12.5 | RHS | 109 | 4800 | 2400 | 1590 | 896 | 574 | 398 | 293 | 224 | 177 | 143 | 119 | 99.6 | 84.9 | 73.2 |
| | | | | 10.0 | RHS | 88.4 | 3990 | 2000 | 1320 | 745 | 477 | 331 | 243 | 186 | 147 | 119 | 98.5 | 82.8 | 70.6 | 60.8 |
| | | | | 8.0 | RHS | 71.6 | 3290 | 1650 | 1090 | 614 | 393 | 273 | 201 | 154 | 121 | 98.3 | 81.2 | 68.3 | 58.2 | 50.2 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 3870 | 1940 | 1100 | 619 | 396 | 275 | 202 | 155 | 122 | 99.1 | 81.9 | 68.8 | 58.6 | 50.6 |
| | | | | 12.5 | RHS | 89.0 | 3240 | 1620 | 921 | 518 | 332 | 230 | 169 | 130 | 102 | 82.9 | 68.5 | 57.6 | 49.0 | 42.3 |
| | | | | 10.0 | RHS | 72.7 | 2720 | 1360 | 772 | 434 | 278 | 193 | 142 | 109 | 85.8 | 69.5 | 57.4 | 48.3 | 41.1 | 35.5 |
| | | | | 8.0 | RHS | 59.1 | 2250 | 1130 | 641 | 361 | 231 | 160 | 118 | 90.1 | 71.2 | 57.7 | 47.7 | 40.1 | 34.1 | 29.4 |
| | | | | 6.0 | RHS | 45.0 | 1750 | 876 | 498 | 280 | 179 | 125 | 91.5 | 70.1 | 55.4 | 44.9 | 37.1 | 31.1 | 26.5 | 22.9 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 2310 | 1150 | 547 | 308 | 197 | 137 | 101 | 77.0 | 60.8 | 49.3 | 40.7 | 34.2 | 29.1 | 25.1 |
| | | | | 12.5 | RHS | 69.4 | 1970 | 986 | 468 | 263 | 168 | 117 | 85.9 | 65.8 | 52.0 | 42.1 | 34.8 | 29.2 | 24.9 | 21.5 |
| | | | | 10.0 | RHS | 57.0 | 1680 | 839 | 398 | 224 | 143 | 99.4 | 73.0 | 55.9 | 44.2 | 35.8 | 29.6 | 24.9 | 21.2 | 18.3 |
| | | | | 9.0 | RHS | 51.8 | 1550 | 773 | 367 | 206 | 132 | 91.6 | 67.3 | 51.5 | 40.7 | 33.0 | 27.3 | 22.9 | 19.5 | 16.8 |
| | | | | 8.0 | RHS | 46.5 | 1410 | 704 | 334 | 188 | 120 | 83.4 | 61.3 | 46.9 | 37.1 | 30.0 | 24.8 | 20.8 | 17.8 | 15.3 |
| | | | | 6.0 | RHS | 35.6 | 1110 | 553 | 262 | 147 | 94.3 | 65.5 | 48.1 | 36.8 | 29.1 | 23.6 | 19.5 | 16.4 | 13.9 | 12.0 |
| | | | | 5.0 | RHS | 29.9 | 942 | 471 | 223 | 126 | 80.4 | 55.8 | 41.0 | 31.4 | 24.8 | 20.1 | 16.6 | 14.0 | 11.9 | 10.3 |

## Notes:

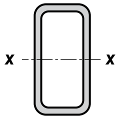
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.

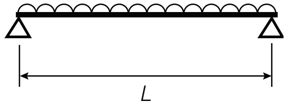
TABLE 5.1-4(2)(A)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS
## FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*





| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | kN | m |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 1030 | 515 | 344 | 258 | 206 | 172 | 147 | 129 | 115 | 103 | 93.7 | 85.9 | 79.3 | 73.6 | 1670 | 6.57 |
| | | | | 9.0 | RHS | 37.7 | 951 | 475 | 317 | 238 | 190 | 158 | 136 | 119 | 106 | 95.1 | 86.4 | 79.2 | 73.1 | 67.9 | 1520 | 6.65 |
| | | | | 8.0 | RHS | 33.9 | 866 | 433 | 289 | 216 | 173 | 144 | 124 | 108 | 96.2 | 86.6 | 78.7 | 72.2 | 66.6 | 61.9 | 1360 | 6.73 |
| | | | | 6.0 | RHS | 26.2 | 681 | 340 | 227 | 170 | 136 | 113 | 97.3 | 85.1 | 75.7 | 68.1 | 61.9 | 56.7 | 52.4 | 48.6 | 1040 | 6.89 |
| | | | | 5.0 | RHS | 22.1 | 581 | 290 | 194 | 145 | 116 | 96.8 | 83.0 | 72.6 | 64.5 | 58.1 | 52.8 | 48.4 | 44.7 | 41.5 | 879 | 6.97 |
| | | | | 4.0 | RHS | 17.9 | 467 | 234 | 156 | 117 | 93.5 | 77.9 | 66.8 | 58.4 | 51.9 | 46.7 | 42.5 | 38.9 | 36.0 | 33.4 | 711 | 7.04 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 376 | 188 | 125 | 94.0 | 75.2 | 62.7 | 53.7 | 47.0 | 41.8 | 37.6 | 34.2 | 31.3 | 28.9 | 26.9 | 778 | 5.12 |
| | | | | 5.0 | RHS | 16.4 | 323 | 162 | 108 | 80.8 | 64.7 | 53.9 | 46.2 | 40.4 | 35.9 | 32.3 | 29.4 | 26.9 | 24.9 | 23.1 | 657 | 5.20 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 645 | 323 | 215 | 161 | 129 | 108 | 92.2 | 80.7 | 71.7 | 64.5 | 58.7 | 53.8 | 49.6 | 46.1 | 1220 | 8.44 |
| | | | | 9.0 | RHS | 30.6 | 599 | 299 | 200 | 150 | 120 | 99.8 | 85.5 | 74.8 | 66.5 | 59.9 | 54.4 | 49.9 | 46.0 | 42.8 | 1120 | 8.55 |
| | | | | 8.0 | RHS | 27.7 | 548 | 274 | 183 | 137 | 110 | 91.3 | 78.3 | 68.5 | 60.9 | 54.8 | 49.8 | 45.7 | 42.2 | 39.1 | 1010 | 8.66 |
| | | | | 6.0 | RHS | 21.4 | 435 | 218 | 145 | 109 | 87.1 | 72.5 | 62.2 | 54.4 | 48.4 | 43.5 | 39.6 | 36.3 | 33.5 | 31.1 | 779 | 8.88 |
| | | | | 5.0 | RHS | 18.2 | 373 | 186 | 124 | 93.2 | 74.6 | 62.2 | 53.3 | 46.6 | 41.4 | 37.3 | 33.9 | 31.1 | 28.7 | 26.6 | 658 | 8.99 |
| | | | | 4.0 | RHS | 14.8 | 302 | 151 | 101 | 75.5 | 60.4 | 50.3 | 43.2 | 37.8 | 33.6 | 30.2 | 27.5 | 25.2 | 23.2 | 21.6 | 534 | 9.10 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 295 | 148 | 98.4 | 73.8 | 59.1 | 49.2 | 42.2 | 36.9 | 32.8 | 29.5 | 26.8 | 24.6 | 22.7 | 21.1 | 749 | 2.23 |
| | | | | 5.0 | RHS | 14.2 | 256 | 128 | 85.2 | 63.9 | 51.1 | 42.6 | 36.5 | 31.9 | 28.4 | 25.6 | 23.2 | 21.3 | 19.7 | 18.3 | 633 | 2.28 |
| | | | | 4.0 | RHS | 11.6 | 212 | 106 | 70.7 | 53.0 | 42.4 | 35.3 | 30.3 | 26.5 | 23.6 | 21.2 | 19.3 | 17.7 | 16.3 | 15.1 | 514 | 2.33 |
| | | | | 3.0 | RHS | 8.96 | 167 | 83.3 | 55.5 | 41.7 | 33.3 | 27.8 | 23.8 | 20.8 | 18.5 | 16.7 | 15.1 | 13.9 | 12.8 | 11.9 | 391 | 2.39 |
| | | | | 2.5 | RHS | 7.53 | 141 | 70.5 | 47.0 | 35.3 | 28.2 | 23.5 | 20.1 | 17.6 | 15.7 | 14.1 | 12.8 | 11.8 | 10.8 | 10.1 | 328 | 2.41 |
| | | | | 2.0 | RHS | 6.07 | 103 | 51.3 | 34.2 | 25.6 | 20.5 | 17.1 | 14.6 | 12.8 | 11.4 | 10.3 | 9.32 | 8.54 | 7.89 | 7.32 | 264 | 2.44 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 223 | 112 | 74.5 | 55.8 | 44.7 | 37.2 | 31.9 | 27.9 | 24.8 | 22.3 | 20.3 | 18.6 | 17.2 | 16.0 | 631 | 2.70 |
| | | | | 5.0 | RHS | 12.5 | 194 | 97.1 | 64.7 | 48.5 | 38.8 | 32.4 | 27.7 | 24.3 | 21.6 | 19.4 | 17.7 | 16.2 | 14.9 | 13.9 | 535 | 2.76 |
| | | | | 3.5 | RHS | 9.07 | 144 | 72.2 | 48.2 | 36.1 | 28.9 | 24.1 | 20.6 | 18.1 | 16.1 | 14.4 | 13.1 | 12.0 | 11.1 | 10.3 | 384 | 2.86 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 273 | 136 | 91.0 | 68.2 | 54.6 | 45.5 | 39.0 | 34.1 | 30.3 | 27.3 | 24.8 | 22.7 | 21.0 | 19.5 | 634 | 5.93 |
| | | | | 5.0 | RHS | 14.2 | 236 | 118 | 78.6 | 58.9 | 47.1 | 39.3 | 33.7 | 29.5 | 26.2 | 23.6 | 21.4 | 19.6 | 18.1 | 16.8 | 538 | 6.02 |
| | | | | 4.0 | RHS | 11.6 | 195 | 97.6 | 65.1 | 48.8 | 39.1 | 32.5 | 27.9 | 24.4 | 21.7 | 19.5 | 17.8 | 16.3 | 15.0 | 13.9 | 438 | 6.12 |
| | | | | 3.0 | RHS | 8.96 | 151 | 75.4 | 50.3 | 37.7 | 30.2 | 25.1 | 21.5 | 18.8 | 16.8 | 15.1 | 13.7 | 12.6 | 11.6 | 10.8 | 334 | 6.23 |
| | | | | 2.5 | RHS | 7.53 | 113 | 56.3 | 37.5 | 28.1 | 22.5 | 18.8 | 16.1 | 14.1 | 12.5 | 11.3 | 10.2 | 9.38 | 8.66 | 8.04 | 281 | 6.27 |
| | | | | 2.0 | RHS | 6.07 | 80.4 | 40.2 | 26.8 | 20.1 | 16.1 | 13.4 | 11.5 | 10.0 | 8.93 | 8.04 | 7.31 | 6.70 | 6.18 | 5.74 | 226 | 6.32 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 200 | 100 | 66.8 | 50.1 | 40.1 | 33.4 | 28.6 | 25.1 | 22.3 | 20.0 | 18.2 | 16.7 | 15.4 | 14.3 | 511 | 7.26 |
| | | | | 5.0 | RHS | 12.5 | 174 | 87.0 | 58.0 | 43.5 | 34.8 | 29.0 | 24.9 | 21.7 | 19.3 | 17.4 | 15.8 | 14.5 | 13.4 | 12.4 | 435 | 7.38 |
| | | | | 3.5 | RHS | 9.07 | 129 | 64.6 | 43.1 | 32.3 | 25.8 | 21.5 | 18.5 | 16.1 | 14.4 | 12.9 | 11.7 | 10.8 | 9.94 | 9.23 | 315 | 7.56 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
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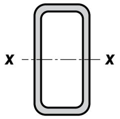
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
6. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with $\beta_m$ = -0.8.

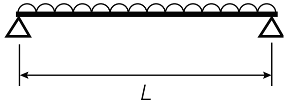
TABLE 5.1-4(2)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*





| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 880 | 375 | 167 | 93.9 | 60.1 | 41.7 | 30.6 | 23.5 | 18.5 | 15.0 | 12.4 | 10.4 | 8.89 | 7.66 |
| | | | | 9.0 | RHS | 37.7 | 819 | 350 | 155 | 87.4 | 55.9 | 38.8 | 28.5 | 21.8 | 17.3 | 14.0 | 11.6 | 9.71 | 8.27 | 7.13 |
| | | | | 8.0 | RHS | 33.9 | 753 | 321 | 143 | 80.3 | 51.4 | 35.7 | 26.2 | 20.1 | 15.9 | 12.8 | 10.6 | 8.92 | 7.60 | 6.55 |
| | | | | 6.0 | RHS | 26.2 | 602 | 257 | 114 | 64.2 | 41.1 | 28.5 | 21.0 | 16.1 | 12.7 | 10.3 | 8.49 | 7.13 | 6.08 | 5.24 |
| | | | | 5.0 | RHS | 22.1 | 518 | 221 | 98.1 | 55.2 | 35.3 | 24.5 | 18.0 | 13.8 | 10.9 | 8.83 | 7.30 | 6.13 | 5.23 | 4.51 |
| | | | | 4.0 | RHS | 17.9 | 427 | 182 | 81.0 | 45.5 | 29.1 | 20.2 | 14.9 | 11.4 | 9.00 | 7.29 | 6.02 | 5.06 | 4.31 | 3.72 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 327 | 106 | 47.2 | 26.5 | 17.0 | 11.8 | 8.66 | 6.63 | 5.24 | 4.24 | 3.51 | 2.95 | 2.51 | 2.17 |
| | | | | 5.0 | RHS | 16.4 | 284 | 92.3 | 41.0 | 23.1 | 14.8 | 10.3 | 7.53 | 5.77 | 4.56 | 3.69 | 3.05 | 2.56 | 2.18 | 1.88 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 558 | 178 | 79.3 | 44.6 | 28.5 | 19.8 | 14.6 | 11.2 | 8.81 | 7.14 | 5.90 | 4.96 | 4.22 | 3.64 |
| | | | | 9.0 | RHS | 30.6 | 523 | 167 | 74.4 | 41.8 | 26.8 | 18.6 | 13.7 | 10.5 | 8.26 | 6.69 | 5.53 | 4.65 | 3.96 | 3.42 |
| | | | | 8.0 | RHS | 27.7 | 484 | 155 | 68.8 | 38.7 | 24.8 | 17.2 | 12.6 | 9.68 | 7.65 | 6.19 | 5.12 | 4.30 | 3.67 | 3.16 |
| | | | | 6.0 | RHS | 21.4 | 392 | 126 | 55.8 | 31.4 | 20.1 | 13.9 | 10.2 | 7.84 | 6.20 | 5.02 | 4.15 | 3.49 | 2.97 | 2.56 |
| | | | | 5.0 | RHS | 18.2 | 339 | 109 | 48.3 | 27.2 | 17.4 | 12.1 | 8.87 | 6.79 | 5.36 | 4.34 | 3.59 | 3.02 | 2.57 | 2.22 |
| | | | | 4.0 | RHS | 14.8 | 282 | 90.1 | 40.1 | 22.5 | 14.4 | 10.0 | 7.36 | 5.63 | 4.45 | 3.61 | 2.98 | 2.50 | 2.13 | 1.84 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 243 | 77.7 | 34.5 | 19.4 | 12.4 | 8.63 | 6.34 | 4.86 | 3.84 | 3.11 | 2.57 | 2.16 | 1.84 | 1.59 |
| | | | | 5.0 | RHS | 14.2 | 213 | 68.2 | 30.3 | 17.1 | 10.9 | 7.58 | 5.57 | 4.26 | 3.37 | 2.73 | 2.26 | 1.89 | 1.61 | 1.39 |
| | | | | 4.0 | RHS | 11.6 | 179 | 57.4 | 25.5 | 14.3 | 9.18 | 6.38 | 4.68 | 3.59 | 2.83 | 2.30 | 1.90 | 1.59 | 1.36 | 1.17 |
| | | | | 3.0 | RHS | 8.96 | 143 | 45.9 | 20.4 | 11.5 | 7.34 | 5.10 | 3.74 | 2.87 | 2.26 | 1.83 | 1.52 | 1.27 | 1.09 | 0.936 |
| | | | | 2.5 | RHS | 7.53 | 122 | 39.0 | 17.3 | 9.76 | 6.24 | 4.34 | 3.19 | 2.44 | 1.93 | 1.56 | 1.29 | 1.08 | 0.924 | 0.796 |
| | | | | 2.0 | RHS | 6.07 | 99.6 | 31.9 | 14.2 | 7.97 | 5.10 | 3.54 | 2.60 | 1.99 | 1.57 | 1.28 | 1.05 | 0.885 | 0.754 | 0.651 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 186 | 50.3 | 22.4 | 12.6 | 8.05 | 5.59 | 4.11 | 3.15 | 2.49 | 2.01 | 1.66 | 1.40 | 1.19 | 1.03 |
| | | | | 5.0 | RHS | 12.5 | 164 | 44.5 | 19.8 | 11.1 | 7.11 | 4.94 | 3.63 | 2.78 | 2.20 | 1.78 | 1.47 | 1.23 | 1.05 | 0.907 |
| | | | | 3.5 | RHS | 9.07 | 125 | 33.8 | 15.0 | 8.46 | 5.41 | 3.76 | 2.76 | 2.11 | 1.67 | 1.35 | 1.12 | 0.940 | 0.801 | 0.690 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 240 | 63.9 | 28.4 | 16.0 | 10.2 | 7.10 | 5.22 | 3.99 | 3.16 | 2.56 | 2.11 | 1.78 | 1.51 | 1.30 |
| | | | | 5.0 | RHS | 14.2 | 210 | 55.9 | 24.9 | 14.0 | 8.95 | 6.21 | 4.56 | 3.50 | 2.76 | 2.24 | 1.85 | 1.55 | 1.32 | 1.14 |
| | | | | 4.0 | RHS | 11.6 | 176 | 46.9 | 20.8 | 11.7 | 7.50 | 5.21 | 3.83 | 2.93 | 2.32 | 1.88 | 1.55 | 1.30 | 1.11 | 0.957 |
| | | | | 3.0 | RHS | 8.96 | 140 | 37.3 | 16.6 | 9.33 | 5.97 | 4.14 | 3.05 | 2.33 | 1.84 | 1.49 | 1.23 | 1.04 | 0.883 | 0.761 |
| | | | | 2.5 | RHS | 7.53 | 119 | 31.7 | 14.1 | 7.93 | 5.08 | 3.52 | 2.59 | 1.98 | 1.57 | 1.27 | 1.05 | 0.881 | 0.751 | 0.647 |
| | | | | 2.0 | RHS | 6.07 | 97.1 | 25.9 | 11.5 | 6.47 | 4.14 | 2.88 | 2.11 | 1.62 | 1.28 | 1.04 | 0.856 | 0.719 | 0.613 | 0.528 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 155 | 38.7 | 17.2 | 9.68 | 6.20 | 4.30 | 3.16 | 2.42 | 1.91 | 1.55 | 1.28 | 1.08 | 0.917 | 0.790 |
| | | | | 5.0 | RHS | 12.5 | 136 | 34.1 | 15.2 | 8.53 | 5.46 | 3.79 | 2.78 | 2.13 | 1.68 | 1.36 | 1.13 | 0.948 | 0.807 | 0.696 |
| | | | | 3.5 | RHS | 9.07 | 103 | 25.9 | 11.5 | 6.47 | 4.14 | 2.87 | 2.11 | 1.62 | 1.28 | 1.03 | 0.855 | 0.718 | 0.612 | 0.528 |

## Notes:

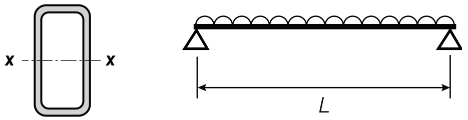
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.

TABLE 5.1-4(3)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | kN | m |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 294 | 196 | 147 | 118 | 97.9 | 83.9 | 73.5 | 58.8 | 49.0 | 42.0 | 36.7 | 32.6 | 29.4 | 24.5 | 489 | 3.21 |
| | | | | 5.0 | RHS | 10.3 | 258 | 172 | 129 | 103 | 85.9 | 73.6 | 64.4 | 51.5 | 42.9 | 36.8 | 32.2 | 28.6 | 25.8 | 21.5 | 417 | 3.29 |
| | | | | 4.0 | RHS | 8.49 | 216 | 144 | 108 | 86.6 | 72.2 | 61.9 | 54.1 | 43.3 | 36.1 | 30.9 | 27.1 | 24.1 | 21.6 | 18.0 | 341 | 3.37 |
| | | | | 3.5 | RHS | 7.53 | 194 | 129 | 97.0 | 77.6 | 64.7 | 55.4 | 48.5 | 38.8 | 32.3 | 27.7 | 24.2 | 21.6 | 19.4 | 16.2 | 301 | 3.40 |
| | | | | 3.0 | RHS | 6.60 | 173 | 115 | 86.4 | 69.1 | 57.6 | 49.4 | 43.2 | 34.5 | 28.8 | 24.7 | 21.6 | 19.2 | 17.3 | 14.4 | 261 | 3.45 |
| | | | | 2.5 | RHS | 5.56 | 147 | 97.9 | 73.5 | 58.8 | 49.0 | 42.0 | 36.7 | 29.4 | 24.5 | 21.0 | 18.4 | 16.3 | 14.7 | 12.2 | 220 | 3.49 |
| | | | | 2.0 | RHS | 4.50 | 118 | 78.6 | 59.0 | 47.2 | 39.3 | 33.7 | 29.5 | 23.6 | 19.7 | 16.9 | 14.7 | 13.1 | 11.8 | 9.83 | 178 | 3.53 |
| | | | | 1.6 | RHS | 3.64 | 80.8 | 53.9 | 40.4 | 32.3 | 26.9 | 23.1 | 20.2 | 16.2 | 13.5 | 11.5 | 10.1 | 8.98 | 8.08 | 6.73 | 143 | 3.56 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 117 | 78.3 | 58.7 | 47.0 | 39.2 | 33.6 | 29.4 | 23.5 | 19.6 | 16.8 | 14.7 | 13.1 | 11.7 | 9.79 | 252 | 2.48 |
| | | | | 3.0 | RHS | 4.90 | 95.9 | 64.0 | 48.0 | 38.4 | 32.0 | 27.4 | 24.0 | 19.2 | 16.0 | 13.7 | 12.0 | 10.7 | 9.59 | 7.99 | 194 | 2.57 |
| | | | | 2.5 | RHS | 4.15 | 82.2 | 54.8 | 41.1 | 32.9 | 27.4 | 23.5 | 20.5 | 16.4 | 13.7 | 11.7 | 10.3 | 9.13 | 8.22 | 6.85 | 164 | 2.61 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 182 | 121 | 90.9 | 72.7 | 60.6 | 52.0 | 45.5 | 36.4 | 30.3 | 26.0 | 22.7 | 20.2 | 18.2 | 15.2 | 356 | 4.11 |
| | | | | 5.0 | RHS | 8.35 | 161 | 108 | 80.7 | 64.5 | 53.8 | 46.1 | 40.3 | 32.3 | 26.9 | 23.0 | 20.2 | 17.9 | 16.1 | 13.4 | 306 | 4.22 |
| | | | | 4.0 | RHS | 6.92 | 137 | 91.3 | 68.5 | 54.8 | 45.7 | 39.1 | 34.3 | 27.4 | 22.8 | 19.6 | 17.1 | 15.2 | 13.7 | 11.4 | 252 | 4.33 |
| | | | | 3.0 | RHS | 5.42 | 111 | 73.8 | 55.4 | 44.3 | 36.9 | 31.6 | 27.7 | 22.1 | 18.5 | 15.8 | 13.8 | 12.3 | 11.1 | 9.23 | 195 | 4.45 |
| | | | | 2.5 | RHS | 4.58 | 94.6 | 63.0 | 47.3 | 37.8 | 31.5 | 27.0 | 23.6 | 18.9 | 15.8 | 13.5 | 11.8 | 10.5 | 9.46 | 7.88 | 165 | 4.51 |
| | | | | 2.0 | RHS | 3.72 | 76.4 | 50.9 | 38.2 | 30.5 | 25.5 | 21.8 | 19.1 | 15.3 | 12.7 | 10.9 | 9.54 | 8.48 | 7.64 | 6.36 | 134 | 4.56 |
| | | | | 1.6 | RHS | 3.01 | 53.5 | 35.7 | 26.8 | 21.4 | 17.8 | 15.3 | 13.4 | 10.7 | 8.92 | 7.65 | 6.69 | 5.95 | 5.35 | 4.46 | 108 | 4.60 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 65.2 | 43.5 | 32.6 | 26.1 | 21.7 | 18.6 | 16.3 | 13.0 | 10.9 | 9.31 | 8.15 | 7.24 | 6.52 | 5.43 | 158 | 1.14 |
| | | | | 2.0 | RHS | 2.93 | 53.8 | 35.9 | 26.9 | 21.5 | 17.9 | 15.4 | 13.5 | 10.8 | 8.97 | 7.69 | 6.73 | 5.98 | 5.38 | 4.49 | 128 | 1.17 |
| | | | | 1.6 | RHS | 2.38 | 44.2 | 29.4 | 22.1 | 17.7 | 14.7 | 12.6 | 11.0 | 8.83 | 7.36 | 6.31 | 5.52 | 4.91 | 4.42 | 3.68 | 104 | 1.19 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 86.0 | 57.4 | 43.0 | 34.4 | 28.7 | 24.6 | 21.5 | 17.2 | 14.3 | 12.3 | 10.8 | 9.56 | 8.60 | 7.17 | 212 | 2.41 |
| | | | | 3.0 | RHS | 4.25 | 71.2 | 47.5 | 35.6 | 28.5 | 23.7 | 20.3 | 17.8 | 14.2 | 11.9 | 10.2 | 8.90 | 7.91 | 7.12 | 5.94 | 165 | 2.51 |
| | | | | 2.5 | RHS | 3.60 | 61.3 | 40.8 | 30.6 | 24.5 | 20.4 | 17.5 | 15.3 | 12.3 | 10.2 | 8.75 | 7.66 | 6.81 | 6.13 | 5.10 | 139 | 2.55 |
| | | | | 2.0 | RHS | 2.93 | 50.5 | 33.7 | 25.3 | 20.2 | 16.8 | 14.4 | 12.6 | 10.1 | 8.42 | 7.22 | 6.32 | 5.62 | 5.05 | 4.21 | 113 | 2.59 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 38.0 | 25.3 | 19.0 | 15.2 | 12.7 | 10.9 | 9.50 | 7.60 | 6.33 | 5.43 | 4.75 | 4.22 | 3.80 | 3.17 | 122 | 1.61 |
| | | | | 2.5 | RHS | 2.62 | 33.1 | 22.1 | 16.5 | 13.2 | 11.0 | 9.45 | 8.27 | 6.62 | 5.51 | 4.73 | 4.14 | 3.68 | 3.31 | 2.76 | 104 | 1.65 |
| | | | | 2.0 | RHS | 2.15 | 27.6 | 18.4 | 13.8 | 11.0 | 9.21 | 7.89 | 6.91 | 5.52 | 4.60 | 3.95 | 3.45 | 3.07 | 2.76 | 2.30 | 85.2 | 1.69 |
| | | | | 1.6 | RHS | 1.75 | 22.8 | 15.2 | 11.4 | 9.14 | 7.61 | 6.53 | 5.71 | 4.57 | 3.81 | 3.26 | 2.86 | 2.54 | 2.28 | 1.90 | 69.3 | 1.72 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 33.4 | 22.3 | 16.7 | 13.4 | 11.1 | 9.55 | 8.36 | 6.68 | 5.57 | 4.77 | 4.18 | 3.71 | 3.34 | 2.79 | 121 | 1.02 |
| | | | | 2.5 | RHS | 2.42 | 29.2 | 19.5 | 14.6 | 11.7 | 9.74 | 8.35 | 7.31 | 5.85 | 4.87 | 4.18 | 3.65 | 3.25 | 2.92 | 2.44 | 103 | 1.05 |
| | | | | 2.0 | RHS | 1.99 | 24.5 | 16.3 | 12.3 | 9.80 | 8.17 | 7.00 | 6.13 | 4.90 | 4.08 | 3.50 | 3.06 | 2.72 | 2.45 | 2.04 | 84.1 | 1.08 |
| | | | | 1.6 | RHS | 1.63 | 20.3 | 13.6 | 10.2 | 8.13 | 6.78 | 5.81 | 5.08 | 4.07 | 3.39 | 2.91 | 2.54 | 2.26 | 2.03 | 1.69 | 68.4 | 1.10 |

## Notes:

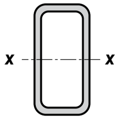
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
6. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with $\beta_m$ = -0.8.
7. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

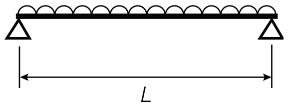
TABLE 5.1-4(3)(B)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## ***SERVICEABILITY*** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*





| Designation d | | b | | t | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 246 | 164 | 105 | 67.2 | 46.7 | 34.3 | 26.3 | 16.8 | 11.7 | 8.57 | 6.56 | 5.19 | 4.20 | 2.92 |
| | | | | 5.0 | RHS | 10.3 | 220 | 147 | 93.9 | 60.1 | 41.7 | 30.6 | 23.5 | 15.0 | 10.4 | 7.66 | 5.87 | 4.64 | 3.75 | 2.61 |
| | | | | 4.0 | RHS | 8.49 | 188 | 125 | 80.3 | 51.4 | 35.7 | 26.2 | 20.1 | 12.8 | 8.92 | 6.55 | 5.02 | 3.96 | 3.21 | 2.23 |
| | | | | 3.5 | RHS | 7.53 | 170 | 113 | 72.6 | 46.4 | 32.3 | 23.7 | 18.1 | 11.6 | 8.06 | 5.92 | 4.54 | 3.58 | 2.90 | 2.02 |
| | | | | 3.0 | RHS | 6.60 | 153 | 102 | 65.4 | 41.9 | 29.1 | 21.4 | 16.4 | 10.5 | 7.27 | 5.34 | 4.09 | 3.23 | 2.62 | 1.82 |
| | | | | 2.5 | RHS | 5.56 | 131 | 87.6 | 56.0 | 35.9 | 24.9 | 18.3 | 14.0 | 8.97 | 6.23 | 4.57 | 3.50 | 2.77 | 2.24 | 1.56 |
| | | | | 2.0 | RHS | 4.50 | 108 | 72.0 | 46.1 | 29.5 | 20.5 | 15.0 | 11.5 | 7.37 | 5.12 | 3.76 | 2.88 | 2.27 | 1.84 | 1.28 |
| | | | | 1.6 | RHS | 3.64 | 88.3 | 58.8 | 37.7 | 24.1 | 16.7 | 12.3 | 9.41 | 6.03 | 4.18 | 3.07 | 2.35 | 1.86 | 1.51 | 1.05 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 99.8 | 57.6 | 32.4 | 20.7 | 14.4 | 10.6 | 8.09 | 5.18 | 3.60 | 2.64 | 2.02 | 1.60 | 1.29 | 0.899 |
| | | | | 3.0 | RHS | 4.90 | 83.9 | 48.4 | 27.2 | 17.4 | 12.1 | 8.89 | 6.80 | 4.35 | 3.02 | 2.22 | 1.70 | 1.34 | 1.09 | 0.756 |
| | | | | 2.5 | RHS | 4.15 | 72.6 | 41.9 | 23.5 | 15.1 | 10.5 | 7.69 | 5.89 | 3.77 | 2.62 | 1.92 | 1.47 | 1.16 | 0.942 | 0.654 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 154 | 87.4 | 49.1 | 31.5 | 21.8 | 16.0 | 12.3 | 7.86 | 5.46 | 4.01 | 3.07 | 2.43 | 1.97 | 1.37 |
| | | | | 5.0 | RHS | 8.35 | 139 | 79.3 | 44.6 | 28.5 | 19.8 | 14.6 | 11.2 | 7.14 | 4.96 | 3.64 | 2.79 | 2.20 | 1.78 | 1.24 |
| | | | | 4.0 | RHS | 6.92 | 121 | 68.8 | 38.7 | 24.8 | 17.2 | 12.6 | 9.68 | 6.19 | 4.30 | 3.16 | 2.42 | 1.91 | 1.55 | 1.08 |
| | | | | 3.0 | RHS | 5.42 | 100 | 57.0 | 32.1 | 20.5 | 14.2 | 10.5 | 8.01 | 5.13 | 3.56 | 2.62 | 2.00 | 1.58 | 1.28 | 0.890 |
| | | | | 2.5 | RHS | 4.58 | 86.3 | 49.1 | 27.6 | 17.7 | 12.3 | 9.02 | 6.90 | 4.42 | 3.07 | 2.25 | 1.73 | 1.36 | 1.10 | 0.767 |
| | | | | 2.0 | RHS | 3.72 | 71.4 | 40.6 | 22.8 | 14.6 | 10.1 | 7.46 | 5.71 | 3.65 | 2.54 | 1.86 | 1.43 | 1.13 | 0.913 | 0.634 |
| | | | | 1.6 | RHS | 3.01 | 58.6 | 33.3 | 18.7 | 12.0 | 8.33 | 6.12 | 4.69 | 3.00 | 2.08 | 1.53 | 1.17 | 0.926 | 0.750 | 0.521 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 54.8 | 31.1 | 17.5 | 11.2 | 7.79 | 5.72 | 4.38 | 2.80 | 1.95 | 1.43 | 1.10 | 0.865 | 0.701 | 0.487 |
| | | | | 2.0 | RHS | 2.93 | 45.8 | 26.0 | 14.6 | 9.37 | 6.51 | 4.78 | 3.66 | 2.34 | 1.63 | 1.20 | 0.915 | 0.723 | 0.586 | 0.407 |
| | | | | 1.6 | RHS | 2.38 | 37.9 | 21.6 | 12.1 | 7.76 | 5.39 | 3.96 | 3.03 | 1.94 | 1.35 | 0.990 | 0.758 | 0.599 | 0.485 | 0.337 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 72.7 | 35.8 | 20.2 | 12.9 | 8.96 | 6.58 | 5.04 | 3.23 | 2.24 | 1.65 | 1.26 | 0.996 | 0.807 | 0.560 |
| | | | | 3.0 | RHS | 4.25 | 62.3 | 30.7 | 17.3 | 11.1 | 7.67 | 5.64 | 4.32 | 2.76 | 1.92 | 1.41 | 1.08 | 0.853 | 0.691 | 0.480 |
| | | | | 2.5 | RHS | 3.60 | 54.2 | 26.7 | 15.0 | 9.61 | 6.68 | 4.90 | 3.76 | 2.40 | 1.67 | 1.23 | 0.939 | 0.742 | 0.601 | 0.417 |
| | | | | 2.0 | RHS | 2.93 | 45.2 | 22.3 | 12.5 | 8.02 | 5.57 | 4.09 | 3.13 | 2.01 | 1.39 | 1.02 | 0.783 | 0.619 | 0.501 | 0.348 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 27.5 | 12.2 | 6.86 | 4.39 | 3.05 | 2.24 | 1.72 | 1.10 | 0.763 | 0.560 | 0.429 | 0.339 | 0.275 | 0.191 |
| | | | | 2.5 | RHS | 2.62 | 24.3 | 10.8 | 6.07 | 3.89 | 2.70 | 1.98 | 1.52 | 0.972 | 0.675 | 0.496 | 0.380 | 0.300 | 0.243 | 0.169 |
| | | | | 2.0 | RHS | 2.15 | 20.6 | 9.16 | 5.15 | 3.30 | 2.29 | 1.68 | 1.29 | 0.824 | 0.572 | 0.420 | 0.322 | 0.254 | 0.206 | 0.143 |
| | | | | 1.6 | RHS | 1.75 | 17.2 | 7.67 | 4.31 | 2.76 | 1.92 | 1.41 | 1.08 | 0.690 | 0.479 | 0.352 | 0.269 | 0.213 | 0.172 | 0.120 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 23.4 | 10.4 | 5.84 | 3.74 | 2.60 | 1.91 | 1.46 | 0.935 | 0.649 | 0.477 | 0.365 | 0.289 | 0.234 | 0.162 |
| | | | | 2.5 | RHS | 2.42 | 20.8 | 9.26 | 5.21 | 3.33 | 2.31 | 1.70 | 1.30 | 0.833 | 0.579 | 0.425 | 0.325 | 0.257 | 0.208 | 0.145 |
| | | | | 2.0 | RHS | 1.99 | 17.8 | 7.90 | 4.44 | 2.84 | 1.97 | 1.45 | 1.11 | 0.711 | 0.494 | 0.363 | 0.278 | 0.219 | 0.178 | 0.123 |
| | | | | 1.6 | RHS | 1.63 | 14.9 | 6.64 | 3.74 | 2.39 | 1.66 | 1.22 | 0.934 | 0.598 | 0.415 | 0.305 | 0.234 | 0.184 | 0.149 | 0.104 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.
5. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 5.1-5(A)

# Square Hollow Sections AS/NZS 1163 Grade C350L0

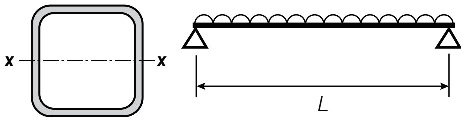
## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***bending about x-axis***

1 SHS

2 C350L0

3 Finish



| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | kN |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 73.2 | 48.8 | 36.6 | 29.3 | 24.4 | 20.9 | 18.3 | 14.6 | 12.2 | 10.5 | 9.16 | 8.14 | 7.32 | 6.10 | 170 |
| | | | | 5.0 | SHS | 6.39 | 66.3 | 44.2 | 33.2 | 26.5 | 22.1 | 18.9 | 16.6 | 13.3 | 11.1 | 9.47 | 8.29 | 7.37 | 6.63 | 5.53 | 149 |
| | | | | 4.0 | SHS | 5.35 | 57.4 | 38.2 | 28.7 | 22.9 | 19.1 | 16.4 | 14.3 | 11.5 | 9.56 | 8.19 | 7.17 | 6.37 | 5.74 | 4.78 | 125 |
| | | | | 3.0 | SHS | 4.25 | 47.3 | 31.5 | 23.7 | 18.9 | 15.8 | 13.5 | 11.8 | 9.46 | 7.89 | 6.76 | 5.91 | 5.26 | 4.73 | 3.94 | 98.6 |
| | | | | 2.5 | SHS | 3.60 | 40.7 | 27.1 | 20.3 | 16.3 | 13.6 | 11.6 | 10.2 | 8.14 | 6.78 | 5.81 | 5.09 | 4.52 | 4.07 | 3.39 | 84.0 |
| | | | | 2.0 | SHS | 2.93 | 33.6 | 22.4 | 16.8 | 13.4 | 11.2 | 9.59 | 8.39 | 6.72 | 5.60 | 4.80 | 4.20 | 3.73 | 3.36 | 2.80 | 68.7 |
| | | | | 1.6 | SHS | 2.38 | 25.7 | 17.1 | 12.9 | 10.3 | 8.57 | 7.35 | 6.43 | 5.14 | 4.29 | 3.67 | 3.21 | 2.86 | 2.57 | 2.14 | 55.9 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 33.9 | 22.6 | 17.0 | 13.6 | 11.3 | 9.70 | 8.49 | 6.79 | 5.66 | 4.85 | 4.24 | 3.77 | 3.39 | 2.83 | 95.6 |
| | | | | 3.0 | SHS | 3.30 | 28.8 | 19.2 | 14.4 | 11.5 | 9.62 | 8.24 | 7.21 | 5.77 | 4.81 | 4.12 | 3.61 | 3.21 | 2.88 | 2.40 | 76.2 |
| | | | | 2.5 | SHS | 2.82 | 25.0 | 16.7 | 12.5 | 10.0 | 8.34 | 7.15 | 6.26 | 5.01 | 4.17 | 3.58 | 3.13 | 2.78 | 2.50 | 2.09 | 65.3 |
| | | | | 2.0 | SHS | 2.31 | 20.8 | 13.9 | 10.4 | 8.33 | 6.94 | 5.95 | 5.21 | 4.17 | 3.47 | 2.98 | 2.60 | 2.31 | 2.08 | 1.74 | 53.8 |
| | | | | 1.6 | SHS | 1.88 | 17.2 | 11.5 | 8.60 | 6.88 | 5.73 | 4.91 | 4.30 | 3.44 | 2.87 | 2.46 | 2.15 | 1.91 | 1.72 | 1.43 | 44.0 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 21.3 | 14.2 | 10.7 | 8.53 | 7.10 | 6.09 | 5.33 | 4.26 | 3.55 | 3.04 | 2.66 | 2.37 | 2.13 | 1.78 | 65.0 |
| | | | | 2.5 | SHS | 2.42 | 18.6 | 12.4 | 9.31 | 7.45 | 6.21 | 5.32 | 4.66 | 3.72 | 3.10 | 2.66 | 2.33 | 2.07 | 1.86 | 1.55 | 56.0 |
| | | | | 2.0 | SHS | 1.99 | 15.6 | 10.4 | 7.80 | 6.24 | 5.20 | 4.46 | 3.90 | 3.12 | 2.60 | 2.23 | 1.95 | 1.73 | 1.56 | 1.30 | 46.3 |
| | | | | 1.6 | SHS | 1.63 | 12.9 | 8.62 | 6.47 | 5.17 | 4.31 | 3.70 | 3.23 | 2.59 | 2.16 | 1.85 | 1.62 | 1.44 | 1.29 | 1.08 | 38.0 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 14.9 | 9.94 | 7.46 | 5.97 | 4.97 | 4.26 | 3.73 | 2.98 | 2.49 | 2.13 | 1.86 | 1.66 | 1.49 | 1.24 | 53.8 |
| | | | | 2.5 | SHS | 2.03 | 13.2 | 8.77 | 6.58 | 5.26 | 4.38 | 3.76 | 3.29 | 2.63 | 2.19 | 1.88 | 1.64 | 1.46 | 1.32 | 1.10 | 46.7 |
| | | | | 2.0 | SHS | 1.68 | 11.1 | 7.41 | 5.56 | 4.45 | 3.70 | 3.18 | 2.78 | 2.22 | 1.85 | 1.59 | 1.39 | 1.23 | 1.11 | 0.926 | 38.8 |
| | | | | 1.6 | SHS | 1.38 | 9.28 | 6.19 | 4.64 | 3.71 | 3.09 | 2.65 | 2.32 | 1.86 | 1.55 | 1.33 | 1.16 | 1.03 | 0.928 | 0.773 | 32.0 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 9.65 | 6.43 | 4.83 | 3.86 | 3.22 | 2.76 | 2.41 | 1.93 | 1.61 | 1.38 | 1.21 | 1.07 | 0.965 | 0.804 | 42.6 |
| | | | | 2.5 | SHS | 1.64 | 8.63 | 5.75 | 4.32 | 3.45 | 2.88 | 2.47 | 2.16 | 1.73 | 1.44 | 1.23 | 1.08 | 0.959 | 0.863 | 0.719 | 37.3 |
| | | | | 2.0 | SHS | 1.36 | 7.39 | 4.93 | 3.69 | 2.96 | 2.46 | 2.11 | 1.85 | 1.48 | 1.23 | 1.06 | 0.924 | 0.821 | 0.739 | 0.616 | 31.4 |
| | | | | 1.6 | SHS | 1.12 | 6.23 | 4.15 | 3.11 | 2.49 | 2.08 | 1.78 | 1.56 | 1.25 | 1.04 | 0.890 | 0.779 | 0.692 | 0.623 | 0.519 | 26.0 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 4.42 | 2.95 | 2.21 | 1.77 | 1.47 | 1.26 | 1.10 | 0.884 | 0.737 | 0.631 | 0.552 | 0.491 | 0.442 | 0.368 | 23.9 |
| | | | | 1.6 | SHS | 0.873 | 3.78 | 2.52 | 1.89 | 1.51 | 1.26 | 1.08 | 0.946 | 0.757 | 0.631 | 0.540 | 0.473 | 0.420 | 0.378 | 0.315 | 20.1 |

**Notes:**

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
3. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

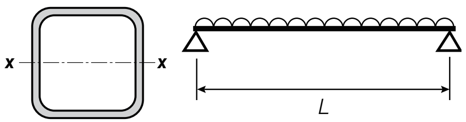
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 5.1-5(B)

# Square Hollow Sections
# AS/NZS 1163 Grade C350L0

## ***SERVICEABILITY*** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W_S^*$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 61.7 | 30.1 | 16.9 | 10.8 | 7.52 | 5.52 | 4.23 | 2.71 | 1.88 | 1.38 | 1.06 | 0.835 | 0.677 | 0.470 |
| | | | | 5.0 | SHS | 6.39 | 57.6 | 28.1 | 15.8 | 10.1 | 7.02 | 5.15 | 3.95 | 2.53 | 1.75 | 1.29 | 0.987 | 0.780 | 0.631 | 0.438 |
| | | | | 4.0 | SHS | 5.35 | 51.2 | 25.0 | 14.1 | 8.99 | 6.25 | 4.59 | 3.51 | 2.25 | 1.56 | 1.15 | 0.878 | 0.694 | 0.562 | 0.390 |
| | | | | 3.0 | SHS | 4.25 | 43.6 | 21.3 | 12.0 | 7.65 | 5.32 | 3.91 | 2.99 | 1.91 | 1.33 | 0.976 | 0.748 | 0.591 | 0.478 | 0.332 |
| | | | | 2.5 | SHS | 3.60 | 38.0 | 18.5 | 10.4 | 6.66 | 4.63 | 3.40 | 2.60 | 1.67 | 1.16 | 0.850 | 0.651 | 0.514 | 0.416 | 0.289 |
| | | | | 2.0 | SHS | 2.93 | 31.7 | 15.5 | 8.69 | 5.56 | 3.86 | 2.84 | 2.17 | 1.39 | 0.966 | 0.710 | 0.543 | 0.429 | 0.348 | 0.241 |
| | | | | 1.6 | SHS | 2.38 | 26.2 | 12.8 | 7.19 | 4.60 | 3.20 | 2.35 | 1.80 | 1.15 | 0.799 | 0.587 | 0.449 | 0.355 | 0.288 | 0.200 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 25.9 | 11.5 | 6.47 | 4.14 | 2.87 | 2.11 | 1.62 | 1.03 | 0.718 | 0.528 | 0.404 | 0.319 | 0.259 | 0.180 |
| | | | | 3.0 | SHS | 3.30 | 22.9 | 10.2 | 5.73 | 3.67 | 2.55 | 1.87 | 1.43 | 0.917 | 0.636 | 0.468 | 0.358 | 0.283 | 0.229 | 0.159 |
| | | | | 2.5 | SHS | 2.82 | 20.2 | 8.97 | 5.05 | 3.23 | 2.24 | 1.65 | 1.26 | 0.808 | 0.561 | 0.412 | 0.315 | 0.249 | 0.202 | 0.140 |
| | | | | 2.0 | SHS | 2.31 | 17.1 | 7.58 | 4.26 | 2.73 | 1.90 | 1.39 | 1.07 | 0.682 | 0.474 | 0.348 | 0.267 | 0.211 | 0.171 | 0.118 |
| | | | | 1.6 | SHS | 1.88 | 14.2 | 6.33 | 3.56 | 2.28 | 1.58 | 1.16 | 0.890 | 0.570 | 0.396 | 0.291 | 0.223 | 0.176 | 0.142 | 0.0989 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 14.6 | 6.50 | 3.65 | 2.34 | 1.62 | 1.19 | 0.914 | 0.585 | 0.406 | 0.298 | 0.228 | 0.180 | 0.146 | 0.102 |
| | | | | 2.5 | SHS | 2.42 | 13.0 | 5.78 | 3.25 | 2.08 | 1.44 | 1.06 | 0.812 | 0.520 | 0.361 | 0.265 | 0.203 | 0.160 | 0.130 | 0.0903 |
| | | | | 2.0 | SHS | 1.99 | 11.1 | 4.92 | 2.77 | 1.77 | 1.23 | 0.904 | 0.692 | 0.443 | 0.308 | 0.226 | 0.173 | 0.137 | 0.111 | 0.0769 |
| | | | | 1.6 | SHS | 1.63 | 9.31 | 4.14 | 2.33 | 1.49 | 1.03 | 0.760 | 0.582 | 0.372 | 0.259 | 0.190 | 0.145 | 0.115 | 0.0931 | 0.0647 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 8.61 | 3.83 | 2.15 | 1.38 | 0.957 | 0.703 | 0.538 | 0.344 | 0.239 | 0.176 | 0.135 | 0.106 | 0.0861 | 0.0598 |
| | | | | 2.5 | SHS | 2.03 | 7.76 | 3.45 | 1.94 | 1.24 | 0.862 | 0.633 | 0.485 | 0.310 | 0.215 | 0.158 | 0.121 | 0.0958 | 0.0776 | 0.0539 |
| | | | | 2.0 | SHS | 1.68 | 6.69 | 2.97 | 1.67 | 1.07 | 0.743 | 0.546 | 0.418 | 0.268 | 0.186 | 0.137 | 0.105 | 0.0826 | 0.0669 | 0.0465 |
| | | | | 1.6 | SHS | 1.38 | 5.67 | 2.52 | 1.42 | 0.908 | 0.630 | 0.463 | 0.355 | 0.227 | 0.158 | 0.116 | 0.0887 | 0.0701 | 0.0567 | 0.0394 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 4.52 | 2.01 | 1.13 | 0.724 | 0.503 | 0.369 | 0.283 | 0.181 | 0.126 | 0.0923 | 0.0707 | 0.0559 | 0.0452 | 0.0314 |
| | | | | 2.5 | SHS | 1.64 | 4.15 | 1.85 | 1.04 | 0.664 | 0.461 | 0.339 | 0.260 | 0.166 | 0.115 | 0.0848 | 0.0649 | 0.0513 | 0.0415 | 0.0288 |
| | | | | 2.0 | SHS | 1.36 | 3.65 | 1.62 | 0.911 | 0.583 | 0.405 | 0.298 | 0.228 | 0.146 | 0.101 | 0.0744 | 0.0570 | 0.0450 | 0.0365 | 0.0253 |
| | | | | 1.6 | SHS | 1.12 | 3.13 | 1.39 | 0.783 | 0.501 | 0.348 | 0.256 | 0.196 | 0.125 | 0.0870 | 0.0640 | 0.0490 | 0.0387 | 0.0313 | 0.0218 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 1.70 | 0.756 | 0.425 | 0.272 | 0.189 | 0.139 | 0.106 | 0.0680 | 0.0473 | 0.0347 | 0.0266 | 0.0210 | | |
| | | | | 1.6 | SHS | 0.873 | 1.49 | 0.664 | 0.373 | 0.239 | 0.166 | 0.122 | 0.0933 | 0.0597 | 0.0415 | 0.0305 | 0.0233 | | | |

## Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $W_S^*$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

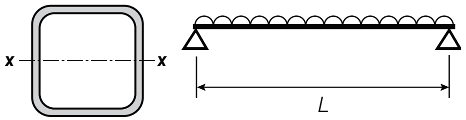
TABLE 5.1-6(1)(A)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*

1 SHS
2 C450PLUS®
3 Finish



| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | kN |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 10800 | 5380 | 3590 | 2690 | 2150 | 1790 | 1540 | 1350 | 1200 | 1080 | 979 | 897 | 828 | 769 | 5650 |
| | | | | 12.5 | SHS | 148 | 7490 | 3750 | 2500 | 1870 | 1500 | 1250 | 1070 | 937 | 832 | 749 | 681 | 624 | 576 | 535 | 4500 |
| | | | | 10.0 | SHS | 120 | 5360 | 2680 | 1790 | 1340 | 1070 | 894 | 766 | 670 | 596 | 536 | 487 | 447 | 412 | 383 | 3650 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 8190 | 4090 | 2730 | 2050 | 1640 | 1360 | 1170 | 1020 | 910 | 819 | 744 | 682 | 630 | 585 | 4880 |
| | | | | 12.5 | SHS | 128 | 6140 | 3070 | 2050 | 1540 | 1230 | 1020 | 878 | 768 | 683 | 614 | 558 | 512 | 473 | 439 | 3900 |
| | | | | 10.0 | SHS | 104 | 4380 | 2190 | 1460 | 1100 | 877 | 731 | 626 | 548 | 487 | 438 | 399 | 365 | 337 | 313 | 3170 |
| | | | | 8.0 | SHS | 84.2 | 3150 | 1570 | 1050 | 787 | 630 | 525 | 450 | 393 | 350 | 315 | 286 | 262 | 242 | 225 | 2570 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 5860 | 2930 | 1950 | 1460 | 1170 | 976 | 837 | 732 | 651 | 586 | 532 | 488 | 451 | 418 | 4120 |
| | | | | 12.5 | SHS | 109 | 4770 | 2380 | 1590 | 1190 | 953 | 794 | 681 | 596 | 530 | 477 | 433 | 397 | 367 | 340 | 3300 |
| | | | | 10.0 | SHS | 88.4 | 3490 | 1750 | 1160 | 873 | 698 | 582 | 499 | 436 | 388 | 349 | 317 | 291 | 269 | 249 | 2690 |
| | | | | 8.0 | SHS | 71.6 | 2490 | 1240 | 830 | 622 | 498 | 415 | 356 | 311 | 277 | 249 | 226 | 207 | 192 | 178 | 2180 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 3910 | 1960 | 1300 | 979 | 783 | 652 | 559 | 489 | 435 | 391 | 356 | 326 | 301 | 280 | 3350 |
| | | | | 12.5 | SHS | 89.0 | 3220 | 1610 | 1070 | 804 | 643 | 536 | 459 | 402 | 357 | 322 | 292 | 268 | 247 | 230 | 2700 |
| | | | | 10.0 | SHS | 72.7 | 2630 | 1310 | 876 | 657 | 526 | 438 | 375 | 329 | 292 | 263 | 239 | 219 | 202 | 188 | 2210 |
| | | | | 9.0 | SHS | 65.9 | 2260 | 1130 | 755 | 566 | 453 | 377 | 324 | 283 | 252 | 226 | 206 | 189 | 174 | 162 | 2000 |
| | | | | 8.0 | SHS | 59.1 | 1900 | 949 | 633 | 474 | 380 | 316 | 271 | 237 | 211 | 190 | 173 | 158 | 146 | 136 | 1800 |
| | | | | 6.0 | SHS | 45.0 | 1230 | 616 | 411 | 308 | 246 | 205 | 176 | 154 | 137 | 123 | 112 | 103 | 94.8 | 88.0 | 1370 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 2360 | 1180 | 787 | 590 | 472 | 393 | 337 | 295 | 262 | 236 | 215 | 197 | 182 | 169 | 2580 |
| | | | | 12.5 | SHS | 69.4 | 1970 | 984 | 656 | 492 | 394 | 328 | 281 | 246 | 219 | 197 | 179 | 164 | 151 | 141 | 2100 |
| | | | | 10.0 | SHS | 57.0 | 1650 | 823 | 549 | 412 | 329 | 274 | 235 | 206 | 183 | 165 | 150 | 137 | 127 | 118 | 1730 |
| | | | | 9.0 | SHS | 51.8 | 1510 | 754 | 503 | 377 | 302 | 251 | 215 | 188 | 168 | 151 | 137 | 126 | 116 | 108 | 1570 |
| | | | | 8.0 | SHS | 46.5 | 1350 | 673 | 449 | 336 | 269 | 224 | 192 | 168 | 150 | 135 | 122 | 112 | 104 | 96.1 | 1410 |
| | | | | 6.0 | SHS | 35.6 | 880 | 440 | 293 | 220 | 176 | 147 | 126 | 110 | 97.8 | 88.0 | 80.0 | 73.4 | 67.7 | 62.9 | 1080 |
| | | | | 5.0 | SHS | 29.9 | 670 | 335 | 223 | 168 | 134 | 112 | 95.7 | 83.8 | 74.5 | 67.0 | 60.9 | 55.9 | 51.6 | 47.9 | 912 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 872 | 436 | 291 | 218 | 174 | 145 | 125 | 109 | 96.9 | 87.2 | 79.3 | 72.7 | 67.1 | 62.3 | 1250 |
| | | | | 9.0 | SHS | 37.7 | 804 | 402 | 268 | 201 | 161 | 134 | 115 | 101 | 89.4 | 80.4 | 73.1 | 67.0 | 61.9 | 57.4 | 1140 |
| | | | | 8.0 | SHS | 33.9 | 732 | 366 | 244 | 183 | 146 | 122 | 105 | 91.5 | 81.3 | 73.2 | 66.6 | 61.0 | 56.3 | 52.3 | 1030 |
| | | | | 6.0 | SHS | 26.2 | 568 | 284 | 189 | 142 | 114 | 94.6 | 81.1 | 71.0 | 63.1 | 56.8 | 51.6 | 47.3 | 43.7 | 40.6 | 795 |
| | | | | 5.0 | SHS | 22.1 | 436 | 218 | 145 | 109 | 87.3 | 72.7 | 62.3 | 54.6 | 48.5 | 43.6 | 39.7 | 36.4 | 33.6 | 31.2 | 672 |

## Notes:

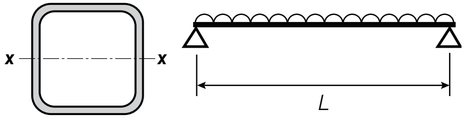
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W^*_{L}$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.

TABLE 5.1-6(1)(B)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 10300 | 5140 | 3420 | 2190 | 1400 | 974 | 715 | 548 | 433 | 351 | 290 | 243 | 207 | 179 |
| | | | | 12.5 | SHS | 148 | 8360 | 4180 | 2790 | 1780 | 1140 | 792 | 582 | 446 | 352 | 285 | 236 | 198 | 169 | 146 |
| | | | | 10.0 | SHS | 120 | 6880 | 3440 | 2290 | 1470 | 939 | 652 | 479 | 367 | 290 | 235 | 194 | 163 | 139 | 120 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 7650 | 3830 | 2540 | 1430 | 914 | 635 | 467 | 357 | 282 | 229 | 189 | 159 | 135 | 117 |
| | | | | 12.5 | SHS | 128 | 6270 | 3130 | 2080 | 1170 | 749 | 520 | 382 | 292 | 231 | 187 | 155 | 130 | 111 | 95.5 |
| | | | | 10.0 | SHS | 104 | 5180 | 2590 | 1720 | 967 | 619 | 430 | 316 | 242 | 191 | 155 | 128 | 107 | 91.6 | 79.0 |
| | | | | 8.0 | SHS | 84.2 | 4250 | 2130 | 1410 | 794 | 508 | 353 | 259 | 199 | 157 | 127 | 105 | 88.2 | 75.2 | 64.8 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 5420 | 2710 | 1540 | 867 | 555 | 386 | 283 | 217 | 171 | 139 | 115 | 96.4 | 82.1 | 70.8 |
| | | | | 12.5 | SHS | 109 | 4480 | 2240 | 1270 | 717 | 459 | 318 | 234 | 179 | 142 | 115 | 94.7 | 79.6 | 67.8 | 58.5 |
| | | | | 10.0 | SHS | 88.4 | 3720 | 1860 | 1060 | 596 | 381 | 265 | 195 | 149 | 118 | 95.4 | 78.8 | 66.2 | 56.4 | 48.6 |
| | | | | 8.0 | SHS | 71.6 | 3070 | 1540 | 874 | 492 | 315 | 218 | 161 | 123 | 97.1 | 78.6 | 65.0 | 54.6 | 46.5 | 40.1 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 3570 | 1790 | 847 | 476 | 305 | 212 | 156 | 119 | 94.1 | 76.2 | 63.0 | 52.9 | 45.1 | 38.9 |
| | | | | 12.5 | SHS | 89.0 | 2990 | 1490 | 709 | 399 | 255 | 177 | 130 | 99.6 | 78.7 | 63.8 | 52.7 | 44.3 | 37.7 | 32.5 |
| | | | | 10.0 | SHS | 72.7 | 2510 | 1250 | 594 | 334 | 214 | 149 | 109 | 83.6 | 66.0 | 53.5 | 44.2 | 37.1 | 31.7 | 27.3 |
| | | | | 9.0 | SHS | 65.9 | 2300 | 1150 | 545 | 307 | 196 | 136 | 100 | 76.6 | 60.6 | 49.1 | 40.5 | 34.1 | 29.0 | 25.0 |
| | | | | 8.0 | SHS | 59.1 | 2080 | 1040 | 494 | 278 | 178 | 123 | 90.6 | 69.4 | 54.8 | 44.4 | 36.7 | 30.8 | 26.3 | 22.7 |
| | | | | 6.0 | SHS | 45.0 | 1620 | 810 | 384 | 216 | 138 | 96.0 | 70.5 | 54.0 | 42.7 | 34.6 | 28.6 | 24.0 | 20.4 | 17.6 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 2110 | 899 | 400 | 225 | 144 | 99.9 | 73.4 | 56.2 | 44.4 | 36.0 | 29.7 | 25.0 | 21.3 | 18.4 |
| | | | | 12.5 | SHS | 69.4 | 1800 | 768 | 341 | 192 | 123 | 85.3 | 62.7 | 48.0 | 37.9 | 30.7 | 25.4 | 21.3 | 18.2 | 15.7 |
| | | | | 10.0 | SHS | 57.0 | 1530 | 653 | 290 | 163 | 104 | 72.6 | 53.3 | 40.8 | 32.2 | 26.1 | 21.6 | 18.1 | 15.5 | 13.3 |
| | | | | 9.0 | SHS | 51.8 | 1410 | 602 | 267 | 150 | 96.3 | 66.9 | 49.1 | 37.6 | 29.7 | 24.1 | 19.9 | 16.7 | 14.2 | 12.3 |
| | | | | 8.0 | SHS | 46.5 | 1280 | 548 | 243 | 137 | 87.6 | 60.9 | 44.7 | 34.2 | 27.1 | 21.9 | 18.1 | 15.2 | 13.0 | 11.2 |
| | | | | 6.0 | SHS | 35.6 | 1010 | 430 | 191 | 108 | 68.9 | 47.8 | 35.1 | 26.9 | 21.3 | 17.2 | 14.2 | 12.0 | 10.2 | 8.78 |
| | | | | 5.0 | SHS | 29.9 | 860 | 367 | 163 | 91.7 | 58.7 | 40.8 | 29.9 | 22.9 | 18.1 | 14.7 | 12.1 | 10.2 | 8.68 | 7.49 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 793 | 254 | 113 | 63.5 | 40.6 | 28.2 | 20.7 | 15.9 | 12.5 | 10.2 | 8.39 | 7.05 | 6.01 | 5.18 |
| | | | | 9.0 | SHS | 37.7 | 738 | 236 | 105 | 59.0 | 37.8 | 26.2 | 19.3 | 14.8 | 11.7 | 9.45 | 7.81 | 6.56 | 5.59 | 4.82 |
| | | | | 8.0 | SHS | 33.9 | 678 | 217 | 96.4 | 54.2 | 34.7 | 24.1 | 17.7 | 13.6 | 10.7 | 8.67 | 7.17 | 6.02 | 5.13 | 4.43 |
| | | | | 6.0 | SHS | 26.2 | 542 | 173 | 77.0 | 43.3 | 27.7 | 19.3 | 14.1 | 10.8 | 8.56 | 6.93 | 5.73 | 4.81 | 4.10 | 3.54 |
| | | | | 5.0 | SHS | 22.1 | 466 | 149 | 66.2 | 37.2 | 23.8 | 16.6 | 12.2 | 9.31 | 7.36 | 5.96 | 4.93 | 4.14 | 3.53 | 3.04 |

## Notes:

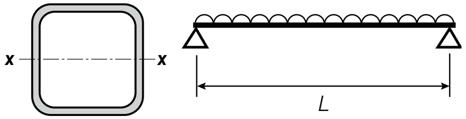
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.

TABLE 5.1-6(2)(A)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_{L1}$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | kN |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 576 | 288 | 192 | 144 | 115 | 96.0 | 82.3 | 72.0 | 64.0 | 57.6 | 52.4 | 48.0 | 44.3 | 41.2 | 1010 |
| | | | | 9.0 | SHS | 30.6 | 534 | 267 | 178 | 134 | 107 | 89.1 | 76.3 | 66.8 | 59.4 | 53.4 | 48.6 | 44.5 | 41.1 | 38.2 | 924 |
| | | | | 8.0 | SHS | 27.7 | 489 | 245 | 163 | 122 | 97.9 | 81.5 | 69.9 | 61.2 | 54.4 | 48.9 | 44.5 | 40.8 | 37.6 | 34.9 | 837 |
| | | | | 6.0 | SHS | 21.4 | 389 | 194 | 130 | 97.1 | 77.7 | 64.8 | 55.5 | 48.6 | 43.2 | 38.9 | 35.3 | 32.4 | 29.9 | 27.8 | 651 |
| | | | | 5.0 | SHS | 18.2 | 329 | 164 | 110 | 82.1 | 65.7 | 54.8 | 46.9 | 41.1 | 36.5 | 32.9 | 29.9 | 27.4 | 25.3 | 23.5 | 552 |
| | | | | 4.0 | SHS | 14.8 | 237 | 119 | 79.1 | 59.3 | 47.4 | 39.5 | 33.9 | 29.7 | 26.4 | 23.7 | 21.6 | 19.8 | 18.2 | 16.9 | 449 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 341 | 171 | 114 | 85.3 | 68.2 | 56.8 | 48.7 | 42.6 | 37.9 | 34.1 | 31.0 | 28.4 | 26.2 | 24.4 | 768 |
| | | | | 9.0 | SHS | 23.5 | 319 | 160 | 106 | 79.8 | 63.9 | 53.2 | 45.6 | 39.9 | 35.5 | 31.9 | 29.0 | 26.6 | 24.6 | 22.8 | 708 |
| | | | | 8.0 | SHS | 21.4 | 295 | 148 | 98.3 | 73.8 | 59.0 | 49.2 | 42.1 | 36.9 | 32.8 | 29.5 | 26.8 | 24.6 | 22.7 | 21.1 | 645 |
| | | | | 6.0 | SHS | 16.7 | 238 | 119 | 79.4 | 59.6 | 47.7 | 39.7 | 34.0 | 29.8 | 26.5 | 23.8 | 21.7 | 19.9 | 18.3 | 17.0 | 507 |
| | | | | 5.0 | SHS | 14.2 | 206 | 103 | 68.6 | 51.4 | 41.2 | 34.3 | 29.4 | 25.7 | 22.9 | 20.6 | 18.7 | 17.1 | 15.8 | 14.7 | 432 |
| | | | | 4.0 | SHS | 11.6 | 168 | 84.1 | 56.1 | 42.1 | 33.6 | 28.0 | 24.0 | 21.0 | 18.7 | 16.8 | 15.3 | 14.0 | 12.9 | 12.0 | 353 |
| | | | | 3.0 | SHS | 8.96 | 111 | 55.7 | 37.1 | 27.8 | 22.3 | 18.6 | 15.9 | 13.9 | 12.4 | 11.1 | 10.1 | 9.28 | 8.56 | 7.95 | 271 |
| | | | | 2.5 | SHS | 7.53 | 84.6 | 42.3 | 28.2 | 21.2 | 16.9 | 14.1 | 12.1 | 10.6 | 9.40 | 8.46 | 7.69 | 7.05 | 6.51 | 6.05 | 228 |
| | | | | 2.0 | SHS | 6.07 | 61.0 | 30.5 | 20.3 | 15.3 | 12.2 | 10.2 | 8.72 | 7.63 | 6.78 | 6.10 | 5.55 | 5.08 | 4.69 | 4.36 | 184 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 72.2 | 36.1 | 24.1 | 18.1 | 14.4 | 12.0 | 10.3 | 9.03 | 8.03 | 7.22 | 6.57 | 6.02 | 5.56 | 5.16 | 204 |
| | | | | 2.0 | SHS | 5.45 | 51.8 | 25.9 | 17.3 | 13.0 | 10.4 | 8.64 | 7.41 | 6.48 | 5.76 | 5.18 | 4.71 | 4.32 | 3.99 | 3.70 | 165 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 184 | 91.9 | 61.2 | 45.9 | 36.7 | 30.6 | 26.2 | 23.0 | 20.4 | 18.4 | 16.7 | 15.3 | 14.1 | 13.1 | 444 |
| | | | | 5.0 | SHS | 12.5 | 159 | 79.7 | 53.2 | 39.9 | 31.9 | 26.6 | 22.8 | 19.9 | 17.7 | 15.9 | 14.5 | 13.3 | 12.3 | 11.4 | 379 |
| | | | | 3.5 | SHS | 9.07 | 116 | 57.9 | 38.6 | 29.0 | 23.2 | 19.3 | 16.5 | 14.5 | 12.9 | 11.6 | 10.5 | 9.65 | 8.91 | 8.27 | 276 |
| | | | | 2.0 | SHS | 5.38 | 51.0 | 25.5 | 17.0 | 12.7 | 10.2 | 8.49 | 7.28 | 6.37 | 5.66 | 5.10 | 4.63 | 4.25 | 3.92 | 3.64 | 163 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 124 | 62.2 | 41.5 | 31.1 | 24.9 | 20.7 | 17.8 | 15.6 | 13.8 | 12.4 | 11.3 | 10.4 | 9.57 | 8.89 | 363 |
| | | | | 5.0 | SHS | 10.3 | 109 | 54.5 | 36.3 | 27.3 | 21.8 | 18.2 | 15.6 | 13.6 | 12.1 | 10.9 | 9.91 | 9.08 | 8.39 | 7.79 | 312 |
| | | | | 4.0 | SHS | 8.49 | 91.5 | 45.8 | 30.5 | 22.9 | 18.3 | 15.3 | 13.1 | 11.4 | 10.2 | 9.15 | 8.32 | 7.63 | 7.04 | 6.54 | 257 |
| | | | | 3.5 | SHS | 7.53 | 82.0 | 41.0 | 27.3 | 20.5 | 16.4 | 13.7 | 11.7 | 10.2 | 9.11 | 8.20 | 7.45 | 6.83 | 6.31 | 5.86 | 228 |
| | | | | 3.0 | SHS | 6.60 | 71.9 | 36.0 | 24.0 | 18.0 | 14.4 | 12.0 | 10.3 | 8.99 | 7.99 | 7.19 | 6.54 | 5.99 | 5.53 | 5.14 | 199 |
| | | | | 2.5 | SHS | 5.56 | 55.2 | 27.6 | 18.4 | 13.8 | 11.0 | 9.20 | 7.89 | 6.90 | 6.13 | 5.52 | 5.02 | 4.60 | 4.25 | 3.94 | 168 |
| | | | | 2.0 | SHS | 4.50 | 39.3 | 19.7 | 13.1 | 9.83 | 7.86 | 6.55 | 5.62 | 4.91 | 4.37 | 3.93 | 3.57 | 3.28 | 3.02 | 2.81 | 136 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 89.1 | 44.6 | 29.7 | 22.3 | 17.8 | 14.9 | 12.7 | 11.1 | 9.90 | 8.91 | 8.10 | 7.43 | 6.86 | 6.37 | 305 |
| | | | | 5.0 | SHS | 8.75 | 78.8 | 39.4 | 26.3 | 19.7 | 15.8 | 13.1 | 11.3 | 9.85 | 8.76 | 7.88 | 7.16 | 6.57 | 6.06 | 5.63 | 264 |
| | | | | 4.0 | SHS | 7.23 | 66.7 | 33.4 | 22.2 | 16.7 | 13.3 | 11.1 | 9.53 | 8.34 | 7.42 | 6.67 | 6.07 | 5.56 | 5.13 | 4.77 | 219 |
| | | | | 3.0 | SHS | 5.66 | 53.7 | 26.8 | 17.9 | 13.4 | 10.7 | 8.95 | 7.67 | 6.71 | 5.97 | 5.37 | 4.88 | 4.47 | 4.13 | 3.84 | 170 |
| | | | | 2.5 | SHS | 4.78 | 44.3 | 22.2 | 14.8 | 11.1 | 8.86 | 7.39 | 6.33 | 5.54 | 4.92 | 4.43 | 4.03 | 3.69 | 3.41 | 3.17 | 144 |
| | | | | 2.0 | SHS | 3.88 | 31.8 | 15.9 | 10.6 | 7.94 | 6.35 | 5.29 | 4.54 | 3.97 | 3.53 | 3.18 | 2.89 | 2.65 | 2.44 | 2.27 | 117 |
| | | | | 1.6 | SHS | 3.13 | 22.7 | 11.4 | 7.57 | 5.68 | 4.54 | 3.79 | 3.24 | 2.84 | 2.52 | 2.27 | 2.06 | 1.89 | 1.75 | 1.62 | 94.9 |

## Notes:

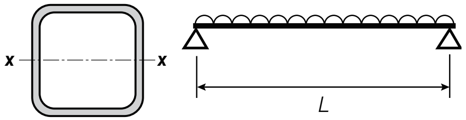
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W^*_{L}$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.

TABLE 5.1-6(2)(B)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## *SERVICEABILITY* LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 515 | 137 | 61.0 | 34.3 | 22.0 | 15.2 | 11.2 | 8.58 | 6.78 | 5.49 | 4.54 | 3.81 | 3.25 | 2.80 |
| | | | | 9.0 | SHS | 30.6 | 483 | 129 | 57.2 | 32.2 | 20.6 | 14.3 | 10.5 | 8.04 | 6.36 | 5.15 | 4.25 | 3.57 | 3.05 | 2.63 |
| | | | | 8.0 | SHS | 27.7 | 447 | 119 | 52.9 | 29.8 | 19.1 | 13.2 | 9.72 | 7.44 | 5.88 | 4.76 | 3.94 | 3.31 | 2.82 | 2.43 |
| | | | | 6.0 | SHS | 21.4 | 362 | 96.6 | 42.9 | 24.1 | 15.5 | 10.7 | 7.88 | 6.04 | 4.77 | 3.86 | 3.19 | 2.68 | 2.29 | 1.97 |
| | | | | 5.0 | SHS | 18.2 | 313 | 83.6 | 37.1 | 20.9 | 13.4 | 9.29 | 6.82 | 5.22 | 4.13 | 3.34 | 2.76 | 2.32 | 1.98 | 1.71 |
| | | | | 4.0 | SHS | 14.8 | 260 | 69.4 | 30.8 | 17.4 | 11.1 | 7.71 | 5.67 | 4.34 | 3.43 | 2.78 | 2.29 | 1.93 | 1.64 | 1.42 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 253 | 63.1 | 28.1 | 15.8 | 10.1 | 7.02 | 5.15 | 3.95 | 3.12 | 2.53 | 2.09 | 1.75 | 1.49 | 1.29 |
| | | | | 9.0 | SHS | 23.5 | 240 | 60.0 | 26.7 | 15.0 | 9.60 | 6.67 | 4.90 | 3.75 | 2.96 | 2.40 | 1.98 | 1.67 | 1.42 | 1.22 |
| | | | | 8.0 | SHS | 21.4 | 225 | 56.2 | 25.0 | 14.1 | 8.99 | 6.25 | 4.59 | 3.51 | 2.78 | 2.25 | 1.86 | 1.56 | 1.33 | 1.15 |
| | | | | 6.0 | SHS | 16.7 | 187 | 46.6 | 20.7 | 11.7 | 7.46 | 5.18 | 3.81 | 2.92 | 2.30 | 1.87 | 1.54 | 1.30 | 1.10 | 0.952 |
| | | | | 5.0 | SHS | 14.2 | 163 | 40.8 | 18.1 | 10.2 | 6.53 | 4.53 | 3.33 | 2.55 | 2.02 | 1.63 | 1.35 | 1.13 | 0.966 | 0.833 |
| | | | | 4.0 | SHS | 11.6 | 137 | 34.2 | 15.2 | 8.56 | 5.48 | 3.80 | 2.79 | 2.14 | 1.69 | 1.37 | 1.13 | 0.951 | 0.810 | 0.699 |
| | | | | 3.0 | SHS | 8.96 | 109 | 27.2 | 12.1 | 6.80 | 4.35 | 3.02 | 2.22 | 1.70 | 1.34 | 1.09 | 0.899 | 0.755 | 0.644 | 0.555 |
| | | | | 2.5 | SHS | 7.53 | 92.5 | 23.1 | 10.3 | 5.78 | 3.70 | 2.57 | 1.89 | 1.45 | 1.14 | 0.925 | 0.765 | 0.643 | 0.548 | 0.472 |
| | | | | 2.0 | SHS | 6.07 | 75.6 | 18.9 | 8.40 | 4.72 | 3.02 | 2.10 | 1.54 | 1.18 | 0.933 | 0.756 | 0.625 | 0.525 | 0.447 | 0.386 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 66.7 | 16.7 | 7.41 | 4.17 | 2.67 | 1.85 | 1.36 | 1.04 | 0.823 | 0.667 | 0.551 | 0.463 | 0.395 | 0.340 |
| | | | | 2.0 | SHS | 5.45 | 54.6 | 13.6 | 6.07 | 3.41 | 2.18 | 1.52 | 1.11 | 0.853 | 0.674 | 0.546 | 0.451 | 0.379 | 0.323 | 0.279 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 127 | 31.7 | 14.1 | 7.92 | 5.07 | 3.52 | 2.59 | 1.98 | 1.57 | 1.27 | 1.05 | 0.880 | 0.750 | 0.647 |
| | | | | 5.0 | SHS | 12.5 | 112 | 27.9 | 12.4 | 6.98 | 4.47 | 3.10 | 2.28 | 1.75 | 1.38 | 1.12 | 0.923 | 0.776 | 0.661 | 0.570 |
| | | | | 3.5 | SHS | 9.07 | 84.7 | 21.2 | 9.42 | 5.30 | 3.39 | 2.35 | 1.73 | 1.32 | 1.05 | 0.847 | 0.700 | 0.588 | 0.501 | 0.432 |
| | | | | 2.0 | SHS | 5.38 | 52.7 | 13.2 | 5.86 | 3.30 | 2.11 | 1.47 | 1.08 | 0.824 | 0.651 | 0.527 | 0.436 | 0.366 | 0.312 | 0.269 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 71.1 | 17.8 | 7.90 | 4.45 | 2.85 | 1.98 | 1.45 | 1.11 | 0.878 | 0.711 | 0.588 | 0.494 | 0.421 | 0.363 |
| | | | | 5.0 | SHS | 10.3 | 63.5 | 15.9 | 7.05 | 3.97 | 2.54 | 1.76 | 1.30 | 0.992 | 0.783 | 0.635 | 0.524 | 0.441 | 0.375 | 0.324 |
| | | | | 4.0 | SHS | 8.49 | 54.2 | 13.6 | 6.02 | 3.39 | 2.17 | 1.51 | 1.11 | 0.847 | 0.669 | 0.542 | 0.448 | 0.376 | 0.321 | 0.277 |
| | | | | 3.5 | SHS | 7.53 | 49.0 | 12.2 | 5.44 | 3.06 | 1.96 | 1.36 | 1.00 | 0.765 | 0.605 | 0.490 | 0.405 | 0.340 | 0.290 | 0.250 |
| | | | | 3.0 | SHS | 6.60 | 44.0 | 11.0 | 4.89 | 2.75 | 1.76 | 1.22 | 0.898 | 0.688 | 0.543 | 0.440 | 0.364 | 0.306 | 0.260 | 0.225 |
| | | | | 2.5 | SHS | 5.56 | 37.7 | 9.43 | 4.19 | 2.36 | 1.51 | 1.05 | 0.770 | 0.589 | 0.466 | 0.377 | 0.312 | 0.262 | 0.223 | 0.192 |
| | | | | 2.0 | SHS | 4.50 | 31.0 | 7.76 | 3.45 | 1.94 | 1.24 | 0.862 | 0.633 | 0.485 | 0.383 | 0.310 | 0.256 | 0.215 | 0.184 | 0.158 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 43.4 | 10.8 | 4.82 | 2.71 | 1.74 | 1.21 | 0.886 | 0.678 | 0.536 | 0.434 | 0.359 | 0.301 | 0.257 | 0.221 |
| | | | | 5.0 | SHS | 8.75 | 39.2 | 9.80 | 4.36 | 2.45 | 1.57 | 1.09 | 0.800 | 0.613 | 0.484 | 0.392 | 0.324 | 0.272 | 0.232 | 0.200 |
| | | | | 4.0 | SHS | 7.23 | 33.9 | 8.48 | 3.77 | 2.12 | 1.36 | 0.942 | 0.692 | 0.530 | 0.419 | 0.339 | 0.280 | 0.235 | 0.201 | 0.173 |
| | | | | 3.0 | SHS | 5.66 | 27.9 | 6.98 | 3.10 | 1.74 | 1.12 | 0.775 | 0.569 | 0.436 | 0.344 | 0.279 | 0.231 | 0.194 | 0.165 | 0.142 |
| | | | | 2.5 | SHS | 4.78 | 24.0 | 6.01 | 2.67 | 1.50 | 0.961 | 0.667 | 0.490 | 0.375 | 0.297 | 0.240 | 0.199 | 0.167 | 0.142 | 0.123 |
| | | | | 2.0 | SHS | 3.88 | 19.9 | 4.96 | 2.21 | 1.24 | 0.794 | 0.551 | 0.405 | 0.310 | 0.245 | 0.199 | 0.164 | 0.138 | 0.117 | 0.101 |
| | | | | 1.6 | SHS | 3.13 | 16.3 | 4.07 | 1.81 | 1.02 | 0.652 | 0.453 | 0.332 | 0.255 | 0.201 | 0.163 | 0.135 | 0.113 | 0.0964 | 0.0831 |

## Notes:

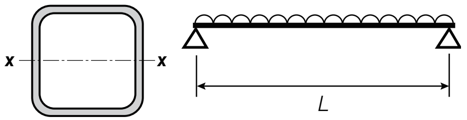
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.

TABLE 5.1-6(3)(A)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## **STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

### *bending about x-axis*



| Designation<br>d | | b | | t | | Mass per m | $W^*_{L1}$ (kN)<br>Span of Beam (L) in metres | | | | | | | | | | | | | | $W^*_{L2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | kN |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 94.2 | 62.8 | 47.1 | 37.7 | 31.4 | 26.9 | 23.5 | 18.8 | 15.7 | 13.5 | 11.8 | 10.5 | 9.42 | 7.85 | 219 |
| | | | | 5.0 | SHS | 6.39 | 85.3 | 56.8 | 42.6 | 34.1 | 28.4 | 24.4 | 21.3 | 17.1 | 14.2 | 12.2 | 10.7 | 9.47 | 8.53 | 7.10 | 192 |
| | | | | 4.0 | SHS | 5.35 | 73.8 | 49.2 | 36.9 | 29.5 | 24.6 | 21.1 | 18.4 | 14.8 | 12.3 | 10.5 | 9.22 | 8.19 | 7.38 | 6.15 | 161 |
| | | | | 3.0 | SHS | 4.25 | 60.8 | 40.6 | 30.4 | 24.3 | 20.3 | 17.4 | 15.2 | 12.2 | 10.1 | 8.69 | 7.60 | 6.76 | 6.08 | 5.07 | 127 |
| | | | | 2.5 | SHS | 3.60 | 52.3 | 34.9 | 26.2 | 20.9 | 17.4 | 14.9 | 13.1 | 10.5 | 8.72 | 7.47 | 6.54 | 5.81 | 5.23 | 4.36 | 108 |
| | | | | 2.0 | SHS | 2.93 | 42.6 | 28.4 | 21.3 | 17.0 | 14.2 | 12.2 | 10.7 | 8.52 | 7.10 | 6.09 | 5.33 | 4.73 | 4.26 | 3.55 | 88.3 |
| | | | | 1.6 | SHS | 2.38 | 30.7 | 20.5 | 15.4 | 12.3 | 10.2 | 8.78 | 7.68 | 6.14 | 5.12 | 4.39 | 3.84 | 3.41 | 3.07 | 2.56 | 71.9 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 43.6 | 29.1 | 21.8 | 17.5 | 14.5 | 12.5 | 10.9 | 8.73 | 7.27 | 6.24 | 5.46 | 4.85 | 4.36 | 3.64 | 123 |
| | | | | 3.0 | SHS | 3.30 | 37.1 | 24.7 | 18.5 | 14.8 | 12.4 | 10.6 | 9.27 | 7.42 | 6.18 | 5.30 | 4.64 | 4.12 | 3.71 | 3.09 | 97.9 |
| | | | | 2.5 | SHS | 2.82 | 32.2 | 21.5 | 16.1 | 12.9 | 10.7 | 9.20 | 8.05 | 6.44 | 5.36 | 4.60 | 4.02 | 3.58 | 3.22 | 2.68 | 84.0 |
| | | | | 2.0 | SHS | 2.31 | 26.8 | 17.9 | 13.4 | 10.7 | 8.93 | 7.65 | 6.70 | 5.36 | 4.46 | 3.83 | 3.35 | 2.98 | 2.68 | 2.23 | 69.1 |
| | | | | 1.6 | SHS | 1.88 | 21.8 | 14.5 | 10.9 | 8.73 | 7.27 | 6.23 | 5.45 | 4.36 | 3.64 | 3.12 | 2.73 | 2.42 | 2.18 | 1.82 | 56.5 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 27.4 | 18.3 | 13.7 | 11.0 | 9.13 | 7.83 | 6.85 | 5.48 | 4.57 | 3.91 | 3.43 | 3.04 | 2.74 | 2.28 | 83.5 |
| | | | | 2.5 | SHS | 2.42 | 23.9 | 16.0 | 12.0 | 9.58 | 7.98 | 6.84 | 5.99 | 4.79 | 3.99 | 3.42 | 2.99 | 2.66 | 2.39 | 2.00 | 72.0 |
| | | | | 2.0 | SHS | 1.99 | 20.1 | 13.4 | 10.0 | 8.02 | 6.68 | 5.73 | 5.01 | 4.01 | 3.34 | 2.86 | 2.51 | 2.23 | 2.01 | 1.67 | 59.5 |
| | | | | 1.6 | SHS | 1.63 | 16.6 | 11.1 | 8.31 | 6.65 | 5.54 | 4.75 | 4.16 | 3.33 | 2.77 | 2.38 | 2.08 | 1.85 | 1.66 | 1.39 | 48.8 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 19.2 | 12.8 | 9.59 | 7.67 | 6.39 | 5.48 | 4.79 | 3.84 | 3.20 | 2.74 | 2.40 | 2.13 | 1.92 | 1.60 | 69.1 |
| | | | | 2.5 | SHS | 2.03 | 16.9 | 11.3 | 8.46 | 6.76 | 5.64 | 4.83 | 4.23 | 3.38 | 2.82 | 2.42 | 2.11 | 1.88 | 1.69 | 1.41 | 60.0 |
| | | | | 2.0 | SHS | 1.68 | 14.3 | 9.53 | 7.15 | 5.72 | 4.76 | 4.08 | 3.57 | 2.86 | 2.38 | 2.04 | 1.79 | 1.59 | 1.43 | 1.19 | 49.9 |
| | | | | 1.6 | SHS | 1.38 | 11.9 | 7.95 | 5.96 | 4.77 | 3.98 | 3.41 | 2.98 | 2.39 | 1.99 | 1.70 | 1.49 | 1.33 | 1.19 | 0.994 | 41.2 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 12.4 | 8.27 | 6.20 | 4.96 | 4.14 | 3.55 | 3.10 | 2.48 | 2.07 | 1.77 | 1.55 | 1.38 | 1.24 | 1.03 | 54.7 |
| | | | | 2.5 | SHS | 1.64 | 11.1 | 7.40 | 5.55 | 4.44 | 3.70 | 3.17 | 2.77 | 2.22 | 1.85 | 1.59 | 1.39 | 1.23 | 1.11 | 0.925 | 48.0 |
| | | | | 2.0 | SHS | 1.36 | 9.50 | 6.33 | 4.75 | 3.80 | 3.17 | 2.71 | 2.38 | 1.90 | 1.58 | 1.36 | 1.19 | 1.06 | 0.950 | 0.792 | 40.3 |
| | | | | 1.6 | SHS | 1.12 | 8.01 | 5.34 | 4.00 | 3.20 | 2.67 | 2.29 | 2.00 | 1.60 | 1.33 | 1.14 | 1.00 | 0.890 | 0.801 | 0.667 | 33.5 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 5.68 | 3.79 | 2.84 | 2.27 | 1.89 | 1.62 | 1.42 | 1.14 | 0.947 | 0.812 | 0.710 | 0.631 | 0.568 | 0.474 | 30.7 |
| | | | | 1.6 | SHS | 0.873 | 4.86 | 3.24 | 2.43 | 1.95 | 1.62 | 1.39 | 1.22 | 0.973 | 0.811 | 0.695 | 0.608 | 0.540 | 0.486 | 0.405 | 25.8 |

## Notes:

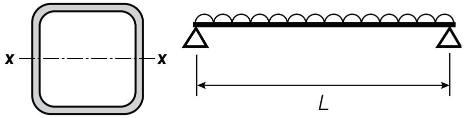
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_{L1}$ = Maximum Design Load based on Design Moment Capacity.
4. $W^*_{L2}$ = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load $W^*_L$ is LESSER of $W^*_{L1}$ and $W^*_{L2}$.
6. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 5.1-6(3)(B)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

### *bending about x-axis*



| Designation | | | | | | Mass per m | $W^*_S$ (kN) Span of Beam (L) in metres | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 67.7 | 30.1 | 16.9 | 10.8 | 7.52 | 5.52 | 4.23 | 2.71 | 1.88 | 1.38 | 1.06 | 0.835 | 0.677 | 0.470 |
| | | | | 5.0 | SHS | 6.39 | 63.1 | 28.1 | 15.8 | 10.1 | 7.02 | 5.15 | 3.95 | 2.53 | 1.75 | 1.29 | 0.987 | 0.780 | 0.631 | 0.438 |
| | | | | 4.0 | SHS | 5.35 | 56.2 | 25.0 | 14.1 | 8.99 | 6.25 | 4.59 | 3.51 | 2.25 | 1.56 | 1.15 | 0.878 | 0.694 | 0.562 | 0.390 |
| | | | | 3.0 | SHS | 4.25 | 47.8 | 21.3 | 12.0 | 7.65 | 5.32 | 3.91 | 2.99 | 1.91 | 1.33 | 0.976 | 0.748 | 0.591 | 0.478 | 0.332 |
| | | | | 2.5 | SHS | 3.60 | 41.6 | 18.5 | 10.4 | 6.66 | 4.63 | 3.40 | 2.60 | 1.67 | 1.16 | 0.850 | 0.651 | 0.514 | 0.416 | 0.289 |
| | | | | 2.0 | SHS | 2.93 | 34.8 | 15.5 | 8.69 | 5.56 | 3.86 | 2.84 | 2.17 | 1.39 | 0.966 | 0.710 | 0.543 | 0.429 | 0.348 | 0.241 |
| | | | | 1.6 | SHS | 2.38 | 28.8 | 12.8 | 7.19 | 4.60 | 3.20 | 2.35 | 1.80 | 1.15 | 0.799 | 0.587 | 0.449 | 0.355 | 0.288 | 0.200 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 25.9 | 11.5 | 6.47 | 4.14 | 2.87 | 2.11 | 1.62 | 1.03 | 0.718 | 0.528 | 0.404 | 0.319 | 0.259 | 0.180 |
| | | | | 3.0 | SHS | 3.30 | 22.9 | 10.2 | 5.73 | 3.67 | 2.55 | 1.87 | 1.43 | 0.917 | 0.636 | 0.468 | 0.358 | 0.283 | 0.229 | 0.159 |
| | | | | 2.5 | SHS | 2.82 | 20.2 | 8.97 | 5.05 | 3.23 | 2.24 | 1.65 | 1.26 | 0.808 | 0.561 | 0.412 | 0.315 | 0.249 | 0.202 | 0.140 |
| | | | | 2.0 | SHS | 2.31 | 17.1 | 7.58 | 4.26 | 2.73 | 1.90 | 1.39 | 1.07 | 0.682 | 0.474 | 0.348 | 0.267 | 0.211 | 0.171 | 0.118 |
| | | | | 1.6 | SHS | 1.88 | 14.2 | 6.33 | 3.56 | 2.28 | 1.58 | 1.16 | 0.890 | 0.570 | 0.396 | 0.291 | 0.223 | 0.176 | 0.142 | 0.0989 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 14.6 | 6.50 | 3.65 | 2.34 | 1.62 | 1.19 | 0.914 | 0.585 | 0.406 | 0.298 | 0.228 | 0.180 | 0.146 | 0.102 |
| | | | | 2.5 | SHS | 2.42 | 13.0 | 5.78 | 3.25 | 2.08 | 1.44 | 1.06 | 0.812 | 0.520 | 0.361 | 0.265 | 0.203 | 0.160 | 0.130 | 0.0903 |
| | | | | 2.0 | SHS | 1.99 | 11.1 | 4.92 | 2.77 | 1.77 | 1.23 | 0.904 | 0.692 | 0.443 | 0.308 | 0.226 | 0.173 | 0.137 | 0.111 | 0.0769 |
| | | | | 1.6 | SHS | 1.63 | 9.31 | 4.14 | 2.33 | 1.49 | 1.03 | 0.760 | 0.582 | 0.372 | 0.259 | 0.190 | 0.145 | 0.115 | 0.0931 | 0.0647 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 8.61 | 3.83 | 2.15 | 1.38 | 0.957 | 0.703 | 0.538 | 0.344 | 0.239 | 0.176 | 0.135 | 0.106 | 0.0861 | 0.0598 |
| | | | | 2.5 | SHS | 2.03 | 7.76 | 3.45 | 1.94 | 1.24 | 0.862 | 0.633 | 0.485 | 0.310 | 0.215 | 0.158 | 0.121 | 0.0958 | 0.0776 | 0.0539 |
| | | | | 2.0 | SHS | 1.68 | 6.69 | 2.97 | 1.67 | 1.07 | 0.743 | 0.546 | 0.418 | 0.268 | 0.186 | 0.137 | 0.105 | 0.0826 | 0.0669 | 0.0465 |
| | | | | 1.6 | SHS | 1.38 | 5.67 | 2.52 | 1.42 | 0.908 | 0.630 | 0.463 | 0.355 | 0.227 | 0.158 | 0.116 | 0.0887 | 0.0701 | 0.0567 | 0.0394 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 4.52 | 2.01 | 1.13 | 0.724 | 0.503 | 0.369 | 0.283 | 0.181 | 0.126 | 0.0923 | 0.0707 | 0.0559 | 0.0452 | 0.0314 |
| | | | | 2.5 | SHS | 1.64 | 4.15 | 1.85 | 1.04 | 0.664 | 0.461 | 0.339 | 0.260 | 0.166 | 0.115 | 0.0848 | 0.0649 | 0.0513 | 0.0415 | 0.0288 |
| | | | | 2.0 | SHS | 1.36 | 3.65 | 1.62 | 0.911 | 0.583 | 0.405 | 0.298 | 0.228 | 0.146 | 0.101 | 0.0744 | 0.0570 | 0.0450 | 0.0365 | 0.0253 |
| | | | | 1.6 | SHS | 1.12 | 3.13 | 1.39 | 0.783 | 0.501 | 0.348 | 0.256 | 0.196 | 0.125 | 0.0870 | 0.0640 | 0.0490 | 0.0387 | 0.0313 | 0.0218 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 1.70 | 0.756 | 0.425 | 0.272 | 0.189 | 0.139 | 0.106 | 0.0680 | 0.0473 | 0.0347 | 0.0266 | 0.0210 | | |
| | | | | 1.6 | SHS | 0.873 | 1.49 | 0.664 | 0.373 | 0.239 | 0.166 | 0.122 | 0.0933 | 0.0597 | 0.0415 | 0.0305 | 0.0233 | | | |

## Notes:

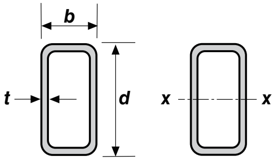
1. ***REFER** to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $W^*_S$ = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
4. Red shading indicates serviceability loads governed by yielding.
5. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 5.2-1(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about x-axis*



| Designation | | | | Mass per m | Design Section Moment Capacities | | | Design Web Capacities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | About x-axis | | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | b | t | | | $\phi M_{sx}$ | FLR | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | mm | mm | | kg/m | kNm | m | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 75 x | 25 x | 2.5 | RHS | 3.60 | 3.17 | 0.736 | 1.35 | 61.5 | **0.519** | 0.697 | 25.0 | 32.5 | 91.0 | **0.499** | 0.625 | 12.5 | 32.5 | 98.8 |
| | | 2.0 | RHS | 2.93 | 2.62 | 0.751 | 1.14 | 49.9 | 0.411 | **0.389** | 20.0 | 33.5 | 117 | 0.399 | **0.342** | 10.0 | 33.5 | 127 |
| | | 1.6 | RHS | 2.38 | 2.15 | 0.764 | 0.954 | 40.4 | 0.326 | **0.208** | 16.0 | 34.3 | 150 | 0.319 | **0.181** | 8.00 | 34.3 | 163 |
| 65 x | 35 x | 4.0 | RHS | 5.35 | 4.18 | 1.55 | 2.37 | 82.4 | **0.704** | 2.09 | 50.0 | 22.5 | 39.4 | **0.611** | 2.03 | 25.0 | 22.5 | 42.8 |
| | | 3.0 | RHS | 4.25 | 3.46 | 1.61 | 1.97 | 64.0 | **0.635** | 1.24 | 30.0 | 26.5 | 61.8 | **0.598** | 1.16 | 15.0 | 26.5 | 67.1 |
| | | 2.5 | RHS | 3.60 | 2.98 | 1.64 | 1.72 | 54.2 | **0.523** | 0.850 | 25.0 | 27.5 | 77.0 | **0.499** | 0.775 | 12.5 | 27.5 | 83.6 |
| | | 2.0 | RHS | 2.93 | 2.46 | 1.66 | 1.44 | 44.1 | **0.413** | 0.493 | 20.0 | 28.5 | 99.8 | **0.399** | 0.438 | 10.0 | 28.5 | 108 |
| 50 x | 25 x | 3.0 | RHS | 3.07 | 1.85 | 1.04 | 0.979 | 47.5 | **0.650** | 1.50 | 30.0 | 19.0 | 44.3 | **0.598** | 1.45 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 2.62 | 1.61 | 1.06 | 0.869 | 40.5 | **0.533** | 1.11 | 25.0 | 20.0 | 56.0 | **0.499** | 1.05 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 2.15 | 1.34 | 1.09 | 0.741 | 33.1 | **0.419** | 0.713 | 20.0 | 21.0 | 73.5 | **0.399** | 0.654 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 1.75 | 1.11 | 1.10 | 0.623 | 27.0 | **0.331** | 0.420 | 16.0 | 21.8 | 95.4 | **0.319** | 0.374 | 8.00 | 21.8 | 104 |
| 50 x | 20 x | 3.0 | RHS | 2.83 | 1.62 | 0.657 | 0.733 | 46.9 | **0.650** | 1.50 | 30.0 | 19.0 | 44.3 | **0.598** | 1.45 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 2.42 | 1.42 | 0.676 | 0.659 | 40.0 | **0.533** | 1.11 | 25.0 | 20.0 | 56.0 | **0.499** | 1.05 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 1.99 | 1.19 | 0.695 | 0.568 | 32.7 | **0.419** | 0.713 | 20.0 | 21.0 | 73.5 | **0.399** | 0.654 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 1.63 | 0.989 | 0.710 | 0.482 | 26.6 | **0.331** | 0.420 | 16.0 | 21.8 | 95.4 | **0.319** | 0.374 | 8.00 | 21.8 | 104 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. FLR based on most conservative case ($\beta_m$ = -1).
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

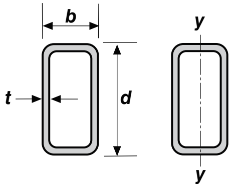
TABLE 5.2-1(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about y-axis*

| Designation | | | | | | Mass per m | Design Section Moment Capacity | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | | mm | | mm | | kg/m | $\phi M_{sy}$ | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 1.36 | 18.9 | **0.587** | 1.49 | 25.0 | 7.50 | 21.0 | **0.499** | 1.47 | 12.5 | 7.50 | 22.8 |
| | | | | 2.0 | RHS | 2.93 | 1.00 | 15.9 | **0.450** | 1.12 | 20.0 | 8.50 | 29.8 | **0.399** | 1.10 | 10.0 | 8.50 | 32.3 |
| | | | | 1.6 | RHS | 2.38 | 0.699 | 13.2 | **0.349** | 0.825 | 16.0 | 9.30 | 40.7 | **0.319** | 0.801 | 8.00 | 9.30 | 44.2 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 2.70 | 40.8 | **0.866** | 2.49 | 50.0 | 7.50 | 13.1 | **0.611** | 2.48 | 25.0 | 7.50 | 14.3 |
| | | | | 3.0 | RHS | 4.25 | 2.24 | 32.9 | **0.683** | 1.72 | 30.0 | 11.5 | 26.8 | **0.598** | 1.69 | 15.0 | 11.5 | 29.1 |
| | | | | 2.5 | RHS | 3.60 | 1.93 | 28.4 | **0.553** | 1.35 | 25.0 | 12.5 | 35.0 | **0.499** | 1.32 | 12.5 | 12.5 | 38.0 |
| | | | | 2.0 | RHS | 2.93 | 1.48 | 23.4 | **0.431** | 0.973 | 20.0 | 13.5 | 47.3 | **0.399** | 0.935 | 10.0 | 13.5 | 51.3 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 1.12 | 21.5 | **0.738** | 1.85 | 30.0 | 6.50 | 15.2 | **0.598** | 1.83 | 15.0 | 6.50 | 16.5 |
| | | | | 2.5 | RHS | 2.62 | 0.982 | 18.9 | **0.587** | 1.49 | 25.0 | 7.50 | 21.0 | **0.499** | 1.47 | 12.5 | 7.50 | 22.8 |
| | | | | 2.0 | RHS | 2.15 | 0.824 | 15.9 | **0.450** | 1.12 | 20.0 | 8.50 | 29.8 | **0.399** | 1.10 | 10.0 | 8.50 | 32.3 |
| | | | | 1.6 | RHS | 1.75 | 0.644 | 13.2 | **0.349** | 0.825 | 16.0 | 9.30 | 40.7 | **0.319** | 0.801 | 8.00 | 9.30 | 44.2 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 0.827 | 15.9 | **0.797** | 1.91 | 30.0 | 4.00 | 9.33 | **0.598** | 1.90 | 15.0 | 4.00 | 10.1 |
| | | | | 2.5 | RHS | 2.42 | 0.729 | 14.2 | **0.623** | 1.55 | 25.0 | 5.00 | 14.0 | **0.499** | 1.54 | 12.5 | 5.00 | 15.2 |
| | | | | 2.0 | RHS | 1.99 | 0.616 | 12.1 | **0.469** | 1.19 | 20.0 | 6.00 | 21.0 | **0.399** | 1.17 | 10.0 | 6.00 | 22.8 |
| | | | | 1.6 | RHS | 1.63 | 0.484 | 10.2 | **0.360** | 0.897 | 16.0 | 6.80 | 29.8 | **0.319** | 0.881 | 8.00 | 6.80 | 32.3 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

## ADDITIONAL NOTES:

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

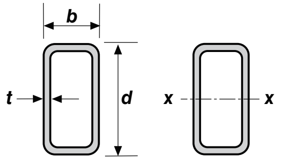
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM’S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 5.2-2(1)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about x-axis*



| Designation | | | | Mass per m | Design Section Moment Capacities | | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | About x-axis | | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| | | | | | $\phi M_{sx}$ | FLR | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| d | b | t | | | | | | | | | | | | | | | | |
| mm | mm | mm | | kg/m | kNm | m | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 400 x | 300 x | 16.0 | RHS | 161 | 1110 | 14.9 | 771 | 2790 | **3.42** | 6.76 | 200 | 160 | 70.0 | **3.14** | 6.15 | 100 | 160 | 76.0 |
| | | 12.5 | RHS | 128 | 901 | 15.1 | 628 | 2220 | **2.61** | 3.58 | 156 | 169 | 94.5 | **2.46** | 3.16 | 78.1 | 169 | 103 |
| | | 10.0 | RHS | 104 | 649 | 15.2 | 518 | 1800 | 2.06 | **1.91** | 125 | 175 | 123 | 1.97 | **1.66** | 62.5 | 175 | 133 |
| | | 8.0 | RHS | 84.2 | 463 | 15.4 | 425 | 1450 | 1.63 | **0.990** | 100 | 180 | 158 | 1.57 | **0.855** | 50.0 | 180 | 171 |
| 400 x | 200 x | 16.0 | RHS | 136 | 866 | 6.73 | 485 | 2730 | **3.42** | 6.76 | 200 | 160 | 70.0 | **3.14** | 6.15 | 100 | 160 | 76.0 |
| | | 12.5 | RHS | 109 | 705 | 6.87 | 401 | 2170 | **2.61** | 3.58 | 156 | 169 | 94.5 | **2.46** | 3.16 | 78.1 | 169 | 103 |
| | | 10.0 | RHS | 88.4 | 581 | 6.97 | 334 | 1760 | 2.06 | **1.91** | 125 | 175 | 123 | 1.97 | **1.66** | 62.5 | 175 | 133 |
| | | 8.0 | RHS | 71.6 | 467 | 7.04 | 275 | 1420 | 1.63 | **0.990** | 100 | 180 | 158 | 1.57 | **0.855** | 50.0 | 180 | 171 |
| 350 x | 250 x | 16.0 | RHS | 136 | 807 | 11.7 | 543 | 2400 | **3.47** | 8.00 | 200 | 135 | 59.1 | **3.14** | 7.42 | 100 | 135 | 64.1 |
| | | 12.5 | RHS | 109 | 657 | 11.9 | 446 | 1920 | **2.64** | 4.47 | 156 | 144 | 80.5 | **2.46** | 4.00 | 78.1 | 144 | 87.4 |
| | | 10.0 | RHS | 88.4 | 533 | 12.1 | 370 | 1560 | **2.08** | 2.44 | 125 | 150 | 105 | **1.97** | 2.14 | 62.5 | 150 | 114 |
| | | 8.0 | RHS | 71.6 | 376 | 12.2 | 304 | 1260 | 1.64 | **1.28** | 100 | 155 | 136 | 1.57 | **1.11** | 50.0 | 155 | 147 |
| 300 x | 200 x | 16.0 | RHS | 111 | 548 | 8.66 | 354 | 2020 | **3.54** | 9.28 | 200 | 110 | 48.1 | **3.14** | 8.80 | 100 | 110 | 52.3 |
| | | 12.5 | RHS | 89.0 | 450 | 8.85 | 294 | 1620 | **2.68** | 5.58 | 156 | 119 | 66.5 | **2.46** | 5.10 | 78.1 | 119 | 72.2 |
| | | 10.0 | RHS | 72.7 | 373 | 8.99 | 246 | 1320 | **2.10** | 3.19 | 125 | 125 | 87.5 | **1.97** | 2.84 | 62.5 | 125 | 95.0 |
| | | 8.0 | RHS | 59.1 | 302 | 9.10 | 204 | 1070 | **1.66** | 1.72 | 100 | 130 | 114 | 1.57 | **1.50** | 50.0 | 130 | 124 |
| | | 6.0 | RHS | 45.0 | 192 | 9.20 | 158 | 813 | 1.22 | **0.743** | 75.0 | 135 | 158 | 1.18 | **0.641** | 37.5 | 135 | 171 |
| 250 x | 150 x | 16.0 | RHS | 85.5 | 338 | 5.73 | 203 | 1630 | **3.65** | 10.5 | 200 | 85.0 | 37.2 | **3.14** | 10.1 | 100 | 85.0 | 40.4 |
| | | 12.5 | RHS | 69.4 | 282 | 5.90 | 173 | 1320 | **2.74** | 6.86 | 156 | 93.8 | 52.5 | **2.46** | 6.44 | 78.1 | 93.8 | 57.0 |
| | | 10.0 | RHS | 57.0 | 236 | 6.02 | 146 | 1080 | **2.14** | 4.23 | 125 | 100 | 70.0 | **1.97** | 3.84 | 62.5 | 100 | 76.0 |
| | | 9.0 | RHS | 51.8 | 216 | 6.07 | 135 | 976 | **1.90** | 3.26 | 113 | 103 | 79.7 | **1.77** | 2.92 | 56.3 | 103 | 86.6 |
| | | 8.0 | RHS | 46.5 | 195 | 6.12 | 122 | 875 | **1.68** | 2.39 | 100 | 105 | 91.9 | **1.57** | 2.11 | 50.0 | 105 | 99.8 |
| | | 6.0 | RHS | 35.6 | 149 | 6.22 | 96.0 | 668 | 1.23 | **1.06** | 75.0 | 110 | 128 | 1.18 | **0.920** | 37.5 | 110 | 139 |
| | | 5.0 | RHS | 29.9 | 111 | 6.26 | 81.8 | 561 | 1.02 | **0.619** | 62.5 | 113 | 158 | 0.983 | **0.534** | 31.3 | 113 | 171 |

## Notes:

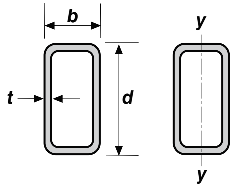
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. FLR based on most conservative case ($\beta_m = -1$).
4. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

TABLE 5.2-2(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about y-axis*



| Designation | | | | Mass per m | Design Section Moment Capacity | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | b | t | | | | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | mm | mm | | kg/m | $\phi M_{sy}$ | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 400 x | 300 x | 16.0 | RHS | 161 | 905 | 2080 | **3.54** | 9.28 | 200 | 110 | 48.1 | **3.14** | 8.80 | 100 | 110 | 52.3 |
| | | 12.5 | RHS | 128 | 641 | 1670 | **2.68** | 5.58 | 156 | 119 | 66.5 | **2.46** | 5.10 | 78.1 | 119 | 72.2 |
| | | 10.0 | RHS | 104 | 454 | 1360 | **2.10** | 3.19 | 125 | 125 | 87.5 | **1.97** | 2.84 | 62.5 | 125 | 95.0 |
| | | 8.0 | RHS | 84.2 | 324 | 1100 | **1.66** | 1.72 | 100 | 130 | 114 | 1.57 | **1.50** | 50.0 | 130 | 124 |
| 400 x | 200 x | 16.0 | RHS | 136 | 527 | 1310 | **3.85** | 11.5 | 200 | 60.0 | 26.3 | **3.14** | 11.3 | 100 | 60.0 | 28.5 |
| | | 12.5 | RHS | 109 | 379 | 1060 | **2.84** | 8.08 | 156 | 68.8 | 38.5 | **2.46** | 7.81 | 78.1 | 68.8 | 41.8 |
| | | 10.0 | RHS | 88.4 | 266 | 875 | **2.19** | 5.48 | 125 | 75.0 | 52.5 | **1.97** | 5.15 | 62.5 | 75.0 | 57.0 |
| | | 8.0 | RHS | 71.6 | 188 | 715 | **1.71** | 3.38 | 100 | 80.0 | 70.0 | **1.57** | 3.07 | 50.0 | 80.0 | 76.0 |
| 350 x | 250 x | 16.0 | RHS | 136 | 641 | 1700 | **3.65** | 10.5 | 200 | 85.0 | 37.2 | **3.14** | 10.1 | 100 | 85.0 | 40.4 |
| | | 12.5 | RHS | 109 | 487 | 1370 | **2.74** | 6.86 | 156 | 93.8 | 52.5 | **2.46** | 6.44 | 78.1 | 93.8 | 57.0 |
| | | 10.0 | RHS | 88.4 | 350 | 1120 | **2.14** | 4.23 | 125 | 100 | 70.0 | **1.97** | 3.84 | 62.5 | 100 | 76.0 |
| | | 8.0 | RHS | 71.6 | 249 | 910 | **1.68** | 2.39 | 100 | 105 | 91.9 | **1.57** | 2.11 | 50.0 | 105 | 99.8 |
| 300 x | 200 x | 16.0 | RHS | 111 | 414 | 1310 | **3.85** | 11.5 | 200 | 60.0 | 26.3 | **3.14** | 11.3 | 100 | 60.0 | 28.5 |
| | | 12.5 | RHS | 89.0 | 341 | 1060 | **2.84** | 8.08 | 156 | 68.8 | 38.5 | **2.46** | 7.81 | 78.1 | 68.8 | 41.8 |
| | | 10.0 | RHS | 72.7 | 254 | 875 | **2.19** | 5.48 | 125 | 75.0 | 52.5 | **1.97** | 5.15 | 62.5 | 75.0 | 57.0 |
| | | 8.0 | RHS | 59.1 | 181 | 715 | **1.71** | 3.38 | 100 | 80.0 | 70.0 | **1.57** | 3.07 | 50.0 | 80.0 | 76.0 |
| | | 6.0 | RHS | 45.0 | 116 | 548 | **1.25** | 1.60 | 75.0 | 85.0 | 99.2 | **1.18** | 1.41 | 37.5 | 85.0 | 108 |
| 250 x | 150 x | 16.0 | RHS | 85.5 | 236 | 918 | **4.29** | 12.5 | 200 | 35.0 | 15.3 | **3.14** | 12.4 | 100 | 35.0 | 16.6 |
| | | 12.5 | RHS | 69.4 | 198 | 759 | **3.04** | 9.14 | 156 | 43.8 | 24.5 | **2.46** | 8.99 | 78.1 | 43.8 | 26.6 |
| | | 10.0 | RHS | 57.0 | 164 | 632 | **2.30** | 6.69 | 125 | 50.0 | 35.0 | **1.97** | 6.50 | 62.5 | 50.0 | 38.0 |
| | | 9.0 | RHS | 51.8 | 143 | 577 | **2.03** | 5.68 | 113 | 52.5 | 40.8 | **1.77** | 5.46 | 56.3 | 52.5 | 44.3 |
| | | 8.0 | RHS | 46.5 | 121 | 521 | **1.77** | 4.64 | 100 | 55.0 | 48.1 | **1.57** | 4.40 | 50.0 | 55.0 | 52.3 |
| | | 6.0 | RHS | 35.6 | 77.5 | 402 | **1.28** | 2.54 | 75.0 | 60.0 | 70.0 | **1.18** | 2.30 | 37.5 | 60.0 | 76.0 |
| | | 5.0 | RHS | 29.9 | 58.5 | 340 | **1.05** | 1.60 | 62.5 | 62.5 | 87.5 | **0.983** | 1.42 | 31.3 | 62.5 | 95.0 |

## Notes:

1. ***REFER** to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

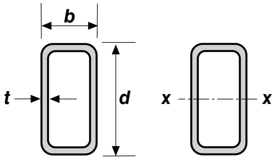
TABLE 5.2-2(2)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about x-axis*

| Designation | | | | Mass per m | Design Section Moment Capacities | | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | About x-axis | | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| | | | | | $\phi M_{sx}$ | FLR | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| d | b | t | | | | | | | | | | | | | | | | |
| mm | mm | mm | | kg/m | kNm | m | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 200 x | 100 x | 10.0 | RHS | 41.3 | 129 | 3.29 | 71.0 | 833 | **2.19** | 5.48 | 125 | 75.0 | 52.5 | **1.97** | 5.15 | 62.5 | 75.0 | 57.0 |
| | | 9.0 | RHS | 37.7 | 119 | 3.33 | 66.0 | 758 | **1.95** | 4.42 | 113 | 77.5 | 60.3 | **1.77** | 4.09 | 56.3 | 77.5 | 65.4 |
| | | 8.0 | RHS | 33.9 | 108 | 3.37 | 60.7 | 681 | **1.71** | 3.38 | 100 | 80.0 | 70.0 | **1.57** | 3.07 | 50.0 | 80.0 | 76.0 |
| | | 6.0 | RHS | 26.2 | 85.1 | 3.44 | 48.5 | 522 | **1.25** | 1.60 | 75.0 | 85.0 | 99.2 | **1.18** | 1.41 | 37.5 | 85.0 | 108 |
| | | 5.0 | RHS | 22.1 | 72.6 | 3.48 | 41.7 | 440 | 1.03 | **0.953** | 62.5 | 87.5 | 123 | 0.983 | **0.830** | 31.3 | 87.5 | 133 |
| | | 4.0 | RHS | 17.9 | 58.4 | 3.52 | 34.4 | 355 | 0.816 | **0.495** | 50.0 | 90.0 | 158 | 0.786 | **0.428** | 25.0 | 90.0 | 171 |
| 152 x | 76 x | 6.0 | RHS | 19.4 | 47.0 | 2.56 | 26.4 | 389 | **1.28** | 2.49 | 75.0 | 61.0 | 71.2 | **1.18** | 2.26 | 37.5 | 61.0 | 77.3 |
| | | 5.0 | RHS | 16.4 | 40.4 | 2.60 | 22.9 | 329 | **1.05** | 1.56 | 62.5 | 63.5 | 88.9 | **0.983** | 1.39 | 31.3 | 63.5 | 96.5 |
| 150 x | 100 x | 10.0 | RHS | 33.4 | 80.7 | 4.22 | 51.3 | 611 | **2.30** | 6.69 | 125 | 50.0 | 35.0 | **1.97** | 6.50 | 62.5 | 50.0 | 38.0 |
| | | 9.0 | RHS | 30.6 | 74.8 | 4.28 | 47.9 | 559 | **2.03** | 5.68 | 113 | 52.5 | 40.8 | **1.77** | 5.46 | 56.3 | 52.5 | 44.3 |
| | | 8.0 | RHS | 27.7 | 68.5 | 4.33 | 44.2 | 504 | **1.77** | 4.64 | 100 | 55.0 | 48.1 | **1.57** | 4.40 | 50.0 | 55.0 | 52.3 |
| | | 6.0 | RHS | 21.4 | 54.4 | 4.44 | 35.6 | 389 | **1.28** | 2.54 | 75.0 | 60.0 | 70.0 | **1.18** | 2.30 | 37.5 | 60.0 | 76.0 |
| | | 5.0 | RHS | 18.2 | 46.6 | 4.49 | 30.7 | 329 | **1.05** | 1.60 | 62.5 | 62.5 | 87.5 | **0.983** | 1.42 | 31.3 | 62.5 | 95.0 |
| | | 4.0 | RHS | 14.8 | 37.8 | 4.55 | 25.5 | 267 | **0.828** | 0.860 | 50.0 | 65.0 | 114 | 0.786 | **0.752** | 25.0 | 65.0 | 124 |
| 150 x | 50 x | 6.0 | RHS | 16.7 | 36.9 | 1.12 | 15.6 | 374 | **1.28** | 2.54 | 75.0 | 60.0 | 70.0 | **1.18** | 2.30 | 37.5 | 60.0 | 76.0 |
| | | 5.0 | RHS | 14.2 | 31.9 | 1.14 | 13.8 | 316 | **1.05** | 1.60 | 62.5 | 62.5 | 87.5 | **0.983** | 1.42 | 31.3 | 62.5 | 95.0 |
| | | 4.0 | RHS | 11.6 | 26.5 | 1.17 | 11.7 | 257 | **0.828** | 0.860 | 50.0 | 65.0 | 114 | 0.786 | **0.752** | 25.0 | 65.0 | 124 |
| | | 3.0 | RHS | 8.96 | 20.8 | 1.19 | 9.30 | 195 | 0.785 | **0.357** | 30.0 | 69.0 | 161 | 0.769 | **0.308** | 15.0 | 69.0 | 175 |
| | | 2.5 | RHS | 7.53 | 17.6 | 1.21 | 7.97 | 164 | 0.651 | **0.208** | 25.0 | 70.0 | 196 | 0.641 | **0.179** | 12.5 | 70.0 | 213 |
| | | 2.0 | RHS | 6.07 | 12.8 | 1.22 | 6.55 | 132 | 0.519 | **0.107** | 20.0 | 71.0 | 249 | 0.513 | **0.0918** | 10.0 | 71.0 | 270 |
| 127 x | 51 x | 6.0 | RHS | 14.7 | 27.9 | 1.35 | 13.3 | 315 | **1.31** | 3.11 | 75.0 | 48.5 | 56.6 | **1.18** | 2.90 | 37.5 | 48.5 | 61.4 |
| | | 5.0 | RHS | 12.5 | 24.3 | 1.38 | 11.8 | 267 | **1.07** | 2.07 | 62.5 | 51.0 | 71.4 | **0.983** | 1.87 | 31.3 | 51.0 | 77.5 |
| | | 3.5 | RHS | 9.07 | 18.1 | 1.43 | 9.04 | 192 | **0.726** | 0.800 | 43.8 | 54.8 | 110 | **0.688** | 0.701 | 21.9 | 54.8 | 119 |
| 125 x | 75 x | 6.0 | RHS | 16.7 | 34.1 | 2.96 | 21.0 | 317 | **1.31** | 3.16 | 75.0 | 47.5 | 55.4 | **1.18** | 2.95 | 37.5 | 47.5 | 60.2 |
| | | 5.0 | RHS | 14.2 | 29.5 | 3.01 | 18.3 | 269 | **1.07** | 2.11 | 62.5 | 50.0 | 70.0 | **0.983** | 1.92 | 31.3 | 50.0 | 76.0 |
| | | 4.0 | RHS | 11.6 | 24.4 | 3.06 | 15.3 | 219 | **0.838** | 1.19 | 50.0 | 52.5 | 91.9 | **0.786** | 1.06 | 25.0 | 52.5 | 99.8 |
| | | 3.0 | RHS | 8.96 | 18.8 | 3.11 | 12.0 | 167 | 0.790 | **0.506** | 30.0 | 56.5 | 132 | 0.769 | **0.439** | 15.0 | 56.5 | 143 |
| | | 2.5 | RHS | 7.53 | 14.1 | 3.14 | 10.2 | 140 | 0.654 | **0.298** | 25.0 | 57.5 | 161 | 0.641 | **0.257** | 12.5 | 57.5 | 175 |
| | | 2.0 | RHS | 6.07 | 10.0 | 3.16 | 8.36 | 113 | 0.521 | **0.154** | 20.0 | 58.5 | 205 | 0.513 | **0.132** | 10.0 | 58.5 | 222 |
| 102 x | 76 x | 6.0 | RHS | 14.7 | 25.1 | 3.63 | 17.0 | 255 | **1.35** | 3.74 | 75.0 | 36.0 | 42.0 | **1.18** | 3.59 | 37.5 | 36.0 | 45.6 |
| | | 5.0 | RHS | 12.5 | 21.7 | 3.69 | 14.9 | 218 | **1.09** | 2.69 | 62.5 | 38.5 | 53.9 | **0.983** | 2.52 | 31.3 | 38.5 | 58.5 |
| | | 3.5 | RHS | 9.07 | 16.1 | 3.78 | 11.2 | 157 | **0.737** | 1.17 | 43.8 | 42.3 | 84.5 | **0.688** | 1.05 | 21.9 | 42.3 | 91.7 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. FLR based on most conservative case ($\beta_m$ = 1).
4. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

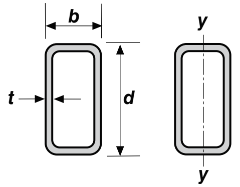
### TABLE 5.2-2(2)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about y-axis*

| Designation | | | | | | Mass per m | Design Section Moment Capacity | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | | $\phi V_v$ | $\phi R_{by}$ / $b_b$ | $\phi R_{bb}$ / $b_b$ | $5r_{ext}$ | $b_{bw}$ | $L_e$ / $r$ | $\phi R_{by}$ / $b_b$ | $\phi R_{bb}$ / $b_b$ | $2.5r_{ext}$ | $b_{bw}$ | $L_e$ / $r$ |
| mm | | mm | | mm | | kg/m | $\phi M_{sy}$ kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 79.1 | 389 | **2.60** | 7.69 | 125 | 25.0 | 17.5 | **1.97** | 7.61 | 62.5 | 25.0 | 19.0 |
| | | | | 9.0 | RHS | 37.7 | 73.1 | 359 | **2.25** | 6.73 | 113 | 27.5 | 21.4 | **1.77** | 6.64 | 56.3 | 27.5 | 23.2 |
| | | | | 8.0 | RHS | 33.9 | 65.9 | 327 | **1.92** | 5.77 | 100 | 30.0 | 26.3 | **1.57** | 5.66 | 50.0 | 30.0 | 28.5 |
| | | | | 6.0 | RHS | 26.2 | 44.4 | 257 | **1.35** | 3.79 | 75.0 | 35.0 | 40.8 | **1.18** | 3.64 | 37.5 | 35.0 | 44.3 |
| | | | | 5.0 | RHS | 22.1 | 33.3 | 219 | **1.10** | 2.74 | 62.5 | 37.5 | 52.5 | **0.983** | 2.58 | 31.3 | 37.5 | 57.0 |
| | | | | 4.0 | RHS | 17.9 | 23.5 | 179 | **0.854** | 1.69 | 50.0 | 40.0 | 70.0 | **0.786** | 1.54 | 25.0 | 40.0 | 76.0 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 28.4 | 187 | **1.44** | 4.31 | 75.0 | 23.0 | 26.8 | **1.18** | 4.23 | 37.5 | 23.0 | 29.1 |
| | | | | 5.0 | RHS | 16.4 | 22.3 | 160 | **1.15** | 3.32 | 62.5 | 25.5 | 35.7 | **0.983** | 3.22 | 31.3 | 25.5 | 38.8 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 60.9 | 389 | **2.60** | 7.69 | 125 | 25.0 | 17.5 | **1.97** | 7.61 | 62.5 | 25.0 | 19.0 |
| | | | | 9.0 | RHS | 30.6 | 56.5 | 359 | **2.25** | 6.73 | 113 | 27.5 | 21.4 | **1.77** | 6.64 | 56.3 | 27.5 | 23.2 |
| | | | | 8.0 | RHS | 27.7 | 51.8 | 327 | **1.92** | 5.77 | 100 | 30.0 | 26.3 | **1.57** | 5.66 | 50.0 | 30.0 | 28.5 |
| | | | | 6.0 | RHS | 21.4 | 40.7 | 257 | **1.35** | 3.79 | 75.0 | 35.0 | 40.8 | **1.18** | 3.64 | 37.5 | 35.0 | 44.3 |
| | | | | 5.0 | RHS | 18.2 | 31.8 | 219 | **1.10** | 2.74 | 62.5 | 37.5 | 52.5 | **0.983** | 2.58 | 31.3 | 37.5 | 57.0 |
| | | | | 4.0 | RHS | 14.8 | 22.6 | 179 | **0.854** | 1.69 | 50.0 | 40.0 | 70.0 | **0.786** | 1.54 | 25.0 | 40.0 | 76.0 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 16.4 | 111 | **1.72** | 4.81 | 75.0 | 10.0 | 11.7 | **1.18** | 4.77 | 37.5 | 10.0 | 12.7 |
| | | | | 5.0 | RHS | 14.2 | 12.9 | 97.2 | **1.30** | 3.85 | 62.5 | 12.5 | 17.5 | **0.983** | 3.81 | 31.3 | 12.5 | 19.0 |
| | | | | 4.0 | RHS | 11.6 | 9.19 | 81.6 | **0.962** | 2.88 | 50.0 | 15.0 | 26.3 | **0.786** | 2.83 | 25.0 | 15.0 | 28.5 |
| | | | | 3.0 | RHS | 8.96 | 5.89 | 64.2 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | | | 2.5 | RHS | 7.53 | 4.40 | 54.7 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | | | 2.0 | RHS | 6.07 | 3.10 | 44.7 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 14.5 | 114 | **1.70** | 4.79 | 75.0 | 10.5 | 12.3 | **1.18** | 4.75 | 37.5 | 10.5 | 13.3 |
| | | | | 5.0 | RHS | 12.5 | 12.4 | 99.6 | **1.29** | 3.83 | 62.5 | 13.0 | 18.2 | **0.983** | 3.79 | 31.3 | 13.0 | 19.8 |
| | | | | 3.5 | RHS | 9.07 | 7.49 | 74.8 | **0.810** | 2.37 | 43.8 | 16.8 | 33.5 | **0.688** | 2.31 | 21.9 | 16.8 | 36.4 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 23.9 | 184 | **1.44** | 4.33 | 75.0 | 22.5 | 26.3 | **1.18** | 4.25 | 37.5 | 22.5 | 28.5 |
| | | | | 5.0 | RHS | 14.2 | 20.5 | 158 | **1.15** | 3.34 | 62.5 | 25.0 | 35.0 | **0.983** | 3.25 | 31.3 | 25.0 | 38.0 |
| | | | | 4.0 | RHS | 11.6 | 15.1 | 130 | **0.884** | 2.32 | 50.0 | 27.5 | 48.1 | **0.786** | 2.20 | 25.0 | 27.5 | 52.3 |
| | | | | 3.0 | RHS | 8.96 | 9.80 | 101 | **0.809** | 1.20 | 30.0 | 31.5 | 73.5 | **0.769** | 1.08 | 15.0 | 31.5 | 79.8 |
| | | | | 2.5 | RHS | 7.53 | 7.39 | 85.1 | **0.667** | 0.756 | 25.0 | 32.5 | 91.0 | **0.641** | 0.670 | 12.5 | 32.5 | 98.8 |
| | | | | 2.0 | RHS | 6.07 | 5.27 | 69.0 | **0.528** | 0.410 | 20.0 | 33.5 | 117 | **0.513** | 0.358 | 10.0 | 33.5 | 127 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 20.5 | 187 | **1.44** | 4.31 | 75.0 | 23.0 | 26.8 | **1.18** | 4.23 | 37.5 | 23.0 | 29.1 |
| | | | | 5.0 | RHS | 12.5 | 17.8 | 160 | **1.15** | 3.32 | 62.5 | 25.5 | 35.7 | **0.983** | 3.22 | 31.3 | 25.5 | 38.8 |
| | | | | 3.5 | RHS | 9.07 | 12.1 | 117 | **0.759** | 1.76 | 43.8 | 29.3 | 58.5 | **0.688** | 1.64 | 21.9 | 29.3 | 63.5 |



## Notes:

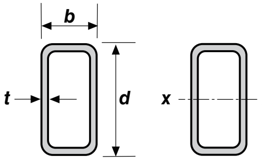
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

TABLE 5.2-2(3)(A)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about x-axis*



| Designation | | | | Mass per m | Design Section Moment Capacities | | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | About x-axis | | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | b | t | | | $\phi M_{sx}$ | FLR | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | mm | mm | | kg/m | kNm | m | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 100 x | 50 x | 6.0 | RHS | 12.0 | 18.4 | 1.60 | 9.94 | 244 | **1.35** | 3.79 | 75.0 | 35.0 | 40.8 | **1.18** | 3.64 | 37.5 | 35.0 | 44.3 |
| | | 5.0 | RHS | 10.3 | 16.1 | 1.64 | 8.87 | 208 | **1.10** | 2.74 | 62.5 | 37.5 | 52.5 | **0.983** | 2.58 | 31.3 | 37.5 | 57.0 |
| | | 4.0 | RHS | 8.49 | 13.5 | 1.68 | 7.58 | 170 | **0.854** | 1.69 | 50.0 | 40.0 | 70.0 | **0.786** | 1.54 | 25.0 | 40.0 | 76.0 |
| | | 3.5 | RHS | 7.53 | 12.1 | 1.70 | 6.85 | 151 | **0.738** | 1.21 | 43.8 | 41.3 | 82.5 | **0.688** | 1.08 | 21.9 | 41.3 | 89.6 |
| | | 3.0 | RHS | 6.60 | 10.8 | 1.73 | 6.08 | 131 | 0.797 | **0.758** | 30.0 | 44.0 | 103 | 0.769 | **0.667** | 15.0 | 44.0 | 111 |
| | | 2.5 | RHS | 5.56 | 9.18 | 1.74 | 5.22 | 110 | 0.659 | **0.455** | 25.0 | 45.0 | 126 | 0.641 | **0.396** | 12.5 | 45.0 | 137 |
| | | 2.0 | RHS | 4.50 | 7.37 | 1.76 | 4.31 | 88.9 | 0.524 | **0.238** | 20.0 | 46.0 | 161 | 0.513 | **0.205** | 10.0 | 46.0 | 175 |
| | | 1.6 | RHS | 3.64 | 5.05 | 1.78 | 3.53 | 71.7 | 0.417 | **0.123** | 16.0 | 46.8 | 205 | 0.410 | **0.106** | 8.00 | 46.8 | 222 |
| 76 x | 38 x | 4.0 | RHS | 6.23 | 7.34 | 1.24 | 4.03 | 126 | **0.883** | 2.30 | 50.0 | 28.0 | 49.0 | **0.786** | 2.17 | 25.0 | 28.0 | 53.2 |
| | | 3.0 | RHS | 4.90 | 6.00 | 1.28 | 3.31 | 97.2 | **0.808** | 1.18 | 30.0 | 32.0 | 74.7 | **0.769** | 1.06 | 15.0 | 32.0 | 81.1 |
| | | 2.5 | RHS | 4.15 | 5.14 | 1.30 | 2.87 | 82.2 | **0.667** | 0.739 | 25.0 | 33.0 | 92.4 | **0.641** | 0.655 | 12.5 | 33.0 | 100 |
| 75 x | 50 x | 6.0 | RHS | 9.67 | 11.4 | 2.05 | 7.11 | 178 | **1.44** | 4.33 | 75.0 | 22.5 | 26.3 | **1.18** | 4.25 | 37.5 | 22.5 | 28.5 |
| | | 5.0 | RHS | 8.35 | 10.1 | 2.11 | 6.41 | 153 | **1.15** | 3.34 | 62.5 | 25.0 | 35.0 | **0.983** | 3.25 | 31.3 | 25.0 | 38.0 |
| | | 4.0 | RHS | 6.92 | 8.56 | 2.17 | 5.52 | 126 | **0.884** | 2.32 | 50.0 | 27.5 | 48.1 | **0.786** | 2.20 | 25.0 | 27.5 | 52.3 |
| | | 3.0 | RHS | 5.42 | 6.92 | 2.23 | 4.47 | 97.4 | **0.809** | 1.20 | 30.0 | 31.5 | 73.5 | **0.769** | 1.08 | 15.0 | 31.5 | 79.8 |
| | | 2.5 | RHS | 4.58 | 5.91 | 2.25 | 3.85 | 82.3 | **0.667** | 0.756 | 25.0 | 32.5 | 91.0 | **0.641** | 0.670 | 12.5 | 32.5 | 98.8 |
| | | 2.0 | RHS | 3.72 | 4.77 | 2.28 | 3.19 | 66.8 | 0.528 | **0.410** | 20.0 | 33.5 | 117 | 0.513 | **0.358** | 10.0 | 33.5 | 127 |
| | | 1.6 | RHS | 3.01 | 3.34 | 2.30 | 2.62 | 54.0 | 0.420 | **0.216** | 16.0 | 34.3 | 150 | 0.410 | **0.186** | 8.00 | 34.3 | 163 |
| 75 x | 25 x | 2.5 | RHS | 3.60 | 4.07 | 0.572 | 1.73 | 79.1 | **0.667** | 0.756 | 25.0 | 32.5 | 91.0 | **0.641** | 0.670 | 12.5 | 32.5 | 98.8 |
| | | 2.0 | RHS | 2.93 | 3.36 | 0.584 | 1.47 | 64.2 | 0.528 | **0.410** | 20.0 | 33.5 | 117 | 0.513 | **0.358** | 10.0 | 33.5 | 127 |
| | | 1.6 | RHS | 2.38 | 2.76 | 0.594 | 1.23 | 51.9 | 0.420 | **0.216** | 16.0 | 34.3 | 150 | 0.410 | **0.186** | 8.00 | 34.3 | 163 |
| 65 x | 35 x | 4.0 | RHS | 5.35 | 5.38 | 1.21 | 3.05 | 106 | **0.906** | 2.56 | 50.0 | 22.5 | 39.4 | **0.786** | 2.47 | 25.0 | 22.5 | 42.8 |
| | | 3.0 | RHS | 4.25 | 4.45 | 1.25 | 2.54 | 82.3 | **0.817** | 1.44 | 30.0 | 26.5 | 61.8 | **0.769** | 1.33 | 15.0 | 26.5 | 67.1 |
| | | 2.5 | RHS | 3.60 | 3.83 | 1.27 | 2.21 | 69.7 | **0.672** | 0.945 | 25.0 | 27.5 | 77.0 | **0.641** | 0.850 | 12.5 | 27.5 | 83.6 |
| | | 2.0 | RHS | 2.93 | 3.16 | 1.29 | 1.85 | 56.7 | 0.532 | **0.528** | 20.0 | 28.5 | 99.8 | 0.513 | **0.465** | 10.0 | 28.5 | 108 |
| 50 x | 25 x | 3.0 | RHS | 3.07 | 2.37 | 0.807 | 1.26 | 61.1 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 2.62 | 2.07 | 0.826 | 1.12 | 52.1 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 2.15 | 1.73 | 0.844 | 0.952 | 42.6 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 1.75 | 1.43 | 0.859 | 0.800 | 34.7 | **0.426** | 0.452 | 16.0 | 21.8 | 95.4 | 0.410 | **0.399** | 8.00 | 21.8 | 104 |
| 50 x | 20 x | 3.0 | RHS | 2.83 | 2.09 | 0.511 | 0.942 | 60.3 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 2.42 | 1.83 | 0.526 | 0.847 | 51.4 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 1.99 | 1.53 | 0.541 | 0.730 | 42.0 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 1.63 | 1.27 | 0.552 | 0.619 | 34.2 | **0.426** | 0.452 | 16.0 | 21.8 | 95.4 | 0.410 | **0.399** | 8.00 | 21.8 | 104 |

## Notes:

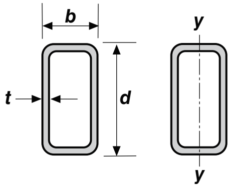
1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. FLR based on most conservative case ($\beta_m = 1$).
4. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
5. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 5.2-2(3)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about y-axis*



| Designation | | | | Mass per m | Design Section Moment Capacity | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | b | t | | | | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | mm | mm | | kg/m | $\phi M_{sy}$ | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 100 x | 50 x | 6.0 | RHS | 12.0 | 11.2 | 111 | **1.72** | 4.81 | 75.0 | 10.0 | 11.7 | **1.18** | 4.77 | 37.5 | 10.0 | 12.7 |
| | | 5.0 | RHS | 10.3 | 9.88 | 97.2 | **1.30** | 3.85 | 62.5 | 12.5 | 17.5 | **0.983** | 3.81 | 31.3 | 12.5 | 19.0 |
| | | 4.0 | RHS | 8.49 | 8.23 | 81.6 | **0.962** | 2.88 | 50.0 | 15.0 | 26.3 | **0.786** | 2.83 | 25.0 | 15.0 | 28.5 |
| | | 3.5 | RHS | 7.53 | 6.92 | 73.1 | **0.814** | 2.39 | 43.8 | 16.3 | 32.5 | **0.688** | 2.33 | 21.9 | 16.3 | 35.3 |
| | | 3.0 | RHS | 6.60 | 5.63 | 64.2 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 5.56 | 4.22 | 54.7 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 4.50 | 2.97 | 44.7 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 3.64 | 2.10 | 36.4 | **0.426** | 0.452 | 16.0 | 21.8 | 95.4 | 0.410 | **0.399** | 8.00 | 21.8 | 104 |
| 76 x | 38 x | 4.0 | RHS | 6.23 | 4.50 | 58.3 | **1.07** | 3.12 | 50.0 | 9.00 | 15.8 | **0.786** | 3.09 | 25.0 | 9.00 | 17.1 |
| | | 3.0 | RHS | 4.90 | 3.61 | 46.7 | **0.866** | 2.09 | 30.0 | 13.0 | 30.3 | **0.769** | 2.04 | 15.0 | 13.0 | 32.9 |
| | | 2.5 | RHS | 4.15 | 2.83 | 40.1 | **0.704** | 1.60 | 25.0 | 14.0 | 39.2 | **0.641** | 1.55 | 12.5 | 14.0 | 42.6 |
| 75 x | 50 x | 6.0 | RHS | 9.67 | 8.56 | 111 | **1.72** | 4.81 | 75.0 | 10.0 | 11.7 | **1.18** | 4.77 | 37.5 | 10.0 | 12.7 |
| | | 5.0 | RHS | 8.35 | 7.61 | 97.2 | **1.30** | 3.85 | 62.5 | 12.5 | 17.5 | **0.983** | 3.81 | 31.3 | 12.5 | 19.0 |
| | | 4.0 | RHS | 6.92 | 6.47 | 81.6 | **0.962** | 2.88 | 50.0 | 15.0 | 26.3 | **0.786** | 2.83 | 25.0 | 15.0 | 28.5 |
| | | 3.0 | RHS | 5.42 | 5.17 | 64.2 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | 2.5 | RHS | 4.58 | 4.03 | 54.7 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | 2.0 | RHS | 3.72 | 2.86 | 44.7 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| | | 1.6 | RHS | 3.01 | 2.03 | 36.4 | **0.426** | 0.452 | 16.0 | 21.8 | 95.4 | 0.410 | **0.399** | 8.00 | 21.8 | 104 |
| 75 x | 25 x | 2.5 | RHS | 3.60 | 1.64 | 24.3 | **0.754** | 1.88 | 25.0 | 7.50 | 21.0 | **0.641** | 1.85 | 12.5 | 7.50 | 22.8 |
| | | 2.0 | RHS | 2.93 | 1.17 | 20.4 | **0.578** | 1.40 | 20.0 | 8.50 | 29.8 | **0.513** | 1.37 | 10.0 | 8.50 | 32.3 |
| | | 1.6 | RHS | 2.38 | 0.816 | 17.0 | **0.449** | 1.01 | 16.0 | 9.30 | 40.7 | **0.410** | 0.973 | 8.00 | 9.30 | 44.2 |
| 65 x | 35 x | 4.0 | RHS | 5.35 | 3.48 | 52.5 | **1.11** | 3.17 | 50.0 | 7.50 | 13.1 | **0.786** | 3.15 | 25.0 | 7.50 | 14.3 |
| | | 3.0 | RHS | 4.25 | 2.88 | 42.3 | **0.878** | 2.15 | 30.0 | 11.5 | 26.8 | **0.769** | 2.11 | 15.0 | 11.5 | 29.1 |
| | | 2.5 | RHS | 3.60 | 2.41 | 36.5 | **0.711** | 1.67 | 25.0 | 12.5 | 35.0 | **0.641** | 1.62 | 12.5 | 12.5 | 38.0 |
| | | 2.0 | RHS | 2.93 | 1.77 | 30.1 | **0.554** | 1.17 | 20.0 | 13.5 | 47.3 | **0.513** | 1.11 | 10.0 | 13.5 | 51.3 |
| 50 x | 25 x | 3.0 | RHS | 3.07 | 1.44 | 27.7 | **0.949** | 2.35 | 30.0 | 6.50 | 15.2 | **0.769** | 2.33 | 15.0 | 6.50 | 16.5 |
| | | 2.5 | RHS | 2.62 | 1.26 | 24.3 | **0.754** | 1.88 | 25.0 | 7.50 | 21.0 | **0.641** | 1.85 | 12.5 | 7.50 | 22.8 |
| | | 2.0 | RHS | 2.15 | 1.05 | 20.4 | **0.578** | 1.40 | 20.0 | 8.50 | 29.8 | **0.513** | 1.37 | 10.0 | 8.50 | 32.3 |
| | | 1.6 | RHS | 1.75 | 0.777 | 17.0 | **0.449** | 1.01 | 16.0 | 9.30 | 40.7 | **0.410** | 0.973 | 8.00 | 9.30 | 44.2 |
| 50 x | 20 x | 3.0 | RHS | 2.83 | 1.06 | 20.4 | **1.02** | 2.44 | 30.0 | 4.00 | 9.33 | **0.769** | 2.43 | 15.0 | 4.00 | 10.1 |
| | | 2.5 | RHS | 2.42 | 0.938 | 18.2 | **0.801** | 1.97 | 25.0 | 5.00 | 14.0 | **0.641** | 1.95 | 12.5 | 5.00 | 15.2 |
| | | 2.0 | RHS | 1.99 | 0.783 | 15.6 | **0.603** | 1.50 | 20.0 | 6.00 | 21.0 | **0.513** | 1.48 | 10.0 | 6.00 | 22.8 |
| | | 1.6 | RHS | 1.63 | 0.582 | 13.1 | **0.463** | 1.12 | 16.0 | 6.80 | 29.8 | **0.410** | 1.10 | 8.00 | 6.80 | 32.3 |

## Notes:

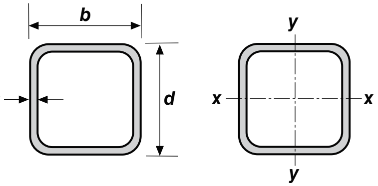
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 5.2-3

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

***about x- and y-axis***



| Designation | | | | | | Mass per m | Design Section Moment Capacities | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Moment | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | $\phi M_{sx}$ | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | | mm | | mm | | kg/m | kNm | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 4.58 | 3.34 | 85.1 | **1.34** | 3.77 | 75.0 | 10.0 | 11.7 | **0.917** | 3.75 | 37.5 | 10.0 | 12.7 |
| | | | | 5.0 | SHS | 6.39 | 4.14 | 3.07 | 74.7 | **1.01** | 3.04 | 62.5 | 12.5 | 17.5 | **0.764** | 3.01 | 31.3 | 12.5 | 19.0 |
| | | | | 4.0 | SHS | 5.35 | 3.59 | 2.70 | 62.7 | **0.748** | 2.30 | 50.0 | 15.0 | 26.3 | **0.611** | 2.26 | 25.0 | 15.0 | 28.5 |
| | | | | 3.0 | SHS | 4.25 | 2.96 | 2.22 | 49.3 | **0.650** | 1.50 | 30.0 | 19.0 | 44.3 | **0.598** | 1.45 | 15.0 | 19.0 | 48.1 |
| | | | | 2.5 | SHS | 3.60 | 2.54 | 1.93 | 42.0 | **0.533** | 1.11 | 25.0 | 20.0 | 56.0 | **0.499** | 1.05 | 12.5 | 20.0 | 60.8 |
| | | | | 2.0 | SHS | 2.93 | 2.10 | 1.61 | 34.3 | **0.419** | 0.713 | 20.0 | 21.0 | 73.5 | **0.399** | 0.654 | 10.0 | 21.0 | 79.8 |
| | | | | 1.6 | SHS | 2.38 | 1.61 | 1.33 | 28.0 | **0.331** | 0.420 | 16.0 | 21.8 | 95.4 | **0.319** | 0.374 | 8.00 | 21.8 | 104 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 2.12 | 1.57 | 47.8 | **0.810** | 2.43 | 50.0 | 10.0 | 17.5 | **0.611** | 2.41 | 25.0 | 10.0 | 19.0 |
| | | | | 3.0 | SHS | 3.30 | 1.80 | 1.34 | 38.1 | **0.668** | 1.65 | 30.0 | 14.0 | 32.7 | **0.598** | 1.61 | 15.0 | 14.0 | 35.5 |
| | | | | 2.5 | SHS | 2.82 | 1.56 | 1.17 | 32.7 | **0.544** | 1.28 | 25.0 | 15.0 | 42.0 | **0.499** | 1.24 | 12.5 | 15.0 | 45.6 |
| | | | | 2.0 | SHS | 2.31 | 1.30 | 0.989 | 26.9 | **0.426** | 0.888 | 20.0 | 16.0 | 56.0 | **0.399** | 0.840 | 10.0 | 16.0 | 60.8 |
| | | | | 1.6 | SHS | 1.88 | 1.07 | 0.824 | 22.0 | **0.335** | 0.571 | 16.0 | 16.8 | 73.5 | **0.319** | 0.523 | 8.00 | 16.8 | 79.8 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 1.33 | 0.978 | 32.5 | **0.683** | 1.72 | 30.0 | 11.5 | 26.8 | **0.598** | 1.69 | 15.0 | 11.5 | 29.1 |
| | | | | 2.5 | SHS | 2.42 | 1.16 | 0.866 | 28.0 | **0.553** | 1.35 | 25.0 | 12.5 | 35.0 | **0.499** | 1.32 | 12.5 | 12.5 | 38.0 |
| | | | | 2.0 | SHS | 1.99 | 0.975 | 0.735 | 23.1 | **0.431** | 0.973 | 20.0 | 13.5 | 47.3 | **0.399** | 0.935 | 10.0 | 13.5 | 51.3 |
| | | | | 1.6 | SHS | 1.63 | 0.808 | 0.616 | 19.0 | **0.338** | 0.658 | 16.0 | 14.3 | 62.6 | **0.319** | 0.615 | 8.00 | 14.3 | 67.9 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 0.932 | 0.676 | 26.9 | **0.704** | 1.78 | 30.0 | 9.00 | 21.0 | **0.598** | 1.76 | 15.0 | 9.00 | 22.8 |
| | | | | 2.5 | SHS | 2.03 | 0.822 | 0.605 | 23.3 | **0.566** | 1.42 | 25.0 | 10.0 | 28.0 | **0.499** | 1.40 | 12.5 | 10.0 | 30.4 |
| | | | | 2.0 | SHS | 1.68 | 0.695 | 0.519 | 19.4 | **0.439** | 1.05 | 20.0 | 11.0 | 38.5 | **0.399** | 1.02 | 10.0 | 11.0 | 41.8 |
| | | | | 1.6 | SHS | 1.38 | 0.580 | 0.439 | 16.0 | **0.343** | 0.745 | 16.0 | 11.8 | 51.6 | **0.319** | 0.710 | 8.00 | 11.8 | 56.1 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 0.603 | 0.430 | 21.3 | **0.738** | 1.85 | 30.0 | 6.50 | 15.2 | **0.598** | 1.83 | 15.0 | 6.50 | 16.5 |
| | | | | 2.5 | SHS | 1.64 | 0.539 | 0.391 | 18.7 | **0.587** | 1.49 | 25.0 | 7.50 | 21.0 | **0.499** | 1.47 | 12.5 | 7.50 | 22.8 |
| | | | | 2.0 | SHS | 1.36 | 0.462 | 0.341 | 15.7 | **0.450** | 1.12 | 20.0 | 8.50 | 29.8 | **0.399** | 1.10 | 10.0 | 8.50 | 32.3 |
| | | | | 1.6 | SHS | 1.12 | 0.389 | 0.292 | 13.0 | **0.349** | 0.825 | 16.0 | 9.30 | 40.7 | **0.319** | 0.801 | 8.00 | 9.30 | 44.2 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 0.276 | 0.200 | 11.9 | **0.469** | 1.19 | 20.0 | 6.00 | 21.0 | **0.399** | 1.17 | 10.0 | 6.00 | 22.8 |
| | | | | 1.6 | SHS | 0.873 | 0.236 | 0.175 | 10.0 | **0.360** | 0.897 | 16.0 | 6.80 | 29.8 | **0.319** | 0.881 | 8.00 | 6.80 | 32.3 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 5.2-4(1)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

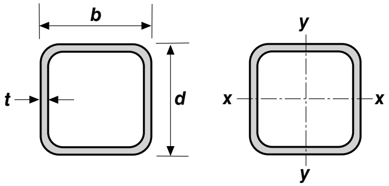
## DESIGN SECTION MOMENT AND WEB CAPACITIES

***about x- and y-axis***

1 SHS

2 C450PLUS®

3 Finish



| Designation | | | | | | Mass per m | Design Section Moment Capacities | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Moment $\phi M_{sx}$ | Torsion $\phi M_z$ | Shear $\phi V_v$ | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | | | | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | | mm | | mm | | kg/m | kNm | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 1350 | 1060 | 2830 | **3.42** | 6.76 | 200 | 160 | 70.0 | **3.14** | 6.15 | 100 | 160 | 76.0 |
| | | | | 12.5 | SHS | 148 | 937 | 856 | 2250 | **2.61** | 3.58 | 156 | 169 | 94.5 | **2.46** | 3.16 | 78.1 | 169 | 103 |
| | | | | 10.0 | SHS | 120 | 670 | 703 | 1820 | 2.06 | **1.91** | 125 | 175 | 123 | 1.97 | **1.66** | 62.5 | 175 | 133 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 1020 | 790 | 2440 | **3.47** | 8.00 | 200 | 135 | 59.1 | **3.14** | 7.42 | 100 | 135 | 64.1 |
| | | | | 12.5 | SHS | 128 | 768 | 644 | 1950 | **2.64** | 4.47 | 156 | 144 | 80.5 | **2.46** | 4.00 | 78.1 | 144 | 87.4 |
| | | | | 10.0 | SHS | 104 | 548 | 530 | 1580 | **2.08** | 2.44 | 125 | 150 | 105 | **1.97** | 2.14 | 62.5 | 150 | 114 |
| | | | | 8.0 | SHS | 84.2 | 393 | 434 | 1280 | 1.64 | **1.28** | 100 | 155 | 136 | 1.57 | **1.11** | 50.0 | 155 | 147 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 732 | 562 | 2060 | **3.54** | 9.28 | 200 | 110 | 48.1 | **3.14** | 8.80 | 100 | 110 | 52.3 |
| | | | | 12.5 | SHS | 109 | 596 | 461 | 1650 | **2.68** | 5.58 | 156 | 119 | 66.5 | **2.46** | 5.10 | 78.1 | 119 | 72.2 |
| | | | | 10.0 | SHS | 88.4 | 436 | 382 | 1340 | **2.10** | 3.19 | 125 | 125 | 87.5 | **1.97** | 2.84 | 62.5 | 125 | 95.0 |
| | | | | 8.0 | SHS | 71.6 | 311 | 314 | 1090 | **1.66** | 1.72 | 100 | 130 | 114 | 1.57 | **1.50** | 50.0 | 130 | 124 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 489 | 373 | 1670 | **3.65** | 10.5 | 200 | 85.0 | 37.2 | **3.14** | 10.1 | 100 | 85.0 | 40.4 |
| | | | | 12.5 | SHS | 89.0 | 402 | 309 | 1350 | **2.74** | 6.86 | 156 | 93.8 | 52.5 | **2.46** | 6.44 | 78.1 | 93.8 | 57.0 |
| | | | | 10.0 | SHS | 72.7 | 329 | 258 | 1100 | **2.14** | 4.23 | 125 | 100 | 70.0 | **1.97** | 3.84 | 62.5 | 100 | 76.0 |
| | | | | 9.0 | SHS | 65.9 | 283 | 236 | 1000 | **1.90** | 3.26 | 113 | 103 | 79.7 | **1.77** | 2.92 | 56.3 | 103 | 86.6 |
| | | | | 8.0 | SHS | 59.1 | 237 | 213 | 899 | **1.68** | 2.39 | 100 | 105 | 91.9 | **1.57** | 2.11 | 50.0 | 105 | 99.8 |
| | | | | 6.0 | SHS | 45.0 | 154 | 165 | 685 | 1.23 | **1.06** | 75.0 | 110 | 128 | 1.18 | **0.920** | 37.5 | 110 | 139 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 295 | 222 | 1290 | **3.85** | 11.5 | 200 | 60.0 | 26.3 | **3.14** | 11.3 | 100 | 60.0 | 28.5 |
| | | | | 12.5 | SHS | 69.4 | 246 | 188 | 1050 | **2.84** | 8.08 | 156 | 68.8 | 38.5 | **2.46** | 7.81 | 78.1 | 68.8 | 41.8 |
| | | | | 10.0 | SHS | 57.0 | 206 | 158 | 864 | **2.19** | 5.48 | 125 | 75.0 | 52.5 | **1.97** | 5.15 | 62.5 | 75.0 | 57.0 |
| | | | | 9.0 | SHS | 51.8 | 188 | 146 | 786 | **1.95** | 4.42 | 113 | 77.5 | 60.3 | **1.77** | 4.09 | 56.3 | 77.5 | 65.4 |
| | | | | 8.0 | SHS | 46.5 | 168 | 132 | 707 | **1.71** | 3.38 | 100 | 80.0 | 70.0 | **1.57** | 3.07 | 50.0 | 80.0 | 76.0 |
| | | | | 6.0 | SHS | 35.6 | 110 | 103 | 541 | **1.25** | 1.60 | 75.0 | 85.0 | 99.2 | **1.18** | 1.41 | 37.5 | 85.0 | 108 |
| | | | | 5.0 | SHS | 29.9 | 83.8 | 87.9 | 456 | 1.03 | **0.953** | 62.5 | 87.5 | 123 | 0.983 | **0.830** | 31.3 | 87.5 | 133 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 109 | 82.9 | 624 | **2.30** | 6.69 | 125 | 50.0 | 35.0 | **1.97** | 6.50 | 62.5 | 50.0 | 38.0 |
| | | | | 9.0 | SHS | 37.7 | 101 | 76.8 | 570 | **2.03** | 5.68 | 113 | 52.5 | 40.8 | **1.77** | 5.46 | 56.3 | 52.5 | 44.3 |
| | | | | 8.0 | SHS | 33.9 | 91.5 | 70.2 | 515 | **1.77** | 4.64 | 100 | 55.0 | 48.1 | **1.57** | 4.40 | 50.0 | 55.0 | 52.3 |
| | | | | 6.0 | SHS | 26.2 | 71.0 | 55.7 | 397 | **1.28** | 2.54 | 75.0 | 60.0 | 70.0 | **1.18** | 2.30 | 37.5 | 60.0 | 76.0 |
| | | | | 5.0 | SHS | 22.1 | 54.6 | 47.8 | 336 | **1.05** | 1.60 | 62.5 | 62.5 | 87.5 | **0.983** | 1.42 | 31.3 | 62.5 | 95.0 |

### Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

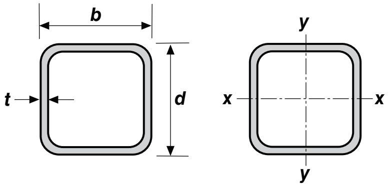
TABLE 5.2-4(2)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

### *about x- and y-axis*

| Designation | | | | | | Mass per m | Design Section Moment Capacities | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Moment | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | $\phi M_{sx}$ | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | | mm | | mm | | kg/m | kNm | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 72.0 | 54.2 | 504 | **2.41** | 7.21 | 125 | 37.5 | 26.3 | **1.97** | 7.08 | 62.5 | 37.5 | 28.5 |
| | | | | 9.0 | SHS | 30.6 | 66.8 | 50.6 | 462 | **2.11** | 6.23 | 113 | 40.0 | 31.1 | **1.77** | 6.09 | 56.3 | 40.0 | 33.8 |
| | | | | 8.0 | SHS | 27.7 | 61.2 | 46.6 | 419 | **1.83** | 5.24 | 100 | 42.5 | 37.2 | **1.57** | 5.07 | 50.0 | 42.5 | 40.4 |
| | | | | 6.0 | SHS | 21.4 | 48.6 | 37.4 | 325 | **1.31** | 3.16 | 75.0 | 47.5 | 55.4 | **1.18** | 2.95 | 37.5 | 47.5 | 60.2 |
| | | | | 5.0 | SHS | 18.2 | 41.1 | 32.3 | 276 | **1.07** | 2.11 | 62.5 | 50.0 | 70.0 | **0.983** | 1.92 | 31.3 | 50.0 | 76.0 |
| | | | | 4.0 | SHS | 14.8 | 29.7 | 26.7 | 225 | **0.838** | 1.19 | 50.0 | 52.5 | 91.9 | **0.786** | 1.06 | 25.0 | 52.5 | 99.8 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 42.6 | 31.6 | 384 | **2.60** | 7.69 | 125 | 25.0 | 17.5 | **1.97** | 7.61 | 62.5 | 25.0 | 19.0 |
| | | | | 9.0 | SHS | 23.5 | 39.9 | 29.8 | 354 | **2.25** | 6.73 | 113 | 27.5 | 21.4 | **1.77** | 6.64 | 56.3 | 27.5 | 23.2 |
| | | | | 8.0 | SHS | 21.4 | 36.9 | 27.8 | 323 | **1.92** | 5.77 | 100 | 30.0 | 26.3 | **1.57** | 5.66 | 50.0 | 30.0 | 28.5 |
| | | | | 6.0 | SHS | 16.7 | 29.8 | 22.7 | 253 | **1.35** | 3.79 | 75.0 | 35.0 | 40.8 | **1.18** | 3.64 | 37.5 | 35.0 | 44.3 |
| | | | | 5.0 | SHS | 14.2 | 25.7 | 19.8 | 216 | **1.10** | 2.74 | 62.5 | 37.5 | 52.5 | **0.983** | 2.58 | 31.3 | 37.5 | 57.0 |
| | | | | 4.0 | SHS | 11.6 | 21.0 | 16.5 | 177 | **0.854** | 1.69 | 50.0 | 40.0 | 70.0 | **0.786** | 1.54 | 25.0 | 40.0 | 76.0 |
| | | | | 3.0 | SHS | 8.96 | 13.9 | 12.9 | 135 | 0.797 | **0.758** | 30.0 | 44.0 | 103 | 0.769 | **0.667** | 15.0 | 44.0 | 111 |
| | | | | 2.5 | SHS | 7.53 | 10.6 | 11.0 | 114 | 0.659 | **0.455** | 25.0 | 45.0 | 126 | 0.641 | **0.396** | 12.5 | 45.0 | 137 |
| | | | | 2.0 | SHS | 6.07 | 7.63 | 8.97 | 92.2 | 0.524 | **0.238** | 20.0 | 46.0 | 161 | 0.513 | **0.205** | 10.0 | 46.0 | 175 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 9.03 | 8.80 | 102 | 0.662 | **0.551** | 25.0 | 40.0 | 112 | 0.641 | **0.482** | 12.5 | 40.0 | 122 |
| | | | | 2.0 | SHS | 5.45 | 6.48 | 7.20 | 82.6 | 0.525 | **0.291** | 20.0 | 41.0 | 144 | 0.513 | **0.252** | 10.0 | 41.0 | 156 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 23.0 | 17.4 | 222 | **1.38** | 4.03 | 75.0 | 29.5 | 34.4 | **1.18** | 3.92 | 37.5 | 29.5 | 37.4 |
| | | | | 5.0 | SHS | 12.5 | 19.9 | 15.3 | 190 | **1.11** | 3.02 | 62.5 | 32.0 | 44.8 | **0.983** | 2.88 | 31.3 | 32.0 | 48.6 |
| | | | | 3.5 | SHS | 9.07 | 14.5 | 11.5 | 138 | **0.746** | 1.44 | 43.8 | 35.8 | 71.5 | **0.688** | 1.31 | 21.9 | 35.8 | 77.6 |
| | | | | 2.0 | SHS | 5.38 | 6.37 | 7.04 | 81.6 | 0.525 | **0.298** | 20.0 | 40.5 | 142 | 0.513 | **0.258** | 10.0 | 40.5 | 154 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 15.6 | 11.7 | 181 | **1.44** | 4.33 | 75.0 | 22.5 | 26.3 | **1.18** | 4.25 | 37.5 | 22.5 | 28.5 |
| | | | | 5.0 | SHS | 10.3 | 13.6 | 10.4 | 156 | **1.15** | 3.34 | 62.5 | 25.0 | 35.0 | **0.983** | 3.25 | 31.3 | 25.0 | 38.0 |
| | | | | 4.0 | SHS | 8.49 | 11.4 | 8.78 | 129 | **0.884** | 2.32 | 50.0 | 27.5 | 48.1 | **0.786** | 2.20 | 25.0 | 27.5 | 52.3 |
| | | | | 3.5 | SHS | 7.53 | 10.2 | 7.90 | 114 | **0.760** | 1.79 | 43.8 | 28.8 | 57.5 | **0.688** | 1.66 | 21.9 | 28.8 | 62.4 |
| | | | | 3.0 | SHS | 6.60 | 8.99 | 6.98 | 99.4 | **0.809** | 1.20 | 30.0 | 31.5 | 73.5 | **0.769** | 1.08 | 15.0 | 31.5 | 79.8 |
| | | | | 2.5 | SHS | 5.56 | 6.90 | 5.98 | 84.0 | **0.667** | 0.756 | 25.0 | 32.5 | 91.0 | **0.641** | 0.670 | 12.5 | 32.5 | 98.8 |
| | | | | 2.0 | SHS | 4.50 | 4.91 | 4.91 | 68.2 | 0.528 | **0.410** | 20.0 | 33.5 | 117 | 0.513 | **0.358** | 10.0 | 33.5 | 127 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 11.1 | 8.31 | 153 | **1.51** | 4.52 | 75.0 | 17.5 | 20.4 | **1.18** | 4.46 | 37.5 | 17.5 | 22.2 |
| | | | | 5.0 | SHS | 8.75 | 9.85 | 7.43 | 132 | **1.19** | 3.55 | 62.5 | 20.0 | 28.0 | **0.983** | 3.48 | 31.3 | 20.0 | 30.4 |
| | | | | 4.0 | SHS | 7.23 | 8.34 | 6.36 | 109 | **0.906** | 2.56 | 50.0 | 22.5 | 39.4 | **0.786** | 2.47 | 25.0 | 22.5 | 42.8 |
| | | | | 3.0 | SHS | 5.66 | 6.71 | 5.11 | 85.0 | **0.817** | 1.44 | 30.0 | 26.5 | 61.8 | **0.769** | 1.33 | 15.0 | 26.5 | 67.1 |
| | | | | 2.5 | SHS | 4.78 | 5.54 | 4.40 | 72.0 | **0.672** | 0.945 | 25.0 | 27.5 | 77.0 | **0.641** | 0.850 | 12.5 | 27.5 | 83.6 |
| | | | | 2.0 | SHS | 3.88 | 3.97 | 3.63 | 58.6 | 0.532 | **0.528** | 20.0 | 28.5 | 99.8 | 0.513 | **0.465** | 10.0 | 28.5 | 108 |
| | | | | 1.6 | SHS | 3.13 | 2.84 | 2.98 | 47.5 | 0.422 | **0.283** | 16.0 | 29.3 | 128 | 0.410 | **0.246** | 8.00 | 29.3 | 139 |



## Notes:

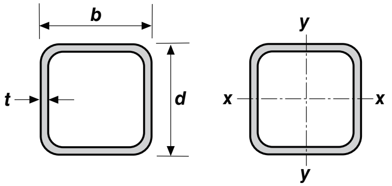
1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

TABLE 5.2-4(3)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

***about x- and y-axis***



| Designation | | | | | | Mass per m | Design Section Moment Capacities | | Design Web Capacities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Moment | Torsion | Shear | Interior Bearing | | | | | End Bearing | | | | |
| d | | b | | t | | | $\phi M_{sx}$ | $\phi M_z$ | $\phi V_v$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ | $\frac{\phi R_{by}}{b_b}$ | $\frac{\phi R_{bb}}{b_b}$ | $2.5r_{ext}$ | $b_{bw}$ | $\frac{L_e}{r}$ |
| mm | | mm | | mm | | kg/m | kNm | kNm | kN | kN/mm | kN/mm | mm | mm | | kN/mm | kN/mm | mm | mm | |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 5.89 | 4.30 | 109 | **1.72** | 4.81 | 75.0 | 10.0 | 11.7 | **1.18** | 4.77 | 37.5 | 10.0 | 12.7 |
| | | | | 5.0 | SHS | 6.39 | 5.33 | 3.95 | 96.0 | **1.30** | 3.85 | 62.5 | 12.5 | 17.5 | **0.983** | 3.81 | 31.3 | 12.5 | 19.0 |
| | | | | 4.0 | SHS | 5.35 | 4.61 | 3.47 | 80.6 | **0.962** | 2.88 | 50.0 | 15.0 | 26.3 | **0.786** | 2.83 | 25.0 | 15.0 | 28.5 |
| | | | | 3.0 | SHS | 4.25 | 3.80 | 2.86 | 63.4 | **0.836** | 1.82 | 30.0 | 19.0 | 44.3 | **0.769** | 1.74 | 15.0 | 19.0 | 48.1 |
| | | | | 2.5 | SHS | 3.60 | 3.27 | 2.48 | 54.0 | **0.685** | 1.31 | 25.0 | 20.0 | 56.0 | **0.641** | 1.22 | 12.5 | 20.0 | 60.8 |
| | | | | 2.0 | SHS | 2.93 | 2.66 | 2.07 | 44.2 | **0.539** | 0.800 | 20.0 | 21.0 | 73.5 | **0.513** | 0.723 | 10.0 | 21.0 | 79.8 |
| | | | | 1.6 | SHS | 2.38 | 1.92 | 1.71 | 35.9 | **0.426** | 0.452 | 16.0 | 21.8 | 95.4 | 0.410 | **0.399** | 8.00 | 21.8 | 104 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 2.73 | 2.02 | 61.4 | **1.04** | 3.08 | 50.0 | 10.0 | 17.5 | **0.786** | 3.05 | 25.0 | 10.0 | 19.0 |
| | | | | 3.0 | SHS | 3.30 | 2.32 | 1.72 | 49.0 | **0.859** | 2.05 | 30.0 | 14.0 | 32.7 | **0.769** | 2.00 | 15.0 | 14.0 | 35.5 |
| | | | | 2.5 | SHS | 2.82 | 2.01 | 1.51 | 42.0 | **0.700** | 1.56 | 25.0 | 15.0 | 42.0 | **0.641** | 1.50 | 12.5 | 15.0 | 45.6 |
| | | | | 2.0 | SHS | 2.31 | 1.67 | 1.27 | 34.6 | **0.548** | 1.05 | 20.0 | 16.0 | 56.0 | **0.513** | 0.975 | 10.0 | 16.0 | 60.8 |
| | | | | 1.6 | SHS | 1.88 | 1.36 | 1.06 | 28.3 | **0.431** | 0.640 | 16.0 | 16.8 | 73.5 | **0.410** | 0.578 | 8.00 | 16.8 | 79.8 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 1.71 | 1.26 | 41.8 | **0.878** | 2.15 | 30.0 | 11.5 | 26.8 | **0.769** | 2.11 | 15.0 | 11.5 | 29.1 |
| | | | | 2.5 | SHS | 2.42 | 1.50 | 1.11 | 36.0 | **0.711** | 1.67 | 25.0 | 12.5 | 35.0 | **0.641** | 1.62 | 12.5 | 12.5 | 38.0 |
| | | | | 2.0 | SHS | 1.99 | 1.25 | 0.945 | 29.8 | **0.554** | 1.17 | 20.0 | 13.5 | 47.3 | **0.513** | 1.11 | 10.0 | 13.5 | 51.3 |
| | | | | 1.6 | SHS | 1.63 | 1.04 | 0.792 | 24.4 | **0.435** | 0.760 | 16.0 | 14.3 | 62.6 | **0.410** | 0.699 | 8.00 | 14.3 | 67.9 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 1.20 | 0.869 | 34.6 | **0.905** | 2.25 | 30.0 | 9.00 | 21.0 | **0.769** | 2.22 | 15.0 | 9.00 | 22.8 |
| | | | | 2.5 | SHS | 2.03 | 1.06 | 0.778 | 30.0 | **0.728** | 1.78 | 25.0 | 10.0 | 28.0 | **0.641** | 1.74 | 12.5 | 10.0 | 30.4 |
| | | | | 2.0 | SHS | 1.68 | 0.893 | 0.667 | 25.0 | **0.564** | 1.29 | 20.0 | 11.0 | 38.5 | **0.513** | 1.25 | 10.0 | 11.0 | 41.8 |
| | | | | 1.6 | SHS | 1.38 | 0.746 | 0.564 | 20.6 | **0.441** | 0.888 | 16.0 | 11.8 | 51.6 | **0.410** | 0.836 | 8.00 | 11.8 | 56.1 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 0.776 | 0.553 | 27.4 | **0.949** | 2.35 | 30.0 | 6.50 | 15.2 | **0.769** | 2.33 | 15.0 | 6.50 | 16.5 |
| | | | | 2.5 | SHS | 1.64 | 0.694 | 0.503 | 24.0 | **0.754** | 1.88 | 25.0 | 7.50 | 21.0 | **0.641** | 1.85 | 12.5 | 7.50 | 22.8 |
| | | | | 2.0 | SHS | 1.36 | 0.594 | 0.438 | 20.2 | **0.578** | 1.40 | 20.0 | 8.50 | 29.8 | **0.513** | 1.37 | 10.0 | 8.50 | 32.3 |
| | | | | 1.6 | SHS | 1.12 | 0.500 | 0.375 | 16.7 | **0.449** | 1.01 | 16.0 | 9.30 | 40.7 | **0.410** | 0.973 | 8.00 | 9.30 | 44.2 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 0.355 | 0.258 | 15.4 | **0.603** | 1.50 | 20.0 | 6.00 | 21.0 | **0.513** | 1.48 | 10.0 | 6.00 | 22.8 |
| | | | | 1.6 | SHS | 0.873 | 0.304 | 0.224 | 12.9 | **0.463** | 1.12 | 16.0 | 6.80 | 29.8 | **0.410** | 1.10 | 8.00 | 6.80 | 32.3 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

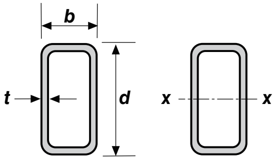
TABLE 5.3-1

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

### *bending about x-axis*

| Designation | | | | | | Mass per m | $\phi M_{sx}$ | $\phi V_v$ | Design Member Moment Capacities, $\phi M_b$ (kNm) Effective Length ($L_e$) in metres | | | | | | | | | | | | | | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | kNm | kN | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | m |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 3.17 | 61.5 | 3.17 | 3.15 | 3.10 | 3.05 | 3.01 | 2.96 | 2.92 | 2.83 | 2.74 | 2.66 | 2.58 | 2.51 | 2.44 | 2.30 | 0.736 |
| | | | | 2.0 | RHS | 2.93 | 2.62 | 49.9 | 2.62 | 2.62 | 2.56 | 2.52 | 2.49 | 2.45 | 2.41 | 2.34 | 2.27 | 2.21 | 2.14 | 2.08 | 2.02 | 1.91 | 0.751 |
| | | | | 1.6 | RHS | 2.38 | 2.15 | 40.4 | 2.15 | 2.15 | 2.10 | 2.07 | 2.04 | 2.01 | 1.98 | 1.93 | 1.87 | 1.82 | 1.77 | 1.72 | 1.67 | 1.58 | 0.764 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 4.18 | 82.4 | 4.18 | 4.18 | 4.18 | 4.18 | 4.18 | 4.10 | 4.06 | 3.99 | 3.93 | 3.86 | 3.80 | 3.73 | 3.67 | 3.55 | 1.55 |
| | | | | 3.0 | RHS | 4.25 | 3.46 | 64.0 | 3.46 | 3.46 | 3.46 | 3.46 | 3.46 | 3.39 | 3.36 | 3.31 | 3.25 | 3.20 | 3.14 | 3.09 | 3.04 | 2.94 | 1.61 |
| | | | | 2.5 | RHS | 3.60 | 2.98 | 54.2 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.92 | 2.89 | 2.85 | 2.80 | 2.75 | 2.71 | 2.66 | 2.62 | 2.54 | 1.64 |
| | | | | 2.0 | RHS | 2.93 | 2.46 | 44.1 | 2.46 | 2.46 | 2.46 | 2.46 | 2.46 | 2.41 | 2.39 | 2.35 | 2.31 | 2.27 | 2.24 | 2.20 | 2.17 | 2.10 | 1.66 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 1.85 | 47.5 | 1.85 | 1.85 | 1.85 | 1.80 | 1.78 | 1.76 | 1.74 | 1.69 | 1.65 | 1.61 | 1.57 | 1.53 | 1.50 | 1.43 | 1.04 |
| | | | | 2.5 | RHS | 2.62 | 1.61 | 40.5 | 1.61 | 1.61 | 1.61 | 1.57 | 1.55 | 1.53 | 1.51 | 1.48 | 1.44 | 1.41 | 1.37 | 1.34 | 1.31 | 1.25 | 1.06 |
| | | | | 2.0 | RHS | 2.15 | 1.34 | 33.1 | 1.34 | 1.34 | 1.34 | 1.31 | 1.30 | 1.28 | 1.27 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.05 | 1.09 |
| | | | | 1.6 | RHS | 1.75 | 1.11 | 27.0 | 1.11 | 1.11 | 1.11 | 1.09 | 1.07 | 1.06 | 1.05 | 1.02 | 0.999 | 0.976 | 0.953 | 0.931 | 0.909 | 0.868 | 1.10 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 1.62 | 46.9 | 1.62 | 1.60 | 1.57 | 1.54 | 1.52 | 1.49 | 1.46 | 1.41 | 1.36 | 1.31 | 1.27 | 1.23 | 1.19 | 1.11 | 0.657 |
| | | | | 2.5 | RHS | 2.42 | 1.42 | 40.0 | 1.42 | 1.40 | 1.38 | 1.35 | 1.33 | 1.31 | 1.28 | 1.24 | 1.20 | 1.16 | 1.12 | 1.08 | 1.04 | 0.978 | 0.676 |
| | | | | 2.0 | RHS | 1.99 | 1.19 | 32.7 | 1.19 | 1.18 | 1.16 | 1.14 | 1.12 | 1.10 | 1.08 | 1.04 | 1.01 | 0.975 | 0.943 | 0.912 | 0.883 | 0.827 | 0.695 |
| | | | | 1.6 | RHS | 1.63 | 0.989 | 26.6 | 0.989 | 0.976 | 0.960 | 0.944 | 0.928 | 0.913 | 0.897 | 0.868 | 0.839 | 0.812 | 0.786 | 0.761 | 0.736 | 0.691 | 0.710 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Values of $\phi M_b$ based on $\alpha_m = 1.0$ (uniform moment over entire segment) in this Table.
3. Values to the left of those of the solid line are for segment lengths with full lateral restraint based on the listed FLR and $\phi M_b = \phi M_{sx}$.
4. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with $\beta_m = -1.0$.
5. For other moment distributions use the appropriate value of $\alpha_m$ obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of $\alpha_m \phi M_b$ and $\phi M_{sx}$ given in this Table.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

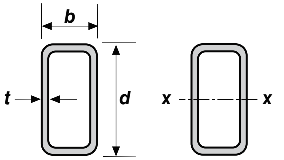
TABLE 5.3-2(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MOMENT CAPACITIES FOR MEMBERS <u>WITHOUT</u> FULL LATERAL RESTRAINT

### *bending about x-axis*

| Designation | | | | | | Mass per m | $\phi M_{sx}$ | $\phi V_v$ | Design Member Moment Capacities, $\phi M_b$ (kNm) Effective Length ($L_e$) in metres | | | | | | | | | | | | | | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | kNm | kN | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | m |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 1110 | 2790 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 1110 | 14.9 |
| | | | | 12.5 | RHS | 128 | 901 | 2220 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 901 | 15.1 |
| | | | | 10.0 | RHS | 104 | 649 | 1800 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 15.2 |
| | | | | 8.0 | RHS | 84.2 | 463 | 1450 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 463 | 15.4 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 866 | 2730 | 866 | 866 | 866 | 866 | 866 | 866 | 853 | 846 | 839 | 833 | 827 | 820 | 814 | 808 | 6.73 |
| | | | | 12.5 | RHS | 109 | 705 | 2170 | 705 | 705 | 705 | 705 | 705 | 705 | 695 | 689 | 684 | 679 | 674 | 669 | 664 | 659 | 6.87 |
| | | | | 10.0 | RHS | 88.4 | 581 | 1760 | 581 | 581 | 581 | 581 | 581 | 581 | 572 | 568 | 564 | 559 | 555 | 551 | 547 | 543 | 6.97 |
| | | | | 8.0 | RHS | 71.6 | 467 | 1420 | 467 | 467 | 467 | 467 | 467 | 467 | 467 | 458 | 454 | 451 | 448 | 444 | 441 | 438 | 7.04 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 807 | 2400 | 807 | 807 | 807 | 807 | 807 | 807 | 807 | 807 | 807 | 807 | 807 | 787 | 783 | 778 | 11.7 |
| | | | | 12.5 | RHS | 109 | 657 | 1920 | 657 | 657 | 657 | 657 | 657 | 657 | 657 | 657 | 657 | 657 | 657 | 640 | 637 | 634 | 11.9 |
| | | | | 10.0 | RHS | 88.4 | 533 | 1560 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 517 | 515 | 12.1 |
| | | | | 8.0 | RHS | 71.6 | 376 | 1260 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 376 | 368 | 367 | 12.2 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 548 | 2020 | 548 | 548 | 548 | 548 | 548 | 548 | 548 | 548 | 535 | 532 | 528 | 524 | 521 | 517 | 8.66 |
| | | | | 12.5 | RHS | 89.0 | 450 | 1620 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 440 | 437 | 434 | 431 | 428 | 425 | 8.85 |
| | | | | 10.0 | RHS | 72.7 | 373 | 1320 | 373 | 373 | 373 | 373 | 373 | 373 | 373 | 373 | 365 | 362 | 360 | 357 | 355 | 353 | 8.99 |
| | | | | 8.0 | RHS | 59.1 | 302 | 1070 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 294 | 292 | 290 | 288 | 286 | 9.10 |
| | | | | 6.0 | RHS | 45.0 | 192 | 813 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 189 | 188 | 187 | 186 | 185 | 9.20 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 338 | 1630 | 338 | 338 | 338 | 338 | 338 | 331 | 328 | 325 | 322 | 318 | 315 | 312 | 309 | 306 | 5.73 |
| | | | | 12.5 | RHS | 69.4 | 282 | 1320 | 282 | 282 | 282 | 282 | 282 | 276 | 274 | 271 | 269 | 266 | 264 | 261 | 259 | 256 | 5.90 |
| | | | | 10.0 | RHS | 57.0 | 236 | 1080 | 236 | 236 | 236 | 236 | 236 | 236 | 229 | 227 | 225 | 223 | 221 | 219 | 217 | 215 | 6.02 |
| | | | | 9.0 | RHS | 51.8 | 216 | 976 | 216 | 216 | 216 | 216 | 216 | 216 | 210 | 208 | 206 | 204 | 202 | 200 | 199 | 197 | 6.07 |
| | | | | 8.0 | RHS | 46.5 | 195 | 875 | 195 | 195 | 195 | 195 | 195 | 195 | 190 | 188 | 186 | 185 | 183 | 181 | 180 | 178 | 6.12 |
| | | | | 6.0 | RHS | 35.6 | 149 | 668 | 149 | 149 | 149 | 149 | 149 | 149 | 145 | 144 | 143 | 141 | 140 | 139 | 138 | 136 | 6.22 |
| | | | | 5.0 | RHS | 29.9 | 111 | 561 | 111 | 111 | 111 | 111 | 111 | 111 | 109 | 109 | 108 | 107 | 106 | 105 | 104 | 103 | 6.26 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the <u>availability</u> of <u>listed</u> <u>sections</u> and associated <u>finishes</u>. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) <u>and</u> C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. Values of $\phi M_b$ based on $\alpha_m$ = 1.0 (uniform moment over entire segment) in this Table.
4. Values to the left of those of the solid line are for segment lengths with full lateral restraint based on the listed FLR and $\phi M_b = \phi M_{sx}$.
5. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with $\beta_m$ = -1.0.
6. For other moment distributions use the appropriate value of $\alpha_m$ obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of $\alpha_m \phi M_b$ and $\phi M_{sx}$ given in this Table.

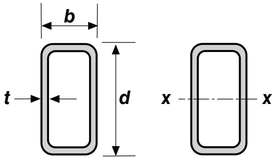
TABLE 5.3-2(2)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MOMENT CAPACITIES FOR MEMBERS
## WITHOUT FULL LATERAL RESTRAINT

### *bending about x-axis*

| Designation d | | b | | t | | Mass per m | $\phi M_{sx}$ | $\phi V_v$ | Design Member Moment Capacities, $\phi M_b$ (kNm) Effective Length ($L_e$) in metres | | | | | | | | | | | | | | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | kNm | kN | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | m |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 129 | 833 | 129 | 129 | 129 | 126 | 124 | 122 | 120 | 118 | 116 | 115 | 113 | 111 | 109 | 108 | 3.29 |
| | | | | 9.0 | RHS | 37.7 | 119 | 758 | 119 | 119 | 119 | 116 | 114 | 113 | 111 | 109 | 107 | 106 | 104 | 103 | 101 | 99.5 | 3.33 |
| | | | | 8.0 | RHS | 33.9 | 108 | 681 | 108 | 108 | 108 | 106 | 104 | 103 | 101 | 99.4 | 97.9 | 96.4 | 95.0 | 93.5 | 92.1 | 90.7 | 3.37 |
| | | | | 6.0 | RHS | 26.2 | 85.1 | 522 | 85.1 | 85.1 | 85.1 | 83.2 | 82.0 | 80.7 | 79.5 | 78.3 | 77.1 | 76.0 | 74.8 | 73.7 | 72.6 | 71.5 | 3.44 |
| | | | | 5.0 | RHS | 22.1 | 72.6 | 440 | 72.6 | 72.6 | 72.6 | 71.0 | 69.9 | 68.9 | 67.8 | 66.8 | 65.8 | 64.8 | 63.9 | 62.9 | 62.0 | 61.1 | 3.48 |
| | | | | 4.0 | RHS | 17.9 | 58.4 | 355 | 58.4 | 58.4 | 58.4 | 57.2 | 56.4 | 55.5 | 54.7 | 53.9 | 53.1 | 52.4 | 51.6 | 50.8 | 50.1 | 49.4 | 3.52 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 47.0 | 389 | 47.0 | 47.0 | 46.0 | 45.0 | 44.1 | 43.3 | 42.4 | 41.5 | 40.7 | 39.9 | 39.1 | 38.4 | 37.6 | 36.9 | 2.56 |
| | | | | 5.0 | RHS | 16.4 | 40.4 | 329 | 40.4 | 40.4 | 39.5 | 38.8 | 38.0 | 37.2 | 36.5 | 35.8 | 35.1 | 34.4 | 33.7 | 33.1 | 32.4 | 31.8 | 2.60 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 80.7 | 611 | 80.7 | 80.7 | 80.7 | 80.7 | 78.2 | 77.1 | 76.1 | 75.0 | 74.0 | 73.0 | 72.0 | 71.0 | 70.0 | 69.1 | 4.22 |
| | | | | 9.0 | RHS | 30.6 | 74.8 | 559 | 74.8 | 74.8 | 74.8 | 74.8 | 72.6 | 71.6 | 70.6 | 69.6 | 68.7 | 67.7 | 66.8 | 65.9 | 65.0 | 64.1 | 4.28 |
| | | | | 8.0 | RHS | 27.7 | 68.5 | 504 | 68.5 | 68.5 | 68.5 | 68.5 | 66.5 | 65.6 | 64.7 | 63.8 | 62.9 | 62.1 | 61.2 | 60.4 | 59.6 | 58.8 | 4.33 |
| | | | | 6.0 | RHS | 21.4 | 54.4 | 389 | 54.4 | 54.4 | 54.4 | 54.4 | 52.8 | 52.1 | 51.4 | 50.7 | 50.0 | 49.4 | 48.7 | 48.0 | 47.4 | 46.8 | 4.44 |
| | | | | 5.0 | RHS | 18.2 | 46.6 | 329 | 46.6 | 46.6 | 46.6 | 46.6 | 45.3 | 44.7 | 44.1 | 43.5 | 42.9 | 42.3 | 41.8 | 41.2 | 40.6 | 40.1 | 4.49 |
| | | | | 4.0 | RHS | 14.8 | 37.8 | 267 | 37.8 | 37.8 | 37.8 | 37.8 | 36.7 | 36.2 | 35.7 | 35.3 | 34.8 | 34.4 | 33.9 | 33.5 | 33.0 | 32.6 | 4.55 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 36.9 | 374 | 36.9 | 35.4 | 34.1 | 32.8 | 31.5 | 30.3 | 29.2 | 28.1 | 27.1 | 26.1 | 25.1 | 24.2 | 23.4 | 22.6 | 1.12 |
| | | | | 5.0 | RHS | 14.2 | 31.9 | 316 | 31.9 | 30.7 | 29.5 | 28.4 | 27.4 | 26.3 | 25.4 | 24.4 | 23.6 | 22.7 | 21.9 | 21.1 | 20.4 | 19.7 | 1.14 |
| | | | | 4.0 | RHS | 11.6 | 26.5 | 257 | 26.5 | 25.5 | 24.6 | 23.7 | 22.8 | 21.9 | 21.2 | 20.4 | 19.7 | 19.0 | 18.3 | 17.7 | 17.1 | 16.5 | 1.17 |
| | | | | 3.0 | RHS | 8.96 | 20.8 | 195 | 20.8 | 20.1 | 19.3 | 18.6 | 17.9 | 17.3 | 16.7 | 16.1 | 15.5 | 15.0 | 14.4 | 13.9 | 13.5 | 13.0 | 1.19 |
| | | | | 2.5 | RHS | 7.53 | 17.6 | 164 | 17.6 | 17.0 | 16.4 | 15.8 | 15.2 | 14.7 | 14.1 | 13.6 | 13.2 | 12.7 | 12.3 | 11.8 | 11.5 | 11.1 | 1.21 |
| | | | | 2.0 | RHS | 6.07 | 12.8 | 132 | 12.8 | 12.5 | 12.1 | 11.7 | 11.3 | 10.9 | 10.6 | 10.2 | 9.92 | 9.61 | 9.31 | 9.03 | 8.75 | 8.49 | 1.22 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 27.9 | 315 | 27.9 | 27.1 | 26.1 | 25.3 | 24.4 | 23.6 | 22.8 | 22.0 | 21.3 | 20.6 | 20.0 | 19.3 | 18.7 | 18.1 | 1.35 |
| | | | | 5.0 | RHS | 12.5 | 24.3 | 267 | 24.3 | 23.6 | 22.8 | 22.0 | 21.3 | 20.6 | 19.9 | 19.2 | 18.6 | 18.0 | 17.5 | 16.9 | 16.4 | 15.9 | 1.38 |
| | | | | 3.5 | RHS | 9.07 | 18.1 | 192 | 18.1 | 17.6 | 17.0 | 16.4 | 15.9 | 15.4 | 14.9 | 14.4 | 13.9 | 13.5 | 13.1 | 12.7 | 12.3 | 11.9 | 1.43 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 34.1 | 317 | 34.1 | 34.1 | 33.5 | 32.8 | 32.2 | 31.6 | 31.0 | 30.4 | 29.9 | 29.3 | 28.8 | 28.2 | 27.7 | 27.2 | 2.96 |
| | | | | 5.0 | RHS | 14.2 | 29.5 | 269 | 29.5 | 29.5 | 29.5 | 28.4 | 27.9 | 27.3 | 26.8 | 26.3 | 25.8 | 25.4 | 24.9 | 24.4 | 24.0 | 23.6 | 3.01 |
| | | | | 4.0 | RHS | 11.6 | 24.4 | 219 | 24.4 | 24.4 | 24.4 | 23.5 | 23.1 | 22.7 | 22.2 | 21.8 | 21.4 | 21.0 | 20.7 | 20.3 | 19.9 | 19.5 | 3.06 |
| | | | | 3.0 | RHS | 8.96 | 18.8 | 167 | 18.8 | 18.8 | 18.8 | 18.2 | 17.9 | 17.5 | 17.2 | 16.9 | 16.6 | 16.3 | 16.0 | 15.7 | 15.4 | 15.1 | 3.11 |
| | | | | 2.5 | RHS | 7.53 | 14.1 | 140 | 14.1 | 14.1 | 14.1 | 13.7 | 13.5 | 13.3 | 13.0 | 12.8 | 12.6 | 12.4 | 12.2 | 12.0 | 11.8 | 11.7 | 3.14 |
| | | | | 2.0 | RHS | 6.07 | 10.0 | 113 | 10.0 | 10.0 | 10.0 | 9.86 | 9.72 | 9.58 | 9.45 | 9.32 | 9.18 | 9.05 | 8.93 | 8.80 | 8.68 | 8.56 | 3.16 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 25.1 | 255 | 25.1 | 25.1 | 25.1 | 24.3 | 23.9 | 23.5 | 23.1 | 22.7 | 22.3 | 21.9 | 21.5 | 21.2 | 20.8 | 20.4 | 3.63 |
| | | | | 5.0 | RHS | 12.5 | 21.7 | 218 | 21.7 | 21.7 | 21.7 | 21.1 | 20.7 | 20.4 | 20.0 | 19.7 | 19.3 | 19.0 | 18.7 | 18.4 | 18.1 | 17.8 | 3.69 |
| | | | | 3.5 | RHS | 9.07 | 16.1 | 157 | 16.1 | 16.1 | 16.1 | 15.7 | 15.4 | 15.1 | 14.9 | 14.6 | 14.4 | 14.1 | 13.9 | 13.7 | 13.4 | 13.2 | 3.78 |



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3. Values of $\phi M_b$ based on $\alpha_m$ = 1.0 (uniform moment over entire segment) in this Table.
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5. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with $\beta_m$ = -1.0.
6. For other moment distributions use the appropriate value of $\alpha_m$ obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of $\alpha_m$ $\phi M_b$ and $\phi M_{sx}$ given in this Table.

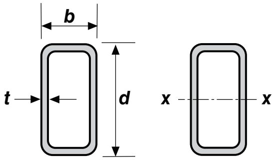
TABLE 5.3-2(3)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MOMENT CAPACITIES FOR MEMBERS <u>WITHOUT</u> FULL LATERAL RESTRAINT

### *bending about x-axis*

| Designation d | | b | | t | | Mass per m | φM<sub></sub>$_{sx}$ | φV$_v$ | Design Member Moment Capacities, φM$_b$ (kNm) Effective Length (L$_e$) in metres | | | | | | | | | | | | | | FLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | kNm | kN | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 6.00 | m |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 18.4 | 244 | 18.4 | 18.4 | 18.4 | 18.4 | 18.4 | 18.1 | 17.9 | 17.6 | 17.3 | 17.1 | 16.8 | 16.5 | 16.3 | 15.8 | 1.60 |
| | | | | 5.0 | RHS | 10.3 | 16.1 | 208 | 16.1 | 16.1 | 16.1 | 16.1 | 16.1 | 15.8 | 15.7 | 15.5 | 15.2 | 15.0 | 14.8 | 14.5 | 14.3 | 13.9 | 1.64 |
| | | | | 4.0 | RHS | 8.49 | 13.5 | 170 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.3 | 13.2 | 13.0 | 12.8 | 12.6 | 12.4 | 12.2 | 12.1 | 11.7 | 1.68 |
| | | | | 3.5 | RHS | 7.53 | 12.1 | 151 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 11.9 | 11.8 | 11.7 | 11.5 | 11.3 | 11.1 | 11.0 | 10.8 | 10.5 | 1.70 |
| | | | | 3.0 | RHS | 6.60 | 10.8 | 131 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.6 | 10.5 | 10.4 | 10.2 | 10.1 | 9.92 | 9.77 | 9.62 | 9.33 | 1.73 |
| | | | | 2.5 | RHS | 5.56 | 9.18 | 110 | 9.18 | 9.18 | 9.18 | 9.18 | 9.18 | 9.04 | 8.98 | 8.84 | 8.71 | 8.57 | 8.44 | 8.32 | 8.19 | 7.95 | 1.74 |
| | | | | 2.0 | RHS | 4.50 | 7.37 | 88.9 | 7.37 | 7.37 | 7.37 | 7.37 | 7.37 | 7.37 | 7.22 | 7.11 | 7.00 | 6.90 | 6.80 | 6.70 | 6.60 | 6.41 | 1.76 |
| | | | | 1.6 | RHS | 3.64 | 5.05 | 71.7 | 5.05 | 5.05 | 5.05 | 5.05 | 5.05 | 5.05 | 4.99 | 4.93 | 4.87 | 4.81 | 4.75 | 4.69 | 4.63 | 4.52 | 1.78 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 7.34 | 126 | 7.34 | 7.34 | 7.34 | 7.25 | 7.17 | 7.10 | 7.03 | 6.88 | 6.74 | 6.61 | 6.47 | 6.34 | 6.21 | 5.97 | 1.24 |
| | | | | 3.0 | RHS | 4.90 | 6.00 | 97.2 | 6.00 | 6.00 | 6.00 | 6.00 | 5.86 | 5.80 | 5.74 | 5.62 | 5.51 | 5.40 | 5.29 | 5.18 | 5.08 | 4.88 | 1.28 |
| | | | | 2.5 | RHS | 4.15 | 5.14 | 82.2 | 5.14 | 5.14 | 5.14 | 5.14 | 5.02 | 4.97 | 4.92 | 4.82 | 4.72 | 4.63 | 4.54 | 4.45 | 4.36 | 4.19 | 1.30 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 11.4 | 178 | 11.4 | 11.4 | 11.4 | 11.4 | 11.4 | 11.4 | 11.4 | 11.0 | 10.9 | 10.7 | 10.6 | 10.4 | 10.3 | 9.98 | 2.05 |
| | | | | 5.0 | RHS | 8.35 | 10.1 | 153 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 9.77 | 9.64 | 9.51 | 9.38 | 9.25 | 9.12 | 8.87 | 2.11 |
| | | | | 4.0 | RHS | 6.92 | 8.56 | 126 | 8.56 | 8.56 | 8.56 | 8.56 | 8.56 | 8.56 | 8.56 | 8.31 | 8.19 | 8.08 | 7.97 | 7.87 | 7.76 | 7.55 | 2.17 |
| | | | | 3.0 | RHS | 5.42 | 6.92 | 97.4 | 6.92 | 6.92 | 6.92 | 6.92 | 6.92 | 6.92 | 6.92 | 6.71 | 6.62 | 6.53 | 6.44 | 6.35 | 6.27 | 6.10 | 2.23 |
| | | | | 2.5 | RHS | 4.58 | 5.91 | 82.3 | 5.91 | 5.91 | 5.91 | 5.91 | 5.91 | 5.91 | 5.91 | 5.74 | 5.66 | 5.58 | 5.51 | 5.43 | 5.36 | 5.21 | 2.25 |
| | | | | 2.0 | RHS | 3.72 | 4.77 | 66.8 | 4.77 | 4.77 | 4.77 | 4.77 | 4.77 | 4.77 | 4.77 | 4.64 | 4.58 | 4.52 | 4.46 | 4.40 | 4.34 | 4.22 | 2.28 |
| | | | | 1.6 | RHS | 3.01 | 3.34 | 54.0 | 3.34 | 3.34 | 3.34 | 3.34 | 3.34 | 3.34 | 3.34 | 3.28 | 3.24 | 3.21 | 3.17 | 3.14 | 3.10 | 3.03 | 2.30 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 4.07 | 79.1 | 4.07 | 3.99 | 3.91 | 3.84 | 3.76 | 3.69 | 3.62 | 3.48 | 3.35 | 3.23 | 3.11 | 2.99 | 2.89 | 2.68 | 0.572 |
| | | | | 2.0 | RHS | 2.93 | 3.36 | 64.2 | 3.36 | 3.30 | 3.24 | 3.18 | 3.12 | 3.06 | 3.00 | 2.89 | 2.78 | 2.68 | 2.58 | 2.49 | 2.40 | 2.24 | 0.584 |
| | | | | 1.6 | RHS | 2.38 | 2.76 | 51.9 | 2.76 | 2.71 | 2.66 | 2.61 | 2.56 | 2.51 | 2.47 | 2.38 | 2.29 | 2.21 | 2.13 | 2.05 | 1.98 | 1.85 | 0.594 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 5.38 | 106 | 5.38 | 5.38 | 5.38 | 5.29 | 5.23 | 5.18 | 5.12 | 5.01 | 4.90 | 4.80 | 4.70 | 4.60 | 4.50 | 4.31 | 1.21 |
| | | | | 3.0 | RHS | 4.25 | 4.45 | 82.3 | 4.45 | 4.45 | 4.45 | 4.45 | 4.33 | 4.29 | 4.24 | 4.15 | 4.06 | 3.98 | 3.89 | 3.81 | 3.73 | 3.58 | 1.25 |
| | | | | 2.5 | RHS | 3.60 | 3.83 | 69.7 | 3.83 | 3.83 | 3.83 | 3.83 | 3.73 | 3.69 | 3.65 | 3.57 | 3.50 | 3.42 | 3.35 | 3.28 | 3.21 | 3.08 | 1.27 |
| | | | | 2.0 | RHS | 2.93 | 3.16 | 56.7 | 3.16 | 3.16 | 3.16 | 3.16 | 3.08 | 3.05 | 3.02 | 2.95 | 2.89 | 2.83 | 2.77 | 2.71 | 2.66 | 2.55 | 1.29 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 2.37 | 61.1 | 2.37 | 2.37 | 2.31 | 2.28 | 2.24 | 2.20 | 2.17 | 2.10 | 2.04 | 1.97 | 1.91 | 1.85 | 1.80 | 1.69 | 0.807 |
| | | | | 2.5 | RHS | 2.62 | 2.07 | 52.1 | 2.07 | 2.07 | 2.02 | 1.98 | 1.95 | 1.92 | 1.89 | 1.83 | 1.78 | 1.72 | 1.67 | 1.62 | 1.57 | 1.48 | 0.826 |
| | | | | 2.0 | RHS | 2.15 | 1.73 | 42.6 | 1.73 | 1.73 | 1.69 | 1.66 | 1.63 | 1.61 | 1.58 | 1.54 | 1.49 | 1.44 | 1.40 | 1.36 | 1.32 | 1.24 | 0.844 |
| | | | | 1.6 | RHS | 1.75 | 1.43 | 34.7 | 1.43 | 1.43 | 1.39 | 1.37 | 1.35 | 1.33 | 1.31 | 1.27 | 1.23 | 1.20 | 1.16 | 1.13 | 1.09 | 1.03 | 0.859 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 2.09 | 60.3 | 2.09 | 2.02 | 1.98 | 1.93 | 1.89 | 1.85 | 1.80 | 1.72 | 1.65 | 1.58 | 1.51 | 1.45 | 1.39 | 1.28 | 0.511 |
| | | | | 2.5 | RHS | 2.42 | 1.83 | 51.4 | 1.83 | 1.77 | 1.73 | 1.70 | 1.66 | 1.62 | 1.59 | 1.52 | 1.45 | 1.39 | 1.33 | 1.28 | 1.22 | 1.13 | 0.526 |
| | | | | 2.0 | RHS | 1.99 | 1.53 | 42.0 | 1.53 | 1.49 | 1.46 | 1.43 | 1.39 | 1.36 | 1.33 | 1.28 | 1.22 | 1.17 | 1.12 | 1.08 | 1.04 | 0.956 | 0.541 |
| | | | | 1.6 | RHS | 1.63 | 1.27 | 34.2 | 1.27 | 1.24 | 1.21 | 1.18 | 1.16 | 1.13 | 1.11 | 1.06 | 1.02 | 0.978 | 0.938 | 0.901 | 0.865 | 0.800 | 0.552 |



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5. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with $\beta_m$ = -1.0.
6. For other moment distributions use the appropriate value of $\alpha_m$ obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of $\alpha_m \phi M_b$ and $\phi M_{sx}$ given in this Table.
7. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

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# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

| Section | | Page |
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| **6.1** | **General** | **6-2** |
| **6.2** | **Design Section Capacity in Axial Compression** | **6-2** |
| **6.3** | **Design Member Capacity in Axial Compression** | **6-2** |
| **6.4** | **Effective Length** | **6-3** |
| **6.5** | **Example** | **6-4** |
| **6.6** | **References** | **6-4** |

| Table | Page |
|---|---|
| **Tables 6-1 to 6-6**<br>Design Member Capacities in Axial Compression | 6-6 |

**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

### 6.1 General

Values of the design member capacity in compression ($\phi N_c$) for buckling about each principal axes for a range of effective lengths ($L_e$) are given in Tables 6-1 to 6-6. The design member capacities are determined from Section 6 of AS 4100. All the Tables for CHS, RHS and SHS are supplemented by graphs of $\phi N_c$ versus $L_e$ placed consecutively after the tables for each corresponding grade and section type. All loads are assumed to be applied through the centroid of the section. The column capacity is associated with flexural buckling as torsional buckling is not a common buckling mode for hollow sections in axial compression.

For RHS only, the Tables in this section have been grouped into two series:

- the (A) series for the member buckling about the x-axis, and
- the (B) series for the member buckling about the y-axis.

The (A) series tables and graphs for each group of sections are immediately followed by the (B) series of tables and graphs for the same group.

### 6.2 Design Section Capacity in Axial Compression

The design section capacity in compression ($\phi N_s$) is obtained from Clause 6.2 of AS 4100 and is given by:

$$\phi N_s = \phi k_f A_n f_y$$

where $\phi$ = 0.9 (Table 3.4 of AS 4100)

$k_f$ = form factor (see Section 3.2.2.3)

$A_n$ = net area of the cross section

= $A_g$ assuming no penetrations or holes (see 3.1 series Tables in Part 3)

$f_y$ = yield stress used in design

The design *section* capacity considers the behaviour of the cross-section only (as in a stub column test), and is affected by the element slenderness of each plate element in the cross-section. The form factor ($k_f$) represents the proportion of the section that is effective in axial compression and is determined from considerations of element slenderness as affected by local buckling, using Clause 6.2.3 and 6.2.4 of AS 4100. See discussion in Section 3.2.2.3.

### 6.3 Design Member Capacity in Axial Compression

The design *member* capacity in axial compression accounts for the effect of overall member buckling for the effective length of the member (amongst other factors) and it is obtained from Clause 6.3 of AS 4100 and given by:

$$\phi N_c = \phi \alpha_c N_s \leq \phi N_s$$

where $\phi$ = 0.9 (Table 3.4 of AS 4100)

$\alpha_c$ = member slenderness reduction factor

The member slenderness reduction factor ($\alpha_c$) depends on the modified member slenderness ($\lambda_n$) and the member section constant ($\alpha_b$). From Clause 6.3.3 of AS 4100:

$$\alpha_c = \xi\left\{1-\sqrt{\left[1-\left(\frac{90}{\xi\lambda}\right)^2\right]}\right\}$$

where

$$\xi = \frac{\left(\frac{\lambda}{90}\right)^2+1+\eta}{2\left(\frac{\lambda}{90}\right)^2}$$

$$\lambda_n = \left(\frac{L_e}{r}\right)\sqrt{(k_f)}\sqrt{\frac{f_y}{250}}$$

$$\lambda = \lambda_n + \alpha_a \alpha_b$$

$$\alpha_a = \frac{2100(\lambda_n - 13.5)}{\lambda_n^2 - 15.3\lambda_n + 2050}$$

$$\eta = 0.00326\,(\lambda - 13.5) \geq 0$$

$L_e$ = effective length of a compression member about the axis of buckling
$r$ = radius of gyration about the axis of buckling

For routine design the above equations need not be used. Table 6.3.3(3) of AS 4100 may be consulted to obtain the value of ($\alpha_c$) directly once $\lambda_n$ and $\alpha_b$ are evaluated.

Note that the design member capacity equals the design section capacity (i.e. $\phi N_c = \phi N_s$) when the effective length is zero (i.e. $L_e = 0$).

Table T6.1 (which is extracted from Table 6.3.3 of AS 4100) lists values of $\alpha_b$ for the sections considered in these Tables.

**Table T6.1: Values of Member Section Constant ($\alpha_b$) for Compression Members**

| Section | Residual Stresses | Yield Slenderness Limit | $\alpha_b$ | |
|---|---|---|---|---|
| | | $\lambda_{ey}$ | $k_f = 1.0$ | $k_f < 1.0$ |
| RHS, SHS | CF | 40 | -0.5 | -0.5 |
| CHS | CF | 82 | -0.5 | -0.5 |

## 6.4 Effective Length

The values of $\phi N_c$ are based on the *effective length* ($L_e$) of the member. The effective length depends on the member length ($L$), the rotational and translational restraints at the ends of the member and is determined from the following formula:

$$L_e = k_e L$$

The member effective length factor ($k_e$) for use in Clause 6.3.2 of AS 4100 can be determined using Clause 4.6.3 of AS 4100 or by a rational frame buckling analysis (Clause 4.7 of AS 4100).

$k_e$ is given in Figure 6.1 for members with idealised end restraints (from Figure 4.6.3.2 of AS 4100). For braced or sway members in frames, $k_e$ depends on the ratio ($\gamma$) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Example 2 of Section 4.3 in Ref [6.1] provides a sample calculation of $k_e$ for columns in an unbraced plane frame.

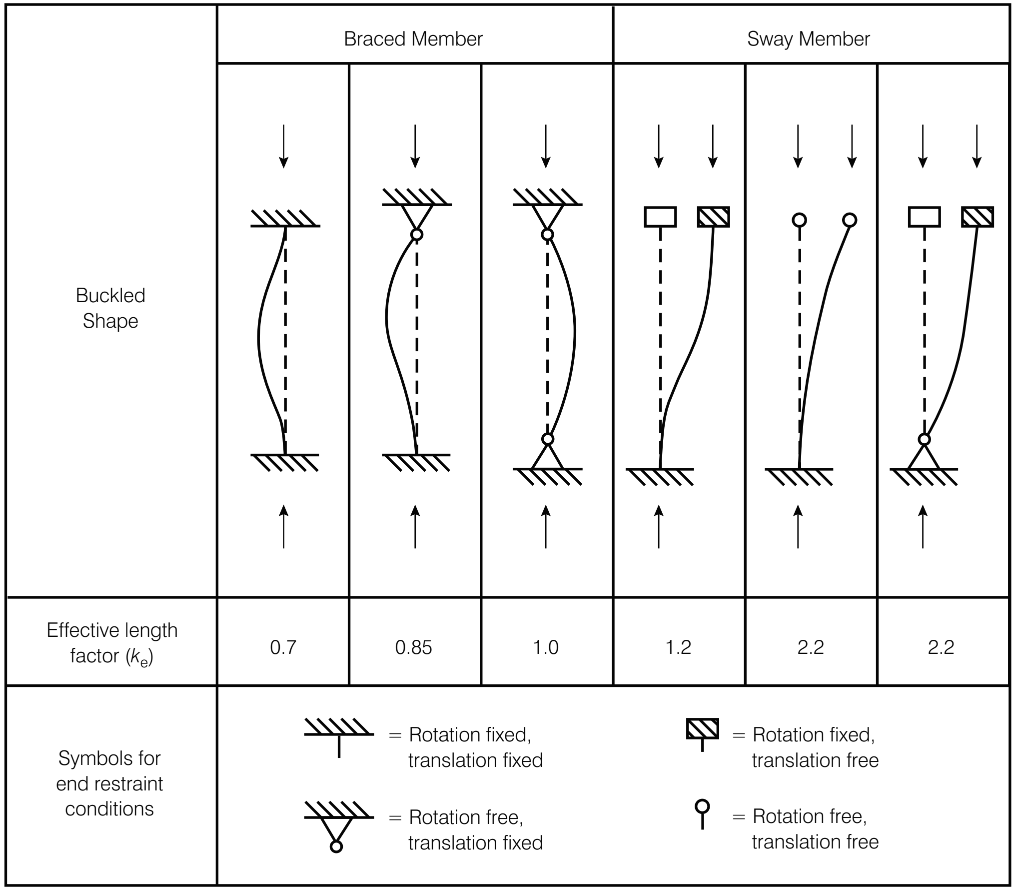

**Figure 6.1: Effective Length Factors for Members with Idealised Conditions of End Restraint**

## 6.5 Example

Design a RHS column, with a length of 5.8 m, in Grade C450L0 (C450PLUS®) steel to resist a design axial force, $N^* = 2400$ kN. Assume that for x-axis buckling both ends are pinned (rotation free, translation fixed), while for y-axis buckling one end is rotation free, translation fixed (pinned) and the other end is rotationally and translationally fixed.

Design Data:

$N^* = 2400$ kN

Solution:

(i) Determine effective lengths

For x-axis buckling $k_e = 1.0$ (Figure 6.1)

$\therefore L_{ex} = k_e L = 1.0 \times 5.8 = 5.8 \text{ m} \approx 6.0 \text{ m}$

For y-axis buckling $k_e = 0.85$ (Figure 6.1)

$\therefore L_{ey} = k_e L = 0.85 \times 5.8 = 4.93 \text{ m} \approx 5.0 \text{ m}$

(ii) Select a member

When looking up Tables 6-4(1)(A) and 6-4(1)(B) from bottom to top there are various sections for which $N^* < \phi N_c$. As such there is the possibility that the first sections being sighted are uneconomical. In order to select a more optimal section it may be prudent to summarise a few of the initial listings for $\phi N_{cx}$ and $\phi N_{cy}$ based on their respective effective lengths. This is summarised in Table T6.2 for the example being considered.

**Table T6.2: Possible C450PLUS® RHS options to resist $N^*$ = 2400 kN compression.**

Buckling about x-axis with $L_{ex}$ = 6.0 m

| Designation<br>d | <br> | <br>b | <br> | <br>t | | Mass per m | $\phi N_{cx}$ (kN) |
|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 6.0m |
| 400 | x | 200 | x | 10.0 | RHS | 88.4 | 3500 |
| | | | | 8.0 | RHS | 71.6 | 2510 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 5940 |
| | | | | 12.5 | RHS | 109 | 4780 |
| | | | | 10.0 | RHS | 88.4 | 3720 |
| | | | | 8.0 | RHS | 71.6 | 2720 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 4440 |
| | | | | 12.5 | RHS | 89.0 | 3610 |
| | | | | 10.0 | RHS | 72.7 | 2970 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 2850 |

Buckling about y-axis with $L_{ey}$ = 5.0 m

| Designation<br>d | <br> | <br>b | <br> | <br>t | | Mass per m | $\phi N_{cy}$ (kN) |
|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 5.0m |
| 400 | x | 200 | x | 10.0 | RHS | 88.4 | 3050 |
| | | | | 8.0 | RHS | 71.6 | $< N^*$ |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 5750 |
| | | | | 12.5 | RHS | 109 | 4630 |
| | | | | 10.0 | RHS | 88.4 | 3620 |
| | | | | 8.0 | RHS | 71.6 | 2660 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 4020 |
| | | | | 12.5 | RHS | 89.0 | 3290 |
| | | | | 10.0 | RHS | 72.7 | 2720 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | $< N^*$ |

Note: shaded values indicate the lightest section in mass (kg/m).

∴ as noted in Table T6.2, adopt a 350 x 250 x 8.0 RHS in C450L0 (C450PLUS) as:

$\phi N_{cx} = 2720$ kN ($L_{ex} = 6.0$ m in Table 6-4(1)(A))

$> N^*$

$\phi N_{cy} = 2660$ kN ($L_{ey} = 5.0$ m in Table 6-4(1)(B))

$> N^*$

## 6.6 References

[6.1] ASI, “Design Capacity Tables for Structural Steel – Volume 1: Open Sections”, fourth edition, Australian Steel Institute, 2009.

**See Section 1.1.2 for details on reference Standards.**

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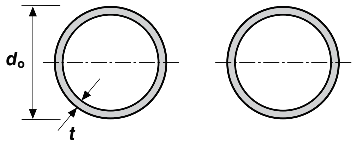
TABLE 6-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

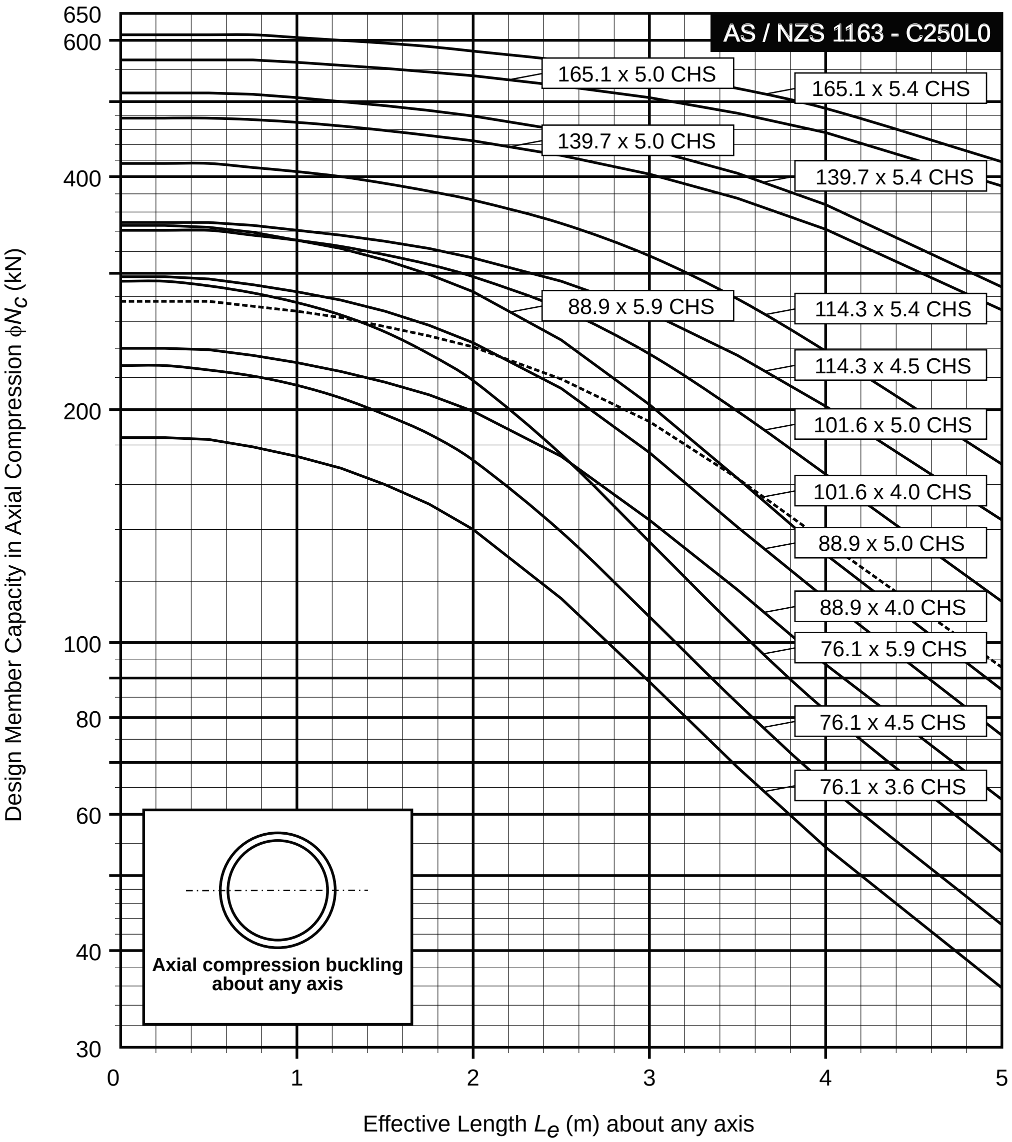
### *buckling about any axis*

| Designation $d_o$ | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 165.1 | x | 5.4 | CHS | 21.3 | 610 | 610 | 610 | 610 | 605 | 600 | 595 | 589 | 581 | 565 | 544 | 520 | 490 | 418 |
| | | 5.0 | CHS | 19.7 | 566 | 566 | 566 | 566 | 562 | 557 | 552 | 546 | 540 | 524 | 506 | 483 | 456 | 389 |
| 139.7 | x | 5.4 | CHS | 17.9 | 513 | 513 | 513 | 511 | 506 | 500 | 494 | 487 | 479 | 459 | 434 | 404 | 368 | 288 |
| | | 5.0 | CHS | 16.6 | 476 | 476 | 476 | 474 | 470 | 465 | 459 | 452 | 445 | 426 | 403 | 375 | 342 | 269 |
| 114.3 | x | 5.4 | CHS | 14.5 | 416 | 416 | 416 | 411 | 406 | 400 | 392 | 383 | 373 | 348 | 316 | 278 | 238 | 170 |
| | | 4.5 | CHS | 12.2 | 349 | 349 | 349 | 346 | 341 | 336 | 330 | 323 | 314 | 293 | 267 | 235 | 202 | 144 |
| 101.6 | x | 5.0 | CHS | 11.9 | 341 | 341 | 341 | 336 | 331 | 325 | 317 | 308 | 297 | 270 | 236 | 199 | 165 | 113 |
| | | 4.0 | CHS | 9.63 | 276 | 276 | 276 | 272 | 268 | 263 | 256 | 249 | 241 | 219 | 193 | 163 | 135 | 92.9 |
| 88.9 | x | 5.9 | CHS | 12.1 | 346 | 346 | 344 | 339 | 331 | 323 | 312 | 299 | 284 | 246 | 203 | 163 | 130 | 86.9 |
| | | 5.0 | CHS | 10.3 | 297 | 297 | 295 | 290 | 284 | 277 | 268 | 257 | 244 | 213 | 176 | 141 | 114 | 75.9 |
| | | 4.0 | CHS | 8.38 | 240 | 240 | 239 | 235 | 230 | 224 | 217 | 209 | 199 | 174 | 144 | 117 | 93.7 | 62.7 |
| 76.1 | x | 5.9 | CHS | 10.2 | 293 | 293 | 289 | 283 | 275 | 265 | 252 | 236 | 218 | 175 | 135 | 104 | 81.7 | 53.6 |
| | | 4.5 | CHS | 7.95 | 228 | 228 | 225 | 221 | 215 | 207 | 197 | 186 | 172 | 139 | 108 | 83.5 | 65.7 | 43.2 |
| | | 3.6 | CHS | 6.44 | 184 | 184 | 183 | 179 | 174 | 168 | 160 | 151 | 140 | 114 | 89.0 | 69.0 | 54.4 | 35.8 |
| 60.3 | x | 5.4 | CHS | 7.31 | 210 | 210 | 205 | 198 | 189 | 176 | 161 | 142 | 122 | 87.2 | 63.3 | 47.5 | 36.9 | 24.0 |
| | | 4.5 | CHS | 6.19 | 177 | 177 | 174 | 168 | 160 | 150 | 137 | 122 | 105 | 75.7 | 55.0 | 41.4 | 32.1 | 20.9 |
| | | 3.6 | CHS | 5.03 | 144 | 144 | 141 | 137 | 131 | 123 | 113 | 100 | 87.1 | 63.0 | 46.0 | 34.6 | 26.8 | 17.5 |
| 48.3 | x | 4.0 | CHS | 4.37 | 125 | 125 | 121 | 114 | 106 | 93.9 | 79.5 | 65.1 | 52.8 | 35.6 | 25.3 | 18.8 | 14.5 | 9.43 |
| | | 3.2 | CHS | 3.56 | 102 | 102 | 98.4 | 93.5 | 86.7 | 77.3 | 65.9 | 54.3 | 44.2 | 29.9 | 21.2 | 15.8 | 12.2 | 7.93 |
| 42.4 | x | 4.0 | CHS | 3.79 | 109 | 108 | 103 | 96.1 | 85.7 | 72.0 | 57.5 | 45.2 | 35.8 | 23.7 | 16.7 | 12.4 | 9.58 | 6.20 |
| | | 3.2 | CHS | 3.09 | 88.7 | 88.0 | 84.4 | 78.9 | 70.7 | 59.9 | 48.2 | 38.0 | 30.2 | 20.0 | 14.2 | 10.5 | 8.11 | 5.25 |
| 33.7 | x | 4.0 | CHS | 2.93 | 84.0 | 82.5 | 76.9 | 67.6 | 53.9 | 40.0 | 29.4 | 22.2 | 17.3 | 11.3 | 7.92 | 5.87 | 4.52 | 2.92 |
| | | 3.2 | CHS | 2.41 | 69.0 | 67.8 | 63.5 | 56.2 | 45.4 | 34.0 | 25.2 | 19.1 | 14.8 | 9.69 | 6.81 | 5.04 | 3.88 | 2.51 |
| 26.9 | x | 4.0 | CHS | 2.26 | 64.7 | 62.6 | 55.6 | 43.1 | 29.3 | 20.0 | 14.2 | 10.6 | 8.19 | 5.31 | 3.72 | 2.75 | 2.12 | 1.37 |
| | | 3.2 | CHS | 1.87 | 53.6 | 51.9 | 46.4 | 36.7 | 25.4 | 17.4 | 12.4 | 9.27 | 7.17 | 4.65 | 3.26 | 2.41 | 1.85 | 1.20 |
| | | 2.6 | CHS | 1.56 | 44.7 | 43.3 | 38.9 | 31.2 | 21.9 | 15.1 | 10.8 | 8.05 | 6.22 | 4.04 | 2.83 | 2.09 | 1.61 | 1.04 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C250L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
650
600
400
200
100
80
60
40
30
0
1
2
3
4
5
Effective Length $L_e$ (m) about any axis
165.1 x 5.0 CHS
165.1 x 5.4 CHS
139.7 x 5.0 CHS
139.7 x 5.4 CHS
88.9 x 5.9 CHS
114.3 x 5.4 CHS
114.3 x 4.5 CHS
101.6 x 5.0 CHS
101.6 x 4.0 CHS
88.9 x 5.0 CHS
88.9 x 4.0 CHS
76.1 x 5.9 CHS
76.1 x 4.5 CHS
76.1 x 3.6 CHS
Axial compression buckling about any axis

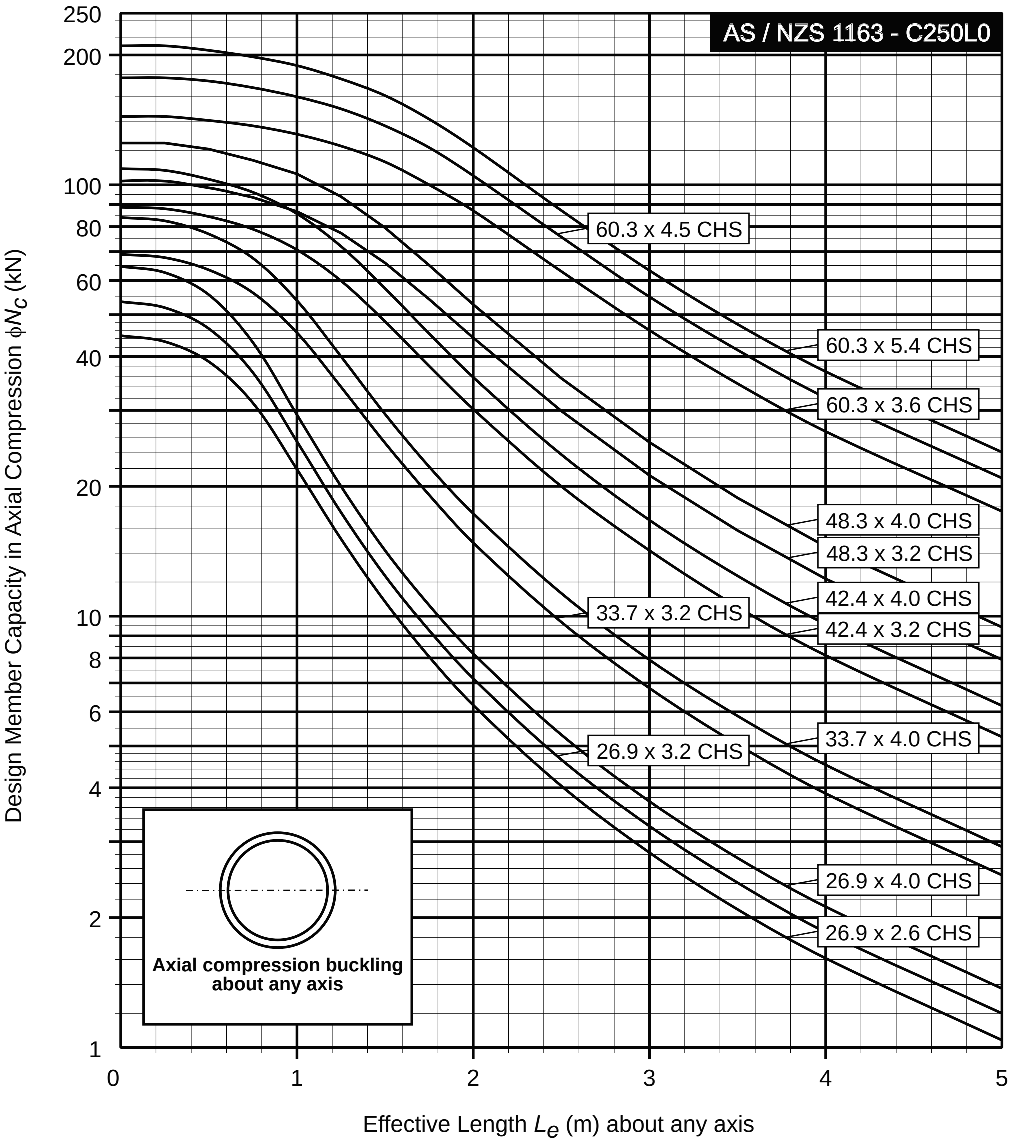
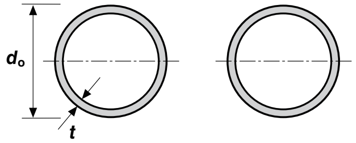

AS / NZS 1163 - C250L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
250
200
100
80
60
40
20
10
8
6
4
2
1
0
1
2
3
4
5
Effective Length $L_e$ (m) about any axis
60.3 x 4.5 CHS
60.3 x 5.4 CHS
60.3 x 3.6 CHS
48.3 x 4.0 CHS
48.3 x 3.2 CHS
33.7 x 3.2 CHS
42.4 x 4.0 CHS
42.4 x 3.2 CHS
26.9 x 3.2 CHS
33.7 x 4.0 CHS
26.9 x 4.0 CHS
26.9 x 2.6 CHS
Axial compression buckling about any axis

TABLE 6-2(1)

# Circular Hollow Sections
# AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

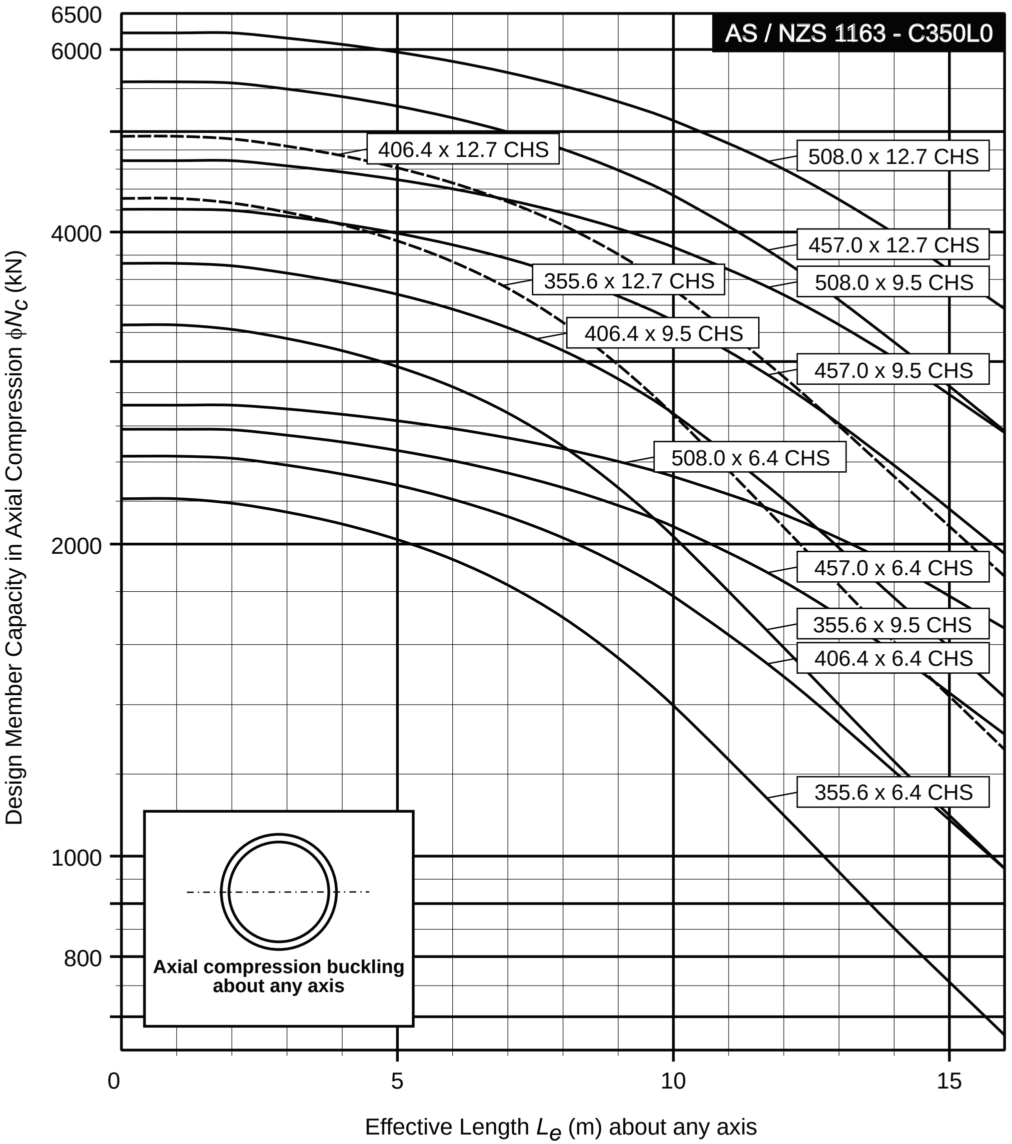
### *buckling about any axis*



| Designation | | | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | kg/m | $L_e$ = 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 12.0 | 14.0 | 16.0 |
| 508.0 | x | 12.7 | CHS | 155 | 6220 | 6220 | 6220 | 6150 | 6070 | 5960 | 5840 | 5700 | 5530 | 5340 | 5120 | 4600 | 3990 | 3370 |
| | | 9.5 | CHS | 117 | 4690 | 4690 | 4690 | 4630 | 4570 | 4490 | 4400 | 4300 | 4170 | 4030 | 3870 | 3480 | 3020 | 2560 |
| | | 6.4 | CHS | 79.2 | 2720 | 2720 | 2720 | 2700 | 2670 | 2630 | 2580 | 2530 | 2470 | 2400 | 2320 | 2140 | 1910 | 1660 |
| 457.0 | x | 12.7 | CHS | 139 | 5580 | 5580 | 5570 | 5490 | 5400 | 5290 | 5150 | 4990 | 4810 | 4590 | 4340 | 3750 | 3130 | 2570 |
| | | 9.5 | CHS | 105 | 4210 | 4210 | 4200 | 4140 | 4070 | 3990 | 3890 | 3770 | 3630 | 3470 | 3280 | 2850 | 2380 | 1960 |
| | | 6.4 | CHS | 71.1 | 2580 | 2580 | 2580 | 2550 | 2510 | 2460 | 2410 | 2340 | 2270 | 2180 | 2080 | 1840 | 1570 | 1310 |
| 406.4 | x | 12.7 | CHS | 123 | 4950 | 4950 | 4920 | 4840 | 4740 | 4610 | 4460 | 4280 | 4060 | 3810 | 3520 | 2900 | 2320 | 1860 |
| | | 9.5 | CHS | 93.0 | 3730 | 3730 | 3710 | 3650 | 3580 | 3480 | 3370 | 3230 | 3070 | 2890 | 2670 | 2210 | 1770 | 1420 |
| | | 6.4 | CHS | 63.1 | 2430 | 2430 | 2420 | 2380 | 2340 | 2280 | 2210 | 2130 | 2030 | 1910 | 1780 | 1490 | 1210 | 973 |
| 355.6 | x | 12.7 | CHS | 107 | 4310 | 4310 | 4270 | 4180 | 4070 | 3920 | 3750 | 3530 | 3270 | 2980 | 2670 | 2080 | 1610 | 1270 |
| | | 9.5 | CHS | 81.1 | 3250 | 3250 | 3220 | 3160 | 3070 | 2970 | 2840 | 2680 | 2490 | 2270 | 2030 | 1590 | 1230 | 973 |
| | | 6.4 | CHS | 55.1 | 2210 | 2210 | 2190 | 2150 | 2090 | 2020 | 1930 | 1830 | 1700 | 1550 | 1400 | 1090 | 852 | 672 |
| 323.9 | x | 12.7 | CHS | 97.5 | 3910 | 3910 | 3860 | 3760 | 3640 | 3480 | 3280 | 3040 | 2750 | 2440 | 2140 | 1610 | 1230 | 961 |
| | | 9.5 | CHS | 73.7 | 2960 | 2960 | 2920 | 2850 | 2750 | 2640 | 2490 | 2310 | 2100 | 1870 | 1640 | 1240 | 946 | 740 |
| | | 6.4 | CHS | 50.1 | 2010 | 2010 | 1980 | 1940 | 1880 | 1800 | 1700 | 1580 | 1440 | 1280 | 1130 | 856 | 655 | 512 |
| 273.1 | x | 12.7 | CHS | 81.6 | 3270 | 3270 | 3200 | 3090 | 2950 | 2750 | 2510 | 2210 | 1900 | 1610 | 1360 | 985 | 740 | 574 |
| | | 9.3 | CHS | 60.5 | 2430 | 2430 | 2380 | 2300 | 2190 | 2050 | 1870 | 1660 | 1430 | 1220 | 1030 | 748 | 562 | 436 |
| | | 6.4 | CHS | 42.1 | 1690 | 1690 | 1650 | 1600 | 1530 | 1430 | 1310 | 1170 | 1010 | 859 | 728 | 530 | 399 | 310 |
| | | 4.8 | CHS | 31.8 | 1270 | 1270 | 1250 | 1210 | 1150 | 1080 | 994 | 885 | 767 | 654 | 555 | 404 | 304 | 236 |
| 219.1 | x | 8.2 | CHS | 42.6 | 1710 | 1700 | 1650 | 1570 | 1450 | 1290 | 1090 | 893 | 724 | 591 | 489 | 347 | 259 | 200 |
| | | 6.4 | CHS | 33.6 | 1350 | 1340 | 1300 | 1230 | 1140 | 1020 | 865 | 711 | 578 | 472 | 391 | 278 | 207 | 160 |
| | | 4.8 | CHS | 25.4 | 1020 | 1010 | 982 | 934 | 865 | 773 | 659 | 543 | 442 | 362 | 299 | 213 | 158 | 122 |
| 168.3 | x | 7.1 | CHS | 28.2 | 1130 | 1120 | 1060 | 964 | 822 | 649 | 495 | 380 | 297 | 238 | 195 | 137 | 102 | 78.4 |
| | | 6.4 | CHS | 25.6 | 1030 | 1010 | 960 | 874 | 746 | 591 | 451 | 346 | 271 | 217 | 178 | 125 | 92.8 | 71.6 |
| | | 4.8 | CHS | 19.4 | 777 | 767 | 728 | 664 | 570 | 453 | 347 | 267 | 209 | 168 | 137 | 96.6 | 71.6 | 55.2 |

## Notes:

1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
6500
6000
4000
2000
1000
800
0
5
10
15
Effective Length $L_e$ (m) about any axis
406.4 x 12.7 CHS
508.0 x 12.7 CHS
457.0 x 12.7 CHS
355.6 x 12.7 CHS
508.0 x 9.5 CHS
406.4 x 9.5 CHS
457.0 x 9.5 CHS
508.0 x 6.4 CHS
457.0 x 6.4 CHS
355.6 x 9.5 CHS
406.4 x 6.4 CHS
355.6 x 6.4 CHS
Axial compression buckling about any axis

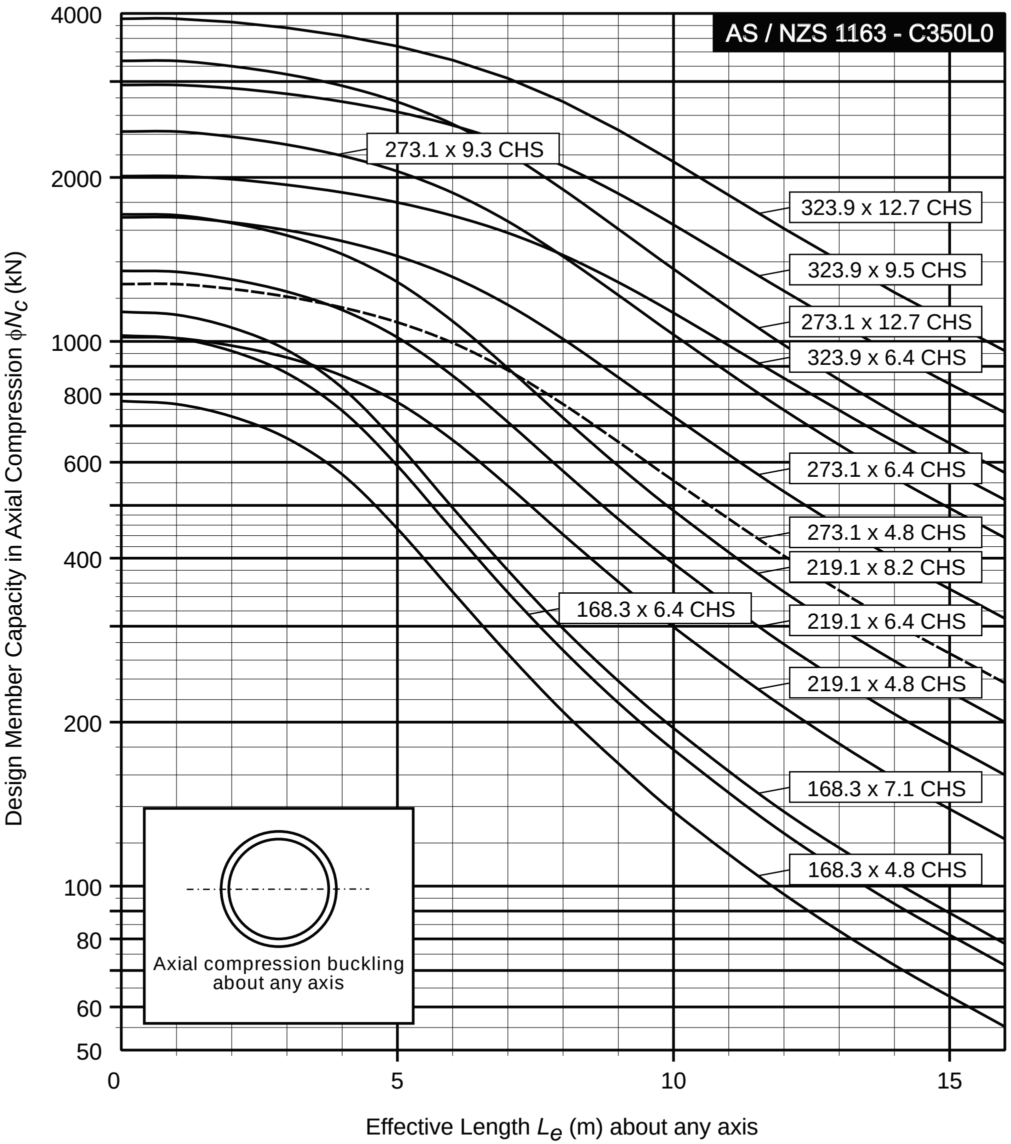

AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
4000
2000
1000
800
600
400
200
100
80
60
50
0
5
10
15
Effective Length $L_e$ (m) about any axis
273.1 x 9.3 CHS
323.9 x 12.7 CHS
323.9 x 9.5 CHS
273.1 x 12.7 CHS
323.9 x 6.4 CHS
273.1 x 6.4 CHS
273.1 x 4.8 CHS
219.1 x 8.2 CHS
168.3 x 6.4 CHS
219.1 x 6.4 CHS
219.1 x 4.8 CHS
168.3 x 7.1 CHS
168.3 x 4.8 CHS
Axial compression buckling about any axis

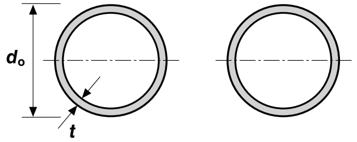
TABLE 6-2(2)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

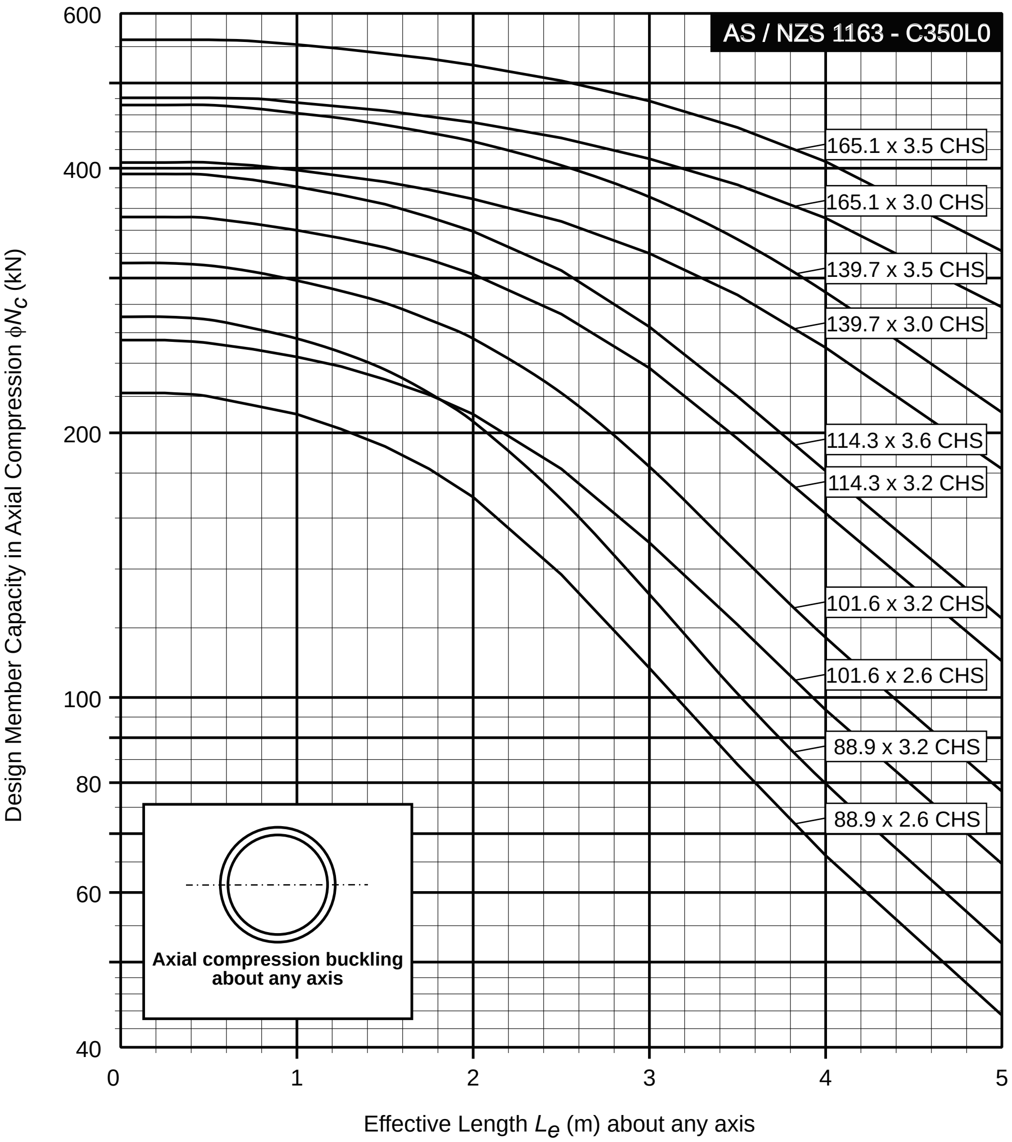
### *buckling about any axis*

| Designation $d_o$ | | Designation $t$ | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 165.1 | x | 3.5 | CHS | 13.9 | 560 | 560 | 560 | 558 | 553 | 547 | 540 | 533 | 524 | 503 | 477 | 445 | 407 | 322 |
| | | 3.0 | CHS | 12.0 | 481 | 481 | 481 | 480 | 475 | 470 | 465 | 458 | 451 | 433 | 410 | 383 | 351 | 278 |
| 139.7 | x | 3.5 | CHS | 11.8 | 472 | 472 | 472 | 468 | 462 | 456 | 448 | 439 | 429 | 403 | 371 | 332 | 289 | 211 |
| | | 3.0 | CHS | 10.1 | 406 | 406 | 406 | 403 | 398 | 392 | 386 | 378 | 369 | 348 | 320 | 287 | 250 | 182 |
| 114.3 | x | 3.6 | CHS | 9.83 | 394 | 394 | 393 | 388 | 381 | 373 | 364 | 352 | 339 | 306 | 264 | 220 | 181 | 123 |
| | | 3.2 | CHS | 8.77 | 352 | 352 | 351 | 346 | 340 | 333 | 325 | 315 | 303 | 273 | 237 | 197 | 162 | 110 |
| 101.6 | x | 3.2 | CHS | 7.77 | 312 | 312 | 310 | 305 | 298 | 290 | 281 | 269 | 256 | 222 | 183 | 146 | 117 | 78.2 |
| | | 2.6 | CHS | 6.35 | 255 | 255 | 253 | 249 | 244 | 238 | 230 | 221 | 210 | 182 | 150 | 121 | 96.8 | 64.7 |
| 88.9 | x | 3.2 | CHS | 6.76 | 271 | 271 | 269 | 263 | 256 | 247 | 236 | 222 | 206 | 168 | 131 | 101 | 79.8 | 52.5 |
| | | 2.6 | CHS | 5.53 | 222 | 222 | 220 | 215 | 210 | 202 | 193 | 182 | 169 | 138 | 108 | 83.9 | 66.1 | 43.5 |
| 76.1 | x | 3.2 | CHS | 5.75 | 231 | 231 | 227 | 221 | 213 | 202 | 188 | 172 | 153 | 115 | 85.1 | 64.5 | 50.2 | 32.8 |
| | | 2.3 | CHS | 4.19 | 168 | 168 | 165 | 161 | 155 | 147 | 138 | 126 | 113 | 85.0 | 63.2 | 47.9 | 37.4 | 24.4 |
| 60.3 | x | 2.9 | CHS | 4.11 | 165 | 164 | 160 | 153 | 143 | 131 | 114 | 96.6 | 80.0 | 54.9 | 39.3 | 29.3 | 22.7 | 14.7 |
| | | 2.3 | CHS | 3.29 | 132 | 132 | 128 | 123 | 115 | 105 | 92.5 | 78.4 | 65.1 | 44.8 | 32.1 | 23.9 | 18.5 | 12.0 |
| 48.3 | x | 2.9 | CHS | 3.25 | 130 | 129 | 124 | 115 | 103 | 86.0 | 68.5 | 53.8 | 42.6 | 28.2 | 19.9 | 14.8 | 11.4 | 7.38 |
| | | 2.3 | CHS | 2.61 | 105 | 104 | 99.6 | 92.9 | 83.1 | 70.0 | 56.1 | 44.1 | 35.0 | 23.2 | 16.4 | 12.2 | 9.38 | 6.07 |
| 42.4 | x | 2.6 | CHS | 2.55 | 102 | 101 | 95.6 | 86.8 | 73.6 | 57.8 | 43.9 | 33.6 | 26.3 | 17.2 | 12.1 | 9.00 | 6.93 | 4.48 |
| | | 2.0 | CHS | 1.99 | 80.0 | 79.0 | 74.8 | 68.1 | 58.1 | 46.0 | 35.1 | 26.9 | 21.1 | 13.8 | 9.74 | 7.22 | 5.56 | 3.60 |
| 33.7 | x | 2.6 | CHS | 1.99 | 80.0 | 78.0 | 71.3 | 59.5 | 43.8 | 30.9 | 22.3 | 16.7 | 12.9 | 8.39 | 5.89 | 4.36 | 3.35 | 2.16 |
| | | 2.0 | CHS | 1.56 | 62.7 | 61.3 | 56.1 | 47.2 | 35.2 | 24.9 | 18.0 | 13.5 | 10.5 | 6.81 | 4.78 | 3.53 | 2.72 | 1.76 |
| 26.9 | x | 2.3 | CHS | 1.40 | 56.0 | 53.6 | 46.0 | 33.0 | 21.2 | 14.2 | 10.0 | 7.45 | 5.75 | 3.73 | 2.61 | 1.93 | 1.48 | 0.956 |
| | | 2.0 | CHS | 1.23 | 49.3 | 47.3 | 40.7 | 29.4 | 19.0 | 12.7 | 9.01 | 6.70 | 5.17 | 3.35 | 2.35 | 1.73 | 1.33 | 0.860 |



## Notes:

1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi N_s = \phi N_c$ for $L_e$ = 0.0.


AS / NZS 1163 - C350L0
600
400
200
100
80
60
40
0
1
2
3
4
5
Design Member Capacity in Axial Compression φN$_c$ (kN)
Effective Length $L_e$ (m) about any axis
165.1 x 3.5 CHS
165.1 x 3.0 CHS
139.7 x 3.5 CHS
139.7 x 3.0 CHS
114.3 x 3.6 CHS
114.3 x 3.2 CHS
101.6 x 3.2 CHS
101.6 x 2.6 CHS
88.9 x 3.2 CHS
88.9 x 2.6 CHS
Axial compression buckling about any axis

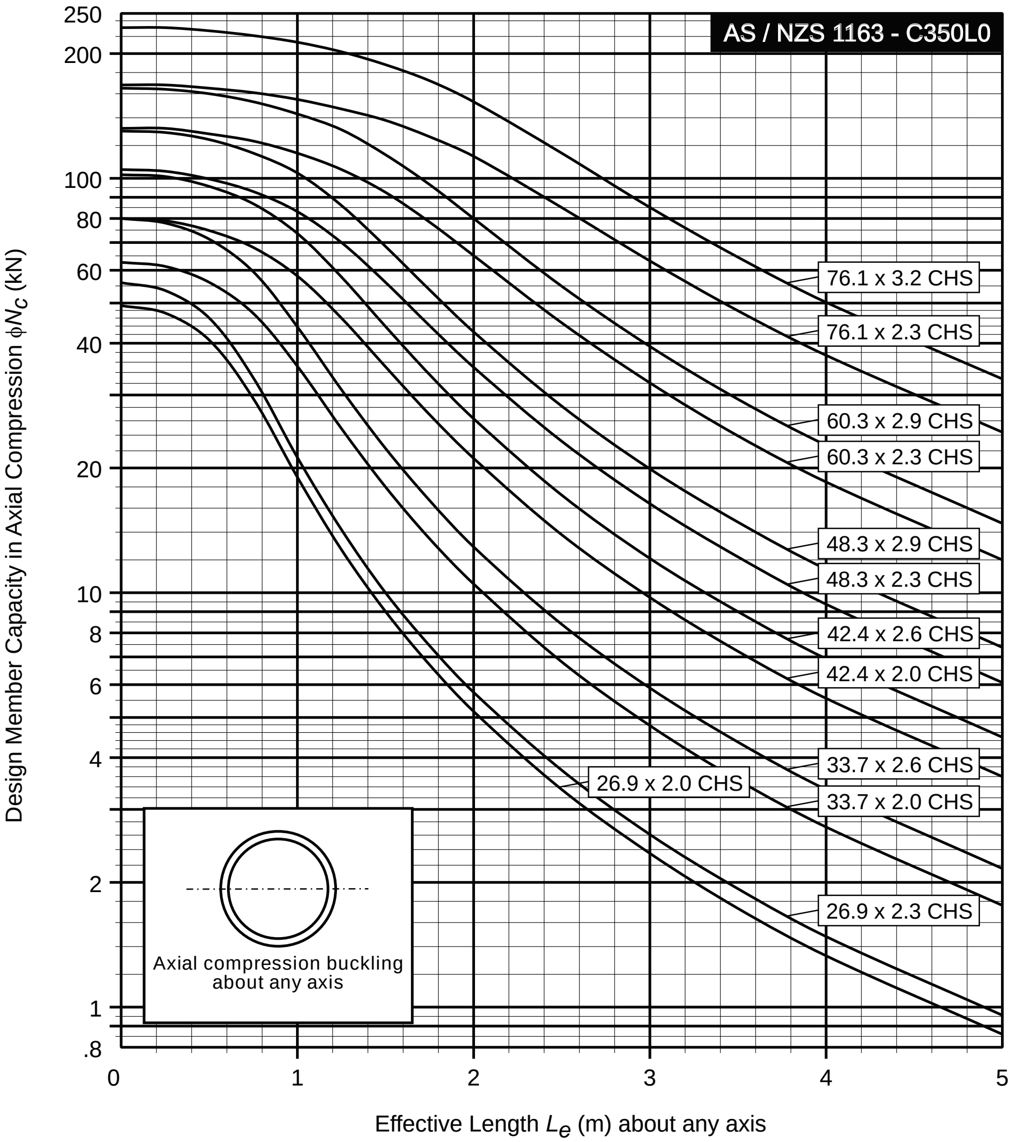

AS / NZS 1163 - C350L0
250
200
100
80
60
40
20
10
8
6
4
2
1
.8
0
1
2
3
4
5
Design Member Capacity in Axial Compression φN$_c$ (kN)
Effective Length $L_e$ (m) about any axis
76.1 x 3.2 CHS
76.1 x 2.3 CHS
60.3 x 2.9 CHS
60.3 x 2.3 CHS
48.3 x 2.9 CHS
48.3 x 2.3 CHS
42.4 x 2.6 CHS
42.4 x 2.0 CHS
33.7 x 2.6 CHS
33.7 x 2.0 CHS
26.9 x 2.0 CHS
26.9 x 2.3 CHS
Axial compression buckling about any axis

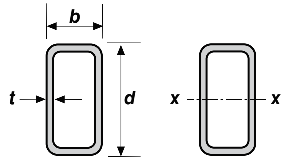
TABLE 6-3(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about x-axis*

| Designation d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 145 | 145 | 142 | 138 | 132 | 125 | 116 | 105 | 92.2 | 68.2 | 50.2 | 37.9 | 29.5 | 19.2 |
| | | | | 2.0 | RHS | 2.93 | 113 | 113 | 112 | 108 | 104 | 99.1 | 92.5 | 84.3 | 74.9 | 56.2 | 41.6 | 31.5 | 24.5 | 16.0 |
| | | | | 1.6 | RHS | 2.38 | 77.6 | 77.6 | 76.7 | 74.9 | 72.6 | 69.6 | 65.9 | 61.4 | 56.0 | 44.0 | 33.5 | 25.6 | 20.1 | 13.2 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 215 | 215 | 209 | 201 | 191 | 177 | 159 | 138 | 117 | 82.0 | 59.1 | 44.3 | 34.3 | 22.3 |
| | | | | 3.0 | RHS | 4.25 | 170 | 170 | 166 | 161 | 153 | 143 | 130 | 114 | 97.5 | 69.4 | 50.3 | 37.7 | 29.3 | 19.0 |
| | | | | 2.5 | RHS | 3.60 | 145 | 145 | 141 | 137 | 130 | 122 | 111 | 97.9 | 84.1 | 60.2 | 43.7 | 32.8 | 25.4 | 16.5 |
| | | | | 2.0 | RHS | 2.93 | 118 | 118 | 115 | 111 | 106 | 99.6 | 91.0 | 80.6 | 69.6 | 50.0 | 36.3 | 27.3 | 21.2 | 13.8 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 123 | 122 | 118 | 110 | 99.6 | 85.4 | 69.4 | 55.2 | 44.0 | 29.3 | 20.7 | 15.4 | 11.9 | 7.68 |
| | | | | 2.5 | RHS | 2.62 | 105 | 105 | 101 | 94.6 | 85.9 | 74.1 | 60.7 | 48.5 | 38.8 | 25.9 | 18.3 | 13.6 | 10.5 | 6.79 |
| | | | | 2.0 | RHS | 2.15 | 86.2 | 85.7 | 82.6 | 77.8 | 70.9 | 61.6 | 50.9 | 40.8 | 32.7 | 21.9 | 15.5 | 11.5 | 8.89 | 5.76 |
| | | | | 1.6 | RHS | 1.75 | 70.3 | 69.9 | 67.4 | 63.6 | 58.2 | 50.8 | 42.2 | 34.0 | 27.3 | 18.3 | 13.0 | 9.63 | 7.44 | 4.82 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 114 | 113 | 108 | 101 | 90.0 | 75.8 | 60.6 | 47.7 | 37.8 | 25.0 | 17.7 | 13.1 | 10.1 | 6.56 |
| | | | | 2.5 | RHS | 2.42 | 97.3 | 96.6 | 92.7 | 86.7 | 77.9 | 66.2 | 53.4 | 42.2 | 33.6 | 22.3 | 15.7 | 11.7 | 9.02 | 5.84 |
| | | | | 2.0 | RHS | 1.99 | 79.9 | 79.4 | 76.3 | 71.5 | 64.6 | 55.3 | 45.0 | 35.7 | 28.5 | 19.0 | 13.4 | 9.96 | 7.68 | 4.97 |
| | | | | 1.6 | RHS | 1.63 | 65.3 | 64.9 | 62.4 | 58.6 | 53.2 | 45.8 | 37.5 | 29.9 | 23.9 | 15.9 | 11.3 | 8.37 | 6.46 | 4.18 |



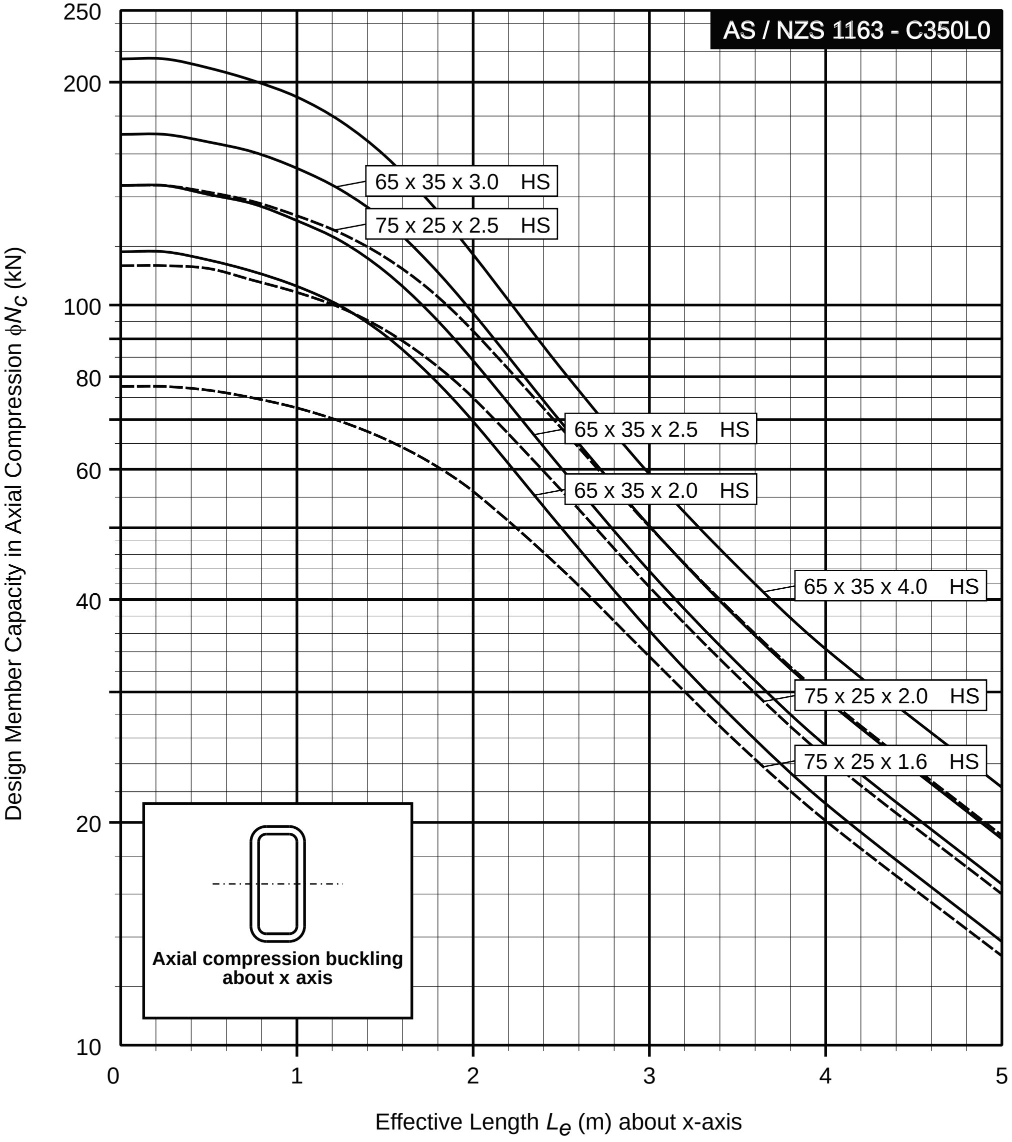
## Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi N_s = \phi N_c$ for $L_e = 0.0$.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**


AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
Effective Length $L_e$ (m) about x-axis
250
200
100
80
60
40
20
10
0
1
2
3
4
5
65 x 35 x 3.0 HS
75 x 25 x 2.5 HS
65 x 35 x 2.5 HS
65 x 35 x 2.0 HS
65 x 35 x 4.0 HS
75 x 25 x 2.0 HS
75 x 25 x 1.6 HS
Axial compression buckling about x axis

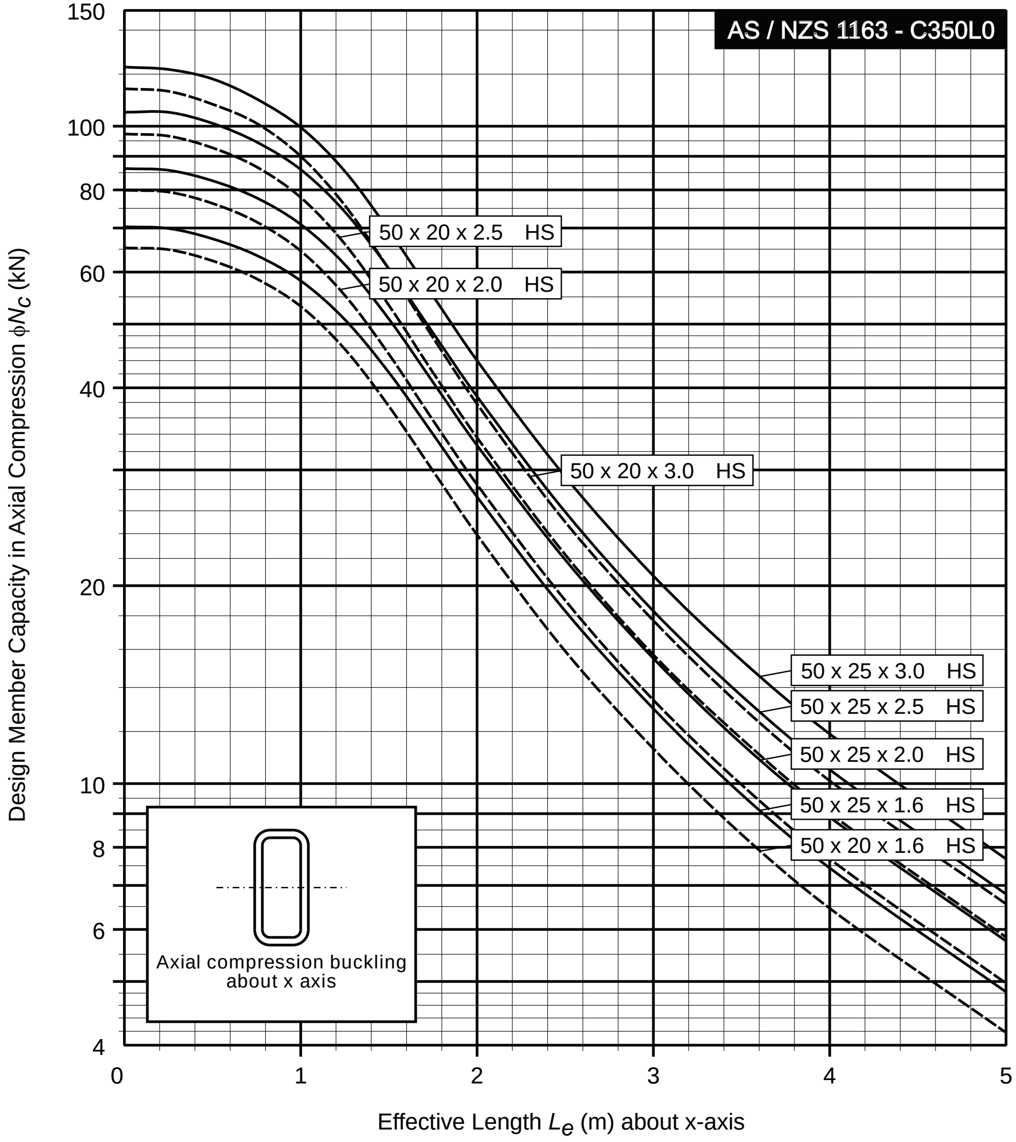

AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
Effective Length $L_e$ (m) about x-axis
150
100
80
60
40
20
10
8
6
4
0
1
2
3
4
5
50 x 20 x 2.5 HS
50 x 20 x 2.0 HS
50 x 20 x 3.0 HS
50 x 25 x 3.0 HS
50 x 25 x 2.5 HS
50 x 25 x 2.0 HS
50 x 25 x 1.6 HS
50 x 20 x 1.6 HS
Axial compression buckling about x axis

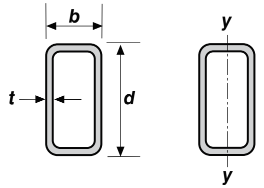
TABLE 6-3(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about y-axis*

| Designation<br>d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 145 | 140 | 126 | 102 | 71.6 | 49.4 | 35.4 | 26.4 | 20.4 | 13.3 | 9.29 | 6.87 | 5.29 | 3.41 |
| | | | | 2.0 | RHS | 2.93 | 113 | 110 | 100 | 82.4 | 59.6 | 41.6 | 29.9 | 22.4 | 17.3 | 11.2 | 7.88 | 5.83 | 4.49 | 2.90 |
| | | | | 1.6 | RHS | 2.38 | 77.6 | 76.0 | 70.3 | 60.6 | 46.8 | 33.8 | 24.7 | 18.5 | 14.4 | 9.37 | 6.58 | 4.87 | 3.75 | 2.42 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 215 | 211 | 199 | 178 | 148 | 113 | 84.9 | 64.6 | 50.4 | 33.0 | 23.2 | 17.2 | 13.2 | 8.55 |
| | | | | 3.0 | RHS | 4.25 | 170 | 168 | 159 | 144 | 122 | 95.1 | 72.0 | 55.1 | 43.1 | 28.2 | 19.9 | 14.7 | 11.3 | 7.33 |
| | | | | 2.5 | RHS | 3.60 | 145 | 143 | 135 | 123 | 105 | 82.4 | 62.7 | 48.1 | 37.7 | 24.7 | 17.4 | 12.9 | 9.93 | 6.42 |
| | | | | 2.0 | RHS | 2.93 | 118 | 116 | 110 | 101 | 86.2 | 68.5 | 52.4 | 40.3 | 31.6 | 20.7 | 14.6 | 10.8 | 8.33 | 5.39 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 123 | 119 | 105 | 81.6 | 55.4 | 37.7 | 26.8 | 20.0 | 15.5 | 10.0 | 7.02 | 5.19 | 4.00 | 2.58 |
| | | | | 2.5 | RHS | 2.62 | 105 | 102 | 90.8 | 71.3 | 49.1 | 33.5 | 23.9 | 17.8 | 13.8 | 8.95 | 6.27 | 4.64 | 3.57 | 2.30 |
| | | | | 2.0 | RHS | 2.15 | 86.2 | 83.6 | 75.0 | 59.7 | 41.7 | 28.6 | 20.5 | 15.3 | 11.8 | 7.66 | 5.37 | 3.97 | 3.06 | 1.97 |
| | | | | 1.6 | RHS | 1.75 | 70.3 | 68.3 | 61.5 | 49.5 | 34.9 | 24.1 | 17.2 | 12.9 | 9.96 | 6.46 | 4.53 | 3.35 | 2.58 | 1.66 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 114 | 107 | 87.0 | 55.7 | 34.1 | 22.5 | 15.9 | 11.8 | 9.07 | 5.87 | 4.10 | 3.03 | 2.33 | 1.50 |
| | | | | 2.5 | RHS | 2.42 | 97.3 | 92.2 | 75.8 | 49.8 | 30.8 | 20.3 | 14.3 | 10.6 | 8.20 | 5.31 | 3.71 | 2.74 | 2.11 | 1.36 |
| | | | | 2.0 | RHS | 1.99 | 79.9 | 76.0 | 63.3 | 42.5 | 26.5 | 17.6 | 12.4 | 9.21 | 7.11 | 4.60 | 3.22 | 2.38 | 1.83 | 1.18 |
| | | | | 1.6 | RHS | 1.63 | 65.3 | 62.2 | 52.3 | 35.8 | 22.5 | 14.9 | 10.6 | 7.84 | 6.05 | 3.92 | 2.74 | 2.03 | 1.56 | 1.00 |



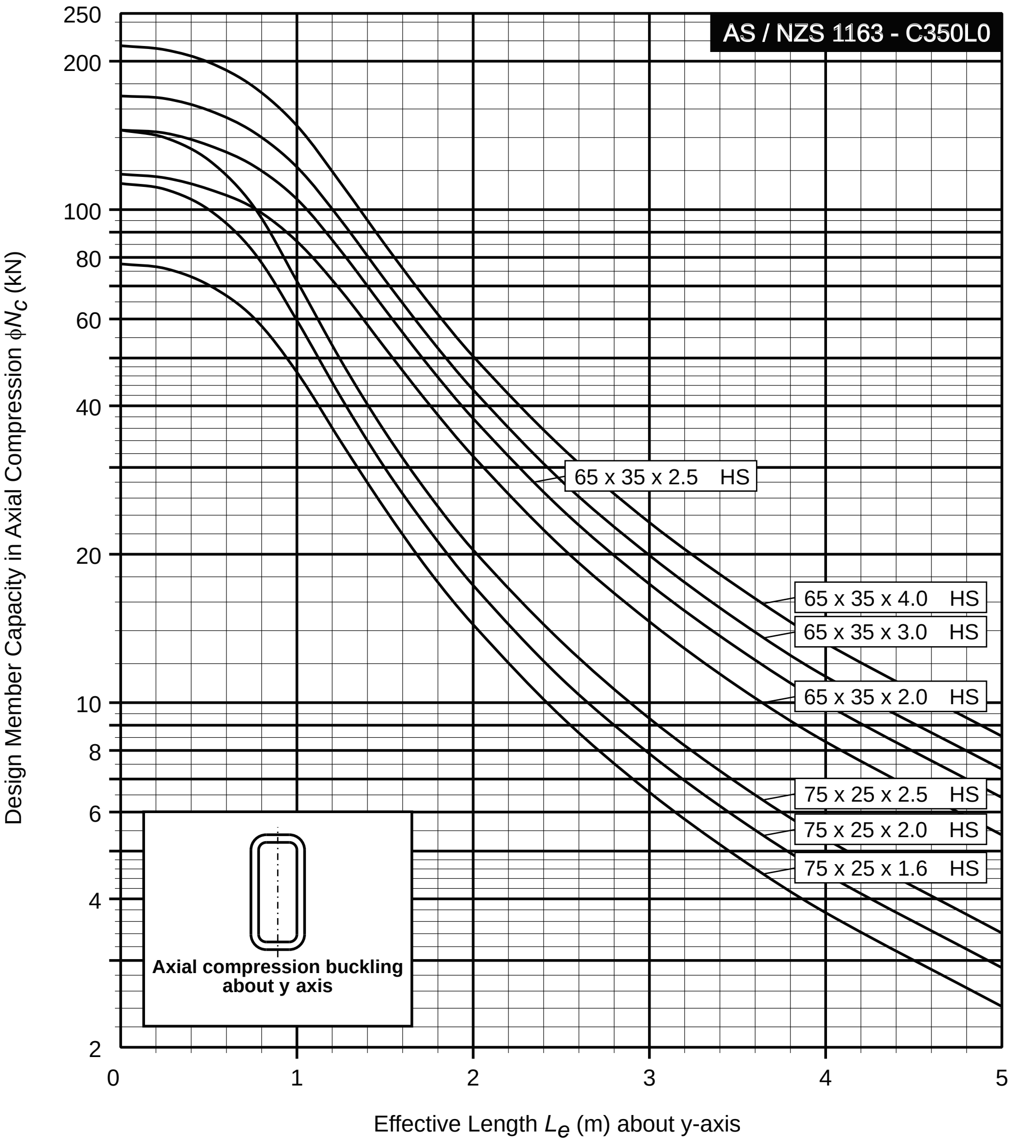
## Notes:

1. ***REFER*** **to the Australian Tube Mills** ***QUICK REFERENCE PRODUCT AVAILABILITY GUIDE*** **(QRPAG) for information on the availability of listed sections and associated finishes. The QRPAG is found at the beginning of this publication.**
2. $\phi N_s = \phi N_c$ for $L_e = 0.0$.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**


AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
250
200
100
80
60
40
20
10
8
6
4
2
0
1
2
3
4
5
Effective Length $L_e$ (m) about y-axis
65 x 35 x 2.5 HS
65 x 35 x 4.0 HS
65 x 35 x 3.0 HS
65 x 35 x 2.0 HS
75 x 25 x 2.5 HS
75 x 25 x 2.0 HS
75 x 25 x 1.6 HS
Axial compression buckling about y axis

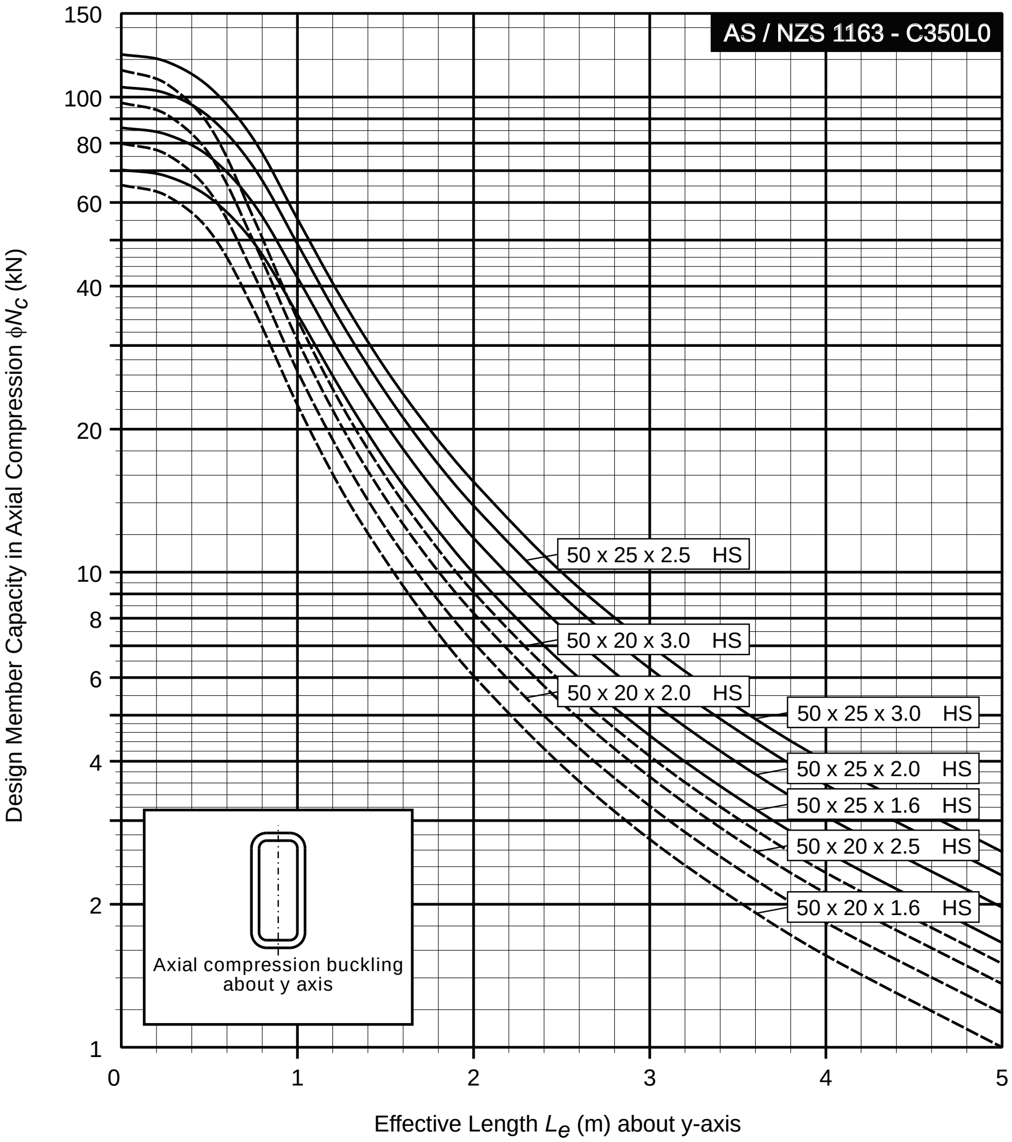

AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
150
100
80
60
40
20
10
8
6
4
2
1
0
1
2
3
4
5
Effective Length $L_e$ (m) about y-axis
50 x 25 x 2.5 HS
50 x 20 x 3.0 HS
50 x 20 x 2.0 HS
50 x 25 x 3.0 HS
50 x 25 x 2.0 HS
50 x 25 x 1.6 HS
50 x 20 x 2.5 HS
50 x 20 x 1.6 HS
Axial compression buckling about y axis

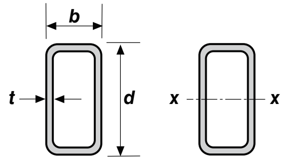
TABLE 6-4(1)(A)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about x-axis*

| Designation | | | | | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | $L_e$ = 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 12.0 | 14.0 | 16.0 |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8300 | 8300 | 8240 | 8090 | 7900 | 7660 | 7370 | 7020 | 6610 | 6120 | 5580 | 4480 | 3530 | 2810 |
| | | | | 12.5 | RHS | 128 | 6590 | 6590 | 6550 | 6430 | 6290 | 6100 | 5880 | 5610 | 5290 | 4920 | 4500 | 3640 | 2880 | 2290 |
| | | | | 10.0 | RHS | 104 | 4710 | 4710 | 4680 | 4610 | 4520 | 4400 | 4270 | 4100 | 3910 | 3680 | 3420 | 2850 | 2310 | 1860 |
| | | | | 8.0 | RHS | 84.2 | 3110 | 3110 | 3100 | 3060 | 3010 | 2950 | 2870 | 2790 | 2690 | 2570 | 2440 | 2120 | 1780 | 1470 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 7010 | 7010 | 6940 | 6800 | 6620 | 6390 | 6110 | 5770 | 5360 | 4890 | 4390 | 3430 | 2670 | 2100 |
| | | | | 12.5 | RHS | 109 | 5580 | 5580 | 5530 | 5420 | 5280 | 5110 | 4890 | 4630 | 4320 | 3960 | 3570 | 2810 | 2190 | 1730 |
| | | | | 10.0 | RHS | 88.4 | 3900 | 3900 | 3870 | 3810 | 3720 | 3620 | 3500 | 3340 | 3170 | 2960 | 2720 | 2220 | 1770 | 1410 |
| | | | | 8.0 | RHS | 71.6 | 2750 | 2750 | 2740 | 2700 | 2650 | 2590 | 2510 | 2420 | 2310 | 2190 | 2050 | 1730 | 1410 | 1140 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 7010 | 7010 | 6910 | 6750 | 6540 | 6270 | 5940 | 5520 | 5030 | 4500 | 3950 | 3000 | 2300 | 1800 |
| | | | | 12.5 | RHS | 109 | 5600 | 5600 | 5540 | 5410 | 5250 | 5040 | 4780 | 4460 | 4080 | 3660 | 3230 | 2460 | 1890 | 1480 |
| | | | | 10.0 | RHS | 88.4 | 4300 | 4300 | 4250 | 4160 | 4050 | 3900 | 3720 | 3490 | 3230 | 2920 | 2610 | 2020 | 1560 | 1220 |
| | | | | 8.0 | RHS | 71.6 | 3080 | 3080 | 3050 | 2990 | 2920 | 2830 | 2720 | 2580 | 2420 | 2230 | 2020 | 1610 | 1260 | 997 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 5710 | 5710 | 5590 | 5410 | 5170 | 4850 | 4440 | 3940 | 3410 | 2910 | 2460 | 1790 | 1350 | 1050 |
| | | | | 12.5 | RHS | 89.0 | 4590 | 4590 | 4500 | 4360 | 4170 | 3930 | 3610 | 3230 | 2810 | 2400 | 2040 | 1490 | 1130 | 874 |
| | | | | 10.0 | RHS | 72.7 | 3750 | 3750 | 3680 | 3570 | 3410 | 3220 | 2970 | 2670 | 2330 | 2000 | 1710 | 1250 | 942 | 732 |
| | | | | 8.0 | RHS | 59.1 | 2750 | 2750 | 2710 | 2630 | 2540 | 2410 | 2250 | 2060 | 1830 | 1600 | 1380 | 1020 | 775 | 604 |
| | | | | 6.0 | RHS | 45.0 | 1750 | 1750 | 1730 | 1690 | 1640 | 1570 | 1490 | 1390 | 1270 | 1140 | 1010 | 770 | 591 | 463 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 4410 | 4400 | 4260 | 4050 | 3750 | 3350 | 2850 | 2350 | 1910 | 1560 | 1290 | 919 | 685 | 529 |
| | | | | 12.5 | RHS | 69.4 | 3580 | 3570 | 3460 | 3300 | 3070 | 2760 | 2380 | 1980 | 1620 | 1330 | 1100 | 783 | 584 | 451 |
| | | | | 10.0 | RHS | 57.0 | 2940 | 2930 | 2840 | 2720 | 2540 | 2290 | 1990 | 1660 | 1370 | 1120 | 932 | 665 | 496 | 383 |
| | | | | 9.0 | RHS | 51.8 | 2670 | 2670 | 2590 | 2470 | 2310 | 2090 | 1820 | 1520 | 1250 | 1030 | 858 | 612 | 457 | 353 |
| | | | | 8.0 | RHS | 46.5 | 2400 | 2390 | 2320 | 2220 | 2080 | 1890 | 1640 | 1380 | 1140 | 938 | 779 | 557 | 415 | 321 |
| | | | | 6.0 | RHS | 35.6 | 1550 | 1550 | 1510 | 1450 | 1380 | 1280 | 1150 | 1000 | 849 | 712 | 598 | 431 | 323 | 250 |
| | | | | 5.0 | RHS | 29.9 | 1180 | 1180 | 1150 | 1110 | 1060 | 995 | 910 | 807 | 696 | 592 | 501 | 364 | 274 | 212 |



**Notes:**

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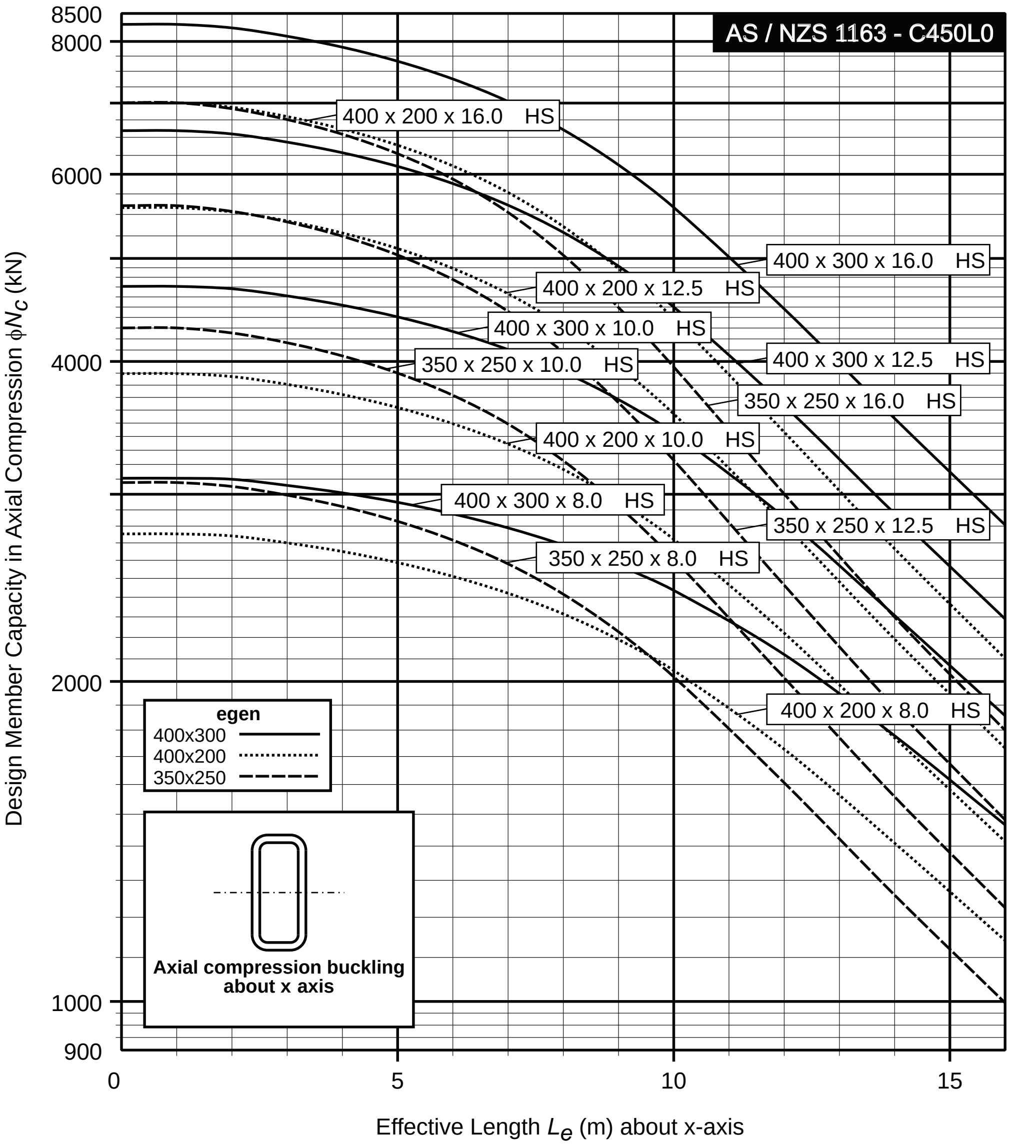
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C450L0
8500
8000
6000
4000
2000
1000
900
0
5
10
15
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
Effective Length $L_e$ (m) about x-axis
400 x 200 x 16.0 HS
400 x 300 x 16.0 HS
400 x 200 x 12.5 HS
400 x 300 x 10.0 HS
350 x 250 x 10.0 HS
400 x 300 x 12.5 HS
350 x 250 x 16.0 HS
400 x 200 x 10.0 HS
400 x 300 x 8.0 HS
350 x 250 x 12.5 HS
350 x 250 x 8.0 HS
400 x 200 x 8.0 HS
egen
400x300 ———
400x200 ·········
350x250 – – – –
Axial compression buckling about x axis

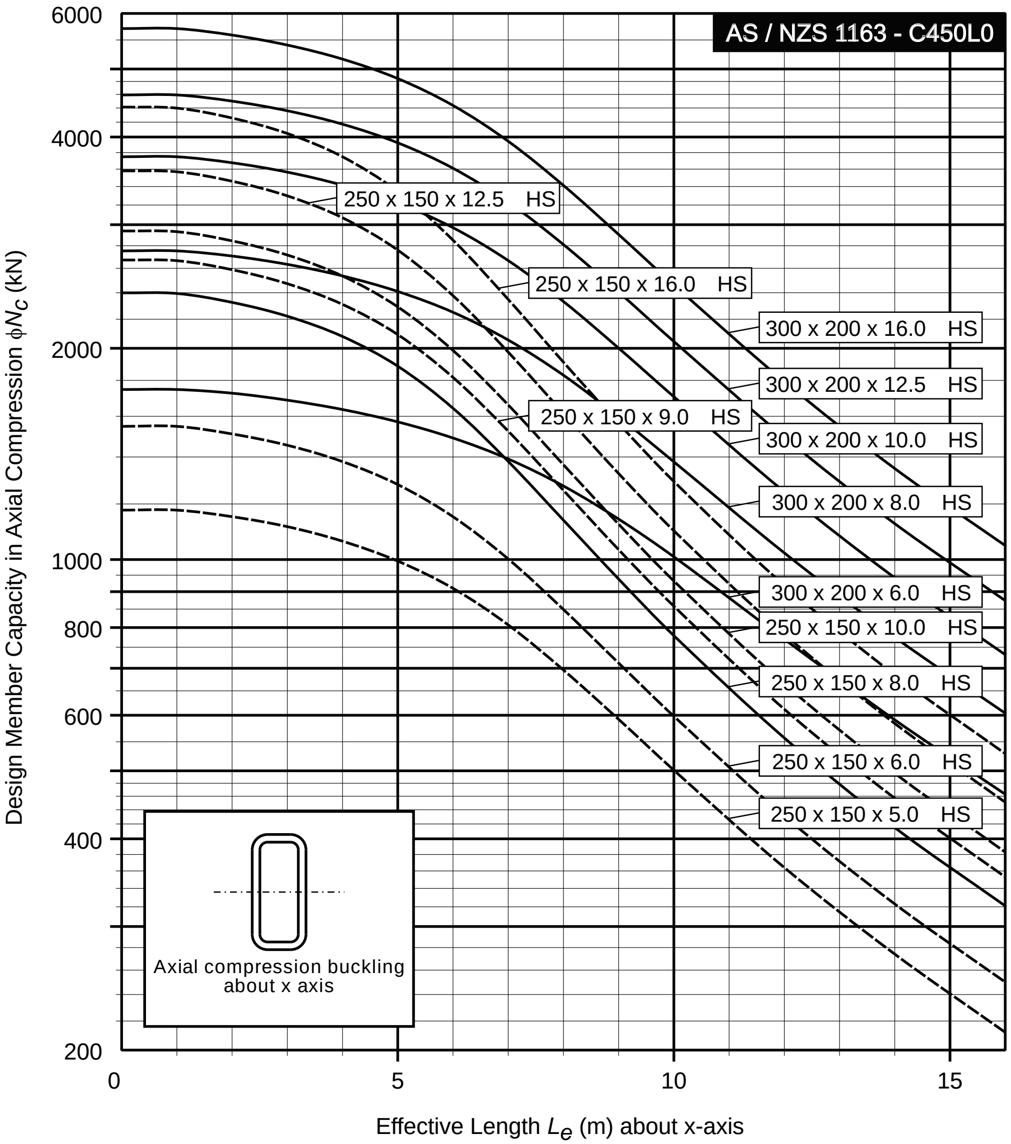

AS / NZS 1163 - C450L0
6000
4000
2000
1000
800
600
400
200
0
5
10
15
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
Effective Length $L_e$ (m) about x-axis
250 x 150 x 12.5 HS
250 x 150 x 16.0 HS
300 x 200 x 16.0 HS
300 x 200 x 12.5 HS
250 x 150 x 9.0 HS
300 x 200 x 10.0 HS
300 x 200 x 8.0 HS
300 x 200 x 6.0 HS
250 x 150 x 10.0 HS
250 x 150 x 8.0 HS
250 x 150 x 6.0 HS
250 x 150 x 5.0 HS
Axial compression buckling about x axis

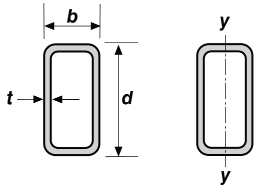
TABLE 6-4(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about y-axis*

| Designation d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e = 0.0$ | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 12.0 | 14.0 | 16.0 |
| 400 | x | 300 | x | 16.0 | RHS | 161 | 8300 | 8300 | 8170 | 7950 | 7670 | 7300 | 6830 | 6260 | 5590 | 4900 | 4230 | 3150 | 2390 | 1870 |
| | | | | 12.5 | RHS | 128 | 6590 | 6590 | 6490 | 6330 | 6110 | 5820 | 5460 | 5020 | 4510 | 3970 | 3440 | 2570 | 1960 | 1530 |
| | | | | 10.0 | RHS | 104 | 4710 | 4710 | 4650 | 4540 | 4410 | 4230 | 4020 | 3750 | 3430 | 3080 | 2720 | 2080 | 1600 | 1250 |
| | | | | 8.0 | RHS | 84.2 | 3110 | 3110 | 3080 | 3020 | 2950 | 2860 | 2740 | 2610 | 2440 | 2250 | 2040 | 1630 | 1280 | 1010 |
| 400 | x | 200 | x | 16.0 | RHS | 136 | 7010 | 6970 | 6720 | 6350 | 5810 | 5080 | 4220 | 3410 | 2740 | 2230 | 1840 | 1300 | 968 | 747 |
| | | | | 12.5 | RHS | 109 | 5580 | 5560 | 5370 | 5080 | 4670 | 4120 | 3460 | 2810 | 2270 | 1850 | 1520 | 1080 | 805 | 622 |
| | | | | 10.0 | RHS | 88.4 | 3900 | 3890 | 3770 | 3610 | 3370 | 3050 | 2660 | 2230 | 1840 | 1510 | 1260 | 896 | 669 | 517 |
| | | | | 8.0 | RHS | 71.6 | 2750 | 2750 | 2680 | 2580 | 2440 | 2250 | 2010 | 1740 | 1460 | 1220 | 1020 | 735 | 550 | 426 |
| 350 | x | 250 | x | 16.0 | RHS | 136 | 7010 | 7000 | 6830 | 6570 | 6210 | 5750 | 5140 | 4450 | 3750 | 3140 | 2630 | 1890 | 1420 | 1100 |
| | | | | 12.5 | RHS | 109 | 5600 | 5600 | 5470 | 5270 | 4990 | 4630 | 4170 | 3630 | 3080 | 2580 | 2170 | 1560 | 1170 | 907 |
| | | | | 10.0 | RHS | 88.4 | 4300 | 4300 | 4200 | 4060 | 3870 | 3620 | 3290 | 2910 | 2500 | 2110 | 1780 | 1290 | 971 | 754 |
| | | | | 8.0 | RHS | 71.6 | 3080 | 3080 | 3020 | 2930 | 2810 | 2660 | 2460 | 2220 | 1950 | 1680 | 1430 | 1050 | 795 | 618 |
| 300 | x | 200 | x | 16.0 | RHS | 111 | 5710 | 5670 | 5460 | 5130 | 4660 | 4020 | 3290 | 2630 | 2100 | 1700 | 1400 | 991 | 737 | 569 |
| | | | | 12.5 | RHS | 89.0 | 4590 | 4570 | 4400 | 4150 | 3780 | 3290 | 2720 | 2190 | 1760 | 1420 | 1170 | 831 | 618 | 477 |
| | | | | 10.0 | RHS | 72.7 | 3750 | 3730 | 3600 | 3400 | 3110 | 2720 | 2260 | 1830 | 1470 | 1200 | 985 | 698 | 519 | 401 |
| | | | | 8.0 | RHS | 59.1 | 2750 | 2740 | 2660 | 2530 | 2340 | 2090 | 1790 | 1470 | 1200 | 982 | 812 | 578 | 430 | 333 |
| | | | | 6.0 | RHS | 45.0 | 1750 | 1750 | 1700 | 1630 | 1540 | 1410 | 1250 | 1070 | 894 | 743 | 620 | 445 | 333 | 257 |
| 250 | x | 150 | x | 16.0 | RHS | 85.5 | 4410 | 4340 | 4050 | 3570 | 2860 | 2130 | 1570 | 1190 | 924 | 738 | 602 | 423 | 313 | 241 |
| | | | | 12.5 | RHS | 69.4 | 3580 | 3520 | 3300 | 2930 | 2390 | 1800 | 1340 | 1020 | 792 | 633 | 517 | 363 | 269 | 207 |
| | | | | 10.0 | RHS | 57.0 | 2940 | 2890 | 2720 | 2430 | 2000 | 1530 | 1140 | 866 | 676 | 540 | 441 | 310 | 230 | 177 |
| | | | | 9.0 | RHS | 51.8 | 2670 | 2630 | 2480 | 2220 | 1840 | 1400 | 1050 | 799 | 623 | 499 | 407 | 286 | 212 | 164 |
| | | | | 8.0 | RHS | 46.5 | 2400 | 2360 | 2230 | 2000 | 1660 | 1270 | 956 | 728 | 568 | 454 | 371 | 261 | 193 | 149 |
| | | | | 6.0 | RHS | 35.6 | 1550 | 1530 | 1460 | 1340 | 1160 | 940 | 727 | 562 | 442 | 355 | 291 | 205 | 152 | 117 |
| | | | | 5.0 | RHS | 29.9 | 1180 | 1170 | 1120 | 1040 | 918 | 763 | 604 | 473 | 374 | 301 | 247 | 174 | 129 | 99.7 |



## Notes:

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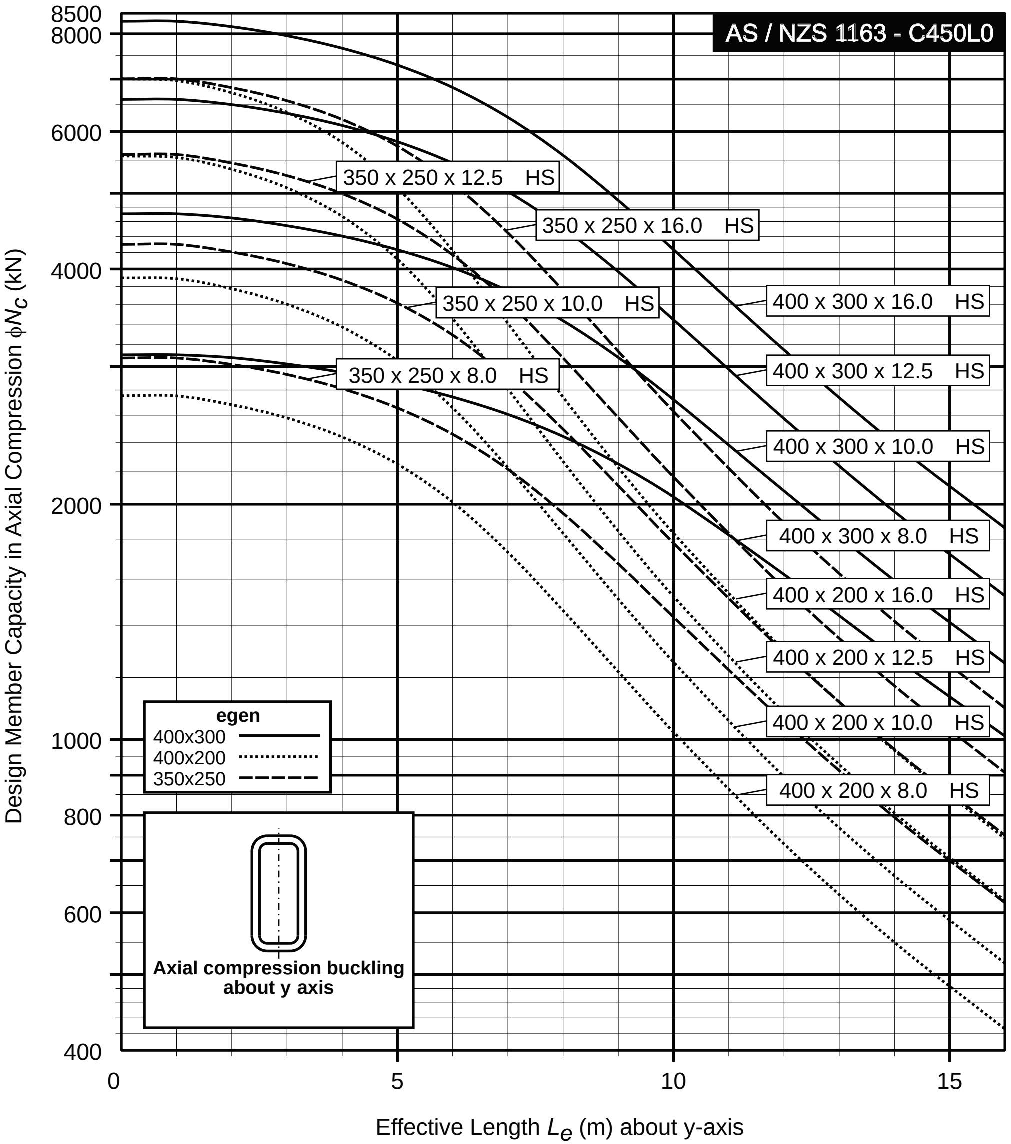
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
8500
8000
6000
4000
2000
1000
800
600
400
0
5
10
15
Effective Length $L_e$ (m) about y-axis
350 x 250 x 12.5 HS
350 x 250 x 16.0 HS
350 x 250 x 10.0 HS
350 x 250 x 8.0 HS
400 x 300 x 16.0 HS
400 x 300 x 12.5 HS
400 x 300 x 10.0 HS
400 x 300 x 8.0 HS
400 x 200 x 16.0 HS
400 x 200 x 12.5 HS
400 x 200 x 10.0 HS
400 x 200 x 8.0 HS
egen
400x300
400x200
350x250
Axial compression buckling about y axis

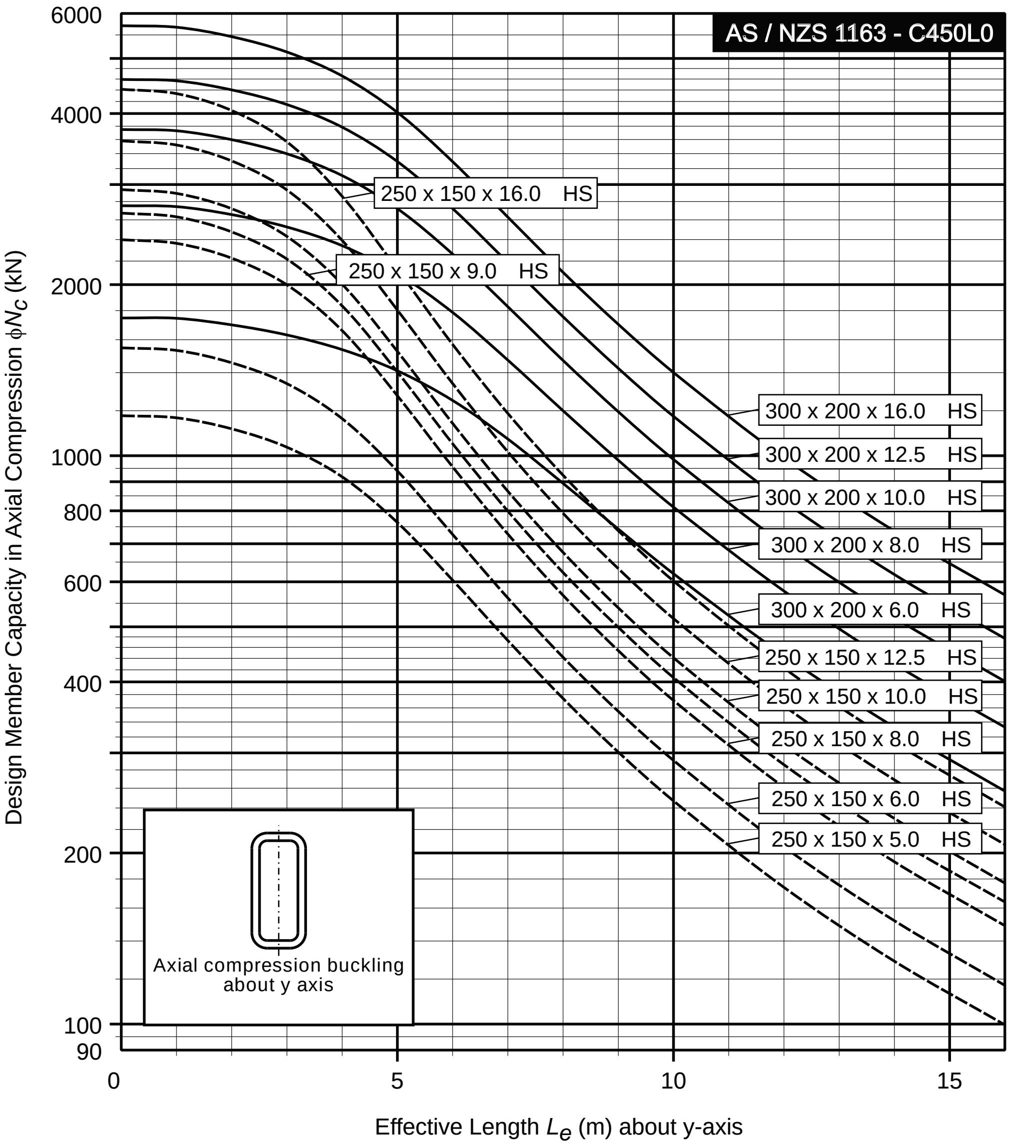

AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
6000
4000
2000
1000
800
600
400
200
100
90
0
5
10
15
Effective Length $L_e$ (m) about y-axis
250 x 150 x 16.0 HS
250 x 150 x 9.0 HS
300 x 200 x 16.0 HS
300 x 200 x 12.5 HS
300 x 200 x 10.0 HS
300 x 200 x 8.0 HS
300 x 200 x 6.0 HS
250 x 150 x 12.5 HS
250 x 150 x 10.0 HS
250 x 150 x 8.0 HS
250 x 150 x 6.0 HS
250 x 150 x 5.0 HS
Axial compression buckling about y axis

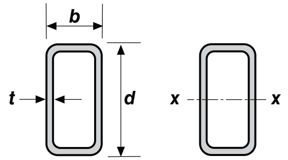
TABLE 6-4(2)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about x-axis*

| Designation |  |  |  |  |  | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d |  | b |  | t |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| mm |  | mm |  | mm |  | kg/m | $L_e$ = 0.0 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 10.0 | 12.0 |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 2130 | 2110 | 2060 | 2010 | 1930 | 1850 | 1740 | 1610 | 1300 | 1010 | 783 | 616 | 405 | 286 |
|  |  |  |  | 9.0 | RHS | 37.7 | 1940 | 1920 | 1880 | 1830 | 1770 | 1690 | 1590 | 1480 | 1200 | 938 | 727 | 573 | 377 | 266 |
|  |  |  |  | 8.0 | RHS | 33.9 | 1750 | 1730 | 1700 | 1650 | 1600 | 1530 | 1440 | 1340 | 1100 | 858 | 667 | 525 | 346 | 244 |
|  |  |  |  | 6.0 | RHS | 26.2 | 1310 | 1290 | 1270 | 1240 | 1200 | 1150 | 1090 | 1020 | 850 | 674 | 528 | 417 | 276 | 195 |
|  |  |  |  | 5.0 | RHS | 22.1 | 974 | 968 | 952 | 931 | 905 | 874 | 836 | 791 | 680 | 555 | 443 | 353 | 235 | 166 |
|  |  |  |  | 4.0 | RHS | 17.9 | 688 | 685 | 675 | 662 | 647 | 628 | 605 | 579 | 512 | 432 | 352 | 285 | 192 | 136 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 1000 | 978 | 946 | 902 | 845 | 772 | 684 | 589 | 423 | 308 | 231 | 179 | 117 | 81.9 |
|  |  |  |  | 5.0 | RHS | 16.4 | 848 | 830 | 804 | 768 | 720 | 660 | 587 | 508 | 367 | 267 | 201 | 156 | 101 | 71.2 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 1720 | 1690 | 1630 | 1550 | 1450 | 1320 | 1160 | 1000 | 715 | 519 | 390 | 302 | 197 | 138 |
|  |  |  |  | 9.0 | RHS | 30.6 | 1580 | 1540 | 1490 | 1420 | 1330 | 1220 | 1080 | 930 | 668 | 486 | 365 | 283 | 184 | 129 |
|  |  |  |  | 8.0 | RHS | 27.7 | 1430 | 1400 | 1350 | 1290 | 1210 | 1110 | 986 | 853 | 616 | 448 | 337 | 262 | 170 | 120 |
|  |  |  |  | 6.0 | RHS | 21.4 | 1110 | 1080 | 1050 | 1010 | 947 | 872 | 780 | 680 | 495 | 362 | 273 | 212 | 138 | 96.8 |
|  |  |  |  | 5.0 | RHS | 18.2 | 937 | 919 | 891 | 854 | 805 | 743 | 667 | 583 | 426 | 312 | 235 | 183 | 119 | 83.7 |
|  |  |  |  | 4.0 | RHS | 14.8 | 688 | 677 | 659 | 634 | 603 | 563 | 514 | 458 | 344 | 256 | 194 | 151 | 98.5 | 69.2 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 864 | 841 | 808 | 764 | 704 | 629 | 542 | 455 | 318 | 228 | 171 | 132 | 85.9 | 60.3 |
|  |  |  |  | 5.0 | RHS | 14.2 | 735 | 716 | 689 | 653 | 604 | 541 | 469 | 396 | 278 | 200 | 150 | 116 | 75.4 | 52.9 |
|  |  |  |  | 4.0 | RHS | 11.6 | 526 | 515 | 499 | 476 | 447 | 410 | 364 | 316 | 228 | 166 | 125 | 97.0 | 63.1 | 44.3 |
|  |  |  |  | 3.0 | RHS | 8.96 | 329 | 324 | 316 | 305 | 291 | 273 | 251 | 226 | 172 | 129 | 98.1 | 76.5 | 50.0 | 35.1 |
|  |  |  |  | 2.5 | RHS | 7.53 | 246 | 243 | 237 | 230 | 221 | 209 | 195 | 178 | 141 | 107 | 82.4 | 64.6 | 42.3 | 29.8 |
|  |  |  |  | 2.0 | RHS | 6.07 | 173 | 172 | 168 | 164 | 158 | 151 | 143 | 133 | 109 | 85.1 | 66.1 | 52.1 | 34.3 | 24.2 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 757 | 729 | 691 | 637 | 564 | 476 | 389 | 315 | 212 | 151 | 112 | 86.6 | 56.1 | 39.3 |
|  |  |  |  | 5.0 | RHS | 12.5 | 646 | 623 | 591 | 547 | 487 | 414 | 340 | 277 | 187 | 133 | 98.9 | 76.4 | 49.5 | 34.7 |
|  |  |  |  | 3.5 | RHS | 9.07 | 423 | 411 | 393 | 368 | 335 | 293 | 247 | 204 | 140 | 100 | 74.8 | 57.9 | 37.5 | 26.3 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 864 | 835 | 796 | 741 | 668 | 576 | 479 | 392 | 267 | 190 | 142 | 110 | 71.1 | 49.8 |
|  |  |  |  | 5.0 | RHS | 14.2 | 735 | 711 | 679 | 634 | 573 | 497 | 415 | 341 | 233 | 166 | 124 | 95.8 | 62.1 | 43.5 |
|  |  |  |  | 4.0 | RHS | 11.6 | 600 | 581 | 556 | 520 | 471 | 411 | 345 | 285 | 195 | 139 | 104 | 80.3 | 52.1 | 36.5 |
|  |  |  |  | 3.0 | RHS | 8.96 | 390 | 381 | 367 | 348 | 323 | 291 | 253 | 215 | 151 | 109 | 81.8 | 63.4 | 41.2 | 28.9 |
|  |  |  |  | 2.5 | RHS | 7.53 | 296 | 290 | 280 | 268 | 251 | 229 | 203 | 176 | 126 | 91.9 | 69.1 | 53.6 | 34.9 | 24.5 |
|  |  |  |  | 2.0 | RHS | 6.07 | 196 | 192 | 187 | 180 | 171 | 160 | 147 | 131 | 98.7 | 73.3 | 55.6 | 43.3 | 28.3 | 19.9 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 757 | 719 | 670 | 599 | 503 | 402 | 316 | 251 | 166 | 117 | 87.0 | 67.1 | 43.4 | 30.4 |
|  |  |  |  | 5.0 | RHS | 12.5 | 646 | 615 | 574 | 515 | 436 | 351 | 277 | 220 | 146 | 103 | 76.6 | 59.1 | 38.2 | 26.8 |
|  |  |  |  | 3.5 | RHS | 9.07 | 468 | 446 | 418 | 378 | 323 | 262 | 208 | 166 | 110 | 78.0 | 58.0 | 44.7 | 29.0 | 20.3 |



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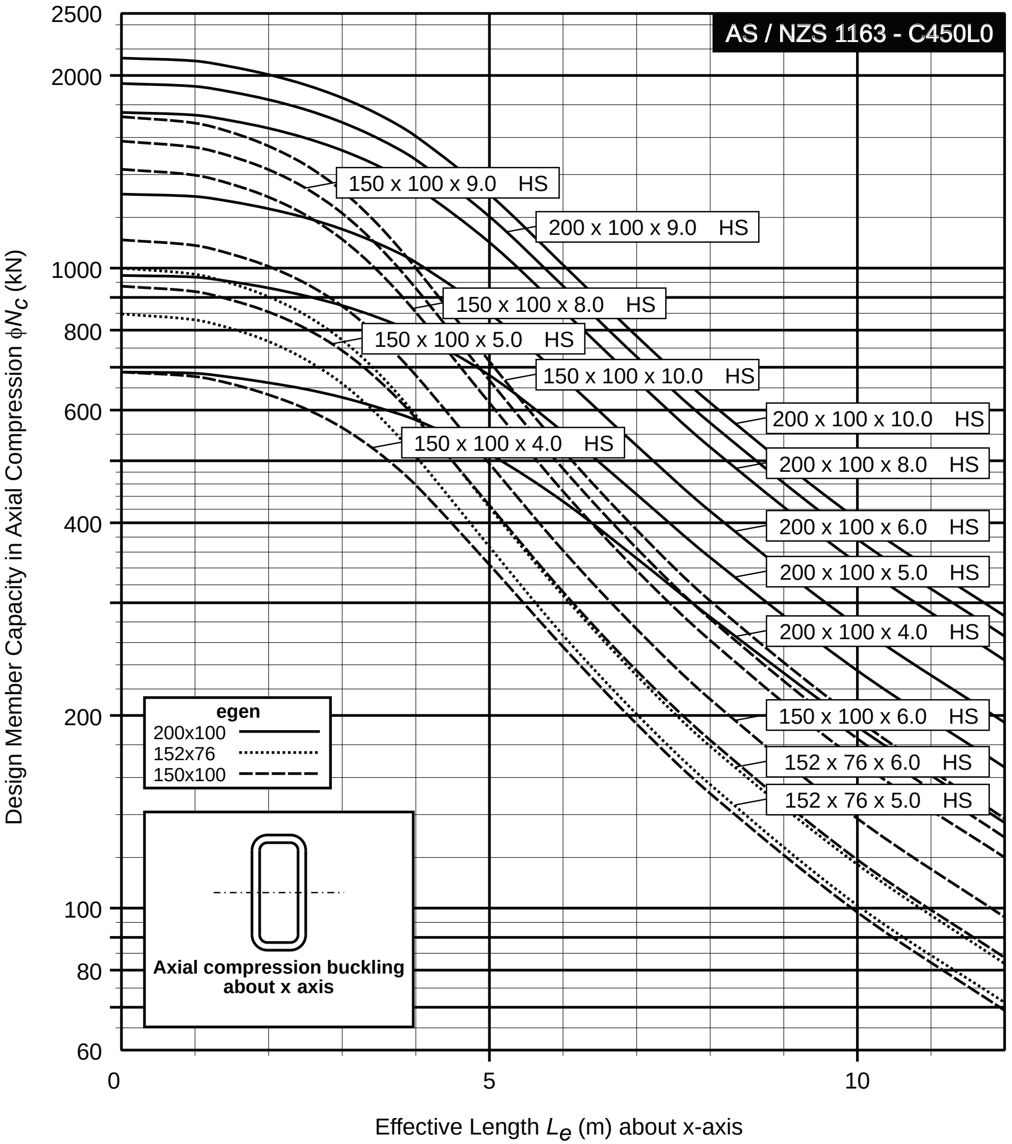
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
2500
2000
1000
800
600
400
200
100
80
60
0
5
10
Effective Length $L_e$ (m) about x-axis
150 x 100 x 9.0 HS
200 x 100 x 9.0 HS
150 x 100 x 8.0 HS
150 x 100 x 5.0 HS
150 x 100 x 10.0 HS
200 x 100 x 10.0 HS
150 x 100 x 4.0 HS
200 x 100 x 8.0 HS
200 x 100 x 6.0 HS
200 x 100 x 5.0 HS
200 x 100 x 4.0 HS
150 x 100 x 6.0 HS
152 x 76 x 6.0 HS
152 x 76 x 5.0 HS
egen
200x100
152x76
150x100
Axial compression buckling about x axis

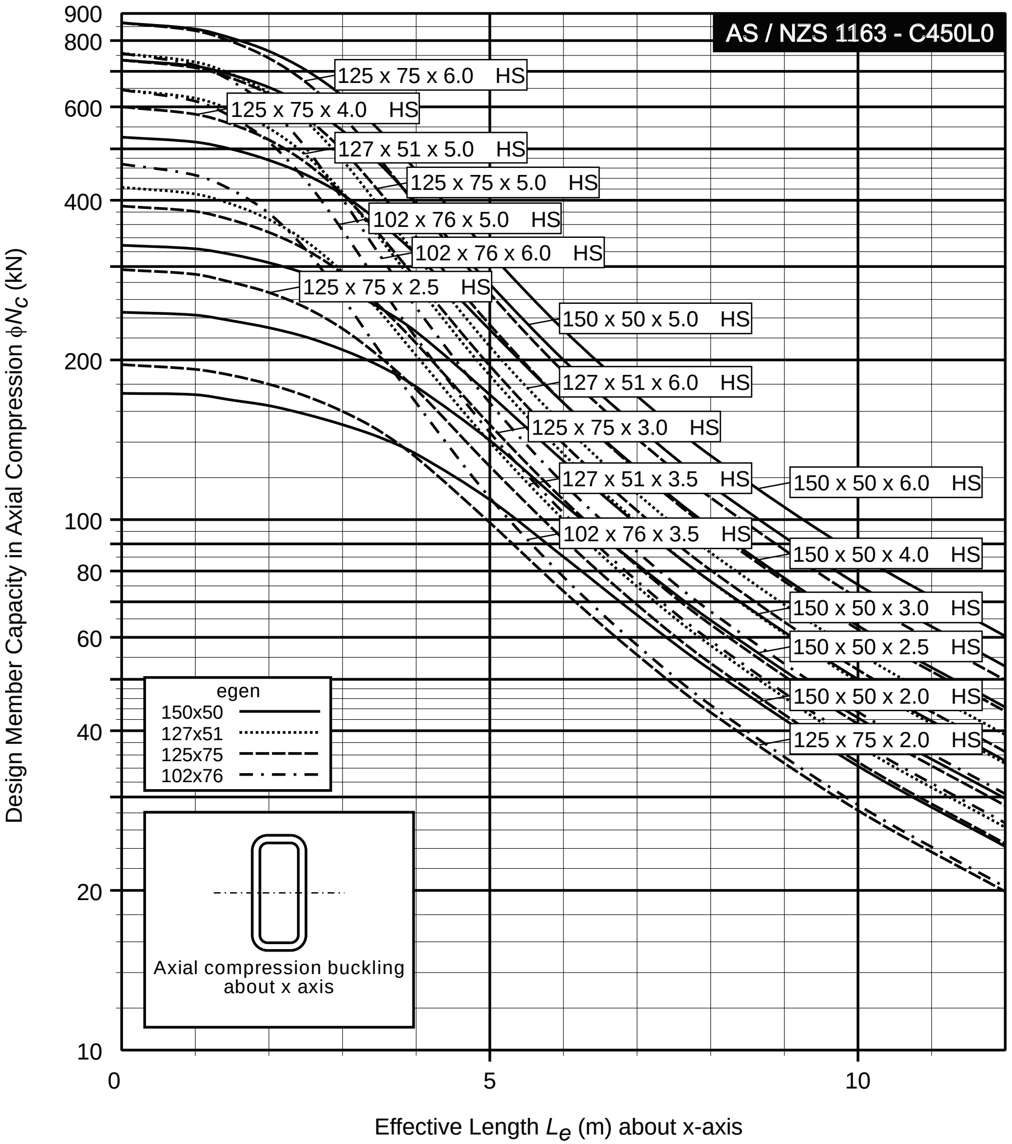

AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
900
800
600
400
200
100
80
60
40
20
10
0
5
10
Effective Length $L_e$ (m) about x-axis
125 x 75 x 6.0 HS
125 x 75 x 4.0 HS
127 x 51 x 5.0 HS
125 x 75 x 5.0 HS
102 x 76 x 5.0 HS
102 x 76 x 6.0 HS
125 x 75 x 2.5 HS
150 x 50 x 5.0 HS
127 x 51 x 6.0 HS
125 x 75 x 3.0 HS
127 x 51 x 3.5 HS
150 x 50 x 6.0 HS
102 x 76 x 3.5 HS
150 x 50 x 4.0 HS
150 x 50 x 3.0 HS
150 x 50 x 2.5 HS
150 x 50 x 2.0 HS
125 x 75 x 2.0 HS
egen
150x50
127x51
125x75
102x76
Axial compression buckling about x axis

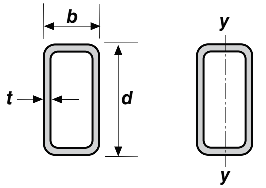
TABLE 6-4(2)(B)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

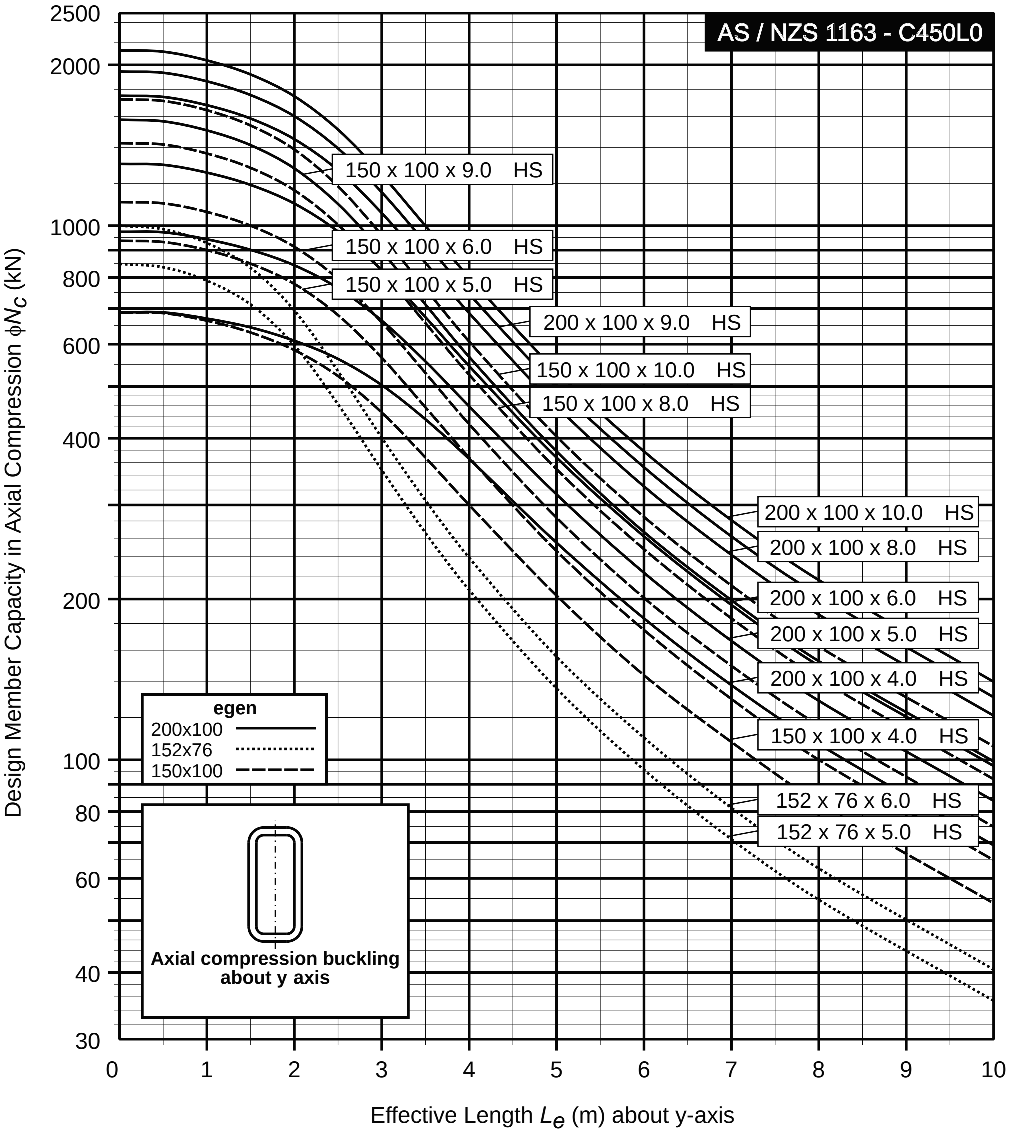
### *buckling about y-axis*

| Designation<br>d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN)<br>Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e = 0.0$ | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 10.0 |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 2130 | 2120 | 2040 | 1920 | 1750 | 1510 | 1250 | 999 | 800 | 534 | 378 | 281 | 217 | 140 |
| | | | | 9.0 | RHS | 37.7 | 1940 | 1930 | 1860 | 1760 | 1600 | 1400 | 1150 | 929 | 745 | 498 | 353 | 262 | 203 | 131 |
| | | | | 8.0 | RHS | 33.9 | 1750 | 1740 | 1680 | 1590 | 1450 | 1270 | 1060 | 852 | 686 | 459 | 325 | 242 | 187 | 121 |
| | | | | 6.0 | RHS | 26.2 | 1310 | 1300 | 1260 | 1190 | 1100 | 975 | 825 | 674 | 546 | 368 | 262 | 195 | 150 | 97.4 |
| | | | | 5.0 | RHS | 22.1 | 974 | 972 | 943 | 901 | 843 | 764 | 664 | 557 | 459 | 314 | 224 | 167 | 129 | 83.8 |
| | | | | 4.0 | RHS | 17.9 | 688 | 688 | 670 | 645 | 609 | 563 | 503 | 434 | 366 | 255 | 184 | 138 | 107 | 69.2 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 1000 | 985 | 928 | 834 | 694 | 534 | 401 | 306 | 239 | 156 | 110 | 81.3 | 62.6 | 40.5 |
| | | | | 5.0 | RHS | 16.4 | 848 | 836 | 789 | 712 | 597 | 463 | 349 | 266 | 208 | 136 | 95.8 | 71.0 | 54.7 | 35.4 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 1720 | 1710 | 1640 | 1540 | 1390 | 1190 | 960 | 762 | 607 | 403 | 285 | 212 | 163 | 106 |
| | | | | 9.0 | RHS | 30.6 | 1580 | 1570 | 1510 | 1410 | 1280 | 1100 | 895 | 712 | 568 | 378 | 267 | 199 | 153 | 99.3 |
| | | | | 8.0 | RHS | 27.7 | 1430 | 1420 | 1370 | 1280 | 1160 | 1000 | 823 | 657 | 526 | 350 | 248 | 184 | 142 | 92.0 |
| | | | | 6.0 | RHS | 21.4 | 1110 | 1100 | 1060 | 1000 | 913 | 795 | 659 | 530 | 425 | 284 | 201 | 150 | 116 | 74.9 |
| | | | | 5.0 | RHS | 18.2 | 937 | 932 | 900 | 849 | 778 | 680 | 566 | 457 | 368 | 246 | 175 | 130 | 100 | 64.9 |
| | | | | 4.0 | RHS | 14.8 | 688 | 686 | 664 | 631 | 585 | 523 | 447 | 368 | 300 | 203 | 144 | 108 | 83.1 | 53.9 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 864 | 828 | 714 | 517 | 335 | 224 | 159 | 118 | 91.1 | 59.0 | 41.3 | 30.5 | 23.5 | 15.1 |
| | | | | 5.0 | RHS | 14.2 | 735 | 706 | 614 | 452 | 296 | 199 | 141 | 105 | 81.0 | 52.5 | 36.7 | 27.2 | 20.9 | 13.5 |
| | | | | 4.0 | RHS | 11.6 | 526 | 509 | 454 | 356 | 245 | 167 | 119 | 88.9 | 68.7 | 44.6 | 31.2 | 23.1 | 17.8 | 11.5 |
| | | | | 3.0 | RHS | 8.96 | 329 | 322 | 295 | 248 | 185 | 131 | 94.5 | 70.8 | 54.9 | 35.7 | 25.0 | 18.5 | 14.3 | 9.20 |
| | | | | 2.5 | RHS | 7.53 | 246 | 241 | 223 | 193 | 151 | 110 | 80.0 | 60.3 | 46.8 | 30.5 | 21.4 | 15.8 | 12.2 | 7.88 |
| | | | | 2.0 | RHS | 6.07 | 173 | 171 | 160 | 142 | 116 | 87.2 | 64.8 | 49.1 | 38.3 | 25.0 | 17.5 | 13.0 | 10.0 | 6.47 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 757 | 726 | 627 | 456 | 296 | 198 | 140 | 104 | 80.6 | 52.2 | 36.5 | 27.0 | 20.8 | 13.4 |
| | | | | 5.0 | RHS | 12.5 | 646 | 621 | 540 | 400 | 262 | 176 | 125 | 93.0 | 71.9 | 46.6 | 32.6 | 24.1 | 18.5 | 12.0 |
| | | | | 3.5 | RHS | 9.07 | 423 | 410 | 365 | 287 | 197 | 135 | 96.0 | 71.6 | 55.3 | 35.9 | 25.1 | 18.6 | 14.3 | 9.23 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 864 | 850 | 797 | 709 | 579 | 438 | 326 | 247 | 193 | 126 | 88.3 | 65.4 | 50.4 | 32.6 |
| | | | | 5.0 | RHS | 14.2 | 735 | 723 | 680 | 608 | 501 | 382 | 285 | 217 | 169 | 110 | 77.5 | 57.5 | 44.3 | 28.6 |
| | | | | 4.0 | RHS | 11.6 | 600 | 591 | 556 | 500 | 415 | 319 | 239 | 182 | 142 | 92.8 | 65.3 | 48.4 | 37.3 | 24.1 |
| | | | | 3.0 | RHS | 8.96 | 390 | 386 | 367 | 337 | 293 | 237 | 184 | 142 | 112 | 73.4 | 51.7 | 38.3 | 29.6 | 19.1 |
| | | | | 2.5 | RHS | 7.53 | 296 | 294 | 281 | 261 | 231 | 192 | 152 | 119 | 94.2 | 62.2 | 43.9 | 32.6 | 25.1 | 16.3 |
| | | | | 2.0 | RHS | 6.07 | 196 | 194 | 187 | 177 | 161 | 141 | 116 | 93.7 | 75.2 | 50.3 | 35.6 | 26.5 | 20.4 | 13.2 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 757 | 744 | 697 | 617 | 500 | 375 | 278 | 211 | 164 | 107 | 75.2 | 55.7 | 42.9 | 27.7 |
| | | | | 5.0 | RHS | 12.5 | 646 | 635 | 596 | 531 | 434 | 329 | 245 | 186 | 145 | 94.4 | 66.4 | 49.2 | 37.9 | 24.5 |
| | | | | 3.5 | RHS | 9.07 | 468 | 461 | 434 | 389 | 322 | 247 | 185 | 141 | 110 | 71.7 | 50.4 | 37.4 | 28.8 | 18.6 |



**Notes:**

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.


AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
2500
2000
1000
800
600
400
200
100
80
60
40
30
0
1
2
3
4
5
6
7
8
9
10
Effective Length $L_e$ (m) about y-axis
150 x 100 x 9.0 HS
150 x 100 x 6.0 HS
150 x 100 x 5.0 HS
200 x 100 x 9.0 HS
150 x 100 x 10.0 HS
150 x 100 x 8.0 HS
200 x 100 x 10.0 HS
200 x 100 x 8.0 HS
200 x 100 x 6.0 HS
200 x 100 x 5.0 HS
200 x 100 x 4.0 HS
150 x 100 x 4.0 HS
152 x 76 x 6.0 HS
152 x 76 x 5.0 HS
egen
200x100
152x76
150x100
Axial compression buckling about y axis

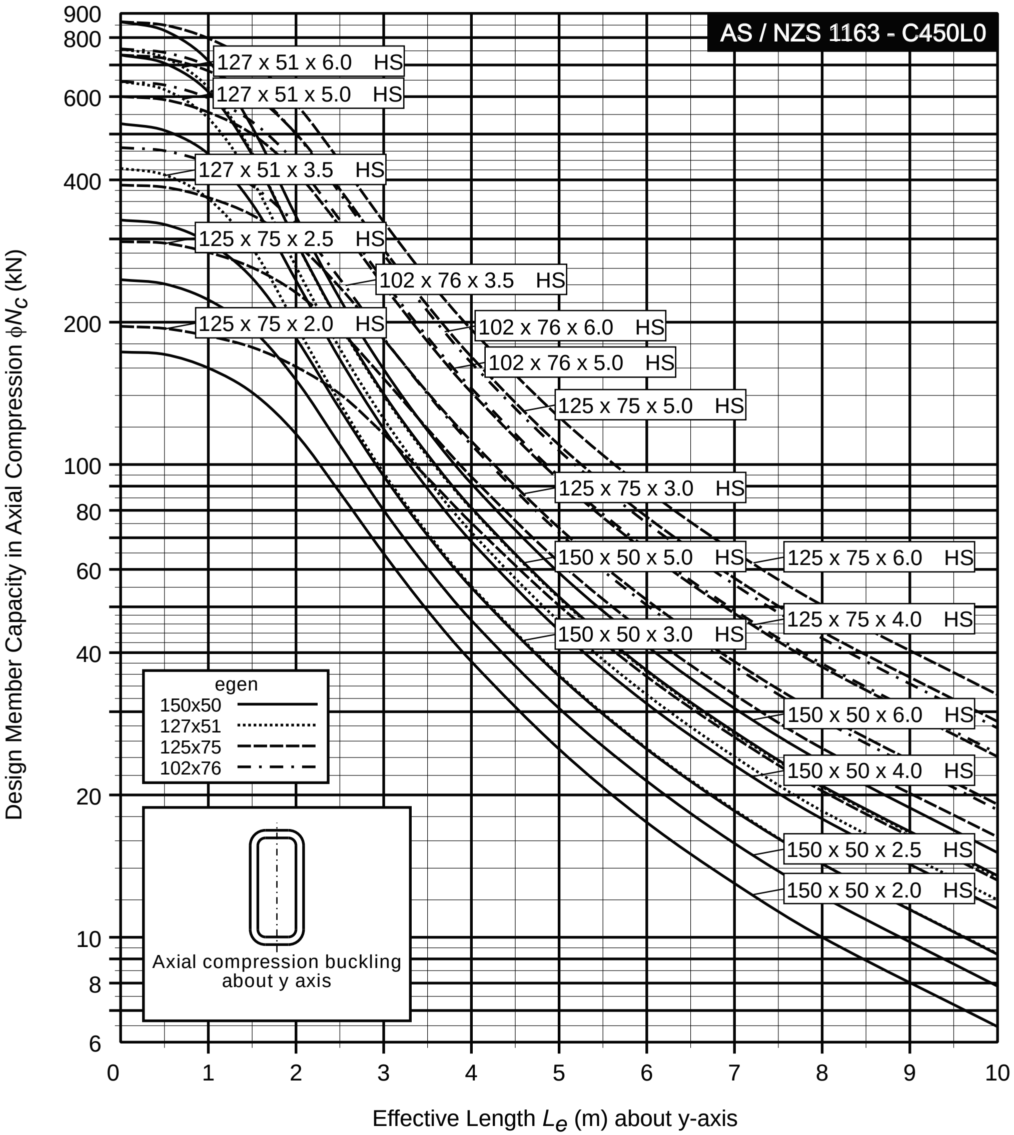

AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
900
800
600
400
200
100
80
60
40
20
10
8
6
0
1
2
3
4
5
6
7
8
9
10
Effective Length $L_e$ (m) about y-axis
127 x 51 x 6.0 HS
127 x 51 x 5.0 HS
127 x 51 x 3.5 HS
125 x 75 x 2.5 HS
102 x 76 x 3.5 HS
125 x 75 x 2.0 HS
102 x 76 x 6.0 HS
102 x 76 x 5.0 HS
125 x 75 x 5.0 HS
125 x 75 x 3.0 HS
150 x 50 x 5.0 HS
125 x 75 x 6.0 HS
125 x 75 x 4.0 HS
150 x 50 x 3.0 HS
150 x 50 x 6.0 HS
150 x 50 x 4.0 HS
150 x 50 x 2.5 HS
150 x 50 x 2.0 HS
egen
150x50
127x51
125x75
102x76
Axial compression buckling about y axis

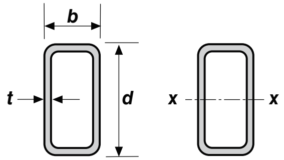
TABLE 6-4(3)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about x-axis*

| Designation<br>d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN)<br>Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 621 | 621 | 614 | 600 | 583 | 561 | 534 | 501 | 462 | 371 | 286 | 220 | 173 | 114 |
| | | | | 5.0 | RHS | 10.3 | 532 | 532 | 527 | 516 | 502 | 484 | 461 | 434 | 402 | 326 | 253 | 196 | 154 | 101 |
| | | | | 4.0 | RHS | 8.49 | 438 | 438 | 434 | 425 | 414 | 399 | 382 | 360 | 335 | 274 | 214 | 167 | 131 | 86.5 |
| | | | | 3.5 | RHS | 7.53 | 388 | 388 | 385 | 377 | 367 | 355 | 340 | 321 | 299 | 246 | 193 | 150 | 119 | 78.1 |
| | | | | 3.0 | RHS | 6.60 | 329 | 329 | 327 | 321 | 313 | 303 | 291 | 276 | 258 | 216 | 171 | 134 | 106 | 70.2 |
| | | | | 2.5 | RHS | 5.56 | 246 | 246 | 244 | 240 | 235 | 228 | 221 | 211 | 200 | 172 | 141 | 112 | 89.6 | 59.7 |
| | | | | 2.0 | RHS | 4.50 | 173 | 173 | 173 | 170 | 167 | 163 | 158 | 153 | 146 | 129 | 109 | 89.0 | 72.1 | 48.5 |
| | | | | 1.6 | RHS | 3.64 | 124 | 124 | 124 | 122 | 120 | 117 | 115 | 111 | 107 | 96.6 | 83.7 | 69.9 | 57.5 | 39.2 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 321 | 321 | 314 | 303 | 288 | 269 | 244 | 214 | 183 | 130 | 94.3 | 70.8 | 54.9 | 35.7 |
| | | | | 3.0 | RHS | 4.90 | 253 | 253 | 248 | 240 | 229 | 214 | 196 | 174 | 150 | 108 | 78.9 | 59.3 | 46.0 | 29.9 |
| | | | | 2.5 | RHS | 4.15 | 214 | 214 | 210 | 203 | 194 | 182 | 167 | 149 | 129 | 93.4 | 68.1 | 51.2 | 39.8 | 25.9 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 499 | 499 | 487 | 470 | 447 | 416 | 376 | 329 | 280 | 198 | 143 | 108 | 83.4 | 54.2 |
| | | | | 5.0 | RHS | 8.35 | 431 | 431 | 421 | 407 | 388 | 362 | 330 | 291 | 250 | 179 | 130 | 97.4 | 75.5 | 49.1 |
| | | | | 4.0 | RHS | 6.92 | 357 | 357 | 349 | 338 | 323 | 303 | 277 | 247 | 213 | 154 | 112 | 84.3 | 65.4 | 42.6 |
| | | | | 3.0 | RHS | 5.42 | 280 | 280 | 274 | 266 | 255 | 240 | 221 | 198 | 173 | 126 | 92.3 | 69.5 | 54.0 | 35.2 |
| | | | | 2.5 | RHS | 4.58 | 236 | 236 | 232 | 225 | 216 | 203 | 188 | 169 | 148 | 108 | 79.4 | 59.8 | 46.5 | 30.3 |
| | | | | 2.0 | RHS | 3.72 | 173 | 173 | 171 | 166 | 160 | 152 | 142 | 130 | 116 | 87.1 | 64.7 | 49.0 | 38.2 | 24.9 |
| | | | | 1.6 | RHS | 3.01 | 124 | 124 | 122 | 119 | 116 | 111 | 105 | 97.0 | 88.2 | 68.8 | 52.0 | 39.8 | 31.1 | 20.4 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 186 | 186 | 181 | 175 | 165 | 153 | 138 | 120 | 101 | 71.2 | 51.3 | 38.4 | 29.8 | 19.4 |
| | | | | 2.0 | RHS | 2.93 | 133 | 133 | 130 | 126 | 120 | 113 | 104 | 92.5 | 80.2 | 58.1 | 42.3 | 31.9 | 24.7 | 16.1 |
| | | | | 1.6 | RHS | 2.38 | 91.6 | 91.6 | 90.1 | 87.7 | 84.4 | 80.3 | 75.1 | 68.6 | 61.2 | 46.2 | 34.3 | 26.0 | 20.3 | 13.2 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 276 | 275 | 267 | 254 | 236 | 212 | 183 | 152 | 124 | 84.3 | 60.0 | 44.8 | 34.6 | 22.4 |
| | | | | 3.0 | RHS | 4.25 | 219 | 219 | 212 | 203 | 190 | 173 | 151 | 127 | 105 | 71.7 | 51.2 | 38.2 | 29.5 | 19.2 |
| | | | | 2.5 | RHS | 3.60 | 186 | 186 | 180 | 173 | 162 | 147 | 129 | 109 | 90.5 | 62.2 | 44.5 | 33.2 | 25.7 | 16.7 |
| | | | | 2.0 | RHS | 2.93 | 149 | 149 | 145 | 139 | 131 | 120 | 106 | 89.8 | 74.8 | 51.7 | 37.0 | 27.7 | 21.4 | 13.9 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 158 | 157 | 149 | 137 | 119 | 96.0 | 74.3 | 57.4 | 45.1 | 29.7 | 20.9 | 15.5 | 12.0 | 7.73 |
| | | | | 2.5 | RHS | 2.62 | 135 | 134 | 128 | 118 | 103 | 83.7 | 65.2 | 50.6 | 39.8 | 26.2 | 18.5 | 13.7 | 10.6 | 6.83 |
| | | | | 2.0 | RHS | 2.15 | 111 | 110 | 105 | 96.9 | 85.2 | 70.0 | 54.9 | 42.7 | 33.7 | 22.2 | 15.6 | 11.6 | 8.95 | 5.79 |
| | | | | 1.6 | RHS | 1.75 | 90.4 | 89.6 | 85.6 | 79.3 | 70.0 | 57.9 | 45.6 | 35.6 | 28.1 | 18.6 | 13.1 | 9.71 | 7.49 | 4.84 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 146 | 144 | 137 | 125 | 106 | 84.2 | 64.3 | 49.3 | 38.7 | 25.4 | 17.8 | 13.2 | 10.2 | 6.59 |
| | | | | 2.5 | RHS | 2.42 | 125 | 124 | 117 | 107 | 92.5 | 74.0 | 56.8 | 43.8 | 34.3 | 22.5 | 15.9 | 11.8 | 9.08 | 5.87 |
| | | | | 2.0 | RHS | 1.99 | 103 | 102 | 96.7 | 88.8 | 77.0 | 62.2 | 48.1 | 37.2 | 29.2 | 19.2 | 13.5 | 10.0 | 7.74 | 5.00 |
| | | | | 1.6 | RHS | 1.63 | 83.9 | 83.0 | 79.1 | 72.8 | 63.5 | 51.7 | 40.2 | 31.1 | 24.5 | 16.1 | 11.4 | 8.43 | 6.50 | 4.20 |



## Notes:

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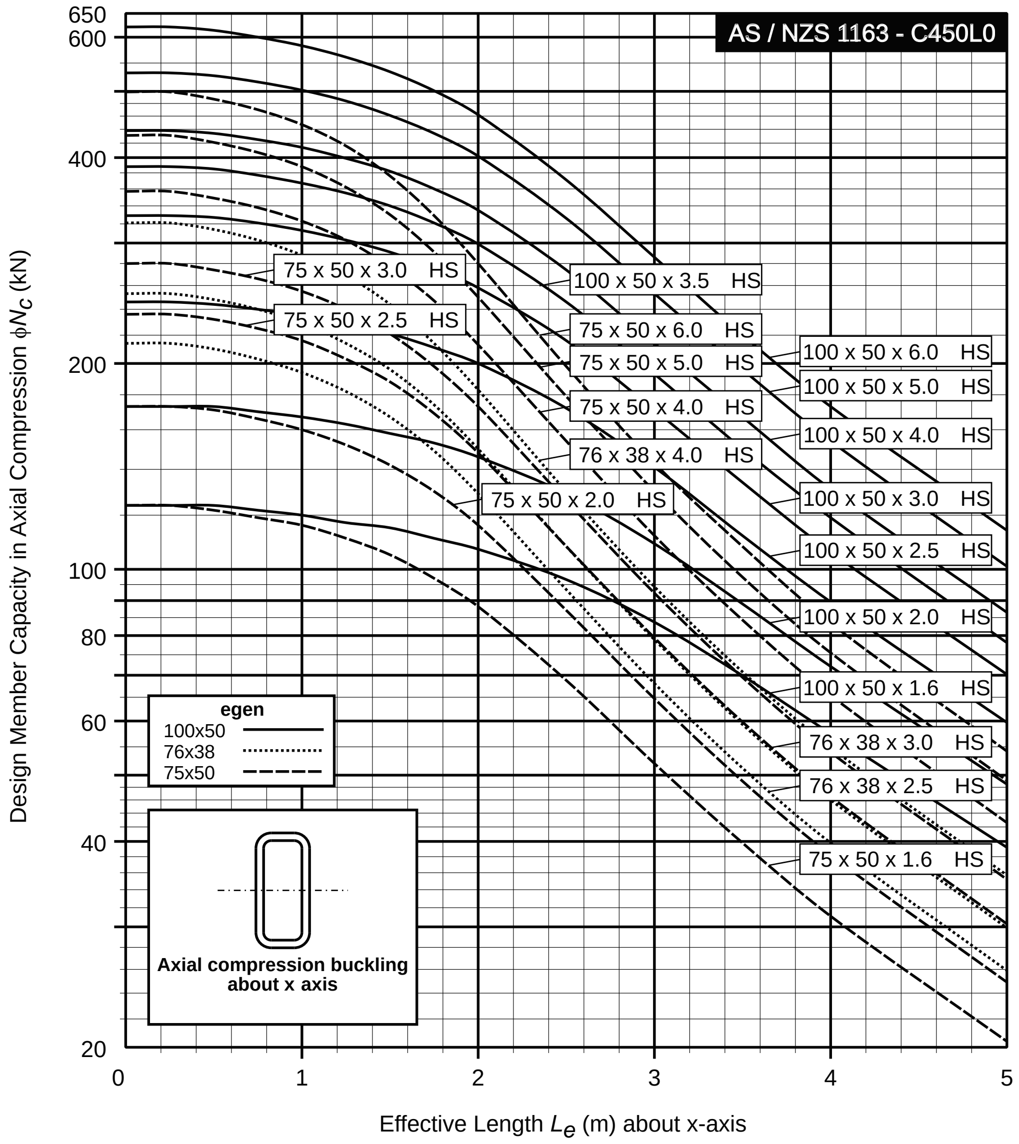
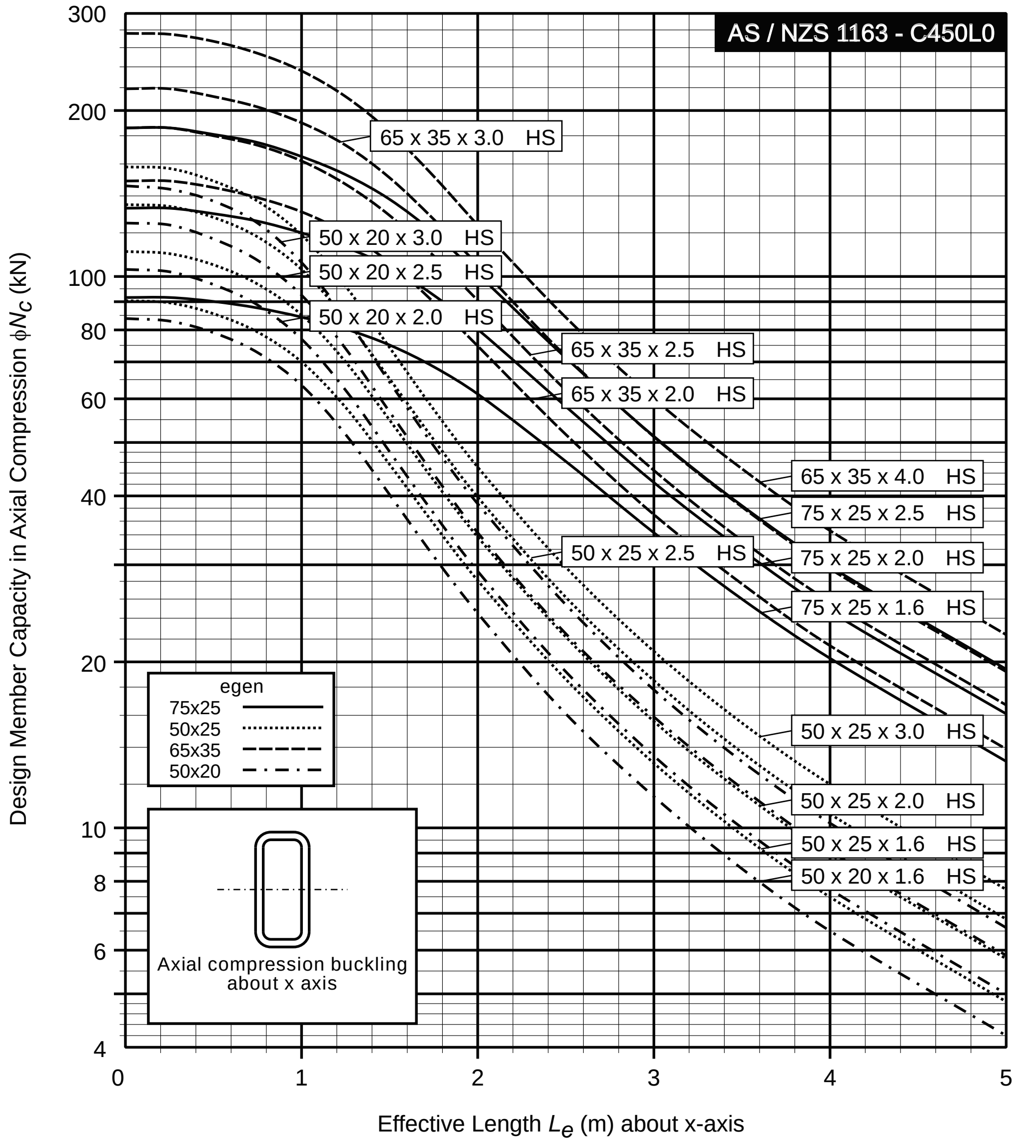
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e$ = 0.0.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**





Refer previous table for notes on steel grade.

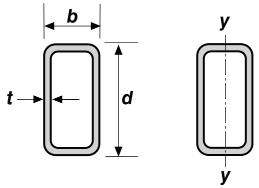
TABLE 6-4(3)(B)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about y-axis*

| Designation | | | | | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 621 | 617 | 593 | 556 | 503 | 432 | 352 | 280 | 223 | 149 | 105 | 78.1 | 60.3 | 39.0 |
| | | | | 5.0 | RHS | 10.3 | 532 | 529 | 510 | 480 | 437 | 378 | 311 | 250 | 200 | 133 | 94.5 | 70.2 | 54.2 | 35.1 |
| | | | | 4.0 | RHS | 8.49 | 438 | 436 | 420 | 397 | 363 | 317 | 264 | 213 | 171 | 115 | 81.3 | 60.5 | 46.7 | 30.2 |
| | | | | 3.5 | RHS | 7.53 | 388 | 387 | 373 | 353 | 324 | 284 | 237 | 192 | 155 | 104 | 73.8 | 54.9 | 42.4 | 27.4 |
| | | | | 3.0 | RHS | 6.60 | 329 | 328 | 317 | 301 | 278 | 247 | 209 | 171 | 138 | 93.3 | 66.3 | 49.3 | 38.1 | 24.7 |
| | | | | 2.5 | RHS | 5.56 | 246 | 245 | 238 | 227 | 213 | 193 | 168 | 141 | 116 | 79.3 | 56.6 | 42.2 | 32.7 | 21.2 |
| | | | | 2.0 | RHS | 4.50 | 173 | 173 | 169 | 162 | 154 | 142 | 127 | 109 | 92.1 | 64.4 | 46.3 | 34.7 | 26.9 | 17.4 |
| | | | | 1.6 | RHS | 3.64 | 124 | 124 | 121 | 117 | 112 | 104 | 95.2 | 84.1 | 72.4 | 51.8 | 37.6 | 28.3 | 21.9 | 14.3 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 321 | 316 | 297 | 264 | 217 | 164 | 122 | 92.7 | 72.3 | 47.2 | 33.2 | 24.6 | 18.9 | 12.2 |
| | | | | 3.0 | RHS | 4.90 | 253 | 249 | 235 | 211 | 176 | 136 | 102 | 77.8 | 60.8 | 39.7 | 27.9 | 20.7 | 16.0 | 10.3 |
| | | | | 2.5 | RHS | 4.15 | 214 | 211 | 199 | 180 | 151 | 117 | 88.5 | 67.6 | 52.8 | 34.6 | 24.3 | 18.0 | 13.9 | 8.98 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 499 | 495 | 475 | 443 | 396 | 334 | 268 | 211 | 167 | 111 | 78.3 | 58.2 | 44.9 | 29.0 |
| | | | | 5.0 | RHS | 8.35 | 431 | 428 | 411 | 385 | 347 | 296 | 240 | 190 | 152 | 101 | 71.2 | 52.9 | 40.8 | 26.4 |
| | | | | 4.0 | RHS | 6.92 | 357 | 355 | 341 | 321 | 291 | 251 | 206 | 164 | 131 | 87.5 | 62.0 | 46.0 | 35.5 | 23.0 |
| | | | | 3.0 | RHS | 5.42 | 280 | 278 | 268 | 253 | 231 | 202 | 167 | 135 | 108 | 72.3 | 51.3 | 38.1 | 29.4 | 19.1 |
| | | | | 2.5 | RHS | 4.58 | 236 | 235 | 227 | 214 | 196 | 172 | 143 | 116 | 93.2 | 62.4 | 44.3 | 32.9 | 25.4 | 16.5 |
| | | | | 2.0 | RHS | 3.72 | 173 | 173 | 167 | 159 | 148 | 132 | 113 | 93.0 | 75.8 | 51.3 | 36.5 | 27.2 | 21.0 | 13.6 |
| | | | | 1.6 | RHS | 3.01 | 124 | 124 | 120 | 115 | 108 | 98.5 | 86.4 | 73.1 | 60.6 | 41.7 | 29.8 | 22.3 | 17.2 | 11.2 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 186 | 179 | 155 | 115 | 75.2 | 50.5 | 35.8 | 26.7 | 20.6 | 13.3 | 9.35 | 6.91 | 5.32 | 3.43 |
| | | | | 2.0 | RHS | 2.93 | 133 | 129 | 115 | 90.0 | 62.0 | 42.3 | 30.2 | 22.5 | 17.4 | 11.3 | 7.91 | 5.85 | 4.50 | 2.90 |
| | | | | 1.6 | RHS | 2.38 | 91.6 | 89.2 | 81.3 | 67.5 | 49.5 | 34.7 | 25.0 | 18.7 | 14.5 | 9.42 | 6.60 | 4.89 | 3.76 | 2.43 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 276 | 270 | 250 | 215 | 166 | 120 | 87.5 | 65.8 | 51.1 | 33.2 | 23.3 | 17.3 | 13.3 | 8.59 |
| | | | | 3.0 | RHS | 4.25 | 219 | 215 | 200 | 175 | 138 | 102 | 74.5 | 56.2 | 43.7 | 28.5 | 20.0 | 14.8 | 11.4 | 7.37 |
| | | | | 2.5 | RHS | 3.60 | 186 | 183 | 170 | 149 | 119 | 88.3 | 65.0 | 49.1 | 38.2 | 24.9 | 17.5 | 13.0 | 9.98 | 6.45 |
| | | | | 2.0 | RHS | 2.93 | 149 | 147 | 137 | 121 | 98.1 | 73.4 | 54.4 | 41.2 | 32.0 | 20.9 | 14.7 | 10.9 | 8.38 | 5.41 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 158 | 151 | 129 | 90.5 | 57.7 | 38.4 | 27.2 | 20.2 | 15.6 | 10.1 | 7.06 | 5.22 | 4.01 | 2.59 |
| | | | | 2.5 | RHS | 2.62 | 135 | 130 | 111 | 79.6 | 51.2 | 34.2 | 24.2 | 18.0 | 13.9 | 9.01 | 6.31 | 4.66 | 3.59 | 2.31 |
| | | | | 2.0 | RHS | 2.15 | 111 | 106 | 92.0 | 67.1 | 43.6 | 29.2 | 20.7 | 15.4 | 11.9 | 7.71 | 5.40 | 3.99 | 3.07 | 1.98 |
| | | | | 1.6 | RHS | 1.75 | 90.4 | 86.9 | 75.6 | 55.9 | 36.7 | 24.6 | 17.5 | 13.0 | 10.0 | 6.50 | 4.55 | 3.37 | 2.59 | 1.67 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 146 | 136 | 101 | 58.5 | 34.8 | 22.7 | 16.0 | 11.8 | 9.13 | 5.90 | 4.12 | 3.04 | 2.34 | 1.51 |
| | | | | 2.5 | RHS | 2.42 | 125 | 117 | 88.9 | 52.5 | 31.4 | 20.5 | 14.4 | 10.7 | 8.25 | 5.33 | 3.73 | 2.75 | 2.12 | 1.36 |
| | | | | 2.0 | RHS | 1.99 | 103 | 96.2 | 74.7 | 45.1 | 27.1 | 17.8 | 12.5 | 9.28 | 7.15 | 4.62 | 3.23 | 2.39 | 1.84 | 1.18 |
| | | | | 1.6 | RHS | 1.63 | 83.9 | 78.8 | 62.0 | 38.1 | 23.1 | 15.1 | 10.7 | 7.90 | 6.09 | 3.94 | 2.75 | 2.03 | 1.56 | 1.01 |



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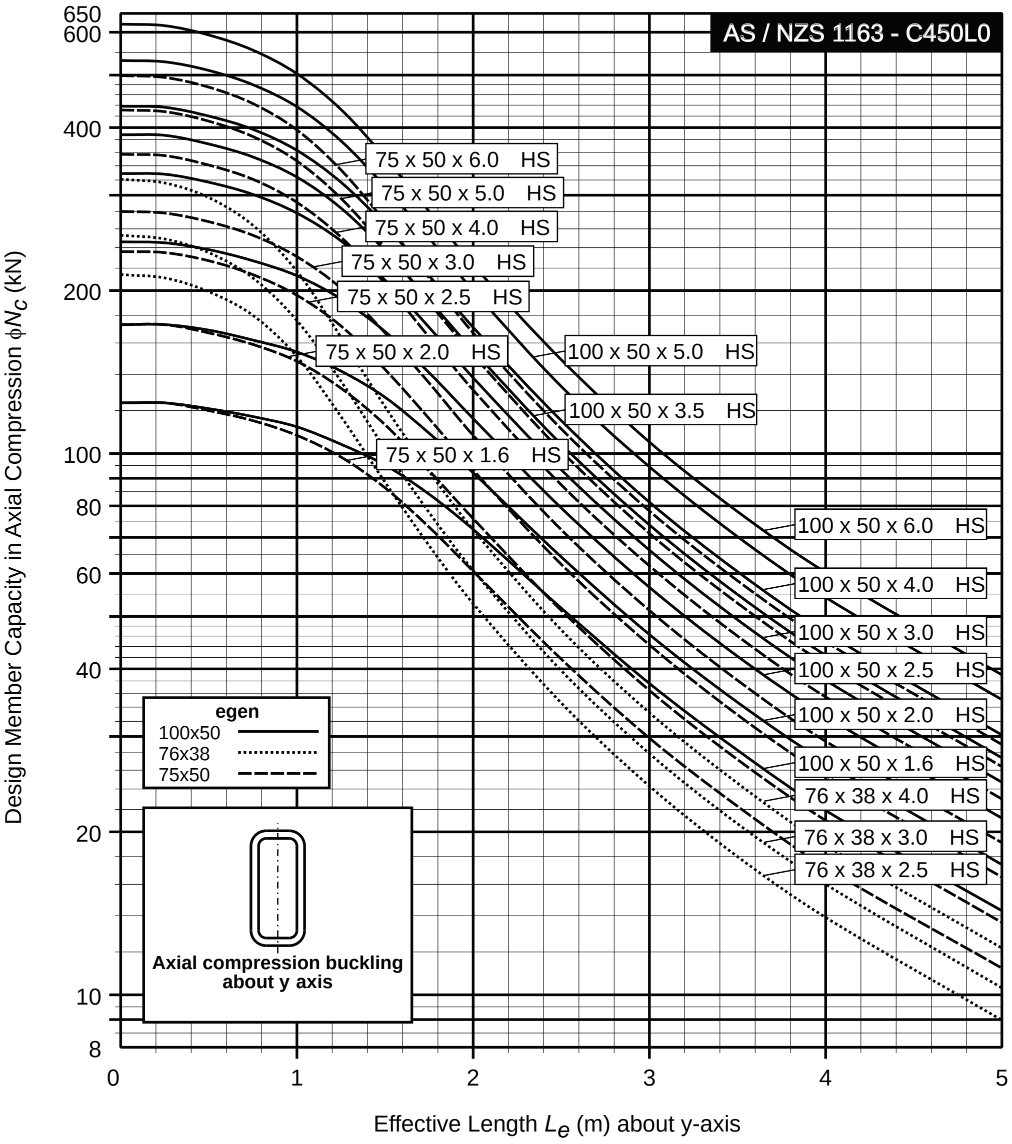
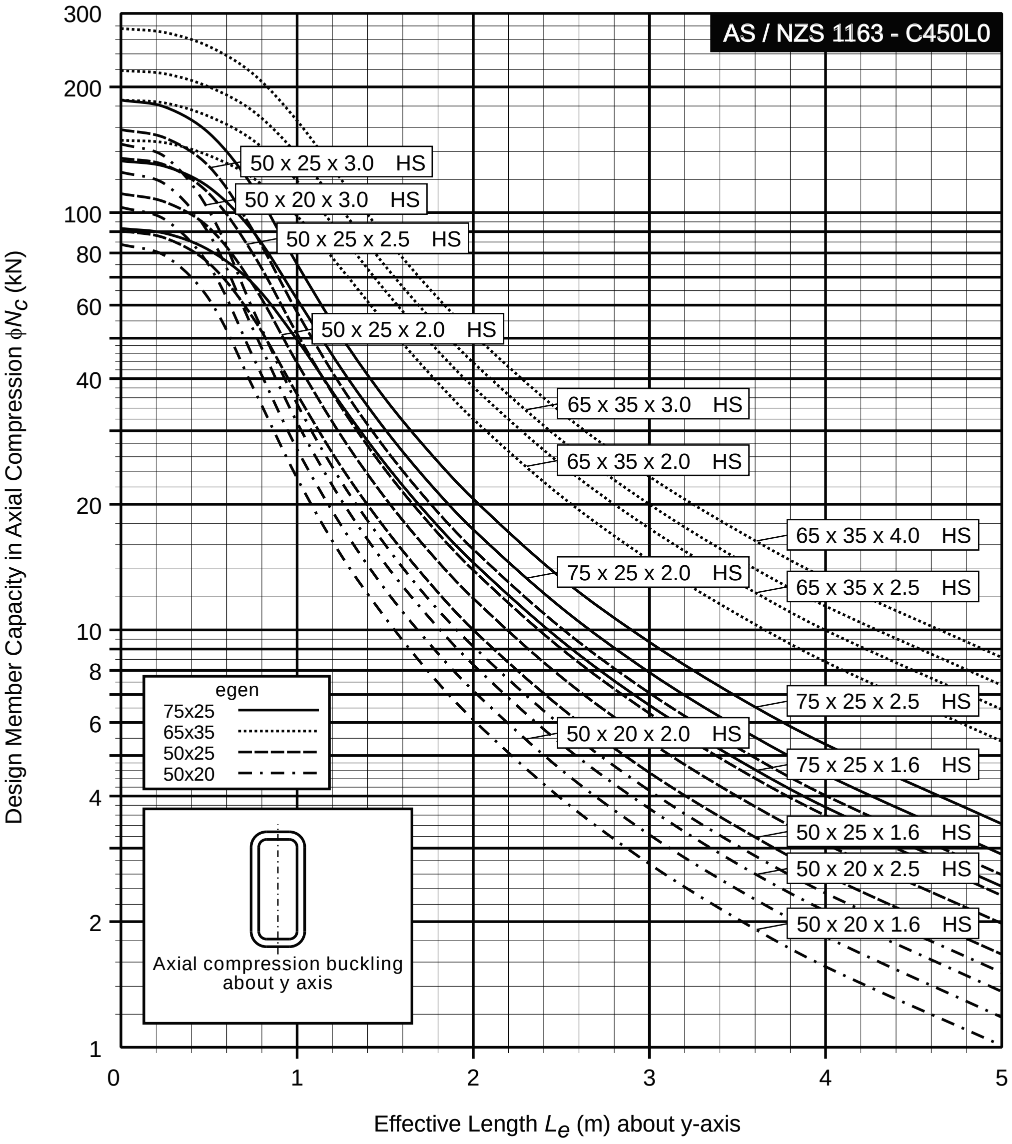
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**





Refer previous table for notes on steel grade.

TABLE 6-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### *buckling about x- and y-axis*

| Designation | | | | | | Mass | $\phi N_s$ | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | per m | (kN) | Effective Length ($L_e$) in metres | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 294 | 292 | 281 | 264 | 240 | 207 | 169 | 135 | 108 | 72.0 | 50.9 | 37.9 | 29.2 | 18.9 |
| | | | | 5.0 | SHS | 6.39 | 256 | 255 | 246 | 232 | 212 | 186 | 154 | 124 | 100 | 66.9 | 47.4 | 35.3 | 27.2 | 17.6 |
| | | | | 4.0 | SHS | 5.35 | 215 | 214 | 206 | 196 | 180 | 159 | 134 | 109 | 88.1 | 59.3 | 42.1 | 31.3 | 24.2 | 15.7 |
| | | | | 3.0 | SHS | 4.25 | 170 | 170 | 164 | 156 | 145 | 129 | 110 | 91.0 | 74.1 | 50.2 | 35.7 | 26.6 | 20.5 | 13.3 |
| | | | | 2.5 | SHS | 3.60 | 145 | 144 | 140 | 133 | 124 | 111 | 95.0 | 78.7 | 64.2 | 43.6 | 31.0 | 23.1 | 17.9 | 11.6 |
| | | | | 2.0 | SHS | 2.93 | 118 | 117 | 114 | 108 | 101 | 90.9 | 78.4 | 65.2 | 53.4 | 36.3 | 25.9 | 19.3 | 14.9 | 9.66 |
| | | | | 1.6 | SHS | 2.38 | 95.5 | 95.3 | 92.4 | 88.2 | 82.2 | 74.2 | 64.2 | 53.6 | 44.0 | 30.0 | 21.4 | 15.9 | 12.3 | 7.99 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 164 | 162 | 153 | 140 | 119 | 93.6 | 71.3 | 54.7 | 42.8 | 28.1 | 19.7 | 14.6 | 11.3 | 7.29 |
| | | | | 3.0 | SHS | 3.30 | 133 | 131 | 125 | 115 | 99.4 | 80.2 | 62.0 | 47.9 | 37.7 | 24.8 | 17.4 | 12.9 | 9.97 | 6.45 |
| | | | | 2.5 | SHS | 2.82 | 113 | 112 | 107 | 98.2 | 85.7 | 69.8 | 54.3 | 42.1 | 33.1 | 21.8 | 15.4 | 11.4 | 8.78 | 5.68 |
| | | | | 2.0 | SHS | 2.31 | 92.5 | 91.6 | 87.4 | 80.7 | 70.9 | 58.1 | 45.5 | 35.4 | 27.9 | 18.4 | 13.0 | 9.61 | 7.41 | 4.79 |
| | | | | 1.6 | SHS | 1.88 | 75.3 | 74.6 | 71.3 | 66.0 | 58.2 | 48.0 | 37.8 | 29.4 | 23.2 | 15.3 | 10.8 | 8.02 | 6.19 | 4.00 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 114 | 112 | 105 | 92.5 | 74.9 | 56.1 | 41.5 | 31.5 | 24.5 | 16.0 | 11.2 | 8.32 | 6.41 | 4.14 |
| | | | | 2.5 | SHS | 2.42 | 97.3 | 95.7 | 89.8 | 79.9 | 65.4 | 49.4 | 36.8 | 27.9 | 21.7 | 14.2 | 9.97 | 7.39 | 5.69 | 3.68 |
| | | | | 2.0 | SHS | 1.99 | 79.9 | 78.7 | 74.0 | 66.2 | 54.7 | 41.7 | 31.2 | 23.7 | 18.5 | 12.1 | 8.49 | 6.29 | 4.85 | 3.13 |
| | | | | 1.6 | SHS | 1.63 | 65.3 | 64.3 | 60.6 | 54.4 | 45.2 | 34.8 | 26.1 | 19.9 | 15.5 | 10.1 | 7.13 | 5.28 | 4.07 | 2.63 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 94.8 | 92.3 | 83.9 | 69.2 | 50.3 | 35.2 | 25.3 | 18.9 | 14.7 | 9.52 | 6.68 | 4.94 | 3.80 | 2.45 |
| | | | | 2.5 | SHS | 2.03 | 81.6 | 79.5 | 72.7 | 60.6 | 44.7 | 31.5 | 22.7 | 17.0 | 13.2 | 8.56 | 6.01 | 4.44 | 3.42 | 2.21 |
| | | | | 2.0 | SHS | 1.68 | 67.3 | 65.7 | 60.3 | 50.8 | 38.0 | 27.0 | 19.5 | 14.6 | 11.3 | 7.38 | 5.17 | 3.83 | 2.95 | 1.90 |
| | | | | 1.6 | SHS | 1.38 | 55.2 | 53.9 | 49.6 | 42.2 | 31.9 | 22.8 | 16.5 | 12.4 | 9.61 | 6.25 | 4.38 | 3.25 | 2.50 | 1.61 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 75.9 | 72.7 | 62.4 | 44.7 | 28.8 | 19.2 | 13.6 | 10.1 | 7.81 | 5.06 | 3.54 | 2.62 | 2.01 | 1.30 |
| | | | | 2.5 | SHS | 1.64 | 65.8 | 63.2 | 54.8 | 40.2 | 26.2 | 17.6 | 12.5 | 9.27 | 7.16 | 4.64 | 3.25 | 2.40 | 1.85 | 1.19 |
| | | | | 2.0 | SHS | 1.36 | 54.7 | 52.7 | 46.1 | 34.5 | 22.8 | 15.4 | 10.9 | 8.12 | 6.27 | 4.06 | 2.85 | 2.10 | 1.62 | 1.04 |
| | | | | 1.6 | SHS | 1.12 | 45.1 | 43.5 | 38.3 | 29.1 | 19.5 | 13.2 | 9.36 | 6.97 | 5.38 | 3.49 | 2.44 | 1.81 | 1.39 | 0.897 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 42.1 | 39.5 | 30.8 | 18.7 | 11.2 | 7.38 | 5.19 | 3.85 | 2.97 | 1.92 | 1.34 | 0.991 | 0.762 | 0.490 |
| | | | | 1.6 | SHS | 0.873 | 35.0 | 32.9 | 26.1 | 16.2 | 9.83 | 6.46 | 4.55 | 3.37 | 2.60 | 1.68 | 1.18 | 0.869 | 0.668 | 0.430 |

**ADDITIONAL NOTES:**

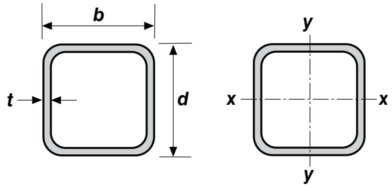
**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

1 SHS

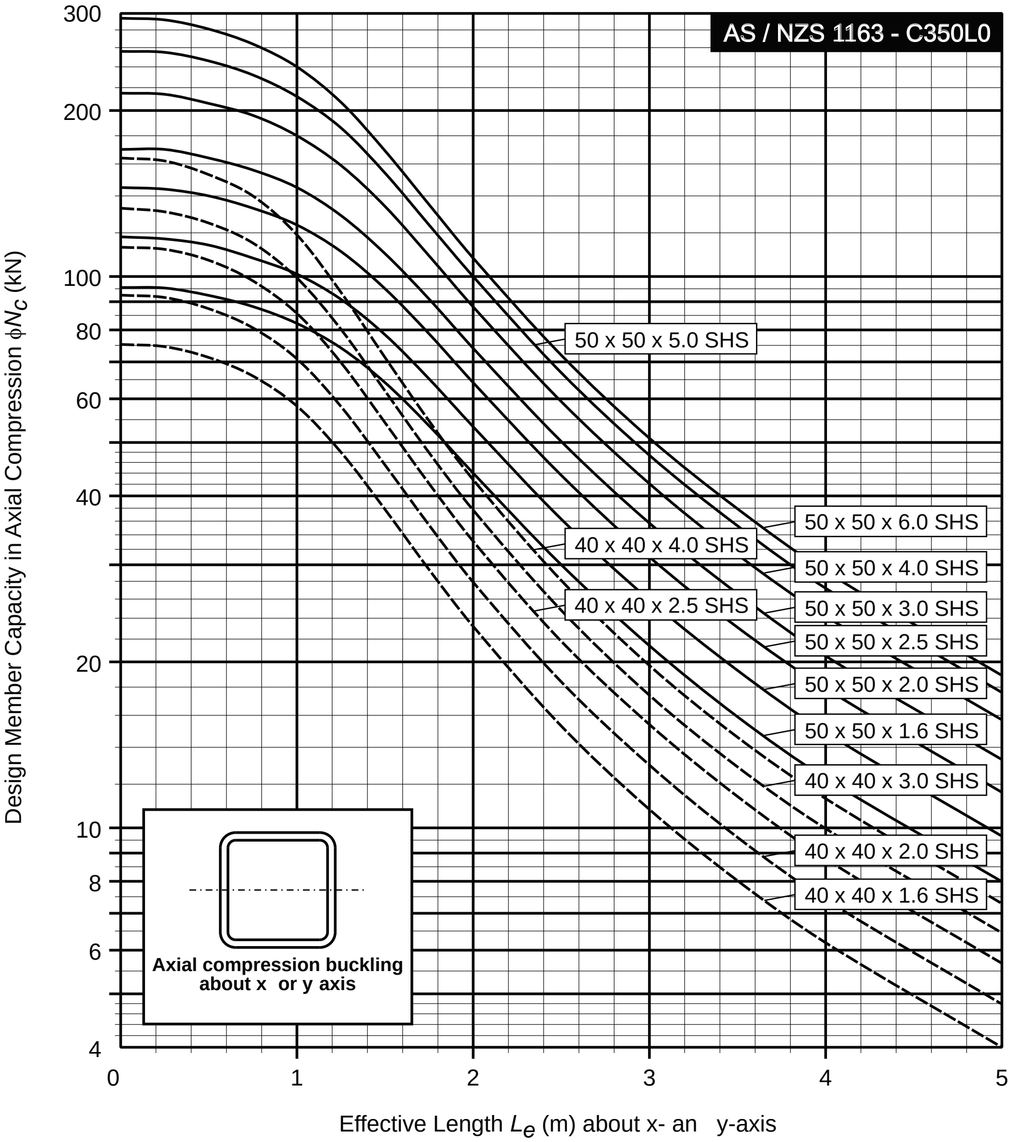
2 C350L0

3 Finish



**Notes:**

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi N_s = \phi N_c$ for $L_e$ = 0.0.


AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression φNc (kN)
300
200
100
80
60
40
20
10
8
6
4
0
1
2
3
4
5
Effective Length Le (m) about x- an   y-axis
50 x 50 x 5.0 SHS
50 x 50 x 6.0 SHS
40 x 40 x 4.0 SHS
50 x 50 x 4.0 SHS
40 x 40 x 2.5 SHS
50 x 50 x 3.0 SHS
50 x 50 x 2.5 SHS
50 x 50 x 2.0 SHS
50 x 50 x 1.6 SHS
40 x 40 x 3.0 SHS
40 x 40 x 2.0 SHS
40 x 40 x 1.6 SHS
Axial compression buckling
about x  or y axis

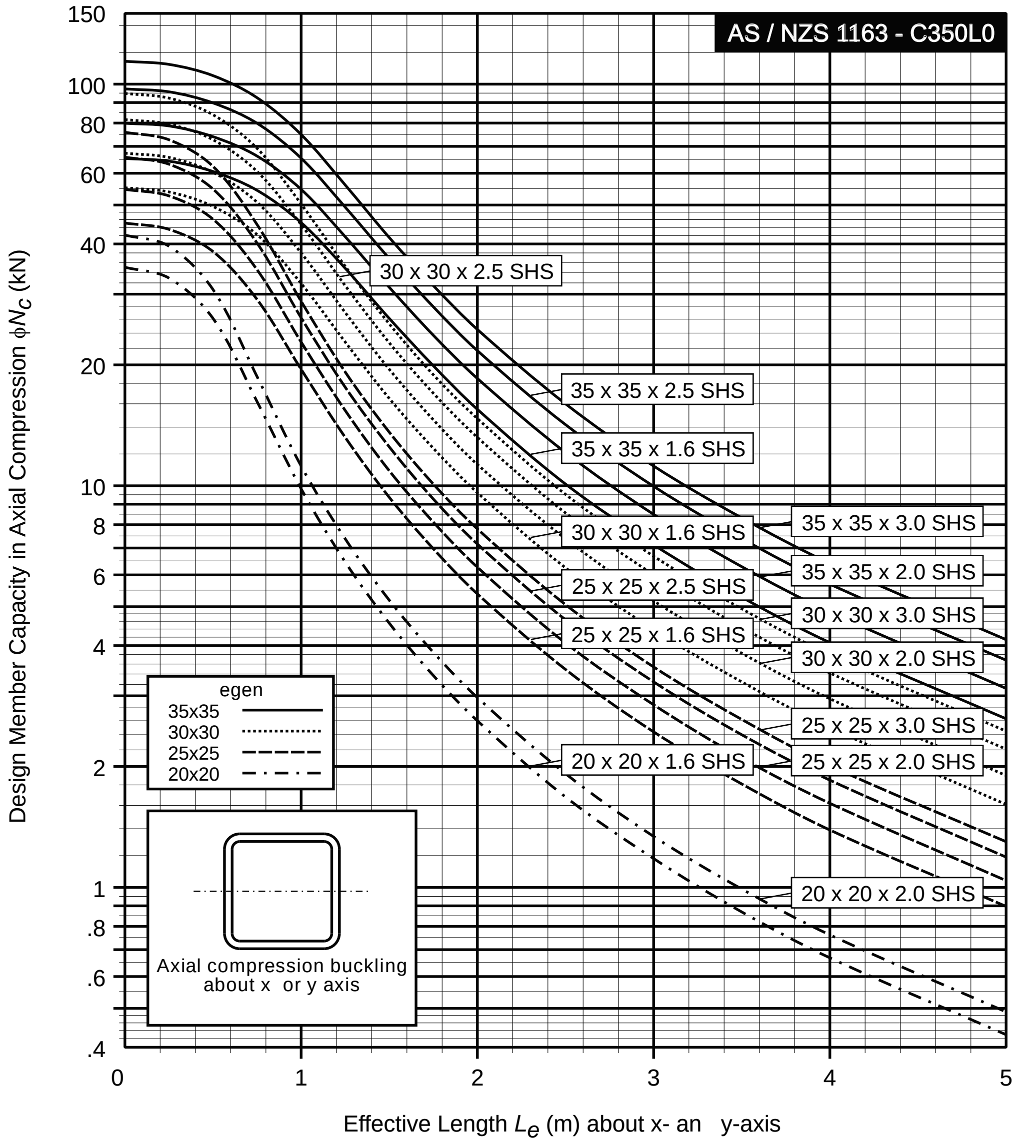

AS / NZS 1163 - C350L0
Design Member Capacity in Axial Compression φNc (kN)
150
100
80
60
40
20
10
8
6
4
2
1
.8
.6
.4
0
1
2
3
4
5
Effective Length Le (m) about x- an   y-axis
30 x 30 x 2.5 SHS
35 x 35 x 2.5 SHS
35 x 35 x 1.6 SHS
30 x 30 x 1.6 SHS
35 x 35 x 3.0 SHS
25 x 25 x 2.5 SHS
35 x 35 x 2.0 SHS
30 x 30 x 3.0 SHS
25 x 25 x 1.6 SHS
30 x 30 x 2.0 SHS
25 x 25 x 3.0 SHS
20 x 20 x 1.6 SHS
25 x 25 x 2.0 SHS
20 x 20 x 2.0 SHS
egen
35x35
30x30
25x25
20x20
Axial compression buckling
about x  or y axis

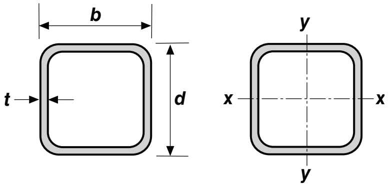
TABLE 6-6(1)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

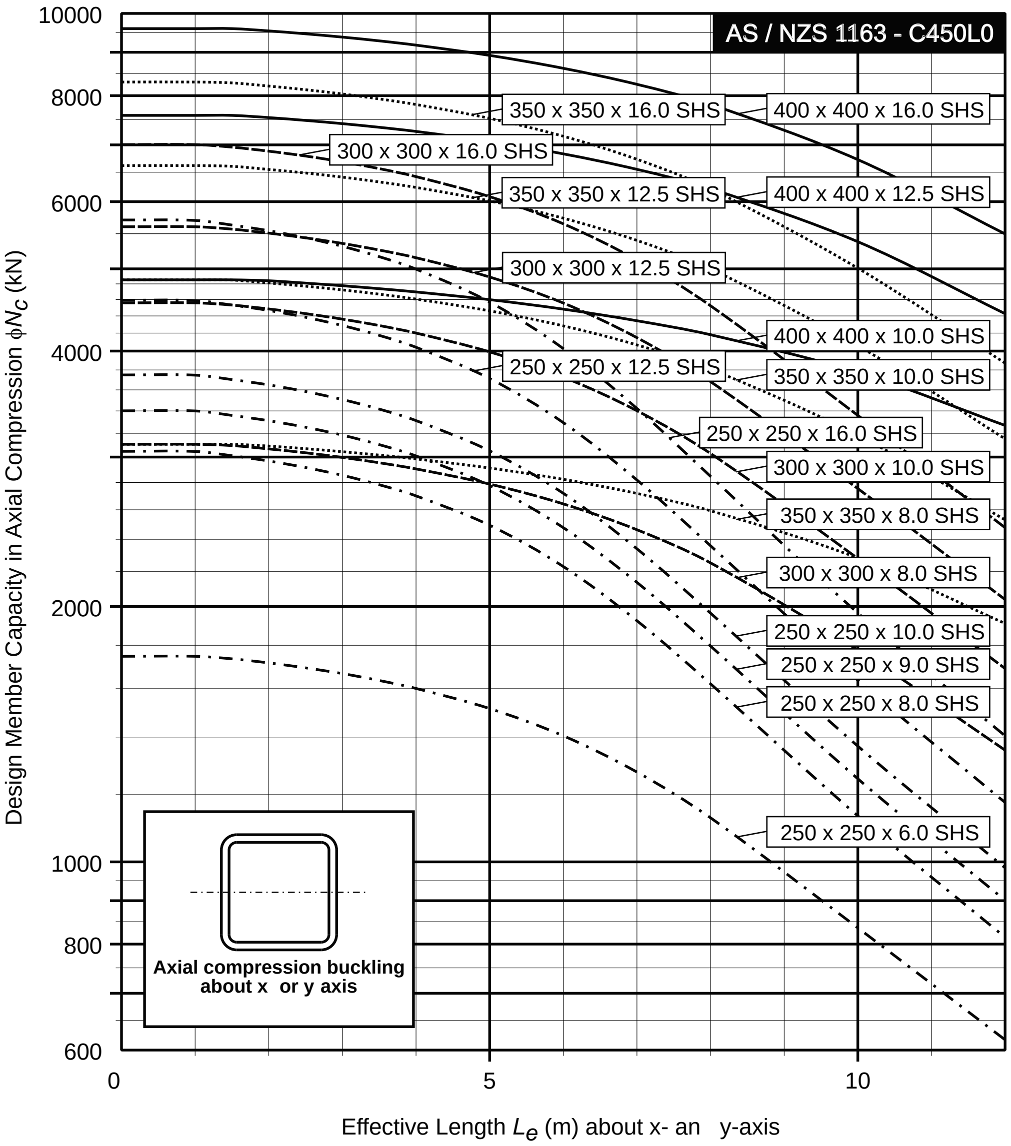
### *buckling about x- and y-axis*

| Designation | | | | | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN)<br>Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | $L_e$ = 0.0 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 10.0 | 12.0 |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 9600 | 9600 | 9600 | 9540 | 9460 | 9380 | 9280 | 9180 | 8920 | 8620 | 8250 | 7810 | 6720 | 5500 |
| | | | | 12.5 | SHS | 148 | 7580 | 7580 | 7580 | 7540 | 7480 | 7420 | 7340 | 7260 | 7070 | 6830 | 6550 | 6220 | 5380 | 4430 |
| | | | | 10.0 | SHS | 120 | 4850 | 4850 | 4850 | 4840 | 4810 | 4780 | 4740 | 4700 | 4600 | 4480 | 4340 | 4180 | 3780 | 3270 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 8300 | 8300 | 8280 | 8210 | 8130 | 8040 | 7930 | 7810 | 7520 | 7170 | 6730 | 6210 | 5010 | 3870 |
| | | | | 12.5 | SHS | 128 | 6620 | 6620 | 6600 | 6550 | 6480 | 6410 | 6330 | 6240 | 6010 | 5740 | 5400 | 5000 | 4060 | 3150 |
| | | | | 10.0 | SHS | 104 | 4850 | 4850 | 4850 | 4810 | 4770 | 4720 | 4670 | 4610 | 4460 | 4280 | 4070 | 3810 | 3180 | 2530 |
| | | | | 8.0 | SHS | 84.2 | 3110 | 3110 | 3110 | 3090 | 3070 | 3040 | 3020 | 2990 | 2910 | 2820 | 2720 | 2590 | 2280 | 1910 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 7010 | 7010 | 6960 | 6880 | 6790 | 6690 | 6560 | 6420 | 6080 | 5650 | 5120 | 4520 | 3360 | 2480 |
| | | | | 12.5 | SHS | 109 | 5600 | 5600 | 5570 | 5510 | 5440 | 5360 | 5260 | 5150 | 4890 | 4560 | 4150 | 3680 | 2750 | 2040 |
| | | | | 10.0 | SHS | 88.4 | 4560 | 4560 | 4530 | 4480 | 4430 | 4360 | 4290 | 4200 | 3990 | 3730 | 3400 | 3030 | 2280 | 1690 |
| | | | | 8.0 | SHS | 71.6 | 3110 | 3110 | 3100 | 3070 | 3030 | 3000 | 2950 | 2910 | 2790 | 2640 | 2460 | 2250 | 1780 | 1350 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 5710 | 5700 | 5630 | 5540 | 5440 | 5310 | 5170 | 5000 | 4570 | 4030 | 3420 | 2850 | 1970 | 1410 |
| | | | | 12.5 | SHS | 89.0 | 4590 | 4590 | 4530 | 4470 | 4380 | 4290 | 4170 | 4040 | 3710 | 3290 | 2820 | 2360 | 1640 | 1170 |
| | | | | 10.0 | SHS | 72.7 | 3750 | 3750 | 3700 | 3650 | 3580 | 3510 | 3420 | 3310 | 3050 | 2720 | 2340 | 1960 | 1370 | 984 |
| | | | | 9.0 | SHS | 65.9 | 3400 | 3400 | 3360 | 3310 | 3250 | 3180 | 3100 | 3010 | 2780 | 2480 | 2130 | 1800 | 1250 | 901 |
| | | | | 8.0 | SHS | 59.1 | 3050 | 3050 | 3010 | 2970 | 2920 | 2860 | 2780 | 2700 | 2490 | 2230 | 1920 | 1620 | 1130 | 815 |
| | | | | 6.0 | SHS | 45.0 | 1750 | 1750 | 1740 | 1720 | 1690 | 1670 | 1640 | 1600 | 1520 | 1410 | 1280 | 1130 | 836 | 617 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 4410 | 4380 | 4300 | 4190 | 4070 | 3910 | 3720 | 3490 | 2930 | 2340 | 1840 | 1460 | 964 | 681 |
| | | | | 12.5 | SHS | 69.4 | 3580 | 3550 | 3490 | 3410 | 3310 | 3190 | 3040 | 2870 | 2440 | 1970 | 1560 | 1240 | 821 | 580 |
| | | | | 10.0 | SHS | 57.0 | 2940 | 2920 | 2870 | 2810 | 2730 | 2630 | 2510 | 2380 | 2030 | 1650 | 1310 | 1050 | 696 | 492 |
| | | | | 9.0 | SHS | 51.8 | 2670 | 2650 | 2610 | 2550 | 2480 | 2400 | 2290 | 2170 | 1860 | 1520 | 1210 | 964 | 641 | 454 |
| | | | | 8.0 | SHS | 46.5 | 2400 | 2380 | 2340 | 2290 | 2230 | 2150 | 2060 | 1950 | 1680 | 1370 | 1100 | 876 | 583 | 413 |
| | | | | 6.0 | SHS | 35.6 | 1750 | 1740 | 1710 | 1680 | 1630 | 1580 | 1520 | 1450 | 1260 | 1050 | 847 | 681 | 456 | 323 |
| | | | | 5.0 | SHS | 29.9 | 1210 | 1210 | 1190 | 1170 | 1150 | 1120 | 1090 | 1050 | 944 | 817 | 682 | 561 | 382 | 273 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 2130 | 2090 | 2030 | 1940 | 1840 | 1700 | 1530 | 1350 | 991 | 728 | 549 | 427 | 278 | 195 |
| | | | | 9.0 | SHS | 37.7 | 1940 | 1910 | 1850 | 1780 | 1680 | 1560 | 1410 | 1240 | 918 | 676 | 510 | 397 | 259 | 182 |
| | | | | 8.0 | SHS | 33.9 | 1750 | 1720 | 1670 | 1610 | 1520 | 1410 | 1280 | 1130 | 840 | 619 | 468 | 364 | 237 | 167 |
| | | | | 6.0 | SHS | 26.2 | 1350 | 1330 | 1290 | 1240 | 1180 | 1100 | 1000 | 888 | 665 | 493 | 373 | 291 | 190 | 133 |
| | | | | 5.0 | SHS | 22.1 | 1140 | 1120 | 1090 | 1050 | 998 | 932 | 850 | 757 | 570 | 423 | 320 | 249 | 163 | 114 |



## Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e$ = 0.0.


AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression φNc (kN)
10000
8000
6000
4000
2000
1000
800
600
350 x 350 x 16.0 SHS
400 x 400 x 16.0 SHS
300 x 300 x 16.0 SHS
350 x 350 x 12.5 SHS
400 x 400 x 12.5 SHS
300 x 300 x 12.5 SHS
400 x 400 x 10.0 SHS
250 x 250 x 12.5 SHS
350 x 350 x 10.0 SHS
250 x 250 x 16.0 SHS
300 x 300 x 10.0 SHS
350 x 350 x 8.0 SHS
300 x 300 x 8.0 SHS
250 x 250 x 10.0 SHS
250 x 250 x 9.0 SHS
250 x 250 x 8.0 SHS
250 x 250 x 6.0 SHS
Axial compression buckling
about x or y axis
0
5
10
Effective Length Le (m) about x- an y-axis

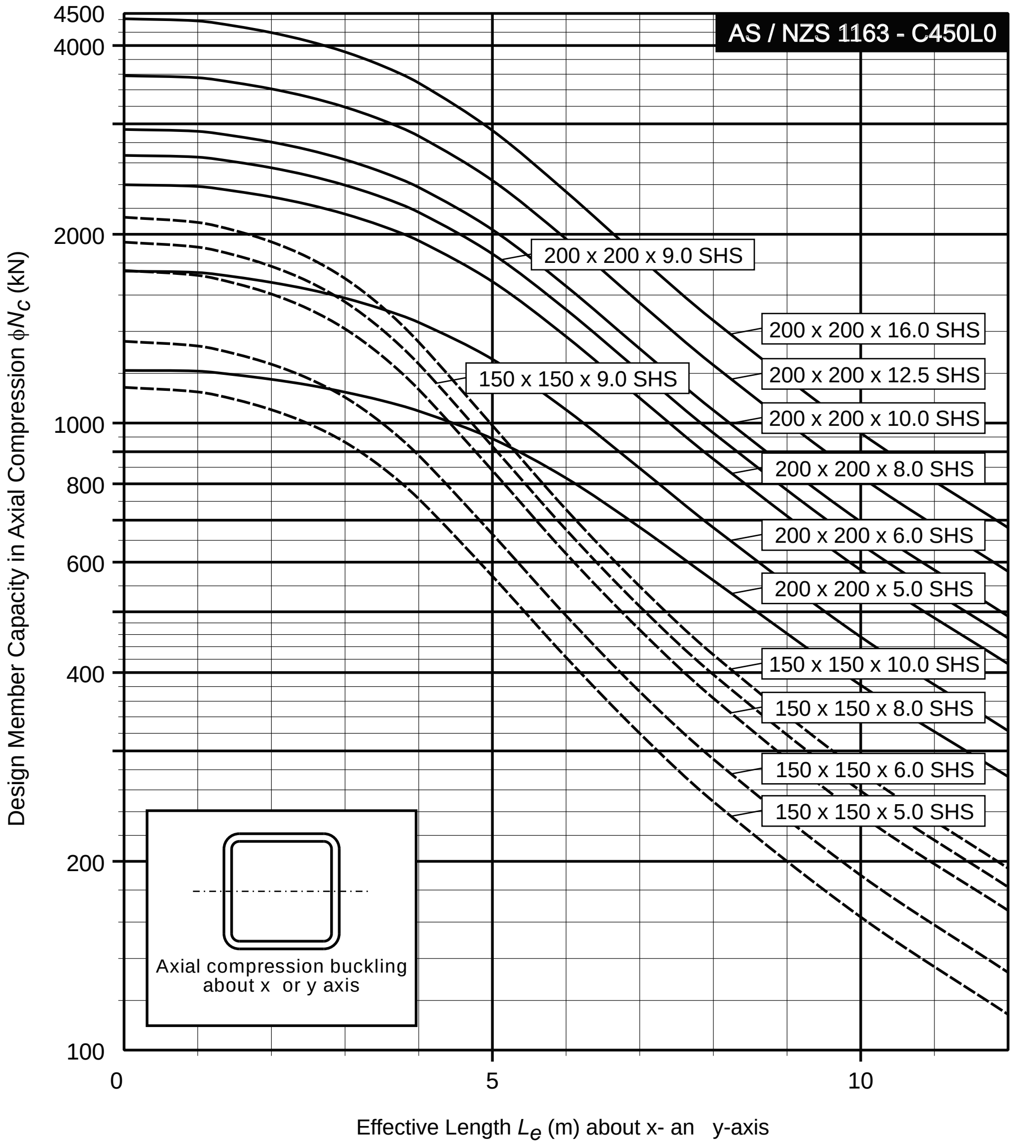

AS / NZS 1163 - C450L0
Design Member Capacity in Axial Compression φNc (kN)
4500
4000
2000
1000
800
600
400
200
100
200 x 200 x 9.0 SHS
200 x 200 x 16.0 SHS
150 x 150 x 9.0 SHS
200 x 200 x 12.5 SHS
200 x 200 x 10.0 SHS
200 x 200 x 8.0 SHS
200 x 200 x 6.0 SHS
200 x 200 x 5.0 SHS
150 x 150 x 10.0 SHS
150 x 150 x 8.0 SHS
150 x 150 x 6.0 SHS
150 x 150 x 5.0 SHS
Axial compression buckling
about x or y axis
0
5
10
Effective Length Le (m) about x- an y-axis

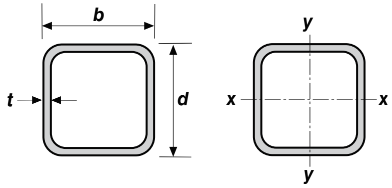
TABLE 6-6(2)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

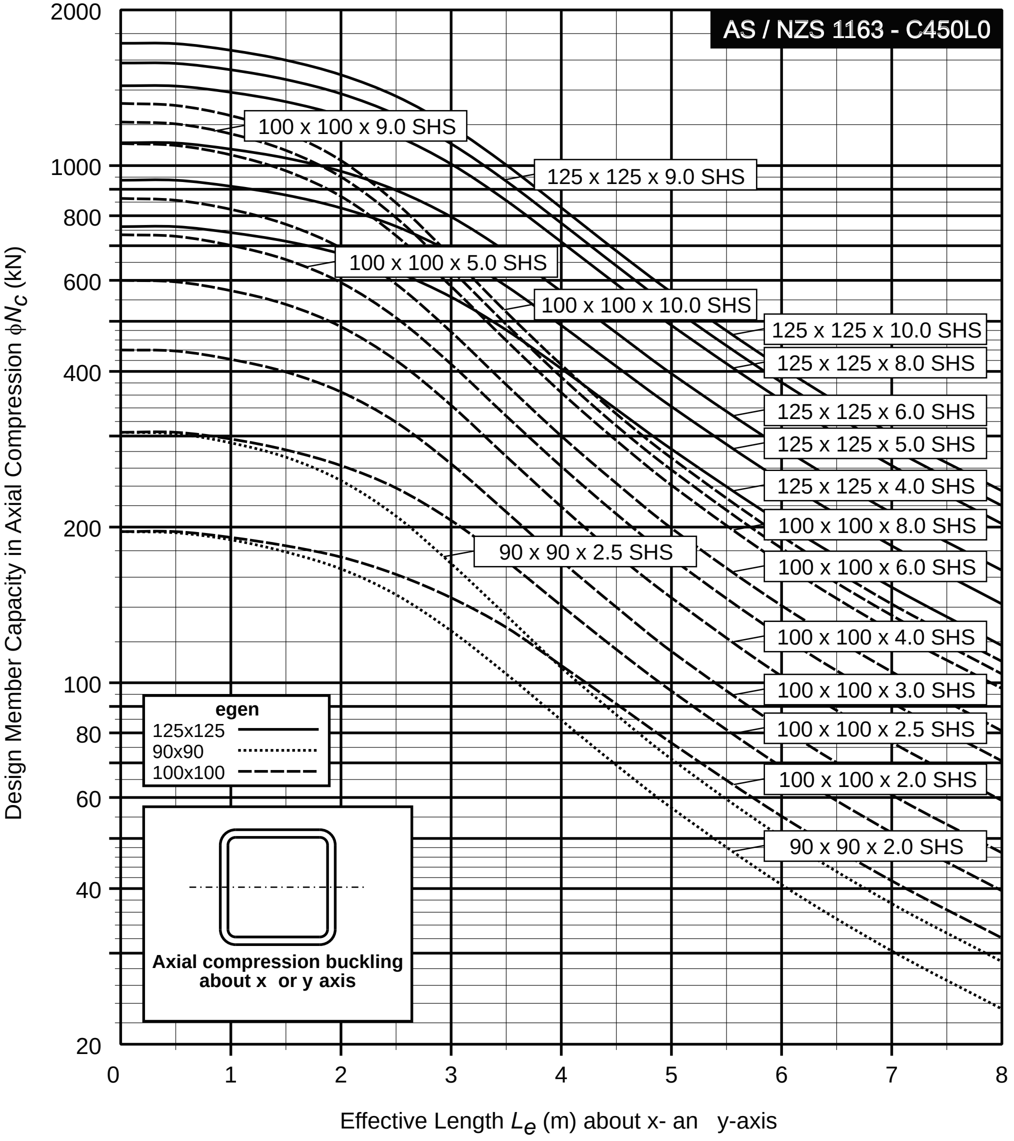
### *buckling about x- and y-axis*

| Designation | | | | | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | | | | | | | | | | | | | | |
| mm | | mm | | mm | | kg/m | $L_e$ = 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 1720 | 1720 | 1670 | 1600 | 1500 | 1360 | 1190 | 1000 | 829 | 684 | 569 | 407 | 303 | 235 |
| | | | | 9.0 | SHS | 30.6 | 1580 | 1580 | 1530 | 1470 | 1380 | 1260 | 1100 | 933 | 774 | 640 | 532 | 381 | 284 | 220 |
| | | | | 8.0 | SHS | 27.7 | 1430 | 1430 | 1390 | 1330 | 1250 | 1140 | 1010 | 856 | 712 | 590 | 491 | 352 | 263 | 203 |
| | | | | 6.0 | SHS | 21.4 | 1110 | 1110 | 1080 | 1030 | 975 | 896 | 796 | 682 | 571 | 475 | 396 | 285 | 213 | 165 |
| | | | | 5.0 | SHS | 18.2 | 937 | 937 | 912 | 877 | 828 | 763 | 680 | 585 | 491 | 409 | 342 | 246 | 184 | 142 |
| | | | | 4.0 | SHS | 14.8 | 762 | 762 | 742 | 714 | 675 | 623 | 557 | 481 | 405 | 338 | 283 | 204 | 153 | 118 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 1320 | 1310 | 1250 | 1160 | 1020 | 847 | 668 | 521 | 412 | 331 | 272 | 192 | 142 | 110 |
| | | | | 9.0 | SHS | 23.5 | 1210 | 1200 | 1150 | 1070 | 951 | 793 | 629 | 493 | 390 | 314 | 258 | 182 | 135 | 104 |
| | | | | 8.0 | SHS | 21.4 | 1100 | 1090 | 1050 | 977 | 872 | 732 | 584 | 459 | 364 | 294 | 241 | 170 | 126 | 97.5 |
| | | | | 6.0 | SHS | 16.7 | 864 | 857 | 823 | 770 | 693 | 590 | 477 | 377 | 300 | 243 | 199 | 141 | 105 | 80.7 |
| | | | | 5.0 | SHS | 14.2 | 735 | 730 | 701 | 658 | 594 | 508 | 413 | 328 | 262 | 212 | 174 | 123 | 91.5 | 70.6 |
| | | | | 4.0 | SHS | 11.6 | 600 | 596 | 573 | 539 | 488 | 420 | 344 | 274 | 219 | 177 | 146 | 103 | 76.7 | 59.2 |
| | | | | 3.0 | SHS | 8.96 | 440 | 438 | 422 | 399 | 365 | 319 | 265 | 214 | 172 | 140 | 115 | 81.7 | 60.7 | 46.9 |
| | | | | 2.5 | SHS | 7.53 | 305 | 305 | 296 | 282 | 263 | 238 | 206 | 172 | 141 | 116 | 96.4 | 68.8 | 51.3 | 39.6 |
| | | | | 2.0 | SHS | 6.07 | 196 | 196 | 191 | 184 | 175 | 162 | 146 | 128 | 108 | 91.0 | 76.5 | 55.2 | 41.4 | 32.1 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 305 | 303 | 291 | 273 | 246 | 210 | 170 | 135 | 107 | 86.7 | 71.2 | 50.3 | 37.4 | 28.9 |
| | | | | 2.0 | SHS | 5.45 | 196 | 195 | 189 | 179 | 166 | 148 | 126 | 104 | 84.7 | 69.3 | 57.3 | 40.7 | 30.3 | 23.4 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 757 | 748 | 711 | 650 | 561 | 449 | 345 | 266 | 209 | 168 | 137 | 96.6 | 71.6 | 55.2 |
| | | | | 5.0 | SHS | 12.5 | 646 | 639 | 608 | 558 | 484 | 391 | 302 | 234 | 184 | 147 | 121 | 85.0 | 63.1 | 48.6 |
| | | | | 3.5 | SHS | 9.07 | 468 | 463 | 441 | 407 | 356 | 291 | 227 | 176 | 139 | 112 | 91.4 | 64.4 | 47.8 | 36.8 |
| | | | | 2.0 | SHS | 5.38 | 196 | 195 | 188 | 179 | 165 | 146 | 124 | 102 | 82.3 | 67.2 | 55.5 | 39.4 | 29.4 | 22.7 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 621 | 608 | 565 | 490 | 384 | 280 | 205 | 154 | 120 | 95.7 | 78.1 | 54.8 | 40.6 | 31.3 |
| | | | | 5.0 | SHS | 10.3 | 532 | 522 | 486 | 425 | 337 | 248 | 182 | 137 | 107 | 85.2 | 69.6 | 48.8 | 36.2 | 27.9 |
| | | | | 4.0 | SHS | 8.49 | 438 | 430 | 401 | 353 | 283 | 210 | 155 | 117 | 91.0 | 72.7 | 59.4 | 41.7 | 30.9 | 23.8 |
| | | | | 3.5 | SHS | 7.53 | 388 | 382 | 357 | 315 | 253 | 189 | 140 | 106 | 82.2 | 65.6 | 53.6 | 37.6 | 27.9 | 21.5 |
| | | | | 3.0 | SHS | 6.60 | 341 | 335 | 313 | 278 | 225 | 169 | 125 | 94.7 | 73.7 | 58.9 | 48.1 | 33.8 | 25.0 | 19.3 |
| | | | | 2.5 | SHS | 5.56 | 287 | 282 | 265 | 235 | 191 | 144 | 107 | 81.0 | 63.1 | 50.5 | 41.2 | 29.0 | 21.4 | 16.5 |
| | | | | 2.0 | SHS | 4.50 | 196 | 193 | 183 | 166 | 142 | 112 | 85.4 | 65.5 | 51.3 | 41.1 | 33.6 | 23.7 | 17.6 | 13.5 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 523 | 508 | 458 | 368 | 260 | 179 | 128 | 95.8 | 74.1 | 59.0 | 48.1 | 33.7 | 24.9 | 19.2 |
| | | | | 5.0 | SHS | 8.75 | 451 | 439 | 397 | 324 | 232 | 161 | 116 | 86.4 | 66.9 | 53.3 | 43.4 | 30.4 | 22.5 | 17.3 |
| | | | | 4.0 | SHS | 7.23 | 373 | 363 | 330 | 273 | 198 | 138 | 99.6 | 74.5 | 57.7 | 46.0 | 37.5 | 26.3 | 19.4 | 15.0 |
| | | | | 3.0 | SHS | 5.66 | 292 | 285 | 260 | 217 | 161 | 113 | 81.7 | 61.2 | 47.4 | 37.8 | 30.8 | 21.6 | 16.0 | 12.3 |
| | | | | 2.5 | SHS | 4.78 | 247 | 241 | 220 | 185 | 137 | 97.2 | 70.2 | 52.6 | 40.8 | 32.5 | 26.5 | 18.6 | 13.8 | 10.6 |
| | | | | 2.0 | SHS | 3.88 | 196 | 191 | 176 | 149 | 112 | 79.8 | 57.8 | 43.4 | 33.6 | 26.8 | 21.9 | 15.3 | 11.4 | 8.75 |
| | | | | 1.6 | SHS | 3.13 | 125 | 123 | 115 | 102 | 83.0 | 62.3 | 46.2 | 35.0 | 27.3 | 21.8 | 17.8 | 12.5 | 9.27 | 7.14 |



## Notes:

1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e$ = 0.0.


AS / NZS 1163 - C450L0
100 x 100 x 9.0 SHS
125 x 125 x 9.0 SHS
100 x 100 x 5.0 SHS
100 x 100 x 10.0 SHS
125 x 125 x 10.0 SHS
125 x 125 x 8.0 SHS
125 x 125 x 6.0 SHS
125 x 125 x 5.0 SHS
125 x 125 x 4.0 SHS
100 x 100 x 8.0 SHS
90 x 90 x 2.5 SHS
100 x 100 x 6.0 SHS
100 x 100 x 4.0 SHS
100 x 100 x 3.0 SHS
100 x 100 x 2.5 SHS
100 x 100 x 2.0 SHS
90 x 90 x 2.0 SHS
egen
125x125
90x90
100x100
Axial compression buckling about x or y axis
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
2000
1000
800
600
400
200
100
80
60
40
20
0
1
2
3
4
5
6
7
8
Effective Length $L_e$ (m) about x- an y-axis

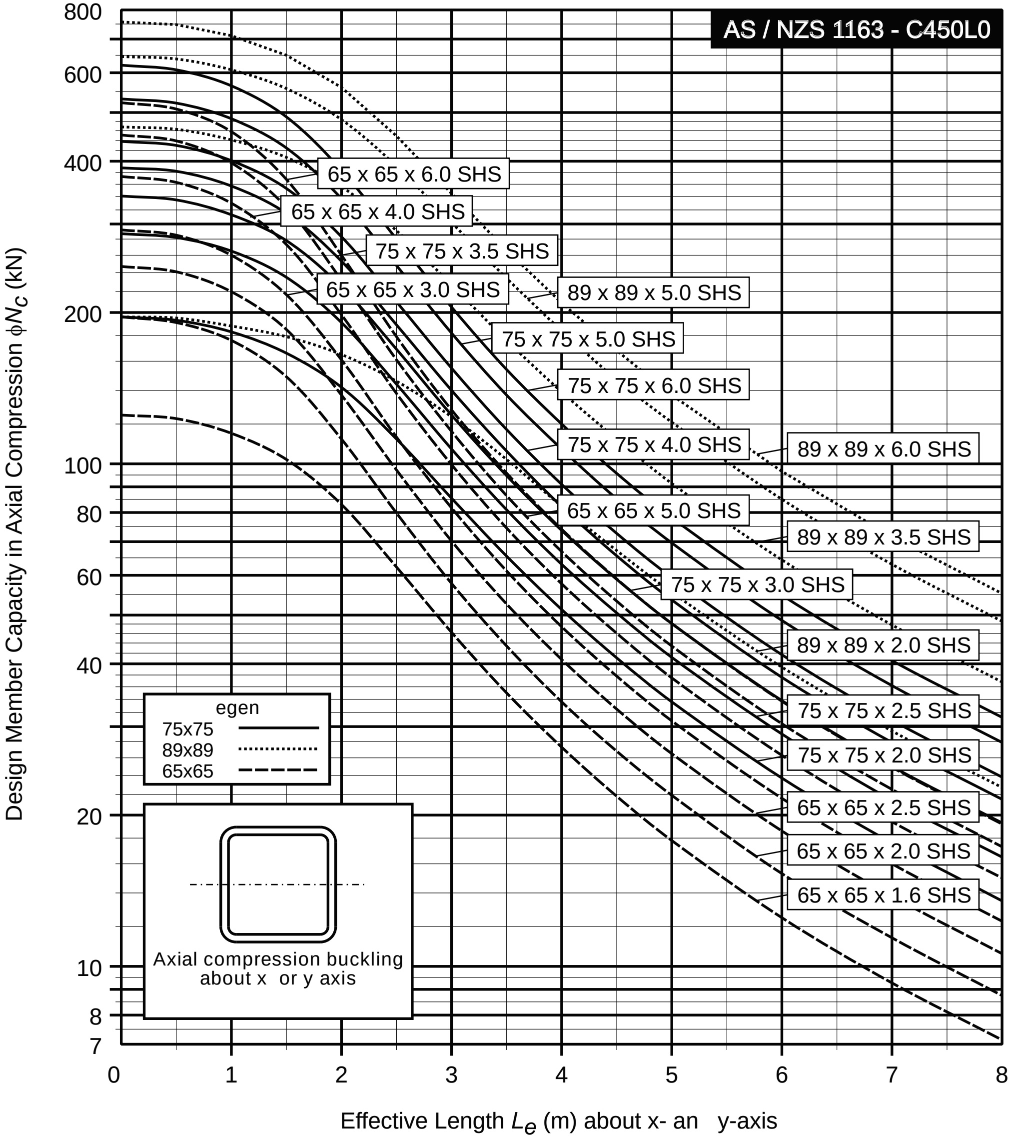

AS / NZS 1163 - C450L0
65 x 65 x 6.0 SHS
65 x 65 x 4.0 SHS
75 x 75 x 3.5 SHS
65 x 65 x 3.0 SHS
89 x 89 x 5.0 SHS
75 x 75 x 5.0 SHS
75 x 75 x 6.0 SHS
75 x 75 x 4.0 SHS
89 x 89 x 6.0 SHS
65 x 65 x 5.0 SHS
89 x 89 x 3.5 SHS
75 x 75 x 3.0 SHS
89 x 89 x 2.0 SHS
75 x 75 x 2.5 SHS
75 x 75 x 2.0 SHS
65 x 65 x 2.5 SHS
65 x 65 x 2.0 SHS
65 x 65 x 1.6 SHS
egen
75x75
89x89
65x65
Axial compression buckling about x or y axis
Design Member Capacity in Axial Compression $\phi N_c$ (kN)
800
600
400
200
100
80
60
40
20
10
8
7
0
1
2
3
4
5
6
7
8
Effective Length $L_e$ (m) about x- an y-axis

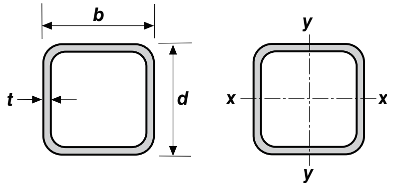
TABLE 6-6(3)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

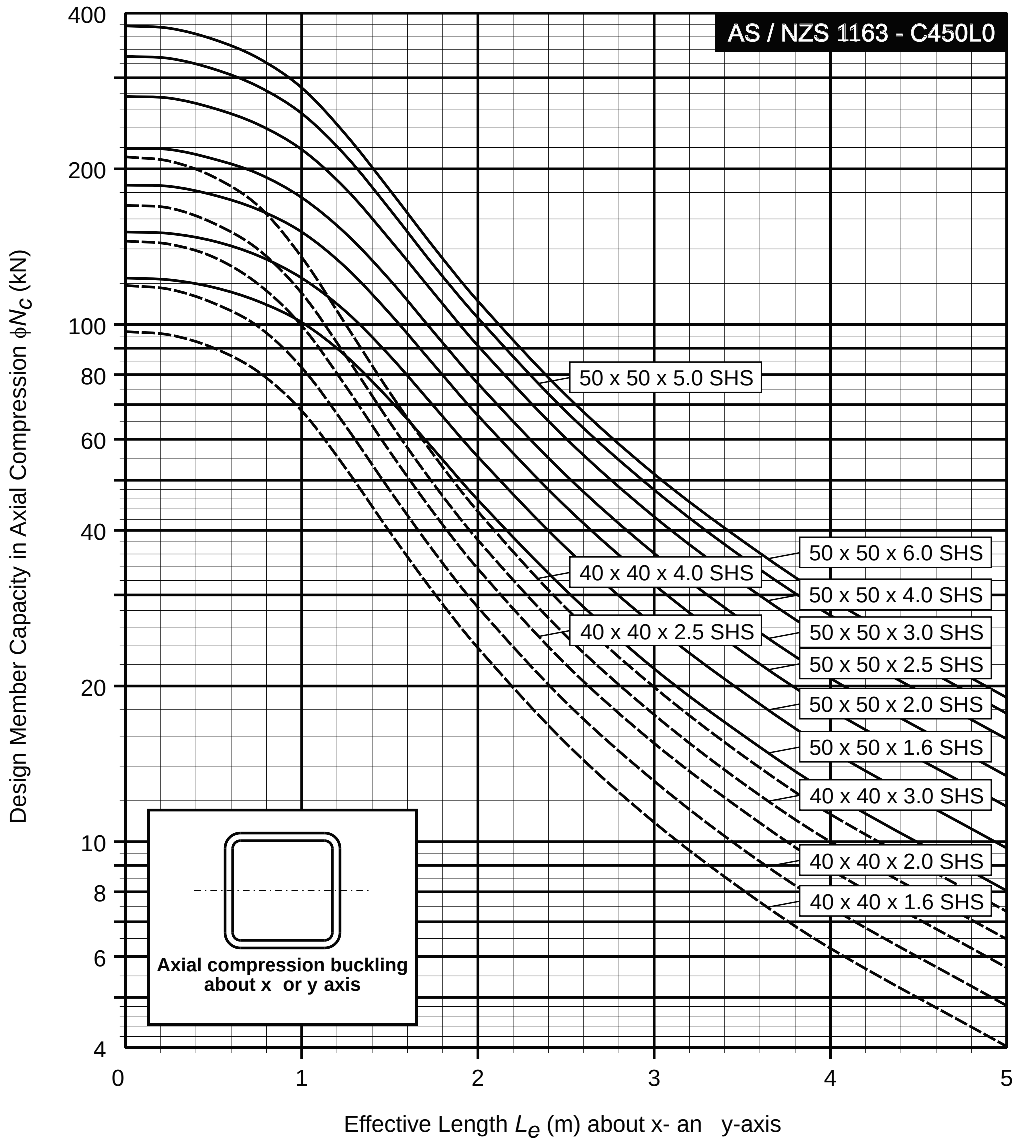
### *buckling about x- and y-axis*

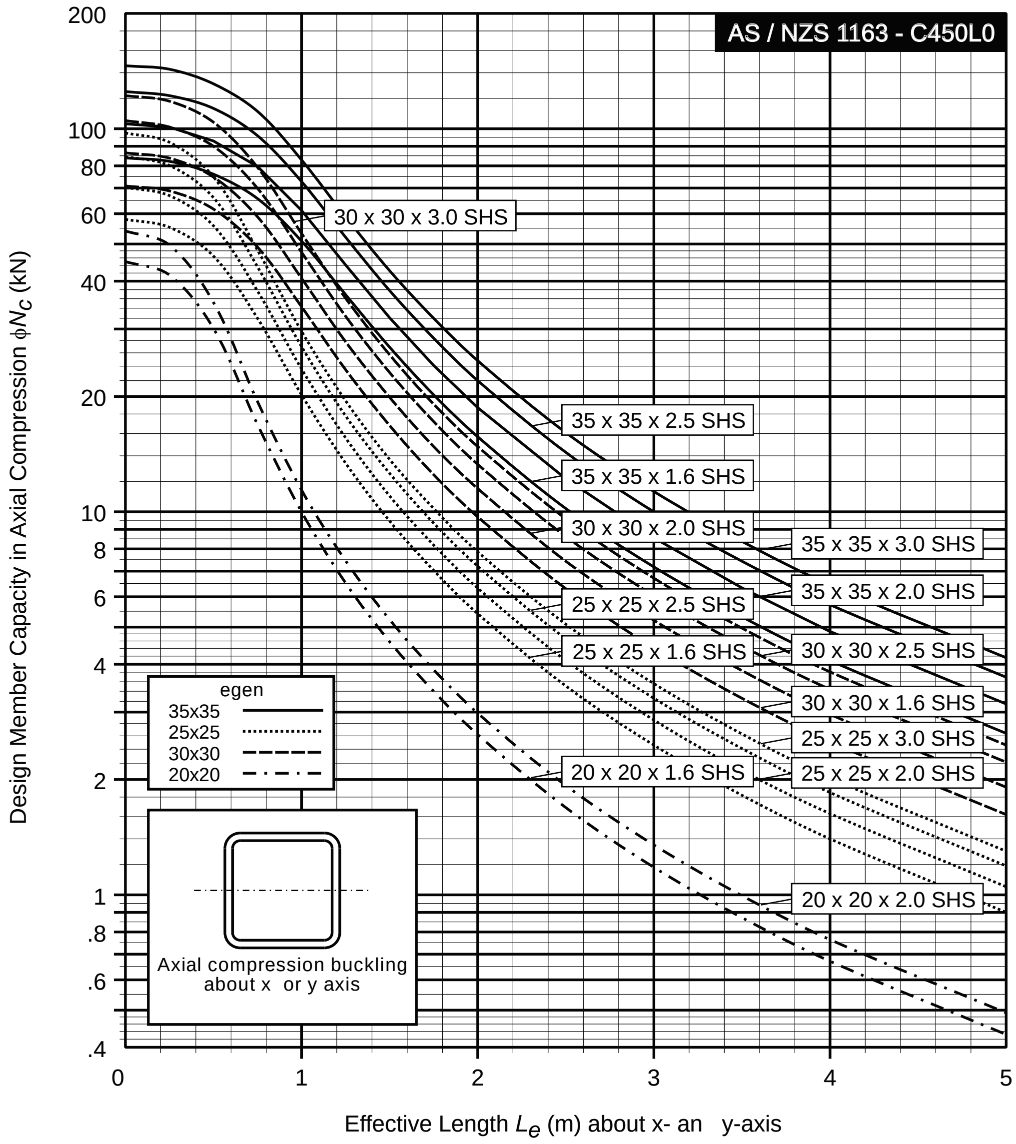
| Designation d | | b | | t | | Mass per m | $\phi N_s$ (kN) | Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ($L_e$) in metres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | mm | | kg/m | $L_e$ = 0.00 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 378 | 374 | 356 | 328 | 287 | 233 | 182 | 141 | 111 | 73.0 | 51.4 | 38.2 | 29.4 | 19.0 |
| | | | | 5.0 | SHS | 6.39 | 330 | 327 | 312 | 289 | 256 | 212 | 167 | 130 | 103 | 67.9 | 47.9 | 35.5 | 27.4 | 17.7 |
| | | | | 4.0 | SHS | 5.35 | 276 | 274 | 262 | 244 | 218 | 183 | 146 | 115 | 91.0 | 60.2 | 42.5 | 31.6 | 24.4 | 15.8 |
| | | | | 3.0 | SHS | 4.25 | 219 | 218 | 209 | 196 | 176 | 150 | 122 | 96.6 | 76.9 | 51.1 | 36.1 | 26.8 | 20.7 | 13.4 |
| | | | | 2.5 | SHS | 3.60 | 186 | 185 | 178 | 167 | 151 | 129 | 105 | 83.6 | 66.7 | 44.4 | 31.4 | 23.3 | 18.0 | 11.7 |
| | | | | 2.0 | SHS | 2.93 | 151 | 150 | 145 | 136 | 123 | 106 | 87.0 | 69.5 | 55.5 | 37.0 | 26.2 | 19.5 | 15.0 | 9.72 |
| | | | | 1.6 | SHS | 2.38 | 123 | 122 | 118 | 111 | 101 | 87.0 | 71.5 | 57.3 | 45.8 | 30.6 | 21.6 | 16.1 | 12.4 | 8.04 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 211 | 207 | 193 | 170 | 135 | 100 | 73.9 | 55.9 | 43.5 | 28.3 | 19.9 | 14.7 | 11.3 | 7.33 |
| | | | | 3.0 | SHS | 3.30 | 170 | 168 | 157 | 140 | 115 | 87.0 | 64.7 | 49.1 | 38.3 | 25.0 | 17.6 | 13.0 | 10.0 | 6.48 |
| | | | | 2.5 | SHS | 2.82 | 145 | 143 | 135 | 120 | 99.5 | 76.0 | 56.8 | 43.2 | 33.7 | 22.0 | 15.5 | 11.5 | 8.83 | 5.71 |
| | | | | 2.0 | SHS | 2.31 | 119 | 117 | 110 | 99.3 | 82.6 | 63.6 | 47.8 | 36.4 | 28.4 | 18.6 | 13.1 | 9.68 | 7.46 | 4.82 |
| | | | | 1.6 | SHS | 1.88 | 96.9 | 95.5 | 90.1 | 81.2 | 68.1 | 52.7 | 39.7 | 30.3 | 23.7 | 15.5 | 10.9 | 8.08 | 6.22 | 4.02 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 146 | 143 | 131 | 111 | 82.9 | 58.9 | 42.6 | 32.0 | 24.8 | 16.1 | 11.3 | 8.37 | 6.44 | 4.16 |
| | | | | 2.5 | SHS | 2.42 | 125 | 122 | 113 | 95.9 | 72.8 | 52.1 | 37.8 | 28.4 | 22.0 | 14.3 | 10.0 | 7.43 | 5.72 | 3.70 |
| | | | | 2.0 | SHS | 1.99 | 103 | 101 | 92.9 | 79.7 | 61.2 | 44.1 | 32.1 | 24.1 | 18.7 | 12.2 | 8.55 | 6.33 | 4.87 | 3.15 |
| | | | | 1.6 | SHS | 1.63 | 83.9 | 82.2 | 76.1 | 65.7 | 50.9 | 36.9 | 26.9 | 20.2 | 15.7 | 10.2 | 7.18 | 5.32 | 4.09 | 2.64 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 122 | 118 | 104 | 79.3 | 53.3 | 36.1 | 25.7 | 19.1 | 14.8 | 9.59 | 6.71 | 4.97 | 3.82 | 2.46 |
| | | | | 2.5 | SHS | 2.03 | 105 | 101 | 90.0 | 69.9 | 47.6 | 32.4 | 23.1 | 17.2 | 13.3 | 8.62 | 6.04 | 4.47 | 3.44 | 2.22 |
| | | | | 2.0 | SHS | 1.68 | 86.5 | 83.8 | 74.8 | 58.9 | 40.7 | 27.8 | 19.9 | 14.8 | 11.5 | 7.43 | 5.21 | 3.85 | 2.96 | 1.91 |
| | | | | 1.6 | SHS | 1.38 | 70.9 | 68.8 | 61.7 | 49.1 | 34.3 | 23.5 | 16.8 | 12.5 | 9.70 | 6.30 | 4.41 | 3.26 | 2.51 | 1.62 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 97.5 | 92.2 | 74.9 | 48.2 | 29.6 | 19.5 | 13.7 | 10.2 | 7.86 | 5.09 | 3.56 | 2.63 | 2.02 | 1.30 |
| | | | | 2.5 | SHS | 1.64 | 84.6 | 80.2 | 66.1 | 43.6 | 27.0 | 17.8 | 12.6 | 9.34 | 7.21 | 4.66 | 3.26 | 2.41 | 1.85 | 1.19 |
| | | | | 2.0 | SHS | 1.36 | 70.3 | 66.9 | 55.8 | 37.7 | 23.6 | 15.6 | 11.0 | 8.19 | 6.32 | 4.09 | 2.86 | 2.11 | 1.63 | 1.05 |
| | | | | 1.6 | SHS | 1.12 | 58.0 | 55.3 | 46.5 | 32.0 | 20.2 | 13.4 | 9.46 | 7.03 | 5.42 | 3.51 | 2.46 | 1.82 | 1.40 | 0.900 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 54.1 | 49.7 | 35.2 | 19.4 | 11.4 | 7.45 | 5.23 | 3.87 | 2.98 | 1.93 | 1.35 | 0.995 | 0.764 | 0.492 |
| | | | | 1.6 | SHS | 0.873 | 45.0 | 41.5 | 30.1 | 16.9 | 9.99 | 6.52 | 4.58 | 3.40 | 2.62 | 1.69 | 1.18 | 0.872 | 0.671 | 0.432 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi N_s = \phi N_c$ for $L_e = 0.0$.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**





Refer previous table for notes on steel grade.

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# Part 7

## MEMBERS SUBJECT TO AXIAL TENSION

| Section | | Page |
|---|---|---|
| **7.1** | **General** | **7-2** |
| **7.2** | **Design Section Capacity in Axial Tension** | **7-2** |
| **7.3** | **Example** | **7-2** |
| **7.4** | **References** | **7-2** |

| Table | Page |
|---|---|
| **Tables 7-1 to 7-6**<br>Design Section Capacities in Axial Tension | 7-3 |

**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 7

# MEMBERS SUBJECT TO AXIAL TENSION

## 7.1 General

Tables 7-1 to 7-6 give values of design section capacity in axial tension. Section 7 of AS 4100 has been used to determine these values.

The Tables list the design section capacity in tension for Australian Tube Mills structural steel hollow sections. It further assumes that there are no eccentricity, shear lag or stress concentration effects such that there is a uniform stress distribution along the cross-section (e.g. as in full perimeter welded connections to uniformly stiff supports - see Clause C7.3.1 of Ref. [7.1]).

## 7.2 Design Section Capacity in Axial Tension

The design section capacity in axial tension ($\phi N_t$) listed in the Tables has been determined from Clause 7.2 of AS 4100 and is taken as the *lesser* of:

$\phi N_t = \phi A_g f_y$ (yielding of the gross section)
$\phi N_t = \phi(0.85) k_t A_n f_u$ (fracture of the net section)

where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$f_y$ = yield stress used in design
$f_u$ = ultimate tensile strength used in design
$A_g$ = gross area of the cross-section
$A_n$ = net area of the cross-section
= $A_g$ (e.g. for full perimeter welded connections to uniformly stiff supports)
$k_t$ = 1.0 (Clause 7.3.1 of AS 4100)

The *lesser* value of $\phi N_t(1) = \phi A_g f_y$ and $\phi N_t(2) = \phi(0.85) A_g f_u$ is **highlighted in bold type** in the Tables.

Note: For AS/NZS 1163 Grade C250L0 and C350L0 CHS, $\phi N_t = \phi A_g f_y$ is always less than $\phi N_t = \phi(0.85) A_g f_u$ though for RHS/SHS to AS/NZS 1163 Grade C450L0 $\phi N_t = \phi(0.85) A_g f_u$ is the *lesser* value of $\phi N_t$.

For sections reduced by penetrations or holes, the value of $\phi N_t$ can be determined from the Tables as the *lesser* value of:

$\phi N_t = \phi A_g f_y$
and $\phi N_t = \phi(0.85) k_t A_g f_u (A_n / A_g)$
where $A_n$ = net area of the cross-section
$k_t$ = tension correction factor (Clause 7.3.1 of AS 4100)

Values of $A_g$ are tabulated in Tables 7-1 to 7- 6. *Note that all the values in Tables 7-1 to 7-6 assume $k_t = 1.0$.*

## 7.3 Example

1. A tension member with a full perimeter welded connection to a uniformly stiff support is subjected to an axial tension force of 150 kN. Design a suitable RHS tension member.

Design Data:

$N^*$ = 150 kN
$k_t$ = 1.0 (for a full perimeter welded connection)

Solution:

Select a suitable RHS member from Tables 7-4(2). The alternatives are:

76 x 38 x 4.0 RHS – Grade C450L0 (C450PLUS) (6.23 kg/m) $\phi N_t$ = 303 kN > $N^*$
100 x 50 x 3.0 RHS – Grade C450L0 (C450PLUS) (6.60 kg/m) $\phi N_t$ = 322 kN > $N^*$

Both these options are suitable for the design as their mass is somewhat similar. The final choice of section may be influenced by other constraints (geometric, availability etc.).

## 7.4 References

[7.1] Standards Australia, AS 4100 Supplement 1-1999: “Steel Structures Commentary” (Supplement to AS 4100–1998), Standards Australia, 1999.

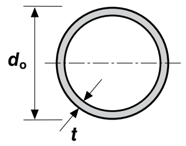
**See Section 1.1.2 for details on reference Standards.**

## TABLE 7-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|
| $d_o$ | | $t$ | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | | mm | | kg/m | kN | kN | mm² |
| 165.1 | x | 5.4 | CHS | 21.3 | **610** | 663 | 2710 |
| | | 5.0 | CHS | 19.7 | **566** | 616 | 2510 |
| 139.7 | x | 5.4 | CHS | 17.9 | **513** | 558 | 2280 |
| | | 5.0 | CHS | 16.6 | **476** | 518 | 2120 |
| 114.3 | x | 5.4 | CHS | 14.5 | **416** | 452 | 1850 |
| | | 4.5 | CHS | 12.2 | **349** | 380 | 1550 |
| 101.6 | x | 5.0 | CHS | 11.9 | **341** | 371 | 1520 |
| | | 4.0 | CHS | 9.63 | **276** | 300 | 1230 |
| 88.9 | x | 5.9 | CHS | 12.1 | **346** | 377 | 1540 |
| | | 5.0 | CHS | 10.3 | **297** | 323 | 1320 |
| | | 4.0 | CHS | 8.38 | **240** | 261 | 1070 |
| 76.1 | x | 5.9 | CHS | 10.2 | **293** | 319 | 1300 |
| | | 4.5 | CHS | 7.95 | **228** | 248 | 1010 |
| | | 3.6 | CHS | 6.44 | **184** | 201 | 820 |
| 60.3 | x | 5.4 | CHS | 7.31 | **210** | 228 | 931 |
| | | 4.5 | CHS | 6.19 | **177** | 193 | 789 |
| | | 3.6 | CHS | 5.03 | **144** | 157 | 641 |
| 48.3 | x | 4.0 | CHS | 4.37 | **125** | 136 | 557 |
| | | 3.2 | CHS | 3.56 | **102** | 111 | 453 |
| 42.4 | x | 4.0 | CHS | 3.79 | **109** | 118 | 483 |
| | | 3.2 | CHS | 3.09 | **88.7** | 96.5 | 394 |
| 33.7 | x | 4.0 | CHS | 2.93 | **84.0** | 91.4 | 373 |
| | | 3.2 | CHS | 2.41 | **69.0** | 75.1 | 307 |
| 26.9 | x | 4.0 | CHS | 2.26 | **64.7** | 70.4 | 288 |
| | | 3.2 | CHS | 1.87 | **53.6** | 58.3 | 238 |
| | | 2.6 | CHS | 1.56 | **44.7** | 48.6 | 198 |



## Notes:

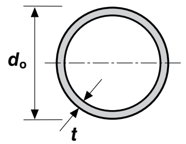
1. ***REFER*** **to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.
3. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 7-2

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|
| $d_o$ | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | mm | | kg/m | kN | kN | mm² |
| 508.0 x | 12.7 | CHS | 155 | **6220** | 6500 | 19800 |
| | 9.5 | CHS | 117 | **4690** | 4890 | 14900 |
| | 6.4 | CHS | 79.2 | **3180** | 3320 | 10100 |
| 457.0 x | 12.7 | CHS | 139 | **5580** | 5830 | 17700 |
| | 9.5 | CHS | 105 | **4210** | 4390 | 13400 |
| | 6.4 | CHS | 71.1 | **2850** | 2980 | 9060 |
| 406.4 x | 12.7 | CHS | 123 | **4950** | 5170 | 15700 |
| | 9.5 | CHS | 93.0 | **3730** | 3900 | 11800 |
| | 6.4 | CHS | 63.1 | **2530** | 2650 | 8040 |
| 355.6 x | 12.7 | CHS | 107 | **4310** | 4500 | 13700 |
| | 9.5 | CHS | 81.1 | **3250** | 3400 | 10300 |
| | 6.4 | CHS | 55.1 | **2210** | 2310 | 7020 |
| 323.9 x | 12.7 | CHS | 97.5 | **3910** | 4080 | 12400 |
| | 9.5 | CHS | 73.7 | **2960** | 3090 | 9380 |
| | 6.4 | CHS | 50.1 | **2010** | 2100 | 6380 |
| 273.1 x | 12.7 | CHS | 81.6 | **3270** | 3420 | 10400 |
| | 9.3 | CHS | 60.5 | **2430** | 2540 | 7710 |
| | 6.4 | CHS | 42.1 | **1690** | 1760 | 5360 |
| | 4.8 | CHS | 31.8 | **1270** | 1330 | 4050 |
| 219.1 x | 8.2 | CHS | 42.6 | **1710** | 1790 | 5430 |
| | 6.4 | CHS | 33.6 | **1350** | 1410 | 4280 |
| | 4.8 | CHS | 25.4 | **1020** | 1060 | 3230 |
| 168.3 x | 7.1 | CHS | 28.2 | **1130** | 1180 | 3600 |
| | 6.4 | CHS | 25.6 | **1030** | 1070 | 3260 |
| | 4.8 | CHS | 19.4 | **777** | 811 | 2470 |
| 165.1 x | 3.5 | CHS | 13.9 | **560** | 585 | 1780 |
| | 3.0 | CHS | 12.0 | **481** | 503 | 1530 |
| 139.7 x | 3.5 | CHS | 11.8 | **472** | 493 | 1500 |
| | 3.0 | CHS | 10.1 | **406** | 424 | 1290 |
| 114.3 x | 3.6 | CHS | 9.83 | **394** | 412 | 1250 |
| | 3.2 | CHS | 8.77 | **352** | 367 | 1120 |
| 101.6 x | 3.2 | CHS | 7.77 | **312** | 325 | 989 |
| | 2.6 | CHS | 6.35 | **255** | 266 | 809 |
| 88.9 x | 3.2 | CHS | 6.76 | **271** | 283 | 862 |
| | 2.6 | CHS | 5.53 | **222** | 232 | 705 |
| 76.1 x | 3.2 | CHS | 5.75 | **231** | 241 | 733 |
| | 2.3 | CHS | 4.19 | **168** | 175 | 533 |
| 60.3 x | 2.9 | CHS | 4.11 | **165** | 172 | 523 |
| | 2.3 | CHS | 3.29 | **132** | 138 | 419 |
| 48.3 x | 2.9 | CHS | 3.25 | **130** | 136 | 414 |
| | 2.3 | CHS | 2.61 | **105** | 109 | 332 |
| 42.4 x | 2.6 | CHS | 2.55 | **102** | 107 | 325 |
| | 2.0 | CHS | 1.99 | **80.0** | 83.5 | 254 |
| 33.7 x | 2.6 | CHS | 1.99 | **80.0** | 83.6 | 254 |
| | 2.0 | CHS | 1.56 | **62.7** | 65.5 | 199 |
| 26.9 x | 2.3 | CHS | 1.40 | **56.0** | 58.5 | 178 |
| | 2.0 | CHS | 1.23 | **49.3** | 51.5 | 156 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.

TABLE 7-3

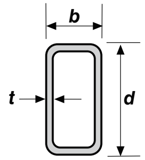
# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

1 RHS

2 C350L0

3 Finish



| Designation | | | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | | mm | | mm | | kg/m | kN | kN | mm² |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | **145** | 151 | 459 |
| | | | | 2.0 | RHS | 2.93 | **118** | 123 | 374 |
| | | | | 1.6 | RHS | 2.38 | **95.5** | 99.7 | 303 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | **215** | 224 | 681 |
| | | | | 3.0 | RHS | 4.25 | **170** | 178 | 541 |
| | | | | 2.5 | RHS | 3.60 | **145** | 151 | 459 |
| | | | | 2.0 | RHS | 2.93 | **118** | 123 | 374 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | **123** | 129 | 391 |
| | | | | 2.5 | RHS | 2.62 | **105** | 110 | 334 |
| | | | | 2.0 | RHS | 2.15 | **86.2** | 90.0 | 274 |
| | | | | 1.6 | RHS | 1.75 | **70.3** | 73.4 | 223 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | **114** | 119 | 361 |
| | | | | 2.5 | RHS | 2.42 | **97.3** | 102 | 309 |
| | | | | 2.0 | RHS | 1.99 | **79.9** | 83.5 | 254 |
| | | | | 1.6 | RHS | 1.63 | **65.3** | 68.1 | 207 |

### Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com..**
2. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

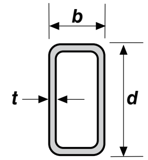
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 7-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|
| d | b | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | mm | mm | | kg/m | kN | kN | mm² |
| 400 x | 300 x | 16.0 | RHS | 161 | 8300 | **7840** | 20500 |
| | | 12.5 | RHS | 128 | 6620 | **6250** | 16300 |
| | | 10.0 | RHS | 104 | 5370 | **5070** | 13300 |
| | | 8.0 | RHS | 84.2 | 4340 | **4100** | 10700 |
| 400 x | 200 x | 16.0 | RHS | 136 | 7010 | **6620** | 17300 |
| | | 12.5 | RHS | 109 | 5600 | **5290** | 13800 |
| | | 10.0 | RHS | 88.4 | 4560 | **4310** | 11300 |
| | | 8.0 | RHS | 71.6 | 3700 | **3490** | 9120 |
| 350 x | 250 x | 16.0 | RHS | 136 | 7010 | **6620** | 17300 |
| | | 12.5 | RHS | 109 | 5600 | **5290** | 13800 |
| | | 10.0 | RHS | 88.4 | 4560 | **4310** | 11300 |
| | | 8.0 | RHS | 71.6 | 3700 | **3490** | 9120 |
| 300 x | 200 x | 16.0 | RHS | 111 | 5710 | **5390** | 14100 |
| | | 12.5 | RHS | 89.0 | 4590 | **4340** | 11300 |
| | | 10.0 | RHS | 72.7 | 3750 | **3540** | 9260 |
| | | 8.0 | RHS | 59.1 | 3050 | **2880** | 7520 |
| | | 6.0 | RHS | 45.0 | 2320 | **2190** | 5730 |
| 250 x | 150 x | 16.0 | RHS | 85.5 | 4410 | **4170** | 10900 |
| | | 12.5 | RHS | 69.4 | 3580 | **3380** | 8840 |
| | | 10.0 | RHS | 57.0 | 2940 | **2780** | 7260 |
| | | 9.0 | RHS | 51.8 | 2670 | **2520** | 6600 |
| | | 8.0 | RHS | 46.5 | 2400 | **2270** | 5920 |
| | | 6.0 | RHS | 35.6 | 1840 | **1730** | 4530 |
| | | 5.0 | RHS | 29.9 | 1540 | **1460** | 3810 |
| 200 x | 100 x | 10.0 | RHS | 41.3 | 2130 | **2010** | 5260 |
| | | 9.0 | RHS | 37.7 | 1940 | **1840** | 4800 |
| | | 8.0 | RHS | 33.9 | 1750 | **1650** | 4320 |
| | | 6.0 | RHS | 26.2 | 1350 | **1270** | 3330 |
| | | 5.0 | RHS | 22.1 | 1140 | **1080** | 2810 |
| | | 4.0 | RHS | 17.9 | 924 | **873** | 2280 |
| 152 x | 76 x | 6.0 | RHS | 19.4 | 1000 | **944** | 2470 |
| | | 5.0 | RHS | 16.4 | 848 | **801** | 2090 |
| 150 x | 100 x | 10.0 | RHS | 33.4 | 1720 | **1630** | 4260 |
| | | 9.0 | RHS | 30.6 | 1580 | **1490** | 3900 |
| | | 8.0 | RHS | 27.7 | 1430 | **1350** | 3520 |
| | | 6.0 | RHS | 21.4 | 1110 | **1050** | 2730 |
| | | 5.0 | RHS | 18.2 | 937 | **885** | 2310 |
| | | 4.0 | RHS | 14.8 | 762 | **720** | 1880 |
| 150 x | 50 x | 6.0 | RHS | 16.7 | 864 | **816** | 2130 |
| | | 5.0 | RHS | 14.2 | 735 | **694** | 1810 |
| | | 4.0 | RHS | 11.6 | 600 | **567** | 1480 |
| | | 3.0 | RHS | 8.96 | 462 | **436** | 1140 |
| | | 2.5 | RHS | 7.53 | 388 | **367** | 959 |
| | | 2.0 | RHS | 6.07 | 313 | **296** | 774 |
| 127 x | 51 x | 6.0 | RHS | 14.7 | 757 | **715** | 1870 |
| | | 5.0 | RHS | 12.5 | 646 | **610** | 1590 |
| | | 3.5 | RHS | 9.07 | 468 | **442** | 1150 |
| 125 x | 75 x | 6.0 | RHS | 16.7 | 864 | **816** | 2130 |
| | | 5.0 | RHS | 14.2 | 735 | **694** | 1810 |
| | | 4.0 | RHS | 11.6 | 600 | **567** | 1480 |
| | | 3.0 | RHS | 8.96 | 462 | **436** | 1140 |
| | | 2.5 | RHS | 7.53 | 388 | **367** | 959 |
| | | 2.0 | RHS | 6.07 | 313 | **296** | 774 |
| 102 x | 76 x | 6.0 | RHS | 14.7 | 757 | **715** | 1870 |
| | | 5.0 | RHS | 12.5 | 646 | **610** | 1590 |
| | | 3.5 | RHS | 9.07 | 468 | **442** | 1150 |



### Notes:

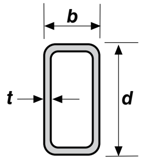
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.

## TABLE 7-4(2)

# Rectangular Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|
| d | b | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | mm | mm | | kg/m | kN | kN | $mm^2$ |
| 100 x | 50 x | 6.0 | RHS | 12.0 | 621 | **586** | 1530 |
| | | 5.0 | RHS | 10.3 | 532 | **503** | 1310 |
| | | 4.0 | RHS | 8.49 | 438 | **414** | 1080 |
| | | 3.5 | RHS | 7.53 | 388 | **367** | 959 |
| | | 3.0 | RHS | 6.60 | 341 | **322** | 841 |
| | | 2.5 | RHS | 5.56 | 287 | **271** | 709 |
| | | 2.0 | RHS | 4.50 | 232 | **219** | 574 |
| | | 1.6 | RHS | 3.64 | 188 | **177** | 463 |
| 76 x | 38 x | 4.0 | RHS | 6.23 | 321 | **303** | 793 |
| | | 3.0 | RHS | 4.90 | 253 | **239** | 625 |
| | | 2.5 | RHS | 4.15 | 214 | **202** | 529 |
| 75 x | 50 x | 6.0 | RHS | 9.67 | 499 | **471** | 1230 |
| | | 5.0 | RHS | 8.35 | 431 | **407** | 1060 |
| | | 4.0 | RHS | 6.92 | 357 | **337** | 881 |
| | | 3.0 | RHS | 5.42 | 280 | **264** | 691 |
| | | 2.5 | RHS | 4.58 | 236 | **223** | 584 |
| | | 2.0 | RHS | 3.72 | 192 | **181** | 474 |
| | | 1.6 | RHS | 3.01 | 155 | **147** | 383 |
| 75 x | 25 x | 2.5 | RHS | 3.60 | 186 | **176** | 459 |
| | | 2.0 | RHS | 2.93 | 151 | **143** | 374 |
| | | 1.6 | RHS | 2.38 | 123 | **116** | 303 |
| 65 x | 35 x | 4.0 | RHS | 5.35 | 276 | **261** | 681 |
| | | 3.0 | RHS | 4.25 | 219 | **207** | 541 |
| | | 2.5 | RHS | 3.60 | 186 | **176** | 459 |
| | | 2.0 | RHS | 2.93 | 151 | **143** | 374 |
| 50 x | 25 x | 3.0 | RHS | 3.07 | 158 | **149** | 391 |
| | | 2.5 | RHS | 2.62 | 135 | **128** | 334 |
| | | 2.0 | RHS | 2.15 | 111 | **105** | 274 |
| | | 1.6 | RHS | 1.75 | 90.4 | **85.4** | 223 |
| 50 x | 20 x | 3.0 | RHS | 2.83 | 146 | **138** | 361 |
| | | 2.5 | RHS | 2.42 | 125 | **118** | 309 |
| | | 2.0 | RHS | 1.99 | 103 | **97.0** | 254 |
| | | 1.6 | RHS | 1.63 | 83.9 | **79.2** | 207 |



### Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 7-5

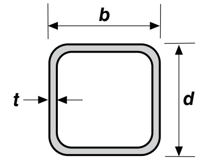
# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

1 SHS

2 C350L0

3 Finish



| Designation | | | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | | mm | | mm | | kg/m | kN | kN | $mm^2$ |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | **294** | 307 | 932 |
| | | | | 5.0 | SHS | 6.39 | **256** | 268 | 814 |
| | | | | 4.0 | SHS | 5.35 | **215** | 224 | 681 |
| | | | | 3.0 | SHS | 4.25 | **170** | 178 | 541 |
| | | | | 2.5 | SHS | 3.60 | **145** | 151 | 459 |
| | | | | 2.0 | SHS | 2.93 | **118** | 123 | 374 |
| | | | | 1.6 | SHS | 2.38 | **95.5** | 99.7 | 303 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | **164** | 171 | 521 |
| | | | | 3.0 | SHS | 3.30 | **133** | 138 | 421 |
| | | | | 2.5 | SHS | 2.82 | **113** | 118 | 359 |
| | | | | 2.0 | SHS | 2.31 | **92.5** | 96.6 | 294 |
| | | | | 1.6 | SHS | 1.88 | **75.3** | 78.7 | 239 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | **114** | 119 | 361 |
| | | | | 2.5 | SHS | 2.42 | **97.3** | 102 | 309 |
| | | | | 2.0 | SHS | 1.99 | **79.9** | 83.5 | 254 |
| | | | | 1.6 | SHS | 1.63 | **65.3** | 68.1 | 207 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | **94.8** | 99.0 | 301 |
| | | | | 2.5 | SHS | 2.03 | **81.6** | 85.2 | 259 |
| | | | | 2.0 | SHS | 1.68 | **67.3** | 70.3 | 214 |
| | | | | 1.6 | SHS | 1.38 | **55.2** | 57.6 | 175 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | **75.9** | 79.2 | 241 |
| | | | | 2.5 | SHS | 1.64 | **65.8** | 68.7 | 209 |
| | | | | 2.0 | SHS | 1.36 | **54.7** | 57.1 | 174 |
| | | | | 1.6 | SHS | 1.12 | **45.1** | 47.1 | 143 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | **42.1** | 44.0 | 134 |
| | | | | 1.6 | SHS | 0.873 | **35.0** | 36.6 | 111 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

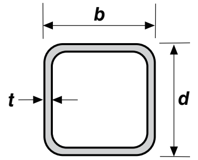
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 7-6(1)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|---|---|
| d | | b | | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | | mm | | mm | | kg/m | kN | kN | mm² |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 9600 | **9060** | 23700 |
| | | | | 12.5 | SHS | 148 | 7630 | **7210** | 18800 |
| | | | | 10.0 | SHS | 120 | 6180 | **5840** | 15300 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 8300 | **7840** | 20500 |
| | | | | 12.5 | SHS | 128 | 6620 | **6250** | 16300 |
| | | | | 10.0 | SHS | 104 | 5370 | **5070** | 13300 |
| | | | | 8.0 | SHS | 84.2 | 4340 | **4100** | 10700 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 7010 | **6620** | 17300 |
| | | | | 12.5 | SHS | 109 | 5600 | **5290** | 13800 |
| | | | | 10.0 | SHS | 88.4 | 4560 | **4310** | 11300 |
| | | | | 8.0 | SHS | 71.6 | 3700 | **3490** | 9120 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 5710 | **5390** | 14100 |
| | | | | 12.5 | SHS | 89.0 | 4590 | **4340** | 11300 |
| | | | | 10.0 | SHS | 72.7 | 3750 | **3540** | 9260 |
| | | | | 9.0 | SHS | 65.9 | 3400 | **3210** | 8400 |
| | | | | 8.0 | SHS | 59.1 | 3050 | **2880** | 7520 |
| | | | | 6.0 | SHS | 45.0 | 2320 | **2190** | 5730 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 4410 | **4170** | 10900 |
| | | | | 12.5 | SHS | 69.4 | 3580 | **3380** | 8840 |
| | | | | 10.0 | SHS | 57.0 | 2940 | **2780** | 7260 |
| | | | | 9.0 | SHS | 51.8 | 2670 | **2520** | 6600 |
| | | | | 8.0 | SHS | 46.5 | 2400 | **2270** | 5920 |
| | | | | 6.0 | SHS | 35.6 | 1840 | **1730** | 4530 |
| | | | | 5.0 | SHS | 29.9 | 1540 | **1460** | 3810 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 2130 | **2010** | 5260 |
| | | | | 9.0 | SHS | 37.7 | 1940 | **1840** | 4800 |
| | | | | 8.0 | SHS | 33.9 | 1750 | **1650** | 4320 |
| | | | | 6.0 | SHS | 26.2 | 1350 | **1270** | 3330 |
| | | | | 5.0 | SHS | 22.1 | 1140 | **1080** | 2810 |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 1720 | **1630** | 4260 |
| | | | | 9.0 | SHS | 30.6 | 1580 | **1490** | 3900 |
| | | | | 8.0 | SHS | 27.7 | 1430 | **1350** | 3520 |
| | | | | 6.0 | SHS | 21.4 | 1110 | **1050** | 2730 |
| | | | | 5.0 | SHS | 18.2 | 937 | **885** | 2310 |
| | | | | 4.0 | SHS | 14.8 | 762 | **720** | 1880 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 1320 | **1250** | 3260 |
| | | | | 9.0 | SHS | 23.5 | 1210 | **1150** | 3000 |
| | | | | 8.0 | SHS | 21.4 | 1100 | **1040** | 2720 |
| | | | | 6.0 | SHS | 16.7 | 864 | **816** | 2130 |
| | | | | 5.0 | SHS | 14.2 | 735 | **694** | 1810 |
| | | | | 4.0 | SHS | 11.6 | 600 | **567** | 1480 |
| | | | | 3.0 | SHS | 8.96 | 462 | **436** | 1140 |
| | | | | 2.5 | SHS | 7.53 | 388 | **367** | 959 |
| | | | | 2.0 | SHS | 6.07 | 313 | **296** | 774 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 348 | **329** | 859 |
| | | | | 2.0 | SHS | 5.45 | 281 | **265** | 694 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 757 | **715** | 1870 |
| | | | | 5.0 | SHS | 12.5 | 646 | **610** | 1590 |
| | | | | 3.5 | SHS | 9.07 | 468 | **442** | 1150 |
| | | | | 2.0 | SHS | 5.38 | 278 | **262** | 686 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 621 | **586** | 1530 |
| | | | | 5.0 | SHS | 10.3 | 532 | **503** | 1310 |
| | | | | 4.0 | SHS | 8.49 | 438 | **414** | 1080 |
| | | | | 3.5 | SHS | 7.53 | 388 | **367** | 959 |
| | | | | 3.0 | SHS | 6.60 | 341 | **322** | 841 |
| | | | | 2.5 | SHS | 5.56 | 287 | **271** | 709 |
| | | | | 2.0 | SHS | 4.50 | 232 | **219** | 574 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 523 | **494** | 1290 |
| | | | | 5.0 | SHS | 8.75 | 451 | **426** | 1110 |
| | | | | 4.0 | SHS | 7.23 | 373 | **352** | 921 |
| | | | | 3.0 | SHS | 5.66 | 292 | **276** | 721 |
| | | | | 2.5 | SHS | 4.78 | 247 | **233** | 609 |
| | | | | 2.0 | SHS | 3.88 | 200 | **189** | 494 |
| | | | | 1.6 | SHS | 3.13 | 162 | **153** | 399 |



## Notes:

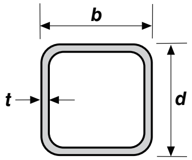
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.

## TABLE 7-6(2)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

| Designation | | | | Mass per m | Axial Tension, $\phi N_t$ | | Gross Section Area |
|---|---|---|---|---|---|---|---|
| d | b | t | | | $\phi N_t$ (1) | $\phi N_t$ (2) | $A_g$ |
| mm | mm | mm | | kg/m | kN | kN | mm² |
| 50 x | 50 x | 6.0 | SHS | 7.32 | 378 | **357** | 932 |
| | | 5.0 | SHS | 6.39 | 330 | **311** | 814 |
| | | 4.0 | SHS | 5.35 | 276 | **261** | 681 |
| | | 3.0 | SHS | 4.25 | 219 | **207** | 541 |
| | | 2.5 | SHS | 3.60 | 186 | **176** | 459 |
| | | 2.0 | SHS | 2.93 | 151 | **143** | 374 |
| | | 1.6 | SHS | 2.38 | 123 | **116** | 303 |
| 40 x | 40 x | 4.0 | SHS | 4.09 | 211 | **199** | 521 |
| | | 3.0 | SHS | 3.30 | 170 | **161** | 421 |
| | | 2.5 | SHS | 2.82 | 145 | **137** | 359 |
| | | 2.0 | SHS | 2.31 | 119 | **112** | 294 |
| | | 1.6 | SHS | 1.88 | 96.9 | **91.5** | 239 |
| 35 x | 35 x | 3.0 | SHS | 2.83 | 146 | **138** | 361 |
| | | 2.5 | SHS | 2.42 | 125 | **118** | 309 |
| | | 2.0 | SHS | 1.99 | 103 | **97.0** | 254 |
| | | 1.6 | SHS | 1.63 | 83.9 | **79.2** | 207 |
| 30 x | 30 x | 3.0 | SHS | 2.36 | 122 | **115** | 301 |
| | | 2.5 | SHS | 2.03 | 105 | **99.0** | 259 |
| | | 2.0 | SHS | 1.68 | 86.5 | **81.7** | 214 |
| | | 1.6 | SHS | 1.38 | 70.9 | **67.0** | 175 |
| 25 x | 25 x | 3.0 | SHS | 1.89 | 97.5 | **92.1** | 241 |
| | | 2.5 | SHS | 1.64 | 84.6 | **79.9** | 209 |
| | | 2.0 | SHS | 1.36 | 70.3 | **66.4** | 174 |
| | | 1.6 | SHS | 1.12 | 58.0 | **54.8** | 143 |
| 20 x | 20 x | 2.0 | SHS | 1.05 | 54.1 | **51.1** | 134 |
| | | 1.6 | SHS | 0.873 | 45.0 | **42.5** | 111 |



### Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of $\phi N_t(1)$ and $\phi N_t(2)$ is highlighted in **bold** type. These terms are defined in Section 7.2.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

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**Tables 8-1 to 8-6 provide the information required to design members for combined actions. All relevant design section capacities in bending, compression, tension and shear are given as well as reduced design section moment capacities. These tables also provide reference to the appropriate tables in Sections 5, 6 and 7 to determine design member capacities in bending, axial compression and axial tension.**

**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

## 8.1 General

This part of the Tables contains design capacities and other parameters which are used to design members subject to combined actions in accordance with Section 8 of AS 4100. Tables 8-1 to 8-6 list design section capacities and references to other tables for checking interaction effects on member capacities.

The design capacities considered in the 8 Series Tables include:

| Design Capacity | Definition | Described in Section No. |
|---|---|---|
| $\phi N_s$ | design section capacity in axial compression | 6.2 |
| $\phi N_t$ | design section capacity in axial tension | 7.2 |
| $\phi M_s$ | design section moment capacity (CHS/SHS) | 5.2.2.1 |
| $\phi M_{sx}$, $\phi M_{sy}$ | $\phi M_s$ about x- and y-axis (RHS) | 5.2.2.1 |
| $\phi M_r$ | $\phi M_s$ reduced by axial force (CHS) | 8.3.1.1, 8.4.1.1 |
| $\phi M_{rx}$ (comp) | $\phi M_{sx}$ reduced by axial compression force (RHS) | 8.3.1.1 |
| $\phi M_{rx}$ (tens) | $\phi M_{sx}$ reduced by axial tension force (RHS) | 8.4.1.1 |
| $\phi M_{ry}$ | $\phi M_{sy}$ reduced by axial force (RHS) | 8.3.2.1, 8.4.2.1 |
| $\phi M_r$ (comp)<br>$\phi M_r$ (tens) | $\phi M_s$ about a principal axis reduced by axial compression and tension force (SHS) | 8.3.1.1, 8.4.1.1 |
| $\phi V_v$ | design shear capacity of a web (CHS/SHS) | 5.2.2.4 |
| $\phi V_{vx}$ | $\phi V_v$ for bending about x-axis (RHS) | 5.2.2.4 |
| $\phi V_{vy}$ | $\phi V_v$ for bending about y-axis (RHS) | 5.2.2.4 |
| $\phi M_z$ | design torsional section moment capacity | 5.2.2.3 |

Note: The above description on direction of shear force on RHS is important - i.e. $\phi V_{vx}$ and $\phi V_{vy}$.

## 8.2 Design for Combined Actions

Sections 8.3 and 8.4 explain the relevant equations from AS 4100 for combined bending and axial compression and combined bending and axial tension respectively. Each of these sections consider uniaxial bending about the major principal x-axis, uniaxial bending about the minor principal y-axis and biaxial bending. Section 8.5 gives the interaction formulae for biaxial bending without axial forces.

In every case both the section capacity and the member capacity must be checked.

**For all cases of combined bending and axial force the designer should first ensure that the appropriate design axial capacity (compression or tension) is greater than the design axial force (i.e. $\phi N \geq N^*$) – see part 6 or 7 as appropriate.**

## 8.3 Combined Bending and Axial Compression

In this section:

$\phi$ = 0.9 (Table 3.4 of AS 4100)
$\phi M_{sx}$ = design section moment capacity for bending about the major principal x-axis
$\phi M_{sy}$ = design section moment capacity for bending about the minor principal y-axis
$N^*$ = design axial compressive force
$\phi N_s$ = design section capacity in compression
$\phi N_{cx}$ = design member capacity in compression, for buckling about the x-axis
$\phi N_{cy}$ = design member capacity in compression, for buckling about the y-axis

### 8.3.1 Compression and Uniaxial Bending – about the major principal x-axis

For a member subject to uniaxial bending about the major principal x-axis and axial compression, the following condition must be satisfied:

$M_x^* \leq \min.[\phi M_{rx}; \phi M_{ix}; \phi M_{ox}]$

where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$M_x^*$ = design bending moment about the major principal x-axis
$\phi M_{rx}$ = design section moment capacity ($\phi M_{sx}$) for bending about the major principal x-axis reduced by axial force (see Section 8.3.1.1)
$\phi M_{ix}$ = design in-plane member moment capacity ($\phi M_i$) for bending about the major principal x-axis (see Section 8.3.1.2(a))
$\phi M_{ox}$ = design out-of-plane member moment capacity ($\phi M_o$) for bending about the major principal x-axis (see Section 8.3.1.2(b))

#### 8.3.1.1 Section Capacity

The value of $\phi M_{rx}$ must be determined at all points along the member and the minimum value used to satisfy the inequality in Section 8.3.1.

$$\phi M_{rx} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_s}\right)$$ (Clause 8.3.2 of AS 4100)

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the x-axis with $k_f = 1.0$ and are subject to bending and compression

$$\phi M_{rx} = 1.18\,\phi M_{sx}\left(1-\frac{N^*}{\phi N_s}\right) \le \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

For RHS and SHS to AS/NZS 1163, which are compact about the x-axis with $k_f < 1.0$ and are subject to bending and compression

$$\phi M_{rx} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_s}\right)\left[1+0.18\left(\frac{82-\lambda_w}{82-\lambda_{wy}}\right)\right] \le \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

where $\lambda_w$ = the element slenderness of the web (Clause 6.2.3 of AS 4100)

$$= \frac{d-2t}{t}\sqrt{\frac{f_y}{250}}$$

$\lambda_{wy}$ = the web yield slenderness limit (Table 6.2.4 of AS 4100)
= 40 for RHS and SHS considered in this publication.

### 8.3.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. Where there is sufficient restraint to prevent lateral buckling, only the in-plane requirements of this Section (Section 8.3.1.2) needs to be satisfied. If there is insufficient restraint to prevent lateral buckling, then both the in-plane and out-of-plane requirements of this Section needs to be satisfied.

**(a) In-plane capacity**

$$\phi M_{ix} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_{cx}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

For braced and sway members, the above value of $\phi N_{cx}$ is calculated using an effective length factor ($k_{ex}$) equal to 1.0 (i.e. $L_{ex} = L$), unless a lower value of $k_{ex}$ has been calculated for a braced member, provided that $N^* \le \phi N_{cx}$ where the value of $\phi N_{cx}$ in this inequality is calculated using the value of $k_{ex}$ as calculated from Clauses 4.6.3.2, 4.6.3.3 or 4.6.3.5 of AS 4100.

**(b) Out-of-plane capacity**

$$\phi M_{ox} = \phi M_{bx}\left(1-\frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.4.1 of AS 4100)}$$

where $\phi M_{bx}$ = design member moment capacity for bending about the major principal x-axis for a member without full lateral restraint.

Clauses 8.4.2.2 and 8.4.4.1 of AS 4100 also provides a higher tier method for evaluating $M_{ix}$ and $M_{ox}$ which is dependent on the ratio of the member's end bending moments. Due to the variable nature of these end bending moments, the further consideration of this higher tier method is beyond the scope of this publication.

### 8.3.1.3 Tables

For CHS, Tables 8-1 to 8-2 list $\phi N_s$, $\phi M_s$ and the relationship to $\phi M_r$ (i.e. the design section moment capacity reduced by compression) as listed in Notes 2 and 3 in those Tables to comply with Clause 8.3.2 of AS 4100. For RHS and SHS, Tables 8-3 to 8-6 list $\phi M_{sx}$, $\phi N_s$ and $\phi M_{rx}$ (comp) – the latter parameter refers to $\phi M_{rx}$ a function of $n$ to comply with Section 8.3.1.1. Designers should evaluate $n = N^*/\phi N_s$, then use it to calculate the value of $\phi M_{rx}$ and ensure that it is **less than or equal to** the design section capacity $\phi M_{sx}$. For specific hollow sections, the 8 Series Tables also provide references to other Tables (e.g. $\phi M_b$ (for RHS only), $\phi N_{cx}$ and $\phi N_{cy}$) to evaluate $\phi M_{ix}$ and $\phi M_{ox}$.

## 8.3.2 Compression and Uniaxial Bending – about the minor principal y-axis

For a member subject to uniaxial bending about the minor principal y-axis and axial compression, the following condition must be satisfied:

$M_y^* \le$ min. $[\phi M_{ry};\phi M_{iy}]$
where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$M_y^*$ = design bending moment about the minor principal y-axis
$\phi M_{ry}$ = design section moment capacity ($\phi M_s$) for bending about the minor principal y-axis reduced by axial force (see Section 8.3.2.1)
$\phi M_{iy}$ = design in-plane member moment capacity ($\phi M_i$) for bending about the minor principal y-axis (see Section 8.3.2.2)

CHS and SHS are not required to be assessed in this instance as this would be covered by the interaction check of Section 8.3.1.

### 8.3.2.1 Section Capacity

The value of $\phi M_{ry}$ must be determined at all points along the member and the minimum value is used to satisfy the inequality in Section 8.3.2:

$$\phi M_{ry} = \phi M_{sy}\left(1-\frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the y-axis and are subject to bending and compression:

$$\phi M_{ry} = 1.18\,\phi M_{sy}\left(1-\frac{N^*}{\phi N_s}\right) \leq \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

### 8.3.2.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. For bending about the minor principal y-axis only the in-plane requirements need to be satisfied.

**(a) In-plane capacity**

$$\phi M_{iy} = \phi M_{sy}\left(1-\frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

For braced and sway members, the above value of $\phi N_{cy}$ is calculated using an effective length factor ($k_{ey}$) equal to 1.0 (i.e. $L_{ey} = L$), unless a lower value of $k_{ey}$ has been calculated for a braced member, provided that $N^* \leq \phi N_{cy}$ where the value of $\phi N_{cy}$ in this inequality is calculated using the value of $k_{ey}$ as calculated from Clauses 4.6.3.2, 4.6.3.3 or 4.6.3.5 of AS 4100.

Clause 8.4.2.2 of AS 4100 also provides a higher tier method for evaluating $M_{iy}$ which is dependent on the ratio of the member's end bending moments. Due to the variable nature of these end bending moments, the further consideration of this higher tier method is beyond the scope of this publication.

### 8.3.2.3 Tables

For RHS, Tables 8-3 to 8-4 list $\phi M_{sy}$, $\phi N_s$ and $\phi M_{ry}$ – the latter parameter uses a function of $n$ to comply with Section 8.3.2.1. Designers should evaluate $n = N^*/\phi N_s$, then use it to calculate the value of $\phi M_{ry}$ and ensure that it is **less than or equal to** the design section capacity $\phi M_{sy}$. For specific hollow sections, the 8 Series tables also provide references to other tables (e.g. $\phi N_{cy}$) to evaluate $\phi M_{iy}$.

## 8.3.3 Compression and Biaxial Bending

For a member subject to biaxial bending and axial compression, both the conditions defined in Sections 8.3.3.1 and 8.3.3.2 must be satisfied.

### 8.3.3.1 Section Capacity

$$\frac{N^*}{\phi N_s}+\frac{M_x^*}{\phi M_{sx}}+\frac{M_y^*}{\phi M_{sy}} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections at all points along the member shall satisfy:

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma}+\left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where $\gamma = 1.4 +. \left(\frac{N^*}{\phi N_s}\right) \leq 2.0$

$\phi M_{rx}$ and $\phi M_{ry}$ are calculated using the alternatives presented in Sections 8.3.1.1 and 8.3.2.1.

### 8.3.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4}+\left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \leq 1.0 \qquad \text{(Clause 8.4.5.1 of AS 4100)}$$

where $\phi M_{cx}$ = *lesser* of $\phi M_{ix}$ and $\phi M_{ox}$ (see Section 8.3.1.2)
and $\phi M_{iy}$ is calculated using the method presented in Section 8.3.2.2.

# Part 8

# MEMBERS SUBJECT TO COMBINED ACTIONS

### 8.3.3.3 Tables

For CHS, Table 8-1 and 8-2 list these parameters as $\phi N_s$ and $\phi M_s$. For RHS and SHS, Tables 8-3 to 8-6 list $\phi N_s$, $\phi M_{sx}$ and $\phi M_{sy}$. As noted in Sections 8.3.1.3 and 8.3.2.3, the parameters $\phi M_{rx}$, $\phi M_{ry}$, $\phi M_{ix}$, $\phi M_{iy}$ and $\phi M_{ox}$ can also be calculated from these and other referenced tables.

## 8.4 Combined Bending and Axial Tension

In this section:

$\phi$ = 0.9 (Table 3.4 of AS 4100)
$\phi M_{sx}$ = design section moment capacity for bending about the major principal x-axis
$\phi M_{sy}$ = design section moment capacity for bending about the minor principal y-axis
$N^*$ = design axial tension force
$\phi N_t$ = design section capacity in axial tension

### 8.4.1 Tension and Uniaxial Bending – about the major principal x-axis

For a member subject to uniaxial bending about the major principal x-axis and axial tension, the following conditions must be satisfied:

$M^*_x \le$ min. $[\phi M_{rx}; \phi M_{ox}]$
where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$M^*_x$ = design bending moment about the major principal x-axis
$\phi M_{rx}$ = design section moment capacity ($\phi M_s$) for bending about the major principal x-axis reduced by axial force (see Section 8.4.1.1)
$\phi M_{ox}$ = design out-of-plane member moment capacity ($\phi M_o$) for bending about the major principal x-axis reduced by axial force (see Section 8.4.1.2(a))

### 8.4.1.1 Section Capacity

The value of $\phi M_{rx}$ must be determined at all points along the member and the minimum value used to satisfy the inequality in Section 8.4.1.

$$\phi M_{rx} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_t}\right) \qquad \text{(Clause 8.3.2 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the x-axis and are subject to bending and tension

$$\phi M_{rx} = 1.18\phi M_{sx}\left(1-\frac{N^*}{\phi N_t}\right) \le \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

### 8.4.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis.
Only the out-of-plane capacity needs to be considered.

**(a) Out-of-plane capacity**

$$\phi M_{ox} = \phi M_{bx}\left(1+\frac{N^*}{\phi N_t}\right) \le \phi M_{rx} \qquad \text{(Clause 8.4.4.2 of AS 4100)}$$

where $\phi M_{bx}$ = design member moment capacity for bending about the major principal x-axis and $\phi M_{rx}$ is calculated using the method presented in Section 8.4.1.1.

### 8.4.1.3 Tables

For CHS, Tables 8-1 to 8-2 list $\phi N_t$, $\phi M_s$ and the relationship to $\phi M_r$ (i.e. the design section moment capacity reduced by tension) as listed in Notes 2 and 3 in those Tables to comply with Clause 8.3.2 of AS 4100. For RHS and SHS, Tables 8-3 to 8-6 list $\phi M_{sx}$, $\phi N_t$ and $\phi M_{rx}$ (tens) – the latter parameter refers to $\phi M_{rx}$ as a function of $n$ to comply with Section 8.3.1.1. Designers should evaluate $n = N^*/\phi N_t$, then use it to calculate the value of $\phi M_{rx}$ and ensure that it is **less than or equal to** the design section capacity $\phi M_{sx}$. For specific hollow sections, the 8 Series Tables also provide references to other Tables – e.g. $\phi M_b$ for RHS (whereas $\phi M_b = \phi M_s$ generally for CHS/SHS) – to evaluate $\phi M_{ox}$.

### 8.4.2 Tension and Uniaxial Bending – about the minor principal y-axis

For a member subject to uniaxial bending about the minor principal y-axis and axial tension, the following condition must be satisfied:

$M^*_y \le \phi M_{ry}$
where $\phi$ = 0.9 (Table 3.4 of AS 4100)
$M^*_y$ = design bending moment about the minor principal y-axis
$\phi M_{ry}$ = design section moment capacity ($\phi M_s$) for bending about the minor principal y-axis reduced by axial force (see Section 8.3.2.1).

CHS and SHS are not required to be assessed in this instance as this would be covered by the interaction check of Section 8.4.1.

### 8.4.2.1 Section Capacity

The value of $\phi M_{ry}$ must be determined at all points along the member and the minimum value is used to satisfy the inequality in Section 8.4.2:

$$\phi M_{ry} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_t}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the y-axis and are subject to bending and compression:

$$\phi M_{ry} = 1.18\,\phi M_{sy}\left(1 - \frac{N^*}{\phi N_t}\right) \leq \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

### 8.4.2.2 Tables

For RHS, Tables 8-3 and 8-4 list $\phi M_{sy}$, $\phi N_t$ and $\phi M_{ry}$ – the latter parameter uses a function of $n$ to comply with Section 8.3.2.1. Designers should evaluate $n = N^*/\phi N_t$, then use it to calculate the value of $\phi M_{ry}$ and ensure that it is **less than or equal to** the design section capacity $\phi M_{sy}$.

## 8.4.3 Tension and Biaxial Bending

For a member subject to biaxial bending and axial tension, both the conditions defined in Sections 8.4.3.1 and 8.4.3.2 must be satisfied.

### 8.4.3.1 Section Capacity

$$\frac{N^*}{\phi N_t} + \frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections at all points along the member shall satisfy:

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where $\gamma = 1.4 + \cdot\left(\frac{N^*}{\phi N_t}\right) \leq 2.0$

$\phi M_{rx}$ and $\phi M_{ry}$ are calculated using the methods presented in Sections 8.4.1.1 and 8.4.2.1.

### 8.4.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{tx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{1.4} \leq 1.0 \qquad \text{(Clause 8.4.5.2 of AS 4100)}$$

where $\phi M_{tx}$ = *lesser* of $\phi M_{rx}$ and $\phi M_{ox}$ (see Sections 8.4.1.1 and 8.4.1.2) and $\phi M_{ry}$ is calculated using the method presented in Section 8.4.2.1.

### 8.4.3.3 Tables

For CHS, Tables 8-1 and 8-2 list these parameters as $\phi N_t$ and $\phi M_s$. For RHS and SHS, Tables 8-3 to 8-6 list $\phi N_t$, $\phi M_{sx}$ and $\phi M_{sy}$. As noted in Sections 8.4.1.3 and 8.4.2.2, the parameters $\phi M_{rx}$, $\phi M_{ry}$, and $\phi M_{ox}$ can also be calculated from these and other referenced tables.

## 8.5 Biaxial Bending in the absence of Axial Force

In this section:

$\phi$ = 0.9 (Table 3.4 of AS 4100)
$M_x^*$ = design bending moment about the major principal x-axis
$\phi M_{sx}$ = design section moment capacity for bending about the major principal x-axis
$M_y^*$ = design bending moment about the minor principal y-axis
$\phi M_{sy}$ = design section moment capacity for bending about the minor principal y-axis

For a member subject to biaxial bending without any axial force, the following conditions defined in Sections 8.5.1 and 8.5.2 must be satisfied.

### 8.5.1 Section Capacity

The following inequality must be satisfied at all points along the member:

$$\frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections of all points along the member shall satisfy:

$$\left(\frac{M_x^*}{\phi M_{sx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1.0 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

## 8.5.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{bx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \le 1.0 \qquad \text{(Clause 8.4.5 of AS 4100)}$$

where $\phi M_{bx}$ = design member moment capacity for bending about the major principal x-axis.

## 8.5.3 Tables

Tables 8-1 to 8-2 list $\phi M_s$ for CHS. For RHS, Table 8-3 and 8-4 lists $\phi M_{sx}$ and $\phi M_{sy}$. For SHS, Tables 8-5 and 8-6 list these parameters as $\phi M_{sx}$. For specific hollow sections, the 8 Series Tables also provide references to other Tables – e.g. $\phi M_b$ for RHS (whereas $\phi M_b = \phi M_s$ generally for CHS/SHS) – to evaluate $\phi M_{bx}$.

## 8.6 Example

Considering further Example 1 of Section 4.3, the adequacy of the braced Beam-Column under the calculated design action effects from a first-order elastic analysis plus moment amplification in accordance with section 4 of AS 4100, is assessed.

<u>Design Data:</u>

Section: 250 x 150 x 12.5 RHS – Grade C450L0 (C450PLUS®) steel
Section is Compact about both axes.

Effective lengths: Flexural buckling (x-axis) = 10.0 m (for axial compression)
Flexural buckling (y-axis) = 5.0 m (for axial compression)
Lateral buckling = 5.0 m (for bending about x-axis)

Design action effects: $N^*$ = 450 kN
$M_x^*$ = 135 kNm
$M_y^*$ = 24.6 kNm

<u>Solution:</u> The example involves biaxial bending and axial compression as described in Section 8.3.3 of these Tables.

(i) Section Capacity Check (Section 8.3.3.1) – using the higher tier provision

From Table 8-4(1):

$\phi N_s$ = 3580 kN $(> N^*)$
$\phi M_{sx}$ = 282 kNm
$\phi M_{sy}$ = 198 kNm

Now $n = \dfrac{N^*}{\phi N_s} = \dfrac{450}{3580} = 0.126$

Using Table 8-4(1) again:

$\phi M_{rx}\ (comp) = 332 \text{ x } (1 - 0.126) = 290 \text{ kNm} > \phi M_{sx}$
$\therefore\ \phi M_{rx} = \phi M_{sx} = 282 \text{ kNm}$
$\phi M_{ry} = 233 \text{ x } (1 - 0.126) = 204 \text{ kNm} > \phi M_{sy}$
$\therefore\ \phi M_{ry} = \phi M_{sy} = 198 \text{ kNm}$

Now $\gamma = 1.4 + \left(\dfrac{N^*}{\phi N_s}\right) = 1.53 < 2.0$

Then $\left(\dfrac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\dfrac{M_y^*}{\phi M_{ry}}\right)^{\gamma} = \left(\dfrac{135}{282}\right)^{1.53} + \left(\dfrac{24.6}{198}\right)^{1.53} = 0.365 \quad (< 1.0 \ \therefore \text{ O.K.})$

The above interaction equation was used as the section is Compact about both x- and y-axes (see Table 3.1-4(1)).

(ii) Member Capacity Check (Section 8.3.3.2)

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \le 1.0$$

From the Tables noted below:

$\phi M_{bx}$ = 282 kNm (Table 5.3-2(1) for $L_e = 5.0$ m) (based on $\alpha_m = 1.0$)
$\phi N_{cx}$ = 1100 kN (Table 6-4(1)(A) for $L_{ex} = 10.0$ m)
$\phi N_{cy}$ = 1800 kN (Table 6-4(1)(B) for $L_{ey} = 5.0$ m)

For this example, the moment distribution for x-axis bending is not uniform though the above value of $\phi M_{bx}$ is based on the uniform moment case. From Table 5.6.1 of AS 4100, $\alpha_m = 1.75$

$\therefore\ \phi M_{bx} = \min.\ [\alpha_m (\phi M_{bx});\ \phi M_{sx}]$
$= \min.\ [1.75 \text{ x } 282\ ;\ 282]$
$= 282 \text{ kNm}$

Calculate the in-plane and out-of-plane capacities

(a) $$\phi M_{ix} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_{cx}}\right)$$

$$= 282 \text{ x } \left(1-\frac{450}{1100}\right)$$

$$= 167 \text{ kNm}$$

(b) $$\phi M_{ox} = \phi M_{bx}\left(1-\frac{N^*}{\phi N_{cy}}\right)$$

$$= 282 \text{ x } \left(1-\frac{450}{1800}\right)$$

$$= 212 \text{ kNm}$$

$$\therefore \quad \phi M_{cx} = \text{min. } [\phi M_{ix}; \phi M_{ox}]$$

$$= 167 \text{ kNm}$$

and $$\phi M_{iy} = \phi M_{sy}\left(1-\frac{N^*}{\phi N_{cy}}\right)$$

$$= 198 \text{ x } \left(1-\frac{450}{1800}\right)$$

$$= 149 \text{ kNm}$$

Thus $$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} = \left(\frac{135}{167}\right)^{1.4} + \left(\frac{24.6}{149}\right)^{1.4}$$

$$= 0.823\,(< 1.0 \therefore \text{O.K.})$$

Further consideration of the use of design capacity tables for members subject to combined actions can be found in Ref.[8.1].

## 8.7 References

[8.1] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., "Worked Examples for Steel Structures", third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – Australian Steel Institute).

**See Section 1.1.2 for details on reference Standards.**

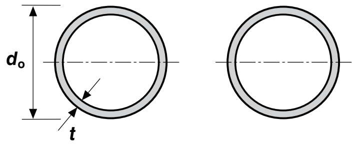
TABLE 8-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN SECTION CAPACITIES

### *about any axis*

| Designation | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | Design Shear Capacity | Torsion |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Comp | Tens | | | |
| $d_o$ | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_s$ | $\phi V_v$ | $\phi M_Z$ |
| mm | | mm | | kg/m | kN | kN | kNm | kN | kNm |
| 165.1 | x | 5.4 | CHS | 21.3 | 610 | 610 | 31.0 | 219 | 28.3 |
| | | 5.0 | CHS | 19.7 | 566 | 566 | 28.8 | 204 | 26.4 |
| 139.7 | x | 5.4 | CHS | 17.9 | 513 | 513 | 21.9 | 185 | 19.9 |
| | | 5.0 | CHS | 16.6 | 476 | 476 | 20.4 | 171 | 18.6 |
| 114.3 | x | 5.4 | CHS | 14.5 | 416 | 416 | 14.4 | 150 | 13.0 |
| | | 4.5 | CHS | 12.2 | 349 | 349 | 12.2 | 126 | 11.1 |
| 101.6 | x | 5.0 | CHS | 11.9 | 341 | 341 | 10.5 | 123 | 9.43 |
| | | 4.0 | CHS | 9.63 | 276 | 276 | 8.58 | 99.3 | 7.77 |
| 88.9 | x | 5.9 | CHS | 12.1 | 346 | 346 | 9.16 | 125 | 8.09 |
| | | 5.0 | CHS | 10.3 | 297 | 297 | 7.93 | 107 | 7.07 |
| | | 4.0 | CHS | 8.38 | 240 | 240 | 6.49 | 86.4 | 5.85 |
| 76.1 | x | 5.9 | CHS | 10.2 | 293 | 293 | 6.56 | 105 | 5.73 |
| | | 4.5 | CHS | 7.95 | 228 | 228 | 5.20 | 82.0 | 4.62 |
| | | 3.6 | CHS | 6.44 | 184 | 184 | 4.26 | 66.4 | 3.83 |
| 60.3 | x | 5.4 | CHS | 7.31 | 210 | 210 | 3.67 | 75.4 | 3.17 |
| | | 4.5 | CHS | 6.19 | 177 | 177 | 3.16 | 63.9 | 2.77 |
| | | 3.6 | CHS | 5.03 | 144 | 144 | 2.61 | 51.9 | 2.32 |
| 48.3 | x | 4.0 | CHS | 4.37 | 125 | 125 | 1.77 | 45.1 | 1.54 |
| | | 3.2 | CHS | 3.56 | 102 | 102 | 1.47 | 36.7 | 1.30 |
| 42.4 | x | 4.0 | CHS | 3.79 | 109 | 109 | 1.33 | 39.1 | 1.15 |
| | | 3.2 | CHS | 3.09 | 88.7 | 88.7 | 1.11 | 31.9 | 0.970 |
| 33.7 | x | 4.0 | CHS | 2.93 | 84.0 | 84.0 | 0.799 | 30.2 | 0.671 |
| | | 3.2 | CHS | 2.41 | 69.0 | 69.0 | 0.672 | 24.8 | 0.578 |
| 26.9 | x | 4.0 | CHS | 2.26 | 64.7 | 64.7 | 0.477 | 23.3 | 0.390 |
| | | 3.2 | CHS | 1.87 | 53.6 | 53.6 | 0.407 | 19.3 | 0.342 |
| | | 2.6 | CHS | 1.56 | 44.7 | 44.7 | 0.347 | 16.1 | 0.297 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi M_r$ = design section moment capacity reduced by compression or tension, and must be less than or equal to $\phi M_s$.
3. For all CHS, $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$.
4. For all CHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
5. For the design member capacity in compression $\phi N_c$, see Table 6-1.
6. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

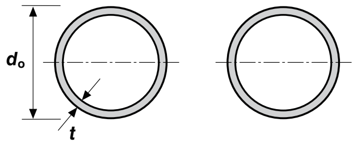
TABLE 8-2(1)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

### *about any axis*

| Designation | | | | Mass per m | Design Section Axial Capacities<br>Comp | <br>Tens | Design Section Moment Capacities | Design Shear Capacity | Torsion |
|---|---|---|---|---|---|---|---|---|---|
| $d_o$ | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_s$ | $\phi V_v$ | $\phi M_Z$ |
| mm | | mm | | kg/m | kN | kN | kNm | kN | kNm |
| 508.0 | x | 12.7 | CHS | 155 | 6220 | 6220 | 962 | 2240 | 902 |
| | | 9.5 | CHS | 117 | 4690 | 4690 | 683 | 1690 | 688 |
| | | 6.4 | CHS | 79.2 | 2720 | 3180 | 408 | 1140 | 472 |
| 457.0 | x | 12.7 | CHS | 139 | 5580 | 5580 | 789 | 2010 | 724 |
| | | 9.5 | CHS | 105 | 4210 | 4210 | 565 | 1510 | 553 |
| | | 6.4 | CHS | 71.1 | 2580 | 2850 | 343 | 1030 | 380 |
| 406.4 | x | 12.7 | CHS | 123 | 4950 | 4950 | 620 | 1780 | 567 |
| | | 9.5 | CHS | 93.0 | 3730 | 3730 | 456 | 1340 | 434 |
| | | 6.4 | CHS | 63.1 | 2430 | 2530 | 282 | 912 | 299 |
| 355.6 | x | 12.7 | CHS | 107 | 4310 | 4310 | 471 | 1550 | 428 |
| | | 9.5 | CHS | 81.1 | 3250 | 3250 | 356 | 1170 | 329 |
| | | 6.4 | CHS | 55.1 | 2210 | 2210 | 224 | 796 | 228 |
| 323.9 | x | 12.7 | CHS | 97.5 | 3910 | 3910 | 388 | 1410 | 351 |
| | | 9.5 | CHS | 73.7 | 2960 | 2960 | 296 | 1060 | 271 |
| | | 6.4 | CHS | 50.1 | 2010 | 2010 | 189 | 724 | 188 |
| 273.1 | x | 12.7 | CHS | 81.6 | 3270 | 3270 | 271 | 1180 | 244 |
| | | 9.3 | CHS | 60.5 | 2430 | 2430 | 204 | 874 | 186 |
| | | 6.4 | CHS | 42.1 | 1690 | 1690 | 139 | 608 | 132 |
| | | 4.8 | CHS | 31.8 | 1270 | 1270 | 98.3 | 459 | 101 |
| 219.1 | x | 8.2 | CHS | 42.6 | 1710 | 1710 | 115 | 616 | 104 |
| | | 6.4 | CHS | 33.6 | 1350 | 1350 | 91.2 | 485 | 83.5 |
| | | 4.8 | CHS | 25.4 | 1020 | 1020 | 66.3 | 366 | 64.0 |
| 168.3 | x | 7.1 | CHS | 28.2 | 1130 | 1130 | 58.2 | 408 | 52.6 |
| | | 6.4 | CHS | 25.6 | 1030 | 1030 | 52.9 | 369 | 48.0 |
| | | 4.8 | CHS | 19.4 | 777 | 777 | 40.4 | 280 | 37.0 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi M_r$ = design section moment capacity reduced by compression or tension, and must be less than or equal to $\phi M_s$.
3. For all CHS, $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$.
4. For all CHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
5. For the design member capacity in compression $\phi N_c$, see Table 6-2(1).

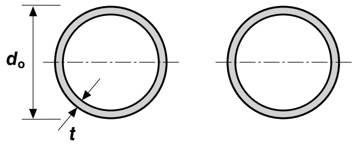
TABLE 8-2(2)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

***about any axis***

| Designation<br>$d_o$ | | $t$ | | Mass per m | Design Section Axial Capacities<br>Comp<br>$\phi N_s$ | <br>Tens<br>$\phi N_t$ | Design Section Moment Capacities<br>$\phi M_s$ | Design Shear Capacity<br>$\phi V_v$ | Torsion<br>$\phi M_z$ |
|---|---|---|---|---|---|---|---|---|---|
| mm | | mm | | kg/m | kN | kN | kNm | kN | kNm |
| 165.1 | x | 3.5 | CHS | 13.9 | 560 | 560 | 27.3 | 201 | 26.6 |
| | | 3.0 | CHS | 12.0 | 481 | 481 | 22.6 | 173 | 23.0 |
| 139.7 | x | 3.5 | CHS | 11.8 | 472 | 472 | 20.1 | 170 | 18.8 |
| | | 3.0 | CHS | 10.1 | 406 | 406 | 16.8 | 146 | 16.3 |
| 114.3 | x | 3.6 | CHS | 9.83 | 394 | 394 | 13.9 | 142 | 12.7 |
| | | 3.2 | CHS | 8.77 | 352 | 352 | 12.4 | 127 | 11.4 |
| 101.6 | x | 3.2 | CHS | 7.77 | 312 | 312 | 9.76 | 112 | 8.92 |
| | | 2.6 | CHS | 6.35 | 255 | 255 | 7.90 | 91.7 | 7.38 |
| 88.9 | x | 3.2 | CHS | 6.76 | 271 | 271 | 7.41 | 97.7 | 6.74 |
| | | 2.6 | CHS | 5.53 | 222 | 222 | 6.10 | 79.9 | 5.59 |
| 76.1 | x | 3.2 | CHS | 5.75 | 231 | 231 | 5.36 | 83.1 | 4.85 |
| | | 2.3 | CHS | 4.19 | 168 | 168 | 3.95 | 60.5 | 3.61 |
| 60.3 | x | 2.9 | CHS | 4.11 | 165 | 165 | 3.01 | 59.3 | 2.71 |
| | | 2.3 | CHS | 3.29 | 132 | 132 | 2.44 | 47.5 | 2.21 |
| 48.3 | x | 2.9 | CHS | 3.25 | 130 | 130 | 1.89 | 46.9 | 1.67 |
| | | 2.3 | CHS | 2.61 | 105 | 105 | 1.53 | 37.7 | 1.38 |
| 42.4 | x | 2.6 | CHS | 2.55 | 102 | 102 | 1.30 | 36.9 | 1.15 |
| | | 2.0 | CHS | 1.99 | 80.0 | 80.0 | 1.03 | 28.8 | 0.926 |
| 33.7 | x | 2.6 | CHS | 1.99 | 80.0 | 80.0 | 0.794 | 28.8 | 0.694 |
| | | 2.0 | CHS | 1.56 | 62.7 | 62.7 | 0.634 | 22.6 | 0.563 |
| 26.9 | x | 2.3 | CHS | 1.40 | 56.0 | 56.0 | 0.440 | 20.2 | 0.381 |
| | | 2.0 | CHS | 1.23 | 49.3 | 49.3 | 0.391 | 17.7 | 0.343 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi M_r$ = design section moment capacity reduced by compression or tension, and must be less than or equal to $\phi M_s$.
3. For all CHS, $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$.
4. For all CHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
5. For the design member capacity in compression $\phi N_c$, see Table 6-2(2).

TABLE 8-3

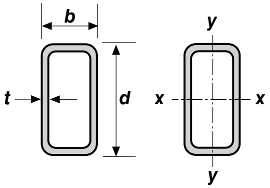
# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

1 **RHS**

2 **C350L0**

3 **Finish**



| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | | | Design Shear Capacities | | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | About x-axis | | | About y-axis | | | | |
| | | | | | | | Comp | Tens | | | | | | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi M_{sy}$ | $\phi M_{ry}$ | $\phi V_{vx}$ | $\phi V_{vy}$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kNm | kNm | kN | kN | kNm |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 145 | 145 | 3.17 | 3.74 (1-n) | 3.74 (1-n) | 1.36 | 1.36 (1-n) | 61.5 | 18.9 | 1.35 |
| | | | | 2.0 | RHS | 2.93 | 113 | 118 | 2.62 | 3.07 (1-n) | 3.09 (1-n) | 1.00 | 1.00 (1-n) | 49.9 | 15.9 | 1.14 |
| | | | | 1.6 | RHS | 2.38 | 77.6 | 95.5 | 2.15 | 2.41 (1-n) | 2.53 (1-n) | 0.699 | 0.699 (1-n) | 40.4 | 13.2 | 0.954 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 215 | 215 | 4.18 | 4.94 (1-n) | 4.94 (1-n) | 2.70 | 3.19 (1-n) | 82.4 | 40.8 | 2.37 |
| | | | | 3.0 | RHS | 4.25 | 170 | 170 | 3.46 | 4.09 (1-n) | 4.09 (1-n) | 2.24 | 2.64 (1-n) | 64.0 | 32.9 | 1.97 |
| | | | | 2.5 | RHS | 3.60 | 145 | 145 | 2.98 | 3.51 (1-n) | 3.51 (1-n) | 1.93 | 2.28 (1-n) | 54.2 | 28.4 | 1.72 |
| | | | | 2.0 | RHS | 2.93 | 118 | 118 | 2.46 | 2.90 (1-n) | 2.90 (1-n) | 1.48 | 1.48 (1-n) | 44.1 | 23.4 | 1.44 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 123 | 123 | 1.85 | 2.18 (1-n) | 2.18 (1-n) | 1.12 | 1.33 (1-n) | 47.5 | 21.5 | 0.979 |
| | | | | 2.5 | RHS | 2.62 | 105 | 105 | 1.61 | 1.90 (1-n) | 1.90 (1-n) | 0.982 | 1.16 (1-n) | 40.5 | 18.9 | 0.869 |
| | | | | 2.0 | RHS | 2.15 | 86.2 | 86.2 | 1.34 | 1.58 (1-n) | 1.58 (1-n) | 0.824 | 0.972 (1-n) | 33.1 | 15.9 | 0.741 |
| | | | | 1.6 | RHS | 1.75 | 70.3 | 70.3 | 1.11 | 1.31 (1-n) | 1.31 (1-n) | 0.644 | 0.644 (1-n) | 27.0 | 13.2 | 0.623 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 114 | 114 | 1.62 | 1.92 (1-n) | 1.92 (1-n) | 0.827 | 0.976 (1-n) | 46.9 | 15.9 | 0.733 |
| | | | | 2.5 | RHS | 2.42 | 97.3 | 97.3 | 1.42 | 1.68 (1-n) | 1.68 (1-n) | 0.729 | 0.861 (1-n) | 40.0 | 14.2 | 0.659 |
| | | | | 2.0 | RHS | 1.99 | 79.9 | 79.9 | 1.19 | 1.41 (1-n) | 1.41 (1-n) | 0.616 | 0.727 (1-n) | 32.7 | 12.1 | 0.568 |
| | | | | 1.6 | RHS | 1.63 | 65.3 | 65.3 | 0.989 | 1.17 (1-n) | 1.17 (1-n) | 0.484 | 0.484 (1-n) | 26.6 | 10.2 | 0.482 |

### Notes:

1. ***REFER*** **to the Australian Tube Mills** ***PRODUCT AVAILABILITY GUIDE*** **(PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi M_{rx}$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_{sx}$.
3. $\phi M_{rx}$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_{sx}$.
4. $\phi M_{ry}$ refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to $\phi M_{sy}$.
5. For the design member moment capacity $\phi M_b$, see Table 5.3-1.
6. For the design member capacity in compression (x-axis) $\phi N_{cx}$, see Table 6-3(A).
7. For the design member capacity in compression (y-axis) $\phi N_{cy}$, see Table 6-3(B).

### ADDITIONAL NOTES:

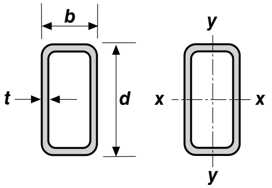
**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 8-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES



| Designation d | b | t | | Mass per m | Design Section Axial Capacities Comp $\phi N_s$ | Tens $\phi N_t$ | Design Section Moment Capacities About x-axis $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | About y-axis $\phi M_{sy}$ | $\phi M_{ry}$ | Design Shear Capacities $\phi V_{vx}$ | $\phi V_{vy}$ | Torsion $\phi M_z$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | mm | mm | | kg/m | kN | kN | kNm | kNm | kNm | kNm | kNm | kN | kN | kNm |
| 400 | x 300 | x 16.0 | RHS | 161 | 8300 | 7840 | 1110 | 1320 (1-n) | 1320 (1-n) | 905 | 905 (1-n) | 2790 | 2080 | 771 |
| | | 12.5 | RHS | 128 | 6590 | 6250 | 901 | 1060 (1-n) | 1060 (1-n) | 641 | 641 (1-n) | 2220 | 1670 | 628 |
| | | 10.0 | RHS | 104 | 4710 | 5070 | 649 | 649 (1-n) | 649 (1-n) | 454 | 454 (1-n) | 1800 | 1360 | 518 |
| | | 8.0 | RHS | 84.2 | 3110 | 4100 | 463 | 463 (1-n) | 463 (1-n) | 324 | 324 (1-n) | 1450 | 1100 | 425 |
| 400 | x 200 | x 16.0 | RHS | 136 | 7010 | 6620 | 866 | 1020 (1-n) | 1020 (1-n) | 527 | 527 (1-n) | 2730 | 1310 | 485 |
| | | 12.5 | RHS | 109 | 5580 | 5290 | 705 | 831 (1-n) | 832 (1-n) | 379 | 379 (1-n) | 2170 | 1060 | 401 |
| | | 10.0 | RHS | 88.4 | 3900 | 4310 | 581 | 658 (1-n) | 685 (1-n) | 266 | 266 (1-n) | 1760 | 875 | 334 |
| | | 8.0 | RHS | 71.6 | 2750 | 3490 | 467 | 467 (1-n) | 467 (1-n) | 188 | 188 (1-n) | 1420 | 715 | 275 |
| 350 | x 250 | x 16.0 | RHS | 136 | 7010 | 6620 | 807 | 952 (1-n) | 952 (1-n) | 641 | 756 (1-n) | 2400 | 1700 | 543 |
| | | 12.5 | RHS | 109 | 5600 | 5290 | 657 | 775 (1-n) | 775 (1-n) | 487 | 487 (1-n) | 1920 | 1370 | 446 |
| | | 10.0 | RHS | 88.4 | 4300 | 4310 | 533 | 533 (1-n) | 533 (1-n) | 350 | 350 (1-n) | 1560 | 1120 | 370 |
| | | 8.0 | RHS | 71.6 | 3080 | 3490 | 376 | 376 (1-n) | 376 (1-n) | 249 | 249 (1-n) | 1260 | 910 | 304 |
| 300 | x 200 | x 16.0 | RHS | 111 | 5710 | 5390 | 548 | 647 (1-n) | 647 (1-n) | 414 | 489 (1-n) | 2020 | 1310 | 354 |
| | | 12.5 | RHS | 89.0 | 4590 | 4340 | 450 | 531 (1-n) | 531 (1-n) | 341 | 402 (1-n) | 1620 | 1060 | 294 |
| | | 10.0 | RHS | 72.7 | 3750 | 3540 | 373 | 440 (1-n) | 440 (1-n) | 254 | 254 (1-n) | 1320 | 875 | 246 |
| | | 8.0 | RHS | 59.1 | 2750 | 2880 | 302 | 302 (1-n) | 302 (1-n) | 181 | 181 (1-n) | 1070 | 715 | 204 |
| | | 6.0 | RHS | 45.0 | 1750 | 2190 | 192 | 192 (1-n) | 192 (1-n) | 116 | 116 (1-n) | 813 | 548 | 158 |
| 250 | x 150 | x 16.0 | RHS | 85.5 | 4410 | 4170 | 338 | 398 (1-n) | 398 (1-n) | 236 | 279 (1-n) | 1630 | 918 | 203 |
| | | 12.5 | RHS | 69.4 | 3580 | 3380 | 282 | 332 (1-n) | 332 (1-n) | 198 | 233 (1-n) | 1320 | 759 | 173 |
| | | 10.0 | RHS | 57.0 | 2940 | 2780 | 236 | 278 (1-n) | 278 (1-n) | 164 | 164 (1-n) | 1080 | 632 | 146 |
| | | 9.0 | RHS | 51.8 | 2670 | 2520 | 216 | 255 (1-n) | 255 (1-n) | 143 | 143 (1-n) | 976 | 577 | 135 |
| | | 8.0 | RHS | 46.5 | 2400 | 2270 | 195 | 230 (1-n) | 230 (1-n) | 121 | 121 (1-n) | 875 | 521 | 122 |
| | | 6.0 | RHS | 35.6 | 1550 | 1730 | 149 | 149 (1-n) | 149 (1-n) | 77.5 | 77.5 (1-n) | 668 | 402 | 96.0 |
| | | 5.0 | RHS | 29.9 | 1180 | 1460 | 111 | 111 (1-n) | 111 (1-n) | 58.5 | 58.5 (1-n) | 561 | 340 | 81.8 |

### Notes:

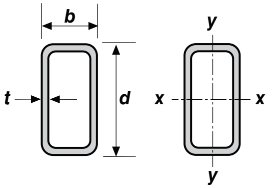
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi M_{rx}$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_{sx}$.
4. $\phi M_{rx}$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_{sx}$.
5. $\phi M_{ry}$ refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to $\phi M_{sy}$.
6. For the design member moment capacity $\phi M_b$, see Table 5.3-2(1).
7. For the design member capacity in compression (x-axis) $\phi N_{cx}$, see Table 6-4(1)(A).
8. For the design member capacity in compression (y-axis) $\phi N_{cy}$, see Table 6-4(1)(B).

TABLE 8-4(2)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | | | Design Shear Capacities | | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | About x-axis | | | About y-axis | | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi M_{sy}$ | $\phi M_{ry}$ | $\phi V_{vx}$ | $\phi V_{vy}$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kNm | kNm | kN | kN | kNm |
| 200 | x | 100 | x | 10.0 | RHS | 41.3 | 2130 | 2010 | 129 | 152 (1-n) | 152 (1-n) | 79.1 | 93.3 (1-n) | 833 | 389 | 71.0 |
| | | | | 9.0 | RHS | 37.7 | 1940 | 1840 | 119 | 140 (1-n) | 140 (1-n) | 73.1 | 86.2 (1-n) | 758 | 359 | 66.0 |
| | | | | 8.0 | RHS | 33.9 | 1750 | 1650 | 108 | 128 (1-n) | 128 (1-n) | 65.9 | 65.9 (1-n) | 681 | 327 | 60.7 |
| | | | | 6.0 | RHS | 26.2 | 1310 | 1270 | 85.1 | 99.7 (1-n) | 100 (1-n) | 44.4 | 44.4 (1-n) | 522 | 257 | 48.5 |
| | | | | 5.0 | RHS | 22.1 | 974 | 1080 | 72.6 | 82.2 (1-n) | 85.6 (1-n) | 33.3 | 33.3 (1-n) | 440 | 219 | 41.7 |
| | | | | 4.0 | RHS | 17.9 | 688 | 873 | 58.4 | 58.4 (1-n) | 58.4 (1-n) | 23.5 | 23.5 (1-n) | 355 | 179 | 34.4 |
| 152 | x | 76 | x | 6.0 | RHS | 19.4 | 1000 | 944 | 47.0 | 55.5 (1-n) | 55.5 (1-n) | 28.4 | 28.4 (1-n) | 389 | 187 | 26.4 |
| | | | | 5.0 | RHS | 16.4 | 848 | 801 | 40.4 | 47.7 (1-n) | 47.7 (1-n) | 22.3 | 22.3 (1-n) | 329 | 160 | 22.9 |
| 150 | x | 100 | x | 10.0 | RHS | 33.4 | 1720 | 1630 | 80.7 | 95.2 (1-n) | 95.2 (1-n) | 60.9 | 71.8 (1-n) | 611 | 389 | 51.3 |
| | | | | 9.0 | RHS | 30.6 | 1580 | 1490 | 74.8 | 88.3 (1-n) | 88.3 (1-n) | 56.5 | 66.7 (1-n) | 559 | 359 | 47.9 |
| | | | | 8.0 | RHS | 27.7 | 1430 | 1350 | 68.5 | 80.8 (1-n) | 80.8 (1-n) | 51.8 | 61.1 (1-n) | 504 | 327 | 44.2 |
| | | | | 6.0 | RHS | 21.4 | 1110 | 1050 | 54.4 | 64.2 (1-n) | 64.2 (1-n) | 40.7 | 40.7 (1-n) | 389 | 257 | 35.6 |
| | | | | 5.0 | RHS | 18.2 | 937 | 885 | 46.6 | 55.0 (1-n) | 55.0 (1-n) | 31.8 | 31.8 (1-n) | 329 | 219 | 30.7 |
| | | | | 4.0 | RHS | 14.8 | 688 | 720 | 37.8 | 37.8 (1-n) | 37.8 (1-n) | 22.6 | 22.6 (1-n) | 267 | 179 | 25.5 |
| 150 | x | 50 | x | 6.0 | RHS | 16.7 | 864 | 816 | 36.9 | 43.6 (1-n) | 43.6 (1-n) | 16.4 | 16.4 (1-n) | 374 | 111 | 15.6 |
| | | | | 5.0 | RHS | 14.2 | 735 | 694 | 31.9 | 37.7 (1-n) | 37.7 (1-n) | 12.9 | 12.9 (1-n) | 316 | 97.2 | 13.8 |
| | | | | 4.0 | RHS | 11.6 | 526 | 567 | 26.5 | 30.4 (1-n) | 31.3 (1-n) | 9.19 | 9.19 (1-n) | 257 | 81.6 | 11.7 |
| | | | | 3.0 | RHS | 8.96 | 329 | 436 | 20.8 | 22.4 (1-n) | 24.6 (1-n) | 5.89 | 5.89 (1-n) | 195 | 64.2 | 9.30 |
| | | | | 2.5 | RHS | 7.53 | 246 | 367 | 17.6 | 17.9 (1-n) | 20.8 (1-n) | 4.40 | 4.40 (1-n) | 164 | 54.7 | 7.97 |
| | | | | 2.0 | RHS | 6.07 | 173 | 296 | 12.8 | 12.8 (1-n) | 12.8 (1-n) | 3.10 | 3.10 (1-n) | 132 | 44.7 | 6.55 |
| 127 | x | 51 | x | 6.0 | RHS | 14.7 | 757 | 715 | 27.9 | 32.9 (1-n) | 32.9 (1-n) | 14.5 | 17.1 (1-n) | 315 | 114 | 13.3 |
| | | | | 5.0 | RHS | 12.5 | 646 | 610 | 24.3 | 28.6 (1-n) | 28.6 (1-n) | 12.4 | 12.4 (1-n) | 267 | 99.6 | 11.8 |
| | | | | 3.5 | RHS | 9.07 | 423 | 442 | 18.1 | 20.8 (1-n) | 21.3 (1-n) | 7.49 | 7.49 (1-n) | 192 | 74.8 | 9.04 |
| 125 | x | 75 | x | 6.0 | RHS | 16.7 | 864 | 816 | 34.1 | 40.2 (1-n) | 40.2 (1-n) | 23.9 | 28.2 (1-n) | 317 | 184 | 21.0 |
| | | | | 5.0 | RHS | 14.2 | 735 | 694 | 29.5 | 34.8 (1-n) | 34.8 (1-n) | 20.5 | 20.5 (1-n) | 269 | 158 | 18.3 |
| | | | | 4.0 | RHS | 11.6 | 600 | 567 | 24.4 | 28.8 (1-n) | 28.8 (1-n) | 15.1 | 15.1 (1-n) | 219 | 130 | 15.3 |
| | | | | 3.0 | RHS | 8.96 | 390 | 436 | 18.8 | 18.8 (1-n) | 18.8 (1-n) | 9.80 | 9.80 (1-n) | 167 | 101 | 12.0 |
| | | | | 2.5 | RHS | 7.53 | 296 | 367 | 14.1 | 14.1 (1-n) | 14.1 (1-n) | 7.39 | 7.39 (1-n) | 140 | 85.1 | 10.2 |
| | | | | 2.0 | RHS | 6.07 | 196 | 296 | 10.0 | 10.0 (1-n) | 10.0 (1-n) | 5.27 | 5.27 (1-n) | 113 | 69.0 | 8.36 |
| 102 | x | 76 | x | 6.0 | RHS | 14.7 | 757 | 715 | 25.1 | 29.6 (1-n) | 29.6 (1-n) | 20.5 | 24.1 (1-n) | 255 | 187 | 17.0 |
| | | | | 5.0 | RHS | 12.5 | 646 | 610 | 21.7 | 25.7 (1-n) | 25.7 (1-n) | 17.8 | 21.0 (1-n) | 218 | 160 | 14.9 |
| | | | | 3.5 | RHS | 9.07 | 468 | 442 | 16.1 | 19.1 (1-n) | 19.1 (1-n) | 12.1 | 12.1 (1-n) | 157 | 117 | 11.2 |



### Notes:

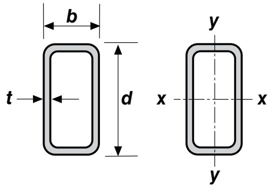
1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y$ = 450 MPa and $f_u$ = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi M_{rx}$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_{sx}$.
4. $\phi M_{rx}$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_{sx}$.
5. $\phi M_{ry}$ refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to $\phi M_{sy}$.
6. For the design member moment capacity $\phi M_b$, see Table 5.3-2(2).
7. For the design member capacity in compression (x-axis) $\phi N_{cx}$, see Table 6-4(2)(A).
8. For the design member capacity in compression (y-axis) $\phi N_{cy}$, see Table 6-4(2)(B).

TABLE 8-4(3)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | | | Design Shear Capacities | | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | About x-axis | | | About y-axis | | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi M_{sy}$ | $\phi M_{ry}$ | $\phi V_{vx}$ | $\phi V_{vy}$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kNm | kNm | kN | kN | kNm |
| 100 | x | 50 | x | 6.0 | RHS | 12.0 | 621 | 586 | 18.4 | 21.7 (1-n) | 21.7 (1-n) | 11.2 | 13.3 (1-n) | 244 | 111 | 9.94 |
| | | | | 5.0 | RHS | 10.3 | 532 | 503 | 16.1 | 19.0 (1-n) | 19.0 (1-n) | 9.88 | 11.7 (1-n) | 208 | 97.2 | 8.87 |
| | | | | 4.0 | RHS | 8.49 | 438 | 414 | 13.5 | 16.0 (1-n) | 16.0 (1-n) | 8.23 | 8.23 (1-n) | 170 | 81.6 | 7.58 |
| | | | | 3.5 | RHS | 7.53 | 388 | 367 | 12.1 | 14.3 (1-n) | 14.3 (1-n) | 6.92 | 6.92 (1-n) | 151 | 73.1 | 6.85 |
| | | | | 3.0 | RHS | 6.60 | 329 | 322 | 10.8 | 12.6 (1-n) | 12.7 (1-n) | 5.63 | 5.63 (1-n) | 131 | 64.2 | 6.08 |
| | | | | 2.5 | RHS | 5.56 | 246 | 271 | 9.18 | 10.4 (1-n) | 10.8 (1-n) | 4.22 | 4.22 (1-n) | 110 | 54.7 | 5.22 |
| | | | | 2.0 | RHS | 4.50 | 173 | 219 | 7.37 | 7.37 (1-n) | 7.37 (1-n) | 2.97 | 2.97 (1-n) | 88.9 | 44.7 | 4.31 |
| | | | | 1.6 | RHS | 3.64 | 124 | 177 | 5.05 | 5.05 (1-n) | 5.05 (1-n) | 2.10 | 2.10 (1-n) | 71.7 | 36.4 | 3.53 |
| 76 | x | 38 | x | 4.0 | RHS | 6.23 | 321 | 303 | 7.34 | 8.66 (1-n) | 8.66 (1-n) | 4.50 | 5.31 (1-n) | 126 | 58.3 | 4.03 |
| | | | | 3.0 | RHS | 4.90 | 253 | 239 | 6.00 | 7.07 (1-n) | 7.07 (1-n) | 3.61 | 3.61 (1-n) | 97.2 | 46.7 | 3.31 |
| | | | | 2.5 | RHS | 4.15 | 214 | 202 | 5.14 | 6.06 (1-n) | 6.06 (1-n) | 2.83 | 2.83 (1-n) | 82.2 | 40.1 | 2.87 |
| 75 | x | 50 | x | 6.0 | RHS | 9.67 | 499 | 471 | 11.4 | 13.4 (1-n) | 13.4 (1-n) | 8.56 | 10.1 (1-n) | 178 | 111 | 7.11 |
| | | | | 5.0 | RHS | 8.35 | 431 | 407 | 10.1 | 11.9 (1-n) | 11.9 (1-n) | 7.61 | 8.98 (1-n) | 153 | 97.2 | 6.41 |
| | | | | 4.0 | RHS | 6.92 | 357 | 337 | 8.56 | 10.1 (1-n) | 10.1 (1-n) | 6.47 | 7.64 (1-n) | 126 | 81.6 | 5.52 |
| | | | | 3.0 | RHS | 5.42 | 280 | 264 | 6.92 | 8.17 (1-n) | 8.17 (1-n) | 5.17 | 5.17 (1-n) | 97.4 | 64.2 | 4.47 |
| | | | | 2.5 | RHS | 4.58 | 236 | 223 | 5.91 | 6.97 (1-n) | 6.97 (1-n) | 4.03 | 4.03 (1-n) | 82.3 | 54.7 | 3.85 |
| | | | | 2.0 | RHS | 3.72 | 173 | 181 | 4.77 | 4.77 (1-n) | 4.77 (1-n) | 2.86 | 2.86 (1-n) | 66.8 | 44.7 | 3.19 |
| | | | | 1.6 | RHS | 3.01 | 124 | 147 | 3.34 | 3.34 (1-n) | 3.34 (1-n) | 2.03 | 2.03 (1-n) | 54.0 | 36.4 | 2.62 |
| 75 | x | 25 | x | 2.5 | RHS | 3.60 | 186 | 176 | 4.07 | 4.81 (1-n) | 4.81 (1-n) | 1.64 | 1.64 (1-n) | 79.1 | 24.3 | 1.73 |
| | | | | 2.0 | RHS | 2.93 | 133 | 143 | 3.36 | 3.86 (1-n) | 3.97 (1-n) | 1.17 | 1.17 (1-n) | 64.2 | 20.4 | 1.47 |
| | | | | 1.6 | RHS | 2.38 | 91.6 | 116 | 2.76 | 3.02 (1-n) | 3.26 (1-n) | 0.816 | 0.816 (1-n) | 51.9 | 17.0 | 1.23 |
| 65 | x | 35 | x | 4.0 | RHS | 5.35 | 276 | 261 | 5.38 | 6.35 (1-n) | 6.35 (1-n) | 3.48 | 4.10 (1-n) | 106 | 52.5 | 3.05 |
| | | | | 3.0 | RHS | 4.25 | 219 | 207 | 4.45 | 5.25 (1-n) | 5.25 (1-n) | 2.88 | 3.40 (1-n) | 82.3 | 42.3 | 2.54 |
| | | | | 2.5 | RHS | 3.60 | 186 | 176 | 3.83 | 4.52 (1-n) | 4.52 (1-n) | 2.41 | 2.41 (1-n) | 69.7 | 36.5 | 2.21 |
| | | | | 2.0 | RHS | 2.93 | 149 | 143 | 3.16 | 3.72 (1-n) | 3.73 (1-n) | 1.77 | 1.77 (1-n) | 56.7 | 30.1 | 1.85 |
| 50 | x | 25 | x | 3.0 | RHS | 3.07 | 158 | 149 | 2.37 | 2.80 (1-n) | 2.80 (1-n) | 1.44 | 1.70 (1-n) | 61.1 | 27.7 | 1.26 |
| | | | | 2.5 | RHS | 2.62 | 135 | 128 | 2.07 | 2.44 (1-n) | 2.44 (1-n) | 1.26 | 1.49 (1-n) | 52.1 | 24.3 | 1.12 |
| | | | | 2.0 | RHS | 2.15 | 111 | 105 | 1.73 | 2.04 (1-n) | 2.04 (1-n) | 1.05 | 1.05 (1-n) | 42.6 | 20.4 | 0.952 |
| | | | | 1.6 | RHS | 1.75 | 90.4 | 85.4 | 1.43 | 1.68 (1-n) | 1.68 (1-n) | 0.777 | 0.777 (1-n) | 34.7 | 17.0 | 0.800 |
| 50 | x | 20 | x | 3.0 | RHS | 2.83 | 146 | 138 | 2.09 | 2.46 (1-n) | 2.46 (1-n) | 1.06 | 1.25 (1-n) | 60.3 | 20.4 | 0.942 |
| | | | | 2.5 | RHS | 2.42 | 125 | 118 | 1.83 | 2.16 (1-n) | 2.16 (1-n) | 0.938 | 1.11 (1-n) | 51.4 | 18.2 | 0.847 |
| | | | | 2.0 | RHS | 1.99 | 103 | 97.0 | 1.53 | 1.81 (1-n) | 1.81 (1-n) | 0.783 | 0.783 (1-n) | 42.0 | 15.6 | 0.730 |
| | | | | 1.6 | RHS | 1.63 | 83.9 | 79.2 | 1.27 | 1.50 (1-n) | 1.50 (1-n) | 0.582 | 0.582 (1-n) | 34.2 | 13.1 | 0.619 |



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi M_{rx}$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_{sx}$.
4. $\phi M_{rx}$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_{sx}$.
5. $\phi M_{ry}$ refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to $\phi M_{sy}$.
6. For the design member moment capacity $\phi M_b$, see Table 5.3-2(3).
7. For the design member capacity in compression (x-axis) $\phi N_{cx}$, see Table 6-4(3)(A).
8. For the design member capacity in compression (y-axis) $\phi N_{cy}$, see Table 6-4(3)(B).
9. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 8-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

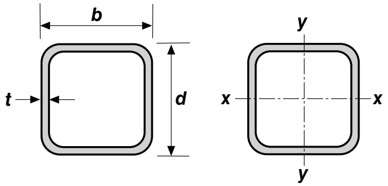
## DESIGN SECTION CAPACITIES

| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | Design Shear Capacities | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | | About x-axis | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi V_v$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kN | kNm |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 294 | 294 | 4.58 | 5.40 (1-n) | 5.40 (1-n) | 85.1 | 3.34 |
| | | | | 5.0 | SHS | 6.39 | 256 | 256 | 4.14 | 4.89 (1-n) | 4.89 (1-n) | 74.7 | 3.07 |
| | | | | 4.0 | SHS | 5.35 | 215 | 215 | 3.59 | 4.23 (1-n) | 4.23 (1-n) | 62.7 | 2.70 |
| | | | | 3.0 | SHS | 4.25 | 170 | 170 | 2.96 | 3.49 (1-n) | 3.49 (1-n) | 49.3 | 2.22 |
| | | | | 2.5 | SHS | 3.60 | 145 | 145 | 2.54 | 3.00 (1-n) | 3.00 (1-n) | 42.0 | 1.93 |
| | | | | 2.0 | SHS | 2.93 | 118 | 118 | 2.10 | 2.48 (1-n) | 2.48 (1-n) | 34.3 | 1.61 |
| | | | | 1.6 | SHS | 2.38 | 95.5 | 95.5 | 1.61 | 1.61 (1-n) | 1.61 (1-n) | 28.0 | 1.33 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 164 | 164 | 2.12 | 2.50 (1-n) | 2.50 (1-n) | 47.8 | 1.57 |
| | | | | 3.0 | SHS | 3.30 | 133 | 133 | 1.80 | 2.13 (1-n) | 2.13 (1-n) | 38.1 | 1.34 |
| | | | | 2.5 | SHS | 2.82 | 113 | 113 | 1.56 | 1.85 (1-n) | 1.85 (1-n) | 32.7 | 1.17 |
| | | | | 2.0 | SHS | 2.31 | 92.5 | 92.5 | 1.30 | 1.54 (1-n) | 1.54 (1-n) | 26.9 | 0.989 |
| | | | | 1.6 | SHS | 1.88 | 75.3 | 75.3 | 1.07 | 1.27 (1-n) | 1.27 (1-n) | 22.0 | 0.824 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 114 | 114 | 1.33 | 1.57 (1-n) | 1.57 (1-n) | 32.5 | 0.978 |
| | | | | 2.5 | SHS | 2.42 | 97.3 | 97.3 | 1.16 | 1.37 (1-n) | 1.37 (1-n) | 28.0 | 0.866 |
| | | | | 2.0 | SHS | 1.99 | 79.9 | 79.9 | 0.975 | 1.15 (1-n) | 1.15 (1-n) | 23.1 | 0.735 |
| | | | | 1.6 | SHS | 1.63 | 65.3 | 65.3 | 0.808 | 0.954 (1-n) | 0.954 (1-n) | 19.0 | 0.616 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 94.8 | 94.8 | 0.932 | 1.10 (1-n) | 1.10 (1-n) | 26.9 | 0.676 |
| | | | | 2.5 | SHS | 2.03 | 81.6 | 81.6 | 0.822 | 0.970 (1-n) | 0.970 (1-n) | 23.3 | 0.605 |
| | | | | 2.0 | SHS | 1.68 | 67.3 | 67.3 | 0.695 | 0.820 (1-n) | 0.820 (1-n) | 19.4 | 0.519 |
| | | | | 1.6 | SHS | 1.38 | 55.2 | 55.2 | 0.580 | 0.684 (1-n) | 0.684 (1-n) | 16.0 | 0.439 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 75.9 | 75.9 | 0.603 | 0.712 (1-n) | 0.712 (1-n) | 21.3 | 0.430 |
| | | | | 2.5 | SHS | 1.64 | 65.8 | 65.8 | 0.539 | 0.637 (1-n) | 0.637 (1-n) | 18.7 | 0.391 |
| | | | | 2.0 | SHS | 1.36 | 54.7 | 54.7 | 0.462 | 0.545 (1-n) | 0.545 (1-n) | 15.7 | 0.341 |
| | | | | 1.6 | SHS | 1.12 | 45.1 | 45.1 | 0.389 | 0.459 (1-n) | 0.459 (1-n) | 13.0 | 0.292 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 42.1 | 42.1 | 0.276 | 0.326 (1-n) | 0.326 (1-n) | 11.9 | 0.200 |
| | | | | 1.6 | SHS | 0.873 | 35.0 | 35.0 | 0.236 | 0.279 (1-n) | 0.279 (1-n) | 10.0 | 0.175 |

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.**

**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**



## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. $\phi M_r$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_s$.
3. $\phi M_r$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_s$.
4. For all SHS, the design member moment capacity ($\phi M_b$) = $\phi M_s$.
5. For the design member capacity in compression $\phi N_c$, see Table 6-5.

TABLE 8-6(1)

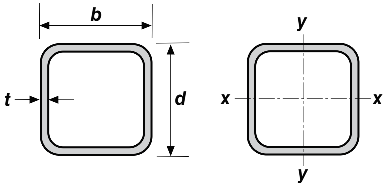
# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

1 SHS

2 C450PLUS®

3 Finish



| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | Design Shear Capacities | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | About x-axis | | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi V_v$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kN | kNm |
| 400 | x | 400 | x | 16.0 | SHS | 186 | 9600 | 9060 | 1350 | 1350 (1-n) | 1350 (1-n) | 2830 | 1060 |
| | | | | 12.5 | SHS | 148 | 7580 | 7210 | 937 | 937 (1-n) | 937 (1-n) | 2250 | 856 |
| | | | | 10.0 | SHS | 120 | 4850 | 5840 | 670 | 670 (1-n) | 670 (1-n) | 1820 | 703 |
| 350 | x | 350 | x | 16.0 | SHS | 161 | 8300 | 7840 | 1020 | 1210 (1-n) | 1210 (1-n) | 2440 | 790 |
| | | | | 12.5 | SHS | 128 | 6620 | 6250 | 768 | 768 (1-n) | 768 (1-n) | 1950 | 644 |
| | | | | 10.0 | SHS | 104 | 4850 | 5070 | 548 | 548 (1-n) | 548 (1-n) | 1580 | 530 |
| | | | | 8.0 | SHS | 84.2 | 3110 | 4100 | 393 | 393 (1-n) | 393 (1-n) | 1280 | 434 |
| 300 | x | 300 | x | 16.0 | SHS | 136 | 7010 | 6620 | 732 | 864 (1-n) | 864 (1-n) | 2060 | 562 |
| | | | | 12.5 | SHS | 109 | 5600 | 5290 | 596 | 703 (1-n) | 703 (1-n) | 1650 | 461 |
| | | | | 10.0 | SHS | 88.4 | 4560 | 4310 | 436 | 436 (1-n) | 436 (1-n) | 1340 | 382 |
| | | | | 8.0 | SHS | 71.6 | 3110 | 3490 | 311 | 311 (1-n) | 311 (1-n) | 1090 | 314 |
| 250 | x | 250 | x | 16.0 | SHS | 111 | 5710 | 5390 | 489 | 577 (1-n) | 577 (1-n) | 1670 | 373 |
| | | | | 12.5 | SHS | 89.0 | 4590 | 4340 | 402 | 474 (1-n) | 474 (1-n) | 1350 | 309 |
| | | | | 10.0 | SHS | 72.7 | 3750 | 3540 | 329 | 329 (1-n) | 329 (1-n) | 1100 | 258 |
| | | | | 9.0 | SHS | 65.9 | 3400 | 3210 | 283 | 283 (1-n) | 283 (1-n) | 1000 | 236 |
| | | | | 8.0 | SHS | 59.1 | 3050 | 2880 | 237 | 237 (1-n) | 237 (1-n) | 899 | 213 |
| | | | | 6.0 | SHS | 45.0 | 1750 | 2190 | 154 | 154 (1-n) | 154 (1-n) | 685 | 165 |
| 200 | x | 200 | x | 16.0 | SHS | 85.5 | 4410 | 4170 | 295 | 348 (1-n) | 348 (1-n) | 1290 | 222 |
| | | | | 12.5 | SHS | 69.4 | 3580 | 3380 | 246 | 290 (1-n) | 290 (1-n) | 1050 | 188 |
| | | | | 10.0 | SHS | 57.0 | 2940 | 2780 | 206 | 243 (1-n) | 243 (1-n) | 864 | 158 |
| | | | | 9.0 | SHS | 51.8 | 2670 | 2520 | 188 | 222 (1-n) | 222 (1-n) | 786 | 146 |
| | | | | 8.0 | SHS | 46.5 | 2400 | 2270 | 168 | 168 (1-n) | 168 (1-n) | 707 | 132 |
| | | | | 6.0 | SHS | 35.6 | 1750 | 1730 | 110 | 110 (1-n) | 110 (1-n) | 541 | 103 |
| | | | | 5.0 | SHS | 29.9 | 1210 | 1460 | 83.8 | 83.8 (1-n) | 83.8 (1-n) | 456 | 87.9 |
| 150 | x | 150 | x | 10.0 | SHS | 41.3 | 2130 | 2010 | 109 | 129 (1-n) | 129 (1-n) | 624 | 82.9 |
| | | | | 9.0 | SHS | 37.7 | 1940 | 1840 | 101 | 119 (1-n) | 119 (1-n) | 570 | 76.8 |
| | | | | 8.0 | SHS | 33.9 | 1750 | 1650 | 91.5 | 108 (1-n) | 108 (1-n) | 515 | 70.2 |
| | | | | 6.0 | SHS | 26.2 | 1350 | 1270 | 71.0 | 71.0 (1-n) | 71.0 (1-n) | 397 | 55.7 |
| | | | | 5.0 | SHS | 22.1 | 1140 | 1080 | 54.6 | 54.6 (1-n) | 54.6 (1-n) | 336 | 47.8 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi M_r$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_s$.
4. $\phi M_r$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_s$.
5. For all SHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
6. For the design member capacity in compression $\phi N_c$, see Table 6-6(1).

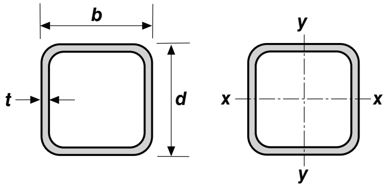
TABLE 8-6(2)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

1 SHS
2 C450PLUS®
3 Finish

| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | Design Shear Capacities | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | | About x-axis | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi V_v$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kN | kNm |
| 125 | x | 125 | x | 10.0 | SHS | 33.4 | 1720 | 1630 | 72.0 | 85.0 (1-n) | 85.0 (1-n) | 504 | 54.2 |
| | | | | 9.0 | SHS | 30.6 | 1580 | 1490 | 66.8 | 78.8 (1-n) | 78.8 (1-n) | 462 | 50.6 |
| | | | | 8.0 | SHS | 27.7 | 1430 | 1350 | 61.2 | 72.2 (1-n) | 72.2 (1-n) | 419 | 46.6 |
| | | | | 6.0 | SHS | 21.4 | 1110 | 1050 | 48.6 | 57.3 (1-n) | 57.3 (1-n) | 325 | 37.4 |
| | | | | 5.0 | SHS | 18.2 | 937 | 885 | 41.1 | 41.1 (1-n) | 41.1 (1-n) | 276 | 32.3 |
| | | | | 4.0 | SHS | 14.8 | 762 | 720 | 29.7 | 29.7 (1-n) | 29.7 (1-n) | 225 | 26.7 |
| 100 | x | 100 | x | 10.0 | SHS | 25.6 | 1320 | 1250 | 42.6 | 50.3 (1-n) | 50.3 (1-n) | 384 | 31.6 |
| | | | | 9.0 | SHS | 23.5 | 1210 | 1150 | 39.9 | 47.1 (1-n) | 47.1 (1-n) | 354 | 29.8 |
| | | | | 8.0 | SHS | 21.4 | 1100 | 1040 | 36.9 | 43.5 (1-n) | 43.5 (1-n) | 323 | 27.8 |
| | | | | 6.0 | SHS | 16.7 | 864 | 816 | 29.8 | 35.1 (1-n) | 35.1 (1-n) | 253 | 22.7 |
| | | | | 5.0 | SHS | 14.2 | 735 | 694 | 25.7 | 30.4 (1-n) | 30.4 (1-n) | 216 | 19.8 |
| | | | | 4.0 | SHS | 11.6 | 600 | 567 | 21.0 | 21.0 (1-n) | 21.0 (1-n) | 177 | 16.5 |
| | | | | 3.0 | SHS | 8.96 | 440 | 436 | 13.9 | 13.9 (1-n) | 13.9 (1-n) | 135 | 12.9 |
| | | | | 2.5 | SHS | 7.53 | 305 | 367 | 10.6 | 10.6 (1-n) | 10.6 (1-n) | 114 | 11.0 |
| | | | | 2.0 | SHS | 6.07 | 196 | 296 | 7.63 | 7.63 (1-n) | 7.63 (1-n) | 92.2 | 8.97 |
| 90 | x | 90 | x | 2.5 | SHS | 6.74 | 305 | 329 | 9.03 | 9.03 (1-n) | 9.03 (1-n) | 102 | 8.80 |
| | | | | 2.0 | SHS | 5.45 | 196 | 265 | 6.48 | 6.48 (1-n) | 6.48 (1-n) | 82.6 | 7.20 |
| 89 | x | 89 | x | 6.0 | SHS | 14.7 | 757 | 715 | 23.0 | 27.1 (1-n) | 27.1 (1-n) | 222 | 17.4 |
| | | | | 5.0 | SHS | 12.5 | 646 | 610 | 19.9 | 23.5 (1-n) | 23.5 (1-n) | 190 | 15.3 |
| | | | | 3.5 | SHS | 9.07 | 468 | 442 | 14.5 | 14.5 (1-n) | 14.5 (1-n) | 138 | 11.5 |
| | | | | 2.0 | SHS | 5.38 | 196 | 262 | 6.37 | 6.37 (1-n) | 6.37 (1-n) | 81.6 | 7.04 |
| 75 | x | 75 | x | 6.0 | SHS | 12.0 | 621 | 586 | 15.6 | 18.4 (1-n) | 18.4 (1-n) | 181 | 11.7 |
| | | | | 5.0 | SHS | 10.3 | 532 | 503 | 13.6 | 16.1 (1-n) | 16.1 (1-n) | 156 | 10.4 |
| | | | | 4.0 | SHS | 8.49 | 438 | 414 | 11.4 | 13.5 (1-n) | 13.5 (1-n) | 129 | 8.78 |
| | | | | 3.5 | SHS | 7.53 | 388 | 367 | 10.2 | 12.1 (1-n) | 12.1 (1-n) | 114 | 7.90 |
| | | | | 3.0 | SHS | 6.60 | 341 | 322 | 8.99 | 8.99 (1-n) | 8.99 (1-n) | 99.4 | 6.98 |
| | | | | 2.5 | SHS | 5.56 | 287 | 271 | 6.90 | 6.90 (1-n) | 6.90 (1-n) | 84.0 | 5.98 |
| | | | | 2.0 | SHS | 4.50 | 196 | 219 | 4.91 | 4.91 (1-n) | 4.91 (1-n) | 68.2 | 4.91 |
| 65 | x | 65 | x | 6.0 | SHS | 10.1 | 523 | 494 | 11.1 | 13.1 (1-n) | 13.1 (1-n) | 153 | 8.31 |
| | | | | 5.0 | SHS | 8.75 | 451 | 426 | 9.85 | 11.6 (1-n) | 11.6 (1-n) | 132 | 7.43 |
| | | | | 4.0 | SHS | 7.23 | 373 | 352 | 8.34 | 9.84 (1-n) | 9.84 (1-n) | 109 | 6.36 |
| | | | | 3.0 | SHS | 5.66 | 292 | 276 | 6.71 | 7.92 (1-n) | 7.92 (1-n) | 85.0 | 5.11 |
| | | | | 2.5 | SHS | 4.78 | 247 | 233 | 5.54 | 5.54 (1-n) | 5.54 (1-n) | 72.0 | 4.40 |
| | | | | 2.0 | SHS | 3.88 | 196 | 189 | 3.97 | 3.97 (1-n) | 3.97 (1-n) | 58.6 | 3.63 |
| | | | | 1.6 | SHS | 3.13 | 125 | 153 | 2.84 | 2.84 (1-n) | 2.84 (1-n) | 47.5 | 2.98 |



### Notes:

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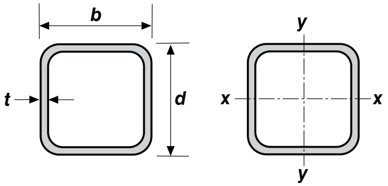
4. $\phi M_r$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_s$.
5. For all SHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
6. For the design member capacity in compression $\phi N_c$, see Table 6-6(2).

TABLE 8-6(3)

# Square Hollow Sections
# C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES



| Designation | | | | | | Mass per m | Design Section Axial Capacities | | Design Section Moment Capacities | | | Design Shear Capacities | Torsion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comp | Tens | About x-axis | | | | |
| d | | b | | t | | | $\phi N_s$ | $\phi N_t$ | $\phi M_{sx}$ | $\phi M_{rx}$ (comp) | $\phi M_{rx}$ (tens) | $\phi V_v$ | $\phi M_z$ |
| mm | | mm | | mm | | kg/m | kN | kN | kNm | kNm | kNm | kN | kNm |
| 50 | x | 50 | x | 6.0 | SHS | 7.32 | 378 | 357 | 5.89 | 6.94 (1-n) | 6.94 (1-n) | 109 | 4.30 |
| | | | | 5.0 | SHS | 6.39 | 330 | 311 | 5.33 | 6.29 (1-n) | 6.29 (1-n) | 96.0 | 3.95 |
| | | | | 4.0 | SHS | 5.35 | 276 | 261 | 4.61 | 5.44 (1-n) | 5.44 (1-n) | 80.6 | 3.47 |
| | | | | 3.0 | SHS | 4.25 | 219 | 207 | 3.80 | 4.49 (1-n) | 4.49 (1-n) | 63.4 | 2.86 |
| | | | | 2.5 | SHS | 3.60 | 186 | 176 | 3.27 | 3.86 (1-n) | 3.86 (1-n) | 54.0 | 2.48 |
| | | | | 2.0 | SHS | 2.93 | 151 | 143 | 2.66 | 2.66 (1-n) | 2.66 (1-n) | 44.2 | 2.07 |
| | | | | 1.6 | SHS | 2.38 | 123 | 116 | 1.92 | 1.92 (1-n) | 1.92 (1-n) | 35.9 | 1.71 |
| 40 | x | 40 | x | 4.0 | SHS | 4.09 | 211 | 199 | 2.73 | 3.22 (1-n) | 3.22 (1-n) | 61.4 | 2.02 |
| | | | | 3.0 | SHS | 3.30 | 170 | 161 | 2.32 | 2.74 (1-n) | 2.74 (1-n) | 49.0 | 1.72 |
| | | | | 2.5 | SHS | 2.82 | 145 | 137 | 2.01 | 2.37 (1-n) | 2.37 (1-n) | 42.0 | 1.51 |
| | | | | 2.0 | SHS | 2.31 | 119 | 112 | 1.67 | 1.98 (1-n) | 1.98 (1-n) | 34.6 | 1.27 |
| | | | | 1.6 | SHS | 1.88 | 96.9 | 91.5 | 1.36 | 1.36 (1-n) | 1.36 (1-n) | 28.3 | 1.06 |
| 35 | x | 35 | x | 3.0 | SHS | 2.83 | 146 | 138 | 1.71 | 2.02 (1-n) | 2.02 (1-n) | 41.8 | 1.26 |
| | | | | 2.5 | SHS | 2.42 | 125 | 118 | 1.50 | 1.77 (1-n) | 1.77 (1-n) | 36.0 | 1.11 |
| | | | | 2.0 | SHS | 1.99 | 103 | 97.0 | 1.25 | 1.48 (1-n) | 1.48 (1-n) | 29.8 | 0.945 |
| | | | | 1.6 | SHS | 1.63 | 83.9 | 79.2 | 1.04 | 1.23 (1-n) | 1.23 (1-n) | 24.4 | 0.792 |
| 30 | x | 30 | x | 3.0 | SHS | 2.36 | 122 | 115 | 1.20 | 1.41 (1-n) | 1.41 (1-n) | 34.6 | 0.869 |
| | | | | 2.5 | SHS | 2.03 | 105 | 99.0 | 1.06 | 1.25 (1-n) | 1.25 (1-n) | 30.0 | 0.778 |
| | | | | 2.0 | SHS | 1.68 | 86.5 | 81.7 | 0.893 | 1.05 (1-n) | 1.05 (1-n) | 25.0 | 0.667 |
| | | | | 1.6 | SHS | 1.38 | 70.9 | 67.0 | 0.746 | 0.880 (1-n) | 0.880 (1-n) | 20.6 | 0.564 |
| 25 | x | 25 | x | 3.0 | SHS | 1.89 | 97.5 | 92.1 | 0.776 | 0.915 (1-n) | 0.915 (1-n) | 27.4 | 0.553 |
| | | | | 2.5 | SHS | 1.64 | 84.6 | 79.9 | 0.694 | 0.818 (1-n) | 0.818 (1-n) | 24.0 | 0.503 |
| | | | | 2.0 | SHS | 1.36 | 70.3 | 66.4 | 0.594 | 0.701 (1-n) | 0.701 (1-n) | 20.2 | 0.438 |
| | | | | 1.6 | SHS | 1.12 | 58.0 | 54.8 | 0.500 | 0.591 (1-n) | 0.591 (1-n) | 16.7 | 0.375 |
| 20 | x | 20 | x | 2.0 | SHS | 1.05 | 54.1 | 51.1 | 0.355 | 0.419 (1-n) | 0.419 (1-n) | 15.4 | 0.258 |
| | | | | 1.6 | SHS | 0.873 | 45.0 | 42.5 | 0.304 | 0.359 (1-n) | 0.359 (1-n) | 12.9 | 0.224 |

## Notes:

1. ***REFER* to the Australian Tube Mills *PRODUCT AVAILABILITY GUIDE* (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at www.austubemills.com.**
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of $f_y = 450$ MPa and $f_u = 500$ MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. $\phi M_r$ (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to $\phi M_s$.
4. $\phi M_r$ (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to $\phi M_s$.
5. For all SHS, the design member moment capacity $(\phi M_b) = \phi M_s$.
6. For the design member capacity in compression $\phi N_c$, see Table 6-6(3).
7. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

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# Part 9

## CONNECTIONS

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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 9
## CONNECTIONS

### 9.1 Bolts

See Ref. [9.1] for information on AS 4100 requirements, bolt types and bolting categories, design capacities of commonly used bolts, minimum edge distances and geometric/design details for bolts.

The ASI has published a suite of Guides which relate to bolts, bolt groups and bolted structural connections. These Guides are also considered in Ref. [9.1].

### 9.2 Welds

See Ref. [9.1] for information on AS 4100 requirements, weld quality, design of butt welds, design of fillet welds.

The ASI has published a suite of Guides which relate to welds, weld groups and welded structural connections. These guides are also considered in Ref. [9.1].

### 9.3 Connection Design

See Ref. [9.2] for information and connection design models for Australian Standards and practice. Ref. [9.2] also notes further quality publications for hollow section connection design.

Ref. [9.1] also provides information on general structural connections and should be consulted for such information. Additional Guides on (open section) structural steel connections are noted in Ref. [9.1].

### 9.4 References

[9.1] ASI, “Design Capacity Tables for Structural Steel – Volume 1: Open Sections”, fourth edition, Australian Steel Institute, 2009.

[9.2] Syam, A.A. & Chapman, B.G., “Design of Structural Steel Hollow Section Connections – Volume 1: Design Models”, Australian Institute of Steel Construction, 1996.

**See Section 1.1.2 for details on reference Standards.**

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