University of Wollongong eight storey light gauge building.

Revised Standard is a Quantum Leap Forward for the Steel Industry

The steel used to construct everything from prefabricated framework and facades, through to lighting poles and fences is the focus of a newly revised Standard, backed by the latest Australian research and technology.

AS/NZS 4600:2018 – *Cold-formed steel structures* was published in May 2018, following extensive consultation with stakeholders across Australia and New Zealand. The new edition has substantial changes compared with the 2005 edition. It has recently been approved as a primary reference in the National Construction Code 2019.

"This new edition Standard is a quantum leap forward for the steel industry," said Professor Greg Hancock, Chair of the Standards Australia Technical Committee responsible for the Standard. "This is a world leading Standard that places Australia at the top of the list in terms of the most innovative steel consumers."

The type of steel covered by AS/NZS 4600:2018—often referred to as light gauge steel—is everywhere. Cold-formed steel structural members and systems have been widely used in Australia since the 1970s, particularly in roof and wall systems including purlins and sheeting, steel storage racks, and steel framed housing.

Modular accommodation unit being craned into place on CSU Student Accommodation, a project recently entered into the 2018 Australian Steel Institute's NSW and ACT Steel Excellence Awards. Photo: Intelligent Building Systems.

Today, mid-rise construction and modular construction are beginning to use cold-formed steel in major structural elements. Delivering safety and durability, strength and flexibility, light gauge steel is in high demand in the construction sector. In fact, light gauge steel is now so light and so strong that it can be used in impressively long spans, effectively negating the necessity for load bearing walls.

Not surprisingly, prefabricated modular construction and light gauge steel work well together, with light gauge steel often used in prefabricated frameworks and facades. Light gauge steel frameworks are particularly useful in constrained pre-fab sites, offering compressed erection times compared to traditional construction methods.

AS/NZS 4600: An Overview

This Standard applies to the design of cold-formed members and, increasingly, structural systems. According to the Standard itself, "This Standard sets out minimum requirements for the design of structural members cold-formed to shape from carbon or low-alloy steel sheet, strip, plate or bar not more than 25mm in thickness and used for load-carrying purposes in buildings. It is also applicable for structures other than buildings, provided appropriate allowances are made for dynamic effects."

Originally published in 1996, the Australian and New Zealand Limit States Standard for Cold-Formed Steel Structures was based partly on the American Iron and Steel Institute Specification at that time, and partly on Australian research on high strength steels to AS 1397.

In 2005, a revision of AS/NZS 4600 occurred, which included design for low ductility G550 steel, as commonly used in steel framed housing. This was followed by substantial updates to the North American Specification AISI S100 in 2016, which now includes distortional buckling and higher strength low ductility steels, as well as substantial updates to the Direct Strength Method (DSM) of design.

The changes made to AS/NZS 4600 are based on both the 2016 edition of the North American Specification, and the latest research in Australia and New Zealand.

Changes to AS/NZS 4600

The Direct Strength Method (DSM) of design has undergone substantial research since the 2005 edition of AS/NZS 4600 was published; this research now features heavily in the revised *Section 7 – Direct Strength Method (DSM) of Design.*

Section 7 now covers sections with holes and inelastic reserve capacity, shear and combined actions, and a wider range of pre-qualified sections, including most sections with longitudinal web and flange stiffeners (based in part on Australian research at the University of Sydney on high strength sections with multiple stiffeners).

Section 8 – Testing has been updated to align with the National Construction Code, which recently underwent changes related to the loading data for wind, snow and earthquake from 50 year to annual probability of occurrence.

According to Hancock, "Two significant changes have been made to *Section 8* in the new edition. They are the determination of design values based on prototype testing where the average of the test results can now be used, and calibration of a strength prediction model based on prototype testing."

New sections have also been added to the revised version of the Standard, including *Section 9 – Fire*, which outlines design requirements for fire protected members at elevated temperatures.

"Based on research undertaken at the Queensland University of Technology, the methodology in Section 9 has been developed for Australian high strength steels to AS 1397, assuming protected cold-formed steel building members," said Hancock.

Other new sections include *Appendix B – Methods of Structural Analysis* (which includes first order, second order and advanced structural analysis based on research at the University of Sydney), and *Appendix D – Buckling Stresses*. *Appendix D* now includes requirements for all elastic buckling solutions for local, distortional and flexural-torsional modes, in order to simplify design compared with the previous 2005 edition of AS/NZS 4600 where the buckling equations were scattered through the standard and difficult to follow.

Finally, *Section 5.3 – Power Actuated Fasteners* (PAFs) now includes requirements for PAFs in tension and shear, and a revised *Section 5 – Connections* includes new requirements for block shear rupture and net section tension and for screw connections under combined shear and tension.

"Significant research has been performed recently at the University of Wollongong on net section fracture and block shear rupture. New equations have been developed and included in *Section 5 – Connections* for net section fracture and block shear rupture where new shear lag factors have been incorporated. Further, the shear planes in block shear rupture are now based on average shear planes rather than gross or net sections at bolted connections," said Hancock.

Direct Strength Method of Design and THIN-WALL-2

Two basic design methods for cold-formed steel members are available in AS/NZS 4600:2018. These are the traditional Effective Width Method (EWM) specified in *Section 2 – Elements* and *Section 3 – Members*, and the newly developed Direct Strength Method of Design (DSM) as specified in *Section 7*.

The EWM has been 'grand-fathered' in the revised edition on the basis that Committee BD/82 of Standards Australia required that all existing design methods are maintained in their current form without restriction.

The Direct Strength Method (DSM) of Design is a new method which accounts for the behaviour of complete cold-formed thin-walled sections including longitudinal stiffeners rolled into the sections. It relies on the ability to compute the buckling stresses of thin-walled sections.

With the inclusion of shear design in the DSM based on research at the University of Sydney, new Finite Strip Method (FSM) software has also been developed at the University of Sydney. Called THIN-WALL-2, this software allows easy DSM design for compression, bending and shear using a MATLAB graphical interface and Visual Studio C++ computational engines.

The THIN-WALL-2 program is written to define input data using a Graphic User Interface (GUI) to perform pre-buckling and buckling analyses of thin-walled sections under generalised loading. The loading may contain uniform loading and localised loading. The GUI is then used to display the results of the analyses.

It is also possible to use the program to perform a cross-section analysis to generate the section properties. The cross-sections can be formed from different shapes can include open and closed sections or mixed sections.

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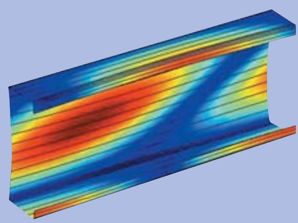
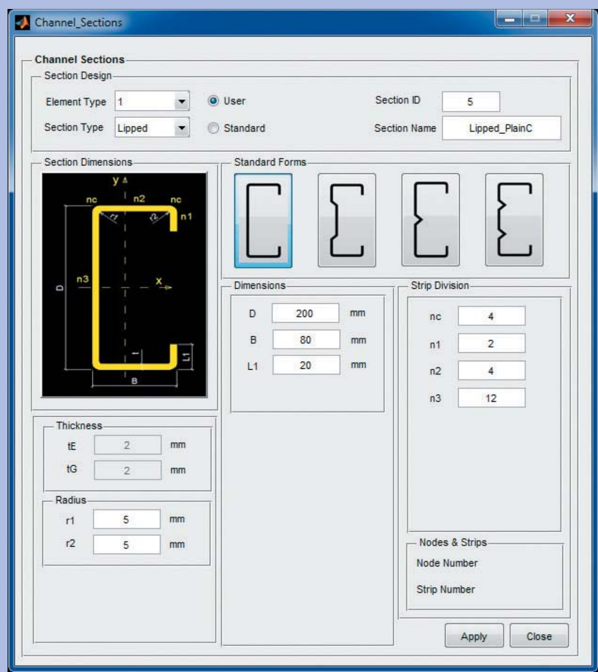


Shear buckling mode in the THIN-WALL-2 software.



The THIN-WALL-2 software.