2. TERMINOLOGY

Some important terminology used in this booklet is summarised in this section. Reference should also be made to Section 2 of DB1.1 and Clause 1.4.3 of AS 2327.1 for additional terminology.

Bottom T-Section

The portion of the steel beam cross-section lying below the penetration.

High Moment End (HME)

The end of a penetration subjected to the higher primary bending moment.

Low Moment End (LME)

The end of a penetration subjected to the lower primary bending moment.

Primary Bending Moment

The bending moment at a beam cross-section due to overall bending action ignoring secondary effects (see Fig. 3.2).

Rigid Arm

A part of a beam assumed to be rigid in the model used for deflection calculations.

Secondary Bending Moment

The additional bending moment induced in the top and bottom T-sections as a result of Vierendeel action over the length of the penetration (see Fig. 3.2).

Steel T-Section

The bottom T-section or the top T-section, excluding the concrete flange in the case of a composite beam.

Top T-Section

The portion of the steel beam cross-section lying above the penetration, inclusive of the concrete flange in the case of a composite beam.

Vierendeel Action

The development of secondary bending moments in the top and bottom T-sections due to the presence of vertical shear force across the penetration.

Web Penetration Reinforcement

Steel plates or flat bars continuously welded to one or both sides of the web of the steel beam, as close as practicable to the top and bottom horizontal edges of the penetration.

Design of Simply-Supported Composite Beams with Large Web Penetrations

Design Booklet DB1.3

OneSteel Market Mills

Composite Structures Design Manual

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Disclaimer

Foreword

OneSteel is a leading manufacturer of steel long products in Australia after its spin-off from BHP Pty Ltd on the 1st November 2000. It manufactures a wide range of steel products, including structural, rail, rod, bar, wire, pipe and tube products and markets welded beams.

OneSteel is committed to providing to design engineers, technical information and design tools to assist with the use, design and specification of its products. This design booklet "Design of Simply-Supported Beams with Large Web Penetrations" was the third design booklet of the Composite Structures Design Manual, which is now being completed and maintained by OneSteel.

The initial development work required to produce the design booklets was carried out at BHP Melbourne Research Laboratories before its closure in May 1998. OneSteel Market Mills is funding the University of Western Sydney's Centre for Construction Technology and Research in continuing the research and development work to publish this and future booklets.

The Composite Structures Design Manual refers specifically to the range of long products that are manufactured by OneSteel and plate products that continue to be manufactured by BHP. It is strongly recommended that OneSteel sections and reinforcement and BHP plate products are specified for construction when any of the design models in the design booklets are used, as the models and design formulae including product tolerances, mechanical properties and chemical composition have been validated by detailed structural testing using only OneSteel and BHP products.

To ensure that the Designer's intent is met, it is recommended that a note to this effect be included in the design documentation.

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Preface

This design booklet forms part of a suite of booklets covering the design of simply-supported and continuous composite beams, composite slabs, composite columns, steel and composite connections and related topics. The booklets are part of the OneSteel Market Mills' Composite Structures Design Manual which has been produced to foster composite steel-frame building construction in Australia to ensure cost-competitive building solutions for specifiers, builders and developers.

The additional design information necessary to allow large web penetrations to be incorporated into simply-supported bare steel and composite beams is presented in this booklet. Design issues with respect to strength and deflection control are addressed. The non-composite bare steel state arises during construction prior to the concrete hardening.

Large rectangular and circular penetrations are often made in the steel web of composite beams for the passage of horizontal building services. This allows the plenum height to be reduced when using economical, standard UB and WB steel sections. However, large penetrations weaken a composite beam locally and reduce its overall flexural stiffness, and therefore their effect must be considered in design.

Neither the Steel Structures Standard AS 4100 nor the Composite Beam Standard AS 2327.1 contains design provisions for large web penetrations. The rules provided in the booklet for designing bare steel beams with large penetrations are compatible with AS 4100. For the composite state, the rules are compatible with AS 2327.1, and have been proposed as an acceptable method of design to be referred to in Amendment No. 1 of this Standard expected to be published this year.

Information is also given to assist design engineers to understand the engineering principles on which the design methods are based. This includes:

(a) explanatory information on important concepts and models;

(b) the limits of application of the methods; and

(c) worked examples.

Design capacity tables are given in Appendix C to simplify the strength design process. The information provided can be used to design for either the bare steel or composite states. The tables cover a range of situations involving 300PLUS® UB and WB steel sections supporting a composite slab and incorporating large web penetrations. A spreadsheet program named WEBPEN™ is available to assist with the strength design calculations.

Although these design aids are intended to make the design process more efficient, it is essential that the user obtain a clear understanding of the basis of the design rules and the design approach by working through this document and the relevant parts of associated design Standards such as AS 4100 and AS 2327.1.