1. SCOPE AND GENERAL

1.1 Scope

The strength design method in Section 6 of Australian Standard AS 2327.1–1996, Composite Structures, Part 1: Simply Supported Beams [1] is addressed in this design booklet.

The type of construction envisaged is shown in Fig. 1.1.

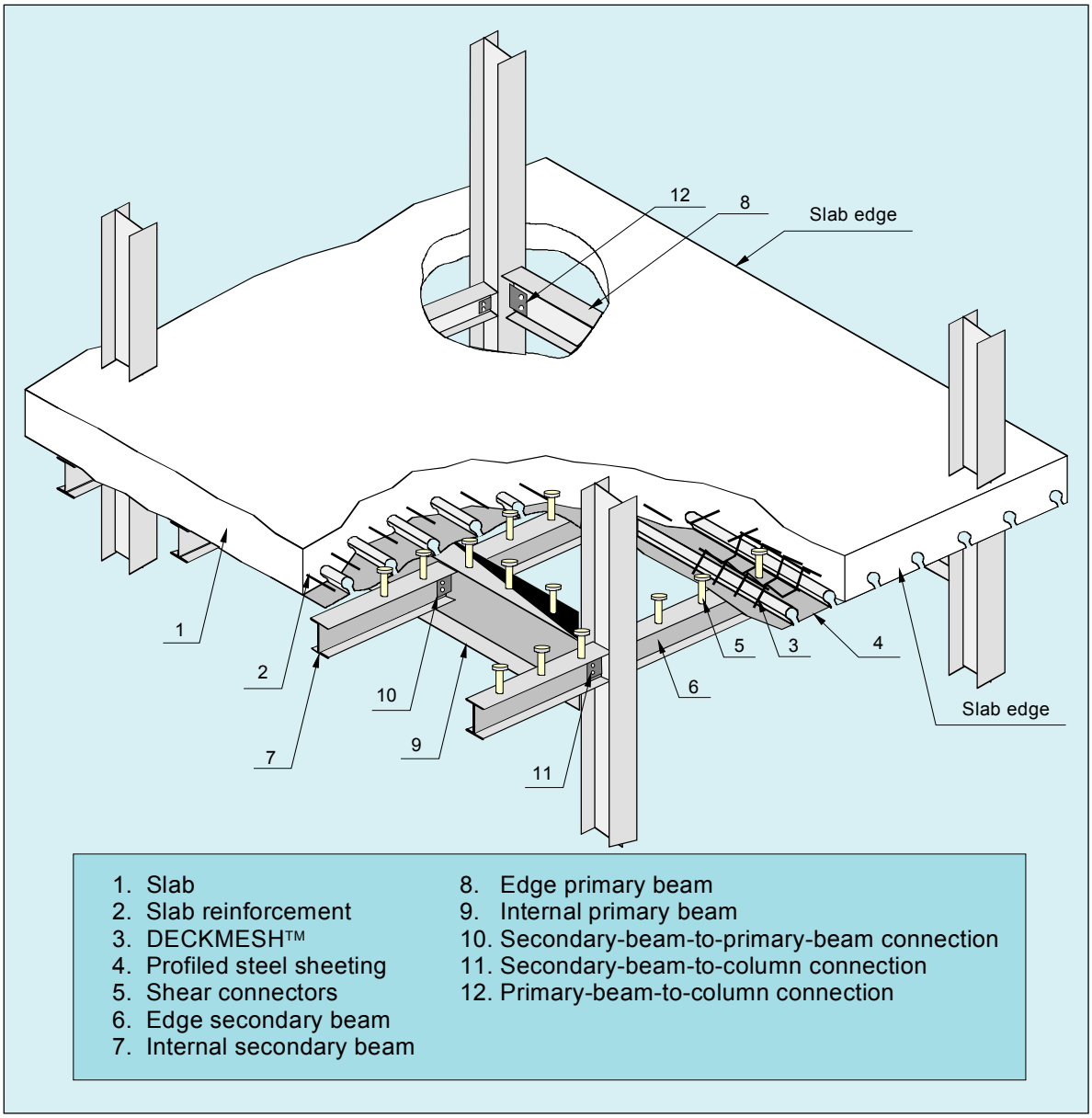

Figure 1.1 Members and Components of a Composite Floor

This booklet does not cover design for serviceability, design of shear connectors, design of the concrete slab for transfer of longitudinal shear or design for fire resistance. Some of these aspects will be covered in later booklets.

1.2 General

The details of the different types of components which may be used in the construction of simply-supported composite beams designed in accordance with this booklet are described in this section.

Steel Beam

The alternative types of steel beams that are permitted are shown in Fig. 1.2. The cross-section of the steel beam must be symmetrical about the vertical axis. Cold-rolled RHS, SHS and channel sections may be used provided that the wall thickness satisfies the requirements of AS 2327.1 (Clauses 5.2.3.3(a) and 8.4.3.1).

The channel sections shown in Fig. 1.2(c) and (d), and the T-sections shown in Fig. 1.2(g) and (h), may not be the most efficient steel sections for use in composite beams. However, these sections may be encountered in design when hollow sections or I-sections are notched to allow the passage of service ducts within the depth of the beams. Optional flange plates may be attached to the bottom flange of some of the steel beam types (see Fig.1.2(a)) to increase the moment capacity of the cross-section.

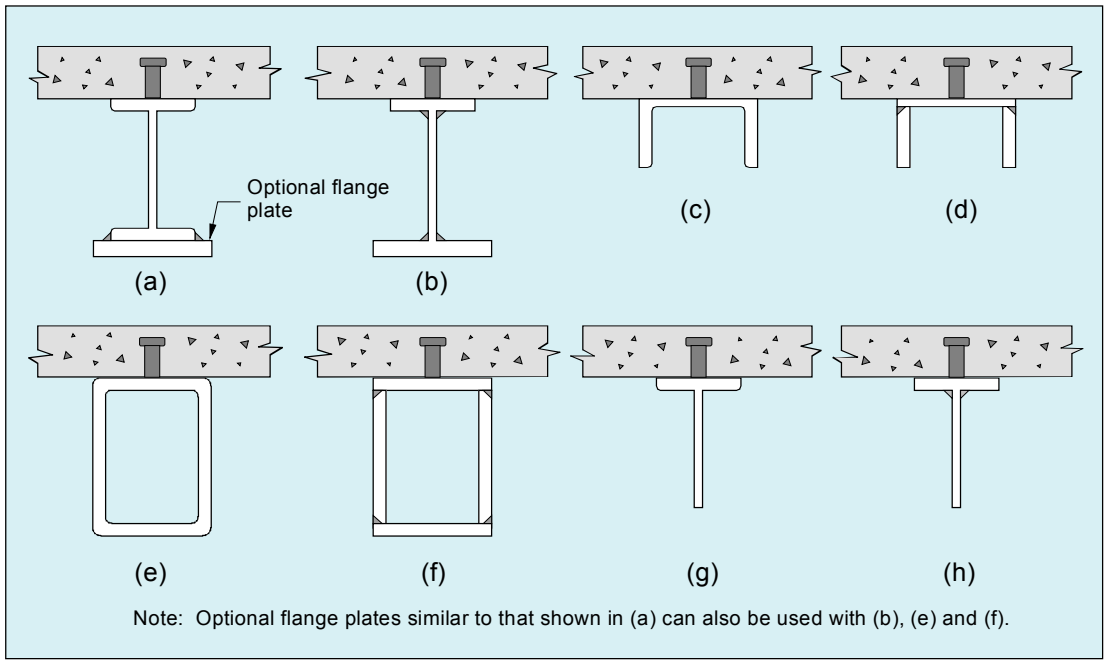

Figure 1.2 Alternative Steel Beam Types

Concrete Slab

The concrete slab forms the top flange of the composite beam. It must be reinforced with deformed bars or mesh to strengthen it against flexure, direct tension or compression, and vertical or longitudinal shear. These action effects can arise due to direct loading, shrinkage and temperature effects, fire, etc. The use of profiled steel sheeting as the bottom-face reinforcement in composite slabs can significantly reduce the amount of conventional reinforcement required in the slab for flexural or shrinkage and temperature effects. The design of solid (reinforced-concrete) slabs must be in accordance with AS 3600. Composite slabs can be designed using the information given in the design booklets provided in Part 3 of this manual. Restrictions which apply to the geometry of the profiled steel sheeting are given in Clause 1.2.4 of AS 2327.1, and, in association with other measures, were necessary to ensure that the shear connection is both efficient and ductile.

The design of composite beams with a precast concrete slab is beyond the scope of AS 2327.1 and, therefore, this booklet.

Profiled Steel Sheeting

The major types of profiled steel sheeting used in Australia, viz. BONDEK II, COMFORM and CONDECK HP (see Products Manufactured From OneSteel and BHP Steel in this manual), all satisfy the geometric requirements specified in Fig. 1.2.4 of AS 2327.1. In accordance with Fig. 1.2.4(a) of AS 2327.1, the minimum cover slab thickness ($D_c - h_r$) is 65 mm. Therefore, the minimum overall slab depth D_c of a composite slab is nominally 120 mm for BONDEK II and CONDECK HP, and 125 mm for COMFORM.

Shear Connectors

Headed studs (manually or automatically welded), channels or high-strength structural bolts shown in Fig. 1.3 may be used as shear connectors. Automatically welded headed studs are the only type of shear connector that may be attached through profiled steel sheeting.

The geometry that the shear connectors must conform with is defined in Clause 8.2.2. It should be noted that the 100TFC section is no longer produced, but the new 300PLUS, 100 PFC section may be used as a direct substitute.

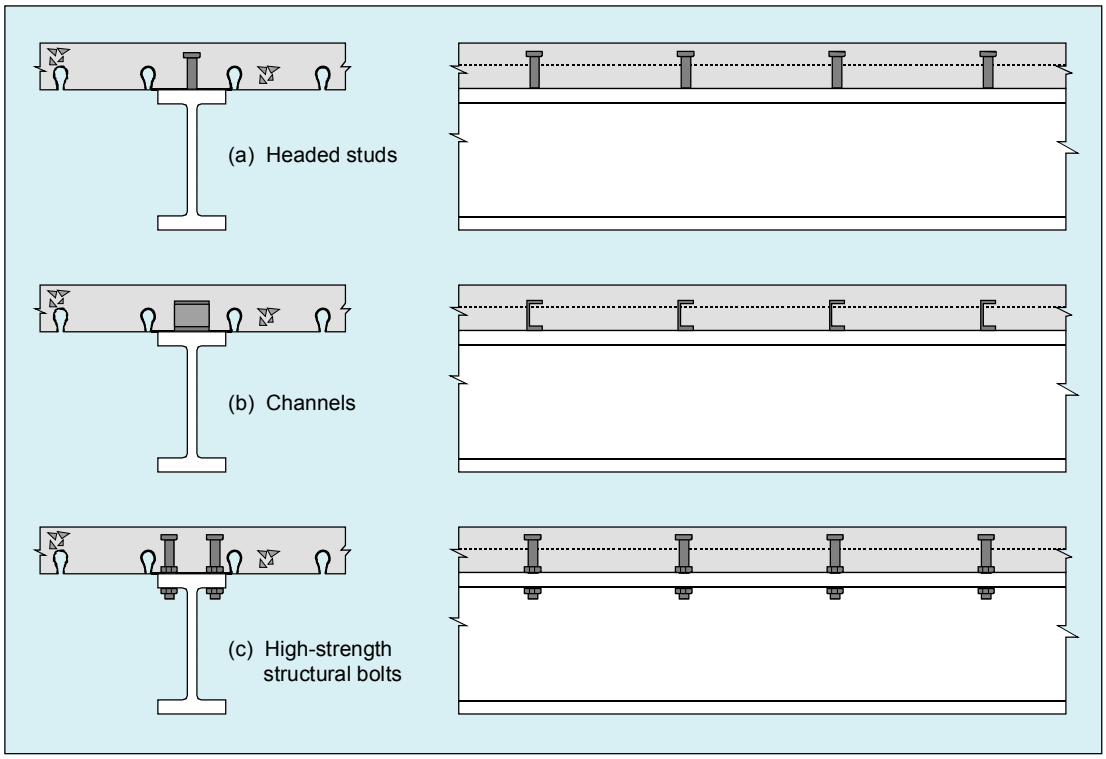

Figure 1.3 Acceptable Shear Connector Types

Steel End Connections

The most commonly used steel end connection for simply-supported composite beams is the web-side-plate connection which is shown in Fig. 1.4.

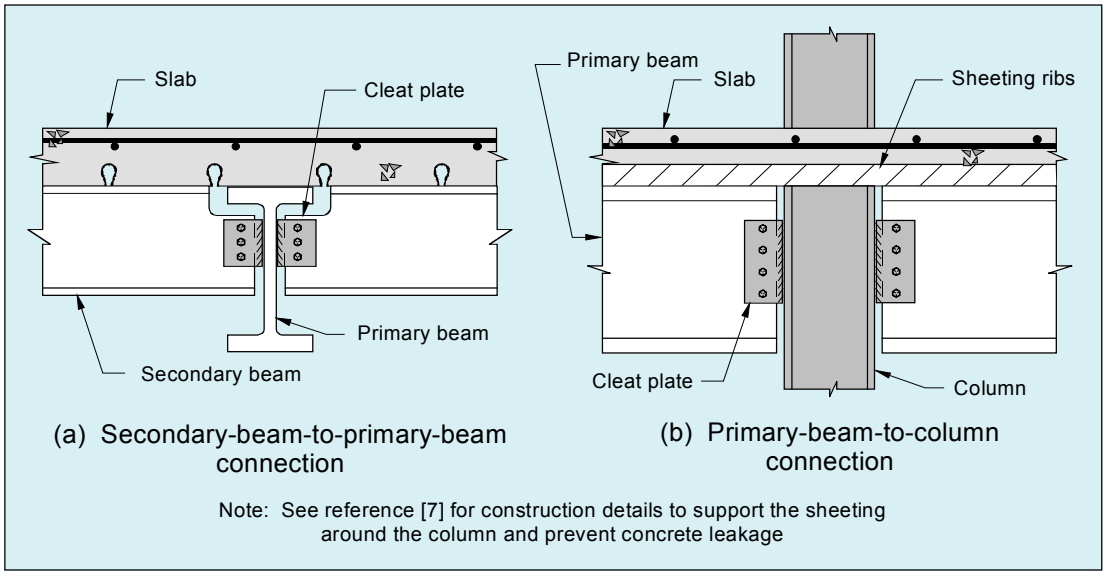

Figure 1.4 Web-Side-Plate Connection

The design of this type of steel connection is addressed in design booklet DB5.1 for the bare steel state, but not when it becomes a semi-rigid composite connection due to continuity of the slab reinforcement as shown in Fig. 1.4. In either case, it is conservative to assume simply-supported support conditions for the design of the beam. In certain types of structures, such as carparks, careful consideration should be given to controlling cracking of the concrete, and accordingly, unpropped construction may be favoured (see Clause 7.3.2 of AS 2327.1), or else the beams may be designed as continuous using design booklet DB2.1 and other types of steel connections used.

Design of Simply-Supported Composite Beams for Strength

(To Australian Standard AS 2327.1–1996)

Design Booklet DB1.1

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 Composite Beams for Strength” was one of the first two design booklets 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.

Contents

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.

Simply-supported composite beams have been favoured in the construction of composite steel-frame buildings in Australia. This is essentially because simple steel connections such as the web-side-plate connection (see design booklet DB5.1 – Design of the Web-Side-Plate Steel Connection) are very economical to use when the steel frame is erected.

This design booklet contains important explanatory information and worked examples about the strength design method in Section 6 of Australian Standard AS 2327.1-1996, Composite Structures, Part 1: Simply Supported Beams. It is intended that this information will assist structural design engineers to understand the engineering principles on which the design method is based. The coverage of the strength design method is continued in design booklet DB1.2 – Design of the Shear Connection of Simply-Supported Composite Beams (To Australian Standard AS 2327.1-1996).

Design aids have already been prepared to support the use of the design method, and are included in the Composite Beam Design Handbook (in Accordance with AS 2327.1-1996) [2] published jointly by the AISC and Standards Australia. These comprise Design Tables (Appendix A) and computer software (COMPBEAM™). Although these design aids are intended to make the design process more efficient, it is essential that the users have a clear understanding of the design concepts and design rules prior to using them.

The strength design method in AS 2327.1 is based on partial shear connection strength theory and rectangular stress block theory, and is applicable to the design of composite beams with compact steel sections and ductile shear connection. Non-compact steel sections can be catered for by representing them in design as equivalent compact sections. Slender steel sections are not permitted. Details for ensuring that ductile shear connection is achieved are given in Sections 8 and 9 of AS 2327.1, and explanatory information about these rules can be found in design booklet DB1.2. Computer program COMPSHEAR™ can be used in association with COMPBEAM™ to design the shear connection in accordance with DB1.2.

The method of strength design presented for simply-supported composite beams has also been extended to cover the design of continuous composite beams, noting that very similar principles apply. The reader is referred to design booklet DB2.1 – Design of Continuous and Semi-Continuous Composite Beams with Rigid Connections for Strength, and an associated computer program COMPSECT™. Partial shear connection strength theory is also applicable to the design of composite slabs with ductile shear connection, which is also covered in a separate design booklet DB3.1 – Design of Composite Slabs for Strength. Finally, it is important to point out that the strength design method in AS 2327.1 is in harmony with leading overseas Codes, Standards and Design Specifications which address the design of composite beams.

Edition 1.0 was published by BHP in May 1998. Edition 2.0 contains some minor corrections to the first edition, and is published by OneSteel.