

AUSTRALIA/NEW ZEALAND STANDARD FOR COMPOSITE STRUCTURES, AS/NZS 2327

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ABSTRACT: *This paper will detail the new draft of the Australia/New Zealand Standard for Composite Structures AS/NZS 2327 which will supersede AS 2327.1 and NZS3404. This paper will outline the current joint Australian/New Zealand standard for composite steel-concrete buildings. The standard has commenced drafting and currently has four sub-committees working on composite slabs, composite beams, composite columns and system behaviour. The standard will be a single document which builds on the historical AS2327.1 standard for the design of simply supported composite beams and the composite provisions in NZS3404. It is envisaged that this standard will consider continuous composite beam design, include provisions for the design of composite slabs and also incorporate rules for the shear connection of composite beams with precast and hollowcore planks. The design approach for composite columns builds on the approach in the current AS/NZS AS5100 Part 6 for bridge structures and will incorporate important design provisions specific to multi-storey building design. It is also envisaged that system approaches for serviceability and fire design of composite floors will be encompassed in the new standard. It is expected that the standard will be published in late 2014 to early 2015.*

KEYWORDS: Buildings, composite construction, concrete structures, steel structures

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1 INTRODUCTION

Recent significant activity on the joint development of an Australian Standard for Bridge Structures in Steel and Composite Structures has highlighted the need and galvanised the industry to begin to develop a harmonised standard for steel-concrete composite structures for buildings. This project submitted to Standards Australia was initially titled “Suite of Standards for Composite Structures for use in Buildings and other non bridge infrastructure incorporating existing AS2327.1-2003, AS2327.2-201X, AS2327.3-201X and ASS2327.4-201X” which received approval in November 2011 and commenced drafting in July 2012 and is due for completion by July 2014. The project is now referred to as the AS/NZS 2327, Composite Structures and will be a single document.



Figure 1: Innovative steel and composite building, One Shelley Street, Sydney, (Hewitt and Edwards, [1])

Composite structures using steel-concrete composite construction techniques generally tend to be the preferred method of construction for steel framed buildings in Australia, New Zealand and most developed countries. Figure 1 illustrates one of the most recent projects to embody all of the beneficial effects of composite construction, that being One Shelley Street, Sydney which has won numerous Architectural and Engineering Excellence Awards. Composite construction tends to reduce the amount of structural steel being used and thus lends itself to greater sustainability benefits than other methods of construction. Furthermore, composite construction also provides steel-frames with the robustness of concrete frames by possessing the added advantages of light-weight which has many other potential benefits for the construction process. The NSW Government Offices completed in 1965 and demolished in 1997 were Australia’s tallest skyscraper on completion reaching 38 levels is illustrated in Figure 2. This building relied on innovative methods of construction to achieve speed of construction and

employed many composite construction methods, namely composite beams spanning 10 metres, composite slabs utilising metal decking. Furthermore, this building involved the first major use of composite construction in columns, namely encased sections.



Figure 2: New South Wales Government Offices, Sydney

Composite steel-concrete structures involving concrete and steel components following the period of significant multi-storey building activity in Australia were able to be designed using a combination of the Australian Standard for Concrete Structures, AS1480-1974, [2] and the Australian Standard for Steel Structures, AS1250-1975, [3]. Both of these standards were based on working stress principles. The limitations on the concrete compressive strength in AS 1480-1974 ranged from 15-50 MPa (N/mm²). The limitations on the tensile strength of the steel reinforcement able to be used in AS1480-1974 ranged from 230-410 MPa (N/mm²). The maximum steel yield stress able to be used in AS1250-1975 was 450 MPa (N/mm²). In addition to these two standards a supplement for composite steel-concrete construction in buildings of AS1480-1974 was also produced, (Standards Australia, [4]). Composite steel-concrete beams following this period were able to be designed using the Australian Standard, AS 2327.1-1980, (Standards Australia, [5]). This standard adopted a working stress design procedure limiting the concrete stress in compression and the steel stress in tension and thus pertained to simply

supported beam construction only. In addition to strength criteria for flexure, serviceability criteria including deflections and vibrations were also covered by this standard. Limit states versions of this were then produced in 1996 and 2003 respectively, (Standards Australia [6] and [7]). Thus, currently in Australia, the design of composite structures for buildings is covered in a piecemeal fashion by three standards AS2327.1-2003, AS3600-2009 and AS4100-2012 (Standards Australia [7, 8 and 9]) and in New Zealand by NZS 3404, (Standards New Zealand, [10]). The development of AS/NZS 2327 will improve cross Tasman harmonisation, will allow innovative aspects of composite construction and design to be incorporated in the one standard and will also allow state of the art international research to be incorporated into a single document drawing heavily on advances in Europe, China and North America, in addition to Australia and New Zealand.

2 PROPOSED STRUCTURE

This section will highlight some of the salient aspects that are proposed to be included in the standard. This is not meant to be the exact table of contents, rather an indication of the main sections that will be covered in the standard. Initially it was proposed to develop four separate standards on beams (simply-supported and continuous), columns and slabs. However, based on the advice of the Australian Building Codes Board the committee has decided a single document to be referred to as AS/NZS 2327 Composite Structures will be developed. The initial proposed layout with notation to describe the various sections is given below

AS/NZS 2327: COMPOSITE STRUCTURES

Section 1	Composite construction
Section 2	Design of composite slabs
Section 3	Design of composite beams
Section 4	Design of composite columns
Section 5	Design for system serviceability
Section 6	Design for system fire
Section 7	Testing methods

3 COMPOSITE CONSTRUCTION

The proposed Section 1 of AS/NZS 2327: Composite structures currently contains seven sub-sections, including Scope and General; Materials; General Design Requirements; Actions and Design Effects; and Methods of Structural Analysis.

3.1 Scope and General

This section will highlight the intent of the standard in terms of what types of structural forms are considered. Thus structural steel section types, shear connector types, profiled steel sheeting types

are all discussed in this section. Furthermore, this is also where definitions and notation for the standard will be specified. Issues associated with construction and erection are also proposed to be covered in this section.

3.2 Materials

This section will outline the various material and the relevant Australian/New Zealand materials standards that need to be adhered to in specifying materials. Materials for structural steel; bolts, nuts and washers; welds and welding; shear connectors; profiled steel sheeting; concrete and reinforcement are all outlined in this section.

3.3 General Design Requirements

This section will outline the general design requirements; including various limit states and their respective capacity factors. Issues relating to durability, fire resistance and prototype testing are also outlined herein. With a number of reliability studies on composite members currently undergoing, there is expected to be some changes proposed herein.

3.4 Actions and Design Effects

This section will describe the typical actions and design effects that need to be considered. Issues associated with erection and construction. Also, in service issues associated with temperature as well as creep and shrinkage are described in this section.

3.5 Methods of Structural Analysis

This section will provide some guidance on methods of structural analysis and will draw on the various approaches in the Australian Concrete and Steel Standards (Standards Australia, [8] and [9]). Furthermore, higher level analyses such as finite element analysis will be introduced in a similar fashion to that being proposed for the new AS/NZS 5100: Part 6, Steel and composite structures.

4 DESIGN OF COMPOSITE SLABS

The intent of this section is to consider the strength and serviceability design of composite slabs utilising metal decking. Issues including flexural strength, longitudinal shear and vertical shear provisions will be covered in this section. Concepts of partial interaction will also be considered and this section will also link quite closely to that being proposed for testing. Other issues that are also being proposed to be covered include the issues associated with the design of slabs using precast panels and topping slabs. Furthermore, post-tensioned concrete construction is also extremely prominent in Australian buildings and recent innovations into post-tensioning concrete slabs with metal decking have been

carried out. One of the major issues is the changes that need to be introduced to deal with the presence of the metal decking for serviceability and strength provisions and these will be considered as part of this section.



Figure 3: Post-tensioned composite slabs, [11]

5 DESIGN OF COMPOSITE BEAMS

This section will detail the design of composite beams, considering flexural strength, shear strength and combined actions as well as serviceability provisions. Partial shear connection approaches will also be a highlight for the design of simply supported and continuous beams. Typical types of composite beam types as illustrated in Figure 4 will be considered. It is also anticipated to treat the design of composite beams using hollow core slabs as outlined in Figure 5.

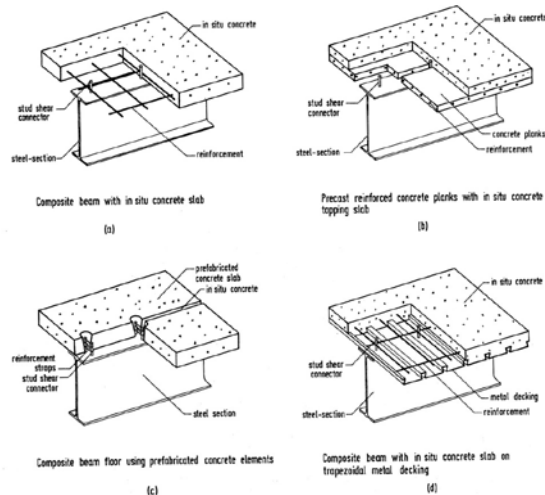


Figure 4: Composite Beams, (Uy and Liew, [12])



Figure 5: Composite Beams with Hollow core Slabs, (Uy and Bradford, [13])

6 DESIGN OF COMPOSITE COLUMNS

This section is proposed to consider the design of composite columns and will closely follow the approach in the AS/NZS 5100 Part 6 (Standards Australia, 2004). The design of composite columns for strength, stability incorporating axial force, uniaxial and biaxial bending will be considered. Composite sections as illustrated in Figures 6 and 7 will be covered in this section. In particular the important effects of confinement are covered by this section. One major area of innovation which this section will cover includes the use of high strength concrete (cylinder strengths up to 100 MPa) and high strength steel (nominal yield strengths up to 690 MPa). There is currently ongoing work to establish appropriate capacity factors to allow the incorporation of these higher strength materials, (Kang et al. [15]).

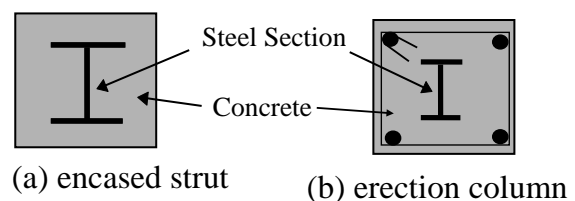


Figure 6: Encased Composite Sections

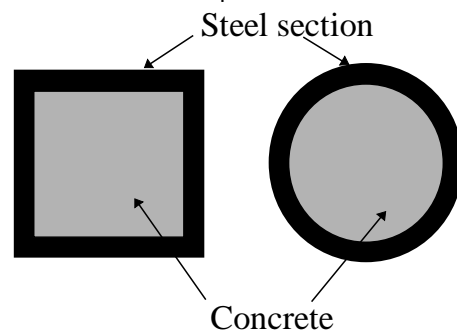


Figure 7: Concrete Filled Steel Columns

7 DESIGN FOR SYSTEM SERVICEABILITY

The intent of this section is to address system behaviour particularly for deflections and vibrations for panels. The behaviour of a floor is thus dependent on the stiffness and damping characteristics of the primary and secondary beams and the slab. This will then provide designers the ability to take into account the beneficial effects of system behaviour in addressing these important serviceability provisions which sometimes penalize steel framed structures from a design perspective, (Steel Construction Institute, 2009).



Figure 8: Composite Steel-Concrete Beam and Slab System, Australia

8 DESIGN FOR SYSTEM FIRE

This section is also intended to provide guidance on design for fire using a system based approach, which acknowledges that for indeterminate systems there is a significant degree of redundancy that provides additional structural capacity within a fire that is unable to be addressed considering single elements within a building. State of the art approaches for dealing with this will be provided herein, (Steel Construction Institution, 2012). It is anticipated that the panel method, whereby primary beams are fire protected and the secondary beams and slabs are left unprotected to allow for membrane action to develop, will also be advocated herein.

9 TESTING

This section of the proposed standard will provide standard test methods for a number of specific issues which are covered. Push test methods for establishing the strength, stiffness and ductility of shear connectors will be outlined in this section as will test methods for establishing the strength characteristics of composite slabs incorporating profiled steel sheeting and hollowcore slabs.

10 OTHER ISSUES

The previous sections have served as an introduction to the scope and structure of the proposed standard AS/NZS 2327: Composite structures. During the drafting process, other issues which have been raised that will inevitably be included, these relate to erection and construction methods and robustness issues. It is expected that some of these issues if felt specific to composite structural design will be included in the standard

11 CONCLUSIONS

This paper has provided some background to the basis of the project to develop a joint Australian/New Zealand standard on composite structures, namely AS/NZS 2327 Composite Structures. A brief history behind the practical uses of composite construction in buildings and the associated design standards that have enabled their wider deployment has been provided. The structure and scope of the proposed AS/NZS 2327 has been provided and innovations in the various sections have been highlighted. Some of the major introductions include the use of higher strength concrete and steel materials. Furthermore, systems approaches will also be addressed in the standard.

ACKNOWLEDGEMENTS

This paper has been prepared by the authors and is meant to be an informative exercise to outline the scope and structure of the proposed AS/NZS 2327 Composite Structures Standard. The final standard is subject to committee decisions and the public comment phase and thus information herein is subject to change. The authors would particularly like to thank the initial working group incorporating Dr Peter Key (Australian Steel Institute) and Mr Anthony Ng (One Steel, Australia) for their leading role in proposing, developing and driving this project. Furthermore, the input of all the Australian and New Zealand nominating organisations and their committee representatives has also been extremely valuable in ensuring that this project received the support in the proposal and drafting stages. We look forward to being able to communicate the progress of this project and hope for its completion in late 2014.

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