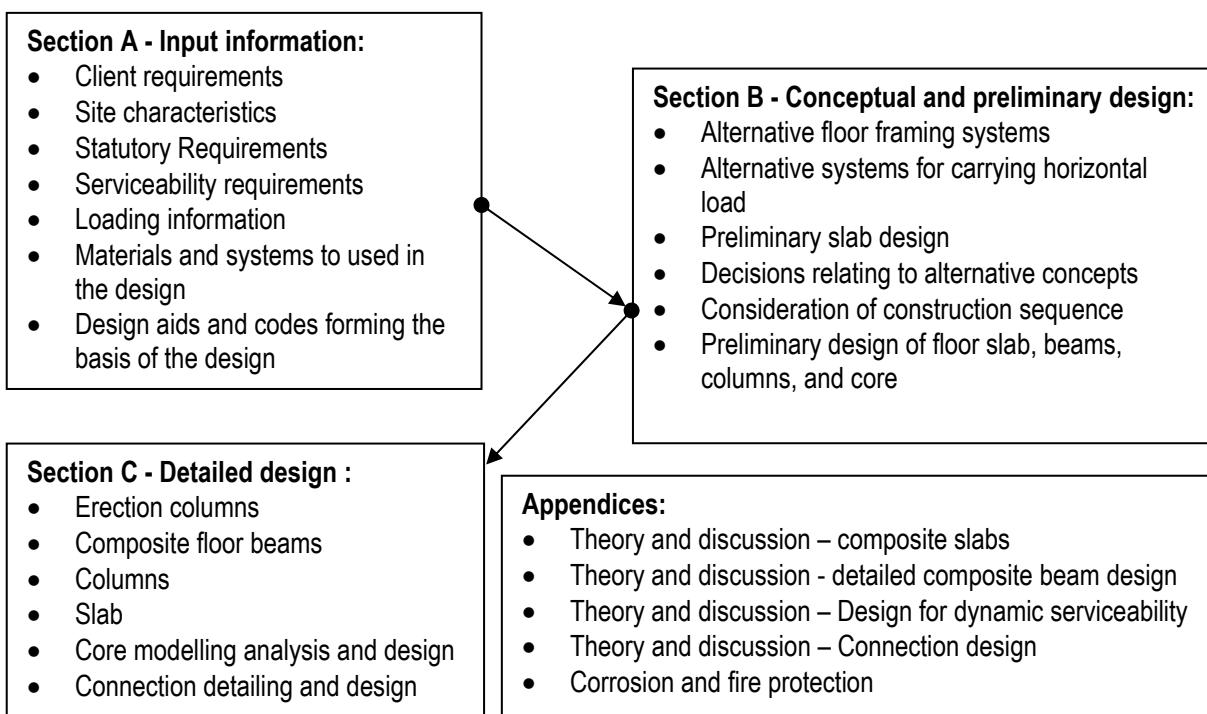


# Preface

The general objective of this publication is to assist building structures engineers to develop as much confidence with the design of composite, steel-framed, multi-storey buildings, as they are likely to have with more traditional reinforced concrete multi-storey buildings. The text consists primarily of a set of design calculations covering most aspects of the design and detailing of a steel framed, composite floored, multistorey building. The appendices to the text provide necessary background to some of the unique aspects of composite design and to interpretation of the Australian Composite Structures Code, AS2327.1, 2003.

The design calculations have been structured in the following fashion that is intended to optimise the learning process rather than being strictly representative of "real" design practice.



In reality the design process is likely to be structured differently for a variety of reasons. In general there may be less strict differentiation between the three major sections of Input Information, Preliminary Design and Detailed Design as used in the text. In addition there is likely to be considerable iteration involved in design, where a scheme may be partly developed, then coordinated with other members of the design team who may suggest changes that then require reworking of certain parts of the design calculations.

If you are not familiar with composite construction systems then you should visit the Stramit, Fielders and Bluescope web sites to access basic information on general composite decking systems and composite construction processes.

The authors acknowledge the valued contribution of numerous people to the development of this text. In particular, thanks are due to John Gardner, State Manager QLD/NT, Australian Steel Institute, for his valued input, support and encouragement and to Nick Van Der Kreek, Technical Development Manager, OneSteel Market Mills, for his detailed proof reading comments and technical advices.

James M Durack  
Max Kilmister  
Connell Wagner  
November 2007

**Connell Wagner**



## Composite Design Example for Multistorey Steel Framed Buildings

Copyright © 2007 by AUSTRALIAN STEEL INSTITUTE

Published by: AUSTRALIAN STEEL INSTITUTE

All rights reserved. This book or any part thereof must not be reproduced in any form without the written permission of Australian Steel Institute.

*Note to commercial software developers: Copyright of the information contained within this publication is held by Australian Steel Institute (ASI). Written permission must be obtained from ASI for the use of any information contained herein which is subsequently used in any commercially available software package.*

FIRST EDITION 2007 (LIMIT STATES)

National Library of Australia Cataloguing-in-Publication entry:

Durack, J.A. (Connell Wagner)

Kilmister, M. (Connell Wagner)

Composite Design Example for Multistorey Steel Framed Buildings

1<sup>st</sup> ed.

Bibliography.

ISBN 978-1-921476-02-0

1. Steel, Structural—Standards - Australia.
  2. Steel, Structural—Specifications - Australia.
  3. Composite, (Engineering)—Design and construction.
- I. Connell Wagner  
II. Australian Steel Institute.  
III. Title

**Disclaimer:** The information presented by the Australian Steel Institute in this publication has been prepared for general information only and does not in any way constitute recommendations or professional advice. The design examples contained in this publication have been developed for educational purposes and designed to demonstrate concepts. These materials may therefore rely on unstated assumptions or omit or simplify information. While every effort has been made and all reasonable care taken to ensure the accuracy of the information contained in this publication, this information should not be used or relied upon for any specific application without investigation and verification as to its accuracy, suitability and applicability by a competent professional person in this regard. Any reference to a proprietary product is not intended to suggest it is more or less superior to any other product but is used for demonstration purposes only. The Australian Steel Institute, its officers and employees and the authors, contributors and editors of this publication do not give any warranties or make any representations in relation to the information provided herein and to the extent permitted by law (a) will not be held liable or responsible in any way; and (b) expressly disclaim any liability or responsibility whatsoever for any loss or damage costs or expenses incurred in connection with this publication by any person, whether that person is the purchaser of this publication or not. Without limitation, this includes loss, damage, costs and expenses incurred as a result of the negligence of the authors, contributors, editors or publishers.

The information in this publication should not be relied upon as a substitute for independent due diligence, professional or legal advice and in this regards the services of a competent professional person or persons should be sought.



# Table of contents

Table of contents .....	iii
Preface .....	v
Section A: INPUT INFORMATION .....	1
A1. Client and Architectural Requirements .....	2
A2. Site Characteristics .....	4
A3. Statutory Requirements .....	5
A4. Serviceability .....	8
A5. Design Loads .....	9
A6. Materials and Systems .....	10
A7. Design Aids and Codes .....	11
Section B: CONCEPTUAL AND PRELIMINARY DESIGN .....	12
B1. Conceptual and Preliminary Design .....	13
B1.1 Consideration of alternative floor framing systems– Scheme A .....	14
B1.2 Consideration of alternative floor framing systems– Scheme B .....	15
B1.3 Framing system for horizontal loading – initial distribution of load .....	16
B1.4 Alternatives for overall distribution of horizontal load to ground .....	17
B2. Preliminary Slab Design .....	21
B3. From Alternatives to Adopted Systems .....	22
B3.1 Adopted floor framing arrangement .....	22
B3.2 Adopted framing arrangement for horizontal loading .....	23
B4. Indicative Construction Sequence and Stages .....	24
B4.1 The importance of construction stages in composite design .....	24
B4.1 Indicative construction sequence and construction stages .....	25
B4.2 Adopted construction sequence for design of erection columns .....	27
B4.3 Core construction alternatives .....	27
B4.4 Adopted construction method for the core .....	27
B5. Preliminary Sizing of Primary and Secondary Beams .....	28
B6. Plenum Requirements and Floor to Floor Height .....	30
B7. Preliminary Column Sizes and Core Wall Thickness .....	33
Section C: DETAILED DESIGN .....	35
C1. Detailed Design - Introduction .....	36
C2. Design Stages and Construction Loading .....	37
C3. Detailed Load Estimation After Completion of Construction .....	38
C3.1 Vertical loading .....	38
C3.2 Wind loading .....	39
C3.3 Seismic loading Not considered .....	40
C4. Erection Column Design .....	41
C4.1 Load distribution for erection column design .....	42
C4.2 Side Column C5 (typical of C5 to C10) .....	43
C4.3 End column C2 (typical of C2, C3, C12 and C13) .....	44
C4.4 Corner column C1 (typical of columns C1, C4, C11 and C14) .....	44
C5. Floor Beams – Construction Stage 1 .....	45
C5.1 Secondary beams Group S1(11 050, 2800) (Beams B22 – B41, B43 – 48) .....	45
C5.2 Primary beams Group P1(9800, 5725) (Beams B1, B7 to B12, B18, B19 – 21, B49 – 51 and B42) .....	46
C5.3 Primary beams Group P2(9250, 6600) (B2, B6, B13 and B17) .....	47
C6. Floor Beams – Construction Stage 3 .....	48
C6.1 Secondary beams Group S1(11 050, 2800) (Beams B22 – 41, B43 – 48) .....	48
C6.2 Primary beams Group P1(9800, 5725) (Beams B1, B7 – B12, B18 – 21, B49 – 51 and B42) .....	49
C6.3 Primary beams Group P2(9250, 6600) (Beams B2, B6, B13, B17) .....	49
C7 Floor Beam Design for Occupancy Loading .....	50
C7.1 Secondary beams Group S1(11 050, 2800) (Beams B19, B21, B22 – B41, B43 – B49 and B51) .....	51
	51



C7.2	Primary beams Group P1(9800,5725) (Beams B1, B7 to B12, B18).....	58
C7.3	Primary beams group P2(9050, 6600) (Beams B2, B6, B13, B17).....	63
C8.	Assessment of Dynamic Performance of Floor System .....	69
C8.1	Definition of the dynamic assessment process.....	69
C8.2	Application of the dynamic assessment process .....	73
C9	Final Slab Design .....	79
C9.1	Slab design for the office areas .....	79
C9.2	Slab design for the compactus areas .....	80
C10.	Longitudinal Shear Reinforcement Design.....	81
C10.1	Introduction.....	81
C10.2	Proprietary longitudinal shear reinforcement products .....	83
C10.3	Secondary beams group S1, B22 typical – longitudinal shear design .....	84
C10.4	Internal primary beams group P2, ( B2 typical) longitudinal shear design.....	85
C10.5	Primary beams P1, (B1 typical) – longitudinal shear design.....	87
C10.6	Perimeter beams B19 to 21 and B49 to 51.....	88
C11.	Floor System Design Review and Final Decisions.....	89
C11.1	Floor design review .....	89
C11.2	Final floor framing plan and deck reinforcement.....	90
C12.	Final Design of RC Columns.....	91
C13.	Detailed Design of the Core .....	91
C13.1	Preliminary discussion and statement of limitations of this section .....	91
C13.2	Basic modelling of the core using beam elements .....	92
C13.3	The Space Gass Analysis Model.....	96
C13.4	Model verification and static deflections for $W_s$ .....	97
C13.5	Dynamic analysis for natural frequency of building .....	98
C13.6	Interpretation and application of stress resultants from Space Gass.....	100
C13.7	Further investigation of the core using a Strand7 finite element model .....	102
C13.8	Review of core investigations .....	105
C14.	Steel Connection Design.....	106
C14.1	Can it be built?.....	106
C14.2	Representative connections .....	108
C14.3	Web side plate connection design for $V^* = 142$ kN.....	108
C14.4	Flexible end plate connection for $V^* = 279$ kN.....	112
C14.5	B2 to core web side plate connection for $V^* = 308$ kN.....	113
C14.6	Column splice for a load of $N^* = 1770$ kN.....	114
C14.7	Column base plate for a load of $N^* = 1770$ kN .....	115
C15.	Web Penetrations .....	116
C16.	Some Final Thoughts and Disclaimers .....	117
Appendix I	Theory and discussion – composite slabs .....	119
Appendix II	Theory and discussion - composite beams.....	133
Appendix III	Dynamic assessment of the floor system .....	149
Appendix IV	Theory and discussion steel connections .....	163
Appendix V	Corrosion and fire protection .....	175

