New Zealand Commentary

on the Precast Concrete Handbook

Introduction

The New Zealand Commentary on the Precast Concrete Handbook is found in the yellow pages at the back of this document. It is intended as a guide that New Zealand engineers should consult when using the Handbook.

Please note:

1. Where no commentary is given, the text in the Handbook is considered suitable for New Zealand conditions, provided New Zealand standards, codes and practices are followed.
2. Tables and diagrams in the Commentary replace the equivalent tables and diagrams in the Handbook.

CONTENTS

of the New Zealand Commentary on the Precast Concrete Handbook

The New Zealand Commentary has the same chapter headings and subheadings as the Handbook (see Contents list on pages VI to IX of the Handbook), except that the Commentary omits those subheadings for which no commentary is given.

Thanks

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Disclaimer

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www.cca.org.nz

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Cement & Concrete Association of New Zealand

PRECAST
NEW ZEALAND INC.

CHAPTER 1

History and Applications

The following text is reprinted from an article that appeared in Issue 27, November 2001, of *National Precaster,* the magazine of National Precast Concrete Association Australia.

1.1 Brief History

Precast New Zealand Inc, a sister organisation of the NPCAA, formed in 1999, promotes, fosters and develops the interests of the precast concrete industry within New Zealand.

Industry Background

Since the early 1960's there has been a steady increase in the use of precast concrete in New Zealand for structural components. Precasters have developed skills to meet the increasing demand, using their experience with increasingly popular loadbearing and non-loadbearing cladding units. Precast flooring systems very rapidly became commonplace with the development of standard profiles, leaving *in situ* floor construction generally less common and uncompetitive.

Until the late 70's to early 1980's, the use of precast elements for seismic resistance in moment-resisting frames and walls was the exception rather than the rule. However, with the availability of deformed reinforcing bar splice sleeves and foot and plate connectors, combined with their competent performance in hinge regions of earthquake resistant structures, precast concrete buildings could now offer the same advantage that steel buildings long held.

During the 1980's construction boom, the popularity of hollowcore flooring systems, and indeed precast component buildings in general, grew out of the requirement to build high quality cost effective structures quickly; precast concrete flooring offers flat or ribbed soffits for architectural effect and most importantly, it has less environmental impact during construction due to the reduction of wet trades on site. Moreover, for the whole structure, off-site precasting of structural frames (cruciform elements), columns, solid beams and shell beams offered the advantage of speed of construction.

The 90's and beyond

Precast and precast prestressed concrete systems are now the preferred method of constructing suspended floors and building frames in New Zealand. In particular precast concrete has achieved floor to floor cycle times which are equal to or, in many cases, superior to, structural steelwork. This is supported by contractors who no longer consider that the erection of precast concrete frames and shear walls are on the critical path of building construction. The *in situ* content on building sites has been further reduced by the development of precast prestressed support beams and precast reinforced column/beam frame assemblies.

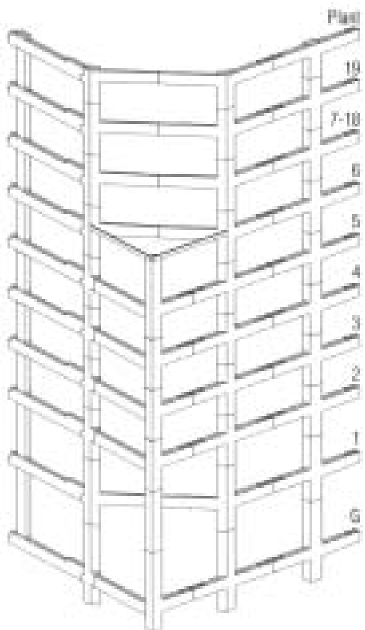
As for the future - while concrete can be customised to be all things to all people, the standardisation of building elements, from manufacture, through transport to site erection and installation, should lead to the greatest economic benefits in multi-storey construction. This includes reduction in design office time, which is also a real cost of construction. Precast NZ Inc. therefore has, as one of its industry projects, a complete overhaul of the building and infrastructure markets with a view to further streamlining the speed and cost of construction through standardisation. This does not mean that innovative designers cannot continue to work with the versatility of concrete but it may mean innovative designs are more often implemented through the use of standardised components.

1.2 New Zealand Case Study: Spencer on Byron

Presented hereunder is an excellent example of a prestigious Auckland building, Spencer on Byron, where the project managers Multiplex Constructions (NZ) Ltd, A.D.C Architects and Stephen R Mitchell Consultant Structural Engineer, chose a totally precast skeletal frame form of construction for its landmark project on Auckland's North Shore.

This 25 storey residential building containing 249 apartments plus penthouses, with an average of 14 apartments per 1000 m^2 typical floor, takes advantage of the repetitive nature of high rise building structures. Close liaison between the architect and the engineer during design development created a precast building with a minimum of component types, all of which had the architectural details incorporated into the precast components.

Spencer on Byron is fully precast with the only *in situ* concrete within the superstructure being the shell beam cores, precast floor topping and wall-beam stitch joints. It featured concrete topped pre-stressed hollowcore floor elements which created a structure with no internal columns, an obvious advantage for architectural planning. The building has a precast concrete shear wall core and the external frames are precast cruciform in one direction and a precast beam/column system in the other direction. The repetitive use of few moulds in the precaster's factory has permitted many advantages perhaps best summed up by the comments made by the Project Manager, Dave Heritage:



Precast cruciform beam and column layout

- **Ease of installation:** The configuration of the cruciform columns allowed precast components to be installed quickly, requiring minimal labour and propping systems to locate.
- **Standardised design:** All precast components were the same configuration from basement to the top of the structure. This allowed efficient utilisation of moulds and a shorter procurement period.
- **Minimised temporary support requirement:** Because the design provided the ability to take the full construction load without specialist propping, benefits were reductions in components to be relocated with each floor cycle, in turn, reducing the site labour requirements.
- **Reduced labour cost:** The configuration of the precast components negated the need for floor slab formwork and with 90% of the reinforcing requirements incorporated in the precast, again greatly reduced the requirement for site labour for floor slab preparation.
- **Short programme cycle:** Programmed floor cycle time was 7 working days. This was reduced to 6 days and fit out load in requirements still accommodated by the one on-site crane. The site team did demonstrate that when required, a structural floor cycle could be achieved in 4 days. This was solely due to the structural compact design allowing ease of installation and no requirements for a support system.
- **Early fit out access:** A further benefit from this being the service trades could commence at an earlier stage of the cycle.

For further information about the New Zealand precast industry including Member details and list of publications, visit the Precast NZ Inc. website www.precastnz.org.nz

Spencer on Byron building under construction

Spencer on Byron completed structure

CHAPTER 2

Products and Processes

This Commentary is intended for New Zealand engineers using Chapter 2 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used. Tables and diagrams in the Commentary replace those in the Handbook.

2.1 Introduction

2.2 Building components

2.2 Designers should refer to Appendices B.4 and B.5 of this Commentary and to PCNZ and its website (www.PrecastNZ.org.nz) for advice on New Zealand manufacturers and their products.

2.2.1 Floors

Instead of Figure 2.2.1.1 in the Handbook, refer to Figure 2.2.1.1 in this Commentary. This shows indicative spans for flooring products generally used in New Zealand. Individual manufacturers should be contacted for section properties and load span tables of their particular products.

The following summarises the precast concrete flooring systems commonly used in New Zealand:

Rib and Timber Infill Floors

Rib and timber infill systems are commonly used in New Zealand buildings. They are described in the PCNZ publication *PCNZ Guide to the Installation of Rib and Timber Infill Flooring Systems* which may be printed from www.PrecastNZ.org.nz

Individual manufacturers should be contacted for section properties and load span tables of their particular product.

Hollowcore floors

Hollowcore floors are widely used in New Zealand but almost invariably with at least 65mm topping. Special end seating requirements, including a minimum of 75mm seating, have been the subject of recent (late 2003) amendments to the New Zealand concrete code, NZS3101. These amendments incorporate recommendations by the precast flooring technical advisory group (TAG), following extensive testing at Canterbury University. Copies of the TAG group's recommendations can be obtained from the Cement and Concrete Association of New Zealand - see Bibliography (Appendix B.3).

The testing has highlighted the need for designers to consider deformation compatibilities between all flooring systems (not just hollowcore) and their supports during severe seismic events and then to detail their supports accordingly.

It is not New Zealand practice to separately grout shear keys. Individual manufacturers should be contacted for section properties and load span tables of their particular product.

Composite flooring

This product is not made in New Zealand at present, although some manufacturers have a similar product.

Solid slabs

A similar product is in common use in New Zealand. Although usually 75 mm thick, it can be up to 125mm thick and occasionally greater. It is usually 1.2 m or 2.4 m wide and requires 75 mm end seating. In New Zealand it is made without shear keys and is usually topped with at least 65 mm of concrete topping. Flat slabs are commonly used in residential applications and light commercial buildings and these require intermediate propping for spans greater than 3.5 to 4 m.

For special orders it may be possible to make a thicker unit.

Individual manufacturers should be contacted for section properties and load span tables of their particular product.

Double Tees

This product is commonly used in New Zealand for commercial and industrial floors. Double Tees are particularly useful where there may be a number of penetrations in the floor. Single Tees are not commonly specified. Individual manufacturers should be contacted for section properties and load span tables of their particular product.

Beams

A number of New Zealand precast manufacturers can manufacture solid prestressed beams. The design charts in this commentary can be used for preliminary sizing.

Reinforced precast solid and half beams are also available in varying widths and depths. Individual manufacturers should be contacted for details of available sizes.

Beam shells

Members as described in Section 2.2.1.7 of the Handbook are uncommon in New Zealand although some precast manufacturers can manufacture such beams. Instead, common New Zealand practice is to use shell beams, typically with widths of either 400 mm or 600 mm and depths of up to 600 mm.

Individual manufacturers should be contacted for section properties and load span tables of their particular product.

Grandstand seating units (Bleachers)

A number of New Zealand precast manufacturers can manufacture bleachers. Individual manufacturers should be contacted regarding the availability and section properties of their moulds, although new moulds can be made for significant jobs.

Figure 2.2.1.1

COMPARATIVE SELECTION CHART FOR FLOOR SYSTEMS

RESIDENTIAL FLOORS

Live Load of 1.5 kPa and 0.5 kPa SDL

FLAT SLAB

Unit	Topping	O/A Depth
75	65	140
75	75	150
75	90	165
75	110	185
75	130	205
100	100	200
100	125	225
100	150	250

RIB & TIMBER INFILL

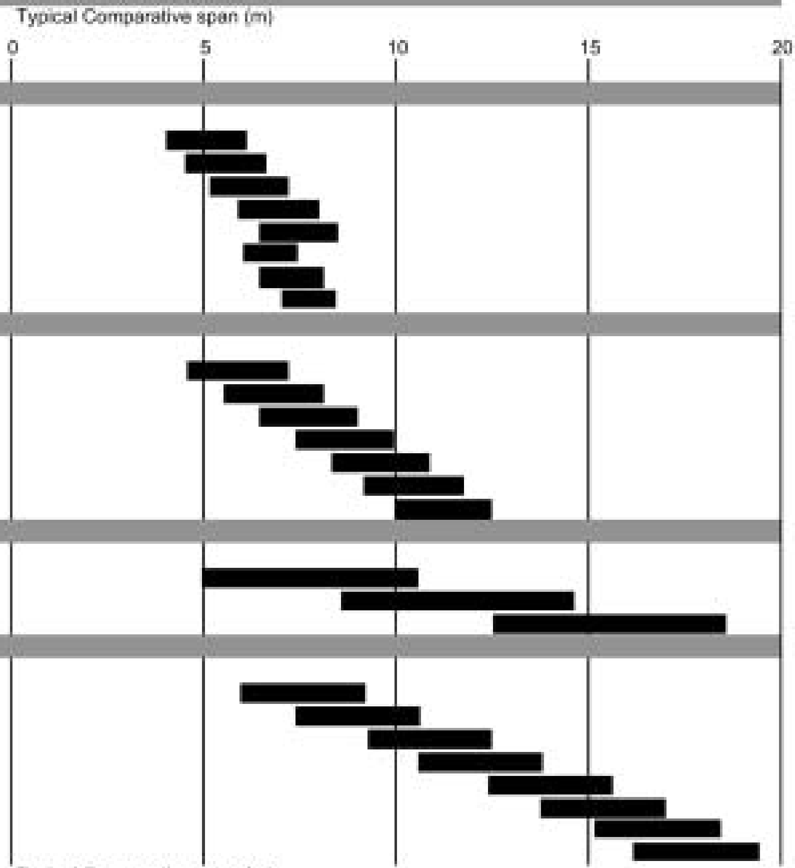
Unit	Topping	O/A Depth*
100	75	200
125	75	225
150	75	250
175	75	275
200	75	300
225	75	325
250	75	350

HOLLOWCORE

Unit	Topping	O/A Depth
200	65	265
300	65	365
400	65	465

DOUBLE TEE

Unit	Topping	O/A Depth
200	65	265
250	65	315
300	65	365
350	65	415
400	65	465
450	65	515
500	65	565
600	65	665



COMMERCIAL FLOORS

Live Load of 3.0 kPa and 0.5 kPa SDL

FLAT SLAB

Unit	Topping	O/A Depth
75	65	140
75	75	150
75	90	165
75	110	185
75	130	205
100	100	200
100	125	225
100	150	250

RIB & TIMBER INFILL

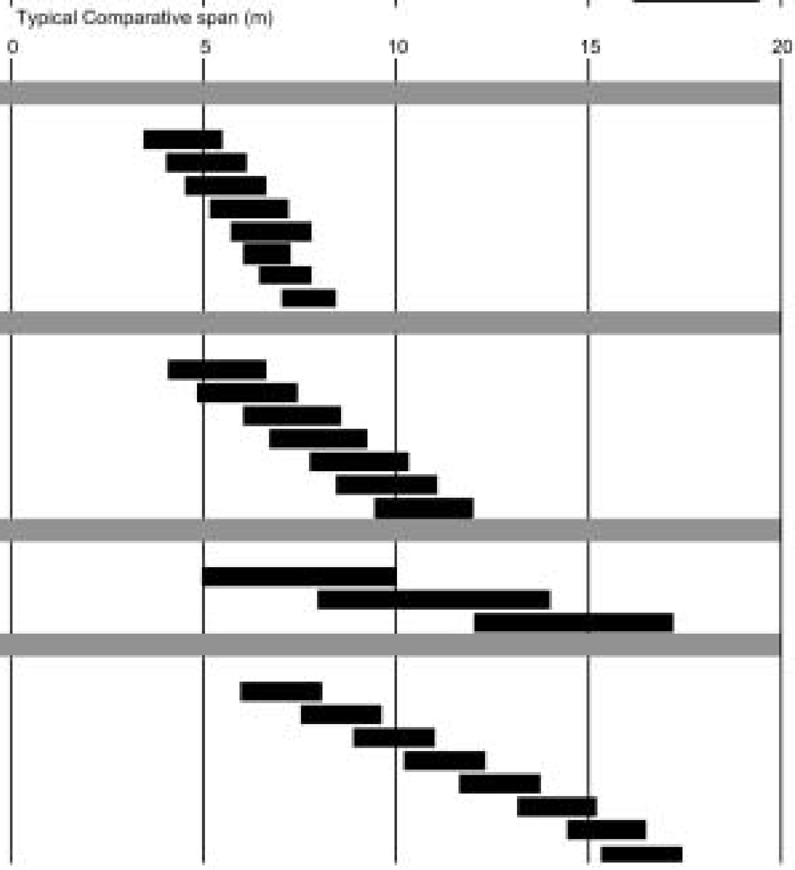
Unit	Topping	O/A Depth*
100	75	200
125	75	225
150	75	250
175	75	275
200	75	300
225	75	325
250	75	350

HOLLOWCORE

Unit	Topping	O/A Depth
200	65	265
300	65	365
400	65	465

DOUBLE TEE

Unit	Topping	O/A Depth
200	65	265
250	65	315
300	65	365
350	65	415
400	65	465
450	65	515
500	65	565
600	65	665



NOTES:

Charts are based on simply supported spans

* Table assumes 25mm for timber infill. Check actual with individual manufacturers

2.2.2 Walls

2.2.2.1 Architectural wall panels

This section is suitable for New Zealand, but refer also to the New Zealand Commentary on Chapter 7: Connections and Fittings.

2.2.2.2 Hollowcore wall panels

Hollowcore wall panels are not typically used in New Zealand. Designers who wish to consider the use of hollowcore slabs as wall panels should refer to a hollowcore manufacturer and discuss details, availability and section properties.

2.2.4 Columns

2.2.4.1 Precast columns

Caution should be exercised when considering the use of the suggested connection configurations. Each connection may be required to transmit combined gravity and lateral loads according to NZS 4203, the Loadings Code. In the case of seismic load transfer, the connection design will be determined by the structural ductility factor used.

Precast column charts

These are a useful guide but the final design should be checked for compliance with NZS 3101.

2.2.5 Stairways

2.2.5.1 Multi-storey construction

The local authority's egress requirements for the number of risers permitted between landings, and other restrictions, should be checked.

Caution should be exercised when considering the use of the suggested connection configurations. Usual practice is to isolate stairways from core elements so that the stairway does not attract additional lateral forces from a surrounding shearwall core. Stairways should remain structurally viable for the safe passage of pedestrian traffic after accommodating seismically induced movements. Each connection should be designed to achieve this.

2.3 Bridge Components

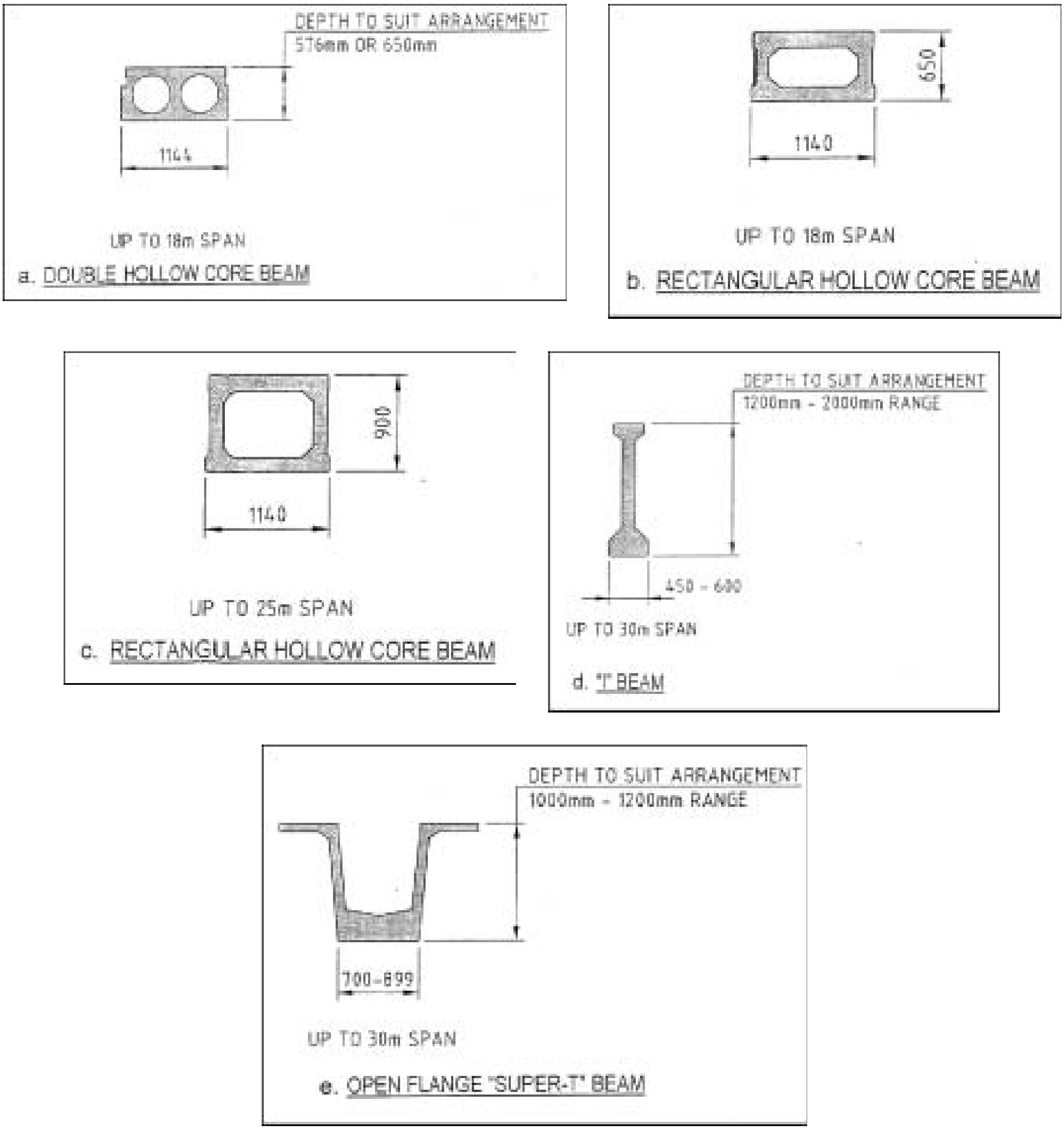
Transfund New Zealand in conjunction with the Cement and Concrete Association of New Zealand have funded a research program (undertaken by Beca Carter Hollings and Ferner, OPUS International Consultants and Precast New Zealand) into standard bridge beams available in New Zealand. The reader is referred to their authoritative report.

The Stage 1 report (No. 252) aimed to determine the current range of shapes available from manufacturers and the likely future shapes that would be suitable for New Zealand conditions. Detailed designs and drawings are to be produced in Stage 2 of the project.

The bridge beam shapes in Figure 2.3 of this Commentary are proposed as New Zealand Standard Precast Bridge Beams for which details of designs and drawings are to be produced, in Stage 2 of the project.

Figure 2.3

New Standard Precast Bridge Beams (Transfund New Zealand Report No. 252)



Double hollow core beams up to 900mm deep are also readily available in New Zealand with spans up to 25m. Super T (T-Roff) beams are also available up to 1.5m deep and capable of spanning 38m.

2.3.1 Highway Bridges

See also comments above, under 2.3 Bridge Components.

Care should be taken when using the selection charts shown on page 2-22 of the Handbook for comparing Australian and New Zealand cross sections in order to take into account any differences in:

- applied traffic loads and
- allowable materials code properties.

2.3.2 Rail Bridges

The cross sections in the Handbook shown may not be available in New Zealand. Designers should consult New Zealand precast manufacturers to determine what sections are available locally. Appropriate applied loadings will be specified by the user of the rail track system.

2.3.3.1 Comparative Selection Chart for Pedestrian and Cycleway Bridges

The selection chart on page 2-33 of the Handbook is indicative only. The sections shown may not be available in New Zealand, and availability within New Zealand will vary with locality. Accordingly, the designer must determine the appropriate live loads and design for local New Zealand conditions.

Culverts for highways in New Zealand are designed using the Transit Bridge Manual and NZS 3101.

2.4 Civil Components

2.4.1 Substructures

The selection charts on 2-38 and 2-39 of the Handbook are indicative only. Accordingly, the designer must determine the appropriate live loads and section availability and design for New Zealand conditions.

Piles (square/octagonal)

The 50 mm cover shown in the examples in the Handbook may need to be adjusted, depending on the cement type, concrete properties and exposure conditions. The allowable service loads given in the table should be checked against NZS 4203.

2.5 Component Manufacture and Production Facilities

2.5.5 Moulds

The availability of complex liners and unusual finishes should be discussed with the precast manufacturer at an early stage.

2.5.6 Concrete

Do not specify higher strengths than necessary. Factors other than strength may have a greater effect on durability.

The precaster's need to achieve a high early strength for handling on prestressing will normally determine the grade of concrete to be used in manufacture. If the structural designer has concerns about excessive strength, these should be made clear to the manufacturer before the contract is awarded.

CHAPTER 3

Materials and Material Properties

This Commentary is intended for New Zealand engineers using Chapter 3 of the *Precast Concrete Handbook* published by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used. Tables in the Commentary replace those in the Handbook.

3.3 Materials

3.3.1 Cement

Cements in New Zealand should comply with:

- NZS 3122 Portland and blended cements (General and special purpose)
- NZS 3123 Portland pozzolan cement - Type PP cement
- NZS 3125 Portland-limestone filler cement

With reference to Table 3.1 on pages 3-4 of the *Precast Concrete Handbook*, the following cements are also covered by New Zealand Standards:

SR Sulphate Resisting Cement (NZS 3122). For use in concrete in contact with, or subject to exposure to sulphates.

SL Shrinkage Limited Cement (NZS 3122). For use where emphasis is placed on drying shrinkage and crack control.

PP Portland Pozzolan Cement (NZS 3123). Concretes produced from this type of cement have a relatively low heat of hydration, and increased resistance to sulphate attack. The inclusion of pozzolan also inhibits harmful expansion that may result from alkali-aggregate interaction. Other characteristics of type PP cement concrete include relatively high long-term strengths, reduced permeability, and, in certain cases, relatively low strengths at early ages.

PLCF Portland-Limestone (NZS 3125). Concretes produced from this cement generally show enhanced workability properties, which can allow for some strength adjustments.

3.3.2 Supplementary cementitious materials (SCM's)

There is no New Zealand Standard for Supplementary Cementitious Materials for Use with Portland Cement. The appropriate parts of Australian Standard AS 3582 can be used.

3.3.3 Aggregates

Aggregates in New Zealand should comply with NZS 3121 Specification for Water and Aggregate for Concrete. Methods of Test for Water and Aggregate for Concrete are given in NZS 3111.

To comply with NZS 3121, aggregates shall be (a) physically suitable and of adequate cleanness for the economic production of concrete with plastic properties satisfactory for handling and placing (b) free of significant quantities of materials which may deleteriously affect the intended performance or long term durability of the concrete. The grading and cleanness value requirements for coarse aggregates, and the desired sand flow times, void contents and cleanness values for sands, are stipulated in NZS 3111.

Additionally, Section 6.4 "Aggregate and Water" of NZS 3109:1997 Concrete Construction stipulates aggregate selection and use precautions associated with Alkali Aggregate Reaction (see also the revised CCANZ publication: TR03 Alkali Silica Reaction), and comments on the maximum aggregate size consistent with reinforcement spacing and cover, member dimensions, and finishing requirements.

3.3.4 Water

In New Zealand, water should comply with NZS 3121 Specification for Water and Aggregate for Concrete. The general requirement is that water shall be free from significant amounts of impurities which may deleteriously affect the setting, hardening, or strength of concrete or its long-term durability. [*Note:* The use of recycled wash water as part of the water added to concrete when it is batched is a relatively recent phenomenon in New Zealand - driven by the Resource Management Act 1991 - and requires special consideration.]

3.3.5 Chemical admixtures

The New Zealand Standard Specification for Chemical Admixtures for Concrete is NZS 3113. However, this Standard is generally considered as outdated - the latest revision was in 1979. Instead, *either* the Australian Standard AS 1478.1 or the American Society for Testing and Materials specifications ASTM C260 and C494 can be adopted, but this should be discussed with the intended admixture suppliers.

Table 3.3 of the *Precast Concrete Handbook* is relevant in New Zealand.

[*Note:* Chloride Content: Section 6.6, "Chlorides", of NZS 3109 Concrete Construction prescribes limits on the total chloride content of concrete arising from aggregate, mixing water and admixtures.]

3.3.6 Pigments (Oxides)

The section on pigments in the Handbook is relevant to New Zealand.

3.3.7 Reinforcement

The New Zealand equivalent of AS 3600 is NZS 3101 Concrete Structures Standard.

3.3.8 Reinforcing bars

Steel reinforcing bars are manufactured in New Zealand to AS/NZS 4671 Steel Reinforcement Materials, which superseded NZS 3402, NZS 3421 and NZS 3422. However, hard drawn mild steel wire for concrete reinforcement, and welded fabric of drawn steel wire for concrete reinforcement are still manufactured to NZS 3421 and NZS 3422, respectively (despite the fact that these standards have been superseded).

Shape

Reinforcing bars in sizes 2.8mm and up are available in New Zealand.

Ductility Class

Class L reinforcement is not generally available in New Zealand. Hard drawn reinforcing wire and reinforcing fabric are produced to NZS 3421 and NZS 3422 respectively - refer to comments under 3.3.8 above.

Class N reflects the normal ductility of hot rolled bars for low ductility requirements and non-seismic design. NZS 3101 states that Class N reinforcement can be used only if particular conditions are met.

Class E reflects the high ductility of hot rolled bars, which is required for seismic design requirements. The rules in NZS 3101 are based on Class E.

Strength Grade

In New Zealand, the commonly available grades of steel reinforcing bars are Grade 300 and Grade 500.

(*Note:* Grade 300E and 500E steel has weldability at least as good as 500N, with no change in properties as happens when quenched and self-tempered 500N is welded.)

The specified mechanical properties of reinforcing steels used in New Zealand are set out in Table 3.4 in this Commentary.

Table 3.4

Mechanical Properties of Reinforcing Steels - AS/NZS 4671 and NZS 3421 & 3422

	Grade of steel			
Characteristic property	300E	500E	500N	NZS 3421/3422
Yield Stress (MPa)				
min $R_{ek.l}$	300	500	500	485
max $R_{ek.u}$	380	600	650	-
Ultimate Stress (MPa)				
Min				575
Max				775*
Ratio R_m/R_e				
Min	1.15	1.15	1.08	-
Max	1.50	1.40	-	-
Uniform elongation, $\varepsilon_{su\,(\%)}$				
Min	15	10	5	-

* Max Ultimate Stress is 855MPa for reinforcement up to and including 3.15mm.

Commonly available bar sizes in New Zealand are shown in Tables 5a, b and c in this Commentary.

Table 3.5a and 3.5c

Nominal Values for Hot Rolled Plain and Deformed Bars of Grade 300E and 500E

Size	Cross-sectional area (mm^2)	Mass/metre (kg)
6	28.3	0.222
10	78.5	0.617
12	113	0.888
16	201	1.58
20	314	2.47
25	491	3.85
32	804	6.31
40	1260	9.86

Table 3.5b

Nominal values for high strength deformed reinforcing wires

Size (mm)	Cross-sectional area (mm^2)	Mass/metre length (kg)
3.15	7.8	0.061
4	12.6	0.099
5	19.6	0.154
5.3	22.1	0.173
6	28.3	0.222
6.3	31.2	0.245
7.1	39.6	0.311
7.5	44.2	0.347
8	50.3	0.395
9	63.6	0.499
9.5	70.9	0.556
10	78.5	0.617
11.2	98.5	0.773

3.3.9 Reinforcing mesh

New Zealand reinforcing fabric is produced to NZS 3422 - see also comment under 3.3.8 in this Commentary.

Available fabric sizes vary with suppliers. The more commonly available sizes are given in Table 3.6 in this Commentary.

Table 3.6

*Commonly available reinforcing fabric sizes available in New Zealand. "Designation" and Effective cross-sectional areas (mm^2/m) **

WIRE SIZE (DIAMETER) (MM)	WIRE PITCH (SPACING) (MM) 75	150	210	260	300
4	"338" 168mm^2/m	"668" 84mm^2/m			
5.3	"335" 294 mm^2/m	"665 or 147" 147 mm^2/m		"D84" 85 mm^2/m	
5.6					"84/10" 82 mm^2/m
6		"664 or 188" 188 mm^2/m			
6.3	"333" 416 mm^2/m	"663 or 212" 208 mm^2/m			
7.1		"662 or 264" 264 mm^2/m			"132" 132 mm^2/m
7.5		"661" 295 mm^2/m	"212" 212 mm^2/m		"147 or 147/10" 147 mm^2/m

Note: Sheet size, cover and description will vary depending on the manufacturer. Consult supplier for specific information.

3.3.10 Steel fibre reinforcement

The use of steel fibre reinforcement is expected to be included as an Appendix to the new NZS 3101.

3.3.11 Prestressing tendons

This section is relevant to New Zealand.

Note: A Draft for Public Comment of AS/NZS 4672 - Steel Prestressing Materials is available on Standards New Zealand's website: www.standards.co.nz

3.3.12 Prestressing hardware

This section is relevant to New Zealand.

3.3.13 Welding of reinforcement

Carbon equivalent and welding provisions are specific to Grade 300E and Grade 500E in New Zealand. Refer to a supplier or welding engineer for qualified welding procedures that comply with AS/NZS 1554.3

3.3.14 Mechanical splicing

This section is relevant to New Zealand.

3.3.15 Durability considerations for reinforcement, tendons and cast-in place items.

Concrete Cover

In New Zealand, the total acid-soluble chloride content of concrete is limited in NZS 3109. The stipulated maximums are as follows:

- Prestressed concrete: 0.50 kg/m³
- Reinforced concrete:

(a) Located in a moist environment or exposed to chloride 0.08 kg/m³

(b) Located in a dry or protected from moisture environment 1.60 kg/m³

The requirements for cover to reinforcement steel and tendons, for both durability and fire resistance, are stipulated in NZS 3101. Durability may be enhanced, or cover reduced, by the use of pozzolanic additives such as microsilica or fly ash.

3.4 Concrete and concrete properties

3.4.1 General

In New Zealand, concrete should be specified in accordance with NZS 3104 and 3109.

The tests and criteria for checking compliance of concrete are stipulated in Section 9 of NZS 3109.

Self-compacting concrete (SCC) is being widely used in the precast concrete industry internationally, and its use in New Zealand is increasing. Currently, SCC is not covered by either NZS 3119 or NZS 3104, but its use will be encouraged by the proposed revision of NZS3101.

The New Zealand equivalent of AS 3600 is NZS 3101.

3.4.2 Workability

This section of the *Precast Concrete Handbook* provides a generic-type commentary, which is equally relevant in New Zealand.

3.4.3 Compressive strength

This section of the *Precast Concrete Handbook* provides a generic-type commentary, which is equally relevant to New Zealand.

3.4.4 Tensile strength

Unlike AS 3600, NZS 3101 does not provide values for tensile strength. Typically, the tensile strength is taken as 2/3 of the modulus of rupture.

The average modulus of rupture, f_r, for normal weight concrete, and the values to be used for the purposes of calculating deflections of members, are given in 3.8.1.3.1 and 3.8.1.3.2, respectively, of NZS 3101:1995. Modifications for the use of lightweight concrete are given in 3.8.1.3.3.

3.4.5 Modulus of elasticity

3.8.1.2 of NZS 3101:1995 provides details of the modulus of elasticity for concrete, E_c, to be used in design.

3.4.6 Poisson's Ratio

3.8.1.4 of NZS 3101:1995 states that Poisson's Ratio for concrete, v, shall be taken as 0.2 or as determined from suitable data.

3.4.7 Coefficient of thermal expansion

3.8.1.5 of NZS 3101:1995 states that the coefficient of thermal expansion for concrete shall either be taken as 12 x 10^{-6}/ °C or determined from suitable data.

3.4.8 Shrinkage and creep

This section of the *Precast Concrete Handbook* provides a generic-type commentary, which is equally relevant to New Zealand. Refer to NZS3101 for the creep and shrinkage properties of New Zealand concretes.

3.4.9 Permeability and absorption

This section of the *Precast Concrete Handbook* provides a generic-type commentary, which is equally relevant to New Zealand.

3.5 Grouts and Mortars

The contents of sections 3.5.1 to 3.5.4 (inclusive) are generic in nature, and are equally relevant to New Zealand.

CHAPTER 4

Tolerances

This Commentary is intended for New Zealand engineers using Chapter 4 of the *Precast Concrete Handbook* published by the National Precast Concrete Association Australia and Concrete Institute of Australia. This Commentary is general in nature and does not follow the headings in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

Preamble

The contents of this chapter are a useful guide for New Zealand conditions, and provide useful examples of good practice, subject to the following comments.

Tolerances for New Zealand practice are specified in NZS 3109 Concrete Construction but more comprehensive and appropriate information for New Zealand conditions is given in Chapter 8, 'Tolerances' of the *Guidelines for the Use of Structural Precast Concrete in Buildings* (Second Edition) from the Centre for Advanced Engineering, University of Canterbury, Christchurch.

Additional items for consideration are as follows:

Manufacturing Tolerances

Tighter tolerances than normally used should not be specified without discussion with the precaster, erector and builder. Tighter tolerances than necessary can have significant impact on costs owing to the greater levels of skill and supervision required and the higher than normal reject rates.

Time

Concrete shrinkage and creep are time-dependant, and tolerances will be affected by the time elapse since casting and the relative ages of both the precast element and the supporting structure

Cumulative Effects

A supporting structure and the precast element being fitted to the structure can both be within their individual tolerances, but an adverse combination of tolerances of different elements can produce unanticipated problems. For instance, an opening within a structure may be filled with several precast panels side by side. Each of the panels may be oversize but within tolerance, and the structural opening into which they are to be located may be undersize and also within tolerance and yet the combination does not fit as intended. This situation may occur, although statistically it should be infrequent.

It should be recognised that within tolerance variations in panel length can produce relatively large and noticeable variations in the width of the joints between the panels.

Cast In Precast Elements

Larger variations in length can be accommodated in items such as precast floor ribs, which are cast into *in situ* concrete at each end. These are usually manufactured with greater length tolerances.

Temperature Differentials

Temperature differentials due to exposure of one face of an element to the sun will cause curvature, which varies over 24-hour cycles. Creep effects can cause some of the curvature to become permanent. These effects can be significant in the case of long slender elements.

CHAPTER 5

Analysis and Design of Buildings

This Commentary is intended for New Zealand engineers using Chapter 5 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

Preamble

In New Zealand the design of precast structures is generally governed by consideration of the behaviour of buildings in the earthquake ultimate limit state. Chapter 5 of the Handbook focuses more on the wind design considerations, which have greater relevance in Australia. Its is recommended that, for New Zealand conditions, designers refer to NZS 3101, Concrete Structures Standard, Guidelines for the Use of Structural Precast Concrete in Buildings (see Reference 5.6 under 5.10 in the Handbook) instead of Section 5.6 in the Handbook. (*Note:* Reference 5.6 is not the same as Section 5.6; it is a coincidence that they both have the same number). Designers should also refer to a report (nearing completion at the time of writing) by the Building Research Association of New Zealand (BRANZ) on the design of slender precast panels.

5.1 Definitions and Notations

5.1.1 Definitions

The definition of a dual system, as stated in the Handbook, refers to one quarter of the horizontal load being resisted by the space frame. No such requirement exists in NZS3101.

5.1.2 Notation

Some of the notation in the Handbook is a little different to that used in NZS3101, and therefore engineers should refer to the latter.

5.2 Introduction

This section of the Handbook implies that precast moment-resisting structures are viable only for squat two and three storey structures. In fact, in New Zealand many multi-storey structures have been built using this construction technique.

This section of the Handbook also implies that the most economical design solution is to strongly delineate between primary and secondary lateral load resisting elements. The Introduction suggests that secondary elements are designed as simply supported elements. This may be an economic solution in many instances, but designers who adopt it must not lose sight of the fact that, because the structure is deformed laterally in an earthquake, the secondary system will require horizontal restraint to prevent P-delta forces causing instability. These restraining forces are provided by the primary lateral load system and need to be considered in the analysis.

5.3 General Design Considerations and the Design Process

5.3.1 Building Code of Australia and Australian Standards requirements

In New Zealand, the governing standard is NZS 3101 Concrete Structures Standards and the relevant code is the Building Code of New Zealand.

5.3.2 Final design

This section of the Handbook implies that it is the designer's responsibility to provide guidance on how the structure will be stabilised during construction. This is not normally the case in New Zealand, where the design of temporary works is the responsibility of the contractor. However, the design engineer needs to consider the matter of stability during construction when devising the construction method and sequence.

5.3.3 Lateral load-resisting system

Definition of building frame system. In New Zealand it is common to refer to a structural system with respect to its method of resisting lateral loads. The example given in the Handbook would, in New Zealand, be more likely called a 'shear wall structure'.

5.4 Applied Loads and Actions

5.4.1 Earthquake loads and detailing

The first two bullet points in the Handbook do not apply in New Zealand. Only bullet point 3 is relevant in this country.

5.5 Control of Volume Change Deformations and Restraint Forces

5.5.4 Figure 5.6

This figure in the Handbook is useful in that it shows the components of the temperature profile. However, the absolute values are unlikely to be attained in New Zealand's temperate environment.

5.6 Diaphragm Action

This section provides some generic information that is relevant in New Zealand. However, because New Zealand is a seismically active country, the requirements of NZS 3101 should be followed. In addition, please refer to the Preamble in this chapter of the Commentary.

5.7 Shear Walls

This section provides little information on the issues specific to the design of precast walls. For more detailed information, refer to NZS 3101 and the BRANZ design guide on slender precast concrete panels. When allocating earthquake actions to individual elements on the basis of stiffness, it is important to consider torsional loads as well. (Section 5.7 of the Handbook does not consider these loads.)

5.8 Base Fixity of Columns

The illustration in Figure 5.18 in the Handbook may not be appropriate for a column that forms part of the primary lateral load resisting elements.

5.9 Analysis of Precast Buildings for Horizontal Action

Examples. 5.1a and 5.1b focus only on the design for wind loading. The details shown are considered inappropriate in a seismic country such as New Zealand.

CHAPTER 6

Design of Elements

This Commentary is intended for New Zealand engineers using Chapter 6 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

Preliminary:

Where Australian Standards or the Building Code of Australia are referenced in the text, the appropriate New Zealand Standards must be substituted unless otherwise noted. This recommendation in particular applies to NZS 4203 Loadings Code and NZS 3101 Concrete Structures Standard.

Note: NZS 3101:1995 is under review at the time of writing. Where this Commentary refers readers to sections of NZS 3101:1995 it will be necessary to find the corresponding section in the new 3101, once this supersedes the current edition.

6.1 Definitions and Notations

6.1.2 Notations

This section of the Handbook is suitable for New Zealand, except that engineers should use the New Zealand strength reduction factors from NZS 3101, for example, from the 1995 edition:

$\varnothing = 0.85$ for flexure

$\varnothing = 0.65$ for bearing

$\varnothing = 0.75$ for shear

6.3 Design Principles

This section of the Handbook is suitable for New Zealand, except that the expression $\varnothing Ru \geq S^*$ should be replaced by the expression $S^* \leq \varnothing Sn$ (Eq. 3-8) of NZS 3101: Part 1:1995.

6.4 Flexure and Shear

Discussion on the mechanics of design in the Handbook is sound advice for New Zealand, except that engineers should refer to NZS 3101 to ensure New Zealand Code compliance.

6.5 Prestress Loss: Development Length and Anchorage Zones

6.5.1 Loss of Prestress

Prestress losses depend on the particular material properties, the magnitude of the stresses in the different materials, environmental factors, and time. Estimations are used but the number of variables mean it is unlikely that prestress losses and their effects can be calculated to a reliable accuracy of better than 10% and in most cases more than 30%. The calculation of prestress losses affects serviceability calculations only.

6.5.2 Development Length for prestressing tendons

This section of the Handbook is suitable for New Zealand, except where it mentions the use of deflected tendons. This is a means of controlling deflections and transfer stresses. Few manufacturers in New Zealand have prestressing beds designed to accommodate the holding down forces required, and use of deflected tendons should only be considered after consulting a manufacturer.

6.5.3 Design of Anchorage Zones and end blocks

This section of the Handbook is largely concerned with post-tensioned design. Pretensioned concrete is normally produced in factory conditions where large-scale production takes place. This enables manufacturers to gain considerable practical experience in anchorage zone conditions. Individual designers will not normally become involved with design of anchorage zones in pretensioned concrete.

Anchorage zone stress conditions are self-checking in pretensioned concrete. The maximum stress occurs at transfer, after which tendon relaxation, concrete creep and shrinkage reduce the stresses on the concrete, while the concrete continues increasing in strength over time.

6.6 Design for Serviceability Limit States Deflection Control

Discussion in the following sections of the Handbook refers to AS 3600 and is considered to be sound advice. However, the reader should refer to NZS 3101 to ensure New Zealand Code compliance.

6.6.4 Elastic deflection

NZS 3101 requires consideration of allowable tensile stress for elements of buildings and of bridges under prescribed circumstances.

6.7 Crack Control

This section of the Handbook is suitable for New Zealand, except that:

1. New Zealand design practice is to use different stress limits. Refer to Table 16.1 of NZS 3101:1995 for tension stress limits in prestressed concrete and steel stress ranges for different load categories, and to Table 3.4 of NZS 3101:1995 for crack widths.
2. For bridge design, note the requirement of 4.2.1 of the Transit NZ Bridge Manual.

Note: Displacement incompatibility can induce cracking and spalling at the supports of precast floor and roof units. An example is the spalling caused by sun-camber in the upper levels of parking buildings or slabs exposed to the weather. Correctly detailed sliding or elastomeric bearing pads are often recommended in this case.

6.8 Vibration Control

This section is generally applicable to New Zealand conditions. However, contrary to the assertion in paragraph 6.8.3 of the Handbook, guidelines for estimating walking vibrations have been developed and the acceptability criteria in Mast's PCI journal paper are accepted in the precast industry. Thus, New Zealand engineers should refer to Reference 6.29 (Mast) in the Handbook and not to Reference 6.15 (Murray and Allen).

6.9 Columns

Instead of AS 3600 section 10.4, New Zealand engineers should refer to NZS 3101:1995 section 8.4.11. However New Zealand column design practice will almost always consider additional effects due to earthquake. See NZS 3101 section 8.5 and Park, R. and Paulay, T. *Reinforced Concrete Structures.* (John Wiley and Sons, New York, 1995.)

6.10 Specific design considerations

6.10.6 Composite Topping

- See Cl 10.3.3.1 of NZS 3101:1995 for New Zealand design practice requirements for horizontal shear transfer.
- Topping of precast floors in New Zealand is commonly 20 or 25MPa. Higher strengths may be specified when needed to increase floor capacity or for durability.

6.11 Handling considerations

This chapter should be read in conjunction with the OSH Publication *Approved Code of Practice for the Safe Handling, Transportation and Erection of Pre-cast Concrete* available for free download on OSH's website: http://www.osh.govt.nz/order/catalogue/196.shtml Refer also to Chapter 11 of the Handbook and the Commentary.

Table 6.10 in the Handbook shows a strand lifting eye encased in steel electrical conduit. This is a wise precaution (to ensure even loading) when multiple strands are used to form a high capacity lifting eye, but it is not suggested that it should be standard practice for single-strand lifting eyes.

The comment on page 6-29 of the Handbook that "a lifting loop should consist of at least two seven wire strands" does not apply in New Zealand.

The paragraphs beginning "*Strand that has been...*" and "*Also the bond...*" do not apply in New Zealand. Instead, New Zealand engineers should note that: Strand deformed with grip marks shall not be used for lifting eyes unless the deformations will be embedded more than 400mm into the concrete.

6.13 Appendix 6A: Design examples

Preliminary:

Where Australian Standards or the Building Code of Australia are referenced in the text the appropriate New Zealand Standards must be substituted unless otherwise noted. This recommendation in particular applies to NZS 4203 Loadings Code and NZS 3101 Concrete Structures Standard.

Note: NZS 3101:1995 is under review at the time of writing. Readers should refer to the appropriate section of the current version of all codes and standards.

EXAMPLE 6A.1 - Design of a precast beam for strength at transfer

Pretensioned units typically hog upwards on transfer of prestress, at which stage they are likely to span from end to end, and the distance l_b (End of beam to centre of bearing) will be very small, particularly in steel moulds, and can usually be taken as zero.

Pre-tensioned strand transmission length.

Transmission lengths used in the codes must be conservative and practical experience indicates much shorter lengths are commonly occurring. It is suggested that engineers use a conservative approach, assuming either zero or half of the code transmission length. This also applies to debonded strands that commence transmission length within the body of a unit where the confinement is likely to be better than at the end.

EXAMPLE 6A.2 Loss of Prestress

Estimation of prestress losses is vital when determining serviceability state conditions of a prestressed concrete unit. Prestress losses affect the concrete stresses and deflections at various stages. This is particularly significant if the sections may crack under load. Loss of prestress is affected by factors such as steel relaxation and concrete shrinkage and creep, each of which is affected by other variables.

EXAMPLE 6A.3 Debonding of strands

For information on transfer lengths, refer to the comments on design example 6A.1 in this Commentary.

EXAMPLE 6A.4 Deflection of a prestressed beam

Deflections of prestressed members depend on assumptions about prestress losses, modulus of elasticity, and concrete creep (all of which vary over time and with temperature and exposure conditions). Deflections are also affected by applied loads, the time after casting that the loads are first applied, and the magnitude and duration of those loads. In addition, deflections are influenced by temporary propping used during curing and or erection. A major consideration is the effect of any end moments which may be developed due to building in of the ends, as commonly occurs with flooring units.

The accuracy of deflection calculations is only as good as the assumptions made. The limitations of the results, likely variations and tolerances should be recognised and accommodated.

Note. Design examples 6A.5 to 6A.9 are applicable in New Zealand.

CHAPTER 7

Connections and Fixings

This Commentary is intended for New Zealand engineers using Chapter 7 of the Precast Concrete Handbook published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used. Figures and tables in the Commentary replace those in the Handbook.

Engineers are also referred to Chapter 3, Frame Connections, in Guidelines for the Use of Precast Concrete in Buildings, published by the Centre for Advanced Engineering, University of Canterbury.

Preamble

1. Where the Handbook refers to Australian Standards or the Building Code of Australia, the appropriate New Zealand Standards and Codes must be used in New Zealand.

This recommendation applies, in particular, to:

- NZS 4203 General Structural Design and Design Loadings for Buildings (known as the Loadings Code)
- AS/NZS 1170 Structural Design Actions, which will replace NZS4203
- NZS 3101 Concrete Structures Standard
- The New Zealand Building Code Handbook and Approved Documents (NZBC).

Note: NZS 3101 is currently being revised.

2. Designers' attention is also drawn to the requirement for parts of structures and their connections to be designed according to the NZS 4203 Loadings Code for seismic forces, as stipulated in Clause 4.12, Requirement for Parts, of the 1992 edition.

7.1 Definitions and Notation

7.1.2 Notation

Use the New Zealand strength reduction factors (Φ) in NZS 3101.

7.3 General Design Criteria

7.3.3 Durability

The Handbook refers to AS 3600 Concrete Structures load factors and capacity reduction factors, which have similar exposure classifications to NZS 3101.

7.3.6 Fire resistance

This section is suitable for New Zealand, except for the following:

1. New Zealand designers should refer to NZS 3101 and the New Zealand Building Code.
2. The requirements in Sections C1, C2 and C3 of the New Zealand Building Code will need to be satisfied when other connections have to be protected from the effects of fire to the same degree as that required for the members connected. For example, an exposed steel bracket that supports a beam has to be protected because it may be softened enough to cause failure. Steel connections can be protected by encasing them in concrete or spraying them with fire-protection material. They can also be enclosed with plasterboard or coated with intumescent paint.

7.4 Loads, Load Factors and Capacity Factors

This section is suitable for New Zealand, except for the following:

Use NZS 4203 in place of AS 1170.

7.5 Cladding Panel Connections

7.5.1 General design principles for cladding panels

This section is suitable for New Zealand, except for the following:

1. The first bullet point on p.7-11. The third sentence should read: All inserts that resist primary load should have sufficient effective depth to prevent brittle failure.

2. The second bullet point on p.7-11. It is not New Zealand practice to restrict the smallest bolt size to M20.

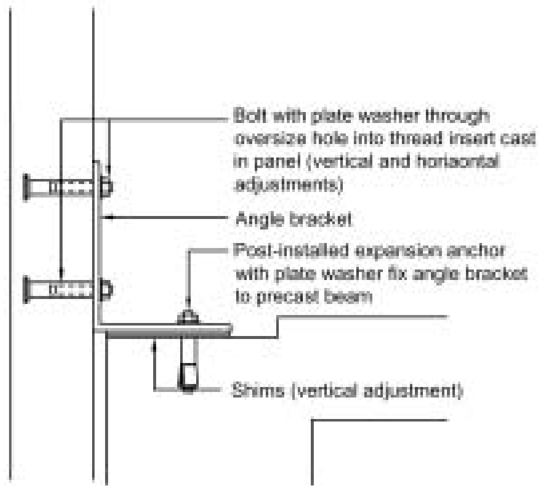
7.5.3 Bearing connections

This section is suitable for New Zealand, except for the following:

The reference in the Handbook to haunches (corbels) is a more expensive detail than bolted or welded cleat. In New Zealand, wall units are often attached to concrete floors using cast in plates with anchors, and supported using steel angles or purpose-made brackets site welded during erection–refer to Figure 7.4 in this Commentary.

Figure 7.4

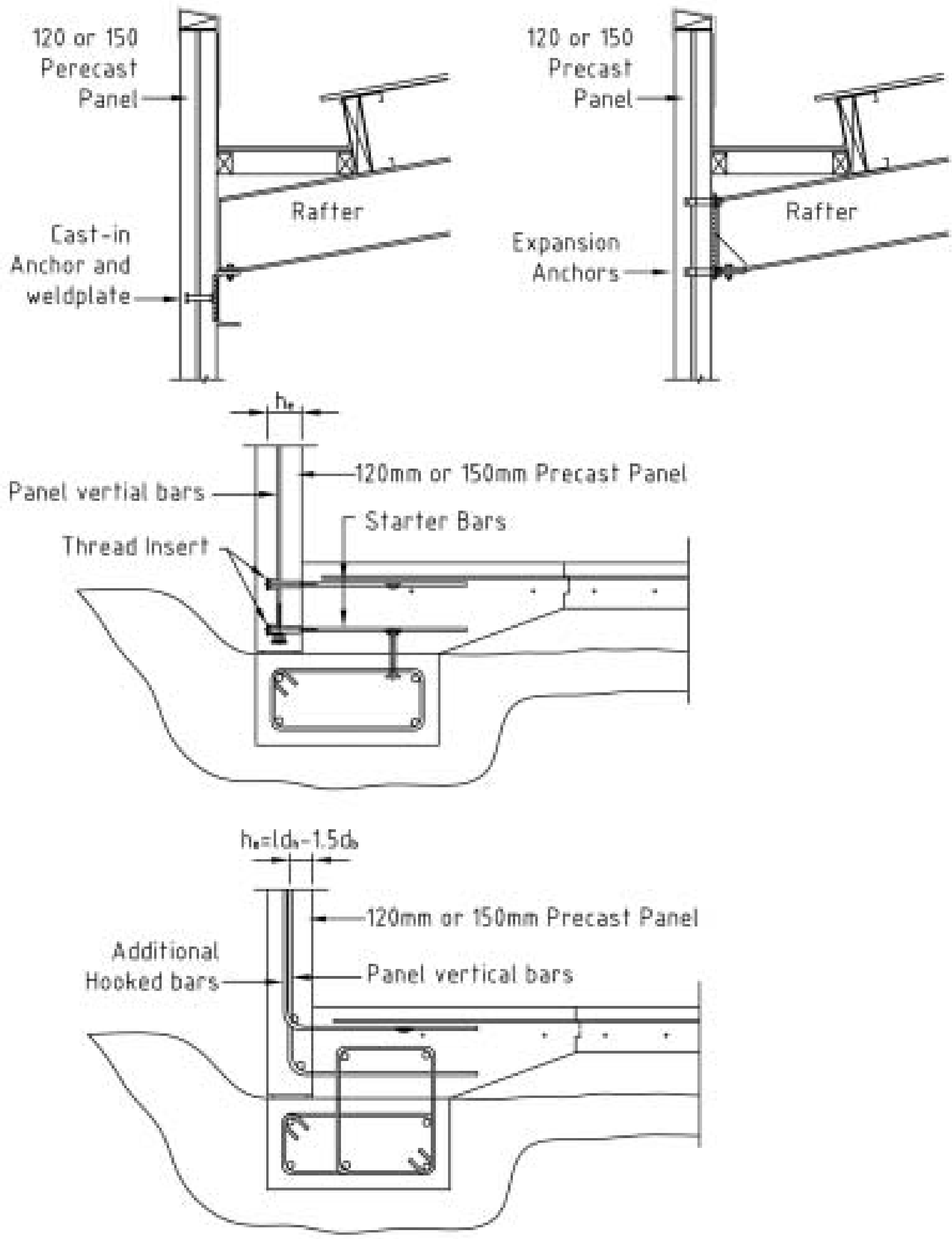
Bearing Connections



7.5.5 Industrial wall panel connections

Figure 7.6a

Wall Panel Connections



Note:

The first two paragraphs of this section of the Handbook, and also Fig. 7.5 on p. 7-13, do not apply to New Zealand conditions. Instead, substitute (a) the text below and (b) Fig. 7.6a in this Commentary.

Solid precast wall panels are normally used to clad low rise industrial buildings, as opposed to hollow core panels. The panels span either vertically or horizontally between frames or, more commonly, are cantilevered from the foundations. The primary loading is wind, or sometimes retained soil, which can cause significant horizontal structural loads. These buildings often have a high risk of fire and the external wall shall be designed to resist prescribed emergency loads at elevated temperatures, and residual loads at ambient temperatures after the fire, as prescribed in AS/NZS 1170 or NZS 4203. Cantilever walls perform well in fire situations as no mechanical connections are required, and the fire rating exceeds code requirements. Designers should refer to NZS 3101 for wall panel fire design.

7.6 Load bearing connections

7.6.1 Column units

This section is suitable for New Zealand, but Fig. 7.7 on p.7-15 may be supplemented by referring to Chapter 3 Frame Connections, in Guidelines for the Use of Precast Concrete in Buildings, published by the Centre for Advanced Engineering, University of Canterbury.

7.6.2 Wall units

This section is suitable for New Zealand, except that Figs 7.8a and 7.9 in the Handbook are replaced by Figs 7.8a and 7.9 respectively in this Commentary.

7.7 Bearing Pads

7.7.2 Design details

This section is suitable for New Zealand, but note that New Zealand does not have a standard for elastomeric bearings. The Australian Standard, AS1523, Elastomeric Bearings for Use in Structures, is sometimes called upon. (It is recommended that designers contact bearing manufacturers for the products available in New Zealand.)

Figure 7.8a

Load-bearing Wall Connections

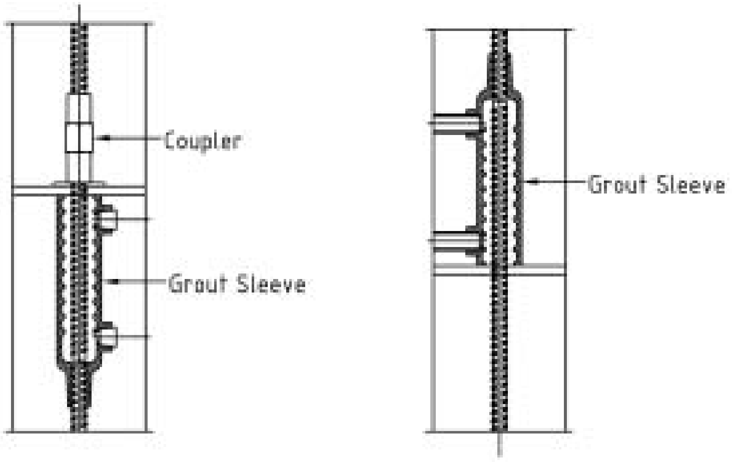
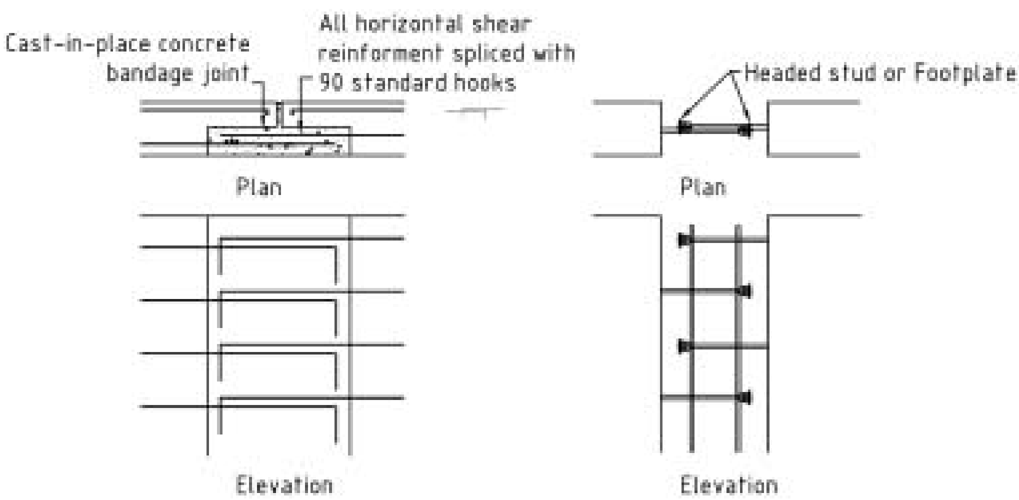


Figure 7.9

Shear Wall Details



7.8 Shear Friction

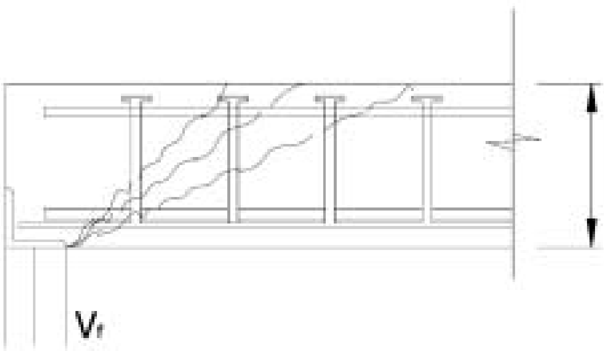
Refer to NZS 3101 for strength reduction factors and specified formulae. This clause in the Handbook does not apply in New Zealand. Instead, substitute the following guidelines:

The shear friction method is covered by NZS3101, which provides the information required for calculation of the reinforcement area. Studs are an effective substitute, particularly when using elements too thin to develop anchorage.

Shear reinforcement in thin slabs is best achieved by anchoring vertical rods (stud rails) anchored at the each ends with flat plates or foot plates having an area of at least 10 times the cross-sectional area of the rods, according to NZS3101:Part 1: 1995. See Figure 7.10 in this Commentary.

Figure 7.10

Alternative shear reinforcement method for thin sections



7.9 Bearing Areas of Reinforced Concrete Members

Refer to NZS 3101 for strength reduction factors and specified formulae.

Bearing is covered in NZS3101:1995 1995 in Clause 8.3.5, which requires a maximum nominal bearing strength of concrete of

$0.85\sqrt{f'_c}$ and a materials reduction factor of $\Phi = 0.75$.

Bearing plates and angles to be anchored with welded studs or reinforcing to prevent shear planes developing due to horizontal forces such as shrinkage.

7.10 Strut and Tie Model

7.10.1 General

Note: This clause in the Handbook refers to Appendix A of ACI 318M-02 2002. This is a universally recognised standard.

7.10.2 Truss geometry

Note: Refer to New Zealand Loadings Code NZS 4203 and NZS 3101 for loadings, strength reduction factors, and material properties.

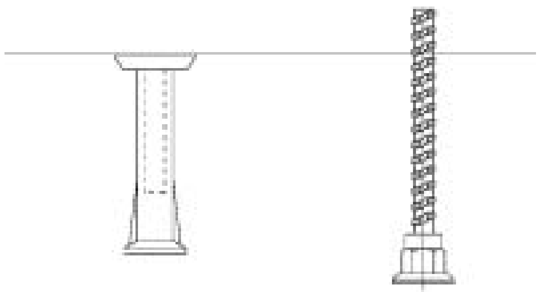
7.11 Cast in Anchors

7.11.1 Introduction

Note: The types of anchor shown in Fig.7.14 of the Handbook can be supplemented by those shown in Fig.7.14 in this Commentary.

Figure 14

Other Anchor Connections



7.11.2 Failure modes

The nominal steel capacity of a bolt or stud is checked in accordance with NZS3404, Steel Structures Standard.

The strength of any welding or means of attachment of the bearing at the base of the anchor must exceed the breakout capacity and the pullout capacity of the bearing.The effective bearing length of transverse anchor reinforcement may be taken as being twice the diameter of the bar, and the length of a plate or washer as being twice its thickness measured from the side of the anchor shaft. Designers should select fittings with adequate foot or anchorage depth to prevent brittle failure.

7.11.4 Failure in tension

Note:

Amendment No. 1, December 1998 to NZS3101: 1995 warns against cone failures prior to ultimate bar strength in thin sections when shallow hooked bars cannot develop the anchorage required by the code. This could typically be the case with the joint between precast walls and a foundation or floor/wall intersections.

7.13 Column Base Plates

This section is suitable for New Zealand, but note that the steel base plate connections shown in Figure 7.23 of the Handbook are pin ended connections which may not be suitable for New Zealand seismic conditions. However, the detail shown is correct in cases where pin ended connections are deemed appropriate.

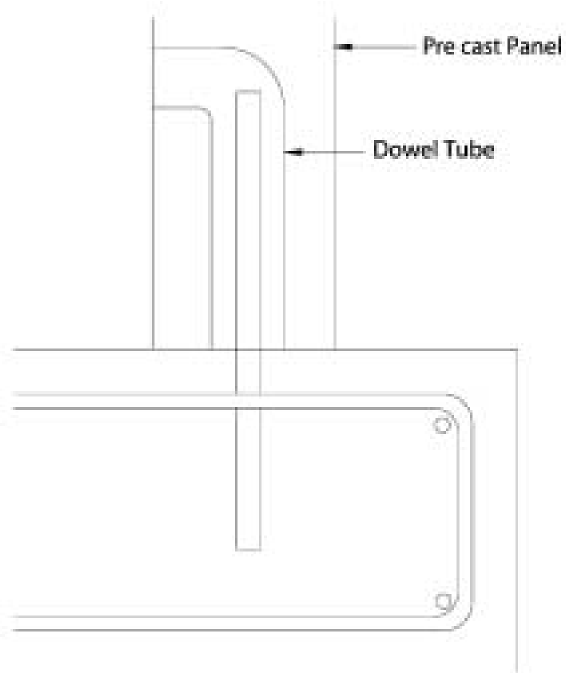
7.14 Dowel Connections

This section is suitable for New Zealand, except for the following:

1. Dowelled connections shown are for a lapped joint only.The lapping bar is not shown in Fig. 7.24 in the Handbook. Refer instead to Fig. 7.24 in this Commentary.
2. Dowelled connections are not recommended for critical stress structural seismic connections.

Figure 7.24

Grouted Tube



7.15 Cast in Place Connections

This section is suitable for New Zealand, but refer to NZS 3101.

7.17 Welding of Reinforcing Bars

This section is suitable for New Zealand, but note the following:

1. Welding should only be undertaken where shown on drawings, or with the specific approval of the supervising engineer.
2. Welding of 'Quenched and Self-tempered' bars is not permitted in NZS 3101. Consult the reinforcing supplier to determine the method of manufacture.Welding is a special process requiring trained and experienced engineers and welders to design and perform the welds.
3. Welds must comply with the requirements of AS/NZS 1554.3 and NZS 3101.

CHAPTER 8

Design of Joints

This Commentary is intended for New Zealand engineers using Chapter 8 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

8.4 Functional Requirements

Common practice in New Zealand is to emphasise three aspects of joint selection:

- Layout of joints
- Design of the joint(s)
- Quality control of the construction.

In addition to these three important considerations, the design and construction should take maintenance requirements into account.

8.6 Types of Joints

8.6.2 Open-drained joints

The use of open drained joints prohibits the edge lifting of panels, as the cast-in anchors interrupt the groove detail. Face lifters must be used, which may cause problems in storage or handling.

8.7 Width of Joints

8.7.1 General

In New Zealand, it will also be necessary to account for anticipated movement in moderate seismic events.

Such events may induce shear forces along the length of the joint as the building deforms. The seismic movement characteristics must be taken into consideration by the structural engineer.

8.8 Joint Sealants

8.8.1 General

The designer may also need to consider the ability of the sealant material to be painted. If this is a requirement, then it will be necessary to seek advice from the paint supplier or painting contractor.

CHAPTER 9

Thermal and Acoustic Properties

This Commentary is intended for New Zealand engineers using Chapter 9 of the *Precast Concrete Handbook* published by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

9.1 Thermal Properties

9.1.1 Introduction

In general, where the Building Code of Australia (BCA) is referred to in the Handbook, New Zealand users should refer to the New Zealand Building Code and Approved Documents (NZBC).

The New Zealand Building Code Clause H1 Energy Efficiency defines the minimum level of thermal performance that all new and altered buildings must achieve. Several means of demonstrating performance are available in the Approved Documents.

The Acceptable Solution H1/AS1 requires that minimum insulation levels be provided for all solid wall, floor and roof areas of the building. Depending on the floor area and use classification of the building, the requirements are stated in:

- NZS 4218: Energy efficiency - housing and small building envelope.
- NZS 4243: Energy efficiency - large buildings.

The Verification Method H1/VM1 allows compliance to be demonstrated through modelling of the building thermal envelope. This method of compliance may be better suited to most forms of precast concrete construction. The performance criteria can be found in the two standards noted above. ALF (Annual Loss Factor), a computer-based building simulation package published by BRANZ, can be used to test the energy performance of detached dwellings.

Another important reference is NZS 4214: Methods of determining the total thermal resistance of parts of buildings.

9.1.8 Air Space Resistances

It should be noted that Example 9.2 in the Handbook refers to a hollowcore floor system. Therefore the rate of heat transfer should also refer to the floor assembly. Similarly, in example 9.2 the rate of heat transfer is for the roof assembly.

9.1.12 Thermal mass, capacitance and inertia

It should be noted that Section H1 of the New Zealand Building Code encourages achievement of better control over the thermal environment in a building. One of the many ways in which this can be achieved is through use of both thermal mass and thermal resistance (insulation).

9.1.13 The effects of thermal mass

Further information on the positive effects that mass can have on the thermal performance of residential buildings in New Zealand can be found in the twin publications *Designing Comfortable Homes* (CCANZ, 2001) and *Building Comfortable Homes* (CCANZ, 2002).

9.1.16 Mass and cooling

It must be stressed that the recommendation to couple interior mass to the exterior should apply only where overheating is seen to be a real problem. A negative consequence of coupling indoor mass to the exterior in most New Zealand conditions is the uncontrolled loss of heat during times of heating. Use of this strategy requires specialist design for New Zealand conditions.

9.1.17 Solar radiation

The designer should determine the most effective shading strategies to reduce solar gain and the effects of solar radiation on building occupants.

Note:

- Horizontal shading devices are effective on facades with a northern orientation.
- Vertical shading devices are effective on those facades oriented to the east or the west. Such shades are most effective when arranged as louvers or screens.
- Shading of south facing facades to reduce solar gain is not necessary in New Zealand; however such shading devices may assist with weather protection or may be included for architectural reasons.

9.2 Acoustic Properties

9.2.1 Architectural acoustics

At the time of writing (March 2004), New Zealand Building Code Clause G6, Airborne and Impact Sound, and the associated Approved Document G6 have undergone a major review, and draft amendments are to be made available for public comment.

9.2.3 Measurement of transmission loss

The following Standards are relevant for Australia and New Zealand:

AS/NZS 1276.1 – Acoustics: rating of sound insulation in building and building elements

AS/NZS 2499 – Acoustics: measurement of sound insulation in buildings and building elements

AS 1191 – Acoustics: method for laboratory measurement of airborne sound transmission of building partitions

AS 2253 – Methods of field measurement of the reduction of airborne sound transmission in buildings.

CHAPTER 10

Architectural Elements

This Commentary is intended for New Zealand engineers using Chapter 10 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

10.2 Introduction

10.2.1 Scope

Prestressed hollowcore units are not commonly used as cladding in New Zealand, as they are in Australia. However, there is nothing to prevent their use here, and it may be an option that designers would like to explore further. The Handbook gives sound guidance to those who do.

10.3 Samples and Prototypes

10.3.1 Samples

The section of the Australian Formwork Standard, AS 3610 that deals with off-form finishes is equivalent to NZS 3114 Specification for Concrete Surface Finishes. It should be noted that each country has a different ranking system: the Australian Standard ranks formed concrete surface finishes from Class 1 (the highest) to Class 5 (indicating that the finish is suitable when the visual quality is not significant) whereas the New Zealand Standard ranks these finishes from F1 (indicating that the finish is suitable when the visual quality is not significant) to F6 (highest).

Other Standard comparisons are as follows:

Australian Standard	New Zealand Standard
AS 1141 Methods of sampling and testing aggregates	NZS 3111 Methods of test for water and aggregates for concrete
AS 2758.1 Aggregates and rock for engineering purposes – concrete aggregates	NZS 3121 Water and aggregates for concrete
AS 1012 Methods of testing concrete	NZS3122 Portland and blended cements (general and special purpose)

The publication makes reference to colour changes that occur over time in finishes that use off-white cement. This is apparently a quality unique to Australian white cements. Other white cements supplied internationally do not change or vary over time in the same manner. The designer/specifier should consider this issue carefully and specify accordingly.

10.4 Shape, Form and Size

10.4.6 Dimensions and overall panel sizes

The transport requirements and restrictions must be carefully checked and confirmed by the project team at the outset of the job. Note that the conditions will vary throughout New Zealand and will probably differ to the conditions cited in the publication. Refer to the New Zealand Commentary on Chapter 11.

10.5 Colours and Off-Form Surfaces

10.5.2 Colour control

NZS 3114 specifies acceptable colour variations for particular classes of finish in New Zealand conditions - see Section 104.2 of the 1987 edition of this Standard.

10.6 Surface Finishes

10.6.3 Water-washed

Water-washes surface finishes are not common in New Zealand. However, similar results can be achieved using surface retarders. Refer to 10.6.4 below.

10.6.4 Retarded

Without local skills in water-washing, the New Zealand concrete industry has traditionally used spirit-based form retarders that offer a range of exposure depths and reaction times to the fresh concrete. Skills have been developed in the use of retarders that give equivalent quality to Australian water-washed work.

10.6.5 Honed or polished

The size of the New Zealand market, high costs and limited local demand have limited the use of honed or polished precast concrete. For prestigious buildings, polished natural stone, pinned to structural precast concrete panels has been preferred. However, it is apparent that interest in the use of honed concrete tiles is increasing and several recent buildings have used the method to great effect.

10.6.7 Acid-etched

In New Zealand the test procedure specified in NZS 3109: 1997 Concrete Construction for determining the acid soluble chloride content of concrete is ASTM C1152.

10.6.9 Hammered-nib

A similar effect to that achieved by hammered nibbing can be achieved by casting the concrete over rope, reinforcing bars or pipe. Immediately on removal from the formwork, the rope/bar/pipe is torn free, breaking the concrete along the narrowest point and leaving a recess between the broken concrete ribs.

10.6.12 Brick- or tile-faced

Precast concrete tiles up to 1800mm x 600mm can be finished with exposed aggregate, honed or polished surfaces. The tiles are cast onto a structural precast concrete panel with both mechanical fixings and surface bonding. The use of the concrete tiles eliminates the problem of differential shrinkage. Similar to the Australian experience, the use of ceramic tiles on concrete panels has tended to be a problem in New Zealand conditions due to differential shrinkage rates.

CHAPTER 11

Handling, Transport and Erection

This Commentary is intended for New Zealand engineers using Chapter 11 of the *Precast Concrete Handbook* published by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

Reference should be made to the *NZ Code of Practice on Handling, Transportation & Erection of Precast Concrete.* This is available for downloading free of charge at www.osh.dol.govt.nz/order/catalogue/196.shtml

11.3 Transportation to Site

11.3.4 Mass and size limitations

Transport regulations are periodically reviewed and the following information may be subject to change. Users should ensure that they comply with regulations that are current at the time.

Loads within the limits shown below are acceptable without restrictions, provided suitable vehicles are used. Loads outside these limits can be subject to restrictions relating to times of travelling, pilot requirements and allowable routes. The availability of suitable vehicles should also be considered.

Mass

For typical loads on flat deck vehicles, limitations are:

- On a 13 metre trailer - 24 tonnes
- On a low loader - 20 tonnes.

If trailers with A frames are used to carry panels, the net weight is reduced by the weight of the A frame. For transporting panels, typical limitations are:

- On a 13 metre trailer - 21 tonnes.
- On a low loader - 18 tonnes.

Size

Height

- Loads exceeding 4.25 metres high require written approval from the owners of overhead obstructions (power lines, railway electrification etc.), if the vehicle can not clear them safely.
- Generally, obstruction should not be an issue on public roads if the loads are less than 4.8 metres high.
- Loads exceeding 4.8 metres high require written approval from owners of overhead obstructions (power lines, railway electrification etc.). A deck height of less than 1.3 metres above the road must be used.Load heights exceeding 6.5 metres require written approval from the Land Transport Safety Authority.

Width

- Widths up to 2.5 metres are unrestricted.
- Widths over 2.5 metres may have restricted travelling times.
- Widths of 3.1 metres are unrestricted for lengths not exceeding 10.5 metres.

Length

On appropriate vehicles:

- Lengths up to 13 metres are unrestricted.
- Lengths of 13 to 16 metres have restricted travelling times.
- Lengths of 16 to 18 metres have restricted travelling times, require a pilot, and require a permit.

11.3.5 Loading of vehicles

The loading shown in Figure 11.9 of the Handbook is not appropriate for hollowcore flooring units. These units must be supported at or close to each end in order to prevent them breaking during handling or transport.

11.4 Erection

11.4.2 Cranes

Crane capacity (load and reach) on building sites is the major factor governing the weight of components to be handled and their location. Access for delivery vehicles and the crane location relative to load placement are limiting factors. These factors vary and are site-specific. Reference should be made to local construction companies for guidance on limitations.

11.4.3 Rigging

Mass-produced elements such as flooring units do not usually have individual components marked with their weight. The weight per unit length is available in manufacturers' literature or can be obtained by contacting the manufacturer.

The NZ Code of Practice on Handling, Transportation and Erection of Precast Concrete requires that "the manufacturer must clearly identify elements requiring a non-standard lift". A non-standard lift is defined as "a lift that does require special rigging or equalisation procedures. This must be noted on the shop drawings." Operators involved in lifting and rigging need to have relevant information regarding any special lifting requirements.

11.4.5 Erection of hollowcore floor planks

Grouting of keyways is not normal New Zealand practice.

Floor units may be spaced by using timber infills to improve economy and reduce weight.

11.4.7 Bracing

Acceptable expansion anchors are specialist items and do not include the majority of expansion anchors available from hardware stores.

CHAPTER 12

Contract Issues

This Commentary is intended for New Zealand engineers using Chapter 12 of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand legislation, standards, codes and practices are used.

12.1 Introduction

12.1.1 General

Construction contract practice between Australia and New Zealand (NZ) is very similar.

In New Zealand, precast concrete manufactured components are defined by the Construction Contracts Act 2002 as construction work and this means that precast concrete manufacturers are primarily sub-contractors.

12.1.3 Manufacturers credentials

Precast New Zealand Inc. is the official New Zealand body that represents commercial offsite precast concrete manufacturers in New Zealand. Offsite precast manufacturers supply high quality prefabricated customised components for both residential and commercial contracts.

12.1.4 Contracts

Advice on subcontract agreements is available from the New Zealand Building Subcontractors Federation, Precast New Zealand, and the Master Builders Federation.

12.2 Contractual Framework and Contract Administration

12.2.1 General

The administration of contractual relationships between owner/contractor/subcontractor in New Zealand is covered by the Construction Contracts Act 2002. This Act seeks to address a number of issues arising from previous construction contracts, in particular:

- procedures for the regular and timely payment between the parties to a construction contract
- speedy resolution of disputes arising under a construction contract
- remedies for the recovery of payments enforceable at law.

12.2.4 Entering into a contract

Bid shopping (sometimes referred to as second tier bargaining) occurs in NZ but is considered unethical unless there is a genuine reason, for example, redesign.

The subcontractor should ensure that no work is carried out without confirmation in writing of an instruction to proceed. Verbal instructions should be confirmed in writing, and the terms and conditions under which the work would be carried out (usually the subcontractor's tender offer) should be clearly stated. Further negotiation may be necessary subsequently to complete an offer and counter offer process.

12.2.5 The (sub) contract agreement

A residential or commercial sub-contract agreement will also be subject to the provisions of the Construction Contracts Act 2002.

An adjudication procedure for the settlement of disputes is provided for under the Act.

12.2.6 Payment for off-site work

Precast manufacturing sub-contractors should carry their own 'comprehensive' off-site yard insurance rather than 'contractor's all risks' insurance.

12.2.7 Retentions

When a precaster engages in a "supply only contract" the statement in the last paragraph of this section of the Handbook is particularly relevant.

12.2.8 Payment for off-site work

A liquidated damages clause is one setting the damages to be paid for a breach of contract in advance of the breach, based on a genuine pre-estimate of the damages likely to be suffered as a result of the breach.

12.3 Responsibility for Engineering Design

12.3.2 Design Practices

Fragmentation of responsibility [REC] again aimed at Graduates

In New Zealand the Building Act 1991empowers Territorial Authorities to grant or refuse applications for building consents. A Territorial Authority (T.A.) must grant a consent if it is satisfied that the provisions of the building code would be met. Building documentation required for the purposes of obtaining a building consent may include design calculations accompanied by specifications and drawings for the building project. Territorial Authorities are at present required to accept certificates issued by building certifiers as establishing compliance with the building code Or, by agreement with the Territorial Authority, the principal designer may provide a Producer Statement which confirms compliance with New Zealand building standards for the building design and documentation and for which the principal designer is taking responsibility.

This is a "global" responsibility for the structure taken as a whole. Components of structure, such as precast flooring, may have been designed by the manufacturer of the flooring. If this is the situation then the T.A. may request a separate producer statement from the manufacturer for those specific structural elements. Thus the total structure and all its elements will have compliance accountability with the appropriate New Zealand Standards.

12.6 Manufacture

12.6.4 Finishes

Refer to NZS 3114:1987 Specification for Concrete Surfaces Finishes.

12.6.5 Reinforcing steel

Substitute reinforcement should comply with AS/NZS 4671:2001 Steel reinforcing materials.

Appendix A.2

Material Properties

This Commentary is intended for New Zealand engineers using Appendix A.2 Material Properties of the *Precast Concrete Handbook* published in 2002 by the National Precast Concrete Association Australia and Concrete Institute of Australia. The headings in this Commentary are the same as in the Handbook. Where no Commentary is given, the text in the Handbook is considered suitable for New Zealand, provided New Zealand standards, codes and practices are used.

A.2 Material Properties

A.2.1 Values of concrete stresses

NZS 3109 recommends the following standardised series of compressive strengths, f'_c, for structural design purposes:

f'_c = 17.5, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65 and 70 MPa.

Note: NZS 3101 recommends a minimum strength of 25MPa and a maximum of 100MPa for structural design purposes. For seismic components designed to absorb energy by ductile yielding, the maximum strength is reduced to 70MPa.

A.2.2 Concrete modulus of elasticity as a function of density and strength

While, strictly speaking, there is no direct relationship between the density and stiffness of concrete for all aggregate types, Figure A.1 in the Handbook is adequate as a general guideline.

A.2.3 Coefficients of thermal expansion

With reference to Table A.3 in the Handbook, concretes made with New Zealand greywackes generally have a coefficient of thermal expansion of 9 to 11 x 10^{-6}/°C, but with some self-compacting concretes this may increase above 12 x 10^{-6}/°C.

A.2.5 Reinforcing bar and fabric data

For New Zealand materials, use the tables in this commentary. Note that Tables A7a in this Commentary replaces Tables A.7a and A7c in the Handbook. Table A.7b in this Commentary should be used for reinforcing wires generally available in New Zealand.

Table A.7a *(Use this table instead of Table A.7a and A.7c in the Handbook.)*

Nominal values for Hot rolled plain or deformed bars of Grade 300E & Grade 500E

Size (mm)	Cross-sectional area (mm^2)	Mass/metre length (kg)
10	78.5	0.617
12	113	0.888
16	201	1.580
20	314	2.470
25*	491	3.850
28*	616	4.830
32*	804	6.310
40*	1260	9.880

* Some size/grade combinations are not available ex- stock.

Table A. 7b

Nominal values for high strength deformed bars of reinforcing wires

Size (mm)	Cross-sectional area (mm^2)	Mass/metre length (kg)
10	78.5	0.617
3.15	7.8	0.061
4	12.6	0.099
5	19.6	0.154
5.3	22.1	0.173
6	28.3	0.222
6.3	31.2	0.245
7.1	39.6	0.311
7.5	44.2	0.347
8	50.3	0.395
9	63.6	0.499
9.5	70.9	0.556
10	78.5	0.617
11.2	98.5	0.773

Table A. 8 *(Use this table instead of Table A.8 in the Handbook.)*

Design areas (mm^2) for specific numbers of Grade 300E & Grade 500E bars

Number of bars	Nominal Size						
	12	**16**	**20**	**25**	**28**	**32**	**40**
1	113	201	314	491	616	804	1257
2	226	402	628	982	1232	1608	2513
3	339	603	942	1473	1847	2413	3770
4	452	804	1257	1964	2463	3217	5027
5	565	1005	1571	2454	3079	4021	6283
6	679	1206	1885	2945	3695	4825	7540
7	792	1407	2199	3436	4310	5630	8796
8	905	1608	2513	3927	4926	6434	10053
9	1018	1810	2827	4418	5542	7238	11310
10	1131	2011	3142	4909	6158	8042	12566

Table A. 9

Design areas (mm²/m) of Grade 300E & 500E bars

Bar Spacing (mm)	Size						
	12	**16**	**20**	**25**	**28**	**32**	**40**
60	1885	3351	•	•	•	•	•
80	1414	2513	3927	•	•	•	•
100	1131	2011	3142	4909	•	•	•
120	942	1676	2618	4091	5131	•	•
140	808	1436	2244	3506	4398	5745	•
160	707	1257	1964	3068	3848	5027	•
180	628	1117	1745	2727	3421	4468	6981
200	565	1005	1571	2454	3079	4021	6283
220	514	914	1428	2231	2799	3656	5712
240	471	838	1309	2045	2566	3351	5236
260	435	773	1208	1888	2368	3093	4833
280	404	718	1122	1753	2199	2872	4488
300	377	670	1047	1636	2053	2681	4189
320	353	628	982	1534	1924	2513	3927
340	333	591	924	1444	1811	2365	3696
360	314	559	873	1364	1710	2234	3491
380	298	529	827	1292	1620	2116	3307
400	283	503	785	1227	1539	2011	3142
450	251	447	698	1091	1368	1787	2793
500	226	402	628	982	1232	1608	2513

Tables A. 10 and 11 *(Use these tables instead of Tables A.10 and A.11 in the Handbook.)*

Minimum length (mm) for hooks

(a) 180° Hook

Pin diameter (mm)	Bar Size									
	6	**8**	**10**	**12**	**16**	**20**	**25**	**28**	**32**	**40**
2db	84	90	96	103	115	143				
3db	93	103	112	122	140	174	218			
4db	103	115	128	140	166	206	257			
5db	112	128	144	159	191	237	296			
6db	122	140	159	178	216	268	336	376	430	537
8db	140	166	191	216	266	331	414	464	530	663

(b) 90° Turn

Pin diameter (mm)	Bar Size									
	6	**8**	**10**	**12**	**16**	**20**	**25**	**28**	**32**	**40**
2db	77	102	128	153	205	256	320	358	409	511
3db	79	105	132	158	211	264	329	369	422	527
4db	81	109	136	163	217	271	339	380	434	543
5db	84	112	140	168	223	279	349	391	447	559
6db	86	115	144	172	230	287	359	402	459	574
8db	91	121	151	182	242	303	379	424	485	606

(c) 135° Stirrup Hook

(i) Plain Bars

Pin diameter (mm)	Bar Size						
	6	**8**	**10**	**12**	**16**	**20**	**25**
2db	57	77	96	115	153	191	
3db	62	83	104	124	166	207	259
4db	67	89	111	134	178	223	279
5db	72	95	119	143	191	239	298
6db	76	102	127	153	203	254	318
8db	86	114	143	171	229	286	357

(ii) Deformed Bars

Pin diameter (mm)	Bar Size						
	6	8	10	12	16	20	25
2db	57	77	96	115	153	191	
3db	62	83	104	124	166	207	259
4db	67	89	111	134	178	223	279
5db	72	95	119	143	191	239	298
6db	76	102	127	153	203	254	318
8db	86	114	143	171	229	286	357

Table A. 12 *(Use this table instead of Table A.12 in the Handbook.)*

*Common Reinforcing Fabric Sizes available in New Zealand. "Designation" and Effective cross-sectional areas (mm²/m)**

WIRE SIZE DIAMETER (MM)	WIRE PITCH (SPACING) (MM)				
	75	150	210	260	300
4	"338" 168mm²	"668" 84mm²			
5.3	"335" 294 mm²/m	"665 or 147" 147 mm²/m		"D84" 85 mm²/m	
5.6					"84/10" 82 mm²/m
6		"664 or 188" 188 mm²/m			
6.3	"333" 416 mm²/m	"663 or 212" 208 mm²/m			
7.1		"662 or 264" 264 mm²/m			"132" 132 mm²/m
7.5		"661" 295 mm²/m	"212" 212 mm²/m		"147 or 147/10" 147 mm²/m

** Sheet size, cover and description will vary from one manufacturer to another. Consult suppliers for specific information.*

A.2.6 Development of lap-splice lengths

With reference to Tables A. 13 to A. 17 inclusive, in New Zealand the requirements for development of lap-splice lengths of reinforcing steel are specified in NZS 3101.

A.2.7 Minimum beam web widths and column sizes for 2d, clear distance between bars

In New Zealand, the cover and arrangement of reinforcing steel, such that the concrete can be properly compacted, are stipulated in NZS 3109.

Appendix B.1

New Zealand Standards – Reference List

NZS 3101 Part 1	Concrete structures standard.
NZS 3101 Part 2	Concrete structures standard – commentary.
NZS 3103	Specification for sands for mortars and plasters.
NZS 3104	Specification for concrete production.
NZS 3106	Code of practice for concrete structures for the storage of liquids.
NZS 3107	Specification for precast concrete drainage and pressure pipes.
NZS 3109	Concrete construction.
NZS 3111	Methods of test for water and aggregate for concrete.
NZS 3112 Part 1	Tests relating to fresh concrete.
NZS 3112 Part 2	Tests relating to the determination of strength of concrete.
NZS 3112 Part 3	Tests on hardened concrete other than for strength.
NZS 3112 Part 4	Tests relating to grout.
NZS 3113	Specification for chemical admixtures for concrete.
NZS 3114	Specification for concrete surface finishes.
NZS 3116	Concrete segmental paving.
NZS 3117	Specification for pigments for Portland cement and Portland cement products.
NZS 3121	Specification for water and aggregate for concrete.
NZS 3122	Specification for Portland and blended cements (general and special purpose).
NZS 3123	Specification for Portland pozzolan cement (type PP cement).
NZS 3124	Specification for concrete construction for minor works.
NZS 3125	Specification for Portland-limestone filler cement.
NZS 3151	Specification for precast lightweight concrete panels and slabs.
NZS 3152	Specification for the manufacture and use of structural and insulating lightweight concrete.
NZS 3402*	Hot rolled steel bars for concrete reinforcement.
NZS 3404 Parts 1 and 2	Steel structures standard.
NZS 3421*	Hard drawn mild steel wire for concrete reinforcement.
NZS 3422*	Welded fabric of drawn steel wire for concrete reinforcement.
NZS 4203	General structural design and design loadings for buildings.
NZS 4206	Concrete interlocking roofing tiles.
NZS 4210	Masonry construction - materials and workmanship.
NZS 4214	Methods of determining the total thermal resistance of parts of buildings.
NZS 4218	Energy efficiency – housing and small building envelope.
NZS 4229	Concrete masonry buildings no requiring specific engineering design.
NZS 4230 Parts 1 and 2	Code of practice for the design of masonry structures.
NZS 4243	Energy efficiency – large buildings.
NZS 4702	Metal-arc welding of grade 275 reinforcing bar.

** Superseded by AS/NZS 4671.*

Australian and New Zealand Standards – AS/NZS

AS/NZS 1276 Part 1	Acoustics – rating of sound insulation in building and building elements.
AS NZS 1554 Part 3	Welding of reinforcing steel.
AS/NZS 2499	Acoustics – Measurements of sound insulation in buildings and of building elements – Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it.
AS/NZS 3108	Approval and test specification – particular requirements for isolating transformers and safety isolating transformers.
AS/NZS 3679 Part 1	Structural steel - Part 1: Hot-rolled bars and sections.
AS/NZS 3750 Part 15	Paints for steel structures - Part 15: Inorganic zinc silicate paint.
AS/NZS 4065	Concrete utility services poles.
AS/NZS 4284	Testing of building facades (The SIROWET Method).
AS/NZS 4455	Masonry units and segmental pavers.
AS/NZS 4456	Masonry unit methods – test.
AS/NZS 4671	Steel reinforcing materials. (This standard has superseded NZS 3402, 3421 and 3422).
AS/NZS 4672D	Steel prestressing materials – draft for public comment.
AS/NZS 4680	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles.
AS/NZS ISO 9001	Quality management systems – requirements.

Appendix B.2

Australian and Other Standards – Reference List

AS 1012	Methods of testing concrete.
AS 1012 Part 20	Methods of testing concrete – Determination of chloride and sulphate in hardened concrete and concrete aggregates.
AS 1141	Methods for sampling and testing aggregates.
AS 1170	SAA Loading code - Minimum design loads on structures.
AS 1170 Part 1	SAA Loading code - Part 1: Dead and live loads and load combinations.
AS 1170 Part 2	SAA Loading code - Part 2: Wind loads.
AS 1170 Part 4	SAA Loading code - Part 4: Earthquake loads.
AS 1191	Acoustics – Method for laboratory measurement of airborne sound transmission loss of building partitions.
AS 1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series).
AS 1276 Part 1	Acoustics – Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation.
AS 1311	Steel tendons for prestressed concrete – 7-wire stress-relieved steel strand for tendons in prestressed concrete.
AS 1313	Steel tendons for prestressed concrete – Cold-worked high-tensile alloy steel bars for prestressed concrete.
AS 1379	Specification and supply of concrete.
AS 1391	Methods for tensile testing of metals.
AS 1478 Part 1	Chemical admixtures for concrete.
AS 1481	SAA Prestressed concrete code.
AS 1523	Elastomeric bearings for use in structures.
AS 1554 Part 3	SAA structural steel welding code - Part 3: Welding of reinforcing steel.
AS 1554 Part 6	SAA structural steel welding code - Part 6: Welding stainless steels for structural purposes.
AS 1897	Electroplated coatings on threaded components (metric coarse series).
AS 2253	Acoustics – Methods for field measurement of the reduction of airborne sound transmission in buildings.
AS 2550	Cranes – safe use.
AS 2627 Part 1	Thermal insulation of dwellings - Part 1: Thermal insulation of roof/ceilings and walls in dwellings.
AS 2758 Part 1	Aggregates and rock for engineering purposes - Part 1: Concrete aggregates.
AS 3582 Part 1	Supplementary cementitious materials for use with Portland cement.
AS 3582 Part 2	Supplementary cementitious materials for use with Portland cement - Part 2: Slag – Ground granulated iron blast-furnace.
AS 3582 Part 3	Supplementary cementitious materials for use with Portland cement - Part 3: Silica fume.
AS 3600	Concrete structures.
AS 3610	Formwork for concrete.
AS 3850	Tilt-up concrete and precast concrete elements for use in buildings.
AS 3850 Part 1	Tilt-up concrete and precast concrete elements for use in buildings.
AS 3972	Portland and blended cements.
AS 4100	Steel structures.

Other Standards

ASTM	**C260**	Air-entraining Admixtures for Concrete.
ASTM	**C494**	Chemical Admixtures for Concrete.
ASTM	**C1152**	Standard Test Method for Acid-soluable Chloride in Mortar and Concrete.
ACI	**318**	Building Code Requirements for Structural Concrete.

Appendix B.3

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Designing Comfortable Homes. Cement & Concrete Association of New Zealand.

Building Comfortable Homes. Cement & Concrete Association of New Zealand.

Further Reading

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Guide to the Design of Prestressed Flooring Systems. Precast New Zealand Inc.

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Use Your Precaster to Best Advantage - A Successful Project Guide. Precast New Zealand Inc.

Appendix B.4

Precast New Zealand: List of Members

The following companies were members of Precast New Zealand Inc. as at March 2004.

Ashburton Prestress Concrete

180 Dobson Street
Ashburton
Phone: 0-3-308-2397
Fax: 0-3-308-1297
Email: apsconcrete@xtra.co.nz
Website: n/a

Atlas Tilt Slab

P O Box 517, Silverdale
Auckland
Phone: 0-9-426-9497
Fax: 0-9-426-2139
Email: atsl@xtra.co.nz
Website: n/a

Bradford Precast Limited

P O Box 214
Ashburton
Phone: 0-3-308-9039
Fax: 0-3-308-6300
Email: precast@bradfords.co.nz
Website: www.bradfords.co.nz

Busck Prestressed Concrete Limited

P O Box 310
Whangarei
Phone: 0-9-438-3059
Fax: 0-9-438-3055
Email: info@busck.co.nz
Website: n/a

C Lund & Son Limited

P O Box 16342
Christchurch
Phone: 0-3-349-6900
Fax: 0-3-349-6901
Email: lund@lund.co.nz
Website: n/a

Emmett Bros Limited

400 Heads Road
Wanganui
Phone: 0-6-344-5057
Fax: 0-6-344-2406
Email: richard.e@xtra.co.nz
Website: n/a

Formstress Industries Limited

P O Box 234
Waiuku
Phone: 0-9-235-7257
Fax: 0-9-235-7258
Email: formstress@suspendedconcrete.co.nz
Website: http://www.suspendedconcrete.co.nz

Fulton Hogan Concrete Division

P O Box 242
Balclutha
Phone: 0-3-418-2880
Fax: 0-3-418-2834
Email: fhconcrete@fh.co.nz
Website: http://www.fh.co.nz

Hynds Pipe Systems

P O Box 58142, Greenmount
Manukau City
Phone: 0-9-274-0316
Fax: 0-9-274-8393
Email: techservice@hynds.co.nz
Website: http://www.hynds.co.nz

Lattey Civil Engineers Limited

Omahu Road
Hastings
Phone: 0-6-879-8364
Fax: 0-6-879-8360
Email: latteyfamily@xtra.co.nz
Website: n/a

Pre-cast Components (Wgtn) Limited
P O Box 20, Otaki Railway
Otaki
Phone: 0-6-364-8355
Fax: 0-6-364-6515
Email: plw.pcc@clear.net.nz
Website: n/a

Precast H.B. Limited
P O Box 5143, Greenmeadows
Napier
Phone: 0-6-835-8315
Fax: 0-6-835-8315
Email: kenahfamily@xtra.co.nz
Website: n/a

Smith Crane & Construction Limited
484 Johns Road
Christchurch
Phone: 0-3-359-7759
Fax: 0-3-359-7713
Email: tim@smithcranes.co.nz
Website: n/a

Smithbridge Precast
21 Aerodrome Road
Mt Maunganui
Phone: 0-7-575-2325
Fax: 0-7-574-6183
Email: paul.sweetman@smithbridge.co.nz
Website: http://www.smithbridge.net

Stahlton Prestressed Flooring
P O Box 21124, Henderson
Auckland
Phone: 0-9-831-0107
Fax: 0-9-833-4408
Email: murray.ford@stahlton.co.nz
Website: http://www.stahlton.co.nz

Stevenson Precast Systems Limited
P O Box 58166
Auckland
Phone: 0-9-274-0726
Fax: 0-9-273-8003
Email: RRM@stevensons.co.nz
Website: n/a

Stresscrete (North Island)
Private Bag 99904, Newmarket
Auckland
Phone: 0-9-525-9947
Fax: 0-9-525-9991
Email: PaulS@stresscrete.co.nz
Website: http://www.stresscrete.co.nz

Stresscrete (South Island)
P O Box 8369, Riccarton
Christchurch
Phone: 0-3-344-3014
Fax: 0-3-344-3018
Email: JohnM@stresscrete.co.nz
Website: http://www.stresscrete.co.nz

Thelin Construction
P O Box 3072, Richmond
Nelson
Phone: 0-3-544-8906
Fax: 0-3-544-8906
Email: thelin.construction@xtra.co.nz
Website: n/a

Unicast Concrete Limited
P O Box 2061
Hastings
Phone: 0-6-879-8399
Fax: 0-6-879-8395
Email: unicast@paradise.net.nz
Website: n/a

Wilco Precast Limited
P O Box 1386, Papakura
Auckland
Phone: 0-9-295-1060
Fax: 0-9-296-5563
Email: info@wilcoprecast.co.nz
Website: http://wilcoprecast.co.nz

Appendix B.5

Precast New Zealand Members' Products

Members	Location	Proprietary Flooring Systems	Structural Wall Panels	Architectural Precast Products	Civil & Infra-structure Precast Products	Drainage Precast Products	Structural Precast Products	Structural Prestressed Precast Products	GRC Products
Ashburton Prestress Concrete	Ashburton	✓	✓	✓	✓		✓	✓	
Atlas Tilt Slab	Auckland		✓				✓		
Bradford Precast Limited	Ashburton		✓	✓	✓	✓	✓		
Busck Prestressed Concrete Limited	Whangarei	✓	✓	✓	✓		✓	✓	
C. Lund & Son Limited	Christchurch		✓		✓		✓		
Emmett Brothers Limited	Wanganui	✓	✓	✓	✓	✓	✓	✓	
Formstress Industries Limited	Waiuku	✓	✓	✓	✓		✓	✓	
Fulton Hogan Concrete Division	Balclutha	✓	✓	✓	✓		✓	✓	
Hynds Pipe Systems Limited	Manukau City				✓	✓	✓		
Lattley Civil Engineers Limited	Hastings	✓	✓	✓	✓	✓	✓	✓	
Pre-cast Components (Wgtn) Limited	Otaki	✓	✓	✓	✓		✓	✓	✓
Pre-cast Components (Wgtn) Limited	Hamilton	✓	✓	✓	✓		✓	✓	
Precast Hawkes Bay Limited	Napier	✓	✓	✓	✓	✓	✓	✓	
Smith Crane & Construction Limited	Christchurch								
Smithbridge Precast	Mt Maunganui	✓	✓	✓	✓	✓	✓	✓	
Stahlton Prestressed Flooring	Auckland	✓			✓		✓	✓	
Stevenson Precast Systems Limited	Auckland		✓		✓		✓		
Stresscrete	Auckland	✓	✓	✓	✓		✓	✓	
Stresscrete	Hamilton	✓	✓	✓	✓		✓	✓	
Stresscrete	Mt Maunganui	✓	✓	✓	✓		✓	✓	
Stresscrete	New Plymouth	✓	✓	✓	✓		✓	✓	
Stresscrete	Otaki	✓	✓	✓	✓		✓	✓	✓
Stresscrete	Bulls	✓	✓	✓	✓		✓	✓	
Stresscrete	Christchurch	✓	✓	✓	✓		✓	✓	
Stresscrete	Invercargill	✓	✓	✓	✓		✓	✓	
Stresscrete	Cromwell	✓	✓	✓	✓		✓	✓	
Thelin Construction	Nelson	✓	✓	✓	✓	✓	✓	✓	
Unicast Concrete Limited	Hastings	✓	✓	✓	✓	✓	✓	✓	✓
Wilco Precast Limited	Auckland		✓	✓	✓		✓		