lewis bradford
CONSULTING ENGINEERS

INVERCARGILL CENTRAL ZONE 1 ANCHOR TENANT

INVERCARGILL

CONSENT ISSUE

STRUCTURAL TRADES DOCUMENTATION

CONTENTS

October 2019

Project N˚: 118083

Christchurch Level 2, 70 Gloucester Street, PO Box 2919 Christchurch Phone 03 379 9096 Email info@lewisbradford.com www.lewisbradford.com

Queenstown Third Floor, 17 Church Street, PO Box 571 Queenstown Phone 03 442 9667 Email info@lewisbradford.com www.lewisbradford.com

BUILDING CONSENT NUMBER
2019/1381

New Zealand Institute of Architects Incorporated

ACENZ

Building Code Clause(s) B1

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance on use of Producer Statements (formerly page 2) is available at www.engineeringnz.org)

ISSUED BY: Lewis Bradford Consulting Engineers
(Design Firm)

TO: HWCP Management Limited
(Owner/Developer)

TO BE SUPPLIED TO: Invercargill City Council
(Building Consent Authority)

IN RESPECT OF: Zone 1: Proposed Anchor Tenant Building
(Description of Building Work)

AT: 33 Esk Street
(Address)

Town/City: Invercargill **LOT** 2 **DP** 540342 (RT 905470) **SO** -
(Address)

We have been engaged by the owner/developer referred to above to provide:

Structural Engineering
(Extent of Engagement)

services in respect of the requirements of Clause(s) B1 Structure of the Building Code for:

☐ All or ☒ Part only (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☒ Compliance Documents issued by the Ministry of Business, Innovation & Employment B1/VM1, AS/NZS1170, NZS3101, NZS3404 (verification method/acceptable solution) or

☐ Alternative solution as per the attached schedule

The proposed building work covered by this producer statement is described on the drawings titled:

Invercargill Central Zone 1 Anchor and numbered Refer attached Drawing Register; together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:
(i) Site verification of the following design assumptions
(ii) All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:

☐ CM1 ☐ CM2 ☒ CM3 ☐ CM4 ☐ CM5 (Engineering Categories) or ☐ as per agreement with owner/developer (Architectural)

I, Craig Brian Lewis am: ☒ CPEng 138515 # ☐ Reg Arch #
(Name of Design Professional)

I am a member of: ☒ Engineering New Zealand ☐ NZIA and hold the following qualifications: BE(Hons), FEngNZ, CPEng, IntPE
The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Design Firm is a member of ACENZ: ☒

SIGNED BY Craig Lewis (Signature)
(Name of Design Professional)

ON BEHALF OF Lewis Bradford Consulting Engineers Date 25 October 2019
(Design Firm)

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000.*

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

Design Engineer **TSS**
Lewis Bradford **has been** engaged to provide monitoring services.

lewis bradford
CONSULTING ENGINEERS

CONSTRUCTION MONITORING SERVICES

Project Number:	118083
Project Title:	Invercargill Central Zone 1 Anchor Tenant
Project Address:	Esk Street, Invercargill
Date:	25 October 2019

Lewis Bradford Consulting Engineers Construction Monitoring engagement is limited to: Structural elements as described on the Producer Statement – Design.

Lewis Bradford Consulting Engineers have been engaged by the client or the client's representative to undertake construction monitoring of the work covered by our Producer Statement – Design. The extent of the construction monitoring will be appropriate to the scale and complexity of the project. At completion, and following provision of suitable quality assurance documentation and all relevant QA statements (i.e. PS3's etc.), and on request Lewis Bradford Consulting Engineers will supply a Producer Statement – Construction Review in the standard ACENZ/NZIA/EngNZ October 2013 format.

Please note that it is the client and/or contractors responsibility to notify Lewis Bradford Consulting Engineers of the commencement of construction, 14 days in advance of any work starting onsite.

A record of each site visit made by our firm to check building code compliance matters will be left on site at the completion of that site visit.

Signed: ----------
Craig B Lewis

(ACENZ/FEngNZ, CPEng)

Zone 1: Anchor Tenant

Invercargill Central

Design Feature Report (Structural)

BUILDING CONSENT ISSUE

Prepared By

.....

Tim Shannon

Technical Director

MIEAust, CMEngNZ, CPEng (Aust) IntPE

Approved By

.....

Craig Lewis

Director

FEngNZ, CPEng, IntPE

Contents

1.0 General

1.1 Scope

Lewis Bradford Consulting Engineer's has prepared this structural design features report for Invercargill Central Zone 1 Anchor Tenant. Zone 1 is defined by the Architectural Zone Model and shown in Figure 1 below:

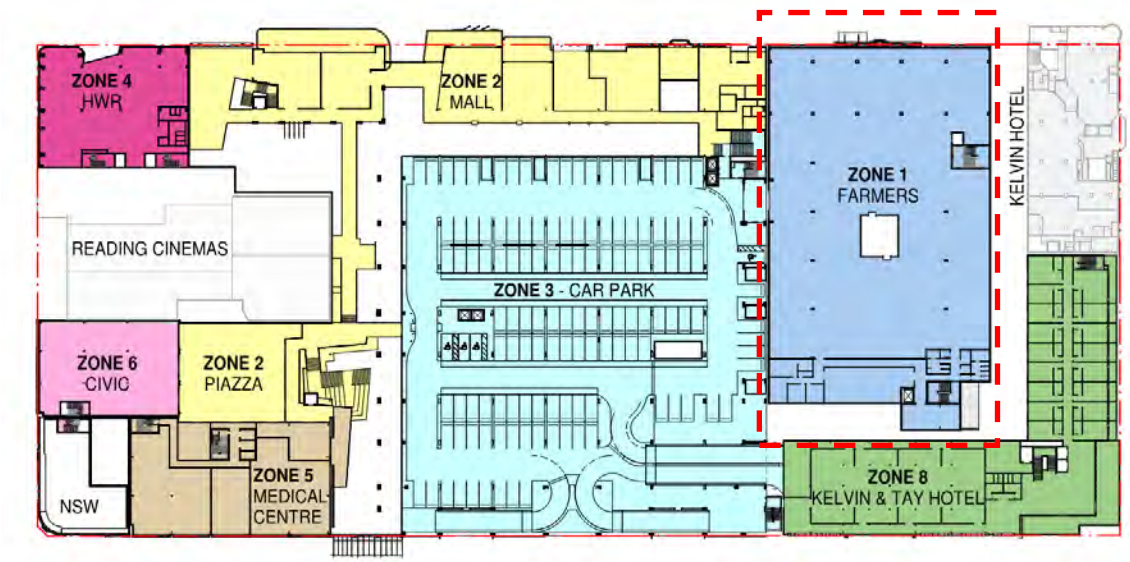


Figure 1: Overall Zone Plan (Zone 1 Indicated Inside Red Dashed Line)

2.0 Structural Description

2.1 Existing Building/s

An existing building called 'Southland Times' currently occupies part of the site proposed for the new Zone 1 Anchor Tenant building. The existing structure will be demolished (including foundations) to approximately 1.5m below ground level. The existing site will be stripped of all uncontrolled fill following demolition, and all demolition excavations will be backfilled with engineered fill to the Geotechnical Engineers' specification. The site strip and backfilling completed during demolition will be suitable for a piling rig to operate. It is intended that the engineered fill will also form the platform for the new ground bearing slab on grade to be constructed. There may be additional preparation required once piling is complete caused by disturbance of the piling rigs.

The northern (heritage) façade located at Esk Street will be retained with temporary shoring at the time of construction and this facade is to be incorporated into the new building. Documentation of the temporary façade retention is covered elsewhere.

Existing piles are known to be located in an isolated area of the Southland Times building footprint and the locations of these have been considered in the new building design. However, a site survey will be undertaken during demolition of the Southland Times to confirm exact set-out of existing piles and any conflicts resolved at this stage. The area of concern is relatively isolated and is shown hatched on the foundation plan for Zone 1.

2.2 New Building

The new building consists of a three-storey structure with an anchor retail tenant located at ground floor and level 1, and a childcare centre located at Level 2 above the retail.

The gravity superstructure generally consists of suspended concrete floors formed from precast, prestressed ribs with timber infills and insitu concrete topping slabs, supported on partially composite steel floor beams in turn supported by steel columns. The stair and lift cores are precast concrete construction with some insitu stitch joints to the north east core to combine panels. Perimeter walls are typically 200mm thick precast concrete.

Foundations consist of shallow concrete beam foundations and/or pile caps over bored or continuous flight auger concrete piles to the depth specified by the Geotechnical Engineer.

The light weight roof consists of steel purlins spanning between steel portal frames. Plant decks are provided above the roof level for plant storage, designed to support the weight of equipment as provided to Lewis Bradford by the building services engineers. The childcare centre is lightweight NZS3604 construction.

The existing Southland Times façade is to have a skin wall of 300mm thick concrete applied to the inner face of the existing brickwork. The new 300mm concrete wall provides gravity load support to areas of new floor that span on to the wall, as well as the necessary support to the existing brickwork wall once the temporary propping is removed during construction of Zone 1.

3.0 Structural Elements

3.1 Lateral Load Resisting System

Global lateral load resistance in each direction is provided by the concrete walls to the perimeter of the building, the northern stair core, precast walls located on Grid C, and the new concrete skin wall to the Southland Times.

The effects of foundation flexibility have been considered in the distribution of base shear to the various seismic resisting elements. It is important to realise that the distribution of base shear is as dependent on the effect of vertical pile stiffness as it is on the length of shear walls resisting the lateral loads.

The primary lateral load resisting elements at ground level are summarised in Figure 2:

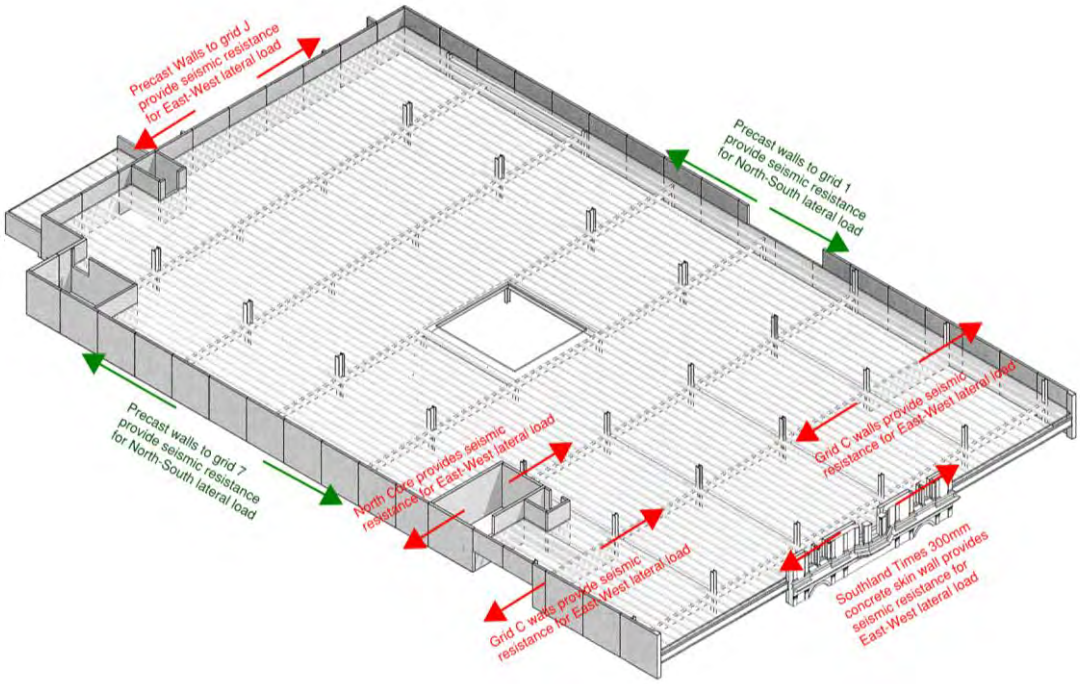


Figure 2: Lateral Load Resisting Elements Ground Floor to Level 1

At roof level between grids D and J the roof bracing transfers the inertial mass of the light weight roof into the side walls on grids 1.1 and 1.7 for north-south seismic load. For the east-west direction, the steel portal frames located on grids E to H provide the lateral load resistance.

The primary lateral load resisting elements at upper level are summarised in Figure 3:

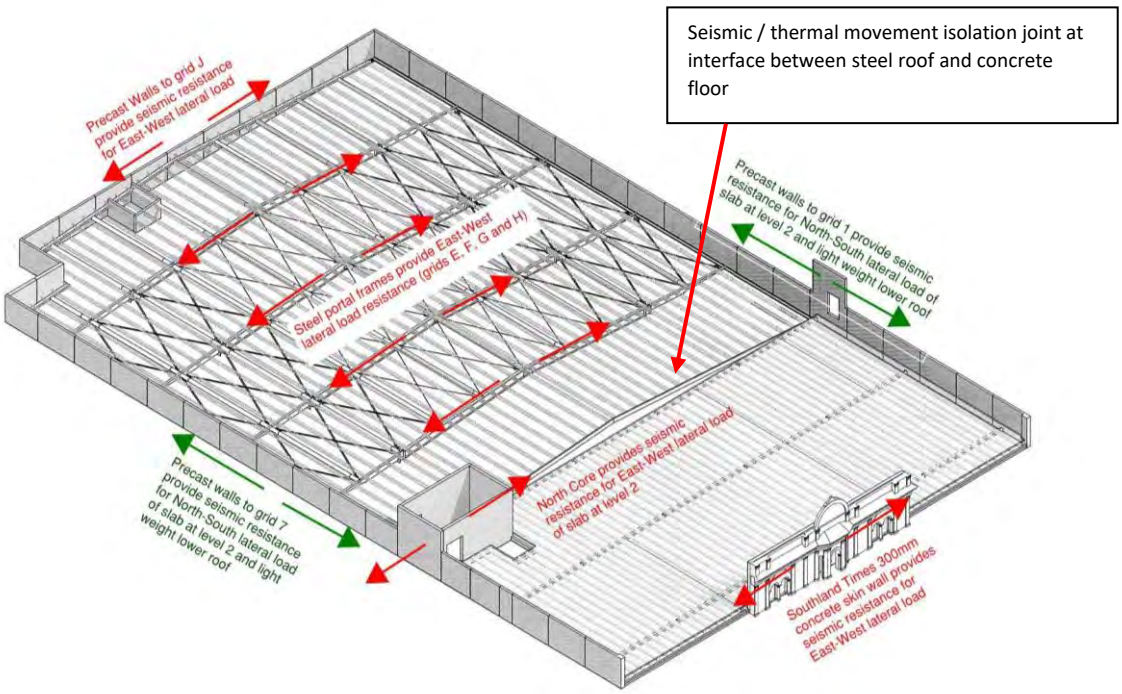


Figure 3: Lateral Load Resisting Elements Upper Level (Including Light Weight Roof)

3.2 Precast Walls

The perimeter precast walls are generally 200mm thick and connected to the foundations with grouted ducts. The perimeter walls have limited ductile regions detailed above the grouted duct connections. The grouted starters at the wall base are designed to overstrength of the hinge zones i.e. the region of wall below the hinge zones can be considered part of the foundation.

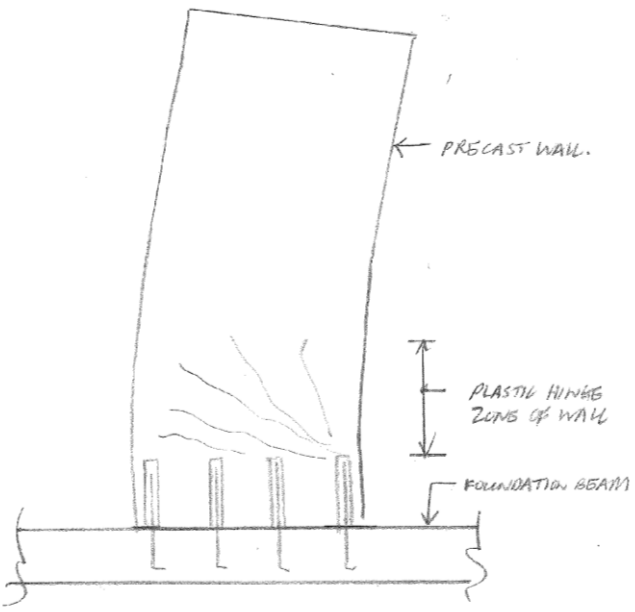


Figure 4: Typical Perimeter Precast Wall Hinge Zones

Some perimeter walls have nominal base connections where uplift from wall overturning can not be easily resisted by the foundation system, for example at building corners where concurrent actions would occur between two adjacent bracing walls. The walls with reduced base connections are assumed not to contribute to lateral load resistance of the overall structure.

The north east core walls are 250mm thick with an insitu stitch joint at midlength to increase the core stiffness. These walls are designed conventionally as nominally ductile and therefore require no specific hinge zone detailing.

The grid C walls are 225mm thick. These walls have significant connection starters to the foundations and require close construction monitoring and accurate set-out to ensure correct placement of the walls over the ducts. These walls are designed conventionally as nominally ductile and also do not have ductile detailing requirements. Nominal stirrups are provided within the neutral axis of these walls as additional redundancy due to the higher compression strut force in the end zone.

3.3 Concrete Suspended Floors

Concrete suspended floors are typically a proprietary precast rib and infill system with a 90mm topping slab. Floor ribs span approximately 10m between steel beams. Overall floor depth is 365mm (250mm ribs, 25mm infills and 90mm slab). Typical reinforcement is HD10-200

reinforcement in each direction. Additional drag bars are provided at locations of high seismic stress and these are nominated on the structural plans.

3.4 Steel Superstructure

Floor beams typically consist of 610UB125 steel composite beams. Sufficient shear studs have been co-ordinated with rib layouts to ensure a minimum of 50% composite action can be achieved with the suspended slabs.

The steel beams run continuously over column supports at the two-storey end (southern part) of the building but are simply supported at the three-storey end (north part) where it was elected to keep the columns continuous for ease of steel erection.

The two-storey end of the building has a steel portal frame above first floor to clear span three column bays. This is to minimise columns in the second storey floor space of the anchor tenancy as required by the anchor tenant performance specification.

Steel columns typically consist of UC and WC columns. The higher than typical 6m ground floor to first floor height causes slightly larger columns than typically utilised in a two or three storey building. Pattern loads on the supported beams each side of each column have been considered in the steel column sizing (i.e. bending moments on columns caused by uneven floor loading).

3.5 Foundations

Foundations consist of shallow reinforced concrete beams, and / or pile caps, with 600mm diameter bored (or continuous fight augured) piles to depth required by the geotechnical engineer. Piles are generally located under columns and precast wall panel joints. Pile capacities assumed are:

Table 1 Pile Load Capacities

Pile Type:	Axial SLS	Axial ULS	Axial Seismic Overstrength	Shear
Pile Type A	950 kN	1425 kN	1995 kN	275 kN
Pile Type B	1100 kN	1650 kN	2310 kN	275 kN
Pile Type D	575 kN	870 kN	1205 kN	220 kN
Pile Type E	575 kN	870 kN	1205 kN	275 kN

Vertical pile stiffness for seismic loading are as per Figure 5:

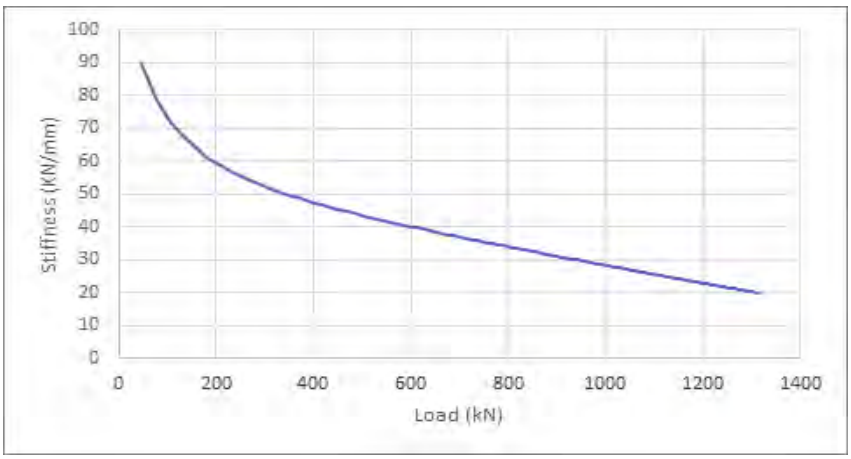


Figure 5: Vertical Stiffness of Piles

Horizontal pile stiffness and lateral bearing strength for seismic loading are as per Table 2. The depth to the medium dense gravel layer has been varied from 2.5m to 3.5m as part of sensitivity test to assumed foundation stiffness.

Table 2: Horizontal Pile Stiffness and Bearing Strength

Layer	Soil Description	Spring stiffness MN/m^3	Limiting Spring Force (kPa)
0-1 m	Fill	-	-
1-2 m	Sands/Silts above gravels	5	50/250
2-3 m		10	80/250
3-4 m	Medium dense gravels	35	250
4-5 m		100	450
5-6 m		40/100	350/525
6-7 m	Dense gravels	100	600

Refer to the Geotechnical report for detailed information on ground conditions. Refer also Appendix A of this DFR which summarises current understanding of shallow ground conditions across the site.

3.6 Ground Floor Slab

The ground floor slab has been designed as a slab on grade. The geotechnical report indicates that liquefaction potential for the site is low. If under ULS seismic conditions some liquefaction does occur, there is potential for limited vertical differential settlement of the ground floor slab.

Some sagging and cracking of the slab is accepted in this case. Refer to the Geotechnical Engineers report for further information regarding liquefaction analysis.

3.7 Fire Protection

Zone 1 areas require 30 minute or 60 minute fire protection to structural elements as shown on the Fire Engineers' drawings. The fire rating is specified on the structural drawings along with limiting temperatures for structural steel elements. 120 minutes is required to the structure that surrounds the substation (also noted on the structural drawings).

Fire ratings to steel elements may be achieved by intumescent painting or enclosing specific elements with fire rated protective claddings.

Fire ratings to concrete elements are achieved intrinsically by concrete cover to steel reinforcement.

Refer also section 7.0 below.

3.8 Seismic Movement Joints

The Zone 1 building interfaces with the new shopping mall located at Zone 2 and Zone 3. Seismic gaps have been allowed between these Zones. The gap allowance has been calculated as the sum of the square root of the squares (SSRS) of MCE building drifts adjacent to each other (currently a 350mm gap between buildings up to the approximately 12m height).

4.0 Design Actions

4.1 Design Life

The design life of the building is 50 years. Design life can generally be understood to mean the time required until first major structural maintenance.

4.2 Importance Level

The building is designed for wind, snow and earthquake loading corresponding to an importance level 2 i.e. a building defined as normal importance to AS/NZS1170.

The annual probability of exceedance (P) has been determined in accordance with clause 3.3 of AS/NZS 1170.0. Applicable design loadings are based on the following criteria:

Table 3: Design Load Criteria

Criteria:	Category:
Design working life of Building:	50 years
Importance Level	IL2
Annual probability of exceedance – ULS	1/500 (wind and earthquake), 1/150 (snow)
Annual probability of exceedance – SLS	1/25 (wind, earthquake and snow)

A Probabilistic Seismic Hazard Assessment has been undertaken by Bradley Seismic for this site which may provide a marginal reduction in seismic load for the Zone 1 building, however the site specific spectra has not been utilised for Zone 1 to ensure a minimum NZS1170.5 1/500 year seismic threshold is achieved.

4.3 Seismic Loads (Primary Lateral Load Resisting System)

Seismic loads are calculated in accordance with NZS 1170.5:2004 and the following performance thresholds:

SLS1: The structure can continue to be used as originally intended without the need for repair and a 1/25 year earthquake event.

SLS2: There are no explicit SLS2 criteria for this building.

ULS: The requirements of NZS1170.5 life safety are met at an ultimate limit state for 1/500 year earthquake.

MCE: Maximum considered earthquake assumed is a 1/2500 year earthquake.

Table 4: Seismic Parameters

Criteria	Value Adopted
C(T) = C_h(T) Z R N(T,D) *(Clause 3.1.1)*	Zone Factor, *Z* = 0.17 Soil Category = D Risk Factor, R_U = 1.0, *Rs = 0.25* Near Fault Factor, *N(T,D)* = 1.0 • Horizontal Design Action Coefficient, $C(T_1)$ = 0.51 ULS • Horizontal Design Action Coefficient, $C(T_1)$ = 0.13 SLS (T_1 < 0.4 seconds applies for all directions of seismic loading)
$C_d(T_1)$ ULS East – West Seismic Loading	North core, Grid C walls and skin wall to Southland Times façade: $C_d(T_1)$ = .40g (S_p = 0.9 and μ = 1.25) Precast walls along grid J: $C_d(T_1)$ = .167g (S_p = 0.7 and μ = 3.0)
$C_d(T_1)$ ULS North – South Seismic Loading	Precast concrete walls to grids 1 and 7: $C_d(T_1)$ = .167g (S_p = 0.7 and μ= 3.0)
$C_d(T_1)$ SLS1	$C_d(T_1)$ = .09g (S_p = 0.7 and μ = 1.0)
Seismic Mass	Level 1 (full building area): 35806 kN Level 2 (childcare area) : 10236 kN Level 2 (lightweight roof) : 5538 kN Total seismic mass = 51,580 kN Note, seismic mass in Etabs model is 5% higher than hand calculations.

Total Base Shear (ULS)	Vbase = 20,760 kN (for S_p = 0.9 and μ = 1.25) Vbase 8,600 kN (S_p = 0.7 and μ = 3.0) Note, seismic loads in Etabs model are slightly conservative but within 5% of hand calculations.

4.4 Seismic Loads (Parts and Portions)

Parts and portions are calculated in accordance with NZS 1170.5:2004.

Floor accelerations are as follows (values may be interpolated between these values):

Table 5: Floor Accelerations

Height	Floor Acceleration %g (ULS)		
µp	1	*1.25*	*3*
Cph	1	*0.85*	*0.45*
hi [m]			
12	1.14	0.97	0.63
11	1.08	0.92	0.59
10	1.02	0.86	0.56
9	0.95	0.81	0.52
8	0.89	0.76	0.49
7	0.83	0.70	0.45
6	0.76	0.65	0.42
5	0.70	0.59	0.38
4	0.63	0.54	0.35
3	0.57	0.49	0.31
2	0.51	0.43	0.28
1	0.44	0.38	0.24
0	0.38	0.32	0.21

4.5 Dead Loads

Dead loads are deemed to be all permanently fixed structural materials; it includes the self weight of the superstructure, including suspended concrete floor toppings, but excludes non structural screeds and light weight permanent partitions. Dead loads are calculated for the materials used.

4.6 Superimposed Dead Loads

Superimposed dead loads (SDL) includes the weight of all permanent (or semi-permanent) non structural elements such as internal partitions, ceilings, floor coverings, escalators, services, floor screeds and the like. Adopted floor SDL allowances are summarised in table 5 below:

Table 6: Superimposed Dead Loads

Location	SDL	Load
Level 1 slab	Ground floor ceiling, building services in ceiling cavity. Internal partitions at level 1. **TOTAL =**	0.50 kPa **1.50 kPa** Note: A total of 1.0 kPa is allowed for SDL when considering the overall seismic load case or column loads as 1.50 kPa over the entire floor plate is too conservative.
Level 2 slab Internal to childcare centre	Level 1 ceiling, building services in ceiling cavity to level 1 Floor finishes and internal partitions to childcare centre. Roof to childcare centre. **TOTAL =**	.50 kPa 1.0 kPa 0.50 kPa **2.0 kPa**
Level 2 slab External to childcare	Level 1 ceiling, building services in ceiling cavity to level 1. Tanking membrane, screed **TOTAL =**	.50 kPa 1.50 kPa **2.0 kPa**

Lower level light weight roof to retail area	Level 1 ceiling Building services in ceiling cavity to level 1 **TOTAL =**	0.15 kPa 0.25 kPa **0.4 kPa**
Cladding Systems (excluding precast panels)	North Elevation per m^2	**0.75kPa**

4.7 Imposed Loads

The recommended loads provided in AS/NZS 1170.1:2002 Clause 3.2.1 have generally been superseded by more onerous tenant performance specification requirements. The following imposed loads have been used in design of floor slabs and roof areas:

Table 7: Imposed Loads

Occupancy Zone	Load
All ground floor and level 1 retail areas	5.0 kPa or 7kN point load
Stairs	4.0 kPa or 4.5kN point load
Childcare (all of level 2)	4.0 kPa or 4.5kN point load
Plant rooms	7.5 kPa
Secure room	5.0kPa and 1 tonne load from safe

Light weight roof	0.75 KPa

4.8 Barriers and Handrails

Handrail loading are calculated as per AS/NZS 1170.1:2002. Generally handrails are designed for 1.5kN/m horizontal applied loads as per Table 3.3 "Retail Occupancy".

4.9 Wind Loads

Wind actions are calculated in accordance with AS/NZS 1170.2:2011 as follows:

Table 8: Wind Actions

Parameter	Serviceability Limit State	Ultimate Limit State
Wind Region	A7	A7
Return Period, R	25 years	500 years
Regional Wind Speed V_r (assumed non-directional)	37 m/s	45 m/s
Wind Direction Multiplier, M_d	1.0	1.0
Building Height (z)	12m	12m
Terrain Category Multiplier (TC3)	0.86	0.86

Shielding Multiplier	1.0	1.0
Site Wind Speed, $V_{site,\beta}$	31.8 m/s	38.7 m/s
Design Wind Pressure, p	**.61 kPA x Cfig**	**0.9 kPa x Cfig**

4.10 Snow Loads

Snow loads are calculated in accordance with AS/NZS1170.3:2003 as follows:

Table 9: Snow Loads

Parameter	Serviceability Limit State	Ultimate Limit State
Region	N5	N5
Return Period, R	25 years	150 years
Probablility Factor, k_p	.85	1.25
Height above Datum	10m	10m
Characteristic Ground Snow Load	0.35 kPa	0.90 kPa
Exposure Reduction Coefficient	1.0	1.0
Shape coefficient	Canopies μ_i = 1.65	Canopies μ_i = 1.65

	Childcare Roof = 0.6 Retail roof μ_i = per figure 7.2 of NZS1170.3	Childcare Roof = 0.6 Retail roof μ_i = per figure 7.2 of NZS1170.3
Minimum Roof Snow Load	Canopy = 0.57 kPa Retail Roof = 0.365 kPa Childcare Roof = 0.24 kPa	Canopy = 1.49 kPa Retail Roof = 0.954 kPa Childcare Roof = 0.63

4.11 Construction Loads

Generally structural elements are not expected to be governed by construction loads.

Construction loads may govern the ground floor slab during precast panel erection. The slab thickness has initially been sized to allow a 200 tonne crane to operate on the slab during panel erection.

It has been assumed that during construction the precast floor systems will be propped with at least 2 bays of props during construction and therefore the steel beams will not require propping due to the minimal floor area supported with non-composite construction.

5.0 Structural Movements

5.1 Earthquake Induced Deflections

The design horizontal deflections are determined from the analysis model for the building and include the effects of foundation flexibility.

Interstorey deflections have been ascertained from the structural analysis model but have typically been rounded to 15mm minimum. Note Sp factor of 1.0 has been used for ULS drifts to ensure that all parts and portions attached to the building are designed for 1/500 year drift with Sp=1.0.

For specifically designed ductile elements in the building to determine seismic design drifts the values in table 10 can be multiplied by a factor of Sp=0.7.

Non structural elements attached to structural elements (for example facades, services, internal partitions and ceilings) shall be designed to tolerate the following movements:

Table 10: Interstorey Seismic Movements

East West Seismic Movement	Serviceability Limit State (Sp=0.7)	Ultimate Limit State (Sp=1.0)
Ground Floor to Level 1	15mm min^{m}	35mm
Level 1 to Level 2 (Three Storey Area with Childcare Centre)	15mm min^{m}	40mm
Level 1 to Roof (Two Storey Area with Light Weight Roof)	20mm	80mm
North South Seismic Movement	**Serviceability Limit State (Sp=0.7)**	**Ultimate Limit State (Sp=1.0)**
Ground Floor to Level 1	15mm min^{m}	20mm
Level 1 to Level 2 (Three Storey Area with Childcare Centre)	15mm min^{m}	35mm
Level 1 to Roof including flexibility of roof X-bracing (Two Storey Area with Light Weight Roof)	25mm	2.2% x height (height of roof varies)

5.2 Serviceability Displacements Under Imposed Loads

Vertical displacements generally meet the criteria set out in table C1 of AS/NZS1170.0.

Post-construction displacements are limited in areas that may be potentially sensitive to such displacements. Non structural elements attached to structural elements (for example facades, services, internal partitions and ceilings) shall be designed to tolerate the following movements:

Table 11: Vertical Movements of Structural Support Elements

Structural Element	Initial deflection under self weight only[1]	Incremental midspan serviceability deflection of structural element (excludes self weight deflection)[2]
Typical Floor Beam	5mm	20mm
Precast Floor System	Refer to Specification	Refer to Specification
Edge Beam Supporting Façade on North Elevation	5mm	5mm
Transfer Beam Grid 1 over Mall Entrance between Grids G and J	30mm (includes weight of panels and roof beam)	10mm
Roof Portal Frame	45mm	20mm
Roof Purlins	3mm (purlin only)	25mm

[1]*Immediately after slab pour for unpropped construction, or immediately after de-propping for propped construction.*

[2]*Includes long term effects of concrete such as creep and concrete cracking.*

5.3 **Wind Deflections**

Table 12: Movements of Structural Support Elements under Wind Pressure[1]

Structural Element	Wind Deflection SLS (Vertical)
Street Canopy	5mm
Primary Rafter to Light Weight Roof of Anchor Tenancy	20mm (at apex of portal) May be linearly interpolated between columns (0 mm) and apex (20 mm)
Purlins	25mm

[1]*Generally seismic drift criteria govern lateral movements.*

6 Durability

Durability provisions are achieved by Acceptable Solutions B2/AS1:

Table 13: Durability Provisions

Material	Acceptable Solution
Reinforced Concrete	NZS3101:2006 Part 1 Section 5 is an acceptable solution. Durability is met by concrete covers equal to or in excess of those for the relevant concrete mix design.

Timber	NSS3604:2003 Part 1 is an acceptable solution for meeting durability through treatment of the timber.
Structural Steel	Structural Steel: Steel Corrosion protection is provided through surface treatment in accordance with NZS/AS 2312:2002.

7.0 Fire Protection

Generally the Zone 1 structure has 30 minute fire rating to the two-storey area and 60 minute fire rating to the three storey area. Protection around the existing substation is 120 minutes.

The structural stability of the new building has been checked for during and post fire stability in accordance with AS/NZS 1170:2002. The structural stability system under design fire loads is as follows;

The global stability of the building during and after fire is provided by the precast and insitu concrete walls in each direction (i.e. the primary lateral load resisting system). The walls achieve the required fire rating by specified thickness and concrete cover.

The precast floors have specified fire ratings achieved by adequate slab thickness and concrete cover to main reinforcement.

The floor to wall panel connections are generally reinforcement bars cast into concrete which provide intrinsically fire rated connections between walls and floors.

The steel floor beams that support concrete floors have protective intumescent paint with limiting temperatures as shown on the floor plans.

The steel columns that support floor beams have protective intumescent paint with limiting temperatures as shown on the floor plans.

The precast panels to the perimeter of the building can cantilever upward from the first floor slab under post fire loads of 0.5kPa, therefore can not collapse inward or outwards during or after fire.

The steel roof structure supporting light weight roof does not require fire protection structurally.

8.0 Materials

8.1 Structural Steelwork

Unless noted otherwise on the structural drawings, structural steelwork grades shall be as follows:

Table 14: Structural Steel Grades

Structural Element	Steel Grade (and Subgrade)
All Hot Rolled UB and UC sections.	Grade 300 (SO)
All Welded Column (WC) and Welded Beam (WB) Sections.	Grade 300 (L15)
Cleats, Stiffeners, Plates.	Grade 300
Steel Purlins	Grade 500
Bolts (Purlins and Timber Framing)	Grade 4.6
Bolts (Structural Steel)	Grade 8.8/S unless noted otherwise on the drawings (Grade 8.8/TB will be specifically noted).
Hold Down Bolts	Grade 8.8/S

Steel beams have shear studs welded to the top flanges to utilise composite action with the floor slabs in the positive moment regions, whilst negative moment regions are assumed to be non-composite. Studs shall be welded to achieve full strength connection between the beam top flange and the stud in accordance with the specification.

8.2 Seismic Category of Steel Elements

The steel frame in Zone 1 is typically a gravity support superstructure and is not part of the primary lateral load resisting system except for the roof portal frame and the roof X-bracing over

the two-storey area part of the building. The entire steel frame can be categorised as Seismic Category 3 (i.e. a minimum of one category lower than the primary concrete lateral load resisting system). Member categories are follows:

Table 15: Steel Member Classification

Structural Element	Member Category
Gravity Columns	3
Primary Beams	3
Steel Roof Bracing	3

8.3 Concrete

Concrete strengths are as follows:

Table 16: Concrete Properties

Structural Element	f'c (MPa)
Precast walls (Xypex additive to external perimeter walls)	35 MPa
Ground floor flab	25 MPa
Suspended floor slab (90mm topping)	30 MPa

Precast floor ribs	To proprietary manufacturers design
Concrete bored (or CFA) piles	30 MPa
Foundations	30 MPa
Lift Pits	35 MPa with Xypex additive

8.4 Reinforcement

Reinforcement properties are as follows:

Table 17: Reinforcement Grades

Reinforcement Type	Grade (MPa)
'HD' or 'HR'	500E
'D' or 'R'	300E

8.5 Timberwork

Timberwork and associated connections shall comply fully with NZS 3604. All timber member sizes or details not shown on the drawings or sketches shall be correctly sized by the Architect and installed by the Contractor, to NZS 3604 specification and details.

All timber is to be machine stress graded 8 (MSG 8), graded dry to NZS 3622:2004 framing with the following structural properties:

Modulus of Elasticity	8.0 GPa
Bending Strength	14.0 MPa

8.6 Wall Bracing Elements (Childcare Centre)

Generally, most timber walls are clad in sheet material to form braced wall elements. These walls are called up on bracing plans attached to the bracing schedules.

The following information is provided to assist in constructing bracing elements correctly. The contractor shall ensure that all bracing elements and framing are constructed in strict accordance with the manufacturers' instructions for the particular bracing system specified, and NZS 3604:2011.

Braced walls are called up in the following way:

A / B / C

A denotes the bracing element

B denotes the bracing type

C denotes length of element

9.0 Seismic Restraint of Non-Structural Elements

9.1 General

The following section summarises the general strategy for the seismic restraint of non structural elements with respect to assumed load points caused by inertial loads of services, ceilings, partitions and the like.

Seismic restraint of services is a sub-contractor design and build item to the Services Engineer's performance specification. Similarly, seismic restraint of ceilings and partitions are a sub-contractor design and build item to the Architects specification.

9.2 Design Parameters

Floor accelerations and derivation factors from AS/NZS 1170.5 are provided in section 4 of this report. The Contractor may elect to derive seismic coefficients from NZS4219. The SLS and ULS seismic lateral drifts are outlined in section 5 of this report. The post-construction vertical movements of structural supports are provided in section 5 of this report.

9.3 Services Restraints

Services restraints are expected to be traditional trapezes and flybraces back to supporting structure above, unless specifically detailed on the structural drawings.

Generally speaking two typical cases of services restraint occur in Zone 1; Services braced to underside of concrete slabs, and services braced to steel purlins at level 1 over the Anchor Tenant area.

There is a great deal of flexibility with respect to bracing services off the underside of the suspended concrete floors and it is anticipated that all services can be braced from the floor slab above. In light weight roof areas seismic brace forces greater than 30kg (unless approved otherwise by the Engineer on a case by case basis) will need to be seismically braced off primary or additional secondary steel beams to specific engineering design.

9.4 Ceiling Restraints

Generally the typical cases of ceiling restraint that occur in Zone 1 are as follows;

Ground floor ceiling and the level 1 ceiling in the concrete slab area; Braced by internal partition walls which are in turn braced by the concrete slab above - generally the intent is summarised in the Architectural documentation for this scenario.

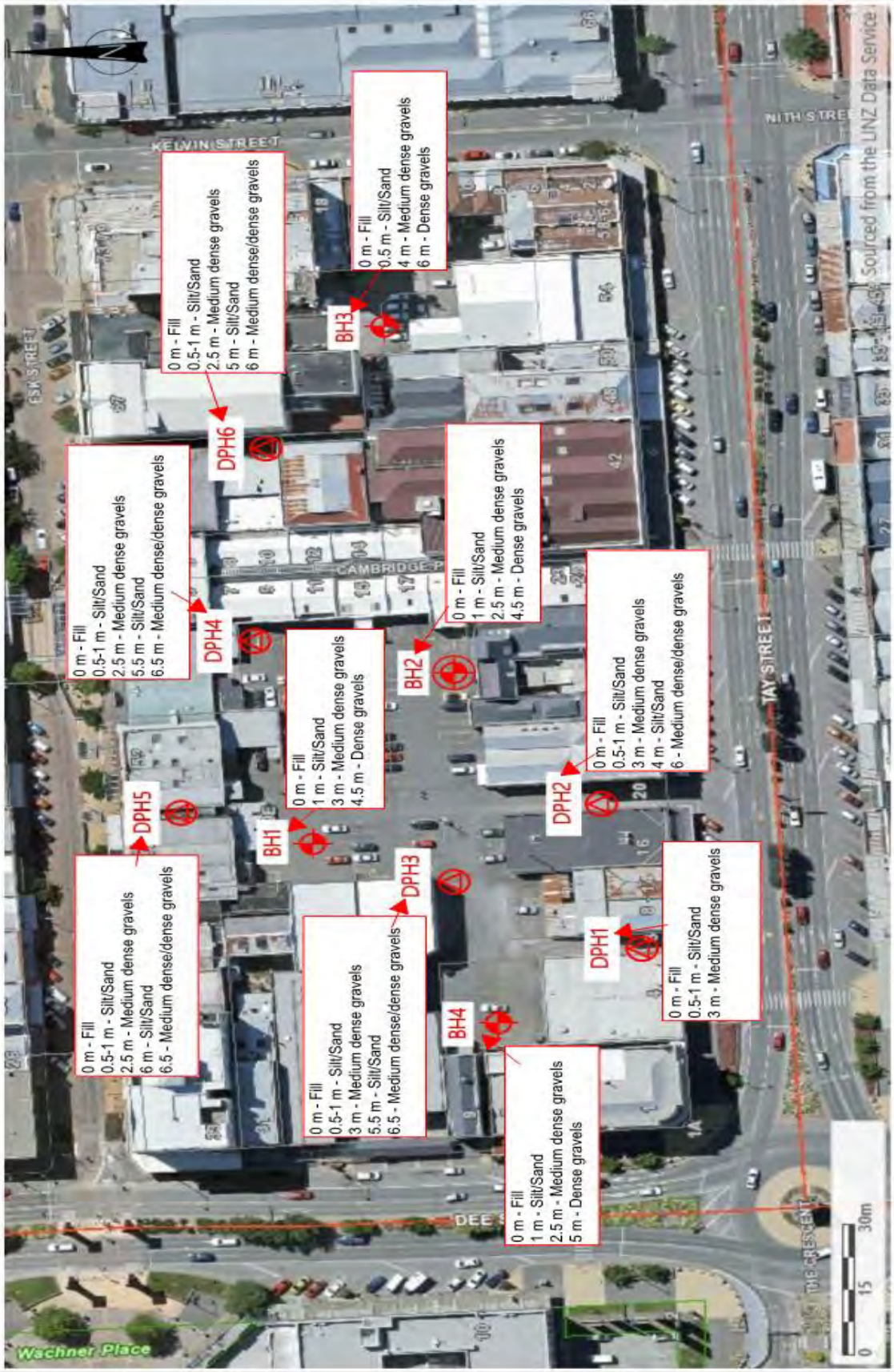
Bulkheads; Typically design build items and assumed to be timber framed elements braced off the slab above. Intent is shown in the Architectural documentation.

Smoke extract ceiling over main escalator void; A secondary steel frame is provided over this area to provide seismic restraint to ceilings and services in this area. The design-build seismic restraint elements may utilise this frame for lateral restraint of ceilings (and services) only in the immediate vicinity of the escalator void.

Level 1 ceiling light weight roof area; Seismic restraint of ceilings can be provided by the purlins in the north-south seismic case as the load can strut along the purlins into the main roof bracing system. However restraint in the east-west direction can only be provided by the precast walls and / or primary rafters. The purlins cannot provide seismic restraint of ceilings about the weak axis of the purlins and secondary steel elements should be provided as necessary for seismic restraint of the ceiling in this area.

APPENDIX A

Assumed Ground Conditions for Pile Design



FIRE DESIGN COORDINATION STATEMENT

lewis bradford
CONSULTING ENGINEERS

To: Building Consent Officer

Company: Invercargill City Council

Copy to: Darin Millar

Company: Holmes Fire and Safety LP

From: Tim Shannon

Date: 25.10.2019

Project Name: Invercargill Central Zone 1 – Anchor Tenant

Total Pages: 1

Project No: 118083

Subject: Fire Coordination Statement; IPENZ Practice Note 22

STATEMENT OF COORDINATION

The Design Coordination Statement is to be provided to the Building Consent Authority and is intended to accompany the documents submitted in the Building Consent application.

The Fire Engineering Strategy Report, prepared by Holmes Fire titled Zone 1 – Anchor Tenant and Childcare, HWCP Invercargill CBD Development, Version B;

Fire Engineering Sketches FS100(C), FS101(C), FS101.1(C), FS101.2(C), FS102.2(C), FS201 (C), FS202A, FS203(A), FS204(A), FS205(A), FS206(A).

have been reviewed by Lewis Bradford Consulting Engineers. We believe on reasonable grounds that the relevant elements of the Fire Strategy Report (including all above registered documents) as they relate to the structural documentation only, have been incorporated into the structural design as proposed on the Structural Documentation issued for Consent (refer attached drawing register).

Signed By

Tim Shannon

Technical Director
BE (Hons), MIEAust, CMEngNZ, CPEng (Aust) IntPE

lewis bradford
CONSULTING ENGINEERS

INVERCARGILL CENTRAL

INVERCARGILL

Building Consent Issue (Zone 1)

STRUCTURAL TRADES SPECIFICATION

SECTION

October 2019
Project N˚: 118083

Christchurch Level 2, 70 Gloucester Street, PO Box 2919 Christchurch Phone 03 379 9096 Email info@lewisbradford.com www.lewisbradford.com
Queenstown Third Floor, 17 Church Street PO Box 571 Queenstown Phone 03 442 9667 Email info@lewisbradford.com www.lewisbradford.com

1.0 EXCAVATION

1.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all trades. This Section of the Specification shall be read in conjunction with all other Sections.

1.2 SCOPE

This Section consists of all excavation, backfilling, hardfilling and making good to be done in conjunction with the construction of the proposed structure.

Note that this contract will need to be carried out in careful conjunction with the demolition and retention works of existing buildings on site including the formation of a piling platform during the demolition works.

1.3 LEVELS

The finished levels shown on the Drawings are in terms of the Datum as shown on the Drawings. Allow to establish and maintain a bench mark on or adjacent to the site.

1.4 QUALITY ASSURANCE

It is the Contractor's responsibility to ensure that all work associated with this part of the contract is performed in accordance with the plans and specifications.

The Contractors quality assurance procedures should encompass, but are not limited to, the following items:

1. Set-out of excavations.
2. Levels of excavations.
3. Compaction of hardfill.
4. Backfill compaction.
5. Testing of subgrade.
6. Location of existing services.
7. Care and protection of existing and adjoining building.

The Contractor shall advise the Engineer in writing of the name of a suitably qualified and experienced representative to be responsible for ensuring that the quality assurance procedures are being followed, prior to commencement on site.

The nominated representative will be required to complete and sign a checklist for all excavated and backfilled foundations detailing, for each pad or group of pads, the depth of excavation, depth of hardfill, level of hardfill, penetrometer readings, and any other information which may be relevant. The nominated representative shall furnish the completed checklists to the Contractor prior to any concrete being poured in the foundation. The Contractor shall check the work covered by each checklist so as to be satisfied that all work complies with the contract documents. All completed checklists and other quality records supplied by the nominated representative shall be collected by the Contractor and stored on site in an orderly manner.

From time to time the Engineer may elect to audit the quality records. They shall be kept up to date and be available for audit by the Engineer at times during the construction of this project.

If so instructed, the Contractor shall forward hard copies of all or part of the records to the Engineer.

The format and detail of the checklist shall be agreed between the Contractor and the Engineer prior to excavation commencing.

1.4.1 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this Producer Statement.

1.4.2 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

1.5 COMPLIANCE

The Contractor shall comply with all requirements of the Local Authorities affected by this work (in particular, the building consent, The New Zealand Building Code, and Occupational Safety and Health requirements) and all other acts, laws, by-laws and regulations that may affect the execution of this Contract.

In particular, comply with all safety requirements as may affect persons on or near the site.

No variations will be allowed on the grounds of ignorance of these requirements.

1.6 PROTECTION OF ADJACENT SITES

The Contractor shall take all necessary precautions to protect adjacent sites from damage. Refer also to the Preliminary and General Clauses of this specification.

The contractor shall also take measures to minimize nuisance from dust, noise and other disturbances affecting adjacent sites and the public.

1.7 EXPLOSIVES

The use of explosives is considered unnecessary and is prohibited.

1.8 NATURE OF THE SITE

The site is located within the central business district of Invercargill bounded by Tay Street, Dee Street, Kelvin Street and Esk Street. The site is surrounded on all boundaries by buildings of various

degrees of fragility relative to the age and construction type of each structure. The condition and protection of the existing nearby buildings and temporarily retained heritage facades along Esk Street will require careful consideration during earthworks. The Contractor is deemed to be fully conversant with local conditions and the nature of the site as they affect this Contract, and make all allowances for the same. No claim will be considered on grounds of ignorance of the same.

It is expected at the beginning of construction all existing buildings and in-ground services will be demolished and removed from site during prior demolition works. It may be assumed the site will be received clear and level with a suitable engineered fill platform for piling.

The site Subsurface soils general consist of the following:

0m o 1.4m of engineered fill overlying (constructed by demolition contractor t.b.c);

1.4m to 2.1m of alluvial silt overlying;

0.8m-1.0m of alluvial sand overlying;

12.3m-13.6m of alluvial gravel overlying;

32m of interbedded alluvial gravel, sand and silt

Groundwater is expected to fluctuate seasonally; groundwater investigations have recorded the water table to be generally 3m to 4m below ground level.

The Contractor is deemed to be fully conversant with normal local conditions as they affect this Contract, and make all allowances for the same. No claim will be considered on grounds of ignorance of the same.

Allow to keep the Engineer informed of progress and co-operate to allow site testing during excavation.

1.9 EXISTING SERVICES

The contractor shall:

1. Give all required notices to the Water, Gas, Sewerage and Electricity Authorities, the Local Council and utilities companies and pay all relevant fees and charges.

2. Locate and protect existing services, rectify any damage or interference to them and provide temporary services whilst repairs are being carried out.

3. Protect footpaths, gutters, crossings, etc and pay all fees required for restoration of these.

4. Keep all thoroughfares free and clear of debris.

1.10 EXCAVATION

1.10.1 Methods of Excavation

The manner of excavation shall be the responsibility of the Contractor, but if, in the opinion of the Engineer, weather conditions or the methods employed are such as to result in undue disturbance of the ground below the levels of final trimming, the Contractor shall suspend the work and shall complete it as and when directed.

The Contractor shall carry out all excavation work in such a way as to minimise the risks of injunction to cease work as far as is practically possible. The costs of any such action shall be borne by the contractor, and no resulting time extensions will be considered.

1.10.2 Surplus Material

Remove from site and dispose of all excavated material, taking care to ensure that this material does not spill onto adjoining streets.

1.10.3 Bulk Excavation

The site is expected to be clear and level at the beginning of construction once demolition of existing buildings on the site is complete. Provide provisional rates for site stripping should additional bulk excavation be required. The quantity will be adjusted accordingly to conditions found.

The general intent of any site stripping will be to excavate down to a clean and undisturbed subgrade using a hydraulic excavator with a smooth edged bucket.

Remove all excavated material from site. Compact the exposed surface with suitable compaction equipment, to achieve 95% standard compaction, as defined in NZS 4431 clause 7.4.1.1.

Refer also the Geotechnical Specification.

1.10.4 Existing Softspots

Excavate further than section 1.10.3 above, all softspots at the direction of the Engineer. Backfill these in accordance with the Backfill section of this specification.

Provide rates for excavation, disposal and backfilling of possible localised softspots. Allow a provisional quantity of 750 m^3 for this material.

1.10.5 Excavations Too Deep

Should the Contractor excavate to a greater depth than called for by the Drawings or by the Engineer's written instructions, he shall fill to the proper level in accordance with the Engineer's instructions with hardfill.

1.10.6 Maintain Excavations

Secure and maintain excavations free from slips, erosion, water and other fluids or fallen materials. Provide and maintain all pile liners, shoring, strutting, sheet piling, planking, pumps and other materials or plant necessary for carrying out and maintaining excavations, and remove them when no longer necessary.

1.10.7 Excavate For Foundations

Excavate further than that allowed in section 1.10.3 above to allow formation of the perimeter slab thickenings and foundations, the foundation beams and bearing pads, the lift pits and pile caps. Excavation shall be to the nominated depth or to good bearing whichever is greater.

This excavation may be done in conjunction with the site stripping in section 1.10.3 above, or after placement of hardfill as in Clause 1.12 below, in which case existing hardfill shall not be contaminated with excavated material.

1.10.8 Excavate For Services

Excavate for all services, including plumbing, drainage, electrical, gas, and utilities as indicated. Cross reference with the services drawings.

Excavate for the lift pits and escalator pits as indicated on the drawings, including the lift manufacturers drawings. Coordinate any excavation for lift services with the lift manufacturers drawings.

Refill trenches with compacted hardfill consolidated in layers not exceeding 200 mm thick.

1.10.9 Dewatering

Excavations shall be maintained free of water. If the water enters excavations which are meant to receive concrete, the water shall be pumped out, any soft materials unsuitable for receiving concrete shall be taken out and replaced with clean compacted hardfill or concrete to the required levels.

1.10.10 Inspection and Testing

No backfilling shall be placed until the relevant area has been inspected by the Engineer.

No reinforcing or site concrete shall be placed in foundations until they have been inspected by the Engineer.

The contractor shall also allow to liaise with the geotechnical engineer GEOSOLVE for possible subgrade testing, required to verify the suitability of founding capacities under the foundations and slab on grade before placing hardfill. This may also include testing of any compacted hardfill layers, the cost of which shall be borne by the contractor to meet the requirements of this specification.

1.10.11 Hardfilling

Hardfill material shall be laid and compacted in uniform layers, with maximum uncompacted thickness 250mm and minimum thickness 130mm.

Hardfill shall be placed and compacted to achieve a uniform dense surface of at least 95% standard compaction, to NZS 4431 clause 7.4.1.1, for each specific layer.

Water may be added to aid compaction as necessary, but must be limited to prevent weaving of the material during compaction and future trafficking.

All hardfill material used shall be CCC AP65 to CSS:Part 1:1992.

1.10.12 Sand Blinding

Place a minimum 20mm of clean sand over all areas where DPM is to be laid. Leave smooth and compact to protect the DPM from any damage (DPM is specified under CONCRETE).

1.10.13 Backfilling Against Foundations

Backfill around foundations and thoroughly consolidate. Remove all timber, rubbish and other loose material before backfilling. Backfill and consolidate in layers using suitable mechanical equipment.

Backfilling material and compaction of the backfill shall be as for hardfill.

1.10.14 Backfill Against Retaining Walls

Before backfilling, ensure that all waterproofing and drains behind the walls have been placed and suitably protected from damage during the backfilling operation.

Backfilling material shall be good quality, clean free draining material (no fines) of approved origin, maximum size 75 mm.

1.10.15 Making Good

Make good Council footpaths, crossings etc to their requirements, however generally with asphaltic concrete, as above.

1.10.16 Coordination

The Contractor shall coordinate with all associated trades to ensure the correct relationship between excavation work and all other trades. This particularly applies to Plumber and Drainlayer.

2.0 CONCRETE - GENERAL

2.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all trades. This Section of the Specification shall be read in conjunction with all other Sections.

2.2 SCOPE

This Section consists of:

(a) The forming, supply and casting of all concrete.
(b) The supply and laying of DPM.
(c) The erection of the precast components.
(d) Grouting of reinforcing bars into hardened concrete.
(e) Building in or grouting of all bolts, plates, fixings and the like, including all items necessary to complete the work indicated on the drawings but not specifically described in this specification.
(f) Sawcutting of concrete

Supply and fixing of reinforcing is covered in REINFORCING STEELWORK.
Supply and placing of grout for blockwork is covered in CONCRETE BLOCKWORK.

2.3 RELATED DOCUMENTS

In this section of the specification, reference is made to the latest revisions of the following documents:

The New Zealand Building Code		(BIA)
NZS 3104	Specification for Concrete Production	(SNZ)
NZS 3109	Specification for Concrete Construction	(SNZ)
NZS 3112	Methods of test for Concrete	(SNZ)
NZS 3114	Specification for Concrete Surface Finishes	(SNZ)
AS 1397	Steel sheet and strip - Hot-dipped zinc-coated or aluminium/zinc-coated	(SA)
AS/NZS 1554.3	Structural Steel Welding – Part 3: Welding of Reinforcing Steel	
Recommended Practice for Erection of Precast Concrete: 1985		(PCI)
Alkali Aggregate Reaction		(C&CA)

2.4 QUALITY ASSURANCE

2.4.1 General

It is the Contractor's responsibility to ensure that the construction of all precast and insitu concrete work complies in all respects with the Drawings and Specifications.

The Contractor's quality assurance procedures should encompass all aspects of the concrete construction including, but not necessarily limited to:

1. Formwork quality.
2. Reinforcing steel placement.
3. Cast-in items, especially cast-in hold down bolts.
4. Concrete quality.
5. Concrete finishes.
6 Concrete curing procedures
7. Construction tolerances.

The Contractor shall advise the Engineer in writing the name of a suitably experienced and qualified representative, to be responsible for the quality control of all precast and insitu concrete. The representative shall review all shop drawings for dimensions, cast-in items, coordination with other trades, and consistency with the Contractor's elected construction sequence before submittal of any shop drawings to the engineer for review. ('Shop drawings' may include but are not limited to: cast-in items, precast elemental drawings and structural steel elemental drawings)

The nominated representative will be required to complete and sign a written quality control check list for each on-site concrete pour. A copy of each completed check list is to be provided to the Engineer before pouring and in sufficient time for the Engineer's pre-pour inspection.

The format and detail of the check list shall be agreed to by the Engineer and the Contractor, prior to the commencement of any concrete work.

The Contractor shall supply evidence of production quality standards to the Engineer in advance of construction in accordance with NZS 3109, clause 6.10.

2.4.2 Inspection

The Engineer will inspect construction in accordance with NZS 3109, clause 1.3. Before pouring commences, the Engineer or his representative shall be notified and a reasonable opportunity given for him to inspect formwork, reinforcement and construction joints.

Where necessary, the Engineer's instructions shall be carried out before concrete placing commences.

2.4.3 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this Producer Statement.

2.4.4 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

2.4.5 Tests

The Ready Mix Supplier shall make control tests in accordance with NZS 3104, and shall pay the cost of such tests. Tests shall be made either at the Ready Mix Plant, or at the site, except that if the Engineer specifically calls for tests at the site as a result of any dissatisfaction with the plant testing procedure, these shall be done by the Ready Mix supplier. Results of these tests shall be made available to the Engineer.

Allow to take test cylinders on site at random for each pour of concrete, in accordance with NZS 3112, part 2, clause 3. Make three standard cylinders for each 100 cubic metres of concrete placed, or part thereof, and test in an approved laboratory. These tests are additional to those required by NZS 3104. Test results for breaking cylinders at 7, 14 and 28 days shall be forwarded to the Engineer on completion of the tests.

Delivery dockets and other certified records of concrete quality and quantity shall be kept on site for inspection by the Engineer.

Allow a P.C. sum of $10,000 for payment of laboratory charges for testing of concrete cylinders taken on site, at the direction of the Engineer.

2.5 MATERIALS & WORKMANSHIP

2.5.1 General

The Contractor shall adhere to all requirements of NZS 3109, except where specified otherwise herein or instructed otherwise by the Engineer. A copy of this standard shall be kept on the site and relevant parts read with the following Clauses of this Specification.

2.5.2 Concrete

2.5.2.1 General

Concrete for exposed slabs, beams, columns and walls shall be SPECIAL CONCRETE with minimum strength and maximum shrinkage strain properties as noted in the table below. ‘Shrinkage strain’ shall be defined as 56 day free shrinkage strain as measured in accordance with AS1012.13., The concrete supplier shall provide historic test records for the proposed mix, or shall allow to test the proposed mix well in advance of the proposed pour date.

"No fines" concrete shall be coarse aggregate/cement/water mix without sand but with selected smaller aggregate where necessary. No minimum specified strength.

All other concrete shall be NORMAL CONCRETE as defined in NZS 3109 and NZS 3104, with sufficient cement quantity to ensure satisfactory finish and durability, from an approved and fully audited Ready Mix plant.

Calcium Chloride shall not be used.

Maximum aggregate size shall generally be 19mm.

The aggregate used, and overall mix design (including the use of any additives) shall meet the provisions of section 2 of Alkali Aggregate Reaction (C&CA). Evidence may be required in support of this by the Engineer. Use of low alkali cements or aggregates from an alternative source may be required where the proposed aggregate contains deleterious material.

2.5.2.2 Concrete Strength

Concrete shall have the following strengths:

SPECIAL CONCRETE

Lift pit slabs and walls (shall have approved waterproof mix additive)	35 MPa
Slabs on grade u.n.o.	25 MPa
Columns (precast and insitu)	40 MPa
Insitu beams, insitu joints (may use 13mm maximum aggregate)	35 MPa
Precast beams (including reinforced and post-tensioned beams)	40 MPa
Precast stairs, precast slabs	35 MPa
Precast walls	35 MPa
Precast walls to external exposed elevation (shall have approved waterproof mix additive)	35 MPa
Insitu walls generally u.n.o,	35 MPa
Insitu walls between grids 3.D & 3.D ground floor to level 1 in carpark	60 MPa
Insitu floor toppings to suspended floors generally (excluding carpark)	30 MPa
Insitu floor toppings to suspended floors in carpark areas (shall have approved surface hardener / dustproof membrane)	35 MPa
Main entrance ramp slab to carpark (on grade) (shall have approved surface hardener / dustproof membrane)	35 MPa
Loading dock / delivery area slabs (on grade) (shall have approved surface hardener / dustproof membrane)	40 MPa
Ramp slabs / Turning Area on ramps (shall have approved waterproof mix additive and surface hardener)	35 MPa
Foundations and Piles	30 MPa

The specific mix design for all concrete for precast shall also take into consideration any additional cement content or additives required to achieve the minimum durability requirements of NZS3101, in conjunction with the contractor's nominated curing methods. All SPECIAL CONCRETE (Invercargill) shall have a median 56 day shrinkage strain of 600 microstrain

Site concrete and concrete required to make good excavations shall be 7 MPa at 28 days or better.

Minimum concrete strength at release for pre-tensioned units shall be 25 MPa.

2.5.3 Concrete Exposure Classification (for curing considerations)

Generally, all internally exposed concrete faces for this project have an exposure classification in accordance with NZS3101 of A1

All externally exposed concrete faces generally have a classification of B1.

Surfaces of concrete directly in contact with the ground have a classification of B2

2.5.4 Reinforcement

Reinforcement, including all necessary distance pieces required to maintain cover, is specified in REINFORCING STEEL.

The Contractor is to be responsible for checking that reinforcement is not displaced during concreting. The Contractor shall have suitably experienced workmen continuously on call during all concrete pours to correct any damage or displacement which may occur. Any reinforcing displaced or damaged through the Contractor's neglect is to be remedied at the Contractor's expense.

2.5.5 Structural Steelwork

All cast-in items of structural steelwork, e.g. weldplates, corbel brackets, etc., are specified in STRUCTURAL STEELWORK.

The Contractor is to be responsible for checking that all cast-in items are correctly located and orientated, and that they are not displaced during concreting. The Contractor shall have suitably experienced workers continuously on call during concreting to correct any displacement that may occur. Any structural steelwork that is damaged or displaced through the Contractors neglect is to be remedied at the Contractors expense.

2.5.6 Permanent Timber Infills

Permanent formwork timber infills shall be 25mm thick, rough sawn, and treated to TPA specification H3. The width of timber used shall be between 200mm and 300mm.

The timber used for permanent infills shall be sound, free from loose knots, and capable of supporting a 100kg point load at mid-point.

2.5.7 Formwork

Formwork shall conform to NZS 3109, Section 5.

Fairface formwork shall be so constructed as to provide straight and true angles and so as to produce cast surfaces within a tolerance of 5mm on the given dimensions, and without visible offsets, bulges, or misalignment of the concrete. Form neat, clean arises, except where chamfers are shown on the drawings, in which case the fillets shall form part of the mould and not be loosely placed.

Steel formwork shall be used where specified or appropriate, with all joints welded and ground smooth and flush.

Surfaces with a ribbed or grooved surface (see elevations) shall be formed by gluing battens of the appropriate profile to the form, and generally treating as above.

The joints of plywood formwork shall be sealed with plastic sealant strips or cover battens to prevent grout loss.

All ties and spreaders shall be placed so as to leave a regular and neat pattern on the surface when withdrawn and filled. Wire ties will not be permitted.

Care shall be taken that oil is kept out of contact with the reinforcement and is compatible with any subsequent paint systems to be applied to the finished product. All rubbish, clippings, shavings and sawdust shall be removed from the formwork immediately before concrete is placed.

Timber formwork which is not being used for the next seven days shall be cleaned, oiled and stored flat. It shall be protected against gross changes of moisture by use of a tarpaulin or similar waterproof cover enclosing the top and all four sides completely.

All formwork shall be removed without shock or vibration which might damage the concrete.

Stripping times shall be as in NZS 3109, Clause 5.4 unless otherwise agreed by the Engineer.

2.5.8 Construction joints

Construction joints shall conform with NZS 3109, Clause 5.6.3, type B, unless agreed otherwise with the Engineer and their position shall be as shown on the drawings, or otherwise as agreed with the Engineer in advance.

Concrete shall be poured between properly positioned stops. The existing concrete shall be cleaned and roughened at all construction joints. Ensure that all laitance is removed over the face of the construction joint.

Kickers at the base of columns and walls shall not be used unless the concrete in the kicker is placed and fully vibrated with the main pour to the Engineer's satisfaction, or unless as a separate pour a special high strength mix is used and fully vibrated. Details of this mix shall be to the Engineer's approval.

All blockwork to concrete construction joints shall be roughened.

Allow also to roughen the end of all the precast column and beam units which form a construction joint, by retarding and washing.

2.5.9 Tolerances

2.5.9.1 General

Dimensional tolerances are to conform to NZS 3109 and to NZS 3114, unless specified otherwise herein. This applies to both precast and insitu concrete.

2.5.9.2 Building tolerances

To ensure that such elements as the external cladding, precast items, and elevators will properly fit the building, it is necessary to maintain good control of the overall building setout.

An absolute tolerance on the position of all structural elements of ± 10mm shall be maintained for the full height of the structure, in all directions, unless noted otherwise for precast concrete elements.

The contractor shall employ a registered surveyor to reset all grid lines and column positions every second floor. Column locations, slab edge positions and positions of openings shall be adjusted to ensure that each is within 10mm of the correct position throughout the height of the building.

Particular care shall be taken to ensure that individual members and the building as a whole do not twist over the height of the building.

2.5.9.3 Tolerances for Erection of Precast Units

All precast units or support elements shall be placed to the following tolerances, unless otherwise stated on the drawings:

Beam location - in elevation	± 10 mm
Beam support brackets	± 5 mm
Differential precamber to adjacent precast flooring units	± 10 mm
Seating of precast flooring on beams	100 mm, -0, +10 mm
Full height precast columns to carpark building	± 20mm (over height of column)

Allow for shimming and sorting of precast units as necessary to obtain these tolerances.

Abrupt surface changes at joint locations and other tolerances shall meet the appropriate requirements of NZS 3114 for the class of finish specified.

Where two or more units are in direct contact (eg precast flooring seating onto a precast beam), the overall tolerance for the units shall be as if they were one. Where the contractor feels that the total allowance for tolerance between a series of units will be inadequate, greater allowance for tolerance may be permitted in the casting of the units, subject to the Engineer's approval.

2.5.10 Concrete finishes

2.5.10.1 General

All concrete finishes shall be in accordance with NZS 3114.

In general, slab finishes shall comply with Part 3, NZS 3114; exposed aggregate finishes with Part 2, NZS3114; and formed finishes shall be to Part 1, NZS 3114.

Finishes not specified elsewhere in this section or on the drawings shall be in accordance with Table 1 or Table 2 of NZS 3114, as appropriate.

2.5.10.2 Slab Finishes

Refer to Schedule of Surface Finishes below for the schedule of slab finishes required.

The Contractor shall arrange the pouring to allow adequate time for floating and finishing.

Floating and any subsequent finishing shall be at the correct time to obtain the quality of compaction and finish required. No trowelling in of fines and dry cement will be permitted.

All trowelling ridges shall be removed while soft, or by subsequent light grinding. Slabs not fulfilling the standard of finish required shall be ground smooth or otherwise treated to the satisfaction of the Engineer. Care shall be taken to avoid ridges where newly poured slabs meet existing edges.

Finish U3X in Schedule of Concrete Finishes below denotes that the surface shall have no abrupt deviations. Gradual deviations shall be limited to 6 mm in 3 m, as for the appropriate panel tolerance. Refer to Precast Tilt-up Wall Panels.

2.5.10.3 Formed Surfaces

Refer to Schedule of Surface Finishes below for schedule of finishes required.

Concrete which will be concealed in the finished building shall be cast with a minimum of grout leakage, honeycombing and without conspicuous offsets or bulges.

Finish F5X1 in Schedule of Surface Finishes below denotes that the surface tolerances of NZS3114 shall be amended such that no abrupt changes shall be allowed.

Finish F5X2 in Schedule of Surface Finishes below denotes that steel formwork only shall be used, to achieve the required finish.

2.5.10.4 Exposed Aggregate

Surface tolerances shall be as for the equivalent formed surface.

Panels will be manufactured using concrete with a specially selected aggregate to be nominated by the Architect.

The surface texture shall be achieved by lightly retarding the exposed concrete surfaces with a high quality surface retarder such as Sika Rugasol, or similar approved.

Sample panels of size no less than 400 x 400 x 30mm shall be prepared for the Architects approval. Once approved, these panels must be kept on site to be used for comparison purposes during the Contract.

2.5.10.5 Schedule of Surface Finishes

Slabs to take Plaster or Tiles	U2
Other internal / external slabs	U3
Carpark, footpath and ramp slabs	U5
Top surfaces of foundation beams and pads	U2
Concrete below Ground	F1
Concrete to take Plaster or Tiles	F2
Concrete surfaces not exposed in the completed building	F3
Concrete surfaces exposed in the completed building, and surfaces to receive enduit plaster; these surfaces to be rubbed down to remove ridges, provided that this should only be done after being referred to and decided upon by the Architect.	F5X1
All Precast surfaces exposed in the finished job excluding carpark areas (off a steel form)	F5X2
All Precast surfaces exposed in the carpark (may be off a steel or timber form)	F5X2

2.5.11 Site Welding

2.5.11.1 General

All welded connections shall be metal arc welded as shown on the drawings.

All site welding, welding inspection and repairs of welding defects shall be as specified in STRUCTURAL STEELWORK.

All contact faces and cleats for weld plates are to be wire brushed or sandblasted prior to placing of units and welding.

All welds shall have slag removed, and welds exposed in the finished building shall have splatter removed and ground to a neat clean joint. Exposed surfaces shall be cleaned by wire brush or sandblasting and finished in accordance with the relevant clauses of STRUCTURAL STEELWORK.

2.5.11.2 Welding Inspection

The Engineer shall be given reasonable notice when each section of the work is prepared and ready for welding and shall be given every opportunity to arrange for inspection and to satisfy himself as to the quality of the work and competence of the operators.

The Contractor shall supply all facilities necessary for adequate access, and shall arrange the sequence of work to allow inspections and testing to be carried out. Testing may include radiographic and ultra-sonic testing. The cost of testing shall be paid for by the Contractor. If welding quality is not satisfactory, the Engineer may arrange for specialist welding advice and inspections to amplify his own inspections. The cost of such services shall be paid for by the Contractor.

Allow a provisional sum of five thousand dollars ($5000) for welding inspection to be arranged by the Engineer.

2.5.12 Vibrators

Vibrators shall be used for the compaction of all concrete. They shall be high frequency.

Vibrators shall be moved to new positions as frequently as necessary to ensure uniform vibration of the whole mass and fully compacted concrete. On no account shall vibrators come within 12mm of the face of the formwork. Vibrators shall not be used to transfer concrete from one position to another.

2.5.13 Damp-Proof Membrane

Unless noted otherwise in the architect's documentation provide and lay 250 Micron Polythene or equivalent DPM over sand blinding on hardfill on existing ground beneath all areas of slab on grade, and all thickenings.

Join DPM as necessary by lapping a minimum of 250mm and completely sealing the joints with 50mm wide pressure sensitive polythene tape to produce a continuous membrane. Turn damp proofing up or down against foundations, walls and columns as appropriate and adequately seal around protrusions and service pipes to ensure the waterproofness of the complete membrane.

Protect the DPM during all operations until the floor slab is completed, and repair any damage that may occur or replace damaged material.

2.5.14 Waterstops

Supply and place Sika Swell Profile swellable waterstops, as shown on the drawings.

Waterstop is to be placed entirely according to the manufacturers specifications. Special care must be taken to ensure its correct position in the finished concrete and that it is free of all debris. Waterstops shall be mechanically fastened in position.

Alternate systems may be used with the approval of the Engineer.

2.5.15 Water Proofing Membranes

Refer to Architects documentation for water proof membranes to all lift pits, escalator pits and retaining walls.

All membranes shall be applied strictly in accordance with the manufacturer's recommendations. At least 24 hours of dry weather must be anticipated before applying membranes in any position exposed to the weather. Any membranes damaged by rain within 24 hours after application, shall be re-coated to the Engineer's satisfaction.

Special care shall be taken to avoid splashes or dribbles of membrane onto exposed faces of concrete or other surrounding work.

Provide and install one layer of 6mm Hardiflex or similar approved to all membrane surfaces prior to backfilling.

2.6 CONCRETING

2.6.1 General

All concreting shall conform to NZS 3109, section 7.

The Contractor shall comply fully both on and off site with the provisions of the New Zealand Building Code in all matters relating to construction safety, in particular with Approved documents F1 (Hazardous Agents on Site), F2 (Hazardous Building Materials), F4 (Safety from Falling), and F5 (Construction and Demolition Hazards).

2.6.2 Curing and Protection

All concrete shall be cured as defined in NZS 3109, Clause 7.8, except that for exposed floor slabs, the minimum curing period shall be 7 days except by specific written approval from the engineer. For other concrete elements with exposure classifications A1, A2 and B1, the minimum curing period for all faces of the concrete shall be 3 days. Where a higher exposure classification is specifically noted on the drawings, the minimum curing period shall be 7 days.

The use of plastic curing compounds as an alternative to water curing shall be as agreed with the Engineer specifically for each occasion before it is used. The Contractor shall be responsible for ensuring that the curing compound proposed is compatible with subsequent floor covering or paint finish.

If the precast contractor opts to provide less curing than required by NZS3109, the precast contractor shall provide details of how the mix design shall be adjusted to ensure the minimum durability requirements of NZS3101 will be met, in conjunction with the proposed alternative curing regime.

2.6.3 Chases, Holes and Nibs

Form all chases, fillets, holes, upstands and nibs as shown on the drawings or required by other trades. Chases and holes shall be accurately positioned and formed at the time of casting the concrete.

Set concrete shall not be cut, hacked or cored unless specific approval is obtained from the Engineer.

2.6.4 Rebates, Reveals, etc.

Cross reference with Architectural Drawings to ensure that all rebates, reveals, etc are correctly formed. This is particularly important in relation to window and door openings.

2.6.5 Building in

As the work proceeds, build in all necessary bolts and other fixings and where not supplied by other trades, supply these. The Contractor shall ascertain from all sub-contractors all particulars relating to their work with regard to order of execution and details of all such provisions of fixings, sleeves, chases, holes etc and of all necessary items to be built into concrete and shall ensure that all such items are provided for and/or positioned.

No claim will be recognised or allowed for extra cost of cutting away or drilling concrete work already executed in consequence of any neglect of the Contractor to ascertain these particulars and make the necessary provision beforehand.

All items detailed or specified to be built in and not shown to be supplied by other trades shall be supplied by the Contractor.

2.6.6 Protection

All concrete elements shall be protected from damage at all times. Any damaged items shall be repaired or remade to the satisfaction of the Engineer.

2.6.7 Erection of Precast

2.6.7.1 General

Precast concrete units should be handled and placed in accordance with the American PCI publication "Recommended Practice for Erection of Precast Concrete".

Erection procedures shall be agreed in advance with the Engineer.

It is the Contractor's responsibility to check all dimensions prior to beginning erection to ensure all supporting elements such as piles, footings, pads, columns, beams and support cleats have been accurately placed to receive precast elements. The Contractor shall determine the propping loads.

The Contractor shall provide propping for precast flooring and beams and temporary bracing for precast wall panels and columns as required and as necessary to stabilise the structure until all permanent bracing and associated elements of the structural system such as block walls, foundations, etc, are completed.

Every effort shall be made to keep units true to dimension, plumb and level. Final fixing of erection connections shall be delayed until each section of the structure is proved true, but shall be completed before any further loads are added to the structure.

Contractor is to co-operate with other Trades in erection of precast units.

2.6.7.2 Handling

Precast items shall be handled with appropriate lifting equipment to comply with all safety regulations and laws. Allow to cast in lifting points as required. The adequacy, location, and design of all lifting equipment and cast in items is the responsibility of the Contractor.

Protect units from any damage due to handling, and make good any that does occur. Allow suitable and adequate dunnage during all operations.

2.6.8 Repairs and Cleaning

After all the concrete work of the building has been completed and the majority of other trades finished (except PAINTER and FLOOR COVERINGS) all finished exposed concrete surfaces throughout, including precast concrete, shall be closely inspected for faults in surface finish, damage to corners or edges, dirty marks, splashes or dribbles and visible imperfections of every kind.

All such imperfections shall be removed by the Contractor as required by the Engineer.

Patching or filling of fairface concrete and making good broken edges and corners shall be done with coloured sands and cement where necessary, to match precisely the colour of the surrounding concrete when dry. Epoxy or similar adhesives shall be used when required.

The removal of surface markings shall be most carefully done by appropriate methods such as wire brushing, pumice stoning, carborundum stone, or washing and scrubbing such as will remove the marks without scratching, discolouring or otherwise affecting the surrounding or underlying concrete.

2.6.9 Sawcutting

The slabs on grade are to be sawcut within 24 hours of pouring (assuming a wet screed pour).

The positions of the sawcut joints are to be to the pattern shown on the drawings or discussed and agreed with the Engineer before pouring the slab.

The saw cuts are to be 50mm depth and 6 mm wide minimum, and maximum 5m centres in each direction u.n.o., and are to be cleaned out and filled to the Architects specification OR with Sika Flex Tank sealant to be applied in accordance with the manufacturer's recommendations as late as possible in the job.

Typically, the slab mesh shall have every second mesh wire cut at sawcut locations prior to pouring the slab u.n.o. on the drawings.

Sawcut joints shall be placed to eliminate re-entrant corners. This will usually require diamond shaped sawcuts around columns.

2.6.10 Epoxy Grouting of Reinforcing Bars into Concrete

Drill and epoxy grout deformed reinforcing bars into concrete as shown on the drawings and when specifically instructed by the Engineer. Generally this will only be required for remedial works - epoxy grouting is not an alternative construction method to the details shown on the drawings. All epoxy grouted bars shall comply with the following provisions and shall be subject to the approval of the Engineer.

The holes must be drilled with hammer drills. Diamond core drilling is not acceptable.

Holes for vertical bars shall be vertical and holes for horizontal starters shall slope downward at 15 degrees.

The depth of hole and embedment of the reinforcing bars shall be to the minimum depths set out in the table below unless noted otherwise.

Embedment Depth

Deformed Bar Size (mm)	Minimum Hole Diameter (mm)	Grade 300	Grade 500
10	16	160	250
12	18	200	330
16	22	270	450
20	26	350	580
25	32	500	850

NOTE: The tabulated values above apply to a deformed bar epoxy grouted into a hole with rough sides brushed clean of dust and loose material, in dry concrete).

Holes must be dry prior to filling with epoxy unless the epoxy used is suitable for wet holes or underwater application.

If the concrete is moist then the bonding surface must be roughened to provide a depth of surface roughness of 2-3mm or more so that the loss in chemical bonding can be replaced by mechanical bonding.

All holes shall be cleaned out using a stiff bristled wire bottle brush and a compressed air source so that all dust and debris are removed from the side of the hole.

When this has been completed the Contractor is to notify the Engineer for inspection of the holes prior to placement of bars and epoxy grout.

The holes shall be partially filled with epoxy grout prior to inserting the reinforcing bar. Holes shall be filled from the bottom up (rather than pouring from the top). Vertical holes can be filled with a pourable grade epoxy. Horizontal holes must be filled with "plastic epoxy using purpose made and filled cartridges in a "sealant" gun. Standard cartridges shall be modified by placing plastic hosing over the cartridge nozzle of sufficient length to reach the base of the drilled hole.

After the bars have been placed in position, ensure that the epoxy fills the hole to the surface of the concrete. Top up holes if necessary.

Bars shall be placed in the holes, given one turn to expel air voids and shall be fully supported (if necessary) and left undisturbed for at least 24 hours. After 24 hours horizontal bars installed at 15 degree slope can be bent horizontal.

Use Hilti HIT RE-500 (or similar with prior approval of the Engineer) for all vertical holes. Use Hilti HIT RE-500 (or similar with prior approval of the Engineer) for all horizontal holes.

The grout shall be non-shrink.

Moisture sensitive epoxy resins should not be used.

If the hole size is larger than the minimum specified, a sand filled grout may be required.

The epoxy grouts shall be used strictly in accordance with the manufacturer's instructions.

Notify the Engineer of the names of the site staff responsible for ensuring that this specification is being followed.

2.6.11 Grouting of ducts

All ducts and associated gaps forming the interface between adjacent concrete components, where noted on the drawings, shall be grouted, with Sika Grout 212 non-shrink high strength grout, or approved equivalent.

Grouting shall be carried out so that air is expelled as grouting continues, and all voids between concrete units are completely grout filled. The grout shall be mixed and placed in strict accordance with the manufacturer's instructions.

The Contractor shall nominate the persons responsible for quality assurance of mixing and placing the grout. A testing programme shall be agreed between the grout manufacturer and the Engineer which shall then be followed throughout the job. The tests shall demonstrate that the grout as placed:

1. Has a minimum 7 day strength of 40 MPa.
2. Flows to entirely cover the beam column interface.
3. Does not bleed mix water to create voids at this interface.
4. Does not shrink.

Clean off any spillage or leakage immediately after the completion of grouting.

Allow at least 24 hours for the grout to cure before applying any load to the grouted joint.

2.7 BUILDING ELEMENT

2.7.1 Foundations

Form and cast all pile caps, beams and pads, the lift pits, escalators, and other foundations as detailed, generally against natural ground. Ensure that the surrounding ground is damp before pouring concrete.

Allow to underpin or otherwise support adjacent foundations as necessary to ensure complete stability and no damage to adjacent buildings at all times.

Cast in sleeves for all pipes through foundations as indicated on Architectural and Engineering Drawings.

2.7.2 Base Floor Slab

Cast the base floor slab in sections as detailed and supply and build in waterstops as detailed. Careful control is essential in the construction of the slab to achieve fully compacted concrete at all parts, with no voids or cracks, to achieve a fully waterproofed slab.

The positions of the construction joints in the area of slab and the waterproofing of those joints shall be discussed and agreed with the Engineer in advance of the construction.

2.7.3 Precast Columns (Zone 3 Carpark)

Before casting the columns review the precast beam and column drawings to become familiar with the implied tolerances in the beam-column joint.

Accurately locate cruciform column reinforcement to facilitate subsequent erection of precast beams.

All columns are highly stressed and therefore patching of honeycombed areas will not be accepted. Such columns will be rejected and required to be broken out and recast.

2.7.4 Precast Beams (Zone 3 Carpark)

The precast beams are jointed with insitu joints at the cruciform column stub locations. Allow at least 48 hours for the insitu joints to cure before placing floor units on the corbels of the precast beams.

The precast beams shall be fully supported during the insitu topping slab pour, and until the topping slab has reach at least 20 MPa.

The insitu concrete splice joints between precast elements may be poured with, or separately to, the floor topping.

2.7.5 Floor Toppings

Cast insitu floor topping, adjusted in thickness such that:

a) the minimum thickness is shown on the drawings.

b) the top of the floor is cast flat for spans up to 5.0m.

c) the top of the floor typically has precambers for spans over 5m – pour slabs such that minimum thickness of slab is maintained following the contours of the supporting precambered precast elements.

Size of pours and position of construction joints shall be previously agreed with the Engineer.

At roof levels, place units to falls as shown on the drawings and cast toppings of various thickness to achieve the final levels shown.

2.7.6 Stairs

Take delivery of precast concrete stairs, cast into topping the top projecting reinforcement, allow the bottom free to slide on the floor. Under no circumstances shall the sliding detail be fixed or impaired in any way.

2.7.7 Plant Rooms

Provide all openings, rebates, recessed upstands and the like as shown on the drawings and as required by the services sub-contractors. Those openings of 100 mm diameter and less may be diamond drilled after casting if desired.

2.7.8 Seismic Joint

Form and cast the seismic joints as shown on the drawings. The Contractor is to ensure all items are cast into the topping at the time of construction.

2.7.9 Lift and Escalator Pits

Form and cast in any required rebates, weld plates, proprietary lift fixings and sumps required for the lifts. The Contractor is to co-ordinate the construction of the lift pit with the lift manufacturers drawings to ensure that all required components are constructed accordingly.

3.0 CONCRETE - PRECAST

3.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all Trades. This section of the specification shall be read in conjunction with all other sections.

3.2 SCOPE

This section of the Contract consists of the manufacture of all precast items except for proprietary floors and proprietary shell beams. Precast items shall be complete with all reinforcement, structural steelwork, weld plates, bolts, inserts and all other fixings or lifting eyes required by the main contractor for erection or bracing purposes.

All reinforcement shall be supplied, bent and placed in accordance with the relevant clause of REINFORCING STEEL.

All metalwork and steelwork shall be supplied, fabricated and placed in accordance with the relevant clauses of STRUCTURAL STEELWORK.

The following clauses relating to precast concrete are in addition to, and are to be read in conjunction with the clauses of the CONCRETE - GENERAL section.

Specifically included are:

1) Precast stair flights,
3) Precast columns (cruciform sections),
4) Precast beams,
5) Precast walls.

3.3 RELATED DOCUMENTS

In this section of the specification, reference is made to the latest revisions of the following documents:

The New Zealand Building Code		(BIA)
NZS 3104	Specification for Concrete Production	(SNZ)
NZS 3109	Specification for Concrete Construction	(SNZ)
NZS 3112	Methods of test for Concrete	(SNZ)
NZS 3114	Specification for Concrete Surface Finishes	(SNZ)

Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products: 1985 (PCI)

Reference shall also be made to the sections of this Specification which apply to Concrete - General, Reinforcing Steel and Structural Steelwork.

3.4 QUALITY ASSURANCE

3.4.1 General

Manufacturing quality control shall be in accordance with PCI "Manual for Quality Control for Plants and Production of Prestressed Concrete Products".

It is the Contractor's responsibility to ensure that the construction of the precast units complies in all respects with the drawings and the specification.

The Contractor's quality assurance procedures should encompass all aspects of Precast concrete construction including, but not necessarily limited to:

1. Formwork quality.
2. Reinforcing steel placement.
3. Cast-in items.
4. Concrete quality.
5. Concrete finishes.
6. Handling and delivery.

The Contractor must advise the Engineer in writing the name of a suitably experienced and qualified representative to be responsible for checking all dimensions, reinforcing, steelwork, cast in fixings, cover and lifting devices before any precast unit is cast.

The representative shall review all shop drawings for dimensions, coordination with other trades, and consistency with the Contractor's elected construction sequence before submittal of any shop drawings to the engineer for review. ('Shop drawings' may include but are not limited to: cast-in items, precast elemental drawings and structural steel elemental drawings)

The nominated representative will be required to complete and sign a written check list for each precast unit. A copy of each completed check list is to be forwarded to the main contractor and the Engineer no more than 7 days after casting each item.

The format and detail of the check list will be agreed to in advance of construction by the Engineer and the Contractor.

The Contractor shall supply evidence to the Engineer in advance of the construction in accordance with NZS 3109:1997 Clause 6.10.

3.4.2 Inspection

The Engineer will inspect construction in accordance with NZS 3109:1997, Clause 1.3.

The Engineer or his/her representative may inspect the precast units at all stages of manufacture to ensure conformity with this Specification. Units which do not conform to the required tolerances, which show grout leakage, which have been damaged or which are otherwise defective shall be liable to rejection and may be used in the structure only at the Engineer's discretion. No repair work shall be done without specific instructions from the Engineer.

3.4.3 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this Producer Statement.

3.4.4 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the application to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

3.4.5 Certification of Precast Units

At two weekly intervals, the Contractor shall provide a certificate signed by a Chartered Professional Engineer, listing all components manufactured in the proceeding two weeks, and certifying that all these units have been manufactured in accordance with shop drawings reviewed by the Engineer and the requirements of the contract documents.

3.5 SHOP DRAWINGS

The Precast subcontractor shall prepare shop drawings of all precast components detailed on the drawings, showing full details of dimensions, layout, reinforcing, connections, inserts, lifting hooks, weld plates or other built in items.

The Structural drawings must be read in conjunction with all Architectural, Mechanical and Electrical drawings to ensure that all cast in items, rebates, and other features are included on the drawings to suit all following trades. Penetrations larger than 100 mm in diameter, at closer than 400 mm centres and not shown on the Structural drawings shall be notified to the Engineer before inclusion on the Shop drawings.

The Precast Contractor shall check all tolerances, and clearances between precast elements to ensure a satisfactory fit between all elements. Notify the engineer of any locations where tolerances or clearances need to be increased to ensure satisfactory construction procedures.

Each unit shall have a Mark No. shown on the shop drawing which shall be clearly identified on the completed unit.

Two hard copies of the shop drawings shall be submitted to the Contractor for forwarding to the Engineer for review, and 10 working days allowed for shop drawing review and approval, prior to commencing fabrication. Any variations between the contract drawings and shop drawings shall be clearly identified and brought to the attention of the Engineer for specific approval.

The drawings shall be reviewed by the Engineer for design concept and general arrangement only. Dimensional accuracy and adequacy of the shop drawings remains the Contractor's responsibility, also refer to clause 4.4.1 above. Approval of drawings from the Engineer shall be obtained prior to manufacture of the precast units.

3.6 MATERIALS AND WORKMANSHIP

3.6.1 General

All materials and workmanship shall be in accordance with the relevant clauses of CONCRETE - GENERAL except where noted otherwise in this section.

3.6.2 Tolerances

All precast units shall be manufactured to the following tolerances, unless otherwise stated on the drawings:

Length	± 6 mm
Cross section	± 3 mm
Squareness (of cross sections and ends)	± 3 mm
Twist (dimension from plane containing other 3 corners)	± 5 mm
Built in items, typically:	± 5 mm

Where more stringent tolerances are required, they are generally shown on the drawings. The above tolerances are given as a guide. Their application in any particular case shall be subject to interpretation by the Engineer.

Notify the Engineer of any locations where tolerances or clearances need to be increased to ensure satisfactory construction procedures.

3.6.3 Marking

Mark all units with mark number, orientation in the finished job and date of casting. The marking shall not be permitted to affect the final finish.

3.6.4 Curing

All concrete shall be cured as defined in NZS 3109, Clause 7.8. For concrete elements with exposure classifications A1, A2 and B1, the minimum curing period for all faces of the concrete shall be 3 days. Where a higher exposure classification is specifically noted on the drawings, the minimum curing period shall be 7 days.

The use of plastic curing compounds as an alternative to water curing shall be as agreed with the Engineer specifically for each occasion before it is used. The Contractor shall be responsible for ensuring that the curing compound proposed is compatible with subsequent floor covering or paint finish.

If the precast contractor opts to provide less curing than required by NZS3109, the precast contractor shall provide details of how the mix design shall be adjusted to ensure the minimum durability requirements of NZS3101 will be met, in conjunction with the proposed alternative curing regime.

3.6.5 Handling

A high standard of finish is required and handling shall be such as to prevent any damage to units before and during placement on site.

Approved lifting devices or hooks shall be provided in all precast units, and these shall be made available to the contractor for erection purposes and removed cleanly after use. The Contractor shall ensure lifting hooks are adequately placed for erection purposes, and that precast components are adequately reinforced for the loads imposed by the intended lifting and erection methods. Any additional reinforcement required for erection loads shall be provided at the Contractor's cost. The safe design and placement of lifting hooks on devices is the responsibility of the Precast Concretor.

Units shall be handled only by hooks or devices provided. Where lifting eyes are not provided, units shall be handled at their ends by clamps or fabric strops. When used strops must not be more than 300 off vertical.

Details of lifting hooks and devices, and their positions, shall be submitted to the Engineer for review before manufacture commences. Lifting hooks and devices set permanently in the units shall have a safety factor of at least 4, and for repetitive use shall have a safety factor of at least 6. Care shall be exercised at all times that hooks or devices suffer no bending or other damage. Any lifting device which has been damaged shall not be used.

Worksafe NZ may require a design certificate for the lifting eyes or devices. If a design certificate is called for then this shall be provided by the Precast Concretor or an engineer engaged by the Precast Concreter. The safe design and placement of lifting hooks on devices is the responsibility of the Precast Concretor. Care shall be exercised at all times that hooks or devices suffer no bending or other damage.

Precast units shall be loaded and transported so that no forces are applied in excess of those occurring during normal lifting. Twisting forces shall not be permitted to occur. Units shall be strapped and secured to prevent movement or damage during transportation.

Units damaged during handling are to be inspected by the Engineer prior to being placed in the structure. Damaged units may be rejected by the Engineer. All repairs are to be made at the Contractor's expense.

Precast elements are to be kept clean of mud, grease or loose material that will affect surface finish, bonding to insitu concrete, or reduce contact area for bearing.

3.6.6 Delivery Programme

Allow to cast units so that they are ready for inspection by the Engineer at least two weeks before required delivery to site. The Contractor shall be responsible for notifying the Engineer when units are ready for inspection. Units shall be stored at the Precast Concretor's factory or other suitable location so as to facilitate a thorough check of the units by the Engineer and Architect.

3.6.7 Stacking

Precast units shall be stacked on timber dunnage and suitable soft packing, but not pinex, placed under the lifting points. Stacking shall at all times be such as to minimise the effects of creep and to avoid undue distortion of beams.

Units shall be stacked on an area capable of withstanding the bearing pressures involved without undue settlement, and in such a way that no damage shall occur to the units, lifting hooks, and to other embedded items.

3.6.8 Repair Work

Repair work on precast elements is to be carried out only on the instruction or under the supervision of the engineer or his representative.

All materials used for this work are to be specified or approved by the engineer or his representative.

3.6.9 Co-ordination

The Contractor shall ensure the correct finished relationship, both as to dimensions, details, and such finishes, between precast concrete and all other surrounding work.

3.6.10 Ducts

Where noted on the drawings, ducts are to be "Drossbach" or "Uniflex" corrugated duct,

Grout tubes shall be incorporated as necessary, to ensure that the ducts may be fully grouted. Where grout tubes exit on the outer face, recess the concrete to enable them to be cut off below the surface.

Extreme accuracy is required for the placing and tying of the ducts, to ensure that the ducts will readily fit over the protruding reinforcing on site. Note that cover requirements for reinforcing generally will be extended for the ducts also, and any stirrups which may pass around them.

Ensure concrete does not leak into the grouting system during casting of the units.

3.7 SPECIFIC ITEMS

3.7.1 Precast Beams

3.7.1.1 Submittals

Formwork for all precast beams and casting techniques shall be fully discussed with the Engineer and Architect before commencing manufacture and shall be subject to approval.

For post-tensioned beams the manufacturer shall supply to the Engineer a full description of the post-tensioning system with sufficient dimensional drawings to indicate detailing requirements, before manufacture.

3.7.1.2 General

Before preparing shop drawings, review the beam drawings to become familiar with the implied tolerances in the insitu stitch joints at the column cruciform. Advise the Engineer if tolerances need to be increased to ensure satisfactory construction procedures.

Accuracy in bending and fabricating the beam reinforcing cage is imperative to ensure fit and minimum covers. Templates for reinforcement projecting from precast beams shall be used to ensure alignment with projecting column cruciform reinforcement. Preassembly of the reinforcing cage at least of the initial units of each type, is recommended as cover requirements will be insisted upon.

3.7.2 Precast Columns

3.7.2.1 Submittals

Formwork for all precast columns and casting techniques shall be fully discussed with the Engineer and Architect before commencing manufacture and shall be subject to approval.

3.7.2.2 General

Before preparing shop drawings, review the column drawings to become familiar with the implied tolerances in the beam-column joint and the insitu stitch joints constructed on site between the precast beams and column cruciform sections. Advise the Engineer if tolerances need to be increased to ensure satisfactory construction procedures.

Accuracy in bending and fabricating the column cruciform reinforcing cage is imperative to ensure fit and minimum covers. A preassembly test case of the reinforcing cages of columns and beams at least of the initial units of each type, is recommended. Reinforcement bars projecting into stitch joints from the cruciform sections shall be constructed using templates to ensure reinforcement bars align with matching beam bars within the joints.

3.7.3 Precast Tilt Up Wall Panels

3.7.3.1 General

If panels are cast on site it will be necessary for the contractor to pre-plan all operations involving the construction, handling, placing, and fixing of all wall panels. The proposed casting layout and erection procedure shall be to the Engineer's approval. Generally the panels shall be cast with the outside face on the slab. After the panels have gained minimum strength they shall be lifted into position and fixed in accordance with the drawings.

3.7.3.2 Casting Surface and Set Out

The floor slab on which the panels are to be cast shall be free from all dirt, moisture, pit-holes etc, and must be level to 4 mm in 3 metres. Indentations in the casting surface shall be made good with plaster of paris or other approved fillers. Panels shall be cast in positions suitable for construction access. Where panels are cast over sawcuts or construction joints the sawcuts and joints shall be filled with plaster of paris or similar and lightly ground smooth.

3.7.3.3 Parting Compound

When the panel forms are complete and before reinforcement and fixings have been placed the casting bed shall be thoroughly cleaned and sprayed with a parting compound approved by the Engineer. A uniform film of compound shall be placed in accordance with the manufacturer's recommendations over the entire area. No foot or other traffic will be allowed on the parting compound. Touching up shall be completed prior to pouring.

3.7.3.4 Reinforcement

The reinforcing steel shown on the drawings shall be placed in the form of a mat after the parting compound has been applied. All such mats shall be supported on chairs or approved supports and shall be sufficient in number to ensure that the steel remains at the correct cover during pouring. All fittings shall be positioned and tied in accordance with the drawings.

3.7.3.5 Lifting Inserts

Lifting inserts shall be Swiftlift or approved alternative. All inserts shall be fixed so that no lateral movement is possible during pouring.

3.7.3.6 Concreting

During each pour a minimum of 4 test cylinders shall be taken at regular intervals during the pour.

The cylinders shall be cured on site under the same conditions as the panels. Prior to erection half of the cylinders shall be tested, usually at a minimum of 14 days after pouring. A minimum strength of 25 MPa is to be attained before erection.

During casting walkboards shall be provided to keep all traffic off the casting bed. Each panel shall be cast in one operation without interruption and shall be mechanically vibrated with a vibrating screed over all sections of the panel. When firm, the panels shall be power floated to a smooth uniform surface.

Panels shall not be poured in inclement weather and shall be coated with an approved curing compound immediately after power floating.

3.7.3.7 Panel Seating and Grouting

Pre-level steel shim plates on top of the foundation beams ready to receive the tilt panels. Seal the joint at the base of the panels and grout the joint and the starter bar ducts as previously specified.

3.7.3.8 Handling and Erection

Confirm concrete strength, on the basis of compression tests on concrete from the panels, before lifting any panels.

Any panels that have cracked prior to lifting shall be liable for rejection by the Engineer and recasting.

When lifting the precast wall panels from their casting beds take all steps necessary to ensure no cracking or other damage occurs during lifting of panels from beds and subsequent handling.

3.7.3.9 Sealing

Provide and install elastomeric sealant such as Silaflex MS or Sikaflex AT-Facade in all joints as shown on the drawings. Apply strictly in accordance with the manufacturers recommendations. Finish all joints slightly concave.

Mortar pack joints in the wall as shown on the drawings and point concave.

3.7.4 Precast Stairs

4.0 CONCRETE - PRECAST PROPRIETARY FLOORING

4.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all Trades. This section of the Specification shall be read in conjunction with all other sections.

4.2 SCOPE

4.2.1 General

This section of the Contract consists of the design, manufacture and supply to site of precast proprietary flooring units complete with all reinforcement, stressing strands and wires and timber infill pieces.

Note that ties will always be required from the precast flooring to the topping, in accordance with NZS 3101 (clause 18.5.5). These areas will be marked on the plans.

The type and extent of flooring is as shown on the plans.

4.2.2 Alternative Systems

Alternative systems may be accepted, providing the requirements of the following clauses are met and providing that the cast-in-place topping that forms part of the alternative system has the same thickness and reinforcement as that detailed. Details of alternative floor systems must be submitted during the tender period for approval by the Engineer. Alternative flooring systems will only be considered if they have a similar appearance to the system detailed and are not significantly heavier than the floors detailed on the drawings.

4.3 RELATED DOCUMENTS

In this section of the specification, reference is made to the latest revisions of the following documents:

The New Zealand Building Code		(BIA)
NZS 1170	Structural Design Actions	……..(SNZ)
NZS 3101	Design of Concrete Structures	(SNZ)
NZS 3104	Specification for Concrete Production - High Grade and Special Grade	(SNZ)
NZS 3109	Specification for Concrete Construction	(SNZ)
NZS 3112	Methods of test for Concrete	(SNZ)
NZS 3114	Concrete Surface Finishes	(SNZ)
Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products: 1985.		(PCI)

Reference shall also be made to the sections of this Specification which apply to Concrete - General & Precast, Reinforcing Steelwork And Structural Steelwork.

4.4 QUALITY ASSURANCE

4.4.1 General

In addition to the provisions of CONCRETE - PRECAST, this section of the contract includes site inspections by the Precast Proprietary Floor and Shell beam manufacturers, and regular reports to the Engineer.

The Contractor shall nominate an engineer who will co-ordinate and take responsibility for this inspection work.

Regular, bi-weekly site inspections shall be made and a brief written report given to the Engineer to the project. Items for checking would include seating dimensions and tolerances, cracked or damaged units, backpropping and any other matters that could affect the structural integrity of the finished floor.

The Contractor shall supply evidence to the Engineer in advance of the construction in accordance with NZS 3109:1997 Clause 6.10.

4.4.2 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this producer statement.

4.4.3 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the application to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

4.5 DESIGN REQUIREMENTS

4.5.1 Flooring

- The design of all flooring shall be in accordance with the New Zealand Building Code, in particular Approved Documents B1 (Structure) and B2 (Durability).

- The flooring shall be designed and constructed in accordance with AS/NZS 1170, NZS 3101 and NZS 3109 and in accordance with accepted engineering practice, to support the following loads, in addition to its self-weight:

ZONE 1 (Anchor Tenant):

Live Load

Plant rooms	7.5 kPa (7 kN point load)
Level 1 suspended slab typically	5.0 kPa (7 kN point load)
Level 2 suspended slab typically	4.0 kPa (4.5 kN point load)

Superimposed Dead Load

Level 1 suspended slab typically	1.5 kPa
Level 2 suspended slab typically	2.0 kPa

ZONE 2: (Mall)

Live Load

Plantrooms	7.5 kPa (4.5 kN point load)
Level 1 slab typically	5.0 kPa (4.5 kN point load)

Superimposed Dead Load

Level 1 suspended slab typically	1.0 kPa
Balconies	2.0 kPa

ZONE 3: (Carpark)

Live Load

Plantrooms	7.5 kPa (13 kN point load)
Typical suspended slabs u.n.o.	2.5 kPa (13 kN point load)
Level 5 suspended slab	5.0 kPa (13 kN point load)
Lift and Stair Lobbies	4.0 kPa (13 kN point load)

Superimposed Dead Load

Typical suspended slabs u.n.o.	0.5 kPa
Level 1 suspended slab	0.75 kPa
Floor units lowered 50mm (allows for drainage fall screed) **this SDL is in addition to above SDL's**	1.0 kPa
At 100mm high kerb locations (shown on Architects drawings) **this SDL is in addition to above SDL's**	2.4kPa

- Façade Loads:

  Double Tee floors shall be designed to support an additional superimposed dead load of 2kN/m for the full length of Grid 3A (i.e. weight of façade to north face of carpark Zone 3).

- In addition floors shall be designed to support all insitu edge strips, concrete nibs, infill sections and construction loads.

- Generally all floor systems shall have a minimum Fire Resistance Rating (F.R.R.) of 1.0 hour unless noted otherwise on the drawings.

- Floors over the Zones 1 and 2 substations shall have minimum Fire Resistance Rating (F.R.R.) 2 hours.

- Zone 3: The floor system shall have a cast-in-place reinforced concrete topping screed 80mm thick unless noted otherwise. At drainage locations around the perimeter of the building and at one location centrally in the building the floor units have been set-down 50mm to allow for drainage falls as shown on the drawings. Thickness of concrete topping at these locations varies from 130mm maximum to 80mm minimum. The topping shall act as a structural diaphragm and provide a wearing surface. Surfaces on which the topping is poured shall conform to NZS 3101 (Clause 13.4.3 or 18.5.4.1 where applicable).

- Zone 1: The floor system shall have a cast-in-place reinforced concrete topping screed 90mm thick unless noted otherwise. At drainage locations at level 2 (Childcare Centre outdoor area) the floor units have a topping thickness that varies with falls. Thickness of concrete topping at these locations varies from 165mm maximum to 80mm minimum. The topping shall act as a structural diaphragm and provide a wearing surface. Surfaces on which the topping is poured shall conform to NZS 3101 (Clause 13.4.3 or 18.5.4.1 where applicable).

- The floor system shall be temporarily propped during construction in accordance with the manufacturers layout drawings.

- The insitu topping shall be cast to a camber if necessary (in accordance with Concrete - General : Floor Toppings) so that the surface of the finished floor shall be within L/500 of level after removal of any temporary propping and four to eight weeks after construction.

- Design of the floor shall be such that deflection due to live load shall not exceed L/400.

- No holes are to be made in the floor and no services accommodated within the structural topping concrete unless shown on the manufacturers layout drawings.

- Cast in holes for drainage fittings, service pipes, conduits etc where shown on the Architects drawings.

- The floor system shall meet the durability provisions of the New Zealand Building Code for the full design life of the building, being not less than 50 years.

4.6 SHOP DRAWINGS

The Contractor shall produce Shop drawings generally in accordance with the Concrete – Precast section of this specification.

The following information shall be provided on the drawings:-

1. Full component and layout drawing showing all setdowns, cutouts, reinforcing, connections, inserts, lifting hooks, weld plates or other built in items. Floor plans are to show the layout arrangement and mark number of each component. Indicate surfaces to be roughened where insitu concrete will subsequently be cast against them.
2. Drawings must be fully dimensioned and indicate accurately details of the supporting structure.
3. Propping requirements, whether required by the Engineer or the manufacturer.
4. Nominal seating length and minimum acceptable seating length.

The Structural drawings must be read in conjunction with all Architectural, Mechanical and Electrical drawings to ensure that all cast in items, rebates, and other features are included on the drawings to suit all following trades.

4.7 SUBMITTALS

4.7.1 Flooring

The Contractor must supply the following information at least 14 days prior to precasting of any units:

1. Two hard copies of the shop drawings. It is the floor manufacturer's responsibility to provide these drawings as required by the Contractor.
2. Average self weight of floor system.
3. Propping locations and precambers required during construction (if any).
4. Reinforcing requirements for the cast-in-situ topping. The minimum acceptable reinforcing is HD10 at 200 ew or its equivalent, and must extend over all beams. Heavier reinforcing and saddle bars are shown on the drawings where required by the Engineer to satisfy other design requirements. This in no way alleviates the flooring manufacturers responsibility to indicate such extra steel as they may require.
5. Design calculations to satisfy the design requirements listed above.
6. Documentation of fire resistance rating.
7. Documentation of Durability rating.
8. Place of manufacture and method of transportation.

Approval of drawings from the Engineer shall be obtained prior to manufacture of floor units.

The Contractor shall provide any further drawings and calculations as required to satisfy the checking authority for the consent.

4.8 MATERIALS AND WORKMANSHIP

4.8.1 General

All materials and workmanship shall be in accordance with the relevant clauses of CONCRETE - PRECAST GENERAL except where noted otherwise in this section.

4.8.2 Tolerances

All precast units shall be manufactured to the following tolerances, unless otherwise stated on the drawings.

Length	± 6 mm
Cross Section	± 3 mm
Squareness (of cross sections and ends)	± 3 mm
Twist (dimension from plane containing the other 3 corners)	± 5 mm
Built in items	± 5 mm

The above tolerances are given as a guide. Their application in any particular case shall be subject to interpretation by the Engineer.

4.8.3 Finishes

Where the undersides of the floors will be visible in the finished job, a very high standard of finish will be required. Surface finish shall comply with NZS 3114 to a F5 finish.

Concrete surfaces shall have a minimum of grout leakage or honeycombing, and no conspicuous offsets or bulges. Any units showing defects which may in the opinion of the Engineer adversely affect the strength or serviceability of the flooring system will be rejected.

5.0 REINFORCING STEEL

5.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract which are equally binding on all Trades. This section of the Specification shall be read in conjunction with all other sections.

5.2 SCOPE

This section of the Contract refers to the supply, bending and placing of all reinforcing for concrete and reinforced blockwork including distance pieces and spacers.

Supply, bending and placing of reinforcing for precast, piling and blockwork may be carried out by the respective subcontractors. However, the reinforcing steel provided shall strictly comply with this section of the specification.

5.3 RELATED DOCUMENTS

In this section of the Specification, reference is made to the latest revisions of the following documents:

The New Zealand Building Code

NZS 3109	Specification for Concrete Construction
NZS 4671	Steel Reinforcing Materials
AS/NZS 1554.1	Structural Steel Welding: Part 1: Welding of Steel Structures
AS/NZS 1554.3	Structural Steel Welding: Part 3: Welding of Reinforcing Steel
BS 5896	High tensile steel wire and strand for the prestressing of concrete.

Reference shall also be made to the sections of this specification which apply to Piling and Structural Steelwork.

5.4 QUALITY ASSURANCE

5.4.1 General

It is the Contractor's responsibility to ensure that the reinforcement placed complies in all respects with the drawings and the specification. The Contractor will be required to nominate a Foreman reinforcing steelplacer, or equivalent, for approval by the Engineer before commencement on site. The Foreman reinforcing steelplacer shall inspect all completed sections of reinforcing steelwork and advise the main contractor that he is satisfied that the work has been carried out in accordance with the drawings and specification.

The Foreman reinforcing steelplacer will be required to sign a prepour reinforcing check list prepared by the main contractor prior to concrete being placed for that section of the works.

A copy of the completed prepour checklist is to be given to the Engineer prior to the Engineer observing the finished section of work.

5.4.2 Inspection

The Engineer shall be informed when reinforcement is being fixed and given a reasonable opportunity to inspect the fixed reinforcement before pouring commences.

5.4.3 Supervision

The Contractor shall be represented on site by a competent leading hand (reinforcing) while steel is being placed.

During pouring, the Contractor shall have appropriately skilled personnel on call to identify and correct any damaged or displaced reinforcing.

5.4.4 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor (and his subcontractors) shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this Producer Statement.

5.4.5 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

5.4.6 Testing

The Contractor shall demonstrate to the Engineer that all reinforcement complies with the Specification and produce manufacturer's certificates and certificates of origin to the Engineer. Should such certificates indicate that the requirements of this Specification may not be met; the Contractor shall pay for such tests as the Engineer may decide are necessary to establish that this steel does meet this specification.

5.5 MATERIALS AND WORKMANSHIP

All materials and workmanship shall conform to the requirements of NZS 3109.

5.5.1 Reinforcing Steel

Grade 300E and Grade 500E reinforcement shall comply with AS/NZS 4671.

All reinforcement shall be manufactured by Pacific Steel Ltd using the microalloy process. Alternative reinforcing may be approved by the Engineer, but only for specific non-structural situations.

Reinforcing mesh shall be hard drawn steel wire fabric to AS/NZS 4671. The finished fabric shall comply in all other respects with AS/NZS 4671.

5.5.2 Prestressing Steel (Prestressed Floor Units)

Hard drawn steel wire and strands made up of stress-relieved cold drawn wire shall comply with BS 5896.

The prestressing strands shall be clean and free from base rust. Rust which is superficial shall be accepted as being acceptable but steel which has corroded to the extent of surface pitting visible to the naked eye shall be rejected.

Prestressing strands shall be 12.5/12.9 mm superstrand, with an ultimate tensile load of 165/192 kN per strand.

5.5.3 Galvanising

Where reinforcing bars are shown on the drawings to be hot dip galvanised, bars shall be galvanised before bending to give a coating of at least 700 grams per square metre.

5.5.4 Bending of Bars

Bars shall be cut and bent according to NZS 3109 Section 3 and to the dimensions and shapes shown or indicated in the drawings. Bend diameters for longitudinal reinforcing shall be in accordance with clause Bend Diameters. Stirrups shall be bent to standard shapes as shown in NZS 3109. Note that larger bend diameters are required around ducts, and at mechanical splices using swaged couplers.

Cranks or sets at laps shall have their inclined portions 12 diameters or a minimum of 300mm long unless specifically shown otherwise.

5.5.5 Bending Schedules

Bending schedules are not included in the documentation for this contract. It is the REINFORCING STEELWORKER'S responsibility to supply a Bending Schedule to be checked by the Contractor before bending and cutting. The Contractor shall be responsible for bringing to the notice of the Engineer discrepancies in the drawings, before cutting and bending.

5.5.6 Bend Diameters

Unless otherwise noted on the drawings, main reinforcing bars shall be bent to the following internal diameters.

Steel grade	Bar size	Minimum bend diameters
300 and 500E	6 - 20	5 bar diameters
	24 - 40	6 bar diameters

Bend diameters for stirrups and ties shall be to suit the diameter of the enclosed bar with a minimum of 2 bar diameters for plain bars and 4 bar diameters for deformed bars.

5.5.7 Bar Numbering

All bundles of steel supplied to the job shall be clearly marked with numbers relating to the Bending Schedule and related drawing.

5.5.8 Abbreviations

Bar diameters are prefixed with the following:

D	deformed grade 300E bar
R	plain grade 300E bar
HD	deformed grade 500E bar
HR	plain grade 500E bar

Abbreviations on the drawings are as follows:

e.f.	each face
n.f.	near face
f.f.	far face
reinf.	reinforcement
c.j.	construction joint
crs	centres
stgd	staggered
e.w.	each way
stps	stirrups
t.	top
b.	bottom
Tt	top (top)
Tb	top (bottom)
Bt	bottom (top)
Bb	bottom (bottom)
alt.	alternate
strs.	starters
cis	cast-in sockets
U.N.O.	unless noted otherwise

5.5.9 Cover

Minimum cover shall be as noted on the drawings or otherwise as specified in the table below. Note that generally covers are greater than specified in NZS 3109.

The ends of wire ties shall be turned away from the concrete face to maintain cover. Wire ties shall not be tied to formwork.

Position	Component	Type of reinforcement	Cast insitu	Precast (manufactured under plant conditions)
Cast on or against ground	All components	All reinforcing, prestressing tendons or ducts	85	-
Not exposed to the weather or in contact with the ground	Beams and Columns	Principal Reinforcement	50	45
		Prestressing tendons or ducts	50	40
		Secondary reinforcement, including stirrups, ties and spirals	35	30

	Walls, slabs, panels and ribs	40 mm and larger reinforcing bars and prestressing tendons or ducts	50	45
		24 mm to 32 mm reinforcing bars	40	35
		20 mm or smaller reinforcing bars or wire	30	25
	Shells and folded plate members	20 mm or larger reinforcing bars, and prestressing tendons or ducts	30	30
		16 mm or smaller reinforcing bars or wire	30	25
Cast against formwork and exposed to weather or in contact with the ground	Foundations	Principal Reinforcement	60	-
		Secondary reinforcement, including stirrups, ties and spirals	50	-
Exposed to the weather	Beams and Columns	Principal Reinforcement	50	50
		Prestressing tendons or ducts	50	50
		Secondary reinforcement, including stirrups, ties and spirals	40	40
	Walls, slabs, panels and ribs	24mm or larger reinforcing bars,and prestressing tendons or ducts	50	50
		20 mm or smaller reinforcing bars or wire	40	40
	Shells and folded plate members	Reinforcing bars and prestressing tendons or ducts	40	40

5.5.10 Tolerances

Tolerances for bending and fixing of reinforcing steel and fixing of prestressing tendons, ducts and strands shall comply with NZS 3109.

5.5.11 Laps in concrete

Position of laps are generally shown on the drawings. The positions of laps other than those detailed shall be discussed and agreed with the Engineer before fabrication.

All lapping bars shall be tied to each other.

Lap lengths shall generally be as detailed on the drawings, but in any case not less than 300mm. Where laps have not been specifically detailed, laps shall comply with the table below.

Bar diameter	Grade 300 deformed	Grade 500E deformed
10	400	600
12	500	700
16	600	900
20	800	1200
25	1000	1600
32	1300	2000

Lap lengths for plain round bar shall be two times the length given in the table above for the corresponding grade of deformed bar.

5.5.12 Laps in blockwork

In blockwork lap lengths shall be a minimum of 450 mm long and not less than that given below, unless specifically noted otherwise:

Grade 300 reinforcing: 40 bar diameters

Grade 500E reinforcing: 70 bar diameters

All lapping bars shall be tied to each other.

5.5.13 Welded Splices

In all cases, approval for welded splices shall be obtained from the Engineer before use. Procedure testing will be required for butt welds, with subsequent field testing, all to be carried out at the cost of the subcontractor.

5.5.14 Mechanical Splices for Bars

Mechanical splices shall be approved by the Engineer before use. In general they shall be capable of developing 1.6 times the yield strength of the larger bar being spliced.

Bars to be mechanically spliced as shown on the drawings shall be joined by using Reidbar Steel Couplers.

Splices shall use the appropriate sleeve size and length for the bars being spliced, as specified by the manufacturer, and shall be swaged onto the reinforcing bars in accordance with manufacturer's instructions, and using the correct die and hydraulic press as specified by the manufacturer of the splices. If screwed couplers are used, these shall also be installed in accordance with manufacturer's instructions.

The Contractor is responsible for ensuring that splice sleeves are properly swaged to bars and shall notify the Engineer so that the swaged splice sleeves may be inspected.

The Engineer may require tests of mechanical splices at the Contractors expense. The Contractor shall arrange and pay for testing and reporting as required.

5.6 FIXING

5.6.1 General

The Contractor shall comply fully both on and off site with the provisions of the New Zealand Building Code in all matters relating to construction safety, in particular with Approved documents F1 (Hazardous Agents on Site), F2 (Hazardous Building Materials), F4 (Safety from Falling), and F5 (Construction and Demolition Hazards).

Steel fixing shall conform to NZS 3109. Bars shall be positioned accurately according to the drawings and securely tied with wire ties to form a rigid cage. Particular attention shall be paid to the correct lapping of all steel and laps shall be checked after fixing.

Reinforcing steel shall not be cut or bent on site without the Engineers specific approval.

Supply and fix all necessary distance pieces and spacers to maintain cover. Distance pieces shall be wired-on concrete spacer blocks, ABIT plastic pieces or similar. Concrete spacer blocks must be accurately made to the appropriate dimensions with a minimum strength of 40 MPa.

Where the formed surface may be visible in the completed work, care shall be taken to select a form of spacer which shall have a minimum of impact on the exposed surface.

Slab steel shall have the bottom layer supported on distance pieces. Purpose made wire chairs or plastic chairs seated on the formwork are the preferred means of supporting the top layer of slab steel. All spacers must be securely tied with wire ties to ensure they are not dislodged during concreting and at sufficiently close centres to ensure the correct cover is maintained, and that they are in general located over distance pieces supporting the bottom mat.

Column and beam steel shall be securely tied to ties or links and shall have distance pieces to the formwork.

Wall steel shall be spaced off the forms with ABIT plastic pieces or similar and maintained at the correct spacing.

The system of distance pieces and spacers to be used shall be such as to firmly hold the steel against all reasonable Contractor's traffic. It shall be discussed in advance with the Engineer, and be to his approval. In general distance pieces and spacers shall be at a maximum of 1200mm centres each way and less where mesh is used.

All starters and other reinforcing protruding from a concrete pour shall be securely braced to prevent movement in the wet concrete. Starters are NOT to be placed into concrete after it has been poured.

5.6.2 Concrete

Supply and place all reinforcing for concrete as detailed on the drawings. Co-operate with the CONCRETOR and fit in with the programme for construction sequence. All starters shall project the minimum distance prescribed for lap lengths unless detailed otherwise, and shall be securely braced to prevent movement in the wet concrete.

Straighten and clean all starters bent during concreting before placing steel for subsequent pouring.

5.6.3 Blockwork

Supply and place all reinforcing steel for blockwork as detailed on the drawings. Set out starters to suit block module layout. Vertical steel, including starters should be central, unless noted otherwise. All starters shall project the minimum distance prescribed for lap lengths unless detailed otherwise. In

general vertical steel shall be placed in advance of blocklaying and temporary braces provided as necessary. BLOCKLAYER will build to this steel with open ended blocks. Horizontal steel shall be placed in bond beams as blocklaying proceeds and shall be securely tied to vertical steel.

In the event of starters being placed out of position, bars are NOT to be bent over into position. The Engineer shall be notified and will provide a remedial detail, which may involve drilling and epoxy grouting of new starters.

5.6.4 Concrete Topping Reinforcement

Supply and place reinforcing to the toppings over precast concrete floor units as detailed. Reinforcing shall adequately lap at all edges.

All reinforcing to extend to within 75 mm of the perimeter of the building floor edges. Cut around columns so that reinforcing projects approximately 50 mm into the column.

Reinforcing shall be continuous over beams unless additional compensating lapping bars are placed across the top of beams to lap with the reinforcement each side. Unless noted otherwise, all saddle bars and other steel shown over the beams on the drawings are additional to the basic topping reinforcement and cannot be included in the required area of compensating steel.

Place topping tie bars as detailed on the drawings. Tie bars shall not be placed in the joints between precast floor units, and shall fully engage the topping reinforcement.

5.6.5 Cleaning Steel

Reinforcement as fixed shall be cleaned to remove any material which adversely affects the bond to concrete. Any mould oil on the steel shall be thoroughly cleaned off before concrete is placed.

Clean all starter bars before placing steel for subsequent pouring.

5.6.6 Welding of Bars

5.6.6.1 General

Welding of all reinforcing bars shall comply with the requirements of AS/NZS 1554.3 and the Structural Steelwork section of this specification.

Reinforcing bars shall not be welded in any way unless detailed on the drawings or prior approval is specifically given by the Engineer. Generally, approval will not be given for welding reinforcement which does not comply with AS/NZS 4671.

The acceptance level for welds shall be in accordance with the requirements of NZS 1554.1 - Class SP.

Site welding shall only be undertaken using Hydrogen controlled electrodes. No site welding shall be permitted in wind velocity exceeding 10 m/s, or rain, and shall not be undertaken without proper protection. Preheating of bars to be joined is required if the metal surface is damp or the metal surface is below 10 degrees, and otherwise to the requirements of NZS 1554.3, clause 4.11.

5.6.6.2 Welding Inspection

Refer to the Structural Steelwork section of this Specification for clauses relating to welding inspection and defects.

5.6.7 Heating of Reinforcement

Heating of grade 300 and grade 500E bar may be carried out with the prior permission of the Engineer, and then only according to specific procedures issued at the time.

6.0 CONCRETE BLOCKWORK

6.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all Trades. This section of the Specification shall be read in conjunction with all other sections.

6.2 SCOPE

This Section of the Contract consists of the supply and laying of all concrete blockwork, placing reinforcing and filling with grout. All block walls are reinforced. Reinforcing is specified in REINFORCING STEEL.

Supply and laying of brick veneers, including veneer ties, is specified under BRICKWORK.

6.3 RELATED DOCUMENTS

In this section of the Specification, reference is made to the latest revisions of the following documents.

The New Zealand Building Code		(BIA)
NZS 4455	Masonry Units and Segmental Pavers	(SNZ)
NZS 3104	Specification for Concrete Production High Grade and Special Grade	(SNZ)
NZS 4210	Code of Practice for Masonry Construction: Materials and Workmanship	(SNZ)
NZS 4230	Design of Reinforced Concrete Masonry Structures	(SNZ)

Reference shall also be made to the sections of this Specification, which apply to Reinforcing Steel, and Concrete.

6.4 QUALITY ASSURANCE

6.4.1 General

It is the Contractor's responsibility to ensure that the construction of all blockwork complies in all respects with the drawings and specification.

Before blocklaying commences on site, the Contractor shall advise the Engineer in writing, the name of the Licensed Building Practitioner who will be responsible for the blockwork. The Contractor shall ensure that the Licensed Building Practitioner is on site in a Foreman capacity at all times and shall satisfy the Engineer that the standards of construction are being continuously monitored and maintained. The Licensed Building Practitioner will be required to complete and sign a written control check list prior to any grouting of blockwork. The format and detail of a check list shall be agreed by the Contractor, prior to the commencement of any blocklaying.

The check list will encompass all aspects of blockwork construction including, but not necessarily limited to:

1. Block and mortar quality

2. Reinforcing steel placement
3. Cleaning of blockwork and reinforcing steel
4. Grouting

A copy of each completed checklist is to be forwarded to the Engineer no more than 7 days after completion of the grouting.

All blockwork may be subject to inspection by the Engineer to check that the requirements of this Specification have been met. The blocklaying sub-contractor shall, as requested, make samples for strength tests on mortar and filling concrete as in NZS 4210, Appendices A and B.

The blocklayer shall advise the Engineer at least 24 hours prior to a pour so that an inspection can be made.

6.4.2 Inspection

The Engineer will inspect construction in accordance with NZS4210, clause 1.4, as appropriate for the nominated grade of masonry. Unless otherwise noted herein or on the drawings, all blockwork should be assumed to be grade B masonry in accordance with NZS4230, clause 3.3.2. Before grouting any sections of the blockwork, the Engineer shall be notified and a reasonable opportunity given to inspect.

Where necessary, the Engineer's instructions shall be carried out before grouting any blockwork.

6.4.3 Producer Statement

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor (and his subcontractors) shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A of this specification for additional explanation and an example of this Producer Statement.

6.4.4 Code Compliance Certificate

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

6.5 MATERIALS AND WORKMANSHIP

6.5.1 General

Materials and workmanship shall comply with NZS 4210 unless noted otherwise herein.

Blockwork shall be erected only under the direction of a Licensed Building Practitioner employed by a Contractor specialising in the laying of concrete blocks. Blockwork in this contract is classified as design Grade B, in accordance with NZS 4230.

6.5.2 Blocks

All concrete blocks shall be of Vibrapac pattern from an approved manufacturer, in accordance with NZS 3102. Blocks shall be of an approved standard grey colour, properly cured, square and true to shape and size. Blocks shall be manufactured from standard aggregates to NZS 3121; lightweight aggregate blocks shall NOT be used.

Excessively damaged or otherwise irregular blocks will NOT be accepted.

Where block types are not shown on the Drawings, the blocks used shall be such as to achieve the joint patterns shown on the Drawings and be capable of being placed to suit reinforcing or steelwork already in place. Standard lintel blocks are to be used over openings.

Blocks shall be cut as necessary, to fit dimensions or to suit reinforcing. Cutting shall be done by means of a special hydraulic block cutting machine or carborundum saw and exposed edges shall be clean, square and even.

6.5.3 Mortar

Mortar shall conform with NZS 4210, clause 2.2. Special attention must be paid to sand grading, and mix proportions of 1 part cement to 3 parts sand are recommended.

Approved workability additives may be used.

Allow to test mortar in accordance with Appendix 2.A of NZS 4210. A test sample of no less than three cylindrical specimens shall be taken for at least every 450 sq.m of wall filled (measured on one face only).The results of these tests shall be submitted upon request to the Engineer for approval.

6.5.4 Grout

Grout shall be 20 MPa coarse grout in accordance with NZS 4210, clause 2.3. Grout shall be mixed at an approved Ready mix plant in accordance with NZS 3104. Site mixing will only be permitted with the express and prior approval of the Engineer.

Allow to test grout in accordance with Appendix A.2 of NZS 4210. A test sample of no less than three cylindrical specimens shall be taken for at least every 450 sq.m of wall filled (measured on one face only).The results of these tests shall be submitted upon request to the Engineer for approval.

6.5.5 Reinforcement

Reinforcement is specified under REINFORCING STEELWORK.

Ensure correct location of blockwork starters, with reference to block layout etc.

In general, vertical reinforcing will be positioned in advance of laying, but horizontal reinforcing will be positioned when the appropriate course is laid. Vertical steel, including starters should be central, unless noted otherwise. Starters which have been cast out of position shall NOT be bent over into position. In the event of bars being out of position, the Engineer should be notified and will supply a remedial detail, which may involve drilling and epoxy grouting of new starters.

Lap lengths shall be a minimum of 450 mm long and not less than that given below, unless specifically noted otherwise:

Grade 300 reinforcing: 40 bar diameters
Grade 500E reinforcing: 70 bar diameters

Lapping bars shall be tied to each other. The position of laps other than those detailed shall be discussed and agreed with the Engineer before fabrication.

Confining plates shall be prefabricated from 3mm stainless steel plate, or galvanised steel, provided that galvanising is carried out after fabrication.

6.6 CONSTRUCTION

6.6.1 General

The Contractor shall comply fully both on and off site with the provisions of the New Zealand Building Code in all matters relating to construction safety, in particular with Approved documents F1 (Hazardous Agents on Site), F2 (Hazardous Building Materials), F4 (Safety from Falling), and F5 (Construction and Demolition Hazards).

All construction of Blockwork shall comply fully with NZS 4210, section 2, unless noted otherwise herein.

6.6.2 Block Laying and Cleaning Out

Block laying shall comply with clause 2.7 of NZS 4210 and cleaning out shall comply with clause 2.8.

The base shall be scored, scabbled or otherwise mechanically roughened to minimum amplitude of 1.5mm prior to laying of blocks. It shall be clean and free from all laitance, loose mortar or any other material, which would prevent the mortar bonding to it.

Blockwork shall be laid in stretcher bond throughout and all panels shall be carefully set out so as to avoid use of cut blocks wherever possible. The set out of the first course of each wall shall be approved by the Engineer before work proceeds.

No blocks shall be laid during inclement weather. No blocks shall be laid on a partially built wall which has been exposed to rain until the wall has dried out. Alternatively, provide adequate cover to the top of block walls under construction during inclement weather.

To facilitate cleaning out of mortar droppings and other debris, the first course of each lift shall be laid using inverted knock-in bond beam blocks. Sand shall NOT be sprinkled at the bottom of the grout space.

All walls including parapet walls shall have cleanout ports at the bottom of each lift. Cleanout ports shall be spaced to match all wall starter locations and at no greater than 800mm centres. Cleanout ports are to be left open to allow time for the Engineer to inspect the tied laps in the reinforcement. On completion of laying, clean out vertical cores of excessive mortar likely to impede the free flow of grout and then thoroughly clean out first course of all mortar droppings. After cleaning out and inspection by the Engineer, face shells are to be mortared in over clean out ports and braced prior to grouting. Alternatively, retain the block fill with a recessed form, later to be plastered to a finish to match the balance of the blockwork.

Build blockwork to vertical reinforcing with open ended type blocks and end closers. Provide bond beam and open ended bond beam type blocks and end closures for horizontal reinforcement. Where blockwork is not course bonded at wall junctions, cut blocks at all levels to allow horizontal reinforcing and grout to pass through. Blockwork shall be so constructed that filling concrete is contained within the grout spaces and does not leak from these spaces.

The maximum lift height shall be 3.6m. Walls higher than 3.6m shall be constructed in sections. Grout each section before laying blocks for the next section.

The Contractor is required to provide and maintain temporary support to block walls until the walls have been filled, the grout filling has cured, and the walls are adequately built into the final structure as shown on the drawings. Block walls on the boundary will usually require temporary support at least until after the wall is tied into the floor or beam at the top. Any damage resulting from failure or neglect to provide adequate support to block walls during construction shall be repaired at the blocklayer's expense.

The Contractor shall obtain approval from the Engineer for laying procedure and block types before commencing blocklaying and before starters are built in by the concretor.

6.6.3 Grout filling

All blocks shall be fully filled. Grouting shall be by the High Lift Grouting Method with expansive admixture, in accordance with NZS 4210, clause 2.12. Expansive admixture shall be Cavex or similar approved and used in accordance with the manufacturer's instructions.

Walls may be filled in a single continuous pour of up to 3.6m lift height with continuous vibration using a pencil vibrator. The top of each pour must be trowelled to compact it, about 2 hours after the pour.

When the air temperature is less than 8 degrees Celsius, Cavex shall not be used and grouting must be by the High Lift Grouting Method, in accordance with NZS 4210, clause 2.13. Grouting using the High lift grouting method without expansive admixtures, or any other method may ONLY be done in specific cases and with the prior approval of the Engineer.

The blocklayer is responsible for ensuring all face shells, supports, forms etc are adequate to prevent bursting of the wall during filling. Do not pour grout until spaces to be filled have been checked for restrictions or debris.

During grout filling around reinforcement ensure that the position of reinforcing is correctly maintained. Prevent any movement of projecting reinforcement while grout is setting.

Finish to a level surface at the top of each pour and water blast or scabble construction joints between pours to remove all laitance.

6.6.4 Joints

Joints, both horizontal and vertical, shall be level and plumb and of uniform thickness throughout, nominally 10mm and perpends on alternate courses shall be in a vertical line.

6.6.5 Control Joints

Build control joints into walls where detailed on Drawings or generally at 8 metre maximum centres where not specifically shown. The Contractor must discuss in advance with the Engineer the location of all control joints when they are not shown on the drawings.

Control joints shall be continuous vertical perpends. Reinforcement and filling grout shall be continuous through joints.

Rake back the vertical joints where accessible, to a depth of 10mm on each face at the block joint. At least four weeks after adjacent blockwork has been poured neatly point interior control joints with mortar to match all normal joints.

Seal the exterior joints before painting with Sika AT-Facade sealant on bond breaking tape. Use in strict accordance with the manufacturer's recommendations.

6.6.6 Pointing and Cleaning Down

Walls to be exposed in the finished work shall be neatly and expertly pointed with ruled concave joints of mortar as specified in NZS 4210, clause 2.7.7, as the work proceeds.

On completion of walls exposed in the finished work, clean down and remove all mortar projections and irregularities. Patch and make good around all pipes, conduits etc., penetrating the block walls. Make good any faults in the pointing.

Walls to be covered in the finished work shall have joints compacted by tooling and left flush. Add additional mortar before tooling to ensure joints are completely full.

6.6.7 Rebates, Reveals etc.

Cross refer to the Architectural Drawings to ensure all blocks around openings etc. are correctly laid with sills, reveals and rebates as necessary.

6.6.8 Switch and Outlet boxes

Allow to drill and chisel out neat rectangular holes in the concrete blocks as work proceeds for electrical plug and switch boxes shown in electrical plan on concrete block faces. Holes shall be accurately positioned and carefully cut to exact sizes and be close fitting to flush boxes. Holes shall be concealed by flush plates. Where part of the hole is not fully covered it shall be neatly patched and finished to match surrounding blockwork to the Architect's approval.

6.6.9 Building in

As the work proceeds, build into blockwork all necessary bolts, STEELWORK and METALWORK items and other fittings and fixings as shown on the Drawings or otherwise required for the work. The blocklayer is to ascertain these particulars and make the necessary provisions beforehand.

6.6.10 Seismic Movement Joints

Maintain clearances to columns and other structural elements as shown on the drawings. Fill joints with approved compressible fireproofing material and sealant, to the Architects details.

6.6.11 Waterproofing and Subsoil Drainage

Provide waterproofing and subsoil drainage behind blockwork walls. Apply approved membrane (refer Architects specification) to back of block walls in accordance with manufacturer's instructions. Each coat is to be identifiable from the previous coat. Provide protective board backing over waterproofing before backfilling behind wall.

7.0 STRUCTURAL STEELWORK

7.1 GENERAL

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract, which are equally binding on all trades. This Section of the Specification shall be read in conjunction with all other Sections.

7.1.1 SCOPE

7.1.1.1 Extent

The work covered in this Specification consists of:

1. The supply of materials and fabrication of structural steel components for the Works, as shown and described on the Project Drawings and in this Specification;
2. The supply of all associated welding consumables and bolted connection components for both in-shop and on-site assembly of the Works;
3. Shop detailing documentation;
4. Surface preparation;
5. Corrosion protection, including 'touch-up' repairs;
6. Handling and storage of all materials and components;
7. Loading and transportation of fabricated components to the job site;
8. Erection of the components and assemblies on-site;
9. Fixing of adjoining building elements connected to or supported on the structural steel;
10. The quality control of all materials, components, assemblies and processes associated with the scope of work; and
11. The compliance management of all materials, components and finished assemblies associated with the scope of the work.

7.1.1.2 Inclusions

Generally, inclusive but not limited to the following:

1. Primary and secondary floor beams and roof beams.
2. Columns.
3. Hold-down bolt assemblies.
4. Purlins / girts and associated components.
5. Roof / wall bracing and struts.
6. External canopy structures.
7. Structural steelwork for secondary structures including bulk heads, fins, pop-up roofs, eaves, external walls, internal partitions / glazing etc.
8. Structural steelwork for proprietary items including crash barriers, operable walls, Monkeytoe plant deck etc.
9. All other structural steelwork shown on the drawings and required for completion of the building including cleats, bolts and other fixings.

7.1.1.3 Co-ordination with other trades

The Structural Steel Contractor shall allow for the extent of liaison and coordination necessary with adjoining trades to identify all necessary fitments, flashing plates, brackets, holding down bolts and the like that either support or are supported by, or otherwise interact with the steelwork under scope of this project.

All work shall be undertaken in accordance with the Project Drawings and shall comply with the various New Zealand Standards and other reference documents as prescribed in this technical specification

7.1.1.4

This Specification forms part of the *Contract Documents*

7.1.2 OTHER DOCUMENTS

Read this Specification in conjunction with the other *Contract Documents*.

7.1.3 DEFINITIONS

For the purposes of this specification, the definitions included in AS/NZS 5131 and the following apply:

- **Contractor**: is the Person with overall responsibility for construction of the building, so named in the Contract Documents and as defined by NZS 3910
- **Construction Reviewer**: is responsible for review of the structural steelwork covered by this specification
- **Design Engineer**: is responsible for design of the structural steelwork covered by this specification
- **Engineer**: The Engineer is the Engineer to the contract as defined by NZS 3910
- **Structural Steel Contractor:** is responsible for fabrication, erection, surface treatment and corrosion protection of the structural steelwork covered by this specification.
- **Hold point**: an identified point in a process beyond which the relevant work cannot proceed without approval.
- **Project Drawings**: the set of drawings that describe in a diagrammatic fashion the extent and detail of the Works and the relationship of the Works to the overall construction. The Project Drawings may include the detail necessary to fabricate and erect the Works, depending on the contractual relationships established for the project.
- **Steelwork**: the fabricated structural steel.
- **Witness point**: An identified point in a construction process at which an activity is observed.

7.1.4 ABBREVIATIONS

For the purposes of this specification, the following abbreviations apply:

- **AESS**: Architecturally exposed structural steelwork
- **CC**: Construction Category (CC1, CC2, CC3, CC4)
- **ESM**: Erection Sequence Methodology
- **FC**: Fabrication Category (FC1, FC2)
- **IL**: Importance Level
- **ILAC**: International Laboratory Accreditation Cooperation
- **ITP**: Inspection and Test Plan
- **MDR**: Manufacturer's Data Report
- **NDE**: Non-Destructive Examination
- **PC**: Coating quality level
- **QP**: Quality Plan
- **SC**: Service Category (SC1, SC2)
- **SCNZ**: Steel Construction New Zealand

- **SDoC**: Supplier Declaration of Conformity
- **SFC**: Steel Fabrication Certification
- **UNO**: unless noted otherwise
- **WPQR**: Welding Procedure Qualification Record
- **WQR**: Welder Qualification Record
- **WPR**: Welding Procedure Record
- **WPS**: Welding Procedure Specification

7.1.5 HEALTH AND SAFETY

All work covered by this Specification must be undertaken in accordance with the requirements of the Health and Safety in Employment Act and the Contractor's health and safety workplan.

7.2 RESPONSIBILITIES

Table B.3 of AS/NZS 5131 details a list of responsibilities to be assigned. Unless otherwise assigned under the scope of the project contract the responsibilities assigned to the Structural Steel Contractor shall be as per Appendix S.B and this specification.

7.3 REFERENCED DOCUMENTS

7.3.1 STANDARDS

The following Standards and codes applicable to and referenced in this Specification shall be regarded as describing the minimum standard of materials and workmanship to be provided:

Standard	Title
AS 1111	ISO metric hexagonal commercial bolts and screws
AS/NZS 1163	Cold-formed structural steel hollow sections
AS/NZS 1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)
AS/NZS 1252.1	High-strength steel bolt assemblies comprising bolts, nuts and washers for structural engineering – Part 1: Technical requirements
AS/NZS 1252.2	High-strength steel bolt assemblies comprising bolts, nuts and washers for structural engineering – Part 2: Verification testing
AS/NZS 1554	Structural steel welding (several parts, as applicable)
AS/NZS 1594	Hot-rolled steel flat products
AS 1710	Non-destructive testing – Ultrasonic testing of carbon and low alloy steel plate and universal sections – Test methods and quality classification
AS 2207	Non-destructive testing – Ultrasonic testing of fusion welded joints in carbon and low alloy steel
AS/NZS 2312.1[1]	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – paint coatings
AS/NZS 2312.2[1]	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – hot-dip galvanizing
AS 3597	Structural and pressure vessel steel – Quenched and tempered plate
AS/NZS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1	Structural steel – Part 1: Hot-rolled bars and sections

AS/NZS 3679.2	Structural steel – Part 2: Welded I sections
NZS 3404	Steel structures
ISO 3834	Quality requirements for fusion welding of metallic materials (several parts, as applicable)
AS/NZS 4600	Cold-formed steel structures
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5131	Structural steelwork – Fabrication and erection
SA TS 101	Design of post-installed and cast-in fastenings for use in concrete
SA TS 102	Structural steel – Limits on elements added
SA TS 103	Welding to AS/NZS 1554 Parts 1, 5 and 7 – Limits on boron in parent materials
SNZ TS 3404.1	Durability requirements for steel structures and components

Note: 1. Alternatively as per SCNZ Steel Advisor MAT1010 acceptance to mechanical requirements of AS/NZS 1252:1996 and dimensional requirements of AS/NZS 1252:1983

Documents listed refer to their latest issue complete with amendments that are current at the time of preparing the Contract Documents.

7.3.2 OTHER REFERENCED DOCUMENTS

This technical specification shall be read in conjunction with:

1. SCNZ Report No 111:2018, *New Zealand Guide to the Sourcing of Compliant Structural Steels*
2. SCNZ Steel Advisor, MAT1010, *Practice Note on the Sourcing of Compliant High Strength Structural Bolts*
3. SCNZ Steel Advisor, MAT1011, *Practice Note on the Sourcing of Threaded Rod Used for Foundation Bolts*

7.4 DESIGN, DOCUMENTATION AND QUALITY CONTROL / MANAGEMENT

7.4.1 CONSTRUCTION CATEGORY

In accordance with the requirements of AS/NZS 5131 the Construction Categories for the project are defined in the table below:

Zone 1 Structural Steel

Element	Importance Level	Service Category	Fabrication Category	Construction Category
All structural steelwork UNO.	IL2	SC1	FC1	**CC3**
All site welded components.	IL2	SC1	FC2	**CC3**

Zone 2 Structural Steel

Element	Importance Level	Service Category	Fabrication Category	Construction Category
All structural steelwork UNO.	IL3	SC1	FC1	**CC3**
All site welded steelwork	IL3	SC1	FC2	**CC3**

Zone 3 Structural Steel

Element	Importance Level	Service Category	Fabrication Category	Construction Category
All structural steelwork UNO.	IL3	SC1	FC1	**CC3**
Steel K Seismic K Frames (located on grids 3K and 3L	IL3	SC2	FC1	**CC3**
All site welded steelwork	IL3	SC1	FC2	**CC3**

7.4.2 TREATMENT GRADES

Unless noted otherwise in the Project Drawings, for the elements on this project, the Treatment Grades according to AS/NZS 5131 shall be:

	Element	Treatment Grade
1	All painted structural steelwork excluding AESS.	P2
2	AESS (refer Architects drawings for locations)	P3/AESS3
3	Steelwork to be galvanized (where shown on the drawings). Note, painted galvanised surfaces may require surface preparation)	REFER AS/NZS 5131 section 9.8.4 for requirements
4	Intumescent coatings may require specific surface preparation and assessment for compatibility with corrosion protection systems. The specifier should review manufacturer data in this regard.	(Confirm with intumescent supplier)

7.4.3 COATING QUALITY LEVEL

Unless noted otherwise in the Project Drawings, for the elements on this project, the Coating Quality Levels according to AS/NZS5131 shall be:

	Element	Coating Quality Level
1	All internal structural steelwork (i.e. inside an enclosed building envelope).	PC1
2	All external structural steelwork.	PC2
3	All internal exposed steelwork within 5m of a large external opening such as sliding doors, roller doors, or other permanent openings.	PC2

7.4.4 QUALITY ASSURANCE

The Structural Steel Contractor shall maintain a quality management system to Appendix D of AS/NZS 5131 relevant to the project Construction Category and the project Coating Quality level. In addition, Factory Production Control (FPC) for welding fabrication shall comply with AS/NZS ISO 3834.3 for CC2 and AS/NZS ISO 3834.2 for CC3 and CC4.

The Structural Steel Contractor shall advise the Engineer in writing the name of a suitably experienced and qualified representative, to be responsible for the quality control of all structural steelwork.

The representative shall review all shop drawings for dimensions, coordination with other trades, and consistency with the Contractor's elected construction sequence before submittal of any shop drawings to the engineer for review. ('Shop drawings' may include but are not limited to: cast-in items, precast elemental drawings and structural steel elemental drawings).

The Structural Steel Contractor shall provide details of the fabrication and erection quality control procedures to the Contractor for forwarding to, and approval of, the Engineer as set out in this specification. These procedures should encompass all aspects of fabrication.

The nominated representative will be required to complete and sign a written quality control check list for each major component after fabrication and after erection. A copy of each completed check list is to be given to the Contractor for forwarding to the Engineer upon request.

The format and detail of the checklist shall be agreed to by the Engineer and the Structural steelworker, prior to the commencement of any structural steelwork.

The Engineer may arrange to have an independent inspection service which may encompass aspects of the above. This is entirely independent of the Structural Steel Contractors own procedures, and alleviates none of the Structural Steel Contractors responsibilities to maintain their own quality assurance programme.

7.4.5 PRODUCER STATEMENT

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate the Contractor (and his subcontractors) shall furnish a fully completed Producer Statement. This certificate shall cover all work completed under this section of the specification for the relevant section of the works.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements covering the structural trades have been received.

Issue and acceptance of Producer Statements shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Refer to Appendix A for additional explanation and an example of this Producer Statement.

7.4.6 CODE OF COMPLIANCE CERTIFICATE

At the completion of the works, a Code Compliance Certificate is to be issued by the Territorial Authority. The Contractor shall furnish all the relevant Producer Statements prior to the application (by others) to the application to the Territorial Authority for the Code Compliance Certificate.

Until the Code Compliance Certificate has been issued, no Final Completion Certificate will be issued, unless the non-issue of the Code Compliance Certificate is due to factors entirely removed from the Contractor's responsibility.

7.4.7 STRUCTURAL STEEL CONTRACTOR QUALIFICATION

The Structural Steel Contractor shall have Steel Fabrication Certification to at least the defined Construction Category level through Steel Construction New Zealand and HERA Certifications Ltd.
Non-certified fabricators will not be accepted under any circumstances.

7.4.8 QUALITY DOCUMENTATION

Provide quality documentation as required by Clause 4.5.1 of AS/NZS 5131.
Provide a Quality Plan as required by Clause 4.5.2 of AS/NZS 5131.

7.4.9 IDENTIFICATION AND TRACEABILITY

The Structural Steel Contractor shall implement systems to ensure identification and traceability complying with AS/NZS 5131 for the appropriate Construction Category, including by all subcontractors.

7.4.10 PURCHASING – COMPONENTS AND SUBCONTRACTED SERVICES

The processes and documentation required for purchasing of components or subcontracted services shall meet the requirements of Clause 4.6 of AS/NZS 5131.

7.4.11 SUBMITTALS

The submittals required are defined in AS/NZS 5131. A summary of all submittals are provided in appendix S.A.

7.4.11.1 Quality Plan and ITPs

The requirements for submission of Quality Plans and ITP's are provided in Section 13 of AS/NZS 5131. The Structural Steel Contractor shall submit ITPs to the Design Engineer for review.

7.4.11.2 Products and materials

7.4.11.2.1 Origin of steel

The requirements in AS/NZS 5131 for documentation to demonstrate compliance with New Zealand Standards apply.

Steel shall be supplied in accordance with SCNZ Report 111:2018 *New Zealand Guide to the Sourcing of Compliant Structural Steels* for the nominated construction category. Provide documentation, verification test reports and a 'Supplier Declaration of Conformity' as required. The Structural Steel Contractor shall submit steel source steel list as described in the SCNZ Report to the Design Engineer for review. Evidence of conformity meeting the requirements of the SCNZ Report shall be submitted to the Construction Reviewer for review. Responsibility for acceptance of steel remains with the Contractor and Structural Steel Contractor.

7.4.11.2.2 Chemical composition of steel

In addition to the requirements of the New Zealand Standards for structural steel (refer Section 4.5.2), the steel shall also comply with the following requirements for boron content:

(a) the material test certificates shall report all elements required by the New Zealand Standards listed above, plus total boron.
(b) If boron is not specified on the material test certificates, then the material shall be tested to determine the total boron.

Parent steel materials with total boron equal to or exceeding 0.0008% will require requalification of welding procedures in accordance with SA TS 103 Structural steel welding – Limits on boron in parent materials.

7.4.11.2.3 Bolts

Provide documentation demonstrating compliance to the relevant Standard (refer Section 4.5.4) prior to delivery of bolts to site. Bolts delivered to site without complete documentation shall be rejected.

The high strength structural bolts for this project are required to have verification testing in accordance with SCNZ Steel Advisor MAT1010. Provide documentation and a 'Supplier Declaration of Conformity' as defined in Steel Advisor MAT1010.

7.4.11.2.4 Cast-in threaded rods

Provide documentation demonstrating compliance to the relevant Standard (refer Section 4.5.11) prior to delivery of cast-in threaded rods to site. Cast-in threaded rods delivered to site without complete documentation shall be rejected.

The high strength threaded rod for this project is required to have verification testing in accordance with SCNZ Steel Advisor MAT1011. Provide documentation and a 'Supplier Declaration of Conformity' as defined in Steel Advisor MAT1011.

7.4.11.3 Shop drawings

The Structural Steel Contractor at their expense shall prepare shop drawings and any supporting documentation providing the range of information required for the shop detailing documentation in AS/NZS 5131.

Shop drawings are to include all provisions documented in all project drawings and any other relevant documents across all design disciplines involved in the project to show full construction details. Where discrepancies are noted in the drawings, it shall be the duty of the Contractor to notify the Design Engineer of these discrepancies as soon as they become evident.

The Design Engineer's drawings provide overall dimensioning, member sizes and typical connections only. Where discrepancies are noted in the drawings, it shall be the duty of the Contractor to notify the Engineer of these discrepancies as soon as they become evident. Failure to do so will not constitute an excuse for failure to perform to programme

Shop drawing numbers shall be maintained. Changes to shop drawings shall be clouded.

The Structural Steel Contractor is to submit all proposed changes to the documented design for approval prior to submitting shop drawings for approval.

The shop drawings shall be reviewed by the Design Engineer for design intent and general arrangement only. Allow 10 (ten) working days review. The accuracy and adequacy of the shop drawings are the Contractors responsibility.

Provide one copy in collated Adobe PDF format.

All non-destructive testing requirements as per Section 4.13 should be noted on the corresponding shop drawings.

7.4.11.4 Execution details

7.4.11.4.1 Subcontractors

Submit names and contact details of any proposed fabricator, detailer, surface preparation contractor, painter/galvanizer and erector/installer.

7.4.11.4.2 Fabrication

Provide documentation to demonstrate a Structural Steel Contractor having Steel Fabrication Certification to at least the defined Construction Category level through Steel Construction New Zealand and HERA Certification Ltd will be utilised for the Works.

7.4.11.4.3 Information required for Code Compliance Certificate (PS3)

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate, or otherwise at key handover dates for this section of the works, the Structural Steel Contractor will be required to certify to the main Contractor that all compliance items covered by this specification have been carried out in full accordance with all Contract Documents and Contract Instructions in the form of a Producer Statement - Construction. This statement will be required to be completed prior to the issue of the Producer Statement – Construction Review by the Construction Reviewer for the whole or sections of the works as appropriate.

7.4.11.4.4 Erection documentation

Submit the 'Erection Sequence Methodology' (ESM) as defined in AS/NZS 5131 for review by the Design Engineer. The adequacy of ESM is the Contractor's responsibility.

If required by the ESM, submit calculations to justify the adequacy of the structure for the intended erection methodology.

7.4.11.4.5 Connections

For bolted connections, submit inspection records for completed installation to the Construction Reviewer.

For bolted connections not fully documented, submit proposals for approval by Design Engineer.

For bolted connections requiring rectification, submit proposals for approval before proceeding to the Design Engineer.

For anchor bolts that do not meet documented location tolerances, submit proposals for rectification for approval before proceeding to the Design Engineer.

For temporary connections, if not documented, submit proposals for approval to the Design Engineer.

If splicing of structural members is proposed, submit details for approval to the Design Engineer.

Where alternative anchors are proposed, submit documentation for approval by the Design Engineer to substantiate the anchor capacity to carry the load where mechanical or chemical anchors are required or proposed for the support or fixing of structural steel.

7.4.11.4.6 Steelwork exposed to view

Submit details of proposed member, connection and component marking for steelwork identified as AESS or otherwise exposed to view to the Design Engineer.

7.4.11.4.7 Rectification works

Proposals for rectification works shall be submitted in writing and approved to the Design Engineer before being undertaken.

7.4.11.5 As-built documentation

Submit the survey of erected structural steelwork to verify the structure and components have been installed as defined on the Project Drawings to the tolerances defined in AS/NZS 5131 and this specification.

Submit as-built documentation.

7.4.11.6 Non-conforming Work

Where a section of the Works does not comply with the requirements of the specification and the Project Drawings (including requirements for inspection and testing), the Structural Steelwork Contractor shall submit a non-conformance report detailing the non-conformance and the proposed rectification method for approval by the Construction Reviewer.

7.4.11.7 Manufacturers Data Report (MDR)

Submittals are required in the form of a fabricator's MDR, the structure and contents of which is defined in the following table. The MDRs shall be made available for the Construction Reviewer to review.

Content	Required		
	CC1	CC2	CC3/CC4
Scope of work:			
Insert a brief description of the contract Scope of Work applicable to the MDR at the front of report.	✓	✓	✓
Section 1 – Design and detailing:			
Design calculations (if relevant)			
Technical queries / requests for information		✓	✓
Authorised deviations		✓	✓
Material and equipment lists			
Drawing list including revision number		✓	✓
General arrangement drawings		✓	✓
Marking plans		✓	✓
Shop detail and vendor drawings		✓	✓
Assembly drawings (where applicable)		✓	✓
As-built drawings		✓	✓
3D model(s)		✓	✓
Section 2 – Steel fabrication:			
Signed off ITPs for each stage of the work		✓	✓
Final Inspection Check Sheets or Reports	✓	✓	✓
Evidence of conformity to the requirements of SCNZ 111:2018	✓	✓	✓
High strength bolt verification test documentation	✓	✓	✓
Material and consumable map for traceability			✓
Welding consumables certificates		✓	✓
Welding Procedure Specifications (WPS)	✓	✓	✓
Welding Procedure Qualification Records (WPQR)	✓	✓	✓
Welder Qualification Records (WQR)	✓	✓	✓
Material Heat Traceability Records		✓	✓

		(partial)	(full)
Inspection and Non Destructive Testing (NDT) Records	✓	✓	✓
NDT Personnel Certifications		✓	✓
Production Test Plate Reports (if applicable)			
NDT records identifying location and the welder		✓	✓
Weld maps identifying welders and WPS used for each weld			✓
Mechanical Test Records (if required)			✓
Heat Treatment Records		✓	✓
Map for identifying heat treatment records against welds and/or location			✓
Inspection records for shop installed bolted connections		✓	✓
Non-conformances, concessions and technical queries	✓	✓	✓
Procedure for modification or repair of existing structures		✓	✓
Final release certificate (works) or Inspection Release and Handover Certificate (Site)		✓	✓
Section 3 – Corrosion Protection:			
Signed off ITPs for each stage of the work		✓	✓
Material batch numbers and test certificates		✓	✓
Surface preparation Records		✓	✓
Coating application and thickness records		✓	✓
Section 4 – Structural Steel Erection:			
Signed off ITPs for each stage of the work		✓	✓
Installation record sheets		✓	✓
Approved Erection Sequence Methodology (ESM)		✓	✓
Any records described in preceding sections that may be relevant to Site Erection		✓	✓
Section 5 – Statutory Approvals, Registrations and Certificates			
Lifting equipment certification (if applicable)			

Note: ✓ = required

7.4.12 INSPECTION

7.4.12.1 Inspection scheduling

Liaise directly with specialist weld inspector.

7.4.12.2 Off-site witness points

The Structural Steel Contractor shall give the Construction Reviewer 2 working days' notice so that inspection may be made of the following:

- Materials including welding consumables prior to fabrication
- Testing of welding procedures and welder qualification tests
- Commencement of shop fabrication
- Commencement of welding
- Prior to placement of root runs of complete penetration butt welds
- High strength bolt tensioning (when completed in shop)
- Completion of fabrication prior to surface preparation
- Surface preparation prior to protective coating

- Completion of protective coating prior to delivery to site

7.4.12.3 On-site witness points

The Structural Steel Contractor shall give the Construction Reviewer 2 working days' notice so that inspection may be made of the following:

- Steelwork on site before commencement of erection
- Anchor bolts in position before casting in
- Column bases prior to grouting
- Installation and tensioning of bolts in categories /TB or /TF
- Pre-tensioning of foundation cast-in hold-down bolts
- Completion of erection prior to any encasing, field protective coating or fixing of cladding
- Mechanical or chemical anchor proof load testing
- Reinforcement and formwork in place prior to any encasement
- After any grouting, encasement, fire protection or field protective coating is completed
- The loading and unloading of temporary works

7.4.12.4 Hold points

The required hold points and submission details are defined in Appendix S.A. Hold points will be released after written approval.

7.5 MATERIALS AND COMPONENTS

7.5.1 GENERAL

Members and components shall be packed, supported, lifted and transported in a manner to prevent distortion, loss of camber or damage to the steelwork and its protective coating.

Damaged items shall be reported and rectified or replaced. Where rectified, the method of rectification shall be subject to approval.

Documentation supplied with materials and components shall conform to the requirements of AS/NZS 5131.

7.5.2 STRUCTURAL STEEL

All structural steel materials and components shall conform to the following tables for Zone 1, Zone 2 and Zone 3 respectively UNO:

Zone 1 Material Grades:

Component	To conform with Standard	Grade
Hot rolled steel sections u.n.o.	AS/NZS 3679.1; TS 102	300S0
Plates and flats	AS/NZS 3678; AS/NZS 1594; TS 102 AS/NZS 1594; TS 102	300 by default, or 350 only as noted on drawings For thickness greater than 50mm typically use 300MPa

		Z25 (lamellar tearing sensitive locations – refer drawings)
Hollow sections: Circular Square Rectangular	AS/NZS 1163; TS 102	C350L0; C350L0; 350L0;
Welded beams and columns	AS/NZS 3679.2; TS 102	300L15
Purlins and girts	AS 1397	G450
Shear studs (composite slab to steel)	AS/NZS 1554.2	380

Zone 2 Material Grades:

Component	To conform with Standard	Grade
Hot rolled steel sections u.n.o.	AS/NZS 3679.1; TS 102	300S0
Plates and flats	AS/NZS 3678; AS/NZS 1594; TS 102 AS/NZS 1594; TS 102	300 by default, or 350 as noted on drawings For thickness greater than 50mm typically use 300MPa Z25 (lamellar tearing sensitive locations – refer drawings)
Hollow sections: Circular Square Rectangular	AS/NZS 1163; TS 102	C350L0 C350L0 C350L0
Welded beams and columns	AS/NZS 3679.2; TS 102	300L15
Purlins and girts	AS 1397	G450
Shear studs (composite slab to steel)	AS/NZS 1554.2	380

Zone 3 Material Grades:

Component	To conform with Standard	Grade
Hot rolled steel sections u.n.o.	AS/NZS 3679.1; TS 102	300S0

Plates and flats	AS/NZS 3678; AS/NZS 1594; TS 102 AS/NZS 1594; TS 102	300L15 typically or equal approved u.n.o. 350L15 when noted grade 350 steel on the drawings. For thickness greater than 50mm typically use 300MPa Z25 (lamellar tearing sensitive locations – refer drawings).
Hollow sections: Circular Square Rectangular	AS/NZS 1163; TS 102	C350L0 C350L0 C350L0
Welded beams and columns	AS/NZS 3679.2; TS 102	300L15 / 300SO
Purlins and girts	AS 1397	G450
Shear studs (composite slab to steel)	AS/NZS 1554.2	380

7.5.3 GIRTS, PURLINS, SAG RODS, AND BRACING CHANNELS

Girts and Purlins shall be Dimond Hi-span grade 450 galvanised steel sections, pre-punched for all bolt fixings and sag rods. Alternate systems will be considered by the Engineer. Galvanizing of purlins / girts shall be appropriate for the exposure category of each member.

All bolts, sag rods and bracing channels shall be galvanised, and fixed in accordance with the manufacturers specifications. Unless specifically noted otherwise on the drawings, all bays of purlins shall have two rows of continuous brace channel support using either bolted braces or 'fast brace' brace channel. Allow to connect the brace channel continuously through the apex using a custom bent threaded rod.

Slotted holes to girts, purlins, and cleats shall not be provided unless otherwise approved in writing by the Engineer.

7.5.4 BOLT ASSEMBLIES

7.5.4.1 Bolt Designation

Designation	To conform with New Zealand Standard	Tightening process	Property class
4.6/S	AS 1111	Snug tight	4.6
8.8/S	AS/NZS 1252.1	Snug tight	8.8
8.8/TB	AS/NZS 1252.1	Fully tensioned to NZS 3404 as a bearing type joint	8.8
8.8/TF	AS/NZS 1252.1	Fully tensioned to NZS 3404 as a	8.8

		friction type joint. Connecting surfaces to be left uncoated.	

7.5.4.2 Bolt assembly verification

High strength bolt assemblies shall be verified to MAT1010. Documentation to meet the requirements of MAT1010 shall be provided.

7.5.4.3 Bolt finish

All bolts shall be hot dip galvanized to AS/NZS 1214.

7.5.5 WELDING CONSUMABLES

Welding consumables shall conform to the requirements of NZS 3404, based on the yield strength of the steel to be welded, as defined in the table below:

Nominal yield strength of steel to be welded	To conform with New Zealand Standard
≤ 500 MPa	AS/NZS 1554.1
>500MPa; ≤ 690 MPa	AS/NZS 1554.4

The nominal tensile strength of weld metal, f_{uw}, shall be 490 MPa UNO.

Welds to the structural members listed below are subject to earthquake loading and shall be made using welding consumables with a Ships' Classification Societies Grade 3 approval:

Zone 1:

- All portal frame knee connections

Zone 2:

- All portal frame knee connections and baseplates

Zone 3:

- All K-frame welds including beams, columns, braces, web stiffeners and baseplates.
- All welds between flanges and webs to steel sections forming part of the K-frames

7.5.6 MECHANICAL AND CHEMICAL ANCHORS

Mechanical and chemical anchors shall meet the requirements defined in SA TS 101.

7.5.7 STUDS AND SHEAR CONNECTORS

Studs and shear connectors shall meet the requirements defined in AS/NZS 5131.

7.5.8 SPECIAL FASTENERS

Special fasteners shall meet the requirements defined in AS/NZS 5131.

7.5.9 FASTENERS FOR THIN GAUGE COMPONENTS

Fasteners for thin gauge components shall meet the requirements defined in AS/NZS 5131.

7.5.10 LOCKING DEVICES

Where required, locking devices to prevent loosening of fasteners are noted on the Project Drawings. Locking devices shall meet the requirements of AS/NZS 5131.

7.5.11 HOLD-DOWN BOLTS

Hold-down bolts shall meet the requirements of AS/NZS 5131. All high strength threaded rod shall meet the requirement of Steel Advisor MAT1011, and shall be hot dip galvanized finish.

7.5.12 GROUTING MATERIALS

Materials used for grouting under steel base plates and bearing plates shall meet the requirements defined in AS/NZS 5131.

7.6 PREPARATION, ASSEMBLY AND FABRICATION

7.6.1 GENERAL

All fabrication including operations comprising cutting, shaping, holing and assembly into fabricated components shall conform to the requirements of AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined in below, together with a reference to the applicable clause in AS/NZS 5131.

7.6.2 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
Architecturally exposed structural steelwork (AESS) Areas applicable to AESS are designated on the Project Architects Drawings.	6.1.5
Identification and traceability	6.2
Hard stamping: Hard stamping marks shall not be visible on any exposed steelwork, regardless of finish.	
Identification marks: Identification marks shall not be visible on any exposed steelwork, regardless of finish.	6.2
Cutting	
Cutting processes: No additional requirements.	6.5.1
Yielding regions: Yielding regions for Category 1,2 & 3 seismic members are the 'active link' regions in the K and D steel frames (Zone 3 Carpark), and the beam regions within 1.5m of portal knee joints in Zone 2. Refer Structural Drawings for locations.	6.5.1
Fatigue detail category: If present, details with fatigue detail category ≥ 80 MPa are designated on the Project Drawings.	6.5.2
Holing	
Friction-type connections: N/A	6.7.4

Weld access holes Weld access holes shall not be filled in with weld metal unless otherwise approved by Design Engineer.	6.7.7
Yielding regions: Yielding regions for Category 1,2 & 3 seismic members are the 'active link' regions in the K and D steel frames (Zone 3 Carpark), and the beam regions within 1.5m of portal knee joints in Zone 2. Refer Structural Drawings for locations.	6.13.1
Full contact bearing surfaces Full contact bearing surfaces are designated on the Project Drawings.	6.8
Assembly	
Camber and preset: Camber and preset requirements are designated on the Project Drawings.	6.9
Assembly check: No additional requirements.	6.10

7.7 WELDING

7.7.1 GENERAL

Welding shall conform to the requirements of AS/NZS 5131 and AS/NZS 1554 (different parts as applicable). Fabricator's Factory Production Control (FPC) shall comply with AS/NZS ISO 3834.3 for CC2 and AS/NZS ISO 3834.2 for CC3 and CC4.

Particular requirements from AS/NZS 5131 are outlined below, together with a reference to the applicable clause in AS/NZS 5131.

7.7.2 WELD CATEGORY

The weld categories shall be as per the table below UNO:

Element	Weld category (GP/SP/FP)
Primary structure (main structural members and connections)	SP
Secondary structure (minor components including cleats)	GP

7.7.3 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
General	
Additional welding requirements: No additional requirements.	7.1.2
Weld details: Weld category, size, type and extent are designated above u.n.o. on the Project Drawings	7.1.3
Non-destructive examination: Extent of non-destructive examination (NDE) is given in Section **'INSPECTION TESTING AND CORRECTION'**	7.1.3
Welding plan No additional requirements.	7.2.2
Welding processes No additional requirements.	7.3
Qualification of welding procedures and welding personnel	

Impact tests: No additional requirements.	7.4.1.1
Welding production testing: No additional requirements.	7.4.1.2
Qualification of welders: No additional requirements.	7.4.2
Qualification of welding supervisor or coordinator: Minimum of IWT or IWE qualifications or higher.	7.4.3
Preparation and execution of welding	
Temporary attachments: Areas where welding of temporary attachments are not permitted are designated on the Project Drawings.	7.5.6
Run-on/run-off tabs: No additional requirements.	7.5.9.1
Backing plates: No additional requirements.	7.5.9.2
Post-weld heat treatment: No additional requirements.	7.5.14
Arc strikes: No additional requirements.	7.5.15.1
Dressing of butt welds: No additional requirements.	7.5.15.1
Additional seismic welding requirements	
Welding of continuity stiffeners in earthquake resisting members No additional requirements.	7.5.16
General (Welding consumables requirements) Welds subject to earthquake load or effects are designated previously.	7.5.17
Removable steel backing The weld access holes required for weld backing shall comply with AS/NZS 5131 6.7.7. Weld access holes required for weld backing shall not be filled in with weld metal unless otherwise approved by Design Engineer.	7.5.17.2
Permanent steel backing The weld access holes required for weld backing shall comply with AS/NZS 5131 6.7.7. Weld access holes required for weld backing shall not be filled in with weld metal unless otherwise approved by Design Engineer.	7.5.17.3
Acceptance criteria	
Alternative acceptance criteria: No additional requirements.	7.6.1
Alternative assessment of nonconformity: No additional requirements.	7.6.1
Fatigue design assumptions: No additional requirements.	7.6.3

7.8 MECHANICAL FASTENING

7.8.1 GENERAL

Mechanical fastening shall conform to the requirements of AS/NZS 5131.

Type /TB and /TF bolts are to be tightened using either the part-turn method or load indicating washers. Where the part-turn method is used, the nut and shank are to be clearly marked to allow easy visual identification of degree of turn.

Where load indicating washers are proposed, provide manufacturer installation data to the Design Engineer prior to installation. Ensure all washers required by the manufacturer are installed in the correct location relative to the part to be turned prior to tightening.

Particular requirements from AS/NZS 5131 are outlined in below, together with a reference to the applicable clause in AS/NZS 5131.

7.8.2 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
Bolts, nuts and washers	
Locking of nuts: Where noted on the Project Drawings bolted connections with vertical or horizontally slotted holes (required to provide a sliding connection in one direction) are to be finger tightened only and nut threads secured with Loctite Thread-locker.	8.2.3
Washers: No additional requirements.	8.2.4
Preparation of contact surfaces on connected plies	
Coating of friction-type connection surfaces N/A	8.4.2
Tensioning of high strength bolts	
Part-turn tightening: No additional requirements.	8.5.6
Specialised fasteners No additional requirements.	8.7
Installation of mechanical and chemical anchors Mechanical and chemical anchors, where required, are noted on the project drawings.	8.8.1

7.9 SURFACE TREATMENT AND CORROSION PROTECTION

7.9.1 GENERAL

Surface treatment and corrosion protection shall conform to the requirements of AS/NZS 5131.

The atmospheric corrosivity category for this project is C1 for all internal steel, and C4 for all external steelwork exposed to the outside environment in accordance with SNZ TS 3404:2018.

The corrosion category C4 is cognisant of possible microclimatic effects such as unwashed steel and shading when the steel is externally exposed.

Particular requirements from AS/NZS 5131 are outlined in below, together with a reference to the applicable clause in AS/NZS 5131.

7.9.2 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
Requirements for painting and galvanizing	

Requirements for painting: (a) Areas to be coated and coating specification are specified in clause 7.9.3. (b) Colour and gloss requirements are as per the Architect's documentation. (c) The connecting surfaces of friction type joints may be coated if the friction coefficient of the coated joint has been tested according to AS/NZS 5131 Appendix G. (d) All damaged areas shall be cleaned and touched up with a system compatible with, and equivalent to, the specified system immediately adjacent. The Contractor shall refer to the painting system manufacturer's recommendations in this regard. (e) Environmental conditions and any special instructions from the painting system manufacturer shall be recorded during paint application and curing. (f) Surface preparation requirements for steelwork receiving painting are specified in clause 7.9.3. (g) All steelwork to be prepared to the Treatment Grade(s) noted in this specification. (h) After surface preparation, painting systems should be applied within the timeframe as given by the manufacturer. At most, painting systems are to be applied within 4 hours. (i) Painting of welded fixings shall not be carried out until after site welding is complete and the areas have been cleaned. (j) Welding and repair of pre-coated steel shall be in accordance with the manufacturer's written instructions.	9.2.3.1
Requirements for hot-dip galvanizing: (a) Members to be hot-dip galvanized are noted on the Project Drawings. (b) Hot-dip galvanizing shall comply with AS/NZS 4680. (c) Preparation, coating thickness, appearance and acceptable quality shall be as set out in the Galvanising Manual of the Galvanisers Association of New Zealand. (d) Where required by the Architect, galvanised steel shall be painted to specified requirements.	9.2.3.2
Preparation of steel surfaces	
Preparation of exterior steelwork No additional requirements.	9.3.2
Testing for soluble salts: No additional requirements.	9.3.2
Weather resistant steel surfaces: No additional requirements.	9.3.5
Surfaces in contact with concrete: Steelwork surfaces in contact with concrete beyond 50 mm into concrete shall be left un-primed.	9.3.7
Abrasive blasting	
Abrasive blast cleaning: No additional requirements.	9.4.1
Alternative surface finishes: No additional requirements.	9.4.4
Sealing of enclosed spaces	
Enclosed spaces: No additional requirements.	9.6.1
Sealed spaces: No additional requirements.	9.6.1
Fabrication and welding considerations	
Rectification of surface defects: The fabricator shall rectify any surface defects not meeting the requirements of AS/NZS 5131.	9.8.3
Surfaces to be painted:	9.8.4

No additional requirements.	
Surfaces to be galvanized: No additional requirements.	9.8.4
Treatment of cut edges: No additional requirements.	9.8.5
Welding and repair of pre-coated steel: Welding and repair of pre-coated steel shall be in accordance with the manufacturer's written instructions	9.8.6
Application of paint coatings	
Monitoring of conditions: Air and surface temperatures, relative humidity and dew point shall be regularly monitored and recorded.	9.9.10
Testing of film continuity: No additional requirements.	9.9.16
Testing of degree of cure: No additional requirements.	9.9.17
Corrosion protection of fasteners: No additional requirements.	9.9.18
Application of galvanized coatings	
Control of distortion: No additional requirements	9.10.4
Galvanizing process – double dipping: Double dipping of galvanized components is permitted, subject to written approval for the particular components.	9.10.5
Galvanizing process – test lot: No additional requirements.	9.10.5
End use of galvanized components: No additional requirements.	9.10.6
Adherence of coating: No additional requirements.	9.10.8
Wet storage staining: Wet storage staining shall be removed.	9.10.10

7.9.3 SCHEDULE OF STEELWORK FINISHES

The nominated finishes are indicative of the standard required – Refer also the Architects Specification.

System No.	Area	Coating System	Dry Film Build (μm)	AS/NZS 2312:2014 System & Durability
1	Internal Concealed & Visible Steelwork (Epoxy Zinc Rich Primer Only Option)	Abrasive blast to AS1627.4 Class 2.5 Epoxy Zinc Rich Primer	- 75	- 15-25 years (C1: Very Low)
2	Interior Visible (Dry) Steelwork Requiring An Architectural Finish	Abrasive blast to AS1627.4 Class 2.5 Epoxy Zinc Rich Primer Polyurethane Finish (colour and gloss level as specified by	- 75 Refer Architect	PUR2 25+ years (C1: Very low)

		Architect		
3	Exterior Inaccessible Steelwork (Zinc Metal Spray Option)	Abrasive blast to AS1627.4 Class 2.5 minimum 50μm blast profile. Zinc Metal Spray. Denib all surfaces. De-dust. Epoxy Primer Topcoat – Refer Architects Specification	- 150 125 Refer Architect	TSZ150S 40 years (C4: High)
4	Exterior Inaccessible Steelwork (Hot Dip Galvanised Option)	Hot Dip Galvanise in accordance with AS/NZS 4680. Do not chromate quench. Degrease and sweep blast to a matte finish. Epoxy Primer Topcoat – Refer Architects Specification	 125 Refer Architect	HDG600 duplex coated 40 years (C4: High)
5	Interior Steelwork Requiring Intumescent Fire Protection	Abrasive blast to AS1627.4 Class 2.5 Zinc Rich Epoxy Primer Intumescent Topcoat – Refer Architects Specification (Note:* For interior concealed (dry) fire rated steelwork application of Topcoat can be omitted)	- 125 As required for FRR Refer Architect	- 25+ years (C1: Very low)
6	Exterior Steelwork Requiring Intumescent Fire Protection	Abrasive blast to AS1627.4 Class 2.5 minimum 50μm blast profile. Zinc Metal Spray. Denib all surfaces. De-dust. Epoxy Primer Intumescent Topcoat – Refer Architects Specification	 150 125 As required for FRR Refer Architect	

7.10 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

7.10.1 GENERAL

Architecturally exposed structural steel (AESS) shall conform to the requirements of AS/NZS 5131.

Areas to be treated as AESS and the AESS category (1,2,3,4 or C) are summarised below. Refer also to the Architectural documentation. In the event of discrepancies, the Architectural documentation takes precedence.

Element / Location	AESS Category
All AESS UNO below	AESS 3
Exposed steel in Zone 3 Carpark	AESS 2

Particular requirements from AS/NZS 5131 are outlined below, together with a reference to the applicable clause in AS/NZS 5131.

7.10.2 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
General	
Category AESS C elements: N/A	10.3
Visual samples: No additional requirements.	10.3
Tolerances No additional requirements.	10.5

7.11 STRUCTURAL STEELWORK ERECTION

7.11.1 GENERAL

Structural steelwork erection shall conform to the requirements of AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined below, together with a reference to the applicable clause in AS/NZS 5131.

The steelwork erection contractor shall supply and install all temporary bracing and the like necessary for the safe erection of the structure.

The contractor shall be responsible for the temporary stability of the structure during construction.

7.11.2 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
Site planning	
Lifting equipment: No additional requirements.	11.2.5

Erection sequence methodology: An Erection Sequence Methodology (ESM) is required by AS/NZS 5131.	11.5.1
Temporary erection (trial assembly)	
No additional requirements.	11.5.10
Supports	
Temporary shims and packers: Temporary shims and packers used during erection shall be removed at the discretion of the Design Engineer.	11.6.3
Grouting at supports: Use high strength non-shrink grout in accordance with the drawings to the underside of all baseplates.	11.6.4
Erection drawings	
No additional requirements.	11.7

7.11.3 TRANSPORTATION AND DELIVERY

Components noted as AESS shall be marked and particular care taken to meet the requirements for handling in AS/NZS 5131.

The Structural Steel Contractor shall perform all work necessary to ensure safe loading, transportation, unloading and storage of structural steel. The Work shall consist of loading at the fabricator's plant, transporting to the site, and unloading and storing at the site, including temporary works for access.
Structural steel shall be loaded for shipping in such a manner that it can be transported and unloaded at its destination in the correct orientation for erection without being excessively stressed, deformed, or otherwise damaged.

Structural steel shall be stockpiled in such a manner to avoid excessive stress, deformation or other damage while stored.

Fabricated steelwork shall be delivered to site in such sequence as shall minimise time for erection, and exposure to potential damage. Where exposure times exceed the protective treatment manufacturer's recommendations, the Contractor shall make arrangements for temporary protection, alter the treatment specification accordingly, or allow for the appropriate maintenance treatment before closing in.

The Structural Steel Contractor shall make all arrangements necessary with relevant authorities for transportation of steelwork

7.12 GEOMETRICAL TOLERANCES

7.12.1 GENERAL

Fabrication and erection tolerances shall conform to the requirements of AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined in Section 4.12.3, together with a reference to the applicable clause in AS/NZS 5131.

7.12.2 CLASS FOR FUNCTIONAL TOLERANCES

The tolerance class for functional tolerances shall be Class 1 UNO on the project drawings.

7.12.3 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131

6.12.3.1 Special or additional tolerances No additional requirements.	12.1

7.13 INSPECTION, TESTING AND CORRECTION

7.13.1 GENERAL

Inspection, testing and correction shall conform to the requirements of AS/NZS 5131.

A quality plan shall be prepared as required covering each stage of the fabrication of the structure.

Particular requirements from AS/NZS 5131 are outlined below, together with a reference to the applicable clause in AS/NZS 5131.

All non-destructive testing requirements should be noted on the corresponding shop drawings.

7.13.2 ADDITIONAL PROJECT SPECIFIC TESTING

Testing of 'Lamellar tearing susceptible joints'

Completed welded joints which are indicted on the project drawings as 'Lamellar tearing susceptible' shall be ultrasonically tested to AS 2207 and AS/NZS 1554.1. The extent of ultrasonic testing is detailed on the Project Drawings.

The proposed Welding Procedure for LT susceptible details shall be approved before work is executed.

Z-plate requirements

Joints that are designated 'LT susceptible' and further require plate to a nominated Z-value are indicated on the project drawings with a designated Z-value. The plate identified in these joints shall be ordered to the designated Z-value and shall be ultrasonically tested to AS 1710 Class 1.

Testing of Web to Flange Welds (Fabricated Welded Sections)

Fabricated sections must comply with the relevant sections of NZS/AS 3679 and NZS 3404 for production and tolerances. Full double-sided welding of fabricated sections is required between the web and flanges designed to develop the full tensile strength of the web unless specifically noted otherwise on the drawings. Weld design is to be undertaken by the Contractors nominated supplier and design is to be supplied to the Engineer for review if requested.

A minimum of two pull-off tests shall be undertaken in accordance with AS/NZS 3679.2:2016 Clause 9 and AS1391 for each welded section type, in addition to the requirements of NZS/AS 3679.2:2016 Appendix B Table B2.

7.13.3 PARTICULAR REQUIREMENTS

	Clause in AS/NZS 5131
Inspection personnel	
Competency of inspection personnel: Independent inspection of welding shall be performed by a welding inspector with the following qualifications: 1. A Certification Board of Inspection Personnel (CBIP) New Zealand Welding Inspector qualification and/or; 2. International Institute of Welding (IWI) diploma as an IIW Welding Inspector, at the appropriate level. Inspection of protective coating systems in locations with surface-specific corrosivity of C3 to CX shall be performed by a New Zealand Certification Board for Inspection Personnel or NACE International certified coating inspector, or ACA hot dipped galvanized certified inspector.	13.2
Inspection of materials and components	
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the relevant Standards for the materials and components.	13.3.2
Non-conforming steel or components: If the documentation supplied does not meet the requirements of AS/NZS 5131, the steel or components shall be treated as non-conforming and treated as unidentified steel according to the requirements of AS/NZS 5131.	13.3.7
Testing of non-conforming steel or components: Testing of non-conforming steel or components shall be to the requirements of AS/NZS 5131.	13.3.8
Inspection of preparation and assembly	
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.5.1 of AS/NZS 5131.	13.5.1
Inspection of welding	
Welding inspector for NDE other than visual means The Structural Steel Contractor shall employ an independent weld inspector to carry out NDE other than visual means.	13.6.1.1
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.6.1.2 of AS/NZS 5131, specifically including a check of the fit-up before welding of SHS members.	13.6.1.2
Scope of inspection after welding: The extent and type of NDE shall be as per Table I6 and I7 of AS/NZS 5131. The weld failure consequence and seismic demand are designated on the Project Drawings. The extent and type of NDE for all other welds shall be 100% visual scanning and 25% visual examination to NZS 5131.	13.6.2.2
Assessment of weld defects: No additional requirements.	13.6.2.5
Welds on enclosed spaces: No additional requirements.	13.6.4
Inspection of mechanical fastening	
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.7.1 of AS/NZS 5131.	13.7.1

Non-conforming mechanical fasteners: If the documentation supplied does not meet the requirements of AS/NZS 5131, the mechanical fasteners shall be treated as non-conforming until such time as it can be reliably established that the mechanical fasteners meet the requirements of AS/NZS 5131.	13.7.4
Testing of mechanical fasteners: If testing of mechanical fasteners is undertaken to establish conformity, the type and extent of testing shall be consistent with that specified in AS/NZS 5131 and shall be sufficient to establish a proper statistical basis. Single or limited test results shall not be acceptable.	13.7.5
Inspection of fully tensioned high strength bolted connections	
Sampling plan: No additional requirements.	13.7.8
Inspection of mechanical and chemical anchors	
Proof testing: No additional requirements.	13.7.11
Inspection of surface treatment	
Inspection and test plan (ITP): For Coating Quality Level PC2, an ITP shall be prepared covering the inspection against the items specified in Section 13.8.1 of AS/NZS 5131.	13.8.1
Inspection of paint coatings	
Inspection and test plan (ITP): For Coating Quality Level PC2, an ITP shall be prepared covering the inspection against the items specified in Section 13.9.1 of AS/NZS 5131.	13.9.1
Inspection of galvanized coatings	
Inspection requirements: Inspection shall be undertaken according to the requirements of AS/NZS 4680.	13.10.1
Additional or special inspection requirements: No additional requirements.	13.10.1
Inspection of erection	
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.11.1 of AS/NZS 5131.	13.11.1
Additional or special inspection requirements: No additional requirements.	13.11.1
Location and frequency of measurements: All precambers to be surveyed following installation of primary steelwork.	13.11.7
Inspection of secondary structural elements	
Inspection of installation: An ITP shall be prepared covering the inspection of purlins and girts against the items specified in Section 13.12.2 of AS/NZS 5131.	13.12.2

7.14 SITE MODIFICATIONS AND REPAIR

7.14.1 GENERAL

Site modifications and repair shall conform to the requirements of Section 14 of AS/NZS 5131.

7.14.2 PARTICULAR REQUIREMENTS

No site modification to any steel member, connection component, mechanical fastener, weld or corrosion protection shall be made without a detailed written procedure. The written procedure shall be approved by the Construction Reviewer.

Appendix S.A

The following information is to be forwarded to the Engineer (Design Engineer or Construction Reviewer) for review, comment and records as described in this specification.

A.1 Submittals Structural Steel Constructor with SFC

Specification Clause	Item	Timeframe	Hold/Witness
7.4.11 7.13	ITPs for: • Material and components • Preparation, assembly and fabrication • Welding • Mechanical fastening • Surface treatment (for PC2 only) • Paint Coatings (for PC2 only) • Erection	Prior to commencing each stage of work	Hold
7.4.11	Steel Source List	Prior to ordering steel	Hold
7.4.11	Evidence of Structural Steel Conformity	Prior to fabrication commencing	Hold
7.4.11	Bolts Documentation	Prior to delivery to site	Hold
7.4.11	Cast-in threaded rod Documentation	Prior to delivery to site	Hold
7.4.11	Shop Drawings	Prior to commencing fabrication	Hold
7.4.11	Subcontractor details	Prior to first procurement of material	Witness
7.4.11	Evidence of certification under SFC scheme	Prior to commencing fabrication	Hold
7.4.5, 7.4.11.4.3	Producer Statement (PS3)	At completion of works	Hold
7.4.11	Erection Sequence Methodology	Prior to commencing erection if requested	Hold
7.4.11	Bolt Installation Inspection records	Regularly from commencement of bolting	Witness
7.4.11	Proposals for bolted connections not fully documented	Prior to fabrication	Hold
7.4.11	Proposal for bolting connection requiring rectification	Prior to further erection	Hold
7.4.11	Proposal for anchor bolts not meeting location tolerances	Prior to further erection	Hold
7.4.11	Proposal for alternate anchors	Prior to erection	Hold
7.4.11	Marking Steelwork exposed to view	Prior to commencing fabrication	Hold
7.4.11	Survey of erected structural steelwork	Completed erected steelwork prior to any encasing or fixing of cladding	Hold
7.4.11	As-built documentation	At completion of works	Hold
7.4.11	Non-conforming Work	As required	Witness
7.4.11	Manufacturers Data Report	At completion of works	Hold

APPENDIX S.B

Responsibilities to be assigned

Appendix B.3 of AS/NZS 5131 tabulates a range of responsibilities detailed in the Standard that need to be assigned. Standards do not assign responsibilities, as this is considered contractual.

For completeness, and to ensure the requirements of the specification are actioned appropriately, the contract documents need to assign at least the following responsibilities to relevant parties. The relevant party depends on the structure of the contract and scope of the project. This appendix provides suggested party to be assigned responsibility.

Responsibility to be assigned	Clause in AS/NZS 5131	Relevant Party Assigned in this Specification
4. Design, specification, documentation and traceability		
Preparation of the construction specification, including the individual parts of the specification	4.1.1	Design Engineer
Where required, preparation of the 'Project BIM brief' or 'BIM management plan'	4.3	Architect
Preparation of the shop detail documentation	4.4.1	Structural Steel Contractor
Approval of shop detail documentation	4.4.4	7.4.11.3
Preparation of quality documentation	4.5.1	Structural Steel Contractor
Preparation of quality plan	4.5.2	Structural Steel Contractor
Preparation of as-built documentation	4.5.4	Structural Steel Contractor
Preparation of purchasing procedure	4.6.1	Structural Steel Contractor
Responsibility for operating the purchasing procedure	4.6.1	Structural Steel Contractor
5. Materials		
Responsibility for operation of quality management system	5.1.2	Structural Steel Contractor
6. Preparation, assembly and fabrication		
Responsibility for operation of quality management system	6.1.2	Structural Steel Contractor
Preparation of work method statements	6.1.3	Structural Steel Contractor
Responsibility for supervision	6.12	Structural Steel Contractor
7. Welding		
Responsibility for operation of quality management system	7.1.1	Structural Steel Contractor
Preparation of welding plan	7.2.1	Structural Steel Contractor
Responsibility for welding coordination	7.4.3	Structural Steel Contractor
8. Mechanical fastening		
Responsibility for operation of quality management system	8.1.2	Structural Steel Contractor
Responsibility for preparation of work method statements	8.1.3	Structural Steel Contractor

Responsibility for supervision	8.9	Structural Steel Contractor
9. Surface treatment and corrosion protection		
9.2 Planning		
Preparation of work method statements	9.2.3	Structural Steel Contractor
9.9 Application of paint coatings		
Responsibility for supervision	9.9.20	Structural Steel Contractor
9.10 Application of galvanized coatings		
Responsibility for supervision	9.10.11	Structural Steel Contractor
11. Erection		
Preparation of safety plan	11.2.1	Structural Steel Contractor
Responsibility for operation of quality management system	11.2.2	Structural Steel Contractor
Preparation of work method statements	11.2.3	Structural Steel Contractor
Preparation of Erection Sequence Methodology (ESM)	11.5	Structural Steel Contractor
Review of ESM	11.5	Design Engineer
Preparation of erection drawings	11.7	Structural Steel Contractor
Responsibility for supervision	11.9	Structural Steel Contractor
13. Inspection, testing and correction		
Responsibility for inspection and testing for each stage of the project	13.2	Structural Steel Contractor
14. Site modifications during erection and modification and repair of existing structures		
Preparation of detailed written procedure	14.2	Structural Steel Contractor

APPENDIX A – PRODUCER STATEMENT

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PRODUCER STATEMENT – STRUCTURAL

The Contractor is required to furnish a completed and signed Producer Statement – Structural prior to the issue of the Certificate of Substantial Completion by the Architect (and Engineer) for the whole of the works or parts of the works as appropriate. A sample certificate is shown as Part A in this clause.

The Producer Statement – Structural is the final quality record statement covering all structural trades. The Producer Statement – Structural shall include the sign off for all structural trades by their nominated representatives as set out in Part B of this clause. The Contractor shall include one Part B certificate for each sub-contractor with his Part A certificate.

The issue and acceptance of the Producer Statement – Structural shall not relieve the Contractor of any responsibilities in respect of the full completion and maintenance of the works.

Part A – Main Contractors Statement

I,……, being the nominated representative of the Contractor, …….., hereby certify that all structural work relating to the ……. Project has been carried out in full accordance with all the Contract Documents and Contract Instructions.

Signed…….. Dated……

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Part B – Sub-Contractors Statement

I,……, being the nominated representative for the Reinforcing Steeltrade representing the subcontractor, ……hereby certify that all reinforcing steelwork relating to the ……..project has been carried out in full accordance with all the Contract Documents and Contract Instructions.

Signed…… Dated……

Similar format Part B Statements are required for each of the following structural trades:

1.0 Excavation
2.0 Concrete – General
3.0 Concrete – Precast
4.0 Concrete – Precast Flooring
5.0 Reinforcing Steel
6.0 Concrete Blockwork
7.0 Structural Steelwork

Drawing Register

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	Reason for Issue										
	PR	BC	BC								

PR: Peer Review
P: Preliminary
S: Schedule
BC: Building Consent
T: Tender

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