Kramer Ausenco

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Structural

Technical Specification

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Kramer Ausenco

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Revision	Date	Description	Author		Approver	
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2	12/10/2023	TENDER	CHRIS BARNES	STRUCTURAL ENGINEERING MANAGER	MARA HUNTER	COUNTRY MANAGER

Table of Contents

1 FORMWORK

1.1 GENERAL

In this specification, "forms" shall mean that part of the formwork in direct contact with the concrete. "Formwork" shall include the forms and all their supports. "Formwork" shall be deemed to include precast slab soffits and any propping to slab and beams.

All formwork is considered to be temporary works, hence the design of and the responsibility for the sufficiency of the whole of the formwork shall rest entirely with the Contractor.

Should any formwork be displaced during concreting or within the periods specified for the retention of formwork, the concrete shall be removed between such limits as the Engineer may determine, construction joints shall be formed and the section of work shall be reconstructed after the formwork has been strengthened and adjusted.

Concrete work which does not comply with the tolerances specified or has other defects due to inadequacy of formwork, shall be removed and replaced or the defect shall be remedied as directed.

Formwork shall be such as to produce concrete to the shapes, lines, level, grades and dimensions, required by the contract drawings within the tolerances specified.

1.1.1 Safety

Notwithstanding the requirements of this specification, nothing contained herein shall absolve the Contractor from responsibility for the safety of the work.

1.1.2 Discrepancies

All discrepancies between the contract documents shall be referred to the Engineer for decision before proceeding with the work.

1.1.3 Inspections

The Contractor is to ensure the formwork has been constructed in accordance with the design intent of the Contractor's Formwork Engineer. Kramer Ausenco Structural Engineers do not undertake inspections for the structural integrity and structural sufficiency of the formwork.

1.2 STANDARDS

Formwork shall comply with the current edition of the standards listed below as applicable, unless specified otherwise:

AS 3610-1995	Formwork for concrete
AS 3600	Concrete structures
AS 4100	Steel Structures
NZS 3104	Concrete Structures
NZS 3404	Steel Structures

1.3 MATERIALS

Formwork shall be constructed of timber, sheet metal or other approved material. Ties shall be of the rod and cone or other approved proprietary type. Ties for use in water-retaining structures shall incorporate a water barrier sleeve or washer to the mid-point of the tie, designed to prevent water passing along the tie.

All materials and equipment used in formwork construction must be fit for the intended purpose and meet design specifications. Materials and equipment must be designed to conform to the relevant Standards or equivalent. Materials and equipment must be manufactured in accordance with a quality assurance system that ensures compliance with the design specification.

1.4 STABILITY

Forms shall be constructed from sound materials properly supported and braced or tied to maintain position and shape during and after the placing of the concrete.

The formwork shall be sufficient for all loadings and stages (I, II & III) in the construction cycle in compliance with Clause 4.4.1 of AS 3610.

Formwork shall be supported in a manner, which will prevent its settlement.

1.5 DESIGN OF FORMWORK

Formwork shall be designed by the Contractors appointed Formwork Engineer.

The design and construction of formwork shall take account of safety and of the surface finish required. The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from fresh concrete or the formation of fins or other blemishes on the concrete.

Formwork and its supports shall maintain their correct shapes and profile so that the final concrete structure is within the limits of the specified dimensional tolerances.

Formwork shall be designed to withstand the worst combination of self-weight, reinforcement weight, wet concrete weight, concrete pressure, construction and weather loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete. Formwork shall not be tied to or supported by the reinforcement.

1.6 TOLERANCES

The dimensional tolerances of the formwork shall be such that the concrete produced from the forms shall conform to the dimensional tolerances specified herein.

The Contractor shall check the lines, levels and grades of the formwork before placing of concrete.

Dimensions, levels and grades for the seating's or supports of all precast units shall be checked and passed before any unit is hoisted and fixed in position.

Dimensional tolerances on formed surfaces and structural member thickness shall be in accordance with those shown below.

1.6.1 Location and Verticality

1.6.1.1 Columns and Beams

No point on a column or beam shall be constructed further from its nominal absolute plan location than the greater of:

- 6 mm
- the height of the point concerned above ground floor divided by 2000

No point on a column or beam shall be constructed further than 6 mm in plan from the corresponding point on the floor below.

1.6.1.2 Walls

No point on an in situ reinforced concrete wall shall be constructed further from its nominal absolute plan location than the greater of:

- 6mm
- the height of the point concerned above ground floor divided by 4000

No point on an in situ reinforced concrete wall shall be constructed further than 3mm in plan from the corresponding point on the floor below.

1.6.1.3 Other Points

The maximum acceptable tolerance in the measured plan distance of any point on the structure from the nearest as-constructed column or beam centre-line shall be the lesser of:

- the distance divided by 400;
- 6 mm.

The maximum acceptable tolerance in any nominal plan dimension of the structure shall be the lesser of:

- the distance divided by 400;
- 25 mm.

1.6.2 Level

No point shall be constructed more than 5mm above or below the required nominal construction level.

The required nominal construction level may differ from the nominal final level at the discretion of the Engineer subject to computations of settlement and column compression.

1.6.3 Size of Openings in Walls and Floors

The tolerance for dimensions of openings in walls and floors shall be -0 + 6 mm.

1.6.4 Cross-Sectional Dimensions

The tolerance for cross-sectional dimensions of columns and beams and in the thickness of slabs and walls shall be -0 + 12 mm.

1.7 FORMWORK CLASS

The physical quality of concrete surfaces are specified under a class number (1, 2, 3, 4 & 5) in accordance with Table 3.3.1 of AS 3610.

The classes or types of forms required are specified in this section.

Without being limited to the following, the formwork types are:

- Class 2 for all surfaces that are to be exposed to view.
- Class 3 for all surfaces that are to receive an applied surface finish.
- Ground formwork.

Physical quality of the concrete surface shall be adhered to as specified. If no available specification is made, then it shall be assumed to be class 3 unless visible and then it will be class 2. When the drawings do not show that elements such as piers and/or beams below ground are to be cast against formwork then no formwork shall be required other than:

- that which may be necessary to prevent the sides of the excavation collapsing and/or;
- as a suitable membrane to prevent the contamination of the concrete or to prevent loss of water, slurry or fines or keep the reinforcement clean during the placing of the concrete.

The approval of the Engineer to install such formwork shall be required.

1.8 ERECTION OF FORMWORK

1.8.1 Re-Use Of Forms

The number of re-uses and the condition of faces and edges of forms shall be consistent with the concrete surface type specified.

1.8.2 Cleaning Of Forms

Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from water, dirt or other foreign matter.

All dust, debris and rust or other stains shall be removed from the interior of the forms before the concrete is placed.

In order to facilitate the removal of major debris and to allow inspection immediately before the placing of concrete certain of the forms shall be readily removable. Minor debris, dust, etc, shall be removed by vacuum cleaning, compressed air or the equivalent.

1.8.3 Treatment of Forms

Except where the surface is subsequently to be rendered, formwork in contact with the concrete shall be treated with a suitable non-staining release agent before the steel is fixed or the concrete placed to prevent the concrete from adhering to it. Care shall be taken to prevent the release agent from touching the reinforcement or concrete at construction joints. Surface retarding agents shall not be used unless specified.

Sufficient evidence of tests shall be provided to ensure that no reaction which will affect the concrete surface will occur between any concrete additives, release agents, form surface coatings or curing compounds. If special form liners are to be used, the manufacturer's specifications and recommendations on application and removal are to be adhered to.

1.8.4 Joints in Forms

All formwork joints shall be mortar tight and any indication in the finished concrete that this was not achieved will render that concrete liable for rejection.

1.8.5 Formwork Openings

Openings for inspection of the inside of the formwork, for the removal of water used for washing down and for placing concrete shall be provided and so formed as to be easily closed before or during placing concrete.

1.8.6 Form Ties

Where ties are built into concrete for the purpose of supporting formwork, part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be within 50mm of the surface in the case of reinforced concrete or 150mm in the case of unreinforced concrete. Holes remaining after removal of such supports shall be neatly filled with epoxy or well rammed dry-pack mortar to the approval of the Engineer.

1.8.7 Built-in Fixtures and Void Formers

Before placing concrete all bolts, pipes or conduits or any other fixtures which are built in shall be fixed in their correct positions, and cores and other devices for forming voids or holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without prior approval of the Engineer.

1.8.8 Exposed Concrete Edges

Unless shown otherwise on the Drawings or permitted by the Engineer, all exposed edges, corners and angles on exterior finished concrete shall have 20mm chamfers and bevels set at 45 degrees to the surface and finished to a neat smooth surface.

1.8.9 Forms for Sloping Work

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds 15 degrees from the horizontal unless otherwise specified, and shall be anchored so that the concrete can be properly compacted and to prevent flotation. Care shall be taken to prevent air being trapped.

1.9 STRIPPING OF FORMS

Formwork shall be so designed as to permit easy removal without resorting to hammering or levering against the surface of the concrete.

Stripping of forms shall be carried out in a controlled and planned manner that ensures the gradual transfer of loads from the formwork or the supports, to the permanent structure. Procedures that may potentially damage the permanent structure shall not be used.

Forms shall not be disturbed until the concrete in contact with them has hardened sufficiently to withstand such action without damage.

The back-propping regime and formwork design is the sole responsibility of the Contractor. The Contractor is to employ at their own expense a competent temporary works engineer to undertake the temporary works design required in developing a back propping regime.

In any case, Table A shall be used as a minimum for stripping times for concrete made with Portland Cement Type 'GP'.

TABLE A
(Table 5.4.1 AS 3610)
Minimum Formwork Stripping Times – In Situ Concrete

Formed surface	Classification	Hot conditions > 20°C	Average conditions ≤ 20°C > 12°C	Cold conditions ≤ 12°C ≥ 5°C
Vertical faces	Classes 1, 2, 3 (see Note 2)	1 day	2 days	3 days
	Classes 4, 5	9 hours	12 hours	18 hours
	All Classes	A minimum of one day applies to the stripping of vertical faces where frost damage is likely		
Beam and slab soffits	Forms	4 days	6 days	8 days
	Supporting members (shores or backdrops)	12 days	18 days	24 days

Notes:

1. The stripping times for beams and slab soffits for members cured in conditions less than 5°C shall be increased by half a day for each day on which the daily average temperature was between 2°C and 5°C, or by a whole day for each day on which the daily average temperature was below 2°C.
2. Where colour-control is specified it may be advisable to strip forms early, subject to the limitations given.

Removal of bottom forms between bearers or props prior to the removal of supports may be permitted by the Engineer provided the formwork has been designed to allow such removal without disturbance of the supports.

Forms shall not be stripped before the concrete supported by them has attained the percentage of the strength designated in Table B. The strength of the concrete at stripping shall be taken as the average strength of two (2) cylinders taken from the pour to be stripped. It shall be the responsibility of the Contractor to obtain such prior approval otherwise stripping time shall be as Table A or as directed by the Engineer.

TABLE B
% of F'c (28 Days Value)

Element	Surface	Design Span (m)	Proportion of Design Load (DL + LL) On Slab At Stripping			
			¼	½	¾	1
Beams and Slabs, including Composite Beams	Horizontal	2 and less	50	60	75	100
		3 and less	55	65	80	100
		5 and less	55	70	85	100
		7 and less	80	80	85	100
		8 and less	85	90	95	100
		Above 8	95	95	95	100
		Design Height (m)				
Walls, Beams, Slabs and Columns	Vertical	2 and less	30	30	40	40
		3 and less	40	40	50	50
		Above 3	50	50	60	60

The Contractor shall provide sufficient back-propping to ensure that the loading caused by green concrete floors (not up to design strength F'c as shown in the Specification or on the drawings) formwork, building equipment and materials is supported by such a number of concrete floors that no floor carries loads exceeding its capacity based on Table B. The number of floors to remain back-propped will depend on the design dead and live load of the floors, the pouring cycle and the rate at which the concrete gains its strength.

TABLE C
(Table 5.4.2 AS 3610)
Early-Age Mean Strengths for Normal-Class Concrete

Minimum Mean Compressive Strength (f_{cm}), MPa			
At 3 days		At 7 days	
Grade designation	f_{cm}	Grade designation	f_{cm}
N20E3	9	N20E7	15
N25E3	12	N25E7	19
N32E3	15	N32E7	24
N40E3	18	N40E7	30
N50E3	23	N50E7	37

The number of levels of back-propping shall be subject to the approval of the Engineer. The Contractor shall submit detailed engineering computations in support of his proposed temporary supports.

Special attention should be made to the requirements of AS 3610 Clause 5.4.4 with relation to back-propping and Table D below.

TABLE D
(Table 5.4.3 AS 3610)
Multistorey Formwork-In Situ Concrete Minimum Number of Levels of Undisturbed Supports

Time Between Pours of Successive Floors, days	Minimum Number of Levels of Supports in Use				
	Average Ambient Temperature, °C				
	5	10	15	20	25
5	5	5	4	4	3

7	4	4	3	3	3
11	3	3	2	2	2
14 or more	3	2	2	2	2

Notwithstanding the foregoing the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

1.10 DEFECTS IN FORMED SURFACES

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.

Any minor surface blemishes shall be repaired to the satisfaction of the Engineer immediately after removal of formwork. Remedial measures may include, but shall not be limited to, the following:

- Holes left by formwork supports shall be thoroughly cleaned out to remove all loose material and the sides shall be roughened, if necessary to ensure a satisfactory bond. They shall then be filled with epoxy or dry-pack mortar.
- Fins, pinhole bubbles, surface discolouration and minor defects may be rubbed down with sacking and cement immediately the formwork is removed.
- Irregularities may be rubbed down with carborundum and water after the concrete has been fully cured.

Where, in the opinion of the Engineer the defect is too extensive to permit satisfactory repair, either from the point of view of structural integrity or appearance, the concrete containing the defect shall be broken out and replaced.

2 CONCRETE

2.1 GENERAL

The work in this section includes, but is not limited to the supply and placing of all concrete work shown on the Drawings together with all sundry items in connection there with. This specification is to be read in conjunction with other Kramer Ausenco related specifications where applicable, i.e. reinforcement, post tensioning, and precast units.

2.1.1 Safety

Notwithstanding the requirements of this Specification nothing contained herein shall absolve the Contractor from responsibility for the safety of the concrete construction work.

2.1.2 Discrepancies

All discrepancies between the contract documents shall be referred to the Engineer for a decision before proceeding with the work.

2.1.3 Inspections

The Contractor shall give a minimum of three full working days' notice to the Engineer for inspection of the following stages of work:

- Formwork ready for concrete;
- Reinforcement in position;
- Other items as directed on the job by the Engineer.

Prior to the inspection by the Engineer, the reinforcement and formwork over the extent of the pour, must be completed and checked by the Contractor.

Please note. Although the Engineer will perform an inspection of a particular element, the performance of this inspection does not relieve the Contractor of their responsibility to construct the element in accordance with the contract documentation.

2.2 STANDARDS

All concrete work shall be carried out in accordance with the requirements of the following Standards:

AS 1012	Methods of testing concrete Part 1 - Sampling of fresh concrete Part 3.1 - Determination of properties related to the consistency of concrete - Slump test Part 8.2 - Method for making and curing concrete - Flexure test specimens Part 13 – Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1141	Methods for sampling and testing aggregates
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout Part 1 – Admixtures for concrete
AS 2758	Aggregates and rock for engineering purposes Part 1 – Concrete aggregates
AS 3610	Formwork for concrete
AS 3972	General purpose and blended cements
AS/NZS 4671	Steel reinforcing materials

ASTM C309	Standard specification for liquid membrane - Forming compounds for curing concrete

Reference to the above Standards shall be deemed to include reference to all parts of each standard and any supplementary volumes and shall be deemed to be the latest edition of the standard.

2.3 MATERIALS

All materials shall be in accordance with AS1379 – (2007).

2.3.1 Cement

Cement shall be Type GP Portland cement, complying with AS 3972, unless specified otherwise, or permitted by the Engineer.

2.3.2 Cement Replacements

Cement replacements or pozzolan, may be used with the Engineer's approval but at no stage exceed 20% cementitious replacement.

2.3.3 Aggregates

2.3.3.1 Fine Aggregates

Fine aggregate shall be clean, hard, durable grains of an approved crushed rock, free from deleterious matter and of a grading to comply with AS 2758 Part 1. The maximum aggregate size shall be 2.36mm.

Submit grading envelope and curves to the Engineer for approval.

2.3.3.2 Coarse Aggregates

Coarse aggregate shall be hard and durable and approved crushed rock free from dust and other deleterious matter and conforming in cleanliness and all other respects with AS 2758 Part 1 and the requirements of AS 1141.

All coarse aggregate shall comply with the requirements of the 'Los Angeles Abrasion Test' described in AS 1141.23.

The maximum nominal size of aggregate which may be used in all grades of concrete shall be 20mm except in mass concrete where the maximum nominal size shall be 40mm.

Submit grading envelope and curves to the Engineer for approval.

If required by the Engineer, samples of all aggregate are to be taken, packaged and classified as set out in AS 1141 and are to be delivered to the Engineer for approval. In the event of such sampling the Contractor shall obtain a written certificate from the Engineer stating that the aggregate is suitable for the class of concrete concerned before proceeding with the work.

2.3.4 Water

Water shall be clean and free from impurities (injurious amounts of oils, acids, alkalis, organic materials) harmful to concrete and its reinforcement and neither salty nor brackish. Water which is not potable for human consumption shall not be used in reinforced concrete.

2.3.5 Admixtures

Admixtures shall not be added to concrete except where specified and only with the prior written approval of the Engineer.

Approval for use of admixtures may be given where the Contractor can show to the satisfaction of the Engineer that it would be in the interest of the work for such admixture to be included without increasing the Contract Sum.

Chemical admixtures and their use shall comply with AS 1478 Part 1. Addition of chloride salts or additives containing significant chlorides shall not be permitted.

2.3.6 Pigments

An approved Manufacturer shall manufacture inorganic colour pigment required to achieve the required colour.

Pigment shall be added to the cement by weight batching at the cement Manufacturer's works. The pigment shall be thoroughly mixed with the cement so as to achieve a uniform colour in the mix. Uniformity of colour is of the utmost importance.

2.4 CONCRETE MIX DESIGN

Unless otherwise stated concrete shall consist of a mixture of Portland cement, fine aggregate, coarse aggregate, water and admixtures if permitted.

The design of the mix shall be such as will produce a plastic concrete which will work readily into corners and angles of forms and around reinforcement with the method of placement employed but without permitting the materials to segregate or excess free water to collect on the surface.

The Contractor shall submit details of the concrete mix he proposes to use for each Grade of concrete together with the records which justify the mix proportions. The maximum allowable water cement ratio shall be in accordance with the mechanical properties table in this specification.

The Contractor shall nominate a slump for each grade of concrete such that it satisfies the requirements of AS 1012 Pt3.

Preliminary mixes shall be made for concrete of Grade 25 MPa or greater where records to justify the mix proportions are not available. The preliminary mixes shall be made in the presence of the Engineer using the approved constituent materials. The average strength of six cylinders tested at 28 days shall be not less than the target strength for the concrete grade and no cylinder shall have strength less than the characteristic strength for the grade.

No concrete shall be placed until the mixes have been examined by the Engineer.

2.5 MECHANICAL PROPERTIES OF CONCRETE

Unless noted otherwise on the relevant Kramer Ausenco drawings, the following mechanical properties are to be achieved with respect to the grade or compressive strength value of the concrete.

Mechanical Properties for various concrete mixes					
Compressive strength (MPa)	**10MPa**	**25MPa**	**30MPa**	**35MPa**	**40MPa**
Flexural Tensile Strength (MPa)	1.9	3	3.3	3.5	3.8
Slump (mm)	80±15	80±15	80±15	80±15	80±15
Maximum Water/Cement Ratio	0.6	0.55	0.55	0.5	0.45
Density (kg/m3)	2,200	2,200	2,200	2,200	2,200
Chloride Content (% by weight of cement)	0.2%	0.2%	0.2%	0.2%	0.2%

Sulphate Content (% by weight of cement)	5%	5%	5%	5%	5%
Drying Shrinkage Strain (μm)	750 μm	750 μm	750 μm	750 μm	750 μm

2.6 COMPLIANCE WITH SPECIFICATION AND TESTING

When requested, the Manufacturer shall submit in writing test certificates from a Laboratory registered with the National Association of Testing Authorities (NATA) as evidence that materials used comply with the requirements specified. Such test shall be conducted at the Manufacturer's experience.

Test specimens from any batch of concrete shall be sampled in accordance with AS 1012 Part 1.

Except in the instance of post tensioned structures, all samples shall consist of three cylinders of 150mm diameter and 300mm in height. One cylinder shall be tested at 7 days and the other two at 28 days. Refer to the Post Tensioning Specification for number of samples required for testing.

To identify samples the following data must be recorded in the Sampler's field book:

- Entry point to site;
- Date and time of taking the sample;
- Air temperature at time and location of placing;
- Name of the Supplier;
- Number of delivery docket or batch;
- Method of sampling;
- Location of sampling;
- Method of identifying cylinder;
- Location of batch of concrete after its placement;
- Slump of sample;
- Characteristic compressive strength

Notwithstanding the requirements of AS 1012 for compliance of concrete if any sample has a test strength less than the specified characteristic strength then the concrete represented by that sample shall be liable to rejection, demolition or strengthening at the discretion of the Engineer and at the Contractor's expense.

2.6.1 Supervision

The Contractor shall be wholly responsible for producing concrete with the specified properties and shall produce all concrete under the supervision of a foreman experienced in this class of work. A well maintained copy of the latest revisions of AS 1012 Part 1 and AS 3610 shall be kept in the site office.

2.6.2 Slump Test

Carry out slump test in accordance with AS 1012.3.1 Method 3.1. These tests may be carried out by suitably trained Manufacturer's personnel and the Manufacturer shall provide all equipment and pay all associated costs.

The slump shall be deemed to comply with that specified if the measured slump is within the limits given in Table 5.1 of AS 1379.

The consistency of the concrete shall be such as to produce a slump under test within the range shown for the specified grade of concrete.

Consistency of the concrete shall not be adjusted by the further addition of water to the mix.

2.6.3 Characteristic Compressive Strength F'c

The characteristic compressive strength of the concrete shall be as noted on the relevant Kramer Ausenco drawings. If no concrete strength is clearly shown, the Engineer is to be contacted or a minimum strength of 40 MPa is to be used.

All aspects of testing, including quantity and methods, shall be in strict accordance with AS 1012 Pt.

The following test regime shall be adhered to for the compression testing of concrete:

Pour Size	Number of Test
1-5 m3	1
6-25 m3	2 (First Delivery and one other)
26–50 m3	3 (First delivery and two others at random)
51 or More	1 additional sample for every 50m3

Once test shall consist of 3 samples of concrete as per AS 1012 Pt1.

The Engineer reserves the right to have all concrete which falls below the compressive strength required removed and replaced at the Contractor's expense without any additional testing. The Contractor shall also replace any associated works affected by the defective concrete at their own expense.

No extension of time of completion will be granted for delays occasioned by removal of concrete and any associated work.

2.6.4 Drying Shrinkage Tests

Where records of an approved mix are not available the concrete shall be tested for drying shrinkage at intervals of not exceeding one month during the manufacturing period.

Anticipated drying shrinkage limits shall be measured for the proposed mix design by submitting samples of drying shrinkage tests in accordance with AS 1012 Part 13. Each sample shall consist of three specimens. The measure of drying shrinkage at 56 days shall not exceed the value on the relevant Kramer Ausenco drawings, or if no figure is present the value in the "Mechanical Properties Table" of this specification. Shrinkage tests shall commence within 14 days of the award of the contract to the manufacturer to enable representative shrinkage results to be available prior to construction. The manufacturer shall report to the Engineer the progressive drying shrinkages of the test samples at each drying period namely air drying of 14, 21, 28 and 56 days duration.

Details of the aggregate origins are to be included in the test reports.

2.6.5 Flexural Tensile Strength

Where records of an approved mix are not available the flexural tensile strength of the proposed mix design shall be determined prior to the commencement of the work by submitting a sample of three specimens to the flexure test prescribed in AS 1012 Part 8.2.

The Concrete shall be further tested for flexural tensile strength at intervals not exceeding one month during manufacture. The number of samples and test procedures shall be as above.

The flexural tensile strength of all specimens shall be as specified on the Kramer Ausenco drawings or if no value is present as per the "Mechanical Properties Table" of this specification.

2.7 MIXING AND PLACING CONCRETE

Concrete shall be mixed and batched in accordance with AS 1379 –(2007)

The Contractor shall ensure that materials for ready-mixed concrete are handled and stored in accordance with the requirements of Section 4 of AS 1379.

Concrete shall be transported from the mixer to the place of final deposit by clean vehicles, skips containers or chutes, as rapidly as possible and in such a manner that avoids segregation or loss of materials, stiffening or proper placing and compacting.

Where the air temperature is less than 5°C or greater than 35°C the provisions of AS 1379 are to be adhered to.

No concrete shall be placed until the foundation material, forms, reinforcing and pressurising materials have been inspected by the Engineer.

Concrete shall be thoroughly compacted by the use of mechanical vibrators and hand methods and carefully worked around into the corners of the formwork. Coarse aggregate shall be worked back from the forms to enable a full surface of mortar against the form without forming excess surface voids. All air or stone pockets are to be eliminated to prevent honeycombing, pitting or places of weakness.

The Contractor shall keep at hand on site one spare mechanical vibrator over and above those for use in an emergency.

No water shall be added to Ready Mix Concrete subsequent to leaving the batching plant without prior approval of the Engineer.

2.8 CURING

2.8.1 General

Freshly cast concrete shall be protected from premature drying and excessively hot and cold temperatures. In windy conditions wind breaks shall be erected to shield the concrete surfaces during and after placement. The concrete shall be maintained at a reasonably constant temperature with minimum moisture loss for the curing period. Curing methods, which do not conform to the requirements of this Specification, shall not be used without prior approval of the Engineer.

2.8.2 Unformed Surfaces

All exposed surfaces of concrete (surfaces which are not in contact with forms) shall be cured by one of the following methods for at least 14 days:

- Ponding or continuous sprinkling with water.
- Covering with an impermeable membrane concrete that has taken its initial set and that has been moistened with a fine spray of water. The covering material shall be held firmly against the concrete for the full length of all edges and laps and at frequent intervals between so that there shall be no air circulation at the concrete surface.
- The use of an absorptive cover kept continuously wet.
- The use of curing compounds conforming to ASTM C309. Such compounds shall be applied in accordance with the Manufacturer's recommendations and shall not be used on any surface against which additional concrete or other finishes are to be placed. Curing compounds must not be used without written approval of the Engineer.

2.8.3 Formed Surfaces

Metal forms heated by the sun and all timber forms in contact with the concrete shall be kept continuously wet during the curing period.

Immediately following stripping of formwork final curing of all formed surfaces of concrete, which have been placed for less than 7 days, shall be carried out by one of the methods stated in the “Finishing” section of this specification and continued for the remainder of the curing period.

Curing shall commence immediately after initial set of the concrete and shall continue until the cumulative number of days or fractions thereof - not necessarily consecutive - during which the temperature of air in contact with the concrete is above 10°C has totalled 7 days for normal Portland cement concrete.

For concrete made with high early strength cement the curing shall continue for 3 days.

Rapid drying out at the end of the curing period shall be prevented.

2.9 PROTECTION

Freshly placed concrete shall be protected from rain damage and from wind exposure in windy conditions by erecting approved windbreaks or covering the concrete with polythene membrane with joins securely taped. It shall also be protected from damage due to excessive loading, heavy shocks and excessive vibration during the curing period. Foot traffic shall not be permitted on freshly placed concrete for at least 24 hours after placement.

Exposed finished concrete surfaces shall be protected from damage, staining and contamination. Starter bars, miscellaneous metal work and other exposed reinforcement shall be protected so as to prevent rusting and the subsequent staining of completed concrete surfaces caused by water run-off. Chemical or other stain removal methods shall not be used as an alternative to prevention of stains on finished concrete surfaces.

All concrete which is cast against ground shall be cast against and approved DPM. The structural requirements of the DPM are as follows:

1) Prevent concrete contaminations with earth and or bedding sand
2) Prevent loss of bleed water into the earth during the concrete curing process.

The mechanical properties of the structural DPM are as follows:

1) Minimum of 200microns in thickness
2) Must be Virgin Plastic
3) High impact Resistance (IR3 in accordance with AS 2870 and AS 4347.6)

The structural use of a DPM does not consider the following in services requirements

1) Resistance of rising water or Damp
2) Resistance to Hydrostatic Pressure
3) Resistance to Vapour
4) Resistance to Gases

2.10 FINISHING

All concrete is to be finished in accordance with the Architectural Specifications; however the following is to be achieved as a minimum for structural compliance.

Should there be discrepancy between the information below and the Architectural Specification the following process is to be adhered to:

i. **Finish type**. The Contractor shall refer to the Architect’s Specification for finish types for formed and unformed surfaces should any discrepancy arise.
ii. **Tolerances**. The Contractor shall use the smaller value of permissible tolerance of both the figures below and the Architect’s Specification if any discrepancy arises.

2.10.1 Formed Surfaces

All formed surfaces which will be exposed to view in the completed structure (other than the underside of slabs or other surfaces exempted by the Engineer) shall be finished in the following manner:

- Immediately upon removal of forms, all fins and projections shall be ground off and the concrete surface washed down.
- A 1:1 fine sand cement paste shall then be bagged over the surface.
- After drying (1 hour approximately) the surface shall be rubbed with a dry bag to remove all bagging marks.
- Curing shall be commenced immediately after rubbing.

2.10.2 Unformed Surfaces

The unformed surface of the concrete shall be finished in accordance with the following table, in which the concrete finish type shall be as described in Type A to Type G below and the tolerance in the “Tolerance” section of this specification.

Element	Concrete Finish Type	Tolerance
Office Floor	Type C	Class A
Footpaths and verandas	Type D	Class B
Plant Room & Wet Area Floors	Type B	Class B
Industrial Pavements	Type	Class A

2.10.2.1 Concrete Finish Type

2.10.2.1.1 Type A - Scratched Finish

After the concrete has been placed, struck off, consolidated and levelled to a Class C tolerance the surface shall be roughened with stiff brushes or rakes before final set.

2.10.2.1.2 Type B - Floated Finish

After the concrete has been placed, struck off, consolidated and levelled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats. Hand floating with wood or corked-faced floats shall be used in locations inaccessible to the power-driven machine. Trueness of surface shall be re-checked at this stage with a 3 metre straight edge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to a Class B tolerance. The slab shall then be re-floated immediately to a uniform smooth granular texture.

2.10.2.1.3 Type C - Steel Trowelled Finished

Where a trowelled finish is specified, the surface shall be finished first with power floats as specified above where applicable; then with power trowels and finally with hand trowels. The first trowelling after power floating shall produce a smooth surface which is relatively free from defects but which may still contain some trowel marks. Additional trowelling shall be done by hand after the surface has hardened sufficiently. The final trowelling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand trowelling operations. The finished surface shall be free from any trowel marks, uniform in texture and appearance, and shall be planed to a Class A tolerance. On surfaces intended to support floor coverings any defects of sufficient magnitude so as to show thorough the floor covering shall be removed by grinding.

2.10.2.1.4 Type D - Broomed Finish

Pavement slabs and slabs in other locations so specified shall be given a coarse transverse scored texture by drawing a stiff broom or hessian belt across the surface. This operation shall follow immediately after floating and shall be performed as outlined in Type C in the foregoing.

2.10.2.1.5 Type E - Non-Slip Finish

Where a non-slip finish is required the surface shall be given a “dry shake” application of crushed chemically bonded aluminium oxide or other abrasive particles acceptable to the Engineer. The rate of application of such material shall be not less than one kilogram per square metre.

2.10.2.1.6 Type F - Two Coarse Heavy Duty Topping

The topping shall be applied on the same day as the base slab is placed.

The topping mixture shall be composed of material selected to impart heavy duty wearing properties to the finished slab.

The mixture shall consist of 1 part Portland cement, 1 part of fine aggregate and approximately $1^{1}/_{2}$ parts coarse aggregate by damp loose volume. The coarse aggregate shall have a minimum size of 10mm. The exact proportions of fine and coarse aggregate shall be adjusted to produce a well-graded total aggregate. Mixing water shall not exceed 20 litres per 40kg bag of cement. The topping mixture shall be of zero slump.

After the base slab has been placed, screeded 25mm below required finish surface and consolidated and as soon as any surface water has disappeared the topping mixture shall be spread, consolidated, floated, checked for trueness of surface, and trowel finished except that power-driven floats shall be of the impact type.

2.10.2.1.7 Type G - Exposed Aggregate Finish.

Immediately after the surface of the concrete has been levelled to a Class B tolerance and set sufficiently to show no surface water, aggregates of selected colour and size (usually 10 to 15mm diameter) shall be spread uniformly over the surface to provide complete coverage to the depth of a single stone.

The spread of selected aggregate shall be embedded into the surface by light tamping and the surface shall be floated until the embedded stone is fully coated with mortar and the surface has been brought to true planes. Exposure of the aggregate shall start after the matrix has hardened sufficiently to prevent dislodgement of the aggregate. Water in copious quantities but without force shall be allowed to flow over the surface of the concrete while the matrix encasing the selected aggregate is removed by brushing with a fine bristle brush. The operation shall continue until the selected aggregate is uniformly exposed but not dislodged.

An approved chemical retarder sprayed on to the freshly floated surface may be used to extend the working time for exposure of aggregate.

2.10.2.2 Concrete Tolerance Class

The surface of the concrete shall be finished as specified to the tolerances listed below.

Class A: True planes within 3mm in 3m, as determined by a 3m straightedge placed anywhere on the slab in any direction.

Class B: True planes within 6mm in 3m, as determined by a 3m straightedge placed anywhere on the slab in any direction.

Class C: True planes within 6mm in 600mm, as determined by a 600mm straightedge placed anywhere on the slab in any direction.

2.11 WORK FOR OTHER TRADES

The Contractor shall build in fillets, cast in fastenings, bolts and sleeves and form all holes, recesses and chases required by all trades and as described in this Specification or indicated on the drawings.

3 REINFORCEMENT

3.1 GENERAL

The required ductility grade of the reinforcement, as described below, shall be as per the reinforcement drawings.

Bar reinforcement shall be bent to the shapes shown on the Drawings. Any ambiguity shall be referred to the Engineer for clarification.

Unless shown otherwise on the detail drawings, cover to reinforcing bars shall be as specified in AS 3600 for the required conditions of exposure. Concrete blocks or plastic chairs shall be used to maintain cover to external faces or faces in contact with earth.

3.1.1 Safety

Notwithstanding the requirements of this Specification nothing contained herein shall absolve the Contractor from responsibility for the safety of the work.

3.1.2 Discrepancies

All discrepancies between the contract documents shall be referred to the Engineer for decision before proceeding with the work.

3.1.3 Inspections

The Contractor shall give a minimum of three full working days' notice to the Engineer, for inspections of the following stages of work:

- Formwork ready for concrete;
- Reinforcement in position;
- Other items as directed on the job by the Engineer.

Prior to the inspection by the Engineer, the reinforcement and formwork over the extent of the pour must be completed and checked by the Contractor.

Please note. Although the Engineer will perform an inspection of a particular element, the performance of this inspection does not relieve the Contractor of his/her responsibility to construct the element in accordance with the contract documentation.

3.2 STANDARDS

Steel reinforcement shall comply with the current standards listed below as applicable:

AS 3600	Concrete structures code
NZS 3104	Concrete structures
AS/NZS 4671	Steel reinforcing materials
AS 1554	Structural steel welding Part 3 – Welding of reinforcing steel

3.3 MATERIALS

The grade of reinforcement shall be specified as follows:

- Bar Shape - Lower Bound Yield Strength-Ductility Class

For Example H**D500N** is a **D**eformed bar and has lower bound yield strength of **500**MPa with a **N**ormal ductility class.

3.3.1 Source of Materials

All materials in this structure are subject to and reliant on the requirements of this specification. Material may only be sourced from Approved Steel Mills which have demonstrated appropriate levels of quality assurance and testing. Approved Steel Mills are steel mills which have been verified by ACRS and certificates of currency from ACRS for the steel supplier at the time of steel purchase are to be provided and approved by KA before fabrication commences

3.3.2 Permissible Reinforcements

Only the following grades of reinforcement shall be used:

- HD500 or D300 class E

3.3.3 Shape and Size

Steel reinforcement is to be supplied as "**D**eformed ribbed" bar in accordance with Clause 5.4 of AS/NZS 4671 unless noted otherwise on the drawings. The only other shape permitted, upon reference to engineering drawings is "**R**ound" bar. This will be clearly denoted on engineering drawings.

The bar sizes shall be as per the engineer's drawings. Unless noted otherwise, the only bar sizes to be used are as follows:

- 8mm
- 10mm
- 12mm
- 16mm
- 20mm
- 25mm
- 32mm

Smaller sizes may be used in meshes and larger sizes may be used in special occasions.

3.3.4 Ductility

Three levels of ductility may be used. They are as follows:

- "L" = Low ductility
- "N" = Normal ductility
- "E" = Seismic (Earthquake) Ductility

3.3.5 Ductility and Yield Values.

The following upper bound and lower bound yield values are to be adhered to for each class of ductility.

Ductility Class	Lower Bound Yield Stress	Upper Bound Yield Stress
"250N' Normal Ductility	250 MPa	N/A
"300E" Seismic Ductility	300 MPa	380 MPa
"500E" Seismic Ductility	500 MPa	600 MPa
"500N" Normal Ductility	500 MPa	650 MPa
"500L" Low Ductility	500 MPa	750 MPa

3.4 TESTING

Should KA require further justification in addition to the provisions of the ACRS certificate of currency specified in the Material section of this specification, then the Manufacturer's certificates shall be submitted if requested by the Engineer to confirm that materials conform to the specified requirements. If such certificates or other adequate evidence of the quality of the material is not available tests shall be made at the Contractor's expense at a laboratory selected by the Engineer.

3.5 WORKMANSHIP

The Contractor shall prepare and furnish to the Engineer upon request, in duplicate, schedules of all the steel reinforcement required under this Specification and supply and incorporate into the work all such reinforcement with tie wire, spacer bars, support bars and bar chairs and the like necessary to complete the work.

All reinforcement shall be thoroughly cleaned of rust, scale and any other coating which reduce bond before being placed in position. Where there is delay in deposition of concrete after placement of reinforcement the reinforcement shall be restored to a satisfactory condition.

Steel, which has become pitted with rust, may be rejected.

Unless otherwise shown on the contract drawings the reinforcement shall be cut and bent or otherwise fabricated to the dimensional tolerances shown in Section 17 of AS 3600.

Bar chairs shall be approved metal or plastic type. Metal chairs must not be used where legs will be exposed in finished concrete surfaces unless they have plastic coated legs or are hot dip galvanized after fabrication. Plastic type chairs manufactured by ARC Engineering Pty Ltd or similar approved, shall be used where legs will be exposed in finished concrete surfaces. The various components shall be used as recommended by the Manufacturer. Plastic type chairs used for supporting wire reinforcing fabric for slabs, must be of sufficient strength so as not to break under construction traffic.

The reinforcement supports shall be adequate to withstand construction traffic and shall be sufficient in number and spacing to maintain the reinforcement in its correct position. If not otherwise indicated on drawings spacing of chairs shall not exceed 60 bar diameters for bars and 750mm (both ways) for mesh. Particular care shall be given to the support of light gauge reinforcement and of reinforcement in general where the concrete is to be cast against the ground. Care shall be taken that no damage occurs to any waterproofing membrane or vapour barrier and a plastic plate or equivalent shall be placed under each chair.

Wood, brick, aggregate, porous or potentially corrosive materials shall not be used as reinforcement supports.

All reinforcement at the site shall be kept stacked above ground with sizes and types segregated and protected with tarpaulins or other approved methods until used.

3.6 PLACING OF REINFORCEMENT

Reinforcement shall be placed accurately in position to the tolerances specified in Section 17 of AS 3600 and fastened securely to prevent displacement during placing of concrete. Concrete cover to reinforcement shall be as indicated on the Drawings.

Ends of bars, which are to be left projecting for any considerable time, shall be protected with a heavy coat of neat cement grout or plastic caps.

Reinforcement shall be secured by annealed iron tie wire or approved fasteners, or as shown on the Drawings. Spot welding by electric arc process must not be used in lieu of the tie wire.

Unless otherwise shown on the Drawings, reinforcing bar lap lengths for bars in tension shall be as shown in the following table:

Bar Diameter mm	Tensile Lap Length in mm					
	Concrete			Masonry		
	500MPa	300MPa	250MPa	500MPa	300MPa	250MPa
10	500	450	650	625	600	600
12	600	500	750	800	600	600
16	850	650	1000	1075	650	600
20	1200	800	1200	1450	875	725
24	1550	N/A	N/A	-	-	-
25	1650	1000	N/A	-	-	-
28	1950	N/A	N/A	-	-	-
32	2300	N/A	N/A	-	-	-
36	2700	N/A	N/A	-	-	-

Lap lengths for horizontal bar with less than 300mm of concrete cast below it may be reduced by a factor of 0.8 times those listed above.

Where shown on the drawings, bundled bars shall comply with AS 3600 Clause 13.2.5. Bundled bars shall be tied together at 24 bar diameter centres with 3 wraps of tie-wire not less than 2.5mm. Lapped splices for unit of bundled bars shall be based on the lap length of the largest bar increased by 20% for 3-bar bundle and 33% for 4-bar bundle.

Unless otherwise shown on the Drawings, lap lengths for bars in compression shall be 40 times diameter of the smallest bar but not less than 500mm, except for R500 plain round bars where lap length shall be 50 bar diameters in concrete and 57 bar diameters in concrete masonry.

Laps for mesh shall be as shown in the following table in accordance with AS 3600 Clause 13.2.3:

Fabric Ref. Designation Spacing	Along the Mesh		Across the Mesh	
	End Lap (mm)	Cross Wire Lap (mm)	Side Lap (mm)	Long Wire Lap (mm)
RL1218 to RL718	500	325	360	225
SL 81 and SL41	360	225	360	225
SL102 to SL42	450	275	450	275

3.7 BENDING, SPLICING AND WELDING

3.7.1 Bending

Reinforcement shall neither be bent nor straightened in a manner that will damage it. Reinforcement shall be bent cold except when approved by the Engineer. If a bar is to be heated, the temperature is not to exceed 450°C. If the temperature of a bar exceeds 450°C, the Engineer is to be contacted and the strength downgraded appropriately.

Bars bent hot shall not be cooled by quenching.

The minimum internal bending radius of any bar shall be as follows:

3.7.1.1 Fitments

- 500L 3 Bar Diameters
- R250N 3 Bar Diameters
- D500N 4 Bar Diameters

3.7.1.2 Bar Fitments for Re-Bending

- 16mm or less 4 Bar Diameters
- 20mm to 24mm 5 Bar Diameters
- 28mm or Greater 6 Bar Diameters

3.7.2 Splices

When splices not already shown on the contract drawings are found necessary, the details of the proposed splices shall be submitted to the Engineer, for approval.

3.7.3 Welding

Welding or tack welding of reinforcement shall not be permitted except as shown on the drawings or with the approval of the Engineer, and shall then comply with AS 1554.3. This specification only covers reinforcement that is described in AS/NZS 4671. No other reinforcements shall be used or welded without written approval from the engineer.

3.7.4 Galvanising

Reinforcement specified to be hot-dip galvanized shall not be bent or welded after galvanizing.

4 MASONRY

4.1 GENERAL

The work contained in this Specification includes the supply, laying and finishing of all concrete masonry blockwork including reinforcement and filling where required, together with all associated work including the building of necessary items supplied by other trades.

4.1.1 Safety

Notwithstanding the requirements of this Specification nothing contained herein shall absolve the Contractor from responsibility for the safety of the construction work.

4.1.2 Discrepancies

All discrepancies between the contract documents shall be referred to the Engineer for a decision before proceeding with the work.

4.1.3 Inspections

If required by the Engineer, inspections of masonry may be required. If inspections of a particular masonry element are required the Engineer will provide adequate notice of the requirement of an inspection.

When an inspection is required, one full working days' notice is to be given to the Engineer to enable such inspection to be carried out.

Please note. Although the Engineer will perform an inspection of a particular element, the performance of this inspection does not relieve the contractor of his/her responsibility to construct the element in accordance with the contract documentation.

4.2 STANDARDS

Materials and workmanship shall comply one or more of the current editions of the following standards as applicable:

AS 2701	Methods of sampling and testing mortar for masonry construction
AS 3600	Reinforced concrete structures
AS 3700	Reinforced masonry structures
AS 1012	Methods of testing concrete
AS 3972	General purpose and blended cements
AS 1316	Masonry cement
AS 2758	Aggregates and rock for engineering purposes Part 1 - Concrete aggregates"
AS 1672	Limes and limestones Part 1 – Limes for buildings
AS/NZS 4455	Masonry units, flags and segmental retaining wall units Part 1 – Masonry units
AS/NZS 4456	Masonry unit and segmental pavers and flags - Methods of test Method 8 - Determining moisture content, dry density and ambient density Method 12 - Determining coefficients of contraction Method 16 - Determining permeability to water
AS 4773	Masonry in small buildings Part 1 – Design

4.3 MATERIALS

Concrete blocks shall be Class A concrete masonry units conforming to the requirements of AS/NZS 4455. Cavities for reinforcing may be formed using open ended blocks for vertical reinforcing and knock out bond beam blocks for horizontal reinforcing. Depressed web blocks may be used when masonry is solid grouted.

If required by Engineer sample blocks shall be submitted for approval before work commences and test certificates shall be produced to ensure that the blocks comply with AS/NZS 4455.

Blocks shall be hard, sound, true to size and form and shall be steam cured. The blocks used shall be specially selected for consistency of colour and texture and any blocks which in the opinion of the Engineer do not meet this requirement shall be replaced by the Contractor whether built-in or not. Blocks shall be clear of defects including surface blemish and have clearance from the ground. The blocks shall be completely protected from wetting and under no circumstances shall damp blocks be built into the work.

Aggregates used in blockwork manufacture shall be dense, hard and durable inert pieces of crushed stone or gravel conforming to AS 2758 Part 1.

Care should be taken in the selection of materials to be used in blockwork manufacture to minimize and preferably eliminate the presence of soluble salts causing efflorescence.

Mix ingredients together on a clean platform with the addition of such water as is necessary to make the mortar workable. Quantities shall be restricted to those required for immediate use and mortar which has stiffened due to hydration shall NOT be used.

4.3.1 Masonry Units

Masonry units shall comply with AS/NZS 4455 and shall be manufactured from concrete.

Masonry units shall not be placed in position until the Contractor has produced documentary evidence showing that the units conform to the requirements of this specification and AS/NZS 4455.

Masonry units shall have a characteristic compressive strength not less than the value specified on the Drawings. In the absence of such specification, masonry units shall have characteristic compressive strength not less than the following values:

Minimum Characteristic Compressive Strength of Masonry units[1]		
Application	**Hollow units[2]**	**Solid units[3]**
Reinforced masonry	12 MPa	
Load bearing masonry	12 MPa	N/A
Non load bearing masonry	12 MPa	N/A

Notes:
1. Values of minimum characteristic compressive strength specified by Engineer override the values given in this table. Designers and specifiers should check with the Manufacturer's on the availability of the particular strength grades.
2. For hollow units compressive strength is measured using face shell bedding.
3. For solid units compressive strength is measured using full bedding.

Masonry units for reinforced masonry applications shall have the following properties:

- If units are intended to incorporate both horizontal and vertical reinforcement and are not protected on both sides by a waterproof membrane they shall be "H" or double "U" configuration.
- Units are to be fully grouted and reinforced both vertically and horizontally.

- Grout may flow easily around and enclose all the reinforcement in all cores, and
- Cover is consistent with the requirements for durability, strength and fire resistance as appropriate.

4.3.2 Cement

Cement used shall be Type GP Portland cement complying with AS 3972.

4.3.3 Lime

Lime shall be hydrated building lime complying with AS 1672.

4.3.4 Sand

Sand shall conform to AS 2758.1. It shall be clean, sharp and free from salts, vegetable matter and impurities.

4.3.5 Mortar

Mortar shall consist by volume of 1 part GP Portland cement, 0.1 parts hydrated lime and 3 parts sand.

Mortar which has stiffened due to hydration shall NOT be used.

4.3.6 Concrete Grout

Concrete grout shall comply with AS 4773 Part 1. Unless noted otherwise, properties shall be:

- A minimum Portland cement content of 300 kg/m^3;
- A maximum aggregate size of 10mm;
- Sufficient slump to completely fill the cores; and
- Minimum characteristic compressive cylinder strength of 20 MPa.

4.3.7 Water

Water shall be clean, fresh and free from injurious amounts of acid, alkali, organic material, oil and other deleterious substance.

4.3.8 Reinforcing Steel

Reinforcing steel shall be grade 500 complying with AS/NZS 4671 unless specified otherwise on the Drawings. All reinforcing shall be of the deformed type, except that ties and stirrups may be plain round bars.

Steel reinforcement shall be clean, rust scale-free and undamaged.

Steel reinforcement shall be cut, bent and placed for construction as shown on the drawings.

4.4 WORKMANSHIP

4.4.1 Masonry

All workmanship and site control in masonry construction shall be in accordance with AS 3700.

The surface on which the first course is to be laid shall be free of all laitance, loose aggregate and any material that could reduce the bond between the masonry elements and the concrete base. It shall be checked for vertical and horizontal alignment and any discrepancy shall be corrected before masonry construction is commenced.

All masonry units shall be laid in mortar in horizontal courses, true to line, plumb, and level to the tolerances of AS 3700 Clause 12.5.

Blocks shall be laid in straight uniform courses with completely filled mortar bed and perpend joints of consistent joint thickness throughout. The work shall be carefully set out to avoid undue cutting of blocks or use of closers.

Extreme care shall be taken to prevent marking of exposed wall surfaces with mortar droppings, timber stains or other materials. The work shall be constructed in such a way that a fair face is produced requiring no further treatment.

Unless detailed or specified to the contrary, walls shall be built in stretcher bond, accurately set out and constructed, using horizontal and vertical rods for the purpose. Face work shall be true to line and face. No section of the work shall rise more than four (4) courses above any other work and at each course the work shall be thoroughly checked for correct alignment.

For bond-beams use purpose-made knock-out bond beam hollow concrete blocks with reinforcement grouted in place.

For lintels use purpose-made U blocks or can combine with a course of knock-out bond beam blocks for a deep lintel with reinforcement grouted in place.

At the end of each day the top course of blocks shall be covered to prevent moisture entering the work.

Use purpose-made clean-out blocks or machine cut a 100mm x 100mm cleaning hole at the base of each reinforced core on the side of the wall which is to be rendered or otherwise concealed. After cleaning out has been inspected and approved, cover the hole with formwork and grout the core.

Pipework conduits, etc., shall not be concealed in block cores, cavities or ducts without the prior approval of the engineer.

Chasing of blockwork will not be permitted without written approval by the Engineer on a case by case basis.

Should cutting of blocks be necessary, it shall be carried out by means of a power driven carborundum saw or diamond blade to provide straight unchipped edges.

4.4.2 Mortar Joints

Bed (horizontal) joints and perpendicular (vertical) joints shall be 10mm. Keep perpends in alternate courses aligned.

Mortar joints in hollow blockwork shall be face-shell bedded and shall be ironed, unless a flush joint is specified for aesthetic reasons.

Mortar shall NOT be spread so far ahead of the actual laying of the blocks that it will tend to stiffen and lose plasticity resulting in poor bond. Final positioning of the blocks must be carried out whilst the mortar is still plastic and when it has stiffened no further attempt shall be made to disturb the blocks.

Excess mortar extruded from the joints shall be struck off flush with the wall face. Where blockwork is to be left exposed the mortar shall be left until it has slightly stiffened and shall be struck off flush.

4.4.3 Control Joints

Vertical control joints shall be constructed to the details and at the locations shown on the drawings and at all points of potential cracking. The spacing of joints shall not exceed 6 metres in any continuous wall length.

The joints must be minimum 10mm wide and completely clean and free from any hard or incompressible material over the full width and depth of the joint.

After completion of the walls a suitable backing rod shall be inserted on both sides of the joint and the joint filled with an elastic polyurethane joint sealant approved by the Superintendent.
Sealing of the joint shall be in accordance with the Sealant Manufacturer's instructions and recommendations.

Control joints on external walls must be weatherproofed.

Unless specified otherwise install R16 dowels 800mm long at 400mm vertical centres placed centrally in the wall with one side debonded with grease or plastic tape.

4.4.4 Water and Fireproofing

The Contractor is responsible for ensuring that the control joints are waterproofed, as necessary, with appropriate fillers and sealers.

4.4.5 Seismic Joints

Seismic joints in concrete masonry shall be constructed with the necessary protection against water ingress and fire at the locations and to the details shown on the Drawings.

Provide horizontal seismic control joints at interface between top of all non-load bearing masonry walls and the underside of floor and/or roof structure as detailed on the Drawings.

Provide vertical seismic control joints at junctions between all non-load bearing masonry walls and vertical structures such as columns and structural walls as detailed on the Drawings.

4.4.6 Wall Junctions

All corners and 'T' junctions shall be made in stretcher bond.

All horizontal reinforcement will be lapped with corner bars unless shown otherwise on drawings.

4.4.7 Reinforcement and Anchorages

Reinforcement shall not be bent on in-situ to correct alignment. The Engineer shall be immediately notified of any misalignment of cast-in starter bars or any other cast-in reinforcing. The Engineer will give written instructions to remedy the misalignment. The starter bars should be checked for position before laying the first course. If they are incorrect, then it will be necessary to cut off bars, drill holes to a significant depth and grout in new steel with epoxy mortar.

Place reinforcement and anchorages in accordance with the sizes, types and to the details and locations shown on the drawings. Completely embed reinforcement in grout and maintain clear cover distance of not less than 12mm between reinforcing bars and any masonry surface or formed surface. Overall cover to reinforcement from the outer face of the shell will depend on durability and fire resistance requirements of the masonry in accordance with AS 3700.

Reinforcing bars shall be placed in lengths as long as possible but not less than 1600mm without laps by using open ended and knock out bond beam blocks or depressed web blocks when masonry is solid grouted. Reinforcement shall be spliced only where indicated on the drawings, unless otherwise specified. Where reinforcement must be lapped, the laps shall be as noted on the structural drawings or not less than 600mm. All lapping reinforcement, including starter bars shall be securely fixed together.

Vertical reinforcement shall be tied to starter bars through cleanout holes in each reinforced hollow core unit and fixed in position at the top of the wall by plastic clips.

Horizontal steel shall be positively located by tying to stirrups or to vertical bars and must be at least 25mm above or below the adjoining mortar joint. Horizontal steel may be laid in contact with recessed webs, provided the reinforcement is completely surrounded by grout, except where it is in contact with the masonry units. It shall be held in position by plastic clips when vertical steel is to be positioned subsequent to wall construction.

Every effort shall be made to ensure that the cores to be reinforced are kept free of mortar droppings.

Reinforcement is to be left undisturbed for at least 12 hours after filling. Any reinforcement showing signs of separation from the filling concrete may render that section of the wall liable to rejection.

Bars in lintels, bond beams, etc., shall be placed and blocks filled as the work proceeds. Reinforcement in bond beams and lintels shall be continuous through control joints.

All openings to be trimmed with N16 bars unless specified otherwise on the drawings.

4.4.8 Concrete Grout Core Fill

Masonry walls shall cure at least 3 days before core filling is placed. Do not commence until the grout spaces are cleaned out and the mortar joints have attained sufficient strength to resist blow-out. Cores to receive filling shall be cleaned at all mortar protrusions and all mortar droppings and foreign material shall be removed before the mix is placed. Cleanout blocks are to be provided at the bottom of all reinforced cores and the Engineer shall be contacted to inspect these before blocking off.

Limit the height of individual lifts in any pour to ensure that the grout can be thoroughly compacted to fill all voids and ensure bond between grout and masonry. Core filling shall be carried out progressively as work proceeds in lifts not greater than:

i. 200 Series - 1200mm when grouted by hand;
ii. 200 Series – 2400mm when grouted by pumping;
iii. 150 Series – 1000mm when grouted by hand;
iv. 150 Series – 1800mm when grouted by pumping.

While filling cores the infill grout shall be thoroughly compacted using pencil immersion vibrator and/or by careful rodding to exclude all air bubbles and to ensure that the concrete completely and intimately surrounds the reinforcement.

4.4.9 Cleaning Down

Upon completion of the blockwork all necessary patching of the mortar joints shall be carried out with fresh mortar. Should any joint show evidence of a broken bond, these shall be raked out 20mm deep and pointed up with fresh mortar to match the adjacent joining.

Should any mortar droppings adhere to the wall surfaces, these shall be allowed to dry and then be removed by rubbing down with a piece of concrete block and finally brushed clean.

At completion clean down all visible work with clean water. Remove all stains and markings and leave in first class condition.

4.4.10 Chasing

Chasing of blockwork is not permitted unless specific permission from the engineer is provided in writing. If chasing is permitted in writing by the engineer, the following is a guide to the maximum values:

- Chasing may only be carried out in core-filled hollow blocks or solid blocks not designated as structural
- Parallel chases on both sides of a wall shall not be closer than 600mm to each other

Concrete Blockwork Chasing Table

Block thickness (mm)	Maximum depth of chase (mm)
190	35
140	25

90	20

4.4.11 Sills

Use precast concrete sill units solidly bedded and lay them so that the top surfaces drain away from the building.

Sill blocks shall be formed up in in-situ concrete to the sizes indicated on the drawings and finished with a wood float ready for decoration.

5 STRUCTURAL STEELWORK

5.1 GENERAL

The work shall consist of the supply and fabrication of all the steelwork shown on the Engineer's drawings and includes surface treatment, storage, delivery to the site, steel-to-steel connections and their fastenings, miscellaneous attachments and anchor bolts.

The work shall consist of the erection of all the steelwork shown on the Contract drawings and includes offloading, erection, field welding, high strength bolting, making steel to steel connections, connection to anchor bolts, permanent grouting and repairs to surface treatment.

The work shall be carried out in strict accordance with the Engineer's drawings and this Specification and in conjunction with Architect's drawings and other relevant plans and details.

5.1.1 Safety

Notwithstanding the requirements of this Specification nothing contained herein shall absolve the Contractor from responsibility for the safety of the concrete construction work.

5.1.2 Discrepancies

All discrepancies between the contract documents shall be referred to the Engineer for a decision before proceeding with the work.

5.1.3 Inspections

All material and work is subject to inspection and the Contractor shall provide the necessary access and facilities. All steelwork is subject to final inspection insitu.

Where steel has been inspected at the shop before being delivered to the site such inspection does not relieve the Contractor of his responsibility to carry out the work in accordance with the Drawings and the Specification.

When an inspection is required, three full working days' notice is to be given to the Engineer to enable such inspection to be carried out.

Please note. Although the Engineer will perform an inspection of a particular element, the performance of this inspection does not relieve the Contractor of his/her responsibility to construct the element in accordance with the contract documentation.

5.2 STANDARDS

Structural steelwork shall conform to the current relevant codes, as follows:

5.2.1 Steel

AS/NZS 1163	Cold-formed structural steel hollow sections
AS/NZS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679	Structural steel
	Part 1 - Hot-rolled bars and sections
	Part 2 – Welded I sections
AS/NZS 4600	Cold-formed steel structures

5.2.2 Electrodes

AS/NZS 4855	Welding consumables – Covered electrodes for manual metal-arc welding of non-alloy and fine grain steels – Classification
AS/NZS 4856	Welding consumables – Covered electrodes for manual metal-arc welding of creep-resisting steels – Classification
AS/NZS 4857	Welding consumables – Covered electrodes for manual metal-arc of high-strength steels – Classification

5.2.3 Bolts, Nuts and Washers

The following Standards apply to the relevant nut bolt or washers.

5.2.3.1 Mild Steel Bolts

AS 1110	ISO metric hexagon bolts and screws Part 1 – Product grades A and B - Bolts
AS 1112 Parts 1 to 4	ISO metric hexagon nuts
AS/NZS 2451	Bolts, screws and nuts with British Standard Whitworth threads
AS B148	Unified black hexagon bolts, screws, nuts (UNC and UNF threads) and plain washers – Heavy series

5.2.3.2 Bright Bolts, Precision Bright Forged Bolts and Nuts

AS 1110	ISO metric hexagon bolts and screws Part 1 – Product grades A and B - Bolts
AS 1112 Parts 1 to 4	ISO metric hexagon nuts
AS/NZS 2465	Unified hexagon bolts, screws and nuts (UNC and UNF threads)

5.2.3.3 Washers

For bolts specified above:

AS 1237 Parts 1 and 2	Plain washers for metric bolts, screws and nuts for general purposes.

5.2.3.4 High Strength Bolts

AS/NZS 1252	High strength steel bolts with associated nuts and washers for structural engineering

5.2.4 Workmanship

AS/NZS 1554 Parts 1 to 7	Structural steel welding
AS 4100	Steel structures
AS 1796	Certification of welders and welding supervisors

5.2.5 Surface Treatment

The following standards apply to the relevant surface treatment.

5.2.5.1 Surface Preparation

AS 1627 Parts 0 to 10	Metal finishing preparation and pre-treatment of surfaces

5.2.5.2 Hot Dip Galvanising

AS 1214	Hot-dip galvanized coatings on threaded fasteners
AS/NZS 1559	Hot-dip galvanized steel bolts and associated nuts and washers for tower construction
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4791	Hot-dip galvanized (zinc) coatings on ferrous open sections, applied by an in-line process
AS/NZS 4792	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

5.3 MATERIAL

All materials in this structure are subject to and reliant on the requirements of this specification. Material may only be sourced from Approved Steel Mills which have demonstrated appropriate levels of quality assurance and testing. Approved Steel Mills are steel mills which have been verified by ACRS and certificates of currency from ACRS for the steel supplier at the time of steel purchase are to be provided and approved by KA before fabrication commences.

Unless otherwise shown on the drawings, all steel shall comply with AS/NZS 3678, AS/NZS 3679 Grade 250 and/or AS/NZS 1163 Structural Steel Hollow Sections, Grade 350 or Grade 200 for small CHS. Other types and grades of steel shall not be used unless noted on the Contract drawings.

All sections of wall thickness less than 3.0mm shall be formed from zinc coated high tensile steel having a minimum yield stress of 450 MPa. This includes Purlins, Girts and associated accessories. The gauge of the material used to form the section shall be as specified on the Contract drawings.

5.4 WEIGHT OF STRUCTURAL STEEL

When the Contractor provides for variations to the contract by supplying a rate per unit weight of structural steel such weight shall mean net theoretical weight unless otherwise noted. This weight shall be based on 0.00785 kilograms per linear metre per 1 square millimetre of cross sectional area as given in AS/NZS 3679 and AS/NZS 3678 and shall exclude additional weight such as wastage, rolling margins, bolts and welding. The rate shall be considered to include any expense associated with such additional weight.

5.5 SUPPLY AND SUBSTITUTION

The Contractor shall be responsible for the ordering of all steel and the tender based on assured sources of supply.

Substitution of structural sections shall not be permitted unless approved by the Engineer and shall not increase the cost of the contract.

Members shall not be made of short lengths unless prior approval has been granted by the Engineer.

5.6 TESTING

Should KA require further justification in addition to the provisions of the ACRS certificate of currency specified in the Material section of this specification, then the Manufacturer's Certificates in accordance with AS/NZS 3678 and AS/NZS 1163 shall be made available for inspection.

Should faulty workmanship be suspected, the Contractor may be asked to remove them for examination and testing. Such testing will be specified by the Engineer as required.

Should a test reveal faulty workmanship or materials, then a test load may be called for. All costs of this load test shall be borne by the Contractor.

5.7 DIMENSIONS

The Contractor shall verify all dimensions and be responsible for their accuracy.

5.8 SHOP DETAILS

The Contractor shall prepare and submit the following for approval and shall obtain an approved copy before commencing fabrication:

- Three copies of all shop drawings
- A PDF of the shop drawings

The drawings shall show in standard engineering drawing manner clear and complete details of the following:

- Marking plan for location of assembly drawings
- Assembly drawings showing the components in their combined fashion,
- All information relative to their fabrication,
- Surface treatment and erection information.

All shop drawings are to have their own unique number and a revision to register any changes made to that drawing.

The Contractor shall verify that all members can be erected properly and should this require variations to the Contract drawings, they shall refer to the Engineer.

The Engineer will provide initial comments on shop drawings within 15 working days of receiving the above mentioned copies. Should shop drawings be rejected by the Engineer and a requirement for resubmission exist, the Engineer will provide subsequent comments within 5 working days from receiving each set of resubmissions. The Contractor is to make adequate allowance for such checking procedures to take place.

The Engineer's drawings describe the structural engineering intent required by the Engineer to provide required structural integrity. These drawings shall be read in conjunction with the Architect's drawings and all other drawings and provisions made for fixings noted therein. Refer to the discrepancies section of this specification for guidance on discrepancies between contract documents.

Engineer’s approval will be required for member sizes, surface treatment and soundness of structural connections. Approval will not include dimensions or holes and cleats to suit other trades. Drawings not approved shall be corrected and resubmitted and approved before fabrication.

Except where otherwise shown, all dimensions are taken to structural and not finished surfaces. Any discrepancies between dimensions on Architectural and Structural drawings shall be brought to the Engineer’s attention for a decision. The Contractor shall check all dimensions on site.

5.9 WORKMANSHIP

Workmanship and finish shall be in accordance with AS 4100.

Where portions of the work are exposed to view and form part of the architectural treatment, attention shall be given to the finish. Shearing, flame cutting and chipping shall be done carefully and accurately. Sharp corners and edges that are marred, cut or roughened in handling or erection shall be faired by grinding or other approved means.

Finished members, plates, brackets and the like shall be true to line and free from twists, bends and open joints.

All shearing, shaping and boring shall be accurately done.

All portions of the work shall be neatly finished.

All materials, before being fabricated, shall be thoroughly cleaned of all loose scale and rust.

If members or plates are to be bent, to set the bends, they shall be correctly made to the radii or angles specified with the materials being heated so as to permit this to be done without leaving hammer marks.

All box sections shall be sealed.

Steelwork exposed to view shall have welds ground smooth.

Where paint is to be applied to the member, a 2mm arris is to be applied to all members being painted.

5.10 CLEARANCES AND TOLERANCES

The end clearances shown on the Contract drawings shall not be exceeded; where these are not shown the Contractor shall ascertain the clearances used in the design of the connections.

Structural members consisting primarily of a single rolled section shall after fabrication and unless otherwise specified conform to the appropriate tolerances allowed for by AS/NZS 3678, AS/NZS 3679. Built up structural members, unless otherwise specified, shall conform to the tolerances allowed for universal beams by AS/NZS 3679.

Completed members shall be free from twists, bends and open joints. Sharp kinks or bends shall be cause for rejection.

Tolerances in length shall conform to AS 4100. Where steel slopes or sections of the length indicated on the drawings cannot be obtained in one piece, details of splices required shall be submitted to the Engineer for approval. Details of such splices on shop drawings are to be noted so as to transmit the full force capable of being carried by the member. Allow for all such splices in the tender.

The above tolerances shall not result in a cumulative error over the whole or any part of the building.

Where marked on drawings beams are to be fabricated with an upward camber of span/360, span/180 for a cantilever measured at mid span or the free end of cantilever unless otherwise shown on the drawings.

5.11 CONNECTIONS

Where end cleats, brackets and other connections are not specifically detailed on the Contract drawings they shall be of a type and proportion to suit the location and reaction shown thereon.

Accurately fit together and either bolt or continuously welds all connections.

No weld of a length less than four times nominal fillet size will be deemed capable of carrying load.

The ends of all tubes and R.H.S. are to be made airtight.

Tube and R.H.S. must not be shorn but cut to fit shapes and angles of associated members.

Drill holes and fix in shop all cleats, lugs, ties and other fixings before protective coatings are applied.

Make no holes in structural steel members other than those shown on the drawings, without approval.

Unless otherwise specified, make holes for bolts 2mm larger in diameter than the specified bolt size.

5.12 BOLTING

5.12.1 General

Bolts in bearing shall be of such lengths that no threaded portion shall be within the thickness of the parts joined.

At least one washer shall be placed under the bolt or nut whichever is to be rotated. Taper washers shall be used where the part under the bolt head or nut is not perpendicular to the centreline of the bolt.

Where the work is not to be concrete encased and where not noted to the contrary, chisel cut, butt or spot weld bolt threads to ensure that nuts do not work loose.

Slotted holes for bolts may be used only where so designated on drawings.

5.12.2 Mild Steel Bolts

Mild Steel bolts shall only be used where shown on the Contract drawings.

5.12.3 High Strength Bolts

High Strength Bolting shall be in accordance with AS 4100. Unless noted otherwise all bolts shall be of high strength.

5.13 WELDING

Manual welding and semi-automatic welding or automatic welding shall be in accordance with AS/NZS 1554, Parts 1 to 5.

Employ the electric arc method of welding.

Unless otherwise specified make all welds 6mm continuous fillet welds continuous around all meeting faces and edges of members to be connected.

Make exposed load bearing fillet welds neat and even in appearance.

All welds are to be carried out by tradesmen certified in accordance with AS 1796 for the appropriate class of weld being undertaken. Certificates for the Welders undertaking the work must be presented upon the request of the Engineer.

5.14 MACHINED COLUMN-SPLICES, BASES & CAPS

Where noted on the Contract drawings as machined, such machining shall comply with AS 4100.

5.15 MISCELLANEOUS ATTACHMENTS FOR FINISHES

The Contractor shall allow for the drilling of cleats indicated on the Contract drawings and necessary to support and connect the architectural finishes. As the work proceeds refer to the Architect's drawings and other relevant drawings for specific details and locations.

5.16 SURFACE TREATMENT

5.16.1 General

All protective coatings are to be in accordance with the Architect's specification; however the following is to be adhered to as a structural minimum and where there is no protective coating specified by the Architect.

The protective paint systems provided below are generic coating types. Alternatives of equivalent performance and formulation may be considered by the Engineer. Application for substitution may be made through the Superintendent.

The Contractor shall confirm with the paint manufacturer a suitable paint for the generic type and Dry Film Thickness of coating appropriate for the level of protection required.

The application of all protective paint systems shall be in strict accordance with the manufacturer's specification.

Protect all steelwork from corrosion using the treatments specified below or as noted on the drawings.

Do not paint steel surfaces to be encased in concrete, fireproofed, prepared for friction type joints and welding. If the welded area requires painting, do not paint until after weld inspections and non-destructive testing requirement if any are satisfied.

Field touch-ups to match finish coat or as otherwise indicated in the Architects specification.

5.16.2 Coating Location

The protective coating types shall be applied in the location outlined in the following table:

Element	Coating Condition	Coating Type
Purlins and Girt	Cold Formed Sections	PC5
Others	Ext.	PC4

5.16.3 Coating Types and Preparations

The following coating types and the required preparations shall be adhered to unless otherwise specified by the Architect or the Contract drawings.

5.16.3.1 PC 1 – Interior Steel in Coastal Environment

All steel prepared for an interior coastal environment shall have the following preparation and protective coatings applied to them.

SURFACE PREPARATION - The surface preparation shall be abrasive blast clean to AS 1627 Part 4 Class 2.5.

COAT 1 - The priming coat shall consist of a zinc rich epoxy primer with a minimum Dry Film Thickness of 80 Microns.

COAT 2 – (if required) Compatible decorative top coats may be applied in accordance with the architect's specification.

REPAIR TO DAMAGED COATING – All repairs to damaged coatings shall be consistent with the original coating system and shall be applied by the original applicator.

5.16.3.2 PC 2 – Exterior Steel in Coastal Environment

All steel prepared for an exterior coastal environment but not a Marine Environment, shall have the following preparation and protective coatings applied to them.

SURFACE PREPARATION - The surface preparation shall be abrasive blast clean to AS 1627 Part 4 Class 2.5.

COAT 1 - The priming coat shall consist of a zinc rich epoxy primer with a minimum Dry Film Thickness of 80 Microns.

COAT 2 – The protective coat shall consist of High build 2 pack epoxy paint with a minimum Dry Film Thickness of 200 microns

COAT 3 – (if required) Compatible decorative top coats may be applied in accordance with the Architect's specification.

REPAIR TO DAMAGED COATING – All repairs to damaged coatings shall be consistent with the original coating system and shall be applied by the original applicator.

5.16.3.3 PC 3 – Exterior and Interior Steel in an Inland Environment

All steel prepared for an interior or exterior inland environment shall have the following preparation and protective coatings applied to them.

SURFACE PREPARATION - The surface preparation shall be abrasive blast clean to AS 1627 Part 4 Class 2.5.

COAT 1 - The priming coat shall consist of a zinc phosphate 2 pack epoxy primer with a minimum Dry Film Thickness of 80 Microns.

COAT 2 – (if required) Compatible decorative top coats may be applied in accordance with the Architect's specification.

REPAIR TO DAMAGED COATING – All repairs to damaged coatings shall be consistent with the original coating system and shall be applied by the original applicator.

5.16.3.4 PC 4 – External and Internal Hot Dipped Galvanised Steel

All galvanising shall be done by the hot dip process.

Prior to galvanising, the surfaces shall be cleaned of all dirt, weld spatter, grease, slag, oil, paint or other deleterious materials.

Steel surfaces shall be pre-cleaned in accordance with AS 1627 Part 1 then treated by acid pickling in accordance with AS 1627 Part 5, or abrasive blast cleaned in accordance with AS 1627 Part 4, the standard of surface preparation being Class 2.

The zinc coating shall consist of a uniform layer of commercially pure zinc, free from abrasions, cracks, blisters, chemical spots or other imperfections and shall adhere firmly to surface of the steel.

Quality and thickness of galvanising shall generally be in accordance with AS/NZS 4680 for fabricated ferrous articles. Galvanising for fabricated ferrous open sections shall be in accordance with AS/NZS 4791 and for ferrous hollow sections in accordance with AS/NZS 4792.

The weight of coating on steel sections, plates and tubes shall be determined in accordance with AS 1650.

Steel to be galvanised shall be dipped in 98.5% pure zinc bath to give a minimum average coating thickness or equivalent coating mass based on its thickness as shown in the following table.

Requirements for Coating Thickness and Mass			
Steel thickness (mm)	**Minimum local coating thickness (µm)**	**Minimum average coating thickness (µm)**	**Minimum average coating mass (g/m^2)**
1.5 or less	35	45	320
Over 1.5 to 3	45	55	390
Over 3 to 6	55	70	500
Over 6	70	85	600

Patch field-damaged galvanised areas with two coats zinc-rich paint and matching finish coat or as otherwise indicated in the Architects specification.

All galvanized items which are cast into concrete shall be passivated in a 0.2% sodium dichromate solution or its equivalent.

All galvanising vent relief holes on hollow sections or box beam members are to be plugged and sealed with a paintable polyurethane sealant, sanded flush and coated unless noted otherwise.

PLEASE NOTE: an epoxy coating may be applied to provide the desired colour. Please refer to the Architectural Specification for any additional coatings.

5.16.3.5 PC 5 – Galvanised Cold Formed Sections

All cold form sections, for example Cee section purlins/Girts and Zed section purlins and Girts, where:

i. The zinc coating is applied before the rolling process
ii. The Base Metal Thickness is less than 3.0mm
iii. The exposure environment is considered non aggressive

Are to have a minimum zinc coating **of 450g/m²** applied in the factory.

5.16.3.6 PC 6 –Marine, Buried or Immersed Steel

All steel to be in a marine environment, buried or immersed shall have the following preparation and protective coatings applied to them.

SURFACE PREPARATION - The surface preparation shall be abrasive blast clean to AS 1627 Part 4 Class 3.0.

COAT 1 - The priming coat shall consist of High build/ High Solids Epoxy (CP compatible) of a minimum Dry Film Thickness of 250 Microns.

COAT 2 – The top coat shall consist of High build/ High Solids Epoxy (CP compatible) of a minimum Dry Film Thickness of 250 Microns.

REPAIR TO DAMAGED COATING – All repairs to damaged coatings shall be consistent with the original coating system and shall be applied by the original applicator.

5.16.3.7 PC 7 – Concrete Encased Steel

All steel to be encased in concrete shall have the following preparation.

SURFACE PREPARATION - The surface preparation shall be abrasive blast clean to AS 1627 Part 2 Class 2.0.

NO PROTECTIVE COATINGS ARE TO BE APPLIED TO THE BARE METAL.

5.17 MARKING

Match mark in the shop all field connections. Provide all columns with clear and adequate levelling and centre marks to enable them to be easily plumbed in two directions at right angles and accurately levelled.

Loose pieces for connections shall be attached to their respective members.

Bolts, where not in holes, shall be metal tagged, each type and size in a separate container.

Connections, which are to be made by High Strength Bolts, shall be given a 75mm wide distinctive flash of colour, clear of holes for easy identification.

The extent and size of all fillet welds which are to be made in the field shall be clearly marked.

Where welds are to be made between dissimilar steels, they shall be given a distinctive flash of colour.

Exposed, unpainted steel shall be marked with tags.

5.18 HANDLING, DELIVERY TO SITE AND STORAGE

Steelwork shall be handled and stored in a manner that will not overstress or deform, and so that the collection of water in troughs and pockets is obviated.

Members shall be stored above the ground surface so as to avoid contamination.

Members bent or buckled from handling or storing shall be liable to rejection.

Bolts, nuts and washers shall be supplied in grit free containers and stored in watertight premises.

Burred, damaged, corroded or otherwise unserviceable bolts shall not be used.

5.19 ERECTION

Safety requirements, erection cranes, equipment, scaffolding and staging shall meet the requirements of the controlling authorities.

The Contractor shall adopt an erection procedure such that all members can be placed and fixed in position without distortion.

The Contractor shall erect, fix, adjust and maintain all members in their intended vertical and lateral alignment and level. Members which do not meet the tolerances specified in AS 4100 shall be liable to rejections.

During erection the steelwork shall be made safe against the wind and all erection stresses and loading conditions, including those due to erection equipment. Permanent bolting or welding shall not be carried out until correct alignment, and camber if any, has been obtained in each member of the structure.

Additional members used to facilitate erection shall be affixed in a manner, which does not weaken or deface permanent steelwork.

Set out lines and levels for the checking of positioning of steelwork within the specified tolerances.

Allow for erection equipment and its operation. Use whatever erection cleats are thought necessary and remove these after erection and grind flush.

Erect steel columns on accurately levelled steel packers.

Leave all bolts and tie rods tight at the completion of erection.

Do not adjust with driven wedges.

Do not use iron sledgehammers in driving or hammering steelwork. Use wooden mauls wherever practicable.

All steelwork shall be plumbed and trued as the work proceeds.

The overall length of members shall be as shown or indicated on drawings and checked against actual site dimensions with a tolerance of 2mm.

Stanchion length shall be straight to within 1/1000th part of length between points which are laterally restrained and trusses and beams shall be straight to within 1/500th of their length.

The several pieces forming one built up member shall be straight and shall fit closely together and finished members shall be free from twists, bends or open joints.

5.20 GROUTING UNDER BASEPLATES

Carry out grouting as soon as practicable. Hold columns to line and level on steel packers placed within 50mm of each holding down bolt. Grout or mortar is to be an approved non-shrink material such as “Embeco”. The mix and application to be in accordance with the Manufacturer's requirement.

All grouting shall conform to materials and methods in AS 4100 and AS 3600.

5.21 SITE CUTTING, DRILLING AND WELDING

During erection steel members shall not be cut, burnt, welded or drilled without approval. Drifting may only be used for bringing parts into position, not to match unfair holes, or enlarge holes, or distort metal.