SPECIFICATION

Tonkin+Taylor

Paekākāriki Seawall

Site-Specific & Technical Specifications

Prepared for
Kāpiti Coast District Council
Prepared by
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1 Extent of contract and general clauses

1.1 Location

The work included in this contract and to which the Specification and Drawings refer is for the replacement of a 960m long section of the existing seawall located on the Paekākāriki coastline. The new seawall will replace the existing timber and rock wall between the boundary of 124 and 125 The Parade, to the north, and Sand Track, to the south.

1.2 Extent of contract

The Contract Works comprises the demolition of the existing seawall and construction of a new seawall and amenities in accordance with the Drawings and this Specification. The work includes but is not limited to:

- A lower concrete, tied back H Pile and panel retaining wall
- A rock revetment slope
- An upper concrete block wall
- A shared use path
- Access ways
- Stormwater drainage
- Provision for planting/landscaped areas
- Reinstatement and minor realignment of the western kerb line of The Parade.

1.3 Drawings

The following drawings (collectively known as the Drawings) are included in and form part of the Contract Documents:

- 86201.3000-001 to 020 – General Arrangement
- 86201.3000-100 to 131 – Plans
- 86201.3000-200 to 281 – Long Sections
- 86201.3000-300 to 371 – Seawall
- 86201.3000-400 to 494 – Accessways
- 86201.3000-500 to 524 – Stormwater
- 86201.3000-600 to 624 – Roading

The Contractor shall inform the Engineer immediately of any apparent errors, inconsistencies or omissions in any of the Drawings. The Engineer will respond to any such information within two working days by means of clarification, confirmation or instruction.

The Contractor shall maintain one full set of drawings at the Site at all times specifically for recording As-Built locations and details. One full set of the marked up drawings shall be supplied to the Engineer by the Contractor on completion of construction with all as-built information marked up legibly in red.

1.4 Standard specifications

These Site Specific and Technical Specifications shall be read in conjunction with KCDC's standard Preliminary and General Specifications located elsewhere in the Tender/Contract Documents.

The standard specifications referred to herein shall be deemed to be incorporated in the Specification and shall apply to those sections of the Contract Works to which they are relevant. Reference to a standard specification refers to the latest edition at the date of closing of tenders and includes the latest amendments or revisions to that standard specification.

1.5 Survey and setting out

A 3D model will be provided to the Contractor for use in the set-out of the works in the form of a 12D model file. A small number of survey points will be shown on the Drawings to allow for corroboration between the model and the Drawings. All survey points will be provided in the NZGD2000 (Wellington Circuit Coordinates) format.

Where specific set-out data is not provided in the 3D model, then the Contractor shall contact the Engineer for the additional set-out locations. Any such set-out must be confirmed on-site by the Engineer before construction of that section of the Works commences.

1.6 Hours of work

In addition to the restrictions on the hours of work that are set out in the Preliminary and General Specifications, the Contractor shall also allow for any other restrictions to the working hours described in the Consent Conditions, Health and Safety Legislation or Regulations and any other relevant documents.

1.7 Noise levels

In addition to the control of noise producing plant that is set out in the Preliminary and General Specifications, permitted construction noise levels shall be the lesser of those required by the local District Plan and those set out in NZS 6803:1999 "Acoustics – Construction Noise". The NZS 6803 limits are as follows:

Table 1.1: NZS 6803 Construction noise limits

Time of Week	Time of Day	Duration of Construction					
		Construction Duration 2 weeks to 20 weeks		Construction Duration less than 2 weeks		Construction Duration more than 20 weeks	
		L_{eq} (dBA)	L_{max} (dBA)	L_{eq} (dBA)	L_{max} (dBA)	L_{eq} (dBA)	L_{max} (dBA)
At Residential/Rural Dwellings							
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000–0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000–0630	45	75	45	75	45	75
Sundays and Public Holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000–0630	45	75	45	75	45	75
At Industrial/Commercial Boundaries							
Every Day	0730-1800	75		80		70	
	1800–0730	80		85		75	

1.8 Archaeological sites and taonga

In addition to the standard requirements for environmental management that are set out in the Preliminary and General Specifications, this section sets out the specific requirements for accidental discovery.

In the event of any discovery of an archaeological site (as defined by the Heritage New Zealand Pouhere Taonga Act) the Contractor shall immediately:

i Cease operations in the affected area and secure the affected area with a buffer area of at least 5m in plan in all directions to protect the object(s) as far as possible from further damage.

ii Advise Heritage New Zealand of the discovery.

iii Advise the Engineer and Principal of the discovery.

If the archaeological material is determined to be Koiwi Tangata (human bones) or Taonga (treasured artefacts) by Heritage New Zealand, the Principal will advise the office of an appropriate Runanga of the discovery.

If wooden artefacts are suspected or discovered, the Contractor shall leave the item(s) in situ and immediately recover with loosely placed dirt/soil/mud sufficient to avoid the artefact deteriorating on exposure to air/sunlight.

If the archaeological material is determined to be Koiwi Tangata (human bones) by Heritage New Zealand, the Contractor shall immediately advise the New Zealand Police of the disturbance.

Work may recommence if Heritage New Zealand (following consultation with Runanga if the site is of Maori origin) provide a statement in writing to the Principal that appropriate action has been undertaken in relation to the archaeological material discovered. Heritage New Zealand may require an archaeological authority to be obtained prior to works recommencing.

The Contractor shall note that it is unlawful for any person to destroy, damage, or modify the whole or any part of an archaeological site without the prior authority of Heritage New Zealand. This is the case regardless of the legal status of the land on which the site is located, whether the activity is permitted under the District or Regional Plan, or whether a resource or building consent has been granted. The Heritage New Zealand Pouhere Taonga Act 2014 provides for substantial penalties for unauthorised damage or destruction.

The Heritage New Zealand Pouhere Taonga Act 2014 defines an archaeological site as any place associated with pre-1900 human activity, where there is material evidence relating to the history of New Zealand. For sites solely of Maori origin, this evidence may be in the form of accumulations of shell, bone, charcoal, and burnt stones. In later sites, artefacts such as bottles or broken glass, ceramics, metals, may be found and/or evidence of old foundations, wells, drains, tailings, races or other structures may be present. Human remains/Koiwi may date to any historic period.

1.9 Inspection and approval

In addition to the requirements for quality management that are set out in the Preliminary and General Specifications and elsewhere in these Technical Specifications, the Contractor shall give the Engineer at least one (1) working days' notice that they wish to proceed to the following key stages of the Works and any other work stages that are agreed through the Contactor's approved Inspection and Testing plan:

- commencement of work after set out
- laying of pipelines
- placement of fill or geotextiles materials over prepared subgrades
- placing of any structural concrete
- covering layers of rock armour and sub armour with subsequent layers
- testing of any part of the Works as required under the Contract
- inspection for Practical Completion

The Contractor shall not proceed to any stage of the Works until the Engineer has inspected, approved and where necessary measured the Works at the previous stage.

The Contractor shall be responsible for notifying the local council and arranging any Building Consent inspections by the council staff.

1.10 Approved materials

In all cases where plant, materials or equipment of "approved" design or make is required by the terms of the Specification and/or Drawings, the Contractor shall obtain the approval of the Engineer in writing before such plant, materials or equipment is constructed or ordered.

Where the Contract requires the Contractor to work in accordance with a given manufacturer's recommendations or requirements, the Contractor shall contact the manufacturer(s) and/or supplier(s) concerned, ascertain the relevant criteria and where appropriate arrange for the manufacturer's representative to be on Site while the relevant work is undertaken.

In all cases where a particular brand or product is specified, the Contractor may, subject to the approval of the Engineer, and at no additional cost to the Principal, substitute an alternative product or brand of the same kind, size and equal or better quality.

1.11 As-builts

In addition to the requirements set out in the Preliminary and General Specifications, the following as-built plans shall be provided that relate to the specific requirements of this contract:

- Retaining wall alignment, embedment depth and pile position for the lower wall
- Retaining wall alignment and founding depth for the upper wall
- Earthworks test locations
- Finished subgrade surface levels
- Geotextile panel layout extents and levels
- The Parade kerb line and extent of reinstatement of the roadway

1.12 Asset Owner information

The contractor shall provide as-built RAMM data to meet KCDC requirements as detailed in Kāpiti Coast District Council Subdivision and Development Principles and Requirements (2012), Schedule 3, Clause 28.

2 Bulk earthworks

2.1 Scope

This section covers all the works necessary to cut and fill the Site to the required levels, grades and standards. It includes the supply of all materials, plant, labour and incidentals necessary for the completion of the works shown on the Contract Drawings. The works include:

- Clearing the site
- Stripping of topsoil
- Excavation of unsuitable materials to waste
- Removal and disposal of the existing timber and rock seawall
- Cut to waste or cut to fill (including fill between geogrid layers) and
- Controlled filling using approved imported materials
- Recovery of existing rock armour

2.2 Standard specifications

Construction works performed under this section shall:

- Be carried out in accordance with New Zealand Transport Agency (NZTA) Specification for Earthworks Construction (TNZ F/1: 1997), except where modified in this Specification
- Comply with the general requirements of the latest revisions of the following documents:
  - NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes – Soil Tests
  - BS 1377: 1999 Methods of Test for Soils for Civil Engineering Purposes
  - NZS 3111: 1986 Methods of Test for Water and Aggregate for Concrete
  - NZS 4407: 1991 Methods for Sampling and Testing Road Aggregates
- Comply with the general requirements of the latest versions of all other Standards, Specifications and Codes of Practice referenced in these Contract Documents
- Comply with the specific requirements of this section and the Contract Drawings and

The Specification shall be read in conjunction with the above Standards and documents, which are deemed to form part of this Specification. In the event of any requirements of this Specification being at variance with any of the above Standards and documents, the requirements of this Specification take precedence.

2.3 Definition of general fill types

2.3.1 Cohesive fill

2.3.1.1 Cement stabilised fill

Defines re-purposed site-won material comprising beach sand with a maximum of 10% fines mixed with 8% cement content by volume. Cement Stabilised Fill shall be screened to be free of fines and organic material and is to be placed and compacted as specified in clauses 2.6 to 2.9.

2.3.2 Cohesionless fill

2.3.2.1 Engineered fill

Defines imported or re-purposed site-won material comprising sand and gravel with a maximum of 10% fines (0.067mm particles) and a maximum particle size of 100mm. Engineered fill shall be screened to be free of fines and organic material and is to be placed and compacted as specified in clauses 2.6 to 2.9.

Alternative types of materials for use as Engineered Fill, (such as site won cohesive materials) may be used in some areas of the site if there are insufficient quantities of cohesionless fill materials meeting the Specification. The use of such materials will be subject to the Engineer's approval and any further restrictions that may be placed on the use of these materials.

2.3.2.2 D1 drainage material

Drainage aggregate shall be uniform, clean, free draining granular stone with a particle size of 30mm, provided from an off-site source that is free of fines and other mineral matter. Details of the source shall be submitted for the Engineer's approval prior to placing an order.

2.3.3 Unsuitable material

Unsuitable material defines material that is either cohesive or organic (other than topsoil) within cut or fill areas, or material that, by its inherent nature, cannot be satisfactory reconditioned by sorting, screening, wetting or drying for use as fill, as set out in this section (Section 2). Unsuitable materials shall be placed sent to an off-site disposal area or otherwise disposed of as otherwise agreed with the Principal and Engineer.

2.3.4 Rubbish

Rubbish is defined as inorganic material, such as steel, concrete, plastic, refuse, and other debris, and is categorised as Unsuitable Material, unless otherwise approved by the Engineer.

2.3.5 Topsoil

Topsoil is defined as either imported or site-sourced organic material that is unsuitable for use as engineered fill, hardfill or rockfill, but which is considered to be suitable by the Engineer for re-spreading as a surface soil layer in designated planting areas for establishing vegetation growth, at the completion of the works.

2.4 General requirements

2.4.1 Drainage control

Wherever practical (i.e. above sea level) earthworks shall be carried out in fully drained conditions with no free water present on working surfaces. All preparatory excavation work and subsequent excavations in borrow areas or areas to be filled shall be kept effectively drained at all times. Cut and fill areas shall be sloped and graded adequately at all times such that ponding of water does not occur at any time. Temporary drains shall be installed or pumping carried out as necessary to remove or deflect water from the areas of operations, or to drain water as soon as it is seen to pond, to the extent required to place and compact fil material as required to meet the requirements of the contract. If the Contractor considers it impractical to maintain excavations or areas to be filled in a fully drained condition, the Contractor shall propose, for the Engineer's approval, any effective and practical measures to revise these drainage requirements.

2.4.2 Erosion and sediment control

Earthworks shall be undertaken in a controlled manner so that erosion of disturbed areas is kept to a practical minimum and eroded material is confined on site as far as possible. Haul roads shall be treated as disturbed areas. Without exception, any stormwater from disturbed areas shall be directed to temporary silt ponds with erosion and sediment controlled in accordance with the Resource Consents and the Kapiti Coast District Council guidelines.

Any necessary temporary silt control measures for a particular area of the Works shall be in place and operational before commencing any earthworks in that area. The silt control measures shall be adequately maintained throughout the period of any earthworks in that area. Wherever possible, clean water from catchment areas above any exposed earthworks areas shall be diverted around those areas to avoid contamination and reduce erosion.

2.4.3 Dust control

Earthmoving shall be carried out, and haul roads and cut / fill areas shall be maintained, so as to ensure that dust is not raised near or blown over the working area and adjacent properties. The Site shall be kept watered as necessary to meet this requirement until covered by dust-free materials, mulch, or established grass cover.

2.4.4 Clearing and removal of vegetation, existing structures, and unsuitable materials

The Contractor shall remove all vegetation from the area of earthworks and clear all obstructions, unsuitable materials and rubbish from the area of the Works, except those specifically identified on the Drawings or by the Engineer as remaining.

Clearing shall mean the removal of all growth, obstruction, rubbish, and extraction of stumps. Extraction of stumps (if any) shall include removal of all roots greater than 25 mm diameter.

Existing structures that clash with the proposed Works (such as, parts of the existing seawall) shall be removed off-site.

Unless otherwise stated, all vegetated materials shall be removed and disposed off-site by the Contractor.

2.4.5 Recovery of existing rock armour materials

The Contractor shall locate and reuse all existing rock armour that meets the requirements of the technical specification. All existing clean, rock armour or large cobble (>150mm) sized rock material that does not meet the requirements of the rock armour or fill specifications shall be used to supplement the existing rock revetments beyond the north end of the works or stockpiled at a site in the vicinity of the works area at a location specified by the Principal. Rock material shall be neatly placed to form an even profile over the face of the existing revetment or in a neat stockpile as required.

2.4.6 Over-excavation

The Contractor shall direct their operations to avoid excavating beyond designated profiles except where specifically instructed by the Engineer. Any excavation beyond the designated profiles carried out without the express instruction of the Engineer shall be made good, to the satisfaction of the Engineer, with any necessary additional placed, compacted and structurally keyed fill of equal quality to the excavated profile.

2.4.7 Preservation and maintenance

The Contractor shall preserve and maintain all earthworks, including partly completed earthworks, within their relevant specified standards, and shall rectify any earthworks, which have deteriorated below the specified standards.

The Contractor shall carry out the works so as to minimise passage of construction plant over areas of fill or cut performed to final profiles. Areas of fill or cut, that are softened or otherwise damaged due repeated passage of construction plant, shall be undercut and replaced. The Engineer shall inspect and approve the depth and extent of any such undercutting and the requirements for the replacement materials.

2.4.8 Tolerances

All earthworks shall be carried out to the lines, levels and grades shown on the Contract Drawings and 3D model or as otherwise instructed by the Engineer. The accuracy of surfaces to be overlain by metal courses or by concrete structures shall be such as to preserve the minimum thickness of the overlying layers. Tolerances shall otherwise be as follows:

- Road Subgrades 0 mm to -20 mm
- Batters 0 mm to +100 mm and
- Other Surfaces 0 mm to +75 mm

2.4.9 Inspections and approvals

Before cut is commenced or fill is placed in any area (including borrow areas), the Engineer shall be given sufficient notice to inspect the stripped surface and instruct whether further excavation and/or undercutting and backfilling is required, or other works such as drainage are necessary. No cut or fill shall be undertaken in an area until such inspections of the stripped surface, and any other works that may be required below the stripped surface, have been made and the Engineer has approved the commencement of cut and/or fill.

The Contractor shall allow sufficient time for any subsurface and surface inspections, and shall programme such operations and provide drainage, access and survey control so that any further works instructed by the Engineer prior to any cut or full operations can be carried out in an orderly manner without delay or damage to the works.

Where there is a delay of more than 24 hours between approval of a stripped area and placement of fill, or rainfall has occurred within the vicinity of the stripped area, the Contractor shall obtain a new approval of the surface finish from the Engineer. The surface shall be maintained by the Contractor in its approved condition until filled over.

2.4.10 Haul roads

Any haul roads proposed by the Contractor will be subject to the approval of the Engineer. The construction and use of haul roads shall not comprise the construction and future integrity of the permanent works.

In general, haul roads in cut areas shall be left at 1.5m, or greater, above finished design levels in order to minimise damage to the permanent works.

2.4.11 Temporary stockpiles

In order to minimise the potential for slope instability, the Contractor shall only place stockpiles in locations approved by the Engineer. Any stockpiles shall be constructed to be free draining with overall grades and profiles such as to avoid ponding and minimise erosion.

2.5 Excavation

2.5.1 General

Excavation includes removal of topsoil, excavation to form the cut profiles shown on the Contract Drawings and in the 3D model, removal of unsuitable materials and rubbish, preparation for stormwater pipes and foundations for structures.

2.5.2 Removal of topsoil

The Contractor shall strip all grass, weeds, turf, organic topsoil, roots and the like from the areas subject to earthworks before other operations commence in these areas. The stripped topsoil shall be separated from other stripped material and separately stockpiled for future reuse in suitable locations. The stockpiles shall have maximum heights of 2 m, with slopes no steeper than 1(V):2(H).

The Contractor shall use appropriate equipment and procedures so as to avoid contaminating or otherwise affecting the topsoil's potential for future reuse.

The depth of topsoil stripping shall be sufficient to remove all organic material, turf and significant plant roots such as to expose soil containing an insignificant amount of organic material, subject to the approval of the Engineer.

2.5.3 Excavation management

Cut areas shall be progressively excavated to form a uniformly graded surface within the batter limits. The Contractor shall form the excavations in a logical and orderly manner to minimise wastage and shall undertake continuous visual inspections of materials as they are excavated. Any unexpected variations in material types or properties, evidence of slope instability or observations of buried vegetation, groundwater flows, seepages, or services should be immediately reported to the Engineer.

The earthworks shall be managed so the appropriate materials are used for the various fill types specified for use in the Contract Documents. The Contractor shall plan its earthworks carefully so as to optimise the use of the available fill materials on-site. In particular, the Contractor shall assess the volumes of different materials available, their locations relative to proposed fill areas and the degree of, screening, drying and conditioning required for the various materials.

Earthworks surfaces in cohesive soils shall be sealed off with appropriate rubber tyre plant when rain is imminent to minimise erosion and protect exposed materials from strength loss due to increase in moisture content.

2.5.4 Cut to waste

All cut material, other than topsoil and material required for fill, shall be removed from Site and disposed of.

2.5.5 Cut to fill

Excavation shall be planned and managed to the Engineer's approval such as to maximise the available volumes of the various material types specified for use in the Works and minimise the need to import materials from external sources.

The selection of the various material types will require care. The Contractor's excavation, screening and handling methodology shall be such as to ensure that all unsuitable materials and other non-specified materials are removed. Existing sand, gravels and other material meeting the project specifications can be re-used.

The Contractor shall work the areas of excavation in a logical and orderly manner so as to minimise wastage and to achieve surface elevations, grades and levels shown on the Contract Drawings or otherwise specified or instructed by the Engineer for the borrow area.

The Contractor shall undertake continuous visual inspections of materials and shall immediately report to the Engineer, any visual changes in the material type or properties, slope movement or groundwater that affects the borrow source.

2.5.6 General undercutting

The requirements for general undercutting shall be as follows:

- All organic unsuitable materials, other unsuitable materials, rubbish or materials otherwise shown on the Contract Drawings, or as otherwise instructed by the Engineer, shall be undercut
- The depth of the required undercut in materials (if any) will be specified by the Engineer when the material at the subgrade level has been exposed, inspected and evaluated
- The Contractor shall treat any excavated undercut material as unsuitable material and dispose of this material accordingly, unless instructed otherwise by the Engineer

2.6 Filling

2.6.1 General

Fill materials shall be sourced from areas of cut or imported where the material type cannot be sourced from the site excavations. If the Contractor wishes to propose materials from alternative sources, then the Contractor shall provide details of such sources for the Engineer's approval. Material types are required to be selected, handled and compacted to form zoned fills as shown on the Contract Drawings or as otherwise instructed by the Engineer. The compaction standards are specified in clause 2.8.

The Contractor shall take all precautions and maintain a tidy operation to minimise the presence of any loose, excavated materials that could become wet during rain, tidal fluctuations or any other means. It is the Contractor's responsibility to protect as far as practical, the exposure of loose un-compacted materials from saturation or erosion. The Contractor shall also ensure that all fill is free of organic matter or other unsuitable materials and any debris washed into the area of works shall be removed and the area made good.

2.6.2 Conditioning and spreading of fill

Before fill is placed in any area, the Contractor shall notify the Engineer that the fill foundation has been stripped, and prepared as required by the Contract Drawings and Specification, and is ready for the Engineer's inspection and approval.

Prior to compaction, the fill materials shall be screened to remove unsuitable materials, spread uniformly in horizontal layers and, if necessary, conditioned to an appropriate water content by aeration and drying or wetting (as the case may be), and/or by blending and mixing "wet" and "dry" materials. When soil is to be dried, the Contractor shall disc the soil and allow it to dry uniformly to its full depth. When the soil is to be wetted, this shall be done with sprinkling equipment ensuring uniform and controlled distribution of water in conjunction with blading and disc-ing. In all cases, the fill shall be mixed and conditioned thoroughly so that immediately prior to compaction the material type, grading and water content of the fill is reasonably uniform and avoids the presence of any gap grading in adjacent layers that will result in future migration of fine materials into adjacent

course layers. The layers prior to compaction shall be less than a maximum of 200 mm loose thickness.

No new fill shall be placed over previously placed fill that has not achieved the required standard or compaction, or has become contaminated, or has deteriorated from the required fill standards, or requires testing and approval prior to placement of a new layers. Previously placed fill that does not comply shall be reworked by scarifying, conditioning and re-compaction so as to meet the Specification or alternatively it shall be removed and replaced with complying material.

Positive and effective drainage shall be maintained during filling operations to minimise deterioration of material exposed in excavation areas and in the uppermost fill layers. Special care shall be taken to avoid hollows, which could pond water. All cohesive fill surfaces shall be sealed off with appropriate rubber tyre plant when rain is imminent, to minimise erosion and protect the fill from strength loss due to increase in moisture content.

Where fill is to be placed against sloping surfaces steeper than 1(V):2(H), the sloping surface shall be excavated or "benched" such that horizontal benches at no greater than 0.5 m height intervals are formed.

In order to ensure adequate compaction of the materials forming the final fill surface profile, all fill batter faces shall be overfilled as necessary and, following compaction, carefully trimmed back to the required design profile. The trimmed overfilled material may be re-used as fill, providing that the material is not contaminated.

2.7 Compaction

2.7.1 General

The Contractor shall employ sufficient dedicated and appropriate compaction plant so as to achieve the specified compaction. Equipment used in transportation and spreading will not be accepted as compaction plant. Compaction plant shall cover the entire area of each layer of fill and give each layer a uniform degree of compact effort. The combined operations of spreading and compacting shall be undertaken using systematic and properly managed procedures, subject to the Engineer's approval, so as to ensure that each loose layer receives the required passes of the roller or other approved compaction equipment before further loose material is spread.

In addition to the testing required by the Contractor, the Engineer may carry out check tests of compaction at any time. The Contractor shall stop or divert its machines as required by the Engineer to allow the tests to be carried out. Where field tests indicate that the specified standard of compaction has not been achieved, corrective action shall be taken to bring the fill to the required standard and as required by the Engineer. This may require the affected fill to be reworked by scarifying, conditioning and re-compacting so as to meet the Specification or alternatively it may need to be removed and replaced with complying material.

Competent and well-experienced Supervisors shall be provided by the Contractor to control procedures and shall carry out their duties primarily at the fill platform and not by delegation.

2.7.2 Compaction trials

Before placing any fill, the Contractor shall carry out compaction trials to confirm to the Engineer the adequacy of the machinery and procedures proposed to be used for each of the fill types defined in clause 2.3 and on the Contract Drawings. The trials shall be carried out using the same compaction equipment and on fill materials considered representative of those to be used for the permanent works. Separate trials will be necessary for each distinct fill material type and on-going compaction trials may become necessary as the works proceed and/or where other fill types are accessed or

identified. The Contractor shall keep the Engineer informed of fill material types being used or encountered during the course of the Works and, depending on the materials encountered, the Engineer may instruct additional compaction trials be carried out.

Prior to commencing any compaction trials, the programme and procedures shall be proposed by the Contractor for the Engineer's approval. The compaction trials shall comprise the spreading and compacting of a minimum of three superimposed 200 mm loose thickness layers of soil. The area of the compaction trial shall be sufficient to allow construction procedures and compactive effort to be representative of those proposed for the permanent works. Compaction standards of the trial areas shall be assessed using procedures and equipment as defined in clause 2.8.

Following completion of the compaction trials, the procedures and construction plant shall be approved by the Engineer and shall not be subsequently modified without the prior approval of the Engineer.

The required standards of compaction shall be as defined in clause 2.8 for the various fill types. However, during the compaction trials, the Contractor may develop ad hoc tests, which the Contractor may use as an approximate guide to the standard of compaction being achieved at any time, subject to their approval by the Engineer.

2.8 Compaction standards and testing

2.8.1 General

The tests and testing frequency described and defined in clause 2.8.4 will be used to confirm that the placed fill materials meet the required Contract standards, design criteria and parameter values. At any time either prior to or during the course of construction, the Engineer may direct modifications to the compaction standards, frequencies and test methods defined in this section with the aim of ensuring that the design criteria and objectives for the particular materials and conditions encountered are achieved.

Compaction and test requirements have been defined in this Specification for the materials expected to be used for the construction of the Works. Should alternative materials be proposed by the Contractor, then the Contractor shall also propose appropriate Quality Control testing methods and procedures in order to demonstrate to the Engineer's satisfaction that the necessary design criteria can be achieved.

The tests necessary to confirm the Contract requirements shall be undertaken using the fully specified methods set out herein, but the Engineer may approve more approximate and rapid methods on a day-to-day basis for preliminary assessment. Where an adequate correlation is established between the rapid and fully specified methods, the Engineer may rely on the results of the rapid methods. Where rapid methods are used, and there are discrepancies between the results obtained by rapid and fully specified methods, the Engineer shall decide which tests apply. Results obtained by rapid methods shall not be used for final acceptance purposes unless otherwise approved by the Engineer.

The locations and levels of all in-situ tests shall be recorded within tolerances of 0.2m horizontally and 0.1m vertically.

All testing, both in-situ and laboratory, shall be carried out using an IANZ accredited testing organisation, with all equipment calibrated to relevant standards at the required frequency. Full details of the proposed testing organisation(s) shall be submitted to the Engineer for their approval.

If the Engineer is satisfied that the quality of materials is consistent and that the Works are being carried out in a systematic and consistent manner, then instructions may be given by the Engineer to reduce the frequency of testing as defined in Table 2.2 of clause 2.8.4.

2.8.2 Fill test methods

The fill testing methods have been defined in Table 2.1 for the materials expected to be used for the construction of the Works. Should alternative materials be proposed by the Contractor, then the Contractor shall also propose appropriate Quality Control testing methods and procedures in order to demonstrate to the Engineer's satisfaction that the necessary design criteria can be achieved.

Table 2.1: Fill test methods

Parameter	Test Description	Test Method
In-situ Density	"Rapid"	NZS 4407:1991, Test 4.2.1 (Nuclear Densometer Direct Mode) or NZS 4407:1991, Test 4.2.2 (Nuclear Densometer Backscatter Mode)
	"Fully Specified"	NZS 4402:1986, Test 5.1.1, 5.1.2, 5.1.3 (sand replacement, balloon densometer or core cutter)
Maximum Dry Density (MDD) & Optimum Moisture Content (OMC)	Standard Compaction	NZS 4402:1986, Test 4.1.1
	Heavy Compaction	NZS 4402:1986, Test 4.1.2
Strength	Scala Penetrometer	NZS 4402:1986, Test 6.5.2
Solid Density	Solid Density	NZS 4402:1986, Test 2.7.1
Moisture Content	Moisture Content	NZS 4402:1986, Test 2.1
Particle Size Distribution (PSD)	PSD Wet Sieving	NZS 4402:1986, Test 2.8.1
	Hydrometer	NZS 4402:1986, Test 2.8.4

Note 1: In the water content test, the oven performance and forced ventilation requirements shall be waived provided that the operating temperature range is verified and checked daily. Before the mass of a dried sampled is accepted, it shall be dried for at least 14 hours, and be weighed at least twice at periods not less than 4 hours apart until the loss in mass between successive weighing less than 0.1 grams per 100 grams.

Note 2: In-situ Density: The air voids content of the compacted soil at any test location shall be taken as the mean of the air voids results from a set of density tests. A set of density tests shall comprise 2 or more individual tests made within an area of 0.5 m2.

Note 3: The solid density test shall be performed using a sample at natural water content, not an oven-dried sample.

Note 4: In-situ density tests may be replaced by the rapid method offered by a nuclear densometer (test method NZS 4407, Test 4.2.1) provided that:

a Appropriate tests are performed to correlate the bulk density obtained by the particular densometer being used to the bulk density obtained by the fully specified method;

b The correlation tests are performed initially at the rate of 1 (or more) correlation test for every 15 nuclear densometer tests until at least 2 satisfactory correlation tests have been performed (these 2 correlation test results can be obtained from previous work in the same material if the same nuclear densometer device is being used);

c Subsequent correlation tests shall be performed at the rate of 1 (or more) correlation test for every 30 nuclear densometer tests;

d The correlation established shall be used to apply a correction to the air voids determined using the nuclear densometer;

e An air voids test result may be calculated immediately after testing, by assuming a value for the soil water content derived by applying a correction to the nuclear gauge water content, based on a correlation developed over recent relevant tests between the nuclear densometer water content and the oven water content – the water content correlation must be renewed each time the air voids correlation is renewed; and

f A separate correlation shall be developed for each soil material type if this method is to be used.

2.8.3 Compaction standards

In conjunction with the frequency of testing defined in Table 2.2 of clause 2.8.4, fill materials shall be compacted so as to achieve the standards defined below:

- Engineered Fill shall be placed in uniform layers not greater than 200 mm loose thickness
- Cement Stabilised fill shall be placed in accordance with clause 2.9
- Compaction on each layer of Engineered Fill materials placed shall be sufficient to obtain the following standards:
    - The in-situ dry density shall not be less than 80% of the maximum solid density, as determined by Test 2.7.1, NZS 4402; or
    - In general the in-situ dry density shall not be less than 95% of the maximum dry density as determined by Test 4.1.3, NZS 4402.
    - in the layers 300mm below all foundations and concrete pavements and within the zone of the mechanically stabilised earth (MSE) walls the in-situ dry density shall not be less than 98% of the maximum dry density as determined by Test 4.1.3, NZS 4402.
- The number of blows to drive the Scala Penetrometer from a depth of 50 mm to 200 mm below the cohesionless fill surface shall not be less than 12.

In-situ materials at the base of the excavation shall be undercut in accordance with clause 2.5.6 or compacted and tested to the relevant standard specification above for fill if so instructed by the Engineer.

2.8.4 Frequency of testing

The frequency of testing has been defined in Table 2.2 and is the minimum considered acceptable. The Engineer may instruct additional tests and/or changes to the testing frequency as the works progress.

The Contractor shall control the earthworks operation so as to minimise the failure rate of any tests carried out as part of the Quality Control testing programme. Should any test result fail to meet the required design criteria, the Contractor shall be required to propose remedial measures for the Engineer's approval. Such measures are expected to usually comprise the removal, replacement and satisfactory re-testing of any fill within the agreed area of influence of the failed test location.

The Contractor shall rework and re-compact, up to the specified compaction standard, any area distributed by any testing undertaken within the site, to the Engineer's approval.

Table 2.2: Minimum testing frequency

Fill Type	Parameter	Test Type	Test Frequency
Engineered Fill	Strength	Scala Penetrometer	1 set per 200m^3, 1 set per 0.5m lift and 1 test per 10m length of wall /cement stabilised footing
Engineered Fill / Cement Stabilised Fill	Particle Size Distribution	Wet sieving	1 initial test for each material type and then 1 test per 5,000m^3 for that particular material 1 test per 200m^3 for cement stabilised fill
	In-situ Density[1,4]	"Rapid" with Moisture Content	1 set per 1,000m^3, 1 set per 0.5m lift and 1 set for each material type and 1 set per 20m length of wall for each layer of geogrid 1 set per 10m length of cement stabilised footing
	Maximum Dry Density & Optimum Moisture Content	"Heavy" Compaction	1 initial test for each material type and then 1 test per 3,000m^3 for that particular material type

Note 1: When In-situ Density "Rapid" tests are carried out, a set shall comprise 2 measurements using the same probe hole but orientated at 90° to each other.

Note 2: Density testing of reinforced fill behind the MSE wall, where the depth of reinforced fill overlying a geogrid layer is less than 400mm, shall involve periodic comparison of results from "Rapid" tests with the Sand Replacement Method as instructed by the Engineer. The reason for this is to ensure that the geogrid presence does not introduce excessive error into the "Rapid" test results. If excessive error is observed, the Engineer may specify that density testing be performed using the Sand Replacement Method.

Note 3: The Contractor shall make every effort to ensure an even spread of test locations, both vertically and horizontally, through all fill areas. Spatial separation of tests within the completed fill areas shall be such that at least 1 set of tests is completed within any given continuous 0.5m thick layer of fill. For the purpose of this Note, a "fill area" is defined as the area or zone of continuous fill placed on a particular working day.

Note 4: Backscatter mode shall be used for Cement Stabilised fill.

2.9 Cement stabilisation

This clause covers the Works necessary for the construction of cement stabilised engineered fill.

The Contractor shall propose, for the Engineer's approval, the construction methodology, plant and cement mix to achieve the required standards as defined in clause 2.9.1.

2.9.1 Concrete mixtures

The concrete mixtures shall be in accordance with the design mix approved appropriate to the work by the Engineer.

2.9.2 Design mix

Engineered fill shall be blended with normal Portland cement to achieve an average strength of 1MPa.

The design shall consist of a minimum 8% cement content by volume with a water/cement ratio of 45%. The dosage rates may need to be adjusted by the Contractor during construction in order to achieve the required strength criteria.

2.9.2.1 Trial mixes

Trial mixes shall be prepared for the grade of concrete specified. The contractor may propose a modified mix design if existing data acceptable to the engineer showing that the proposed mix proportions and manufacture will produce a concrete of the strength and quality required, having adequate workability for compaction by the method to be used in placing.

2.9.2.2 Mix strength verification testing

Unconfined Compressive Strength (UCS) testing shall be completed for verification. Results to be provided for 7, 14 and 28 days curing.

The final design mix shall be verified on a minimum of five large bulk samples obtained from across the full extents of the Site, as directed by the Engineer.

2.10 Shaping and topsoiling

2.10.1 General

Shaping, topsoiling and grassing shall be carried out progressively as soon as the earthworks are complete in each area or as instructed by the Engineer.

2.10.2 Shaping

The finished shape of the earthworks shall be as shown on the Drawings and 3D model, specified elsewhere or as instructed by the Engineer. The earthworks profiles shall generally be trimmed so as to match and blend with adjacent sections of earthworks and/or undisturbed existing ground.

2.10.3 Topsoiling

For the placement of topsoil the Contractor shall use “low-ground-pressure” equipment such as tracked vehicles rather than wheeled vehicles. Prior to commencing spreading topsoil the Contractor shall loosen the prepared subgrade to a depth of 100 mm with a toothed excavator bucket or similar. These surfaces shall be left in a loose condition until ready to accept the re-spread topsoil.

All topsoil shall be spread to a uniform layer thickness similar to that which was stripped to allow full coverage of the area to be reinstated, over all exposed earthworks surfaces to be grassed. The topsoil shall not be spread when the ground or the topsoil is excessively wet or plastic or otherwise in a condition detrimental to successful construction of the work. If the Engineer approves placement of the topsoil when it is wet or plastic then it shall be loosely spread and traffic kept off and the topsoil allowed to dry before being worked. The topsoil shall be smoothed by hand using rakes in order to eliminate all minor depressions, wheel marks and other irregularities and to produce a smooth, evenly graded, open textured surface, free draining and which will not pond water.

3 Rock Armouring

3.1 Scope

This section covers supply and construction of rock breakwaters, including supply and placement of underlayer and rock armour.

3.2 Standard specifications

Materials and construction work performed under this section shall be tested to the general requirements of the following documents and the specific requirements of this section:

- NZS 4407 Methods of testing road aggregates.
- EN 1367-2:2009 Tests for thermal and weathering properties of aggregates
- ISRM (1981) Methods for determining hardness and abrasiveness of rocks

3.3 Materials

3.3.1 Rock Type and Mineralogy

Rock armour and underlayer material shall generally be well graded, angular, quarried rock of igneous or high-grade thermal metamorphic origin, and shall conform to the requirements of this specification. Generally good quality basalt, andesite or greywacke will often be acceptable. Sedimentary rock such as shales, mudstones, claystones, bedded sandstones or slates are not suitable.

3.3.2 Density

The rock density of all sources of armour and underlayer rock shall be determined in accordance with NZS 4407:2015, Test 3.7. All armour and underlayer rock shall have a density as specified on the Drawings. Where no density requirement is specified on the Drawings, the required density of rock shall be not less than 2650kg/m^3. The rock density of a rock source shall be determined from a series of 5 density tests on different randomly selected stones, with 80% of the rocks having a density of greater than 2650kg/m^3 and no rock with a density lower than 2550kg/m^3.

Rock of lesser density may be approved, at the sole discretion of the Principal's representative, however rock density affects indicative 'mean diameter' values in Table 3.1, and lower density rock will result in the need for larger diameter rock and greater placed thicknesses. If lower density rock is accepted the indicative 'mean diameter' stated in Table 3.1 will require updating as will the required rock layer thicknesses. The Contractor will not be entitled to any additional payment as a result of needing to construct thicker armour layers or supply a larger volume of rock, and all measurement and payment shall be based of the original design layer thicknesses.

3.3.3 Weathering resistance

For rock sourced from a quarry, rock weathering resistance shall be tested in a laboratory in accordance with the requirements of NZS 4407:2015 Test 3.11, and the resulting quality index shall be AA, AB, BA or BB.

Where required by the Principal's representative, water absorption shall be tested in a laboratory in accordance with the requirements of Section 12 of NZS 3111:1986 and the results shall be less than 1.5%.

In addition, if water absorption results are greater than 0.5% (and/or if required by the Principal's representative), the sodium sulphate soundness test according to AS1141.24 shall be undertaken. The resulting percentage loss shall be less than 9%.

3.3.4 Abrasion resistance

If required by the Engineer, rock shall be tested for abrasion resistance in a laboratory in accordance with a Los Angeles Abrasion Test in accordance with NZS4407:2015 Test 3.12. The weight loss after 500 revolutions is to be less than 25%.

3.3.5 Material grading

Rock armour and underlayer material shall be well graded, angular, quarried rock, unless approved otherwise by the Principal's representative, and shall conform to the following grading limits:

Table 3.1: Rock and underlayer grading requirements

Rock Gradings		Mean	Range	>60% by mass to be between
Armour Rock	Block weights (kg)	1800	850-3800	960-2500
	Indicative "mean diameter" (mm)[1]	*1100*	*850-1400*	*880-1200*
Secondary Armour	Block weights (kg)	70	20-200	30-110
	Indicative "mean diameter" (mm)[1]	*350*	*250-500*	*260-420*

1. Indicative mean diameter is given for guidance only and is based on the rock density specified and estimate of rock shape.

Indicative 'mean diameter' shall be checked by the quarry based on provided mass grading provided and agreed with the Principal's representative prior to adoption. Refer Section 3.5.2 for guidance on determination of mean rock diameter.

Poorly graded or gap graded armour and underlayer rock shall not be permitted except as approved by the Principal's representative.

3.3.6 Roundness (Angularity)

All armour and underlayer rock shall be quarried angular unless shown otherwise on the Drawings. Semi-rounded or rounded rock will only be permitted if specifically approved the Principal's representative. Note that the hydraulic stability of semi-rounded or rounded rock varies from that of angular rock, and larger weights and sizes will be required if used in the works. If other than quarried angular rock is proposed to be used the degree of angularity should be evaluated, and revised weights and sizes for each grading should be obtained from the Designer prior to the acceptance of semi-rounded or rounded rock in the works.

The angularity of the rock shall be determined based on visually inspection of for each source of rock by the Principal's representative. Examples of angular (fresh), semi-rounded and fully rounded rock according to Bradbury et al. (1988) are shown in Appendix C.

3.3.7 Shape

The rock armour shall not contain stones with a length to thickness (L/d) ratio greater than 3; where the length, L, is defined as the greatest distance between any two points on the stone (and could be

measured on a diagonal) and the thickness, d, as the minimum distance between two parallel straight lines through which the stone can just pass.

Armour rocks showing clear signs of significant edge or corner wear or of severe rounding on more than one face shall not be used, except as approved by the Principal's representative.

3.3.8 Rock integrity

At least 95% of rocks in the stockpile shall be free from visually observable cracks, veins, fissures, laminations, unit contacts, cleavage planes, or other such flaws which could result in breakage during loading, unloading or placing.

All rock damaged and broken during handling to the extent that the remaining intact pieces no-longer comply with the rock grading, shall be rejected and removed from the works.

3.3.9 Impurities

Rock shall be visually clean and free from impurities such as clays and soils when placed in the construction works.

3.4 Construction

3.4.1 General

The works shall be constructed in the locations and to the dimensions shown on the Drawings. The Contractor is responsible for arranging stockpile areas and work areas with the Principal and local authorities.

3.4.2 Construction tolerances

Rock materials shall be placed to the levels, dimensions and slopes shown on the Drawings. When the surface profile is measured using the techniques specified, the following vertical tolerances shall be achieved.

Subgrade levels:	-0.1m to +0.1m
Armour underlayer thickness (average per profile):	-0.1m to +0.2m
Armour rock thickness (average per profile):	-0.1m to +0.5m

3.4.3 Subgrade preparation

Approved seawall toe excavated material or embankment trimmings may be used as fill beneath the geotextile filter layer, if shown on the drawings or as directed by the Principal's representative. All placed material shall be placed to the lines and levels as shown on the Drawings and shall be compacted/track rolled/tamped down to form a stable fill beneath the geotextile. If the placed fill slumps/slips or settles prior to the placement of the overlying geotextile and underlayer rock, the Contractor shall make good at the Contractors expense.

The subgrade shall be shaped and prepared for the subsequent placing of geotextile fabric, underlayer and armour rock layers as specified, and to the lines and levels as shown on the Drawings. All prepared surfaces shall be trimmed to a smooth surface, to receive the geotextile.

All trimmed and prepared subgrade surfaces shall be even and smooth and shall not contain any protrusions or material that may damage the geotextile. Large diameter stones which extend beyond the trimmed profile shall be removed and either placed elsewhere within the fill or disposed of as directed by the Principal's representative.

3.4.4 Protection of placed material

Each layer shall be protected by the subsequent layer as soon as possible after placement, with a maximum unprotected length of each material of 20 metres, in order to minimise wave damage or slumping in the event of storms during the construction period.

The Contractor shall obtain daily weather forecasts and if storms are predicted every effort shall be made to complete armour layers to protect partially completed works. Where the Contractor is to leave the works for the weekend and there is a possibility of storm erosion of the constructed works, particularly the exposed subgrade or underlayer construction, the Contractor shall provide all necessary temporary protection in the form of temporary placement of geotextile and armour across the end of the construction, or other methods, as may be necessary. These temporary protection works shall be removed prior to construction commencing again. No payment will be made for temporary protection works.

Material eroded by wave action or other causes shall be made good at the Contractor's cost before placing the subsequent layer. All material eroded and deposited on the foreshore or seabed outside the area of the Works shall be removed by the Contractor at his own cost.

3.4.5 Rock armour

The placement method of armour and underlayers directly on geotextile filter fabric shall be approved by the Principal's representative prior to placement and shall NOT include, end tipping, drifting or rolling stones down the slope.

Armour rock shall be carefully placed to avoid damage to any already placed geotextile, rock or underlayers, with rock sizing well distributed throughout revetment. All rock armour units shall be placed to ensure a minimum of three points of contact with adjacent rock. No rocking of unstable rock is permitted.

Armour rock shall be placed as a minimum of two layers (unless otherwise directed), and all voids in the first layer of armour rock shall be substantially covered by the second layer of armour rock. Any voids in the final surface shall be kept to a minimum, and it should not be possible to see through the two layer armour rock to the underlayer beneath.

The finished surface texture shall be irregular and rough, and shall NOT present a smooth sloping face to the waves. The layer thickness lines and dimensions shown on the Drawings are average rock layer thicknesses (allowing for irregular rock shapes and voids between rock), and it is expected that the tips of individual rocks will protrude above the general layer thickness dimensions and lines shown on the Drawings.

Where armour directly contacts the geotextile, armour stones shall be individually placed onto the geotextile with a maximum drop height of 300 mm.

3.5 Testing requirements

3.5.1 Testing

The Contractor shall arrange all required testing and shall supply results to the Principal's representative for approval. The Principal's representative reserves the right to carry out additional testing which, if uncovering deficiencies or discrepancies, shall be paid for by the Contractor.

The Contractor shall interrupt or divert his operations as necessary to permit any tests required with complete safety. The following tests shall be used as a minimum to confirm material properties and construction accuracy.

Table 3.2: Testing requirements

	Test No.	Test	Test method	Frequency of testing	Target
LABORATORY	1	Solid density	NZS 4407: 2015, Test 3.7.2 (non-vesicular aggregate)	*One per source [1]*	Refer Section 3.3.1
	2	Weathering resistance	Weathering Quality Index, NZS 4407: 2015, Test 3.11	*One per source [1]*	AA, AB, BA or BB
	3	Weathering resistance	Water absorption, NZS 3111:1986 Section 12	*One per source [1]*	<1.5%
	4	*Weathering resistance*	*Sodium Sulphate Soundness Test, AS1141.24*	*One per source (subject to results of Test 3).*	<9%
	5	*Weathering resistance*	*Schmidt Rebound Hardness, I.S.R.M 1981*	*Twenty for each 200 m^3 of rock sourced.*	>50
AT QUARRY	1	Rock angularity	Visual inspection	*Once per source (at least 20 stones).*	Refer Section 3.3.6
	2	Armour rock 'mean diameter' to mass relationship check	Visual inspection and rock weigh (refer Section 3.5.2)	*Once per source (at least 50 stones).*	N/A
ON SITE	1	Rock shape	Visual inspection (incl. measurements)	*In stockpile prior to inclusion in the works, and check grading at approximately 10m intervals along the wall.*	L/d<3
	2	Rock integrity	Visual inspection	*In stockpile prior to inclusion in the works.*	See Section 3.3.8
	3	Armour rock grading	See following notes	*In stockpile prior to inclusion in the works. Visually inspect grading distribution at approximately 10m intervals along the wall.*	See Table 3.1
	4	Underlayer rock grading	NZS 4407: 2015, Test 3.8 or visual inspection depending on underlayer rock size	*One per 500 m^3 per source [1] or in stockpile prior to inclusion in the works.*	See Table 3.1
	5	Set out dimension	Survey	*One section per 10 m of wall.*	See drawings
	6	Layer thicknesses	Survey as specified in following notes	*One section per 10 m of wall.*	See drawings
	7	Rock interlock	Visual inspection	*Completed face of seawall/revetment at 10m intervals of wall during construction.*	See Section 3.4.5

Note: [1] A rock "source" is defined as each new face opened within a quarry, or each 1,000 m3 of rock from the same face or lava flow

3.5.2 Testing armour grading

The process for testing conformance with the armour rock grading is as follows:

a Individual rock weighing at the quarry to test specific mass grading and determine quarry specific relationship between mass and equivalent mean diameter for use during on-site grading testing.

b Rocks representative of design grading to be set aside at quarry for operator eye selection of grading during truck loading.

c Contractor to provide results to Principal's representative to update 'indicative mean diameter' in Table 3.1 if significantly different from those included in the table.

d Calibrated relationship between mass and equivalent mean diameter to be used to check rock gradings in site stockpile.

3.5.2.1 Quarry grading testing

Armour rock grading shall be checked in the Quarry prior to transport to site to determine correlation between specified mass and rock armour 'mean diameter'.

The contractor shall assist the Principal's representative to complete the grading check by supplying machinery to select and spread out a sample from the stockpile of at least 50 randomly selected stones for measurement. Each rock shall be weighed with suitable calibrated load cell (or equivalent) and the weight recorded.

For each stone weighed, measurements in three orthogonal directions shall be made that will best represent the rock volume. When making these measurements the measurer needs to evaluate the general shape of the stone and determine the most representative way to measure it as "point to point" measurements will result in an over estimation of rock volume. The following guidance is provided:

- Three orthogonal diameters approximately around the stone centre of mass may be measured from the stone and averaged to determine the stones equivalent spherical diameter. The diameter measured in each orthogonal plane needs to be an estimate of the diameter of a circle that would represent the equivalent stone cross-sectional area in the plane being considered. Small projections outside the estimated diameter should be approximately balanced against voids within the estimated diameter.

The Contractor shall record weight and measurement results for each rock tested. A spreadsheet for recording these results can be provided by the Designer. Once the test is complete this spreadsheet shall be provided to the Principal's representative for updating the mean diameters in Table 3.1 if required.

When all sample stones from the stockpile have been measured, select 3 stones that are representative of the lower mass limit, three at about the mean mass and three at about the maximum acceptable weight, spray paint the stones with their size, and keep these 9 stones separate from but adjacent to the loading area as reference stones to assist the operator in achieving the required grading.

3.5.2.2 Site stockpile testing

In addition to quarry measurements, the rock grading shall be checked at once rock has arrived on site to stockpile. A grading check shall be undertaken approximately every 1000m^3 rock delivered to site by selecting a sample of at least 20 rocks and evaluating their "mean diameter" by measurement (refer measurement guidance notes in Section 3.5.2.1). This shall be undertaken prior to the rocks being placed in their final position in the works.

3.5.2.3 Following installation

All completed rock faces shall be visually inspected for distribution and randomness of large and small sized rock. Any groupings of smaller sized rock shall be avoided and shall be replaced as directed by the Principal's representative.

3.5.3 Survey technique for both setout and as-builts

Land based surveys shall be carried out at the frequencies specified to measure any underlayer and armour layer thicknesses. Cross-section profiles shall be surveyed at the specified intervals across the profile, as follows:

- prior to placement of rock armour
- after placement of each rock armour layer

When surveying subgrade, fill, core material and underlayers, a conventional survey staff or target (including boning rod) shall be used.

When surveying armour rock the staff or target shall include a spherical end of diameter equal to $0.5D_{50}$ of the armour being surveyed. Zero on the staff or target shall be at the base of the sphere. The sphere on the staff or target shall be inserted between rocks when surveying (refer Appendix C). The value of D_{50} is defined in Table 3.1.

3.6 Particular safety issue

On some sands, it has been found that any areas of the beach undercut to allow construction have a tendency to become quicksand after backfilling.

This effect is only evident once the tide has reached the backfilled sand. At this time, the sand, which was perfectly firm and safe to walk on, can lose all ability to support load, resulting in people and animals sinking instantly through the sand to almost the base of the excavation.

Historically, the passage of two tidal cycles (i.e. 24 hours) has remedied this and rendered the beach safe to walk on.

The Contractor shall be alert to this hazard and shall take measures to preclude access until the sand is safe to walk on.

4 Segmental block units

The arrangement and type of modular precast concrete block units and locking bar is set out on the Drawings.

The concrete blocks shall be installed in accordance with the manufacturer's instructions, except as specifically set out on the Drawings.

The combinations of different block units within the Anchorbloc range are shown in the Contract Drawings, include the following:

- Standard block;
- Half height block;
- Left hand block (standard or half height); and
- Right hand block (standard or half height)

All block units shall be used in conjunction with the proprietary locking bar, as specified by the manufacturer (Humes).

The exposed surface of the block units shall be free of chips, cracks, or other imperfections when viewed from a distance of 3.0m under diffused light. The Engineer is responsible for inspecting and approving the blocks' condition prior to use.

Alternative products may be used where approved by the Engineer. It shall be the Contractor's responsibility to provide all necessary documentation to demonstrate to the Engineer that an alternative product will integrate with other elements of the works (such as handrails), will be able to provide the required alignment and geometry, and meets or exceeds the performance of the proposed segmental block units.

5 Geotextiles

5.1 Scope

This section covers supply and placement of all geogrids and geotextile fabrics.

5.2 Standard specifications

Materials and construction work performed under this section shall be tested to the general requirements of the following documents and the specific requirements of this section:

- AS 3706 Geotextiles – Methods of test
- AS 2001 Methods of test for textiles – Physical tests
- TNZ F/7:2003 Specification for geotextiles

5.3 Materials

5.3.1 Geogrids

Uniaxial, high-density polyethylene geogrid shall be used in all areas with the specification for the geogrid as set out on the Drawings. All geogrids shall be in transported, stored, handled and placed in accordance with the manufacturer's specifications. Alternative products to those specified on the drawings may be used subject to the prior approval of the Engineer.

The geogrid reinforcement structure shall be dimensionally stable and able to retain its geometry under construction stresses over the 50 year design life. The geogrid shall have high resistance to damage during construction, to ultraviolet degradation and to all forms of chemical and biological degradation encountered within the soil being reinforced. Where required, geogrids shall be cut to the manufacturer's recommendations.

During progress of work, all geogrids shall be protected from moisture, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geogrids shall be stored off the ground or on a well-drained, smooth ground surface, out of direct sunlight, and protected from flooding and precipitation. The geogrids shall be stored in accordance with any additional requirements of the manufacturer. Geogrids that have been damaged due to inadequate transportation, storage or protection procedures shall not be used for the Works.

The Contractor shall provide all necessary QA/QC documentation for all geogrids incorporated into the permanent works. Such documentation shall include the following:

- Manufacturer's batch numbers
- Delivery dockets and
- Product certification

Installed geogrids shall be referenced to batch numbers and/or delivery dockets so as to allow the locations of any product quality failures to be readily identified.

All geogrid reinforcement for the MSE wall shall be attached to the Anchorbloc block units using the locking bar, as specified by Humes (Anchorbloc manufacturer).

All geogrid reinforcement for the lower concrete pile and panel wall shall be cast into the panels as shown on the Contract Drawings.

5.3.2 Geotextile filter fabric

All geotextile filter fabric shall comprise non-woven, needle-punched, continuous filament polyester or polypropylene geotextile, as set out on the Drawings. Where approved alternative geotextiles are permitted, these shall be Engineer-approved, non-woven, needle-punched, continuous filament polyester or polypropylene geotextile, and shall as a minimum comply with the following minimum requirements:

- Tensile strength MD/XMD (AS 3706.2) > 45/50 kN/m
- Grab tensile strength MD/XMD (AS 3706.2) > 2,500/3,000 kN
- CBR burst strength (AS 3706.4) > 8,000 N
- CBR toughness (AS 3706.4) > 9 kJ/m^2
- Accelerated UV resistance (AS 3706.11) minimum 80% of strength retained

All geotextile filter fabric shall be supplied, placed and lapped in accordance with TNZ F/7 unless otherwise shown on the Contract Drawings.

Storage and handling of fabric shall be in accordance with the manufacturer's recommendations, except that in no case shall the fabric be exposed to heat or direct sunlight to the extent that its strength or toughness is diminished. Fabric which is not to be installed immediately shall not be stored in direct sunlight.

5.4 Fabric shall not be stored in contact with the ground. The storage area shall be such that the cloth is protected from mud, soil, dust, debris, and direct sunlight. Torn or punctured fabric shall not be used. Construction

5.4.1 General

The Contractor shall handle, protect and store all geotextile materials in accordance with the manufacturer's recommendations and with good practice. The Engineer will inspect the components prior to its installation and any component, which is in any way damaged, contaminated or fails to meet the specified requirements will be rejected.

Contact with mud, wet cement, epoxy and other similar materials, which could permanently affix themselves to the geotextiles, shall be eliminated without damaging the geotextiles in any way. Geotextile lengths and set out details are presented on the Contract Drawings.

5.4.2 Geogrid Installation

Prior to any engineered fill placement, the subgrade shall be cleaned and cleared of all debris and loose material, and proof rolled, so as to provide a uniform and competent surface upon which to place the engineered fill. The Engineer shall observe subgrade clearance work and confirm the area is acceptable prior to commencing engineered fill placement.

The geogrid and engineered fill material shall be placed, filled and tensioned in accordance with the Contractor's approved Method Statement and the manufacturer's guidelines, including the following:

- The geogrids shall be placed as detailed in the Contract Drawings, and as directed by the Engineer, in structurally continuous, flat, longitudinal strips and oriented with the highest strength axis perpendicular to the wall alignment. The geogrid shall be placed within 50mm of the design elevations and extend the lengths shown on the Contract Drawings;

- The geogrid strips shall be laid horizontally on the subgrade and subsequently on the compacted engineered fill. A layer of engineered fill is then placed, sufficient to stabilise the geogrid, and the geogrid tensioned, one reinforcing strip at a time, using a tensioning beam inserted into the apertures in the free ends of the grid and applying a nominal load of 1.5kN/m. Alternatively, U-shaped pins, or similar, can be used to stabilise the tensioned geogrid;
- The geogrid shall then remain tensioned, with no wrinkles, while the balance of the engineered fill is placed and compacted up to the level of the next geogrid layer;
- Geogrid reinforcement strips shall be placed side-by-side, with no gaps, so as to provide 100% coverage at each level. The geogrid shall be placed so as to ensure that the tolerances given in this Specification and on the Contract Drawings are achieved. The position of the boundaries between geogrid strips shall be such that they are staggered between adjacent layers and do not have the boundary aligned vertically;
- All geogrid reinforcements are to be cut to length and no jointing shall be allowed;
- Under no circumstances shall any vehicle or compaction plant be allowed on the geogrid before at least 150 mm of engineered fill has been placed over the geogrid layer. Turning of tracked vehicles on this fill should be kept to a minimum to prevent tracks from displacing the fill and the geogrid.

5.4.3 Geotextile handling and placement

Geotextile material delivered to site shall be stored in a dry condition and shall remain in its protection wrapper until use. Geotextile shall be carefully handled at all times. Damage such as rips, tears or holes shall be repaired as directed by the Engineer. When patching of the geotextile is permitted by the Engineer to repair damage, the patch shall extend a minimum of 1000mm in all directions from the damaged area, and, if required, shall be sewn in place to the manufacturer's recommendations.

The subgrade shall be shaped and prepared for the subsequent placement of geotextile filter fabric. All prepared surfaces shall be trimmed to a smooth surface to receive the geotextile. All trimmed and prepared subgrade shall be even and smooth and shall not contain any protrusions or material that may damage the geotextile. Larger diameter stones which extend beyond the trimmed profile shall be removed and incorporated in other areas of the works or removed from site.

All geotextile fabric sheets shall be placed loosely and flat against the prepared slope without any folds or wrinkles. All adjacent geotextile fabric sheets shall be lapped to form a continuous membrane. Unless placed under a rock layer (underlayer or armour rock), laps in all directions shall be a minimum of 500mm unless otherwise shown on the Drawings. When placed under a rock layer, laps in all directions shall be a minimum of 1000 mm when the subgrade consists of cohesive silts or clays, or pit run or graded aggregate with top size 40mm or larger. For other subgrade materials (including sand), the minimum lap shall be 1500mm.

If approved by the Engineer, the geotextile fabric may be sewn into sheets prior to placement in the works, with the size of the sheet being determined by the Contractor to suit the placement method. All sewn joints shall be to the manufacturer's recommendations, a copy of which shall be forwarded to the Engineer. The Engineer shall inspect and approve the joints prior to the sheets being placed in the works.

The geotextile sheets shall be firmly held in place to prevent movement during the placement of overlying fill and rock materials. If movement occurs prior to or during placement of fill or rock, then the overlying materials shall be removed and the geotextile re-laid.

If the geotextile fabric needs to be placed underwater, the contractor shall provide a method statement to be approved by the Engineer prior to commencing placing.

Geotextile fabric shall only be placed on Designer-approved, prepared subgrade.

6 Concrete

6.1 Scope

The work covered by this section includes the supply of all labour, materials and plant for the mixing and placing of all concrete, together with all other associated trade work, complete as shown, all as described in the Drawings and/or Specification. It shall apply to components precast off site as well as those cast on site.

The Contractor shall do all preparation necessary to receive or adjoin other work, and shall generally be responsible for the installation of embedments in concrete, and shall form all penetrations, chases, nibs, etc. necessary for the work of other trades as shown in the Drawings unless directed otherwise by the Engineer.

6.2 Standard specifications

The requirements of the following standard specifications and any Standards quoted therein shall apply except where modified by this Specification. Where this Specification differs from any provision of the Standards the requirements of this Specification shall take precedence. Reference to any Standard shall include any amendments and any Standard in substitution thereof. Materials and workmanship shall comply with these Standards unless expressly noted otherwise.

NZS 3101	The Design of Concrete Structures
NZS 3104	Specification for Concrete Production – normal and special mix grades
NZS 3109*	Concrete Construction (and the Standards to which it refers)
AS/NZS 4671	Steel Reinforcing Materials

*Construction Reviewer as defined in this Standard shall mean the Engineer.

6.3 Materials

6.3.1 General concrete requirements

The Contractor's attention is drawn to the important requirement for dense, durable, concrete. To minimise concrete shrinkage, mix designs shall provide concretes with the minimum possible water cement ratios and minimum cement contents which are consistent with a cohesive concrete of adequate workability, density, surface finish and required strength.

To ensure uniform concrete quality and compliance with the above requirements, all materials and concrete will be subject to detailed inspection at the construction site by the Engineer and all concreting operations shall be within effective quality assurance procedures.

Any subcontractor supply from off-site shall be under a quality plan approved by the Engineer which assures meeting of the requirements of this Specification. Notwithstanding this clause, the Contractor shall be responsible for supply of all materials.

The following concrete mixes as specified in Table 6.1 shall be used in different parts of the Works as shown on the Drawings.

Table 6.1: Concrete mixes

Grade Designation	50 (special mix)	30 (normal mix)	25 (normal mix)
Maximum Aggregate Size (mm)	19	19	19
Specified Compressive Strength (MPa)	50	30	25
Method of Placement	NBC	NBC	NBC
Specified Slump (mm)	NBC	NBC	NBC
Maximum water to binder ratio	0.45	-	-
General Location	Retaining wall piles, panels, capping beam, pavements, stairs, ramps	Rock armour founding concrete	Site concrete
Additional Data	Min. binder content 350 kg/m3 Concrete shall contain a supplementary cementitious material (SCM). SCM options are: 30% FA 65% GBS 8% MS	-	-
Note 1: NBC denotes nominated by Contractor			

Prescribed mixes will only be permitted on small remote projects outside operating areas of ready-mix plants, and where concrete strength is less than 25MPa.

Normal and special mix concrete shall be supplied from an off-site plant approved by the N.Z. Ready Mix Concrete Association to produce normal grade and special grade concrete, and satisfying the requirements of this Specification. Plant including transit trucks shall have sufficient capacity to meet comfortably the requirements of the largest daily pour required to be undertaken continuously between authorised concrete joints.

Concrete shall be delivered to where it will be placed and be discharged either directly into formwork or concrete buckets. Transport or placement by concrete pump will not be permitted without the approval of the Engineer.

The concrete shall be composed of the following materials: ordinary Portland cement, coarse and fine aggregates and water. An air entraining admixture and a retarder may be used. No other ingredients shall be added to the concrete unless requested and permitted in writing by the Engineer.

Special mix concrete shall generally apply to performance requirements outside the strength range of 17.5 – 50MPa or have special features such as shrinkage, exterior durability etc. The use of high slump self-compacting concrete will require prior approval of the Engineer.

6.3.2 Aggregates

Fine and coarse aggregates shall comply with the requirements of NZS 3121 and NZS 3111. The maximum size of coarse aggregate shall be 19mm. The Contractor shall provide the Engineer with details of the types and source of supply of the aggregates, a minimum of two weeks before work is to commence. In addition, they shall provide confirmation from the supplier that the proposed

aggregates are non-reactive as defined in clause 6.1 of the CCANZ report no. TR3, Alkali Silica Reaction: Minimising the Risk of Damage to Concrete: Guidance Notes and Recommended Practice (2 no. edn) 2003. Once approval has been obtained for the aggregates to be used, neither the quality nor source shall vary without the prior approval of the Engineer.

6.3.3 Additives and admixtures

Unless specified otherwise, chemical admixtures will generally not be permitted in concrete except as provided for in NZS 3104 for High Grade and Special Grade and Special Grade Mass concrete or when special circumstances clearly warrant their use and for their use in special-class concrete.

All approved chemical admixtures and their use shall comply with AS 1478 and shall be used in accordance with the manufacturer's recommendation.

Technical details including data of all admixtures proposed to be used shall be forwarded to the Engineer for approval including written indication from the manufacturer(s) of its compatibility to other chemical admixtures and concrete ingredients.

Any admixture used shall not adversely affect the concrete or any reinforcement including protective coatings and shall be used only in locations and in such quantities as approved by the Engineer.

The chloride content of any products used in a mix shall be reported and included in the calculation of the total chloride ion content referred to in Table 3.11 of NZS 3101:2006. Calcium chloride as an admixture will not be permitted.

The total alkali contribution levels (measured as Na20 equivalent) of all admixtures shall be reported and included in the calculation of the total alkali content.

Admixtures shall not be mixed together prior to introduction to the mix.

Requirements for the use of shrinkage limiting admixtures in order to achieve the specified shrinkage test limits shall be determined by trial mixes and subsequent testing.

6.3.4 Corrosion inhibitors

Where the use of Corrosion Inhibiting admixtures is specified or where the Contractor requires its use to achieve required performance, the Contractor shall submit the following data / information to the Engineer for review and approval:

Corrosion inhibitor type and manufacturer's printed technical information including the manufacturer's recommendations for application dosage and usage method.

Proposed dosage and procedures for introducing of corrosion inhibitor with evidence that the fresh and hardened concrete properties will not be adversely affected and the corrosion inhibitor is uniformly distributed.

Technical data on long-term protection capability of the nominated corrosion inhibitor.

6.3.5 Shrinkage reducing admixtures

If a shrinkage-reducing admixture is proposed by the Contractor, product details, manufacturer's printed technical information, intended dose rate and other relevant technical data on short and long term performance of the concrete shall be submitted to the Engineer for review and approval.

Any such admixtures shall be included in trial mixes for the works. They shall not be detrimental to the achievement of the strength and durability requirements of the Specification.

6.3.6 Reinforcing steel

Reinforcing bars shall be higher ductility plain carbon steel Grade 300E or 500E as shown on the Drawings, and shall comply with AS/NZS 4671. Grade 500E bars shall be produced by the Micro-Alloy process unless otherwise permitted by the Engineer. Grade 250N or Grade 500N reinforcement is permitted where specifically indicated on the drawings. Grade 250L or 500L is not permitted. Reinforcing mesh shall be Super Ductile Grade 500E or Grade 300E. Where permitted by the Engineer the use of low ductility mesh may be used in structures where ductile behaviour is not critical.

6.3.7 Mortar

The mortar mix proportions shall be such as to meet the following requirements:

Compressive strength at 28 days – fc (50mm diameter x 100mm cylinders tested in a similar manner to the concrete compression test) shall be 20MPa, unless specified elsewhere on the Drawings.

Volumetric proportions of cement including fly ash where approved to moist sand with 3 to 5% moisture content (or equivalent proportions if weigh-batched) shall be not less than one part of cement to three parts of sand.

Admixtures or fly ash containing chlorides, nitrates or any other compounds likely to adversely affect the strength or durability of the mortar shall not be used.

The mortar shall be mixed to a uniform consistency before application.

Epoxy resin mortar shall be an approved sand filled epoxy resin prepared and placed in accordance with the manufacturer's recommendations. Concrete surfaces which are to receive epoxy resin mortar shall be cleaned of all laitance immediately prior to covering with an epoxy resin tack coat.

The curing of epoxy mortar shall be in accordance with the manufacturer's recommendations. Unused epoxy resin, either filled or unfilled, shall be discarded when it loses its plastic condition. Excess or spilled resin shall be cleaned up while in a plastic state.

6.3.8 Cement

Cement shall be type GP – general purpose Portland cement and/or blended cements complying with AS 3972 / NZS 3122 and the following requirements governing supply, quality and storage.

The intended source and brand to be used shall be advised as soon as possible and be to the Engineer's approval and, once approved, the cement shall not be changed without the written consent of the Engineer.

The Contractor shall arrange for cement manufacturer's test certificates to be forwarded to the Engineer. The certificate shall be provided prior to use of any cement from that batch to which the certificate applies.

The temperature of the cement shall not exceed 30°C prior to mixing.

The Contractor may seek approval for the use of Portland Pozzolan cement complying with NZS 3123 or Portland Limestone Filler cement complying with NZS 3125 where necessary.

6.3.9 Water

The water shall not exceed 30°C temperature prior to mixing. Water used for making concrete shall be free from visible contamination by oil or organic matter, and shall comply with the requirements of NZS 3121. Where it is intended to use recycled water from within the batch plant for the production of concrete its effect on the total alkali content of the concrete shall be considered when

determining the susceptibility for AAR. Where water is used for concrete curing the water used shall not stain the concrete.

6.3.10 Proprietary grout

Proprietary grout shall be provided in a pre-mixed form. 10mm aggregate may be added where permitted by the manufacturer and where the thickness of voids to be grouted permits.

6.4 Concrete mix design

6.4.1 Concrete supplied from a non-approved ready mix concrete producer

No less than two weeks before concreting work is due to commence, the Contractor shall supply to the Engineer details of his concrete mix design for approval. These shall include the following:

- weights of aggregates and water
- cement weight
- water/cement ratio by weight
- target slump
- target compressive strength
- admixtures
- concrete grade
- mix designation

Concreting shall not commence before the mix design has been approved by the Engineer and no variation shall occur without the written approval of the Engineer. Approval by the Engineer shall not relieve the Contractor of his responsibility to produce a satisfactory concrete.

For each grade a mix shall be designed in accordance with ACI 211 "Recommended Practice for Selecting Proportions for Normal Weight Concrete". All mixes shall be continuously graded. The design of over-sanded mixes shall be avoided. However, all mixes shall be cohesive, workable, not prone to segregation, and provide for good surface finish.

The water/cement ratio shall be consistent with the overall requirement that the mix design shall aim to minimise the water content of the fresh concrete in order to reduce shrinkage. An upper limit on the water/cement ratio will be set by the Engineer once the mix designs have been submitted and the results of trial mixes are available. Sufficient cycles of trial mix procedures will be necessary to establish a mix with satisfactory 56 day shrinkage characteristics.

The temperature of the fresh concrete at the time of placing shall not exceed 32°C.

6.4.2 Concrete from an audited NZRMCA plant

The Contractor shall advise the Engineer of his mix details, concrete supplier and provide all supporting documentation if requested to do so to confirm the audit status of the ready mix plant.

6.5 Concrete supply

6.5.1 Production

Concrete shall be produced by one of the following:

a A ready mix concrete plant having a current grading as determined by the Qualification Committee of the N.Z. Ready Mix Concrete Association.

b A concrete plant complying fully with the requirements of NZS 3109 and the appropriate standard for factory or site mixed concrete.

6.5.2 Delivery records

Records shall be kept at the batching plant for each batch including the following:

- Batch number and docket number which can be referred back to the batch plant
- Specified slump
- Mix designation (minimum strength, aggregate size and admixtures)
- Specified strength
- Date and time of mixing
- Quantity delivered
- Actual weight and type of cement, fine and coarse aggregate, weight of free water and hence the free water / cement ratio.

If concrete is delivered by truck from an off-site batching plant, delivery dockets containing this information shall accompany each truck. These dockets shall be made out in triplicate by the batch plant operator. The original shall be retained by the batch plant. The remaining two copies shall be given to the truck driver who shall retain one copy and give the other copy to the Engineer at the work area.

If delivery records do not agree with the approved mix design, the Engineer may reject the concrete for placement in the Works.

6.5.3 Discharge time

Discharge of concrete into the structure or formwork shall be completed within the following period of time after the first introduction of the cement to the aggregates or of mixing water to the cement and aggregates:

- For concrete without an approved retarder 45 minutes
- For concrete containing an approved retarder 100 minutes

In the event that the Contractor can measure concrete placing temperatures the discharge placement time limits may be modified by Table 6.2.

Table 6.2: Concrete Discharge time limits

Concrete Temperature at Time of Placement	Maximum Elapsed Time After Introduction of Water
Less than 10°C	Not permitted
10oC to 24°C	1.5 hours
24oC to 27°C	1 hour 15 minutes
27oC to 30°C	1 hour
30oC to 32°C	45 minutes
Greater than 32°C	Not permitted

6.5.4 Mixing and transport equipment

All materials and concrete shall be fully discharged from any mixing and transporting equipment used before it is charged with a new mix. The drum of the mixer and the trucks shall be thoroughly cleaned of all adhering concrete at frequent intervals during continuous operation; the mixers which have been out of use for more than 30 minutes shall be cleaned before any fresh concrete is mixed or introduced. Any water in mixing or transporting equipment shall be removed before concrete or materials are discharged into it.

6.5.5 Additional water

After discharge from the batching plant, no water shall be added to special mix concrete in the transit mixer trucks, for any reason whatsoever.

For normal mix concrete water may be added on site subject to the requirements of clause 9.4.2.1 of NZS 3109. The quantity of added water shall be recorded on the delivery docket. Under no circumstances shall the amount of added water exceed 10 litres per m^3 of concrete.

6.5.6 Large concrete pours

For large concrete pours where the lesser dimension of concrete to be placed exceeds 500 mm the Contractor shall ensure early age thermal crack control is implemented by providing and installing temperature sensing devices of type and locations to the approval of the Engineer. The Contractor shall address the following variables for controlling temperature rise:

- Section thickness
- Formwork and insulation
- Ambient conditions
- Concrete placing temperature
- Concrete mix proportions
- Controlling rate and lift height of concrete placement
- Types and sources of cementitious materials
- Adding flaked or chipped ice to mix water
- Use of internal cooling pipes

Temperature of the concrete at placement shall not exceed 25°C. Maximum temperature of the concrete shall not be more than 70°C and temperature differential between the core and outer surfaces of the concrete shall not exceed 20°C.

6.6 Testing of concrete

6.6.1 General

All equipment for the tests as required in NZS 3112 shall be provided by the Contractor. The Contractor shall supply all necessary labour to assist with sampling of the concrete and supply all necessary concrete for the testing.

The Contractor shall supply all equipment and labour necessary to prepare the samples and perform on-site tests, which shall be carried out under the Engineer's observation. All laboratory tests shall be performed by a registered testing laboratory approved by the Engineer and the Contractor shall pay all costs and incidental expenses incurred for testing services.

Where stripping times are required to be reduced because of the construction timetabling or for other reasons deemed valid by the Engineer, the number of specimens shall be increased. This number will be determined by the Engineer but will not normally be fewer than six compressive strength test specimens.

6.6.2 Slump tests

The results of slump tests taken on samples of concrete supervised by the Engineer at the point of delivery shall be the only basis for defining the slump of the mixes supplied.

The slump for cast in situ concrete shall be as specified unless authorised by the Engineer as a variation. Tolerances for slump shall be in accordance with NZS 3109, Table 9.1. Where a test sample at the time of placing fails to come within these tolerances the concrete is liable for rejection by the Engineer. Slump tests shall be carried out in accordance with NZS 3112: Part 1. At least one slump test shall be performed on each batch of concrete.

6.6.3 Compressive strength test samples

Each day during concrete placement on site a total of three compressive strength test specimens shall be moulded for each 75 m3 of concrete placed unless the Engineer directs otherwise. The specimens shall be prepared, stored and cured in accordance with NZS 3112: Part 2. If a specimen is required for testing for early strength indication at 7 days, a fourth sample shall be made.

Three specimens shall be tested at 28 days and the other specimen (if required) shall be tested for early age strength at 7 days. The strength of the concrete will be determined from the cylinder test strengths with tolerances as set out in NZS 3109. If concrete is supplied from more than one plant then this requirement shall apply to the concrete from each plant.

6.6.4 Core sampling

If after 28 days the compressive test specimens do not reach the required strength, the Engineer may at his discretion order the concrete represented by the failed tests to be removed from the work. The Contractor may elect, at his expense, to take core samples of the concrete to confirm the in situ strength of the concrete. The Contractor shall notify the Engineer before such samples are taken.

Sampling of cores shall be performed in accordance with BS EN 12504-1 and core sample testing is to be performed in accordance with NZS 3112 Part 2, Section 9. Sampling and testing shall be performed by an independent agency.

6.7 Execution of work

6.7.1 Excavation, filling and compaction

All excavation and filling, including sub-base, basecourse and compaction, necessary for the construction of the concrete works, shall comply with the relevant clauses of this Specification detailing bulk earthworks and unbound granular pavement layer.

Filling behind retaining structures shall not commence until one week after the concrete pour. Specified compaction behind retaining structures shall be achieved using hand-held compaction equipment and the Contractor shall not allow heavy compaction equipment within 1.5m of retaining structures.

6.7.2 Formwork

6.7.2.1 General

Formwork shall comply in all respects with AS 3610 and NZS 3109 Chapter 5. The Contractor shall be responsible for the design of all formwork. The Contractor shall ensure thorough checking of the formwork design as part of quality assurance. Where the Contractor uses proprietary materials, these shall be used in accordance with the manufacturer's recommendations and designed in accordance with the relevant New Zealand Standard.

Off the form surface finish shall comply with NZS 3114 and the Drawings.

6.7.2.2 Tolerances

The Contractor shall provide final concrete tolerances as set out on the Drawings and in accordance with NZS 3109.

6.7.2.3 Striking of formwork

The striking of formwork shall be carried out in accordance with NZS 3109. Where formwork is required to be removed early, the Contractor shall obtain the written approval of the Engineer. The Engineer will only give this approval if results of compressive tests show that the concrete is up to the strength that would normally be obtained at the minimum stripping time as given in Table 5.3 of NZS 3109.

6.7.2.4 Re-use of formwork

Where formwork is to be re-used, the forms shall be clean and free of any laitance that may exist on the surface. Oil or other approved formwork release agents shall be applied to the surface of the form before it is reused.

6.7.2.5 Support of formwork

Formwork shall be designed and constructed to provide the necessary rigidity and strength to support the loads to be carried. Bracing shall be provided both transversely and longitudinally and provision shall be made by means of wedges or jacks for adjusting the formwork.

6.7.2.6 Embedded items

Where metal accessories are used they shall be constructed to be wholly or partially removable without damage to the concrete. Any embedded portion shall terminate not less than twice its minimum dimension from the concrete surface but in no case less than minimum cover requirements.

Resulting cavities shall be filled with cement mortar or epoxy mortar and the surface left sound, smooth, even and uniform in colour.

6.7.3 Steel reinforcing

6.7.3.1 General

Reinforcing materials shall be higher ductility plain carbon steel complying with AS/NZS 4671. The placing of steel reinforcing shall comply with NZS 3109, unless otherwise specified.

6.7.3.2 Stacking and protection

Reinforcing steel shall be stacked clear of the ground at all times. The steel shall be protected from damage at all times, and any grease, mud, spilled concrete or other coating on the steel shall be removed before it is concreted in the final work.

6.7.3.3 Bending, threading and welding of steel reinforcing

All bars shall be bent cold unless otherwise permitted by the Engineer. No bar shall be bent twice in the same place. Bends shall be as shown on the Drawings, and there shall be no kinks or bends on straight sections of reinforcement.

Grade 500E reinforcement produced by the Quenched and Self Tempered (QT) process may only be bent once and shall not be rebent on site. Grade 300E QT reinforcement may be rebent once only in accordance with the requirements of NZS 3109.

Grade 500E reinforcement of 16mm bar diameter or less produced by the Micro-Alloying (MA) process may be rebent on site. The rebending process shall comply with the requirements of NZS 3109 (i.e. heating to cherry red heat). Grade 500E MA reinforcement greater than 16mm diameter may only be bent once, and shall not be rebent on site. Grade 300E MA reinforcement may be rebent once only in accordance with the requirements of NZS 3109.

Grade 500E QT and grade 300E QT reinforcement shall not be threaded or welded.

Welding of reinforcement, including tack welding, shall be carried out in accordance with an approved method statement and welding procedure. Proposed weld locations and details shall also be approved by the Engineer.

All welding procedures shall be in accordance with AS/NZS 1554. Detailed welding procedures including proposed welding techniques and electrodes, with drawings and schedules as required, shall be prepared prior to welding commencing on site. Only welders qualified to AS/NZS 1554.3 (Clause 10.2) shall be used for permanent works welding. Proof of welder's proficiency and qualification shall be made available on request.

Under no circumstances shall quenched and tempered reinforcement be welded.

All welds shall be category SP in accordance with AS/NZS 1554.

All welding work shall be protected from the weather.

The standard for interpretation of non-destructive testing shall be AS/NZS 1554. The extent of non-destructive examination (NDE) is set out in Table 6.3.

Table 6.3: Extent of non-destructive testing

Extent of Non-Destructive Testing				
Weld Category	**Visual Means**		**Other Means**	
	Visual Scanning (Note 1)	**Visual Examination (Note 2)**	**Magnetic Particle or Liquid Penetrant**	**Radiography or Ultrasonics (Note 3)**
SP fillet welds	100%	10%	NA	NA
SP Butt welds	100%	10%	NA	Refer Note 3

Note 1: Visual scanning shall determine that no welds called for in the drawings or specification are omitted. Visual scanning shall also detect gross welding defects.

Note 2: Visual examination shall determine whether the required weld quality (in accordance with Table 6.2.2 of AS/NZS 1554.1) has been achieved. Visual examination shall be carried out by a suitably qualified and experienced welding inspector. Should the welding inspector have concerns with the weld quality, other NDE may be requested.

Note 3: The extent of radiography testing for full butt splices of reinforcement will be determined on a case by case basis, taking into account the size and number of bars affected and their position in the structure.

Where the proportion of non-destructive examination (either visual or other means) called for above is less than 100%, the programme of testing shall be agreed prior to commencement of any welding. The programme shall involve full testing of the first 5% of welds, in order to pick up and correct the cause of any major defect at the commencement of welding. Once compliance is established, the frequency of subsequent testing may then be progressively reduced to achieve the overall level of testing specified above. In the event of a non-compliant test result, a return to full testing of the next 5% of welds will be required.

If the tests of any weld do no conform to the specified requirements, two additional specimens from the same weld shall be tested. In the case of failure of one or both of these additional tests, the length of weld covered by the tests shall be rejected.

Weld test results shall be cross-referenced to the weld location and shall be maintained on site as part of the as-built record.

6.7.3.4 Placing and fixing

The Contractor shall provide all labour and materials for the support of the reinforcing steel to maintain its correct position during the placing and compaction of concrete. Such supports are not shown on the Drawings. The minimum number of rigid supports to be provided by the Contractor shall be:

- Slab steel: Two approved supports per square metre
- Panel wall steel: One approved support per two square metres
- Beam and column steel: One line of support per metre length

The Contractor shall be responsible for ensuring that the reinforcing is be held in position with the aid of approved spacers or supports. When access is required across light reinforcing bars or mesh, the Contractor shall make use of walking boards to avoid the need for workmen to walk on the reinforcing steel. Tie wire using annealed iron not smaller than 1.25mm diameter or by approved clips shall be used to secure reinforcement at intersections. The ends of wire ties shall be bent away from the nearby faces of forms and shall not project into the concrete cover.

Plastic spacers or plastic footed steel high chairs are preferred. Concrete blocks used to fix the steel from the forms shall be at least as strong as the adjacent placed concrete and firmly wired to the

reinforcement using wires cast into the blocks but may only be used where the concrete surface will not be exposed or the concrete surface will be plastered.

Starter bars shall be secured to prevent damage including restraint against swaying in the wind.

Where the height of bars extending above freshly placed concrete exceeds 1.5m, the bars shall be fixed to a timber plate or similar to ensure no movement at the bar / concrete interface before the concrete sets. Bars shall only be lapped where shown on the drawings. Splices in adjacent bars shall be staggered by at least 600mm unless shown otherwise on the drawings.

Reinforcing bar tolerances shall be as specified in NZS 3109.

Clear cover to all reinforcement, including stirrups and ties shall be as shown on the Drawings.

6.7.3.5 Reinforcement schedules

Copies of bar bending schedules provided by the Contractor's suppliers shall be provided to the Engineer for approval not less than two weeks before commencing any cutting or bending to enable review by the Engineer.

The bar bending detailer shall cross reference all schedules to the appropriate drawings and bar call up numbers.

6.7.3.6 Testing of reinforcement

The Contractor shall supply a test certificate issued by the manufacturer of the steel, for each grade and parcel of reinforcement material supplied to the site. Independent tests shall also be carried out by the Contractor in accordance with the following procedures.

One tensile and two bend tests shall be carried out on a random sample of every bar size, type and grade, for every 250 tonnes batch of reinforcing steel delivered to the site, with a minimum of one series of tests for each bars size, type and grade. The tests shall be carried out in accordance with AS/NZS 4671, by an independent TELARC registered testing laboratory and the samples shall be selected by the Engineer.

Reinforcement carrying a manufacturer's certificate of compliance with AS/NZS 4671 may have its tests carried out whilst initial use has commenced.

Reinforcing steel shall be deemed acceptable if it complies fully with the requirements of AS/NZS 4671 when tested in accordance with the above.

6.7.4 Concrete placing

All concreting shall conform to NZS 3109, Section 7 and this Specification.

Concrete shall not be pumped without the Engineer's approval. Where such approval is given, only a special concrete mix design suitable for pumping may be used.

The Engineer, or his/her representative, shall be advised at least 48 hours before the Contractor intends to place any concrete to enable him to inspect the formwork and reinforcement.

The concrete shall not be placed if the slump as measured in accordance with this Specification is not within the acceptance criteria specified within. Concrete not complying with NZS 3109:1997 Clause 9.3 shall be liable for rejection.

Concreting must be carried out in one continuous operation between ends of members and/or construction joints. Except at properly formed construction joints, fresh concrete must not be placed against concrete that has taken its initial set.

The concrete must be supplied and placed at an adequate rate to ensure that all the concrete in the forms can be kept plastic until placed in its final position and compacted, and all temporarily exposed surfaced covered by and knit in with fresh concrete so that no cold joints are formed. Equipment and personnel must be adequate to maintain the rate of concrete placement adopted.

The concrete shall be placed in the form as near as practicable in its final position to avoid rehandling. The depositing of large quantities of concrete at any one point and running or working it along the forms will not be allowed.

Concrete shall not be dropped from a height greater than 2m unless the Contractor can demonstrate that their method of placement prevents segregation and that the mix design used for the concreting has been specifically designed to minimise the potential for segregation. The Contractor shall clearly specify in the Construction Method Statement the method of concrete placement. It shall remain the sole discretion of the Engineer to accept or reject the Contractor's mix design and any proposal to freely drop concrete from heights in excess of that specified above. The Contractor shall comply with the Engineer's decision at no additional cost of the project.

Concrete must not be moved horizontally more than 1.0m by the use of vibrators.

All concrete shall be placed so as to completely avoid segregation. Segregated concrete will be taken as evidence of improper workmanship or incorrect mix proportions and such concrete shall be removed at the Contractor's expense.

When the concrete is conveyed by chutes, the angle and shape of the chutes shall be such as to allow the concrete to flow without separation of the ingredients. Chutes must be baffled or hooded at the discharging end to prevent segregation. These chutes shall be kept as vertical as possible and shall be kept as far as practicable full of concrete with their lower ends immersed in the newly placed concrete.

The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with fresh clean water before and after each run, the water used for this purpose being discharged outside the form.

Concrete shall be deposited continuously and as rapidly as practicable until the section of the work is completed. Any concrete which has taken its initial set shall be rejected.

In hot weather, where necessary, the surfaces against which concrete is to be placed, including reinforcement and formwork, shall be lightly sprayed with water to prevent excessive absorption of water from the fresh concrete. Pre-wetted surfaces shall be free from excessive water before concreting.

Accumulations of water on the surface of the concrete due to water gain, segregation or other causes during placing and compacting shall be prevented as far as possible by adjustments in the mixture. Provision shall be made for the removal of such water as may accumulate so that under no circumstances will concrete be placed in such accumulations.

The concrete shall be placed in horizontal layers not more than 500mm thick and each layer shall be compacted before the preceding layer has taken its initial set.

Cofferdams constructed to maintain a dry work area shall be sufficiently tight to prevent the flow of water through the space in which the concrete is being placed.

Concrete surfaces, upon or against which concrete is to be placed and to which new concrete is to adhere, that have stiffened to such an extent that the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of construction joints shall be prepared in accordance with this Specification.

6.7.5 Transporting

The concrete shall be transported to its final position as rapidly as possible, by means which will prevent segregation, loss of materials and contamination.

Pump lines shall be supported clear of the reinforcement.

The equipment used in placing the concrete, and the method of its operations, shall be such as will permit introduction of the concrete into its final location without high-velocity discharge and resultant segregation.

Concrete pumps shall have a variable speed control and shall be capable of pumping concrete containing 20mm aggregate through delivery lines not less than 75mm diameter and for a distance required for placement within the works to meet requirements of this Specification.

Under no circumstance shall aluminium alloy pipes or fittings be used nor shall concrete be permitted to come into contact with aluminium during its manufacture, transport or placing.

Where delivery lines are exposed to the direct sunlight, they shall be protected by a covering of bags, fully saturated hessian or other approved means.

During delays in delivery of concrete to the pump, concrete in the lines shall be pumped at regular intervals to ensure that the concrete is “live.” For piston type pumps, at least two strokes of the piston shall be made at each pumping interval.

6.7.6 Compaction

The concrete shall be thoroughly compacted using form vibrators of approved types and such hand tools, vibrators and methods as necessary to ensure that the concrete is carefully worked around the reinforcement and embedded fixtures and into the corners of the formwork. Extreme care shall be exercised in thoroughly compacting concrete.

The Contractor shall maintain immersion vibrators in addition to the form vibrators to enable additional manual compaction where required to thoroughly compact the concrete.

Depth and rate of placement of concrete shall be such that preceding layers shall remain in a soft and plastic state when covered by each succeeding lift or layer. Vibration and other compaction measures shall extend through the full depth of each layer of fresh concrete and 150 mm minimum into the preceding layer to completely consolidate successive batches and merge them with each other. The vibrator shall not be allowed to penetrate into partially hardened concrete or to disturb reinforcement. Vibrators shall be inserted on a regular pattern with the radii of influence overlapping.

Immersion vibrators shall be inserted into the concrete continuously and progressively along the pour for sufficient time for each insertion to compact the concrete thoroughly and remove bubbles of entrapped air.

Form vibrators shall be firmly attached to the forms but the vibrator shall be capable of being moved up or down or laterally along the forms.

Immersion vibrators shall of such diameter and capable of transmitting a frequency such that the compaction and durability of the completed concrete can be achieved to the required standard.

At least one vibrator in working order shall be held in reserve for emergency use.

If pools of grout, water or laitance form readily during vibration, the concrete mixture shall be modified and submitted to the Engineer for review.

The use of self-compacting concrete may be permitted by the Engineer where circumstance prevents the use of vibrators to remove entrapped air pockets.

6.7.7 Construction loads and deflections

In providing support to construction from a previously constructed portion of the works the Contractor shall plan the removal of propping such that stresses and deflections are not excessive.

The construction loads imposed on a structure of age 28 days or more shall be such that the strength requirements do not exceed those induced by the design loading, unless it is demonstrated by calculation that the strength requirements are within the capacity of the supporting structure.

Where the structure is less than 28 days old, the allowable loads shall be appropriately reduced. The Contractor shall seek approval from the Engineer for all loads imposed during construction.

The Contractor shall demonstrate that calculated final deflections (following removal of construction loads and application of design loads) are either less than the calculated deflections which would be caused by the application of the design loading or within acceptable limits as defined by the Engineer. Such calculations shall take into account, where appropriate, non-recoverable deflections due to creep of young concrete.

6.7.8 Concrete curing and protection

6.7.8.1 General

The method of curing and protection of concrete proposed by the Contractor shall be such that the strength and durability requirements of the concrete as required by the Specification and the Drawings are met.

The minimum concrete curing requirements are as provided in Table 6.4 below. This table reflects, with some amendment, to the requirements of Table 3.5 of NZS 3101:2006 and Table 5.1 of NZS 3101:1995 for Exposure Classification U.

Table 6.4: Minimum concrete curing requirements (based upon NZS 3101:2006)

Exposure Classification	Curing Period (1) (3) (4) (under ambient conditions)
C	7 days (2)
Note 1: Curing shall comply with Clause 7.8 of NZS 3109.	
Note 2: Concrete in C, XA2, and XA3 zones shall be cured continuously by direct water application such as ponding or continuous sprinkling, or by continuous application of a mist spray.	
Note 3: In addition to the requirements of Table 1.3 the concrete shall be cured for at least the period required to achieve the 7-day compressive strength of the concrete taken from cylinders cast at the time and place of the concrete pour for the element in question. The longer of the two durations defined by the curing time specified and the 7-day compressive strength shall apply.	
Note 4: Curing shall commence immediately after initial set of the concrete and shall continue until the cumulative number of days during which the temperature of the air in contact with the concrete is above 10°C has totalled the minimum number of days required for curing in accordance with this Table.	

Where curing compounds are accepted by the Engineer for use in the Works the Contractor shall be responsible for ensuring that the curing compound proposed is compatible with any subsequent covering or surface treatments including coatings, sealers, paints, or waterproofing membranes.

When concreting in hot weather the work shall, where practicable, be protected from the direct rays of the sun and from drying winds.

When rain is likely to cause damage to fresh concrete or leaching of cement, the work shall be protected.

6.7.8.2 Curing

Freshly cast concrete shall be protected from premature drying and temperatures not permitted in this Specification. 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.

Where heat accelerated curing is proposed for non-prestressed precast concrete elements it shall be as described in the relevant clause of this Specification.

6.7.8.3 Curing methods

Curing methods shall comply with Clause 7.8 of NZS 3109.

6.7.8.4 Curing compounds

Curing compound details shall be approved in writing by the Engineer. Membrane curing compounds applied to the surface of construction joints or bearing areas where concrete or grout is subsequently to be placed shall be removed by scabbling, grinding or sand blasting. Only approved coloured liquid membrane-forming compounds are to be used.

The compound shall be applied in strict accordance with the Manufacturer's Specification and shall be applied as soon as the surface water has disappeared.

At least six (6) days prior to the use of curing compound, full details of the proposed compound shall be submitted to the Engineer for review. Such details shall be accompanied by test certificates to show that the compound will give satisfactory results for the proposed application.

Curing compounds shall be delivered to the Site in suitably labelled containers to enable identification of the batch number and date of manufacture.

Curing compounds shall comply with the requirements of AS 3799 for the classes and types specified in Table 6.5.

Table 6.5: Classes and types of curing compounds

Description of Curing Compound	Class (to AS 3799)	Type (to AS 3799)
Wax-based compounds (wax emulsion)	A	1-D
Resin-based compounds (Hydrocarbon resin)	B	
Water-borne compounds	Z	

The water retention efficiency of the curing compounds for concrete works (AS 3799 – Appendix B) shall not be less than 92%. Curing compound shall be applied in two coats at a rate of not less than 0.2 litres per m^2 per coat. The time between first and second coat must be in accordance with the manufacturer's printed recommendations.

The curing compound supplier shall implement and maintain a quality system in accordance with AS/NZS ISO 9001, as a means of ensuring that the product conforms to the Specification requirements.

For each curing compound proposed for the Work, a Certificate of Compliance to AS 3799 and this Specification shall be submitted to the Engineer for approval.

6.7.8.5 Cold weather curing

Precaution shall be taken to prevent the plastic concrete from freezing at any time. When the temperature of the surrounding air during curing is less than 10°C the temperature of the concrete shall be maintained at a temperature between 10°C and 20°C for the required curing period. Salts or chemicals shall not be used for the prevention of freezing.

6.7.8.6 Curing period

The minimum period for curing shall be in accordance with Table 6.4 of this Specification.

6.7.8.7 Protection against damage

The concrete shall be protected from damage due to load overstresses, heavy shocks, excessive vibrations and the effects of rain and running water particularly during the curing period.

All finished concrete surfaces shall be protected from damage from any cause including construction equipment, materials or methods.

Damaged concrete shall be repaired or replaced in accordance with this Specification or as otherwise approved by the Engineer.

6.7.8.8 Heat accelerated curing

Low pressure steam curing of precast concrete unit cast in steel forms shall be performed in accordance with NZS 3109. Where steam curing is proposed the Contractor shall provide a Construction Method Statement to the Engineer for approval. The method of steam curing shall be such that the strength and durability requirements of the concrete as required by the Specification and the Drawings are met. As a minimum the following requirements shall be addressed in the Method Statement;

- The form of enclosure to ensure containment of live steam in order to minimise moisture and heat losses
- The period of initial application of steam after the final placement and compaction of concrete, and after the initial set of concrete
- The maximum rate of temperature increase of the air within the steam enclosure in Centigrade per hour
- Maximum temperature of the air within the steam enclosure
- The maximum rate of cooling per hour

Confirmation that steam jets will not be allowed to impinge upon any part of the concrete units or of a test specimen, or of their formwork or moulds. Neither shall any steam delivery pipe be attached directly to any formwork nor moulds in such a manner as may cause localised overheating of the concrete.

The number of steam jets to ensure that a substantially uniform temperature is maintained under the steam covers such that the difference in temperature between any two points adjacent to the concrete units is not more than 10°C.

The method of allowing the concrete to cool gradually and evenly.

The proposed timing to expose the concrete to the surrounding environment indicating the temperature of the concrete in relation to the ambient temperature.

6.8 Embedded items

6.8.1 Cast-in items

Holding down bolts and inserts shall be secured and fixed before the concrete is placed or, if shown on the Drawings or if directed by the Engineer, recesses or blockouts shall be made in the concrete and the holding down bolts or inserts shall be grouted in place, or embedded in the second-stage concrete. The surfaces of all holding down bolts or inserts to be in contact with concrete shall be thoroughly cleaned immediately before the grout or concrete is placed. Holding down bolts and/or inserts shall be positioned and aligned in accordance with the tolerances specified or shown on the Drawings before the concrete is placed, and shall be held securely in the correct position during placing and setting of the concrete. All proprietary cast in bolts and inserts shall be installed strictly in accordance with the manufacturer's instructions.

The position tolerance on cast-in items shall be as follows:

- bolts and inserts +/- 10mm

All cast-in items shall meet the durability requirements of the New Zealand Building Code.

6.8.2 Epoxy grouting of reinforcement

This section covers the general requirements for the materials and workmanship relating to the epoxy grouting of reinforcing bars into hardened concrete. Generally this will only be required for remedial works – epoxy grouting is not an alternative construction method to the Drawing details. Grout materials shall be supplied as pre-proportioned factory packaged products, and shall be stored, handled, placed and cured to the manufacturer's printed instructions. The Contractor shall obtain from the manufacturer a written procedure for use of the product, together with certification that the product is suitable for the intended application. These details shall be supplied to the Engineer not less than one week prior to commencing work. A copy of the manufacturer's procedure and instructions shall be kept on the site of the work for reference at all times. Reinforcing bars shall be deformed grade 300 or grade 500 bars complying with AS/NZS 4671. Concrete shall be at least seven days old before epoxy grouting work may proceed. Holes required for setting of bars shall be hammer drilled and shall comply with the Drawings unless otherwise specified/approved by the Engineer. Diamond core drilling will not be accepted.

All holes shall be thoroughly cleaned. This will require the use of clean water to flush out all dust and foreign matter. A wire bottle brush shall be used to ensure no dust or paste remains on the side of the hole. All free water shall be removed prior to grouting. Holes for vertical bars shall be vertical and holes for horizontal starters shall slope downward at 15 degrees.

Areas of bars to be bonded shall be blast cleaned to a "Near White" metal finish according to Australian Standard 1627, Part 4 Class 2½.

After blast cleaning all traces of loose material, blast products etc. shall be removed by brushing with a clean brush. Blast cleaning shall be carried out not more than 6 hours before grouting bars into place. Epoxy grout has a limited working time after mixing. This working time shall be as specified by the manufacturer. The placing of grout shall be performed only during this specified working time and any unused grout remaining beyond this time shall be discarded.

Particular care shall be taken to ensure that:

Ambient conditions during placing and curing are correct for the product used.

- Epoxy components are thoroughly mixed, and in the correct ratio.
- The annular space around the bar is completely filled with epoxy (no air locks).

- The Contractor shall use an epoxy grout suitable for the conditions.

Completed anchorages shall be randomly selected by the Engineer for testing by loading to twice the working load specified on the drawings, or the yield strength of the bar whichever is the lesser. The Contractor shall allow to test 10% of the completed anchors, with a minimum of two, unless directed otherwise by the Engineer. Test loading shall be carried out in the presence of the Engineer or his representative.

6.8.3 Drilled-in fixings

All post-installed anchors shall be either mechanical (expansive type) anchors or chemical (adhesive type) anchors manufactured and supplied from an approved anchor supplier. The selection of anchor type, embedment depth and spacing shall be as shown on the Drawings or otherwise approved by the Engineer. The installation of these anchors shall be carried out strictly in accordance with the manufacturer's instructions. To avoid splitting failure in the base concrete tension anchor spacing shall be not less than 9 x hole diameter and concrete edge distance less than 4.5 x hole diameter.

The Contractor shall advise the Engineer immediately where anchors are to be drilled in cracked concrete zones. All anchors shall meet the durability requirements of the

New Zealand Building Code and be tested in accordance with the same requirements as for epoxy grouted reinforcement.

6.8.4 Embedded sleeves, conduits and pipes

Sleeves, conduits, pipes, cores or other penetrations shall not be cast into the concrete unless they are stipulated on the Drawings, Specification, or instructed to be inserted by the Engineer.

6.9 Construction and contraction joints

6.9.1 General

Construction and contraction joints shall be formed in the positions shown on the Drawings unless a change is approved by the Engineer. Additional construction joints may not be provided nor may any horizontal or vertical joints be omitted without written approval by the Engineer. Any such approval will not be a Variation.

Construction joints shall be made in accordance with Section 5.6 of NZS 3109. Movement control joints shall have a concrete finish similar to that of the adjacent concrete.

Proprietary products included in or at the joints shall be installed in strict accordance with the supplier's specifications and recommendations.

Unless shown otherwise on the Drawings all joints between precast and in situ concrete shall be prepared and constructed to meet the requirements for 'Type B' construction joints in accordance with NZS 3109.

The Contractor's proposals for the pattern of joints for surfaces that will be visible on completion of the work shall be agreed by the Engineer before any concrete is poured, including precast concrete.

20mm x 20mm fillets and chamfers shall be used on all corners, unless expressly noted otherwise on the Drawings. All external angles in exposed members shall be protected against damage after stripping of formwork. The Contractor shall give a slight bevel to all insertions to ensure easy removal without damage to the concrete.

The Contractor shall nominate a limited number of responsible personnel who shall be involved in the mixing and placement of the in situ joints. The Contractor shall demonstrate his familiarity with the procedures required to ensure that the quality requirements shown on the Drawings and contained in this Specification are achieved.

Should edges at construction joints be damaged the Engineer reserves the right to nominate the method of repair, at the Contractor's cost.

6.9.2 Preparation of joints

For horizontal joints the Contractor shall prepare the surface of the concrete by green cutting (using high velocity water/air jets or vigorous wire brushing) to remove all laitance and inferior surface concrete after the concrete has hardened sufficiently to prevent loosening of any aggregate which is not removed. The time during which green cutting is feasible may be extended by the application of a surface retarder (Rugasol or equal approved). Light scabbling will be permitted providing the Contractor can demonstrate to the Engineer that the joint surface does not become cracked and exposed aggregate loosened.

For other than horizontal joints a retarder shall be used to prepare the joint. Immediately on removal of the formwork the surface of the concrete shall be prepared in a similar manner to horizontal joints. Surfaces to all joints shall be in a saturated condition prior to placing of the fresh concrete but all standing water shall be removed to leave a bright clean surface free of laitance before concreting commences. Care shall be taken to avoid damage to the edges of the surface and to the aggregate forming the surface of the joint. Construction joint types as shown on the Drawings shall comply with clause 5.6.3 of NZS 3109.

6.9.3 Sealants

Joints so designated on the Drawings shall be sealed, with all work being undertaken strictly in accordance with the manufacturer's instructions. The Contractor shall submit to the Engineer for approval, details of his proposed sealants and the Contractor shall provide to the Engineer a suitable manufacturer's guarantee. This guarantee shall be subject to approval by the Engineer. All work shall be undertaken by an experienced applicator approved by the manufacturer and evidence of such approval shall be furnished to the Engineer before any sealing work is undertaken.

The concrete to which the sealant is to be attached shall be of the highest quality, with no loose laitance honeycombing or air voids. The standard of cleanliness of the joint and the amount of moisture in the concrete shall be controlled to the manufacturer's requirements. The applicator shall be responsible for the supply and application of all sealants and he shall have the right to require restoration of the joint if the standard of concrete at the joint is considered to be unsatisfactory. The applicator shall liaise with the Engineer at all times and if necessary shall consult with him before concrete is placed to ensure that the method of forming the chase for the sealant will give a satisfactory surface finish.

6.10 Tolerances and surface finishes

All concrete work shall be set out and constructed to achieve the structural tolerances specified in NZS 3109. The Contractor as part of quality assurance shall check setting out for all concrete work for accuracy. Surface finishes shall comply with the requirements of

NZS 3114 Specification for Concrete Surface Finishes and additional special requirements as designated in the concrete notes Drawing.

All penetrations, nibs, chases, embedments, etc. shall be positioned as required. The Contractor shall check the requirements of other trades and shall be wholly responsible for the accuracy of

locating all such items. The Contractor shall confirm any penetration not detailed in the Drawings before work starts in that area.

The surface finishes shall be to NZS 3114 "Specification for Concrete Surface Finishes". For various parts of the work, these shall be as designated in Table 6.6.

Table 6.6: Concrete surface finishes

Location of Concrete Surface	Type of Finish Required
Exposed concrete	F4
Buried or hidden from view	F1 U1
Top surface of capping beam	U5
Top surface of ramps, stairs and shared pathway	U5

6.11 Repair of concrete

6.11.1 General

The Contractor shall advise the Engineer of the presence of any defective concrete.

Unless otherwise approved by the Engineer, repair of imperfections in the concrete shall be completed within seven days of removal of the forms. Where epoxy resin repairs are required, the repair shall not be made until 28 days after the concrete has been placed. Repair of the concrete shall be performed by skilled workmen, and the repairs shall be of a quality comparable to the adjacent area of the structure. Special attention may be required to achieve acceptable long term surface finish match to visible areas such as colour and texture matching.

6.11.2 Mortar or repair with new concrete

Existing concrete surfaces to which the new concrete or dry pack mortar is to be bonded shall be clean and rough. The surface shall, if necessary be roughened, and all damaged, loosened or unbonded portions of existing concrete shall be removed.

The methods of repair shall follow the procedures set out in the Guide to Concrete Repair and Protection (Standards Australia) for dry pack mortar, concrete or plaster. Where steel remains exposed after all areas of loose or otherwise unacceptable concrete have been removed, the material for repair shall be concrete. Existing concrete shall be removed from behind the steel for a distance of at least twice the normal aggregate size, and fresh concrete placed in accordance with the above referenced guide. The repair shall be free of shrinkage cracks and drummy areas.

Dry pack mortar filling shall not be used for holes extending entirely through concrete sections, for holes which are greater in area than 300mm square and deeper than 100mm or for holes in reinforced concrete which extend beyond the reinforcement nearest the surface.

Holes remaining after dismantling form ties shall be neatly plugged with mortar filling. The mortar shall be colour matched with surrounding concrete and the finished surface of the repair shall be recessed 3 mm below the surface.

6.11.3 Epoxy resin repair

Epoxy resin or epoxy resin bonded repairs shall be used when the repairs have not been made within 48 hours after the removal of forms, or, in the case of unformed concrete, within 48 hours after the placing of concrete. Such repairs shall not be undertaken until the parent concrete has had a minimum of 28 days curing.

Imperfections to be repaired with epoxy resin shall be chipped back to sound concrete and the edges of the holes trimmed square for a minimum depth of 3mm. If reinforcement is exposed, remove concrete to 30mm behind it prior to the filling of the repair.

Immediately prior to carrying out a repair, the surface of the concrete in the hole shall be cleaned of all contaminants by sandblasting.

The surface of the hole shall be mopped dry, and where necessary, effective means taken to exclude all surface water. The surface of the hole and the concrete immediately surrounding it shall be dried using lamps, an oxy-acetylene flame fitted with a descaling tip, heater, dry oil-free compressed air or other suitable means approved by the Engineer. Prevent damage to the concrete during drying. When the hole is free from surface moisture, a temperature of approximately 25°C shall be maintained over the whole affected area for a period of 30 minutes.

When so prepared, the surface of the hole shall be painted with one or more coats of an approved unfilled epoxy resin prepared and cured in accordance with the manufacturer's written instructions.

A compatible epoxy resin with approved filler prepared in accordance with the manufacturer's written instructions or wet concrete shall be applied to the clean surface of the unfilled epoxy resin, steel trowelled to a smooth surface and allowed to cure as detailed in the manufacturer's written instructions. During that time the area shall be kept dry.

Unused epoxy resin, either filled or unfilled, shall be discarded when it loses its plastic condition. Excess or spilled resin shall be cleaned up whilst in a plastic state.

Should it be necessary to use formwork to mould the filled resin mixture, the forms shall be coated with an appropriate release agent.

The finished surface of the epoxy resin mortar or concrete shall conform to NZS 3114. Any grinding required shall be performed using a silicon carbide or other suitable abrasive, and under water if possible.

Repairs shall not be made with epoxy resin mortar infills to surfaces for which F3 or better finish are specified, but an epoxy bonded repair may be used. Care shall be taken that accumulation of foreign matter or staining due to any cause does not occur on such finished surfaces. Any accumulation or staining which is in the Engineer's opinion unsightly, shall be cleaned off by the Contractor using a method approved by the Engineer.

6.11.4 Crack repair

The Contractor shall notify the Engineer prior to commencing the repair of concrete cracks. When repairs are to be undertaken the methodology and selection of repair material shall take account of whether the crack is dormant or live, width and depth, whether or not sealing against pressure is required, appearance of repair surface or colour match is necessary.

The Contractor shall obtain the Engineer's approval for the crack repair method and the materials used shall be applied strictly in accordance with the manufacturer's instructions by suitably qualified applicators.

6.12 Precast units

Previous clauses shall apply unless noted otherwise. The Contractor shall comply with the recommendations of the Precast Concrete Handbook as amended by the New Zealand Commentary.

6.12.1 Concreting and curing

Each unit shall be cast in one continuous operation, and shall be properly cured as soon as possible after casting. Steam curing may be used (subject to clause 6.7.8.8), or wrapping in polythene. Final units shall be crack free.

6.12.2 Inspection and testing

The Contractor shall provide delivery records for each unit constructed in accordance with clause 6.5.2 of this Specification.

6.12.3 Handling, transportation and erection

Units shall be handled, transported and erected so that no damage is caused to them at any stage. Every care shall be taken against damage or soiling in transit. Any damaged unit will be rejected by the Engineer. Units shall be lifted only by using the lifting eyes. The Contractor shall be responsible for the design, provision and subsequent removal and making-good of such lifting eyes as may be required.

The Contractor shall be responsible for erection and shall notify the Engineer of his methodology for lifting. Should the Contractor wish to modify the lifting eyes and connection details to facilitate his assembly method, he shall notify the Engineer in sufficient time to allow his modifications to be properly considered by the Engineer prior to the casting of the units.

6.13 Tolerances

The onus is on the Contractor to study the Drawings, and to advise the Engineer, before construction begins, if he considers he will not be able to meet the tolerances inherent in the details shown in the Drawings. In this connection, his attention is drawn to the fact that the total tolerance indicated by a detail may have to be achieved by the co-operation of several trades (e.g. Precaster for fixings in precast work, Metalworker for brackets and the like, and Concretor for cast in situ fixings).

6.14 Shop drawings

The Contractor shall produce Shop Drawings for all precast units and metal work cast into concrete, and submit them to the Engineer for approval prior to commencing operations.

The Contractor shall be responsible for the accuracy of all such Drawings and details. These Drawings shall be produced so as to enable competent tradesmen to fabricate the structures to the dimensions and standards given in the Drawings and this Specification.

7 Structural steelwork and metalwork

7.1 Scope

The work covered in this section of the Specification consists of:

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

7.2 Co-ordination with other trades

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

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

7.3 Abbreviations

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

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

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

7.4 Referenced documents

7.4.1 Standards

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

Standard	Title
AS 1111	ISO metric hexagonal commercial bolts and screws
AS/NZS 1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)
AS/NZS 1252.1[1]	High-strength steel bolt assemblies comprising bolts, nuts and washers for structural engineering – Part 1: Technical requirements
AS/NZS 1252.2[1]	High-strength steel bolt assemblies comprising bolts, nuts and washers for structural engineering – Part 2: Verification testing
AS/NZS 1554	Structural steel welding (several parts, as applicable)
AS/NZS 1594	Hot-rolled steel flat products
AS/NZS 2312.1	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – paint coatings
AS/NZS 2312.2	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – hot-dip galvanizing
AS 3597	Structural and pressure vessel steel – Quenched and tempered plate
AS/NZS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1	Structural steel – Part 1: Hot-rolled bars and sections
AS/NZS 3679.2	Structural steel – Part 2: Welded I sections
NZS 3404	Steel structures
ISO 3834	Quality requirements for fusion welding of[2] metallic materials (several parts, as applicable)
AS/NZS 4600	Cold-formed steel structures
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5131	Structural steelwork – Fabrication and erection
SA TS 101	Design of post-installed and cast-in fastenings for use in concrete
SA TS 102	Structural steel – Limits on elements added
SA TS 103	Welding to AS/NZS 1554 Parts 1, 5 and 7 – Limits on boron in parent materials
SNZ TS 3404.1	Durability requirements for steel structures and components

[1] Alternatively as per SCNZ Steel Advisor MAT 1010 acceptance to mechanical requirements of AS/NZS 1252:1996 and dimensional requirements of AS/NZS 1252:1983

7.4.2 Other referenced documents

- SCNZ Report No 111:2018, New Zealand Guide to the Sourcing of Compliant Structural Steels
- SCNZ Report No 112.2018, New Zealand Structural Steelwork Specification in Compliance with AS/NZS 5131
- SCNZ Steel Advisor, MAT1010, Practice Note on the Sourcing of Compliant High Strength Structural Bolts
- SCNZ Steel Advisor, MAT1011, Practice Note on the Sourcing of Threaded Rod Used for Foundation Bolts

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

7.5 Design, documentation and quality control/management

7.5.1 Construction category

In accordance with the requirements of AS/NZS 5131, the Construction Categories for the works are defined in Table 7.1.

Table 7.1: Construction categories

Element	Importance Level	Service Category	Fabrication Category	Construction Category
All structural steelwork (unless noted otherwise)	IL2	SC1	FC1	CC2

7.5.2 Treatment grades

Unless noted otherwise in the Project Drawings, for the elements on this project the treatment grades according to AS/NZS 5131 shall be as defined in Table 7.2.

Table 7.2: Treatment grades

Element	Treatment Grade
All painted structural steelwork (unless noted otherwise)	P3

7.5.3 Quality assurance

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

7.5.4 Structural steel contractor qualification

The Contractor shall have Steel Fabrication Certification to at least the defined Construction Category level through Steel Construction New Zealand and HERA Certifications Ltd.

7.5.5 Quality documentation

The Contractor shall provide quality documentation as required by Clause 4.5.1 of AS/NZS 5131.

The Contractor shall provide Quality Plan as required by Clause 4.5.2 of AS/NZS 5131.

7.5.6 Identification and traceability

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

7.5.7 Purchasing – components and subcontracted services

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

7.5.8 Submittals

The Contractor shall provide all submittals required as defined in AS/NZS 5131 for Engineer approval. A summary of all submittals are provided in Appendix A of this standard.

In particular, submittals shall include the following:

- Personnel
- Quality Plan and ITPs
- Origin of steel
- Chemical composition of steel
- Bolts
- Footing bolts
- Shop drawings
- Execution details
- Subcontractors
- Fabrication
- Information required for Code Compliance Certificate (PS3)
- Erection documentation
- Connections
- Steelwork exposed to view
- Rectification works
- As-built documentation
- Non-conforming work
- Manufacturers data report (MDR)

7.5.9 Inspection

7.5.9.1 Off-site witness points

The Contractor shall give the Engineer two working days' notice so that inspection may be made of the following:

- Materials including welding consumables prior to fabrication
- Testing of welding procedures and welder qualification tests
- Commencement of shop fabrication
- Commencement of welding

- Completion of fabrication prior to surface preparation
- Surface preparation prior to protective coating
- Completion of protective coating prior to delivery to site

7.5.9.2 On-site witness points

The Contractor shall give the Engineer two working days' notice so that inspection may be made of the following:

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

7.5.9.3 Hold points

The required hold points and submission details are defined in Appendix A of AS/NZS 5131. Hold points will be released after written approval from the Engineer.

7.6 Materials and components

7.6.1 General

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

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

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

7.6.2 Structural steel

All structural steel materials and components shall conform to Table 7.3, unless noted otherwise.

Table 7.3: Structural steel component requirements

Component	To conform with Standard	Grade
Plates and flats	AS/NZS 3678; AS/NZS 1594; TS 102	300
Note 1: Plate to AS/NZS 3678 Grade 350 (can/cannot) be substituted for AS/NZS 3678 Grade 300		

7.6.3 Fasteners

7.6.3.1 Fastener designation

Fasteners shall comply with Table 7.4.

Table 7.4: Fastener requirements

Designation	To conform with Standard	Tightening process	Property class
4.6/S	AS 1111	Snug tight	4.6

7.6.3.2 Mechanical and chemical anchors

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

7.6.3.3 Studs and shear connectors

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

7.6.3.4 Fasteners for thin gauge components

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

7.6.3.5 Footing bolts

Footing bolts shall meet the requirements of AS/NZS 5131. High strength threaded rod shall meet the requirement of Steel Advisor MAT1011.

7.6.3.6 Locking devices

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

7.6.3.7 Finishes

All fasteners shall be hot-dip galvanized to AS/NZS 1214, unless noted otherwise.

7.6.4 Welding consumables

Welding consumables shall conform to the requirements of NZS 3404, based on the yield strength of the steel to be welded, as defined in **Error! Reference source not found.**.

Table 7.5: Welding requirements

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

The nominal tensile strength of weld metal, fuw, shall be 490MPa, unless noted otherwise.

7.6.5 Grouting materials

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

7.7 Preparation, assembly and fabrication

7.7.1 General

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

Particular requirements from AS/NZS 5131 are outlined in clause 7.7.2, together with a reference to the applicable clause in AS/NZS 5131.

7.7.2 Particular requirements

Table 7.6: Particular fabrication requirements

	Clause in AS/NZS 5131
Architecturally exposed structural steelwork (AESS) Areas applicable to AESS are designated on the Drawings.	6.1.5
Identification and traceability Hard stamping: Areas where hard stamping is prohibited are designated on the Project Drawings. Identification marks: Areas where identification marks are not permitted or shall not be visible after completion are designated on the Project Drawings.	6.2 6.2
Cutting Cutting processes: No additional requirements.	6.5.1
Assembly Camber and preset: Camber and preset requirements are designated on the Project Drawings. Assembly check: No additional requirements.	6.9 6.10

7.8 Welding

7.8.1 General

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

Particular requirements from AS/NZS 5131 are outlined in clause 7.8.2, together with a reference to the applicable clause in AS/NZS 5131.

7.8.2 Weld category

The weld categories shall be as per Table 7.7, unless noted otherwise.

Table 7.7: Steelwork weld category

Element	Weld category (GP/SP/FP)
All steelwork	GP

- Element: Weld category (GP/SP/FP)
- All steelwork: GP

Weld categories for specific details are indicated on the project drawings.

7.8.3 Particular requirements

Table 7.8: Particular welding requirements

	Clause in AS/NZS 5131
General	
Additional welding requirements: No additional requirements.	7.1.2
Weld details: Weld category, size, type and extent are designated on the Project Drawings and clause 7.8.2 of this specification.	7.1.3
Non-destructive examination: Extent of non-destructive examination (NDE) is given in clause 7.13.2 of this specification	7.1.3
Welding plan	
No additional requirements.	7.2.2
Welding processes	
No additional requirements.	7.3
Qualification of welding procedures and welding personnel	
Impact tests: No additional requirements.	7.4.1.1
Welding production testing: No additional requirements.	7.4.1.2
Qualification of welders: No additional requirements.	7.4.2
Qualification of welding supervisor or coordinator: No additional requirements.	7.4.3
Preparation and execution of welding	
Temporary attachments: Areas where welding of temporary attachments are not permitted are designated on the Project Drawings.	7.5.6
Run-on/run-off tabs: No additional requirements.	7.5.9.1
Backing plates: No additional requirements.	7.5.9.2
Post-weld heat treatment: No additional requirements.	7.5.14
Arc strikes: No additional requirements.	7.5.15.1
Dressing of butt welds: No additional requirements.	7.5.15.1
Acceptance criteria	
Alternative acceptance criteria: No additional requirements.	7.6.1
Alternative assessment of nonconformity: No additional requirements.	7.6.1
Fatigue design assumptions: No additional requirements.	7.6.3

7.9 Mechanical fastening

7.9.1 General

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

Particular requirements from AS/NZS 5131 are outlined in clause 7.9.2, together with a reference to the applicable clause in AS/NZS 5131.

7.9.2 Particular requirements

Table 7.9: Particular requirements for mechanical fasteners

	Clause in AS/NZS 5131
Bolts, nuts and washers Locking of nuts: No additional requirements. Washers: No additional requirements.	 8.2.3 8.2.4
Preparation of contact surfaces on connected plies Coating of friction-type connection surfaces: Friction type connection surfaces are not to be coated unless noted otherwise on the project drawings	8.4.2
Tensioning of high strength bolts Part-turn tightening: No additional requirements.	8.5.6
Specialised fasteners No additional requirements.	8.7
Installation of mechanical and chemical anchors Mechanical and chemical anchors, where required, are noted on the project drawings	8.8.1

7.10 Surface treatment and corrosion protection

7.10.1 General

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

The Coating Quality Level (PC1, PC2) shall be assessed according to AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined in clause 1.10.2, together with a reference to the applicable clause in AS/NZS 5131.

7.10.2 Particular requirements

Table 7.10: Particular requirements for surface treatment and corrosion protection

	Clause in AS/NZS 5131
Requirements for painting and galvanizing	
Requirements for painting: Paint coating, where required, are noted on the project drawings	9.2.3.1
Requirements for hot-dip galvanizing: Hot-dip galvanizing shall comply with AS/NZS 4680.	9.2.3.2
Preparation of steel surfaces	
Preparation of exterior steelwork: No additional requirements.	9.3.2
Testing for soluble salts: No additional requirements.	9.3.2
Weather resistant steel surfaces: No additional requirements.	9.3.5
Surfaces in contact with concrete: No additional requirements.	9.3.7
Abrasive blasting	
Abrasive blast cleaning: No additional requirements.	9.4.1
Alternative surface finishes: No additional requirements.	9.4.4
Sealing of enclosed spaces	
Enclosed spaces: No additional requirements.	9.6.1
Sealed spaces: No additional requirements.	9.6.1
Fabrication and welding considerations	
Rectification of surface defects: The fabricator shall rectify any surface defects not meeting the requirements of AS/NZS 5131.	9.8.3
Surfaces to be painted: No additional requirements.	9.8.4
Surfaces to be galvanized: No additional requirements.	9.8.4
Treatment of cut edges: No additional requirements.	9.8.5
Welding and repair of pre-coated steel: Welding and repair of pre-coated steel shall be in accordance with the manufacturer's written instructions.	9.8.6
Application of paint coatings	
Monitoring of conditions: Air and surface temperatures, relative humidity and dew point shall be regularly monitored and recorded.	9.9.10
Testing of film continuity: No additional requirements.	9.9.16
Testing of degree of cure: No additional requirements.	9.9.17
Corrosion protection of fasteners: No additional requirements.	9.9.18
Application of galvanized coatings	
Control of distortion: No additional requirements.	9.10.4
Galvanizing process – double dipping: Double dipping of galvanized components is permitted, subject to written approval for the particular components.	9.10.5
Galvanizing process – test lot: No additional requirements.	9.10.5
End use of galvanized components: No additional requirements.	9.10.6
Adherence of coating: No additional requirements.	9.10.8
Wet storage staining: Wet storage staining shall be removed.	9.10.10

7.11 Structural steelwork erection

7.11.1 General

Structural steelwork erection shall conform to the requirements of AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined in clause 7.11.2, together with a reference to the applicable clause in AS/NZS 5131.

The steelwork erection contractor shall supply and install all temporary bracing and the like necessary for the safe erection of the structure.

The contractor shall be responsible for the temporary stability of the structure during construction.

7.11.2 Particular requirements

Table 7.11: Particular requirements for structural steelwork erection

	Clause in AS/NZS 5131
Site planning Lifting equipment: No additional requirements. Erection sequence methodology: An Erection Sequence Methodology (ESM) shall be prepared if assessed as required by AS/NZS 5131.	 11.2.5 11.5.1
Temporary erection (trial assembly) No additional requirements.	 11.5.10
Supports Temporary shims and packers: Temporary shims and packers used during erection shall be removed. Grouting at supports: No additional requirements. State if any treatment of the steelwork, baseplates, bearings or concrete surfaces is required before grouting [Optional]	 11.6.3 11.6.4
Erection drawings No additional requirements.	 11.7

7.11.3 Transportation and delivery

Components noted as AESS shall be marked and particular care taken to meet the requirements for handling in AS/NZS 5131.

The Contractor shall perform all work necessary to ensure safe loading, transportation, unloading and storage of structural steel. The Work shall consist of loading at the fabricator's plant, transporting to the site, and unloading and storing at the site, including temporary works for access.

Structural steel shall be loaded for shipping in such a manner that it can be transported and unloaded at its destination in the correct orientation for erection without being excessively stressed, deformed, or otherwise damaged.

Structural steel shall be stockpiled in such a manner to avoid excessive stress, deformation or other damage while stored.

Fabricated steelwork shall be delivered to site in such sequence as shall minimise time for erection, and exposure to potential damage. Where exposure times exceed the protective treatment manufacturer's recommendations, the Contractor shall make arrangements for temporary protection, alter the treatment specification accordingly, or allow for the appropriate maintenance treatment before closing in.

The Contractor shall make all arrangements necessary with relevant authorities for transportation of steelwork

7.12 Geometrical tolerances

7.12.1 General

Fabrication and erection tolerances shall conform to the requirements of AS/NZS 5131.

Particular requirements from AS/NZS 5131 are outlined in clause 7.12.3, together with a reference to the applicable clause in AS/NZS 5131.

7.12.2 Class for functional tolerances

The tolerance class for functional tolerances shall be Class 1 UNO on the project drawings.

7.12.3 Particular requirements

Table 7.12: particular requirements for geometric tolerances

	Clause in AS/NZS 5131
Special or additional tolerances No additional requirements.	12.1

7.13 Inspection, testing and correction

7.13.1 General

Inspection, testing and correction shall conform to the requirements of AS/NZS 5131 and the approval of the Engineer.

A quality plan shall be prepared as required covering each stage of the fabrication of the structure.

Particular requirements from AS/NZS 5131 are outlined in clause 7.13.2 of this standard, together with a reference to the applicable clause in AS/NZS 5131.

7.13.2 Particular requirements

Table 7.13: Particular requirements for inspection, testing and correction

	Clause in AS/NZS 5131
Inspection personnel <u>Competency of inspection personnel:</u> Independent inspection of welding shall be performed by a welding inspector with the following qualifications: 1 A Certification Board of Inspection Personnel (CBIP) New Zealand Welding Inspector qualification and/or 2 International Institute of Welding (IWI) diploma as an IIW Welding Inspector, at the appropriate level. Inspection of a protective coatings systems in locations with surface-specific corrosivity of C3 to CX shall be performed by a New Zealand Certification Board for Inspection Personnel or NACE International certified coating inspector, or ACA hot dipped galvanized certified inspector.	13.2

	Clause in AS/NZS 5131
Inspection of materials and components Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the relevant Standards for the materials and components. Non-conforming steel or components: If the documentation supplied does not meet the requirements of AS/NZS 5131, the steel or components shall be treated as non-conforming and treated as unidentified steel according to the requirements of AS/NZS 5131. Testing of non-conforming steel or components: Testing of non-conforming steel or components shall be to the requirements of AS/NZS 5131.	13.3.2
Inspection of preparation and assembly Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.5.1 of AS/NZS 5131.	13.5.1
Inspection of welding Welding inspector for NDE other than visual means: The Contractor shall employ an independent weld inspector to carry out NDE other than visual means. Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.6.1.2 of AS/NZS 5131. [Optional for CC1, CC2. Mandatory for CC3, CC4] Scope of inspection after welding: The extent and type of NDE shall be as per Table I6 and I7 of AS/NZS 5131. The weld failure consequence and seismic demand are designated on the project drawings. Assessment of weld defects: No additional requirements. Welds on enclosed spaces: No additional requirements.	13.6.1.1 13.6.1.2 13.6.2.2 13.6.2.5 13.6.4
Inspection of mechanical fastening Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.7.1 of AS/NZS 5131. Non-conforming mechanical fasteners: If the documentation supplied does not meet the requirements of AS/NZS 5131, the mechanical fasteners shall be treated as non-conforming until such time as it can be reliably established that the mechanical fasteners meet the requirements of AS/NZS 5131. Testing of mechanical fasteners: If testing of mechanical fasteners is undertaken to establish conformity, the type and extent of testing shall be consistent with that specified in AS/NZS 5131 and shall be sufficient to establish a proper statistical basis. Single or limited test results shall not be acceptable.	13.7.1 13.7.4 13.7.5
Inspection of fully tensioned high strength bolted connections Sampling plan: No additional requirements.	13.7.8
Inspection of mechanical and chemical anchors Proof testing: No additional requirements.	13.7.11
Inspection of surface treatment Inspection and test plan (ITP): For Coating Quality Level PC2, an ITP shall be prepared covering the inspection against the items specified in Section 13.8.1 of AS/NZS 5131.	13.8.1
Inspection of paint coatings Inspection and test plan (ITP): For Coating Quality Level PC2, an ITP shall be prepared covering the inspection against the items specified in Section 13.9.1 of AS/NZS 5131.	13.9.1

	Clause in AS/NZS 5131
Inspection of galvanized coatings	
Inspection requirements: Inspection shall be undertaken according to the requirements of AS/NZS 4680.	13.10.1
Additional or special inspection requirements: No additional requirements.	13.10.1
Inspection of erection	
Inspection and test plan (ITP): An ITP shall be prepared covering the inspection against the items specified in Section 13.11.1 of AS/NZS 5131.	13.11.1
Additional or special inspection requirements: No additional requirements.	13.11.1
Location and frequency of measurements: No additional requirements.	13.11.7
Inspection of secondary structural elements	
Inspection of installation: An ITP shall be prepared covering the inspection of purlins and girts against the items specified in Section 13.12.2 of AS/NZS 5131.	13.12.2

7.14 Site modifications and repair

7.14.1 General

Site modifications and repair shall conform to the requirements of Section 14 of AS/NZS 5131.

7.14.2 Particular requirements

No site modification to any steel member, connection component, mechanical fastener, weld, or corrosion protection shall be made without a detailed written procedure. The written procedure shall be approved by the Engineer.

8 Installation of precast concrete piles and panels

8.1 Scope

This section covers the method of installation and standards of workmanship to be furnished in relation to the installation of the precast reinforced concrete H-piles and precast concrete panels constituting the lower vertical seawall as shown on the Contract Drawings.

Construction/fabrication and supply of the piles and panels is covered in other sections of these Technical Specifications.

8.2 Methodology statement

The Contractor shall provide a detailed Methodology Statement, setting out the proposed procedures and timeframes for the construction operation to be undertaken in executing the installation of piles and panels. The method statement shall describe all proposed equipment, arrangements of equipment to be used and detail the proposed installation sequence. The Method Statement shall be submitted to the Engineer at least four weeks prior to commencement of construction of this element on Site.

The Engineer's review of the Contractor's method statement shall not relieve the Contractor of its obligations to meet the requirements of this Specification.

8.3 Precast concrete elements

The precast concrete H-piles and the panels shall be properly cured and all QA testing requirements completed prior to installation. The concrete piles and panels shall include the fabrication features required in preparation for installation by jetting (such as a cast-in-place jet-pipe system) unless an alternative construction method is proposed and approved by the Engineer.

Units shall be handled, transported and stored so that no damage is caused to them at any stage. Units shall only be lifted using properly designed and installed lifting devices. The Contractor shall be responsible for the design, provision and subsequent removal of lifting devices as required to suit the construction method.

8.4 Pile and panel design

The requirements specified on the Drawings are the minimum requirements for the piles and panels in the completed structure. The anticipated length of piles and panels are as shown on the Contract Drawings.

The drawings show the dimensions and requirements for the completed physical works and do not necessarily show all of the requirements for installation of the piles and panels. The design of such elements shall be the responsibility of the Contractor and the details shall be submitted in the methodology statement.

Piles and panels shall be installed by jetting and vibrating (unless another method is approved) to the minimum depths shown on the drawings and to the construction tolerances set out on this document.

8.5 Pile and precast panel installation by jetting & vibration

The Contractor shall install the piles of the type and dimensions specified on the Contract Drawings, to the requirements of this Specification.

The Contractor shall carry sole responsibility for providing all necessary equipment for the pitching, positioning, and jetting and vibrating (installation) of piles. The jetting and vibrating procedure shall avoid both, damage to the piles being installed and damage, misalignment or damage of adjacent piles already installed.

The Contractor shall provide the Engineer with all information (performance, efficiency, applied pressures, flow rates, water volumes etc.) on the jetting and vibrating equipment during the installation of piles and panels.

The Contractor shall inform the Engineer without delay if an unexpected change in jetting and vibrating characteristics is encountered.

Submission of a tender shall be considered as evidence that the Contractor accepts the full and sole responsibility for the method of working, including the maintenance of any excavation stability, the installation of defect free piles and positioning the completed piles within the required tolerances to the approximate founding depth specified on the Contract Drawings.

8.6 Installation record card

The Contractor shall complete an Installation Record Card for every pile and panel installed on the Site. A copy of the proposed Installation Record Card shall be submitted to the Engineer two weeks prior to commencing installation. The Installation Record Card shall contain the following information as a minimum:

- Contract and structure name;
- Pile/panel number, location, chainage, type and dimensions;
- Date and time of jetting and vibration, including stoppages and delays, from start to finish;
- All relevant information relating to jetting and vibration equipment (performance, efficiency, applied pressures, flow rates, water volumes etc.);
- The height of the working platform on which the installation equipment operate;
- Any information regarding obstructions, delays and other interruptions to the sequence of work;
- The expected and actual achieved founding levels;
- The design and actual elevation of the top of the pile installed, including compliance with tolerances;
- The Contractor's signature verifying that all work has been completed satisfactorily.

Pile and panel Installation Records shall be submitted to the Engineer within 24 hours of the completion of each pile and panel installation.

The requirements of these installation records may be revisited depending on the consistency of the installation process and the information recorded in other documents.

8.7 Handling, storage & marking of piles and panels

All operations such as handling, transporting, lifting and pitching of piles shall be carried out in such a manner as to prevent damage to the piles and panels.

Piles and panels shall be stacked on suitable supports on firm ground, in a manner which will avoid excessive handling stresses or other damage.

All piles and panels shall be clearly marked on the rear face (at a location that will not be visible in the permanent works) with paint prior to installation with the pile/panel number and other details.

8.8 Nature of ground & subsurface conditions

It is considered that the Contractor has a good understanding of the soil types supporting the piles and panels after the Contractor has inspected the Site and considered the nature of the ground through which piles and panels are to be installed. The Contractor shall use the anticipated soil conditions to design the appropriate and most effective working details of the pile jetting procedure (such as, the applied water pressures, the flow rates through the jet pipes, jet pipe outlets and pump selection) that ensures good controllability and alignment of the pile being installed.

The Contractor shall inform the Engineer of any discrepancies between the ground conditions encountered on Site and those reported or which could have been inferred from ground investigation information available at the time of Tender.

Should the Contractor consider that such discrepancies in the ground conditions could not have been reasonably foreseen by an experienced contractor when tendering and will in the Contractor's opinion change the construction methodology or substantially increase the Contractor's costs, the redress may be sought in accordance with the unforeseen physical conditions of the project Conditions of Contract.

No warranty is expressed or implied that any information, opinions or conclusions, given in any factual or interpretive ground investigation report, supplied in good faith by the Engineer, will present a complete or accurate representation of the whole Site. The Contractor shall be responsible for any inference it may draw from any information made available to it.

8.9 Tolerances

Pile installation tolerances shall be as follows:

- Pile location ± 50mm
- Pile length + 100mm / - 0mm
- Pile depth + 100mm / - 0mm
- Initial pile inclination ± 1°

The Contractor shall make all necessary provisions to the pile installation procedure, initial spotting and inclination of piles in order to achieve installation of piles to the specified tolerances. The panels shall be installed using the piles.

If records or measurements indicate that piles have been installed outside the specified tolerances, the Contractor shall provide the Engineer with details of measures to be adopted to enable the piles to comply with the Specification. Forcible correction of laterally displaced piles shall not be made.

Should the Contractor fail to meet the abovementioned requirements, the Engineer reserves the right to order such additional work as may be required to overcome the resultant structural problems. No additional cost to the Principal shall arise from any such additional work. Any additional engineering design work required due to piles placed outside the specified tolerances (such as, the strengthening of existing piles or design of additional piles) shall be carried out by the Engineer and paid for by the Contractor.

The Contractor shall not carry out any remedial work on any pile, without the written approval of the Engineer.

8.10 Pile stability during installation

At all times during pile installation and until incorporation of the piles in the completed structure, the free length of the pile shall be adequately restrained and supported by a pile support system

(such as, by leaders, trestles, temporary supports, stay laths or other arrangements) to maintain position and to prevent damage to the piles.

8.11 Erosion control during jetting

The Contractor shall make any necessary arrangements in advance to avoid (as far as practical) and control erosion and turbidity issues caused by the water run-off from the pump discharge hose during jetting of piles.

9 Stormwater drainage: general and structures

The work specified in this section consists of the general conditions related to all Stormwater Drainage works.

9.1 Applicability

9.1.1 Precedence

This Specification shall be read in conjunction with:

- Any documentation provided by the Supplier following the procurement process; and
- Relevant design and construction information contained in each work package.

In the event of the requirements of the Drawings being at variance with the provisions of this Specification or Supplier's/Manufacturer's information then the Engineer shall confirm precedence.

9.2 Standard specifications

This Specification shall be read in conjunction with the following standards, which are deemed to form a part of this Specification. In the event of this Specification being at variance with any provision of these standards, the requirements of this Specification take precedence over the provision of the standard. The latest version and amendments to the standards below shall be used.

All materials and workmanship shall comply with these standards unless expressly noted otherwise:

- Kapiti Coast District Council, 2012, Subdivision and Development Principles and Requirements
- AS 1646 Elastomeric seals for waterworks purposes
- AS 1726: 2017 Geotechnical site investigations
- AS 1830: 2007 Grey Cast Iron
- AS 3996: 2006 Access covers and grates
- AS/NZS 2312: 2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
- AS/NZS 3725: 2007 Design for Installation of Buried Concrete Pipes
- AS/NZS 4058: 2007 Precast Concrete Pipes (Pressure and Non-Pressure)
- AS/NZS 4680: 2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
- Manual of the Galvanising Association of New Zealand
- TNZ/F3 Specification for Pipe Culvert Construction
- NZS 3103: 1991 Specification for Sands, Mortars and Plasters
- NZS 3500.3: 2003 Plumbing and Drainage – Part 3: Stormwater Drainage
- NZS 3109: 1997 Specification for Concrete Construction
- NZS 3114:1987 Specification for concrete surface finishes
- NZS 4402: 1986 Methods for Testing Soils for Civil Engineering Purposes
- NZS 4404: 2004 Land Development and Subdivision Infrastructure
- AS 2129 Flanges for pipes, valves and fittings
- AS 4087 Metallic flanges for waterworks purposes
- NZS 4452 Code of practice for the construction of underground pipe sewers and drains
- SNZ NZS/BS 2494 Elastomeric seals for Joints in Pipework and Pipelines

- Building Code E1 Compliance Document for New Zealand Building Code Clause E1 Surface Water (2017)
- Pipe Inspection Manual New Zealand Water & Wastes Association New Zealand Pipe Inspection Manual Third Edition (2006)

9.3 Materials

9.3.1 Design life

All drainage pipework, manholes, sumps, outlet structures and other drainage structures shall have a design life expectancy of 100 years. Suppliers shall provide documentation demonstrating design life compliance based on supplied data.

Any cutting of precast concrete materials shall include covering exposed reinforcing with an approved water proof protective layer.

Materials shall be stored, handled, and distributed on Site with care to avoid damage and in accordance with the manufacturer's recommendations. All materials to be used in the works shall be in new condition.

This specification shall be read in conjunction with the following Kapiti Coast District Council (KCDC) Standard Drawings:

KCDC-CM-001 Embedment and Trenchfill Typical Arrangement

KCDC-CM-002 Standard Embedment Flexible and Rigid Pipes

KCDC-CM-004 Manholes Standard Details

KCDC-CM-008 Manhole Details

KCDC-SW-001 Standard Single Sump

KCDC-SW-002 Standard Double Sump

9.3.2 Concrete pipes

Concrete pipes shall be reinforced concrete rubber ring jointed as specified on the Drawings.

Pipes discharging through the revetment to be Class 4 marine environment 20mm concrete cover to the reinforcement, Hydura Concrete pipe, or similar approved. Refer to AS/NZS 4058:2007, Table 3.1 for cover details. Refer to the Drawings for pipe cross-sections.

Concrete drainage pipes shall be manufactured in accordance with the requirements of AS/NZS 4058 and shall be installed in accordance with AS/NZS 3725.

Rubber rings for pipe joints shall comply with NZS/BS 2494:1990 Specification for Elastomeric Seals for Joints in Pipework and Pipelines.

Pipe material types, sizes and classes shall be as specified on the Drawings and/or as issued under Construction Information Correspondence.

Unless otherwise stated on Drawings, reinforced concrete rubber ring jointed (RCRRJ) (minimum Class 2) minimum 300 mm diameter shall be used for KCDC stormwater systems.

9.3.3 Elastomeric rings

Elastomeric rings for pipe joints shall be in accordance with AS 1646 and shall be of a type approved by the pipe manufacturer for use with the particular joint. Rings shall be stored away from direct

sunlight and shall be kept free of grease, oil, paint and other substances deleterious to rubber. Rings showing any signs of damage or fault shall be removed from the Site and replaced.

9.3.4 Fittings

Fittings shall be to the standards specified on the Drawings and in this Specification. Cast iron fittings and specials shall be manufactured from high quality grey iron and coated with a proven bituminous compound. When no standard is specified on the Drawings, fittings shall be to KCDC standards. All bends and fittings shall be suitable for jointing with gibault and rubber ring joints unless otherwise indicated on the Drawings.

Fittings such as gibault joints, tapping straps and saddles not covered by standard specifications shall be approved types. Bolts used in these fittings shall be hot dip galvanised to AS 1650 after threading. Nuts shall be tapped after galvanising up to 0.4 mm oversize to enable them to mate with the bolts and the threads shall be oiled. The bolts shall be liberally coated with an approved anti-seize lubricant prior to assembly. Following assembly of the unit the nut and exposed thread on the end of the bolt shall be securely wrapped with at least two layers of Denso tape to form an impermeable cover.

Grade 316 stainless steel bolts and nuts can be used as an alternative to galvanized fasteners unless stated otherwise on the Drawings or by the Engineer. Neoprene washers shall be used to prevent the nuts and bolts making contact with other metals.

9.3.5 Manholes

9.3.5.1 General

Manhole materials shall be as specified on the Drawings. Where particular items are not detailed they shall be to KCDC standards. Manholes including covers and frames shall be constructed in accordance with the Drawings, the 3D model and to KCDC standards and drawings.

Manhole risers shall comply with AS/NZS 4058. Manhole sizes and depths shall be as shown on the Drawings and 3D model. Manholes shall have precast flanged bases unless otherwise approved by the Engineer. Access entry into the manholes shall be a 600mm diameter clear opening. Manholes, except at the start and end of lines, shall be haunched to the top of the pipe soffit. Prefabricated benching and haunching may be permitted at the discretion of the Engineer.

The manholes shall be watertight from the ground surface to the bottom of the manhole when the inlet and outlet pipes are plugged.

9.3.5.2 Loadings

The structural integrity of the manhole shall be maintained at pipe connections into the manhole. Covers, lids, risers and manhole installations shall be designed to withstand HN-HO-72 loadings, unless otherwise noted. Manhole lids in trafficked areas, or where there is the potential for vehicle loadings, shall be a minimum of 150mm thick.

9.3.5.3 Covers and frames

Manhole covers and frames on local roads shall comply with the KCDC Stormwater Standard Details.

The covers and frames shall, in addition to withstanding HN-HO-72 loadings, comply with Class D loadings of AS 3996. Covers shall not rock in their frames. The covers shall be Humes type bolt down frames or equivalent approved.

Manhole cover and frames shall be haunched with 30MPa concrete and either plastered or trowelled off to a smooth surface. All manhole covers shall be set flush with and have the same cross-fall as the finished surfaces of the road, footway or ground, unless detailed otherwise.

9.3.5.4 Manhole foundation

The manhole structure shall be constructed or placed on a levelling course placed on top of the subgrade material. The levelling course shall comprise a 150mm minimum layer of compacted approved AP20 granular material.

The suitability of the subgrade material shall be confirmed by the Engineer. Where the material is not suitable for the manhole foundation, the Contractor shall upon receipt of an order from the Engineer over-excavate the material as necessary and backfill with an approved compacted granular bedding material.

9.3.5.5 Testing

The Engineer may require a water tightness test to be carried out at manholes.

The water tightness test shall be carried out after pre-soaking the manhole filled with water for one hour. The water tightness test shall comprise the filling of the manhole to its lid level after plugging manhole pipe connections and checking the water volume drop in the manhole for a period of one hour. The manhole shall be considered watertight if the drop does not exceed 0.2 litre per square metre of internal cross-section area per metre depth of the manhole.

9.3.5.6 Pipe connections

At pipe connections to manholes, flexible joints shall be provided as detailed on KCDC Standard Detail KCDC-CM-004.

9.3.5.7 Manhole rungs

Manhole rungs are required for all manholes greater than 1m in depth. They shall be suitably protected from corrosion, shall be bolt through type or alternative approved by the Engineer, and be 'dropper' or safety type that do not enable the foot to slip sideways off the rung. The first rung shall be within 550mm of the lid, and the rungs shall be arranged parallel to the flow and above the benches.

The manhole entry shall be arranged such that it is over the manhole rungs in flat ground, and also on the lower side in sloping ground unless otherwise noted on the Drawings, and such that is not blocked / covered by obstructions such as barriers.

9.3.6 Castings

Castings shall be made from cast iron of a quality to AS 3996 and shall be free from all defects. All covers and grates shall not rock in their frames. All lids, covers and grates shall be Class D, heavy duty (HN-HO-72 traffic loads) unless noted otherwise.

Sump grates shall be cast iron Class D and be cycle safe, unless noted otherwise on the Drawings.

9.3.7 Galvanising

All galvanised items are to be hot dipped galvanised with a minimum average coating weight of zinc of 610 g/m2 to AS/NZS 4680.

9.3.8 Concrete

Concrete work shall be in accordance with Section 6, unless stated otherwise in the Specification and/or on the Drawings. All exposed concrete faces shall be F3 as defined in NZS 3114.

9.3.9 Mortar

Mortar shall consist of one part of cement to two parts of fine, clean, sharp sand that complies with NZS 3103: 1991 Specification for sands for mortars and plasters, measured in dry loose volume, and just sufficient water to make it workable. The mortar shall be mixed either by hand or in an approved mechanical mixer, as required. Any mortar which is not used within 30 minutes of mixing shall be discarded.

9.3.10 Flowable fill

Flowable fill used to fill pipes for decommissioning existing infrastructure (refer clause 9.4.5) shall have minimum compressive strength of 5.0MPa at 28 days.

Flowable fill or Controlled Low Strength Material used as pipe haunching and side support shall be in accordance with Appendix A of AS/NZS 3725, as described further in clause 9.3.11. Where flowable fill is used as pipe haunching and side support, 40mm thick polystyrene (EPS) spacers, cut to the shape of the barrel, are to be provided at each pipe joint over the full height of the flowable fill.

9.3.11 Backfill and surround materials for concrete pipe bedding

Embedment and backfill material shall meet the grading requirements specified below. A grading curve (tested in accordance with NZS 4402) for each material type used shall be provided to the Engineer for approval prior to construction.

9.3.11.1 Bed, haunch, side and overlay zone

Unless otherwise specified on the Drawings, the material shall consist of either clean sand or 13mm uniform graded metal as specified on KCDC Standard Details drawing KCDC-CM-001. The material shall be free from vegetation, other organic matter or clay.

Table 9.1: Bed, haunch, side and overlay zone grading requirements (clean sand) as defined in AS/NZS 3725

Sieve size (mm)	19.0	2.36	0.60	0.30	0.15	0.075
% Mass passing	100	100-50	90-20	60-10	25-0	10-0
Note 1: The material passing the 0.075m sieve must have low plasticity as described in Appendix D of AS 1726.						

9.3.11.2 Backfill

Backfill material to be Engineered Fill in accordance with Section 2 Bulk Earthworks and KCDC Standard Details KCDC-CM-001 and CM-002.

9.3.12 Sumps

9.3.12.1 General

Sumps including surface componentry shall be constructed in accordance with the Drawings and to KCDC standards and drawings.

Sumps shall be watertight from the ground surface to the bottom of the sump when the outlet pipe is plugged.

Sumps shall be standard precast concrete structures to the size shown on the Drawings from any approved manufacturer. Sumps shall be minimum 675mm long x 450mm wide x 1200mm deep with outlet pipe minimum 450mm from sump invert.

Precast manufactured sumps shall comply with NZS 3109. Surface finishes shall comply with NZS 3114 and shall be F4 and U2 for formed and trowelled surfaces respectively.

Sump leads shall have a flexible connection as detailed on KCDC Standard Details. All sumps shall be serviced by a 300 mm nominal diameter RCRRJ lead unless noted otherwise on the Drawings.

9.3.12.2 Sump foundation

The sump shall be constructed or placed on a levelling course placed on top of the subgrade material. The levelling course shall comprise a 150 mm minimum layer of compacted approved GAP 65 granular material.

The suitability of the subgrade material shall be confirmed by the Engineer. Where the material is not suitable for the sump foundation, the Contractor shall upon receipt of an order from the Engineer over-excavate the material as necessary and backfill with an approved compacted granular bedding material.

9.3.12.3 Structural strength

The sump structure shall be suitable for the lateral and vertical loadings imposed on the sump. The structural integrity of the sump shall be maintained at pipe connections into the sump.

9.3.12.4 Testing

The Engineer may require a water tightness test to be carried out at sumps.

The water tightness test shall be carried out after pre-soaking the sump filled with water for one hour. The water tightness test shall comprise the filling of the sump to its lid level after plugging sump pipe connections and checking the water volume drop in the sump for a period of one hour. The sump shall be considered watertight if the drop does not exceed 0.2 litre per square metre of internal cross-section area of the sump.

9.4 Construction

9.4.1 General

Construction of pipe drainage shall be carried out in accordance with AS/NZS 3725 unless noted otherwise on the Drawings. Work shall be done by registered drain layers, using the best modern trade practice.

The Contractor shall be responsible for the transport (unless noted otherwise), handling, storage and security of all pipe and fittings which shall be handled and stacked and/or stored strictly in accordance with the manufacturer's recommendations.

The Contractor shall inspect the materials to ensure that they are free from defects, and shall also provide the Engineer with the opportunity to inspect the materials at his/her discretion, upon delivery to Site or as soon thereafter as practicable. The Contractor shall provide every assistance, including lifting and rotating pipes, to enable these inspections to be undertaken efficiently. Where a pipe, fitting or other structure is damaged prior to installation or while installing, it will be rejected

or the defect repaired and installed to the manufacturer's specifications. The Contractor shall forward details of the manufacturer's serial/batch numbers of all pipes and fittings to the Engineer.

Damaged or unsatisfactory materials noted at that time will be marked and the Contractor shall either replace the item or, if the Engineer permits, repair the defect in an approved manner.

9.4.2 Safety

The Contractor shall comply with all statutory health and safety requirements and the requirements of this Specification relating to construction of and working in trenches. The Contractor's attention is particularly drawn to the provisions of AS/NZS 3725:2007 Design for installation of buried concrete pipes and Clause 3.3 of TNZ F/3 (Specification for Pipe Culvert Construction) relating to the safe construction of trenches and other excavations. The Contractor shall ensure that all trenches and other excavations are securely and adequately supported by timbering, cages or sheet piling where required.

9.4.3 Setting out

The Contractor shall provide all equipment necessary to accurately set out pipelines in both the horizontal and vertical planes. The methods that are proposed to be used shall be submitted to the Engineer for approval prior to the commencement of the works.

9.4.4 Minimum material testing and frequency required

Table 9.2: Material testing and frequency

Testing	Test standard	Frequency	IANZ Lab Required
Trench bed compaction and undercut requirements	Scala penetrometer test as per NZS 4402.6.5.2:1988 for non-cohesive materials Shear vane test as per NZ Geotechnical Society Inc. "Guideline for hand held shear vane" for cohesive materials	1 per 10m culvert line and 1 per ancillary structure Plus 1 inspection by the Engineer per culvert	Yes
Material grading for embedment, bed, haunch, side, and overlay zones	NZS 4402 Supplement No 1:1988 - Test 2.8.1 Determination of the particle size distribution Standard method by wet sieving	1 per source then 1 per 100m^3	Yes
Compaction curves for embedment, bed, haunch, side, and overlay zones (to establish optimum moisture content and minimum and maximum dry density)	NZS 4402 Supplement No 1:1988 - Test 4.1.1 NZ Standard compaction test	3 sets (5 points) for each fill material type	Yes
Compaction testing for embedment, bed, haunch, side, and overlay zones (insitu moisture content and minimum and maximum dry density)	Test 4.2.1 Nuclear Densometer Direct Mode or NZS 4407:1991 or Test 4.2.2 Nuclear Densometer Backscatter Mode and NZS 4407:1991, Test 4.2.1 Nuclear Densometer Direct Mode or NZS 4407:1991 or Test 4.2.2 Nuclear Densometer Backscatter Mode	1 per backfill layer at 10 m max centres for each placed layer, alternate each side of pipe	Yes
Visual Test – line and level	N/A	Every line	No
Manufacturer's certificate to TNZ F/3 for pipe and pre-cast units	N/A	With each delivery	Yes
Low pressure air test	Method to be submitted by Contractor for approval by the Engineer	Every line	No
As built survey of coordinates and invert levels at manholes, structures and pipe ends	N/A	Every line	No
Visual inspection of all manholes, looking for infiltration, settlement and joint cracking.	N/A	2 inspections for every manhole, first inspection at 1 month and second inspection between 3 and 6 months	No

9.4.5 Existing stormwater infrastructure

Prior to decommissioning any existing drainage systems the Contractor shall undertake investigations as required to determine existing active service connections. Such existing service connections shall be temporarily diverted as required during the works, and the connections re-established to the new drainage systems.

Existing stormwater drainage features made redundant by the new design shall be treated as follows:

- All inlet and outlet structures, headwalls, wing walls, etc shall be removed;
- All manholes and sumps shall be removed;
- All sump leads under the local road networks shall be removed where possible, otherwise approval may be provided to fill pipes with 5MPa flowable fill;
- Pipes under the local road networks shall be removed where possible, otherwise approval may be provided to fill pipes with 5MPa flowable fill;
- All trench lines under the local road network shall be tested and certified by a Chartered Professional Engineer that the backfill meets the standard required of new pipes. If this standard is not achieved the full depth of substandard backfill is to be removed and replaced with material that meets the specification for new pipelines.

Existing pipes that are salvaged shall not be re-used for new drainage.

Where existing manholes will be located in the road surface, existing frames and covers shall be replaced with non-rock units.

9.4.6 Trench excavation

The Contractor shall remove sufficient vegetation and topsoil to enable pipe laying to proceed without risk of contamination of bedding or backfilling.

Where drains are to be constructed in areas of fill, they shall be constructed after filling has been completed to a sufficient level so that the pipe is set in a trench at least half the pipe diameter deep.

The Contractor shall be responsible for all shielding, shoring, timbering, strutting of the trench as necessary, including design.

The trench bed shall be tested for compaction in accordance with Table 9.2. Results shall be recorded as part of the Quality Assurance records for construction. Soft spots in the trench bed shall be immediately brought to the attention of the Engineer who will inspect and instruct extent of undercutting and further testing as required.

The Contractor shall be responsible for enacting site control measures so that the trench does not fill with rain or runoff and that water does not pond in the bottom of a trench. Where groundwater is encountered the Contractor shall be responsible for de-watering.

Any temporary sump excavated in the bottom of a trench for the purpose of draining groundwater shall be constructed off line and beyond the extent of the standard trench wall. When finished with, temporary sumps shall be backfilled and consolidated in layers with suitable fill or concrete.

9.4.6.1 Excavation

For nominal pipe diameters less than 700mm, trench sides shall be vertical from the pipe invert to at least 150mm above the pipe crown.

Trench excavation shall be carried out quickly and efficiently, and subject to all specific requirements of the Contract. Other than in grassed areas, all surfaces shall be neatly sawcut prior to the commencement of excavation.

Excavated material shall be stacked well clear of the edge of the excavation and the size of the stockpile shall be limited to avoid any danger to the stability of the trench or adjacent services and facilities. Any surplus material shall be disposed of off-site.

The Contractor shall not open the trench more than 50m ahead of the pipe layers and, where soft ground is encountered, not further than approved by the Contractor. The open trench length may also be limited as shown on the Drawings for excavations close to buildings and structures and when there is a risk of wet weather disruption.

Unsuitable excavated material shall be loaded out and removed immediately from the Site.

The trench invert shall be tested for strength to determine if it has sufficient strength or if over-excavation and material replacement is required. A hand held Shear Vane or Scala Penetrometer shall be used depending on the material type and depth of testing required. A Clegg Hammer may be used if the foundation material is non-cohesive. The test results shall be used to derive equivalent Scala Penetrometer blows per 50mm penetration using the correlations in Table 9.3.

The test frequency shall be as per Table 9.2.

Table 9.3: Material strength correlations

Estimated CBR value	Scala Penetrometer Number of blows per 50 mm penetration	Approximate minimum Shear Vane soil strength (kPa)	Approximate minimum Clegg Impact Hammer value (CIV)
3.5	1	50	7
5	1.5	75	8
8	2	100	10
10	2.5	150	12
13	3	200	14

9.4.6.2 Unsuitable foundation

Where the material in the trench bottom is not suitable for a pipe foundation, the Contractor shall over-excavate the trench as instructed by the Engineer and backfill with engineered fill or other approved material in accordance with Section 2.

A basis for determining whether over-excavation is required is given in Table 9.4.

Table 9.4: Trench culvert values

Trench Situation	Minimum Required Scala Penetrometer Number of Blows per 100mm Penetration Trench Culvert
In non-road areas	3
In permanent road areas: - with pipe cover to road subgrade less than or equal to 0.3m - with pipe cover to road subgrade greater than 0.3m	 5 4

Table 9.5: Trench invert strength

Trench situation	Minimum required CBR value for trench invert
1 In non-road areas	5
2 In permanent road areas with pipe cover to road subgrade less than 0.3 m	10
3 As in 2. but with pipe cover between 0.3 m and 1.0 m	8
4 As in 2. but with pipe cover greater than 1.0 m	5
5 Beneath temporary construction haul roads	10

Over-excavation shall be carried out if the strength of the trench invert is less than the Scala Penetrometer values in Table 9.4. The depth of over-excavation shall extend to foundation material with the above strength values or as directed by the Engineer.

Replacement material shall be compacted in layers not exceeding 150mm thickness after compaction, or as otherwise approved by the Engineer. The replacement material shall be tested for strength using a Clegg Hammer or Scala Penetrometer and shall achieve Scala Penetrometer blows per 50mm penetration equal to or greater than those given in Table 9.3.

If the natural bottom of the trench becomes weakened or disturbed by the Contractor's own operations, then the Contractor shall undertake all necessary remedial action to strengthen the foundation with approved compacted granular backfill at its own cost.

9.4.6.3 Shoring

Shoring shall be provided as necessary to ensure the security of the work and safety of people, and to comply with the Health and Safety at Work Act and its related Regulations and Codes of Practice including Worksafe's Excavation Safety Good Practice Guidelines.

Notwithstanding the above, excavations with a depth exceeding 1.5m depth shall be shored unless the excavated sides are battered to a stable slope.

The shoring shall protect existing buildings and other structures in the vicinity of the excavation from settlement and damage.

9.4.6.4 Water in trenches

Should water be present in a trench, the level shall be kept below the level of the top of the bedding until each joint has been made and backfilled.

The Contractor shall provide adequate plant as required to remove and dispose of water without interfering with pipe laying work.

The Contractor shall take precautions to prevent flotation of pipes in locations where open trench excavations may become flooded. The precautions may include partial backfilling of the trench leaving pipe joints exposed while awaiting testing of the joints.

The Contractor shall not permit any flooding of property, footpaths, or roadways to result from pumping operations. All water shall be disposed of at the nearest adequate and approved drain point. Pumping of sand and silt from excavations shall be avoided by providing a suitable trap to prevent such material being uplifted by pumping equipment. Any material inadvertently deposited in adjacent services or surface areas shall be removed immediately.

9.4.6.5 Maintenance of trenches

Where trenches are excavated for pipes or services to be supplied and laid by others, the open trenches shall be suitably maintained to the satisfaction of the Contractor.

9.4.7 Pipe laying and jointing

9.4.7.1 General

Pipes and fittings shall be thoroughly cleaned before lowering into the trench, and shall be kept clean throughout the jointing and testing procedures. Whenever work is discontinued or whenever there is any likelihood of entry of foreign matter, the open ends of the laid pipes shall be closed with suitable caps. If the excavations are likely to be flooded by storm water, these end caps shall be watertight and effective precautions taken to prevent the pipeline from floating. The jointing and laying of all pipes shall be carried out strictly in accordance with the manufacturer's written instructions.

The maximum horizontal deflection at a structure is to be 45 degrees unless specified otherwise on the drawings.

Notwithstanding any tolerance given in this Specification, pipes shall be laid so that deviations at joints do not exceed 66% of the manufacturer's recommended maximum deviations.

All pipes and fittings shall be thoroughly cleaned before placing, and all scale, burrs, sand, slag and other obstructions shall be removed. All open ends of pipework shall be properly sealed by a metal or plastic cap at the end of each day's work or at the end of each section of work. The Contractor shall be liable for costs due to any damage caused by debris in pipes.

Refer also to requirements in clause 9.4 for inspection of pipes and fittings prior to pipe laying to ensure that they are free of defects.

9.4.7.2 Concrete pipes and fittings

Concrete pipes shall be laid with their collars pointing upstream.

Pipe shall be installed in accordance with the manufacturer's requirements and AS/NZS 3725.

Most concrete pipes manufactured in New Zealand are lifted using an appropriately fitted lifting anchor. However, where a concrete pipe has lifting holes these shall be closed with a mortar, as specified in clause 9.3.9 of this Specification, before backfilling.

9.4.7.3 Gravity lines

Each separate pipe shall be individually set to line and within 10 mm of the invert levels shown on the Drawings and in the 3D model, provided that the deviation from a string line extending over two pipe lengths shall not exceed 10 mm. Each joint shall be completed before the adjoining pipe is laid.

Pipes shall be laid soffit to soffit across manholes unless noted otherwise in the Drawings.

9.4.7.4 Transporting of pipes

Pipes shall be lifted using a centrally placed nylon sling. Pipes shall not be placed directly on the ground. Timber cradles shall be used to keep the pipes clear of the ground. During pipe lifting, the pipe shall be kept under control by the use of tag lines, for example, to avoid bumping the pipe against hard or sharp obstacles. Loads shall not be suspended over traffic lanes that have not been closed to vehicles.

The trench floor or bedding at the position of slinging of each pipe shall be locally excavated to enable the removal of the slings.

9.4.8 Bedding and embedment

9.4.8.1 Bedding and embedment for concrete pipes

Pipe embedment and trenchfill shall be in accordance with the following KCDC Standard and contract Drawings:

- KCDC-CM-001 Embedment and Trenchfill Typical Arrangement
- KCDC-CM-002 Standard Embedment Flexible and Rigid Pipes, and
- AS/NZS 3725 Figures 12-13

Pipe bedding for concrete pipe shall be H2 standard for pipes under the shared path and HS2 standard for pipes under the road.

The trench shall be excavated to grade, with a flat bottom 100mm below the pipe if pipe outside diameter < 1500 mm. The bedding shall be placed in the trench to a compacted depth of 100 mm if pipe outside diameter < 1500 mm, excluding the central un-compacted zone under the pipe. The bedding shall provide a uniform bedding surface for the pipe barrel except at joint positions which shall be scalloped out so that the pipe does not bear on its collars.

The pipe bedding, haunch and overlay material shall be free from organic materials, hard and durable. The grading requirements are provided in clause 9.3.11.1. The haunch zone shall extend from the top of the bed zone to 0.3 times the pipe outside diameter for H2 and HS2 bedding.

The pipe side zone material for HS2 installation shall be free from organic materials, hard and durable. The grading requirements are also provided in clause 9.3.11.1. The side zone shall extend from the bottom of the haunch zone to 0.5 times the pipe outside diameter.

The material of the bedding, haunch, side and overlay zones shall be placed uniformly over the full width of the trench either in layers not exceeding 150mm compacted thickness and compacted by conventional methods or compacted in one operation by saturation and vibration to achieve the following:

- A minimum Density Index (DI) for cohesionless material of 60% for H2 and HS2 bedding as defined and in accordance with Table 5 from AS/NZS 3725 Bedding Factors For Working Dead Loads; or
- A minimum Dry Density Ratio (RD) for cohesive material of 90% for HS2 bedding as defined and in accordance with Table 5 from AS/NZS 3725 Bedding Factors For Working Dead Loads.

Other methods may be used with approval of the Engineer. Compaction compliance shall be in terms of density and shall be measured using a Nuclear Densometer at intervals as specified in Table 9.2.

9.4.9 Backfilling

No backfilling above the side zone shall be done until laying and jointing of the line has been inspected and approved by the Engineer.

Heavy construction equipment shall not be operated over or near the pipes until the minimum construction cover has been achieved as per Table B1 of AS/NZS 3725 and as shown on the Drawings. Any pipe moved or damaged during compaction shall be replaced. Replacement shall be from the damaged pipe to the nearest manhole/structure. Undamaged pipes may be re-used if salvageable.

Backfilling above the pipe support layers and surface reinstatement of the trenches shall commence as soon as possible after laying, inspection and testing (if applicable) of each section of pipeline.

Backfilling above the overlay zone is to be done in accordance with the Drawings and Section 2, including the requirements for subgrade improvement areas where relevant.

Backfilling around pipes and structures shall be carried out in a manner which does not cause displacement of or excessive stresses in the buried structure. In general the backfill level on one side of the structure shall be within 300mm of the level of the other side. The compaction techniques employed shall not overstress the structures.

9.4.10 Concrete structures

9.4.10.1 General

Concrete work shall be carried out in accordance with Section 6. All exposed concrete faces shall be F3 as defined in NZS 3114. Concrete structures are to be constructed to an accuracy of within 10mm both horizontally and vertically.

9.4.10.2 Sumps

The shafts shall be carried up to such height that when cast iron frames and grates are set in position the top of the frame shall be 30 mm below the invert of the adjacent channel. Positions shall be set out from the geometric model of the kerbs, confirmed by the Contractor against kerb set out to make sure sumps are located at sag points, and adjustments made as required.

Pipe connections shall be haunched and surrounded with concrete at the sump wall in accordance with the Drawings.

9.4.10.3 Manholes

Manholes shall be formed from manholes with flanged precast bases unless otherwise approved by the Engineer. Alternative benching materials proposed by the Contractor shall not be used unless approved by the Engineer.

All leaks shall be carefully stopped and the manholes made watertight. Benching in manholes to be formed with 30 MPa concrete or 30 MPa concrete in combination with a half round channel.

RCRRJ pipes shall be haunched and supported with an in situ concrete collar as per the KCDC Standard Drawing KCDC-CM-004.

Manhole rungs are required for all manholes greater than 1m in depth, and shall be as described in clause 9.3.5.7. The first rung shall be within 550mm of the lid, and the rungs shall be arranged parallel to the flow and above the benching.

Manhole concrete lids shall be set to levels to ensure the finished lid levels and slopes match the surrounding road, path or ground surface as relevant. Manhole cover frames shall be haunched with 30MPa concrete and either plastered or trowelled off to a smooth surface. All manhole covers shall be set flush with and have the same crossfall as the finished surfaces of the road, footway or ground. In sloping ground, the manhole access and cover shall be on the lower side, unless detailed otherwise.

Manhole concrete lids and metal covers shall be heavy duty Class D in accordance with AS 3996:2006 (suitable for HN-HO-72 loading) unless noted otherwise on Drawings.

Connections to manholes shall be constructed as shown on the KCDC Standard Drawings KCDC-CM-004 and 008.

Precast manhole components shall be assembled and jointed strictly in accordance with the manufacturer's written recommendations, and shall consist of reinforced concrete elements to the diameters shown on the Drawings. Holes for manhole rungs shall be factory made with manhole rungs bolted into the manhole wall and the outer end of the holes filled with mortar. The base benching and mortar shall be constructed in accordance with the detail shown on the KCDC Standard Drawing KCDC-CM-004.

The manhole structure shall be constructed or placed on a levelling course placed on top of the subgrade material. The levelling course shall comprise a 150mm minimum layer of compacted approved GAP65 granular material.

Manholes over 2.4 m deep shall have a bottom riser section of minimum length 1.8m, unless otherwise approved by the Engineer. Except at the base, all joints in the manholes shall be sealed with an approved sealant as specified by the manufacturer.

9.4.11 Surplus spoil

All surplus spoil from excavations shall be treated as specified in the Section 2.

9.4.12 Reinstatement

Ground disturbed by works constructed under this section shall be reinstated to its pre-contract condition, or to such other condition as the Engineer may instruct.

All permanent surface reinstatement shall be as defined on the Drawings. Road resurfacing shall be similar in type, quality, texture, skid resistance and strength to the surrounding materials. Any traffic markings present prior to the Contract Works shall be reinstated on completion of the works.

The reinstated finished surface shall match the surrounding surface level. Trench or other excavation over-break will require fresh surface cutting to maintain straight lines and a tidy appearance to the surface finish.

Topsoil layers and surface layers in paved areas and roads shall be reinstated to match the surrounding surfaces or as shown on the Drawings.

All excess excavated material and any other material not used in the works shall be disposed of offsite unless instructed otherwise.

9.5 Testing and acceptance

The Contractor shall submit an inspection and test sheet listing the results of the inspections and tests shown below.

The following tests shall be undertaken:

- All pipelines shall be inspected for truth of line and grade. Sighting through each line between manholes and/or outlets after backfilling shall show a full circle at the far end with all pipes concentric.
- Scala Penetrometer, Shear Vane or Clegg Hammer tests on base of trench excavation.
- Compaction tests on embedment/bedding/haunch/side zones.
- Material grading for embedment/bedding/haunch/side zones.
- Manholes shall have no visible leakage through joints.
- All mainline drainage pipelines (i.e. not sumps) shall be inspected with CCTV and surveyed on completion and the records and the video forming part of the construction Quality Assurance documentation. A spreadsheet should be prepared linking CCTV footage to asset IDs. This test shall be carried out in accordance with NZ Pipe Inspection Manual and the drains approved

prior to the finished surfacing being constructed in paved areas. In the event that defects are evident in the CCTV inspection, then KCDC at its discretion may request that the CCTV is re-surveyed using MSI Laser Profiling to determine the severity of the defect.

- Low pressure air test for all main lines.
- Hydrostatic head test for pipes under local roads may be requested at KCDC's discretion. If a hydrostatic head test is required it shall be in accordance with Appendix C of NZS 4404 for KCDC pipes.

9.5.1 Pipe air testing

If deviating from the test method specified in NZS 4404, prior to the commencement of air testing the Contractor shall submit for approval details of its proposed methods, including details of test equipment and programme for testing.

For KCDC pipes and culverts, the method for air testing specified in NZS 4404 should be adopted.

The Contractor shall provide all equipment and temporary works necessary for the flushing of all debris from pipelines and to carry out the specified tests.

If any pipeline fails to meet the specified test acceptance criteria, the Contractor shall locate faults, perform all necessary remedial work and re-test the pipeline or manhole until the acceptance criteria are satisfied.

It is strongly recommended the Contractor carry out its own intermittent testing during its drain laying operations to ensure the final test requirements are satisfied. The Contractor shall submit for approval the method and equipment it proposes to use for any such intermittent testing. Care shall be taken when releasing air/water to avoid damage to the pipes and trench.

Prior to testing, the pipe system shall be completely cleaned out of all silt, rubbish and debris.

9.5.2 Visual inspection of drainage lines

The drainage lines shall be checked by means of a mirror and lamp to ensure there are no obstructions in the barrel and to ensure the pipes are laid straight. Every line, manhole and sump to be inspected by the Engineer.

9.5.3 Leaks, cleaning and maintenance

Should any leaks develop in any pipes, sumps or manholes, such portions shall be removed and re-laid. Lining of the pipe may be permitted by the Engineer if the pipe will be difficult to relay. However all lining methodologies and products must be approved by KCDC prior to the Engineer's acceptance. Foreign matter shall not be permitted to enter any existing drainage system and all new drainage components should be cleaned out prior to handover and inspection.

9.5.4 Manhole and sump testing

Manholes and sumps shall not typically be tested. Notwithstanding this, all manhole and sump joints shall be sealed and any obvious sign of infiltration or exfiltration shall be remedied prior to commissioning.

9.6 Quality assurance guide

The following is a summary of the information to be supplied, testing and hold points and witness points associated with this stormwater drainage. Refer to the main document for a more comprehensive description.

In addition, refer to the separate sections listed below for the information to be supplied, testing, hold points and witness points for the following elements:

1 Backfill above the pipe support layers and backfill where unsuitable material is undercut in trenches is to be in accordance with Section 2

2 Concrete work is to be in accordance with Section 6.

9.6.1 Information to be supplied

Table 9.6: Information to be supplied for stormwater drainage

Clause	Description	Timing	Witness/Hold Point
9.4	The Contractor shall submit a low pressure air test methodology to the Engineer for approval	2 weeks prior to pipe testing	Hold point
9.4 and 9.5	The Contractor shall submit an inspection and test sheet listing the results of the inspections and tests shown in clause 9.5 and Table 9.2 of the specification	Refer to specification	
9.3	The Contractor shall submit details for alternative flowable fill (other than detailed in this specification, clause 9.3.10) where proposed as pipe haunching and side support	2 weeks prior to backfilling with alternative flowable fill	Hold point
9.4	Review of manufacturer's certificate to TNZ F/3 for pipe and pre cast units	Each delivery to site Prior to installation	Witness point
9.4	The Contractor shall forward details of the manufacturer's serial/batch numbers of all pipes and fittings to the Engineer	Each delivery to site Prior to installation	Witness point

9.6.2 Testing

Testing results for the items below shall be recorded as part of the quality assurance records for construction.

Table 9.7: Testing for quality assurance of stormwater drainage

Clause	Test	Frequency	IANZ	Hold/Witness Point
9.4	The trench bed and foundation of ancillary structures, including manholes shall be tested with a Scala Penetrometer, Shear Vane or Clegg Hammer. Soft spots, including scala penetrometer results less than 4 blows/100mm, shall be immediately brought to the attention of the Engineer who will inspect and instruct extent of undercutting and further testing as required	1 per 10m and 1 per ancillary structure, plus 1 inspection by the Engineer per culvert/pipe	Yes	Hold point – Engineer to approve prior to backfilling
9.4	Material grading for embedment, bed, haunch, side and overlay zones. Variances in material grading from AS/NZS 3725 (concrete pipes) shall be immediately brought to the attention of the Engineer who will inspect and instruct if further testing is required	1 per source then 1 per 100m^3	Yes	Hold point – Engineer to approve prior to backfilling
9.4	Compaction curves for embedment, bed, haunch, side and overlay zones to establish optimum moisture content and minimum and maximum dry density. (Minimum and maximum dry densities are required to calculate Density Index)	3 sets (5 points) for each fill material type	Yes	Hold point – Engineer to approve prior to backfilling
9.4	Compaction testing for embedment, bed, haunch, side, and overlay zones (insitu moisture content and density) using a Nuclear Densometer. (Minimum and maximum dry densities are required for calculating Density Index.). Soft spots shall be immediately brought to the attention of the Engineer who will inspect and instruct if further compaction and/or testing is required	1 test per backfill layer at 10m max centres for each placed layer, alternate each side of pipe	Yes	Witness point
9.4	Testing for Engineered fill where specified on the Stormwater Drawings shall be as per the requirements Section 2 including grading and maximum dry density testing	As per Section 2	Yes	Hold point – Engineer to approve prior to backfilling
9.3	Testing for minimum compressive strength at 28 days for flowable fill used as pipe haunching and side support and to decommission existing infrastructure	1 test per delivery	Yes	Hold point – Engineer to review

Clause	Test	Frequency	IANZ	Hold/Witness Point
9.4	Visual Test – line and level. Any pipe deformation and/or variation in vertical alignment shall be brought to the attention of the Engineer who will instruct if any further action is required	Every line	No	Hold point
9.4	Visual inspection of all manholes, looking for infiltration, settlement and joint cracking. Any infiltration, settlement or joint cracking observed shall be brought to the attention of the Engineer who will instruct if any further action is required	2 inspections for every manhole, first inspection at 1 month and second inspection between 3-6 months	No	Hold point
9.4 and 9.5	As-built survey – coordinates and invert levels at manholes / wingwalls / pipe inlets / pipe outlets (refer KCDC as-built checklist for local lines). Any variation in levels greater than +/- 10mm to be brought to the attention of the Engineer who will instruct if further action is required. As-built survey to be submitted to KCDC within 1 month of completion of the stormwater installation and not at the end of the main contract	Every line	No	Hold point
9.5	CCTV inspection of all pipes in accordance with NZ Pipe Inspection Manual	Every line. Before laying of pavement over pipelines	No	Hold point
9.4	Low pressure air test If any pipes fail the air test, this shall be brought to the attention of the Engineer who will instruct what further action is required	Every line	No	Hold point

9.6.3 Hold points

Table 9.8: Hold points for stormwater drainage

Clause	Item	Frequency
	Hold points listed in clauses 9.6.1 and 9.6.2 above	
9.4	No backfilling shall be done until laying and jointing the line has been inspected and approved	Before any backfilling above the side zone

9.6.4 Witness points

Table 9.9: Witness points for stormwater drainage

Clause	Item	Frequency
	Witness points listed in clauses 9.6.1and 9.6.2 above	
9.4	Check pipes and manholes for defects	Each delivery to site

10 Unbound granular pavement layers

10.1 General

This section sets out the requirements for the construction of unbound granular pavement layers.

The material shall be constructed on the prepared surface of the subgrade or sub-basecourse in accordance with this Specification and in conformity with the lines, levels, grades and typical cross sections shown on the Drawings.

10.2 Standard specifications

Construction work performed under this section shall comply with the general requirements of the following documents and the specific requirements of this section:

NZS 4407:1991	Methods of sampling and testing road aggregates
NZTA M/4:2006	Specification for Basecourse Aggregate
ASTM C131-03	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
NZS 4404:2010	Land Development and Subdivision infrastructure

10.3 Testing aggregates

The Contractor shall have tests to check the compliance with this Specification performed by an IANZ Registered Laboratory on representative samples of aggregates selected from the stockpile or truck and weighing not less than 30 kg at the rate of one full test for every 400 m^3 (truck measure) of aggregate delivered to the Site.

The full set of tests shall be performed and the results of the tests shall be forwarded to the Engineer within seven days of the sampling and prior to commencing construction.

Unless otherwise stated or implied below, the requirements shall be met by every sample tested.

10.4 Sub-basecourse aggregate (AP65 or GAP65)

10.4.1 General

The sub-basecourse aggregate shall consist of sound crushed quarried rock or river gravel free from all non-mineral matter. The sub-basecourse aggregate shall be well graded, all in crushed granular aggregate, free of non-mineral matter, 50% by weight shall be two (2) or more broken faces and shall meet all requirement of TNZ M/4 (except broken faces and grading).

10.4.2 Crushing resistance

The minimum crushing resistance shall not be less than 100kN when the aggregate is tested according to NZS 4407:1991 Test 3.10 “The Crushing Resistance of Coarse Aggregate under a specific load".

An aggregate will be considered to have met this criterion if the sample produces less than 10% fines when loaded so that the specified peak load is reached in 10 minutes. In this case the test shall follow the standard method in all other respects.

10.4.3 Grading

The aggregate shall have a grading when tested according to NZS 4407:1991 Test 3.8.1 “The Particle Size Distribution – Preferred Method by Wet Sieving” which falls within the limits defined in Table 10.1 below:

Table 10.1: Grading envelope

Aperture Size	Percentage Passing by Weight
D	100
0.5D	50 to 70
0.25D	30 to 50
0.125D	20 to 35
0.063D	10 to 25
0.032D	8 to 21
0.008D	4 to 13
0.002D	2 to 6
Note 1: D is nominated maximum particle size of the aggregate as shown on the Drawings	

10.5 Basecourse aggregate

10.5.1 General

The basecourse aggregate shall consist of sound crushed rock free from all non-mineral matter, lime rock and argillite or Council approved recycled materials, provided it is equivalent or superior in performance to NZTA specified M/4 materials. Council approval of an alternative material does not convey approval in general and each proposal will be judged on its merits.

Testing results confirming that the basecourse meets specification shall be provided to the Council prior to road surfacing.

10.5.2 Proportion of broken rock

In each of the aggregate fractions between 37.5mm and 4.75mm sieves not less than 70% by weight shall have two or more broken faces, when tested according to NZS 4407:1991, test 3.14 “The Broken Faces content of Aggregate”.

The Engineer may waive this test requirement for materials sourced from crushed, quarried rock.

10.5.3 Crushing resistance

The minimum crushing resistance shall not be less than 130kN when the aggregate is tested according to NZS 4407:1991 Test 3.10 “The Crushing Resistance of Coarse Aggregate under a Specific Load".

10.5.4 Weathering resistance

The aggregate shall have a quality index of AA, AB, AC, BA, BB or CA when tested according to NZS 4407:1991 Test 3.11. "The Weathering Quality Index of Coarse Aggregate”.

10.5.5 Plasticity index

The plasticity index of the fraction of basecourse passing the 425µm sieve shall not be greater than 5 when the aggregate is tested according to NZS 4407, Test 3.4 Plasticity Index.

10.5.6 Sand equivalence

The sand equivalent shall not be less than 40 when the aggregate is tested according to NZS 4407:1991 Test 3.6 "The Sand Equivalent".

10.5.7 Grading

When tested according to NZS 4407:1991 Test 3.8.1 “The Particle Size Distribution Preferred method by Wet Sieving”, the grading of the aggregate shall fall within the respective envelopes defined in Table 10.2 and Table 10.3.

Table 10.2: Grading envelope

Test Sieve Aperture	Percentage by Weight Passing	
	AP40	AP20
37.5mm	100	100
19.0mm	66 – 81	100
9.5mm	43 – 57	55 - 75
4.75mm	28 – 43	33 - 55
2.36mm	19 - 33	22 - 42
1.18mm	12 - 25	14 - 31
600µm	7 - 19	8 - 23
300µm	3 - 14	5 - 16
150µm	10 max.	12 max.
75µm	7 max.	8 max.

Table 10.3: Grading shape control

Fractions	Percentage of material within the given fraction	
	AP40	AP20
19.0 - 4.75mm	28 - 48	-
9.5 - 2.36mm	14 - 34	20 - 36
4.75 - 1.18mm	7 - 27	9 - 34
2.36 – 600µm	6-22	6-26
1.18 – 300µm	5-19	3-21
600 – 150µm	2-14	2-17

In addition, the percentage by weight passing the 2.36mm sieve shall not be less than three times the percentage by weight passing the 150µm sieve.

Where GAP7 is specified, the Contractor shall provide the Engineer with a grading envelope.

10.6 Preparation of subgrade

The entire surface of the subgrade to be covered by the unbound granular material shall be made firm, uniform and smooth by blading and grading with a long wheel base grader to the profiles shown on the Drawings and following with a smooth wheeled roller rated at 2.71–5.50 tonnes/m width to compact the subgrade.

Trimming and rolling shall be carried out under dry weather and ground conditions and care shall be taken not to over-compact or disturb sensitive soils. Should the subgrade show signs of weaving or heaving, rolling shall be suspended immediately in that area and the Engineer's direction sought.

The subgrade shall not be covered until it has been inspected during final proof rolling and approved by the Engineer.

Adequate time shall be allowed for in the Contractor's programme to enable the Engineer to carry out his inspections and tests.

10.7 Protection of subgrade

On completion of the subgrade improvement work, the Contactor shall assume entire responsibility for its maintenance, protection and the subsequent construction of pavement layers.

Under no circumstances shall the prepared and compacted subgrade be left uncovered to suffer damage by weather, construction traffic or any other cause.

Should the Contractor fail to adequately protect the subgrade, or any weaknesses subsequently develop in the subgrade, the Contractor shall restore the subgrade to the specified standards at his own expense before proceeding with any further pavement construction.

10.8 Depth and width of pavement layer

The pavement layers shall be constructed uniformly to the nominated finished surface level, compacted thickness and width within the specified tolerances. When not contained by kerbing the edge of the material shall be tapered off as detailed on the Drawings, the taper being entirely outside the specified edge of construction.

10.9 Control of construction

To ensure that the compacted depth of material, the true surface shape and the finished surface levels are obtained, construction shall be controlled by accepted methods which the Contractor shall supply.

Should string lines and lift pegs be used, the pegs shall be positioned no further than 10 m apart. They shall be suitably marked to indicate the finished surface level of the subgrade, sub-base and basecourse layers being constructed.

10.10 Tolerances and surface shape

The Contract Works shall be set out from data shown on the Drawings and shall be constructed to conform to the lines, levels, grades, and cross-sections, within the following tolerances.

10.10.1 Subgrade

Vertical + 0mm to - 20mm

Except that there shall be no point on the finished surface that varies more than 15 mm from a 3m straight edge laid parallel to or at right angles to the centreline of the road. No area of the surface shall have depressions that will cause water to pond.

10.10.2 Pavement layers

The standard of smoothness shall be such that when all free dust and loose material has been removed there shall be no point on the surface that varies more than 10 mm from a 3 m straight edge placed parallel or at right angles to the centreline. Furthermore, there shall be no area of the completed surface that shall have depressions that will cause water to pond. Table 10.4 below shows the required tolerances.

Table 10.4: Pavement layer tolerances

Unconstrained layer	Horizontal	Vertical
Sub-base course	- 20 mm + 100 mm	- 25 mm + 5 mm
Base course	- 20 mm + 100 mm	- 5 mm + 15 mm

10.11 Spreading and compaction of pavement aggregates

10.11.1 Supply of aggregate

The supply of aggregate to the work, stockpiling and placing shall be rigidly controlled to prevent any contamination or segregation of the material. Contaminated or segregated aggregate shall not be used in the work. Aggregate shall have a moisture content of less than 5.5% when used in the works. Water content shall be measure in accordance with NZS 4407 Test 3.1 “Water Content of Aggregate”.

10.11.2 Placement of the aggregate

The aggregates shall be placed in uniform layers not greater than four times the maximum particle size and not exceeding 250mm maximum thickness. No layer shall be less than twice the nominal maximum size of the aggregate in any location.

The layers shall be placed to produce a compacted surface true to the grades and levels required with a minimum of grader usage. Grader use shall be restricted to essential shaping only.

10.11.3 Compaction of layers

The construction of the layers shall be carried out in such a manner that it will avoid any degradation of the aggregate and ensure the production of a tightly bound stone mosaic surface. Each layer of aggregate shall be compacted to a uniform, dense, stable condition in which it does not weave or creep under the roller.

Each layer of aggregate shall be uniformly compacted by the minimum practical number of multiple passes of a vibrating roller.

The vibrating roller shall be either double or single vibrating drum of not more than 3.2 tonnes mass per metre of roll width and having a vibration frequency of not less than 2200 vibrations per minute with a nominal amplitude of less than 0.5mm, or as confirmed in compaction trials.

The finished surface shall be compacted by a three wheel steel tyred roller having rear wheels at least 0.5 m wide and a load not less than 4500kg per metre of roll width.

Throughout the shaping, placing and compaction of the layers the aggregate shall be kept at close to its Optimum Moisture Content. This may involve the controlled application of water. The Contractor shall take particular care to avoid excess water reaching the formation and sub-base layers. Should the formation or any layer become so wet as to adversely affect its strength or compaction the Contractor shall, at his own cost, remove and replace all the affected material to the satisfaction of the Engineer.

Aids to compaction such as dilute bituminous emulsion may be used provided the written approval of the Engineer is obtained in each case.

10.11.4 Compaction testing/density tests

The Contractor shall have in-situ density tests using NZS 4407:1991 Test 4.2.2 "Nuclear surface moisture density gauge - backscatter mode" with correlation testing every 100 nuclear densometer tests (not less than three correlations for any one project) to NZS 4407:1991 Test 4.1.1 "Sand Replacement Method" or other approved methods performed by an IANZ Registered Laboratory. He shall locate his tests at 15m centres in a grid pattern or at 10 m centres along the roads at random positions on the road cross-section. The Contractor shall also have a solid density test carried out on a sample of each type of aggregate to be used. The results of all tests shall be forwarded to the Engineer within 24 hours of performing the test. The cost of these tests shall be borne by the Contractor.

The compacted layer shall have mean and minimum compaction values that comply with Table 10.5.

Table 10.5: Mean and minimum value of pavement layer compaction as percentage of maximum dry density

Values	Sub-basecourse pavement layer	Base course pavement layer
Mean value	≥ 95	≥ 98
Minimum value	≥ 92	≥ 95

Maximum dry density shall be determined from laboratory testing in accordance with paragraph 2 of clause 7.5 of TNZ B/02:2005 (NZS 4402:1986 test 4.1.3 – Maximum dry density and NZS 4407:1991, test 3.7 – Optimum water content).

Should in situ density tests of layers disclose a lack of uniformity and/or any areas compacted to below this standard, the Contractor shall remove, replace, further compact or otherwise strengthen the sub-standard areas in accordance with the Engineer's directions.

10.12 Defects to be remedied

Any defects or damage of any nature resulting from the operations of the Contractor during the construction or maintenance of the layers shall be made good immediately by the Contractor at his own expense.

10.13 Maintenance

Every precaution shall be taken to ensure that the surface of the layers does not pothole, ravel, rut or become uneven, but should any of these conditions become apparent, the surface of the affected area shall be completely scarified to the depth directed by the Engineer. It shall be patched with additional aggregate, reshaped and recompacted to the standards set out herein at the Contractor's own expense.

The Contractor shall maintain to the satisfaction of the Engineer the surface water channels, side drains and other drainage channels until the end of the maintenance period.

11 Sealing for road surfaces

11.1 Scope

The two coat chip seal shall be applied in accordance with this Specification upon the finished surface of the compacted basecourse at locations shown on the Drawings.

11.2 Standard specifications

Construction work performed under this section shall comply with the general requirements of the following documents and the specific requirements of this section:

TNZ P3:1995	Specification for First Coat Sealing
TNZ M/1:2006	Specification for Roading Bitumens
TNZ M/6:2004	Specification for Sealing Chips
NZTA M/1:2011	Specification for Roading Bitumens
NZTA M/6:2011	Specification for Sealing Chips
TNZ M/13:1989	Specification for Adhesion Agents
TNZ Q/1:1995	Specification for Quality Assurance for Chipsealing
TNZ M11:1975	Specification for Pre-coating sealing chips
TNZ M/13:1989	Specification for Adhesion Agents
TNZ SP/M/010	Code of Practice for Temporary Traffic Management
NZ BCA 9904	Code of Practice for Safe Handling of Bituminous Materials Used in Roading
NZS 4404:2010	Land Development and Subdivision infrastructure

11.3 Pre sealing requirements

Prior to sealing, the Contractor shall meet the presealing requirements as stated in Clause 12 of TNZ B/02 2005. To achieve the requirements of this clause the basecourse layer may have to be left for a period of time to dry. The Contractor should therefore aim to prepare the surface for sealing in a good weather window where drying is possible.

The basecourse surface must be inspected and passed by the Engineer prior to any first coat sealing being carried out. No payment shall be made for sealing where the requirements of this clause have not been complied with.

11.4 Sealing

A clean dry stone mosaic surface shall exist before the first coat seal is applied and if an adhesion agent is not used the seal should be applied only during warm dry settled weather between 1 October and 15 March. If a suitable adhesion agent is used, sealing may be carried out outside these dates.

On no account must sealing or paving or preparatory work be carried out if there is not to be warm (i.e. not less than 10^{o}C) settled weather for the next 48 hours.

A two coat chip seal shall be applied. The contractor shall provide a proposed seal design for approval by the Engineer in accordance with the guidelines presented within the 'Chipsealing in New

Zealand' handbook, and NZTA specifications M/01, M/06, M/13, P/03, P/04 and Q/1. The proposed seal design shall include:

- Design binder application rate
- Chips sizes
- Chip spread rates

Further to clause 26 of the NZTA specification P/03, the Contractor shall control traffic such that the full width of new seal is trafficked evenly.

Chip shall comply with the requirements of NZTA M/6 and the Polished Stone Value (PSV) shall be a minimum of 59 for all chip.

12 Traffic signage

12.1 Scope

Traffic signage shall be installed in accordance with this Specification at locations, heights and directions shown on the Drawings.

12.2 Standard specifications

Construction work performed under this section shall comply with the general requirements of the latest version of the following documents and the specific requirements of this section:

- Ministry of Transport Traffic Control Devices Rules (2004)
- NZ Transport Agency Manual of Traffic Signs and Markings (MOTSAM) Part 1 Signs (1994)
- NZ Transport Agency P/24 Performance Based Specification for Traffic Signs (2008)
- Road Safety Manufacturers Association (RSMA) Compliance Standard for Traffic Signs (2008)
- AS/NZS 1906.1:2017 Retro-reflective materials and devices for road traffic control purposes (2017)
- NZ Transport Agency Code of Practice for Temporary Traffic Management (COPTTM, 2012)
- Kāpiti Coast District Council Subdivision and Development Principles and Requirements (2012)

12.3 Permanent signage

12.3.1 General

Signs, posts and fixings shall be re-used where possible. To be suitable for re-use, the signs must be intact, be washed, have adequate reflectiveness, and comply with current MOTSAM and Council requirements. Care shall be taken during removal and storage to ensure that the maximum number of signs, posts and fixings are suitable for re-use. Any signs, posts and fixings damaged due to the Contractor's lack of care shall be replaced by the Contractor at no cost to the Principal.

Common sense shall be applied when locating sign poles (for example, not in the middle of footpaths or in line with pedestrian crossing points). It is the Contractor's responsibility to suitably locate signs on site within the approximate location shown on the Drawings.

12.3.2 Design

Except where noted otherwise, sign design including shape, colour, pattern and symbols shall comply with the requirements of MOTSAM. The sign size shall be as shown on the drawings or otherwise confirmed by the Engineer.

Where applicable, this may be superseded by Council Standards for parking, street name and guide signs. Any such changes shall be specifically instructed on the Drawings or by the Engineer.

12.3.2.1 Bespoke or special signs

Bespoke or special signs are signs where the proposed text or symbols are not specifically shown in MOTSAM. Examples include Council specific parking restrictions and guide signs.

For bespoke or special signs, the Contractor shall provide the Engineer in writing the proposed sign layout and dimensions in accordance with the Drawings for specific approval prior to manufacture.

12.3.3 Materials

Sign manufacture is to be in accordance with the RSMA Compliance Standard for Traffic Signs. The design life without any major renovation for signs are as specified in Section 7.2 of TNZ P/24.

The following reflective requirements shall apply to all signs unless otherwise specified;

- All Stop (RG5), Giveway (RG6), Keep Left (RG17) and street name plates are to be of Class 1W Wide Observation Angle retro-reflective materials;
- All other regulatory, warning and information signs are to be Class 1 High Intensity (HI) retro-reflective materials; and
- All parking signs are to be non-reflective.

Fluorescent material shall meet the fluorescent requirements of colours (to AS/NZS 1906.1:2007) and shall remain retro-reflective for a minimum of 10 years.

Any black legend or symbols shall be made using either durable vinyl that is compatible with and recommended by the retro-reflective sheeting manufacturer. The vinyl shall be part of the matched component system from one manufacture to ensure that it is fully compatible with the retro-reflective sheeting. This vinyl shall be a durable, dimensionally stable, glossy film designed for use on signs and able to withstand severe weather and handling conditions.

All ground mounted signs shall be manufactured with a tough, transparent and solvent resistant graffiti protection overlay film. This film shall assure similar day and night appearance and not reduce retro-reflectivity appreciably. It shall be a barrier to staining by many types of graffiti including spray paint, permanent markers, etc., and shall be approved for use by the retro-reflective sheeting manufacturer.

The Contractor shall provide a warranty from the retro-reflective sheeting manufacturer that the signs will remain retro-reflective for 10 years under normal conditions. This warranty shall include approval the black vinyl and anti-graffiti overlays proposed for the sign manufacture.

The signs shall be suitably identified on the back lower right hand side showing manufacturer name and suitable information to substantiate the sign warranty. A durable sticker bears the sign owner's name and the date of sign installation is to be placed immediately adjacent to the sign manufacturer's warranty compliance label. Markings size shall be a maximum of 500mm^2.

12.3.4 Support systems

Existing utility poles such as street light poles shall be used for sign mounting where appropriate. Approval from the utility provider, including any specific mounting requirements, shall be obtained by the Engineer and provided to the Contractor prior to installation.

The use of timber posts is not permitted, except where an existing timber post is still in good condition suitable for the attachment of new signs.

Unless otherwise specified on the Drawings or by the Engineer, all new support poles shall be white powder-coated aluminium or electro-galvanized steel with a white PVC cap. Foundations, fixings and other signs details shall comply with Kāpiti Coast District Council Standard Details drawing KCDC-RD-014.

Before commencing installation, the Contractor shall provide the Engineer in writing the brand and Product Specification Sheet for the proposed pole and ground socket. The brand shall not be changed without written approval.

12.3.4.1 Brackets and fittings

Brackets and fittings shall be approved proprietary items with a design life equal or greater than the sign face. All bracket and fixing hardware shall be made from Stainless Steel or 6261 T6 alloys.

All clamps shall have anti-rotational properties. Brackets and clamps shall be designed specifically for the size of pole or post used.

Before commencing installation, the Contractor shall provide the Engineer in writing the brand and Product Specification Sheet for the proposed bracket and fixing hardware. The brand shall not be changed without written approval.

12.3.5 Installation

For specific reference, the following requirements are repeated from MOTSAM (Section 1). Unless specified otherwise, all traffic signs shall be installed at or just above the minimum mounting height and facing the direction shown on the drawings to the following requirements:

- Minimum mounting height (to the lowest edge of the sign);
  - General minimum: 2.1m from the ground surface; and
  - Over a footpath: 2.5m from the footpath surface.
- Lateral clearance (to the nearest edge of the sign);
  - Non-mountable kerbs: minimum of 0.3m from the kerb face;
  - Mountable kerbs: minimum of 0.5m from the kerb face; and
  - Un-kerbed roads: minimum of 0.6m from the outer edge of the road shoulder, maximum of 5.0m from the nearest lane line.
- Orientation;
  - 5^{o} away from the approaching driver's line of sight.
- Back-to-back sign fixing;
  - All back-to-back signs shall be installed so that the top of the signs are at the same level.

12.3.6 Quality and maintenance

Traffic signs that are, or become defective during the defects liability period shall be located by the Contractor and relocated, repaired or replaced with new signs to meet the requirements of the Specification at no cost to the Principal.

A traffic sign is deemed defective when:

- It is missing, or
- It is facing the wrong direction, or
- It is in the incorrect position, or
- It exhibits discolouring, spalling, peeling, fading, "yellowing", chalking, cracking or exhibits any other form of deterioration (other than fair wear and tear) resulting in the sign not complying with MOTSAM requirements, or
- It can be tilted, removed or swivelled about their axis by hand, or
- Reflectorised signs are not clearly visible for a forward distance of 150m, or as far forward as possible until obstructed by the road geometry if less than 150 m, when viewed from a vehicle at night (with lights on full beam) in the absence of overhead lighting.

In addition, all signs and sign systems shall be maintained free of graffiti until handover to the Principal. Graffiti removal during the contract period shall be done in accordance with the coating manufacturer's specifications.

12.4 Temporary signage

All temporary signage to be installed during construction shall be in accordance with COPTTM and the approved Traffic Management Plan(s).

Where permanent road signs are to be removed, covered or amended temporarily during construction, care shall be undertaken to ensure that the sign is adequately secured and protected during the works. Any adhesive applied to the reflective face of the sign shall be approved for use by the reflective coating manufacturer. The Contractor shall be responsible for replacing any damaged or lost signs, fixings and poles at no cost to the Principal.

12.5 Quality assurance requirements

Specific quality assurance requirements are detailed above in the preceding sections and the referenced standard specifications. For ease of reference, Table 12.1 below summarises the main requirements to meet this section of the Specification.

Table 12.1: Quality assurance requirements

Section	Quality assurance requirement
12.3.2.1 Bespoke or special signs	For bespoke or special signs, the Contractor shall provide the Engineer in writing the proposed sign layout and dimensions in accordance with the Drawings for specific approval prior to manufacture.
12.3.3 Materials	The Contractor shall provide a warranty from the retro-reflective sheeting manufacturer that the signs will remain retro-reflective for 10 years under normal conditions. This warranty shall include approval the black vinyl and anti-graffiti overlays proposed for the sign manufacture.
12.3.4 Support systems	Before commencing installation, the Contractor shall provide the Engineer in writing the brand and Product Specification Sheet for the proposed pole and ground socket. The brand shall not be changed without written approval.
12.3.4.1 Brackets and fittings	Before commencing installation, the Contractor shall provide the Engineer in writing the brand and Product Specification Sheet for the proposed bracket and fixing hardware. The brand shall not be changed without written approval.

13 Road marking

13.1 Scope

Road markings shall be applied in accordance with this Specification upon the finished pavement surface at locations shown on the Drawings.

13.2 Standard specifications

Construction work performed under this section shall comply with the general requirements of the latest version of the following documents and the specific requirements of this section:

- NZ Transport Agency Land Transport Rule: Traffic Control Devices 2004 with amendments (TCD Rule, 2004)
- NZ Transport Agency Traffic Control Devices Manual (TCD Manual 2008)
- NZ Transport Agency Manual of Traffic Signs and Markings (MOTSAM) Part 2 Markings (1994)
- NZ Transport Agency M/7 Road Marking Paints (2009)
- NZ Transport Agency P/12 Pavement Marking (1999)
- NZ Roadmarkers Federation Line Removal Guide (2017)
- AS/NZS 2009:2006 Glass Beads for Road-Marking Materials (2006)
- NZ Transport Agency P/22 Reflectorised Pavement Marking (2005)
- NZ Transport Agency M/20 Long-life Roadmarking Materials (2003)
- NZ Transport Agency P/30 High Performance Roadmarking (2009)
- NZ Transport Agency M/6 Specification for Sealing Chip (2019)
- NZ Transport Agency P/33 Specification for Coloured Surfacings (2017)
- Kāpiti Coast District Council Subdivision and Development Principles and Requirements (2012)

13.3 Permanent pavement marking treatment

13.3.1 General

Pavement marking shall be located as detailed on the drawings. The types and pattern of new pavement markings being set out shall be as specified in MOTSAM or as directed by the Engineer.

The proposed line marking is to be set out in accordance with the accepted drawings, and any location marking out provided by the Client, with modifications as necessary to make the ‘lines’ pleasing to the eye.

Unless otherwise specified on the drawings, the following minimum requirements apply:

- All lines other than parking markings shall be reflectorised.
- All limit lines shall be long-life road marking materials.

13.3.2 Materials

13.3.2.1 Paint

Paint used for road marking shall meet the minimum requirements of the current TNZ M/7. The TNZ M/7 Notes (Appendix A) provides a list of approved paints for use.

Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and TNZ M/7 compliance certification (if not listed in TNZ M/7 Notes Appendix A) for the proposed paints. The brand and type shall not be changed without written approval.

13.3.2.2 Reflectorised beads

All glass beads added to the paint for reflectorised line application shall be in accordance with AS 2009 “Glass Beads for Road-Marking Materials”.

13.3.2.3 Long-life road marking materials

Paint used for road marking shall meet the minimum requirements of the current TNZ M/20. The TNZ M/20 Notes (Table 1) provides a list of approved long-life materials for use.

Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and TNZ M/20 compliance certification (if not listed in TNZ M/20 Notes Table 1) for the proposed long-life materials. The brand and type shall not be changed without written approval.

13.3.3 Application

Before commencing application, the Contractor shall provide the Engineer in writing the name of the applicator machine and the TNZ T/8 (paint) or TNZ T/12 (long-life material) compliance certificate for the applicator machine. The applicator machine shall not be changed without written approval.

The application of markings shall conform to the following standards:

- Paint: TNZ P/12 and P/12 Notes for Pavement Marking.
- Reflectorised markings: TNZ P/22 for Reflectorised Pavement Marking.
- Long-life materials: TNZ P/30 and P/30 Notes for High Performance Road Marking.

Under no circumstances shall the work be undertaken during adverse weather conditions or conditions where loose dirt, metal chips, or other deleterious material will reduce the quality of the markings.

Any spillage, over-spray, or similar shall be immediately removed from the roadway in accordance with NZRF line removal guide. Black paint elimination of errors as a permanent solution is unacceptable. The method of clean up needs to consider the requirements of the Resource Management Act. In particular, under no circumstances shall paint be permitted to enter into the stormwater drainage system.

13.3.4 Spacing and dimensional tolerances

Markings shall be applied at the spacing shown on the drawings.

For specific reference, the following dimensional tolerances are repeated from TNZ P/12 (Section 10). The maximum permitted dimensional tolerances shall be:

- Gap length between segments where;
  - Gap is 3.0m or more: ± 300mm;
  - Gap is less than 3.0m but greater than 1.0m: ± 150mm;
  - Gap is 1.0m or less: ± 50mm.
- Length of segments where;
  - Segment is longer than 5.0m: ± 150mm;
  - Segment is shorter than 5.0m but longer than 1.0m: ± 75mm;

  - Segment is 1.0m or shorter: ± 50mm.
- Paint line width: + 10% - 5%
- Thermoplastic line width: + 10% - 5%
- When markings already exist, within 15mm of the average centreline of the existing marking;
- For new markings when spotting out is provided by the Engineer, within 15mm of the pilot line; and
- Separation of centreline and no overtaking lines to be between 100mm and 130mm.

13.3.5 Quality and maintenance

Pavement markings that are, or become defective during the defects liability period shall be located by the Contractor and replaced with new markings to meet the requirements of the Specification at no cost to the Principal.

A pavements marking is deemed defective when:

- It is missing, or
- It is out of tolerance as specified in TNZ P/12, or
- It exhibits signs of spalling, flaking, or any other form of deterioration (other than fair wear and tear) resulting in the roadmarking not complying with the specified requirements for width and thickness, or
- It shows signs of excessive wear, or
- It exhibits lack of adhesion to the road surface, or
- Reflectorised markings not clearly visible for a forward distance of 150m, or as far forward as possible until obstructed by the road geometry if less than 150m, when viewed from a vehicle at night (with lights on full beam) in the absence of overhead lighting.

The Contractor shall ensure that the removal of all non-complying pavement markings shall be such that the underlying seal surface is not damaged, or else repair the pavement to the condition required in the Specification at no cost to the Principal.

13.4 Re-markings

A re-mark shall be undertaken within 3-6 months (or prior to completion of defects period if shorter). This re-mark will be with the final paint type specified in clause 13.3.2.1. Approval must be obtained from Engineer prior to completing this re-mark to determine the paint type and final layout of the line marking.

13.5 Temporary pavement marking treatment

Only final road markings shall be applied to the final pavement surfaces, unless specifically approved by the Engineer for each location.

If temporary road marking is required this shall be in the form of temporary marking tape of a suitable colour and size for the application. Tape shall be inspected on a daily basis and replaced if it is beginning to uplift.

13.6 Marking removal

Markings to be removed (where shown on the drawings, for defective markings, or otherwise instructed by the Engineer) shall be removed permanently in accordance with NZRF Line Removal

Guide immediately prior to the application of new markings to eliminate the potential for any confusion between markings by road users.

The Contractor shall permanently remove all pavement marking that has been applied outside the specified tolerances, including all run-ins and run-outs unless otherwise instructed by the Engineer.

The removal of the pavement marking applied outside the specified tolerance shall be undertaken such that:

- The shape of the marking cannot be distinguished;
- The final surface texture is similar to the surrounding pavement; and
- No evidence of the paint remains.

Once complete, the surrounding area shall be swept clean of all sand, paint chips or other debris. This material shall be suitably disposed of with care being taken to ensure that no solid matter enters any waterway or stormwater system as a result of the removal operation. This may require the placement of filters or similar on catch pits and other drainage features.

Blacking out of markings (with paint or temporary marking tape) is not a permanent removal method but may be used with the Engineer's approval as a temporary measure until permanent removal can be completed. Blacked out markings shall be inspected on a daily basis and repainted or replaced if the underlying marking becomes visible.

13.7 High friction or coloured aggregate surfacing

13.7.1 General

The high friction or coloured aggregate surfacing materials and application method shall be proposed by the Contractor for approval by the Engineer.

13.7.2 Materials

13.7.2.1 Binder

Binder used for high friction or coloured aggregate surfacings shall be a suitable epoxy, polyurethane or other approved proprietary product compound. Thermoplastic binders shall not be used. The cured binder shall be flexible so that it does not crack or delaminate under traffic loadings on non-rigid pavements.

When used in conjunction with coloured aggregates the binder shall be pigmented to the same colour as the aggregate.

Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and product specification sheet for the proposed binder. The brand and type shall not be changed without written approval.

13.7.2.2 High friction aggregate

Aggregate used for high friction or coloured aggregate surfacings shall meet the minimum requirements of the current NZTA M/6 with the exception of the grading as amended below.

Replacing NZTA M/6 requirements, the grading of the aggregate shall be as follows:

- Less than 5% aggregate by weight retained on 4.75mm BS sieve; and
- Less than 5% aggregate by weight passing the 1.18mm BS sieve.

Before commencing installation, the Contractor shall provide the Engineer in writing the quarry, grading and NZTA M/6 compliance certification for the proposed aggregate. The quarry and type shall not be changed without written approval.

Chemically inert synthetic aggregates may also be used with the Engineers approval. The Contractor shall provide adequate documentation to demonstrate compliance with the NZTA M/6 and grading requirements detailed above.

13.7.3 Application

Before commencing installation, the Contractor shall provide the Engineer in writing an Installation Method Statement in accordance with the manufacturer's guidelines and the installation requirements of NZTA P/33. These shall not be changed without written approval.

The Installation Method Statement needs to consider the requirements of the Resource Management Act. In particular, under no circumstances shall binder or surfacing materials be permitted to enter into the stormwater drainage system.

The installation of high friction or coloured aggregate surfacings shall conform to NZTA P/33 and the Contractors Installation Method Statement.

13.7.4 Spacing and dimensional tolerances

High friction or coloured aggregate surfacings shall be placed as shown on the drawings.

13.7.5 Quality and maintenance

High friction or coloured aggregate surfacings that are, or become defective during the defects liability period shall be located by the Contractor and replaced with new surfacings to meet the requirements of the Specification at no cost to the Principal.

A high friction or coloured aggregate surfacing is deemed defective when:

- It is missing, or
- It does not present a uniform surface (uniform thickness and free from bars and stripes unless otherwise specified), or
- It exhibits signs of spalling, flaking, aggregate loss, or any other form of deterioration (other than fair wear and tear), or
- It shows signs of excessive wear, or
- It shows fading or loss of colour, or
- It exhibits lack of adhesion to the road surface.

The Contractor shall ensure that the removal of all non-complying high friction or coloured aggregate surfacings shall be such that the underlying seal surface is not damaged, or else repair the pavement to the condition required in the Specification at no cost to the Principal.

13.8 Quality assurance requirements

Specific quality assurance requirements are detailed above in the preceding sections and the referenced standard specifications. For ease of reference, Table 13.1 summarises the main requirements to meet this section of the Specification.

Table 13.1: Quality assurance requirements

Section	Requirement
13.3.2.1 Permanent pavement marking treatment - Paint	Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and TNZ M/7 compliance certification (if not listed in TNZ M/7 Notes Appendix A) for the proposed paints. The brand and type shall not be changed without written approval.
13.3.2.3 Permanent pavement marking treatment - Long-life road marking materials	Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and TNZ M/20 compliance certification (if not listed in TNZ M/20 Notes Table 1) for the proposed long-life materials. The brand and type shall not be changed without written approval.
13.3.3 Permanent pavement marking treatment - Application	Before commencing application, the Contractor shall provide the Engineer in writing the name of the applicator machine and the TNZ T/8 (paint) or TNZ T/12 (long-life material) compliance certificate for the applicator machine. The applicator machine shall not be changed without written approval.
13.7.2.1 - High friction or coloured aggregate surfacing - Binder	Before commencing installation, the Contractor shall provide the Engineer in writing the brand, type and product specification sheet for the proposed binder. The brand and type shall not be changed without written approval.
13.7.2.2 High friction or coloured aggregate surfacing - High friction aggregate	Before commencing installation, the Contractor shall provide the Engineer in writing the quarry, grading and NZTA M/6 compliance certification for the proposed aggregate. The quarry and type shall not be changed without written approval.
13.7.3 High friction or coloured aggregate surfacing - Application	Before commencing installation, the Contractor shall provide the Engineer in writing an Installation Method Statement in accordance with the manufacturer's guidelines and the installation requirements of NZTA P/33. These shall not be changed without written approval.

14 Applicability

This Specification has been prepared for the benefit of Kapiti Coast District Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
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Jan Noering Senior Project Manager	Andrew Kennedy Project Director

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Appendix A: Structural Steelwork – Information to be forwarded to the Engineer

The following information is to be forwarded to the Engineer for review, comment and records as described in this specification.

Appendix A Table 1: Submittals Structural Steel Constructor with SFC

Clause in SCNZ Report No 112.2018	Item	Timeframe	Hold/Witness
4.8.2, 13.3.2.1, 13.3.3.1, 13.3.4.1, 13.3.5.1, 13.3.8.1, 13.3.9.1, 13.3.11.1	ITPs for: Material and components Preparation, assembly and fabrication Welding Mechanical fastening Surface treatment (for PC2 only) Paint Coatings (for PC2 only) Erection	Prior to commencing each stage of work	Hold
4.8.3.1	Steel Source List	Prior to ordering steel	Hold
4.8.3.1	Evidence of Structural Steel Conformity	Prior to fabrication commencing	Hold
4.8.3.3	Bolts Documentation	Prior to delivery to site	Hold
4.8.3.4	Footing Bolts Documentation	Prior to delivery to site	Hold
4.8.4	Shop Drawings	Prior to commencing fabrication	Hold
4.8.5.1	Subcontractor details	Prior to first procurement of material	Witness
4.8.5.2	Evidence of certification under SFC scheme	Prior to commencing fabrication	Hold
4.8.5.3	Producer Statement (PS3)	At completion of works	Hold
4.8.5.4	Erection Sequence Methodology	Prior to commencing erection	Hold
4.8.5.5	Bolt Installation Inspection records	Regularly from commencement of bolting	Witness
4.8.5.5	Proposals for bolted connections not fully documented	Prior to fabrication	Hold
4.8.5.5	Proposal for bolting connection requiring rectification	Prior to further	Hold
4.8.5.5	Proposal for anchor bolts not meeting location tolerances	Prior to further erection	Hold

4.8.5.5	Proposal for alternate anchors	Prior to erection	Hold
4.8.5.6	Marking Steelwork exposed to view	Prior to commencing fabrication	Hold
4.8.6	Survey of erected structural steelwork	Completed erected steelwork prior to any encasing or fixing of cladding	Hold
4.8.6	As-built documentation	At completion of works	Hold
4.8.7	Non-conforming Work	As required	Witness
4.8.8	Manufacturers Data Report	At completion of works	Hold
5.12.1	Welding Procedure for 'LT susceptible' details	Prior to commencement of welding	Hold

Appendix A Table 2: Submittals Structural Steel Constructor without SFC

Clause in SCNZ Report No 112.2018	**Item**	**Timeframe**	**Hold/Witness**
4.8.1	Personnel	Prior to fabrication commencing	Hold
4.8.2	Quality Documentation, Quality Plan	Prior to fabrication commencing	Hold
4.8.2, 13.3.2.1, 13.3.3.1, 13.3.4.1, 13.3.5.1, 13.3.8.1, 13.3.9.1, 13.3.11.1	• ITPs for: • Material and components • Preparation, assembly and fabrication • Welding • Mechanical fastening • Surface treatment (for PC2 only) • Paint Coatings (for PC2 only) • Erection	Prior to commencing each stage of work	Hold
4.8.3.1	Steel Source List	Prior to ordering steel	Hold
4.8.3.1	Evidence of Structural Steel Conformity	Prior to fabrication commencing	Hold
4.8.3.3	Bolts Documentation	Prior to delivery to site	Hold
4.8.3.4	Footing Bolts Documentation	Prior to delivery to site	Hold
4.8.4	Shop Drawings	Prior to commencing fabrication	Hold
4.8.5.1	Subcontractor details	Prior to first procurement of material	Hold
4.8.5.3	Producer Statement (PS3)	At completion of Works	Hold
4.8.5.4	Erection Sequence Methodology	Prior to commencing erection	Witness

4.8.5.5	Bolt Installation Inspection records	Regularly from commencement of bolting	Witness
4.8.5.5	Proposals for bolted connections not fully documented	Prior to fabrication	Hold
4.8.5.5	Proposal for bolting connection requiring rectification	Prior to further bolt connection	Hold
4.8.5.5	Rectification proposal for anchor bolts not meeting location tolerances	Prior to further erection	Hold
4.8.5.5	Proposal for alternate anchors	Prior to erection	Hold
4.8.5.6	Marking Steelwork exposed to view	Prior to commencing fabrication	Hold
4.8.6	Survey of erected structural steelwork	Completed erected steelwork prior to any encasing or fixing of cladding	Hold
4.8.6	As-built documentation	At completion of works	Hold
4.8.7	Non-conforming Work	As required	Witness
4.8.8	Manufacturers Data Report	At completion of works	Hold
5.12.1	Welding Procedure for 'LT susceptible' details	Prior to commencement of welding	Hold
Appendix B in this Specification	Independent Materials and Components Inspector Reports	Regularly from commencement of fabrication	Witness
Appendix B in this Specification	Independent Preparation, Assembly and Fabrication Inspector Reports	Regularly from commencement of fabrication	Witness
Appendix B in this Specification	Independent Welding Inspector Reports (Visual and Non-visual)	Regularly from commencement of welding	Witness
Appendix B in this Specification	Independent Surface Treatment Inspector Reports	Regularly from commencement of surface treatment	Witness
Appendix B in this Specification	Independent Paint Coatings Inspector Reports	Regularly from commencement of paint coatings	Witness
Appendix B in this Specification	Independent Galvanized Coating Inspector Reports	Regularly from commencement of galvanizing	Witness
Appendix B in this Specification	Independent Erection Inspector Reports	Regularly from commencement of erection	Witness
Appendix B in this Specification	Independent Fasteners Inspector Reports	Regularly from commencement of fastener installation	Witness
Appendix B in this Specification	Final Independent Material and Component Inspector Certificate	Prior to PS3 issued	Hold

Appendix B in this Specification	Final Preparation and Assembly Compliance Inspector Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Weld Inspector Compliance Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Fastener Inspector Compliance Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Surface Preparation Compliance Inspector Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Paint Coating Inspector Compliance Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Galvanizing Compliance Inspector Certificate	Prior to PS3 issued	Hold
Appendix B in this Specification	Final Erection Inspector Certificate	Prior to PS3 issued	Hold

Appendix B: Structural Steelwork – Independent Inspection requirements

Independent Inspection for non-SFC Structural Steel Contractors

B1 General

The Contractor shall employ independent inspectors for areas as defined in the following table to demonstrate compliance of Structural Steelwork with AS/NZS 5131 and this specification. The cost of all additional testing or retesting shall be borne by the Contractor.

Independent Inspection Area	**Required**	
	CC2	**CC3/CC4**
Materials and Components	✓	✓
Preparation, Assembly and Fabrication		✓
Welding	✓	✓
Fastening		✓
Surface Treatment (PC2 only)	✓	✓
Paint Coatings (PC2 only)	✓	✓
Galvanized Coatings (PC2 only)	✓	✓
Erection		✓

Note: Independent Inspectors may cover more than one area

Independent inspection shall be additional to the Structural Steel Contractor's own in-house inspection and quality assurance. The extent of inspection, testing and review shall be agreed with the Construction Reviewer and to the satisfaction of the Construction Reviewer. If initial reviews find existing procedures or works inadequate, the Construction Reviewer reserves the right to require the extent of review to be increased.

The independent inspector's appointment shall be approved by the Construction Reviewer. The independent inspectors shall have suitable training and experience with New Zealand standards and steelwork of similar scale and complexity as part of this contract acceptable to the Construction Reviewer. Independent inspectors shall hold qualifications as required by AS/NZS 5131. The independent inspector's qualification and experience shall be submitted to the Engineer for acceptance two weeks prior to commencing fabrication.

Inspection by the independent inspectors shall be performed in the Structural Steel Contractor's shop to the fullest extent possible. Such inspections shall be in sequence, timely and performed in such a manner as to minimize disruptions in operations and to permit the repair of all non-conforming work while the work is in process.

Inspection of site work shall be carried out promptly, so that correction of non-complying work can be made without unnecessary delays to the progress of the project.

All instructions to the Structural Steel Contractor must be given in writing by the inspectors during the relevant site visit. A copy of those instructions must be sent to the Contractor and the Construction Reviewer.

Reports are required to be provided regularly to the Structural Steel Contractor, main Contractor and Engineer.

Independent inspectors shall forward to the Contractor and the Engineer a Final Compliance Certificate when all structural steelwork is complete and prior to the Engineer issuing its PS4 for the project. This certificate shall cover compliance of all the structural steelwork inspected and referred to in this section of the specification.

Additional specific requirements for independent inspectors are described in the following sections.

B2 Independent Materials and Components Inspector

The independent materials and component inspector shall review the qualifications of the Structural Steel Contractor's materials and component in-house inspectors.

The independent materials and component inspector shall review the Structural Steel Contractor's materials and components traceability.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.3.

B3 Independent Preparation, Assembly and Fabrication Inspector

The independent materials and component inspector shall inspect the Structural Steel Contractor's preparation, assembly and fabrication.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.5.

B4 Independent Welding Inspector

The independent Welding Inspector shall review and approve the Structural Steel Contractor's shop and site welding procedures and inspect, test and re-test shop and site welds as necessary to ensure compliance.

The independent welding inspector shall review the qualifications of the Structural Steel Contractor's in-house inspectors, welding supervisors, and welders.

The welds to be inspected shall be chosen by the independent welding inspector.

The extent of NDE by visual means shall be as per Table I6 of AS/NZS 5131.

The first 2 welds for each weld type shall be visually examined for each welder.

The extent and type of NDE other than by visual means shall be as per Table I7 of AS/NZS 5131.

100% of site welds with a weld failure consequence category A (Major) and B (Moderate) as describe by Section I.2.2.2 of AS/NZS 5131 shall be non-visual, non-destructive tested.

The extent of non-destructive examination after non-compliance shall be as specified in Section I2.2.5 of AS/NZS 5131.

B5 Independent Fastening Inspector

The independent fastening inspector shall review the qualifications of the Structural Steel Contractor's fastening in-house inspectors.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.7.

B6 Independent Surface Treatment Inspector

The independent surface treatment inspector shall review the qualifications of the Structural Steel Contractor's surface treatment in-house inspectors.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.8.

B7 Independent Paint Coating Inspector

The independent coating inspector shall review the qualifications of the Structural Steel Contractor's coating in-house inspectors.

The independent coating inspector shall, in discussion with the coating applicator, produce a specification for the extent and frequency of independent inspection to the approval of the Construction Reviewer, in accordance with AS/NZS 2312.1 Section 9, 2 weeks prior to application of any coating, and that specification shall form part of the Contract Documents.

B8 Independent Galvanized Coatings Inspector

The independent galvanized coating inspector shall review the qualifications of the Structural Steel Contractor's galvanized coating in-house inspectors.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.10.

B9 Erection Inspector

The independent erection inspector shall review the qualifications of the Structural Steel Contractor's erection in-house inspectors.

Extent of inspection and testing shall be to AS/NZS 5131 Section 13.11.

Appendix C: Rock Armour Supporting Information

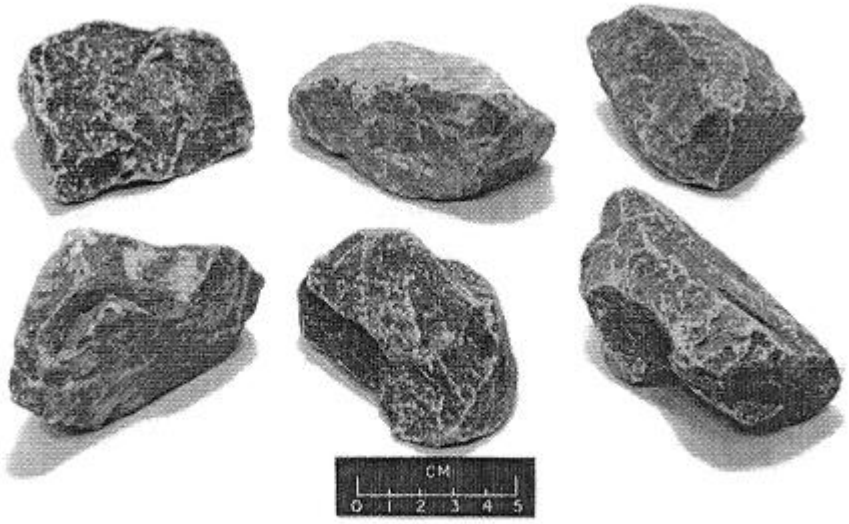

PLATE 1 Fresh rock

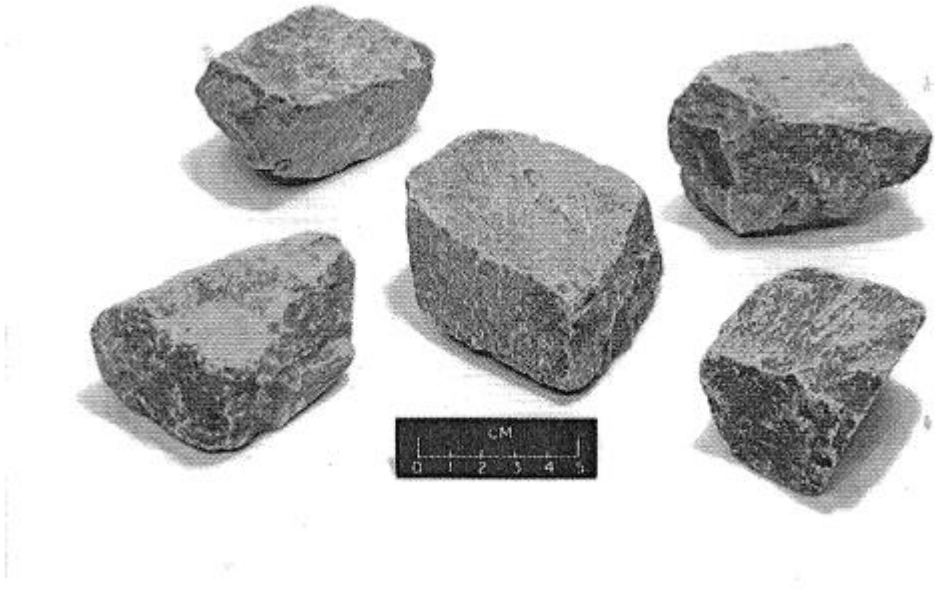

PLATE 2 Equant rock

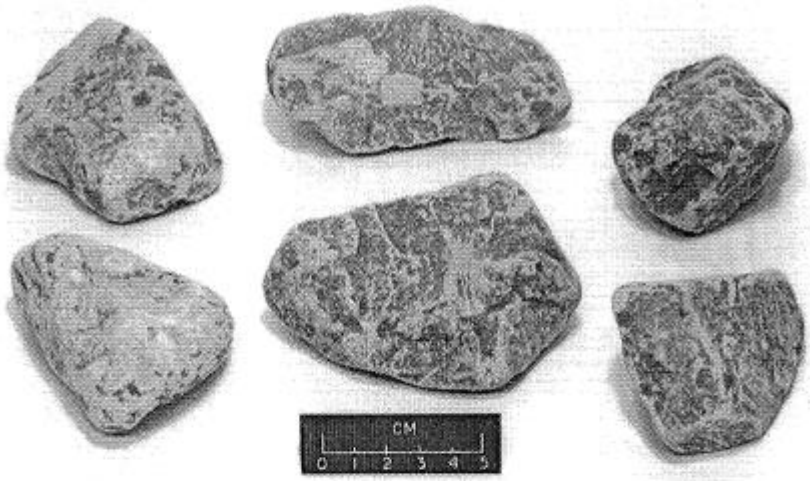

PLATE 3 Semi-rounded rock (7% weight loss)

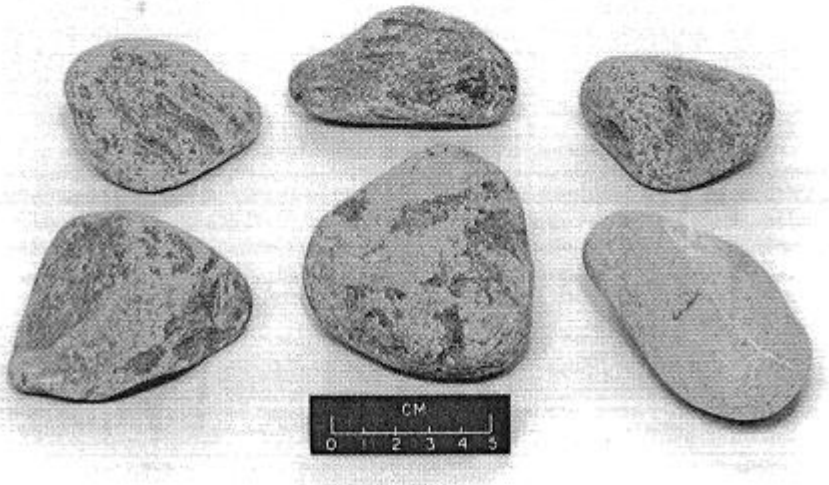

PLATE 4 Rounded rock (23% weight loss)

Figure 1: Angularity of rock examples. (Source: Bradbury et al. 1988)

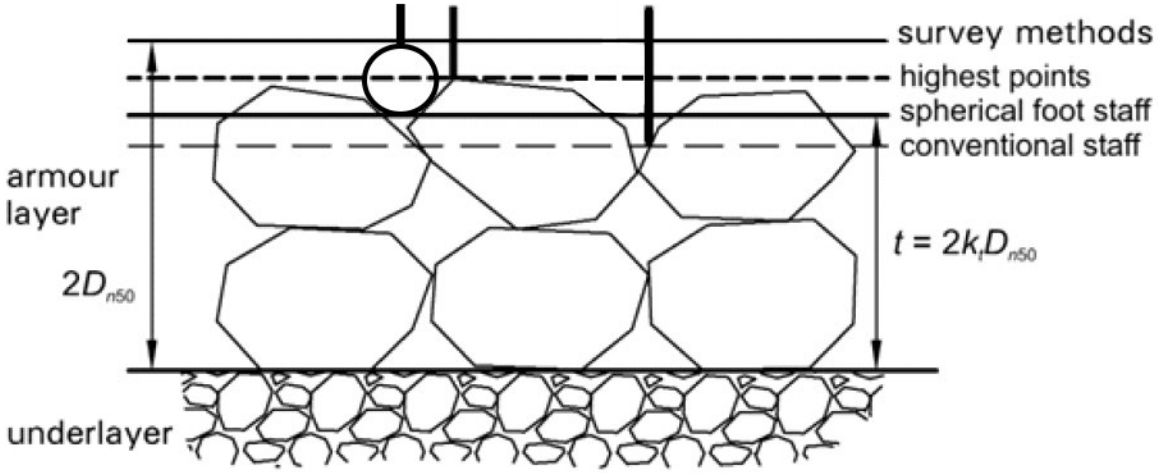

Figure 2: Spherical ball survey method compared with conventional staff showing effect on measured layer thickness. (Source: Figure 9.71, CIRIA Rock Manual 2012).

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