

ACS1460 Lining of pipelines and culverts with structural concrete liners

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ACS1460.1 Scope

This section covers the rehabilitation of pipelines and culverts with structural concrete liners using proprietary formwork systems and concrete injection under pressure.

ACS1460.2 Materials

All imported materials, products, and systems, shall be tested, appraised, and certified in New Zealand or Australia by an IANZ/NATA accredited laboratory to the requirements of the Auckland Codes of Practice, appropriate AS/NZ Standard and NZ Building Code (as applicable).

In addition, the Contractor shall provide evidence of the material's/product's manufacturing process (e.g. mill certificates). Any alternative testing regime, of an equivalent standard, shall be agreed by the Engineer.

Where testing is done outside of New Zealand and Australia the Contractor shall be required to prove the chain of custody of materials to ensure that there has been no substitution of untested materials.

ACS1460.2.1 Concrete

Concrete shall be in accordance with Auckland Council Standard Specification *ACS610: Concrete Construction*.

The concrete mix shall be a high slump, self-compacting concrete suitable for pumping into the forms without air becoming entrained. Aggregates shall be selected to ensure that the concrete flows around and behind reinforcement without honeycombing.

The Contractor shall determine the exposure conditions due to soils, groundwater and conveyed stormwater based on data supplied with the Tender. The concrete shall be designed accordingly in accordance with *NZS3101 (Concrete structures standard – The design of concrete structures)*.

ACS1460.2.2 Reinforcement

Reinforcement shall be in accordance with Auckland Council Standard Specification *ACS610 Concrete Construction*.

Stainless steel reinforcement shall be Grade 316 steel conforming to *BS 6744:2023. (Stainless steel bars. Reinforcement of concrete. Requirements and test methods)* Where stainless steel is used, tying wire shall also be Grade 316 steel conforming to *BS 6744:2023*.

ACS1460.2.3 Fibre reinforcement

If fibre or non-ferrous reinforcement is proposed, the Contractor shall supply full details with their tender including:

- a) Specifications for the reinforcing material
- b) Track record for the material in comparable applications
- c) Evidence that the liner will be sufficiently durable for the application
- d) Design assumptions
- e) Method of ensuring fibres are correctly distributed
- f) Testing regime to confirm fibre distribution is correct.

Fibre or non-ferrous reinforcement will only be accepted if, in the opinion of the Engineer, the Contractor has clearly demonstrated that the finished liner will meet the structural performance and durability requirements for the Works.

ACS1460.3 Lining design

ACS1460.3.1 Structural design

The lining shall be designed in accordance with AS/NZS 3101 and other relevant standard(s), as required.

The Contractor shall supply full details of their structural design calculations with the tender. These calculations shall be specific to the size, loadings, and other conditions relating to each section of lining. The calculations shall verify that the proposed nominal wall thickness of each lining section, given by the Contractor in the schedule of design information, is greater than, or equal to, the required design thickness.

Design calculations shall be in sufficient detail to allow for the calculation to be checked and independently verified. Each calculation is to be complete, showing the following details:

- a) Definition of terms used in the calculation
- b) All input data values
- c) References to test results to justify material properties
- d) All units of measurement and conversion factors, where applicable
- e) Calculation formulae, with references to the equation numbers or relevant clauses given in the standard
- f) Details of any proposed deviation from the design standard.

For the purpose of structural design, it shall be assumed that in the long term, there will be no bond between the existing pipe and the lining.

The lining shall be designed and fabricated in a manner that when installed, will fit the internal wall and length of the pipe being lined, within the tolerances nominated by the Contractor in the accepted design.

Design calculations shall include all the assumptions and material properties incorporated into lining, and any relevant formulae or other information utilised to determine the lining thickness required.

Review of the Contractor's design calculations shall not be construed as acceptance of the calculations. Responsibility of the design shall remain with the Contractor.

All work on the preparation of the design calculations, including proof checking and review, shall be incorporated in the Contractor's quality assurance system.

Unless specific deviations from the design submitted with the Tender are agreed with the Engineer, the liner installation shall faithfully reproduce the parameters set out in the liner design supplied with the Tender.

ACS1460.3.2 Design loading

The finished lined pipe for each section shall be designed to carry the full ground loads arising from the maximum depth of fill over that section of pipeline. Vertical earth pressures shall comprise the full height of soil and construction materials and other temporary live loads above the pipe without reductions for trench effects.

The liner shall be designed to withstand groundwater pressure, such as may be applied through joints or cracks in the surrounding pipe wall, without separating or bulging away from the pipe wall. If not otherwise specified, the groundwater level is to be assumed to be at ground level.

The superimposed live load under roadways, industrial access ways, yards, and commercial storage areas shall be in accordance with the NZTA Bridge Manual. In other areas such as parks, residential sections, or the like, the heaviest load likely to be encountered shall be considered.

Railway loads under main traffic lines or railway reserve shall be as advised by KiwiRail.

The design loading for any one length of lining shall be the maximum load produced from the combination of soil loadings, ground water level, live surcharge permanent loadings, and temporary construction loadings over that length.

ACS1460.3.3 Lining size

In determining the lining diameter, allowance is to be made for the difference in actual diameter between the pipes originally specified for the pipeline and the most severely deteriorated pipes in each section of the pipeline.

The pipe diameters given in the tender documents shall be used only as a basis for pricing. The Contractor shall be responsible for measuring the existing pipe prior to liner installation to ensure that required liner wall thicknesses are achieved.

ACS1460.3.4 Hydraulic requirements

The internal diameter of the lining shall be maximised to limit the loss of pipe's hydraulic capacity.

Surface finishes shall be F4 complying with NZS 3114 to provide a smooth finish that limits friction losses.

ACS1460.3.5 Material properties and service life

Unless otherwise specified, the minimum service life of the installed lining system shall be 50 years.

Where material properties under load vary with time, material properties of the lining at the end of the 50-year service life shall be used in design calculations. The exception to this is design of the lining for loads applied only during installation, which may be based on short-term material properties.

The material properties used in the design shall be consistent with the actual properties of the lining materials utilised in the rehabilitation. These properties shall have the same values as those nominated by the Contractor in the product information.

ACS1460.4 General

A Work Method Statement for the lining works shall be accepted by the Engineer prior to the start of any works.

Where amendments are required to the methodology, equipment or labour, such amendments shall be discussed with the Engineer in advance of the implementation thereof and the Engineer's acceptance of these amendments obtained.

ACS1460.5 Ventilation and lighting

The Contractor shall provide adequate ventilation and lighting in the pipeline, entry and exit points to ensure that a safe working environment is maintained at all times. The Contractor shall provide, maintain, and operate gas monitoring in the confined spaces.

ACS1460.6 Confirmation of information shown on construction drawings

Construction drawings are generally prepared from the Council's GIS. The Contractor is responsible for ensuring that the data provided is accurate and complete and shall take any steps necessary to collect additional data as required for the Works. The Contractor shall be responsible for confirming all dimensions and the location of all pipeline features before undertaking any work or purchasing any materials.

The host pipe shall be inspected to confirm the extent of all pre-installation works required to be undertaken, in accordance with *ACS1460.8 (CCTV inspections)*. The Engineer shall be notified immediately of any differences between the construction drawings and site observations and any required actions shall be agreed before proceeding.

ACS1460.7 Pipe preparation

ACS1460.7.1 Cleaning

The interior surfaces to be rehabilitated shall be fully cleaned to remove all loose and degraded material in accordance with Auckland Council Standard Specification *ACS1410 Pipe Cleaning* (full cleaning).

The substrate shall be thoroughly cleaned and prepared. This shall include removal of:

- Grease, fat, oils, slime deposits, mineral deposits, laitance
- Corrosion products, laitance, loose or corroded mortar and / or concrete
- Any previously applied coating or lining materials
- Any substance that could adversely affect the lining.

The cleaning of concrete surfaces must be continued until the completely clean, uncorroded remaining concrete is exposed. A satisfactory phenolphthalein etch test result shall be obtained, demonstrating consistent alkalinity, and complete removal of all decayed concrete.

ACS1460.7.2 Surface preparation

All inflow and infiltration defects shall be rectified. The Contractor shall agree with the Engineer the method for sealing prior to the start of the liner installation.

ACS1460.8 CCTV inspections

A pre-installation, post-cleaning CCTV inspection and laser profiling survey, in accordance with Auckland Council Standard Specification ACS1510 *Internal Inspection of Pipelines*, shall be carried out to confirm that the standard of preparation has been satisfactory.

Inspection records are to be reviewed with the Engineer, and no other repair preparation work shall proceed until the Engineer is satisfied with the level of cleaning.

ACS1460.9 Flow management

The Contractor shall manage flow in the pipe to be rehabilitated, and in any connecting pipes.

ACS1460.9.1 Flow management plan

The Contractor shall provide a Flow Management Plan to accommodate pipe flow for any sections around which flow is to be diverted for the works. The Flow Management Plan shall include contingency provisions for failure of equipment, power supply, or other components of the flow management facilities. It shall also provide for the increased flows caused by rain in the bypass pumping period.

The Flow Management Plan and the Project Programme shall allow for each bypass operation to be in service for an agreed trial period before any of the works in the pipeline proceed.

Details of each flow diversion operation shall be submitted for approval to the Engineer and shall be approved before each flow diversion commences. The Engineer shall have the final decision as to when, and whether, a diversion operation shall commence. The Contractor shall make reasonable allowance for inability to work during periods of wet weather.

Approval of the Flow Management Plan shall not relieve the Contractor of their responsibilities to ensure that sufficient and adequate pumping or other flow arrangements are provided at all times for the flows.

ACS1460.9.2 Bypass capacity and pipe protection

When flow in the main and connecting pipes is plugged, blocked, or bypassed, sufficient precaution shall be taken to protect all upstream pipelines from surcharging and damage. Precautions shall be taken to ensure that control operations do not cause overflows, flooding, or other damage to public or private properties.

The Contractor shall ensure that surcharges or overflows of the pipe as a result of lack of capacity in the main diversion system do not occur. It will be the Contractor's responsibility to

assess the flow in each line and to ensure that all plant and equipment used for the temporary diversion of flows is adequate for the required duties.

If the diversion capacity is exceeded by flow in the pipeline, the Contractor shall either:

- Cease work at the earliest possible time and reinstate flow to the main and connecting pipes

OR

- Continue to work by increasing the diversion system capacity to match the higher actual or anticipated flow.

The Contractor shall be responsible for clean-up and restoration of any area affected by surcharge, overflows, or spillage associated with these works, to the satisfaction of the Engineer.

An indication of the flows that will need to be pumped at various stages in the project may be shown in the tender documents. Where such flows are shown, the minimum installed capacity of bypass provisions should exceed these values with a satisfactory safety margin.

ACS1460.9.3 Bypass pumping

Where required, the Contractor shall set up pumps and hose or pipeline routes with the capacity to maintain the stormwater service to all the properties within the catchment.

Where hose or pipeline routes cross roads, access ways, etc., the Contractor shall make all necessary arrangements for continued vehicle access with property owners and occupiers and obtain all necessary permits from local authorities.

Where properties cannot readily be served by the bypass pumping arrangements, suitable provision shall be made to hold back flow or other suitable means to maintain stormwater service.

All costs of establishment of bypass pumping routes, traffic management, obtaining of permits, reinstatement of surfaces, and tidying up on completion shall be included for in the Schedule of Prices.

ACS1460.9.4 Flow management contingency plans

These and other flow contingencies need to be provided for:

- a) Full or partial blockage or failure of bypass pumping equipment (pump or hoses)
- b) Failure of a pipe plug
- c) Flow from any major source upstream increasing rapidly

- d) Any other likely cause of high flows or flow levels in the specific location.

The Contractor's Safety Management Plans shall recognise and make provision for these eventualities.

ACS1460.9.5 Standby pumps and equipment

At all times during the period of bypass pumping, the Contractor shall have standby pumps kept on site, sufficient to maintain the full bypass pumping requirement. Standby pumps shall be capable of full operation independent of primary pump power sources.

Additional pipelines, hoses, and fittings shall be available on site to provide for any pipeline failure during a bypass operation, and to meet all Flow Management Contingency Plans.

ACS1460.9.6 Work downstream from plugged pipelines

The Contractor shall take particular care to secure in place any pipe plugs that are required for bypass pumping or for flow retention.

ACS1460.10 Water

The Contractor shall make his own arrangements for supply of water for the purposes of the pipeline cleaning and lining application.

ACS1460.11 Lining installation

Once the surface preparation in any area is complete, the surface must be kept free from any form of contamination. The lining is to be installed in newly cleaned sections of pipe as soon as possible following cleaning, and in all cases, before it is exposed to stormwater flows again. If the surface does become re-contaminated, a further cleaning operation shall be undertaken.

ACS1460.11.1 Construction of formwork

Formwork shall be constructed in accordance with Auckland Council Standard Specification *ACS610 Concrete Construction*.

ACS1460.11.1.1 Stop ends

Stop ends shall be capable of withstanding concrete pumping pressures and hydrostatic loads without loss of grout and shall be readily removable without damaging the installed liner or the host pipe.

ACS1460.11.2 Cover to reinforcement

Cover to reinforcement shall be as required by the Contractor's design to meet the durability requirements. In situations where the cover to reinforcement is less than specified in Auckland Council Standard Specification *ACS610 Concrete Construction*, stainless or other corrosion resistant reinforcement shall be used.

ACS1460.11.3 Fixing reinforcement

Reinforcement shall be fixed in accordance with Auckland Council Standard Specification *ACS610 Concrete Construction*.

Reinforcement shall be firmly fixed in position such that it does not move during shuttering and concrete injection. Sufficient plastic chairs or spacers shall be used on both internal and external faces to adequately hold the reinforcement in place and maintain minimum cover, in the opinion of the Engineer.

ACS1460.11.4 Construction joints

At all construction joints, special care shall be taken to ensure that no joint will, in the opinion of the Engineer, be a source of future weakness or leakage and the method agreed with the Engineer. In cases where they are not shown on the drawings or specified, they shall be placed only in positions approved by the Engineer.

Immediately before placing the new concrete on a horizontal joint, the roughened surface shall be primed with a fresh cement grout layer of 5 mm thickness and a water cement ratio not exceeding 0.35. Any alternative joint surface preparation shall be subject to approval by the Engineer.

ACS1460.11.5 Concrete

Placement of concrete shall be in accordance with Auckland Council Standard Specification *ACS610 Concrete Construction*.

ACS1460.11.6 Finishing

The finished surface of linings be F4 complying with NZS 3114.

ACS1460.12 Quality assurance

The Contractor shall submit test data to substantiate the values for material properties of the proposed lining.

The installation is to be recorded by photographs in the As-built Quality Assurance Records for the project, which shall be supplied on completion of the works, and accepted by the Engineer. The information shall include but is not limited to the following:

- a) Identification and timing information, including the date and time at which critical elements were undertaken. Where relevant, temperature information shall also be recorded
- b) Observations, measurements and tests, and all necessary Hold, Witness, and Verification Points
- c) All tasks carried out by Sub-contractors employed to perform works under the contract
- d) Verification by the operator of all works performed, and acceptance of responsibility for the works performed, whether by Contractor or Sub-contractor personnel. The verification shall include a statement that all of the works have been performed in accordance with the Contractor's Process Plans
- e) Procedures where test results do not conform with specified parameters.

The QAP shall also include appropriate completed checklists, tests of samples of the installed concrete, video records, photographs, approvals, computer printouts, electronic information, as-built details recorded, and the like.

ACS1460.13 Quality tests

The Contractor shall be responsible for the quality of all products, processes and services utilised or provided under the contract, and shall procure and provide all test facilities required to verify conformance of all products, processes, and services to the technical requirements of the contract.

Unless otherwise agreed with the Engineer, all laboratory tests undertaken by the Contractor shall be performed by laboratories currently registered with an authority recognised by International Accreditation New Zealand (IANZ).

The Contractor shall establish and maintain documented procedures for unique identification of individual products or batches of work as appropriate. This traceability shall include but not be limited to:

- a) The source(s), specifications, and quality assurance procedures for material and equipment used
- b) Instructions, equipment (processing, inspection, measuring and testing equipment) and personnel utilised for performing activities essential in meeting the specified customer needs, throughout the production, installation, delivery and commissioning phase of the product
- c) The distribution and location of the product after delivery.

The Contractor shall submit to the Engineer, original copies of documents as evidence that the work has complied with the specified quality requirements, including all pertinent Sub-contractor or secondary consultant records.

The Contractor is to advise the Engineer as soon as practicable in case of any significant non-conformance. Otherwise, quality records are to be submitted within 5 working days after completion of the process to which they relate.

ACS1460.14 Quality process audits

Upon request, the Engineer shall be given access in conjunction with or through the Contractor, to carry out quality audits, quality monitoring, assessment, or reviews to ascertain the effectiveness of the quality system put in place by the Contractor and their Sub-contractors.

The Engineer shall be entitled to carry out the second or third party audits of the Contractor's and Sub-contractors' quality system by:

- a) A review of the Contractor's conformance to the Quality Plan
- b) A review and verification of the Contractor's quality procedures and work instructions and documentary evidence of compliance with the technical requirements of the Contract.

Should the Engineer identify any examples of non-compliance with approved quality processes, a non-conformance notice may be issued in respect of that non-compliance. In extreme cases, where it is considered by the Engineer that there may be a risk to health and safety, or that the quality of the completed works may be compromised, the Engineer may order suspension of work in accordance with NZS 3910:1998, Clause 6.7 until such time that the Contractor rectifies the cause of the non-compliance to the satisfaction of the Engineer.

ACS1460.15 Quality records

The Contractor shall submit to the Engineer, original documents as evidence that the work has complied with the specified quality requirements, including all pertinent Sub-contractor or secondary consultant records.

ACS1460.16 Inspection

The Engineer shall be given access in conjunction with or through the Contractor to all laboratories and other facilities used for quality control tests to verify that specified requirements are being met.

The Contractor shall make suitable arrangements to notify the Engineer when a Hold, Witness, or Verification Point will be reached so that the Engineer can review and/or witness, if required, any work process or test being undertaken by the Contractor.

The Engineer shall have the right to carry out at Hold, Witness, or Verification Points, inspections, or tests to verify that the Contractor is implementing and maintaining the quality system in accordance with the contract documents.

ACS1460.16.1 Post-installation CCTV inspections

A post-installation CCTV inspection shall be carried out in compliance with the Stormwater Standard Specification *ACS1510 Internal Inspection of Pipelines*.

An inspection is to be carried out on each newly rehabilitated section of pipeline. Flow shall not be allowed through the pipeline until the Engineer is satisfied that the quality of the rehabilitation meets the requirements of the specification.

A final CCTV inspection is to be carried out at the end of the defects' liability period.

ACS1460.17 Completion and handover procedure

On completion of the rehabilitation refurbishment of both pipes and manholes (where included in the Contract), the following as-built information is to be provided by the Contractor:

- a) A description of the pipe preparation work
- b) A record of the condition of each section of the pipe after cleaning but before application of the mortar commenced
- c) A list of the materials utilised in the liner and in any associated work, with relevant test certificates for the materials

- d) Records detailing the concrete preparation and installation procedures, including copies of the log sheets recording compliance with the Quality Plan for each stage of the installation process
- e) A CCTV record of the completed works, clearly showing critical aspects of the concrete rehabilitation and any associated manhole repairs.