



Concrete Lined Irrigation Channels

Repair and Replacement

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1. Materials

1.1 Cementitious grout

Cementitious grout shall consist of type GP Portland cement or GB blended cement and water, with or without the inclusion of sand and admixtures, in a combination to produce a fluid and consistent material. The fluidity of the grout shall be such as to allow placing without bleeding or honeycombing.

In the case of grout to be used for intrusion of pre-packed aggregate, a 4.75 mm screen shall be used between the mixer and the pump or agitator to remove large particles which might clog small voids in the aggregate mass.

Proposed grout mixes and details of proposed admixtures shall be submitted to the Superintendent. All variations to the proposed mixes and materials shall be approved before implementation.

If proprietary grout mixes are to be used, full details and manufacturers' data sheets shall be submitted to the Superintendent for approval before work commences.

1.2 Cementitious mortars

Cementitious mortars shall consist of type GP Portland cement or type GB blended cement, sand and water with or without the inclusion of admixtures in a combination to produce a workable but not fluid material. The consistency of the mortar shall be such as to allow placing in the final position without voids, honeycombing or segregation.

In the case of dry-packed mortar, the water content shall be the minimum necessary to allow the mortar to be compacted by ramming without crumbling.

Proposed mortar mixes and details of proposed admixtures shall be submitted to the Superintendent. All variations to the proposed mixes and materials shall be approved before implementation.

If proprietary modified cementitious repair mortars are to be used, full details and manufacturers' data sheets shall be submitted to the Superintendent for approval before work commences.

1.3 Concrete

Pre-mixed concrete is the preferred method of concrete supply for this contract.

Whether site-mixed or pre-mixed, concrete shall be supplied in accordance with AS 1379, The Specification and Supply of Concrete.

Any site-mixed concrete shall be mixed in an approved plant. Batches of 1 m³ or less shall be mixed for a minimum time of 1.5 minutes and this time shall be increased by 30 seconds for each cubic metre or part thereof.



The supplier of pre-mixed concrete shall be approved by the superintendent prior to the commencement of the works and shall submit mix designs for the concrete grade(s) required.

Pre-mixed concrete shall not be delivered in non-agitating trucks.

The maximum elapsed time from the addition of water to the mix to the discharging of the pre-mixed concrete at the site shall not exceed the following values:

Concrete temperature at time of placement	Maximum elapsed time from water addition to the mix to discharge
<10°C	Not permitted
10°C – 24°C	2 hours
24°C – 27°C	1.5 hours
27°C – 30°C	1 hour
30°C – 32°C	45 minutes
>32°C	Not permitted

These times may be extended in special circumstances, but compliance of the concrete with the specified performance requirements, including that of slump, shall still be required.

The Contractor shall advise the pre-mixed concrete supplier of all requirements of this specification and shall require that each truck of pre-mixed concrete be accompanied by a docket bearing the following information:

- The specific part of the works for which the concrete has been ordered
- The quantity of concrete contained
- The time of dispatch
- The class and grade of concrete supplied, with any performance requirements for special class
- The amount of any water added at the site

The Contractor shall retain these dockets as a record of the pre-mixed concrete delivered and this information shall be available to the Superintendent on request.



Concrete which has commenced to harden and which is within the elapsed times from initial mixing to discharge required by this specification may be re-mixed (re-tempered) provided that if additional water is used during the re-mix, the limits of the designed or specified water:cement ratio are not exceeded and the original mix design is maintained. Nevertheless the performance requirements of this specification, including that of slump, shall be achieved.

1.4 Sprayed concrete

Refer to Specification for “Shotcrete”.

1.5 Crack injection resins

Crack injection resins shall be sourced only from approved manufacturers and the manufacturers’ material data sheets and recommended work methods shall be submitted to the Superintendent for approval before work commences.

Resin viscosity shall be chosen in accordance with the manufacturer’s recommendations to match the width of the crack to be filled and the injection method in use.

When required by the Superintendent, adequate filling of cracks and adhesion of resins to the concrete substrate shall be demonstrated by taking core samples from a chosen area, which includes a filled crack, for examination.

1.6 Crack bridging materials

All crack bridging materials or systems shall be sourced from approved manufacturers and the manufacturers’ material data sheets and recommended work methods shall be submitted to the Superintendent for approval before work commences.

All crack-bridging materials shall be certified by the manufacturers for service while continuously immersed in water.

1.7 Sheet plastic membranes

Refer to Specifications for “HDPE Geomembranes”, and or “Flexible Geomembranes (other than HDPE)”.



1.8 Grout injection mattresses

All mattresses for filling by grout injection shall be purpose-made and sourced from approved manufacturers. The manufacturers' data sheets for the mattress type and the material(s) of which it is woven shall be submitted to the Superintendent for approval, together with their recommendations for handling, joining, anchoring and filling the mattresses.

The manufacturers' data shall include the results of testing of the mattress fabric for resistance to moisture, alkalis and exposure to sunlight.

2. Site Preparation

2.1 Subgrade repair

Any voids in the subgrade behind the concrete channel lining shall be filled to obtain a firm smooth surface suitable to for supporting repair materials when the lining is reinstated. Methods for subgrade repair shall be chosen for compatibility with the existing soils and proposals submitted to the Superintendent for approval before work commences.

Suitable methods for subgrade repair could include, but are not limited to:

2.1.1 Flowable fill

Refer to Specification for "Flowable Fill".

2.1.2 Soil fill

Natural soils can be used as fill for voids up to 400 mm deep. Soils shall be placed in layers not exceeding 150 mm deep and well compacted by mechanical means. Clay fill shall be moist during compaction.

2.1.3 Sand fill

Sand can be used as fill for voids up to 800 mm deep. Sand shall be placed in layers not exceeding 300 mm deep and well compacted by mechanical means.

2.1.4 Resin injection methods

Small voids detected behind a concrete channel lining may be filled by techniques such as injection of foam-forming urethane resins. These techniques can also be used to raise or re-align panels of the concrete lining which have become sunken or otherwise misaligned.



The materials for any resin injection technique shall be sourced from approved manufacturers and the manufacturers' material data sheets and recommended work methods shall be submitted to the Superintendent for approval before work commences. The work shall be executed by suitably experienced personnel in accordance with the manufacturers' recommendations.

2.2 Subgrade stabilisation

It may be possible to stabilise some subgrade soils which have proved prone to washout, settlement or similar instabilities. Available techniques include grout injection, mixing with cement or lime, and replacement with imported materials.

Proposals and specifications for work of this nature should be obtained from a qualified Geotechnical Engineer.

2.3 Concrete preparation

2.3.1 Removal and cleaning

All damaged, deteriorated, loosened or unbonded portions of existing concrete shall first be removed by water blasting, bush hammering, jack hammering or other approved mechanical means, after which the existing concrete surfaces so exposed shall be prepared by contained shotblasting, wet gritblasting or water blasting to remove any microfractured material resulting from the initial removal process.

All surfaces to receive repairs shall then be cleaned and allowed to dry thoroughly, unless the repair techniques to be employed require application to a saturated surface.

Concrete removal processes involving heavy jackhammers, dry gritblasting or sandblasting, or scabblers shall not be used without the approval of the Superintendent. The use of acids for cleaning or preparing concrete surfaces for repair will not be permitted.

2.3.2 Saw cut edges

The perimeter of repairs to concrete that involve concrete removal and/or subsequent material replacement shall be saw cut perpendicular to the repair surface to a minimum depth of 20 mm. Featheredge repairs to concrete will not be permitted.

2.3.3 Maintenance of prepared surfaces

After the concrete has been prepared and cleaned, it shall be kept in a clean, dry condition until the repair has been completed. Any contamination, including oil, solvents, dirt accumulation or foreign material shall be removed by additional wet gritblasting and air-water jet cleanup followed by drying.



3. Execution of repairs

3.1 Grouting

Cementitious grouts shall be mixed with the materials and to the consistencies specified in clause 1.1.

The grout shall be kept agitated during the whole grouting application, which shall be a continuous process, proceeding from the lowest pouring or injection point to the highest until the crack or void to be grouted is full and all air and water has escaped.

3.2 Prepacked aggregate concrete placing

After grout pipes have been placed in position, graded coarse aggregate shall be placed in the repair area in such a manner that the grading of the aggregate in place will be as uniform as practicable. The voids ratio in the coarse aggregate shall be within the range 35-40%. Care shall be taken to ensure that the grout pipes are not damaged or displaced during packing of the aggregate.

Sufficient grout pipes shall be provided to ensure continuous grouting in the event of blockage in one or other of the pipes.

Grouting shall begin at the lowest point under a minimum head of 10 m and shall proceed slowly and continuously upwards in such a manner as to ensure that all voids in the coarse aggregate are completely filled as any water in the repair area is displaced by the grout.

3.3 Application of repair mortars

Repair mortars shall be mixed with the materials and to the consistencies specified in clause 1.2.

3.3.1 Sand/cement mortars

The concrete against which the mortar is to be placed shall be saturated but surface dry at the time of placing of the mortar. This can be accomplished by thoroughly soaking the concrete and then letting it dry until the wet sheen just disappears from the surface.

The existing concrete surfaces may be primed with a bonding agent, which shall either be a proprietary bonding agent intended for concrete repair, or a cement /water slurry mixed to a creamy consistency. Cement/water slurry shall be applied to the concrete surface immediately ahead of the application of the repair mortar so that it is still wet when the mortar is applied.

Proprietary bonding agents, if approved by the Superintendent for use, shall be applied strictly in accordance with the manufacturer's recommendations. The use of PVA bonding agents will not be permitted in concrete channel repairs.

The repair mortar shall be placed against the existing concrete and compacted fully in such a manner as to ensure that succeeding layers bond with each other and that no air is trapped within the repair to form voids.

After completion of the repair, the exposed surface of the mortar shall be worked in such a manner as to match the level and texture of the surrounding concrete as closely as is practicable.

3.3.2 Modified cementitious repair mortars

Modified cementitious repair mortars shall be applied strictly in accordance with their manufacturers' recommendations and using any bonding agents specified by the manufacturers for such application.

3.4 Concrete

3.4.1 Transporting

Concrete shall be transported from the pre-mixed concrete truck or site mixing plant to its final position in the work as rapidly as possible by means which will prevent segregation or loss of materials and contamination and in such a way that the proper placing and compaction of the concrete will not be adversely affected.

The Contractor shall seek approval from the Superintendent before using pumping equipment and lines to transport concrete. If a pump is to be used to transport concrete, the concrete mix shall be ordered or designed to suit this method of delivery.

3.4.2 Placing

Concrete shall not be placed if its slump is not within the limits specified in AS 1379.

There shall be no addition of water or any other material to the concrete at the site without the approval of the Superintendent.

Concrete shall be placed in such a manner as to avoid segregation or loss of materials. The maximum free fall of concrete shall be limited to 2 m. Otherwise the Contractor shall deposit the concrete through enclosed chutes, which shall be kept as vertical as possible and shall be kept as far as practicable full of concrete and with their lower ends immersed in the newly placed concrete.

The depositing of a large quantity of concrete at any point with the intention of moving it along the work will not be permitted. The use of troughs, chutes and pipes to aid in depositing concrete in its final position shall be permitted provided that they are kept clean and free of any coating of hardened concrete. The use of water to facilitate the movement of concrete along the troughs, chutes or pipes will not be permitted.

Concrete placing shall be carried out continuously between construction joints and in such a manner that a plastic concrete edge is maintained.



Before fresh concrete is deposited against hardened concrete in repairs, the surfaces of the hardened concrete shall be prepared as specified for mortar repairs in clause 3.3.1.

Concrete shall be placed in horizontal layers not exceeding 300 mm in thickness and each layer shall be compacted before the preceding layer has taken its initial set.

3.4.3 Compaction

Concrete shall be thoroughly compacted by mechanical vibration and/or hand methods to suit the application. It shall be carefully worked against formwork, onto waterstops, around any reinforcement and into repair areas.

The degree of compaction shall be such as to eliminate all air or stone pockets which may cause honeycombing, pitting or places of weakness. Vibrators shall not be used to transport concrete along the work and shall not be placed in contact with freshly hardened plastic concrete.

3.4.4 Concreting under water

Concreting underwater shall not be permitted where it is feasible to drain the channel to enable concreting in the dry.

Where underwater concreting cannot be avoided, then the cement content of the mix shall be increased beyond that required for the particular grade of concrete by 25%.

Concreting shall be carried out by placing the concrete in a compact mass in its final position by tremie pipe, closed bottom buckets or the like. The discharge end of the tube or bucket shall be kept within the deposited concrete and no water shall enter the tube or bucket. Concrete shall not be placed in running water without protection being afforded to the deposited concrete so that no agitation or disturbance to the mix will occur.

3.4.5 Sprayed concrete

Refer to Specification for "Shotcrete".

3.5 Crack injection

Crack injection resins shall be chosen and/or mixed to have the correct viscosities for the cracks being repaired, as recommended by the manufacturers and outlined in clause 1.5.

The methods selected for preparing and priming cracks, drilling into cracks, sealing cracks at the concrete surface and injecting the resins themselves shall be in accordance with the resin manufacturers' recommendations. All such work methods shall be submitted to the Superintendent for approval before work commences.



3.6 Crack sealing

Crack sealing materials shall be chosen to suit the degree of activity or movement anticipated in the crack after sealing, in accordance with the sealant manufacturers' recommendations.

Cracks to be sealed must be routed out to a width at the surface suitable for the application of the chosen sealant. Routing may be omitted in the case of a wider crack, provided the texture of the crack sides will not impair the permanence of the seal.

The surface temperature of the concrete at the time of sealing shall be within the limits set by the sealant manufacturers. Procedures selected for crack routing, flushing, priming and other preparation and the application of the sealant shall be in accordance with the sealant manufacturers' recommendations. All such work details shall be submitted to the Superintendent for approval before work commences.

3.7 Crack bridging

Crack bridging materials or systems shall be chosen to suit the degree of activity or movement anticipated in the crack after sealing, in accordance with the material manufacturers' recommendations.

Procedures selected for surface cleaning, keying, priming and other preparation and for the application of the bridging material or system shall be in accordance with the material manufacturers' recommendations. All such work details shall be submitted to the Superintendent for approval before work commences.

3.8 Sheet plastic membranes

Refer to Specifications for "HDPE Geomembranes", and or "Flexible Geomembranes (other than HDPE)".

3.9 Grout injection mattresses

All procedures for handling, placing, temporarily anchoring, permanently anchoring, joining and filling the mattresses shall be in accordance with the mattress manufacturer's recommendations.

The proposed work procedures shall be submitted to the superintendent for approval before work commences.

3.10 Curing and protection

The Contractor shall be responsible for the provision of the curing and protection requirements of this section of the specification.



Freshly placed concrete or cementitious materials shall be protected from premature drying and excessively hot or cold temperatures. In drying conditions (high temperatures, wind, low humidity, or combinations of any of the above), the fresh concrete shall be covered with sheet plastic which is held in place, or shall be sprayed with an aliphatic alcohol while setting and until the selected curing regime can commence.

The curing period shall commence immediately after the initial set of the concrete and shall continue until the cumulative number of days, not necessarily consecutive, during which the temperature of the air in contact with the concrete is above 10°C has totalled seven.

During the curing period, one of the following curing methods shall be applied By the Contractor to all exposed concrete faces:

- a) Ponding or continuous sprinkling with water.
- b) The use of an absorptive cover, kept continuously wet.
- c) The use of curing compounds conforming to AS 3799.
- d) The use of an impermeable sheet membrane over a moistened surface, so fixed and lapped that no air circulation can occur at the concrete surface.

Aliphatic alcohols and curing compounds shall be sourced from approved manufacturers and shall be applied strictly in accordance with their manufacturers' recommendations. The use of all such substances shall be approved by the superintendent before work commences.

3.11 Safety

Appropriate safety precautions shall be taken when using all types of mechanical means of cutting, cleaning or tooling concrete. Appropriate protective gear (gloves, eye protection, ear protection, dust masks, boots, etc) shall be worn by all personnel operating such equipment.

Wet concrete and cementitious material is highly alkaline and shall not be allowed to remain in contact with the skin. Any splashes or spills shall be washed off with fresh water immediately they occur.

When handling injection resins and similar chemical compounds, all precautions recommended by their manufacturers on containers or on safety data sheets shall be strictly observed. These may include methods of handling, pouring and mixing, restrictions on storage conditions, ventilation and/or breathing protection required, skin or eye protection required and safe disposal of containers and residues.



4. Testing

4.1 Cementitious grout

Samples of grout for testing shall be taken from both the agitator tank and from grout issuing from the outlet end of the first pipe grouted. Each sample shall be tested separately.

4.1.1 Bleeding

A test of the bleeding characteristics of the proposed grout shall be made prior to commencement of the work and during the work if any change of material or mixing methods is introduced.

The bleeding test may be carried out as follows:

- Fill with grout a 600 mm bottle having a neck diameter of 25 mm (a milk bottle or similar). Rod the grout 25 times with a 2.5 mm diameter rod to remove entrapped air. Top up the bottle to provide a level grout surface.
- Cover the bottle to prevent evaporation and do not disturb for 24 hours.
- If the total settlement exceeds 10 mm, the grout is unacceptable.

4.1.2 Relative density

The relative density of the grout shall be tested at the commencement of each grouting session. The relative density may be tested by weighing a known volume of grout, or by hydrometer.

The value of the relative density shall fall in the range 1.85 to 2.0.

4.1.3 Compressive strength

The compressive strength of grout shall be determined by crushing 100 mm cubes (or other standard specimens such as 75 mm by 150 mm cylinders, with an appropriate correction factor). Each test shall be the mean of three cubes.

Cubes shall be made, cured and tested in accordance with AS 1012, parts 8 & 9.

4.2 Concrete

In addition to the production assessment testing required to demonstrate compliance with AS 1379 by the concrete producer, project assessment samples shall be made on site in accordance with Appendix B of AS 1379.

Slump testing of samples of the concrete delivered to site shall be in accordance with Section 5.2 of AS 1379.



Where slump is a principal compliance criterion for the concrete, such as for concrete for slipforming, then the slump of a sample shall be determined from each load of concrete delivered until constancy in the concrete supplied has been established.

4.3 Crack filling

The success of injection repairs shall be demonstrated by taking three core samples from repaired cracks at locations chosen by the superintendent and at the expense of the Contractor. Each sample shall result in a concrete core containing a portion of filled crack in order to permit examination of the extent of filling and bonding achieved on site.

In the event of non-achievement of successful crack filling, the Contractor shall institute a remedial crack injection programme and then demonstrate the success of the remedial work by taking three more samples as before.

Further core samples may be requested by the Superintendent for Quality Assurance purposes, but these shall not be taken at the Contractor's expense.

5. Records

(This section will depend largely on the various Authorities' preferred ways of working. Some guidance would be appreciated concerning the degree to which record keeping is normally taken)