



Concrete Lined Irrigation Channels – Patch Repairs

1 Overview

Patch repairs, or the replacement of small portions of a concrete channel lining, are necessary when part of the lining is missing or fragmented. This can happen as a result of accidental damage, water turbulence acting in the vicinity of a number of cracks, or when a crack system breaks an area of unreinforced lining into pieces small enough to become dislodged.

The ideal size for a patch repair is one metre or less across, to minimise problems arising from drying shrinkage of the patch itself. If a much larger area of lining than this becomes fragmented, it will usually be more effective to replace the affected length of lining completely. Patches seem to perform best if their dimensions make them 'chunky' rather than forming thin sheets of concrete.

Once the area has been exposed, broken concrete removed and any missing soil outside the lining replaced, the edges of the lining concrete must be prepared and the patch material applied to replace the missing concrete.

A cementitious mortar or concrete, with or without resin modifiers in the mix, will usually be the best material to use for patch repairs. The mix may also contain plastic or steel fibres to enhance its homogeneity, improve its plastic properties, or increase its toughness once hardened.

As with other repairs, correct preparation of the parent concrete is essential if a good and lasting bond is to be achieved between the existing lining and the new material.

Proper preparation must include removal of all loose or substandard material, cutting-in of the repair's sides to avoid feather-edged material and cleaning away of all dust and debris.

Before application of the repair material, the old concrete must also be at a suitable moisture content and be treated with an appropriate bonding agent. The repair material can then be applied to the patch area, worked in well and compacted.

When the repair is complete and smoothed off, it must then be cured. For cementitious materials, this means keeping them continuously wet for three to seven days – longer, if possible. Suitable curing methods include the application of wet hessian and/or covering with a sheet of plastic, the application of a film-forming curing compound, or 'ponding' the area to keep the repair under water.

Given proper attention to all of the above, there is no reason why a patch repair should not last the remaining life of the concrete lining. At worst, the repair material will shrink a little and the resulting very fine cracks will have to be sealed as described in the relevant section of this document. If suitable modified materials are employed, even this small amount of shrinkage can be minimised.



2 Issues to be Considered

As with much other repair work, it is vital that the cause(s) of the problem are identified and countered before implementing the work, in order to avoid wasting resources on a repair which is doomed to failure.

It may be necessary to stabilise the soils behind the lining, to recompact them, or to replace them with a sand/cement mixture or similar before proceeding. It may also be necessary, if panels of the concrete lining are displaced, to apply slabjacking or similar techniques to restore the lining to correct line and level.

It is good practice, for patch repairs, to avoid backfilling any void behind the lining completely. The patch repair will then be thicker than the parent concrete and correspondingly robust.

Good practices in connection with preparation of the edges of the parent concrete are discussed in section 4. If this preparation work is skimmed, then the adhesion and useful life of the patch will be impaired.

Choice of appropriate materials is discussed in section 3 and will also have a bearing on the success of the repair. The cheapest materials are not always the most cost-effective, especially when the life of the repair is reduced by their adoption.

An ideal patch will become part of the channel lining, will be at least as hard as the parent concrete, will withstand all the erosion and other damaging agents applied to it and will not shrink away from the sides of the repair area to any significant degree.

3 Materials

For best compatibility with the properties of the lining concrete, the material for the patch repair should be cementitious, not an epoxy concrete. Normal cement mortars or concretes, although well known and easy to mix and modify, are not necessarily the most economical choice for patching, especially when the life of the repair is considered (cost per square metre per year).

To be fully effective, the patch material must be highly durable, bond well to the parent concrete, be relatively elastic and have minimal shrinkage characteristics. These properties are usually best met by a proprietary modified cementitious repair mortar.

One limitation of these materials is the thickness which can be built up in one application – usually limited to around 80 mm for a high-build formulation. If time or other constraints dictate that two successive applications are not possible, then a concrete mix might be more appropriate. For best results, this should be a rich mix with a low water/cement ratio.

If this is the case, then consideration should be given to the inclusion of fibres in the mix. Polypropylene fibres will stiffen the concrete to minimise slumping, will help to combat early drying and plastic shrinkage cracking and will give a slight increase in toughness in the hardened concrete.

An alternative approach, particularly if several repairs are to be executed in one location, is the adoption of the dry-shot gunite process, using a proprietary gunite mix with polymer modifiers. Refer to Guidelines for “Shotcrete” for more information.

Each of the above options will need a primer or bonding agent to be applied to the edges of the parent concrete in order to promote adhesion at the margins of the repair. Most of the proprietary systems have their own bonding agents, which should be applied and used as recommended by the manufacturers.

For normal concretes, a slurry of cement and water is a good bonding agent, provided it is still fresh when the patching concrete is placed against it. Most bonding agents will actually reduce bond if too dry when the patch is applied.

One further technique which may prove valuable is the use of pre-placed aggregate concrete (PAC). In this repair method, the stone aggregate is packed into the void or area to be filled, together with one or more grout tubes. A sand/cement grout is then pumped through the grout tube(s) to rise through the packed stones.

This method produces a dense concrete with little or no shrinkage and can be used under water, since the grout displaces water as it penetrates the mass of the stones. Often used for large repairs, this technique could be invaluable for patching an area of missing lining with a void behind it when the channel can not be taken out of service.

4 Patch Installation

Installation of a patch repair starts with proper preparation of the area to be patched. The remainder involves good concrete practices and close attention to following the manufacturer’s recommendations for any proprietary materials being used.

After attending to any necessary stabilisation or replacement of the supporting soils behind the lining, the edges of the lining concrete must be prepared. A good bond of new to old concrete depends on the removal of all loose, weak, cracked or otherwise damaged concrete from this area.

If the repair material is to adhere well to the parent concrete, it must not be trowelled out to a feather edge. Experience in the Murrumbidgee Irrigation Area had found that effective patch repairs on concrete lining were achieved when the patch was inserted into a saw cut area where the saw cut was angled downstream. The angle of the saw cut is typically in the range of 30°.

The angling of the saw cut downstream means that the patch is not being subjected to direct pressurisation by the flow of water past the joint between the existing concrete lining and the patch. This reduces the possibility of uplift pressures developing behind the patch and ultimately leading to the failure of the patch.

Once all substandard material has been removed and the concrete cleaned to remove all dust and debris, pre-wetting of the parent concrete will be required. The ideal condition of the concrete faces for most cementitious repairs is 'saturated but surface dry' to minimise the tendency for dry concrete to suck water from the patch material. To achieve this, the concrete should be thoroughly wetted, then allowed to dry to the point where the glisten of water disappears from the surfaces. This process will also cool the concrete usefully in hot conditions.

The required primer, bonding agent or cement slurry should then be applied to the concrete edges. The manufacturer's instructions should be followed closely in this operation, but most systems require the patch repair material to be applied before the primer/bonder dries. A cement slurry should certainly be still quite wet when the repair area is filled with concrete.

The repair mortar or concrete should then be packed into the hole, using as dry a mix as possible, and worked well up against the primed concrete edges. Care must be taken to avoid trapping air pockets between layers of patch material, which must be compacted as fully as possible.

If building up two layers, the first should be left with a roughened, scored surface to provide a key for the second. When the first layer is dry, it should be treated in the same way as the parent concrete before applying the second layer, which should be trowelled smooth on completion.

Application of a gunite patch repair is a specialised operation and should be left to experienced operators. All the preparation work, however, will be the same and must be carried out with equal care. The gunite applicator can then shoot the repair mix tightly against the parent concrete faces and against the exposed soils, building up a thick layer of concrete without air voids.

It is vitally important that the freshly placed repair material be protected from moisture loss. It should be shaded from the sun and covered with wet hessian or similar. For the first week after placing, the patch should be cured by preventing it from drying. Proper curing enables cementitious materials to gain their full potential strength and impermeability.

This can be achieved by wetting the patch and covering it with plastic sheeting, covering it with wet hessian and covering the hessian with plastic sheeting, applying a proprietary film-forming curing compound, or arranging to cover the patch with standing water. Hosing the patched area with water from time to time will not help to cure the concrete and may actually impair its strength gain.



5 Summary and Recommendations

In short, the preferred patching material for most repairs is a polymer-modified cementitious mix, applied in accordance with the manufacturer's recommendations.

Where the repair is bulky, or there are many repairs in one location, a fibre reinforced concrete may be appropriate, or a dry-shot gunite process could be used.

Patch repairs which must include filling of a void behind the lining, especially if they must be executed underwater, may best be achieved by the preplaced aggregate concrete technique.

6 References

Ryan, W.G. and Samarin, A., "Australian Concrete Technology", Longman Cheshire.

"Guide to Concrete Repair and Protection", published jointly by Standards Australia, Standards New Zealand, CSIRO and the Australian Concrete Repair Association.

Manufacturers' Product Guides and Technical Data from:

Epirex, Parbury Technologies, Sika, and Master Builders Technologies