

GUIDELINES FOR THE REPAIR AND/OR REPLACEMENT OF CONCRETE LINED IRRIGATION CHANNELS

CONTROLLED LOW STRENGTH MATERIAL (Flowable Fill) For Foundation Stabilisation

1 Overview

Controlled Low Strength Material (CLSM) is also known as Flowable Fill, Liquifill and Controlled Density Fill. It is a free flowing, self levelling, self compacting, low strength fill material for use in many situations where compacted fill is normally used. The high flowability of CLSM makes placement relatively simple. Placement is possible from an agitator or tip truck or it can be pumped. The material will flow into narrow spaces or voids under gravity alone. This can make it an attractive option for filling voids or sinkholes that extend under concrete structures and or concrete lined irrigation channels.

CLSM can be manufactured to a range of strength and flowability properties using a range of materials. It can be placed in a single lift and achieves strength similar to compacted soil (95% maximum dry density) under its own weight in a few hours after placement.

2 Issues to be Considered

The high flowability properties of CLSM could present problems where sub-surface drainage exists beneath concrete lined channels. CLSM flowability will need to be limited so as to ensure sub surface drains are not filled and blocked. Such issues may be addressed by the adoption of a slightly less flowable mix design.

High hydrostatic pressures will be developed on the underside of the channel lining during placing of the fill. As such, deep sink holes may need to be filled in layers so as to avoid excessive hydrostatic pressure beneath the concrete lining.

3 Product Type & Method Details

The principal raw ingredients of CLSM are cement, fly ash, sand, and water. It is often manufactured in a concrete plant and delivered in an agitator truck. Despite this, CLSM is not concrete and is not intended to be a structural product. Unlike concrete it does not segregate at the high flowability state in which it is used, and lower strength CLSM can be excavated by hand if required. The mix design for CLSM can vary greatly, depending on cost and availability of materials.

The two main parameters for specifying CLSM are strength and flowability.

The strength of CLSM is generally intended to match the strength of the surrounding earth, although in some applications higher strengths are used. The chosen strength depends on the load carrying capacity required and the long term requirements of the fill material. For material that may need to be excavated at a later date the ultimate strength should be limited to a maximum of 1.0 MPa. Strengths exceeding 1.0 MPa generally require removal by jack-hammers or breakers. For hand removal the strength should not exceed 0.5MPa. Testing for strength is done on cured cylinders, in a similar manner to concrete testing.

Flowability can be measured by "Modified Flow Test". A 76mm diameter x 152mm open ended cylinder is filled with the material, the cylinder pulled straight up, and the diameter of the spread material is measured. For good flow a spread of at least 200mm is required.

When comparing CLSM fill to conventional compacted earthfill the final cost in place should be considered. CLSM as a material will almost always be more expensive than conventional earthfill. However once excavation, compaction, quality control, and other costs are included CLSM will often prove a more cost effective solution.

Most ready mixed concrete suppliers can produce CLSM to meet various project specifications. Depending on the type and location of void to be filled CLSM can be placed by chute, conveyor, pump, or bucket. Because CLSM is self levelling it needs little spreading and no compacting. This makes it ideal for fill spaces where access is difficult or impossible such as voids beneath concrete channel lining.

CLSM mix designs can be adjusted to meet specific fill requirements. Mixes can be adjusted to improve or reduce flowability as required. Extra cement or fly ash can be added to increase strength. Admixtures can be added to adjust setting times and other performance characteristics. CLSM self compacts consistently and does not settle. CLSM will displace any standing water left reducing the need for de-watering.

Other irrigation industry applications may include filling wash outs and sink holes, backfilling underground pipes, and filling abandoned underground structures such as drains. Some of these uses have already been proved practical and transfer to the irrigation field would present no undue problems. In some cases, eg filling sinkholes, the techniques have not been proven and may present unforeseen problems or require special techniques.

4 Installation Considerations

CLSM is normally delivered to the site in mixer trucks and where possible discharged direct from the chute. Vehicular access is normally provided along both sides of irrigation channels for maintenance. In wet weather, access may be limited. Where trucks can not access the site directly a concrete pump may be used.

The high flowability of CLSM makes placement relatively simple. Properly made, the material is self levelling and self compacting, and will flow into narrow spaces or voids with no external effort. A sinkhole or animal burrow extending under the edge of the channel could be completely filled with CLSM by simply filling from the surface.

5 Summary and Recommendations

Failure of the earthworks beneath concrete channel linings is a common problem. Voids often form beneath concrete channel linings as a result subsidence, erosion or animal Burrows.

Flowable fill or Controlled Low Strength Material (CLSM) is a mixture of fly ash, sand, water, and a small amount of cement. It is commonly used as an alternative to compacted earthfill. It's ability to flow into and fill small cavities makes it an ideal fill medium where access is difficult or impossible. Once set, it's strength is comparable to compacted earthfill.

Although untested in this application, flowable fill has the potential to be used for filling voids beneath concrete channel linings.

6 References

1. *Flowable Fill*, Pozzolan Industries Pty Ltd
2. ACI 229, *Controlled Low Strength Materials*, ACI Manual of Concrete Practices, Vol. 1, Detroit, Michigan, 1995 edition.