



CONCRETE IN PRACTICE

**CIP
17**

What, Why & How? Flowable Fill Materials

WHAT is Flowable Fill?

A low strength material mixed to a wet, flowable slurry used as an economical fill or backfill material placed by pouring it into the cavity to be filled. Slumps measured in the ordinary way are generally 8 in. or higher. It is self-leveling with a consistency similar to pancake batter; it can be placed with minimal effort and no vibration or tamping. It hardens and develops strength.

ACI Committee 229 calls it "Controlled Low Strength Material" (CLSM); it is not considered concrete. Other names used for this material are — flowable mortar or lean-mix backfill. If it is *anticipated or specified* that the flowable lean-mix backfill *may be excavated at some point in the future* the strength must be much lower than the 1200 psi which ACI uses as the upper limit for CLSM. The late-age strength of removable CLSM materials should be in the range of 30 to 150 psi as measured by compressive strength in cylinders.

WHY is CLSM Used?

Flowable CLSM mixtures are an economical alternative due to the saving of labor and time over placing and compacting soil or granular materials.



Uses of Flowable Fill Include:

1. BACKFILL (Sewer Trenches, Utility Trenches, Bridge Abutments, Conduit Trenches, Pile Excavations, and Retaining Walls)
2. STRUCTURAL FILL (Foundation Subbase, Subfooting, Floor Slab Base, and Pipe Bedding)
3. OTHER USES (Abandoned Underground Storage Tanks, Wells, Abandoned Utility Company Vaults, Voids Under Pavement, Sewers and Manholes, and to contend with Muddy Conditions)

HOW is Flowable Fill Ordered?

Ask for it by intended use and indicate whether it is required to be easily removed later. Ready mixed concrete producers generally have developed proportions for flowable CLSM products that make best use of economical aggregates and/or fly ash.

Strength (for later removability) At least 20 psi is needed at 3 days and 30 psi at 28 days (ASTM C 403 Penetration Resistance Numbers of 500 to 1500) should be obtained to assure required bearing capacity in-place as a fill. However, later age strength must be limited to assure convenient removal with power equipment.

Strength (when it can or must be higher) When higher strength structural fills are required or can be tolerated because removal is not required, use higher cement and/or fly ash contents.

Testing Flowable CLSM Mixtures:

- Sample and remix sample (ASTM C 172).
- Compressive strength. Use 6 x 12 in. plastic cylinder molds, fill to overflowing and then tap sides lightly. Cure cylinders in the molds (covered) until time of testing (or at least 14 days). Strip carefully using a knife to cut plastic mold off. The process of capping with sulfur compounds can break these low strength materials. Neoprene caps have been used, some do not cap, but high strength gypsum plasters seem to work best.
- Slump testing is not recommended since a very wet consistency is required for the proper self-leveling consistency. ASTM C 939 for flow of grout can be used by wet screening to remove coarse particles. An efflux time of 10 to 26 sec. through a special flow cone with a 1/2 in. discharge tube has been used.
- Unit weight and yield (ASTM C 138) by normal procedures.
- Air content by pressure meter (ASTM C 231). (if air entrainment is being used.)
- Penetration resistance tests such as ASTM C 403 may be useful in judging the setting and strength development up to a penetration resistance number of 4000 (roughly 100 psi compressive cylinder strength).
- Density tests are not required since it becomes rigid after hardening.

Setting and Early Strength may be important where equipment, traffic, or construction loads must be carried. Judge setting by scraping off loose accumulations of water and fines on top and see how much force is necessary to cause an indentation in the material. ASTM C 403 penetration can be run to estimate bearing strength.

Density in place is usually in the 115 to 145 lb./cu.ft. range, higher than that obtained from most compacted soils or aggregates. If lightweight fills are needed or if greater thermal insulation is needed, high air-entrainment, foam materials, and/or lightweight aggregates can be used.

Flowability of CLSM is important, so the mixture will flow into place and consolidate due to its fluidity without vibration or puddling action.

Durability. CLSM fill materials are not designed to resist freezing and thawing, abrasive or erosive actions, or aggressive chemicals. If this is required, use a high quality concrete. Fill materials are usually buried in the ground or otherwise confined. If CLSM deteriorates in place it will continue to act as a granular fill.

HOW is Flowable Fill Delivered and Placed?

CLSM is delivered in ready mixed concrete trucks and placed easily by chute in a flowable condition directly into the cavity to be filled or into a pump for final placement. Keep the drum agitating. For efficient pumping some granular material is needed in the mixture.

CAUTIONS

- (1) Fluidized CLSM is a heavy material and during placement (prior to setting) will exert a high fluid pressure against any forms, embankment, or wall used to contain the fill.
- (2) Placement of Flowable Fill around and under tanks, pipes, or large containers such as swimming pools can cause the container to float or shift.

References

1. "Fly Ash Design Manual for Road and Site Applications," Volume 2: Slurried Placement, by GAI Consultants, Inc., for the Electric Power Research Institute, Palo Alto, California.
2. NRMCA Promotion Pointer No. 273, "Flowable Fill, A New Product - A New Market," July, 1985.
3. Iowa Department of Transportation Supplemental Specifications for Flowable Mortar, January 19, 1988.
4. Specification for Lean Mix Backfill, prepared by Scientific Service, Inc., Under HUD Contract, Reprinted by NAA and NRMCA, August, 1984.

