STANDARD OPERATING PROCEDURE
FOR

CONTROLLED LOW-STRENGTH MATERIAL BACKFILL

(10 November 2021)

A controlled low-strength material (CLSM) is designed to be an excavatable soil replacement to encase pipes, surround structures, or fill excavations. The mix design in Table 1 (per cubic yard) produces a material suitable for general placements but it is not recommended for placement on slopes. The mix design in Table 2 has been successfully used on 3H:1V slopes in above freezing temperatures, but the specifications associated with such use should require a 1-cubic-yard test section be performed at the anticipated angle.

Table 1: CLSM Mix for General Placement

MATERIAL	DOSAGE
Portland Cement (ASTM C 150 - Type I or II)	80-100 lbs. (Air temp. >32° F) 150-175 lbs. (Air temp. <32° F)
Fly Ash (ASTM C 618 - Class F, C, or N)	200-400 lbs. (Air temp. >32° F) 200-300 lbs. (Air temp. <32° F)
Sand (ASTM C 33)	2000 to 3000 lbs. (Depends on air, water & cementitious materials)
Potable Water	Dosed to create a water-to-cement ratio of 1.0 to 1.3
Air Content (ASTM C 260)	10 to 20%
Unit Weight	110 to 126 pcf
Shrinkage Reducing Material	Bentonite dosed at half the weight of the Portland Cement used, -- or -- a Shrinkage Reducing Admixture dosed at a rate recommended by the admixture manufacturer.

Table 2: CLSM Mix for Placement on Inclines

MATERIAL	DOSAGE
Portland Cement (ASTM C 150 - Type I or II)	100 lbs.
Fly Ash (ASTM C 618 - Class F, C, or N)	400 lbs.
Sand (ASTM C 33)	2722 lbs.
Potable Water	250 lbs. (Dosed to create a water-to-cement ratio of 0.5)
Air Content (ASTM C 260)	10%
Bentonite	50 lbs.
Slump	3 - 6 inches

Important Notes:

- The addition of a Shrinkage Reducing Material is not optional.
- The increased air content is obtained using an admixture according to ASTM C 260, and the higher the air content the more excavatable the final product will be.
- Higher fly ash amounts will increase the long-term strength gain and typically lower the water demand.
- Fresh CLSM should have a consistency similar to batter without being watery. The consistency can be tested by filling an open-ended 3-inch diameter, 6-inch-high cylinder to the top and immediately pulling the cylinder straight up. The correct consistency will produce roughly an 8-inch diameter circular-type spread with no segregation.
- In addition to traditional placement, the CLSM can be placed by belt or pump truck and is more easily pumped by increasing the air content.
- Placing the CLSM in lifts, anchoring the pipe, or a combination of both must be used if calculations indicate that a single encasing pour will 'float' the pipe. If hanging dead weights are used, they should be positioned so they are fully encased in the first lift, which will likely require they be pushed back down since the CLSM tends to lift them up.
- Some pipes can move laterally if the CLSM is not placed equally on both sides at the same time. Movement can be minimized of prevented by providing formwork to secure the pipe, or by pouring the mix directly on the top of the pipe so it spills over both sides equally. However, the thicker mix in Table 2 does not flow as readily as the Table 1 mix so it will require assistance to fill beneath and the pipe and fill its haunches while the Table 1 mix will usually do this naturally. Vibration is allowed if it does not induce bleed water. If the pipe is secured from moving, it has been observed that a swift release of the Table 2 mix on just one side of the pipe has successfully filled the lower portions of the pipe without further assistance.
- Any excess water must be suctioned off the top or allowed to migrate off the top of the CLSM pour if the surrounding soil is too cohesive to absorb it.
- CLSM will set faster in warmer weather and slower in colder weather.
- The 28-day strength should be between 30 and 300 psi. and the 3-, 5- or 7-day compressive breaks are not necessarily indicators of what the 28-day strength will be.