

**A PERFORMANCE SPECIFICATION
FOR
CONTROLLED LOW STRENGTH MATERIAL
CONTROLLED DENSITY FILL (CLSM-CDF)**

1.0 DESCRIPTION

This work shall consist of the manufacturing and placement of non-settling backfill mixtures described as a Controlled Low Strength Material (CLSM). The CLSM shall be a flowable material consisting of portland cement, fly ash and/or sand with an expected 28 day and long term (1yr) unconfined compressive strength generally less than 100 pounds per square inch. These trench backfill materials possess flowability for placement, support strength for traffic loads, and removability at a later date after placement. This material may be produced off-site or on-site. In either case, the producer of the material must meet certification requirements as outlined in Section 2.0 PRODUCER AND MATERIAL CERTIFICATION of this specification. In addition to this document, two guides (Producer's Guide) (Contractor's Guide) are also part of this specification.

2.0 PRODUCER AND MATERIAL CERTIFICATION

Prior to manufacture of any CLSM mixture, the producer shall comply with the following requirements.

2.1 Demonstrate the ability to produce a uniform CLSM mixture as outlined in this specification. The National Ready Mix Concrete Association's (NRMCA) plant and truck certification will satisfy the producer certification requirement.

2.2 Certified engineering data, for the proposed mixture to be used, shall be submitted on the Engineering Data Report form for:

2.2.1 Thirty (30) and (90) day compressive strength (C) tests as described in ASTM D 4832 with the following exception: cylinders will not be capped.

2.2.2 Cured unit weight, wet unit weight, and yield (ASTM 6023)

2.2.3 Flow Consistency (ASTM D6103)

2.2.4 Removability (Removability Modulus $RE \leq 1.0$)

$$RE = \frac{w^{1.5} \times 104 \times C^{0.5}}{10^6} \leq 1.0$$

where:

w = dry unit weight (hardened material) (pcf)

C' = thirty day unconfined compressive strength (psi)

2.2.5 Permeability Coefficient (ASTM 5048)

2.2.6 Electrical Resistivity (Pending Test Results and Research)

2.2.7 Mixture's components (cement, water, fly ash, filler aggregate, admixture) and sources (company and location). Previous test results on the same mixtures using the same mixture components will satisfy this requirement. If it is determined, that for the engineering data presented, flowability, adequate strength, and removability requirements are not acceptable, the use of this mixture will not be allowed.

Meeting these certification requirements does not relieve the producer of the material liability referenced in Section 7.0 of this specification.

This engineering data should be submitted using HAMCIN's *Engineering Data Report Form* with pertinent laboratory test data. Table 1 shows Removability Modulus (RE) values for various combinations of compressive strengths (C') and unit weights (w) as determined by Equation (1). If it is determined, for the engineering data presented: flow, adequate strength, and removability requirements are not acceptable, the use of this mixture will not be allowed. Meeting these certification regulations does not relieve the producer of the material liability referenced in Section 7.0 of the performance specification.

3.0 MATERIALS

Materials for CLSM mixtures will be the responsibility of the producer. A Material Safety Data Sheet (MSDS) for each component in the mixture must be available upon request. A CLSM producer's guide is available to help the producer meet specification requirements for materials. Materials shall be:

- 3.1 Water used for the mixture shall be free from oil, salts, acid, strong alkalis, vegetable matter, and other impurities that would have an adverse effect on the quality of the backfill material.
- 3.2 Cement : ODOT 701.01 or 701.04
- 3.3 Fly Ash: Any fly ash must be nontoxic as defined by Division of Surface Water Policy 400.007 "Beneficial Use of NonToxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Wastes," OEPA DSW 400.007.
- 3.4 Fine aggregate shall be natural sand or sand manufactured from stone, gravel or air-cooled blast furnace slag. The gradation of the sand shall meet the requirements of ODOT 703.05. The sand shall be fine enough to stay in suspension in the mixture to ensure proper flow. Foundry sand may be used if it meets the requirements of the Division of Surface Water Policy 400.007 "Beneficial Use of NonToxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Wastes," . Ten days prior to using a mixture using foundry sand on the project, the Producer shall submit written permission from the Ohio EPA to the City or County Engineer.
- 3.5 Materials for CLSM mixtures shall be evaluated as non-corrosive by appropriate ASTM standards including ASTM A 674. If the CLSM mixture has a electrical resistivity value of less than 5000 Ω cm, then to ensure compatibility with any proposed or encountered conduit, a polyethylene encasement shall be required conforming to ASTM A 674.

4.0 MIXTURES

Mixes must be submitted to the City or County Engineer for approval. The Producer shall submit the mix design and test data from an independent test lab 30 days prior to the intended usage for approval.

The proportioning, yield, flow consistency, compressive strength and all other requirements are the sole responsibility of the Producer. The mixture will be rejected for failure to meet, or sustain, the mixture's consistency for the previously stated properties.

Where gas leak, odor migration, is a concern for the identification of possible gas leaks, the CLSM material shall meet a minimum permeability coefficient (k) of 1×10^{-5} (cm/sec), or more, based on ASTM 5048.

5.0 PLACING (POURING)

The mixture shall be discharged within 2.5 hours after the water is added. The CLSM mixture shall be placed directly into the trench or excavation. The material's flow characteristic will be such that no labor will be required in the trench or excavation. No vibration or compaction equipment shall be used. If the trench or excavation contains water, the CLSM mixtures may be used to displace the water.

A Fast Setting Mixture shall be used for backfilling trenches under pavement within the public right-of-way when it is deemed that the pavement must be quickly reopened to traffic so as to minimize inconvenience to vehicular traffic as shown on the plans. The use of a Fast Setting Mixture is intended to allow for placement of an asphaltic concrete pavement within two hours after mixture placement. Fast Setting Mixture shall produce an unconfined compressive strength of 20 psi in two hours as measured with a penetrometer using the 1.124" diameter head (ASTM D 1558). (A reading of 60 psi on the penetrometer is estimated to be equivalent to a 20 psi unconfined compressive strength)

6.0 CONSTRUCTION REQUIREMENTS

The basic construction requirement for the use of CLSM is that the trench or excavation has vertical wall limits. Vertical wall limits mean that the flowable CLSM mixture must be confined in a given area. For long trenches, requiring large amount of CLSM material, temporary bulkheads can be used to control required placement quantities.

The CLSM material shall be brought up uniformly to the lines or limits shown on the plans or as directed by the Engineer. The placing of portland cement concrete and/or asphaltic concrete pavements can be performed when a unconfined compressive strength of 20 psi is achieved as referenced in Section 5.0.

6.1 The following limitations of operations shall govern:

6.1.1 The mixtures shall not be placed on frozen ground.

6.1.2 The placed mixtures shall be protected from freezing.

6.1.3 Each filling stage shall be as continuous as possible.

6.1.4 Setting time of CLSM may be affected by temperature. At temperatures near freezing, or below, additional time may be needed for proper setting of the material prior to any type of paving operation.

7.0 ACCEPTANCE OF MATERIAL AND FIELD TEST REQUIREMENTS

The material acceptance will be based on the following.

7.1 Producer certification (Section 2.1 of this specification.)

7.2 Flow Consistency of Controlled Low Strength Material (CLSM) (ASTM D 6103)

7.3 Sampling freshly mixed Controlled Low-Strength Material (ASTM D 5971)

7.4 Cylinder (3" x 6" (preferred) or 6" x 12") strengths (ASTM D 4832). Six (6) cylinders will be required for any placement of 100 cubic yards and each 100 cubic yards there after. Three (3) cylinders will be broken at 30 and 90 days. If the placement is less than 100 cubic yards, three (3) cylinders will be taken every fifty cubic yards of production. Two cylinders will be broken at 30 days and one (1) cylinder at 90 days.

The contractor shall be responsible for the curing and protection of the cylinders until such time that they are ready to be picked up by the testing laboratory. The contractor shall coordinate this activity. The cylinders will be held by a testing laboratory until the required breaking date.

7.5 Unit weight tests (ASTM D 6023) will be performed when cylinders are made.

It is important to understand that the CLSM mixture must be able to flow into the excavation, thereby significantly reducing labor requirements for placing. Tests have been developed for the determination of adequate flow. "Standard Test Method for Flow Consistency of controlled Low Strength Material (CLSM) ASTM D6103 is such a test. An average flow diameter of approximately 8" is considered adequate.

TABLE 1 - REMOVABILITY MODULUS (RE)								
w (pcf)	Compressive Strength (C') (psi)							
	25	50	75	100	125	150	175	200
50	0.18	0.26	0.32	0.37	0.41	0.45	0.49	0.52
70	0.30	0.43	0.53	0.61	0.68	0.75	0.81	0.86
90	0.44	0.63	0.77	0.89	0.99	1.09	1.17	1.26
110	0.66	0.85	1.04	1.20	1.34	1.47	1.59	1.70
130	0.77	1.09	1.33	1.54	1.72	1.89	2.04	2.18
150	0.96	1.35	1.65	1.91	2.14	2.34	2.53	2.70

Note: Hard clay's RE = 1.15 psi
Very stiff clay's RE = 1.00 psi
3000 psi portland cement concrete's RE = 10.26 psi
The values in the shaded area would not meet the material removability requirement.

All tests are to be performed by laboratories approved by Hamilton County and/or the City of Cincinnati. Copies of all test reports, from approved testing laboratories, shall be submitted to the material producer and governing agency. If the produced CLSM material fails any of these acceptance tests, indicating future removal difficulty (RE > 1.0), the material will be rejected with the possibility of removal. The Engineer may modify or change CLSM material testing requirements. All CLSM tests are to be performed by qualified testing personnel. The minimum acceptable requirement is ACI Level I, Concrete Technician.

8.0 METHOD OF MEASUREMENT

When paid for separately, measurement will be based on (cubic yards) computed plan quantities. No additional compensation will be allowed for over excavation. The material producer and the contractor should be aware that there is a difference between the plastic (wet) state and the material's hardened state. The plastic (wet) state will be greater than the hardened state.

9.0 BASIS OF PAYMENT

Unless otherwise specified in the Contract or Agreement, the Contractor will be paid for the volume of mixture furnished and placed, per plan quantities, at the Contract unit price per cubic yard. This payment shall be full compensation for placing the CLSM mixture and for furnishing all materials, equipment, labor and incidentals necessary to complete this item; unless included under other items in the Contract or Agreement. Payment will be made under:

ITEM	UNIT	DESCRIPTION
Special	Cu. Yd.	CLSM
Special	Cu. Yd.	CLSM, Fast Set