INFORMATION: Engineering Brief No. 55 May 21, 1996
Controlled Low Strength Material (CLSM)

From: Acting Manager, Engineering and
Specifications Division, AAS-200

To: All Regions and FAA Academy
Attn: Airports Division Managers

Attached is a copy of Engineering Brief No. 55, Controlled Low-Strength Material (CLSM). This brief presents interim specification Item P-153 CONTROLLED LOW-STRENGTH MATERIAL (CLSM). CLSM is a low strength flowable backfill material made from Portland cement, fly ash, sand, and water. The materials are mixed to a flowable condition and can be placed with minimal effort and no vibration or tamping. CLSM hardens and develops strength. The recommended 28-day compressive strength range is 100 to 200 psi. CLSM may be an economical alternative to placing and compacting soil in trenches and around, pipes, vaults, sewers and manholes. In general, this material should be used to replace subgrade. Subbase and base may not be replaced with CLSM.

The purpose of engineering briefs is to inform Airports field offices of new construction materials, methods and products which have been successfully used in limited areas, but are not yet covered by an FAA specification. Any comments you have concerning this brief will be appreciated.

Please advise this office of any use of this material.

ORIGINAL SIGNED BY:
JOHN L. RICE

Attachment

Engineering Brief No. 55, Controlled Low-Strength Material (CLSM).

1. PURPOSE. The purpose of this engineering brief is to provide guidance on the use of controlled low-strength material (CLSM) and includes an interim specification

2. BACKGROUND. CLSM has been used as backfill, structural fill, and to fill abandoned underground tanks, wells, and vaults since the 1980's. The American Concrete Institute (ACI) Committee 229 calls it "Controlled Low Strength Material," the name that has been adopted for airport construction. Other names used for this material are--flowable mortar, lean-mix backfill, and flowable fill.

3. DESCRIPTION. CLSM is a low strength flowable backfill material made from Portland cement, fly ash, sand, and water. The materials are mixed to a self-leveling flowable condition and can be placed with minimal effort and no vibration or tamping. CLSM hardens and develops strength. The recommended 28-day compressive strength range for airport construction as described in this brief is 100 to 200 psi. It is recommended that CLSM contain a minimum of 50 pounds of cement and 250 pounds fly ash per cubic yard, with the remainder of the volume composed of sand, water, and any approved admixtures. At these cementitious levels there should be no significant strength gain after 28 days. The consistency of the freshly mixed CLSM can be measured in a number of ways. Conventional slump tests have been used and a modified grout flow test have been used. The test for determining proper consistency that has been adopted for this brief consists of filling an open-ended three inch diameter cylinder, six inches high to the top with the mixture. The cylinder is immediately pulled straight up. The correct consistency of the mixture will produce an approximate eight inch diameter circular-type spread without segregation. Adjustments of the proportions of materials should be made to achieve these suspension and flowable characteristics.

4. ADVANTAGES. CLSM may be an economical alternative to placing and compacting soil in trenches and around, pipes, vaults, sewers and manholes. There could be considerable savings of time and labor over conventional backfill methods. CLSM can be delivered in ready mixed concrete trucks and placed by chute directly into the area to be filled or into a pump for final placement.

5. LIMITATIONS AND CAUTIONS ON USE. This material should be used to replace subgrade (refer to ITEM P-152 EXCAVATION AND EMBANKMENT.) Subbase and base may not be replaced with CLSM since the material is not designed to resist freezing and thawing or to withstand high stress loads. If the CLSM deteriorates in place as a confined subgrade material, it will continue to act as subgrade fill. CLSM is a heavy fluid material and during placement will exert high fluid pressures against any form, embankment, or walls. Placing CLSM in multiple layers may be required to control movement or shifting and prevent floating of pipes or vaults.

6. SPECIFICATION. Attached is an interim specification for CLSM.

ORIGINAL SIGNED BY
Jeffrey L Rapol
Civil Engineer

INTERIM SPECIFICATION
ITEM P-153 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

DESCRIPTION

153.1.1 This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Engineer.

MATERIALS

153-2.1 MATERIALS

a. Portland Cement. Portland cement shall conform to the requirements of ASTM **[ ]** Type **[ ]**. If for any reason, cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

* *

The Engineer shall specify one of the following : ASTM C 150 - Type I, II.
ASTM C 595 - Type IP, IS, S, I(PM).

* *

b. Fly Ash. Fly Ash shall conform to ASTM C-618, Class C or F.

c. Fine Aggregate (Sand). Fine aggregate shall conform to the requirements of ASTM C 33 except for aggregate gradation. Any aggregate gradation which produces performance characteristics of the CLSM specified herein will be accepted, except as follows.

Sieve Size	Percent Passing by weight
3/4 inch (19.0 mm)	100
No. 200 (0.075 mm)	0 - 12

d. Water. Water used in mixing shall be free of oil, salt, acid, alkali, sugar, vegetable matter, or other substances injurious to the finished product.

* *

Dyes and other methods of coloring the backfill material may be incorporated if desired.

* *

MIX DESIGN

153-3.1 PROPORTIONS. The contractor shall submit, to the Engineer, a mix design including the proportions and source of materials, admixtures, and dry cubic yard (cubic meter) batch weights. The mix shall contain a minimum of 50 pounds of cement and 250 pounds fly ash per cubic yard (30 kg of cement and 148 kg of fly ash per cubic meter), with the remainder of the volume composed of sand, water, and any approved admixtures.

a. Compressive Strength. CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 3 680 kPa)when tested in accordance with ASTM C 39. There should be no significant strength gain after 28 days. Test specimens shall be made in accordance with ASTM C-31 except that the samples will not be rodded or vibrated and shall be air cured in their molds for the duration of the cure period.

b. Consistency. Consistency of the fresh mixture shall such that the mixture may be placed without segregation. A desired consistency may be approximated by filling an open-ended three inch (75 mm) diameter cylinder, six inches (150 mm) high to the top, with the mixture and the cylinder immediately pulled straight up. The correct consistency of the mixture will produce an approximate eight inch (205 mm) diameter circular-type spread without segregation. Adjustments of the

proportions of materials should be made to achieve proper solid suspension and flowable characteristics, however the theoretical yield shall be maintained at one cubic yard (cubic meter) for the given batch weights.

CONSTRUCTION METHODS

153-4.1 PLACEMENT.

a. Placement. CLSM may be placed by any reasonable means from a mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed in such a manner that structures or pipes are not displaced from their desired final position and intrusion of CLSM into undesirable areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed to the Engineer. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one layer, the base layer shall be free of surface water and loose or foreign material prior to placement of the next layer.

b. Limitations of Placement. CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air temperature is at least 35 degrees F (2 degrees C) and rising. At the time of placement, CLSM shall have a temperature of at least 40 degrees F (4 degrees C). Mixing and placement shall stop when the air temperature is 40 degrees F (4 degrees C) and falling or when the anticipated air temperature will be 35 degrees F (2 degrees C) or less in the 24 hour period following proposed placement.

153-4.2 CURING AND PROTECTION

a. Curing. The air in contact with the CLSM should be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32 degrees F (0 degrees C), the material may be rejected by the Engineer if damage to the material is observed.

b. Protection. The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the Engineer that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

MATERIAL ACCEPTANCE

153-5.1 Acceptance. Acceptance of CLSM delivered and placed as shown on the plans or as directed by the Engineer shall be based upon mix design approval and batch tickets provided by the Contractor to confirm that the delivered material conforms to the mix design. The Contractor shall verify by additional testing, each 5,000 cubic yards (3 825 cubic meters) of material used. Verification shall include confirmation of material proportions and tests of compressive strength to confirm that the material meets the original mix design and the requirements of CLSM as defined in this specification. Adjustments shall be made as necessary to the proportions and materials prior to further production.

METHOD OF MEASUREMENT

153-6.1 Measurement. Controlled low strength material shall be measured by the number of **[cubic yards (cubic meters)]** as computed from the neatline plan and section, adjusted for the quantities for any embedments, and as specified, completed, and accepted..

BASIS OF PAYMENT

153-7.1 Payment. Accepted quantities of controlled low strength material shall be paid for at the contract unit price per **[cubic yard (cubic meter)]**. Payment shall be full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified.

TESTING REQUIREMENTS

ASTM C 31	Making and Curing Concrete Test Specimens in the Field
ASTM C 39	Compressive Strength of Cylindrical Concrete

MATERIAL REQUIREMENTS

ASTM C 33	Specification for Concrete Aggregates
ASTM C 150	Specification for Portland Cement
ASTM C 618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 595	Specification for Blended Hydraulic Cements