

FLOWABLE FILL

The only backfill material that provides a safer working environment, reduces total project expenditures, achieves 100% compaction, provides versatility and durability, and effectively fills voids or empty spaces that traditional compacted fill proves to be inadequate.

WHAT IS FLOWABLE FILL?

- DEFINITION* - Flowable Fill is a self leveling and self compacting, cementitious material with an unconfined compressive strength of 1200psi or less. Flowable Fill is primarily used as a backfill material in lieu of compacted granular fill.

*NRMCA Flowable Fill Guide Specification



Flowable Fill is also commonly referred to as:

- **(CLSM)** - Controlled Low Strength Material
- **(CDF)** - Controlled Density Fill
- Flowable Compacting Fill
- Lean Fill
- Unshrinkable Fill
- Flow Mortar
- Fly Ash Flow
- Liquid Dirt

Typical Flowable Fill Mix Components

Main Ingredients:

- Cement
- Sand
- Water

with

- Fly Ash
- GGBF Slag
- CLSM Air Generating Admixtures



Properties of Flowable Fill

- Flowability
- Subsidence/Settlement
- Strength
- Permeability
- Excavatability
- Thermal
Insulation/Conductivity

Flowability

- The unique property that represents an advantage of flowable fill compared to compacted granular fill. High flowability and self leveling characteristics allow flowable fill to eliminate voids and access spaces that prove to be difficult or impossible with compacted granular fill.

*ASTM D6103



Subsidence and Settlement

- Subsidence is the reduction in the initial in-place volume caused by the displacement of water and release of entrapped air as a result of consolidation. Typically, 1/8in per foot of depth is experienced.
- Settlement does not occur to flowable fill mixtures once they have hardened.



Strength (Bearing Capacity)

- A measure of the ability of the hardened flowable fill to support gravity loads or stresses. The most commonly used flowable fill mixtures are proportioned with consideration of possible excavation in future years and range in compressive strengths between 50 and 150psi.



Density

- Density of flowable fill is a measure of the in place unit weight. Flowable fill mixtures may range in unit weight from 20 to 145 lbs/ft³.
- The addition of ASTM C260 air entrainment admixtures will typically reduce the unit weight to a range between 90 and 100 lbs/ft³.
- The addition of lightweight aggregates, CLSM air generating admixtures, or foamed cell systems can reduce the unit weight to as low as 20 lbs/ft³.

Permeability

- The rate at which water passes through a backfill material.
- Flowable fill may be designed to be as permeable as a uniform coarse sand or as dense as clay. It is recommended that flowable fill mixtures have a minimum water conductivity coefficient equal to that of a fine sand, (4.0×10^{-3} cm/sec).

Soil Type	Permeability (cm/sec)
Uniform Coarse Sand	4.0×10^{-1}
Clean, Sand & Gravel	1.0×10^{-1}
Uniform Fine Sand	4.0×10^{-3}
Silty Sand & Gravel	4.0×10^{-4}
Silty Sand	1.0×10^{-4}
Sandy Clay	5.0×10^{-6}
Silty Clay	1.0×10^{-6}
Clay	1.0×10^{-7}

Typical coefficients of water conductivity for various backfill materials.

Excavatability

- Flowable fill with a compressive strength less than 150psi may be excavated manually while at the same time have adequate bearing capacity to support an automobile.
- Flowable fill exhibiting strengths between 150 and 300psi will require mechanical equipment for excavation.
- Flowable fill strengths exceeding 300psi are not considered excavatable.



Thermal Insulation/Conductivity

- Normal density flowable fill mixtures should not be considered as a good insulating material. In order to achieve sufficient insulation properties, high porosity and low density should be considered during mix proportioning.
- Foaming agents exhibit very low densities and provide good insulation.



Benefits of Flowable Fill

- **Reduced in-place costs**
 - less labor, equipment, & time
- **Eliminates settlement**
 - subsidence of 1/8 in. per foot of depth is common
- **Easily excavatable**
 - less than 150psi = manual
 - less than 300psi = mechanical

Benefits of Flowable Fill (continued)

- Year-round availability & placement
- No compaction required yet still achieves greater bearing capacity than compacted granular fill
- Self leveling
- Increased worker safety
- Can be color-coded for utility identification
- Can be placed in standing water

Flowable Vs. Granular: Flowable would have prevented this.



Flowable Fill Applications

- **Backfill**
 - utility trenches
 - retaining walls
- **Structural Fill**
 - poor soil conditions
 - mud jacking
 - floor / footing support
 - bridge conversion
- **Pavement Bases**
- **Erosion Control**
- **Void/Space Filling**



Flowable Fill as Backfill

- Where speed of construction is advantageous and better performance is required.
- Ideal for use in tight or restricted areas where placing soil fill is difficult.
 - Trenches: utilities, primarily under roadways
 - Bridge abutments
 - Pipe bedding
 - Building excavations



**FLOWABLE FILL – A CONTROLLED
LOW STRENGTH FILL MATERIAL FOR
THE RAILROAD INDUSTRY!**



Kennebunk, ME Railroad Project:

- *Existing soils (clays) were not supporting tracks.*
- *Confined space and quick turn around time made flowable fill a perfect choice for the application.*
- *Existing soils were excavated right in front of flowable fill pour.*
- *Railroad was “back on track” within 28 hours of first pour!*



NORTHERN NEW ENGLAND
CONCRETE PROMOTION
ASSOCIATION



Backfill Applications

- Two 8' Culverts installed under road



Forming & Pouring



Easily Applied, Quickly Paved



Flowable Fill as Erosion Control

- Flowable fill has proven to stand the test of time along the Iowa River bank. The flowable fill erosion mat, shown here, has acted as a preventive measure taken to protect downtown Wapello from flood waters.



Flowable Fill as Void/ Space Fill

- Abandoned tunnels and sewers are just a couple of the underground flowable fill applications.
- Flowable fill was used to fill an abandoned tunnel that crossed under the Menomonee River in Milwaukee. (Right) The flowable fill mixture was designed to flow over 200 feet.







Providence, RI Pool Project:

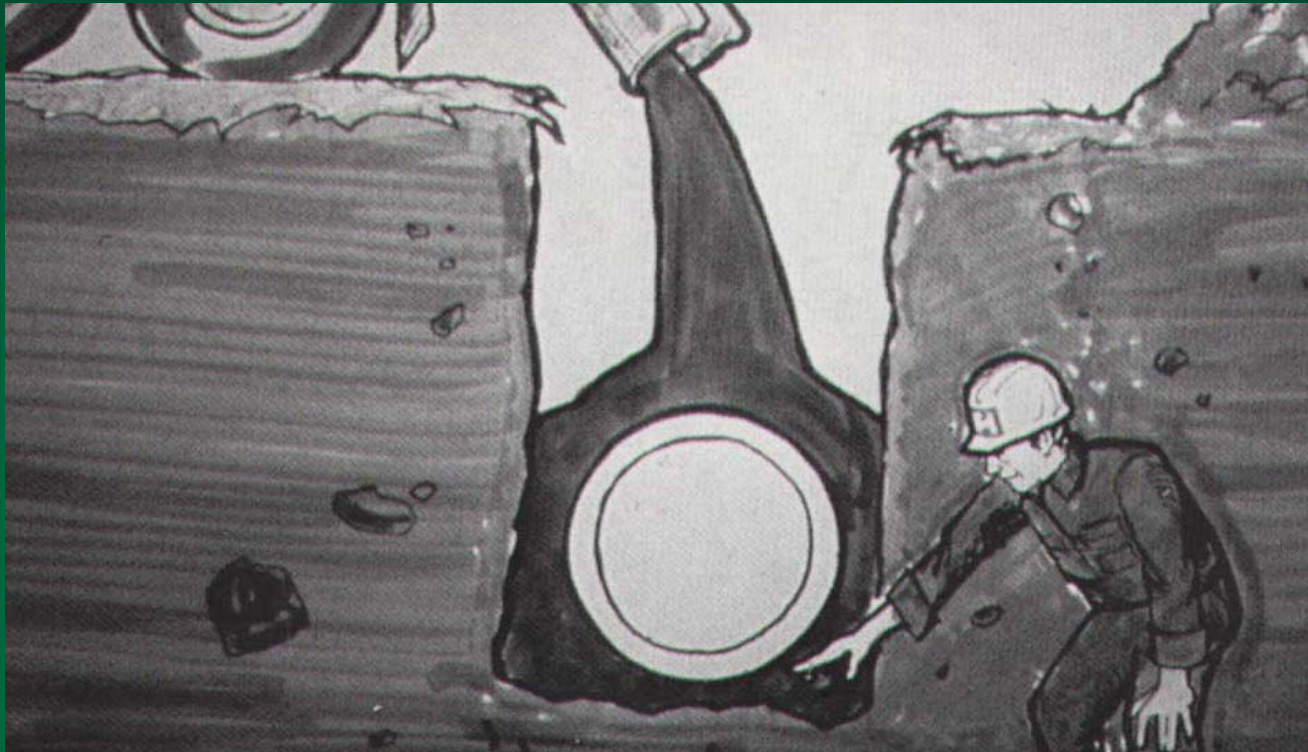


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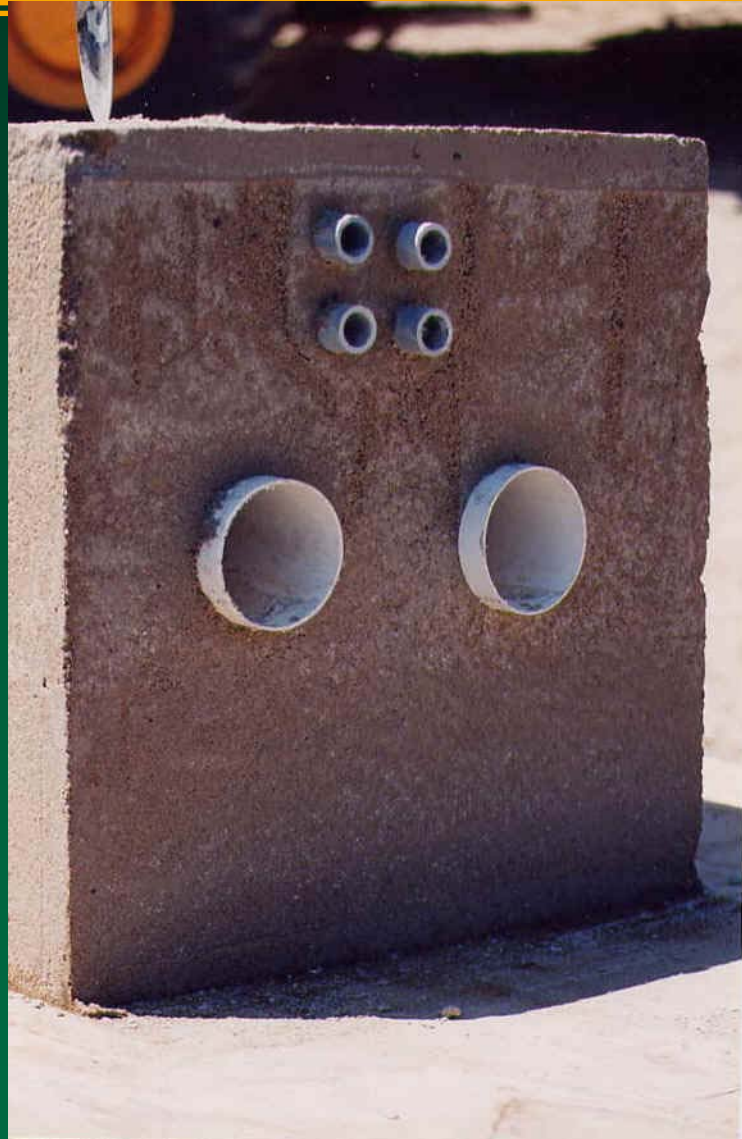


Typical Areas Which are Difficult to Compact

- Road Cuts
- Under & Around Pipes
- Underground Tanks
- Foundation Wall Backfilling



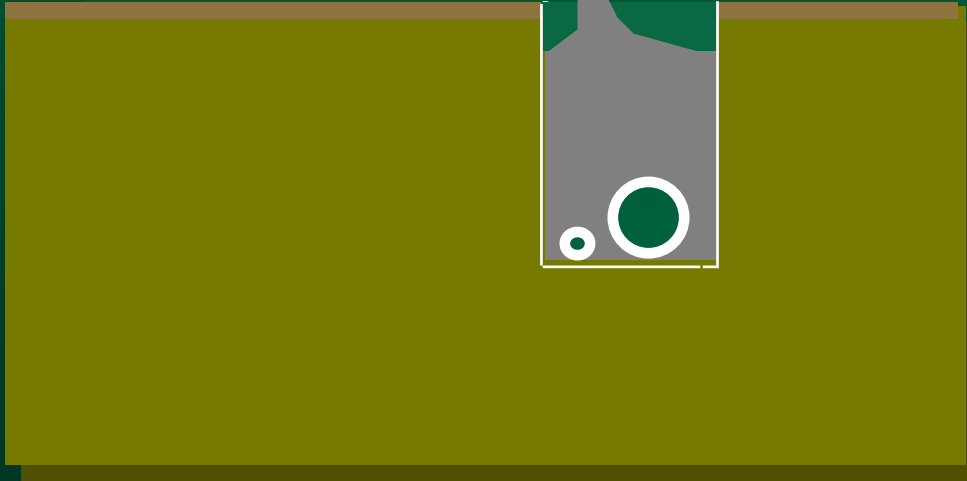
Demonstration for city of Nashua, N.H.



Fast Track Fill and Pave



- Backfill trench with CLSM to 4" below street level.
- Place a concrete overlay of 4000 PSI (28 Mpa) concrete pavement.





Comprehensive Procurement Guidelines

Flowable Fill

Flowable fill is commonly used as an economical fill or backfill in road construction. It is usually a mixture of coal fly ash, water, a coarse aggregate (such as sand), and portland cement. Flowable fill can take the place of concrete, compacted soils, or sand commonly used to fill around pipes or void areas. Other applications include filling in bridge abutments, foundation subbases, or abandoned man holes and wells. Flowable fill can help put significant quantities of coal fly ash and spent foundry sand, two types of recovered materials, back to good use.



Comprehensive Procurement Guidelines

- **Recommended Recovered Materials Content Ranges:**
- **EPA recommends that procuring agencies use flowable fill containing coal fly ash and/or ferrous foundry sands for backfill and other fill applications.** Specific content levels will depend on the specifics of the job, including the type of coal fly ash (Class C or Class F) or foundry sand used, strength, set time, flowability needed, bleeding, and shrinkage.



Specifications, Test Methods, and Practices

EPA recommends that procuring agencies use ACI229R-94 and the ASTM standards listed in the following table when purchasing flowable fill or contracting for construction that involves backfilling or other fill applications.

ASTM Specification Number	Title
D 4832-95e1	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
D 5239-92	Standard Practice for Characterizing Fly Ash for Use in Soil Stabilization
D 5971-96	Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material
D 6103-07	Standard Test Method for Flow Consistency of Controlled Low Strength Material
D 6023-96	Standard Test Method for Unit Weight, Yield, Cement Content and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
D 5971-96	Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material
D 6024-96	Standard Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application

More than 20 states have specifications for flowable fill containing coal fly ash. They include California, Colorado, **Delaware**, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, **Massachusetts**, Michigan, Minnesota, Nebraska, **New Hampshire**, New Mexico, North Carolina, Ohio, Texas, Washington, West Virginia, and

Lightweight Fill

- Low-Density CLSM
- Density (Unit Wt.) < 50 lb/ft³ (800 kg/m³)
- Up to 80% air

Typical Lightweight Flowable Fill Mix Components

Main Ingredients:

- Cement
- Water
- CLSM Air Generating Admixtures
- Foaming Agent
with
- Fly Ash
- GGBF Slag



Lightweight Fill - CLSM

Preformed foam is typically produced on-site by:

- Diluting the foam concentrate with water prior to combining it with compressed air
- Passing the mixture through a foam generator



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CLSM

- Flowable Fill
- (Regular CLSM)

- Densities $> 50 \text{ lb/ft}^3$
- 15% to 35% air content

- Lightweight Fill
- (Low-Density CLSM)

- Densities $< 50 \text{ lb/ft}^3$
- Up to 80% air content

Where Can I Get Flowable Fill?



**From Your Local
Ready Mix Producer**

IN CONCLUSION

For better quality construction,
consider using
FLOWABLE FILL
on your next project.

For Further Information-Contact:

**Northern New England Concrete
Promotion Association**

www.nnecpa.com

OR

Your local ready mix producer.

OR,,,,,



www.flowablefill.org

Questions?