TECHNICAL NOTE

Flowable Fill Backfill for HDPE Pipe

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Introduction

The use of flowable fill, also known as controlled low strength material (CLSM), controlled density fill (CDF), and slurry fill, as pipe bedding and backfill material has steadily been increasing. The term “flowable fill” encompasses a variety of fill materials that are used as alternates to compacted granular fill. The materials are comprised of mixtures of sand, Portland cement, Class C or Class F fly ash, and water. In addition, the mix is typically flowable and self-leveling at the time of placement.

Flowable fill is an alternative to conventional soil or stone backfill and has been used for unique applications and installations of pipe for some time. It has the advantage of providing excellent strength quickly while providing an easy and efficient placement system. Flowable fill has proven to be a viable alternative when stone, sand, or other backfills have limited availability or cost prohibits their use. Even with these advantages it is necessary that the fill be controlled and care taken to provide for the proper installation.

Use of Flowable Fill

The following provides some advantages and disadvantages when deciding whether flowable fill should be specified or recommended on a project.

Advantages

- Allows for narrower trench and less disturbance to the native material.
- Eliminates the need for backfill compaction.
- Ensured proper distribution of support around the pipe.
- Reduces of the amount of material excavated on a project.
- Time, personnel and equipment required to install flowable fill are typically less than that required for proper placement and compaction of conventional backfill materials, particularly fine-grained soils.
- Flowable fill may be made on-site using native soil as part of the mix where silty sands exist.
- Time and equipment required for compressive strength testing is often less than that required to test soil compaction.

Disadvantages

- More costly than granular backfill due to the many components required and specialized delivery.
- Improper mix components can cause difficult future excavation if taps or extensions are required.
- Cannot be stockpiled on site like granular backfill. Time saved during the placement of the flowable fill can be wasted waiting on ready-mix delivery.
- Unless precaution is taken, the potential for pipe flotation is high during the installation process.

Mix Design

The mix design of CLSM for flowable fill is beyond the scope of this document. However, care should be taken to make sure that the mix is designed to provide adequate strength but remain soft enough to be excavated should it be necessary to do so. A suggested range is between 50 psi and 100 psi for the 28 day strength; mixes that have 28-day compressive strengths greater than 100 psi should be avoided due to increased difficulty in future excavation, if needed. The mix design should be laboratory tested prior to installation ensure that the proper results are obtained during field batching. The field mix may also require monitoring and adjustments to maintain the proper mix and properties. These variations in the field mix can be due to many factors including water content, temperature and humidity during placement.

Installation Considerations

Environment

Flowable fill cannot be used in all temperature and weather conditions. It is recommended that the temperature be at least 40˚F and that the soil exposed to the flowable fill be unfrozen. There should be no appreciable precipitation during the first 24 hours after placement.

Joints

For flowable fill applications, the use of a watertight joint is recommended. For other types of joints, precautionary measures should be taken to prevent infiltration. With this type of joint, water can "bleed" through the joint during the fill material curing, facilitating the process. This will depend nearly entirely on the consistency of the mix design. The fine-grained materials in the fill material are not permitted to infiltrate the joint.

Placement of Flowable Fill

Trench excavation should follow normal procedures and meet all OSHA safety regulations. Trench width will be dictated by the native material strength. When acceptable in-situ material exists in the trench, like rock or other high-bearing soils, it is possible that the trench widths may be reduced to within 6-in along each side of the pipe, provided there is enough space to place and properly compact the fill in the pipe haunches. Table 1 depicts typical trench widths for a flowable fill installation. In soft in-situ materials a wider trench width may be necessary. Once the trench is excavated to the proper line and grade, placement of pipe may begin. The pipe should be laid in the trench and joined in accordance with publish recommended installation guidelines.

Table 1
Recommended Trench Widths for Flowable Fill Backfill

Nominal Pipe Diam, in. (mm)	Minimum Trench in. (m)	Nominal Pipe Diam, in. (mm)	Minimum Trench in. (m)
12 (300)	22 (0.6)	36 (900)	59 (1.5)
15 (375)	27 (0.7)	42 (1050)	66 (1.7)
18 (450)	33 (0.8)	48 (1200)	74 (1.9)
24 (600)	42 (1.0)	54 (1350)	82 (2.0)
30 (750)	51 (1.3)	60 (1500)	90 (2.3)

*AASHTO LRFD Section C12.6.6.1, 2006

It is recommended that both an anchoring system and incremental lifts be utilized during installation. Refer to Figure 1 and Table 2 below for lift recommendations. Keep in mind that the fill should be brought up evenly on both sides to prevent unbalanced forces from acting on the pipe. A waiting period should be provided between lifts, as specified by the design engineer. This time is dependent on the mix design as well as ambient temperature and moisture. The mix supplier should be contacted to determine the site-specific waiting period recommended between lifts. Compressive strength typically seen with flowable fill is 40-60 psi within one week. NOTE: The use of plasticizers or other add mixtures can greatly affect cure time and final compressive strength. For most construction projects, work can resume 4 to 6 hours after final placement. While it is recommended to place the flowable fill in incremental lifts, it should be noted, one continuous lift may be used provided flotation restraints have been properly designed and installed.

If additional backfill is to be placed over the flowable fill to reach final grade it should not be placed until the flowable fill has reached a minimum compressive strength as determined by the design engineer. Because moisture is beneficial to curing it may be desirable to place a thin layer of soil (6 inches) on top of the flowable fill section for enhanced curing.

Figure 1
Typical Backfill Structure

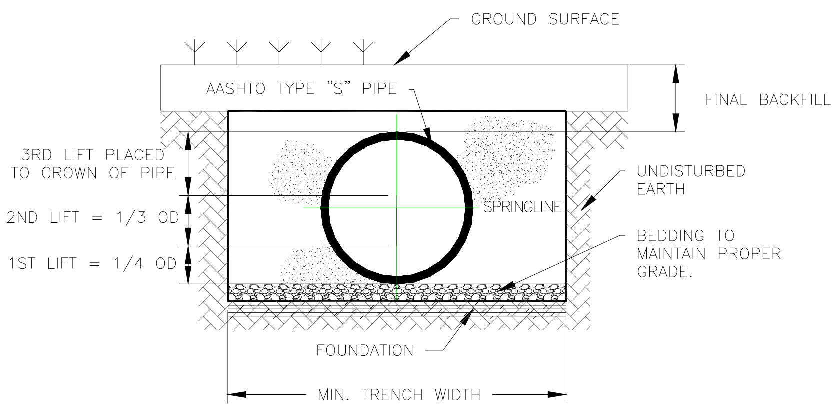

Table 2
Recommended Lift Heights

Nominal Pipe Diam, in. (mm)	1st Lift Height, in. (mm)	2nd Lift Height, in. (mm)
12 (300)	4 (101)	5 (127)
15 (375)	5 (127)	6 (152)
18 (450)	6 (152)	7 (178)
24 (600)	7 (178)	9 (229)
30 (750)	9 (229)	12 (305)
36 (900)	11 (280)	14 (356)
42 (1050)	12 (305)	16 (406)
48 (1200)	14 (356)	18 (457)
54 (1350)	15 (381)	20 (508)
60 (1500)	17 (432)	22 (559)

Anchoring Systems

Probably the greatest concern associated with flowable fill during installation is its tendency to float the pipe. Flotation and misalignment issues are extremely critical and should not be ignored. When backfilling with CLSM, the absence of soil overburden will cause the pipe to float since the pipe weight does not offset the CLSM uplift. Therefore, the pipe must be anchored to keep the intended alignment and grade. There are a number of acceptable methods for anchoring the pipe in the trench. It may be assumed that flowable fill acts as a fluid with a density of 140 - 150 lb/cu ft. prior to stiffening. When properly designed, pipe restraints should account for buoyant forces exerted by the fluid. When the fill hardens, flotation is no longer a concern.

Common methods include the use of dry CLSM placed at intervals along the pipe to hold it down, use of native material at intervals along the pipe to hold it down, or rebar placed in an "X" pattern above the pipe and anchored into the trench sidewall. Additional methods may include a pre-cast concrete swamp weight, or a commercially available screw anchor assembly. Anchor design and spacing shall be determined by the project design engineer. For other restraint options and additional technical information related to floatation, refer to Technical Note 5.05: *HDPE Pipe Floatation*.