TECHNICAL NOTE

Flowable Fill Backfill for Thermoplastic Pipe

TN 5.02
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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 adequate 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 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 sands or 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 flowable fill can vary widely. The flowable fill mix should be designed to meet all strength and flowability requirements. A suggested strength ranges 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 flowable fill should be able to flow into all voids between the pipe and the trench walls. 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 placement to initial set. Flowable fill should be protected from freezing temperatures.

Joints

For flowable fill applications, the use of a watertight joint is recommended. For soiltight joints, precautionary measures should be taken to prevent infiltration of flowable fill mix material. This will depend nearly entirely on the consistency of the mix design.

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, the trench widths may be reduced to within 6-in along each side of the pipe, provided there is enough space to properly place the flowable fill in the pipe haunch areas. Table 1 depicts typical trench widths for a flowable fill installation. 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)

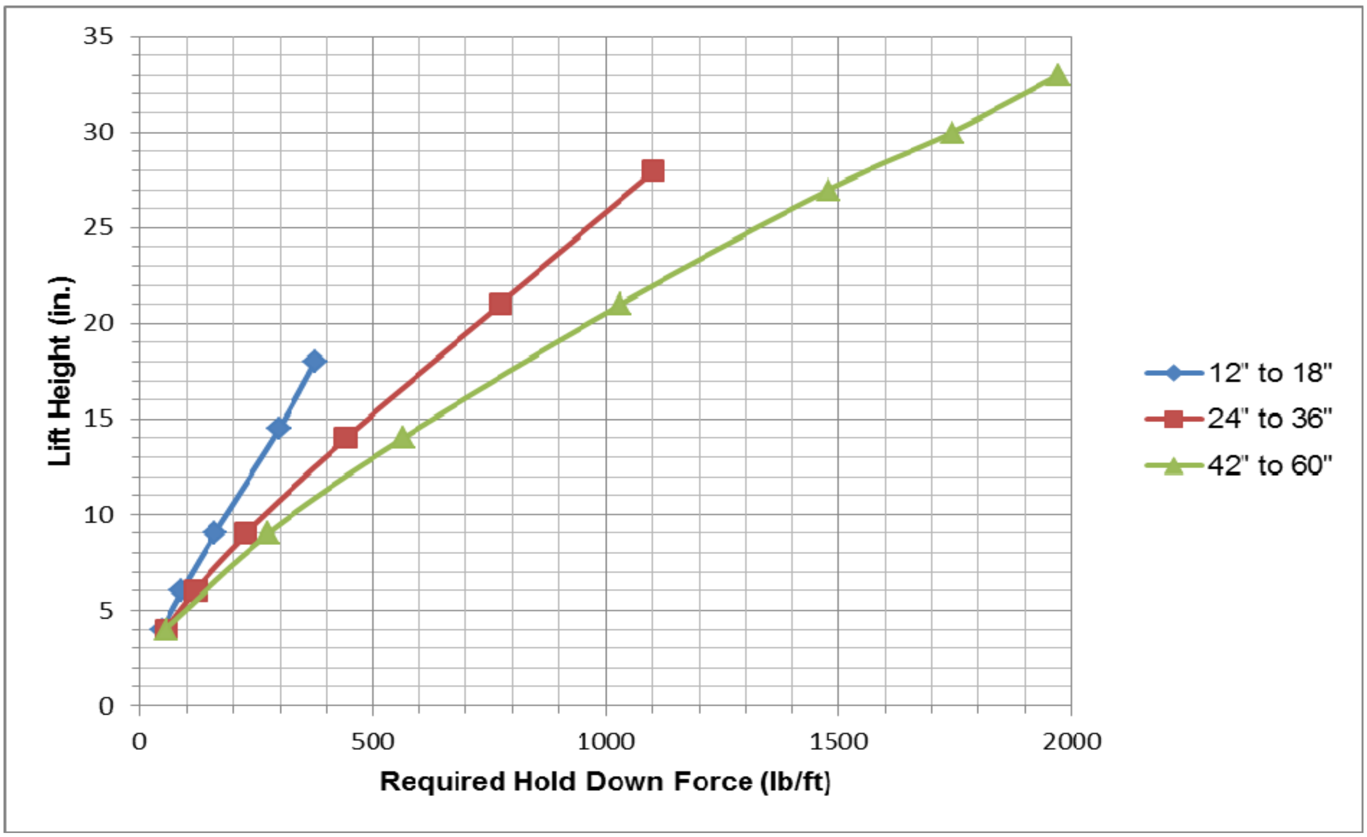
*AASHTO LRFD Section C12.6.6.1, 2006

It is recommended that both an anchoring system and incremental lifts be utilized during installation. Refer to Figure 1 below for lift recommendations and corresponding recommended anchoring forces. Keep in mind that the fill should be brought up evenly on both sides to prevent unbalanced forces from acting on the pipe. Each lift should be allowed to reach initial set, prior to placing the next lift. Time to initial set 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. NOTE: The use of plasticizers or other admixtures can greatly affect cure time and final compressive strength. 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, see Table 2 for recommendations.

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. If minimum strength is not specified or time constraints do not allow for testing of cylinders, ASTM C403 and ASTM D6024 can be referenced to determine if flowable fill has gained adequate strength.

Since 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
Hold Down Force for Incremental Lifts



*Assumes a unit weight of flowable fill of 150 pcf and no water in the pipe at time of placement

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 flowable fill, the absence of soil overburden will cause the pipe to float since the pipe weight does not offset the flowable fill 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.

Common methods include placing bags of soil or cement or heaping native material at intervals along the pipe, rebar placed in an “X” pattern above the pipe and anchored into the trench sidewall, or use of on-site construction equipment that can be left in place while curing (e.g. boom/bucket of excavator). 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: *Pipe Flotation*.

Table 2
Hold Down Force, One Continuous Lift

Full Depth Placement of Flowable Fill Backfill		
Nominal Pipe Diam, in. (mm)	Lift Height (Pipe OD), in. (mm)	Required Hold Down Force, lb/ft (kg/m)
12 (300)	14.5 (368)	186 (276)
15 (375)	18 (457)	287 (426)
18 (450)	22 (559)	429 (638)
24 (600)	28 (711)	693 (1032)
30 (750)	36 (914)	1149 (1710)
36 (900)	42 (1067)	1566 (2330)
42 (1050)	48 (1219)	2044 (3042)
48 (1200)	54 (1372)	2590 (3854)
54 (1350)	61 (1549)	3311 (4927)
60 (1500)	67 (1702)	3990 (5938)