CHAPTER 5

INSTALLATION OF REPLACEMENT PIPE

Foundation

Trench load design for all pipe is based upon a firm and unyielding foundation. It is essential that the trench bottom remain stable during backfilling, compaction, and under all subsequent trench operations. This foundation provides uniform longitudinal support to minimize differential movement of the pipeline.

Stable uniform support for the pipe is critical to the performance of the repair section of the line. The foundation must be firm and unyielding, as it needs to support the bedding, pipe, backfill, and compactive efforts.

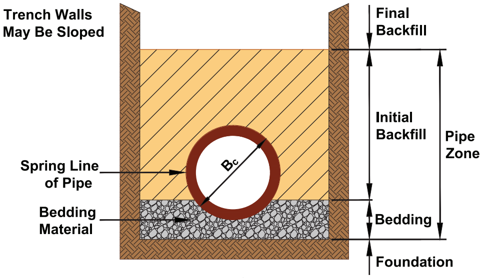

Figure 18: *Trench Cross Section (Class C shown)*

For trench bottoms above the water table, a general rule-of-thumb is that the foundation is firm and unyielding if a person can walk on the foundation without sinking into the soil or feeling it move underfoot. When an unstable trench bottom is encountered, it is necessary to over-excavate and create a firm and unyielding foundation.

Replacement with native materials, crushed rock, gravel, slag or coral are commonly used to build a foundation capable of properly supporting the bedding, pipe, backfill and compactive efforts.

When necessary, these materials can be combined with a geotextile, or the geotextile can be used in place of those materials to stabilize the trench bottom. The over-excavation depth, as well as whether a geotextile is necessary to stabilize the trench bottom, will vary according to the field conditions encountered.

Bell or Coupling Holes

Pipe are generally installed with the bells pointing upgrade. Bell or coupling holes must be carefully excavated so that the bells or couplings support no part of the load. The pipe barrel is designed to support the trench load and must rest firmly and evenly on the trench bottom or bedding material. Bell or coupling holes must be dug to ensure the pipe barrel, and not the bells or couplings, support the trench load as shown in Figure 19.

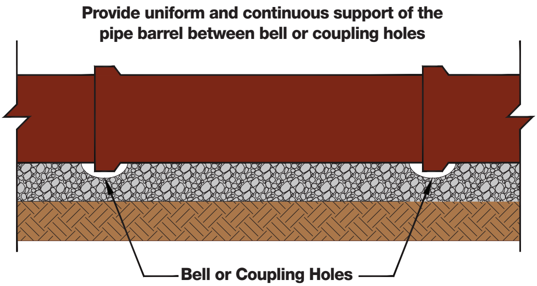

Figure 19: *Clay bell or couplings should support no part of the trench backfill load*

When properly installed, there should be room to slide a hand around the lower half of the bell or coupling before the next pipe is installed.

If a trench box is used within the limits of the pipe zone, re-excavation of the bell hole may be necessary on the last pipe laid if the bell hole is filled with bedding material as the box is advanced.

Reconnecting to Existing Pipeline

Repair Coupling Installation

Rubber repair couplings should be sized to fit the outside diameter of the existing pipe and the newly installed pipe. Vitrified clay pipe outside diameters vary by manufacturer and pipe strength designation, which correlates to the date of original installation. Measure both pipe ODs using a diameter tape measure that wraps around the circumference of the pipe and record the measured diameter to the nearest hundredth of an inch. This will confirm that the pipe OD is within the tolerance range provided by the coupling manufacturer and ensure a leak-free connection when installed.

Figure 20: *Torque wrench used for installation of repair couplings.*

Before installation, loosen all tightening bands completely but do not remove from the coupling. Loosen the bolts on the stainless-steel shield assembly (worm drive clamps) and end clamps (nut & bolt or worm drive). Do not remove the shield assembly (if equipped) or end clamps from the gasket.

Slide the repair coupling over the existing pipe end, and then insert the second pipe. Center the mated pipe ends to the midpoint of the coupling. Tighten all band clamps with a torque wrench as recommended by the rubber coupling manufacturer/supplier.

Factory Compression Joint Assembly

Compression joints should be assembled in accordance with the manufacturer's recommendations. Particular care should be taken to keep foreign materials from

Figure 21: *A finished repair coupling near a manhole.*

interfering with proper joint assembly. The mating surfaces of the joint should be clean and lubricated prior to assembly.

All compression joints are manufactured in accordance with ASTM C425 *Compression Joints for Vitrified Clay Pipe and Fittings*. Lubricate both joint surfaces, line up the bell and spigot and shove the pipe together with a steady pressure. Pipe should be in straight alignment during assembly.

For small diameter pipe, joint assembly can be done by hand or with a bar as an aid. When using a bar, care should be taken not to damage the edges of the bell or coupling. A wood block may be used to cushion the bar pressure. For larger sizes, a nylon sling, cable, or other approved device used to lower the pipe can be used as an aid in the assembly of the compression joint. Care must be taken to ensure that the joint is fully-homed.

Bedding and Haunching

Haunching of the bedding or initial backfill should be performed along the length of both the excavated portion of the existing pipe and the new replacement pipe. Haunching can be done via shovel slicing which will fill the voids and consolidate the materials in this area (see Figure 22).

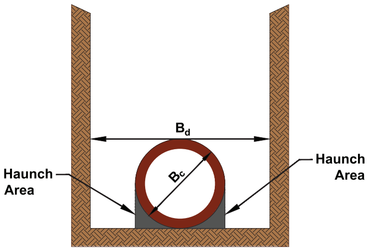

Figure 22: *Terminology*

B_c = the outside diameter of the pipe.
B_d = the design trench width measured at the horizontal plane at the top of the pipe barrel.

Shovel slicing should be done when the bedding material is no higher than one-fourth of the pipe diameter. **Shovel-slicing the bedding material in the haunch areas is critical.** It takes little time, maintains grade, eliminates voids beneath the pipe and in the haunch areas, consolidates the bedding, and adds little or nothing to the cost of the installation.

Good haunch support:

- Significantly increases the load carrying capacity of buried pipe
- Requires compacting the soil in the haunch area using a shovel, spade, or other suitable tool
- Can be attained by using CLSM (flowable fill) with the proper flowability
- Is not attained by dumping gravels and crushed rock beside the pipe
- Can be aided by pipe settling into uncompacted bedding to mobilize the strength of the haunch soil

Figure 23: *Shovel slicing the pipe haunches*

Initial and Final Backfill

The initial backfill is then carefully placed to a minimum height of 12" above the top of the pipe. This is done to maintain pipe alignment and protect the pipe from damage during final backfilling. The initial backfill should be free from large material and conform to Allowable Bedding Material & Initial Backfill per Bedding Class (Table 4) on page 29.

The final backfill extends from the initial backfill to the top of the trench. Final backfill shall be placed in lifts or stages not to exceed 10 feet when using water or as required by designated methods of mechanical compaction. Final backfill shall have no rock or stones having a dimension larger than 6 inches within 2 feet of the top of the initial backfill.

Uniform Soil Groups for Pipe Installation from ASTM C12[1]		
Soil Class	**Definition**	**Symbols**
Class I[2]	**Crushed Rock** 100% passing 1-1/2 in. sieve, </= 15% passing #4 sieve, </= 25% passing 3/8 in. sieve, </= 12% passing #200 sieve	
Class II[3]	**Clean, Coarse Grained Soils** Or any soil beginning with one of these symbols (can contain up to 12% fines) Uniform fine sands (SP) with more than 50% passing a #100 sieve should be treated as Class III material	GW, GP, SW, SP
Class III	**Coarse Grained Soils With Fines** Or any soil beginning with one of these symbols	GM, GC, SM, SC
	Sandy or Gravelly Fine Grained Soils Or any soil beginning with one of these symbols, with >/= 30% retained on #200 sieve	ML, CL
Class IV	**Fine-Grained Soils** Or any soil beginning with one of these symbols, with < 30% retained on a #200 sieve	ML, CL
Class V[4]	**Fine-Grained Soils, Organic Soils** High compressibility silts and clays, organic soil	MH, CH, OL, OH, Pt

[1] Soil Classification descriptions and symbols are in accordance with ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and ASTM D2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*

[2] For Class I, all particle faces shall be fractured.

[3] Materials such as broken coral, shells, slag, and recycled concrete (with less than 12% passing a #200 sieve) should be treated as Class II soils.

[4] Class V soil is not suitable for use as a bedding or initial backfill material.

Table 3: *Uniform Soil Groups for Pipe Installation (from ASTM C12 “Standard Practice for Installing Vitrified Clay Pipe Lines”)*

Allowable Bedding Material & Initial Backfill per Bedding Class					
Bedding Class	**Allowable Bedding Material**			**Allowable Initial Backfill**	
	Soil Class	**Gradation**	**Size**	**Soil Class**	**Particle Size**
Class D	N/A	N/A	N/A	I, II, III or IV	1"
Class C	I or II		1"	I, II, III or IV	1½"
Class B	I or II	- 100% passing a 1" sieve - 40 – 60% passing a ¾" sieve - 0 – 25% passing a ⅜" sieve	1"	I, II, III or IV	1½"
Crushed Stone Encasement	I or II		1"	I, II, III or IV	1½"
CLSM	I or II		1"	I, II, III or IV	1½"
Concrete Cradle	N/A	N/A	N/A	I, II, III or IV	1½"

Table 4: *Allowable Bedding Material and Initial Backfill per Bedding Class (from ASTM C12)*

Compaction

Compaction of the backfill material is usually required to prevent settlement of the ground surface or to support paving or structures. In areas where support of the pavement over a trench is required, compaction of part or all of the backfill material may be specified.

To achieve the specified compaction with the lowest risk and cost, the correct selection of compaction equipment and methods is necessary. Depending upon the soil type and requirements, a wide choice of compaction equipment is available.

Extreme care should be taken when using heavy mechanical compaction equipment. There should be a minimum of 5 feet of cover over the top of the pipe before any heavy mechanical compaction equipment is employed. This will tend to reduce dangerous impact loads on the pipeline. Walk behind and hand-held, light compaction equipment within the trench can be used at cover depths less than 5 feet.

Testing Newly Repaired Lines

All acceptance tests must be performed by qualified personnel.

Low-Pressure Air Test

The Low-Pressure Air Test is the most commonly used post-installation acceptance testing method because it is not subjective and allows no room for interpretation. The low-pressure air test is not a subjective test.

Complete procedures for the Low-Pressure Air Test are available online in the *Low-Pressure Air Test for Sanitary Sewers* booklet, or in ASTM C828 *Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.*

CCTV Inspection

The high-quality video and images now available using CCTV have led to wide-spread usage of these systems. The visual record created has become an important reason for many agencies to require CCTV inspections as part of final acceptance testing on newly installed pipelines. This visual record has become a useful tool in the overall assessment of the collection system. However, it may not be an option when repairing a section of a line and operators should be aware that the wheels or tracks can damage some pipe materials.

Figure 24: *CCTV wheels show evidence of damage to flexible thermoplastic pipe.*

Ongoing training for CCTV operators is also critical as unintentional errors and incorrect observations have led to unnecessary and expensive repairs. See the NCPI document *A Guide to Analyzing CCTV Inspection.*