Designation: A 798/A 798M – 07

Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications[1]

This standard is issued under the fixed designation A 798/A 798M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers procedures, soils, and soil placement for the proper installation of corrugated steel pipe and pipe-arches produced to Specification A 760/A 760M or A 762/A 762M, in either trench or embankment installations. A typical trench installation and a typical embankment (projection) installation are shown in Figs. 1 and 2, respectively. The pipes described in this practice are manufactured in a factory and furnished to the job in lengths ordinarily from 10 to 30 ft [3 to 9 m], with 20 ft [6 m] being common, for field joining. This practice applies to structures designed in accordance with Practice A 796/A 796M.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.3 This specification is applicable to design in inch-pound units as A 798 or in SI units as A 798M. Inch-pound units and SI units are not necessarily equivalent. SI units are shown in brackets in the text for clarity, but they are the applicable values when the installation is to be performed in accordance with A 798M.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 760/A 760M Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

A 762/A 762M Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

A 796/A 796M Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications

A 902 Terminology Relating to Metallic Coated Steel Products

A 978/A 978M Specification for Composite Ribbed Steel Pipe, Precoated and Polyethylene Lined for Gravity Flow Sanitary Sewers, Storm Sewers, and Other Special Applications

A 1019/A 1019M Specification for Closed Rib Steel Pipe with Diameter of 36 in. [900 mm] or Less, Polymer Precoated for Sewers and Drains

A 1042/A 1042M Specification for Composite Corrugated Steel Pipe for Sewers and Drains

D 698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3(600 kN-m/m^3))

D 1556 Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

D 2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D 2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[3]

D 2937 Test Method for Density of Soil in Place by the Drive-Cylinder Method

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this practice, refer to Terminology A 902. For definition of terms specific to this standard, refer to 3.2.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bedding*, *n*—the earth or other material on which a pipe is supported.

3.2.2 *haunch*, *n*—the portion of the pipe cross section between the maximum horizontal dimension and the top of the bedding.

3.2.3 *invert*, *n*—the lowest point on the pipe cross section; also, the bottom portion of a pipe.

3.2.4 *pipe*, *n*—a conduit having full circular shape; also, in a general context, all structure shapes covered by this practice.

[1] This practice is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.17 on Corrugated Steel Pipe Specifications.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn.

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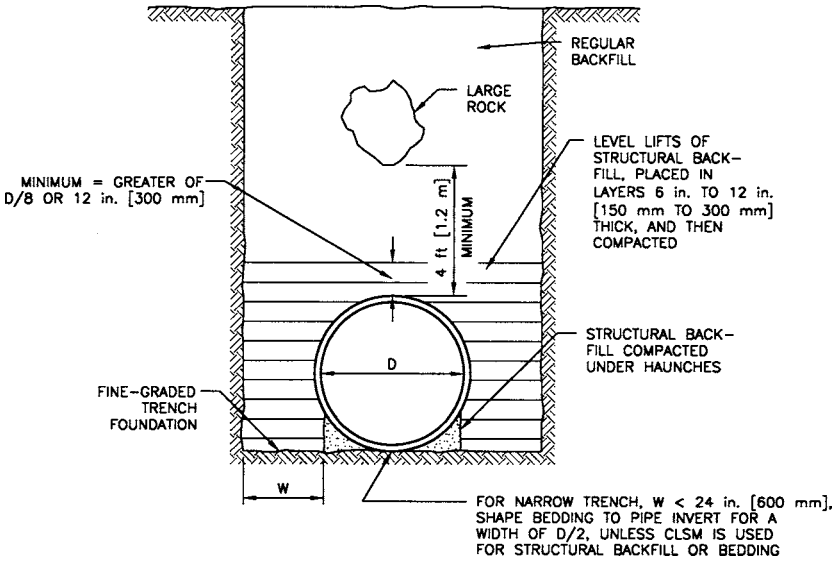

FIG. 1 Typical Trench Installation

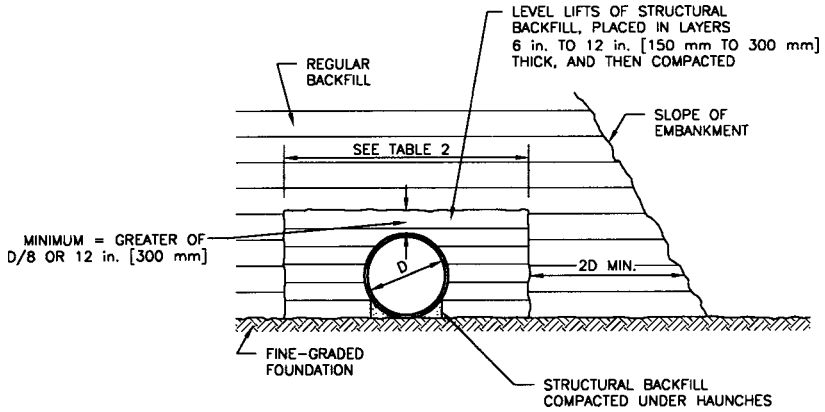

FIG. 2 Typical Embankment (Projection) Installation

3.2.5 *pipe-arch*, *n*—an arch shape with an approximate semicircular crown, small-radius corners, and large-radius invert.

4. Significance and Use

4.1 Corrugated steel pipe functions structurally as a flexible ring which is supported by and interacts with the compacted surrounding soil. The soil constructed around the pipe is thus an integral part of the structural "system." It is therefore important to ensure that the soil structure or backfill is made up of acceptable material and well-constructed. Field verification of soil structure acceptability using Test Methods D 1556, D 2167, D 2922, or D 2937, as applicable, and comparing the results with Test Method D 698 in accordance with the specifications for each project is the most reliable basis for installation of an acceptable structure. The required density and method of measurement are not specified by this practice but must be established in the specifications for each project.

5. Trench Excavation

5.1 To obtain anticipated structural performance of corrugated steel pipe it is not necessary to control trench width beyond the minimum required for proper installation of pipe and backfill. However, the soil on each side beyond the excavated trench must be able to support anticipated loads. When a construction situation calls for a relatively wide trench, it may be made as wide as required, for its full depth if so desired. However, trench excavation must be in compliance with any local, state, and federal codes and safety regulations.

6. Foundation

6.1 The supporting soil beneath the pipe must provide a reasonably uniform resistance to the imposed load, both longitudinally and laterally. Sharp variations in the foundation must be avoided. When rock is encountered, it must be excavated and replaced with soil. If the pipe runs along a continuous rock foundation, it is necessary to provide a suitable soil bedding under the pipe. See Fig. 3.

6.2 Lateral changes in foundation shall never be such that the pipe is firmly supported while the backfill alongside is not. When soft material is encountered and must be removed in order to maintain the pipe on grade during construction, it must be removed for at least three pipe widths, unless the engineer has set another limit.

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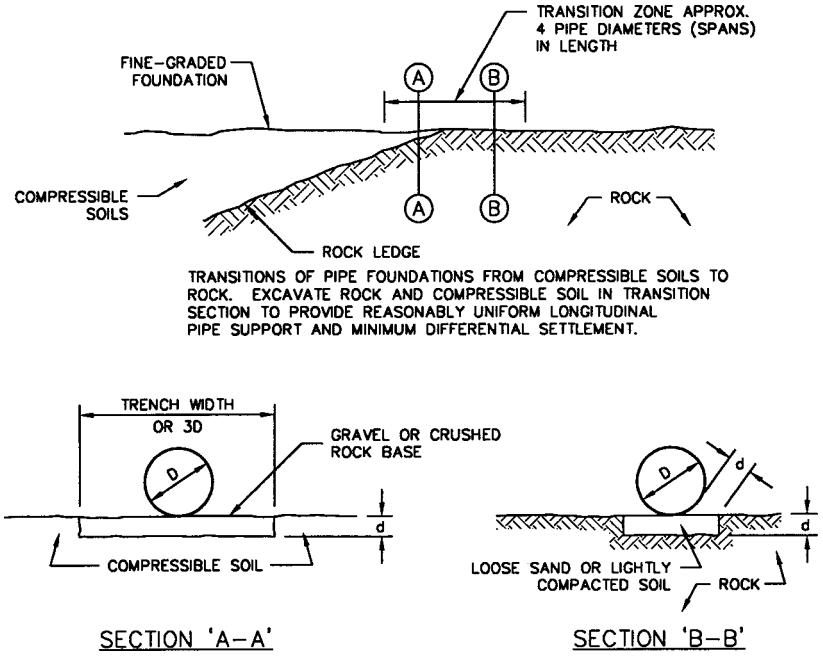
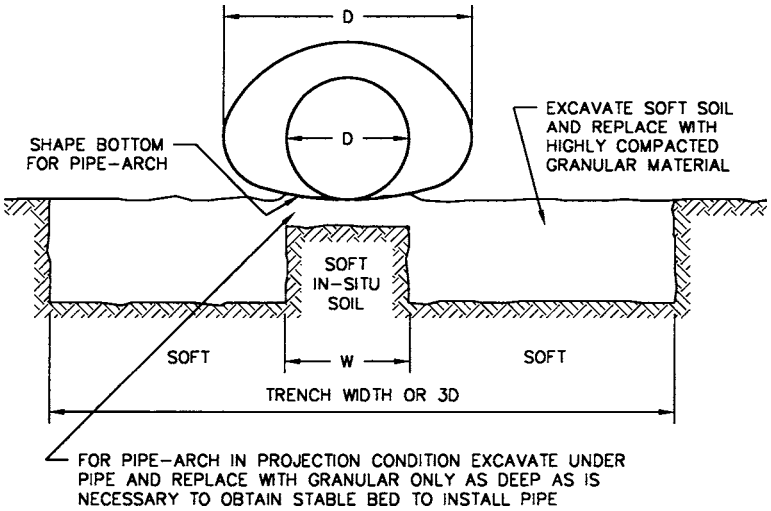


NOTE 1—d = ½ in./ft [40 mm/m] of fill over pipe, with a 24 in. [600 mm] maximum.
NOTE 2—Section B–B is applicable to all continuous rock foundations.

FIG. 3 Foundation Transition Zones and Rock Foundations

6.3 Performance of buried pipe is enhanced by allowing the pipe to settle slightly under load compared to the columns of soil alongside. Thus, for larger pipes it can be beneficial to purposely create a foundation under the pipe itself which will yield under load more than will the foundation under the columns of soil to each side. It can usually be obtained by placing beneath the structure a suitable-thickness layer of compressible soil, less densely compacted than the soil alongside. This creates "favorable" relative movement between pipe and the soil on each side. It is of particular importance on pipe-arches.

6.4 *Pipe-Arches*—All pipe-arch structures shall have excellent soil support at their corners by both the in-situ foundation and the structural backfill. See Figs. 4 and 5. They do not require the same degree of support under their large-radius inverts.



NOTE 1—$W = D$ for round pipe, and W = width of flat bottom arc for pipe-arch.

FIG. 4 Soft Foundation Treatment

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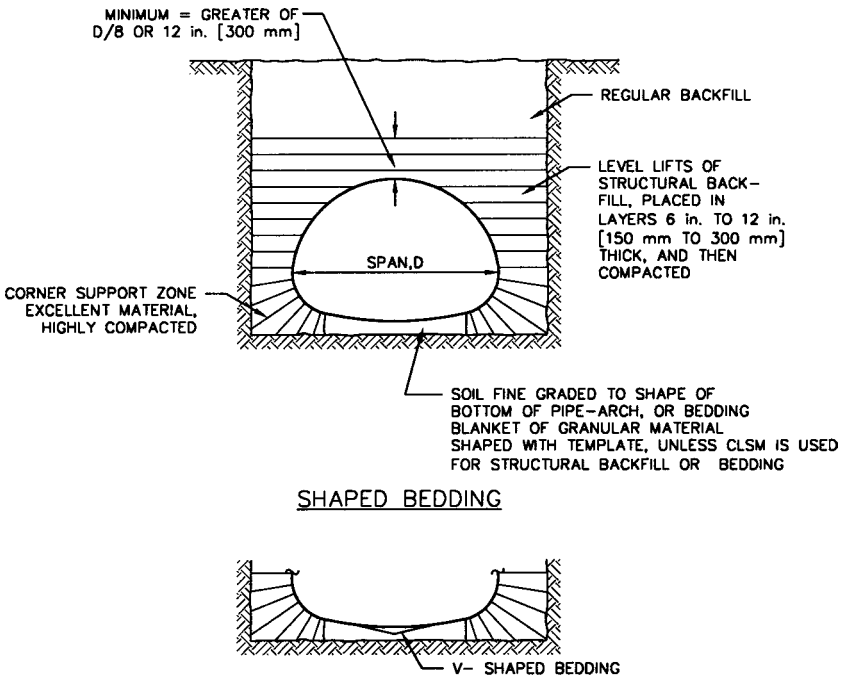

FIG. 5 Bedding and Corner Zone Treatment for Pipe Arch Structures

6.5 The engineer is encouraged to develop details specific to the site based on the general principles for foundation conditions given in 6.1 through 6.4.

7. Bedding

7.1 .Material used for bedding beneath the pipe shall meet the requirements of this section. Material in contact with the pipe shall not contain rock retained on a 3-in. [75-mm] ring, frozen lumps, chunks of highly plastic clay, organic matter, corrosive material, or other deleterious material. It is not required to shape the bedding to the pipe geometry. However, for pipe-arches, it is recommended to either shape the bedding to the relatively flat bottom arc or fine-grade the foundation to a slight v-shape. This avoids the problem of trying to backfill the difficult area beneath the invert of pipe-arches. See Fig. 5.

8. Pipe Installation

8.1 All pipe shall be unloaded and handled with reasonable care. Pipe shall not be rolled or dragged over gravel or rock and shall be prevented from striking rock or other hard objects during placement on bedding. Pipe with protective coatings shall be handled with special care to avoid damage. Paved inverts shall be placed and centered in the invert. Riveted pipe should be installed so that outside circumferential joints point upgrade.

8.2 *Joining Systems*:

8.2.1 *Purpose of Joining Systems*—Joining systems for corrugated steel pipe serve several purposes: to maintain pipe alignment during installation; to join the ends of the pipe sections that will subsequently be buried; to create a continuous flow line; to limit the amount of infiltration of backfill material into the pipe and to limit exfiltration of the flow through the pipe line.

8.2.2 *Joining System Components*—The joining system shall be specified by the project engineer. It shall conform to the requirements of Specification A 760/A 760M. The pipe fabricator shall provide the components specified for the project or as designated by the fabricator in accordance with the Ordering Information section of Specification A 760/A 760M. Conformance of the joining system components with the project requirements shall be verified upon delivery to the project site.

8.2.3 *Joining System Installation*—The performance of the pipe line and the joining system will be achieved only when all components of the pipe system are properly installed. As an integral portion of the pipe system, the joining system must be assembled in accordance with the details in the project drawings or the recommendations provided by the pipe fabricator.

8.2.3.1 *Gaskets*—If gaskets are a required component of the joining system, they shall be placed on the pipe ends, at the required location on the pipe, prior to installation of the coupler or bands or prior to stabbing a bell and spigot joint. For joining systems incorporating O-rings, the O-ring shall be placed on the spigot end of the pipe when the joint is a stab-type joining system, or one shall be placed on the end of each pipe that forms a joining system that incorporates a coupling band. If the joining system includes a single flat gasket, the gasket shall be placed over the end of the pipe previously placed and then extended over the end of the adjacent pipe after it is positioned, such that approximately half the gasket width is on each pipe. Instead of a single flat gasket, two smaller gaskets may be used with one gasket placed on each end of the pipes forming the joint. For pipe supplied with a factory installed band or coupler, no field installed gasket will be required on the pipe end with the factory installed device. When recommended by

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the pipe manufacturer, lubricant shall be applied to the designated surfaces. Once installed, the gasket shall be protected against damage until the joint is completely installed.

8.2.3.2 *Coupling Bands*—Coupling bands shall be placed on the end of the last pipe installed. When installing two part bands, the first portion of the band shall be placed to cover the bottom portion of the pipe. When the subsequent pipe is placed the installation of the joining system is completed to ensure proper alignment of the pipeline. The width of the opening between pipe ends shall be as recommended by the pipe fabricator. The band shall be tightened around the pipe ends to the extent necessary to achieve proper performance of the joining system. The band shall be placed over the pipe being joined in a manner that matches any corrugations or dimples in the band with the corrugations in the pipe. Follow the pipe fabricators' instructions and methods for tightening the bands.

8.2.3.3 *Sleeve Coupler and Bell and Spigot Joining Systems*—If a field installed sleeve coupler is utilized it shall be placed on the end of the pipe previously placed. With a bell and spigot system, the first pipe is to be oriented so the bell is open in the direction in which construction will proceed. The subsequent pipe is installed by inserting the spigot, or pipe end without the sleeve coupler, to the maximum depth permitted by the joining system. Follow the pipe fabricators instructions for the method of assembly and use of insertion force.

8.2.4 *Joint Backfill*—The joining system shall be selected based on the expected site conditions, specifically the type and gradation of backfill material. The structural backfill material used around the pipe shall be in accordance with the project specifications. Backfill material shall conform to Section 9, and shall be placed in accordance with Section 10. Care shall be exercised during backfill placement not to damage or dislodge the joining system.

9. Structural Backfill Material

9.1 Structural backfill is that material which surrounds the pipe, extending laterally to the walls of the trench, or to the fill material for embankment construction, and extending vertically from the invert to an elevation of 1 ft [300 mm], or ⅛ the diameter or span, whichever is greater, over the pipe. The necessary width of structural backfill depends on the quality of the trench wall or embankment material, the type of material and compaction equipment used for the structural backfill, and in embankment construction, the type of construction equipment used to compact the embankment fill. The width of structural backfill shall meet the requirements given in Table 1.

9.2 Structural backfill material shall be readily compacted soil or granular material with no material retained on a 3-in [75-mm] ring. Select materials such as bank-run gravels or processed granular materials with excellent structural characteristics are preferred. Desired end results can be obtained with this type of material with a minimum of compaction effort over a wide range of moisture content, lift depth, and compaction equipment characteristics. Excavated native soils used as structural backfill shall not contain frozen lumps, highly plastic clay, organic material, corrosive material, or other deleterious foreign materials. Soils meeting the requirements of Soils Groups GW, GP, GM, GC, SW, and SP as described in Test Method D 2487 are generally acceptable, when compacted to the specified percent of maximum density as determined by Test Method D 698. Test Methods D 1556, D 2167, D 2922, and D 2937 shall be used, as applicable, to determine the in-place density of the soil. Soil Groups SM and SC are acceptable, but will require closer control to obtain the specified density. Soil Groups ML and CL are not preferred materials, while Soil Groups OL, MH, CH, OH, and PT are not acceptable.

TABLE 1 Structural Backfill Width Requirements[A,B]

Adjacent Material	Required Structural Backfill Width
Normal highway embankment compacted to minimum of 90 % Test Method D 698 density or equivalent trench wall.	As needed to establish pipe bedding and to fill and compact the backfill in the haunch area and beside the pipe. Where backfill materials that do not require compaction are used, such as cement slurry or controlled low-strength material (CLSM), a minimum of 3 in. [75 mm] on each side of the pipe is required.
Embankment or trench wall of lesser quality.	Increase backfill width as necessary to reduce horizontal pressure from pipe to a level compatible with bearing capacity of adjacent materials.

[A] For pipe-arches and other multiple-radius structures, as well as for all structures carrying off-road construction equipment, the structural backfill width, including any necessary foundation improvement materials, must be sufficient to reduce the horizontal pressure from the structure so that it does not exceed the bearing capacity of the adjacent material.

[B] In embankment construction, the structural backfill width must be adequate to resist forces caused by the embankment construction equipment. Generally, the width on each side of the pipe should be no less than 1 diameter or span, or 2 ft [600 mm], whichever is less.

9.3 Special materials other than soil may be used as described in 10.1.

10. Structural Backfill Placement

10.1 Structural backfill shall be placed in layers from 6 to 12 in. [150 to 300 mm] in depth depending on the type of material and compaction equipment or method. Each layer or "lift" shall be compacted before adding the next lift. On flat bedding, care must be taken to place material under the pipe haunches and compact it firmly. Structural backfill on each side of the pipe shall be kept in balance. Generally, no more than one lift difference shall be permitted. Construction equipment shall not be used over or alongside the pipe without sufficient compacted soil between it and the pipe to prevent distortion, damage, or overstressing. Mechanical soil compaction of layers is preferred. However, when it is demonstrated that acceptable end results can be achieved with water consolidation, this method shall be acceptable, subject to the approval of the engineer. When water consolidation methods are used, care must be taken to prevent flotation. It shall be used only with free-draining structural backfill and foundation materials. If cohesive soils are used as structural backfill, good compaction can only be obtained at proper moisture content. Shallower lifts are generally required for acceptable end results with cohesive soils than with granular or mixed soils. In general, much closer inspection and testing must be exercised to ensure good results with cohesive structural backfill material. Water compaction is not acceptable with cohesive material. Unusual field conditions may make relatively costly special backfill material practical. Materials that set up without compaction, such as cement slurry, controlled low-strength material (CLSM), and various

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foamed mixtures, provide excellent structural backfill provided they are designed to yield the compressive strength required. As with water compaction, care must be taken to avoid flotation.

10.2 The compaction of structural backfill shall provide a soil structure around the pipe to uniformly apply overburden pressures on the crown of the pipe and provide uniform bearing for the pipe side walls and lower haunches. The required degree of compaction will vary with the job and structural backfill material. The structural backfill is an integral part of the design process. Therefore, required end results regarding in-place density of structural backfill shall be in accordance with job specifications. Most structural design tables for corrugated steel pipe establish maximum overfill depths based on a specified field density of 90 % in accordance with Test Method D 698 with good structural backfill material. However, the majority of sewer pipe installations do not require deep overfills. For relatively shallow buried pipes not subject to live load, an acceptable structural backfill material and its degree of compaction may be determined by the character of the adjacent ground. A "balanced design" making the conduit homogeneous with the ground on either side is often desirable. For this reason, it is not practical to establish arbitrary minimums for soil characteristics of structural backfill for all installations.

10.3 *Pipe-Arches*—Special attention must be given to the material used and compaction obtained around the corners of pipe-arches. Vertical load over the pipe is transmitted into the soil principally at the corners. Therefore, the quality of structural backfill is particularly important adjacent to pipe-arch corners. In the case of higher fills or deep trenches, special designs may be required for corner backfill zones.

10.4 Generally, construction experience and a site appraisal will establish the most economical combination of material, method, and equipment to yield acceptable end results. Test Method D 698 is the preferred means of determining maximum (standard) density and optimum moisture content. A construction procedure must then be established that will result in the specified percent of maximum density. Once that is established, direct the primary inspection effort to ensure that the established procedure is followed. Such a procedure will likely involve material, depth of lift, moisture content, and compactive effort. Only occasional checks will then be required, as long as the material and procedures are unchanged. In situ density shall be determined by Test Methods D 1556, D 2167, D 2922, or D 2937 as applicable, for field verification. Testing should be conducted on both sides of the structure. Any construction methods and equipment that achieve required end results without damage to or distortion of the pipe shall be acceptable.

10.5 *Shape Control*—Excessive compaction, unbalanced loadings, loads from construction equipment, as well as inadequate compaction or poor backfill materials, can cause excessive pipe distortion. For larger pipe, the construction contractor may set up a shape monitoring system, prior to placement of structural backfill, to aid in establishing and maintaining proper installation procedures. Direct measurement of span and rise, offset measurements from plumb bobs hanging over reference points, and similar types of measurements are effective means for monitoring shape change during backfill placement and compaction. In general, it is desirable for the crown of the pipe to rise slightly, in a balanced concentric manner, during placement and compaction of soil beside the pipe. Under the load of the completed fill and the service load, vertical deflections will be a small percentage of the pipe rise dimension if backfill compaction is adequate.

11. Regular Backfill

11.1 Regular backfill in trench installation is that material replaced in the trench above the structural backfill. In projection conditions, it is also the embankment fill adjacent to the structural backfill.

11.2 Regular backfill shall consist of native materials and shall be placed and compacted as required by job specifications. Large rocks or boulders shall not be placed within 4 ft [1.2 m] of the pipe. Large boulders are not be permitted in regular backfill in trenches that are under surface structures, including pavements. Construction equipment shall not be used over or alongside the pipe without sufficient compacted soil in between it and the pipe to prevent distortion, damage, or overstressing.

12. Multiple Structures

12.1 When two or more structures are installed in adjacent lines, the minimum spacing requirements given in Practice A 796/A 796M must be provided.

13. Keywords

13.1 corrugated steel pipe; installation; sewers; steel pipe

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