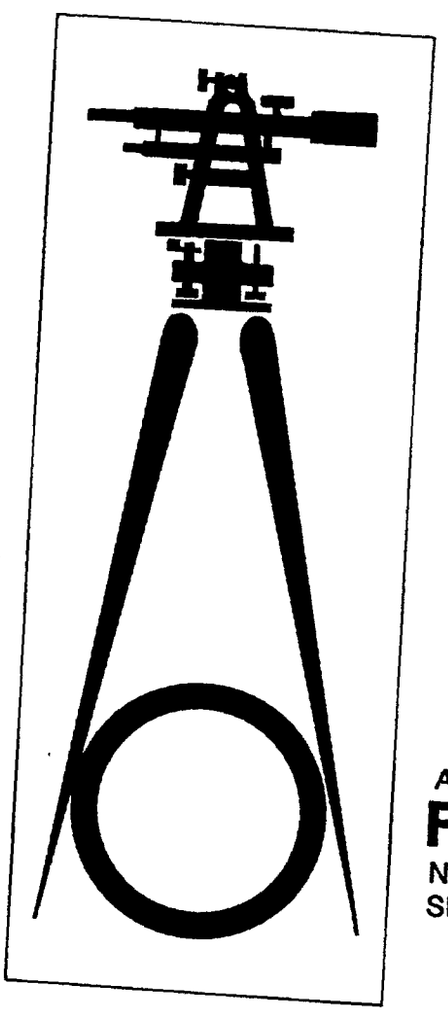
CertainTeed

PLAINTIFF'S EXHIBIT

CT-997

installation guide



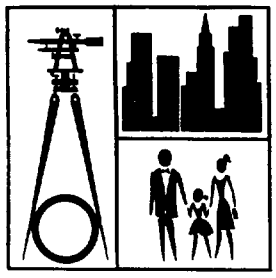
ASBESTOS-CEMENT

FLUID-TITE®

NON-PRESSURE
SEWER PIPE

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How to install Certain-teed sewer pipe



IN THIS SECTION...

Preceding Sections of this book have stressed the important role that adequate sewers play in a Growing America. As stated so succinctly, "You have to build down to build up."

Involved is more than just a question of providing the funds, the will, and the plan to assure adequate sewer construction. The consulting engineers who design the sewer systems of today must always consider the needs of tomorrow. All of the careful planning and designing that takes place prior to actual sewer construction can be for naught if the construction itself does not meet the high standards required for long, trouble-free service.

This Section will cover the installation of Certain-teed sewer pipe, as well as certain basic fundamentals applicable to all sewer construction. Modern asbestos-cement sewer pipe is designed to provide the fullest realization of the "Ten Commandments" set forth for good sewer pipe. It is, therefore, most important that the advantages built into this modern-day material be utilized to their fullest extent by proper installation.

It should be emphasized that engineering judgment in the field must be relied upon in all cases where there are conflicting theories with respect to installation. While certain basic elements of sewer construction can be enumerated, it is impossible to anticipate all of the widely varying conditions encountered in actual construction practice and to attempt to provide adequately for each contingency. However, the principles outlined in the following pages, coupled with competent "on-the-job" engineering, will assure that the sewer systems of today will become the basic building blocks for tomorrow's communities.

*Reprinted from "Sewers For Growing America" by Dr. Morris M. Cohn
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From shipment . . . to backfill

The installation of Certain-teed asbestos-cement sewer pipe really begins with the day a shipment of pipe leaves its modern factory and ends with the placement of the backfill over the installed sewer.

For this reason, it is proposed to discuss installation under several headings which will deal with this entire time span. The information that will be presented here is based on accumulated experience from countless installations in communities across the nation, which have used the specific physical characteristics of Certain-teed sewer pipe to solve on-the-job sewer construction problems.

No attempt will be made to write specific engineering standards for installation. If detailed questions arise on the design and installation of Certain-teed sewer pipe to meet the special field conditions, information of this nature will be provided gladly to consulting engineers or other engineering personnel.

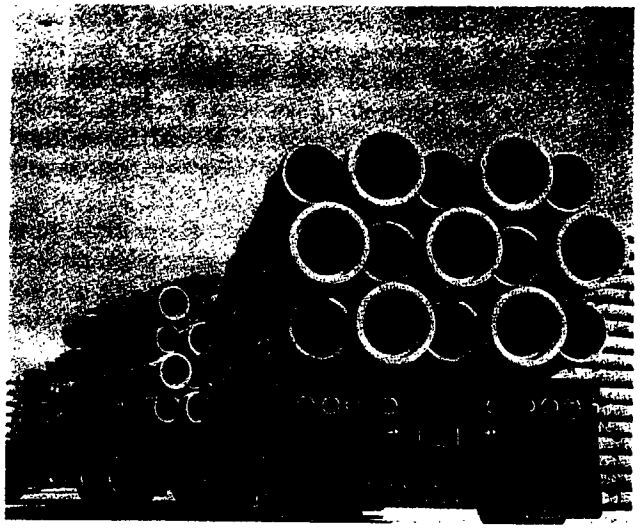
Receiving and unloading

Inspection . . . Check Packing List

In the modern Certain-teed pipe plants, sewer pipe, after manufacturing and finishing, is tested and then palletized for shipment. Before the material is placed on a pallet, the coupling for the class of pipe being used is assembled onto one end of the pipe. This assembly is done mechanically, using the same kind of gasket that will be used to make the final connecting assembly between lengths in the field.

When the pipe is ready for shipment, the pallets are loaded onto flat-bed trucks or flat-bed rail cars by means of fork lift trucks. Methods of shipment are determined by the Company. In addition to the pipe lengths and attached couplings, the shipment includes fittings and a carton or burlap bag containing the necessary gaskets and lubricant. For truck shipments, the fittings may be placed either on the top of the load or in the "box" at the front end of the trailer.

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Every shipment is carefully loaded, and the load secured with steel banding tapes to insure safe arrival at the job site. However, despite every precaution, extremely rough roads may cause shifting and damage while enroute.

The receiver should begin by making an over-all inspection of the load. If the bands or wooden braces are intact, no shifting damage has occurred. He should make sure the wooden chocks are still in place, securely fastened to each end of the stacking boards between the pipe layers.

If the load has shifted, as evidenced by broken straps or braces, inspect the load *carefully*. Each piece of pipe and accessory should be examined as it is unloaded and the truck driver should make an itemized notation of any damage on the Bill of Lading and have it *signed by the receiver*. On rail shipments, the carrier's agent should be notified and any damage should be noted on the carrier's receipt or on the inspection report supplied by the railroad and signed by the Inspector.

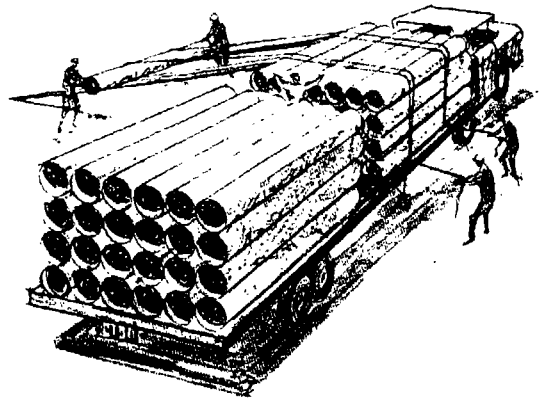
Ends which may be chipped or gouged do not indicate that the entire pipe length is unusable, as the damaged end can be cut off and re-machined in the field. If the damage extends into the machined area more than one-half inch, the entire end should be cut off and re-machined. Cutting and machining tools are readily available which make this operation a relatively simple matter.

Truck Unloading

Certain-teed asbestos-cement sewer pipe is manufactured to withstand normal field handling, but, like any pipe, it can be damaged by careless handling. Before starting, enough help and equipment should be on hand to properly handle the load. The following steps should be taken:

1. Spot the truck on level ground. Place supports of ample size on level ground so that the pipe, when stacked, will be resting on the supports and not on the ground. A support should be placed about three feet from each end of the 13-foot pipe lengths.

2. Insert a stake made from a 2" x 4" in the socket on the truck bed at a point about two feet from each end of the pipe pile to be unloaded. These stakes are placed on the side opposite the one to be unloaded.



3. Use two lengths of rope at least 50 feet long as slings. Tie one end of each rope to the stakes placed in the previous step.

4. Run the free end of each rope under the top layer of pipes, and double the rope back across the top of the load.

5. Place two sturdy skids at least 14 feet long at the edge of the pipe row to be unloaded. The top of the skids should be beveled.

6. Cut the metal straps holding the top rows. Use a hacksaw, heavy wire cutters or snips. Do not use a cold chisel. DO NOT CUT THE STRAPS WHILE STANDING ON THE PILE.

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7. For 8" pipe or smaller, station a man at one end of the pipe to start the pipe down the skids. A single snub line located at the center of the pipe is sufficient to lower the pipe down to the men on the ground. DO NOT ALLOW MEN ON TOP OF LOAD AFTER THE BANDS ARE CUT.

8. After the pipe is safely down, slide the rope out from underneath both ends.

9. Remove the two wooden chocks from the separator board between the top two rows of pipe. These chocks were left in place until now to keep other lengths of pipe in the top row from rolling off.

10. Place chocks between the next two lengths of pipe in the top row and unload the next outside length.

11. Continue in this manner until the truck is unloaded. Be sure to use the chocks to keep loose pipes from rolling.

12. Pass down extra couplings, fittings, and accessories, including burlap bag or carton by hand.

When unloading pipe 10" and larger, a crew of five men is required: One man snubbing rope at each of the two snubbers on the opposite side of unloading; one man at the end starting pipe on skid; and two men receiving pipe on the ground.

Rail Car Unloading

On large orders, delivery is often made by rail car to the nearest rail siding. Flat-bed cars are used, and the pipe is loaded in essentially the same manner as on the truck. When the car has been placed and unloading is to begin, the load should be carefully inspected. Before cutting the bands, make sure the necessary equipment to safely transfer the pipe to the truck is available.

The following steps should be taken:

1. Place the transfer truck six to eight feet from the side of the freight car.

2. Place skids from the edge of the freight car to the truck. The skids should be cleated or have a hook so they cannot slip. They should be strong enough to support the pipe being handled.

3. Heavy pipe should be handled with ropes fastened around the pipe. Use two turns of the rope around each end of the pipe to insure control as the pipe is being lowered from the rail car to the bed of the transfer truck.

4. If slings are used, use a continuous length of rope, cable or chain, fastened around the center of the pipe. This type of sling prevents pipe from slipping. A tight sling should be used because a loose sling allows the pipe to slip.

5. At times, the contractor may elect to use hoisting hooks. These should be selected so that no damage to the machined ends of the pipe may occur. A tight hook cannot be used, as it may slip and damage the machined pipe end. The open hook can be used with care, provided that the tie-in alignment to the hoisting cable is properly spaced to prevent "end-pull" against the pipe and exerts all of the force in the vertical direction.

Trucking from Storage Area or Rail Siding to Site

When moving the pipe from a storage area or rail siding to the site, some precautions should be taken to protect the pipe. The length of the truck bed should be sufficient to support the pipe along its full length whenever possible. Do not allow the pipe to project beyond the end of the truck. Prevent the pipe from rolling back and forth and banging into each other.

When a flat-bed truck is used, place two timbers across the floor of the truck about thirty inches from each end of the pipe. Nail stop blocks on each side of the timber to prevent movement.

If more than one tier of pipe is carried, use stacking boards between each tier. Secure the load with load binders, using two for each pile. Locate binders outside of and close to the bottom timbers.

Stringing Pipe

Certain-teed asbestos-cement sewer pipe with FLUID-TITE Couplings is light enough to handle and assemble easily. It is not absolutely necessary to distribute the pipe along the trench before the trench is opened, although many contractors prefer to string the pipe as it is delivered. This reduces future handling time to a minimum.

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When the pipe is being strung, it should be placed so that there is adequate room to perform the necessary excavating and other related functions. Decision must be made as to where the excavated material will be placed, so that the pipe can be on the opposite side. It is further recommended that the fittings not be strung. The preferable method is to stock them at one central location, as well as the short lengths that will be used to place them in the line.

When unloading pipe, be careful not to drop it or let it strike against another pipe. Make sure you have enough men and equipment on hand. A crew of four men is needed for 6-inch and 8-inch pipe, two on the ground and two on the truck. Handle each length separately.

Be careful not to damage the machined ends of the pipe. Scratches or chipping may necessitate cutting and re-machining the pipe end.

Short lengths of pipe, fittings, lubricant and rubber gaskets should be stored at a central point where they will be protected against loss. Keep rubber gaskets away from oil and grease, direct sunlight and excessive heat. Store in their original container in a cool, dark place.

Chain Binders

When reloading pipe, and banding is not available, chain binders may be used. Padding should be placed under the chain at points where the chain binds on the pipe. Place the chain over the area where stacking boards are placed. Do not use a pipe or other extension to increase the leverage on the binder.

The Trench

The engineer who has designed the project will specify in his plans many of the details pertaining to the construction of the trench. He will provide construction stakes for the alignment and grade directly, or reference stakes from which this information can be obtained. In addition to the line and grade data, the engineer will also specify the width of the trench to be provided at the bottom where the pipe is to be installed. It is most important that the installer follow carefully the data which the engineer provides,

as deviations can cause serious consequences. Variations from grade, for example, can cause shoaling and future maintenance problems. Excessive width of trench at the bottom not only requires extra excavation for the contractor, but it can affect the earth load imposed upon the pipe.

The contractor must take such precautionary measures as are necessary to assure the protection of other existing underground structures. In the case of other utilities, adequate maps are usually available showing their location. Utility companies are willing to locate these structures for the contractors to avoid possible damage. It is the responsibility of the contractor in following out the engineering design to minimize surface inconvenience due to construction, storage of materials, moving of equipment, and other facets of the sewer project. This is particularly true in built-up sections where disregard of these practices could cause extreme inconvenience for residents.

Excavating

It is not the intention of this Section to discuss the relative merits of the various methods that can be used to excavate the sewer trench. The contractor must determine the suitability of various types of equipment based on the depth of the trench, soil conditions, and availability. Trenching machines, where adaptable, provide a dependable and rapid method of trenching. A backhoe in the hands of a skillful operator also provides an efficient trench excavating method. Because of its ability to reach to substantial depths and maintain trench widths with straight sides, it is a highly favored piece of equipment. Draglines are sometimes used for large sewer pipe installations, particularly where the sides of the trench are required to be sloped to eliminate the need for sheeting and bracing.

In any event, whatever type of equipment is used, the contractor should attempt to separate the soil for later backfilling. In some areas, it may be impossible to obtain suitable backfill material on the site. In these cases, the engineer will specify that accessory material be brought in for this purpose. In many areas, since the depth of the trench is an average six to eight feet, various soil layers may be encountered. Part of this material may be suitable for use in bedding the pipe and backfilling around

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it. The contractor should endeavor to classify excavated soil and preserve the usable portions for fill purpose.

When the sewer line and grade have been established, the contractor may then begin excavating; it is normal for the excavation to proceed in the opposite direction to that of the sewage flow. There is a good basic reason for this procedure, because the trenching equipment normally moves the bucket toward the cab of the machine. In this movement, excavation produces a shallower trench depth the closer the bucket gets to the machine. Since the sewage flows by gravity from a higher to a lower elevation, this natural tendency assists the contractor in following the established grade. While the excavation is proceeding, the contractor should constantly check the grade line to avoid an uneven trench bottom. This careful attention to the work being done by the trenching machine will subsequently pay off in the faster dressing of the trench bottom to meet the requirement specified by the engineer. Every effort should be made by the contractor to keep the width of the trench as narrow as possible in order to provide minimum loads on the installed pipe, while at the same time assuring adequate room for the workmen to install the pipe.

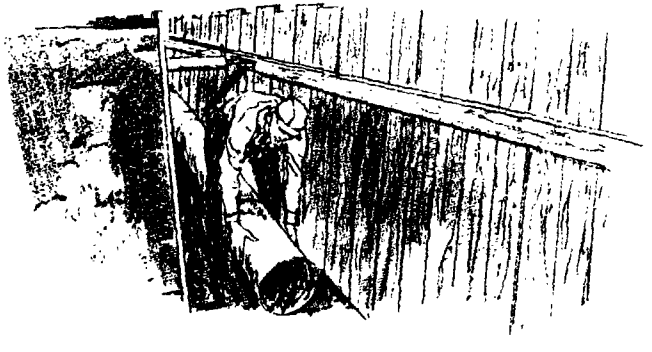
If the engineer approves and conditions permit, the contractor may wish to slope the sides of the ditch to eliminate the need for sheeting and bracing. Where this is done, the contractor should maintain a narrow trench width in the lower portion of the ditch so that the pipe itself is in a trench not wider than that specified, with vertical sides extending a foot to a foot and a half above the top of the pipe. While the vertical height of 1 to 1½ feet above the top of the pipe is not critical insofar as establishing the ultimate dead load on the sewer pipe applied by the fill, it does provide a good workable depth for the contractor and eliminates the danger of the pipe moving laterally during backfilling.

Sheeting and Bracing

Sheeting and bracing practices can not be covered in any detail in a Section of this nature, because the methods to be used and points where it is required will vary from sewer job to sewer job. In some areas, bracing is all that is needed, and in others continuous sheeting should be

employed. Many states regulate this practice, and the contractor must familiarize himself with existing safety regulations. In other cases, the engineer may specify this procedure, particularly in the case of continuous sheeting, in order to reduce the danger to workmen and to reduce soil loads ultimately applied to the pipe. The contractor must, obviously, include additional cost factors in his bid, depending on the type of sheeting and bracing required. On some jobs, the need for bracing may constitute only a minor part of the entire trench length, whereas in others every lineal foot of the trench must be braced or sheeted to prevent caving.

It would be prudent to point out that removal of sheeting extending below the top of the pipe can cause a change in the lateral support offered by the backfill. It is good practice, where sheeting is to be reclaimed, to have it cut prior to backfill above the top of the pipe, so that the portion extending down to the bottom of the pipe can be permanently left in place



A more recent method of installation has been adopted by many contractors to eliminate the necessity for both bracing and continuous sheeting in many cases. In this method, the contractor constructs a steel shield of sufficient width and height to cover the majority of pipe-laying requirements. This steel box, which is open top and bottom, need not have a vertical height great enough to cover all trench depths. Instead, the top of the trench in very deep excavations can be sloped to the point where the height of the box will project sufficiently to insure the safety of the workmen. The box then is pulled along by the excavating equipment into the area which has just been excavated.

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Behind the box, backfilling should be continuous and sufficiently completed to insure against sudden cave-ins that can produce heavy crushing blows on the installed pipe. With the long lengths of asbestos-cement sewer pipe, when using a steel box it is usually necessary only to complete one joint before the box is pulled ahead to a new location.



Well Pointing

In some areas the ground water table is so high that special problems are added to the installation of sewer mains. In such areas, before trench excavation can be started, the trench must be dewatered. Several methods can be utilized for this purpose.

Excessive trench water can be removed by properly constructed underdrains. At times these drains may take the form of French drains constructed from granular materials, such as crushed stone or gravel. In other cases, perforated pipe, strategically placed and graded, can be used to remove the water from the trench area. In this method, care must be exercised to handle the drainage water at the discharge end of such drains.

Probably the most common method used to dewater a sewer trench is the well point system. Well point equipment is available to the contractor from various sources. Since much of this equipment is somewhat expensive, many contractors rent the facilities or subcontract the well pointing job to someone in the area who specializes in this type of work.

In the well point system, perforated pipes are normally driven or jetted into position along the trench line, to a depth of about one foot below the trench bottom. The tops of these pipes are provided with connections which allow them to be connected to a single header pipe. A suction pump is then installed on the header to dewater the soil through the perforated pipe. Here again, the point of discharge must be carefully chosen to provide for the disposal of the water. Well points must be placed a sufficient distance from the center line of the trench to provide the proper amount of room for the excavation work and the laying of the pipe. While well pointing is expensive, its cost is often justified by the fact that its use can eliminate continuous sheeting and prevent expensive and damaging trench cave-ins.

It should be pointed out that the removal of the water from the trench is not required to satisfactorily complete the jointing procedure with Certain-teed sewer pipe. The joining of the pipe can be accomplished with the utmost degree of tightness even when it is completely covered by water. However, the presence of water in the trench bottom, while not interfering with the joint procedure, does pose other installation problems.

Installing Certain-teed Sewer Pipe

Certain-teed sewer pipe is available in five crushing strength classifications. The design engineer uses these five strengths as required by the loading conditions in a judicious manner so as to provide the taxpayer with economies of purchase. He must specify certain types of trench bottom preparation to enhance or add to the supporting strength of the sewer conduit. Although he has provided reasonable safety factors in the design, the load-bearing calculations can be negated or impaired by lack of attention to the method of preparing the trench bottom.

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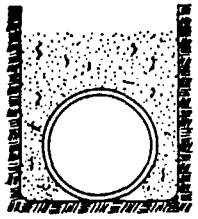
Much work on the theory of trench loading has been carried out by Marston and further expanded by Spangler, which subsequently led to the development of the Marston formula. This formula is the recognized method of computing the loads imposed on sewer conduits by the various factors encountered in trench backfilling and the live load.

It is not advisable to analyze the various factors of the Marston formula in this Section, because these data are available from other sources. However, as part of Marston's work, factors were evolved which when multiplied by the three-edge bearing strength of pipe will provide what has come to be known as the "Safe Supporting Strength" of sewer conduit. This multiplication results in a direct evaluation of the pipe's ability to withstand crushing loads, but it does not provide for a safety factor. The addition of such safety factors as are considered necessary and practical is left to the discretion of the design engineer.

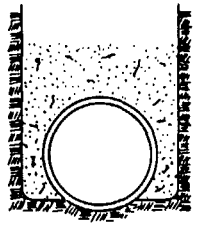
The safe supporting strength is what might be called the pipe's basic strength ability. It represents the laboratory strength of the sewer conduit and the way in which it will be bedded in the field. This strength should not be confused with the "working strength" of the pipe which is the safe supporting strength times the engineer's chosen safety factor. The Water Pollution Control Federation Manual of Practice Number 9 recommends the use of a safety factor of 1.5 for rigid conduits.*

In the work by Marston and others, bedding is divided into four types. The researchers demonstrated that these various types could be represented by "Load Factors" to supply a mathematical interpretation of their function. The load factor, when multiplied by the three-edge bearing test load, provides the so-called "Safe Supporting Strength" in pounds per linear foot. These four types of bedding are defined as follows:

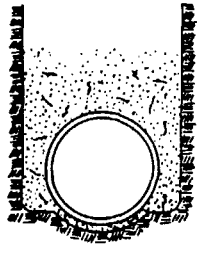
*This Manual was jointly prepared under auspices of the American Society of Civil Engineers and the Water Pollution Control Federation.



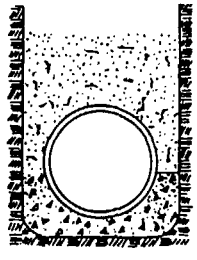
Impermissible Bedding: In this method, little care is used to shape the foundation of the ditch to fit the bottom of the pipe, or to backfill carefully around the pipe and tamp this material. The Load Factor equals 1.1.



Ordinary Bedding: In this method, "ordinary" care is used to shape the bottom of the trench under the pipe for a distance of one-half the diameter of the pipe with granular materials placed by hand and tamped to insure reasonable compactness around and over the pipe. The Load Factor equals 1.5.



First Class Bedding: This is the method whereby the pipe is placed on fine granular materials, carefully shaped to fit the bottom of the pipe for a width of at least 60% of the pipe diameter, and the backfill is placed by hand in six-inch layers to a depth of at least one foot over the top of the pipe and thoroughly tamped on each layer to insure good compaction around and over the pipe. The Load Factor equals 1.9.



Concrete Cradle Bedding: In this method, the bottom of the pipe is bedded in plain or reinforced concrete of suitable thickness, as determined by the engineer, and extended upward on each side for a greater or lesser proportion of its height. The Load Factor equals 2.2-3.4.

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Manual of Practice Number 9 of the Water Pollution Control Federation identifies these four types of bedding by classes, namely, Class A, B, C and D, and gives a more complete description of the construction methods.

The description of the various bedding methods and the accompanying changes in load factor shows how important the preparation of the trench bottom is in providing the proper conditions to insure long service for the sewer conduit. Certain-teed does not recommend the use of trench bottom preparation which would fall under the category of "Impermissible Bedding." As a matter of fact, it would be preferable in all cases to attempt to obtain "First Class Bedding" conditions. Contractors and design engineers should give careful consideration to employing this method, as it can actually result in economies of installation and will provide a better bedding and supporting condition for the sewer conduit than any other method except concrete cradling.

With today's modern excavating machines and the speed with which they can be operated, it is an obvious economy to use this equipment in preference to hand labor, wherever possible. In many sewer installations, depending on local availability of material, the contractor will find it less expensive to undercut the trench bottom and bring it back to proper grade by use of granular materials hauled to the trench site. These granular materials can be placed in the trench by mechanical means and can be easily shaped by hand to provide a satisfactory trench bottom that will provide full and continuous support for the pipe length. More and more engineers are specifying this method as they realize the additional expense, if any, is extremely nominal and provides for a much more satisfactory installation.

Assembling Certain-teed Pipe

The actual pipe assembly in which two lengths of Certain-teed sewer pipe are coupled together is probably the most simple of all of the operations to be encountered in installing the sewer conduit. Every attempt has been made to simplify the procedure and to reduce to the barest minimum the factors which could lead to an error in joint construction. The use of asbestos-cement sleeves and rubber gaskets, installed over finely machined surfaces, eliminates the possibility of infiltration and assures the contractor of a tight joint. This feature alone can save the contractor many dollars of unnecessary expense when it comes to passing the test procedures which the engineer will insist upon in his specifications. And it can assure the design engineer and the municipality of the most effective sanitary sewer system.

Certain-teed sewer pipe, by virture of its light weight, will, in most sizes, permit the use of manual labor to lower the pipe in the ditch. In the larger, heavier sizes, the pipe can be lowered by use of slings or snaphooks attached to the end of a backhoe, where available, or by means of auxiliary trench-side equipment. When the pipe is lowered by hand, two men, each equipped with ropes, should be used on each length. When a thirteen-foot pipe is secured only in the middle, it is not easily controlled by only one man, and it could cause injury to the workmen in the ditch.

While the pipe is being lowered, the spigot end should be inspected to insure cleanliness. Any debris, mud or other material that may have become attached to the machined surface of the spigot end can be removed readily at this stage of the operation. Likewise, an inspection should be made of the interior of the pipe and the "pre-belled" end of the pipe. Cleanliness of the interior of the pipe barrel is highly important to prevent future maintenance problems, and any foreign matter should be removed before assembling. The pre-belled end of the pipe should be checked to make sure that no stones, dirt, or other materials have gotten into the ring groove into which the rubber gasket will be placed. Many contractors prefer to perform this inspection and install the remaining rubber gasket on the top of the trench before lowering it into position. While the choice of methods is one of preference, it is necessary that a careful inspection of the coupling and spigot end be made.

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At the time that the pipe is lowered, the trench bottom which will receive this pipe section should already be prepared and brought to such a grade that when the pipe thickness is laid on the trench bottom, the invert of the pipe will be at the prescribed grade. Likewise, the coupling holes should have been provided so that the pipe cannot rest on the outer portion of the coupling. Too small a coupling hole is not desirable, nor should the coupling hole be excessively large. In the one case, the men need sufficient room to line up the pipe ends without getting them into the dirt on the bottom, while in the other extreme, too large a hole can be left improperly backfilled upon completion of the joint and result in stresses being set up at that point.

The pipe, on delivery from the factory at the job site, arrives with the coupling assembled on one end of the pipe, using one of the two FLUID-TITE gaskets that will be used in the final assembly. Before or after lowering the pipe into position and after the groove has been checked for foreign material, the remaining gasket, which arrived at the job site on the truck either in a bag or a carton, should be inserted into the groove.

An examination of the FLUID-TITE gasket will reveal that the gasket is tapered, and on its flat side will have equally-spaced indentations. These indentations should be placed so that, after the gasket is installed in the groove, the indentations will face to the center of the coupling. The gasket and groove are so designed that when the gasket is properly placed, it will expand slightly and more or less "snap into" the groove. By running fingers around the installed gasket, it is possible to immediately feel if the gasket is properly seated. If the gasket bulges upward at any point, it should then be removed and a check made of the groove for foreign matter which prevents the gasket from resting in its normally flat position.

When the pre-belled end of the pipe and the spigot end of the entering pipe are on grade and in alignment, the lubricant supplied with the pipe should be applied. The lubricant arrives on the site packed in cans. It is important, when working around and in the trench, that adequate precautions be employed to prevent dirt, sand and other debris from getting into this can or onto the lubricated surfaces. It is suggested that the top of the can be replaced lightly between each use to insure cleanliness.

The lubricant should be applied to the spigot end of the pipe so as to provide an even coating over the *entire* machined area, as illustrated. Likewise, lubricant should be applied to the surface of the gasket which was field-inserted into the coupling. Application of this lubricant can be accomplished by the use of the hand, rag, or paint brush. The lubricant must completely encircle the pipe. Unlubricated spots could cause enough friction to cause the gasket to pull upward and out of the groove.

After alignment, insertion of the gasket, and lubrication, the assembly is completed by simply pushing the pipe home. In many sizes, and, depending upon the trench bottom, the pipe can be pushed home by hand. In larger sizes, or where more leverage is required, a bar and block of wood can be used. The bar is inserted into the ground at the end of the length and the block of wood is inserted between the bar and the pipe end to protect it against damage as the pipe is pushed home using the leverage of the bar.

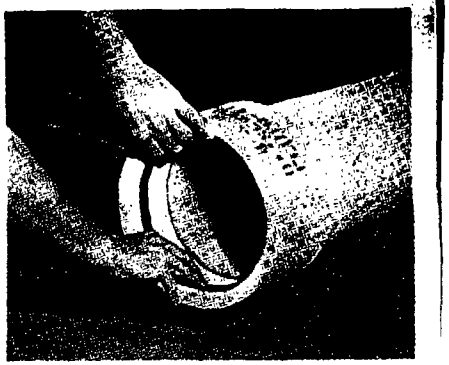
In the very large sizes, the contractor may elect to leave the pipe attached to the machine which lowered it into the trench. After the pipe is lubricated and guided by the workmen, a movement of the mechanical equipment in the direction of the assembly will allow the pipe to be pushed home. It is never necessary to use a great amount of force to assemble Certain-teed sewer pipe. If excessive pressure is required, the assemblers should immediately stop the assembly, pull back the entering pipe and check the gasket and coupling area for foreign materials.

Certain-teed pipe is designed to provide automatic, pre-arranged end separation of the pipe lengths within the couplings. This separation allows for expansion and contraction and also provides a degree of flexibility which is invaluable in resisting and minimizing any earth movements at and around the pipe. Likewise, the rubber gaskets provide the sewer with cushioned flexibility. They act as vibration dampeners at the same time that they provide the tightest possible seal. To make a satisfactory assembly, therefore, the entering pipe should be pushed all the way into the coupling until it can go no farther. On the opposite end of the coupling, there is provided a CERTA-SPACER band to absorb any future linear expansion. This band is a crushable PVC compound especially prepared to resist the thrust of assembly while offering token resistance to the force of linear expansion.

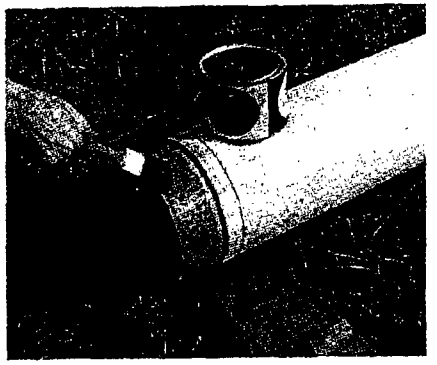
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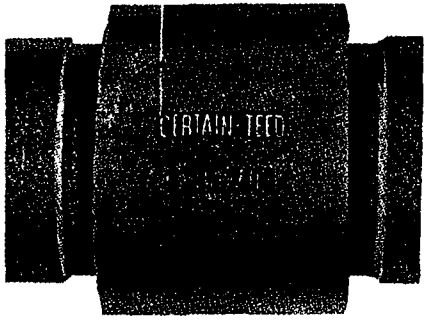
1. CLEAN GROOVE



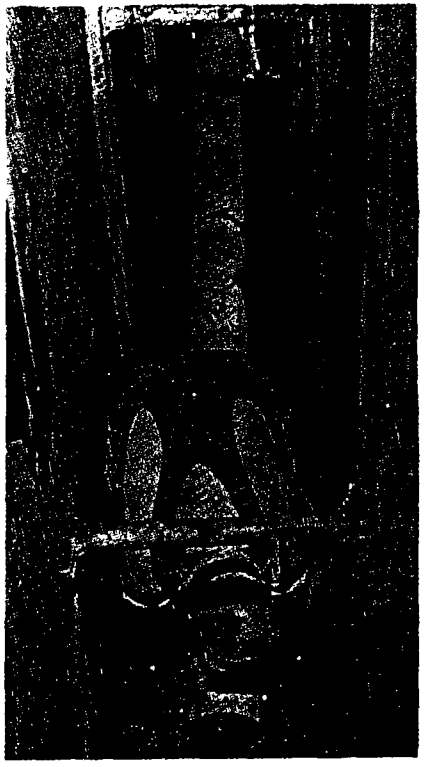
2. INSERT FLUID-TITE GASKET



3. LUBRICATE PIPE



4. PUSH PIPE HOME



CAUTION | Asbestos cement pipe contains asbestos fibers. Do not cut or machine without protection. Breathing asbestos dust may cause serious bodily harm.

House Connections

While installing a street sewer, it is necessary to provide the means whereby the users of the sewers can be connected to the main conduit. The number and frequency of these connection areas will vary greatly, depending upon the type of area through which the sewer main passes. In heavily populated urban areas, these connections are frequent and often two are made at or near the same point of entry into the sewer main. In the suburban areas, these connections are often far apart, depending upon the size of property lots.

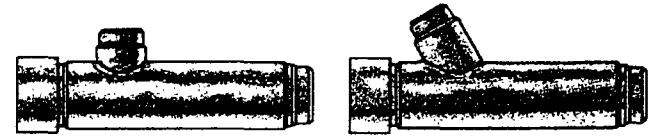
It is the purpose here to discuss only that portion of the house sewer that is included within the public right-of-way. The portion of the house sewer that is laid within the individual property line is regulated by some local code or one of several more encompassing codes. At any rate, it cannot be overemphasized that all of the house sewer connections, whether in the public right-of-way or on private property, should be constructed with the same care and attention to detail as that given to the public sewer. Where extreme infiltration is encountered, house connections are often a major contributor to the high flows.

Certain-teed asbestos-cement wyes and tees are available to provide the necessary connections for the house laterals. These connections are provided in the normal I.D. range of 4", 5", and 6" to cover the average domestic or commercial installation. Larger sizes are available to provide connections from industries, commercial establishments, schools or other major installations. However, most engineers prefer to use a manhole for large diameter connections. Certain-teed wyes or tees come complete with the FLUID-TITE coupling assembled on the end that will receive the sewage flow.

The proper fitting can be assembled into the line at any designated or designed location, employing the same techniques of assembly as were used for the individual pipe lengths. The location of the fitting is further facilitated by making available half-lengths and quarter-lengths in limited quantities, as required by the contractor. In almost every case, by combining the standard length and one or more of the short lengths, exact placement can be accomplished. If, however, this cannot be accomplished, it is extremely simple to cut and machine the sewer pipe right at the job site.

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The ease of working with this material is further demonstrated by the fact that these operatons usually can be done entirely by hand. Various cutting tools are commercially available, but in lieu of such a device, the pipe can be cut by easily obtainable saws. A two-man buck saw has often been used for this purpose. However, when a contractor will be installing a large job or many jobs, he will probably find it to his advantage to procure one of the commercial cutting tools. Likewise, the machining tools which are readily available through various contractor supply companies can provide the contractor with excellent field-machined ends.



Certain-teed wyes and tees are provided with spurs of asbestos-cement for connection to house lateral pipe of the same composition. Since this lateral pipe in 4", 5", and 6" diameters is available with rubber gasket joints, assembly is easy and water-tightness of the entire installation is assured. Various fittings are available to provide for almost any type of connection from the main to the property line. Furthermore, other fittings are available to complete the house connection with asbestos-cement building sewer pipe right up to the exit of the sanitary sewer of the building. If, however, pipe of a different material is to be used for the house connection, Certain-teed building sewer adaptors are available to permit a simple connection.

Cast iron branch connections are available to provide entry into asbestos-cement sewer mains. These vary somewhat in design, but most are equipped with a groove to permit the use of the same rubber gasket as is used in connecting asbestos-cement pipe ends. Some of these fittings bolt directly to the wall of the pipe, while others are applied by means of non-corrodible straps over the outside of the pipe wall. Assembly is accomplished by using the fitting as a template to inscribe on the pipe surface the necessary opening and then removing this portion from the pipe wall. This can be accomplished in several ways,

including the use of commercially available machines which can cut the hole into the wall of the pipe. After the hole has been cut, the gasket material is placed around the hole, and the fitting placed over the gasket to produce a water-tight connection. Following this, the fitting is tightened by the appropriate means. These cast iron branch connections, while infrequently used during initial construction to provide for lateral connections, are widely used to provide outlets at a future date in currently undeveloped areas through which the sewer pipe is laid.

At the time that the sewer main is being laid and fitting connections are being installed, certain precautions should be taken. First of all, every attempt should be made to prohibit the entrance of foreign material into the opening. If the lateral is not to be connected at that time, the spur should be protected by means of an asbestos-cement end cap or by a plug inserted into the end of the spur. For later connection, the exact location of these fittings should be marked by a stake or suitable device, so that subsequent installation of the laterals will in no way damage the projecting spur. If the connection and extension to the curb are made during initial installation, special care must be exercised to prevent damage to the lateral during backfilling and tamping operations. Since the lateral will normally be placed on a fairly steep grade, it must be remembered that the covering or fill over the lateral will not be equivalent to that over the main sewer. The moving of heavy equipment should be so regulated as to eliminate any breakage that might be caused by surface loading.

Back Filling

After all the care which has gone into preparing the trench, the aligning of the pipe and assembling it, the final success and longevity of the sewer conduit depend upon the backfilling procedure. Proper and close attention to good backfilling practices at this juncture can avoid many unnecessary expenses in the future for operating and maintaining sewer systems. The average sewer specifications are very explicit as to the manner in which the backfill is to be performed. The municipalities' and consultants' inspectors will observe this portion of the installation with the same attention to detail given to the construction phase.

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The backfill should begin by using selected excavated material wherever possible. In many cases, the material excavated is suitable for at least partial use, but where special soil conditions are encountered that render it unsuitable, the engineer should specify that new fill material be hauled to the job site.

There are several methods of placing the initial backfill. In the case of small diameter pipes, up to 12", good practice would require the placing of selected material around the pipe up to the top of the pipe at each side. This material should then be thoroughly tamped by hand or mechanical tamping device until proper compaction has been determined by the engineer's inspectors. During this phase, there are two important points to remember: (1) Particular attention should be given to the tamped area around and adjacent to any lateral connections; (2) coupling holes must be completely compacted and fill material must be consolidated under the pipe coupling to give it the same uniform support afforded to the pipe lengths.

In the case of pipe 12" and smaller, the next backfill after the initial placement should also be carefully selected material placed to a height one foot over the top of the pipe and thoroughly compacted.

In the case of pipe diameters 14" and larger, selected fill material should be placed to a depth not to exceed one-half the pipe's vertical height. When this has been placed, it should be thoroughly tamped to provide the necessary degree of compaction. The second placing of fill should bring the fill to the level of the top of the pipe and the tamping resumed. The next step would be the placing of selected fill material to a height of one foot over the pipe and thoroughly tamping it.

In all instances, care must be taken to eliminate any lateral displacement of the pipe, particularly when using air-driven mechanical equipment. Hammer blows must not be directed against the pipe wall. Mechanical tamping can also cause damage during compaction of the one-foot layer over the pipe if the tamper is allowed to operate continuously in one spot.

After the material has been properly compacted for a distance of at least one foot above the top of the pipe, additional backfill can be added in the manner prescribed by the design engineer. However, when completing the fill, no large boulders or stones should be used in the next foot of cover above the material already placed.

Pieces of paving such as asphalt or concrete should not be placed in the trench in the area immediately above the pipe. Failure to comply with this can cause future problems, since chunks of paving and large stones may work their way down through the fill and cause damage to the pipe and subsidence of the completed paving. If it is necessary to dispose of this type of material, it should be held out until the top portion of the fill is reached or hauled completely away from the job site for disposal. In all of the final steps of the placing of the backfill, it is imperative that the engineer's instructions be followed with respect to tamping.

In some cases, final backfilling is completed by use of water jetting, but the indications for the use of this method can only be determined by an adequate knowledge of the type of soil conditions and other local factors. This method of compaction should be used only where the design engineer feels the conditions are favorable. The final backfill should be completed in a workmanlike manner which will ultimately provide the minimum of trench settlement. Any excessive settlement is an indication of poor backfill, and could be justification for thorough examination by visual inspection of that portion of the sewer from manhole to manhole.

Appurtenances

Manholes

Various sizes and types of manholes may be required in a large sewer project. Present day manholes are made of brick, manhole block and, more recently, of pre-cast sections. The purpose of the manhole is to provide means of entrance for cleaning and inspection and also to provide for changes in sewer direction. It has been customary to design sewer systems in straight lines and to locate manholes at points where this alignment is varied. The general rule has been to place manholes not in excess of 300 feet apart where the sewer is of middle size or smaller. The distance, however, varies in many localities. In some areas, notably on the West Coast, manholes have been reduced in number by using gently curved sewers in all sizes. It is authentically reported that this practice has not resulted in unusual maintenance problems. The practice will

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no doubt be increasingly applied in future construction. Certain-teed pipe is particularly suitable for this type of construction by virtue of its flexible FLUID-TITE joint that can be deflected 5° per joint while still retaining a water-tight seal against external pressure equivalent to 58 feet of water (25 psi).



Drop manholes are used to provide for sudden changes of elevation or grade as a result of area topography. Certain-teed can provide the necessary fittings and connections to construct the drop manholes, and it provides a special section of pipe specifically for the vertical pipe portion required in such a structure. However, it is recommended that drop manholes be used as infrequently as possible. As pointed out in the Water Pollution Control Manual of Practice No. 9, Chapter 6, hydrogen sulfide gas where present in the sewage flow is more likely to be released at points of high turbulence. The agitation which occurs at drop manholes can cause the release of this gas into the atmosphere and the dissemination of odors, or it can produce lethal concentrations of the gas and coincident corrosion of manhole structures.

There are several acceptable methods of connecting Certain-teed pipe to manholes. In the case of precast manholes, couplings suitable for the size and class of pipe can be cast directly into the manhole to facilitate connection. Where the manholes are constructed at the site during pipe-laying, it is recommended that the Certain-teed flexible coupling be placed at a distance from the edge of the footing slab not to exceed 6'-6". In a majority of cases, a certain amount of settling occurs at the manhole; by placing a joint close to the manhole, the necessary flexibility to accommodate this settling can be provided without destroying the structural integrity of the sewer conduit.

Another method sometimes used is to excavate for the manhole base ahead of the pipe-laying and then lay the pipe lines directly across this space. As the base of the manhole is normally four feet in diameter, the distance from the edge of the slab to the nearest joint complies with the maximum 6'-6" distance recommended when a 13-foot length of asbestos-cement pipe is used. After the base slab has been poured, the brick or manhole block should be laid up around the pipe to a reasonable height, and careful attention paid to the joint area or point of contact between the manhole wall and the pipe. When a reasonable height has been reached, the top portion of the pipe should be removed down to the level of the manhole base. This method provides a very satisfactory invert for the sewage flowing through the manhole. Where more than one sewer line entrance is provided at a manhole, as in a junction manhole, this method is not recommended.

Manholes are often located at street intersections which are not at that time completely constructed. It is anticipated that at a future date, other streets will intersect at such points, and so provision must be made in the manhole for these connections. A half-length of pipe, 6'-6" long, can be built into the manhole during construction, and the end outside the manhole can be sealed off by use of an asbestos-cement end cap. This half-length would provide a recommended flexible joint no greater than 6'-6" from the structure. An alternate method would be to place into the wall of the manhole a "Manhole Stub" which is specially made for this purpose. The manhole stub is 2' in length and is furnished with one rough barrel end and one machined end. The rough barrel end is carefully cemented into the manhole wall, and the machined end is sealed with an end cap. These Certain-teed end cap seals utilize rubber gasket connections which can be readily removed at a later date and connected to the new line by the normal coupling procedure.

Tunneling

Frequently, situations arise due to local conditions which make the use of an "open cut" installation impossible. At such times, the engineer will specify tunneling. To handle this problem, it may be practical to insert a steel sleeve through the obstruction by several means.

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Normally, in smaller diameters, the sleeve is placed by means of boring. This involves the use of boring equipment and the placing of steel sleeves as the length of the tunnel progresses. Where this method is employed, recommended practice is to use smooth steel pipe, as opposed to corrugated, to facilitate moving the asbestos-cement pipe through the sleeve. In larger diameters, most of the tunnel construction is done by jacking of the pipe from prepared pits. Where the length of line is excessive, many such jacking locations may be required. In all cases, careful attention must be paid to the alignment of the sleeve, so that final pipe placement will maintain the established invert grade.

After the sleeve has been placed, the asbestos-cement sewer pipe can be either pulled or pushed through the line. To pull the pipe, cable is inserted into the sleeve and the end secured to a crossbar, which then covers the pipe end and exerts the necessary force against the end of the pipe. The crossbar must be so constructed as to permit it to be folded against the cable for the threading of the cable through each successive pipe length. To push the pipe through the sleeve, suitable pushing machinery should be used that will provide constant and even pressure against the entering pipe. The pushing machine should be firmly anchored.

Whichever method is employed to insert the pipe through the sleeve, skids must be provided on each pipe length to facilitate insertion. With the long pipe lengths, it is advisable to use two skids for each length, placed close to the coupling area. The distance of each skid from the coupling should be identical on each pipe. This will tend to prevent any buckling and make insertion easier. It must be remembered in constructing the skid, to allow sufficient thickness for the skid to raise the coupling above the sleeve wall. The skids may be attached to the pipe by use of steel banding tape, cables or chain. In any event, the attachment should be secure, so as to prevent movement of the skid during the pull or push operation. It is also possible to apply some type of lubricant to the bottom runners of each skid for the purpose of making the operation easier.

With gravity sewer pipe, internal pressures are not normally encountered in these lines. It is, therefore, not necessary in most cases to backfill around the pipe inside the

sleeve. However, local regulations sometimes require backfilling and prescribe the material and the method to be used.

Lift Stations

Lift stations along sewer lines are becoming more prevalent as collection systems are expanded into suburban areas. The majority of such on-the-line lift station units are pre-built and simply dropped into position ready for connection to the sewer conduits. Regardless of whether a pumping station is built on site or supplied pre-built, the problems of connection are the same.

The piping in lift stations is made up of cast iron or steel, and so the external sewer lines must be capable of adapting to this type of material. The pipe connections are usually of the flange type, which allow easy removal for replacement or repair, when required. To make this connection, Certain-teed can supply an adapter piece to join the sewer line to mechanical joint cast iron pipe. The mechanical joint is made up in the usual manner by means of the specially machined asbestos-cement connector. Connection to the flange can be made with a cast iron "transition piece" which is mechanically jointed on one end and flanged on the other. The asbestos-cement adapter is connected to the mechanical joint and the flange is joined to the inlet and outlet connection on the lift station.

Testing

Testing of the completed sewer installation is highly important to eliminate construction errors and give added assurance to the owner of long-term, trouble-free service. Broken pipe, faulty lateral connections or poorly constructed joints are the source of future maintenance problems because of the entry of ground water infiltration and debris into the sewer. Illustrative of the importance of poor sewer conditions is the fact that recent cases have reported infiltration equivalent to 50% of the planned capacity of sewers without any connected properties. Tree roots and soil from around the pipe can enter through these openings and result in excessive maintenance costs. Where fill is washed into the pipe line, the ever-present danger of pavement subsidence can be extremely dangerous and expensive.

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Testing should be done in short sections as determined by the engineer. It is preferable for the contractor to perform these tests before reaching the final backfill phase of the installation. In this way, if any trouble does develop, it is easier to locate and repair. However, where open-cut installation is being used, the local traffic problems may affect the contractor's ability to perform these tests with proper timing. The testing itself can be performed by one of three generally accepted methods: The infiltration test; the ex-filtration test; and the low-pressure air test. The two former tests have long usage. The latter is a more recent test method which is becoming more widely used.

Infiltration Test

The infiltration test, where practical, is probably the easiest and least expensive to perform. This test, however, has no real significance as a measure of tightness, unless the ground water table completely surrounds the pipe and is at sufficient elevation to penetrate the pipe line. The measurement of the infiltration for circular pipe can be readily accomplished by means of a V-notch weir, which has relatively good accuracy up to flows of 5,000 gallons per minute.

In this method the length of line to be tested, as determined by the engineer, is selected by means of adjacent manholes. At the upstream manhole, all outlets are plugged or stoppered except that which is to be tested. All house laterals or other entrances into the sewer should be properly capped or plugged, so that no ground water will enter the line except that which could enter through defects. Where more than one manhole is located in the line being tested, all contributory lines should be plugged at the manhole unless it is decided to test the tributary lines.

At the downstream manhole, the V-notch weir is inserted far enough back into the pipe so that it can be read with ease and will establish a good seal against the interior pipe surfaces. Many weirs are constructed by the contractor; it is highly important that the V-notch be of utmost accuracy to prevent misleading measurements. The weir must be securely installed so that the bottom quadrant is water-tight to prevent by-passing the V-notch. The readings, due to the possible variation in flow resulting from local conditions, should be made as directed by the

local engineer. One manufacturer has recently placed on the market a pre-fabricated weir with a rubber sealing gasket on the lower quadrant, which is economical, lightweight, and extremely easy to use. The weir face is calibrated in gallons per day and eliminates the necessity for calculating the flows from empirical formulas. Before any measurements are taken, sufficient time should be allowed to permit the head of water to build up to a sufficiently stabilized point behind the weir face. [1]

Exfiltration Test

The exfiltration test, while more complicated than the infiltration, is necessary where the ground water table is not sufficiently high during construction to permit accurate testing of the condition of the sewer. In some areas, the elevation of the ground water table fluctuates with seasonal changes. A determination at the time of construction by the engineer should enable him to decide whether the exfiltration test is the one to be used.

In the exfiltration test the sewer line is pressurized. A water supply must be available to provide connection to the water system, or it can be accomplished by the use of tank trucks. The line to be tested, once again should be of reasonable length to permit adequate testing and yet be reasonable from the standpoint of the required water volume. The downstream manhole should be fitted with a plug to which a water connection can be made for filling the pipe. The pipe line should be filled from the bottom, so that the air in the line can escape from the upper portion. All of the laterals and any tributary line not included in the test should be thoroughly plugged.

It is extremely important when making an exfiltration test to consider the blocking of plugs or end caps, for it must be realized that the sewer line will be under pressure. For example, if a pressure of four pounds per square inch is applied, a six-inch plug or end cap would have a total force exerted against it of approximately 100 lbs. It is obvious, then, that the plugging for this test must be done with care, and all outlets adequately braced to withstand the pressures. Another problem to consider is that the downstream end of the line, because of its lower elevation, will have a greater pressure than the upper reaches of the sewer.

[1]Certain-teed FLUID-TITE Couplings when assembled and tested in accordance with Certain-teed instructions shall be capable of meeting specifications of 10 gal. per inch of diameter per mile per 24 hours.

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Water should be introduced into the line at the downstream manhole until the upstream manhole terminus of the line under test has been completely filled. The line should then be allowed to stand after filling for at least several hours before any attempt at measurement is made. During this time, there will be some absorption of the water into the manhole structure and the sewer conduit. When, in the opinion of the engineer, this absorption has been stabilized, the test can be made.

Most engineers specify tests of from 4 to 10 feet of head as adequate to determine the condition of the conduit. Where the grade of the sewer is steep, consideration must be given to the downstream part of the sewer to prevent excessive pressures at these low-lying sections. Furthermore, if the upstream manhole is very deep, it may be advisable not to fill it to the level of the manhole ring. After the water inside the line has been allowed to stabilize, additional water can be added to bring the water to the desired level for the beginning of the test.

To determine the leakage, it is necessary to measure the drop in water elevation and calculate the amount lost during a given time period. The simpler method is to choose the specific time lapse for the test and then measure the amount of water which must be added to bring the water level back to its original position. The actual amount of the allowable leakage will be determined by the consulting engineer who designed the system. Just as the infiltration rate may vary in specifications, so the degree of tightness to exfiltration may also vary. It is important to the owner of the sewer line to reduce to the barest minimum the amount of allowable leakage, in consultation with his engineer, to protect against future maintenance problems.

Air Testing

The text of this book has traced sewer service from the ancient paddle stick to a discussion of modern sewer techniques. One of the newer methods of testing a sewer conduit is the use of low-pressure air. While the use of this method has recently increased, the test has actually been in use by some engineers for many years. The experience gained in these tests has prompted a study and a report on this subject to the American Society of Civil Engineers.

Criteria have been established, based on the data collected from these various tests; and the method is recognized as acceptable and will no doubt grow in usage.

The test itself is basically a measurement of air-pressure drop plotted against time and pipe diameters. The reach of pipe to be tested should be isolated by completely blocking all outlets in the section under test. Here again, careful attention must be given to the bracing of all plugs, as the line will be under pressure just as it is in an exfiltration test. One of the plugs used at the manhole must be equipped for an air inlet to fill the line from the air compressor. The air compressor which feeds air into the pipe section must be equipped to control the air entry rate and to prevent the pressure from exceeding 5 psig. The air compressor should be fitted with a blow-off valve set to operate at 5.0 psig to prevent an increase in pressure which would be hazardous to the pipe line.

The test for air leakage must be performed on a pipe which has a wet inside condition. Since many specifications require newly installed lines to be flushed by water after installation, this will normally suffice to achieve the wet condition if the air test is carried out immediately thereafter. Wetting is necessary to minimize any loss of air through the pipe wall as a result of permeability in the dry condition.

After the pipe has been wetted, the air should be allowed to slowly fill the pipe line until a constant pressure of 4.0 psig is maintained. At this point, the compressor should be controlled so that the internal pressure in the line is maintained between 4.0 and 3.5 psig for at least two minutes to permit the temperature of the entering air to equalize with the temperature of the pipe wall. During the two-minute stabilization period, it is advisable to check for tightness with a soap solution all of the plugs and exposed fittings. If leakage is found at such points, the pressure in the line should be released, and the offending plugs tightened to stop the leakage. If it is necessary to bleed off the air to repair a faulty plug, a new two-minute interval must be allowed when the line has been refilled.

When the temperature of the air has reached equilibrium with that of the pipe wall, the air source should be disconnected. Before disconnecting the air supply, the pressure should be at 4.0 psig. The gauge is then watched until the air pressure reaches 3.5 psig. When the pressure

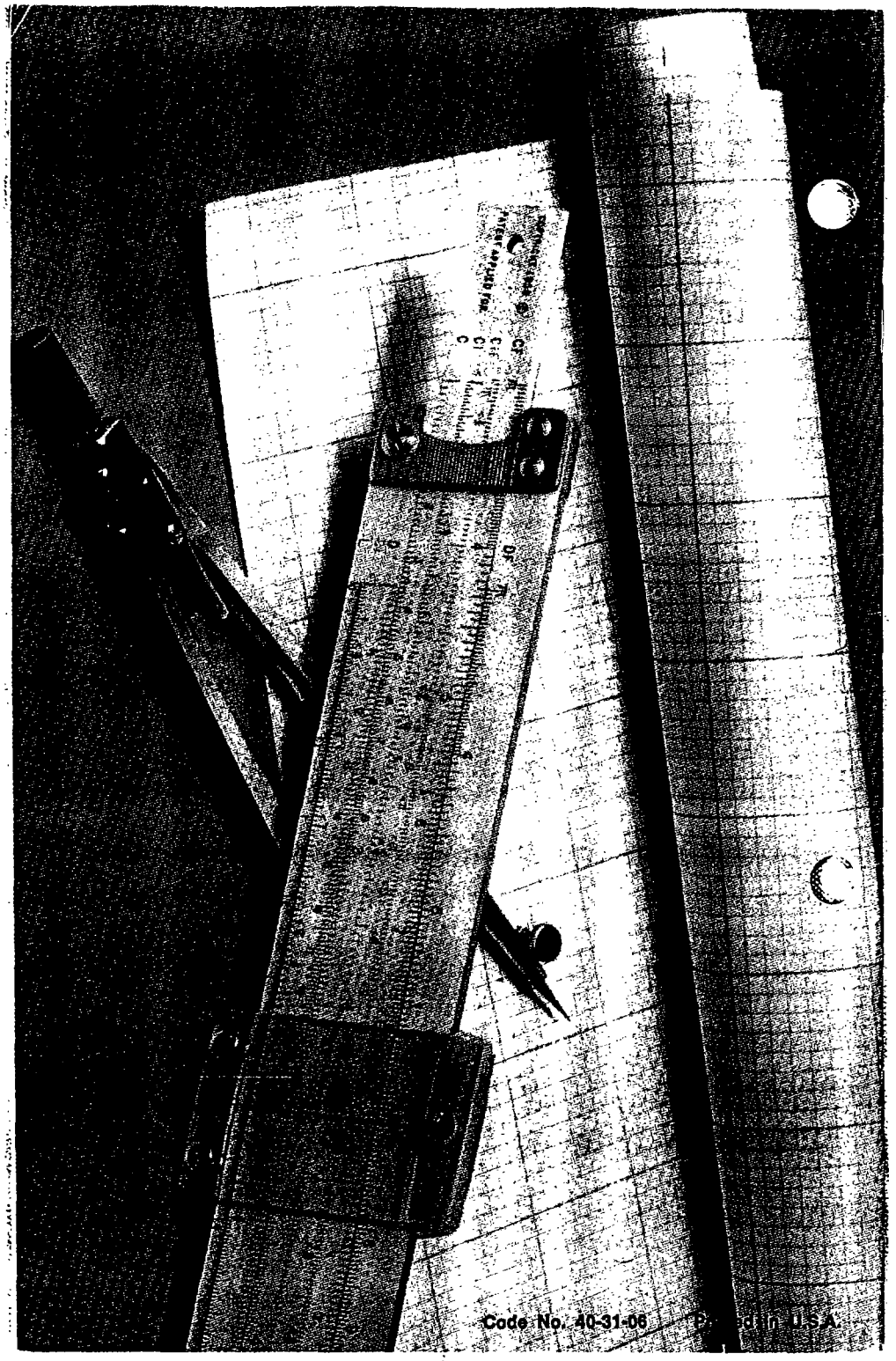
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has reached 3.5, a stop watch should be started and stopped when the pressure has reached 2.5 psig. The time required, as shown on the watch, for a loss of 1.0 psi at an average pressure of 3.0 psig, is used to calculate the rate of air loss. It is generally considered unnecessary to determine the air temperature inside the pipe line and the barometric pressure.

When the entire reach of sewer from manhole to manhole is to be tested, the engineer must allow for the size of the laterals. It would not be an accurate test to test an 8" line with 6" laterals and use the air-loss figure for the 8" pipe. The consulting engineer can determine his requirements in this respect, as the number and size of the lateral connections vary. If the engineer elects to average sizes, he can multiply the diameter used by 28.3 seconds. This will give the time in seconds for the chosen diameter which would be acceptable for a pressure drop of 1 psi.

The pipe line may be considered to have passed the air loss test successfully if the loss of air is not greater than a rate of 0.0030 cubic feet per minute per square foot of internal pipe surface. For any reach of sewer being tested, the line is also acceptable when the loss of air is greater than 0.0030 cubic feet per minute per square foot of internal pipe surface, but the total rate of air loss from the entire section does not exceed 2 cubic feet per minute. The loss of air is acceptable and the line is considered to be reasonably free from defects if the time in seconds for the pressure to go from 3.5 psig to 2.5 psig is not less than the amount shown in the following table, for the respective pipe diameters.

PIPE DIAMETER	TIME MIN.	SEC.
8"	3	57
10"	4	43
12"	5	40
14"	6	36
15"	7	5
16"	7	33
18"	8	30
20"	9	26
21"	9	50
24"	11	20
27"	12	45
30"	14	10
36"	17	00



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