Saudi Arabia Concrete Products (SACOP)
Products Guide
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1 General

Amiantit Group of Companies

The Amiantit Group is a leading global industrial organization which manufactures high-quality pipe systems and researches, develops, owns and licenses advanced pipe technologies; it also provides water management services. The Group supports global infrastructure development projects and delivers to municipal, industrial, agricultural and energy markets worldwide.

Amiantit has a presence in more than 70 countries, including almost 30 wholly-owned or joint-ventured manufacturing facilities in the Middle East, Europe, Latin America, North Africa, The Far East, Central Asia, the Indian Subcontinent and Africa. Amiantit’s manufacturing capabilities are supported by technology companies and sales offices across the globe.

Other members of the Group are predominantly limited liability companies, owned by the Amiantit Group in varying percentages, which operate under individual commercial registrations.

Saudi Arabian Concrete Products (SACOP) Ltd

SACOP was commissioned in 1978 in Jeddah to provide high quality precast concrete products for projects in the Kingdom of Saudi Arabia. The company is manufacturing reinforced concrete pipes, jacking pipes, manholes and inspection chambers in Jeddah’s 3rd Industrial City and is jointly owned by Ameron Saudi Arabia Ltd (ASAL) and Ameron International U.S.A. SACOP is a member of Amiantit Group of Companies, a Saudi Joint Stock company.

The products manufactured are backed by Ameron’s more than 80 years experience in the design, manufacture and quality assurance of precast concrete products. The Company produces reinforced concrete pipes, reinforced concrete pipes with PVC and HDPE T-liners or GRP liners and reinforced concrete jacking pipes. SACOP also produces reinforced concrete manholes with PVC and HDPE T-liners or GRP liners and inspection chambers.
2 Introduction

Modern sanitation in cities across the world owes much to concrete. Concrete pipes carry water, industrial wastes and sewage.

As a material, concrete is rugged and lasts for years without maintenance. Its load-bearing heavy-duty pipes can take up to 10 meters of earth cover and the smooth interior of concrete pipes gives them excellent flow characteristics.

Rugged, easy to install and problem-free in performance, reinforced concrete pipes with concrete bell and spigot joint sealed by a confined rubber gasket, are manufactured for many applications. Storm drains, sanitary sewers, culverts, gravity water supply and irrigation systems are all typical of their versatility.

Security and long-term economy are the main features of this multi-purpose pipe. With minor modifications to its steel reinforcement at the design stage, reinforced concrete pipe can be specified for jacking operations. Its smooth exterior wall and material strength provide additional jacking advantage.

Incorporating accurately placed steel reinforcements in its densely compacted concrete wall or reinforced concrete wall, reinforced concrete pipes are designed to withstand substantial live and dead loads. Rugged, reliable concrete pipes are a safeguard against system failures. They can’t be crushed and won’t buckle, split or deflect, regardless of the service conditions.

The concrete bell and spigot joint, sealed by a confined rubber gasket for pipe and manhole sections, provides a flexible watertight joint to eliminate infiltration from ground water and provides safety for slight movements due to expansion, contraction, settlement or lateral displacement.

3 Advantages and Specifications

When looking for a strong, reliable and economical concrete pipe, consider the characteristics inherent in SACOP's reinforced concrete pipe.

3.1 Advantages

Concrete pipes and its different modifications show many advantages in several applications versus other piping systems. These are in detail:

- Strength - concrete and steel are combined for optimum strength.
- Permanence - concrete pipe has conveyed water and waste for centuries.
- Flow characteristics - the smooth, enduring interior wall provides excellent flow characteristics.
- Uniformity - quality control and in-plant inspections guarantee uniform quality and performance.
- Economy - simple installation, maintenance-free performance, corrosion resistance and longevity add to its superior cost-effectiveness.

3.2 Specifications

SACOP's reinforced concrete pipes and pre-cast reinforced concrete manhole sections are designed and manufactured in accordance with the specifications relating to their end use. SACOP manufactures its products in accordance to:

- ASTM C76M
- ASTM C443M
- BS 5911, Part 1
- ASTM C478M
4 Production Process

The basic materials of concrete pipes are fine and coarse aggregate, cement Sulfate Resistant Cement (SRC) or Ordinary Portland Cement (OPC), reinforcement, water and admixture. These are combined in a systematic manner, using quantities and proportions specially designed for each product. Fine and coarse aggregates are mixed with cement, water and admix to provide a concrete mix which is formed into pipes by a method known as the dry cast process. The newly formed pipe is steam-cured and then moved to the coating and finishing area before being shipped to the construction site.

4.1 Batching And Mixing Of Concrete Materials

Highly sophisticated batching plant with computerized batching system will be batched according to the approved mix design. And also each batching reports will be produced by the system.

The approved quality of the raw materials supplied, such as cement, sand and aggregates, conform to the requirement of ASTM C-150 and C-33. The water used must be clean, free from chlorine and undesirable quantities of organic materials, alkali, salt or other impurities which might reduce the strength, durability or other desirable qualities of the concrete.

The scales and water meter used in batching are maintained in good working order and calibrated on a semi-annual basis.

4.2 Reinforcement (Cage) Fabrication

The welding impulse is electronically released. The welding intensity and welding time are infinitely adjustable via an electronic welding control.

The bell-sockets will be manufactured without interruption of the continuous production. To produce bell-sockets, the diameter of the reinforcement cage is increased by expanding the slide dies whereby expanding speed and longitudinal wire feed speed are adjusted independently.

The reinforcement cage diameter and the length between the start and the final wraps (i.e. rings, vertical to reinforcement cage axis) as well as the taper of the socket are programmable.

4.3 Dry Cast Process

Reinforced concrete pipes are produced in a dry cast process. This process uses a device rotating at high speed that forms the interior surface of the pipe. It is drawn up through the exterior form as the mix is fed into the form. The head has rollers mounted on the top, which compact the mix. The profile rings press and move to build the shape of the spigot. Then both form and pipe are moved to a curing area where the exterior form is removed.

A forklift is used to lift the pipe from the machine to the steam curing kiln. There, the saturated steam will accelerate the rate of hydration, producing concrete pipe of the required strength in a shorter time than is possible when curing at ambient temperature.
4.4 Wet Cast Process

The wet cast process is primarily used for producing manholes and jacking pipes. These are produced by placing concrete in an assembled pipe mold and consolidating the concrete by means of pneumatic vibrators attached to the outer mold. The mold parts, consisting of a base ring, inner form, outer form and top header ring are cleaned and form oiled. The automatic cage machine fabricates the reinforcing cage. GRP, HDPE and PVC liners are provided in a cylindrical sleeve that becomes the internal lining of the pipe. High-frequency vibrators are bolted to the outer form to consolidate the concrete. The concrete is then batched by weight, mixed and transported to the mold assembly. The concrete is poured uniformly into the mold, which is vibrated to consolidate the material. When the mold is filled, and the spigot end is formed in the concrete at the top end of the pipe, the pouring bucket and cone are removed. The mold assembly, filled with concrete, is enclosed in a cell and cured overnight at a controlled temperature. After curing, the pipe is removed from the mold and transported to yard for final touch-up.

4.5 Steam Curing

The pipe is placed in a curing chamber and cured in a moist atmosphere which is maintained by the injection of steam for a set period of time and at a precise temperature - this is required to enable the pipe to meet the strength requirements. The curing chamber is constructed in such a way as to allow full circulation of steam around the entire pipe.

Picture 4-7 Wet Cast Pipe Machine

Picture 4-8 Mould removal after casting.

Picture 4-9 Curing Chamber

Picture 4-10 Curing chamber
5 Products

5.1 Storm Drain Pipe

SACOP’s reinforced concrete pipes, with bell and spigot joint sealed by a confined rubber gasket, are extremely suitable for high water table conditions where infiltration is a continuing and aggravating problem. Designed specifically for the conveyance of water and wastewater for low head and gravity flow systems, it has been used in hundreds of Saudi Arabian and Arabian Gulf State projects.

Economical to install, its positive and flexible seal requires neither pointing nor grouting, and bedding and backfill can follow immediately.

Manufactured in diameters of between 300 and 3500 mm, the pipes can be designed for substantial external loads. The bell or spigot ends of the pipe, as well as the full pipe sections, contain both circumferential and longitudinal steel reinforcement.

Special pipe and fittings, including short pipe lengths, laterals, outlets, and wye elbows are available as part of the pipeline system and shop drawings can be provided in accordance with site requirements. When the application entails the conveyance of sanitary sewage or corrosive industrial wastes, SACOP’s reinforced concrete lined sewer pipes should be used (see pages 7 & 8).

When brackish water is to be conveyed, the inside of the pipe should be coated with bitumen emulsion paint, coal-tar epoxy, or according to the project specification.

Specifications

All sizes of SACOP reinforced concrete storm drain pipes are designed and manufactured in accordance with ASTM C76M. Pipe larger than 1200 mm also conforms with the requirements of BS Specification 5911, Part 1. The bell and spigot joints, sealed with a confined rubber gasket, meet the requirements of ASTM C443M.

<table>
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Table 5-1 Reinforced concrete storm drain pipe product range

* Diameters from 2600 mm to 3500mm can be designed upon customer request.

** Maximum angular deflection is based on deflecting the joint from its normal assembled position a maximum of 25 mm for 600 mm through 1800 mm diameters, and a maximum of 32 mm for 1900 mm and larger diameters.
5.2 Reinforced Concrete Sewer Pipe with Lining

Durability, long life, economy, resistance to acids and alkalis all are combined in reinforced concrete sewer pipe lined with any project-specific lining materials like GRP, HDPE, PVC, and others. When reinforced concrete sewer lines are installed in aggressive soils, the external pipe surface can be coated with 100% solids coal-tar epoxy.

They have the same internal and external lining options as the reinforced concrete pipes. However, T-lined pipes use polyvinyl chloride (PVC) and Polyethylene (PE) polymers welded by a high frequency welding machine in 2 meter widths. This additional protection against corrosive liquids and gases gives the pipe a life time of service.

Specification

SACOP’s reinforced concreted sewer pipes are designed and manufactured in accordance with ASTM C76M and BS 5911, Part 1. The bell and spigot joints sealed with confined rubber gaskets meet the requirements of ASTM C443M.

PVC or HDPE T-Lining

Lining continuity is guaranteed by fusing each individual pipe liner with the next. This results in a lining that is permanently flexible, withstands temperatures up to 83°C has a lower friction coefficient than concrete, has a minimum elongation factor of 200%, and offers no sustenance to either fungus or bacterial slimes.

Maintaining PVC or HDPE T-lining is no problem. The dense, glossy surface of the plastic will neither absorb nor retain precipitated or crystalline materials. It is easily decontaminated and maintained in a sanitary condition.

Although the lining rarely sustains damage once the pipeline is in place, repairs are simple. The damaged area is cut away leaving the tees embedded and another piece of lining is welded in place. The newly fused section is as fully corrosion-resistant as the original sheet. With the increasing demands placed on urban wastewater systems, PVC or HDPE offer the most effective solution to total pollution control at the lowest cost, based on the service life of the system.

### Table 5-2 Reinforced concrete sewer pipe wih lining product range

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<th>Nominal Pipe Wall Thickness (mm)</th>
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** Maximum angular deflection is based on deflecting the joint from its normal assembled position a maximum of 25 mm for 600 mm through 1800 mm diameters, and a maximum of 32 mm for 1900 mm and larger diameters.
Glass-fiber Reinforced Polyester (GRP) Lining

Manufactured and designed as per the customer’s specification. The embedded liner is the interior of the reinforced concrete pipe, where its thickness ranges from 4 mm to the required thickness of the project specification. The liner is a resin rich layer of fiberglass with a surface veil of chop glass.

5.3 Reinforced Concrete Jacking Pipe (RCJ Pipes)

When surface conditions make it difficult to install pipe by conventional open excavation and backfill methods, or when it is necessary to install pipe under an existing embankment, installation by jacking or tunneling is used. Reinforced concrete pipe is ideally suited for tunneling and jacking. The pipe can be pushed forward immediately after the soil is bore, providing a complete tunnel liner for the protection of workers and equipment. Thanks to technological advances and increased experience, many pipelines are now being jacked. Reinforced concrete pipes, from 500 mm diameter up to 3500 mm diameter, have been installed by jacking. Since conventional jacking procedures require access by workmen through the pipe to the heading, a 500 mm diameter pipe is generally the smallest practical size for most jacking operations. More detailed dimensions of O.D, pipe length, weight and thickness can be obtained from SACOP.

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Table 5-3 Reinforced Jacking Pipe Internal Diameter

Jacking (RCJ) pipes under railroads, airport runways, congested streets and highways is a common practice. It does not interfere with traffic and it eliminates the costly maintenance which often results from trench settlement. Reinforced concrete pipe is particularly suitable for jacking due to its strength and because it is not easily deflected from the established line and grade, as its smooth exterior surface offers little frictional resistance.

During jacking and after installation, the pipelines are not subjected to unbalanced stresses: when the pipe is pushed through the soil, it becomes an integral part of the soil mass as it occupies practically the same space as the excavated material.
Advantages
Compared to the traditional method, i.e. laying the pipe in a trench with the resulting surface disruption, the advantages of the jacking method is described below:

- Minimizes disruption to residents and traffic, requiring only a jacking and reception shaft.
- Reduces the risk of damage to adjacent properties.
- Ground tolerant, minimizing de-watering and ground stabilization.
- Accurate installation to 25 mm tolerance of line and level.
- Final installed pipes are stronger than standard open cut pipes.
- Fully remote-controlled, reducing the risk of accidents.
- Requires less road surface reinstatement.

Loads on Jacked Pipe
The two types of load imposed upon concrete pipe installed using the jacking method are the axial load resulting from the jacking forces applied during installation and external earth and live loads.

- Axial Loads
The axial or thrust loads are transmitted from one concrete pipe section to another through the joint surfaces. To prevent localized stress concentrations, it is necessary to provide relatively uniform distribution of the axial loads around the periphery of the pipe. This is accomplished by ensuring that the pipe ends are parallel within the tolerances prescribed by ASTM standards, using a cushion material - plywood - between the pipe sections, and care on the part of the contractor to ensure that the jacking force is properly distributed through the jacking frame and parallel with the axis of the pipe.

- Earth loads
The major factors influencing the vertical earth load on pipes installed by jacking are:
  - The weight of the prism of earth directly above the bore.
  - The upward shearing or frictional forces between the prism of earth directly above the bore and the adjacent earth.
  - The cohesion of the soil.

- Live loads
Jacked installations are generally constructed at such depths of cover that the effects of live loads are negligible. Highway and aircraft loads are considered insignificant at depths greater than three meters; however, railroad loads are considered significant at up to nine meters depth of cover.
5.4 Reinforced Concrete Manholes and Inspection Chambers

SACOP precast reinforced concrete manhole and inspection chambers combine convenience and economy of installation with the strength and durability of concrete and steel. Manufactured in a variety of sizes, these precast assemblies are designed to fit diverse governmental agency and industry specification.

Reinforced Concrete Manholes

Manholes provide one or more of the following functions in storm water drainage and sanitary sewer lines:

- Pipeline access for the purposes of cleaning and inspecting.
- Directional changes in pipeline alignment.
- Convergence of two or more pipelines.
- Size increase.

SACOP manholes are all circular in section. Since they are always installed vertically and the external loads imposed on them due to the surrounding soil is radially inward. With the section therefore in uniform compression, the steel reinforcement in the vertical walls is minimal. In the case of unusual conditions which result in non-uniform loads around the manholes, the purchaser must provide SACOP with design requirement details.

The bottoms of the manholes are reinforced for protection against normal hydraulic uplift, in cases where the manhole is installed in wet conditions. Should a project involve unusual situations or very deep manholes, the purchaser must provide SACOP with design requirement details.

Flat manhole covers are reinforced to support the normal and reasonable loads imposed by city traffic. Their configuration also anticipates at least 20 cm of cover. Should more severe loads or less cover be expected, the purchaser must provide SACOP with design requirement details.

1200 mm is the most common manhole size. However, SACOP also offers 1800 mm, 1600 mm and 1000 mm manholes. All are available with pre-cast bases and flat top covers.
**Reinforced Concrete Inspection Chamber**

The basic function of an inspection chamber is to provide an access point into sewer or storm drain systems large enough to allow people to enter it and perform inspection and cleaning procedures manually.

Inspection chambers are designed to provide access into sewer or storm drain systems for inspection, cleaning and sampling. Inspection chambers allow all maintenance work to be carried out from ground level.

SACOP can supply any diameter of inspection chamber. All are available with pre-cast bases. The purchaser must provide SACOP with design requirement details.

**Advantages**

- Convenient for pipe networks.
- Cast iron cover locked in a frame to prevent unauthorized access and noise under passing traffic.
- Load conveyance during seasonal air temperature fluctuations.
- Excellent performance in high groundwater level environments.
- Easy cleaning due to smooth interior, convenient access and use with high pressure water jetting for removing sedimentation or blockages within collection systems.

**Common uses include:**

- Line clean-out access
- Interim access points in long pipe sections
- Effluent sampling stations
- Monitoring pits

**Liners**

For sanitary and sewer use, manhole and inspection chambers can be protected internally with PVC, HDPE, GRP or coal tar epoxy liners.

**Specification**

SACOP reinforced concrete manholes are manufactured in accordance with ASTM Specification C478M, and can be according to the customers specification.
Reinforced concrete pipe for gravity flow pipelines in DN 300 mm through DN 2500 mm sizes may be specified by D-load strength classification in accordance with ASTM C76M or by class in accordance with BS 5911 Part I. As an aid to designers, external loads by diameter are given in Table Appendix for various heights of earth cover. D-load strength is classified as 0.3 mm crack strength, D_{0.3}, or the ultimate strength, D_{ult}. The required D-load strength in the three-edge bearing test for reinforced concrete pipe is:

\[
D_{0.3} = \left( \frac{W_E + W_L}{L_E} \right) \frac{1}{ID} \]

\[
D_{ult} = \left( \frac{W_E + W_L}{FS} \right) \frac{1}{ID} \]

Where
- \( W_E \) = earth cover load, (kN/m)
- \( W_L \) = live load, (kN/m)
- \( L_E \) = load factor for earth load based upon class of bedding selected
- \( L_L \) = load factor for live load (LE or 1.5, whichever is less)
- \( ID \) = pipe inside diameter, (m)
- \( FS \) = the relationship between \( D_{ult} \) and \( D_{0.3} \)

The relationship between ultimate D-load and 0.3 mm crack D-load is specified in the ASTM standard C655M as:
- For \( D_{0.3} \) equal to 100D or less
  \[ FS = 1.5 \]
- For \( D_{0.3} \) equal to 150D or more
  \[ FS = 1.25 \]
- For \( D_{0.3} \) more than 100D but less than 150D

\[ FS = 1.5 \left( \frac{D_{0.3} - 100}{50} \right) (0.25) \]

The D-load strength required for any external cover load may be determined by:
- Selecting the method of installation.
- Determining the external load. (Table A-1 on Appendix)
- Calculating the required D-load strength.
- Selecting the class of pipe.

![Figure 6-1 Classes of bedding - trench conduit](image-url)
Design Example

ID: 1000 mm
Depth of Cover: 3 m
Installation method: Trench

Conduit with “Class B” bedding
Load factor: 1.9
Earth load: 80.2 kN/m (Please see Appendix)
The load: 4.2 kN/m (Please see Appendix)

\[
R = \frac{L}{2\sin(\Delta/2)}
\]

Where
- \( R \) = Centerline radius, (m)
- \( L \) = Centerline laying length of pipe section, (m)
- \( \Delta \) = Angle turned at pipe joint, (°)

(see Table 5-1 or 5-2)

Straight pipe sections may be installed with joint spaces different from the normal position by deflecting the joint or by opening or closing the space (F) as illustrated in figure 6-2 or a combination of deflecting and opening or closing. These methods are used to lay pipe around curves, through angle points or for adjustment of line and grade.

To deflect the joint during installation, insert the spigot into the bell to the normal joint closure position and rotate the pipe by maintaining the normal inside joint space width from Table 5-1 or 5-2 on one side of the joint space width on the opposite side of the joint.

To open or close a joint to adjust for stationing, insert the spigot into the bell to the normal joint closure position and then push the joint closed by reducing the inside joint space width, or open by increasing the inside joint space width. Neither the sum of nor the difference between the measured widths of the total inside joint spaces, measured at the widest point \((F_1)\) and the closest point \((F_2)\) around the circumference, shall not exceed the values in Table 6-1.

\[
D_{3,3} = \left[ \frac{W_E}{L_E} + \frac{W_L}{L_L} \right] \frac{1}{ID}
\]

\[
= \left[ \frac{80.2}{1.9} + \frac{4.2}{1.5} \right] \frac{1}{1.0}
\]

\[
= 45.0
\]

\[
D_{4,4} = \left[ \frac{W_E}{L_E} + \frac{W_L}{L_L} \right] \frac{FS}{ID}
\]

\[
FS = 1.5 \text{ for } D\text{-load 100 or less.}
\]

\[
= \left[ \frac{80.2}{1.9} + \frac{4.2}{1.5} \right] \frac{1.5}{1.0}
\]

\[
= 67.5
\]

Referring to the ASTM manual section C76M Table 2. Class II pipe would be selected \((D_{3,3} = 50)\).

6.1 Joint Deflection

Reinforced concrete pipe can be laid around long radius curves and across angle points by deflecting the joint from the normal closed joint position. The centerline radius of curvature for any case of deflected joint can be calculated by the following equation:

<table>
<thead>
<tr>
<th>Pipe Inside Diameter (mm)</th>
<th>Maximum Sum of Total Inside Joint Space ((F_1 + F_2)) (mm)</th>
<th>Maximum Deflection ((F_1 - F_2)) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For reinforced concrete storm drain pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 through 1800</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>1900 through 2500</td>
<td>50</td>
<td>32</td>
</tr>
<tr>
<td>For lined reinforced concrete sewer pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>700 through 1800</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>1900 trough 2500</td>
<td>50</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 6-1 Inside joint spacing
6.2 Types of Joints

SACOP offers a range of joint systems depending on the pipes it uses, to ensure proper sealing of the gasket and smooth operation. The following section explains the various types.

Joints for Concrete Sewer pipes and Storm Drain pipes

Pipe joint shall be either with flair at the Bell end, 300 mm up to DN 1000 mm or flush for larger diameters. As illustrated in the drawings

SACOP has its own fully equipped in-house laboratory, located in the plant. The laboratory operates strictly in accordance with the factory’s quality control procedures.

Raw materials are tested at source before they are purchased, to ensure that they comply with the standards. Concrete mixtures are tested regularly.

All of SACOP’s products – standard or bespoke – have to meet the Quality Control standards policed by the company’s in-house laboratory. Nothing leaves the factory without rigorous testing.

Joint for Reinforced Jacking Pipe

Pipe joints for all reinforced concrete jacking pipe are flush, with a rubber ring gasket to ensure sealing seal and a steel collar to control the pipe’s angle. In the center a wooden ring is set between the pipes as a pressure absorber to prevent the pipes from cracking during the jacking process.
8 Underground Installations for Buried Pipe

8.1 Introduction
This is the abridged version of the Reinforced Concrete Pipe Installation Guide, which is a full installation guide to ensure that pipes are installed to comply with a controlled installation procedure, in order to ensure that they meet all requirements. It does not replace the specification or any contractual requirements and should be regarded as complementing these documents.

This abridged version is directed primarily at sub-division type works and reflects a growing trend among local authorities to nominate rubber gaskets for the joining of pipes of 300 to 3500 mm.

With a focus on safety, it is intended that this guide will illustrate to all involved that the right way is invariably the quickest and least expensive way to install reinforced concrete pipes (RCP).

8.2 Unloading and Handling
Reinforced concrete pipes can be handled with most conventional lifting equipment but should not be handled carelessly. Damaged pipe ends may have to be repaired so that effective joints can be made and such repairs can be time-consuming and costly. Appropriate lifting chains and equipment are necessary for safe handling.

Unloading locations should be chosen with care to ensure there will be a minimal amount of rehandling and intra-site transport prior to getting the pipe into the trench.

Caution: Profits can be made or lost in this area. Pay particular care to potential interference from overhead wiring. This is a source of great danger!

Pipe sections should be adequately chocked while stockpiled at the job site. A slight slope, soft ground or vibration from trenching operations could start the pipes rolling and the results could be disastrous. The cost of chocking is a very small price to pay for insurance against possible construction delays, not to mention the potential for injury or loss of life.

It is good practice to inspect each pipe as it comes off the truck. Pipes damaged in transit or not up to specification should be put on-hold for inspection and repair. This inspection plan will then ensure that only first class product will be installed. The driver should be instructed to inspect the pipes as they are loaded and to carry them so as to avoid damage in transit.

8.3 Rubber Gaskets
Rubber gaskets should be kept clean and away from contaminants like petroleum products, and should be stored undercover if the pipes are not to be installed in the trench within a few days.

Caution: Do not attempt to use Rubber Gaskets other than those shipped with the pipes. They are matched to the product. Any other type of gaskets may be too large and make jointing difficult, or if too small will not effects a proper seal.

Angular Rubber Gasket Installation Procedure
1. The pipe should be handled with extreme caution to avoid chipping of the spigots or bell grooves.
2. The clean spigot end, including the step seating, are for the gaskets. Place the gasket in the step of the spigot, making sure that the pointed end of the gasket is toward the end of the pipe.

Figure 8-1 Joint lubricant area

3. Remove all dirt and other foreign matter from the inside surface of the bell. Apply lubricant to the inner surface of the bell including the lead-in taper surface on the outer edge of the bell. Align the spigot with the bell. The gasket should touch lead-in taper around the entire circumference before the pipe is pushed home.

4. Proper bedding is necessary to ensure continuous support of the entire pipe and joint.

5. Push the pipe carefully, until the spigot is all the way home.

Drawing 8-1 Diameter 300 mm - 1000 mm

Drawing 8-2 Diameter 1100 mm - 2500 mm
8.4 Trench

Site Investigations
Before work commences, contractors, manufacturer and authorities should endeavor to obtain as much information as possible about the ground conditions of the work site. Sources of information, which may be available, are:

- Natural surface features, such as rocky outcrops, watercourses or swamps should be inspected and the drainage system for the surface run off located in relation to the line of the proposed excavation.
- Information on ground conditions may be available from nearby works such as existing railway cuttings or roadways, electric and telephone lines.

Excavating the Trench
The information outlined in this section refers to excavations with vertical faces or near-vertical sides and does not apply to those excavations where the sides of the excavation have been battered back so as to slope at such an angle that there is no danger of them collapsing. The subject of trench-shoring methods is fully covered in the unabridged version.

Trench walls which are firm and solid when first dug may not remain so. In hot dry weather, enough of the soil's moisture may be evaporated from the exposed faces to cause eventual collapse. In wet weather, water may saturate an initially stable trench wall and cause it to fail. Also vibrations from nearby construction equipment may be enough to trigger a collapse. The time to prevent a trench wall movement is before it starts.

Excavated Material
Excavated material should be placed far enough away from the top of the trench to allow sufficient clearance for installation operations and to minimize the danger of rocks and or lumps rolling back into the trench. Where there is restricted room it may prove economical to load out all or part of the excavated material and stockpile it for use as backfilling elsewhere. A large proportion of the cost of a trenched pipeline installation is in the excavation and backfill. And therefore large savings can be made by taking care when planning these operations and by evaluating the alternatives available, including shoring.

8.5 Foundations

The foundation for a pipeline is the material under the pipes. Its stability and uniformity along the line rates as one of the most important aspects to ensure crack free installations. Pipes are designed to be uniformly loaded along their length and to be uniformly supported along their length to carry the load.

Unless the disturbed foundation material is replaced with carefully compacted material the pipes laid above will be left with inadequate support and pipes may crack circumferentially as a result. Where the pipes are connected to pits and manholes it is good design and installation practice to use two short lengths, thereby increasing the flexibility of the line in this area of potential ground movement.

Problems are also associated with hard foundation material. Where it consists of rock or other very firm material it becomes difficult or impossible to excavate a trench with a bottom even enough to provide uniform support for the pipes. It is therefore necessary to over excavate and replace a sufficient depth with suitable material to ensure a uniform and slightly yielding support all along the pipeline. The depth of the over excavation must be sufficient for the effect of unevenness of the hard material below not to be transmitted through the pipes, as this is a source of point loading. Most importantly holes (recesses) must be excavated to allow a cushion to be provided underneath the sockets and so remove the most common cause of point loading.
8.6 Bedding

The bedding is the cushion material between the pipes and the foundation. Its function is to ensure uniform support for the pipeline both with regard to grade and hardness. A bedding specification must form part of any pipe laying specification as it influences the pipe strength required.

Depending on the foundation the bedding material may consist of the foundation material or of an imported material.

The best bedding material is granular and uniformly graded which assists in handling and spreading. It only needs sufficient compaction to ensure that laying tolerances are maintained when pipes are laid and backfilled. Holes (recesses) in the bedding must be provided for the protruding socket to ensure uniform support of the barrel and hard point supports must be avoided.

8.7 Laying the pipes

Before handling the pipes, check their mass, weight and dimensions and make sure the handling equipment is of adequate strength. Pipes laying usually progresses in an upstream direction with the spigot pointing downstream having been inserted into the socket. Doing it this way restrains the joints from opening up as a result of pipeline movement and joint surfaces are protected against entry of foreign matter. If adequate precautions are taken with regard to these items, there is no reason why the order may not be reversed.

Many pipes are manufactured with elliptical steel reinforcement and as such must be laid in a specific direction. These pipes are supplied with a top mark, to make sure that they are laid “top up”.

To ensure that pipes are laid to the correct grade within the specified tolerances some installers will optionally lay the pipes on timber, brick or stone supports. Such supports, if placed on a hard foundation can result in damage to the pipes due to the point load (concentrated reaction) they impose on the pipe when backfilled. Such supports must be removed before backfilling. The desire to achieve tight laying inline and grade tolerances must not result in the uniform support of the pipe being compromised.

Rubber gasket jointed pipes must be laid with joint gaps between the pipes to ensure that the lines are able to deflect without causing damage to the pipes. Recommended joint gaps are shown on all product drawings and are tabulated. Witness marks are provided on the outside of pipes to show maximum and minimum gaps.

8.8 Jointing

The rubber gasket must be assembled dry (put on spigot) and without the use of lubricant.

Before jointing, clean and inspect all joint surfaces. Dirt, dust and foreign matter must be removed from the spigot and bell and pipes with damaged joints must be repaired. Rubber gaskets must be clean and dry and damaged rubber gaskets must not be used.

Place the rubber gaskets on the spigot and ensure that the gasket is free of unevenness or twists. The spigot should then be offered to the socket with uniform contact of 360° to the socket lead in. The pipe is then pushed home.
8.9 Backfilling

The most important point about backfilling is to realize that compaction loads/ construction vehicle loads will in most cases be the most severe load to which the pipe is subjected. Make sure the manufacturer has allowed for this.

- Avoid damaging the pipes by direct impact. Keep heavy rocks and other such material out of the fill adjacent to the pipe and the embedment zone.

- Bring up the fill on both sides together to ensure that pipeline alignment is maintained. Use a hand held compactor to do this, to ensure that there is no overload.

- Avoid running heavy construction equipment over the pipes in an uncontrolled manner.

- Ensure that the pipe is compacted with a pedestrian roller to the requisite level over the top of the pipe prior to bringing on compaction and construction loads.

- If the backfill procedure is to be varied from the design seek approval from the manufacturer.
A-1 External Loads for Trench Conditions

Load values given in the table below are for the field conditions described in these criteria conditions other than those indicated appropriate adjustments must be made or new calculations will be required.

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<tr>
<th>Load in kN/m</th>
<th>Pipe Diameter in mm</th>
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<th>400</th>
<th>500</th>
<th>600</th>
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</tr>
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Table A-1 External Loads for Trench conditions
Backfill

Earth loads in Table A-1 are based on Marston’s trench load curve for saturated topsoil. When $K_u=0.150$ the table is conservative for sands, gravels and cohesionless materials. The earth load should be recomputed for clay backfills when $K_u$ is less than 0.150 using the correct coefficient.

Table A-1 has been computed for materials with a mass/unit volume of 1900 kg/m³. For materials with a mass per unit volume other than 1900 kg/m³ the correct earth load can be calculated by multiplying the earth load shown in Table A-1 by the desired unit mass and dividing by 1900.

Trench width

The earth loads on Table A-1 are given for all pipe diameters for covers of 0.5 and 1.0 and 1.5 meters are independent of trench width.

This condition is true because the trench width generally exceeds the calculated transition width for these covers. i.e., the calculated earth load for the trench condition exceeds the maximum load as calculated for the positive projecting condition.

The design assumptions are for $r_{dp} = 0.5$ and the backfill $K_u$ is 0.192 for all the soil types.

Loads given in Table A-1 for cover of 2.0 meters and greater are based on trench widths (at top of pipe) of pipe OD plus 400mm for pipe diameters 800mm or less, and pipe OD plus 600mm for pipe diameters greater than 800mm.

Pipe ODs are based on wall thicknesses given in the dimensional data table for pipe.

Live loads

Live load distribution in Table A-1 is calculated from the dimensions for a single AASHTO H-20 or H-20 truck. The force exerted by each dual-tired wheel is 72 kN. For different wheel forces correct live loads can be obtained by multiplying live loads shown by the desired wheel load in kN and dividing by 72. The live load at 0.5 meters is increased by 20% for impact. For covers 3.5 meters and greater, the small effect of live loads is included in the tabulated load (see Table A-1).
Utmost care has been taken to ensure that all the contents of this brochure are accurate. However, Amiantit and its subsidiaries do not accept responsibility for any problems which may arise as a result of errors in this publication. Therefore customers should make inquiries into the potential product supplier and convince themselves of the suitability of a given products supplied or manufactured by Amiantit and/or its subsidiaries before using them.

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