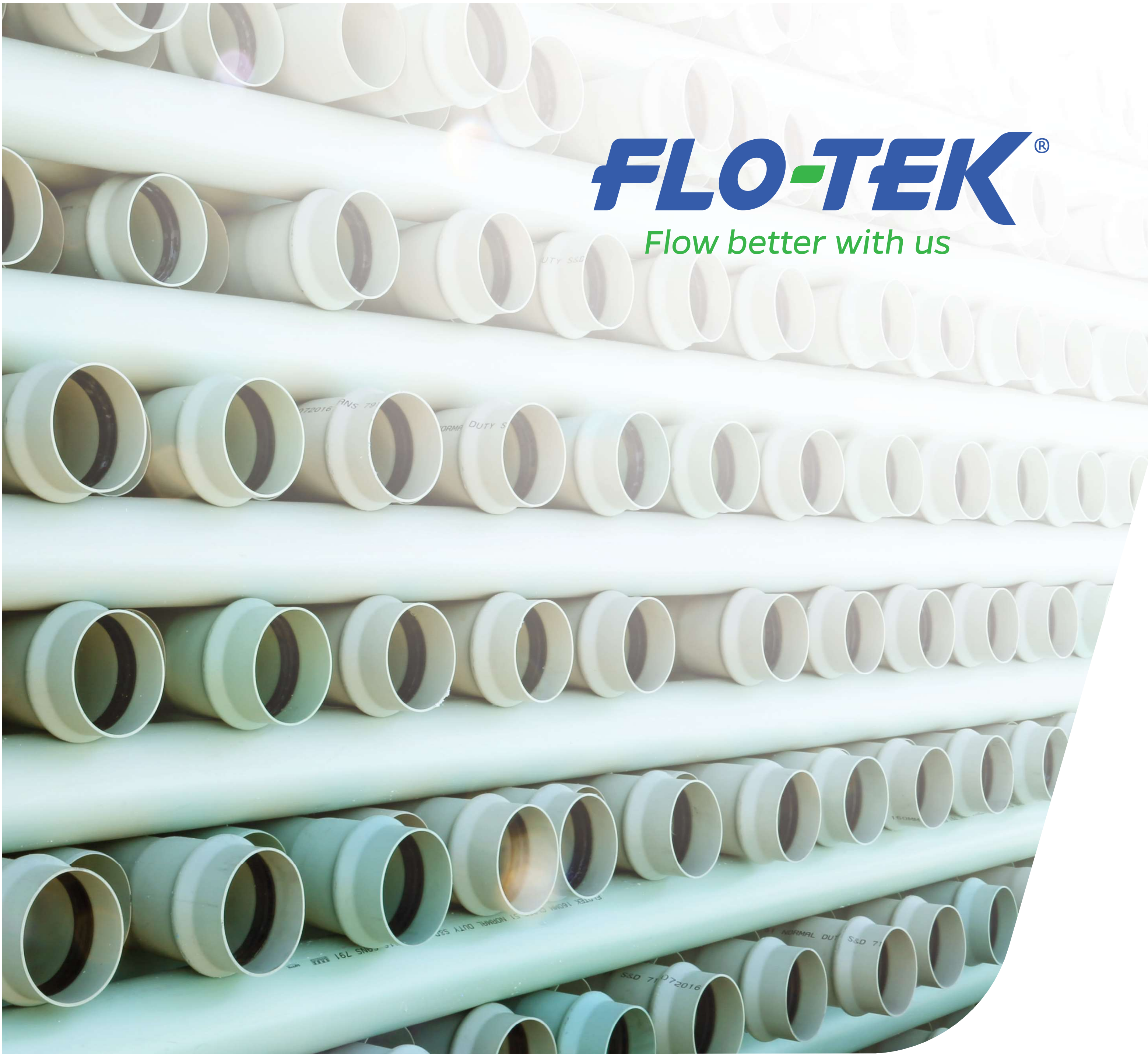


Flow better with us

# **PVC** *Sewer & Drain Systems*

Pipes | Fittings


# PIPES

# OVERVIEW

## Composition of PVC Pipe Materials

**Polyvinyl Chloride or PVC is one of the most versatile type of pipe materials. It is produced by the polymerisation of vinyl chloride which is made from coal (or oil) and common salt. In fact, salt makes up over 50% of the polymer, thus making PVC one of the most environmentally friendly plastic materials, being least dependent on increasingly scarce hydrocarbon resources.**

The unique properties of PVC can be enhanced by the addition of special additives, for example, to create strong yet tough pipe materials such as modified PVC (PVC-M), foamed multilayer sewer and drainage pipes, and weather resistant, above ground drainage pipes. These additives, as well as heat stabilisers and lubricants, which are necessary to facilitate the extrusion of the pipes, are added to the PVC raw material in a special high speed mixer to produce a dry blend specially formulated for the pipe extrusion process.

During the manufacture of the pipe the dry blend is mixed in the extruder and through a combination of heat and shear, the material is 'gelled' into a homogeneous molten mass ready for passage through the die and calibrator to form a pipe which has tight tolerances in terms of the outside diameter, wall thickness and mechanical properties.

The integral pipe end rubber ring socket is formed at the end of the extrusion line and the sealing ring fitted. A similar process is used in the injection moulding of the fittings; the material is gelled in the barrel and screw of the machine and then injected into the mould where it is cooled to form the fitting.

Rubber sealing rings and retainer caps are fitted during subsequent assembly of the finished fitting.

It should be noted that in recent years heat stabilisers and lubricants have been changed from lead based compounds to alternative, environmentally friendly materials such organic and calcium/zinc compounds.

## Applications - PVC Pipe and Fittings Systems

PVC-U gravity effluent and sewer sanitation pipe and fittings systems and water purification. (SANS 791 and SANS 1601).

· PVC-U weather resistant pipes and fittings for above ground drainage. (SANS 967).


## Features and Benefits

- *Excellent flow characteristics: reduces friction losses.*
- *Best long-term strength/ cost ratio of all pipe materials: economical and cost effective and lowers the capital cost of projects for the provision of potable water and sanitation.*
- *Service performance in excess of 50 years.*
- *Unique combination of mechanical properties: long-term strength and stiffness, making it ideal for sewer and drainage pipes.*
- *Resistant to acids and alkalis: no problems when installed in acidic soils and resistant to acidic chemicals in sewerage and in mining.*
- *Resistant to abrasion and scouring and modern cleaning methods: ideal for use as sewer and drainage pipes.*
- *Above ground soil, waste and vent pipes and fittings (white colour) - excellent long-term resistance to UV (sunlight).*
- *Light mass: lower transport costs and easy handling and installation, ideally suited for labour intensive projects.*
- *Elastomeric locked-in sealing ring system: resistant to most chemicals, long-term sealing performance and easy low cost installation with unskilled labour.*

## Physical Properties

Major properties of PVC pressure and sewer and drain pipes are given in Table. Please note that as with all thermoplastics, properties are dependent on the operating temperature and the duration of the stress application.

For example, working pressures of pipes used at higher temperatures should be lowered (or a higher class used) in order to maintain the long—term design life of the pipe.

In the case of buried sewer and drain pipes, the correct pipe stiffness should be selected depending on installation and soil and live traffic loads (refer below).

## Product Range

| PRODUCT | RANGE (ia) | SPECIFICATION |
|---|---|---|
| PVC-U Sewer & Drain Pipes | 110 - 500mm | SANS 791 |
| PVC-U Sewer and Drain Fittings | 110 - 160mm | SANS 791 |
| PVC-U Soil & Vent Pipes | 40 - 160mm | SANS 967 |
| PVC-U Soil and Vent Fittings | 50 - 110mm | SANS 967 |
| PVC-U Structured Wall Sewer & Drain Pipes (Multi-Layer Foamcore) | 110 - 200mm | SANS 1601 |

## Product Properties

| PHYSICAL | UNITS | PVC-U |
|---|---|---|
| Co-Efficient of Linear Expansion | $k^{-1}$ | $6 \times 10^{-5}$ |
| Density | $Kg/m^3$ | $1.4 \times 10^3$ |
| Flammability (oxygen index) | % | 45 |
| Shore Hardness (D) | | 70—80 |
| Softening Point (Vicat- minimum) | °C | > 80 |
| Specific Heat | J/Kg/K | $1.0 \times 10^3$ |
| Thermal Conductivity (0°C—50°C) | W/m/K | 0.14 |
| **MECHANICAL** | | |
| Elastic Modulus (long term: 50 years) | MPa | 1500 |
| Elastic Modulus (short term: 100 seconds) | MPa | 3300 |
| Elongation at break (Minimum) | % | 45 |
| Poisons Ratio | | 0.4 |
| Tensile Strength (50 year - extrapolated) | MPa | 26 |
| Tensile Strength (short-term / Minimum) | MPa | 45 |
| **FRICTION FACTORS** | | |
| Manning | | 0.008—0.009 |
| Hazen Williams | | 150 |
| Nikuradse Roughness (k) | mm | 0.03 |

# PIPE DIMENSIONS

## WALL THICKNESS & MASS / METER

**Sewer and drainage pipes**

Flo-Tek's PVC Sewer and Drainage pipes are made to SABS Specifications in an ISO 9001:2008 accredited factory. This accreditation demonstrates the company's ability to manufacture quality products to SABS and International standards.

All pipes are made to provide an effective length of 6.0 meters from 110mm — 250mm and 5.8 meters from 315mm — 500mm after installation. The outside diameters are the same for both classes of the same size. Pipe sizes 110mm and 160mm are available with plain ends (for solvent welding) or with integral rubber ring socket. The minimum wall thicknesses (as per the applicable SASS Standard) and mass per meter are given in the Tables.

Foamcore sewer and drain pipes have a multi-layered structure as shown below. The three layers provide strength and resistance to soil loads.

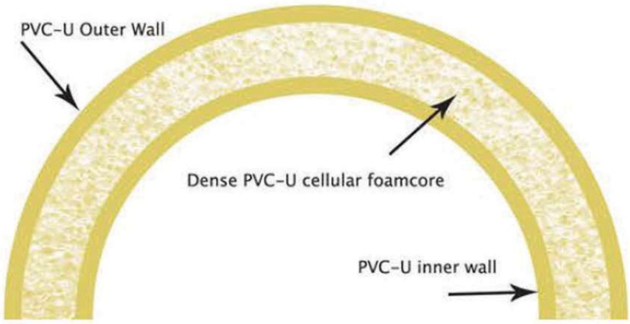



*Figure showing the multi-layered structure of foamcore pipes*

These pipes have smooth inner and outer walls and a middle layer consisting of dense cellular, foamed PVC having a high stiffness to weight ratio, providing weight and cost savings and higher pipe stiffness. Outside diameters are the same as solid wall pipes made to SANS 791. Foamcore pipes are thus compatible with all moulded and fabricated sewer and drain fittings.

### SANS 791 PVC-U SEWER & DRAIN PIPE (Solid Wall)

| NOMINAL SIZE (mm) | MIN. WALL THICKNESS (mm) | | MASS (kg/m) | |
|---|---|---|---|---|
| OUTSIDE DIAMETER | NORMAL DUTY | HEAVY DUTY | NORMAL DUTY | HEAVY DUTY |
| 110 | 2.2 | 3.0 | 1.2 | 1.6 |
| 160 | 3.2 | 4.7 | 2.5 | 3.6 |
| 200 | 3.9 | 5.9 | 3.8 | 5.7 |
| 250 | 5.0 | 7.3 | 6.1 | 8.8 |
| 315 | 6.2 | 9.2 | 9.6 | 14.1 |
| 355 | 7.0 | 10.2 | 12.2 | 17.7 |
| 400 | 7.9 | 11.7 | 15.6 | 22.9 |
| 450 | 8.8 | 13.2 | 19.6 | 29.1 |
| 500 | 9.8 | 14.6 | 23.3 | 35.8 |

- **Normal Duty:** Class 51 (SDR 51): Pipe Stiffness 100 kPa
- **Heavy Duty:** Class 34 (SDR 34): Pipe Stiffness 300 kPa.

### SABS 1601 Structured Wall Sewer and Drain Pipes

| NOMINAL SIZE (mm) OUTSIDE DIAMETER | STIFFNESS CLASS (in KPa) | STIFFNESS CLASS (in KPa) | STIFFNESS CLASS (in KPa) |
|---|---|---|---|
| 110 | 100 | 200 | 400 |
| 160 | 100 | 200 | 400 |
| 200 | 100 | 200 | 400 |

## Soil, Waste and Vent Pipes

### SABS 967 Soil, Waste and Vent Pipes

| NOMINAL SIZE (mm) OUTSIDE DIAMETER | MIN. WALL THICKNESS (mm) | MASS (kg/m) |
|---|---|---|
| 40 | 2.0 | 0.4 |
| 50 | 2.2 | 0.5 |
| 75 | 2.2 | 0.8 |
| 110 | 3.2 | 1.6 |
| 160 | 3.3 | 2.5 |

Flo-Tek's soil, waste and vent pipes are specially formulated for resistance to sunlight and long-term outdoor exposure. Minimum wall thickness and mass per meter are given in Table.

# DESIGN CONSIDERATIONS

Solid wall PVC sewer and drain pipes have been used throughout the world for over 40 years and given exceptional service. Structured wall foamcore pipes are a later development designed to give weight and cost savings with greater pipe stiffness and performance. These pipes have been in use for over 25 years in Europe and elsewhere and at least 15 years in Southern Africa.

A detailed account of sewer and drain pipes, their properties, design parameters, pipe deflection, soil and traffic loads and installation is given in the SAPPMA (Southern African Plastic Pipe Manufacturers Association) Technical Manual 2013, 4th Revision.

This manual is available from Flo-Tek Pipes and Irrigation and from the SAPPMA website (www.sappma.co.za). The following notes summarise some of the important considerations which are covered in detail in the SAPPMA Technical Manual.

Pipe stiffness test with the pipe sample placed between parallel plates in the Tensometer at the start of the test and prior to any force being applied.

A 200mm foam core pipe deflected far beyond the 5% required for the test. Note the absence of buckling and the strength and toughness of the pipe at a deflection of 40%.

Various parameters are used to define pipe stiffness. They all relate to the ability of a pipe to resist deformation. Knowledge of these parameters is important to prevent overloading and excessive deflection of pipes.

Pipe stiffness is determined from a parallel plate test on a pipe.

$$PS = F/\Delta Y$$

Where:
- PS is pipe stiffness expressed as kPa (kN/m2)
- F is the force necessary to deflect the pipe by a given percentage taken from the relevant specifications
- $\Delta Y$ is the vertical deflection of pipe

The pipe stiffness factor used in the DIN standards is calculated from the pipe material properties and the pipe geometry.

$$PSF = EI/r^3$$

Where:
- PSF is the pipe stiffness factor in kN/m/m
- E is the elastic modulus of the pipe material
- I is the moment of inertia of the pipe wall
- r is the pipe radius

Pipe ring stiffness used in ISO standards is also calculated from the pipe material properties and the pipe geometry. It is an eighth of the PSF.

$$PRS = EI/D3$$

Where:
- PRS is the pipe ring stiffness in kN/ m/m
- E is the elastic modulus of the pipe material
- I is the moment of inertia of the pipe wall
- D is the pipe diameter

The relationship between these three factors is:

0.149 PS= PSF = 8 PRS; PS= 6.71 PSF = 53.69 PRS

PRS is also referred to as the nominal stiffness, SN.

**PS, PSF and PRS**

| PIPE STIFFNESS (kPa) | PIPE STIFFNESS FACTOR (kN/m/m) | PIPE RING STIFFNESS (kN/m/m) |
|---|---|---|
| 100 | 14.9 | 1.860 |
| 200 | 29.8 | 3.725 |
| 300 | 44.7 | 5.588 |
| 400 | 59.6 | 7.450 |

## LOADS ON FLEXIBLE PIPES AND INSTALLATION

### Vertical loads

The strength of buried drain pipes and sewers is invariably dictated by external loads rather than internal pressure. External loads arise mainly from vertical soil and live traffic loads. However, these loads are considerably reduced by friction and cohesion between the backfill material and the trench walls and provided recommended installation procedures have been followed, these loads on the pipes are transferred to the trench walls.

The determination of pipe deflections is covered in the SAPPMA Technical Manual for various soil loads, soil density and soil moduli. Proper bedding, side fill and backfill with selected granular material and composition to a specified density of 90% modified ASSHTO, to a depth of at least 300mm above the crown of the pipe, combined with the load shedding ability of the pipe, will ensure acceptable deflections.

The load shedding ability of the pipe to the surrounding soil is due to the creep properties of plastic pipes under high stresses. Creep effectively lowers the modulus of elasticity of the pipe material and deflection will gradually increase with time until reaching an equilibrium at about 12 months. The 3 year or long-term elastic modulus should therefore be used by the design engineer.

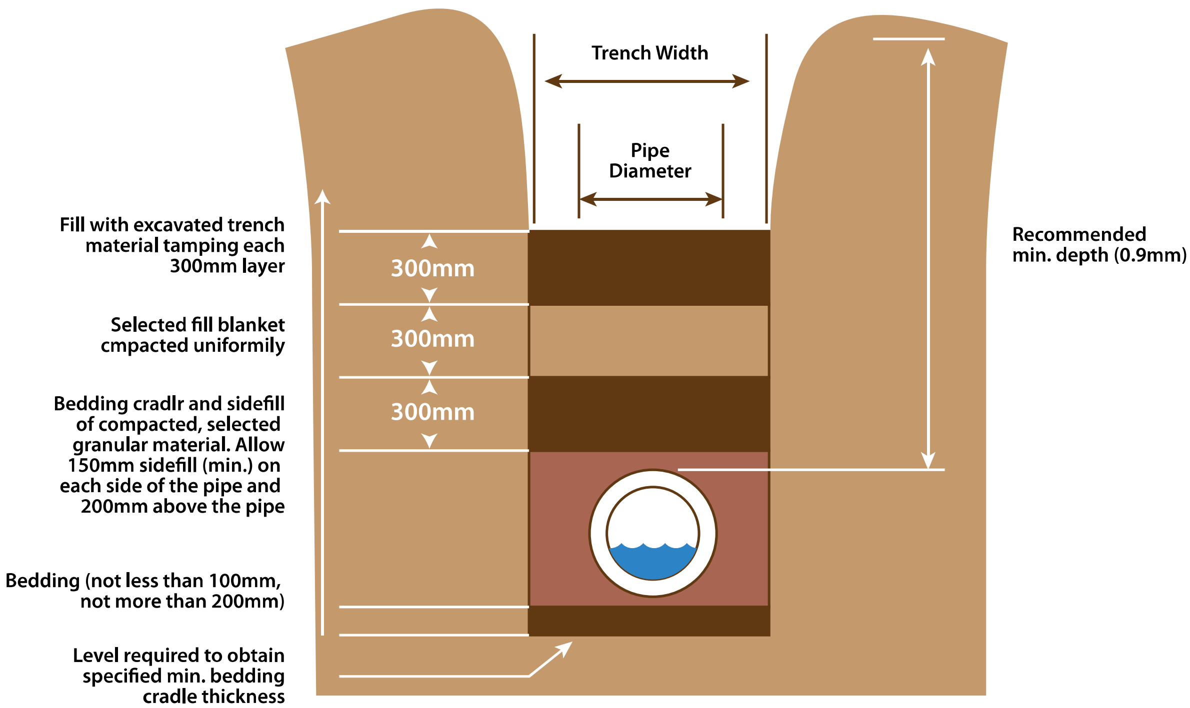
### Live traffic loads

These loads are momentary and the instantaneous or short-term elastic modulus should be used in estimating additional deflections due to live loads.

### Trenching, Bedding & Backfilling

These procedures are covered in the Standard Specification for Civil Engineering Construction, SABS 1200. Further recommendations are given in the Code of Practice SANS 0120. Provided installations are carried out according to these codes of practice, Flo-Tek's sewer and drain pipes will give excellent service well over and above their minimum design life of 50 years.

An illustration of the installation of PVC-U sewer and drain pipes is shown below:



# PIPE JOINTING

## JOINTING METHODS

### 1. Cutting

PVC pipes can be easily cut using a number of different cutting tools, such as proprietary cutting tools which cut, deburr and chamfer in one operation, circular saws or hand saws. It is important to ensure that, after cutting, the pipe end is thoroughly deburred.

### 2. Rubber Ring Joints

A rubber ring socket is integrally moulded on one end of the pipe and incorporates a factory fitted rubber sealing ring which is retained in position. The opposite end of the pipe (spigot end) is suitably chamfered and has a depth of entry mark near its end. Each joint is capable of handling expansion and contraction as well as angular deflection of up to 2°C and a pressure of up to 75kPa below the ambient atmospheric pressure. The seal ring is designed to provide a watertight joint at high and low pressures.

### 3. Depth of Entry

The depth of entry mark is a guide to ensure correct depth of insertion of the spigot into the socket of the next pipe. If pipes are cut to measure on site it is necessary to remark the depth of entry according to the dimensions given in the following table or as per the pipe being installed at the same time.

Re-marking can be done with a permanent felt tipped marker pen. The correct depth of entry allows for expansion and contraction of the pipes in the pipeline.

| PIPE SIZE (mm) | DEPTH OF ENTRY (mm) | APPROX. LENGTH OF CHAMFER (mm) |
|---|---|---|
| 50 | 88 | 10 |
| 63 | 93 | 10 |
| 75 | 98 | 10 |
| 90 | 105 | 15 |
| 110 | 113 | 15 |
| 125 | 114 | 15 |
| 140 | 126 | 20 |
| 160 | 129 | 20 |
| 200 | 159 | 25 |
| 250 | 183 | 25 |
| 315 | 189 | 30 |
| 355 | 203 | 30 |
| 400 | 225 | 30 |
| 450 | 235 | 35 |
| 500 | 235 | 35 |

### 4. Chamfering

The spigot end of all rubber ring jointed pipes is chamfered at the time of manufacture. Chamfering facilitates the insertion of the spigot end into the socket of the next pipe without damaging or dislodging the rubber ring. If however, the chamfering has been cut off it is important to re-chamfer the end correctly. Re-chamfering can easily be done using a file that leaves no sharp edges which may cut the rubber ring

It should be at an angle of about 12 - 15" and the length of the chamfer should be such that at least half the wall of the thickness is removed. The chamfering should not be done to such an extent that a sharp edge is made at rim of the bore.

### 5. Lubricant

It is the most important to use correct lubricant when making a joint. The lubricant considerably reduces the effort required to insert the spigot into the socket and at the same time minimizes the possibility of dislodging the rubber ring. The lubricant should be water soluble, non-toxic and of a gel consistency. Alternative lubricants such as Oil, grease, diesel, dishwashing liquid, etc. must under no circumstances be used.

## JOINTING PROCEDURE

### Rubber Ring Joints of Pipes

1. Check the spigot end of the pipe for correct chamfering (12 - 15 with the correct length - see table) as described in "chamfering" above. Ensure that the "depth of entry" mark is visible and that there are no burrs and damage present.
2. Wipe the spigot end clean.
3. Check the socket end of the pipe to ensure that the rubber ring is present and correctly fitted. Make sure that no dirt or mud is present.
4. Apply the thin film of lubricant evenly around the circumference of the spigot up to about half the distance to the "depth of entry" mark.
5. Lubricate the rubber ring sparingly.
6. Place the spigot end of the pipe into the socket so that it rests against the rubber ring.
7. Ensure the two pipes are correctly aligned both horizontally and vertically. Failure to do this could lead to the rubber ring being dislodged when the next step is carried out.
8. Push the spigot into the socket until the "depth of entry" mark is just visible at the end of the socket. It should not be necessary to use undue force — if this becomes necessary it is normally an indication that something is amiss and the joint making process should be started again.

### Solvent Weld Joints

**It must be stressed that solvent cement jointing is a welding and not gluing process. It is important therefore that there is an interference-fit between the spigot and socket to be joined.**

Do not attempt to make a joint when an interference-fit between a dry spigot and socket is not achieved (ie. a rattle fit). There are different types of solvent cement available for pressure pipes and for non-pressure applications. Make sure that the appropriate cement is being used. Do not dilute or add anything to the solvent cement.

Excellent solvent weld joints can be made to withstand high pressures, providing the correct welding procedure is followed.

### Solvent Cement Joints of Pipes & Fittings

***Assemble all the required fittings, pipes and equipment.***
***For the best results, follow the jointing procedure below.*** .

a. Make sure that the spigot has been cut square and that all burrs have been removed.

b. Mark the spigot with a pencil line (or similar) at a distance equal to the internal depth of the socket.

c. Check that, while dry, there is an interference fit between the spigot and the socket before the spigot reaches the full depth indicated by the pencil line.

d. Ensure that both the spigot and the socket are properly dry (not illustrated).

e. Degrease and clean both with an appropriate etch cleaner (not illustrated). This also acts as a primer first.

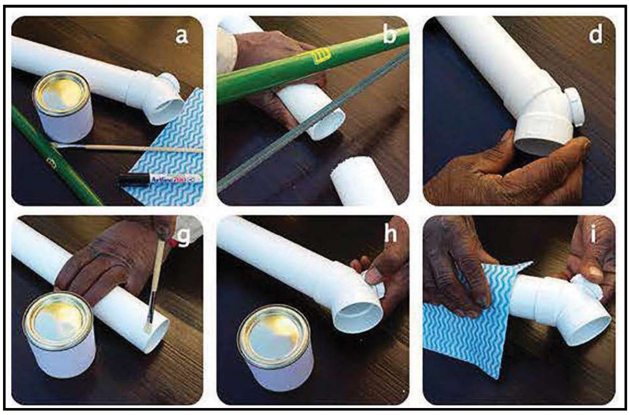
f. With a suitable brush apply a thin film of solvent cement to the internal surface of the socket. Then apply the solvent cement in a similar manner up to the mark on the spigot. Do not use excess solvent cement. The brush width should be such that the solvent cement can be applied to both surfaces within about 30 seconds.

g. Make the joint immediately. While inserting the spigot rotate it by about 90° and ensure that it is fully inserted up to the pencil mark, as there is a bead of excess solvent cement indicating the correct amount has been applied. Hold steady for at least 30 seconds. Mechanical assistance may be necessary for large pipes.

h. Wipe off any excess solvent cement with a clean rag.

i. Do not disturb for at least 5 minutes.

j. Do not apply pressure for at least 24 hours.



## STORAGE AND TRANSPORTATION

### Storage

Pipes should be sorted on level, flat ground, free of stones. They may be stored on timber supports of at least 75mm width placed 1.5 meters apart with side supports. The height of pipe stacks should not exceed 1.5 meters.

All pipe stacks and stored fittings should be covered to avoid prolonged exposure to direct sunlight. Where the pipes are fitted with an integral socket, they should be stacked with sockets protruding at alternate ends. This prevents damage or distortion of the socket and spigot, especially under hot storage conditions.

### Transportation

A flat-bodied vehicle is ideal for transporting pipes and fittings. Pipes with integral sockets should be loaded and spaced so that sockets protrude at alternate ends. When a mixed load of pipes (i.e. varying diameters) is to be transported, the larger pipes should be place at the bottom. Pipes should not overhang the vehicle by more than 1 meter.

## PIPE SELECTION CRITERIA

**PRESSURE & NON-PRESSURE PIPES**

A very good description of the criteria which may be used for the selection of the various plastics pipes available for each application is given in the SAPPMA Technical Manual (Second Edition, March 2009) (1).

The section in the Technical Manual covers the following:

**HYDRAULIC REQUIREMENTS**

- Basic Principles
- Operating Pressure, Hoop Stress and Wall Thickness
- Surge and Fatique
- Factory Tests

**EXTERNAL LOADS**

- Design Basis
- Load Classification
- Pipe Stiffness
- Determining Required Pipe Stiffness
- Vertical Deflection

**DURABILITY REQUIREMENTS SYSTEM COMPONENTS**

- Secondary Loads
- Manholes
- Joints and Fittings
- Valves

**PIPE INSTALLATION**

An excellent section in the SAPPMA Manual covers the following on pipe installation procedures:

- Pre-construction Activities
- Excavation
- Embedment
- Pipe Laying and Jointing
- Backfilling
- Anchoring
- Support Spacing for Mine Pipes
- Support Spacing for Soil, Waste and Vent Pipes
- Site Tests

## REFERENCES


1. SANS 791: 2004. Unplasticised poly(vinyl chloride)(PVC-U) sewer and drain pipes and pipe fittings
2. SANS 1601: 2004. Structured wall pipes and fittings of unplasticised poly(vinyl chloride) (PVC-U) for buried drainage and sewerage systems
3. SANS 967: 2004. Unplasticised poly(vinyl chloride)(PVC-U) soil, waste and vent pipes and pipe fittings
4. Southern African Plastics Manufacturing Association (SAPPMA) Technical Manual 2013, 4th Revision