BOSSPIPE COMPLIANCE TO AS/NZS 5065:2005

And

ADDITIONAL INFORMATION ON BOSSPIPE AND FITTINGS

Author: **Leon Tabachnik, PhD**

Plastics Technical Manager

Ref number: **BP167/T**

Waters & Farr
105 Neilson St, Onehunga
PO Box 13329, Onehunga
Auckland, New Zealand
Phone +64 9 622 4036
Fax +64 9 622 4037

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OVERVIEW

The first section provides information on the Bosspipe range of civil drainage pipe manufactured in Wanganui by Waters and Farr a business unit of InterPipe Holdings Limited. In particular it looks to illustrate the compliance of Bosspipe to AS/NZS 5065:2005 which was published on the 18th October 2005. The long title of the standard is Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications.

Bosspipe that is manufactured in accordance with AS/NZS 5065:2005 is supplied in two product categories:

StormBoss - stormwater drainage pipe and fittings,

SewerBoss - sewer pipe and fittings.

In Section Two additional information is provided on Bosspipe - dimensions, chemical resistance, operating temperatures, abrasive resistance, flow data and structural design including embedment, installation and testing and in Section Three details on Bosspipe fittings – manhole connectors, couplers and saddles.

We trust that this comprehensive document will answer all your questions.

FORWORD:

AS/NZS 5065:2005 covers pipes and fittings that are classified in terms of stiffness. Common stiffness classes are SN2, SN4, SN8 and SN16 being based on the requirements of ISO 8772:1991 – PE pipes and fittings for buried sewerage systems and ISO 8773:1991 PP pipes and fittings for buried drainage and sewerage systems.

It specifies the requirements for polyethylene (PE) and polypropylene (PP) pipes and fittings for sewerage and drainage applications where these are operating under gravity flow and when the operating pressure is low.

The standard covers requirements to solid wall pipe (incorporating Jacket pipe) as well as structured wall (incorporating Bosspipe) pipes and fittings.

MEANS FOR DEMONSTRATING COMPLIANCE:

Appendix A of AS/NZS 5065:2005 sets up the means for demonstrating compliance to the standard. As Waters & Farr is certified to AS/NZS ISO 9001:2000 by SAI Global and has its own laboratory, we comply with the requirements of *Clause A5 Minimum sampling and testing frequency plan”.*

Table A sets out the minimum sampling and testing required by a manufacturer to demonstrate compliance. We will work through this in detail to clearly illustrate that Bosspipe does comply with the requirements of AS/NZS 5065:2005.

Raw Materials:

Clauses 2.1.6, 2.1.7, 2.1.8 and 2.1.10 relate to PE compounds

Clause 2.1.2 relates to solid wall pipe.

Clause 2.2 is not relevant as all compounds used to manufacture Bosspipe either are black or contain more than 0.2% by mass of HALS.

Clauses 2.1.1, 2.1.3 – 2.1.5 plus 2.1.9

Bosspipe is manufactured from polypropylene (PP), a material that combines high resistance to impact, stress cracking, abrasion and chemical attack with durability in excess of 100 years in drainage systems. Bosspipe has excellent hydraulic properties and may be used in various soils and can operate at temperatures up to 60℃, or up to 90℃ short term.

Both layers are made of PP compounds containing antioxidants, UV stabilizers and pigments necessary for them to be used in the manufacture of pipes and fittings. Carbon black content of PP compound of outer layer complies with the requirements of AS/NZS 5065, PP compounds of inner layer and stripe contain more than 0.2% by mass of HALS. Base PP-B compounds used in both layers comply with ISO 8773 in respect of internal pressure resistance.

Outer layer of Bosspipe is black to ensure lifetime UV resistance. Inner layer also contains additives for UV protection during storage (up to 1 to 2 years depending on storage conditions), and allows for colour identification by CCTV inspection:

- StormBoss identification – grey inside (RAL7035 to RAL7042 in lightness),
- SewerBoss identification – terracotta inside (RAL8023).

Clause 2.3 Elastomeric seals

Joints are of push-fit type creating an elastomeric seal using a rubber ring. Rubber rings are supplied with the pipes or separately and are made of EPDM complying with AS 1646.1 and AS 1646.2. Rubber rings are moulded so do not contain any joint seams, are marked and colour coded for clear identification to ensure that the correct ring is used.

Performance Requirements - Tests on Pipes and Fittings

Clause 3.1 relates to PE

Clause 3.2.1 relates to plain wall pipe

Clause 3.2.2

Stiffness is determined to AS/NZS 1462.22 (Note in the clause approximates polyethylene plain wall pipes of SDR 17 to SN16 class, SDR 21 – to SN8, SDR 26 – to SN4).

Minimum stiffness of Bosspipe is within the range of 6000 N/m/m to 20000 N/m/m. In all cases Bosspipe exceeds the SN rating specified in Table 3.1.

Waters & Farr currently stocks StormBoss of Nominal Stiffness SN6, SN8 and SN16, and SewerBoss in SN16. In addition to labeling the stiffness rating is also identified by a coloured external stripe.

- SN6 identification – a yellow stripe,
- SN8 identification – a blue stripe,
- SN16 identification – a red stripe,
- SN20 identification – a purple stripe.

Clause 3.2.3

Bosspipe ring flexibility is determined to AS/NZS 1462.23 and complies with the requirements of this standard.

Clause 3.3.2 is not relevant and 3.3.3 relates to electrofusion joints

Clause 3.3.1

Bosspipe fittings are Hydrostatic pressure tested to AS/NZS 1462.10

Clauses 3.4.1, 3.4.2 and 3.4.3

All Bosspipe elastomeric seal joints are tested for hydrostatic pressure resistance to AS/NZS 1462.10, liquid infiltration to AS/NZS 1462.8 and contact pressure to AS/NZS 1462.13(Int). The rubber ring is placed in the second groove in for DN225 and DN300 and in the first groove in for DN375 and DN450 Bosspipe.

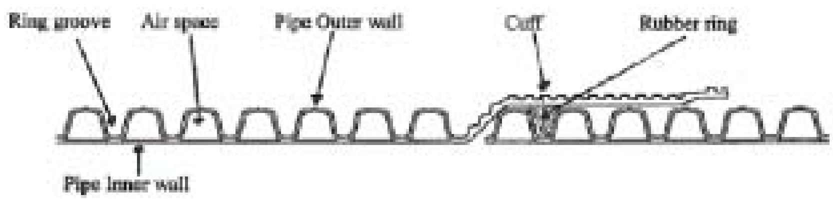
Pipes Type A1 and Plain Wall

Clauses 4.1.1, 4.1.2, 4.1.3.1, 4.1.3.2, 4.1.3.3, 4.1.3.4 relate to OD Series solid wall pipe and to sandwich construction pipe referred to as Type A1 pipe in the standard.

Pipes Type B and ID Series

Clauses 4.1.4.1 – 4.1.4.4

Bosspipe is an advanced twin-walled corrugated pipe that is classified as and fully complies to the requirements to Type B – ID Series pipe of the standard.



Bosspipe is currently produced in 4 sizes: DN225, DN300, DN375 and DN450 (Nominal Inside Diameter).

Clauses 4.1.4.5, 4.1.4.6, 4.1.4.7 refer to OD Series pipe

Clause 4.1.4.2, 4.1.4.3

Bosspipe wall thickness and dimensions of sockets and spigots fully comply with the dimensions listed in Table 4.6 and Table 4.7 of the standard.

Clause 4.2

The effective length of Bosspipe is 6m as determined by AS/NZS 1462.1

Clause 4.3

Bosspipe spigot ends are cut nominally square

Clause 4.4 relates to plain wall pipe

Clause 4.5

Bosspipe is produced with an integrated socket that complies with the requirements of this standard.

Clause 4.6

All Bosspipe and associated fittings are visually inspected to ensure that they are supplied free from any defects that may affect the performance of the pipe in service.

Clause 4.7

All Bosspipe marking complies with the requirements of the standard.

Clause 4.8

All Bosspipe is supplied with a witness mark in accordance with the standard.

Fittings

This section relates to solid wall pipe fittings.

In Summary:

Waters & Farr has been manufacturing solid wall polyethylene pipe since it was established in 1954. It supplies polyethylene pipes and fittings for distribution of gaseous fuels, potable water and for drainage and sewerage applications in accordance to the requirements of AS/NZS 4130:2001 and AS/NZS 5065:2005. It also manufactures power and telco ducting and an extensive range of rural piping.

Bosspipe was added to the product offering in 2005.

Waters & Farr operates a Quality System certified to AS/NZS ISO 9001:2000 by SAI Global.

Conclusion:

StormBoss and SewerBoss manufactured and tested by Waters & Farr fully complies with the requirements of AS/NZS 5065.2005.

SECTION TWO

ADDITIONAL INFORMATION ON BOSSPIPE

Dimension Chart

Pipe \ Nominal Stiffness		SN6, SN8 and FarmBoss *	SN16
DN	OD	Mean ID, mm	Mean ID,mm
225	259	224	220
300	353	306	296
375	442	383	370
450	531	460	444

* FarmBoss is a rural culvert and drainage type of Bosspipe

Chemical resistance

Polypropylene (PP) is noted for its excellent resistance to most common organic and mineral acids, their salts, strong and weak alkali and most organic chemicals, and is not affected by usual domestic sewage. Some concentrated acids and active oxidizing agents as well as aromatic and chlorinated hydrocarbons can attack it, especially at elevated temperatures.

EPDM (terpolymer combining ethylene, propylene and a diene monomer) used for sealing rings has excellent resistance to water and steam, acids, alkali, salt solutions, etc. , and also is not affected by usual domestic sewage. At the same time EPDM has poor resistance to petroleum and some other mineral oils, to concentrated acids and active oxidizing agents, to diester-base lubricants, especially at elevated temperatures.

Operating temperature

Bosspipe made of polypropylene (PP-B) can operate at temperatures up to 60℃, and short-term – up to 90℃.

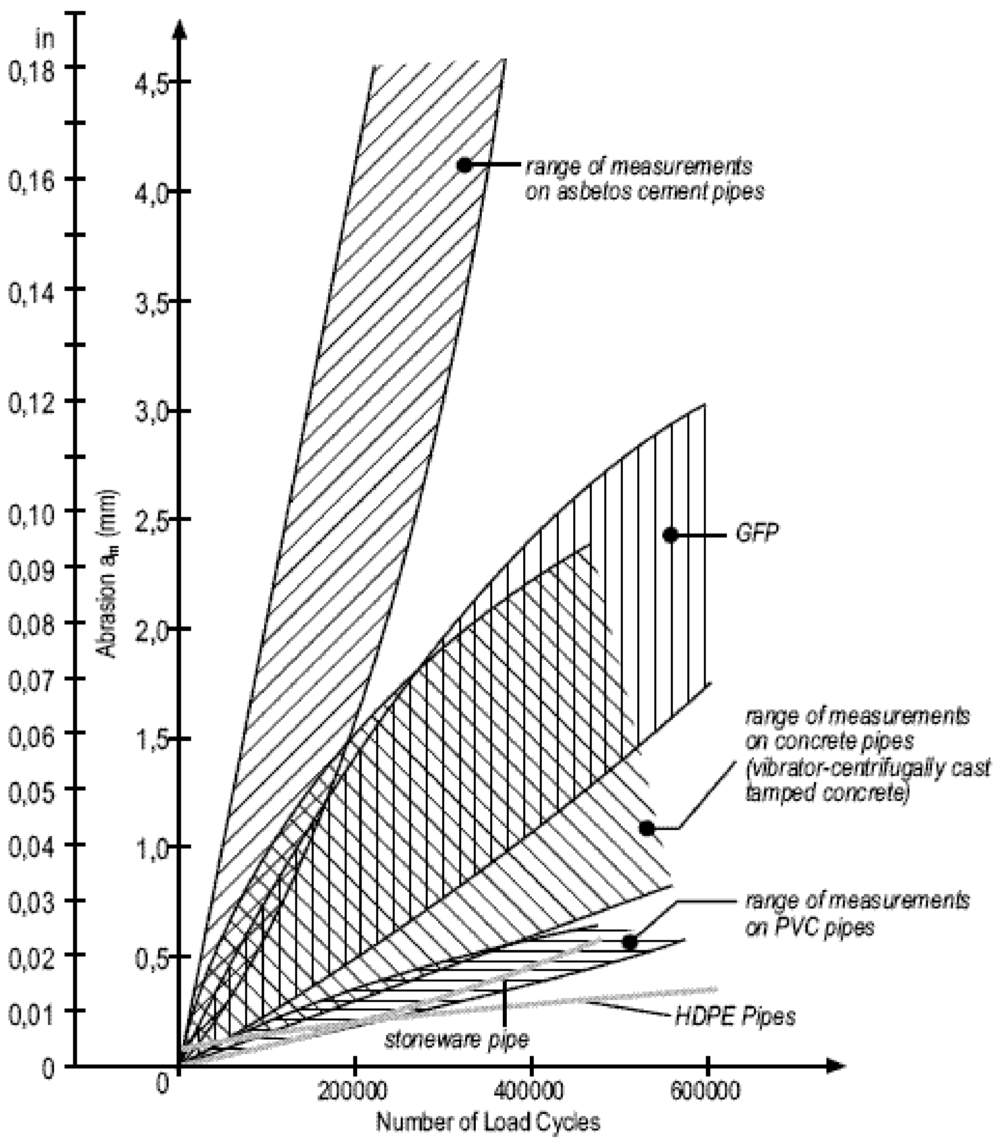
For structural design purposes, at elevated temperatures a de-rating factor should be applied – typically as follows:

- at 30℃ – de-rating factor of 0.85,
- at 40℃ – de-rating factor of 0.70,
- at 50℃ – de-rating factor of 0.55.

Abrasion Resistance

A study in Germany of abrasion wear in piping was performed by tilting back and forth 1 m of pipe containing an abrasive mixture of 46% by volume quartz sand in water [ADS Technical Note 2.116]. Results of testing may be represented as a function of a number of cycles (see picture below). Using this method, HDPE pipe has an average abrasion of 0.3 mm after 400,000 cycles that is noticeably superior to concrete pipes and PVC pipes. Abrasive resistance of polypropylene is regarded as being superior to HDPE. Typically, when tested to ASTM D 1044, abrasion resistance of PP is 4-5% higher than that of PE.

Average Abrasion Values for Pipes Made of Various Materials



Structural Design:

Bosspipe lines are classified as flexible pipelines, the structural design of which relies upon side support to resist vertical loads without excessive deformation. Detailed practice for the structural design of buried flexible pipelines is given in AS/NZS 2566.1:1998 and its Supplement.

The structural performance of Bosspipe is dependent on pipe characteristics, properties of native soil and embedment material, external and internal loadings.

According to AS/NZS 2566.1:1998 the performance of flexible pipe materials in relation to structural design of buried pipelines is limited by vertical pipe deflection, ring strain, ring stress, or buckling resistance. For polyethylene and polypropylene, allowable long-term vertical pipe deflection for non-pressure pipelines is 7.5%, allowable long-term ring-bending strain is 4.0%.

AS/NZS 2566.1:1998 uses ring-bending stiffness as basis for structural design. Bosspipe is manufactured in three classes of nominal stiffness:

- SN6 - minimum nominal stiffness of 6000 N/m/m,
- SN8 - minimum nominal stiffness of 8000 N/m/m,
- SN16 - minimum nominal stiffness of 16000 N/m/m.

Typical embedment geometry is shown on Figure 1 and Table 1 (based on requirements of AS/NZS 2566.1:1998).

Table 1. Minimum embedment zone dimensions

millimetres

Bosspipe size	Minimum dimension		
	l_b	l_c	l_o
DN225	100	150	100
DN300	100	200	150
DN375	100	200	150
DN450	150	300	150

B - trench width measured at springline of pipe.

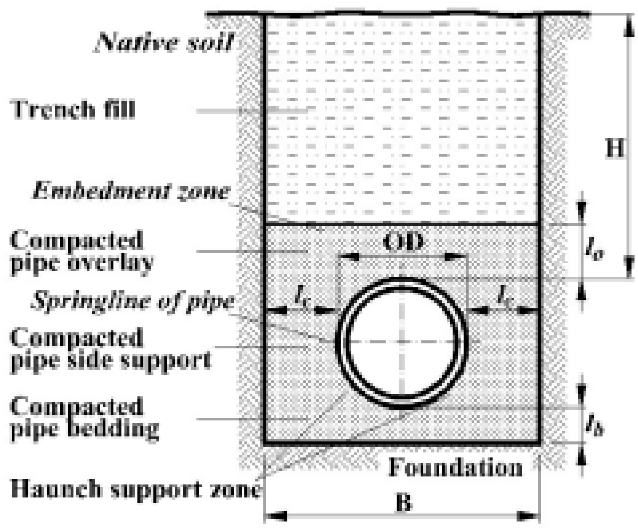


Figure 1. Typical installation in a trench

Trench width shall be sufficient for placement and compaction of embedment materials, and for making and inspection of joints. To minimise the load on the pipe, the trench width should be kept as close to the specified minimum as possible.

Typical embedment material is gravel or coarse aggregate. The embedment material shall be free of organic materials and of other materials that would be harmful to a pipe or rubber ring (e.g., mineral oils, fuels, etc.). The recommended maximum particle size is 14 mm and in no case should be over 20 mm. For better compaction, we recommend that content of fines should not exceed 12%, preferably less than 5%.

In structural design of buried flexible pipelines, soil support is expressed in terms of combined soil modulus of embedment material and native soil. AS/NZS 2566.1:1998, Table 3.2, gives typical values of embedment material modulus (E'_e) and native soil modulus (E'_n) for different types of soils and degrees of compaction of embedment material (see Table 2).

Table 2. Embedment and native soil - materials and moduli*

Materials			Moduli E'_e and E'_n, MPa				
Description	Classification		Uncompacted	Dry density ratio R_D (%)			
				85	90	95	100
	AS 1726†	AS 2758.1		Density index I_D (%)			
				50	60	70	80
			Standard penetration test ‡ Number of blows				
			≤ 4	> 4 ≤ 14	>14 ≤ 24	>24 ≤ 50	> 50
Gravel-single size	-	} Coarse aggregate	5§	7§	7§	10§	14
Gravel-graded	GW		3§	5§	7§	10§	20
Sand and coarse-grained soil with less than 12% fines	GP, SW, SP and GM-GL, GC-SC etc	-	1	3§	5§	7§	14
Coarse-grained soil with more than 12% fines	GM, GC, SC SM and GM-SC, GC-SC	-	NR	1§	3§	5§	10
Fine-grained soil (LL<50%) with medium to no plasticity and containing more than 25% coarse-grained particles	CL, ML, mixtures ML-CL and ML-MH	-	NR	1§	3§	5§	10
Fine-grained soil (LL<50%) with medium to no plasticity and containing less than 25% coarse-grained particles	CI, CL, ML, mixtures ML-CL, CL-CH and ML-MH	-	NR	NR	1	3	7
Fine-grained soil (LL>50%) with medium to high plasticity	CH, MH and CH-MH	-	NR	NR	NR	NR	NR

* Values apply for covers to 10.0 m and are conservative for greater covers.

† See Appendix A of AS 2566.1 Supp 1.

‡ For native soils only. See AS 1289.6.3.2.

§ These values are the more commonly used and achieved in practice.

NR = No reliable modulus values for these materials. May be appropriate where external load is nominal or where evaluation permits its use.

NOTES:

1 Values are conservative as they contain a reduction in modulus, which occurs when the ground water is above the pip. Allowance can be made for dry ground conditions. (See AS/NZS 2566.1 Supp 1.)

2 Where appropriate, geotextile is to be placed between native soil and embedment material to prevent migration of fines.

3 Where stabilized materials are used the designer shall determine values $E'e$ for the specified material.

Source: AS/NZS 2566.1:1998, Table 3.2.

Guide to the description and identification of soils is given in AS/NZS 2566.1 Supplement 1:1998, Appendix A, or AS 1726. For example, “SM” group includes silty sands and sand-silt mixtures (particle size ~0.2 mm), “SC” group includes clayey sands, sand-clay mixtures (particle size ~0.075-0.1 mm), “CL” and “CI” groups include inorganic clays of low to medium plasticity and medium to high dry strength, and so on.

The flexible pipelines are installed at a depth exceeding minimum pipeline cover *H* (see Fig. 1) requirements given in Table 3 (requirements of AS/NZS 2566.2:2002). Note that for pipe buried in soil with low soil modulus, in conditions of traffic loading minimum cover requirements given in the Table 3 may be insufficient.

Table 3. Minimum cover (*H*)

Loading condition	***H****, m
Not subject to vehicle loading	0.30
*Land zoned for agricultural use **	0.60
Subject to vehicular loading – (a) no carriageway; (b) sealed carriageways; and (c) unsealed carriageways	 0.45 0.60 0.75
Pipelines in embankments or subject to construction equipment loads	0.75

* Under cultivated agricultural land ***H*** should not be less than 0.6 m. Railway crossings are covered by other requirements.

** This requirement is taken directly from AS/NZS 2566.2:2002 . Obviously, when culvert piping is not expected to serve 100 years the cover may be reduced to suit the particular conditions, strength pipe, ground conditions, depth of drain etc.

Maximum pipeline cover depends on soil type, embedment material, degree of compaction, as well as on pipe characteristics. Graphs on Figures 2 to 4 may serve as a guide (with increase of native soil modulus, the soil conditions change from unstable ground to rock). The graphs for Bosspipe lines are prepared based on recommendations of AS/NZS 2566.1:1998 (construction equipment loads, external hydrostatic loads, superimposed dead loads, temperature effects, soil subsidence and differential settlement, are not taken into account; traffic loadings in shallow cover conditions may exceed buckling resistance).

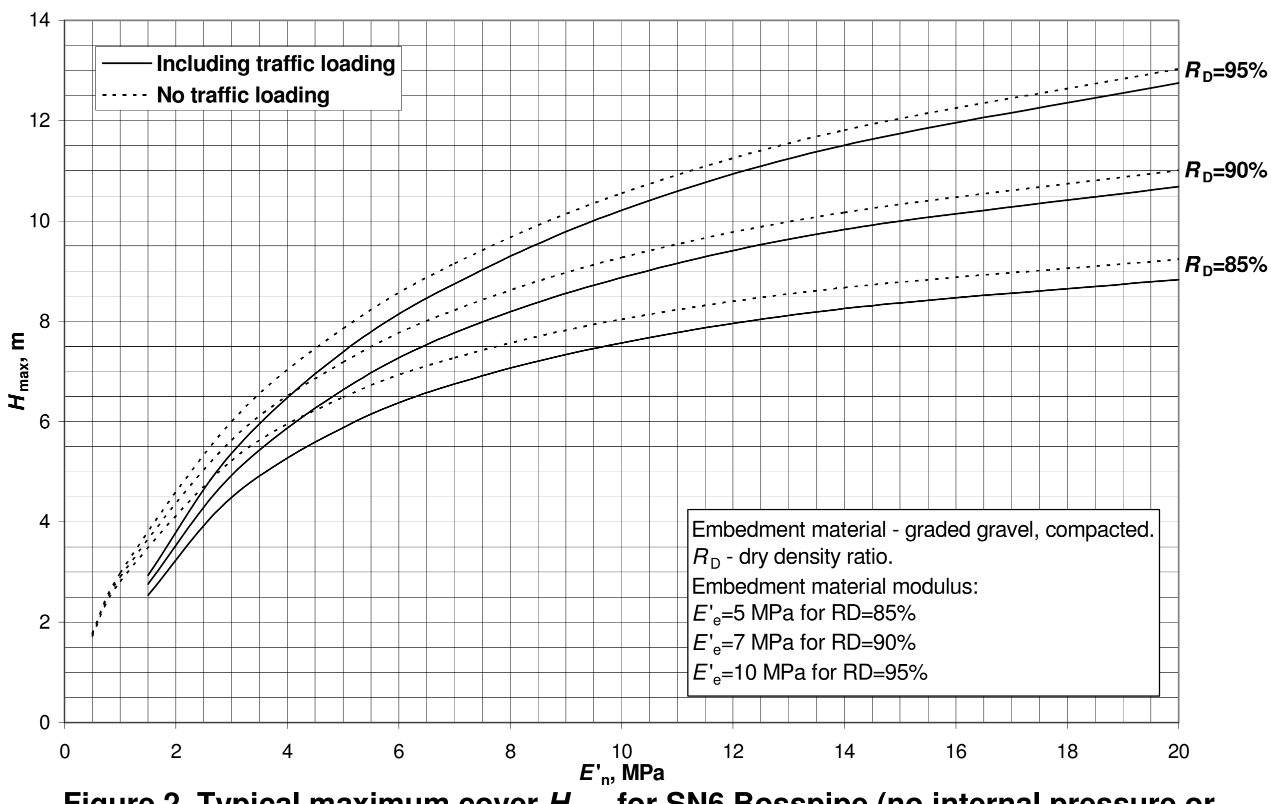


Figure 2. Typical maximum cover H_{max} for SN6 Bosspipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and

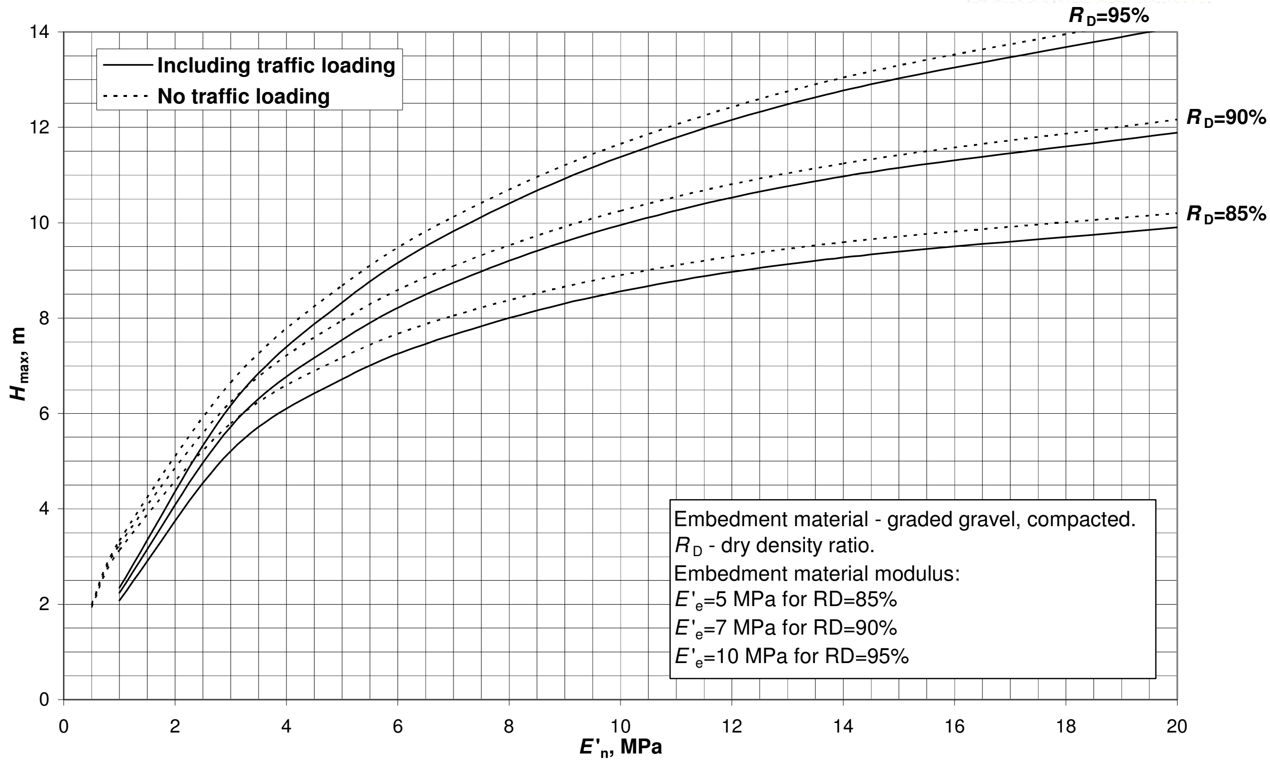


Figure 3. Typical maximum cover H_{max} for SN8 Bosspipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and embedment material compaction.

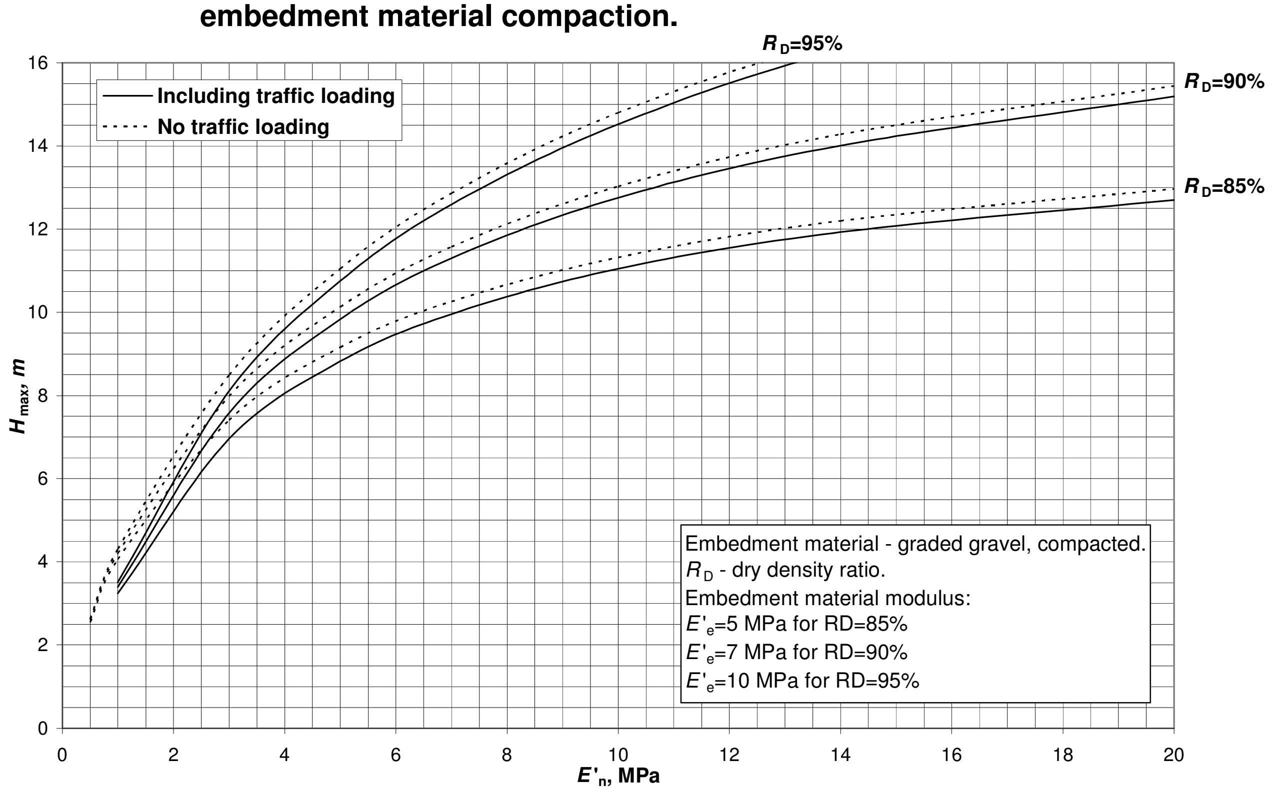


Figure 4. Typical maximum cover H_{max} for SN16 Bosspipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and embedment material compaction.

Hydraulic Design

Waters & Farr Bosspipe offers a hydraulically smooth bore that provides excellent flow characteristics. Other advantages of Waters & Farr Bosspipe, light weight, inert, corrosion free pipe material, excellent toughness and abrasion resistance, ensure excellent durability of the pipes.

Flow of fluids in a pipe is a subject to resistance due to viscous shear stresses within the fluid and friction against the pipe wall, resulting in a pressure loss. A number of formulas, both theoretical and empirical, are used for flow calculations.

In general flow calculations, the **Colebrook-White formula** for the velocity of water in a smooth bore pipe under laminar conditions is regarded as the most accurate:

$$V = -2 \times \sqrt{2gDJ} \times \log\left\{\frac{k}{3.7D} + \frac{2.51\nu}{D \times \sqrt{2gDJ}}\right\} \qquad \text{(HD-1)}$$

Where J – hydraulic gradient (slope), m/m.

D – mean internal diameter of pipe, m,

V – average flow velocity, m/s; V may be estimated as follows:

$$V = \frac{4 \times 10^{-3} \times Q}{\pi \times D^2} \qquad \text{(HD-2)}$$

Q – flow, l/s,

g – gravitational acceleration; g = 9.807 m/s² may be assumed,

ν – kinematic viscosity, m²/s; a value of 1.141×10^{-6} m²/s may be assumed for water at 15℃, or a value of 1.31×10^{-6} m²/s for sewage at 12℃,

k – linear measure of roughness, mm.

Extensive research and years of service show that polyethylene and polypropylene smooth bore pipes offer flow characteristics superior to those of traditional materials like concrete, vitrified clay, etc. Based on that, AS 2200-1978 specifies roughness coefficient ***k*** for polyethylene (and polypropylene pipes display similar flow properties) in the range of 0.003-0.015 mm, whereas the specified values for concrete are 0.03-0.15 mm, for vitrified clay 0.15-0.6 mm.

Polypropylene and polyethylene provide excellent resistance to abrasion and growth of slime. At the same time, hydraulic design of pipelines should allow for variations in flow during their long service life due to characteristics of the carried fluids.

For a straight, clean and concentrically jointed new Bosspipe line, k = 0.006 mm may be used for clean water flow, k = 0.06 mm may be taken for a new Sewerboss line. A value of k = 0.6 mm may be assumed for mature, with a variety of manholes, feeding pipes and angle variations, Sewerboss systems, or for mature storm water drainage where debris transportation may be anticipated.

The flow charts developed based on these values of k are given in Figures 1 to 4.

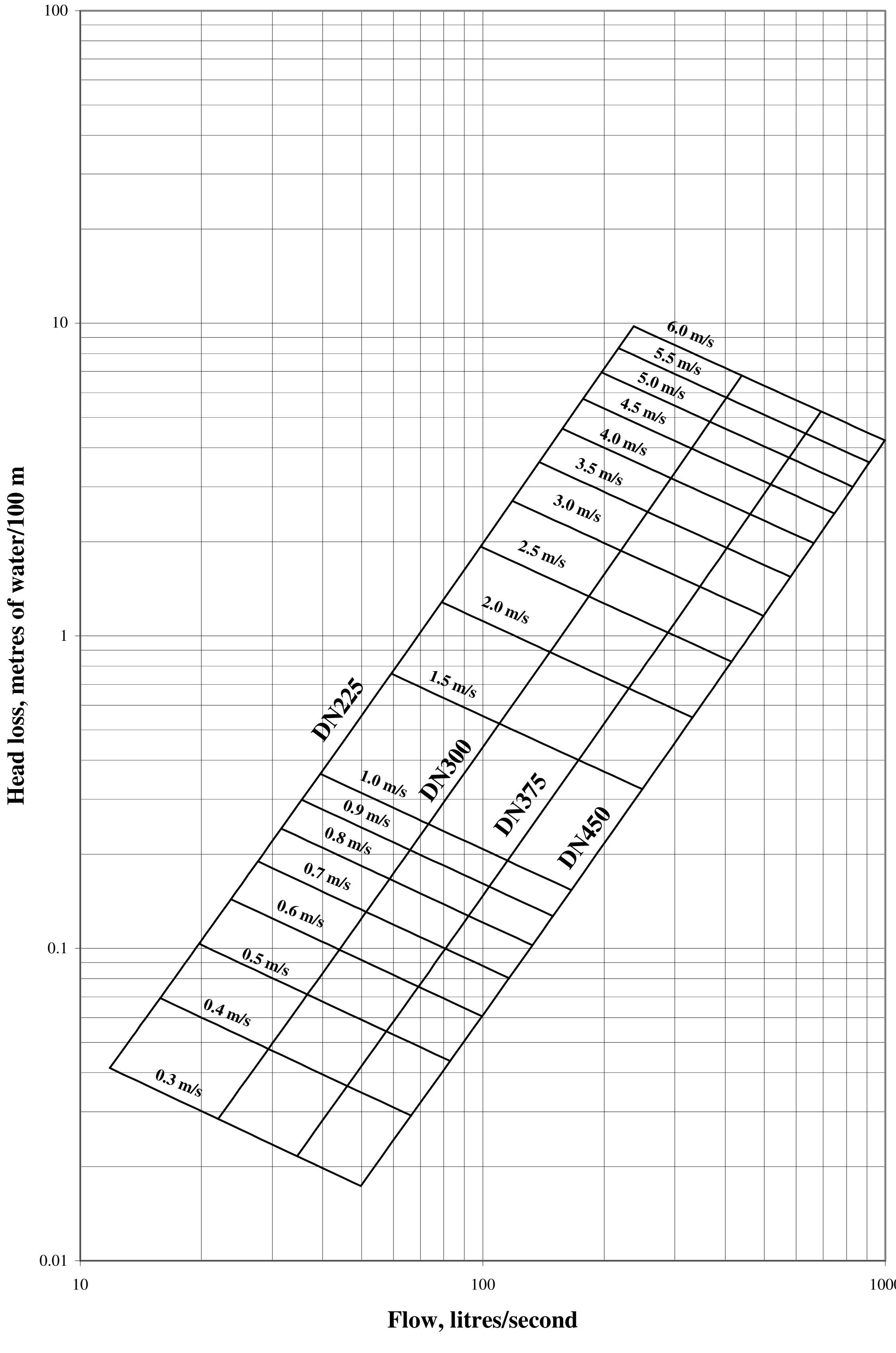


Fig. 1. Colebrook-White friction loss chart for new SN8 Bosspipe and FarmBoss lines running full of clean water at 15°C (*k* = 0.006 mm)

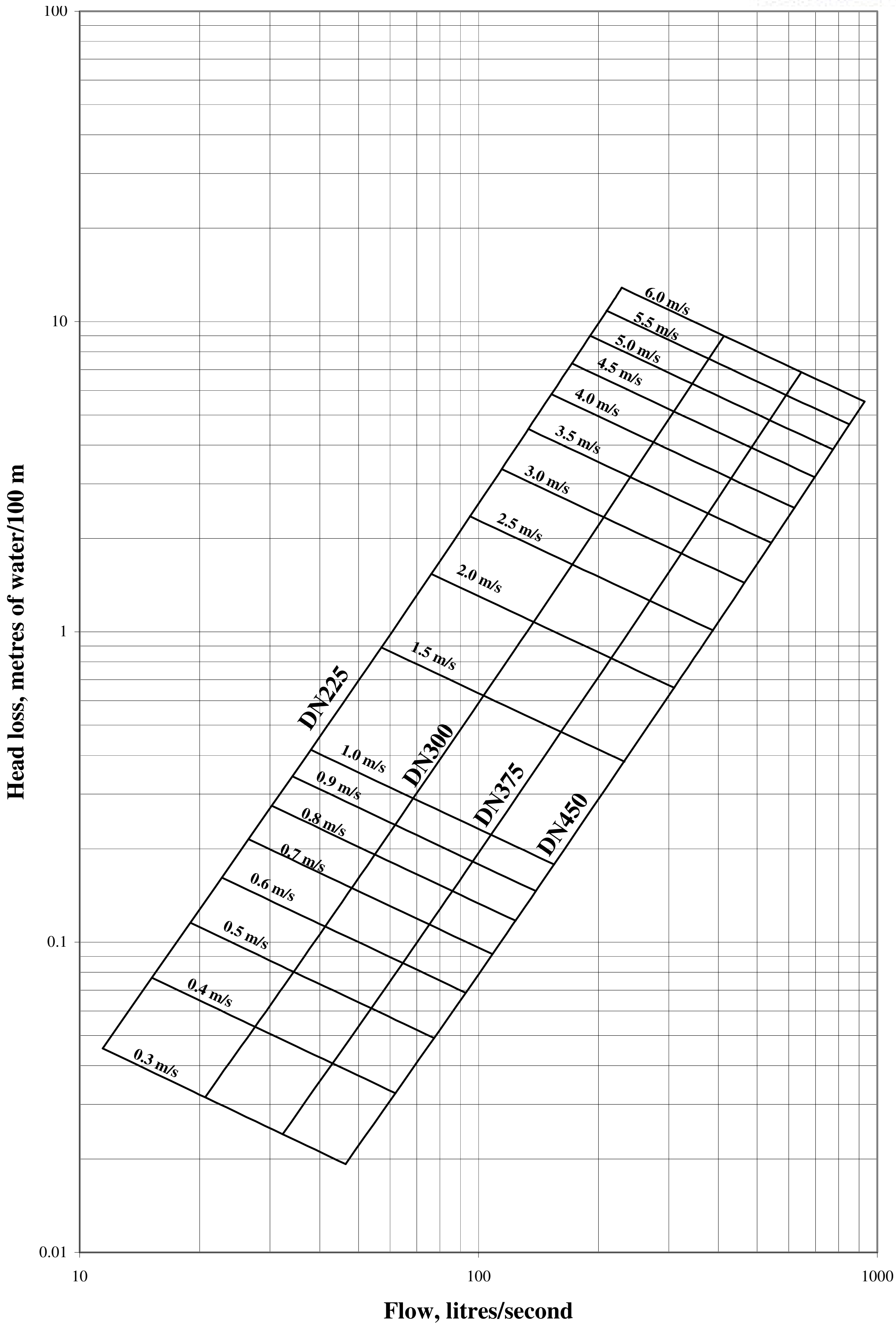


Fig. 2. Colebrook-White friction loss chart for new SN16 Sewerboss pipelines running full at 12℃ (*k* = 0.06 mm)

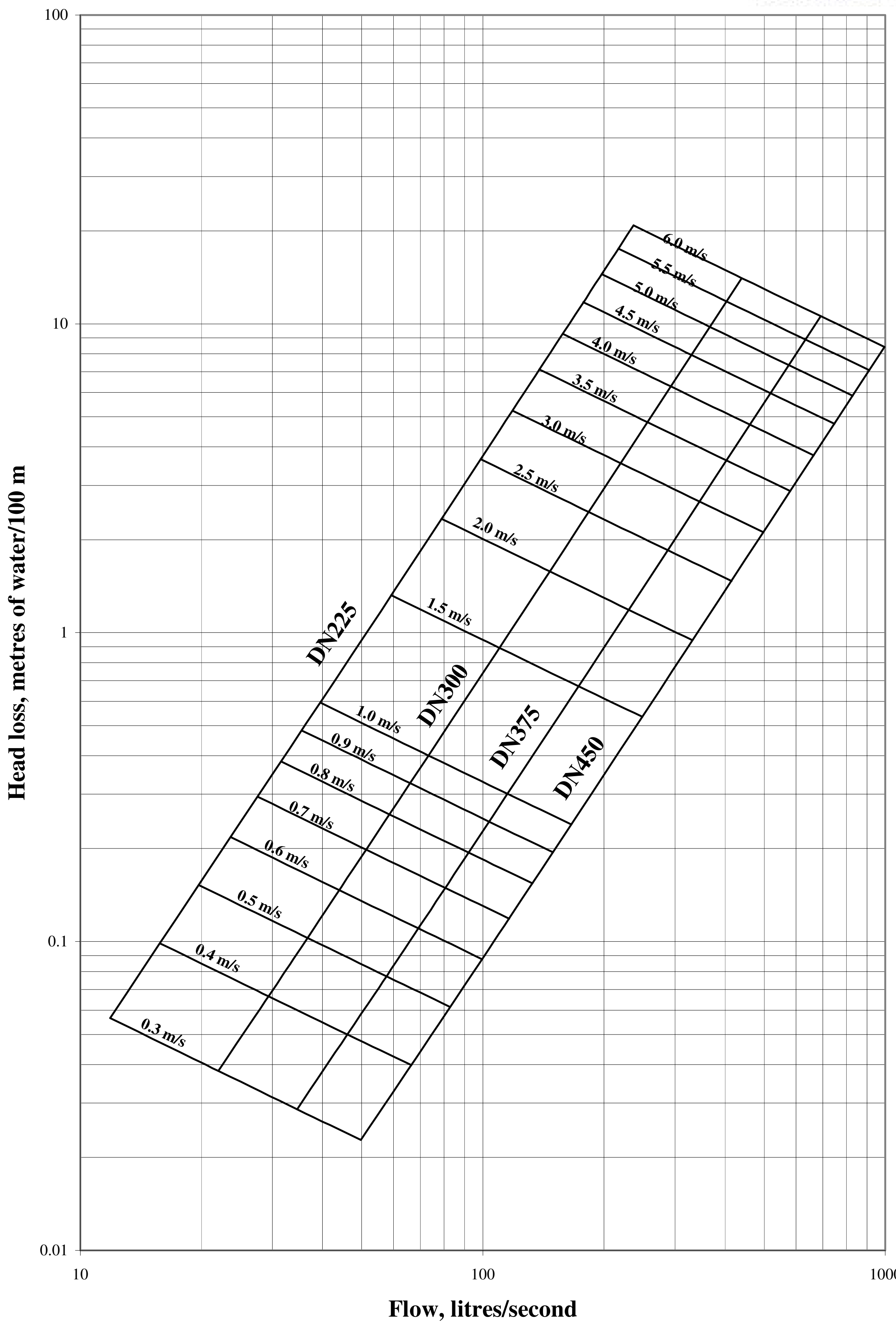


Fig. 3. Colebrook-White friction loss chart for mature SN8 Bosspipe lines running full of water at 15°C where debris transportation is anticipated (*k* = 0.6 mm)

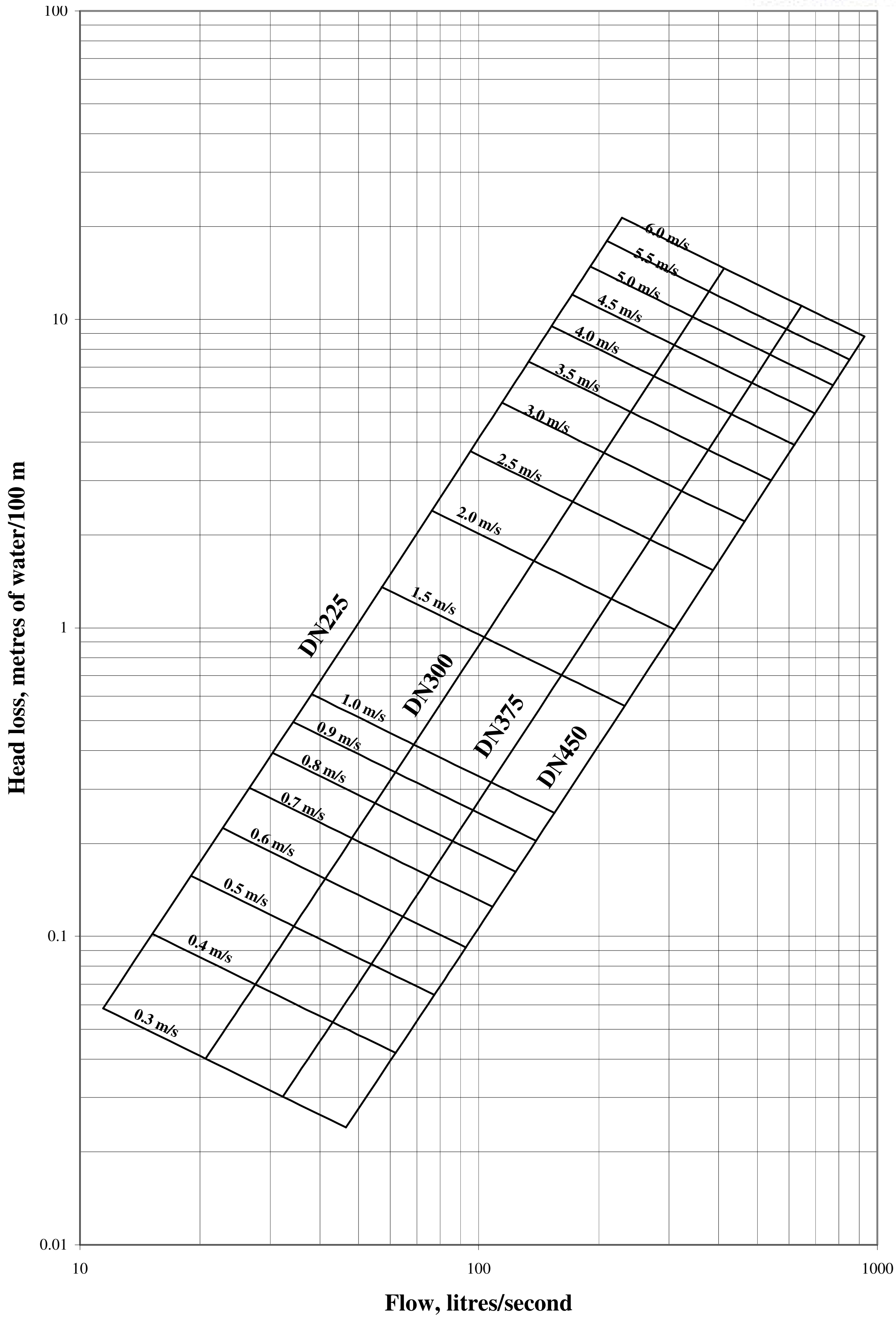


Fig. 4. Colebrook-White friction loss chart for mature SN16 Sewerboss pipelines running full at 12°C (*k* = 0.6 mm)

For non-pressure gravity flow under conditions of constant slope, and uniform channel cross-section (as often is the case where the pipes are only **partially filled**), the **Manning equation** is commonly used (for clean water):

$$V = \frac{1}{n} R^{2/3} J^{1/2} \qquad \text{(HD-3)}$$

Where V – average flow velocity, m/s,

n – Manning roughness coefficient, dimensionless; a value of 0.008 to 0.009 (AS 2200) may be taken for BOSS pipelines,

R – hydraulic radius, m; R may be calculated as follows:

$$R = \frac{A}{P} \qquad \text{(HD-4)}$$

J – hydraulic gradient (slope), m/m,

A – flow cross-sectional area, m²,

P – wetted perimeter, m.

Manning equation for gravity flow in pipelines running full of clean water:

$$Q = \frac{4000}{n} \pi \left(\frac{D}{4}\right)^{8/3} J^{1/2} \qquad \text{(HD-5)}$$

Where Q – flow, l/s,

D – mean internal diameter of pipe, m.

Design charts for hydraulic design of pipes using Manning formula (and examples) are given in AS 2200 and other literature.

Fittings are causing additional friction losses to the flow of fluids in a pipeline. The Darcy-Weisbach equation modified for head losses in fittings is:

$$H = K \frac{V^2}{2g} \qquad \text{(HD-6)}$$

Where H – head loss, m,

K – friction coefficient, dimensionless, dependent on type of fitting: commonly used values for ***K*** are given in the table to the left (source: Polyethylene Pipe Systems, WRC, UK),

V – average flow velocity, m/s,

g – gravitational acceleration, m/s².

Fitting type	K
Elbow 90°	1.0
Elbow 45°	0.4
Elbow 22.5°	0.2
Bend 90°	0.2
Bend 45°	0.1
Bend 22.5°	0.05
Tee 90° - flow in line	0.35

Head losses at manholes are dependent upon relative manhole/pipe size, changes in flow direction and pipe sizes, flow depth, differences in inflow and outflow, relative position of inflow pipes and manhole benching. As a result, the value for ***K*** can vary between 0.2 to 2.5.

Due to change in flow velocity, **head loss at the pipe exit** should be taken into account:

$$H = K \frac{V^2 - V_d^2}{2g} \qquad \text{(HD-7)}$$

Where V_d – average flow velocity downstream of the outlet, m/s.

In usual circumstances, drainage and sewer pipelines are only **partially filled** (see Figure 5).

The diagram on Figure 6 showing the relationship between partial and full average velocity V/V_f (based on Manning equation), flow Q/Q_f, hydraulic radius R/R_f and utilised area A/A_f, at various filling levels may be used in partially filled pipeline flow calculations.

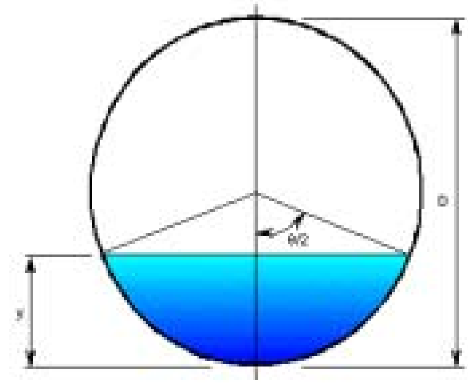


Fig. 5. Partially filled pipe

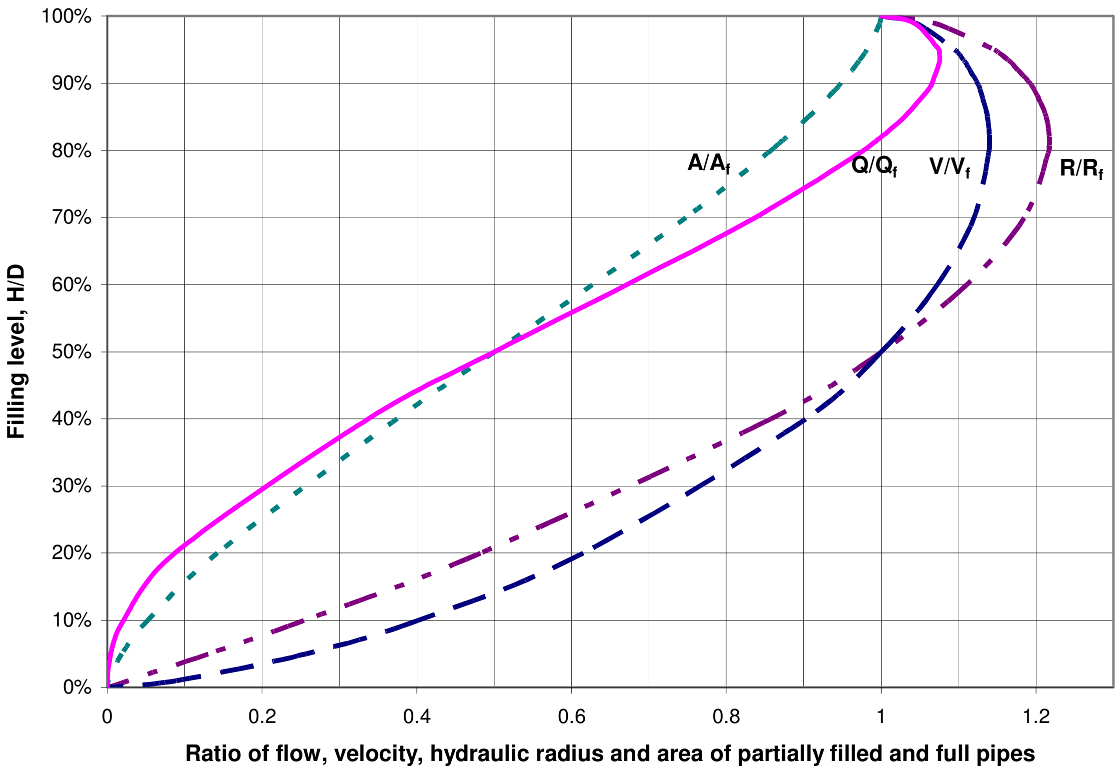


Fig. 6. Proportional flow in partially filled pipes.

Sewer pipeline design is often based on average daily dry weather flow (ADWF) of 225 litres per capita per day and peak wet weather flow/ADWF ratio of 4 (which depends on system design in respect of storm water inflow).

Sewers and storm water drains are also designed to ensure minimum self-cleansing flow at least once daily. Traditionally it is regarded that self-cleansing velocity is achieved at 0.6-0.75 m/s. More accurate design for partially filled pipes is based on theory of fluid flow in open channel. Bottom (boundary) shear stress equation may be expressed as:

$$\tau = \rho g R J \qquad \text{(HD-8)}$$

Where τ – boundary shear stress, N/m²,

ρ – fluid density, kg/m³; for water, □ = 1000 kg/m³ may be assumed,

g – gravitational acceleration, m/s²,

R – hydraulic radius, m,

J – hydraulic gradient (slope), m/m.

For circular sewer pipe, the required gradient may be calculated by the following equation:

$$J = \frac{4\tau}{\rho g D(R/R_f)} \qquad \text{(HD-9)}$$

Where D – mean internal diameter of pipe, m,

R/R_f – ratio of hydraulic radius for partially filled and full pipe. For known daily peak flow in dry weather and full pipe flow, the R/R_f ratio may be determined using data on Figure 6.

A value of $\tau \geq 1.5$ N/m² is generally regarded as a criterion of self-cleansing flow of water ensuring separation of organic solids. Then the minimum slope for self-cleansing flow is:

$$J_{\min} \approx \frac{6 \times 10^{-4}}{D(R/R_f)} \qquad \text{(HD-10)}$$

The resulting minimum slopes as a function of Bosspipe filling level during daily dry weather peak flow are given on Figure 7.

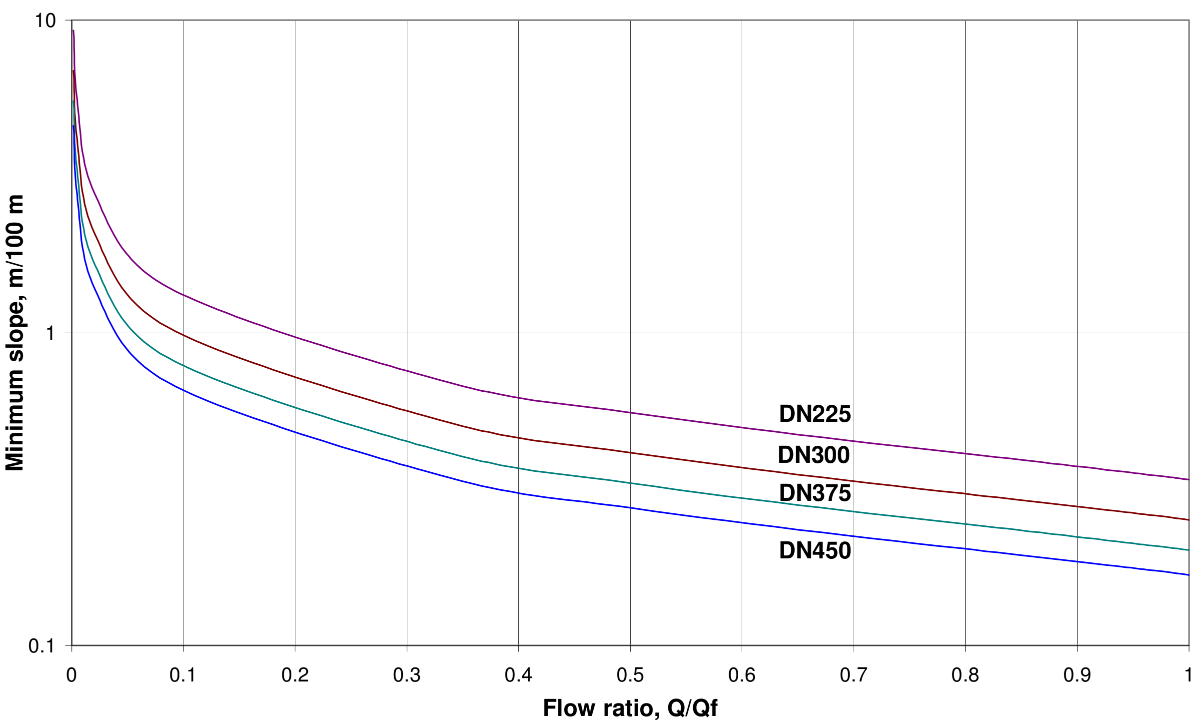


Fig. 7. Minimum self-cleansing slope for SN16 Bosspipe as a function of ratio of daily dry weather peak flow (partially filled pipe) and full pipe flow

Testing:
Leakage testing for non-pressure polypropylene pipelines is used for detection of incorrectly made connections or of damaged pipeline components. Stormwater drains are usually not tested.

Leakage testing procedures are outlined in AS/NZS 2566.2:2002, Clause 6.4 and Appendix N, and include:

- Low pressure air testing.
- Vacuum testing.
- Hydrostatic testing.
- Infiltration testing.

Low pressure air test is usually conveyed on pipeline sections between maintenance holes. This method should not be used for testing sections in excess of 250 m.

Air test pressure is usually 25 kPa (in excess of any external hydrostatic pressure due to ground water). The pipeline is accepted when no leaks are visually detected, and gauged pressure exceeds 18 kPa after the specified holding time.

Vacuum test is also usually conveyed on pipeline sections between maintenance holes. Negative pressure of 25 kPa to 30 kPa is applied. The pipeline is accepted when no leaks are visually detected, and the drop of vacuum in magnitude is under the maximum of 7 kPa within the specified holding time.

Hydrostatic pressure test is conveyed at water pressure within the limits of 20 kPa to 60 kPa (steeply graded pipelines are tested in stages). Water is added to maintain the pressure for 2 hours. The pipeline is accepted when no leaks are visually detected, and quantity of added water does not exceed the allowable make up water volume (as a rule, 0.5 litre per hour per metre length per metre diameter).

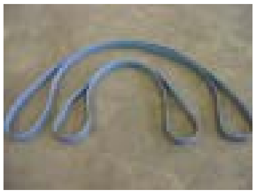
Infiltration test is often conducted in place of any of the previous tests where a freestanding water table is present at a level of at least 1.5 m above the test section, and 150 mm above any sideline connections. The pipeline is accepted when no leaks are visually detected.

SECTION THREE

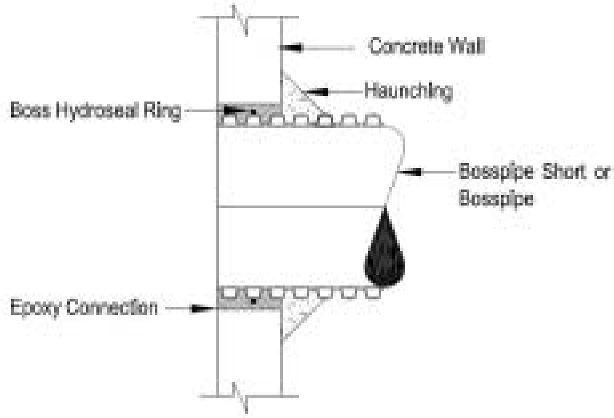
FITTINGS

Connection of Bosspipe to concrete manholes:

1. Bosspipe short inserted directly into the wall of the manhole

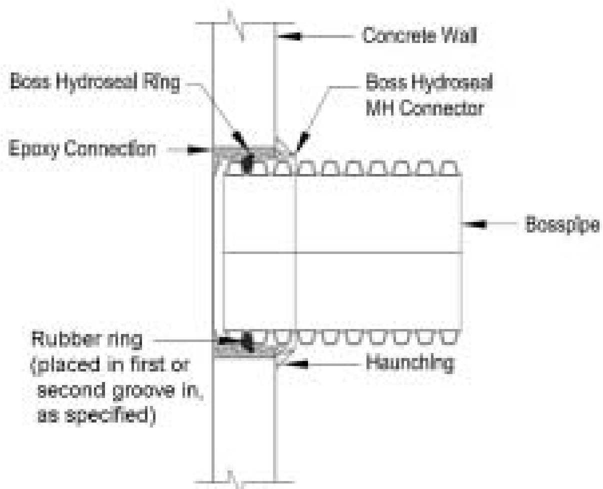


Bosspipe's corrugated profile provides an excellent anchor in the wall of the manhole when used in conjunction with a Boss Hydroseal Ring and epoxy mortar. Any possible shrinkage between the epoxy mortar and Bosspipe is taken up as the hydroseal expands in reaction to the moisture in the mortar. Using a Bosspipe short provides a flexible joint between the main pipeline and the manhole.

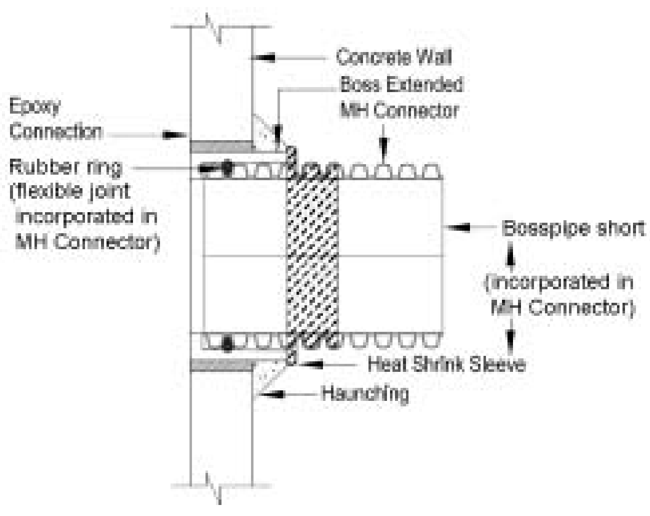


2. Boss Hydroseal manhole connector

Epoxy mortared into the manhole it provides the same outcome as the one above but may be easier to install in some circumstances. While outer ribs of the connector ensure good grip, the hydroseal ring expands to prevent water penetration in or out of the manhole. Bosspipe is inserted into the connector using a rubber ring providing a flexible joint (Bosspipe short may be used if second flexible joint is required).



3. Boss Extended manhole connector



Designed to meet the requirements of some Councils that require 2 flexible joints between the pipe and manhole in sewer applications.). A Bosspipe short is sealed within concrete ring with a rubber ring; second flexible joint is made when Bosspipe is connected utilizing integrated Bosspipe socket or Bosspipe Coupler.

Couplers are used for jointing of manhole adaptors or Bosspipe shorts to Bosspipe spigots with rubber rings on each side of the coupler. Couplers are made of high density polyethylene, and contain additives ensuring the same UV resistance as outer layer of Bosspipe.

For repairs, a damaged portion of the pipe is cut out, and a new Bosspipe short is jointed using slip-couplers which are initially fully inserted on both existing or new pipe spigots, and slid in place following insertion of the Bosspipe repair short. Elastomeric seal joints on both ends ensure integrity of the repairs.

Lateral Connections:

Connection of smaller sized drains to StormBoss pipes can be made using **StormBoss saddles.** Rubber gasket on the base of saddle is shaped to provide tight fit to the outside corrugation of StormBoss pipe.

A hole in Stormboss pipe is cut prior to installation using enclosed template, butyl mastic (a tube is supplied with each saddle) is applied to the gasket, and saddle is affixed to the outer corrugation of the pipe using stainless steel screws in the saddle. The screws do not penetrate inner core of the pipe.

StormBoss saddles are provided for lateral connections of DN100 and DN150 PVC and DN110 and DN160 PE at both 90° and 45° angle.

Fabricated Fittings:

A range of specialty fittings including bends, junctions, tees, etc. are fabricated and will be available at request. All fabricated fittings are tested to ensure quality of the welds.