

Australian/New Zealand Standard™

Buried flexible pipelines

Part 1: Structural design



AS/NZS 2566.1:1998

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-028, Design and Installation of Buried Flexible Pipes. It was approved on behalf of the Council of Standards Australia on 17 October 1997 and on behalf of the Council of Standards New Zealand on 5 November 1997. This Standard was published on 5 January 1998.

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This Standard was issued in draft form for comment as DR 94114.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

RECONFIRMATION
OF
AS/NZS 2566.1:1998
Buried flexible pipelines
Part 1: Structural design

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Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 22 February 2018.

Approved for reconfirmation in New Zealand on behalf of the New Zealand Standards Approval Board on 26 June 2018.

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NOTES

Australian/New Zealand Standard™

Buried flexible pipelines

Part 1: Structural design

Originated in Australia as AS CA68—1972.
Final Australian edition AS 2566—1982.
Jointly revised and redesignated AS/NZS 2566.1:1998.
Reissued incorporating Amendment No. 1 (August 2017).

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Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, PO Box 1473, Wellington 6140.

ISBN 0 7337 1627 X

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS/28, Design and Installation of Buried Flexible Pipes, to supersede AS 2566—1982, Plastics pipelaying design.

This Standard incorporates Amendment No. 1 (August 2017). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is one of a proposed series which deal with buried flexible pipes. The series so far comprises:

Part 1: Structural design (this Standard).

Part 2: Installation (in course of preparation).

The objective of this Standard is to provide designers with procedures for the structural design of buried flexible pipelines.

Published concurrently with this Standard is AS/NZS 2566.1 Supp 1, *Buried flexible pipeline—Part 1: Structural design—Commentary* (Supplement to AS 2566.1—1997, which contains additional information on and explanations of particular technical aspects of this Standard. It also includes an appendix with examples showing the applications of the provisions of this Standard.

Statements expressed in mandatory terms in notes to figures and tables are deemed to be requirements of this Standard.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

A1 | The purpose of Amendment 1 to AS/NZS 2566.1 is to include typical characteristics for polypropylene (PP) structured wall pipes in Table 2.1. PP pipes were not in common use at the time of original publication but have since become well established in the Australian market. Additional changes to Table 2.1 to reflect other developments in pipe materials and specifications since the original publication date of AS/NZS 2566.1 have also been made.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Buried flexible pipelines

Part 1: Structural design

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out a practice for the structural design of buried flexible pipelines which rely primarily upon side support to resist vertical loads without excessive deformation. The interactive pipe/embedment structure is considered only in the transverse direction. Structural performance is predicted in the long-term for pipes in trenches and embankments but not for jacked or bored lines. For the purposes of this Standard, the long-term design basis is 50 years, to take account of creep and other time- dependent effects. The equations used in this Standard apply to pipes with outside diameters equal to or greater than 75 mm, initial ring-bending stiffness equal to or greater than 1250 N/m/m and long-term ring-bending stiffness equal to or greater than 625 N/m/m.

This Standard provides methods and data for calculating the response of a pipe to loadings from—

- (a) soil;
- (b) superimpositions on the soil; and
- (c) both positive and negative internal pressures.

1.2 APPLICATION

This Standard provides a basis for assessing the selection of pipe class and embedment methods. It applies to flexible pipes conveying water, waste water, storm water or slurry, for both pressure and non-pressure applications, or as conduits for the later installation of cables or pipes.

This Standard is applicable to flexible pipes, manufactured from the materials listed in the table below, that are—

- (a) homogeneous or composite;
- (b) creep affected (plastics) or unaffected (metallic); or
- (c) plain or structured wall.

Abbreviation	Material
Plastics	
ABS	Acrylonitrile butadiene styrene
GRP	Glass filament reinforced plastics
PVC	Polyvinyl chloride
OPVC	Oriented PVC
PE	Polyethylene
PP	Polypropylene
Metallic	
Text deleted	
DI	Ductile iron
MS	Steel

Provided suitable data can be obtained, this Standard may be used for materials not listed in the above table.

This Standard does not give design guidelines for—

- (i) hydraulic pipeline design, including allowance for positive surges, and similar conditions;
- (ii) above-ground pipe systems;
- (iii) rigid pipes, e.g. fibre-reinforced concrete and steel-reinforced concrete;
- (iv) access chambers.
- (v) corrugated metal pipes, arches and non-circular shapes (see AS 1762, AS/NZS 2041.1, AS/NZS 2041.2, AS/NZS 2041.6 and AS 3703.2);
- (vi) bored, jacked or mole-ploughed installations;
- (vii) submarine pipelines; and
- (viii) pipe branches and fittings.

1.3 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix A.

1.4 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.4.1 Embedment

The material surrounding a pipe (see Figure 1.1), and which is composed of the following zones:

- (a) *Bedding*—the zone between the foundation and the bottom of the pipe.
- (b) *Haunch support*—the part of the side support below the spring line of the pipe.
- (c) *Side support*—the zone between the bottom and the top of the pipe.
- (d) *Overlay*—the zone between the side support and either the trench fill or the embankment fill.

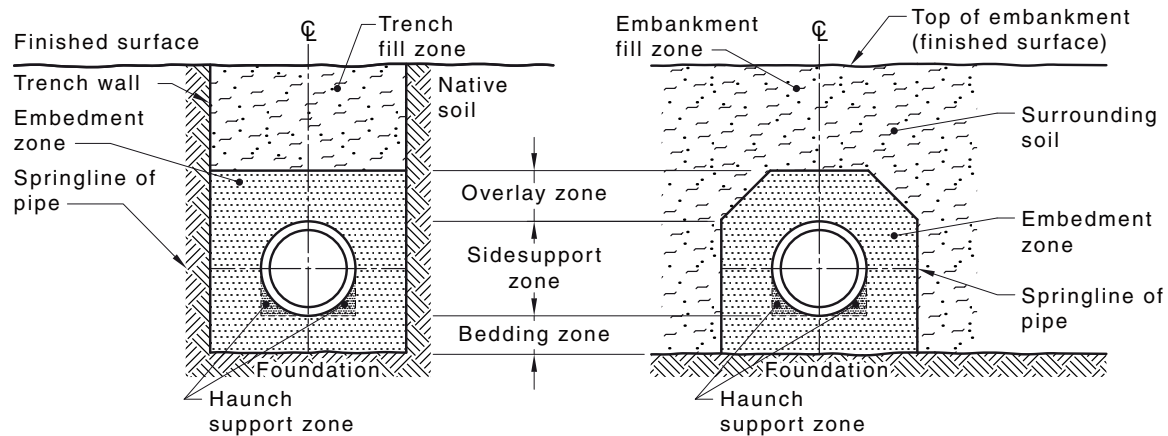


FIGURE 1.1 BURIED FLEXIBLE PIPE INSTALLATION—TERMINOLOGY

1.4.2 Existing surface

The undisturbed ground level.

1.4.3 Fill**1.4.3.1 Embankment fill**

Fill material placed over the overlay for the purpose of creating an embankment.

1.4.3.2 Trench fill

Fill material placed over the overlay for the purpose of refilling a trench.

1.4.4 Finished surface

The paved or unpaved surface of a filled trench or an embankment.

1.4.5 Foundation

A naturally occurring or replaced material beneath the bedding.

1.4.6 Pipe**1.4.6.1 Composite pipe**

A pipe having more than one structural material in the wall.

1.4.6.2 Flexible pipe

A pipe that relies primarily upon side support to resist vertical loads without excessive deformation.

1.4.6.3 Homogeneous pipe

A pipe having one structural material in the wall.

1.4.6.4 Plain wall pipe

A pipe of homogeneous material with plain inside and outside surfaces.

1.4.6.5 Profiled wall pipe

A pipe with a plain inside surface and with an outside surface which is helical, annular ribbed or corrugated.

1.4.6.6 Rigid pipe

A pipe that supports vertical loads primarily by virtue of its resistance to bending or deformation as a ring.

1.4.6.7 Structured wall pipe

A term used to collectively describe sandwich, ribbed, cored wall and hollow profile pipes.

1.4.7 Nominal size, DN

An alphanumeric designation of size for components of a pipework system, which is used for reference purposes. It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

1.4.8 Ring-bending stiffness

A measure of resistance of a pipe to ring deflection determined by testing or calculation, in newtons per metre per metre length.

1.4.9 Soil modulus

A measure of resistance of the soil to deformation, in megapascals.

1.5 NOTATION

The following symbols are used in this Standard:

Symbol	Definition	Unit of measurement	Text reference
a	= length of wheel or track load contact area	m	Figure 4.2
B	= width of trench or embedment measured at the spring line	m	Equation 3.4.3(3), Figure 3.1, Note to Figure 3.2
b	= width of wheel or track load contact area	m	Figure 4.2
c_1	= distance from pipe wall neutral axis to extreme external surface	m	Figure 1.2
c_2	= distance from pipe wall neutral axis to internal surface	m	Figure 1.2
D	= diameter at neutral axis of pipe wall	m	Table 2.1, Equations 2.2.1.1(1), 2.2.1.1(2), 5.2(1), 5.2(2) and 5.3.1(2)
D_e	= diameter of the most extreme external surface along the pipe barrel (see Appendix B for appropriate product Standard or manufacturer)	m	Clause 3.4.1, Appendix B Equation 3.4.3(3), Equations 5.4(1) and 5.4(3), Figure 3.1, Note to Figures 3.1 and 3.2
D_f	= shape factor	—	Equations 5.3.1(2), 5.3.1(3) and Figure 5.1
D_i	= internal diameter of the barrel of a pipe (see Appendix B for appropriate product Standard or manufacturer)	m	Tables CB2 and CB3 of AS/NZS 2566.1 Supplement 1
E_b	= initial 3-minute ring-bending modulus	MPa	Table 2.1, Equation 2.2.1.1(1)

Symbol	Definition	Unit of measurement	Text reference
E_{bL}	= long-term ring-bending modulus	MPa	Table 2.1, Equation 2.2.1.1(2)
E'	= effective combined soil modulus	MPa	Clause 3.4.3, Equation 3.4.3(1), Equations 5.2(2), 5.3.1(3) and 5.4(5), Figure 5.1
E'_e	= embedment soil modulus	MPa	Clause 3.4.2, Table 3.2, Equations 3.4.3(1) and 3.4.3(2), Figure 3.2
E'_n	= native soil modulus	MPa	Clause 3.4.1, Table 3.2, Equation 3.4.3(2), Figure 3.2
F_s	= design factor for buckling	—	Clause 5.4, Equations 5.4(4) and 5.4(5)
G	= distance between centre-line of wheel or track loads	m	Figure 4.2
h	= time of determination of short-term stiffness	h	Clause 2.2.3
H	= cover, vertical distance between the top of the pipe and the finished surface	m	Clauses 5.4(a), 5.4(b), 5.4(i), 5.4(ii), Equations 5.4(1) and 5.4(3)
H_w	= height of water surface above the top of the pipes	m	Clauses 5.4(a) and 5.4(b), Equations 5.4(1) and 5.4(3)
I	= second moment of area of the pipe wall for ring-bending	m ⁴ /m	Equations 2.2.1.1(1), 2.2.1.1(2) and 2.2.1.2
A1 I_D	= density index (see AS 1289.5.6.1)	%	Clause 3.3.2.2(a), Table 3.2
K	= bedding constant	—	Clause 5.2, Equation 5.2(2)
L_1	= length of the base of the live load distribution, resulting from wheel or track loads, measured perpendicular to the direction of travel of the vehicle at the top of the pipe	m	Figure 4.2
L_2	= length of the base of the live load distribution, resulting from wheel or track loads, measured parallel to the direction of travel of the vehicle at the top of the pipe	m	Figure 4.2
l_b	= depth of bedding below the bottom of the pipe	mm	Clause 3.2.2, Figure 3.1

Symbol	Definition	Unit of measurement	Text reference
l_c	= horizontal distance at the springline between the external face of the pipe and— (a) the trench wall; or (b) that of an adjacent pipe, in a trench with two or more pipes	mm	Figure 3.1, Note to Figure 3.1
l_o	= depth of overlay above the top of the pipe	mm	Clause 3.2.2, Figure 3.1
P	= wheel load (ΣP is the sum of the individual wheel loads)	kN	Equation 4.7.2(1), Figure 4.2
P_{all}	= allowable long-term internal pressure obtained from the relevant product Standard or manufacturer or, for plain wall pipes, calculated from the following equation: $P_{all} = \frac{2 \sigma_{hall} t}{D}$	MPa	Equation 5.3.2
P_w	= internal working pressure	MPa	Clause 5.3.3, Equations 5.3.2 and 5.3.3
q_{all}	= allowable buckling pressure for material	kPa	Equations 5.4(1) and 5.4(3)
q_{all1}	= allowable buckling pressure, based on pipe alone	kPa	Equation 5.4(4)
q_{all2}	= allowable buckling pressure, based on pipe/embedment interaction	kPa	Equation 5.4(5)
q_v	= internal vacuum	kPa	Note to Clause 5.4(b), Note to Clause 5.4(ii), Equations 5.4.(1) and 5.4.(3)
R_D	= dry density ratio (see AS 1289.5.4.1)	%	Clause 3.3.2.2(b), Table 3.2
r_c	= re-rounding coefficient	—	Clause 5.3.3, Equation 5.3.3
S_{DI}	= initial (3-minute) ring-bending stiffness of the pipe	N/m/m	Clause 2.2.3, Equations 2.2.1.1(1) and 2.2.3
S_{DL}	= long-term ring-bending stiffness of the pipe (per metre length)	N/m/m	Clause 2.3.3, Equations 2.2.1.1(2), 2.2.3, 5.2(2), 5.3.1(3), 5.4(4) and 5.4(5), Figure 5.1
$S_{DL\ 2}$	= long-term (2-year) ring-bending stiffness of pipe	N/m/m	Equation 2.2.3

	Symbol	Definition	Unit of measurement	Text reference
	$S_{DL\ 50}$	= long-term (50-year) ring-bending stiffness of pipe	N/m/m	Equation 2.2.3
A1	t	= minimum wall thickness of plain wall pipe in accordance with product Standard (see Appendix B) except for DI pipes where t = (specified minimum wall thickness + specified nominal wall thickness)/2 for pipe stiffness calculations. t = specified nominal wall thickness shall be used for the allowable long-term deflection calculation	m	Equation 2.2.1.2
	t_c	= thickness of cement mortar lining	m	Clause C2.2.1 of AS/NZS 2566.1 Supplement 1
	t_{es}	= effective wall thickness of the pipe for the determination of ring-bending strain is equal to— (a) for a plain wall, the wall thickness (t); or (b) for a profiled wall, the greater of $2c_1$ and $2c_2$ as shown in Figure 1.2	m	Equation 5.3.1(2)
	u	= superimposed, uniformly distributed dead load at the finished surface	kPa	Clause 4.6(a)
	w_g	= vertical design load pressure at top of pipe due to soil dead load	kPa	Equations 4.3 and 5.2(2)
	w_{gs}	= vertical design load (pressure at top of pipe) due to surface-applied dead load	kPa	Clause 4.6(a), Equations 5.2(2), 5.4.(1), 5.4(3)
	w_q	= vertical design load (pressure at top of pipe) due to surface-applied live load	kPa	Note to Clause 5.4(b), Equations 4.7.2(1) 5.2(2), 5.4(1) and 5.4(3), Figure 4.1
A1	YS	= specified or nominal yield strength	MPa	Table 2.1
	γ	= assessed unit weight of trench fill or embankment fill	kN/m ³	Equations 4.3 and 5.4(1), 5.4.(2)
	γ_L	= assessed unit weight of liquid external to the pipe, e.g. 10.0 for water	kN/m ³	Equations 5.4.(1) and 5.4(3)
	γ_{sub}	= submerged unit weight of trench fill or embankment fill	kN/m ³	Equations 5.4(1), 5.4(2) and 5.4(3)
	α	= live load impact factor	—	Equations 4.7.2(1) and 4.7.2(2)