

Australian/New Zealand Standard™

Design for installation of buried concrete pipes



AS/NZS 3725:2007

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-006, Concrete Pipes. It was approved on behalf of the Council of Standards Australia on 07 September 2006 and on behalf of the Council of Standards New Zealand on 15 December 2006.

This Standard was published on 23 January 2007.

The following are represented on Committee WS-006:

Australasian Railway Association
Australian Chamber of Commerce and Industry
Brisbane City Council
Business New Zealand
Cement & Concrete Association of New Zealand
Engineers Australia
Main Roads Department, QLD
Master Builders Australia
New Zealand Water and Waste Association
Precast New Zealand
University of Tasmania
Water Services Association of Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.standards.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR 04236.

Australian/New Zealand Standard™

Design for installation of buried concrete pipes

Originated as AS CA33—1962.
Revised and designated AS 3725—1989.
Jointly revised and redesignated AS/NZS 3725:2007

COPYRIGHT

© Standards Australia/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 7982 4

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS-006, Concrete Pipes, to supersede AS 3725—1989, *Loads on buried concrete pipes* by a Joint Australian/New Zealand Standard that incorporates current best practice.

The objective of the Standard is to enable an appropriate class of concrete pipe, manufactured in accordance with AS 4058, *Precast concrete pipes—pressure and non-pressure* or AS 4139, *Fibre reinforced concrete pipes*, to be selected for use in below-ground installations.

NOTE: At the time of publication of this Standard, AS 4058 is under review by the Committee and intended to be replaced by a Joint Australian/New Zealand Standard in due course (to become AS/NZS 4058). In the meantime, for New Zealand applications, all references to AS 4058 throughout this Standard should be deemed to include references to NZS 3107, *Specification for precast concrete drainage and pressure pipes*, as appropriate and applicable.

The Standard provides rules for calculating the working loads on concrete pipes due to fill and superimposed loads and a range of installation options. It relates these to the test loads applied to sample pipes in accordance with the methods of test set out in the product standards.

Where a choice is given between an Australian Standard and a New Zealand Standard (for example AS 1289, *Methods of testing soils for engineering purposes* and the equivalent NZS 4402, *Methods of testing soils for civil engineering purposes*), the Australian Standard will apply in Australia and the New Zealand Standard will apply in New Zealand.

The procedures in the Standard also apply to the calculation of external working loads on concrete pressure pipes. In this case, however, the loads due to internal pressures need to be considered in conjunction with the external loads. The method of assessing the required strength of a pipe under this combination of loads is included in the Standard.

AS/NZS 3725 Supp 1 is a Commentary on this Standard. The Commentary contains additional information and explanations of particular technical aspects of the Standard. It includes, as an appendix, examples of calculations in accordance with this Standard, particularly with reference to the selection of a pipe class from AS 4058, *Precast concrete pipes—Pressure and non-pressure* and AS 4139, *Fibre reinforced concrete pipes*. The Commentary is an informative document and does not form part of the Standard.

Statement expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

CONTENTS

	<i>Page</i>
1 SCOPE	4
2 APPLICATION	4
3 REFERENCED DOCUMENTS.....	4
4 DEFINITIONS.....	6
5 NOTATION	11
6 VERTICAL LOADS ON PIPES	13
7 INTERNAL WATER LOADS.....	25
8 COMPACTION	25
9 PIPE SUPPORT AND BEDDING FACTORS.....	25
10 TEST LOADS.....	32
APPENDICES	
A CONTROLLED LOW STRENGTH MATERIALS—CLSM	33
B SUPERIMPOSED LIVE-LOADS	35

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Design for installation of buried concrete pipes

1 SCOPE

This Standard sets out methods and provides data for the following:

- (a) Calculating the vertical working loads on buried concrete pipes due to—
 - (i) the materials covering the pipes; and
 - (ii) superimposed loads.
- (b) Relating the minimum proof test load to the selection of appropriate pipes made in accordance with either AS 4058 or AS 4139, to the calculated vertical working loads on concrete pipes installed under particular conditions, including that of combined vertical load plus internal pressure.

In addition, the Standard classifies types of pipe installation and types of bedding and sets minimum requirements for the soil materials around the pipes and compaction of these materials.

NOTE: AS/NZS 3724 Supp 1 is a Commentary on this Standard. It provides further information relevant to many Clauses in this Standard. The Supplement, while bound with the Standard, is 'informative' and does not form an integral part of the Standard.

2 APPLICATION**2.1 General**

This Standard applies to concrete pipes complying with AS 4058 or AS 4139, where they are laid or intended to be laid in one or other of the specified installation conditions.

This Standard does not apply to flexible buried pipes.

2.2 Use of other materials or methods

This Standard shall not be interpreted so as to prevent the use of materials or methods of design or construction not specifically referred to herein, provided that such materials or methods can be shown to meet the intent of this Standard.

2.3 Existing structures

Where the strength or serviceability of an existing structure is to be evaluated, the general principles of this Standard may be applied. The actual properties of the materials in the structure shall be used.

3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|------------|--|
| 1289 | Methods of testing soils for engineering purposes |
| 1289.3.4.1 | Method 3.4.1: Soil classification tests—Determination of the linear shrinkage of a soil—Standard method |
| 1289.3.6.1 | Method 3.6.1: Soil classification tests—Determination of the particle size distribution of a soil—Standard method of analysis by sieving |

AS

- 1289.5.1.1 Method 5.1.1: Soil compaction and density tests—Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.3.1 Method 5.3.1: Soil compaction and density tests—Determination of the field dry density of a soil—Sand replacement method using a sand-cone pouring apparatus
- 1289.5.3.2 Method 5.3.2: Soil compaction and density tests—Determination of the field dry density of a soil—Sand replacement method using a sand pouring can, with or without a volume displacer
- 1289.5.3.5 Method 5.3.5: Soil compaction and density tests—Determination of the field dry density of a soil—Water replacement method
- 1289.5.4.1 Method 5.4.1: Compaction control test—Dry density ratio, moisture variation and moisture ratio
- 1289.5.5.1 Method 5.5.1: Soil compaction and density tests—Determination of minimum and maximum dry density of a cohesionless material
- 1289.5.6.1 Method 5.6.1: Soil strength and consolidated tests—Compaction control test—Density index method for a cohesionless material
- 1289.5.8.1 Method 5.8.1: Soil compaction and density tests—Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge—Direct transmission mode

1379 The specification and manufacture of concrete

1726 Site investigations

3582 Supplementary cementitious materials for use with Portland and blended cement

3582.1 Part 1: Fly ash

3972 Portland and blended cements

4058 Precast concrete pipes (pressure and non-pressure)

NOTE: See Preface of this Standard.

4139 Fibre-reinforced concrete pipes and fittings

5100 Bridge design

5100.2 Part 2: Design loads

5100.7 Part 7: Rating of existing bridges

AS/NZS

3725 Supp 1 Design for installation of buried concrete pipes—Commentary

NZS

3107 Specification for precast concrete drainage and pressure pipes

NOTE: See Preface of this Standard.

3122 Specification for Portland and blended cements (General and special purpose)

4402 Methods of testing soil for civil engineering purposes

4402.1 Method 1: Preliminary and general

4402.2.6 Method 2.6: Soil classification tests—Determination of linear shrinkage

4402.2.8.2 Method 2.8.2: Soil classification tests—Subsidiary method by dry sieving

4402.4.1.1 Method 4.1.1: Soil classification tests—Determination of the dry density/water content relationship—New Zealand Standard compaction test

4402.4.2.1 Method 4.2.1: Soil compaction tests—Determination of the minimum and maximum dry densities and relative density of cohesionless soil—Minimum dry density

- 4402.4.2.2 Method 4.2.2: Soil compaction tests—Determination of the minimum and maximum dry densities and relative density of cohesionless soil—Maximum dry density
- 4402.5.1.1 Method 5.1.1: Soil density tests—Determination of the density of soil—Sand replacement method for the determination of in-situ density
- 4402.5.1.5 Method 5.1.5: Soil density tests—Determination of the density of soil—Water displacement method

TRANSIT NEW ZEALAND

Bridge Manual—SP/M/014 (with Amendments 1, 2, 3 and 4)

4 DEFINITIONS

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

4.1 Bed zone

The area between the foundation and the level of the bottom of the pipe, whose depth is determined in accordance with Clause 9.2 (see Figure 1 (a) and (b)).

4.2 Bedding

The specified type and extent of materials supporting the lower portion of the pipe, usually taken to be the materials occupying the bed zone and the haunch zone (see Figure 1(a) and Figure 1(b)).

4.3 Bedding factor (F)

The ratio of the calculated working load on a pipe to the appropriate test load specified in AS 4058 or AS 4139.

4.4 Fill

One or more of the following:

- (a) *Backfill or embankment fill* The material placed over the overlay zone for the purpose of refilling a trench or creating an embankment (see Figure 1 (a) and (b)).
- (b) *Ordinary fill* The material obtained from excavation of the pipe trench or elsewhere and containing not more than 20% by mass of stones with a size between 75 mm and 150 mm and none larger than 150 mm.
- (c) *Select fill* The material obtained from excavation of the pipe trench or elsewhere with a particle size not greater than 75 mm, and which conforms with the soil classes given in Table 1.

TABLE 1
SOIL CLASSES AS DEFINED IN AS 1726

Abbreviation	Description
SC	Clayey sands with fines of low plasticity
SP	Poorly graded sands
SW	Well-graded sands
GC	Clayey gravels with fines of low plasticity
GW	Well-graded sand and gravel mixtures with little or no plastic fines
GP	Poorly graded sand and gravel mixtures with little or no plastic fines

4.5 Foundation

A naturally occurring or replaced material beneath the pipe bed.

4.6 Haunch zones

The areas bounded by the trench walls and the outside of the pipe, the top of the bed zone and a level surface whose height above the bottom of the pipe is determined in accordance with Clause 9.3 (see Figure 1 (a) and (b)).

4.7 Installation condition

The configuration of the cross-section of a pipe installation being one of the following:

- (a) *Trench condition* The installation condition illustrated by Figure 2.
- (b) *Embankment condition*:
 - (i) *Positive projection* The installation condition illustrated by Figure 3(a).
 - (ii) *Negative projection* The installation condition illustrated by Figure 3(b).
- (c) *Multiple pipes condition* The installation condition illustrated by Figure 4.
- (d) *Jacked (thrust) or bored pipes condition* The installation condition illustrated by Figure 5.

4.8 Overlay zone

The area extending around the outside of the pipe to the tops of the last placed side zone, haunch zone or bed zone, as appropriate. Each has a breadth of not less than 150 mm at any point measured radially from the outside of the pipe (see Figure 1 (a) and (b)).

4.9 Pipe

A length of pipe cast as a single unit.

4.10 Settlement ratio (r_s)

A dimensionless number indicative of the relative settlements of the pipe and adjacent fill in an embankment condition.

4.11 Side zones

The areas bounded by the trench walls and the outside of the pipe, the top of the haunch zones and a level surface whose height above the bottom of the pipe is not less than $0.5D$ (see Figure 1 (a) and (b)).

4.12 Superimposed load

The vertical components of a load applied to the fill above a pipe.

4.13 Test loads

The loads calculated in accordance with Clause 10.

4.14 Working load

Vertical component of the maximum external dead load and any load acting concurrently at the level of the top of an installed pipe, calculated in accordance with Clause 6.

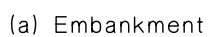


FIGURE 1 FILL AND PIPE SUPPORT TERMS

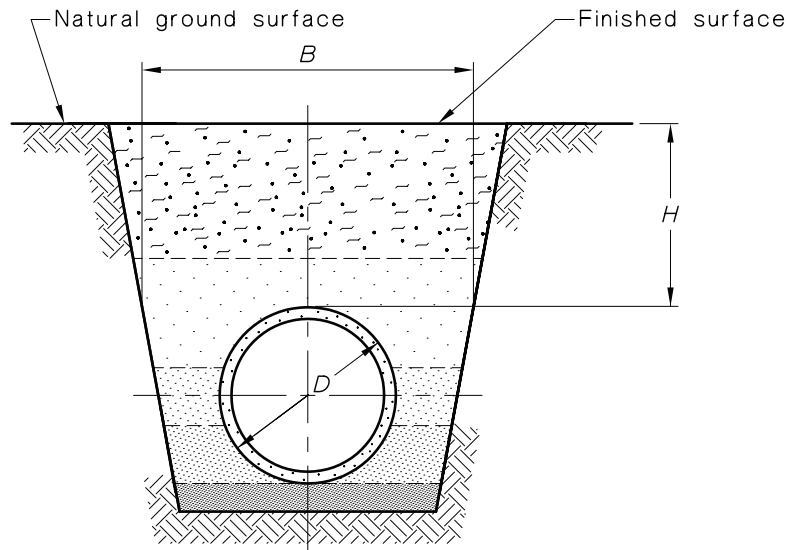
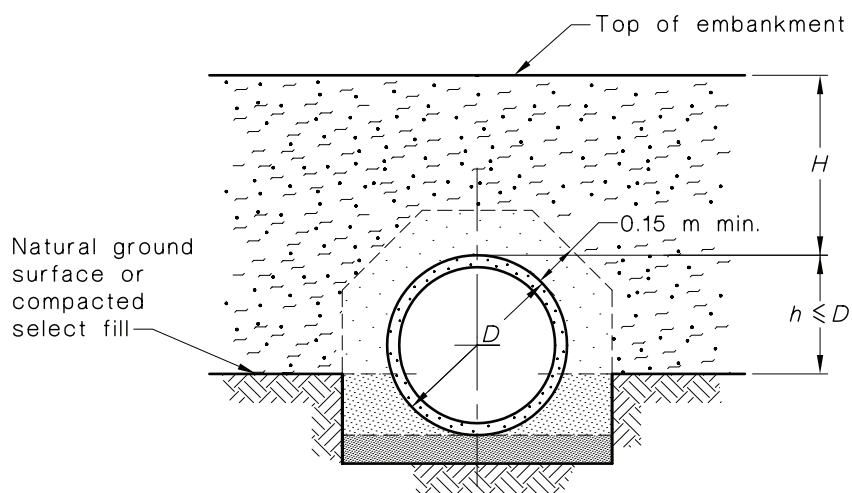
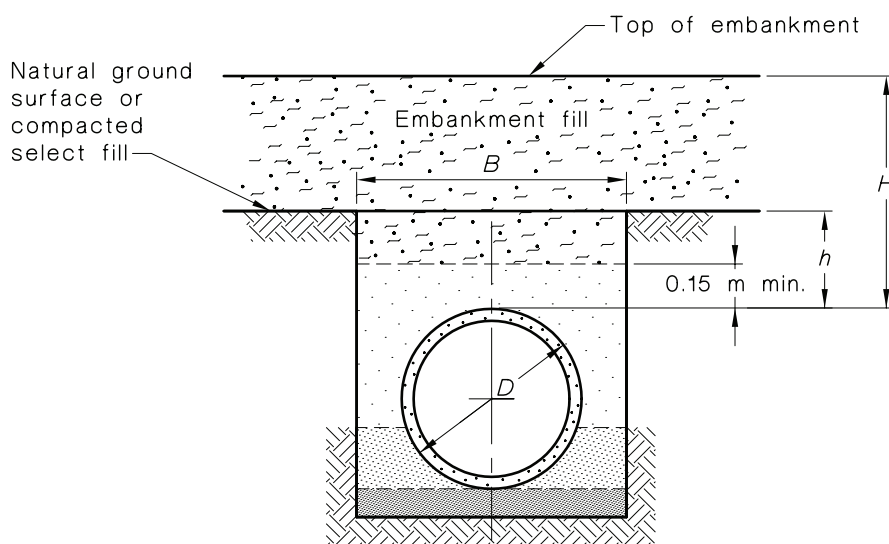


FIGURE 2 TRENCH CONDITION

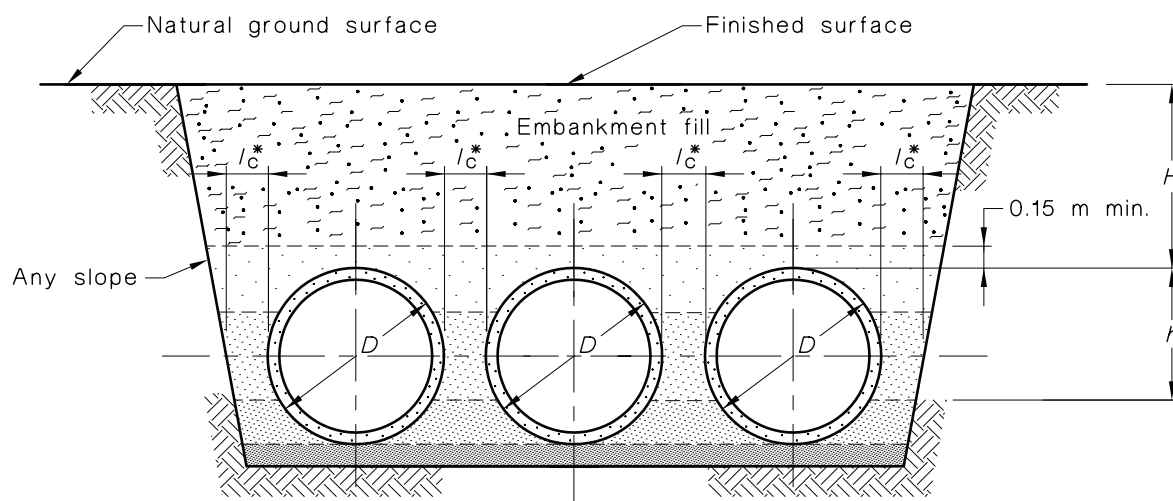


(a) Positive projection



(b) Negative projection

FIGURE 3 EMBANKMENT CONDITION



<i>D</i>	Minimum l_c	
	Compacted fill, (see Clause 4.4)	CLSM* (see Appendix A)
≤ 600	150	100
$> 600, \leq 1200$	200	100
> 1200	$D/6$	100

* For socketed pipes, a minimum of 50 mm should be maintained between adjacent pipe sockets

NOTE: The minimum values should only be used when necessary compaction between the pipes can be assured.

FIGURE 4 MULTIPLE PIPES CONDITION

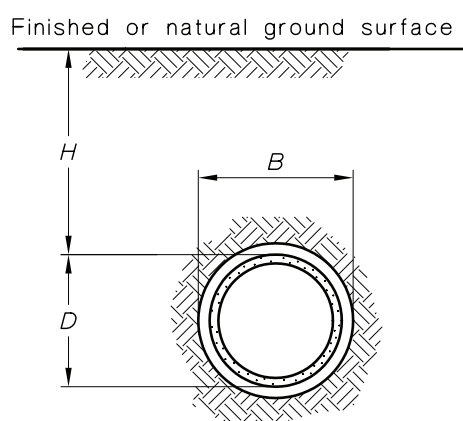


FIGURE 5 JACKED (THRUST) OR BORED PIPES CONDITION

5 NOTATION

The quantity symbols used in this Standard are listed in Table 2.

TABLE 2
QUANTITY SYMBOLS

Quantity symbol	Definition	Unit of measurement	Text reference
A	area of the base of a load prism	m ²	Clause 6.5.3.2
a	length defined in Figure 9	m	Clause 6.5.3.2
α	dynamic load allowance	—	Clause 6.5.3.2
B	width of the trench measured at the top of the pipe(s)	m	Figures 2, 3, 5
b	length defined in Figure 9	m	Clause 6.5.3.2
C'_e	coefficient obtained from Figure 7*	—	Clause 6.3.3.1, Equation 2
C'_n	coefficient obtained from Figure 8*	—	Clause 6.3.3.2, Equation 3
C_t	coefficient obtained from Figure 6*	—	Clauses 6.3.2, 6.3.5, Equations 1, 4
c	soil parameter—value of the apparent soil cohesion based on measurements of loads in the fill above the pipe	kPa	Clause 6.3.3.4, Table 3
D	external diameter of a pipe	m	Figures 1, 2, 3, 4, 5
F	bedding factor for fill and superimposed dead loads	—	Clauses 4.3, 9.1.2, 9.3
F_q	live load bedding factor	—	Clauses 9.1.2, 10.2, 10.3, 10.4
G	wheel spacing defined in Figures 9 and 10	m	Clause 6.5.3.2, Figures 9, 10
H	vertical distance from the top of a pipe to the finished ground or road surface, or to the top of the rails	m	Figures 4, 5
H_{eq}	equivalent height of fill	m	Clause 6.4
h	vertical distance from the top of the pipe to the level of the adjacent undisturbed foundation, or compacted select fill, or trench bottom, whichever is the lesser	m	Figures 3, 4
I_D	density index	%	Clause 8, Table 4
J	sum of axle spacings; e.g., 2.5 m for M1600 tri-axle	m	Clause 6.5.3.2
$K\mu$	Soil parameter	—	Figure 7
l_c	horizontal distance at the spring-line between the external face of the pipe and— the trench wall; <i>or</i> the wall of an adjacent pipe, in a trench with two or more pipes	mm	Figures 1, 4, 12, 13
L_1	length of the base of the load prisms measured parallel to the pipe axis	m	Clauses 6.5.3.2, 6.5.3.4, Paragraph B4, Appendix B, Figures 9, 10
L_2	length of the base of the load prisms measured perpendicular to the pipe axis	m	Clause 6.5.3.2, Paragraph B4, Appendix B, Figure 9
L_e	effective length of pipe supporting the load	m	Clause 6.5.3.4, Figure 10

* See AS/NZS 3725 Supp 1.

(continued)

TABLE 2 (continued)

Quantity symbol	Definition	Unit of measurement	Text reference
P	wheel load; or a railway axle load	kN	Clause 6.5.3.2, Figures 9, 10
P_t	hydrostatic test pressure determined in accordance with AS 4058	kPa	Clause 10.4
P_m	Minimum dry test load at failure	kN/m	Clause 10.2
P_w	maximum internal working pressure	kPa	Clause 10.4
p	positive projection ratio, h/D	—	Figure 7
p'	negative projection ratio, h/W	—	Figure 8
q	average intensity of the working live load at the level of the top of the pipe	kPa	Clause 6.5.3, 6.5.4
R_D	dry density ratio	%	Clause 8, Table 4
r_s	settlement ratio	—	Clause 4.10
S	L_2 or D , whichever is the lesser	m	Clause 6.5.3.4, 6.5.4
T_c	proof load for reinforced concrete pipe or the long-term design load for FRC pipe pipes not subject to internal pressure	kN/m	Clause 10.2, Table B2, Appendix B
T_{cp}	proof load for pipes subject to internal pressure	kN/m	Clause 10.4
T_u	test ultimate load	kN/m	Clause 10.2, 10.3
u	superimposed uniformly distributed dead load	kPa	Clause 6.4
W_g	calculated working load on a pipe due to external dead loads	kN/m	Clause 6.3, 10.2, Equations 1, 2, 3, 4, 5
W_q	calculated working load on a pipe due to external live loads	kN/m	Clause 6.5.4, 10.2, Equations 7, 8
w	assessed unit weight of fill material	kN/m ³	Clauses 6.3.5, 6.4, Equations 1, 2, 3, 4, 5
x	depth of bed zone	m	Figures 12, 13, Table 4
y	depth of haunch zones	m	Figure 12, 13, Table 4
z	height of top of side zone above bottom of pipe	m	Figure 13

6 VERTICAL LOADS ON PIPES

6.1 Types of loading

In the design or selection of a concrete pipe an assessment shall be made of the following types of vertical loads:

- Working load due to the fill material.
- Working load due to superimposed dead loads.
- Working load due to superimposed live loads.

6.2 Data required

To assess the working loads on pipes in accordance with this Standard, the following known or assumed data is required:

- Height of the fill material above the top of the pipes.
- Assessed unit weight of the fill material.
- Magnitude and nature of any superimposed loads.
- Type of support and foundation materials.