

Australian/New Zealand Standard™

Precast concrete pipes (pressure and non-pressure)



AS/NZS 4058:2007

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 22 January 2007 and on behalf of the Council of Standards New Zealand on 19 December 2006.

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The following are represented on Committee WS-006:

Australasian Railway Association
Australian Chamber of Commerce and Industry
Brisbane City Council
Business New Zealand
Concrete Pipe Association of Australasia
Engineers Australia
Main Roads Department, QLD
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Australian/New Zealand Standard™

Precast concrete pipes (pressure and non-pressure)

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS—006, Concrete Pipes, to supersede AS 4058—1992, *Precast concrete pipes (pressure and non-pressure)* and NZS 3107:1978, *Specification for precast concrete drainage and pressure pipes*.

The objective of this revision is to update the Standard for publication as a joint Australian/New Zealand Standard.

Where a choice is given between an Australian Standard and a New Zealand Standard (for example, Testing) the Australian Standard will apply in Australia and the New Zealand Standard in New Zealand.

Users of the Standard are reminded that the means for determining whether a pipe, manufactured in accordance with this Standard, is suitable for a particular loading application, are contained in AS/NZS 3725, *Design for installation of buried concrete pipes*.

The in-service life of a pipeline installation is dependent on the pipe's manufacture, application and installation conditions. Based on past experience of concrete pipe installations, a service life of 100 years could be expected when pipes are manufactured in accordance with this Standard and installed in accordance with AS/NZS 3725 in a 'normal environment' and 'marine environment', as defined in this Standard. Pipes subject to 'other environments' (i.e. more aggressive) should be assessed for suitability using appropriate engineering judgement. See Appendix E of this Standard.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard. All other notes are for information only.

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Australian/New Zealand Standard
Precast concrete pipes (pressure and non-pressure)

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard describes minimum requirements for materials and manufacture of controlled quality precast concrete pipes. It also describes minimum requirements for sampling, testing and classifying concrete pipes manufactured in accordance with this Standard.

This Standard applies to circular precast pipes manufactured from concrete, unreinforced or with circumferential steel reinforcement, that are intended for pressure or non-pressure water supply, drainage, sewerage or service duct applications.

This Standard does not apply to the following:

- (a) Cast in situ pipes, box culverts, or structural members covered by other Australian Standards.
- (b) Precast prestressed concrete pipe, embedded steel cylinder pipe, and fibre-reinforced concrete pipe or precast concrete cylindrical access chamber components, or pipes made of other materials.

Requirements for fittings fabricated from pipes complying with this Standard are not specified in this Standard.

Requirements for ordering and supplying concrete pipes are given in Section 6 (see Note 2).

NOTES:

- 1 This Standard does not cover the assessment of external service loads to which a pipe will be subjected in particular installation conditions. Therefore, purchasers should specify pipe design characteristics and routine testing requirements that are appropriate to the intended embedment and service conditions. Where a purchaser is not the concrete pipe asset owner, the purchaser should consult with the asset owner's designer or specifier to determine these requirements, prior to ordering.
- 2 AS/NZS 3725 should be referred to for the selection, design and specification of buried concrete pipe installations.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|--------|--|
| 1379 | Specification and supply of concrete |
| 1478 | Chemical admixtures for concrete, mortar and grout |
| 1478.1 | Part 1: Admixture for concrete |
| 1646 | Elastomeric seals for waterworks purposes |
| 1646.1 | Part 1: General requirements |
| 1646.2 | Part 2: Material requirements for pipe joint seals used in water and wastewater applications—Specifies by prescription formulation |
| 1646.3 | Part 3: Material requirements for pipe joint seals used in water and wastewater applications with the exception of natural rubber and polyisoprene compounds |

AS	
1726	Geotechnical site investigations
2758	Aggregates and rock for engineering purposes
2758.1	Part 1: Concrete aggregates
3582	Supplementary cementitious materials for use with portland and blended cement
3582.1	Part 1: Fly ash
3582.2	Part 2: Slag—Ground granulated iron blast-furnace
3582.3	Part 3: Amorphous silica
3610	Form for concrete
3972	Portland and blended cements
AS/NZS	
3725	Design for installation of buried concrete pipes
4671	Steel reinforcing materials
NZS	
3114	Specification for concrete surface finishes
3121	Specification for water and aggregate for concrete
3122	Specification for Portland and blended cements (General and special purpose)

1.3 DEFINITIONS

1.3.1 Administrative definitions

1.3.1.1 *Approved*

Approved by the purchaser or its nominated representative.

1.3.1.2 *Manufacturer*

The person(s) or corporate body responsible for the manufacture of the pipes.

1.3.1.3 *Purchaser*

The person(s), corporate body, or authorized agent thereof, with whom the manufacturer has contracted to manufacture or supply the pipes.

1.3.1.4 *Specified*

Stated in writing in any document (including an order, drawing and specification) that forms a part or the whole of a contract between the purchaser and the manufacturer.

1.3.2 Technical definitions

1.3.2.1 *Batch*

A group of pipes of the same class complying with a particular design and produced, under uniform conditions during a given production period, by the same process.

NOTE: A batch may be defined and identified by the pipe manufacturer.

1.3.2.2 *Class*

Pipes with common characteristics, classified in accordance with Clause 1.4.

1.3.2.3 *Concrete cover*

The thickness, in millimetres, of concrete between any surface of circumferential and longitudinal steel reinforcement, excluding nibs, end spacers and the ends of the longitudinal reinforcement, and the nearest concrete surface of the pipe.

1.3.2.4 Diameter

- 1 *Design diameter* The design internal diameter, nominated by the manufacturer for a specified nominal size load or pressure class of pipe to which specified tolerances are applied (see Note below).
- 2 *External diameter* The measured external diameter.
- 3 *Internal diameter* The measured internal diameter.
- 4 *Nominal diameter* (DN) The nominal internal diameter. Nominal diameter is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

NOTE: For a given nominal diameter, the design diameter usually decreases as the load or pressure class increases. The design diameter is normally the value used for hydraulic calculations.

1.3.2.5 Deflection

The maximum angle (of deviation) between two adjoining pipes that is quoted by the manufacturer as being able to be obtained without loss of joint performance for an appropriate service condition.

NOTE: Design deflections are normally only a proportion of the maximum deflection to allow for installation tolerances and future ground movement.

1.3.2.6 Length

- 1 *Effective length* The length (L_e) given in Figure 1.1, specified by the manufacturer and subject to the permissible tolerances.
- 2 *Laying length* The effective length plus the manufacturer's recommended laying gap.

1.3.2.7 Lifting element

A device cast into the pipe wall that is designed specifically to facilitate handling of the pipe.

1.3.2.8 Normal environment

An underground environment having negligible influence on the in-service life expectancy of pipe and having a minimum cover to reinforcement complying with this Standard.

NOTE: A guide to the concentration limits applicable to this environment is provided in Appendix E.

1.3.2.9 Marine environment

An underground environment for a pipe where the interior surface of the pipeline is also subject to tidal flow (i.e. not openly exposed to direct wave action or wind-driven salt-borne spray).

NOTE: A guide to the concentration limits applicable to some environment constituents is provided in Appendix E.

1.3.2.10 Other environment

An environment that does not comply with the definitions for either normal or marine environments.

NOTE: Includes environments in which one or more of the limits in Appendix E is exceeded.

1.3.2.11 Splay ended pipe

A pipe manufactured to have one or both ends at a specified non-perpendicular angle to the pipe axis.

1.3.2.12 *Standard feeler gauge*

A feeler gauge of the shape specified in Appendix C and of thickness given in Table C1, Appendix C.

1.3.2.13 *Test crack*

A crack developed in a pipe when the appropriate proof load has been applied and maintained in accordance with Appendix C.

1.3.2.14 *Proof load (T_c)*

The specified load applied to and sustained by a pipe without the appearance of cracks greater than the appropriate test crack.

1.3.2.15 *Test pressure (P_t)*

The hydrostatic pressure applied internally to pipes and fittings when factory-tested for strength and watertightness.

1.3.2.16 *Test ultimate load (T_u)*

The specified load that can be sustained by a pipe without loss of load.

1.3.2.17 *Test ultimate pressure (P_u)*

The specified factory hydrostatic pressure that can be sustained by a pipe without rapid loss of pressure.

1.3.2.18 *Allowable working pressure (P_w)*

The maximum internal hydraulic pressure, including surge pressure effects, that a pipe can sustain in continuous service with an appropriate design factor of safety.

1.3.2.19 *Routine test*

A test performed on a sample from a batch of pipes, to confirm conformance to the requirements of this Standard.

1.3.2.20 *Sample*

One or more pipes drawn from a batch selected at random irrespective of quality.

NOTE: The number of units of continuous product in the sample is the sample size.

1.3.2.21 *Sampling scheme*

An overall system of sampling pipe production that comprises sampling plans for the tests to be carried out on finished pipes and includes related procedures.

1.3.2.22 *Sampling plan*

A specific plan or statement that gives the number, size and class of samples to be taken from a production batch of pipes, the frequency of inspection or testing and the associated acceptance or rejection criteria.

1.3.2.23 *Inspection*

An evaluation of the quality of pipe samples by inspection or examination.

1.4 CLASSIFICATION OF PIPES**1.4.1 Criteria**

Concrete pipes shall be classified on the basis of the criteria given in Clauses 1.4.2 to 1.4.4. Pipes shall be considered to be of the same class if all the relevant classification criteria are the same.

1.4.2 Size class

The size class of a pipe shall be determined by the nominal diameter (DN) of the pipe in millimetres. Size classes for unreinforced concrete pipes are given in the first columns of Table 4.1. Size classes for reinforced concrete pipes are given in the first column of Table 4.2.

1.4.3 Load class

1.4.3.1 General

The load class of a pipe shall be determined in accordance with—

- (a) Clause 1.4.3.2 for unreinforced pipes; or
- (b) Clause 1.4.3.3 for reinforced pipe.

1.4.3.2 Unreinforced pipes

All unreinforced pipes shall be classified as light-duty load class in accordance with Table 4.1 and shall be designated by the size class followed by the letters 'LDU' (light duty unreinforced).

1.4.3.3 Reinforced pipes

Reinforced pipes shall be classified according to the size class and the corresponding test load(s) (proof and ultimate) given in the Table 4.2. The load class shall be designated by the size class followed by the class number specified at the top of the relevant column of Table 4.2.

1.4.3.4 Jacking pipes

This Standard does not provide data or criteria to design of concrete pipes for jacking loads. An appropriate engineering method shall be used.

1.4.4 Watertightness or pressure class

1.4.4.1 General

Where watertightness or pressure testing is specified in accordance with Clauses 4.4 or 4.5, as appropriate, a pipe and joint system shall be classified as either—

- (a) watertight (90 kPa);
- (b) pressure, where the specified test pressure (P_t) is ≥ 50 kPa.

Where no watertightness or pressure testing is specified for a pipe and joint system, it shall not be accorded a pressure classification.

Unreinforced (Load class LDU) pipes shall not be classified as pressure pipes.

1.4.4.2 Watertightness class

The watertightness class of a reinforced concrete non-pressure pipe shall be verified by a 90 kPa watertightness test.

1.4.4.3 Pressure class

The pressure class of a reinforced concrete pressure pipe shall be the test pressure (P_t) (see Clause 4.5). The pressure class shall be designated by the value of P_t , (in kPa), and the maximum permissible proof load (T_{cp}) (in kN/m), determined in accordance with AS/NZS 3725, but not less than that given in Clause 4.2(c).

NOTE: Pressure class designations for pressure pipe are a P_t value ≥ 50 kPa.

1.4.4.4 Joint selection

Where a pipe joint system is accorded a pressure or watertightness class, the pipe joint shall incorporate an elastomeric seal in accordance with Clause 2.4.

NOTES:

- 1 Some non-pressure applications, where a watertightness class is not required, may involve the use of a pipe joint design that incorporates an elastomeric seal, which is intended to facilitate safe joint installation practices or to prevent soil or root migration into or through the joints.
- 2 Some flush or similar joint designs may have no watertightness or pressure class but may incorporate sealing elements including external bands to prevent soil migration into or through the joints

1.5 MARKING

1.5.1 Marking on each pipe

Each pipe shall have clearly and indelibly marked on it, in an easily visible location, the following information:

- (a) The manufacturer's name or registered trademark and the location of manufacture.
- (b) The date on which the pipe was cast.
- (c) For pipes manufactured for—
 - (i) non-pressure or non-watertight applications, the nominal diameter and load class, e.g., DN 750/3 or DN 750/LDU
 - (ii) watertight applications (90 kPa), the nominal diameter and load class, e.g., DN 750/3/WT
 - (iii) pressure applications (e.g., pressure ≥ 50 kPa), the nominal diameter, the load class and the hydrostatic test pressure, e.g., DN 750/3/600 (750 nominal diameter, Class 3, 600 kPa hydrostatic pressure).
- (d) For pipes manufactured for 'marine' or 'other' environments, in accordance with Item (c)(i), (c)(ii) or (c)(iii) above, as applicable, and the internal cover followed by the external cover, e.g., 10/20 or 20/10.
- (e) Where an elliptical reinforcement cage has been incorporated in the pipe, the word 'TOP' indicating the correct laying position of the pipe with respect to the direction of vertical loading and the orientation of the reinforcement.
- (f) The maximum mass in kilograms of pipe for the particular pipe class.
 In New Zealand, for pipes with lifting elements in accordance with Clause 3.5.3, where the maximum mass that may be lifted using the lifting element has been marked on the lifting element, this requirement shall be deemed to have been met.
- (g) For splay-ended pipes—
 - (i) markings 50 mm long on the outside of the pipe, at four locations on each end, to define the vertical and horizontal axes of the pipe; and
 - (ii) the specified curve identification for splay pipes, e.g., R 5 being for a 5 m radius curve, e.g., DN 750/3/R 5, or angle of splay in degrees, e.g., DN 750/3/2°.
- (h) The number of this Standard, i.e., AS/NZS 4058.

NOTE: Manufacturers making a statement of compliance with this Australian/New Zealand Standard on a product, packaging, or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

1.5.2 Colour coding for load class

The pipe shall be indelibly marked, or a corrosion-resistant marker shall be securely fastened to the reinforcement, within 300 mm of the face of the pipe spigot end. The colour of the mark or marker for the appropriate load class shall be in accordance with Table 1.1. Markers shall not be employed with pipes for internal pressure applications.

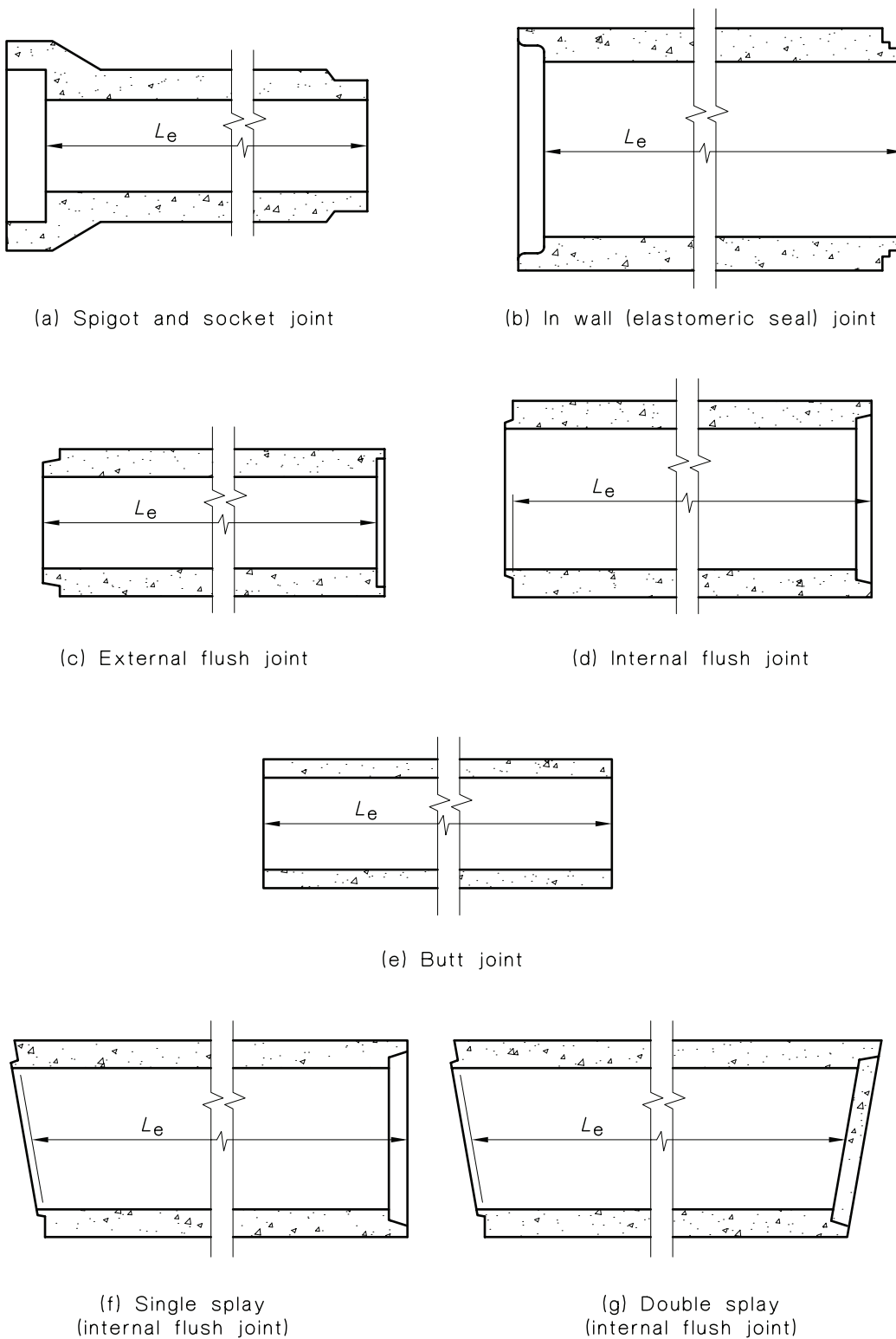
For pipes having elliptical reinforcement, the mark or marker shall be fixed at the top of the pipe so that it will be clearly visible after the pipe is removed from the mould. Alternatively, marks or markers may be equally spaced each side of the top and in a plane perpendicular to the pipe length. Where marks or markers are located each side of the top of the pipe, a minimum of two sets (locations) are required. These marks or markers shall be in addition to the requirement of Clause 1.5.1(e).

TABLE 1.1
COLOUR CODING OF MARKERS

Load class designation of pipe (see Clause 1.4.3)	Marker colour	
	Australia	New Zealand
LDU	No marker	No marker
2	No marker	Yellow
3	Red	Blue
4	Yellow	Red
>4	Green	Red

NOTES:

- 1 In Australia, where elliptical reinforcement is used in Class 2 pipe, use white coloured markers to indicate top of pipe.
- 2 In New Zealand, where elliptical reinforcement is used in Class 2 pipe, a yellow marker shall be used to indicate top of pipe.



NOTES:

- 1 Joints depicted are schematic only and not intended to restrict the development of different joint designs.
- 2 For splay pipes L_e is the pipe centre-line dimension.

FIGURE 1.1 KEY PIPE ATTRIBUTES

SECTION 2 MATERIALS

2.1 VERIFICATION OF MATERIALS COMPLIANCE

The manufacturer shall have an auditable system of control that provides verification that concrete pipe materials comply with this Section.

2.2 CONCRETE MATERIALS

2.2.1 Cement

Cement shall comply with AS 3972 or NZS 3122, as applicable.

2.2.2 Supplementary cementitious materials

Supplementary cementitious materials shall comply with the relevant part(s) of AS 3582, as applicable.

2.2.3 Aggregates

Aggregates shall comply with AS 2758.1 or NZS 3121, as applicable, and with any additional requirements that may, according to that Standard, need to be separately specified for a particular usage or application of the pipes

Lightweight aggregates and non-ferrous metallurgical slag aggregates shall not be used in concrete for pipes.

NOTE: Attention is drawn to the fact that as AS 2758.1 and NZS 3121 include a number of options, they cannot be used on their own as a specification for contract purposes. The particular options selected as appropriate to the intended usage of the pipes will therefore need to be separately referred to by the purchaser. When not specified by the purchaser, the manufacturer should select the appropriate options in accordance with AS 2758.1 or NZS 3121.

2.2.4 Water

Water shall comply with the water requirements of AS 1379 or NZS 3121, as applicable.

2.2.5 Admixtures

Chemical admixtures shall comply with AS 1478.1. Chemical admixtures shall not contain nitrates, significant chlorides or other strongly ionized salts unless it can be shown that they do not adversely affect durability.

2.2.6 Restriction on chemical content

The materials shall not contain acid-soluble chloride or sulfate salts in excess of the values given in Table 2.1.

Other strongly ionized salts, such as nitrates, shall not be added to concrete unless it can be shown that they do not adversely affect durability.

TABLE 2.1
MAXIMUM VALUES OF ACID-SOLUBLE CHLORIDE AND SULFATE
ION CONTENT IN CONCRETE AS CAST

Condition	Maximum acid-soluble chloride ion content (kg/m ³)	Maximum acid-soluble sulfate ion content percent (by mass of cement)
Concrete cured at ambient temperature	0.8	5.0
Steam-cured concrete	0.8	4.0

2.3 REINFORCEMENT

Reinforcement shall be steel bars, steel wire or welded-wire fabric complying with AS/NZS 4761.

2.4 JOINT MATERIALS

Where elastomeric seals or joint bands are used, they shall comply with AS 1646.1, and AS 1646.2 or AS 1646.3, as appropriate, and shall be supplied by the pipe manufacturer. When ordering elastomeric joint seals, the pipe manufacturer, as seal joint purchaser, shall document, as appropriate, the information described in Appendix B of AS 1646.1.

Other joint materials shall comply with the relevant Australian Standard or, where no such Standard exists, an appropriate current ISO, BS EN or ASTM Standard, by agreement between manufacturer and purchaser.

SECTION 3 MANUFACTURE, HANDLING AND STORAGE

3.1 VERIFICATION OF MANUFACTURING PROCESS COMPLIANCE

For each established and newly commissioned manufacturing facility, the manufacturer shall have an auditable system of control that verifies concrete pipe manufacturing, handling and storage comply with this Section.

3.2 DESIGN DETAILS

3.2.1 Joints

The ends of pipes shall be formed so that when pipes of the same nominal diameter and load class are laid together—

- (a) for rigid joints, the diameters of the joined pipes shall be concentric in the plane of the joint; and
- (b) for flexible joints, the axes of the joined pipes shall intersect in the plane of the joint.

Pipe ends intended for watertightness or pressure testing shall be designed to produce watertight pipeline joints in service (see Clause 5.2.3)

3.2.2 Structural continuity

Structural continuity shall be provided between the socket and pipe barrel.

NOTE: Barrel and socket reinforcement do not need to be interconnected.

3.2.3 Reinforcement

3.2.3.1 General

Where used, reinforcement shall be in the form of circular or elliptical cages concentric with the longitudinal axis of the pipe, and shall extend the length of the pipe barrel and socket.

At the time of placing concrete, the reinforcement shall be free of materials or coatings likely to impair its bond with the concrete.

3.2.3.2 Fabrication

Reinforcement shall be fabricated so that it can be easily placed and accurately held in the required position during pipe manufacture.

3.2.3.3 Splicing of circumferential reinforcement

Where it is necessary to splice the circumferential reinforcement, this shall be done by lapping the reinforcement not less than 50 diameters of the bar or wire, or by welding in a manner that will ensure that the ultimate strength of the reinforcement is developed by the splice. For lap splicing of welded wire fabric, the length of the lap shall be not less than the spacing of the transverse bars.

3.2.4 Concrete

Concrete shall be control batched and mechanically mixed. The batching and mixing shall be controlled to produce fresh concrete of uniform quality throughout each production run.

The fresh concrete shall be cast and cured to produce dense hardened concrete to a smoothness equivalent to a steel trowel finish and free from defects that would impair the strength or serviceability of the pipe. The interior or exterior concrete surfaces of pipes shall not be coated unless otherwise specified.

The manufacturer shall produce concrete with properties that provide a durability consistent with the water absorption limits specified in Clause 4.6 and strengths appropriate to the nominated load class and pressure class performance requirements.

NOTE: To achieve the required water absorption limits, typical concrete material requirements include the use of water/binder ratios (w/b) ≤ 0.4 and binder contents $\geq 330 \text{ kg/m}^3$.

3.3 DIMENSIONS AND TOLERANCES

3.3.1 General

The dimensions of pipes, including concrete cover to reinforcement, shall be determined in accordance with Clauses 3.3.2 to 3.3.7, at the place of manufacture. Where specified, sampling and testing shall be in accordance with Clause 5.2.

3.3.2 Concrete cover to reinforcement

The concrete cover to reinforcement, excluding radial ribs to circumferential reinforcement, end spacers, and longitudinal reinforcement ends, when measured in accordance with Appendix G shall be not less than the values given in Table 3.1.

TABLE 3.1
CONCRETE COVER TO STEEL REINFORCEMENT

millimetres						
Method of manufacture	Minimum cover—Barrel and socket			Minimum cover—Mating surface of spigot		
	Environment					
	Normal	Marine	Other	Normal	Marine	Other
Machine made—						
Wall thickness						
≤25	6	N/A	(See	4	N/A	(See
>25, ≤35	8	N/A	Note 3)	5	N/A	Note 3)
>35	10	20		6	10	
Wet cast (50 MPa concrete)	25	35		25	35	

NOTES:

- 1 The minimum cover specifications apply to pipes with water absorption no greater than the values given in Clause 4.6.
- 2 Appendix E gives information on concentration limits applicable to some constituents of the buried environment when using concrete with water absorption in accordance with Clause 4.6.
- 3 'Other environment' refers to environments that do not comply with the definitions for either normal or marine environments. These include environments in which one or more of the limits in Appendix E is exceeded (e.g., above-ground salt-water exposure with severe wetting and drying). Specification of cover or other protective treatment for these situations requires an informed assessment drawing on information not available in this Standard.
- 4 Where pipes are loaded to less than 50% of the proof load for a marine environment, barrel cover for pipes with water absorption in accordance with Clause 4.6, may be reduced to 15 mm for machine made and 20 mm for wet cast.
- 5 Maximum 10 mm reinforcing bar or wire for nominated concrete covers to reinforcement.
- 6 N/A = Not applicable. Pipe wall geometry does not permit a pipe wall $\leq 35 \text{ mm}$ to be specified for a marine environment.

3.3.3 Internal diameter

The internal diameter shall not vary from the design diameter nominated by the manufacturer by more than the tolerances given in Table 3.2.

No individual measurement of the internal diameter shall vary from the design diameter by more than—

- (a) 10 mm for design diameters less than or equal to 1200 mm; or
- (b) 15 mm for design diameters greater than 1200 mm.

The internal diameter shall be determined by taking two measurements, mutually at right angles, at 200 mm from each end and at the centre of the length. For socket and spigot joints, the distance from the socket end shall be measured from the point at which the socket meets the barrel. The internal diameter shall be taken as the mean of the six values.

TABLE 3.2
PERMISSIBLE TOLERANCES ON INTERNAL DIAMETER

Design diameter	millimetres	
	Permissible internal diameter tolerances	
	Drainage and sewerage pipes	Pressure pipes
≤600	±7	±5
>600, ≤1200	±8	±7
>1200, ≤1650	±10	±10
>1650	±13	±13

NOTE: Where specified, the tolerances in this Table may be applied to external diameter (see Clause 3.3.4).

3.3.4 External diameter

Where specified, the external diameter (D_e) shall be determined by taking two measurements mutually at right angles, at 200 mm from each end of the pipe barrel and at the centre of the length. For socket and spigot joints, the distance from the socket end shall be measured from the point at which the socket meets the barrel. The external diameter shall be taken as the mean of the six values.

3.3.5 Wall thickness

Wall thickness shall comply with the tolerances given in Table 3.3.

The wall thickness shall be determined by direct measurement. The wall thickness shall be determined by taking two measurements through the pipe barrel, mutually at right angles, at 200 mm from each end of the pipe. The wall thickness shall be taken as the mean of the four values.

TABLE 3.3
PERMISSIBLE TOLERANCES ON WALL THICKNESS

		millimetres
Designated wall thickness *		Permissible tolerance
	≤30	−2,+5
>30,	≤50	−3,+5
>50,	≤65	−4,+5
>65,	≤75	±5
>75,	≤95	±6
>95,	≤115	±7
>115,	≤135	±8
>135,	≤155	±9
	>155	±10

* Refer to manufacturer's appropriate designated wall thickness for each pipe size class and load class.

3.3.6 Effective length

The effective length (L_e) shall not vary from the value nominated by the manufacturer by more than ± 15 mm.

The lengths of the long and short sides of a splay-ended pipe shall not vary from the nominated values by more than ± 7 mm.

The effective length (L_e) shall be determined by measuring along the barrel, at each of the one-third points of the internal circumference, and taken as the mean of the three values. For splay-ended pipes, L_e shall be determined by measuring along the barrel, at each of the one-quarter points of the internal circumference, and taken as the mean of the four values.

3.3.7 Straightness

For straight lengths of pipe, the total deviation from straightness of the inner surface when measured along the pipe axis from end to end shall not exceed 12 mm. In addition to this, the deviation from a straight line taken between any two points, one metre apart, along the pipe barrel shall not exceed 3 mm.

3.3.8 End squareness of pipes

End squareness of a pipe or jacking pipe shall comply with the tolerances given in Table 3.4.

The end squareness of a pipe shall be determined by measuring across three external end-diameters at 60 degrees to one another as shown in Figure 3.1.

TABLE 3.4
PERMISSIBLE TOLERANCE ON END SQUARENESS FOR PIPES

millimetres			
Pipe		Jacking pipe	
Design diameter	Permissible tolerance	Design diameter	Permissible tolerance
≤450	±2	<900	±2
>450	$d/200$ or 10	≥900, ≤1500	±4
		>1500, ≤2400	±5.5
		>2400	±7

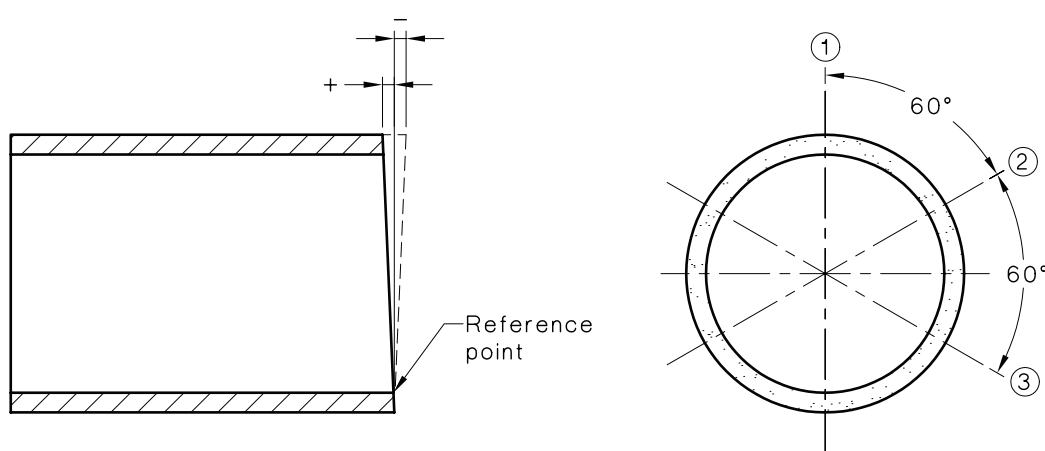


FIGURE 3.1 MEASUREMENT OF END SQUARENESS

3.4 WORKMANSHIP AND FINISH

3.4.1 Inspection and acceptance

Each pipe shall be inspected for defects in accordance with Clauses 3.4.2 and 3.4.4, and accepted in accordance with Clauses 3.4.3 and 3.4.4.

3.4.2 Defects in reinforced pipes

3.4.2.1 Classification of defects by type

Defects in untested reinforced pipes, or in such pipes after testing, shall be classified by type in accordance with Clause 3.4.2.2, and the acceptability or otherwise of pipes containing a particular type of defect shall be determined in accordance with Clause 3.4.3.

Surface craze cracks (usually of irregular pattern) and hairline cracks (cracks just visible to the naked eye) not extending through the pipe wall, shall not be classified as defects.

3.4.2.2 Defect types

Defects shall be classified as follows:

- (a) *Type 1*—Clearly visible cracks not extending through the pipe wall and whose width as determined in accordance with Paragraph C4.3, Appendix C, at a depth of 3 mm is not greater than the relevant value given in Table 3.5, except that for sewerage pipes and pipes intended for use in marine environments, the maximum crack width for a Type 1 defect is 0.10 mm regardless of cover.