EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 598:2007+A1

June 2009

ICS 23.040.10; 23.040.40

Supersedes EN 598:2007

English Version

Ductile iron pipes, fittings, accessories and their joints for sewerage applications - Requirements and test methods

Tuyaux, raccords et accessoires en fonte ductile et leurs assemblages pour l'assainissement - Prescriptions et méthodes d'essai

Rohre, Formstücke, Zuberhörteile aus duktilem Gusseisen und ihre Verbindungen für die Abwasser-Entsorgung - Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 11 August 2007 and includes Amendment 1 approved by CEN on 23 May 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Tables

Figures

Foreword

This document (EN 598:2007+A1:2009) has been prepared by Technical Committee CEN/TC 203 "Cast iron pipes, fittings and their joints", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2009-05-23.

This document supersedes A1 EN 598:2007 A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Construction Products Directive (89/106/EEC).

For relationship with EU Construction Products Directive, see informative Annex ZA, which is an integral part of this document.

This European Standard is in conformity with the general requirements already established by CEN/TC 165 in the field of sewerage.

Annex ZA includes the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC). Only if the requirements specified in Annex ZA are met, the CE marking will be effected.

For reasons of conformity with mandate M/131 "Pipes, tanks and ancillaries not in contact with water intended for human consumption", EN 598:1994 has been revised by extension with Annex ZA (see Resolution CEN/BT 113/1994 and CEN/BT 63/1996) and Clause 9 for the evaluation of conformity.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the requirements and associated test methods applicable to ductile iron pipes, fittings, accessories and their joints for the construction of drains and sewers outside buildings:

— operating without pressure (gravity sewerage), or with positive or negative pressure (see Table 5);

— to be installed below or above ground;

— to convey surface water, domestic waste water and certain types of industrial effluents, either in separate systems or in combined systems.

This European Standard applies to pipes, fittings and accessories which are:

— manufactured with socketed, flanged or spigot ends;

— normally delivered externally and internally coated;

— suitable for continuous fluid temperatures between 0 °C excluding frost, and 45 °C for DN ≤ 200 or 35 °C for DN > 200, according to EN 476;

— not intended for use in areas subject to reaction to fire regulations.

NOTE 1 This does not preclude special arrangements for the products to be used at higher temperatures.

This European Standard covers pipes, fittings and accessories cast by any type of foundry process or manufactured by fabrication of cast components, as well as corresponding joints, of a size range extending from DN 80 to DN 2000 inclusive.

This European Standard specifies requirements for materials, dimensions and tolerances, mechanical properties and standard coatings of ductile iron pipes and fittings. It also gives performance requirements for all components including joints. Joint design and gasket shapes are outside the scope of this European Standard.

NOTE 2 In this European Standard, all pressures are relative pressures, expressed in bars (100 kPa = 1 bar).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies (including any amendments).

EN 196-1, *Methods of testing cement — Part 1: Determination of strength*

EN 545, *Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods*

EN 681-1, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications - Part 1: Vulcanised rubber*

EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 10002-1, *Metallic materials - Tensile testing — Part 1: Method of test at ambient temperature*

EN 14901, *Ductile iron pipes, fittings and accessories — Epoxy coating (heavy duty) of ductile iron fittings and accessories — Requirements and test methods*

EN ISO 4016, *Hexagon head bolts — Product grade C (ISO 4016:1999)*

EN ISO 4034, *Hexagon nuts — Product grade C (ISO 4034:1999)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 9001:2000, *Quality management systems — Requirements (ISO 9001:2000)*

EN ISO 7091, *Plain washers — Normal series — Product grade C (ISO 7091:2000)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ductile iron
cast iron used for pipes, fittings and accessories in which graphite is present substantially in spheroidal form

3.2
pipe
casting of uniform bore, straight in axis, having either socket, spigot or flanged ends, except for flanged-socket pieces, flanged-spigot pieces and collars which are classified as fittings

3.3
fitting
casting other than a pipe which allows pipeline deviation, change of direction or bore. In addition flanged-socket pieces, flanged-spigot pieces and collars are also classified as fittings

3.4
accessory
any casting other than a pipe or fitting which is used in a pipeline, for example:

— inspection chambers (see 3.5);

— manholes (see 3.6);

— glands and bolts for mechanical flexible joints (sec 3.15);

– glands, bolts and locking rings for restrained flexible joints (see 3.16);

— adjustable flanges and flanges to be welded or screwed

NOTE Valves of all types are not covered by the term accessory.

3.5
inspection chamber
component of a discharge system, of a drain or of a sewer providing access from the ground surface for inspection and maintenance equipment

[EN 476:1997]

3.6
manhole
component of a sewer of sufficient size to provide access from the ground surface for inspection and maintenance operations by personnel and equipment

[EN 476:1997]

3.7
flange
flat circular end of a pipe or fitting extending perpendicular to its axis, with bolt holes equally spaced on a circle

NOTE A flange is either fixed (e.g. integrally cast or welded-on) or adjustable; an adjustable flange comprises a ring, in one or several parts assembled together, which bears on an end joint hub and can be freely rotated around the pipe axis before jointing.

3.8
spigot
male end of a pipe or fitting

3.9
spigot end length
spigot over a length equal to maximum insertion depth plus 50 mm

3.10
socket
female end of a pipe or fitting to make the connection with the spigot of the next component

3.11
gasket
sealing component of a joint

3.12
joint
connection between the ends of two pipes and/or fittings in which a gasket is used to effect a seal

3.13
flexible joint
joint which permits significant angular deflection both during and after installation and which can accept a slight offset of the centreline

3.14
push-in flexible joint
flexible joint assembled by pushing the spigot through the gasket in the socket of the mating component

3.15
mechanical flexible joint
flexible joint in which sealing is obtained by applying pressure to the gasket by mechanical means, e.g. a gland

3.16
restrained flexible joint
flexible joint in which a means is provided to prevent separation of the assembled joint

3.17
flanged joint
joint between two flanged ends

3.18
nominal size (DN)
alphanumerical 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

[EN ISO 6708:1995]

3.19
nominal pressure (PN)
alphanumerical designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system. It comprises the letters PN followed by a dimensionless number

[EN 1333:2006]

NOTE All equipment of the same nominal size DN designated by the same PN number have compatible mating dimensions.

3.20
leak tightness test pressure
pressure applied to a component during manufacture in order to ensure its leak tightness

3.21
allowable operating pressure (PFA)
maximum hydrostatic pressure that a component can withstand continuously in service

[EN 773:1999]

3.22
allowable maximum operating pressure (PMA)
maximum hydrostatic pressure, including surge, that a component can withstand from time to time in service

[EN 773:1999]

3.23
allowable test pressure (PEA)
maximum hydrostatic pressure that a newly installed component can withstand for a relatively short duration, when either fixed above ground level or laid and backfilled underground, in order to ensure the integrity and tightness of the pipeline

[EN 773:1999]

NOTE This test pressure is different from the system test pressure (STP), which is related to the design pressure of the pipeline and is intended to ensure its integrity and leak tightness.

3.24
diametral stiffness of a pipe
haracteristic of a pipe which allows it to resist ovalization under loading when installed

3.25
discharge system
system of pipes, fittings, accessories and joints used to collect and drain waste water and rainwater of a building

NOTE It comprises discharge pipes, stack ventilation pipes and rainwater downpipes, installed within the limits of a building or attached to the building.

3.26
drain
system of pipes, fittings, accessories and joints installed outside the limits of a building in order to connect the discharge system of this building to a sewer or a septic tank

3.27
sewer
pipeline designed to collect waste water and rainwater from buildings and surface water and to convey them to the point of disposal or treatment

3.28
gravity sewer
sewer operating normally under free flowing conditions (see Table 5)

3.29
pressure sewer; pumping sewer
sewer (or section of a sewer) operating under positive pressure (see Table 5)

3.30
vacuum sewer
sewer operating under negative pressure (see Table 5)

3.31
combined system
sewerage system collecting together rainwater, surface water and waste water

3.32
separate system
sewerage system which collects waste water separately from rainwater and surface water

3.33
performance test (initial type test – ITT)
test which is done once and is repeated only after change of design, material or process

3.34
length
effective length of a pipe or fitting as shown on Figure 6 for socket and spigot pipes and as given in 4.2.3.2 for flanged pipes and 4.2.3.3 for fittings

3.35
deviation
design length allowance with respect to the standardised length of a pipe

3.36
ovality
out of roundness of a pipe section; it is equal to : $100\left(\frac{A_1 - A_2}{A_1 + A_2}\right)$

where

A_1 is the maximum axis in millimetres;

A_2 is the minimum axis, in millimetres

4 Technical requirements

4.1 General

4.1.1 Ductile iron pipes and fittings

Nominal sizes, thicknesses, lengths and coatings are specified in 4.1.1, 4.2.1, 4.2.3, 4.4 and 4.5 respectively. When, by agreement between manufacturer and purchaser, pipes and fittings with different wall thicknesses, lengths and/or coatings and other types of fittings than those given in 8.1, 8.2 and 8.3 are supplied with reference to this European Standard, they shall comply with all the other requirements of this European Standard.

NOTE 1 Other types of fittings include tees and tapers with other combinations DN × dn, draining tees etc.

The standardized nominal sizes, DN of pipes and fittings are as follows: 80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1400, 1500, 1600, 1800, 2000. These DN values are DN/ID according to EN 476.

The functional properties of ductile iron pipes and fittings shall be as given in Clause 5.

NOTE 2 When installed and operated under the conditions for which they are designed (see Annexes A to E) ductile iron pipes, fittings, accessories and their joints maintain all their functional characteristics over their reasonable economic operating life, due to the constant material properties, to the stability of their cross section and to their design with high safety factors.

4.1.2 Surface condition and repairs

Pipes, fittings and accessories shall be free from defects and surface imperfections which could lead to non-compliance with Clauses 4 and 5.

When necessary, pipes and fittings may be repaired, for example by welding, in order to remove surface imperfections and localized defects which do not affect the entire wall thickness, provided that:

- the repairs are carried out according to the manufacturer's written procedure;
- the repaired pipes and fittings shall comply with all the requirements of Clause 4 and of Clause 5.

4.1.3 Types of joints and interconnection

4.1.3.1 Gasket materials

Rubber gasket materials shall comply with the requirements of EN 681-1 for the type WC or WG. When materials other than rubber are necessary (e.g. for high temperature flanged joints), they shall comply with the appropriate European Technical Specification or where no European Technical Specification exists, the appropriate International Standard.

4.1.3.2 Flanged joints

Flanged joints shall be designed such that they can be attached to flanges whose dimensions and tolerances comply with EN 1092-2. This ensures interconnection between all flanged components (pipes, fittings, valves etc.) of the same PN and DN and adequate joint performance.

Bolts and nuts shall comply as a minimum with the requirements of EN ISO 4016 and EN ISO 4034, grade 4.6. Where washers are required they shall comply with EN ISO 7091.

Although it does not affect interconnection, the manufacturer shall make the information available as to whether his products are normally delivered with fixed flanges or adjustable flanges.

Flange gaskets may be one of any type given in EN 1514.

4.1.3.3 Flexible joints

Pipes and fittings with flexible joints shall comply with 4.2.2.1 for their spigot external diameters DE and their tolerances. This offers the possibility of interconnection between components equipped with different types of flexible joints. In addition, each type of flexible joint shall be designed to fulfil the performance requirements of Clause 5.

NOTE 1 For interconnection with certain types of joints operating within a tighter tolerance range on DE, the manufacturer's guidance should be followed as to the means of ensuring adequate joint performance at high pressures (e.g. measurement and selection of external diameter).

NOTE 2 For interconnection with existing pipelines having external diameters not in compliance with 4.2.2.1, the manufacturer's guidance should be followed as to the appropriate means of interconnection (e.g. adaptors).

4.1.4 Colour identification

Pipes for sewers and drains shall be identified externally by one of the following colours: brown, red or grey. This is to allow easy identification of installed sewers and drains. Pipes specifically intended for rain water or surface water sewers (separate systems) may be identified by a different colour other than those used for potable water pipes.

4.2 Dimensional requirements

4.2.1 Wall thickness

For pipes the standardised thicknesses and limit deviations are given in Table 11. They are such that the diametral stiffnesses of pipes are not less than the values shown in Table 10. The measurement of the wall thickness shall be in accordance with 6.1.1.

The iron thickness of fittings used for pressure sewers shall be in accordance with EN 545.

The iron thickness of fittings used for gravity sewers shall be equal to or higher than those of pipes of the same DN.

4.2.2 Diameter

4.2.2.1 External diameter

8.1 specifies the values of the external diameter DE of the coated spigot end length of pipes and fittings and their maximum allowable tolerances, when measured using a circumferential tape in accordance with 6.1.2.

NOTE 1 Certain types of flexible joints operate within a tighter range of tolerance (see 4.1.3.3).

NOTE 2 Thick external coatings should be removed, according to the manufacturer's guidance, in order to comply with the specified external diameter DE, when the pipe needs to be cut on site.

For DN < 300, the external diameter of the pipe barrel measured with a circumferential tape shall be such as to allow the assembly of the joint over at least two thirds of the pipe length from the spigot end when the pipe needs to be cut on site.

In addition, the ovality (see 3.9) of the spigot end of pipes and fittings shall

— remain within the tolerance on DE (see Table 11) for DN 80 to DN 200 and

— not exceed 1 % for DN 250 to DN 600 or 2 % for DN > 600.

NOTE 3 The manufacturer's guidance should be followed as to the necessity and means of ovality correction; certain types of flexible joints can accept the maximum ovality without a need for spigot re-rounding prior to jointing.

4.2.2.2 Internal diameter

The nominal values of the internal diameters of pipes, expressed in millimetres, are equal to the numbers indicating their nominal size, DN, and the tolerances shall be as given in Table 1 which applies to cement mortar lined pipes.

These tolerances apply only to the pipe with iron thickness as given in Table 11 and cement mortar lining thickness as given in Table 4.

NOTE Due to the manufacturing process of the ductile iron pipes and their internal linings, internal diameters with the lower limit deviation will only appear locally along the pipe length.

Compliance shall be demonstrated according to 6.1.3 or by calculation from the measurements taken for pipe external diameter, iron wall thickness and lining thickness.

Table 1 — Limit deviation on internal diameter

DN	Limit deviation [a] mm
80 to 1000	10
1100 to 2000	– 0,01 DN
[a] The lower limit only is given.	

4.2.3 Length

4.2.3.1 Standardized lengths of socket and spigot pipes

Pipes shall be supplied to the standardized lengths given in Table 2.

Table 2 — Standardized length of socket and spigot pipes

DN	Standardized length L_u [a] m
80 to 600	3 or 5 or 5,5 or 6
700 to 800	5,5 or 6 or 7
900 to 1400	6 or 7 or 8,15
1500 to 2000	8,15
[a] See 3.34.	

The permissible deviations (see 3.35) on the standardized length L_u of pipes shall be as follows:

— for standardized length 8,15 m ± 150 mm;

— for all other standardized lengths ± 100 mm.

Pipes shall be designed to a length taken in the range: standardized length plus or minus the permissible deviation; they shall be manufactured to this design length plus or minus the limit deviation given in 4.2.3.4.

The manufacturer shall make the information available as to his design lengths.

The length shall be measured according to 6.1.4 and shall be within the limit deviations given in 4.2.3.4.

Of the total number of socket and spigot pipes to be supplied in each diameter, the percentage of shorter pipes shall not exceed 10 %, in which case the length reduction shall be:

– up to 0,15 m for the pipes in which samples have been cut for testing (see 4.3);

– up to 2 m by increments of 0,5 m for DN < 700;

— up to 3 m by increments of 0,1 m for DN ≥ 700.

4.2.3.2 Standardized lengths of flanged pipes

The length of flanged pipes shall comply with EN 545.

4.2.3.3 Standardized lengths of fittings

The length of the fittings used for pressure sewers shall be in accordance with EN 545 (see 8.3).

The length of fittings used for gravity sewers shall be made available by the manufacturer (see 8.2 for usual types of fittings).

4.2.3.4 Limit deviations on lengths

The limit deviations on lengths of the socket and spigot pipes shall be within − 30 mm, + 70 mm.

The limit deviations on lengths of flanged pipes and of fittings shall be in accordance with EN 545.

The limit deviations on lengths of fittings used for gravity sewers shall be made available by the manufacturer.

4.2.4 Straightness of pipes

Pipes shall be straight, with a maximum deviation of 0,125 % of their length.

The verification of this requirement is usually carried out by visual inspection, but in case of doubt or in dispute the deviation shall be measured in accordance with 6.2.

4.2.5 Inspection chambers

Inspection chambers (see 3.5) shall be manufactured either as an integral item or by site assembly of a bottom part (inspection tee) and a vertical part.

Opening dimensions shall be as follows: 250 mm, 300 mm, 400 mm, 600 mm.

4.2.6 Manholes

Manholes (see 3.6) shall comprise a vertical part of DN ≥ 800, a bottom plate, a top plate capable of receiving a frame and a manhole cover, and two or more inlets/outlets fixed to the vertical part.

The number and location of inlets/outlets shall preserve the hydraulic continuity of the manhole.

4.3 Material characteristics

4.3.1 Tensile properties

Pipes, fittings and accessories of ductile iron shall have the tensile properties given in Table 3.

The tensile strength shall be tested in accordance with 6.3.

Table 3 — Tensile properties

	Minimum tensile strength, R_m MPa	Minimum elongation after fracture, A %	
	DN 80 to DN 2000	DN 80 to DN 1000	DN 1100 to DN 2000
Pipes centrifugally cast	420	10	7
Pipes not centrifugally cast, fittings and accessories	420	5	5
By agreement between manufacturer and purchaser, the 0,2 % proof stress ($R_{p0,2}$) may be measured. It shall be not less than: — 270 MPa when $A \geq 12$ % for DN 80 to DN 1000 or A >10 % for DN > 1000; — 300 MPa in other cases.			

.3.2 Hardness

The hardness of the various components shall be such that they can be cut, drilled, tapped and/or machined with normal tools. The reference test for hardness shall be the Brinell hardness test in accordance with 6.4.

The Brinell hardness shall not exceed 230 HBW for pipes and 250 HBW for fittings and accessories. For components manufactured by welding, a higher Brinell hardness is allowed in the heat affected zone of the weld.

4.4 Coatings and linings for pipes

4.4.1 General

All pipes conforming to this document shall be delivered with an external coating of zinc with finishing layer in accordance with 4.4.2, and an internal lining of high alumina cement mortar in accordance with 4.4.3.

This shall not preclude special coating arrangements for products which deviate from the requirements of this document for specific design reasons. Annex B indicates possible alternative coatings.

Except for pipes intended only for the transport of rainwater, the surfaces which can come into contact with the ffluents (internal surface of the socket and external surface of the spigot end) shall be coated with a synthetic resin (epoxy, polyurethane etc.) in accordance with 4.4.4.

NOTE 1 This does not preclude the possibility that for special design reasons the upper limit deviation on the external diameter DE of the coated spigot can be greater than that specified in 8.1, provided that the interconnection of the products is ensured by the joint design.

Pipes with cast flanges may be coated as fittings (see 4.5).

The maximum fluid temperature may be limited to 35 °C for some polymeric coatings. If such coatings are to be used at higher temperatures, additional performance testing should be carried out.

NOTE 2 Annexes B and C give advice on the field of intended use for pipes with coatings and linings according to this document.

4.4.2 External coating of zinc with finishing layer

4.4.2.1 General

The external coating of centrifugally cast ductile iron pipes shall comprise a layer of metallic zinc, covered by a nishing layer of a synthetic resin (epoxy, polyurethane etc.) compatible with zinc. Both layers shall be works applied.

The zinc is normally applied on oxide-surfaced pipes after heat treatment; at the manufacturer's option, it may also be applied on blast-cleaned pipes. Prior to application of the zinc, the pipe surface shall be dry and free from rust or non-adhering particles or foreign matter such as oil or grease.

4.4.2.2 Coating characteristics

The metallic zinc coating shall cover the external surface of the pipe and provide a dense, continuous, uniform layer. It shall be free from such defects as bare patches or lack of adhesion. The uniformity of the coating shall be checked by visual inspection. When measured in accordance with 6.7, the mean mass of zinc per unit area shall be not less than 130 g/m^2. The purity of the zinc used shall be at least 99,99 %.

The finishing layer shall uniformly cover the whole surface of the metallic zinc layer and be free from such defects as bare patches or lack of adhesion. The uniformity of the finishing layer shall be checked by visual inspection. When measured in accordance with 6.8, the mean thickness of the finishing layer shall be not less than 70 µm and the local minimum thickness not less than 50 µm.

4.4.2.3 Repairs

Damage to coatings where the area of total removal of zinc and finishing layer has a width exceeding 5 mm and areas left uncoated (e.g. under test token, see 6.7) shall be repaired.

Repairs shall be carried out by:

— metallic zinc spray complying with 4.4.2.2, or application of zinc-rich paint containing at least 90 % zinc by mass of dry film and with a mean mass of applied paint not less than 150 g/m^2 and

— application of a finishing layer complying with 4.4.2.2.

4.4.3 Internal lining of high alumina cement mortar

4.4.3.1 General

Unless otherwise specified in the corresponding European Standard, the internal cement mortar lining of ductile iron pipes shall comply with the requirements of 4.4.3.

The cement mortar lining of ductile iron pipes shall constitute a dense, homogeneous layer covering the total internal surface of the pipe barrel.

It shall be works-applied by a centrifugal spinning process or a centrifugal spray head or a combination of these methods. Smoothing with a trowel is permitted.

Prior to application of the lining, the metal surface shall be free from loose material and oil or grease.

The cement mortar mix shall comprise high alumina cement (with a minimum alumina content of 40 %), sand and water; chloride-free admixtures may be used when necessary. The ratio by mass of sand to cement shall not exceed 3,5. At mixing stage, the ratio by mass of total water to cement depends on the manufacturing process and shall be determined such that the lining is in conformance with 4.4.3.2 and 5.10; it shall not exceed 0,38 in the fresh lining immediately after application.

The sand shall have a grading which is adapted to the lining process and thickness, and it shall not contain organic impurities or fine clay particles which can affect the lining quality.

The water used in the mortar mix shall be drinking water quality or water that has no harmful effect on the characteristics of the lining.

After application of the fresh lining, controlled curing shall be carried out so as to provide sufficient hydration to the cement.

The cured lining shall comply with 4.4.3.2, 5.8, 5.9 and 5.10.

4.4.3.2 Thickness and surface condition

The nominal thickness of the cement mortar lining and its tolerance shall be as given in Table 4. When measured in accordance with 6.9, the lining thickness shall be within the specified tolerance.

The surface of the cement mortar lining shall be uniform and smooth. Trowel marks, protrusion of sand grains and surface texture inherent to the method of manufacture are acceptable. However, there shall be no recesses or local defects which reduce the thickness to below the minimum value given in Table 4. The grinding of the lining in order to remove the top surface of the internal layer is permitted provided the finished lining complies with all requirements of 4.4.3.

Fine crazing and hairline cracks associated with cement rich surfaces may appear in dry linings. Shrinkage cracks inherent to cement-bound materials may also develop in the dry linings. After curing of the lining and under normal storage conditions, the crack width and the radial displacement (disbondment) shall not exceed the values given in Table 4.

Table 4 — Thickness of cement mortar lining

DN	Thickness		Maximum crack width and radial displacement
	Nominal value	Limit deviation [a]	
80 to 300	4	– 1,5	0,4
350 to 600	5	– 2,0	0,5
700 to 1200	6	– 2,5	0,6
1400 to 2000	9	– 3,0	0,8

[a] The lower limit only is given.

Cement mortar linings at pipe ends may have a chamfer of maximum length 20 mm.

NOTE Storage of pipes and fittings in a hot, dry environment can cause metal expansion and mortar shrinkage which can result in the dry lining developing areas of disbondment and shrinkage cracks exceeding the width given in Table 4. When the lining is re-exposed to water, it will swell by absorption of moisture and the cracks will close to conform to Table 4 and will eventually heal by an autogenous process.

4.4.3.3 Repairs

Repairs to areas of damaged linings shall be effected by the use of either cement mortar (see 4.4.3.1) or a compatible polymer mortar; application may be by hand held implement.

Prior to the application of the repair mortar, the damaged area shall be cut back to the sound lining or to the metal surface and all loose material shall be removed. After completion of the repair, the cement lining shall comply with 4.4.3.1, 4.4.3.2 and 5.10.

4.4.4 Coating of the joint areas

The coating shall uniformly cover the whole surface; it shall have a smooth regular appearance and be free from defects which may affect its function.

The minimum coating thickness shall be such that the coating complies with 5.8. When measured according to 6.8, the coating thickness shall be not less than the minimum thickness given in the quality plan of the manufacturer.

4.5 Coatings for fittings and accessories

4.5.1 General

Fittings, accessories and pipes not centrifugally cast shall be delivered with an external and internal epoxy coating, conforming to 4.5.2.

This shall not preclude special coating arrangements for products which deviate from the requirements of this document for specific design reasons. Annex B indicates possible alternative coatings.

NOTE Annexes B and C give advice on the field of intended use for fittings and accessories with coatings and linings according to this document.

4.5.2 Epoxy coating

The coating shall comply with the applicable requirements of EN 14901. In addition the requirements for chemical resistance (see 5.8) and for abrasion resistance (see 5.9) shall apply.

4.6 Marking of pipes and fittings

All pipes and fittings shall be legibly and durably marked and shall bear at least the following information:

— manufacturer's name or mark;

— identification of the year of manufacture;

— identification as ductile iron;

— DN;

— PN rating of flanges for flange components;

— identification of the application (gravity or pressure);

— reference to this European Standard, i.e. EN 598 or EN 545 for pressure fittings.

In addition, pipes of DN > 300 suitable for cutting shall be identified (unless all pipes of the same DN are suitable fc cutting).

The first five markings given above shall be cast-on or cold stamped; the two other markings can be applied by any method e.g. painted on the casting or attached to the packaging.

NOTE For CE marking and labelling ZA.3 applies. Where ZA.3 requires the CE marking to be accompanied by the same information as required by this subclause, the requirements of this subclause are met.

4.7 Leak tightness

4.7.1 Systems design requirements

Sewer systems constructed with ductile iron components in conformity with this standard shall be leak tight at the pressures given in Table 5, depending on the way they are normally operated. This applies under all normal service conditions, including foreseeable external loads and joint movements (angular, radial and axial).

Table 5 — Pressure

Type of operation	Internal pressure bar		External pressure bar
	Continuous	Occasional	Continuous
Gravity	0 to 0,5	2	1
Positive pressure	See PFA in Annex A	see PMA in Annex A	1
Negative pressure	– 0,5	– 0,8	1

4.7.2 Leak tightness of pipeline components

Pipes, fittings, inspection chambers and manholes shall be leak tight when used under the conditions for which they are designed (see 4.7.1). When tested in accordance with 6.5, pipes and fittings for positive pressure applications shall exhibit no visible leakage, sweating or any other sign of failure.

When tested in accordance with 6.6, pipes and fittings for negative pressure applications shall exhibit no visible leakage, sweating or any other sign of failure.

Pipes, fittings, inspection chambers and manholes for gravity applications shall comply with the performance requirements of 5.4.

4.7.3 Leak tightness of joints

All joints shall be leak tight when used under the conditions for which they are designed (see 4.7.1). All joints shall comply with the performance requirements of 5.5.

5 Performance requirements

5.1 General

The performance of all pipes, fittings, accessories and joints specified in Clause 4 shall be in conformity with the requirements of 5.2 to 5.10. This ensures their fitness for purpose in the field of sewerage in conformity with EN 476. There shall be at least one performance test for each of the groupings given in Table 6. One DN is representative of a grouping when the performances are based on the same design parameters throughout the size range. If a grouping covers products of different designs and/or manufactured by different processes, the grouping shall be sub-divided. If for a manufacturer a grouping contains only one DN, this DN may be considered as part of the adjacent grouping provided that it is of identical design and manufactured by the same process.

Table 6 — DN groupings for performance tests

Performance tests	DN groupings			
Longitudinal bending of pipes (see 5.2)	DN 80 to DN 200	–	–	–
Diametral stiffness of pipes (see 5.3)	DN 80 to DN 250	DN 300 to DN 600	DN 700 to DN 1000	DN 1100 to DN 2000
Leak tightness for gravity pipelines (see 5.4)				
Joint tightness to positive internal pressure (see 5.5.2)				
Joint tightness to negative internal pressure (see 5.5.2)				
Joint tightness to positive external pressure (see 5.5.2)				
Joint tightness to cyclic internal hydraulic pressure (see 5.5.2)				
Chemical resistance to effluents (see 5.8)	DN 80 to DN 2000			
Abrasion resistance (see 5.9)				
Strength of the cement mortar lining (see 5.10)				

5.2 Longitudinal bending of pipes

5.2.1 General

When tested according to 7.2, pipes with an aspect ratio (length/diameter) equal to or greater than 25 shall comply with 5.2.2 and subsequently 5.2.3.

5.2.2 Integrity under service conditions

The pipes shall withstand the maximum service bending moments given in Table 9 without residual deflection and without visible damage to their external and internal coatings.

5.2.3 Bending resistance

After the integrity test specified in 5.2.2, the pipes shall withstand the proof bending moments given in Table 9 without failure of the iron wall.

5.3 Diametral stiffness of pipes

5.3.1 General

When tested according to 7.3, the pipes shall comply with the requirements of 5.3.2 and subsequently 5.3.3.

5.3.2 Integrity under service conditions

The diametral stiffness of the pipes shall be not less than the values specified in Table 10, which means that they shall withstand the test loads given in Table 10 with an ovalization not exceeding the allowable values. The ovalization shall be measured and recorded (see 5.3.3).

In addition, there shall be no damage to the internal and external coatings which could affect their performance. Local damage to the external coating at the bearing area is acceptable.

NOTE 1 As ductile iron pipes are not subject to creep, the short-term and long-term values of the diametral stiffness are identical.

NOTE 2 The designed heights of cover of buried pipes, which depend largely on the diametral stiffness, are given in Annex D.

5.3.3 Resistance to ovalization

The pipes shall withstand twice the ovalization attained in the integrity under service conditions test (5.3.2) without failure of the iron wall.

5.4 Leak tightness of components for gravity pipelines

When tested in accordance with 7.4, pipes, fittings, inspection chambers and manholes shall exhibit no visible leakage, sweating or any other sign of failure.

5.5 Leak tightness of flexible joints

5.5.1 General

All joints shall be designed to be fully flexible; consequently, the allowable angular deflection declared by the manufacturer shall be not less than :

— 3°30' for DN 80 to DN 300;

— 2°30' for DN 350 to DN 600;

— 1°30' for DN 700 to DN 2000.

All joints shall be designed to provide axial movement; the allowable withdrawal shall be declared by the manufacturer.

NOTE This permits the installed pipeline to accommodate ground movements and/or thermal effects without incurring additional stresses.

5.5.2 Test conditions

All joint designs shall be performance tested under the most unfavourable, applicable conditions of tolerance and joint movement as given below:

a) joint of maximum annulus (see 5.5.3.1) aligned, withdrawn to the allowable value to be declared by the manufacturer, and subject to shear (see 5.5.3.3);

b) joint of maximum annulus (see 5.5.3.1), deflected to the allowable value to be declared by the manufacturer (see 5.5.1).

The joints shall exhibit no visible leakage when subjected to the tests given in Table 7.

Table 7 — Performance tests for joints

Test	Test requirements	Test conditions	Test method
1. Positive internal hydrostatic pressure	Test pressure: 2 bar for gravity or negative pressure pipelines (1,5 PFA + 5) bar for positive pressure pipelines Test duration: 2 h No visible leakage	Joint of maximum annulus, aligned and withdrawn, with shear load Joint of maximum annulus, deflected	In accordance with 7.5
2. Negative internal pressure	Test pressure: – 0,9 bar [a] Test duration: 2 h Maximum pressure change during test period: 0,09 bar	Joint of maximum annulus, aligned and withdrawn, with shear load Joint of maximum annulus, deflected	In accordance with 7.6
3. Positive external hydrostatic pressure [b]	Test pressure: 2 bar Test duration: 2 h No visible leakage	Joint of maximum annulus, aligned, with shear load	In accordance with 7.7
4. Cyclic internal hydraulic pressure [c]	24 000 cycles Test pressure: between PMA and (PMA – 5) bar No visible leakage	Joint of maximum annulus, aligned and withdrawn, with shear load	In accordance with 7.8

[a] 0,9 bar below atmospheric pressure (approximately 0,1 bar absolute pressure).

[b] For joints intended for use deeper than 5 m below the water level (e.g. river, lake, aquifer).

[c] For joints intended for positive pressure applications.

Test 3 (positive external pressure) may be omitted for mechanical joints, provided they have been performance-tested according to tests 1 and 2.

5.5.3 Test parameters

5.5.3.1 Annulus

All joints shall be performance tested at the extremes of manufacturing tolerance such that the annular gap between the sealing surfaces of the socket and of the spigot is equal to the maximum design value plus 0 %, minus 5 %. It is permissible to machine socket internal surfaces to achieve the required annulus for the performance test even though the resultant diameter can be slightly outside the normal manufacturing tolerance.

5.5.3.2 Pipe thickness

All joints shall be performance tested with a spigot having an average iron wall thickness (over a distance of 2 DN in millimetres from the spigot end face) equal to the specified minimum value for the pipe for which the joint is designed plus 10 %, minus 0 %. It is permissible to machine the spigot end of the test pipe in the bore to achieve the required thickness.

5.5.3.3 Shear

All joints shall be performance tested with a resultant shear force across the joints of not less than 30 × DN in newtons, taking into account the weight of the pipe and of its contents and the geometry of the test assembly (see 7.5).

5.5.4 Restrained flexible joints

All restrained joints shall be designed to be at least semi-flexible; consequently, the allowable angular deflection declared by the manufacturer shall be not less than half of the value shown in 5.5.1.

All restrained joint designs shall be performance tested in accordance with 7.5 to 7.8 following the requirements of 5.5.2 and 5.5.3, except that:

— the withdrawal condition of 5.5.2 a) shall not apply;

— there shall be no external axial restraint in positive internal pressure tests so that the joint is subjected to the full end thrust.

During the positive internal pressure tests, the axial movement shall reach a stable value and cease.

When the restraining mechanism and the sealing component of a restrained joint are independent, such a joint does not need to be subjected to test 2 and test 3 of 5.5.2 if the unrestrained version of the joint has passed these tests.

5.6 Flanged joints

The performance requirements of flanged joints shall be in accordance with EN 545.

5.7 Pipes with screwed or welded flanges

The performance requirements of pipes with screwed or welded flanges shall be in accordance with EN 545.

5.8 Chemical resistance to effluents

Except for components intended only for the transport of rainwater, long-term performance of pipes, fittings and joints shall be demonstrated by six-month exposure tests to an acid solution and to an alkaline solution according to 7.9. Their field of use is given in Annex C.

After six months of testing, the following conditions shall be met:

— thickness of the cement mortar lining shall be within 0,2 mm of the original thickness;

— there shall be no visible cracking, blistering or disbonding of the epoxy or polyurethane based coatings (fittings, pipe spigots and sockets and pipe linings);

— there shall be no visible cracking on the rubber gasket; its hardness, tensile strength and elongation shall remain in conformity with the specified values.

All other combinations of coatings may be tested according to the same procedure; the values of pH may be modified in order to demonstrate long-term behaviour in different environments.

The test method detailed in 7.9 has been improved with respect to the test method described in the first edition of this European Standard in order to achieve a better reproducibility of the results. Materials which have been successfully performance tested according to the test method described in the first edition of this European Standard may not have to be re-tested in accordance with this edition provided there has been no change in materials or design or manufacturing method that would have a detrimental effect on the performance of the chemical resistance of the product.

5.9 Abrasion resistance

When tested in accordance with 7.10, the pipes shall not have an abrasion depth greater than 0,6 mm after 100 000 movements (50 000 cycles) for every type of cement lining, or 0,2 mm for epoxy or polyurethane linings.

In order to test the abrasion resistance of fittings, pipes may be lined as fittings, and tested according to 7.10.

The test method detailed in 7.10 has been improved with respect to the test method described in the first edition of this European Standard in order to achieve a better reproducibility of the results. Materials which have been successfully performance tested according to the test method described in the first edition of this standard may not have to be re-tested in accordance with this edition provided there has been no change in materials or design or manufacturing method that would have a detrimental effect on the performance of the abrasion resistance of the product.

5.10 Strength of the cement mortar lining

When measured according to 7.1, the compressive strength of the cement mortar lining after 28 days of curing shall be not less than 50 MPa.

The compressive strength of the lining is directly related to other functional properties such as high density, good adhesion and low porosity.

The measurement of the compressive strength of the lining shall be carried out as initial performance test and when a change occurs in the manufacturing process or in the raw materials used.

6 Test methods

6.1 Pipe dimensions

6.1.1 Wall thickness

Pipe wall thickness compliance shall be demonstrated by the manufacturer. He may use a combination of various means, e.g. direct wall thickness measurement, mechanical or ultrasonic measurement.

The iron wall thickness shall be measured by suitable equipment having an error limit of ± 0,1 mm.

6.1.2 External diameter

Socket and spigot pipes shall be measured at their spigot end by means of a circumferential tape or controlled by pass-fail gauges. In addition, they shall be visually inspected for compliance with the spigot allowable ovality and, in case of doubt, the maximum and minimum spigot axes shall be measured by suitable equipment or controlled by pass-fail gauges.

6.1.3 Internal diameter

The internal diameter of the lined pipes shall be measured by means of suitable equipment

either

a) two measurements shall be taken at right angles, at a cross section 200 mm or more from the end face. The mean value of these two measurements may then be calculated

or

b) a system of pass / fail gauges shall be passed along the bore of the pipe.

6.1.4 Length

The length of socket and spigot pipes shall be measured by suitable equipment

— on one pipe from the first batch of pipes cast from a new mould, for as-cast pipes, or

— on the first pipe, for pipes which are systematically cut to a pre-set length.

6.2 Straightness of pipes

The pipe shall be rolled on two gantries or rotated around its axis on rollers, which in each case are separated by not less than two-thirds of the standardized pipe length.

The point of maximum deviation from the straight axis shall be determined and the deviation measured at that point.

6.3 Tensile testing

6.3.1 Samples

6.3.1.1 General

The thickness of the sample and the diameter of the test bar shall be as given in Table 8.

6.3.1.2 Centrifugally cast pipes

A sample shall be cut from the spigot end of the pipe. This sample may be cut parallel with or perpendicular to the pipe axis, but in case of dispute the parallel with axis sample shall be used.

6.3.1.3 Pipes not centrifugally cast, fittings and accessories

At the manufacturer's option, samples shall be either cast integrally with the castings or cast separately. In the latter case they shall be cast from the same metal as that used for the castings. If the castings are subjected to heat treatment, the samples shall be subjected to the same heat treatment cycle.

6.3.2 Preparation of test bar

. test bar shall be machined from each sample to be representative of the metal at the mid thickness of the sample, with a cylindrical part having the diameter given in Table 8.

The test bar shall have a gauge length equal to at least five times the nominal test bar diameter. The ends of the test bar shall be such that they will fit the testing machine.

The surface roughness profile of the cylindrical part of the test bar shall be such that $Rz \leq 6{,}3$ µm.

If the specified diameter of the test bar is greater than 60 % of the measured minimum thickness of the sample, it is allowed to machine a test bar with a smaller diameter, or to cut another sample in a thicker part of the pipe.

Table 8 — Dimensions of test bar

Type of casting	Nominal diameter of the test bar Mm	Limit deviations on diameter mm	Tolerance on shape [a] mm
Centrifugally cast pipes, with a wall thickness (mm) of:			
— less than 6	2,5		
— 6 up to but not including 8	3,5	− 0,06	0,03
— 8 up to but not including 12	5,0		
— 12 and over	6,0		
Pipes not centrifugally cast, fittings and accessories:			
— integrally cast samples	5,0	+ 0,06	0,03
— separately cast samples:			
• sample thickness 12,5 mm for casting thickness less than 12 mm	6,0	± 0,06	0,03
• sample thickness 25 mm for casting thickness 12 mm and over	12,0 or 14,0	± 0,09 ± 0,09	0,04 0,04

[a] Maximum difference between the smallest and the largest measured diameter of the test bar.

The tensile strength shall be calculated either from the nominal diameter of the test bar when it has been machined to fulfil all the tolerances given in Table 8, or, if it is not the case, from the actual diameter of the test bar measured before the test; the actual diameter shall be measured using a measuring device having an error limit ≤ 0,5 % and shall be within ± 10 % of the nominal diameter.

6.3.3 Apparatus and test method

The tensile test shall be carried out in accordance to EN 10002-1.

6.3.4 Test results

Test results shall comply with Table 3. If they do not comply, the manufacturer shall:

a) in the case where the metal does not achieve the required mechanical properties, investigate the reason and ensure that all castings in the batch are either re-heat treated or rejected. Castings which have been re-heat treated are then re-tested in accordance with 6.3;

b) in the case of a defect in the test bar, carry out a further test. If it passes, the batch is accepted; if not, the manufacturer may proceed as in a) above.

The manufacturer may limit the amount of rejection by making tests until the rejected batch of castings is bracketed, in order of manufacture, by a successful test at each end of the internal in question.

6.4 Brinell hardness

When Brinell hardness tests are carried out (see 4.3.2), they shall be performed either on the relevant casting or on a sample cut from the casting. The surface to be tested shall be suitably prepared by slight local grinding and the test shall be carried out in accordance with EN ISO 6506-1 using a hard metal ball of 2,5 mm, 5 mm or 10 mm diameter.

6.5 Works leak tightness test for pipes and fittings for positive pressure pipelines

6.5.1 General

Pipes and fittings shall be tested in accordance with 6.5.2 or 6.5.3 respectively. The test shall be carried out on all pipes and fittings before the application of their external and internal coatings, except for the metallic zinc coating of pipes which may be applied before the test.

The test apparatus shall be suitable for applying the specified test pressures to the pipes and/or fittings. It shall be equipped with an industrial pressure gauge with an error limit of ± 3 %.

6.5.2 Centrifugally cast pipes

The internal hydrostatic pressure shall be raised steadily until it reaches a test pressure of at least 32 bar for pipes up to and including DN 300 and 25 bar for pipes greater than DN 300. The test pressure shall be maintained for a sufficient time to allow visual inspection of the pipe barrel. The total duration of the pressure cycle shall be not less than 15 s, including 10 s at test pressure.

6.5.3 Pipes not centrifugally cast and fittings

At the manufacturer's option, they shall be submitted to a hydrostatic pressure test, to an air test or to a vacuum test of equivalent performance.

When a hydrostatic pressure test is carried out, it shall be as indicated in EN 545 for pipes not centrifugally cast and fittings.

When an air test is carried out, it shall be with an internal pressure of at least 1 bar and a visual inspection time not less than 10 s; for leak detection, the castings shall be either uniformly coated on their external surface by a suitable foaming agent or submerged in water.

When a vacuum test is carried out, it shall be based on the detection of leakage of a known gas, by any means, when the casting is subjected to a vacuum, either internally or externally, the non-evacuated side being exposed to the known gas.

6.6 Works leak tightness test for pipes and fittings for negative pressure pipelines

All the pipes and fittings shall be subjected to an air test with an internal pressure of at least 1 bar and a visual inspection time not less than 10 s for fittings and 1 min for pipes. For leak detection, pipes and fittings shall be submerged in water or uniformly coated on their external surface by a suitable foaming agent.

6.7 Zinc mass

A rectangular token of known weight per unit area shall be attached longitudinally along the axis of the pipe before passing it through the coating equipment. After zinc coating and trimming, the size of the token shall be 500 mm × 50 mm. It shall be weighed on a scale having an error limit of ± 0,01 g.

The mean mass M of zinc per unit area shall be determined from the mass difference before and after coating.

$$M = C\left(\frac{M_2 - M_1}{A}\right)$$

where

M is the mean mass of zinc in grammes per square metre;

M_1 and M_2 are the masses of the sample token, in grammes, before and after coating;

C is the predetermined correction factor, taking account of the nature of the token and of the difference in surface roughness between the token and the iron pipe;

A is the actual area of the trimmed token, in square metres.

The value of C is generally between 1 and 1,2 and shall be given in the manufacturer's FPC procedures.

The uniformity of the coating shall be checked by visual inspection of the token; in the event of a lack of uniformity, 50 mm × 50 mm pieces shall be cut from the token in the lighter mass zones and the mean mass of zinc determined on each piece by mass difference.

Alternatively the mass of zinc per unit area can be measured directly on the coated pipe by any method having proven correlation with the reference method described above, e.g. X-ray fluorescence or chemical analysis.

6.8 Thickness of paint coatings

The dry film thickness of paint coatings shall be measured by one of the three following methods:

directly on the casting by means of suitable gauges, e.g. magnetic, or by using a 'wet film' thickness gauge when a correlation between wet film thickness and dry film thickness can be demonstrated, or

— indirectly on a token which is attached to the casting before coating and is used after coating to measure the dry film thickness by mechanical means, e.g. micrometer, or by a weight method similar to 6.7, or

— indirectly on a test plate made of steel or of ductile iron, which is coated by the same process as the castings to be controlled.

For each casting to be controlled, at least three measurements shall be taken (either on the casting or on the token or on a test plate). The mean thickness is the average of all the measurements taken and the local minimum thickness is the lowest value of all the measurements taken. The manufacturer shall record the method used in his documented FPC procedures.

6.9 Thickness of cement mortar lining

During manufacture, the thickness shall be measured on the freshly applied lining by a spear having a diameter of 1,5 mm or less and controlled on the finished hardened lining by means of a suitable gauge, e.g. magnetic.

For pipes, the measurements shall be taken approximately 200 mm from the end face. The manufacturer's process control system shall specify the frequency of this test.

7 Performance test methods

7.1 Compressive strength of the cement mortar lining

The compressive strength shall be the arithmetic mean of six compressive strength tests performed on three prism samples after 28 days of curing.

The compressive strength shall be determined by a performance-test in accordance with EN 196-1, except that:

— sand, cement and the water used for the prism samples are identical with those used for the mortar before application of the lining;

— sand/cement ratio used for the prism samples is equal to that used for the mortar before application of the lining;

— water/cement ratio used for the prism samples is equal to that of the lining immediately after application to the pipe wall;

— test samples are prepared using either an impact table (in accordance with EN 196-1) or a vibrating table (2 min at 63 Hz) when the water/cement ratio is below 0,35.

NOTE This takes into account the influence of the centrifugal spinning process which allows expelling the excess water.

7.2 Longitudinal bending of pipes

The test shall be carried out on a finished pipe resting on two supports 4 m apart (see Figure 1); the load shall be applied at mid-span by means of a loading block. The two supports and the loading block shall have a *V* shape of 120° and shall be covered with a sheet of elastomer having a thickness of 10 mm ± 5 mm and a hardness greater than or equal to 50 IRHD; their width shall not exceed 100 mm. Before the test, the pipe shall be immersed in water at ambient temperature for approximately 24 h.

In the first part of the test, the load shall be increased steadily until the pipe is subjected to the maximum service bending moment given in Table 9, which is kept constant for 10 min. The load shall then be released and the pipe visually inspected.

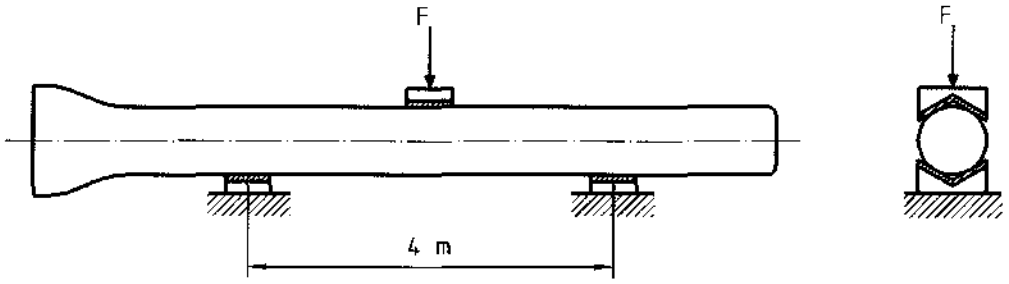


Figure 1 — Longitudinal bending test

In the second part of the test, on the same pipe, the load is steadily increased until the pipe is subjected to the proof bending moment given in Table 9. The rate of loading shall not exceed 2 kN/s. The proof load shall be applied for 1 min.

Table 9 — Test bending moments

DN	Maximum service bending moments kN·m		Proof bending moments kN·m	
	Gravity pipe	Pressure pipe	Gravity pipe	Pressure pipe
80	4	6	7	10
100	6	9	10	15
125	9	13	13 [a]	22
150	13	19	17 [a]	32
200	22,5	33	27 [a]	56

[a] These proof bending moments have been limited to a value lower than the bending moment calculated using the equation given in Note 2 below, in order to avoid local deformation of the pipe wall in the vicinity of the supports.

NOTE 1 These bending moments, expressed in kilonewton metres, are achieved by application of loads *F* of the same numerical value, expressed in kilonewtons.

NOTE 2 The bending moments are calculated by the following equation:

$$M = 0{,}25\pi \times 10^{-6}\ R_f \times D^2 \times e$$

where

M is the bending moment, in kilonewton metres;

R_f is the allowable stress in the pipe wall, in megapascals;

D is the mean pipe diameter $(DE - e)$, in millimetres;

DE is the nominal pipe external diameter, in millimetres (see Table 11);

e is the minimum pipe wall thickness, in millimetres (see Table 11).

The maximum service bending moments are calculated with R_f = 250 MPa and the proof bending moments with R_f = 420 MPa.

7.3 Diametral stiffness of pipes

The test shall be carried out on a pipe section 500 mm ± 20 mm long, cut from a finished pipe barrel. The pipe section shall be placed on a support approximately 200 mm wide and 600 mm long, having a *V* shape with an angle between 170° and 180° (see Figure 2). The load shall be applied at the pipe crown through a loading beam approximately 50 mm wide and 600 mm long. Both the *V* support and the loading beam shall be covered with a sheet of elastomer with a thickness of 10 mm ± 5 mm and a hardness greater than or equal to 50 IRHD. Before the test, the pipe section shall be immersed in water at ambient temperature for approximately 24 h.

The load shall be increased steadily until it reaches the test load corresponding to the minimum diametral stiffness given in Table 10 and kept constant for 1 min. The vertical deflection of the pipe section shall be measured, recorded and the calculated ovalization shall not exceed the allowable value given in Table 10. In addition, the pipe section shall be visually inspected in order to check that there is no damage to the external and internal coatings which can affect their function.

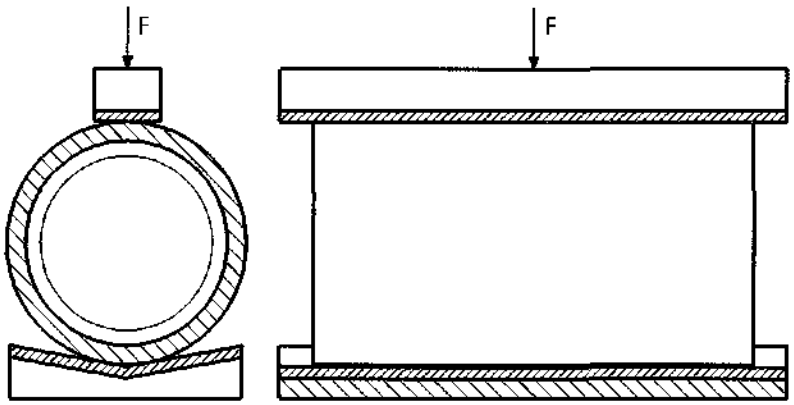


Figure 2 — Diametral stiffness test

The load shall then be increased until the vertical deflection reaches twice the value previously measured. The load shall be kept constant for 1 min.

Table 10 — Diametral stiffness test requirements

DN	Minimum diametral stiffness, *S* kN/m²	Test load, *F* kN/m	Allowable pipe ovalization %	e_{calc} mm
Gravity pipe				
80	400	30,9	1,5	2,9
100	227	25,3	1,8	2,9
125	123	21,4	2,3	2,9
150	74	17,8	2,7	2,9
200	32	13,4	2,8 (3,6)	2,9
250	32	17,1	2,9 (3,7)	3,6
300	32	20,6	3,0 (3,75)	4,3
350	32	24,2	3,1 (3,8)	4,9
Pressure pipe				
80	1 270	62,4	1,1	4,2
100	710	49,2	1,3	4,2
125	380	40,0	1,6	4,2
150	230	34,0	1,9	4,2
200	105	30,7	2,5	4,3
250	66	26,6	2,8	4,5
300	47	24,2	3,0	4,8
350	38	22,8	3,1	5,2
400	31	22,2	3,2	5,5
450	26	22,2	3,3	5,8
500	22	21,5	3,4	6,1
600	18	22,2	3,6	6,8
700	23	36,4	3,8	8,6
800	20	36,4	4,0	9,4
900	18	36,8	4,0	10,1
1000	16	36,2	4,0	10,9
1100	22	54,7	4,0	13,2
1200	20	54,3	4,0	14,1
1400	18	56,9	4,0	15,8
1500	17	57,5	4,0	16,5
1600	17	61,3	4,0	17,5
1800	16	64,6	4,0	19,2
2000	16	72,0	4,0	20,9

NOTE 1 The values for *S* have been calculated assuming a pipe wall thickness e_{calc} equal to the nominal thickness minus half the limit deviation.

NOTE 2 For gravity pipes DN 200 to 350, the values of the allowable pipe ovalization given in brackets apply for pipes with a flexible lining (epoxy or polyurethane).

NOTE 1 The ovalization is 100 times the measured vertical deflection in millimetres (caused by the applied load) divided by the measured pipe external diameter in millimetres.

NOTE 2 The diametral stiffness, the vertical deflection and the applied load are linked by the following equation:

$$S = 0{,}019\,\frac{F}{Y}$$

where

S is the diametral stiffness, in kilonewtons per square metre;

F is the applied load, in kilonewtons per metre length of pipe;

Y is the vertical deflection, in metres.

NOTE 3 The diametral stiffness S of a pipe is calculated by the following equation:

$$S = 1\,000\,\frac{E \times I}{D^3} = 1\,000 \times \frac{E}{12}\left(\frac{e_{calc}}{D}\right)^3$$

where

S is the diametral stiffness, in kilonewtons per square metre;

E is the modulus of elasticity of the material, in megapascals (170 000 MPa);

I is the second moment of area of the pipe wall per unit length, in millimetres to the third power;

e_{calc} is the wall thickness of a pipe for calculation purposes;

D is the mean diameter of the pipe $(DE - e_{calc})$, in millimetres;

DE is the nominal pipe external diameter, in millimetres (see Table 11).

7.4 Leak tightness of components for gravity pipelines

Ductile iron pipes, fittings, inspection chambers and manholes, equipped with appropriate end restraints, shall be filled with water and suitably vented of air The internal hydrostatic pressure shall then be raised to 2 bar and maintained constant for at least 2 h, during which a visual inspection for leak detection shall be carried out. The test shall be carried out at ambient temperature on coated products.

These performance tests may be performed at the same time as those described in 7.5 for joints.

7.5 Leak tightness of flexible joints to positive internal pressure

The test shall be carried out on an assembled joint comprising two pipe sections, each at least 1 m long (see Figure 3).

The test apparatus shall be capable of providing suitable end and lateral restraints whether the joint is in the aligned position, or deflected, or subjected to a shear load. It shall be equipped with a pressure gauge with an accuracy of ± 3 %.

The vertical force W shall be applied to the spigot end by means of a V shaped block with an angle of 120°, located at approximately 0,5 DN in millimetres or 200 mm from the socket face, whichever is the largest; the socket shall bear on a flat support. The vertical force W shall be such that the resultant shear force F across the joint is equal to the value specified in 5.5.3.3 taking into account the mass M of the pipe and its contents and the geometry of the test assembly:

$$W = \frac{F \times c - M(c - b)}{c - a}$$

where a, b and c are as shown in Figure 3.

The test assembly shall be filled with water and suitably vented of air. The pressure shall be raised steadily until it reaches the test pressure given in 5.5.2; the rate of pressure increase shall not exceed 1 bar per s. The test pressure shall be kept constant within ± 0,5 bar for at least 2 h during which the joint is thoroughly inspected every 15 min.

NOTE All necessary safety precautions should be taken for the duration of the pressure test.

For a restrained joint, the test assembly, the test apparatus and the test procedure shall be identical except that there shall be no end restraint, so that the axial thrust is taken by the restrained joint under test. In addition, possible axial movement of the spigot shall be measured every 15 min.

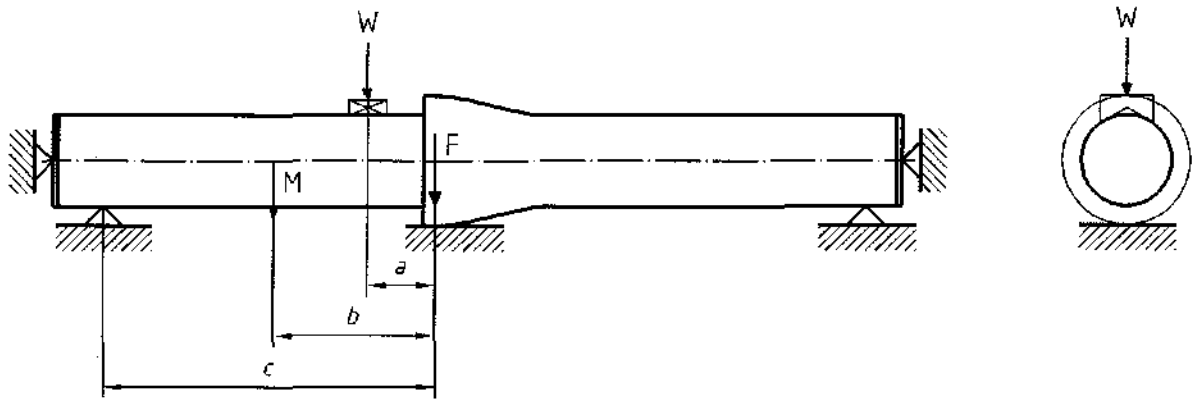


Figure 3 — Leak tightness test of joints (internal pressure)

7.6 Leak tightness of flexible joints to negative internal pressure

The test assembly and test apparatus shall be as given in 7.5, with the pipe sections axially restrained to prevent them moving towards each other.

The test assembly shall be empty of water and shall be evacuated to a negative internal pressure of 0,9 bar (see 5.5.2) and then isolated from the vacuum pump. The test assembly shall be left under vacuum for 2 h, during which the pressure shall not have changed by more than 0,09 bar. The test shall begin at a temperature between 5 °C and 40 °C. The temperature of the test assembly shall not vary by more than 10 °C for the duration of the test.

For a restrained joint, the test assembly, the test apparatus and the test procedure shall be identical.

7.7 Leak tightness of flexible push-in joints to positive external pressure

The test assembly shall comprise of two joints made with two pipe sockets welded together and one double-spigot piece (see Figure 4); it creates an annular chamber which allows testing one joint under internal pressure and one joint under external pressure.

7.10 Abrasion resistance

7.10.1 Cement mortar lining

The test shall be carried out on a one metre long DN 200 pipe sample, closed at both ends after enclosing the test material. The pipe section shall be internally brushed in order to remove the loose sand and loose mortar parts using a hard plastic brush and cleaned with compressed air.

Before test, the cement mortar lined pipe section shall be immersed in water at ambient temperature for approximately 24 h.

The cement mortar lining thickness shall be measured along a longitudinal line located at 6 o'clock at 15 regularly spaced measurement points on each line excluding 150 mm at both ends. The location of the measurement points shall identical before and after testing, preferably using a template. The thickness is measured using an electromagnetic measuring device.

The test material shall contain natural siliceous gravel to reach a level of 38 mm ± 2 mm above the invert with enough water to reach the same level. The gravel particle shall be of the rounded and not crushed type and shall have a size between 2 mm and 10 mm with an average of approximately 6 mm.

The pipe sample shall be fixed horizontally on a testing device capable of inclining the sample successively to an angle of plus 22,5° and minus 22,5° every 3 s to 5 s.

The pipe sample shall be examined after 100 000 movements (or 50 000 cycles). The depth of abrasion of the cement mortar lining is calculated as the difference between the average thickness before and after testing.

7.10.2 Epoxy or polyurethane lining

The test shall be carried out on a one metre long DN 200 pipe sample, closed at both ends after enclosing the test material.

The epoxy or polyurethane lining thickness shall be measured along a longitudinal line located at 6 o'clock at 15 regularly spaced measurement points on each line excluding 150 mm at both ends. The location of the measurement points shall identical before and after testing, preferably using a template. The thickness is measured using an electromagnetic measuring device.

The test material shall contain natural siliceous gravel to reach a level of 38 mm ± 2 mm above the invert with enough water to reach the same level. The gravel particle shall be of the rounded and not crushed type and shall have a size between 2 mm and 10 mm with an average of approximately 6 mm.

The pipe sample shall be fixed horizontally on a testing device capable of inclining the sample successively to an angle of plus 22,5° and minus 22,5° every 3 s to 5 s.

The pipe sample shall be examined after 100 000 movements (or 50 000 cycles). The depth of abrasion of the epoxy or polyurethane lining is calculated as the difference between the average thickness before and after testing.

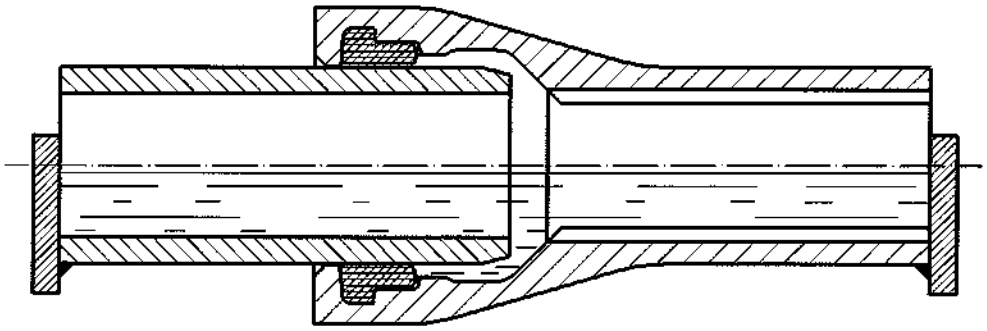


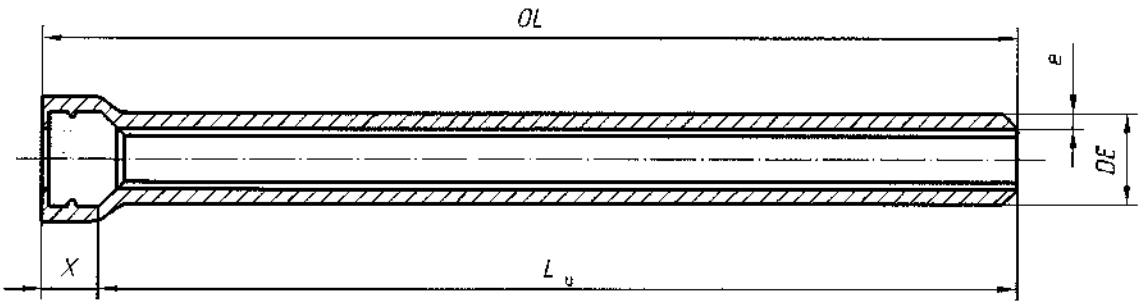
Figure 5 — Chemical resistance test

8 Tables of dimensions

8.1 Socket and spigot pipes

The dimensions of socket and spigot pipes shall be as given in Table 11. The values of L_u are given in Table 2. For external and internal coatings see 4.4.

The values of *DE* and their limit deviations apply also to the spigot ends of fittings (see 4.2.2.1).



Key

OL overall length, in metres

X maximum insertion depth, in metres

$L_u = OL - X$ is the effective length, in metres

Figure 6 — Socket and spigot pipes

Table 11 — Dimensions of pipes

DN	External diameter, *DE* mm		Iron thickness, e mm			
			Pressure pipes		Gravity pipes	
	Nominal	Limit deviation	Nominal	Limit deviation [a]	Nominal	Limit deviation [a]
80	98	+ 1/ – 2,7	4,8	– 1,3	3,4	– 1,0
100	118	+ 1/ – 2,8	4,8	– 1,3	3,4	– 1,0
125	144	+ 1/ – 2,8	4,8	– 1,3	3,4	– 1,0
150	170	+ 1/ – 2,9	4,8	– 1,3	3,4	– 1,0
200	222	+ 1/ – 3,0	4,9	– 1,3	3,4	1,0
250	274	+ 1/ – 3,1	5,3	1,6	4,1	– 1,0
300	326	+ 1/ – 3,3	5,6	– 1,6	4,8	– 1,0
350	378	+ 1/ – 3,4	6,0	– 1,7	5,5	– 1,2
400	429	+ 1/ – 3,5	6,3	– 1,7		
450	480	+ 1/ – 3,6	6,7	– 1,8		
500	532	+ 1/ – 3,8	7,0	– 1,8		
600	635	+ 1/ 4,0	7,7	– 1,9		
700	738	+ 1/ – 4,3	9,6	– 2,0		
800	842	+ 1/ – 4,5	10,4	– 2,1		
900	945	+ 1/ – 4,8	11,2	– 2,2		
1000	1 048	+ 1/ – 5,0	12,0	– 2,3		
1100	1 152	+ 1/ – 6,0	14,4	– 2,4		
1200	1 255	+ 1/ – 6,0	15,3	– 2,5		
1400	1 462	+ 1/ – 6,6	17,1	– 2,7		
1500	1 565	+ 1/ – 7,0	17,9	– 2,8		
1600	1 668	+ 1/ – 7,4	18,9	– 2,9		
1800	1 875	+ 1/ – 8,2	20,7	– 3,1		
2000	2 082	+ 1/ – 9,0	22,5	– 3,3		

[a] The minimum thickness can only appear locally at a few distinct points, not along the length or the circumference of the pipe.

8.2 Fittings for gravity sewers

8.2.1 Collars

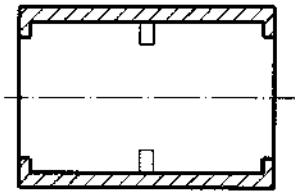


Figure 7 — Collars

The standardized DN of collars (see Figure 7) are all those from DN 80 to DN 2000.

8.2.2 Manhole connectors

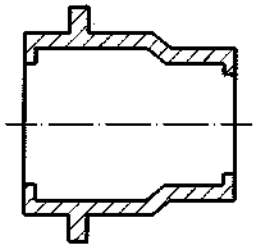


Figure 8 — Manhole connectors

The standardized DN of manhole connectors (see Figure 8) are all those from DN 150 to DN 2000.

8.2.3 Double socket bends

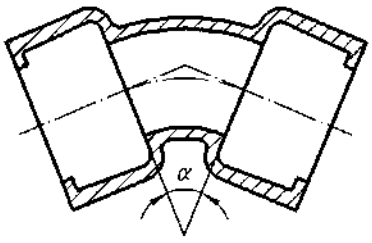


Figure 9 — Double socket bends

The standardized DN of double socket bends (see Figure 9) are all those from DN 80 to DN 2000. The manufacturer shall make available the information as to the angles α of his bends.

8.2.4 Angle branches

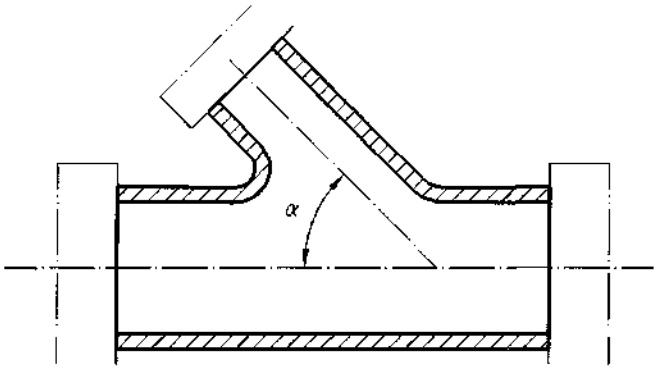


Figure 10 — Angle branches

The standardized DN of angle branches (see Figure 10) are all those from DN 100 to DN 500 for the body and from dn 80 to dn 250 for the branch. The manufacturer shall make available the information as to his DN X dn combinations, types of end (socket or spigot) and branch angle.

8.2.5 Connection branches

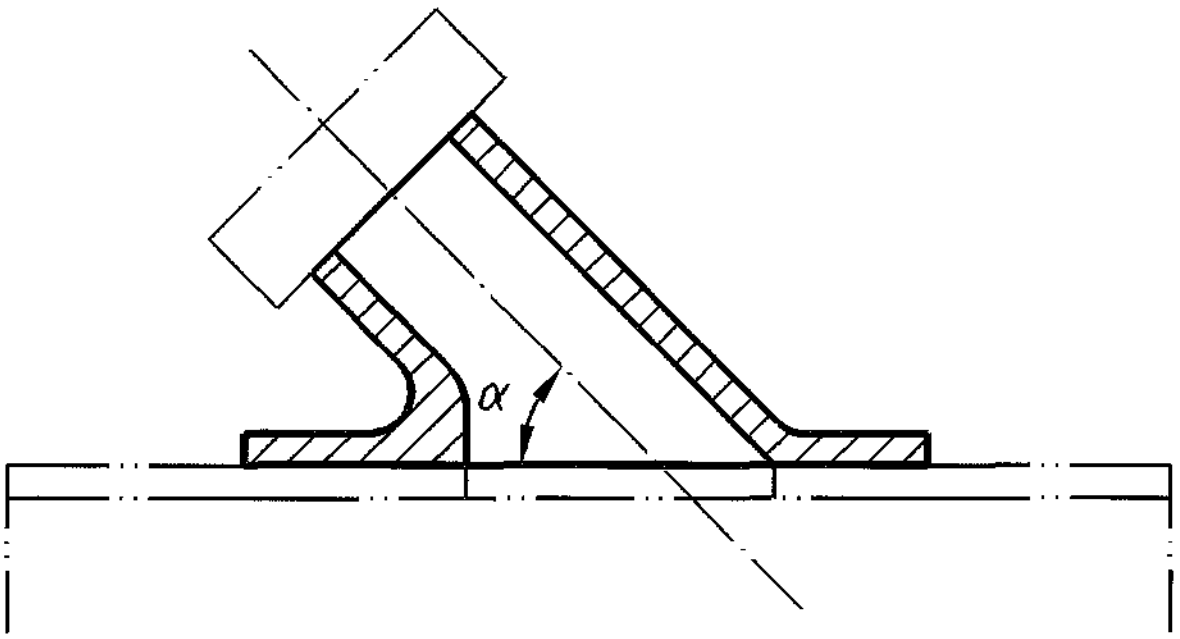


Figure 11 — Connection branches

The standardized DN of connections branches (see Figure 11) are all those from dn 100 to dn 250 for connection to pipes from DN 200 to DN 2000. The manufacturer shall make the information available as to his types of end (socket

or spigot) for connection with different pipe materials, branch angles and shape of hole to be cut in the pipe (circular, square or rectangular).

8.2.6 Inspection tees

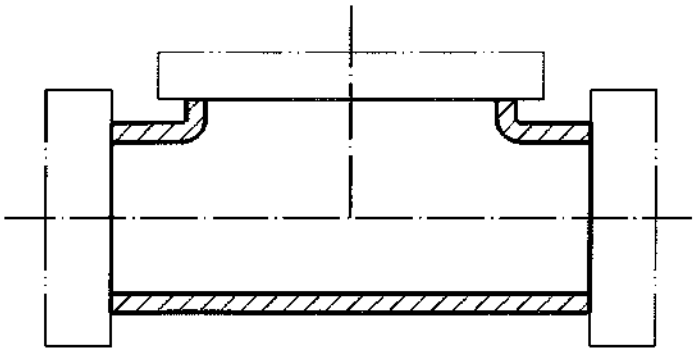


Figure 12 — Inspection tees

The standardized DN of inspections tees (see Figure 12) are all those from DN 100 to DN 800. The manufacturer shall make the information available as to his types of end (socket or spigot) and shape and dimensions of the access branch.

8.2.7 Access traps

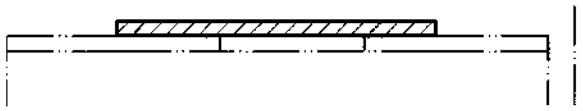


Figure 13 — Access traps

The standardized DN of access traps (see Figure 13) are all those from DN 150 to DN 1400. The manufacturer shall make the information available as to the shape and dimensions of the hole to be cut in the pipe and the method of connection to the pipe.

8.3 Fittings for pressure sewers and vacuum sewers

The types and dimensions of fittings shall be those given in EN 545.

9 Evaluation of conformity

9.1 General

The conformity of ductile iron pipes, fittings, accessories and their joint with the requirements of this standard and with the declared values (including classes) shall be demonstrated by:

— initial type testing (3.33);

— factory production control by the manufacturer, including product assessment.

For the purposes of testing, the products may be grouped into families (see 5.1), where it is considered that the results for one or more characteristics from any product within the family are representative for the same characteristics for all products within that family.

9.2 Initial type testing

9.2.1 General

Initial type testing shall be performed to show conformity with this European Standard. Tests previously performed in accordance with the provisions of this European Standard (same product, same characteristic(s), test method, sampling procedure, system of attestation of conformity, etc.) may be taken into account. In addition, initial type testing shall be performed at the beginning of the production of a new type of product or at the beginning of a new method of production (where this may affect the stated properties).

Where components are used whose characteristics have already been determined by the component manufacturer, on the basis of conformity with other product standards, these characteristics need not be reassessed provided that the components' performance or method of assessment remain the same, that the characteristics of the component are suitable for the intended end use of the finished product, and insofar as the manufacturing process does not have a detrimental affect on the determined characteristics.

Components and raw materials CE marked in accordance with appropriate harmonised European specifications may be presumed to have the performances stated with the CE marking, although this does not replace the responsibility on the manufacturer of ductile iron pipeline product to ensure that the product as a whole is correctly designed and its component products have the necessary performance values to meet the design.

9.2.2 Characteristics

All characteristics in Clause 5 shall be subject to initial type testing, with the following exceptions:

— release of dangerous substances may be assessed indirectly by controlling the content of the substance concerned;

— flange joints (see 5.6) and screwed or welded flanges (see 5.7) which are already assessed according to EN 545.

Whenever a change occurs in the product, the raw material or supplier of the components, or the production process (subject to the definition of a family), which would change significantly one or more of the characteristics, the type tests shall be repeated for the appropriate characteristics.

9.2.3 Treatment of calculated values and design

In those cases where conformity with this standard is based on calculations, type testing will be limited to the verification of the calculations made and that the resulting products correspond to the assumptions made in the design.

9.2.4 Sampling, testing and conformity criteria

9.2.4.1 Sampling procedure

Initial type testing shall be performed on samples of products representative for the manufactured product type.

The random sampling method shall be used, except for the assessment of the leak tightness of joints which requires samples at the extreme of tolerances (see 5.5).

9.2.4.2 Testing and compliance criteria

The number of test samples to be tested (or assessed) shall be in accordance with Table 12.

The results of all type tests shall be recorded and held by the manufacturer for at least 10 years after the last date or production of the product(s) to which they apply.

Table 12 — Number of test samples for initial type testing

Items to be tested	Number of samples (minimum)				Test method in accordance with	Requirements in accordance with
Internal pressure strength (1)	1 per DN				Calculation A.2	4.7.1
Longitudinal bending of pipes (2)	1 of the DN of the grouping					5.2
Integrity under service conditions	DN 80 to 200				7.2	5.2.2
Bending resistance					7.2	5.2.3
Diametral stiffness of pipes (3)	1 of each DN grouping					5.3
Integrity under service conditions	DN 80 to DN 250	DN 300 to DN 600	DN 700 to DN 1000	DN 1100 to DN 2000	7.3	5.3.2
Resistance to ovalization					7.3	5.3.3
Leak tightness of components for gravity pipelines	1 of each DN grouping					
	DN 80 to DN 250	DN 300 to DN 600	DN 700 to DN 1000	DN 1100 to DN 2000	7.4	5.4
Leak tightness of joints (4)	1 of each DN grouping					5.5
To internal hydrostatic pressure	DN 80 to DN 250	DN 300 to DN 600	DN 700 To DN 1000	DN 1100 to DN 2000	7.5	5.5.2
To negative internal pressure					7.6	5.5.2
To positive external pressure					7.7	5.5.2
To cyclic internal pressure					7.8	5.5.2
Chemical resistance to effluents	1 DN of the grouping DN 80 to DN 200				7.9	5.8
Abrasion resistance	1 DN of the grouping DN 80 to DN 200				7.10	5.9
Compressive strength of the cement mortar lining	Mean of 6 tests on 3 samples				7.1	5.10

NOTE Highlighted items are essential characteristics according to the mandate: (1) Internal pressure strength, (2) Longitudinal bending strength, (3) Maximum load for admissible deformation, (4) Tightness: gas and liquid.

9.3 Factory production control (FPC)

9.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform to the declared performance characteristics and to all requirements of this standard. The FPC system shall consist of procedures (works' manual), regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product. Records shall remain legible, readily identifiable and retrievable.

The FPC system may be part of a Quality Management System, e.g. in accordance with EN ISO 9001.

An FPC system conforming with the requirements of EN ISO 9001, and made specific to the requirements of this standard shall be considered to satisfy the above requirements.

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The action to be taken when control values or criteria are not met shall be recorded and retained for the period specified in the manufacturer's FPC procedures.

If the manufacturer has the component designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, FPC of the original manufacturer may be taken into account. However, where subcontracting takes place, the manufacturer shall retain the overall control of the component and ensure that he receives all the information that is necessary to fulfil his responsibilities according to this European Standard.

9.3.2 FPC requirements for all manufacturers

9.3.2.1 General

The manufacturer shall establish procedures to ensure that the production tolerances allow for the products performances to be in conformity with the declared values, derived from initial type testing.

The characteristics, and the means of verification, are given in Table 13. The minimum testing frequencies apply to permanent production in large quantities with a stable process. The actual testing frequencies to be used in order to ensure permanent conformity of the products shall be fixed by the manufacturer's FPC, taking into account the production rate and the process control measures which are implemented.

The manufacturer shall record the results of the tests specified above. These records shall at least include the following information:

— identification of the product tested;

— date of sampling and testing;

— test methods performed;

— test results.

Table 13 — Minimum frequency of product testing as part of FPC

Items to be tested	Test method in accordance with	Requirements in accordance with	Minimum frequency of test
Dimensions			
Wall thickness	6.1.1	4.2.1	1 per shift
External diameter	6.1.2	4.2.2.1	10 %
Internal diameter	6.1.3	4.2.2.2	1 per shift
Length	6.1.4	4.2.3	1 per week
Straightness of pipes	6.2	4.2.4	1 %
Material characteristics			
Tensile testing	6.3	4.3.1	see 9.3.2.2
Brinell hardness	6.4	4.3.2	1 per week
Coatings and linings of pipes			
Zinc coating mass	6.7	4.4.2.2	1 per shift
Thickness of paint coatings	6.8	4.4.2.2	1 per shift
Thickness of cement mortar lining	6.9	4.4.3.2	1 per shift
Coatings of fittings and accessories			
Epoxy coating	EN 14901	4.5.2	1 per shift
Leak tightness for pipes and fittings			
For positive pressure pipelines	6.5	4.7.2	100 %
For negative pressure pipelines	6.6	4.7.2	100 %

9.3.2.2 FPC for tensile testing

During the manufacturing process the manufacturer shall carry out suitable tests in order to verify the tensile properties specified in 4.3.1. These tests may be:

a) a batch [1)] sampling system whereby samples are obtained from the pipe spigot or, for fittings, from samples cast separately or attached with the castings concerned. Test bars are machined from these samples and tensile tested in accordance with 6.3, or

b) a system of process control (e.g. by non-destructive testing) where a positive correlation can be demonstrated with the tensile properties specified in Table 3. Testing verification procedures are based on the use of comparator samples having known and verifiable properties. This system is supported by tensile testing in accordance with 6.3.

The frequency of testing is related to the system of production and quality control used by the manufacturer. The maximum batch sizes shall be as given in Table 14.

[1)] Batch is the quantity of castings from which a sample is taken for testing purposes during manufacture.

Table 14 — Maximum batch sizes for tensile testing

Type of casting	DN	Maximum batch size	
		Batch sampling system	Process control system
Centrifugally cast pipes	80 to 300	200 pipes	1 200 pipes
	350 to 600	100 pipes	600 pipes
	700 to 1000	50 pipes	300 pipes
	1100 to 2000	25 pipes	150 pipes
Pipes not centrifugally cast, fittings and accessories	80 to 2000	4 t [a]	48 t [a]

[a] Weight of crude castings, excluding the risers.

9.3.3 Manufacturer-specific FPC system requirements

9.3.3.1 Personnel

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product conformity, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-conformities from occurring, actions in case of non-conformities and to identify and register product conformity problems. Personnel performing work affecting product conformity shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

9.3.3.2 Equipment

All weighing, measuring and testing equipment necessary to achieve, or produce evidence of, conformity shall be calibrated or verified and regularly inspected according to documented procedures, frequencies and criteria. Control of monitoring and measuring devices shall comply with the appropriate clause of EN ISO 9001.

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use; wear or failure does not cause inconsistency in the manufacturing process.

Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

9.3.3.3 Design process

The factory production control system shall document the various stages in the design of the products; identify the checking procedure and those individuals responsible for all stages of design.

During the design process itself, a record shall be kept of all checks, their results, and any corrective actions taken. This record shall be sufficiently detailed and accurate to demonstrate that all stages of the design phase and all checks have been carried out satisfactorily. Compliance with EN ISO 9001:2000, 7.3, shall be deemed to satisfy the requirements of this subclause.

9.3.3.4 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their conformity. The verification of conformity of the raw materials with the specification shall be in accordance with EN ISO 9001:2000, 7.4.3.

9.3.3.5 In-process control

The manufacturer shall plan and carry out production under controlled conditions. Compliance with EN ISO 9001:2000, 7.5.1 and 7.5.2, shall be deemed to satisfy the requirements of this subclause.

9.3.3.6 Non-conforming products

The manufacturer shall have written procedures which specify how non-conforming products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures. Compliance with EN ISO 9001:2000, 8.3, shall be deemed to satisfy the requirements of this subclause.

9.3.3.7 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence. Compliance with EN ISO 9001:2000, 8.5.2, shall be deemed to satisfy the requirements of this subclause.

Annex A
(normative)

Allowable pressures for pressure sewers

A.1 General

The maximum values of PFA, PMA and PEA for pipes and fittings, as defined in 3.21, 3.22 and 3.23 respectively, shall be as given (in bars) in A.2, A.3 and A.4.

A.2 Socket and spigot pipes for pressure sewers

The maximum values of PFA, PMA and PEA as given in Table A.1 for pressure sewers are calculated as follows:

a) $PFA = \dfrac{20 \cdot e_{min} \cdot R_m}{D \cdot S_F}$ with a maximum of 40 bar

where

e_{min} is the minimum pipe wall thickness, in millimetres (see Table 11);

D is the mean pipe diameter ($DE - e_{min}$), in millimetres;

DE is the nominal pipe external diameter, in millimetres (see Table 11);

R_m is the minimum tensile strength of ductile iron, in megapascals (R_m = 420 MPa, see 4.3.1);

S_F is a safety factor of 3.

b) PMA: as PFA, but with SF = 2,5; therefore

PMA = 1,2 × PFA.

c) PEA = PMA + 5 bar.

Appropriate limitations shall be taken into account which may prevent the full range of these pressures being used in an installed pipeline, for example:

— operation at the PFA and PMA values given in A.2 for socket and spigot pipes may be limited by the lower pressure capability of other pipeline components, e.g. flanged pipework (see A.4), certain types of tees (see A.3) and specific designs of flexible joints (see 5.5.2);

— site hydrostatic testing at the high PEA values given in A.2 may be limited by the type and design of the pipeline anchorage system and/or the design of flexible joints.

Table A.1 — Allowable pressures

DN	Pressure pipes		
	PFA	PMA	PEA
80	40	48	53
100	40	48	53
125	40	48	53
150	40	48	53
200	40	48	53
250	38	46	51
300	35	42	47
350	32	39	44
400	30	36	41
450	29	35	40
500	28	33	38
600	26	31	36
700	29	35	40
800	28	33	38
900	27	32	37
1000	26	31	36
1100	29	35	40
1200	29	35	40
1400	28	33	38
1500	27	32	37
1600	27	32	37
1800	27	32	37
2000	26	31	36
NOTE See limitations given in A.1.			

A.3 Fittings for socketed joints

See EN 545.

A.4 Flanged pipes and fittings for flanged joints

See EN 545.

Annex B
(informative)

Alternative coatings and field of use in relation to characteristics of soils

B.1 Alternative coatings

B.1.1 Pipes

The following pipe coatings may also be supplied, depending on the external and internal intended conditions of use:

a) external coatings:

— zinc rich paint coating having a minimum mass of 150 g/m^2, with finishing layer;

— thicker zinc coating having a minimum mass of 200 g/m^2, with finishing layer;

— polyethylene sleeving (as a supplement to the zinc coating with finishing layer);

— alloy of zinc and aluminium with or without other metals, having a minimum mass of 400 g/m^2, with finishing layer;

— extruded polyethylene coating in accordance with EN 14628;

— polyurethane coating in accordance with EN 15189;

— reinforced cement mortar coating having a nominal thickness of at least 5 mm;

— adhesive tape.

b) internal coatings (linings):

— cement mortar lining other than made from high alumina cement;

— epoxy lining;

— polyurethane lining.

These external and internal coatings should comply with the appropriate European Technical Specification or, where no European Technical Specification exists, with the appropriate International Standard, national standard or agreed specification.

B.1.2 Fittings

The following fitting coatings may also be supplied depending on external and internal intended conditions of use:

a) external coatings:

— bituminous paint;

— zinc coating with finishing layer;

— polyethylene sleeving (as a supplement to the bituminous paint or to the zinc coating with finishing layer);

— polyurethane;

— adhesive tapes.

b) internal coatings (linings):

— high alumina cement mortar lining (see 4.4.3);

— blast furnace cement mortar lining;

— polyurethane.

These external and internal coatings should comply with the corresponding European Technical specification or, where no European Technical specification exists, with the appropriate International Standard, national standard, or agreed specification.

B.2 Field of use in relation to characteristics of soils

B.2.1 Standard coating

Ductile iron pipes complying with 4.4.2 and ductile iron fittings and accessories complying with 4.5.2 may be buried in contact with a large number of soils, which can be identified by soil studies on site, except:

— soils with a low resistivity, less than 1 500·Ω·cm when laid above the water table or less than 2 500 Ω·cm when laid below the water table;

— mixed soils, i.e. comprising two or more soil natures;

— soils with a pH below 6 and a high reserve of acidity;

— soils containing refuse, cinders, slags or polluted by wastes or industrial effluents.

In such soils, and also in the occurrence of stray currents, it is recommended that an additional protection is used (such as polyethylene sleeving) or other types of external coatings as appropriate (see B.1, B.2.2 and B.2.3).

An increase of the mass of the zinc coating (e.g. 200 g/m^2) combined with a thicker finishing layer (e.g. 100 µm polyurethane or epoxy) may extend the field of use to a resistivity of 1 500 Ω·cm when laid below the water table.

B.2.2 Alloy of zinc and aluminium with or without other metals

Ductile iron pipes coated with an alloy of zinc and aluminium with or without other metals, having a minimum mass of 400 g/m^2 with finishing layer, and ductile iron fittings complying with 4.5.2, may be buried in contact with the majority of soils, except:

— acidic peaty soils;

— soils containing refuse, cinders, slag, or polluted by wastes or industrial effluents;

— soils below the marine water table with a resistivity lower than 500 Ω·cm.

In such soils, and also in the occurrence of stray currents, it is recommended to use other types of external coatings adapted to the most corrosive soils (see B.1 and B.2.3).

8.2.3 Reinforced coatings

Ductile iron pipes and fittings with the following external coatings may be buried in soils of all levels of corrosivity:

— extruded polyethylene coating (pipes);

— polyurethane coating (pipes and fittings);

— epoxy coating complying with 4.5.2 (fittings);

— fibre reinforced cement mortar coating (pipes);

— adhesive tapes (pipes and fittings).

Annex C
(informative)

Field of use in relation to characteristics of effluents

Except for components intended only for the transport of rainwater, ductile iron pipelines supplied with the internal linings complying with 4.4.3 and 4.5.2 can be used to transport all types of surface water and domestic effluents and certain types of industrial effluents, provided that they are not exposed to values below pH 4 or greater than pH 12.

By agreement between manufacturer and purchaser, the use can be extended to special applications, after consideration of other parameters such as temperature, nature of the main aggressive substances, frequency of occurrence etc.

Annex D
(informative)

Calculation method for buried pipelines, permissible heights of cover

D.1 Calculation

D.1.1 Calculation equation

The method is based on an ovalization calculation according to the equation below:

$$\Delta = \frac{100K\left(P_e + P_t\right)}{8S + \left(f \times E'\right)}$$

where

Δ is the pipe ovalization, in percent;

K is the bedding factor;

P_e is the pressure from earth loading, in kilonewtons per square metre;

P_t is the pressure from traffic loading, in kilonewtons per square metre;

S is the pipe diametral stiffness, in kilonewtons per square metre, see values in Table 10;

f is the factor of lateral pressure (f = 0,061);

E' is the modulus of soil reaction, in kilonewtons per square metre.

The ovalization calculated by means of this equation should not exceed the allowable ovalization shown in Table 10. The allowable ovalization increases with DN while remaining well below the value that the internal cement mortar lining can withstand without damage; in addition, it provides a safety factor of 1,5 with respect to the elastic limit of ductile iron in bending (500 MPa minimum) by limiting the stress in the pipe wall at 330 MPa; finally, it is limited to 4 % for DN ≥ 800.

D.1.2 Pressure from earth loading

The pressure P_e, uniformly distributed at the top of the pipe over a distance equal to the external diameter, is calculated following the earth prism method by the equation below:

$$P_e = \gamma \times H$$

where

P_e is the pressure from earth loading, in kilonewtons per square metre;

γ is the unit weight of backfill, in kilonewtons per cubic metre;

H is the height of cover, in metres, that is the distance from the top of the pipe to the ground surface.

In the absence of other data, the unit weight of the soil is taken as being equal to 20 kN/m^3 in order to cover the vast majority of cases. If a preliminary geotechnical survey confirms that the actual unit weight of the backfill will be less than 20 kN/m^3, the actual value may be used for determining P_e. If, however, it appears that the actual value will be more than 20 kN/m^3, the actual value should be used.

D.1.3 Pressure from traffic loading

The pressure P_t, uniformly distributed at the top of the pipe over a distance equal to the external diameter, is calculated by means of the equation below:

$$P_t = 40 \cdot \left(1 - 2 \cdot 10^{-4} \cdot DN\right) \frac{\beta}{H}$$

where

P_t is the pressure from traffic loading in kilonewtons per square metre;

β is the traffic load factor;

H is the height of cover, in metres, that is the distance from the top of the pipe to the ground surface.

This equation is not valid for $H < 0{,}3$ m.

Three types of traffic loading are to be considered:

— traffic areas with main roads, $\beta = 1{,}5$: this is the general case of all roads, except access roads;

— traffic areas with access roads, $\beta = 0{,}75$: roads where lorry traffic is prohibited ;

- rural areas, $\beta = 0{,}5$: all other cases.

It should be noted that all pipelines should be designed for $\beta = 0{,}5$ even where they are not expected to be exposed to traffic loading. In addition, pipelines laid in the verge and embankment of roads should be designed to withstand the full traffic loading expected on these roads. Finally, for pipelines which may be exposed to particularly high traffic loading, a factor $\beta = 2$ should be adopted.

D.1.4 Bedding factor, K

The bedding factor K, depends upon the soil pressure distribution at the top of the pipe (over a distance equal to the external diameter) and at the invert of the pipe (over a distance corresponding to the theoretical bedding angle 2α.

K normally varies from 0,11 for $2\alpha = 20°$ to 0,09 for $2\alpha = 120°$. The value of 20° corresponds to a pipe which is simply laid on the flat trench bottom, with no compaction effort.

D.1.5 Factor of lateral pressure, f

The factor of lateral pressure f, is equal to 0,061; this corresponds to a parabolic distribution of the lateral soil pressure over an angle of 100°, according to the IOWA-Spangler model.

D.1.6 Modulus of soil reaction, E'

The modulus of soil reaction E', depends upon the nature of soil used in the pipe zone and upon the laying conditions.

In a given situation, the modulus of reaction which is required can be determined by means of the equation below:

$$E' = \frac{4\,000K}{\delta \times f}\left[\frac{\beta}{H}\left(1 - 2\times 10^{-4}\ DN\right) + 0{,}5\ H\right] - \frac{8\,S}{f}$$

where

E' is the modulus of soil reaction, in kilonewtons per square metre;

δ is the allowable ovalization, in percent.

In Tables D.1 and D.2, values of E' equal to 1 000 kN/m^2, 2 000 kN/m^2 and 5 000 kN/m^2 are taken as guidelines; they correspond to a compaction level which is respectively nil, low and good. The value $E' = 0$ has also been shown as the limit case for unfavourable laying conditions in poor soils (no compaction, water table above the pipe, trench shoring removed after backfilling or embankment conditions).

If a preliminary geotechnical survey allows the determination of the value of the modulus of soil reaction, this value should be taken into account in the calculations.

D.2 Heights of cover

Tables D.1 and D.2 gives the most pessimistic range of values of the allowable heights of cover for each group of diameters. These values can be used without any additional calculation; they are given in metres, with E' in kilonewtons per square metre.

For heights of cover outside the ranges given in Tables D.1 and D.2 and for better laying conditions, a verification can be made using the equations given in D.1.

Table D.1 — Pressure pipes

	DN	80 to 300	350 to 450	500 to 2 000
K (2α)		0,110 (20°)	0,105 (45°)	0,103 (60°)
β = 0,5	E' = 0	0,3 to 5,0	0,3 to 3,0	0,4 to 2,2
	E' = 1 000	0,3 to 5,8	0,3 to 4,0	0,3 to 3,5
rural	E' = 2 000	0,3 to 6,6	0,3 to 5,0	0,3 to 4,7
areas	E' = 5 000	0,3 to 9,2	0,3 to 8,0	0,3 to 7,8
β = 0,75	E' = 0	0,3 to 4,8	0,5 to 2,8	0,6 to 2,0
	E' = 1 000	0,3 to 5,7	0,4 to 3,9	0,4 to 3,5
access	E' = 2 000	0,3 to 6,6	0,3 to 4,9	0,3 to 4,6
roads	E' = 5 000	0,3 to 9,1	0,3 to 7,9	0,3 to 7,8
β = 1,50	E' = 0	0,6 to 4,5	[a]	[a]
	E' = 1 000	0,5 to 5,4	0,8 to 3,4	0,9 to 3,0
main	E' = 2 000	0,4 to 6,3	0,6 to 4,6	0,6 to 4,3
roads	E' = 5 000	0,3 to 9,0	0,4 to 7,7	0,4 to 7,6

[a] Not recommended : only a specific calculation for each case can provide an adequate answer.

Table D.2 — Gravity pipes

DN		80 to 300	350
K (2α)		0,110 (20°)	0,105 (45°)
β = 0,5	E' = 0	0,3 to 3,2	0,3 to 3,5
	E' = 1 000	0,3 to 4,1	0,3 to 4,5
rural	E' = 2 000	0,3 to 5,0	0,3 to 5,4
areas	E' = 5 000	0,3 to 7,5	0,3 to 8,2
β = 0,75	E' = 0	0,5 to 3,0	0,4 to 3,4
	E' = 1 000	0,4 to 4,0	0,3 to 4,4
access	E' = 2 000	0,3 to 4,9	0,3 to 5,4
roads	E' = 5 000	0,3 to 7,5	0,3 to 8,1
β = 1,50	E' = 0	1,3 to 2,2	[a]
	E' = 1 000	0,8 to 3,5	0,7 to 4,0
main	E' = 2 000	0,6 to 4,5	0,6 to 5,0
roads	E' = 5 000	0,4 to 7,3	0,4 to 8,0

[a] Not recommended : only a specific calculation for each case can provide an adequate answer.

NOTE The calculations are made with the maximum ovalization allowed for cement mortar lined pipes.

Annex E
(informative)

Resistance to jet cleaning and to root penetration

E.1 Jet cleaning

Ductile iron pipes complying with this standard can be cleaned with standard jet cleaning equipment used under normal conditions: controlled pressure and energy, efficient distance and direction of the nozzle.

E.2 Root penetration

The penetration of roots into sewer pipes through the pipe joints causes severe problems: pipe obstruction mechanical damages to the pipes.

Joints for ductile iron pipes complying with this standard, and specifically with the performance tests specified in 5.5, employ elastomers and gasket compression allowing a high resistance to the penetration of roots.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

ZA1 Scope and relevant characteristics

This European standard has been prepared under the mandate M/131 "Pipes, tanks and ancillaries not in contact with water intended for human consumption" given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European standard shown in this annex meet the requirement of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness to ductile iron pipes and fittings, their joints and accessories covered by this annex for the intended uses indicated herein. Reference should be made to the information accompanying the CE-marking.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

NOTE 1 For dangerous substances, there may be requirements applicable to the products falling within the scope of this standard (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA, accessed through http://europa.eu.int/comm/enterprise/construction/internal/dangsub/dangmain.htm).

This annex has the same scope as Clause 1 of this standard. It establishes the conditions for the CE marking of ductile iron pipes and fittings, their joints and accessories for sewerage applications intended for the uses indicated in the relevant clauses applicable (see Table ZA.1).

[A1] Table ZA.1 — Relevant clauses for ductile iron pipes, fittings, accessories and their joints for sewerage applications

Product : Ductile iron pipes, fittings, accessories and their joints **Intended use(s)** : Sewerage applications		
Essential characteristics requirement	**Requirement clauses in this European Standard**	**Notes**
Dimension tolerances (on external diameter DE for compatibility purposes)	4.2.2.1 External diameter	Pass/fail
Internal pressure strength (tensile strength)	4.3 Material characteristics and Table 3	6.3 Tensile testing (420 MPa – threshold value) By calculation considering the tensile characteristics of the material.
Impact resistance	4.3.1 Tensile properties 4.3.2 Hardness	As tensile strength Threshold (230 HBW for pipes, 250 HBW for fittings and accessories)
Longitudinal bending strength	5.2 Longitudinal bending of pipes	Pass/fail
Maximum load for admissible deformation	5.3 Diametral stiffness of pipes	Pass/fail
Tightness : gas and liquid	5.5 Leaktightness of joints and Table 7 : - internal pressure - vacuum - external pressure - cyclic pressure	 Threshold (2 bar) Threshold (- 0,9 bar) Threshold (2 bar) Threshold (24000 cycles)
Durability aspects		
External coating for pipes	4.4.1 General, and 4.4.2 External zinc coating 4.4.1 General, and B.1 Alternative coatings, active zinc based coatings 4.4.1 General, and B.1 Alternative coatings, passive coatings	Threshold (130 g/m2 for zinc and 70 µm for finishing layer) Threshold (150, 200 or 400 g/m2 as given in B.1.1) EN 14628, EN 15189, EN 15542
External coatings for fittings	4.5.1 General, and 4.5.2 Epoxy	EN 14901
Internal lining for pipes and fittings	5.8 Chemical resistance to effluents 5.9 Abrasion resistance	Pass/fail Pass/fail

[A1]

[A1] The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option "No performance determined" (NPD) in the information accompanying the CE marking (see Clause ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level. [A1]

ZA.2 Procedure for attestation of conformity of ductile iron pipes, fittings, accessories and their joints for sewerage applications

ZA.2.1 System of attestation of conformity

[A1] The system(s) of attestation of conformity of ductile iron pipes, fittings, accessories and their joints for sewerage applications indicated in Table ZA.1, in accordance with the Decision of the European Commission 1999/472/EC of 1999(published under L184 the 17.07.99) amended by the Decision 01/596/EC of 8 January (published under L209 the 02.08.01) and as given in Annex III of the mandate M131 for "Pipes, tanks and ancillaries not in contact with water intended for human consumption", is shown in Table ZA.2 for the indicated intended use(s) and relevant level(s) or class(es). [A1]

Table ZA.2 — System of attestation of conformity

Product(s)	Intended use(s)	Level(s) or class(es)	Attestation of conformity system(s)
Ductile iron pipes, fittings, accessories and their joints for sewerage applications	Drains and sewers operating without pressure or with positive or negative pressure, installed below or above ground, for conveyance of surface water, domestic wastewater and certain types of industrial effluents, either in separate systems or in mixed systems	—	System 4
System 4 : See Directive 89/106/ECC (CPD) Annex III.2.(ii), third possibility.			

The attestation of conformity of ductile iron pipes, fittings, accessories and their joints for sewerage applications in Table ZA.1 shall be based on the evaluation of conformity procedures indicated in Table(s) ZA.3 resulting from application of the clauses of this or other European Standard indicated therein.

Table ZA.3 — Assignment of evaluation of conformity tasks for ductile iron pipes, fittings, accessories and their joints for sewerage applications under system 4

Tasks		Content of the task	Evaluation of conformity clauses to apply
Task for the manufacturer	Factory production control (FPC)	Parameters related to all characteristics of Table ZA.1	9.3
	Initial type testing	All characteristics of Table ZA.1	9.2

ZA.2.2 Declaration of conformity

When compliance with the conditions of this annex is achieved, the manufacturer or his agent established in the EEA (European Economic Area) shall prepare and retain a declaration of conformity (EC Declaration of conformity), which authorises the affixing of the CE marking. This declaration shall include:

— name and address of the manufacturer, or his authorised representative established in the EEA, and place of production;

— description of the product (type, identification, use,...), and a copy of the information accompanying the CE marking;

— provisions to which the product conforms (e.g. Annex ZA of this EN);

— particular conditions applicable to the use of the product, (e.g. provisions for use under certain conditions);

— name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or his authorised representative.

The above-mentioned declaration shall be presented in the official language or languages accepted in the Member State in which the product is to be used.

ZA.3 CE marking and labelling

For all ductile iron pipes and fittings, the producer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol shall be in accordance with Directive 93/68/EC and shall be shown on the ductile iron pipes and fittings.

The following information shall appear legibly and indelibly on the product (see also 4.6):

— CE marking symbol.

The following information shall appear on the commercial documents:

— CE marking symbol;

— name or identifying mark and registered address of the producer or his authorised representative;

— last two digits of the year of affixing the CE marking;

— reference to this European Standard, i.e. EN 598 (only if all the requirements specified in this standard are fulfilled);

— description of the product : generic name, material, dimensions, intended use and place of installation;

— characteristics covered by EN 598:

  — dimension tolerances;

  — internal pressure strength;

  — impact resistance;

  — longitudinal bending strength;

  — maximum load for admissible deformation;

  — tightness gas and liquid;

  — durability (zinc coating, chemical resistance, abrasion resistance).

The "No performance determined" (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements.

NOTE 1 In addition to any specific information relating to dangerous substances shown above, the product should also be accompanied, when and where required and in the appropriate form, by documentation listing any other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

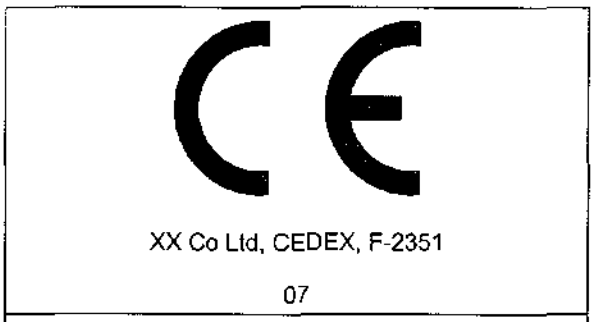
NOTE 2 European legislation without national derogations need not be mentioned.

Figure ZA.1 gives an example of the information to be given on the product.

CE conformity marking consisting of the 'CE'-symbol given in Directive 93/68/EEC.

Figure ZA.1 — Example of CE marking information for marking on the product

Figure ZA.2 gives an example of the information to be given on the accompanying documents.



XX Co Ltd, CEDEX, F-2351

07

CE conformity marking consisting of the 'CE'-symbol given in Directive 93/68/EEC.

Name, or identifying mark and registered address, of producer

Last two digits of year in which marking was affixed

EN 598

DN 150 zinc coated ductile iron gravity pipe x 6 m

Dimensional tolerances	Pass
— Internal pressure strength (tensile strength)	420 MPa
— Impact resistance:	
- tensile strength	420 MPa
- hardness	230 HBW
Longitudinal bending strength	Pass
— Maximum load for admissible deformation	Pass
— Tightness (gas and liquid):	
- internal pressure	2 bar
- vacuum	- 0,9 bar
- external pressure	2 bar
- cyclic pressure	50 000 cycles
— Durability:	
- zinc coating	200 g/m²
- chemical resistance	Pass
- abrasion resistance	Pass

Description of product and information on regulated characteristics

In the case of threshold values the manufacturer may either state the required or the actual value achieved, providing the actual is better than the minimum required performance

Figure ZA.2 — Example of information on the accompanying documents

Bibliography

[1] EN 476:1997, *General requirements for components used in discharge pipes, drains and sewers for gravity systems*

[2] EN 752 (all parts), *Drain and sewer systems outside buildings*

[3] EN 773:1999, *General requirements for components used in hydraulically pressurised discharge pipes, drains and sewers*

[4] EN 1333:2006, *Flanges and their joints — Pipework components — Definition and selection of PN*

[5] EN 1514 (all parts), *Flanges and their joints — Dimensions of gaskets for PN-designated flanges*

[6] EN 1610, *Construction and testing of drains and sewers*

[7] EN 45011, *General requirements for bodies operating product certification systems (ISO/IEC Guide 65:1996)*

[8] EN ISO 6708:1995, *Pipeworks components — Definition and selection of DN (nominal size) (ISO 6708:1995)*

[9] EN ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems (ISO/IEC 17021:2006)*

[10] ISO 10803, *Design method for ductile iron pipes*

[11] Council Directive 93/68/EEC of 22 July 1993 amending Directives 87/404/EEC (simple pressure vessels), 88/378/EEC (safety of toys), 89/106/EEC (construction products), 89/336/EEC (electromagnetic compatibility), 89/392/EEC (machinery), 89/686/EEC (personal protective equipment), 90/384/EEC (non-automatic weighing instruments), 90/385/EEC (active implantable medicinal devices), 90/396/EEC (appliances burning gaseous fuels), 91/263/EEC (telecommunications terminal equipment), 92/42/EEC (new hot-water boilers fired with liquid or gaseous fuels) and 73/23/EEC (electrical equipment designed for use within certain voltage limits), "Description of the CE marking"

[12] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products, known as "Construction Products Directive"

[13] EN ISO 9000, *Quality management systems — Fundamentals and vocabulary (ISO 9000:2005)*

[14] EN 14628, *Ductile iron pipes, fittings and accessories — External polyethylene coating for pipes — Requirements and test methods*

[15] EN 15189, *Ductile iron pipes, fittings and accessories — External polyurethane coating for pipes — Requirements and test methods*