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Fibre-reinforced cement pipe, joints and fittings for gravity systems

Tuyaux, joints et accessoires en ciment renforcé de fibres pour réseaux gravitaires

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22306 was prepared by Technical Committee ISO/TC 77, *Products in fibre reinforced cement*.

Fibre-reinforced cement pipe, joints and fittings for gravity systems

1 Scope

This International Standard specifies the properties of the piping system and its components made from fibre-reinforced cement, based upon Portland cement, intended to be used for drainage or sewerage systems. This International Standard is applicable to fibre-reinforced cement pipes and fittings suitable primarily for use in gravity systems at atmospheric pressure in buried applications.

Pipes satisfying the requirements of this International Standard, although exhibiting some flexible characteristics, are intended for installations designed using rigid pipe principles.

NOTE 1 In a pipe work system, pipes and fittings of different strength classification can be used together.

NOTE 2 Piping systems conforming to this International Standard can be used also for non-buried applications provided the influences of the environment and the supports are considered in the design of the pipes, fittings and joints.

NOTE3 This International Standard addresses aspects of long-term performance of pipe (see Annex J).

NOTE 4 Purchasers should satisfy themselves that the class of pipe specified on the basis of this International Standard is suitable for its intended application.

NOTE 5 Compliance with Annex G of this International Standard might not satisfy national regulatory requirements.

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 (including any amendments) applies.

ISO 10928, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*

3 Terms and definitions

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

3.1
nominal size
DN
alphanumerical designation of size, which is common to all components in a piping system, in order to provide a convenient designation for reference and marking purposes, consisting of the letters “DN” followed by a round number related to the internal diameter when it is expressed in millimetres

3.2
declared diameter
diameter which a manufacturer states to be the mean internal or external diameter produced in respect of a particular nominal size DN and crushing strength class

3.3
specific ring stiffness
S
calculated physical characteristic of the pipe, indicating the resistance to ring deflection per metre length under external load as defined in Equation (1):

$$S = (E \cdot I) / d_m^3 \quad (1)$$

where

E is the apparent modulus of elasticity as determined using Annex E of this International Standard, expressed in newtons per square metre (N/m^2)

I is the second moment of area in the longitudinal direction per metre length, expressed in metres to the fourth power per metre, (m^4/m), i.e.

$$I = e^3 / 12 \quad (2)$$

where

e is the wall thickness, expressed in metres (m)

d_m is the mean diameter of the pipe, expressed in metres (m) (see 3.4)

NOTE The specific ring stiffness is expressed in newtons per square metre (N/m^2).

3.4
mean diameter
d_m
diameter of the circle corresponding with the middle of the pipe wall cross-section calculated by either Equation (3) or (4):

$$d_m = d_i + e \quad (3)$$

$$d_m = d_e - e \quad (4)$$

where

d_i is the internal diameter of the pipe in metres (m)

d_e is the external diameter of the pipe in metres (m)

e is the wall thickness of the pipe, in metres (m)

NOTE The mean diameter is expressed in metres (m).

3.5
type test
test carried out in order to assess the fitness for purpose of a product or assembly of components to fulfil its or their function(s) in accordance with the product specification

3.6
nominal length
numerical designation of a pipe length which is equal to the pipe's effective laying length (see 3.8)

NOTE The nominal length is expressed in metres (m), rounded to one decimal place.

3.7
total length
L
distance between two planes normal to the pipe axis and passing through the extreme end points of the pipe

NOTE The total length is expressed in metres (m).

3.8
effective laying length
total length of a pipe minus, where applicable, the insertion depth of the spigot(s) in the socket as recommended by the manufacturer

3.9
normal service conditions
conveyance of surface water or sewage in the temperature range 2 °C to 50 °C, with or without pressure

3.10
crush load
T_u
minimum crush test load required for a saturated pipe, when tested according to Annex B to demonstrate that it complies with its designated crush class

3.11
non-pressure pipe or fitting
pipe [fitting] subject to an internal pressure not greater than 100 kPa

3.12
buried pipeline
pipeline that is subjected to the external pressure transmitted from soil loading, including traffic and superimposed loads and, possibly, the pressure head of water

3.13
design service temperature
maximum sustained temperature at which the system is expected to operate

NOTE The design service temperature is expressed in degrees Celsius (°C).

3.14
draw
D
longitudinal movement of a joint

See Figure 1.

NOTE The draw is expressed in millimetres (mm).

3.15
total draw
T
sum of the draw, D, and the additional longitudinal movement, J, of joint components due to the presence of angular deflection

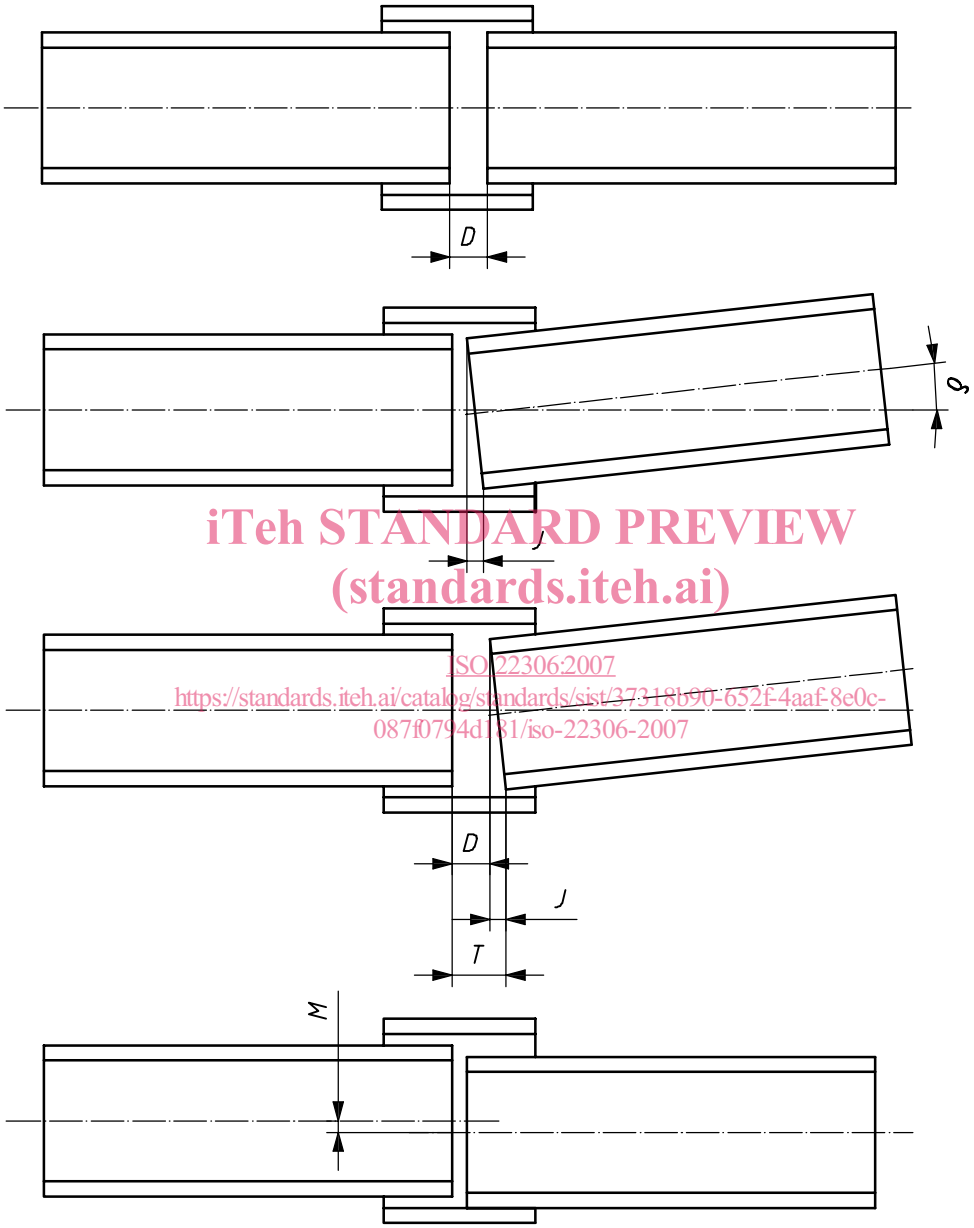
See Figure 1.

NOTE The total draw is expressed in millimetres (mm).

3.16
misalignment
M
amount by which the centrelines of adjacent components fail to coincide

See Figure 1.

NOTE The misalignment is expressed in millimetres (mm).



Key

D draw
δ angular deflection
J longitudinal movement
T total draw
M misalignment

NOTE The angular deflection causes a longitudinal movement.

Figure 1 — Joint movements

3.17
flexible joint
joint that allows relative movement between components being joined

3.18
break
condition when the test piece can no longer carry load

3.19
reinforcement fibre
organic and/or inorganic synthetic reinforcement fibres used for the manufacture of fibre cement pipes complying with this International Standard

See 4.2.2.

4 General

4.1 Classification

4.1.1 Categories

Pipes and fittings shall be classified according to nominal size (DN) (see 3.1), design crush strength and joint type.

4.1.2 Nominal size

The nominal size (DN) of pipes and fittings in the range DN 200 to DN 2500 shall conform to the appropriate table in Clause 5 of this International Standard.

4.1.3 Crushing strength (T_u)

The pipes shall be classified in accordance with their minimum crush load, T_u, into the following classes based on load per unit internal area:

40 kN/m^2, 60 kN/m^2, 75 kN/m^2, 90 kN/m^2, 100 kN/m^2, 120 kN/m^2, 150 kN/m^2, 175 kN/m^2

The load per unit area is the breaking load per metre length of pipe divided by the nominal diameter of the pipe in metres (1/1 000 of the nominal diameter DN values).

Pipes may also be designed to satisfy breaking load requirements that are specified either by the designer or in the national standards of the country where the product is to be used.

4.2 Materials

4.2.1 General

The pipe or fitting shall be constructed using reinforcing fibres (see 3.19) and an inorganic hydraulic binder or a calcium silicate binder formed by chemical reaction of a siliceous and a calcareous material.

Process aids, fillers, aggregates and pigments that are compatible with fibre-reinforced cement may be added.

4.2.2 Reinforcement

Reinforcement may be any of the following:

a) cellulose fibre;

b) plastic fibre;

c) glass filament;

d) steel fibre.

No further restriction is placed on the choice of fibre-reinforcement materials, their combination, their proportion in the finished product, or the method of pipe manufacture, except that pipes manufactured using these materials shall comply with the requirements of this International Standard. The manufacturer shall provide the purchaser with documented evidence that the fibres employed are compatible with the other materials in the pipes for the intended purpose of the pipes under normal service conditions (see 3.9).

4.2.3 Cement

The cement shall comply with the relevant national standard in the country of manufacture.

4.2.4 Aggregates and fillers

Where aggregates or fillers are added to the mix in the manufacturing process, the filler shall be inorganic and shall be compatible with other materials in the mix to ensure the long-term performance durability.

Lightweight aggregate and non-ferrous metallurgical slag shall not be used in pipes and fittings.

4.2.5 Restriction on chemical content

The materials shall not contain acid-soluble chloride or sulfate salts in excess of the values given in Table 1.

Table 1 — Maximum values of acid-soluble chloride ion and sulfate ion content in cement as cast

Condition	Maximum acid-soluble chloride ion content kg/m^3	Maximum acid-soluble sulfate ion content % (by mass of cement)
Cement cured other than by steam or autoclaving	0,8	5,0
Steam-cured and autoclaved cement	0,8	4,0

4.3 Appearance and finish

Both internal and external surfaces shall be free from irregularities which would impair the ability of the component to conform to the requirements of this International Standard.

The internal surface of the pipe shall be regular and smooth. The surfaces that are in contact with elastomeric seals shall be free of irregularities that can affect the performance of the joints.

Pipes shall be free from fractures and cracks wider than 0,1 mm and deeper than 0,3 mm (see ISO 3126[1]). Pipes shall be free from delamination. Dents on either the inside or outside surfaces shall not exceed 3 mm in depth and bulges shall not exceed 3 mm in height. Dents and bulges shall not extend laterally in any direction on a surface by more than 50 mm.

If necessary, pipes may be impregnated and/or coated internally and/or externally to meet special working conditions as agreed between manufacturer and purchaser. The coating and finish should satisfy the requirements of national standards, if existing.

4.4 Joints

4.4.1 General

If requested, the manufacturer shall declare the length and the maximum external diameter of the assembled joint.

4.4.2 Types of joints

The joints for fibre-reinforced cement pipes and fittings covered by this International Standard shall be spigot and sockets or sleeves.

4.4.3 Materials

Spigot and sockets joints and sleeves may be formed in fibre-reinforced cement using the same production process as the pipes or, alternatively, they may be made of other materials such as plastics or metal, providing that they comply with the relevant International Standard or national standard, if existing. All materials shall be specified by the pipe manufacturer.

4.4.4 Sealing rings

Sealing rings shall be of an elastomeric material, suitable for use with the liquid being conveyed. The elastomeric material(s) of the sealing component shall conform to the applicable national standard.

4.4.5 Allowable angular deflection

The manufacturer shall declare the maximum allowable angular deflection for which each joint is designed.

4.4.6 Maximum draw

The manufacturer shall declare the maximum draw for which the joint is designed.

4.5 Reference conditions for testing

4.5.1 Temperature

The mechanical, physical and chemical properties specified in all clauses of this International Standard shall, unless otherwise specified, be determined at (23 ± 5) °C.

4.5.2 Properties of water for testing

The water used for tests referred to in this International Standard shall be tap water having a pH of 7 ± 2.

4.5.3 Loading conditions

Unless otherwise specified, the mechanical, physical and chemical properties specified in all clauses of this International Standard shall be determined using circumferential and/or longitudinal loading conditions, as applicable.

4.5.4 Measurement of dimensions

In case of dispute, the dimensions of components shall be determined at the temperature specified in 4.5.1. Measurements shall be made in accordance with ISO 3126[1] or otherwise using any method of sufficient accuracy to determine conformity, or otherwise, to the applicable limits. Routine measurements shall be determined at the prevailing temperature or, if the manufacturer prefers, at the temperature specified in 4.5.1.

5 Pipes

5.1 Geometrical characteristics

5.1.1 Diameter

5.1.1.1 Diameter series

Pipes shall be designated by nominal size in accordance with Table 2. Nominal diameters without brackets are preferred sizes.

Table 2 — Specified pipe internal diameters

Nominal size DN mm	Nominal size DN mm
100	(900)
125	1 000
150	(1 050)
200	(1 100)
(225)	1 200
250	(1 300)
300	1 400
(350)	(1 500)
(375)	1 600
400	(1 700)
(450)	1 800
500	(1 900)
(525)	2 000
600	(2 100)
(675)	2 200
(700)	(2 300)
(750)	(2 400)
800	2 500
(825)	

5.1.1.2 Internal diameter

The mean internal diameter, d_i, shall be declared by the manufacturer and, when measured, it shall be within the tolerance limits given below:

	$d_i \leqslant 300$	± 5 mm
300 <	$d_i \leqslant 600$	± 7 mm
600 <	$d_i \leqslant 1\,200$	± 8 mm
1 200 <	$d_i \leqslant 1\,650$	± 10 mm
1 650 <	d_i	± 13 mm

The mean internal diameter, d_i, may be determined by taking two measurements mutually at right angles at 200 mm from each end. The mean internal diameter shall be taken as the mean of the four values.

Alternatively, the mean internal diameter may be determined by measuring the average external diameter with a diameter tape and subtracting the mean of four measurements of wall thickness taken at equal intervals around the circumference.

5.1.1.3 External diameter

The external diameter d_e of the plain pipe or machined end of the pipe when measured in millimetres, shall comply with the value stated in the manufacturer's literature.

5.1.2 Thickness of wall

The wall thickness, e, expressed in millimetres, excluding the machined end, shall be determined by direct measurement and shall not vary from the value stated in the manufacturer's literature by more than 0,1e mm.

5.1.3 Length

5.1.3.1 Nominal length of pipes

The nominal length, L (see 3.6), measured in metres, shall be one of the following values:

2,0; 2,5; 3,0; 4,0; 5,0; or 6,0

NOTE Pipes of nominal length of 5,0 and 6,0 apply only to sizes greater than DN 200.

Other lengths may be supplied as agreed between the manufacturer and purchaser.

5.1.3.2 Effective laying length

The pipe shall be supplied in effective laying lengths (see 3.8) in accordance with the requirements given in the following paragraph.

Of the total number of pipes supplied in each diameter, the manufacturer may supply up to 10 % in lengths shorter than the nominal length unless a higher percentage of pipes is being supplied by agreement between the manufacturer and purchaser. The tolerance of the manufacturer's nominated effective lengths shall be ± 15 mm.

5.1.4 Straightness

When tested in accordance with the test method given in Annex A, the deviation on straightness, f, of a full length of pipe, L, shall not exceed the values given in Table 3.

Table 3 — Maximum straightness deviation

DN	Maximum deviation f mm
100 to 150	3,0 L
200 to 1 000	2,5 L
1 100 to 2 500	1,5 L

5.2 Mechanical characteristics

5.2.1 Crush Strength

5.2.1.1 General

When tested to determine the initial crush break load, T_u, in the saturated condition, according to the test method given in Annex B, the minimum initial crush break values for pipes in the diameter range DN 100 to DN 1 000 shall not be less than those given in Table 4.

The minimum initial crush break load, T_u, expressed in kilonewtons per metre, for pipe having a nominal diameter DN greater than 1 000 is determined using Equation (5):

$$T_u = C \cdot DN \cdot 10^{-3} \tag{5}$$

where

C pipe class, expressed in kilonewtons per metre;

DN pipe nominal diameter, expressed in millimetres.

When sampling from continuous production, crush tests may also be conducted on dry, equilibrium or wet specimens, provided a relationship can be established between this testing and the specified fully saturated minimum break load values. A method for determining such a relationship is given in Annex I. The relationship between the initial saturated crush load, T_u, to the installation design load is dependent upon the long-term install behaviour of the pipe (see Annex J).

Table 4 — Minimum initial crush break load, T_u, per metre length for fully saturated pipe

Values in kilonewtons per metre

DN	Class 40	Class 60	Class 75	Class 90	Class 100	Class 120	Class 150	Class 175
100	—	—	—	—	—	20 [a]	25 [a]	29 [a]
125	—	—	—	—	—	21 [a]	26,5 [a]	30,5 [a]
150	—	—	—	—	—	22 [a]	27,5 [a]	32 [a]
200	15 [a]	15 [a]	15	18	20	24	30	35
250	15 [a]	15	19	22,5	25	30	37,5	44
300	15 [a]	18	22,5	27	30	36	45	52,5
350	15 [a]	21	26,5	31,5	35	42	52,5	61,5
400	16	24	30	36	40	48	60	70
450	18	27	34	40,5	45	54	67,5	79
500	20	30	37,5	45	50	60	75	87,5
600	24	36	45	54	60	72	90	105
700	28	42	52,5	63	70	84	105	122,5
800	32	48	60	72	80	96	120	140
900	38	54	67,5	81	90	108	135	157,5
1 000	40	60	75	90	100	120	150	175

[a] Minimum breaking loads exceed the calculated minimum requirement to satisfy other design criteria.

5.2.1.2 Number of test pieces for type test purposes

Two test pieces, of the same size and classification and conforming to 5.2.1.3 shall be used.

5.2.1.3 Length of test pieces

The minimum length, L_p, of the test piece shall be 150 ± 5 mm.

5.2.1.4 Conditioning of test piece

a) Specimens that are to be tested in a saturated condition shall be immersed in water at an ambient temperature above 5 °C for a period of at least 28 days, immediately prior to testing.

b) Specimens which are to be tested in a dry condition shall be stored in air at a temperature of 23 ± 5 °C and at 50 ± 10 % RH for $7\,^{+1}_{0}$ days, immediately prior to testing.

Other conditioning methods that can be shown to give the same sample strength and steady state are acceptable. In the event of a dispute, the requirements of 5.2.1.4 a) shall apply.

5.2.1.5 Method of test to determine initial crush strength

The method of test for determining the initial crush strength is detailed in Annex B of this International Standard.

5.2.2 Flexural bending strength

5.2.2.1 General

When tested for bending strength in the saturated condition, according to the test method given in Annex C of this International Standard, pipes in the nominal size range DN 100 to DN 200 shall have breaking loads not less than the values given in Table 5.

NOTE The flexural bending strength test is a performance test that relates to the ability of the pipe to withstand axial flexure in service. The loads given in Table 5 do not represent the maximum service loads that can occur in service and apply to pipe lengths 3,6 m and longer.

Table 5 — Minimum breaking bending loads

DN mm	Class	Minimum breaking load in bending N
100	40 and 60 90 120	1 800 2 400 2 800
125	40 and 60 90 120	2 400 3 200 3 730
150	40 and 60 90 120	5 200 6 600 7 900
200	40 and 60 90 120	6 600 8 380 10 030
NOTE 1 This test is not a requirement for pipe larger than DN 200 or classes greater than 120. NOTE 2 Break load values for classes intermediate between values given may be linearly interpolated.		