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Plastics piping systems for drainage and sewerage without pressure — Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) — Dimensions, requirements and tests

Systèmes de canalisation en plastiques pour réseaux d'assainissement sans pression — Tuyaux non-circulaires, assemblages de tuyaux et raccords en plastiques thermodurcissables renforcés de verre (PRV) à base de résines de polyester non saturé (UP) — Dimensions, exigences et essais

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 6, *Reinforced plastics pipes and fittings for all applications*.

This second edition cancels and replaces the first edition (ISO 16611:2017), which has been technically revised.

The main changes are as follows:

— the normative references have been updated;

— the definition of the initial ring stiffness has been aligned with that used in other GRP pipe standards, see 3.3;

— the definition of the wet creep factor has been aligned with that used in other GRP pipe standards, see 3.5;

— the short-term flexural capacity was introduced as alternative parameter to measure the short-term bending resistance, see 5.2.4;

— a new subclause on “Assessment of conformity” has been introduced (see 4.6);

— inconsistencies in Clause 7 "Joint performance” have been removed.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The purpose of this document is to standardize the requirements for non-circular glass-reinforced thermosetting plastics pipes (GRP).

This document specifies the requirements for non-circular GRP pipe systems, designed to be used for the renovation of existing channels or open cut installation.

This document specifies dimensions, requirements and tests of non-circular pipes, including short and long-term properties. To establish long-term properties, it is recommended to use the circular pipes samples.

Annex A provides commonly used calculation methods for informational purposes. The calculation method is selected by the designer.

This document does not include the recommended practice for installation.

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Plastics piping systems for drainage and sewerage without pressure — Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) — Dimensions, requirements and tests

1 Scope

This document specifies the required properties of the piping system and its components made from glass-reinforced thermosetting plastics (GRP), based on unsaturated polyester resin (UP) intended to be used for drainage or sewerage without pressure including culverts.

It is the responsibility of the purchaser or specifier to make the appropriate selections taking into account their particular requirements and any relevant national regulations and installation practices or codes.

This document is applicable to non-circular GRP-UP pipes, with flexible or rigid joints, primarily intended for use in buried installations but may also be used to reline existing non-circular pipe lines.

NOTE 1 GRP-UP includes pipes with vinyl ester liners or made entirely from vinyl ester.

NOTE 2 Piping systems conforming to this document can be used also for non-buried applications provided the influence of the environment, e.g. from UV-radiation, and the supports are considered in the design of the pipes, fittings and joints.

This document is applicable to pipes, fittings and their joints of nominal sizes from DN 150 to DN 4000, which are intended to be used for the conveyance of surface water or sewage at normal service conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178, *Plastics — Determination of flexural properties*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 4633, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials*

ISO 8513, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the initial longitudinal tensile strength*

ISO 8533, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of cemented or wrapped joints*

ISO 8639, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods for leaktightness and proof of structural design of flexible joints*

ISO 10468, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the ring creep properties under wet or dry conditions*

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

ISO 10952, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack for the inside of a section in a deflected condition*

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

CEN/TS 14632, *Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure — Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) — Guidance for the assessment of conformity*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
nominal size
BN × *HN*
alphanumerical designation of size, which is common to all components in a piping system, it is a convenient pair of numbers for reference purposes that is related to the maximum internal breadth (*B*) and the maximum internal height (*H*)

Note 1 to entry: The designation for reference or marking purposes consists of the letters *BN*(*B*) × *HN*(*H*) and the numerical values for (*B*) and (*H*), when expressed in millimetres.

3.2
specific ring stiffness
S
physical characteristic of a circular pipe which is a measure of the resistance to ring deflection per metre length under external load

Note 1 to entry: Specific ring stiffness is determined using the formula below and is expressed in Newtons per square metre (N/m^2):

$$S = \frac{E \cdot I}{d_m^3}$$

where

E is the apparent modulus of elasticity, which can be derived from the result of the ring stiffness test, i.e. ISO 7685,[1] expressed in Newtons per square metre (N/m^2);

d_m is the mean diameter of the pipe, in metres (m) (see 3.5);

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

$$I = \frac{e^3}{12}$$

where e is the wall thickness of the pipe, in metres.

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3.3
initial ring stiffness
S_0
value of ring stiffness S obtained when a circular pipe is tested in accordance with ISO 7685[1]

Note 1 to entry: Initial ring stiffness is expressed in newtons per square metre (N/m^2).

3.4
mean diameter
d_m
diameter of the circle corresponding to the middle of a circular pipe wall cross-section and given by either of the following formulae:

$$d_m = d_i + e$$

or

$$d_m = d_e - e$$

where

d_i is the internal diameter, in millimetres(mm);
d_e is the external diameter, in millimetres (mm);
e is the wall thickness of the pipe, in millimetres(mm).

Note 1 to entry: It is expressed in millimetres (mm).

3.5
wet creep factor
$\alpha_{x,creep,wet}$
ratio of the long-term ring creep stiffness, $S_{x,wet}$ at x years to the ring stiffness $S_{0,1}$ at position 1 at 0,1 hour

Note 1 to entry: See 4.4.6 for value of x.

Note 2 to entry: Determined using circular test-pieces under sustained diametrical loading in wet conditions when tested in accordance with ISO 10468.

Note 3 to entry: Wet creep factor is a dimensionless number given by the formula:

$$\alpha_{x,creep,wet} = \frac{S_{x,wet}}{S_{0,1}}$$

3.6
long-term ring stiffness
$S_{x,wet}$
determined value of ring stiffness S at x years for circular pipe

3.7
rerating factor
R_{RF}
multiplication factor that quantifies the relationship of a product's mechanical, physical and chemical properties under service conditions above 35 °C [*design service temperature* (3.17)] to those applicable at a standard test temperature of 23 °C

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3.8
short-term bending strength
σ_f
maximum flexural stress sustained by the test specimen during a bending test, when tested in accordance with ISO 178

Note 1 to entry: Short-term bending strength is determined using the following formula and is expressed in megapascals (MPa):

$$\sigma_f = \frac{3FL}{2bh^2}$$

where

F is the load, in newtons (N);
L is the span, in millimetres (mm);
h is the thickness of the specimen, in millimetres (mm);
b is the width of the specimen, in millimetres (mm).

3.9
long-term bending strength
σ_{fx}
calculated value of σ_f at x years for circular pipe

Note 1 to entry: Long-term bending strength is determined using methodology given in 5.2.5.3, using linear regression analysis according to ISO 10928 on data of bending stress in hoop direction, and is expressed in megapascals (MPa):

$$\sigma_{fx} = \frac{6 \cdot F_{max} \cdot \frac{d_m}{2} \cdot \frac{1}{\pi}}{l \cdot e^2} \cdot \alpha_{ki}$$

with

$$\alpha_{ki} = \frac{3 \cdot d_i + 5 \cdot e}{3 \cdot d_i + 3 \cdot e}$$

where

F_{max} is the maximum force, in newtons (N);
d_m is the mean diameter, in millimetres (mm);
d_i is the inside diameter, in (mm);
e is the wall thickness, in millimetres (mm);
l is the length of specimen, in (mm);
α_{ki} is the correction factor inner surface.

3.10
short-term bending modulus
E_f
value of flexural modulus obtained when tested in accordance with ISO 178

Note 1 to entry: Short-term bending modulus is determined using the following formula and is expressed in megapascals (MPa):

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$$E_f = \frac{L^3}{4b \cdot h^3} \cdot \frac{F_{max}}{s_{max}}$$

where

F_{max} is the maximum force, which corresponds to maximum deflection, in newtons (N);
s_{max} is the maximum deflection of specimen, in millimetres (mm);
b is the width of the specimen, in millimetres (mm);
h is the wall thickness of the specimen, in millimetres (mm);
L is the span of the specimen, in millimetres (mm).

3.11
long-term creep bending modulus
E_{fx}
calculated value of E_f at x years for circular pipe when tested in accordance with ISO 10468

Note 1 to entry: Long-term bending modulus is determined using the following formula and is expressed in megapascals (MPa):

$$E_{fx} = E_0 \cdot \alpha_{x,creep,wet}$$

where

E_0 is the short-term bending modulus as a result of the creep test on circular profiles according to ISO 10468, in megapascals (MPa);
$\alpha_{x,creep,wet}$ is the wet creep factor, see 3.6.

3.12
declared flexural capacity
M_B
maximum unitary bending moment declared by the manufacturer

Note 1 to entry: Declared flexural capacity is determined using the following formula and is expressed in N·mm/mm:

$$M_B = \frac{\sigma_{fd} \cdot e^2}{6}$$

where

σ_{fd} is the declared short-term bending strength, in megapascals (MPa);
e is the wall thickness of the pipe, in millimetres (mm).

3.13
short-term flexural capacity
$M_{B,u}$
maximum unitary bending moment sustained by the test specimen during a bending test, when tested in accordance with ISO 178

Note 1 to entry: flexural capacity is determined using the following formula and is expressed in N·mm/mm:

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$$M_{B,u} = \frac{F \cdot L}{4 \cdot b}$$

where

F is the load corresponding to the maximum flexural stress σ_{fM} as defined in ISO 178, in Newtons (N);

L is the span of the specimen, in millimetres (mm);

b is the width of the specimen, in millimetres (mm).

3.14
type test
test carried out to prove that a material, component, joint or assembly is capable of conforming to the relevant requirement

3.15
laying length
total length of a pipe minus, where applicable, the manufacturer's recommended insertion depth of the spigot(s) in the socket

Note 1 to entry: Laying length is expressed in metres (m).

3.16
normal service conditions
conveyance of surface water or sewage, in the temperature range 2 °C to 50 °C, with maximum water table of 10 m, for 50 years

3.17
design service temperature
maximum sustained temperature at which the system is expected to operate

Note 1 to entry: Expressed in degrees Celsius (°C).

3.18
flexible joint
joint which allows relative movement between the pipes being joined

Note 1 to entry: Examples of this type of joint are: socket-and-spigot joint with an elastomeric sealing element (including double socket designs)

3.19
rigid joint
joint which does not allow relative movement between the pipes being joined

Note 1 to entry: Examples of this type of joint are: flanged joint, including integral and loose flanges, wrapped or cemented joint.

3.20
angular deflection
δ
angle between the axes of two adjacent pipes

Note 1 to entry: See Figure 1.

Note 2 to entry: Angular deflection is expressed in degrees (°).

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3.21
draw
D
longitudinal movement of a joint

Note 1 to entry: See Figure 1.

Note 2 to entry: Draw is expressed in millimetres (mm).

3.22
total draw
T
sum of the draw, *D*, and the additional longitudinal movement, *J*, due to the presence of angular deflection

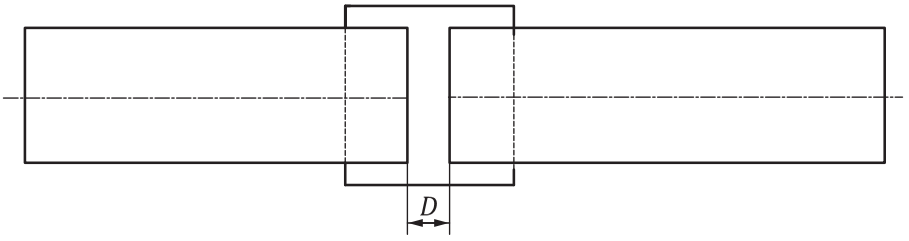
Note 1 to entry: See Figure 1.

Note 2 to entry: Total draw is expressed in millimetres (mm).

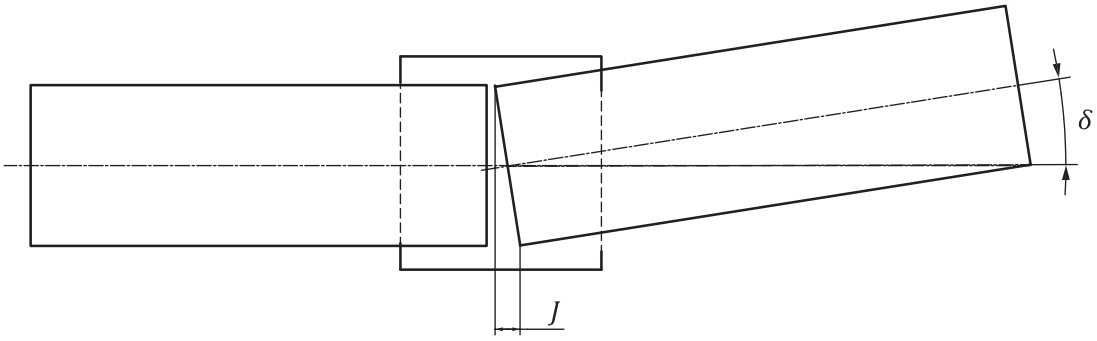
3.23
misalignment
M
distance by which the centrelines of adjacent pipes fail to coincide

Note 1 to entry: See Figure 1.

Note 2 to entry: Misalignment is expressed in millimetres (mm).

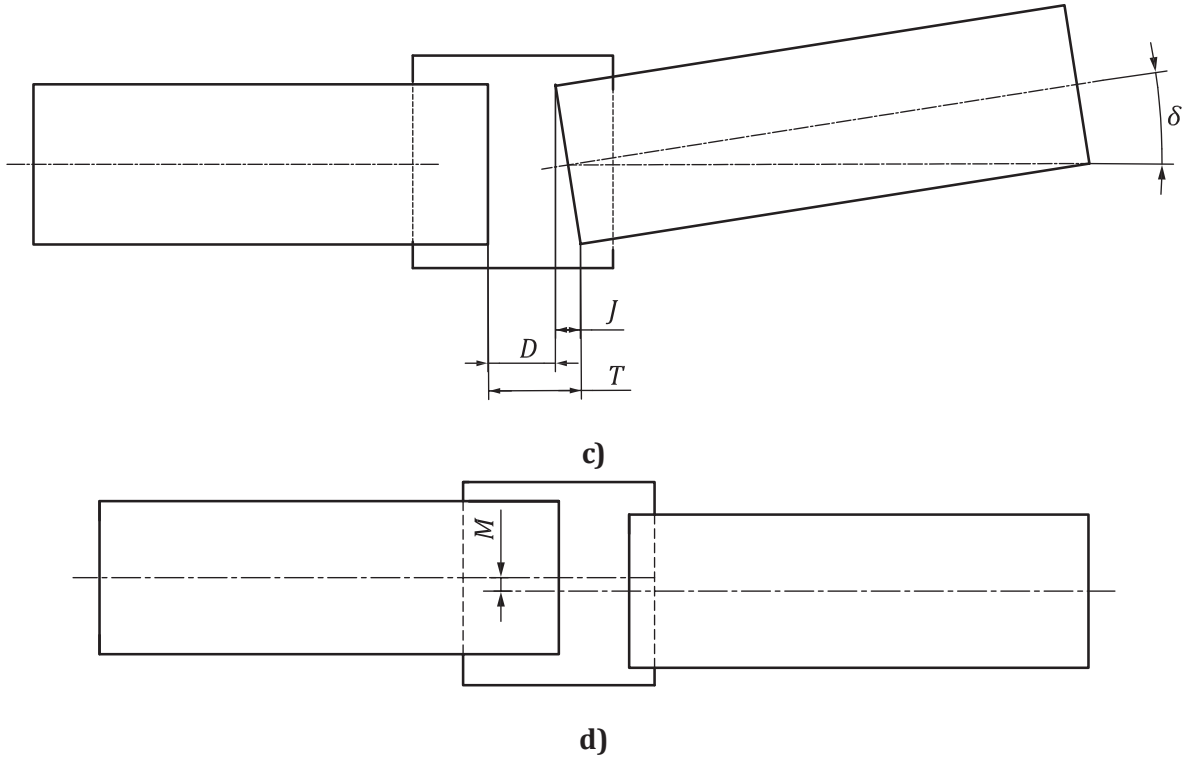


a)



b)

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Key

D	draw
J	longitudinal movement arising from angular deflection of the joint
δ	angular deflection of the joint
T	total draw
M	misalignment

Figure 1 — Joint movement

4 General requirements

4.1 Classification

4.1.1 Categories

Pipes conforming to this document shall be classified according to nominal size (*BN* × *HN*) (see 3.1), and joint type, i.e. flexible or rigid (see 3.18 or 3.19).

4.1.2 Nominal size

The nominal size (*BN* × *HN*) (see 3.1) of pipes shall conform to the product declaration of the manufacturer.

4.2 Materials

4.2.1 General

The pipe shall be constructed using chopped and/or continuous glass filaments, strands or rovings, mats or fabric synthetic veils, and polyester resin with or without fillers and if applicable additives necessary to impart specific properties to the resin. The pipe or fitting may also incorporate aggregates, and if required a thermoplastic liner.

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