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Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

Systèmes de canalisation en matières plastiques pour les branchements et les collecteurs d'assainissement avec ou sans pression — Systèmes en plastiques thermodurcissables renforcés de verre (PRV) à base de résine de polyester non saturé (UP)

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO 10639:2017 (second edition) and ISO 10467:2018 (second edition), which have been technically revised.

The main changes compared to the previous editions are as follows:

— documents combined;

— editorial changes throughout.

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.

Introduction

This document has been produced by merging ISO 10639, ISO 10467, EN 1796 and EN 14364. As these standards were almost identical, apart from the requirements for chemical resistance of sewer pipes on the one hand, and no negative impact on water quality of drinking water pipes on the other hand, it was decided that it would be beneficial for users to be able to refer to a single document, irrespective of application or region.

The content of this document is summarized as follows:

Clause 4 specifies the general aspects of GRP UP piping systems intended to be used in the field of drainage or sewerage with or without pressure.

Clause 5 specifies the characteristics of pipes made from GRP UP with or without aggregates and/or fillers. The pipes can have a thermoplastics or thermosetting resin liner. Clause 5 also specifies the test parameters for the test methods referred to in this document. For pipes intended for sewer applications, the resistance to chemical attack is stated in 5.4. For other applications, the requirements in 5.3.4 apply.

Clause 6 specifies the characteristics of fittings made from GRP UP, with or without a thermoplastics or thermosetting resin liner, intended to be used in the field of drainage and sewerage. Clause 6 specifies the dimensional and performance requirements for bends, branches, reducers, saddles and flanged adaptors. Clause 6 covers requirements to prove the structural design of fittings. It is applicable to fittings made using any of the following techniques:

— fabrication from straight pipes;

— moulding by

1) filament winding,

2) tape winding,

3) contact moulding, and

4) hot or cold compression moulding.

Clause 7 is applicable to the joints to be used in GRP UP piping systems, both buried and non-buried. It covers requirements to prove the design of the joint. Clause 7 specifies type test performance requirements for the following joints as a function of the declared nominal pressure rating of the pipeline or system:

a) socket-and-spigot (including double-socket) joints or mechanical joints;

b) locked socket-and-spigot joints;

c) cemented or wrapped joints;

d) bolted flange joints.

Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

1 Scope

This document specifies the properties of piping system components made from glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). It is suited for all types of water supply, drainage and sewerage with or without pressure. Types of water supply include, but are not limited to, raw water, irrigation, cooling water, potable water, salt water, sea water, penstocks in power plants, processing plants and other water-based applications. This document is applicable to GRP UP piping systems, with flexible or rigid joints with or without end thrust load-bearing capability, primarily intended for use in direct buried installations.

NOTE 1 For the purpose of this document, the term polyester resin (UP) also includes vinyl-ester resins (VE).

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

NOTE 3 This document can also apply for other installations, such as slip-lining rehabilitation of existing pipes.

NOTE 4 This document is also referenced in ISO 25780, which specifies requirements for GRP-pipes used for jacking installation.

The requirements for the hydrostatic pressure design of pipes referring to this document meet the requirements of ISO/TS 20656-1 and the general principle for the reliability of structures detailed in ISO 2394 and in EN 1990. These International Standards provide procedures for the harmonization of design practices and address the probability of failure, as well as possible consequences of failures. The design practices are based on a partial safety factor concept, as well as on risk management engineering.

This document is applicable to circular pipes, fittings and their joints of nominal sizes from DN 50 to DN 4000, which are intended to be used for the conveyance of water at normal service conditions, with or without pressure.

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 75-2:2013, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 527-5, *Plastics — Determination of tensile properties — Part 5: Test conditions for unidirectional fibre-reinforced plastic composites*

ISO 1452-3, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 3: Fittings*

ISO 2394:2015, *General principles on reliability for structures*

ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*

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

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

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

ISO 7432, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals*

ISO 7509, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of time to failure under sustained internal pressure*

ISO 7685, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial ring stiffness*

ISO 8483, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of bolted flange joints*

ISO 8513:2016, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the initial longitudinal tensile strength*

ISO 8521:2020, *Glass-reinforced thermosetting plastic (GRP) pipes — Test methods for the determination of the initial circumferential tensile wall 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 10466, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test method to prove the resistance to initial ring deflection*

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

ISO 10471, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term ultimate bending strain and the long-term ultimate relative ring deflection under wet conditions*

ISO 10928:2016, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*

ISO 10952, *Plastics piping systems — 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*

ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 18851, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test method to prove the structural design of fittings*

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 terminological databases for use in standardization at the following addresses:

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

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

3.1
break
condition where the test piece can no longer carry the load to which it is being subjected

3.2
coefficient of variation
V
ratio of the *standard deviation* (3.18) to the absolute value of the arithmetic mean, given by the following formula:

V = standard deviation of the population / mean of the population

Note 1 to entry: In this document, it is expressed as a percentage.

3.3
mean diameter
d_m
diameter of the circle corresponding to the middle of the pipe wall cross-section and given, in metres (m), by either of the following formulae:

$$d_m = d_i + e$$

$$d_m = d_e - e$$

where

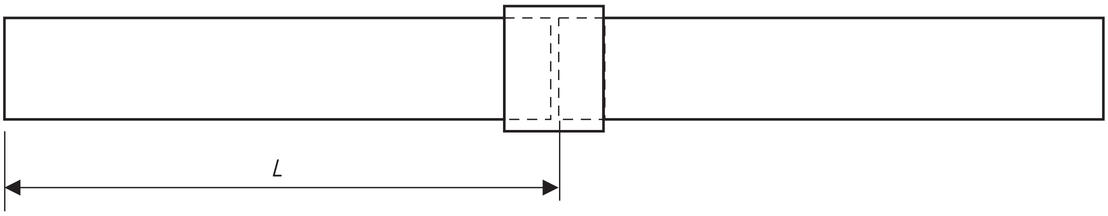
d_i is the internal diameter, in m;

d_e is the external diameter, in m;

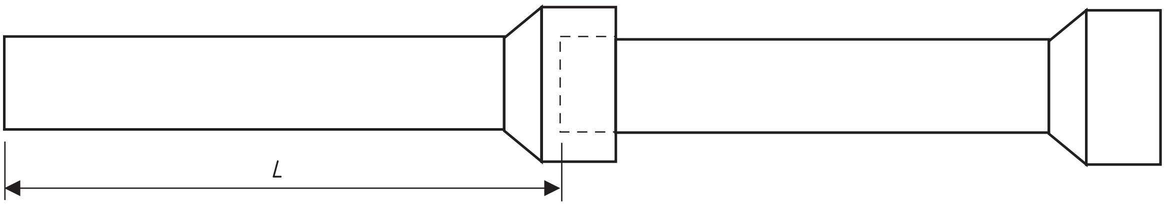
e is the wall thickness of the pipe, in m.

3.4
laying length
total length (3.20) of a pipe minus or plus, as applicable, the manufacturer's recommended insertion depth of the spigot(s) in the socket

Note 1 to entry: See Figure 1.



a) For pipes with double bell coupling



b) For pipes with integrated joints

Key

L laying length

Figure 1 — Joint movements

3.5 Joint movement

3.5.1
angular deflection
δ
angle between the axes of two consecutive pipes

Note 1 to entry: It is expressed in degrees (°).

Note 2 to entry: See Figure 2.

3.5.2
deformation
M
pipe deformation in the coupling as a result of a vertical force of 20 N/mm of the *nominal size* (3.6), on the pipe and a supported coupling causing a step between the two pipe spigots at the loading position

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

Note 2 to entry: See Figure 2.

3.5.3
draw
D
longitudinal movement of a joint

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

Note 2 to entry: See Figure 2.

3.5.4
flexible joint
joint which allows relative movement between the components being joined

Note 1 to entry: Examples of this type of joint are:

a) socket-and-spigot joints with an elastomeric sealing element (including double-socket designs) (non-end-load-bearing);

b) locked socket-and-spigot joints with an elastomeric sealing element (including double-socket designs) (either end-load-bearing or not);

c) mechanically clamped joints, e.g. bolted couplings including components made of materials other than GRP (either end-load-bearing or not).

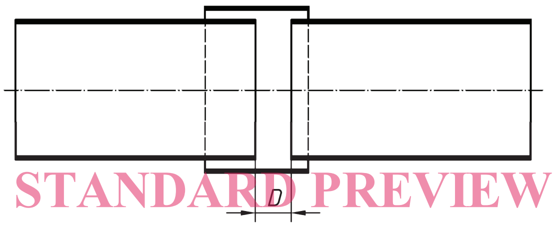
3.5.5
rigid joint
joint which does not allow relative movement between the components being joined

Note 1 to entry: Examples of this type of joint are:

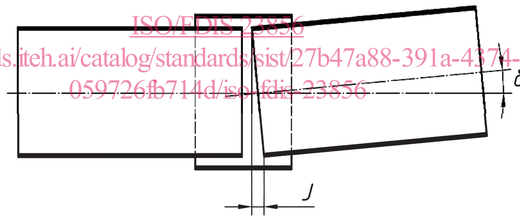
a) flanged joints including integral or loose flanges;

b) wrapped or cemented joints.

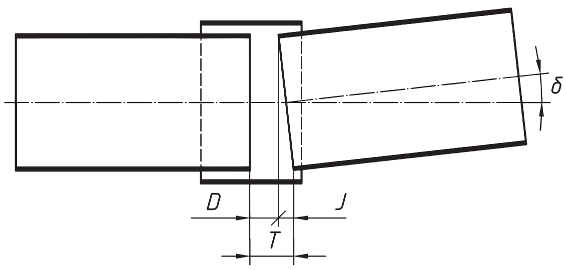
Both a) and b) can be either end-load-bearing or not.



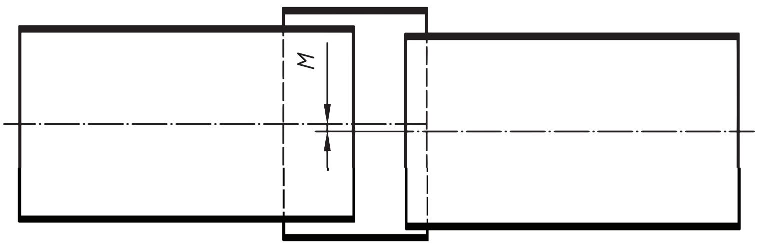
a) Draw



b) Angular deflection



c) Total draw



d) Deformation

Key

D draw

J longitudinal movement arising from angular deflection of the joint

δ angular deflection of the joint

T total draw

M deformation

Figure 2 — Joint movements

3.5.6
total draw
T
sum of the *draw*, *D* (3.5.3), and the additional longitudinal movement, *J*, of joint components due to the presence of *angular deflection* (3.5.1)

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

Note 2 to entry: See Figure 2.

3.6
nominal size
DN
alphanumerical designation of size, which is a convenient round number for reference purposes and is related to the internal diameter in millimetres (mm)

Note 1 to entry: The designation for reference or marking purposes consists of the letters DN plus a number.

3.7
nominal length
numerical designation of pipe length which is equal to the *laying length* (3.4), in metres (m), rounded to the nearest whole number

3.8
nominal stiffness
SN
alphanumerical designation for stiffness classification purposes, which has the same numerical value as the minimum initial value required, when expressed in newtons per square metre (N/m^2)

Note 1 to entry: See 4.1.3.

Note 2 to entry: The designation for reference or marking purposes consists of the letters SN plus a number.

3.9
non-pressure pipe or fitting
pipe or fitting subjected to an internal pressure not greater than 1 bar

3.10
pressure pipe or fitting
pipe or fitting subjected to an internal pressure greater than 1 bar

Note 1 to entry: Pressure pipes and fittings are classified as:

a) non-end-load-bearing pressure pipes and fittings are designed to resist internal pressure without hydraulic end thrust

b) end-load-bearing pressure pipes and fittings are designed to resist internal pressure, including hydraulic end thrust

3.11
normal service conditions
conveyance of water or sewage in the temperature range 2 °C to 50 °C, with or without pressure, for 50 years

Note 1 to entry: At temperatures above 35 °C, it may be necessary to rerate the pipe, see 3.14 and 4.5.1.

3.12 Pressure

3.12.1
initial failure pressure
p_0
mean pressure at which failure occurs with specimens subjected to short-term tests performed in accordance with ISO 8521

3.12.2
nominal pressure
PN
alphanumeric designation for a pressure, which is the maximum sustained hydraulic internal pressure for which a pipe is designed in the absence of other loading conditions than internal pressure

Note 1 to entry: The designation for reference or marking purposes consists of the letters PN plus a number.

3.12.3
minimum initial failure pressure
$p_{0,QC}$
initial failure pressure (3.12.1), determined in accordance with ISO 8521, which 95 % of products are required to exceed

3.12.4
minimum long-term design pressure
$p_{x,d}$
least value for mean long-term burst failure pressure, which is evaluated in accordance with the procedures described in ISO 10928 and includes a design factor of safety, FS_{mean}

Note 1 to entry: It is expressed in bar.

Note 2 to entry: It is one of the parameters used to determine the minimum initial design pressure.

Note 3 to entry: See 4.6 for subscript x.

Note 4 to entry: The value of the design factor of safety, FS_{mean}, see Table A.1.

3.12.5
minimum long-term failure pressure
$p_{x,min}$
least value for long-term burst failure pressure, which is evaluated in accordance with the procedures described in ISO 10928 and includes a factor of safety, FS_{min}

Note 1 to entry: It is expressed in bar.

Note 2 to entry: It is one of the parameters used to determine the minimum initial design pressure.

Note 3 to entry: For the value of the factor of safety, FS_{min}, see Table A.1.

3.12.6
mean design pressure
$p_{0,d}$
mean design initial failure pressure to ensure 95 % of products will exceed the *minimum initial failure pressure*, $p_{0,QC}$ (3.12.3)

3.12.7
pressure regression ratio
$R_{R,p}$
ratio of the *projected failure pressure at 50 years*, p_{50} (3.12.10), to the *projected failure pressure at 6 min*, p_6 (3.12.9), obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

Note 1 to entry: See Annex A.

3.12.8
pressure pipe or fitting
pipe or fitting having a nominal pressure classification, greater than 1 bar and which is intended to be used at internal pressures up to its *nominal pressure (PN)* (3.12.2)

Note 1 to entry: It is expressed in bar.

3.12.9
projected failure pressure at 6 min
p_6
value at 6 min derived from the pressure regression line obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

3.12.10
projected failure pressure at 50 years
p_{50}
value at 50 years derived from the pressure regression line obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

3.12.11
working pressure
p_w
maximum internal hydrostatic pressure, excluding surge, at which a system shall be continuously operated

Note 1 to entry: It is expressed in bar.

Note 2 to entry: Working pressure is represented by the following formula:

$$p_w \leq \text{PN}$$

where

p_w is the working pressure, in bar;
PN is the nominal pressure, in bar.

3.12.12
correction factor
C
ratio of the mean value of the tested *initial failure pressure*, $p_{0,mean}$ (3.12.1) to the *projected 6 min failure pressure*, p_6 (3.12.11) calculated from the regression line

3.13
quality control test
test carried out for the purpose of process control and/or release of product

3.14
rerating factor
R_{RF}
multiplication factor that quantifies the relationship of a product's mechanical, physical and chemical properties under service temperature above 35 °C [*service temperature* (3.20)] to those applicable at a standard test temperature of 23 °C

3.15 Ring deflection

3.15.1
extrapolated long-term relative ultimate ring deflection
$y_{u,wet,x}/d_m$
ratio of the deflection value at *x* years, derived from the ultimate deflection regression line obtained from long-term deflection tests performed under wet conditions in accordance with ISO 10471 and analysed in accordance with ISO 10928, to the *mean diameter*, d_m (3.3)

Note 1 to entry: For *x* years, see 4.6.

Note 2 to entry: It is expressed as a percentage by multiplying by 100.

3.15.2
relative ring deflection
y/d_m
ratio of the change in diameter of a pipe, *y*, in metres (m), to its *mean diameter*, d_m (3.3)

Note 1 to entry: See 3.3.

Note 2 to entry: It is derived as a percentage from the formula:

$$\text{relative ring deflection} = \frac{y}{d_m} \cdot 100$$

3.15.3
minimum initial relative ring deflection before bore cracking occurs
$(y_{2,bore}/d_m)_{min}$
initial relative ring deflection at 2 min which a test piece is required to pass without bore cracking when tested in accordance with ISO 10466

Note 1 to entry: It is expressed as a percentage by multiplying by 100.

3.15.4
minimum initial relative ring deflection before structural failure occurs
$(y_{2,struct}/d_m)_{min}$
initial relative ring deflection at 2 min which a test piece is required to pass without structural failure when tested in accordance with ISO 10466

Note 1 to entry: It is expressed as a percentage by multiplying by 100.

3.15.5
minimum long-term relative ultimate ring deflection
$(y_{u,wet,x}/d_m)_{min}$
required minimum extrapolated value at *x* years derived from the ultimate deflection regression line obtained from long-term deflection tests performed under wet conditions in accordance with ISO 10471

Note 1 to entry: It is expressed as a percentage by multiplying by 100.

Note 2 to entry: For *x* years, see 4.6.

3.16 Resistance to strain corrosion