INTERNATIONAL STANDARD

ISO 10467

Second edition
2018-06

Plastics piping systems for pressure and non-pressure drainage and 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)

Reference number
ISO 10467:2018(E)

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Published in Switzerland

Contents

Page

Foreword ..... **v**
1 Scope **1**
2 Normative references **2**
3 Terms and definitions **3**
4 General **12**
4.1 Classification 12
4.1.1 Categories 12
4.1.2 Nominal size 12
4.1.3 Nominal stiffness 12
4.1.4 Nominal pressure 12
4.2 Materials 13
4.2.1 General 13
4.2.2 Reinforcement 13
4.2.3 Resin 13
4.2.4 Aggregates and fillers 14
4.2.5 Thermoplastics liners 14
4.2.6 Elastomers 14
4.2.7 Metals 14
4.3 Wall construction 14
4.3.1 Inner layer 14
4.3.2 Structural layer 14
4.3.3 Outer layer 14
4.4 Appearance 14
4.5 Reference conditions for testing 15
4.5.1 Temperature 15
4.5.2 Properties of water for testing 15
4.5.3 Loading conditions 15
4.5.4 Conditioning 15
4.5.5 Measurement of dimensions 15
4.6 Elapsed time, x, for determination of long-term properties 15
4.7 Joints 15
4.7.1 General 15
4.7.2 Types of joint 16
4.7.3 Flexibility of the joint 16
4.7.4 Sealing ring 16
4.7.5 Adhesives 16
4.8 Effect on water quality 16
4.9 Assessment of conformity 17
5 Pipes **17**
5.1 Type of pipes 17
5.2 Geometrical characteristics 17
5.2.1 Diameter 17
5.2.2 Wall thickness 23
5.2.3 Length 23
5.3 Mechanical characteristics 23
5.3.1 Initial specific ring stiffness 23
5.3.2 Long-term specific ring stiffness under wet conditions 24
5.3.3 Initial resistance to failure in a deflected condition 25
5.3.4 Ultimate long-term resistance to failure in a deflected condition 27
5.3.5 Initial specific longitudinal tensile strength 28
5.3.6 Initial design and failure pressures for pressure pipes 30
5.3.7 Long-term failure pressure 32
5.4 Resistance to strain corrosion 32

5.4.1 General ... 32
5.4.2 Procedure using failure points ... 32
5.4.3 Procedure using specified levels of strain ... 33
5.4.4 Test piece length ... 35
5.4.5 Test solution ... 35
5.5 Marking ... 35

6 Fittings ... 35
6.1 All types ... 35
6.1.1 General ... 35
6.1.2 Diameter series ... 35
6.1.3 Nominal pressure (PN) ... 35
6.1.4 Nominal stiffness (SN) ... 36
6.1.5 Fitting type ... 36
6.1.6 Mechanical characteristics of fittings ... 36
6.1.7 Installed leaktightness of fittings ... 36
6.1.8 Dimensions ... 37
6.2 Bends ... 37
6.2.1 Classification of bends ... 37
6.2.2 Dimensions and tolerances of bends ... 37
6.3 Branches ... 40
6.3.1 Classification of branches ... 40
6.3.2 Dimensions and tolerances of branches ... 40
6.4 Reducers ... 43
6.4.1 Classification of reducers ... 43
6.4.2 Dimensions and tolerances of reducers ... 43
6.5 Non pressure saddles ... 45
6.5.1 Classification of saddles ... 45
6.5.2 Dimensions of saddles and associated tolerances ... 46
6.6 Flanges ... 46
6.6.1 Classification of flanges ... 46
6.6.2 Dimensions and tolerances for adaptors ... 47
6.7 Marking ... 48

7 Joint performance ... 49
7.1 General ... 49
7.1.1 Interchangeability ... 49
7.1.2 Requirements ... 49
7.1.3 Test temperature ... 50
7.1.4 Non-pressure piping and joints ... 50
7.1.5 Dimensions ... 50
7.2 Flexible joints ... 50
7.2.1 General ... 50
7.2.2 Maximum allowable draw ... 50
7.2.3 Maximum allowable angular deflection ... 50
7.2.4 Flexible non-end-load-bearing joints with elastomeric sealing rings ... 50
7.2.5 Flexible end-load-bearing joints with elastomeric sealing rings ... 51
7.3 Rigid joints ... 51
7.3.1 Wrapped or cemented ... 51
7.3.2 Bolted flange joints ... 52
7.4 Marking ... 52

Annex A (normative) **Principles used to establish the design requirements based on regression testing and consideration of the variability of the product ... 54**

Bibliography ... 59

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 on 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 the following URL: 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*.

This second edition cancels and replaces the first edition (ISO 10467:2004), which has been technically revised. It also incorporates the Amendment ISO 10467:2004/Amd. 1:2012.

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

— inclusion of a guidance for the harmonization of design practices which are based on a partial safety factor concept and risk management engineering, as well as inclusion of the probability of failure and possible consequences of failures;

— addition of references to the general principle for the reliability of structures detailed in ISO 2394 and EN 1990;

— addition of a new safety factor concept for the hydrostatic pressure design;

— addition of a clear reference for assessment of conformity;

— changes in Clause 6, including pressure tests requirements for fittings;

— changes in Clause 7;

— changes in Annex A for the establishment of the design requirements.

Plastics piping systems for pressure and non-pressure drainage and 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 drainage and sewerage with or without pressure. 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 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 temperatures up to 50 °C, with or without pressure. In a pipework system, pipes and fittings of different nominal pressure and stiffness ratings may be used together. 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 may have a thermoplastics or thermosetting resin liner. Clause 5 also specifies the test parameters for the test methods referred to in this document.

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 to be used for the conveyance of surface water and sewerage, 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.

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 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, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific 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 8521:2009, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the apparent initial circumferential tensile strength*

ISO 8533, *Plastics piping systems for pressure and non-pressure drainage and sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — 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 long-term specific ring creep stiffness under wet conditions and calculation of the wet creep factor*

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*

ISO/TS 20656-1, *Plastics piping systems — General rules for structural design of glass-reinforced thermosetting plastics (GRP) pipes — Part 1: Buried pipes*

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:

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

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

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* (3.17) to the absolute value of the arithmetic mean, given by the following formula:

$$V = \text{standard deviation of the population} \,/\, \text{mean of the population}$$

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

3.3 Diameter

3.3.1
declared diameter
diameter which a manufacturer states to be the internal or external diameter produced in respect of a particular *nominal size* (DN) (3.6)

3.3.2
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

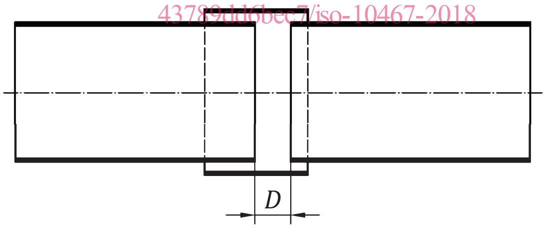
d_i is the internal diameter, in m;

d_e is the external diameter, in m;

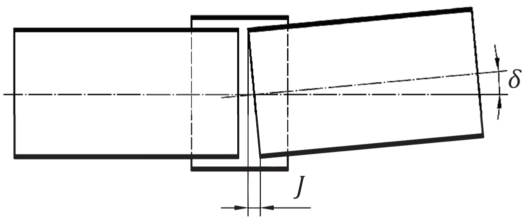
e is the wall thickness of the pipe, in m.

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

3.5 Joint movement



a)



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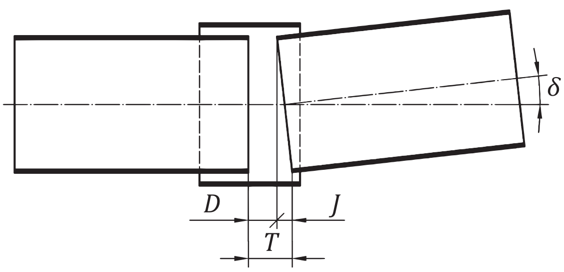

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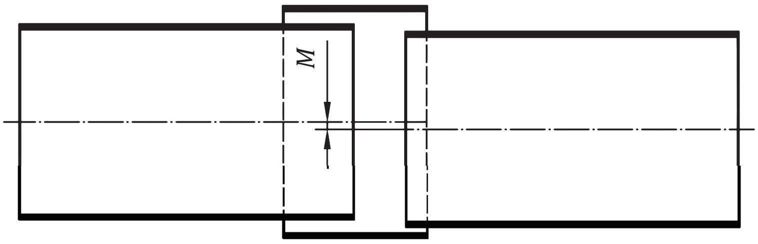

d)

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 1 — Joint movements

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 1.

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), in millimetres (mm) on the pipe and a supported coupling causing a step between the two pipe spigots at the loading position in millimetres (mm)

Note 1 to entry: See Figure 1.

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 1.

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

Note 1 to entry: Flexible joints which have resistance to axial loading are classified as end-load-bearing. Examples of this type of joint are:

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

b) locked socket-and-spigot joints with an elastomeric sealing element (including double-socket designs);

c) mechanically clamped joints, e.g. bolted couplings including components made of materials other than GRP.

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

Note 1 to entry: Rigid joints which do not have resistance to axial loading are classified as non-end-load-bearing. Examples of this type of joint are:

a) flanged joints including integral or loose flanges;

b) wrapped or cemented joints.

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 1.

3.6
nominal size
DN
alphanumerical designation of size, which is common to all components in a piping system, 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 of 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
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.

3.11 Pipeline

3.11.1
buried pipeline
pipeline which is subjected to the external pressure transmitted from soil loading, including traffic and superimposed loads and possibly the pressure of a head of water

3.11.2
non-buried pipeline
pipeline which is subjected to negative and positive pressure, forces resulting from its supports and environmental conditions

Note 1 to entry: Examples of environmental conditions are snow, wind and temperature.

3.11.3
sub-aqueous pipeline
pipeline which is subjected to an external pressure arising from a head of water and conditions such as drag and lift caused by current and wave action

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 nominal pressure class, which is the maximum sustained hydraulic internal pressure for which a pipe is designed in the absence of other loading conditions than internal pressure, this means that the nominal pressure shall be equal to or greater than the *working pressure* (3.12.11)

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

Note 2 to entry: The definition for the PN has been changed from the previous version of this document. The definition is more specific and related to internal pressure load exclusively.

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
mean design pressure
$p_{0,d}$
mean design initial failure pressure to ensure 95 % of products will exceed the *initial failure pressure*, $p_{0,QC}$ (3.12.1)

3.12.5
minimum safety factor for long-term pressure
FS_{min}
minimum safety factor for long-term pressure which is applied to the *nominal pressure* (PN) (3.12.2)

3.12.6
mean safety factor safety factor for long-term pressure
FS_{mean}
mean safety factor for long-term pressure which is applied to the *nominal pressure* (PN) (3.12.2)

3.12.7
minimum failure pressure at 50 years
$p_{50,min}$
95 % lower confidence level (LCL) of the failure pressure after 50 years

3.12.8
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, obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

3.12.9
pressure pipe or fitting
pipe or fitting having a nominal pressure classification, expressed in bar, 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.

3.12.10
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 can 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 ($p_{0,mean}$) to the projected 6 min failure pressure (p_6) calculated from the regression line

3.13
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 [*service temperature* (3.19.1)] to those applicable at a standard test temperature of 23 °C

3.14 Ring deflection

3.14.1
extrapolated long-term relative ultimate ring deflection
$y_{u,wet,x}/d_m$
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

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

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

3.14.2
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 (3.3.2)

Note 1 to entry: See 3.3.2.

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

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

3.14.3
minimum initial relative specific ring deflection before bore cracking occurs
$(y_{2,bore}/d_m)_{min}$
initial relative 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.

3.14.4
minimum initial relative specific ring deflection before structural failure occurs
$(y_{2,struct}/d_m)_{min}$
initial relative 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.

3.14.5
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.

3.15 Resistance to strain corrosion

3.15.1
minimum long-term relative ring deflection in a corrosive environment
$(y_{corr,x}/d_m)_{min}$
required minimum extrapolated value at x years derived from the ultimate deflection regression line obtained from long-term deflection tests performed under corrosive conditions in accordance with ISO 10952

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

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