BS EN 14758-1:2023

BSI Standards Publication

Plastics piping systems for non-pressure underground drainage and sewerage — Polypropylene with mineral modifiers (PP-MD)

Part 1: Specifications for pipes, fittings and the system

bsi.

National foreword

This British Standard is the UK implementation of EN 14758-1:2023. It supersedes BS EN 14758-1:2012, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/88/1, Plastics piping for non-pressure applications.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene with mineral modifiers (PP-MD) - Part 1: Specifications for pipes, fittings and the system

Systèmes de canalisations en plastique pour les branchements et les collecteurs d'assainissement enterrés sans pression - Polypropylène avec modificateurs minéraux (PP-MD) - Partie 1 : Spécifications pour les tubes, les raccords et le système

Kunststoff-Rohrleitungssysteme für erdverlegte drucklose Abwasserkanäle und -leitungen - Polypropylen mit mineralischen Additiven (PP-MD) - Teil 1: Anforderungen an Rohre, Formstücke und das Rohrleitungssystem

This European Standard was approved by CEN on 3 March 2023.

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Contents

European foreword

This document (EN 14758-1:2023) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

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of an identical text or by endorsement, at the latest by October 2023, and conflicting national standards shall be withdrawn at the latest by October 2023.

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

This document supersedes EN EN 14758-1:2012.

The main changes compared to the previous edition are listed below:

— the Scope has been changed by introducing skin layer;

— updating of the Normative references;

— updating of the Terms and definition with the material definitions in EN 14541-1 and a new definition of the skin;

— the Material clause has been modified by specifying the PP compound used in the skin and defining a minimum content of mineral modifier;

— the maximum thickness of each skin has been introduced;

— the Ring stiffness class SN16 for pipes and fittings has been introduced;

— two alternatives for inside diameter of sockets has been introduced – normal and close tolerance (CT);

— the water tightness test of fabricated fittings has been introduced;

— Annex A Utilization of reworked material and recyclate has been modified to be in line with CEN/TS 14541-2;

— a new informative Annex D for testing of PP recyclates with the CRB-method has been added.

System Standards are based on the results of the work undertaken in ISO/TC 138 “Plastics pipes, fittings and valves for the transport of fluids”, which is a Technical Committee of the International Organization for Standardization (ISO).

They are supported by separate standards on test methods to which references are made throughout the System Standard.

The System Standards are consistent with general standards on functional requirements and on recommended practice for installation.

The EN / CEN/TS 14758 series, *Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene with mineral modifiers (PP-MD)*, consists of the following parts:

— EN 14758, *Part 1: Specifications for pipes, fittings and the system*;

— CEN/TS 14758, *Part 2: Guidance for the assessment of conformity*.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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

1 Scope

This document specifies the requirements for solid-wall pipes and fittings with or without internal and/or external skin, and the system of piping systems made from mineral modified polypropylene materials (PP-MD) in the field of non-pressure underground drainage and sewerage outside the building structure (application area code "U"), and non-pressure underground drainage and sewerage for both buried in ground within the building structure and outside the building structure (application area code "UD").

This is reflected in the marking of products by "U" and "UD".

NOTE 1 The skins are made of PP compound without mineral modifier.

It also specifies the test parameters for the test methods referred to in this document.

This document covers a range of nominal sizes, a range of pipe stiffness classes and gives recommendations concerning colour.

NOTE 2 It is the responsibility of the purchaser or specifier to make the appropriate selection from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

In conjunction with Part 2 of EN 14758 (see European foreword) it is applicable to PP-MD pipes and fittings, their elastomeric sealing ring joints and to joints with components of other plastics and non-plastics materials intended to be used for buried piping systems for non-pressure underground drainage and sewerage.

This document is applicable to PP-MD pipes with or without an integral socket and fittings with an integral socket.

NOTE 3 The fittings can be manufactured by injection-moulding or be fabricated from pipes and/or mouldings.

NOTE 4 Pipes, fittings and other components conforming to any of the plastics product standards listed in Annex C can be used with pipes and fittings conforming to this document, when they conform to the requirements for joint dimensions given in Clause 7 and to the requirements of Table 11.

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.

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

EN 681-2, *Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Part 2: Thermoplastic elastomers*

EN 12099, *Plastics piping systems - Polyethylene piping materials and components - Determination of volatile content*

EN ISO 472, *Plastics - Vocabulary (ISO 472)*

EN ISO 580:2005, *Plastics piping and ducting systems - Injection-moulded thermoplastics fittings - Methods for visually assessing the effects of heating (ISO 580:2005)*

EN ISO 1043-1, *Plastics - Symbols and abbreviated terms - Part 1: Basic polymers and their special characteristics (ISO 1043-1)*

EN ISO 1133-1, *Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method (ISO 1133-1)*

EN ISO 1167 (all parts), *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure (ISO 1167 (all parts))*

EN ISO 1183-1, *Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1)*

EN ISO 1183-2, *Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method (ISO 1183-2)*

EN ISO 2505:2005, *Thermoplastics pipes - Longitudinal reversion - Test method and parameters (ISO 2505:2005)*

EN ISO 3126, *Plastics piping systems - Plastics components - Determination of dimensions (ISO 3126)*

EN ISO 3127, *Thermoplastics pipes - Determination of resistance to external blows - Round-the-clock method (ISO 3127)*

EN ISO 3451-1, *Plastics - Determination of ash - Part 1: General methods (ISO 3451-1)*

EN ISO 9969, *Thermoplastics pipes - Determination of ring stiffness (ISO 9969)*

EN ISO 11173, *Thermoplastics pipes - Determination of resistance to external blows - Staircase method (ISO 11173)*

EN ISO 11357-6, *Plastics - Differential scanning calorimetry (DSC) - Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT) (ISO 11357-6)*

EN ISO 13254, *Thermoplastics piping systems for non-pressure applications - Test method for watertightness (ISO 13254)*

EN ISO 13257:2018, *Thermoplastics piping systems for non-pressure applications — Test method for resistance to elevated temperature cycling (ISO 13257:2018)*

EN ISO 13259:2020, *Thermoplastics piping systems for underground non-pressure applications — Test method for leaktightness of elastomeric sealing ring type joints (ISO 13259:2020)*

EN ISO 13263, *Thermoplastics piping systems for non-pressure underground drainage and sewerage - Thermoplastics fittings - Test method for impact strength (ISO 13263)*

EN ISO 13264, *Thermoplastics piping systems for non-pressure underground drainage and sewerage - Thermoplastics fittings - Test method for mechanical strength or flexibility of fabricated fittings (ISO 13264)*

EN ISO 13967, *Thermoplastics fittings - Determination of ring stiffness (ISO 13967)*

EN ISO 13968, *Plastics piping and ducting systems - Thermoplastics pipes - Determination of ring flexibility (ISO 13968)*

CEN/TS 17627, *Plastics - Recycled plastics - Determination of solid contaminants content*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 472, EN ISO 1043-1 and the following apply.

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

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

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

3.1
application area code
code used in the marking of pipes and fittings to indicate the application area for which they are intended, as follows:

— U: code for the area more than 1 m from the building to which the buried piping system is connected;

— D: code for the area under and within 1 m from the building where the pipes and the fittings are buried in ground and are connected to the soil and waste discharge system of the building

Note 1 to entry: In code D application areas, the existence of hot water discharge in addition to the external forces from the surroundings is usual.

Note 2 to entry: Components intended for use for both code U and code D application areas are marked UD.

Note 3 to entry: Other application area codes B and BD not covered by this document are defined elsewhere, e.g. in EN 1451-1 [1].

3.2
nominal size
DN
numerical designation of the size of a component, which is a convenient round number approximately equal to the manufacturing dimension, in millimetres

3.3
nominal size
DN/OD
nominal size, related to the outside diameter

3.4
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a nominal size (DN/OD)

3.5
outside diameter
d_e
value of the measurement of the outside diameter through its cross section at any point of a pipe or spigot end of a fitting, rounded up to the next greater 0,1 mm

3.6
mean outside diameter
d_{em}
value of the measurement of the outer circumference of a pipe or spigot end of a fitting in any cross section, divided by π (≈ 3,142), rounded to the next greater 0,1 mm

3.7
mean inside diameter of a socket
d_{sm}
arithmetical mean of a number of measurements of the inside diameter of a socket in the same cross section

3.8
wall thickness
e
value of the measurement of the wall thickness at any point around the circumference of a component

3.9
mean wall thickness
e_m
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross section

3.10
pipes series
S
dimensionless number related to the nominal outside diameter d_n and nominal wall thickness e_n given by the following formula:

$$S = \frac{SDR - 1}{2}$$

[SOURCE: ISO 4065:2018, 3.6]

3.11
standard dimension ratio
SDR
numerical designation of a pipe series, which is a convenient round number approximately equal to the ratio of the nominal outside diameter, d_n, and the minimum wall thickness, e_{min}

3.12
nominal ring stiffness
SN
numerical designation of the ring stiffness of a pipe or fitting, which is a convenient round number, relative to the determined stiffness in kilo Newtons per square metre (kN/m^2), indicating the minimum ring stiffness of a pipe or fitting

3.13
design length
Z
length of a fitting (e.g. the main pipe of a branch) excluding any spigot or socket length. In case of a change in direction (e.g. in case of a bend or the service pipe of a branch), it is the length from one end to the intersection of the straight axis of this end with the straight axis of the other end of the fitting, excluding any spigot or socket length

Note 1 to entry: See the dimensions Z_1 and Z_2 in e.g. Figures 7 and 11.

3.14
virgin material
plastics material in the form of pellets, granules, powder, floc, etc. that has not been subjected to use or processing other than that required for its initial manufacture

Note 1 to entry: Does not contain any reworked plastics material and/or plastics recyclate.

Note 2 to entry: Sometimes also referred to as “primary material” or “primary plastics feedstock”.

Note 3 to entry: It is understood that the addition of additives such as stabilizers and pigments is still resulting into a virgin (plastics) material.

[SOURCE: ISO 472:2013, 2.1231, modified - Note 1 to entry, Note 2 to entry and Note 3 to entry added]

3.15
mineral modified [polypropylene] material
PP-MD
[polypropylene] material to which has been added minerals during specific processing operation(s) which during such processing is well distributed in the material

3.16
mean particle size
D50
diameter which 50 % by mass of the particles of a mineral modifier is smaller than

3.17
particle top cut
D98
diameter which 98 % by mass of the particles of a mineral modifier is smaller than

3.18
reworked material
plastics material from rejected unused products or trimmings capable of being reclaimed within the same process that generated it

Note 1 to entry: Reworked material does not change the status of the feedstock.

Note 2 to entry: This definition does not cover the conditions for the use of reworked material, which can be found in the applicable product standard.

Note 3 to entry: Previously referred to as “own reprocessed material”.

3.19
pre-consumer material
plastics material diverted from the waste stream during a manufacturing process, excluding reworked (plastics) material

Note 1 to entry: Previously referred to as “post-industrial material”.

Note 2 to entry: Different categories of pre-consumer material may be considered in the applicable product standard.

[SOURCE ISO 14021:2016, 7.8.1.1, modified – ‘plastics’ added, text deleted after ‘rework’ and 2 Notes to entry introduced]

3.20
post-consumer material
plastics material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose

Note 1 to entry: This includes returns of material from the distribution chain.

Note 2 to entry: Different categories of post-consumer material may be considered in the applicable product standard.

[SOURCE ISO 14021:2016, 7.8.1.1, modified – ‘plastics’ added, last sentence changed into Note 1 to entry and Note 2 to entry introduced]

3.21
recyclate
plastics material resulting from the recycling of pre-consumer and post-consumer plastics products

Note 1 to entry: Also referred to as “secondary raw material” or “recycled plastics” or “regenerate”.

Note 2 to entry: Recycling can be chemical, physical or mechanical.

[SOURCE: ISO 472:2013, 2.1705, modified — Note 1 to entry and Note 2 to entry deleted, new Note 1 to entry and Note 2 to entry introduced and "plastic waste" changed into "pre-consumer and post-consumer plastics products"]

3.22
agreed specification
specification of the relevant material characteristics agreed between the supplier of the recyclate and the pipe and/or fitting manufacturer

Note 1 to entry: The agreed specification is often considered in the context of certification by a third party organization.

3.23
solid wall pipe
pipe with smooth internal and external surface with same compound/formulation throughout the wall

3.24
skin
coating applied to the inner and/or outer side of a solid wall pipe

Note 1 to entry: A coating can be applied for example for the purpose of colour coding, video inspection and/or UV-protection.

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this document, the following symbols apply.

A	length of engagement
C	depth of sealing zone
$d_{\mathrm{im,min}}$	minimum mean inside diameter
d_{s}	inside diameter of a socket
e_2	wall thickness of a socket
e_3	wall thickness in the groove area
l	effective length of a pipe
L_1	length of spigot
M	length of spigot of a plug
R	radius of swept fittings
Z_1	design length of a fitting
Z_2	design length of a fitting
Z_3	design length of a fitting
α	nominal angle of a fitting

4.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

MFR	melt mass-flow rate
$CaCO_3$	calcium carbonate
$MgCO_3$	magnesium carbonate
$Mg_3Si_4O_{10}(OH)_2$	magnesium silicate
OIT	oxidation induction time
PP	polypropylene
PP-MD	mineral modified polypropylene
SDR	standard dimension ratio
SN	nominal ring stiffness
TIR	true impact rate

5 Material

5.1 PP-MD compound

The compound for production of pipes and fittings shall be a PP base material, with added mineral modifier(s) of known specification, additives needed to facilitate the manufacture of components, and with added reworked material and recyclate (if applicable) conforming to the requirements of this document.

The content of mineral modifier in pipes and fittings shall be > 10 % and less than 50 % by mass. The actual quantity and specification of mineral modifier shall be specified in the manufacturer's quality plan.

5.2 PP compound for the skin

The compound for production of skins shall be a PP base material, with added additives needed to facilitate the manufacture of components, and with added reworked material and recyclate (if applicable) conforming to the requirements of this document.

5.3 Utilization of reworked material and recyclate

For the utilization of reworked material and recyclate, conditions and requirements are given in Annex A.

5.4 Melt mass-flow rate

For pipes and fittings made from PP-MD, the PP base material shall have an MFR as follows:

MFR (230/2,16) ≤ 1,5 g/10 min.

The MFR of the PP base material shall be tested in accordance with EN ISO 1133-1, using the test parameters: temperature 230 °C and loading mass 2,16 kg.

5.5 Fusion compatibility of fabricated fittings

Fabricated fittings made by the manufacturer by butt fusion welding shall be made of pipes, fittings and mouldings with the similar MFR to secure the quality of the weld.

5.6 Mineral modifiers

5.6.1 Types of mineral modifiers

The mineral modifiers shall be:

— coated calcium carbonate, $CaCO_3$;

— talc.

When it is calcium carbonate following apply:

— content of $CaCO_3$ ≥ 96 % by mass;

— content of $MgCO_3$ ≤ 4 % by mass;

— content of $CaCO_3$ and $MgCO_3$ in total ≥ 98 % by mass.

When it is talc following apply:

— content of magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$) ≥ 97 % by mass.

NOTE The addition of mineral modifiers is an effective way of increasing the E-modulus of the base polypropylene material.

5.6.2 Characteristics of mineral modifiers

The physical properties of modifiers shall conform to the following:

For $CaCO_3$:

— mean particle size, D50 ≤ 2,5 µm;

— particle top cut, D98 ≤ 20 µm.

For talc:

— mean particle size, D50 ≤ 7 µm;

— particle top cut, D98 ≤ 30 µm.

5.6.3 Dispersion of mineral modifiers

The pipe and fitting shall be pressure tested in accordance with EN ISO 1167 (all parts) at 80 °C with circumferential (hoop) stress of 5,5 MPa. No failure within the test period of one hour.

The compounds used for the manufacture of pipes and fittings may be tested separately or together in the form of an injection moulded or an extruded pipe.

5.7 Long-term behaviour

When tested in accordance with the test method as specified in Table 1, using the indicated parameters, the compounds (PP-MD compound and PP skin compound) shall have characteristics conforming to the requirements given in Table 1.

The compounds used for the manufacture of pipes and fittings may be tested separately or together in the form of an injection moulded or an extruded pipe.

Table 1 — Material characteristics

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure	No failure during the test period	Test 1 End caps Test temperature Orientation Number of test pieces Circumferential (hoop) stress Conditioning period Type of test Test period	 Type A or B 80 °C Free 3 4,2 MPa 1 h water-in-water 140 h	EN ISO 1167-1 [a] EN ISO 1167-2
		Test 2 End caps Test temperature Orientation Number of test pieces Circumferential (hoop) stress Conditioning period Type of test Test period	 Type A or B 95 °C Free 3 2,5 MPa 1 h Water-in-water 1 000 h	
[a] Pressure shall be calculated according to EN ISO 1167-1:2006, 7.2 (measured dimensions of the test piece).				

5.8 Thermal stability (OIT)

The oxidation induction time of the compound shall not be less than 8 min.

The test shall be carried out on manufactured solid wall pipes and/or fittings including skin(s), if applicable in accordance with EN ISO 11357-6 using a test temperature of 200 °C.

5.9 Sealing ring retaining means

Sealing rings may be retained using means made from polymers other than PP-MD.

6 General characteristics

6.1 Appearance

When viewed without magnification, the following requirements apply.

The internal and external surfaces of pipes and fittings shall be smooth, clean and free from grooving, blistering, impurities and pores and any other surface irregularity likely to prevent their conformity to this document.

Pipe ends shall be cleanly cut and the ends of pipes and fittings shall be square to their axis.

6.2 Colour

The pipes and fittings shall be coloured through the wall. External and internal skins may have a different colour.

The colour should preferably be black, orange-brown (approximately RAL 8023) [2] or dusty grey (approximately RAL 7037) [2]. Other colours may be used.

7 Geometrical characteristics

7.1 General

Dimensions shall be measured in accordance with EN ISO 3126.

NOTE The figures are schematic sketches only to indicate the relevant dimensions. They do not necessarily represent the manufactured components.

7.2 Dimensions of pipes

7.2.1 Outside diameters

The mean outside diameter, d_{em}, shall conform to Table 2 or Table 3, as applicable.

Table 2 — Mean diameters

Dimensions in millimetres

Nominal size DN/OD	**Nominal outside diameter** d_n	**Mean outside diameter** [a]		**Minimum mean inside diameter** [b]		
		$d_{em,min}$	$d_{em,max}$	$d_{im,min}$		
				SN 4	SN 8	SN 16
110	110	110,0	110,4	102,0	99,2	95,7
125	125	125,0	125,4	116,0	112,6	108,8
160	160	160,0	160,5	148,8	144,4	139,2
200	200	200,0	200,6	185,8	180,6	175,2
250	250	250,0	250,8	232,6	226,0	217,5
315	315	315,0	316,0	293,2	284,8	274,1
355	355	355,0	356,1	330,4	321,0	308,9
400	400	400,0	401,2	372,4	361,8	348,0
450	450	450,0	451,4	419,2	407,2	391,5
500	500	500,0	501,5	465,8	452,4	435,0
630	630	630,0	631,8	587,0	570,4	548,1
800	800	800,0	802,0	745,6	724,2	696,0
1 000	1 000	1 000,0	1 002,0	932,2	905,4	870,0

[a] The tolerances for mean outside diameters conform to ISO 11922-1 [3], grade C.

[b] The minimum inside diameter was introduced in this document to secure the sufficient free bore because no maximum wall thickness is specified.

7.2.2 Outside diameters with close tolerance (type CT)

For the purposes of this document in addition to the dimensions and tolerances given in Table 2 for spigot ends of pipes and fittings, tolerances which are in accordance with EN 1401-1 [4], may be used.

If these tolerances, classified as close tolerance (CT), are required, the mean outside diameter, d_{em}, and the tolerances shall conform to Table 3.

Table 3 — Mean outside diameters with close tolerances type CT

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter	Mean outside diameter	
	d_n	$d_{em,min}$	$d_{em,max}$
200	200	200,0	200,5
250	250	250,0	250,5
315	315	315,0	315,6
355	355	355,0	355,7
400	400	400,0	400,7
450	450	450,0	450,8
500	500	500,0	500,9
630	630	630,0	631,1
800	800	800,0	801,3
1 000	1 000	1 000,0	1 001,6

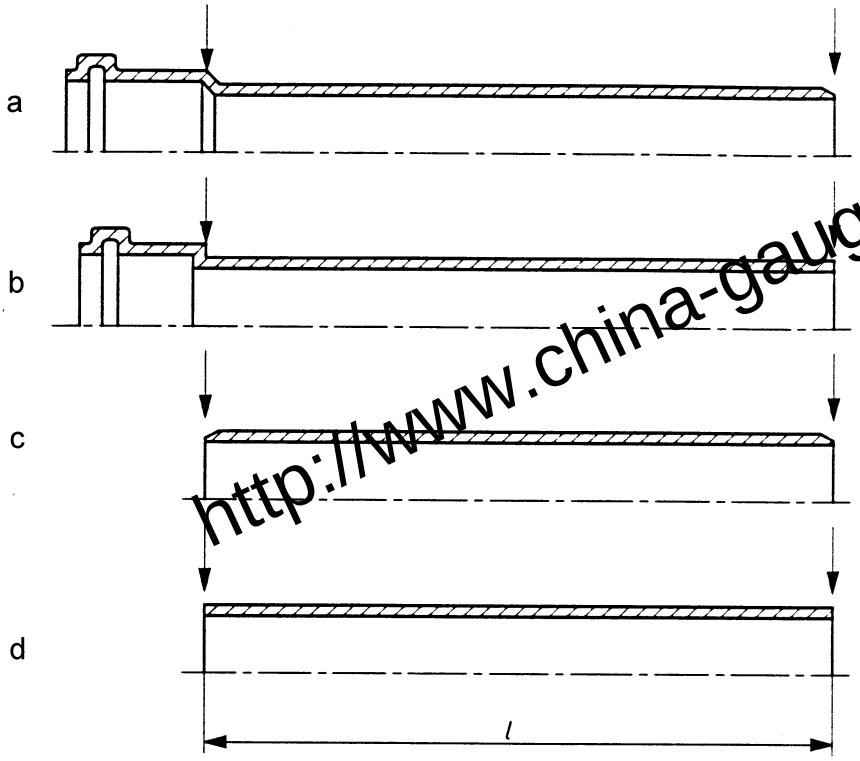
NOTE Spigot ends of pipes and fittings with maximum mean outside diameters conforming to this table can be used with pipes and fittings conforming to EN 1401-1 [4] provided that the socket(s) for these pipes and fittings are intended to be used for elastomeric ring seal joints.

7.2.3 Minimum mean inside diameter

The mean inside diameter, $d_{im,min}$ shall conform to Table 2.

7.2.4 Length of pipes

The effective length of a pipe, l, shall be not less than that declared by the manufacturer when measured as shown in Figure 1.



Key

a single-socketed pipe with ring seal, with chamfer
b single-socketed pipe with ring seal, without chamfer
c plain ended pipe, with chamfer
d plain ended pipe, without chamfer
l effective length of a pipe

Figure 1 — Effective length of pipe

7.2.5 Chamfering

If a chamfer is applied, the angle of chamfering shall be between 15° and 45° to the axis of the pipe.

The remaining wall thickness of the end of the pipe shall be at least ⅓ of e_{min}.

7.2.6 Wall thicknesses

The actual wall thickness of the pipe including skins shall be sufficient to give the pipe the ring stiffness for which the pipe is classified, but shall not be less than specified in Table 4.

The wall thickness, e_{min}, measured as minimum value on the test samples used for classification of ring stiffness class according to 7.3, shall be recorded and further used as minimum wall thickness, e_{min}, that the manufacturer is allowed to use in the current production of pipe.

The thickness of each skin shall be less than or equal to the value specified in Table 4.

Table 4 — Wall thickness

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Minimum wall thickness including skin(s) [a] e_{min}	Maximum thickness of each skin e
110	110	3,4	0,3
125	125	3,9	0,3
160	160	4,9	0,3
200	200	6,2	0,4
250	250	7,7	0,4
315	315	9,7	0,4
355	355	10,9	0,5
400	400	12,3	0,5
450	450	13,8	0,5
500	500	15,3	0,6
630	630	19,3	0,6
800	800	24,5	0,6
1 000	1 000	30,6	0,7

[a] The minimum required wall thickness is according to the pipe series S 16 of ISO 4065 [5] which corresponds to SDR 33.

7.3 Ring stiffness classes

The pipe shall be classified by ring stiffness either as SN 4, SN 8 or SN 16. The classification shall be based upon ring stiffness testing in accordance with EN ISO 9969.

7.4 Dimensions of fittings

7.4.1 Outside diameters

The mean outside diameter, d_{em}, of the spigot shall conform to Table 2 or Table 3, as applicable.

7.4.2 Design lengths

The design lengths shall be declared by the manufacturer.

NOTE The design lengths (see the dimensions *Z* in Figures 7 to 9 and Figures 13 to 17) are intended to assist in the design of moulds and are not intended to be used for quality control purposes. ISO 265-1 [6] can be used as a guideline.

7.4.3 Wall thicknesses and stiffness

The actual wall thickness of the fitting shall be sufficient to give the fitting the stiffness for which the fitting is classified, but shall not be less than specified in Table 4.

The wall thickness that is measured as minimum value on the body of the fitting sample used for classification of the stiffness of the fitting shall be recorded and further used as the minimum wall thickness, e_{min}, that the manufacturer is allowed to use in the current production of fittings.

The minimum wall thickness, e_{min}, of the body or the spigot of a fitting shall conform to Table 4, except that a reduction of 5 % resulting from core shifting is permitted. In such a case, the average of two opposite wall thicknesses shall be equal to or exceed the values given in Table 4.

Stiffness of fittings shall be classified by stiffness either as SN 4, SN 8 or SN 16. The classification shall be based upon stiffness testing in accordance with EN ISO 13967.

When a fitting conforming to this document has the same wall thickness and material composition as the corresponding pipe, the stiffness of this fitting because of its geometry, is equal to or greater than the stiffness of that pipe. Consequently, fittings are classified with the corresponding pipe stiffness.

For DN/OD ≥ 500 the manufacturers guaranteed minimum stiffness of a fitting, between the SN values, may be used for calculation purposes.

Where a fitting or adaptor provides for a transition between two nominal sizes, the wall thickness of each connecting part shall conform to the requirements for the applicable nominal size. In such a case, the wall thickness of the fitting body is permitted to change gradually from the one wall thickness to the other.

The wall thickness of fabricated fittings, except for spigot and socket, may be changed locally due to the fabrication process, providing that the minimum wall thickness of the body conforms to, $e_{3,min}$, as specified in 7.5.2, as appropriate for the pipe series concerned.

7.5 Dimensions of sockets and spigots

7.5.1 Diameters and lengths of elastomeric ring seal sockets and spigots

The diameters and lengths of elastomeric ring seal sockets and lengths of spigots shall conform to Table 5 (see Figures 2, 3, 4 or 5, as applicable).

Where sealing rings are firmly retained, the dimensions for the minimum value for *A*, and the maximum value for *C*, shall be measured to the effective sealing point (see Figure 5) as specified by the manufacturer.

This point shall give a full sealing action.

Different designs of elastomeric ring seal sockets and spigots are permitted, provided the joints conform to the requirements given in Table 11.

Table 5 — Socket diameters and lengths of sockets and spigots

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter	Minimum mean inside diameter of the socket		Socket		Spigot
		Normal tolerance	Close tolerance CT			
	d_n	$d$sm,min [a]	$d$sm,min [b]	A_{min} [c d]	C_{max} [e]	$L_{1,min}$
110	110	110,4		40	22	62
125	125	125,4		43	26	68
160	160	160,5		50	32	82
200	200	200,6		58	40	98
250	250	250,9	250,8	68	50	118
315	315	316,1	316,0	81	63	144
355	355	358,3	356,1	89	71	160
400	400	403,7	401,2	98	80	178
450	450	454,2	451,4	108	90	198
500	500	504,6	501,5	118	100	218
630	630	635,8	631,9	144	126	270
800	800	807,2	802,4	178	160	334
1 000	1 000	1 009,0	1 003,0	218	200	418

[a] For nominal sizes DN/OD < 250, $d_{sm,min}$ conforms to EN 1401-1 [4]. For nominal sizes DN/OD ≥ 250, $d_{sm,min}$ conforms to EN 1852-1 [7].

[b] For CT sockets the nominal sizes DN/OD ≥ 250, $d_{sm,min}$ conforms to EN 1401-1 [4].

[c] The socket is designed for an effective length of pipe of 6 m.

[d] A_{min} values conform to the formula for A_{min} below.

[e] Higher values for C are allowed. In that case the manufacturer shall state in his documentation the actual required $L_{1,min}$ according to the equation $L_{1,min} = A_{min} + C$.

For pipe lengths longer than 6 m the length of engagement, A, in the socket shall be calculated from the formula:

$A_{min} = (0{,}2d_n + 3 \times l)$ mm

where

d_n is the nominal outside diameter in mm;

l is the pipe length in metres.

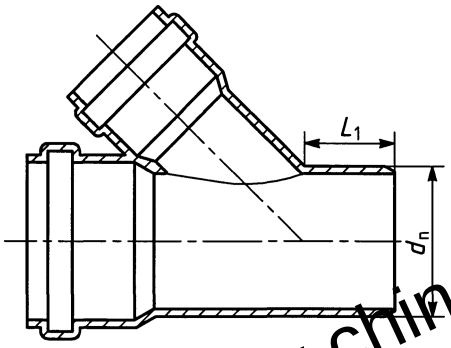


Figure 2 — Spigot length

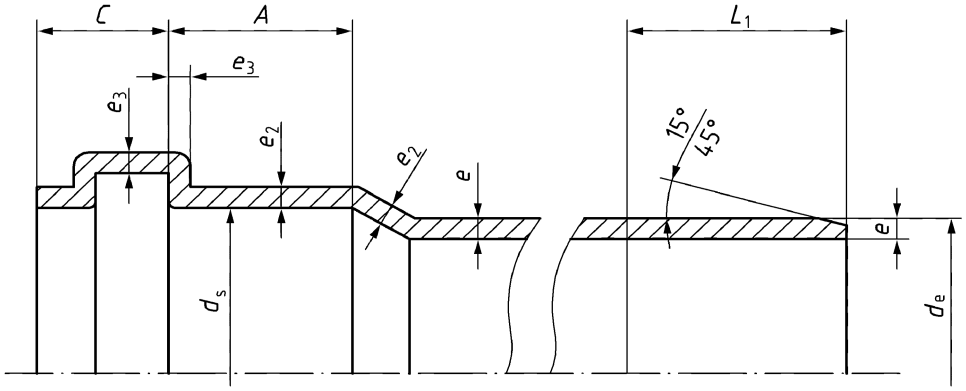


Figure 3 — General dimensions of sockets with elastomeric ring seal joints and spigot ends with elastomeric sealing joints

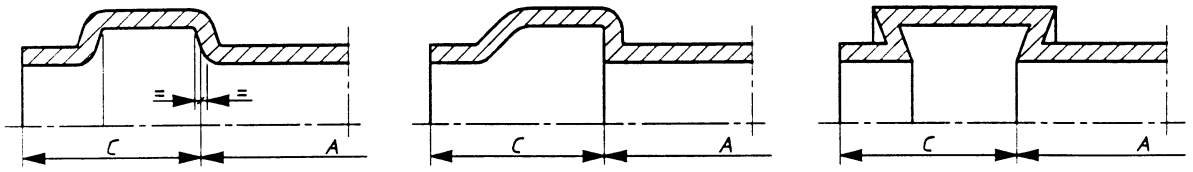


Figure 4 — Typical groove designs for elastomeric ring seal sockets

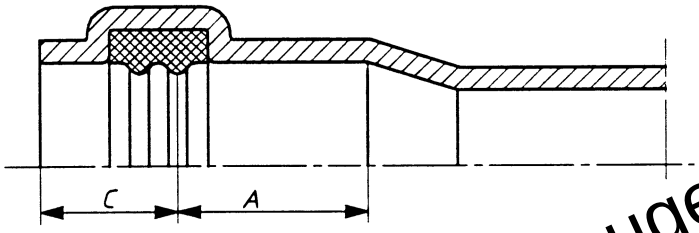


Figure 5 — Example for measuring the effective sealing point

7.5.2 Wall thicknesses of sockets

The minimum wall thicknesses of sockets, e_2 and e_3 (see Figure 3), excluding the socket mouth, shall conform to the following formulae:

— $e_{2,min}$ shall be at least 0,9 × actual e_{min}

— $e_{3,min}$ shall be at least 0,75 × actual e_{min}

Both values shall be rounded up to nearest 0,1 mm.

A reduction of 5 % of e_2 and e_3 resulting from core shifting is permitted. In such a case the average of two opposite wall thicknesses shall be equal to or exceed the values calculated from the formulaes.

It shall be noted that the actual wall thickness of a component (pipe or fitting) depen*ds* on the E-modulus of the material and shall be so that the required stiffness of the component is satisfied. If the actual minimum wall thickness e_{min} of a component is larger than e_{min} according to Table 4, then the dimensions $e_{2,min}$ and $e_{3,min}$ shall be increased in same ratio as the actual e_{min} of the body.

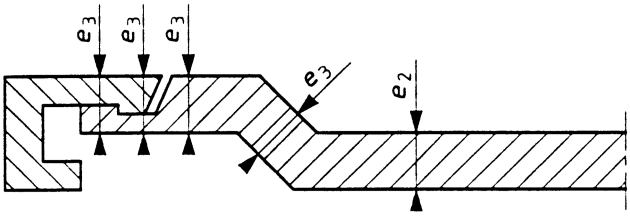


Figure 6 — Example for calculation of the wall thickness of sockets with retaining cap

7.6 Types of fittings

This document is applicable for the following types of fittings. Other designs of fittings are permitted.

a) bends (see Figures 7, 8, 9 or 10):

— unswept and swept angle (see ISO 265-1 [6]);

— spigot/socket and socket/socket;

— butt fused from segments;

NOTE 1 Preferred nominal angles α: 15°, 30°, 45°, 87,5° to 90°.

b) couplers and slip couplers (see Figures 11 or 12);

c) reducers (see Figure 13);

d) branches and reducing branches (see Figures 14, 15, 16 or 17):

— unswept and swept angle;

— spigot/socket and socket/socket.

NOTE 2 Preferred nominal angles α: 45°, 87,5° to 90°.

e) plugs (see Figure 18): minimum length of spigot, M_{min} = (C_{max} + 10) mm, (see Table 5).

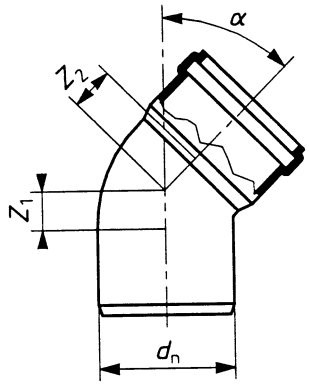


Figure 7 — Bend with single socket (unswept)

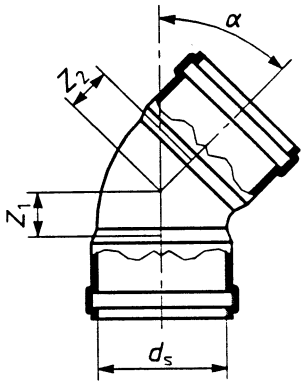


Figure 8 — Bend with all sockets (unswept)

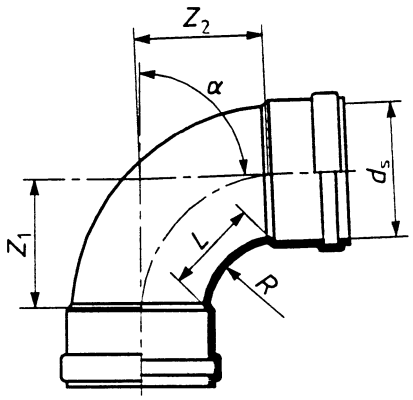


Figure 9 — Bend with all sockets (swept)

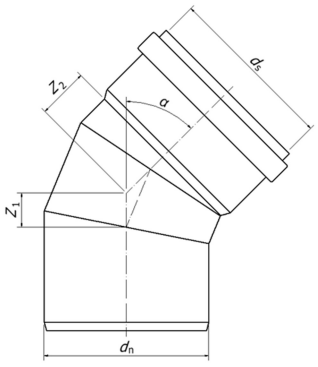


Figure 10 — Bend with socket and spigot end, butt fused from segments

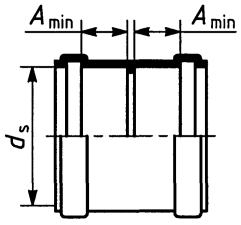


Figure 11 — Coupler

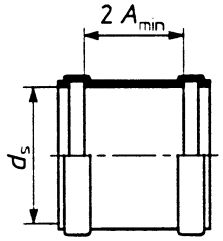


Figure 12 — Slip coupler

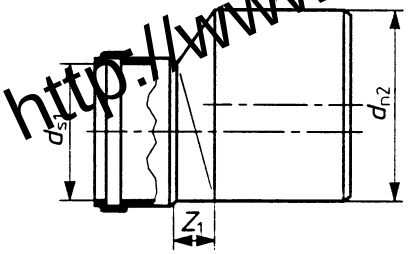


Figure 13 — Reducer

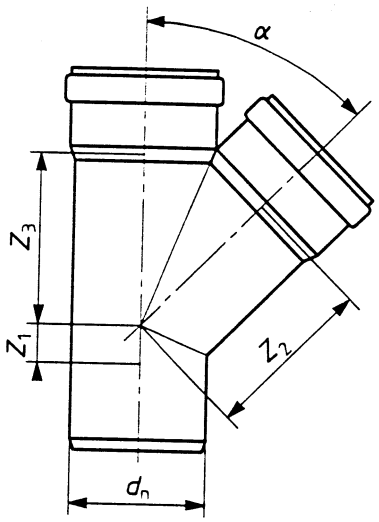


Figure 14 — Branch (unswept)

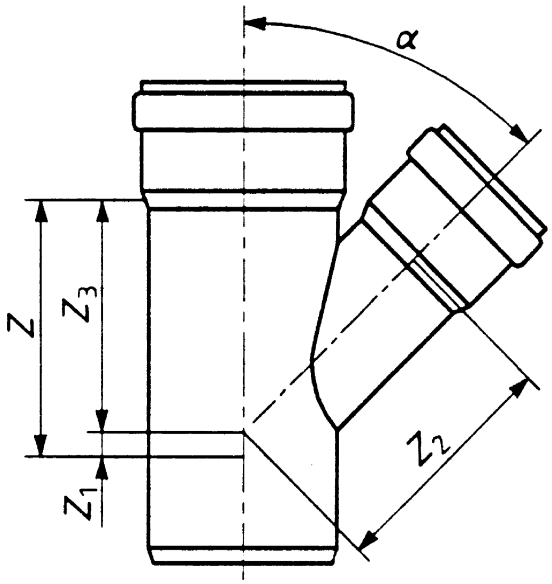


Figure 15 — Reducing branch

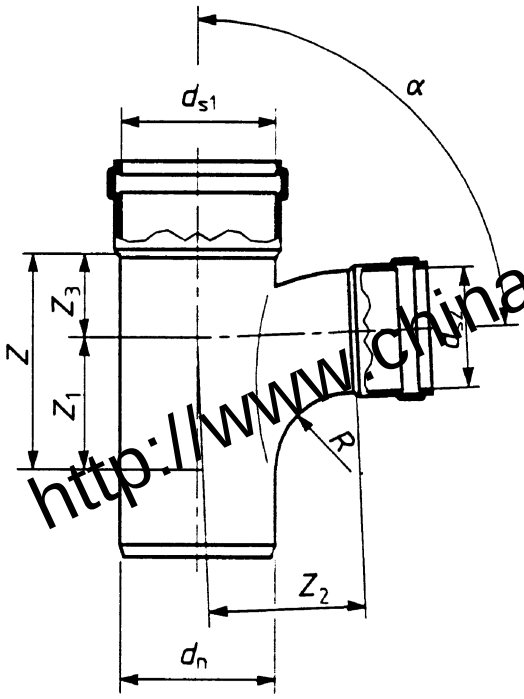


Figure 16 — Reducing branch (swept)

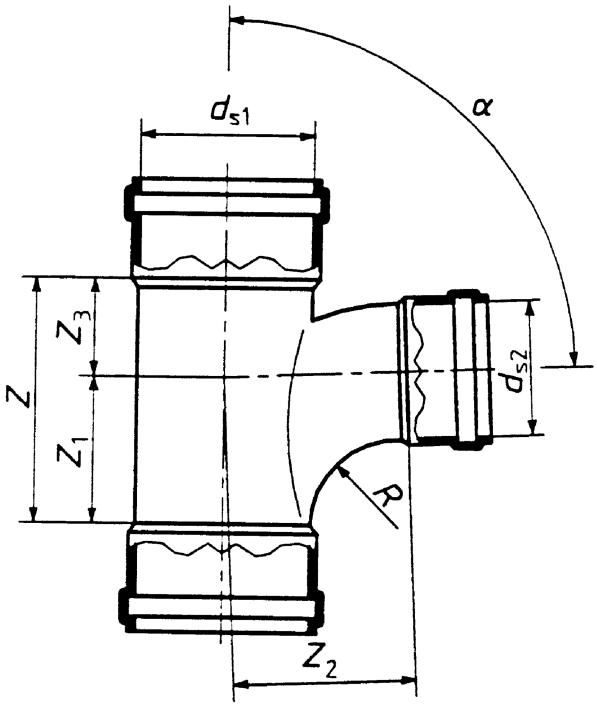


Figure 17 — All socket reducing branch (swept)

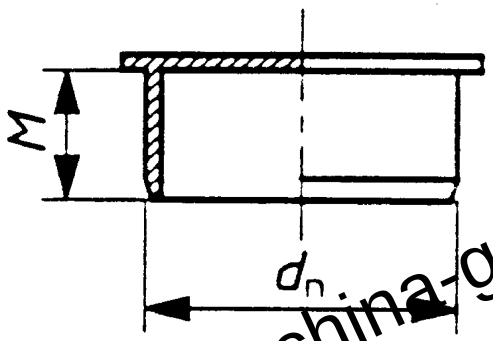


Figure 18 — Plug

8 Mechanical characteristics

8.1 Mechanical characteristics of pipes

8.1.1 General requirements

When tested in accordance with the test method as specified in Table 6 using the indicated parameters, the pipe shall have general mechanical characteristics conforming to the requirements given in Table 6.

Table 6 — General mechanical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Impact resistance [a] (round-the-clock method)	TIR ≤ 10 %	Test/conditioning temperature	0 °C	EN ISO 3127
		Conditioning medium	water or air	
		Type of striker	d 90	
		Mass of striker for:		
		d_n = 110 mm	1,0 kg	
		d_n = 125 mm	1,25 kg	
		d_n = 160 mm	1,6 kg	
		d_n = 200 mm	2,0 kg	
		d_n = 250 mm	2,5 kg	
		d_n ≥ 315 mm	3,2 kg	
		Fall height of striker for:		
		d_n = 110 mm	1 600 mm	
		d_n ≥ 125 mm	2 000 mm	
Ring stiffness	SN 4: ≥ 4 kN/m^2 SN 8: ≥ 8 kN/m^2 SN 16: ≥ 16 kN/m^2	Test temperature	(23 ± 2) °C	EN ISO 9969
		Deflection	3 %	
		Deflection speed for:		
		110 mm < d_n ≤ 200 mm	(5 ± 1) mm/min	
		200 mm < d_n ≤ 400 mm	(10 ± 2) mm/min	
		400 mm < d_n ≤ 1 000 mm	(20 ± 2) mm/min	
Ring flexibility	Shall conform to 8.1.2	Deflection	30 % of d_{em}	EN ISO 13968
[a] If the manufacturer chooses to use indirect testing, the preferred temperature is (23 ± 2) °C.				

8.1.2 Ring flexibility

When tested in accordance with the test method described in Table 6 using the indicated parameter and visually inspected without magnification a) and b) shall be conformed to during the test.

a) there shall be no decrease of the measured force;

b) there shall be no cracking in any part of the wall structure;

and c) and d) shall be conformed to after the test:

c) there shall be no other types of rupture in the test piece;

d) permanent buckling in the pipe wall shall not occur.

8.1.3 Additional mechanical requirements

Pipes intended to be used in areas where installation also is carried out at low temperatures, it may be required in the national foreword to conform to the requirements of an impact test (staircase method) as specified in Table 7.

The pipes shall be marked with an ice crystal in accordance with Table 12.

Table 7 — Additional mechanical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Impact resistance (staircase method)	H50 TIR max. one break below 0,5 m	Test/conditioning temperature	−10 °C	EN ISO 11173
		Type of striker	*d* 90	
		Mass of striker for:		
		d_n = 110 mm	4 kg	
		d_n = 125 mm	5 kg	
		d_n = 160 mm	8 kg	
		d_n = 200 mm	10 kg	
		$d_n \geq 250$ mm	12,5 kg	

8.2 Mechanical characteristics of fittings

When tested in accordance with the test methods as specified in Table 8 using the indicated parameters, the fitting shall have mechanical characteristics conforming to the requirements given in Table 8.

Table 8 — Mechanical characteristics of fittings

Characteristic	Requirements	Test parameters		Test method
Stiffness [a]	SN 4: ≥ 4 kN/m^2 SN 8: ≥ 8 kN/m^2 SN 16: ≥ 16 kN/m^2	Shall conform to EN ISO 13967		EN ISO 13967
Flexibility or mechanical strength [b]	No sign of splitting, cracking, separation and/or leakage	Test period Minimum displacement or: Minimum moment for: DN ≤ 250 DN > 250	15 min 170 mm 0,15 × [DN]^3 × 10^{-6} kNm 0,01 × [DN] kNm	EN ISO 13264
Impact strength (Drop test)	No damage	Test/conditioning temperature Fall height for: d_n = 110 mm d_n = 125 mm d_n = 160 mm d_n = 200 mm Point of impact	0 °C 1 000 mm 1 000 mm 500 mm 500 mm mouth of the socket	EN ISO 13263

[a] When a fitting according to this document has the same material and wall thickness as a corresponding pipe, the stiffness of the fitting, because of its geometry, is equal to or greater than that of the pipe. Such fitting can be classified with same stiffness class as that pipe without testing of the stiffness.

[b] Only for fabricated fittings made from more than one piece. A sealing ring retaining means is not considered as a piece.

9 Physical characteristics

9.1 Physical characteristics of pipes

When tested in accordance with the test methods as specified in Table 9 using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 9.

Table 9 — Physical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Longitudinal reversion	≤ 2 % The pipe shall exhibit no bubbles or cracks	Test temperature Immersion time	150 °C 30 min	Method A: Liquid, in accordance with EN ISO 2505:2005
		or		
		Test temperature Immersion time for: $e \leq 8$ mm 8 mm < $e \leq$ 16 mm $e >$ 16 mm	150 °C 60 min 120 min 240 min	Method B: Air, in accordance with EN ISO 2505:2005

9.2 Physical characteristics of fittings

When tested in accordance with the test method as specified in Table 10 using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in Table 10.

Table 10 — Physical characteristics of fittings

Characteristic	Requirements	Test parameters		Test method
Effects of heating	a b	Temperature Heating time for: $e \leq$ 10 mm $e >$ 10 mm	150 °C 30 min 60 min	Method A: Air oven, in accordance with EN ISO 580:2005
Watertightness c	No leakage	Water pressure	0,5 bar	EN ISO 13254
		Duration	1 min	

a The depth of cracks, de-lamination or blisters shall not be more than 20 % of the wall thickness around the injection point(s). No part of the weld line shall open to a depth of more than 20 % of the wall thickness.

b Mouldings that shall be used for fabricated fittings, may be tested separately.

c Only for fabricated fittings made from more than one piece. A sealing ring retaining means is not considered as a piece.

10 Performance requirements

When tested in accordance with the test methods as specified in Table 11 using the indicated parameters, the joints and the system shall have fitness for purpose characteristics conforming to the requirements given in Table 11.

Table 11 — Fitness for purpose characteristics

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric sealing ring joint		Temperature Spigot deflection Socket deflection	(23 ± 5) °C 10 % 5 %	EN ISO 13259:2020, Condition B
	No leakage	Water pressure	0,05 bar	
	No leakage	Water pressure	0,5 bar	
	≤ −0,27 bar	Air pressure	−0,3 bar	
Tightness of elastomeric sealing ring joint		Temperature Angular deflection for: $d_n \leq 315$ mm 315 mm < $d_n \leq 630$ mm $d_n > 630$ mm	(23 ± 5) °C 2° 1,5° 1°	EN ISO 13259:2020, Condition C
	No leakage	Water pressure	0,05 bar	
	No leakage	Water pressure	0,5 bar	
	≤ −0,27 bar	Air pressure	−0,3 bar	
Elevated temperature cycling [a]	No leakage	Shall conform to EN ISO 13257		EN ISO 13257:2018 Test assembly (Figure1 and/or Figure 2 of EN ISO 13257:2018)

[a] Test required only for components intended to be used for application area code "D" and for DN/OD ≤ 200.

11 Sealing rings

The sealing ring shall have no detrimental effects on the properties of the pipe and the fitting and shall not cause the test assembly to fail to conform to Table 11.

Materials for sealing rings shall conform to all the requirements in EN 681-1 or EN 681-2, as applicable.

12 Marking

12.1 General

The marking of an EN standard reference on a component requires conformance with all mandatory requirements of the standard, and that the component comes within the scope of standard.

Marking elements shall be printed or formed directly on the component or be on a label, in such a way that after storage, weathering, handling and installation, the required legibility is maintained.

Two levels of legibility of the marking on components are specified for the individual marking aspects given in Tables 12 and 13. The required durability of marking is coded with decreasing stringency as follows:

— A: durable in use;

— B: legible until the system is installed.

NOTE The manufacturer is not responsible for marking being illegible due to actions caused during installation and use such as painting, scratching, covering of the components or by use of detergents etc. on the components unless agreed or specified by the manufacturer.

Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe or the fitting.

Marking by indentation reducing the wall thickness not more than 0,25 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness given in 7.2.6.

The size of the marking shall be such that the marking is legible without magnification.

12.2 Minimum required marking of pipes

Pipes shall be marked at intervals of maximum 2 m, at least once per pipe.

The minimum required marking of pipes shall conform to Table 12.

Table 12 — Minimum required marking of pipes

Aspects	Marking or symbols	Legibility code
Number of the standard	EN 14758-1	A
Application area code	U or UD, as applicable	A
Manufacturer's name and/or trademark	XXX	A
Nominal size (DN/OD)	e.g. 200	A
Minimum wall thickness	(Value in mm as determined in accordance with 7.2.6)	A
If applicable, the symbol for close tolerance,	CT (pipe and/or socket)	A
Ring stiffness class	e.g. SN 8	A
Material	PP-MD	A
Manufacturer's information	[a]	A
Cold climate performance [b]	❆ (One ice-crystal, when tested at −10 °C)	A

[a] For providing traceability the following details shall be given:
— the production period, year and month, in figures or in code;
— a name or code for the production site if the manufacturer is producing in different sites, nationally and/or internationally.

[b] This marking is only applicable to pipes which by testing have proved to conform to 8.1.3.

12.3 Minimum required marking of fittings

The minimum required marking of fittings shall conform to Table 13.

Table 13 — Minimum required marking of fittings

Aspects	Marking or symbols	Legibility code
Number of the standard	EN 14758-1	B
Application area code	U or UD, as applicable	A
Manufacturer's name and/or trademark	XXX	A
Nominal size /DN/OD)	e.g. 200	A
If applicable, the symbol for close tolerance,	CT (spigot and/or socket)	B
Nominal angle, when applicable	e.g. 45°	B
Ring stiffness class	e.g. SN 8	A
Minimum wall thickness of body	(Value in mm as determined in accordance with 7.4.3)	A
Material	PP-MD	A
Manufacturer's information	[a]	B

[a] For providing traceability the following details shall be given:
— production period, year and month, in figures or in code;
— name or code for the production site if the manufacturer is producing in different sites, nationally and/or internationally.

12.4 Additional marking

Pipes and fittings conforming to this document, which also conform to other standards, may be additionally marked with the required marking of those standards.

Annex A
(normative)

Utilization of reworked material and recyclate

A.1 Reworked material

The use of clean reworked material of components conforming to this document for the production of pipes and fittings is permitted without limitations.

A.2 Pre-consumer materials

Pre-consumer materials with an agreed specification may be used alone or added to virgin or reworked material or post-consumer material from pipes and fittings with an agreed specification or a mixture of those three materials for production of pipes and fittings, if all of the conditions specified in 5.1, 5.2, 5.4, 5.5, 5.6 and Table A.1 and A.5 are met.

Table A.1 — Characteristics of pre-consumer materials and of post-consumer materials from pipes and fittings that shall be included in the agreed specification

Characteristics	Requirements	Test method
Density	To be agreed between the manufacturer and supplier	EN ISO 1183-1 or EN ISO 1183-2
Thermal stability OIT	To be agreed between the manufacturer and supplier	EN ISO 11357-6 Temperature: 200 °C
MFR	To be agreed between the manufacturer and supplier	EN ISO 1133-1
Ash residue	To be agreed between the manufacturer and supplier	EN ISO 3451-1
Extraneous polymers	≤ 5 %	IR analyses or DSC
Impurities (solid contaminants content)	The test method e.g. mesh/melt filtering should be stated in the agreed specification	CEN/TS 17627
Type of mineral modifier, if applicable	PP recyclate shall not contain uncoated calcium carbonate ($CaCO_3$)	
Volatile matters	≤ 300 mg/kg	EN 12099
Source of material	Pre-consumer or Post-consumer from pipes and fittings To be specified by the recyclate supplier	

Slow crack growth resistance testing, according to Annex D, is based on CEN/TS 14541-2 [8]. This is still a voluntary test to gain experience and is intended to be included in Table A.1 as a normative test in the future.

A.3 Post-consumer materials from pipes and fittings

Post-consumer material from pipes and fittings with an agreed specification may be used alone or added to virgin or reworked material or pre-consumer materials with agreed specification or a mixture of those three materials for production of pipes and fittings, if all of the conditions specified in 5.1, 5.2, 5.4, 5.5, 5.6 and Table A.1 and A.5 are met.

A.4 Post-consumer materials from other products than pipes and fittings

Post-consumer PP material from other products than pipes and fittings shall not be used for the production of pipes and fittings conforming to this document.

A.5 Additional specifications for the agreed specification

Each delivery shall be covered by a declaration to demonstrate conformity with the agreed specification. This declaration can be made by either the material supplier or the product manufacturer as agreed between the parties.

The quality plan of the supplier of pre-consumer and/or post-consumer material should conform to EN ISO 9001 [9].

When drafting an agreed specification, the following should be considered:

— the recycling process and sources of the material because of risk of impurities;

— the processing of the material into the end product;

— the required characteristics of the end product;

— possible limitations of sources for the recyclable material;

— the intended dosage level of the material.

NOTE Guidance on sampling procedures, sample preparation and testing can be found in CEN/TS 16010 [10] and CEN/TS 16011 [11].

Annex B
(informative)

General characteristics of PP-MD pipes and fittings

B.1 General

EN 476 [12] specifies the general requirements for components used in discharge pipes, drains and sewers for gravity systems. Pipes and fittings conforming to this document fully meet these requirements.

Further the following information is given.

B.2 Material characteristics

The material of pipes and fittings conforming to this document has generally these characteristics:

Modulus of elasticity: (Increasing value with increasing amount of minerals)	$E_{(1\ min)}$: 1 600 MPa to 3 600 MPa
Average density: (Increasing value with increasing amount of minerals)	1,0 g/cm^3 to 1,4 g/cm^3
Average coefficient of linear thermal expansion: (Decreasing value with increasing amount of minerals)	0,07 mm/mK to 0,12 mm/mK
Thermal conductivity: (Increasing value with increasing amount of minerals)	0,2 WK^{-1} m^{-1} to 0,6 WK^{-1} m^{-1}
Specific heat capacity: (Decreasing value with increasing amount of minerals)	1 300 J/kgK to 1 800 J/kgK
Surface resistance:	> 10^{11} Ω
Creep ratio:	≤ 4 at 2 years extrapolation when tested according to EN ISO 9967 [13]

Values are dependent on the material used. Therefore, it is recommended to contact the manufacturer, or see the manufacturer's documentation, for the relevant values in each individual case.

B.3 Ring stiffness

The ring stiffness of pipes conforming to this document is determined in accordance with EN ISO 9969 and is either SN 4, SN 8 or SN 16.

When a fitting conforming to this document has the same wall thickness as the corresponding pipe, the stiffness of this fitting because of its geometry, is equal to or greater than the stiffness of that pipe. Consequently, fittings are classified with the corresponding pipe stiffness.

The actual value of stiffness of the fittings can be determined in accordance with EN ISO 13967.

B.4 Chemical resistance

PP-MD piping systems conforming to this document is resistant to corrosion by water with a wide range of pH-values such as domestic wastewater, rainwater, surface water and ground water.

If piping systems conforming to this document are intended to be used for chemically contaminated waste waters, such as industrial discharges, chemical and temperature resistance have to be taken into account. For information about the chemical resistance of PP-MD materials guidance is given in ISO/TR 10358 [14] and for rubber materials in ISO/TR 7620 [15].

B.5 Abrasion resistance

Pipes and fittings conforming to this document is resistant to abrasion. For special circumstances, the abrasion can be determined from the test method given in EN 295-3 [16].

B.6 Hydraulic roughness

The design of joints and fittings ensure good hydraulic performances. For further information about hydraulic capacity of pipes and fittings conforming to this document refer to the manufacturer's information. Information regarding hydraulic roughness can be found in CEN/TS 15223 [17].

B.7 Diametric deflection

In normal installation conditions, the expected average deflection of the outside diameter of the pipes will be less than 8 %. Further information regarding diametric deflection can be found in CEN/TS 15223 [17].

Annex C
(informative)

Product standards of components that can be connected to components conforming to this document

EN 1329-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Unplasticized poly(vinyl chloride) (PVC-U) - Part 1: Specifications for pipes, fittings and the system*

EN 1401-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U) - Part 1: Specifications for pipes, fittings and the system*

EN 1451-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system*

EN 1455-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Acrylonitrile-butadiene-styrene (ABS) - Part 1: Specifications for pipes, fittings and the system*

EN 1519-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Polyethylene (PE) - Part 1: Requirements for pipes, fittings and the system*

EN 1565-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Styrene copolymer blends (SAN+PVC) - Part 1: Specifications for pipes, fittings and the system*

EN 1566-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Chlorinated poly(vinyl chloride) (PVC-C) - Part 1: Specifications for pipes, fittings and the system*

EN 1852-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system*

EN 12666-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Polyethylene (PE) - Part 1: Specifications for pipes, fittings and the system*

EN 13476-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 1:General requirements and performance characteristics*

EN 13476-2, *Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 2: Specifications for pipes and fittings with smooth internal and external surface and the system, Type A*

EN 13476-3, *Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 3: Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B*

Annex D
(informative)

Testing PP recyclates with the CRB-method

D.1 General

The cracked round bar test (CRB) was developed to characterize the slow crack growth resistance of different PE pressure grades. In parallel to this research the CRB method was standardized and as a result ISO 18489 [18] was published.

Within further studies the principle of applicability of CRB test to other thermoplastic materials as well as to thermoplastic recyclates has been successfully proven [19] [20] [21]. Further investigation is in progress.

Based on experience gained so far it seems realistic to extend the scope of ISO 18489 [18] to other thermoplastic materials like PP and PVC by specifying the right test parameters.

However, to enable the application of CRB test to PE, PP and PVC recyclates before ISO 18489 [18] is revised the specific test parameters and procedure are described in D.3.

D.2 Principle

To characterize the slow crack growth resistance of a PP recyclate, a CRB failure curve should be determined according to ISO 18489 [18].

This failure curve should be included as reference failure curve in the agreed specification for a PP recyclate.

For quality assurance or batch control of PP recyclates, 2 (short-term) CRB verification tests should be executed. Both verification results should exceed the values of the failure curve.

D.3 Procedure

D.3.1 Sample preparation

In general, specimens for CRB testing can be manufactured from compression moulded sheets as well as from extruded or injection moulded finished products such as pipes or fittings. The sample source should have a minimum solid wall thickness of 14 mm. The machining into CRB specimens should follow ISO 2181 [22] and ISO 18489 [18].

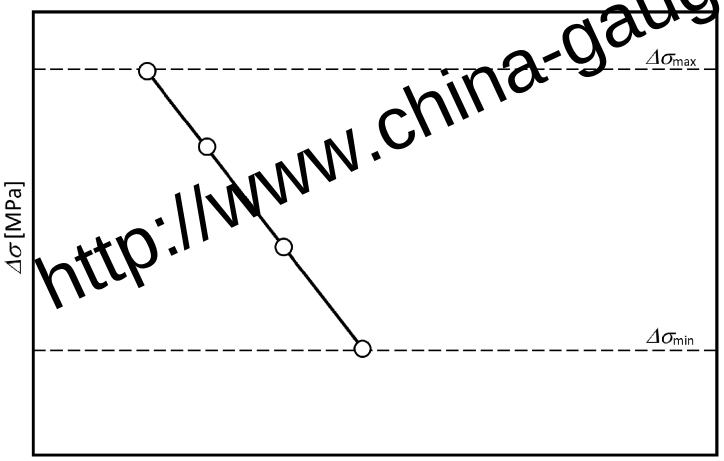
The material source and sample preparation may influence the test results due to different processing history. For a comparison of CRB test results for material ranking, quality assurance or batch control, it is essential that specimens are always prepared by the same procedure (either compression moulding, extrusion or injection moulding), using the same processing conditions.

Sample preparation from compression moulded sheets is recommended as this processing techniques creates the lowest amount of processing related residual stresses inside the specimens. General guidelines for compression moulding of thermoplastic materials are provided in ISO 293 [23].

Specific conditions for compression moulding of PP are given in ISO 19069-2 [24] (3.4).

D.3.2 CRB failure curve

To characterize the slow crack growth resistance of a PP recyclate, a CRB failure curve should be determined according to ISO 18489 [18]. This failure curve should be based on at least four single CRB tests at different testing loads Δσ (Figure D.1).



Key

○ CRB data point reference failure curve

Figure D.1 — Schematically determination of the reference failure curve with the CRB test method

D.3.3 PP test parameters

Test frequency f = 5 Hz.

Testing loads Δσ within the range of Δσ min = 13 MPa to Δσ max = 16 MPa.

Test temperature (23 ± 2) °C.

Waveform sinusoid.

The failure mode: brittle crack growth.

NOTE Ductile behaviour using high stress levels will give misleading results.

D.3.4 Verification procedure

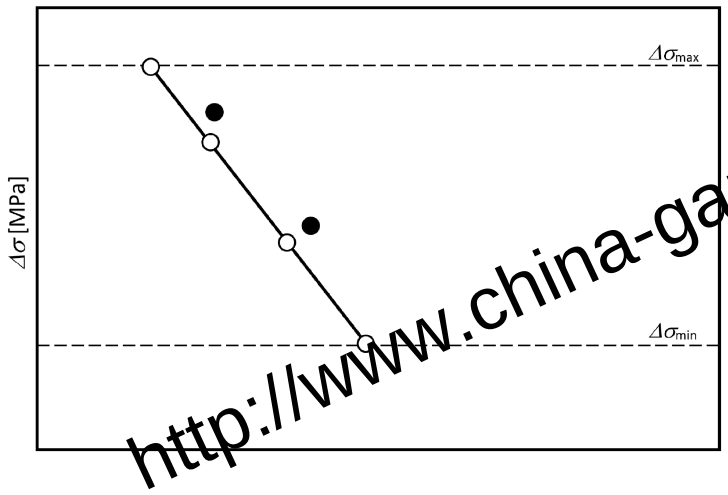
For quality assurance or iterative batch control of a PP recyclate, within the respective testing load range two CRB tests at different Δσ in the upper and in the lower range, respectively, should be conducted.

The pass criteria are as follows:

— The failure cycle numbers N_f in both (batch) control tests exceed the respective values of the reference failure curve (Figure D.2). The individual tests need not to be continued until fracture and may be stopped before failure.

The fail criteria are as follows:

— The failure cycle numbers N_f in one or both (batch) control tests does not reach the respective values of the reference failure curve (Figure D.3 and Figure D.4).

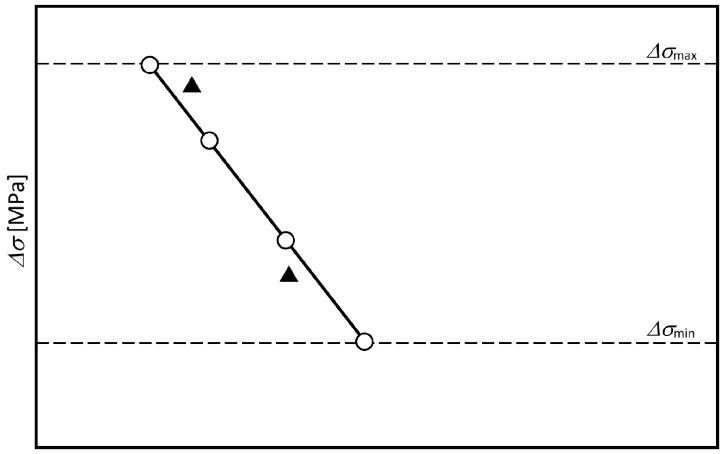


Key

○ CRB data point reference failure curve

● CRB data point batch control, passed

Figure D.2 — Schematically illustration of the pass criteria with the CRB test method

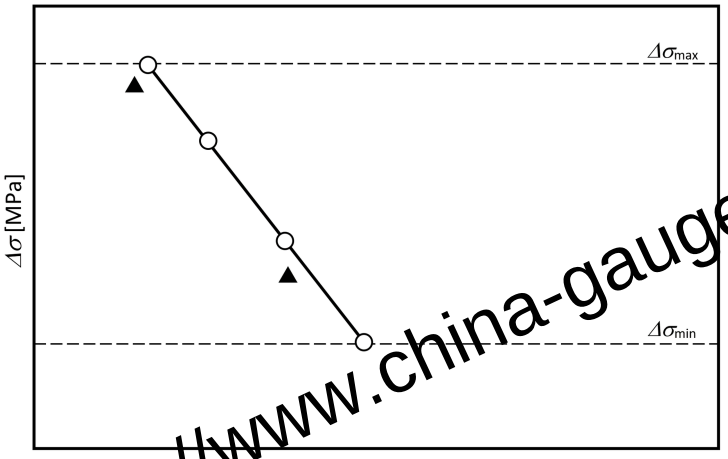


Key

○ CRB data point reference failure curve

▲ CRB data point batch control, failed

Figure D.3 — Schematically illustration of a failure criteria with the CRB test method



Key

○ CRB data point reference failure curve

▲ CRB data point batch control, failed

Figure D.4 — Schematically illustration of a failure criteria with the CRB test method

Bibliography

[1] EN 1451-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system*

[2] RAL 840-HR, Colour register

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

[4] EN 1401-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U) - Part 1: Specifications for pipes, fittings and the system*

[5] ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

[6] ISO 265-1, *Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes — Basic dimensions: Metric series — Part 1: Unplasticized poly(vinyl chloride) (PVC-U)*

[7] EN 1852-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system*

[8] CEN/TS 14541-2, *Plastics pipes and fittings - Utilisation of thermoplastics recyclates - Part 2: Recommendations for relevant characteristics*

[9] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[10] CEN/TS 16010, *Plastics - Recycled plastics - Sampling procedures for testing plastics waste and recyclates*

[11] CEN/TS 16011, *Plastics - Recycled plastics - Sample preparation*

[12] EN 476, *General requirements for components used in drains and sewers*

[13] EN ISO 9967, *Thermoplastics pipes - Determination of creep ratio (ISO 9967)*

[14] ISO/TR 10358, *Plastics pipes and fittings for industrial applications — Collection of data on combined chemical-resistance*

[15] ISO/TR 7620, *Rubber materials — Chemical resistance*

[16] EN 295-3, *Vitrified clay pipe systems for drains and sewers - Part 3: Test methods*

[17] CEN/TS 15223, *Plastics piping systems - Validated design parameters of buried thermoplastics piping systems*

[18] ISO 18489, *Polyethylene (PE) materials for piping systems — Determination of resistance to slow crack growth under cyclic loading — Cracked round bar test method*

[19] Frank A, Pinter G, *"Cyclic Cracked Round Bar Test: Final Results of International Round Robin Test:2014. doi:10.13140/RG.2.1.1817.6400.*

[20] ARBEITER F., SCHRITTESSER B., FRANK A., BERER M., PINTER G. Cyclic tests on Cracked Round Bars as a quick tool to assess the long term behaviour of thermoplastics and elastomers. *Polym. Test.* 2015, **45** pp. 83–92

[21] FRANK A., BERGER I.J., MESSIHA M., EK C.-G., SCHULER N., STORHEIL J.-M. et al. "Slow Crack Growth Resistance of Non-Virgin Polymers", in proc: Plastic Pipes XIX Conference, Las Vegas, NV, USA:2018

[22] ISO 2818, *Plastics — Preparation of test specimens by machining*

[23] ISO 293, *Plastics — Compression moulding of test specimens of thermoplastic materials*

[24] ISO 19069-2, *Plastics — Polypropylene (PP) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

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