

**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**

The European Standard EN 13476-1:2007 has the status of a
British Standard

ICS 23.040.20; 93.030

National foreword

This British Standard is the UK implementation of EN 13476-1:2007. It does not supersede any current British Standards. However, the Water Industry has indicated that following the publication of this British Standard, Industry Specification WIS 4-35-01 will be declared obsolescent by May 2009 and retained for reference where applicable.

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

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Sewerage undertakers and other entities deemed to be within the scope of the Public Procurement Directive (PPD) are obliged to use Parts 1 to 3 of this series of European Standards, produced under EC/U mandate, if they are to comply with structured wall pipe systems or components within its scope. National Annex NA (informative) gives additional guidance on the use of Parts 1 to 3 of BS EN 13476:2007.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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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

Systèmes de canalisations en plastique pour les branchements et les collecteurs d'assainissements sans pression enterrés - Systèmes de canalisation à parois structurées en poly(chlorure de vinyle) non plastifié (PVC-U), polypropylène (PP) et polyéthylène (PE) - Partie 1: Exigences générales et caractéristiques de performance

Kunststoff-Rohrleitungssysteme für erdverlegte drucklose Abwasserkanäle und -leitungen - Rohrleitungssysteme mit profilierter Wandung aus weichmacherfreiem Polyvinylchlorid (PVC-U), Polypropylen (PP) und Polyethylen (PE) - Teil 1: Allgemeine Anforderungen und Leistungsmerkmale

This European Standard was approved by CEN on 5 March 2007.

CEN members are bound to comply with the CEN/GENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This document (EN 13476-1:2007) 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 November 2007, and conflicting national standards shall be withdrawn at the latest by November 2007.

This standard is a part of a System Standard for plastics piping systems of particular materials for specified applications. There are a number of such System Standards.

System Standards are based on the results of the work being 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.

EN 13476 consists of the following Parts under the general title 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 (this standard);*
- *Part 2: Specifications for pipes and fittings with smooth internal and external surface and the system, Type A;*
- *Part 3: Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B;*
- *Part 4: Assessment of conformity (CEN/TS);*
- *Part 5: Guidance for installation (CEN/TS).¹*

For pipes and fittings which have conformed to the relevant national standard before May 2007, as shown by the manufacturer or by a certification body, the national standard may continue to be applied until May 2009.

National standards specifically for pipes and fittings for the transport of surface water are not considered to be conflicting with this standard and may thus be allowed to coexist.

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

¹ The feasibility of this project is under study.

Introduction

Due to the variety in materials, pipe constructions, application areas and classes, several combinations are possible.

The purchaser or specifier may select between these possibilities by designating the pipe and fitting he or she prefers to use for each case, as described in Annex C, Designation of pipes and corresponding fittings, taking into account any particular requirements and relevant national regulations and installation practices or codes.

1 Scope

This European Standard, together with EN 13476-2 and EN 13476-3, specifies the definitions and general requirements for pipes, fittings and the system based on unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) structured-wall piping systems that are to be used for non-pressure underground drainage and sewerage systems.

This standard is applicable to:

- a) structured-wall pipes and fittings, which are to be used buried in the ground outside a building structure only; reflected by the marking of products by "U";
- b) structured-wall pipes and fittings, which are to be used buried in ground both outside (application area code "U") and within a building structure (application area code "D"); reflected in the marking of products by "UD".

In conjunction with EN 13476-2 and EN 13476-3 it is applicable to structured-wall pipes and fittings with or without an integral socket with elastomeric ring seal joints, as well as welded and fused joints.

This part specifies general aspects and gives guidance concerning a national selection of requirement levels and classes where part 2 and part 3 of this standard provide options.

EN 13476-2 and EN 13476-3 specify material characteristics, dimensions and tolerances, test methods, test parameters and requirements for pipes with smooth internal and external surfaces, Type A, and pipes with smooth internal and profiled external surfaces, Type B.

This standard, together with EN 13476-2 and EN 13476-3, covers a range of pipe and fitting sizes, materials, pipe constructions, stiffness classes and tolerance classes and offers recommendations concerning colours.

NOTE 1 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

NOTE 2 Pipes, fittings and other components conforming to any plastic product standards referred to in clause 2 can be used with pipes and fittings conforming to this standard, when they conform to the requirements for joint dimensions given in part 2 and part 3 of this standard and to the performance requirements given in Clause 9.

NOTE 3 For dimensions larger than DN 1200 OD/ID this document may serve as general guideline regarding appearance, colour, physical and mechanical characteristics as well as performance requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 — Materials requirements for pipe joint seals used in water and drainage applications — Part 2: Thermoplastic elastomers*

EN 681-4, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 4: Cast polyurethane sealing elements*

EN 13476-2:2007, *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 13476-3:2007, *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*

EN ISO 472:2001, *Plastics — Vocabulary (ISO 472:1999)*

EN ISO 1043-1:2001, *Plastics - Symbols and abbreviated terms - Part 1: Basic polymers and their special characteristics (ISO 1043-1:2001)*

EN ISO 9969, *Thermoplastics pipes — Determination of ring stiffness (ISO 9969:1994)*

ISO 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 13967, *Thermoplastics fittings — Determination of ring stiffness*

3 Terms and definitions, symbols and abbreviations

For the purposes of this standard, the terms and definitions given in EN ISO 472:2001, EN ISO 1043-1:2001, ISO 11922-1:1997 and the following apply.

3.1 Definitions

3.1.1 General definitions

3.1.1.1

application area code

code used to mark pipes and fittings to indicate the permitted application area(s) 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 fittings are buried underground and are connected to the soil and waste discharge system of the building

NOTE In the “D” application area, the existence of hot water discharge in addition to external forces from the surroundings is usual.

3.1.1.2

structured-wall pipes and fittings

products which have an optimised design with regard to material usage to achieve the physical, mechanical and performance requirements of this standard

NOTE For a description of the particular designs covered by this standard, see clause 5 in EN 13476-2:2007 and EN 13476-3:2007.

3.1.1.3

fabricated fitting

fitting manufactured by heat forming and/or joining more than one piece of pipe and/or moulded component

NOTE Sealed ring retaining components are not considered as a piece.

3.1.2 Geometrical definitions

3.1.2.1

nominal size, DN

numerical designation of the size of a component, other than a component designated by thread size, which is approximately equal to the manufacturing dimension in mm

3.1.2.2

nominal size, DN/OD

nominal size, related to the outside diameter

3.1.2.3

nominal size, DN/ID

nominal size, related to the inside diameter

3.1.2.4

nominal diameter

d_n

specified diameter, in mm, assigned to a nominal size (DN/OD or DN/ID)

3.1.2.5

outside diameter

d_e

value of the measurement of the outside diameter through its cross-section at any point of a pipe or spigot, rounded to the next greatest 0,1 mm

NOTE For Type B constructions, see EN 13476-3.

3.1.2.6

mean outside diameter

d_{em}

value of the measurement of the outer circumference of a pipe or spigot in any cross-section divided by π ($\pi = 3,142$), rounded to the next greatest 0,1 mm

NOTE For Type B constructions, see EN 13476-3.

3.1.2.7

mean inside diameter

d_{im}

average value of a number of equally spaced measurements of inside diameter in the same cross-section of a pipe or fitting

3.1.2.8

wall thickness

e

measured wall thickness at any point of the body of a component

3.1.2.9

construction height

e_c

radial distance between the top of ribs or corrugation or, in case of Type A1 and Type A2 pipes and fittings, the external surface of the wall and the internal surface of the wall

3.1.2.10

ring flexibility

ability of a pipe to resist diametric deflection without the loss of structural integrity

3.1.2.11**ring stiffness**

mechanical characteristic of a pipe, which is a measure of the resistance to ring deflection under an external force as determined in accordance with EN ISO 9969

3.1.2.12**fitting stiffness**

mechanical characteristic of a fitting which is a measure of the resistance to ring deflection under an external force as determined in accordance with ISO 13967

3.1.2.13**ring stiffness class, SN**

numerical designation of the ring stiffness of the pipe or fitting which is a convenient round number, indicating the minimum required ring stiffness of the pipe or stiffness of the fitting

3.2 Symbols and abbreviations

$d_{n,1}$ nominal diameter of the main of a branch/saddle branch

$d_{n,2}$ nominal diameter of the branch of a branch/saddle branch

L axial cover by a saddle branch

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 fitting

DN nominal size

DN/ID nominal size related to inside diameter

DN/OD nominal size related to outside diameter

PE polyethylene

PP polypropylene

PP-MD Mineral modified PP

PVC-U unplasticized poly(vinyl chloride)

RF ring flexibility performance

S pipe series S

SDR standard dimension ratio

SN ring stiffness class

4 Material

4.1 General

The material shall be one of the materials specified in the relevant annexes of EN 13476-2 or EN 13476-3, as applicable.

NOTE Information about general material characteristics is given in Annex A.

4.2 Utilisation of non-virgin material

The specifications for the material and levels of permitted addition are specified in EN 13476-2 or EN 13476-3.

4.3 Sealing ring retaining components

It is permitted that sealing rings are retained using components made from polymers other than PVC U, PP or PE.

4.4 Sealing rings

The sealing ring material shall conform to EN 681-1, EN 681-2 or EN 681-4, as applicable.

The sealing ring shall have no detrimental effects on the component properties.

4.5 Fused or welded joints

When fused or welded joints are used, the component manufacturer's instructions for jointing shall be followed.

5 Designation of wall construction

Pipes and fittings with smooth internal and external surfaces are designated as Type A.

Pipes and fittings with smooth internal and profiled external surfaces are designated as Type B.

Definitions of wall constructions including schematic sketches and examples of typical jointing methods are given in EN 13476-2 for Type A pipes and in EN 13476-3 for Type B pipes.

6 Appearance and colour

6.1 Appearance

When viewed without magnification the following requirements apply:

- a) visible surfaces of pipes and fittings shall be smooth, clean and free from grooving, blistering, visible impurities or pores and any other surface irregularity likely to prevent conformity to this standard;
- b) pipe and fittings ends shall be cleanly cut square to the axis of the pipe, and within any cutting zone recommended by the manufacturer, or according to the profile geometry as specified by the manufacturer;
- c) edges on spirally formed pipes and fittings which become sharp when cut, shall be rounded off.

6.2 Colour

The inner and outer layer of pipes and fittings shall be coloured throughout. The external layer of pipes and fittings should preferably be black, orange-brown (approximately RAL 8023 ^[1]) or dusty grey (approximately RAL 7037 ^[1]). Other colours may be used.

7 Geometrical characteristics

This standard specifies nominal sizes for DN/ID given in Table 1 and for DN/OD given in Table 2

Table 1 - Nominal sizes DN/ID

Nominal sizes: DN/ID (in mm)
100, 125, 150, 200, 225, 250, 300, 400, 500, 600, 800, 1 000, 1 200

Table 2 - Nominal sizes DN/OD

Nominal sizes: DN/OD (in mm)
110, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1 000, 1 200

Other sizes are permitted when following the conditions given in EN 13476-2 or EN 13476-3.

8 Types of fittings

8.1 General

This standard is applicable for the following types of fittings.

Figures 1 to 7 give examples for typical designs. Other designs of fittings including all socket and all spigot, are permitted.

a) Bends un-swept and swept angle (see Figure 1 and Figure 2).

NOTE 1 Preferred nominal angles, α , are the following: 15°, 22,5°, 30°, 45° and between 87,5° and 90°.

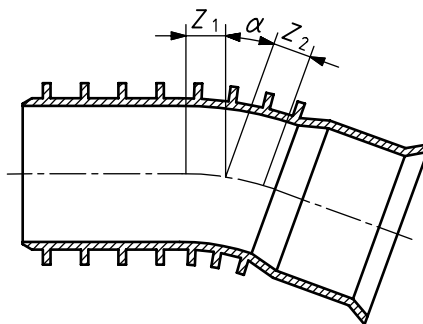


Figure 1 — Example of an un-swept bend

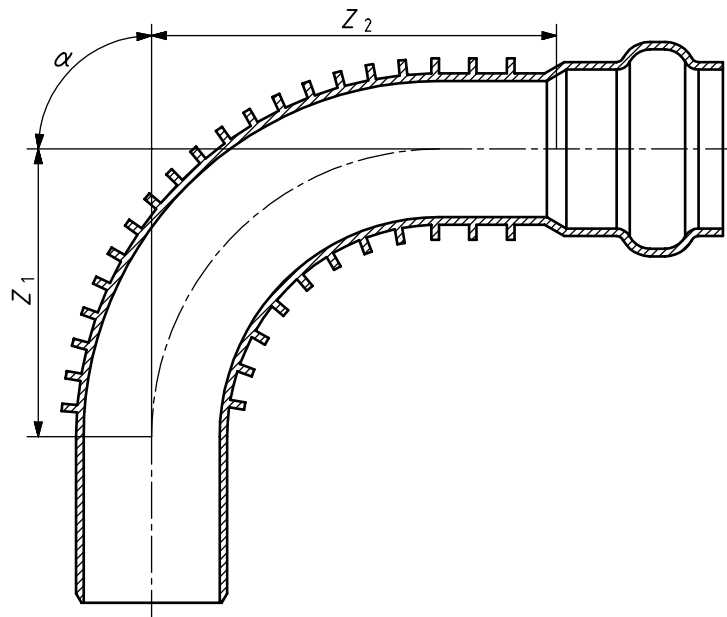


Figure 2 — Example of a swept bend

b) Couplers and slip couplers (see Figure 3).

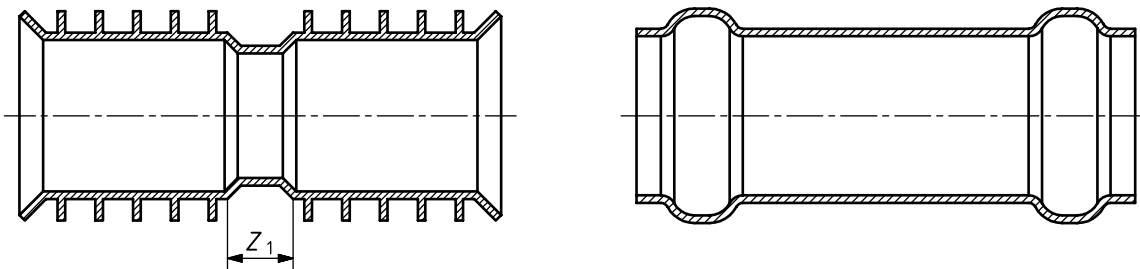


Figure 3 — Example of coupler and slip coupler

c) Reducers (see Figure 4).

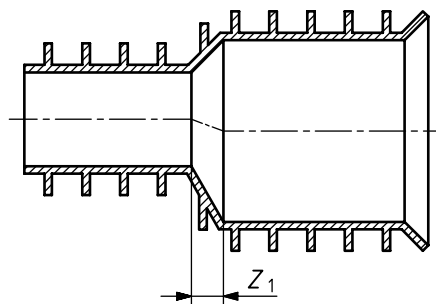


Figure 4 — Example of reducer

d) Branches and reducing branches un-swept and swept entry (see Figure 5).

NOTE 2 Preferred nominal angles, α , are 45° and between $87,5^\circ$ and 90° .

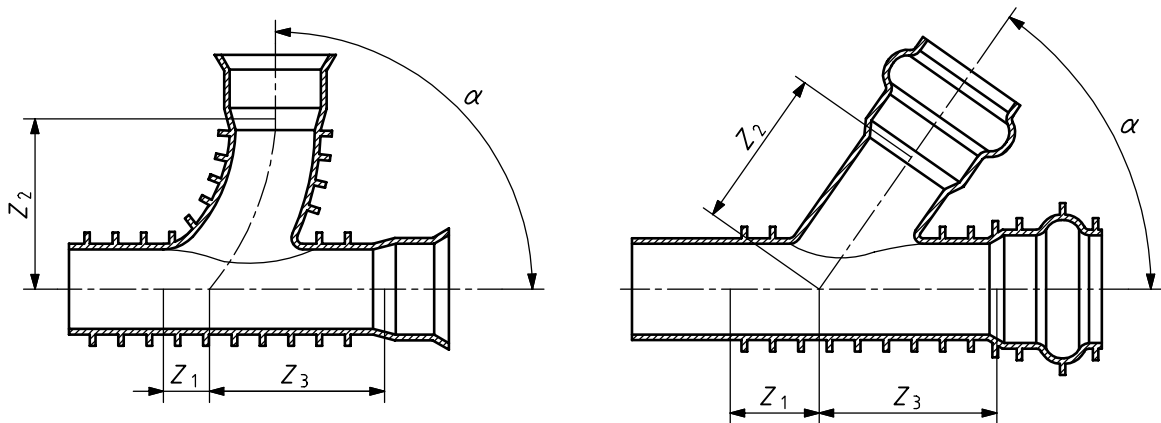


Figure 5 — Example of a swept entry and a straight branch

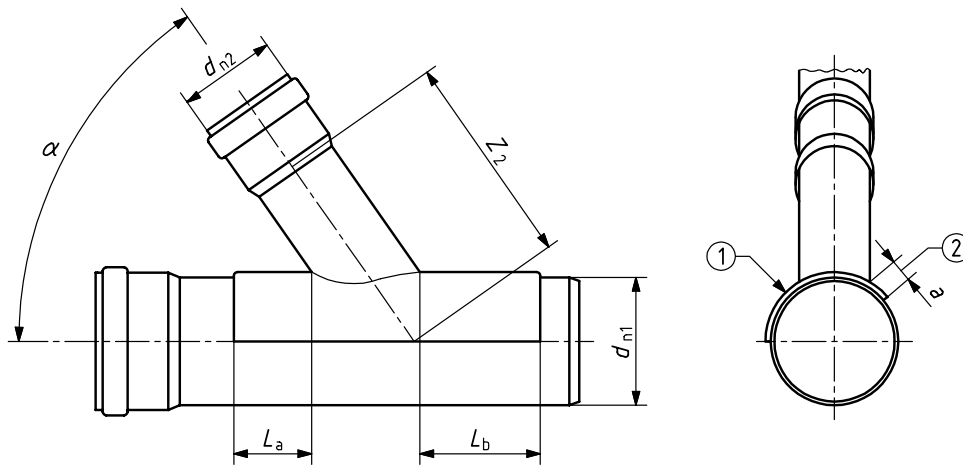
- e) Saddle branches for solvent cementing, fusion or welding (see Figure 6):
- axial cover, L , in mm, shall conform to the following:

Table 3 - Axial cover of saddle branches

Dimensions in millimetres				
	$d_{n2} \leq 110$	$110 < d_{n2} \leq 125$	$125 < d_{n2} \leq 160$	$160 < d_{n2} \leq 200$
L	≥ 50	≥ 60	≥ 70	≥ 80

- saddles having $d_{n1} < 315$ mm, the cover shall be not less than half a circumference, see Figure 6 key 1;
- saddles having $d_{n1} \geq 315$ mm, the circumferential cover, a , shall not be less than 80 mm, see Figure 6 key 2.

NOTE 3 The preferred nominal angle, α , for saddle branches is 45°. When $(d_{n2}/d_{n1}) \leq 2/3$; the nominal angle, α , can be 90°.



Key

- 1 $d_{n1} < 315$
- 2 $d_{n1} \geq 315$

Figure 6 — Example of a solvent cementing, fusion or welding saddle

f) Plugs (see Figure 7).

- insert length, L_1 , shall be sufficient to ensure engagement of the sealing ring of at least 10 mm:
 - a) when measured from the effective sealing point to the end of the cylindrical part of the spigot when the sealing ring is positioned in the socket, or
 - b) when measured from the effective sealing point to the mouth of the cylindrical part of the socket when the sealing ring is positioned on the spigot.

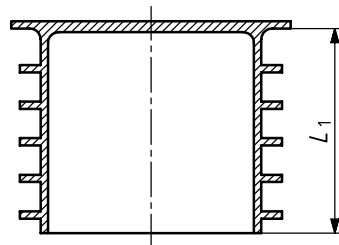


Figure 7 — Example of a plug

8.2 Design length of fittings

The design length(s) (Z -lengths) of the fittings (see Figure 1 to Figure 6) shall be declared by the manufacturer.

NOTE The design lengths (Z -lengths) are intended to assist with the design of moulds and are not intended to be used for quality control purposes, ISO 265-1^[2] can be used as a guideline.

9 System performance related test methods and characteristics

The performance of the installed piping system depends on the quality of the system components and installation conditions and workmanship.

The performance requirements of the system components and their relation to the tested characteristics specified in EN 13476-2 or EN 13476-3, as applicable, are explained in Table 4.

Annex B gives guidelines for structural design.

Table 4 — Relationship between system performance and tested characteristics

System Performance	Tested characteristic		Reference		Test Method
			EN 13476-2	EN 13476-3	
Handling, transport, storing and installation robustness	Pipes	Impact strength Tensile strength of seam	Table 15	Table 14	EN 744 [3] or EN 1411 [4] EN 1979 [5]
	Fittings	Impact strength	Table 17	Table 16	EN 12061 [6]
Resistance to soil load including traffic load, both during and after installation	Pipes	Ring stiffness Ring flexibility Tensile strength of seam Creep ratio	Table 15	Table 14	EN ISO 9969 (6.3 of EN 476:1997 [7]) EN 1446 [8] EN 1979 [5] EN ISO 9967 [9] (6.3 of EN 476:1997 [7])
	Fittings	Ring stiffness Mechanical strength or flexibility of fabricated fitting	Table 17	Table 16	ISO 13967 /same stiffness class as pipe if same wall construction as pipe EN 12256 [10]
Ability to hold fluid inside and outside the system (leak tightness)	System	Dimensions and tolerances	7	7	EN ISO 3126 [11]
		Tightness	Table 18	Table 17	EN 1277 [12] (6.5 of EN 476:1997 [7])
		Long-term performance of TPE seals	Table 18	Table 17	EN 14741 [13]
		Water tightness – fabricated fittings	Table 18	Table 17	EN 1053 [14] 6.5 of EN 476:1997 [7] EN 1979 [5]
Resistance to high temperature	System	Elevated temperature cycling - for sizes up to 160 mm (ID)/200m (OD)	Table 18	Table 17	EN 1055:1996 [15], assembly B, Figure 2 (8.2 of EN 476:1997 [7])
		Box loading			Method A or B of EN 1437 [16]
Cleaning and maintenance	System	Rodding Flushing – High volume low pressure High pressure cleaning			See ^a
Durability, processing	Pipes	Resistance to dichloromethane Resistance to heating – oven test – Type B Longitudinal reversion – Type A	Table 9 na Table 9, 11, 13	Table 8 Table 8, 10, 12 na	EN 580 [17] (PVC only) ISO 12091 [18] EN ISO 2505 [19]
	Fittings	Resistance to heating – oven test	Table 10, 12, 14	Table 9, 11, 13	EN ISO 580 [39]
Durability, material	Material	Resistance to internal pressure	Table 1, 2, 3, 4	Table 1, 2, 3, 4	EN ISO 1167-1 [20] and EN ISO 1167-2 [21]
		Chemical resistance Thermal stability, raw material	Table 2, 3, 4	Table 2, 3, 4	ISO/TR 10358 [22] EN 728 [23] (PE and PP only)

^a Test methods for cleaning and maintenance are not included in this standard. Experience has shown that the wall thickness, impact resistance and material requirements given in EN 13476-2 or EN 13476-3, as applicable, ensure that the systems can resist the normal cleaning procedures. See also Annex D for guidance on practical cleaning

10 Marking, general

10.1 Presentation

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

Three levels of legibility of the marking on components are specified for the individual marking aspects given in EN 13476-2 and EN 13476-3. The required legibility of marking is coded as follows:

- a) durable in use;
- b) legible at least until the system is installed;
- c) marking on the packaging is legible at least until the component is installed.

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

10.2 Marking process

Marking shall be carried out so it does not initiate cracks or other types of defects which are likely to prevent conformity to this standard.

10.3 Size

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

Annex A (informative)

Characteristics of PVC-U, PP and PE pipes and fittings

A.1 General

EN 476 [7] specifies general requirements for components used in discharge pipes, drains and sewers for gravity systems. Pipes and fittings conforming to this standard meet these requirements.

A.2 Material characteristics

The materials of pipes and fittings conforming to this standard have the characteristics given in Table A.1.

Table A.1

Characteristic	PVC-U	PP	PE	Unit
Modulus of elasticity, E (1min)	$\geq 3\ 200$	$\geq 1\ 250$	≥ 800	MPa
Average density	≈ 1400	≈ 900	≈ 940	kg/m ³
Average coefficient of linear thermal expansion	$\approx 8 \times 10^{-5}$	$\approx 14 \times 10^{-5}$	$\approx 17 \times 10^{-5}$	K ⁻¹
Thermal conductivity	$\approx 0,16$	$\approx 0,2$	$\approx (0,36 \text{ to } 0,50)$	WK ⁻¹ m ⁻¹
Specific heat capacity	$\approx (850 \text{ to } 2\ 000)$	≈ 2000	$\approx (2\ 300 \text{ to } 2\ 900)$	Jkg ⁻¹ K ⁻¹
Surface resistance	$> 10^{12}$	$> 10^{12}$	$> 10^{13}$	Ω
Poisson ratio	0,4	0,42	0,45	(-)

NOTE 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.

If information regarding the tensile strength and/or elongation of break of a material is needed, they can be determined in accordance with EN ISO 6259-1 [24] combined with EN ISO 6259-2 [25] or EN ISO 6259-3 [26] as applicable.

A.3 Chemical resistance

Piping systems conforming to this standard are 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 standard are to be used for chemically contaminated wastewaters, such as industrial discharges, chemical and temperature resistance have to be taken into account.

For information about the chemical resistance of PVC, PP and PE materials, guidance is given in ISO/TR 10358 [22] and for rubber materials in ISO/TR 7620 [27].

A.4 Abrasion resistance

Pipes and fittings conforming to this standard are resistant to abrasion.

The abrasion can be determined from the test method given in EN 295-3:1991 [28].

A.5 Hydraulic roughness

The internal surfaces of pipes and fittings conforming to this standard are hydraulically smooth. The design of joints and fittings ensure good hydraulic performances. For further information about hydraulic capacity of pipes and fittings conforming to this standard refer to the manufacturer's information.

Annex B (informative)

Structural design

B.1 General

In general creating a structural design of a thermo-plastics pipeline construction by applying analytical or numerical methods is not needed. Any calculated prediction of the pipe behaviour and reality is strongly dependent on the conditions used for the calculation being the same as used for the installation. Therefore, it is important that effort is put into controlling the input values by extensive soil surveys and monitoring the installation. In many cases, practical and/or reference information is available and results in a sound prediction of the pipe performance.

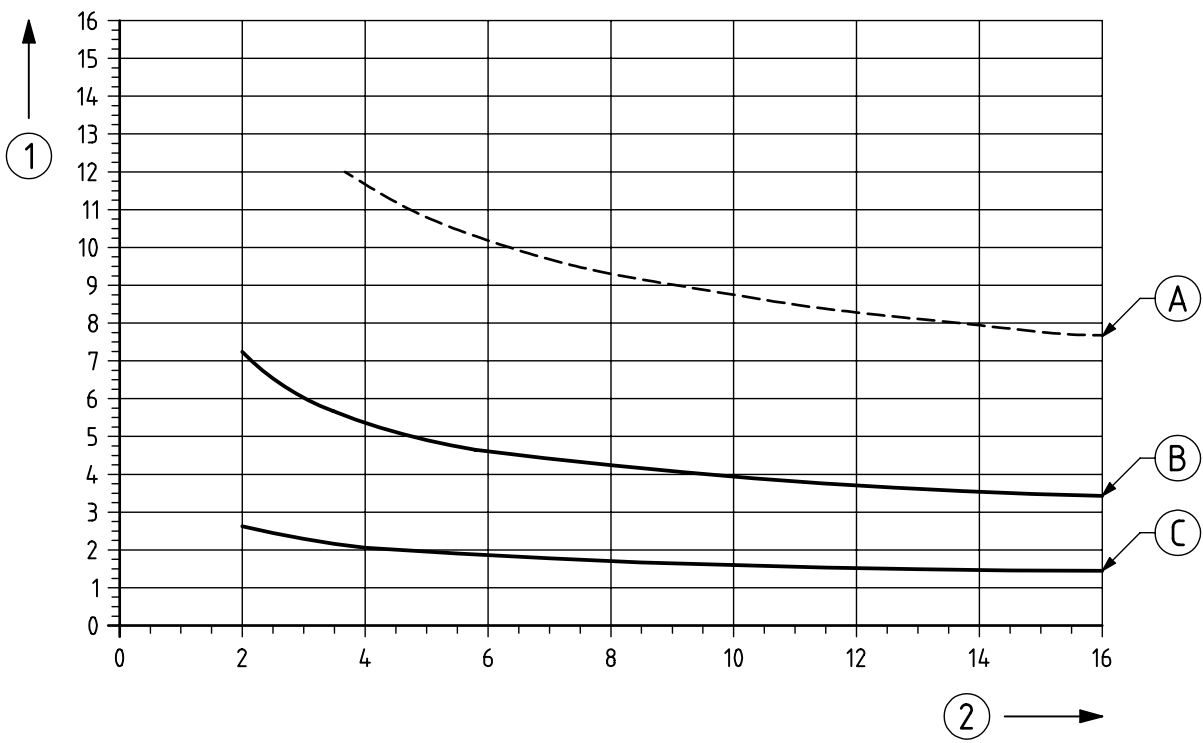
B.2 Structural design based on practical experience

The following method described below fulfils 4.2 of EN 1610:1997 [29].

Designers first need to establish permitted deflections, average and maximum. (National requirements, product standards, this standard etc. offer guidance.)

An intensive study of the deflection history of pipes installed under different conditions up to 25 years ago has resulted in experience as presented in the design graph shown in Figure B.1.

For the deflection mentioned in the design graph, the strain will be far below the design limit.



Key

- | | | | |
|---|------------------------------------|---|-------------------------------------|
| A | “NONE” compaction, not recommended | 1 | Pipe deflection (%) |
| B | “MODERATE” compaction | 2 | Ring stiffness (kN/m ²) |
| C | “WELL” compaction | | |

Figure B.1 — Design graph — Long-term pipe deflection, maximum values

The design graph according to Figure B.1 is valid under the following conditions:

Table B.1 — Validity of the design graph

Pipe system	Fulfilling requirements in EN 1401 1 [30], EN 1852-1 [31], EN 12666-1 [32], EN 13476-2, EN 13476-3 or EN 14758-1 [33] as applicable.
Installation depth	0,8 m – 6,0 m
Traffic loading	Included
Installation quality	<p>“Well” compaction Embedment granular soil is carefully placed in the haunching zone and compacted followed by placing the soil in shift of a maximum of 30 cm after which each layer is compacted carefully. The pipe should be covered at least by a layer of 15 cm. The trench is further filled with soil of any type and compacted. Typical values for the standard proctor density are above 94 %.</p> <p>“Moderate” compaction Embedment granular soil is placed in shifts of a maximum of 50 cm, after which each layer is compacted carefully. The pipe should at least be covered by a layer of 15 cm. The trench is further filled with soil of any type and compacted. Typical values for the standard proctor density are in the range of 87 % to 94 %.</p> <p>Sheet piles should be removed before compaction, in accordance with the recommendations in EN 1610:1997 [29]. If, however, the sheet piles are removed after compaction, one should realise that the “well” or “moderate” compaction level will be reduced to the “none” compaction level.</p>
Installation categories “well”, “moderate” (and “none”) should reflect the workmanship on which the designer can rely.	
Additional	National rules may apply.

B.3 Structural design based on a design calculations

When structural design is required, e.g. in cases where installation conditions are outside the validity of Table B.1 and no other information exists, then a method as defined in EN 1295-1 [34] should be used. As far as input values for the pipes are required, the values for the modulus of elasticity, poisson ratio and linear expansion coefficient given in Table A.1 are recommended.

Recommended deflection values can be found in prCEN/TS 15223 [35].

NOTE Deflections up to 15 % will not affect the proper functioning of the piping system.

B.4 Selection of fitting stiffness or class

Because of their geometry, solid-wall fittings have a stiffness greater than the stiffness of the pipe with corresponding wall-thickness series. Therefore the recommended stiffness classes/wall-thickness series of fittings for use with structured-wall pipes given in Table B.2 applies:

Table B.2 — Minimum fitting classes recommended for use with structured wall pipes

Pipe stiffness class	Minimum stiffness of fittings according to:		Minimum wall-thickness series of fittings according to		
	EN 13476-2 and EN 13476-3	EN 14758-1 [33]	EN 1852-1 [31]	EN 1401-1 [30]	EN 12666-1 [32]
SN 2	SN 2	SN 4	S 20	SDR 51	SDR 33
SN 4	SN 4	SN 4	S 20	SDR 51	SDR 33
SN 8	SN 8	SN 8	S 16	SDR 41	SDR 26
SN 16	SN 16	—	S 11.2 or S 13.3	SDR 34	SDR 21

Annex C (informative)

Designation of pipes and corresponding fittings

The specifier is responsible for ensuring that he or she identifies his or her requirements as follows:

Pipes

Standard	EN 13476-2 or EN 13476-3, as applicable
Diameter	required diameter expressed either as the outside or inside diameter (DN/OD or DN/ID)
Diameter tolerance	for PP and PE only, the designation CT if the tolerance is required
Type	required construction of the pipe expressed as either Type A or Type B
Ring stiffness	required stiffness class expressed as SN
Ring flexibility	see Annex I of EN 13476-2:2007 or EN 13476-3 as applicable
Material	required material expressed as PVC-U, PP or PE
MFR	required MFR class of any PP pipe intended for site thermal fusion
Application area	intended application expressed either as U if remote from the building or UD if intended for use under or close to the building
Impact	see Annex G and Annex H of EN 13476-2:2007 or EN 13476-3:2007 as applicable
Socket	if a short socket is required the designation "Short Socket"

Fittings

Standard	required standard either as EN 13476-2 or EN 13476-3 or one of equivalent plastics pipe standards, as applicable
Size	diameter of the pipe with which the fitting is intended to be jointed expressed either as DN/OD or DN/ID
Diameter tolerance	for PP and PE only the designation CT if a tighter tolerance is required
Angle	nominal angle of any branch or bend
Ring stiffness	required stiffness class expressed as SN
Material	required material expressed as PVC-U, PP or PE
MFR	required MFR class of any PP intended for site thermal fusion
Application area	intended application expressed either as U if remote from the building or UD, if intended for use under or close to the building

Annex D (informative)

Guidance in cleaning plastics pipes

D.1 Introduction

All types of gravity drain and sewer systems require a regular cleaning regime to ensure they achieve efficient performance. A new European Standard for the management and control of these cleaning operations is finalised: EN 14654-1 [36].

This annex summarises a recommended practice for the effective use of pressurized jetting to clean and unblock sewer pipes, while minimising any risk of damage to the pipe system.

A brief review of other cleaning methods is also included.

D.2 Cleaning and unblocking

D.2.1 Choosing the right equipment

In one or two European countries, sewer cleaning is typically carried out using small portable rigs that employ low volumes of water at high pressure through small-bore (typically 1 mm) nozzles.

However, there is increasing evidence from independent jetting tests (see D.3), that high volume water at low pressures is a more effective way to remove obstructions and thoroughly cleanse accumulated sediments from pipes, as well as for routine maintenance. These methods use a larger bore (typically 2,8 mm) nozzles.

D.2.2 Comparing techniques

When comparing these two jetting methods, the use of high pressure/low volume jetting has the following disadvantages:

- smaller active cleaning area and volume of water, insufficient to carry debris to a manhole for removal;
- new blockage can form downstream of the area being cleaned;
- significantly increased risk of damage to the pipe wall, particularly if the pipeline is in poor condition.

This may be contrasted with low pressure/high volume jetting which has the following benefits:

- cleaning of full pipe circumference;
- significantly increased hammer action of jet-head on blockages;

NOTE A 2,8 mm nozzle at 120 bar is calculated to generate approximately 5 times the energy of a 1 mm nozzle at 340 bar.

- higher volume of water flushes debris to manhole for removal;
- minimal risk of damage to pipes.

D.3 Conclusions from independent jetting tests

D.3.1 Assessing efficiency and impact

Inevitably, the question arises whether low pressures (not exceeding 120 bar, for example), are capable of achieving the necessary cleaning efficiency for typical maintenance operations.

The efficiency and impact of jetting on the various pipe materials and constructions have been explored in a variety of independent tests over recent years. These studies have been conducted under controlled conditions to ensure the testing can be fairly and consistently replicated.

D.3.2 Testing of plastic pipes

Test work and general practice throughout Europe has demonstrated that, in practice, a pressure of 120 bar is sufficient for all plastics materials. This will remove blockages likely to occur in service, while debris is carried to the manhole by high water volume.

Plastics pipe materials (PVC-U, PE and PP), in solid and structured-wall construction types, were included in an extensive laboratory testing programme. New plastics pipes, as well as those which had been in service for several years, were subjected to 120 bar water pressures with a 2,8 mm nozzle over 50 cycles without damage to the pipe.

The test parameters conform to CEN/TR 14920 [37].

D.3.3 Clearing tests

A university study first questioned jetting contractors to identify the various causes of blockages in sewer pipes and map the frequency with which these tended to occur. Of these, two of the more problematic causes were selected to be the subject of simulated clearing tests using jetting:

- Grease/fat: full bore blockage of solidified fat and disposable nappies, consistent with typical in-service operational blockages;
- Solids: one-third bore partial blockage of cured concrete, simulating residual builders' waste left in the pipe invert after installation, primarily encountered pre-commissioning of newly-installed pipes.

The pressure required to remove these blockages was measured for new plastics pipes.

Table D.1 — Required pressure for block removal

Material	Pressures in bar	
	Grease	Solids
Solid and structured-wall plastics	70	Between 70 and 110

D.4 Supplementary cleaning techniques

In most situations, low pressure/high volume water jetting, in accordance with the recommended practice, is generally sufficient for the removal of blockages and efficient cleaning of plastics sewer pipes. However, for any sewer from time to time, certain other cleaning techniques may also be required, in addition to jetting, to help deal with specific situations. These include the following²:

a) Cleaning ball:

Spherical device, slightly smaller than the sewer pipe bore, which is passed down through the sewer. Its fluted surface creates localized turbulence and increased flow velocity adjacent to the pipe wall as it passes. This loosens, and helps release, deposited sediments.

b) Flushing:

Placing a dam or flushing valve at the upstream end of the pipe section to be cleaned in order to temporarily interrupt the flow through the sewer pipe and create flow volume build-up. When this is released, the temporary substantially-increased flow removes obstructions and loose deposits from the pipe.

c) Rodding:

Using a tool on the end of a flexible rod that is pushed (via a suitable access point) through a sewer pipe to remove blockages. Typically only suitable for pipes up to a 250 mm nominal diameter that are no more than 2 m below ground.

d) Winching:

Using a tool that is pulled on a cable through a sewer pipe between adjacent manholes to help remove obstructions or sediments. The tool is typically bucket-shaped or shaped as appropriate to the nature of the deposits. In order to minimise the risk of damage to the pipe wall, the procedure begins with a small-sized tool/bucket. This may be subsequently increased in size up to the maximum for the size of pipe concerned. A cleaning pass through the pipe is usually made in both directions.

The following technique is also used.

e) Root cutters:

Mechanical tools to remove roots that have penetrated a sewer pipe through cracks or displaced joints. Tools may be cutters or rotating chains, however, these carry a high risk of severe damage to the pipeline and will only provide a temporary solution because the roots will grow back. Only replacement of the affected section of the pipeline and/or removal of the trees concerned can provide a long-term solution.

SAFETY NOTE Personnel entry to sewer systems is not generally recommended. If necessary, all health & safety regulations should be observed. If the flushing technique is used, it is especially important to ensure that no personnel are present in sewers downstream.

D.5 Recommended practice principles for jetting

To achieve efficient cleaning and unblocking of plastics sewer pipes, the following practice principles are recommended.

a) Personnel:

Jetting equipment should only be used by trained personnel.

b) Preparatory:

- 1) Evaluate, as far as possible, the nature and condition of the sewer to be cleaned, including:

² The techniques a) to d) are included in EN 752-7:1998, *Drain and sewer systems outside buildings – Part 7: Maintenance and operations*.

- material type and size;
 - structural condition;
 - operational condition: flow performance and nature of deposits/blockage(s).
- 2) Evaluate the associated health and safety factors, particularly in relation to regulations concerning personnel entry into confined spaces.
- c) Jetting equipment:
- 1) Use low pressure/high volume jetting.
 - 2) Avoid high pressure/low volume cleaning techniques.
 - 3) Select nozzle size appropriate to jetting equipment and size of pipe.
- d) Jetting pressure/flow rate
- 1) Maximum pressure at nozzle: 120 bar.
NOTE 60 bar is sufficient to remove soft debris. 80 bar to 120 bar may be required to remove a more substantial build-up of material.
 - 2) Recommended draw-back speed: 6 m/min to 12 m/min.
- e) After jetting:
- 1) Review the operational condition of the cleaned pipe.
 - 2) If jetting was used to clear a blockage, use CCTV to investigate the possible cause of the blockage that had to be cleared, for example, was it due to structural problems/defects (e.g. cracking or collapse)?

Report and record any information, which may be useful for future maintenance or refurbishment works.

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National Annex NA (informative) to BS EN 13476-1:2007 Additional guidance for UK users

NA.1 Designation of pipes and corresponding fittings

Annex C of BS EN 13476-1 'Designation of pipes and corresponding fittings' gives the requirement options a specifier is responsible for ensuring are identified.

NA.1.1 Initial ring stiffness

BS EN 13476 specifies four nominal ring stiffness classes (SN):

DN ≤ 500: SN 4, SN 8 or SN 16;

DN > 500: SN 2, SN 4, SN 8 or SN 16.

From the viewpoint of installation, SN 8 or SN 4 are the traditionally recommended classes used in the UK for Water Company adopted sewers and are to be used if the system is to be installed in accordance with BS EN 752, BS EN 1610 or BS 5955-6 in order to achieve the intended resistance to long-term deformation.

If it is intended to use SN 2 class of pipe or fitting, the installation should be first subject to a structural design soil load/traffic load calculation and the installation technique modified to suit the results of that calculation.

The appropriate calculation method is given in the National Annex NA (informative) for BS EN 1295-1. The short-term E modulus for the material should be taken from Table A.1 of BS EN 13476-1. The long-term value of E should be taken as the short-term value divided by the creep ratio. The creep ratio is derived from the tests specified in the mechanical characteristics section in BS EN 13476-2 or -3 as appropriate.

NA.1.2 Ring flexibility

Annex I of BS EN 13476-2 and -3 permits a ring flexibility test at 20 % diametric distortion. This is permitted in the UK for diameters greater than 300 mm.

NA.1.3 Impact

Annex G of BS EN 13476-2 and -3 details an impact resistance test at 23 °C. This is the preferred test in the UK in line with the current requirements in WIS 4-35-01.

NA.2 General

NA.2.1 Recycled material

The use of recyclable / reprocessable materials is encouraged in the UK. However, their use should be strictly in accordance with the requirements specified in this standard.

NA.2.2 Interchangeability

The standard does not guarantee interchangeability between manufacturers. It is strongly advised that users specify the bore series of pipes (DN/ID), as specified in BS EN 13476-2 and -3 to maximize the hydraulic performance of these products.

NA.2.3 Colour

For colour, it is the practice of UK sewerage undertakers and installers for the outside layer of structured wall plastic pipes and fittings to be brown in the range 06D45 to 06D43 of BS 4901:1976 to facilitate identification of buried utilities in accordance with the recommendations of the National Joint Utilities Group (NJUG) concerning the colour coding of pipelines and other services.

NA.2.4 Jetting resistance

A requirement for jetting resistance is not included within the standard. A suitable test that is applicable to UK practice is included in WIS 4-35-01.

NA.2.5 Puncture resistance

A requirement for resistance to internal puncture is not included within the standard. A suitable test that is applicable to UK practice is included in WIS 4-35-01.

NA.2.6 Longitudinal bending resistance

No requirement has been given in respect of resistance to longitudinal bending as included in WIS 4-35-01. In the absence of such a requirement it is advised that shorter lengths of pipe than the 6 m allowed by EN 13476 should be specified.

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