SLOVENSKI STANDARD
SIST-TS CEN/TS 15223:2008

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Cevni sistemi iz polimernih materialov - Veljavni parametri za naļ rtovanje plastomernih cevnih sistemov, poloģenih v zemljo

Plastics piping systems - Validated design parameters of buried thermoplastics piping systems

Kunststoff-Rohrleitungssysteme - Gültige Berechnungsparameter von erdverlegten thermoplastischen Rohrleitungssystemen

Systèmes de canalisations en matières plastiques - Paramètres de calcul validés pour les systèmes enterrés de canalisations en matières thermoplastiques

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23.040.01	Deli cevovodov in cevovodi na splošno	Pipeline components and pipelines in general

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Plastics piping systems - Validated design parameters of buried thermoplastics piping systems

Systèmes de canalisations en matières plastiques - Paramètres de calcul validés pour les systèmes enterrés de canalisations en matières thermoplastiques

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Contents

Foreword

This document (CEN/TS 15223:2008) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this CEN Technical Specification: 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.

Introduction

In Europe several design methods exist and some are still under development. The plastics pipes industry has carried out a lot of research with full-scale trials. From these research graphs have been made that shows the deflection in the pipes immediately after installation. Also the so-called settlement period is measured. This settlement will always take place. In case that heavy traffic is present, the final deflection will be reached faster.

It is strongly advised to check any calculated deflection with the values in the two design graphs.

The information compiled is meant to be used by designers. The values given are meant for general guidance.

For the purpose of design using simple methods, two soil groups are used, granular and cohesive. For more detailed and sophisticated design, more soil groups are used, for which reason reference is made to EN 1295-1 [11] and to national methods.

1 Scope

This document covers thermoplastics pipe material related properties and design topics to be taken into account when carrying out any static pipe calculation. It also provides *guidance to* applying structural design of thermoplastics piping systems for pressure and non-pressure applications. It furthermore provides documentation based on long term experience, to be *used in justifying and/or verification of* any structural design method.

NOTE For piping systems for the conveyance of gaseous fluids additional guidance is given in EN 12007-2.

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 476, *General requirements for components used in discharge pipes, drains and sewers for gravity systems*

EN 773:1999, *General requirements for components used in hydraulically pressurized discharge pipes, drains and sewers*

EN 805:2000, *Water supply — Requirements for systems and components outside buildings*

CEN/TR 1295-2, *Structural design of buried pipelines under various conditions of loading — Part 2: Summary of nationally established methods of design*

CEN/TR 1295-3, *Structural design of buried pipelines under various conditions of loading — Part 3: Common method*

EN 1446, *Plastics piping and ducting systems — Thermoplastics pipes — Determination of ring flexibility*

EN 12007-2, *Gas supply systems — Gas pipelines for maximum operating pressure up to and including 16 bar — Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar)*

EN ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation (ISO 9080:2003)*

EN ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient (ISO 12162:1995)*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
constant load
load on a pipe, e.g. from internal pressure, that is not changing with time

3.1.2
constant deformation
deformation due to deflection of the pipe that is not changing with time, e.g. due to constraint from the soil

3.1.3
design stress
σ_s
allowable stress, in megapascals, for a given application. It is derived from the MRS by dividing it by the overall service coefficient C

3.1.4
minimum required strength
MRS
value of σ_{LPL}, rounded down to the next smaller value of the R10 series or of the R20 series depending on the value of σ_{LPL}

NOTE R10 and R20 series are the Renard number series according to ISO 3 [1] and ISO 497 [2].

3.1.5
overall service coefficient
C
overall service coefficient with a value greater that one, which takes into consideration service conditions as well as properties of the components of a piping system others than those represented in the lower confidence limit

3.1.6
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the component of a piping system. It corresponds to the maximum continuous operating pressure in bars

3.1.6
pipe stiffness
S_p
theoretical pipe stiffness determined with the Young's modulus and the Poisson ratio

3.1.7
critical buckling pressure
q_{crit}
critical internal pressure causing buckling of the pipe

3.1.8
nominal stiffness
SN
numerical designation of the ring stiffness of a pipe or fitting, which is a convenient round number indicating the minimum required ring stiffness of the pipe or fitting

NOTE It is designated by the letters “SN” followed by the appropriate number.

3.2 Symbols

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

C overall service coefficient

β deflection correction factor

C_{100} 100 year overall service coefficient

C_{50} 50 year overall service coefficient

C_f deflection factor, in percent

d_n	nominal outside diameter of the pipe, in millimetres
δ	deflection of the pipe, in millimetres
d_{em}	mean outside diameter of the pipe, in millimetres
d_m	the midwall diameter, in millimetres
d_e	outside diameter of the pipe, in millimetres
e	wall thickness of the pipe, in millimetres
ε	strain
E_p	the Young's modulus of the pipe material, in megapascals
E_t	tangent modulus, in kilopascals
f_a	application rating factor
$F_{fitting}$	maximum tensile force, in newton
f_T	temperature rating factor
g	gravity, in m/s^2
K	value of the measured molecular weight
k	absolute roughness, in millimetres
k_{water}	viscosity of water, in m^2/s
v	poisson ratio
q_{crit}	critical buckling pressure, in kilopascals
ρ	density, in kilograms per cubic meter
R	bending radius of the pipe, in millimetres
R_{max}	maximum bending radius of the pipe, in millimetres
ρ	density of water
S	geometrical pipe characteristic defined as: $S = (d_n - e)/(2e)$
S_p	pipe stiffness value determined by $(1 - \upsilon^2)/E_p \cdot (d_{em}/e - 2)$, in [MPa^{-1}]
σ_s	design stress, in newtons per square millimetre
$\sigma_{tensile\ strength}$	tensile strength, in megapascals

3.3 Abbreviations

HDS	hydrostatic design stress
MRS	minimum required strength
PE	Polyethylene
PEA	allowable site test pressure
PFA	allowable operating pressure

PMA allowable maximum operating pressure

PN nominal pressure

PP polypropylene

PVC poly(vinyl chloride)

SDR standard dimension ratio

4 General material properties

4.1 General material properties

Plastics pipe properties related to design are given in Table 1.

Table 1 — Material properties: values [a] typical for calculations

Material	Poisson ratio [-]	Coefficient of linear expansion [1/ °C]	Young's modulus [MPa]	Relaxation coefficient [-]	Tensile strength [MPa]
PVC-HI	0,4	6×10^{-5}	2 500	0,06	40
PVC 250	0,4	8×10^{-5}	3 200	0,05	50
PVC 315	0,4	8×10^{-5}	3 500	0,05	60
PVC 355	0,4	8×10^{-5}	3 500	0,05	60
PVC 400	0,4	8×10^{-5}	3 500	0,05	60
PVC 450	0,4	8×10^{-5}	3 500	0,05	60
PVC 500	0,4	8×10^{-5}	3 500	0,05	60
PE 63	0,45	19×10^{-5}	800	0,06	17
PE 80	0,45	19×10^{-5}	850	0,07	19
PE 100	0,45	19×10^{-5}	1 100	0,08	21
PP-B	0,42	12×10^{-5}	1 250	0,07	27
PP-HM	0,42	12×10^{-5}	1 700	0,07	31
PP-H	0,42	12×10^{-5}	1 250	0,07	30
PP-R	0,42	12×10^{-5}	950	0,07	23

[a] If values are needed related to specific products, these shall be acquired from the manufacturer or specific standards.

4.2 Pressure pipes (stress design based)

4.2.1 Minimum Required Strength (MRS)

The minimum required strength shall be classified according to EN ISO 12162. The classification shall be determined out of the lower confidence limit tangential stress, which divides the MRS values into ranges. In the pressure test according to EN ISO 9080 the LPL-value shall be determined for the pipe material. This LPL-value gives the classification for the MRS value. For classification reasons 50 year have been taken and the relevant design coefficient is applied. In practise the lifetime will be longer. Therefore also the remaining design factor 100 year is given. For the different thermoplastics materials used in buried pipes, the MRS values are given in Table 2.

Table 2 — Material properties relevant for pressure pipes at 20 °C

Material [a]	MRS σ classification [MPa]	Overall service design coefficient [b] C_{50} [-]	Overall design coefficient [c] C_{100} [-]	Allowable approximately one hour stress [MPa]
PVC-HI	18	1,4	1,38	35
PVC 250	25,0	2,0	1,94	42
PVC 315	31,5	1,6	1,58	45
PVC 355	35,5	1,6	1,58	51
PVC 400	40,0	1,6	1,58	57
PVC 450	45,0	1,4	1,38	64
PVC 500	50,0	1,4	1,38	71
PE 63	6,3	1,25	—	10
PE 80	8,0	1,25	1,23	12,6
PE 100	10,0	1,25	1,23	16

[a] If values are needed related to specific products, these shall be acquired from the manufacturer or specific standards.

[b] The overall design coefficient is determined in EN ISO 12162 and the values shown in the table are minimum values. The values may be increased by users when specific fluids which are harmful for the environment or mankind.

[c] Based on regression curves it is shown that the C_{100} coefficients slightly differ from the C_{50} values.

NOTE At temperatures below 20 °C the values will be higher than those shown.

4.2.2 Overall service (design) coefficient *C*

Minimum overall service design coefficients shall be determined in accordance with EN ISO 12162. The overall service design coefficient lowers the nominal pressure (PN) as given in the following equation:

$$\mathrm{PN} = \frac{10\sigma_{\mathrm{s}} / S}{C} e \tag{1}$$

where

$$S = (d_{\mathrm{n}} - e)/2e \tag{2}$$

4.2.3 Design stresses

The design stress of the pipe is determined with the MRS divided by the overall service coefficient.

4.2.4 Pressure rating PN

The pressure rating shall be determined using Equation (1).

4.3 Non-pressure pipes (strain design based)

Non-pressure pipes do not require a stress analysis because of the visco-elastic behaviour and redistribution of stresses. Studies of Moser [3] and Janson [4] have discussed whether thermoplastics are strain limited or not. In these studies strain by bending as well as through-wall strains have been evaluated. It was shown that for all practical purposes these materials are not strain limited. Nevertheless, Moser [3] has proposed rather conservative values that are not based on the occurrence of a failure. If one wishes to calculate the material strain value then the table below supplies conservative guidance about the levels that can be accepted.

The combination of pipe construction and integrity shall be tested by means of a ring flexibility test up to 30 % deflection as described in EN 1446. Passing this test ensures stability against buckling.

Table 3 (taken from Janson [4]) — Strainability, ε, for non-pressure pipes

Material	ε %
PVC-U	2,5
PE	5,0
PP	5,0

4.4 Piping systems for gaseous fluids

For guidance for the design of gas supply systems EN 12007-2 shall apply.

5 System and operation related aspects

5.1 General

According to EN 476, EN 773 and EN 805 the information on following aspects, when relevant, shall be provided in product standards.