SLOVENSKI STANDARD
SIST-TS CEN/TS 15223:2018

01-januar-2018

Nadomešča:
SIST-TS CEN/TS 15223:2008

Cevni sistemi iz polimernih materialov - Veljavni parametri za načrtovanje plastomernih cevnih sistemov, položenih 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

Ta slovenski standard je istoveten z: **CEN/TS 15223:2017**

ICS:

23.040.20	Cevi iz polimernih materialov	Plastics pipes

SIST-TS CEN/TS 15223:2018 **en,fr,de**

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 15223

November 2017

ICS 23.040.01

Supersedes CEN/TS 15223:2008

English Version

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

Kunststoff-Rohrleitungssysteme - Bestätigte Berechnungsparameter von erdverlegten thermoplastischen Rohrleitungssystemen

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Ref. No. CEN/TS 15223:2017 E

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European foreword

This document (CEN/TS 15223:2017) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

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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 researches, graphs have been made that show the deflection in the pipes immediately after installation. In addition, 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 compactible soil groups are used, granular and cohesive.

If applicable, reference is made to EN 1295-1, EN 1610, CEN/TR 1046 and national practices.

1 Scope

This Technical Specification covers validated design parameters of buried thermoplastics piping systems for functional and structural design for the following applications:

– pressure (excluding piping systems for gaseous fluids and industrial applications);

– non-pressure.

The functional design is based on relevant standards and commonly used practices.

Depending on the project parameters, the route for structural design can be

– either established by long term experience (within certain limitations),

– or calculated according to CEN/TR 1295-2 [8] by using thermoplastic pipe material related properties and design criteria.

NOTE 1 The route for the structural design is shown in the flowchart given in Figure 1 in 4.1.

NOTE 2 Industrial applications also includes district heating

Since in practice precise details of types of soil and installation conditions are not always available at the design stage, the choice of design assumptions is left to the judgement of the designer/specifier. In this connection, this guide can only provide general indications and advice.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 drains and sewers*

EN 805, *Water supply - Requirements for systems and components outside buildings*

EN 1295-1, *Structural design of buried pipelines under various conditions of loading - Part 1: General requirements*

EN 1610:2015, *Construction and testing of drains and sewers*

CEN/TR 1046:2013, *Thermoplastics piping and ducting systems - Systems outside building structures for the conveyance of water or sewage - Practices for underground installation*

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

EN ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications - Classification, designation and design coefficient (ISO 12162)*

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

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
deflection
deviation of the circle cross section of the pipe

Note 1 to entry: Deflection is expressed as percentage [%].

3.1.2
minimum required strength
MRS
value of σLPL at 20 °C and 50 years, rounded down to the next lower value of the R10 series when σ_{LPL} is below 10 MPa, or to the next lower value of the R20 series when σLPL is 10 MPa or greater

Note 1 to entry: R10 and R20 series are the Renard number series according to ISO 3 [1] and ISO 497 [2]

3.1.3
lower confidence limit of the predicted hydrostatic strength
$\sigma_{\mathbf{LPL}}$
quantity, with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature θ and time t

Note 1 to entry: It is expressed in megapascals.

3.1.4
design coefficient
C
design coefficient with a value greater than 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

3.1.5
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the component of a piping system

For plastic piping systems conveying water, it corresponds to the allowable operating pressure (PFA) in bar, which can be sustained with water at 20 °C with a design basis of 50 years, and based on the minimum design coefficient:

$$\mathrm{PN}=\frac{20\times\mathrm{MRS}}{C\times(\mathrm{SDR}\text{-}1)}$$

3.1.6
critical buckling pressure
$q_{\mathbf{crit}}$
critical internal pressure causing buckling of the pipe

3.1.7
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 1 to entry: It is designated by the letters "SN" followed by the appropriate number.

3.1.8
standard dimension ratio
SDR
numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness, e_n

3.1.9
allowable maximum operating pressure
PMA
maximum pressure occurring from time to time, including surge, that a component is capable of withstanding in service

3.1.10
allowable operating pressure
PFA
maximum hydrostatic pressure that a component is capable of withstanding continuously in service

3.1.11
allowable site test pressure
PEA
maximum hydrostatic pressure that a newly installed component is capable of withstanding for a relatively short duration, in order to ensure the integrity and tightness of the pipeline

3.2 Symbols

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

C	design coefficient
C_f	deflection factor depending on compaction level, in percent
d_n	nominal outside diameter of the pipe, in millimetres
d_{em}	mean outside diameter of the pipe, in millimetres
e	wall thickness of the pipe, in millimetres
E_p	the Young's modulus of the pipe, in megapascals
E_t	tangent modulus, in kilopascals
e_n	Nominal wall thickness of the pip, in millimetres
f_a	application rating factor
f_τ	temperature rating factor
g	gravity, in m/s^2
K	compressive modus [N/m2]

k	absolute roughness, in millimetres
k_{water}	viscosity of water, in m²/s
q_{crit}	critical buckling pressure, in kilopascals
R	bending radius of the pipe, in millimetres
R_{max}	maximum bending radius of the pipe, in millimetres
S	geometrical pipe characteristic defined as $S = (d_n - e) / (2e)$
$ß$	deflection correction factor
δ	deflection of the pipe, in millimetres
ε	tangential strain
ε_{max}	maximum acceptable strain

3.3 Abbreviations

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

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
PP-B	Polypropylene block copolymer
PP-H	Polypropylene homopolymer
PP-MD	Polypropylene mineral modified
PVC-HI	High impact poly(vinyl chloride)
PVC-O	Poly(vinyl chloride) oriented unplasticized
PVC-U	Poly(vinyl chloride) unplasticized
SDR	Standard dimension ratio

4 Route for structural design

4.1 General

At the start of a project, first the parameters need to be investigated as given in Clause 5.

In general creating a validated structural design of a thermo-plastics pipeline construction by applying analytical or numerical methods is not needed – provided the parameters of the project are within the value range given in Table 1.

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.

The flowchart in Figure 1 provides the necessary steps to establish the structural design of a pipeline.