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Structural design of buried pipelines under various conditions of loading - Part 4: Parameters for reliability of the design

Statische Berechnung von erdverlegten Rohrleitungen unter verschiedenen Belastungsbedingungen - Teil 4: Parameter für die Zuverlässigkeit der Auslegung

Calcul de résistance mécanique des canalisations enterrées sous diverses conditions de charge - Partie 4 : Paramètres pour la fiabilité de la conception

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English Version

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This Technical Report was approved by CEN on 13 April 2015. It has been drawn up by the Technical Committee CEN/TC 165.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 1295-4:2015) has been prepared by Technical Committee CEN/TC 165 “Wastewater engineering”, the secretariat of which is held by DIN.

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

This document, EN 1295: “*Structural design of buried pipelines under various conditions of loading”,* consists of the following parts:

— Part 1: General requirements (EN);

— Part 2: Summary of nationally established methods of design (CEN/TR);

— Part 3: Common method (CEN/TR);

— Part 4: Parameters for reliability of the design (CEN/TR).

Introduction

The structural design of buried pipelines constitutes a wide ranging and complex field of engineering, which has been the subject of extensive study and research, in many countries over a period of very many years.

While many common features exist between the design methods, which have been developed and established in the various member countries of CEN, there are also differences reflecting such matters as geological and climatic variations, as well as different installation and working practices.

In view of these differences, and of the time required to develop a common design method that would fully reflect the various considerations identified in particular national methods, a multiple stage approach has been adopted for the development of a European Standard.

In accordance with this approach, a Joint Working Group, at its initial meeting, resolved "first to produce an EN giving guidance on the application of nationally established methods of structural design of buried pipelines under various conditions of loading, whilst working towards a common method of structural design".

EN 1295-1, "*Structural design of buried pipelines under various conditions of loading — Part 1: General requirements*" represents the implementation of the first part of that resolution, and CEN/TR 1295-2 "*Structural design of buried pipelines under various conditions of loading — Part 2: Summary of nationally established methods of design*" represents the full implementation of the first part of that resolution.

In 2003, CEN/TC 164 and CEN/TC 165 accepted a recommendation from JWG1 that the two structural design options should be published as CEN/TR 1295-3 "*Structural design of buried pipelines under various conditions of loading — Part 3: Common method*", because there was no prospect of the group reaching agreement on a "Common Method", and the human and financial resources needed to continue were, in any case, no longer available.

In 2011, CEN/TC 165 has decided to complete this approach to list the parameters for the reliability of the structural design of buried water and wastewater pressure pipelines, drains and sewers in relation with the installation conditions.

1 Scope

This Technical Report lists the parameters for the reliability of the structural design of buried water and wastewater pressure pipelines, drains and sewers.

The reliability of the design of buried pipelines is based on the selection of appropriate design parameters for a chosen design method. This document identifies the parameters appropriate to the chosen design method, which should all be clearly stated.

This Technical Report does not aim to specify the requirements for the structural design of water and wastewater pressure pipelines, drains and sewers. These requirements are defined in EN 1295-1.

This Technical Report does not apply for offshore laying, pipes supported on piles, no dig pipelines, or laid above ground. Supplementary considerations need to be taken into account for these specific installations.

Special situations (e.g. landslide, earthquake, fire) are outside the scope of this document.

Design parameters for calculation of longitudinal effects (including bending moments, shear forces and tensile forces resulting for example from non-uniform bedding and thermal movements and, in the case of pressure pipelines, from Poisson's contraction and thrust at change of direction or cross-section) are not covered in this document.

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.

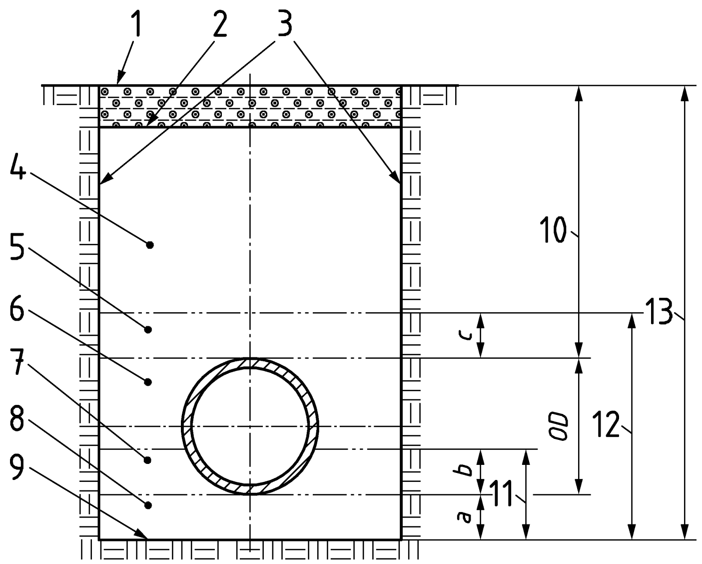
EN 1295-1, *Structural design of buried pipelines under various conditions of loading - Part 1: General requirements*

3 Terms and definitions

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

3.1 Installation terms

Installation terms are given in Figure 1. The same terms apply for embankment installations and for trenches with sloping sides.



Key

1 surface

2 bottom of road or railway construction, if any

3 trench walls

4 main backfill

5 initial backfill

6 sidefill

7 upper bedding

8 lower bedding

9 trench bottom

10 depth of cover

11 depth of bedding

12 depth of embedment

13 trench depth

a thickness of lower bedding

b thickness of upper bedding

c thickness of initial backfill

NOTE The terms in Figure 1 are the same as in EN 1610.

Figure 1 — Trench installation

3.1.1
compaction
deliberate densification of soil during the construction process

[SOURCE: EN 1295-1:1997, 3.1.1]

3.1.2
consolidation
time-dependent densification of soil by processes other than those deliberately applied during construction

[SOURCE: EN 1295-1:1997, 3.1.2]

3.1.3
embedment
arrangement and type(s) of material(s) around a buried pipeline which contribute to its structural performance

[SOURCE: EN 1295-1:1997, 3.1.3]

3.2 Design terms

3.2.1
allowable maximum operating pressure (PMA)
maximum pressure occurring from time to time, including surge, that a component is capable of withstanding in service

[SOURCE: EN 805:2000, 3.1.1]

3.2.2
allowable operating pressure (PFA)
maximum hydrostatic pressure that a component is capable of withstanding continuously in service

[SOURCE: EN 805:2000, 3.1.2]

3.2.3
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

[SOURCE: EN 805:2000, 3.1.3]

3.2.4
bedding factor

ratio of the maximum design load for the pipe, when installed with a particular embedment, to the test load which produces the same maximum bending moment

[SOURCE: EN 1295-1:1997, 3.2.1]

3.2.5
design pressure (DP)
maximum operating internal pressure of the system or of the pressure zone fixed by the designer considering future developments but excluding surge

[SOURCE: EN 805:2000, 3.1.4]

3.2.6
limit states
states beyond which the structure no longer fulfils the relevant design criteria

[SOURCE: EN 1990:2002, 1.5.2.12]

3.2.7
load bearing capacity
load per unit length that a particular combination of pipe and embedment can sustain without exceeding a limit state

[SOURCE: EN 1295-1:1997, 3.2.3]

3.2.8
maximum design pressure (MDP)
maximum operating internal pressure of the system or of the pressure zone fixed by the designer considering future developments and including surge, where:

— MDP is designated MDPa when there is a fixed allowance for surge;

— MDP is designated MDPc when the surge is calculated

[SOURCE: EN 805:2000, 3.1.5]

3.2.9
serviceabilty limit states
states that correspond to conditions beyond which specified service requirements for a structure or structural member are no longer met

[SOURCE: EN 1990:2002, 1.5.2.14]

3.2.10
silo effect
effect whereby lateral earth pressure in trench backfill causes friction at the trench wall to carry part of the weight of the backfill

[SOURCE: EN 1295-1:1997, 3.2.5]

3.2.11
system test pressure (STP)
hydrostatic pressure applied to a newly laid pipeline in order to ensure its integrity and tightness

3.2.12
ultimate limit states
states associated with collapse or with other similar forms of structural failure

[SOURCE: EN 1990:2002, 1.5.2.13]

4 General requirements

All pipelines shall withstand the various loadings to which they are expected to be subjected, during construction and operation, without detriment to their function and to the environment.

The designer of the pipeline shall therefore specify the parameters for the structural design. These parameters shall be consistent with the requirements of the installation and the earthworks.

The structural designer shall state the chosen method for the design. The structural designer shall determine whether or not the pipeline comes within the scope of the chosen method of design including level of safety. The structural designer shall declare the selected parameters to ensure the reliability of the calculation.

Methods of design, when presented in the form of tables, charts or computer programmes, shall be deemed equivalent to a full calculation, provided that any simplification does not reduce the level of safety below that which would be obtained by a full design.

For the chosen design method, the designer shall use the whole method including the associated allowable limits on the results and shall assess that the chosen method is applicable for the project and shall express the resulting design safety.

Probable consequences of pipeline failure shall be identified prior to the structural design. The structural designer shall consider probable consequences of pipeline failure by establishing an acceptable level of safety consistent with the chosen design method.

At each stage of the design, the values of the selected parameters, including factors of safety, shall be in accordance with the chosen method and with site conditions, and shall be stated by the structural designer.

5 Declaration of the parameters

5.1 General

The designer shall state the chosen method by referring to a published document or by a detailed description of it.

The designer needs to clearly state the input data used and the analyses done.

The designer shall state the selected parameters, and at least refer to the following:

a) input data and characteristics:

  1) pipe parameters;

  2) external loads parameters:

    i) soil loads parameters;

    ii) traffic loads and construction loads parameters;

    iii) groundwater parameters;

  3) internal pressure parameters;

  4) pipes own weight parameters;

  5) weight of fluid parameters;

  6) subsidence parameters;

  7) temperature parameters;

b) parameters for limit state analysis;

c) safety parameters.

As stated in EN 1295-1:

— *Field and experimental studies of pipelines show variations in observed earth pressures and pipe deformations, stresses and strains. The main cause of these variations is the inevitable inconsistency of soil characteristics and construction practices. The magnitude of the variation can be reduced by good supervision, control measurement and by the use of fill materials, which are easily placed and treated, but some degree of variation is inevitable.*

— *Variations in pipe characteristics, such as strength or elasticity, also occur in practice.*

— *Appropriate allowance for these variations should be made at the design stage and be in accordance with one of the following design philosophies:*