SLOVENSKI STANDARD
SIST EN 1295-1:1998

01-december-1998

Projektiranje vkopanih cevovodov pri različnih pogojih obremenitve - 1.del: Splošne zahteve

Structural design of buried pipelines under various conditions of loading - Part 1: General requirements

Statische Berechnung von erdverlegten Rohrleitungen unter verschiedenen Belastungsbedingungen - Teil 1: Allgemeine Anforderungen

Calcul de résistance mécanique des canalisations enterrées sous diverses conditions de charge - Partie 1: Prescriptions générales

Ta slovenski standard je istoveten z: EN 1295-1:1997

ICS:

93.025	Zunanji sistemi za prevajanje vode	External water conveyance systems
93.030	Zunanji sistemi za odpadno vodo	External sewage systems

SIST EN 1295-1:1998 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1295-1

July 1997

ICS 23.040.01

Descriptors: sanitation, water supply, water removal, water pipelines, buried pipes, pressure pipes, sewage, computation, mechanical strength, loads : forces

English version

Structural design of buried pipelines under various conditions of loading - Part 1: General requirements

Calcul de résistance mécanique des canalisations enterrées sous diverses conditions de charge - Partie 1: Prescriptions générales

Statische Berechnung von erdverlegten Rohrleitungen unter verschiedenen Belastungsbedingungen - Teil 1: Allgemeine Anforderungen

This European Standard was approved by CEN on 1997-06-29. CEN members are bound to comply with the CEN/CENELEC 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 Central Secretariat or to any CEN member.

The European Standards exist 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart,36 B-1050 Brussels

Ref. No. EN 1295-1:1997 E

CONTENTS

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165 "Waste water engineering", the secretariat of which is held by DIN.

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 January 1998, and conflicting national standards shall be withdrawn at the latest by January 1998.

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

This standard is intended for use in conjunction with the series of product standards covering pipes of various materials for the water industry.

This standard comprises two parts :

— part 1, General requirements : it deals with the requirements for structural design of pipelines and gives the basic principles of the nationally established methods of design ;

— part 2, Summary of the nationally established methods of design : it gives an overview of these methods as prepared by the various countries where they are in use.

0 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.

Whilst 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 which would fully reflect the various considerations identified in particular national methods, a two stage approach has been adopted for the development of this European Standard.

In accordance with this two stage approach, the 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". This standard represents the implementation of the first part of that resolution.

1 Scope

This standard specifies the requirements for the structural design of water supply pipelines, drains and sewers, and other water industry pipelines, whether operating at atmospheric, greater or lesser pressure.

In addition, this standard gives guidance on the application of the nationally established methods of design declared by and used in CEN member countries at the time of preparation of this standard.

This guidance is an important source of design expertise, but it cannot include all possible special cases, in which extensions or restrictions to the basic design methods may apply.

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 engineer. In this connection the guide can only provide general indications and advice.

This part of the standard specifies the requirements for structural design and indicates the references and the basic principles of the nationally established methods of design (see annexes A and B).

2 Normative references

This European Standard incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of the publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

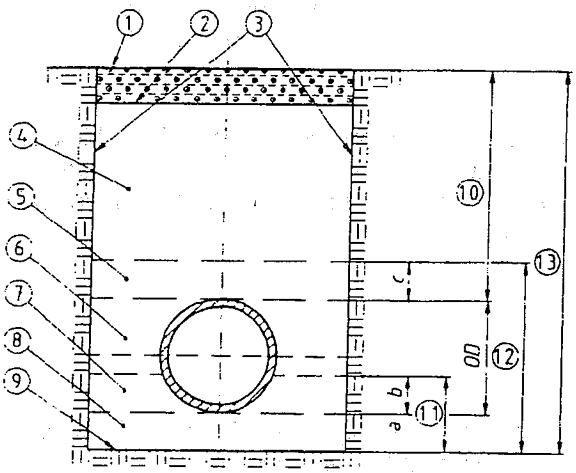
prEN 1610 Construction of pipelines for drains and sewers.

3 Definitions

For the purposes of this standard, the following definitions apply (see also annex A).

3.1 Installation terms

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



1 Surface
2 Bottom of road or railway construction, if any
3 Trench walls
4 Main backfill (3.6)
5 Initial backfill (3.5)
6 Sidefill (3.12)
7 Upper bedding
8 Lower bedding
9 Trench bottom
10 Depth of cover (3.3)
11 Depth of bedding (3.1)
12 Depth of embedment (3.4)
13 Trench depth (3.13)

a Depth of lower bedding
b Depth of upper bedding
c Depth of initial backfill

Figure 1 : Trench installation

NOTE : The terms in figure 1 are the same as in prEN 1610.

3.1.1 Compaction : Deliberate densification of soil during the construction process.

3.1.2 Consolidation : Time-dependent densification of soil by processes other than those deliberately applied during construction.

3.1.3 Embedment : Arrangement and type(s) of material(s) around a buried pipeline which contribute to its structural performance.

3.2 Design Terms

3.2.1 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.

3.2.2 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.

3.2.3 Load bearing capacity : Load per unit length that a particular combination of pipe and embedment can sustain without exceeding a limit state.

3.2.4 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.

3.2.5 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.

3.2.6 Soil-structure interaction : Process whereby the deformations of soil and/or pipe caused by the contact and reaction pressures between a pipe and the surrounding soil distribute the pressures to achieve equilibrium.

3.2.7 System test pressure (STP) : Hydrostatic pressure applied to a newly laid pipeline in order to ensure its integrity and tightness.

4 Requirements

4.1 All pipelines shall be designed to 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.

4.2 The future owner of the pipeline is free to specify the appropriate method of design to be adopted.

4.3 The designer shall determine whether or not the pipeline comes within the scope of the methods covered by this standard.

4.4 The design adopted shall be such that construction may be carried out safely and so as to ensure that the design assumptions regarding the influence of construction procedures and soil characteristics will be satisfied.

4.5 Subject to the other requirements of clause 4, design should be carried out preferably using in its entirety one of the methods in annex B of this standard.

4.6 Methods of design, in accordance with annex B, 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 full design. Outputs from computer programmes shall be capable of verification.

4.7 Where a design method other than one of those in annex B is employed, the designer shall satisfy himself that the method constitutes a coherent system and provides the level of safety required.

4.8 Account shall be taken of the probable consequences of pipeline failure in establishing the acceptable level of safety.

4.9 The values adopted for all variables, including factors of safety, shall be in accordance with the method used.

5 Basis of design procedures

5.1 General

Whilst there are differences between some of the established national design procedures, there are no differences in respect of the fundamental basis of design, which is the interactive system consisting of the pipe and the surrounding soil.

The external loadings to be considered shall include that due to the backfill, that due to the most severe surface surcharge or traffic loading likely to occur, and those due to any other causes, producing a loading of significant magnitude such as self-weight of the pipe and water weight, as appropriate. The internal pressure in the pipeline, if different from atmospheric, shall also be treated as a loading.

The design of the pipeline, and its embedment, shall provide an adequate level of safety against the appropriate ultimate limit state being exceeded. In addition, the design loading shall not result in any appropriate serviceability limit state being exceeded.

5.2 External loads

Account shall be taken of the effect of the stiffness of the pipe and the stiffness of the surrounding soil.

Where appropriate, account shall be taken of the effects of trench construction, of groundwater and of time dependent influences. The design should take into consideration, however, the possible effect on trench conditions of any further planned works.

The effective pressure due to the backfill and any distributed surface loads shall be calculated on the basis of the principles of soil - structure interaction.

The pressure exerted on pipelines by concentrated surface surcharges, such as vehicle wheels, shall be calculated in accordance with a method based on Boussinesq, and account shall be taken of impact.

5.3 Limit states

The ultimate limit state for all types of pipe is reached when the pipe ceases to behave in the manner intended in the structural design.

Serviceability limit states may be dictated by effects either on the performance of pipelines or on their durability (for example leakage, deformation or cracking beyond allowable limits).

Additional serviceability limit states may apply to particular pipe materials, and reference shall be made to the relevant standards.

The design of the pipeline shall ensure that these above limit states are not reached. This will include consideration of one or more of the following factors:

— strain, stress, bending moment and normal force or load bearing capacity, in the ring or longitudinal direction as appropriate;

— instability (e.g. buckling);

— annular deformation;

— watertightness.

Where fluctuating loads of significant magnitude and frequency will exist, appropriate consideration should be given to their cumulative effects.

5.4 Longitudinal effects

Longitudinal effects include bending moments, shear forces and tensile forces resulting for example from non uniform bedding and thermal movements and, in the case of pressure pipelines (see 6.5), from Poisson's contraction and thrust at change of direction or cross-section.

These effects may be accommodated by the angular deflection and/or the shear resistance of flexible joints and by the flexural strength of pipes, the serviceability limits of which should be obtained from the different product standards.

The designer shall check that these provisions, together with the embedment design, are sufficient for the project and, where needed, specify adequate additional measures.

6 Additional considerations for pressure pipelines

6.1 General

Pipelines operating at internal pressures above or below atmospheric are subjected to loadings in excess of those at atmospheric pressure.

The application of internal pressure not only introduces additional stresses and strains in the circumferential direction, but can also modify the deformation of flexible and semi-rigid pipes. In addition, pressure pipelines, containing changes of direction or other discontinuities, shall be designed for the longitudinal tensile loading, or the thrusts at the discontinuities.

Special consideration shall be given to pipelines which will be subject to transient surge pressures. Both positive and negative transient pressures shall be considered, but it may not be appropriate for these to be taken in combination with the full vehicle surcharge load.

The design shall take account of the design pressure, the maximum design pressure, and the system test pressure (see 3.2).

Pressure pipelines shall also satisfy the design criteria which would apply if they were non-pressure pipelines, in order to ensure their satisfactory structural performance for the initial period between construction and the application of the internal water pressure, and subsequently when emptied for maintenance.

6.2 Stresses and strains resulting from simultaneous loads

Internal pressures above or below atmospheric produce circumferential stresses and strains which act simultaneously with bending stresses and strains due to external loadings.

Design cases to be considered depending on pipe material and/or type and respective load intensities, can be one or more of the following:

— circumferential stresses resulting from combined loads ;

— circumferential strains resulting from combined loads;

— separate analysis of circumferential stresses or strains.

Similar cases shall be considered for the longitudinal direction, when appropriate.

NOTE : If the cross-section of the pipe is truly circular, circumferential stresses and strains due to internal pressure will be purely tensile or compressive, but if the pipe cross-section is not truly circular or has been deformed there will also be bending stresses and strains due to internal pressure.

6.3 Effect of pressure on deformation

When positive internal pressure is applied to a not truly circular pipe, it tends to re-round the deformed pipe, i.e. to reduce the out-of-circle deformations.

The re-rounding process may have the beneficial effect of reducing the bending stresses and strains in the pipe wall. The extent to which the re-rounding process reduces pipe deformation depends on pipe property and on other various factors, such as the ratio of the internal pressure to the external pressure and the amount of consolidation of the soil which has taken place around the pipe. Thus, the beneficial effects of re-rounding are likely to be greater if the pressure is applied soon after backfilling, and less if there is a longer delay until the first pressurisation.