TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 1295-3

July 2007

ICS 23.040.01

English Version

Structural design of buried pipelines under various conditions of loading - Part 3: Common method

Calcul de résistance mécanique des canalisations enterrées sous diverses conditions de charge - Partie 3: Méthode commune

Statische Berechnung von erdverlegten Rohrleitungen unter verschiedenen Belastungsbedingungen - Teil 3: Einheitliches Berechnungsverfahren

This Technical Report was approved by CEN on 11 July 2005. It has been drawn up by the Technical Committee CEN/TC 165.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (CEN/TR 1295-3:2007) has been prepared by Technical Committee CEN/TC 165 “Wastewater engineering”, the secretariat of which is held by DIN.

This document has been prepared by a joint working group of the Technical Committee CEN/TC 165 “Wastewater engineering”, the secretariat of which is held by DIN and the Technical Committee CEN/TC 164 "Water supply", the secretariat of which is held by AFNOR.

This document is a composition of two options for the structural design of buried pipelines, including the annexes of each option, which have been combined in one single document. The document includes therefore the followind Annexes:

Annex A , Structural design of buried pipelines – option 1, including the Annexes to option 1 (Annex AA to Annex AG);

Annex B, Structural design of buried pipelines – option 2, including the Annexes to option 2 (Annex BA to Annex BG);

Annex C , Classification of soils;

Annex D, Factors of safety and failure probability;

Annex E, Longitudinal effects;

Annex F, Detailed notes relative to longitudinal effects.

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.

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Introduction

The history

In the mid-eighties the European Commission gave CEN an Order Voucher to develop a so-called "Common Structural Design Method for Buried Pipes" and the work was allocated jointly to CEN/TC 164 (Water supply) and CEN/TC 165 (Waste water engineering). To avoid duplication of work a Joint Working Group (CEN/TC 164/165 JWG1) was created in 1990. As a first step the group produced EN 1295-1, which was published in July 1997 and is a general part describing the "principles and input parameters" for structural design of buried pipelines and gives guidance on the application of these principles to nationally established methods of design. Reference was made to those methods and sources of information on them are given.

The second step was to produce CEN/TR 1295-2, which was published in August 2005 and describes national or regional methods. JWG1 continued its work with the aim of developing a single method for the structural design of buried pipes for water and wastewater, planned as EN 1295-3 (WI 00165155).

NOTE The work on WI 00165155 concentrated on pipes, not the piping system involving all components.

In 1992 JWG1 decided to give the work on a "Common Method" to a small group of experts (TG1). By this means it was thought to create optimal conditions for dealing with such a difficult task. The task, however, proved to be much more difficult than had been expected, because different design cultures exist throughout Europe. After much debate and analysis JWG1 finally arrived at a situation where two options were provided for internal TC enquiry, which closed in May 2002. The comments received from CEN members varied widely from strongly against one or both options, to very much in favour of one of them.

Faced with this result, CEN/TC 164 and CEN/TC 165 decided that the two options should not go to CEN enquiry, even though they would have been presented in an informative annex of the document. (A note would have been included in the short normative text, stating that a single "Common Method" could not yet be agreed but, during the next five years, the two options should be checked and reported upon by European experts working in this field. In the meantime, CEN/TC 164 and CEN/TC 165 continued its efforts to develop the "Common Method".

Current European practices

The "designer" is responsible for structural design in accordance with EN 1610,

JWG1 collated the national approaches to the structural design of buried pipelines in the countries of the CEN members who were participating in the work. The outcome was EN 1295-1, which facilitates a common basis of relevant requirements for application to nationally established methods of design. Although widely varying in their approach, these design cultures have been shown to provide continuity of acceptable design practice throughout Europe.

Later, CEN/TC 164 and CEN/TC 165 requested all CEN members to submit their current nationally established method for such structural designs. The collated outcome is given in CEN/TR 1295-2.

A common factor in all of the nationally established methods is that the parameters for pipe material and surface loads (i.e. mainly traffic loads) are well known and (depending on national requirements for the manufacturers' and any third-party quality control) in several countries even quality-controlled. On the other hand, only a few nationally established methods demand that soil parameters are obtained from each prospective construction site and not many of them prescribe test methods for soil parameters.

Furthermore, the multitude of calculation methods employed throughout Europe, now collated in CEN/TR 1295-2, use different soil parameters and these cannot be "transferred" from one calculation method to another.

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Whilst pipe material parameters are easily available from product standards and/or pipe manufacturers, the definition of soil parameters is the responsibility of the prospective pipeline owner or his designer. This possibly explains why, in many European countries, the traditional practice continues whereby detailed structural analysis of buried pipelines for water and wastewater systems is not carried out. The pipe manufacturers often provide information about the loading that the chosen pipe will withstand and this can often avoid investigating actual soil conditions.

If the structural design of a buried pipeline for a water or wastewater system is demanded, many construction companies and designers approach the pipe manufacturer, who will usually have the necessary expertise. But here too the same problems can occur, for the pipe material parameters are usually clearly defined (and a quality control system often established), whilst the soil parameters are uncertain. Only in a very few cases is there a quality control system for the earthworks at the construction site.

It is fundamental that, for a "Common Method" to apply throughout Europe, agreement shall first be reached on the definitions and test methods for soil parameters and a certain quality control system for the earthworks on site (see Clause 3), not withstanding that specific pipe material features are more easily recognized and taken into account.

The results obtained so far from the work of CEN/TC 164/165 JWG1 are shown in Clause 4. In 2003 CEN/TC 164 and CEN/TC 165 accepted a recommendation from JWG1 that the two structural design options should be published as a CEN Technical Report (CEN/TR) and work on a European Standard terminated, 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.

CEN/TC 164 and CEN/TC 165 accepted that it would be a pity to lose all the previous work, which should be made available to designers and the general public. The outcome is this document and it is hoped that the two options will provide a basis for continued debate and investigation.

The "Common Method"

Any future proposal for a new work item for the development of a European Standard for a "Common Method" for the structural design of buried pipelines would have to be approved by both CEN/TC 164 and CEN/TC 165, taking into account experience gained with the two options detailed in this document. There would also have to be a reasonable certainty of agreement being reached on a "Common Method" within the three-year limit for developing European Standards.

NOTE 1 Each structural analyst remains responsible for the choice of the calculation or design method.

NOTE 2 Subject to the requirements of the EU Procurement Directives as to the use of European Standards in public sector contracts, any future "Common Method" would be applied on the responsibility of the designer.

NOTE 3 One of the aims of a "Common Method" was to facilitate a general comparison between different pipeline materials and types for certain cases. It would also have been applicable to the general pressure classification of all pipes, as requested in EN 805:2000. For the time being, it would help if product standards indicated a method for that purpose.

Concluding remarks

This document describes the outcome of the work aimed at a "Common Method". Although the resulting two options could not be distilled into a single one, they are believed to be valid for many loading conditions for buried pipes. A survey of differences between option 1 and option 2 is given in Table 1. The report does not reflect the comments received from CEN members on the two options and the answers given by the principal advocates of each one.

CEN/TC 164 and CEN/TC 165 are aware that they did not fully succeed in agreeing a single "Common Method", but the development of two methods still represents considerable progress in underground pipeline applications.

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The two options should provide a good basis for future discussions about a single method and time will tell which seems the more feasible. In the meantime it is hoped that they will both be used and experience with them documented. Experts are invited to send experiences or questions to the secretariat of CEN/TC 165.

1 Scope

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

It applies for the structural design of buried piping systems, made from all materials used for the conveyance of fluids under pressure or gravity conditions.

Pipes to be designed for installations in abnormal or unusual conditions, e.g. in quick soils or a marine sea bed, are not covered by this document, it may require special engineering.

The design of very large diameter pipe installations may require considerations to be given to other additional parameters, e.g. the homogeneity of the surrounding soil.

The design method is intended to be used for pipes operating at different temperatures provided that the corresponding temperature re-rating factors for the relevant pipe properties are used as specified in the referring standard(s). Nevertheless, high services temperatures may require an additional analysis of the longitudinal stresses and strains and/or a special design of the joints.

2 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 amendments) applies.

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

EN 1991-2, *Eurocode 1 – Actions on structures — Part 2: Traffic loads on bridges*

3 Structural design issues

3.1 Soils

Soil is the load-carrying, load distributing and load transmitting structure. Different types of soils may be used for the bedding and embedding of the pipe and the main backfill of the trench.

Soil has also many parameters – as pipe materials – which have to be considered for structural design of earth-buried pipelines. At least the following parameters need to be taken into consideration:

— relative density (Proctor density) D_{pr};

— soil density;

— friction angle;

— soil modulus.

The soil parameters vary depending on the type of soil, its degree of compaction and the presence of groundwater. Option 1 and 2 use different soil moduli (Option 1: Oedometer; Option 2: Pressiometer).

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