TECHNICAL REPORT

ISO TR 10465-1

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Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes —

Part 1: Installation procedures

Installation enterrée de canalisations flexibles en plastique renforcé de fibres de verre/résine thermodurcissable (PRV) —

Partie 1: Procédures d'installation

Reference number
ISO/TR 10465-1:1993(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 10465-1, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Sub-Committee SC 6, *Reinforced plastics pipes and fittings for all applications*.

This document is being issued in the type 2 Technical Report series of publications (according to subclause G 6.2.2 of part 1 of the IEC/ISO Directives) as a "prospective standard for provisional application" in the field of underground use of GRP pipe because there is an urgent need for guidance on how standards in this field should be used to meet an ident-

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ified need. The reasons which led to the decision to publish this document in the form of a type 2 Technical Report are explained in the introduction.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this type 2 Technical Report will be carried out not later than two years after its publication with the options of: extension for another two years; conversion into an International Standard; or withdrawal.

ISO/TR 10465 consists of the following parts, under the general title *Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes*:

— *Part 1: Installation procedures*

— *Part 2: Static calculation methods*

— *Part 3: Parameters and application limits*

Annex A forms an integral part of this part of ISO/TR 10465. Annex B is for information only.

Introduction

0.1 Historical background

Work within ISO/TC 5/SC 6 (now ISO/TC 138) on writing standards for the use of glass-reinforced plastics (GRP) pipes and fittings was approved at the subcommittee meeting in Oslo in 1979. An ad hoc group was established and the responsibility for drafting various standards was later given to a Task Group (now ISO/TC 138/SC 6).

At the SC 6 meeting in London in 1980, Sweden proposed that a working group be formed for establishing documents regarding a code of practice for GRP pipes. This was approved by SC 6, and Working Group 4 (WG 4) was formed for this purpose. Since 1982, eleven WG 4 meetings have been held and various Task Groups have been formed, with research being carried out in the following areas:

— procedures for underground installation of GRP pipes;

— pipe/soil interaction with pipes having different stiffness values;

— minimum design features;

— overview of various static calculation methods.

During the work of WG 4 it became evident that no unanimous proposal could be reached within the WG upon specific methods to be employed and therefore WG 4 agreed that, pending further development and experience, all prepared descriptions with minimum acceptance levels should be compiled into a Technical Report (Type 2). This is to be prepared in three Parts, of which the present document is Part 1.

In Part 2, a survey will be given of different methods for static calculation of underground GRP pipe installations which are used on an international basis (e.g. ATV 127, December 1988 and AWWA C-950-88). Also, recommendations will be given for the choice of important parameters for those calculations, such as soil modulus, bedding angles, time lag factor and strain (shape) factors.

In Part 3, advice will be given, based on pipe installations according to Part 1 and static calculations according to Part 2, on such items as:

a) allowable depth of cover for different pipe stiffnesses in different native soils;

b) minimum pipe stiffness, depth of cover, and compactions for GRP pipes installed under traffic surfaces;

c) minimum pipe stiffness in relation to embedment conditions for GRP pipes which need to sustain negative pressures;

d) rerating of pressure pipes which are used under conditions, such as depth of cover, other than those for which the standard pipe has been designed;

e) influence of sheeting on allowable depth of cover.

0.2 Basic technical concepts

Glass-reinforced thermosetting resin (GRP) pipes are classed as flexible pipes that may be expected to deflect under external load with no structural damage. The performance of GRP pipe is affected by the amount of strain induced in the pipe wall by external loads and/or internal pressure. Allowable strain levels vary with the type of resin, lamination, manufacturing process and other variables. It is necessary to control the deflection and distortion of the pipe to ensure that the manufacturer's allowable strain level is not exceeded.

In an underground installation, the soil and traffic loads above a buried flexible pipe cause a decrease in the vertical diameter and an increase in the horizontal diameter of the pipe. The horizontal movement of the pipe walls into the soil material at the sides of the pipe develops a passive resistance that helps the pipe support the external load. The resistance of the soil is affected by the type of soil, its density, depth of overburden and the presence of groundwater. The higher the soil resistance, the less the pipe will deflect. Proper installation techniques are essential to develop the passive soil resistance required to prevent excessive pipe deflections and/or distortions.

The deflection of a buried flexible pipe depends on the soil and on the pipe. It is a function of the depth of burial, the stiffness of the pipe, the passive resistance of the soil at the sides of the pipe, the time-consolidation characteristics (time lag factor) of the soil and pipes and the degree of support given to the bottom of the pipe (bedding constant). Several procedures exist that can be used to obtain the mathematical relationship of these parameters and the deflection that will occur in a particular installation.

The methods of calculating the pertinent parameters will be covered in ISO/TR 10465-2.

It is important to recognize the effects of handling and installation on GRP pipes during initial pipe embedment. Care in soil placement and compaction will minimize deflection and distortion that is attributable to certain treatment during this phase of construction.

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Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes —

Part 1:
Installation procedures

1 Scope

This part of ISO/TR 10465 describes the procedures for underground installation of glass-reinforced thermosetting resin (GRP) pipes. The report refers generally to GRP pipes in particular stiffness classes for which performance requirements have been specified in at least one product standard, but it can also be used as a guide for the installation of pipes of other stiffness classes.

2 Terminology

Because pipeline installation terminology varies throughout the world, figure 1 has been prepared to illustrate the meaning and limits of the terms used in this part of ISO/TR 10465.

3 Soil conditions

The soil conditions that relate to trench construction and pipe installation should be determined prior to construction. If this information has not previously been established to the satisfaction of the engineer, a site exploration investigation programme should be conducted. The results of this programme should not only indicate the proper backfill and compaction procedures (see figure 2) to be followed, but should also indicate the areas of suitable materials so that importation of material may be minimized. Fine-grained soils with medium to high plasticity and organic soils with Group 4 classification (see annex A) are generally considered unsuitable for primary pipe zone backfill (see figure 1) material, unless the pipe has been specifically designed for this condition.

An important part of the site investigation is also to classify the native soil. Such a classification should be made in accordance with annex A, because this will facilitate the choice of suitable pipe stiffnesses in accordance with clause 4.

4 Selection of pipe stiffness (SN)

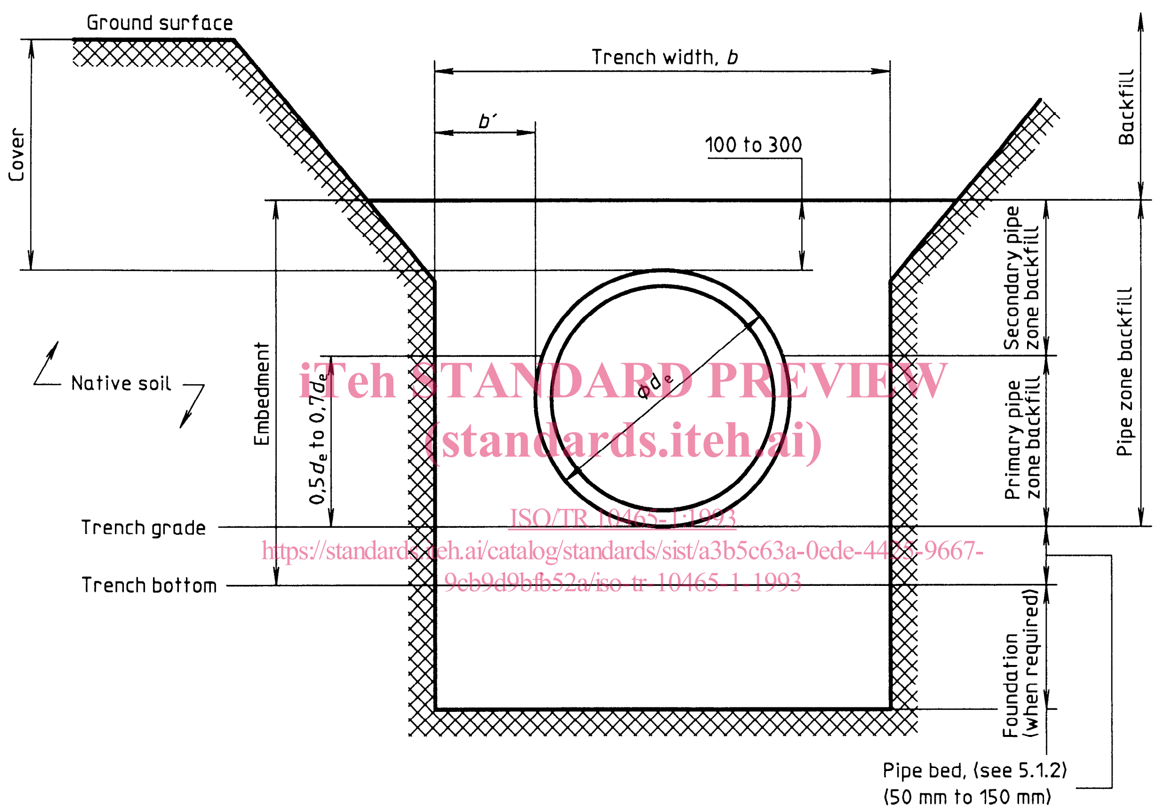
4.1 For general installations, the selection of SN from those classified in the relevant product standard is mainly dependent upon the native soil.

For other installations, such as installations under traffic surfaces or where considerable negative pressure can occur, other parameters also influencing the selection of SN will be dealt with in Part 3 of ISO/TR 10465.

4.2 In order to facilitate the selection of SN, the native soil can be classified in one of the four main groups described in annex A.

Based on this native soil classification, the minimum SN is then primarily chosen in accordance with figure 2, with due regard to the applicable installation system detailed in clause 7 and without consideration of traffic loads. Specific recommendations based upon the depth of cover should be made only after calculations based upon Part 3 of ISO/TR 10465.

Dimensions in millimetres

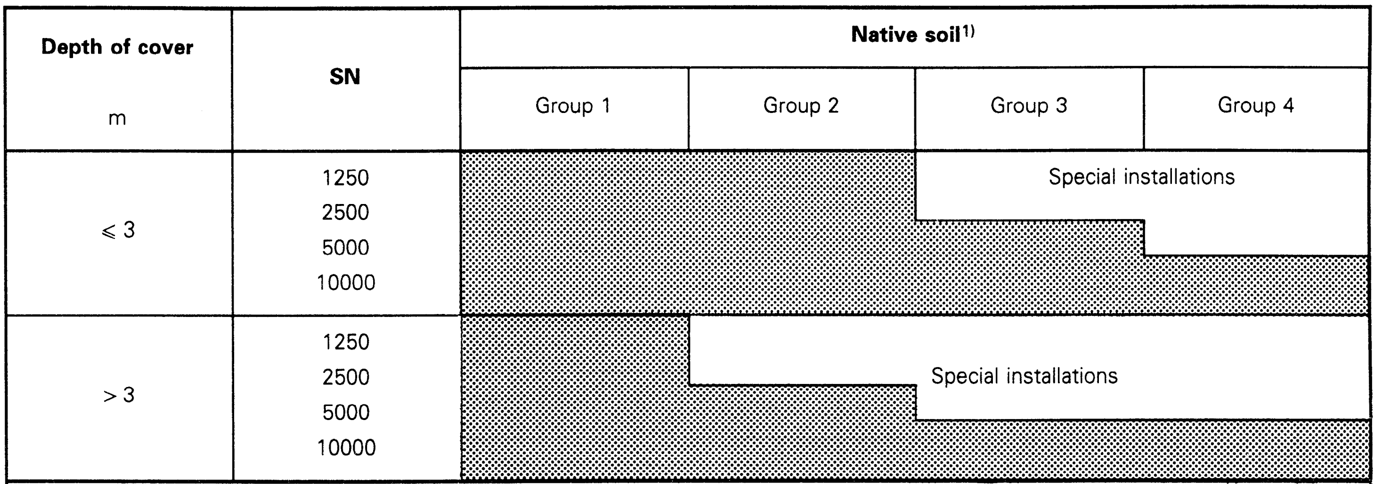


NOTES

1 For bedding thickness, see 5.1.2.

2 For dimension *b*′, see table 2.

Figure 1 — Trench cross-section showing terminology relationships



1) The suitability of the various standard embedments given in clause 7 for use at maximum depth or at minimum cover with or without traffic loads are discussed in Part 3 of ISO/TR 10465. Selection of a higher class of installation may permit the use of a specific pipe stiffness under more severe loading conditions, if verified by calculations.

Attention is drawn to the limitations that may apply to negative pressure in service and to mechanical compaction requirements during installation of SN 1250 and SN 2500 pipe.

It is very important when selecting SN to have knowledge of the properties of the native soil and its variations along the pipeline. If doubt exists regarding the accuracy of the information, consideration should be given to either increasing the SN or upgrading the installation.

Figure 2 — Minimum combinations of pipe stiffness (SN) and types of installation required for soil groups and depth of cover

5 Pipe trench construction

5.1 Trench bottom

5.1.1 Trench grade

The surface at the trench grade shall be continuous, smooth and free of particles greater than those specified in table 1, unless the maximum particle size in parentheses is permitted by the referring specification.

NOTE 1 Backfill free fall to the pipe crown should be kept to a minimum but never more than 2 m.

Table 1 — Trench grade particle size limits

Nominal pipe size DN	Maximum particle size mm
DN ≤ 300	10 (15)
300 < DN ≤ 600	15 (20)
600 < DN ≤ 1 000	20 (30)
1 000 < DN	25 (40)

5.1.2 Bedding and foundation

Where rock, hardpan or cobbles is/are encountered, the trench should be over-excavated to provide a minimum pipe bed of DN/4 (normal maximum 150 mm, unless socket requires more; minimum 50 mm). Very soft or expansive clays, irregular or fragmented rock and saturated soils are unsuitable foundation materials and do not uniformly support the loads placed upon them. The engineer may specify that further excavation be carried out and a foundation zone be provided. It is essential that each such situation is evaluated during construction to determine the extent of over-excavation and the type of foundation material to be used. Where over-excavation is performed, including inadvertent over-excavation during construction, the material for the foundation zone and its degree of compaction should be such as to result in soil resistance properties equal to that of the compacted primary pipe zone backfill material. The foundation zone material should be compacted uniformly in accordance with 7.2 and 7.3.

5.1.3 Special conditions

Where groundwater conditions are such that running or standing water occurs in the bottom of the trench, or are such that the soil in the bottom of the trench exhibits a quicksand tendency, remove the water by suitable means, such as well points or underdrains, until the pipe has been installed and the trench backfilled to a height great enough to prevent flotation of the pipeline. The gradation of the pipe zone backfill, bedding and foundation material shall be such that, under saturated conditions, fines from these areas will not migrate into the adjacent soil of the trench bottom or walls, and material from the trench bottom or walls will not migrate into the pipe zone material. Any migration or movement of soil particles from one area to another can result in the loss of the necessary foundation or side support for the pipe, or both. The migration of fine materials can be prevented by use of a filter fabric.

5.1.4 Jointing preparation

When installing pipe, provide jointing holes beneath the joint, unless the manufacturer recommends otherwise, to allow for proper assembly of the joint and to prevent the weight of the pipe from being carried on the joint. Each jointing hole shall be no larger than is necessary to accomplish proper joint assembly. When the joint has been made, carefully fill and compact the jointing hole with bedding material to provide continuous support of the pipe throughout its entire length.

5.2 Trench width

The width of the trench at the top of the pipe need not be greater than necessary to provide adequate room for jointing the pipe in the trench and compacting the pipe zone backfill at the haunches. The trench width b can be determined using the recommended minimum values for b' (see figure 1) given in table 2.

Table 2 — Recommended values for b'

Nominal pipe size DN	b' mm
50 ⩽ DN ⩽ 100	150
100 < DN ⩽ 200	150
200 < DN ⩽ 300	150
300 < DN ⩽ 500	200
500 < DN ⩽ 900	300
900 < DN ⩽ 1 600	450
1 600 < DN ⩽ 2 400	600
2 400 < DN ⩽ 4 000	900

NOTE — Wider trenches may be necessary for deep burials for reasons of safety owing to soil instability.

5.3 Trench depth

Determine the trench depth by considering the pipeline design, intended service, pipe properties, size of pipe and local conditions such as the properties of soil and combination of static and dynamic loading. Take care to ensure that the burial depth is sufficient to prevent the conveyed fluids from being affected by frost penetration. Provide sufficient cover to prevent accidental pipe flotation in potentially high ground water areas.

5.4 Safety

Shore, sheet, brace, slope or otherwise support the trench walls with sufficient strength to protect any worker(s) in the trench.

NOTE 2 Attention is drawn to any local or national safety regulations.

6 Pipe installation practice and control

6.1 Background information

At the beginning of the construction, the installer should seek advice and instruction on installation practices and control from the pipe manufacturer.

6.2 Handling and storage

Store and handle the pipe so as to prevent pipe damage. Carefully inspect each pipe internally and externally for damage prior to installation. Precautions should be taken when handling and/or moving the pipe.

When handling PVC-lined pipe at temperatures below 0 °C, precautions should be taken to avoid damage to the liner.

If the manufacturer permits long sections of piping to be assembled along the side of the trench and lowered into the trench after assembly, then when lowering the pipe into the trench avoid any strains that may overstress or buckle the pipe or impose excessive stress on the joints. Detailed installation requirements should be obtained from the pipe manufacturer.

6.3 Jointing the pipe

Skill and knowledge on the part of the installer are required. Use the manufacturer's recommended techniques, tools and equipment to obtain sound joints.

GRP pipe may be jointed together or to other pipe of dissimilar material using a number of different techniques. It is essential that the techniques used be suitable for the particular pipes being joined to one another. Consult the manufacturer for specific instructions not covered by existing specifications or for instructions concerning unusual service applications.

6.4 Angular deflection

When installed in a trench, the pipe may be deflected at the joint up to the maximum angle of deflection recommended by the manufacturer for the particular pipe and joint. If no recommendation is given, make changes in direction using fittings.

6.5 Anchoring

Where a change in horizontal or vertical direction, or both, will produce sufficient thrust to cause movement of the pipe, provide anchors or a restraining system designed accordingly.

6.6 Casing

It may be desirable, in certain cases, to install the pipe within a concrete or steel casing which has been installed under a railroad, roadway or other obstacle where normal trenching procedures are not applicable. In such cases, ensure that the inner surface of the casing material does not damage the GRP pipe when it is inserted in the casing. The rubbing surfaces may also be lubricated, or the pipe overwrapped with a protective material, to facilitate insertion into the casing. In order to avoid shearing loads on the pipe, compact the trench soil at the casing ends to a density that results in soil resistance properties equal to, or greater than, that of the compacted initial pipe zone backfill material. To prevent movement, secure the inner pipe by blocking that will not result in load concentration, or by partially or completely filling the void space with sand or grout. As the space is filled, use the pipe manufacturer's recommended allowable external grouting pressure to ensure that excessive deflection, distortion or damage does not occur.

6.7 Connection to rigid structures

Where differential settlement may be expected, such as at the ends of casing pipe or where the pipeline enters and exits a structure or anchor block, provide a flexible joint as shown in figure 3 or 4.

When casting a coupling or bell in concrete, be sure to maintain its roundness so that later joint assembly may be accomplished easily.

Since a concrete cast coupling or bell is quite rigid, it is important to minimize the vertical deflection and deformation of the adjacent pipe. This may be accomplished by placing a flexible joint at a distance of $L = 400$ mm or $d_e/2$, whichever is greater (see figure 4).

Optional rubber or bitumen wrap at the concrete interface may provide stress relief from expansion, shear and/or bending loads. This is particularly important for limiting radial shear and discontinuity stresses in a pressure pipe.

To minimize shear and bending stresses, support is particularly required for the pipe protruding from the concrete wall.

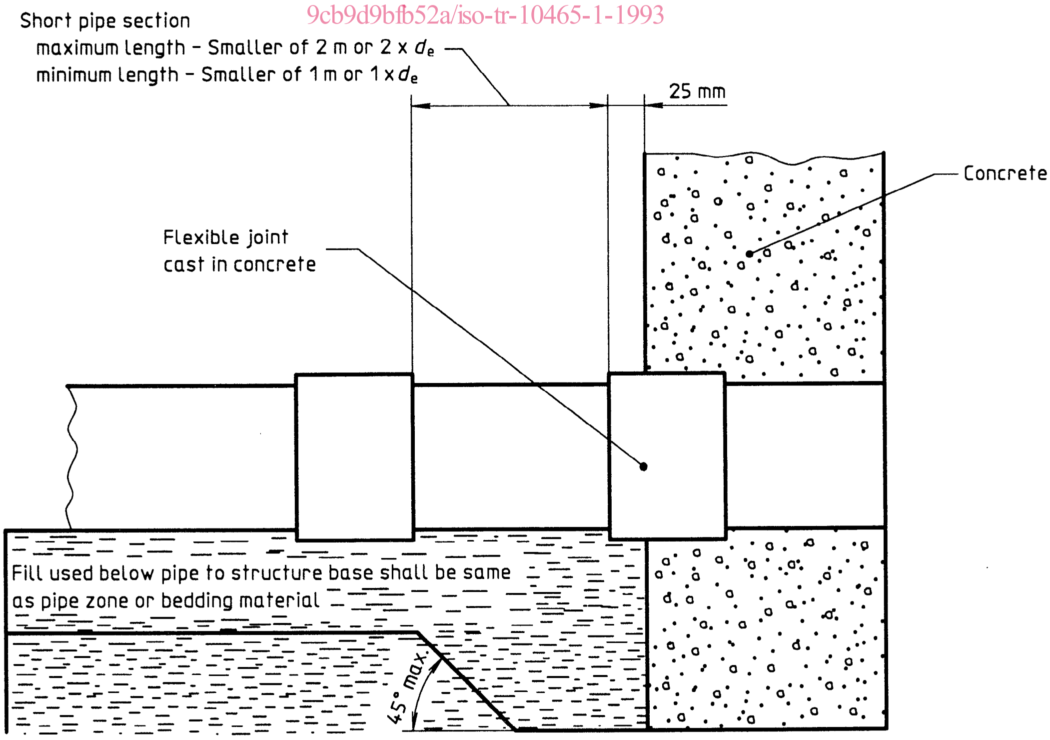


Figure 3 — Connection at a rigid structure — Flexible joint cast in concrete