SLOVENSKI STANDARD
SIST ENV 1046:2002

01-junij-2002

Cevni sistemi iz polimernih materialov - Sistemi zunaj stavb za transport vode ali kanalizacije - Postopki za vgradnjo nad zemljo in pod njo

Plastics piping and ducting systems - Systems outside building structures for the conveyance of water or sewage - Practices for installation above and below ground

Kunststoff-Rohrleitungs- und Schutzrohr-Systeme - Systeme außerhalb der Gebäudestruktur zum Transport von Wasser oder Abwasser - Verfahren zur ober- und unterirdischen Verlegung

Systemes de canalisations et de gaines en plastique - Systeme d'adduction d'eau ou d'assainissement a l'extérieur de la structure des bâtiments - Pratiques pour la pose en aérien et en enterré

Ta slovenski standard je istoveten z: ENV 1046:2001

ICS:

23.040.20	Cevi iz polimernih materialov	Plastics pipes
93.025	Zunanji sistemi za prevajanje vode	External water conveyance systems
93.030	Zunanji sistemi za odpadno vodo	External sewage systems

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English version

Plastics piping and ducting systems - Systems outside building structures for the conveyance of water or sewage - Practices for installation above and below ground

Systèmes de canalisations et de gaines en plastique - Système d'adduction d'eau ou d'assainissement à l'extérieur de la structure des bâtiments - Pratiques pour la pose en aérien et en enterré

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The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. ENV 1046:2001 E

Contents

Foreword

This European Prestandard has been prepared by Technical Committee CEN/TC 155 "Plastics piping systems and ducting systems ", the secretariat of which is held by NEN.

This prestandard is based on the results of the work being undertaken in ISO/TC 138 "Plastics pipes, fittings and valves for the transport of fluids", which is a Technical Committee of the International Organization for Standardization (ISO) (see bibliography), modified as necessary to be applicable to piping systems of any plastics materials and any relevant application.

This prestandard is a guidance document only. It provides a set of guidelines which gives correct practices for installation of plastics piping and ducting systems outside building structures above and below ground.

It relates to standards on general functional requirements and codes of practice.

CEN/TC 164 and CEN/TC 165 are preparing standards covering pipe laying and pipe design. When these standards are published this prestandard will be revised to take account of those standards.

It includes the following:

Annex A, which is normative, gives criteria for classification of soils;

Annex B, which is normative, details calculation procedures for assessing thermal effects on piping designs and/or layouts above ground;

Annex C, which is informative, describes the behaviour of buried flexible pipes;

Annex D, which is normative, describes joints and examples thereof;

Annex E, which is normative, details calculation procedures for assessing the need to apply the beam-column theory and determining the maximum deflection of above ground pipes;

Bibliography.

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

Introduction

This prestandard contains guidance for installation procedures for plastics piping systems and their components intended to be used above or below ground for pressure and non-pressure applications outside building structures. It is intended to be used in conjunction with general standards for installation recommendations, for example those issued by CEN/TC 164 "Water supply" and CEN/TC 165 "Waste water engineering".

This prestandard includes recommendations for the pipe surround and backfilling procedures but not road base and road sub-base details. Attention is drawn to any national regulations which may cover these or other aspects of installation.

This prestandard does not cover matters relating to renovation of existing pipeline systems using lining techniques, or replacement of existing pipeline systems using trenchless techniques.

This prestandard is intended to be used by authorities, design engineers, installation contractors and manufacturers.

In this prestandard, much of the guidance is expressed as requirements, e.g. by use of "shall" or by instructions in the imperative. It is strongly recommended that these be followed whenever applicable.

Other guidance is presented for consideration as a matter of judgement in each case, e.g. by use of "should".

1 Scope

This prestandard is applicable to the installation of plastics piping systems to be used for the conveyance of water or sewage under gravity and pressure conditions above and below ground. It is intended to be used for pipes of nominal size up to and including DN 3000.

Where in this prestandard the term "pipe" is used then it serves also to cover any "fittings", "ancillary" products and "components".

NOTE 1 It is assumed that additional recommendations and/or requirements are detailed in the individual materials System Standards. Instances where this is expected to apply include those indicated in this prestandard as follows:

a) any special transportation requirements (see 4.2.6);

b) maximum storage height (see 4.4.3 and 4.4.4);

c) maximum storage period in direct sunlight (see 4.4.6);

d) any climatic conditions requiring special storage (see 4.4.7);

e) limiting initial and/or long-term deflections (see 5.1.1 and 5.1.2);

f) information on mole ploughing and boring (see and 5.2), if applicable;

g) longitudinal tensile modulus and strength (see 5.3.1.2);

h) coefficient of thermal linear expansion (see 5.3.2.2 and Annex B);

i) suitability for use in areas exposed to sunlight (see 5.3.3);

j) selection of appropriate jointing system (see clause 6);

k) recommended radii of curvature for cold bending (see 7.1);

l) permitted rates of loss of water under test (see 8.2.1);

m) if applicable the relationship between SDR and stiffness.

NOTE 2 Guidance and instructions concerning commissioning of systems can be found in the standards prepared by CEN/TC 164 and by CEN/TC 165 and the relevant national and/or local regulations.

NOTE 3 Concerning the character of this document see Foreword and Introduction.

2 Normative references

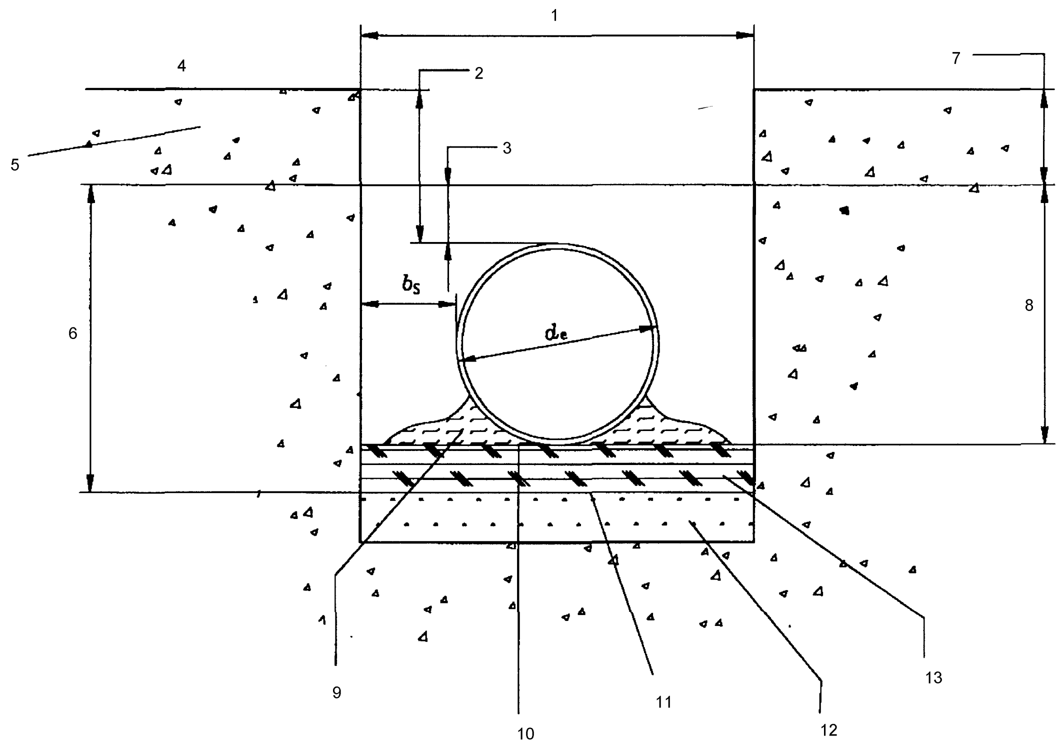
This prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications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

EN 1295-1:1997, *Structural design of buried pipelines under various conditions of loading — Part 1: General requirements*

3 Terms and definitions

3.1 Terminology

See Figure 1 for an illustration of the meaning and limits of the terms used in this prestandard.



key
1 Trench width, *b*
2 Depth of cover
3 100 mm to 300 mm
4 Ground surface
5 Native soil
6 Embedment
7 Main backfill
8 Pipe zone
9 Haunch zone
10 Trench grade
11 Trench bottom
12 Foundation, if required
13 Bedding, if required

Figure 1 — Trench cross-section showing terminology

3.2 Symbols

For the purposes of this prestandard, the following symbols apply:

A a specific type of U-shaped expansion joint (see Figure B.6);

a clearance between a pipe joint and an adjacent support (see Figure B.1);

A_p area of a pipe cross-section, $\pi \times (d_e - e) \times e$ (see Annex E);

B a specific type of U-shaped expansion joint (see Figure B.7);

b width of a trench cross-section (see Figure 1);

b_c bearing width of a cradle support (see Figure 17);

b_S horizontal clearance between the pipe or fitting and the trench sidewall or an adjacent pipe or fitting (see Figure 1);

c a factor for thermal expansion in relationships between fixed anchorages and compensation section pipe lengths (see Annex B);

d_e (mean) external diameter of a pipe (see Figure 1);

d_i (mean) internal diameter of a pipe [see equation (E.5)];

DN nominal size of a pipe and associated fittings;

e pipe wall thickness;

E_H hoop tensile modulus of elasticity (see Annex E);

E_x elasticity modulus of the pipe material in the longitudinal direction (see Annex B and Annex E);

F net sum of axial loads (see Annex E);

f_1 deflection multiplication factor (deflection) (see Annex E);

f_2 deflection multiplication factor (end rotation) (see Annex E);

f_3 deflection multiplication factor (moment) (see Annex E);

F_H horizontal reaction force on a pipework anchorage or sleeve (see Figure B.4);

F_ϑ thermal load (see Annex E);

F_ν Poisson load (see Annex E);

F_p load due to pressure (see Annex E);

F_S factor of safety [see equation (5)];

F_T reaction force on a fixed anchorage by thermal expansion or contraction of a pipe [see equation (B.2)];

F_V vertical reaction force on a pipework anchorage or sleeve (see Figure B.4);

h_s depth of snow (see Annex E);

I second axial moment of area (for a pipe) (see Annex B and Annex E);

L_1 first pipe length along the span (L_a) of an expansion joint from a fixed point to the offset leg (see figures B.4, B.5 and B.6);

L_{1C} the compensation portion of the first pipe length along the span of an expansion joint, i.e. from the offset pipe leg to the nearest preceding guide or anchorage (see figures B.4 to B.7);

L_2 second pipe length along the span (L_a) of an expansion joint from the first offset leg to the next offset leg or fixed point (see figures B.5 and B.6);

L_{2C} the compensation portion of the second pipe length along the span of an expansion joint, i.e. from the offset pipe leg to the next guide or anchorage (see Figure B.5);

L_3 third pipe length along the span (L_a) of an expansion joint from the second offset leg to the next fixed point;

L_{3C} the compensation portion of the third pipe length along the span of an expansion joint, i.e. from a second offset pipe leg to the next guide or anchorage (see Figure B.6);

L_a span of supported pipework between fixed anchorages;

l_b buckling length (see Annex E);

L_{BC} the compensation portion of a branch pipe, i.e. from the branch junction to the first guide or anchorage along the branch (see Figure B.2);

l_d length of the pipe influencing the deflection (see Annex E);

L_f free length of a straight pipe (see Figure B.1);

L_L free length from a fixed point of the second leg of an L-shaped expansion joint (see Figure B.4);

L_{LC} the compensation portion of the second leg of an L-shaped expansion joint, i.e. from the elbow to the next guide or anchorage (see Figure B.4);

L_O offset length of an expansion joint (see figures B.5 and B.6);

L_{OC} the compensation portion of the offset length of an expansion joint, i.e. from the first elbow to the next guide, anchorage or elbow (see Figure B.3);

L_S length of pipe span between support centres (see Annex B and Annex E);

$L_{S,max}$ maximum span width for pipe support (see Annex B);

M compaction classification: Moderate (see Table 5);

M_b bending moment (see Annex E);

N compaction classification: Not (see Table 5);

p internal pressure (see Annex E);

P_1, P_2 fixed points associated with expansion joints in a piping system (see figures B.3 to B.6);

p_{crit} critical negative pressure creating global buckling (see Annex E);

Q net sum of all axial loads acting on the pipe and in the liquid column (see Annex E);

q sum of laterally distributed loads (see Annex E);

q_0 linear load arising from the mass of the pipework itself (see Annex E);

Q_{crit} critical buckling load for the pipe as a column (see Annex E);

q_l linear load arising from the mass of liquid in a full pipe [see equation (E.8)];

q_s linear load arising from snow supported by the pipe [see equation (E.9)];

R_0 ratio of offset to linear compensation piping lengths [see equation (B.9)];

R_1 ratio of linear to offset compensation piping lengths [see equation (B.10)];

S initial specific stiffness (see Tables 1 and 2);

SN stiffness number or classification (see Tables 1 and 2);

W compaction classification: Well (see Table 5);

α_L linear coefficient of thermal expansion;

δ deflection of pipe at midspan between supports;

$+\Delta l_2$ thermal expansion;

$-\Delta l_1$ thermal contraction;

Δl variation in length;

$\Delta L_{1,h}$ thermal expansion of a pipe in horizontal direction [see equation (B.5a)];

$\Delta L_{L,v}$ thermal expansion of a pipe in vertical direction [see equation (B.5b)];

ΔT temperature difference creating load;

γ correction factor (see Table E.5);

γ_0 apparent specific weight of pipe wall material [see equation (E.7)];

γ_l specific weight of liquid contained in pipe in service [see equation (E.8)];

γ_s specific weight of snow (see Table E.5);

ν Poisson ratio (see Table E.5);

σ_b axial bending stress (see Annex E);

$\sigma_{c,b}$ axial compressive bending stress (see Annex E);

$\sigma_{c,crit}$ critical axial compressive stress (see Annex E);

$\sigma_{c,max}$ maximum axial compressive stress (see Annex E);

$\sigma_{c,n}$ axial compressive normal stress (see Annex E);

σ_n axial normal stress (see Annex E);

$\sigma_{x,d}$ allowable longitudinal stress in the pipe wall;

$\sigma_{x,p}$ longitudinal stress in the pipe wall induced by internal pressure;

$\sigma_{x,q}$ longitudinal stress in the pipe wall induced by distributed loads;

$\sigma_{x,r}$ remaining longitudinal design stress capability in the pipe wall [see equation (B.3)];

$\sigma_{x,u,L}$ longitudinal stress limit for long-term failure strength.

4 Transport, handling and storage at depots and sites

4.1 General

Plastics pipes may be supplied in straight lengths or coiled forms (either free standing or on drums).

NOTE Attention is drawn to the need for consideration of personnel safety during the transport, handling and storage, especially in wet and cold weather conditions. Particular care should be exercised when decoiling coiled pipes as considerable forces can be released.

Additional information should be given in the System Standards, if applicable.

4.2 Transport

NOTE Attention is drawn to the need to conform to national and/or local transport regulations.

4.2.1 When transporting pipes, use either flat-bed or purpose made vehicles. The bed shall be free from nails and other protuberances.

4.2.2 Secure the pipes effectively before transporting them. Any side support post shall be flat and free from sharp edges.

4.2.3 When loading socket-ended pipes, stack the pipes so that the sockets are not in contact with adjacent pipes.

4.2.4 The largest diameter pipes should be placed on the bed of the vehicle.

4.2.5 Pipes should not be allowed to overhang the vehicle by more than five times the nominal size, DN, expressed in metres or 2 m, whichever is the smaller. These recommendations may not apply when rigid bundles of pipes are being transported.

4.2.6 When pipes and/or fittings require special transportation practices the manufacturer shall notify the customer of the procedures to be used.

4.3 Handling

4.3.1 When handling the pipes, take care to prevent damage.

4.3.2 Plastics pipes can be damaged when in contact with sharp objects or if dropped, thrown or dragged along the ground.

4.3.3 It is preferable to use fabric slings or rope to lift the pipe. Metal bars, slings, hooks or chains will damage the pipe if they are used incorrectly. When loading or unloading pipes with fork lift equipment, then only fork lift trucks with smooth forks should be used. Care should be taken to ensure that forks do not strike the pipe when lifting.

4.3.4 The impact resistance of plastics pipes is reduced at very low temperatures and under these conditions, take more care during handling.

4.4 Storage

4.4.1 Although plastics pipes are light, durable and resilient, take reasonable precautions during storage.

4.4.2 Stack the pipes or coils on surfaces free from sharp objects, stones or projections. For the maximum stacking height, see the referring standard.

When storing pipes in racks, ensure that any sockets lie alternately within the pile and project sufficiently for the pipes to be correctly supported.

4.4.3 Where the pipes are supplied in coils, store them either vertically or stacked flat one on top of the other, taking care to protect the pipes from extremes of temperature. For further information, see the referring standard.

Each coil of pipe of nominal size greater than DN 90 should be stored vertically in purpose-built racks or cradles. For further information, see the referring standard.

4.4.4 When straight pipes are stored on racks, these shall provide sufficient support to prevent permanent deformation.

4.4.5 Do not place pipes or rubber seals in close proximity to fuels, solvents, oils, greases, paints or heat sources.

4.4.6 For the recommended maximum storage period for pipes in direct sunlight, see the referring standard.

4.4.7 In extreme climatic conditions special storage requirements may be necessary. Follow the advice given in the manufacturer's technical data accordingly.

4.4.8 If pipes are supplied in a bundle or other packaging, the restraints and/or packaging should be removed as late as possible prior to installation.

5 Installation

5.1 Pipes in trenches

5.1.1 Behaviour of flexible pipes under load

The behaviour of a pipe when subject to a load depends upon whether it is flexible or rigid. Plastics pipes are flexible. When loaded a flexible pipe deflects and presses into the surrounding material. This generates a reaction in the surrounding material which controls deflection of the pipe. The amount of deflection which occurs is limited by the care exercised in the selection and laying of the bedding and sidefill materials. Hence flexible pipes rely for their load-bearing properties on the bedding and sidefill materials.

In the case of rigid pipes, the load on a pipe is borne primarily by the inherent strength of the pipe material and when this load exceeds a limiting value the pipe breaks. Standards for rigid pipes, therefore, usually include ultimate crushing strength tests to determine this limiting value and thus assess the loadings which may be allowed above the installed pipe.

Flexible pipes on the other hand deflect under load and can be deflected to a high degree without fracture. The level of deflection reached by a buried pipe depends on the properties of the surrounding material and to a much less extent on the stiffness of the pipe but not on its strength properties. Hence for flexible pipes the crushing strength test and design procedures applied to rigid pipes are not appropriate.

When a flexible pipe is installed and backfilled it will be deflected. This is called the initial deflection. The pipe continues slowly to have an increase in deflection but reaches a limiting value within a reasonable period of time. The use of the installation procedures detailed in this prestandard will minimize the levels of both the initial and final deflections. If the pipeline is pressurized then a reduction in the amount of deflection will occur. A more detailed description of this behaviour is given in Annex C.

5.1.2 Limiting deflection

There are several methods of structural design (see EN 1295-1:1997) that are used to estimate the deflection of a pipe under load but, though they are capable of being in reasonable agreement, they do not give exactly the same answers for a given condition. The values calculated are usually the expected average deflections.

Pipes made from different materials have different limiting deflection levels. For the applicable maximum permissible initial and, if appropriate, long-term deflection see the relevant System Standard. If this installation prestandard is followed it is expected that the deflections will be less than the limiting values given in the relevant System Standards.

Where it can be expected that a product covered by the System Standard may be delivered with some distortion, e.g. pipes delivered in coils, then this should be stated. The average deflection is to be assumed to be in addition to this distortion.

5.1.3 Design considerations

5.1.3.1 General

If it is essential to determine the soil conditions that relate to trench construction and pipe installation prior to construction, the native soil and the backfill material shall be classified in accordance with Annex A. The classification shall be used to choose a suitable pipe stiffness in accordance with 5.1.3.2.

NOTE The classification will also indicate the areas of suitable materials for pipe zone backfill, so that importation of material may be minimized. Native materials conforming to 5.1.6.3 and group 1, 2, 3 and 4 are all suitable as backfill in the pipe zone. If backfill materials have to be imported it is suggested that group 1 or 2 materials are used.

5.1.3.2 Choice of pipe stiffness

The choice of pipe stiffness shall be made either using the tables in this prestandard or on the basis of calculations in accordance with EN 1295-1:1997 or on the basis of previous experience.

Where calculations show that a pipe stiffness lower than that given in Table 1 or Table 2 is appropriate, then pipes with this lower stiffness may be used. Where pipes are intended to be used in conditions where they have by previous experience proved to be satisfactory it is not necessary to verify this by detailed calculation even though their stiffness may be lower than the appropriate value given in Table 1 or Table 2.

If such experience is not available then the minimum stiffness required shall be selected from Table 1 or Table 2. These tables have been prepared to cover the following conditions:

a) non-trafficked areas with depths of cover between 1 m and 3 m and between 3 m and 6 m see Table 1);

b) trafficked areas with depths of cover between 1 m and 3 m and between 3 m and 6 m (see Table 2).

In the absence of prior satisfactory experience, where pipes have a depth of cover less than 1 m or more than 6 m the pipe stiffness and the installation shall be designed by calculation.

Where a System Standard uses SDR for classification purposes instead of stiffness it shall also give the equivalent stiffness values in its relevant part.

Generally the choice of pipe stiffness depends upon the native soil, the pipe zone backfill material and its compaction, the depth of cover, the loading conditions and the limiting properties of the pipes.

In order to make a choice of pipe stiffness possible, the native soil and backfill materials have been classified into six main groups as described in Annex A.

Based on the native soil, backfill details and depth of cover, the minimum pipe stiffness is selected from Tables 1 or 2. Using a pipe of this stiffness installed in an embedment formed from the appropriate backfill material compacted to the specified degree of compaction should result in deflections of not more than the limiting values given in the relevant System Standard.

NOTE Whenever a common structural design method for buried pipelines (at least one for plastics materials) becomes available, Tables 1 and 2 will be reviewed.

Table 1 — Recommended minimum stiffness for non-trafficked areas

Values in newtons per square metres

Backfill Material group [3]	**Compaction-class** [2]	**Pipe stiffness** [1]					
		For depth of cover ≥ 1 m and ≤ 3 m					
		Undisturbed native soil group [3]					
		1	2	3	4	5	6
1	W M N	1250 1250 2000	1250 2000 2000	2000 2000 2000	2000 4000 4000	4000 5000 8000	5000 6300 10000
2	W M N		2000 2000 4000	2000 4000 6300	4000 5000 8000	5000 6300 8000	5000 6300 **
3	W M N			4000 6300 **	6300 8000 **	8000 10000 **	8000 ** **
4	W M N				6300 ** **	8000 ** **	8000 ** **
		For depth of cover > 3 m and ≤ 6 m					
1	W M	2000 2000	2000 4000	2500 4000	4000 5000	5000 6300	6300 8000
2	W M		4000 5000	4000 5000	5000 8000	8000 10000	8000 **
3	W M			6300 **	8000 **	10000 **	** **
4	W M				** **	** **	** **

1) Initial specific stiffness, *S*, determined in accordance with the relevant System Standards
2) See Table 5.
3) See Annex A.
**) Structural design is necessary to determine trench details and pipe stiffness.

NOTE 1 If a pipe of given stiffness is intended to be used under more severe loading conditions (than originally envisaged), it may be possible to achieve this by the use of a higher class of installation. It is essential that this is verified by structural design.

NOTE 2 Attention is drawn to the limitations that may apply due to negative pressure in service and due to mechanical compaction requirements during installation for pipe stiffness up to and including SN 2500.

NOTE 3 In cases of combined loading conditions (such as soil load plus internal pressure) special considerations and possibly precautions should be taken.

Table 2 — Recommended minimum stiffness for trafficked areas

Values in newtons per square metres

Backfill Material group 3)	Compaction class 2)	Pipe stiffness 1)					
		For depth of cover ≥ 1 m and ≤ 3 m					
		Undisturbed native soil group 3)					
		1	2	3	4	5	6
1	W	4000	4000	6300	8000	10000	**
2	W		6300	8000	10000	**	**
3	W			10000	**	**	**
4	W				**	**	**
		For depth of cover > 3 m and ≤ 6 m					
1	W	2000	2000	2500	4000	5000	6300
2	W		4000	4000	5000	8000	8000
3	W			6300	8000	10000	**
4	W				**	**	**

1) Initial specific stiffness, *S*, determined in accordance with the relevant System Standards
2) See Table 5.
3) See Annex A.
**) Structural design is necessary to determine trench details and pipe stiffness.

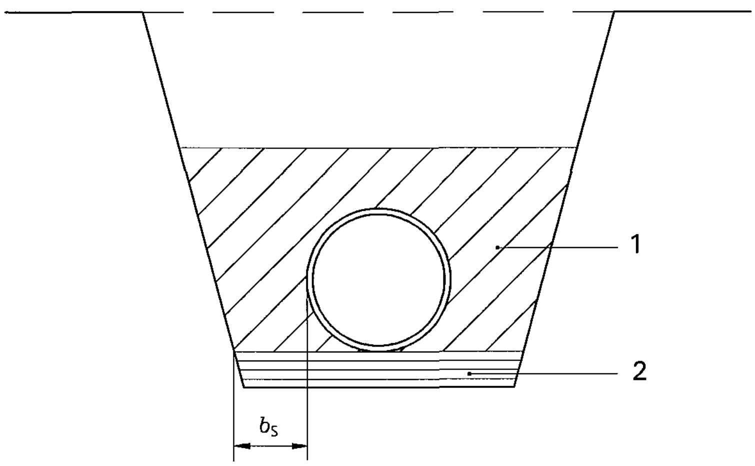
NOTE 1 If a pipe of given stiffness is intended to be used under more severe loading conditions (than originally envisaged), it may be possible to achieve this by the use of a higher class of installation. It is essential that this is verified by structural design.

NOTE 2 Attention is drawn to the limitations that may apply due to negative pressure in service and due to mechanical compaction requirements during installation for pipe stiffness up to and including SN 2500.

NOTE 3 In cases of combined loading conditions (such as soil load plus internal pressure) special considerations and possibly precautions should be taken.

5.1.3.3 Types of installation

The two most commonly used practices for the installation of plastics pipes are either to surround the pipe with the same material (see Figure 2) or splitting the surround into two materials or degrees of consolidation (see Figure 3). The use of such a split embedment is normally only found to be practical with pipes of nominal sizes greater than DN 600.



Key
1 Pipe zone
2 Bedding

Figure 2 — Trench with full surround pipe zone