BRITISH STANDARD

BS EN 1610 : 1998

Construction and testing of drains and sewers

The European Standard EN 1610 : 1997 has the status of a British Standard

ICS 91.140.80

National foreword

This British Standard is the English language version of EN 1610 : 1997, published by the European Committee for Standardization (CEN).

The UK participation in its preparation was entrusted by Technical Committee B/505, Wastewater engineering, to Subcommittee B/504/505/1, Design and installation of buried pipelines, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or by using the 'Find' facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 31 and a back cover.

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Descriptors: Sanitation, pipelines, buried pipes, pressure pipes, junctions, definitions, materials, earthworks, coating processes, implementation, tests

English version

Construction and testing of drains and sewers

Mise en oeuvre et essai des branchements et collecteurs d'assainissement

Verlegung und Prüfung von Abwasserleitungen und -kanälen

This European Standard was approved by CEN on 18 May 1997. 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.

This European Standard exists 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.

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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 1610 : 1997 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165, Wastewater 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 March 1998, and conflicting national standards shall be withdrawn at the latest by March 1998.

Annexes A, B and C are informative.

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.

Contents

1 Scope

This European Standard is applicable to the construction and testing of drains and sewers normally buried in the ground and normally operating under gravity.

The construction of pipelines operating under pressure is covered by this European Standard together with prEN 805 as appropriate.

This European Standard is applicable to drains and sewers laid in trenches, under embankments or above ground. Trenchless construction will be covered in prEN 12889. Additionally other local or national regulations should be taken into account, e.g. concerning health and safety, pavement reinstatement and requirements for leaktightness testing etc.

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 these 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.

EN 476	*General requirements for components used in discharge pipes, drains and sewers for gravity systems*
EN 752-3	*Drain and sewer systems outside buildings – Part 3: Planning*
prEN 805	*Water supply – Requirements for external systems and components*
EN 1295-1	*Structural design of buried pipelines under various conditions of loading – Part 1: General requirement*
prEN 12889	*Trenchless construction and testing of drains and sewers*

3 Definitions

For the purposes of this standard the following definitions, including figure 1, apply.

3.1 bedding

Part of the construction which supports the pipe between the trench bottom and the sidefill or initial backfill. The bedding consists of upper and lower bedding. In the case of the pipe laid on natural trench bottom, the trench bottom is the lower bedding.

3.2 compaction layer thickness

Thickness of each new layer of fill material prior to its compaction.

3.3 depth of cover

Vertical distance from the top of the pipe barrel to the surface.

3.4 embedment

Fill around the pipe including bedding, sidefill and initial backfill.

3.5 initial backfill

Layer of fill material immediately above the crown of the pipe.

3.6 main backfill

Fill between the top of the embedment and the level of the ground, top of embankment or, when applicable, the bottom of the road or railway construction.

3.7 minimum trench width

Minimum distance needed for safety and construction between the trench walls at the top of the lower bedding or when applicable between the trench supports at any level.

3.8 native soil

Soil from the excavation of the trench.

3.9 nominal size (DN)

Numerical designation of size of component, which is a convenient integer approximately equal to a manufacturing dimension in millimetres. This may apply to either the internal diameter (DN/ID) or the external diameter (DN/OD) (EN 476).

3.10 pipeline

Assembly of pipes, fittings and joints between manholes or other structures.

3.11 prefabricated component

Product manufactured separately from the installation process, generally in circumstances where a product standard applies and/or a manufacturer's quality control is in place.

3.12 sidefill

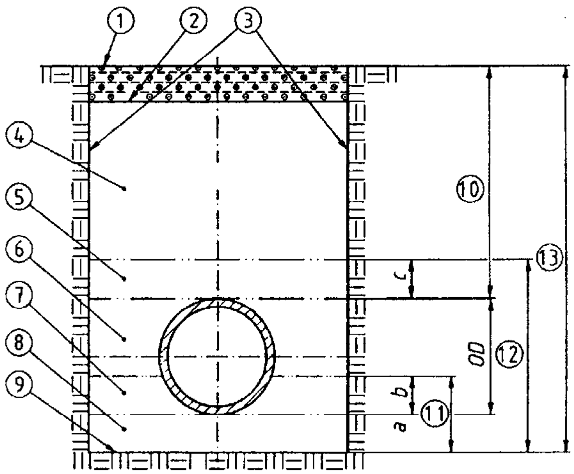
Material between bedding and initial backfill.

3.13 trench depth

Vertical distance from the bottom of the trench to the surface.

The same definitions apply for trenches with sloping sides and for embankments where appropriate.

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



$b = k \times \text{OD}$ (see clause **7**)

where:

k is a dimensionless factor relating the upper bedding thickness, *b*, to OD;
OD is the outside diameter of the pipe in millimetres.

NOTE 1. For minimum values of *a* and *c*, see clause **7**.

NOTE 2. $k \times \text{OD}$ replaces the designation of bedding angle in some existing national standards. The bedding angle is not the bedding reaction angle used in structural design.

Figure 1. Illustration of definitions

4 General

4.1 Concepts

Pipelines and manholes are essentially engineering structures in which the combined performance of construction components, bedding, and fill constitute the basis for stability and safety in operation. The pipes, fittings and joint materials supplied, together with the work carried out at site, such as the pipe bedding, the jointing of pipes, the sidefilling and backfilling are all important factors in achieving a structure with adequate performance.

4.2 Safeguarding design assumptions

The strength of a pipeline shall be determined, decided or specified before construction work is undertaken in accordance with EN 752-3 and EN 1295-1.

In the execution of the work, it should be ensured that the assumptions made in the design are safeguarded or adapted to changed conditions.

The design assumptions are affected in particular by any variation of the following:

- trench width compared to the design width;
- trench depth compared to the design depth;
- trench support system and the effect of its removal;
- degree of compaction of the embedment;
- degree of compaction of main backfill;
- pipe support and trench bottom conditions;
- construction traffic and temporary loads;
- soil types and soil parameters (e.g. subsoil, trench walls, backfill);
- shape of trench (e.g. stepped trench, trench with sloping walls);
- ground and soil condition (e.g. frost and thaw, rain, snow, flooding);
- groundwater table;
- additional pipelines in the same trench.

NOTE. The above list is not exhaustive.

5 Construction components and materials

5.1 General

Construction components and materials shall conform to national standards, transposing European Standards as available, or to European technical approvals, or, in the absence of these, the components and materials shall comply with the requirements of the specifier.

5.2 Construction components

Construction components shall comply with **5.1**.

Any supplementary instructions of the manufacturer shall be observed.

5.3 Materials used for embedment

5.3.1 *General*

The materials used for embedment shall comply with the appropriate subclauses of **5.3** in order to be capable of providing permanent stability and loadbearing capacity for the pipeline buried in the ground. Such materials shall not be detrimental to the pipe or pipe materials, or to the groundwater.

Frozen materials shall not be used.

Materials used for embedment shall conform with the design requirements. The materials may either be native soil (see **5.3.2**), if proved to be suitable, or imported materials (see **5.3.3**). Materials for bedding should contain no particles with sizes above:

– 22 mm for DN ≤ 200;

– 40 mm for DN > 200 up to DN ≤ 600.

5.3.2 *Native soil*

Requirements for re-use of native soil are:

– conformity with design requirements;

– compactability if specified;

– freedom from materials detrimental to the pipe, e.g. 'oversized' particles (depending on pipe material, wall thickness and diameter), tree roots, rubbish, organic material, clay lumps > 75 mm, snow and ice.

Native soil meeting the requirements of **5.3.3.1** or **5.3.3.3** is considered suitable.

5.3.3 *Imported materials*

The following materials, which may include recycled materials, are suitable.

5.3.3.1 *Granular materials*

Granular materials include:

– single-size granular material;

– graded granular material;

– sand;

– all-in aggregates;

– crushed aggregates.

Guidance on granular materials is given in annex B.

5.3.3.2 *Hydraulically bonded materials*

Hydraulically bonded materials include:

– soil cement;

– lightweight concrete;

– lean concrete;

– unreinforced concrete;

– reinforced concrete.

They shall be as specified in the design.

5.3.3.3 *Other materials*

Materials other than those described in **5.3.3.1** to **5.3.3.2** may be used for embedment if their suitability as defined under **5.3.1** is proved. Natural or artificial substances which may cause damage to the pipeline and manholes are unsuitable.

Environmental consequences should be considered.

5.4 Materials used for main backfill

Materials used for main backfill shall conform to the design requirements.

Materials specified in **5.3** may be used for main backfill.

The maximum size of stones in excavated material used for backfill should be 300 mm or the thickness of the initial backfill or half of the compaction layer thickness, whichever is the smallest. The maximum size may be further limited depending on soil conditions, groundwater and pipe material. Special conditions may be specified for rocky areas.

6 Excavation

6.1 Trenches

Trenches shall be designed and excavated in such a way as to ensure correct and safe installation of pipelines.

If construction access is required to the outside face of underground structures, e.g. manholes, a protected minimum working space 0,50 m wide shall be provided.

Where two or more pipes are being laid in the same trench or embankment, a minimum horizontal working space shall be observed for the distance between the pipelines. If not otherwise specified, it shall be: 0,35 m for pipes up to and including DN 700, and 0,50 m for pipes greater than DN 700.

Where necessary, appropriate safety measures for other supply pipelines, drains and sewers, constructions or surfaces shall be observed to protect these against detrimental effects.

6.2 Trench width

6.2.1 *Maximum trench width*

The trench width shall not exceed the maximum width specified in the structural design.

If this is not possible, the matter shall be referred to the designer.

6.2.2 *Minimum trench width*

The minimum trench width shall be the greater of the values taken from tables 1 and 2, except as provided in **6.2.3**.

Table 1. Minimum trench width in relation to nominal size DN

DN	Minimum trench width (OD + x) m		
	Supported trench	Unsupported trench	
		$\beta > 60°$	$\beta \leq 60°$
≤ 225	OD + 0,40	OD + 0,40	OD + 0,40
> 225 to ≤ 350	OD + 0,50	OD + 0,50	OD + 0,40
> 350 to ≤ 700	OD + 0,70	OD + 0,70	OD + 0,40
> 700 to ≤ 1200	OD + 0,85	OD + 0,85	OD + 0,40
> 1200	OD + 1,00	OD + 1,00	OD + 0,40

In the values OD + x, x/2 equals the minimum working space between the pipe and the trench wall or support, where:

OD is the external diameter, in metres;

β is the angle of unsupported trench side measured to the horizontal (see figure 2).

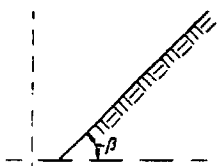


Figure 2. Angle β of unsupported trench wall

Table 2. Minimum trench width in relation to trench depth

Trench depth m	Minimum trench width m
< 1,00	No minimum width required
≥ 1,00 ≤1,75	0,80
> 1,75 ≤ 4,00	0,90
> 4,00	1,00

6.2.3 *Exceptions to minimum trench width*

The minimum width of trench obtained from tables 1 and 2 may be modified in the following circumstances:

– where personnel will never be required to enter the trench, e.g. automated laying techniques;

– where personnel will never be required to enter between pipeline and trench wall;

– in unavoidable constricted situations.

In each of these cases, special measures will be required in design and construction.

6.3 Trench stability

Trench stability shall be ensured either by means of a trench support system, by battering the trench sides or by other suitable means. Trench support systems shall be removed in accordance with the assumptions in the structural design in such a way that the pipeline is not moved or damaged.

6.4 Trench bottom

The gradient of the trench bottom and the trench bottom material shall comply with the design specifications. Trench bottom material should not be disturbed. If it is disturbed, its original bearing capacity shall be restored by some suitable means.

Where pipes are to be laid on the trench bottom, this shall be trimmed to the required gradient and shape to provide support to the barrel of the pipe. Socket holes shall be provided in the lower bedding or trench bottom as appropriate.

In freezing conditions, it may be necessary to protect the trench bottom so that frozen layers are not left under or around the pipeline.

Where the trench bottom is unstable or the soil has low bearing capacity, suitable precautions shall be taken (see **7.1** and **7.3**).

6.5 Dewatering

During installation work, excavations should be kept free from water, e.g. rainwater, seepage water, spring water or water from leaks from pipelines. Methods of dewatering shall not affect embedments and pipelines (see also annex A).

Precautions shall be taken to prevent loss of fine material during dewatering.

The influence of dewatering on groundwater movement and the stability of the surrounding area shall be taken into account.

On completion of dewatering, any temporary drains shall be adequately sealed.

7 Embedment and support

7.1 General

Materials, bedding, support and embedment layer thickness shall be in accordance with the design requirements. Materials in accordance with **5.3.2** and **5.3.3** should be chosen. The embedment material and its grading, together with any support, shall be selected with regard to:

- the size of the pipe;
- the pipe material and pipe wall thickness;
- the nature of the soil.

The width of the bedding shall be the width of the trench unless otherwise specified. For pipelines laid within embankments, the width of the bedding shall be four times OD unless otherwise specified.

Minimum thickness *c* (see figure 1) of the initial backfill shall be 150 mm above the barrel and 100 mm above the joint. When using materials described in **5.3.3.2** and **5.3.3.3**, *c* shall be as specified in the design.

Any localized quantity of soft ground below the trench bottom shall be removed and replaced with suitable bedding material. If more extensive quantities are encountered, a re-evaluation of the structural design should be undertaken.

7.2 Bedding construction types

7.2.1 *Bedding construction type 1*

Bedding construction type 1 (figure 3) may be used in any case of embedment, providing support for the pipes over their whole barrel length, using the layer thickness requirements for *a* and *b*. This includes any size and shape of pipes, e.g. circular, non-circular, flat-based.

Unless otherwise specified, the thickness of the lower bedding *a*, measured under the barrel, shall not be less than:

- 100 mm in normal soil conditions;
- 150 mm in rock or hard soil conditions.

The thickness *b* of upper bedding shall be as specified in the structural design.

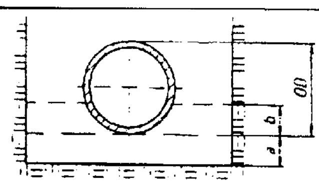


Figure 3. Bedding construction type 1

7.2.2 *Bedding construction type 2*

Bedding construction type 2 (figure 4) may be used in uniform, relatively soft, fine-grained soil providing support for the pipes over their whole barrel length. Pipes may be laid directly on the shaped, trimmed bottom of the trench.

The thickness *b* of upper bedding shall be as specified in the structural design.

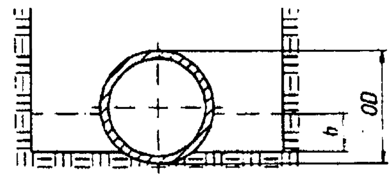


Figure 4. Bedding construction type 2

7.2.3 *Bedding construction type 3*

Bedding construction type 3 (figure 5) may be used in uniform, relatively soft, fine-grained soil providing support for the pipes over their whole barrel length. Pipes may be laid directly on the trimmed bottom of the trench.

The thickness *b* of upper bedding shall be as specified in the structural design.

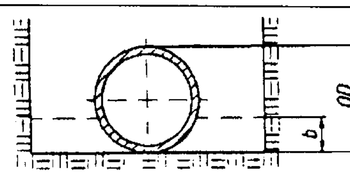


Figure 5. Bedding construction type 3

7.3 Special methods of bedding or support

Where the trench bottom has little bearing strength to support the pipe bedding material, special construction measures will be necessary. This is likely to occur in unstable soils, e.g. peat, running sand.

Examples of possible measures include replacement of soil with other materials, e.g. sand, gravel and hydraulically bonded materials, or supporting the pipeline on piled structures, e.g. using cross beams or cradle support, longitudinal beams or reinforced concrete slabs spanning the piles.

Consideration should also be given, during design and installation, to the transition from one ground condition to another with different settlement properties.

Special methods of bedding or pipeline support shall only be used if their suitability has been confirmed by structural design calculations.

NOTE. Pipelines laid on piles below ground may be subjected to extremely high loads.

8 Installation

NOTE. Within the context of this clause, the term 'pipes' includes also fittings and other pipeline components unless stated otherwise.

8.1 Setting-out

Prior to setting-out, a sufficient survey shall be conducted to locate pipes, cables or other underground works. If the results of the survey affect line and level the designer shall be notified.

The centreline and top width of trench shall be accurately set out, marked and referenced.

When required, temporary bench marks shall be established in stable positions where they are unlikely to be disturbed.

8.2 Delivery, handling and transportation on site

Pipes, pipeline components and jointing accessories shall be inspected on delivery to ensure that they are appropriately marked and comply with the design requirements.

Any instructions from the manufacturer shall be adhered to.

Products shall be examined both on delivery and immediately prior to installation to ensure that they are free from damage.

8.3 Storage

Any instructions from the manufacturer, and the requirements of the appropriate product standards, shall be adhered to.

All materials should be stored in a manner which will keep them clean and avoid contamination or degradation; for example, elastomeric jointing components should be kept clean and be protected from sources of ozone (e.g. electrical equipment), sunlight and oil, where necessary.

Pipes shall be secured to prevent rolling. Excessive stacking heights should be avoided so that pipes in the lower part of the stacks are not overloaded. Stacks of pipes shall not be placed close to open trenches.

Pipes with protective coatings shall be stored where necessary, on supports which keep them clear of the ground to avoid damage to coatings and joints. All pipes should be stored on supports in very cold weather to avoid freezing to the ground.

8.4 Lifting of components

Components shall be lifted using suitable equipment and methods, for safety reasons and to avoid damage.

8.5 Laying

8.5.1 *General*

Pipe laying should start at the downstream end, the pipes being normally laid with the sockets upstream.

Consideration should be given to the need for the ends of pipes to be temporarily plugged when work is significantly interrupted. Any protective end-caps should not be removed until immediately prior to jointing. Materials should be prevented from entering the pipes. Any material left in the pipe shall be removed.

Where a particular orientation of the pipes is necessary, e.g. a mark indicating top of pipe, this shall be complied with.

8.5.2 *Line and level*

The pipes shall be laid true to the line and level within tolerances specified by the design. Any necessary adjustments to the level shall be made by raising or lowering the bedding, always ensuring that the pipes are finally provided with support along their whole length. Permanent adjustment shall never be made by local packing.

8.5.3 *Jointing*

Protective end-caps shall be removed immediately prior to jointing. The parts of the pipe surface coming into contact with the jointing materials shall be undamaged, clean and, if necessary, dry. Sliding joints shall be lubricated using the lubricants and methods recommended by the manufacturers.

When pipes cannot be jointed manually, appropriate jointing equipment shall be used. Where necessary, the ends of the pipes shall be protected. The pipes should be jointed by means of an axial force applied progressively without overstressing the components. Alignment should be verified and corrected if necessary after jointing.

Where a gap is specified between the end of the spigot and the shoulder of the next pipe, it shall be within the tolerances indicated by the manufacturer.

8.5.4 *Socket holes*

Where necessary, socket holes shall be provided to allow sufficient space for proper assembly of the joint and to prevent the pipe from resting on the joint. The socket hole should not be larger than is necessary to accomplish proper joint assembly.

8.5.5 *Pipe cutting*

Cutting should be performed with the correct tools and as recommended by the pipe manufacturer. The cuts shall be such as to ensure the adequate performance of the ensuing joint. Suitable repairs to coatings and linings shall be carried out in accordance with the manufacturer's instructions.

8.5.6 *Provisions for future connections*

Pipe ends or branches, to which future connections are to be made after backfilling, shall be provided with adequate watertight seals and suitable anchorage where appropriate. Their positions shall be measured and recorded.

8.5.7 *Other instructions*

Any supplementary laying instructions, primarily from other relevant standards and then from the pipe manufacturer, shall be complied with.

8.6 Special constructions

8.6.1 *Pipelines above ground*

Individual design and construction is required for pipelines above ground (e.g. on support or suspended). Pipelines should be protected against any detrimental effects of the environment.

8.6.2 *Pipelines within protective pipes*

Under certain conditions, e.g. in water protection areas or on industrial premises, it may be necessary to construct pipelines within protective pipes. Both the protective pipes and the pipeline shall be tested separately.

In the case of pipelines within ducts, it may not be necessary to test the leaktightness of the duct.

8.6.3 *Brick and in situ concrete sewers*

Individual design and construction is required for brick and in-situ concrete sewers.

8.6.4 *Pipelines through, under or close to structures*

Where pipelines pass through structures, including manholes and inspection chambers, flexible joints shall be incorporated within the wall or as close as is feasible to the outside faces of the structures, except where the pipeline and the structure are an integral construction on a rigid foundation. Where pipelines pass under or close to structures, similar precautions should be considered.

Additional flexibility may be introduced by inserting short-length pipes to provide articulation. The length of those pipes and the design detail should be related to the diameter and type of pipe and the design of the joints. For pipes passing through a structure, a sleeve or lintel may be required.

8.7 Supporting and anchoring

Where there is a risk of flotation during installation, pipelines shall be secured by appropriate loading or anchoring. In the case of pressure pipelines, if fittings and valves are installed without positive locking in the longitudinal direction, they shall be secured so that the forces occurring can be resisted. For further details see prEN 805.

NOTE. Such forces can reach significant levels.

In the case of gravity pipelines it may be necessary to anchor fittings securely, possibly only temporarily, during testing for watertightness.

Additional forces, such as can occur with suspended pipelines and steeply sloping sections, should be allowed for in the construction, e.g. by forming a concrete bedding, by a concrete casing or by a barrier which at the same time provides protection against washout or drainage effects of the bedding. If necessary, soil analyses shall be carried out.

8.8 Manholes and inspection chambers

Manholes and inspection chambers shall be leaktight as tested in accordance with clause **13** and shall comply with the design.

Prefabricated components shall be assembled and installed according to any supplementary instructions of the manufacturer.

9 Connection to pipes and manholes

9.1 General

Connections to pipes and manholes shall be made by using prefabricated components.

Where a connection is provided for future use, see **8.5.6**.

Where connections are made to pipes and manholes, care shall be taken to ensure that:

- the loadbearing capacities of the connected pipelines are not impaired;
- the pipe to be connected cannot project beyond the inside surface of the pipe or manhole to which it is to be joined;
- the connection is made leaktight in accordance with clause **13**.

In order to fulfil the above conditions, it may for example be necessary to reinforce the pipeline in the region of the connection, or to replace the pipe section with a new structure, e.g. a manhole.

The methods to be used for connection are given under **9.2**, **9.3**, **9.4** and **9.5**.. The choice depends on the user's requirements, the pipe size and the pipe material.

Other methods for connection may be used, provided that they ensure the same quality of connection.

9.2 Connection by junctions

The junction should be fixed at the appropriate angle to receive the incoming pipeline. Where a pipe junction is to be inserted in an existing line of pipes, it may be necessary to disturb or remove one or more pipes depending on the material of the pipes, their length, joint types and bedding. In order to maintain pipe continuity, only sufficient length of pipe should be removed to enable the junction to be inserted in the pipeline. The operation may involve the insertion of a short length of pipe in addition to the junction. Whether socketed or sleeved joints are used, they shall be appropriate to the pipeline, ensure accurate line and position and provide effective seals.

9.3 Connection by connecting fittings

Connecting fittings are components which fit into circular holes drilled into the wall of a pipe in such a way as to form a leaktight joint.

The pipe is cut with a drilling device to obtain a circular hole appropriate to the connecting fitting, taking care to prevent any undesirable materials from entering the pipe.

The connecting fitting should be positioned on the upper half of the pipe, preferably with its axis at 45° to the vertical plane through the longitudinal axis of the pipe.

For details of assembling connecting fittings, refer to the manufacturers' instructions.

9.4 Connection by saddle fittings

Saddle fittings are components with leaktight joints between the outside surface of a pipe and the inner surface of the flange of the saddle. The hole in the wall of the existing pipe fits with the saddle fitting to be used and is cut by drilling or trepanning or, where practicable, by the use of a suitable saw and purpose-made template, taking care to prevent any undesirable materials from entering the pipe.

The saddle fitting should be positioned on the upper half of the pipe, preferably with its axis at 45° to the vertical plane through the longitudinal axis of the pipe.

For details of assembling saddle fittings, refer to the manufacturers' instructions.

9.5 Connection by welding

When connections are to be made by welding, any supplementary instructions of the pipe manufacturer shall be followed.

9.6 Connection to manholes and inspection chambers

Methods described above under **9.3**, **9.4** and **9.5** may be in part applicable for connection to manholes and inspection chambers. The position of the connection shall be as given in the design.

10 Testing during construction

The inspections/tests as given in clause **12** may be used during construction, as applicable.

When specified, initial testing for leaktightness shall be applied before backfill is placed. Control of sidefill and backfill compaction (see **11.1**) is recommended as work proceeds.

11 Backfilling

The placement of sidefill and main backfill shall only be commenced when the pipe joints and bedding are in a condition to permit loading.

Backfilling, including placing of the embedment and main backfill, removal of sheeting and compaction, should be carried out in such a way as to ensure that the loadbearing capacity of the pipeline meets the design requirements.

11.1 Compaction

The degree of compaction shall be as specified in the structural design of the pipeline. Specified degrees of compaction shall be controlled by a method specification related to the particular equipment used (compaction means) or, where required, verified by testing.

The initial backfill directly above the pipe should be compacted by hand where required. Mechanical compaction of the main backfill directly above the pipe should not be commenced until there is a total depth of cover at least 300 mm above the top of the pipe. The total depth of the cover directly above the pipe before mechanical compaction is commenced depends on the type of compaction device. The choice of compaction equipment, the number of passes and the thickness of layer to be compacted shall take account of the material to be compacted and the pipe to be installed.

Compaction by saturating the backfill or sidefill is permissible only in exceptional cases, and then only in suitable, non-cohesive soils.

11.2 Placement of the embedment

The embedment should be installed in such a way as to prevent the intrusion of the existing soil or migration of embedment material into the existing soil. In some circumstances the use of a geotextile fabric or graded filter may be necessary to contain the pipe embedment, particularly where groundwater is present.

Where the flow of groundwater may transport fine soil particles or lower the groundwater level, suitable precautions shall be taken.

Bedding, sidefilling and initial backfilling shall be carried out in accordance with the design and specification. The embedment should be protected against any foreseeable change of its loadbearing capacity, stability or position that could be caused by:

- removal of sheeting;
- groundwater influences;
- other adjacent excavation work.

When parts of a pipeline need anchoring or strengthening, this shall be done before placement of the embedment.

During placement of the embedment special attention should be given to the following:

- avoidance of displacement of the pipeline from line and level;
- care for placement of upper bedding to ensure that the voids under the pipe are filled with compacted material.

11.3 Placement of the main backfill

Main backfill shall be placed in accordance with the design and specification, limiting settlement at the surface. Special attention should be given to sheeting removal.

11.4 Removal of sheeting

Removal of sheeting should be carried out progressively during placement of the embedment.

NOTE. Removal of sheeting, at the level of or below the embedment, after the main backfill is placed, may lead to serious consequences for loadbearing capacity, line and level.

Where removal of sheeting is impractical before completion of backfilling (e.g. sheet piling, trench box), special measures are necessary, for example:

- special structural design;
- leaving parts of sheeting in the ground;
- special selection of material for embedment.

11.5 Surface reinstatement

On completion of backfilling, surfaces shall be reinstated as specified.

12 Final inspection and/or testing of pipelines and manholes after backfilling

After completion of the installation, inspections and/or tests, as appropriate, shall be carried out in accordance with **12.1** to **12.3**.

12.1 Visual inspection

Visual inspection includes:

- line and level;
- joints;
- damage or deformation;
- connections;
- linings and coatings.

12.2 Leaktightness

Leaktightness of pipeline including connections, manholes and inspection chambers shall be tested according to clause **13** or clause **14**, as appropriate.

12.3 Embedment and main backfill

The adequacy of embedment can be verified by checking compaction and/or pipe deformation, as specified. The adequacy of main backfill can be verified by checking compaction.

12.3.1 *Compaction*

The degree of compaction of bedding, sidefill and backfill shall be checked, if required, for compliance with **11.1**.

12.3.2 *Pipe deformation*

The vertical change in diameter of flexible pipes shall be checked, if required, for compliance with the structural design.

13 Procedures and requirements for testing gravity pipelines

13.1 General

Testing for leaktightness of pipelines, manholes and inspection chambers shall be conducted either with air (method L) or water (method W) as given in figures 6 and 7. Separate testing of pipes and fittings, manholes and inspection chambers, e.g. pipes with air and manholes with water, may be undertaken. In the case of method L, the number of corrections and retests following failure is unrestricted. In the event of a single or continued air test failure, recourse to a water test is allowed and the result of the water test alone shall be decisive.

If the groundwater level is above the crown of the pipeline during testing, an infiltration test may be applied with an individual specification.

Initial testing may be applied before any sidefill is placed. For final acceptance, the line shall be tested after backfilling and removal of sheeting; choice of testing by air or water may be given by the specifier.

13.2 Testing with air (method L)

The testing times for pipelines, excluding manholes and inspection chambers, are given in table 3 in relation to pipe size and testing methods (LA; LB; LC; LD). The testing method should be given by the specifier. Suitable airtight plugs shall be used in order to avoid errors arising from the test equipment. Special care is required for large DN during testing, for safety reasons.

Air testing of manholes and inspection chambers is difficult to implement in practice.

NOTE 1. Until there is sufficient experience of air testing manholes and inspection chambers, a testing time of half that for a pipeline of equivalent diameter may be used.

An initial pressure approximately 10 % in excess of the required test pressure, p_0, shall first be held for approximately 5 min. The pressure shall then be adjusted to the test pressure shown in table 3 related to testing method LA, LB, LC or LD. If the pressure drop measured after the testing time is less than Δp given in table 3, then the pipeline complies.

NOTE 2. The test requirements for negative air pressure testing are not given in this European Standard as there is currently insufficient experience of this method.

The equipment used for measuring the pressure drop shall allow a measurement with an accuracy of 10 % of Δp. The accuracy of measurement of time shall be 5 s.

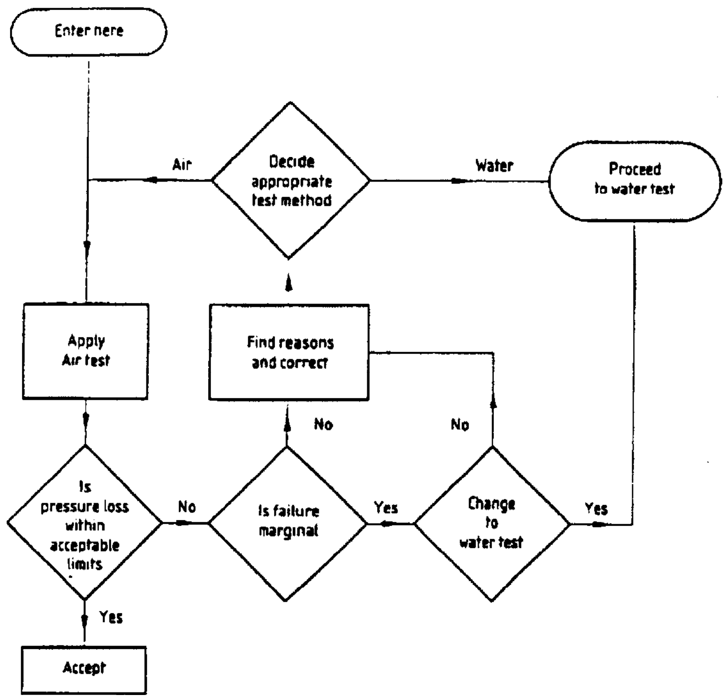


Figure 6. Flow diagram method L

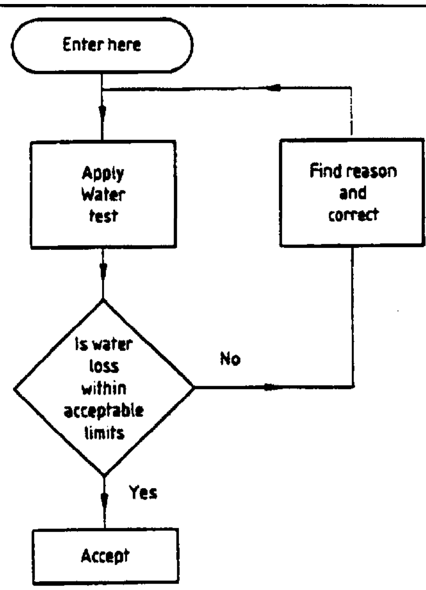


Figure 7. Flow diagram method W

Table 3. Test pressure, pressure drop and testing times for testing with air

Material	Testing method	p_0 *) mbar (kPa)	Δp mbar (kPa)	Testing time min DN 100	DN 200	DN 300	DN 400	DN 600	DN 800	DN 1000
Unsoaked concrete pipes	LA	10 (1)	2,5 (0,25)	5	5	5	7	11	14	18
	LB	50 (5)	10 (1)	4	4	4	6	8	11	14
	LC	100 (10)	15 (1,5)	3	3	3	4	6	8	10
	LD	200 (200)	15 (1,5)	1,5	1,5	1,5	2	3	4	5
K_p-values**)				0,058	0,058	0,053	0,040	0,0267	0,020	0,016
Soaked concrete pipes and all other materials	LA	10 (1)	2,5 (0,25)	5	5	7	10	14	19	24
	LB	50 (5)	10 (1)	4	4	6	7	11	15	19
	LC	100 (10)	15 (1,5)	3	3	4	5	8	11	14
	LD	200 (20)	15 (1,5)	1,5	1,5	2	2,5	4	5	7
K_p-values**)				0,058	0,058	0,040	0,030	0,020	0,015	0,012

*) Pressure above atmospheric pressure.

**) $t = \frac{1}{K_p} \times \ln \frac{p_o}{p_o - \Delta p}$

For unsoaked concrete pipes, $K_p = \frac{16}{DN}$ with a maximum of 0,058.

For soaked concrete pipes and all other materials, $K_p = \frac{12}{DN}$ with a maximum of 0,058.

With t rounded to the nearest 0,5 min when $t \leq 5$ min, and to the nearest minute when $t > 5$ min.

ln = $\log_e$

13.3 Testing with water (method W)

13.3.1 *Test pressure*

The test pressure is the pressure equivalent to or resulting from filling the test section up to the ground level of the downstream or upstream manhole, as appropriate, with a maximum pressure of 50 kPa and a minimum pressure of 10 kPa measured at the top of the pipe.

Higher test pressures may be specified for pipelines which are designed to operate under permanent or temporary surcharge (see prEN 805).

13.3.2 *Conditioning time*

After the pipelines and/or manholes are filled and the required test pressure applied, conditioning may be necessary.

NOTE. Usually 1 h is sufficient. A longer period may be needed, for example for dry climatic conditions, in the case of concrete pipes.

13.3.3 *Testing time*

The testing time shall be (30 ± 1) min.

13.3.4 *Test requirements*

Pressure shall be maintained within 1 kPa of the test pressure defined in **13.3.1** by topping up with water. The total amount of water added during the test to achieve this requirement shall be measured and recorded with the head of water at the required test pressure.

The test requirement is satisfied if the amount of water added is not greater than:

– 0,15 l/m^2 during 30 min for pipelines;

– 0,20 l/m^2 during 30 min for pipelines including manholes;

– 0,40 l/m^2 during 30 min for manholes and inspection chambers.

NOTE. m^2 refers to the wetted internal surface.

13.4 Testing individual joints

Unless otherwise specified, testing of individual joints, instead of testing of the whole pipeline, can be accepted for pipelines, normally those larger than DN 1000.

For individual pipe joints to be tested, the surface area for test W is taken as that represented by a 1 m length of pipe, if not otherwise specified. Test requirements shall be as given in **13.3.4** with a test pressure of 50 kPa at the top of the pipe.

The conditions for test L shall follow the principles given in **13.2** and be specified individually.

14 Testing of pressure pipelines

Pressure pipelines shall be tested as specified in prEN 805.

15 Qualifications

The following factors concerning qualifications are to be taken into account:

– suitably trained and experienced personnel are employed for the supervision and the execution of the construction project;

– contractors appointed by the employer possess the qualifications necessary for the execution of the work;

– employers satisfy themselves that the necessary qualifications are held by the contractors.

See annex C.

Annex A (informative)
Dewatering

A.1 General

If there is any reason to suspect that groundwater can exist in the proximity of the trench, at a level higher than the intended trench bottom, then a sufficient site investigation should be undertaken to establish a suitable method for groundwater control as well as trench support. The various temporary works associated with groundwater control (dewatering) may influence the design of the permanent work. The design assumptions should be conveyed to the installer either through the work specification or drawings.

The design of dewatering systems is complex and specialist advice should be sought before a method is selected. Dewatering can reduce groundwater levels over a considerable distance and may affect abstraction for other uses.

Some of the available methods of groundwater control are listed below with the factors which affect their selection. The operating ranges of permeability are given as an indication only and will vary slightly with different equipment specifications and local circumstances.

A.2 Sump pumping from trench bottom

This is the simplest means of groundwater control and comprises pumping away water which has entered the trench. In soils where there is a risk of fine particles being drawn from the ground by the passage of water it may be necessary to take additional measures to reduce the rate of flow. This can be achieved by driving close sheeting to a depth below the trench bed. The pipeline designer shall decide whether it is necessary to leave the sheeting in place as part of the permanent work. The cost of the sheeting left in and the toe-in depth required, effectively limit the method to situations where either the soil is cohesive or the depth below groundwater level is small.

The depth range can be increased by using specialist additional means such as ground freezing or grout injections to limit the flow of groundwater in the vicinity of the excavation.

A.3 Deep wells

This method involves a deep well, typically 250 mm to 600 mm in diameter, and the installation of a liner with a filter section or a perforated wall near its base. The incoming water is removed using a borehole type submersible pump. The filter is necessary to prevent loss of fines and must be selected to suit the local soil grading. They are most effective in soils where the vertical and horizontal permeabilities are similar and lie within the range 10^{-3} m/s to 1 m/s. The successful application of deep wells to soil of permeability as low as about 10^{-5} m/s can be achieved by capping the well and attaching a vacuum pump to it. In this case the submersible pump will have an additional head to pump against.

This system is more widely used in the construction of basements and pumping chambers than for pipelines.

A.4 Vertical well points

Well points are tubes perforated over the lower part of their length which are inserted into the ground by jetting (pumping water down the tubes). A valve in the bottom end allows water to exit the tube during jetting but prevents water from entering through the end during dewatering. The well point is generally surrounded with a coarse sand to act as a graded filter. Where required, sand is installed during the jetting process. Well points are normally installed along a line parallel to the line of the proposed trench and are typically at 0,6 m to 3,0 m intervals, depending upon soil and groundwater conditions. They can be used on one or both sides of the trench.

After installation, the tops of the well points are connected to a vacuum pump. Groundwater enters the well points through the perforations. The well points may be of a disposable variety which avoids the possibility of ground movement during and following withdrawal and the difficulties associated with attempting to fill and compact the deep, narrow hole which would be created.

Well points are generally limited to soils with permeabilities 10^{-6} m/s to 10^{-3} m/s. The maximum depth of trench which can be dewatered by a single stage of well pointing is around 6,5 m.

A.5 Horizontal pipe dewatering

A perforated plastic pipe can be inserted into the ground using a trenching machine or a trenchless method such as directional drilling. The system is installed along a line parallel to the proposed trench, on one or both sides and at a level below the proposed trench bottom. The ends of such pipes are connected to vacuum pumps in the same way as for vertical well points. The range of operation is similar to vertical well points (10^{-6} m/s to 10^{-3} m/s).

The principal advantages of horizontal well points are the absence of temporary pipework at ground level and the speed of installation.

A.6 Eductor well pointing

The eductor well pointing system involves sinking a well with a filter section near its base and installing a pressure feed pipe, venturi and riser pipe.
High-pressure water is supplied to the pressure pipe and the pressure drop in the venturi section is used to draw in water from the well which passes up to the riser pipe to be discharged to the collection pipework at the surface. As with deep wells, great depths are possible (up to 45 m) but only comparatively low flows can be achieved in each one. This limits the range of permeabilities which can be dealt with to those where the flow would be small (typically less than 10^{-5} m/s). As with deep wells, eductor wells require both vertical and horizontal permeabilities to be comparable, in order to operate effectively in drawing down the groundwater level. The high installation cost and restrictive range of suitable operating conditions generally limit their use to fixed sites such as basement or pumping station sites.

Annex B (informative)

Additional information to 5.3.3.1 on material properties

B.1 General

Current practice in different CEN countries differs widely in the way it designates granular materials. As it has proved impracticable to harmonize this in advance of a European Standard on aggregate gradings (CEN/TC 154), the existing designations have been drawn together in this informative annex.

B.2 CEN members contributing to this informative annex

The following CEN members have contributed to this informative annex and the tables B.2 to B.19 as indicated in table B.1: Austria, Belgium, Denmark, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland and United Kingdom.

Table B.1 Specifications on granular materials by CEN members as given in tables B.2 to B.19

CEN member	Tables B.2 to B.19 on granular materials																	
	B.2	B.3	B.4	B.5	B.6	B.7	B.8	B.9	B.10	B.11	B.12	B.13	B.14	B.15	B.16	B.17	B.18	B.19
Austria	x	x	x	x	x		x											
Belgium								x	x	x								
France											x	x	x					
Germany	x		x			x	x											
Ireland														x	x	x		
Netherlands	x		x			x	x											
Norway																	x	
Sweden																		x
Switzerland	x		x			x	x											
United Kingdom														x	x	x		

B.3 A — Austria, CH — Switzerland, D — Germany, NL — Netherlands

B.3.1 Examples of nominal single-size granular materials are (in millimetres):
8; 16; 32 (A; CH; D; NL) and 10; 14; 20; 40 (A).
Examples of grading of nominal single-size granular materials are given in table B.2 and in table B.3.

Table B.2 Grading of nominal single-size granular material (relevant for A; CH; D; NL)

Sieve size mm	Percentage by mass passing sieves by nominal size Sieve set mm 32	16	8
63	100	—	—
31,5	85 – 100	100	—
16,0	0 – 25	85 – 100	100
8,0	0 – 5	0 – 25	85 – 100
4,0	—	0 – 5	0 – 25
2,0	—	—	0 – 5
1,0	—	—	—
0,50	—	—	—
0,25	0 – 3	0 – 3	0 – 3

Table B.3 Grading of nominal single size granular material (only relevant for A)

Sieve size mm	Percentage by mass passing sieves by nominal size Sieve set mm 40	20	14	10
50	100	—	—	—
37,0	85 – 100	100	—	—
20,0	0 – 25	85 – 100	—	—
14,0	—	—	85 – 100	100
10,0	0 – 5	—	0 – 50	85 – 100
5,0	—	0 – 5	0 – 10	0 – 25
2,36	—	—	—	0 – 5

B.3.2 Examples of nominal graded granular material are (in millimetres):
2/8; 8/16; 16/32 (A; CH; D; NL) and 5/14; 5/20; 5/40 (A).
Examples of grading of nominal graded granular material are given in table B.4 and in table B.5.

Table B.4 Grading of nominal graded granular material (relevant for A; CH; D; NL

Sieve size	**Percentage by mass passing sieves by nominal particle size ranges**		
	Sieve set mm		
mm	**2/8**	**8/16**	**16/32**
63	—	—	100
31,5	—	100	90 – 100
16,0	100	90 – 100	0 – 15
8,0	90 – 100	0 – 15	—
4,0	10 – 65	—	—
2,0	0 – 15	—	—
1,0	—	—	—
0,50	—	—	—
0,25	0 – 3	0 – 3	0 – 3

Table B.5 Grading of nominal graded granular material (only relevant for A)

Sieve size	**Percentage by mass passing sieves by nominal size**		
	Sieve set mm		
mm	**5/14**	**5/20**	**5/40**
50	—	—	100
37,0	—	100	90 – 100
20,0	100	90 – 100	35 – 70
14,0	90 – 100	—	—
10,0	50 – 85	30 – 60	10 – 40
5,0	0 – 10	0 – 10	0 – 5
2,36	—	—	—

B.3.3 Examples of nominal sand are (in millimetres): 0/1; 0/2; 0/4.

Examples of grading of nominal sand are given in table B.6. and in table B.7.

Table B.6 Grading of nominal sand (only relevant for A)

Sieve size mm	Standard gradings 0/4 mm	0/2 mm	0/1 mm
8,0	100	—	—
5,6	98 – 100	—	—
4,0	85 – 99	100	—
2,8	—	98 – 100	—
2,0	—	85 – 99	100
1,4	—	—	98 – 100
1,0	—	—	85 – 99
0,063	< 5	< 5	< 5

In CH, D and NL, sand is suitable for all nominal sizes of pipe if the content of material < 0,063 mm is less than 5 % by mass.

Standard gradings are (in millimetres): 0/4; 0/2; 0/1.

Guidance for grading of sands is given in table B.7.

Table B.7 Grading of sand (relevant for CH; D; NL)

Sieve size mm	Percentage by mass passing sieves for nominal particle size ranges 0/4 mm	0/2 mm	0/1 mm
8,0	100	—	—
4,0	90 – 100	100	—
2,0	55 – 85	90 – 100	100
1,0	—	—	85 – 100
0,25	*)	0 – 25	*)
0,063	0 – 5	0 – 5	0 – 5

*) On request, the manufacturer has to submit figures on mean value and range.

Other gradings of sand are acceptable if their suitability has been proven and their use is specified by the designer.

B.3.4 Examples of nominal all-in aggregates are (in millimetres): 16; 20; 32; 40.

Examples of grading of nominal all-in aggregates are given in table B.8.

Table B.8 Grading of all-in aggregates

Aggregate	Size	Oversize		Undersize		
		Percentage passing by mass				
		2*D*	1,4*D*[1)]	*D*[2)]	*d*	*d*/2
All-in	$D \leq 63$ mm and $d = 0$	100	98 – 100	90 – 99	—	—

[1)] Where the sieves calculated as 1,4*D* and *d*/2 are not exact sieve numbers in the ISO 565/R20 series, then the next higher or lower sieve size respectively shall be adopted.

[2)] If the percentage retained on *D* is < 1 % by mass, the supplier shall document and declare the typical grading, including the sieves *D*, *d*, *d*/2 and sieves in the basic set plus set 1 or basic set plus set 2 intermediate between *d* and *D*.

B.3.5 *Crushed aggregates*

Austria: All examples given in **B.3.1** to **B.3.4** are applicable also to crushed aggregates.

Switzerland; Germany; Netherlands: Crushed aggregates shall comply with the grading requirements as follows:

Maximum grain size	Pipe size
11 mm	DN < 900
20 mm	DN ≥ 1000

Source: DIN 4226-1

B.4 B — Belgium

B.4.1 *Classification of granular materials*

Grading of granular materials is given in table B.9.

Table B.9 Grading of granular materials

Granular size	Percentage passing by mass										
	1,00	2,00	4,00	7,10	10,0	14,0	20,0	28,0	35,5	40,0	50,0
2/7	0 to 5	1 to 15	25 to 55	85 to 99	100	—	—	—	—	—	—
4/7	0 to 3	0 to 7	1 to 20	80 to 99	100	—	—	—	—	—	—
4/14	0 to 3	0 to 7	1 to 15	18 to 47	85 to 99	100	—	—	—	—	—
4/28	0 to 3	0 to 7	1 to 15	—	14 to 37	—	50 to 80	85 to 99	100	—	—
14/28	0 to 3	—	—	—	0 to 10	1 to 15	29 to 59	85 to 99	100	—	—

B.4.2 *Classification of sand*

Grading of sand is given in table B.10.

Table B.10 Grading of sand

Sieve size mm	Percentage passing by mass		
	Coarse-grained sand	Medium-grained sand	Fine-grained sand
2	100	0	0
1	95 to 45	100	0
0,50	80 to 20	100 to 70	100
0,25	50 to 5	70 to 5	100 to 70
0,125	15 to 0	20 to 0	50 to 0
0,080	0	0	0

B.4.3 *Grading of all-in aggregates*

Grading of all-in aggregates is given in table B.11.

Table B.11 Grading of all-in aggregates

Granular size	Percentage passing by mass													
	1,00	2,00	4,00	6,30	7,10	10,0	14,0	20,0	25,0	31,5	40,0	50,0	56,0	71,0
2/4	0 to 5	1 to 20	80 to 99	100	—	—	—	—	—	—	—	—	—	—
2/7	0 to 5	1 to 15	25 to 55	—	85 to 99	100	—	—	—	—	—	—	—	—
4/7	0 to 3	0 to 7	1 to 20	—	80 to 99	100	—	—	—	—	—	—	—	—
7/10	0 to 3	—	0 to 8	—	1 to 20	80 to 99	100	—	—	—	—	—	—	—
7/14	0 to 3	—	0 to 8	—	1 to 15	28 to 58	85 to 99	100	—	—	—	—	—	—
7/20	0 to 3	—	0 to 8	—	1 to 15	14 to 38	39 to 69	89 to 99	—	100	—	—	—	—
10/14	0 to 3	—	—	0 to 9	—	1 to 20	80 to 99	100	—	—	—	—	—	—
14/20	0 to 3	—	—	—	—	0 to 12	1 to 20	80 to 99	—	100	—	—	—	—
20/32	0 to 3	—	—	—	—	—	0 to 11	1 to 20	29 to 59	80 to 99	100	—	—	—
20/40	0 to 3	—	—	—	—	—	0 to 11	1 to 15	15 to 42	41 to 71	85 to 99	100	—	—
32/40	0 to 3	—	—	—	—	—	—	0 to 9	—	1 to 20	80 to 99	100	—	—
40/56	0 to 3	—	—	—	—	—	—	—	0 to 9	—	1 to 20	46 to 76	80 to 99	—

Sources: NBN B 11-101 for granular materials and all-in aggregates;
NBN B 11-011 for sand.

B.5 DK — Denmark

B.5.1 *General requirements of materials for bedding, sidefill and initial backfill*

Grading	Maximum grain size, *D*:	≤ 8 mm
	Maximum content of fines (< 0,075 mm):	9 %
	Coefficient of uniformity, *U*:	< 3

Purity — The material is not allowed to be frozen or contain damaging plant residues, humus or lumps of clay or silt.

The material is not allowed to contain substances aggressive to the pipe.

Sidefill — Sidefill of rigid pipes, for example concrete pipes, can above the centre level normally be compacted by heavy equipment. Provided that there is space for this equipment, the requirements for maximum grain size and coefficient of uniformity can therefore be waived. However, particle size above 64 mm is not allowed.
For sidefill below the centre level of rigid pipes, for example concrete pipes, the same is valid, provided that the equipment used permits an effective compaction from the surface of the bedding layer and close to the pipe, and further that the bedding layer for circular pipes has a thickness at least as great as that for improved bedding, i.e. a quarter of the pipe's outer diameter.

Source: DS 475 and DS 475/A 1 *Code of practice for trenching for underground pipes and cables.*

B.5.2 *Rigid pipes*

The material shall fulfil the specifications in DS 475. However, below areas without pavement the specifications of the material are as follows.

Bedding	Particle size above 32 mm is not allowed. The content of material between 16 mm and 32 mm shall not exceed 10 %.
Sidefill and initial backfill	Particle size above 64 mm is not allowed. The material shall be sufficient to compact as specified.

Source: DS 437 Dansk Ingeniørforening's *Code of practice for the laying of underground rigid pipelines of concrete.*

B.5.3 *Flexible pipes*

The material shall fulfil the specifications in DS 475. However, below areas without pavement the specifications of the material are as follows.

Bedding	Particle size above 16 mm is not allowed. The content of material between 8 mm and 16 mm shall not exceed 10 %. The material may not be sharp flint or a similar material. The material shall be sufficient to compact.
Sidefill and initial backfill	Same specifications as for bedding material; however, clay may be used.

Source: DS 430 Dansk Ingeniørforening's *Code of practice for the laying of underground flexible pipelines of plastic.*

B.6 F — France

B.6.1 *French requirements for embedment*

Extracts from: Circulaire no. 92-42 du 1er juillet 1992 relative au Fascicule no. 70 *Ourages d'assainissement* NO2: EQUE 92 10 108C.

Item 5.4.3.1, page 77: Construction of the bedding

The bedding is constructed from materials containing less than 5 % of particles smaller than 0,1 mm and containing no component larger than 30 mm. In wet ground conditions the bedding shall be composed with materials between 5 mm and 30 mm.

Item 5.8.1, page 97: Construction of the sidefill and initial backfill

The construction of the sidefill and initial backfill is carried out with all materials (sand, gravel, all-in) agreed by the specifier and compatible with the characteristics of the pipes.

Item 5.8.1.1 Construction of the sidefill

Above the bedding and up to the axis of the pipe, the backfill material is pushed under the sides of the pipe and compacted so as to avoid any movement of the pipe and to establish the projected sidefill.

In order to provide a sidefill that will not loosen later, the sidefill shall be installed after the partial removal of the sheeting, if any.

If the sidefill is loosened, the specifier will assess the importance of the loosening and take it into consideration, along with the strength of the pipes, in modifying the choice of the sidefill materials.

Item 5.8.1.2 Construction of the initial backfill

Above the sidefill, the backfill and its compaction will be executed by placing successive layers symmetrically then uniformly, up to a thickness of at least 0,10 m above the crown of the joint so as to complete the embedment.

B.6.2 ***French Standard concerning the relevant granular materials***

Source: Standard NF P 18-101 December 1990: *Aggregates — Vocabulary — Definitions and classification* (clauses **1** to **5** and clause **8**).

For examples of grading, see tables B.12, B.13 and B.14.

Table B.12 Grading requirements for 4/10, 6/14, 6/20, 6/31,5 according to NF P 18-101

Sieve size	Percentage passing by mass			
mm	4/10	6/14	6/20	6/31,5
63	—	—	—	—
40	—	—	—	100
31,5	—	—	100	85 – 99
20	—	100	85 – 99	25 – 75
14	100	85 – 99	25 – 75	—
10	85 – 99	25 – 75	—	—
6,3	25 – 75	1 – 75	1 – 15	1 – 15
4	1 – 15	0 – 3	0 – 3	0 – 3
2	0 – 3	—	—	—

Table B.13 Grading requirements for sands according for NF P 18-101

Sieve size	Percentage passing by mass		
	Examples of product sizes		
mm	0/4	0/2	0/1
6,3	100	—	—
4	85 – 99	100	—
2	—	85 – 99	100
1	—	—	85 – 99

Table B.14 Grading tolerances for sands according to NF 18-101

Sieve size	Percentage passing by mass		
	Examples of product sizes		
mm	0/4	0/2	0/1
4	± 5	—	—
2	± 7,5	± 5	—
1	—	—	± 5
0,5	± 5	± 5	± 5
0,08	± 2 ± 3	± 2 ± 3	± 2 if passing < 12 % ± 3 if passing ≥ 12 %

B.7 IRL —Ireland, UK — United Kingdom

The United Kingdom's requirements for embedment materials are set out in the references listed at the end of this section. The following tables B.15 to B.17 have been extracted from these references.

Table B.15 Coarse aggregate (relevant for IRL, UK)

Sieve size	Percentage by mass passing BS sieves for nominal sizes							
	Graded aggregate mm			Single-sized aggregate mm				
mm	40 to 5	20 to 5	14 to 5	40	20	14	10	5
50,0	100	—	—	100	—	—	—	—
37,5	90 – 100	100	—	85 – 100	100	—	—	—
20,0	35 – 70	90 – 100	100	0 – 25	85 – 100	100	—	—
14,0	—	—	90 – 100	—	—	85 – 100	100	—
10,0	10 – 40	30 – 60	50 – 85	0 – 5	0 – 25	0 – 50	85 – 100	100
5,0	0 – 5	0 – 10	0 – 10	—	0 – 5	0 – 10	0 – 25	45 – 100
2,36	—	—	—	—	—	—	0 – 5	0 – 30

Table B.16 Fine aggregate (relevant for IRL, UK)

Sieve size	Percentage by mass passing BS sieve			
	Overall limits	Additional limits for grading		
		C	M	F
10,00 mm	100	—	—	—
5,00 mm	89 – 100	—	—	—
2,36 mm	60 – 100	60 – 100	65 – 100	80 – 100
1,18 mm	30 – 100	30 – 90	45 – 100	70 – 100
600 µm	15 – 100	15 – 54	25 – 80	55 – 100
300 µm	5 – 70	5 – 40	5 – 48	5 – 70
150 µm	0 – 15	—	—	—

Table B.17 All-in aggregate (relevant for UK)

Sieve size	Percentage by mass passing BS sieves for nominal sizes			
	40 mm	20 mm	10 mm	5 mm
50,0 mm	100	—	—	—
37,5 mm	95 – 100	100	—	—
20,0 mm	45 – 80	95 – 100	—	—
14,0 mm	—	—	100	—
10,0 mm	—	—	95 – 100	100
5,0 mm	25 – 50	35 – 55	35 – 65	70 – 100
2,36 mm	—	—	20 – 50	25 – 100
1,18 mm	—	—	15 – 40	15 – 45
600 µm	8 – 30	10 – 35	10 – 30	5 – 25
300 µm	—	—	5 – 15	3 – 20
150 µm	0 – 8*)	0 – 8*)	0 – 8*)	0 – 15

*) Increased to 10 % for crushed rock fines.

ad Table B.16 Fine aggregate

When determined in accordance with BS 812 : Part 103, using test sieves of the size given in table B.16, conforming to BS 410, full tolerance, the grading of the fine aggregate shall conform to the overall limits given in table B.16. Additionally, not more than one in ten consecutive samples shall have a grading outside the limits for any one of the gradings C, M or F given in table B.16.

ad Table B.17 All-in aggregate

When determined in accordance with BS 812 : Part 103, using test sieves of the size given in table B.17, conforming to BS 410, full tolerance, the grading of all-in aggregate for concrete shall be within the appropriate limits given in table B.17.

Sources:

Clause **B.7** of this annex makes reference to the latest edition of the following publications (except where otherwise stated) including all addenda and revisions, which should also be consulted.

British Standards

BS 882 *Specification for aggregates from natural sources for concrete*

BS 1047 *Specification for air-cooled blast furnace slag aggregate for use in construction*

BS 1377 *Methods of test for soils for civil engineering purposes*

BS 3797 *Specification for lightweight aggregates for masonry units and structural concrete*

BS 8005 : Part 1 *Guide to new sewerage construction*

Irish Standard

IS 5 : 1990 *Aggregates for concrete* Part 1: *Specification*

Water industry specifications/information and guidance notes

WIS No. 4-08-02 *Specification for bedding and sidefill materials for buried pipelines*

IGN No. 4-11-02 *Revised bedding factors for vitrified clay drains and sewers*

Water Services Association

Civil engineering specification for the water industry, 4th Edition

WSA *Sewers for adoption*, edition 4, 1995

Transport and Road Research Laboratory

Simplified tables of external loads on buried pipelines, 1986

BRE Digest 363

Sulphate and acid resistance of concrete in the ground, 1995

Specification for the reinstatement of openings in highways, HMSO, 1992

ER201E *Guide to the water industry for structural design of underground non-pressure uPVC pipelines*, 1986

For pipes laid under highways, reference should be made to the specification for the reinstatement of openings in highways (HAUC specification). In particular, this gives requirements that clays having a liquid limit (LL) exceeding 90 or a plasticity index (PI) exceeding 65 when tested in accordance with BS 1377 : Part 2, methods 4 and 5.4 respectively, are not to be used, and stone sizes in excess of 37,5 mm are unacceptable.

B.8 N — Norway

See table B.18.

Table B.18 Overview of refilling materials

Trench zone	Material type						
	Single-size graded materials between 2 mm and 16 mm (e.g. crushed stone 4 mm – 8 mm)	Granular materials[1)], maximum size 32 mm, standard fraction 22 mm – 32 mm ≤ 10 %	Granular materials[1)], maximum standard size 50 mm	Granular materials[1)], maximum standard size 64 mm	Existing native materials, maximum stone size 32 mm	Existing native materials, maximum stone size 50 mm	Existing native materials, maximum stone size 64 mm
Zone 1 (reinforced bottom):							
— change of material	x	x	x	x			
Zone 2 (lower bedding):							
— rigid pipes	x	x	x				
— flexible pipes	x	x					
Zone 3 (sidefill in road):							
— rigid pipes:							
— general	x	x	x				
— concrete pipes, $d > 500$ mm	x	x	x	x			
— flexible pipes	x	x					
Zone 3 (sidefill outside road):							
— rigid pipes:							
— general	x	x	x				
— concrete pipes, $d > 500$ mm	x	x	x	x			
— no compaction requirements	x	x	x	x	x	x	
— concrete pipes $d > 500$ mm and no compaction requirements	x	x	x	x	x	x	x
— flexible pipes	x	x					

Table B.18 Overview of refilling materials *(continued)*

Trench zone	Material type						
	Single-size graded materials between 2 mm and 16 mm (e.g. crushed stone 4 mm – 8 mm)	Granular materials[1], maximum size 32 mm, standard fraction 22 mm – 32 mm < 10 %	Granular materials[1], maximum standard size 50 mm	Granular materials[1], maximum standard size 64 mm	Existing native materials, maximum stone size 32 mm	Existing native materials, maximum stone size 50 mm	Existing native materials, maximum stone size 64 mm
Zone 4 (initial backfill): — general	Same requirement as for zone 3 for side layers outside road.						
Zone 5 (main backfill): — native materials	Native materials with maximum stone size 0,5 m. Stone size and stone content to be considered in each individual case depending on the risk of frost etc.						

[1] The materials shall be protected from freezing until the trench has been refilled, and shall be capable of being compacted without the addition of water. This may result in increased compaction work.

B.9 S — Sweden

No national standards exist for embedment materials in Sweden. National guidelines exist (Mark AMA 83 and VAV P 70) which ought to be followed if not otherwise specified by the designer. Normally, the designer specifies the embedment material to be used.

Table B.19 Swedish guidelines for embedment materials

Pipe material	Material to be used for:	
	Bedding	Sidefill and initial backfill
Plastic pipes	Maximum particle size 20 mm	The soil shall in general have a maximum particle size not greater than 20 mm. Occasional, not sharp-edged stones not greater than 0,1 × DN mm or 60 mm, whichever is the smaller, are allowed.
Other pipes	Maximum particle size 20 mm	The soil shall in general have a maximum particle size not greater than 20 mm. Occasional stones not greater than 60 mm are allowed.

The guidelines are applicable for:

- single size granular material;
- graded granular material;
- all-in aggregates;
- crushed aggregates.

Swedish guidelines for reinforced bedding with concrete (Mark AMA 83):

- unreinforced concrete: class K 15;
- reinforced concrete: class K 25.

Sources:

MARK AMA 83 *Allmän material — och arbetsbeskrivning för markabeten*
VAV P 70 *Anvisningar för projektering och utförande av markförlagda självfallsledningar av plast*

Annex C (informative)

Abstract from Council Directive of 17 September 1990 on the procurement procedures of entities operating in the water, energy, transport and telecommunication sectors

Title IV

Qualification, selection and award

Article 24

1. Contracting entities which so wish may establish and operate a system of qualification of suppliers or contractors.
2. The system, which may involve different qualification stages, shall operate on the basis of objective rules and criteria to be established by the contracting entity. The contracting entity shall use European Standards as a reference where they are appropriate. The rules and criteria may be updated as required.
3. The rules and criteria for qualification shall be made available on request to interested suppliers or contractors. The updating of these criteria and rules shall be communicated to the interested suppliers and contractors. Where a contracting entity considers that the qualification or certification system of certain third entities or bodies meet its requirements, it shall communicate to interested suppliers and contractors the names of such third entities or bodies.
4. Contracting entities shall inform applicants of their decision as to qualification within a reasonable period. If the decision will take longer than six months from the presentation of an application, the contracting entity shall inform the applicant, within two months of the application, of the reasons justifying a longer period and of the date by which its application will be accepted or refused.
5. In reaching their decision as to qualification or when the criteria and rules are being updated, contracting entities may not:

   — impose conditions of an administrative, technical or financial nature on some suppliers or contractors that are not imposed on others;

   — require tests or proof that duplicate objective evidence already available.

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