BRITISH STANDARD

BS 4962:1989

Incorporating
Amendment No. 1

Specification for

Plastics pipes and fittings for use as subsoil field drains

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics Standards Policy Committee (PLM/-) to Technical Committee PLM/9, upon which the following bodies were represented:

British Board of Agrément
British Gas plc
British Plastics Federation
British Plumbing Fittings Manufacturers' Association
British Valve and Actuator Manufacturers' Association
Department of the Environment (Building Research Establishment)
Department of the Environment (Construction Industries Directorate)
Department of the Environment (Property Services Agency)
Department of Transport
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Health and Safety Executive
Institution of Civil Engineers
Institution of Gas Engineers
Institution of Production Engineers
Institution of Water and Environmental Management (IWEM)
National Association of Plumbing, Heating and Mechanical Services Contractors
Plastics and Rubber Institute
Plastics Land Drainage Manufacturers' Association
Royal Institute of Public Health and Hygiene
Society of British Gas Industries
Water Authorities Association
Water Companies Association
Water Research Centre

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Adhesives and Sealants Association
Department of Agriculture and Fisheries for Scotland
Department of Agriculture Northern Ireland
Heating and Ventilating Contractors' Association
Institute of Plumbing
Land Drainage Contractors' Association
Ministry of Agriculture, Fisheries and Food
National Association of Agricultural Contractors
National Farmers' Union

This British Standard, having been prepared under the direction of the Plastics Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 July 1989

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Amendments issued since publication

Amd. No.	Date of issue	Comments
9131	July 1996	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been prepared under the direction of the Plastics Standards Policy Committee. It is a revision of BS 4962:1982 which is withdrawn.

The main differences between this revision and the previous edition are as follows.

a) The title of the specification has been changed:

1) to indicate that the specification applies to pipes and fittings;

2) to delete "light duty" and substitute "field", for clarity of purpose.

b) The maximum design outside diameter for pipes has been increased from 200 mm to 400 mm.

c) The scope and requirements have been extended to include unperforated pipes otherwise corresponding to the perforated pipes for use as carrier drains or where systems of perforated pipes are to be linked by unperforated sections, as in the vicinity of tree roots.

d) Methods for testing pipe in a stretched condition have been detailed, by introduction of Appendix H.

e) *Text deleted*

f) The severity of the impact test has been increased by doubling the mass of the striker to be used.

g) The marking requirements include the date of this British Standard and this together with the number of this British Standard is to be marked on each pipe and fitting to supplement the manufacturer's identification.

The standard remains largely a performance specification and no restriction is made on the type of plastics material to be used for the manufacture of pipes and fittings in accordance with this standard.

In the preparation of this British Standard attention has been given to the work of Technical Committee 138 of the International Organization for Standardization (ISO). In this British Standard, however, general performance requirements are specified whereas the ISO approach will be to issue specifications for each type of material which can be used for this application.

Appendix J gives general guidance on the nature of the requirements and the primary purpose of the test methods, to assist in the preparation of quality plans.

Appendix K gives guidance for storage and laying conditions for pipes and is based on a technical note originally prepared by the Ministry of Agriculture, Fisheries and Food (MAFF).

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

Attention is drawn to the provisions of the Health and Safety at Work etc. Act 1974 and the need to ensure that appropriate precautions are taken to ensure the safety of personnel when carrying out methods of test required by this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This British Standard specifies requirements for the construction, dimensions, materials and performance of plastics pipes of up to 400 mm nominal outside diameter, with or without perforations, and for any associated fittings for normal field drainage.

No restrictions are placed on the type of plastics material to be used.

Methods of test, associated guidance and information on quality control testing are given in appendices.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1
coilable pipe

pipe which, together with associated joints, is intended for machine laying, i.e. it is required to be able to bend reasonably freely and to withstand tensile forces without excessive extension during the laying process. Typically, such pipe will have a corrugated wall and employ a jointing system which positively engages with the pipe

2.2
design internal diameter

the internal diameter of a pipe declared by the pipe and fitting manufacturer

2.3
design outside diameter

the outside diameter of a pipe declared by the pipe and fitting manufacturer

2.4
design perforation length

the design length of individual perforations declared by the pipe manufacturer

NOTE This is the length against which the requirements of **4.5** are determined.

2.5 *Text deleted*

2.6
non-coilable pipe

pipe which, together with associated joints, is neither required to be able to bend appreciably nor to withstand tensile forces. Typically, such pipe will be smooth walled on both interior and exterior surfaces and employ a spigot and socket jointing system

2.7
specific tangential end stiffness ($STES_{2\ year}$)

the stiffness corresponding to the 2 year value of STES in accordance with Annex A of BS EN ISO 9967

3 Materials

The material used for the manufacture of the pipe or fitting shall comprise any plastics material.

4 Construction and dimensions

4.1 Construction

The pipe shall be smooth and/or corrugated in conformation and of any design outside diameter up to 400 mm.

4.2 Internal diameter

The internal diameter of the pipe shall be not less than the design value stated by the manufacturer.

Before assessing a pipe for compliance, re-rounding of the pipe is permissible.

For pipe of design internal diameter not greater than 200 mm, compliance shall be checked using a plug gauge to suit the design diameter stated by the manufacturer and at least half that pipe diameter in length. Before using this gauge, any swarf or small protrusions on the inside of the pipe shall be removed.

For larger diameter pipes, compliance shall be checked using any device capable of measuring internal diameter to an accuracy of within ± 0.2 %, such as a bore micrometer or calipers, to determine the minimum internal diameter over a length corresponding to not less than half the design internal diameter.

4.3 Outside diameter

The outside diameter of the pipe shall comply with **4.1** and shall not differ from the design value stated by the manufacturer by more than $^{+\ 0.5}_{-\ 1.5}$ mm or $^{+\ 0.25}_{-\ 0.75}$ %, whichever is the greater.

Before assessing a pipe for compliance, re-rounding of the pipe is permissible.

For pipe of design internal diameter not greater than 200 mm, compliance shall be checked using the ring gauges appropriate to the pipe design outside diameter, and the applicable tolerance thereon, and having a length of at least half their internal diameter. Before using these gauges any swarf on the cut end shall be removed.

For larger diameter pipes, compliance shall be checked using any device capable of measuring outside diameter to an accuracy of within ± 0.02 %, such as a circumferential tape or calipers, to determine the maximum and minimum outside diameter over a length corresponding to not less than half the design outside diameter.

4.4 Ovality

The largest outside diameter of the pipe shall be such that it is not more than 110 % of the outside diameter at right angles to it.

4.5 Perforations

4.5.1 Pipes shall be perforated or unperforated. If perforated, the pipe shall have perforations for water entry which comply with **4.5.2** to **4.5.4**, except for zones within two pipe diameters of either end of a length or coil, where such zones may be either perforated or unperforated.

If the extension of the pipe is greater than 10 % when tested in accordance with Appendix G, additional test pieces shall comply with **4.5.2** to **4.5.4** when stretched to the extension obtained (see Appendix H).

4.5.2 Perforations in their least dimension, except as given in **4.5.3**, shall be not less than 0.8 mm and not greater than 2.0 mm. Compliance shall be checked for at least the design perforation length using a GO gauge of 0.8 mm and a NOT-GO gauge of 2.0 mm. No force shall be applied in using the gauges, in particular no material shall be removed to facilitate the entry of the gauge.

When some types of pipe are coiled, there is a tendency for the perforations to distort slightly: therefore, in cases of dispute, the check with the GO/NOT-GO gauges shall be made on a straightened length of pipe.

4.5.3 Provided that there are not less than 500 mm total length of perforations complying with **4.5.2** per metre of pipe, perforations measured on any metre of pipe taken at random need not comply with **4.5.2** in that up to 25 % of the perforations may have a least dimension of less than 0.8 mm, and up to 2 % of the perforations may have a least dimension greater than 2.0 mm but not greater than 3.0 mm. The length of the individual perforations shall not exceed the design perforation length by more than 50 %.

4.5.4 The distribution of perforations shall be such that there is at least one perforation in every 50 mm length of pipe and at least one perforation per 120° segment in every 150 mm length of pipe, except for zones unperforated in accordance with **4.5.1**.

5 Pipe stiffness

5.1 Specific tangential end stiffness ($STES_{2\ year}$)

NOTE 1 This test is intended as a type test (see Appendix J).

When tested in accordance with Appendix B the predicted 2 year (17 520 h) $STES_{2\ year}$ value shall be not less than 1.00 kN/m^2.

NOTE 2 For some pipe constructions, the arrangement of perforations is such that the orientation of the pipe with regard to the applied force significantly affects the stiffness. The requirements apply to the least favourable orientation.

5.2 Ring stiffness (S)

5.2.1 For type test purposes, when tested in accordance with **B.2.2** the ring stiffness of each test piece, e.g. S_a as designated in that method, shall be not less than 2.00 kN/m^2.

5.2.2 For inspection testing purposes, when tested in accordance with BS 2782-11:Method 1114B (BS EN ISO 9969) the ring stiffness of each test piece, e.g. S_a as designated in that method, shall be not less than the higher of the following limits, as applicable:

a) 2.00 kN/m^2;

b) not less than:

1) 90 % of the value of S obtained in accordance with **5.2.1** if the corresponding $STES_{2\ year}$ value was not greater than 1.50 kN/m^2;

2) 80 % of the value of S obtained in accordance with **5.2.1** if the corresponding $STES_{2\ year}$ value was greater than 1.50 kN/m^2.

6 Resistance to impact

When tested in accordance with Appendix E using the procedure described in **E.5** the pipe shall fulfil one of the following conditions:

a) in the first 17 test pieces tested no failures occur (in which case the seventeenth impact height will be 2 m);

b) during the sequence of passes and failures a test piece is tested at 2 m and passes at that height;

c) neither a) nor b) is applicable but the mean value of the drop heights of the 50 test pieces minus twice the standard deviation of the values of their drop heights exceeds 500 mm.

NOTE Test results are evaluated on a statistical basis, since plastics pipes of the types that are currently in use commonly exhibit a variation in impact strength between individual test pieces in any one batch. It is important, therefore, that any test should not only determine the average impact strength of the batch but take some account of the degree of scatter as well. The simplest way of allowing for scatter is to consider the range of the test results; this, however, is not entirely satisfactory since a single exceptionally high or low figure can give a false impression of the ability to withstand impact. For this reason the frequently used statistical concept of standard deviation has been introduced as a measure of the scatter or dispersion of the results.
There are two apparent complications. The first is that an assumed mean has been used rather than the absolute mean since this enables the calculations to be reduced to one comprehensive equation. The second is that in the case of strong pipes it may not be possible to obtain the data which are necessary for the statistical calculations. In order to cater for such cases the maximum drop height has been fixed at such a level that any pipe which withstands the test at that level can be regarded as satisfactory.

7 Flexibility of coilable pipe and associated joints

When tested in accordance with Appendix F, using either the 1, 2, 3, 4 or 5 m radius duct as stated by the manufacturer, the end force required to pull a length of pipe, including a joint, through the duct shall be less than or equal to the greater of the following:

a) (1.5 × *D*) N, where *D* is the pipe mean outside diameter (in mm);

b) 300 N.

NOTE The duct radius used corresponds with the minimum bend radius of the pipe [see item f) of **10.2**].

After being left in the duct for 10 min, the pipe shall not show any fracture or kinking when removed.

8 Extensibility of coilable pipe and associated joints

8.1 The pipe shall comply with **8.2** or **8.3** when tested in accordance with Appendix G using the greater applied force of the following:

a) (1.5 × *D*) N, where *D* is the pipe mean outside diameter (in mm);

b) 300 N.

8.2 The extension of the pipe shall be not greater than 10 % (but see **8.3**).

8.3 If the extension is greater than 10 %, additional test pieces stretched to and held at this greater extension and tested in accordance with Appendix H shall comply with **4.5**, **5.1** and clause **6**.

9 Fittings for joints and junctions

9.1 The jointing system shall ensure that the ends of the pipes are located without any obstruction to the pipe bore, and the fit shall be such that no gap in the joint is greater than 2 mm. Compliance shall be checked by examination of three joints or junctions assembled from the pipe and other necessary joint components chosen at random.

9.2 Joints made to connect coilable pipe shall not separate when tested in accordance with Appendix G using the greater applied force of the following:

a) (1.5 × *D*) N, where *D* is the pipe mean outside diameter (in mm);

b) 300 N.

Where pipes of different diameter are being joined then the value of *D* shall be that applicable to the larger pipe.

9.3 Junctions shall permit the connection of branch pipes, which may be of either equal or different diameters.

The fit shall be such that no gap in the junction is greater than 2 mm. Compliance shall be checked by examination of three junctions assembled with pipes and other necessary joint components chosen at random.

10 Marking

10.1 General

The marking shall remain legible under handling, storage and installation procedures in accordance with Appendix K and with BS 5955-6 and BS 8301 as applicable. Marking by indentation to a depth not greater than 0.15 mm shall be deemed to comply with this clause without infringing any applicable design limits for wall thickness or outside diameter (see **4.3**). If the marking is effected by means of printing or labels (see **10.2** and/or **10.3**), it shall comply with **B.1.2** or **B.1.3** (as applicable) and **B.1.4** of BS 3955:1986 and, as applicable, with BS 4781-1 except that, if the label is to be applied directly to a plastics pipe or fitting, the substrate to be used for the method of test for adhesion shall comprise a film made of the corresponding plastics material.

10.2 Pipe

Pipe manufactured in accordance with this standard shall be clearly marked with the following.

a) Manufacturer's identification and month and year of manufacture.

b) The number and date of this British Standard, e.g. BS 4962:1989[1)].

c) Manufacturer's type reference (where appropriate).

d) Design outside diameter and minimum inside diameter.

e) "UNPERFORATED" or the design perforation length, as applicable.

f) For coilable pipes, "Minimum bending radius *X* metres", where *X* is the value stated by the manufacturer in accordance with the performance requirements given in clause **7**.

In addition, in cases where the pipe will only comply with clause **7** in a preferred direction of bending, this shall be clearly stated together with the necessary instructions to inform the user of the installation practice to be followed.

The manufacturer's identification and the number and date of this British Standard shall be indelibly marked (see **10.1**) on the pipe at intervals not exceeding 5 m or on each length of pipe if this is shorter than 5 m. All other markings shall either be indelibly marked on the pipe at intervals not exceeding 10 m or shall appear on indelible labels (see **10.1**) which shall be securely attached to each coil or bundle of pipes.

NOTE It is preferred that all other markings are indelibly marked on the pipes.

10.3 Fittings for joints and junctions

Each fitting and any loose components required to effect the joints or junctions between pipes shall be clearly and indelibly marked (see **10.1**) with the manufacturer's identification.

In addition, they shall be marked with the following information, either directly on to the components or by indelible labels (see **10.1**) or, in the case of loose components, securely attached to each package.

a) Manufacturer's identification and month and year of manufacture.

b) Number and date of this British Standard, e.g. BS 4962:1989[1)].

c) Manufacturer's type reference (where appropriate).

d) Design outside diameter of the pipe with which the component is intended to be used.

NOTE It is preferred that all other markings are indelibly marked on the fitting or components. Where the joint components are supplied attached to the pipe, the pipe identification alone will suffice.

[1)] Marking BS 4962:1989 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Appendix A

Text deleted

Appendix B Determination of specific tangential end stiffness (STES) and ring stiffness (*S*) of the pipe

B.1 Principle

A cut length of pipe is placed between two flat parallel horizontal plates and a constant compressive force is applied for a minimum of 1 008 h (42 days). The deflection of the pipe is recorded at specified intervals so as to prepare a plot of pipe deflection against time. The linearity of the data is analysed and used to calculate the extrapolated 2 year deflection, Y_2. Y_2 is then used in calculation of the specific tangential end stiffness after 2 years ($STES_{2\ year}$).

To provide reference data for inspection testing (see **5.2**), the ring stiffness of the pipe is determined using a further set of test pieces taken from the same sample of pipe as that used for type testing for $STES_{2\ year}$ of a pipe conforming to this standard.

B.2 Procedure

B.2.1 *Determination of specific tangential end stiffness ($STES_{2\ year}$)*

B.2.1.1 Prepare a set of three test pieces, marked **a, b** and **c** respectively, conforming to BS 2782:Method 1114A (see also **B.2.2.1**).

B.2.1.2 For test piece **a,** determine in accordance with BS 2782:Method 1114A the deflection/time data necessary to calculate the extrapolated 2 year deflection Y_2 for that test piece (see in **8.1** of Method 1114A:1995 the 1st, 2nd and 3rd paragraphs and, if applicable, the 4th paragraph and **8.3**). Record the result as Y_{2a} together with the corresponding values for the length of the test piece L_a and the average internal diameter of the pipe d_i, all in millimetres, and for the pre-load force F_0 and the full loading force F, in newtons.

Calculate and record the specific tangential end stiffness of the test piece after 2 years, $STES_{2a}$, in kilonewtons per square metre, using the following equation:

$$STES_{2a} = \left(0.0186 + 0.025\ \frac{Y_{2a}}{d_i}\right) \frac{F}{l_a\, Y_{2a}} \qquad \text{(B.1)}$$

where Y_{2a}, d_i and L_a are all in metres and F is in kilonewtons.

B.2.1.3 For test pieces **b** and **c** in turn, using the corresponding values for Y_2 and L, repeat the procedure given in **B.2.1.2** to obtain values for $STES_{2b}$ and $STES_{2c}$ respectively.

B.2.1.4 Calculate and record as the specific tangential end stiffness of the pipe after 2 years, $STES_{2\ year}$, as the average of the STES results for the three test pieces, i.e.

$$STES_{2\ year} = (STES_{2a} + STES_{2b} + STES_{2c})/3$$

B.2.2 *Determination of ring stiffness (S)*

B.2.2.1 If testing for type test purposes, prepare from the same sample of pipe as that used for type testing for $STES_{2\ year}$ at least one set of three test pieces as necessary to conform to BS 2782:Method 1114B:1995 and designated **a, b** and **c** respectively in accordance with that method.

B.2.2.2 Using test pieces conforming to **B.2.2.1**, determine the ring stiffness of the pipe, *S*, in accordance with BS 2782:Method 1114B. If the pipe from which the samples were taken conforms to this standard, i.e. BS 4962, record the results obtained, in kilonewtons per square metre, for the ring stiffness of each test piece (S_a, S_b and S_c, to three decimal places) and of the pipe (*S*, to two decimal places), for reference purposes (see **5.2**).

B.3 Test report

The test report shall include the following:

a) a full description of the pipe, including manufacturer's identification, size and month and year of manufacture;

b) a reference to this method of test, e.g. Appendix B of BS 4962:1989, as amended by amendment No. 1;

c) all other information required for a test report conforming to BS 2782:Method 1114A:1995 except the two items relating to the creep ratio;

d) the full loading force, *F*, applied, in kilonewtons to three decimal places;

e) the calculated values for $STES_{2a}$, $STES_{2b}$, and $STES_{2c}$, in kilonewtons per square metre to three decimal places;

f) the calculated value for $STES_{2\ year}$, in kilonewtons per square metre to two decimal places;

g) the calculated values for S_a, S_b and S_c, in kilonewtons per square metre to three decimal places;

h) the calculated value for *S*, in kilonewtons per square metre to two decimal places;

i) all additional information required for a test report conforming to BS 2782:Method 1114B.

Figure 1 *Figure deleted*

Appendix C

Text deleted

Figure 2 *Figure deleted*

Appendix D

Text deleted

Appendix E Determination of resistance to impact

E.1 Principle

Successive test pieces conditioned to 0 °C are submitted to blows from a striker with a mass of 0.50 kg falling from varying heights. The test pieces are subsequently examined for cracks or perforations.

For routine inspection and quality control, a sequence of blows from a specified minimum height is sufficient, provided no incidence of failure is observed (see **E.8**).

E.2 Apparatus

E.2.1 *Impact apparatus,* consisting essentially of the following (see Figure 3):

a) striker assembly, with a mass of 0.50 kg, including a hard cylindrical head having a length of 100 mm and a section radius of 12.7 mm;

b) vertical guide system, which permits the striker to be dropped from varying known heights up to 2 000 mm on to the top surface of the test piece;

c) test piece holder, comprising a vee-block of included angle 120° and minimum length of 230 mm, positioned on the base such that the projection of the path of the centre of the striker head is not more than 2.5 mm from either axis of the vee-block. The vee-block and its underlying support or foundation shall not deform or move in response to the impact on the pipe under test.

E.2.2 *Conditioning bath,* containing an aqueous solution of an inert liquid, e.g. polyethylene glycol, maintained at 0 ± 1 °C.

E.3 Test pieces

A minimum of 17 complete sections of pipe, each 200 mm in length, are tested.

NOTE For full testing, a total of 66 test pieces may be required, or possibly more if it is necessary to carry out preliminary tests (see **E.5.1**).

E.4 Conditioning and test temperature

Submerge the test pieces in the conditioning bath at 0 ± 1 °C for at least 1 h prior to testing (within 15 s, see **E.5.2**) in ambient conditions maintained at 20 ± 5 °C.

E.5 Procedure for testing resistance to a striker falling from progressively changing heights

E.5.1 *Preliminary tests*

Carry out a series of preliminary tests to determine the manner of presentation of the test piece to the striker which is most likely to cause a failure. Use this manner of presentation in the subsequent tests.

NOTE For most types of pipe, failure is most likely when the striker hits a perforation, but this is not invariably the case. The preliminary test may be omitted if previous experience with the particular type of pipe has established the manner of presentation most likely to cause failure.

E.5.2 *Individual test*

Remove the test piece from the conditioning bath and place on the test piece holder such that the point of striker impact is not less than 50 mm from either end of the test piece.

Within 15 s of the removal of the test piece from the bath release the striker. Examine the test piece for failure; test pieces showing cracks or holes are to be regarded as failing the individual test, but discoloration is permitted.

E.5.3 *Test sequence*

Carry out the first test by dropping the striker from a height of 400 mm above the upper surface of the test piece. If the first test piece fails, decrease the drop height by 100 mm for the next test piece: if the first test piece passes, increase the drop height by 100 mm for the next test piece.

After testing each test piece alter the drop height in a similar manner.

If the first 17 results are passes, terminate the test sequence. Otherwise, if the initial sequence of results is one of passes, count the first failure as the first test piece of the test run and test a further 49 test pieces. Similarly, if the first few results are failures, count the first pass as the first test piece of the test run and test a further 49 test pieces.

E.6 Evaluation of results

Calculate the mean drop height of the 50 test pieces less twice the standard deviation of the values of their drop heights, for example by tabulating the data as shown in Table 2 and Table 3 and using equation (4).

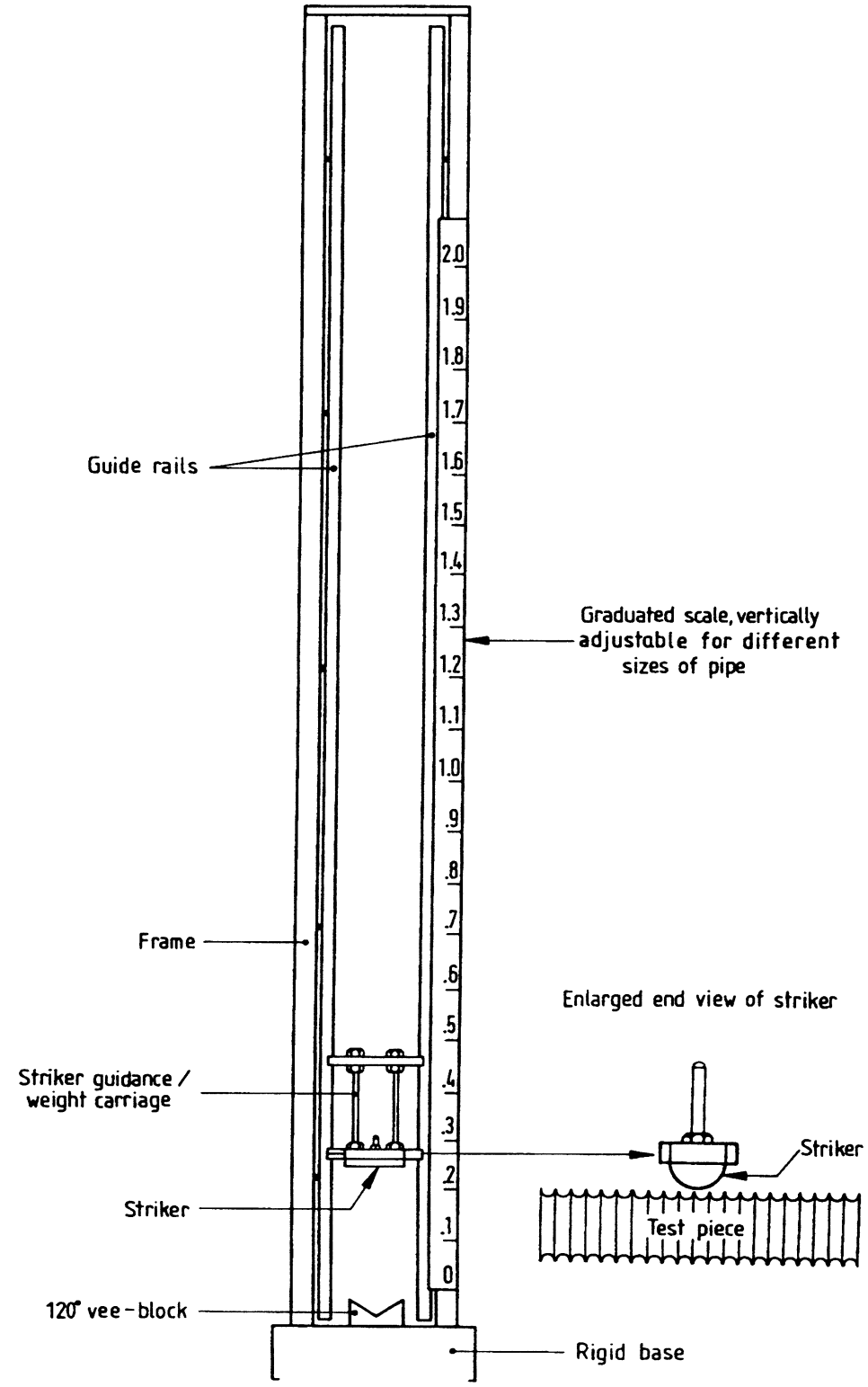


Figure 3 — Typical test apparatus for determination of resistance to impact

Table 2 — Example of the typical plot of impact test data

Dropping height	Ignored for calculation purposes	Test piece number				
		1 to 10	11 to 20	21 to 30	31 to 40	41 to 50
mm						
2 000						
1 900						
1 800						
1 700						
1 600						
1 500						
1 400			×		×	
1 300		×	× √ ×	×	√ ×	× × ×
1 200	√	× × √ √	√ √ × ×	√ × ×	× × √	× × √ √ ×
1 100	√	√ √	√	√ × √ ×	√ √ √	√ √
1 000	√	√	√	√	√	
900	√					
800	√					
700	√					
600	√					
500	√					
400	√					
down to 0						

NOTE A cross denotes a failed test piece. A tick denotes a passed test piece. All test pieces tested prior to the first change in sequence (i.e. the first failure if the initial test pieces passed or conversely the first success if the initial test pieces failed), are ignored for calculation purposes since they would distort the statistical calculation. (In the above example the first nine test pieces are ignored.)

Table 3 — Example of data tabulation

Dropping height	F[a]	x[b]	Fx	Fx^2
mm				
1 400	3	2	6	12
1 300	13	1	13	13
1 200	20	0	0	0
1 100	12	1	− 12	12
1 000	2	− 2	− 4	8
Total	50	[c]	3	45

NOTE Both the assumed mean and x are mathematical devices to simplify calculation.

[a] F is the frequency, i.e. the number of samples tested at each drop height.

[b] x is the number of increments of 100 mm by which the height differs from the assumed mean drop height (1 200 mm in the example).

[c] This total is not required for the calculation.

$$H = m + \left(100 \times \frac{\Sigma Fx}{\Sigma F}\right) - \left\{\left(\frac{2 \times 100}{\Sigma F}\right) \sqrt{\left[(\Sigma Fx^2 \times \Sigma F) - (\Sigma Fx)^2\right]}\right\} \quad (4)$$

where

H is the mean drop height less twice the standard deviation (in mm);

F is the frequency, i.e. the number of samples tested at each drop height;

x is the number of increments of 100 mm by which the height differs from the assumed mean drop height (1 200 mm in the example);

m is the assumed mean drop height (in mm) (1 200 mm in the example).

Applying equation (4) to the example data:

$$H = 1200 + \left(100 \times \frac{3}{50}\right) - \left\{\left(\frac{2 \times 100}{50}\right) \sqrt{[(45 \times 50) - (3)^2]}\right\}$$

$H = 1200 + 6 - 189$ mm

$H = 1017$ mm

NOTE The calculated result (H) is greater than 500 mm and therefore the pipe complies with item *c*) of clause **6**.

E.7 Test report

The test report shall include the following:

a) a full description of the pipe, including manufacturer's identification, size and month and year of manufacture;

b) a reference to this method of test, e.g. Appendix E of BS 4962:1989;

c) for the progressively changing drop height test (see **E.5**), the number of test pieces tested and, if the test run of 50 test pieces is used, the mean drop height less twice the standard deviation;

d) the date of the test.

E.8 Procedure for testing resistance to a striker falling from a constant height

NOTE This procedure may be used for inspection testing of a type of pipe which has been proved satisfactory by type testing in accordance with **E.5**. If doubt or conflict arises, the full test as described in **E.5** is carried out.

E.8.1 *Test sequence*

Test five test pieces as described in **E.5.3**, dropping the striker from a height of 1 000 mm.

E.8.2 *Retests*

If any test pieces fail, subject the pipe to the test detailed in **E.5**. Otherwise report that five test pieces passed this test, together with information in accordance with items a), b) and d) of **E.7**.

Appendix F Determination of flexibility

F.1 Principle

A test piece of coilable pipe is forced into one of a set of curved ducts, kept there for 10 min and after withdrawal is examined for damage. The pipe is pulled through the duct exerting an end force as specified in clause **7**.

F.2 Apparatus

F.2.1 *A set of open-ended ducts,* (see Figure 4), made of low carbon steel, of cross section of 110 mm × 110 mm for pipes up to 100 mm in diameter, a set of 225 mm × 225 mm cross section for pipes between 101 mm and 200 mm in diameter, and a set of 450 mm × 450 mm for pipes between 201 mm and 400 mm in diameter. Each set shall have ducts with centreline radii of 1, 2, 3, 4 and 5 m; the length of each duct shall be approximately equal to its radius at the duct centreline.

For ease of observation and/or unloading, one side of the duct may comprise a transparent material or may be open subject to having a lip of sufficient depth to retain a test piece moving longitudinally through the duct.

F.2.2 *A calibrated spring device,* or other means of exerting an end force on the test piece as specified in clause **7**.

F.3 Test piece

The test piece shall be at least 0.5 m longer than the test duct employed. The test piece shall include a joint.

F.4 Conditioning and test temperature

Condition the test piece at 23 ± 2 °C for at least 1 h before carrying out the test at that temperature.

F.5 Procedure

Insert the test piece into one end of the duct of the radius equivalent to the minimum bend radius (see clause **7**) and as soon as the leading end emerges from the other end of the duct measure and record the force needed to pull the test piece further through the duct. Leave in position for 10 ± 1 min. At the end of this period remove the test piece from the duct and examine for damage.

F.6 Evaluation of damage

Test pieces showing any cracking or kinking are to be regarded as failing the test, but discoloration is permitted.

Despite appearing undamaged, the test piece shall not be re-used for any other tests.

F.7 Test report

The test report shall include the following:

a) a full description of the pipe system, including manufacturer's identification, size, minimum bend radius and month and year of manufacture;

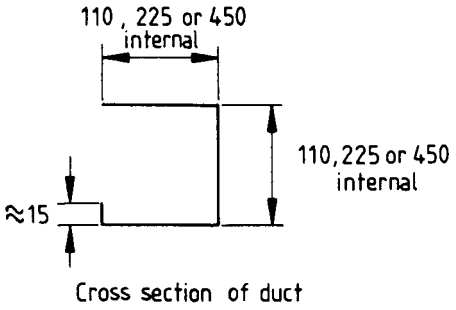
b) a reference to this method of test, e.g. Appendix F of BS 4962:1989;

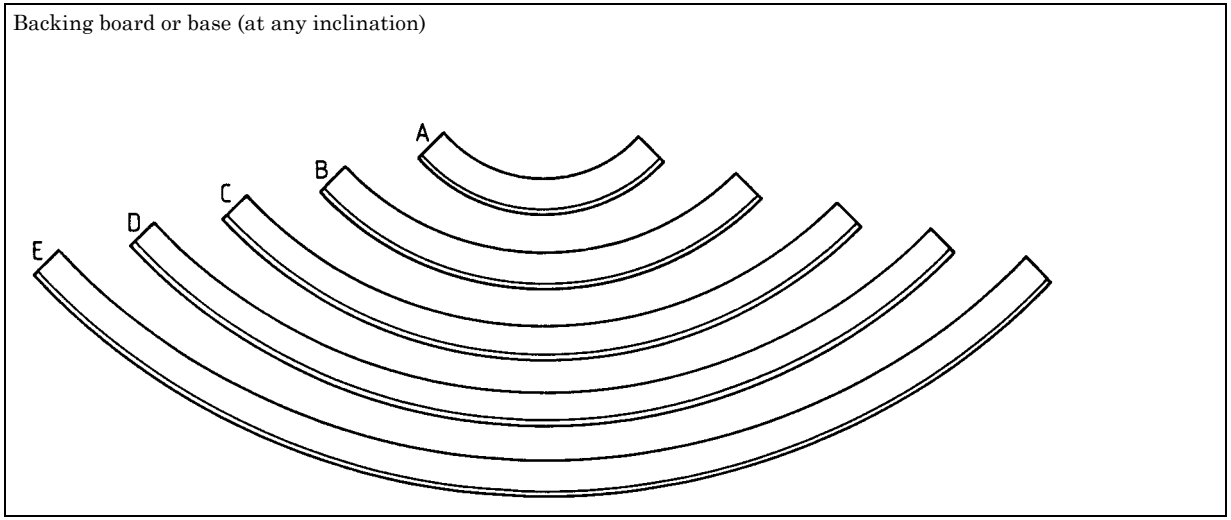
c) the duct radius used;

d) the force required to pull the test piece through the duct;

e) description of any failure of the pipe or joint;

f) the date of the test.





Duct	Mean Radius	Length
	m	m
A	1	1
B	2	2
C	3	3
D	4	4
E	5	5

All dimensions are in millimetres

Figure 4 — Typical layout of ducts for determination of flexibility

Appendix G Extensibility and joint tests

G.1 Principle

NOTE 1 This test is designed to assess both the extensibility of a length of pipe and/or the strength of a joint (see clauses **8** and **9**).

A tensile force is applied to a test piece of coilable pipe, with or without a joint. After a brief specific period (10 min), one of the following is assessed:

a) for test pieces without joints, the extension of the pipe (see clause **8**);

b) for test pieces with joints, the strength of the joint (see clause **9**);

c) for test pieces with joints, both a) and b).

NOTE Extensibility and joint testing can be carried out as one test or as two separate tests.

G.2 Apparatus

NOTE See Figure 5.

G.2.1 *A means of rigidly holding a test piece,* in a vertical position and that is capable of applying the greater force of the following:

a) (1.5 × D) N, where D is the (larger) pipe mean outside diameter (in mm);

b) 300 N.

NOTE Suitable end grips may take the form of plugs of plaster of Paris cast inside the ends of the test piece into which eye bolts or similar attachments are embedded: any other equally suitable method of gripping the pipe may be used.

G.2.2 *A scale rule,* or other means of determining the longitudinal extension of the test piece, to an accuracy of 1.0 mm.

G.3 Test piece

The two types of test piece required, as appropriate, shall be as follows.

a) The test piece for assessing the extensibility of the pipe shall consist of a length of pipe 500 mm long together with sufficient extra length to allow for the end grips.

b) The test piece for assessing the strength of the joint or for carrying out the combined test shall consist of a joint and two equal lengths of pipe, such that the length of pipe not used for jointing or for the end grips shall be 500 mm.

G.4 Conditioning and test temperature

Condition the pipe or the assembly at 23 ± 2 °C for at least 1 h before carrying out the test at that temperature.

G.5 Procedure

Attach one end of the test piece rigidly to the apparatus and then affix the load carrier which, with any ancillary attachments, will apply a pilot force of 10 N. Zero the deflection measuring device and apply to the weight carrier, without snatch, the total main force of the greater of the following:

a) (1.5 × D) N, where D is the pipe mean outside diameter (in mm) of the (larger) pipe (if a joint test employing different diameters is being carried out);

b) 300 N.

Maintain the main force for 10 min. At the end of this period examine the test piece and record the following:

1) for the extensibility test, details of longitudinal extension or any breakage of the pipe;

2) for the joint test, details of any breakage or parting of the joint.

G.6 Assessment of results

G.6.1 *Extensibility test*

After test, assess the results as follows.

a) If the test piece shows any cracking or breakage, the pipe shall be reported as unsatisfactory.

b) If there is no cracking or breakage and if the extension is less than 45 mm, the pipe shall be reported as satisfactory.

c) If the extension is in the range 45 mm to 55 mm, repeat the test on two further test pieces and average the three values. If this average is less than 50 mm, i.e. 10 %, the pipe shall be reported as satisfactory; in cases where either of the repeat test pieces fails as in a), the pipe shall be reported as unsatisfactory.

d) If the extension is greater than 55 mm or the average value of the extension of the three test pieces in c) is greater than 50 mm, only when compliance with **8.3** has been established shall the pipe be reported as satisfactory.

If, as a result of the design of some joints, the measured extensibility exceeds 10 % when the two requirements are assessed together, the value of the extensibility shall be assessed on a length of pipe without a joint, and if necessary, compliance with the requirements of **8.3** shall be determined.

G.6.2 *Joint test*

If the joint breaks or separates, the joint shall be reported as unsatisfactory. Otherwise it shall be reported as satisfactory.

G.7 Test report

The test report shall include the following:

a) a full description of the pipe system including manufacturer's identification, size and month and year of manufacture;

b) a reference to this method of test, e.g. Appendix G of BS 4962:1989;

c) a description of the pipe system after the test;

d) the extension of the pipe and/or pipe and joint;

e) if the extension is greater than 10 %, the results of the additional tests as specified in **8.3**;

f) the date of the test.

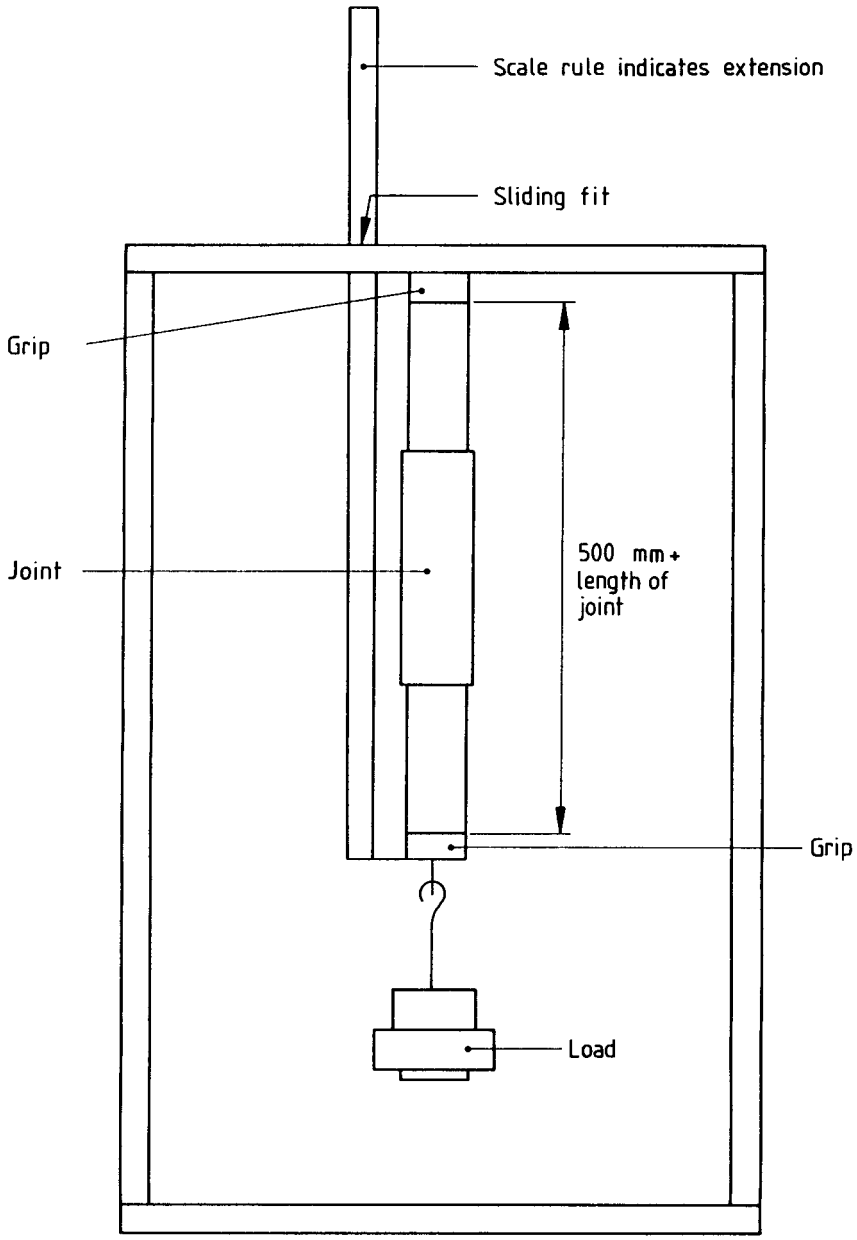


Figure 5 — Diagrammatic representation of extensibility and joint strength tests

Appendix H Methods of test for stretched pipe

H.1 Principle

NOTE See **8.3**.

Pipe having an extensibility greater than 10 % when tested in accordance with Appendix G is stretched to the corresponding extension and tested in a stretched condition so as to assess the extended pipe against the requirements applicable to less extensible pipe. The test procedures are modified to suppress, or compensate for, interference with the results by the use of the stretching equipment and/or of modified test piece dimensions.

H.2 Apparatus

H.2.1 *Stretching machine,* providing means for positioning two grips to accommodate a test piece of pipe between 650 mm and 1 200 mm in length and to extend the test piece to the average extension ($\overline{E}_p$) obtained, in percent, when standard length (500 mm) test pieces of such pipe were tested in accordance with Appendix G. The extension relates to the gripped portion of the test piece, i.e. the free length of the test piece between the nearest points of contact of the grips at opposite ends of the test piece, e.g. the tips of pairs of grips in accordance with Figure 6. The apparatus shall maintain axial alignment of the test piece to within ± 2 mm and shall inhibit twisting or disengagement of the test piece during its extension.

Figure 6 shows a suitable form of the mechanism required, featuring an assembly of end plates and tubes which fit within the test piece and two pullers, the prongs of which bear on the end plates while hooks engage the test piece internally. The 3 hooks are equi-spaced around the inside of the pipe and can be spread to engage a corrugation near the end of the test piece. In Figure 6, only part of one puller, featuring one of the hooks and a prong, is shown. For this type of mechanism, which is applicable to pipes having an internal diameter greater than about 100 mm, the tip of each hook shall have a width of 10 ± 1 mm.

Figure 7 shows another suitable form of mechanism, featuring pairs of split shell grips shaped to engage the external profile of the pipe and extend it relative to a coaxial lead screw.

NOTE The method of use of the type of apparatus shown in Figure 6 is as follows.

a) Adjust the length of the assembly of end plates and tubes until it is approximately that of the test piece and then mount within same.

b) Using the tommy bar, adjust the spread of the hooks until they firmly engage a corrugation, preferably beyond the first two corrugations within the end of the test piece.

c) Tighten the nut on the central spindle, so causing axial displacement of the set of hooks relative to the set of prongs, until the required amount of stretching of the test piece is achieved.

H.3 Method of test for perforations in stretched pipe

H.3.1 *Test piece*

The test piece shall comprise a piece of pipe of 1 150 mm to 1 200 mm in length.

H.3.2 *Procedure*

Using apparatus in accordance with **H.2**, mount the test piece so that the gripped portion of the test piece is not less than 1 100 mm.

Stretch the gripped portion of the test piece to the percentage extension $\overline{E}_p$ (see **H.2.1**). Maintain that extension while inspecting the central 1 000 mm portion of the test piece between the grips for compliance with **4.5**.

H.4 Method of test for specific tangential end stiffness ($STES_{2\ year}$) of stretched pipe

H.4.1 *Test pieces*

Six pieces of pipe, each at least 650 mm in length, are tested.

NOTE In the absence of a prior result for a value for $STES_{2\ year}$ for the pipe when determined in accordance with Appendix B, three test pieces conforming to **B.2.1.1** are also required.

H.4.2 *Procedure*

H.4.2.1 *Testing of test pieces in a stretched condition.* Using apparatus conforming to **H.2**, mount a test piece (**H.4.1**) so that the gripped portion of the test piece is 600 mm ± 10 mm.

Stretch the gripped portion of the test piece to the percentage extension $\overline{E}_p$ (see **H.2.1**). Maintain that extension while testing the central 200 mm portion of the stretched test piece in accordance with **B.2.1.2**. Record the deflections obtained.

Repeat this procedure for two more test pieces in a stretched condition. Determine and record as value *B* the specific tangential end stiffness for the three test pieces in accordance with **B.2.1.4**.

H.4.2.2 *Testing of test pieces in an unstretched condition.* Using three test pieces (**H.4.1**) test the central 200 mm portion of each test piece in accordance with Appendix B. Record as value *C* the specific tangential end stiffness obtained.

Determine, if not already available, the specific tangential end stiffness in accordance with Appendix B using test pieces conforming to **B.2.1.2**. Record as value *A* the long-term pipe stiffness obtained.

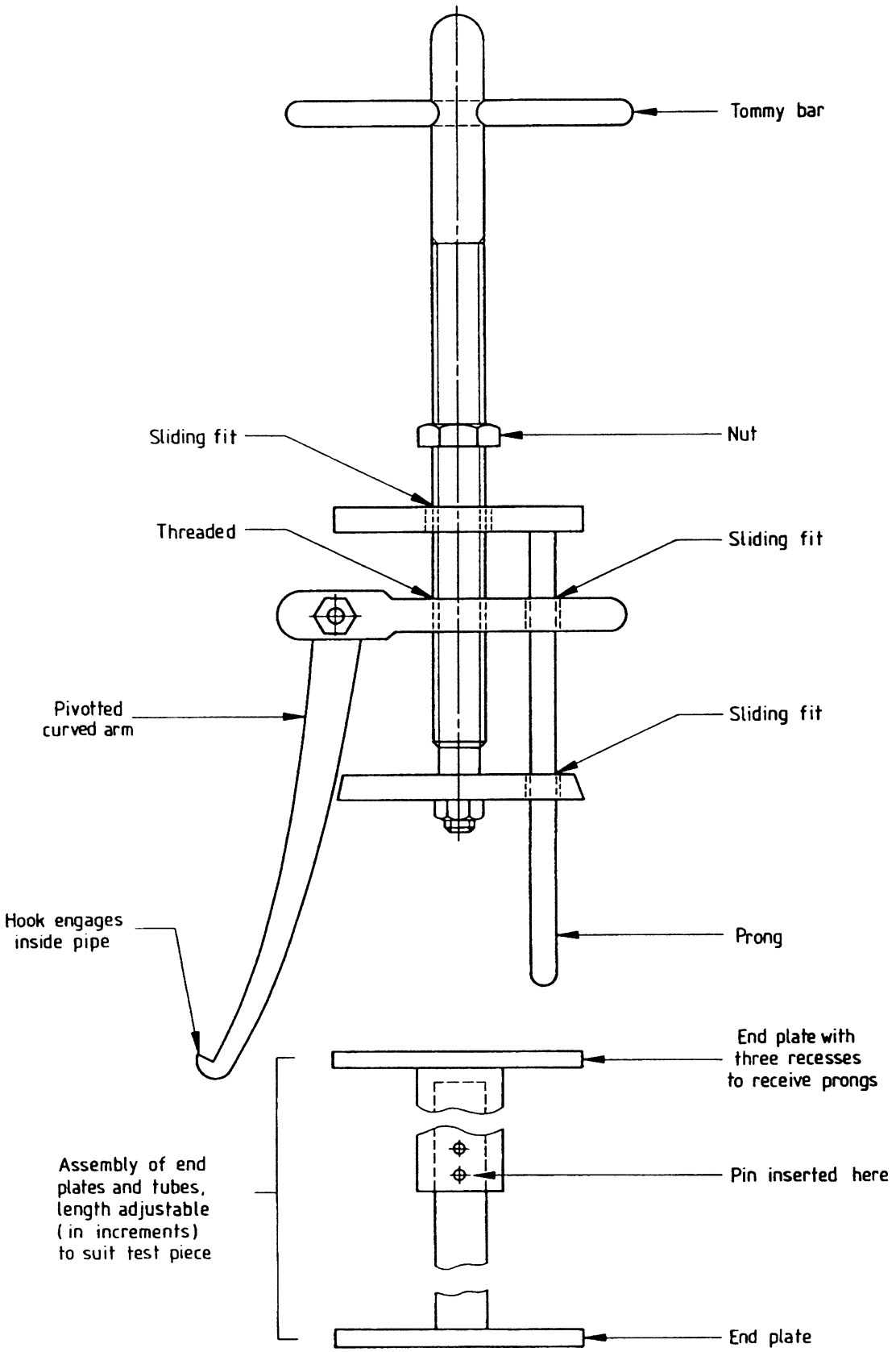
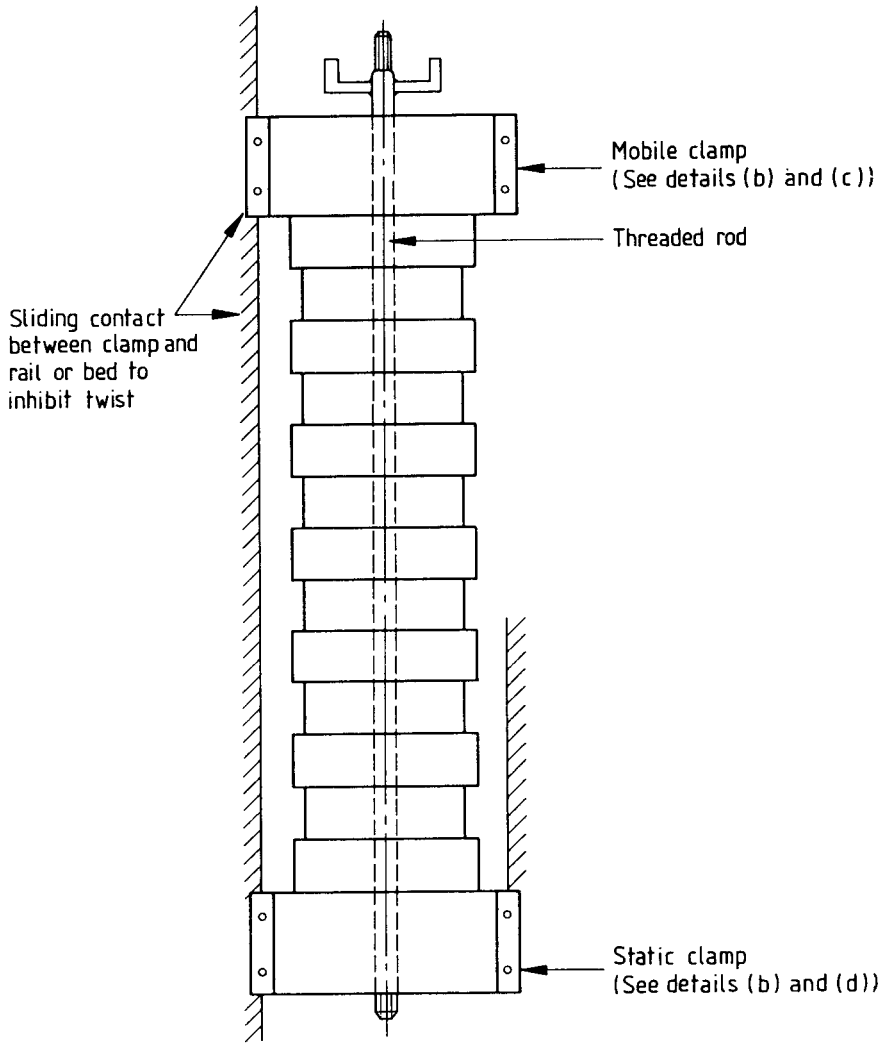
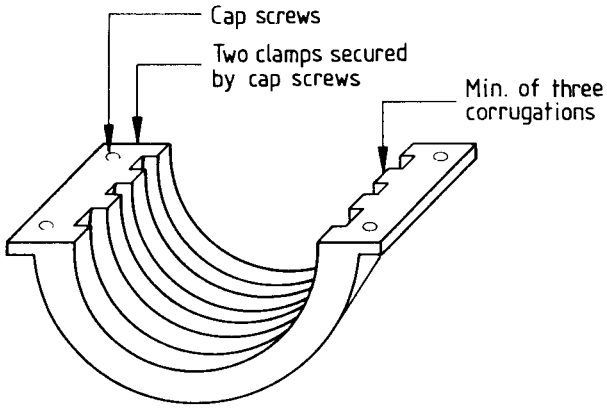


Figure 6 — Typical internal grip for extending test pieces



(a) General assembly



(b) Detail of split clamp

Figure 7 — Typical external grips for extending test pieces *(continued)*

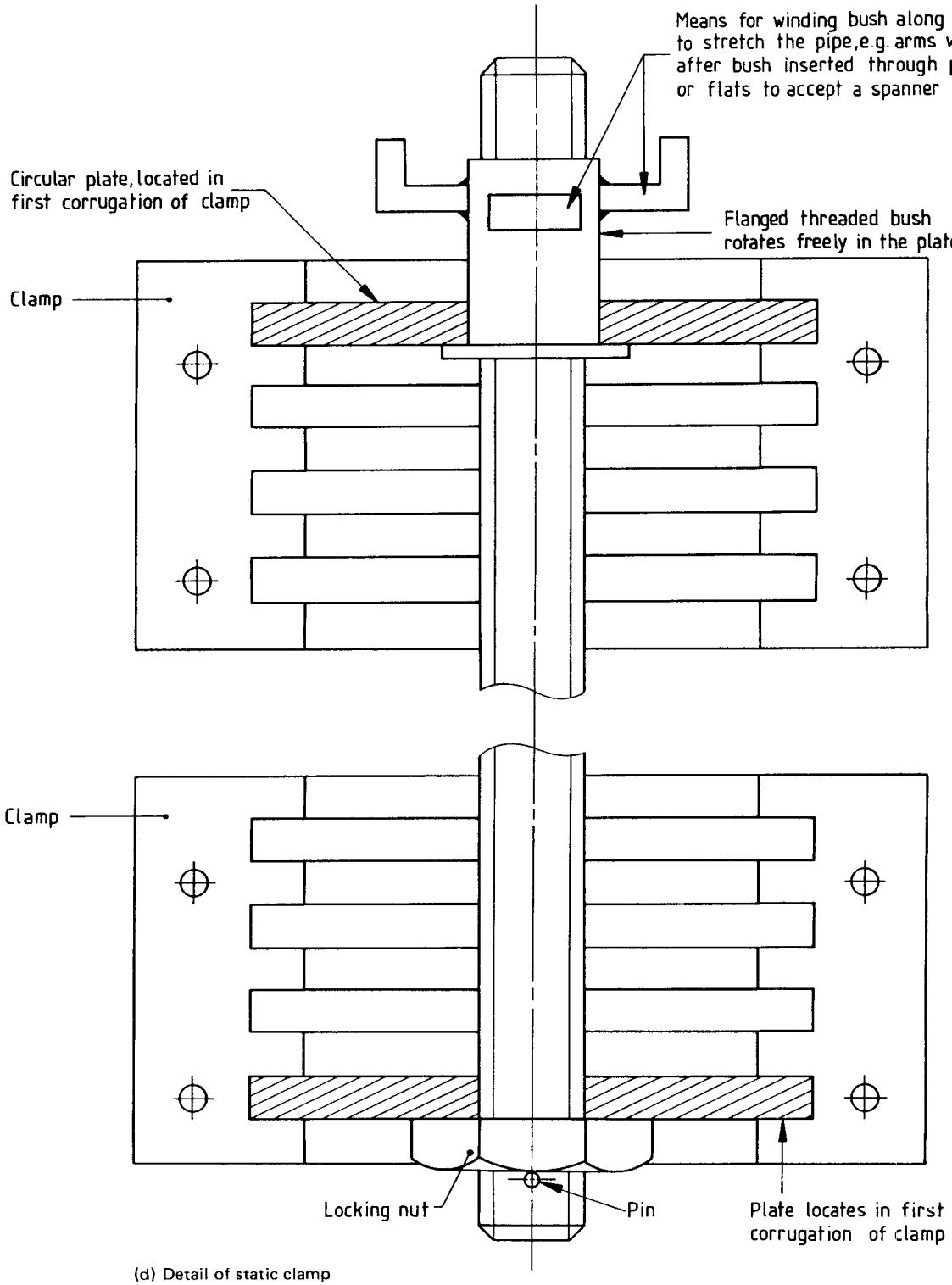


Figure 7 — Typical external grips for extending test pieces *(concluded)*

H.4.3 ***Calculation of results***

Calculate the estimated specific tangential end stiffness ($ESTS_{2\ year}$) (in kilonewtons per square metre) for stretched pipe using the following equation:

$$ESTS_{2\ year} = \frac{AB}{C}$$

where

A is the specific tangential end stiffness (in kilonewtons per square metre) obtained using unstretched test pieces of 200 mm length;

B is the specific tangential end stiffness (in kilonewtons per square metre) obtained using stretched test pieces of 650 mm minimum initial length;

C is the specific tangential end stiffness (in kilonewtons per square metre) obtained using unstretched test pieces of 650 mm minimum initial length.

Record the estimated specific tangential end stiffness ($ESTS_{2\ year}$) for comparison with the specified requirement (i.e. not less than 1.00 kN/m^2, see **5.1**, **8.3** and **H.1**).

H.5 Method of test for resistance to impact of stretched pipe

H.5.1 *Test pieces*

Each test piece shall comprise a piece at least 650 mm in length. Sufficient test pieces are required to perform the test procedure in accordance with Appendix E using test pieces maintained in a stretched condition and to repeat the test procedure using test pieces in an unstretched condition, i.e. 132 or more test pieces may be required (see **E.3**).

NOTE In the absence of a prior result for the mean drop height less twice the standard deviation for the pipe when determined in accordance with Appendix E, a further set of test pieces in accordance with **E.3** may be required (see **H.5.2.1** and **H.5.2.2**).

H.5.2 *Procedure*

H.5.2.1 *Testing of test pieces in a stretched condition.* Using apparatus in accordance with **H.2**, mount a test piece (**H.5.1**) so that the gripped portion of the test piece is 600 ± 10 mm.

Stretch the gripped portion of the test piece to the percentage extension $\overline{E}_p$ (see **H.2.1**). Maintain that extension while conditioning the test piece. Locate a point within the central 100 mm portion of the stretched test piece as the position of impact in accordance with Appendix E.

Strike the test piece and repeat the test with the other test pieces. Record a result for resistance to impact in accordance with **E.7**.

If the result obtained complies with item a) or item b) of clause **6**, then **8.3** is satisfied in respect of clause **6** and testing may be terminated. Otherwise determine and record, as value *Q*, the result obtained for the mean drop height less twice the standard deviation of stretched pipe and proceed with testing in accordance with **H.5.2.2**.

H.5.2.2 *Testing of test pieces in an unstretched condition.* Using test pieces in accordance with **H.5.1**, test the central 100 mm portions of the test pieces in accordance with Appendix E. Record, as value *R*, the result for the mean drop height less twice the standard deviation obtained.

Determine, if not already available, the mean drop height less twice the standard deviation for the pipe in accordance with Appendix E using test pieces in accordance with **E.3**. Record as value *P* the value obtained.

H.5.3 *Calculation of results*

Calculate the estimated mean drop height less twice the standard deviation for a 200 mm length of stretched pipe using the following equation:

$$H = \frac{PQ}{R} \qquad (7)$$

where

H is the estimated mean drop height less twice the standard deviation (in mm) for stretched pipe;

P is the mean drop height less twice the standard deviation (in mm) obtained using unstretched test pieces of 200 mm length;

Q is the mean drop height less twice the standard deviation (in mm) obtained using stretched test pieces of 600 ± 10 mm length;

R is the mean drop height less twice the standard deviation (in mm) obtained using unstretched test pieces of 600 ± 10 mm length.

Record the value of estimated mean drop height less twice the standard deviation for stretched pipe for comparison with the specified requirement [i.e. not less than 500 mm, see item c) of clause **6**, **8.3** and **H.1**].

Appendix J Guidance on quality control testing

The following guidance on the nature of the requirements and test methods specified in this British Standard is provided to assist the preparation of quality plans for the manufacture of pipes or fittings complying with this standard.

The applicability of specific requirements and associated methods of test to different types of pipe or fitting is summarized in Table 4, in which each requirement is classified as being considered particularly suitable for type test and/or inspection test purposes.

Type tests are intended to prove the suitability and performance of a material composition, a compounding or processing technique or a design or size of pipe, fitting, or joint assembly. Such tests should be performed when any introduction or change is made in one or more of these aspects, but they may be performed more frequently by incorporation into a plan for monitoring the consistency of manufacture.

Inspection tests are carried out during and/or following manufacture to monitor the quality of a product item as applicable. Certain test methods and associated requirements have been included because of the practicality and speed with which they may be performed in conjunction with a production process in comparison with some of the type tests.

Some of the requirements in this standard are relevant to both type test and inspection purposes, e.g. those for dimensions. Attention is drawn to guidance given in **4.14** of BS 5750-5:1981 concerning possible use of alternative inspection procedures and equipment for quality control purposes under production conditions, e.g. on-line monitoring of extruded profile dimensions, to the methods required by a British Standard for establishing the properties of the final product under laboratory conditions specified in that standard.

Table 4 — Applicability of requirements and test methods

Product	Property	Clause	Method	Test type	
				Type test	Inspection test
All pipes and fittings	Materials	**3**		×	
All pipes	Construction and dimensions	**4.1** to **4.4**		×	×
Perforated pipes	Perforations	**4.5**	[a]	×	×
All pipes	Stiffness	**5.1**	Appendix B[a]	×	
	Stiffness	**5.2**	Appendix B[a]	×	×
All pipes	Resistance to impact	**6**	Appendix E Clause **E.5**[a]	×	
			Appendix E Clause **E.8**		×
All coilable pipes	Flexibility	**7**	Appendix F	×	×
All coilable pipes	Extensibility	**8**	Appendix G[a]	×	×
All fittings and joint components	Joint form and fit	**9**	Appendix G	×	×
All pipes	Marking	**10.2**			×
All fittings and joint components	Marking	**10.3**			×

[a] Appendix H may be applicable (see **8.3**).

Appendix K Guidance on storage and installation

K.1 Storage

If the pipe or fitting is unlikely to be installed within one year of manufacture, it should be stored in such a way as to exclude direct sunlight, e.g. covered with opaque sheeting which, to avoid excessive heat build-up, should be light in colour.

K.2 Installation of unperforated pipes

Unperforated pipes should be used in subsoil field drain systems in either of the following circumstances:

a) where leakage from the pipes is to be prevented, e.g. to avoid soil erosion;

b) where drains have to be laid within 5 m of hedges or of trees other than trees in orchards.

K.3 Depth of installation

The depth of installation should be such that there is a minimum depth of cover of 600 mm from the top surface of all pipework to the original ground surface.

K.4 Interaction between soil water and subsoil drain system components

Because of the variety of soil waters which may be encountered at the applicable depth of installation (see **K.3**) and the variety of materials from which pipes or fittings may be made, the possibility of interaction between any unusual soil water conditions to be encountered in a particular installation and the material of construction of the intended pipe or fittings should be considered in order to decide whether or not the performance of the pipe or fitting after installation would prematurely become unacceptable.

K.5 Pipe laid in trenches excavated by machine or by hand

The pipe should be laid in a trench the bottom of which should normally be in accordance with condition a) as follows, but condition b) can be used if the contractor has notified the employer that condition a) is not practical, and if the engineer inspecting the work is satisfied that the alternative bedding practice is of the standard required.

a) Normally the base of the trench should be shaped by a tool to form a V-shaped groove of nominally 90° included angle, with the base of the groove radiused to a value not less than the outside radius of the pipe being laid.

b) Where the groove described above cannot be economically made, a bedding practice to give equivalent lateral support should be utilized. This may consist of a layer of granular fill on the base of the trench, filling all voids up to the pipe centreline, where the size of the fill should not exceed ¼ of the outside diameter of the pipe or 40 mm, whichever is the lesser.

These conditions are illustrated in Figure 8.

K.6 Pipe laid by a trenchless laying technique

The groove in which the pipe is laid should comply with **K.5** a).

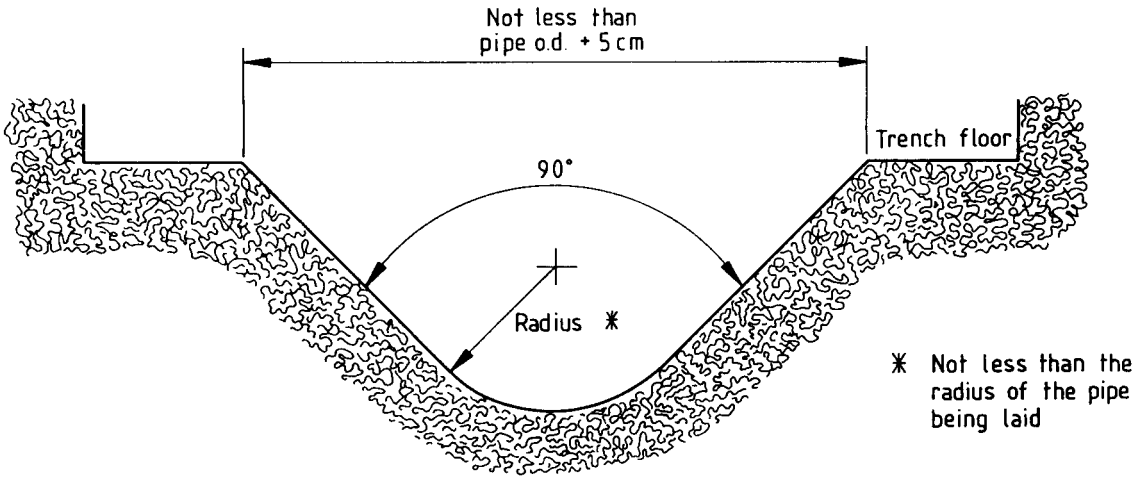
In this type of installation the finished work is out of sight. In order that the engineer may check it the contractor should open up lengths of drain at intervals as requested by the engineer. Other means adopted by the contractor to demonstrate that the pipes have been laid to proper line and levels and, where applicable, that sufficient permeable fill has been installed, may be accepted by the engineer in appropriate cases.

K.7 Assembly of junctions

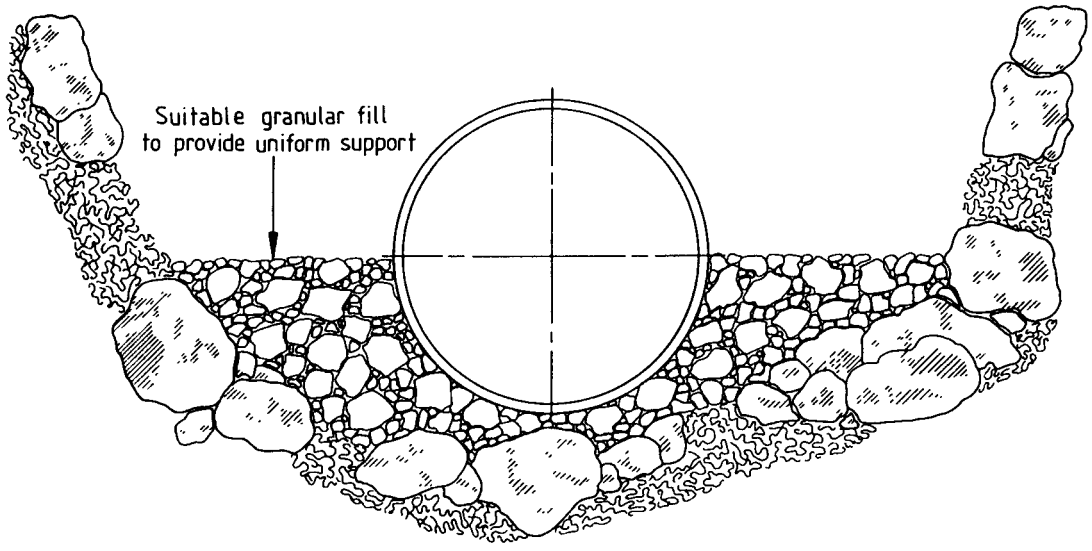
When assembled, the branch pipe should not protrude into the bore of the main pipe nor the main pipe obstruct flow from the branch pipe.

K.8 Unplasticized PVC pipes or fittings

Such items should not be installed at temperatures below 0 °C and care should be taken when installing at temperatures below 5 °C.



(a) Cross section of typical normal bedding



(b) Cross section of typical bedding for difficult conditions

Figure 8 — Bedding conditions for open trench laying

Publications referred to

BS 2782, *Methods of testing plastics.*
BS 2782:Method 1114A, *Thermoplastics pipes — Determination of creep ratio (≡ BS EN ISO 9967).*
BS 2782:Method 1114B, *Thermoplastics pipes — Determination of ring stiffness (≡ BS EN ISO 9969).*
BS 3955, *Specification for electrical controls for household and similar general purposes.*
BS 4781, *Specification for self-adhesive plastics labels for permanent use.*
BS 4781-1, *General purpose labels.*
BS 5750, *Quality systems.*
BS 5750-5, *Guide to the use of BS 5750-2 "Specification for manufacture and installation".*
BS 5955, *Plastics pipework (thermoplastics materials).*
BS 5955-6, *Code of practice for the installation of unplasticized PVC pipework for gravity drains and sewers.*
BS 8301, *Code of practice for building drainage.*

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