BRITISH STANDARD

BS 65:1991

Incorporating Amendment No. 1

Specification for

Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings

Confirmed January 2010

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Technical Committee for Waste Water Engineering B505 to Subcommittee B/505/2, upon which the following bodies were represented:

British Ceramic Research Limited
Clay Pipe Development Association Limited
Department of the Environment (Property Services Agency)
Department of Transport
Federation of Civil Engineering Contractors
Institution of Civil Engineers
Institution of Water and Environmental Management
Society of British Water Industries
Water Services Association of England and Wales

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The following BSI references relate to the work on this standard:
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Contents

Foreword

This British Standard has been prepared under the direction of the Technical Committee for Waste Water Engineering by the Subcommittee for Vitrified Clay Pipes. It covers those products previously specified in BS 65:1988 "Vitrified clay pipes, fittings, joints and ducts" which are not specified in the European Standard BS EN 295 "Vitrified clay pipes and fittings and pipe joints for drains and sewers Part 1: Requirements or Part 5: Requirements for perforated vitrified clay pipes and fittings".

This has been accomplished by the deletion of all reference to normal pipes with flexible mechanical joints, which are covered by BS EN 295, and which has necessitated a change of scope of the standard. A previously omitted definition of "pipe section" has been included.

Perforated vitrified clay pipes and fittings may be produced to either BS 65:1991 or BS EN 295-5:1994 until 31 March 1995, after which date BS 65 will cease to apply to perforated pipes.

Requirements appropriate to each of several types of pipe, fitting and duct are specified for dimensions and tolerances and for performance. These requirements are supported by sampling procedures to facilitate quality control and by test methods for verification of compliance with the standard. The sampling procedures are consistent with BS 6000, BS 6001 and BS 6002.

Requirements for extra chemically resistant pipes and fittings are included, but the standard does not apply to joints for these products, since these have to be formulated to be specifically resistant to the chemical effluents to be conveyed.

The attention of users of this standard is drawn to the advantages to be gained from an assurance of compliance afforded by independent schemes of continuing supervision and control.

Purchasers ordering to this standard are advised to specify in their purchasing contract that the supplier operates a quality system which complies with Part 2 of BS 5750, to assure themselves that products claimed to comply with BS 65 consistently achieve the required level of quality.

This edition introduces technical changes but it does not reflect a full review or revision of the standard, which will be undertaken in due course.

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 18, 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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Section 1. General

1 Scope

This British Standard specifies requirements for vitrified clay pipes and fittings with or without sockets, and compatible accessories, for the construction of drainage and sewerage systems, operated as gravity pipelines, or for use as ducts.

Normal and extra chemically resistant pipes and fittings are covered by the standard, when supplied without flexible mechanical joints, for example to meet repair situations or for use with special jointing compounds. Surface water pipes and fittings are also covered by the standard, together with ducts. The standard applies to both glazed and unglazed products.

The standard also specifies performance requirements for flexible mechanical joints used with surface water clay pipes and fittings.

NOTE The pipes and fittings specified may be suitable for use with joints other than flexible mechanical joints but such joints are outside the scope of this standard.

The requirements specified cover certain dimensions and tolerances, physical and performance characteristics, marking and sampling, and testing and inspection procedures to verify compliance and to facilitate quality control.

2 References

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

3 Definitions

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

3.1 Types of pipes and fittings

3.1.1
normal

suitable for drainage and sewerage systems, other than where extra chemical resistance is required

3.1.2
surface water

suitable only for the conveyance of surface water

3.1.3
extra chemically resistant

suitable for drains and sewers where extra chemical resistance is required

3.1.4
ducts

suitable for the enclosure and protection of underground cables or other services

3.2 Other definitions

3.2.1
curvature

the angle subtended by the length of a curved fitting at the centre of a circle of nominal radius through the centre-line of the fitting

3.2.2
joint assembly

the adjacent ends of two pipes and the means of joining them

3.2.3
pipe section

a short length of pipe barrel equal to or greater than 300 mm

3.2.4
nominal size (DN)

a numerical designation of the size of a unit, which is a convenient round number approximately equal to a manufacturing dimension

NOTE For the purposes of this standard, this dimension is the nominal bore of the pipe or fitting.

4 Materials and manufacture

4.1 Pipes and fittings. Pipes and fittings shall be made from suitable clays and when fired shall be sound and free from such defects as would impair their function when in service. Pipes and fittings may be unglazed, or glazed on the interior and/or exterior. When glazed, they need not be glazed on the jointing surfaces of the spigot and socket. Pipes and fittings marked as “Duct” shall not have sharp ends to the internal barrel.

Fittings may be completed by affixing fired parts together. Fired fittings may be surface treated after firing. They shall be deemed to comply with this standard provided that the completed fittings meet all the appropriate requirements specified in clauses **7** and **8**.

4.2 Flexible mechanical joints

4.2.1 Each component shall be fabricated having regard to its individual function in such a way that the physical performance of the joint assembly in service will be maintained.

4.2.2 Elastomeric joint rings shall satisfy the physical property and type test requirements of rings of type D (drainage) specified in BS 2494.

Section 2. Pipes

5 Dimensions and tolerances

5.1 Bore. The bore of the barrel of a pipe shall not deviate from the nominal size given in the first column of Table 1(a) or Table 1(b) beyond the limits of minimum and maximum shown.

5.2 Length. Preferred nominal lengths are not specified in this standard, but the limits of tolerance on the manufacturer's stated nominal length shall be:

a) for normal pipes, extra chemically resistant pipes and ducts, – 1 % + 4 % subject to a minimum value of ± 5 mm;

b) for surface water and perforated pipes, – 2 % + 5 % subject to a minimum value of ± 10 mm.

5.3 Straightness. When tested in accordance with Appendix A, the permissible deviation from straightness of the barrel of a pipe of any nominal bore shall not exceed that specified in Table 2.

For intermediate lengths the permissible deviation from straightness shall be interpolated linearly.

Table 1 — Dimensions of barrels

(a) Preferred nominal sizes

Nominal size (DN)	Limits of bore			
	Normal pipes, extra chemically resistant pipes and ducts		Surface water and perforated pipes	
	min.	max.	min.	max.
	mm	mm	mm	mm
90[a]	87	96	—	—
100	96	105	95	107
150	146	158	145	160
225	221	236	219	239
300	295	313	292	317
400	394	414	392	420
500	494	514	492	520
600	591	615	590	629
700	689	719	679	739
800	788	822	777	850
900	886	926	876	953
1 000	984	1 030	970	1 050

[a] This size is for ducts only.

(b) Non-preferred nominal sizes

Nominal size (DN)	Limits of bore			
	Normal pipes, extra chemically resistant pipes and ducts		Surface water and perforated pipes	
	min.	max.	min.	max.
	mm	mm	mm	mm
75	72	80	71	81
125	122	132	119	135
200	196	210	193	213
250	246	262	242	266
375	371	391	366	396
450	444	464	442	472

Table 2 — Maximum permissible deviation from straightness (D_S)

Nominal length of pipe L_N	Normal pipes, extra chemically resistant pipes and ducts	Surface water and perforated pipes
	D_S	D_S
m	mm	mm
0.3	2	4
0.6	4	7
0.9	5	10
1.0	6	11
1.2	7	13
1.5	8	16
2.0	10	1.0 % of nominal length
2.5	11	
3.0	12	
3.5	13	
4.0	14	

6 Performance requirements

6.1 General. Pipes or pipe sections shall be sampled and tested in accordance with the requirements of the relevant clauses listed in Table 8.

6.2 Crushing strength. The pipe or pipe section, when tested in accordance with Appendix B, shall with-stand either the intensity of loading appropriate to its size and class, as stated in Table 3(a) or Table 3(b), or such higher intensity as is claimed by the manufacturer.

NOTE The sampling procedures set out in section 5 enable the crushing strength values given in Table 3(a) or Table 3(b) or claimed by the manufacturer to be used in structural design.

6.3 Bending moment resistance (BMR). The normal, surface water or extra chemically resistant pipe or pipe section, when tested in accordance with Appendix C, shall have either the bending moment resistance appropriate to its size and class, as stated in Table 4(a) or Table 4(b), or such higher resistance as is claimed by the manufacturer.

NOTE Testing for bending moment resistance is applicable only to pipes up to and including DN 225 with nominal lengths equal to or greater than 1.1 m.

Where the manufacturer claims a higher intensity of loading for crushing strength than specified in Table 3(a) or Table 3(b), then an appropriate higher bending moment resistance shall also be claimed by the manufacturer.

6.4 Impermeability. When subjected to the water pressure test described in Appendix D the barrels of normal and extra chemically resistant pipes or pipe sections shall withstand an internal water pressure of 60 kPa[1)] for 5 min without leakage.

6.5 Chemical resistance. When subjected to the chemical resistance test described in Appendix E, the mass loss of any specimen shall not exceed 0.25 %.

NOTE Normal pipes and surface water pipes and ducts should be resistant to attack by chemicals likely to be found in waste water, surface water or ground water.

Table 3 — Crushing strength

(a) Preferred nominal sizes

Nominal size (DN)	Strength class[a]		
	Standard strength	Extra strength	Super strength
	kN/m	kN/m	kN/m
90	20	22	28
100	20	22	28
150	20	22	28
225	20	25	28
300	22	29	34
400	39	44	52
500	40	48	60
600	40	57	70
700	40	67	81
800	40	72	86
900	40	84	106
1 000	40	94	120

[a] See **6.2** regarding pipes and pipe sections of higher strength.

(b) Non-preferred nominal sizes

Nominal size (DN)	Strength class[a]	
	Standard strength	Extra strength
	kN/m	kN/m
75	16	20
125	20	22
200	20	25
250	22	29
375	34	38
450	34	44

[a] See **6.2** regarding pipes and pipe sections of higher strength.

Table 4 — Bending moment resistance

(a) Preferred nominal sizes

Nominal size (DN)	Strength class[a]		
	Standard strength	Extra strength	Super strength
	kN·m	kN·m	kN·m
100	0.90	1.00	1.30
150	2.40	2.80	4.00
225	6.50	8.10	9.00

[a] See **6.3** regarding pipes and pipe sections of higher strength.

(b) Non-preferred nominal sizes

Nominal size (DN)	Strength class[a]	
	Standard strength	Extra strength
	kN·m	kN·m
200	4.00	6.00

[a] See **6.3** regarding pipes and pipe sections of higher strength.

Table 5 — Maximum water absorption

Wall thickness of test piece	Maximum water absorption
	%
up to and including 20 mm	4
greater than 20 mm	6

6.6 Tests for extra chemical resistance. When subjected to the tests described in Appendix F, extra chemically resistant pipes shall comply with the requirements specified in **6.6.1** and **6.6.2**.

[1)] 1 kPa = 10 mbar = 1 kN/m^2 $\triangleq$ 0.1 m head of water (conventional).

6.6.1 Water absorption. The percentage gain in mass of the test piece when tested in accordance with **F.2** shall not exceed the values given in Table 5.

6.6.2 Acid resistance. The percentage loss in mass as determined by the method described in **F.3** shall not exceed 3 %.

Section 3. Fittings

7 Dimensions and tolerances

7.1 Bore. The bore of the inlet or outlet of a fitting shall not deviate from the nominal size beyond the limits given in Table 1(a) or Table 1(b).

7.2 Length. The limits of tolerance on the nominal length of a straight fitting shall be as given in **5.2** for pipes.

7.3 Water seal. Trapped fittings shall provide a water seal not less than 50 mm deep.

7.4 Curvature and radius. Preferred nominal values for curvature and radius are not specified in this standard, but the tolerance on curvature shall be ± 5° on the manufacturer's stated nominal value. The radius shall have a tolerance of ± 10 % on the manufacturer's stated value.

7.5 Branch angle. The tolerance on branch angle of a junction shall be ± 5° on the manufacturer's stated nominal angle.

NOTE Variations in the design of inlets and outlets are permissible depending on their specific functions and the manufacturer's type of joint.

8 Performance requirements

8.1 General. Fittings shall comply with the relevant test requirements as given in Table 6.

8.2 Impermeability. When subjected to the water pressure test described in **D.1**, the barrels of normal and extra chemically resistant fittings or sections, of nominal size up to and including DN 300, shall withstand an internal water pressure of 40 kPa[2)] for 5 min without leakage.

Normal and extra chemically resistant fittings of sections greater than DN 300 but less than DN 600 shall be tested either with water pressure as described in **D.1** or by the air pressure test described in **D.2**. The internal water pressure, which shall be 40 kPa, shall be withstood for 5 min without leakage. The initial air pressure shall be 100 mm water gauge and this shall not drop below 75 mm water gauge in 5 min.

Impermeability tests are not applicable to fittings of DN 600 or greater.

8.3 Chemical resistance. When subjected to the chemical resistance test described in Appendix E, the mass loss of any test piece shall not exceed 0.25 %.

NOTE Normal, surface water and duct fittings should be resistant to attack by chemicals likely to be found in waste water, surface water or ground water.

8.4 Test for extra chemical resistance. When subjected to the test described in Appendix F, extra chemically resistant fittings shall comply with the requirements specified in **6.6.1** and **6.6.2**.

8.5 Crushing strength. Where bends, junctions, taper pipes or bell mouths are fired in a plant alongside pipes, using the same materials and firing process, the crushing strength of these fittings is deemed to be that of the pipes when tested to **6.2**. If pipes are not normally fired alongside these fittings, straight fittings or short lengths of pipes made for test purposes, using the same materials and firing process as for these fittings, shall be type-tested for compliance with the requirements of **6.2**.

NOTE This clause also applies to fittings of strengths higher than those specified in Table 3(a) and Table 3(b).

[2)] 1 kPa = 10 mbar = 1 kN/m^2 ≙ 0.1 m head of water (conventional).

Table 6 — Applicable dimensional and performance requirements for fittings

Fittings group	Internal size			Curvature or branch angle	Impermeability	Chemical resistance or extra chemical resistance
	Bore (7.1)[a]	Length (7.2)	Water seal (7.3)	(7.4 or 7.5)	(8.2)	(8.3 or 8.4)
Taper pipes, splay pipes and bell mouths	X	X			X	X
Access and inspection pipes and chambers Channels and taper channels	X	X				X
Bends, cleaning arm, taper, rest, round elbow and mitred	X			X	X	X
Channel bends, access and inspection bends, saddles and oblique saddles	X			X		X
Junctions	X	X		X	X	X
Channel junctions, access junctions, taper channel bends	X	X		X		X
Trapped gullies, low back traps, syphons and interceptors	X		X			X
Trapless gullies, rainwater shoes, connectors, drain chutes, hoppers and raising pieces	X					X
Junction blocks				X		X
Dished tops, loose collars and double sockets						X

NOTE The symbol "X" denotes the subclause applicable.

[a] Applies to pipeline connections only.

Section 4. Flexible mechanical joints

9 Performance requirements

9.1 General. This section specifies the performance requirements for flexible mechanical joints suitable for surface water clay pipes and their fittings.

Surface water pipe joint assemblies shall satisfy the test requirements of **9.2** to **9.4** at a pressure of 30 kPa[3)].

A component shall not be tested in more than one assembly.

If it is not practicable to apply precisely the deflection, pressure, load or separation specified, a joint assembly shall be deemed to satisfy the test requirements provided that the levels applied are greater than those specified.

NOTE Different jointing systems and similar systems by different manufacturers, while individually complying with the requirements of this standard, may not necessarily be interchangeable.

9.2 Deflection. One pipe in a joint assembly shall be deflected by the method described in **G.2** by the amount specified in Table 7 for its relevant nominal size and when so deflected shall withstand the constant internal pressure specified in **9.1** for 5 min without visible leakage.

Deflection is defined as the distance from the extended longitudinal axis of one pipe to the longitudinal axis of the other pipe at its free end.

9.3 Straight draw. The pipes within a joint assembly shall be separated by 10 mm using the method described in **G.3** and when separated shall withstand the constant internal pressure specified in **9.1** for 5 min without visible leakage.

[3)] 1 kPa = 10 mbar = 1 kN/m^2 ≙ 0.1 m head of water (conventional).

Table 7 — Deflections

Nominal size (DN)	Deflection per metre of deflected pipe length	Approximate equivalent angular deflection
	mm	
100 – 200	50	3°
225 – 500	30	1 ¾°
600 – 1 000	20	1 ¼°

9.4 Shear resistance. A joint assembly shall be tested by the methods described in **G.4**. A load of 15 N per millimetre of nominal size of pipe shall be applied to a surface water pipe joint assembly. The joint assembly shall withstand the constant internal pressure specified in **9.1** for 5 min without visible leakage.

Section 5. Sampling for tests

10 Sampling of pipes and fittings

10.1 Sampling for quality control at the manufacturer's works. Sampling and testing procedures in respect of any batch shall be completed prior to removal from the works and shall be in accordance with either:

a) Table 11, Table 12 and Table 14 of Appendix H and their switching rules, which are consistent with BS 6001-1 at an AQL of 6.5 % and inspection level S.3, or

b) BS 6002 at an AQL of 6.5 % and inspection level S.3.

NOTE For sampling after delivery from the manufacturer's works, sampling should be in accordance only with Table 11 of Appendix H, except where the batch is resubmitted after rejection, when **10.2** should then apply. The relevant tests are the same as those listed under **10.1** in Table 8.

Isolated batches of units shall be assessed in accordance with Table 15 of Appendix H with a maximum batch size of 1 200.

10.2 Sampling for resubmitted rejected batches. Batches rejected under the sampling procedure specified in **10.1**, or after delivery from the manufacturer's works, may be resubmitted once, after removal of pipes with previously undetected visible defects, under the tightened inspection procedures given in Table 15 of Appendix H, in respect only of the defect that caused initial rejection.

10.3 Type tests. Type testing shall be carried out at least annually, at the rate of one pipe or fitting from each nominal size manufactured.

For the purposes of **8.5**, straight fittings or short lengths of pipes shall be tested at a frequency of at least one sample per month.

10.4 Sampling and testing. The relevant sampling procedures and test clauses are as given in Table 8.

Table 8 — Relevant sampling procedures and test clauses for pipes and fittings

Item	Relevant test clauses		
	Sampling procedure 10.1	Sampling procedure 10.2	Sampling procedure 10.3[b]
Normal pipes	**6.2**, **6.3**, **6.4**[a]	In respect only of the defect that caused initial rejection	**6.5**
Surface water pipes	**6.2**		**6.3**, **6.5**
Extra chemically resistant pipes	**6.2**, **6.3**, **6.4**[a], **6.6**[a]		
Ducts	**6.2**		**6.5**
Fittings	**8.2**[a], **8.4**[a]		**8.3**, **8.5**
Duct fittings			**8.3**, **8.5**

[a] Sampling to BS 6002 is not appropriate to these attribute tests.
[b] The internal pressure test has been withdrawn.

11 Sampling of joints

11.1 Sampling for quality control of joint assemblies at the manufacturer's works. The sampling procedures specified in **11.1.1** to **11.1.3** shall be used.

NOTE For sampling after delivery from the manufacturer's works, sampling should be in accordance with the procedures specified in **11.1.1** to **11.1.3**.

11.1.1 Testing in accordance with **9.2** to **9.4** shall be carried out at the rate of one joint assembly from each nominal size and each type of joint manufactured for batches up to and including 1 000 and two joint assemblies from each nominal size and each type of joint manufactured for batches greater than 1 000.

11.1.2 Where a joint assembly fails to pass any of the tests in **11.1.1**, three additional joint assemblies shall be taken from the same batch for each failure and subjected to the same test. If all these additional joint assemblies pass the test, the batch shall be accepted. If one further failure occurs, the batch shall be rejected.

11.1.3 For resubmitted rejected batches, any batch which has been rejected under the procedures specified in **11.1.2** may, after removal of items with previously undetected visible defects, be resubmitted once, in respect only of the defect which caused initial rejection. Three joint assemblies per batch for batches up to and including 1 000 and six joint assemblies per batch for batches greater than 1 000 shall be tested. If any failure occurs, the batch shall be rejected.

12 Limitations

The requirements specified in section 5 shall not be taken to imply that the manufacturer has the right to supply knowingly any defective unit of product.

Section 6. Marking

13 Marking

13.1 A company trade mark or the name of the manufacturer, and a means of identifying the date of manufacture shall preferably be impressed before firing, or, if this is not possible, shall be indelibly marked after firing on each pipe and fitting. The marking shall include identification of factory location if the manufacturer has more than one works.

Where, in the production of fabricated units using fired components, the original marking cannot be retained, a marking shall be applied by the same methods as those used to comply with **13.2** to **13.5**, showing a company trade mark or the name of the manufacturer and a means of identifying the date of fabrication.

13.2 All pipes and fittings shall be clearly and indelibly marked before despatch with the number of this British Standard, i.e. BS 65[4)].

In addition, surface water pipes and fittings shall be marked "surface water" or "SW", and extra chemically resistant pipes and fittings shall be marked "ECR". Ducts and duct fittings shall be marked "Duct".

13.3 In addition to the above marking, pipes and pipe sections claimed to comply with the requirements of clause **6** for "Extra strength" or "Super strength" classes shall be marked with the words "Extra strength" or "Super strength" as appropriate.

Pipes claimed by the manufacturer to exceed the requirements for super strength pipes or pipe sections shall be marked with the claimed crushing strength and bending moment resistance, e.g. "... kN/m ... kN·m".

13.4 Pipes and fittings suitable for use with flexible mechanical joints complying with the requirements specified in section 4 shall also be marked with the letter "J".

13.5 Flexible mechanical joints supplied as separate components (e.g. "sleeves" but not an integral spigot and socket system) shall be clearly and durably marked with the following:

a) the trademark or name of the manufacturer;

b) the identification of the factory location if the manufacturer has more than one works;

c) the number of this British Standard, i.e. "BS 65"[4)];

d) the letters "J" and "SW" for use with surface water pipes;

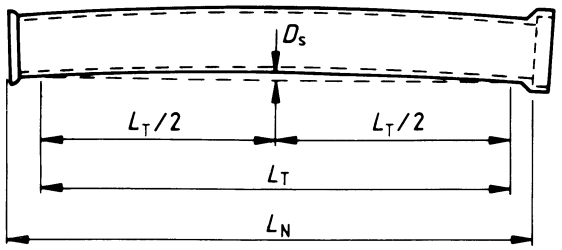
e) if the joints are not supplied by the manufacturer of the pipes and fittings with which they are intended to be used, or if the manufacturer supplies incompatible systems (see the note to **9.1**), the joints shall be clearly and durably marked to identify the pipes or fittings with which they are compatible.

[4)] Marking BS 65 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 [5] Straightness test

The deviation from straightness of a pipe barrel is the maximum distance from the centre of a straight line equal to the test length spanning any concave curve on the outside of a pipe barrel to the pipe surface (D_s) as shown in Figure 1. It is permissible to test for straightness using any suitable apparatus. An example is drawn in Figure 2.

The test length shall be 150 mm less than the nominal length of the pipe to allow for clearance at the shoulder of any socket and at any jointing material at the spigot end.



L_N is the nominal length of the pipe
L_T is the test length
D_s is the deviation from straightness
$L_N - L_T$ = 150 mm

Figure 1 — Terminology for straightness test method

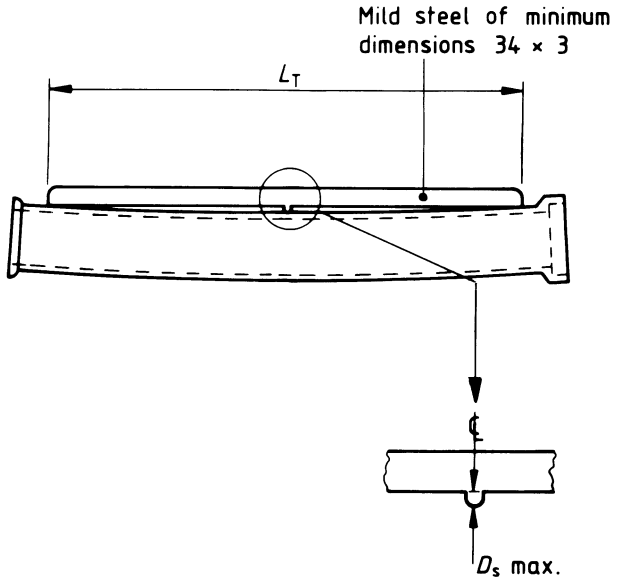


Figure 2 — Example of use of suitable straightness test apparatus

Appendix B Crushing strength test

B.1 General

B.1.1 Preconditioning. Prior to crushing strength tests on normal or ECR pipes of extra, super or higher strengths, sample pipes or pipe sections shall be preconditioned by complete immersion in water for the minimum times given in Table 9.

Table 9 — Preconditioning time for strength tests

Wall thickness[a]	Minimum preconditioning time	
	Unglazed and salt glazed	Ceramic glazed
mm	h	h
Up to 20	18	42
> 20 ⩽ 35	42	66
> 35	66	90

[a] "Wall thickness" is the mean wall thickness of the batch.

B.1.2 Testing machine. The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part. The machine and bearers shall be designed to transmit the load in a vertical plane through the longitudinal centre lines of the bearers and pipe.

The load shall be applied to the top bearer in such a way that the combination of supports, bearers and bearing strips is free to rotate in a vertical plane through the longitudinal centre lines of the top and bottom bearers.

The testing machine load shall be verified by the means detailed in BS 1610.

B.1.3 Loading. Place the pipe or pipe section not less than 0.3 m long between the bearer strips. When using the rigid system described in **B.3.3** the plane of any permitted longitudinal curvature shall be approximately horizontal.

Apply the load to the pipe or pipe section without vibration or sudden shock, at a uniform rate between 0.40 kN per metre of pipe per second and 0.60 kN per metre of pipe per second, or in increments of not more than 0.50 kN per metre at the same rate.

For crushing strength tests sampled in accordance with **10.1**, calculate the total load required in kN by multiplying the required intensity of loading by the nominal inside length of the barrel. For ultimate crushing strength tests sampled in accordance with **10.1**, calculate the intensity of loading by dividing the total ultimate applied load by the nominal inside length of the barrel.

[5] Throughout the appendices in this standard, reference to "pipes" includes pipe sections where these are suitable for the tests.

B.2 Bearers and bearing strips

B.2.1 Bearers. The bearers shall consist of metal, teak or similar hard wood, be straight and free from warping or twisting, and shall be centrally located on their supports.

The top and bottom bearers shall both have a minimum thickness of 25 mm and widths not less than those of the corresponding bearing strip assemblies.

The cross-sectional shape of the bearers shall be in accordance with Figure 3.

B.2.2 Bearing strips. The bearing strips shall consist of elastomeric material having a hardness of 50 ± 5 IRHD[6)].

The strips shall be of rectangular cross section having a width of 50 ± 5 mm and a thickness of not less than 25 mm or more than 40 mm. The 50 mm dimension shall be in contact with the pipe.

The top bearing strip shall be concentric with the top bearer.

The bottom bearing strips shall be symmetrically disposed on the bottom bearer, of equal thickness and parallel to one another at a distance apart of 25 ± 5 mm.

B.3 Support systems

B.3.1 Flexible hose system (for use with any length of pipe or pipe section). The overall bearer length shall be $B - 50$ mm for pipes up to and including 1 500 mm nominal length and $B - 100$ mm for pipes greater than 1 500 mm nominal length, where B is the nominal length (in millimetres) of the external barrel unobstructed by socket shape and/or jointing configuration at either end (see Figure 4).

The top and bottom bearers shall be divided, along their length, into separate segments. These segments shall be supported by flexible high pressure hoses which are closed at each end. These hoses shall be filled with liquid and carried in U shaped channels below the bottom bearers and above the top bearers. Each segment shall have a nominal length of 100 mm except for individual shorter sections used to make up the overall bearer length.

The length of each bearing strip shall be equal to the length of each appropriate bearer segment.

No part of any bearer segment shall overhang either end of the pipe.

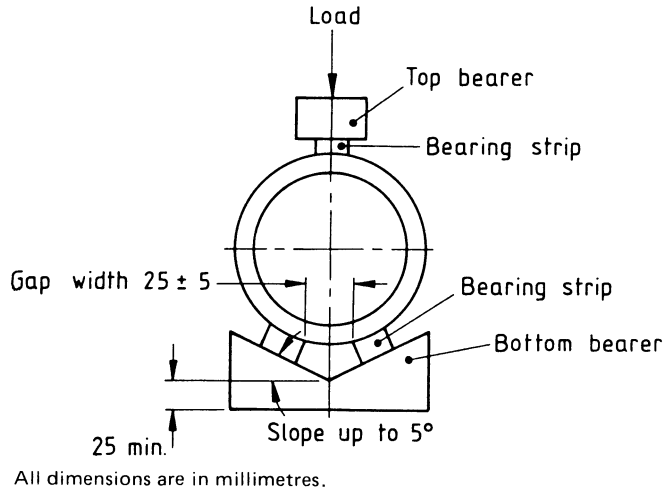


Figure 3 — Bearer shape

[6)] International rubber hardness degrees (see BS 903-A26).

B.3.2 Common hydraulic manifold system (for use with any length of pipe or pipe section). The overall bearer length shall be $B - 50$ mm for pipes up to and including 1 500 mm nominal length and $B - 100$ mm for pipes greater than 1 500 mm nominal length, where B is the nominal length (in millimetres) of the external barrel unobstructed by socket shape and/or jointing configuration at either end (see Figure 4).

The top and bottom bearers shall be divided along their length into separate segments. Each segment shall be supported by a common hydraulic system and be of the same length which shall not be greater than 300 mm.

The length of each bearing strip shall be equal to the length of each bearer segment.

The distance by which the overall bearer exceeds the total length of the bearer segments shall be distributed evenly as gaps between the segments. No gap shall be greater than one third of a bearer segment.

No part of any bearer segment shall overhang either end of the pipe.

B.3.3 Rigid system (restricted to use with pipes or pipe sections less than or equal to 1.1 m nominal length). The overall length of each bearing strip shall be $B - 50$ mm, where B is the nominal length (in millimetres) of the external barrel unobstructed by socket shape and/or jointing configuration at either end (see Figure 4).

The overall bearer length shall not be less than the length of the bearer strip.

No part of any bearing strip shall overhang either end of the pipe.

B.4 Position of test load

B.4.1 Plain ended pipes. The test load shall be applied at the longitudinal centre of the overall bearer length for the systems described in **B.3.1** and **B.3.2**, and at the longitudinal centre of the overall bearing strip length for the system described in **B.3.3**.

B.4.2 Socketted pipes. The test load for the systems described in **B.3.1** and **B.3.3** shall be applied at the positions given in **B.4.1**. For the system described in **B.3.2** the position of the application of the test load may be adjusted to maintain horizontal stability.

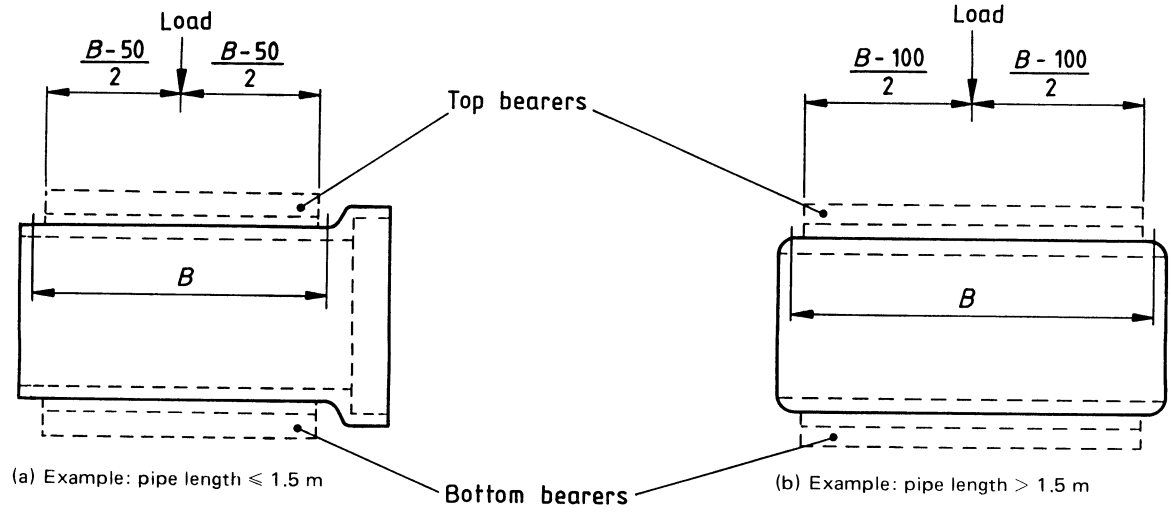
B.5 Alternative methods of test

B.5.1 ASTM standard test. The segmented bearings test using a common hydraulic manifold loading system as specified in **5.3** of ASTM C301:1987 may also be used.

B.5.2 DIN standard test. The method B crushing strength test specified in **4.1.4.1** of DIN 1230-2:1986 may also be used. The felt in contact with the pipe shall be in accordance with DIN 61200 at 0.3 ± 0.03 kN/m, thickness 20 ± 2 mm.

B.5.3 Disputes. Where any dispute over the verification of crushing strength arises, the tests shall be carried out using the same test method as the manufacturer.

B.5.4 Reporting. Where ASTM or DIN tests are used, this shall be recorded in the test report.



NOTE. Segmented bearers may be used for all nominal pipe lengths.
Rigid bearers may only be used for pipes of nominal length ⩽ 1.1 m.

Figure 4 — Typical arrangement for crushing strength test

Appendix C Bending moment resistance (BMR) test

C.1 General

C.1.1 Preconditioning. Prior to BMR tests on normal or ECR pipes of nominal sizes up to and including DN 225 of extra, super or higher strengths, sample pipes or pipe sections shall be preconditioned by complete immersion in water for the minimum times given in Table 9.

C.1.2 Testing machine. The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part. The method of support and loading for the pipe shall be as specified in either **C.2** or **C.3** and the load shall be applied to the pipe without vibration or sudden shock. The testing machine load shall be verified by the means detailed in BS 1610.

C.1.3 Loading. Apply the load at a uniform rate (in kN/s) of between 0.04 DN/50 and 0.06 DN/50 or in increments of not more than 0.05 DN/50 at the same rate, where DN is the nominal size of the pipe or pipe section in millimetres.

C.2 Four point loading test. A whole pipe or a shorter piece with or without a socket and with a nominal length not less than 1.1 m shall be used in the test.

Support the pipe in a horizontal position on two slings. Each sling shall be perpendicular to the axis of the pipe and symmetrical about the centre of its length. The two supporting slings shall be separated by a minimum support span of 0.9 m (see Figure 5). Apply the load to the pipe through two further slings, also perpendicular to the axis of the pipe. These loading slings shall be placed on top of the barrel, symmetrical about the centre of the gap between the support slings with a distance between centres fixed at 0.3 m.

Each sling shall be 0.15 m wide and shall be so designed that there is a contact angle of at least 120° around the pipe circumference. At no time during the test shall the pipe make contact with anything other than the four slings.

Calculate the BMR as:

$$M = P_b \times \frac{a}{2}$$

where

M is the BMR (kN·m)

P_b is the total applied load (kN)

a is the lever arm length = ½ (S – 0.3) (m)

S is the support span (m)

C.3 Three point loading test. A whole pipe or a shorter piece with or without a socket and with a nominal length not less than 1.1 m shall be used in the test (see Figure 6).

Support the pipe to be tested on two bearing strips in a horizontal position so that the concave side of any permitted longitudinal curvature faces upwards. The distance between the centres of the bottom bearing strips shall be 0.15 m less than the external length of the pipe barrel and they shall be placed symmetrically about the centre of its length. Apply the load vertically to the top centre of the pipe barrel through a similar bearing strip.

Bearing strips shall each be at least 75 mm long, the pipe lying at right angles to the length and shall be made from elastomeric material having hardness of 50 ± 5 IRHD. They shall be of rectangular cross section having a thickness of 30, – 5 + 10 mm and a width of 50 ± 5 mm. The two lower bearing strips shall be of equal thickness.

Place the lower bearing strips on a firm unyielding horizontal support and apply the load to the upper bearing strip through a rigid backing having an area at least as great as the bearing strip beneath it.

Calculate the BMR as:

$$M = P_b \times \frac{d}{4}$$

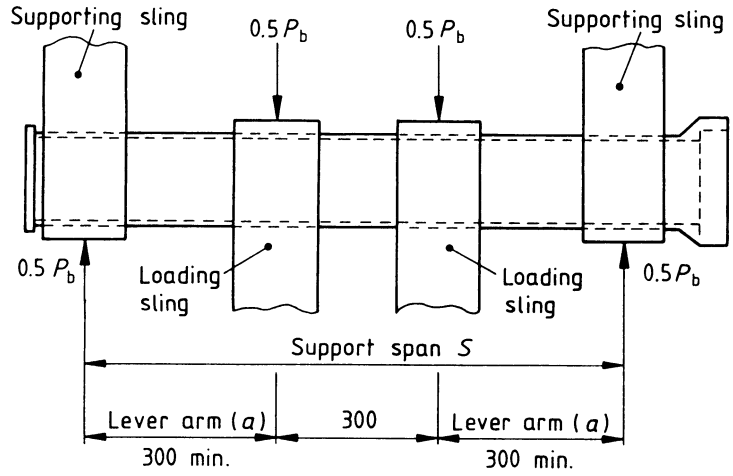
where

M is the BMR (kN·m)

P_b is the total applied load (kN)

d is the distance between the centres of the bottom bearing strips (m).

NOTE The test method specified in **C.3** is suitable where the mode of any failures produced in pipe samples is clearly one of beam fracture.
If it is clear that such fractures are not being induced (e.g. if end-crushing is evident) then the test specified in **C.2** should be used.



All dimensions are in millimetres.

Figure 5 — Diagrammatic arrangement of the four point loading test method

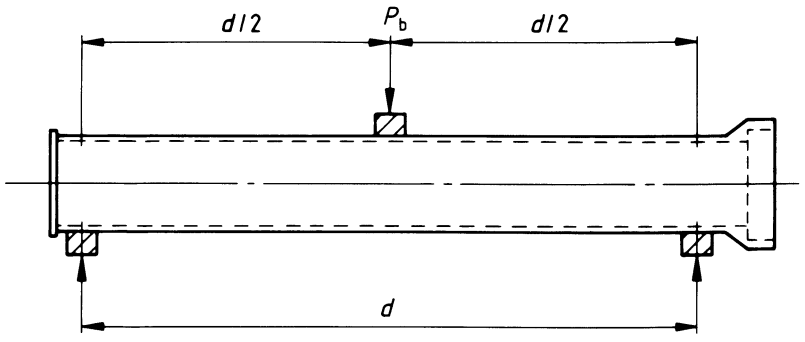


Figure 6 — Diagrammatic arrangement of the three point loading test method

Appendix D Pressure tests

D.1 Water pressure test (impermeability). Clamp the pipe or fitting in a suitable apparatus and close the ends with watertight seals. Fill it slowly, and vent it completely. Apply the test pressure at a rate not exceeding 10 kPa[7] in 1 s, and maintain it for the required period.

D.2 Fittings air pressure test (impermeability). Close the ends of the fitting or section with air tight seals. Connect a clear plastics or glass U tube gauge (manometer) to one of the air tight seals and a means of applying the air pressure to another air tight seal.

Apply pressure to achieve a value of slightly more than 100 mm water gauge for the impermeability test and allow 5 min for stabilizing of the air temperature. Adjust air pressure to 100 mm water gauge at the commencement of the test.

During stabilization and testing the ambient temperature and atmospheric conditions of the test should, as far as possible, remain constant.

Appendix E Chemical resistance test for pipes and fittings

Test pieces shall be freshly broken pieces of pipe, each 5×10^4 mm^3 to 9×10^4 mm^3 in volume, free from cracks or shattered edges. Clean and dry them thoroughly at a temperature of not less then 150 °C until no further loss of mass is noted on successive weighings. Immerse the test pieces for 48 h in 500 mL of the test solutions at a temperature of 20 ± 5 °C.

The test solutions shall be:

a) sulphuric acid solution, c (H_2SO_4) = 0.5 mol/L prepared by adding 28.5 mL of concentrated acid (c = 1.84 g/mL) to 971.5 mL distilled water to produce 1 L of solution;

b) sodium hydroxide solution, c (NaOH) = 1.0 mol/L taken as containing 40 g of sodium hydroxide per litre.

The weighing apparatus used shall be accurate to within 0.01 g when loaded with 200 g.

On removal from the solution, carefully and thoroughly wash each test piece with hot distilled water and then boil in 500 mL of distilled water for half an hour. Thereafter boil it in a further 500 mL of distilled water for another half an hour. Then dry the test piece at a temperature of not less than 150 °C until no further loss of mass can be noted on successive weighings. Calculate the loss of acid or alkali soluble matter in the test piece as a percentage of the dry mass as follows. If the mass in grams of the test piece before treatment is M_1 and the mass in grams of the test piece after treatment is M_2, then:

$$\text{percentage loss in dry mass} = \frac{(M_1 - M_2) \times 100}{M_1}$$

Appendix F Water absorption and acid resistance tests for extra chemically resistance pipes and fittings

F.1 Selection of test pieces. Test pieces should be taken either from the body of a pipe but not from within 150 mm of the end or, to avoid breaking sound articles, particularly in large nominal sizes, special test pieces of the same material may be manufactured and fired at the same time.

The test pieces shall be of a thickness equal to the thickness of the pipe and the two unbroken surfaces shall each have an area of not less than 5×10^3 mm^2 and not more than 1.25×10^4 mm^2. The absorption and acid resistance tests shall be carried out on similar pieces which have undergone similar firing conditions.

F.2 Absorption test. Dry the test piece at a temperature of not less than 150 °C until no further loss of mass can be noted on successive weighings. Then immerse it in cold water and raise the temperature to boiling point. Maintain the water at that temperature for 1 h and, after it has been allowed to cool, remove the test piece, carefully wipe it with a dry cloth and then reweigh it.

If the mass in grams of the test piece before treatment is M_1 and the mass in grams of the test piece after treatment is M_2, then:

$$\text{percentage water absorption over dry mass} = \frac{(M_2 - M_1) \times 100}{M_1}$$

F.3 Acid resistance test. Break the test piece down by a jaw-crusher or by a percussive method and take 100 g to pass a 6.70 mm aperture BS 410 test sieve but retained on a 4.75 mm aperture test sieve.

[7] 1 kPa = 10 mbar = 1 kN/m^2 ≙ 0.1 m head of water (conventional).

Wash the graded sample free from dust by boiling it twice in distilled water complying with the requirements of BS 3978 and decanting, followed by boiling for the third time and washing the sample to constant mass on a 4.75 mm aperture BS 410 sieve. Then dry to constant mass at 110 °C.

Weigh 50 g samples in two BS 2071 glass Soxhlet thimbles of BS 1752 porosity grade no. 2[8] and transfer them to the Soxhlet apparatus.

The flask of the apparatus shall be of 500 mL capacity and shall contain 300 mL of AR[9] hydrochloric acid diluted 1 : 1 with distilled water complying with the requirements of BS 3978. Treat the samples with the acid for 16 h by continuous boiling of the contents of the flask. Allow the apparatus to cool slightly, remove the acid from the upper chamber and replace that in the flask with distilled water. Restart heating and continue washing for 48 h. Remove the Soxhlet thimble; dry the sample in situ to constant mass at 110 °C and weigh.

If the mass in grams of the sample after treatment is M_2, and the mass in grams of the sample before treatment is M_1, then:

$$\text{percentage loss in dry mass} = \frac{(M_1 - M_2) \times 100}{M_1}$$

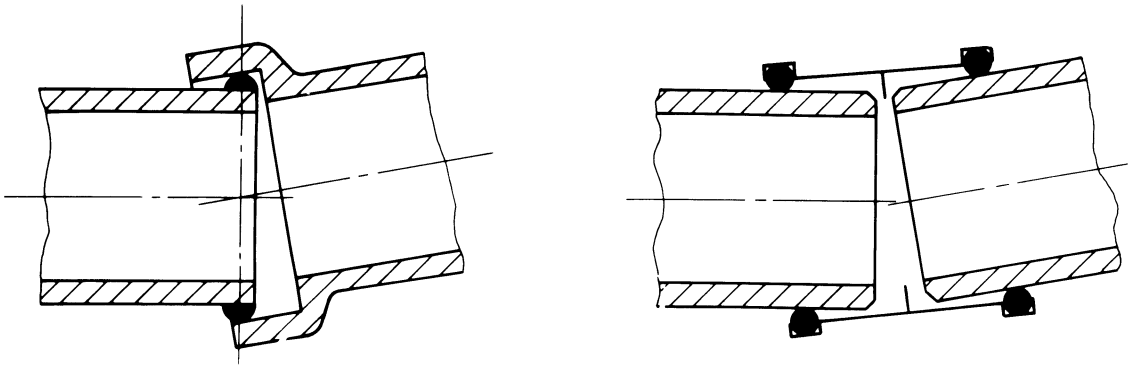
Appendix G Mechanical test methods for joint assemblies

G.1 General. The apparatus shall accommodate two pipes, flexibly jointed and supported in such a way that they can move in relation to each other to the limits required by the tests.

With the ends of the pipes closed by watertight seals, fill the pipes with water at a temperature not exceeding 30 °C; expel all air before the test pressure is applied.

NOTE Owing to the requirements for the test rigs, these tests are only applicable to pipes over 800 mm in length.

G.2 Deflection test (see **9.2**, Table 7 and Figure 7). Fully engage the pipes in the joint, axially align them and then separate them on the longitudinal axis with their ends restrained to prevent further longitudinal movement. The separation shall be 5 mm for pipes of less than 300 DN. For pipes of 300 DN and larger, the separation shall be the minimum to permit the angular deflection given in Table 7 to be applied. Deflect to the test requirement one pipe angularly with respect to the other with the fulcrum on the longitudinal axis of the pipes and within the joint.



NOTE. Figure is diagrammatic only and not meant to represent any particular joint designs.

Figure 7 — Deflection test

[8] Grade no. 2 provides a range of maximum pore diameter from 40 µm to 90 µm.

[9] AR: analytical reagent quality.

G.3 Straight draw test (see **9.3**). Fully engage the pipes in the joint, axially align them and then separate them by the test requirement on the longitudinal axis with their ends restrained to prevent further longitudinal movement.

G.4 Shear resistance tests (see **9.4**). The pipes shall be fully engaged in the joint, axially aligned and then separated by 5 mm on the longitudinal axis with their ends restrained to prevent further longitudinal movement (see Figure 8). The tests described in **G.4.1** and **G.4.2** shall be carried out as appropriate.

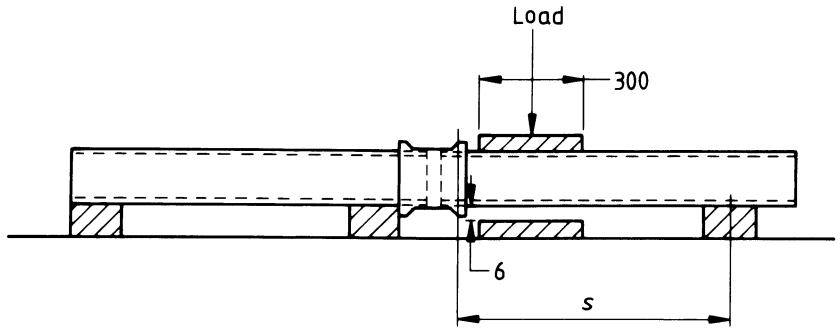
G.4.1 The pipe having the socket of the joint assembly or either pipe in a sleeve joint assembly shall be supported under the barrel at both ends and restrained from movement. The second pipe shall be supported at a distance not less than *s* from the joint under test (as specified in Table 10) and the shear load shall be uniformly applied to this pipe over a longitudinal distance of 300 mm from the face of the socket or face of the sleeve of the assembled joint.

The vertical movement of the free pipe at the joint shall be restricted to a maximum of 6 mm, by a stop of suitable dimensions to prevent damage to the pipe.

G.4.2 For joint assemblies which undergo the full 6 mm vertical movement in **G.4.1**, the following additional test shall be carried out. The load shall be applied with the pipes set up as before but with the underside of the joint assembly supported on a firm flat surface and restrained from movement.

Table 10 — Support distance for shear resistance tests

Nominal length of pipe L_N (m)	**Support distance** ***s*** (m)
> 0.8 ⩽ 1.2	Immediately behind socket or at the end of the pipe remote from the joint assembly
> 1.2 ⩽ 1.6	1.0
> 1.6 ⩽ 2.2	1.2
> 2.2 ⩽ 3.0	1.6
> 3.0 ⩽ 4.0	2.2



All dimensions are in millimetres.

Figure 8 — Shear resistance test

Appendix H Inspection procedures

H.1 Acceptability determination

H.1.1 Single sampling. If the number of defectives found in the sample is equal to or less than the acceptance number, the batch shall be accepted. If the number of defectives is equal to or greater than the rejection number, the batch shall be rejected.

When reduced inspection is in effect and the acceptance number has been exceeded, but the rejection number has not been reached, the batch shall be accepted and normal inspection reinstated.

If the rejection number has been reached or exceeded, the batch shall be rejected and normal inspection reinstated.

H.1.2 Double sampling. The number of sample units shall be equal to the first sample size given in the plan. If the number of defectives found in the first sample is equal to or less than the first acceptance number, the batch shall be accepted. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the batch shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection numbers, the second sample of the size given in the plan shall be inspected.

The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number, the batch shall be accepted. If the cumulative number of defectives is equal to or greater than the second rejection number, the batch shall be rejected. If this occurs on reduced inspection, normal inspection shall be reinstated for the next batch.

When reduced inspection is in effect and after the second sample the acceptance number has been exceeded but the rejection number has not yet been reached, the batch shall be accepted and normal inspection reinstated.

H.2 Normal inspection. The sample size appropriate to the batch size and the values of acceptance and rejection numbers of defectives shall be in accordance with Table 11. Sample units shall be selected at random.

H.3 Normal to reduced inspection. A reduced inspection level as shown in Table 12 shall be used when normal inspection is in effect provided that the following conditions are satisfied:

a) the preceding ten batches (except where they consist of less than 30 sample units in total, see Table 13) have been on normal inspection, and none has been rejected on original inspection;

b) the total number of defectives in the samples from the ten preceding batches (or such other number required by Table 13) is equal to or less than the applicable number given in Table 13.

When double sampling is in use, all samples inspected should be included, not first samples only.

H.4 Reduced to normal inspection. When reduced inspection is in effect, normal inspection shall be reinstated if a batch is rejected, or if a batch is accepted without either acceptance or rejection criteria having been met (see **H.1.1** and **H.1.2**).

H.5 Tightened inspection. Tightened inspection as shown in Table 14 shall be used either when inspecting a new product or when two or more batches have been rejected in any five consecutive batches of normal inspection.

Table 11 — Normal inspection for both single and double sampling plans

Batch size	Single sampling			Double sampling					
	Sample size	Acceptance no.	Rejection no.	1st sample size	Acceptance no.	Rejection no.	2nd sample size	Acceptance no.	Rejection no.
2 – 50	2	0	1	not applicable	—	—	—	—	—
51 – 500	8	1	2	5	0	2	5	1	2
501 – 3 200	13	2	3	8	0	3	8	3	4
3 201 – 20 000	20	4	4	13	1	4	13	4	5

Table 12 — Reduced inspection for both single and double sampling plans

Batch size	Single sampling			Double sampling					
	Sample size	Acceptance no.	Rejection no.	1st sample size	Acceptance no.	Rejection no.	2nd sample size	Acceptance no.	Rejection no.
2 – 50	2	0	1	not applicable	—	—	—	—	—
51 – 500	3	0	2	2	0	2	2	0	2
501 – 3 200	5	1	3	3	0	3	3	0	4
3 201 – 20 000	8	1	4	5	0	4	5	1	5

Table 13 — Limit numbers for reduced inspection

Number of sample units from last ten batches	Limit number of defectives
20 – 29	[a]
30 – 49	0
50 – 79	0
80 – 129	2
130 – 199	4
200 – 319	8

[a] The number of sample units from the last ten batches is not sufficient for reduced inspection. In this instance more then ten batches may be used for the calculation, provided that the batches are the most recent ones in sequence, that they have all been on normal inspection and that none has been rejected while on original inspection.

Table 14 — Tightened inspection for both single and double sampling plans

Batch size	Single sampling			Double sampling					
	Sample size	Acceptance no.	Rejection no.	1st sample size	Acceptance no.	Rejection no.	2nd sample size	Acceptance no.	Rejection no.
2 – 50	3	0	1	not applicable	—	—	—	—	—
51 – 3 200	13	1	2	8	0	2	8	1	2
3 201 – 20 000	20	2	3	13	0	3	13	3	4

H.6 Tightened to normal inspection. Tightened inspection shall continue until five consecutive batches are accepted when normal inspection shall be resumed.

H.7 Discontinuation of inspection. If ten consecutive batches remain on tightened inspection, the provision of these sampling plans shall be discontinued pending action to improve the quality of the submitted products.

H.8 Tightened inspection for rejected batches. Tightened inspection as shown in Table 15 shall be used when inspecting a batch which has previously been rejected, after removal of pipes with previously undetected visible defects.

Table 15 — Tightened inspection for resubmission of rejected batches

Batch size	Sample size	Acceptance no.	Rejection no.
2 – 25	3	0	1
26 – 500	13	1	2
501 – 1 200	20	2	3
1 201 – 10 000	32	3	4
10 001 – 20 000	50	5	6

blank

Publication(s) referred to

BS 410, *Specification for test sieves.*
BS 903, *Physical testing of rubber.*
BS 903-A26, *Determination of hardness.*
BS 1610, *Materials testing machines and force verification equipment.*
BS 1752, *Specification for laboratory sintered or fritted filters including porosity grading.*
BS 2494, *Specification for elastomeric seals for joints in pipework and pipelines.*
BS 3978, *Specification for water for laboratory use.*
BS 5750, *Quality systems.*
BS 5750-2, *Specification for production and installation.*
BS 6000, *Guide to the use of BS 6001, sampling procedures and tables for inspection by attributes.*
BS 6001, *Sampling procedures for inspection by attributes.*
BS 6002, *Specification for sampling procedures and charts for inspection by variables for percent defective.*
BS EN 295, *Vitrified clay pipes and fittings and pipe joints for drains and sewers.*
BS EN 295-1, *Requirements.*
BS EN 295-2, *Quality control and sampling.*
BS EN 295-3, *Test methods.*
BS EN 295-5, *Requirements for perforated vitrified clay pipes and fittings.*

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