

Precast concrete pipes and ancillary concrete products —

**Part 103: Specification for prestressed
non-pressure pipes and fittings with
flexible joints**

Committees responsible for this British Standard

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- Association of Consulting Engineers
- British Precast Concrete Federation Ltd.
- Concrete Pipe Association
- Concrete Society
- County Surveyors' Society
- Department of the Environment (Property Services Agency)
- Department of Transport
- Federation of Civil Engineering Contractors
- Institution of Civil Engineers
- Institution of Highways and Transportation
- Institution of Water and Environmental Management
- Pipe Jacking Association
- Water Services Association of England and Wales

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Foreword

This Part of BS 5911, covering prestressed concrete pipes of the non-cylinder type, for the conveyance of water in non-pressure applications, has been prepared under the direction of Technical Committee B/505, Waste Water Engineering.

The standard is one of the series of Parts of BS 5911, covering various types and applications of concrete pipes, and supersedes BS 5178:1975 which is withdrawn. The foreword to BS 5178 stated that the desirability of including some form of test for initial surface absorption of the cement mortar cover coat had been considered, but had found that insufficient information was available to justify such an inclusion. The question was reviewed during the preparation of this standard, but, since the forthcoming draft European Standard (EN) for precast concrete pipes includes provisions for oxygen permeability testing, it was considered prudent to await the publication of that standard before deciding whether or not to insert similar requirements into this standard.

As far as practicable, this Part of BS 5911 specifies performance requirements and tests similar to those specified in BS 5911-100, with the similar intention of ensuring that pipelines will carry sewage or surface water at atmospheric pressure without leaking, or suffering structural damage.

In order to reflect the forthcoming harmonized European Standard for precast pipes, this Part of BS 5911 provides for the manufacture and supply of units with rationalized metric sizes.

For a purchaser's enquiry or order to be fully understood, it is essential that the manufacturer be given the information set out in Annex A.

Annex G recommends facilities that are of assistance to purchasers.

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 standard of the BS EN ISO 9000 series (formerly 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.

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 30, 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.

Section 1. General

1.1 Scope

This Part of BS 5911 specifies requirements and associated methods of test for prestressed concrete pipes, bends, junctions and splays with flexible joints intended to be used for the conveyance, under atmospheric pressure, of sewage and surface water, and for the construction of culverts.

Requirements are given for materials, design and manufacture, dimensions, inspection procedures and marking.

This standard does not include the structural or hydraulic design of the pipeline, its durability under unusual environmental conditions, or standards of workmanship and supervision during construction and operation.

NOTE For guidance on these topics, BS 8005-1 and BS 8010-2.7 should be consulted, and work on various European Standards is in hand.

1.2 References

1.2.1 Normative references

This Part of BS 5911 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 30. For a dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 5911 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This Part of BS 5911 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Part of BS 5911 the following definitions apply.

1.3.1

unit

a pipe (including splay), bend or junction

1.3.2

prestressed concrete pipe

a concrete core pipe circumferentially prestressed to withstand design loads

NOTE A typical section through a prestressed concrete pipe with spigot and socket joint is shown in Figure 1.

1.3.3

slurry coat

a coat of cement and water sprayed over the concrete core pipe and circumferential prestressing wire before application of the cover coat

1.3.4

concrete core pipe

a concrete pipe reinforced with non-tensioned steel, or longitudinally prestressed with pretensioned high tensile steel wire, or a combination of both, embedded in the concrete (see Figure 1)

1.3.5

cover coat

a coat of cement mortar applied to the outside of a prestressed concrete pipe, to protect the circumferential prestressing wire (see Figure 1)

1.3.6

nominal size (DN)

a numerical designation of the bore of a unit, which is a convenient round number approximately equal to the internal diameter in millimetres

1.3.7

manufacturing diameter

a diameter of a unit that a manufacturer seeks to achieve

1.3.8

actual diameter

a diameter found by measurement

1.3.9

effective length

the length of a pipe measured as shown in Figure 2

1.3.10

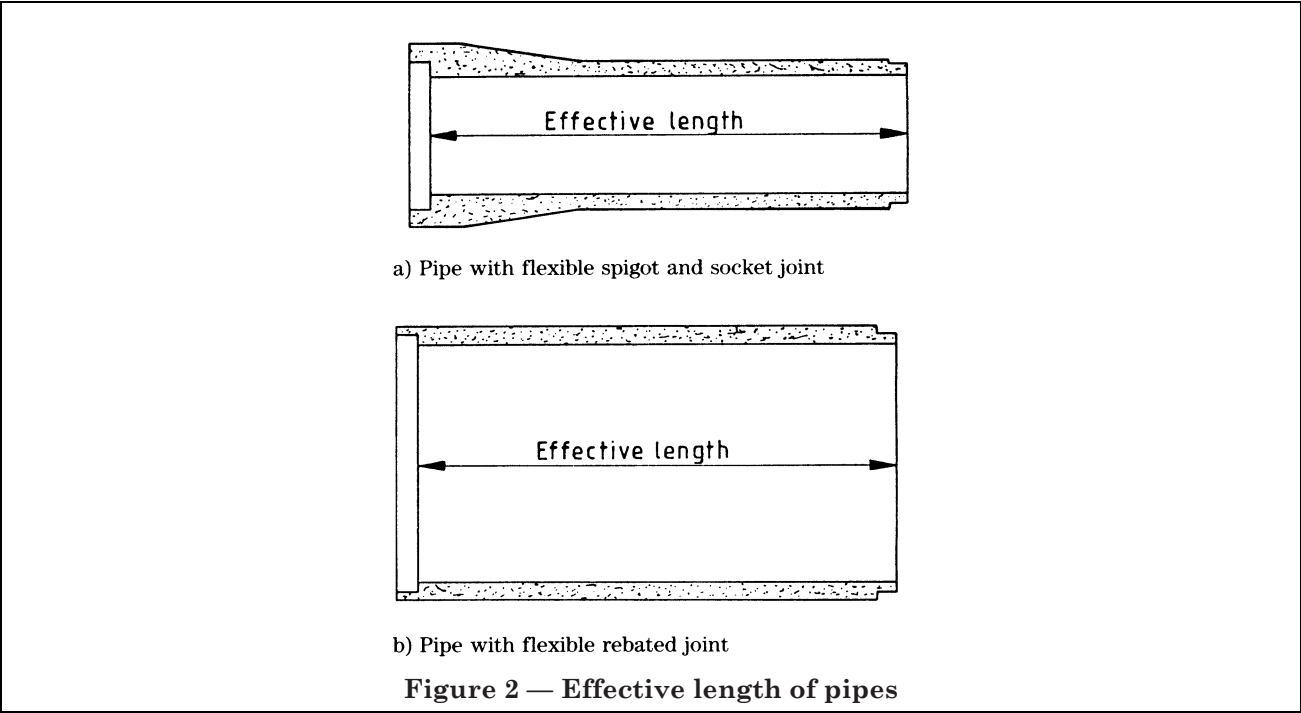
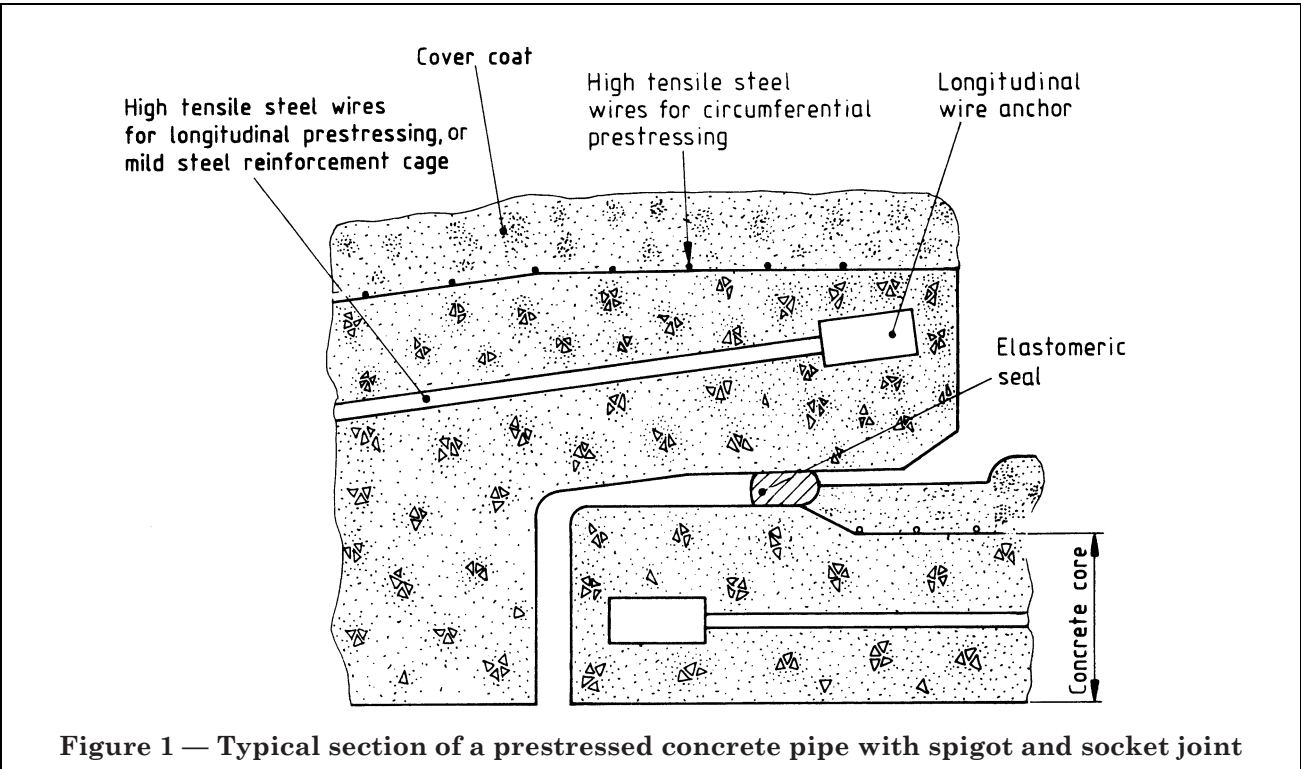
reinforcement

steel, other than stainless steel, within a unit so as to prestress or reinforce the concrete, or to locate steel for the latter purpose

1.3.11

batch

the number of units of a particular specification produced under uniform conditions during a given period by one particular process



Section 2. Materials

2.1 Cement

The cement shall either:

- a) be factory-produced by the cement manufacturer and conform to one of the following standards as appropriate:

Type of cement	Standard to be conformed to
ordinary and rapid-hardening Portland	BS 12
Portland blastfurnace	BS 146
sulfate-resisting Portland	BS 4027
Portland pulverized-fuel ash (p.f.a.)	BS 6588

or

- b) consist of a normal or special combination of cement conforming to BS 12 and ground granulated blastfurnace slag (g.g.b.s.) or p.f.a. in accordance with the following, to be included as part of the concrete mix by simultaneously combining them with the other concrete materials at the concrete mixer:

Cementitious component other than cement	Standard to be conformed to	% (<i>m/m</i>) of total cementitious content
g.g.b.s.	BS 6699	0 % to 65 %
p.f.a.	BS 3892-1	15 % to 35 %

Where special combinations of cement conforming to BS 12 and g.g.b.s. or p.f.a. are to be used for additional resistance to sulfate attack (see note), the percentage by mass of the total cementitious content shall be in the ranges 70 % to 90 % or 25 % to 40 % respectively.

In all cases where combinations of cement conforming to BS 12 and g.g.b.s. or p.f.a. are used, the relevant proportion of g.g.b.s. or p.f.a. shall be fully documented in the production records.

NOTE The requirements specified in 2.4.1 for minimum cement content and maximum water/cement ratio ensure that any of the permitted cements or standard combinations of cement conforming to BS 12 and g.g.b.s. or p.f.a. provide resistance to sulfate attack equivalent to classes 1 and 2 of Table 6.1 of BS 8110-1:1985. Where resistance to either class 3 or class 4 conditions as specified in Table 6.1 of BS 8110-1:1985 is required, see 2.4.1.

2.2 Aggregates

2.2.1 General

Aggregates shall consist of materials conforming to BS 882.

NOTE The manufacturer may modify the gradings to suit the manufacturing process (see clause 0 of BS 882:1992).

2.2.2 Mechanical properties

The limiting values on the mechanical properties of coarse aggregates shall be either:

- a) a minimum 10 % fines value of 100 kN, when tested in accordance with BS 812-111; or
- b) a maximum aggregate impact value of 30 %, when tested in accordance with BS 812-112.

When tested in accordance with BS 812-105.1, the flakiness index shall be not more than 35.

2.2.3 Nominal maximum size

The nominal maximum size of aggregate shall not exceed the least of the following:

- a) 20 mm;
- b) the concrete cover of the steel in the core pipe.

2.3 Other concrete materials

2.3.1 Water

Water shall be clean and free from harmful matter in such quantities as affect the properties of the concrete in the plastic or hardened state, or of the steel embedded in the concrete.

NOTE 1 See Appendix A of BS 3148:1980.

NOTE 2 As a general rule, potable water, whether treated for distribution through the public supply or untreated, is suitable for making concrete.

2.3.2 Admixtures

2.3.2.1 Admixtures shall conform to BS 5075.

NOTE Admixtures should not impair the durability of the concrete, nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of reinforcement.

2.3.2.2 The chloride ion content of admixtures shall not exceed 2 % (*m/m*) of the admixture nor 0.03 % (*m/m*) of the cement.

2.3.2.3 The following information shall be documented:

- a) the relevant production records;
- b) the admixture(s) used;
- c) the dosage rate of each admixture;
- d) the effect of under-dosing and over-dosing.

2.4 Concrete mix, casting and finish

2.4.1 Cement content (see 2.1)

2.4.1.1 Core pipe

2.4.1.1.1 The fully compacted concrete shall contain not less than 360 kg/m³ of cement (inclusive of any g.g.b.s. or p.f.a.) and shall have a water/cement ratio not greater than 0.45.

2.4.1.1.2 Where a special combination of cement conforming to BS 12 and g.g.b.s. or p.f.a. is used (see item d) of Annex A) the minimum cementitious content shall be increased from 360 kg/m³ to 380 kg/m³ where the purchaser's requirement is for class 3 conditions as specified in Table 6.1 of BS 8110-1:1985 (see item d) of Annex A).

2.4.1.1.3 Where the requirement is for class 4 conditions as specified in Table 6.1 of BS 8110-1:1985 (see item d) of Annex A), cement conforming to BS 4027 shall be used and the minimum cement content shall be increased from 360 kg/m³ to 370 kg/m³.

2.4.1.2 Slurry coat

The mix shall be one part by mass of water to 1.5 to 1.6 parts by mass of Portland cement. This shall be sprayed over the core pipe and high tensile wire immediately before application of the cover coat.

2.4.1.3 Cover coat

The mix shall be one part by mass of Portland cement and not more than three parts by mass of sand grading C of Table 4 of BS 882:1992. The water/cement ratio shall be not greater than 0.45.

2.4.1.4 Cement compatibility

Cement conforming to BS 4027 shall not be used with any other cement within the same unit.

2.4.2 Chloride content

The total chloride ion content of the concrete or mortar mixes shall not exceed 0.10 % by mass of cement (inclusive of p.f.a. or g.g.b.s. when used).

2.4.3 Temperature of concrete and other materials

When placed, concrete and mortar shall be maintained at a temperature of at least 5 °C until hardened. If aggregate and water are heated before mixing, it shall be to a temperature not exceeding 60 °C.

The temperature of any other materials and moulds used shall be at least 0 °C.

2.4.4 Compaction

All units shall be compacted so that, when hardened, they shall be free from honeycombing and from any individual large void as described in 4.4.1 of BS 1881-120:1983. Blistering shall not be regarded as a void.

NOTE Any individual void larger than 6 mm is unacceptable.

2.4.5 Surface finish

NOTE After a unit has been cured prior to despatch, it is permissible to rub down where necessary to produce a surface finish that conforms to the requirements of this clause.

2.4.5.1 Surface evenness

When tested in accordance with B.1, the internal surface of a unit shall not have irregularities that cause the central portion of the gauge to touch the unit.

2.4.5.2 Surface voids

Surfaces of units shall be free from voids that, when tested in accordance with B.2, permit diametrically opposite points of the rim of the gauge to touch simultaneously the surface of the unit.

Units shall not exhibit surface voids greater than 12 mm deep.

NOTE Voids up to and including 12 mm deep may be made good using material conforming to 2.4.6.1.

2.4.6 Making good

2.4.6.1 Materials

Materials for making good shall be one of the following:

- a) neat cement grout, with or without the addition of styrene-butadiene rubber (SBR), or styrene acrylic copolymer admixture, the type of cement being consistent with that in the unit to be made good;
- b) 1 : 3 cement/sand mortar proportioned by mass with or without the addition of SBR or styrene acrylic copolymer admixture. The cement shall be compatible with that in the unit to be made good and the sand shall conform to the requirements for sand in BS 882 but have a grading such that 100 % of the material passes a 5 mm sieve;
- c) a sample of the concrete mix minus the aggregate retained on the 5 mm sieve, with or without the addition of SBR or styrene acrylic copolymer admixture;
- d) epoxy or polyester resin, or polymer latex mortar.

NOTE For guidance on the use of epoxy and polyester resins, see CIRIA Report 69 [1]. See also *The repair of concrete structures* [2], which also deals with polymer latex mortars, and 6.10.5 of BS 8110-1:1985.

2.4.6.2 Blistering

Any blistering shall be made good using material conforming to 2.4.6.1 d).

NOTE Flaking of the surface of a unit does not constitute blistering.

2.4.6.3 Joint surfaces

Prior to testing, making good of joint surfaces shall only be carried out in the following circumstances.

a) If the requirements of 2.4.4 have been met, a joint profile may be reworked for conformity to 3.8 by one of the following methods:

- 1) whilst the concrete is green, by application of material conforming to 2.4.6.1 b) or c) to a depth not exceeding 5 mm;
- 2) by the application of material conforming to 2.4.6.1 d);
- 3) by grinding off.

b) If the requirements of 2.4.4 have been met and the conditions given in 1) and 2) apply, any spalling of the arisses of spigots or sockets that has occurred during demoulding or handling may be made good by the application of material conforming to 2.4.6.1 b) or c).

- 1) In any unit the total exposed area of broken concrete does not exceed $6 \times (\text{DN}) \text{ mm}^2$ and no individual area exceeds $3 \times (\text{DN}) \text{ mm}^2$.

Example. The total area for a DN 900 pipe is $5\,400 \text{ mm}^2$ with no individual area exceeding $2\,700 \text{ mm}^2$.

- 2) No exposed area of broken concrete is in contact with both the outer and inner surface of the spigot or socket of the unit.

c) If the requirements of 2.4.4 have been met, any spalling of the arisses of spigots or sockets that has occurred during demoulding or handling may be made good by the application of material conforming to 2.4.6.1 d) provided that in any unit the total exposed area of broken concrete does not exceed $12 \times (\text{DN}) \text{ mm}^2$ and no individual area exceeds $6 \times (\text{DN}) \text{ mm}^2$.

2.5 Reinforcement

All steel used as reinforcement in the core pipe, and in longitudinal and circumferential prestressing of the core pipe shall conform to one of the following standards, as appropriate.

Uses	Types of steel	Standard to be conformed to
Reinforcement in core pipe	Hot rolled steel bars for the reinforcement of concrete	BS 4449
Reinforcement in core pipe	Cold reduced steel wire for the reinforcement of concrete	BS 4482
Reinforcement in core pipe	Steel fabric for the reinforcement of concrete	BS 4483
Prestressing of core pipe	Cold drawn high tensile steel wire, straightened and stress relieved	BS 5896

NOTE For the arrangement of steel in a unit see section 4.

Reinforcement shall be free from mud, oil, paint, retarders, loose rust, loose mill scale, snow, ice, grease or any other substance which can be shown to affect adversely the steel or concrete chemically, or to reduce the bond between steel and concrete.

Section 3. Dimensions and tolerances

3.1 Nominal size and effective length

3.1.1 Nominal size (DN)

The nominal sizes (see 1.3.6) of units shall be either:

a) those given in column 1 of Table 1; or

b) for units in the ranges given in Table 2, those at the intervals specified.

If nominal sizes as specified in item b) are used, the tolerances on internal diameter and wall thickness shall be those relating to the next higher nominal size given in Table 1.

Table 1 — Nominal sizes and tolerances for units [see 8.1 b)]

1	2		3	4
Nominal size of units DN (see 3.1.1)	Limits of internal manufacturing diameter (see 3.2)		Deviation of actual internal diameter from internal manufacturing diameter (see 3.2)	Variation of core pipe wall thickness (see 3.4)
DN	Maximum diameter mm	Minimum diameter mm	(±) mm	mm
450	460	440	6	6
525	535	515	6	6
600	610	590	6	6
675	695	655	6	6
750	770	730	6	6
825	845	805	6	6
900	920	880	6	6
975	995	955	6	6
1 050	1 070	1 030	6	6
1 125	1 145	1 105	6	6
1 200	1 220	1 180	10	10
1 350	1 380	1 330	10	10
1 500	1 530	1 480	10	10
1 650	1 680	1 630	10	10
1 800	1 830	1 780	10	10
1 950	1 980	1 925	16	16
2 100	2 135	2 075	16	16
2 250	2 285	2 225	16	16
2 400	2 435	2 375	16	16
2 550	2 590	2 525	16	16
2 700	2 740	2 675	16	16
2 850	2 890	2 825	16	16
3 000	3 040	2 975	16	16
3 150	3 190	3 125	16	16