
Draft for Development

Precast concrete pipes of composite construction

Part 2. Precast concrete pipes strengthened by chopped zinc-coated steel fibres

Projet à développer

Tuyaux en béton prémoulé de construction composite

Partie 2. Tuyaux en béton prémoulé renforcés à la fibre d'acier galvanisée tranchée

Entwurf zur weiteren Ausarbeitung

Verbundfertighre aus Beton

Teil 2. Mit zerkleinerten verzinkten Stahlfasern verstärkte Fertigbetonrohre

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This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature for the reasons given in the foreword. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

A review of this Draft for Development will be carried out not later than two years after its publication. Notification of the start of the review period, with a request for the submission of comments from the users of this Draft for Development will be made in an announcement in the appropriate issue of *BSI News*. Observations which it is felt should receive attention before the official call for comments will be welcomed. A questionnaire prepared by

BSI will be available on request from the Secretary to Committee CAB/12, British Standards Institution, 2 Park Street, London W1A 2BS.

According to the replies received, the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Because of its provisional nature, BSI requests manufacturers not to mark products with claims of compliance with this publication. Since such claims would not have the effect of indicating conformity with a definitive national standard, they could be judged misleading trade descriptions.

Foreword

This Draft for Development has been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee and covers various types of precast concrete pipe of composite construction that have not been in service for as long as the products covered by BS 5911 : Part 1. Part 1 of the Draft for Development deals with pipes strengthened by continuous alkali-resistant glass fibre rovings.

This Part of the Draft for Development covers pipes incorporating chopped zinc-coated steel fibres instead of the traditional cold drawn steel wire cage. Development began in the UK in 1963, after initial investigations in the USA. Commercial production of pipes incorporating steel fibres started in the UK in 1971.

A Study Group set up by the BSI Committee responsible for standards for all concrete pipes and fittings considered various areas of technical concern relating to concrete pipes strengthened by steel fibres. This appraisal included witnessing tests; examination of test results; consideration of the mode of failure under crushing loads compared with the traditionally reinforced pipes; the function, orientation and dispersal of the fibres throughout the pipe wall section.

Concrete pipes are normally expected to remain in service for 50 years to 100 years, so the introduction of new materials or methods makes it necessary to assess long term durability. Research has shown that unprotected steel fibres embedded in concrete are not affected significantly by corrosion. However the Committee considered it prudent to

recommend the use of zinc-coated fibres pending further experience of performance in service. Stainless steel fibres have not been recommended because they have not been used in the UK to any significant extent.

The rates of carbonation of uncracked specimens of plain and steel fibre reinforced concrete are essentially the same. (See Building Research Establishment Current Paper CP69/74. 'Steel fibre reinforced concrete' Edgington, Hannant and Williams.*) Hence the recommendations for the works proof load test in 21.4 are similar to the test requirements for unreinforced pipes specified in BS 5911 : Part 1.

A full explanation of the differences in performance between these pipes and pipes covered by BS 5911 : Part 1 is not yet available but the Committee considers that they can be regarded as composite structures rather than as pipes reinforced in the conventional sense. Further test data and supporting field evidence will lead to a more complete understanding of the mechanism involved. The information obtained in this way will have an important effect on the review of this Part of this Draft for Development to be made in two years time.

Apart from the asterisked clauses, the recommendations of this Draft for Development are equivalent to the requirements specified in BS 5911 : Part 1.

For an enquiry and order to be fully understood, the information set out in appendix A should be given to the manufacturer.

*Available from the Building Research Establishment, Garston, Watford WD2 7JR.

Draft for Development

Precast concrete pipes of composite construction

Part 2. Precast concrete pipes strengthened by chopped zinc-coated steel fibres

Section one. Specification

1. Scope

This Draft for Development covers precast concrete cylindrical pipes, bends and junctions strengthened by chopped zinc-coated steel fibres and intended to be used for the conveyance, under atmospheric pressure, of sewage or surface water, and for the construction of culverts.

A range of nominal sizes (DN) of units is covered, namely DN 375 to DN 1200, by increments of 75.

A range of minimum crushing strengths, as determined by standard tests, is given for each nominal size of pipe.

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

2. Definitions

For the purposes of this Draft for Development, the following definitions apply.

2.1 unit. A pipe, bend or junction.

2.2 pipe. A hollow cylinder manufactured from concrete, cast as one piece and of uniform cross section throughout its length, except at the joint, and strengthened by chopped zinc-coated steel fibres to resist tensile stresses imposed by the specified test loads.

2.3 splayed end pipe. A pipe having one or both of its ends designed in a plane not at right angles to the longitudinal axis.

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.

2.5 manufacturing diameter. The internal diameter of a unit that a manufacturer seeks to achieve.

2.6 actual diameter. Any internal diameter found by measurement.

2.7 effective length. The length of a unit measured as shown in figure 1.

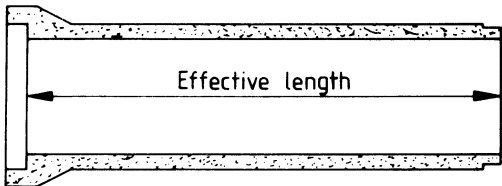
2.8 batch. The number of units of a particular specification produced under uniform conditions during a production period by the same process.

2.9 aspect ratio. The ratio of fibre length to fibre diameter.

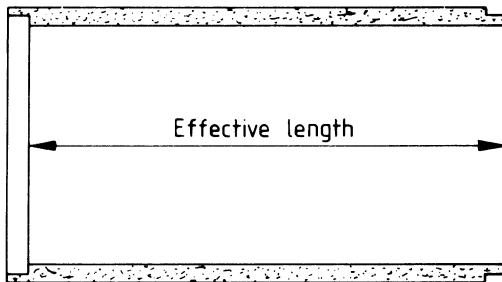
3. Cement

The cement shall comply with the relevant requirements of one of the following standards as appropriate.

Type of cement	Standard to be complied with
Ordinary Portland	BS 12
Sulphate-resisting Portland	BS 4027



(a) Unit with flexible spigot and socket joint



(b) Unit with flexible rebated joint

Figure 1. Effective length of units

4. Aggregates

4.1 General. Aggregates shall consist of materials complying with BS 882, 1201 : Part 2, except that the manufacturer shall be permitted to modify gradings to suit the manufacturing process.

NOTE. Typical samples of aggregates and evidence of satisfactory performance should be made available to purchasers on request (see appendix A).

4.2 Testing. The coarse aggregates, when tested in accordance with BS 812 : Parts 1 and 3, shall fulfil the following respective requirements:

- (a) flakiness index: not more than 35;
- (b) 10 % fines test: not less than 100 kN.

The maximum nominal size of aggregate as defined in BS 882, 1201 : Part 2 shall not exceed 20 mm.

5. Other concrete materials

5.1 Water. Water shall be clean and free from harmful amounts of deleterious matter, either in suspension or in solution.

5.2 Admixtures. The composition and use of admixtures, including calcium chloride, shall follow the recommendations in 6.2.4 of CP 110 : Part 1 : 1972.

6. Concrete

***6.1 Cement content.** The fully compacted concrete should contain not less than 360 kg of cement per cubic metre and should have a maximum water/cement ratio of 0.35.

6.2 Chloride content. The total chloride ion content of the concrete mix shall follow the recommendations of 6.3.8 of CP 110 : Part 1 : 1972.

6.3 Work in cold weather. Concrete, when placed, shall have a temperature of at least 5 °C, which shall be maintained until the concrete is thoroughly hardened. It is permissible to heat aggregates and water before mixing, to a temperature not exceeding 60 °C. Other materials and moulds, if frozen, shall not be used.

*7. Chopped steel fibre

7.1 Material. The fibres should consist of zinc-coated steel wire of circular cross section complying with the requirements for general purpose wire specified in BS 2763, subject to the following provisos.

- (a) The minimum tensile strength should be 1000 N/mm² (see 10.1 of BS 2763 : 1982).
- (b) There should be no limit on the maximum tensile strength (see table 3 of BS 2763 : 1982).
- (c) There should be no limits on the number of twists or reverse bends (see 10.2 and 10.3 of BS 2763 : 1982).
- (d) The zinc coating should have a mass of not less than 30 g/m² (see clause 11 of BS 2763 : 1982).

The fibres should be 25 mm to 65 mm in length and should have an aspect ratio not greater than 100. Plain or deformed ends are permitted.

The fibres should be free from oil, grease or any other contamination.

7.2 Content and distribution of fibre in mix. The fibres should be introduced into the concrete mix in such a way as to achieve even distribution.

Where the fibres are introduced in bundles, the bundles should separate into individual fibres after introduction into the mix.

When tested as described in appendix B, the fibre content of each sample taken from the mix should be not less than 25 kg/m³.

8. Nominal size (DN)

The nominal sizes (see 2.4) of pipes shall be those shown in column 1 of table 1.

9. Manufacturing diameter and actual diameter

The manufacturing diameter (see 2.5), which shall be stated by the manufacturer prior to the order being placed, shall not be outside the limits shown in column 2 of table 1.

The actual diameter (see 2.6) shall not deviate from the manufacturing diameter by an amount greater than that given in column 3 of table 1.

10. Permissible variation in the thickness of wall

The radial thickness of the wall of any unit shall not vary by more than the amount stated in column 4 of table 1, for the appropriate nominal size.

11. Squareness of ends

The ends of each unit (except splayed end pipes) shall be square with its longitudinal axis or, for a bend, the tangent to it, within the manufacturer's stated tolerances.

NOTE. In practice, methods of computing and measuring any variation will differ for pipes of different sizes, lengths and wall thicknesses.

12. Permissible deviation from straightness

When measured as described in appendix C, the maximum permissible deviation from straightness shall be 3.5 mm per metre of the total effective length (see 2.7) of the pipe.

Table 1. Nominal sizes and permissible tolerances for units

1	2		3	4
Nominal size of pipes, bends and junctions	Permissible limits of manufacturing diameter (see clause 9)		Permissible deviation of actual diameter (plus or minus) from manufacturing diameter (see clause 9)	Permissible variation of wall thickness (see clause 10)
	Maximum diameter	Minimum diameter		
DN	mm	mm	mm (±)	mm
375	385	365	6	6
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
1050	1070	1030	6	6
1125	1145	1105	6	6
1200	1220	1180	10	10

* See foreword.

This publication is a Draft for Development and is therefore not to be regarded as a British Standard. See inside front cover.

13. Permissible irregularity of internal surface

After testing in accordance with the procedure given in appendix H, the internal surface of a pipe shall not retain irregularities that cause either of the 2 mm rims of the gauge to lose contact with the surface.

Stoning off isolated protuberances or projecting fibres in order to secure compliance with this clause shall be permitted.

NOTE. The requirement for checking surface irregularity inside (but not outside) pipes is to resolve differences of opinion on site regarding what is an acceptable finish. It is recognized that minor variations of surface finish arising from the manufacturing process (but not from subsequent physical damage) have no practical significance as regards the long term hydraulic performance of the pipeline.

14. Joints

Joints of pipes, bends and junctions shall be of the flexible spigot and socket type or of the flexible rebated type.

The joint and joint ring dimensions shall conform to the manufacturer's standard dimensions and tolerances.

The joint ring shall be of such size and shape that, when jointed in accordance with the manufacturer's instructions, it will provide a watertight seal within the specified range of angular deflection, straight draw and shear loading (see 21.6) under all combinations of joint and joint ring dimensional tolerances.

Joint rings shall comply with the requirements for type 2 as specified in BS 2494.

Joints shall be tested in accordance with 21.6.

NOTE. For typical joints, see figure 2.

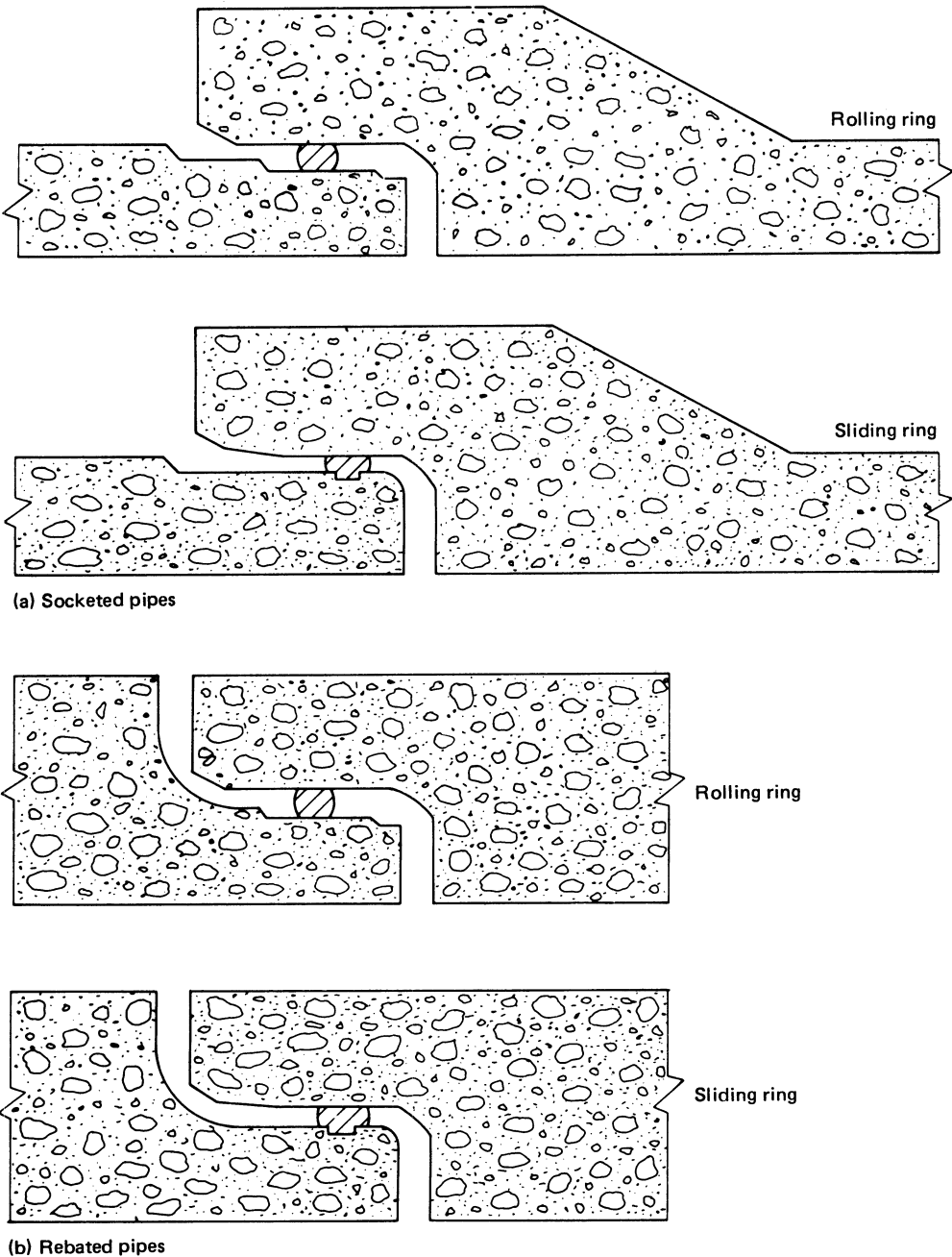


Figure 2. Typical flexible joints for pipes