

# BRITISH STANDARD SPECIFICATION FOR PRECAST CONCRETE FLAGS

## FOREWORD

This British Standard, which was first issued in 1929, was revised in 1936 and 1956, and has been revised again in the light of present-day practice in the manufacture of concrete flags under the authority of the Cement, Lime and Gypsum Industry Standards Committee. Considerable changes have been made to this standard both to its technical requirements and to the arrangement of the clauses.

The clauses dealing with materials have been revised to take into account revised and new British Standards, and this standard specifies the requirements for the use of pulverized-fuel ash in concrete flags.

The dimensions and tolerances permitted are given in metric units and the methods of measuring the flags are given in a new appendix.

Since flags are normally tested in a testing machine rather than by applying loads to a simply supported specimen, the relevant appendix has been revised to describe both the requirements of the testing machine and the testing procedure. As a result of further research conversion factors are given for the required transverse strength at ages beyond 28 days. These factors are identical with those given in BS 340\*.

As a result of research work on durability and the method of performing the test for absorption of water, the previous tests at 10 min and 24 h have been deleted and replaced by a 30 min absorption test. This test is carried out on specimens sawn from the corners of the flag, to give more uniform results, instead of cut as previously. Due to the change in the test procedure the absorption limit has been changed and different values are given for different ages at test and a requirement for the flakiness index of the coarse aggregate has been added.

The rate of wear test has been deleted but an additional requirement for the mechanical strength of the aggregate is given.

The clauses dealing with methods of manufacture and with the colour, finish and freedom from defects have been revised and re-arranged.

The clauses dealing with sampling for testing for compliance have been revised to take account of the increased practice of testing by the purchaser, as well as that required for independent testing. A uniform rate of sampling is specified and the test results are applied to consignments of 2000 flags, or less, instead of to the whole order as previously.

\* BS 340, 'Pre-cast concrete kerbs, channels, edgings and quadrants'.

In accordance with the change to the metric system, this standard has been prepared giving values in terms of SI units. For further information on SI units, reference should be made to BS 3763, 'International System (SI) units,' and PD 5686, 'The use of SI units.'

NOTE. Attention is drawn to certification facilities offered by BSI; see the back cover of this standard.

## SPECIFICATION

### 1. SCOPE

This British Standard specifies requirements for precast paving flags manufactured from a concrete mixture in a range of sizes and thicknesses for use in the construction of footways and other paved areas.

### 2. CEMENT

The whole of the cement used in the manufacture of the paving flags shall comply with one of the following British Standards:

BS 12, 'Portland cement (ordinary and rapid hardening)',  
or  
BS 146, 'Portland-blastfurnace cement'.

When specially ordered by the purchaser, high alumina cement complying with BS 915\*, or sulphate-resisting Portland cement complying with BS 4027†, or hydrophobic cement complying with the physical requirements of BS 12‡, or white or coloured Portland cement complying with BS 12, may be used.

### 3. AGGREGATES

**3.1 Quality.** The fine and coarse aggregate shall consist of either naturally occurring materials, crushed or uncrushed, complying with the quality requirements of 4a and 5d of BS 882 : 1965§, or of 4a and 5d of BS 1201 : 1965||, or alternatively coarse aggregate complying with the quality requirements of Clause 5 of BS 1047 : 1952¶ may be used.

The coarse aggregate to be used, when tested in accordance with BS 812\*\*, shall meet the following requirements:

- (1) 10 % fines test: Not less than 10 tonnes.
- (2) Flakiness index: Not more than 35 % unless otherwise agreed between the purchaser and the manufacturer on the basis of acceptable evidence of durability.

\* BS 915, 'High alumina cement'.

† BS 4027, 'Sulphate-resisting Portland cement'.

‡ BS 12, 'Portland cement (ordinary and rapid hardening)'.

§ BS 882, 'Coarse and fine aggregates from natural sources'.

|| BS 1201, 'Aggregates for granolithic concrete floor finishes'.

¶ BS 1047, 'Air-cooled blastfurnace slag coarse aggregate for concrete'.

\*\* BS 812, 'Methods for the sampling and testing of mineral aggregates, sands and fillers'.

**3.2 Maximum size.** The nominal maximum size of the aggregate shall not exceed 14 mm as specified in BS 882\*.

#### 4. OTHER MATERIALS

**4.1 Pulverized-fuel ash.** Where pulverized-fuel ash is used, it should comply with the requirements of BS 3892†, and should have a specific surface within Zone B.

The total sulphate content of the concrete mix shall not exceed 4.0 % as SO<sub>3</sub> by weight of the cement. The sulphate content shall be calculated from the known sulphate contents of the cement, aggregates (where applicable) and pulverized-fuel ash, as determined by tests carried out in accordance with the requirements of BS 12‡, BS 1047§ and BS 3892† respectively.

**4.2 Pigments.** Any pigments used in the colouring of the flags shall comply with BS 1014||.

**4.3 Others.** Any additional material required to produce special properties such as a special texture, colour or grip shall not have any deleterious effect upon the concrete.

#### 5. FINISH AND COLOUR

Special surface finishes may be agreed upon between the vendor and the purchaser. All arrises shall be clean and sharp.

Unless otherwise specified by the purchaser, the flags shall be supplied in natural colour. When the products are ordered coloured, the colour shall be agreed between the vendor and the purchaser at the time of placing the order. The vendor and purchaser shall agree whether the products shall be coloured throughout or only in a surface layer. In the latter case the surface layer shall be not less than 12 mm thick and cast as an integral part of the flag.

#### 6. CASTING AND CURING

**6.1 Casting.** The flags may be made by any process. The escape of the finer particles of mortar during the process of manufacture shall be prevented as far as practicable.

A flag described as 'pressed' shall only be made by employing a pressure of not less than 7 MN/m<sup>2</sup> over the entire surface receiving the pressure.

**6.2 Curing.** After casting, the flags shall be stored so as to prevent undue loss of moisture particularly during the early stages of curing.

\* BS 882, 'Coarse and fine aggregates from natural sources'.

† BS 3892, 'Pulverized-fuel ash for use in concrete'.

‡ BS 12, 'Portland cement (ordinary and rapid hardening)'.

§ BS 1047, 'Air-cooled blastfurnace slag coarse aggregate for concrete'.

|| BS 1014, 'Pigments for cement, magnesium oxychloride and concrete'.

**6.3 Work in cold weather.** Special precautions shall be taken to prevent the temperature of the concrete falling to 0°C during the early stages of hardening, viz:

(1) The temperature of the concrete at the time of placing shall be at least 5°C.

(2) The temperature of the mould itself shall be above 0°C.

(3) No material which has been exposed to temperatures below 0°C shall be used until it has been completely thawed.

Flags shall be protected from damage by frost.

#### 7. DIMENSIONS AND TOLERANCES

**7.1 Dimensions.** Flags shall be manufactured to the dimensions given in Table 1, subject to the tolerances permitted in 7.2, and shall be available in two thicknesses, viz. 50 mm and 63 mm.

TABLE 1. FLAG DIMENSIONS

Flag type	Co-ordinating size	Work size	Maximum limit of manufacturing size	Minimum limit of manufacturing size
	mm	mm	mm	mm
A	600 × 450	598 × 448	600 × 450	596 × 446
B	600 × 600	598 × 598	600 × 600	596 × 596
C	600 × 750	598 × 748	600 × 750	596 × 746
D	600 × 900	598 × 898	600 × 900	596 × 896

NOTE. When ordering, it will be necessary only to specify the type followed by the thickness, e.g. 'A 50'.

**7.2 Tolerances.** When sampled in accordance with Clause 11 and measured as described in Appendix A, the flags sampled shall be within the tolerances given in 7.2.1 to 7.2.4.

**7.2.1 Thickness.** The average thickness of the twelve values obtained from the four measurements on each of the three flags shall be within ± 3 mm of the specified thickness.

**7.2.2 Length and width.** Each individual flag of the sample shall be within the maximum and minimum limits of manufacturing size specified in 7.1.

**7.2.3 Squareness of plan.** The difference between the two diagonals measured on the same face of each individual flag of the sample shall not exceed 3 mm.

**7.2.4 Flatness, winding and bowing.** The maximum deviation from a 550 mm straightedge placed in any position on the wearing surface of each individual flag of the sample shall not exceed 2 mm.

The flatness etc. shall be measured by means of the notched straightedge and the 25 mm × 25 mm × 4 mm test gauge shown in Fig. 1.

### 8. TEST REQUIREMENTS

The flags sampled in accordance with the provisions of Clause 11 shall comply with the following test requirements for transverse strength and absorption of water.

**8.1 Transverse strength.** The failing loads of individual flags when tested in the manner described in Appendix B shall be not less than the appropriate value given in Table 2.

TABLE 2. TRANSVERSE STRENGTH REQUIREMENTS

Flag type	Minimum failing load	
	50 mm thick	63 mm thick
	kN	kN
A	8.3	12.7
B, C or D	11.1	16.9

The minimum test loads given in Table 2 relate to transverse strength tests carried out on flags up to an age of 28 days from the date of manufacture.

If tests are carried out at later ages, the failing load shall be not less than the appropriate load given in Table 2 multiplied by the following conversion factors:

Age of sample at test	Conversion factor
Months	
2	1.10
3	1.15
4	1.20
5	1.25
6 and over	1.30

Conversion factors for intermediate ages shall be obtained by linear interpolation.

**8.2 Absorption of water.** When tested in the manner described in Appendix C the average increase in weight of the test pieces from each flag shall not exceed the value appropriate to the age of test given in Table 3.

TABLE 3. WATER ABSORPTION LIMITS

Age of sample at test	Maximum average absorption by weight
Months	%
Up to 1	3.6
2	3.2
3	3.0
4	2.9
5	2.8
6 and over	2.7

Maximum average absorption values for intermediate ages shall be obtained by linear interpolation.

### 9. MANUFACTURER'S CERTIFICATE

The manufacturer shall satisfy himself by regular testing that at the time of delivery the flags comply with the requirements of this British Standard and, if requested, shall forward a certificate to this effect to the purchaser or his representative.

The manufacturer shall, if requested to do so, supply a certificate stating the date of manufacture of the flags.

### 10. FACILITIES FOR SAMPLING

The purchaser or his representative shall at all reasonable times have access to the place where the flags are manufactured or stored, for the purpose of examining and sampling the materials and the finished flags, inspecting the process of manufacture, and marking the flags. The vendor shall, free of extra charge, provide or make arrangements for the provision of such facilities and labour required for examination, sampling, inspecting and marking before delivery as may be necessary to establish that the flags comply with the requirements of this standard.

### 11. SAMPLES FOR TESTING

**11.1 General.** When required the samples shall be taken at random from the appropriate consignment representing the whole or part of the order; these samples may be taken as required in 11.2 or 11.3.

**11.2 Purchaser's sampling.** For the checking of the dimensions specified in Clause 7 and for carrying out the tests specified in Clause 8, the purchaser or his representative may take before or immediately after delivery three sample flags for every order for 2000 or less. For orders for more than 2000 flags, three sample flags may be taken from every 2000 flags forming part of the order.

**11.3 Sampling for independent testing.** When it is agreed that independent testing as described in Clause 13 is required, the random sample of three flags shall be selected and marked when both the purchaser and the manufacturer, or their representatives, are present.

## 12. TEST RESULTS

Should any of the test results not comply with the requirements of Clauses 7 or 8, then the whole of the consignment of 2000 flags, or less, comprising the whole or part of the order, shall be deemed not to comply with this standard.

## 13. INDEPENDENT TESTS

**13.1 Sampling and testing.** If requested by the manufacturer, or the purchaser, independent tests shall be carried out by a mutually-agreed, independent testing laboratory whose results shall be accepted.

The samples required for these independent tests shall be taken as specified in Clause 11, measured and tested in accordance with Clauses 7 and 8 and the test results judged as specified in Clause 12.

**13.2 Costs of tests.** Unless otherwise specified at the time of the enquiry and order, the cost of the independent tests shall be borne as follows:

(1) By the manufacturer, in the event of results showing that the flags do not comply with the standard.

(2) By the purchaser, in the event of the results showing that the flags comply with the standard.

## APPENDIX A

### METHODS OF MEASURING

**A.1 Thickness.** The thickness of each of the three sample flags is measured with a caliper gauge having jaws suitable for measuring the thickness 30 mm in from the edge of the flag. The thickness of each flag is measured 30 mm in from the edge of the flag at a distance not more than 100 mm from each corner. The four measurements obtained from each of the three flags give twelve results, the average of these is calculated and expressed to the nearest 1 mm.

**A.2 Length and width.** The length and width of each of the sample flags is measured at any position across the wearing face with a steel tape complying with the requirements of BS 4484\* and are expressed to the nearest 1 mm.

**A.3 Squareness of plan.** The squareness of plan of each of the sample flags is determined by measuring the two diagonals of the wearing face with a steel tape complying with the requirements of BS 4484\* and these dimensions are expressed to the nearest 1 mm.

**A.4 Flatness, winding and bowing.** Flatness, winding and bowing are measured by means of the notched straightedge and gauge block, both made of steel, shown in Fig. 1. When the notched straightedge is placed in any position on the wearing face of each sample flag, if the surface of the flag touches the notched section of the straightedge, both the support ends of the notched straightedge shall be in contact with the flag. Also, when placed in any position on the wearing face of each flag, the gauge block shall not pass between the notched straightedge and the surface of the flag.

## APPENDIX B

### TEST FOR TRANSVERSE STRENGTH

**B.1 Testing machine.** The transverse testing machine complies with the requirements of a Grade A or Grade B machine when verified in accordance with BS 1610† and is of sufficient capacity to apply loads 50 % higher than is required in Clause 8 (i.e. 25 kN). It is provided with two steel supporting rollers each 38 mm diameter, spaced 450 mm between centres. Alternatively two steel bearers each 6 mm wide on the supporting surfaces, spaced 450 mm‡ apart internally, may be used. In either case, one support is horizontal and the other is so mounted, e.g. by pivoting about an axis parallel to the length of the specimens,

\* BS 4484, 'Measuring instruments for constructional works', Part 1, 'Metric graduation and figuring of instruments for linear measurements'.

† BS 1610, 'Methods for the load verification of testing machines'.

‡ If convenient, 457 mm spacing may be used.

as to enable loads to be applied without inducing any torsional restraint in the specimen. The upper member of the loading frame is provided with a spherical seating to ensure that the load is applied axially and without inducing any torsion in the specimen, and a steel platen at least 50 mm wide and of length not less than the width of the widest specimen to be tested, normally 600 mm (see Figs 2 and 3).

**B.2 Testing procedure.** Place the specimen symmetrically on the bearers of the testing machine and with its shorter sides parallel to the supporting rollers or bearers.

The load is applied through the medium of a hardwood fillet 50 mm wide, on the upper surface of the specimen at the midpoint of the span and extending the whole width of the specimen parallel to the supporting rollers or bearers.

Apply the load steadily and uniformly starting from zero, at a rate not exceeding 0.75 kN per 10 s for slabs 450 mm wide and 1.0 kN per 10 s for slabs 600 mm wide (measured parallel to the bearers), until the specimen breaks or the capacity of the machine is reached. Record the individual failing loads in the report, except that when a specimen does not fail at the upper limit of testing machine, record the failing load as 'greater than —kN'.

## APPENDIX C

### TEST FOR THE ABSORPTION OF WATER

**C.1 Apparatus.** The following apparatus is required:

- (1) Suitable concrete sawing machine.
- (2) Balance capable of weighing up to 2 kg to an accuracy of 1 g.
- (3) Well ventilated oven complying with BS 2648\* in which the temperature is controlled to between 100°C and 105°C.
- (4) Desiccator or small, dry, airtight vessel to contain the specimens.
- (5) Tank approximately 150 mm deep in which the specimens can be immersed in water.

**C.2 Preparation of test pieces.** Two square test pieces are sawn from diagonally opposite corners of each of the three sample flags. These test pieces are approximately 100 mm × 100 mm, sawn from the full thickness of the flag and have two sawn and two moulded edges.

\* BS 2648, 'Performance requirements for electrically-heated laboratory drying ovens'.

Amendment Slip No. 2  
published and effective from 31 December 1979  
to BS 368 : 1971

## Precast concrete flags

### Revised text

**Clause 7.2.4 Flatness, winding and bowing.** In paragraph 1, line 1, delete 'a 550 mm' and substitute 'the specified'.

In paragraph 2, line 1, insert 'appropriate' before 'notched'.

**Clause A.4 Flatness, winding and bowing.** In line 2 insert 'appropriate' before 'notched'.

**Figure 1. Notched straightedge and gauge block.** Delete the existing figure and substitute the following:

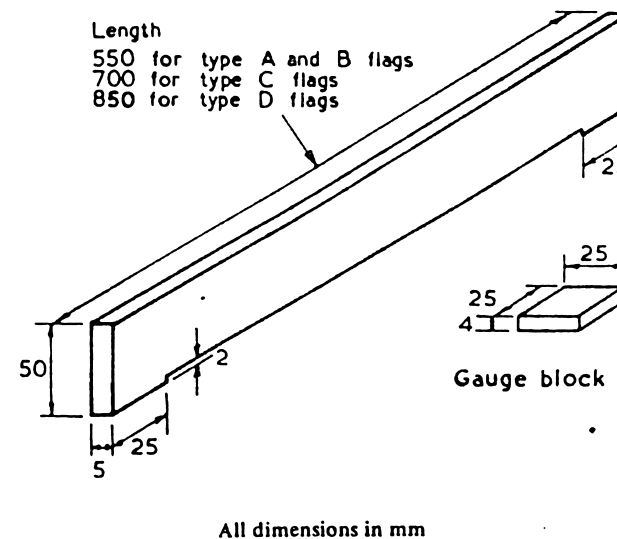


Fig. 1. Notched straightedge and gauge block

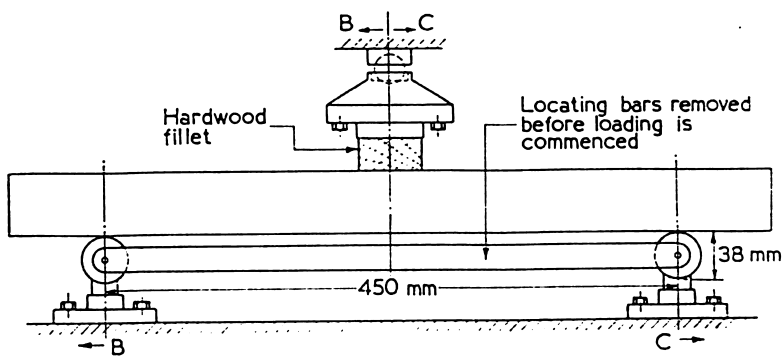


Fig. 2. Arrangement of loading for transverse strength test; side elevation

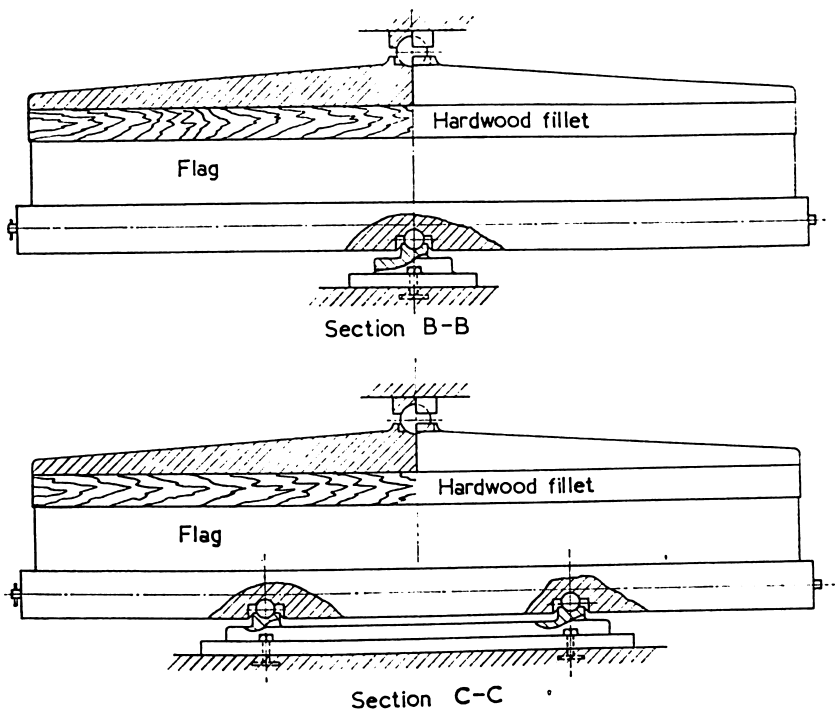


Fig. 3. Arrangement of loading for transverse strength test; end elevations