BRITISH STANDARD

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1983

Testing of resin compositions for use in construction —

Part 1: Method for preparation of test specimens

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Contents

Foreword

This Part of this British Standard has been prepared under the direction of the Civil Engineering and Building Structures Standards Committee. It provides general information and describes sampling and specimen preparation techniques for resin compositions.

Further Parts describe particular methods of test for the measurement of basic physical properties of resin based materials, both on their own and also in conjunction with other materials. The Parts of this standard together provide a rationalized collection of methods for testing the performance of resin based compositions as used in the construction industry.

The methods described in this standard allow for the tests to be carried out either under specified ambient conditions or under agreed and declared conditions so allowing the freedom necessary for research purposes (e.g. assessing performance under various conditions) or for checking maintenance of quality. If the purpose of the tests is to prepare general data for facilitating comparison between resin compositions from different sources, then it is strongly recommended that the more specific ambient conditions described are adopted. Whichever testing programme is adopted, the precise details need to be listed in the test report alongside the data obtained.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 4, 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.

0 Introduction

As techniques of civil engineering, and building construction and renovation evolve so the need for new materials grows. To satisfy this need resin suppliers and formulators are developing new products in ever increasing numbers. This proliferation of products often leads to confusion and indeed suspicion on the part of the specifier.

The advantages to be gained from using resin based products now appreciated by the majority of engineers and as their use becomes accepted in ever more demanding situations the consequences of the incorrect choice or application of material become increasingly serious. Data for such materials are, however, difficult to interpret unless based on standard test methods and these in turn need to be related to the application and conditions of use.

The mechanical properties of resin based materials are generally so different from those of, for example, hydraulic cement concrete, that the same performance criteria are seldom applicable to both. In particular, compressive strength alone would not be sufficient to characterize the special features of resin compositions. When hydraulic cement concrete fails under stress it is largely by brittle fracture, i.e. with comparatively little movement taking place. Resin compounds, on the other hand, are amorphous networks of coiled and entangled polymer chains. Under stress the chains display a degree of mobility both within the molecule and between molecules; they are able to dissipate some of the stress by straightening out and sliding over one another. The rate of movement is time and temperature dependent and the degree of movement occurring before chains are ruptured is a function of the molecular construction and the degree of connection between adjacent chains (cross-linking). The presence of mineral fillers, particularly if in sufficient quantity to achieve physical contact and hence mechanical interaction between filler particles, can greatly restrict the degrees of movement.

Thus, while some resin compounds (particularly those formulations containing a very high proportion of mineral fillers and aggregates) may fail under load in a similar manner to the more familiar hydraulic cement concretes, others may deform beyond all useful limits and still support an increasing load. Ultimate failure under load may occur at a strain of 10 % or more. It follows then, that the ultimate strength of a resin compound should be viewed with caution and interpreted in conjunction with, for instance, creep and modulus of elasticity. Two other important factors that need to be considered when using resin compositions are their generally higher thermal expansion and lower compressive modulus. It is important that those considering the use of these materials are cautioned against interpreting their strength solely in the light of experience of hydraulic cement concrete behaviour.

NOTE The units of measurement used in this standard are those of the International System of Units (SI). For further information, reference should be made to BS 3763 and PD 5686.

1 Scope

This Part of this British Standard gives a general introduction to the testing of resin compositions and describes a procedure for obtaining samples of resin compositions and preparing test specimens under either declared practical conditions or more closely controlled laboratory conditions. It is applicable to thermoset cold curing resin formulations, e.g. epoxide, polyester, acrylic, polyurethane. These formulations may include liquid resins, liquid or powder hardeners, aggregates and fillers, and include polymer based grouts.

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

2 Definitions

For the purposes of this Part of BS 6319 the definitions given in BS 1755, BS 2787, BS 4049 and BS 4627 apply together with the following.

2.1
cold curing resin system

a resin system that can harden without the external application of heat

NOTE This is the principal type of system used in the construction industry.

2.2
cure

the process leading to permanent hardening of a resin by chemical reaction, such as by cross-linking

2.3
exotherm

the heat evolved when a synthetic resin hardens

2.4
filler

a solid material in powder, granular or fibrous form that is added to a synthetic resin system to reduce cost, exotherm and shrinkage and often increase hardness, abrasion resistance, heat distortion temperature or other specifically selected property of a cured system. Fillers may also modify the flow properties of the system before cure. Coarse fillers are often referred to as aggregates in the same sense as in concrete technology

2.5
forced action mixer

a machine for the blending of solids and/or liquids wherein the agitation of the material is brought about by the relative movement of the two or more parts of the machine each of which are in contact with the materials, typically by the action of paddles in a fixed or moving container

NOTE This is in contrast to a free-fall concrete mixer that contains only fixed mixing elements within a rotating vessel.

2.6
hardener

a material that chemically combines with a synthetic resin to give a hardened product

NOTE The terms catalyst, initiator, promoter and accelerator, may also be encountered in this connection and are used to describe a hardener or an additional component necessary for the hardening process. The term curing agent is sometimes used in this sense but conflicts with its meaning in concrete technology and is therefore a deprecated term in this context.

2.7
pot life

the time elapsing between the blending of a resin with its hardener and that stage in its reaction when it is no longer suitable for its intended application

2.8
resin concrete

a blend of resin and hardener with graded aggregate where a significant proportion of the aggregate is retained on a 5.00 mm BS 410 test sieve

2.9
resin grout

a resin system, with or without fillers, of sufficient mobility to be pumped, poured or injected, according to design, into cracks, fissures or voids

2.10
resin mortar

a blend of resin and hardener with graded aggregate where a small proportion of the aggregate is retained on a 5.00 mm BS 410 test sieve

2.11
thermosetting resin

a resin that, when hardened, is converted into an essentially infusible and insoluble product

3 Apparatus

3.1 *Moulds*

3.1.1 *Mould construction.* Where moulds are required they shall be of metal that is unaffected by the materials incorporated in the specimen. They shall be rigid enough to prevent distortion and shall be constructed in such a manner as to facilitate the removal of the moulded specimens without damage. The parts of the mould, when assembled, shall be positively and rigidly held together and suitable means of ensuring this, both during the filling and the subsequent handling of the filled mould, shall be provided.

Each mould shall be provided with a rigid base plate that provides a leak-proof joint with the sides of the mould.

NOTE Further requirements for moulds are specified in the appropriate Part of this standard.

3.1.2 *Mould tolerances*

3.1.2.1 *General.* The moulds shall be made so that, when assembled ready for use, the dimensions and internal faces are accurate within the limits specified in **3.1.2.2** to **3.1.2.6**. The principles given in BS 308-3 shall be followed for flatness and squareness and those in BS 1134-1 for surface texture.

3.1.2.2 *Dimensions*[1)]

3.1.2.2.1 *Prisms.* The depth and internal width of each compartment based on the average of six measurements symmetrically placed along the axis of the compartment shall be the nominal size ± 0.1 mm. The length of each compartment shall be the nominal size ± 0.4 mm.

[1)] The tolerances for dimensions should be considered in conjunction with those for flatness, squareness and parallelism.

3.1.2.2.2 *Cubes.* The depth of the mould and the distance between either pair of opposite internal faces, each based on the average of four symmetrically placed measurements, shall be the nominal size ± 0.15 mm.

3.1.2.3 *Flatness.* The surface of each internal face shall lie between two parallel planes 0.03 mm apart. The joints between the sections of the mould and between the bottom surface of the mould and the top surface of the baseplate shall lie between two parallel planes 0.06 mm apart.

3.1.2.4 *Squareness.* The surface of each internal face shall lie between two parallel planes 0.5 mm apart that are perpendicular to the bottom surface of the mould and also to the adjacent internal faces.

3.1.2.5 *Parallelism.* The top surface of the mould shall lie between two parallel planes 1.0 mm apart, parallel to the bottom surface.

3.1.2.6 *Surface texture.* The R_a value for the surface texture of each internal face shall be a maximum of 3.2 μm when assessed in accordance with BS 1134-1.

NOTE Roughness values of finishes by common manufacturing processes are given in Table 1 of BS 1134-2:1972.

3.1.3 *Mould preparation.* Moulds shall be thoroughly cleaned and lightly and uniformly treated with a suitable release agent such as silicone, hard wax or polyvinyl alcohol solution.

NOTE Standard mould oils as used for concrete specimens are not generally suitable.

In assembling the mould ready for use the joints between the sections of the mould and between the bottom of the mould and the baseplate shall, if necessary, be sealed to prevent escape of the resin composition. Any excess sealant shall be carefully removed.

3.1.4 *Conditioning of moulds.* Moulds shall be conditioned for a minimum of 3 h at the temperature specified for the materials to be tested (see **4.2**).

3.2 Ancillary equipment

3.2.1 *Compacting tool,* having a square end approximately 12 mm × 12 mm.

3.2.2 *Palette knife,* having a straight edge long enough to span the mould.

4 Procedure

4.1 Sampling. Preferably use a manufacturer's complete pre-measured pre-pack or, alternatively, where the mixing can be carried out in laboratory conditions, prepare a mix from individual components in the proportions specified by the manufacturer. It is then generally desirable that the total mass of the mix is such that no component weighs less than 10 g. Carry out all weighings to an accuracy of ± 0.5 %.

Where a quantity of a filler, sand or aggregate has to be subdivided, sample the aggregate according to the method described in BS 812-1. Carefully agitate liquids before sampling to ensure homogenity and to ensure that any settled component is redispersed.

NOTE It is recommended that where a liquid component is involved the complete contents of the liquid container are used as the use of part contents may make it difficult to achieve the specified mix proportions due to the materials sticking to the sides of its container because of its viscosity.

Prepare all the test specimens from the same batches of materials. Record all batch references for insertion in the test report.

4.2 Conditioning of materials. For assessment under laboratory conditions, condition the material or individually proportioned components at 20 ± 1 °C for a minimum of 16 h before mixing unless alternative conditions are agreed. For site testing, record and declare the conditioning procedure.

4.3 Mixing. Mix the constituent parts in the order specified in the manufacturer's instructions.

Mix the conditioned materials in such a manner as to ensure uniformity, minimize the entrapment of air, and avoid heat generation by excessive agitation. Take care not to introduce any contamination into the mixture. Continue mixing until the material is homogenous in appearance or for such longer time as may be specified by the manufacturer. Observe any special requirements indicated by the manufacturer.

For quantities up to 1 L, mixing may be carried out by hand in an appropriate receptacle. This shall be the manufacturer's container if specified or other suitable vessel of low form. Use an implement appropriate to the configuration of the mixing vessel and the nature of the mix.

Where the total quantity of mix exceeds 1 L, mix it efficiently in a forced action mixer.

NOTE Suitable mixers are described in BS 4550-3.4 and BS 4551; these incorporate as an essential feature, a blade that scrapes the inside of the mixing vessel. High speed whisking action mixers are generally unsuitable.

4.4 Filling moulds. Transfer the material to the moulds immediately after mixing, unless otherwise specified by the manufacturer. If the compound is not free flowing, compact it into the mould so as to fill it completely and minimize voids. A suitable compacting tool is described in **3.2.1**.

NOTE Vibration in itself provides no compaction force. It only agitates the particles of aggregate; the compaction is then effected by gravity. With hydraulic cement mortars and concretes this is very effective, but with most resin bound compositions the cohesion between the resin coated particles is too great to be overcome by gravity within the period of oscillation of a mechanical vibrator. Compaction is better achieved by firm pressure with a flat ended tool, as described in **3.2.1**. Provided this covers only a fraction of the plan area of the mould, it gives the combination of downward disperse pockets of air and achieve optimum compaction. This process of firm ramming should be repeated systemmatically over the layer of compound until no further consolidation is evident.

For free flowing compounds, keep the moulds level during filling and curing. Air should be substantially excluded during filling. If the formation of a meniscus makes it difficult to produce a casting with an upper face flush with the top of the mould, use a loosely fitting glass or metal top plate coated with release agent.

Finish the upper surface of the specimen so that it is smooth and flush with the mould surface. A suitable tool is the palette knife described in **3.2.2**.

4.5 Curing specimens. Maintain the filled moulds in air at 20 ± 1 °C for 7 days unless other conditions are specified. Demoulding can take place at any time during or after cure.

4.6 Demoulding. Take care not to damage the specimen when removing it from the mould. If the specimen is damaged prior to testing, discard it and replace by an intact specimen.

4.7 Weighing. After curing and removal from the mould, and prior to test, weigh the specimens. Record the mass to the nearest 0.1 g for specimens weighing up to 1 kg, to the nearest 1 g for specimens up to 2 kg, and to the nearest 5 g for specimens weighing in excess of 2 kg.

NOTE It is recommended that, as a check that effective compaction has been achieved, the density of the mixed material is determined in accordance with BS 6319-5.

4.8 Conditioning specimens. Maintain specimens in air for at least 16 h before test at 20 ± 1 °C or any other specified conditions which shall be declared. Store the specimens in single layers and on a level surface.

Publications referred to

BS 308, *Engineering drawing practice.*
BS 308-3, *Geometrical tolerancing.*
BS 410, *Specification for test sieves.*
BS 812, *Methods for sampling and testing of mineral aggregates, sand and fillers.*
BS 812-1, *Sampling, size, shape and classification.*
BS 1134, *Method for the assessment of surface texture.*
BS 1134-1, *Method and instrumentation.*
BS 1134-2, *General information and guidance.*
BS 1755, *Glossary of terms used in the plastics industry.*
BS 2787, *Glossary of terms for concrete and reinforced concrete.*
BS 3763, *The International System of units (SI).*
BS 4049, *Glossary of terms applicable to internal plastering, external rendering and floor screeding.*
BS 4550, *Methods of testing cement.*
BS 4550-3, *Physical tests.*
BS 4550-3.4, *Strength test.*
BS 4551, *Methods of testing mortars, screeds and plasters.*
BS 4627, *Glossary of terms relating to types of cements, their properties and components.*
BS 6319, *Testing of resin compositions for use in construction.*
BS 6319-5, *Method for determination of density.*
PD 5686, *The use of SI units.*

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