

British Standard

Testing of resin compositions for use in construction

Part 10. Method for measurement of temperature of deflection under a bending stress

Essais des compositions de résines à utiliser en construction

Partie 10. Méthodes de mesurage de la température de fléchissement sous contrainte de flexion

Prüfung von Kunstharzverbindungen im Bauwesen

Teil 10. Verfahren zur Bestimmung der Formbeständigkeit unter Biegebeanspruchung

Foreword

This Part of BS 6319 has been prepared under the direction of the Civil Engineering and Building Structures Standards Committee. It describes a method for measurement of the temperature of deflection under a bending stress, alternatively known as the heat distortion temperature (HDT), and is one of a series of Parts describing methods for measuring basic physical properties of resin based materials.

This method is derived from methods 121A and 121B of BS 2782 : Methods 121A to 121C : 1976 which have been adapted to the testing of resin compositions used in construction.

The precision of this test method has not been considered in detail because it has been derived from tests which are already established. The method is suitable for quality control and comparative purposes but it does not alone provide sufficient information for direct use in structural design.

This Part of BS 6319 should be read in conjunction with Part 1 which provides general information and describes a method for preparing test specimens.

Compliance with a British Standard does not of itself confer immunity from legal obligations. In particular, attention is drawn to the Health and Safety at Work etc. Act 1974.

1 Scope

This Part of BS 6319 describes a method of measurement for the temperature of deflection under a bending stress (alternatively known as heat distortion temperature) for resin based mortars and concretes cast in the form of rectangular prisms. The method is not applicable for compositions which contain aggregate larger than 1.7 mm (see note to 3.2).

NOTE 1. The effect of temperature on resin compositions is an important but complex subject and interpretation of test data requires care. Several relevant points are discussed in appendices A and B.

NOTE 2. The titles of the publications referred to in this standard are listed on page 3.

2 Principle

The principle of this method is the determination of the temperature, referred to in this standard as the heat distortion temperature (HDT), at which a specified deformation occurs when the test specimen, in the form of a rectangular prism, is subjected to a specified bending stress and conditions of uniform rate of temperature increase.

3 Test specimens

NOTE. A number of standard test methods have been published for the determination of the heat distortion temperature of plastics materials using specimens in the form of rectangular prisms which are subjected to three-point loading. These standards have adopted similar rates of raising the temperature of the specimen (2.0 ± 0.2 °C/min for the heat transfer medium), the same fibre stresses (1.8 MPa, 264 psi and 0.45 MPa, 66 psi) and, for a given specimen depth, the same deformation (0.25 mm for a specimen depth of 12.8 mm to 13.0 mm). However, no standard refers specifically to filled thermosetting resin compositions and, furthermore, for the types of materials which are specified, the recommended specimen dimensions often vary from standard to standard. The present method is derived from methods 121A and 121B of BS 2782 : Methods 121A to 121C : 1976.

3.1 Preparation of specimens

The preparation of specimens, including the conditioning, proportioning and mixing of materials, and the conditioning and filling of moulds shall be in accordance with BS 6319 : Part 1.

3.2 Dimensions of test specimens

Specimen dimensions of 110 mm (minimum) × 12.8 mm × 12.8 mm shall be used for compositions containing aggregate that, when sampled in accordance with BS 812 : Part 1, completely passes through a 1.7 mm BS 410 test sieve (mesh number 10).

NOTE. Although in principle, the specimen size can be increased in order to accommodate larger aggregate, practical difficulties can then arise due to the modifications which have to be made to the test procedure.

3.3 Curing of specimens

Any desired curing regime may be used and shall be declared in the test report. Any conditioning as part of the curing regime shall be declared in the test report.

4 Procedure

Using two specimens, weigh each to the nearest 0.1 g. Use either of the following procedures:

procedure A: the procedure given for method 121A in BS 2782 : Methods 121A to 121C;

procedure B: the procedure given for method 121B in BS 2782 : Methods 121A to 121C.

If only one bending stress is to be utilized use preferably procedure A (maximum fibre stress 1.8 MPa).

Adjust the initial temperature of the heating medium to the curing temperature, or to 20 °C, whichever is the lower.

5 Test report

The following information shall be included in the test report:

- (a) date of sample preparation;
- (b) date of test;
- (c) a complete identification of the material tested including the type, source, manufacturer's code numbers and history, etc.;
- (d) ambient conditions during the preparation of the specimens and the curing regime and conditioning adopted;
- (e) a reference to the procedure used, e.g. 'procedure A of BS 6319 : Part 10';
- (f) the individual test results and the mean heat distortion temperature under the specified bending stress;
- (g) the nature and initial temperature of the heat transfer medium;
- (h) the mass of each specimen to the nearest 0.1 g.

Appendix A. Effect of temperature on resin compositions

In contrast to more familiar construction materials such as concrete, steel and wood, the mechanical properties of many thermosetting resin compositions are particularly sensitive to relatively small temperature variations. The effects of temperature may be observed both in the short term, i.e. in minutes, where changes in elastic properties of the material are revealed and, also, over very much longer periods due to variations in the viscoelastic properties of the resin (creep and stress relaxation phenomena).

Subjecting a fully cured thermosetting resin composition to temperature increases will not lead to visible flow of the bulk resin (an effect which is readily observed with many thermoplastic polymers). Nevertheless, for cross-linked resins such as epoxides, polyesters, and polyurethanes, increases in the temperatures of use or testing will generally reduce the elastic modulus and ultimate strength (the converse effects will result from a decrease in temperature). This variation is often quite marked within the temperature range which the resin compositions would commonly be expected to meet in service, e.g. -10°C to 50°C .

Resin compositions used in construction and repair are generally in intimate contact with a second material, e.g. concrete, steel or wood which normally exhibits a quite different response to temperature variations. Consequently, in addition to considering the influence of temperature changes on the resin, effects on the performance of the composite have also to be taken into account.

The method described in this Part of BS 6319 is concerned solely with the short term softening effects of a temperature increase on the cured resin composition in isolation from any substrate.

Several points concerning the significance of heat distortion temperature (HDT) have to be appreciated. The test conditions and the standard deflection employed in this determination are arbitrary and, in general, will differ from those met in service. Thus, the data is not intended for direct use in design. The measurement of the heat distortion temperature is useful, however in quality control work, in assessing the degree of cure of thermosetting resins, and also in the development of such compositions.

In order to assess the short term performance of resin compositions at elevated temperatures, particularly in structural applications, any determination of the heat distortion temperature should be complemented by information obtained from other appropriate test methods. Use of a suitable combination of test procedures should permit the determination of a temperature limit below which the resin composition will perform satisfactorily in the short term, i.e. rapid, catastrophic failure or unacceptable strain will not occur when a given stress is applied to a heated resin (or heat to a stressed system).

The longer term effects of elevated temperatures on resin compositions may also have to be considered for some applications, particularly those of a structural type. Thus, the upper service temperature limit of a resin composition may be set, for example, not by failure, but by the maximum degree of creep which is permissible. Measurement of the heat distortion temperatures does not enable predictions to be made in this regard.

Appendix B. Degree of cure

Two following points should be appreciated with regard to the cure state of the resin in relation to measurement of the HDT (or other physical properties).

(a) High temperature (40°C to 50°C), particularly if applied for a period of hours, will often induce further reaction (cross-linking) within the bulk of the solid resin. This post-curing effect will in general increase the HDT as well as the modulus and ultimate strength of the resin.

(b) Resin compositions mixed and maintained at low temperatures (10°C and below) may be incompletely cured yet, if tested at that low temperature, may appear to have satisfactory modulus and strength. If these same specimens are conditioned briefly and tested at the normal laboratory ambient of 20°C much lower figures may result, indicating inadequate cure. HDT measurements provide a better means of indicating the state of cure of a resin composition. Incomplete cure will be clearly indicated by a low HDT result relative to a fully cured specimen.

Publications referred to

BS 410	Specification for test sieves
BS 812	Testing aggregates Part 1 Methods for determination of particle size and shape
BS 2782	Methods of testing plastics *Method 121A Determination of temperature of deflection under a bending stress of 1.8 MPa of plastics and ebonite *Method 121B Determination of temperature of deflection under a bending stress of 0.45 MPa of plastics and ebonite
BS 6319	Testing of resin compositions for use in construction Part 1 Method for preparation of test specimens

*Included in one publication BS 2782 : Methods 121A to 121C.

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The following BSI references relate to the work on this standard:
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Committees responsible for this British Standard

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- British Adhesives and Sealants Association
- British Plastics Federation
- Concrete Society
- Construction Industry Research and Information Association

- County Surveyors' Society
- Department of the Environment (Building Research Establishment)
- Department of Transport (Highways)
- Federation of Epoxy Resin Formulators and Applicators Ltd.
- Institution of Civil Engineers
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