

Testing of resin compositions for use in construction —

Part 4: Method for measurement of bond strength (slant shear method)

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- British Adhesive Manufacturers Association
- British Plastics Federation
- Cement and Concrete Association
- Concrete Society
- Construction Industry Research and Information Association
- County Surveyors' Society
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Property Services Agency)
- Department of the Environment (Transport and Road Research Laboratory)
- Federation of Resin Formulators and Applicators Ltd.
- Institution of Civil Engineers
- Institution of Highway Engineers
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Foreword

This Part of this British Standard has been prepared under the direction of the Civil Engineering and Building Structures Standards Committee. This Part describes a method for measurement of bond strength and is one of a series of Parts describing methods for measuring basic physical properties of resin based materials.

The compressive testing of concrete prisms having bonded scarf joints is a well established procedure for assessing bond strength. It has been used in one form or another over the past twenty years to assess such features as bonds in segmental construction and repairs. It has been variously referred to as a composite cylinder test, a combined compression and shear test and a slant shear test. The last of these terms has gained acceptance and has been adopted in this standard.

The use of this form of test does not seem to have become widespread, although a form of slant shear test using cylindrical specimens (the Arizona test) was published by the ASTM¹⁾ in 1978. In that instance the test was designed to measure the strength of the bond between two separately cast specimens and was of very limited use for the evaluation of crack injection systems. Like the other methods current at the time there were also other deficiencies, not least being the difficulty of casting specimens with two faces coming to a 30° angle.

This method of test is a further development of the earlier methods and has overcome the deficiencies previously apparent, allowing a better simulation of the situations in which resin compositions are used. Of particular importance is that it can be successfully used to evaluate crack repair materials and techniques. The committee acknowledges with gratitude the assistance given by Mr L Tabor during the preparation of this standard. It is anticipated that as a result of the publication of this method of test and as subsequent experience in its use is gained, knowledge of the behaviour of these materials and the ability to interpret the test results obtained will both increase.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, 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.

¹⁾ American Society for Testing and Materials. *Bond strength of epoxy-resin systems used with concrete*. ASTM C882-78.

0 Introduction

Most uses of resin compositions involve their application to hydraulic cement concrete and require the development of a strong adhesive bond between these two materials. The purpose of this test is to investigate the strength of that bond.

If the bond is loaded in compression little information will be obtained, since the only failure likely to occur as a direct result of the compressive stress would be compressive failure of one or other material. Prior failure of the bond line could only be an indirect effect resulting from shear stresses due to differences in the elastic responses of the two materials.

In most cases, if the bond is loaded in tension the result is a tensile failure of the hydraulic cement concrete, a mode in which this material is known to be weak. Hence, "pull-off" tests tend to be of little value since they most often measure only the tensile strength of the concrete, not of the bond.

When hydraulic cement concrete members are required to accommodate a tensile force, this is always achieved by the introduction of a tensile reinforcement, most commonly steel. The high tensile strength of the reinforcement is mobilized by way of shear stresses in the concrete. Shear stresses are also generated as a result of elastic response when concrete is loaded in compression. Thus it would appear that the shear properties of the adhesive bond are the most worthy of investigation if an indication of its useful strength is required.

The generation of pure shear stresses in the bond line between hydraulic cement concrete and a resin composition requires an elaborate set-up if turning moments and tensile stresses are to be avoided. A simpler approach is to apply a compressive load to a specimen taking the form of a composite prism with a bond line running diagonally through it. This method of investigation of the strength of an adhesive bond is known as a diagonal or slant shear bond test. It subjects the bond to a combination of shear and compressive stresses, the type of regime most likely to be encountered in concrete structures. The ratio of shear to compressive stress increases as the angle between the bond line and the vertical axis is reduced. An angle of 30° has been found to be the shallowest practicable angle at which a joint can be formed in a prism of modest dimensions.

The prism may be of hydraulic cement concrete with the resin composition forming a scarf joint between the two halves, or half the prism may be of hydraulic cement concrete and the other half of resin mortar or resin concrete, the interface forming the scarf joint.

Failure of the joint (at a stress of, say, $x \text{ N/mm}^2$) before concrete failure occurs could be taken as an indication that the jointing composition and procedure employed would only give monolithic failure of a composite prism if the hydraulic cement concrete was of compressive strength $x \text{ N/mm}^2$. To confirm this, or for any other declared reason, the test may be performed with a hydraulic cement concrete mix of any declared design.

The bond may be formed in a variety of ways to correspond to the variety of applications and circumstances for which resin compositions are used. These include the resin injection of cracks (for which a cracked or split test piece is required) and repair techniques using either resin based or hydraulic cement based mortars or concretes. To obviate the difficulties of compacting concretes or mortars into a 30° angle (or of producing a split running out of the concrete at such an acute angle) the test piece is a prism sawn from a larger plaque (see Figure 2). Thus any areas of difficulty are confined to the discarded pieces.

The slant shear bond test may be used not only to appraise the bond strength of materials but also to investigate the effect of concrete pre-treatments (e.g. acid etching) upon the bond strength.

Appendices describe the preparation of composite test plaques representing the more typical constructions in which resin compositions are used. The principle of the test may be adopted for various other composite constructions, provided that full details are given in the test report. Similarly, the resin system may be applied, for instance, to damp hydraulic cement concrete, or be applied underwater, to investigate the effect of environmental conditions upon bond strength.

Where the purpose of testing is to provide basic data with which to compare the performance of resin compositions from different sources, it is recommended that these data are determined from tests using plaques made from the high-strength concrete mix described in 5.1.1. It is important that the compressive strength of the concrete mix used is quoted against the slant shear bond strength of the resin composite. The compressive strength of the mortar or concrete used to prepare a built-up specimen should also be quoted.