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Determination of strength for reinforcement yarn in cement

增强纱线在水泥中强度的测定

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1 Scope

This document specifies the principle, the test environment, the materials and equipment, the specimens, the operating procedure, the calculation of results and the test report for the determination of the strength of reinforcement yarn in cement.

This document applies to the evaluation of the alkali resistance of reinforcement yarns such as alkali-resistant glass fibre yarn, basalt fibre yarn and carbon fibre yarn, and also to the evaluation of the resistance of new reinforcement yarn systems to alkali attack and of the alkali attack of new cement systems. Other reinforcement yarns may be tested with reference to this document.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through the normative references made to them in the text. For dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB 175-2023 Common portland cement

GB/T 1446-2005 General rules for test methods of properties of fibre-reinforced plastics

GB/T 6682-2008 Water for analytical laboratory use - Specification and test methods

GB/T 7690.1 Reinforcement materials - Test methods for yarns - Part 1: Determination of linear density

GB/T 17671-2021 Test method of cement mortar strength (ISO method)

GB/T 18374 Terminology for reinforcement materials

GB/T 30019 Carbon fibre - Determination of density

GB/T 41063 Glass fibre - Determination of density

3 Terms and definitions

The terms and definitions defined in GB/T 18374 apply to this document.

4 Principle

The reinforcement yarn is embedded in cement mortar to make a specimen of a particular form; the cement mortar is cured so that it hardens, and ageing treatment is then carried out under set conditions. The alkalinity of the cement causes alkaline corrosion of the reinforcement yarn and lowers its strength; by determining the tensile strength of the reinforcement yarn after ageing treatment, the alkali resistance of the reinforcement yarn, or the alkaline attack of the cement system on the reinforcement yarn, is evaluated.

5 Test environment

Specimen preparation and testing are to be carried out under laboratory conditions of a temperature of 23 °C plus or minus 2 °C and a relative humidity of 50 % plus or minus 10 %.

6 Materials and equipment

6.1 Materials. 6.1.1 Cement, conforming to the requirements for grade P.O 42.5 in GB 175-2023. 6.1.2 Standard sand, conforming to the requirements for Chinese ISO standard sand in GB/T 17671-2021. 6.1.3 Water, conforming to the requirements for grade three water in GB/T 6682-2008. 6.1.4 Epoxy resin, with a viscosity below 0.2 Pa.s under laboratory conditions. 6.1.5 Silicone sealant, commercially available.

6.2 Equipment. 6.2.1 Specimen preparation mould, made of 304 stainless steel, of the construction shown in Figure 1. 6.2.2 Electronic balance, with a maximum capacity of not less than 300 g and a scale interval of not more than 0.1 g. 6.2.3 Curing cabinet, conforming to GB/T 17671. 6.2.4 Constant temperature water bath, with a temperature control range from room temperature to 80 °C and a permissible temperature deviation of plus or minus 1 °C. 6.2.5 Tensile testing machine, fitted with tensile grips having rubber liners, the relative error of the load not exceeding plus or minus 1 %. 6.2.6 Cement trowel.

The key to Figure 1, the schematic diagram of the specimen preparation mould, is: 1 mould frame; 2 base; 3 stainless steel stop block; 4 gauge length marking line; 5 spacer block; 6

yarn winding terminal; 7 groove in the mould base; 8 top plate; 9 bottom plate; 10 top plate; 11 bottom plate; 12 plywood base; 13 frame.

7 Specimens

7.1 Shape and dimensions of the specimen. The shape and dimensions of the specimen are shown in Figure 2; the total length of the specimen is about 180 mm and the dimensions of the cement block are 30 mm by 10 mm by 10 mm. The part more than 30 mm away from the cement block is the gripping portion.

The key to Figure 2, the schematic diagram of the specimen, is: 1 the resin-impregnated length of yarn; 2 the silicone sealant; 3 the cement block, of length L equal to 30 mm, width W equal to 10 mm and thickness H equal to 10 mm; 4 the length of bare yarn, 20 mm; 5 the distance from the gripping length to the end of the cement block, 30 mm; 6 the gripped end, of length not less than 45 mm.

7.2 Number of specimens. 7.2.1 Each set is to contain not fewer than 10 specimens. 7.2.2 For the evaluation of the alkali resistance of a reinforcement yarn, one set of specimens is required. 7.2.3 For the evaluation of the alkali resistance of a new reinforcement yarn system or of a new cement system, four sets of specimens are required.

8 Operating procedure

8.1 Specimen preparation. 8.1.1 Yarn free of visible damage in appearance is taken. The yarn is wound on the yarn winding terminals of the specimen preparation mould, care being taken that the yarn remains taut throughout specimen preparation. 8.1.2 A 20 mm length of bare yarn is left in the middle part of the yarn and the remaining part is coated with epoxy resin and cured. 8.1.3 Silicone sealant is applied over a length of about 5 mm on the epoxy-coated specimen immediately adjacent to the two ends of the bare length. The silicone sealant is not to be applied onto the bare yarn. 8.1.4 According to the quantity of specimens to be made, cement mortar in the prescribed proportion is weighed out on the electronic balance, the prescribed mass mixing ratio of the cement mortar being cement to standard sand to water equal to 75 to 25 to 32; after thorough mixing and stirring it is poured into the specimen preparation mould. The mould is vibrated and the surface is struck off with the cement trowel, so that the mould cavity is filled completely and evenly. 8.1.5 Curing is carried out for 24 h in a curing cabinet at a temperature of 20 °C plus or minus 2 °C and a relative humidity of 90 % to 100 %, and the specimens cured in the mould cavity are demoulded.

8.2 Accelerated ageing treatment. 8.2.1 The prepared specimens are immersed in a constant temperature water bath at 80 °C plus or minus 1 °C for ageing treatment; the ageing times are: - for the evaluation of the alkali resistance of a reinforcement yarn, one set of specimens is required, immersed for 96 h; - for the evaluation of the resistance of a

new reinforcement yarn system to alkali attack, or of the alkaline attack of a new cement system, four sets of specimens are required, immersed respectively for 24 h, 36 h, 64 h and 96 h. 8.2.2 The aged specimens are immersed for 15 min in water at 20 °C plus or minus 2 °C and then taken out and placed in a tray lined with absorbent paper; the excess water is blotted off, a damp cloth is laid over them, and the tensile strength test is carried out at once.

8.3 Tensile strength test. 8.3.1 The gripped ends of the specimen are clamped in the grips of the tensile testing machine, the rate of extension is set at 1 mm per minute, the specimen is loaded to failure, and the maximum load is recorded in newtons (N) as a whole number. 8.3.2 Failure of the specimen is to occur inside the cement block; where failure occurs outside the cement block the specimen is discarded. If more than two of the ten specimens fail outside the cement block, the cause is to be analysed and specimens are to be made and tested again.

9 Calculation of results

9.1 The tensile strength of each specimen is calculated by formula (1). In the formula, the symbol σ is the tensile strength, expressed in megapascals (MPa); F is the maximum load, expressed in newtons (N); T is the linear density of the reinforcement yarn determined as specified in GB/T 7690.1, expressed in grams per metre; and the symbol ρ is the density of the reinforcement yarn determined as specified in GB/T 41063 or GB/T 30019, expressed in grams per cubic centimetre. The formula itself is corrupted in the source text and is not reproduced here.

9.2 The arithmetic mean, the standard deviation and the coefficient of dispersion of the test results are calculated as specified in Clause 6 of GB/T 1446-2005.

9.3 Where the coefficient of variation of the tensile strength exceeds 14 %, specimens are to be made and tested again.

9.4 Where the test is used to evaluate a new reinforcement yarn or a new cement system, the four sets of specimens aged for 24 h, 36 h, 64 h and 96 h are determined separately, and a tensile strength against ageing time curve is plotted with tensile strength on the ordinate and ageing time on the abscissa.

10 Test report

The test report is to include the following: a) a statement that the test was carried out in accordance with this document; b) the necessary information on the sample tested; c) the ageing conditions; d) the number of specimens; e) the test results, giving the mean value and, where required, the individual values; f) the test date; g) any other detail or factor that may have affected the test results.