Sample preparation for testing of concrete crack repair resins

There are various repair techniques for cracked concrete – repair mortars, concretes and resins, and sprayed concrete.

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Of the repair technique options, low-viscosity non-shrink epoxy resins are a commonly applied method. Low-viscosity grades are used for flowing into thin cracks and this method can be used for repairing fine and hairline cracks in concrete floors, walls, panels, columns and other concrete features, as well as masonry and brickwork. The technique can be used on horizontal, vertical and overhead surfaces to fill cracks and eliminate further water penetration. Examples of the types of cracks that can be filled are shown in Figure 1.

The resins are usually gun-applied through a plastic hose and flange at the surface of the crack, with the epoxy resin flowing into and filling the crack.

In order to specify the correct grade of resin, a number of parameters are used, including bond strength, coefficient of thermal expansion and flexural strength. In terms of the strength of the cured resin, the following parameters are used: compressive strength, tensile strength and splitting strength.

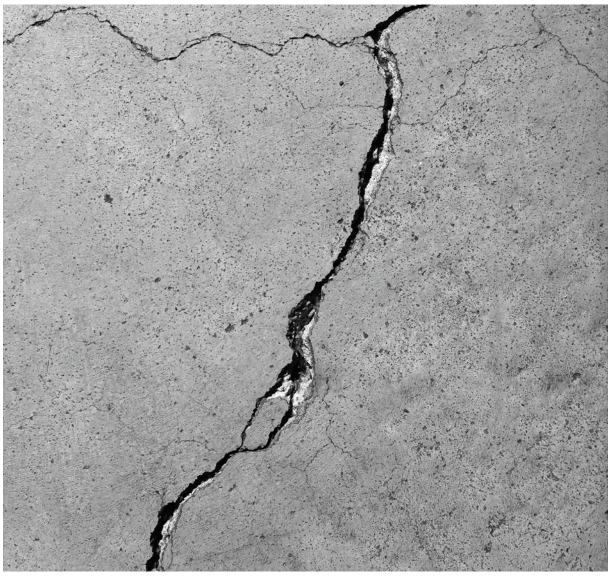

Figure 1: Diagonal cracks in concrete floor.

Figure 2: Pressure vessel – central metal container restrained in place and the pressure lid with attached rising tube.

In order to conduct strength testing, cylindrical test samples are produced and subsequently tested for the various types of strength. The method of sample preparation is a critical factor as it requires the injection process to be replicated but must also be representative of the amalgamated final product (resin and existing concrete).

A sample preparation method in compliance with BS EN 1771[1] using the sand column test is therefore applicable; this provides consistent samples required for testing.

The principle of the test consists of injecting, under a constant pressure, the product in a transparent plastic (polymethylmethacrylate) tube (column) filled with graded sand and held in a vertical position. The column is injected from its lower end, with the time taken by the product to attain different reference marks along the tube recorded.

The process of test sample production therefore requires a test column to be filled with graded sand, which will then have the test resin injected into it under pressure. The graded sand is required to conform to BS EN 196-1[2] and the required mass of sand is weighed out using a balance accurate to within 0.1g.

The graded sand is screened using 0.63mm, 0.80mm, 1.00mm and 1.25mm sieves, manufactured to BS ISO 3310-1[3]. The following proportions of required sand are required:

- sand between 1.25 and 1.00mm (large grain) = 37%
- sand between 1.00 and 0.80mm (medium grain) = 30%
- sand between 0.80 and 0.63mm (small grain) = 33%.

Screening is conducted using a sieve shaker, with separate piles of large grain, medium grain and small grain being produced. The quantities are weighed out on the balance and then thoroughly mixed together to produce the amount required to fill the test column.

Sand is compacted into the test column by adding sand to one third of the height of the tube and applying 50 lateral shocks evenly distributed over the height of the layer while rotating the injection column. Likewise, this is then conducted for the second third and then the final third.

The test column containing the sand is then filled with resin under pressurised conditions, replicating the way that resin may enter a crack. This is achieved by mixing the resin and hardener as required and placing the mixture into a container that sits inside a pressure vessel (Figure 2). The pressure vessel is then sealed and the sand-containing tube is positioned in such a way that the resin will flow under pressure into the base of the tube (Figure 3).

Air is supplied to the pressure vessel from the left line (on Figure 3) and a pressure gauge measures the air pressure supplied. The air supply is turned on and the regulator is set at 0.075MPa. The valve on the outlet of the pressure vessel is then opened and the resin mixture flows into the base of the test column (Figure 4).

For additional product information, flow rates can be

Figure 3: Test set-up.

Figure 4: Column test (damp) showing sample progressing through the column.

measured by recording the time taken for the mixture to reach the 50, 100, 150, 200, 250, 300 and 350mm levels. Resin injection continues until 20ml excess is collected in the measuring vessel on the outlet of the test column. At this point, the pressure is vented from the pressure vessel and the copper ends of the inlet and outlet are crimped to prevent the resin escaping.

Following the required curing period, the samples are removed from the test column and the test samples are produced (Figure 5). The samples would then be ready for compressive, tensile and splitting strength testing. ■

References:
1. BRITISH STANDARDS INSTITUTION, BS EN 1771. *Products and systems for the protection and repair of concrete structures. Test methods. Determination of injectability and splitting test*. BSI, London, 2004.
2. BRITISH STANDARDS INSTITUTION BS EN 196-1. *Methods of testing cement. Determination of strength*. BSI, London, 2016
3. BRITISH STANDARDS INSTITUTION, BS ISO 3310-1. *Test sieves. Technical requirements and testing. Test sieves of metal wire cloth*. BSI, London, 2016.

Figure 5: Six cylindrical samples from two test columns.