



Over the coming months we will be publishing a series of technical notes covering aspects of glass-fibre-reinforced concrete (GRC) technology.

The Glassfibre Reinforced Concrete Association (GRCA) is a Special Sector Group of The Concrete Society.

GRC Standards and testing

Glass-fibre-reinforced concrete (GRC) is a composite material consisting of a mortar of cement and fine aggregate reinforced with alkali-resistant glass fibres. GRC is normally of relatively thin cross-section, typically 12mm thickness depending on application, and as such the tests carried out to measure performance and ensure consistent quality differ from those of precast concrete. Whereas precast concrete is usually characterised by compression strength measured in cube tests, the properties of GRC are measured by flexural strength testing of thin samples, where the performance imparted by the fibre reinforcement is evident.

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From its inception, the GRC industry has endeavoured to promote a culture of quality control and routine testing. A series of wet- and dry-state tests have been developed and used for a long period. Routine strength testing of hardened GRC is based around the flexural testing of samples (coupons) cut from test boards. The Glassfibre Reinforced Concrete Association (GRCA) has issued various publications and also administers an Approved Manufacturers Scheme. More recently, European Standards have been issued covering the main test methods. These are summarised below:

Current British/European Standards relating to GRC

- BS EN 1169⁽¹⁾
- BS EN 1170⁽²⁾
- DD ENV 1170⁽³⁾
- BS EN 14649⁽⁴⁾
- EN 15422⁽⁵⁾

Current American Standards relating to GRC (GFRC)

- ASTM Technical Committee C27.40 – Glass Fiber Reinforced Concrete Made by the Spray-Up Process:
 - C947-03⁽⁶⁾
 - C948-81⁽⁷⁾
 - C1228-96⁽⁸⁾
 - C1229-94⁽⁹⁾
 - C1230-96⁽¹⁰⁾
 - C1560-03⁽¹¹⁾

The generation of new Standards is inevitably a relatively slow process and work is ongoing. In Europe, committee TC229/WG3/TG2 is tasked with work on GRC material and, in addition to the above, further Standards are currently in preparation, including prEN 15191⁽¹²⁾ and a separate Design Standard.

The flexural testing of GRC coupons, which relates to standard BS EN 1170-5⁽¹⁾, is illustrated in the photographs. A proprietary testing machine (Figure 1) may

be used, with the sample or coupon of GRC, typically 50mm wide by 10mm thick and span of 250mm, held in a special four-point bending jig (Figure 2).

As load is applied, deflection is also recorded such that a load-deflection curve of the behaviour is produced. Figure 3 shows the form of the curves for different grades of GRC material.

By analysis of the test, normally now assisted by suitable software, together with measurement (Figure 4) of the exact dimensions of the sample, the elastic limit (Limit of Proportionality or LOP) and ultimate bending strength (Modulus of Rupture or MOR) are found. Additionally, Young's modulus for the initial elastic region of behaviour can be determined and also the strain to failure.



Figure 1 above: Testing machine.



Figure 2 top right: GRC coupon in 4-point test jig.

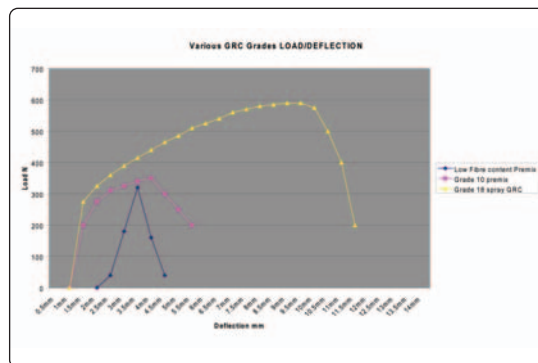


Figure 3 centre right: Typical load-deflection curves for GRC in flexural tests.



Figure 4 bottom right: Measurement of coupon dimensions.

Concluding remarks

These tests provide the background to specifying GRC products correctly. Guidance on specification values can be found in a GRCA/Concrete Society publication *Specification for the manufacture, curing and testing of GRC products*⁽¹³⁾. For sprayed GRC, typical specification requirements are a characteristic MOR value of 18MPa

and LOP value of 7MPa. By long experience these levels are consistent with good-quality material and in turn allow design calculations to be performed with confidence. ■

Further information

Visit: www.grca.co.uk or e-mail: info@grca.co.uk

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