

GRC Standards and testing

Glassfibre reinforced concrete (GRC or GFRC) 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 down to 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.

NEIL SPARROW
DIRECTOR, GRCA

From its inception, the GRC industry has endeavoured to promote a culture of quality control and routine testing. A series of standards and wet- and dry-state tests, have been developed and have now been in use for a long period.

One of the most important of these tests is the flexural strength test, also known as the 'bending test' or 'MOR/LOP test'. This is an essential test for GRC products which should be carried out at an agreed frequency. The International Glassfibre Reinforced Concrete Association (GRCA) recommends that as a minimum the flexural strength testing shall be carried out weekly for poured GRC and twice weekly for sprayed GRC, but tests are often carried out more frequently. These tests are ideally carried out on coupons cut from the GRC components themselves but where this is not practical it is normally acceptable on coupons of GRC cut from test boards, using specially developed test equipment to determine the limit of proportionality (LOP) and modulus of rupture (MOR) values.

The International Glassfibre Reinforced Concrete Association (GRCA) has produced and issued various technical documents, including the GRCA 'Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products' (1) and GRCA 'Methods of Testing Glassfibre Reinforced Concrete (GRC)' (2), which are all freely available. Additionally, the GRCA operates a GRC manufacturing Full Member scheme whereby

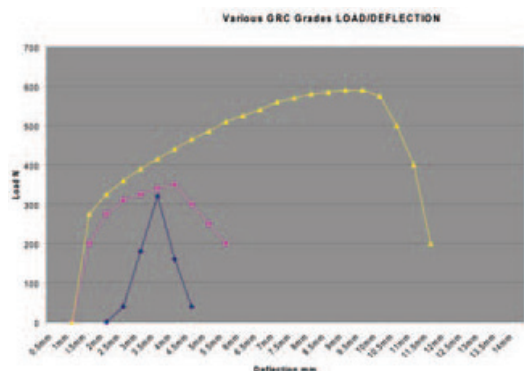


Figure 1 Above:
Testing machine.

Figure 2 Left:
Typical load-deflection curves for GRC in flexural tests.



This is the second techNOTE in a series of technical notes covering aspects of glassfibre reinforced concrete (GRC/GFRC) technology.



participating companies have shown to the Association they have the procedures, plant and equipment necessary to comply with the specific Requirements of this grade of GRCA membership.

All GRCA Members have to comply with the Association's 'Specification' (1) and 'Methods of Testing' (2) as a condition of membership and more recently, worldwide Standards have been issued covering the main test methods. These are summarised below.

Current British/European Standards relating to GRC:

- BS EN 1169 (3)
- BS EN 1170 (4)
- BS EN 14649 (5)
- BS EN 15191 (6)
- BS EN 15422 (7)



Figure 3 Left: Measurement of coupon dimensions.

Figure 4 Right: GRC coupon in 4-point test jig.

Current American Standards relating to GRC (GFRC),

Produced by the ASTM sub-committee C27.40 – Glass Fiber Reinforced Concrete:

- C947-03 (8)
- C1228-96 (10)
- C1230-96 (12)
- C948-81 (9)
- C1229-94 (11)
- C1560-03 (13)

The flexural testing of GRC coupons, which relates to the GRCA 'Methods of Testing Glassfibre Reinforced Concrete (GRC)' (2) and standard BS EN 1170-5 (4), 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 3). As load is applied, deflection is also recorded such that a load-deflection curve of the behaviour is produced.

Figure 2 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.

Concluding remarks:

These standards and test methods provide the background to specifying GRC products correctly. Guidance on specification values can be found in the GRCA 'Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products' (1) and on test methods in the GRCA 'Methods of Testing Glassfibre Reinforced Concrete (GRC)' (2). For sprayed GRC, typical specification requirements are a characteristic MOR value of 18 MPa and characteristic LOP value of 7 MPa, and for poured GRC, typical specification requirements are MOR values of either 10 MPa or 8 MPa with corresponding LOP values of 6 MPa and 5 MPa respectively. By long experience these levels have been determined to be consistent with good-quality material and manufacture, and in turn allow design calculations to be performed with confidence.

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