

Right and far right: Use of GRC for architectural purposes.

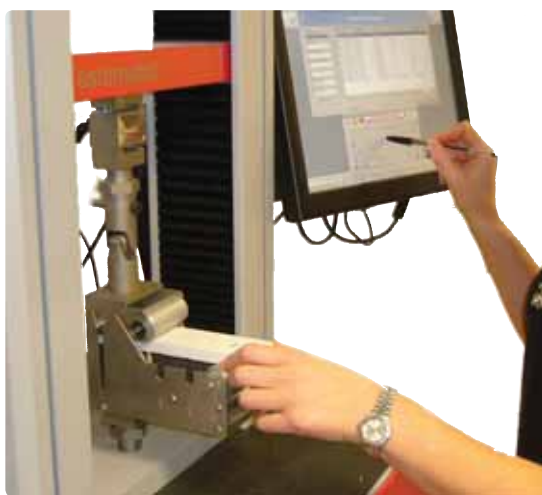
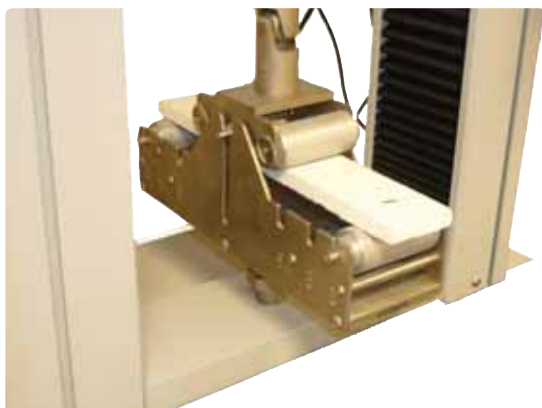


■ This is the eighth in a series of technical notes covering aspects of glass-fibre-reinforced concrete (GRC) technology.

The Glassfibre Reinforced Concrete Association is part of The Concrete Society.

Specifying GRC

Glass-fibre-reinforced concrete (GRC) is a versatile material, which is used on some of the world's largest and most prestigious building projects and is gaining popularity with architects, contractors and house builders as a lightweight and durable alternative to more traditional architectural cast stone dressings. It is, however, vital that the specifier or user understands the need to specify the GRC correctly and be assured that the product will be manufactured to best standards. **Ian Morrison**, GRC technical advisor at **The Concrete Society**, reports.



Above: Some examples of GRC flexural testing.

It is important that GRC components are correctly designed and manufactured for their intended purpose with appropriate quality control procedures in place. GRC is a cement-based composite reinforced with special alkali-resistant glass fibres, which are blended throughout the concrete matrix. The resulting material has highly usable tensile, flexural and impact-resisting properties, the precise level being a function of mix design and, most importantly, glass-fibre content.

Whereas traditional concrete is classified by its compressive strength, GRC is classified by reference to its characteristic flexural strength (termed in the industry as modulus of rupture or MOR). For convenience of specification, GRC is graded into three categories, Grade 8, Grade 10 and Grade 18, each grade representing numerically the characteristic MOR value in MPa. Correct GRC manufacture requires that a regular testing regime is operated to measure and record MOR values (and other parameters) on a continuous basis.

Knowledge exists for GRC to be manufactured in accordance with the best practices developed in Europe, America, Asia and Australasia over the last 40 years. *The Specification for the manufacture, curing and testing of GRC products⁽¹⁾* is an important reference for ensuring good-quality GRC. This is consistent with, and refers to, national Standards BS EN 1169⁽²⁾ and BS EN 1170:1998 Parts 1–7⁽³⁾. A copy of the specification may be downloaded from the websites of the GRCA (www.grca.org.uk/technical/downloads.asp).

Standard BS EN 1170 Parts 1–7 contain a series of test methods for GRC covering various stages of production from manufacturing control of the wet product through to strength assessment of the cured material, the latter being most important in the design and specification of GRC items. The significant test methods are:

- BS EN 1170-1: The 'slump test' is carried out daily to ensure the consistency of the matrix.
- BS EN 1170-2: The 'bag and bucket test' is again carried out daily on Grade 18 material to ensure the correct calibration of the delivery ratio of slurry and fibre.



- BS EN 1170-3: The 'wash out test' is a daily test to verify fibre content on Grade 18 material.
- BS EN 1170-4/5: The 'bending tests' are essential tests which should be carried out at agreed frequency, normally daily. These tests are carried out on coupons of GRC cut from test boards using specially developed test equipment to determine the limit of proportionality (LOP) and MOR values.
- BS EN 1170-6: While not considered as critical as those above, tests for density and water absorption may be carried out on a monthly basis.

To ensure satisfactory in-service performance products must be designed to provide adequate strength and appropriate fixing. Information from regular test results of a manufacturer, notably the LOP/MOR data, is essential in validating the values used in design. Engineering design competence, either in-house by the GRC supplier or subcontractor, is essential. This is particularly important for the larger cladding panels, which may be formed in GRC, or built-in items such as heads and band courses.

When selecting a GRC product the specifier or user should therefore be satisfied that:

- an appropriate specification is to be followed
- design will be carried out in a competent manner
- the grade of GRC used is consistent with the design
- the GRC manufacturer has the necessary manufacturing capability, ensured by a visit to the factory, and can carry out the required testing in-house or via a third party
- there is a history of successful work, if possible confirmed by visiting completed projects.

GRC is an excellent material and can be made in many different forms and formulations. It is nevertheless important to distinguish between correctly formulated and produced GRC and a material purporting to be GRC, which is little more than mortar with a small amount of added fibre. Consideration of the factors above will assist in this understanding. GRC manufacturers who are members of the Glass Reinforced Concrete Association will be conversant with requirements and have access to advice and documentation. Additionally, the GRCA operates an Approved Manufacturers Scheme whereby participating companies have shown to the Association they have the procedures, plant and equipment to comply with the required specifications and standards. For further details about the GRCA and its Approved Manufacturers Scheme please visit: www.grca.org.uk. ●

References

1. INTERNATIONAL GLASS REINFORCED CONCRETE ASSOCIATION. *Specification for the manufacture, curing and testing of GRC products*. The Concrete Society, Camberley, Third Edition, March 2010.
2. BRITISH STANDARDS INSTITUTION, BS EN 1169. *Precast concrete products. General rules for factory production control of glass-fibre reinforced cement*. BSI, London, 1999.
3. BRITISH STANDARDS INSTITUTION, BS EN 1170. *Precast concrete products. Test method for glass-fibre reinforced cement. Part 1 – Measuring the consistency of the matrix. 'Slump test' method. Part 2 – Measuring the fibre content in fresh GRC, 'Wash out test'. Part 3 – Measuring the fibre content of sprayed GRC. Part 4 – Measuring bending strength. 'Simplified bending test' method. Part 5 – Measuring bending strength, 'complete bending test' method. Part 6 – Determination of the absorption of water by immersion and determination of the dry density. Part 7 – Measurement of extremes of dimensional variations due to moisture content. Part 8 – Cyclic weathering type test*. BSI, London, 1998.

Clockwise from top left: International use of GRC including: Marriott Hotel in Istanbul; Uphill Court in Istanbul; for cladding purposes in Spain; and Emirates Palace Hotel, Abu Dhabi.