This series of Technical Notes covers issues which manufacturers, users and specifiers may wish to consider in their approach to the application of manufactured GRC elements for façade cladding

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GRC TECHNICAL NOTE 1

GRC FACING/BACKING COAT COMPATIBILITY

Background

Most GRC manufactured for use as large scale architectural cladding panels will be made using the Spray Process as defined in the GRCA Specification[1] BS EN 1169[2] and BS EN 15191[3]. This process involves the cementitious matrix being combined at the point of delivery with Alkali Resistant glass fibres which provide ductility to what would otherwise be a brittle material.

The typical fibre reinforcement used in the process would be a 25-32mm long strands typically constituting 5% of the material weight. This volume of the lightweight fibres in the mix would create an unacceptable aesthetic finish and therefore best practice is to apply either a “mist coat” or a “facing coat” prior to the build-up of the structural GRC layers.

A mist coat is simply the matrix without any of the glass fibre reinforcement and is applied to a depth of 1-2mm to the face of the mould. This will clearly have very similar properties to the GRC and provide a finish which is similar to Portland stone after surface treatment such as acid washing, grit blasting or removal of surface retardants.

More popular with specifiers however is to feature a mixture of exposed aggregates such as quartz, granite, dolomite, mica etc. to give a more unique finish to the GRC. This is again sprayed onto to the mould surface, generally to a thickness of +1mm above the largest aggregate size. This is known as a facing coat which may well have different properties to the GRC mix.

Most GRC mixes feature a high cement content (typically 50% of the dry mix) and therefore have a relatively high volumetric and thermal movement during its in-service life. After production there will be an initial shrinkage from the as cast dimensions. This is known as the irreversible movement. Subsequent wetting will cause a counter expansion but not significant enough to restore the manufactured unit to the original size. There will then be a constant reversible movement as the element is subjected to both wet and dry environmental conditions.

Typical GRC Mix – Spray Process

Application of Facing Coat using hopper gun

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Visual Architectural Finish

It is essential that during the development of any facing coat consideration is given to any differential thermal or volumetric movement between the GRC mix and the facing coat.

Any excessive movement between the layers can cause crazing or in worse case situations cracking and/or delamination as well as panel bowing

Compatibility Test Methods

Given the above good practice would always be to carry out proof testing of any GRC/Facing mix compatibility to avoid any issues arising over the lifetime of the installed product.

The current BS EN test 1170-7:1998 [4] does provide a test method for determining such differential movement. This test however is seldom carried out due to the complexity of the equipment required creating a situation where many combinations of architectural finish and GRC may have different movement properties.

The test however can be simplified by minor modifications which should not affect the overall outcome and validity of the test.

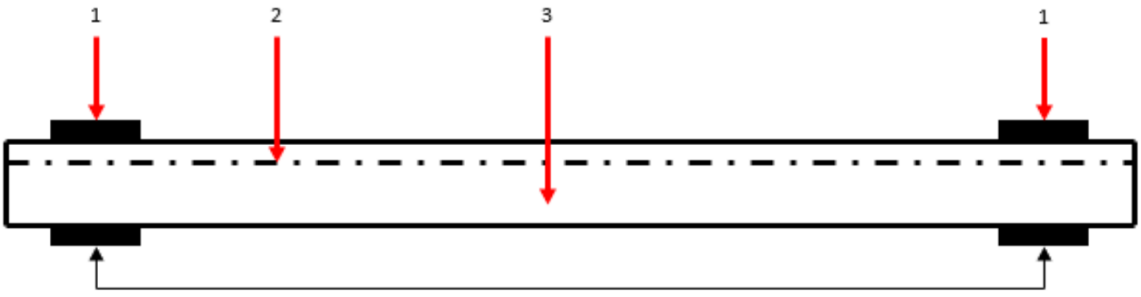
The basic test principle is to manufacture a test board from which two sets of specimens are cut. The first set are placed into an oven set at 33ºC for 21 days. By taking an accurate measurement both before and after the from the front (facing) and rear (GRC) any differential residual shrinkage can be compared.

The second set is likewise measured but placed into a water bath set at 20ºC for 96 hours. Before and after measurements can then be taken of facing and backing as shown in Figure 1

The modifications to the test method are the replacement of the extensometers specified with a more commercially available measuring device such as laboratory callipers, height measuring gauges or DEMEC gauges.

Whichever measuring device is used pre-drilled stainless-steel discs should be bonded to both sides of the specimen as shown in Figure 1 below.

Such minor modifications should not affect the outcome of the test and should be validated in accordance with ISO 17025:2017 Section 7.2.2.1 Note 2 b)[5]



Maximum Distance between drilled centre holes = maximum gauge length – 10mm

1 = Stainless steel discs with centre drilled hole bonded to opposite sides of specimen

2= Facing layer

3 = Backing Layers

Figure 1

An alternative method is based on PCI MNL 130-09 Division 5-40 [6]

Two GRC flat panels are manufactured 3048mm x 610mm x 15mm. One is produced from the GRC mix only and one as a composite with 3mm facing mix and 12mm backing mix. The panels should be produced at the same time to ensure a compatible curing environment.

After 24 hours the elements should be de-moulded after turning the moulds into a landscape orientation thus ensuring no demoulding stress create any bowing

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Both panels should then be placed on edge into a suitable rack allowing them to stand on the long edge and unrestrained at any point. After 14 days curing the panels should be measured.

Evaluating Test Results

The specifying authority would need to determine what is an acceptable level of differential movement between the facing and backing layers. Historically variations of more than 0.04% have been known to cause excessive bowing, cracking and delamination in composite materials[6]

Summary

Any issues effecting either the appearance or structural integrity of installed GRC on any structure should be carefully considered. To mitigate any possibility of such problems we would recommend both specifiers and manufacturers to incorporate testing similar to the one detailed above into the project Inspection and Testing Plan (refer to GRC Technical Note 3)

Further Help

We offer a full consultancy-based service to anyone involved in the GRC industry – manufacturers, specifiers, users and end clients. We can assist with any aspect of the full GRC supply chain from initial concept designs to final on-site installation activities

Please note the information provided is on an general and advisory basis only. GRC is a complex composite material and project specific application advice should be obtained from suitably experienced professionals.

References

1 GRCA Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products. Publication Date February 2021

2 BS EN 1169. Precast concrete products – General rules for factory production control of glass-fibre reinforced cement. Publication Date November 1999

3 BS EN 15191. Precast concrete products – Classification of glassfibre reinforced concrete performance. Publication Date December 2009

4 BS EN 1170-7. Precast concrete products – Test method for glass-fibre reinforced cement. Part 7 Measurement of extremes of dimensional variations due to moisture content. Publication Date March 1998

5 BS EN ISO/IEC 17025 incorporating corrigendum. General requirements for the competence of testing and calibration laboratories. Publication Date March 2018

6 PCI Manual for Quality Control for Plants and production of Glass Fiber Reinforced Concrete Products. Second Edition. Publication Date 2009