



**Specification for the
Manufacture, Curing & Testing of
Glassfibre Reinforced Concrete (GRC)
Products.**

**The International
Glassfibre Reinforced Concrete
Association (GRCA)**

October 2017

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Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products.

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SPECIFICATION FOR THE MANUFACTURE, CURING & TESTING OF GRC PRODUCTS

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FOREWORD

This Specification is designed to enable architects, engineers and specifiers to specify GRC. It covers all aspects of GRC production from raw materials, through production, curing and storage to quality assurance and testing.

Grades of GRC covered are:

- General purpose cast premix GRC: Grades 8 and 8P
- Sprayed premix or high quality cast premix GRC: Grades 10 and 10P
- Normally sprayed GRC: Grades 18 and 18P

where 'P' refers to the use of acrylic polymer emulsion in the GRC mix design.

In consultation with a producer, the specifier should select the grade of GRC required. The specifier can then ensure that the product is manufactured and tested according to the specification.

The Specification is a material and manufacturing specification. An engineer should be consulted to ensure that the material grade selected is consistent with the engineering design of the product. This Specification supersedes all previous GRCA GRC specifications. It has been prepared by the GRCA Technical Group.

This Specification should be used in conjunction with the GRCA's "Methods of Testing Glassfibre Reinforced Concrete (GRC) Material"

1 INTRODUCTION

1.1 Scope

This specification covers the requirements for the manufacture, curing and testing of GRC products. It gives detailed requirements for grades of GRC manufactured by three different methods:

- 'Spray' Grades 18 and 18P
- 'Premix' Grades 10 and 10P
- 'Premix' Grades 8 and 8P

'P' refers to the use of acrylic thermoplastic polymer emulsion in the GRC mix design.

The specification covers mixes with and without polymers. Selection of the applicable grade should be made by the producer in consideration of the engineering design of the product. This choice should then be approved by the purchaser.

1.2 References

Standards and other publications referred to in this specification are listed in "Further reading".

1.3 Definitions

Aggregate/cement ratio

The ratio of the mass of total dry aggregate to the mass of dry cement in the GRC.

AMS

The GRCA Approved Manufacturer Scheme.

AMS Member

A GRC manufacturing Member of the GRCA who has been audited by an independent certifying body appointed by the GRCA and accepted into the GRCA as an AMS Member.

'Bag and bucket' tests

Methods for the calibration of GRC spray equipment.

Characteristic property

The value of a property above which 95% of the population of all possible measurements of that property of the specified GRC are expected to lie.

Dry curing

A method of curing which prevents early loss of moisture and allows curing to take place without keeping the GRC damp. Dry curing is carried out by adding an appropriate quantity of the polymer into the GRC mix. (See Tables 3 & Section 4.5.)

Engineer

The person or authority responsible for the design of the GRC component.

Extremes of dimensional variations

The maximum dimensional variations (residual hydraulic shrinkage and reversible expansion) of a GRC composition attributable to variations in the water content to which products exposed to the elements may be subjected.

Facing coat

An initial layer without fibre but containing decorative sands or aggregates and often pigment.

Glassfibre content by weight (WF)

The ratio (expressed as a percentage) of the mass of glassfibre to the mass of GRC in the uncured [wet mix] state.

GRCA

The International Glassfibre Reinforced Concrete Association.

High shear mixer

A mixer with a high shear action capable of the preparation of the fine sand/cement slurries required for the spray process.

Limit of proportionality (LOP)

Also known as elastic limit. The stress in a flexural bending test where the stress/strain plot deviates from a straight line.

MFFT

Minimum film formation temperature (for acrylic polymers).

Mist coat

An initial cementitious sprayed coating without glassfibre.

Modulus of rupture (MOR)

The highest stress on a stress/strain plot during a flexural bending test.

Polymer-modified GRC

GRC which has been modified by the addition of an acrylic thermoplastic polymer dispersion either for 'dry curing' or for property enhancement.

Premix GRC

A method of manufacture in which the pre-cut AR glassfibres and the cementitious slurry are blended during mixing.

Premix mixer

A two-stage or variable speed mixer designed to prepare fine sand/ cement slurries (stage 1) and to blend in chopped AR glassfibres (stage 2) in the premix process.

Producer

The person or authority entering into a contract to manufacture a GRC product.

Purchaser

The person or authority entering into a contract to buy a GRC product.

Simultaneous Sprayed GRC

A method of manufacture in which GRC is produced by simultaneously spraying the cementitious slurry and the AR glassfibre which is chopped from roving within the spray gun.

Slump test

A test for measuring the consistency of the cementitious slurry.

Supplier

The person or authority entering into a contract to supply goods to the producer.

Test board

A sheet of GRC manufactured during production for the purpose of assessing the quality of the GRC products being made. The test board may be a specimen of the product itself. The test board must be made in the same way and at the same time as the GRC product so that it is representative of the quality of the GRC.

Test board mean

The arithmetic mean value for a property calculated from all the individual test coupon results from one test board. For statistical analysis, this mean is regarded as one result.

Test coupons

Number of specimens taken from a test board for the purpose of determining a property.

Top/bottom ratio

The ratio of the MOR results of samples tested with the mould face in tension to those with the trowelled face in tension.

Uncured state

The stage in the manufacture of GRC when all physical processes that could alter the composition of the material are complete but the fibre can still be separated from the matrix by the action of running water.

Water/cement ratio

The ratio of the mass of total water to the mass of dry cement in the GRC in the uncured state. When pozzolanic fillers are used they can be considered as cementitious and the water/cement ratio can be expressed as a water/total binder ratio; examples of such pozzolanic fillers are fly ash, silica fume and metakaolin.

2 CONSTITUENT MATERIALS

2.1 Alkali-resistant glassfibre

Glassfibre shall be an alkali-resistant continuous filament fibre developed and formulated to have high strength retention in hydraulic cement environments. The producer shall provide certification from the supplier to show that the glass fibre conforms to EN 15422:2008 or approved National Standard

2.2 Cement

Cement shall be supplied by a manufacturer of assessed capability, made to recognised standards such as BS EN 197 or appropriate national standard and supported by suitable certification. Cement shall be correctly stored and kept dry to avoid deterioration.

2.3 Fine aggregates

Fine aggregate or sand shall be washed and dried to remove soluble matter and permit accurate control of the water/cement ratio. The particle shape should be round or irregular and should have a smooth surface without honeycombing.

For spray GRC, the maximum particle size shall be 1.2mm; for premix GRC, the maximum particle size shall be 2.4mm. In both cases the fine fraction, i.e. sand passing a 150 micron sieve, shall be less than 10% of the total weight of sand.

Silica sands are widely used and should conform to the specification in Table 1.

Sands with a higher moisture content may be used provided the moisture content is known and the mix design is altered accordingly.

Sands other than silica sands may be used but the producer should provide evidence of their suitability. Soft building sands must not be used.

Table 1: Specification for silica sand

Silica content	> 96%
Moisture content	< 2%
Loss-on-ignition	< 0.5%

2.4 Water

Water shall be clean and free from deleterious matter, see BS EN 1008, *Mixing water for concrete*.

2.5 Admixtures

Admixtures are permitted and their use is encouraged as they can enhance the properties of GRC. They should always be used strictly in accordance with the suppliers' recommendations and the producer must ensure that their use has no adverse effect on the product.

Calcium chloride-based admixtures must not be used if the GRC component contains steel reinforcement, fixing sockets or other cast-in devices.

2.6 Acrylic polymers

Acrylic thermoplastic polymer dispersions should be used in accordance with the manufacturers' instructions and should conform to the specification in Table 2.

Polymers with properties outside the above specification may be used with the agreement of the purchaser and adequate test results.

Table 2: Specification for polymer curing aid.

Compound type	Aqueous thermoplastic polymer dispersion
Polymer type	Acrylic based
Solids	45-55%
Appearance	Milky white creamy, free from lumps
Minimum film-formation temperature	7-12 °C
Ultraviolet resistance	Good
Alkali resistance	Good

2.7 Pigments

Powder pigments or dispersions may be used to produce coloured GRC. The pigments should conform to international or national standards. The purchaser should recognise that colour variation may occur and must agree an acceptable range of variation with the producer.

2.8 Other component materials

Other component materials (e.g. silica fume, metakaolin, fly ash, reinforcing fillers, admixtures, meshes), may be added to modify the properties of the mix. They must be used in accordance with the supplier's instruction and the producer must demonstrate that their use will not adversely affect the properties of the GRC

3 COMPOSITION OF GRC

3.1 Mix design

It is the responsibility of the producer to select a suitable mix design for the product. The mix design must be such that the mechanical properties of the GRC in Section 8 of this Specification are achieved and that these requirements are consistent with the engineering design of the product.

The mix designs in Table 3a, 3b and 3c are intended as a guide indicating typical figures; designs falling outside these guidelines may be acceptable but should be scrutinised before use.

Table 3a: Guide mix designs — Grade 8

Premix Grade	Grade 8	Grade 8P
Description	General purpose premix	
Aggregate/cement ratio	0.5 -1.50	0.5 -1.50
Water/cement ratio	0.30 - 0.40	0.30 - 0.40
Glassfibre content (% by weight of total mix)	2.0 - 3.0%	2.0 - 3.0%
Polymer solids content (% by weight of cement)	Nil	4-7%
Extreme dimensional variations mm/m	0.6 – 1.2	0.6 – 1.2
Water Absorption	5 – 11%	5 – 11%
Minimum bulk dry density kg/m ³	1800	1800
Minimum bulk wet density kg/m ³	2000	2000

Table 3b: Guide mix designs — Grade 10

Premix Grade	Grade 10	Grade 10P
Description	Sprayed premix or High quality cast premix	
Aggregate/cement ratio	0.5 -1.50	0.5 -1.50
Water/cement ratio	0.30 - 0.38	0.30 - 0.38
Glassfibre content (% by weight of total mix)	2.0 - 3.5%	2.0 - 3.5%
Polymer solids content (% by weight of cement)	Nil	4-7%
Extreme dimensional variations mm/m	0.6 – 1.2	0.6 – 1.2
Water Absorption	5 – 11%	5 – 11%
Minimum bulk dry density kg/m ³	1800	1800
Minimum bulk wet density kg/m ³	2000	2000

Table 3c: Guide mix designs — Grade 18

Spray Grade	Grade 18	Grade 18P
Description	Direct sprayed GRC	
Aggregate/cement ratio	0.5 -1.5	0.5 -1.5
Water/cement ratio	0.30 - 0.38	0.30 - 0.38
Glassfibre content (% by weight of total mix)	4.0 - 5.5%	4.0 - 5.5%
Polymer solids content (% by weight of cement)	Nil	4-7%
Extreme dimensional variations mm/m	0.6 – 1.2	0.6 – 1.2
Water Absorption	5 – 11%	5 – 11%
Minimum bulk dry density kg/m ³	1800	1800
Minimum bulk wet density kg/m ³	2000	2000

4 MANUFACTURE

GRC products manufactured only by premix and spray production methods are covered in this Specification.

4.1 Manufacture by simultaneous spray

4.1.1 Weighing/batching

Dry ingredients shall be batched by weight using calibrated weighing equipment capable of an accuracy of $\pm 2\%$ of the stated batch weight. Liquids should be weighed, volume batched or automatically dispensed. The producer must demonstrate that the method employed will give an accuracy of $\pm 2\%$.

4.1.2 Mixing

The cementitious slurry should be mixed in a suitable mixer in accordance with the manufacturer's instructions and using the stated mix design. The producer must demonstrate that this type of mixing system is to be used. The consistency of the mix should be tested by measuring the slump in accordance with GRCA's Methods of Testing GRC Part 5 or applicable national standards

4.1.3 Spraying

Spraying should be carried out using specialist equipment that allows the simultaneous deposition of known quantities of cementitious slurry and chopped glassfibre. Before starting production, the spray equipment must be calibrated to ensure that the specified glassfibre percentage is achieved. Calibration to measure the deposition rates of the glassfibre and cementitious slurry should be carried out using 'bag and bucket tests' in accordance with GRCA's Methods of Testing GRC Part 4 or applicable national standards.

These tests should be carried out for each pump at the beginning of each shift, after any alteration of the equipment controls and after any unsatisfactory 'wash out' test results (Section 7.1).

If the equipment used gives continuous readings of glass and slurry output these tests need not be carried out.

A mist coat without fibre may be sprayed; this coat should be as thin [$\sim 1\text{mm}$] as practicable and should be followed immediately by the first GRC spray.

When a facing coat is used this may be sprayed or poured. This coat may be allowed to stiffen but the first GRC coat must be applied before initial set takes place. Typical thickness is 3-5mm depending on subsequent treatment e.g. grit blasting or acid etching.

The GRC materials must be sprayed and built up in thin layers of 3-4mm until the required thickness is achieved. The sprayed GRC should be compacted by a hand roller before spraying the next layer. After the final layer has been sprayed the thickness of the GRC must be checked using a template or depth gauge and compared to the design thickness.

Unless specifically stated in the agreed product manufacturing specification, the design thickness should be considered as a minimum and no part of the component should be below this thickness.

Over-thickness will be permitted and is to be expected particularly at corners or areas with a deep profile. It will not be permitted if:

1. Any flat areas exceed the design thickness by 4mm.
2. The weight of the component exceeds the maximum design weight as specified by the engineer.

After checking the thickness, any areas of under-thickness should be re-sprayed and areas of over-thickness removed and the material discarded. The specified finish to the 'back' of the unit should be applied using a float or roller.

4.2 Manufacture by premix

4.2.1 Weighing/batching

Dry ingredients should be batched by weight using calibrated weighing equipment capable of an accuracy of $\pm 2\%$ of the stated batch weight. Liquids should be weighed, volume batched or automatically dispensed. The GRC manufacturer should demonstrate that the method employed will give an accuracy of $\pm 2\%$.

4.2.2 Mixing

The GRC should be mixed in a two-stage or other suitable mixer. The producer must demonstrate that the equipment is suitable for manufacturing premix GRC.

First the cementitious slurry should be mixed at high speed in an intensive shear mixer or other approved mixer. The slurry is then transferred to a second mixer or the mixing action of the shear mixer adapted so that the AR glassfibre is blended uniformly into the slurry.

The AR glassfibre may be added manually or automatically as chopped fibres or automatically as AR glassfibre roving using a fibre chopper.

4.2.3 Cast Premix

The premixed GRC material should be pumped or carried in a holding vessel to the filling station. The material should then be poured or pumped into the mould ensuring that the method of filling expels the air from the product and planes of weakness are avoided. Compaction may be by internal or external vibration or by the use of a 'self-compacting' mix. The producer must ensure that the method chosen is consistent with the required surface finish and mechanical properties.

4.2.4 Sprayed Premix

The premixed GRC material may also be sprayed onto or into moulds using specialist sprayed premix equipment. A facing coat or a mist coat may be sprayed first. The GRC material should be sprayed in layers 4-6mm and compacted by roller before spraying the next layer. The thickness should be checked as in 4.1.3

4.3 Storage before demoulding

Filled moulds must be stored at temperatures between 5°C and 40°C. 'P' grades must be stored at a temperature higher than the MFFT but below 40°C.

Moulds must be stored on a level surface and supported in such a manner that they will not bow or twist.

Once the initial set has taken place the mould shall be covered with polythene of 500 gauge or above and should not be moved until demoulding.

4.4 Demoulding [inc. lifting and fixing]

The GRC component must not be demoulded until it has gained sufficient strength to be removed from the mould and transported without being over-stressed. The time required will be temperature dependent.

Demoulding must be carried out in such a manner that no damage occurs to the component. Unique demoulding, lifting and fixings sockets must be embedded in the component. All embedded items should be of a suitable material [preferably austenitic stainless steel or non-ferrous] and encapsulated in a block of GRC; size and procedures to be used should be agreed with the engineer before starting production.

4.5 Curing

4.5.1 Moist curing (for non-polymer grades)

GRC components should be cured at controlled temperature and humidity. Ideally this should be for seven days at 20°C and 95% RH. This is not always practical and alternative curing regimes are satisfactory providing the producer demonstrates that the procedure:

1. Enables the component to achieve the physical properties given in Section 8.
2. Ensures that excess shrinkage caused by a too rapid drying of the product does not occur.
3. The curing method is acceptable to the purchaser and engineer.

4.5.2 Curing of polymer grades

Components produced using polymer grades of GRC should be loosely covered overnight and should be dry cured after demoulding. Moist curing can be detrimental. Temperature above 35°C or below 5°C should be avoided for the first two days after manufacture.

Products should not be exposed to drying winds or excessive heat for a minimum of two days.

4.6 Storage, handling and transport

GRC components must be stored, handled and transported in such a way that:

1. No part of the component is overstressed.
2. Bowing or twisting is not induced in the component.
3. No damage is caused to any part of the component, particularly edges and corners.
4. No permanent staining or discoloration is caused either by the storage conditions or the stacking/protection material.

For large components, the method of handling, storage, loading and transporting shall be agreed with the engineer.

5 QUALITY CONTROL AND ASSURANCE

5.1 Quality management system

The manufacturer should demonstrate that a quality assurance system is operated. This shall comply with the GRCA Full Member Regulations, ISO 9001 or similar

6 SAMPLING

6.1 Sampling and Test Boards

Tests may be carried out on coupons cut from the GRC components themselves but this is not normally practical. It is acceptable to produce a Test Board for testing. This shall be manufactured, demoulded and cured in the same manner as the component it represents. Its quality should be the same as the component, as far as possible.

However, due to testing equipment restraints, the thickness should be limited to 12mm. Test Boards must be large enough for sufficient coupons to be cut to meet the testing requirements; 500 x 800mm is proposed so that with spray processes, any directional effects can be identified.

6.2 Frequency

The frequency of production of Test Boards shall be not less than 1 board per day per mixer/pump, for both spray and premix processes. Spray process Test Boards not tested shall be kept for a minimum of one year for any future testing requirements.

7 TESTING

The following tests shall be carried out and the required properties shall be as shown in Tables 3a, 3b, 3c, 4 and 5.

7.1 AR Glassfibre content

The AR glassfibre content shall be determined in accordance with either the "GRCA Methods of Testing Glassfibre Reinforced Concrete (GRC) Material Part 1" or BS EN 1170-2 or other approved national standards. With spray processes, the test shall be carried out once per day per spray station as a minimum.

7.2 Limit of proportionality [LOP] and modulus of rupture [MOR]

The LOP and MOR shall be determined at 7 and/or

14 and/or 28 days in accordance with either the "GRCA Methods of Testing Glassfibre Reinforced Concrete (GRC) Material Part 3" or EN 1170-5 or other approved national standards. 7 and 14 day results shall only be acceptable if they already exceed design requirements.

Additional information such as % Strain to LOP, % Strain to MOR and Young's Modulus provided by modern test equipment should be recorded for information only.

The minimum LOP and MOR testing frequency shall be:

Spray: Twice per week per spray station or every 10 tonnes of GRC produced, whichever is the greater.

Premix: Once per week per mixer or every 10 tonnes of GRC produced, whichever is the greater.

These frequencies are an absolute minimum and individual manufacturers may elect to test more frequently, as they feel appropriate.

Table 4: Characteristic Values

GRADE	8 or 8P	10 or 10P	18 or 18P
Characteristic LOP*	5	6	7
Characteristic MOR*	8	10	18

*A minimum of 40 Test Board Mean shall be analysed in the calculation of the Characteristic Values.

7.3 Bulk density, water absorption and apparent porosity

These properties shall be determined in accordance with either the "GRCA Methods of Testing Glassfibre Reinforced Concrete (GRC) Material Part 2" or BS EN 1170-6 or other approved national standards. All of these tests shall be carried out a minimum of once per month.

7.4 Other tests

Other tests of GRC may be carried out when required by the purchaser, including extreme dimensional variation tests BS EN 1170-7, full-scale load tests of products and components, fire tests, performance testing of cast-in fixings etc. These tests should be supervised by the Engineer.

8 COMPLIANCE

8.1 General

The constituent materials should comply with the requirements of Section 2 and the composition of the GRC shall comply with Section 3. The GRC should be produced and cured in accordance with Section 4. It should be sampled at a frequency complying with Section 6 and tested in accordance with Section 7. It should meet the requirements of Section 8.

8.2 Minimum values for compliance

Table 5 indicates minimum LOP and MOR values using in-process inspection results as a guideline for initial compliance only. To conform to this specification, the manufacturer must also be able to demonstrate via their testing regime and documentation that analysis shows Characteristic Values as shown in Table 4. This analysis must form part of their Quality Assurance procedures to be allowable.

If other properties, e.g. density or porosity, are considered to be critical for an application, compliance values and testing frequency should be agreed between the purchaser and the producer.

9 NON COMPLIANCE

9.1 Failure to comply

- a. If any single test board fails to meet any of the compliance requirements, the GRC at risk shall be that produced between the previous complying test board and the next complying test board.
- b. Where testing is not carried out on a daily basis retained sample boards (see 6.2) may be tested to determine the extent of the non compliant product.

9.2 Action in the event of non-compliance

The action to be taken over GRC products that do not comply with this specification should be determined with due regard to the technical consequences of adopting remedial measures or replacing the rejected products.

In estimating the quality of the sub-standard GRC and in determining the action to be taken, the following should be established wherever possible.

The validity of the testing shall be confirmed by checking that the sampling, testing and calculations have been carried out in accordance with this specification.

- a. That the raw materials and mix proportions used in the GRC under investigation comply with both the specifications and/or with those agreed between purchaser and producer.
- b. That the curing regime adopted before testing complies with the recommendations in this Specification. Re-testing of test boards may be appropriate when it is considered that the storage conditions of the product might result in improved properties because of extended curing.
- c. The effect of any reduction in GRC properties on the strength and durability of the product.

Three points should be considered:

- i. The safety factors adopted in the design.
- ii. The thickness of GRC produced compared to the design thickness.
- iii. LOP/MOR strengths required by engineering calculations

Table 5: Minimum strengths

GRADE	8 or 8P	10 or 10P	18 or 18P
LOP MPa			
Mean of 4 consecutive test board means	7.25	8.00	8.00
Minimum for individual test board mean	5.75	6.00	6.00
MOR MPa			
Mean of 4 consecutive test board means	9.50	12.00	21.00
Minimum for individual test board mean	7.50	8.50	15.00

FURTHER READING

GRCA “Methods of Testing Glassfibre Reinforced Concrete (GRC) Material”

GRCA “Specifiers Guide to Glassfibre Reinforced Concrete”

GRCA “Assessment of GRC Test Results”

GRCA “Approved Manufacturer Scheme (AMS) Regulations”

Other GRCA Publications: See www.grca.org.uk for up to date list of publications.

The Concrete Bookshop

Tel: 07004 607777 (UK only) or +44 (0)1276 607140

Email: enquiries@concretebookshop.com

Web: www.concretebookshop.com

In addition, The International Glassfibre Reinforced Concrete Association (GRCA) holds a database of past GRCA Congress Proceedings and many other GRC related publications including some free downloads. Web: www.grca.org.uk.

NBS Specification H40 May 2002 *Glassfibre reinforced concrete cladding components.*

European Standards

BS EN 1169: 1999: *Precast concrete products — General rules for factory production control of glass-fibre reinforced cement products.*

BS EN 1170: 1998: *Parts 1-8 Precast concrete products: Test methods for glass-fibre reinforced cement.*

Part 1. Measuring the plasticity of the mortar— '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 the dry density

Part 7. Measurement of extremes of dimensional variations due to moisture content.

Part 8. Cyclic weathering type test

BS EN 14649: 2005 *Precast concrete products — Test method for strength retention of glass fibres in cement and concrete (SIC TEST).*

BS EN 15422: 2008 *Precast Concrete Products - Specification of glassfibres for reinforcement of mortars and concretes.*

USA

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Recommended Practice for Glass Fiber Reinforced Concrete Panels - Fourth Edition, 2001.
Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products, 1991.

ACI 549.2R-04

Thin Reinforced Cementitious Products. Report by ACI Committee 549

ACI 549.XR. Glass Fiber Reinforced Concrete premix. Report by ACI Committee 549

ASTM

C948 Standard Test Method for Wet Bulk Density, Water Absorption and Apparent Porosity of Thin Section Glass Fiber Reinforced Concrete.

C1229 Standard Practice for Preparing Coupons for Flexural and Washout Test for Glass Fiber Reinforced Concrete.

C1229 Standard Test Method for Determination of Glass Fiber Content in Glass Fiber Reinforced Concrete

C1230 Standard Test Method for Performing Tension Tests on Glass Fiber Reinforced Concrete [GFRC] Bonding Pads

C1560 Standard Test Method for Hot Water Accelerated Aging of Glass Fiber Reinforced Concrete

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Design, Manufacture and Installation of Glass Reinforced Concrete (GRC)