

GRC @ AMIANTIT - TECHNICAL DATA

Materials:

The basic materials used in Amiantit GRC are:

Cement:

Ordinary Portland and Rapid Hardening Portland Cement. Other cements, including sulphate resisting and HAC, are also used.

Aggregates:

Fine sand with an aggregate / cement ratio from 0.25 upwards and a particle size in the range 150 microns to 1 mm are typically used. Other fine inorganic aggregates can be used.

Water:

Clean and fresh water should be used. The water / cement ratio is low by concrete standards.

Admixtures:

Water reducing, plasticising and workability aids may be used. Accelerators may be used to speed demoulding.

Amiantit AR Glass Fibre

Supplied as continuous roving, which is cut during the making of GRC in to strands 12 to 38 mm long, or as precut chopped strands 12 to 25 mm long. The typical level of fibre used in GRC is between 4 and 6% of total weight.

Manufacture:

Amiantit GRC can be produced by several differing techniques, ranging from very manual processes to sophisticated mechanized systems. All systems first require the production of a slurry of the matrix components. The fibre is then added either at a further mixing stage before casting or by simultaneous spraying on or in to moulds. Compaction and cure of the product then takes place followed by demoulding. The time required for production depends on the type of component and manufacturing method and can range from days to minutes. Amiantit GRC products are normally manufactured in a factory to a high standard of finish and to close tolerances. After cure they can be machined by normal masonry techniques if required.

Fixing and assembly:

Amiantit GRC components can be fixed using conventional precast concrete techniques and can be assembled by normal techniques such as screwing, bolting, bonding etc.

Surface finish and textures:

The surface of components made in Amiantit GRC is as varied as the range of surfaces against which it can be formed. High quality flat surfaces can be obtained and almost all textures can be achieved, depending on the type of mould used. Deep and re-entrant shapes can be produced using flexible mould techniques. Aggregate facings, as found in the precast concrete industry are often used. By means of coloured cements or pigments, through colour can be achieved though often surfaces are painted.

Mechanical properties:

The properties of GRC are influenced by factors such as fibre content and distribution, type of matrix and method of manufacture. The properties can therefore be tailored to meet the design requirements of particular components. This data sheet gives typical characteristics for two types of GRC: sprayed material containing 5% fibre and premix material containing 4% (Table 1). In the case of the sprayed material the alignment of the fibres is random in two dimensions (a laminar construction) whilst in the case of a premix the orientation of the fibre is three-dimensional.

The values are at 28 days – the normal test period for concretes.

The stress / strain characteristics of a typical 5% sprayed composite are illustrated in the graph opposite. The fibre significantly improves both the tensile and bending strengths and increases the strain to failure resulting in a strong and tough material.

Typical design stresses used for Amiantit GRC are shown in Table 2.

Creep and stress rupture:

GRC is capable of bearing loads over prolonged periods of time. In common with other cementitious materials, GRC components show an initial elastic deformation under load which is followed by a further slow creep deformation. These creep strains are small and the creep strain rate decreases with time. No stress rupture has been observed in tests carried out at twice the recommended working design stress in period up to 8 years.

Fatigue:

At the normal working stress levels, fatigue lives greater than 10 million cycles are obtained, both in bending and tension.

Physical properties:

The thermal, fire, moisture and acoustic properties are indicated in Table 3. Most of these are controlled by the matrix components, i.e. the hydraulic cement and aggregate.

Chemical resistance:

The chemical resistance of Amiantit GRC is broadly similar to that of concrete and the effect of the chemical on the cement is the predominant factor. Because Amiantit GRC has high density and a high cement content, it generally has a higher chemical resistance than concrete. Further improvements can be obtained by using specially formulated cements such as sulphate resisting, super sulphate and alumina cements. Alkaline solutions do not present a problem to Amiantit GRC.

Electrical:

The electrical properties of Amiantit GRC are largely determined by the amount of moisture present in the material in the prevailing conditions of use. In common with that of other cementitious materials, the electrical resistivity of GRC can be increased by surface coatings or impregnation.

Table 1- Mechanical Properties of Amiantit GRC

| Property | Unit | Hand or Machine spray | Premix |
|-----------------------------|------------------------|------------------------------|---------------|
| Amiantit fibre content | % by wt | 5 | 4 |
| Density (normal) | Tonne / m ³ | 1.9 – 2.1 | 1.8 – 2.0 |
| Compressive strength | N/mm ² | 50 - 80 | 40 - 60 |
| Tensile strength (UTS) | N/mm ² | 8 - 11 | 4 - 7 |
| Bending strength (MOR) | N/mm ² | 21 - 31 | 10 - 14 |
| Impact strength (Izod) | Nmm/mm ² | 10 - 25 | 8 - 14 |
| Bending elastic limit (LOP) | N/mm ² | 7 - 11 | 5 - 8 |
| Young's Modulus | kN/mm ² | 10 - 20 | 13 - 18 |
| Poisson's Ratio | | 0.20 – 0.25 | 0.20 – 0.25 |
| Strain to failure | % | 0.60 – 1.2 | 0.1 – 0.2 |
| Interlaminar shear strength | N/mm ² | 3 - 5 | N/A |
| In plane shear strength | N/mm ² | 8 - 11 | 4 – 7 |

The mechanical properties of GRC can vary from their initial levels with time depending upon the particular material and the working environment. In dry conditions there is little change but in moist or wet conditions there is some loss of tensile and impact strength. The long term strength levels are well known and are taken in to consideration in the design levels used.

Table 2 – Typical design stresses used for Amiantit GRC

| Design value | Loading example | Unit | Hand or machine spray | Premix |
|-------------------|---|-------------------|-----------------------|--------|
| Compression | Compressive | N/mm ² | 12 | 12 |
| Tension | Cylinder hoop stress. Bending sandwich panels | N/mm ² | 3 | 2 |
| Tensile / Bending | Bending box sections or channels | N/mm ² | 4 | 2.5 |
| Bending | Bending solid beams or plates | N/mm ² | 6 | 4 |
| Shear stress | Shear loading | N/mm ² | 1 | 1 |

These design values may be varied in certain product areas e.g. formwork. Limit state methods are also used.

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Table 3 – Physical properties of Amiantit GRC

| | Property | Unit or Test | Performance |
|----------|---|---|---|
| Thermal | Expansion Conductivity Freeze - thaw | Per °K W/m°K BS 4264 Din 274 ASTM C666.73 | 10 – 20 x 10 0.5 – 1.0 no visible or mechanical change no visible or mechanical change after 300 cycles ±20° C relatively little change |
| Fire | Non-combustibility Ignitability Fire propagation Spread of flame Fire resistance Smoke | BS 476 Pt4 BS 476 Pt5 BS 476 Pt6 BS 476 Pt7 BS 476 Pt8 ASTM STP 422-67 | Non-combustible Class P (not easily ignitable) Class 0 Class 1 (zero spread) 0-4 h depending on construction Dm=2-6 negligible smoke production |
| Moisture | Water vapour Permeability Water permeance Moisture absorption Moisture movement | BS 3177 BS 473/550 -- -- | Permeance less than 1.3 metric perms at 10 mm thick. 0.02 – 0.4 ml/m ² min on 8 mm thick. 10-20% from oven dry to saturation 0.15-0.2% from saturation to oven dry. |

| | | | |
|---------------------|------------------|---------------|--|
| Acoustic | Sound absorption | dB | 8 mm sheet: 23dB at 125 Hz 40dB at 4000 Hz |
| Abrasion resistance | | ASTM C418-68 | 0.27 – 0.30 cm ³ volume loss. Lower loss than normal concrete, A/C sheet or brick |
| Safety | Fibres in air | Micron | The fibre diameter used for Amiantit is greater than 12 microns and is therefore well above the upper limit of respirability (3.5 microns) diameter). Detailed medical information is available on request. |
| | Fibre in water | WHO standards | Amiantit GRC can be used for systems carrying potable water. The fibres are firmly bonded in to the composite and not therefore released in to the water. GRC containing Amiantit fibre produced no taste; colour and turbidity were unaffected and toxic metals were not detected at levels exceeding specification. |

General Information for GRC

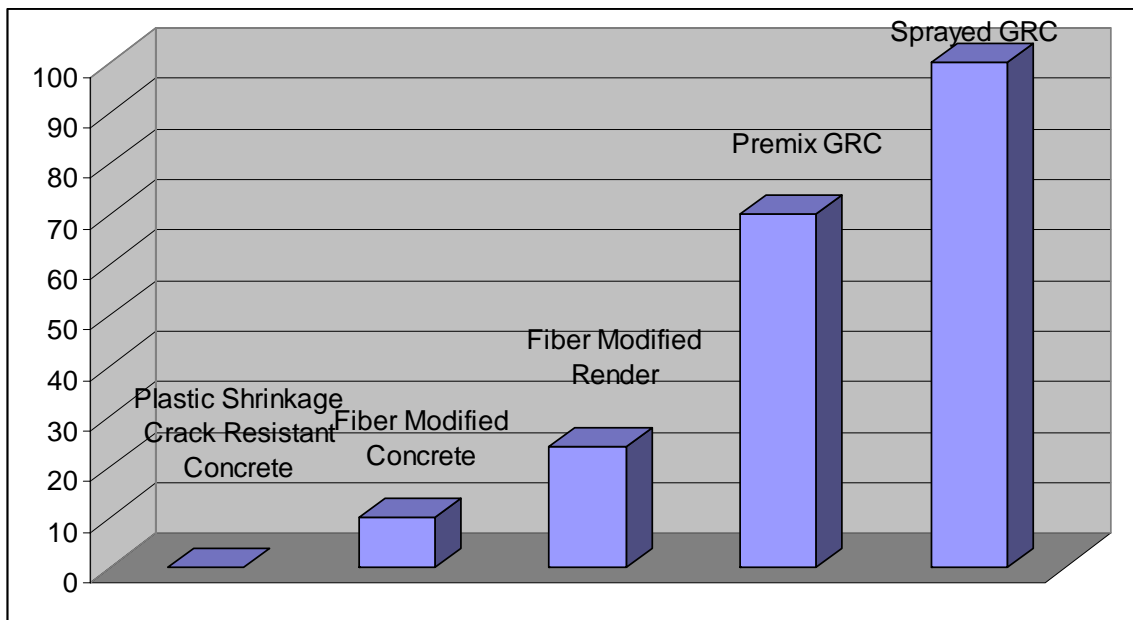
Glassfibre Reinforced Concrete (GRC*) is one of the most versatile building materials available to architects and engineers. Developed in the twentieth century, GRC has been making a significant contribution to the economics, technology, and aesthetics of modern construction worldwide for over 30 years.

GRC is not a single material but a family of high-performance cement-based composites reinforced with special alkali resistant glass fibres, which can be engineered to suit a wide range of applications.

GRC products can be formed into sections as thin as 6 mm (1/4 inch) so their weight is much less than traditional precast concrete products. The design and manufacture of GRC products is covered by international standards, which have been developed in Europe, America, Asia and Australasia. GRC is manufactured in over 100 countries.

Technical Appendix

GRC is a family of materials that can be defined by the addition rate of alkali resistant glass fibre. At one end of the spectrum low dosages of dispersible fibres are used to control plastic shrinkage cracks in normal concretes (PCR). At the other end, integral fibres are used at high dosage levels to reinforce cement-rich mortars (GRC). Fibre contents for different GRC product types (kg of fibre per m³ of concrete)



Most GRC products are manufactured by one of two processes – Vibration Casting and Spraying.

The vibration cast form is normally referred to as “Premix GRC”. Premix GRC is produced in a two stage process. A mixture of cement, sand, water and chemical admixtures is first prepared in a high speed mixer. Fibres are added in the second stage with a slower speed. The Premix GRC is then poured into moulds and compacted by vibration.

Sprayed GRC is sometimes called “Hand Spray GRC” or “Machine Spray GRC” depending on the method of manufacture. A mixture of cement, sand, water and chemical admixtures is prepared in a high shear slurry mixer. This is then placed in a machine that conveys the slurry to a special spray gun where the fibres are added at the nozzle as the GRC material is sprayed onto a mould.

A third production process called “Spray Premix” is also often used for the manufacture of smaller elements and the application of renders.

| Property | Hand or Mc Spray | Vibration Castemix GRC |
|--|------------------|------------------------|
| Glassfibre Content by weight of mix | 5% | 3% |
| Bending: | | |
| Ultimate Strength (Module of Rupture-MOR) MPa | 20-30 | 10-14 |
| Elastic Limit (Limit of Proportionately-LOP) MPa | 7-11 | 5-8 |
| Tension: | | |
| Ultimate Strength (Module of Rupture-MOR) MPa | 8-11 | 4-7 |
| Elastic Limit (Limit of Proportionately-LOP) MPa | 5-7 | 4-6 |
| Shear: | | |
| Interlaminar Shear Strength MPa | 3-5 | N.A. |
| In-plane Shear Strength Mpa | 8-11 | 4-7 |
| Compressive Strength Mpa | 50-80 | 40-60 |
| Impact Strength kJ/m ² | 10-25 | 10-15 |
| Elastic Modules Gpa | 10-20 | 10-20 |
| Strain to Failure % | 0.6-1.2 | 0.1-0.2 |
| Dry Density Tonne/m ³ | 1.9-2.1 | 1.8-2.0 |



Hand Spray GRC



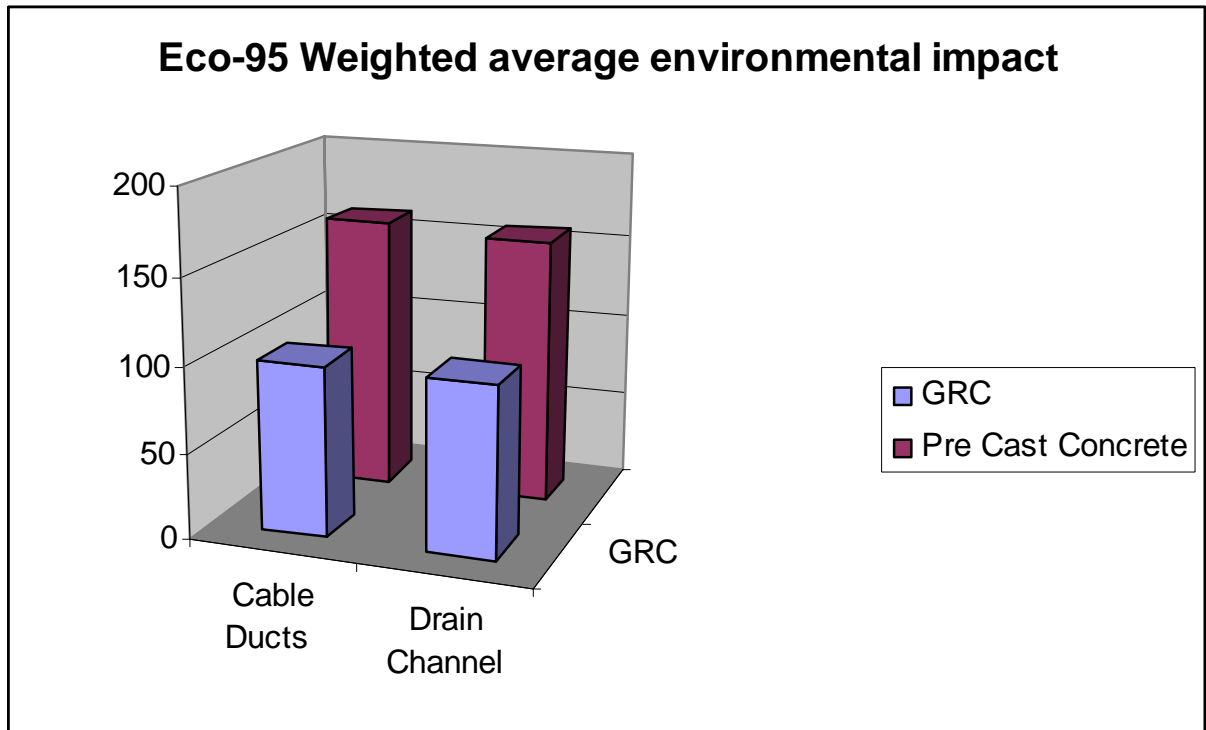
Spraying Pre-mix GRC Render



Vibrant Cast Premix GRC

GRC and the Environment

The main constituents of GRC are based on the naturally occurring earth oxides that are used in the manufacture of cement and glass fibres. These are not generally regarded as pollutants. Wash water from the manufacturing process contains cement and this is alkaline. It is normal for factories to have settlement tanks so that solids do not enter the drainage system.



The reduced weight of GRC compared to steel reinforced concrete products does provide environmental benefits. An assessment carried out as part of a UK government ETR/Concrete Industry Alliance 'Partners in Technology' project compared two precast concrete and GRC products that fulfil the same function. The results show that GRC has a lower environmental impact. The main reasons for the reduced environmental impact of GRC compared to traditional precast concrete are:

- *Reduced cement usage per product*
- *Reduced transport costs*