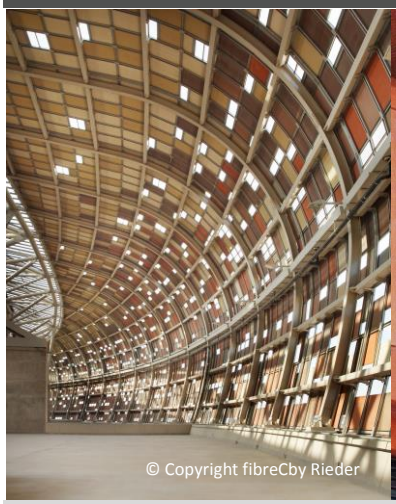
APPLICATION SHEET

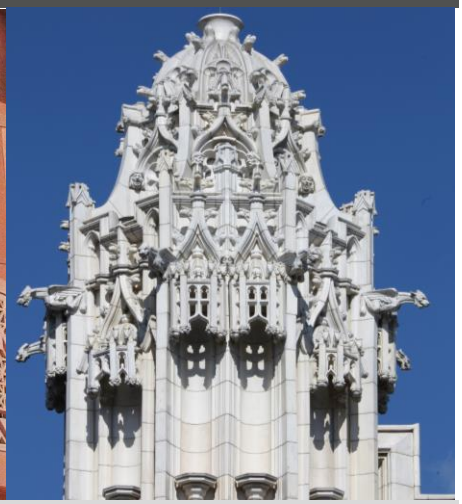
CEM-FIL® AR-GLASS FIBER SOLUTIONS FOR GRC

FAÇADE CLADDING



Soccer City Stadium, South Africa: 30,000 m² Cem-FIL® fibre panels

Masdar Institute, Abu Dhabi: pigmented and acid-etched GRC façade



Shepard Hall, City College of New York: 75,000 GRC elements replacing weathered glazed terracotta

DESCRIPTION

Cem-FIL® AR-glass fiber solutions for GRC gives architects and engineers a material from which the most ambitious designs can be created. Its versatility of shape, colour and texture enable it to be used to create complex modern forms or to replace traditional materials.

For the past 45 years Cem-FIL® GRC has been used to produce architectural facades on many of the world's most prestigious buildings in more than 120 countries.

BENEFITS

GRC has many characteristics which make it ideally suited for use as a façade cladding material:

- **Thin and light-weight**: rapid erection without heavy lifting equipment. Reduced load allows savings to foundation and structure costs, economical transport
- **Durable**: GRC will not rot or corrode, and is resistant to biological attack. No embedded steel, so no spalling or staining. Matrices can be modified to further enhance long-term ductility, reduce shrinkage, etc.
- **High quality matrix**: low permeability and a hard dense surface. Carbonation 1/10th the rate of regular concrete. High compressive and flexural strength. Low maintenance
- **Attractive and versatile**: can be formed with complex shapes, colours and textures. Can be used to accurately simulate natural materials (timber, rock, stone, etc.). Makes aesthetic solutions possible
- **Non-combustible**
- **Excellent acoustic performance**: The good transmission loss qualities of solid GRC can be further enhanced by incorporating acoustic insulation into the panel, or using shape to control the direction of reflected noise

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MATERIALS AND MANUFACTURING METHODS

There are 3 common processes for the manufacture of GRC façade panels, and the choice of the process will depend upon the size of panel to be produced, the applied loadings, and the panel complexity. In all cases the materials used for the matrix are similar, but different Cem-FIL® fibre types may be used as indicated below.

The basis of a typical GRC matrix is:

Cement	1 part
Sand	1 part
Water	0.3 – 0.35 parts
Cem-FIL® fibres	(quantities indicated below for each process)

This basic formulation can be adapted with the use of admixtures and additives to enhance the processing, appearance and performance of the GRC:

- Plasticisers – to improve workability and reduce water
- Accelerators or retarders to regulate the setting time
- Acrylic Polymer – to ensure that the thin panel gets an adequate cure and does not dry prematurely
- Metakaolin, Silica Fume or other pozzolans to enhance long term ductility
- Oxide pigments if an integral colour is required

	Simultaneous Spray	Premix-Spray	Vibration-Cast Premix
Typical fibre content	5% by weight	3 – 4% by weight	3% by weight
Typical fibre type	Cem-FIL® 54 or 61 Series Spray Roving	Cem-FIL® 60 Series Chopped Strands	Cem-FIL® 60 Series Chopped Strands
Description	Cem-FIL GRC façade panels are most commonly produced by the Simultaneous Spray process. In this process the spray gun is supplied with both a Cem-FIL® Spray Roving and the premixed mortar. The gun uses compressed air to atomise the mortar and chop the roving into strands typically 30 - 40mm in length, and sprays both materials simultaneously onto the mould surface where it is compacted with rollers. (For comprehensive details of the simultaneous spray process, refer to "Guide to Spray Manufacture").	Premix-Spray is a process which is becoming increasingly popular for the manufacture of smaller elements used in building facades (e.g. cornices and column facias). In this process the Cem-FIL® high-integrity chopped strands are mixed with the mortar and supplied to the spray gun through a peristaltic pump. Compressed air is used to spray the fibrous mortar onto the mould. (For comprehensive details of the premix-spray process, refer to "Guide to Premix Manufacture").	This process is the most similar to the manufacture of precast concrete. All materials are mixed together (with the Cem-FIL® chopped strands being added to the mix last) and poured into a mould, with the use of vibration to aid compaction. This process is not commonly used for façade panels, as the quantity of reinforcement is less than in the spray process, but it is used in producing mouldings which may complement the panels on a façade. (For comprehensive details of the premix process, refer to "Guide to Premix Manufacture").

APPEARANCE / FINISHES

In architectural applications the appearance of the façade panels is of great importance, and this is an area where GRC excels. GRC can be painted, faced with fine aggregates, coloured with pigments or stains, or it can reproduce any desired texture from the mould.

Durability of the finish is also very important. Because of the high cement content and impermeability of the matrix, GRC is less prone to carbonation than precast concrete, and has better resistance to aggressive environments (chemical exposure, freeze-thaw, etc).

Acid etching, sand blasting or surface retarders may be used to add texture to the surface of a GRC panel. If a GRC face coat needs to be reinforced, to reduce the risk of crazing, but the fibres should not be visible after the surface is etched, mono-filament Cem-FIL® fibres may be used (e.g. Anti-CRAK® HD).

Although GRC does not require the application of a surface sealer for waterproofing, these can be useful to reduce the accumulation of dirt on an architectural finish. Typical sealers include silane and siloxane.

The range of finishes for GRC can also be enhanced by the use of natural stone veneers (e.g. granite, marble, limestone, etc). In this case particular care should be taken regarding differential expansion and contraction of the two materials due to temperature and moisture changes. (Examples of suitable attachment methods for veneers can be seen in the "PCI Recommended Practice for GFRC Panels").

Samples of finishes

Panel assembly prepared for installation

FIXING AND JOINTING

As with all cement based materials GRC is subject to movement caused by changes in temperature and moisture conditions. The fixing system should make allowance for these movements of the GRC, and also for site and manufacturing tolerances, and movement of the structure. For example, with a 4-point fixing system, one of the lower fixings can be used to locate the panel while the others allow movement relative to it.

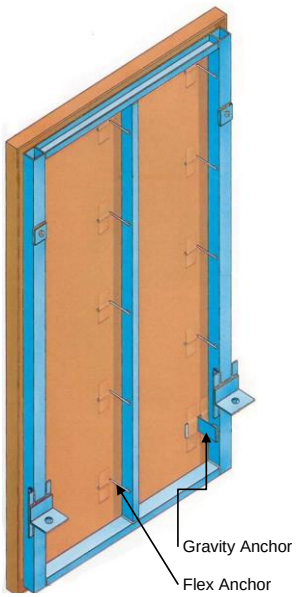
Where possible it is preferable for the weight of panels to be carried by lower fixings, so that the panel is in compression and is able to use its full flexural / tensile strength to resist applied loads.

In all cases the fixing system should be designed so that the force transmitted through the fixing is transferred to a sufficiently large area of GRC to ensure that the load is spread.

A popular system of fixing GRC façade panels uses a steel stud frame attached to the back of the GRC panel during manufacture by flexible steel anchors at 600mm intervals. This allows large and complex profile panels to be produced, handled and installed with ease.

Jointing systems must also be designed to make allowance for in-service movement, and preparation of the GRC surface should follow the guidelines of the sealant supplier.

(Details of the typical allowances for movement of GRC, and also examples of different fixing methods are shown in the "Cem-FIL® GRC Technical Data Manual", "GRCA Guide to Fixings for GRC Cladding", and the "PCI Recommended Practice for GFRC Panels").



Typical stud frame fixing assembly

DESIGN

The methods of designing GRC façade panels are well documented, and reference can be made to the "Cem-FIL® GRC Technical Data Manual", "PCI Recommended Practice for GFRC Panels", and "GRCA Practical Design Guide".

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SPECIFICATIONS

A number of Guide Specifications are available to simplify the specification and use of GRC and to give confidence to the user. These include: "Cem-FIL® GRC Typical Cladding Specification – Sprayed GRC"; "Specification for the Manufacture, Curing and Testing of GRC Products" (GRCA); "Recommended Specification for Manufacture, Curing and Testing of GRC Products" (NPCAA, Australia); "Guide Specification for GFRC" (PCI, USA).

ADDITIONAL CHARACTERISTICS OF CEM-FIL® AR-GLASS FIBER SOLUTIONS FOR GRC

Typical mechanical properties of Cem-FIL® GRC at 28 days

Property		Unit	Simultaneous Spray	Premix Spray	Vibration-Cast Premix
Fibre Content		Weight (%)	5	2.5 – 4.2	3
Bending Strength	MOR	MPa	22 – 32	12 – 14	10 – 12
	LOP	MPa	7 – 13	7 – 10	6 – 9
Tensile Strength	UTS	MPa	8 – 12	5 – 9	4 – 7
	BOP	MPa	5 – 7	4 – 6	4 – 6
Compressive Strength		MPa	50 – 80	40 – 60	40 – 60
Shear Strength	Inter-laminar	MPa	3 – 5	N/A	N/A
	In-Plane	MPa	8 – 12	4 – 7	4 – 7
Impact Strength		kj/m²	10 – 25	10 – 15	10 – 15
Elastic Strength		GPa	10 – 20	10 – 20	10 – 20
Strain to Failure		%	0.6 – 1.2	0.2 – 0.3	0.1 – 0.2
Dry Density		t/m³	1.9 – 2.1	1.8 – 2.0	1.8 – 2.0

Cem-FIL® AR glass fibres are manufactured under a quality management system approved to ISO 9001. Cem-FIL® fibres are not classified as dangerous by the regulation 1272/2008/EC.

Information about any aspect of the use of Cem-FIL® fibres and/or performance of GRC may be obtained from the regional representative of Owens Corning or their local distributor.

For further info please send a email to: cem-fil@owenscorning.com / www.cem-fil.com

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