Registered in England No. 05064069
VAT Reg. No. UK 833 9936 86

Cement Composites Technology Ltd

►*Expert assistance with GRC*◄

PREMIX GRC

Introduction

Premix GRC products are made from a mixture of 1:1 cement and sand slurry with chopped strands of Cem-FIL AR glass fibre blended in. This mixture is then poured, pumped, sprayed or hand-laid into a mould.

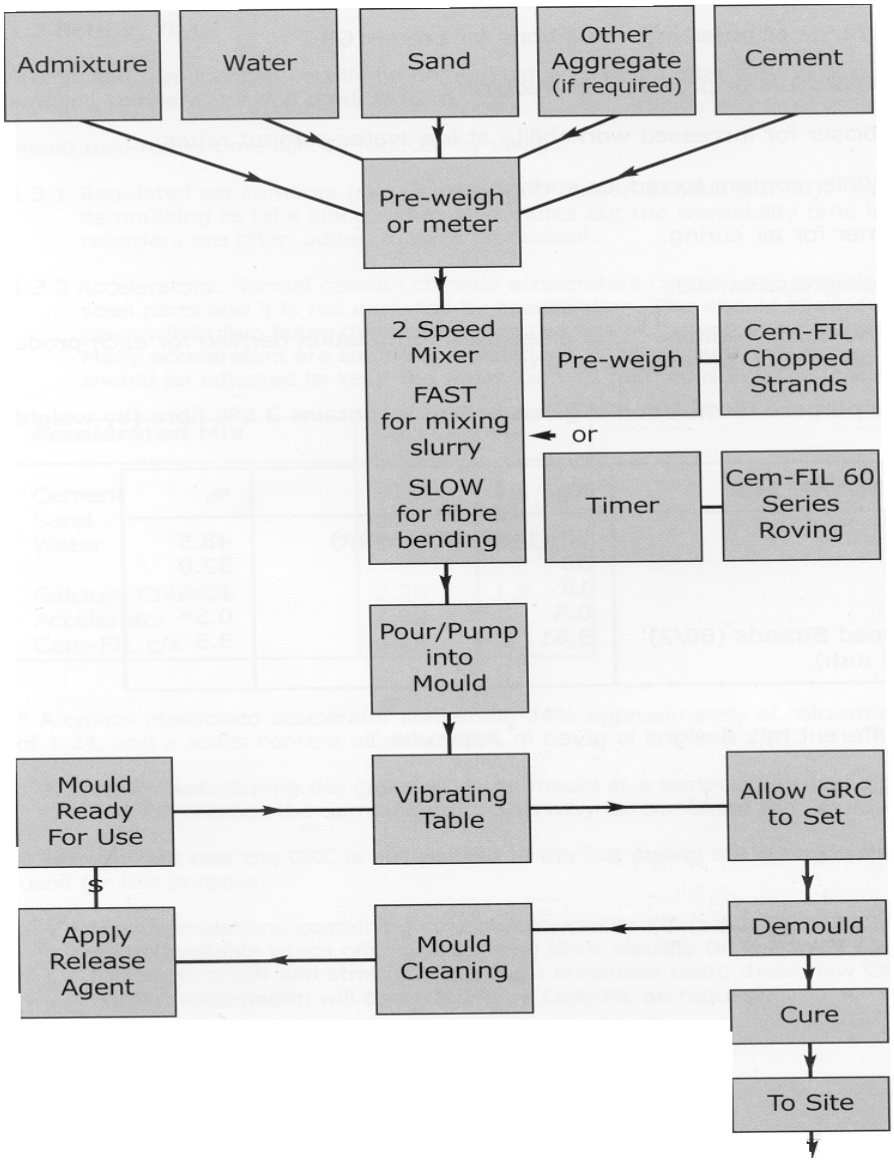
The premix process is relatively simple to control and mechanise. It is capable of manufacturing products with good dimensional control and complex components can be made with relative ease starting with a low capital investment and building up as demand increases.

The process has low material losses together with accurate and reproducible detailing. A wide variety of product shapes can be made, these only requiring moulds for the product to be made.

It is, however, labour intense until industrial quantities of standardised products are made with a substantial investment in equipment.

13 Yewdale, Shevington, Wigan, WN6 8DE, England
Tel +44(0) 1257 425 423 Mb +44(0) 777 069 7941
E-mail *info@cemcotec.com*

Schematic Production Cycle for Premix GRC



A typical GRC factory will consist of 500-1000sq.m. covered area and outside storage equivalent to the overnight storage area multiplied by to number of days that a product has to be held before delivery, usually 1-2 weeks.

Space will also be needed for Quality Control and Offices

Mix Design

Since a wide variety of raw materials can be used to make GRC and each product has its own unique blend of properties, it is only possible to provide guideline mix designs. Final mix formulations will need a degree of trial and error so as to achieve the desired rheological and mechanical properties for the equipment used and the end application requirements.

ALWAYS keep the water content as low as possible using admixtures, good mixing and good mould design. Water reducing admixtures, particularly the recent ones developed for self consolidating concrete, greatly improve the fluidity of premix GRC but care has to be taken to avoid segregation of the sand and fibre in such mixes. The use of Viscosity Modifying Admixtures [VMA] is recommended to improve flow without segregation in highly fluid formulations.

The type of sand used can have a considerable affect on the mix. Dry bagged, silica sand to a specified grading is strongly recommended. General purpose dried, building sands can give variable results and should be suitable evaluated before being used in production. Bulk, non-dried building sand are not acceptable and will create expensive production problems. They frequently contain higher percentages of ‘fines’ which increase the water demand and reduce fluidity. Bulk sands are usually moist with at least 10% water which is variable and therefore they should not be used.

Use adequate fibre content. Small items can be made with only 2% of AR fibres but generally 3% should be considered as a minimum. Larger items will need even more fibre and premix with 4.0% fibre have been successfully made but do require skill and expertise.

Acrylic polymers should be used for all but the smallest, non critical products. Their main function is to ensure adequate curing of the GRC without draconian curing regimes and to reduce the permeability of GRC products. However, they also greatly improve the fluidity of the mix reduce segregation and improve surface appearance. Long term properties are also improved especially strain capacity

If major improvements to long term strength are of paramount importance, particularly strain capacity, the use of a pozzolan material should be considered. Metakaolin of a particular reactivity has been found to work well and it also significantly reduces efflorescence.

General Purpose Mix

Material	[kg]
Cement	50
Dry, Silica Sand	50
Water	13-14
Polymer* [50% solids]	5
Superplasticiser [%]	0.1->1.0
AR fibre CS 6 or 12mm	2.5->3.5

*This can be supplied by Cement Composites Technology Ltd

If the mix has specific requirements then other admixtures can be usefully employed e.g. pumping aids, accelerators or retarders, pigments or special rapid-setting cements.

Mixing Process

The key to making good premix GRC is:

1. To make a "creamy" mortar by using a high energy mixer which shears the wet cement particles down to small particles [not larger lumps]

2. Followed by a gentler "folding" in of the fibre. High shear can also be used to incorporate the fibre but mixing time MUST be kept to an absolute minimum to prevent damage and filamentisation of the strands.

Mixing procedure

Add all liquid ingredients into the mixing vessel and start the mixer. It is good practice to keep back a known quantity of water. Since cement varies, slurry consistency can also vary and a good operator can make minor adjustments.

Add the sand and start the mixer

Add the cement at a steady rate and continue mixing until a "creamy" consistency is achieved. It should still be a very fluid mix for casting and spraying but thicker for hand applied mixes.

Quickly add the fibre avoiding large, bundles; this will speed up incorporation. Mix for the minimum time possible until no dry fibre is visible usually 1-2 min. If a shaft type mixer is used, it is important not to leave this turning for a long time after fibre addition has started as the high shear action will damage the fibre.

Pre-chopped fibre can be added by hand or, for larger production via a vibrating chute. Fibre rovings can be chopped directly into the mix with automated dosage by using specially designed equipment.

The mix will look thick but will cast with a little vibration [avoid excessive vibration which can result in segregation]. For difficult mouldings the use of special anti-segregation additives may be necessary. Trowels and screeding bars can be used to assist placing on large flat areas and will help to prevent segregation. *The mix will thicken with time* so only mix as much as can be placed within 30 min [less if hot, more if cold] particularly if complex 2 part moulds are to be filled.

Do not use old cement.
Do not use sands with excess of fines or wet sand
Do clean the mixer especially the blades. GRC is very difficult to remove once set.

Mould filling

The basic principle is to fill a mould so as to sweep out air and not trap it. Therefore, the mix must be correct for the mould - fairly fluid for flat mould with no returns or complex closed moulds, stiffer for moulds which are to be hand-laid.

Always fill from one central point to avoid multiple flows meeting with the risk of fibre free zones where the flows meet; these areas would be prone to crack propagation.

If a high quality finish is required, the mould is frequently sprayed with a ‘mist-coat’ prior to placing the GRC. The mist coat is usually the initial cement;sand slurry [excluding fibre] which is sprayed in using a hopper gun. [Small additions, 0.1->0.5%, of water dispersible AR fibre will help to reduce or eliminate micro-cracking of the mist coat].

Generally, if the mix is correctly made, it will pour or can be placed into a mould without any difficulties. However, pouring the mix via a vibrating plate will speed up casting, helps to limit air entrapment in the mould and partially degasses the GRC prior to filling the mould.

Placing the premix with a peristaltic pump also reduces air content as well as reducing labour fatigue thus increasing productivity.

Over the past few years, the technique of spraying premix into the mould has become increasingly popular. It has the advantage of simpler 1-part moulds, like hand-lay placing, but at a rate of 15-20kg/min so greater productivity is possible. Spraying large, near vertical areas is also possible with sprayed premix.

The Moulds

The moulds themselves can be made from wood, steel, FRP or rubber depending on the numbers to be cast and the complexity of the finished products. Avoid sharp corners and include tapered sides. Ensure that all joints are tight to avoid flash marks and that the construction is strong and stiff enough to avoid distortion.

The mould should be easy to dismantle, clean and re-assembled. Avoid sharp corners and include a minimum of 5º taper. Cleaning should take place immediately after demoulding.

Premix GRC products are normally 12 or 15mm thick so the moulds need to be constructed for this thickness.

Use the correct release agent for the material used in the construction of the mould. Use good quality release agents preferably chemically based. Cheap ones can result in poor surface finish, poor demoulding and can prove to be more expensive because of the extra work in demoulding and finishing after demoulding. A well made product should need very little post demoulding work whereas a poorly made one could require hours of extra work and still look patchy.

Once filled, the moulds should be kept covered in a frost free environment. **It is important to remember** that the setting rate for any Portland cement based product, including GRC, is determined by the temperature. If the temperature approaches 0^0C, then the product will not set overnight and will break on demoulded. Therefore, it is worth keeping the moulds together and covered in an area where the temperature can be maintained above 5^0C as a minimum and 10^0C by preference. In cold conditions the use of an accelerator is recommended.

Demoulding

It takes more time to demould, clean and re-apply release agents than it does to fill the mould so some prior thought about the best way of demoulding can save time and money as well as avoiding expensive breakages.

A steady force is always better than hammering the mould so inclusion of lifting points to the GRC and restraining the mould will help.

If the finished product requires a core as part of the mould, this can often be removed a few hours after casting before the GRC has shrunk and set onto it. If it can be made from a flexible material or a ribbed material with a rubber sleeve this will facilitate the easy removal of difficult cores

The demoulding of large surface area products can be aided by the inclusion of compressed air-release valves in the mould or by forcing compressed air down the side of the mould to create the first separation.

Manpower

It is difficult to specify manpower requirements since this will depend on the complexity and number of units to be made, the quality of the labour and the factory layout and suitability together with the equipment purchased.

Generally, the minimum team should consist of 3 men. One for mixing and general help, one for mould filling and the third for compaction and filling in of edge details, trimming of excess, checking thickness etc. All 3 are used to demould, clean and apply the mould release. At least one of the team should be capable of finishing the demoulded product. If correctly made, there should be very little 'make good' work. However, corners and edges are susceptible to voids being left and pin holes are also possible. These are easy to fill in provided they are not excessive.

As a guideline, 3 men should be able to produce approximately 250-350kg [8-12sq.m./day] of premix GRC finished products containing a simple profile to architectural standards. Standardised products will have increased production rates and more complicated, short run elements will need more labour.

Curing

After demoulding, if GRC product contains an acrylic polymer, then it simply needs to be kept at ambient temperature for several days avoiding excessive heat or winds.

If no polymer is used then the GRC needs to be kept in a 95% RH atmosphere for 7 days so as to avoid dehydration and severe loss of strength

Fine tuning

- Adequate strength of a finished product is first a matter of design then a function of production control and regular quality checks.

- Well made GRC is basically impermeable to water. However, care is needed to ensure that no cracks or pin holes are inadvertently introduced and that voids are not locally created.

- Once cured, GRC is an extremely tough material so it will stand abuse without actually failing. However, it can be over-stressed when it is young resulting in hair line cracks which can allow water penetration. Care should be taken particularly during demoulding and early handling but also during transport and avoid site abuse.

- Care should be taken to avoid bundles of dry fibre being only partially distributes. If pin gauges are used to check the thickness, these holes must be well compacted afterwards.

- The use of acrylic polymers will substantially improve the impermeability of GRC. Since it also helps to make better, stronger GRC, it is highly recommended for premix elements.

- If a decorative facing mix is to be included in the product, then this will be prone to micro-crazing. This can be reduced or eliminated by using 0.1-0.5% of 3 or 6mm water dispersible AR fibre in the mix.

- Also, avoid rebound [dry sand collecting in the corners] when the face mix is sprayed in.

- If there are difficult recesses to be filled in the mould, as in highly decorative architectural products or engineered type elements, then substituting 6mm fibre instead of 12 mm will result in a more fluid mix with very little, if any, loss of strength.

- The pore structures in the GRC can also be reduced by the use of a pozzolan such as silica fume or reactive metakaolin. Basically, pozzolans react with the lime generated when cements hydrates thus replacing soft, soluble lime crystals with hard cement hydrate. They also reduce or eliminate efflorescence

Examples of Premix GRC Products

Acknowledgements

The writer wishes to thank O.C.V Reinforcements for permission to use some data from their published literature