

Sprayed premix – the new GRC

This first techNOTE in a series of technical notes covering aspects of glassfibre reinforced concrete (GRC/GFRC) technology describes an evolutionary production technique – sprayed premix – which finds application for the manufacture of relatively small but intricate components, often as architectural details in house construction.

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Over the coming months we will be publishing a series of technical notes covering aspects of glassfibre reinforced concrete (GRC) technology.

Sprayed premix is a relatively new method of producing GRC products and it can be used to replace or complement the traditional production methods of hand sprayed and vibration-cast premix. The fibre is added to the matrix during the mixing process and the mixed fibre and matrix are pumped to a spray gun and sprayed onto the mould.

The advantages compared to vibration cast are:

- Vibration-cast premix requires complex moulds, which as well as being expensive to produce are also time consuming to strip and reassemble.
- As sprayed premix, GRC can be sprayed directly onto vertical sides and mould returns; an inner mould as used in vibration-cast premix is not necessary.
- It is difficult to produce stone finishes with the vibration-cast process, and the range of products that can be produced is limited.

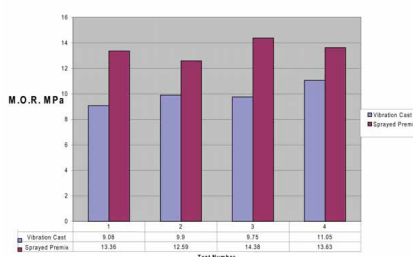
There are no such limitations with sprayed premix. Tests using the same mix design and fibre content have shown that higher flexural strengths are obtained compared to vibration-cast premix. It is believed that this is due to the spraying resulting in a more two-dimensional fibre orientation compared with the random three-dimensional array with conventional premix.

Figure 2 shows the results of four separate comparisons.



Figure 1: With sprayed premix, the fibre is added to the matrix during the mixing process and the mixed fibre and matrix are pumped to a spray gun and sprayed onto the mould.

Figure 2: Comparison of sprayed premix/vibration cast premix.



In each case, a 60kg batch of premix GRC was prepared in a variable-speed mixer. After mixing, half the batch was sprayed onto sample moulds and half was cast using vibration. Curing and storage was identical for each method and hence the only difference must be down to the production method. The increase in flexural strength averaged 35%.

Comparison to hand spray

Spraying premix is a much simpler process than conventional hand spray. It is less labour-intensive and requires less skill. The spray gun is smaller and there are fewer hoses, making the spraying of small products easier. Although established manufacturers with trained staff are capable of producing high-quality hand-sprayed products, newcomers to the industry find the technique difficult.

Producing high-quality hand-sprayed GRC requires rigorous factory control and it is necessary to:

- Use a low water:cement ratio
- Ensure a glass fibre content in the range 4–5.5%
- Calibrate the spray equipment regularly (bag and bucket tests)
- Measure the glass content (wash-out test)
- Spray the GRC in two or three passes, with compaction between every coat
- Cure the GRC while it is in the mould and after de-moulding
- Spray daily sample boards and carry out flexural testing at seven and/or 28 days.

If all the above is performed regularly then the anticipated properties can be achieved. If not, then material of indeterminate quality will be produced.

The fibre-dependent mechanical properties, particularly tensile and flexural strength, are lower than the properties that can be achieved with hand spray. Grade 18 GRC (characteristic flexural strength of 18MPa) will not be obtained with this production method but Grade 10 can be comfortably achieved. Although some mechanical properties are lower it is much easier to achieve them consistently.

The fibre content is determined by weighing. There is no calibration or 'bag and bucket' tests and washout tests are unnecessary. The mix has to be strictly controlled. If the water:cement ratio is too high or too low then spraying is difficult or impossible.

Compaction is used to ensure a good surface finish but it is not required to expel air or to ensure that the fibre is encapsulated by the cement.

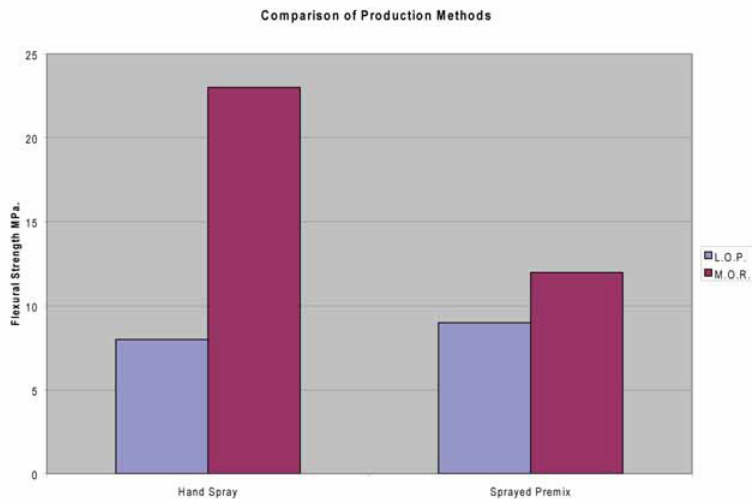
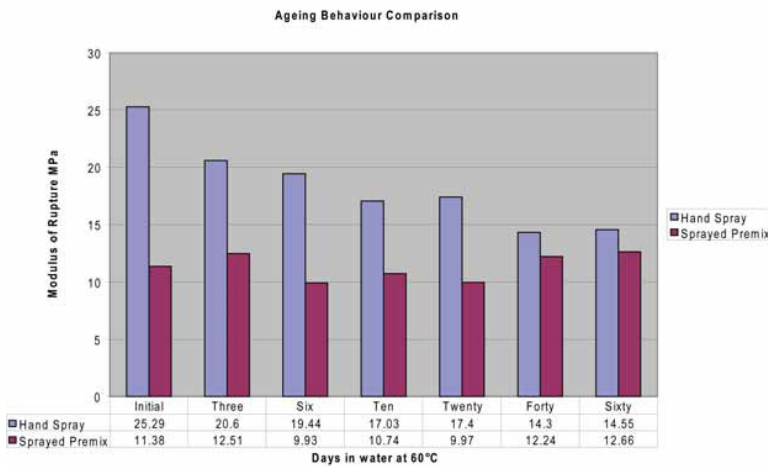
The sprayed material is homogeneous and unlike hand spray, over-sprayed material can be used, thus reducing wastage. As the properties achieved are more consistent, fewer sample boards are required, which in turn reduces testing costs.

The equipment is much easier and quicker to clean and uses less water. As the moving parts of the pump do not come into contact with the mix then it can be used for faster-setting materials.

Aged properties

The change in time with certain fibre-dependent properties is well understood and is allowed for in conservative design rules. With hand spray the decline can appear quite dramatic, although in the fully aged state there remains a significant factor of safety.

For sprayed premix with lower initial properties, the decline is very small and the 28-day properties are very similar to the fully aged properties. In practice, this can mean that the potential for an in-service failure is removed.



Essentials to produce a good-quality sprayed premix

In order to produce consistent high-quality sprayed premix GRC, the following are required:

High-quality raw materials

It is particularly important that the alkali-resistant fibre should be formulated for use in premix; chopped hand spray fibre is not suitable.

Specific mix design

A suitable mix design should be established and once determined must be used consistently.

Controlled batching/weighing of materials

In order to maintain consistency, controlled batching/weighing of raw materials is important. Dry materials can be used from weighed bags but the water, polymer and other liquid additives should be automatically batched and dispensed.

Mixer designed for premix GRC

High shear mixing is required for producing the sand/cement slurry but the fibre must be blended into the mix at slower speed. A mixer specifically designed for premix GRC should be used.

Premix spray station comprising pump and spray gun

A peristaltic-type pump is required together with a premix spray gun.

Figure 3: Comparison of production methods.

Figure 4: Ageing behaviour comparison.

Sprayed premix produces GRC with consistent properties (some mechanical properties are lower but they are more stable) and the fibre content is guaranteed. The process is much simpler than traditional hand spray and is less labour-intensive. As labour costs increase, sprayed premix will become increasingly popular.

Further Information

The technical note is a result of development work over a number of years and was presented in full at the 2005 GRCA International Congress, in Hong Kong.