

This series of Good Practice Notes covers issues which users and specifiers may wish to consider when working on projects featuring cladding products manufactured from glass fibre reinforced concrete (commonly referred to as GRC or GFRC)

## GOOD PRACTICE GUIDE 1 SPECIFICATIONS & ITP

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The importance of a strict approach to quality control and conformity assessment testing has been an integral part of GRC manufacturing since the introduction of the composite 50 years ago. Established processes and procedures must be strictly followed, given GRC is recognised as the most complex material widely used in current construction practice (as per Bartos<sup>(1)</sup>).

Although advances have been made with the introduction and development of the GRCA *Specification*<sup>(2)</sup> and BS EN 1169<sup>(3)</sup> these publications only cover minimum general requirements for both spray and premix production methods. As such, they cover basic manufacturing and are generally not comprehensive enough for large and high-rise construction projects using the spray process, which is the method recommended for elements with a large surface area such as cladding elements.

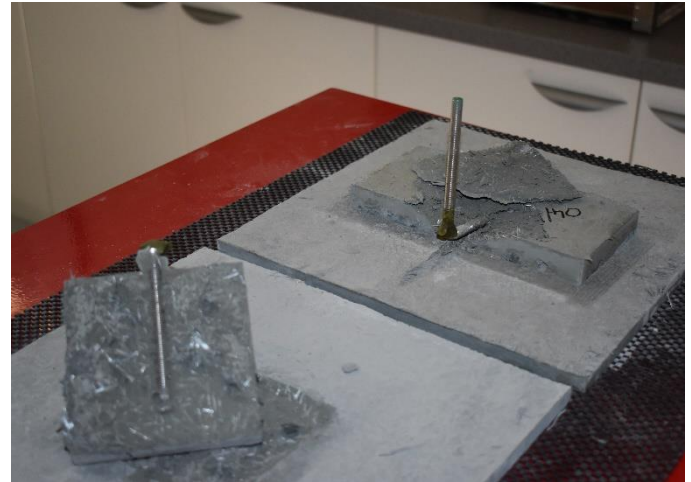
### Prestressed/Precast Concrete Institute Standards

The American PCI MNL-130-09<sup>(4)</sup> has been developed, primarily for this market and is far more robust. While this covers some 180 pages, the GRCA and BS EN equivalents are 17 and 10, respectively.

As well as enhanced quality process control for the actual material this standard expands to cover the actual application when products will form part of large scale or high-rise cladding developments.

Additional considerations that are covered in PCI-MNL-130-09 that are not included with the UK/European standards include:

- **Certification of Quality Control personnel**
- **Design responsibilities**
- **Aggregate testing**
- **Development of project samples**
- **Facing mix evaluation and testing**
- **Application of veneers including brick and stone**
- **Fixing anchors and inserts good practice and testing**
- **Application of surface coatings**
- **Product tolerances**



Anchor bonding pad test – as required under PCI-MNL-130-09. Not required under EN or GRCA standards

GRC Centre laboratory

### Considerations when specifying GRC/GFRC

It is essential when specifying GRC/GFRC for large scale or high-rise applications that a methodical approach is taken to determining required standards.

Given that all the standards mentioned overlap in some ways and that some are more robust than others in individual parts the specifier should research each one and determine what requirements should be incorporated into the specific project requirements

As an example, there is no merit in having compliance specifications for facing coats if the production does not include this. Conversely if a facing coat which consists of a different mix design to the structural GRC/GFRC is to be used all aspects need to be considered and evaluated through testing.

Another area that the specifier should consider is that of testing both in regards frequency and independence.

Frequency of testing varies enormously within all the published standards. Critical testing can be mandated once a year or everyday dependent on which standard is chosen. Often specifications will refer to both BS EN 1169 and the GRCA Specification which are totally contradictory in relation to frequency.

The frequency of testing should reflect the potential consequence of failure which is the case of high-rise buildings is significant.

How the tests are carried out is also of critical importance. Some of the current standards recommend testing of finished products however all have alternative methodologies for testing specially prepared test boards.

With a hand produced product that may be over 10 times the size of a sample board and be of a complex geometrical shape rather than a simple flat panel it would seem obvious the critical inputs such as method of spray application and compaction will not be the same. On this basis GRC/GFRC panels are being installed on buildings some of which are 200-300 metres tall without any validation of the material properties.

Sense would dictate that on any large project a percentage of the manufactured population is tested for compliance



Sample from finished product being tested for facing coat/structural GRC thickness

GRC Centre laboratory

The conformity of the testing competency and independence should also be considered. Whilst most testing is done in-house by the manufacturer there should be also be validity testing by independent and impartial testing laboratories.

## Inspection and Testing Plans

The provision of an ITP is not required under any current standard however they are an incredibly valuable tool that is essential in the production of high quality GRC/GFRC products.

The ITP should be prepared from the specification. In this way it will reflect every single process required to take the finished product from design to despatch. It can also of course be extended to include logistics and installation if required.

The basic principle of a good ITP can be summarised as below:

## WHAT NEEDS DOING

## WHEN DOES IT NEED DOING

## WHO TAKES OWNERSHIP

## WHERE IS IT RECORDED

Once published the ITP will create the benchmark for every single task within the delivery cycle.

It squarely places responsibility for each step with an individual or an organisation and it along with the associated reporting documentation creates a reliable part of the finished projects OEM manual

## Summary

A well-constructed specification and associated ITP that is carefully monitored throughout the product delivery cycle will repay the investment many times over.

The adoption of project specific quality and testing requirements along a monitored system of inspection and testing also provides a unique “golden thread” traceability in the unlikely event of any issues

## INSPECTION & TESTING PLAN

Project Title	
Client Details	
Manufacturer Details	
Inspection and Testing Plan Ref	

Revision	Date	Reason

Prepared By:	Name	Signature	Date
Approved by Main Contractor:			
Agreed by manufacturer:			

Ref	Activity	Control Document	Frequency	Requirements	Responsible	Record Documentation
<b>SECTION 1 - PRE-MANUFACTURING DOCUMENTATION</b>						
1.1	Inspection & Testing Plan	This document	Before manufacturing	To be agreed by all parties	TBA	N/A
1.2	Quality Management System	Manufacturers QMS	Before manufacturing	To be agreed by all parties	TBA	N/A
1.3	GRC Fabrication Details	Documentation	Before manufacturing	To be agreed by all parties	TBA	N/A
1.4	GRC Fixing Details	Documentation	Before manufacturing	To be agreed by all parties	TBA	N/A
1.5	GRC Engineering Calculations	Documentation	Before manufacturing	To be agreed by all parties	TBA	N/A
1.6	Repair and Finishing Procedure	Documentation	Before manufacturing	To be agreed by all parties	TBA	N/A
<b>SECTION 2 - PRE-MANUFACTURING APPROVALS</b>						
2.1	6Nr Representative Samples	Sample Approval Report	Before manufacturing	To meet client acceptance - VMU	All Parties	N/A
2.1	Facing Mix Evaluation	GRC Centre Evaluation Report	Before manufacturing	Best practice compliance	GRC Centre	GRC Centre Report
2.2	Polymer/Curing Process Approval	Manufacturers Data Sheet/Method Statement	Before manufacturing	Meets GRCA Requirements	GRC Centre	GRC Centre Report
2.3	Logistics Proposals	Delivery Plan	Before manufacturing	Meets established best practice	GRC Centre	GRC Centre Report
2.4	Design Engineering Review	Engineering Calculations	Before manufacturing	Meets established best practice	GRC Centre	GRC Centre Report
<b>SECTION 3 - MOULD FABRICATION</b>						
3.1	Identification of moulds	Specification/ITP	Before released to production	Fully referenced	TBA	TBA
3.2	Final mould inspection	Specification/ITP	Before released to production	Meets agreed tolerances	TBA	TBA
<b>SECTION 4 - RAW MATERIALS</b>						
4.1	Purchase of materials	Specification/ITP	Each order	All meet applicable standards	TBA	TBA
4.2	Reception of materials	Specification/ITP	Each Delivery	Retain delivery notes/maintain schedule	TBA	TBA
4.3	Retention of samples	Specification/ITP	Each Delivery	Retain in accordance BS EN 1169 4.1/4.2	TBA	TBA
4.4	Stock rotation	Specification/ITP	Throughout project	BS EN 1169 4.3	TBA	TBA
<b>SECTION 5 PRODUCTION</b>						
5.2	Slump Test	Specification/Tender Supplements	Minimum four times daily until consistency obtained using digital readouts	Number of rings to be advised by mfg	TBA	TBA
5.3	Replace all cutter blades	Specification/ITP	Before work starts each morning	N/A	TBA	TBA

Sample of a project specific Inspection and Testing Plan

### References

1. BARTOS, P.J.M. *Glassfibre Reinforced Concrete: Principles, Production, Properties and Applications*. Whittles Publishing, Dunbeath, August 2017.
2. THE INTERNATIONAL GLASSFIBRE REINFORCED CONCRETE ASSOCIATION. *Specification for the Manufacture, Curing and Testing of Glassfibre Reinforced Concrete (GRC) products*. GRCA, Northampton, revised February 2021.
3. BRITISH STANDARDS INSTITUTION, BS EN 1169. *Precast concrete products. General rules for factory production control of glass-fibre reinforced cement*. BSI, London, 1999.
4. PRECAST/PRESTRESSED CONCRETE INSTITUTE, PCI MNL-130-09. *Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products*. PCI, Chicago, USA, Second Edition, 2009.