# Developing a new generation of quality control for GRC

**Quality is of the essence when talking about production of glass-fibre-reinforced concrete (GRC) elements for the building industry. Now a new breed of quality control for production of GRC is seeing the light of day; a quality control method that can potentially increase both precision and efficiency. A method based on 3D scanning.**

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As Industry 4.0 technologies are slowly but surely making their entry into the building industry, they are also making their entry into GRC production, which is supplying the construction sector with GRC elements primarily for façades and balconies. We have already seen the first tests with 3D printing of moulds and RFID augmentation of production. And now 3D scanning is being introduced.

Working in conjunction with the Centre for Information Technology and Architecture at The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation (CITA) and Tick Cad, BB fiberbeton is developing a quality control method based on 3D scanning in a project called Precision Partner.

**An InnoBYG project**

The Precision Partner project is a project under InnoBYG – a partnership with many of the leading knowledge institutions in the Danish construction industry. InnoBYG aims to create, collect and apply new knowledge on energy efficiency and sustainability in the building industry. InnoBYG is co-funded by the Danish Ministry of Higher Education and Science.

The Precision Partner project was accepted under InnoBYG as an innovation project as it explores methods of bringing Industry 4.0 technologies into use in new ways. Besides being funded from InnoBYG, the rest of the funding is provided by the participating parties – BB fiberbeton, Tick Cad and CITA.

**Figure 1: Spray-casting of GRC.**

Figure 2: GRC used as exoskeleton at Penta Investment's Sky Park by Zaha Hadid.

**Quality is key**

As with many other materials for the building industry, quality is at the core of production – and so also for GRC. Of paramount importance is the strength of the concrete mainly stemming from a correct mixture, including the dosage of glass fibres and from the actual production process of compacting the concrete slurry with the fibres. When the strength of the material is assured, other quality aspects can be addressed. After strength, the most important attribute is quality of the moulds, as GRC manufacture is predominantly a mould-based production.

GRC is most often used as the defining part of a building's geometry. It is the GRC elements that help shape the external character and aesthetics of the building (Figure 2). Achieving quality in the aesthetics starts with the moulds in which the GRC elements are cast. This is in terms of both surface and geometry. As GRC is extremely fine in its character, it takes everything from the mould – every small inaccuracy will be visible in the finished elements. If elements are out of geometry, the building will not look as intended. In other words, in order to achieve the intended look using GRC elements, the moulds need to have the correct geometry.

Production quality for GRC is extremely important. GRC is not 'just GRC'. The craftsmanship going into the production is high – and higher than for most other façade materials.

When selecting a supplier of GRC elements, it is very important to choose a producer with thorough and externally verified quality systems, factory control, and documented material strength, eg, a producer that is a GRCA full member.

**Introducing 3D scanning**

The Precision Partner project proposes a new way of ensuring correct mould geometry using 3D scanning and comparing this point cloud data with existing 3D modelling (eg, BIM model) of the element in question. This is both during mould building and as a quality-control check before casting.

Furthermore, the project explores 3D scanning as the final geometry control check of the finished GRC elements, prior to packaging and shipping.

The aim is a further digitisation of the production environment and to improve precision and quality control in both the mould-making process and the finished element by enabling direct and easy measurement, and checking processes against a digital model – straight from the factory floor.

**The first steps**

Initially, the project has focused on getting closer to the correct scanning methods. This has meant scanning of both moulds and elements (Figure 3). A range of different scanners and settings have been tested to best capture both small- and large-scale moulds, while not getting too much or too little data in order to compare with the digital model of the element.

Second, these point clouds (scanning data) have been compared with the digital models and reports generated

Above: Figure 3 – Picture of point cloud from scanned mould.

to show deviations (see Figures 4 and 5). Reports have been established and almost any parameter can be highlighted and shown in an easy to read manner.

As soon as the comparison is complete, the report generation is the easiest part. The tricky bit is to ensure the alignment between the point cloud and the digital model is correct.

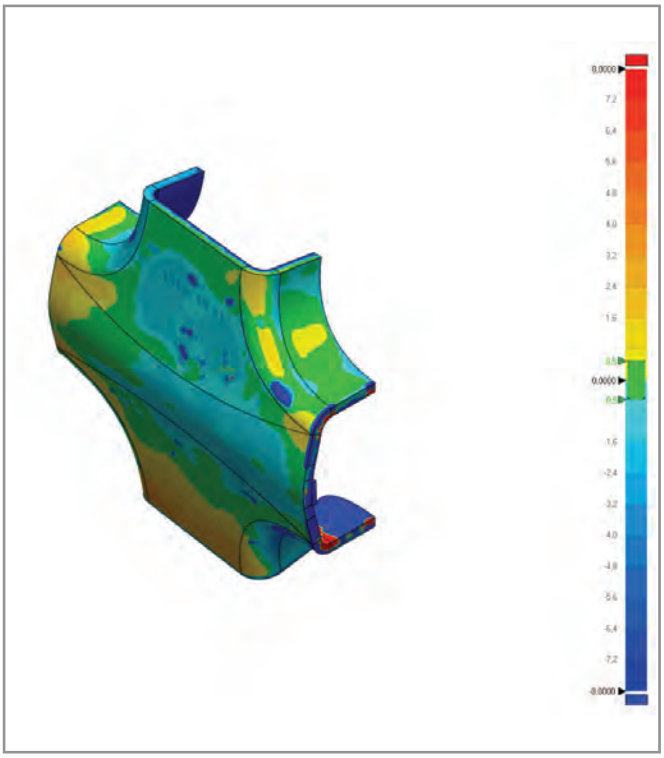
**Challenging aspects**

Aligning the point clouds with the digital model requires precise reference points. So far, this has been a task for skilled and experienced technicians. It is a question of best possible positioning to distribute deviations equally and not have alignment on one side and large deviations on the other side. When done skilfully, it is very insightful to watch and extract data. But to make this alignment is tricky.

Currently, the project is working on the solution for this alignment, to be undertaken either automatically or at least with the fewest steps possible to perform from the factory floor.

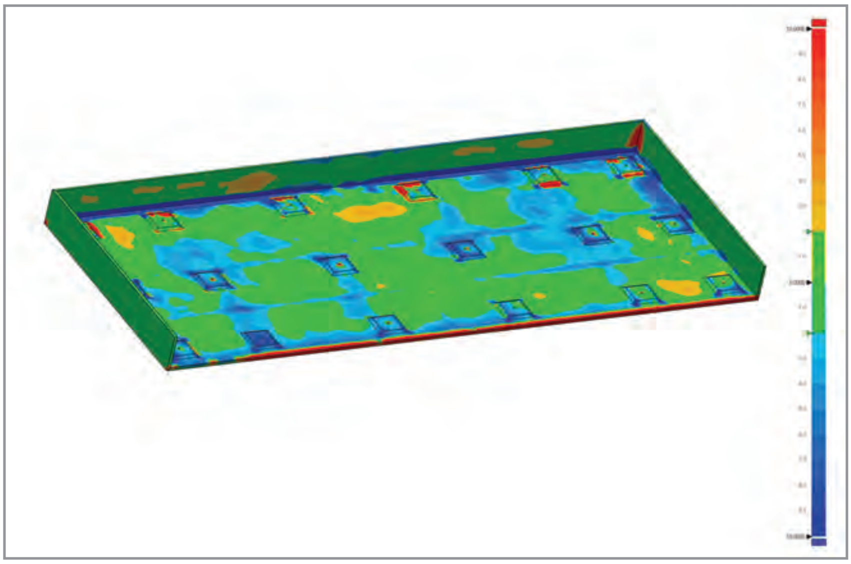
**The route ahead**

The Precision Partner project looks to develop a mobile 3D-scanning station that provides direct feedback to the physical craft-based production. A robotic arm will hold the 3D scanner and screens will allow for comparison and feedback to the craftsmen. In order to achieve this,



Above: Figure 5 – Comparison of complex shape with digital model.

Below: Figure 4 – Comparison of simple mould with digital model.



an automatic comparison between the captured 3D point cloud and the digital model is being developed. The automated comparison needs to be able to give easy-to-understand feedback to the production, showing deviations both during mould building and before casting is commenced.

Closing the gap between vision and reality, the project partners are optimistic in achieving these goals by summer 2020. ■