Clad rack for Quinn Glass

Photo: Quinn Glass

Figure 1: A pneumatic integration machine.

Twintec Industrial Flooring of Rugby, part of the Twintec international group of companies based in Luxembourg, has recently designed and installed a steel-fibre-reinforced concrete (SFRC), pile-supported foundation slab for Quinn Glass, manufacturer of 750 million glass containers each year, at its new plant at Elton, Cheshire. Quinn Glass project managed the works in-house with Babtie carrying out the structural engineering work. The facility, the first of its kind, will provide a 'one-stop shop' for the production, storage and filling of product for the drinks industry.

DARRYL EDDY, TWINTEC INDUSTRIAL FLOORING

Project challenges

As part of this £200 million development, Quinn Glass is constructing a 'clad rack' warehouse that will become the largest individual pallet storage facility in Europe. The structure will be 35m high, cover an area of 52,000m^2 and contain 282,000 pallet storage spaces. With such a building, the floor slab is constructed first and the main structure fixed directly to the floor. The demands placed upon the slab by the structure were high, with the entire slab suspended on 425mm continuous flight auger (CFA) piles on a grid of 3.6 × 3.6m. The most critical load pattern was four legs placed just inside two rows of piles. The equivalent unfactored line load was 178kN/m with an equivalent uniformly distributed load (UDL) of 75kN/m^2. The design also assessed the tolerance on the pile position that was highly critical with regard to the level of the stresses. The flatness tolerance for the whole of the floor area had to achieve The Concrete Society Technical Report 34[(1)] classification FM2. There were a number of methods that Twintec employed in order to overcome these challenges:

Design

The solution for this project was a simply supported, jointless, flat slab, 400mm-thick and reinforced with 45kg/m^3 of advanced fibre technology (AFT) +1/60 steel fibres. A 3.5m-wide strip of bottom reinforcement (T25 straight bar @ 200mm centres) was used along two edges of the building to cater for uplift forces, but apart from this no additional structural bar reinforcement was required. The floor concrete was C40 with 0.5 water/cement ratio and a flexural strength of 4.6MPa. The adopted design checked both serviceability limit state (SLS) and ultimate limit state (ULS). SLS controlled the cracking and deflection of the concrete slab under unfactored loading and ULS ensured sufficient safety with regard to the failure of the floor in accordance with the yield-line theory. The yield-line theory assumes that SFRC has sufficient rotational capacity within a crack; the ductility of the steel-fibre-reinforced concrete has been proved by load tests on concrete specimens and full-scale suspended slabs.

Site-batched concrete

The size of the panels required 600m^3 of concrete daily. This, together with the need for guaranteed delivery rate and consistent quality of product, was achieved by batching on site using a dedicated plant installed by Hanson Premix. Six concrete mixer trucks with capacities of 6 and 9m^3 were needed to supply the site. The short distances between the batching plant, the fibre integration machines and the workface facilitated good control over the quality, consistency, workability and production rate of the concrete.

Steel fibre reinforcement

High-tensile, undulated steel fibres (60mm long and 1mm in diameter) from Synthetic Industries were used to reinforce the concrete. The most effective way of incorporating the fibres to ensure uniform distribution is with a pneumatic integration machine (see Figure 1).

Placing the concrete

As no 'virtual' beams or shear mats over piles were required, the concrete mixer trucks could discharge the SFRC directly at the workface. This led to increased pro-

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ductivity, simplified laserscreed use and meant that there were no compaction problems over piles, unlike designs that combine steel fibres and bars.

Flatness

There were concerns that it would be difficult to achieve the FM2 tolerance classified in TR34 with a 400mm depth of concrete and no weather protection, but it proved possible to work to the specified tolerances consistently.

Design co-ordination

Twintec has now constructed five 'clad rack' floor slabs using SFRC and is familiar with the peculiarities of the system and the complex nature of the imposed loads. This was perhaps the key to success on this contract, the floor slab being constructed faster than anticipated and within budget.

Concluding remarks

Using 20,000m^3 of concrete, 1000 tonnes of steel fibres, 220 tonnes of Sika Armorex Armorshield dry shake topping and 5000 litres of Proseal 90 curing agent/sealer, Twintec produced the floor slab in just 35 casting days over ten weeks. The surface is virtually fibre-free, and the survey results for flatness are outstanding, demonstrating that, in spite of the industry's skills shortage, high-quality results can still be achieved. ■

References:

1. THE CONCRETE SOCIETY. Technical Report 34 (third edition): *Concrete in industrial ground floors – a guide to design and construction*, The Concrete Society, Camberley, 2003.