Case study

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Glass-fibre reinforcement reduces acoustic vibration noise at rail crossovers

Glass-fibre reinforcement offers a highly effective alternative solution to steel in civil engineering and construction applications where a high strength, non-metallic, non-electromagnetically sensitive, machinable reinforcement is called for. Even in harsh environments. We look first at the product in use on a project for the Bielefeld Stadbahn (light rail) network in Germany.

The Bielefeld Stadbahn, part of the transportation network serving over 33 million commuters a year in the north western German city of Bielefeld, is effectively a hybrid system of tram and subway. Similar to those operating in Stuttgart, Cologne, Frankfurt and nearby Hanover. Where the track passes through heavily built-up areas, unacceptable levels of acoustic vibration emissions generated at the crossover sections can be generated. This is particularly the case where the 'frog', also known as the common crossing, is negotiated. Now, for the first time in Bielefeld, to combat this problem the rail system uses a two-dimensional mass-spring system – designed to reduce vibration noise levels by up to 30 decibels.

Mass-spring systems for fixed tracks typically consist of a rail carrier plate and a U-Trough shaped foundation of reinforced concrete; the two components being isolated to prevent mechanical vibration. Isolation is achieved initially through the large and inert mass of the rail carrier plate. Then the spring element, made from elastomer plays its part and dampens the vibrations of this high-mass component. As a result of these actions, the acoustic vibration effects of a passing tram on nearby buildings are significantly reduced.

No interference to sensitive electronic track control systems

Traditionally, steel reinforcement is used as part of the crossover's concrete components. However, the sensor system of modern point-blocking circuits works by creating a resonant circuit in the area of the crossover. As a tram approaches the crossover, its large steel mass affects the resonant circuit, which is sensed by the track control system. If the carrier plate is reinforced using steel, this disturbs the resonant circuit in a similar way to the mass of the tram. This may lead to faults in the point-blocking circuit – making it much more difficult for sensors to identify the presence of the rail cars – and putting safety at risk. As a result, reinforcement for about 12 metres of the track adjacent to the point-blocking circuit had to be achieved without the use of steel in the carrier plate and U-Trough. The solution was to use Schöck ComBAR (composite rebar) glass fibre reinforced polymer; a ribbed reinforcing bar made of corrosion resistant glass fibres. Unlike steel solutions, the use of this glass-fibre reinforcement poses no threat of interference to sensitive electronic track control systems and greatly reduces noise levels at crossover sections in built-up areas. Where the product was installed in the area of the U-Trough and rail carrier plate, elastomer sheeting was used to completely isolate the carrier plate from its surroundings. The elastomer layer also served as lost formwork within the trough, where the glass-fibre elements were installed crosswise, using cable ties. Concrete, strength class C30/37, being poured in the respective section. The ribbed reinforcement bars have a smooth base and no sharp detailing, so there is no risk of them penetrating the elastomer layer and causing acoustic bridges. After the trough had cured, the 25cm carrier plate, also reinforced by the units, was then poured using concrete of the same strength class. Overall, around three tons of glass fibre reinforcement was used in these areas. Glass fibre reinforcement has a proven record over steel in track construction. "It was for this reason, in collaboration with the designers, that we decided to use it in the mass-spring plate for the new crossover system": comments Volker Quest, Head of the Department, Tracks and Lines at moBiel GmbH.

Manufacturing process is key

A two-part manufacturing process is key to ComBAR's performance. First, during the pultrusion process, high-strength glass fibres are bundled together as tightly as possible and pulled through a closed chamber, where they are saturated with a synthetic resin. This is followed by profiling, where the ribs are cut into the hardened bars and given a final resin coating.

The fibres provide the longitudinal strength and stiffness of the material, while the resin matrix holds the fibres in place, distributes the load and protects the fibres against damage. High loads can be transferred from the concrete into the ComBAR bars. The characteristic material properties of the units result from the unidirectional orientation of the fibres: high axial tensile strength, relatively low tensile and compressive strength perpendicular to the fibres [(1).]

A fibre composite reinforcement solution has wider applications

The Bielefeld Stadbahn rail project is a good example of where the use of a fibre composite reinforcement combines strength, with a non-conductive, non-magnetic solution. Other applications where this non-conductive benefit also applies is with high voltage transformers and reactors. If steel reinforcement is used and located too close to the coils, inductive currents and heat are generated within the reinforcing steel, reducing the rebar strength. To avoid this, steel reinforced concrete elements must not be located within the magnetic clearance contour of the coils. The use of a fibre composite solution means that reinforced foundations, walls and ceilings can be built closer to the transformer coils and reactors, reducing build space and saving on construction costs. Another major benefit with the product is its resistance to corrosion. Exposure to salts, acids or bases has no effect, making it ideal for new build or reparation in aggressive environments such as bridge, marine and harbour construction and reinforcement. Finally, in shafts and tunnels a tunnel boring machine cannot drill through the steel reinforced shaft walls. These have to be opened manually and the soil behind stabilised. All of this is avoided by using a fibre composite solution as the tunnel boring machine cuts directly through the head wall.

For enquiries, in the first instance contact: design@schoeck.co.uk / tel: 01865 290 890

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[1] Test reports and expert opinion
ComBAR has been extensively tested by independent experts around the world and at the in-house laboratory of Schöck in conjunction with the certifications in Germany, the Netherlands and Canada. The majority of these tests were carried out at the Schöck laboratories, which were specifically certified to perform them. The tests were monitored by independent experts. English language reports and expert opinion on tests of the material and mechanical properties can be found in the download section at www.schoeck-combar.com

Info for Editors - Construction Team: Bielefeld Project

Site:	Triangular junction, August-Bebel-Str. / Nikolaus-Dürkopp-Str., Bielefeld
Client:	moBiel GmbH, Bielefeld
Structural engineer:	Bockermann Fritze IngenieurConsult GmbH, Enger
Lead contractor:	Wittfeld GmbH, Hansastraße 83, Wallenhorst
Construction period:	March to September 2015

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Images

[Installation Overview.jpg]

Twelve metres of glass fibre reinforcement are installed in a Bielefeld Stadbahn crossover system Image: Schöck Ltd.

[Installation detail.jpg]

The use of glass fibre reinforcement ensures trouble-free operation of the crossover system Image: Schöck Ltd.

[Spacers.jpg]

Spacers ensure stability of the multi-layer reinforcement
Image: Schöck Ltd.

[Cutting ComBAR to size.jpg]

ComBAR reinforcement bars are cut to size by hand saw
Image: Schöck Ltd.

[ComBAR.jpg]

Glass fibre reinforcement Image: Schöck Ltd.