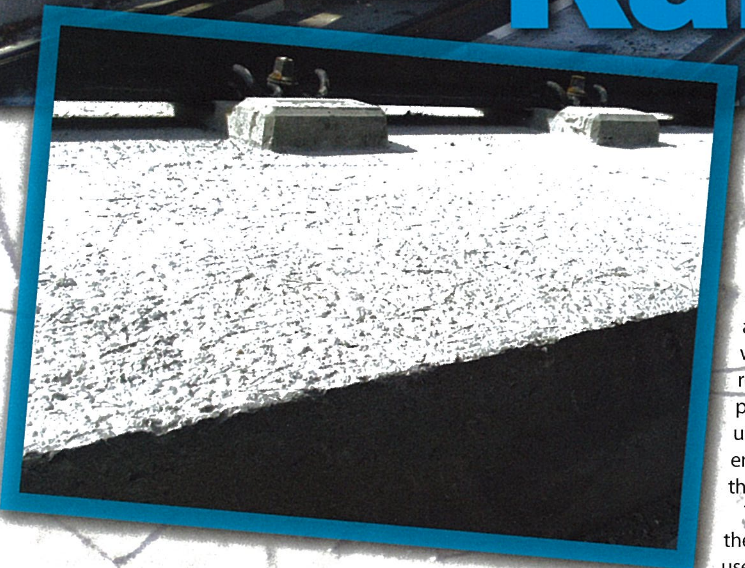
Clever Karlsruhe



(Above) Completed tram track with synthetic fibres, at Gottesauer Platz tram station, Karlsruhe.

For several years, the mass rapid transit (MRT) system in the German city of Karlsruhe and its surrounding region has been the subject of an interesting transportation initiative. Continuous expansion of its network, with constantly increasingly passenger numbers, has proved the "Karlsruhe Model" to be a success.

A total of 19 mass transit companies, including the Karlsruhe public-transport authority (VBK), have merged to form the Karlsruhe network of MRT companies known as Karlsruher Verkehrsverbund GmbH (KVV). With its MRT network of 685 km, the KVV is the third-largest public transport network in the German state of Baden-Württemberg. In addition to the lines operated solely by the urban rapid-transit systems, the MRT network also includes 178 km of Deutsche Bahn lines that are also used by the KVV.

Ballastless track

Since 2003, RHEDA CITY ballastless track has been installed in the Karlsruhe urban-transport network. For the recent construction of the south-east tram extension, this system used synthetic fibre concrete for the first time. The new 2.2km section, popularly known as the "Culture Line", will connect the southern part of Karlsruhe with the east of the city and will also provide good tram access to the Karlsruhe Music Academy and the National Theatre. This resulting new public transit network will therefore also have benefits for those who live outside the new residential areas in the eastern part of the city. The extensive use of turf tracks will further enhance the attractiveness of the Karlsruhe city landscape.

The conventional version of the RHEDA CITY track system, used until now in Karlsruhe, has featured continuous longitudinal steel reinforcement in the track concrete layer. This application for urban tramways was developed from the basic original RHEDA system, the first ballastless track system in Germany, that had been installed in the Westphalian train station of Rheda in 1972 by Professor Josef Eisenmann.

As reported in issue 84 of the rail engineer (October 2011), RAIL.ONE GmbH tested the use of synthetic-fibre concrete in the track concrete layer for the first time on the network of the Berlin Public Transport Authority (BVG) in 2010. The success of this test application was one of the reasons that VBK decided to use the RHEDA CITY system with synthetic-fibre concrete for its planned network expansion and for the new tram station at Gottesauer Platz. The new RHEDA CITY system will replace existing cross-sleeper tram tracks that were installed flush with the street surface.

Benefits of synthetic-fibre concrete

Substituting synthetic fibres for steel reinforcement does not alter the basic characteristics of ballastless track. It does not affect the system of free crack formation but, at the same time, the synthetic fibres determine the distribution of cracks in the track concrete layer. Rosenberg Engineering Offices played a key role in development of this new concrete mix design following extensive preliminary laboratory investigations and a great number of tests.

Using a synthetic-fibre concrete layer offers numerous benefits over conventional track design. The space available for track construction is often severely limited, particularly in an urban situation or on heavily used traffic arteries. These space restrictions force construction companies to invest in time - and cost-intensive construction methods.

The use of synthetic fibres can reduce these costs. In Karlsruhe for example, 16.5 tonnes of steel reinforcement were previously used in each kilometre of RHEDA CITY track. With the new synthetic fibre concrete, only 2.8 tonnes of fibres are used per km. These fibres are added directly in the concrete mixing plant, which means no logistics and no space requirements for rebar on the construction site. Likewise, this reduction in the use of heavy, steel components considerably improves the transport budget for the entire system. In addition, the lack of continuous longitudinal reinforcement allows significant time gains in installation of the track panels, reducing labour costs on the construction site.

Earthing and signalling

There are other benefits too. Trams are usually powered by direct current which requires any steel installation to be earthed. The use of synthetic fibres eliminates the need for these measures, with appreciable cost savings.

Elimination of longitudinal steel reinforcement in the track concrete layer furthermore prevents any undesirable interaction between reinforcement steel and the track signal systems. Until now, and particularly in cases of mass detectors and track circuits, it was necessary to electrically insulate the longitudinal reinforcement steel from the other system components. This is no longer required.

Track construction

In the pilot project in Berlin, the synthetic fibres were directly added to the concrete in the ready-mix lorry before pouring the track concrete layer. In Karlsruhe, however, the synthetic fibres were mixed directly into the concrete at the factory. This involves manually adding the bundles of fibres to the fresh concrete, as the final component in the concrete mix, through a special opening on the mixing plant. At this stage, the concrete must have already attained the normal consistency of freshly mixed concrete although the addition of the synthetic fibres will have an effect on that consistency. This ensures that the concrete can be processed on the construction site without delay, and it prevents possible mistakes such as in calculation of the fibre amounts per vehicle and in manual dosing of fibres for in-transit mixing.

On the construction site, the freshly mixed concrete can be poured by concrete pump or chute into the completely assembled and adjusted track panels. There is no difference between working with the synthetic-fibre concrete and normal, every-day concrete. The Karlsruhe project has confirmed that synthetic-fibre concrete is well suited for use in the track concrete layer. Proper curing of the concrete is important as, if the correct post-treatment is not carried out, the synthetic fibres might not bond correctly with the concrete matrix. Shrinkage cracks could arise which could possibly impair the long-term performance of the concrete layer.

(Left) Concreting the track panel with synthetic-fibre concrete. (Below) No need for continuous longitudinal reinforcement.

The VBK in Karlsruhe is the first public transport company in Germany to use synthetic fibre concrete in its MRT network as standard. So far, the results of this pioneering approach are more than satisfactory. ■

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