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IVES SLAB TRACK SYSTEM

KNOWLEDGE 200 TRACK

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THE FUTURE OF SLAB TRACK SYSTEMS IS MODULAR AND EXCHANGEABLE

Modern railway tracks have high requirements when it comes to availability, reduction of maintenance and lifetime. Slab track has proven to be an efficient way to build – not only high-speed – but also urban and heavy haul railway lines. Current trends demand additional features of future-proof track systems: namely modularity and ease of dismantling, as thinking from cradle-to-cradle is more and more important than decades ago. This article explores the requirements and presents a novel system, the IVES slab track system, that tackles some of these issues. The last part deals with experiences from real tracks, where IVES has been successfully in use.

REQUIREMENTS FOR SLAB TRACK

Slab track, ballastless or high fixity systems, as these track systems are called in different regions of the world have literally solidified their presence in the railway superstructure in the past decades.

Being used in tracks across the globe, in various operating environments, they have moved far from being niche. Still, on a global scale ballasted track is the far more widely used version of infrastructure. One particular upside of ballasted track is the relative ease of making post-installation adjustments by tamping the track. The construction is also highly modular, making replacements – even of singular sleepers – a possibility.

There are different approaches to slab track construction, many of which end up in a monolithic body of concrete, that includes some elastic elements to counteract the rigidity of the reinforced concrete slab and add some resilience to the superstructure.

Slab track systems started to gain popularity in the sixties of the past century, so some of the oldest systems are already reaching the end of their design life span. Contrary to ballasted track, where it is rather easy to cut the rails and remove complete track panels, a lot of the demolishing work when dismantling a slab track is much trickier to execute. Also, in the case of accidents, the simple replacement of track components cannot always be realised. Especially in an age of resource scarcity and the need for a more circular economy, systems that are modular and enable the exchange of components can be advantageous. Other challenges that the track construction industry is facing, similar to other industries, is the shortages of skilled workforce: fewer and fewer people are willing and able to work night shifts and weekend possessions. There is a certain pressure on contractors to not only automate in order to gain efficiency and stay relevant, but also to make up for the lack of workers.

THE "LEGO WAY" OF CONSTRUCTING SLAB TRACK

About 14 years ago Rhomberg Sersa set out to funnel its decade long experience in slab track construction, having built all the major European slab track systems (PORR STA, LVT, Rheda, Getrac amongst others) in different projects, into the development of a new slab track system. Besides construction, the company also gained experience with refurbishing and repairing different track systems. The synthesis was a combined approach between bottom-up and top-down construction approaches. The IVES slab track system was developed with both modularity, high construction quality and automation potential in mind. The process starts with the construction of an asphalt base layer, harnessing the advantages of this quick to build construction material, that is fast-curing, can be worked with even in temperatures where concreting is a hazard and proves to be long-lasting. In curves the asphalt layer is executed in a wedge shape (laterally), to create superelevation (cant). The next step is the installation of pre-fabricated concrete blocks, that can be manufactured with pre-stressed and non-stressed reinforcement. These building blocks can be thought of as supersized LEGO bricks: whether they are used on a straight track or in curves, even in areas of high superelevation, the block design remains the same. Due to their slim dimensions (2400 mm width, 610 mm length, 255 mm height) they can be laid in curves as tight as 40m radius. The blocks were designed to have a flat surface with one thing in mind: minimising difficult logistics, especially in tunnels. The design of the blocks allows rubber-tyred vehicles, even heavy lorries, to drive over the blocks during construction. In very tight conditions one tyre could even be running over the centre of the block, with the other tyre running on the safety walkway next to the track. Longitudinal and lateral forces are transferred from the block to the asphalt layer mainly by friction, as an extra measure of safety a shear dowel is installed according to routing parameters: e.g. in tight curves every block uses a dowel, in straight track fewer dowels are used. After core drilling into the asphalt to be able to insert the stainless-steel dowels, the bottom-up portion of the installation is done, (for build-up and main components of IVES slab track system see **Figure 1**).

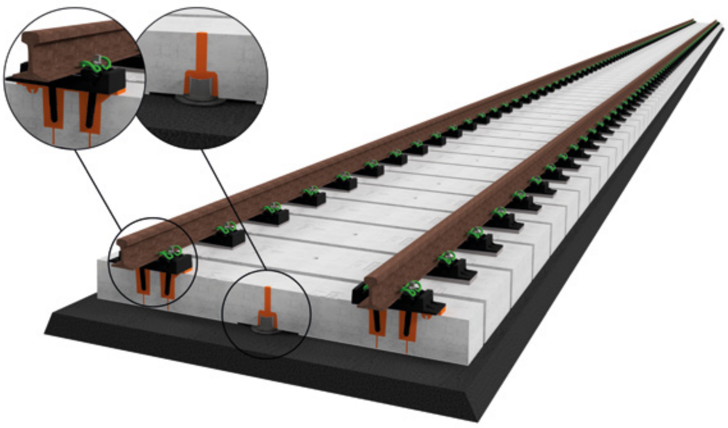

Figure 1: IVES slab track system – details show direct fastener type Vossloh DFF 300 RS and the stainless-steel dowel embedded in the asphalt layer providing additional longitudinal and lateral fixation, both held in place by a fast-setting grout, depicted in orange. (Copyright RSRG).

Figure 2: Vossloh DFF 300 RS before assembly of track panel; also visible are the grouting pockets on top of the IVES blocks.

Figure 3: Track adjustment system RhoFAS supporting the track panel, placed on IVES blocks. Formwork installed around the fastening system. (Copyright RSRG).

FIRST: BOTTOM-UP, SECOND: TOP-DOWN

The next step is where the methodology switches to top-down: an especially developed direct fastening system (DFF 300 RS, see **Figure 2**), that is based on one of the most successful slab track fasteners, the system 300 fastener, is used to construct track panels depending on the length of the rails used. The panels are very accurately positioned with a track adjustment system (see **Figure 3**), enabling high accuracy. While resting on the adjustment system spindles, the track can be used for logistics by construction vehicles up to a certain tonnage. Once the final position is confirmed by surveyors, the direct fasteners (type Vossloh DFF 300 RS, refer to **Figure 4**) are permanently bonded to the blocks with fast-curing cementitious or epoxy grouts. The direct fastener combined with the prefabricated block is a lesser-known approach that allows for bigger construction tolerances in the asphalt base layer and the block itself. At the time of grouting, all previously accumulated construction tolerances can be set to zero again. Track gauge widening in tight curves can be executed just by positioning the direct fasteners at a wider position, without needing special angled guide plates. This leads to higher reserves for post-installation adjustments during the lifetime of the track. The same is true for the vertical adjustments inside the fastening system, should track settlements occur.

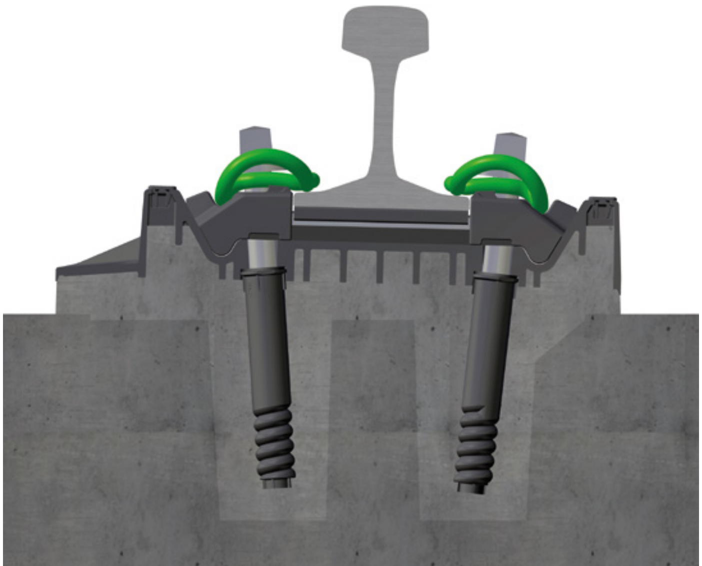

Figure 4: Direct Fixation Fastening System Vossloh DFF 300 RS: shown as installed on an IVES block with fast-setting grout permanently bonding the DFF to the slab track blocks. (Copyright Vossloh Fastening Systems).

Figure 5: Standard version of the IVES system as installed in Asfordby tunnel in 2014.

Figure 6: Longitudinal version of the IVES system as installed on viaduct at New Bailey Street, Manchester.

PRACTICAL EXPERIENCE WITH IVES

The first ever project executed with the system is the Asfordby Tunnel (see **Figure 5**) in the Melton Rail Innovation & Development Centre of Network Rail in Great Britain. The tunnel which is part of the test track there is not in heavy use, but it was a great starting point for gaining experience with the system. A particularly noteworthy project is the project in New Bailey Street, Manchester where a longitudinal version of the blocks was used on a viaduct (see **Figure 6**).

When it comes to longevity, experiences from real tracks provide better data than laboratory tests any day. IVES was installed in a portion of track of Australian Rail Track Corporation in Australia as part of the construction of a new weighbridge. The system has experienced 120 million gross tonnes (MGT) for more than seven years now, totalling around 860 MGT, while still being in very good condition. A year after Australia, the system was first installed in the network of Deutsche Bahn (DB) in the Zierenberg tunnel in the centre of Germany. This milestone was possible through extensive laboratory testing and refining the design until all the strict requirements were met. The full approval for the network of DB is expected to be released in 2025, after more than six years of successful operational testing. Since some projects were executed in Great Britain already, Rhomberg Sersa is working together with Network Rail to achieve product acceptance for the system, to simplify the use in upcoming projects.

ADVANTAGES OF IVES SLAB TRACK SYSTEM

Due to its particular design and modularity, the IVES system has the following advantages in different life cycle phases:

Advantages during construction:

- Asphalt base layer: quick to install and high proportion of recycled material possible (CO2 reduction)
- Prefabricated blocks: no in-situ concrete logistics, there is only one standard block for straight sections and bends, simplified logistics, laid blocks can be driven over for construction logistics, automation of laying possible
- Direct fastening: very precise creation of the track position in the final construction step, compensates for transverse inclination (drainage), gauge widening in tight curves and installation tolerances; setting times vary depending on the grouting material
- No readjustment ('levelling') in the rail fastening during the construction phase

Advantages in operation:

- Excellent drainage: also on straight track a transverse cross slope is possible without compromising track geometry
- In the event of an accident (e.g. derailment), individual blocks can be replaced very easily
- Complete maintenance reserve in the fastening is available for readjustment during operation
- Rail replacement simplified, as standardized rail pads layers can be used

Advantages at end of life:

- Dismantling at the end of the service life is much easier than with monolithic construction methods, as blocks only laid on the base layer or connected via form-fit with the shear dowel, an important feature for future recycling management and the circular economy

SUMMARY

The IVES high fixity system is a new way of constructing railway tracks, enabling high levels of automation during operation, easy component exchange in case of accidents and fast dismantling at the end of the lifetime. Its safety and longevity have been proven in projects in Switzerland, Germany, Australia and Great Britain since 2014.

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