Construction of the PY slab track test section for the University of Pretoria

Slab track test section for University of Pretoria Railway Research Facility

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BACKGROUND

Slab track is an alternative to conventional ballasted track and has been used locally and internationally for more than 50 years. The scale of implementation has varied from extensive, in the case of some metro and high-speed passenger systems in Japan, such as on the Shinkansen network, to intermittent and limited scale in many other countries, including South Africa.

The Chair in Railway Engineering (sponsored by Transnet Freight Rail) at the University of Pretoria (UP), has established several research facilities over the last ten years. These include advanced laboratory testing equipment in the Civil Engineering Laboratory on the Hatfield campus, as well as full-scale test tracks on the Hillcrest campus.

The most recent addition to the Test Track Facility, is the construction of a PY Slab Track section.

TECHNOLOGY

Track slab, also referred to as ballastless track, is the collective name for various rigid concrete slab track technologies. The general principle is that load transfer and track stability are provided by the rigid concrete slabs, and that elastomeric components, such as pads, bearings or springs, provide flexibility.

The technology behind the PY Slab Track, as installed at UP, has been in use on the Transnet Freight Rail network since the construction of the heavy-haul lines in the 1970s. It was designed and developed by Henry de Wet, currently Chief Design Engineer for BridgePort/RCE.

Use of the PY Slab system reduces the cost of construction by eliminating the need for rail chairs and the associated high installation costs. Track fastenings are cast directly into the slab in a single-pass operation, resulting in significant time and cost savings. The system relies on the correct and appropriate use of a jig procedure, which is designed and supplied by BridgePort/RCE who also provide the track design, training and high-level supervision of construction required to ensure that the end product can be signed off in terms of technical compliance and defined professional accountability.

BENEFITS AND DRAWBACKS

Track life cycle studies have shown that the design life of slab track is up to four times that of ballasted track, but that the high construction costs have detracted from its widespread adoption. The cost of components, mainly rail chairs, as well as the cost of labour, primarily associated with the high skills required for the achievement of tight tolerances, need to be addressed to facilitate economical construction.

In terms of operational cost, slab track requires very little routine maintenance. This results in the reduction of maintenance costs, on-track maintenance time and associated train service disruptions. In addition, aesthetics and the ease of keeping station emplacements clean also play a role. In comparison, ballasted track in essence requires regular maintenance to reinstate alignment and track level, as well as cleaning and replacement of ballast.

APPLICATION OF SLAB TRACK IN SOUTH AFRICA

After a hiatus of some decades after the construction of slab track in tunnels on the Coal Line, Hex River Tunnel and Natal Main Line tunnels in the 1970s and 80s, during which time some of the track components were discontinued, BridgePort/RCE re-developed the system to accommodate current fastening systems whilst incorporating alterations to improve construction tolerances.

Typical applications of the system include its use in and between passenger stations on the PRASA network, in tunnels, in runways for heavy-duty gantry cranes, and on railway viaducts.

Projects are typically relatively small-scale, intermittent and geographically distributed. These characteristics dictate that the system adopted must have low establishment costs, be simple to construct and be scalable to accommodate project size and construction tempo.

The need for PRASA to implement slab track at selected passenger stations is driven mainly by the requirement to maintain constant clearances between coaches and platforms for safety reasons. As this is not possible in the case of ballasted track, owing to track disturbance during track maintenance, the use of a fixed alignment is becoming mandatory.

Recent projects include the reconstruction of the Metrorail route between the Pretoria and Walker Street stations, as well as on the incrementally launched bridge over the Vaal River on the 67 km heavy-haul railway line between the Coal Line and the Majuba Power Station.

PY SLAB TRACK TESTING FACILITY AT UP

The PY Slab Track section on UP's Hillcrest campus has a length of 30 m.

PY slab track installation on Metrorail route between Pretoria and Rissik Stations

Cleveland Station up-grade to PY slab track

The substructure was designed according to the Transnet Freight Rail heavy-haul (26 ton/axle) specification. Three different rail profiles were used in the construction for research purposes, namely 48 kg/m, 57 kg/m and 60 kg/m, each 10 m in length.

RESEARCH OBJECTIVES

The Chair in Railway Engineering aims to carry out a number of PhD, MEng and BEng final year research projects on this section of track, focusing on the following topics:

- Structural behaviour of the different rail profiles when subjected to typical train loading
- Performance of the fastening system and rail pads under vertical and lateral loading
- Track formation behaviour and substructure characterisation
- Unsaturated soil behaviour in response to climatic change and seasonal variations in moisture content
- Comparisons of track performance and behaviour between ballastless and conventional ballasted track.

The research will also assist in the development of appropriate track structures for different applications in the railway industry, locally and internationally.

CONCLUSION

Slab and ballasted track both have unique *and* general applications in railway perway design and construction. The obvious advantages of the use of slab track on selected rail applications, such as Metro rail systems, make it a good choice from a functional point of view.

It is believed that the outcomes of the research enabled by the University of Pretoria's slab track test line will assist in further quantifying the characteristics, and by implication, the application of slab track as an alternative to ballasted track. The optimisation of modern slab track design and construction can furthermore reduce capital cost to levels comparable to that of conventional ballasted track.

Both of the above-mentioned factors can ultimately result in the application of optimised technology solutions in rail design and construction, lowering rail system life cycle costing and increasing rail's competitive edge.

PROJECT TEAM

The test track at UP's Hillcrest Campus was designed by BridgePort/RCE Consultants and constructed by Stefanutti Stocks Civils. Materials were sponsored by voestalpine VAE SA, Aveng Rail, Kaytech, Pandrol and AfriSam.

Stress and temperature monitoring of the incrementally launched Vaal River Bridge and PY track slab