A new test track at the University of Pretoria

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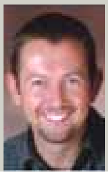

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BACKGROUND

The Department of Civil Engineering at the University of Pretoria recently constructed a 30 m long railway test section on the University's Experimental Farm (better known as the "Proefplaas") in Pretoria. The track will further enhance the university's research capabilities in the railway environment. The project was made possible with the help of civil engineering students and sponsorship from industry. It was constructed as part of the Workshop Practice module presented to the first year students during the December/January 2012/2013 break. All the first year, and a few third and final year, civil engineering students assisted with the track construction which took approximately one month to complete.

DESIGN AND CONSTRUCTION

The track (30 m long and 4 m wide) was instrumented with various transducers for track substructure monitoring and full-scale railway track testing. Manholes were also constructed next to the track for access to the instrumentation running across the railway track and to control drainage. To keep the instrumentation safe, a control room was constructed next to the track.

The track structure was designed in accordance with Transnet Freight Rail's 26 ton/axle heavy haul formation specification, similar to the Coal Line formation. The track components used are shown in Table 1. A lateral slope of 1:25 and a longitudinal slope of 1:115 were used for the drainage of the constructed layers. The drainage system was constructed with A10 bidim, a fin drain and geopipe.

The construction of the track was conducted by the civil engineering students. A TLB was used for major excavations and backfilling and a 2.7 ton dynamic roller was used for the compaction of the layer works. The 30 m x 4 m excavation was completed before the students started their work on the track. With their assistance, the trench was cleared and shaped in accordance with the design. This work included two small excavations along the sides of the trench for the drainage pipes. The base of the trench was compacted (Figure 1) and the geotextiles and geopipe were installed as shown in Figure 2.

Table 1 Track components used for the construction of the test track

Component	Description	Supplier
Rail	60E1 LHT	VAE SA (Pty) Ltd
Fastening	E-clip	Pandrol South Africa
Sleeper	PY concrete sleepers	Aveng Manufacturing
Ballast	300 mm S1 (dolerite)	AfriSam
Subballast	200 mm SSB-layer (G1, various) 98% Mod AASHTO Density	AfriSam
	200 mm SB-layer (G5) 95% Mod AASHTO Density	AfriSam
Subgrade	200 mm A-layer (in situ) 95% Mod AASHTO Density	AfriSam
	200 mm B-layer (in situ) 93% Mod AASHTO Density	AfriSam

The layer works were placed after the drainage system had been secured (Figure 3). The subgrade layer material used was sourced from the in situ material excavated at the same site. These layers (A-layer and B-layer) were backfilled in 100 mm increments, whilst removing all large rocks from the layers. The layers were compacted to the correct levels and were continuously monitored by surveying the settlements.

The subballast layer material (SB-layer and SSB-layer) was a mixture of G5 and G1 material, and these layers were also placed

Figure 1: Dynamic compaction of the in situ material

Figure 2: Placement of the drainage system in the excavation

Figure 3: Levelling and clearing the A-layer and B-layer

Figure 4: Compacted SB-layer

Figure 5: Final formation (SSB layer)

in 100 mm increments. The compacted SB-layer is shown in Figure 4 and the final formation is shown in Figure 5. A 300 mm thick ballast layer was placed on top of the formation (Figure 6). The PY concrete sleepers and 60E1 LHT rails were then placed on top of the ballast and fastened with e-clips. The completed test track is shown in Figure 7.

RESEARCH POSSIBILITIES

The newly constructed test track on the University's Experimental Farm provides exciting opportunities for further research in railway engineering. The facility will enable students and researchers to investigate railway track foundation behaviour with full-scale measurements, and testing of different components will be possible within a controlled environment. The following topics will be studied during 2013:

- Full-scale stress and strain tests in a controlled environment
- The effect of moisture on the strength of the track foundation under loading
- The evaluation of earthworks specifications under loaded conditions and with different moisture conditions
- The evaluation of Pencel pressuremeter tests carried out at different depths

Some tests have in fact already been conducted, and permanent instrumentation installed to monitor the condition of the track. Troxler density tests were done on each layer to ensure the compaction and quality of the layers. Light-weight

deflectometer (LWD) tests were also conducted on each layer at 3 m intervals to obtain the E-modulus values of the completed formation layers (Figure 8). Moisture sensors (three per layer) were placed inside each layer and at the surface of the bottom geotextile to monitor the moisture condition of the track Figure 9. To further investigate the moisture conditions, valves to control the flow of water out of the track were installed at the ends of the drainage pipes. This will enable researchers to control the moisture in the formation for studies into the effect of moisture on various other aspects.

Continuous surface wave (CSW) testing was done at the base of the excavation on the in situ material to measure the small-strain stiffness of the track foundation. Pipes were also installed across the track in the middle of each layer and will be used to monitor the deflection and settlement of the track, as well as for the development of new track instrumentation.

CONCLUDING REMARKS

The Chair in Railway Engineering at the University of Pretoria is excited about the opportunities that the new test track facility offers. Students will now have access to a short track section where formation behaviour will be studied and on which newly-developed instrumentation can be tested. The test track has been constructed in such a way that an array of formation and superstructure tests can be carried out to improve understanding of rail track behaviour.

Figure 6: Ballast layer construction

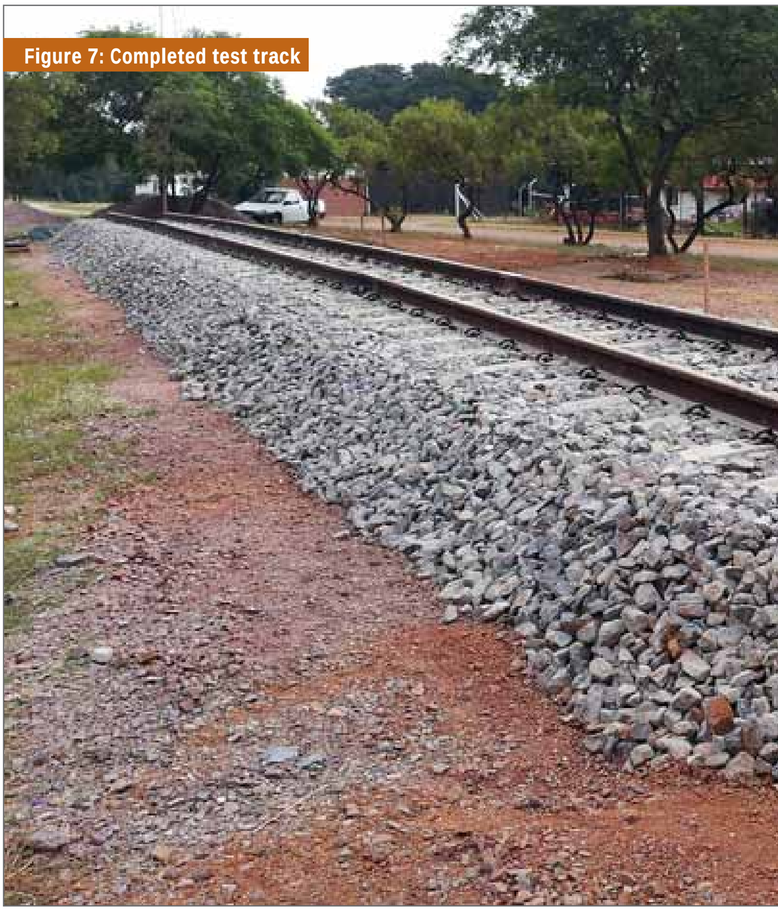

Figure 7: Completed test track

Figure 8: Light-weight deflectometer (LWD) testing

Figure 9: Placement of moisture sensors

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- Geostrada for the soil and laboratory testing
- Aveng Manufacturing – Lennings Rail Services for the placement of the sleepers and rails
- University of Pretoria laboratory staff and personnel for assistance with laboratory and field testing

Figure 10: Transverse pipes for future formation layer instrumentation

Source:
http://www.saice.org.za/downloads/monthly_publications/2013/2013-Civil-Engineering-May/#/0