An inside look at the stresses due to **lateral forces in Tubular Modular Track**

PROJECT DESCRIPTION

The Tubular Modular Track system is a relatively new innovation in railway technology. This ballastless track structure provides a more stable and reliable track structure, and requires less track maintenance. These improvements in railway track structures are important, as there is a demand for higher capacity, faster, safer and more economical public transport systems. This research project focused on the strains and stresses experienced by the gauge bar, in three different sections along a track structure, namely a transitional curve, a circular curve and a tangent section of track.

The testing was done by installing strain gauges at different positions on the gauge bars on an active PRASA (Passenger Rail Agency of South Africa) line in Hatfield, Pretoria, to the west of Rissik Station, as shown in Figure 1.

Figure 1: Aerial photograph of testing site

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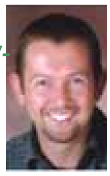
Tubular Modular Track (TMT) is a non-ballasted track system developed in South Africa and implemented since 1989. Originally used in the mining industry, Tubular Track also has applications in the passenger and freight transport sectors, as it provides a stable and low-maintenance track



WHAT IS TUBULAR MODULAR TRACK?

Tubular Modular Track (TMT) is a non-ballasted track system developed in South Africa and implemented since 1989. Originally used in the mining industry, Tubular Track also has applications in the passenger and freight transport sectors, as it provides a stable and low-maintenance track.

A TMT module is commonly 5.9 m in length and consists of two parallel steel rails held in place by Pandrol fastening clips on parallel, reinforced concrete beams. To maintain the gauge, i.e. the spacing between the rails, gauge bars connect the concrete beams at a spacing of approximately 3 m, depending on the specific application, axle load and whether it is on a curved or straight section of track.

TRACK LOADING

A moving train induces complex loading on a railway track. The resultant force can be divided into three separate components, namely a vertical, longitudinal and a lateral force component, as illustrated in Figure 3.

The focus of the study was on the lateral forces induced on the track and on the behaviour of a specific component, the gauge bar, when subjected to train loading. The resultant lateral force on the track has mainly four contributing factors –firstly, the lateral force of the wheel flange pressing on the outer rail; secondly, the lateral force due to centrifugal force; thirdly, a component for cross wind; and lastly dynamic lateral forces.

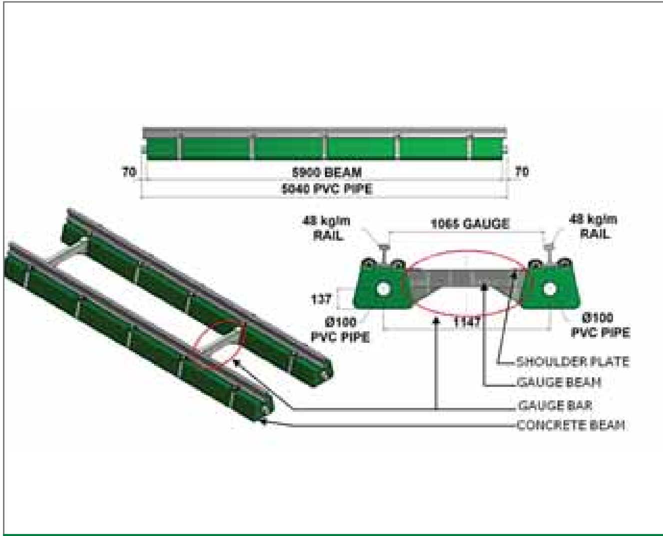


Figure 2: Tubular Modular Track module

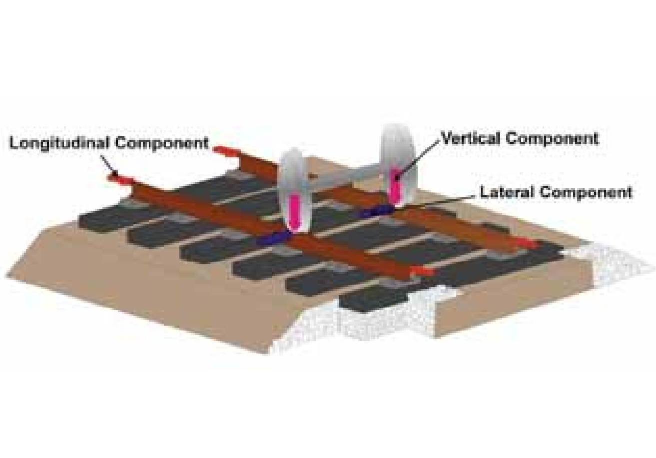


Figure 3: Schematic illustration of forces acting on track structures

OBJECTIVES OF STUDY

The objectives of the project were as follows:

- To determine the strains and stresses induced by lateral forces in the gauge bar at different sections of the TMT test section, namely tangent track, the circular curve and the transitional curve.
- To investigate the strains and stresses throughout the top of the gauge bar of a TMT system.
- To confirm how the results can be optimised to enhance the performance of the TMT system with regard to the gauge bar.

TESTING

Three gauge bars were used for the testing, one on the tangent portion of the track, one in the transitional curve and one in the circular curve, as indicated in Figure 4. This was to identify the portion of the track in which the highest lateral forces were generated.

Strain gauges were installed at different positions along a gauge bar (Figure 5) in each of the above-mentioned sections of the track. As the trains passed the test section, the strains were measured and recorded.

RESULTS FROM TESTING

Typical results obtained from the strain gauge readings are shown in Figure 6. The figure shows the strains of all seven strain gauges of one gauge bar as a single train passes. In this

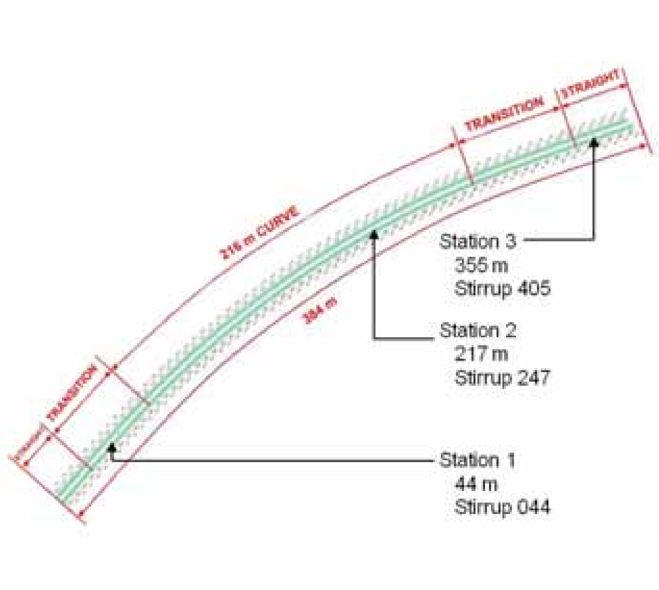


Figure 4: Track layout showing testing stations

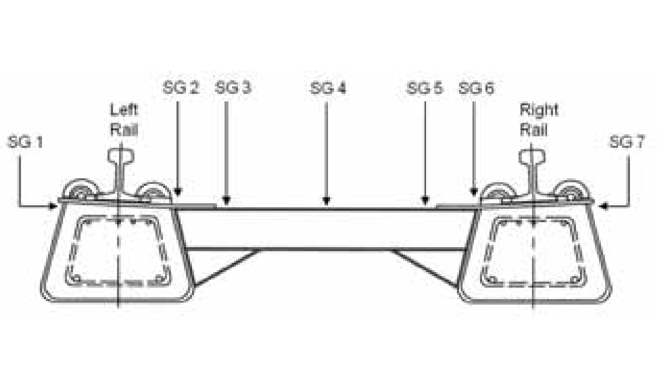


Figure 5: Placement of strain gauges on gauge bar

article, positive values indicate compression and negative values tension. The highest peak values coincide with the wheels of the motorised coaches (weighing 60 metric tons), and the lower peaks represent the carriages (weighing 30 metric tons).

The strains measured were used to calculate the stresses throughout the top of the gauge bar and are indicated as maximum calculated stresses in Figure 7.

CONCLUSIONS

The following conclusions were drawn after evaluating the results:

- The largest stresses were generated in the transitional curve. Exceptions were measured where the maximum was located in the circular curve. This is a result of the relative lateral movement of the train as it travels through the curve.
- Different strains measurements were obtained along the top of the gauge bar. The highest stresses were measured next to the weld connecting the gauge beam and the shoulder plate. The high peak stresses are believed to be as a result of the welding, as well as the change in stiffness between the combined action of the gauge beam and shoulder plate in comparison to the gauge beam only.

  Gauge bars can be subjected to tension as well as compression forces. The top of the gauge bar, between the two rails, experienced tension, regardless of its position in the track. In the transition zone, the outside of the gauge bar was in pure tension, and in the circular curve in pure compression. However, on the straight portion of the track, the outside of the gauge bar experienced, firstly, compression as the train wheel neared the gauge bar, tension as the wheel reached the gauge bar and then compression as the train wheel moved away.

  Two factors were identified to have an influence on the stresses in the gauge bar, namely the weight of the train and the speed of the train. As expected, the heavier the train, the higher the stresses that were measured. On the other hand, it was observed that higher speeds resulted in lower gauge bar stresses. This can be explained in terms of the balancing speed of this specific curve. Due to the close proximity of the site to the station, most trains travelled at lower speeds than what the curve had been designed for. This excess in super-elevation at low speed is responsible for the unbalance in lateral forces and the resultant higher gauge bar stresses.
- When designing the gauge bars for Tubular Modular Track, it should be taken into account that the gauge bar can experience tension and compression forces depending on its position in the track section, and not only compression stresses as originally designed for.

ACKNOWLEDGEMENTS

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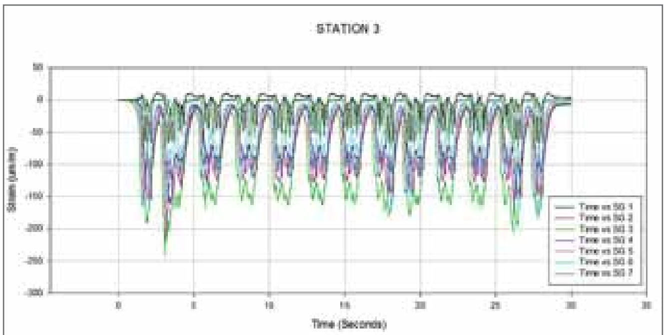

Figure 6: Graph to give an example of data collected

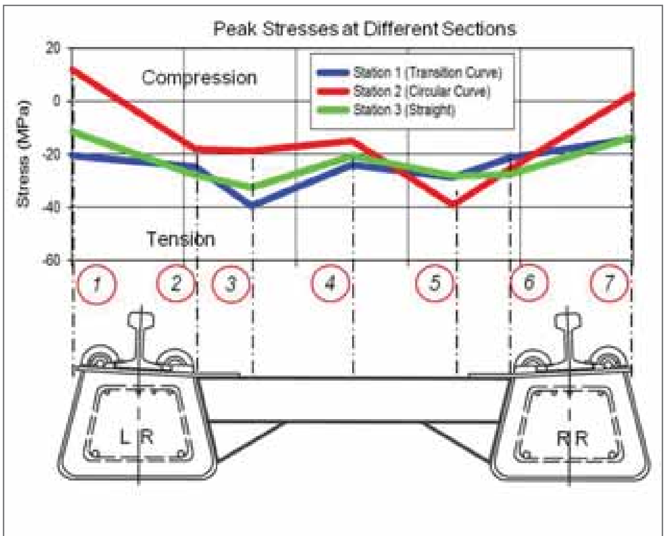

Figure 7: Stresses along top of gauge bar

Source:
http://www.saice.org.za/downloads/monthly_publications/2012/2012-Civil-Engineering-May/#/0