CHAPTER 3

ON-TRACK TESTING

In this chapter, the on-track tests that were conducted to simultaneously measure the behaviour of the vehicle and the track are described in terms of measurements taken and the test methodology. The purpose of the on-track tests was:

- To gain an improved understanding of the dynamic interaction between the vehicle and the track, and the degradation of the track, as a function of vehicle speed, axle load, track condition and accumulating traffic.
- To validate the Track Deterioration Prediction Models in terms of the predicted dynamic behaviour and the predicted differential track settlement.
- To have measured track geometry and track stiffness values available to be used as excitation input in the Track Deterioration Prediction Models to be developed.

The tests were conducted on the Heavy Haul Coal Export Line in South Africa. This line links the coal fields in the Witbank area with the export harbour in Richards Bay on the East coast of South Africa. Presently the line carries 60 million tons of coal per annum. The line was selected for this investigation due to its high annual tonnage and heavy, that is 26 ton per axle, load carrying capacity.

For the on-track tests a 150 sleeper long section of straight track with a uniform ballast layer thickness was selected. Figure 3.1 shows the middle thirteen sleepers of the test section which were instrumented to measure their dynamic behaviour as caused by passing vehicles.

To conduct controlled simultaneous measurements of vehicle and track behaviour a loaded CCL-5 gondola coal wagon, as shown in Figure 3.2, was selected as the test vehicle and placed in the test train. The CCL-5 wagon has a loaded mass of 104 tons and is the most common vehicle running on this particular line. Further detail on both the track and the vehicle is given in Appendix B.

Figure 3.1: Instrumented test site.

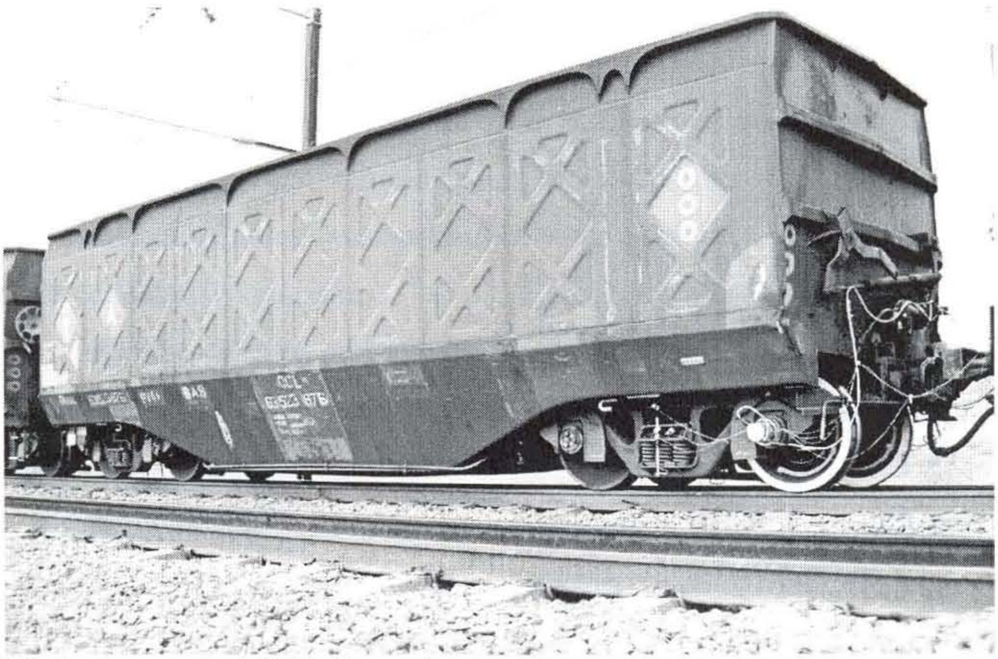

Figure 3.2: Instrumented CCL-5 gondola coal wagon.

3.1 MEASUREMENTS

In this section the general measurements that were taken during the tests are listed together with a short description of their specific purpose and the measurement method used. The measurements taken are:

- *Vertical space curve.* The vertical space curve of the track was measured at regular intervals to determine the unloaded track geometry as well as differential and overall track settlement with accumulating traffic. A digital level was used for this purpose.
- *Vertical track stiffness.* The spatial variation in the vertical track stiffness was measured using a track loading vehicle. These measurements were done repeatedly with accumulating traffic. The measured track stiffness was used as input to, and in the development of the Track Deterioration Prediction Model.
- *Dynamic wheel load.* The dynamic wheel load was measured to investigate the influence of vehicle speed and track condition on the dynamic interaction between the vehicle and the track. On the vehicle measurement were done using a load measuring wheelset in the leading position of the leading bogie of the test vehicle, and on the track by strain gauges on the rail between fourteen consecutive sleepers.
- *Sleeper reaction force.* The reaction force between the sleeper and the ballast was measured to determine the dynamic track stiffness as well as changes in sleeper support conditions due to vehicle speed, axle load and accumulating traffic. To measure this parameter, strain gauges were placed on the rail directly above thirteen consecutive sleepers.
- *Sleeper deflection.* The dynamic deflection of thirteen consecutive sleepers was measured relative to a reference frame anchored 3.15m below the rail. These measurements were essential in obtaining the dynamic track stiffness at each of the thirteen sleepers. Furthermore, changes in the sleeper deflection due to vehicle speed, axle load and accumulating traffic were also recorded.
- *Substructure layer deflection.* Using a Multi Depth Deflection Meter, the deflection of the various sub-structure layers was measured to establish

substructure layer properties with accumulating traffic.

- *Vehicle behaviour*. The dynamic behaviour of the test vehicle was measured in terms of the dynamic displacement across the secondary suspension of the leading bogie of the test vehicle. Again changes in the dynamic behaviour due to vehicle speed and changing track conditions were observed.

A more comprehensive description and discussion of the experimental work that was done as part of this research, is given in Appendix B. In Appendix B, the rolling stock used and the infrastructure at the test site is described in detail. Further detail on the instrumentation that was used on both the test vehicle and the test track is also given. Finally, Appendix B also presents and discusses some test results that show the measured influence of axle load, vehicle speed and accumulating traffic on the performance of the vehicle/track system.

3.2 METHODOLOGY

The following is a brief outline of the test methodology that was followed.

- After instrumenting the track and the vehicle, initial measurements were taken to assess whether meaningful results are obtained, and to establish correctness, consistency and repeatability of the readings.
- The next step was to tamp the selected section of track. This was done to be able to monitor track deterioration starting directly after track maintenance through tamping had been done. No dynamic track stabilisation was done.
- Immediately after tamping, the vertical space curve and the vertical stiffness of the track were measured and recorded.
- This was followed by conducting the first series of controlled tests. In these tests the test train which had several wagons with varying axle load passed over the test section at speeds varying between 10km/h and 70km/h while simultaneously measuring track and vehicle behaviour. Dynamic measurements included wheel loads, sleeper reaction forces, sleeper deflections, and vehicle suspension behaviour.