CHAPTER 6

TRACK DETERIORATION PREDICTION MODELS

In this chapter the development of the Dynamic Track Deterioration Prediction Model and the Static Track Deterioration Prediction Model is presented.

6.1 DYNAMIC TRACK DETERIORATION PREDICTION MODEL

In principle, the Dynamic Track Deterioration Prediction Model is simply the joining of the eleven degree-of-freedom vehicle/track model and track settlement as defined by Equation (4.7). Using the measured vertical space curve of the track and the spatial variation in the track stiffness as excitation input, the vehicle/track model is excited into its dynamic motions. These dynamic motions cause a certain dynamic loading of the track and thus the ballast. This causes stresses in the ballast which in turn leads to permanent strain. The resulting settlement varies from sleeper to sleeper causing differential settlement along the track. The different local settlements are then added to the loaded track geometry and the dynamic behaviour of the vehicle can again be simulated while running over the now settled track. This results in a different wheel loading pattern, more stress in the track, more permanent strain in the ballast and subsequent further differential track settlement.

Using the settlement algorithm, the vertical track geometry is thus always changed before the next dynamic simulation is done. This sequence of calculations is repeated until the required gross tonnage of traffic has passed over the selected track while continuously predicting new dynamic wheel loads and a prevailing

differential track settlement. Averaging the settlement of the individual sleepers over three sleepers is done to spread settlement in accordance with deflection basin behaviour.

In reality a variety of track stiffness values are present during the settlement process. As these stiffness values are dependant on measurement accuracy, weather conditions, tamping repeatability, and a complex interrelationship during settlement, stiffness measurement would be required at regular intervals. This is impractical and would defeat the object. Therefore, only one measurement of track stiffness is taken after the initial high rate of track settlement has decreased. This stiffness is then used as a reference stiffness for the prediction of differential track settlement.

To be able to compute and predict the dynamic behaviour of the vehicle and the response of the track, especially in terms of track settlement, the computer program VEHTRAS (Vehicle Track System) was developed. VEHTRAS is based on the Dynamic Track Deterioration Prediction Model and uses the numerical techniques as described in Section 5.4.1.

6.2 STATIC TRACK DETERIORATION PREDICTION MODEL

When assuming that there is no or very little dynamic wheel loading, which would be a good approximation under relatively good track conditions, the ratio between the dynamic wheel load and the static reference wheel load in Equation (4.7) approaches one and the prediction of differential track settlement becomes independent of the dynamic track loading. The advantage of this simplification is that the modified settlement equation can be applied directly to the measured spatial variation of the track stiffness to determine differential track settlement and subsequent changes in track roughness. Note that the three sleeper filter which is applied in the dynamic settlement model still needs to be applied. If however the track geometry or track stiffness variations are high, the dynamic component of the

wheel load has to be included. Furthermore, if the dynamic loading of the track or the dynamic response of the vehicle is required, the Dynamic Track Deterioration Prediction Model has to be used.