R3.105 Rail Squats – Progress Report 2 – Executive Summary

Rail Squats Progress Report 2

This summary reports progress (as at December 2009) on the study of rail squats; a form of rolling contact fatigue of increasing concern to railways worldwide. A rail squat is literally a depression of the surface of railway track, also caused a dark spot. This arises from plastic flow of the surface of the rail, which becomes possible because a subsurface crack frees the layer of steel above it to flow. The present project "R3.105 Rail Squats" examines the formation of rail squat cracks, with an aim to identify formation mechanisms, and to investigate methods of prevention of rail squats, and factors driving early growth.

The project R3-105 on rail squats focuses on four key areas of investigation:

(1) detection of rail squats
(2) metallurgical investigation of rail squats
(3) the role of traction, slippage and adhesion
(4) crack growth characteristics.

Detection work at Railcorp has involved ongoing monitoring of squat size at Chatswood and Erskineville, setting up of a water spray test site on track, and compilation of a database of squats on the Illawarra Line.

Work on infra-red squat detection has continued at Monash University, Plans are being made at Central Queensland University to use eddy current methods to detect white etching layers on track. A white etching layer (WEL) is a surface brittle layer caused by severe heating of the rail.

Metallurgical investigations at the University of Queensland are described in Chapter 2 of the full report. Notable in the results of microscopic examination of squats is the prevalence of a white etching layer frequently associated with squats, and a difference in the appearance of the fracture surface in the early stages of cracks growing in the traffic direction, or against it.

Thermal stressing of a rail has been investigated at Central Queensland University, as reported in Chapter 3, and has identified conditions of slippage that lead to a white etching layer on the running surface of a rail. Railcorp has continued with investigation of the distribution of squat defects, including comparing frequency of squats to curvature of track. Squats arising from checking cracks on the high rail of a transition into a curve continue to be a common case encountered.

Monash University has conducted crack growth tests, for short cracks growing in rail steel, and a crack growth law has been fitted to the short crack growth data, as reported in Chapter 4 of the full report. Many tests with fluid in the crack have been conducted, and consistently show a significant increase in crack growth rate. This is of great interest, as the presence of water in a crack is invariably involved in the growth of squats. The role of fluid in accelerating crack growth in the crack testing remains to be clarified.

Growth of a squat crack is mixed-mode crack growth, with the shear modes (modes II and III) of crack growth contributing to the process. Mixed mode crack growth is reviewed in Chapter 5 of the full report, and a possible process by which a squat crack forms is postulated.