RAIL CRC

Project #18 – RAIL CORRUGATION PREDICTION AND PREVENTION.

Paul Meehan, Bill Daniel - University of Queensland
John Powell - QR, Karl Ikaunieks – RIC, Karen Bendal - ARTC

Background Issues

Rail corrugation occurs on nearly every railway system in the world, in one manifestation or another and often in several forms. Its removal by grinding provides work for several international grinding companies and costs the railway industry in the order of 5-20% of maintenance costs per annum. These costs appear to be increasing in line with the significant increase in usage, development and speed of railway systems throughout the world. Much research has been performed on this problem over the past decade, however, a reliable cure remains elusive.

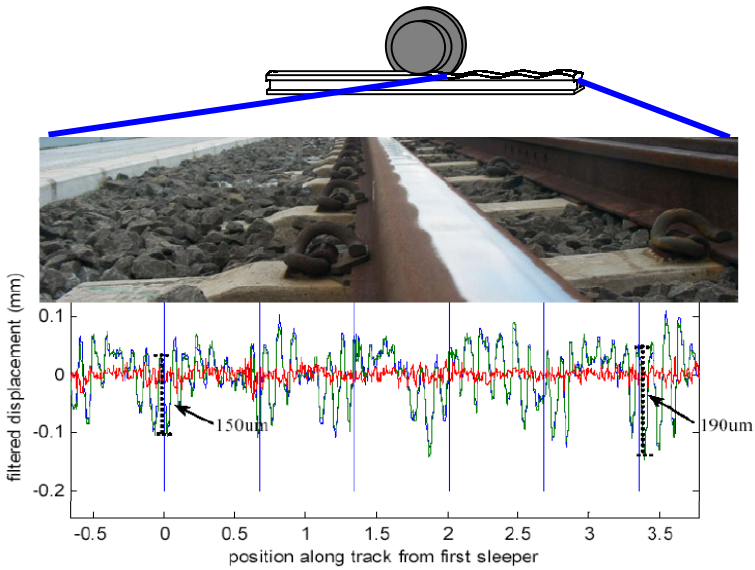

Figure 1. Wear-type rail corrugation and measurements

It is aimed to provide the theoretical and practical groundwork for solution to the phenomenon of rail corrugation. Although recent research in rail corrugation has resulted in a range of numerical models for this phenomenon, they are typically too simple, focusing on only one part of the problem, or highly complex involving large finite element models, and thus fail to identify the critical parameters and mechanism of instability involved. In addition, validated predictions of corrugation growth rates and the identification of the critical parameters have not been obtained.

The key aims of this project are to determine the fundamental mechanism associated with the occurrence of wear-type rail corrugation and subsequently develop a rail corrugation estimator system that may be used to monitor and predict growth of rail corrugation based upon critical parameters such as traffic, tonnage, speeds track radius etc. Such a system may be used to optimise maintenance scheduling and minimise the occurrence of rail corrugation on existing, as well as newly designed track. The research is also expected to provide significant new insight, required for the suppression of rail corrugation.

Progress Results

The major progress has been focussed upon developing rail corrugation growth prediction models, validation, organisation and inspection of field testing, and the design and development of a wear-type rail corrugation testrig. More details are provided below:

- Collaboration has been established with world leading experts on rolling contact phenomena; Dr S. Grassie, Dr A. Ilias and Profs K Johnson & D. Thompson, ISVR (UK & Germany), Prof J. Nielsen, CHARMEC, M. Berg KTH, A. Bracciali (Sweden,Italy) as well as local experts (QUT,CQU,Monash).
- An extensive collation and review of literature was completed and resulted in the development of a rail corrugation database system in electronic and hardcopy form. The usability of the system has encouraged continual updating as the project progresses in which time the system has grown to over 300 references. The system has proven extremely useful for the development of models for rail corrugation.
- Both simplified and advanced models for growth prediction of wear-type corrugation have been completed. A simplified model of a moving wheel on a rail with wear has been developed, based on a modal analysis of the dynamics. It is used to simulate the growth of corrugations based on a relatively small number of important parameters. An advanced finite element model with sleepers coupled to a

moving wheelset has also been developed in order to validate the assumptions of the simplified model and investigate and identify important dynamic behaviour and modelling considerations such as during cornering conditions. Benchmarking tests of these models have shown good comparisons with other well known models and characteristics of rail corrugation found in practice (see Figure 2).

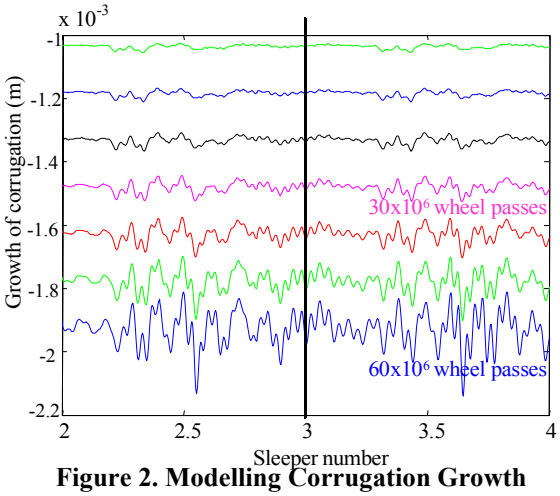

Figure 2. Modelling Corrugation Growth

- A stability analysis of the developed simplified model has been performed to provide an approximate estimation of corrugation growth rate. The results are extremely useful and insightful as they simplify the interaction of more than 20 railway parameters down to 3 meaningful measurable and/or calculable ones. This developed analytical expression for estimation of corrugation growth rate has been validated using the simplified and advanced models. In particular, a sensitivity analysis of parameters on growth rate provided predictions well matched to recent field results in relation to rail hardness, friction modifiers and tractional conditions. Important recent analysis and results have been obtained, predicting the effect of multiple wheel passage dynamics on corrugation growth.
- With guidance from QR, RIC and the ARTC, 15+ rail corrugation sites have been monitored over the past year in QLD, NSW and SA. QR has recently purchased a corrugation measuring device known as the "CAT" that has been used for this purpose. Field measurements are being used to validate modelling results. Growth measurements for one year have been achieved.
- The design of the rail corrugation test rig, has been completed and QR generously offered inkind resources to build the prototype. The testrig has been developed in order to investigate and obtain rail corrugation measurements faster and more easily. Commissioning is occurring at present.
- Progress has resulted in over 20 technical reports, 5 refereed publications and an RTSA award winning UG thesis.

Expected Outcomes

- Development of integrated, analytical and numerical models for wear type rail corrugation. *(complete- enhancements & validation underway)*
- A wear-type rail corrugation test rig for model verification. *(built- commissioning underway)*
- Database of measurements of rail corrugation on track in several sites in Australia to obtain better understanding of the phenomenon and for model development and tuning. *(underway)*
- Determination of the fundamental mechanism and critical parameters associated with the occurrence of rolling contact instability. *(complete- validation in progress)*
- Development of a rail corrugation estimator system that may be used to monitor and/or predict the first appearance and growth of rail corrugation based upon critical parameters such as traffic, tonnage, speeds track radius etc. (*completion due in 6/2006*)

Flow on Benefits to Industry

This project provides the necessary development of modelling and experimental tools as well as problem insight required for the prediction and prevention of rail corrugation. In particular, the estimator system may be used to optimise maintenance strategies and avoid the occurrence of rail corrugation on new and existing rail. These outcomes will also provide the insight required for a subsequent research project, focused on the design and development of a rail corrugation suppression device.

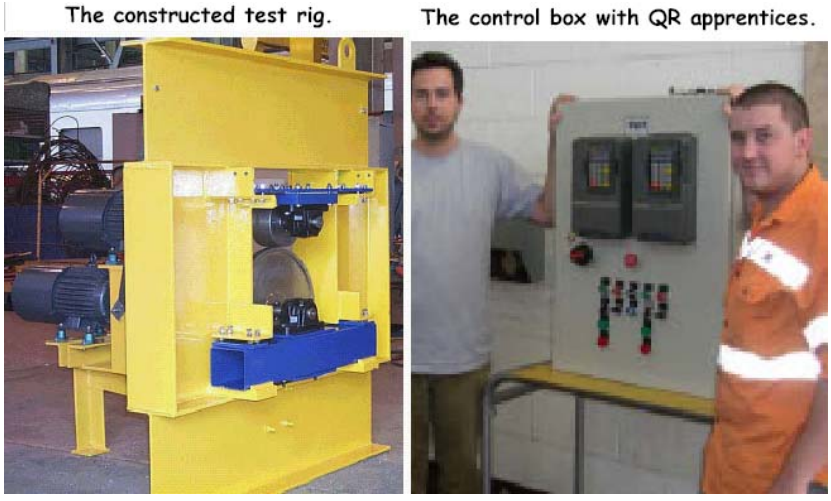

Figure 3. Corrugation testrig