IITB-Monash Research Academy

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Project title

Investigation of transient wheel-rail contact conditions resulting in rail squat defects

Project number: IMURA0095

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Research Academy theme/s

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure engineering

The problem

Contact conditions between the wheel and rail involved a combination of rolling and sliding contact, commonly referred to as mixed rolling/sliding contact. Material damage modes that develop as a result of these contact conditions involve material loss (wear), and the development of surface-initiated cracking (rolling contact fatigue). The inter-relationship between wheel/rail contact conditions and material response is well understood for steady state conditions.

Transient wheel-rail contact conditions may arise from a number of causes: impact loading at vertical irregularities, and as a result of wheel slip under traction or wheel slide under braking. The latter generally result in material damage on both rails.

A particular form of rolling contact fatigue damage, possibly associated with transient behaviour at the wheel/rail interface, has become more common in both mass transit, freight and heavy haul rail systems. Examination of damaged rails indicates that damage initiation and propagation behaviour is not easily explained for current models for wheel-rail contact and material damage. One suggestion is that damage initiation is due to localised, random events that involve fluctuations on both vertical load (and hence contact stress) and creepage, and which may also result in transient temperature increases below the contact patch. Material response under these conditions is likewise not well understood.

Project aims

To identify transient wheel-rail contact conditions that may result in the initiation of localised, random and discrete forms of rolling contact fatigue damage commonly referred to as “squats”.

Expected outcomes

The proposed program encompasses both the mechanical aspects of vehicle-track interaction (and hence wheel-rail contact) and material response, and may therefore suit a project team encompassing students from both mechanical engineering and materials engineering disciplines.

The following program of work is envisaged:

- Familiarisation with wheel/rail contact conditions and material damage modes, including those associated with transient behaviour at the wheel/rail interface.

- Familiarisation with existing analytical techniques used for the examination of vehicle/track interaction, including derivation of wheel/rail contact conditions.
- Investigate alternative analytical approaches that could be applied to the examination of transient behaviour of the wheel-rail interface (eg vertical or torsional oscillation within individual wheelsets, possible in combination with track geometry variations.
- Conduct simulations to examine transient behaviour at the wheel/rail interface as a function of a representative range of influence factors.
- Reporting.