Overview of Rail Corrugation Test Rig

Introduction

The key aims of the Rail CRC Project #18 are to determine the fundamental mechanism associated with the occurrence of wear-type rail corrugation and to subsequently develop a rail corrugation estimator system. This system may be used to monitor and predict growth of rail corrugation based upon critical parameters.

Therefore a test rig has been built in the laboratory of Mechanical Engineering at the University of Queensland with much resources and assistance provided by Queensland Rail.

Description

- The test rig was modelled on the dynamics of the real wheel-rail system, but it has to be scaled for laboratory use (as shown below in Fig 1 & 2).

- It consists of two unequal sized discs, one representing the train wheel, and one other one for the track. Both discs are supported on springs representing the stiffness of the track and the suspension of the train. The weight of the train is simulated with the preload of the springs that applies a normal contact force between the two discs.

- Two vector controlled motors are used, one to power the wheel disc to reach the desired speed and the other one to apply a controlled torque to the track disc, providing the desired traction force and slip conditions.

- In practice, a bump initiates the vibrations, then the simulation is left to run and the corrugations are formed over many rotations. Each track disc rotation represents a wheelset passage. In such a manner, many wheelset passages can be simulated under controlled conditions in a much shorter time than in the field.

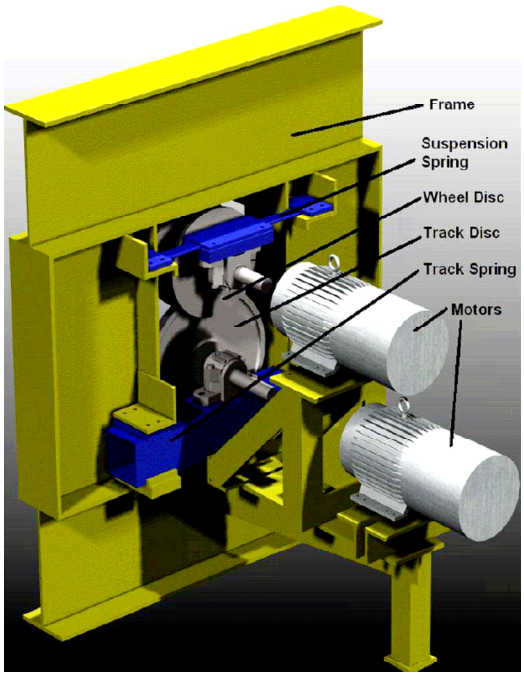

Fig 1: The design model

Fig 2: The constructed test rig

Testrig model

- One of the most important factors in the testrig design is correctly representing the dynamics of the original system. Indeed the rig has to excite the same natural frequencies as the real system. The schematic used in dynamical design is shown in Fig 3:

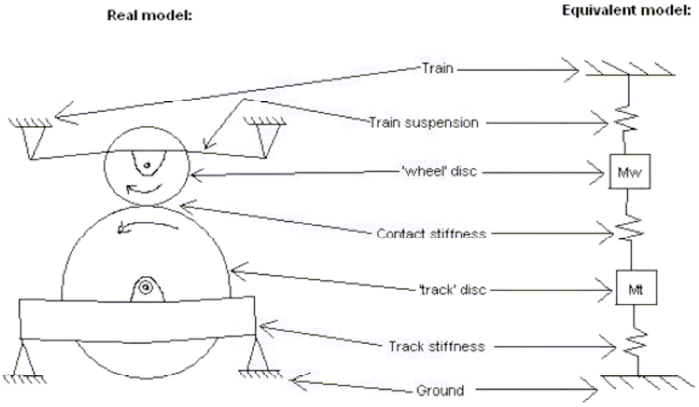

Fig 3: Test rig schematic and discrete dynamic model

- The basic concept of the model used to study rail corrugation consists of a feedback interaction between wheel/track structural dynamics, rolling contact mechanics and wear on the rail surfaces. In this test rig model the final dynamics of each pass become the initial dynamics of the next one. This effect of circular boundary conditions is included in both the UQ numerical and analytical models.

- Several sensors have been installed on the rig to obtain and control the desired effects of the critical parameters. In particular we measure:
    - the static load and the contact force with strain gauges on the springs,
    - the torque using a wireless strain gauge system installed on each shaft,
    - the profile of the track with an accurate proximity probe,
    - the rotation speed of the discs with accurate shaft speed encoders.

Summary of features

- This test rig facilitates controlled investigations of the effect of important parameters such as mechanic (load, mass, stiffness…), dynamic (natural frequencies…), wear (material hardness, lubrication) and tractional (torque, speed…) conditions on wear-type corrugation growth.

- It is designed to propagate wear-type corrugations much more quickly than in the field (approx. 10^3-10^4 times faster) and to be run continuously.

- This rig has been built to reproduce the growth of corrugation in a laboratory. Thus corrugations are created in a controlled environment and the causes effects can be studied more closely.