# Friction modification of the wheel/rail contact – A comparison between full-scale and twin disc experimentation.

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## 1. Introduction

Top of rail friction modifiers used to treat the rail head are designed to reduce several common problems that arise from the wheel/rail contact conditions such as; lateral forces, noise and wear/rolling contact fatigue.

A range of experimental test approaches of varying complexity have been used to investigate traction coefficients at the wheel/rail contact, from twin disc testing to full-scale tests using actual wheels and rail. While twin disc testing can give a good appraisal of wear and RCF mitigation it is not clear whether values of traction coefficient are representative of those in the field.

Therefore, experiments have been carried out to bench mark the traction coefficient of two such friction modifiers using a full-scale wheel/rail traction rig and a twin disc rig. Traction levels have been compared for several rail/wheel contamination conditions, as well as for variation in levels of slip within the contact. Retentivity tests have also been conducted.

## 2. Experiment Details

Two types of friction modifier (FM), FM A, a water based product designed to work when mixed with oxides present on the rail head, and FM B an oil based product, have been tested.

The full-scale wheel/rail traction rig, which has been described previously [1], has a free rotating wheel set above a length of rail which is mounted onto a slide bed. The wheel is loaded by a hydraulic actuator, and the rail bed is moved using another actuator fixed to the base of the rig. Slip is controlled with a smaller actuator, which sits on the slide bed that connects to a chain fixed to the wheel. Normal force is recorded using a load cell on the wheel actuator. The friction force is measured using a load cell on the slip actuator. Rig control and data capture is via a PC.

The twin disc rig [2] has independently driven discs loaded together using a hydraulic jack. Slip between the discs is achieved by close control of the relative disc speeds. A torque transducer on one shaft enables friction measurement.

Tests were carried out to build creep curves. For the full-scale tests a new layer of FM was applied before each test. For the twin disc tests, product had to be reapplied (in scaled amounts) intermittently as it was consumed as the test progressed. Retentivity tests were also run to measure how long the FMs remain active within the contact. This was done by applying a fixed amount of product to the rail disc/rail head and then running at the same load and slip conditions and assessing evolution in traction coefficient. Test conditions for both rigs are shown in Table 2.

Table 1: Test Conditions

| Rig | Load (kN) | Contact Press. (MPa) | Surface Velocity (mm/s) | Slip (%) |
|---|---|---|---|---|
| Full-Scale (creep curve) | 86 | 1000 | 40 | 0-5 |
| Twin Disc (creep curve) | 7 | 1500 | 1000 | 0-10 |
| Full-Scale (retentivity) | 86 | 1000 | 40 | 2 |
| Twin Disc (retentivity) | 7 | 1500 | 1000 | 2 |

## 3. Results

Comparing the traction coefficient values for the two types of test, the ranking given by the two types of experiment was equivalent, only the twin disc showed traction coefficients consistently lower than that of the full-scale rig and steadily falling. For FMA this is thought to be due to the complex transfer of product taking place as the two discs run together and because full mixing of oxides and FM does not take place as it does in the full-scale test. In the full-scale retentivity tests a durable third-body layer builds up that gives a constant level of traction coefficient of around 0.35 for FMA. For FMB, however, there was a continuous rise back to dry conditions

## 4. Discussion/Conclusions

Although twin disc experimentation is useful for certain measurements, absolute values of traction coefficient must be used in context. The full-scale rig allowed repetition of test results and, although it has a relatively slow velocity, allowed field comparable traction coefficients to be accurately measured.

## 5. References

[1] Burstow, M.C. "Rolling contact fatigue: laboratory testing" RSSB Report AEATR-ES-2004-907, 2006.

[2] Fletcher, D.I. Beynon, J.H. "Development of a machine for closely controlled rolling contact fatigue and wear testing" *Testing and Evaluation*, vol. 28, pp. 267-275, 2000.