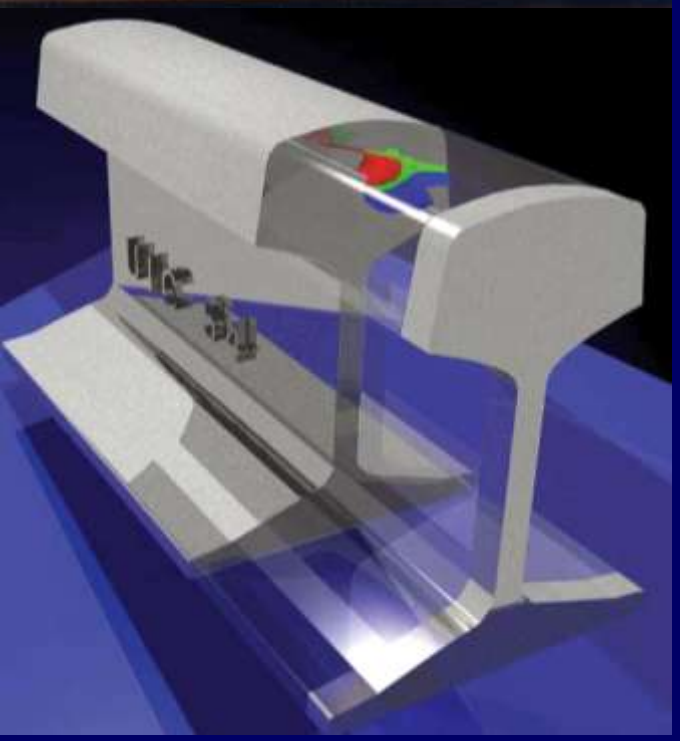

'Relationship between Track Geometry Disturbances and the Development of Rolling Contact Fatigue Damage'

Project commissioned by Dutch Rail Infra Provider 'ProRail'.

Presented by Martin Hiensch, AEA Technology Rail BV.

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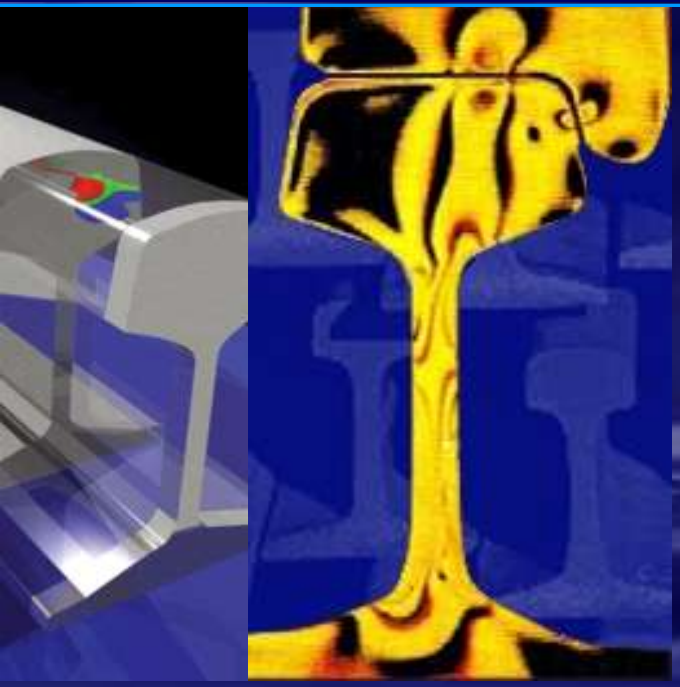
Motivation to research effect of track alignment on RCF

- ✓ Focus of Dutch RCF program has been on inspection, rail grade development and grinding.
- ✓ Significant Improvement has been achieved (RCF damage has reduced > 50% compared to situation of 2002).
- ✓ Rolling Contact Fatigue today still put a strong demand on the maintenance budget.
- ✓ Need to further optimise RCF management strategy.
- ✓ Historic RCF data acquired over the last 5 years provide the opportunity.

Purpose of the investigation



Investigate influence of Track geometry regarding RCF initiation and development.

Recognise ‘new’ triggers to reduce RCF damage

Evaluate maintenance intervention levels from RCF

Stronger incorporate RCF susceptibility regarding track geometry into track maintenance standards

General Approach

Statistical analysis

RCF inspection database

Track Geometry database

Case study of RCF test site

Site survey

Track-Train Modelling

Statistical analysis

For the complete Dutch Network (6500 km)

the data available consists of

- **RCF damage data**
- **tonnage**
- **foot angle of the rail**
- **horizontal and vertical alignment**
- **Cant**
- **wear values on rail head height and width**

Multiple regression analysis was used to identify correlation between RCF damage and track geometry and other variables of the dataset.

Site Survey – Head Check development

Monitored for 5 years.

- Visual inspection combined with manual US-crack depth measurements at a three monthly interval at pre-defined measuring positions.
- Every six months the full curve has been visually inspected within the standardised national RCF inspection routine.
- The track geometry recording train has frequently measured the site.
- Train mounted Head Check detection has been carried out once during the operational life of this test track, using the eddy current measurement system ‘ECTrackScan’.

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Head Check initiation prediction

Prediction model based on

Ratchetting limit Rail material

Wear resistance of rail material

Contact position on railhead

Validation

Modelling prediction of Head Check initiation using historic track geometry development as measured.

Comparing to Head Check development as measured manually and by EC Trackscan.

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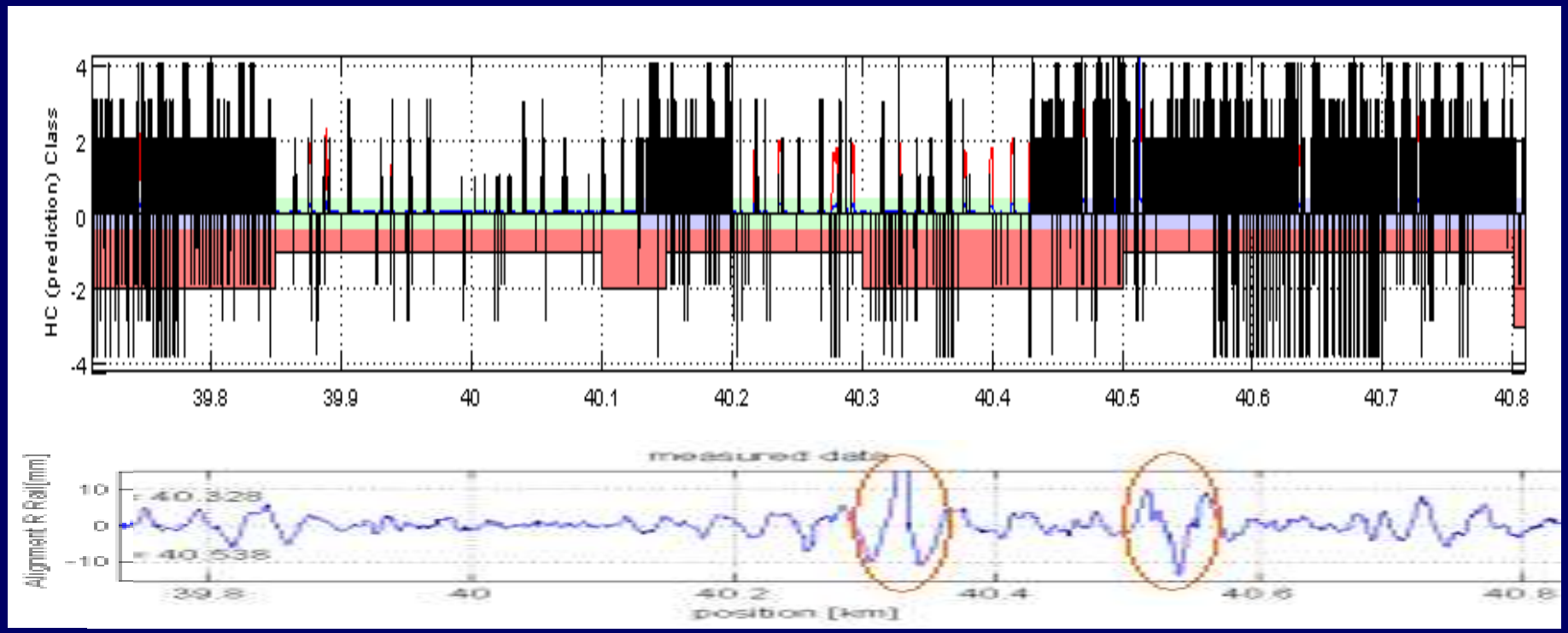
Validation result; Predicted and found Head Checks on test site



Black spikes/bars above axis; predicted HC damage

Black spikes under axis; EC Trackscan results (fall 2005)

Red bar under axis; visual HC inspection results (spring 2004)

Blue bar below axis; position of the 260Mn rail grade

Green bar on the horizontal axis; position of MHH grade

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Modelling Head Check development

The Head Check prediction model is used to quantify the effect of individual parameters on Head Check development and their combinations, e.g.

- Effect of Standard deviation track alignment
- Effect of rail inclination
- Effect of Anti Head Check profile
- Effect of rail grade
- Effect of gauge width

Modelling Results

Head Check susceptibility hardly decreases when lowering standard deviation of track alignment.

When track alignment for selected curve is ideal, Head Checks will still initiate in 260 rail grade. MHH is predicted to remain free from HC damage in this case.

Applying the AHC profile will reduce Head Check susceptibility to almost zero; this confirms the outcome of statistical analysis. Cost; increased flange wear.

Narrow gauge (-5 mm) increases Head Check susceptibility strongly, wide gauge (+5 mm) shows a weak positive influence.

Conclusions

- The effect of track geometry on Head Check initiation is strongly dependent on the RCF probability of the location derived from loading, rail grade and rail head profile.

- Local track geometry disturbances noticeably increase HC susceptibility for all track designs considered in this study.

- From the evaluated factors within track geometry, short wavelength horizontal alignment has the major effect on Head Check initiation.

- The Anti Head Check profile (54E4), as currently introduced to the Dutch rail infrastructure, has a strong potential to sharply decrease the probability of Head Check damage.

Regarding maintenance standards

- Introduce a new track maintenance assessment that recognises the Head Check damage initiated by the harmful high frequency responses,
- This could be based on first or second derivative of the horizontal track irregularities.
- Discriminate for straight track, curves, rail grade and profile.

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Thank you for you attention

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