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Sustainable Railway Switches

Structural Performance of the Switch Panel



M2i Project 'Sustainable Switches' nr. T91.1.12475a

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Content

Introduction

Scope of the work

Results

Conclusions

Outlook

Why have Switches and Crossings

A turnout (S&C) has two high level functions:

- Provide safe guidance of the railway vehicle
- Allow change of direction



S&C have a strong impact on system vulnerability

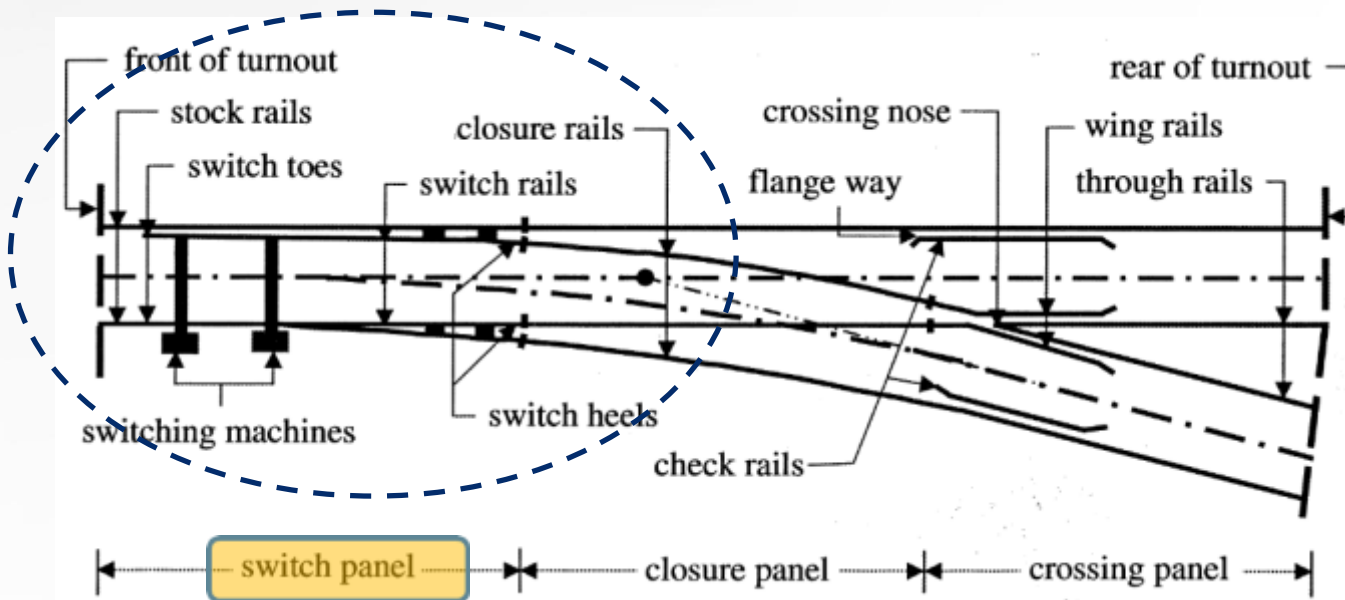
In 2010, train delays due turnouts were responsible for 55% of the total **disruption** time *(source: ProRail)*.

‘**Switch wear**’ in top three of main reported track problems by European infrastructure managers *(source: Innotrack)*.

Switch maintenance claims a **disproportionate** amount of the overall track maintenance budget *(40% in 2014, source: ProRail)*.

Aim of the research

To address the current industry needs relating to switch panel rail damage (switch and stock rail)



Research objective

Improve the understanding of the root causes of switch panel rail damage and potential mitigation measures



Severely worn switch blade



RCF damaged stock rail

Reaching sustainability

I. Reducing switch panel loading levels



II. Improving switch panel response to loading 'fit-for purpose'

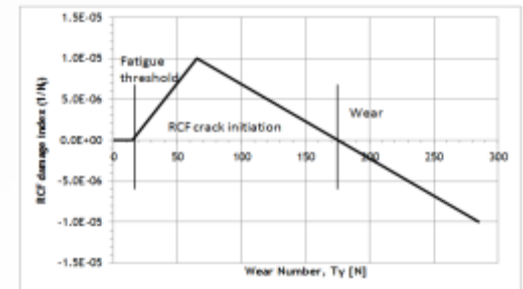
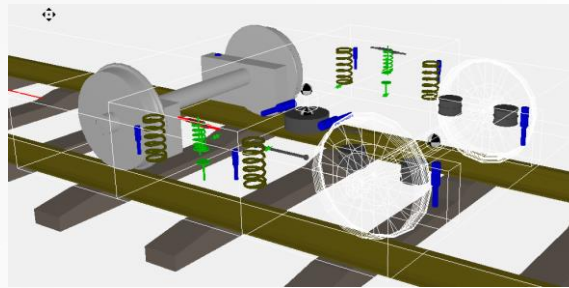
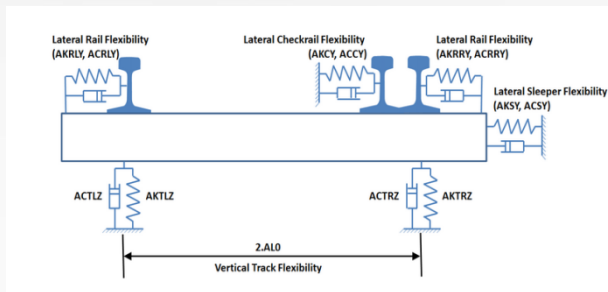
Project set up

Research topics

- (V) Vehicle-Track interaction
- (A) Assessment of operational factors
- (M) Materials deterioration
- (D) Damage response / design rules

Assessment

- Vehicle –track simulations;



Output: e.g. wheel-rail contact forces, creepage, contact positions, displacement,

RESEARCH RESULTS

Vehicle-Track interaction / track friendliness

Concept of Frequency Selective Stiffness

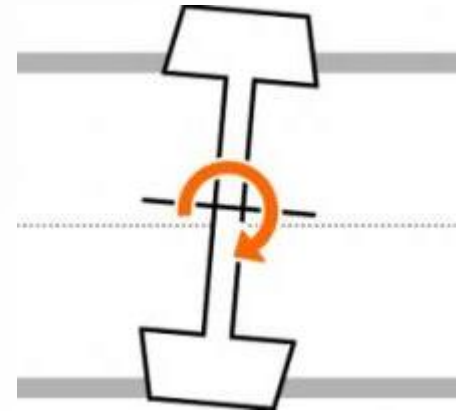
Switch panel deterioration

The observed rail head damage is related with excessive loading at the wheel-rail interface;

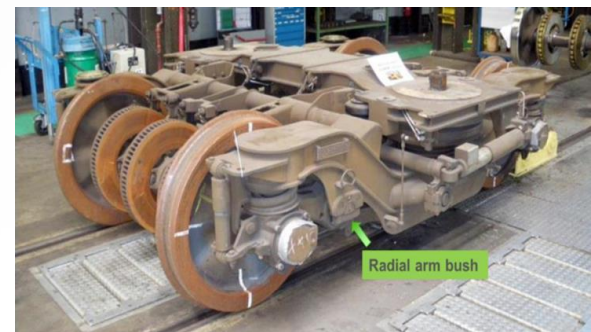
Level of forces and slip are determined strongly by the vehicle characteristics;

(determining it's 'Track Friendliness')

Especially the primary suspension stiffness (PYS).



PYS - VIRM-4 bogie



Vehicle stability vs. curving behaviour

The conflict:

- High PYS stiffness at tangent track for running stability
- Low PYS stiffness at curves and switches to reduce wear and RCF damage

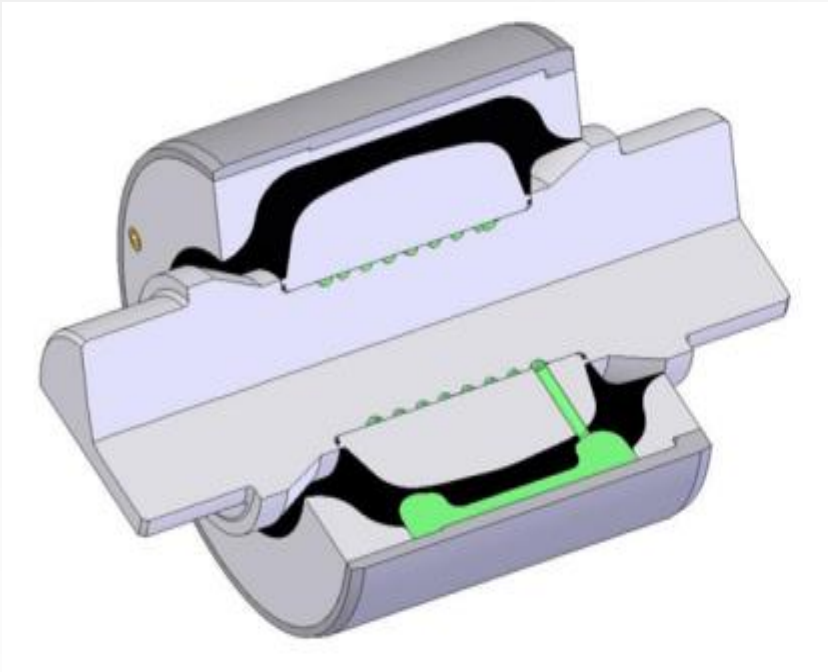
Running behaviour

Tangent track is characterized by high PYS movement velocities (high loading frequencies);

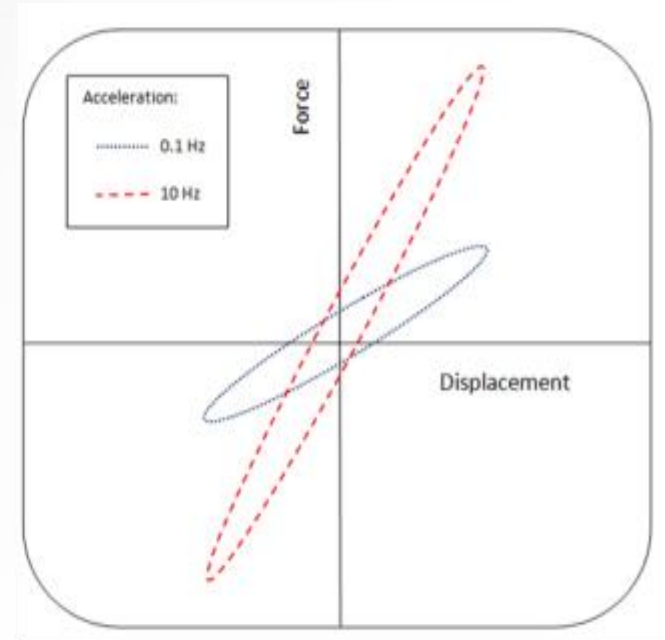
Curves and switches are characterized by low PYS movement velocities;

If suspension behaviour could be made dependent of these loading characteristics this conflict could be overcome.

Frequency Selective Stiffness (FSS)

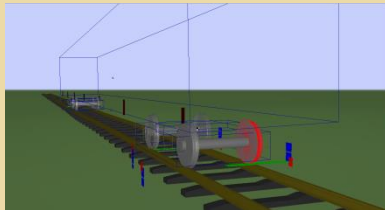
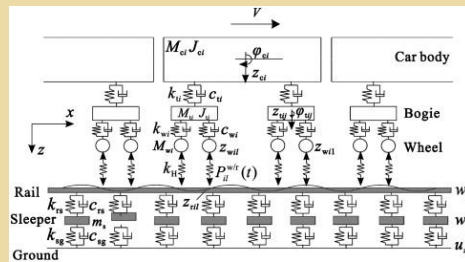


'Hydro bush'

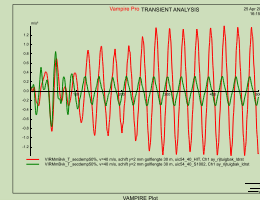
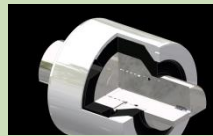


Assessment of 'track-friendliness'

I. Modelling



II. Parameter research

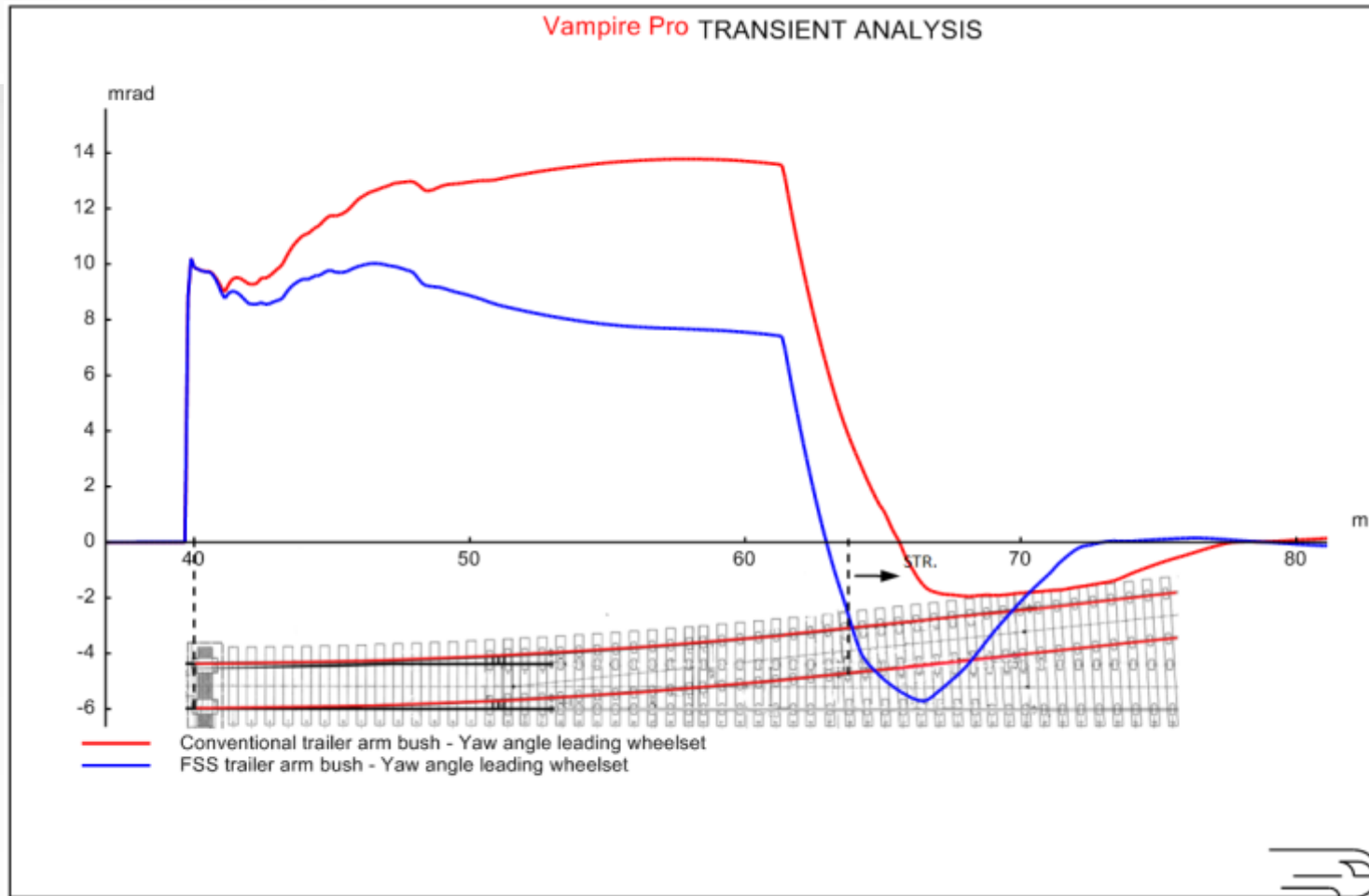


III. Measuring



IV. Validation





Yaw angle development at the diverging route through switch and closure panel

Findings – FSS primary suspension design

- The 'conflict' has been resolved
- Track friendliness of trains is improved significantly
- Observed 40 to 50% reduction in wear loading when negotiating a turnout
- Good correlation between modelling output, measurements and track observations.

Assessment of operational factors

Switch loading

Objective – understanding of:

- Switch panel damage types and development
- Dominating operational factors at switch loading /damage development.
 - e.g. vehicle type, vehicle speed, direction of traffic, tonnage, lubrication, traction, axle load, push-pull service, wheel-rail profiles.

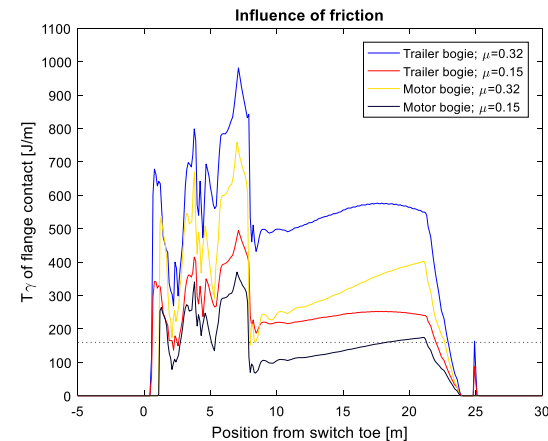
Sensitivity analysis

I. Track inspections



II. Assessment of operational data

III. Vehicle- track simulations



Findings with regard to lateral switch wear

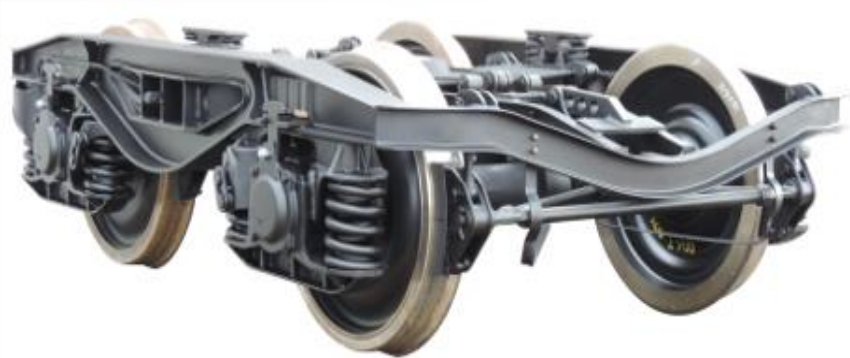
- For the assessed S&C configuration only (flange)lubrication is seen to reduce wear loading to levels preventing abnormal lateral switch wear
- Other investigated parameters are found not to be a governing factor

Switch panel deterioration

Switch loading and cost

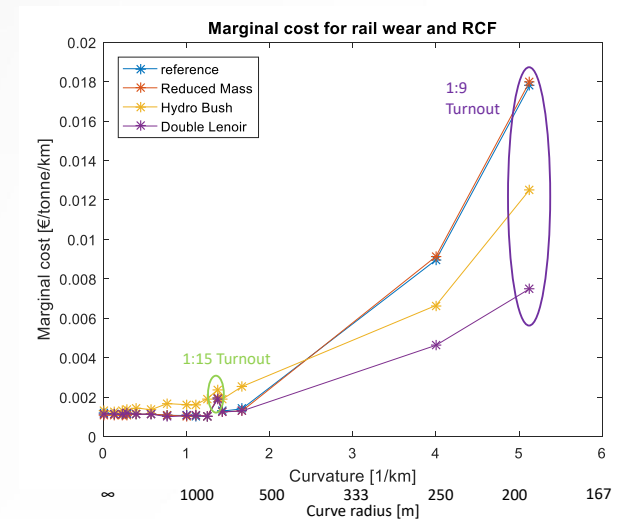
Scope

- Freight Bogie design improvement (track friendliness)
- Quantifying the impact of track friendliness regarding track deterioration, in terms of:
 - Damage development (Ty)
 - Marginal cost (cost per train km)



Findings

- Track friendly vehicle concepts behave more cost friendly at switch negotiation, with up to 60% marginal cost reduction.
 - *However calculated cost reduction for the 200km route being only 1.8%.*
- S&C: 12 times the cost, high impact on track availability.
- Currently benefits are insufficiently reflected in the cost model overall assessment result.



Switch panel damage response

Rail damage function development

Goal

- Understanding in rail material response
- Defining rail grade selection criteria in relation to the occurring damage mechanism (fit-for-purpose)

Approach

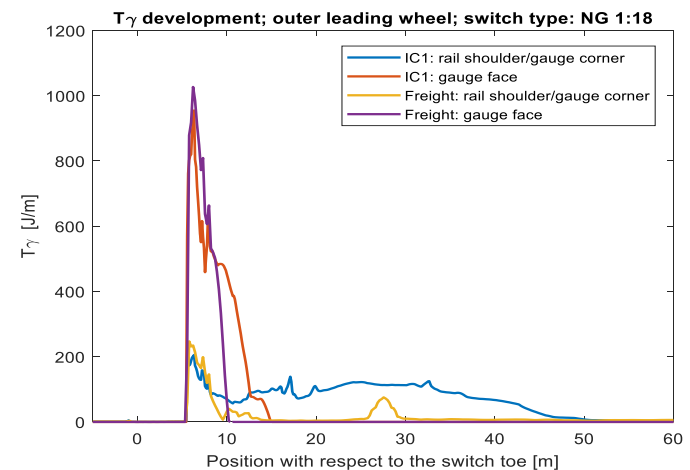
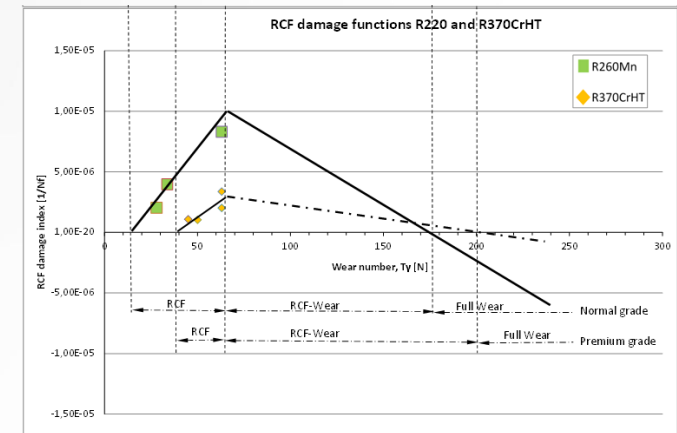
- Development of rail damage models

derived from:

- Field testing (damage development)
- Vehicle-track modelling

Findings

- New established RCF damage functions provide the tools for a fit-for-purpose rail grade selection approach
- Expected improvement of switch panel performance when applying these damage functions for rail grade selection has been demonstrated.



OUTLOOK

Outlook in improved track friendliness

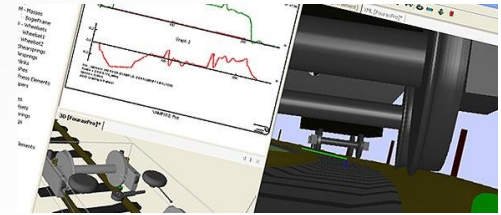
- Supporting boardroom decision on FSS hydro-bush implementation
- Improved transparency in benefits towards S&C sustainability
- Stimulating track friendliness by the system of Track Access Charging (TAC)
- Supporting friction management



Outlook in switch panel rail grade selection



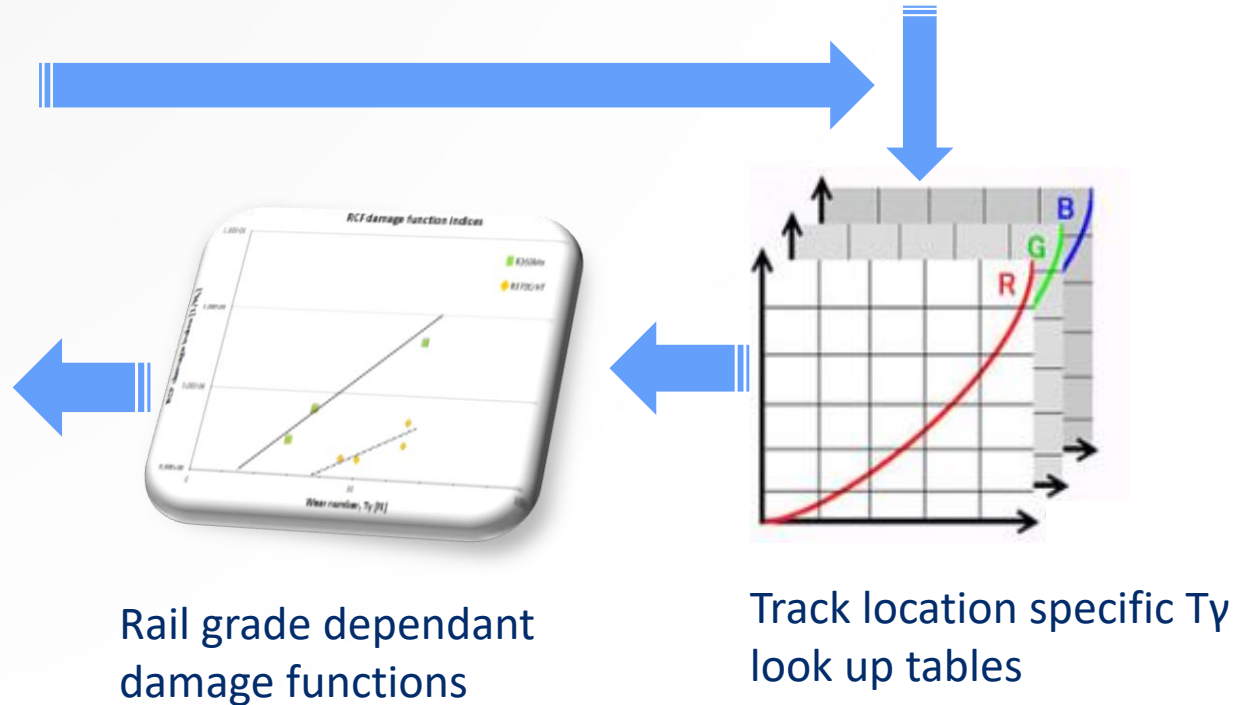
Railway engineer



Track & traffic characteristics



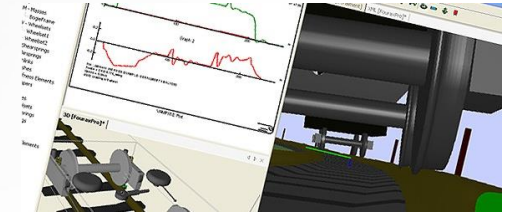
Fit-for-purpose



Outlook in switch panel maintenance



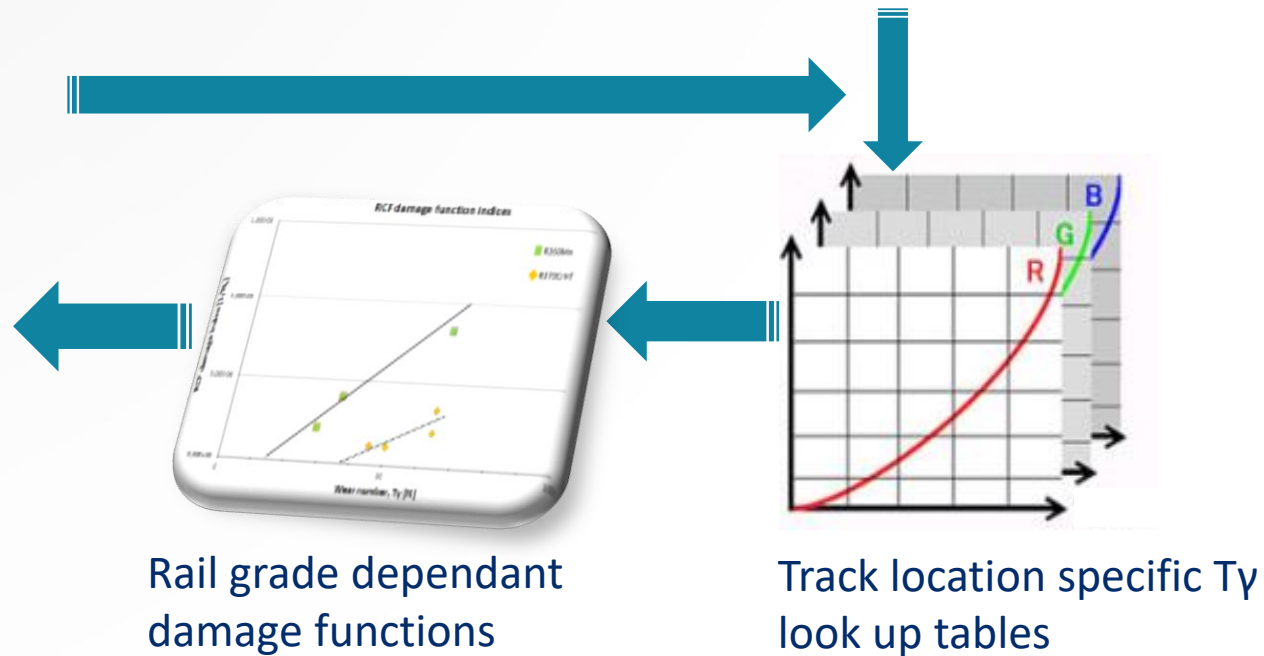
Railway engineer



Track & traffic characteristics



Measures
(e.g. lubrication, grinding)



THANK YOU!

ANY QUESTIONS ?



“Real system improvement
requires a joined effort!”