WP 1.3 Innovative concepts and designs for resilient S&Cs
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Introduction

- C4R WP13 second task: “Resilient S&C” D132
  - Objectives:
    - Collect and organise relevant information on S&C related failure modes, based on the expertise available within the consortium and outside where possible (D131)
    - Propose innovative design to minimize material deterioration and failures
    - Suggest innovative design and operational practices to ensure resilience to extreme weather conditions
    - Survey optimized sensor strategies

- Minimizing S&C loads and deterioration
  - Based on failure catalogue
  - Short/Middle/Long-term solutions

- Resilience to extreme weather condition
  - Failure catalogue

- Sensor strategy
S&C overview

Crossing panel

Switch panel

Point machine

Switch blade

Stock rail
Characteristics: Running surface: small crack in the outer face of the rail head (few mm below running surface). At a later stage, a piece of the metal may break or peel away.

(Possible) Causes:
- High contact stresses → sub-surface or near surface cracks that merge together to cause localised loss of structural integrity that results in spalling/shelling of the material. (Rolling Contact Fatigue, RCF)

Preventive/corrective measures:
- Resurfacing or repair welding.
- Replacement of rail

Detection:
- By ultrasonic testing/eddy current
Short term solutions
Modelling – switch panel

- Minimizing the effect of high lateral and longitudinal force
- Predicting the effect of design changes in the switch panels
  - Switch and stock rail design changes (cutting angles, nominal and
gauge widening, rail profiles, rail inclination...)

Inclination

Section at 1722 mm

y-coordinate [mm]

x-coordinate [mm]
Short term solutions
Modelling – switch panel

Output

– Cumulative contact band and cumulative damage estimates for:
  • Wear
  • RCF
**Rail profile optimisation**

**$T_\gamma$ – Energy function for RCF initiation**

Diverging route, facing move, 70 km/h, $\mu = 0.3$

**Contact point top**

**Contact point side**

Positive coordinate towards track centre

Distance from front of turnout [m]

Contact position - cp1 [mm]

Positive coordinate towards track centre

Distance from front of turnout [m]

Contact position - cp2 [mm]
Material influence

Wear  20-40 % for R350HT compared to R260
RCF   30-50 % for R350HT compared to R260

Less wear in laboratory test (INNOTRACK)
Medium term solutions
Crossing panel

P1 – axle weight

P2 – train weight

Nominal
Worn
Hollow

P1 force
P2 force

+115%
+60%
Medium term solutions
Crossing panel

Wheels vertical motion

Vertical contact Force

Conclusion Crossing needs to be maintained carefully The degradation goes fast with wrong geometry
Medium term solutions
Crossing panel

Cumulative contact band viewed from the top – crossing rails

High pressure wing edge; very high pressure on nose; repeated impact load
Medium term solutions
Crossing panel

Ballast forces

Load transfer area

Linked sleepers
Long term solutions

New design
Improved material

Bainitic crossing

In field test (Sweden) since August
Longitudinal stresses give increased probability of buckling and will also affect the longitudinal position of the switch blade. Inside the S&C, some forces also come from diverging track.

Buckling within S&C
Caused by:
- Extreme positive temperature gradients - rail expansion
- Insufficient lateral resistance

Preventative measure:
- Proper stress compensation done at assembly and welding.
- Stress redistribution after the S&C is set in operation (according to the real temperature range in the rail)

Longitudinal stresses give increased probability of buckling and will also affect the longitudinal position of the switch blade.
Strategy for condition monitoring of S&C
Fixed installations

Switch blade movement

Dynamic forces

Switch heating
Strategy for condition monitoring of S&C
Measurements from trains

- Track geometry
- Stiffness
- Acceleration (Indirectly force)
- Image analysis

![Graph showing deflection and level measurements](image)

- Deflection and Level
- Flp 21a
- EV-60E-580-1:15
- End
- Crossing
- Front

- Deviation vs. Km+m
- Deflection L
- Level L
- S&C
Thank you for your kind attention

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