FIELD STUDY OF INSULATED RAIL JOINT DEGRADATION ON VÄSTKUSTBANAN

CHARMEC

TRAFIKVERKET

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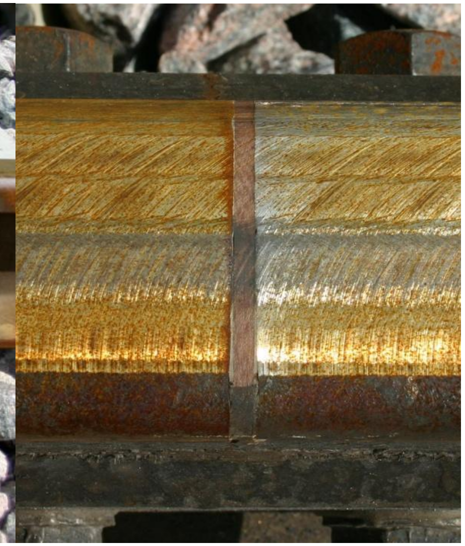
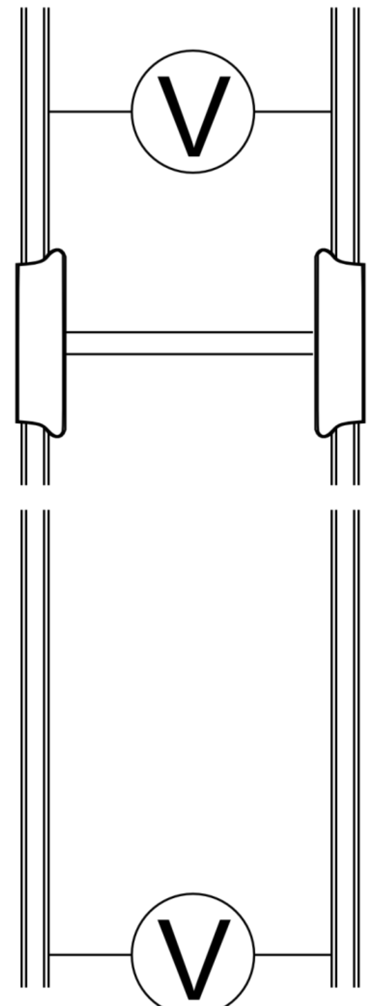
Insulated rail joints

6-hole prefabricated insulated joint



2008-06-11 (the week before the start of operational traffic, but after grinding)



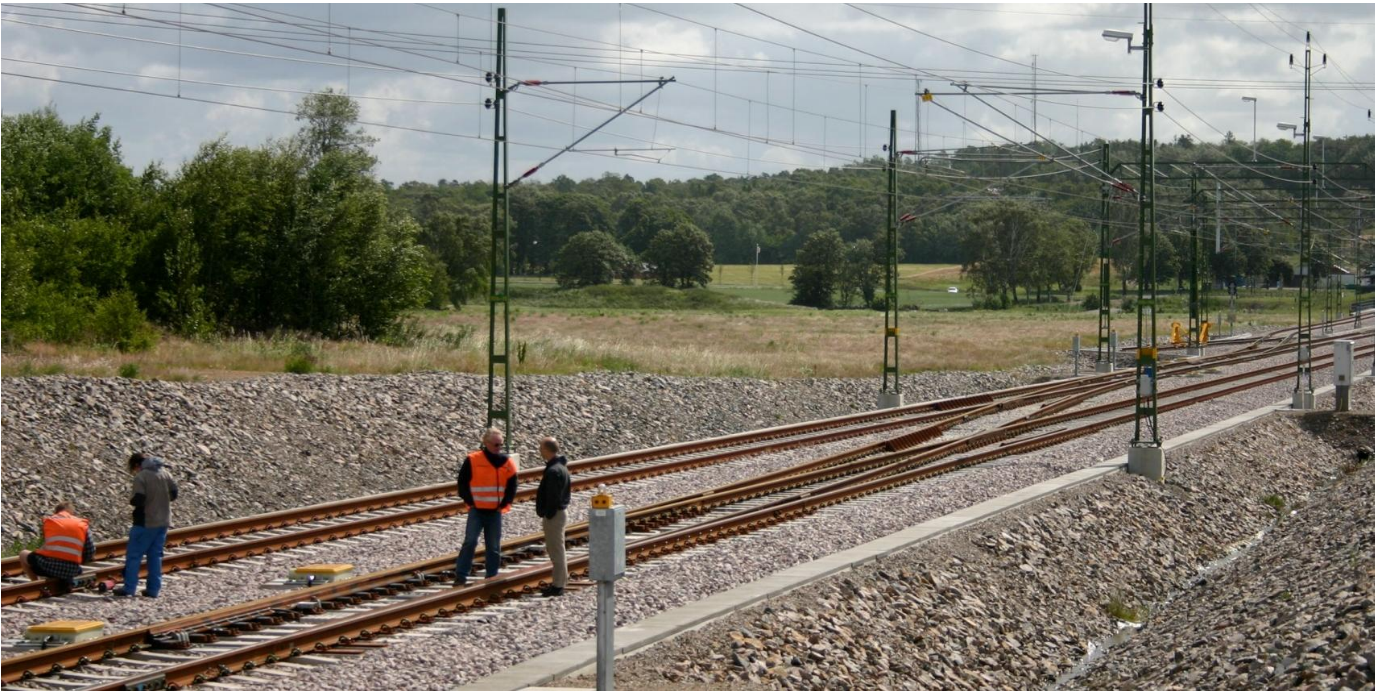
- All-welded rails are divided by gaps that electrically insulate different sections of the track. This allows for electrical signals to be bounded to a certain section of the rail
- The insulated rail joint is designed to ensure a gap between two rail ends
- To ensure electrical insulation a non-conductive material is inserted into the gap

Deterioration of insulated joints

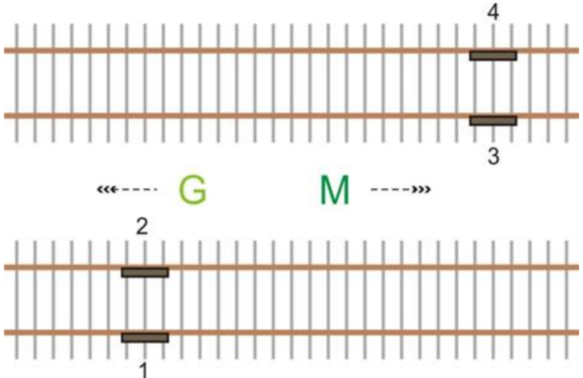
- The contact between the wheel and joint end causes stress magnitudes far above the yield limit of the rail steel
- As a result, plastic strain and fatigue damage accumulates in the material and causes roll-out and material failure
- One consequence is that metallic material starts bridging the gap, forming a conductive bridge
- Troublesome traffic disturbances are experienced when the joint gets short-circuited
- Other consequences are cracking of the joint and joint dipping

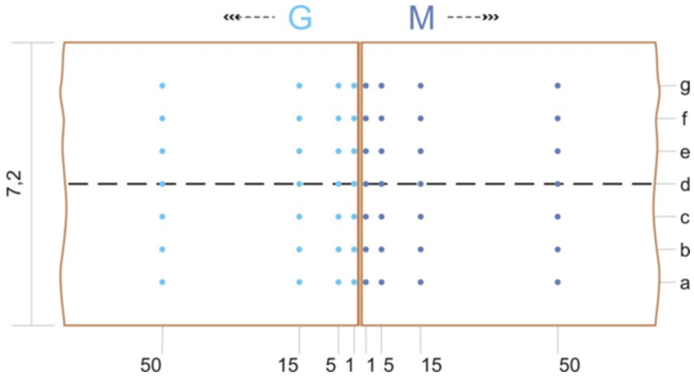
Field study

- Four newly installed insulated joints studied from the beginning of service
- Located about 300 m from Falkenberg station on the Swedish West Coast Line



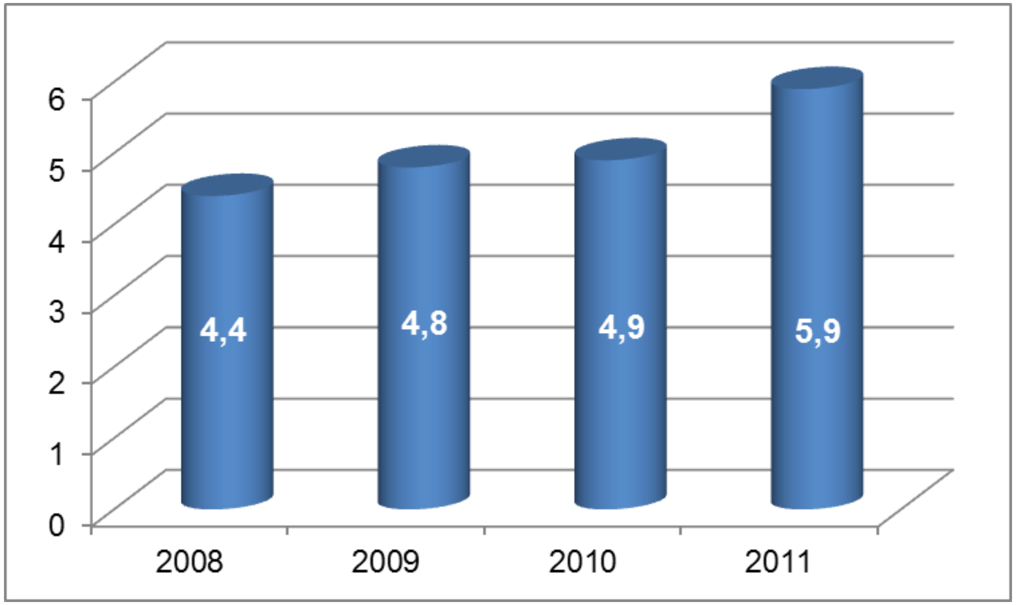
Measure-ment number	Date	Time in traffic [days]
1	2008-06-11	0
2	2008-08-20	70
3	2009-02-20	254
4	2009-11-11	518
5	2011-01-21	954
6	2011-09-02	1178





Field study – operational conditions

- Mildly loaded track:
  - maximum axle load normally 22.5 tonnes (designed for 25 tonnes)
  - estimated traffic about 5 MGT/track/year
- Maximum allowed speed on the line is 200 km/h
- UIC 60 rail
- Prefabricated 6-hole insulated rail joint with 4 mm gap (standard in Sweden)

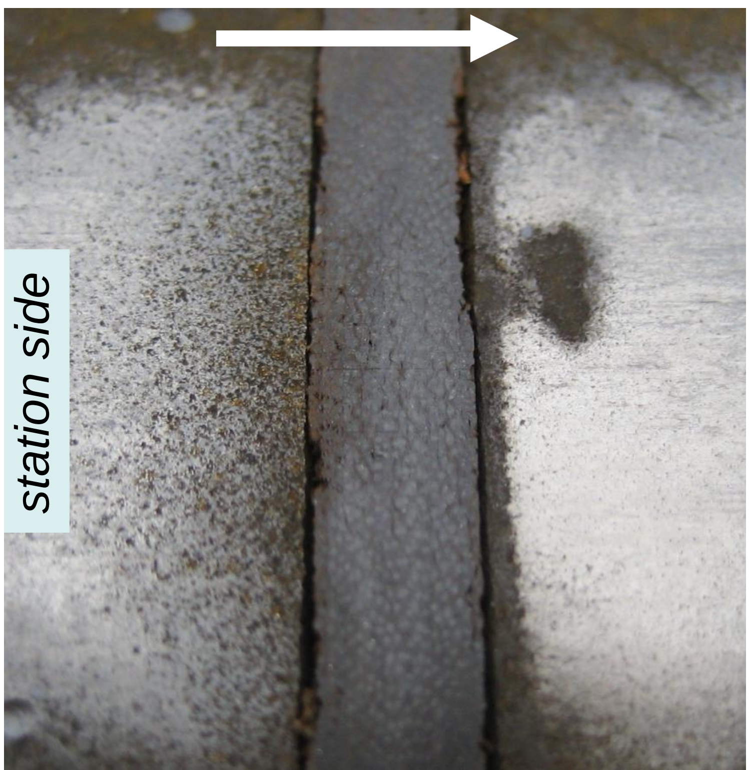


Annual traffic loading [MGT/year] on the studied track near the city of Falkenberg

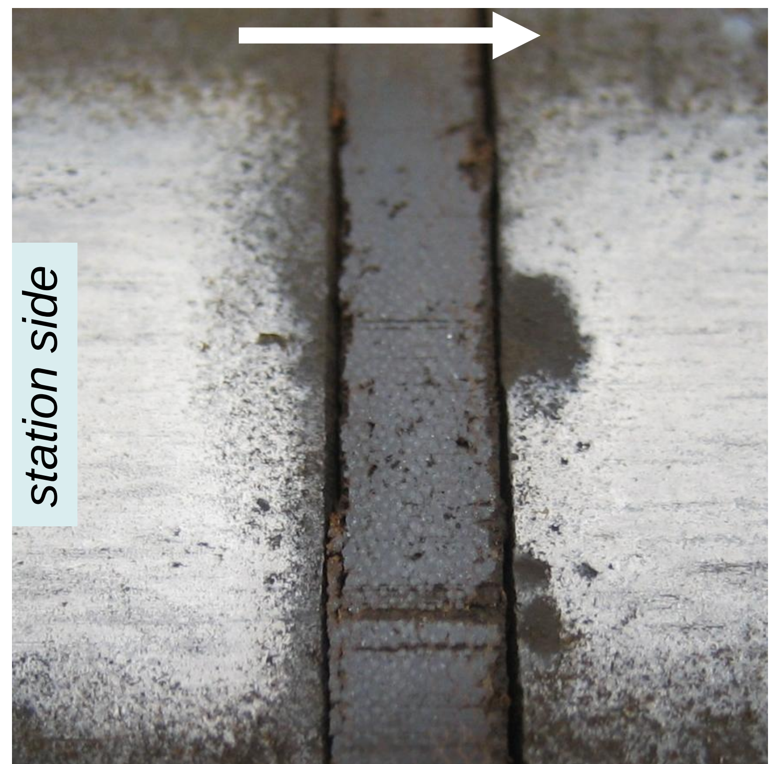
Field observations, in general

- All joints showed similar damage patterns
- Wear-like pattern appearing quickly on the station side
- Failure-like (material detachment) on the other side of some joints

traffic direction

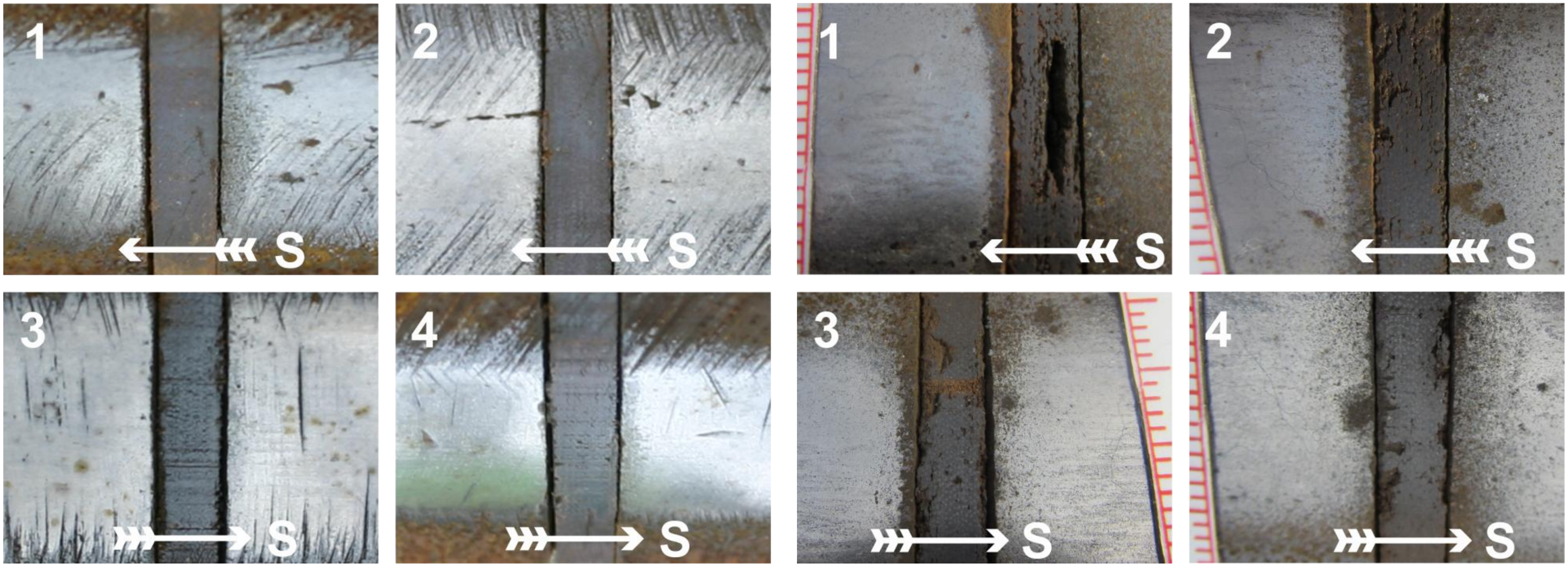


traffic direction

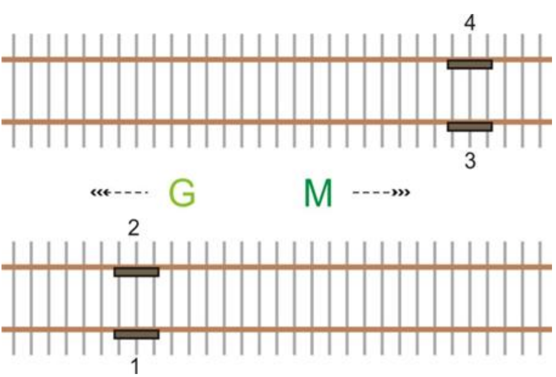


Influence of train travelling direction

measurement 2 measurement 6

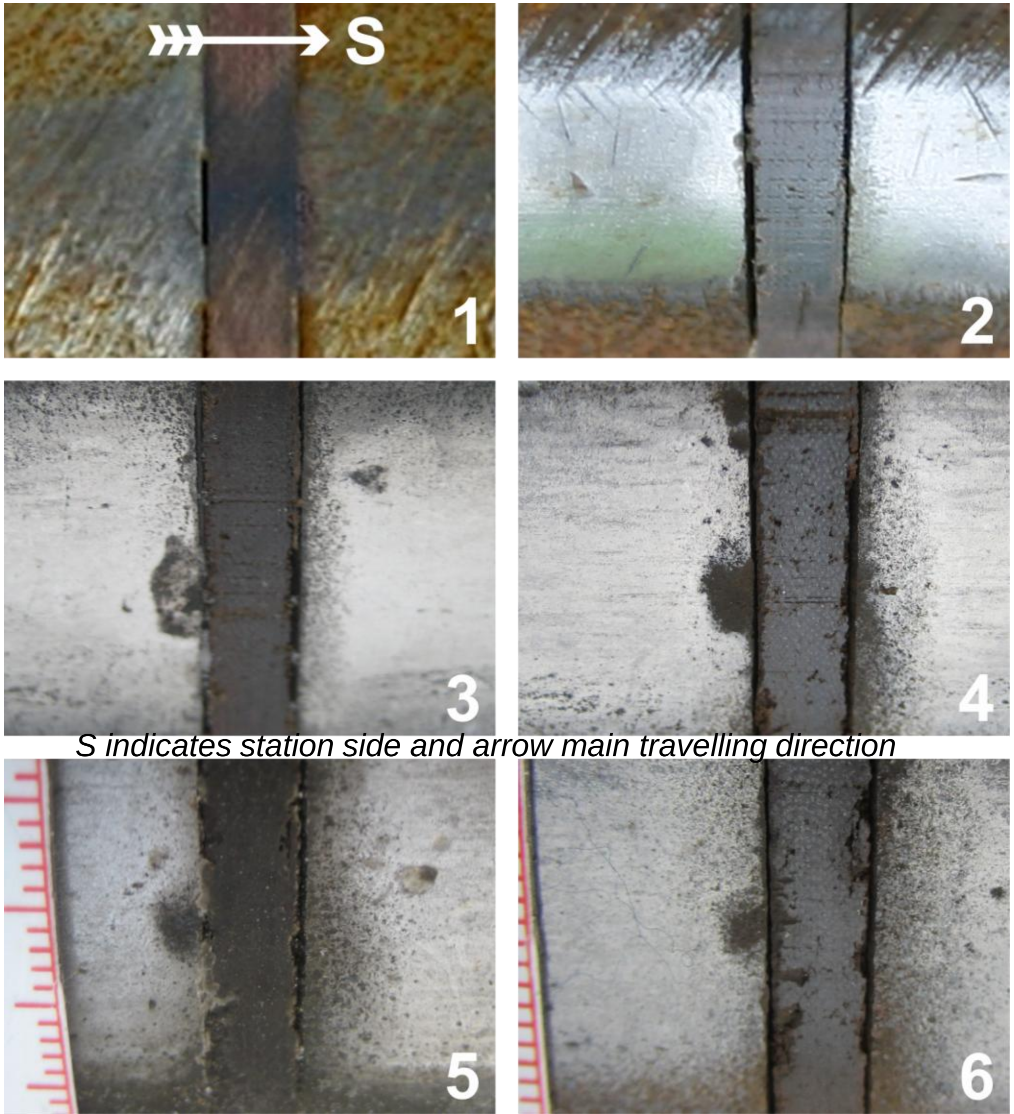


Typical damage pattern occurring on the station side. S indicates station side and arrow main travelling direction



- Vertical impact is not the dominating cause of damage here
- Compressive longitudinal force lifts up the rail on the station side (while train is accelerating and braking at the station)
- “Cavity-like” damage was found after a half a year on two of the joints (2 and 4) on the side of the joint away from the station

Damage evolution of the insulated joint 4

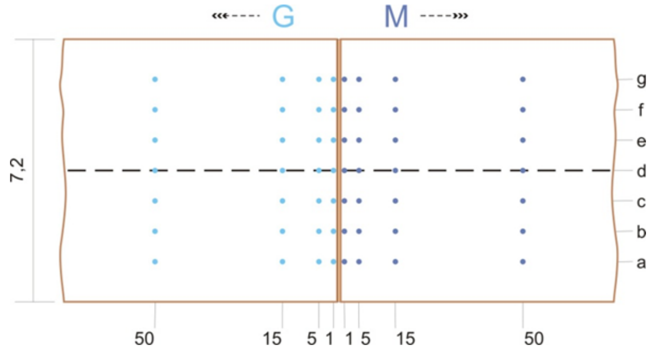


S indicates station side and arrow main travelling direction

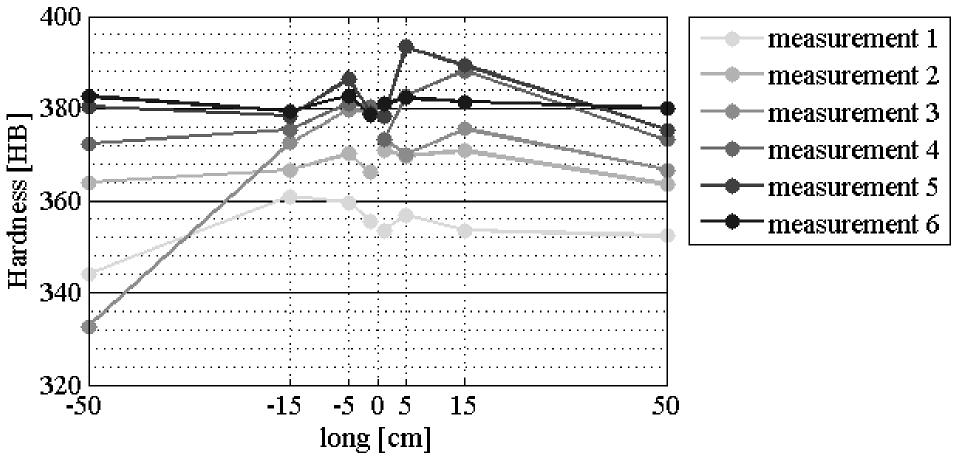
- Photographs taken show the degradation pattern of the joint during three years

Measurement number	Time in traffic (roughly)
1	0
2	2 months
3	8 months
4	1.5 years
5	2.5 years
6	3 years

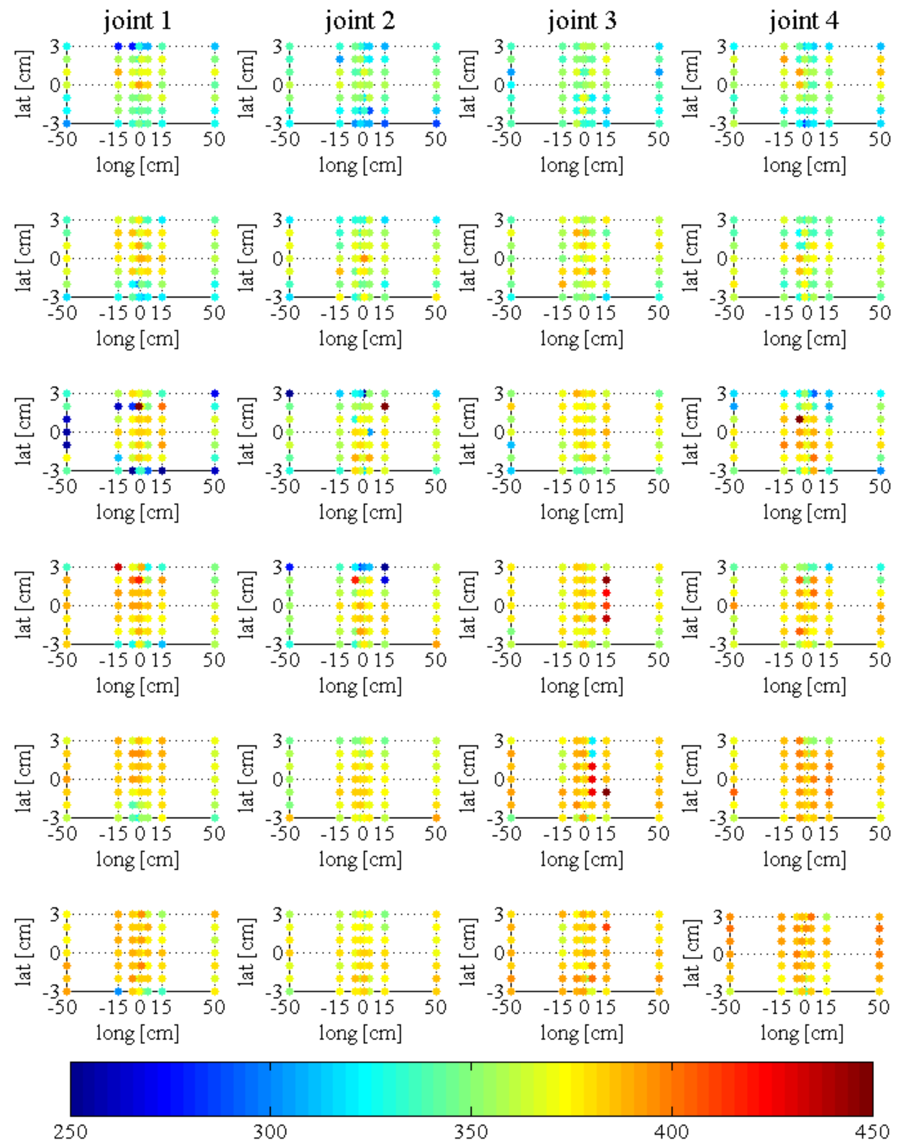
Hardness measurements



- Performed at the rail head surface close to the joint
- The joints manufactured from head hardened steel
- Hardness seems to have stabilized at the end of the observation period

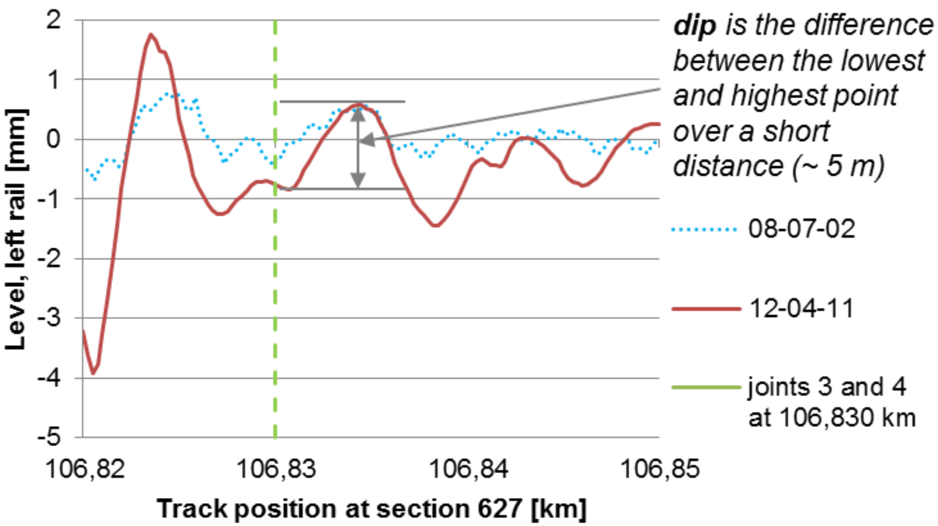


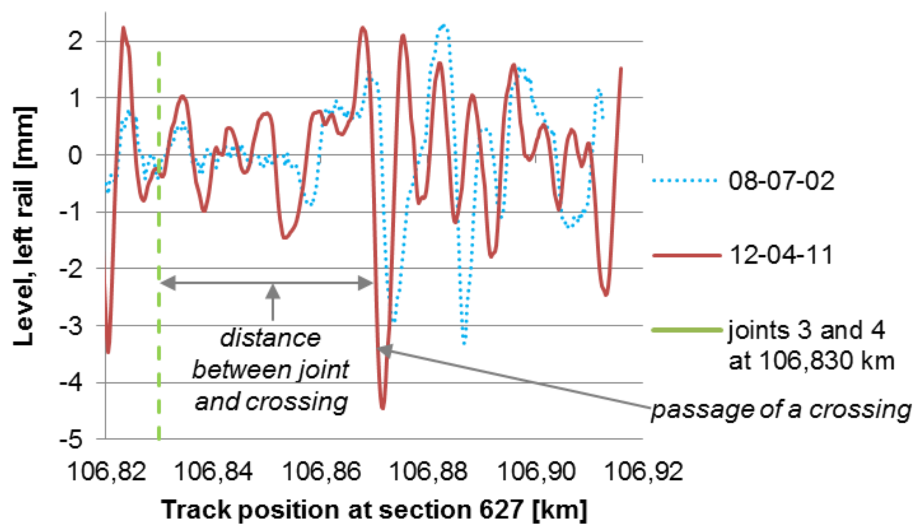
Hardness averaged for the three lines closest to the rail head centre (“c”, “d” and “e”) for all joints at all six measurements



Hardness for all joints and measurements

Track geometry evaluation





- From geometry measurements by Trafikverket using the measurement car STRIX
- The insulated rail joints are identified in the measurements by their distance from the nearby crossings

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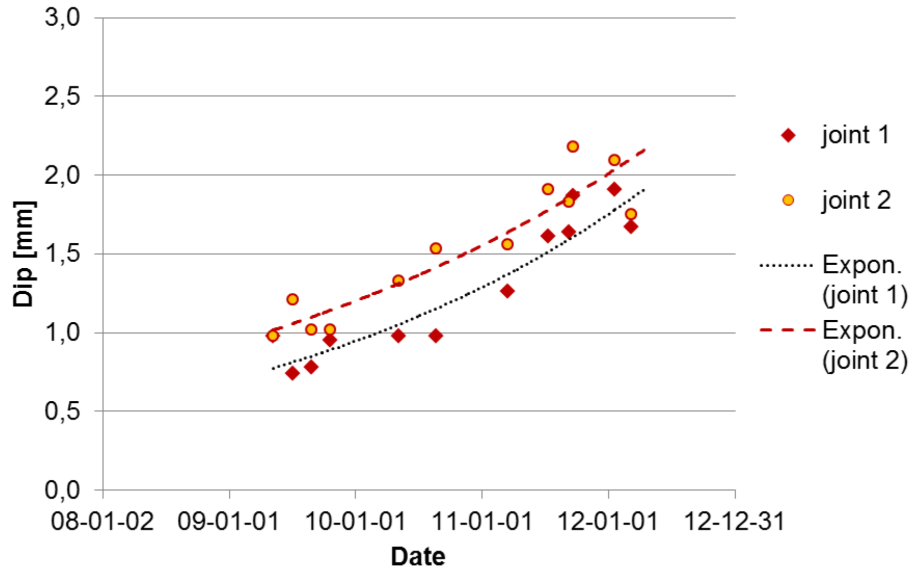
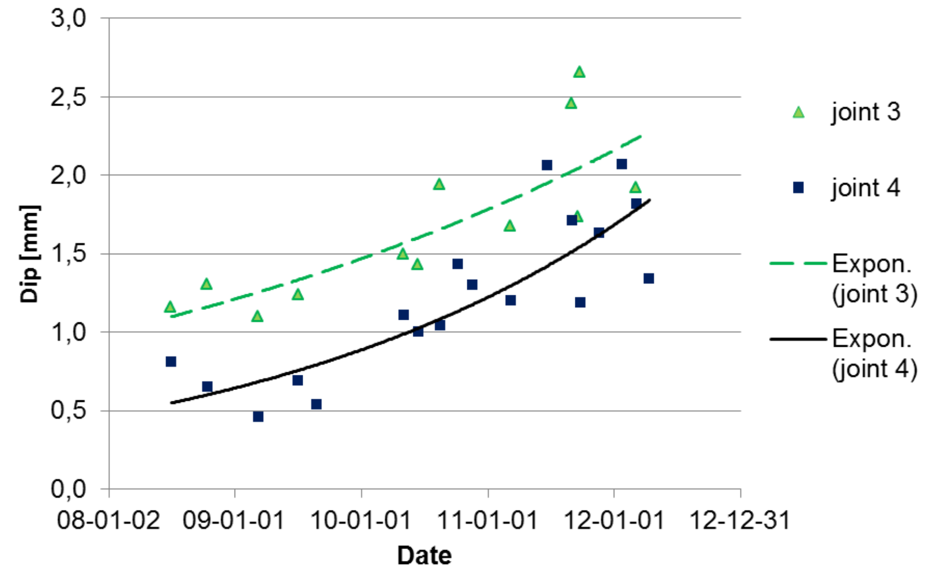
Track geometry degradation

Vertical geometry degradation of insulated rail joints 1 and 2



Vertical geometry degradation of insulated rail joints 3 and 4



- Track geometry degradation increases the loading, which in turn increases the deterioration
- Geometry degradation is not a linear phenomenon

Conclusions

- Four operational joints have been monitored regarding the evolution of degradation
- Six inspections during three years have been performed at half year intervals with the first on the completely newly built track
- Initial damage occurs very fast in the vicinity of insulated joints, also at rather benign operational conditions
- Wear is largest on the side towards a nearby station
- The damage pattern was found to be similar on all studied joints
- Measurements of track geometry have shown an increase in joint dip that is seen to accelerate with time