Inspection and Maintenance of Rails in Relatively High Slope Region of Thailand

1. Mechanical Properties and Microstructure of Rail Steels
2. Corrosion map for rail tracks and fastening system
3. Failure Analysis of Railways in Northen Line
4. Digital Platform for Rail Maintenance Database

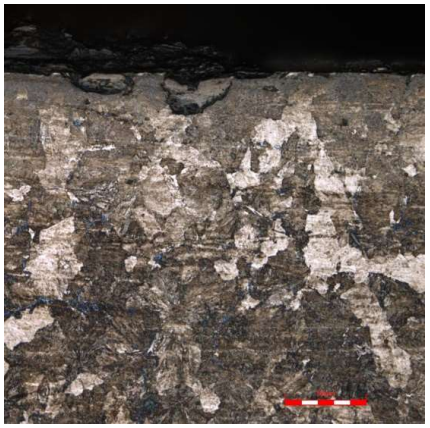
Collaborators

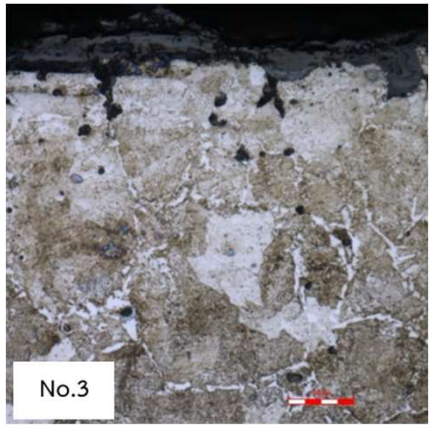
- NSTDA (Project Investigator)
- State Railways of Thailand
- Department of Rail Transport

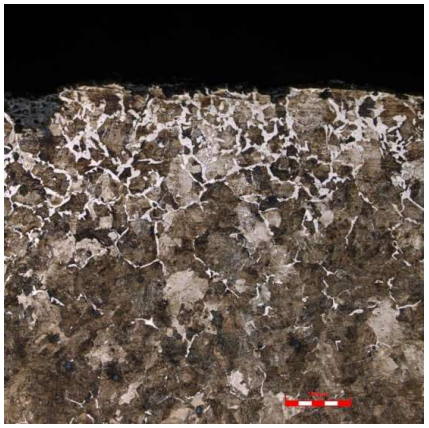
Location for Case Study : Lampang Province in the Northern Region of Thailand.

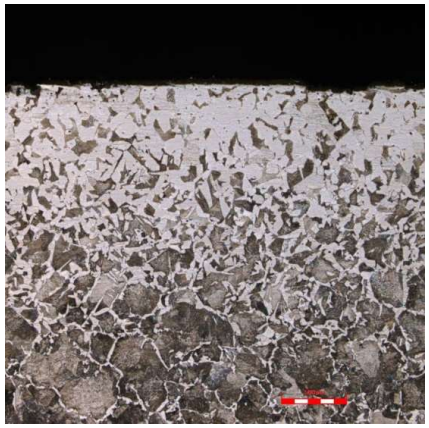
1. Mechanical Properties and Microstructure of Rail Steels Used in Thailand

- **Recommended General Standard for New Rail Acceptance for Surface Grinding and Storing**







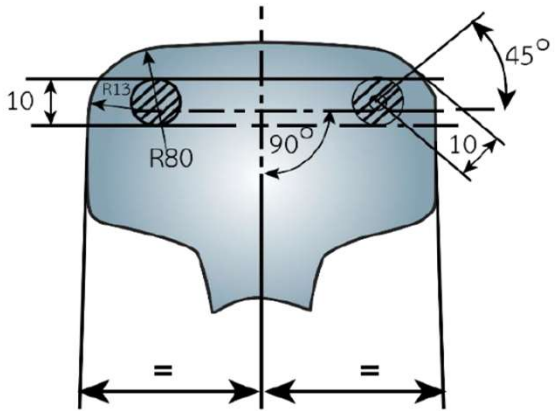


Corrosion and decarburization were observed on the running surface

- Corrosion pits on the contact surface could act as a stress concentrator and can be the starting point for cracks, especially under cyclic loads.
- A decarburized layer with a ferrite network was found at the contact surface.
- EN 13674: The maximum amount of decarburization allowed on rail, defined as a complete ferrite network at the surface, is 0.5mm.
- Therefore, there should be storage requirements, such as a roof or a rust-proof coating, etc., and the degraded layer removed.

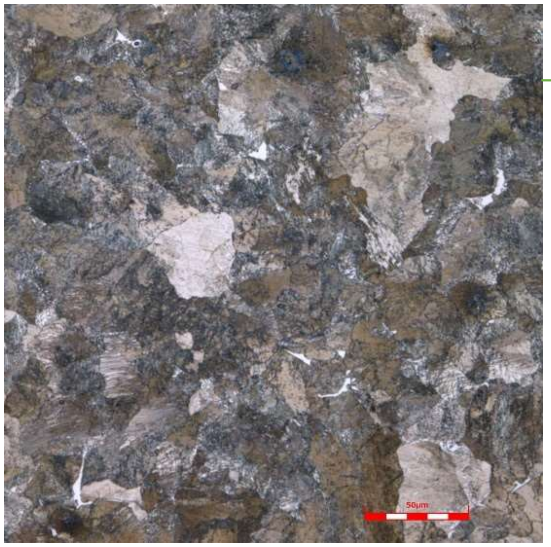
Redesignation of the Location for Microstructural Analysis

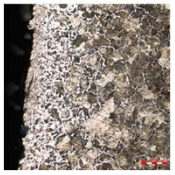
Cross-section of the rail head showing the areas for preparing tensile strength and microstructure test samples (in mm) designed by SRT. It should be redesigned to cover the contact surface.



Area for removing the material for preparing the tensile test sample

Area for removing the material for preparing the microstructure analysis sample





2. Corrosion map for rail tracks and fastening system

http://home.iitk.ac.in/~vyas/tmrs/P2a.html

Corrosion map for **rail tracks and fastening system** will be constructed based on crevice corrosion studies in accelerated corrosion tests and field test validation.

Chloride map data
- **4 levels**

ISO 16539 test
- Rail
- Fasteners

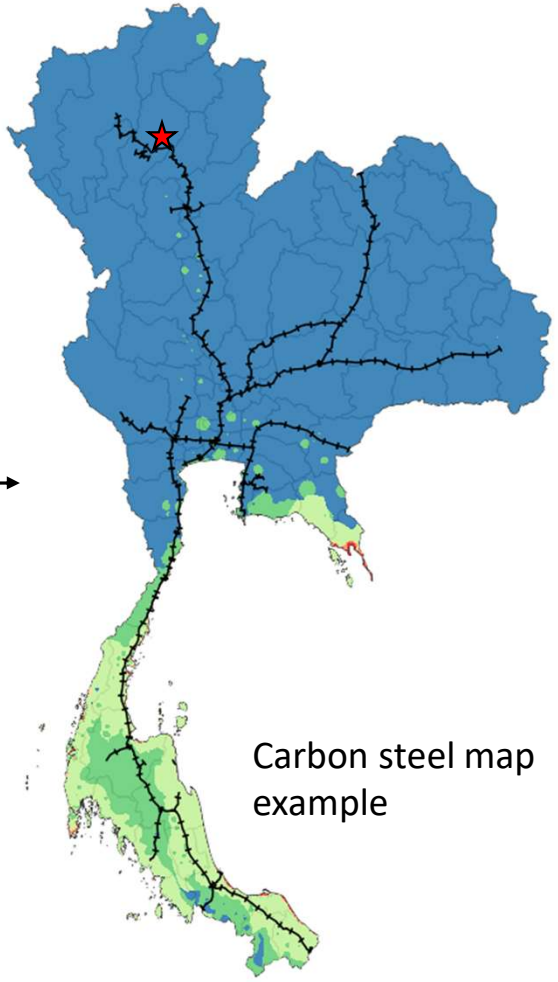
(Crevice corrosion)

Zoning corrosion map

Validate low Cl- area (Northern zone) ★

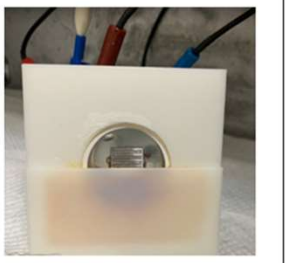
Exposure test (1 year)
- **Crevice corrosion sensor**

- Weather data
- Monitor Cl- and SO_2

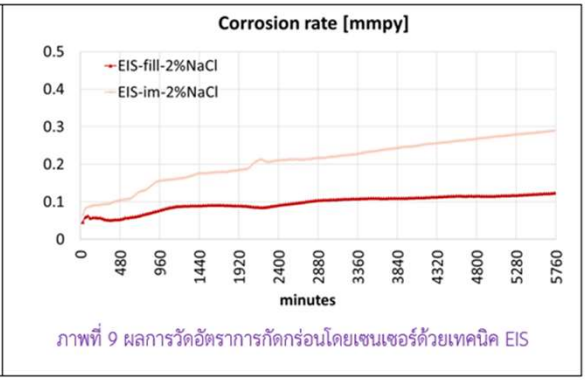


Carbon steel map example

Crevice corrosion sensor (Lab Prototype)

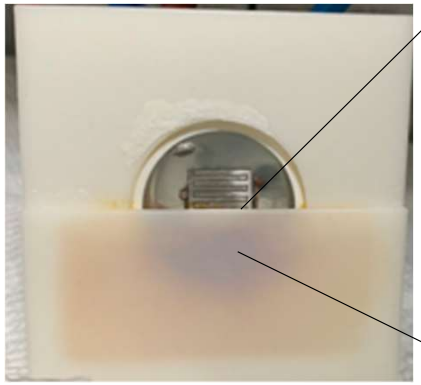


ภาพที่ 8 ต้นแบบการจำลองซอกบนเซนเซอร์แบบสองขั้ว



ภาพที่ 9 ผลการวัดอัตราการกัดกร่อนโดยเซนเซอร์ด้วยเทคนิค EIS

Bi-electrode sensor
Relevant steel grades (900A, R260)



Severe corrosion inside the crevice area

fill: fill the crevice with NaCl 2%wt solution (solution dry up)
im: immerse sensor in NaCl 2%wt solution (always in contact with NaCl)

Corrosion rate of fill = 0.5 x (corrosion rate of im)

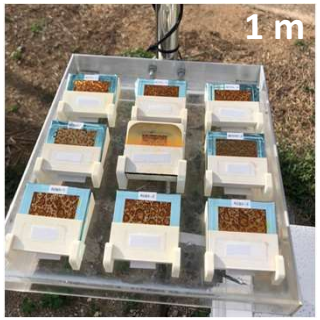
Exposure test (1 year)

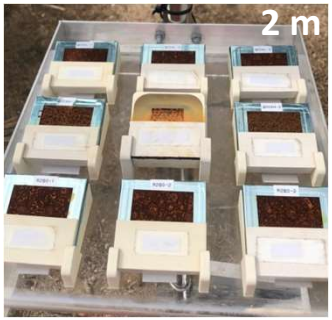
- **Crevice corrosion sensor**

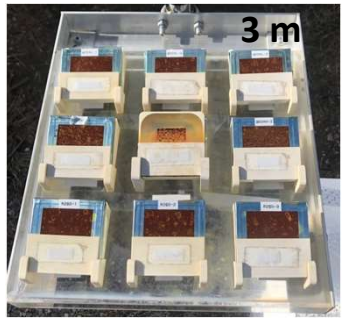
Mae Jang Station

- Weather data
- Monitor Cl- and SO_2

Relevant steel grades (900A, R260)



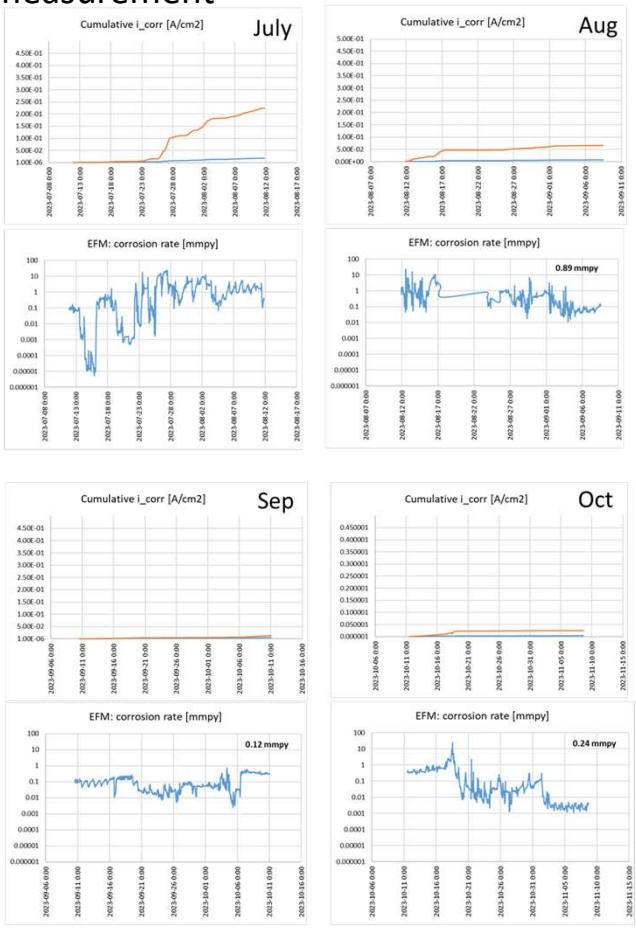




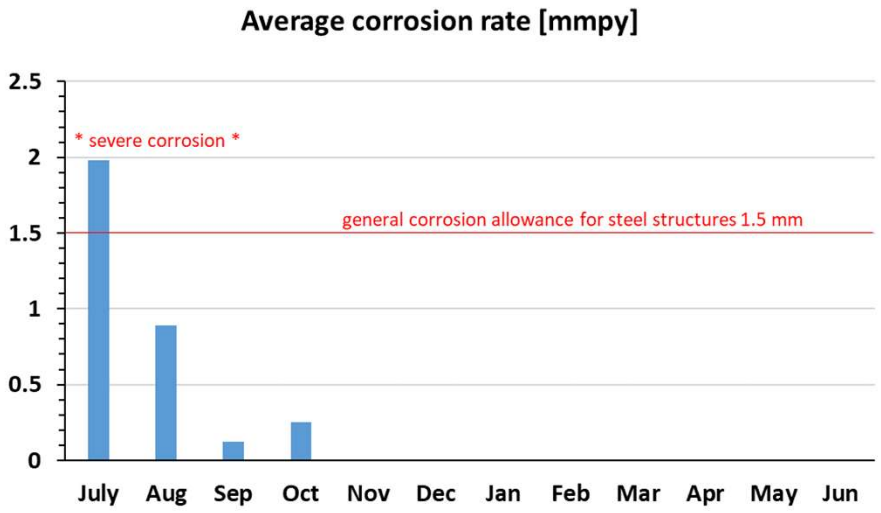
Corrosion current density (I corr) and corrosion rate from EIS measurement

Mae Jang Station

Exposure test (1 year)
- **Crevice corrosion sensor**



Sensor output



Average crevice corrosion rate for 4 months was **30X** faster than general corrosion rate in marine test site.

Corrosion classification ISO 9223

C1 -> least aggressive
C2
C3
C4
C5
CX -> most aggressive

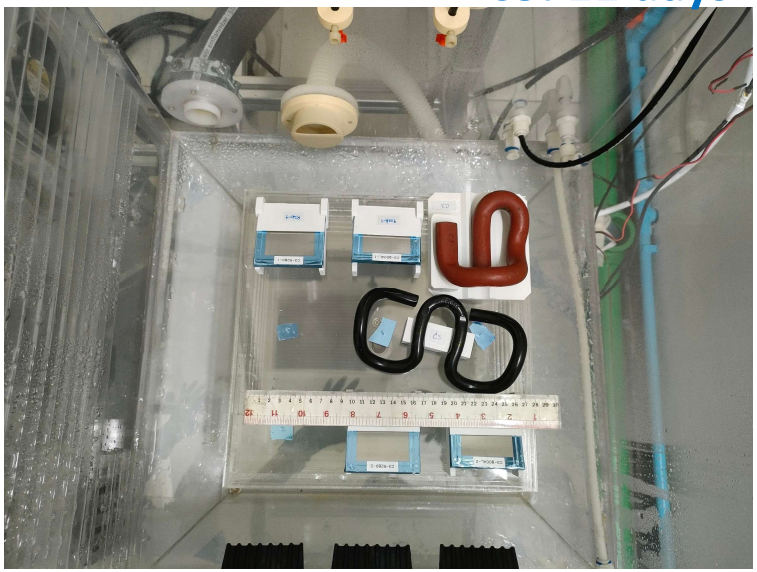
ISO 16539 test

- Rail
- Fasteners

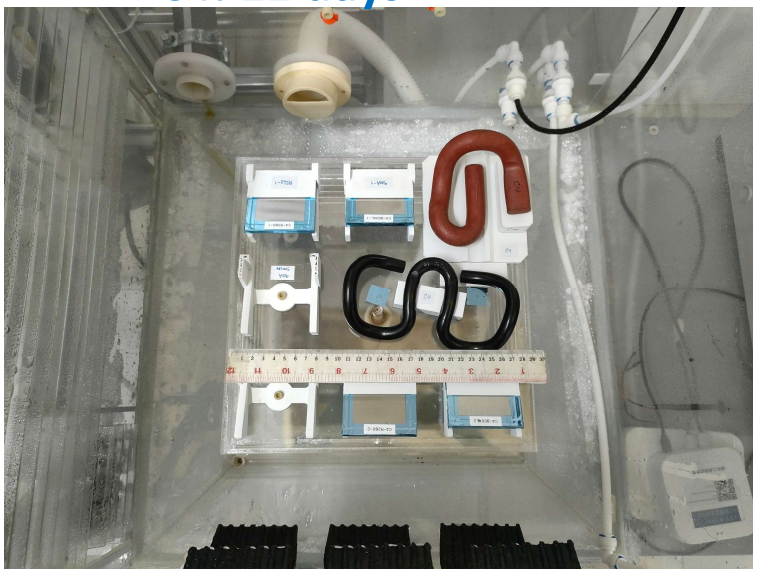
(Crevice corrosion)

On-going test

C3: 21 days



C4: 21 days



Scribe through sealant layer, top and contact surfaces

3. Failure Analysis of Railways in Northen Line

Sample1

Sample2

Sample 3

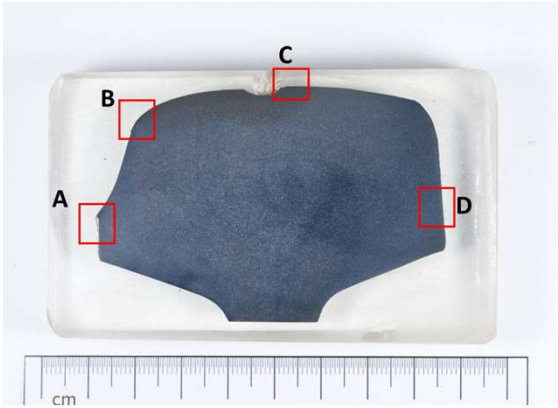
Sample4

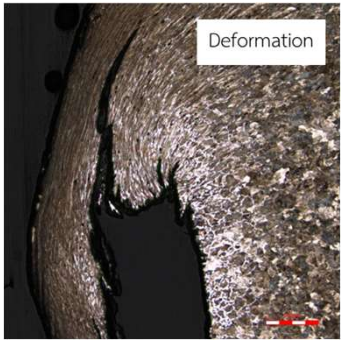
Sample5

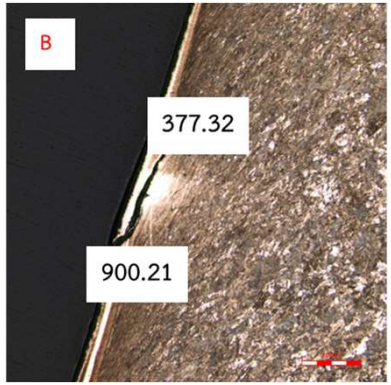
Sample 6

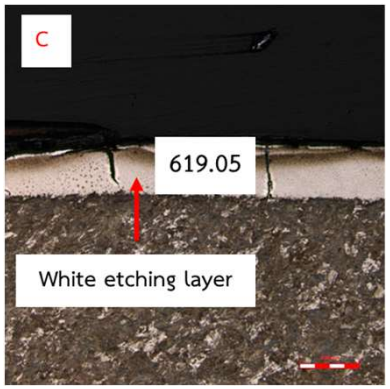
Sample1

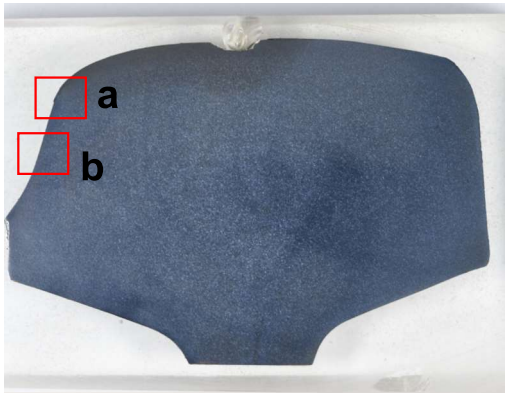
- Failure of railway in northern Line

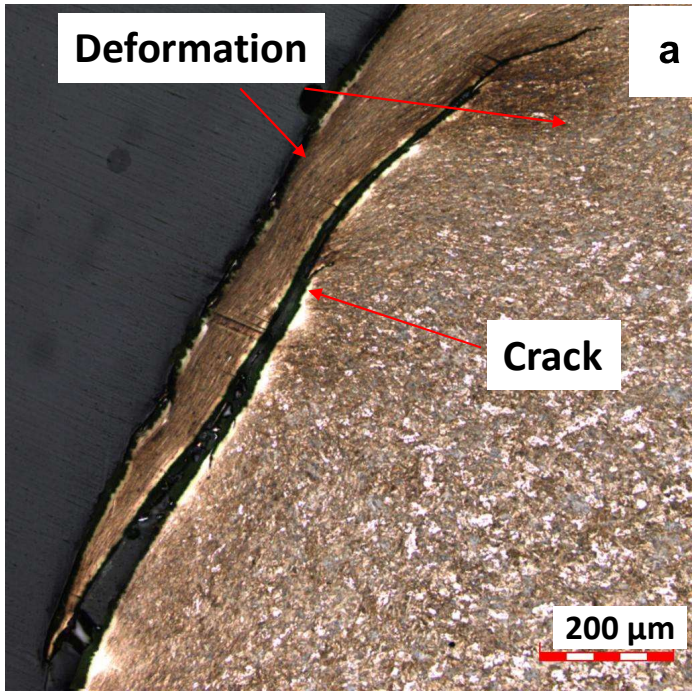


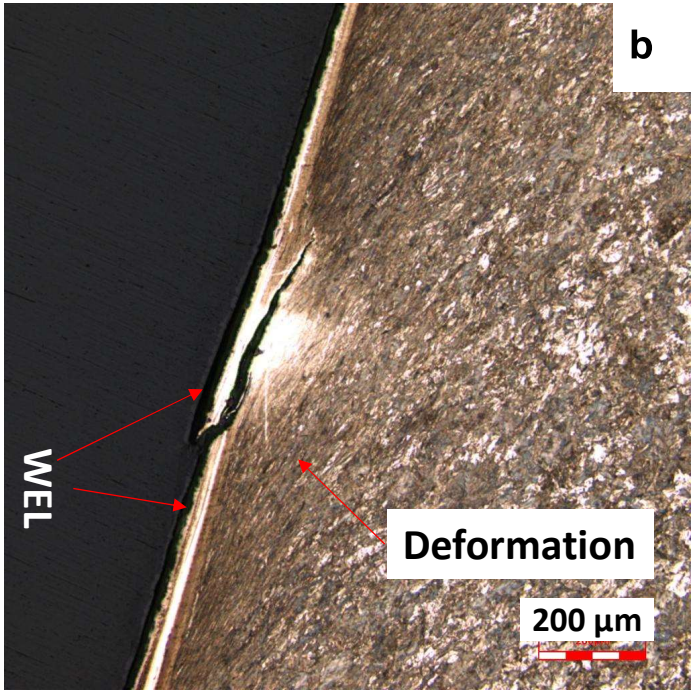




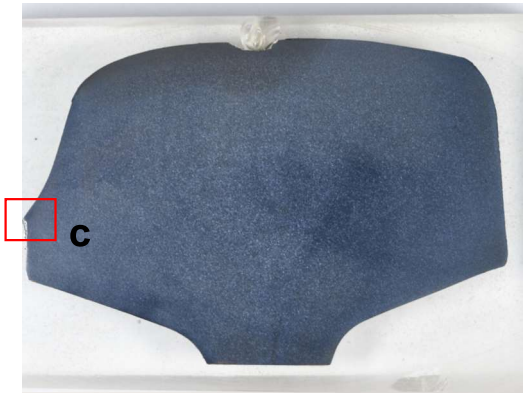


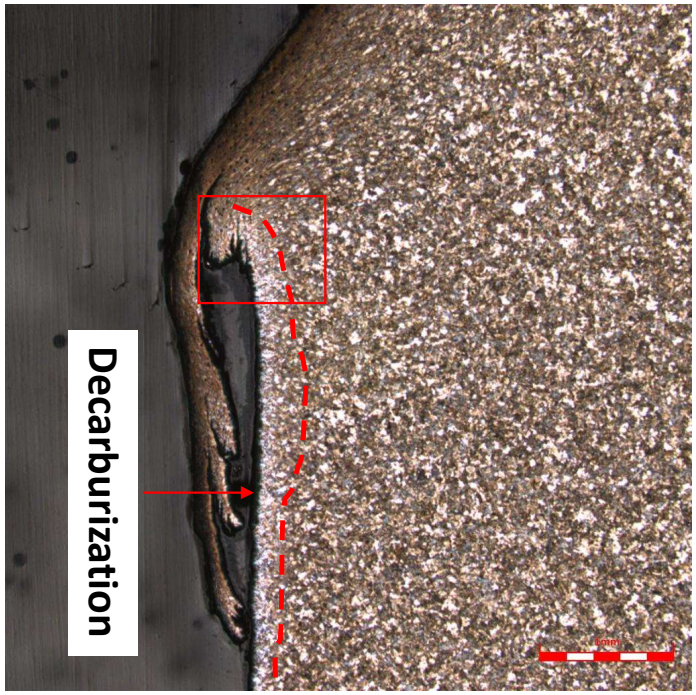


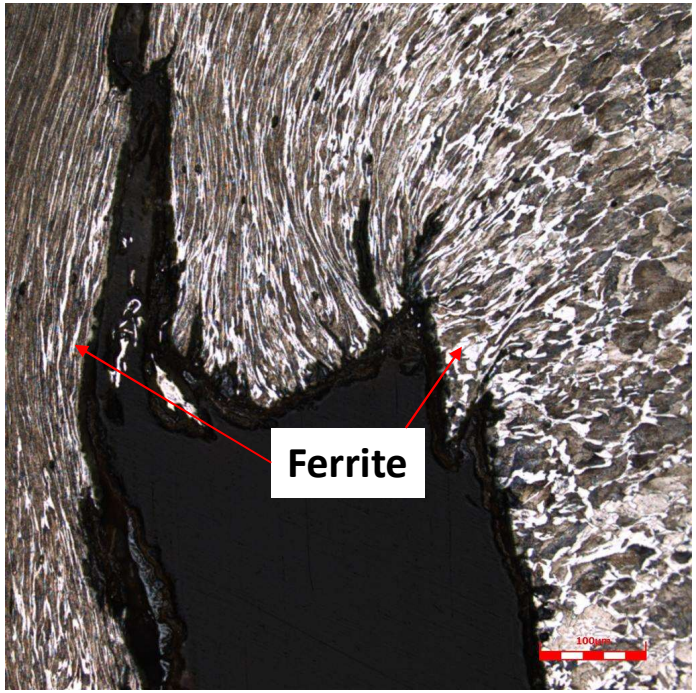




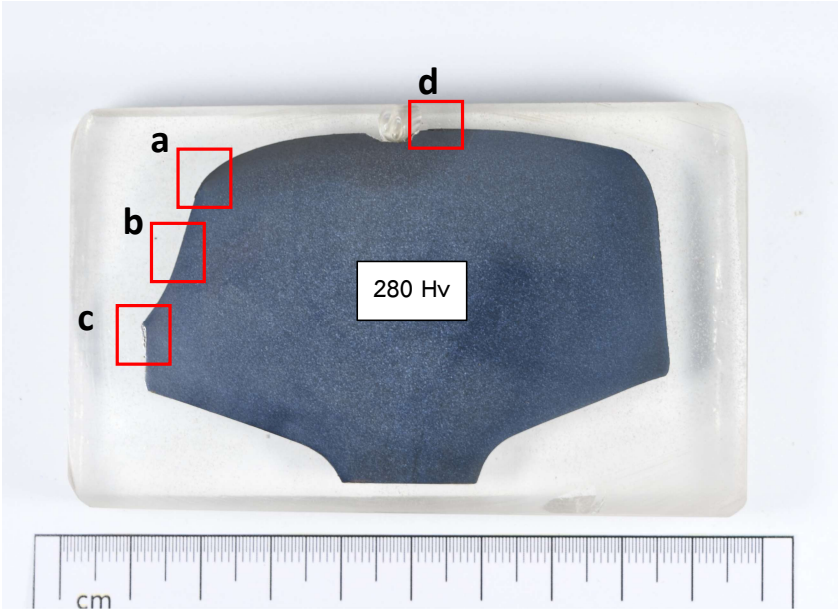
At gauge side near the rail head, (White Etching Layer: WEL), cracks and materials deformation were found.

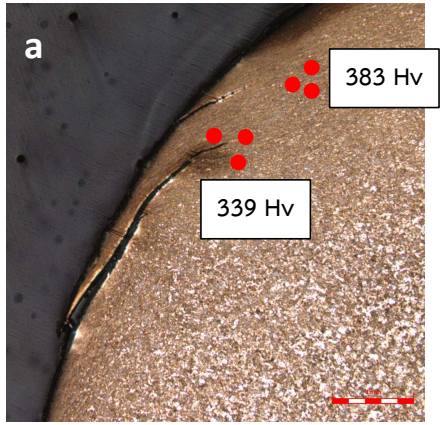


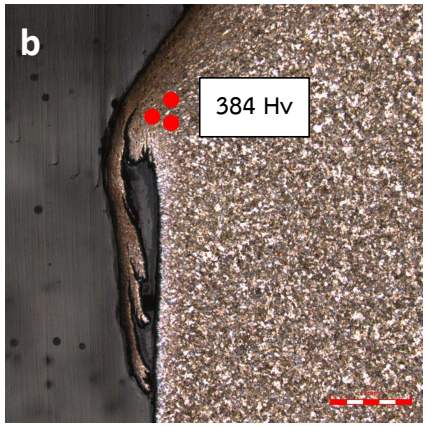


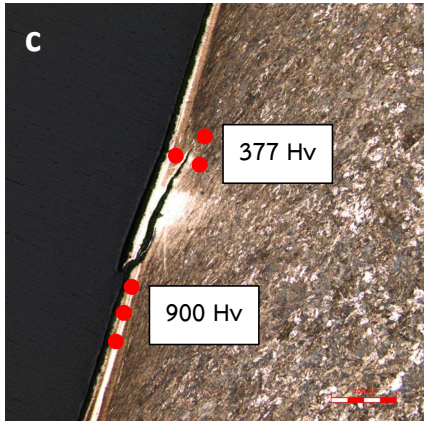


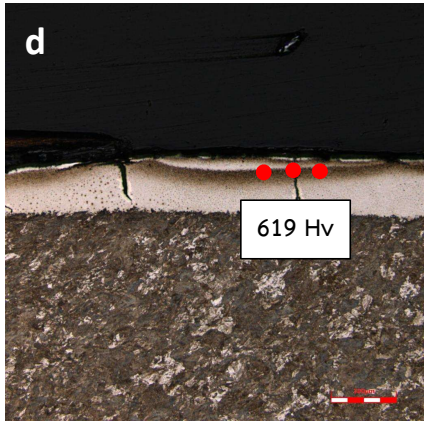
At position c, cracks were found at decarburization area. Crack propagated along ferrite phase.











Hardness at deformation area and WEL higher than normal area.

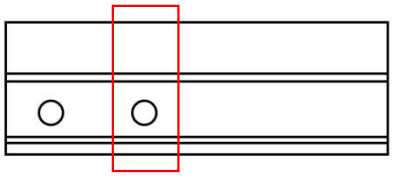
Summary

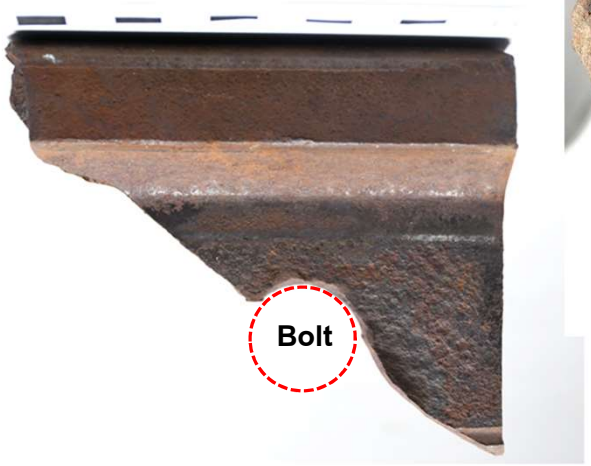
- The location where severe wear occurs on the gauge side is typically the point of contact between the wheel and the rail.
- Deformation and WEL, high hardness phase was found at wear area.
- Crack initiated at deformation area and crack propagated along ferrite phase

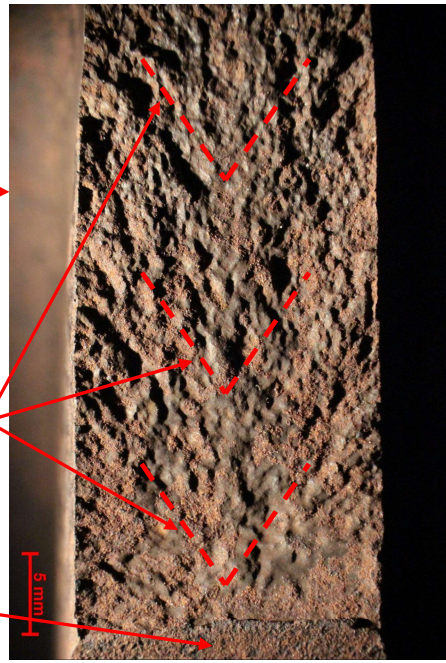
Sample #3

Deformation was found at fish plate hole

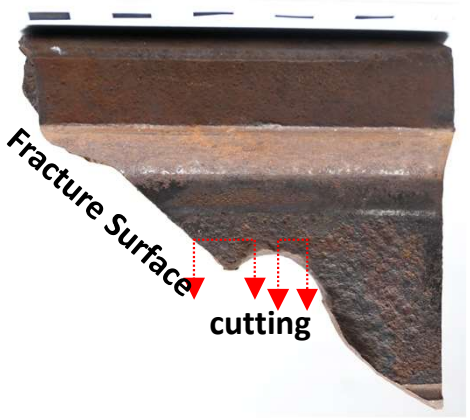
Deformation

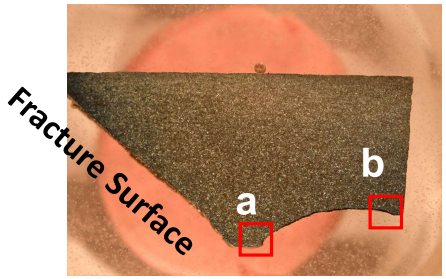


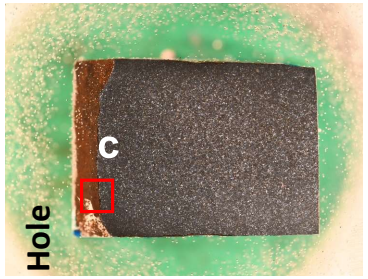


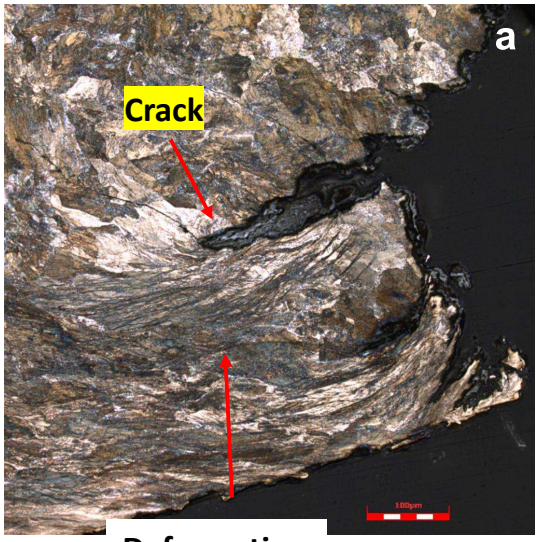


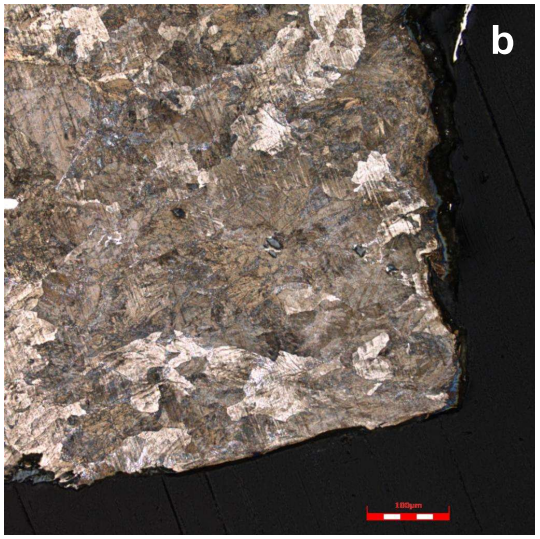
Chevron marks indicated that crack initiated from fish plate hole


Fracture Surface
cutting


Fracture Surface
a
b


c
Hole


a
Crack
Deformation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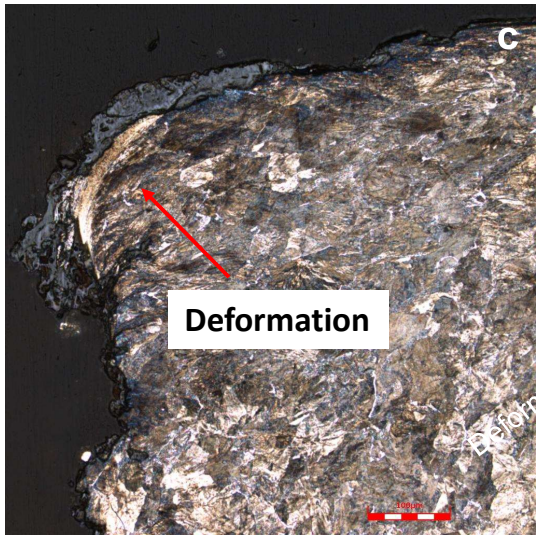
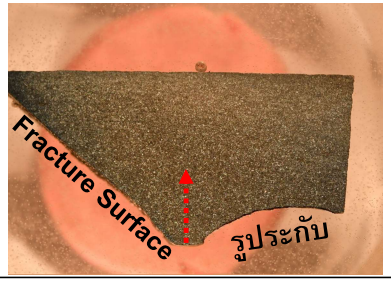
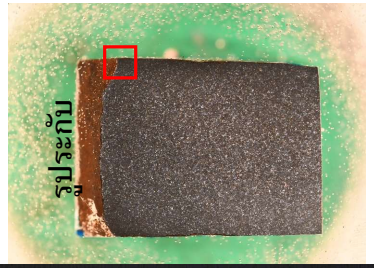
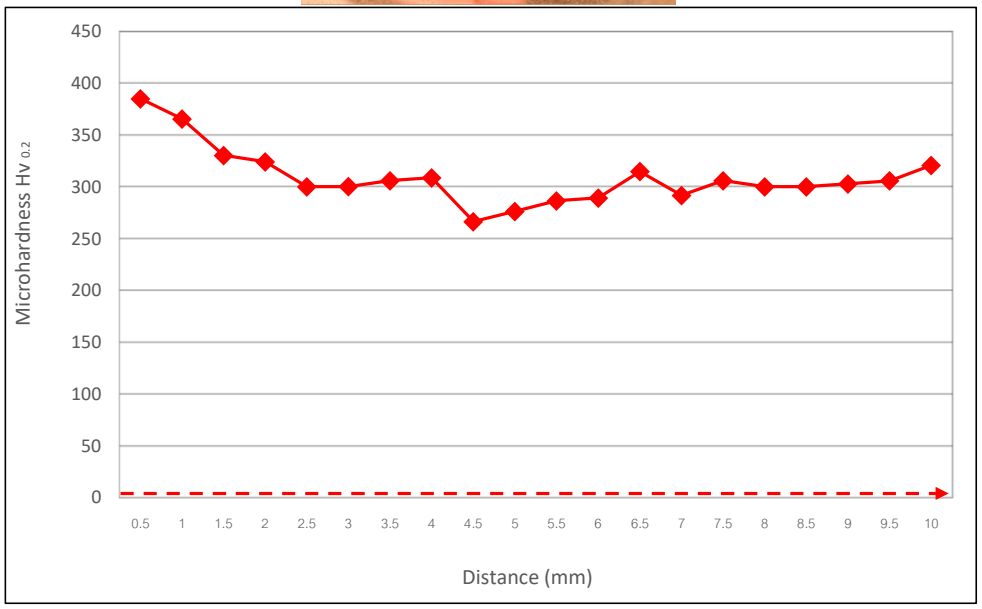
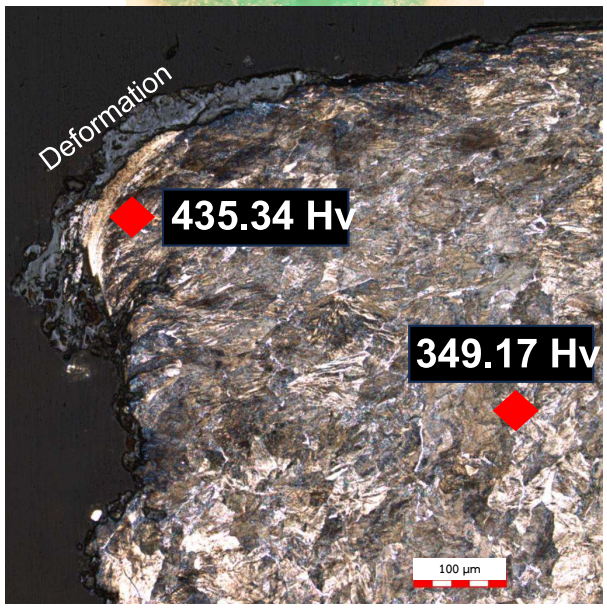

c
Deformation









Hardness at crack origin and deformation area higher than UIC 900A standard.

Summary

- Crack initiated from fish plate hole.
- Deformation was found at fish plate hole.
- Hardness at crack origin and deformation area higher than UIC 900A standard.

Thank You

Smart manufacturing and maintenance technology research team
Railways and Modern Transportation Research Group
National Metal and Materials Technology Centre
National Science and Technology Development Agency