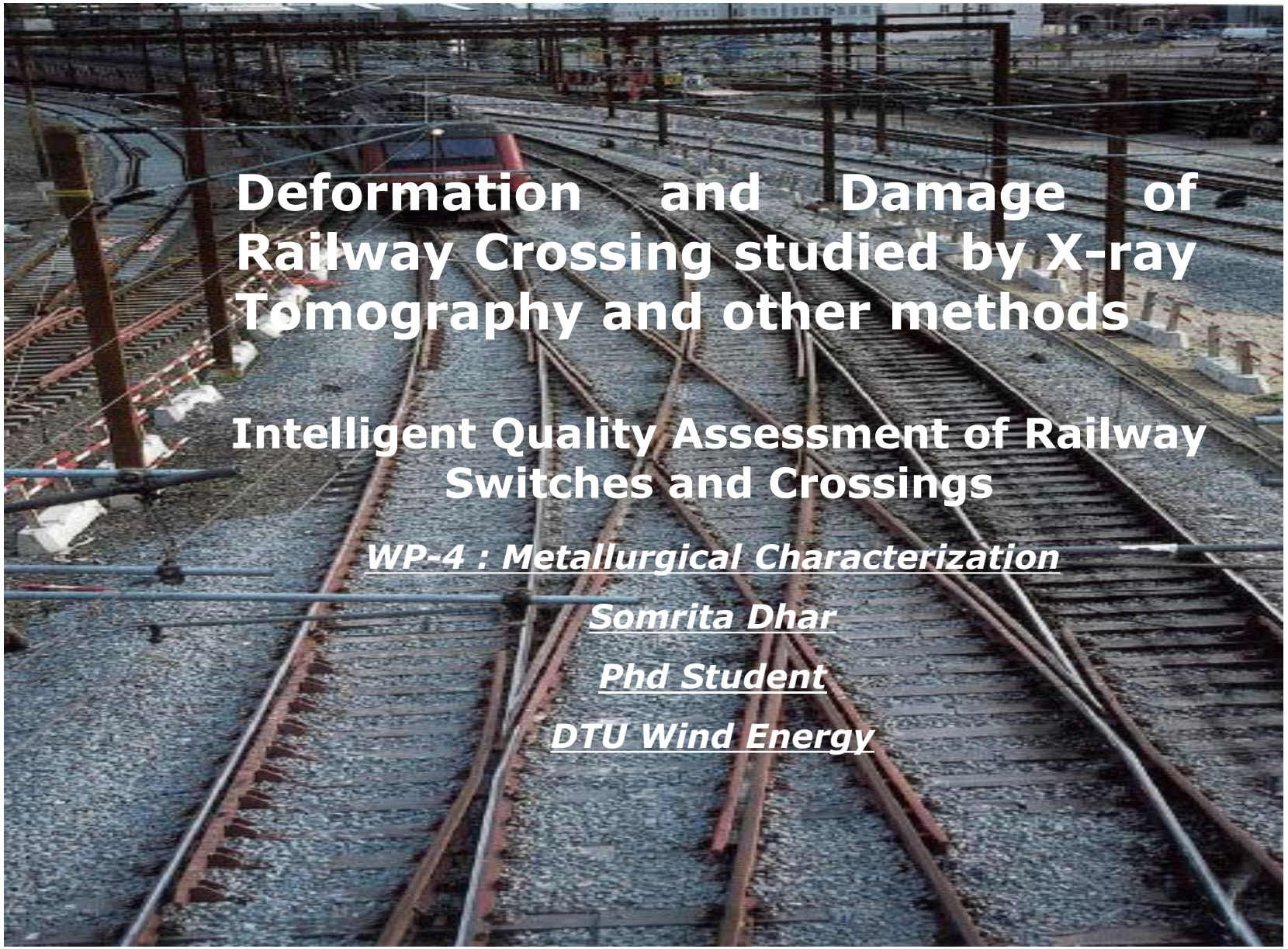


Deformation and Damage of Railway Crossing studied by X-ray Tomography and other methods

Intelligent Quality Assessment of Railway Switches and Crossings

WP-4 : Metallurgical Characterization

Somrita Dhar

Phd Student

DTU Wind Energy

Objectives of the WP4

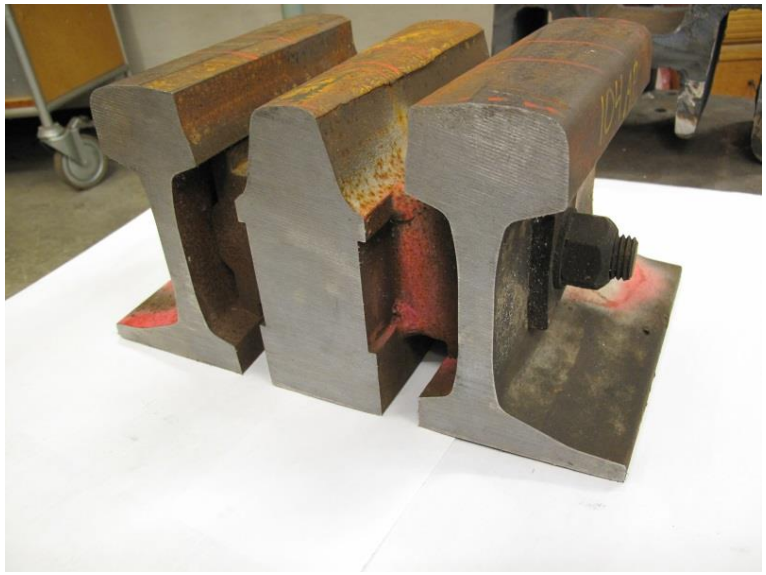
- Damage assessment of components
- Identification of failure mechanisms in rails
- Present a comparative study of the mechanical properties and damage characteristics
- Establish relations between damage characteristics and local microstructure in the rail steels using metallographic techniques
- Overall recommendations for improvements in material choice for switches and crossings

Damages in a Crossing

Crossings Received for Investigation

Crossings selected for Investigation

Vestfyn



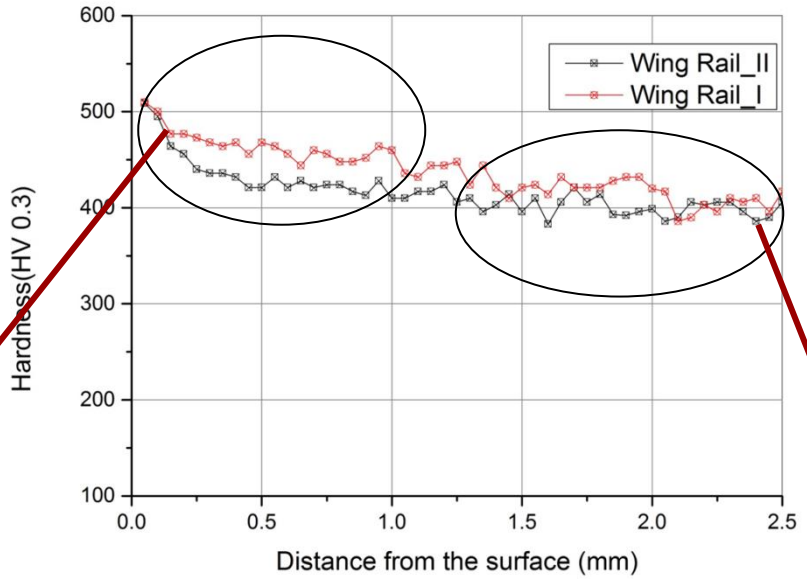
Pearlitic Railway Crossing

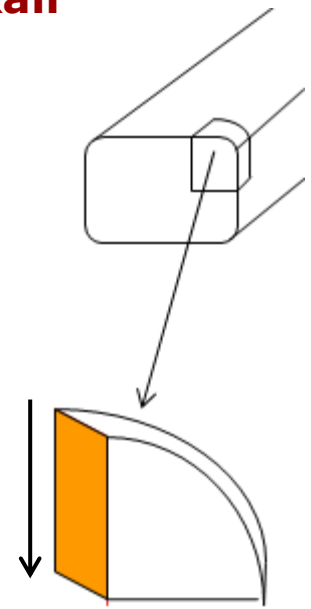
Tommerup

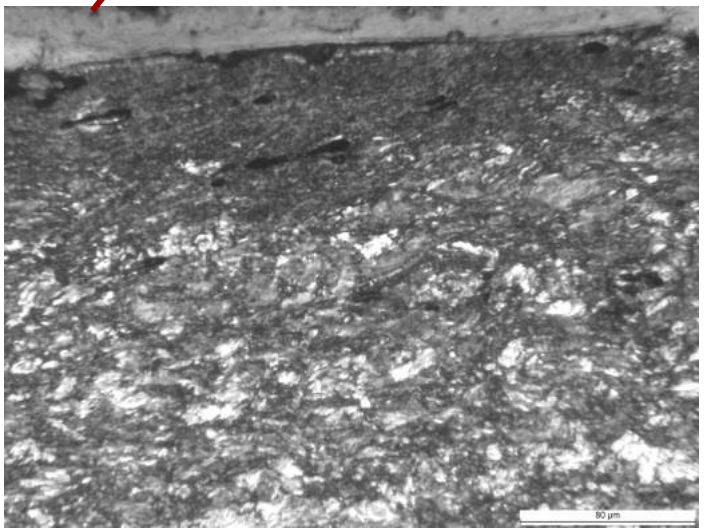
Manganese Railway Crossing

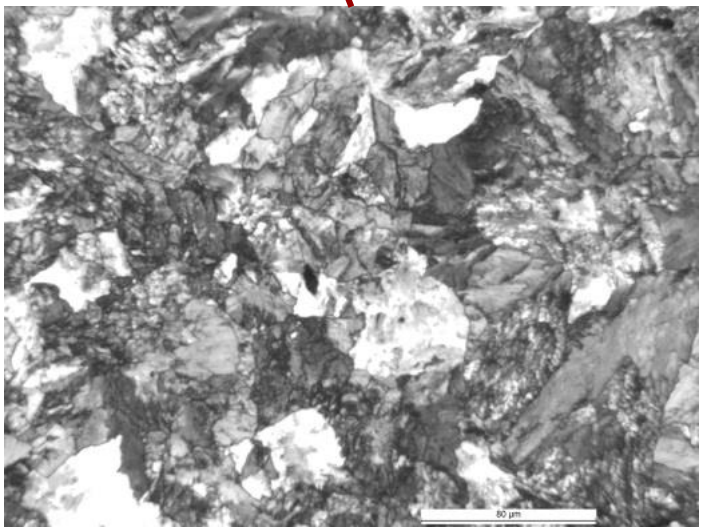
Investigation of Pearlitic Crossing

Hardness Profile of the Pearlitic Wing Rail

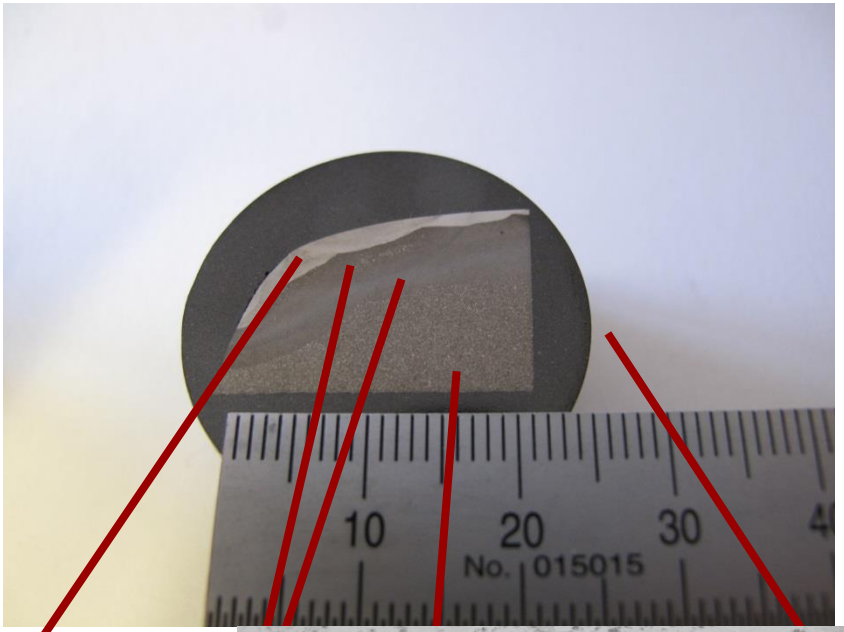


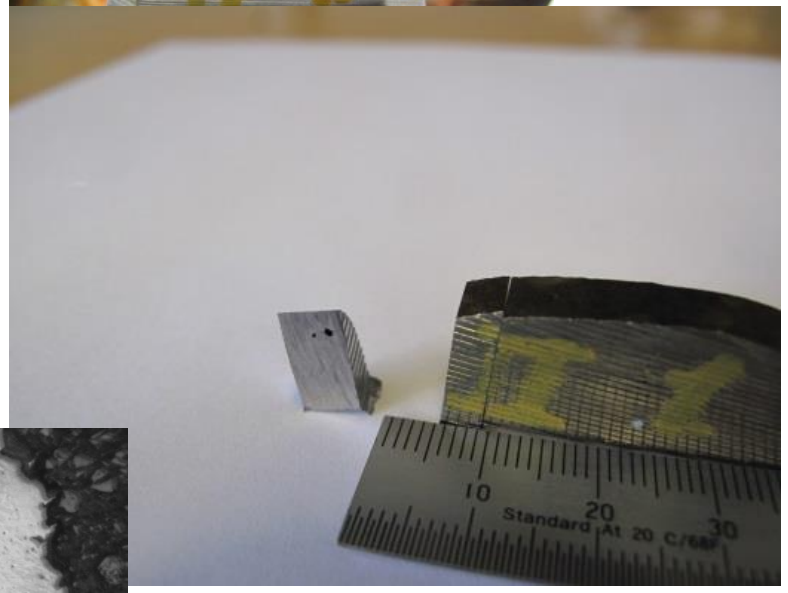






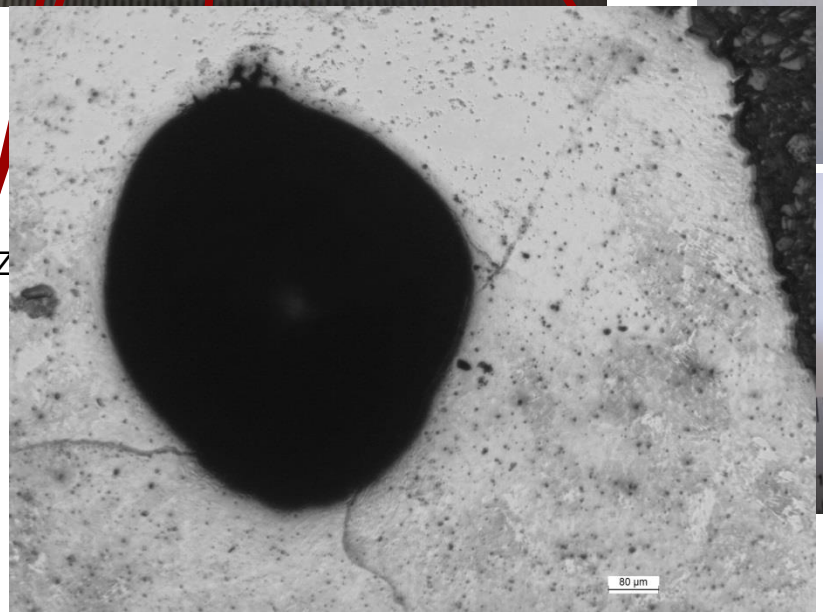
Defects in Nose :

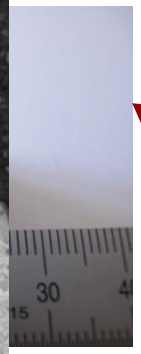


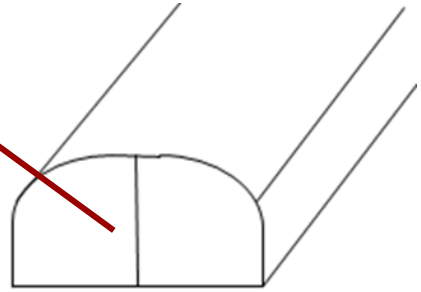


Weld
Layer

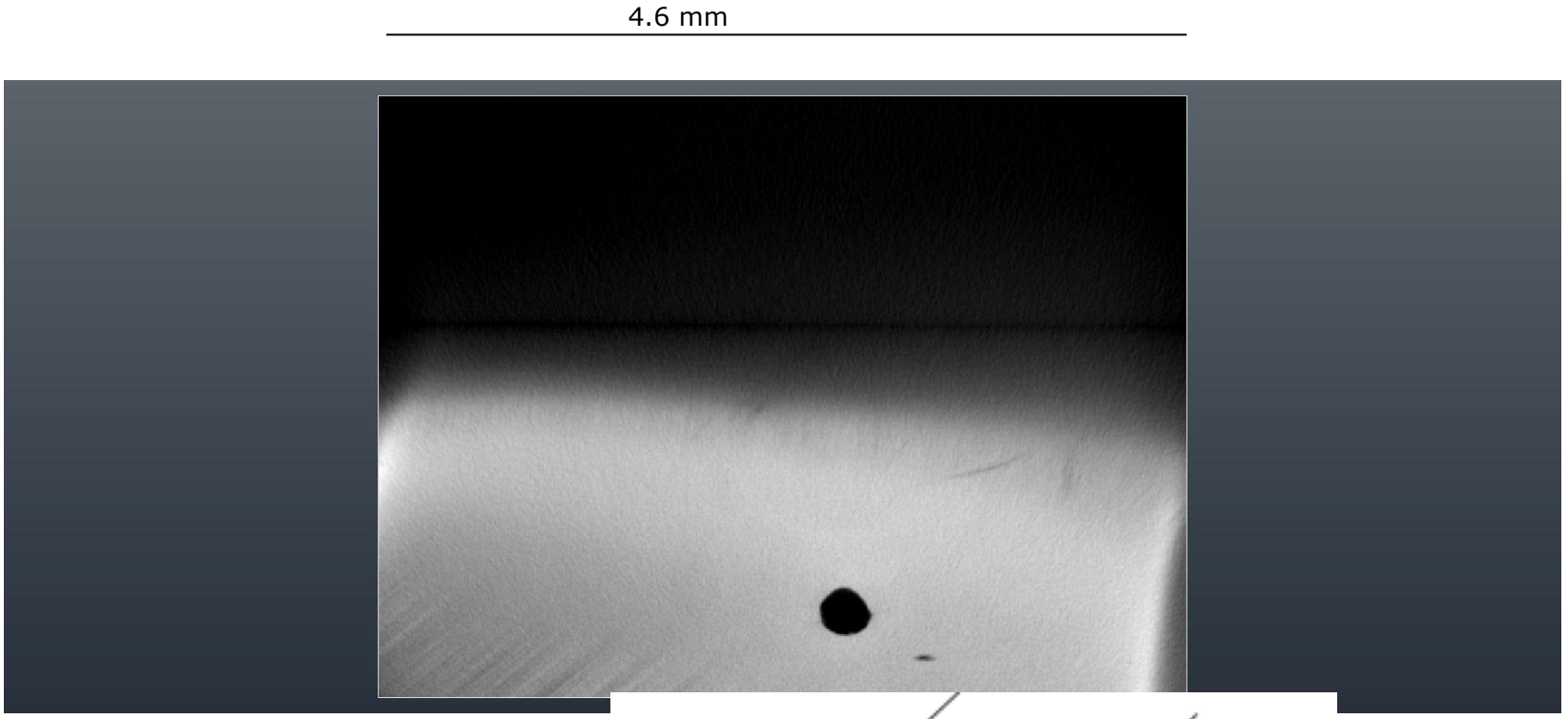
HAZ



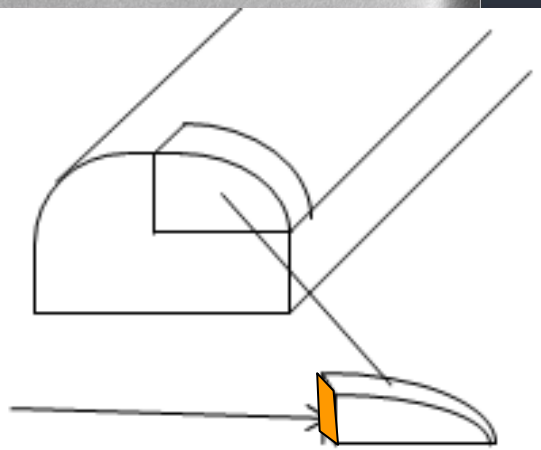




X-Ray CT Scanning of Nose

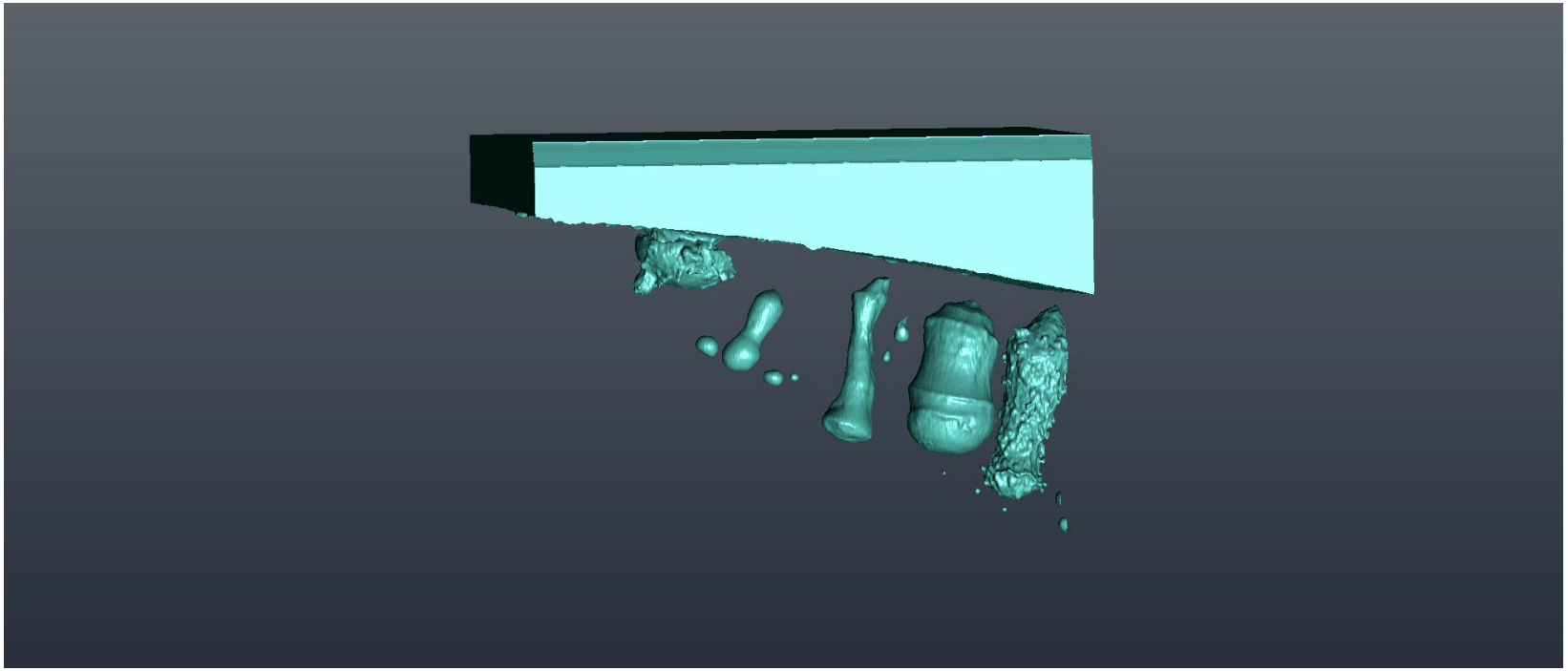


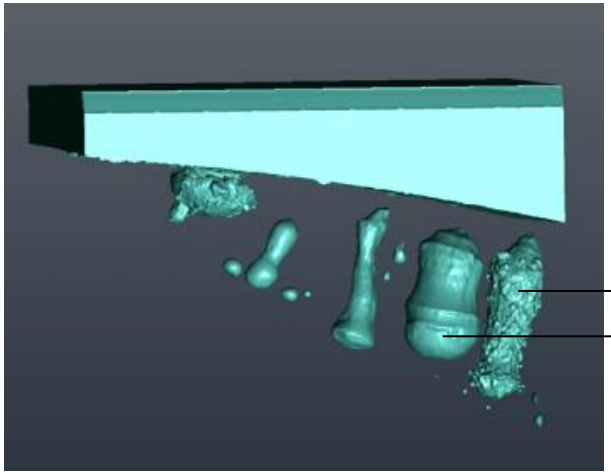
We are looking through this surface into the specimen



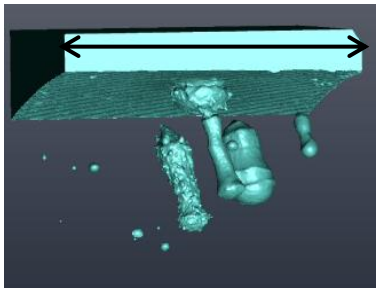
AP104 II Nose rail section

3D Imaging of Oxides and Porosities



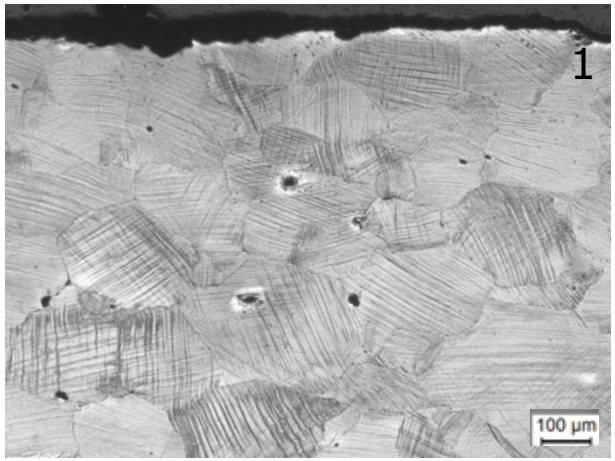


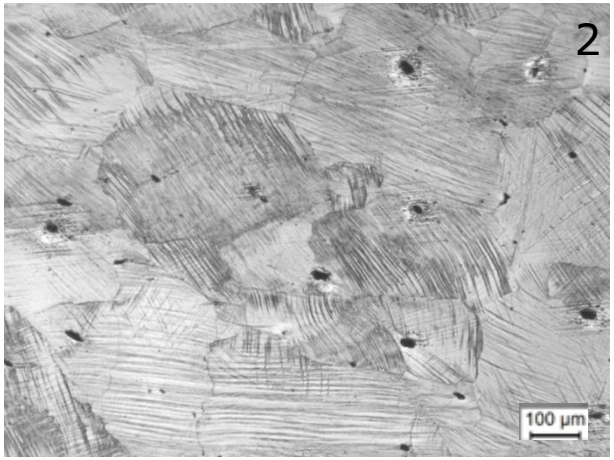
4.6 mm

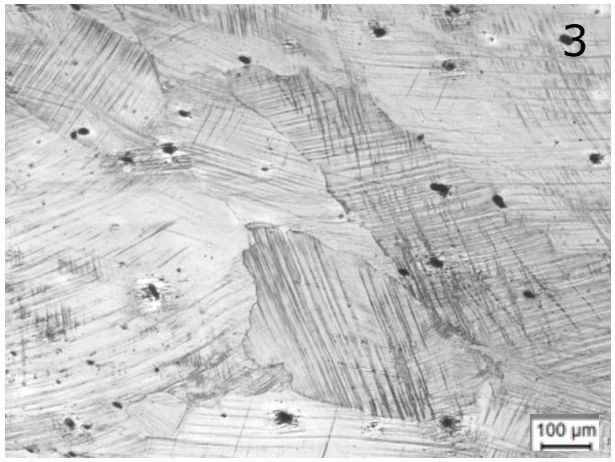


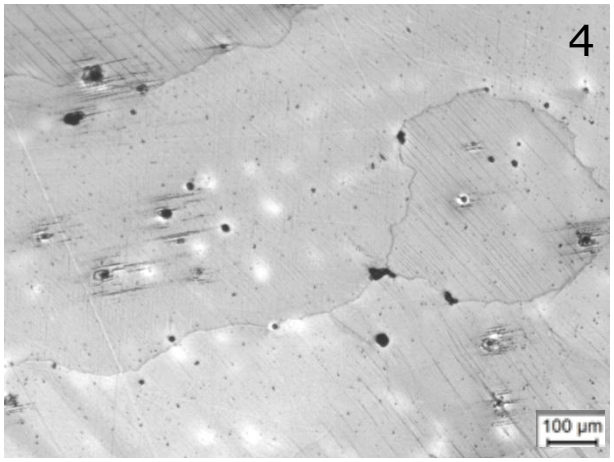
Investigation of Manganese Rail Crossing

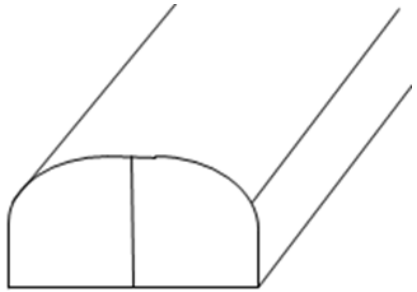
Microstructure of manganeese rail from top to bottom

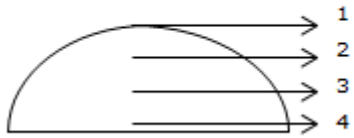




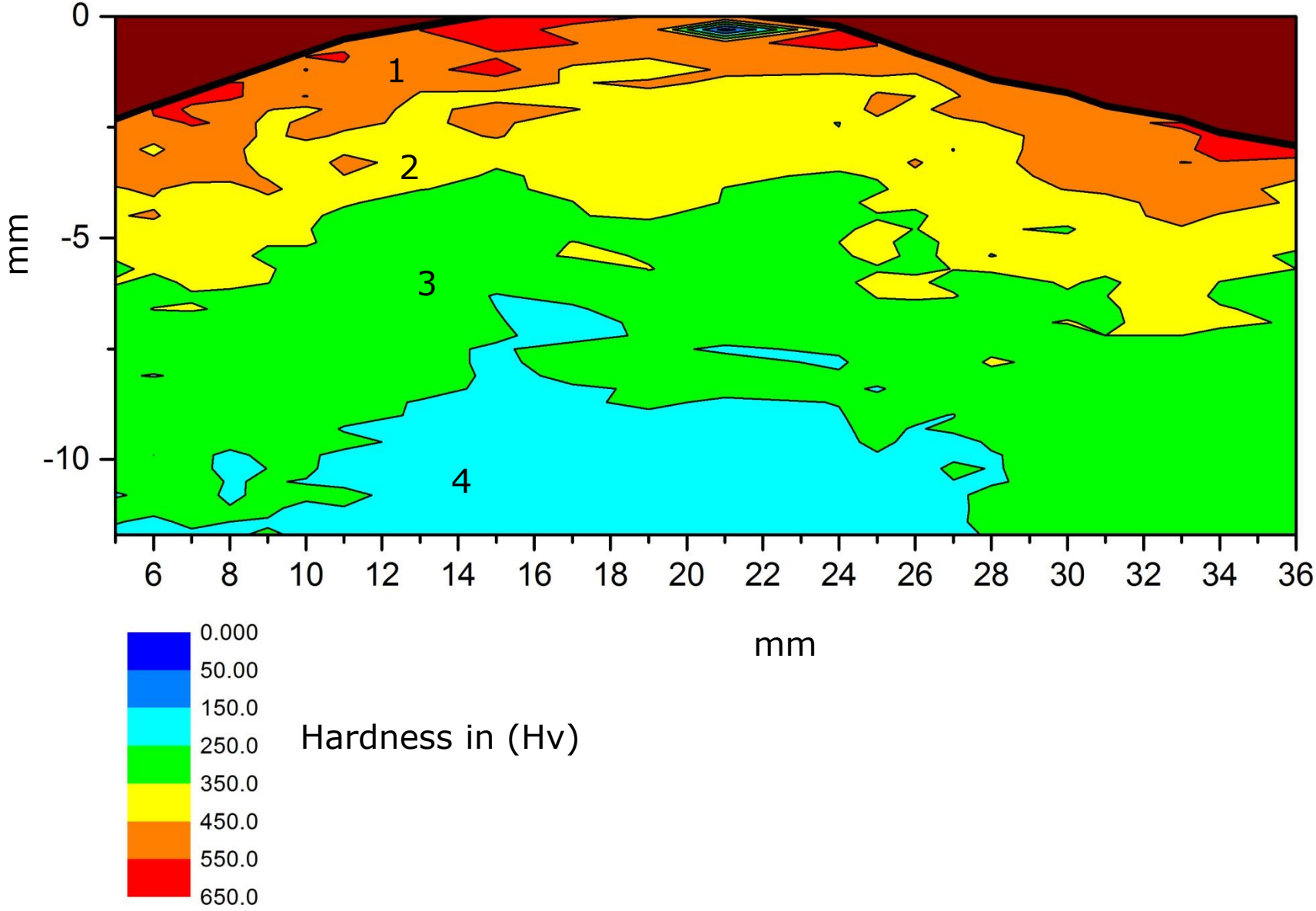






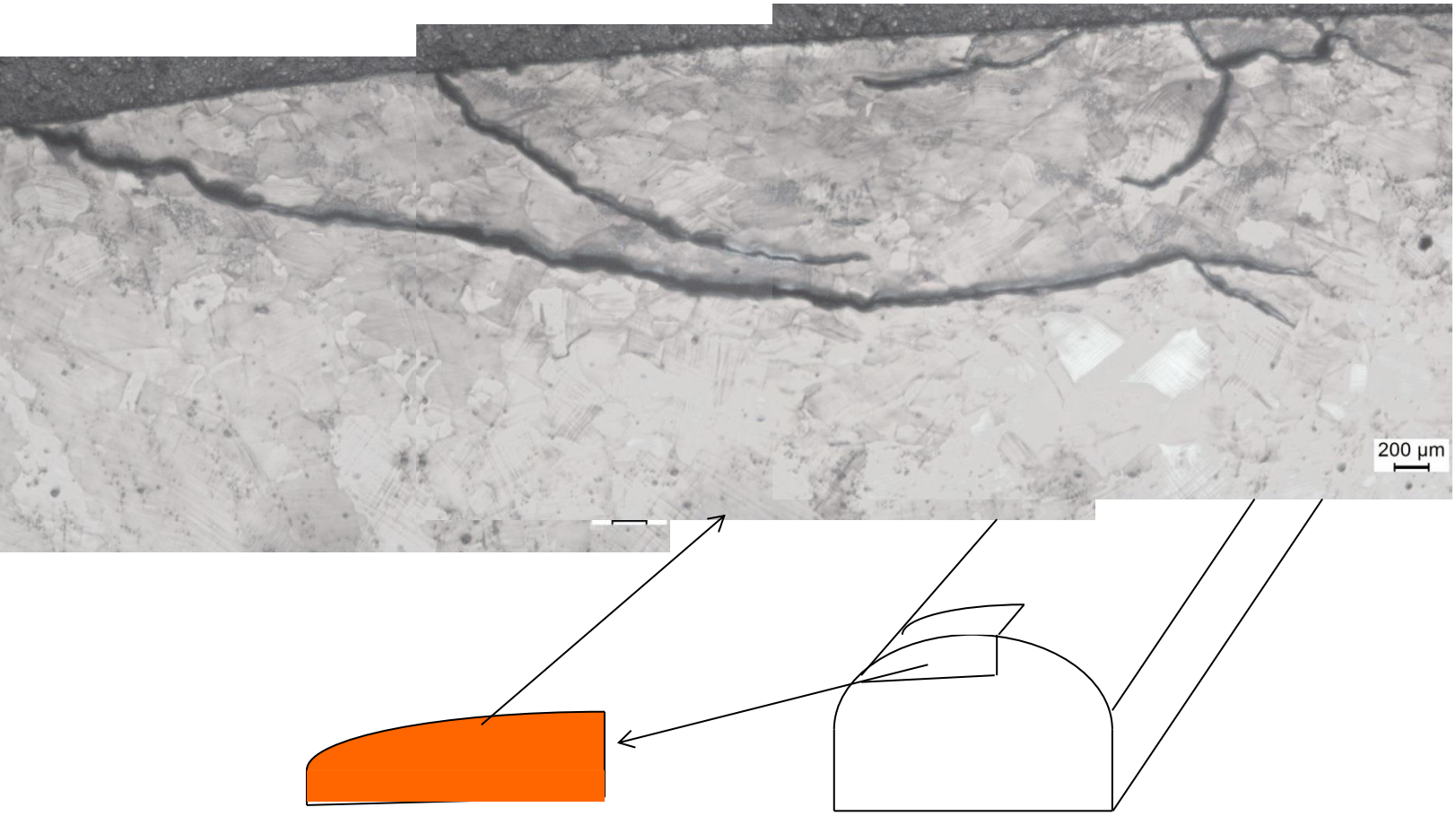


Hardness Profile of the Nose Rail

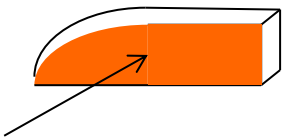


Damages in Manganese Rail Nose

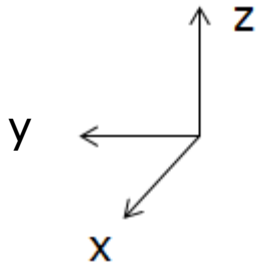
Cracks in the nose



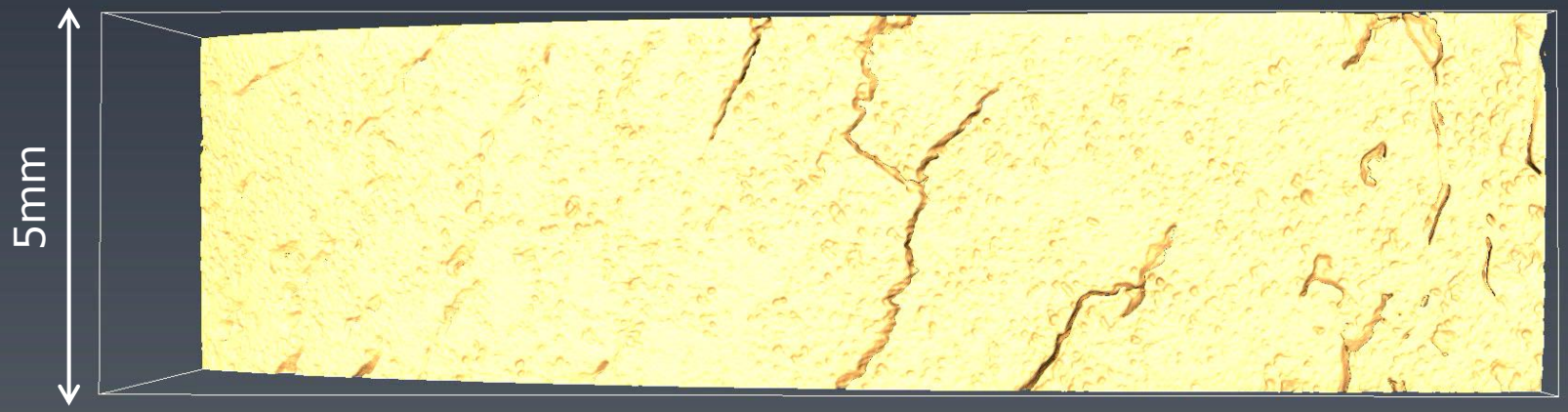
Tomography imaging of the nose in yz plane



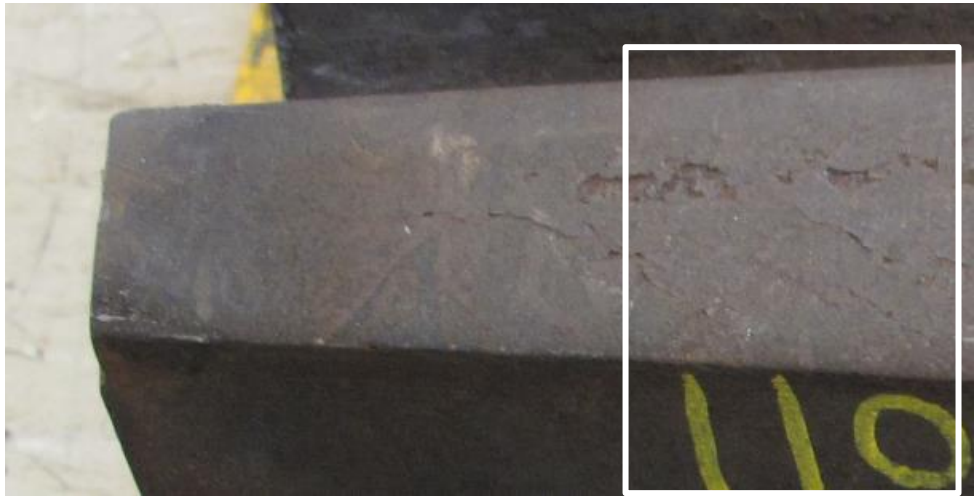
We are looking through this surface into the specimen



3-Dimensional Imaging of Crack

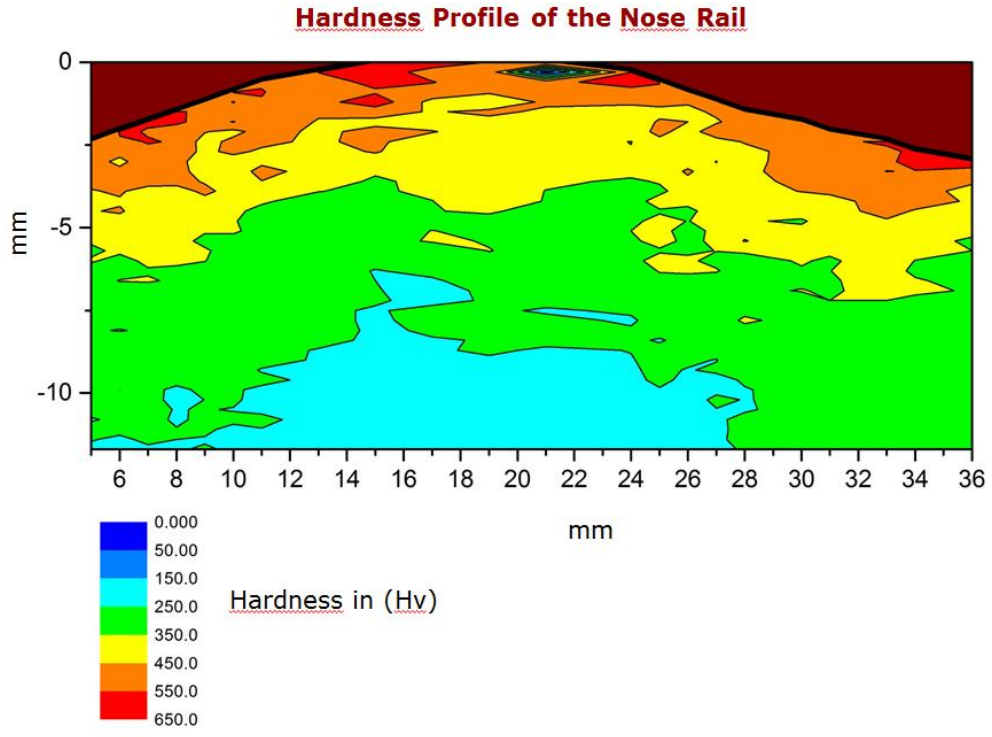


3-Dimensional Imaging of Crack



test_y.mpg

Maintainance Performance Indicator



~3 mm

- Relate hardness data with profile and deformation

- High Deformation ⟶ Changes in Profile

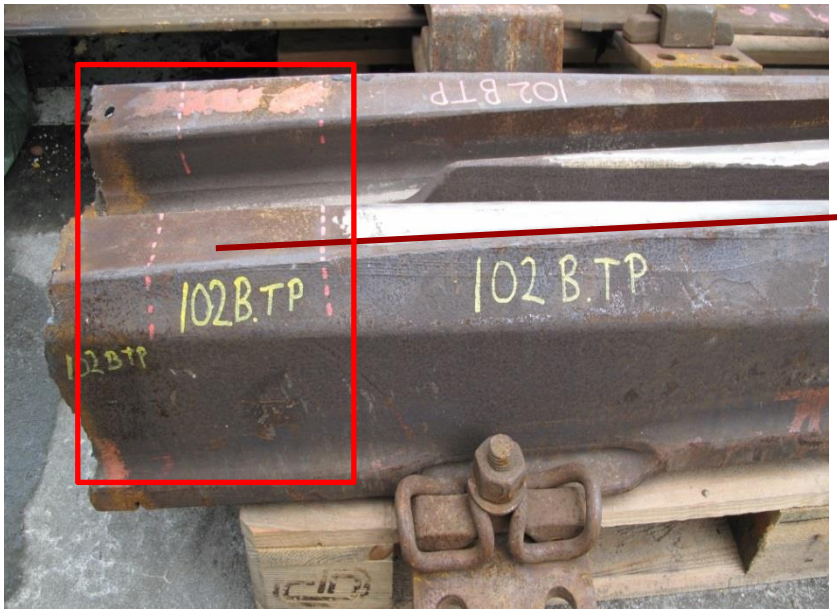
  Change in Hardness

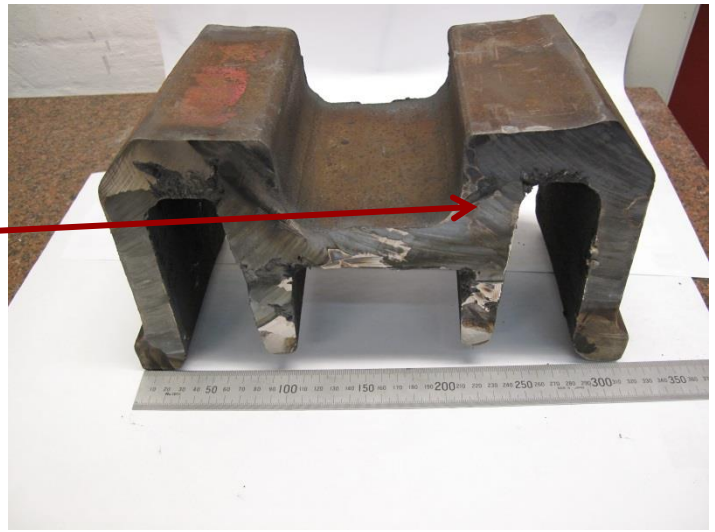
  ↓

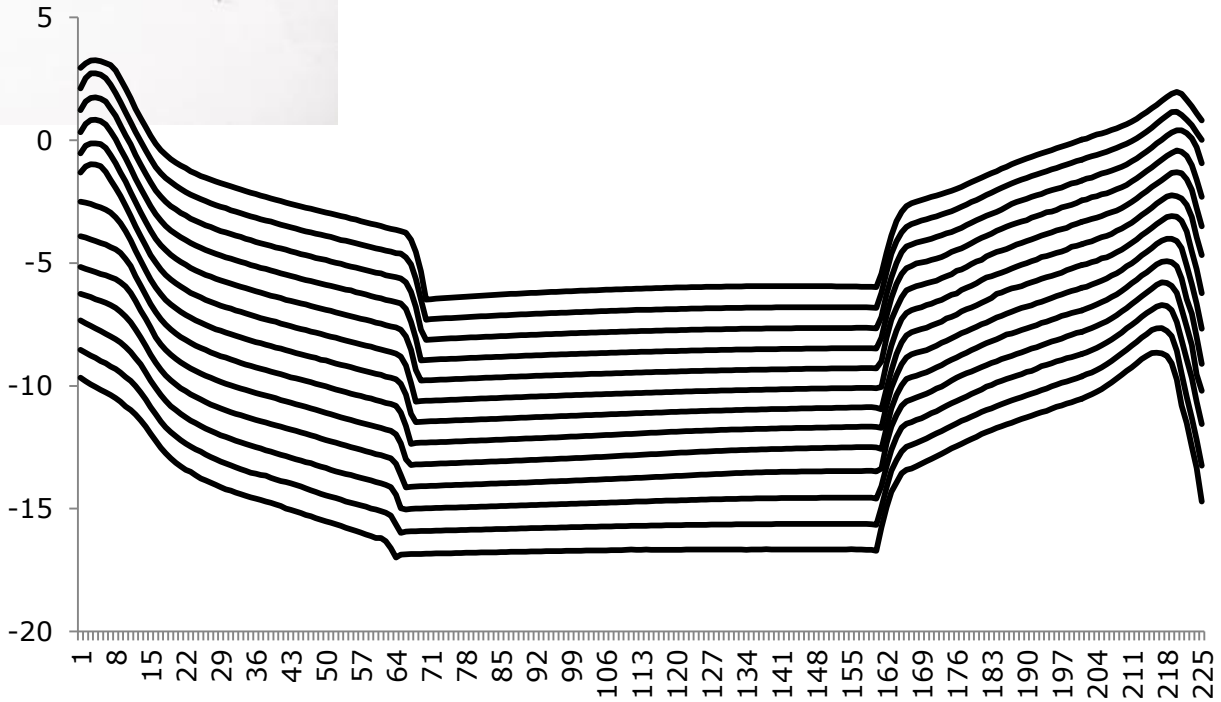
  Chances of crack formation

Hardness as Maintainace Performance Indicator

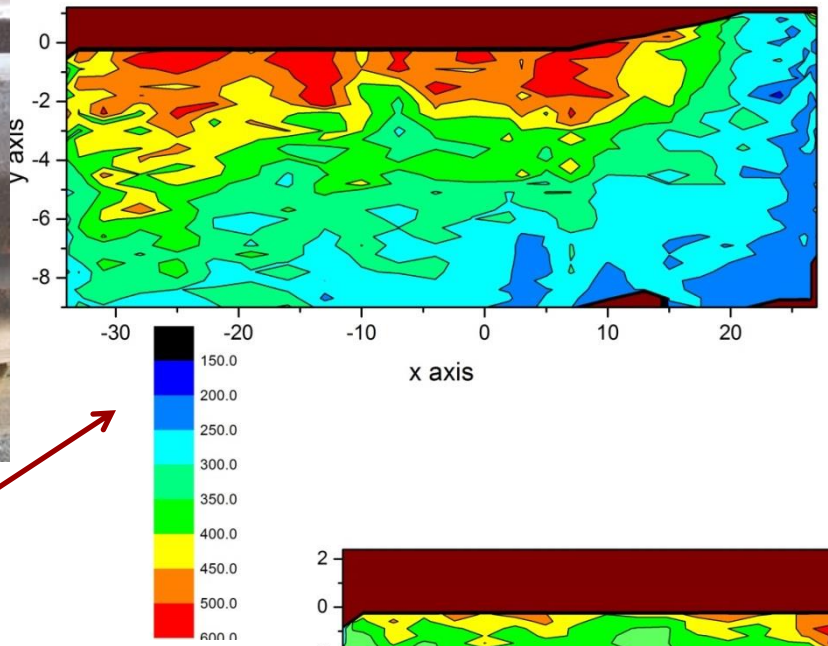
Another Manganese crossing

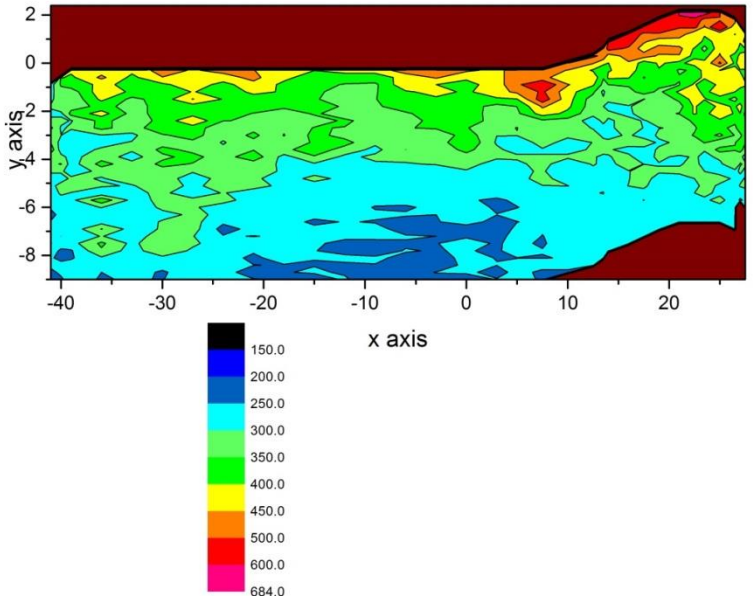


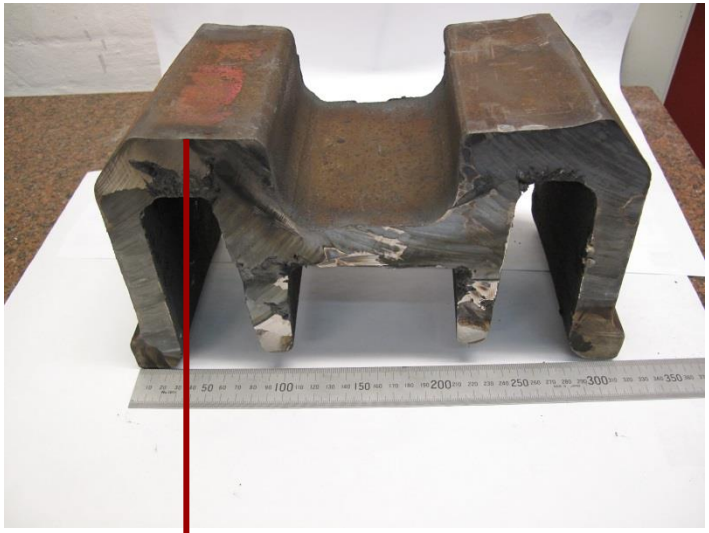


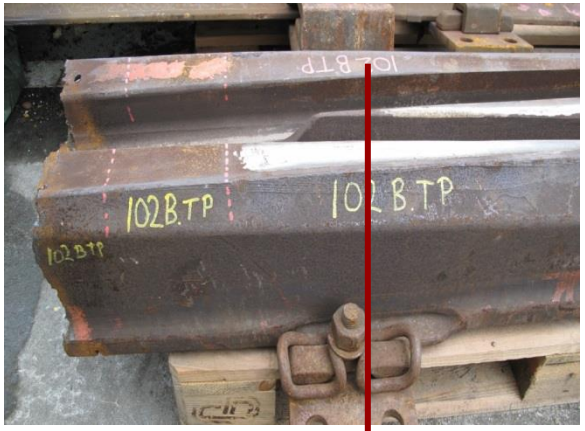

5
0
-5
-10
-15
-20
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
113
120
127
134
141
148
155
162
169
176
183
190
197
204
211
218
225

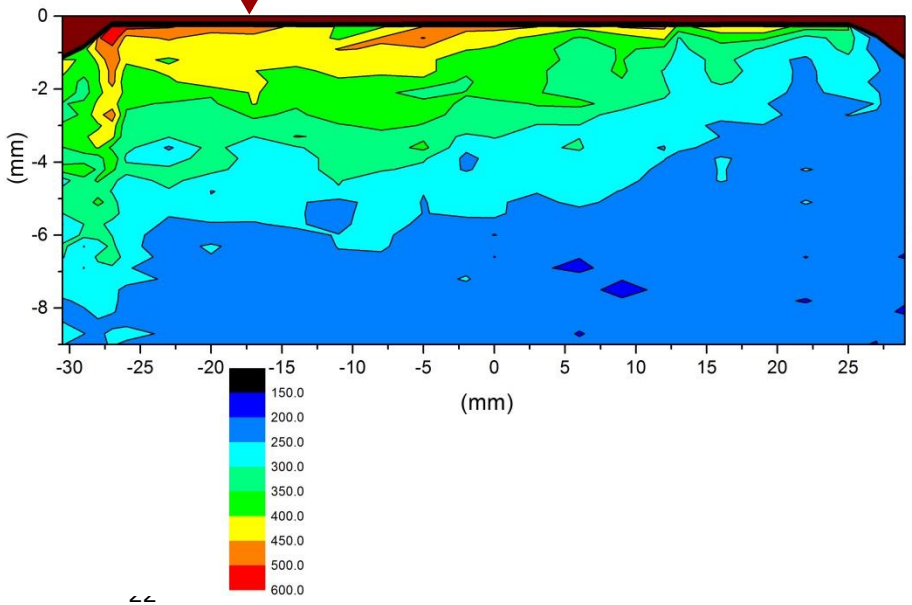

102B.TP
102 B.TP

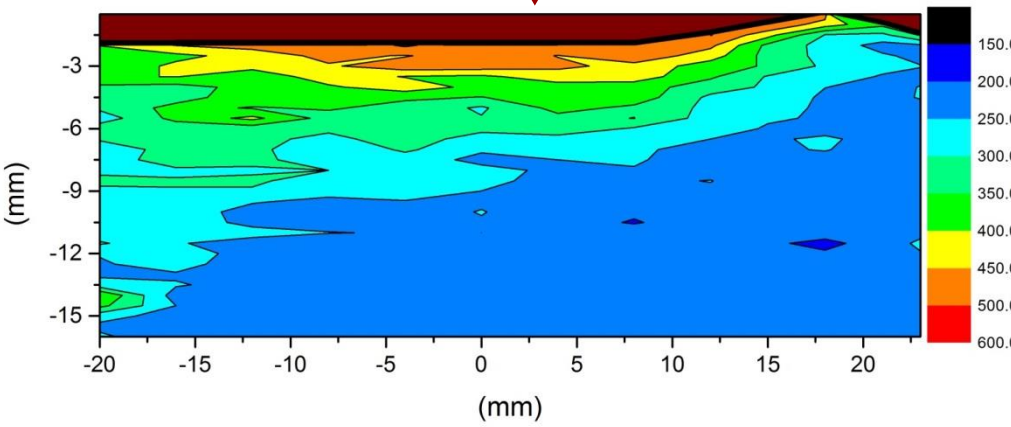

y axis
x axis
0
-2
-4
-6
-8
-30
-20
-10
0
10
20
150.0
200.0
250.0
300.0
350.0
400.0
450.0
500.0


y axis
x axis
2
0
-2
-4
-6
-8
-40
-30
-20
-10
0
10
20
150.0
200.0
250.0
300.0
350.0
400.0
450.0
500.0
600.0
684.0




102B.TP
102B.TP


0
-2
-4
-6
-8
(mm)
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
(mm)
150.0
200.0
250.0
300.0
350.0
400.0
450.0
500.0
600.0


-3
-6
-9
-12
-15
(mm)
-20
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-10
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15
20
(mm)
150.
200.
250.
300.
350.
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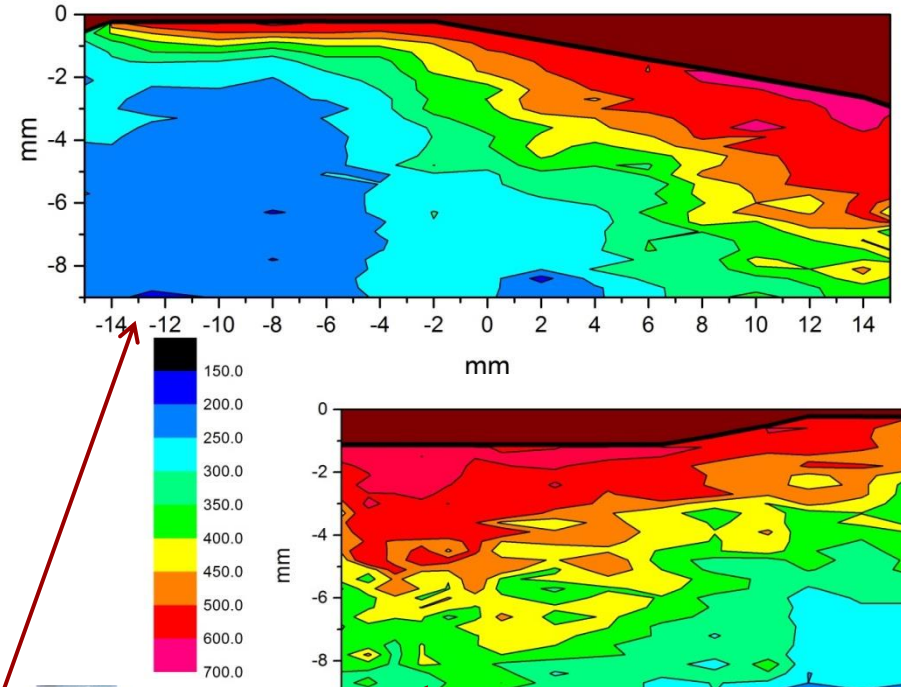
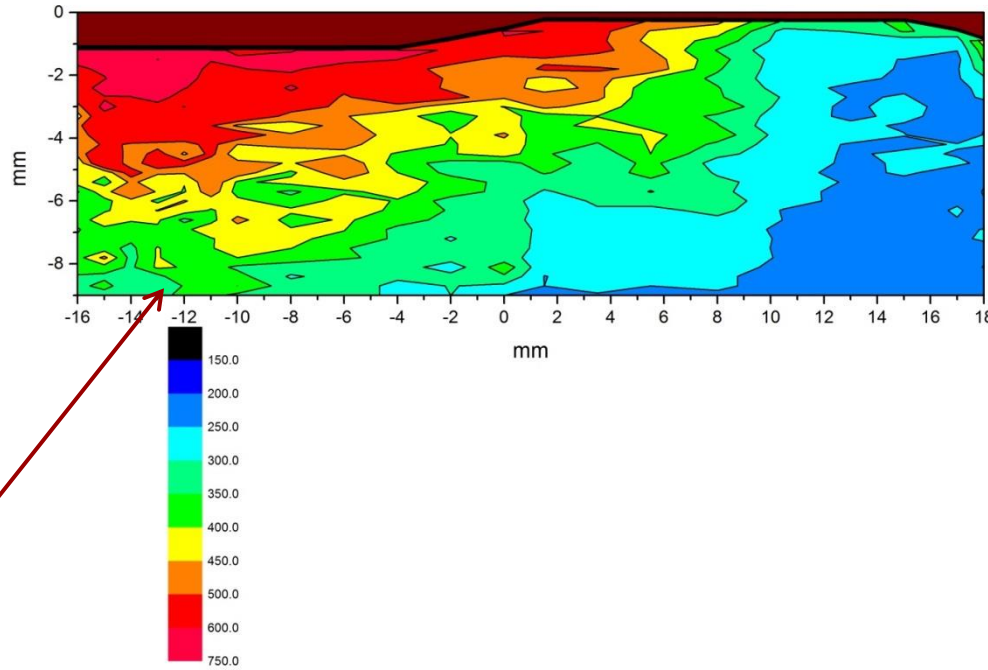
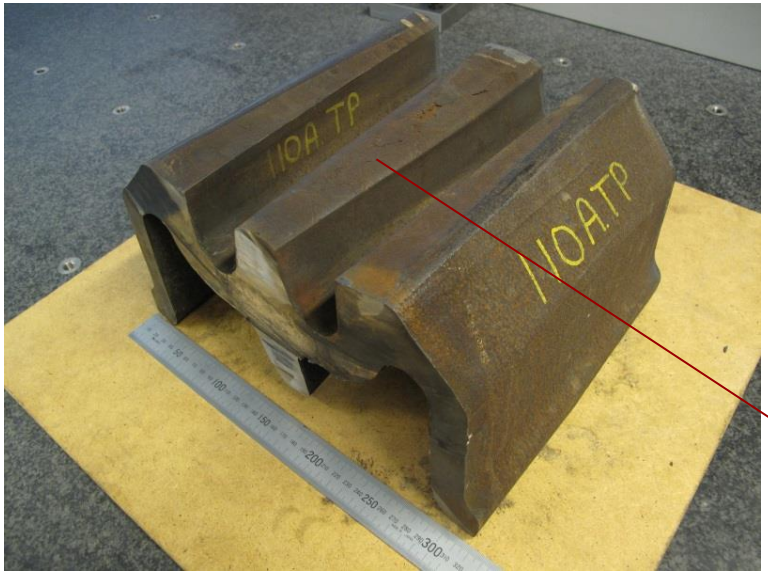
450.
500.
600.





High Hardness but No Crack!!!



Nearly all traffic goes in the direction from the wing to the nose.

Region of Impact → Chances of crack

Nearly all traffic goes in the direction from the nose to the wing

Conclusions & Outlook for Future Work:

- Deformation due to rail-wheel contact in Manganese crossing runs as deep as 8-10 mm from the surface.
- Cracks are mostly confined in the plastically deformed layers(first 3 mm)
- Most of the cracks has a definite path. They deviate from their main path after certain depth from the surface and propagate parallel to the running surface.
- The extension of the cracks was found to be as long as 8mm or more.
- High deformation causes changes in profile and hardness. The hardness can be as high as 600 Hv.

- However, its not the deformation which causes the crack but rather the impact from the wheel which leads to the crack formation.

Future Work:

- Mechanical testing to study material and damage properties of steels used in crossings
- Establish relations between damage and local microstructure
- Develop Maintainance Performance Indicators(MPIs) from the damage assesement


Thank
You