Crack initiation at martensite surface layers from profile grinding

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BaneDanmark has provided extracted rails
New rails, grinded then extracted
No traffic

R350

R260
Continuous martensite layer found, White Etching Layer (WEL)

Martensite formed by friction heating and rapid cooling
R350 rail from service
Grinded in 2010, extracted in 2012 (from a curve)
Annual traffic 2.1 MGT

Gauge side etched with Nital
Relatively homogenous WEL
Oxidized grinding marks

Oxidation products contain presence of martensite
Transverse martensite bands

Transverse WEL located on the gauge side
Crack form at interface between martensite and pearlite

Martensite with regular interval

Cracks for at the interface
Conclusion

Spalling defects, over lengths up to hundreds of metres, on heat-treated pearlitic rails exhibit typical periodicity in geometry, in material properties such as hardness and the presence of a WEL, and in the position of crack initiation in the running band. This suggests a relationship between maintenance grinding on a regular basis and the initiation of RCF. ...
R200 rail from service
Grinded 2013, extraction 2016
annual traffic 2.7 MGT

Periodic WEL bands, same intervals as grinding marks
WEL present with cracks

Cracks usually turn up, spallation to be expected
Squat was also found

May or may not be related to transverse WEL
3D characterisation method: X-ray Computerised Tomography
Tomography imaging of a crossing nose

We are looking through this surface into the specimen
Tomography imaging of a crossing nose
X-ray tomography of WEL cracks, R350
3d representation of the martensite crack
X-ray tomography of WEL cracks, R200
X-ray tomography of WEL cracks, R200
Conclusion

• Transverse bands were observed on R350 and R200

• Transverse bands consisted of martensite

• Transverse bands contained cracks

• Transverse bands had same intervals as grinding marks