Effect of Steel Microstructure at the Wheel-Rail Interface

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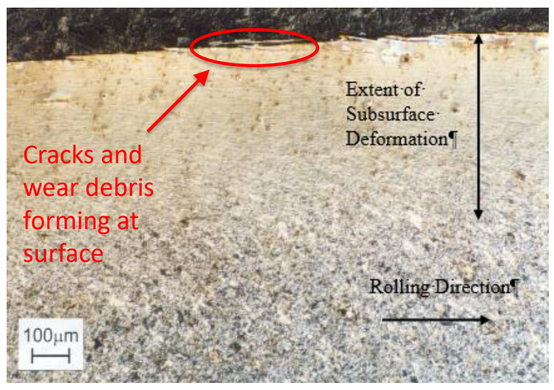
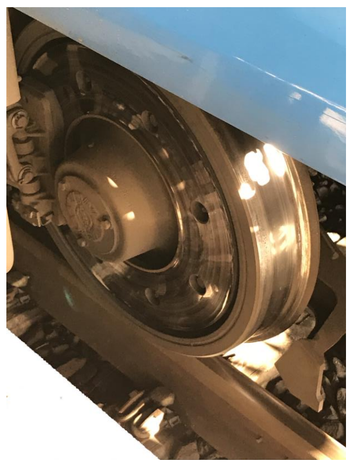
Introduction

- Wheel/rail contact pressure can be as high as 1500MPa on an area the size of a ten pence coin
- Leads to strain accumulation leading to the formation of a deformed layer
- RCF and wear occur in the deformed layer so important to understand properties – but how?
- Deformed layer is extremely small and not enough to manufacture a specimen from.





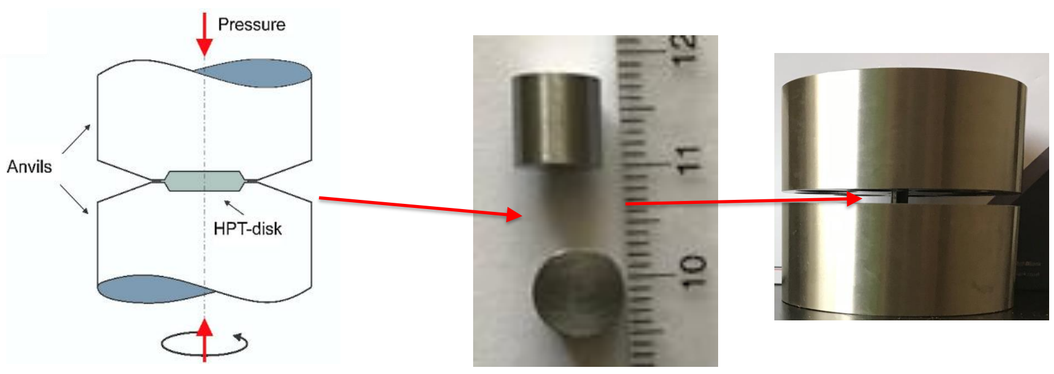
Aim of the project

- Develop “high pressure torsion” (HPT) technique to help create deformed layer in steel samples
- Process material to similar strain level at wheel-rail interface
- Perform fatigue crack propagation test using small samples cut from deformed material

Methodology

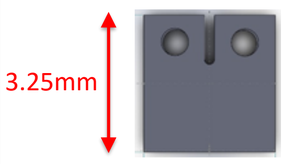
High Pressure Torsion approach

- Sample is compressed and then twisted to create deformed layer
- Both HPT sample and anvil have been designed and manufactured as shown below
- Strain within the deformed HPT sample is calculated using $\varepsilon = 2\pi rn/t$ where r is the radius of interest, t is the thickness of the deformed layer created and “n” is the number of rotations

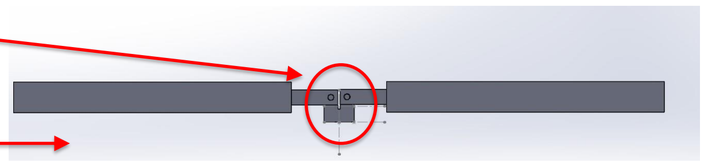


Fatigue Crack Growth propagation test

- FCG specimen designed based on ASTM E647 parameters
- Clevis and pins also designed based on ASTM E647 parameters



Grip and loading set-up

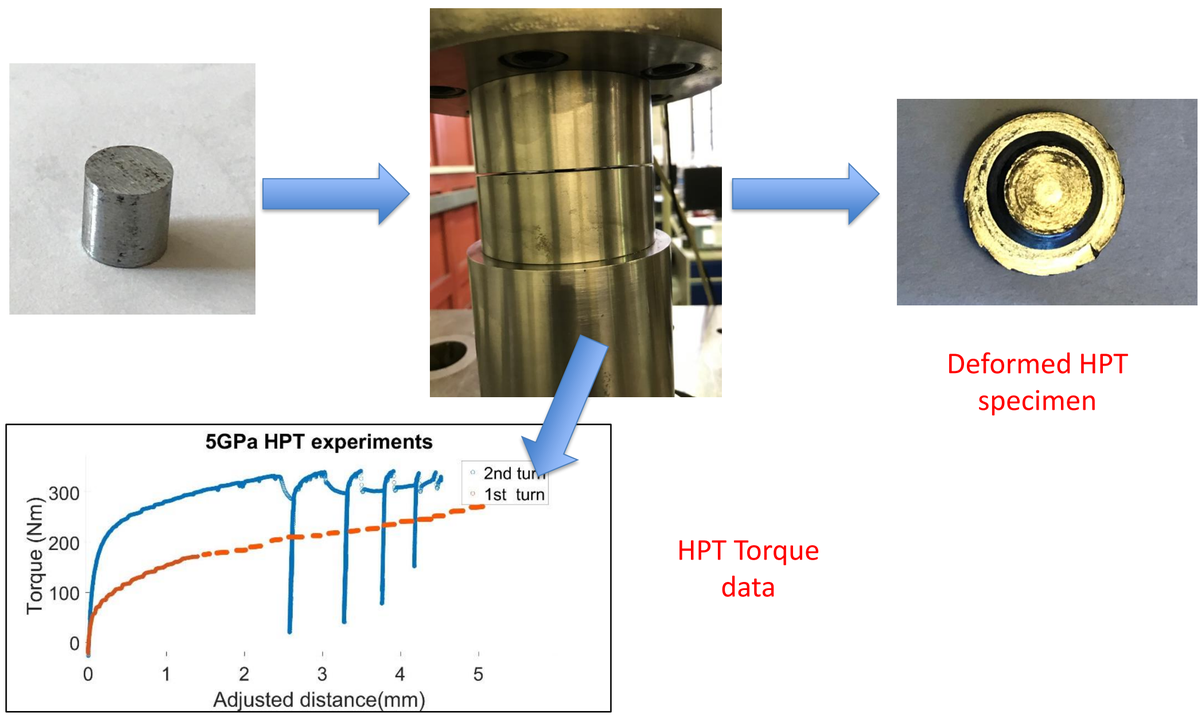


References

[1] Lewis & Dwyer-Joyce, 2004, Proc. IMechE Part J, 218, 467-478.

[2] Leitner et al., 2018, Int. J. of Fatigue, 124, 528–536.

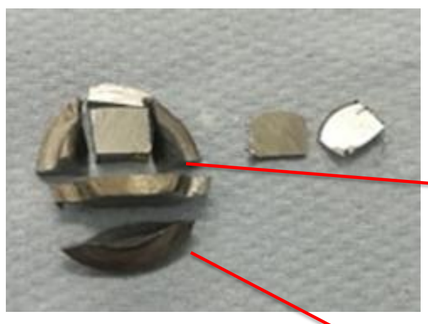
High pressure torsion testing



Deformed HPT specimen

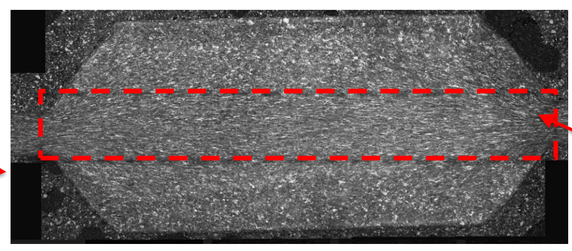
HPT Torque data

HPT deformation features

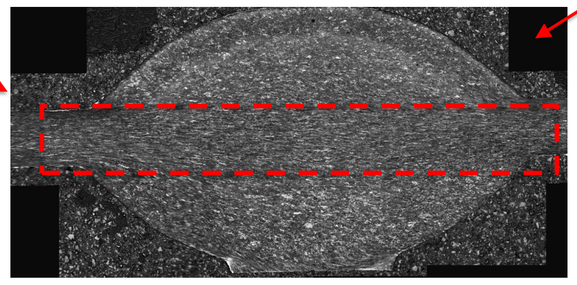


HPT specimen sectioned and mid-point and point of FCG specimen manufacture

Mid-point



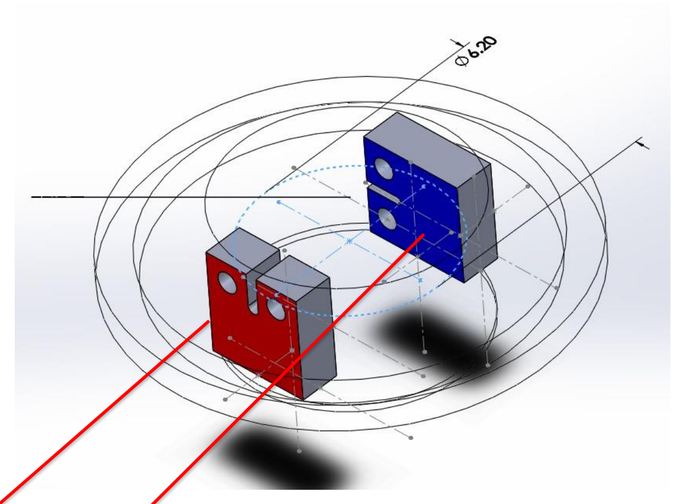
Clear deformed layer in middle of the specimen

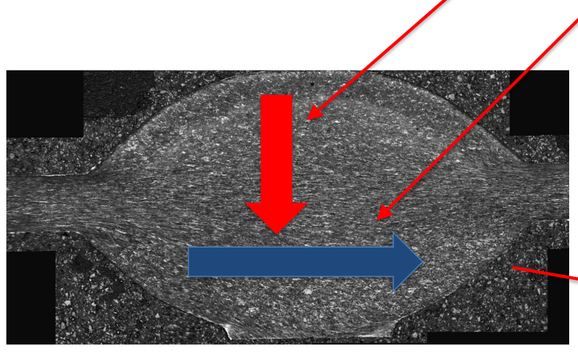


Point of FCG specimen manufacture

Fatigue crack propagation testing

Orientation of FCG specimens taken from HPT specimen





Actual FCG specimen

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