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FAILURE ANALYSIS OF PITMAN ARM, INFLUENCE OF MICROSTRUCTURE ON FAILURE

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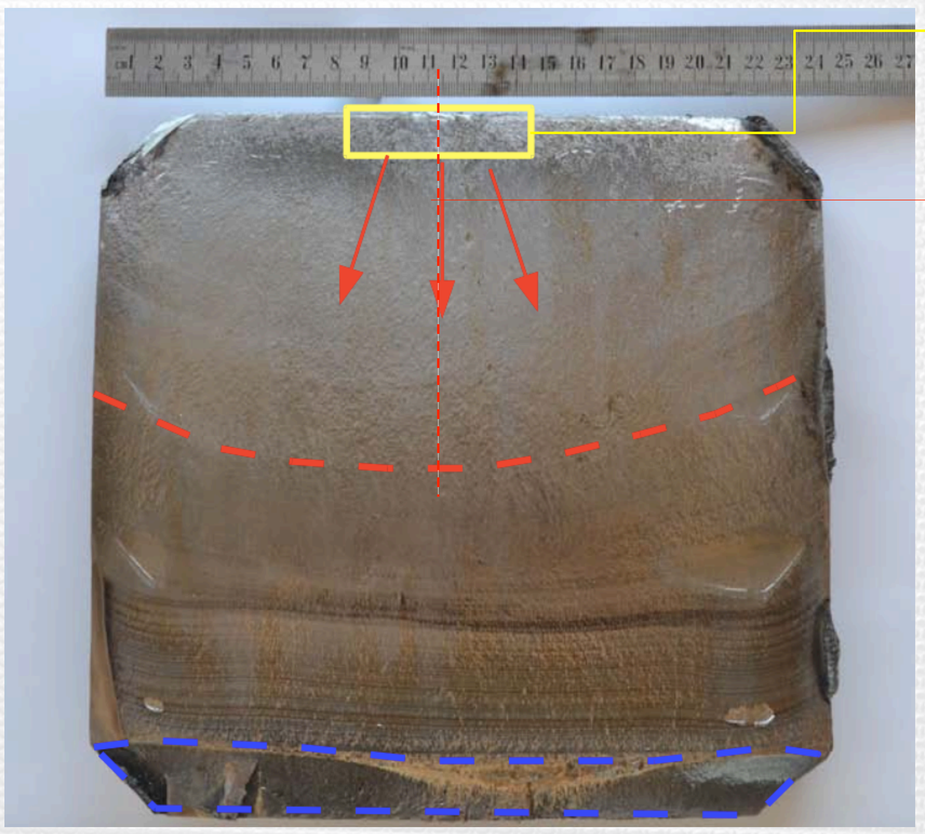
ABSTRACT

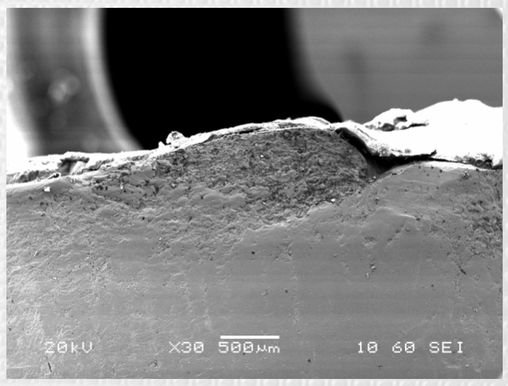
A failure investigation of fracture was conducted on pitman arm of stamping press. Fracture area was investigated by means of scanning electron microscope. Detailed investigation of microstructure on the locality of fracture initiation was performed. The fracture initiation occurred on the weld, where the lubrication accessories were connected to the pitman arm. The presence of high residual stresses from welding are generally found to be cause of such fracture. Article shows how crucial the heat treatment of the weld is for prevention of the failure. Further examples of other failure analysis show the most often cause of failures due to non-conforming microstructure of material.

Investigation of the Failure

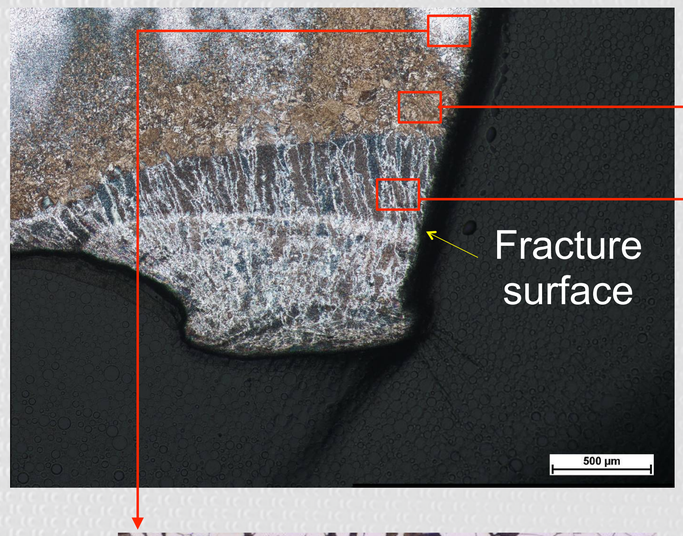


Fracture area of broken pitman arm

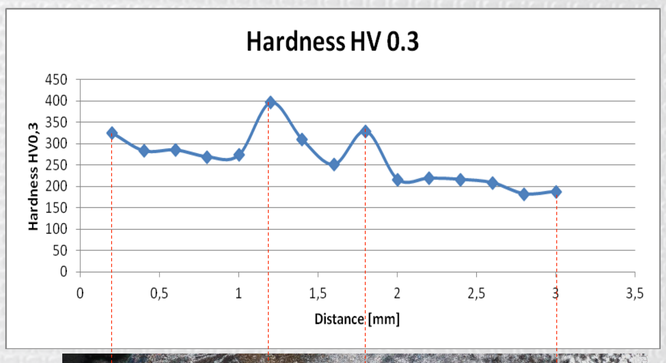
Locality of failure origin (SEM)

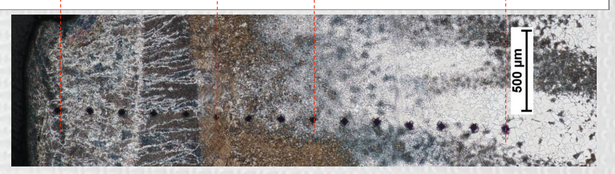


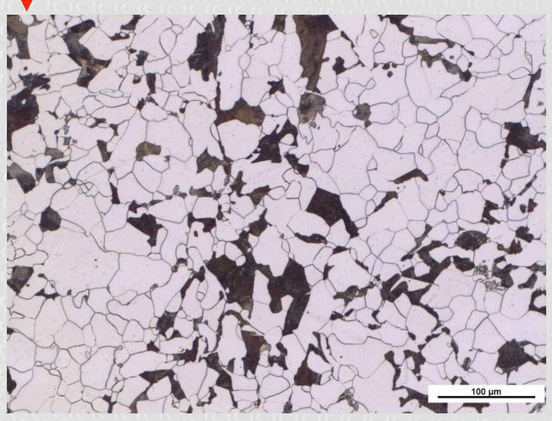
Microstructure in the failure origin (cross section)

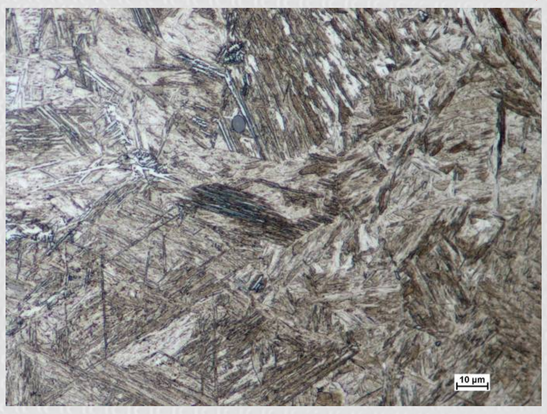


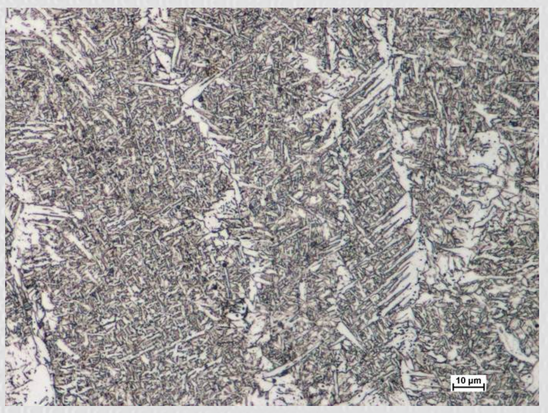
Hardness of the pitman arm affected by weld







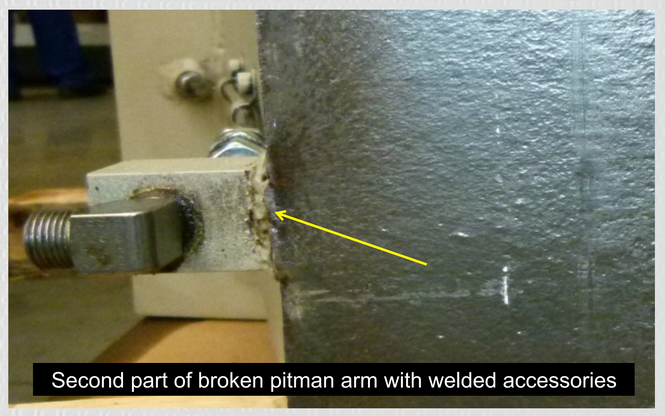




Locality of failure origin was observed by means of scanning electron microscope. Locality shows some marks of different fracture surface. This fact indicates different material or microstructure in the failure origin. There was also observed small cavity on the surface of arm. There was prepared sample for analysis of microstructure in the locality of failure origin. The cross section was made through the initiation locality. Microstructure was revealed by means of Nital etchant. There is a weld on the locality of failure origin (see figures on the right). There is clearly visible, that microstructure of arm is changed due to the welding process. Microstructure in the core of arm consists of ferrite and pearlite. This microstructure changed due to the weld into martensite near the weld. Microstructure in the weld metal is composed from bainite and widmanstadten ferrite.

It is obvious that the weld in the microstructure considerably affect the hardness and inner stress in this locality of pitman arm. Microstructure shows, that the weld was not heat treated, there was no evidence of tempering in the martensitic microstructure below the weld. Therefore the hardness profile was measured on this sample by means of Struers Durascan 50 hardness tester. Load 0,3 kg was chosen for evaluation of Vickers hardness. Hardness was measured from the weld on the surface to the core of pitman arm. Hardness in the heat affected zone reaches 400 HV 0.3 (see figure above thist text). This value is two times the hardness of pitman arm in not affected microstructure. This heat affected zone is the source of high inner stresses and in this case, it likely served as an origin of failure.

It was presumed, that the weld was made for repair of the arm, until the customer sent the photograph of second part of pitman arm. That is clear from the photograph (on the right) that there is some part welded on the arm. It is a lubrication accessories welded on. But the weld was not heat treated and caused failure. It also has a notch like effect and serves as a stress concentrator.


Second part of broken pitman arm with welded accessories

CONCLUSION

Failure analysis of broken pitman arm was done. Fatigue failure has its origin on untreated zone affected by welding. The hardness on heat affected zone reaches 400 HV in comparison to 200 HV of non affected microstructure of pitman arm. The presence of high residual stresses from welding was found to be cause of the fracture.

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