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"Excellence in Metallurgical Engineering"

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Case Study: Prototype Evaluation

By

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Subject

Evaluation of surface defects on a Prototype Parker-Compatible, hydraulic hose crimp fitting to determine if the defects would affect the life of the fitting. The fitting was machined from free machining steel, AISI/SAE 1215, and was examined by visual examination, hardness testing, and metallographic examination to determine the cause of the visual defects, and if they would affect the life of the fitting.

Visual Examination



Figure 1 – Fitting Body

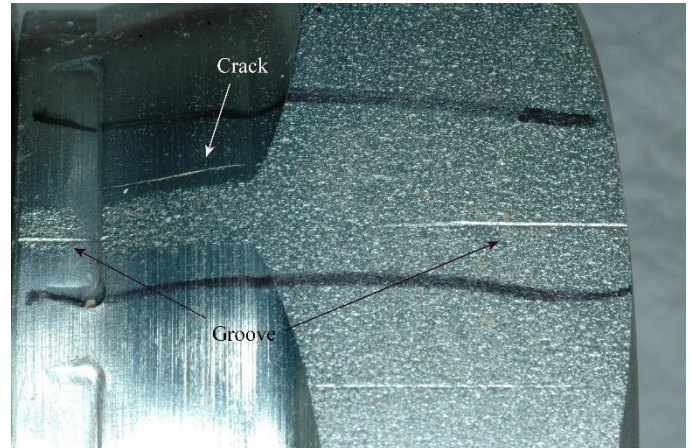


Figure 2 – Crack and Grooves, Body

Figure 1 shows the body of the fitting. There were several defects on the right end of the body, as shown in Figure 1. Figure 2 shows several grooves that were on the surface of the body. These grooves appeared to be tool marks caused by the screw machining process used in forming the body from the specified steel bar, or by the device used during the crimping assembly of the Body and Sleeve.

A crack, which was not a surface defect, is shown in Figure 3. The crack appeared to have been initiated by a nonmetallic inclusion, not still present, but typical of those found on or near the surface of free machining steels. The crack opened up during crimping.

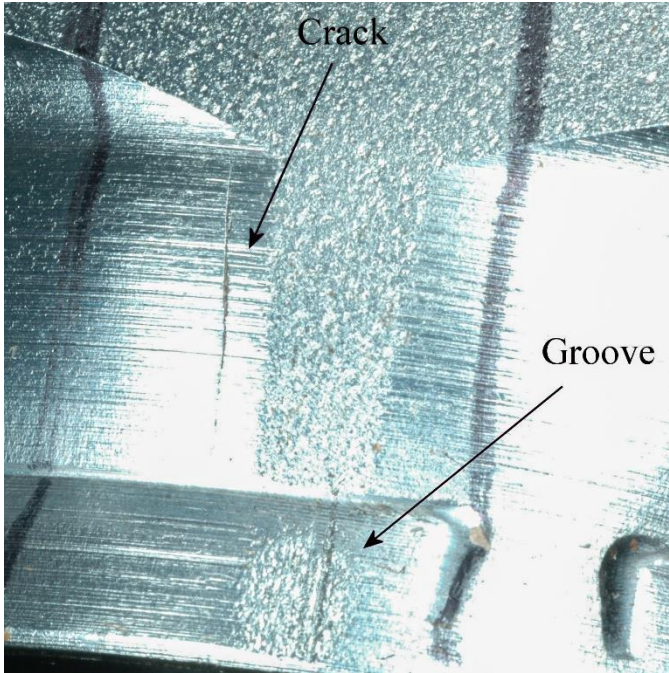


Figure 3 – Crack and Groove in Body



Figure 4 – Sleeve

Hardness Testing

Hardness testing was done according to ASTM E384, using a Vickers indenter and a 500 gram load. The results of the testing are given in the table that follows.

The hardness readings, which were taken on the HEX end, and on the Crimp end of the body, were in the correct range for cold drawn, low carbon free machining steel, such as 1215.

Hardness Test Data (Rockwell B Scale)					
Sample	VICKERS	STD DEV	MAXIMUM	MINIMUM	HARDNESS
Body Hex End	196	2.17	199	194	92.16 RB
Body Crimp End	221	4.51	225	216	96.88 RB
Sleeve	121	5.46	128	115	68.06 RB

The Sleeve was annealed, as indicated by a hardness of 68.06 RB. The low hardness was necessary to ensure proper crimping of the sleeve without cracking.

Metallographic Examination

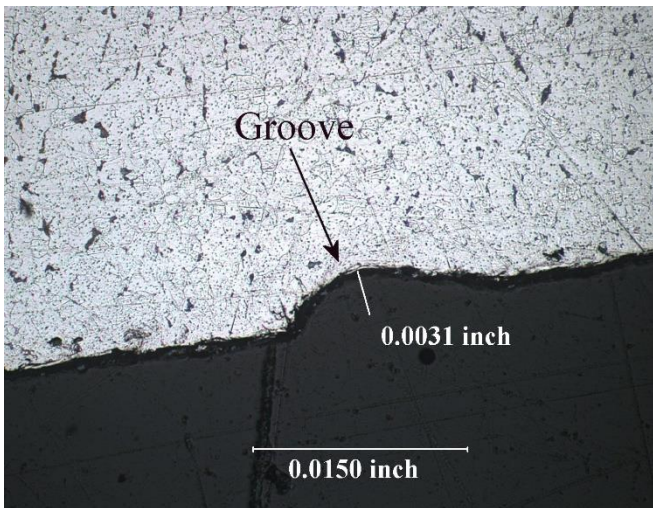


Figure 5 – 100X Body, Groove on Hex Flat

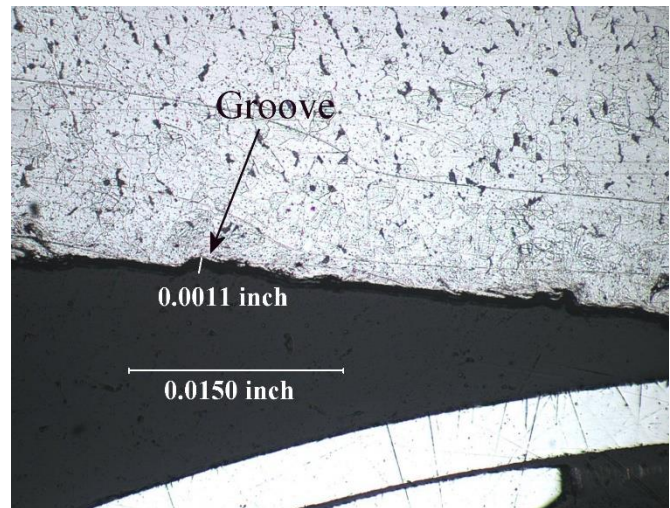


Figure 6 – 100X Body, Groove Crimp Area

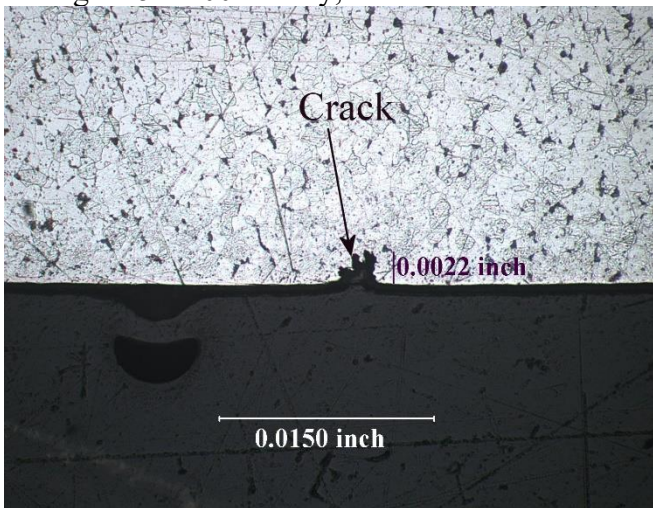


Figure 7 – 100X Body, Crack on Crimp Area

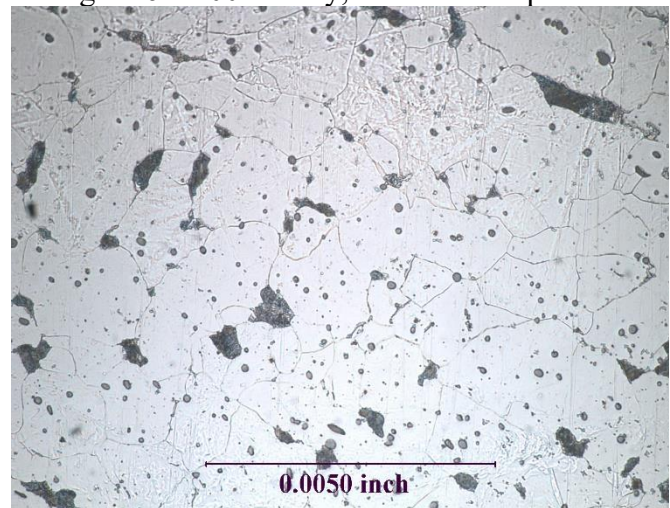


Figure 8 – 400X Sleeve Microstructure

Figures 5 and 6 show the groove in two locations in the Body: the hex flat, and the crimp area. The depth of the groove in the hex flat was approximately 0.003 of an inch. In the crimp area, the depth was 0.001 of an inch. Grooves of this type, without sharp edges to act as stress risers, would not be a problem for the coupling's function.

Figure 7 shows the 0.002 of an inch deep crack in the crimp area of the Body. The crack was likely caused by an inclusion in the surface of the steel, and had opened up during crimping. Cracks of this nature were not acceptable and would affect the fittings function.

Figure 8 shows the microstructure of the Sleeve. The grain size was 22 microns, which is equivalent to ASTM 8.0. This grain size, and the hardness of 68 Rockwell B, indicated that the sleeve was properly annealed. The microstructure of the sleeve was a mixture of ferrite at 94%, the white phase, pearlite, the larger dark phase at 6%, and inclusions, the very small dark phase. The microstructure indicated that the steel used for the Sleeve was AISI/SAE 1215. This grade, like other grades of free machining steel, has

very poor, short, transverse fracture toughness, meaning that small surface cracks, like the one shown in Figure 7, would likely cause failure.

Conclusions

1. Surface Grooves in the steel were not detrimental to the functioning of connectors based on this Prototype.
2. Cracks that formed in the Body or Sleeve during crimping, though not acceptable, would not be affected by changing to another grade of free machining material. Nonmetallic inclusions are typically found in free machining grades of steel.
3. The annealing process for the Sleeve was acceptable.