Hot Crack Susceptibility Framework

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Scope

Hot cracking susceptibility is analyzed including a sensitivity analysis, and a post-processor for a computational weld mechanics (CWM) framework is developed to identify the transient 3D region susceptible to hot cracking for a welded structure.

Theory

Hot cracking requires 4 conditions to occur:
1. Cooling thermal profile
2. Temperature in the Britteness Temperature Range (BTR) range
3. A strain rate greater than a certain rate to initiate the crack
4. Tensile stress/strain to grow the crack.

Test set up

The specimen is 50 X 25 X 0.25 mm 316 stainless steel sheet welded with a TIG process with a constant transverse force applied on the side surfaces.

Chemical composition C 0.018, Ni 12.16, Cr 17.04, Mo 1.98, Mn 1.70, Si 0.34, Cu 0.05, N 0.047, P 0.032, S 0.010 Wt %

There is a jig that applies a transverse stress and modeled numerically as pressure BCs on side edges.

Conclusion

Increasing the tensile traction transverse to the weld path and reducing the weld speed increases the chance of hot cracking along the weld path.

A post-processor that provides a 3D transient field of hot cracking susceptible region, gives the information about the region size, shape, location, and a probability measure for the Gauss points in the susceptible region.

This 3D field predicts that increasing the welding speed at constant power per unit length can reduce the risk of hot cracking along the weld path but can increase the risk of hot cracking beside the weld path. The speed needs to be optimized.