Low cycle fatigue life assessment of welded high-strength structural steels based on nominal and local design concepts

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Abstract

Fatigue life curves of butt joints, transverse stiffeners and sample components with tube-clevis connections, manufactured by active gas metal arc welding (GMAW) of S960QL, S960M and S1100QL high-strength steels, show a linear extension into the low cycle fatigue (LCF) regime with a constant slope up to the yield strength of the material. An extended S-N design curve based on fatigue class FAT 160 (k = 5) gives conservative results for high quality butt welds below the ultimate tensile strength. In comparison to high frequency hammer peening and grinding, TIG dressing of S1100QL butt joints is most favorable for the increase of fatigue life.
The effective notch stress approach with r_{ref} = 1.00 mm and measured radii of post treated welds leads to a reliable fatigue assessment up to at least $N = 5 \cdot 10^3$ cycles to failure, which confirms FAT 225. The stress averaging approach using the microstructural support increases the assessment quality. A similar assessment reliability for damage parameter Wöhler lines, derived from elastic-plastic FE-analysis, is achieved, if support effects are considered.

Keywords

Low cycle fatigue (LCF)
Welded high-strength structural steel
Cyclic material behavior
Linear damage accumulation
Post weld treatment