

SPA8. Comparing Weld Fatigue Behavior Of Stainless Steels: Duplex Vs Austenitic

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Introduction

A frequent cause of failure in welded structures is fatigue, or corrosion fatigue. Since there is a growing need for corrosion resistant structural welds, tests were conducted to provide additional data pertinent to the use of stainless steels as a structural material for corrosive environments. A standard austenitic stainless steel (316L) was compared with two types of duplex stainless steels (2205 and SAF 2304) using different welding methods and different material thickness. High cycle fatigue tests were performed on the welds both with polished specimens and with specimens having the weld reinforcement intact.

Technical Approach & Results

This presentation will show a comparison between austenitic and duplex stainless steels, with regard to their fatigue strength levels and notch sensitivity in weldments. A series of table, figures, and diagrams will display:

- Welding parameters for (smooth/polished) butt weld specimens, and (reinforcement intact) butt and fillet weld specimens.
- Fatigue test results (including corrosion fatigue) for the different grades/sizes of parent metals, and weldments.
- Geometry and dimensions of the test specimens reported, and chemical composition of alloys, and mechanical properties of parent metals tested.
- The design part will cover fatigue performance of stainless steel joints in as welded condition in comparison with smooth specimen data for parent and welded materials.

The results of test conducted show:

- Duplex steels have higher fatigue strength than austenitic stainless steels.
- The superior behavior of the duplex parent material is, to a great extent, also retained in the weldments.
- Submerged arc welds (SAW) showed even higher fatigue strengths than the base material itself.
- Corrosion fatigue tests in synthetic seawater environment, resulted in a 25% reduction of the fatigue strength of 316L compared to a 10% reduction for the duplex grade 2205.

Conclusions

Duplex stainless fatigue behavior shows marked improvement over austenitic, especially in corrosive environments. However, contractors should keep in mind that: 1. fatigue strength in GMAW duplex is slightly reduced compared to parent material, 2. stress concentration at the GTAW and GMAW weld toe greatly influences fatigue performance, and 3. when stress raisers become more severe, on load-carrying fillet welds, the fatigue strength drops significantly. Nevertheless, stainless steels and especially duplex show very promising fatigue behavior on the same level or better than ordinary structural steel and should be considered for corrosive environment structural applications, such as off-shore and sea-side structures.