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Applicability of Low Transformation Temperature welding consumables to increase fatigue strength of welded high strength steels

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Abstract

Application of Low Transformation Temperature (LTT) consumables in welding is a recent approach to increase the fatigue strength of welds. In this paper high strength steels with yield strengths ranging from 650-1021 MPa were fillet and butt welded using different LTT and conventional consumables. The effects of weld metal chemical composition on phase transformation temperatures, residual stresses and fatigue strength were investigated. Lower transformation start temperatures and hence lower tensile or even compressive residual stresses were obtained close to the weld toe for LTT welds. Fatigue testing showed very good results for all combinations of LTT consumables and high strength steels with varying strength levels. For butt welds, the characteristic fatigue strength (FAT) of LTT welds at 2 million cycles was up to 46% higher when compared to corresponding welds made with conventional filler materials. In fillet welds, a minimum FAT improvement of 34% and a maximum improvement of 132% was achieved when using LTT wires. It is concluded that different LTT consumables can successfully be employed to increase fatigue strength of welds in high strength steels with yield strength up to 1021 MPa. Weld metals with martensite transformation start temperatures close to 200°C result in the highest fatigue strengths.

Keywords: Low Transformation Temperature Welding Consumables; Fatigue Strength; Residual Stress; Martensite Start Temperature

1 Introduction

Welds are often the main location of fatigue failure. This is mainly due to the stress concentration at the weld toe resulting from geometrical changes and high tensile welding induced residual stresses. Thus, methods which modify the weld toe geometry and/or residual stresses may be effective to increase the fatigue life of welds. The former can be achieved mainly by increasing the weld toe radius. The latter can be achieved by reducing the tensile