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Influence of weld quality on the fatigue strength in seam welds

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ABSTRACT

In this paper a research study has been carried out on the link between weld quality of production welds and the fatigue strength. It has been carried out as a part of a Swedish Technology Platform for lightweight optimised welded structures (LOST), where some of the work packages within the project intend to connect the design and analysis to production and weld quality. One of the results is a new weld quality system from Volvo Group, which has a scientific background, is open for public use and focus on features important for fatigue in welded joints. In this study the emphasis is on a couple of features within the new weld quality system: weld toe radius and the possible existence of weld defects such as cold laps. Large scatter of the local weld geometry was observed for different welding processes. Also the results show that the weld position has a significant effect on the quality and the fatigue resistance of fillet welds and that it may be the difference between normal quality and high quality welds.

1. Introduction

Manufacturers of cars, trucks, busses, construction machinery, forest machines, agricultural machines, power generation, industrial robots, aero engines and consultancy firms have to design and produce to prevent fatigue failure during the operational life. A common goal for these organisations is also to minimize weight in order to increase productivity and decrease fuel consumption. This will support the use of efficient and more accurate fatigue design methods which must be connected to quality requirements which can be understood and managed during production. However, welding without any improvement gives rise to local stress concentration, residual stresses and different types of defects, these features combined with high cyclic and complex service loading give rise to fatigue failure. Stress concentrations at the weld toe are caused by the geometrical discontinuities and, thus, fatigue cracks are easily initiated at these locations especially in connection with small toe radius. Fatigue crack may also start from weld defects, e.g. at weld toe from cold laps and undercuts, and at the weld root from incomplete fusion and small effective throat thickness see Fig. 1. In case of fillet welds without any degree of penetration or not completed butt welds, these defects (or design cracks) size can be in the order of the plate thickness. These defects behave more or less as sharp macro cracks which motivate the use of fracture mechanics as a tool to establish a link between the weld quality (e.g. local weld geometry, defects and residual stresses) for production welds and the fatigue life.

Residual stress that arises in welded joints is another important factor which needs to be considered in the fatigue assessment of welded structures. It is well known that tensile residual stresses in welded structures can be as high as the yield strength of the material and they have a detrimental effect on the fatigue behaviour. The combination of tensile welding residual stresses and operating stresses to which engineering structures and components are subjected can promote failure

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