Optimisation of Welds with Manufacturing Considerations

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Abstract: *Fatigue is the main in-service failure mode for automotive chassis & suspension parts, especially weld fatigue. Over the years, Tata Steel Automotive Engineering (TSAE) has developed techniques for CAE durability assessment including the optimisation of seam-welded chassis/suspension structures. Seam weld optimisation at TSAE has previously been based on a constant weld length and constant gap between welds for each weld run. This method has two drawbacks; weld patterns generated are regular in nature, reducing the flexibility to position welds where they are most effective and· excessively short welds are often left at the end of a run of welds. The objective was to develop an improved optimisation technique using Isight that always produced a manufacturing feasible design and allowed more flexible and irregular positioning of welds. Manufacturing constraints considered were minimum weld length, minimum gap length and minimising the number of start/stop operations.*

To reduce the number of design variables, a new load-case-weighted optimisation scheme was developed using a single weighting factor for each load case. These factors were used to generate weld patterns by scaling the strain energy density in finite elements from an initial fully welded design. Weld elements were selected for retention/deletion by comparing a weighted sum across all load cases with a threshold value. During each optimisation, Isight varied the weighting factors as "design variables" to minimise overall weld length, while achieving stiffness and fatigue life targets. The process has been extended to function for laser weld designs where an intermittent weld pattern is generally the most effective.

Keywords: Design Optimisation, Fatigue, Fatigue Life, Minimum-Weight Structures, Optimisation, Seam Welding, Welding, Automotive Chassis, Automotive Body, Steel.

1. Introduction

Researchers and engineers have found that, gauge for gauge, there is often little difference in the fatigue performance of welded conventional mild steel joints and welded Advanced High Strength Steel (AHSS) joints, for similar welding processes and weld quality, e.g. metal active gas (MAG) welding (Lewis, 1996). In other words, fatigue performance of welded thinner AHSS structures may become poorer. Consequently, in order to ensure full mass-saving potential of AHSS grades, more rigorous assessments of weld fatigue performance and optimisation of weld placement have become an important parts of any new vehicle development.