Fatigue Performance of GMAW Welded Joint Using Hot Rolled Dual Phase Steels

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Introduction

Advanced high strength steels (AHSS) such as dual phase and TRIP steels are of considerable interest for automotive applications due to their potential of fulfilling the requirements for both fuel economy (weight reduction) and crash-worthiness. Dual phase steel with tensile strength of 600 MPa (DP600) is currently considered for structural parts with high potential of weight reduction opportunities. Advantages of those materials have been well documented in formability and crash performance. However, little effort has been made on fatigue performance of arc welded joint for those materials although a few publications are available on fatigue performance of spot weld. It is important to understand the fatigue performance of weld joints since welding fatigue performance is one of key design parameters in automotive applications.

Procedure

In this paper, fatigue performances of hot rolled dual phase steels (DP600) were evaluated. Three different hot-rolled DP600 with 5.5 mm gauge from different steel makers were selected against one production mild steel with 6.1 mm gauge currently used in vehicle structure. The welding process was gas metal arc welding (GMAW) with different filler metals (undermatch). Non-load carrying weld cruciform fatigue tests were conducted across the DP600 steels and mild steel by fully reversed axial loading (R=-1). S-N curves corresponding to different welding heat inputs were evaluated and constructed. Optical microscopy and scanning electronic microscopy (SEM) were used to examine the weld location, microstructure and fracture surfaces of the crack initiation and propagation site.

Results and Discussion

The welding fatigue performance of DP600 was better than the BS7608 Class F design curve. It was observed that all DP600 materials performed better than mild steel when the applied stress ranges were 250 MPa or higher in this study, due to the lower yield strength of the mild steel. The weld fatigue performance was better at relatively low heat input level for DP 600 while mild steel didn't show this trend. It is mainly due to the thermal processing history of the DP600 materials. All the fatigue cracks initiated at the weld toe. One of the DP600 materials showed HAZ hardening effect especially when the heat input is high. No brittleness was observed on the fracture surface of the fatigue samples for all materials.

Conclusions

1. The fatigue performance of weld joints was slightly different for different DP600 materials. However, the fatigue results for all DP600 materials were better than the BS7608 class F design curve.
2. For P600 weld joints, lower heat input yielded relatively better fatigue performance than high heat input.
3. At higher applied stress ranges, the weld Joint of DP600 showed better fatigue performance than that of mild steel
4. According to metallurgical evaluation results, all DP600 welded joints in this study showed no brittleness under fatigue loading.
5. It is recommended that welded DP600 coupon by different welding processes be evaluated in order to verify weld integrity across the processes.