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High Cycle Fatigue Behaviour of a Resistance Spot Welded Advanced High Strength Steel

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Abstract

An automobile body is comprising of various metal sheets joined by resistance spot welding. These welded structures undergo vibration from road surface, engine, floor panel, wind screen, etc. which results in cyclic loading of the spot-welded joints leading to fatigue failure. This work is carried out to understand the fatigue behaviour of spot welded DP980 steel. 1.2 mm thick cold rolled galvanized DP 980 steel sheets were used for this study. Spot welding was done using a spot and projection welding machine, operated at a current frequency of 50 Hz. The welding parameters were optimized for industrially accepted nugget diameter. The welding was done with an electrode force of 4 kN and welding time of 300 msec. The nugget diameter of 6.92 mm (~4.5 mm (thickness of the work piece)) was observed at 8 kA welding current and 6.2 mm (~4 mm (thickness of the work piece)) was observed at 7 kA welding current. Welds were prepared at two welding currents of 7 kA and 8 kA for fatigue analysis. Microstructural observations were made on the welds and microhardness was measured. Tensile testing was done on the spot-welded specimen in lap shear and cross tension mode at a strain rate of 0.03/min. In each welding condition, five tests were conducted and the average values of weld strength, plug ratio and the failure energy were obtained. Fatigue testing was conducted on the spot-welded specimens in lap shear mode using Rumul Gigaforte 50 machines at different maximum load levels (5% to 30% of weld strength) with the load ratio of 0.1. The specimens were tested either until failure or up to 108 cycles. Fracture surface of the tested samples were observed using scanning electron microscope. Results indicate that the weld joint could withstand 108 cycles without failure when the maximum load was at 5% of weld strength. While full plug failure was observed in the sample tested at the maximum load of 7 % to 25 % of weld strength, partial plug failure was observed in the samples tested at the maximum load of 30% of weld strength. The welds made using 8 kA welding current exhibited superior fatigue performance compared to the welds using 7 kA current.