
Fatigue of Self-Piercing Riveted Joints in 5754 Aluminum Alloy Sheets

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Doctor of Engineering in Manufacturing Oral Defense

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From 10:00 a.m. – 12:00 Noon

1515 HH Dow Building

If you plan to attend Pamela's Oral Defense, please let Kathy Bishar at kbishar@umich.edu know by February 25.

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Self-piercing riveting is emerging as a strong alternative to spot welding for joining aluminum sheets. Self-piercing riveting is the pressing of semi-tubular rivets into two overlapping sheets. Flaring out of the rivet in the bottom sheet creates a mechanical interlock between the sheets. Sometimes self-piercing riveting is combined with adhesive to improve the joint strength. Previous studies have shown that self-piercing riveted joints in aluminum alloys have a longer fatigue life than spot-welded joints.

Since cold forming during self-piercing riveting operation can significantly alter the material properties and influence the fatigue failure of self-piercing riveted joints, the first part of the thesis was involved in determining the effect of cold work on the fatigue life of AA5754 alloy. It was observed that introducing of a hole by either drilling or punching greatly decreased the fatigue strength. However, the fatigue strength of punched-hole specimens was greater than the drilled-hole specimens, presumably due to cold work induced by punching.

Failure of self-piercing riveted joints in AA5754 under fatigue was either due to conventional fatigue or due to fretting depending on the sheet thickness combination. Conventional fatigue cracks were observed in the top substrate collar slightly away from the hole boundary, whereas fretting was observed around the hole edge on the faying surfaces of the two sheets. The former was due to high longitudinal tensile stresses, while the latter was due to lack of interlocking between the sheets and slippage at the contacting surfaces. The rivet-bonded joints showed a significantly better fatigue performance than the self-piercing riveted joints. The typical paint baking condition used in the auto industry did not affect the fatigue of self-piercing riveted joints. Ring coining improved fatigue life of self-piercing riveted joint; however, the degree of improvement depended on the coining condition and the sheet thickness combination.

