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Refill Friction Stir Spot Weld Repair of a Fatigue Crack

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Objective:

•Develop a procedure to repair fatigue cracks in a 2024 aluminum skin using the Refill Friction Stir Spot Welding process.

Figure 1 shows a dog boned sample with an arrow pointing to a fatigue pre crack.

Materials:

- .125inch thick 2024 Al T3 sheet
- .020inch thick 2024 Al T3 sheet
- Riftec RPS100 RFSSW
- MTS 810 Tensile Machine

Approach:

•Optimize the parameters for 2024 Al T3 .125 inches thick by modifying the rotation speed and weld time. This process is detailed in figure 2. 1600 rpm at 12 sec. were the optimized parameters.

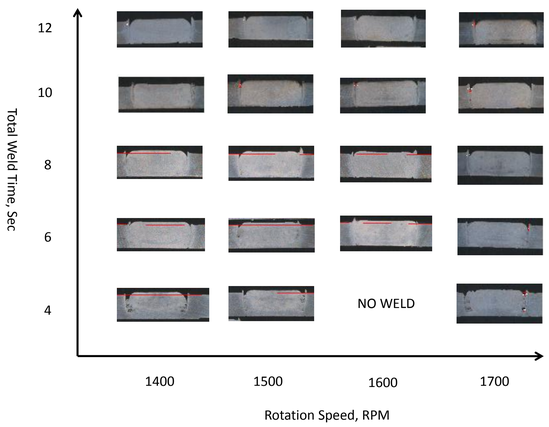

Figure 2 is a matrix showing the parameter development. Rotation speed and Weld time were changed to show the trends in metallurgy. The weld time determines plunge rates.

•Optimize the top surface. It must be flush and defect free at the surface to maximize life.

•We then determined that we had to modify then plunge depth to 3.3 mm to ensure full penetration. The crack must be repaired completely

•The spacing was then determined. This involved making overlapping welds within an inch, then pulling them as tensile samples. A single weld, 4 welds/inch, 5 welds/inch, and 6 welds/inch were tested.

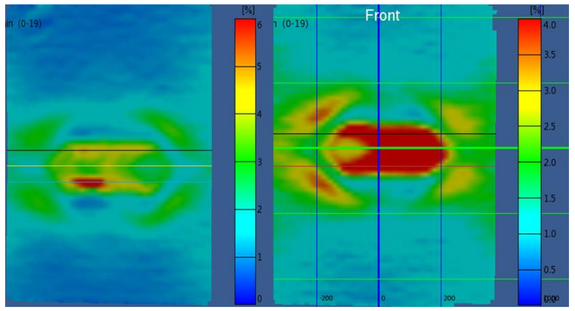

Figure 4 shows strain fields as seen by our DIC cameras as the samples are pulled in tension. On the left is a 6 welds/inch and the right is 5 welds/inch. The ending welds have least strain.

- It was determined by tensile strength that 4 welds/inch was not enough. There was little difference between the 5 welds/inch and the 6 welds/inch samples. At least 5 welds/inch would be needed.

•Micro hardness was also performed to show how the hardness changed along the overlapping welds. This is shown in figure 5 and 6.

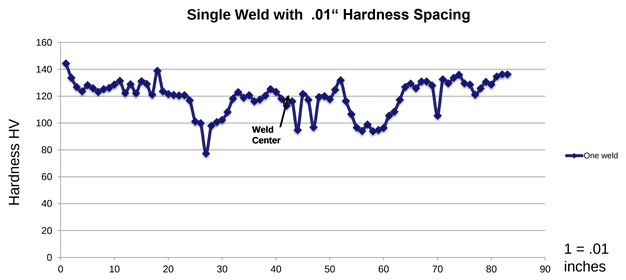

Figure 5 shows a Vickers micro hardness test on a single weld.

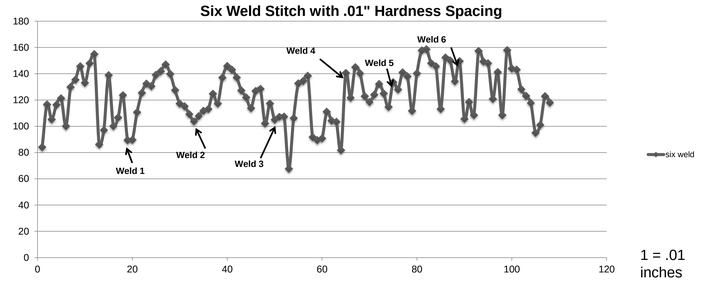

Figure 6 shows a six weld stitch weld. The harness increases as the welds progresses. Weld 6 is the last weld in stitch.

- Fatigue pre cracks are made in the MTS 810 tensile machine. Crack measurements are made, and the repair procedure is applied.

Results:

•Initial results show that the repairs seem to be improving the fatigue life. The RPS 100 will need repairs to give consistency.

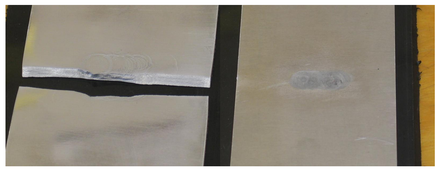

Figure 7 on the left shows a repair failure during a fatigue test. On the right is the bottom surface of a repaired crack.

Figure 8 shows the initial results of fatigue test. More testing is required to complete the data.

# of Cycles to Failure		
Stress %	Cracked	Repaired
30	11655	23815
45	1949	49587

Future Work:

•Repairs will continue on the pre cracked specimens.

•Samples will be analyzed for cyclic fatigue life and results will be compared to parent, and cracked samples.

Acknowledgments:

W. Arbegast, Dr. M. West, Dr. A. Boysen, AMP Personnel

Funcded By: REU Supplemental to NSF I/UCRC CFSP