Benchmarking Wire-Fed Laser Welding Systems Powered by Static Beam Shaping and Beam Wobbling on Tensile Strength and Fatigue Life of Aluminium 6082 Grades

Rehab Al Botros[1], Pasquale Franciosa[1]

1- WMG, University of Warwick, Coventry, West Midlands, United Kingdom

Corresponding author: r.al-botros.1@warwick.ac.uk

Aluminium 6xxx alloys are very attractive for the aerospace, automotive and, in general, the transportation sector, as they serve with the structural part of the body due to their lightweight, superior strength, formability and workability, corrosion resistance, and great recycling characteristics. However, due to the complex interplay between the chemical composition, microstructure evolution and solidification behaviour, during welding they are highly susceptible to solidification cracking and porosity [1, 2]. This affects the weld properties, especially the fatigue performance of the joint, as cracks and pores can act as an initiating site for the fatigue fractures. The state-of-the-art approach for laser welding of 6xxx aluminium alloys uses lasers in conjunction with filler wires, known as wire-fed laser welding, to alter the freezing range and hence reduce the crack susceptibility [3]. Although this process allows achieving sound welds, it necessitates raising the laser power to heat-up and melt the wire itself. This has a knock-down effect on production costs and welding speed. To give manufacturers the tools they want and need, advancements in the laser beam industry has revolutionised the welding process by offering wobbling beams and beam shaping technologies. Unfortunately, limited data are available comparing weld performances across these new laser welding technologies, especially for fatigue SN-curves.

This presentation offers a benchmarking study for comparison of different wire-fed laser welding processes and their effect on the weld quality of butt-welded 6082 aluminium 1.5 mm sheets. Tensile lap shear test and fatigue SN-curves were obtained for three welding configurations of wire-fed laser welding: static gaussian beam with defocus; wobbling gaussian beam on focus; and static beam shaping (gaussian inner spot with outer large square beam). Final remarks will also highlight current research endeavours to move away from wire-fed systems to fully autogenous and non-contact laser welding processes.

[1] M. H. Khan, S. Jabar, Q. Hayat, H. Kotadia, T. I. Khan, D. Ceglarek, P. Franciosa, (2024), Controlling solidification cracks during remote laser welding of AA6005 alloy using Al2O3 alumina nanoparticles dispersed coating, Procedia CIRP, 124, 478-483.

[2] U. Avci, P. Franciosa (2024) Effect of laser power on weld microstructure of AA6082 sheets remote laser welded by circular beam wobbling. Weld World 68, 2761–2777.

[3] M. Rasoulisamar, P. Franciosa, H. R. Kotadia, D. Ceglarek, A. Prabakar, (2024), Benchmarking wire-fed and autogenous laser beam welding to study the effect of Cu additions on weld integrity of 6060-T6 aluminium extrusion, Procedia CIRP, 124, 424-429.