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OPTIMIZATION OF PROCESS PARAMETERS FOR TENSILE BEHAVIOR OF FRICTION STIR WELDED ALUMINUM JOINT

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ABSTRACT

In this work, friction stir welding of pure Aluminium was carried out on the vertical milling machine with the help of an indigenously developed robust fixture. Taguchi parametric design and optimization approach was used to perform parametric analysis and to determine optimum process parameters viz. tool rotation speed, welding speed, and tool geometry with reference to the tensile strength of the weld joint. Further, Analysis of Variance (ANOVA) and Signal-to-Noise ratio (SNR) analysis were employed to evaluate the relative impact of process parameters and to find out the optimal condition. The predicted optimal condition was affirmed by conducting a confirmation experiment. A hardness measurement of welded joints and scanning electron microscopy (SEM) of fractured specimens was also carried out of the specimens for the worst and best tensile strength (welded joints). Comparative analysis was also done of both specimens with the fractured specimen of base Al test specimen. Optimum parameter combination, A3B2C3 (tool rotation speed 1850 rpm, welding speed 90 mm/min & straight square tool), yielded an optimum value of tensile strength (143.6 MPa). From ANOVA and SNR results, rotational tool speed found out to be the most significant parameter followed by welding speed and tool geometry. Hardness results showed an increased value of hardness at the welding zone, i.e., nugget zone for both specimens (least and highest tensile strength) as compared to the base material. Fractography for the highest tensile strength specimen exhibited a combination of fine and coarse dimples with micro-void coalescence. In contrast, tunnel defects, voids, featureless regions, and coarse dimples were displayed for the least tensile strength specimen.

Keywords: Friction stir welding, tensile strength, ANOVA, signal to noise ratio, tool, fractographs.