Optimizing the pulse wave mode low power fibre laser welding parameters of 22Mnb5 boron steel using response surface methodology

K.I. Yaakob, M. Ishak, M.M. Quazi, M.N.M. Salleh
Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

ABSTRACT

Recently, high strength and lightweight components requirement in the automotive industry have intensified the interest of utilizing tailor welded blank (TWB) technology for boron steel. Furthermore, with greater demands for efficiency and productivity of laser-welded products, the pulse wave mode of laser welding has been proposed to replace the continuous wave mode. Hence, in this study, the effect of pulse wave mode laser welding parameters (i.e. peak power, pulse duration and pulse repetition rate) on the mechanical properties of 1.6 mm thick boron steel (22MnB5) was investigated. The response surfacemmethod (RSM) was used to develop models to predict the relationship between the processing parameters and tensile strength. Additionally, the optimal parameters combinations of input variables were identified showing superior joint strength. As a result of utilizing optimal combinations, a highest ultimate tensile strength value of 533 MPa was obtained while the fracture being restricted at the base metal. The most significant parameter was found to be peak power when compared with pulse duration and pulse repetition rate in determining the weld penetration due to the impact of applied thermalenergy. Besides, the low error percentage of 4.26% for tensile strength indicated that the results predicted by RSM were very close to experimental values. The microstructure in the fusion zone was transformed into martensitic and despite austenite transformation from pearlite, not all ferrite grains were transformed into austenite in the heat affected zone. The optimized samples showed a remarkable increase in hardness from 200 Hv of base metal to that of 535 Hv in the fusion zone.

Keywords: Boron steel; 22MnB5; Laser welding; Pulse wave mode; Response surface methodology