

A. Weld Sizing And High Speed Hybrid GMAW/LBW For Sheet Steel

by Ian D. Harris, Edison Welding Institute

Introduction

There has been very limited work on weld sizing for sheet metal structures, based largely on the limitations of GMAW to produce consistent fillet weld leg length below 1/8-in. Most production welding with GMAW is carried out in the 20-60 in/min travel speed range for conventional welding practice, whether by robotic or other means. This work evaluated the capability of hybrid GMAW/LBW to produce small size fillet welds for lap and T-butt joints in hot rolled sheet steel with the aim of significantly increasing production welding speeds.

Technical Approach

The technical approach used GMAW-P and GMAW-VP to control wire addition and heat input from the GMAW portion of the hybrid operation. Scanning optics were used for deploying the laser energy and directing it to the weld toes to increase wetting, since the laser energy is not required for penetration in sheet metal welds. Both Nd:YAG and carbon dioxide lasers were used to increase toe wetting and suppress the onset of bead humping which is characteristic of high speed welding with GMAW alone.

Results/Discussion

Welding travel speed is limited by pool dynamics and the onset of bead humping as the wetting angle of the bead becomes less than 90 degrees. To suppress humping, the bead wetting needs to be increased to enable the bead to remain continuous and further increase in travel speed and weldin productivity to be increased. Directing the laser energy to the weld toes increases the wetting in these areas and allows the weld toe angle to be kept above 90 degrees. The laser energy required to achieve this condition is around 3 kW, so flying optics which are limited in power capability were not successful in achieving significant bead wetting improvements. Use of 3-4 kW of Nd:YAG laser power was successful, as was a similar energy level supplied by a carbon dioxide laser. It was found that in the case of both lap and T-butt joints, directing the laser energy at the lower toe of the fillet weld was sufficient to achieve the desired amount of wetting, such that the welding speed could be increased to 160 in/min (4 m/min)

Calorimetry was conducted for GMAW-P, GMAW-VP, LBW, and hybrid GMAW/LBW to measure process efficiency. High speed video and data acquisition were used to characterize the stability of metal transfer in each case. The laser spot size and thus power density were examined to determine the best balance between toe wetting and the lateral increase in the bead size that was available from a larger laser spot size.

Conclusion

Welding travel speeds were increased from 30-40 in/min to a maximum of 85-in/min using the GMAW-P process. Addition of laser energy at the weld toes was developed to the extent that welding speeds for lap and T-butt joints were increased to 160 in/min without humping defects.