High Deposition Welding for Shipbuilding

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ABSTRACT: A new welding process has been developed which uses a hybrid concept. A portable induction coil is operated ahead of the arc welding torch, and heats the surfaces of the weld to near the melting point. Then the heat generated by the welding arc is primarily used only to melt the welding wire.

Because the process does not depend exclusively on the heat from the arc plasma, there is no need to cut or machine a bevel on the sides of the joint. So, it can produce high quality welds in flame cut or plasma cut square butt joint configurations. This eliminates the costly and time consuming step of beveling the joint.

The process can put several times as much heat into the weld as an arc plasma. So, the weld speed can be increased significantly. Previously, the fastest arc welding process was Submerged Arc Welding, typically achieving welding speeds of 30 inches per minute with a single torch. This new hybrid induction arc welding process in preliminary testing can easily achieve speeds of 5 feet per minute. Initial heat flow analysis indicates that speeds of as much as 100 inches per minute may be possible with further development.

Although the total amount of heat per unit time is very high, because of the speed and the very small volume of metal deposited (square butt joint instead of a Vee or bevel joint), the heat input per unit length is relatively low and the amount of in-plane shrinkage is less from cooling weld metal is less than other arc welding processes – resulting is a lower level of in-plane strain. Although it has not been measured, it is expected that the in-plane distortion will be reduced.

The induction heating ahead of the weld tends to generate a very uniform temperature field through thickness. This reduces the asymmetry of the through thickness shrinkage. The result is a weld with very little angular distortion as shown in figure 1.

Figure 1. Square butt weld 0.75 inch thick DH-36 marine steel. No fixturing – part lays completely flat on the floor.

The process is being used in production to produce wind energy towers. A portable robot that runs on tracks which are attached with welded studs operates the process, and the robot is heavy enough to "self-fixture" then joint locally at the weld arc.

Figure 2 shows the process in operation making a 40 foot long square butt weld in 0.625 inch thick A 709 Grade 50 steel plates.

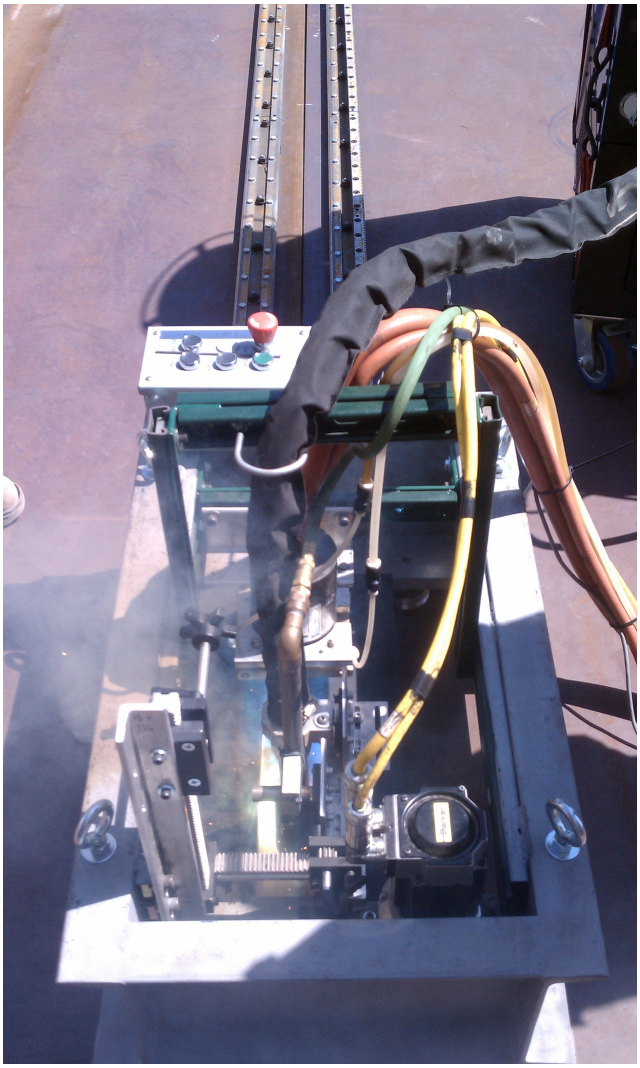

Figure 2. HiDep Welding process portable robot in production of wind energy towers.

The process appears to reduce distortion, increase productivity, and decrease cost. The system in operation producing wind energy towers, uses a Gas Metal Arc (GMAW) torch and a metal cored wire. This eliminates the need for costly flux and slag clean-up after the Submerged Arc process (SAW), which achieving welding speed significantly higher than SAW.

The presentation will include a video of the process in operation, discussion and infrared imaging of the heat distribution, and metallurgical analysis of weld properties. On-going work is developing a lap welding process and optimizing the operation.

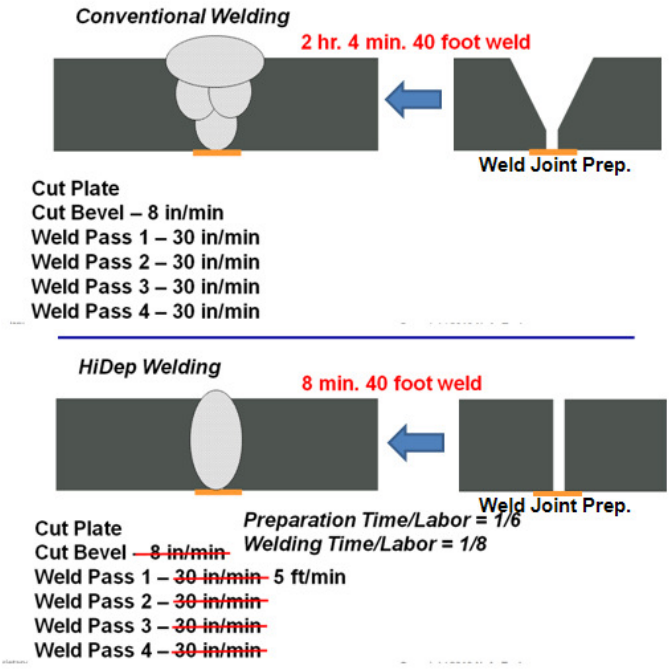

Figure 3. Comparison of HiDep weld using the portable robot versus conventional field weld using a crawler type weld torch holder.

Figure 4. Comparison of two identical welds, except that the weld on the left had the induction heating turned on and the weld on the right had no induction heating.