Three-Sheet Spot Welding of Advanced High-Strength Steels

The automotive industry has introduced the three-layer weld configuration, which represents new challenges compared to normal two-sheet lap welds. The process is further complicated by introducing high-strength steels in the joint. The present article investigates the weldability of thin, low-carbon steel to two thicker, high-strength steels of high-strength low-alloy (HSLA) 340, DP600, or TRIP700. Factorial experimentation and statistical analysis are used to illustrate how the robustness of the process is affected by the electrode size and is heavily influenced by the protective zinc coating. The weld mechanisms are analyzed numerically and compared with metallographic analyses showing how the primary bonding mechanism between the thin, low-carbon steel sheet and the thicker sheet of high-strength steel is solid-state bonding, whereas the two high-strength steels are joined by melting, forming a weld nugget at their mutual interface. Despite the absence of the typical fusion nugget through the interface between the low-carbon steel and high-strength steel, the weld strengths obtained are acceptable. The failure mechanism in destructive testing is ductile fracture with plug failure.