Abstract

The automotive companies introduced several new grades of advanced high strength steels into vehicles launched since 2001. These steels possess high strength and good ductility, hence their popularity. Resistance spot welding is the main joining method used in automobile body and frame assembly. Prior to releasing steels into production, spot weld properties are investigated to ensure that they meet automotive company requirements. One common test that is used to evaluate the quality of the spot weld is the "shear-tension" test. In this test, two sheet samples are overlapped and joined with a single spot weld. An increasing tensile load is applied to the sample until failure occurs. The maximum load and mode of failure are recorded. There are two different failure modes that can occur in these tests - "interfacial" or "full button pullout". In the interfacial failure, the weld fails at the interface of the two sheets, leaving half of the weld nugget in one sheet and half in the other. In a full button pullout failure, the weld remains intact and is completely torn from one of the sheets. In the evaluation of the test results, interfacial fractures have traditionally been considered unacceptable. This has typically been true for low strength steels in which interfacial failure is normally associated with cold welds or some sort of welding deficiency. A combination of computer modeling and fracture mechanics calculations was performed to determine if this same conclusion applies to the advanced high strength steels. Several dual phase and Transformation-Induced Plasticity (TRIP) high strength steels were evaluated. The net result of the analysis is that, for the shear-tension test, interfacial failures become the expected failure mode for some combinations of sheet thickness, button size and material strength and that the true indication of whether the weld is sound is the load bearing capacity of the weld and not the failure mode.