FORMABILITY OF STEEL AND ALUMINIUM TAILOR WELDED BLANKS

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ABSTRACT

In this investigation the formability behaviour of Laser steel welded blanks, with narrow weld beads, and Friction Stir Welded (FSW) aluminium blanks, with wide weld beads, will be compared. The base materials are two Steel Alloys (DC06 and DP600) and two Aluminium Alloys (AA 5182-H111 and AA 6016-T4) very popular in automotive industry. The TWBs were made from 1 mm thick plates by considering similar (DP600/DP600, DC06/DC06, AA 5182-H111/ AA 5182-H111 and AA 6016-T4/ AA 6016-T4) and dissimilar (DP600/DC06 and AA 6016-T4/ AA 5182-H111) combinations of both types of base materials.

The formability behaviour of the TWBs was analysed by stamping Axissimetrical Cylindrical Cups in a Deep-Drawing laboratorial testing device specially developed to work in a classical tensile test machine. The main reported results were the punch force-displacement curves and geometrical data from the Axissimetrical Cylindrical Cups. Results from the formability tests in all type of welds were compared.

In order to understand the dissimilar DP600/DC06 TWB behaviour during the stamping test a numerical simulation reproducing the experimental test was performed by using an implicit three dimensional finite element program (DD3IMP).

TESTING PROCEDURE

Before the formability tests, the heterogeneity in mechanical properties across the different weld zones was assessed by performing hardness tests.

The formability behaviour of the tailored blanks and homogeneous base materials was studied by stamping Axissimetrical Cylindrical Cups in a laboratorial deep drawing device specially developed to work in a classical tensile test machine.

RESULTS AND DISCUSSION

STEEL

CONCLUSIONS

Based on the results obtained in this work, it is possible to conclude that the formability behaviour of the TWBs depends mainly on the mismatch in mechanical properties between the base materials joined together, on the weld width and on the macro and microstructure of the tailored blanks. In current study it was possible to perform with success several axissimetrical cups with the DC06 and DP600 base materials and its similar welds. The same process parameters were used for the stamping of the homogeneous (base material) and welded specimens. The results obtained shows that a strong mismatch in mechanical properties, if localized in a narrow weld zone (as indicated by the hardness profiles registered for these materials), doesn’t have any influence on the formability behaviour of the tailored blanks. However, if the two different steels are joined together, the plastic behaviour of the dissimilar TWB is substantially different from the similar ones. In fact, rupture of the dissimilar welded blanks was observed under the same deep-drawing conditions of the similar blanks. From the results of the numerical simulation of the experimental test it is expected that changing the blank shape, more precisely, removing the central hole of the blank, it will be possible to shape with success the dissimilar TWBs.

The results obtained from the formability tests of the AA 5182-H111 and AA 6016-T4 base materials and its similar welds shown a different type of behaviour from that registered with the steel samples. In fact, despite the relative homogeneity in mechanical properties across the welds revealed by the hardness measurements, the similar TWBs suffer strong wrinkling under the same test conditions of the base materials. This behaviour can be associated with severe changes in material microstructure, surface finishing and thickness of the weld relative to the base material, which induces non-homogeneous behaviour of the blank. Optimization of the process parameters for the stamping of the aluminium TWBs is currently in progress.