# FRACTURE MODELLING CORRELATION STUDY FOR SPOTWELDED COUPONS WITH DP600 AND BORON STEEL SHEET

**David Norman* Michael Buckley****

***Tata Steel Automotive Engineering **Jaguar Land Rover**

## ABSTRACT

Fracture modelling is becoming an essential technology for the successful adoption of Advanced High Strength Steels (AHSS) and Ultra High Strength Steels (UHSS) in vehicle structures.

Recent advances in fracture modelling have established the fundamental principles of phenomenological fracture in order to develop fracture models that are generally applicable to a wide range of engineering problems and materials. The key features of these fracture models are a dependency of the fracture strain on the stress or strain triaxiality and a means of accounting for the reduction in stiffness in the material due to void growth or instability due to necking. Some of these models also incorporate non-linear strain accumulation and may have sophisticated plasticity models, which can be invaluable for modelling certain types of materials. A number of phenomenological fracture models are now available in the standard finite element codes used in industry. The work in this study uses the CrachFEM fracture model from MATFEM, which is available as a user defined material model within DYNA.

One area of concern for fracture in automotive structures is at or near to welds, where the fracture performance in the sheet can be worse than predicted if conventional finite element techniques are used for modelling the welds. This is due to effect of the welding process on the localised mechanical properties of the sheet.

This initial study considers how a weld may detrimentally affect the fracture performance of DP600 and Boron Steel sheet material, and how this can be modelled using finite element methods. A spot welded test geometry and loading is designed so that the load is carried only by the sheet and not by the weld. This eliminates the influence of the joint strength and only considers how the sheet material properties may be adversely affected by the weld.

The results showed that it is necessary to model the Heat Affected Zone (HAZ) in the CAE model and account for the HAZ strength in the HAZ region. For DP600, the increased strength of the HAZ region helps to increase the loads and displacements at fracture. For Boron Steel, the reduced strength of the HAZ leads to a reduction of the loads and displacements at fracture. This behaviour was observed in the tests and a good correlation was achieved between the CAE model and test.

For spotweld connections, it is recommended that the work is extended to consider fracture from joints where the joint itself bears the critical load in the structure. It is also recommended that a more detailed understanding of the properties of the weld

nugget and HAZ is developed in order to better understand the fracture behaviour of spotwelds when subject to a range of load cases.