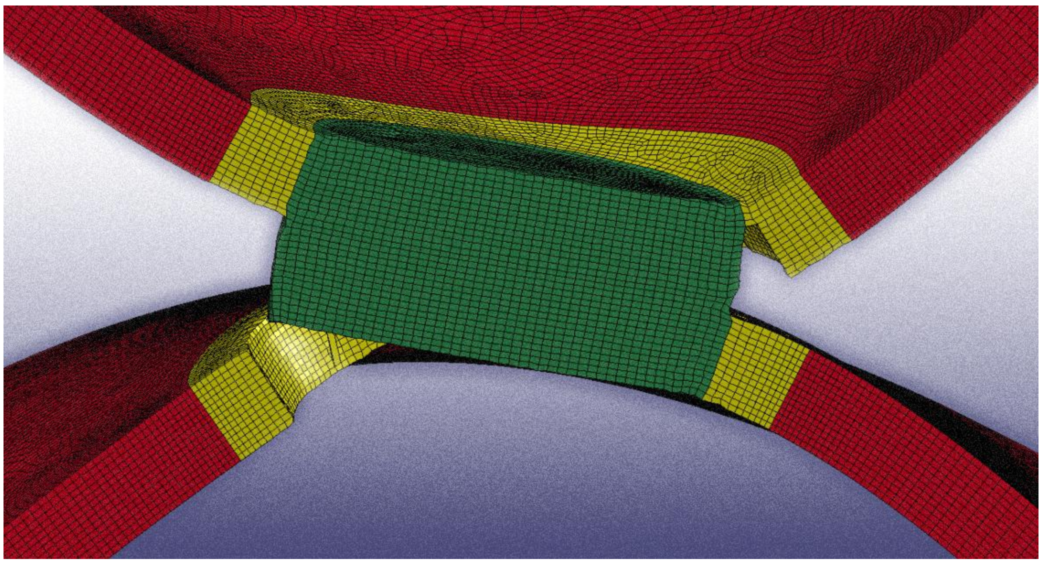
Sustainable Development of Spot Welded Structures, Part 2



Project within Vehicle Development

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Content

1. Executive summary

Development of more efficient and accurate simulation models for joining are of utmost importance for the Swedish automotive industry. This project has focused on developing finite element technique (FEM) to enable simulation of the behaviour of spot welded joints under loading conditions, e.g. crash. Simulation of fracture of spot welded structure is not possible with sufficient reliability today other than in certain special cases. To enable efficient modelling of adhesively bonded structures there exists a cohesive element, developed at the University of Skövde. The project goal has been to develop a similar element for spot welded joints. The project has been ended prematurely due to the bankruptcy of the industrial partner Saab Automobile AB. The project has provided possibilities of further development of simulation techniques for fracture of spot welded structures. A test method is partly developed but not verified for parameter determination for finite element simulation use.

Project content: Development of experimental model to study spot welded structures subjected to loading. The overall project goal has been to achieve sufficient simulation capability to assess relevant crash behaviour of spot welded automotive structures.

The project has laid the foundation for a test method and test specimen geometry for efficient determining of fracture parameters of spot welded structures. With this method, it will be possible to measure parameters for usage in simulation models of crash behaviour of spot welded structures, with engineering accuracy. The project resulted in a proposal of a test specimen geometry developed using the proven method developed for adhesive research at the University of Skövde. This test specimen is called Reinforced Double Cantilever Beam, RDCB.

The project is performed purely in computer environment and the physical testing was supposed to follow, but since the project ended prematurely, this was unfortunately not possible. Generally, the simulation work is to be regarded as dimensioning of the specimen geometry and a verification that the parameters assigned to the spot weld are to be able to recover from the simulated test. This has been proven in computer simulations, but unfortunately not in physical tests.

2. Background

Development of simulation modelling technique has long been a prioritised area of research within the automotive industry. Development of an automotive structure must be performed without requiring any physical testing of prototypes. Crash simulation has to be reliable and it should be possible to assess the crash behaviour with engineering accuracy.

Existing simulation modelling techniques for spot welded structures do not reach the desired level of accuracy or reliability, to refrain from testing of physical prototypes. Simulation of fracture of spot welded joints is only possible in special cases today. Only very detailed, and therefore expensive, models show reliable results for single spot welds. Full scale simulation of a complete automotive structure lacks such modelling technique. For efficient simulation of adhesively bonded structures, such as a complete automotive body, simulation technique has been developed at the University of Skövde. The main goal of this project has been to develop a similar element for use in spot welded structures.

3. Objective

The project objective has been to develop a similar, so-called interphase element, as previously developed for adhesive joints at the University of Skövde. This element is expected to work for full scale simulation of complete automotive structures. Moreover, the suggested test specimen shall give the desired material parameters required to calibrate the simulation model to physical tests.

4. Project realization

Computer simulations of a modified test specimen, RDCB, have proven promising. Development of this specimen has given rough dimensions showing the feasibility of this approach. The suggested specimen geometries are expected to give stable experimental results in existing testing equipment. The developed test specimen renders properties in pure peel mode, and it will be necessary to develop a specimen for extracting the properties in shear mode. Analogously with the research on adhesive joining and the RDCB specimen, the future seems prosperous for this area too. A reference model, consisting of a very detailed geometry of a single spot weld between two metal sheets has been performed based on solid elements and a Gurson material model.

5. Results and deliverables

5.1 Delivery towards FFI-goals

Through achievement of the project goals, ensuring the crash simulation capability of spot welded structures, the project will contribute to the overall program goals “development methods”, “materials for more efficient vehicles” and “other closely related areas with potential to strengthen the competitiveness of Swedish automotive industry in a global perspective". Through enabling reliable crash simulation of spot welded structures, the development methods within the automotive industry will be improved. This additionally leads to the possibility of better material usage and optimisation of joints, in a manner not previously reached. These possibilities give the Swedish automotive industry an advantage regarding designing vehicles for optimised passive safety at lowest possible weight.

6. Dissemination and publications

6.1 Knowledge and results dissemination

Knowledge of the power of cohesive zone modelling has been conveyed to the members of the crash simulation group at Saab Automobile AB. Since the bankruptcy of Saab, these members have been scattered to other companies in Sweden like Volvo Cars, Volvo Areo and Saab Combitech. It is plausible that the knowledge will come to use within relevant areas in the development organisations in these companies. Since several companies have been members of the newly completed research project Material- and simulation models for adhesives, MASLIM, where cohesive modelling was explored, the reputation will be efficiently disseminated.

6.2 Publications

Unfortunately, the project has not lead to any publications yet.

7. Conclusions and future research

The promising results from the development of the test specimen geometry leave hope for a new project with new project partners to prosper. As the project was staged, several industrial partners were keen on participating, but unfortunately budget issues lead to a limited project with only one industrial partner. Further research within this area is believed to be fruitful.

8. Participating parties and contact person

Project leader:
Thomas Carlberger, University of Skövde

Industrial part:
Saab Automobile AB