SIMULATION METHOD OF A-PILLAR TRIM AIRBAG TEST
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ABSTRACT

In this paper a new simulation method of Airbag test is introduced. The method is aimed at validation of A-Pillar trim. The FE simulation is based on explicit solver using Abaqus software. Thanks to the simulation potential problems were discovered and non-beneficial design variants were eliminated.

KEYWORDS

Airbag, A-Pillar, plastics, Abaqus, explicit, Python, OpenCV

INTRODUCTION

Each component in an automobile has to pass certain number of tests ranging from a small number to even tens of tests per component. These tests might be rather simple such as assembly tests, but also very complex and expensive such as crash tests. Testing is often performed in a later phase of component development when hardware parts are available. Naturally a wide range of problems might occur during testing which leads to a need for countermeasures. As start-of-production (SOP) approaches the countermeasures are getting exponentially more expensive to implement. In order to prevent this our company developed a new simulation method for A-Pillar trim Airbag test – a test that has been never performed in a virtual environment before which leads to saving of costs in the product development process.

A-PILLAR TRIM

A typical representation of an A-Pillar trim is in Fig. 1.

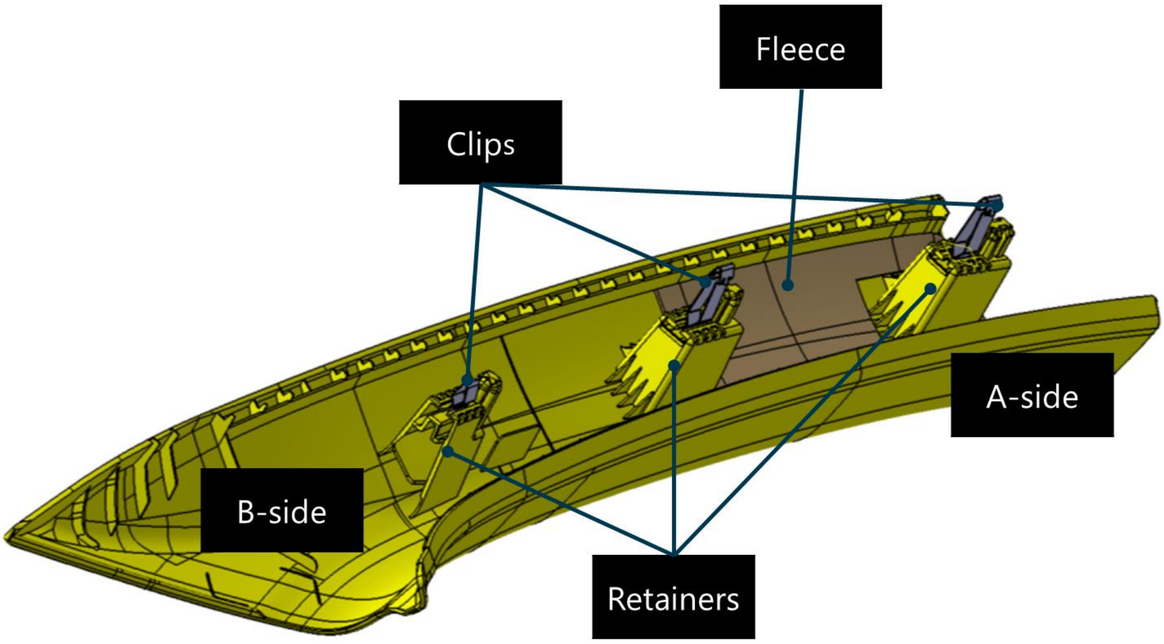

Fig. 1 A-Pillar trim

A-Pillar trim consists of a number of design features. The purpose of clips is to attach the trim to the body in white. Retainers provide housing for the clips. Fleece helps maintaining integrity of the part during low-temperature airbag test. Lastly each trim has a visible A-side and a hidden B-side.

PRODUCT DEVELOPMENT PROJECT SCHEDULE

In Fig. 2 an example of a project schedule is shown. Each project is started with the nomination when a supplier is awarded the project by the OEM. In case of A-Pillar trim approximately after 2 years from nominations there is SOP, an acronym for start of production, which is a crucial deadline which must be kept. Right after nomination the OEM provides the supplier with so called Strak data. These are CAD data of outer surfaces that must be obeyed. According to these A-side surfaces the part is designed. There is a number of milestones over the course of the project and two sets of parts are sold to the customer. Firstly there are prototype parts manufactured in cheaper and less durable aluminium moulds having a longer cycle time as well. These parts are used for initial validation and testing. If a problem in testing occurs during the prototype phase it is still fairly inexpensive to fix. After this phase series parts are produced based on series tools. These tools are very durable and enable shot cycle time which is a key aspect for series production. On the other hand each modification to the series mould is very expensive. Furthermore body-in-white design is frozen at the later stage and more significant modifications are no longer feasible.

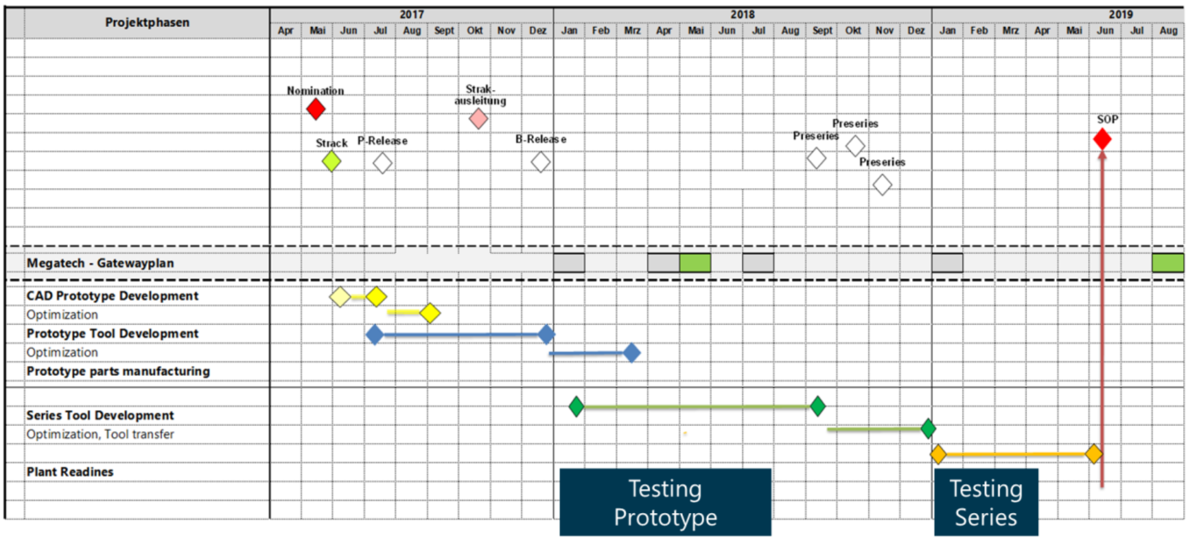

Fig. 2 Sample A-Pillar trim project schedule

AIRBAG TEST

As mentioned above each component in a car has to pass a certain number of tests. For A-Pillar trim airbag test is usually the most critical one. The reason being is that the test is performed at the drastically different levels of temperatures ranging from as low as -35 °C to as high as 90°C as per OEM's standards. For a metal part this would not be such a problem; however, plastic part changes its behavior completely in this range of temperature. From fairly stiff (E = approx. 2000 MPa) and brittle to almost butter-like behavior (E = approx. 500 MPa) at high temperature. A-Pillar Trim needs to stay securely attached to body-in-white without causing any threat to occupants during side crash at the whole range of temperatures which makes it very complicated to achieve.

SIMULATION METHOD OVERVIEW

The method itself is divided into two steps. First a high-speed video record of a hardware airbag test analysed by an in-house developed Python module. The module utilizes OpenCV library for computer vision and image processing. Significant features of the video record are tracked and the output of such process is expansion rate and direction of the airbag and trim part. These pieces of information are used as an input for consequent FE analysis which is performed in Abaqus/Explicit solver.

In Fig. 3 a sample of the Python module output is shown.

Fig. 3 Image processing in Python

In Fig. 4 a material model for the simulation is illustrated. For such demanding application simple datasheet information are far from acceptable. The material samples has to be thoroughly tested at different strain rates so that the dynamic behaviour is correctly captured and at the desired level of temperature. Not only tensile tests are performed to identify material properties but 3-point bending tests as well. Thanks to this test the difference in behaviour between tension and compression is captured allowing us to develop an accurate failure model.

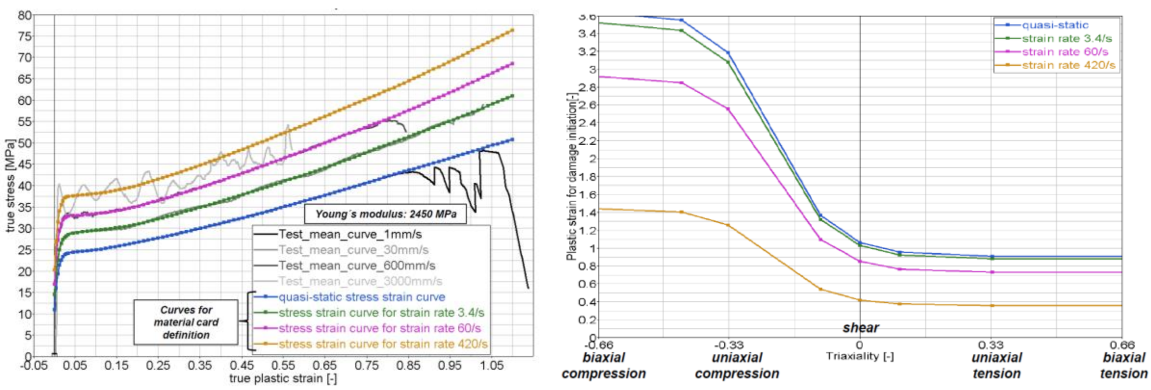

Fig. 4 Material model

CONCLUSION

The newly developed simulation method enabled a unique insight especially in retainer behaviour during curtain airbag deployment. The correlation between hardware test and simulation is more than acceptable as same failure modes are present. This relates to lip opening, bending of clip and damage and buckling of ribs. The implementation of the new simulation method has lead to cost reduction as some of the proposed design variants were eliminated decreasing the number of expensive modifications in series injection moulds.

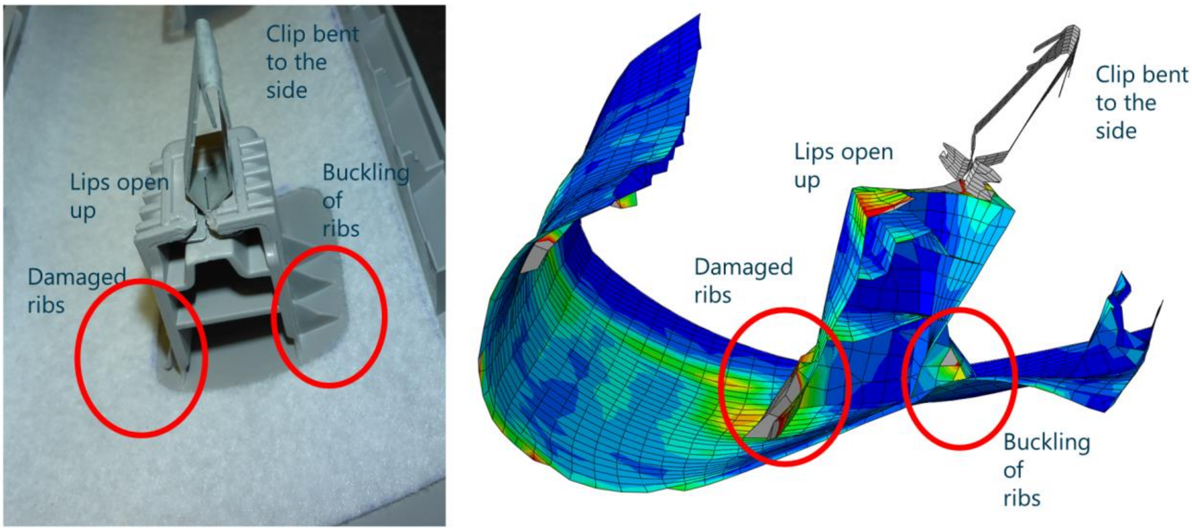

Fig. 5 Correlation between test and simulation

ACKNOWLEDGEMENT
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REFERENCES

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