Seat belt anchorage CAE correlation & Simulation in Radioss

Ashish Kumar Choudhary  
Manager Engineering  
Eicher Polaris Pvt Ltd.  
Kukas  
Jaipur- 302028, India  
akchoudhary1@eicherpolaris.in

Rakesh Grover  
Vice President  
Eicher Polaris Pvt Ltd.  
Kukas  
Jaipur- 302028, India  
rgrover@eicherpolaris.in

Abbreviations: CAE- Computer added engineering, AIS – Automotive Indian standard  
SBA- Seat Belt Anchorage, FEM- Finite Element Method

Keywords Seat belt anchorage, Correlation, Simulation, AIS: 015, RADIOSS

Abstract

Crashworthiness of Seat structure has become an essential Limb of the product development process. This is required to do CAE Simulations in terms of meeting regulatory requirements of seat belt anchorage as well as it has to generate a path to reduce effort and physical testing in design validation. Nowadays it is unavoidable to virtual simulation in the product development process as correlation gives better confidence to go ahead in next level of design iterations.

RADIOSS as an explicit solver provide us a platform to correlate and generate design solutions in this complete process of seat belt anchorage analysis. The focus area of the paper is to correlate physical test and further develop, design solutions to reduce weight and validate structural integrity of the seat structure as per AIS: 015 seat belt anchorage safety regulation. The Paper includes various challenges during correlation with physical test and design iteration to meet safety regulation.

Introduction

Seat belt anchorage is mandatory requirement of vehicle safety, which is governed by Indian Automotive standards. Seatbelts are considered as Primary Restraint Systems, because of their vital role in occupant safety. Driver and Co-driver safety is prime objective in the first row passenger compartment, as most of the crash energies passing through it during crash event. A seatbelt applies an opposing force to the driver and passengers to prevent them from falling out or making contact with the interior of the car [Figure No.1]

To ensure strength of anchorage location of vehicle in three point belt configuration, it must sustain regulatory requirements of AIS: 015. A load curve input with different loading force on torso and lap blocks as per regulatory requirements of AIS: 015. Vehicle Constrained at Chassis Location as shown with red circle in [Figure No.2]
As per the test configuration, a prescribed load 13.5KN is applied in a forward direction at an angle of 10° above the horizontal in a plane parallel to the median longitudinal plane of the vehicle. If one of the anchorage locations mounting on seat than additional load 20 times of seat weight will have to add during the test. So it is better to design seat such a way that anchorages locations of three point seat belt should not come on seat.

The seat belt anchorages must withstand the specified load for not less than 0.2 second. In CAE Corresponding to test configuration, load and boundary conditions applied on finite element model. After the test Plastic strain at anchorage location must be well within the material failure limit.

**Process Methodology (details with figures)**

CAD Data transform in FEM through Hypermesh. Finite element modelling is done using shell elements with appropriate integration points through the thickness. Seat is connected to chassis through bolts which is modelled as solid bolt with appropriate property class. Seat belt is modelled through 2D elements. 1D element is used to pull Lap & Torso block. An average element size of 10mm is used along with the global quality parameters for jacobian, warpage, element minimum and maximum angles, aspect ratio, skew angle etc. Contacts have defined between seat foam to Lap block, seat belt to blocks & anchorage locations. The simulations were performed using RADIOSS explicit solver [Figure No. 3].

Below cross-checks required insuring quality of the finite element modal:

a) Connections: - Through modal analysis all the connections can be checked very quickly. There should not be any missing connection in the modal kindly make sure before going to run seat belt anchorage simulation.

b) Lap & Torso block position: Cross verify the H points of dummy, because if H point is not correct seat belt routing will also not correct. Later will give definitely wrong results.

c) Debugging: Error check is very easy in Hyper-crash and immediately we can resolve it. Import model in hyper-crash and do a quick error check.

d) Material & Property: This is very important check in the analysis must ensure the correctness of these data. In hyper-mesh there is option called Utility component table from where we can easily overlook the component material and property.

e) Contacts: It is playing a measure roll in seat belt anchorage analysis, must be about it. The best way to review all the contacts in either in HyperMesh or HyperCrash.
Results & Discussions:

Correlation was developed between physical test vs CAE in initial simulations [Figure 4], further correlation was improved with the help of Physical test data which includes pictures, videos, displacement curves etc. Design change iterations were performed on correlated modals, Results was meeting regulatory criteria as per AIS: 015. Below Points is represents the focus area during post processing.

a) Energy plot: Internal Energy by part need to verify, which part is absorbing most of the energy during simulation. As shown below an Energy Curve of seat belt anchorage [Figure 5].

b) Plastic strain: It must be within the material failure limit of the component.

c) Anchorages: It must be cross verify in details with respect to plastic strain & displacements.
Figure 5: Energy curve & Simulation results of Plastic strain at center anchorage location

Benefits Summary
Altair Radioss play a vital role to correlate SBA modal and further reduce number of physical tests during design change. Seat belt anchorage simulations provide us a significant input in terms of meeting regulatory requirements, design improvement at anchorage location area etc. There was cost & weight reduction of 1kg achieved after design change implementation.

Challenges
Key challenge was correlating physical test in CAE, Which derives or help new design changes in the seat structure. Center anchorage location was another key challenge because most of the load transferred to this location to meet regulatory requirements; it was the most concern area.

Future Plans
Analogy generates during entire SBA correlation and design change process, will carry forward in second row seat belt anchorage in same category M1 or in different category N1.

Conclusions
A good correlation was observed between physical test vs CAE in terms of deformation at anchorage location. Center anchorage location was meeting regulatory criteria in spite of challenges mention in the process. There was cost & weight reduction applied in the further seat design process which provides us significant improvement in complete exercise.

Acknowledgements
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References
[1] Altair HyperWorks 14.0 Help
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