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FMVSS HEAD CRASH TARGET POINT AROUND BP2 USING FEA SIMULATION

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1.Abstract

In automobile accidents significant fraction of fatalities for passengers is due head injury. Head impact safety is the major consideration where automobile manufacturers are giving high importance for passenger vehicles.

In this paper we describe the CAE technique for the simulation of interior head impact test as per Federal Motor Vehicle Safety Standard (FMVSS 201).Where FMVSS 201 is the standards for occupant protection for interior impacts. This paper describes how we carried out iteration to meet FMVSS standard to reduce Head Impact Criteria value below 1000.

2.Introduction

Road traffic accidents are increasing continuously as number of vehicles increasing with improper road conditions, loss of control, brake failures etc.

The test procedure FMVSS 201 was established to increase protection from head injury in crashes.

FMVSS 201U regulations

- The FMVSS has set the stanadard guidelines to be followed on which the safety of the occupant in the passenger vehicle has to be followed.
- As per FMVSS if the value of head impact criteria is more than 1000 it will cause fatality and vehicle is considered as unsafe.

Head Injury Criteria

- Head injury criteria are a measure of likelihood of head injury due to an impact.
- Normally the variable is derived from the acceleration vs time history of an accelerometer mounted at the center of gravity of dummy head. When the dummy is experiencing crash forces.

  Head Injury Criterion Equation with Abbreviations

$$HIC = \max_{t_1,t_2}\left\{\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} a(t)dt\right]^{2.5}(t_2 - t_1)\right\}$$

Where t1 and t2 are the initial and final times (in seconds) of the interval during which HIC attains a maximum value and acceleration is measured in g's. Note also the maximum time duration of HIC, t2 - t1, is limited to a specific value, usually 15 ms.

HIC (d) =0.75446(Free Motion Headform HIC) + 166.4

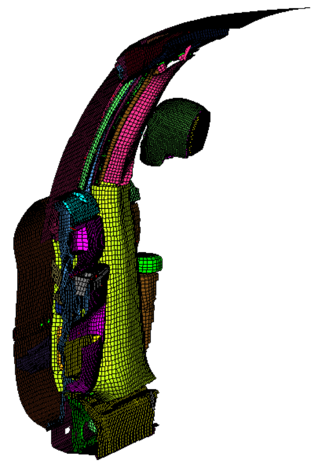

Figure 02

3. Experimental Work

By using the available cad model simulation has been carried out.

CAD Model Overview

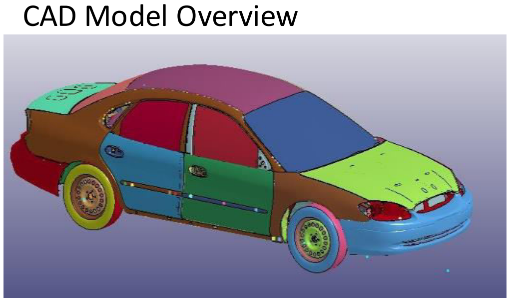

Figure 01

As the model is failing for HIC value as per FMSS standard carried out for points 50mm 3'O clock and 9'O clock of the BP2 points deck has been set according to required areas to reduce the cpu time.

Meshing has been carried out as per the instruction from the simulation experts.

Meshing: Types of meshing carried out are 2d shell mesh, 3d solid mesh and 1d mesh.

Numbering of Parts are done as mentioned below,

Dummy: 1-8

Bpillar:50000001-50000058

Materials: The type of materials used in this simulation are listed below

- Rigid- Mat20
- Deformable – Mat24
- Null- Mat09
- Elastic- Mat01
- Weld- Mat100
- Rubber- Mat07

Vehicle Connections

- Nodal Rigid Body to Connect Deformable to Deformable materials
- Rigid Bodies to Connect Rigid to Rigid materials
- Extra Node to Connect Rigid to Deformable materials
- Spot-weld to Connect two sheet metal components
- Revolute Joint to achieve the revolutionary motion
- Spherical Joint to achieve the Spherical motion
- Adhesives for gluing the plastic components
- Beam Weld to connect Sheet metal components using 1D elements

Initial Velocity:

15MPH i.e. 6.7mm/ms a per USNCAP (United State New Car Assessment Program Regulation)

Units Used:

- Mass in Kg
- Time in ms
- Distance in mm
- Stress in GPA

Free Motion Headform Positioning:

The FMH is made positioned against the Vehicle B Pillar A-Surface using USNCAP FMVSS201U Regulation.

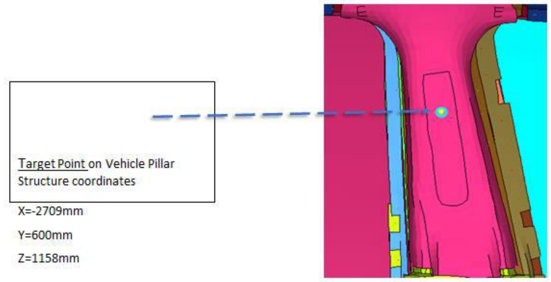

Figure 03

The FMH is made positioned against the Vehicle B Pillar A-Surface using USNCAP FMVSS201U Regulation.

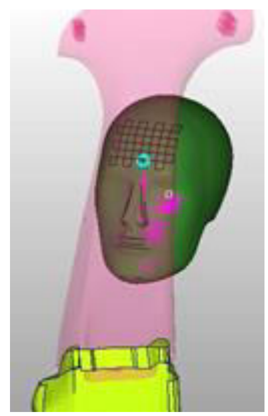

Figure 04

Hit On Head HOH at Primary Touch with the Pillar, Height=16mm Side=55mm at 3'Oclock and 9'Oclock of BP2 point

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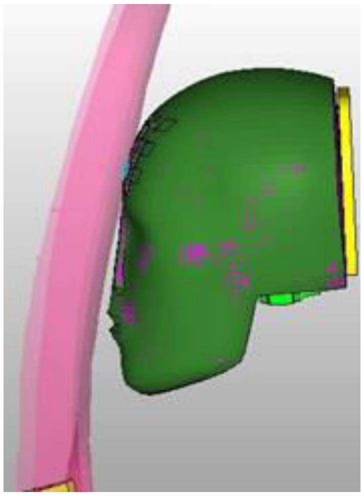

Figure 05

Hit On Head HOH at Shooting Position Shooting Position with the Pillar Height=21mm Side=55mm at 3'Oclock and 9'Oclock of BP2 point

Dyna Deck

LS-DYNA is a general-purpose finite element program capable of simulating complex real world problems.

Full Vehicle is de-contented & trimmed based on required portion of the vehicle to reduce the CPU time

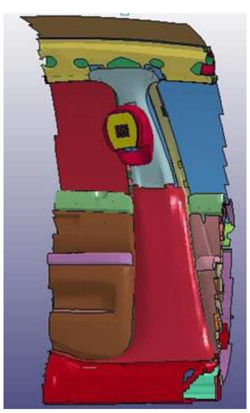

Figure 06

- Current B Pillar structure is not meeting the Regulation with respect to Head loading & Head injury requirement for 50mm 3' O clock and 9'O clock from the BP2 point.
- Iterating the vehicle pillar structure with Energy Absorbers like Honeycomb & Cross ribbing structure or Crash Foam
- Review includes Dummy Loading, Crash Energies, Energies balance, Head Injury, Reaction forces

FMVSS 201U Procedure and Requirements

- Target the vehicle
- Establish vertical and horizontal angles (defined in CFR) for impact
- Select targets likely to be worst-case (based on engineering judgment)
- Evaluate targets for airbag proximity Standard impacts conducted at V = 24 kmph Impacts near airbags conducted at V = 19 kmph
- Conduct test and analyze data

4. Results and discussion

Baseline model_1- 50mm +X from BP2 point

In the base line model no ribs are considered when the head position is 50mm 3'O clock from BP2 point .

Simulation Energies Balance

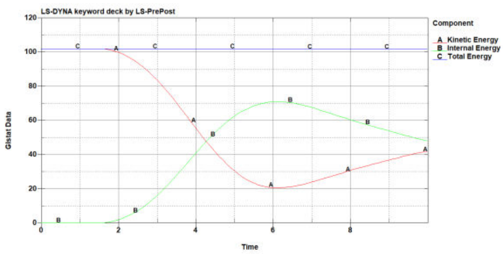

Figure 8

Observation:

- Glstat (Joule) Vs Time (ms) is plotted.
- As the kinetic energy is mirror image of internal energy , global energy is balanced.

Simulation Part Energies

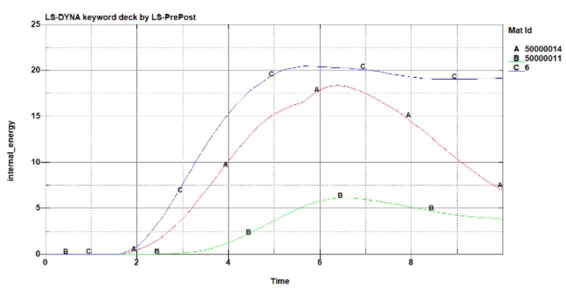

Figure 09

Observation:

Internal Energy (Joule) Vs Time (ms) is plotted.

Maximum crash energy observed in Part ID's --- 50000014 , 50000011 & 6

B pillar absorbing the Energy 50000014 = 18 Joule

Vehicle sheet metal absorbing the Energy 50000011 =6 Joule

Dummy Skull observing the energy is 6=

21 Joule

FMH Injury

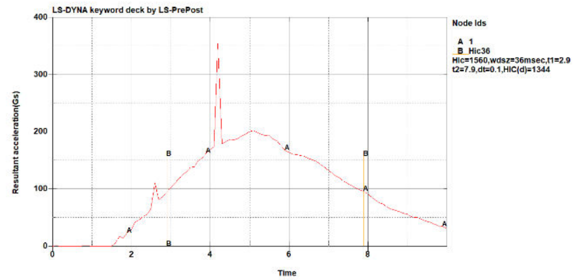

Figure 11

Observation:

Acceleration (mm/ms2) Vs Time (ms) is plotted.

Head Injury Criteria for Dummy (HIC (d)) is recorded at the CG of the FMH is 1344.

Baseline Conclusion

- Global Energies of the trimmed B pillar Structure is Balance
- Trim with BIW component along with Dummy Skull is absorbing the maximum crash energy during simulation
- HIC(d) = 1344, which far more than the USNACP injury limiting value of 1000
- Current B pillar of Ford Taurus vehicle doesn't meet the NHTSA performance requirement
- Next task is to optimize the B Pillar by using different energy absorbers.

Baseline model_1- 50mm +X from BP2 point Iteration1:

In iteration 1 the base line model are added with ribs.

Simulation Energies Balance

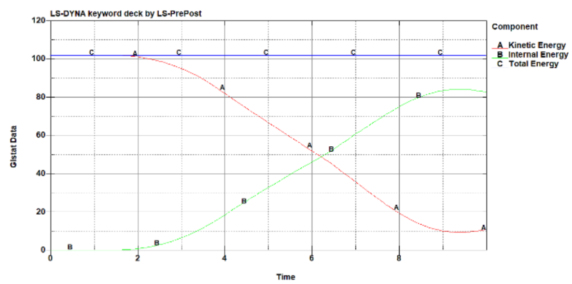

Figure 8

Observation:

- Glstat (Joule) Vs Time (ms) is plotted.
- As the kinetic energy is mirror image of internal energy , global energy is balanced.

Simulation Part Energies

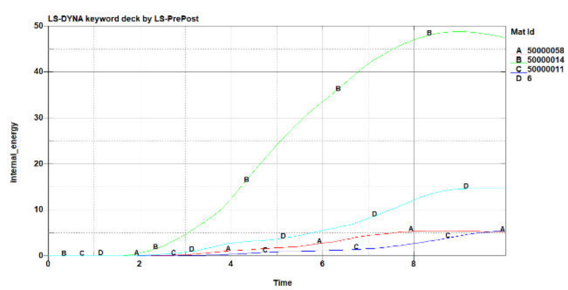

Figure 09

Observation:

Internal Energy (Joule) Vs Time (ms) is plotted.

Maximum crash energy observed in Part ID's --- 50000014 , 50000011 ,50000058 & 6

B pillar absorbing the Energy 50000014 = 49 Joule

Vehicle sheet metal absorbing the Energy 50000011 =6 Joule

Dummy Skull observing the energy 6=15 Joule

Ribbing 50000058=5 Joule

FMH Injury

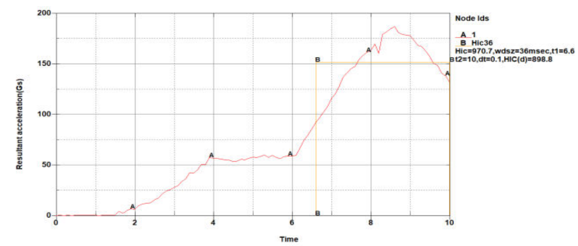

Figure 11

Observation:

Acceleration (mm/ms2) Vs Time (ms) is plotted.

Head Injury Criteria for Dummy (HIC (d)) is recorded at the CG of the FMH is 898.8.

Baseline Conclusion

- Global Energies of the trimmed B pillar Structure is Balance
- B pillar is absorbing the maximum crash energy during simulation
- HIC(d) = 898.8, which is far more than the USNACP injury limiting value of 1000

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Baseline model_2- 50mm -X from BP2 point

In the base line model no ribs are considered when the head position is 50mm 9'O clock from BP2 point .

Simulation Energies Balance

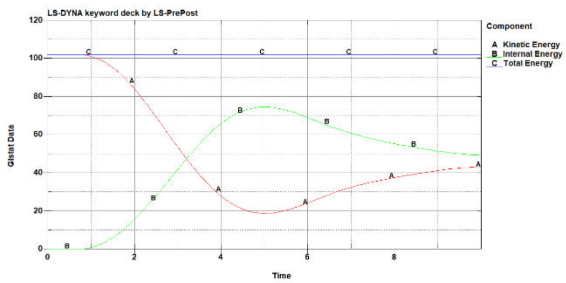

Figure 8

Observation:

- Glstat (Joule) Vs Time (ms) is plotted.
- As the kinetic energy is mirror image of internal energy , global energy is balanced.

Simulation Part Energies

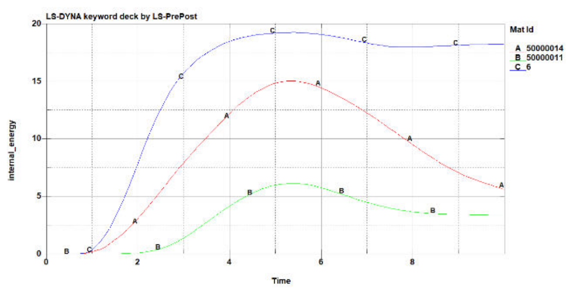

Figure 09

Observation:

Internal Energy (Joule) Vs Time (ms) is plotted.

Maximum crash energy observed in Part ID's --- 50000014, 50000000 & 6

B pillar absorbing the Energy 50000014 = 15Joule

Vehicle sheet metal absorbing the Energy 50000011 =6 Joule

Dummy Skull observing the energy is 6= 18 Joule

FMH Injury

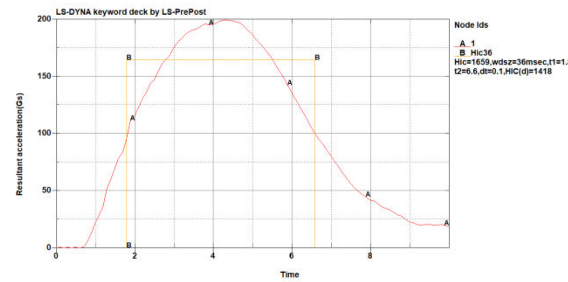

Figure 11

Observation:

Acceleration (mm/ms2) Vs Time (ms) is plotted.

Head Injury Criteria for Dummy (HIC (d)) is recorded at the CG of the FMH is 1418.

Baseline Conclusion

- Global Energies of the trimmed B pillar Structure is Balance
- Trim with BIW component along with Dummy Skull is absorbing the maximum crash energy during simulation
- HIC(d) = 1418, which is far more than the USNACP injury limiting value of 1000
- Next task is to optimize the B Pillar by using different energy absorbers.

Baseline model_2- 50mm -X from BP2 point Iteration1:

In iteration 1 the base line model 2 are added with ribs.

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Simulation Energies Balance

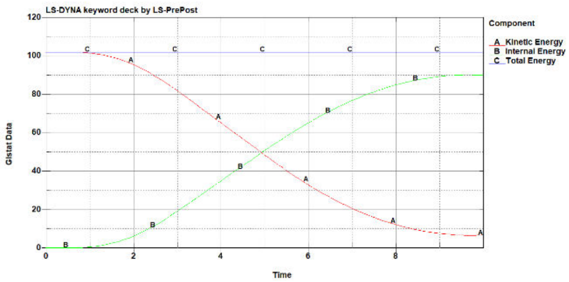

Figure 8

Observation:

- Glstat (Joule) Vs Time (ms) is plotted.
- As the kinetic energy is mirror image of internal energy , global energy is balanced.

Simulation Part Energies

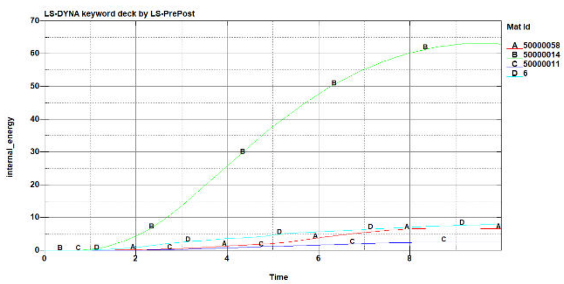

Figure 09

Observation:

Internal Energy (Joule) Vs Time (ms) is plotted.

Maximum crash energy observed in Part ID's --- 50000014 , 50000011 ,50000058 & 6

B pillar absorbing the Energy 50000014 = 63 Joule

Vehicle sheet metal absorbing the Energy 50000011 =4 Joule

Dummy Skull observing the energy 6=8 Joule

Ribbing 50000058=7 Joule

FMH Injury

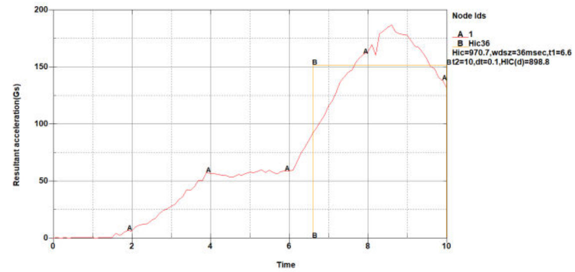

Figure 11

Observation:

Acceleration (mm/ms2) Vs Time (ms) is plotted.

Head Injury Criteria for Dummy (HIC (d)) is recorded at the CG of the FMH is 898.8.

Baseline Conclusion

- ➢ Global Energies of the trimmed B pillar Structure is Balance
- ➢ B pillar is absorbing the maximum crash energy during simulation
- ➢ HIC(d) = 898.8, which is far more than the USNACP injury limiting value of 1000

Conclusion

- Baseline models 1 and 2 of B pillar which are without rib doesn't meet the FMVSS standards
- In Base line models as there are no energy absorbers maximum energy is transferred to head.
- Iterations were carried with ribbing Energy Absorbers.

- After using ribs in the B pillar maximum energies are transferred to B pillar and its ribs so less injury head.

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