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Impact Strength Analysis on Passenger Seat during Crash by Using Hyper Works

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Abstract:

Automobiles are main transport medium in the present days, buses plays a major role in public transport. Bus cabin has so many components among them seats are most important one.Under Federal Motor Vehicle Safety Standards (FMVSS) 210, 207, 222 and 225; automotive and bus seats are tested under extreme conditions to ensure that the seat will not fail and cause human injury. Besides the requirement that the seat not be torn from the floor of the vehicle during a crash (FMVSS 210), the seat must also not be too rigid, or that is to say, we want the seat to act as an energy absorber during a collision (FMVSS 222). Lastly, new bus seats must also be able to support the head impact, knee impact, horizontal bar from front side impact and horizontal bar from reward side impact. To do this kind of different impact tests FEA tool is required. Altair Radioss is highly non-linear solver to do impact tests, before this step we need cad model, after that pre-processing is needed and apply the present running Steel Material to the bus seat frame and check the results. For this thesis the standard FMVSS 222 is selected and the analysis is carried out. Depends on the analysis results the design changes are made using CATIA software, Hypermesh is for meshing the seat frame and solved using Radioss. For post processing Altair Hyperview is used.

Keywords: Bus passenger seat; Impact analysis; FMVSS 222

INTRODUCTION:

Millions of automobiles on the road today, which poses a substantial threat to life, seats which fail in low speed to moderate impact collisions. As a direct result of weak and defective designs of seats and their components, such as seatbacks, recliner mechanisms and seat tracks, thousands of otherwise preventable injuries occur each year in impact collisions, and many involve fatalities as well as Catastrophic Injuries, including brain damage and quadriplegia.

Federal Motor Vehicle Safety Standards have defined several tests that evaluate automotive sub-systems for safety issues in a frontal crash. Standard No.222, “School bus passenger seating and crash protection” gives the basic test procedure requirements.

The study includes the modification with proper safety features. As in India, people prefer economical way of transit, it would be better if we can offer safety in seat design itself apart from seat belts and airbags. In this study school bus seat is analysed by technique called Finite Element Analysis

Federal Motor Vehicle Safety Standard (FMVSS) No. 222 establishes occupant protection requirements for school bus passenger seating and restraining barriers. The purpose of this standard is to reduce the number of deaths and the severity of injuries that result from the impact of school bus occupants against structures within the vehicle during crashes and sudden driving maneuvers.

This standard 222 applies to school buses in two separate classes where Vehicles with a gross vehicle weight rating of more than 4,536 kg under class1 and Vehicles with a gross vehicle rating of 4,536 kg or less under class2.

Main aim of the project:

It is a fundamental principle of automotive safety that vehicles should be designed in such a manner as to reduce or eliminate, as much as reasonably practical, risks of injury associated with foreseeable collisions and impacts.

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The main aim of the project is to accurately simulate, different impacts that a passenger seat undergoes during collision. The various impacts we considered are given below. The finite element simulation of the reference seat is conducted beyond the component level by using a complete seat model formed by integrating the major structural components of the backrest, connectors and base frame.

1) Deflection Test – Forward at Upper Loading Position,
2) Deflection Test – Rearward at Upper Loading Position,
3) Head impactand
4) Knee impact

Methodology:

Geometric Modelling:

A geometric model is used to represent the physical seat. The geometric modeling of the passenger seat is carried out in the Computer-Aided Design-software CATIA which is capable of producing precise solid and surface geometry. The dimensions of the reference seat were measured a close representation of the important geometric parameters to the physical seat were modeled.

Base model:

Fig: base model

Importing and meshing seat model:

After modelling in CATIA it was then converted into <.step or IGES format>, then imported to HyperMesh. By considering meshing parameters required for proper mesh automatic meshing is done in Hypermesh, by keeping Radioss as default solver.

Fig: Mesh model

Boundary conditions and Deck Preparation:

After meshing individual components rigid connections are made at various joining points by one dimensional elements. After that seat was fixed to the bus floor and analysis was carried out as discussed below.

Deflection test forward on upper loading position: The loading bar was created as per FMVSS222 for the deflection test, force of 44.48 N was applied at the upper cross member of the backrest in forward horizontal direction. The results were listed in below table.

Fig: Deflection in forward

Deflection test rearward on upper loading position: For the deflection test 222 N was applied at the upper cross member of the backrest in rearward horizontal direction by loading bar. The results are listed in below table.

Fig: Deflection in rearward

Head impact: A initial velocity of 6.69m/sec was applied at CG of the Head form towards the seat backrest.

Fig: Head impact

Knee impact: knee form was formed by joining cylinder and sphere. A initial velocity of 4.86m/sec was applied at CG of the Knee form in forward. The results are shown in below table.

Fig: Knee impact

Results for base model:

CASE	**BASE MODEL**		
	STRESS (MPa)	DEFLECTION(mm)	PLASTIC STRAIN
Knee impact	404.4	3.346	0.131
Head impact	524.9	2.633	0.223
Deflection Test – Forward	639.2	402.8	0.337
Deflection Test – Rearward	589.7	254.3	0.502

Based on the above results, the seat was re modelled so as to minimise the stress during the impact. The modified seat was shown in the below fig.

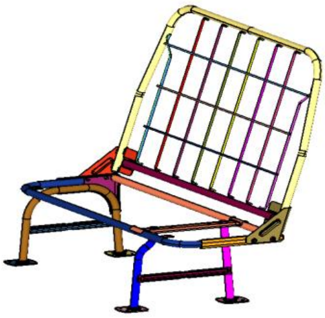


Fig: Modified Model

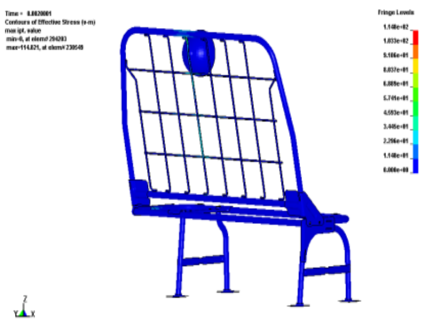
For the modified model again analysis was done which gives satisfactory results under same conditions. The results are tabulated below.

Deflection test forward on upper loading position:

Deflection test rearward on upper loading position:

Head impact:

Knee impact:



Results for modified model:

CASE	Modified Model		
	STRESS(MPa)	DEFLECTION(mm)	PLASTIC STRAIN
Knee impact	113.2	9.396	0
Head impact	114.8	13.86	0
Deflection Test – Forward	484.3	405.8	0.182
Deflection Test – Rearward	380.4	267.6	0.11

Conclusions:

As per the FVMS 222 the seat was carried out for four tests, which were knee impact, Head Impact, Horizontal Bar backward and Forward Impacts. From the above discussions to reduce the stress and plastic deformation the base model is modified based on results. By observing the above results the second model was finalized for the Bus seat manufacturers. The results comparisons are considered for displacement and stresses as the important criteria. For the second model the results were less compared to the base line design. Finally the second design is considered in this thesis

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