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Commercial Passenger Vehicle Seat Design and Testing Using Advance Simulation Procedure

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Abstracts

Advanced manufacturing engineering is an approach to build an object with the inclusion of all technical aspects including durability as well as safety. In automobile manufacturing approach,It can be a great opportunity to save life of occupant if safety parameters were designed successfully. Commercial passenger vehicles can carry several people at a time, and if accident happens, several people can die altogether. These types of vehicle can have collision from different side i.e. front, side, rear etc. Among this directional collision frontal impact is the most severe one. In front impact passenger can get injuries by hitting the seat structure mounted just next front to them. In order to design these seats properly to avoid these injuries, government also enforced some regulations related to seat design. In order to pass the compulsory regulations, properly designed seat has to be sent to the government agency to have to test certificate. Advanced simulation tools can also assist to improve the design with weight optimization. In this study, Finite Element Analysis was used to analyze the load bearing capacity of the vehicle seat. The enforced test was also simulated and final designed was obtained with significant weight reduction and enhanced safety measures of the seat.

Keywords: FEA, Seat model, ARAI Standards, optimization.

Introduction

The Government of India feel the need for a permanent agency to advance the publication of values and development of test amenities in parallel when the work on the preparation of the standards is going on, as the growth of improved safety significant parts can be undertaken only after the periodical of the standard and commissioning of test conveniences. To this conclusion, the Ministry of Surface Transport (MOST) has constituted a enduring Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards arranged by AISC will be accepted by the permanent CMVR Technical Standing Committee (CTSC). After agreement, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, has print this standard. For improved distribution of this information ARAI may issue this document on their Web site. Seats, seat belts, seat belt anchorages etc., are safety significant items for occupant in case of rapid accelerations/decelerations and accidents. Additional, seats and their design, mounting etc. constitute substantially to the ride relieve of the vehicle users. The Indian Standard/AIS have been in place for M1 category of vehicles. The require was felt for such item for covering M2, M3, N1, N2 and N3 type vehicles. Already this has been identified as main concern item in Safety Road Map. Therefore AIS-023 has been formulated to cover these requirements.

Now a day's road condition of India is getting better. Because of this average speed of vehicles also increases. Passenger commercial vehicles are commonly used by people for their conveyance. Because of high speed of vehicles the frequency of road accidents has also increased. The most representative accident types involving this type of passenger carriers are frontal and rollover crash. Every year thousands of people die because of these accidents.

As per Standard Passenger Commercial Vehicle Guidelines, the passenger seating arrangements can be such that seating ability is maximized. There are a number of potential for the array of seats. Passenger seats can be given in crossways, frontward facing pattern or given in longitudinal rows in front of the centerline of the bus. A limited number of backward facing seats can be used with the articulated sanction of the procurement organization. Also it is promising to have a amalgamation of frontward facing and boundary seating planning. The Procuring organization recognizes that ramp site, foot space, hip-to-knee space, seat building etc ultimately affect seating ability and outline.

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The most typical accident type involving passenger commercial vehicles are side, rear, frontal and rollover. Although rollover crashes did not occur very frequently, when they did, the number of gravely hurt occupants was far above the ground compared to other collapse types. In case of a rollover, passengers run the danger for being uncovered to expulsion, partial expulsion, protrusion, or imposition and thus uncovered to a high casualty danger. In manufacturing engineering, every part of the vehicle should be manufactured by assuring the safety of the passengers. This study includes the seat design of commercial passenger vehicles with safety features during accidents.

The study includes the development the seat design 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 single seated seat of commercial passenger vehicle is developed using advanced simulations technique called Finite Element Methods.

Methodology

As physical tests are often expensive and hard to perform for multiple times. In this situation a strong need of an advanced simulation tool is developed. Finite Element Methods is a key player to solve complex and simple experimental methodology by converting them in the form of simulation. Hyper mesh is the product of Altair Engineering is the preprocessor which is widely used to finite element modeling. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. FEA uses a complex system of points called nodes which make a grid called a mesh. This mesh is programmed to contain the material and structural properties which define how the structure will react to certain loading conditions. Nodes are assigned at a certain density throughout the material depending on the anticipated stress levels of a particular area. Regions which will receive large amounts of stress usually have a higher node density than those which Finite element method provides a greater flexibility to model complex geometries than finite difference and finite volume methods do. It has been widely used in solving structural, mechanical, heat transfer, and fluid dynamics problems as well as problems of other disciplines.

The advancement in computer technology enables us to solve even larger system of equations, to formulate and assemble the discrete approximation, and to display the results quickly and conveniently. This has also helped the finite element method become a powerful tool. According to dimension we will prepare the seat model. The steps need to complete this process are given below. Optistruct is the solver of Altair engineering to solve mainly quasi static simulations. In the user profile there are many solvers to solve different analysis. We use optistruct to solve this problem. With the help of finite element anallysis and optistruct we will prepaire model of the seat.there are steps need to prepair model.

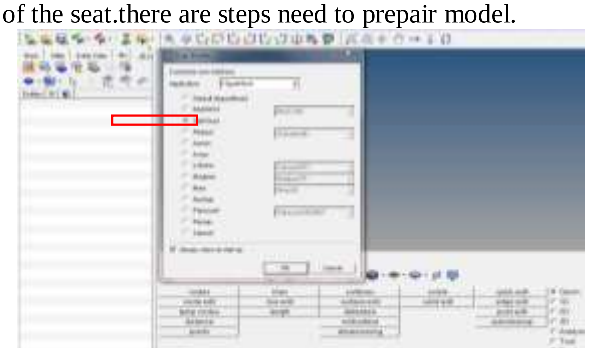

Figure 2.1 User Profile of Hyper Mesh.

Figure 2.2 Substitution of coordinate values

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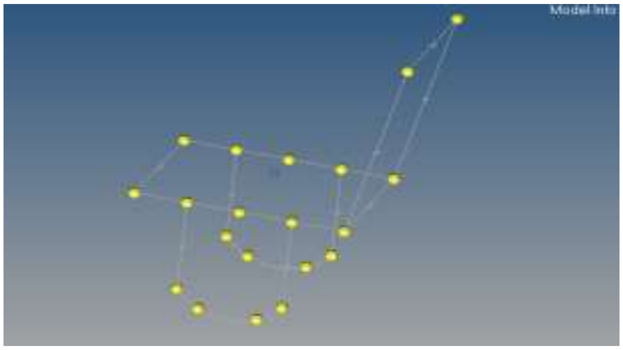

Figure 2.3 Translated nodes

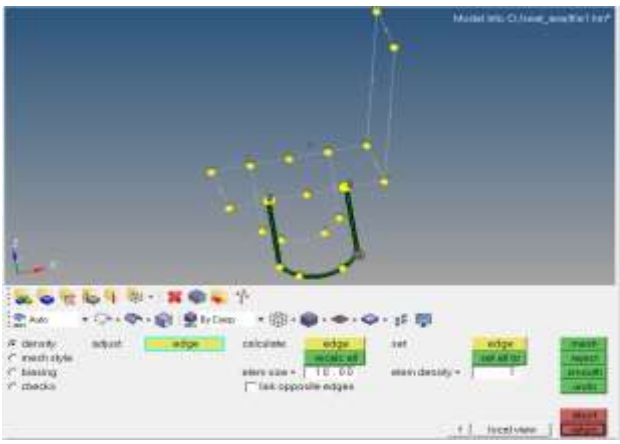

Figure 2.4 Meshing done on one side of seat leg frame

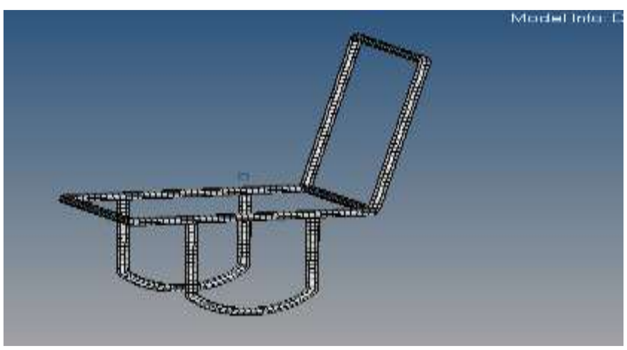

Figure 2.5 Seat structure frame

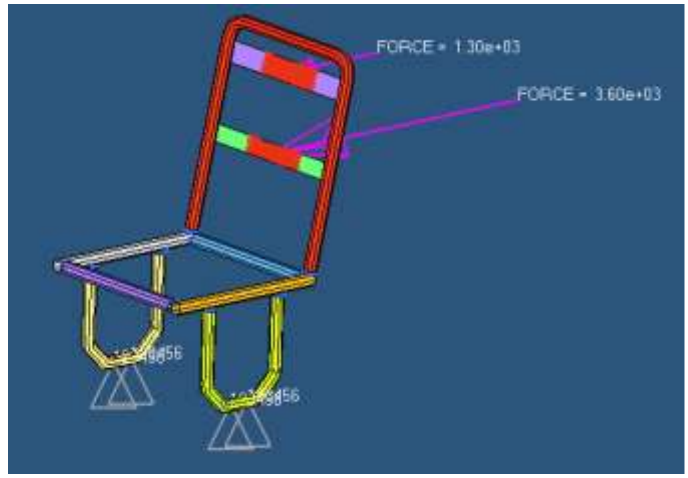

Figure 2.6 Seat frame with applied forces

Design analysis

Analysis of design 1

Design 1 is simulated by keeping all the members and brackets of seat as 5mm. The total weight of the Design was found to be as 15.8 Kg. The deformation of the Design 1 is showing in the fig. 4.1 below.

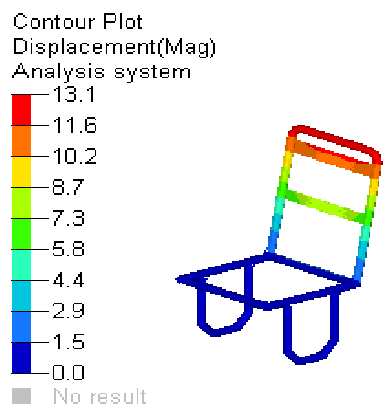

Figure 3.1 Displacement of Design1

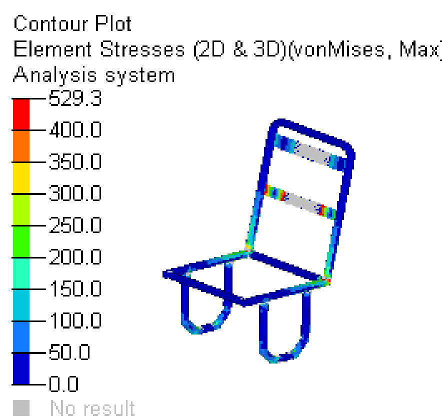

Figure 3.2 Stresses of Design1

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Based on fig. 3.1 & 3.2 maximum deformation of the upper seat back is around 13mm and lower side is about 5mm. As per criteria Design1 is not able to meet the requirement because minimum displacement is not achieved at both the locations.

Analysis of design 2

Design 2 is simulated by keeping all the members and brackets of seat as 1mm. The total weight of the Design was found to be as 3 Kg. The deformation of the Design 1 is showing in the fig. 3.3 below.

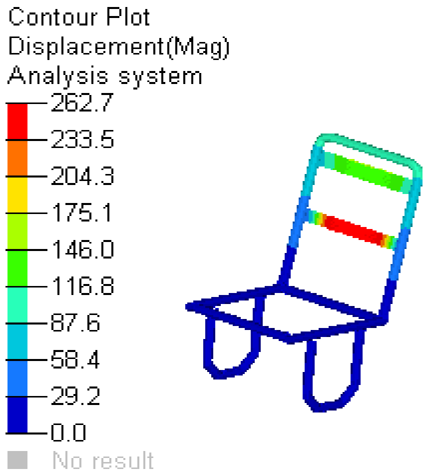

Figure 3.3 Displacement of Design2

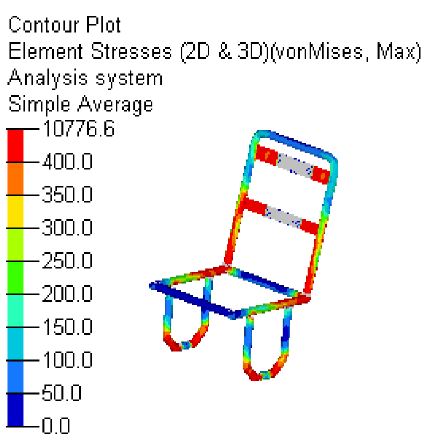

Figure 3.4 Stresses of Design2

Based on fig. 3.3 maximum deformation of the upper seat back is around 146 mm and lower side is about 260 mm. However as per criteria Design2 is meeting the requirement but as shown in fig. 3.4 maximum stresses were very high in the seat members. Because of this high stresses, the Design2 can break during the load application.

Analysis of design 3

Based on stress results of Design 2, member 1,2,3,4 and 5 were facing very high stresses. Following thickness values were assigned to minimize these stresses in design 3.

Member 1:	1.2 mm
Member 2:	2 mm
Member 3:	1 mm
Member 4:	1.2 mm
Member 5:	1.2 mm

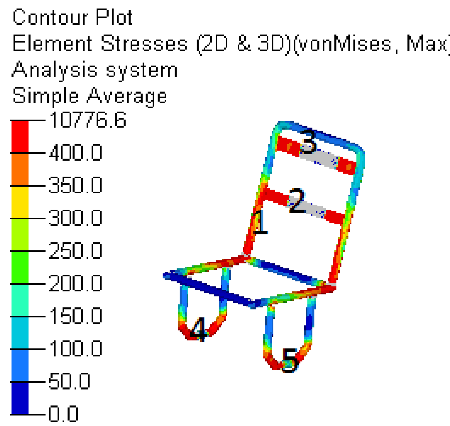

Figure 3.5 Stresses of Design2 (Member locations)

The total weight of design 3 was found to be around 3.6 kg. The displacement at different locations of Design3 is shown in fig. 3.6 below. It is clear from the figure below that upper seat back displacement was found to be around 120 mm while lower seat back displacement is around 66mm which is meeting the test criteria.

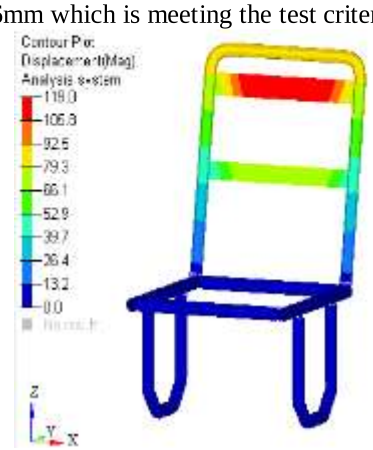

Figure 3.6 Displacement of Design3

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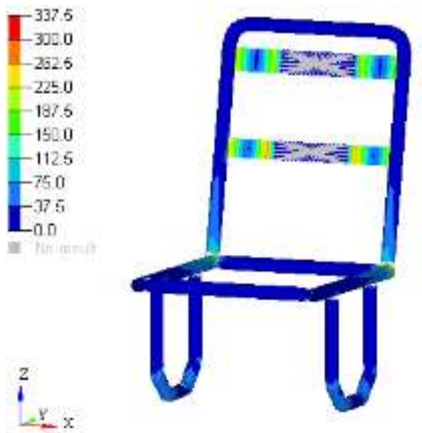

Figure 3.7 Stresses of Design3

Maximum stresses are also found to be within the failure limit of the material.
It can also be seen clearly that with these multiple design iterations, more than 500% weight saving was possible.

Conclusion

The Hyper Mesh software for the testing of the seat model considers both cost reduction and weight optimization. The method involves a set of procedures which include design as well as analysis of the seat model. This technique is used in order to test the component of the automobile as well as for other sectors also. It is also very helpful cost reduction.
After designing the seat model and analysis the weight was reduce to 3.6 Kg and with this method 500% weight saving is possible which can result in an including of less material. Automobile companies invest large amount of money in testing of the seat model. This method can save large amount of resources and cost.

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