VEHICLE SEAT DESIGN STRENGTH ASSESSMENT USING FINITE ELEMENT ANALYSIS (CORNERING EVENT)

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Abstract— *Vehicle seat has great importance as it is the primary component of vehicle that provides comfort to the occupants. The seat should have proper strength and durability in case of accidents of when vehicle passes through bumps. If seat structure breaks, severe injury can be occurred to the passengers. In present scenario fuel consumption of the vehicle should be minimum; hence there is a need to weight optimization of vehicle components without compromising the strength. To check these qualities of any physical components, Finite Element Analysis (FEA) is an imperative simulation tool. In this method CAD model of seat structure is prepared and developed FE model of complete seat assembly. Steel properties were used to model seat members. Passenger mass was distributed to the seat floor and seat back.*

Keywords— Seat Design; Safety; FEA; Optimization etc

1. INTRODUCTION

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.

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 seater seat of commercial passenger vehicle is developed using advanced simulations technique called Finite Element Methods.

2. LITERATURE REVIEW

Seat belts can play an important role to prevent fatalities in accidents. Albertson and others (2006) studied that 128 injured person in rollover accidents. They found that seat belt helped passengers to keep them on their original position. This will reduce the sudden deceleration during rollover crash and reduce the fatalities. Other studies also done by Matolcsy in 2007 and Rona Kinetics in 2002 on rollover accidents. They found that during a rollover, travelers run the danger for being uncovered to expulsion, protrusion, or invasion and thus opened to a high casualty danger.

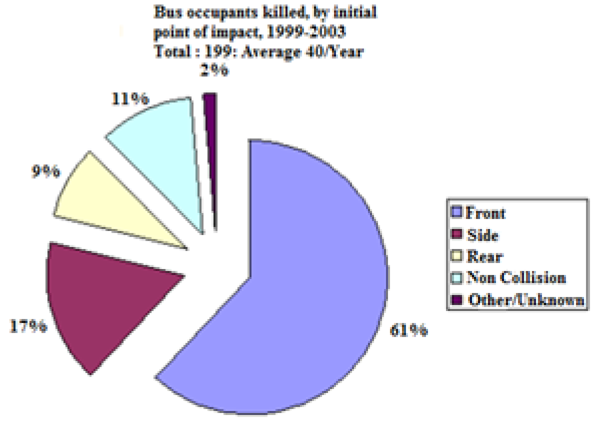

Fig.1 Occupants killed from 1999 to 2003

Mehmet and others performed simulations studies on the effects of seatbelts on these fatalities. Simulation results showed that when dwellers had no seat belt they undergone grave risk of fatalities. Gerardo Olivares performed the study to find the mechanism of fatalities during frontal accidents. They performed s series of tests for frontal impact with crash dummies. The results of this study shown that the most frequent damage mechanisms to bus travelers are head and neck. The main reason behind these injuries is due to the body-body contact between passenger's seats.

3. RESEARCH 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. In this work we select YSt 210 having tensile steress is 210 MPa. As per the Indian standards we developed a seat (for commercial passenger vehicle) using FEA.

TABLE I TENSILE PROPERTY OF HOT FORMED SECTIONS

Sr. No.	Grade	Tensile Strength, min (in MPa)	Yield Stress min. (in MPa)	Elongation, Min (in %)
1	**YSt 210**	**330**	**210**	**20**
2	YSt 240	410	240	15
3	YSt 310	450	310	10

Fig. 2 Seat Arm development in FEA (Step-I)

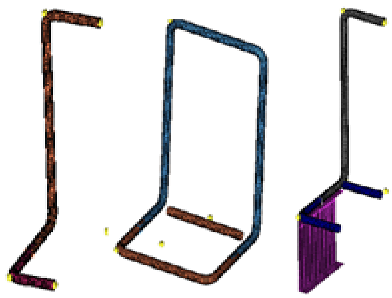

Fig.3 Back Rest Development (Step-II)

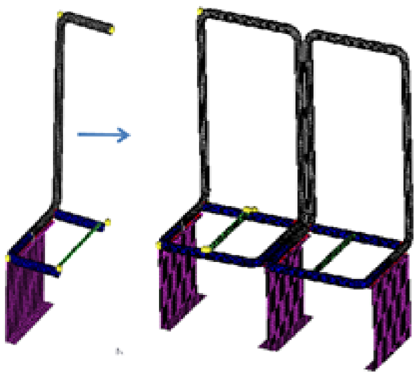

Fig.4 Bottom Rest Development (Step-III)

As we know the following load are considered while design a seat for ant vehicle

1) Passenger weight
2) Load act on Corner
3) Load Act due to Breaking

In this work we only considered Load act on corner i.e. cornering action of seat.

Let us take Passenger Weight (W) =100 Kg= 0.1 Ton

Force=Mass × Gravitational Acceleration

F=0.1×9810

F=981 N

Fig. 5 Cornering Action on Vehicle

A cornering load always acts in lateral direction of the seat as shown in fig. 5.2.5. Then we take slandered load i.e. 0.75*9.81 =7.3575 N and also consider passenger total weight 1962 N i.e. (100*9.81=981N and 100*9.81=981).

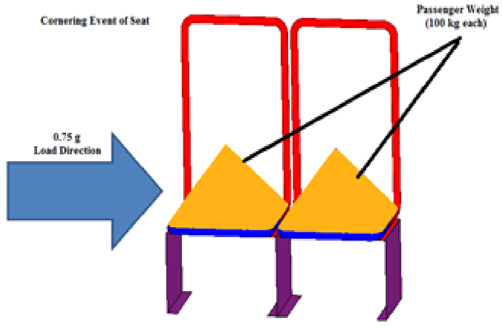

Fig. 6 cornering action on Vehicle

Hear we consider lateral deflection of seat, so only consider X Positive axis i.e. N1=0.750 in FEA. Remaining Y and Z axis are not considered so N2= N3=0 in FEA as shown in fig. 5.2.6.

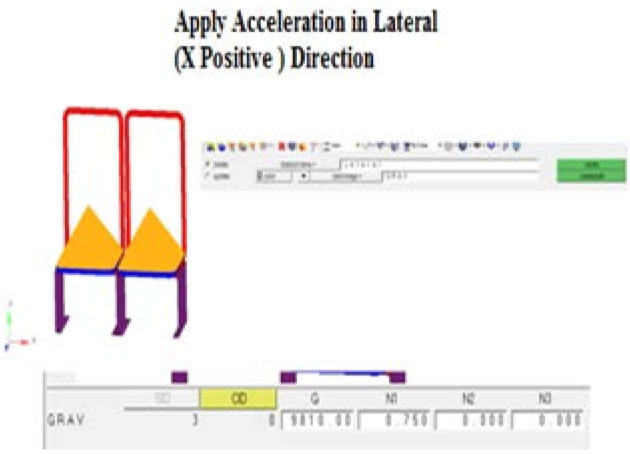

Fig. 7 Coordinate in FEA

A. Application of FEA

Now apply FEA tool using above condition so as a result we found that stress level is 131 MPa (fig. 5.2.7) which is not standard value i.e 210 MPa at seat bracket (as shown in page no. 19). If hear we not done any modification so this is the also one of the cause of failure of seat and as result passenger are injured.

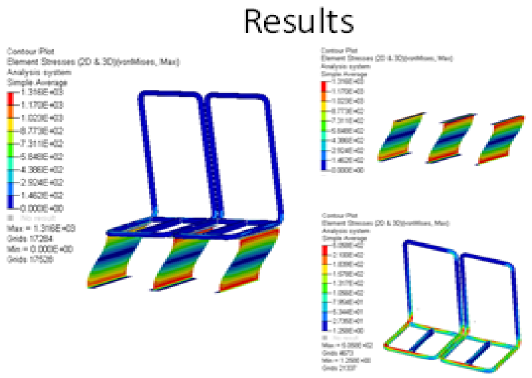

Fig. 8 Result in FEA

Now we change our design for stress level with in the limit. We done two iterations and after that we find that result are in limit.

Iteration First:- In first iteration all bending pipes and bracket are made of same i.e. Yt 210 i.e. σt= 210 MPa and also thickness of material is 3 mm. Strip plate or support plate thickness is 1.2 mm as shown in fig. 5.2.8.

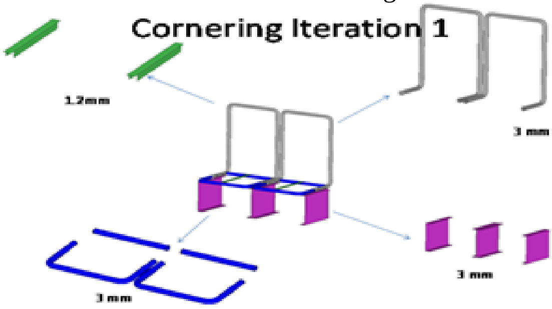

Fig. 9 Iteration First

After applying all above dimensions we find that stress level of bracket is reduce up to the desired level (i.e. 213 MPa) in FEA which is very close to the standard value (i.e. 210MPa) as shown in fig. 5.2.9.

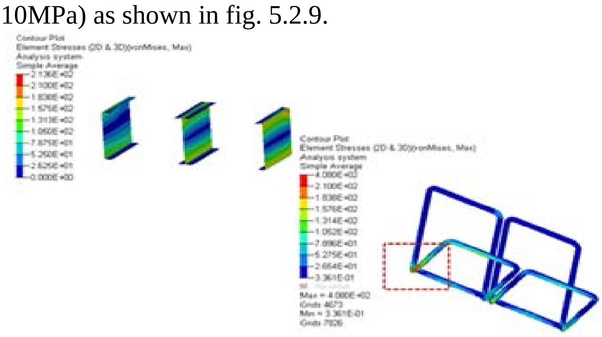

Fig. 10 FEA Result after First Iteration

Iteration Second: - Now one more iteration is applying for optimum design of seat. We change the design of bracket because if we change the design of bracket stress level is not effect and cost is reduce as shown in fig. 5.2.10.

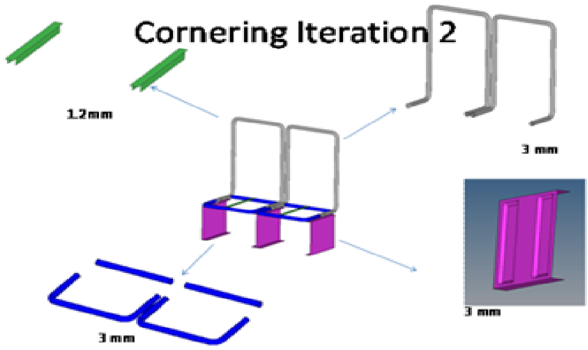

Fig. 11 Iteration Second

Results of second iteration as shown in fig. 5.2.11 all parts of seat is blue i.e. no any part of seat is in red zone and stress level is 236 MPa which is 26 MPa more than slandered value i.e.210 MPa but we optimize seat also so this tolerance will be acceptable.

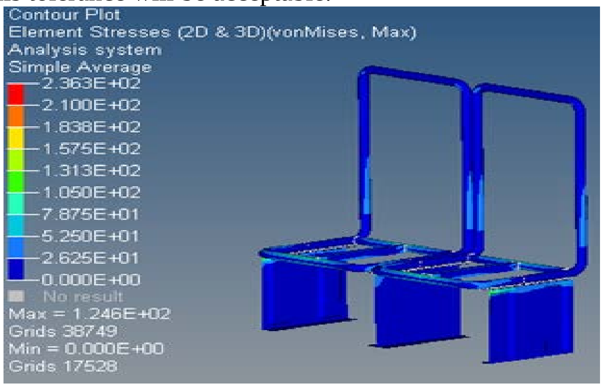

Fig. 12 Result after Second Iteration on FEA

4. RESULTS AND CONCLUSION

The main objective of this research is to assess the strength of seat and safety of passenger, so under the view if this objective the work is done on FEA and using FEA we can say that from the figure 17 the strength as well as material assessment is done under the design rule. So due to this result passenger is safe while traveling.

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