International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 3, May-June-2021, ISSN (Online): 2395-566X

Finite Element Analysis of Vehicle Seat

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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 thru 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. As vehicle can have braking, cornering and bump event while passing on the roads, three load cases were simulated on seat and measured the stresses generated on seat members.

Keywords- vehicle seat, FEA, stress, load, design

I. INTRODUCTION

The vehicle seat has great importance as it is the primary component of the vehicle that provides comfort to the occupants. The seat should have proper strength and durability in case of accidents of when the vehicle passes thru bumps. If seat structure breaks, severe injury can occur to the passengers.

Depending upon type of vehicle and its utility there are numbers of seats can be used in a tropical car there can be this types of seats can be used Bucket seat and bench seat folding seatsA bucket seat is a car seat contoured to hold one person, distinct from a flat bench seat designed to fit multiple people. In its simplest form it is a rounded seat for one person with high sides, but may have curved sides that partially enclose and support the body in high-performance automobiles.

1.1 Structural Components of Seats

The seat structural components are generally made up of structural tubes to maintain good economy and strength. Depending upon the type of seats various structural components can also be used like plates and circular tubes to give proper structural strength and ergonomics. Characteristics of good structure of Seat are Passenger Comfort, Safety as per Govt.

Safety Regulation, Lower cost and light weight, Compact. Structural failure of seats are generally during some crash the structural failure can occur and generally the structure are designed in such a way that it generally avoided to dislocation and rupture of tubes at it place. At the worst case scenario, the structural component might displace from its original position.

Fig.1 components of seats.

II. LITERATURE REVIEW

According to the survey of Ministry of Road Transport and highway transport Research wing presented in a government article on road accidents in India 2017 stated that represents that in India bus calamities 12,088 passengers were killed, 50,686 passengers were injured and consequential 7.8% in total accidents in India [4]. Albertson et al in 2006 [2] found that seat belts playa prior role to prevent fatalities in accidents. They did their study with 128 injured persons in rollover accidents. The came to a conclusion that seatbelt was the major reason to held the passenger in their original position. This reduced the sudden deceleration during the time of rollover crash and reduced the injuries.Matolcsy et al, 2007 [3] and Rona Kinetics 2002 [4] further produced their studies on rollover accidents. They found that during a rollover, travelers run the danger for being uncovered to removal, lump, or incursion and thus opened to a high casualty danger.

When a crash happens, restraint seats are one of the utmost vital constituents for minimizing the injury hazards of occupants. The safety regulations set by different government organizations must be encountered by passenger seats. The occupant must be guarded by the seat from a crash impact; consequently, safety necessities are measured, on the occasion of a vehicle crash the strength and deflection of the seats are tested. Seat structure is subjected to great forces on numerous devices and systems, in those tests. The harm should be repelled by the defined loads by all the components of the seat and anchorages. For structural stability of the seat it must consume sufficient stiffness.

These validation tests must be cleared by each manufactured seat. ECE R80 is one of the important regulations related to passenger seats. [5] To assess the structural resistance and passenger injury hazards, numerous investigators have examined the consequence of the seat and restraint systems as well as structural performance in a crash accident. To appraise the structural resistance and passenger- injury perils Guler et al examined the consequence of the seats and restraint systems as well as the structural behavior in a rollover accident. During a rollover accident seat structures engage substantial energy and help the pillars to yield less distortion as quantified by Guler et al. [6-7]

For the accurate clarification of the seat distortion to properly calculate the movement of the passenger inside the vehicle it is essential to precisely designate the structural behavior of the seat throughout the rollover as specified by Bernardi et al. [8]. Elitok et al. [9] executed ECE R66 analysis with the seat structure to inspect the consequence of the seat structure and specified that the seat structure has a constructive result of about 20% on bending distortion behavior.

Two dissimilar analysis types were compared by Hessen Berger [10] to meet the ECE R14 regulation for passenger seats.Safety necessities gave rise to the effort towards the studies for light weigh design. Hojnacki [11], Polavarapu [12], and Thiyagarajan [13] used finite element analysis and topology optimization to design lightweight automotive seat structures. Their studies discovered that the seat achieves the standards of the ECE R17 safety test with weight reductions of 13%–20%.

Material replacement is the other technique designated by numerous researchers. Yuce [14], Gleich et al. [15] and Bartus et al. [16] accomplished weight reductions of the seat structures using high strength steel and composites. Moreover, these researchers declared cost savings due to high-quality surfaces and reduced part difficulty. Also, the Low Carbon Vehicle Technology Project (LCVTP), the CAMISMA (Carbon fiber-/Amid-/Metallic Structural Interior Component using a Multi-Material Approach) and ACC (Automotive Composites Consortium) are some international projects that directed at light weighting the seat structure. In these lessons, scholars manufactured lightweight seat structures using different materials and manufacturing techniques. Several weight reductions were achieved in these studies without compromising safety criteria [17,18,19].

III. METHODOLOGY

As stated overhead frontal accidents are the most recurrent and hazardous events, this research also comprises the development the seat design with proper protection features. In the literature review unit, it was clear that most of the research were focused on safety restrained systems. As talking about country like India who prefers the economical methods to the solution. It was noted that seat design was way more economical than the use of air bags and other restraint system. In this study we design Vehicle Seat and will perform Durability and Strength Assessment using Finite Element Analysis.

The key purpose of this investigation is to examine and develop the approach to lower the weight of the vehicle by redesigning the seat structure and validating it according to the norms. Plethora of literature reviews were accompanied clarifying the limited present explanations to this problem accompanied by an outline of existing patents. The objective is then to create and design a process for developing the lightest and most feasible design of seat structure. For designing the seat arrangement, it was job in CAD but then to validate the task we need to develop a Finite element validation method.

Sometimes it is very hard and impossible to conduct series of physical tests to assess the safety qualities of vehicle components. Finite Element analysis (FEA) is an imperative tool to simulate and reconstruction of the accidents. The main objective of this study is to develop FEA process to assess Vehicle Seat Design Durability and Strength Assessment using Finite Element Analysis. So this leads to divide our objective in multiple parts.

AIS twenty-three are one of the ARAI standards. This standard includes the design guideline of seats and seatbelts. As Seats and seat belts are safety critical items for occupant in case of sudden accelerations/decelerations and accidents. This standard includes the dimensions and strength guideline for all types of passenger seats.

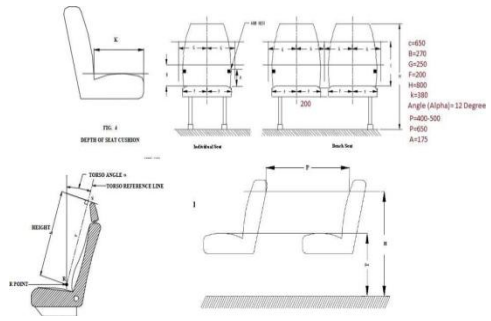

Fig. 2 Seat dimensions

The complete seat model is as shown in fig.

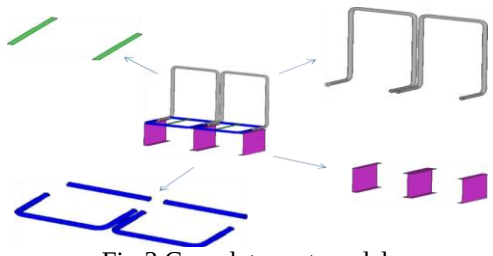

Fig.3 Complete seat model

IV. RESULTS AND DISCUSSION

In this section analysis for following cases is done

1. Stress Model of Design1: Design 1 is simulated by keeping all the members and brackets of seat as 1mm. The total weight passenger applied to be as 100 Kg.
2. Stress Model of Design 2: Design 2 is simulated by keeping all the members and brackets of seat as 2mm.
3. Changing Member of Design3:Based on stress results of Design 1 and design 2 the base plate member section change to c -section.
4. Decrease thickness of Design4: Based on stress results of Design 3 the member thickness 1.2mm apply to seat. the changes of the Design 4 with 1.2mm section thicknesses.

Based on above methods, Maximum stresses are also found to be within the failure limit of the material with lower thickness. It can also be seen that the seat pass in cornering and braking. Table No.1 show the experimental result at different part of seat and all result found below the standard result after applying different iteration on parts of seat.

Table 1 Experimental result at different part of seat

S.No.	Name Of Event	Part Name	Experimental Result(N/mm^2)
1	Passenger Weight	Back Arm	34.95
2		Side Bracket	42.02
3		Bottom Part	32.01
4		Strip(1.2mm)	14.25

V. CONCLUSIONS

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, the strength as well as material assessment is under the design rule. So due to this result passenger is safe while traveling.

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