LMV automobile car seat design for frontal impact- A review

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Abstract- *An automobile seat plays a vital role in the comfort and smoothness of the ride. With the development in the automobile industry, safety of the car has increasingly become an important area of research. In regard with the development of the automobile industry vehicle seat is an important safety component providing a decisive protection to the occupant. Due to this the analysis and design of seat vehicle and impact analysis of a car is the best area of research. In the current study we are investigating on different impacts of an automobile light motor vehicle (LMV) car, LMV car seat design structures, studying in detail about the ECE R17 regulation and also a fine study on different regulation as well related to the design of car seat structure, impact analysis using LS DYNA, and also various analysis done on the seat structure by using ECE R17 regulation. This brief literature survey reviews some of these aspects.*

Keywords- Accidents, Car Seat Structure, crash, ECE R17 regulation, Front impact, hypermesh, LS-DYNA, Seat optimization.

I. INTRODUCTION

A frontal crash is the most common type of crash resulting in fatalities. Major strides have been made in frontal protection. As the automotive technology is developing day by day the speed limit of the vehicle has drastically increased. In order to avoid these injuries safety of the occupant has become a crucial thing.

Our new generation customers are not only looking for power, performance, and attractive design but also more concerned about safety. Vehicle provides many features one of those is the extension of luggage area or trunk space to transport oversized items by folding the rear seat. In past years a lot of safety devices such as air bags, advanced seat belts have been introduced.

In this paper we are reviewing a number of research papers, the main purpose of this paper is to have a detailed study about the methodology of analysing a crash of an automobile LMV car, to study the design and various safety regulations of LMV car seat. Seat safety refers to the ability to prevent vehicle accidents effectively and to reduce the damage to the occupants to a minimum at the time of accident. Research on vehicle seat in a frontal and rear collision mechanism of injury to the occupant can provide theoretical technical support for seat design, research and development. It can improve vehicle passive safety performance in a collision and have a great significance for traffic safety [5].

II. LITERATURE REVIEW

1. LMV sedan automobile vehicle seat design

While designing an automobile LMV car seat it is important to study in detail about the different seat which are presently being used in automobiles, to study the automobile car seat for its various designs and other important parameters like vibration, ergonomics, aesthetics and various safety related design.

Rakesh Singh et al. [1] presented different tools and methods used for optimization of structural properties of seats to reduce shocks while applying brake and further perspective of making suitable changes in design to obtain better results. They also suggested important guidance to the users for the selection of required cross-section properties at different positions. They also presented various reports about optimal design of the car driver seat, considering various aspects like biomechanical, vibration absorption, safety etc. The aim of his work was to design and develop driver seat which is ergonomically satisfied with less weight and is cheap in cost. They invented a new design in which driver car seat lever system is replaced by press button and an automatic seat adjusting lock system used to restrict the movement of the seat. [1]

T.C Fai et al. [2] Described large number of studies and up to date techniques developed for a vehicle seats which are used by different types of transportation systems. His main objective is to describe the state of the art and recent development of vehicle seat design which are existing in current literature and to give a general idea about unsolved

problems that arise in practice. From this literature we can find out that majority of vehicle seat studies are concentrating on vibration, pressure and ergonomics but in this paper the author has also given a glance about the artificial intelligence, medical approach and mechanical research. [2]

Hanumant N.Kale at el. [3] In this paper the author has presented all the parameters of driver seat such as anthropometry of human, ergonomics related parameters, seat materials, safety realted parameters, comfort related parameters as well as weight and aesthetics with classification and basics of driver seat. The authors also suggested different parameters affecting the driver seat design which included vibration, thermal comfort and pressure distribution over the seat. [3]

2. Seat structure analysis using hypermesh and LS-DYNA

In this part a brief study about the frontal car impact is done with the help of hypermesh and LS-Dyna. A brief study about the crashworthiness of the car is done, predicting the behaviour of various car's during a frontal collision.

Tejasagar Ambati et al. [4] had studied on frontal crash test. The objective of his work is to simulate frontal impact crash of an automobile and some of the material of the components with a view to reduce the forces experienced during the crash. The software used for the simulation is LS-DYNA. It is widely used by the automotive industry to analyse vehicle designs. It accurately predicts a car's behaviour in a collision. The results obtained by the simulation were then validated by comparing it with the test results of the same test performed by the NCAC (National Crash Analysis Centre). [4]

In further research Yali Yang at el. [5] Elaborated that seat is one of the most important part for occupant safety during impact. In order to improve occupant safety during impact, the research on the seat structure optimization in front and rear impact is conducted in this paper. Basically dummy seat finite element simulation model was established and analysed by using hypermesh and LS DYNA and further analysis was conducted to determine the performance of seat in dummy protection during front and rear impacts. Results showed that the structure was needed to be modified to ensure passenger safety. [5]

S. Heimbs at el. [6] Studied the crash behaviour of the nose cone as the F1 racing car front impact structure. In this paper the authors have tested that the nose box is able to dissipate the kinetic energy involved in the crash and the driver is protected from the injuries. The test sled strikes the immovable steel plate mounted on a huge concrete block. The mesh is generated in hypermesh, element size was kept as 3mm. Almost all the elements of the nose box are eroded in a continuous crushing process. A fair correlation with respect to qualitative and quantitative results could be obtained with this model. [6]

Haining Chen at el. [7] Used HYPERMESH and LS_DYNA software to establish a dummy seat finite element simulation model. Analysis was conducted to determine performance of seat during front and rear impact. The main purpose of this paper was to analyse the performance of the seat and the improvement and optimization of the structure, thus improving the dummy injury indicators, hence providing effective protection and also providing a modern seat design and passenger protection evaluation. Results showed that structure was needed to be modified to ensure passenger safety. The seat structure was optimized and improved. [7]

During further research on car frontal collision Chunke liu at el. [8] Created a finite element model of a car by using hypermesh software. LS DYNA software was adopted in order to calculate the deformation of the car and the acceleration time history curves during the crashing process. The results showed that the front longitudinal beams don't have enough strength to prevent bending deformation. The dash panel invasion and front longitudinal beam deformation was effectively improved by changing their thickness. [8]

3. Analysis using ECE R17 regulation

In this part typical study about the conditions where ECE R17 regulation is used being done. A brief study about the ECE R17 regulation and its use while designing a seat and having a frontal crash is being done in this part.

Hruskumar G Donde at el. [9] According to the authors ford automobile company wanted to redesign the rear seat with major feature enhancement, they wanted to convert the 60-40 rear seat configuration to 40-20-40 configuration. The engineers redesigned the seat accordingly and had to test it using the ECE R17 regulation for the seat to pass the luggage retention test. The initial design of the seat failed as the mounting brackets failed due to the luggage hit and the tube crumbled as well. The model of the seat was refined to include all the design modifications, material changes, mechanism etc. The performance was again evaluated using LS DYNA simulation and the results were found to be safe. [9]

Vincent Laurent al et. [10] In the research work they have constructed seat back frame over molded Short Fiber Reinforced Thermoplastic (SFRT) on continuous fiber reinforced Thermoplastic (CFRT) inserts are described. CAE tools using LS-Dyna were developed to model accurately the rear crash and Luggage retention behaviour. Design validated through CAE analysis were used to cut the tool and build the prototype parts. Physical Tests on prototype parts confirmed good correlation between Test and FEA. [10]

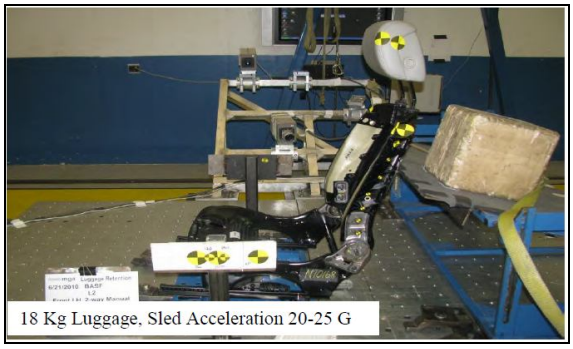

Figure 1. luggage retention test set-up [10]

Ronald Vroman et al. [11] on behalf of ANEC (2003) studied the testing of Rear seat in the Cars. The authors have analysed the car seat based on two condition ECE 17 pulse and luggage and the other one realistic pulse and luggage. They tried to highlight shortcomings in current legislation concerning rear seat strength in cars. By testing different designs of current production models tried to demonstrate that in the existing car fleet there are differences in performance and that mode demanding requirements are needed and achievable ANEC will use the test results to lobby the European Commission, EuroNCAP and UN-ECE GRSP and WP29, the international committee dealing with car safety, in order to achieve more severe test specifications for rear seat strength. [11]

Prasad Kangralkar at el. [12] in this paper study of cargo barrier is done using ECE 17 test. The cargo barrier is placed behind the second row seat. Cargo barrier is to provide the ultimate protection under the most demanding driving condition. To meet the ECE R17 regulation, movement of the seat when the blocks impact the cargo barrier was observed. If the seat doesn't cross the transverse plane, the regulation is met. [12]

4. Current research on vehicle crashing and other regulation

In this session we are studying the various regulation which can be used other than the ECE R17 regulation while designing a car seat.

In a case study done by Dhananjay Shinde at el. [13] a seat model of Toyota yaris sedan vehicle was taken from the national crash analysis centre (NCAC). Seat is modelled and analysed using hypermesh and LS Dyna software's respectively as per standards recommendation. The seat was fine meshed during the modelling, small welding's of the seat part was also carried out. Modal analysis of the seat was also done and frequencies of different parts were known by doing the modal analysis. [13]

In an approach to enhance the strength of driver seat as per federal motor vehicle safety Mulla Salim Husen el at. [14] Performed the analysis on the seat to check the seat belt system and anchorages. Seat is modelled and analysed using hypermesh and LS Dyna software's. The seat did not meet the required criteria as seat tracks were showing strain more than permissible one. Accordingly the material and the design was changed and after a number of iterations the seat model was claimed safe. [14]

III. CONCLUSION

The frontal collision is the most common type of accidents causing fatalities. The car seat plays a vital role in the safety of the occupant during a collision. The seat should be designed considering the parameters discussed in paper [1], [2], [3]. The crashworthiness of the car must be improved so that the car observes high amount of kinetic energy during a crash. The seat must be so designed that it restrains the kinetic energy coming on it during a collision. The impact of the luggage can damage the car seat and contribute to more risk of fatalities. As per study till date the researchers have done analysis on car seat considering frontal, rear impact and also luggage retention for second row seat. Damage to the occupant can be more severe when a luggage is kept behind the seat during a crash. The seat can be designed considering a scenario of frontal impact when a luggage is kept behind the seat.

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