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DESIGN AND ANALYSIS OF INNOVATIVE SEATING SYSTEM FOR SAFETY PURPOSE IN AUTOMOBILES

Chukka Bhagavan Naidu[1], Palleti Sadhana[2]
[1]*Student, Avanthi institute of engineering and technology*
[2]*M.tech, Assistant Professor, Avanthi institute of engineering and technology.*

Abstract— **Most of the injuries that happen in an automobile accident happen due to the impact of the passengers with the front dashboard and steering wheel. This is the case in head- on or bumper to bumper crashes. The driver will get struck in the chest are by the steering wheel causing grievous internal injuries. These injuries are fatal in most cases. To prevent such fatal injuries we have come up with an innovative design. The design consists of a mechanism that will sense the impact and then automatically move the seat so that the driver is protected from the crash. In this project we shall design a seating system that will be fitted with a kinematic mechanism that will change the seating position automatically when the sensors get activated. The sensors are proximity sensors that monitor the distance of the front bumper. In a crash the bumper is the first impact object. When this bumper is pushed back the proximity sensors will send a signal to the kinematic mechanism. The sensor triggers the mechanism which moves the seat so that the occupants are saved from injury.**

Index terms— **Strss, strain, deformation, seatframe, lumber supports, hip joint seat components.**

I. INTRODUCTION

Automobile (or car) – wheeled passenger vehicle that carries its own motor. A car is a wheeled, self-powered motor vehicle used for transportation and a product of the automotive industry. Most definitions of the term specify that cars are designed to run primarily on roads, to have seating for one to eight people, to typically have four wheels with tyres, and to be constructed principally for the transport of people rather than goods.

The year 1886 is regarded as the birth year of the modern car. In that year, German inventor Karl Benz built the Benz Patent-Motorwagen. Cars did not become widely available until the early 20th century. One of the first cars that was accessible to the masses was the 1908 Model T, an American car manufactured by the Ford Motor Company. Cars were rapidly adopted in the United States of America, where they replaced animal-drawn carriages and carts, but took much longer to be accepted in Western Europe and other parts of the world.

Cars are equipped with controls used for driving, parking, passenger comfort and safety, and controlling a variety of lights. Over the decades, additional features and controls have been added to vehicles, making them progressively more complex. Examples include rear reversing cameras, air conditioning, navigation systems, and in car entertainment.

Most cars in use in the 2010s are propelled by an internal combustion engine, fuelled by deflagration of gasoline (also known as petrol) or diesel. Both fuels cause air pollution and are also blamed for contributing to climate change and global warming. Vehicles using alternative fuels such as ethanol flexible-fuel vehicles and natural gas vehicles are also gaining popularity in some countries. Electric cars, which were invented early in the history of the car, began to become commercially available in 2008.

Most previous seatback design recommendations have been based on physiological rationales intended to reduce lower-back stresses.

In this report, only those findings that directly affect the specification of the seatback contour are discussed. These include:

Preferred postures, defined by body segment orientations, differ widely among subjects. In particular, pelvis angle and net spine flexion relative to standing vary considerably.
Most seated back contours in preferred postures are nearly flat for about 180 mm above the point of maximum lordosis, even with the large range of posture variability observed.
The mean location of the point of maximum lordosis in the lumbar back contour is about 144 rnrn above the sitter's hip joint centers.
The mean preferred lumbar support apex location is about 152 mm above the sitter's hip joint centers. . The mean hip joint center location is about 7 mm above the manikin-measured seat H-point for lumbar support conditions for which the H-point can be reliably measured. Adding 7 mm to the values reported above, the location of the maximum prominence of the back contour and the mean preferred lumbar support position are 151 and 159 mm above the seat design H-point, respectively. These values are rounded to 150 mm and 160 mm for purposes of this report

1.1 BASIC SEAT COMPONENTS.

When designing a new seat system it is important to understand the current system, and a good way of understanding this is to describe the different components in the system and what functions theyperform. Because this thesis focuses on the driver's seat the rear seats are not included in this system analysis. The subsystem 'Front Seats' consists of two seats, the driver's seat and the passenger seat. The driver's seat is often the heaviest as it encompasses additional comfort features such as power assisted adjustments and lumbar support. The subsystem shall provide all customers, for which the cars are designed, with the ability to adjust the seat manually or electrically to ensure that an ergonomically correct driving position is possible. It shall together with the seat belt, and side airbags protect the occupants in the event of an accident. In this section a breakdown of this subsystem is explained.

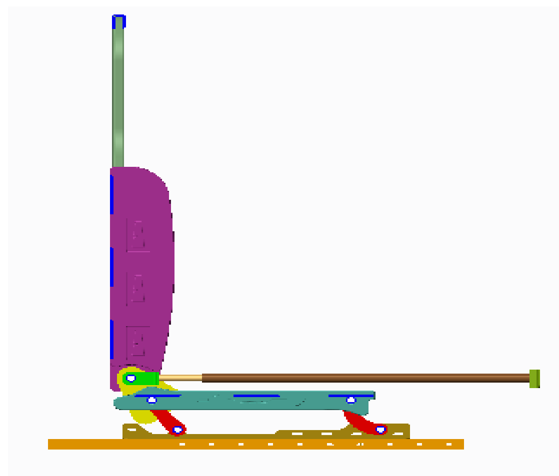
1.2 Vehicle Ergonomics

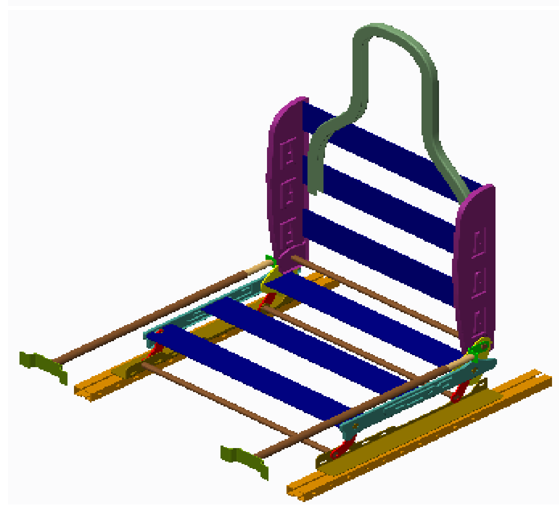
Ergonomics satisfies the condition of occupational health and safety, productivity, comfort and discomfort. Ergonomics is the application of methodical philosophy, method, and statistics careworn from a range of discipline for the maturity of engineering system in which individuals play a noteworthy responsibility.[Bridger,1995],[Grujicic 2010],[Kroemer,1994]. The Institute for Occupational ergonomics (IOE) (1999) defines ergonomics as an research or work philosophy to understand the requirements, restrictions, and abilities of people in the consideration of safety and comfort, and the use of this understanding for the design of products and environments in which people live.[IOE,1999]. Japan ergonomics society defines that Ergonomics Association between "Labors" and "health", in other words, the kinds of "health issues" caused by "working" was frequently reported even in the time of earliest Egypt and the Greek and Roman period[JES], [SAE standards J1100 ,2001]. Ergonomics study of wily equipment and devices that make fit for the human body, and that gives you more comfort and desirable seat. The Ergonomics is the study of the dealings between people and apparatus and the factor that has an effect on the interface for the seat. Its purpose is to improve the performance of systems by improving human machine interaction. This can be done by designing-in a better interface. Consumer expectation for automobile seat comfort continues to rise. Main aim to improve the interface between occupant and vehicle.[Kulkarni,2011]. It can be happened by designing-in a superior interface. It is very important to enhance the user probability for auto vehicle seat comfort continues to get higher. In a present scenario in the industrialized the human race, sitting is the largely common working posture and perchance the generally frequent leisure posture.[Looze ,2013] For the driving comfort, it is well-known that inhibited sitting postures be capable of lead to discomfort and health disorders regarding to whole body posture like Back pain, neck–shoulder complaint.[Rakesh,2013].According to (The International Ergonomics Association Ergonomics) in the account for human factors, is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. The International Society of Automotive Engineers (1998) is a professional organization for mobility engineering professionals in the aerospace, automotive, and commercial vehicle industries. The Society is a standards development organization for the engineering of powered vehicles of all kinds, including cars, trucks, boats, aircraft, and others. A scientific loom, for the benefit of ourselves and others in the consideration of minimum effort and maximum fulfillment.

Vehicle Seat Body-"Seating Comfort and Discomfort"

Seat cushion or seat pan ,seat back rest ,head restraint seat length and seat height established a overall seat model or when we talks about the seat then its study indulge with the seat cushion seat back and seat head restraint. These are the body parts of the seat The joint, which have been showed the links between these bodies are having connection between seat pillow and its atmosphere, one for the link between seat cushion and seat back, and one for the bond between seat back and head restraint modification in the seat back angle and head restraint angle allows by these joint according to the need, but, in adding up, correspond to the hardness of the associates between seat cushion– seat back and seat back–head restraint. [Rakesh, 2013]. Various studies have investigated the relationship between seat characteristics and seat comfort. Foam thickness and foam hardness were important parameters for seat comfort. Physical characteristics of seats to subjective seat comfort. The seat comfort obtained from cushion occupant feelings and body pressure distribution, and a linear spring characteristic was recommended. [Griffin, 2001]. During the proper design of vehicle seat we concentrated on some important factors that are mainly Backrest angle, cushion edge, Fore-and-aft position, Headrest angle, Headrest level, lumbar position, seat depth, seat depth, seat height, cushion tilt, turning seat.

1.3 KINEMATIC MECHANISM USED IN THIS SEATING SYSTEM





Individual parts of the seatframe such as
1.BASE FRAME
2.BASE LINK
3.BASE FRMAE ASSEMBLY
4.BASE REAR LINK

5.BASE FRONT LINK
6.FRAME LEFT MEMBER
7.FRAME RIGHT MEMBER
8.REAR LEFT SIDE SUPPORT
9.REAR RIGHT SIDE SUPPORT
10.REAR SIDE LINK
11.REAR BRACKET
12.SEAT FRAME ASSEMBLY
13.TELESCOPIC_CYLINDER ASSEMBLY
are designed individually by using the designing software package CREO PARAMETRIC 2.0

II. REVIEW OF LITARATURE

Minakshi Das: in his paper stated that the 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.

Mohan D Karambe: in his project states that this project deals with the analysis of seat backrest of car. Computer aided design and finite element analysis are essential in order to predict accurately for the safety performance of automotive seat in an event of crash. In this work, finite element analysis is used to evaluate the strength, deflection and maximum stress characteristics of a reference automotive seat in an event of vehicle rear impact. The safety function is measured based on a backrest moment test in accordance with (ECE R-17) regulations and FMVSS 2O7 regulations which is particularly for rear impact.

Rakesh Singh: in his study discussed that to design and develop a comfortable driver's seat, cheaper in cost and adds value to the customer is an important issue in an automotive industry. It is tough to design such a driver car seat. However, taking account all these things many researchers have put effort to design and developed a driver car seat considering various aspects (e.g. Biomechanical, materials, vibration absorption, safety etc.) which provides more comfortable value to driver with safety and operational durability, but still having a chance to do improvement in design and material to get an ideal designed driver car seat.

D.A. Wahab: in his study stated that Today, intelligent safety systems are installed in modern cars in view of minimising road hazards. An intelligent air bag system for example, comprised several subsystems that are integrated to include the weight sensor system, image sensor system, crash sensor system and tyre pressure monitoring system. These systems when poorly positioned into the car seat, will certainly affect comfort and reliability of the car seat.

III. ANALYSIS OF SEATFRAME:

BOUNDARY CONDITIONS:

The boundary conditions for the Seat at 90 deg position is as shown in the Fig.

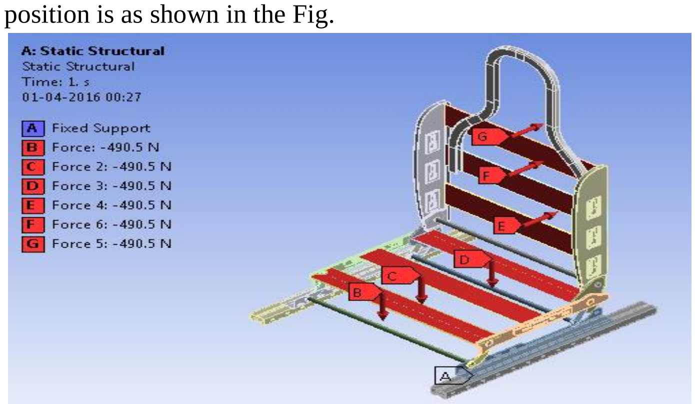


Fig. 3.1 Boundary Conditions of the Seat at 90^0 position

Load acting on the seat

W = 150 kg

F = W x 9.81

F = 150 x 9.81 =1471.5 N

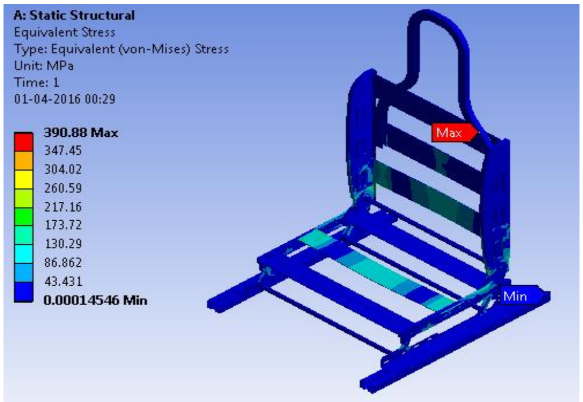
Force acting in downward direction per plate = 1471.5 / No. of plates

F = 1471.5/3

= 490.5 N

3.2. ANALYSIS OF EQUIVALENT STRESS

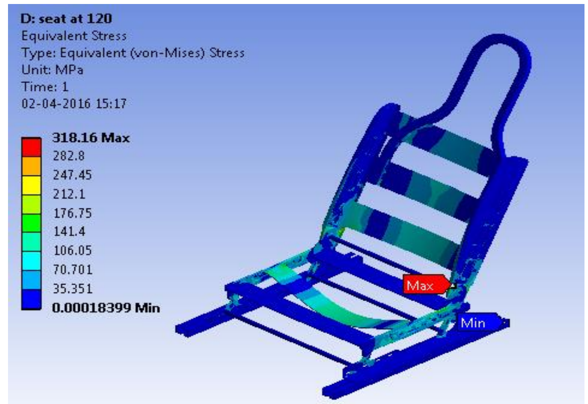
3.2.1 Equivalent stress at 90^0



3.2.2 Equivalent stress at 100^0

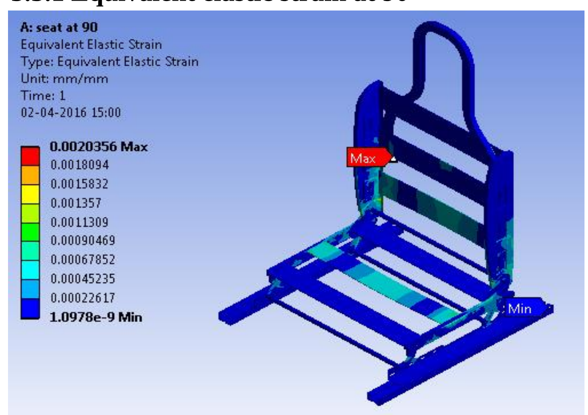
3.2.3 Equivalent stress at 110^0

3.2.4 Equivalent stress at 120^0



3.3 Analysis of Equivalent elastic strain:

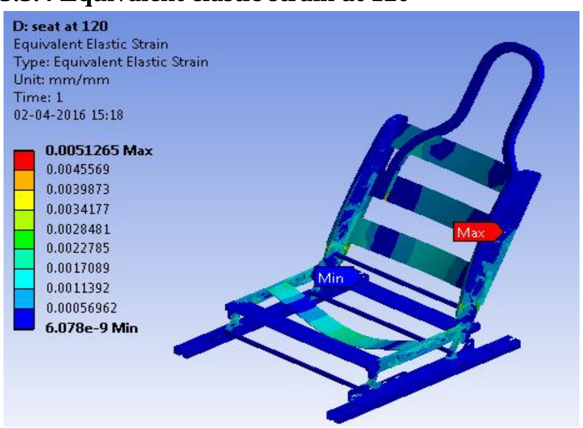
3.3.1 Equivalent elastic strain at 90^0



3.3.2 Equivalent elastic strain at 100^0

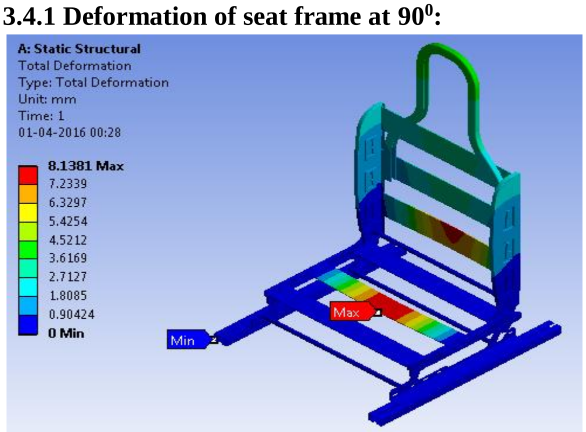
3.3.3 Equivalent elastic strain at 110^0

3.3.4 Equivalent elastic strain at 120^0

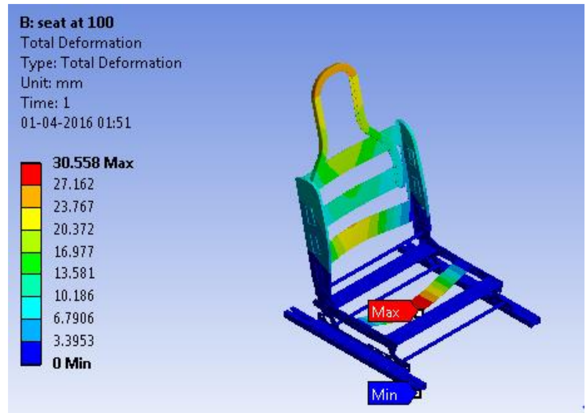


3.4 DEOFRMATION:

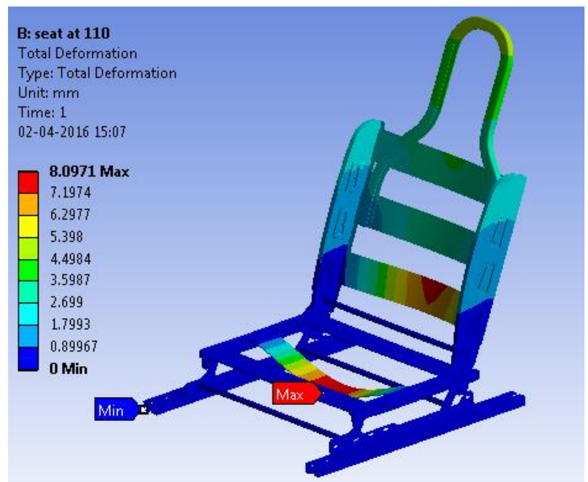
3.4.1 Deformation of seat frame at 90^0:



3.4.2Deformation of seatframe at 100^0:



3.4.3 Deformation of seatframe at 110^0



3.4.4 Deformation of seatframe at 120^0

IV. RESULTS

S.NO	MODEL	EQUIVALENT STRESS
	SEATFRAME AT 90^0 POSITION	390.88
	SEATFRAME AT $1O0^0$ POSITION	328.86
	SEATFRAME AT 110^0 POSITION	434.68
	SEATFRAME AT 120^0 POSITION	318.16

S.NO	MODEL	STRAIN
	SEATFRAME AT 90^0 POSITION	0.0208
	SEATFRAME AT 100^0 POSITION	0.09292
	SEATFRAME AT 110^0 POSITION	0.018627
	SEATFRAME AT 120^0 POSITION	0.09540

S.NO	MODEL	DEFORMATION
	SEATFRAME AT 90^0 POSITION	8.1381
	SEATFRAME AT 100^0 POSITION	30.558
	SEATFRAME AT 110^0 POSITION	8.0971
	SEATFRAME AT 120^0 POSITION	30.353

V. CONCLUSION

The work presented in this thesis reports optimal design of the car driver seat, taking into account of various aspects (e.g. Biomechanical, materials, vibration absorption, safety etc.) which provide more comfortable value to driver with safety and operational durability. Previously for adjustment of seat the lever system was used. In our work the lever system will be replaced by press button mechanism. Spring and plunger damping system is used to reduce shock during brakes applied by the driver. It will reduce unbalancing and help the driver to auto adjust himself. The press button mechanism would be actuated by a sensor. The mechanism is in such a way that the telescopic cylinder will be actuated towards the rear side of the seat frame with an elevated angle by the sensor press button alert. The designing and modeling of car driver seat is done in Creo Parametric 2.0 softwareand simulation model is done in Ansys 15.0 under different operating conditions.

FUTURE SCOPE

This gives rise for better analysis of reference seat frame under various loading conditions and for different orientations of the seat frame. In future free size optimization of seat frame can be done to reduce the weight which may increase the efficiency of car. In present thesis, the finite element analysis is performing only on the seat frame part. This work can be extended by integrating the backrest frame and base frame also in FEA

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