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Automobile Seat Design Ergonomics and Whiplash Protection System

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***Abstract*— As the evolution of automobile performance had surpassed to a greater heights the safety demands have also accelerated their evolution. Seating position determines the safety and performance of the vehicle. The aspects like driver vision, driver fatigue and driver comfort determines the winner in racing. Even the seat is ergonomic the deaths caused by unexpected collisions and injuries caused by whips generated by an accelerating, decelerating vehicle are sky high. Seat is normally restrained to a position and in case of collisions the seat transfers all the shock to the driver as the driver is a flexible body.**

The human body absorbs all the stresses causing major damages to human system and also deaths. Whiplash injuries are sometimes deadly and most of the times cause lifelong injuries to cranial spine region and sometimes causing permanent breathing problems and other minor spinal injuries, in severe cases the neck ligament is damaged or torn, which is also called internal decapitation, which completely disables the neck motion of the person almost for lifetime.

Whenever the vehicle is knocked from behind the shock pushes it in the forward direction. The knocked vehicle accelerates immensely and decelerates with the same rate. But the inertia of the restrained seat and driver remains the same. This makes the body to absorb all the shock instead of frame or seat.

The following article describes an ergonomic seat with a novel whiplash and collision protection system comprising of basic whiplash absorption system and major collision absorption system. The following seat comprises of three main sections.

The first section is located at the neck support position wherein there is a sliding contact is located. The neck support section is hinged with the main seat. The frame of the seat consists of main seating stock and a back supporting frame wherein the both are hinged. The back support frame is pulled up, a torsional spring is placed either side of the hinge support to provide the seat optimum shock absorption and smooth support to the back of the driver. The pulled seat is restrained in the position with restrainers. The restrainers are hinged so that the backrest frame absorbs the shock by moving backwards, while the spring makes sure the backrest frame comes back to its original position.

The major collision absorption and neck protection mechanism is placed behind the backrest frame. The whole system can be manufactured with aluminum or hard plastic fiber, carbon fiber, while the restrainers can be made of steel.

While driving highway or long distances is very stressful, driving with strained hands is also more stressful and hazardous. Steering is nearly zero, while driving on a highway and one rarely steers hard, keeping hands straight for a long time without anything supporting it, strains the elbows. Any normal or high performance car needs a relaxed driving position. Long term strain on the elbows results in many elbow injuries, which last long or life time. One of the most common and hazardous impact on strained joints is osteoarthritis, where the regular strain and micro damage leads to into inflammation of ligament. Sometimes due to chronic strain the synovial fluid might leak and form cysts in the elbow. This can trigger auto immune disease wherein the immune system to attack its own cells and this in turn can lead to many auto immune diseases, which are, for now are stated incurable. The following article describes an ergonomic retractable arm/elbow rest, which is necessary on highways. While in city or places with sharp corners the can be pushed back in their slot. The seating position in itself is similar to natural positions of neck, spine and pelvis while sitting. The knee position is raised to reduce the stresses on knee joint and also in the lumbar area.

Keywords*— *Automobile seat; ergonomics; whiplash protection;

I. INTRODUCTION

More than half a million people worldwide suffer from whiplash injury. And in India whiplash injury is always ignored as baseless neck pain or tiredness. Which has resulted in numerous diseases as mentioned above. The possibility of creating awareness in mass population always seems impossible, but where a design solution itself can secure the people without needing to create any awareness or law.

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II. PROBLEM STATEMENT

A. An average automobile lacks a seat with ergonomics based on varying anthropometric data, lack adjustable seat part and lack of whiplash injury protection. There is no any specific component to support knee, which causes various ailments mentioned above. The elevated elbow position causes elbow ailments and osteoarthritis. Upper arm support to hold hands elevated while driving long distances can reduce the stress on elbows and shoulder and arm muscles. Maintaining the Integrity of the Specifications

III. WHIPLASH INJURY

Whiplash always takes its roots up till a collision. A major or minor neck whiplash moment causes the ligaments around the spine to tear or to break. This injury has a fatal version simply called snapped neck. The intense and swift to and fro of the neck can not only cause injuries, but death itself. The short head rest is main component and also is main reason of the whiplash injury. An unrestrained head not only causes injuries in accidents, but in long run, it damages the tissues, ligaments and spinal discs to an almost irreversible condition. A static head rest may provide support in mundane drive and chores, but in a collision it fails to support the neck of the driver and keep the head in a relatively stable and safe position.

IV. JOINT OSTEOARTHRITIS

Osteoarthritis is caused by prolonged strain on joints. The reasons vary from high performance sports, accident to bad posture and procrustean seat design. The reason quite clear in automobile seats, which is a compromised design which doesn't answer to the varying anthropometry of people.
Osteoarthritis has some long term and life threatening side effects.

V. OBJECTIVES

- To understand the natural anthropometry and structural construction of the human body
- To understand ergonomic importance in human health and overall wellbeing.
- To design a seat that provides support to vital areas, like neck, lumbar region and knee.
- To incorporate a simplified whiplash protection system.
- To incorporate critical ergonomic features
- To analyze the stability, durability and manufacturability of the designed seat.
- To minimize all costs of seat manufacturing and systems.
- To provide future scope for more in depth researches and inventions

VI. DESIGN AND MEASUREMENTS AND SPECIFICATIONS

The main features include the whiplash protection system, seat with novel whiplash and collision protection system and ergonomics. The seat is designed to mask the driver from left and right unlike the existing car seats, neck head and other vital organs are completely protected with the help of novel seat.
The backrest frame is a hollow metal construction is hinged to the main seating frame of the seat. It is mounted with torsional soring and the backrest frame is pulled up and hinged below the backrest frame, in such a way that the backrest frame can only be pushed backwards by body weight and brought back to its original position and not the other way.
The whiplash protection system consists of novel ergonomic cushioned seat and a backrest pad which is precisely designed in the shape of the spine and pelvis, and the smooth cushion provides more comfort to the individuals with body structures which are not similar to the seat and backrest pad. The novel ergonomic backrest pad is mounted against the backrest frame of the seat. These components are separated by an assembly of springs which are connected to the cushioned backrest pad and backrest frame. The same construction is mounted on the head rest. The novel ergonomic headrest is connected against the headrest frame which is hinged with the main backrest frame. The head rest is pulled up with the help of torsional spring similar to the method of back frame. The head rest is raised to protect the head from whiplash and collisions with the help of limited restrained slider which lifts up the headrest when needed. It is connected to the upper connecting rod which is in turn connected main connecting rod with the help of link, which in turn is hinged with the seat frame. In case of whiplash jerk, the springs are entitled to absorb the varying shocks and the raising headrest is entitled to restrain the head from varying jerks which are inflicted by the uncontrolled and instantaneous to and fro movement caused by inertia of the body and seat. The main seating frame is reinforced with horizontal bars. The empty section of the seating frame is mounted with rigid or non-rigid plastic component, above which the smooth cushion is placed.

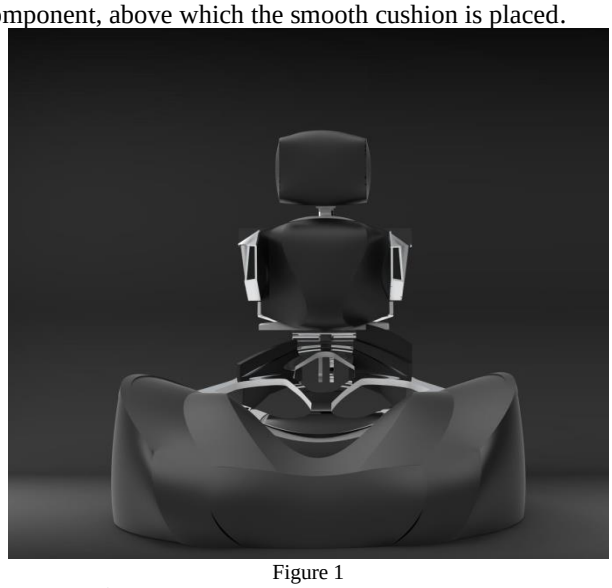

Figure 1
Front view of the 3d rendered model, modeled in Autodesk inventor 2021

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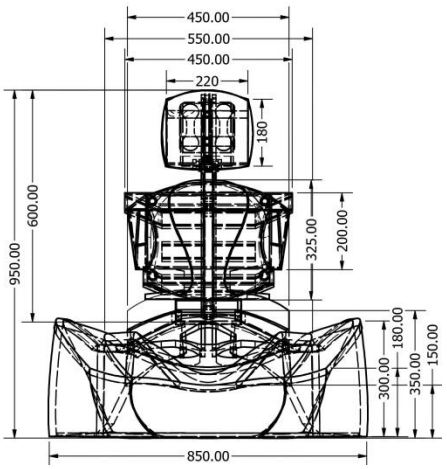

Figure 2
Front view the measurements of the seat

VII. FUNCTIONING DESCRIPTION

The whiplash protection system is trigger by the backward motion of the driver. The primary connecting rods move parallel to the backrest frame and pushes the connecting link upward. The link in turn pushes the secondary connecting rods upwards and the slider which is connected on its end moves up and thus provides support to the constantly The head rest is supposed to provide support constantly and in case of rear collision the head rest slides up and provides strong and rigid support to the neck and head. The system is triggered by smallest of loads which is essential for constantly varying anthropometric support.

The armrests are provided 6 to 7 inches below the armpit, they provide arm and not elbow support, they keep the elbows relaxed and the major load is imposed upon the armrests.

The knee position is raised and lightened to provide support to the lower thighs, knees and upper shins elevated which strains the entire lower body along with knees.

The lumbar region is smooth and thick cushion pad and adjusts to the spinal shape of the driver.

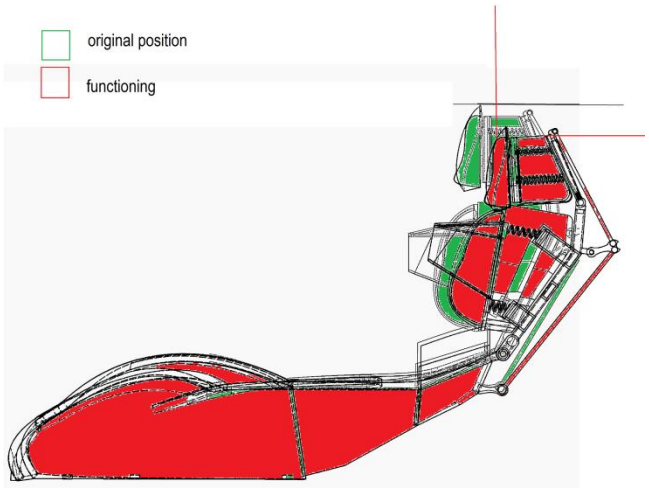

Figure 3
Illustrated functioning, side view

VIII. RESULT AND CONCLUSION

The following design, backrest frame and the seating frame were subjected to multi axial loads and stresses in Ansys Workbench 19.2

Material used: Aluminum 6061 T-6

Yield stress: 280Mpa

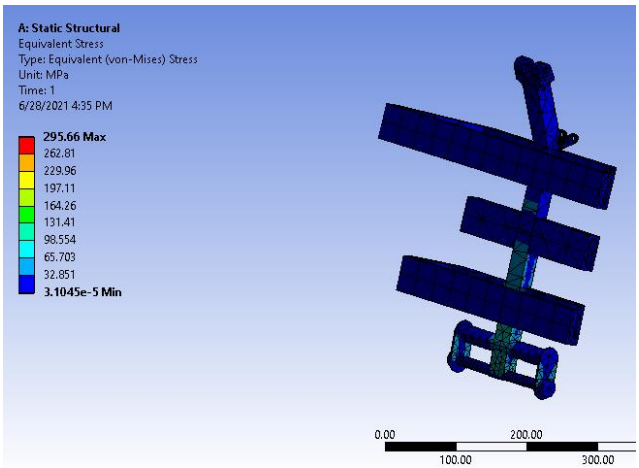

Figure 4
Backrest frame stress analysis equivalent stress

Backrest frame:

Total load applied was 1000N was applied on the frame.

Acquired results are as following

Equivalent stress: 0 to 65Mpa

Factor of safety: 0.8 to 15

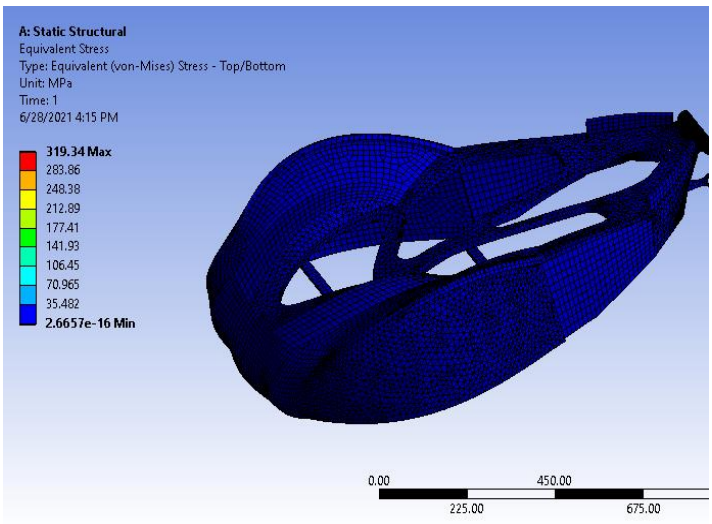

Figure 5
Seating frame stress analysis equivalent stress

Seating frame:

Total load applied on the seating frame was 2000N

Acquired results are as following

Equivalent stress: 0 to 35Mpa

Factor of safety: 15

A. Authors and Affiliations

The template is designed so that author affiliations are not repeated each time for multiple authors of the same affiliation.

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The proposed seat was successfully designed, modeled and tested. The whiplash system was incorporated in the seat. The structural stability test was done for the main seating frame and backrest frame. The result was found that seat was stable and reliable. Factor of safety ranged up to 15. The ergonomic features were also incorporated in the design.

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Dr. A. Sujin. Jose, Thanks, for guiding us through major milestones and possibilities.

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