Ergonomic Evaluation of Passenger Car Vehicle Seat Design

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Abstract. Automotive seats are one of the most significant parts of vehicles and customers desires for comfort in vehicle seats in recent years. In the automotive field, the solace of the traveler, just as the driver, is to be guaranteed. Inappropriate and different contemplations may prompt forces a tremendous measure of stress in the driver over a while. If the seat of the driver isn’t satisfactory, then the performance of the driver may lessen and it might prompt exhaustion and another musculoskeletal issue, ultimately causes an accident to the driver just as the traveler. Aside from this, the inconvenience may happen on account of inadequate space in the lodge, drivers see, reachability etc. Hence, by considering different parameters an examination is performed and given the accompanying. The comfort analysis of passenger car seat was done by utilizing the DELMIA software and the appraisal is broken down. The manikin is made in such a manner according to the Indian standard life structures and the investigation is completed with 95 percentile man and 5 percentile female estimations of Indian manikin.

1. Introduction
Since the automotive sector is a developing sector, there must be a worldwide need to make do with the contenders and to fulfill the requirements of the client. Subsequently, it cleared a route to the appearance of different items in the market over some time. Furthermore, the produced models may have new variations concerning the past ones. This makes the business one of a kind when contrasted with different contenders. In these variations, numerous changes may come yet the driver lodge is especially basic in these redesigns. These changes may likewise happen because of wounds, to give wellbeing to the driver during any effect at the front.

Today is an industrialized world and we may see that the most widely recognized movement done by the individual is the sitting posture. It may have different sick impacts on the body parts like neck, back, and so forth, and when it is untreated it turns into a significant issue. Thinking about the sitting stances, the driver may encounter different impacts while driving. The impact might be diminished by altering the seat and the position of the seat. Considered the impact of autonomous and manual driving on comfort in two stances that could be utilized at Level 3-4 self-sufficiency and the impact of giving a neck rest [1]

The investigation is completed utilizing the DELMIA (Digital Enterprise Lean Manufacturing Interactive Application) software. The observed stances are made and simulated by this product. The appraisal like RULA, REBA, and so on are led and the outcomes are seen with the Indian standard life systems. Various parameters are considered during these observations like fit parameter, feel parameter, support parameter, etc. By observing the results, the following can be achieved. Manages investigation of different unique parameters of seat cushions and suspensions along with improving strategies for seat transmissibility [2]

- To eliminate the discomfort of the driver
• To remain in an optimized posture of the human
• To increase the safety of the driver during a crash

1.1. Design and Structural Parameters of Seat
The decision of auxiliary parameters for the seat is one of the fundamental methodologies in seating ergonomics. The parameters must be taken by the human estimations and the simplicity of the driver. The space between the accelerator and the seat must be in an adjustable manner, for the flexibility of the driver. The cushion width should be extended with the desire for the complimentary leg space of the driver. The pressure dispersal between the seat and the driver must be appropriately analyzed. Examined the connection between the agreeable postural angles, anthropometric information and seat modification [3] While designing a seat, which various people with different postures and loads, data about the populace and anthropometry of the human body, will use, is required. A comprehensively used structure decides is that the seat should suit the people from the populace who lie between the 5 percentile-female and 95th-percentile-male characteristics to some extent of interest. The seating stances of the human ought to moreover be inspected to design a pleasing driver seat.

2. Fit Parameter
The fit parameter exhibits the dimensions of the seat, for example, the length and width of the cushion and the backrest. Seat changes depend upon driver body shape and size for instance anthropometry. Thusly, the seat architect must assess the colossal proportion of data related to anthropometry before manufacturing a prototype. The seat point is likewise responsible for pressure appointment over the seat.

2.1. Feel Parameter
For better solace and genuine help of driver health, uniform pressure appointment along the human body over the seat is a noteworthy parameter. Pressure conveyance over a seat is dependent on the properties of cushion material, for instance, robustness, evasion, and structure of cushion. Exhibited the suitability of this expanding approach by building up a design for seat cushion length that will decrease client grievances.[4] In like manner, it depends upon the idea of stacking, seat design, and backrest structure. A real seat holder shape flows a uniform load over the seat and avoids the assembly of stress in the human rear. Fittingly, inclined backrest avoids stress at the back.

2.2. Support Parameter
The support parameter impacts the position of the sitter. These parameters consolidate the state of the seat and the relative position and heading of the seat pad and backrest. Undeniably, there is a critical joint effort between the Support parameters and the Fit and Feel parameters. The design parameters of seat cushion is shown in Table 1 and Modelling of seat Cushion is shown in Figure 1.

![Figure 1. Modelling of Cushion](image-url)
Table 1. Design parameters of seat Cushion

| Cushion Parameters (mm) |   |
|-------------------------|---|
| Front width             | 495|
| Midpoint width          | 552|
| End Width               | 552|
| Front to Rear Contact   | 457|
| Mid-point Length        | 191|
|                         |   |
| Outside Width           |   |
| Section A               | 546|
| Section B               | 546|
| Section C               | 546|
| Inside Width            |   |
| Section A               | 483|
| Section B               | 483|
| Section C               | 483|
| Main Width              |   |
| Section A               | 356|
| Section B               | 356|
| Section C               | 356|
| Depth                   |   |
| Section A               | 15 |
| Section B               | 20 |
| Section C               | 23 |

2.3. Vibrations
The driving surface isn't uniform, all finished at this point it is manufactured properly by developing advancement. Such a surface is at risk for vibrations at driver seats. The human body can withstand 4-7 Hz of vibrations. Some tractor semi-dynamic hydraulic-powered and dynamic mechanical suspension structures are used to debilitate vibration moved to the driver. The driver seat is expected to such a degree, that amazingly decrease vibrations moved to the driver and provides stability. Proposed a reduced module for estimating in-vehicle vibrations at seat and human body [5]

2.4. Lumbar Support
The lumbar support of the spine bears the most bodyweight and moreover gives the most flexibility, a mix that makes it frail to injury. A couple of muscles in the low back assistance with insurgency, versatility, and quality. A low back muscle strain can be fantastically anguishing yet will heel in two or three days or weeks. Our spinal length even varies by as much as 2 cm for the day. The seatback expects a fundamental activity in supporting the spine and must change as per these differentiations among people. Design parameters and Modelling of Backrest is shown in Table 2 and Figure 2 respectively.
Table 2. Design parameters of Backrest

| BACKREST Parameters (mm) |  |
|-------------------------|--|
| HEADREST WIDTH          | 300 |
| BACKREST                |  |
| Top width               | 406 |
| Middle width            | 470 |
| Bottom Width            | 508 |
| length                  | 584 |
| Mid-top Length          | 203 |
| Outside Width           |  |
| Section D               | 495 |
| Section E               | 508 |
| Section F               | 521 |
| Inside Width            |  |
| Section D               | 406 |
| Section E               | 419 |
| Section F               | 419 |
| Main Width              |  |
| Section D               | 292 |
| Section E               | 292 |
| Section F               | 292 |
| DEPTH                   |  |
| Section D               | 38  |
| Section E               | 73  |
| Section F               | 102 |

Figure 2. Modelling of Backrest
3. Designing of Manikin
After the design of the backrest and the cushion get finished, the examination of the cushion and backrest is conducted. The human builder is planned in DELMIA software. Here the stance that is finished by the people can be imported to the manikin and the outcome will be acquired and equivalent to the person. By and large, the Indian puppet measurement is to be given according to the geography and is given physically according to the standard of Indian anthropometry. It might incorporate the separation between the leg to head, length of fingers, length of the lower arm, and so forth the stress experienced by the manikin shows the impact in that pose. Manikin on Indian Anthropometric is shown in Figure 3.

![Manikin on Indian Anthropometric](image)

**Figure 3. Manikin on Indian Anthropometric**

3.1. Analysis of the driver seat
Here the modified driver seat is designed in the CATIA software and the manikin simulation is finished by utilizing the DELMIA software. The stance is to be imported at the different appendage and the ergonomic evaluation tools are utilized. RULA and REBA examination are done and the investigation result shows preferred outcomes over the regular seats. The stress experienced by the individual can be seen and the change can be made in order to diminish his uneasiness and give adaptability to the driver. RULA analysis in the driver seat is shown in Figure 4. REBA analysis in the driver seat is shown in Figure 5 and 6 respectively.

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![RULA Analysis (Manikin2)](image)

**Figure 4. RULA analysis in the driver seat**
4. Conclusion
The Parameters affecting driver seat arrangement are precarious and require elaborate examination of human anthropometry, seat estimations, instruments, materials of seat compartments and its abilities, safety components of the driver, structures for security. Besides every other parameter, security and wellness related parameters are noteworthy. The appropriate lumbar support on the driver seat is required to diminish the lower back torment of the driver. The seat must be made mobile in armrests similarly as in the pad and backrest. The leg space ought to likewise be checked on while arranging and designing a seat. This paper depicts the plan parameters and encouragement of the driver and the structure is made with the goal that it reduces the torment and misery of the drivers to have a pleasant and safe journey.
5. References

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