



RESEARCH ARTICLE

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Reviwe of design aspects of major components of Automotive Seat

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ABSTRACT

Automotive seat design has been always challenge for engineers as design parameters for automotive seats are complex. Three design objectives, to be satisfied simultaneously are comfort, safety, and health. For comfort, various ergonomic and human factors considerations are discussed ranging from seat dimensions and adjustments to cushioning and occupant perceptions of comfort. For safety, the principal consideration is the effectiveness of the seat in providing spinal support during accidents-particularly in rear end collisions. An additional safety consideration is the ability of the seat to keep an occupant "in position" during an accident. Finally, for health concerns, the focus is upon maintenance of spinal stability, seat ergonomics, and road induced vibration attenuation. The paper presents design parameters satisfying these design objectives. These parameters include seat dimensions and their adjustments; cushioning for vibration suppression; fabric design to help maintain occupant position during periods of high acceleration; back rest strength for thoracic and lumbar spine protection; and head rest geometry for cervical spine protection.

Keywords

Automotive Seat, Safety, Ergonomics, Vibration Attenuation

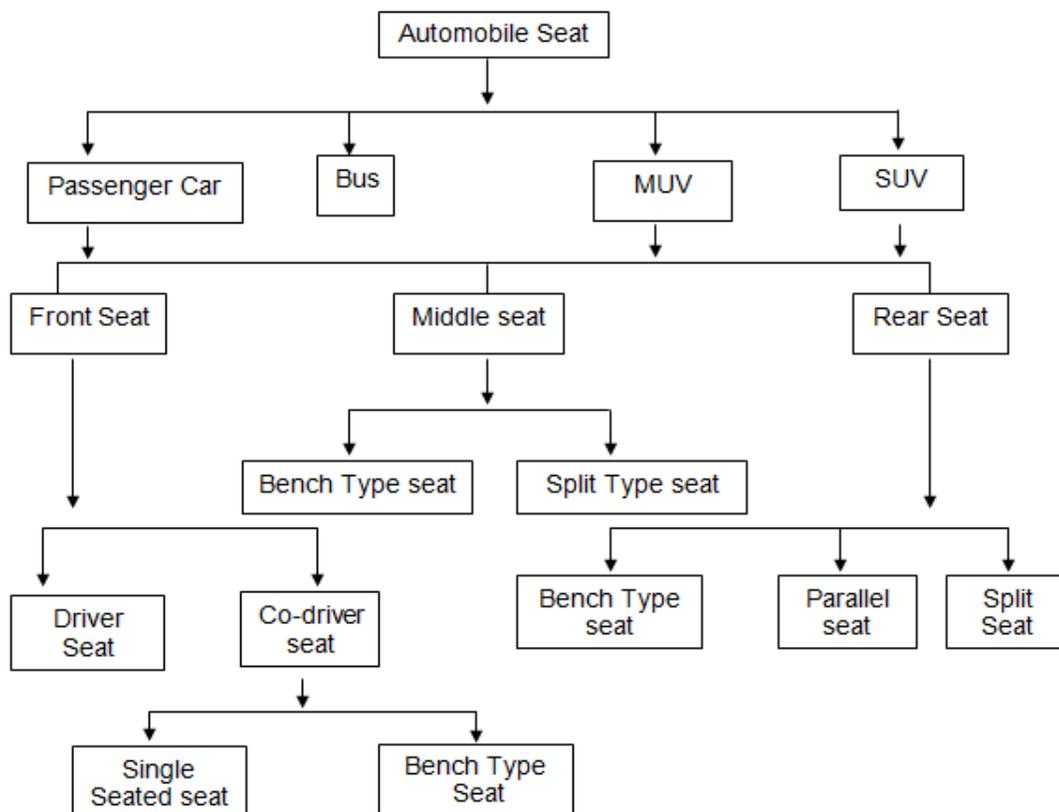
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1. INTRODUCTION

Seat means a structure, which may or may not be integral with the vehicle, structure complete with trim, intended to seat one adult person. The term covers both an individual seat and part of a bench seat intended to seat one person. The function of automotive seating is to support, protect and to provide comfortable seating posture to its occupants. In the above categories, task analysis reveals, there are three different occupants in the vehicle: Driver, front seat passenger and Rear seat passenger.

Following Flow Chart shows the different types of automotive seats:



There are 4 design criteria's for the driver seat:

1. The seat should position the driver with un-obstructive vision and within reach of all vehicle control.
2. The seat must accommodate the driver's size and shape.
3. The seat should be comfortable for extended periods.
4. The seat should provide a safe zone for the driver in case of a crash.

SEAT PARAMETERS

- ◆ **Hip point:** A point, which simulates the pivot center of the human torso and thigh and provides the guidelines on where a passenger sits on the seat.
- ◆ **Back angle:** Angle between the torso line and vertical axis through hip point.
- ◆ **Hip angle:** Angle between the torso line and the thigh axis.
- ◆ **Knee angle:** Angle between the thigh axis and lower leg axis.
- ◆ **Foot angle:** Angle between the lower leg axis and paddle plane.
- ◆ **Thigh angle:** Angle between thigh axis and horizontal axis.

R- POINT AND H-POINT

'R - Point' or seating reference point means a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system. 'H-Point' values are the actual measured values. Theoretically H-point should correspond to the R-point. Practically speaking the values should be met within the following conditions. The relative position of the 'R' point and the 'H' point and the relationship between the design torso angle and the actual torso angle shall be considered satisfactory for the sitting position in question if the 'H' point, as defined by its co-ordinates, lies within a square of 50 mm side length with the horizontal and vertical sides whose diagonals intersect at the 'R' point, and if the actual torso angle is within 5° of the design torso angle.

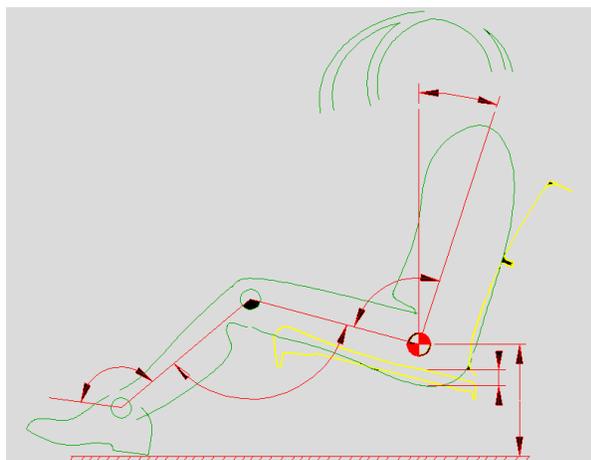


Fig.1: Locating Reference Point

CUSTOMER SURVEY

Different level of inputs for seats can be obtained, varying from customer to customer and that input has to be converted into the concept designing. Certain points are to be discussed by the seat designer with the customer so as to come out with an optimum design. Customer survey was conducted and different inputs have been discussed with the customer as follows.

1. **Application of Vehicle:** Small Car, Luxury Cars, Multi Utility Vehicle (MUV), Sports Utility Vehicle (SUV).
2. **Cost Targets:** 'A' Class Segment, 'B' Class, 'C' Class, 'C+' Class.
3. **Type of Car:** One Box, Two Box, Three Box
4. **Car Data:** Body CAD data / drawings, Floor CAD data / drawings, Anchorage points, Seat layout, other important parameters (R-point or H-Point, Accelerator Heel point, etc.)
5. **Comfort Requirements:** Preference of seat fabric, Arm Rest, Adjustable Lumber support, Height Adjuster, Adjustable headrest, Type of leavers or knobs to be used and their location, Vibrations and their damping requirements, if any. Aesthetics and Customer Specific Comfort requirement.
6. **Specific Requirements:** Somersaulting, Rotate able Seats, Folding Seats, Walk – in – mechanism.
7. **Product Quality:** Customer has to specify if any particular standards to be followed.

CONCEPT DESIGN

After understanding the customer requirements, different concepts are built for the seat to be designed, covering all the following parameters: Overall appearance of the seat to be prepared as per the customer inputs by making a sketch (2 ~ 4 proposals) giving overall dimensions and specific requirements.

- Concept design of PU pads.
 - ❑ Contours & Profiles & Aesthetics.
- Concept design of Seat Trim.
- Concept design of Suspension.
 - ❑ Spring Type, Mat Type and Pan Type
- Concept design of frames.
 - ❑ Sheet Metal structure, Tubular structure and U – Section structure
- Concept design of Anchorage methods.
- Concept design of Height Adjusters.
 - ❑ Mechanical and Push button / Automatic
- Concept design of Recliners.
- Concept design of Adjusters (Sliders).
- Concept design of Head Restraint.
- Integral, Detachable and Adjustable
- Concept design for other specific requirement.

After developing the preliminary concept for the desired seat, all the functions and tentative cost of various parts and overall cost of the seat were reviewed with the customer.

SEAT ASSEMBLY

Automotive seat basically consists of the following parts shown in fig.2 below

1) Cushion Assembly. 2) Back Assembly 3) Head Restraint Assembly

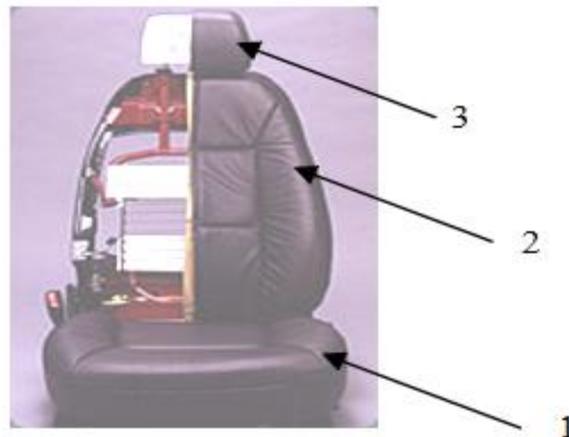


Fig.1: Seat Assembly

1. CUSHION ASSEMBLY

Cushion Assembly is a part on which the Passenger sits. Sub components of cushion assembly are as follows (Front Seat):

(a) Frame complete seat cushion

- (1) Spring Type Cushion Frame.
- (2) Mat type Cushion Frame.
- (3) Pan Type Cushion Frame.

The main parts of the frame are as follows: -

- Sheet metal structure/ pipe structure
- Hinge bracket (for recliner on one side of seat)
- Springs
- Spring hook

(b) Pad complete seat cushion:

- **PU pad:** To give comfort to the passenger and to provide aesthetic looks to the seat.
- **Insert wire seat cushion:** It is used to hold the Trim with the Pad at a particular profile.
- **Non-woven seat cushion:** It is used to avoid the tearing of the Pad from the corner edges & bottom surface where it is continuously in contact with the frame/spring/mat.

(c) Trim complete seat cushion:

- **Trim:** is the seat cover assembled on the PU Foam.

Trim is wrapped around pad

- ❑ To prevent damage to PU pad
 - ❑ To give it a good look
 - ❑ To provide comfort to the occupant.
- **PVC pocket:** to hold the trim wire inside which is joined with the insert wire of Pad by C-rings.

Wire Trim: It is used to hold the Trim with the Pad at a particular profile.

Different fabrics used for the seat cover Trims are:

- Woven , Knitted or Pile Knit, Leather, PVC

(d) Recliner: are used for the angular adjustment of the seat back as desired by the passenger sitting.

(e) Adjuster set: are used to move the seat position in front and back in horizontal direction.

General parameters to be kept in consideration while designing Seat Cushion:

1. Cushion Length: Cushion size accommodates the seated occupant's buttock and thigh dimensions. The distance from buttock to popliteal region delimits the loaded cushion back from seat back to waterfall line. The length of 5th percentile female is 440 mm and 95th percentile male is 545 mm.

2. Cushion Width: Lateral space is important for physical & psychological comfort. In a bucket seat, bolstering and lateral contours must accommodate the physical dimensions of large torso. Female hip breadth is greater than

male hip breadth. Thus, the 95th percentile female hip breadth determines cushion breadth. The 5th percentile width is 432 mm, however 480 mm has been recommended for margins considering clothing and leg play.

2. SEAT BACK ASSEMBLY

The function is to back support to passenger. Sub Components of Back Assembly are

(A) Frame complete seat back

- (1) Main Pipe
- (2) Holders
- (3) Cross Plate
- (4) Recliner Bracket
- (5) Stay Bracket
- (6) Springs / FB Mat
- (7) Hook springs

(B) Guide H/R Set: is fixed in the holder, which is welded on the pipe frame.

Function : To support & guide the vertical movement of H/R assy.
To lock H/R in different heights.

Material : PP

Spring Material: SWC, wire ϕ 0.4 mm.

Pin Head restraint: Material SWB, Rod ϕ 1.0 with

Surface finish MF Zn 5-K plating.

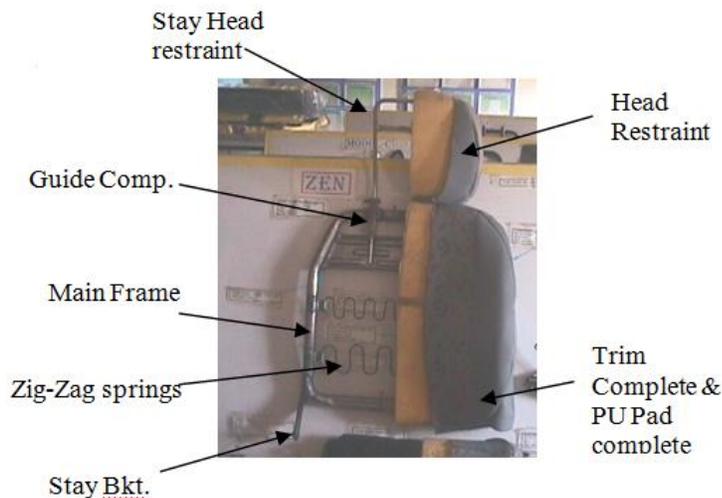


Fig. 3 Back Seat Assembly

(C) Trim complete seat back

- (1) **Main fabric:** To prevent damage to PU foam and to give good appearance and comfort.
- (2) **PVC pocket:** Hold the trim wire inside which is joined with the insert wire of pad by C- rings.
- (3) **Trim wire:** Used to hold trim with the pad maintaining a certain profile.
- (4) **Bolster:** Used where seating area is not in contact with occupant, to provide the better aesthetic looks and simultaneously being less costly to main fabric.

(D) Pad complete seat back

- (1) **PU Pad:** Is used to give comfort to passenger and to provide looks to the seat.
- (2) **Insert wire seat back:** To fix the trim with the pad at a particular profile.
- (3) **Non woven seat back:** Is used on the back side of PU to save it from getting tearing – off by coming in direct contact with the metallic parts having sharp edges like springs, wires, brackets etc.
- (4) **Nylon net:** Is used on the backside of PU to save it from getting tearing – off. It is used where less rubbing friction is observed. Nylon net is comparatively cheaper to the non-woven.

General parameters to be kept in consideration while designing seat back:

- 1) **Seat back height:** Seat back supports the trunk while sitting, but it also is considered a barrier to arm reach and vision. Small female sitting shoulder height therefore determines seat back height. Accordingly, 509 mm is recommended.
- 2) **Seat back width:** Seat back width may be divided into lower and upper regions. Large torso width at the hip

waist and chest determine the lower space requirement. The lower region must accommodate a tapered shape from 432 mm at the hip to 367 at the chest.

Comfort related requirements

Static comfort indicates that the higher pressure on the seat back should be in lumber region. However, long – term automotive sitting suggests that the stiffness of lumber support in the seat back must be carefully considered. Initially, occupant's preferred a very stiff, well-defined lumber support. After sitting of 3 hours however the initial valuation was reversed. Contour, upholstery seams, foam and suspension affect pressure distribution in the seat occupant. As the contour changes, the distribution of pressure between the seat and the body changes. Seats should be covered with material that provides friction between the occupants and the seat. Thus, seats should support a variety of seated postures.

3. HEAD RESTRAINT

A device whose purpose is to limit the rearward displacement of an adult occupant's head in relation to his torso in order to reduce the danger of injury to the cervical vertebrae in the event of an accident.

Different types of Head Restraints are:

- Integrated head restraints
- Detachable head restraints
- Separate head restraints

Comfort related requirements

Seat comfort can be measured both on static & dynamic conditions. Hardness of the cushion, back and contour primarily determines static & dynamic seat comfort. Adjustments by occupants to change position also contribute to the comfort.

Cushion hardness affects the vibrations transmitted to the occupants and pressure distribution in the seat. As hardness of the seat increases, higher frequencies are transmitted. As hardness of the seat decreases, pressure is distributed over a greater area. Thus, the occupant's evaluation of dynamic and static comfort is affected by cushion hardness.

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