Study & Review of Automotive Seating System  
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Abstract— Seat is a sub system of automobile or vehicle. It is the main aggregate in a vehicle, which impacts the visibility, comfort, safety for the occupant. There is even more increasing demand towards occupant safety and comfort in complex crash and driving condition besides the pressure from environmental regulations. As a designer, one should know seating system terminologies and parts it holds. Seat system architecture is same but requirement differs with vehicle category. The objective of this paper is to study automotive seat as one product, its subassemblies with purpose & functionality. It speaks about typical automotive seat, seat functions, seat aggregates & its role in an automobile.

Key words: Automotive parts, Seating system, driver seat, mechanisms

I. INTRODUCTION

A seat system is a single seat with all its components comprised as shipped to the customer, ready for fitment into the vehicle. The total of all seat system make up the seat set for a particular vehicle. Seat set comprised of all the seats in the vehicle such as front seat, rear seats, and jump seats. A seat system can be located in the front or rear of the vehicle. Front seat is the systems located in the front vehicle and in the rear are called as rear seats system. The seat system can also be located on either side of the vehicle. The side of the vehicle where the steering wheel is located referred to as driver side. The side without steering wheel referred as passenger’s side. Consequently names to seat system are driver seat and passenger seat. To locate all components in the vehicle, the three dimensional reference systems are used. It relates the seat system and other component designs to the total vehicle. The reference system allows the identification of points of interest, such as the driver’s eye location, seating reference point, and the centre line of the vehicle.

II. IMPORTANCE AND FUNCTION OF A SEAT SYSTEM

There are four main functions of the seat system

(1) Support the occupant: It is the most basic function of the seat
(2) Position the occupant: The position of the occupant is most important to vehicle safety because it provides the occupant with access to vehicle control.
(3) Provides comfort to the occupant: while designing the seat the focus should be on long term comfort.
(4) Protects the occupant: The seat is meant to prevent the occupant from moving about inadvertently, or in the event of the accident. This requires seat to interface with several other systems to provide protection.

III. TYPES OF SEATS

There are different varieties of seats available in the market. Depending on vehicle class, market, functions & style, particular type of seat can be selected. In general seat type has been defined by the position of seat in vehicle. Front seat & rear seat are the two main types. Front seat consists of driver seat and co-driver seat. Mostly front seats are adjustable and have maximum features compared to other seats. Front seats are classified as bench seat and bucket seat. Now a day’s use of bucket seat is a practice used by many OEM’s. [1]

Depending on available degree of adjustment and its shape, rear seats can be categorised as

(1) Foldaway rear seat.
(2) Split Bench seat.
(3) Split bench & split back seat.
(4) Bucket seat.

Depending on features seat have, it can be classified as,

(1) Bed seat.
(2) Integrated structural seat.
(3) Bench integrated structural seat.
(4) Integrated child restraint system.

Fig. 1: Automotive Seat (Driver)

IV. PURPOSE OF SEAT

To provide support and constraint the occupant is the foremost purpose of the seat. It also provides comfortable access to all vehicle control, such as display, gear shifter, accelerator brake and clutch paddle unit. It affects the controls like window mechanism, HVAC controls. The entire above purpose seat should satisfy by keeping safety of the occupant in mind. [1]

V. COMPONENTS OF SEAT

Seat system has a vast focus. Subsequently reviewing the subject material and literature available, following information has been gathered.
On the other hand seat system consists of major parts and components can be categorize location wise as,

1. Seat back
2. Seat cushion
3. Wings
4. Bolste
5. Inserts
6. Head restraints
7. Armrest

(1) Seat Back is a part that supports occupant’s back. The seat back often consists of recliner, adjustable lumbar and/or adjustable wings. A fully trimmed seat back that has a cover on it is called as trimmed back.

(2) Seat Cushion is the part of seat that supports ischium or buttock and thighs of the occupant. Cushion may have fore-aft adjuster and adjustable thigh support 7 bolsters. A fully trimmed seat cushion that has a cover on it is referred as trimmed cushion. Trimmed back and trimmed cushion then married together with marriage bolts.

(3) Wings are located on the outsides of the seat back and help to prevent torso movement side to side. There are two wings on each seat back, inboard & outboard.

(4) Bolsters are located on the outsides of the seat cushion and helps to prevent lateral movement of occupants lower body.

(5) Inserts are the areas that lie between the wings at seat back and bolsters on the seat cushion.

(6) Head restraint is located at the top of the seat back. The purpose of HR is to avoid neck and head injuries in case of collision. In case of rear crash, HR supports head & neck by absorbing the force applied by neck and head’s backward movement. It is a device which can be used for anti-whiplash.

(7) Armrest [1, 2, 3, 4]

By considering seat as a system, we have to look into sub-system. Seat broadly consists of sub-systems or aggregates on the basis of base material/ assembly point of view.

1. Frame/ structure
2. Mechanism
3. Foam
4. Trim & plastic covers

A. Frame/ Structure

It consists of all the metal parts except mechanisms. It is the component/ part or sub-assembly. The components are Assembly Backrest frame, Assembly cushion frame, assembly head restraint or head restraint tube. Seat mountings, cross members, suspension spring, assembly riser or riser stamp members or cushion support assembly.

The assembly seat back is to support occupant’s back. It consists of tubular or stamped frame, two side stamp members, headrest tube, back frame upper stamp member and lower stamp members, suspension mat or S springs. It reclines and may have adjustable lumbar support or adjustable wings. A fully trimmed back is ready to be married to cushion frame.

In tubular frame, complete back frame is made out of tubular members. For wings small diameter wires are welded to the each side of frame.

Side stamp member or side support wires I case of tubular frame support wings, wings are at both sides of frame and help to prevent the occupant’s torso from moving side to side. Two wings are called as inboard and outboard wings.

The back frame assembly supports and keeps in position to occupant in case of crash or accident. Head restraint also supports the head from serious spinal, head and neck injuries. The head restraint absorbs the force of head and neck if they are thrown in backward direction in case of accidents. It also limits the travel of head and neck to prevent a type of injury called whiplash.

The assembly cushion frame is to support cushion foam and the trimmed seat cushion supports the ischium and thighs of the occupant. The ischium is the lowest of the three major bones comprising each half of the pelvis. The seat cushion may have a fore aft adjuster and adjustable thigh support and bolsters. A ready cushion trimmed is ready to married to a trimmed seat back.

Cushion frame consists of two cushion side members, cross tube, anti-submarine tube, cushion pan, suspension mat/ S- springs. In many cases side stamp members are considered as riser member. Mostly it has seat belt anchorage points on it.

Cushion frame plays important role by preventing the occupant from dislocating and jumping out from seat in case of accidents or crash. It also provides anti-submarine effect to occupant which prevents the occupant from sliding forward.

Likewise back frame, cushion frame is also stamped or tubular or in combination. Bolsters are located outside of the cushion and helps to prevent the occupant’s lower body from moving side to side. Each cushion has two bolsters inboard and outboard.

Seat frame and structure includes Riser. It may be stamped member or tubular frame. In automotive seats, seat adjuster track is mounted on the riser; in rare cases riser is mounted on the track in this second case riser plate is termed as side member. The main purpose of riser is to raise the seat to its H-Point from the floor. It plays significant role in crash and accident. It should not pill-off from its mountings. It plays main role in load path. Load path is the path through which load is getting transferred from seat to vehicle floor in case of crash. The complete load is getting transferred from seat to floor is through the riser plate or riser assembly.
One more metal part is seat mounting bracket, in many case those are part of riser or small stamped parts on which riser is mounted. These brackets are used to mount the seat on vehicle floor. [1]

Five basic types for frame assembly are available. These types have been defined on the basis of manufacturing procedure & material it uses.

1. Tubular.
2. Stamped
3. Wire
4. Die Cast magnesium

Tubular frame consists of tubular members. The basic advantage of tubular frame is low cost compared to other types. But these frames are heavier than any other types. In addition, controlling the dimensions is difficult than other types.

Seat Frame assembly or structure assembly can consists of different types

B. Mechanisms

These are the sub-assemblies in the seat system which facilitates occupant to adjust the position of the seat as per occupants comfort. Because of the movement of these mechanisms occupant is able to reach to vehicle controls such as steering, gear shifter, Accelerator Paddle Unit. Easy ingress egress can be achieved by mechanism. These mechanisms are main strengthening parts in load path. Typical front seat comprises of mechanisms such as seat adjuster track, height adjuster, recliner, movable head restraint, adjustable lumbar. These mechanisms can be operated manually or powered as per customer requirement.

Seat adjuster track/slider mechanism: It helps occupant to move the seat in X-direction i.e. in forward and rearward position. It is fitted between the cushion frame and seat mountings or riser.

Height Adjuster: It helps the occupant to raise or lower the seat height. Practically it changes the Z-position of H Point. It is incorporated in cushion frame.

Recliner: It helps the occupant to recline the seat back comfortably. Mainly the complete recliner assembly is mounted on the seat back. The inner recliner part is mounted on the cushion frame and outer part is mounted on seat back. [1]

C. Foam

It is also named as foam pad. Foam pad provides cushioning and support in addition to the seat suspension. Foam pad is moulded in mould by pouring chemicals in the mould at specified temperature, it causes chemical reaction in the mould and foam is formed as per mould. There are two main types of foam.

Encapsulated foam pad- seat frame is placed in the foam mould the foam chemicals are poured in around the frame and foam rises and flows around the contents of the mould to encapsulate the frame components

A lay on foam pad lies on the seat frame. The foam pad is moulded separately. It is easier to disassemble and recycle the foam pad.

Foam pad provides cushioning effect and protection from hard points it restricts meet to metal condition which is very significant from ergonomic point of view. Foam plays vital role in aesthetic point of view. Foam A-surface and B-surface plays critical role. [1]

D. Trim and plastic covers.

The trim cover assembly is the fabric covering on the seat, along with miscellaneous components used to close or finish the trimming operation. Trim cover assembly require making choices regarding processing, trim levels and attachments/closure that are used in manufacture of seat. Plastic cover many times considered as trim parts. It is made up of plastic; it also has A-surface and B-surface for attachment or fitment with metal. It is mainly used for handles, levers, side valance cover, recliner cover to cover the mechanisms or moving parts.

Trim and plastic covers are used in a seat to offer aesthetic look, visualization, and styling. Plastic covers help to hide metal parts and avoid metal or moving parts contact with the occupant. [1]

E. Riser.

As from previous section we know that, riser plays significant role in deciding the mounting and total height of seat. It is most important metal part in frame or structure. It is of two types by means of material, stamped or sheet metal riser and second is tubular riser.

Sheet metal/stamped riser is produced by thin steel sheet; the thickness varies from mm to 2.0mm. It is produced by stamping, piercing, forming, clinching or processes like bending. Depending on strength requirement local embosses or deformations incorporated/design.

In tubular type riser, it is produced by steel tubes. Numbers of steel tubes are welded to each other to form riser frame. Processes like tube cutting, bending, flattening etc. Tubular riser is bolted to vehicle. Sheet metal formed bracket can be welded to tubular frame or tube may be flattened locally for bolting.

As already stated riser plays significant role in load path, load is transferred from complete seat to vehicle floor through riser.

In many cases Seat adjusting sliding mechanism, or slider, height adjuster mechanisms is fitted on the riser Belt buckle can be mounted on the riser which is one of the safety features.

Riser is also accountable for H-point and occupant comfort. [1]

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