Testing Consideration In Designing of Automotive Seat Recliner Mechanism

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Abstract-The current trend in automotive industry is to produce vehicles with lighter materials & economic cost yet ensuring the safety for the occupant. Same principle applies to automotive seat design. In seating measure cost involves in seat mechanisms like slider, recliner, height adjuster etc. The Recliner is a mechanism which allows the seat back to rotate forward & rearward direction from a pivot point at the base of the seat back according to the passenger's seating comfort. The aim of this paper work is to guide design and optimise the automotive seat recliner subjected to loading. The present work focused on testing & safety consideration while designing recliner mechanism.

Keywords: Seat, Recliner, Head rest performance, Frontal Impact, Luggage Retention.

I. INTRODUCTION

Generally, seat recliner mechanism includes a base and an arm mounted on the seat cushion and seat back respectively, to house a locking and unlocking by external locking and internal unlocking means, which is effected by a rotatable cam operated by operating lever, which is mechanically linked to the cam for producing rotary motion of the cam. Safety is a basic consideration in all aspect of automotive engineering.

The current trend in automotive industry is to produce vehicles with lighter materials yet ensuring the safety for the occupant. In order to achieve this goal with minimum of expensive prototyping testing, new designs must be investigated numerically for strength and failure terms. The main objective of a good automotive seating system is not only to provide comfort but also to provide style and more importantly the safety feature. Pavan Gupta et al [1] studied that Anti-submarine Performance of an Automotive Seating System - A DOE study. But the system yet is sufficiently light weight to facilitate vehicle fuel economy and to minimize collision stresses. D. M. Severy et al were [2] developed Collision Performance LM Safety Car. Seating system design and materials must be affordable and durable to give acceptable service life. F W Babbs et al [3] studied that the packaging of car Occupants – A British Approach to seat designs. In addition to provisions for comfort and position adjustments, a seating system should have adequate structure for housing safety and convenience accessories. A. W. Siegel et al [4] were developed Bus Collision Causation and Injury Patterns. The design of seat recliner is very important because during an accident or a crash, occupants tend to be thrown back against their seat backrest due to inertial forces and if the recliner is not built to withstand such an impact, it results in failure. Toshiki Nonka et al [5] studied that the Development of Ultra-High Strength Cold-Rolled Steel Sheets for Automotive Use. Sarah Smith et al [6] were developed that the Improved seat and head restraint evaluations. Recliner failures result in Seat backrest twisting and collapse and which can lead to severe neck, back and spinal injuries. G. Nadkarni et al [7] also studied that Advanced High Strength Steel Strategies in Future Vehicle Structures. The area of interest in a recliner is usually the locking mechanism, which holds the seat back at the angle desired by the occupant. The locking mechanism needs to be designed for sufficient strength, so that the seat back does not collapse during an impact. Guillén Abásolo et al [8] developed that Magnesium: the weight saving option. C. Blawert et al [9] studied that the automotive applications of magnesium and its alloys.The renewable materials also used in automotive, Dr.Thomas et al [10] studied that Renewable Materials for Automotive Applications. For accurate positioning of recliner and to accept the recliner mechanism the lever release should be able to with stand the applied load in the locking position. When the load is applied then the whole assembly is subjected to combined stresses. Hence the lever release strength is the basic parameter for analysis. The desired position of back rest is achieved by operating the lever. When lever is operated force is transformed to cam. Which intern unlocks the upper tooth and lower tooth.

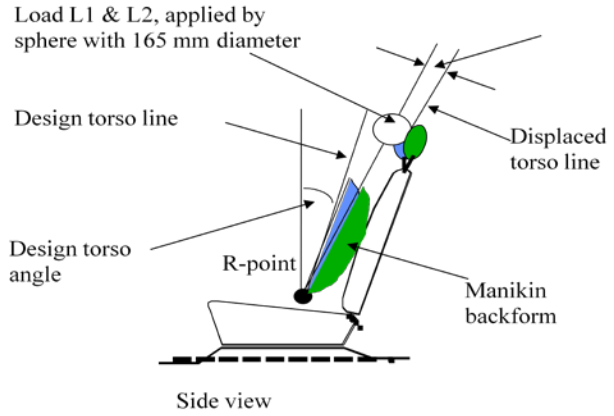
II. TESTING REQUIRED

A. Head Rest Performance

Requirement: The head restraint and its anchorage shall be such that the maximum backward displacement X of the head permitted by the head restraint and measured in conformity is less than 102 mm. The head restraint and its anchorage shall be strong enough to bear without breakage the load specified [12]

Test Procedure: If the head restraint is adjustable, it shall be placed in the most unfavorable position (generally the highest position) allowed by its adjustment system. In the case of a bench seat, where part or all of the supporting frame (including that of the head restraints) is common to more than one seating position, the test shall be conducted simultaneously for all those seating positions.

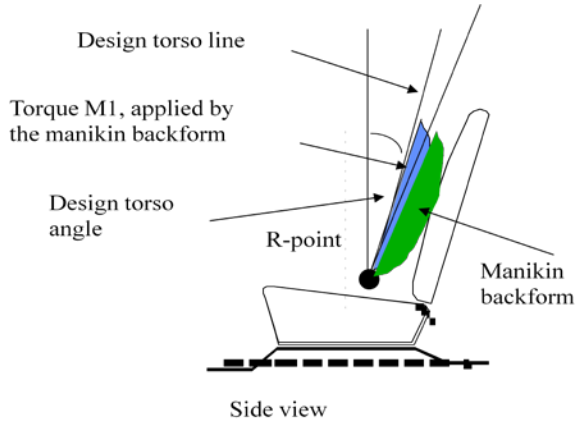
By means of a spherical head form 165 mm in diameter, an initial force producing a moment of 373 Nm (L1) about the R point is applied at right angles to the displaced reference line at a distance of 65 mm below the top of the head restraint & increased the load till 890 N (L2) or unless the breakage of the seat whichever occurs earlier. [12]



B. Seat Back Strength

Requirement: Seat back shall withstand the 530 Nm load without any breakage. No failure shall occur in the seat frame or in the seat anchorage, the adjustment and displacement systems or their locking devices during or after the tests. Permanent deformation, including ruptures, may be accepted, provided that these do not increase the risk of injury in the event of collision and the prescribed loads were sustained. For seats with more than one seating position, test each position simultaneously. [12][13]

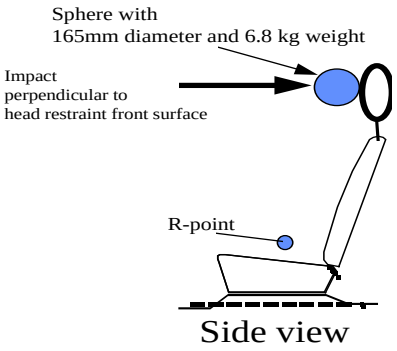
Test Procedure: A force producing a moment of 530 Nm in relation to R point shall be applied longitudinally and rearwards to the upper part of the seat back frame through a component simulating the back of the manikin described in IS:13749-1993. In the case of a bench seat, where part or all of the supporting frame (including that of the head restraints) is common to more than one seating position, the test shall be conducted simultaneously for all those seating positions. [12][13]



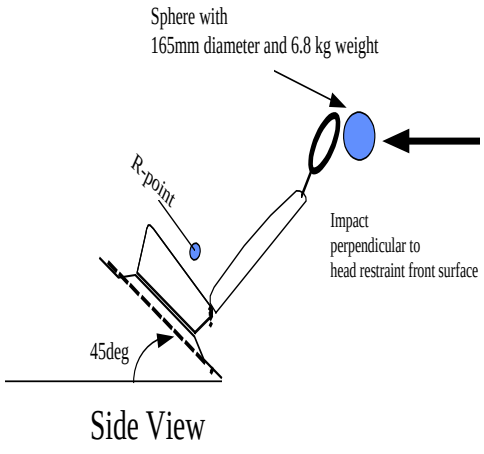
C. Head Rest Energy Absorption Test

Requirement: The deceleration (average of both accelerometers) shall not exceed 80g's continuously for more than 3ms. There shall be no breakage or sharp corners to the head restraint and seat back system. The displacement system intending for permitting/facilitating the egress of an occupant must work at least once. Purpose of this test is to verify the energy absorption effect of the head restraint system when subjected to a head form loading. [13]

Test Procedure: Load application-Impact the head restraint with a 6.8 kg, 165 mm diameter hemi-spherical head form. The impact velocity shall be equal to or greater than 24.1 kph. *Front Impact*- Assemble the seat to the test device which simulates the body floor conditions. Set the seat tracks in the most unfavourable position. Set the seat back angle to design position or close to 25°.Set the head restraint in most unfavourable position (usually full down).Set all comfort devices in the off position. Locate the impact area on the front surface of the head restraint (65 mm below the top of the head restraint at the vertical centreline).[13]



Rear Impact-Assemble the seat to the test device which simulates the body floor conditions. Set the seat tracks in the most unfavourable position.



Set the seat back angle to design position or close to 25°.Set the head restraint in most unfavourable position

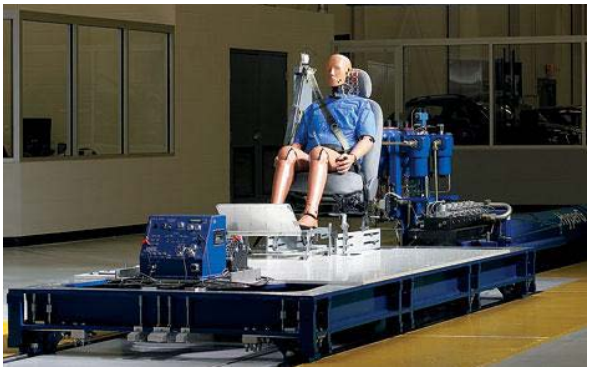
(usually full down).Set all comfort devices in the off position. Locate the impact area on the rear surface of the head restraint (at an angle of 45° at the vertical centreline). [13]

D. Forward & Rearward Impact Test (SLED)

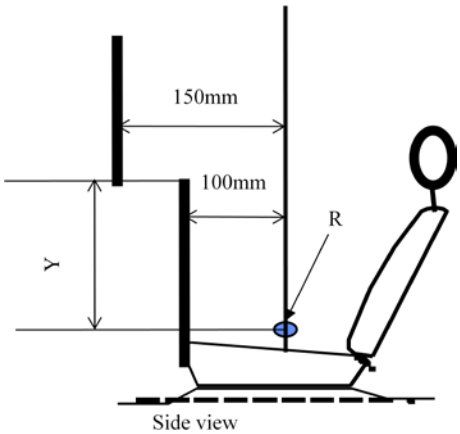
Requirement: The seat shall withstand a 20 g impact in the forward and rearward direction for not less than 30ms. No breakage in the seat frame, seat anchorage, adjustment/displacement /locking systems. No release of any locking system shall occur during the test. The displacement system intending for permitting/facilitating the egress of an occupant must work at least once. [12][13]

Test Procedure: Load application- Subject the BIW to a rearward impact acceleration of not less than 20 g's for 30 ms[12][13]

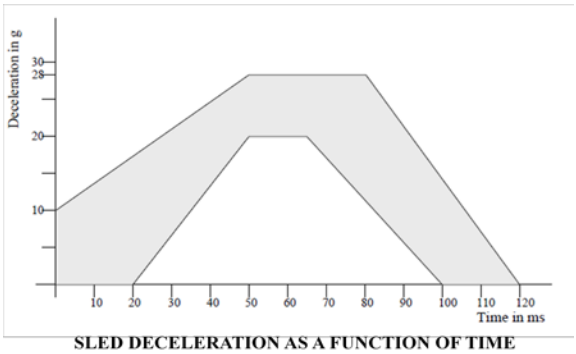
Forward and Rear Impact- Assemble the seat into a body-in-white (BIW) or fixture. Set the seat back angle to design or close to 25°.Set the head restraints to the most unfavourable position. Set the seat tracks and the cushion height adjustment to the most unfavourable position. For forward impact seat moved forward & rear impact seat moved rearward with speed between 45 km/h and 55 km/h. [12][13]



E. Luggage Retention

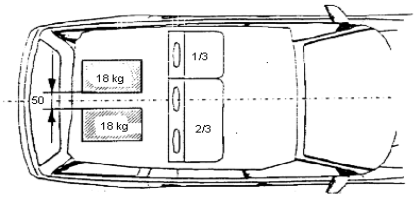


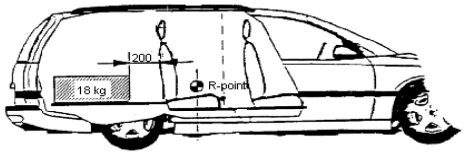
Requirement: No release of the locking systems shall occur during the test. The test blocks shall remain behind the seat backs during the test. The free impact speed shall be 50 km/h,-2/+0 km/h. Deformation of the seat backs and their fastenings during the test is permitted provided the forward contour of parts harder than 50 Shore A do not move forward of a transverse vertical plane which passes through a point 100 mm forward of the R-point and 150 mm for head restraints [12][13].



SLED DECELERATION AS A FUNCTION OF TIME (FRONTAL IMPACT)

Test Procedure: Type-1(Rear seats without gap, without partitioning system)

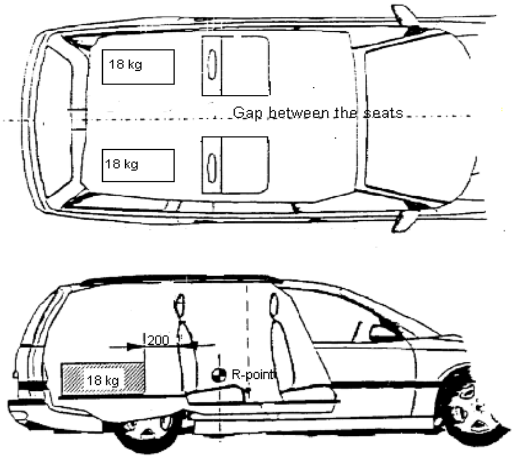




Type-2(seats with gap to each other e.g. bucket seats)

2 x 18 kg rigid block, 300 x 300 x 300mm, edges with radii of 20 mm place 200 mm rear of the rear seat (measured from the top of the block to seat back) and each block shall be 25 mm apart from the longitudinal median plane of the vehicle (in total 50 mm).Seat track position one notch or 10 mm in front of the rearmost position. Head rest position in most unfavourable position (generally the highest) [12][13]

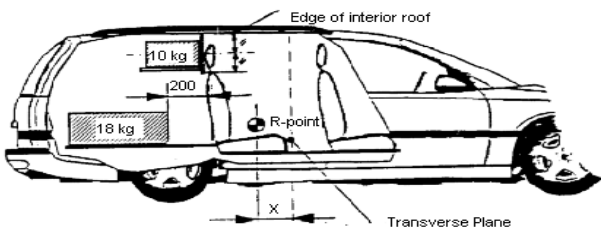
If there is a gap which could allow the sliding of one type 1 block past the seats, then the test blocks shall be installed behind the seats after agreement between the technical service and the manufacturer(50mm distance in type 1).All other test procedure is same as of type 1 [12][13]



Type-3(Seats with partitioning system)

Load 1: 2 x 18 kg rigid block, 300 x 300 x 300mm, edges with radii of 20 mm place 200 mm rear of the rear seat (measured from the top of the block to seat back) and each block shall be 25 mm apart from the longitudinal median plane of the vehicle (in total 50 mm) [12][13]

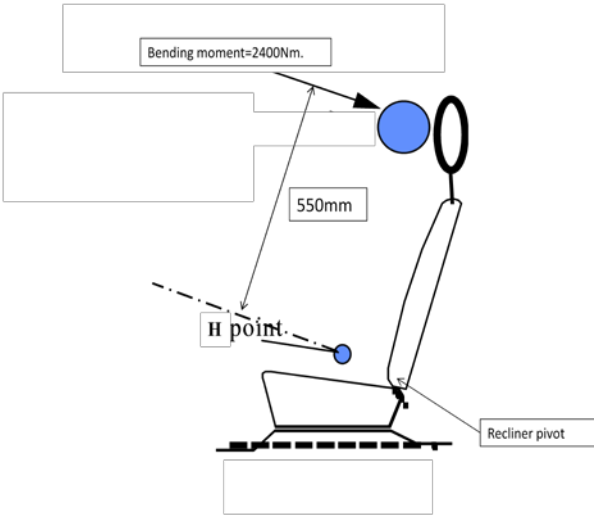
Load 2: 1 x 10 kg rigid block, 500 x 350 x 125mm, edges with radii of 20 mm place on the raised test floor with 500 x 350 mm surface to longitudinal median plane of the vehicle and with 500 x 125 mm surface to front, block are placed directly in contact with partitioning system (e.g. net) Seat track position one notch or 10 mm in front of the rearmost position. Head rest position in most unfavourable position (generally the highest) [12][13]



III. CALCULATIONS

Figure shows the typical loads we consider when designing a seat recliner mechanism. The most important load is the bending moment about the H-point. AIS015 and ECE both require 530 Nm for this load. However, most OEM's have much higher requirements. For example, one OEM requires 2400 Nm. The resistance to this load is directly related to the capability of the recliner to take rear impact load. Higher resistance means better performance in rear impact.

The load is mostly taken by the locking teeth, A-bracket, B-bracket, locking cam etc. of the recliner. Consider F is the force coming on top of seat back(550mm from H-pont) due to bending moment M=2400Nm



The load on the top of the seat back is:

F = 2400/(550/1000)

= 4364 N.

If we take safety factor as 20% over the requirement, SF = 1.2, then

M=2400 X 1.2 = 2880Nm

If per seat used two recliner, then load on each recliner is,

2880/2=1440Nm

All recliner parts should design to meet bending moment requirement specified by OEM or seat back strength regulatory requirement. By combination of part thickness, material type we can achieve required strength.

IV. CONCLUSION

Seat testing is critical in regards to a customer's perception of a vehicle. Since a seat plays such a key role in areas related to safety, durability and reliability. In frontal & rear crash accident the safety of occupant is measurably depend on seat system design. The design of seat recliner is very important because during an accident or a crash, occupants tend to be thrown back against their seat backrest due to inertial forces and if the recliner is not built to withstand such an impact, it results in failure & may cause measure injury to occupant. While designing seat recliner it is very important to consider testing such as Head rest

performance, Seat back strength, Head rest energy absorption, forward & rearward impact, Luggage retention.

V. FUTURE SCOPES.

This paper scope limited to study ECE 17 regulatory requirement for designing automotive seat recliner. There are similarly FMVSS202, FMVSS225 regulatory requirement for USA market, IS regulatory requirement for global market, AIS14/15 requirement for Indian market. Studying this all regulatory requirement will help to understand & define unique global design standard for designing automotive seat recliner.

VI. REFERENCES

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