Cockpit Parts Projection Optimization in Head Impact area as per ECE-R21 & IS 15223 Regulation.

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ABSTRACT— Severe competition in current market situation forcing automobile companies and their suppliers to reduce the development time and development costs. The biggest challenge in design phase is to predict the potential failure as early as possible and address these failures in initial design. IP design is govern mainly by functional, environmental, safety, personalization and manufacturing aspects of product. ECE R21 regulatory requirement address occupant safety by limiting 3ms head acceleration response below 80g, when head interacts with IP then IP projection should meet ECE R21 requirment. The head acceleration response is function of dynamic IP stiffness . Virtual CAE validation of ECER21 load case has shown close agreement with physical tests. The CAE validation process is time consuming because of model size, time step requirements, material nonlinearities, contact nonlinearities aspects of solution Head impact tests done on IP as part of meet the ECE R21 specification . India follow the ECE R21 and it became compulsory in 2005 for models manufactured after April 2005 and April 2006 for prototypes being manufactured before April 2005. Energy degeneracy testing of vehicle's interior fitments is done at various locations across india such as ARAI.Now in india it is compulsory that each and every car manufacturer should do the tests and verifies their product to comply with the energy dissipation and projection principles as mention in ECE R21

Keywords— ECE R21,CAE,IS,IP.

I. INTRODUCTION

Occupant interactions with interior parts such as Instrument panel, console, trims etc are addresses briefly by regulations ECE R 21 and IS15223 . The main requirement of these regulations to address head injuries and emphasis is given to keep these injuries below target injury. The damage response function is function of stiffness of Instrument panel. ECE-R 21 covers the "uniform provisions concerning the approval of vehicles with regard to their interior fittings". A part of this regulation, covers defaults for deceleration of an occupant head after impacting on cockpit assembly. A steel ball is used as test piece. For the approval test an extreme deceleration should not be more than 80 g during a continuous period of 3ms. In these tests it frequently damages cockpit, which required high set-up cost as well as time at larger test series. By using old measuring technique only the results after the test are measureable. Initiation of the actual impact test and thus the simple information for a possible perfection mostly remain un-identified. Here the replication can be used for a better analysis of the kinematics at a crash and accumulate and evaluate enhancements based on them. Main objective of use of simulation is to save time and cost by providing fast alternative formation without part availability of the cockpit

EXAMPLES OF HEAD IMPACT POINT :

Fig.1 Head Impact point

II. METHODOLOGY

Procedure to determine head impact region:
Step 1.

The head impact zone cover area of non-glazed surfaces of car interior which can arriving into static contact with a spherical head of 165 mm diameter that is an primary part of a measuring device whose distance from the pivotal point of the hip to the highest of the head is adjustable in range of 736mm and 840 mm.

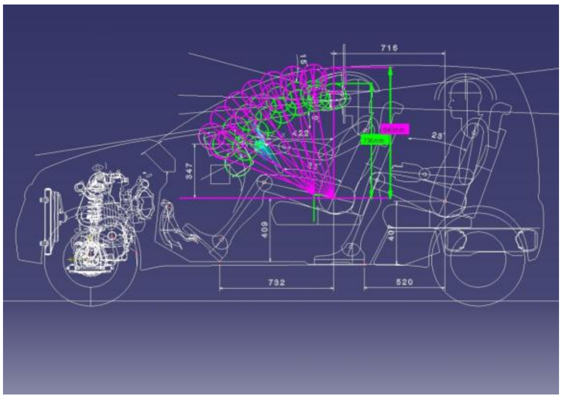


Fig2. H-point at design and forward condition as per ECE R21

Step 2. The pivotal point of the measuring In the Circumstance of Non-moving Seats At the location of H-point of seat.
In Case of Moving Seats: Point located horizontally 127 mm onward of the H-point, whichever at a height resulting from the deviation in the elevation of the H-point affected by a frontward shift of 127/19 mm

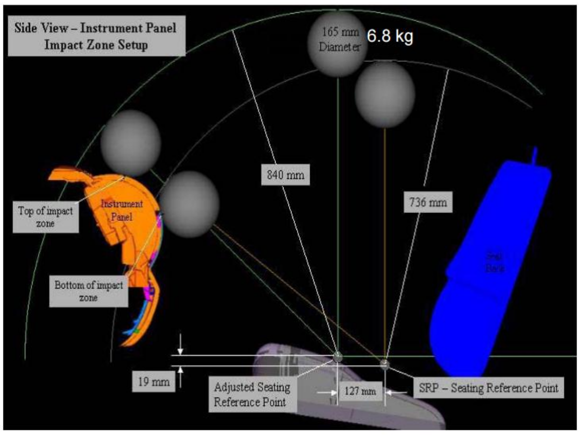


Fig3. Head impact zone mapping in case of sliding seat

Step 2.1 Short Arm Zone of R736mm and considered R82.5mm fillet for Head form radius as per ECE R21.
Step 2.2 Long Arm Zone of R840mm and considered R82.5mm fillet for Head form radius as per ECE R21

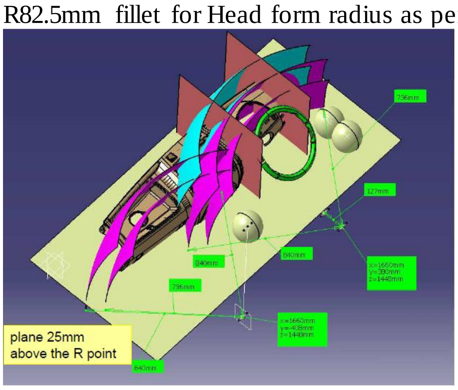


Fig 4. Head Impact zone mapping in CATIA V5

Literature Review :

A brief review of resent research supporting this paper is presented below. Anindya Deb et al., worked on "A lumped parameter-based approach for simulation of automotive head form impact with countermeasures". A new nonlinear lumped mass Model has been presented for simulating head form impact with rotation on a stiff target with countermeasure for HIC reduction. This paper deals with a new nonlinear lumped parameter model that can serve as a preliminary design tool. Knotz Christoph, et al., worked on "Virtual aided development process according to FMVSS201u". A reliable, fast and robust methodology is shown to deal with impactor testing on the virtual testing side. They have showed a complete virtual development process for the FMH regulation (FMVSS 201U), where a combination of self-developed and standard software has been used.

The ECE (resp. UNECE) is the United Nations Economic Commission for Europe. It specifies regulations for uniform minimum standards in its member countries, which have to be fulfilled during the permission of motorcar types.

The regulation ECE-R21 contains uniform provisions concerning the approval of vehicles with regard to their interior fittings. The scope of this regulation contains: Interior parts of the compartment (excluded rear-view mirror) arrangement of the controls, roof and sliding roof, seat-back and rear part of the seats. The defined reference zone shall exhibit no dangerous roughness or sharp edges likely to increase the risk or severity of injury to the occupants. Basis for the verification is a sphere with a diameter of 165mm that will roll off on the cockpit. Parts, which cannot be contacted by this sphere, will not be verified for their surface integrity.
In addition for fulfillment of the ECE-R 21 the cockpit has to pass a head-impact test. The head-impact zone comprises all the non-glazed surfaces of the interior of a vehicle, which are capable of entering into static contact with a spherical head 165mm in diameter. This is an integral part of a measuring apparatus whose dimensions from the pivotal point of the hip to the top of the head is continuously adjustable between 736mm and 840mm.
The head form shall strike the test component at a speed of 24,1 km/h or with 19,3 km/h at parts, which contain a non-filled airbag (e.g. impact on the airbag cap).

The test apparatus consists of a pendulum whose reduced mass at its center of percussion is 6,8 kg. The lower extremity of the pendulum consists of a rigid head form 165mm in diameter whose center is identical with the center of percussion of the pendulum. In these kinds of head impact tests, the deceleration of the head form shall not exceed 80g continuously for more than 3 milliseconds.

Experimental Validation:

Virtual Validation:

Final Head Impact area of Cockpit:

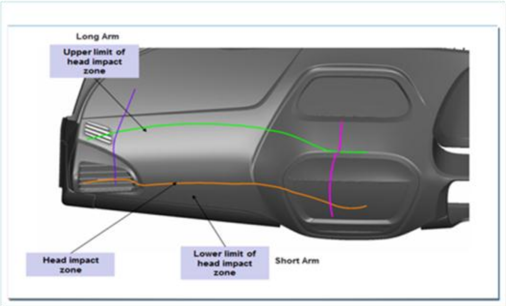


Fig5. Final head impact area

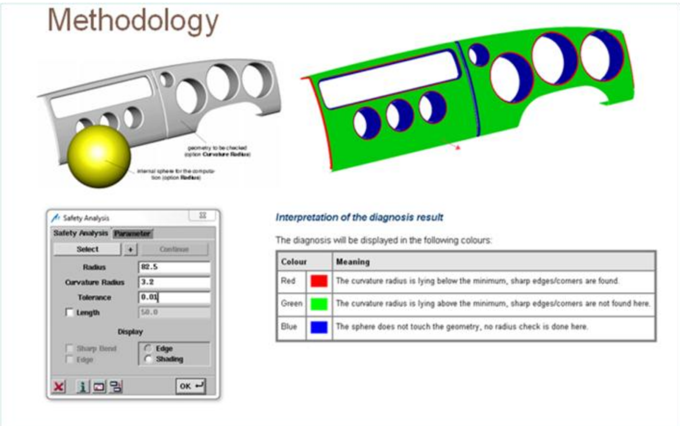


Fig6. Color indication

Virtually part Radius\Projection Measurements :

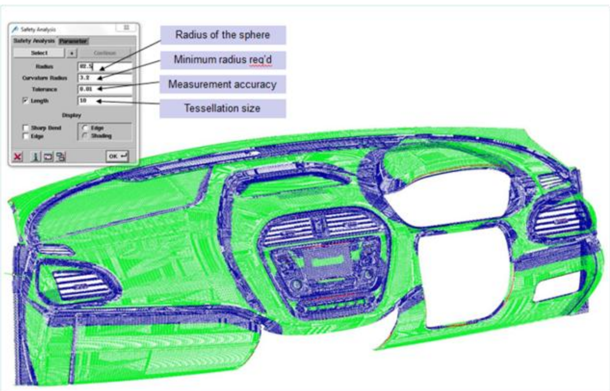


Fig 7. Virtually projection measurement

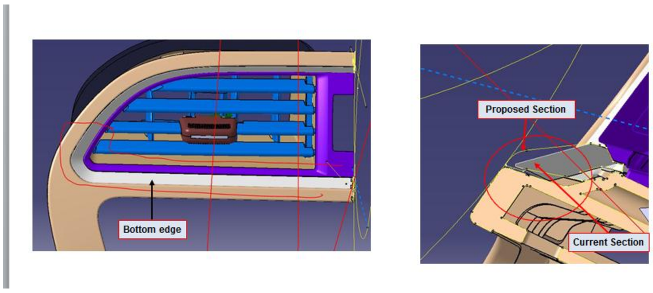


Fig.8 Proposed projection optimization Section

A cavity will be designed in the head form by dragging the ram and the traveling index will be placed beside the ram.

1) The device should be applied to the projection to be check and measured so that the head-form interact the maximum surrounding surface area and force should not be more than 2 daN.
2) Ram Should be pressed forward until it touch with the projection to be check & measured , amount of the projection should be detected on the scale.
3) Head form should be customize to detect maximum projection and that should be list down.

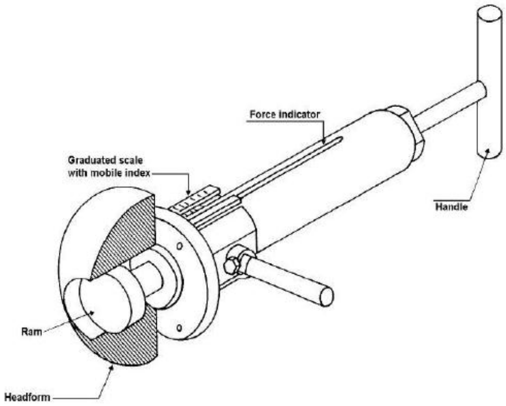
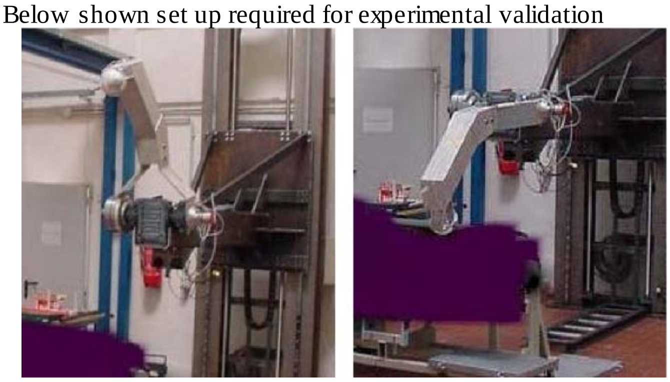


Fig 8 . Device used for measuring projections

Below shown set up required for experimental validation



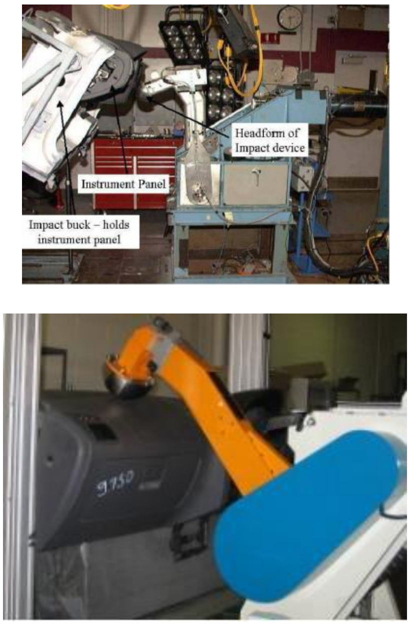


Figure 9: Testing facility Requirement of head-impact test

Actual Experimental Validation:

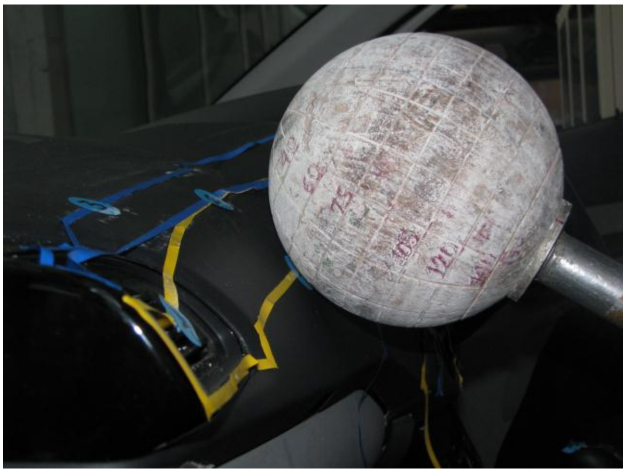


Fig 10. Experimental validation of projection

Fig11. Radius verification by using gauge (Radius is more than 3.5mm)

Result:

Actual validation of cockpit assembly meet the projection requirement of 3.2 mm radius in head impact area as per ECE R-21 and IS 15223. It improves performance robustness and avoid risk of failure due to exposure of sharp edge in head impact area in front crash condition .

A) Acceptance criteria

For parts in front of the first row seat H-point and above the level of IP.

•Reference zone should not contain any unsafe sharp edges.

•Parts within the reference zone should be energy dissolving

•Supportive metal fittings should not have sharp edges come out.

• If any part of cockpit assemblies is develop by material less than 50 shore A hardness, with support. Test for energy degeneracy shall relate only to the rigid support. Smooth material with hardness lower than 50 shore A Should not cut during exact head impact test. For the approval of ECE R21 requirement test a extreme deceleration of 80 g during a continuous duration of 3ms should not be surpassed.

Radius Requirement

SR. NO.	DISCREPTION	PROJECTION (mm)	CONDITION	RESULT	C/S AREA (cm2)	MEASURED LENGTH (mm)	RADIUS (mm)
	FORWARD INTERIOR PARTS OF THE PASSENGER CAMPARTMENT ABOVE THE LEVEL OF THE INSTRUMENT PANEL IN FRONT OF THE FRONT SEAT H-POINT.						
1	Lower edge of instrument panel						≥ 19
2	Switches, pull-knobs	3.2 - 9.5			≥ 2	2.5mm from the point projecting farthest	≥ 2.5
3	Switches, pull-knobs	if > 9.5	longitudinal horizontal force of 37.8 daN delivered by a flat ended ram of not more than 50 mm diameter.	retract to the surface of panel until they do not project by more than 9.5mm or to become detached	≥ 6.5	6.5	No dangerous projections of more than 9.5 shall remain.
	FORWARD INTERIOR PARTS OF THE PASSENGER COMPARTMENT BELOW THE LEVEL OF THE INSTRUMENT PANEL AND IN FRONT OF THE FRONT SEAT H-POINT.						
4	Shelves :-Part facing the vehicle	≥ 25mm high					≥ 3.2
	Shelves		forward acting horizontal longitudinal force of 37.8 daN exerted by a cylinder of 10mm dia .diameter with its axis vertical	become detached, break up, be substantially distorted or retract without producing dangerous features on the rim of the shelf. The force must be directed at the strongest part of the shelves or other similar items.			
5	Interior fittings in the passenger compartment : control handles, levers, knobs						≥ 3.2
6	Control levers, knobs		forward acting longitudinal force of 37.8 daN	≤ 25 or become detach or bend			no dangerous projections shall remain
7	Window winders		forward acting longitudinal force of 37.8 daN	≤ 35 or become detach or bend			no dangerous projections shall remain
	Hand brake controls		Release position		≥ 6.5	6.5	≥ 3.2
	Grab handle, lights, sunvisor etc		(The metal wires which stretch the lining of the roof and the frames of the sunvisors must have a maximum diameter of 5 mm)				≥ 3.2

Table No. 1

Conclusion :

Actual validation of cockpit assembly meet the projection requirement of 3.2 mm in head impact area as per ECE R-21 and IS 15223.It improve performance robustness and avoid risk of failure due to exposure of sharp edge in head impact area in front crash condition. Virtual validation help to reduced overall cost development cost and help to produced part first time right.

Initial design model of a cockpit assembly projection need to be improved as per ECE-R 21 regulations to meet head impact requirement. On the basis of standard model for a cockpit it is list out that the assembly structure should be enhanced by exact measures in-line with the guidelines of the ECE-R 21. Input of the simulation has been verified as a useful utility, to guide in understanding the actions within the cockpit during the impact test. By simple variant structure and quick find out of possibilities for enhancements, the total enhancement could be completed in least time as well as least resources.

Acknowledgment

It is indeed a great pleasure to present this paper on “Head Impact study as per ECE R21 & IS 15223 Regulation ”. This provides me with the first and the best opportunity to put my engineering knowledge to practical use.

I take this opportunity with great pleasure to express my deep sense of gratitude towards our esteemed guide Prof. K.H.Munde (HOD Mechanical Engineering. Department) for his valuable guidance and incessant encouragement and co-operation extended to us during this paper work. And also thanks to Prof. G. E. Kondhalkar(HOD Mechanical Engineering. Department) for his valuable guidance and encouragement.

We would also like to thank Prof. S. B. Thakare (Principal, AnantraoPawar College of Engineering & Research, Parvati, Pune) for their unflinching help, support and cooperation.

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