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Design and Optimization of Upper and Lower Rail for Automotive Seat Track Mechanism

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ABSTRACT

Objectives of automotive industries are to design quicker more efficient vehicles & it travelling greater distances in short interval of time. Safety & comfort of passengers are very important. Tracks are the mechanisms which translate the seat. Seat track assembly is the most critical criteria in the design of seat structures in automotive industries. From all seat parts, the seat tracks (upper and lower tracks) carry most of the load on seat structure considering human load & structure load.The aim of this project is to design & optimize upper & lower rail of an automotive seat track mechanism subjecting to static analysis by changing parameters & maintain feasibility of seat track. Also, achieving the feasibility of peel offof track. Scope of the present work involves Finite Element Modeling of Seat track mechanism using FEA software like Hypermesh&Ls-Dyna. The results in the form of stress, load and displacement are extracted using FEA result. It compare with analytical.

***Keywords*— Seat track upper and lower rail, Track mechanism, Low Cost, Safety, Rail thickness, FEA, Validation.**

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I. INTRODUCTION

Generally, good automotive seating system is not only to provide comfort but also to provide style and more importantly the safety feature. Seat structures play a major role in the car passive safety. Due to their adjustment function mechanisms are generally involved in the seat failure mode.Automotive seating structures are subject to an important set of comfort and safety demands requiring the accommodation of variation of users while meeting safety standards under crash.DOF required by all seating structure designs is the forward and backward movement of the seat.Forward and backward movement is typically achieved using a sliding track assembly consisting of interlocking rail sections. Due to the random probability distribution nature of manufacturing processes, track assembly performance is affected by manufacturing variation. During last years, the ecologic legislations have led to lot of changing in the automotive industry strategy. Nowadays one of the main priorities is the reduction of car weight without impact on safety or cost. To fulfill this need, the global approach goes through a structure optimization and the use of high strength steel material. This kind of material has generally the drawback to have a more brittle behavior. Rupture is now more present during development phase. Akbar BashaS., et al [1] studied the analysis and optimization of automobile seat track by reducing the thickness of the seat track. Mahesh morge, et al [2] studied analysis and optimization of cushion seat supporting members. The seat track is analyzed using carbon steel material. In order to reduce the cost, weight and to increase the efficiency of an automobile as it is the main aim of an automotive industry; composite material is used so that there is an overall cost reduction and weight of the seat track with an increased strength and safety feature. Pavan Gupta et al [3] studied that anti-submarine performance of an automotive seating system. But the system yet is sufficiently light weight to facilitate vehicle fuel economy and to minimize collision stresses. D. M. Severy et al were [4] 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 [5] 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 [6] 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. ToshikiNonka et al [7] studied that the development of ultra-high strength cold-rolled steel sheets for automotive use. Sarah Smith et al [8] 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 [9] also studied that advanced high strength steel strategies in future vehicle structures. Seat assembly performance is one of the most important criteria in the design of Seat structures in automotive industries. The seat tracks (upper and lower tracks) carry most of the load in seat structure considering human load. During the past years, new materials and techniques have improved the comfort while simultaneously reducing their weight and cost. In line with the increased comfort and style, significant safety related improvement in seating system design has been given the priority.In this present case, work is carried out by reducing the thickness of the seat track from 1.7 thk. to 1.6 thk. and by reducing its weight with change of material. Material used in this case is different from the previous one.

I. DESIGN

A. Requirement

As per ECE17, automotive seat should pass Head rest performance, Seat back strength, Head rest energy absorption, Forward & rearward impact test, Luggage retention test etc. From this tests in seat belt anchorage testing maximum load is coming on track. As per seat belt anchorage test requirements, 13.5KN load apply on shoulder block, 13.5KN load apply on lap block & CG load of 20 times more than seat weight apply at CG point. Our aim is to design or optimize track to meet this requirement.

B. CAD Modelling

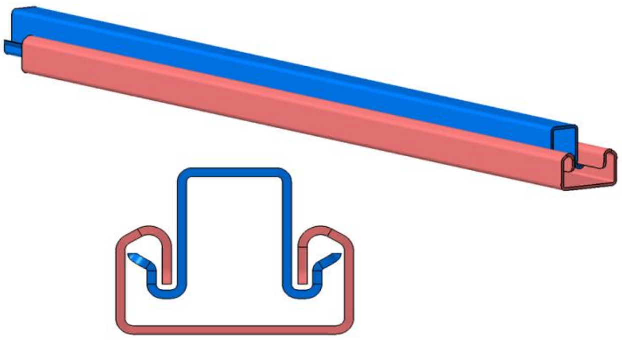

Fig 1 CAD Model of Seat Track Assembly

C. Seat track peel off Strength Calculation

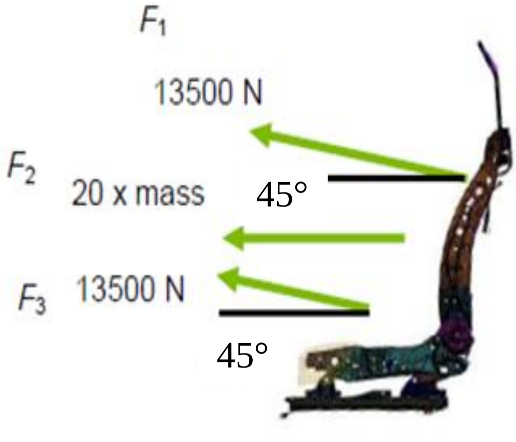

Fig2Load Acting On Seat Track Assembly

For seatbelt anchorage test, three loads are acting on seat. In which, F_1 & F_3 are seat belt load which are acting ontrack assembly. F_2 is load of seat. Now, we want to calculate load on track under seat belts. Assume, track angle is 0° from horizontal & belt load are 45°from horizontal. Also we can consider weight of seat 20kg.

Peel load (F_P) on track can be estimated as

$F_P = (F_1 + F_3)\sin 45°$

$=2 \times 13500 \times 0.707$

$=19089.2N$

We take safety factor of 30% more

Factor of safety = 1.3

Peel loadon track = $F_P \times 1.3$

= 24815.7N

=24.8KN

Peel load on individual track = 24.8/2

=12.4KN

Hand calculations shows that individual track should meet peel of strength more than 12.4KN

II. MATERIAL PROPERTIES

Mechanical properties of the material are required for finite element models. There is little information on the material properties of seat rail, recliner and few components in the literature. In this project DP800 is used for seat rail. Table 1 and 2 describes material properties used for analysis.

Table I
Existing Material& ThicknessUsed for Upper & Lower Track

Material-SAE J2340-420Y	
% Elongation	16
Density	7860kg/mm3
Poisson’s ratio	0.3
Yield strength	420
Ultimate strength	520
Thickness	1.7mm

Table II
Proposed Material& Thickness for Upper & Lower Track

Material- DP 800	
% Elongation	17
Density	7860kg/mm3
Poisson's ratio	0.3
Yield strength	490Mpa
Ultimate strength	785Mpa
Thickness	1.6mm

III. STATIC ANALYSIS

A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads.Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Finite element method is a numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Although originally developed and applied to the broad field of continuum mechanics. Because of its diversity and flexibility as analysis tool, it is receiving much attention in engineering schools and industry. In more and more engineering situation today, it is necessary to obtain numerical solutions to problem rather than exact closed from solutions. For FEA result, we used Hypermash & Ls-Dyna. The material properties are defined. In an elastic analysis of an isotropic solid these consist of the Young's modulus and Poisson's ratio of the material. Then the structure is meshed into small elements. This involves defining the types of elements into which the structure will be broken, as well as Specifying how the structure will be subdivided into elements. Apply boundary condition and external loads.Then the solution is generated based on the previously input parameters. In post processing, forobtaining result used Ls-Dyna software.

A. *Loading condition*

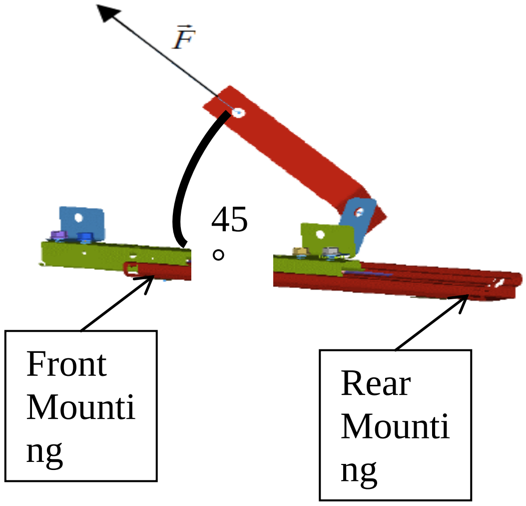

Fig 3 Load Condition On Seat Track for Peel Off

Two mountings, front & rear considered fix to BIW. Load is applied at 45 degree angle & increased till peel off.

B. *FEA iteration I*

Material- SAE J2340-420Y

Upper & lower rail thickness-1.7mm

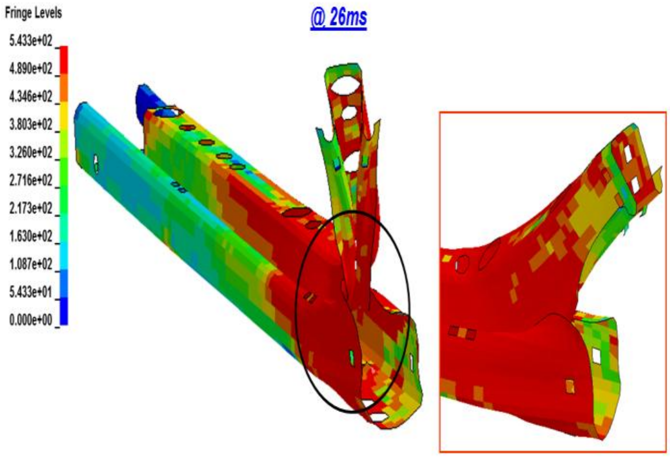

Fig 4 FEA for 1.7mm thk Seat Track Assembly

Von Mises Stress contour in upper & lower track Weight for track assembly is 1.113 Kg.Stresses which are more than 420MPa are shown in red colour.The IB Upper Track is started to peel around 16.2KN of load. The maximum average stress value in the IB Track is 695MPa which is more than the material yield value of 420MPa and more than the ultimate value of 520MPa.Material yield is observed.

C. *FEA iteration II*

Material- DP 800
Upper & lower rail thickness-1.6mm

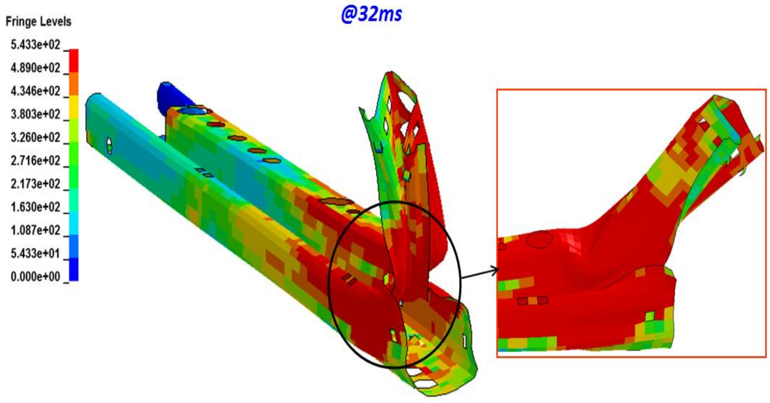

Fig 5 FEA for 1.6mmthkSeat Track Assembly

Von Mises Stress contour in upper & lower track.
Weight for track assembly is 1.032 Kg.Stresses which are more than 490MPa are shown in red colour.The IB Upper Track is started to peel around 16.0KN of load. The maximum average stress value in the IB Track is 720MPa which is more than the material yield value of 490MPa and less than the ultimate value of 785 MPa. Material yield is observed.

IV. EXPERIMENTAL SETUP

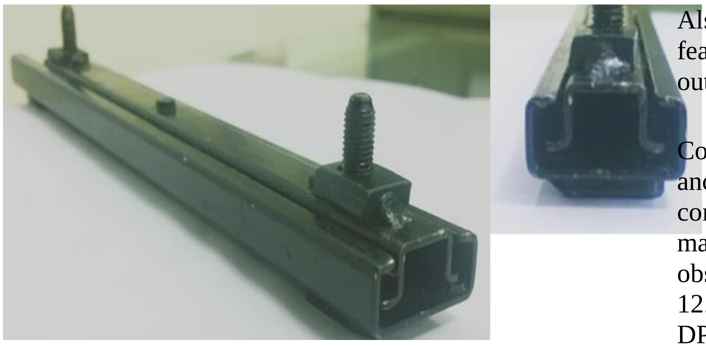

Fig 6Seat track assembly with fastener attachment

Fig 7Experimental Setup of Peel Off test for Seat track assembly

Fig no. 6 shows seat track assembly with tooling& fastener attachment use for experimental setup, which is manufacture by stamping process as per design of track. Stamping process of seat track for both upper and lower track done with different compoundtool. For experimental test setup to find peel off strength of track assembly shown in fig no.7 which is applicable for all type of seat track. In this setup front & rear mounting attach with track by using fastener which is already shown in fig no 6. And load applied to seat track assembly at 45° around 12.4 KN as per calculation. After applied force to track assembly with increasing force above 12.4 KN peel off of track not started. It started to peel off of track system above 15.8 KN loads, which is feasible condition for present seat trackassembly.

V. RESULT SUMMARY

Sr. No.	Method	Condition	Load	Weight
1	Hand Calculation	Complete seat load	12.4KN	
2	FEA-I	Individual track-Material -SAE J2340-420Y,1.7mm Thk.	16.2KN	1.113 Kg
3	FEA-II	Individual track-Material-DP800,1.6mm Thk.	16.0KN	1.032 Kg

Also, by using experimental test of peel off test, we obtained feasible result for seat track assembly to achieve required output.

VI. CONCLUSIONS

Considering complete seat loading condition as per seat belt anchorage requirement, hand calculation shows 12.4KN load coming on individual track.FEA iteration I shows by using material SAE J2340 420Y, 1.7mm Thickness. Track peel off observed at load 16.2KN which is more than calculated load 12.4KN.Similarly, in FEA iteration II shows by using material DP800, 1.6mm Thickness. Track peel off observed at load 16.0KN which is more than calculated load 12.4KN. By experimentally, after applied force to track assembly with increasing force above 12.4 KN peel off of track not started. It started to peel off of track system above 15.8 KN loads, which is feasible condition for present seat track assembly.

With this study it observed that by using DP800 material only 0.2KN peel off strength reduction which is acceptable & gives measure weight reduction as we are reducing thickness from 1.7mm to 1.6mm

VII. ACKNOWLEDGMENT

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