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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 off of track. Scope of the present work involves Finite Element Modelling 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.

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.

II. SYSTEM MODEL

As per ECE 14 & 17 automotive seat regulation, automotive seat should pass Head rest performance, Seat back strength, Head rest energy absorption, Forward & rearward impact test, Luggage retention test etc.ECE R14 and FMVSS 210 are tests to ensure the strength of the seats, the seatbelts and the anchorage points. Therefore, test loads are applied over loading devices, so called body blocks, see Figure 2.1, and transferred by the seatbelts to the vehicle structure. Loading devices are not tied to the seatbelts or the seats, contact and slipping between all parts can occur. Therefore these parts (seat, seatbelt, slip ring, loading device) build a complex kinematic system and the configuration under load determines the distribution of the applied loads to the anchorage points. Hence correct modelling of the kinematics is essential for significant and accurate computational results. There are mainly two differences between the European ECE R14 and the FMVSS. The ECE R14 classifies the vehicles on basis of their maximum allowed weights and requires them to sustain different loads dependent on their weight (see Table), whereas in tests according to FMVSS 210 the same loads are applied to all vehicles.

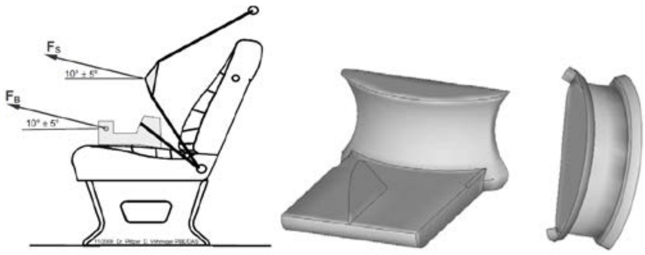


Fig. 2.1 Seatbelts and the anchorage points

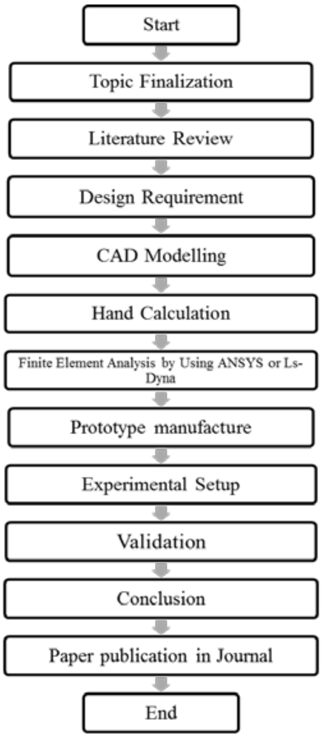
TABLE 1: CLASSIFICATION OF VEHICLE AND TEST LOADS

	Classification		
	N1: m < 3.5 t	N2: 3.5 < m < 12 t	N3: m > 12 t
Shoulder Block	13.5 kN	6.75 kN	4.5 kN
Lap Block	13.5 kN	6.75 kN	4.5 kN
Seat	20 x seat weight	10 x seat weight	6.6 x seat weight

III. PREVIOUS WORK

From literature review it clearly understood that significant seat track system need for regulatory requirement for automotive industry. The numbers of papers have given thickness of seat track rail, peel off load either theoretically or experimentally. The few papers gave the effect of material of track on seat belt anchorage test. Few authors have explained effect peel off strength effect on seat track assembly life cycle. But, apart from this seat track with change in material and thickness also key area for automotive industry. Nobody has worked on this topic. So, in my project work focus on seat track rail thickness and change in material with proper validation of component which is eligible for seat regulatory requirement of automotive industry globally.

IV. PROPOSED METHODOLOGY



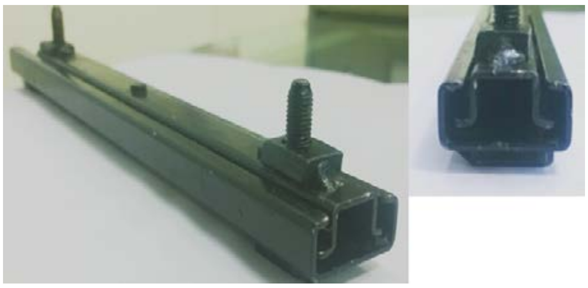


Fig. 4.1 Prototype model

V. SIMULATION/EXPERIMENTAL RESULTS

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 :

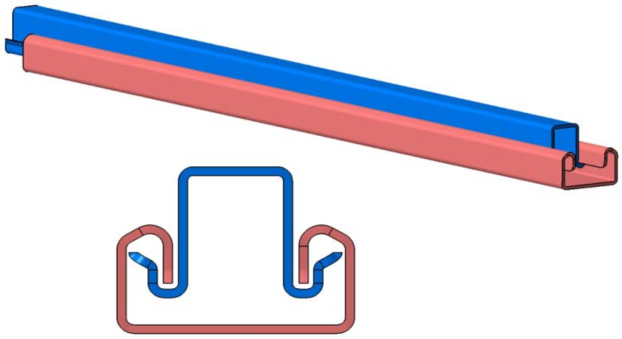


Fig 5.1 CAD Model of Seat Track Assembly

C. Seat track peel off Strength Calculation

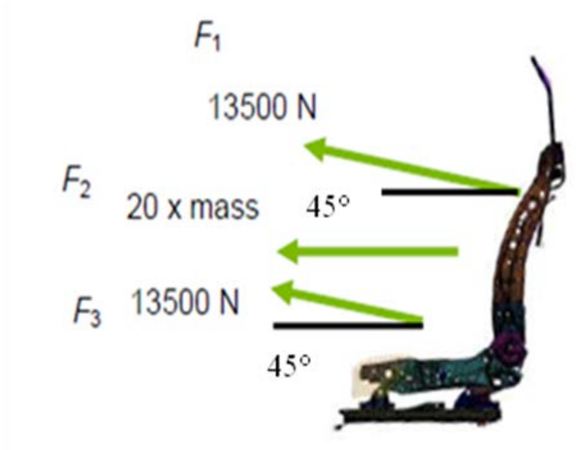


Fig 5.2 Load Acting On Seat Track Assembly

For seatbelt anchorage test, three loads are acting on seat.In which, F_1 & F_3 are seat belt load which are acting on track 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 load on 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

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, for obtaining result used Ls-Dyna software.

A. Loading condition

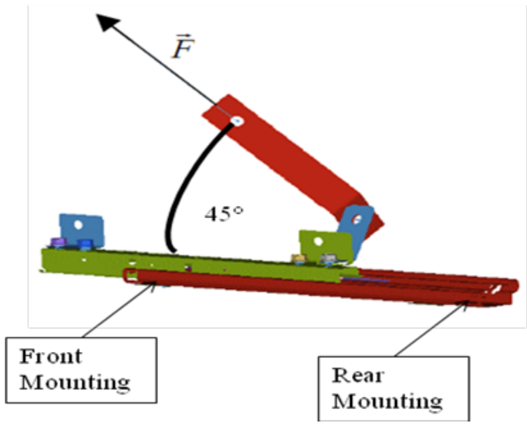


Fig 5.3 Load Condition On Seat Track for Peel Off

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

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.

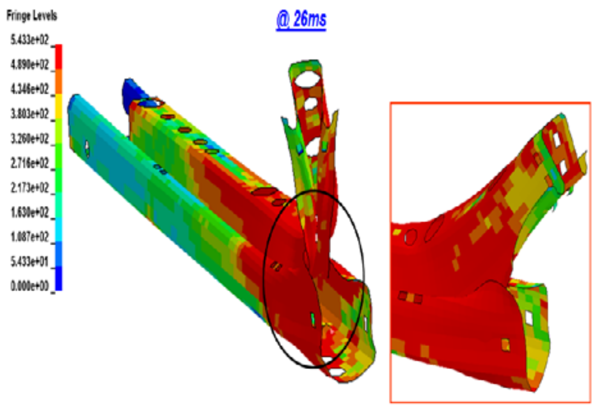


Fig 5.4 FEA for 1.7mm thk Seat Track Assembly

C. FEA iteration II

Material- DP 800

Upper & lower rail thickness-1.6mm

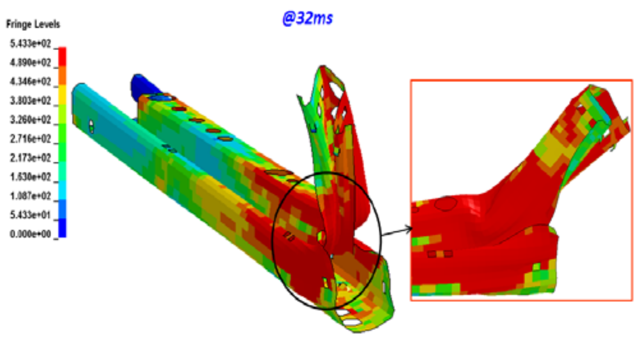


Fig 5.5 FEA for 1.6mm thk Seat Track Assembly

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.

Fig 5.6 Experimental setup for peel off test for Seat Track Assembly

TABLE 2. RESULT SUMMERY

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. CONCLUSION

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. FUTURE SCOPES

As per regulatory standard, current seat track rail has been developed & validated. But as per OEM's specification, additional requirements are, seat should comply with are as durability- for full forward position of track, durability- for full backward position of track and validation with different track profile. To check whether track is complying with above requirements, respective forces need to be resolve for hand calculations. Dynamic FEA needs to be done accordingly.

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