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Design and analysis of B pillar as per FMVSS 216 using finite element method

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ABSTRACT

Indian roads are one of the longest and busiest in the world after United States. Every day Indian roads transport 65 percent freight and over 85 percent of passenger vehicles. Indian Automotive sector secure its position on forth in Asia with 3.5 million new vehicle registrations, along with that accident fatalities also increase in our county, Road accident is a leading cause of death, and India raked at top in road accident death across 199 countries and account for almost 11% of accident in the world. As per National Highway Traffic Safety Administration more than 250,000 car rollover accidents happen and more than 10,000 individuals are killed. It has been observed that car rollover is a worst of all other accidents because occupant has to suffer with series injuries like Head injury, neck injury and spine injury. To avoid this type of fatalities we have to ensure our BIW should sustain that type of load during accident specifically B pillar designed to absorb energy with minimum amount of deformation to avoid intrusion in passenger compartment for that B pillar has been developed using composite material. The purpose of this Research work is to perform the roof crush analysis as per FMVSS 216 using Ls-Dyna explicit code.

1 INTRODUCTION

Today automotive industries face many different challenges to survive like reduce vehicle emission, improve fuel efficiency, increase passenger safety for that composites material became important topic to discuss for innovative engineering solutions having big advantage over steel, especially composite are being considered to make lighter vehicle without compromise with strength which may help to develop more fuel efficient vehicle with lighter weight. In general composites are made up of high performance fibers such as carbon and glass fiber, which are embedded in a complex polymer matrix that when combined enhance mechanical strength compared to individual one. As per research composite material weight is about one fifth of stainless steel with same strength and stiffness.

The necessities for roof crush safety of an automobile are defined in Federal Motor Vehicle Safety Standard (FMVSS- 216). The motivation behind the standard is to reduce injury and wounds coming about because of the breakdown of the top into the passenger's compartment in a rollover accident. A force is executed quasi-statically to the side of the forward edge of the vehicle top structure through a vast force plate with suitable dimension according to NHTSA (National Highway Traffic Safety. Administration). Exact and productive limited component demonstrating of the top pound safety test can encourage the outline of more secure automobiles and additionally lessen advancement and testing expenses. Safety standard FMVSS-216 was made to build insurance from Rollover of a car in accidents. FMVSS-216 looks to diminish passing and genuine wounds coming about because of the top being smashed and pushed into the tenant compartment when the top strikes the ground amid rollover crashes.

2 FINIT ELEMET MODEL OF BIW

The full vehicle finite element model is modeled in HYPERMESH preprocessor, only body in white of a car has been used excluding interior and exterior trims because it has a negligible effect on the overall roof crush resistance response. In our methodology, we have used linear steel as a rigid material with card image MAT 20 In LS DYNA and properties with suitable stress- strain value has been executed for the force plate. Laminated glass has been used for the front and rear mirror and side window as well and used MAT 24 for all deformable parts with suitable stress strain values.A rigid plate was modeled with the dimension according to NHTSA and targeted over the roof also is put longitudinally at an edge of 5 degree to the level towards the front of the vehicle pivot is at a detachable point of 25 degrees beneath the flat. According to IIHS (insurance institute of highway safety) plate should bear the load of unloaded vehicle up to 4 times. This type of plate will be come under the good plate rating. Force will be applied according to Gross vehicle weight rating (GVWR) and the platen displacement should not exceed over 127mm for the safety purpose.

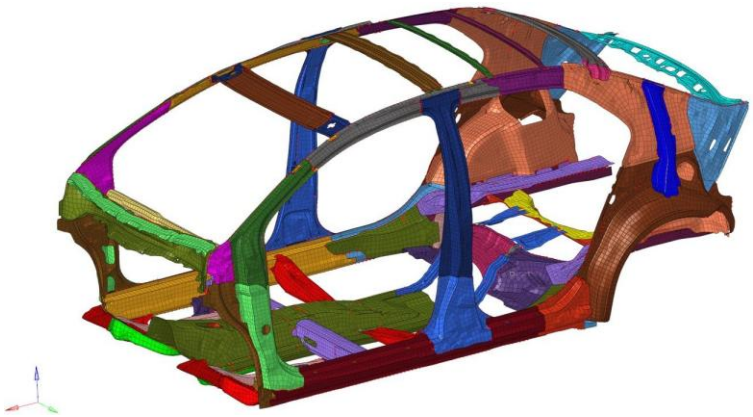

Fig 1 Meshed model

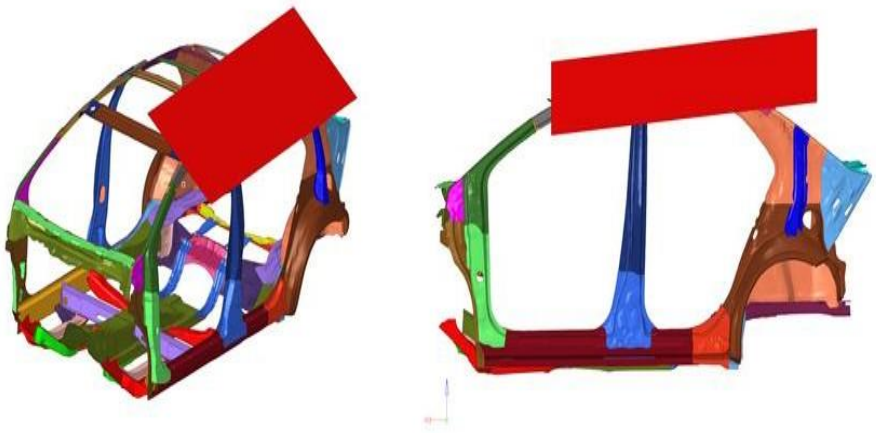

Fig 2 Boundary conditions

3 LOADING CONDITION

Placed the body frame of the vehicle on a rigid horizontal surface and fixed the vehicle rigidly in position by the use of SPC (single point constraints) and assumed all the windows are closed and all the doors are locked. Then apply Apply force in a downward direction perpendicular to the lower surface of the test device at a rate of not more than 13 millimetres per second until reaching a force in newtons of 1\1/2\ times the unloaded vehicle weight of the tested vehicle, measured in kilograms and multiplied by 9.8 or 22,240 newtons, whichever is less and then find out desired results of our simulation. Much iteration have been performed by varying the thickness of sheet metal and pillars and then resultant displacement has been measured over LS- DYNA PREPOST until it does not come less than 127mm which is desirable for the safety point of view.

4 RESULTS

As shown in results Structure not enough capable to carrying load because result we have observed the maximum displacement on B pillar is 224 mm and it should be below than 127mm as per FMVSS 216. To avoid that failure we have to make some modification in BIW structure, so we are using composite material in B pillar.

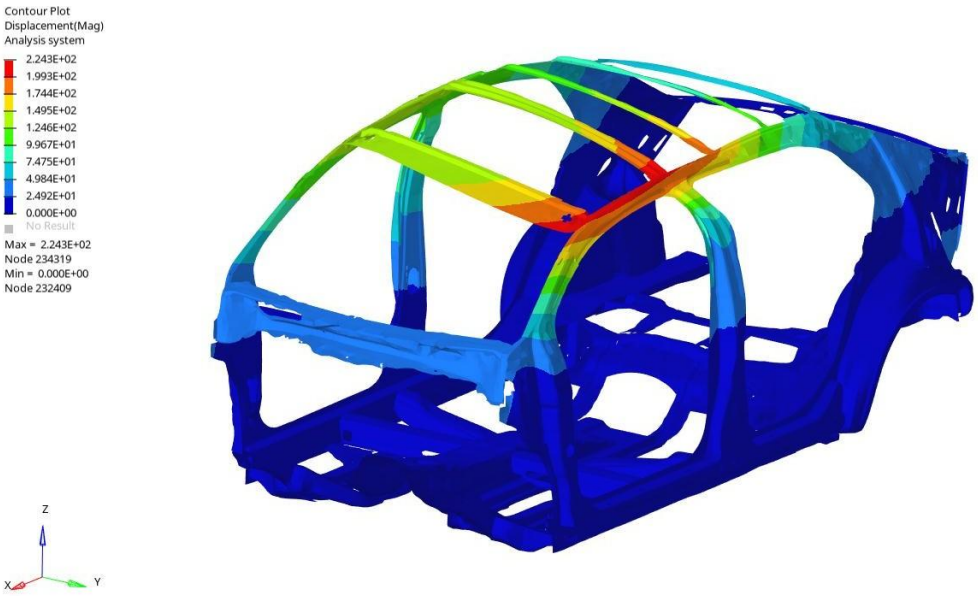

Fig 3B pillar Deformation

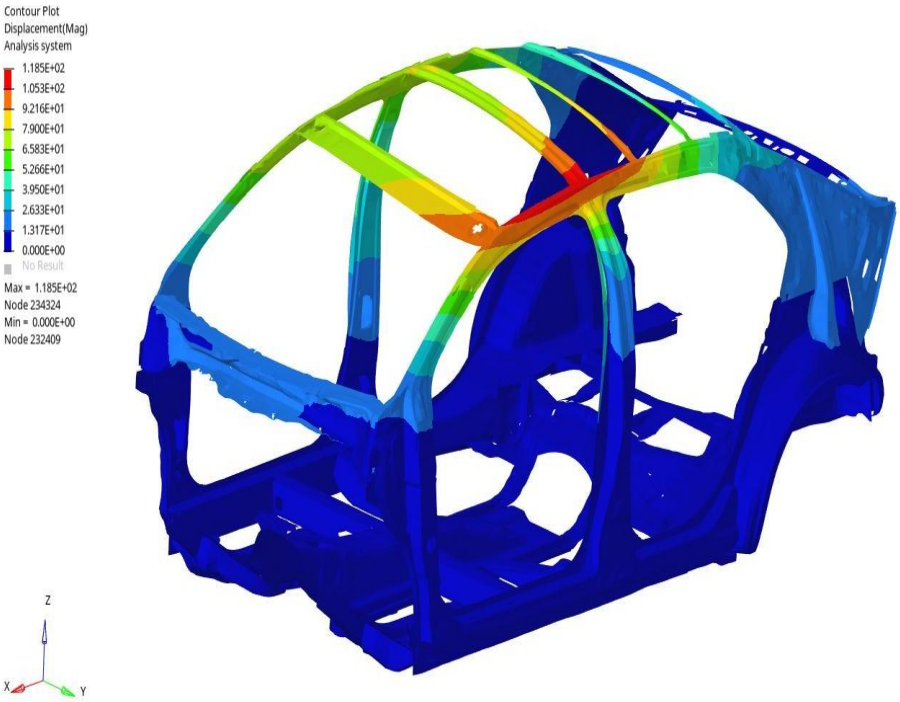

Fig 4 B Pillar Stress

As we can observe after modification we got maximum deformation value is 118 mm only which is less than 127mm, so this design meet the regulation standard.In Dynamic analysis According to law of conservation of energy, the energy neither be created nor be destroyed it changed from one from to another. We can validate our finite element analysis results by energy balance curve as shown in figure below.

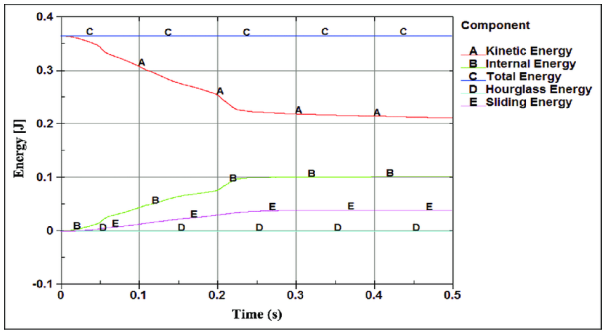

Fig 5 Energy balance curve

Total energy reported in GLSTAT is the sum of internal energy, kinetic energy, sliding interface energy and hourglass energy

5 CONCLUSION

With the help of CAE tools it's become easier to perform numerical analysis on real automotive components like B pillar. B pillar plays an important role in case of side impact or roof Crash happened. In this research work we observed composite material may be used as a alternative in the vehicle B-Pillar because it's helpful in reducing risk of injuries on the occupant.

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