Midas NFX project application

Free Motion Headform Impact analysis - FMVSS201U

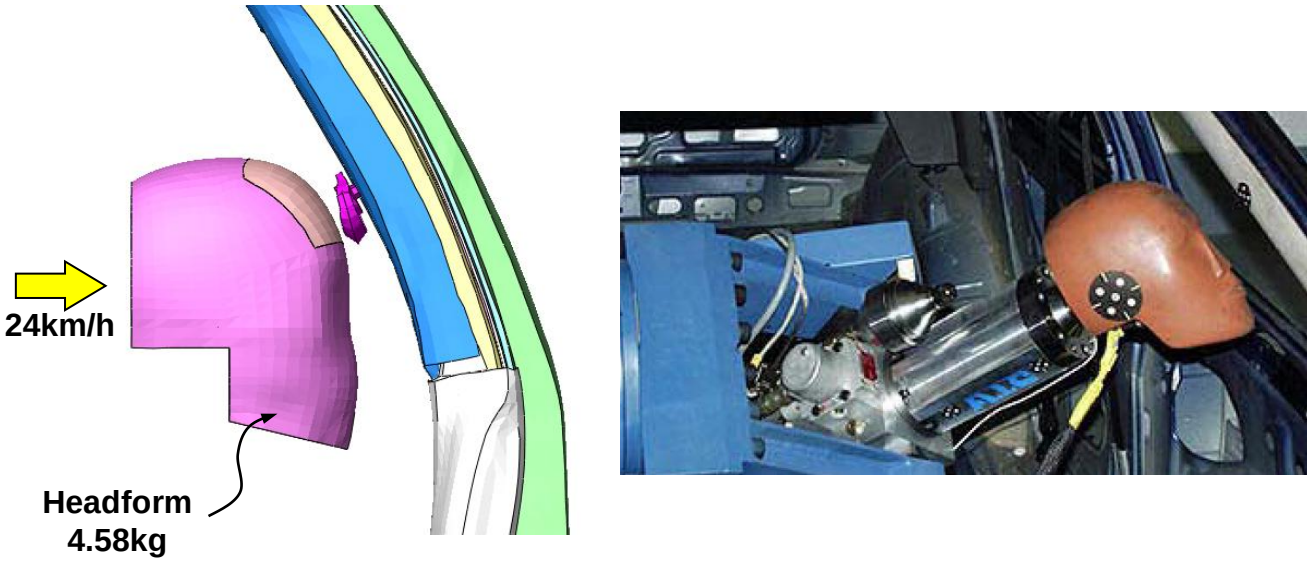

Figure 1.1 FMVSS201U - Federal Motor Vehicle Safety Standard

Analysis and development of countermeasures in meeting vehicle upper interior free motion headform (FMH) impact safety requirement (FMVSS 201) has become an important aspect for engineers. FMVSS 201 safety regulation stipulates that the Head Injury Criterion, HIC (d) should be less than 1000 when a FMH is impacted at a speed of 15 mph. The interior components of a vehicle generally do not generate high HIC (d) numbers by themselves but the steel structures behind them to which they are attached do so. The gap between the interior component and the steel structure makes a provision for the introduction of some countermeasures which can absorb the kinetic energy of the FMH in the form of internal energy so that the acceleration response of the FMH does not generate high HIC (d) and Peak G force[1].

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Federal Motor Vehicle Safety Standard (FMVSS) 201 upper interior head impact protection specifies the requirements to afford impact protection for occupants. This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, busses with a GWR of 10,000 pounds or less. The criterion for compliance to FMVSS 201 is based on Head Injury Criterion (HIC (d)) which is calculated from the center of gravity of the head resultant acceleration. The performance criterion set by FMVSS 201 is that the HIC (d) shall not exceed 1000 when calculated in accordance with the formula[1]:

$$HIC(d) = 0.75446\,(Free\ Motion\ Headform\ HIC) + 166.4$$

$$HIC = (t_2 - t_1)\left[\frac{\int_{t_1}^{t_2} A_R\,dt}{(t_2 - t_1)}\right]^{2.5}, A_R = \sqrt{A_x^{\,2} + A_y^{\,2} + A_z^{\,2}}$$

Figure 2.1 FMVSS201U - Federal Motor Vehicle Safety Standard

Finite Element Analysis (FEA) is an effective tool which is used to study and develop new concepts and reduce prototyping costs. By the use of FEA, many alternatives could be tried and parametric studies can be easily carried out. The main objective of this study was to analyze, compare and summarize the FMVSS 201 correlation study done on some countermeasures. The main aim was to compare the finite element analysis results to the test results as per the FMVSS 201 specifications in terms of HIC(d) and Peak Acceleration values and also to develop a methodology for simulating safety plastic accurately in computer simulations using a Finite Element Codes[1].

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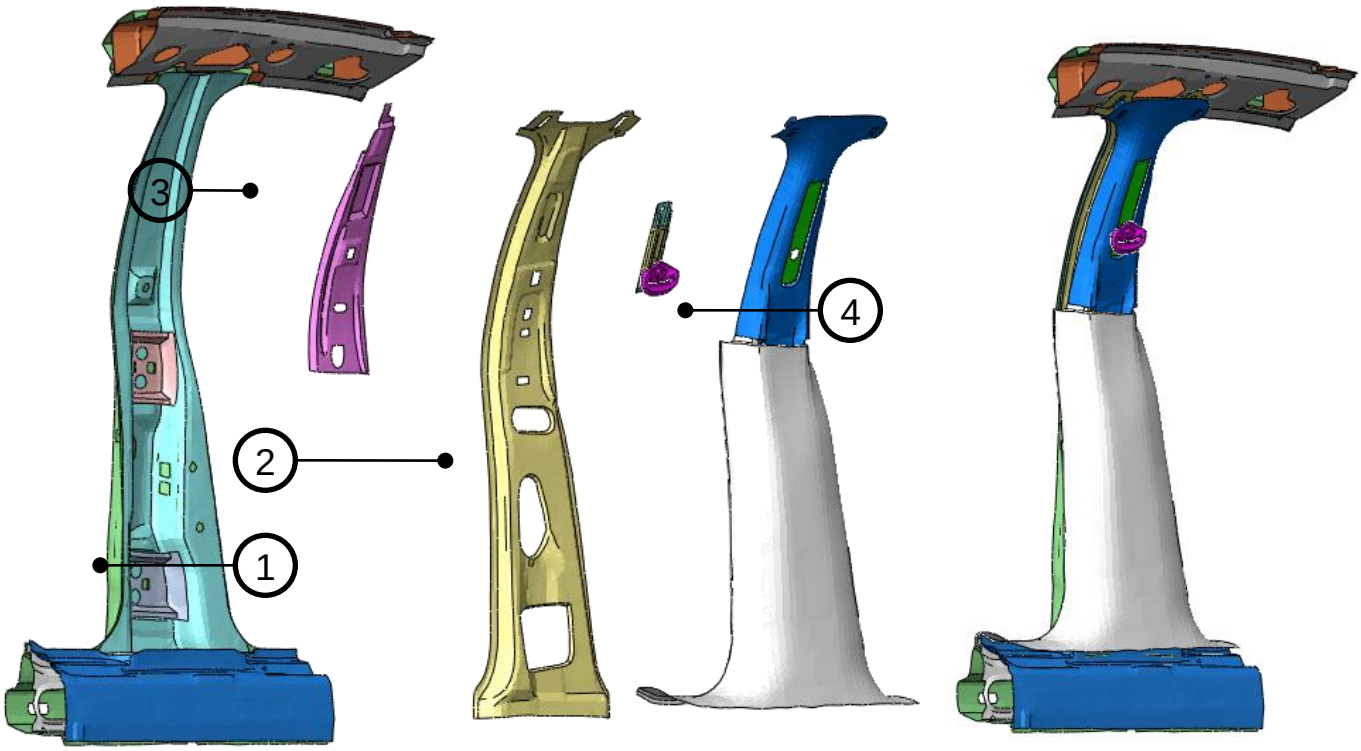

Figure 3.1 B-Pillar Structure

	Part	Thickness (mm)	modulus of elasticity (N/mm^2)	Poisson's ratio	Density (kg/mm^3)	Plasticity curve
1	REINF_B_PILLAR	1.1	210000	0.3	7.89e-6	300Y
2	PNL_B_PILLAR_INR	1.15	210000	0.3	7.89e-6	300Y
3	STIFFENER_UPR	1.55	210000	0.3	7.89e-6	300Y
4	GARNISH_UPR	3.1	2800	0.3	1.2e-6	45Y

Figure 3.2 Nonlinear material properties

Nonlinear Material properties used for the head impact simulation are show in the Figure 3.2.

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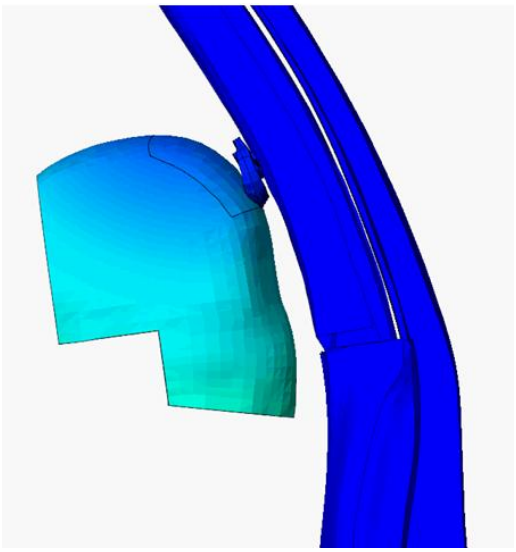

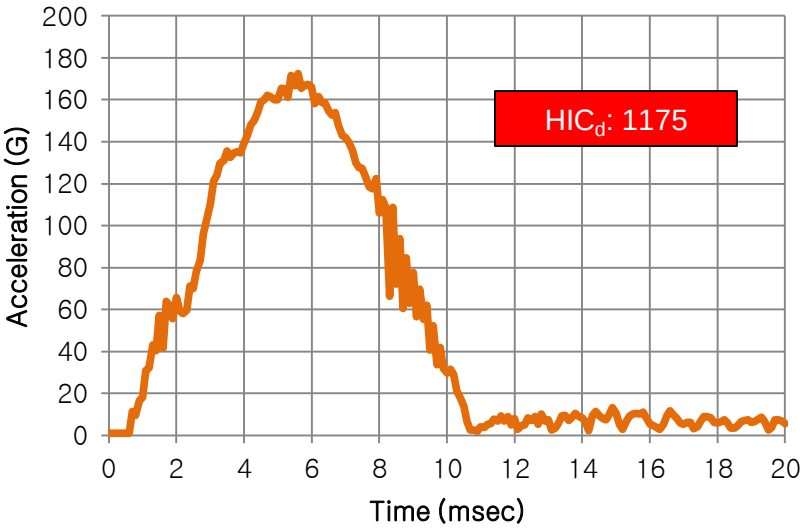

Satisfy the law :HIC$_d$<1000

Doesn't satisfy the law :HIC$_d$>1000

Simulation with midas NFX showed that the HICd factor was equal to 1175, which is superior to the regultion. Therefore, the system didn't complied to the FMVSS 201 regulation and had to be designed again.

[1]Ref. : Effectiveness of countermeasures in response to FMVSS 201 upper interior head impact protection - Arun Chickmenahalli

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