

Static Analysis of Truck Chassis using different materials

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ABSTRACT: The chassis frame forms the backbone of a heavy vehicle, its principle function is to safely carry the maximum load for all designed operating conditions. This paper describes design and analysis of heavy vehicle chassis. Weight reduction is now the main issue in automobile industries. In the present work, the dimensions of an existing heavy vehicle chassis of a TATA 2515EX vehicle is taken for modelling and analysis of a heavy vehicle chassis with three different composite materials namely, Carbon Steel, HSLA Steel, Structural Steel, High Strength Steel, Alloy Steel, ASTM A710 Steel, Aluminium 6061T6, AISI4130 Alloy subjected to the same pressure as that of a steel chassis. The design constraints were stresses and deflections. All the heavy vehicle chassis have been modelled by considering three different cross-sections, namely C, I and Box type cross sections. For validation the design is done by applying the vertical loads acting on the horizontal different cross sections. Software is used in this work SolidWorks for modelling, ANSYS Workbench 15 for analysis.

KEYWORDS: heavy vehicle chassis, Static analysis, Carbon Steel, HSLA Steel, Structural Steel, High Strength Steel, Alloy Steel, ASTM A710 Steel, Aluminium 6061T6, AISI4130 Alloy.

I. INTRODUCTION

Automobile chassis is a skeletal edge on which different mechanical parts like motor, tires, hub congregations, brakes, guiding and so forth are catapulted. The chassis is thought to be the most noteworthy segment of a vehicles. It is the most vital component that gives quality and soundness to the vehicle under diverse conditions. Vehicles outlines give quality and adaptability to the Automobile. The foundation of any Automobile, it is the supporting casing to which the body of a motor, hub congregations are fastened. Tie bars, that are vital parts of Automobile edges, are clasp that tie diverse Automobile parts together. Automobile casings are essentially made from steel. Aluminum is another crude material that has progressively ended up prominent for assembling these auto outlines. In a vehicles, front casing is an arrangement of metal parts that structures the system which likewise underpins the front wheels. It gives quality expected to supporting vehicular parts and payload set upon it.

Automobile chassis is thought to be one of the huge structures of a vehicles. It is normally made of a steel edge, which holds the body and engine of a Automobile vehicle. All the more decisively, Automobile chassis or Automobile chassis is a skeletal edge on which different mechanical parts like motor, tires, hub congregations, brakes, controlling and so on are darted. At the season of assembling, the body of a vehicle is adaptably shaped by structure of chassis. Automobile chassis is generally made of light sheet metal or composite plastics. It gives quality expected to supporting vehicular segments and payload put upon it. Automobile chassis or Automobile chassis keeps Automobile inflexible, firm and rigid. Auto chassis guarantees low levels of clamor, vibrations all through the Automobile. The different types of automobile chassis include:

Ladder chassis: Ladder chassis is thought to be one of the most established types of car chassis or vehicles chassis that is still utilized by the greater part of the SUVs till today. As its name indicates, ladder chassis takes after a state of a ladder having two longitudinal rails entomb connected by a few horizontal and cross supports.

Monocoque Chassis: Monocoque Chassis is an one-piece structure that endorses the general state of a vehicle. This kind of car chassis is produced by welding floor skillet and different sorts out. Since monocoque chassis is financially savvy and suitable for robotized creation, the majority of the vehicles today make utilization of steel plated monocoque chassis.

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Backbone Chassis: Backbone chassis has a rectangular tube like backbone, usually made up of glass fibre that is used for joining front and rear axle together. This type of automotive chassis or automobile chassis is strong and powerful enough to provide support smaller sports car. Backbone chassis is easy to make and cost effective.

II. SPECIFICATION OF THE PROBLEM

The objective of the present work is to design and analyses of alloy steel chassis made and also heavy vehicle chassis made of different materials viz., Carbon Steel, HSLA Steel, Structural Steel, High Strength Steel, Alloy Steel, ASTM A710 Steel, Aluminium 6061T6, AISI4130 Alloy. Heavy vehicle chassis was created in SolidWorks. Model is imported in ANSYS Workbench 15for analysis by applying normal load conditions. After analysis a comparison is made between existing conventional steel chassis and vehiclechassis made of other materials in terms of deflections and stresses, to choose the bestone.

III. SPECIFICATION OF EXISTING HEAVY VEHICLECHASSIS

Table 1 shows the specifications of a TATA 2515EX OF STEEL HEAVY vehicle. The typical chemical composition of the material is 0.565C, 1.8% Si, 0.7%Mn, 0.045%P and 0.045% S.

Table: 1 Specifications of heavy vehiclechassis

S.No	Parameters	Value
1	Total length of the chassis (Eye toEye)	8200mm
2	Width ofchassis	80 mm
3	Thickness ofchassis	6mm
4	Front cabin chassislength	2400mm
5	Front cabin chassisarea	492800 mm ²
6	Front cabin chassis applyingload	19620N
7	Backbody chassislength	5800mm
8	Backbody chassisarea	1200000 mm ²
9	Backbody chassis applying load	196200 N
10	Young's Modulus of steel chassis	2.1e5 N/mm ²
11	Density of steelchassis	7.86*10 ⁻⁰ N/mm ²

IV. STRUCTURAL ANALYSIS OF HEAVY VEHICLECHASSIS:

Dimensions of heavy vehicle chassis (HVC) are taken as that of the conventional steel heavy vehicle chassis (SHVC). Width of the chassis is 80mm. The loading conditions are assumed to be static. The element chosen is SHELL LAYERED 46, which is a layered version of the 8-node structural shell model. The element has six degrees of freedom at each node: translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z-axes. The finite element analysis is carried out on steel chassis as well as on three different types of polymeric composite heavy vehicle chassis. From the analysis the equivalent stress (Von-mises stress) anddisplacements were determined

and are shown in below figures. Tableshowthe comparative analysis of steel chassis and other heavy vehicle chassis of differentmaterials.

V. STRUCTURAL ANALYSIS OF C - CHANNELSECTION

The load is applied as UDL on the whole chassis C-Channel section with supports and the stress distribution and displacement patterns are observed for different materials as shown in below figures.

5.1 Conventional Steel Alloy

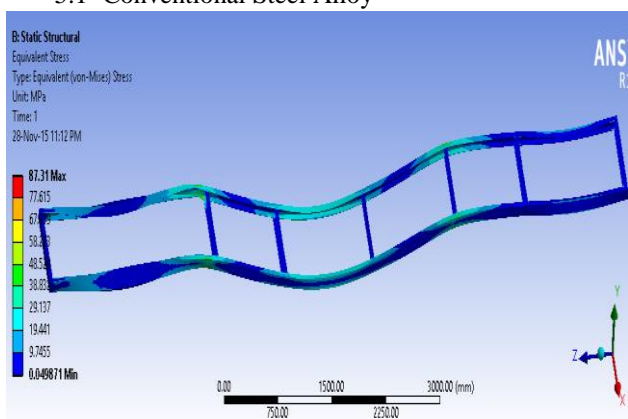


Fig 1: Stress distribution forSteel Alloy.

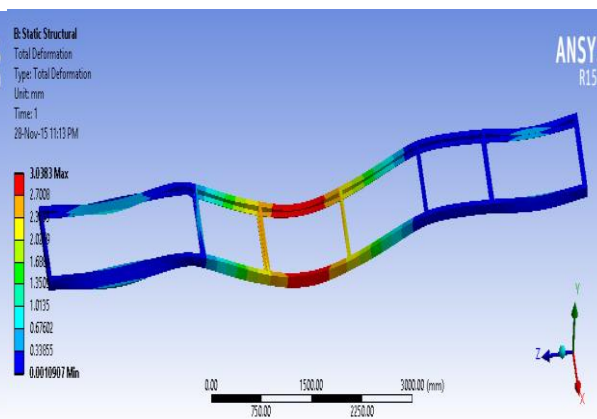


Fig 2: Displacement pattern for Steel Alloy

5.2 HSLA Steel

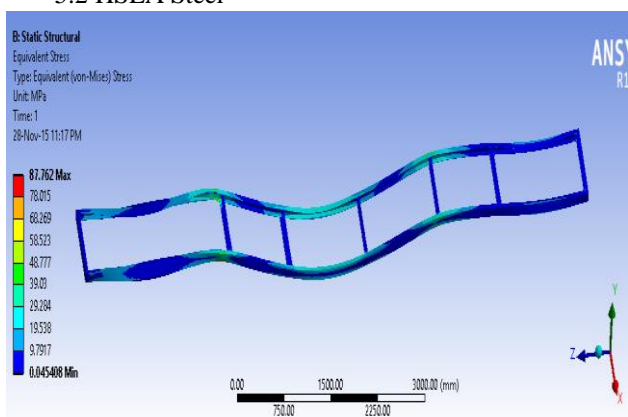


Fig 3: Stress distribution forHSLA Steel.

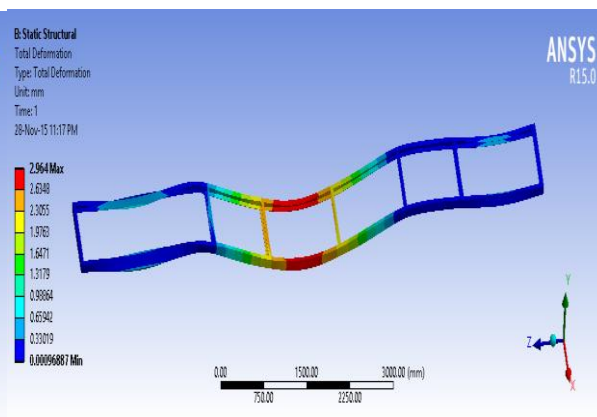


Fig 4: Displacement pattern for HSLA Steel

5.3 High Strength Steel

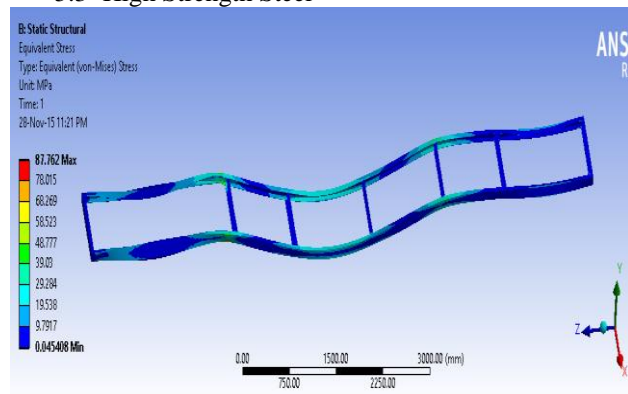


Fig 5: Stress distribution forHigh Strength Steel.

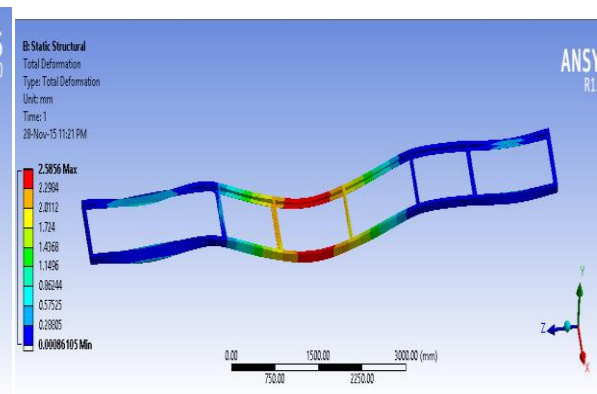


Fig 6: Displacement pattern for High Strength Steel

5.4 Carbon Steel

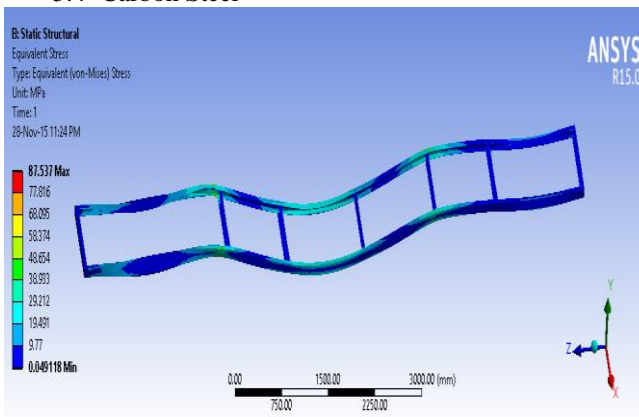


Fig 7: Stress distribution for Carbon Steel.

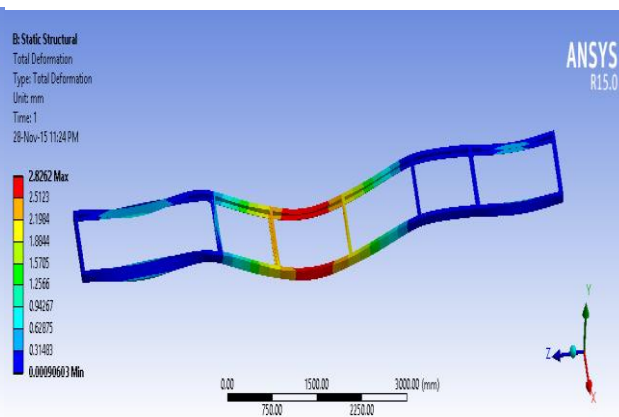


Fig 8: Displacement pattern for Carbon Steel

5.5 ASTM A710 Steel

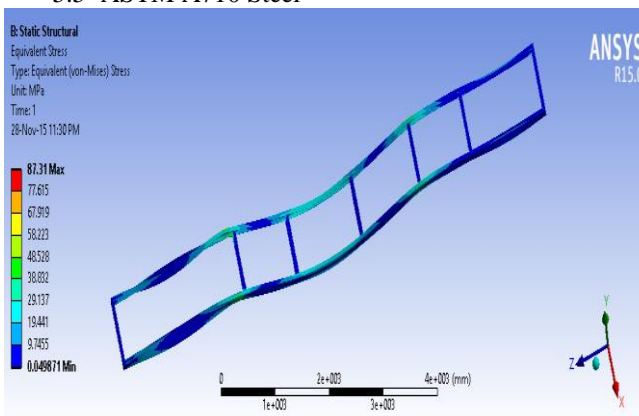


Fig 9: Stress distribution for ASTM A710 Steel.

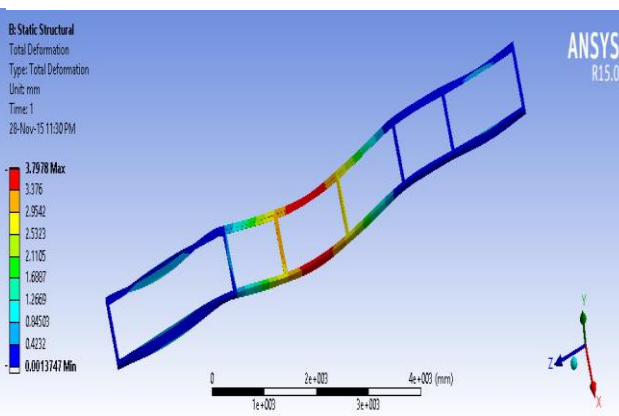


Fig 10: Displacement pattern for ASTM A710 Steel

5.6 Aluminium 6061T6

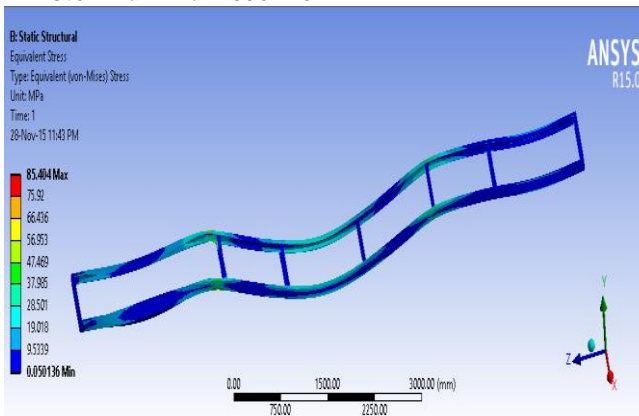


Fig 11: Stress distribution for Aluminium 6061T6.

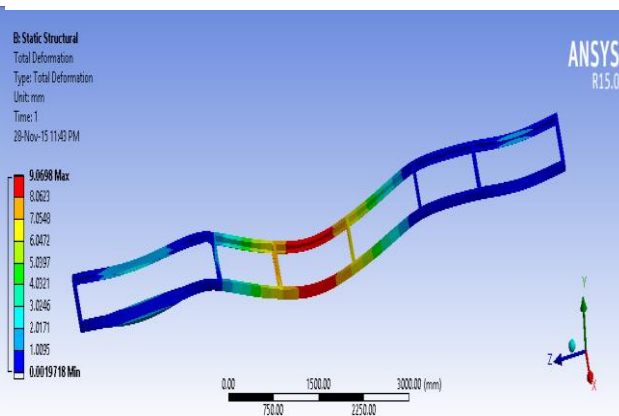


Fig 12: Displacement pattern for Aluminium 6061T6

5.7 Carbon Steel

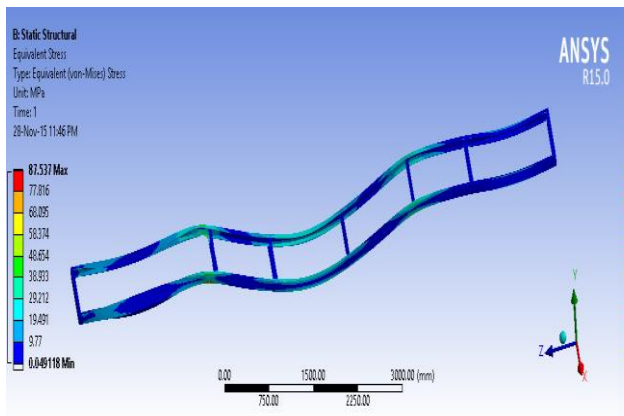


Fig 13: Stress distribution for Carbon Steel.

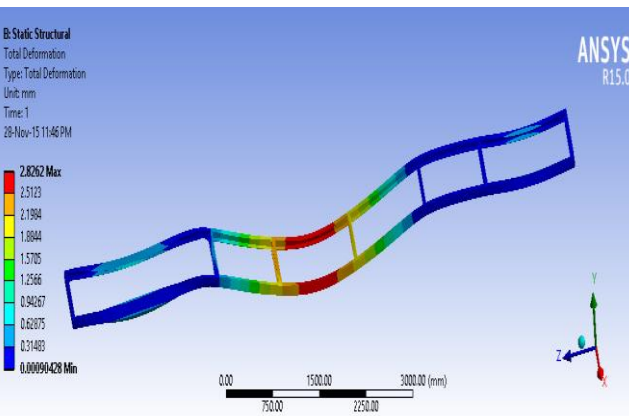


Fig 14: Displacement pattern for Carbon Steel

5.8 Structural Steel

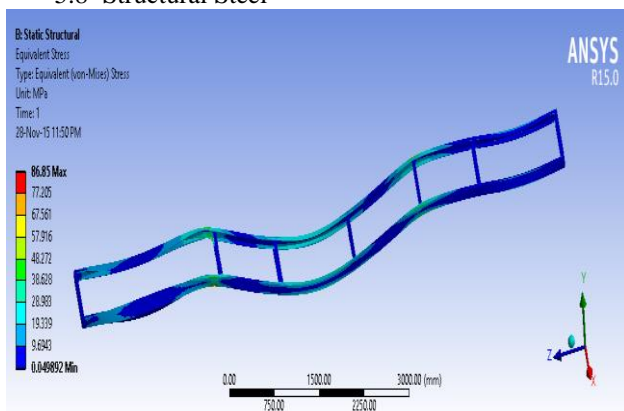


Fig 15: Stress distribution for Structural Steel.

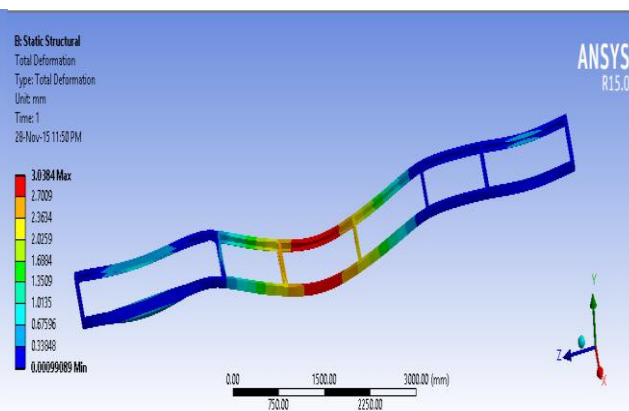


Fig 16: Displacement pattern for Structural Steel

5.9 AISI 4130 Alloy

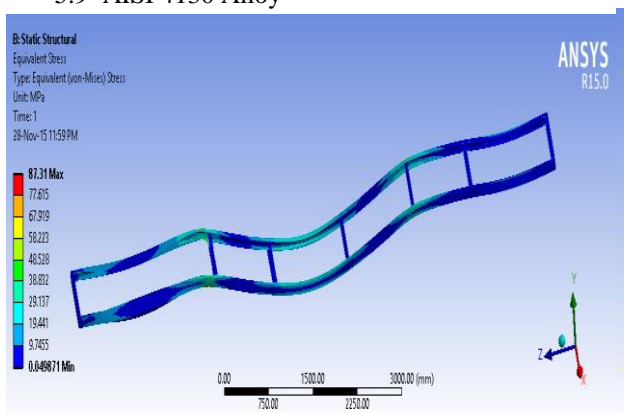


Fig 17: Stress distribution for AISI 4130 Alloy Steel.

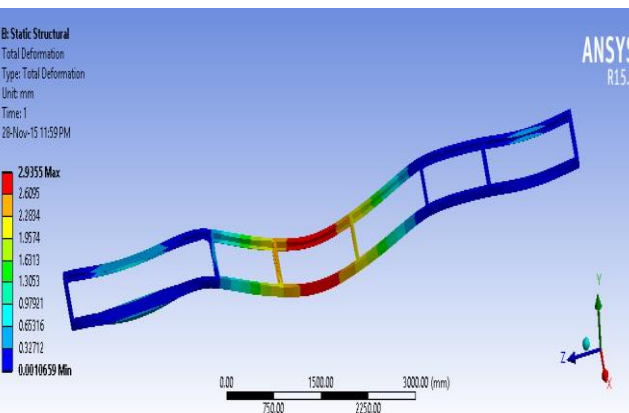


Fig 18: Displacement pattern for AISI 4130 Steel

VI. STRUCTURAL ANALYSIS OF I- CHANNELSECTION

The load is applied as UDL on the whole chassis I-Channel section with supports and the stress distribution and displacement patterns are observed for different materials as shown in below figures.

6.1 Alloy Steel

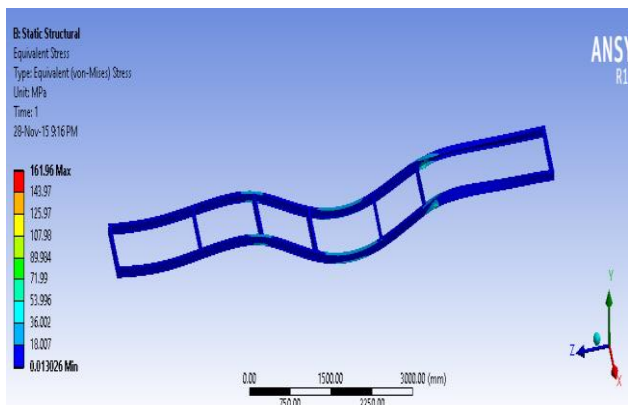


Fig 19: Stress distribution for Conventional Alloy Steel.

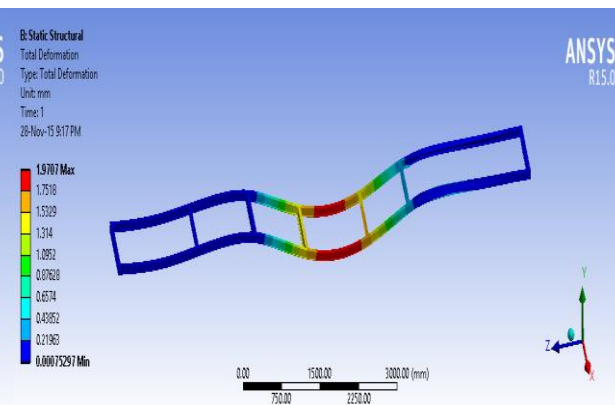


Fig 20: Displacement pattern for steel alloy

6.2 Structural Steel

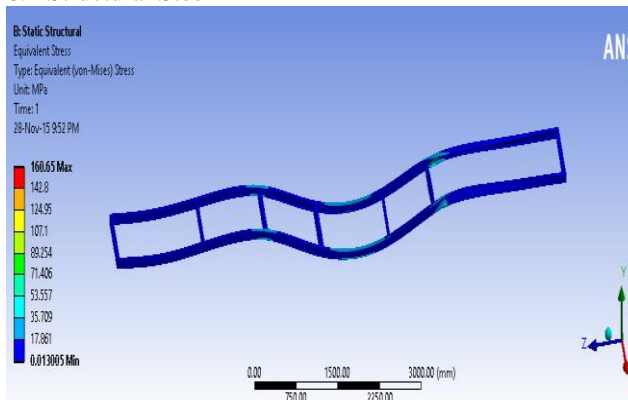


Fig 21: Stress distribution for Structural Steel.

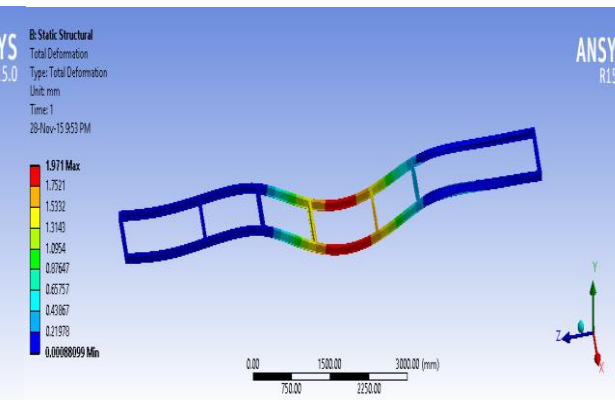


Fig 22: Displacement pattern for Structural Steel

6.3 HSLA Steel

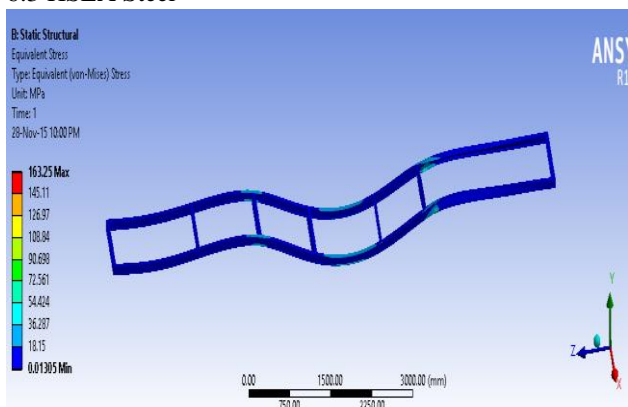


Fig 23: Stress distribution for HSLA Steel.

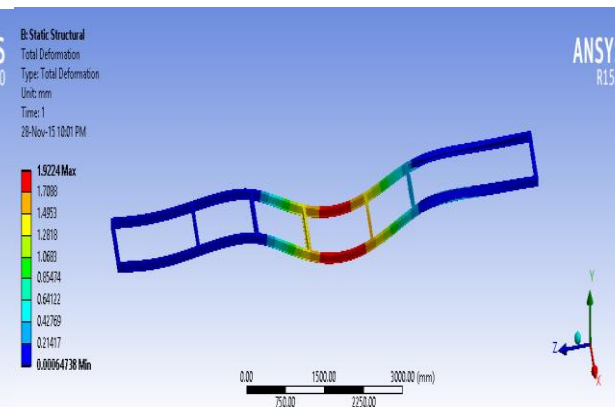


Fig 24: Displacement pattern for HSLA Steel

6.4 High Strength Steel

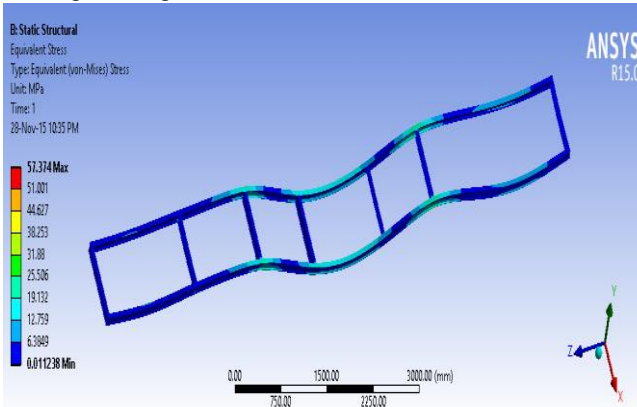


Fig 25: Stress distribution for High Strength Steel.

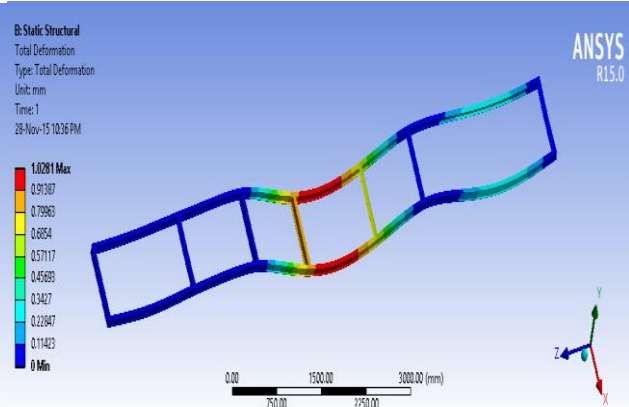


Fig 26: Displacement pattern for High Strength Steel

6.5 Carbon Steel

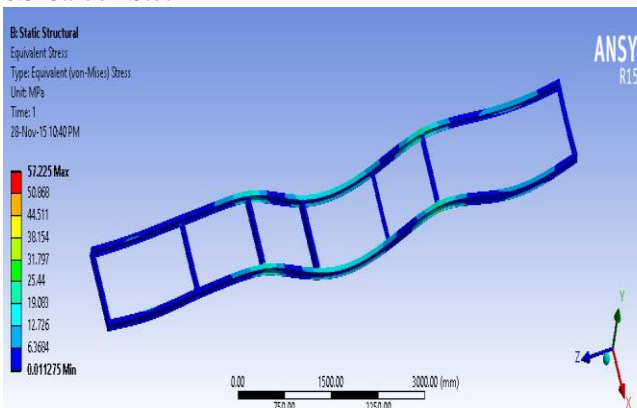


Fig 27: Stress distribution for Carbon Steel.

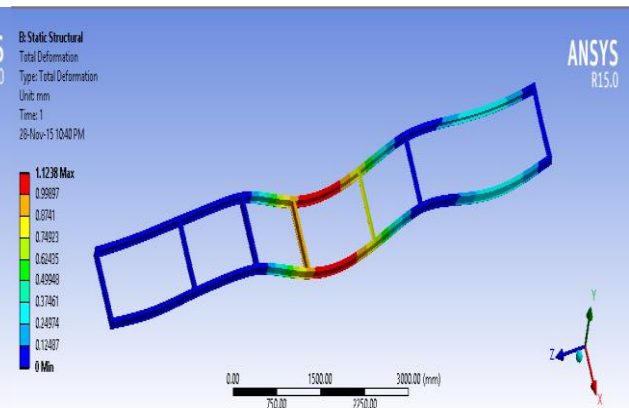


Fig 28: Displacement pattern for Carbon Steel

6.6 ASTM 710 Steel

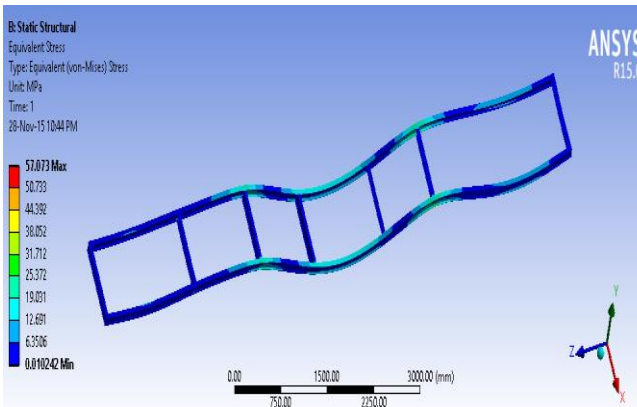


Fig 29: Stress distribution for ASTM A710 Steel.

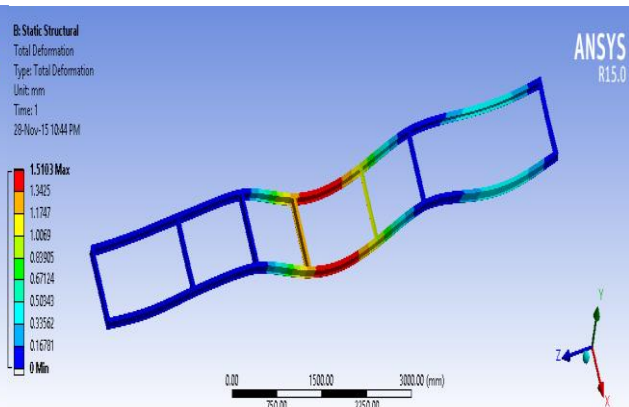


Fig 30: Displacement pattern for ASTM A710 Steel

6.7 Aluminium 6061T6

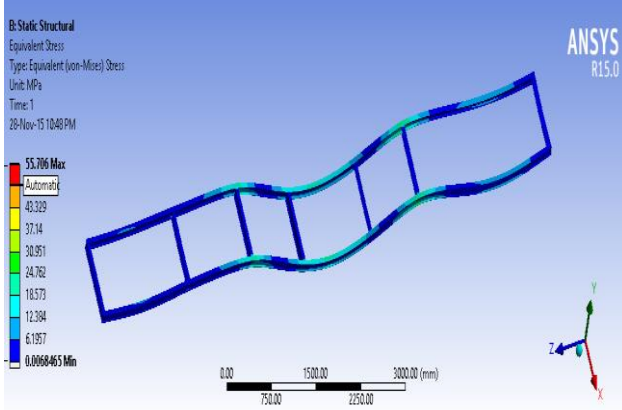


Fig 31: Stress distribution for Aluminium 6061T6 Alloy.

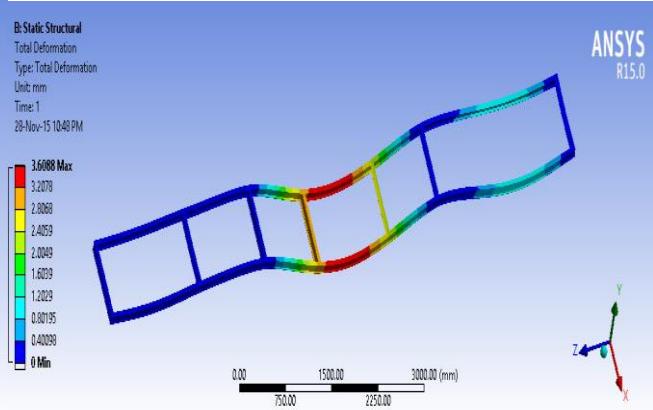


Fig 32: Displacement pattern for Aluminium 6061T6

6.8 AISI 4130 Alloy

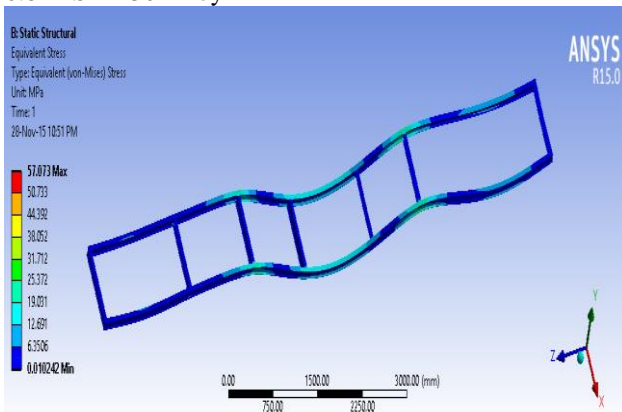


Fig 33: Stress distribution for AISI 4130 Alloy Steel.

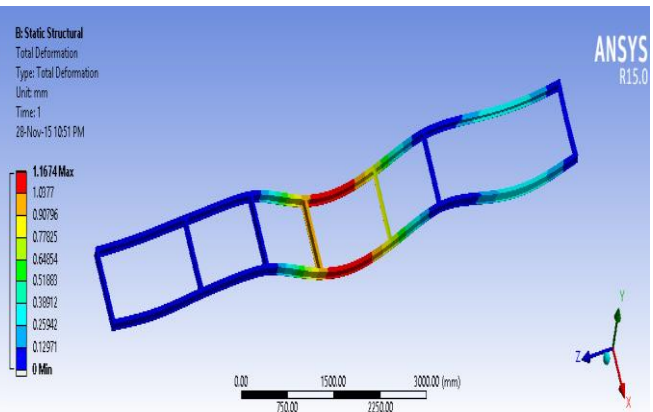


Fig 34: Displacement pattern for AISI 4130 Alloy

VII. STRUCTURAL ANALYSIS OF BOX- CHANNEL SECTION

The load is applied as UDL on the whole chassis Box-Channel section with supports and the stress distribution and displacement patterns are observed for different materials as shown in below figures.

7.1 AISI 4130 Alloy

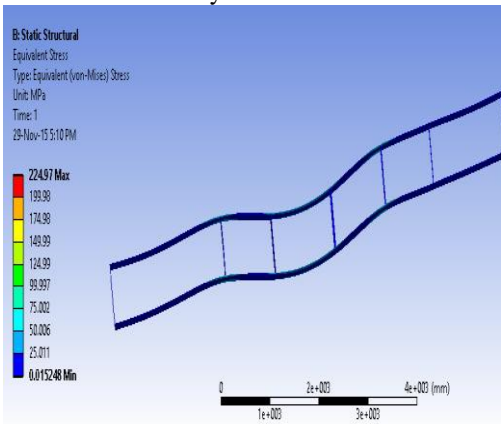


Fig 37: Stress distribution for AISI 4130 Alloy Steel.

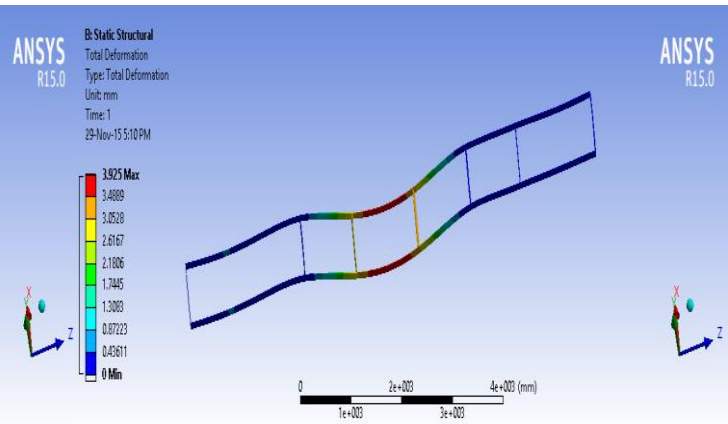


Fig 38: Displacement pattern for AISI4130 Alloy

7.2 ASTM A710 Steel

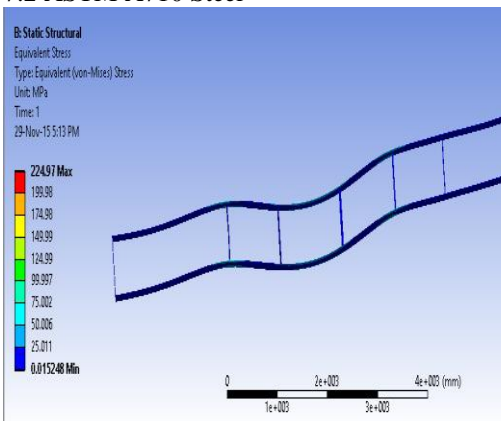


Fig 39: Stress distribution for ASTM A710 Steel.

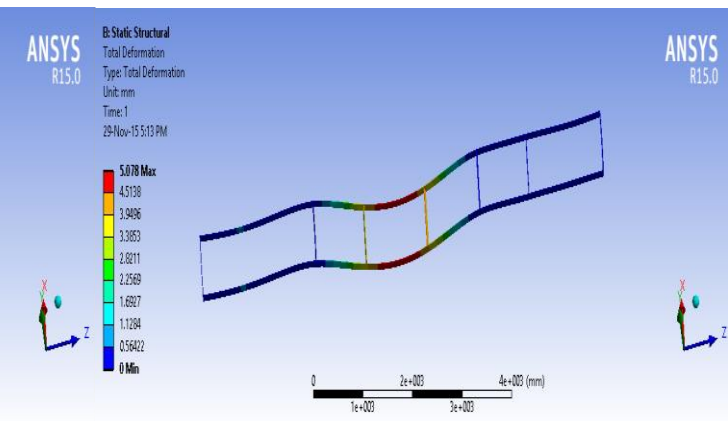


Fig 40: Displacement pattern for ASTM A710 Steel

7.3 Carbon Steel

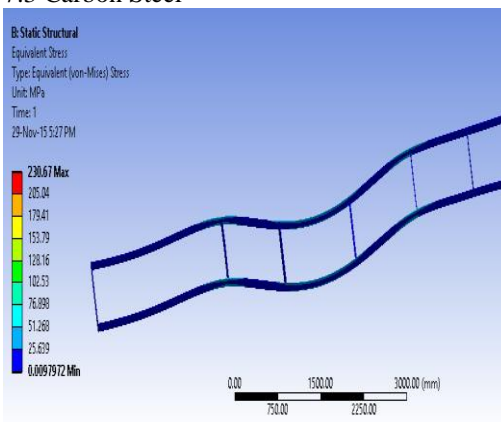


Fig 41: Stress distribution for Carbon Steel.

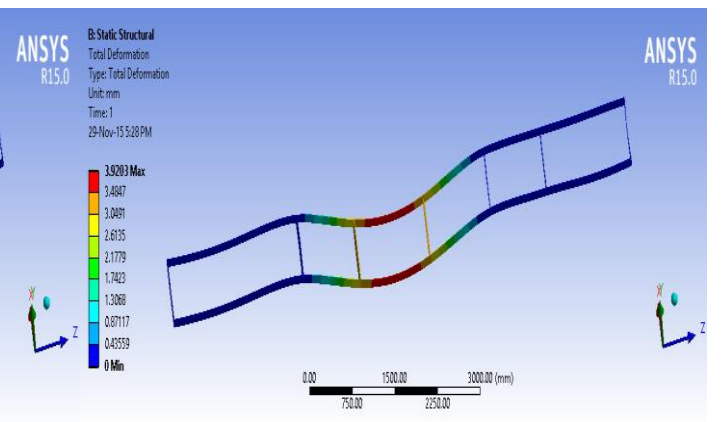


Fig 42: Displacement pattern for Carbon Steel

7.4 Aluminium 6061T6

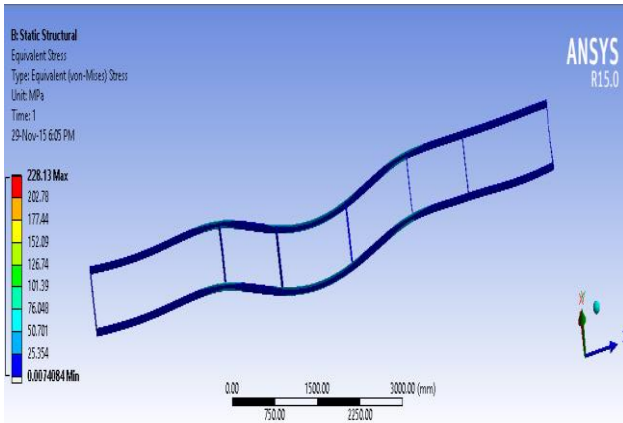


Fig 43: Stress distribution for Aluminium 6061T6 Alloy.

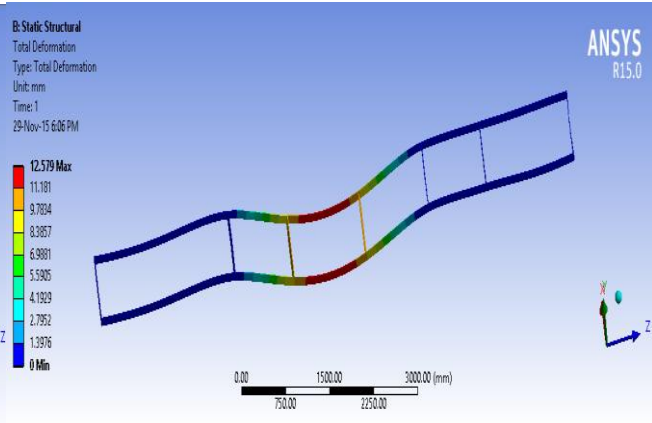


Fig 44: Displacement pattern for Aluminium 6061T6

7.5 HSLA Steel

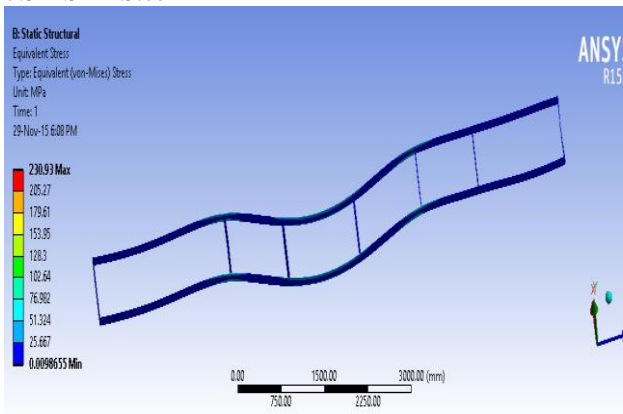


Fig 45: Stress distribution for HSLA Steel.

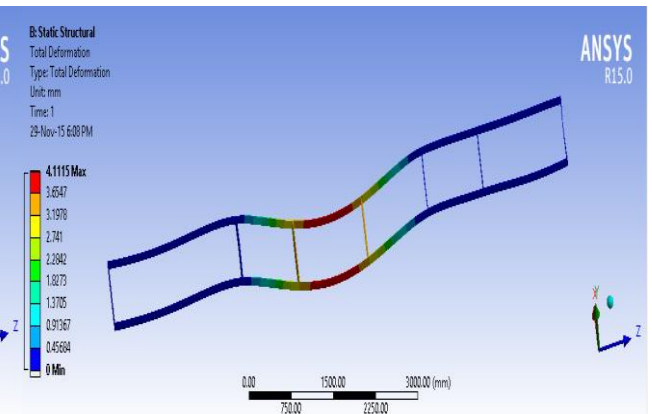


Fig 46: Displacement pattern for HSLA Steel

7.6 High Strength Steel

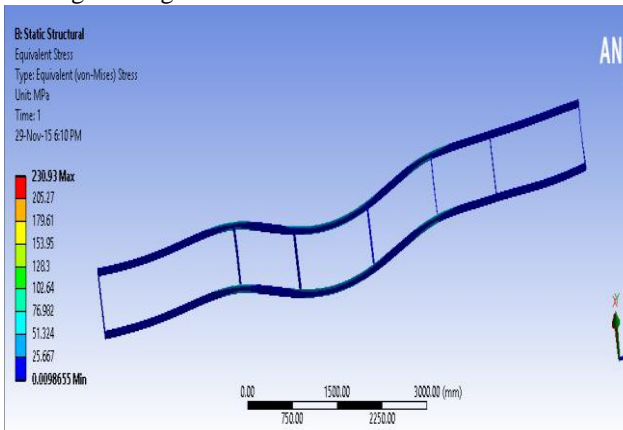


Fig 47: Stress distribution for High Strength Steel.

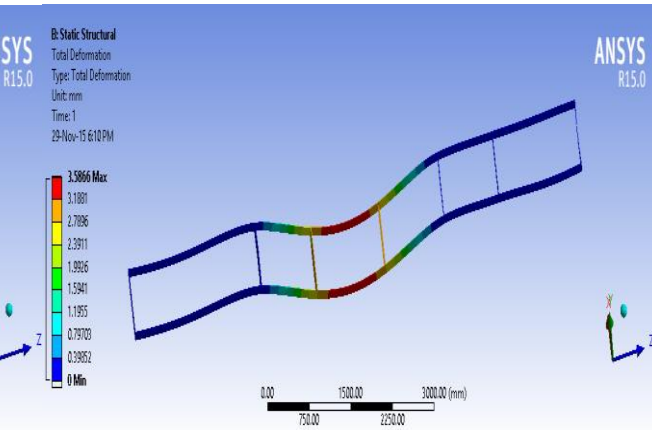


Fig 48: Displacement pattern for High Strength Steel

7.7 Steel Alloy

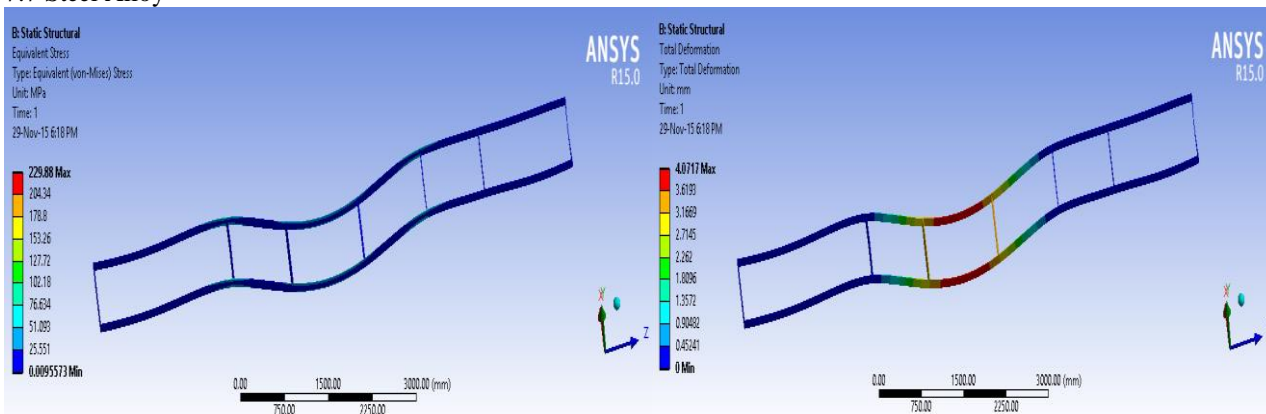


Fig 49: Stress distribution for Conventional Alloy Steel. Fig 50: Displacement pattern for Conventional Alloy Steel

7.8 Structural Steel

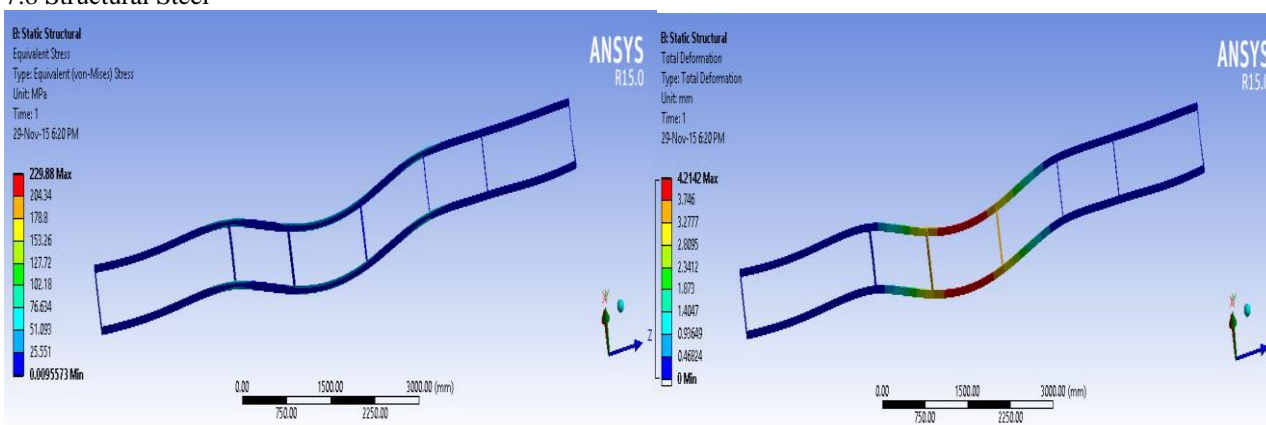


Fig 51: Stress distribution for Structural Steel.

Fig 52: Displacement pattern for Structural Steel

VIII: NUMERICAL SIMULATION RESULTS

The conventional steel chassis is compared with the different materials and with different cross-sections. All the results obtained from the above simulations are consolidated into the tables as given below.

Table 2: Comparative Analysis of Steel Heavy vehicle Chassis with other materials for C-Section

S.No	Material/Parameter	Weight (Kg)	Stress (MPa)	Displacement (mm)
1	Carbon Steel	190.51	87.537	2.8262
2	HSLA Steel	190.51	87.762	2.964
3	Structural Steel	191.73	86.85	3.0384
4	High Strength Steel	188.07	87.762	2.5856
5	Steel Alloy	188.07	87.31	3.0383
6	ASTM A710 Steel	191.88	87.31	3.7978
7	Aluminium 6061T6	65.947	85.404	9.0698
8	AISI 4130 Alloy	190.46	87.31	2.9355

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Table 3: Comparative Analysis of Steel Heavy vehicle Chassis with other materials for I-Section

S.No	Material/Parameter	Weight (Kg)	Stress (N/mm ²)	Displacement (mm)
1	Carbon Steel	189.23	57.225	1.1238
2	HSLA Steel	189.23	57.374	1.1786
3	Structural Steel	190.45	56.757	1.2084
4	High Strength Steel	186.81	57.374	1.0281
5	Steel Alloy	189.23	56.757	1.1676
6	ASTM A710 Steel	190.59	57.073	1.5103
7	Aluminium 6061T6	65.504	55.706	3.6088
8	AISI 4130 Alloy	189.19	57.073	1.1674

Table 4: Comparative Analysis of Steel Heavy vehicle Chassis with other materials for Box-Section

S.No	Material/Parameter	Weight (Kg)	Stress (N/mm ²)	Displacement (mm)
1	Carbon Steel	159.38	230.67	3.9203
2	HSLA Steel	159.38	230.93	4.1115
3	Structural Steel	160.4	229.88	4.2142
4	High Strength Steel	157.34	230.93	3.5866
5	Steel Alloy	159.38	229.88	4.0717
6	ASTM A710 Steel	160.53	224.97	5.078
7	Aluminium 6061T6	55.171	228.13	12.579
8	AISI 4130 Alloy	159.34	224.97	3.925

IX. CONCLUSIONS

All the results are observed and compared to the heavy vehicle chassis of different materials and steel heavy vehicle chassis with respect to weight, stiffness and strength. By employing a High Strength Steel heavy vehicle chassis for the same load carrying capacity, there is a reduction in weight of 1.5~2%, natural frequency of heavy vehicle chassis are 32%~54% higher than conventional steel chassis and 8~10% stiffer than the steel chassis.

Present used material for chassis is conventional steel alloy. Carbon Steel, HSLA Steel, Structural Steel, High Strength Steel, Alloy Steel, ASTM A710 Steel, Aluminium 6061T6, AISI4130 Alloy are considered for chassis material. Based on the results, it was inferred that High Strength Steel heavy vehicle chassis I-SECTION chassis has superior strength and stiffness and lesser in weight compared to steel and other materials and other cross sections considered in this investigation.

From the results, it is observed that the high strength steel heavy vehicle chassis is lighter and more economical than the conventional steel chassis with similar design specifications.

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