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Shape Optimization of a Heavy Vehicle Chassis for Maximum Load Conditions

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ABSTRACT:

Truck chassis is a major component in a vehicle system. This work involved static and dynamics analysis to determine key characteristics of a truck chassis. The Static characteristics include identifying location of High Stress Area and determining the Torsion Stiffness of the chassis. The Dynamic characteristics of truck chassis such as the Natural Frequency and Mode shape were determined by using Finite Element Method. Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile.

It is the most crucial element that gives strength and stability to the vehicle under different conditions. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. Tie bars, that are essential parts of automotive frames, are fasteners that bind different auto parts together. Automotive frames are basically manufactured from steel. Aluminum is another raw material that has increasingly become popular for manufacturing these auto frames.

In an automobile, front frame is a set of metal parts that forms the framework which also supports the front wheels. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis is considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. This study is to produce results to rectify problems associated with structures of a commercial vehicle such as strength, stiffness and fatigue properties along with stress, bending moment and vibrations. This can be achieved by static and dynamic (modal) analysis, combining existing theoretical knowledge and advanced analytical methods.

Design of a Chassis is carried by using CATIA. And finite element analysis will be carried out by using ANSYS.

I. INTRODUCTION:

Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. Tie bars, that are essential parts of automotive frames, are fasteners that bind different auto parts together. Automotive frames are basically manufactured from steel.

Aluminum is another raw material that has increasingly become popular for manufacturing these auto frames. In an automobile, front frame is a set of metal parts that forms the framework which also supports the front wheels. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis is considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. More precisely, automotive chassis or automobile chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies; brakes, steering etc are bolted.

At the time of manufacturing, the body of a vehicle is flexibly molded according to the structure of chassis. Automobile chassis is usually made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis or automobile chassis helps keep an automobile rigid, stiff and unbending. Auto chassis ensures low levels of noise, vibrations and harshness throughout the automobile. The different types of automobile chassis include:

- Backbone chassis
- Body-on-frame
- Chassis
- EVTraxer
- Exoskeleton car
- Ladder chassis
- Monocoque
- Space frame chassis
- Stressed member engine
- Sub frame
- Superleggera

ADVANTAGES:

• High track density (up to 500 I/O signals in 3U systems).

• Does not require custom backplane I/O signal routing.

• Shaped to fit where other solutions cannot.

• Provides superior signal integrity and electrical performance.

• Built-in signal track ground shielding.

• Greater standardization and repeatability.

• Greatly reduced installation time and cost.

• Signal impedance & cross-talk are consistent batch-to-batch.

• Occupies minimum space and volume.

• Minimizes I/O harness weight.

• Customized to provide optimum trace characteristics.

• Superior reliability with respect to conventional techniques.

• Not prone to human signal wiring errors.

• Straight forward disassembly from the backplane.

• Reduced internal chassis airflow restriction.

• High tech professional approach.

DISADVANTAGES:

• Requires careful design engineering and planning.

• Requires detailed chassis and backplane electrical knowledge.

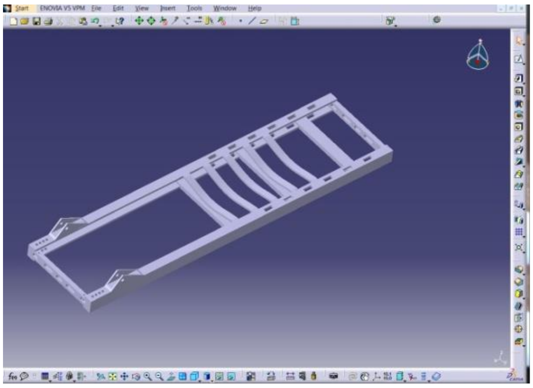
• Initial development time and cost.

• Hard to modify/repair once established (due to rigidity of printed circuits, no signal changes or system upgrades are possible).

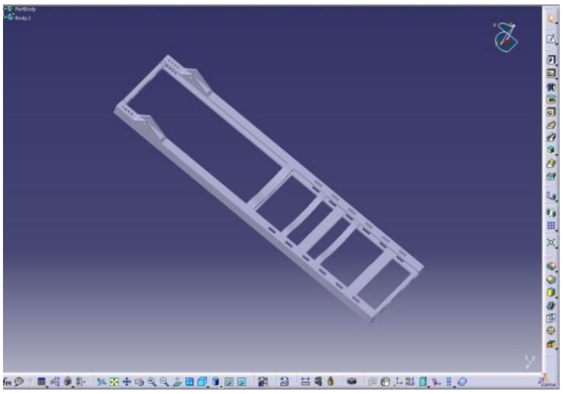
• May be susceptible to damage if not properly handled.

• Only suitable for low and medium power signals.

MODEL 1



MODEL 2



MATERIAL PROPERTIES

Structural Steel

Structural Steel > Constants

Density	7850 kg m^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	434 J kg^-1 C^-1
Thermal Conductivity	60.5 W m^-1 C^-1
Resistivity	1.7e-007 ohm m

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Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength Pa
0

Structural Steel > Compressive Yield Strength

Compressive Yield Strength Pa
2.5e+008

Al 7475

Al 7475 > Constants

Thermal Conductivity	138 W m^-1 C^-1
Density	2810 kg m^-3
Specific Heat	880 J kg^-1 C^-1

Al 7475 > Isotropic Elasticity

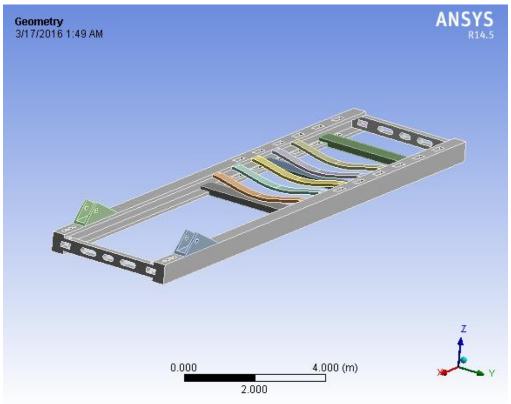
Temperature C	Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
	7.03e+010	0.33	6.8922e+010	2.6429e+010

Al 7475 > Tensile Yield Strength

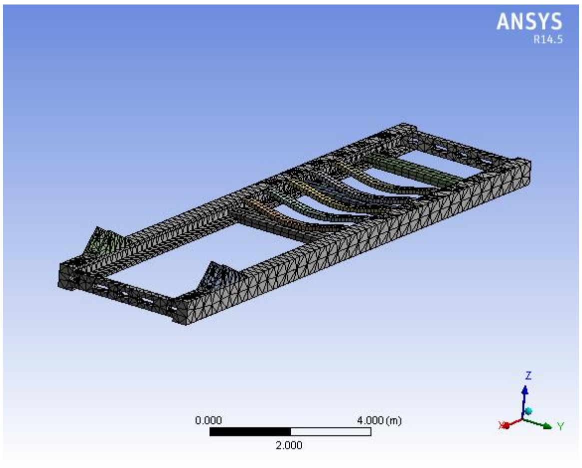
Tensile Yield Strength Pa
4.9e+008

ANALYSIS OF MODEL-1 WITH STRUCTURAL STEEL:

IMPORT MODEL



MESH MODAL



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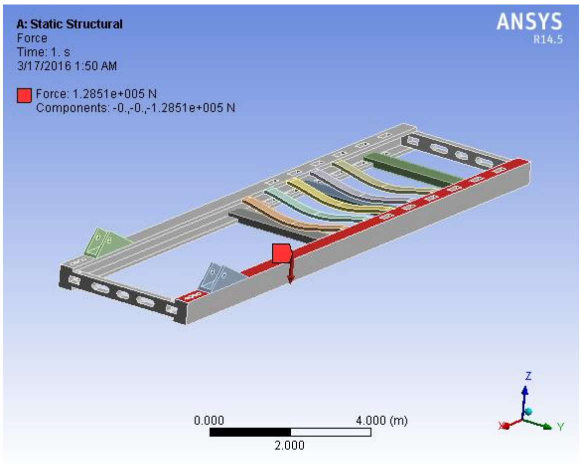

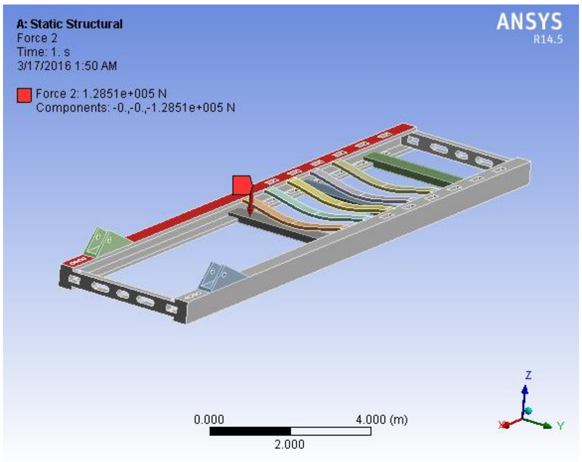

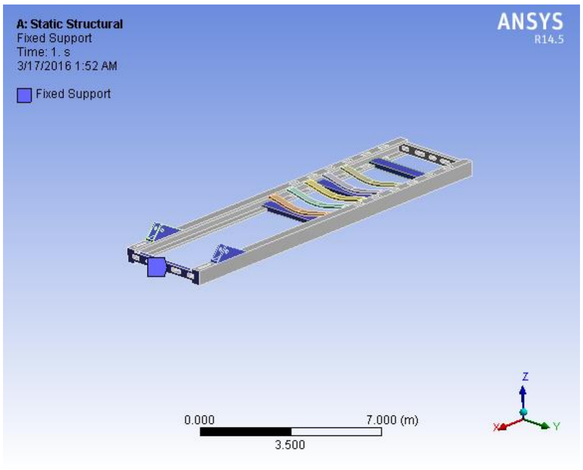

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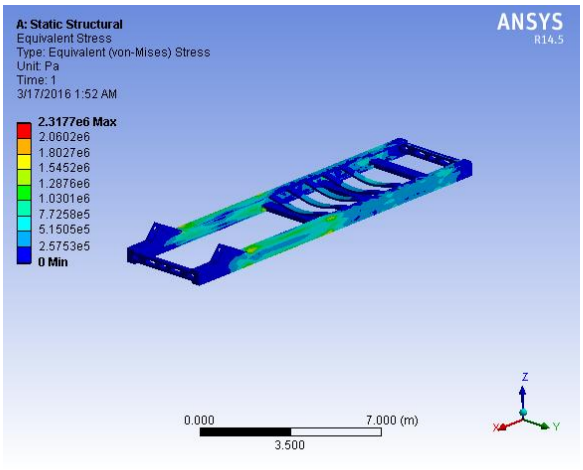
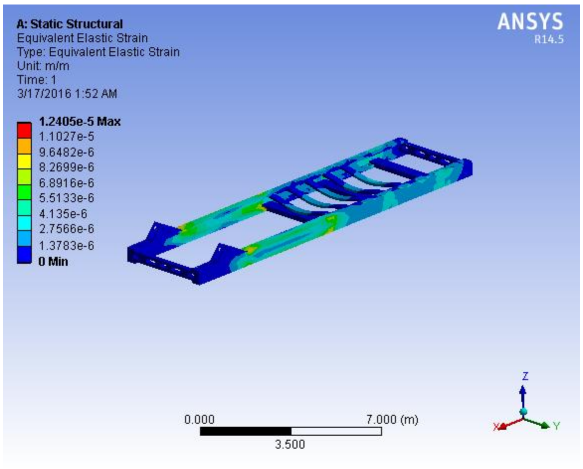
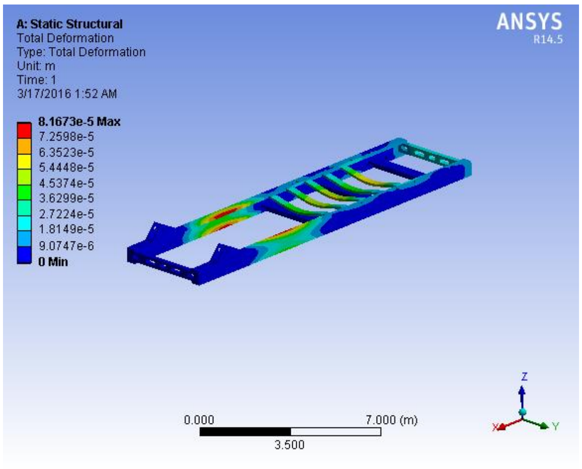


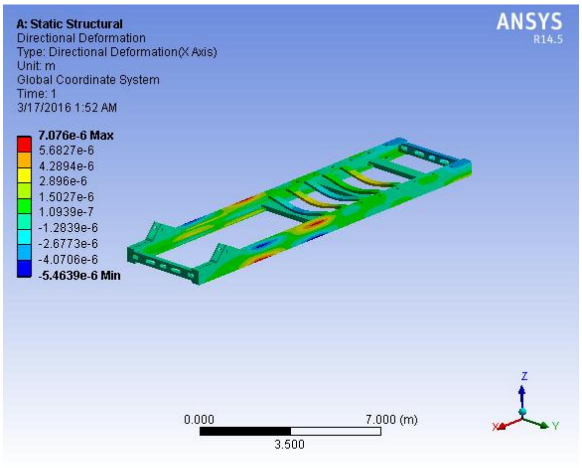
STRAIN



TOTAL DEFORMATION

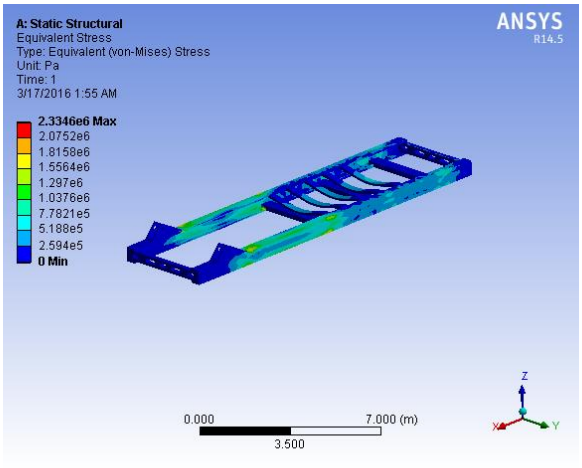


DIRECTIONAL DEFORMATION



ANALYSIS OF MODEL 1 WITH AL 7475

STRESS



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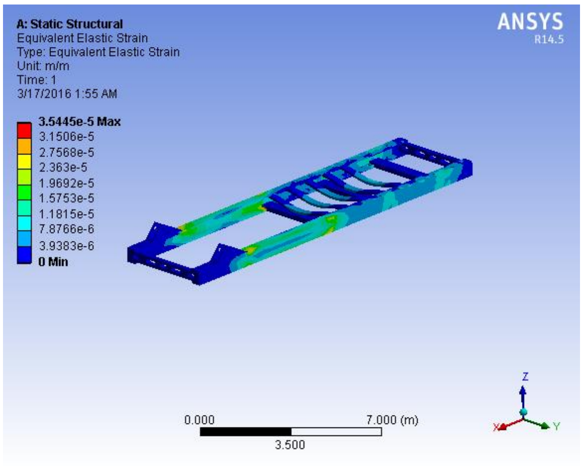
STRAIN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Equivalent Elastic Strain
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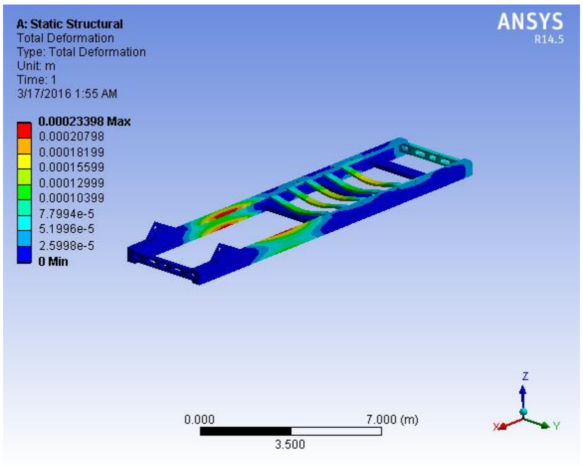
3/17/2016 1:55 AM

TOTAL DEFORMATION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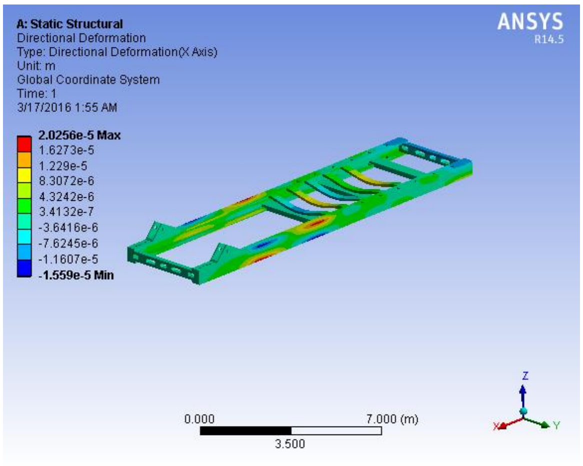
A: Static Structural
Directional Deformation
Type: Directional Deformation(X Axis)
Unit: m
Global Coordinate System
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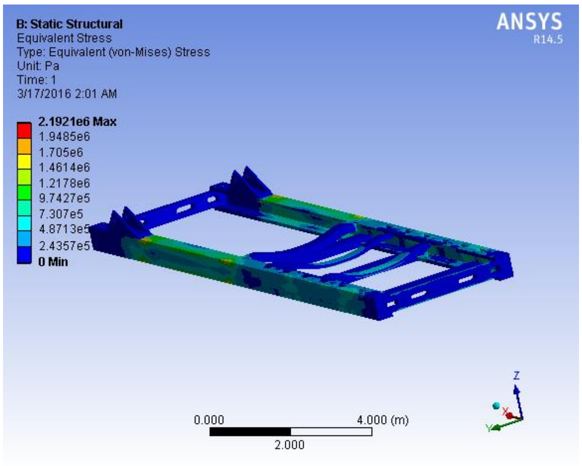
ANALYSIS OF MODEL - 2 WITH STRUCTURAL STEEL

STRESS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Equivalent Stress
Type: Equivalent (von-Mises) Stress
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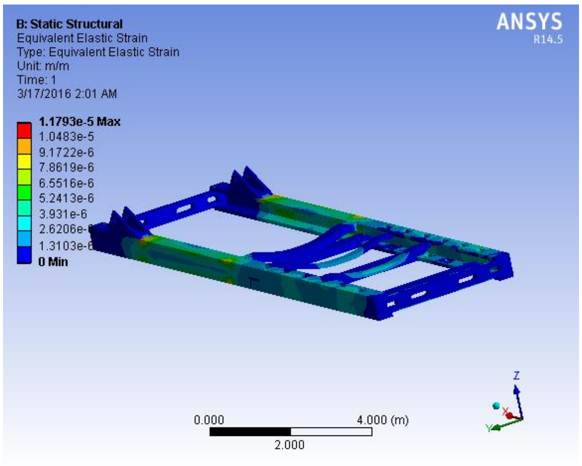
STRAIN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Equivalent Elastic Strain
Type: Equivalent Elastic Strain
Unit: m/m
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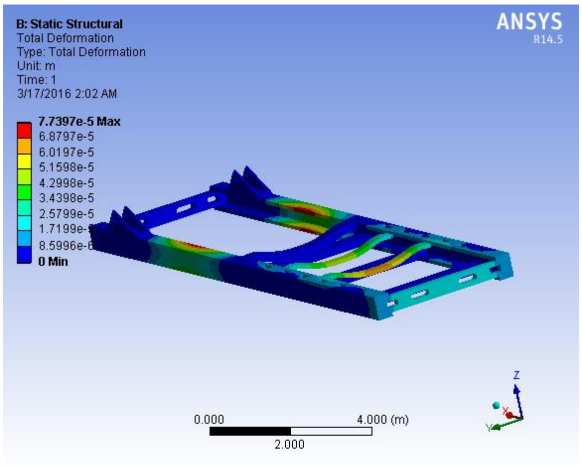
TOTAL DEFORMATION


B: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
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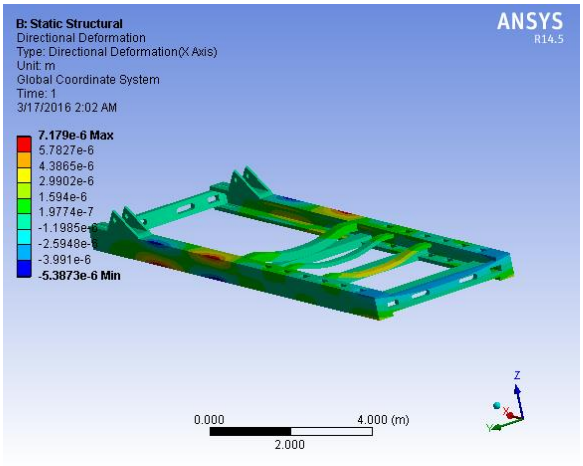
DIRECTIONAL DEFORMATION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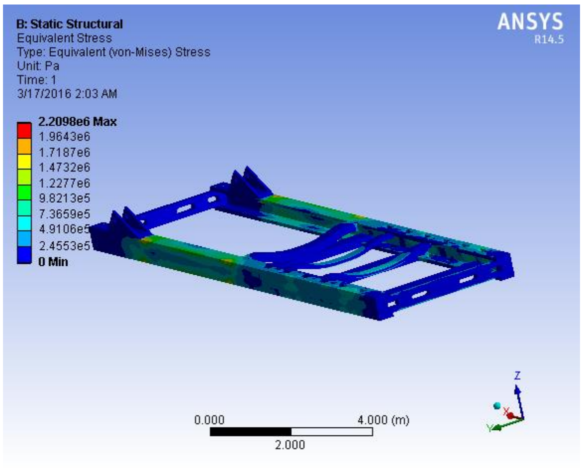
ANALYSIS OF MODEL 2 WITH AL 7475 STRESS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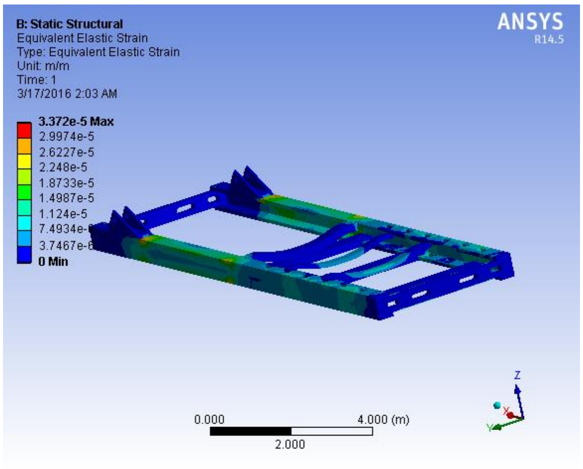
STRAIN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Equivalent Elastic Strain
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Unit: m/m
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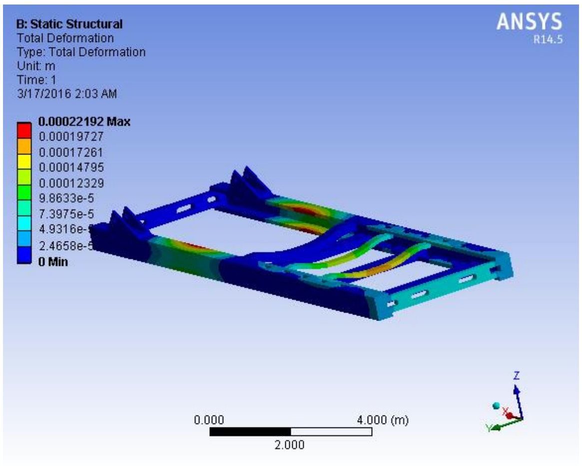
TOTAL DEFORMATION


B: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
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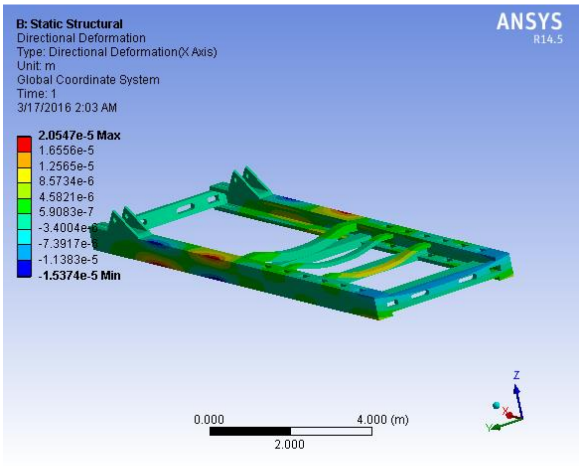
DIRECTIONAL DEFORMATION


B: Static Structural
Directional Deformation
Type: Directional Deformation(X Axis)
Unit: m
Global Coordinate System
Time: 1
3/17/2016 2:03 AM

Result comparison table for MODEL 1

	STRESS	STRAIN	TOTAL DEFORMATION	DIRECTIONAL DEFORMATION	
				MIN	MAX
STRUCTURAL STEEL	2.32E+06	1.24E-05	8.17E-05	-5.46E-06	7.08E-06
AL 7475	2.33E+06	3.54E-05	0.00023398	-1.56E-05	2.03E-05

Result comparison table for MODEL 2

	STRESS	STRAIN	TOTAL DEFORMATION	DIRECTIONAL DEFORMATION	
				MIN	MAX
STRUCTURAL STEEL	2.19E+06	1.18E-05	7.74E-05	-5.39E-06	7.18E-06
AL 7475	2.21E+06	3.37E-05	0.00022192	-1.54E-05	2.05E-05

CONCLUSION:

In this project we have designed a chassis by reverse engineering process from ashok Leyland, and here we have shape optimized the original chassis. And the designs are done in Pro-e software and analysis is carried out in ANSYS software. As if we see the results in the model 1, stress is almost same for both the materials i.e. for structural steel and for the AL 7475 material. While coming to the strain (1.24E-05) has the better value for the structural steel when compared with AL 7475 alloy. But while coming to the total deformation and directional deformations, the AL 7475 material has the best deformation than the structural steel material.

so here we can conclude that the AL 7475 material is the best material in the original design.As if we see the results in the model 2, stress is almost same for both the materials i.e. for structural steel and for the AL 7475 material. While coming to the strain (1.18-05) has the better value for the structural steel when compared with AL 7475 alloy. But while coming to the total deformation and directional deformations, the AL 7475 material has the best deformation than the structural steel material. So here we can conclude that the AL 7475 material is the best material in the shape optimized design.By seeing the results here the shape optimized design also has the best results when compared with the original design, when compared in stress, and deformations.

So here by seeing the results we can considered that the model 2 have the better life efficiency with better output.

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