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PULCHOWK CAMPUS

REPORT ON STATIC ANALYSIS OF BIKE CHASSIS.

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ABSTRACT

The chassis frame forms the backbone of a vehicle, its principle function is to safely carry the maximum load for all designed operating conditions. Automotive chassis is the main carriage system of a vehicle. The chassis serves as a skeleton upon which parts like gearbox and engine are mounted. The two-wheeler chassis consists of a frame, suspension, wheels and brakes. The chassis is what truly sets the overall style of the two wheeler. Commonly used material for two-wheeler chassis is steel which is heavy in weight or more accurately in density. There are various alternate materials like aluminum alloys, titanium, carbon fiber, magnesium, etc. which are lesser in weight and provide high strength and thus can be used for chassis. This report deals with the design of two-wheeler chassis frame. The static loading was carried out on the chassis and the design is improving the mechanical behavior of the chassis The modeling work was carried out by the CATIA V5 and analysis was done by ANSYS software. The modeling would consider the geometry characteristics and analysis would consider the geometry import, meshing, loading condition, result evaluation. Where geometry import IGS file format was followed.

1. INTRODUCTION

Whenever to build a motorcycle, the frame determines the basic look of the bike. Of course motorcycle frames affect not only the appearance of the bike but the handling and safety of the finished machine. Frames are the basic skeleton to which other components are attached. They hold the motorcycle tanks and engine and provide support to the whole bike. Motorcycle frames are usually made from welded aluminium, steel or alloy, carbon-fiber is used in some expensive or custom frames. The purpose of a motorcycles frame is to act as a base on which all the various components can be bolted. The engine generally sits inside the frame, the rear swing arm is attached by a pivot bolt (allowing the suspension to move) and the front forks are attached to the front of the frame. The frame can also help to protect the more sensitive parts of a motorcycle in a crash. A motorcycle frame includes the head tube that holds the front fork and allows it to pivot. Some motorcycles include the engine as a load-bearing, stressed member. The rear suspension is an integral component in the design. Traditionally frames have been steel, but titanium, aluminium, magnesium, and carbon-fiber, along with composites of these materials, have been used. Because of different motorcycles' varying needs of cost, complexity , weight distribution, stiffness, power output and speed, there is no single ideal frame design.

2. CAD MODEL:

CAD model of existing chassis has been prepared in CATIA V5 as shown in fig.the dimensions were measured from existing chassis by reverse engineering.

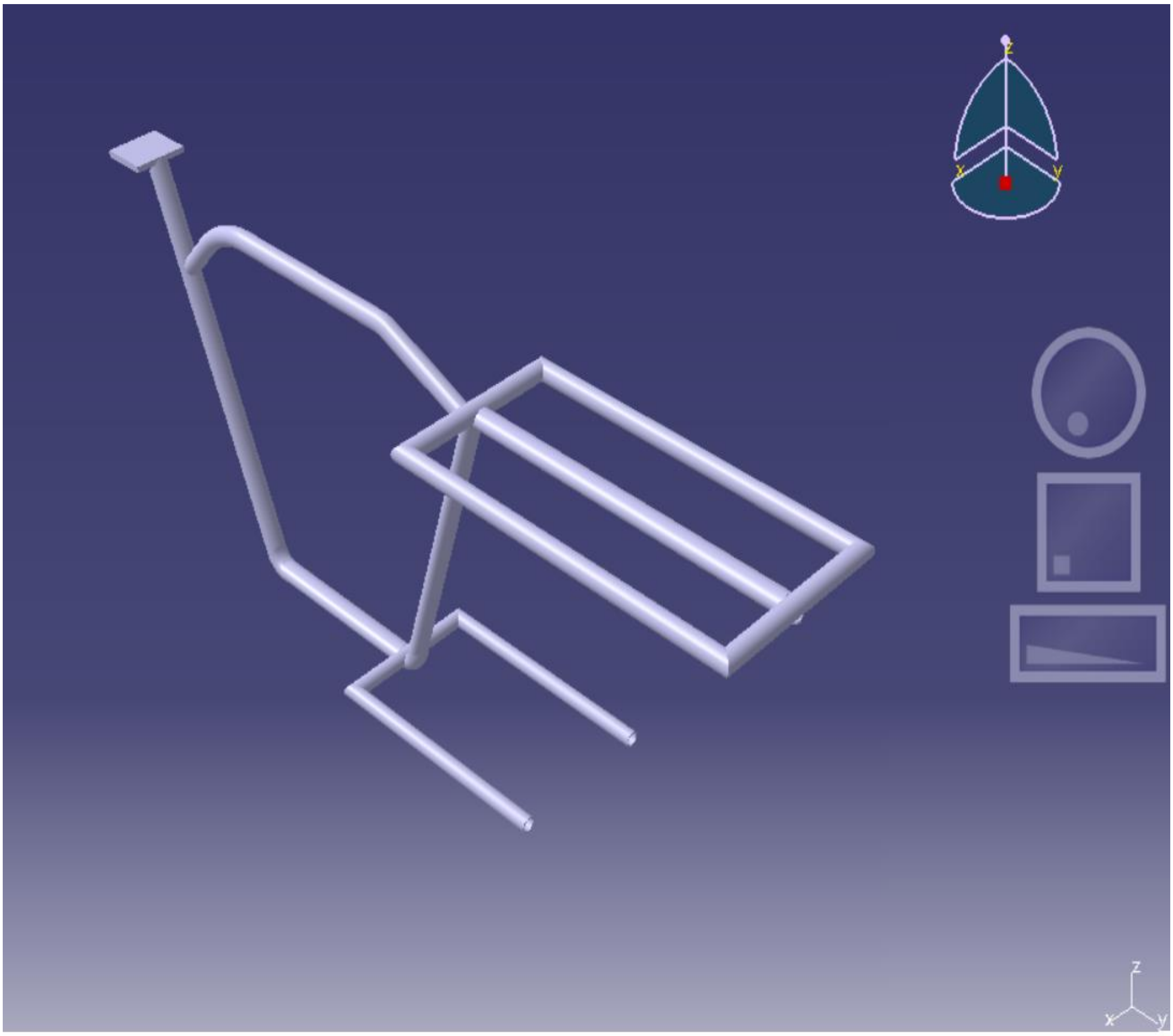

Figure 1 Cad Model

3. STRUCTURAL ANALYSIS OF BIKE CHASSIS:

A general-purpose commercial finite element code, Hyper-Mesh and ANSYS is applied to conduct the static simulations. A full 3-D solid model is constructed for the static test simulation. Mixed type of elements which contain quadrilateral as well as triangular elements, have been used in analysis. These 2D elements are converted into 3D tetra elements. The sensitive regions have been re-meshed manually considering the shape and size of the parts. From the analysis the maximum principle stress and total deformation were determined and are shown. Table 13 shows the Material properties of steel.

3.1.LOADING CONDITIONS

The portion of the handle in front is made fixed (as shown in figure 2 by blue color) and then various loads are applied as shown in figure 2 and the analysis was done.

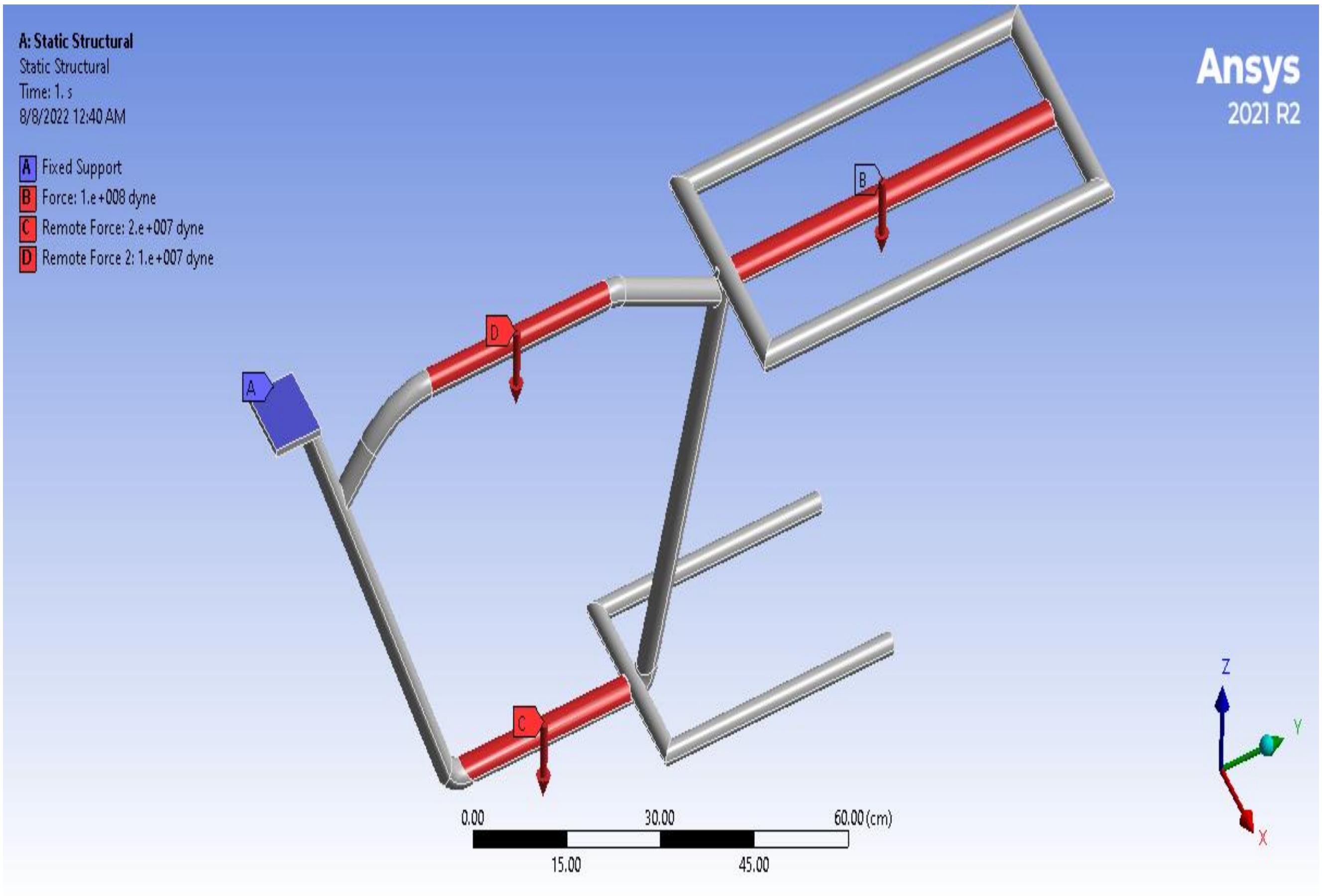

Figure 2 Loading Conditions

3.2.Static Structural

Object Name	Fixed Support	Force	Remote Force	Remote Force 2
State	Fully Defined			
Scope				
Scoping Method	Geometry Selection			
Geometry	1 Face			
Object Name	Fixed Support	Force	Remote Force	Remote Force 2
State	Fully Defined			
Scope				
Coordinate System			Global Coordinate System	
X Coordinate			1.1833e-008 cm	8.1942e-017 cm
Y Coordinate			16.742 cm	10.583 cm
Z Coordinate			0.353 cm	56.008 cm
Location			Defined	
Definition				
Type	Fixed Support	Force	Remote Force	
Suppressed	No			
Define By		Components		
Applied By		Surface Effect		
Coordinate System		Global Coordinate System		
X Component		0. dyne (ramped)		
Y Component		0. dyne (ramped)		
Z Component		-1.e+008 dyne (ramped)	-2.e+007 dyne (ramped)	-1.e+007 dyne (ramped)
Behavior			Deformable	
Advanced				
Pinball Region			All	

Table 1Loads

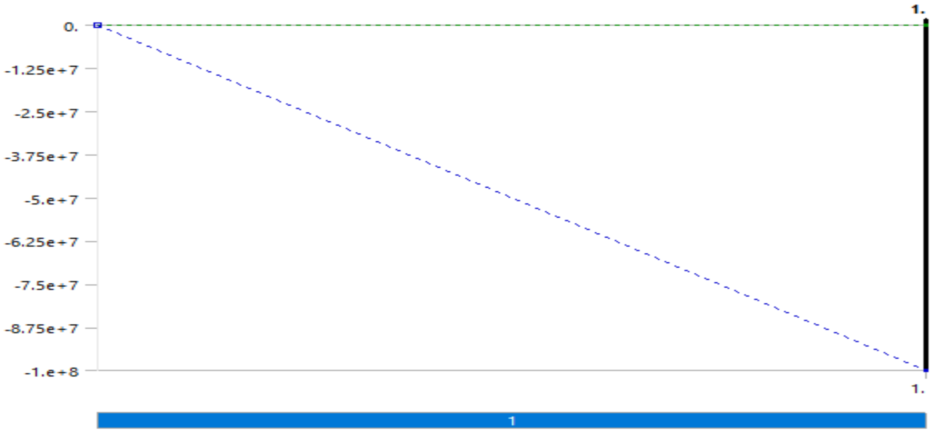

Figure 3Force

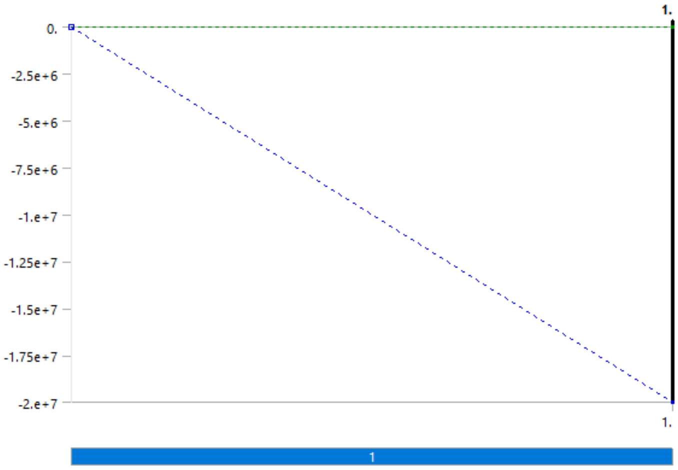

Figure 4Remote Force

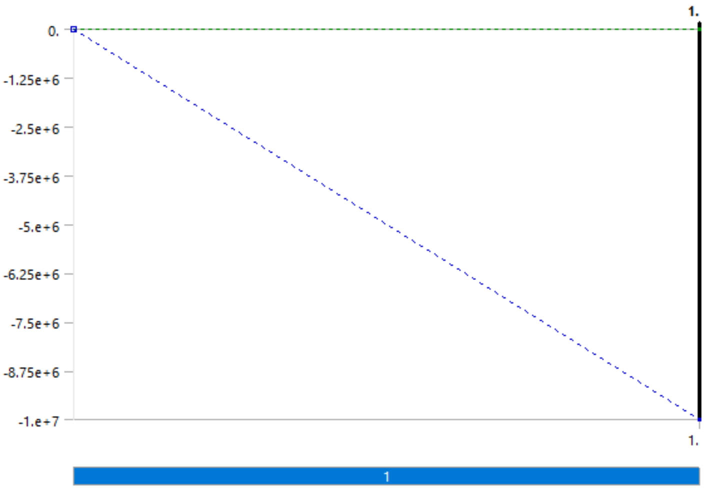

Figure 5Remote Force 2

4. Results

Object Name	Total Deformation	Maximum Principal Stress	Maximum Shear Stress	Equivalent Stress	Strain Energy	Equivalent Elastic Strain
State	Solved					
Scope						
Scoping Method	Geometry Selection					
Geometry	All Bodies					
Definition						
Type	Total Deformation	Maximum Principal Stress	Maximum Shear Stress	Equivalent (von-Mises) Stress	Strain Energy	Equivalent Elastic Strain
By	Time					
Display Time	Last					
Calculate Time History	Yes					
Suppressed	No					
Results						
Minimum	0. cm	-1.1294e+010 dyne/cm²	0.16492 dyne/cm²	0.29296 dyne/cm²	3.8603e-015 erg	6.9901e-013 cm/cm
Maximum	27.935 cm	5.8874e+010 dyne/cm²	2.7718e+010 dyne/cm²	5.103e+010 dyne/cm²	3.9272e+007 erg	3.0693e-002 cm/cm
Average	15.81 cm	3.491e+008 dyne/cm²	3.4117e+008 dyne/cm²	6.4549e+008 dyne/cm²		3.6262e-004 cm/cm
Minimum Occurs On	chasis-FreeParts|Brep With Voids					
Maximum Occurs On	chasis-FreeParts|Brep With Voids					
Total					1.1803e+009 erg	

Table 2Geometry

4.1.Mesh

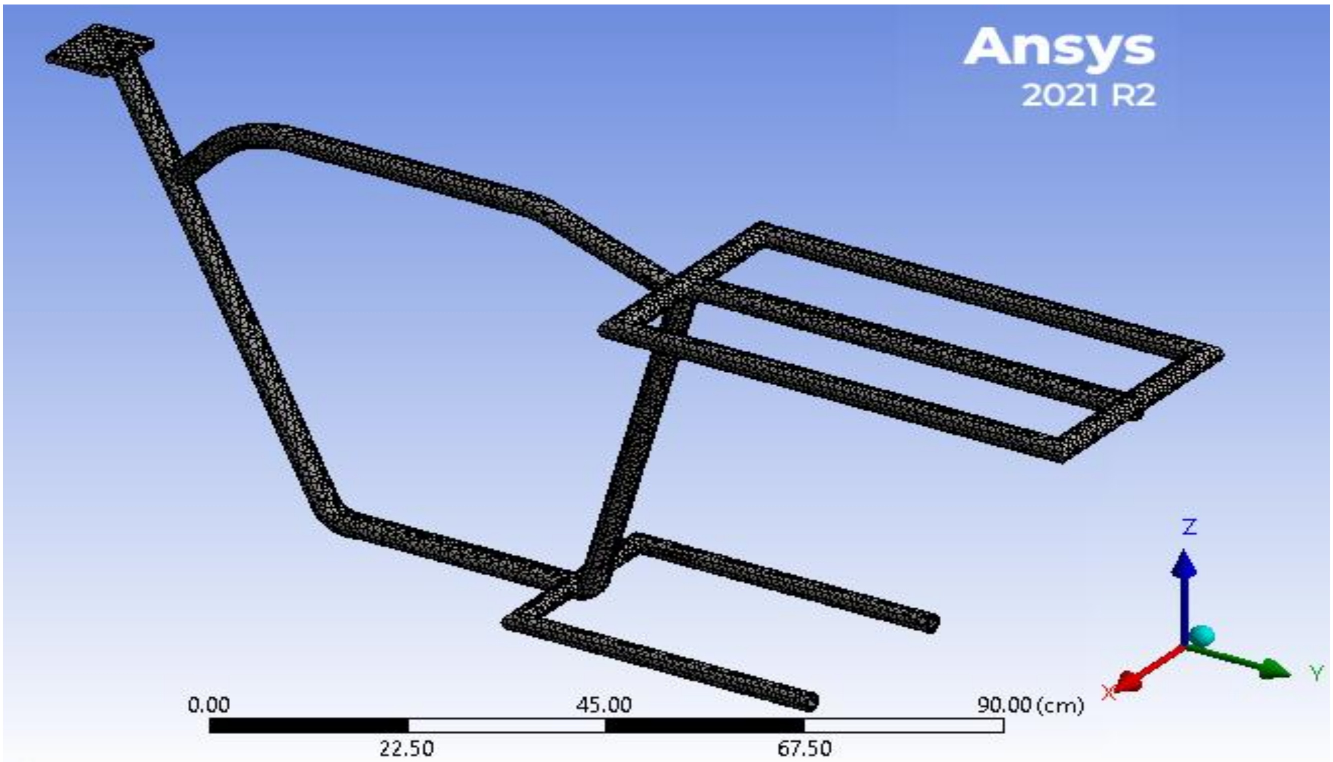

Figure 6Mesh

Definition	
Suppressed	No
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Treatment	None
Material	
Assignment	Structural Steel
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
Properties	
Volume	1218. cm^3
Mass	9561.2 g
Centroid X	-3.2211e-004 cm
Centroid Y	41.807 cm
Centroid Z	36.673 cm

Moment of Inertia Ip1	2.0685e+007 g·cm²
Moment of Inertia Ip2	5.3207e+006 g·cm²
Moment of Inertia Ip3	1.6834e+007 g·cm²
Statistics	
Nodes	78812
Elements	39598

Table 3Geometry

4.2.Total Deformation

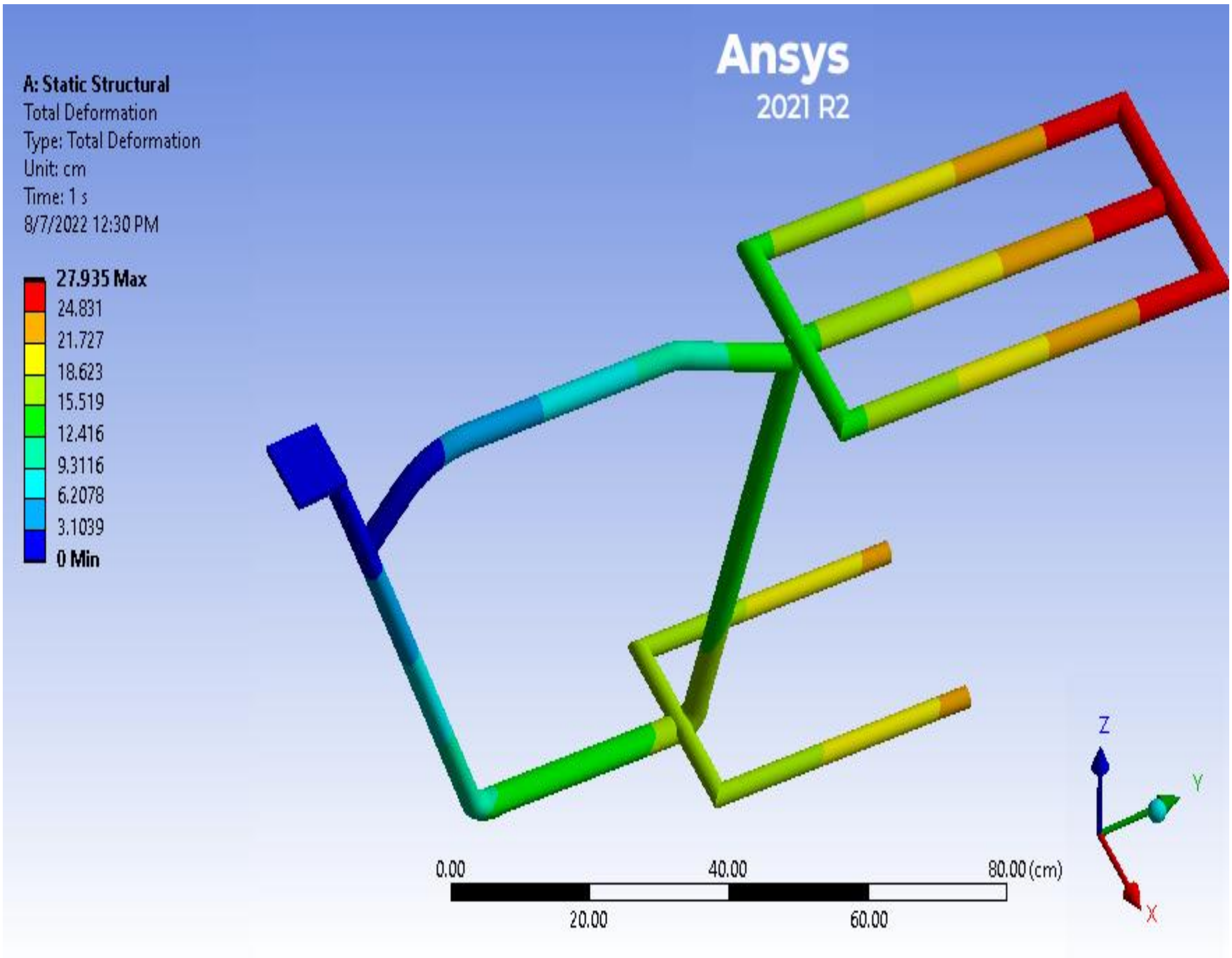

Figure 7Total Deformation

Time [s]	Minimum [cm]	Maximum [cm]	Average [cm]
1.	0.	27.935	15.81

Table 4Total Deformation

4.3.Maximum Principal Stress

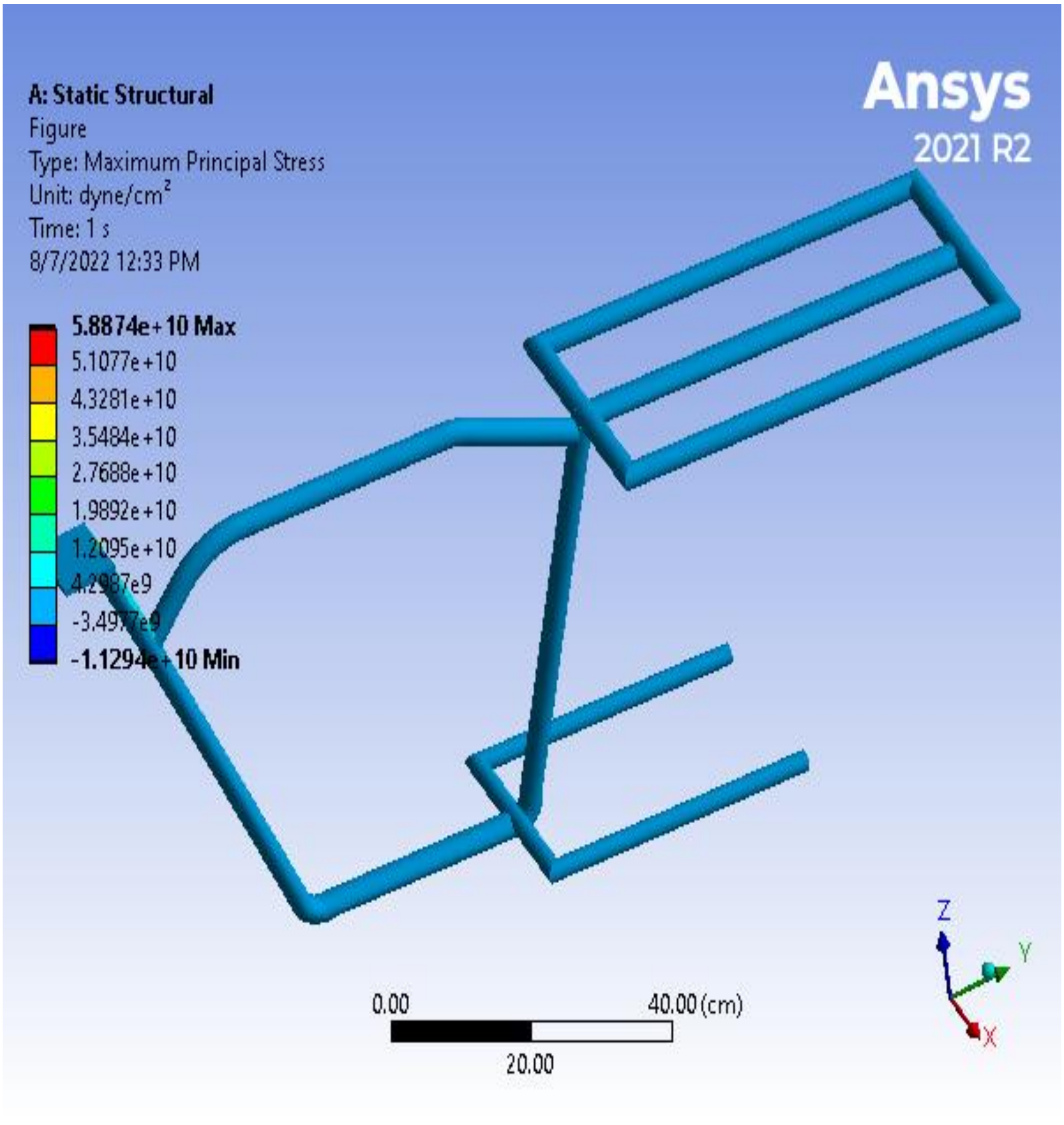

Figure 8Maximum Principal Stress

Time [s]	Minimum [dyne/cm²]	Maximum [dyne/cm²]	Average [dyne/cm²]
1.	-1.1294e+010	5.8874e+010	3.491e+008

Table 5Maximum Principal Stress

4.4.Maximum Shear Stress

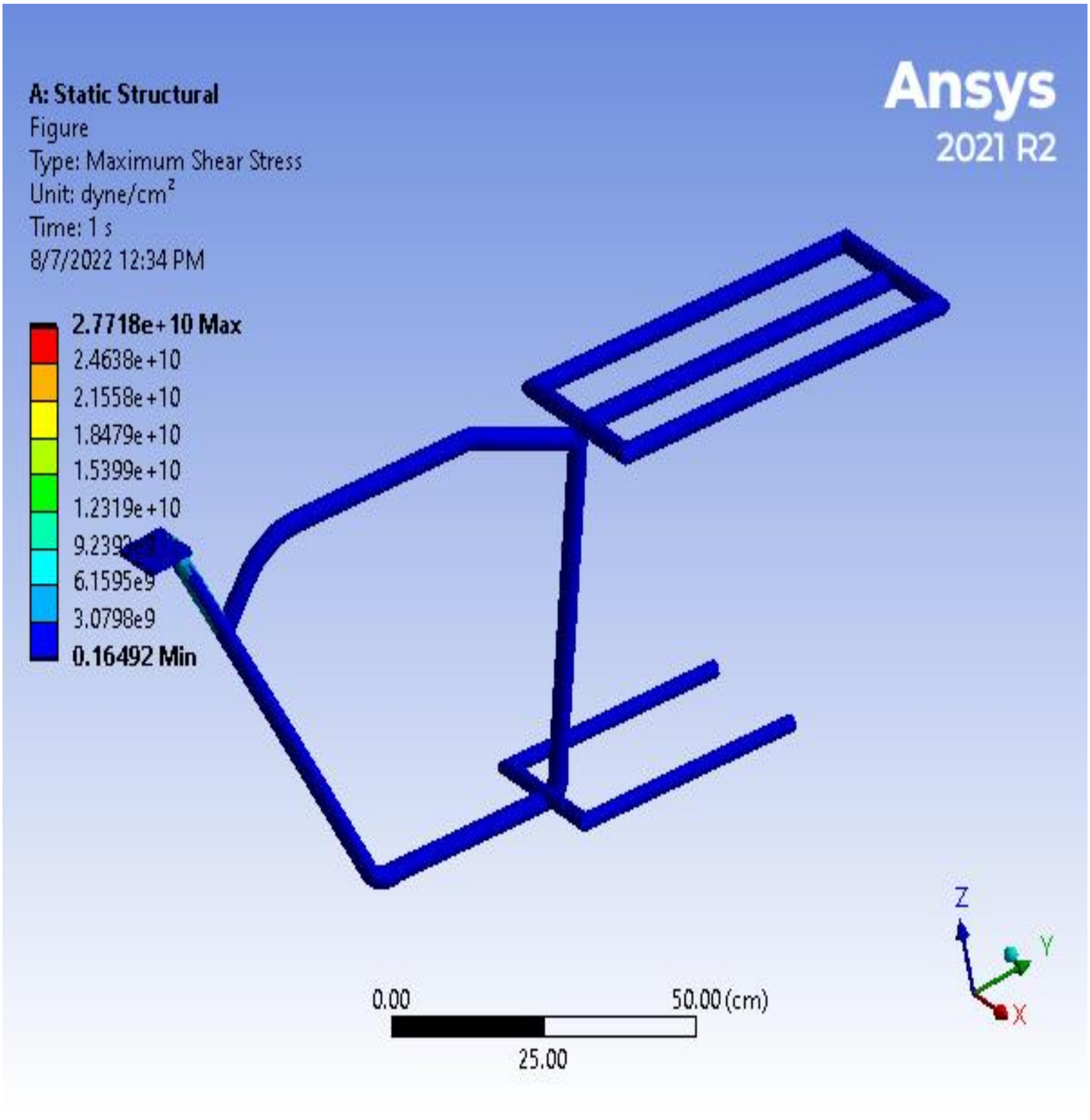

Figure 9Maximum Shear Stress

Time [s]	Minimum [dyne/cm²]	Maximum [dyne/cm²]	Average [dyne/cm²]
1.	0.16492	2.7718e+010	3.4117e+008

Table 6Maximum Shear Stress

4.5.Equivalent Stress

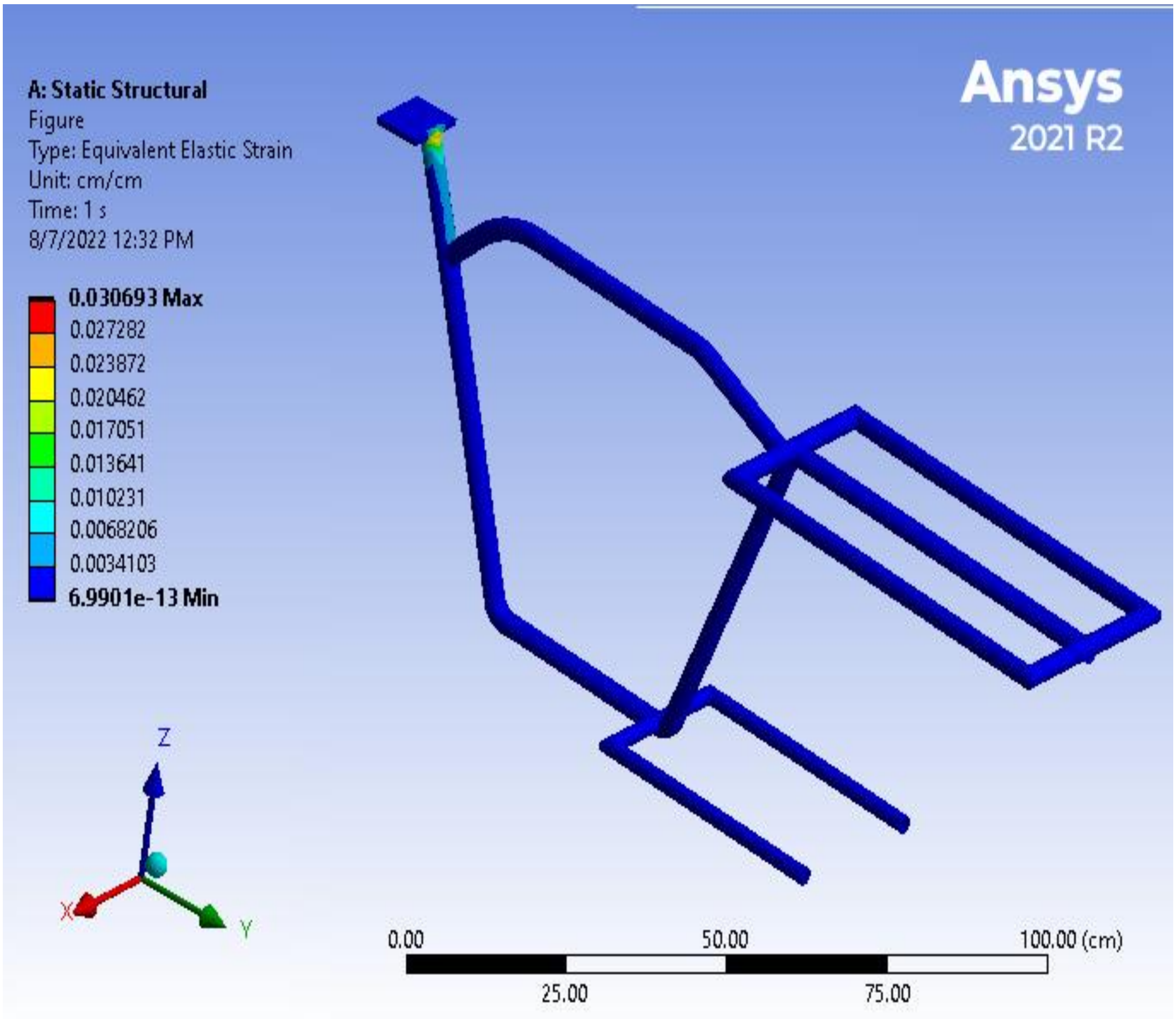

Figure 10Equivalent Stress

Time [s]	Minimum [dyne/cm²]	Maximum [dyne/cm²]	Average [dyne/cm²]
1.	0.29296	5.103e+010	6.4549e+008

Table 7Equivalent Stress

4.6.Strain Energy

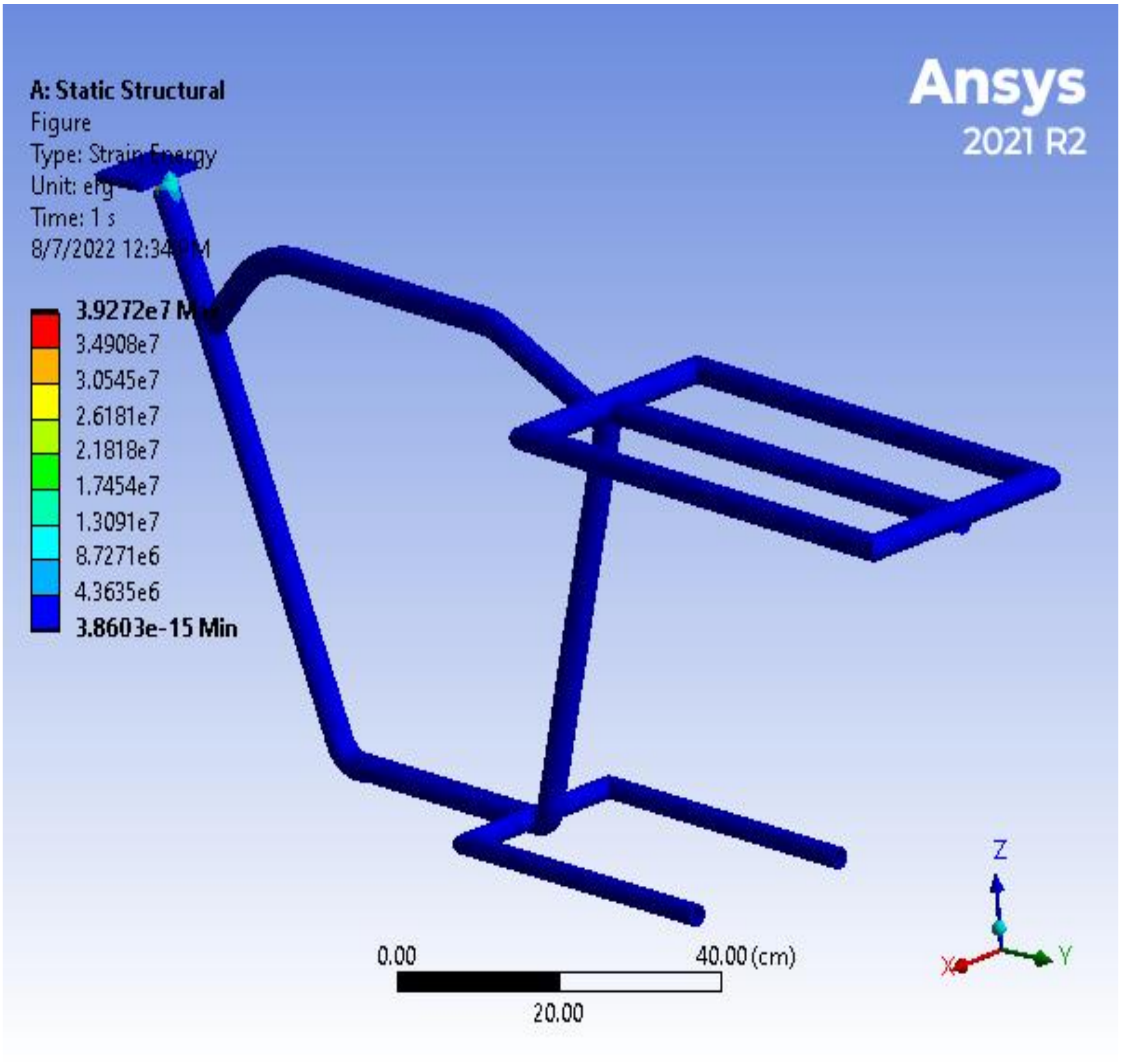

Figure 11Strain

Time [s]	Minimum [erg]	Maximum [erg]	Total [erg]
1.	3.8603e-015	3.9272e+007	1.1803e+009

Table 8Strain Energy

4.7.Equivalent Elastic Strain

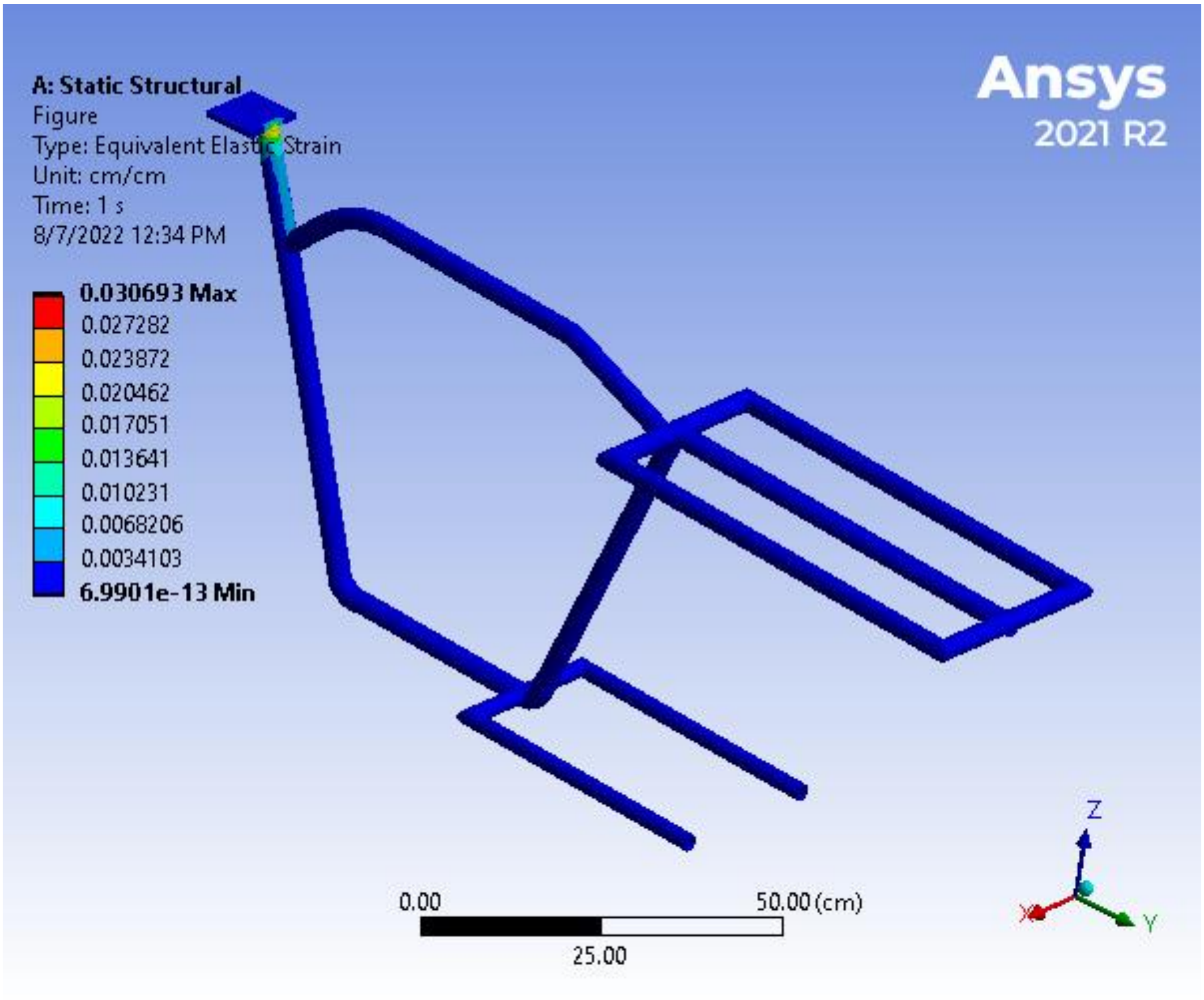

Figure 12Equivalent Elastic Strain

Time [s]	Minimum [cm/cm]	Maximum [cm/cm]	Average [cm/cm]
1.	6.9901e-013	3.0693e-002	3.6262e-004

Table 9Equivalent Elastic Strain

4.8.Safety Factor

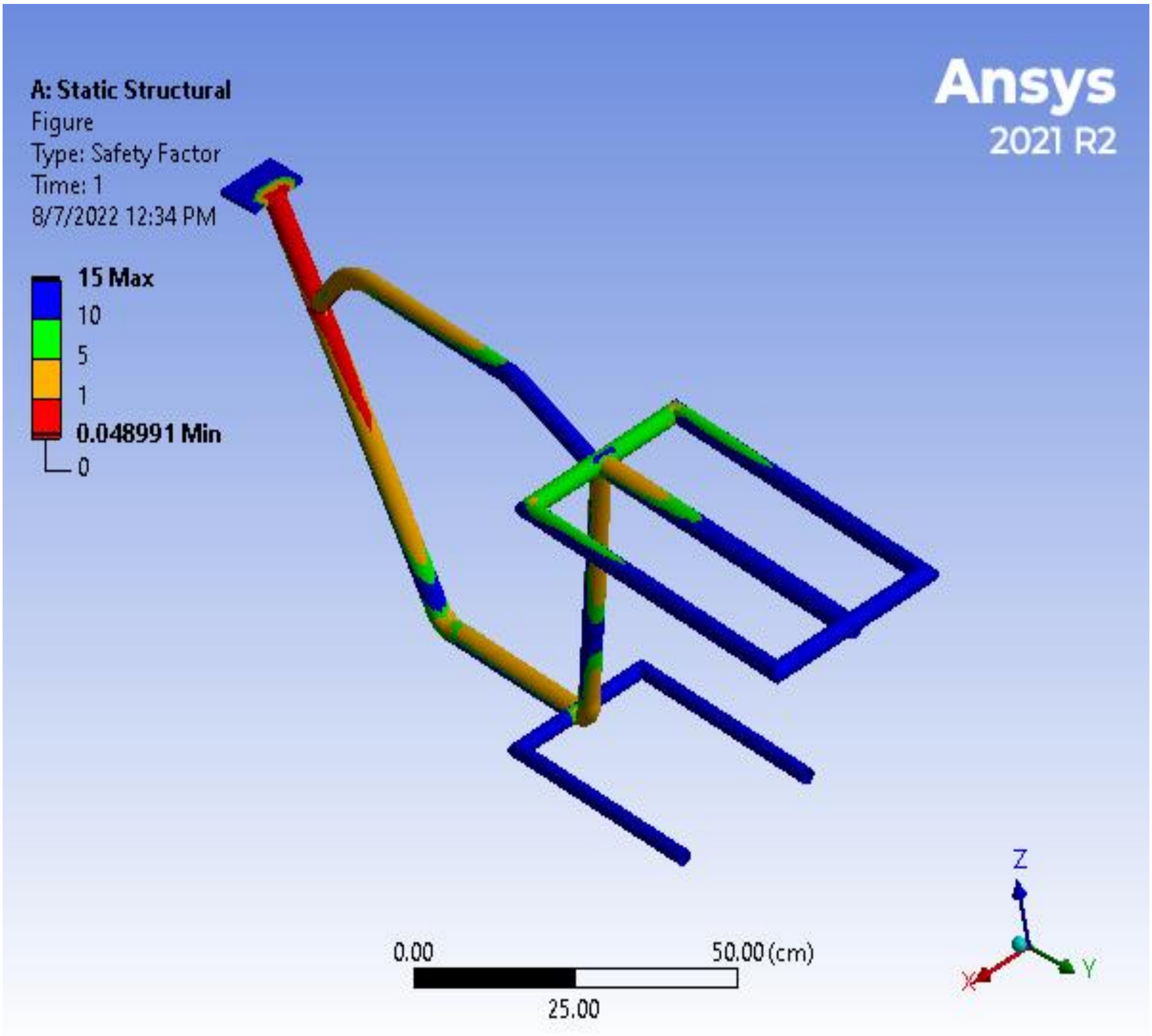

Figure 13Safety Factor

Time [s]	Minimum	Maximum	Average
1.	4.8991e-002	15.	10.054

Table 10Safety Factor

Object Name	Stress Tool
State	Solved
Definition	
Theory	Max Equivalent Stress
Stress Limit Type	Tensile Yield Per Material

Table 11 Safety Tools

Object Name	Safety Factor
State	Solved
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Safety Factor
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	4.8991e-002
Minimum Occurs On	chasis-FreeParts|Brep With Voids
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Table 12 Stress Tool

4.9. Harmonic Response

Harmonic Response of the chassis was done by fixing handle portion as same in other analysis and load was just applied in the seat considering the force due to the applied load and the result is found to be as below.

Object Name	Force
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
Type	Force
Define By	Components
Applied By	Surface Effect
Coordinate System	Global Coordinate System
X Component	0. N
Y Component	0. N
Z Component	-800. N
X Phase Angle	0. °
Y Phase Angle	0. °
Z Phase Angle	0. °
Suppressed	No

Table 13Harmonic Response on Loads at seat

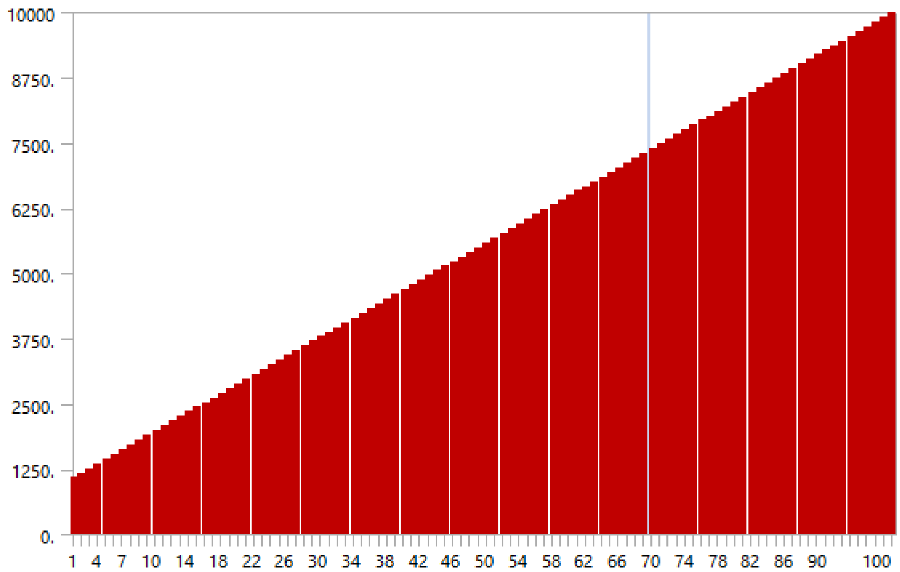

Figure 14 Harmonic Response Solution

Object Name	Total Deformation	Maximum Principal Elastic Strain
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Maximum Principal Elastic Strain
By	Frequency	
Frequency	Last	
Amplitude	No	
Sweeping Phase	0. °	
Identifier		
Suppressed	No	
Results		
Minimum	2.8095e-011 m	-8.1773e-008 m/m
Maximum	6.194e-007 m	6.7067e-006 m/m
Average	3.5218e-008 m	1.9526e-007 m/m
Minimum Occurs On	chasis-FreeParts|Brep With Voids	
Maximum Occurs On	chasis-FreeParts|Brep With Voids	
Information		
Reported Frequency	10000 Hz	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

Table 14**Harmonic Response Solution Results**

5. Material Data

Structural Steel

Density	7.85 g cm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+006 erg g^-1 C^-1
Thermal Conductivity	0.605 W cm^-1 C^-1
Resistivity	1.7e-005 ohm cm

Table 15 Structural Steel Constants

Red	Green	Blue
132	139	179

Table 16Structural Steel Color

Compressive Ultimate Strength dyne cm^-2
0

Table 17Structural Steel Compressive Ultimate Strength

Compressive Yield Strength dyne cm^-2
2.5e+009

Table 18Structural Steel Compressive Yield Strength

Tensile Yield Strength dyne cm^-2
2.5e+009

Table 19Structural Steel Tensile Yield Strength

Tensile Ultimate Strength dyne cm^-2
4.6e+009

Table 20Structural Steel Tensile Ultimate Strength

Zero-Thermal-Strain Reference Temperature C
22

Table 21 Structural Steel Isotropic Secant Coefficient of Thermal Expansion

Alternating Stress dyne cm^-2	Cycles	Mean Stress dyne cm^-2
3.999e+010	10	0
2.827e+010	20	0
1.896e+010	50	0
1.413e+010	100	0
1.069e+010	200	0
4.41e+009	2000	0
2.62e+009	10000	0
2.14e+009	20000	0
1.38e+009	1.e+005	0
1.14e+009	2.e+005	0
8.62e+008	1.e+006	0

Table 22Structural Steel S-N Curve

Strength Coefficient dyne cm^-2	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient dyne cm^-2	Cyclic Strain Hardening Exponent
9.2e+009	-0.106	0.213	-0.47	1.e+010	0.2

Table 23Structural Steel Strain-Life Parameters

Young's Modulus dyne cm^-2	Poisson's Ratio	Bulk Modulus dyne cm^-2	Shear Modulus dyne cm^-2	Temperature C
2.e+012	0.3	1.6667e+012	7.6923e+011	

Table 24Structural Steel Isotropic Elasticity

Relative Permeability
10000

Table 25Structural Steel Isotropic Relative Permeability

6. CONCLUSION:

Hence structural analysis of the Stainless steel has be done by using stainless steel using ANSYS software. From the result it is observed that the stresses are maximum at the joint location and also for all the materials the stress value values are less that their permissible yields stress values. So the design is safe. Stainless steel materials is also cheap in cost, so this is the best suitable material for chassis frame and is expected to perform better with satisfying amount of weight reduction