

Use of ANSYS Workbench for Modeling Concrete Road Patch

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Abstract

It is important to construct the durable roads and there should not be necessity of maintenance after short span. The concrete roads have many advantages as compared to the flexible pavement. The durability, Strength and life are the main characteristics of good road. In the developing countries like India, the flexible roads are deteriorated very easily due to heavy loads of the vehicles. Therefore it is also important to know the stresses and strains coming out on the concrete pavement due to different loads of vehicles. The present paper has describes the deformation, maximum stress and maximum strain. The present paper has consider these aspects using analysis in finite element software i.e. ANSYS workbench.

Keywords: *Concrete road, ANSYS, stress, Strain and deformation*

INTRODUCTION

The flexible pavement includes the construction by the materials like asphalt / bitumen while the rigid pavement construction consists of cement concrete with / without reinforcement. The flexible pavement is less costly as compared to the rigid pavement. Therefore the aim of the present work is to find out the middle path

between the flexible pavement and rigid pavement. The introduction part consists of various methods adopted by the researchers to construct the grouted macadam.

The design of flexible and flexible composite pavements has traditionally been carried out by using design charts

whereby the thickness of each layer is obtained as a function of the design traffic. Furthermore, this approach has recently been used in a revision of the design methodology in order to improve the pavement design principles to respond to the evolution of traffic characteristics. Thus, following the same principles, several design charts should be developed for pavements incorporating grouted macadam, which show enhanced

properties when compared with conventional asphalt mixtures.

METHODOLOGY

The concrete model using finite element software i.e. ANSYS workbench is carried out. The figures and tables show the respective parameters of the concrete modeling using ANSYS workbench. The analysis of model road patch is carried out, the results are also tabulated and figures are also used for describing it.

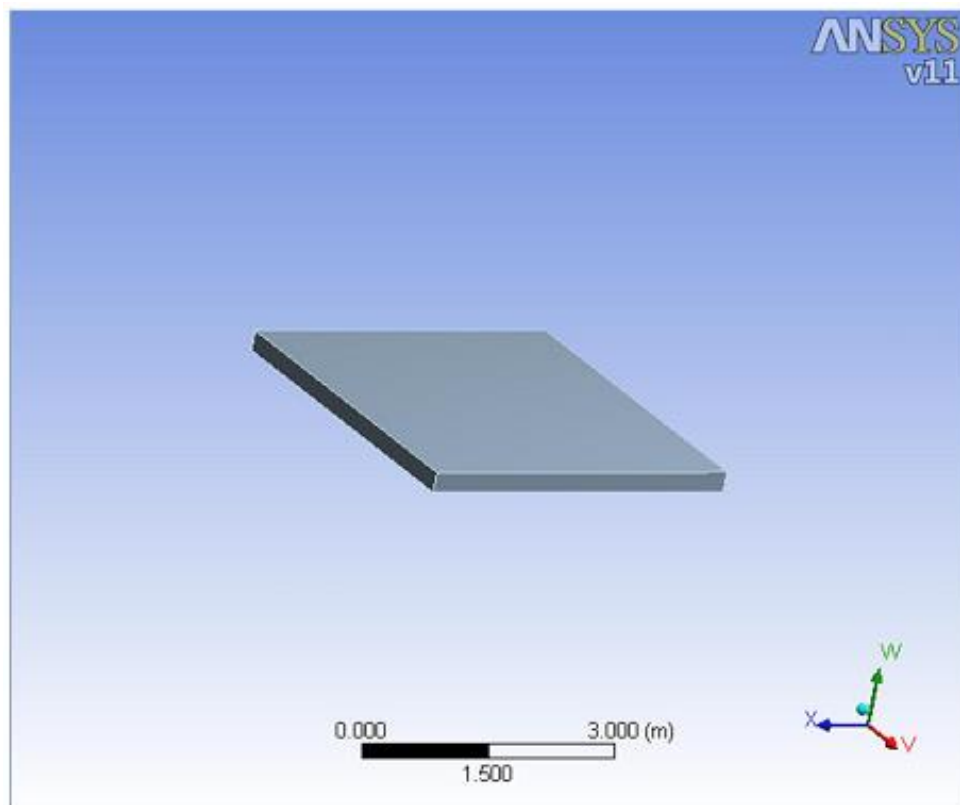


Figure No.1: View of Model in ANSYS

Table No.1: Unit System

Unit System	Metric (m, kg, N, °C, s, V, A)
Angle	Degrees
Rotational Velocity	rad/s

Table No.2: Geometry details of Model

Object Name	Geometry
State	Fully Defined
Definition	
Source	Unnamed.agdb
Type	Design Modeler
Length Unit	Millimeters
Element Control	Program Controlled
Display Style	Part Color
Bounding Box	
Length X	4.5 m
Length Y	0.25 m
Length Z	4. m
Properties	
Volume	4.5 m ³
Mass	10350 kg
Statistics	
Bodies	52
Active Bodies	1
Nodes	9371
Elements	1620
Preferences	
Import Solid Bodies	Yes
Import Surface Bodies	Yes
Import Line Bodies	Yes
Parameter Processing	Yes

Personal Parameter Key	DS
CAD Attribute Transfer	No
Named Selection Processing	No
Material Properties Transfer	No
CAD Associativity	Yes
Import Coordinate Systems	No
Reader Save Part File	No
Import Using Instances	Yes
Do Smart Update	No
Attach File Via Temp File	No
Analysis Type	3-D
Mixed Import Resolution	None
Enclosure and Symmetry Processing	Yes

Table No.3: Geometry Model parts

Object Name	<i>Solid</i>
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	1
Definition	
Suppressed	No
Material	Concrete
Stiffness Behavior	Flexible
Nonlinear Material Effects	Yes
Bounding Box	
Length X	4.5 m

Length Y	0.25 m
Length Z	4. m
Properties	
Volume	4.5 m ³
Mass	10350 kg
Centroid X	2.25 m
Centroid Y	0.125 m
Centroid Z	2. m
Moment of Inertia Ip1	13854 kg·m ²
Moment of Inertia Ip2	31266 kg·m ²
Moment of Inertia Ip3	17520 kg·m ²
Statistics	
Nodes	9371
Elements	1620

Table No.4: Model Geometry Body Groups

Object Name	<i>Rebar</i>
State	Suppressed
Graphics Properties	
Visible	No
Definition	
Suppressed	Yes
Material	Structural Steel 2
Bounding Box	
Length X	4.3773 m
Length Y	0. m
Length Z	3.75 m
Properties	
Volume	7.013e-002 m ³
Mass	550.52 kg
Statistics	

Nodes	0
Elements	0

Table No.5: Model Geometry Rebar parts

Object Name	Line Body	Line Body	Line Body	Line Body	Line Body
State	Suppressed				
Graphics Properties					
Visible	No				
Definition					
Suppressed	Yes				
Material	Structural Steel 2				
Nonlinear Material Effects	Yes				
Beam Section	Circular1				
Bounding Box					
Length X	4.3773 m				
Length Y	0. m				
Length Z	0. m				
Properties					
Volume	1.3751e-003 m³				
Mass	10.794 kg				
Length	4.3773 m				
Cross Section Area	3.1414e-004 m²				
Cross Section IYY	7.8529e-009 m²m²				
Cross Section IZZ	7.8529e-009 m²m²				
Statistics					

Nodes	0
Elements	0

Table No.6: Model Connections

Object Name	Connections
State	Fully Defined
Auto Detection	
Generate Contact On Update	Yes
Tolerance Type	Slider
Tolerance Slider	0
Tolerance Value	1.5065e-002 m
Same Body Grouping	Yes
Transparency	
Enabled	Yes

Table No.7: Model Mesh

Object Name	Mesh
State	Solved
Defaults	
Physics Preference	Mechanical
Relevance	0
Advanced	
Relevance Center	Coarse
Element Size	0.15 m
Shape Checking	Standard Mechanical
Solid Element Midside Nodes	Program Controlled

Straight Sided Elements	No
Initial Size Seed	Active Assembly
Smoothing	Low
Transition	Fast
Statistics	
Nodes	9371
Elements	1620

Table No.8: Static structural solution

Object Name	Maximum Principal Stress	Maximum Principal Elastic Strain	Total Deformation
State	Solved		
Scope			
Geometry	All Bodies		
Definition			
Type	Maximum Principal Stress	Maximum Principal Elastic Strain	Total Deformation
Display Time	End Time		
Results			
Minimum	-45.653 Pa	-1.7105e-012 m/m	0. m
Maximum	346.31 Pa	1.6886e-008 m/m	5.1859e-009 m
Information			
Time	1. s		
Load Step	1		
Substep	1		
Iteration Number	1		

Table No.9: Static structural solution

Object Name	<i>Total Deformation₂</i>	<i>Directional Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Maximum Principal Elastic Strain₂</i>	<i>Middle Principal Elastic Strain</i>
State	Solved				
Scope					
Geometry	All Bodies				
Definition					
Type	Total Deformation	Directional Deformation	Equivalent (von-Mises) Elastic Strain	Maximum Principal Elastic Strain	Middle Principal Elastic Strain
Display Time	End Time				
Orientation		X Axis			
Results					
Minimum	0. m	-1.6151e-009 m	1.3078e-011 m/m	-1.7105e-012 m/m	-1.6405e-009 m/m
Maximum	5.1859e-009 m	1.96e-010 m	3.8877e-008 m/m	1.6886e-008 m/m	5.2056e-009 m/m
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				

Table No.10: Static structural solution

Object Name	Maximum Shear Elastic Strain	Strain Energy	Vector Principal Elastic Strain	Equivalent Stress	Maximum Principal Stress 2
State	Solved				
Scope					
Geometry	All Bodies				
Definition					
Type	Maximum Shear Elastic Strain	Strain Energy	Vector Principal Elastic Strain	Equivalent (von-Mises) Stress	Maximum Principal Stress
Display Time	End Time				
Results					
Minimum	1.613e-011 m/m	1.2331e-014 J		0.39234 Pa	-45.653 Pa
Maximum	5.0586e-008 m/m	1.9048e-009 J		1166.3 Pa	346.31 Pa
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				

Table No.11: Static structural solution

Object Name	<i>Maximum Principal Stress</i> 3	<i>Middle Principal Stress</i>	<i>Minimum Principal Stress</i>	<i>Maximum Shear Stress</i>	<i>Stress Intensity</i>
State	Solved				
Scope					
Geometry	All Bodies				
Definition					

Type	Maximum Principal Stress	Middle Principal Stress	Minimum Principal Stress	Maximum Shear Stress	Stress Intensity
Display Time	End Time				
Results					
Minimum	-45.653 Pa	-90.587 Pa	-939.77 Pa	0.20504 Pa	0.41008 Pa
Maximum	346.31 Pa	86.192 Pa	3.5942 Pa	643.04 Pa	1286.1 Pa
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				

Table No.12: Material data for concrete

Structural	
Young's Modulus	3.e+010 Pa
Poisson's Ratio	0.18
Density	2300. kg/m ³
Thermal Expansion	1.4e-005 1/°C
Tensile Yield Strength	0. Pa
Compressive Yield Strength	0. Pa
Tensile Ultimate Strength	5.e+006 Pa
Compressive Ultimate Strength	4.1e+007 Pa
Thermal	
Thermal Conductivity	0.72 W/m·°C
Specific Heat	780. J/kg·°C

Table No.13: Material data for structural steel

Young's Modulus	2.e+011 Pa
Poisson's Ratio	0.3
Density	7850. kg/m ³
Thermal Expansion	1.2e-005 1/°C

Tensile Yield Strength	2.5e+008 Pa
Compressive Yield Strength	2.5e+008 Pa
Tensile Ultimate Strength	4.6e+008 Pa
Compressive Ultimate Strength	0. Pa
Thermal	
Thermal Conductivity	60.5 W/m·°C
Specific Heat	434. J/kg·°C
Electromagnetics	
Relative Permeability	10000
Resistivity	1.7e-007 Ohm·m

RESULTS

After analysis part is over, the results of stress, strain and deformation of the model is described through figures. The maximum and minimum values are also indicated in that figures which explains the results.

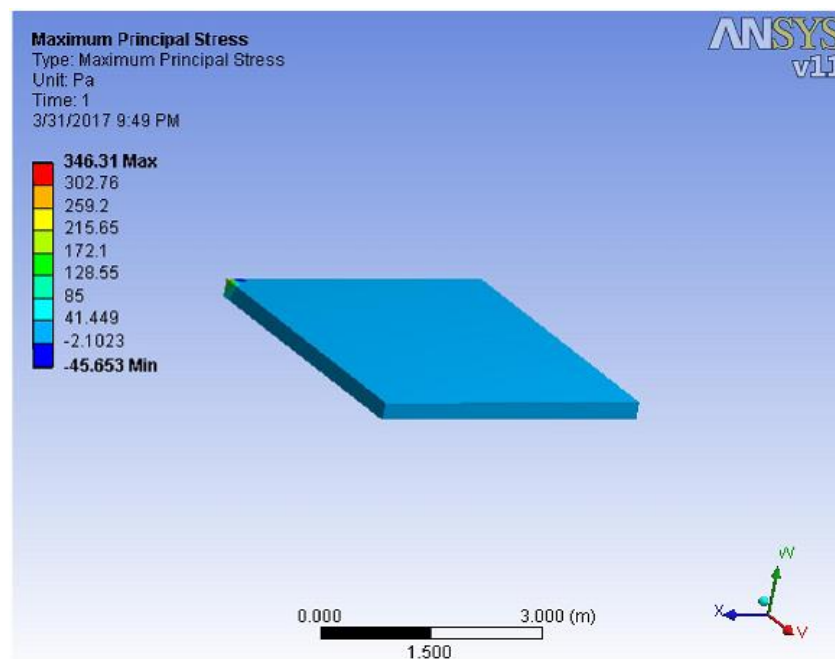


Figure No. 2: Maximum Principal Stress

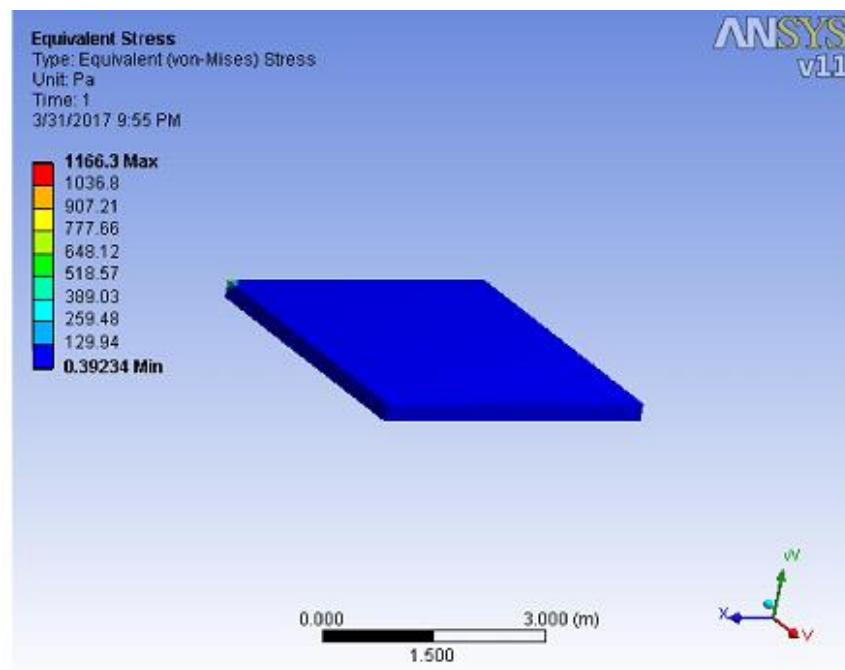


Figure No.3: Equivalent Stress

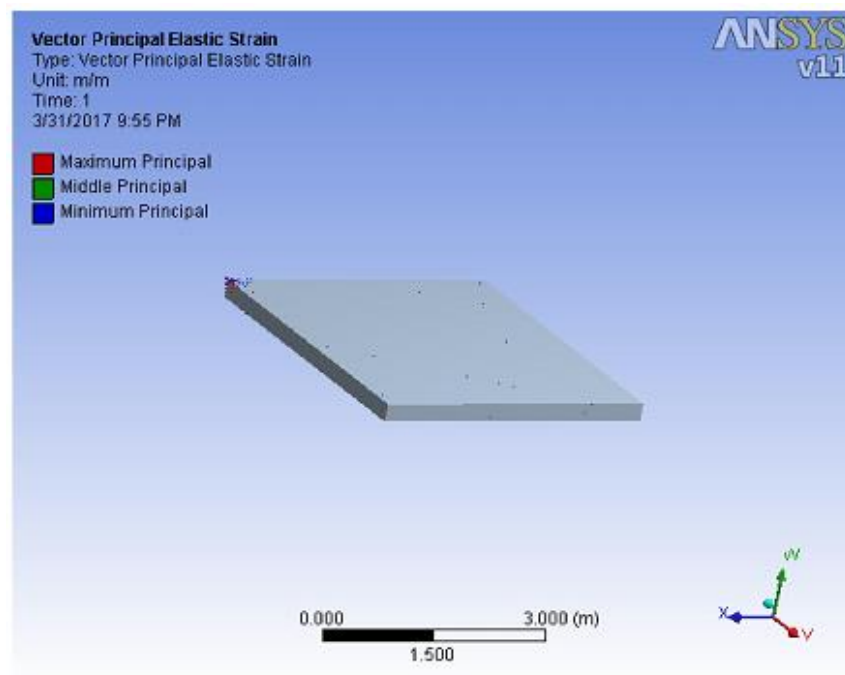


Figure No.4: Vector Principal Elastic strain

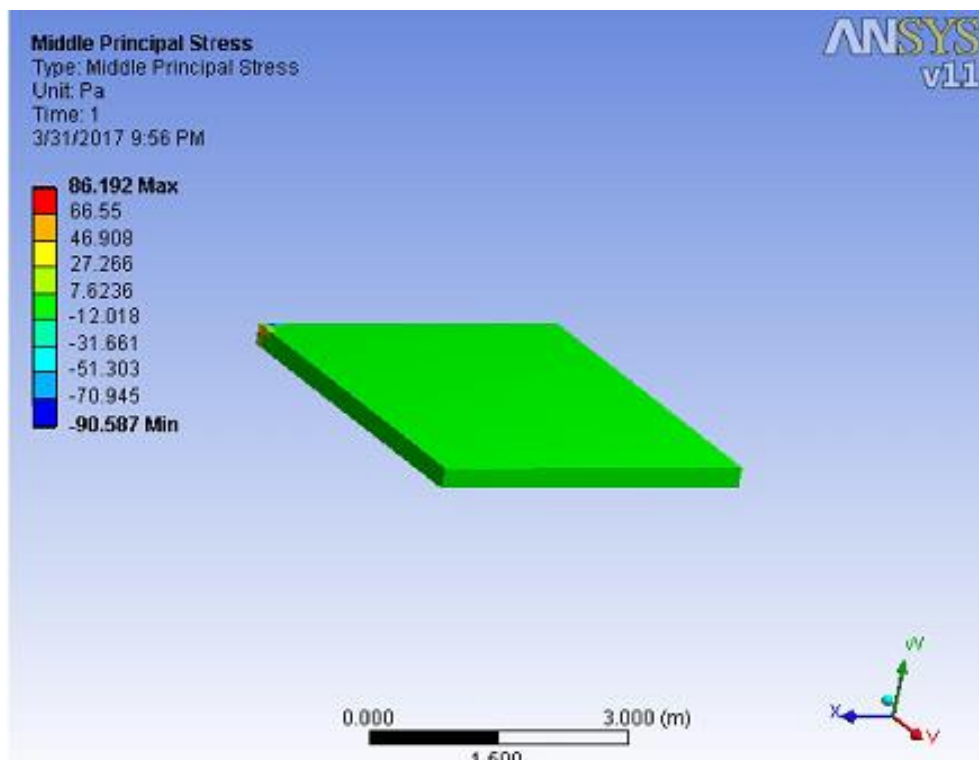


Figure No.5: Middle Principal Stress

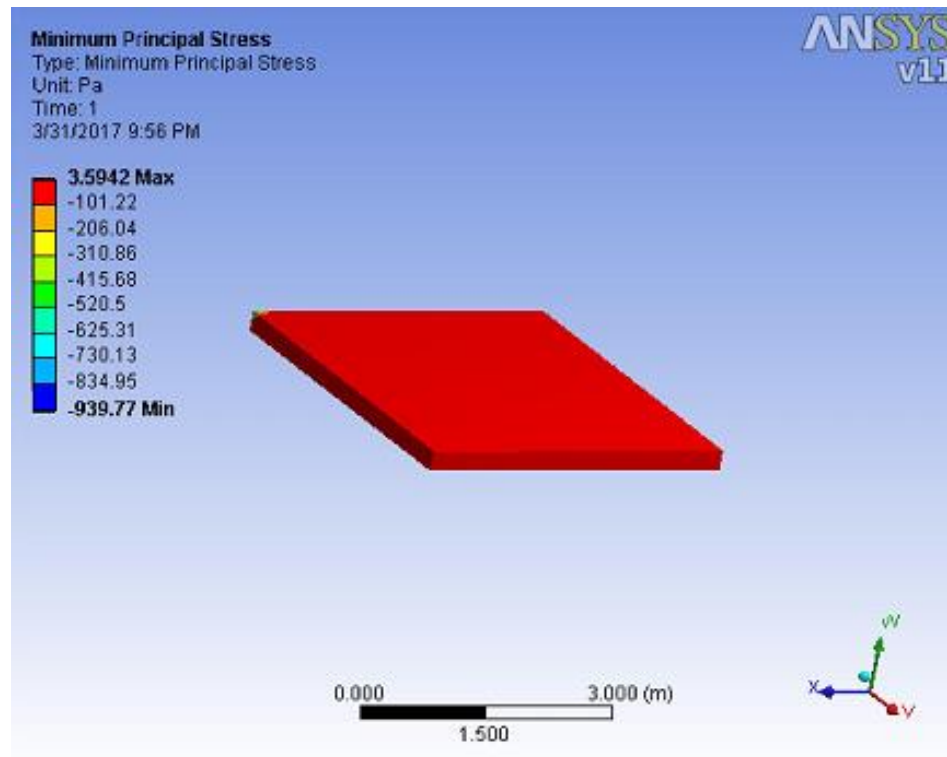


Figure No.6: Minimum Principal stress

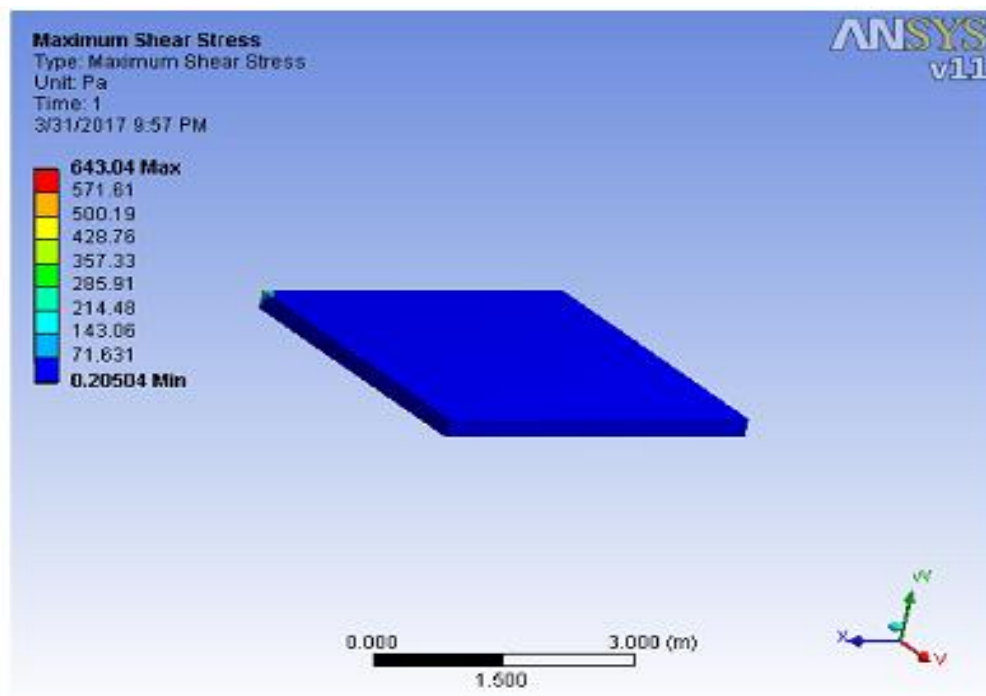


Figure No.7: Maximum Shear Stress

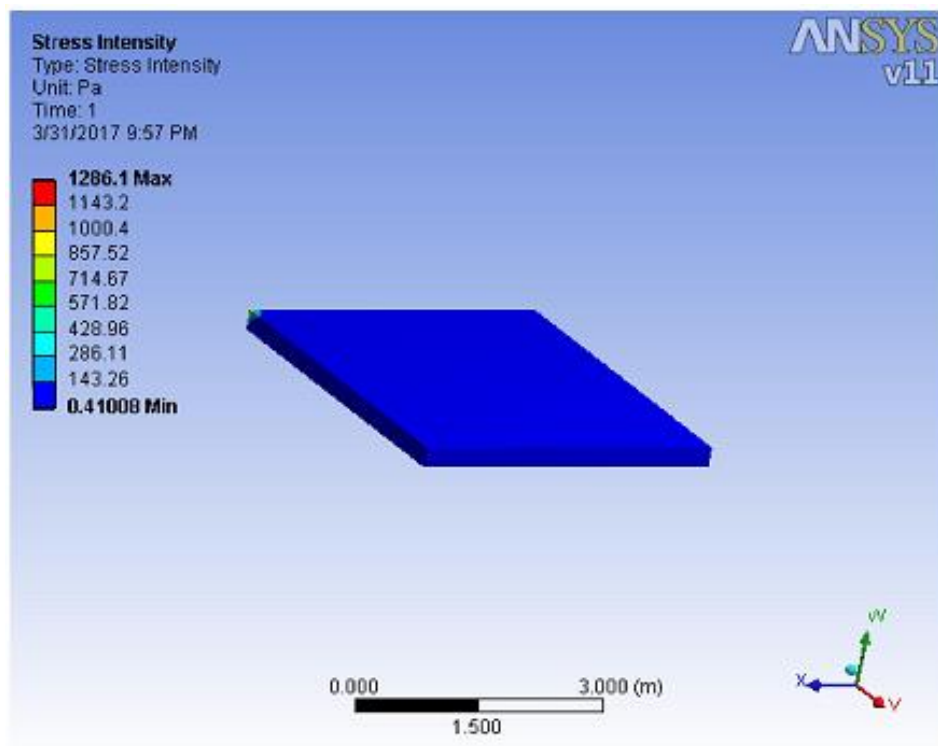


Figure No.8: Stress Intensity

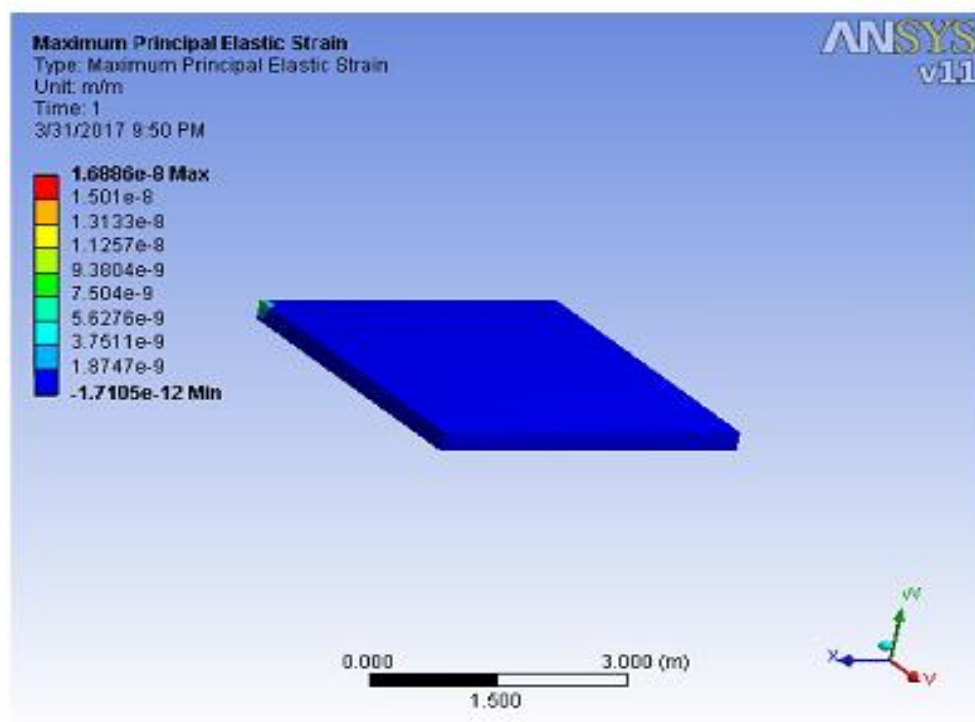


Figure No.9: Maximum Principal Elastic Strain

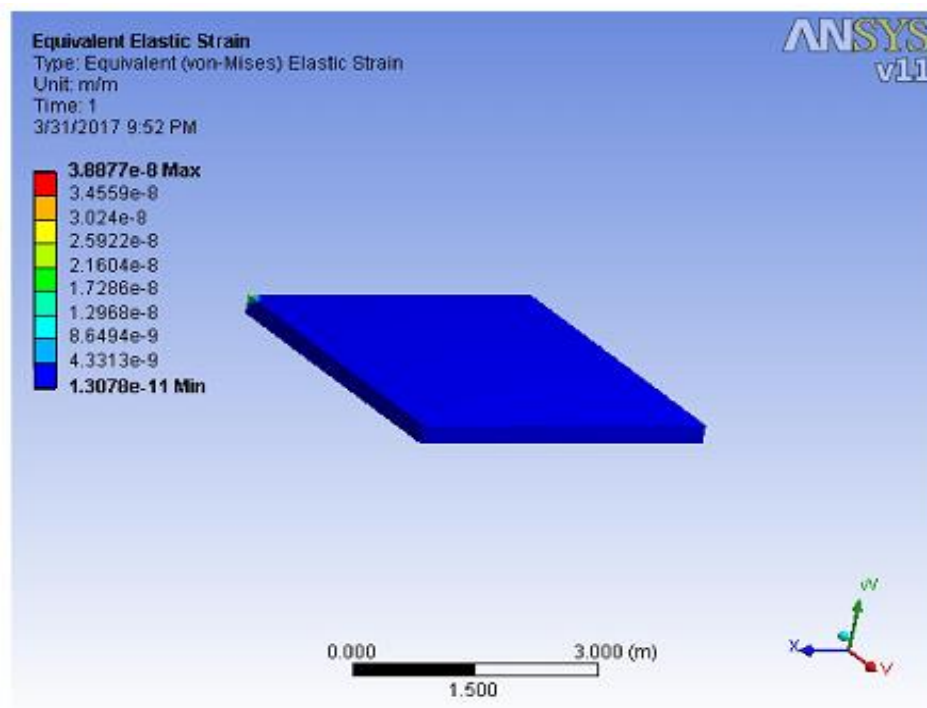


Figure No.10: Equivalent Elastic strain

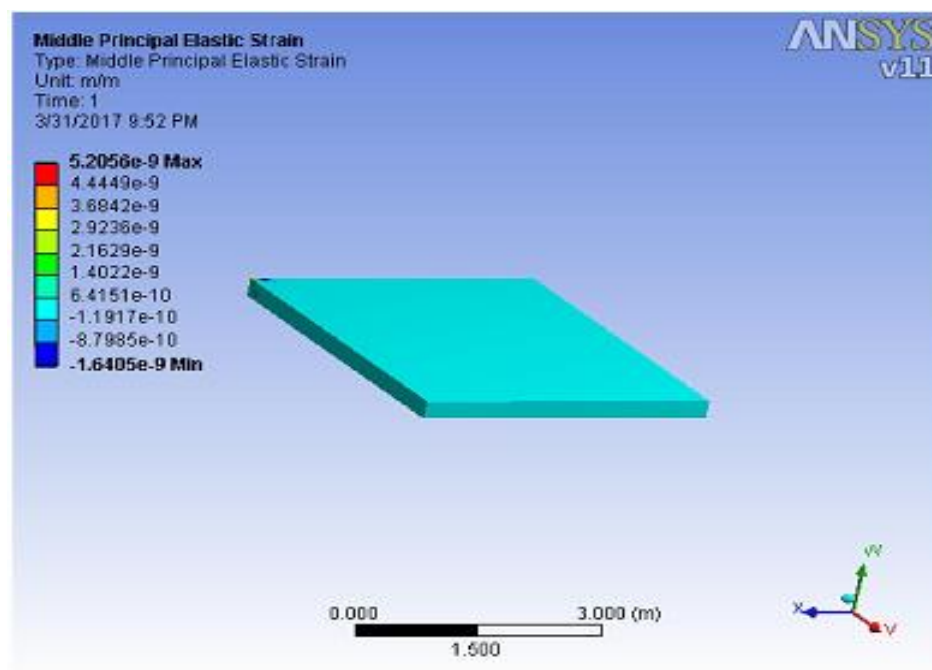


Figure No.11: Middle Principal Elastic strain

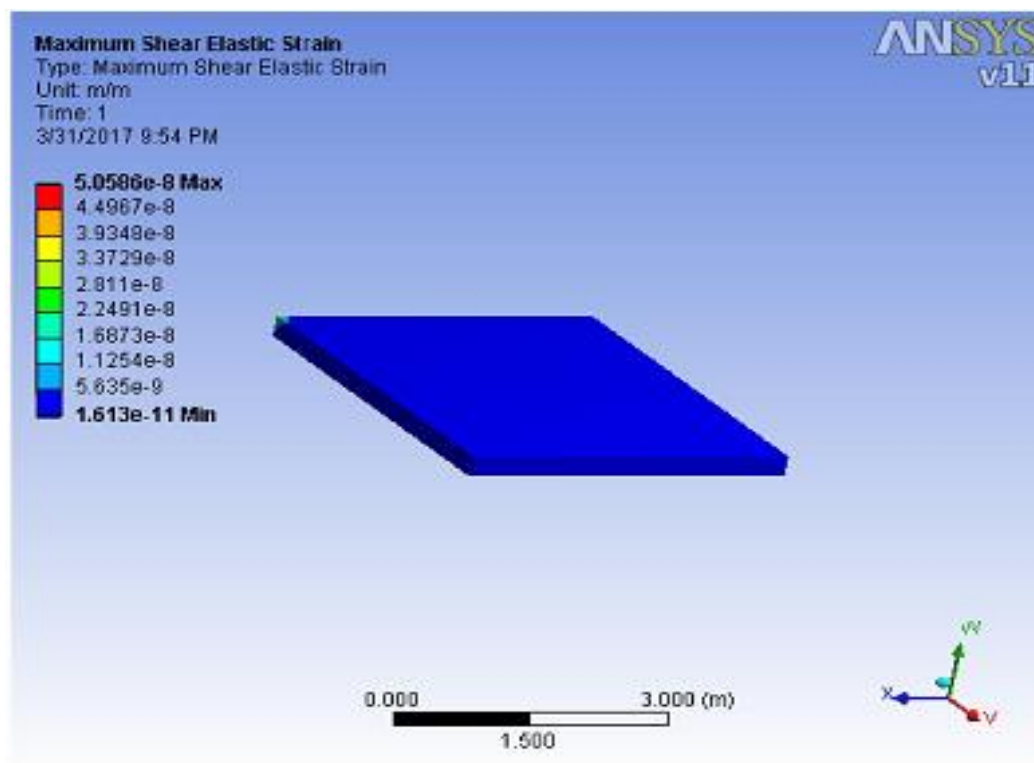


Figure No.12: Maximum Shear Elastic strain

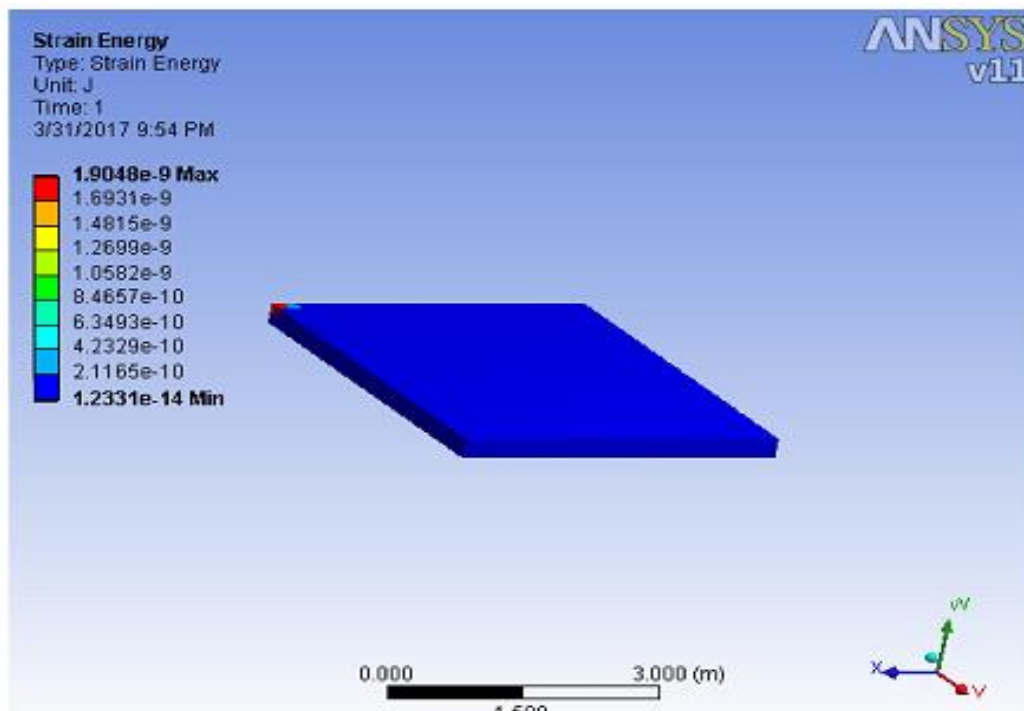


Figure No.13: Strain Energy

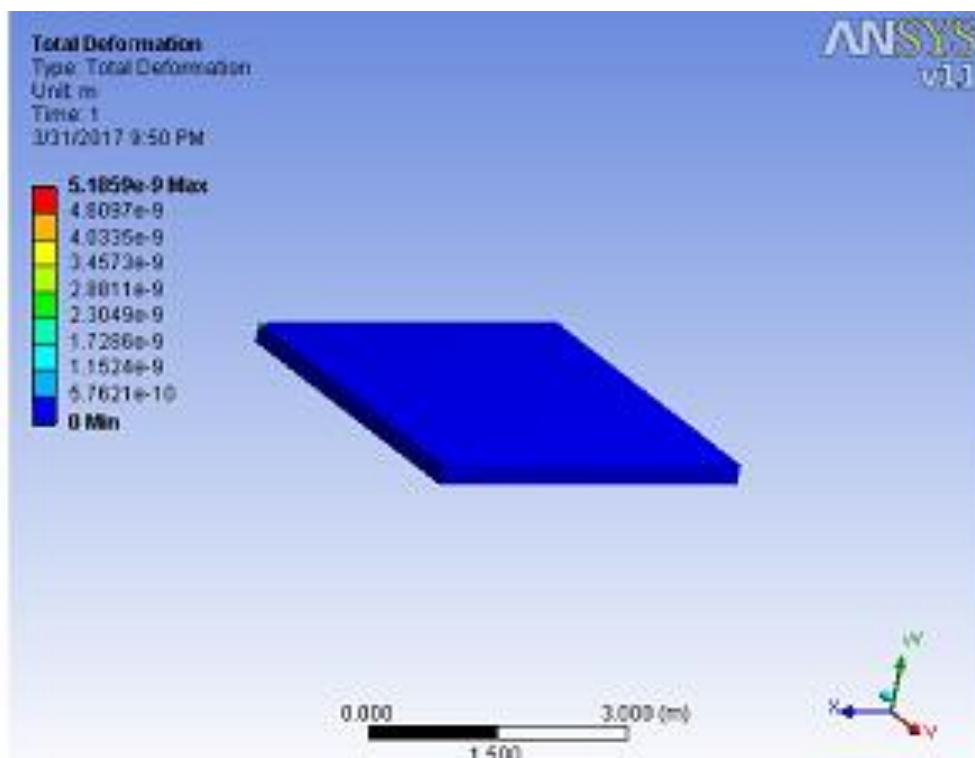


Figure No.14: Total Deformation

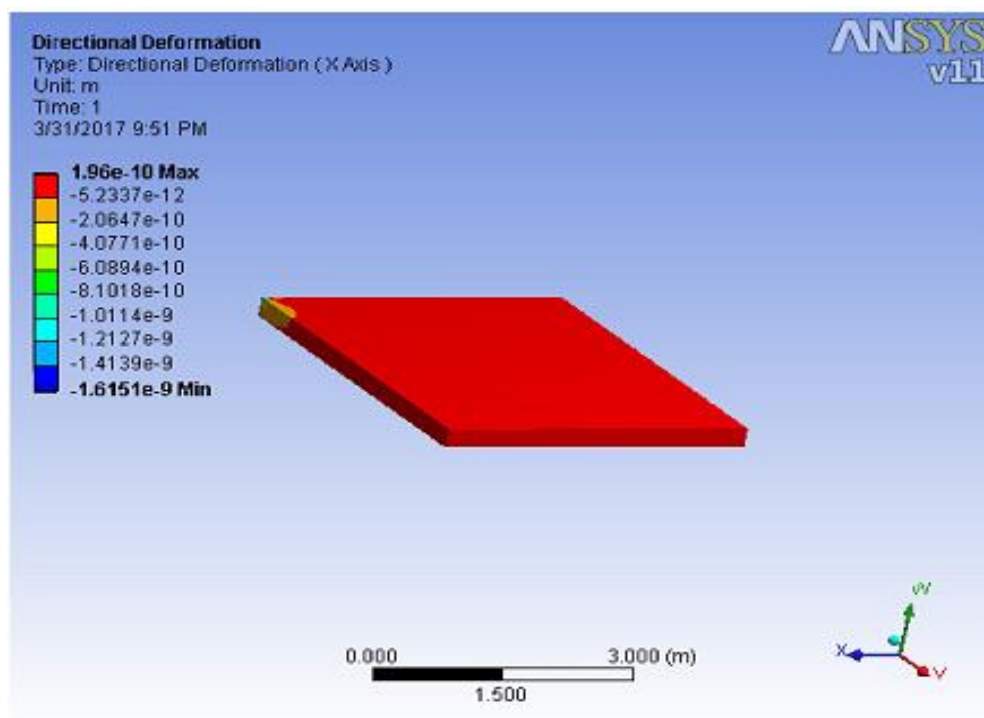


Figure No.15: Directional Deformation

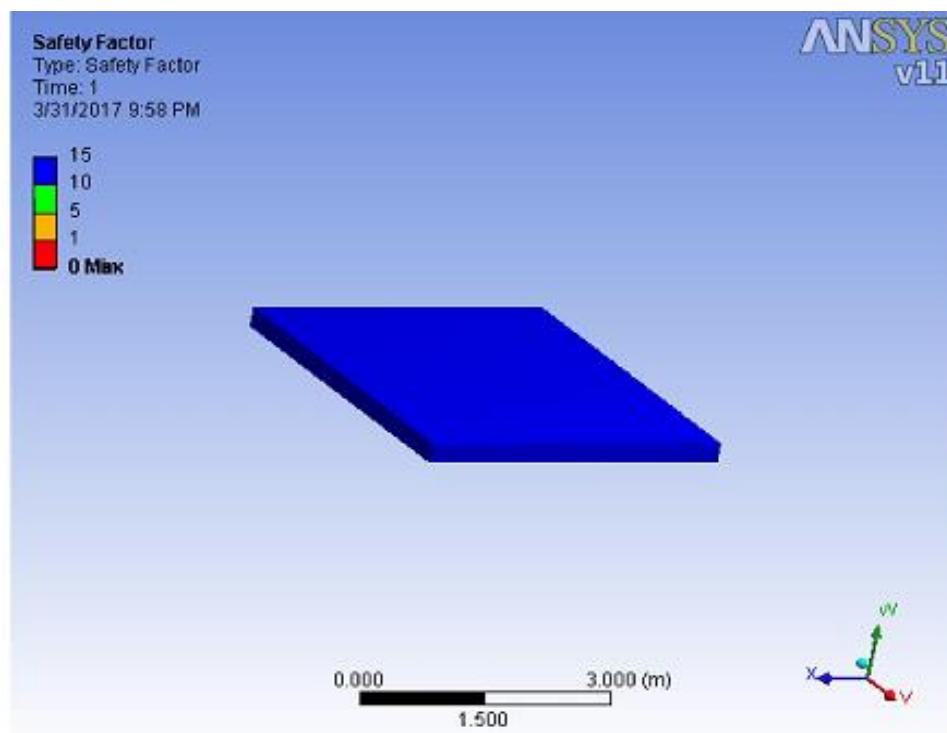


Figure No.16: Safety Factor

CONCLUSION

- The principal stresses are found as minimum all over the surface of the model.
- Equivalent stress is also found as minimum on the model.
- Middle Principal Stress has the values distributed across the model.
- Shear stress is also minimum on the model
- Total deformation is minimum
- Directional deformation is found as maximum
- Safety factor is in between 10 to 15.

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