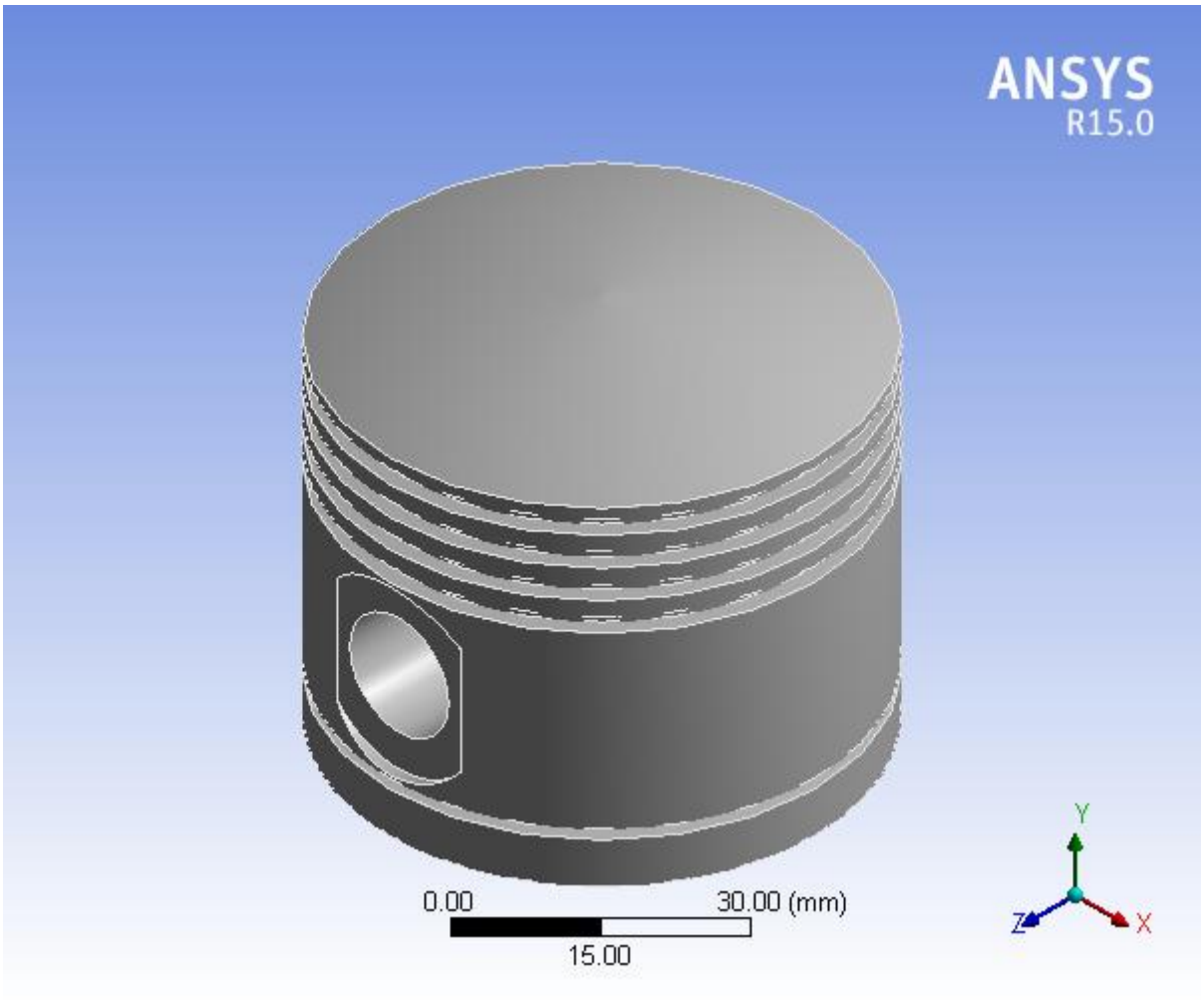
Project

First Saved	Wednesday, April 11, 2018
Last Saved	Wednesday, April 11, 2018
Product Version	15.0 Release
Save Project Before Solution	No
Save Project After Solution	No



Contents

Units

TABLE 1

Unit System	Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (A4)

Geometry

TABLE 2
Model (A4) > Geometry

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\Ramesh Kumar\Desktop\piston.SLDPRT
Type	SolidWorks
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	59.969 mm
Length Y	51.33 mm
Length Z	60. mm
Properties	
Volume	62353 mm³
Mass	0.27622 kg
Scale Factor Value	1.
Statistics	

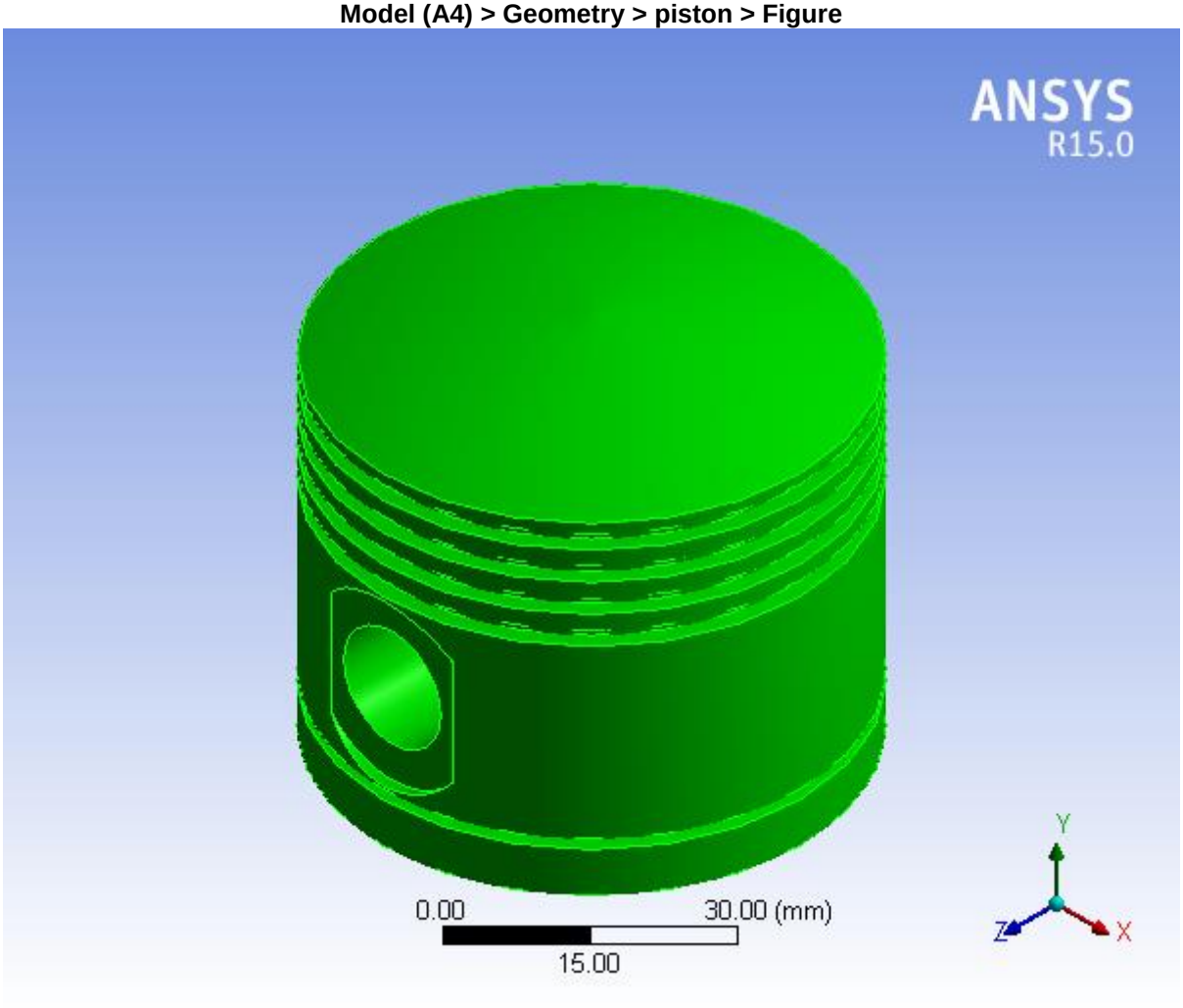
Bodies	1
Active Bodies	1
Nodes	90114
Elements	51858
Mesh Metric	None
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Compare Parts On Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\Ramesh Kumar\AppData\Local\Temp
Analysis Type	3-D
Mixed Import Resolution	None
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (A4) > Geometry > Parts

Object Name	*piston*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	1
Definition	
Suppressed	No
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Material	
Assignment	Ti-6Al-4V
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
Bounding Box	
Length X	59.969 mm
Length Y	51.33 mm
Length Z	60. mm
Properties	
Volume	62353 mm^3
Mass	0.27622 kg
Centroid X	1.8733e-004 mm

Centroid Y	26.34 mm
Centroid Z	-2.1544e-004 mm
Moment of Inertia Ip1	140.7 kg·mm²
Moment of Inertia Ip2	156.34 kg·mm²
Moment of Inertia Ip3	137.33 kg·mm²
Statistics	
Nodes	90114
Elements	51858
Mesh Metric	None

FIGURE 1
Model (A4) > Geometry > piston > Figure



Coordinate Systems

TABLE 4
Model (A4) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. mm

Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

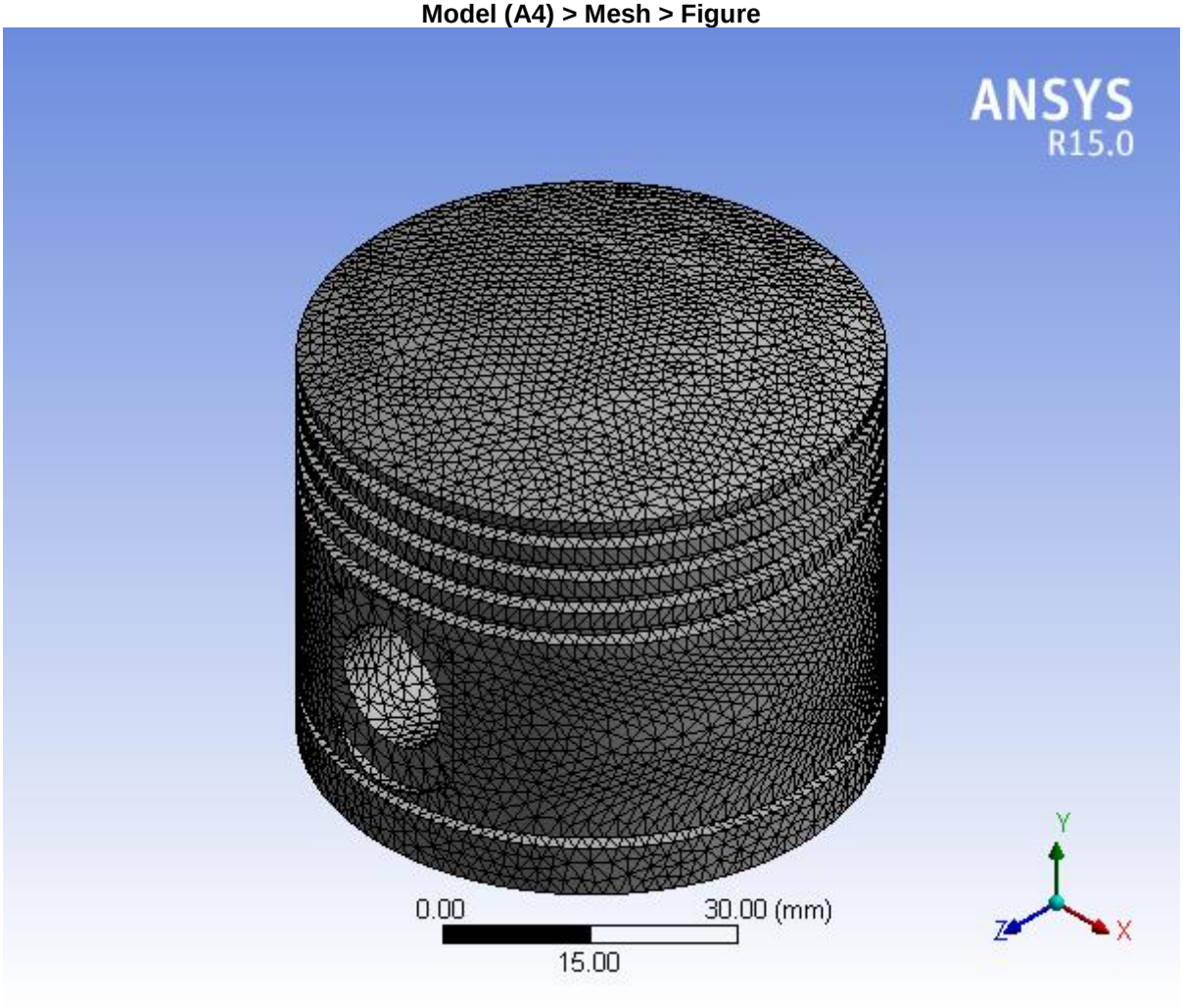
Mesh

TABLE 5
Model (A4) > Mesh

Object Name	*Mesh*
State	Solved
Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Fine
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge Length	14.70 mm
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	Yes
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	Standard Mechanical
Element Midside Nodes	Program Controlled
Straight Sided Elements	No
Number of Retries	Default (4)
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Please Define
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default
Statistics	

Nodes	90114
Elements	51858
Mesh Metric	None

FIGURE 2
Model (A4) > Mesh > Figure



Static Structural (A5)

TABLE 6
Model (A4) > Analysis

Object Name	*Static Structural (A5)*
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Static Structural
Solver Target	Mechanical APDL
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 7
Model (A4) > Static Structural (A5) > Analysis Settings

Object Name	*Analysis Settings*

State	Fully Defined
Step Controls	
Number Of Steps	1.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Program Controlled
Solver Controls	
Solver Type	Program Controlled
Weak Springs	Program Controlled
Large Deflection	Off
Inertia Relief	Off
Restart Controls	
Generate Restart Points	Program Controlled
Retain Files After Full Solve	No
Nonlinear Controls	
Newton-Raphson Option	Program Controlled
Force Convergence	Program Controlled
Moment Convergence	Program Controlled
Displacement Convergence	Program Controlled
Rotation Convergence	Program Controlled
Line Search	Program Controlled
Stabilization	Off
Output Controls	
Stress	Yes
Strain	Yes
Nodal Forces	No
Contact Miscellaneous	No
General Miscellaneous	No
Store Results At	All Time Points
Analysis Data Management	
Solver Files Directory	C:\Users\Ramesh Kumar\AppData\Local\Temp\WB_RAMESH_Ramesh Kumar_6904_2\unsaved_project_files\dp0\SYS\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Delete Unneeded Files	Yes
Nonlinear Solution	No
Solver Units	Active System
Solver Unit System	nmm

TABLE 8
Model (A4) > Static Structural (A5) > Loads

Object Name	*Fixed Support*	*Force*	*Pressure*
State	Fully Defined		
Scope			
Scoping Method	Geometry Selection		
Geometry	2 Faces	1 Face	
Definition			
Type	Fixed Support	Force	Pressure
Suppressed	No		
Define By		Components	
Coordinate System		Global Coordinate System	
X Component		0. N (ramped)	0. MPa (ramped)
Y Component		-6035.2 N (ramped)	-19.72 MPa (ramped)
Z Component		0. N (ramped)	0. MPa (ramped)

FIGURE 3
Model (A4) > Static Structural (A5) > Fixed Support > Figure

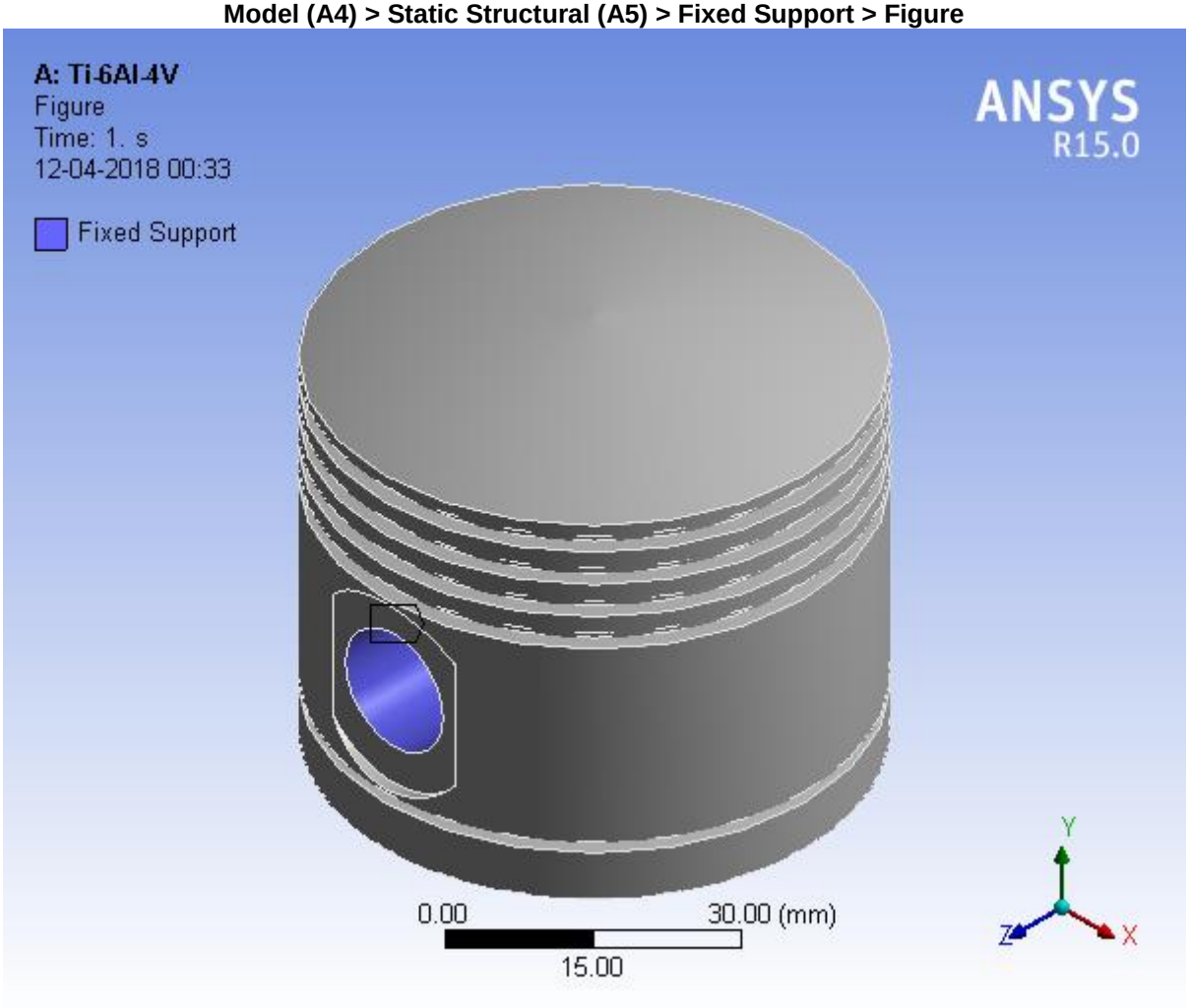


FIGURE 4
Model (A4) > Static Structural (A5) > Force

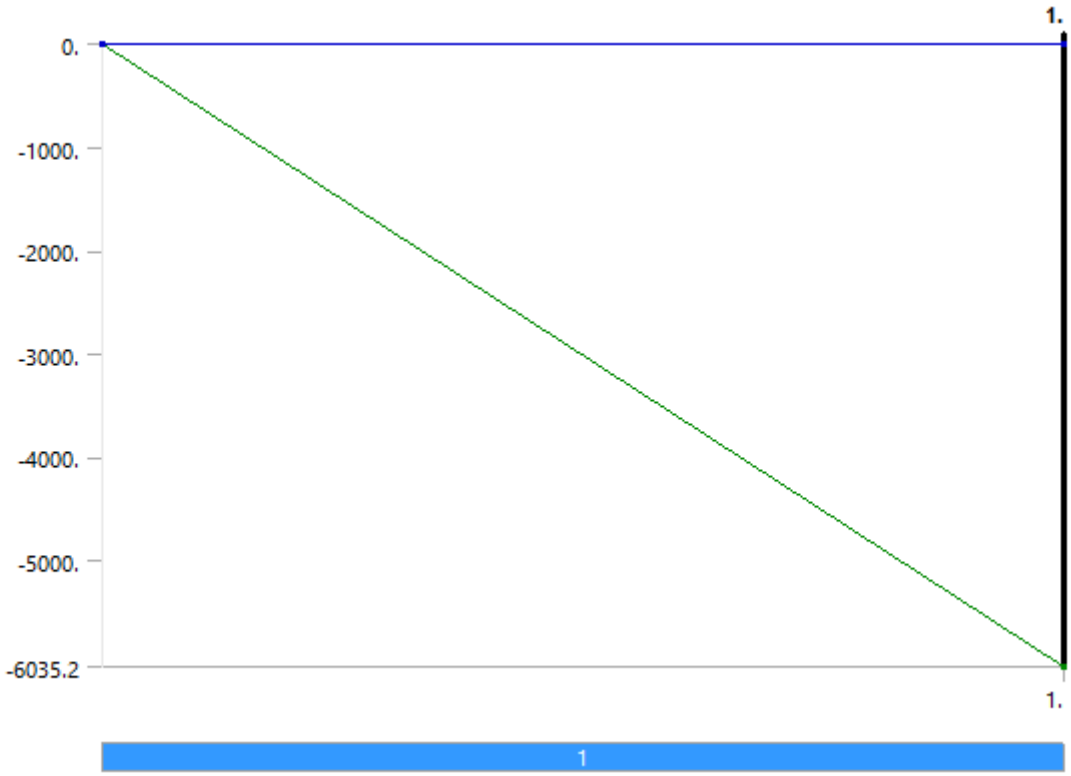


FIGURE 5
Model (A4) > Static Structural (A5) > Force > Figure

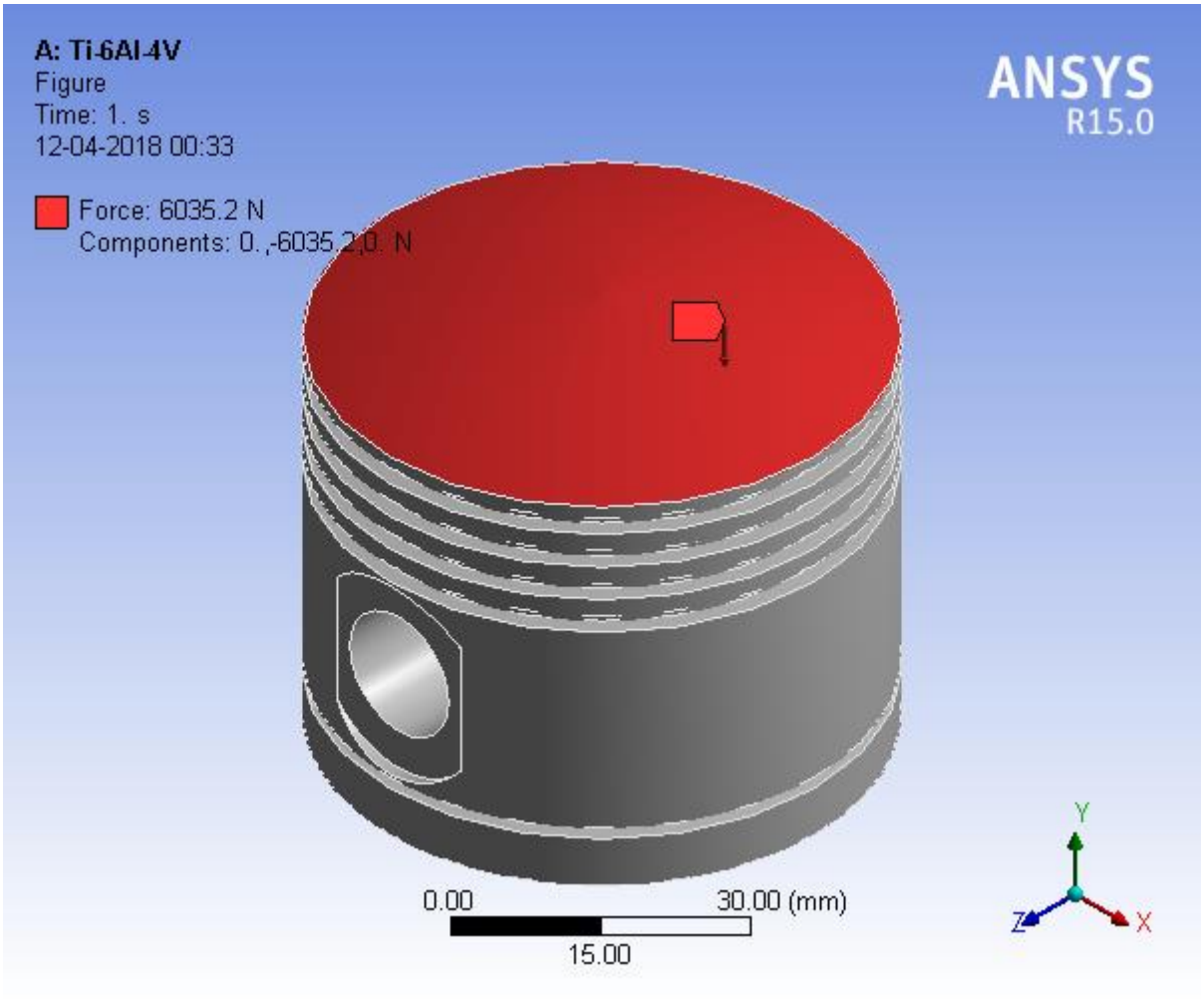


FIGURE 6
Model (A4) > Static Structural (A5) > Pressure

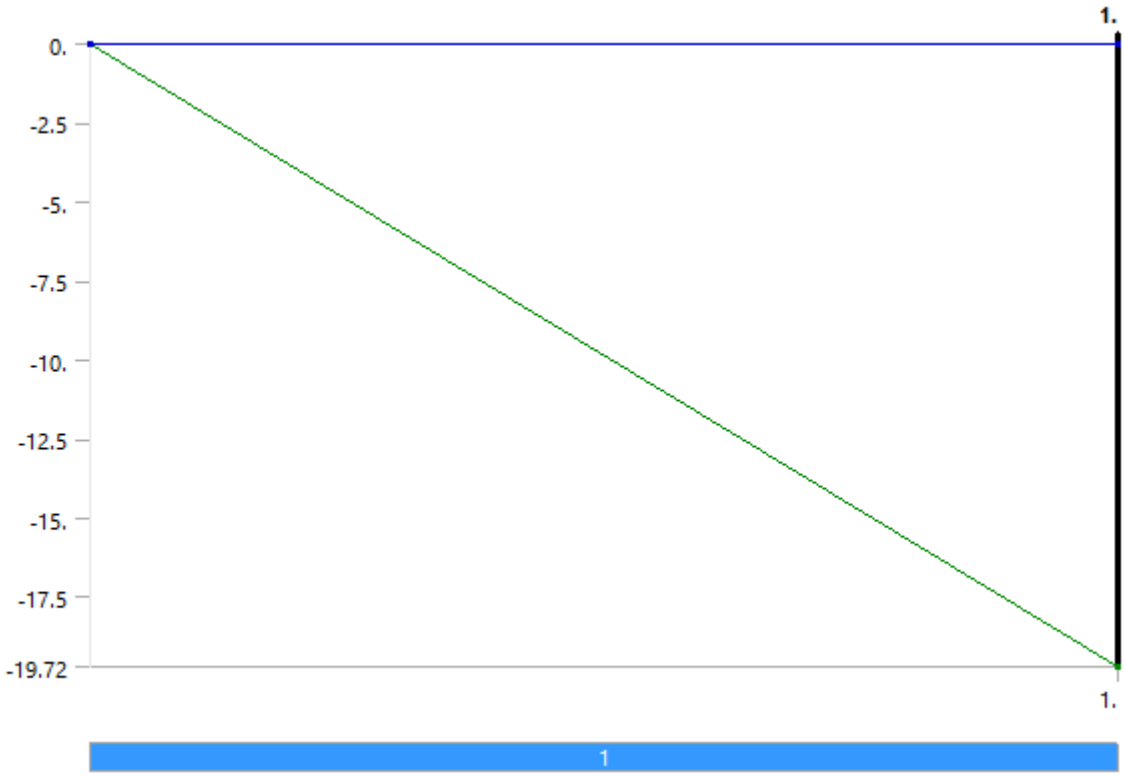
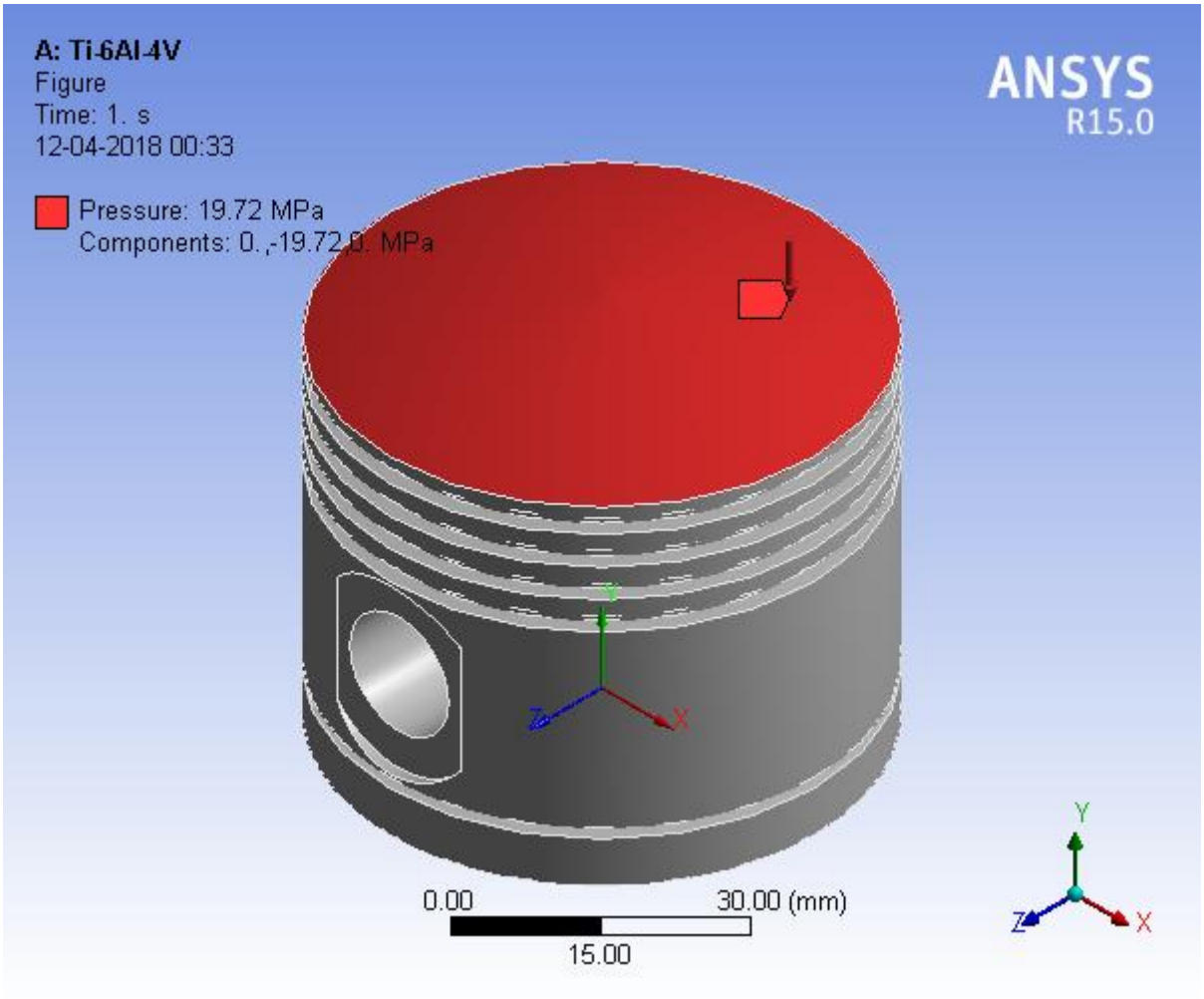


FIGURE 7
Model (A4) > Static Structural (A5) > Pressure > Figure



Solution (A6)

TABLE 9
Model (A4) > Static Structural (A5) > Solution

Object Name	*Solution (A6)*
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	
Status	Done

TABLE 10
Model (A4) > Static Structural (A5) > Solution (A6) > Solution Information

Object Name	*Solution Information*
State	Solved
Solution Information	
Solution Output	Solver Output
Newton-Raphson Residuals	0
Update Interval	2.5 s
Display Points	All
FE Connection Visibility	
Activate Visibility	Yes

Display	All FE Connectors
Draw Connections Attached To	All Nodes
Line Color	Connection Type
Visible on Results	No
Line Thickness	Single
Display Type	Lines

TABLE 11
Model (A4) > Static Structural (A5) > Solution (A6) > Results

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Normal Stress*	*Equivalent Stress*
State	Solved			
Scope				
Scoping Method	Geometry Selection			
Geometry	All Bodies			
Definition				
Type	Total Deformation	Equivalent Elastic Strain	Normal Stress	Equivalent (von-Mises) Stress
By	Time			
Display Time	Last			
Calculate Time History	Yes			
Identifier				
Suppressed	No			
Orientation			X Axis	
Coordinate System			Global Coordinate System	
Results				
Minimum	0. mm	2.1592e-005 mm/mm	-210.69 MPa	0.98249 MPa
Maximum	7.9662e-002 mm	3.8624e-003 mm/mm	133.7 MPa	439.42 MPa
Minimum Value Over Time				
Minimum	0. mm	2.1592e-005 mm/mm	-210.69 MPa	0.98249 MPa
Maximum	0. mm	2.1592e-005 mm/mm	-210.69 MPa	0.98249 MPa
Maximum Value Over Time				
Minimum	7.9662e-002 mm	3.8624e-003 mm/mm	133.7 MPa	439.42 MPa
Maximum	7.9662e-002 mm	3.8624e-003 mm/mm	133.7 MPa	439.42 MPa
Information				
Time	1. s			
Load Step	1			
Substep	1			
Iteration Number	1			
Integration Point Results				
Display Option		Averaged		
Average Across Bodies		No		

FIGURE 8
Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure

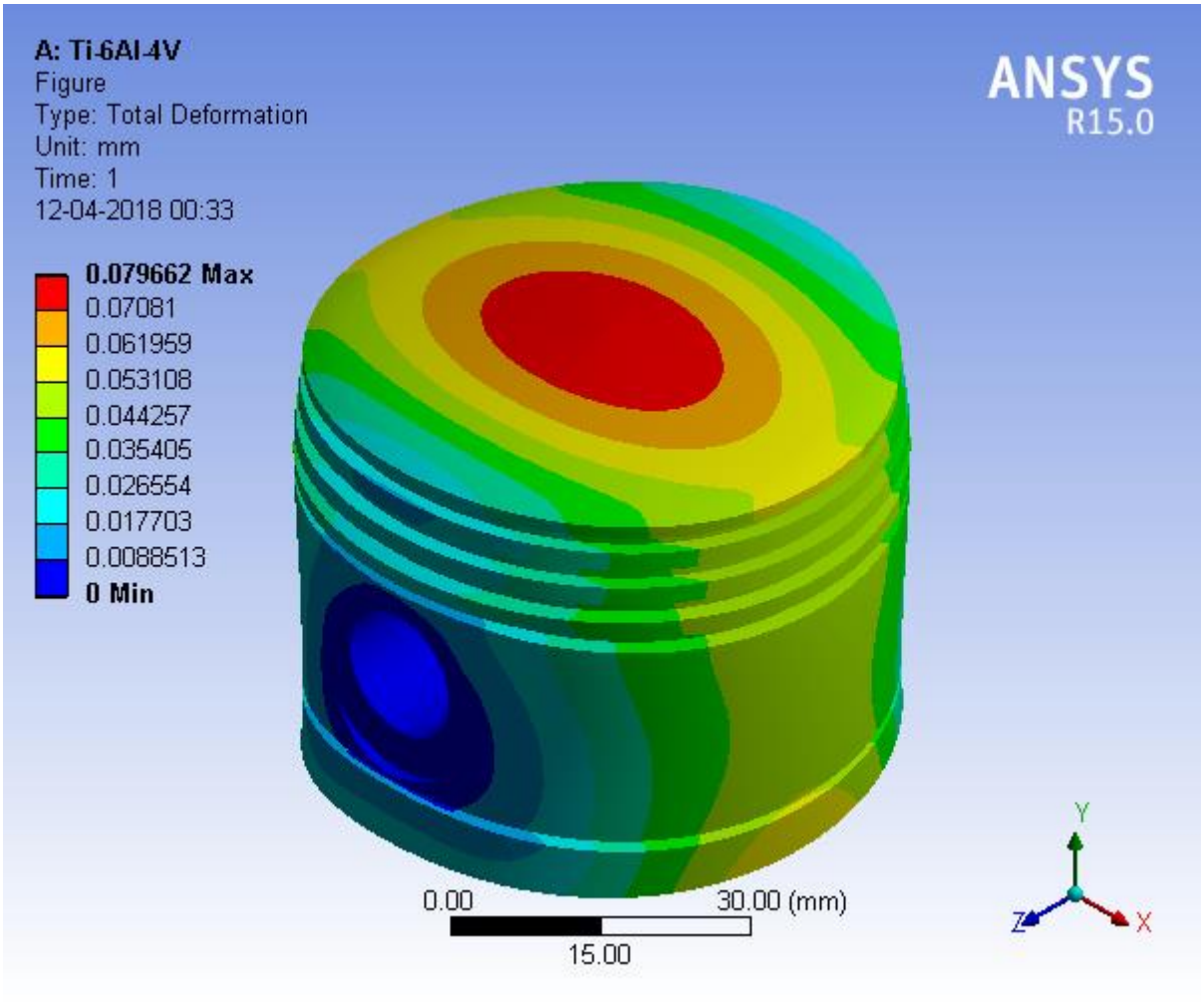


FIGURE 9
Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain > Figure

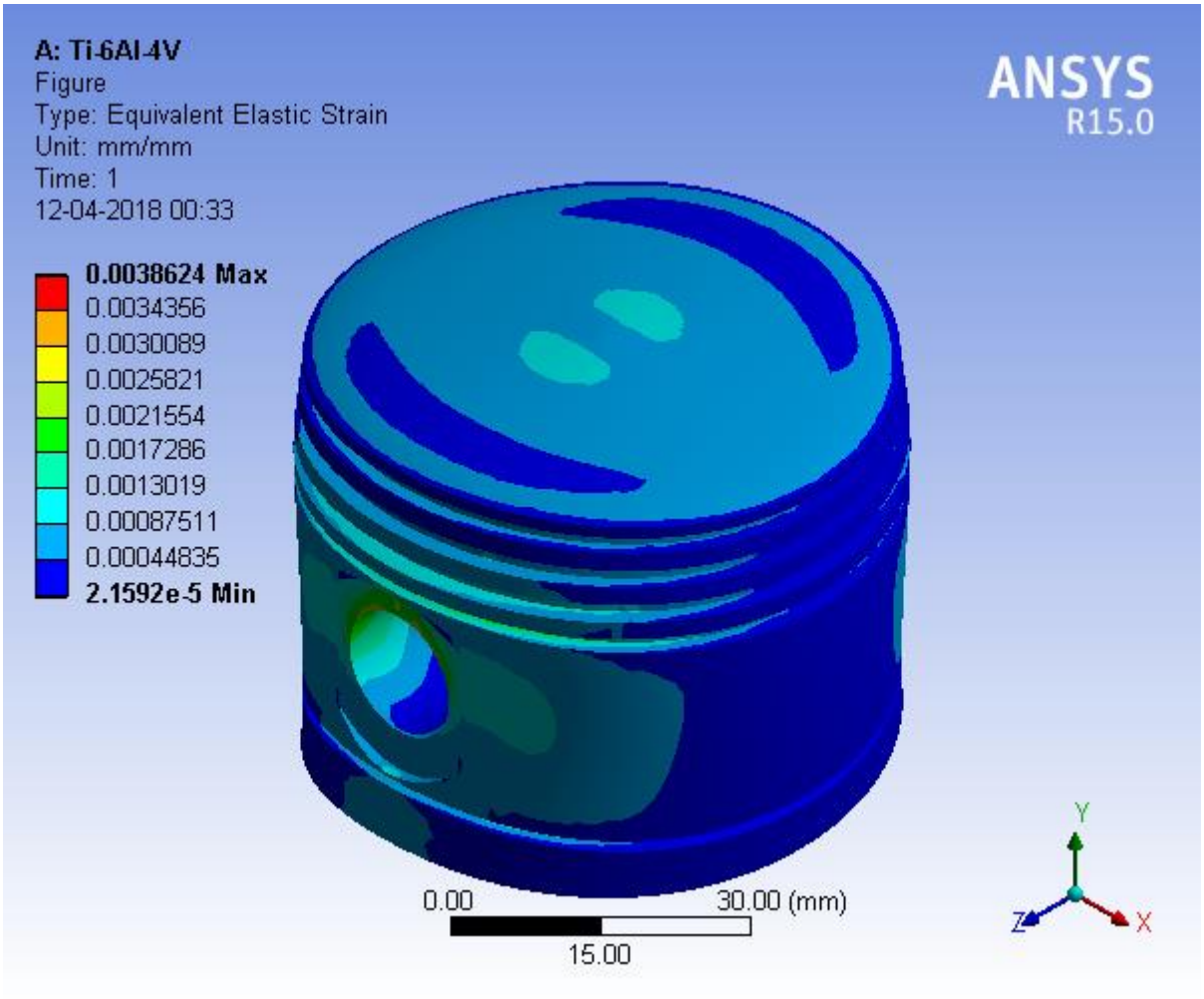


FIGURE 10
Model (A4) > Static Structural (A5) > Solution (A6) > Normal Stress > Figure

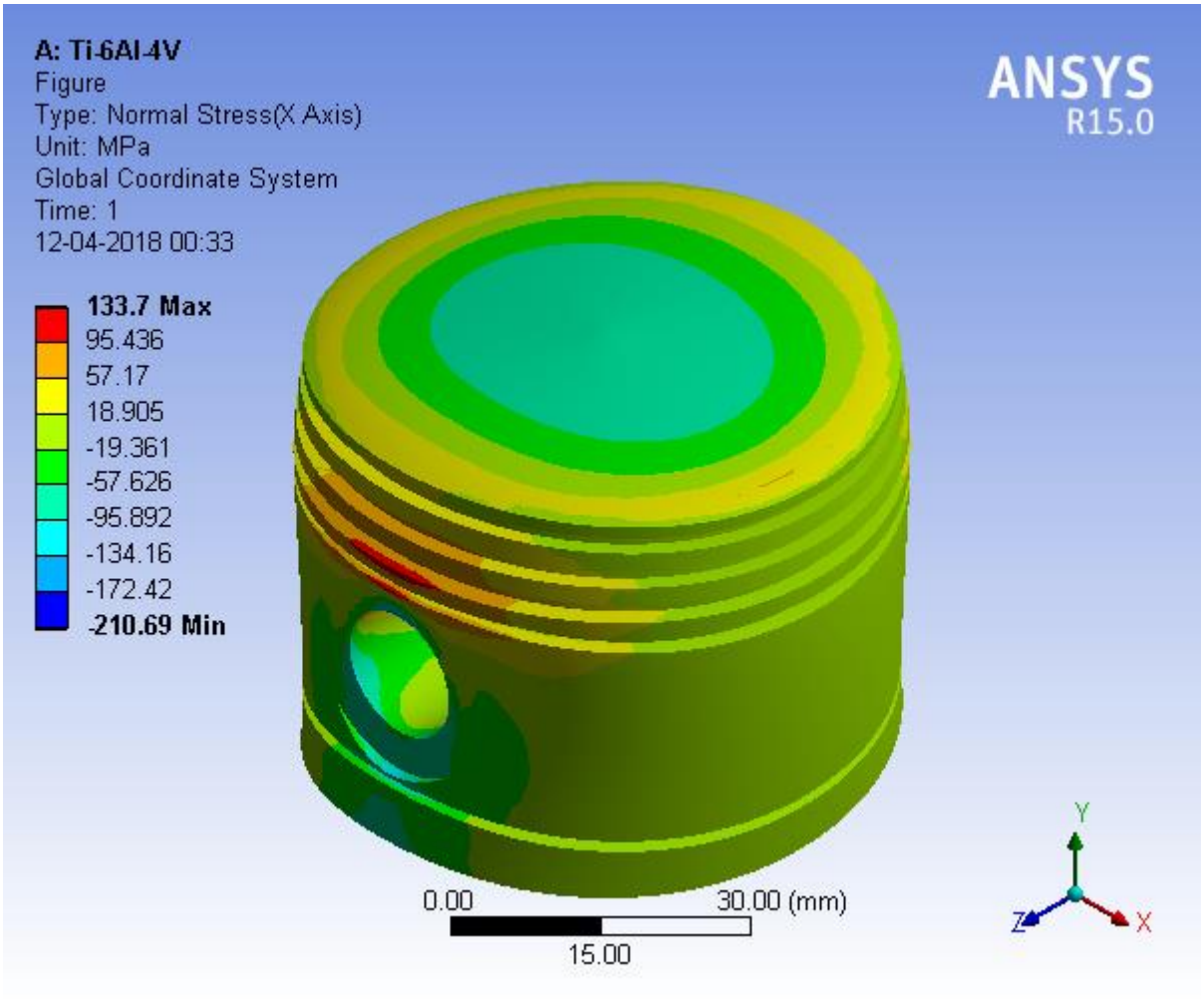


FIGURE 11
Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress > Figure

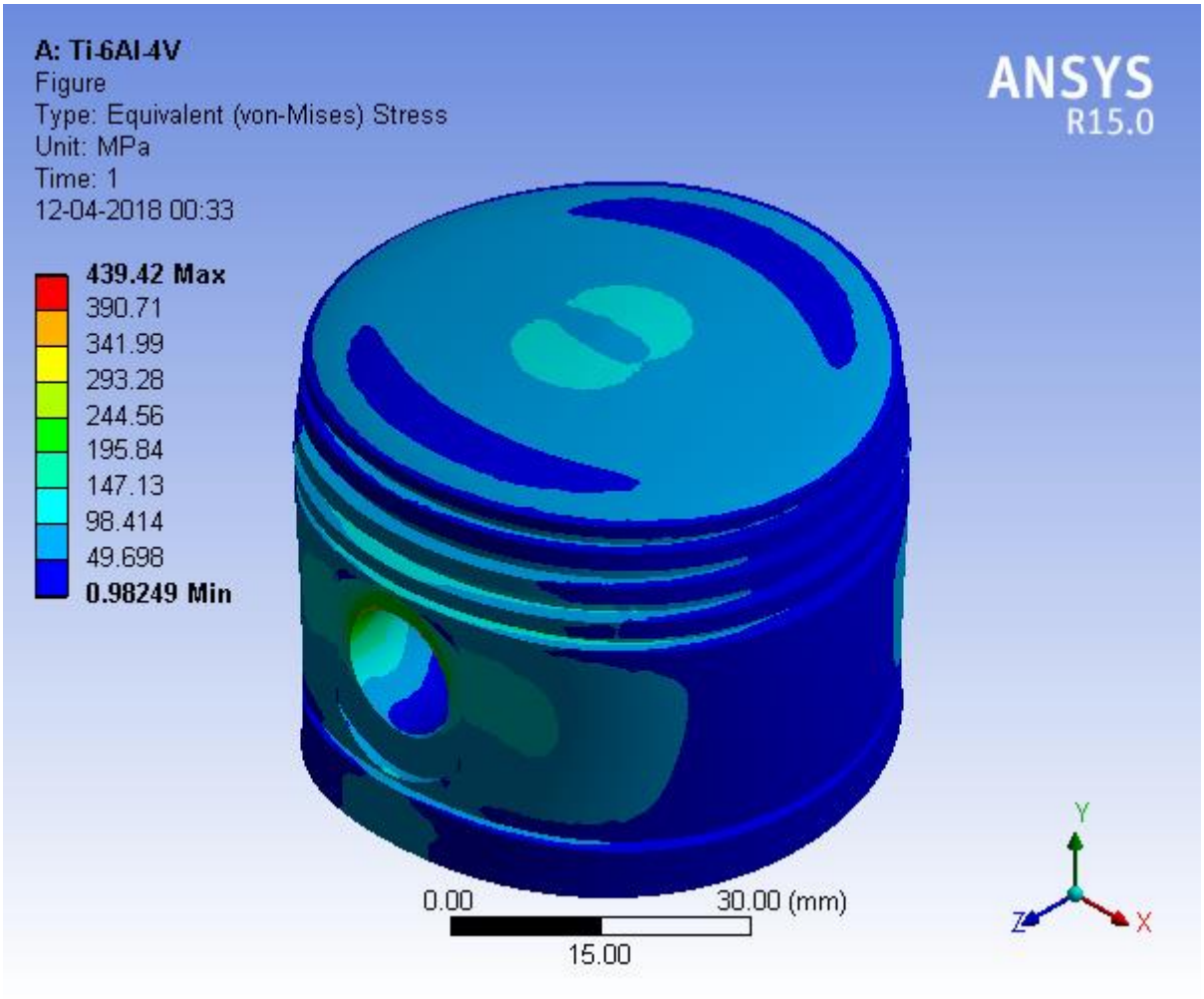


TABLE 12
Model (A4) > Static Structural (A5) > Solution (A6) > Stress Safety Tools

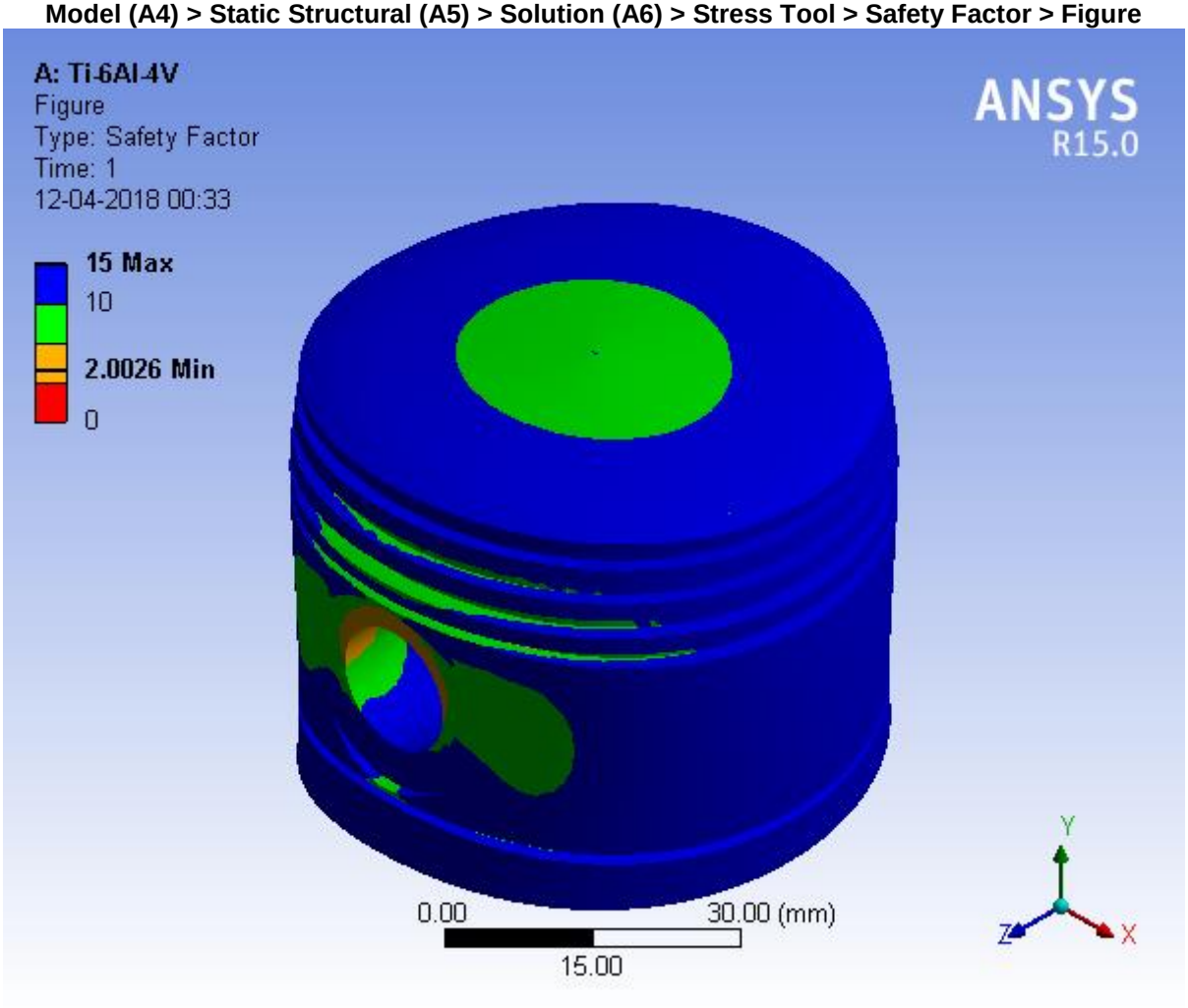
Object Name	*Stress Tool*
State	Solved
Definition	
Theory	Max Equivalent Stress
Stress Limit Type	Tensile Yield Per Material

TABLE 13
Model (A4) > Static Structural (A5) > Solution (A6) > Stress Tool > Results

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	2.0026
Minimum Value Over Time	
Minimum	2.0026
Maximum	2.0026
Maximum Value Over Time	
Minimum	15.
Maximum	15.
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

FIGURE 12
Model (A4) > Static Structural (A5) > Solution (A6) > Stress Tool > Safety Factor > Figure



Material Data

Ti-6Al-4V

TABLE 14
Ti-6Al-4V > Constants

Density	4.43e-006 kg mm^-3

TABLE 15
Ti-6Al-4V > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	1.138e+005	0.342	1.2004e+005	42399

TABLE 16
Ti-6Al-4V > Tensile Yield Strength

Tensile Yield Strength MPa
880

TABLE 17
Ti-6Al-4V > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
950