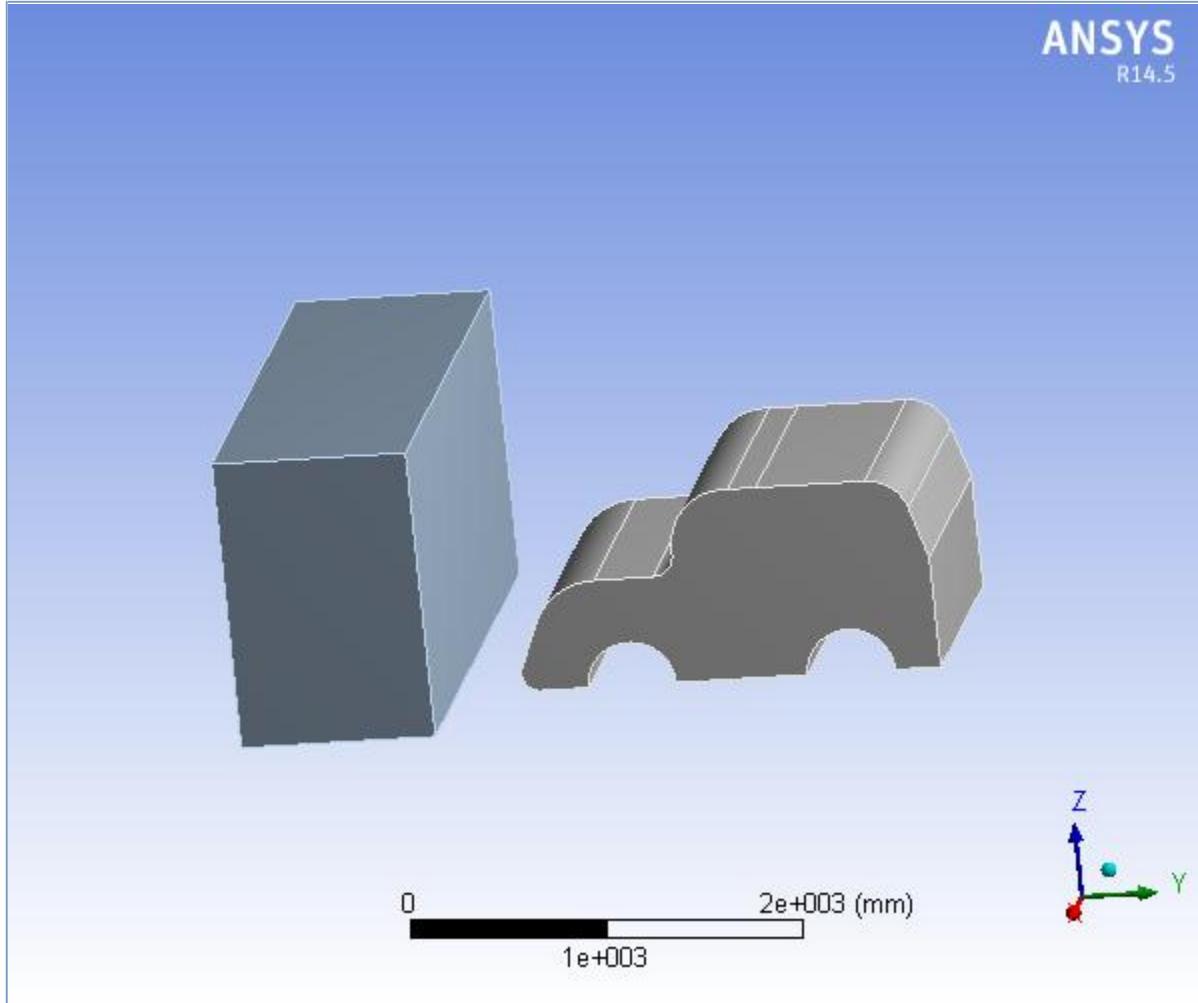




Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
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Save Project Before Solution	No
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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\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	41667 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Aluminum Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	6342.2 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	2.3912e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.5854e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	3.1842e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Explicit Dynamics (A5)

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

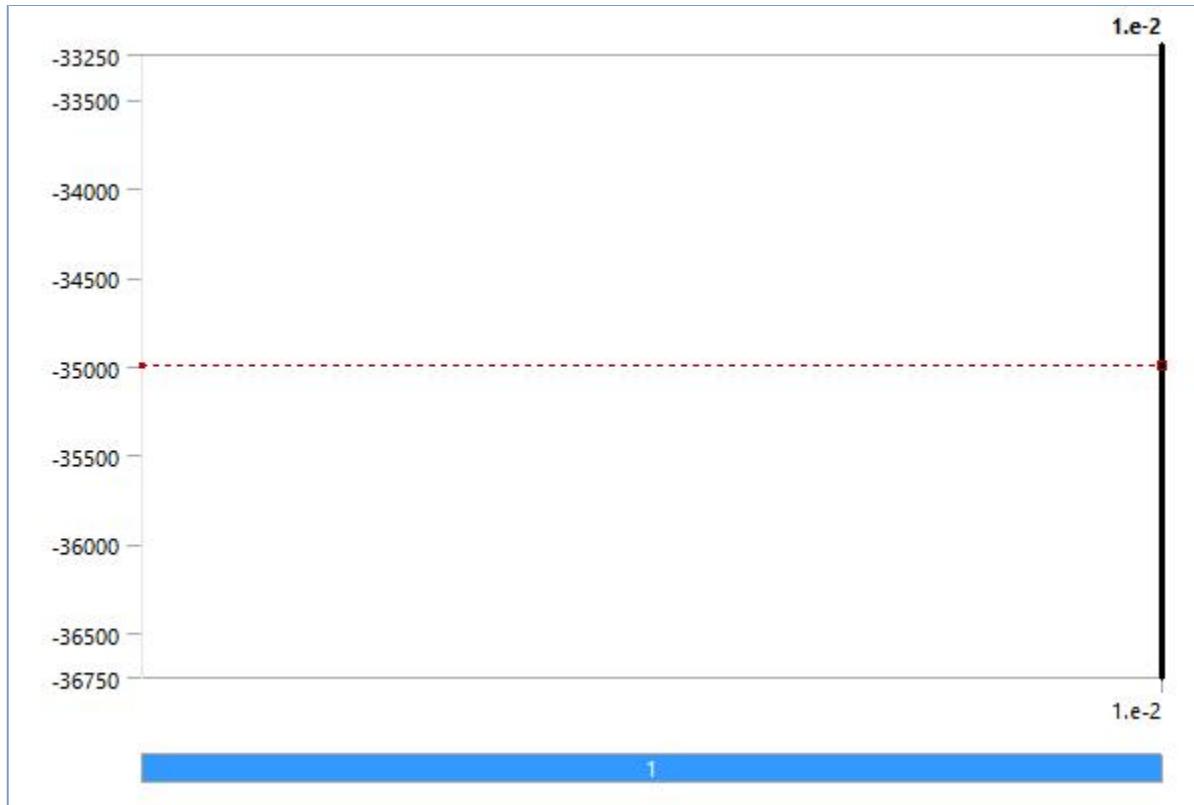
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-35000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time				
Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Results					
Minimum	3.3297e-004 mm	0. mm/mm	0. MPa		
Maximum	350.02 mm	1.6977e-003 mm/mm	117.68 MPa		
Minimum Occurs On	Solid	PartBody			
Maximum Occurs On	PartBody				
Minimum Value Over Time					
Minimum	0. mm	0. mm/mm	0. MPa		
Maximum	3.3297e-004 mm	0. mm/mm	0. MPa		
Maximum Value Over Time					
Minimum	0. mm	0. mm/mm	0. MPa		
Maximum	350.02 mm	1.6977e-003 mm/mm	117.68 MPa		
Information					
Time	1.e-002 s				
Set	21				
Integration Point Results					
Display Option	Averaged				

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

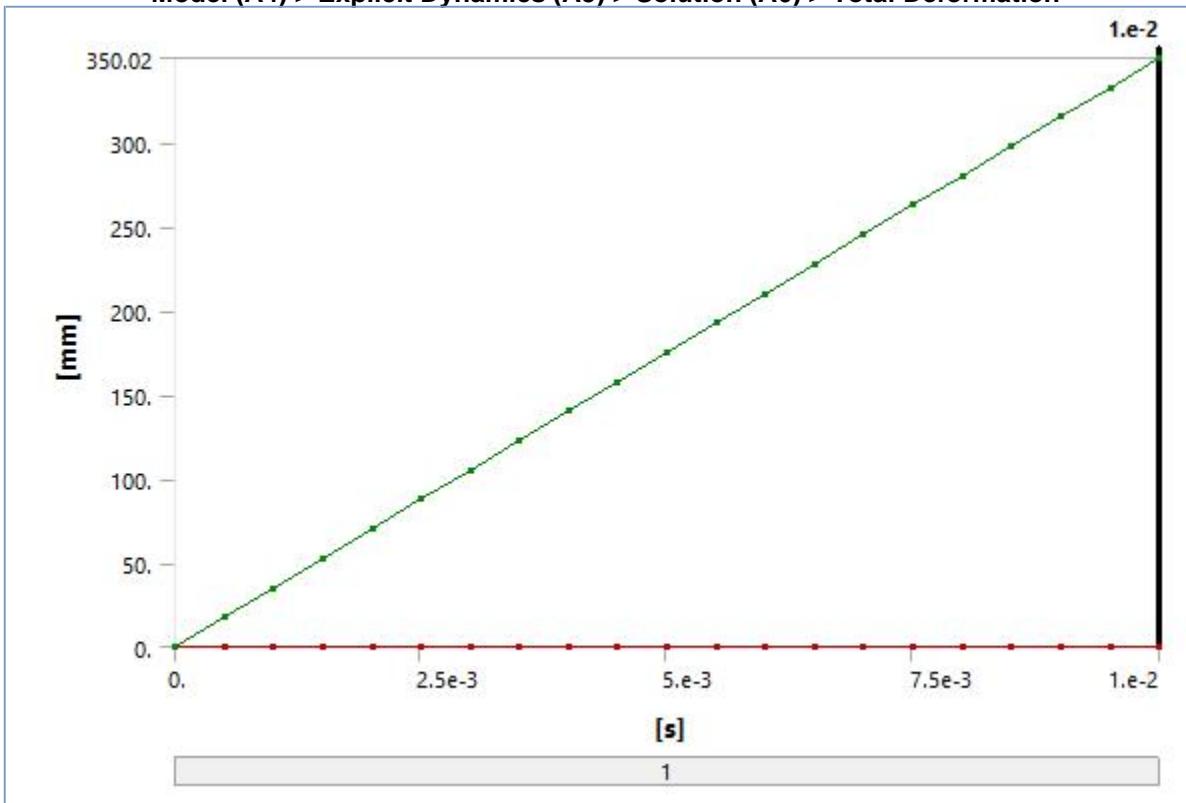


TABLE 17
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		0.

5.0102e-004		17.536
1.0015e-003		35.051
1.5019e-003		52.567
2.0024e-003		70.083
2.5028e-003		87.599
3.0002e-003		105.01
3.5007e-003		122.52
4.0011e-003		140.04
4.5016e-003		157.56
5.002e-003	0.	175.07
5.5025e-003		192.59
6.0029e-003		210.1
6.5003e-003		227.51
7.0008e-003		245.03
7.5012e-003		262.54
8.0017e-003		280.06
8.5021e-003		297.57
9.0026e-003		315.09
9.503e-003		332.61
1.e-002	3.3297e-004	350.02

FIGURE 3
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

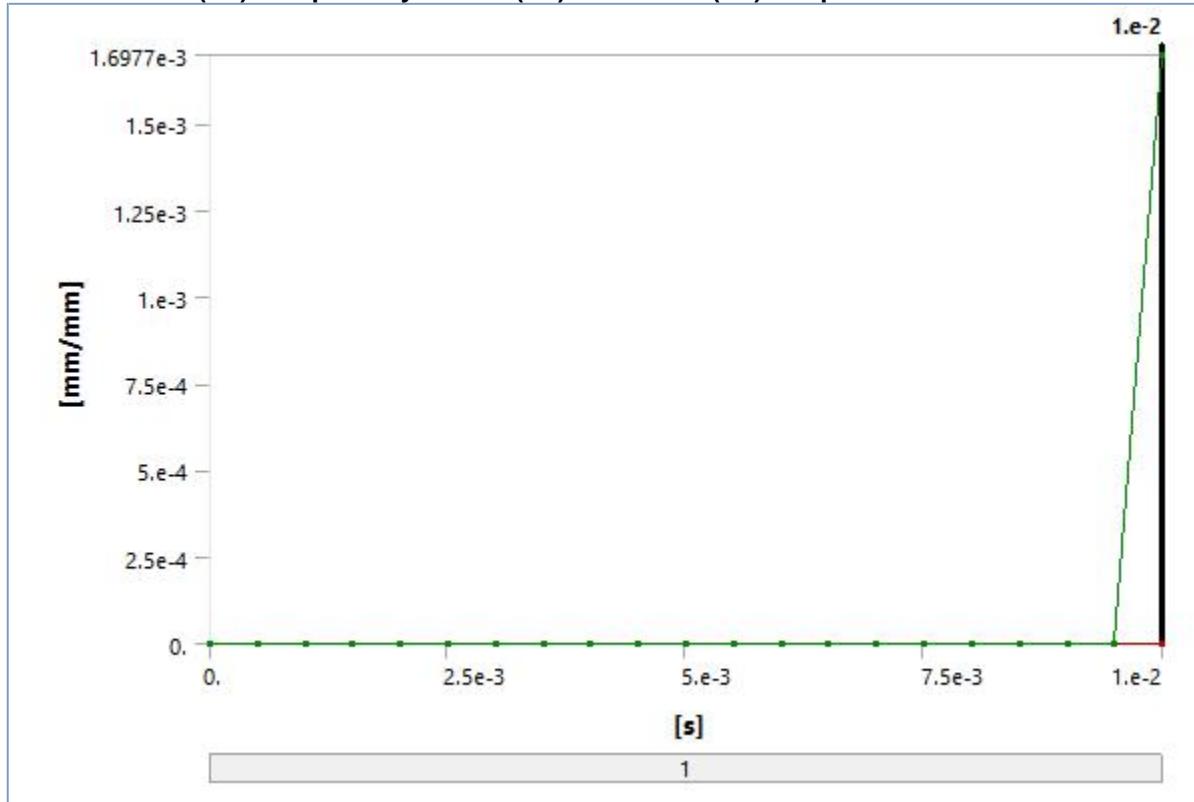


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0102e-004		

1.0015e-003	
1.5019e-003	
2.0024e-003	
2.5028e-003	
3.0002e-003	
3.5007e-003	
4.0011e-003	
4.5016e-003	
5.002e-003	
5.5025e-003	
6.0029e-003	
6.5003e-003	
7.0008e-003	
7.5012e-003	
8.0017e-003	
8.5021e-003	
9.0026e-003	
9.503e-003	
1.e-002	1.6977e-003

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

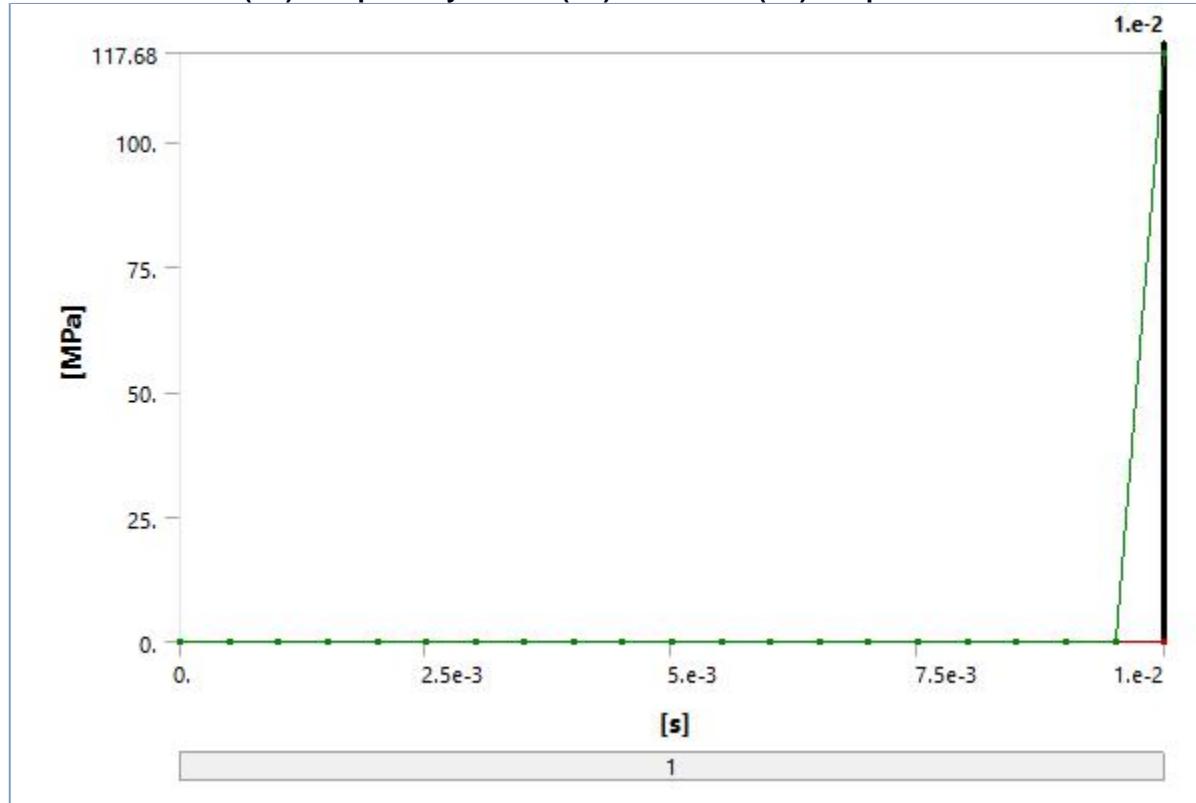


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0102e-004		
1.0015e-003		

1.5019e-003		
2.0024e-003		
2.5028e-003		
3.0002e-003		
3.5007e-003		
4.0011e-003		
4.5016e-003		
5.002e-003		
5.5025e-003	0.	0.
6.0029e-003		
6.5003e-003		
7.0008e-003		
7.5012e-003		
8.0017e-003		
8.5021e-003		
9.0026e-003		
9.503e-003		
1.e-002		117.68

Material Data

Aluminum Alloy

TABLE 20
Aluminum Alloy > Constants

Density	2.77e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.3e-005 C ⁻¹
Specific Heat	8.75e+005 mJ kg ⁻¹ C ⁻¹

TABLE 21
Aluminum Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Aluminum Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 23
Aluminum Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 24
Aluminum Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
310

TABLE 25
Aluminum Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C

TABLE 26
Aluminum Alloy > Isotropic Thermal Conductivity

Thermal Conductivity W mm^-1 C^-1	Temperature C
0.114	-100
0.144	0
0.165	100
0.175	200

TABLE 27
Aluminum Alloy > Alternating Stress R-Ratio

Alternating Stress MPa	Cycles	R-Ratio
275.8	1700	-1
241.3	5000	-1
206.8	34000	-1
172.4	1.4e+005	-1
137.9	8.e+005	-1
117.2	2.4e+006	-1
89.63	5.5e+007	-1
82.74	1.e+008	-1
170.6	50000	-0.5
139.6	3.5e+005	-0.5
108.6	3.7e+006	-0.5
87.91	1.4e+007	-0.5
77.57	5.e+007	-0.5
72.39	1.e+008	-0.5
144.8	50000	0
120.7	1.9e+005	0
103.4	1.3e+006	0
93.08	4.4e+006	0
86.18	1.2e+007	0
72.39	1.e+008	0
74.12	3.e+005	0.5
70.67	1.5e+006	0.5
66.36	1.2e+007	0.5
62.05	1.e+008	0.5

TABLE 28
Aluminum Alloy > Isotropic Resistivity

Resistivity ohm mm	Temperature C
2.43e-005	0
2.67e-005	20
3.63e-005	100

TABLE 29
Aluminum Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

TABLE 30
Aluminum Alloy > Isotropic Relative Permeability

Relative Permeability

Structural Steel

TABLE 31
Structural Steel > Constants

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

TABLE 32
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 33
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 34
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 35
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 36
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 37
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 38

Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 39
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 40
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

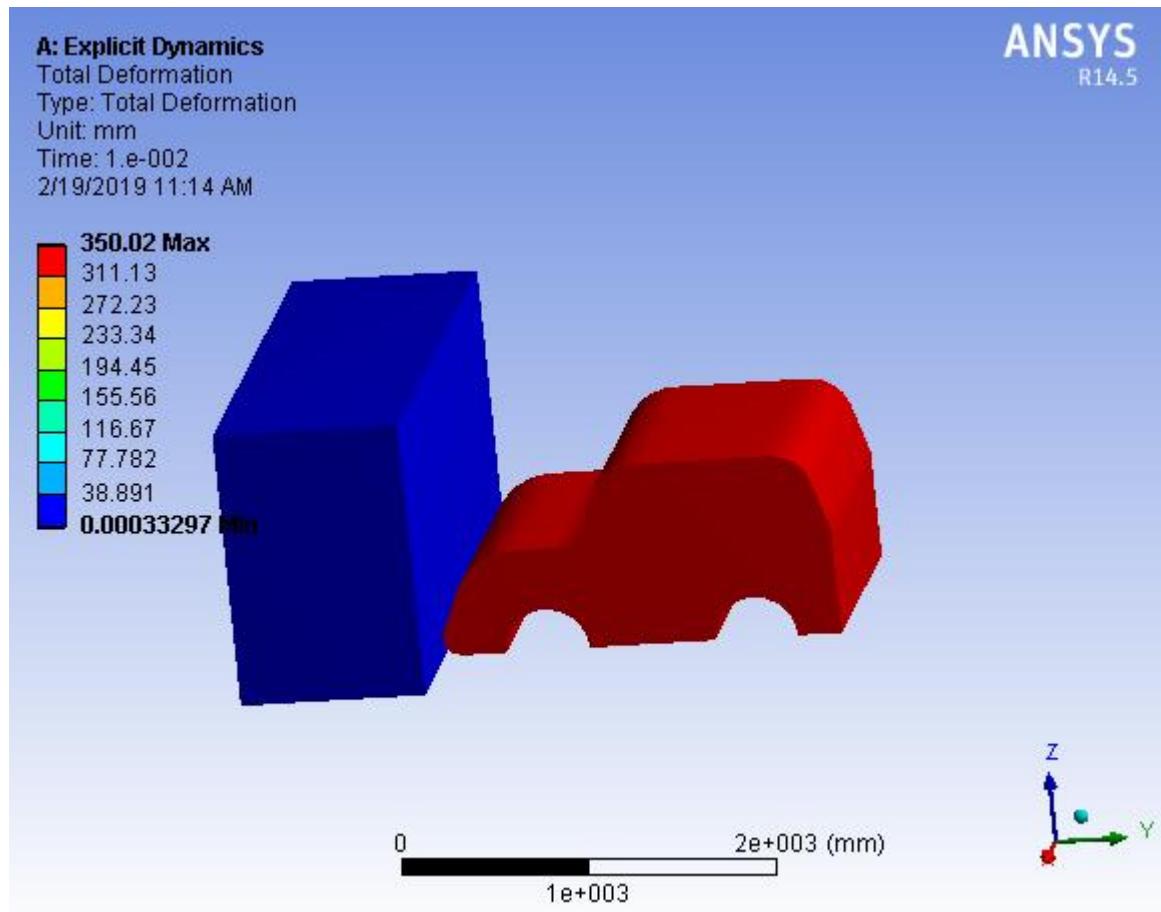
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Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

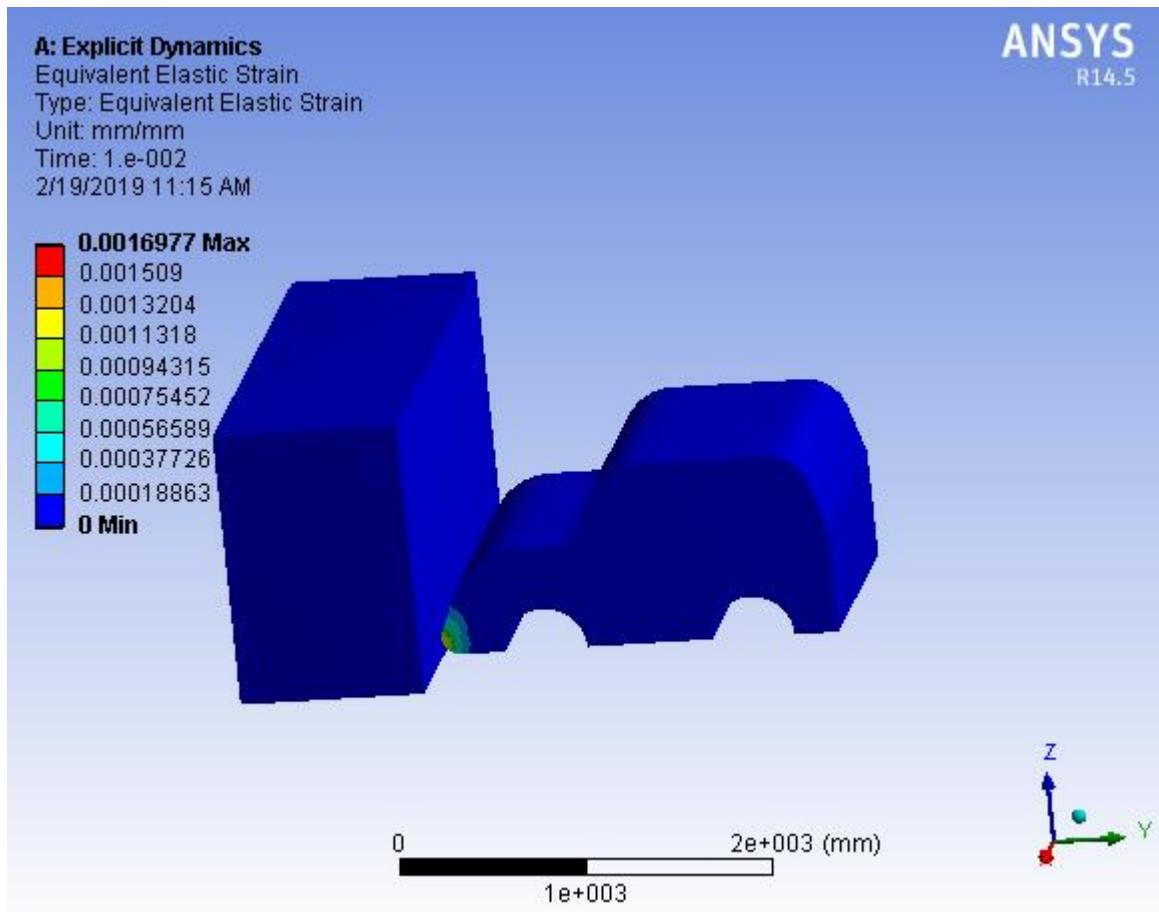
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Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

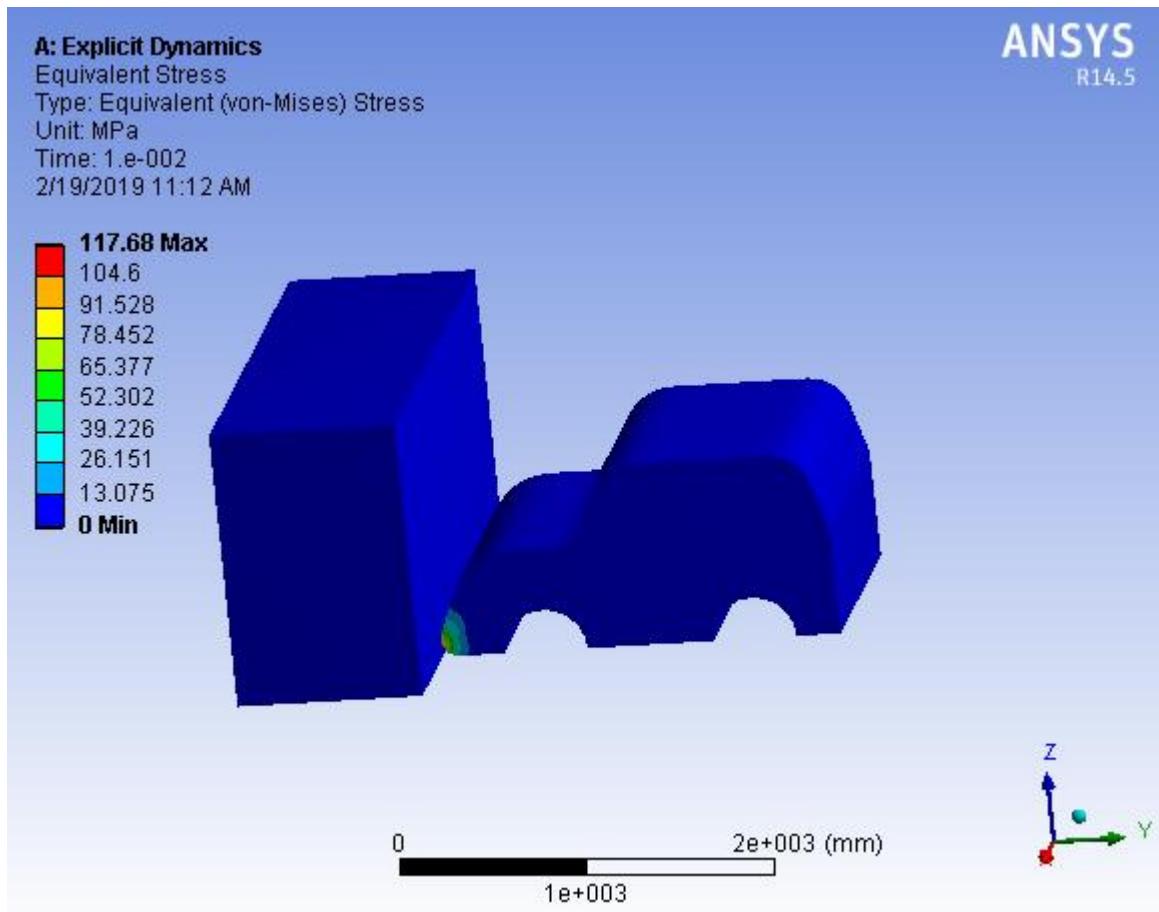
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Author:

Prepared For:

Date Tuesday, February 19, 2019

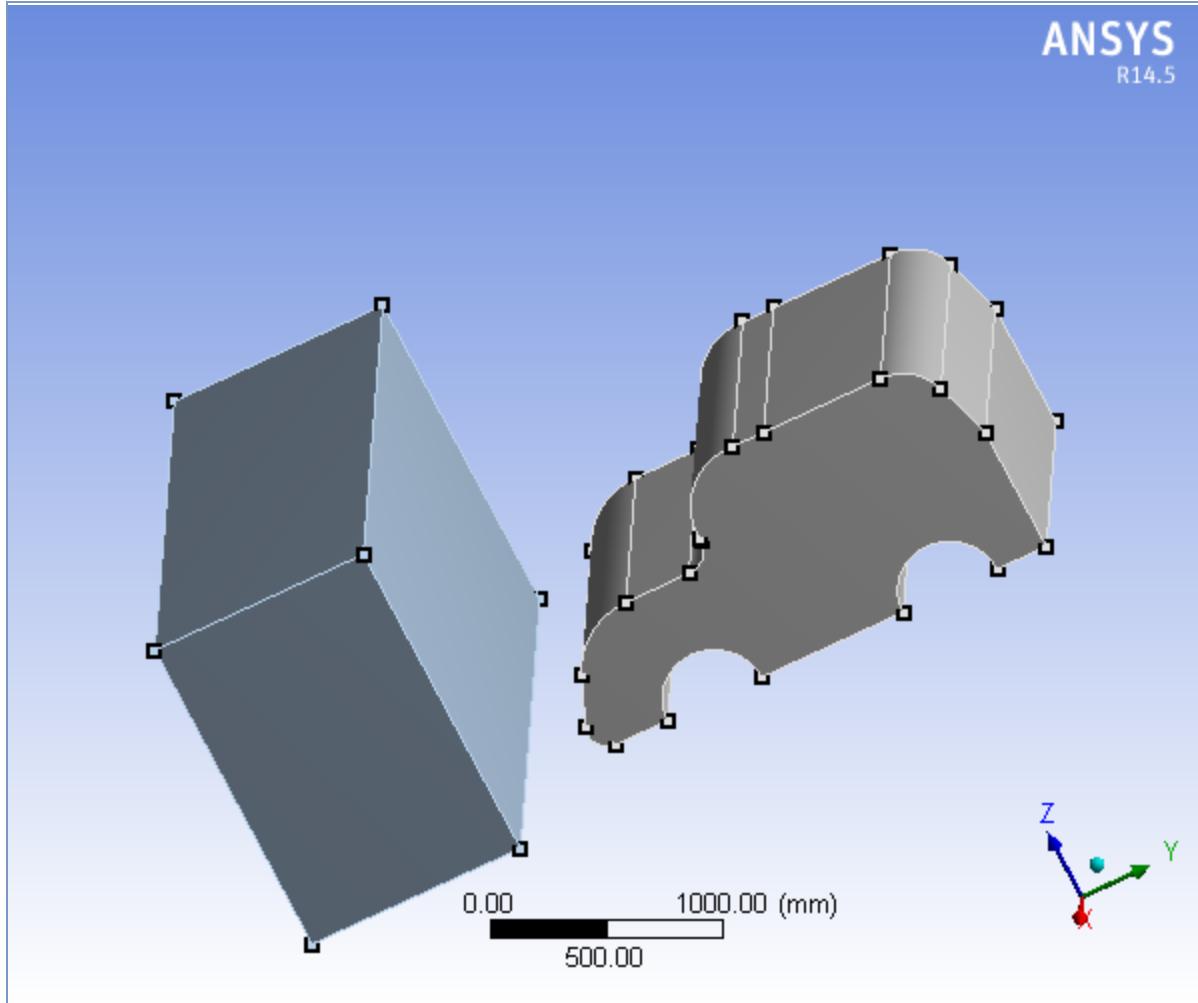
Comments:





Project

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Save Project Before Solution	No
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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\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	39446 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Magnesium Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	4121.3 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	1.5539e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.0302e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	2.0691e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Dynamics**(A5)**

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

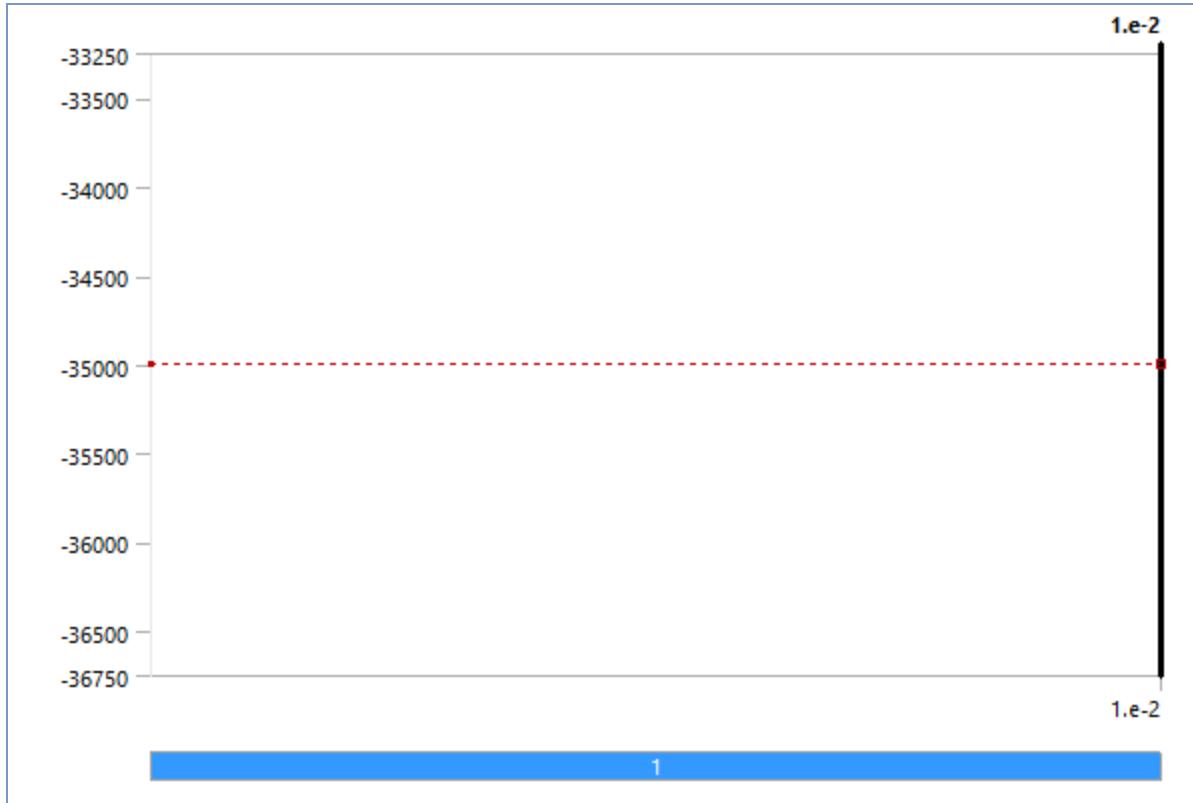
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-35000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

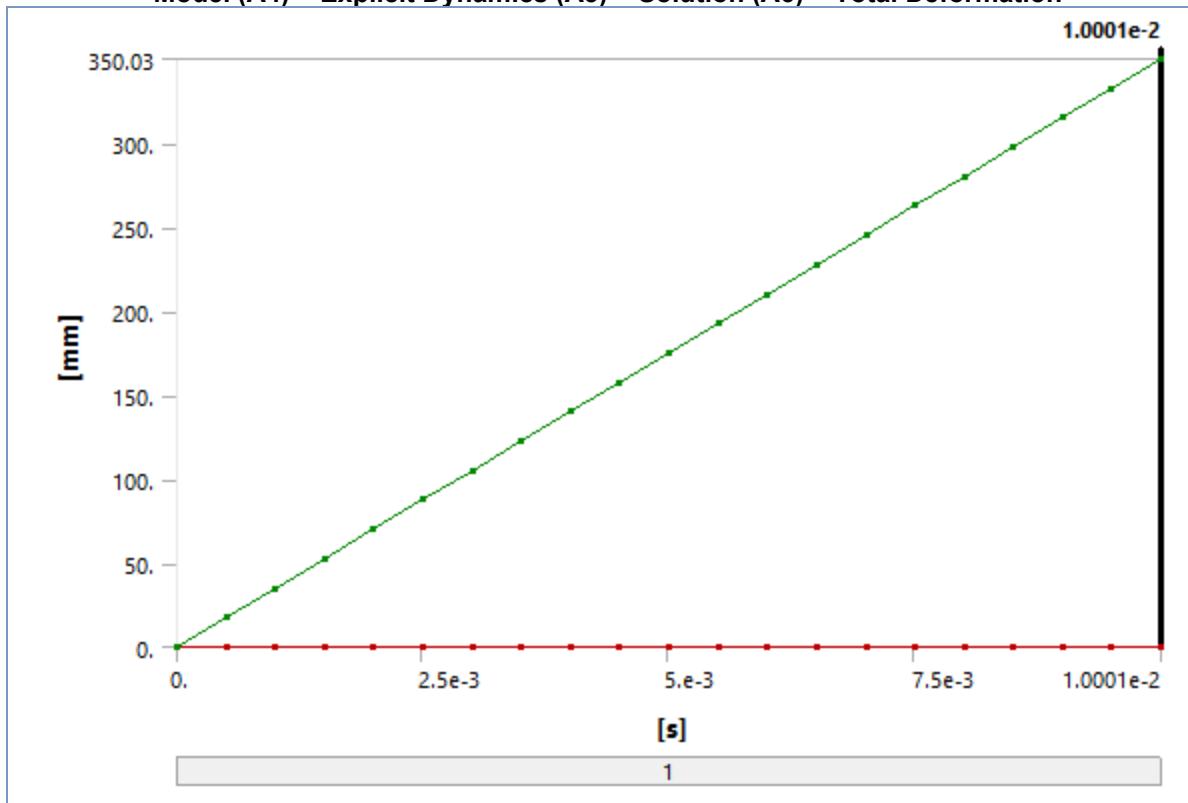
Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time				
Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Results					
Minimum	2.314e-004 mm	0. mm/mm	0. MPa		
Maximum	350.03 mm	1.8185e-003 mm/mm	80.148 MPa		
Minimum Occurs On	Solid	PartBody			
Maximum Occurs On	PartBody				
Minimum Value Over Time					
Minimum	0. mm	0. mm/mm	0. MPa		
Maximum	2.314e-004 mm	0. mm/mm	0. MPa		
Maximum Value Over Time					
Minimum	0. mm	0. mm/mm	0. MPa		
Maximum	350.03 mm	1.8185e-003 mm/mm	80.148 MPa		
Information					
Time	1.0001e-002 s				
Set	21				
Integration Point Results					
Display Option	Averaged				

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation



5.0219e-004		17.577
1.0009e-003		35.031
1.5025e-003		52.588
2.0012e-003		70.042
2.5028e-003		87.599
3.0015e-003		105.05
3.5002e-003		122.51
4.0018e-003		140.06
4.5005e-003		157.52
5.0021e-003	0.	175.07
5.5008e-003		192.53
6.0025e-003		210.09
6.5011e-003		227.54
7.0028e-003		245.1
7.5015e-003		262.55
8.0001e-003		280.
8.5018e-003		297.56
9.0005e-003		315.02
9.5021e-003		332.57
1.0001e-002	2.314e-004	350.03

FIGURE
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

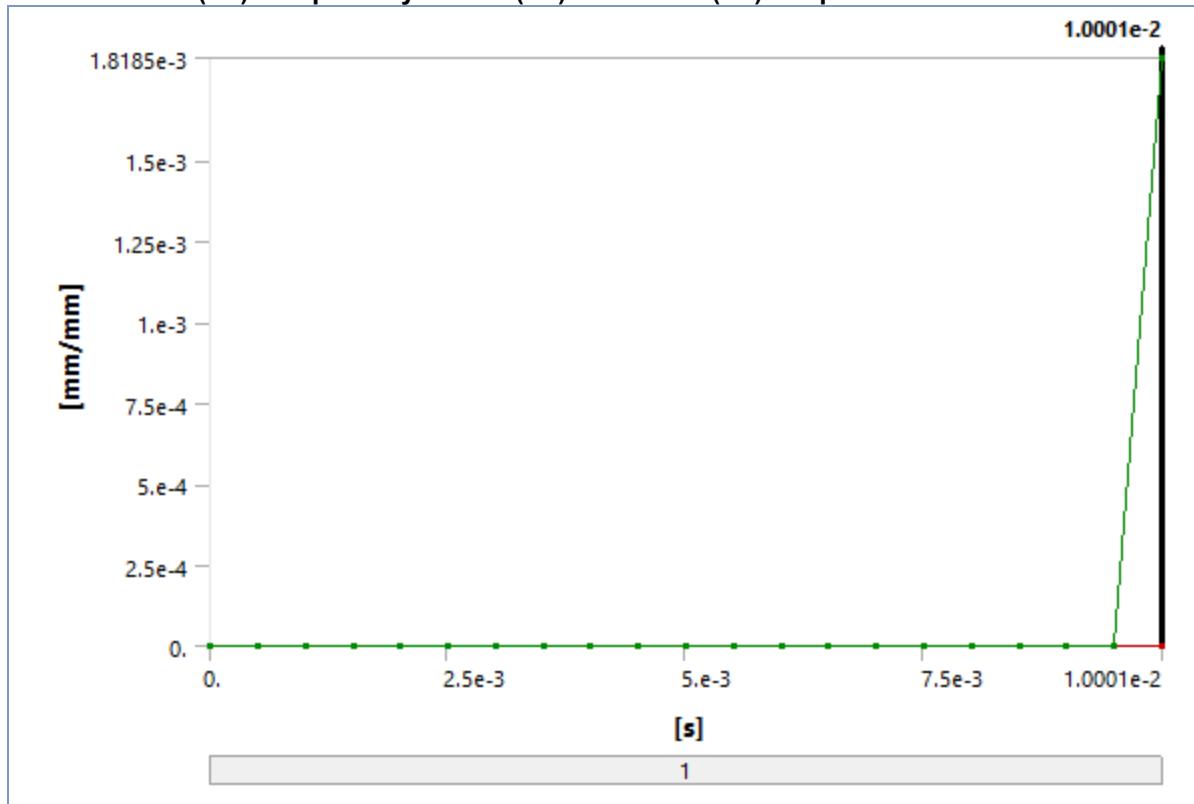


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0219e-004		

1.0009e-003	
1.5025e-003	
2.0012e-003	
2.5028e-003	
3.0015e-003	
3.5002e-003	
4.0018e-003	
4.5005e-003	
5.0021e-003	
5.5008e-003	
6.0025e-003	
6.5011e-003	
7.0028e-003	
7.5015e-003	
8.0001e-003	
8.5018e-003	
9.0005e-003	
9.5021e-003	
1.0001e-002	1.8185e-003

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

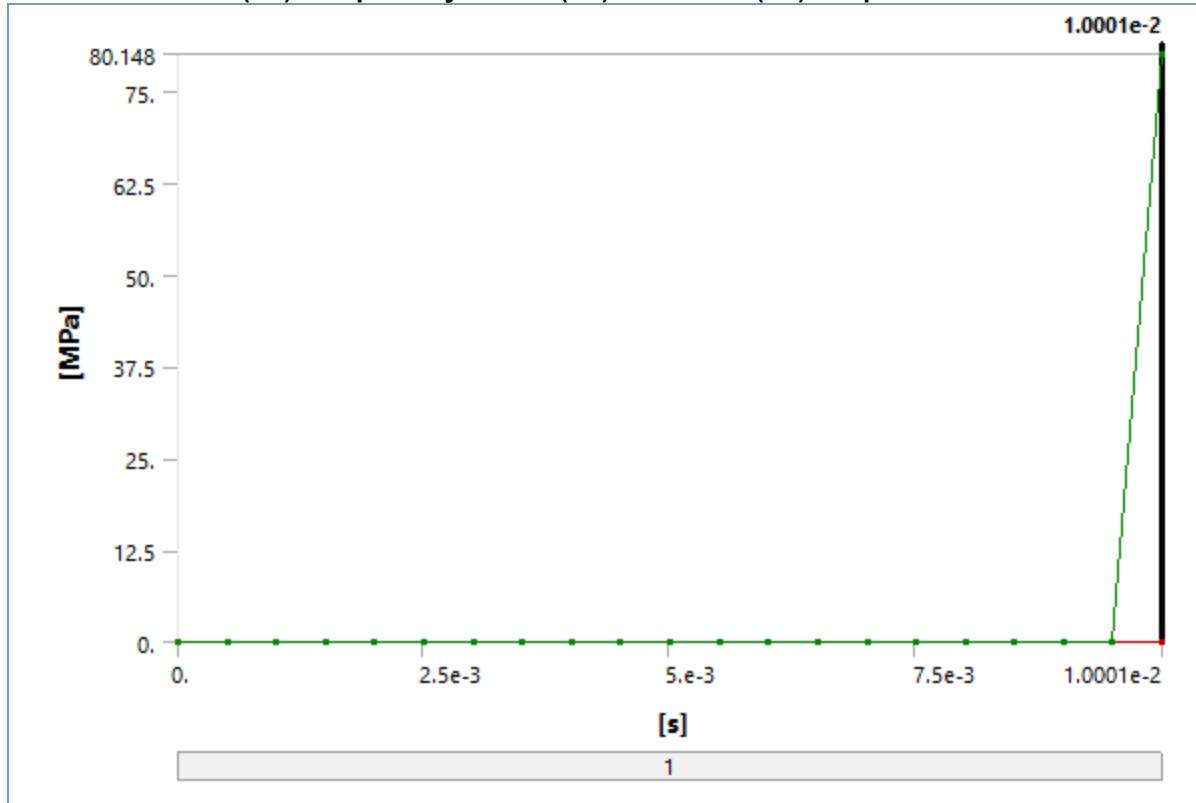


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0219e-004		
1.0009e-003		

1.5025e-003		
2.0012e-003		
2.5028e-003		
3.0015e-003		
3.5002e-003		
4.0018e-003		
4.5005e-003		
5.0021e-003		
5.5008e-003	0.	0.
6.0025e-003		
6.5011e-003		
7.0028e-003		
7.5015e-003		
8.0001e-003		
8.5018e-003		
9.0005e-003		
9.5021e-003		
1.0001e-002		80.148

Material Data

Magnesium Alloy

TABLE 20
Magnesium Alloy > Constants

Density	1.8e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.6e-005 C ⁻¹
Specific Heat	1.024e+006 mJ kg ⁻¹ C ⁻¹
Thermal Conductivity	0.156 W mm ⁻¹ C ⁻¹
Resistivity	7.7e-004 ohm mm

TABLE 21
Magnesium Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Magnesium Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
193

TABLE 23
Magnesium Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
193

TABLE 24
Magnesium Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
255

TABLE 25

Magnesium Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 26
Magnesium Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	45000	0.35	50000	16667

TABLE 27
Magnesium Alloy > Isotropic Relative Permeability

Relative Permeability
10000

Structural Steel

TABLE 28
Structural Steel > Constants

Density	7.85e-006 kg mm ⁻³
Coefficient of Thermal Expansion	1.2e-005 C ⁻¹
Specific Heat	4.34e+005 mJ kg ⁻¹ C ⁻¹
Thermal Conductivity	6.05e-002 W mm ⁻¹ C ⁻¹
Resistivity	1.7e-004 ohm mm

TABLE 29
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 30
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 31
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 32
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 33
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 34
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0

2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 35
Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 36
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 37
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

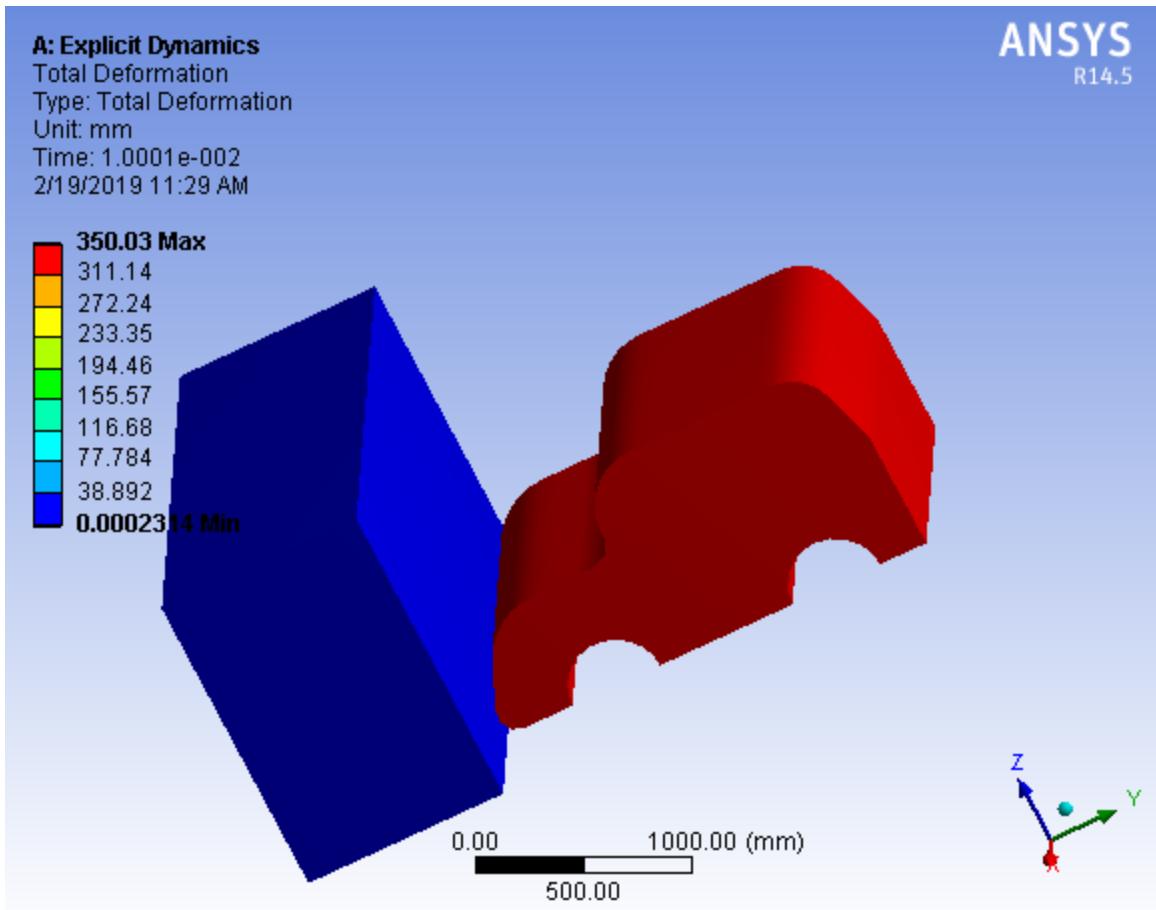
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Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

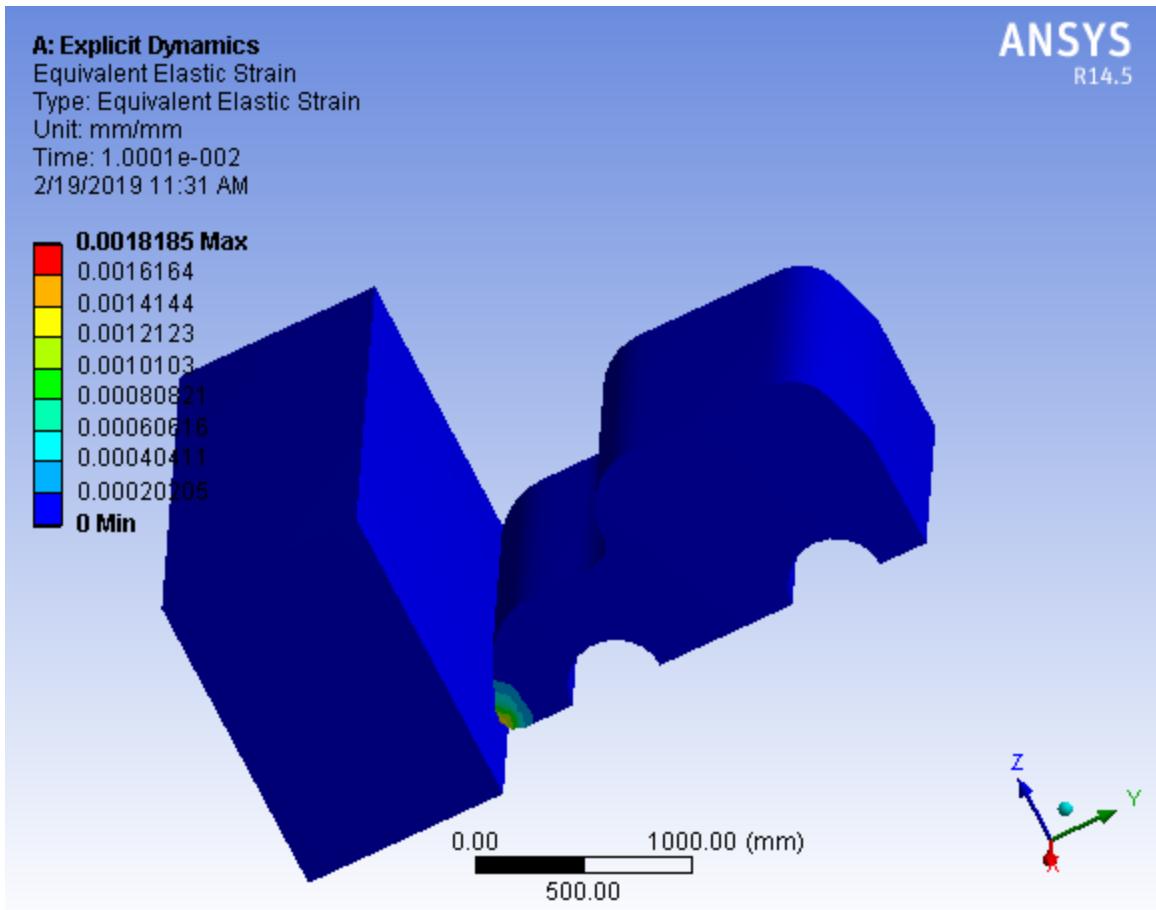
Subject: 35+MG+SS+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

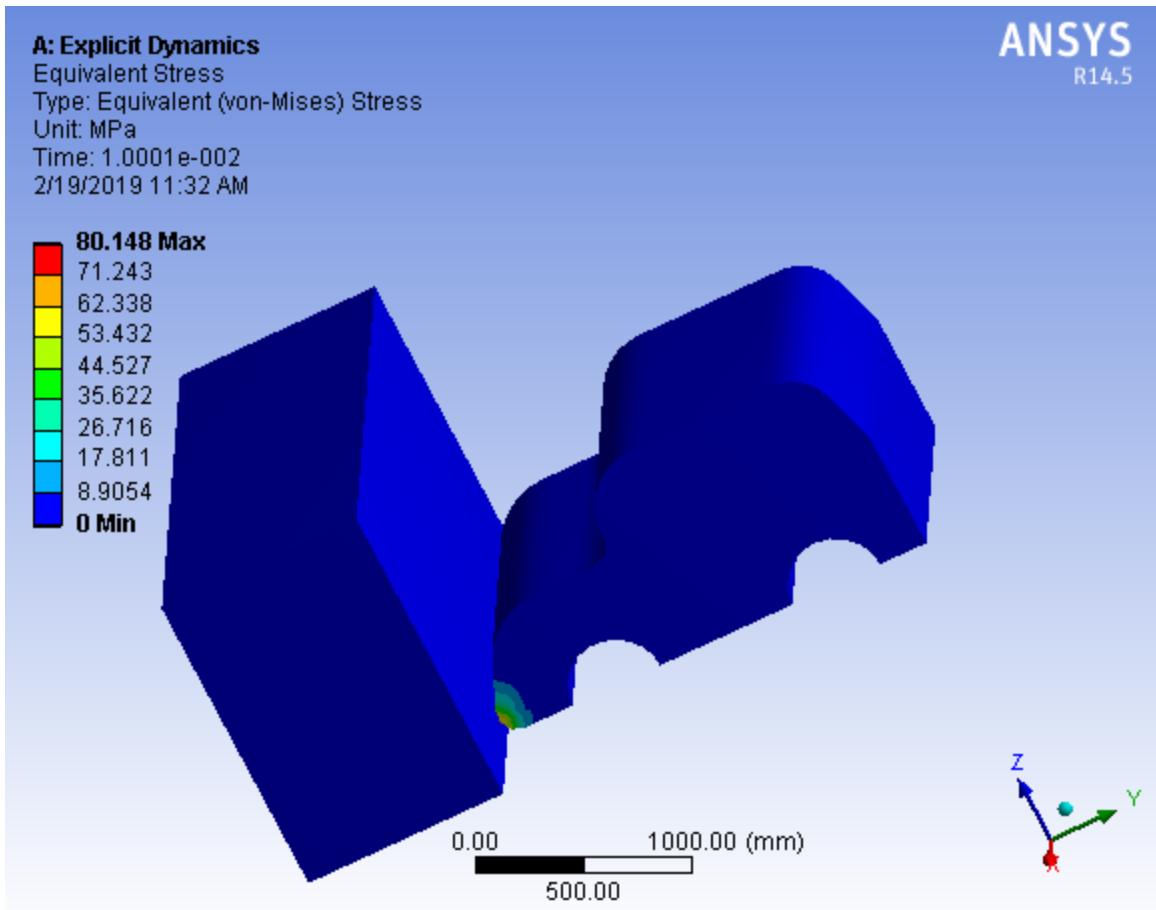
Subject: 35+MG+SS+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

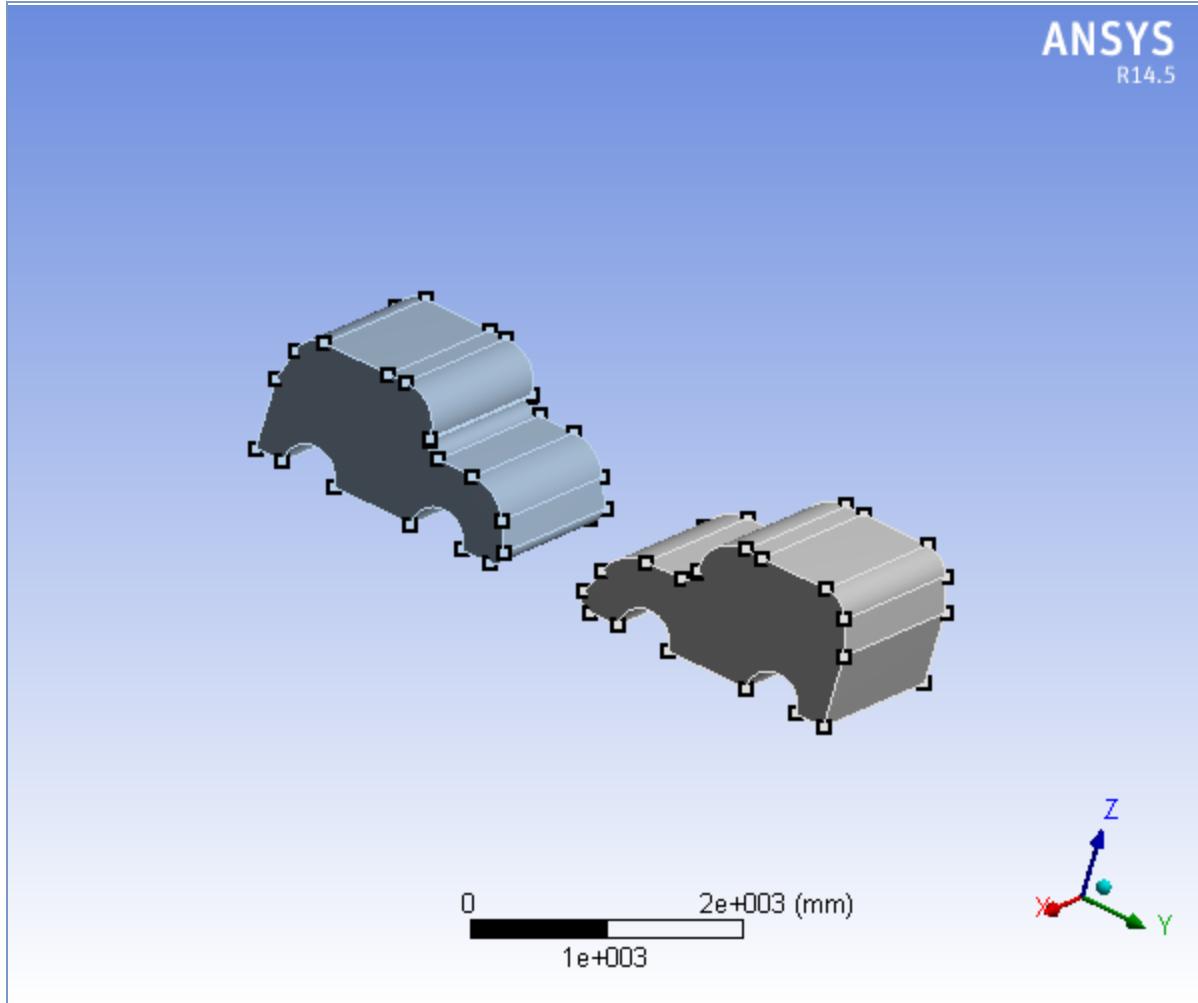
Comments:





Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
Product Version	14.5 Release
Save Project Before Solution	No
Save Project After Solution	No



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 - [Solution \(A6\)](#)
 - [Solution Information](#)
 - [Results](#)
- [Material Data](#)
 - [Aluminum Alloy](#)

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\mech\Desktop\nag main project\CAR TO CAR.igs
Type	Iges
Length Unit	Meters
Display Style	Body Color
Bounding Box	
Length X	1500. mm
Length Y	5001.7 mm
Length Z	1000.6 mm
Properties	

Volume	4.5792e+009 mm ³
Mass	12684 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	13560
Elements	11324
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
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\mech\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	PartBody	PartBody
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Aluminum Alloy	
Bounding Box		
Length X	1500. mm	
Length Y	2154.4 mm	
Length Z	1000.6 mm	
Properties		
Volume	2.2896e+009 mm ³	

Mass	6342.2 kg	
Centroid X	-2.0333e-002 mm	-3.7596e-007 mm
Centroid Y	1591.3 mm	-1591.2 mm
Centroid Z	463.98 mm	463.96 mm
Moment of Inertia Ip1	2.3899e+009 kg·mm ²	2.39e+009 kg·mm ²
Moment of Inertia Ip2	1.5852e+009 kg·mm ²	1.5853e+009 kg·mm ²
Moment of Inertia Ip3	3.1828e+009 kg·mm ²	3.1831e+009 kg·mm ²
Statistics		
Nodes	6660	6900
Elements	5548	5776
Mesh Metric	None	

Coordinate Systems

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

Object Name	Global Coordinate System
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	Connections
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	Body Interactions
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.776180 mm)
Max Face Size	Default (77.6180 mm)
Max Size	Default (155.240 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (0.698560 mm)

Generate Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.388090 mm)
Statistics	
Nodes	13560
Elements	11324
Mesh Metric	None

Explicit Dynamics

(A5)

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9
Characteristic Dimension	Diagonals

Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No
On Minimum Element	No

Time Step	
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_5068_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity	Velocity 2
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	1 Body	
Definition		
Type	Velocity	
Define By	Components	
Coordinate System	Global Coordinate System	
X Component	Free	
Y Component	-45000 mm/s (step applied)	45000 mm/s (step applied)
Z Component	Free	
Suppressed	No	

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity

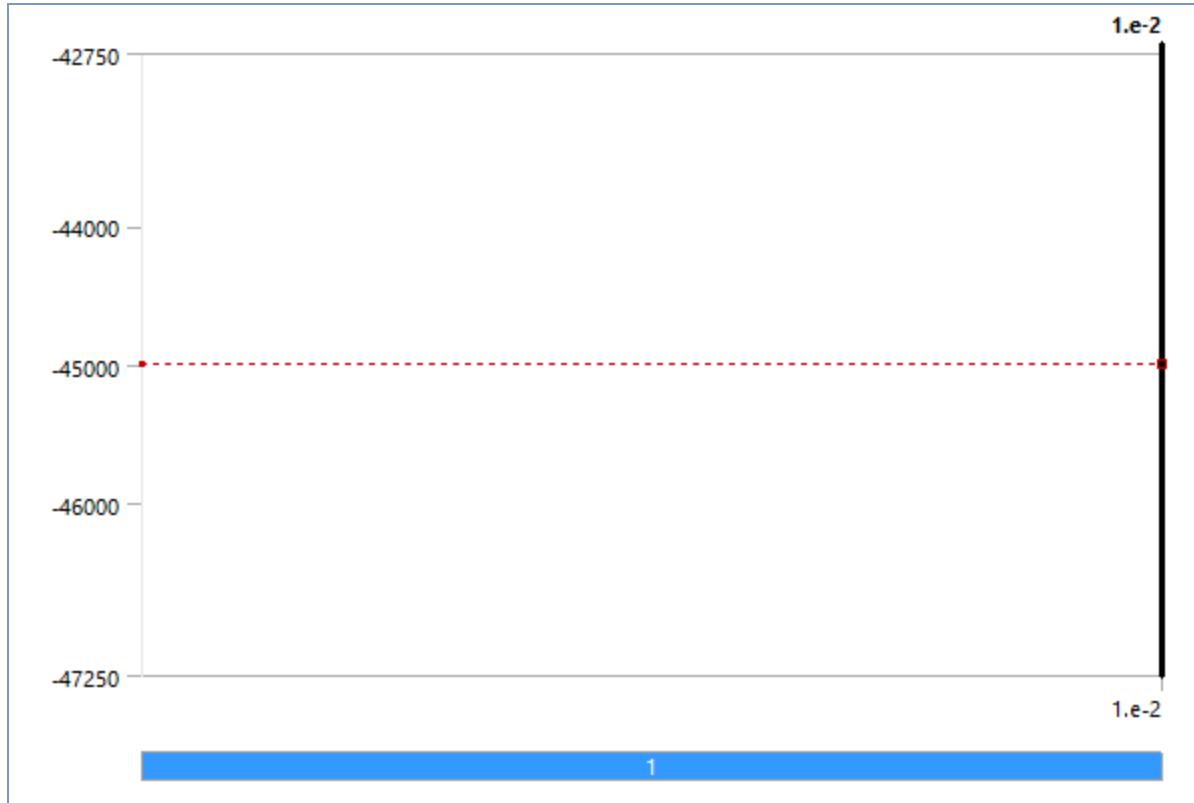
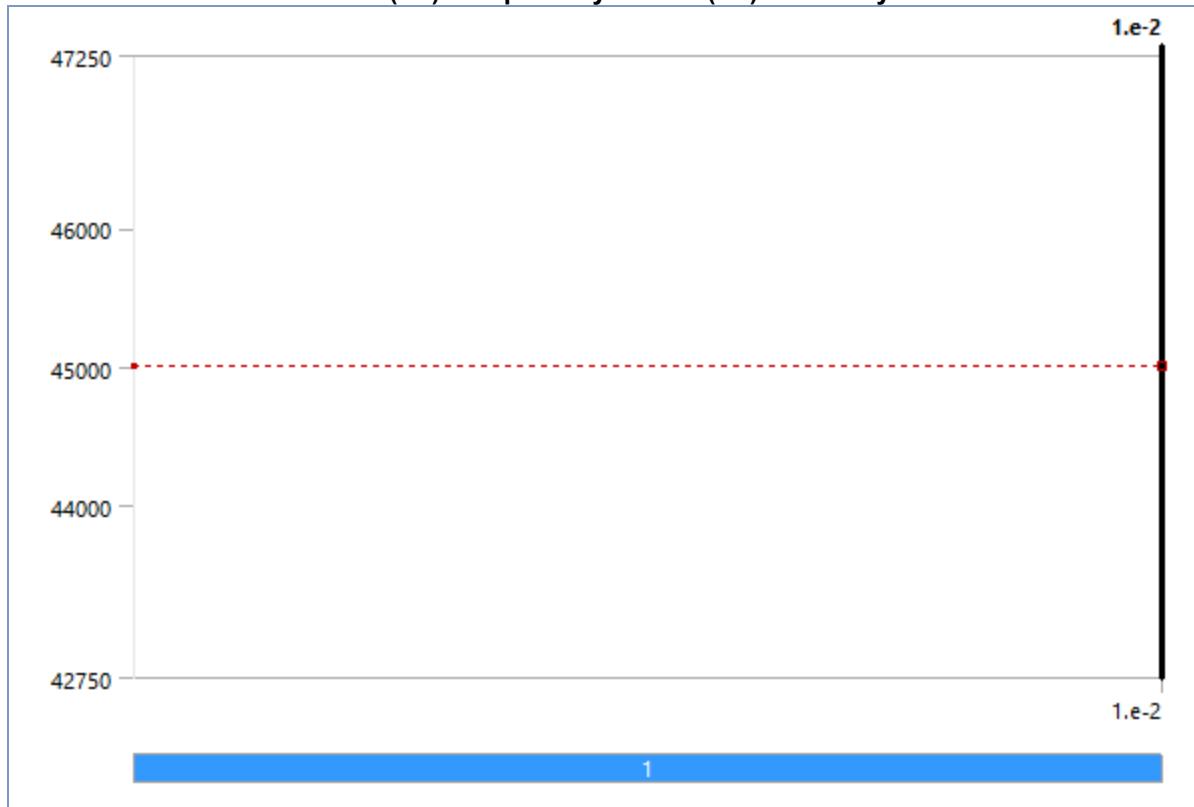


FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Velocity 2



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	Solution (A6)
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	Solution Information
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	Total Deformation	Equivalent Elastic Strain	Equivalent Stress
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	450. mm	2.4026e-004 mm/mm	0. MPa
Maximum	654.84 mm	0.18102 mm/mm	9491. MPa
Minimum Occurs On	PartBody		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	450. mm	2.4026e-004 mm/mm	5.4073 MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	654.84 mm	0.18102 mm/mm	9491. MPa
Information			
Time	1.e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 3
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

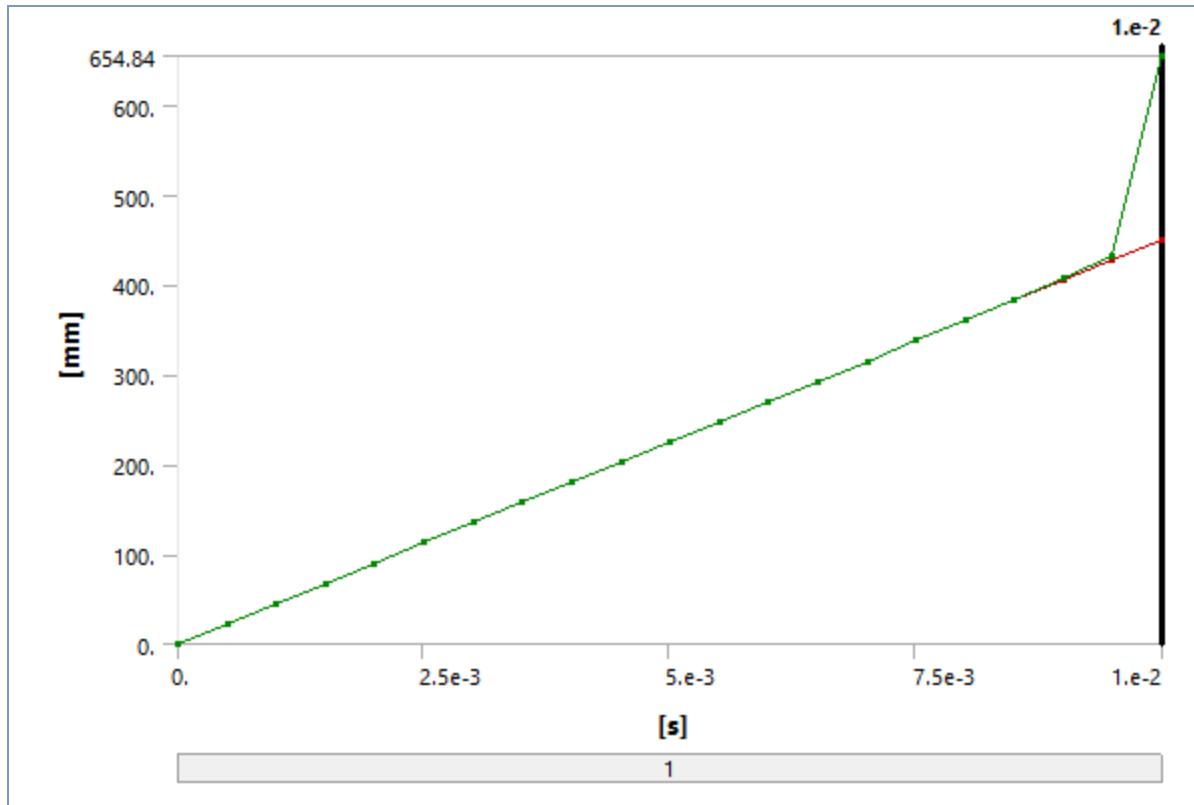


TABLE
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Tsje	Minimum [mm]	Maximum [mm]
1.1755e-038	0.	0.
5.0247e-004	22.611	22.611
1.002e-003	45.088	45.088
1.5014e-003	67.565	67.565
2.0009e-003	90.041	90.041
2.5004e-003	112.52	112.52
3.0037e-003	135.17	135.17
3.5032e-003	157.64	157.64
4.0027e-003	180.12	180.12
4.5021e-003	202.6	202.6
5.0016e-003	225.07	225.07
5.5011e-003	247.55	247.55
6.0006e-003	270.03	270.03
6.5001e-003	292.5	292.5
7.0034e-003	315.15	315.15
7.5029e-003	337.63	337.63
8.0023e-003	360.11	360.11
8.5014e-003	382.56	383.62
9.0012e-003	405.06	406.69
9.5003e-003	427.51	433.03
1.e-002	450.	654.84

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

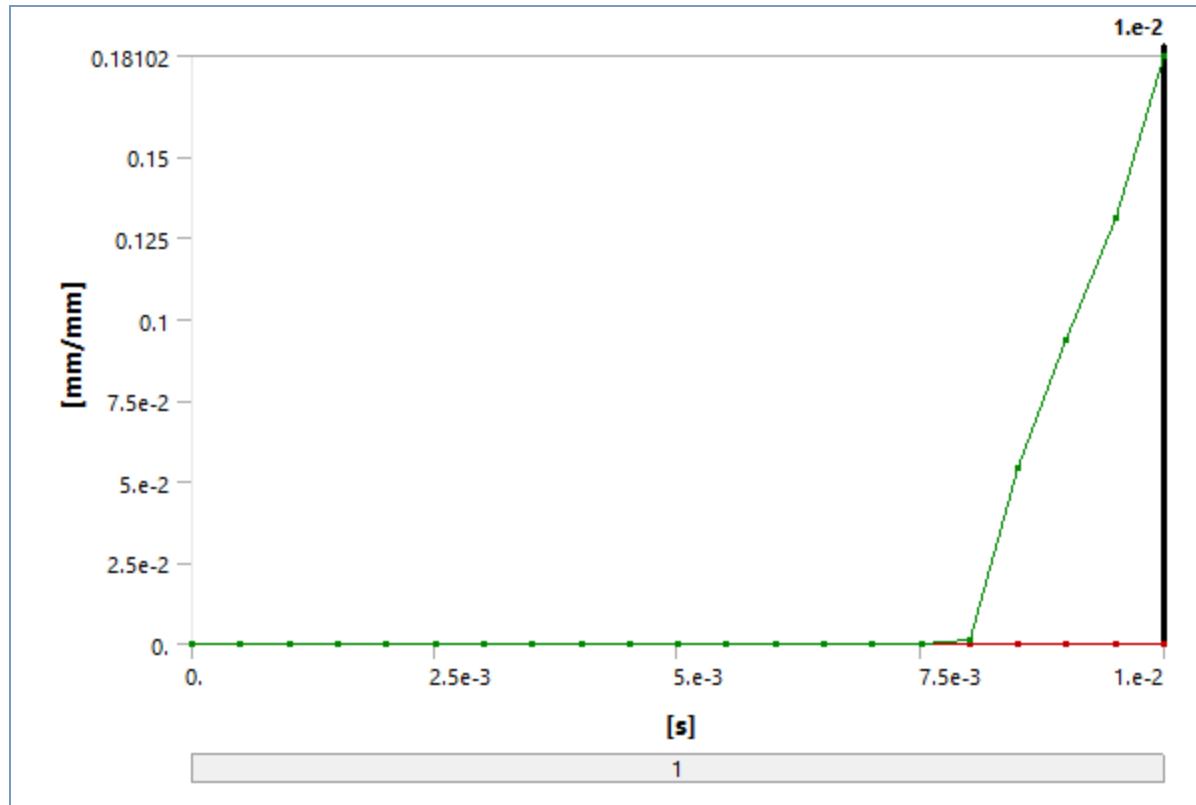


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0247e-004		
1.002e-003		
1.5014e-003		
2.0009e-003		
2.5004e-003		
3.0037e-003		
3.5032e-003		
4.0027e-003	0.	0.
4.5021e-003		
5.0016e-003		
5.5011e-003		
6.0006e-003		
6.5001e-003		
7.0034e-003		
7.5029e-003		
8.0023e-003		1.0805e-003
8.5014e-003	3.3126e-008	5.3969e-002
9.0012e-003	8.1615e-005	9.3441e-002
9.5003e-003	1.8547e-004	0.13102
1.e-002	2.4026e-004	0.18102

FIGURE 5
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

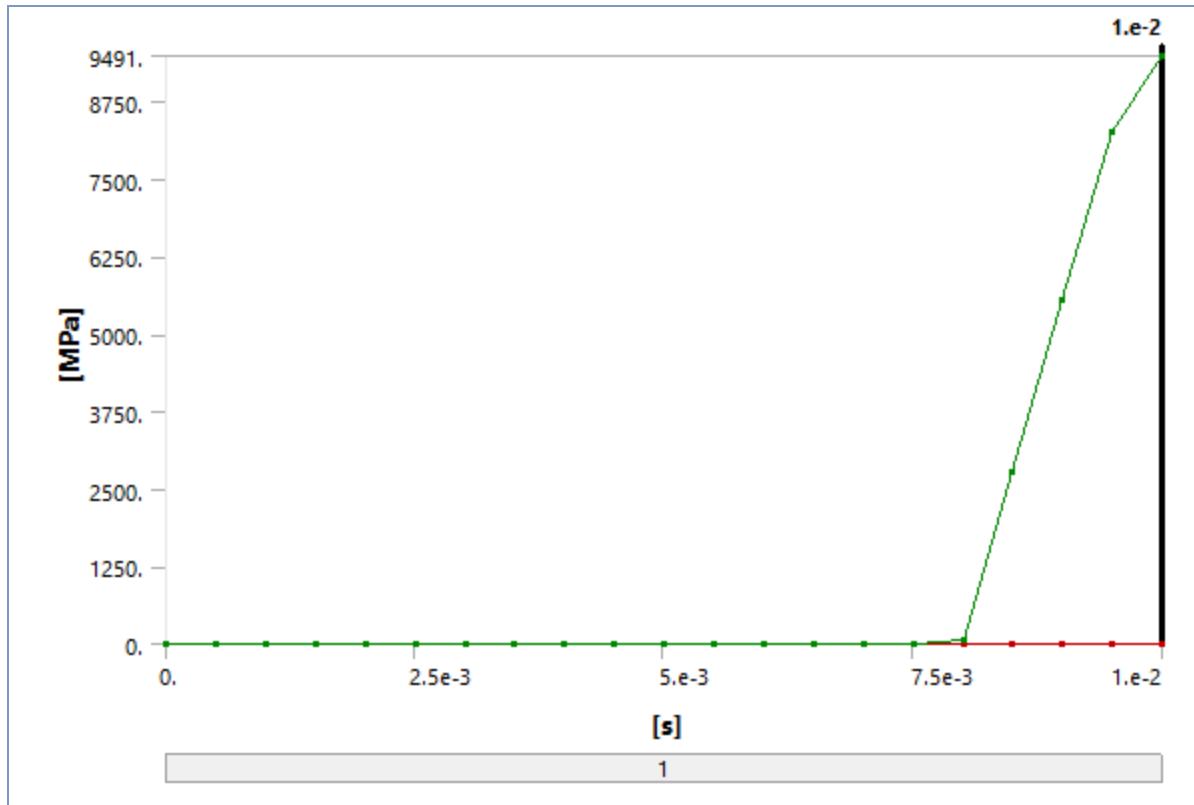


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0247e-004		
1.002e-003		
1.5014e-003		
2.0009e-003		
2.5004e-003		
3.0037e-003		
3.5032e-003		
4.0027e-003	0.	0.
4.5021e-003		
5.0016e-003		
5.5011e-003		
6.0006e-003		
6.5001e-003		
7.0034e-003		
7.5029e-003		
8.0023e-003		61.703
8.5014e-003	1.9923e-003	2766.9
9.0012e-003	5.2844	5552.8
9.5003e-003	5.4073	8272.9
1.e-002	0.	9491.

Material Data

Aluminum Alloy

TABLE 20
Aluminum Alloy > Constants

Density	2.77e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.3e-005 C ⁻¹
Specific Heat	8.75e+005 mJ kg ⁻¹ C ⁻¹

TABLE 21
Aluminum Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Aluminum Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 23
Aluminum Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 24
Aluminum Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
310

TABLE 25
Aluminum Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 26
Aluminum Alloy > Isotropic Thermal Conductivity

Thermal Conductivity W mm ⁻¹ C ⁻¹	Temperature C
0.114	-100
0.144	0
0.165	100
0.175	200

TABLE 27
Aluminum Alloy > Alternating Stress R-Ratio

Alternating Stress MPa	Cycles	R-Ratio
275.8	1700	-1
241.3	5000	-1
206.8	34000	-1
172.4	1.4e+005	-1
137.9	8.e+005	-1
117.2	2.4e+006	-1
89.63	5.5e+007	-1
82.74	1.e+008	-1
170.6	50000	-0.5

139.6	3.5e+005	-0.5
108.6	3.7e+006	-0.5
87.91	1.4e+007	-0.5
77.57	5.e+007	-0.5
72.39	1.e+008	-0.5
144.8	50000	0
120.7	1.9e+005	0
103.4	1.3e+006	0
93.08	4.4e+006	0
86.18	1.2e+007	0
72.39	1.e+008	0
74.12	3.e+005	0.5
70.67	1.5e+006	0.5
66.36	1.2e+007	0.5
62.05	1.e+008	0.5

TABLE 28
Aluminum Alloy > Isotropic Resistivity

Resistivity ohm mm	Temperature C
2.43e-005	0
2.67e-005	20
3.63e-005	100

TABLE 29
Aluminum Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

TABLE 30
Aluminum Alloy > Isotropic Relative Permeability

Relative Permeability
1

Total Deformation

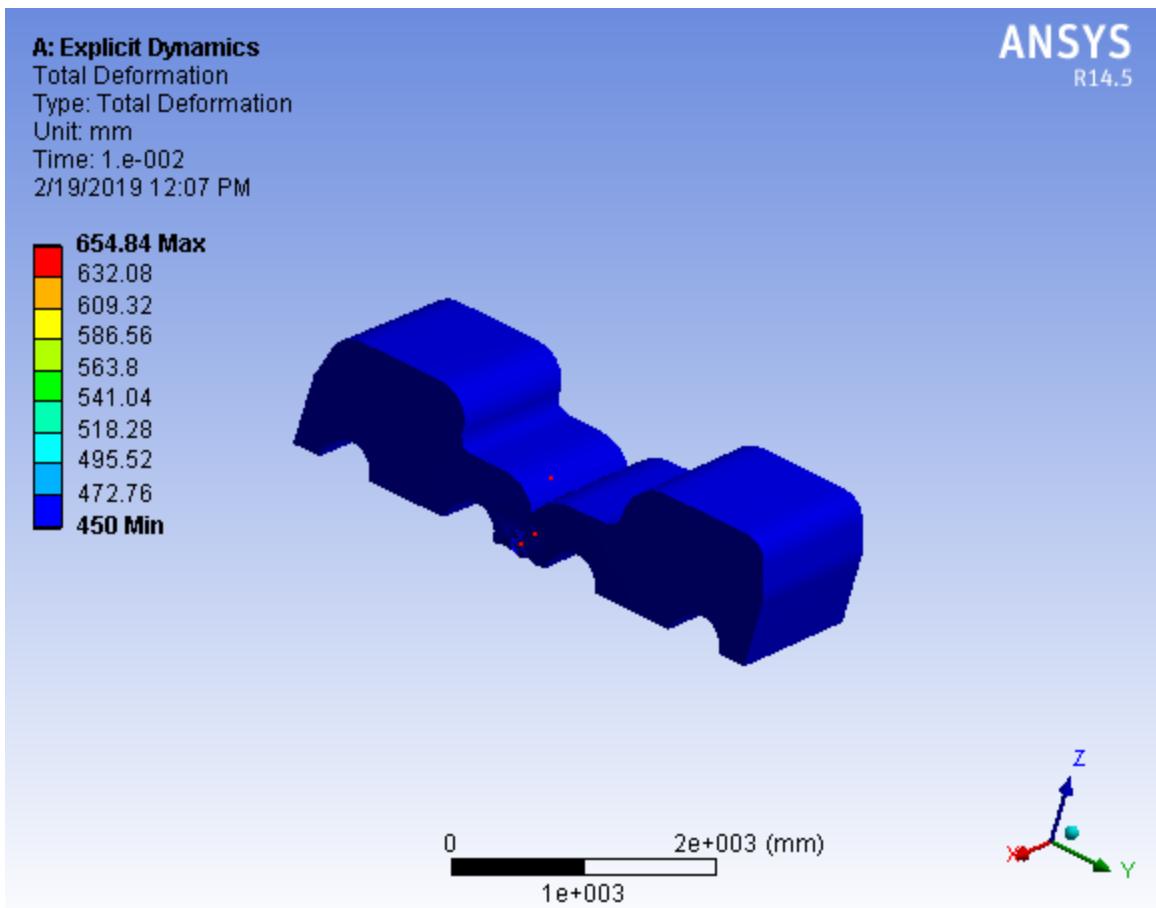
Subject: 45+AL+AL+F+DEFORAMTION

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

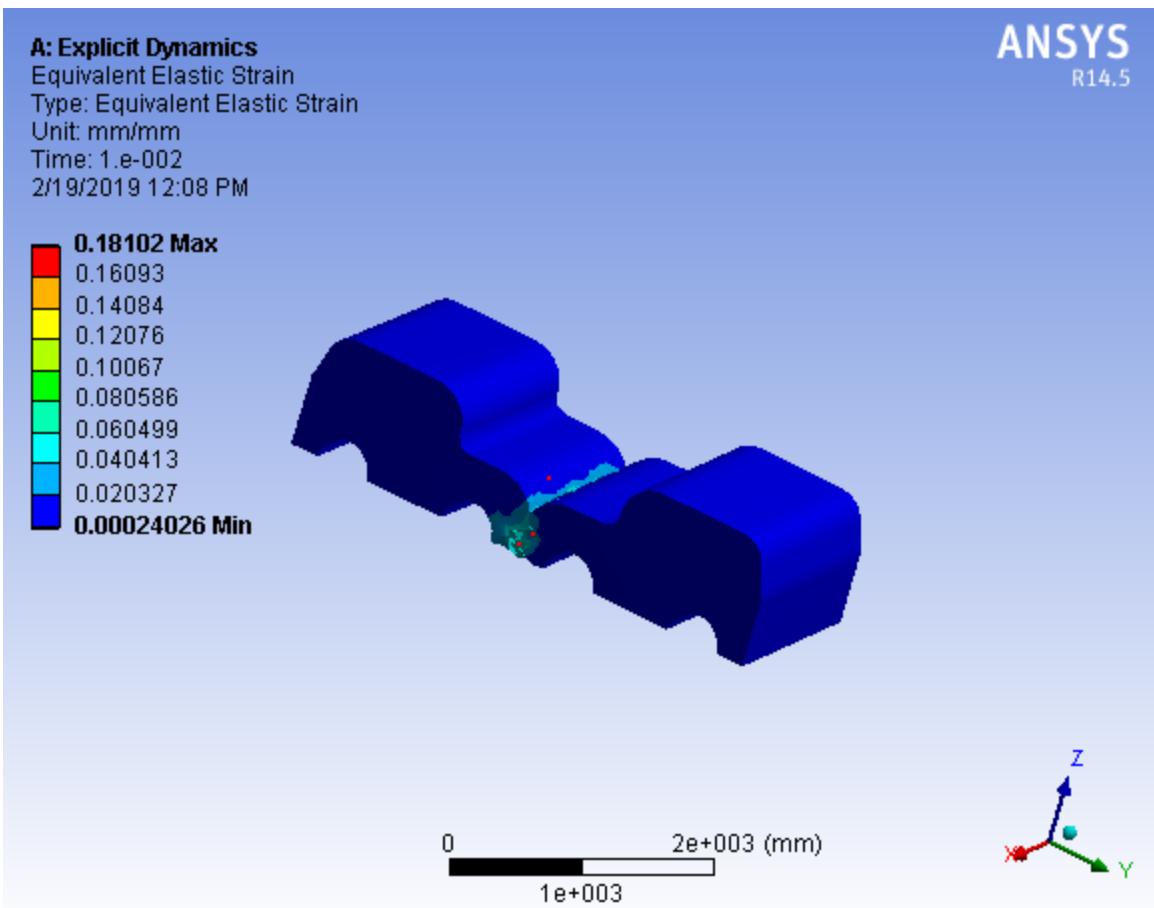
Subject: 45+AL+AL+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

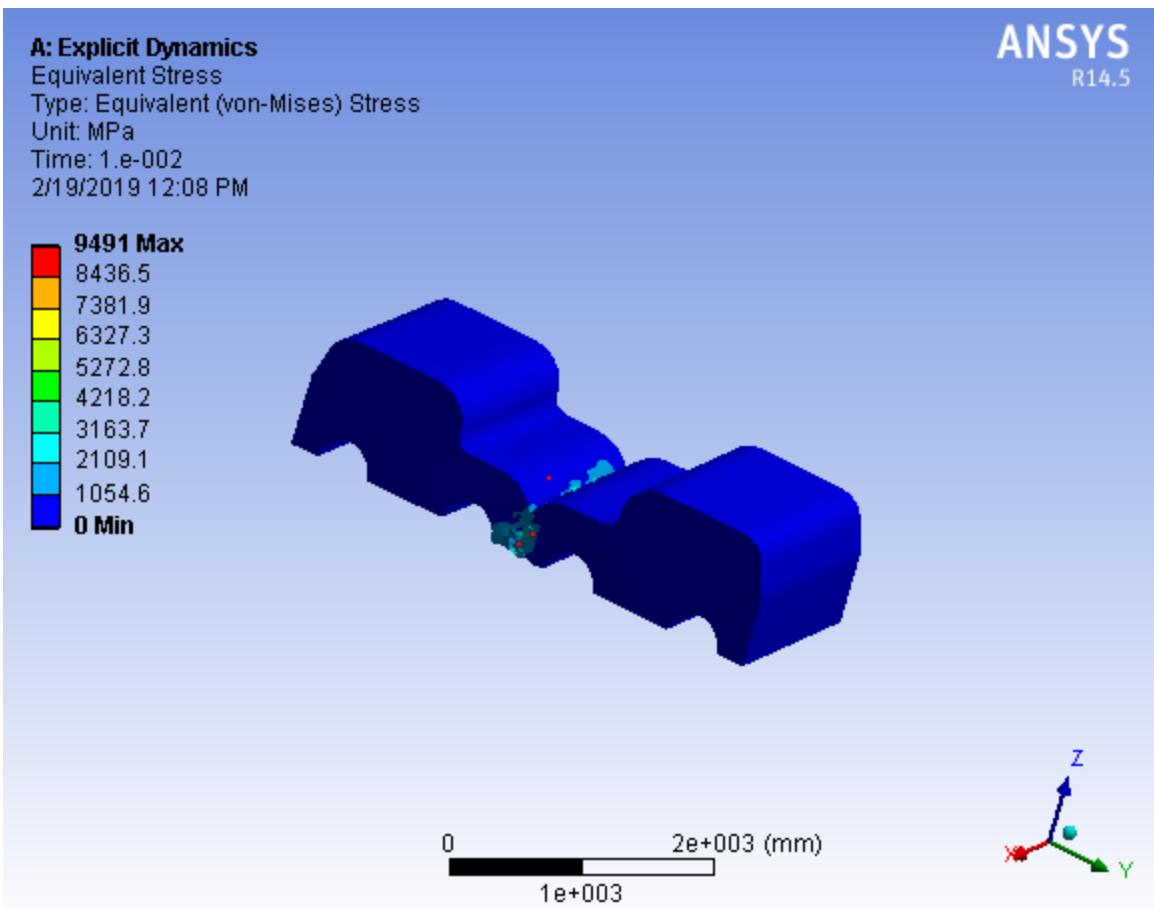
Subject: 45+AL+AL+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

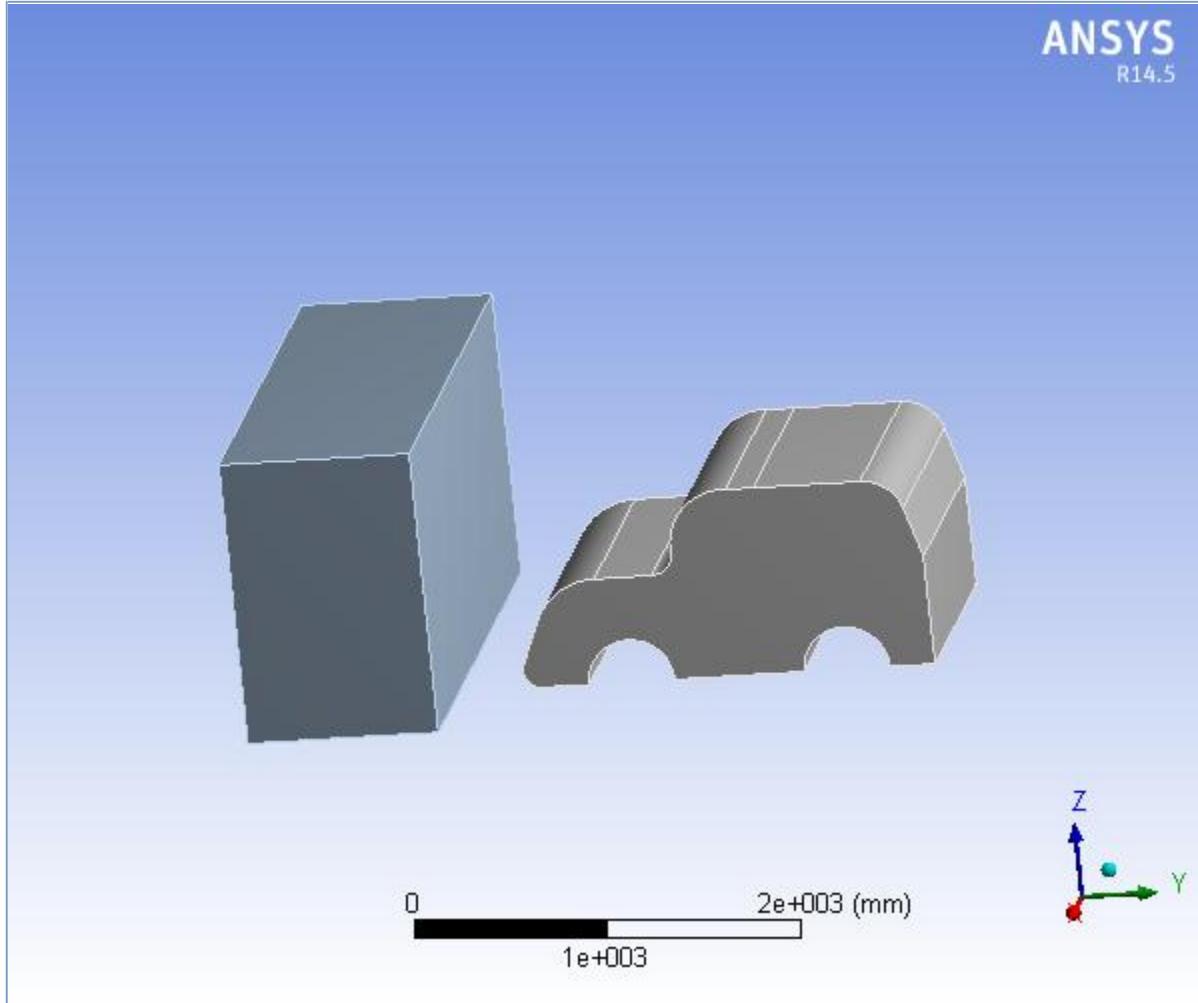
Comments:





Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
Product Version	14.5 Release
Save Project Before Solution	No
Save Project After Solution	No



Contents

- [Units](#)
- [Model \(A4\)](#)
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 - [Solution \(A6\)](#)
 - [Solution Information](#)
 - [Results](#)
-) [Material Data](#)
 - » [Aluminum Alloy](#)
 - » [Structural Steel](#)

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\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	41667 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Aluminum Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	6342.2 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	2.3912e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.5854e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	3.1842e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Explicit Dynamics (A5)

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

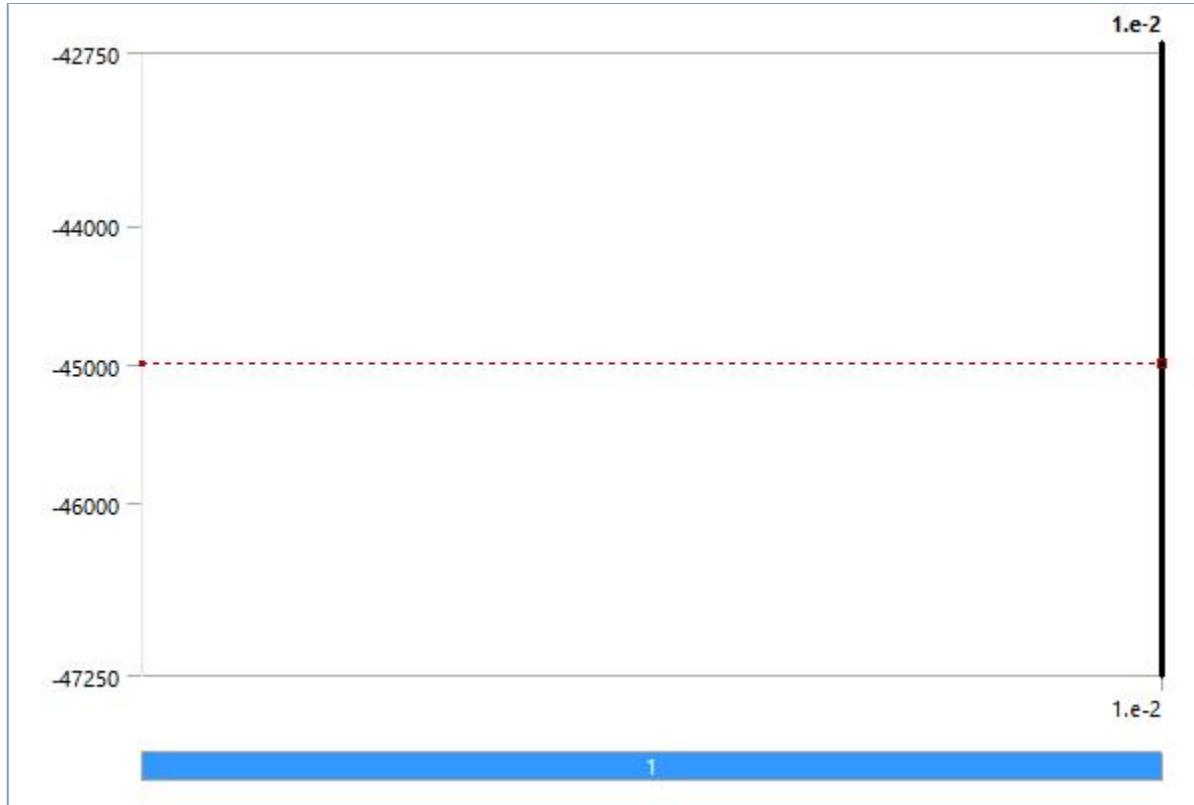
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-45000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	4.6136 mm	0. mm/mm	0. MPa
Maximum	450.26 mm	3.3969e-003 mm/mm	240.82 MPa
Minimum Occurs On	Solid		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	4.6136 mm	0. mm/mm	0. MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	450.26 mm	9.2573e-003 mm/mm	642.26 MPa
Information			
Time	1.e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

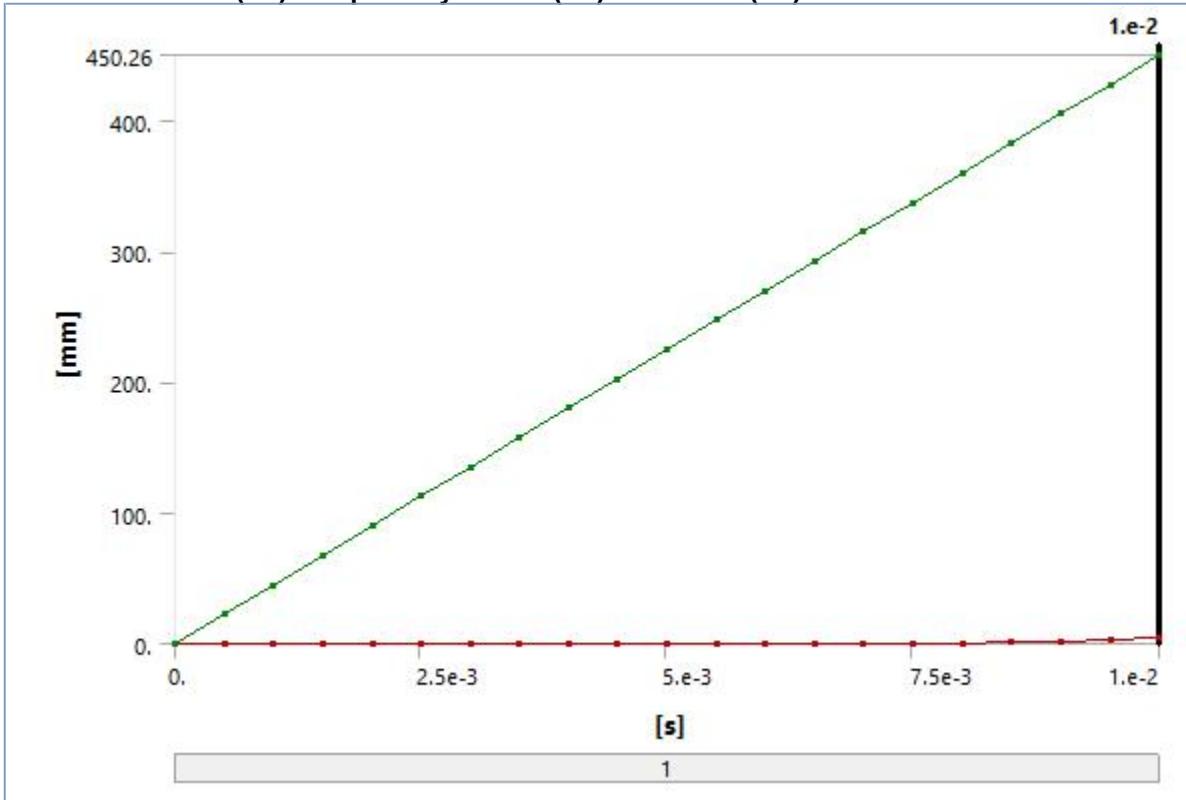


TABLE 17
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		0.

5.0099e-004		22.545
1.0014e-003		45.065
1.5019e-003		67.585
2.0023e-003		90.105
2.5028e-003		112.63
3.0002e-003		135.01
3.5007e-003		157.53
4.0011e-003		180.05
4.5015e-003		202.57
5.002e-003		225.09
5.5024e-003		247.61
6.0029e-003		270.13
6.5003e-003		292.51
7.0008e-003		315.03
7.5012e-003		337.55
8.0018e-003	4.073e-002	360.09
8.5029e-003	0.80614	382.72
9.0027e-003	1.822	405.22
9.5027e-003	3.0048	427.75
1.e-002	4.6136	450.26

FIGURE 3
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

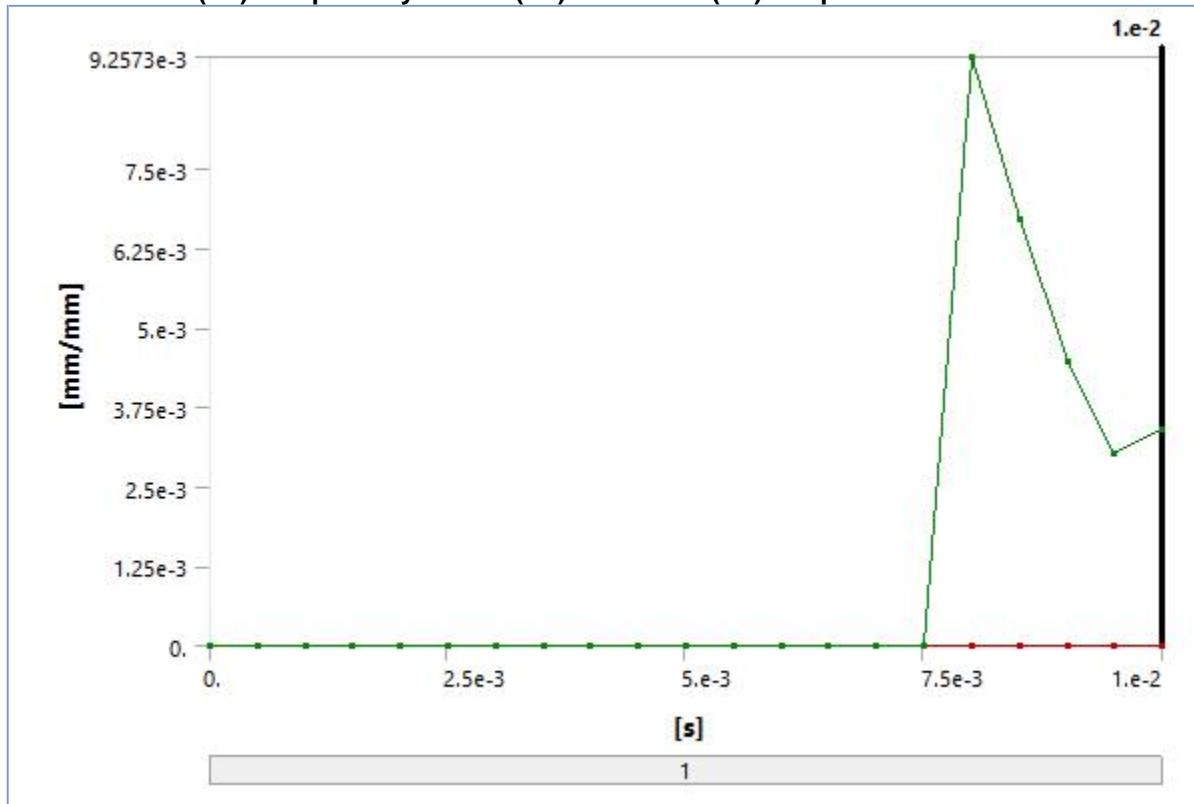


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0099e-004		

1.0014e-003	
1.5019e-003	
2.0023e-003	
2.5028e-003	
3.0002e-003	
3.5007e-003	
4.0011e-003	
4.5015e-003	
5.002e-003	
5.5024e-003	0.
6.0029e-003	0.
6.5003e-003	
7.0008e-003	
7.5012e-003	
8.0018e-003	9.2573e-003
8.5029e-003	6.708e-003
9.0027e-003	4.478e-003
9.5027e-003	3.0222e-003
1.e-002	3.3969e-003

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

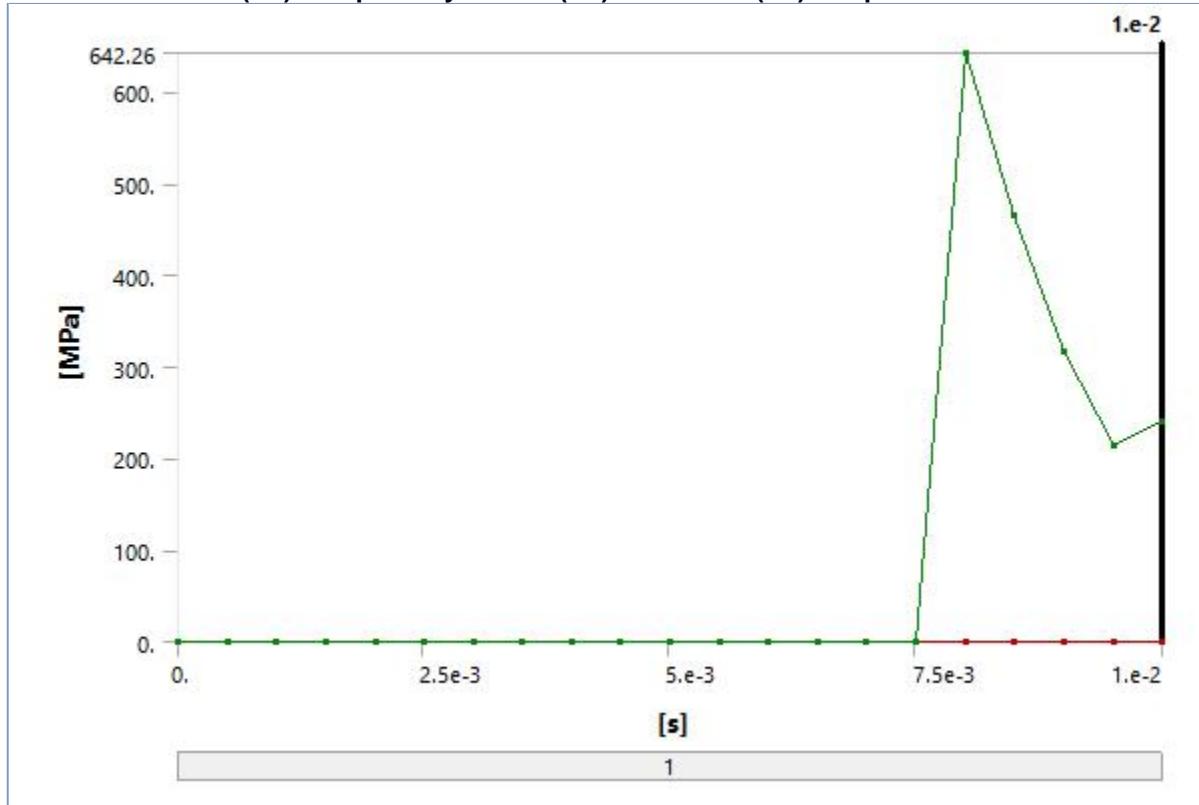


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0099e-004		
1.0014e-003		

1.5019e-003	
2.0023e-003	
2.5028e-003	
3.0002e-003	
3.5007e-003	
4.0011e-003	
4.5015e-003	
5.002e-003	
5.5024e-003	
6.0029e-003	
6.5003e-003	
7.0008e-003	
7.5012e-003	
8.0018e-003	642.26
8.5029e-003	465.94
9.0027e-003	316.91
9.5027e-003	213.9
1.e-002	240.82

Material Data

Aluminum Alloy

TABLE 20
Aluminum Alloy > Constants

Density	2.77e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.3e-005 C ⁻¹
Specific Heat	8.75e+005 mJ kg ⁻¹ C ⁻¹

TABLE 21
Aluminum Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Aluminum Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 23
Aluminum Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 24
Aluminum Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
310

TABLE 25
Aluminum Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C

TABLE 26
Aluminum Alloy > Isotropic Thermal Conductivity

Thermal Conductivity W mm^-1 C^-1	Temperature C
0.114	-100
0.144	0
0.165	100
0.175	200

TABLE 27
Aluminum Alloy > Alternating Stress R-Ratio

Alternating Stress MPa	Cycles	R-Ratio
275.8	1700	-1
241.3	5000	-1
206.8	34000	-1
172.4	1.4e+005	-1
137.9	8.e+005	-1
117.2	2.4e+006	-1
89.63	5.5e+007	-1
82.74	1.e+008	-1
170.6	50000	-0.5
139.6	3.5e+005	-0.5
108.6	3.7e+006	-0.5
87.91	1.4e+007	-0.5
77.57	5.e+007	-0.5
72.39	1.e+008	-0.5
144.8	50000	0
120.7	1.9e+005	0
103.4	1.3e+006	0
93.08	4.4e+006	0
86.18	1.2e+007	0
72.39	1.e+008	0
74.12	3.e+005	0.5
70.67	1.5e+006	0.5
66.36	1.2e+007	0.5
62.05	1.e+008	0.5

TABLE 28
Aluminum Alloy > Isotropic Resistivity

Resistivity ohm mm	Temperature C
2.43e-005	0
2.67e-005	20
3.63e-005	100

TABLE 29
Aluminum Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

TABLE 30
Aluminum Alloy > Isotropic Relative Permeability

Relative Permeability

Structural Steel

TABLE 31
Structural Steel > Constants

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

TABLE 32
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 33
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 34
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 35
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 36
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 37
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 38

Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 39
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 40
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

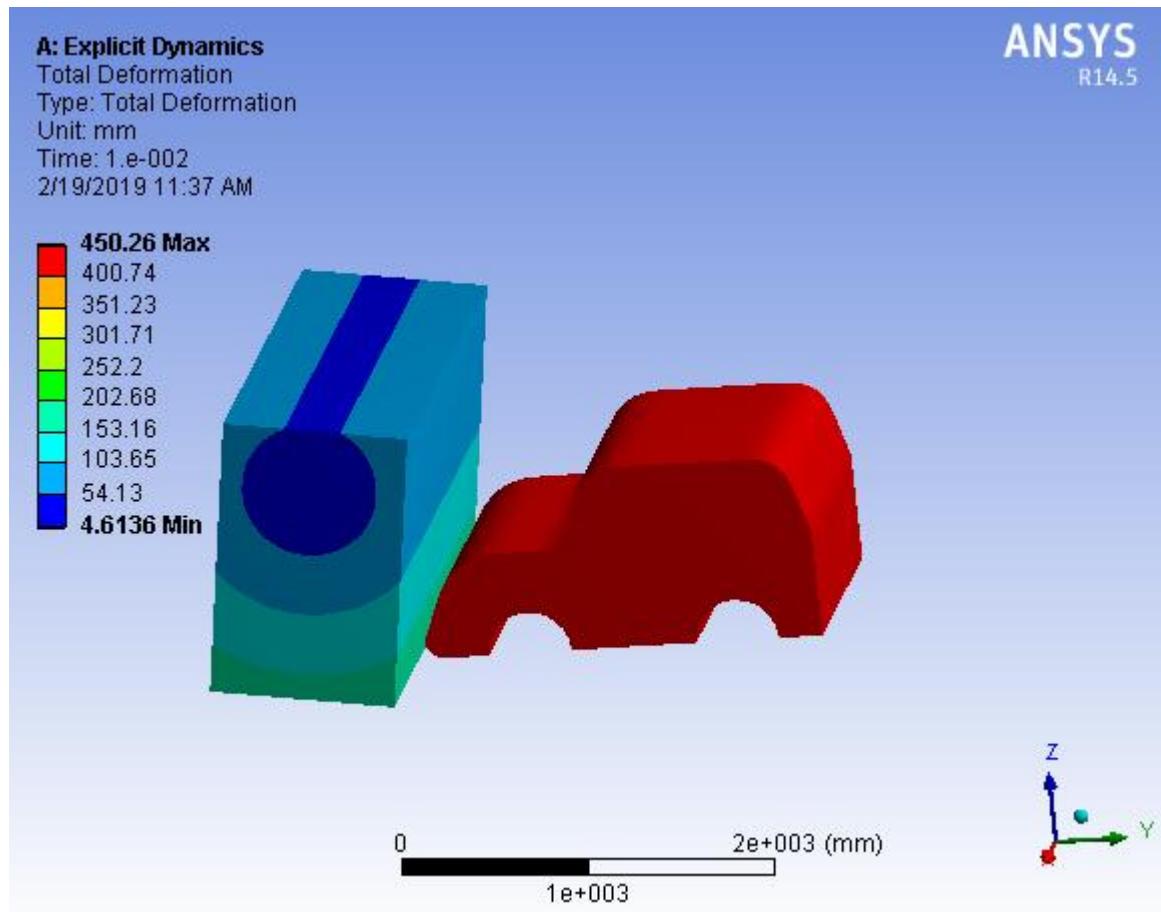
Subject: 45+AL+SS+F+DEFORMATION

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

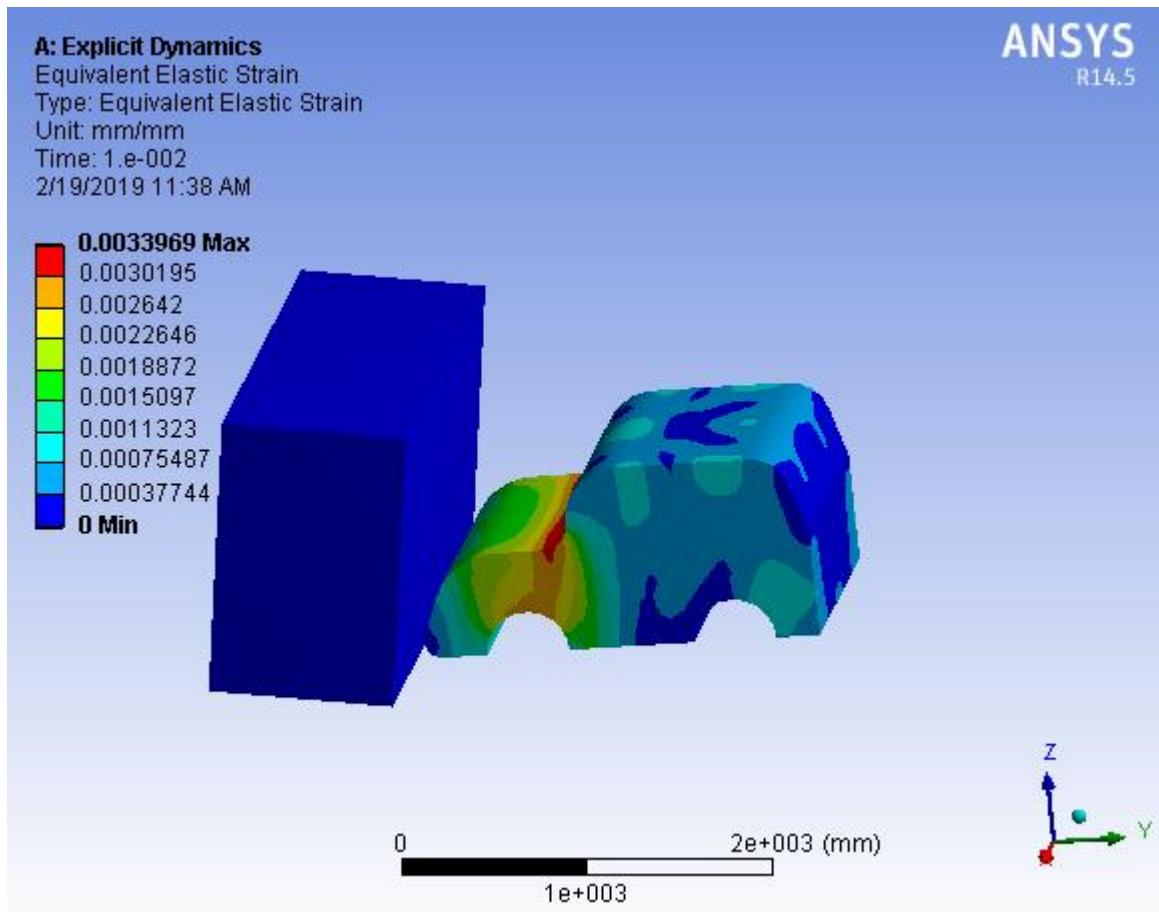
Subject: 45+AL+SS+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

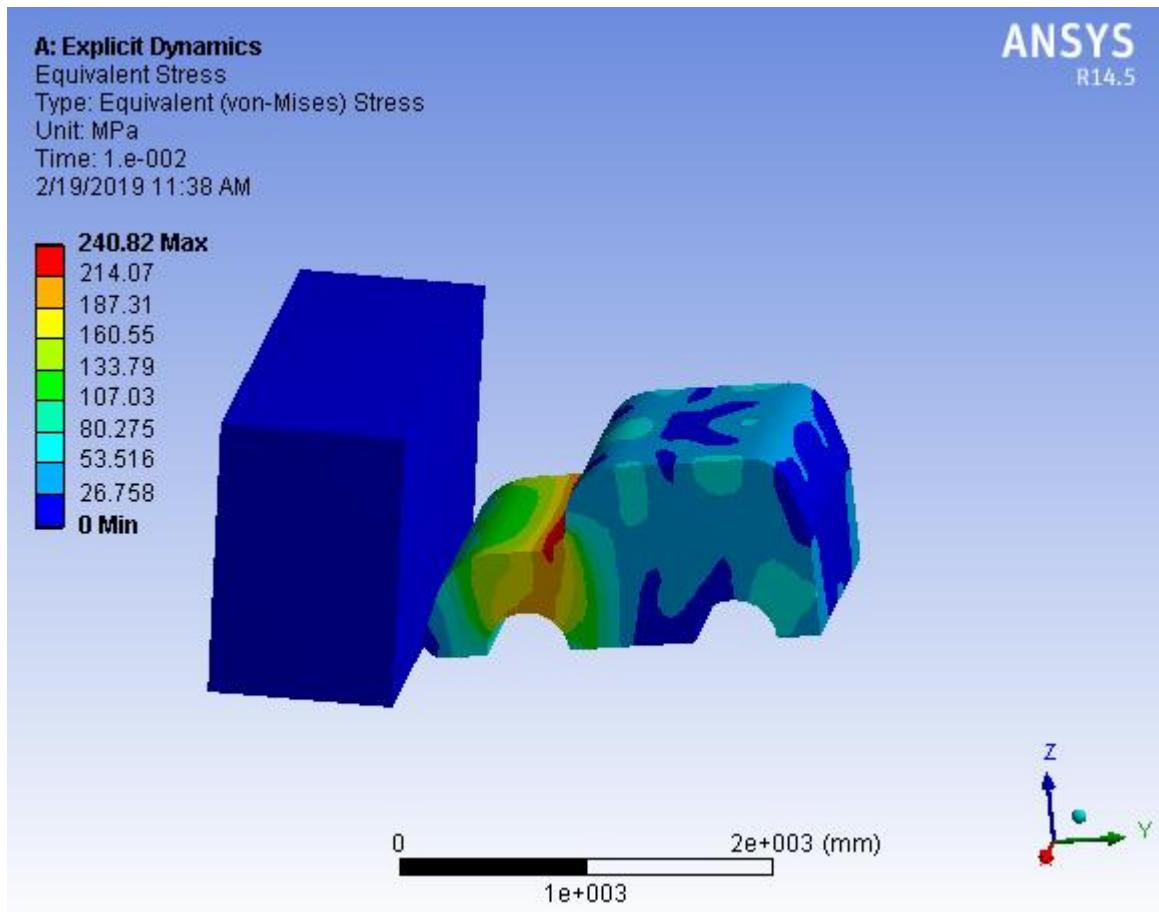
Subject: 45+AL+SS+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

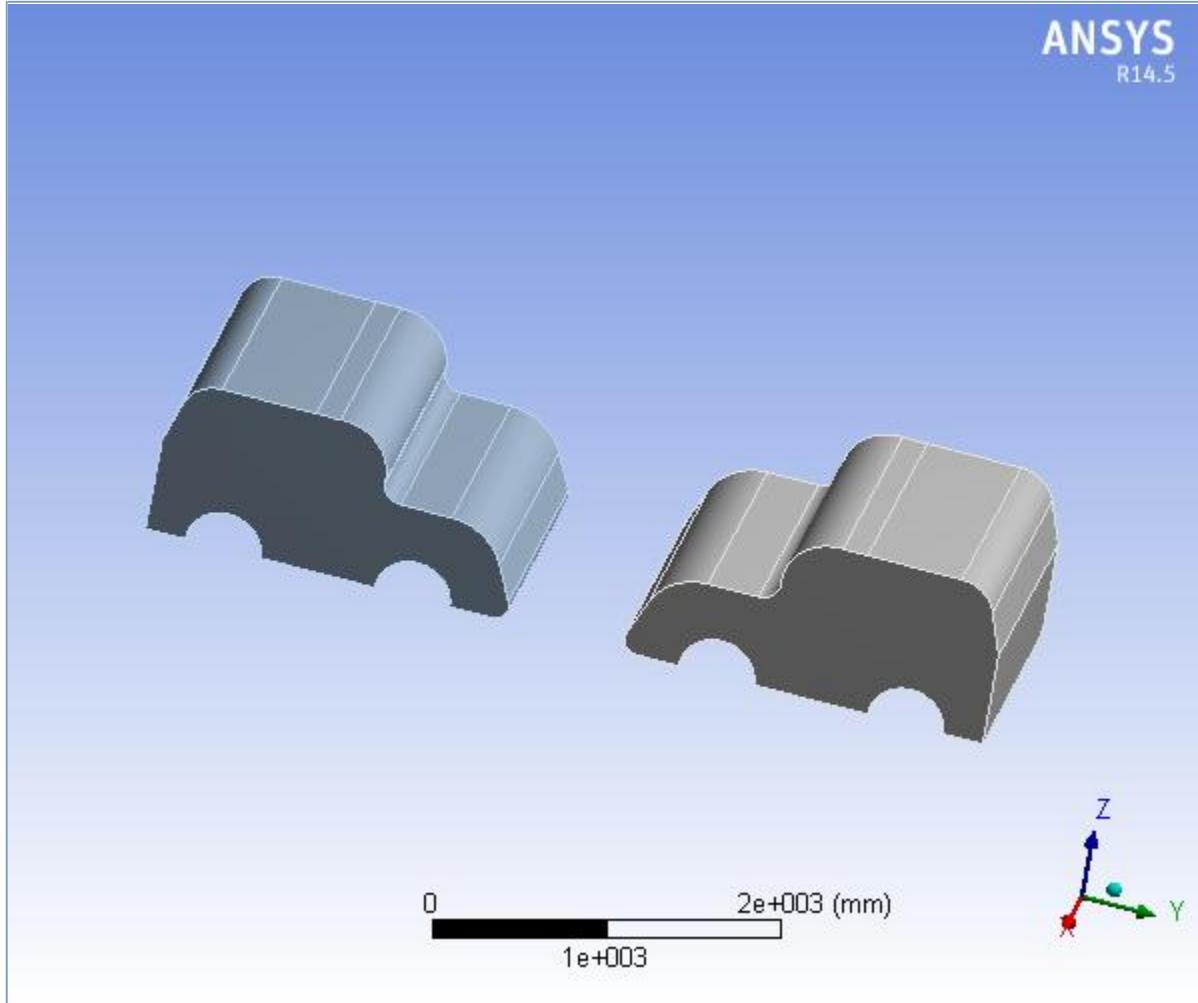
Comments:





Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
Product Version	14.5 Release
Save Project Before Solution	No
Save Project After Solution	No



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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 (B4)

Geometry

TABLE 2
Model (B4) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	C:\Users\mech\Desktop\project\final\CAR TO CAR.igs
Type	Iges
Length Unit	Meters
Display Style	Body Color
Bounding Box	
Length X	1500. mm
Length Y	5001.7 mm
Length Z	1000.6 mm
Properties	

Volume	4.5792e+009 mm ³
Mass	8242.5 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	13560
Elements	11324
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
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\mech\AppData\Local\Temp
Analysis Type	3-D
Mixed Import Resolution	None
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (B4) > Geometry > Parts

Object Name	PartBody	PartBody
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Magnesium Alloy	
Bounding Box		
Length X	1500. mm	
Length Y	2154.4 mm	
Length Z	1000.6 mm	
Properties		
Volume	2.2896e+009 mm ³	

Mass	4121.3 kg	
Centroid X	-2.0333e-002 mm	-3.7596e-007 mm
Centroid Y	1591.3 mm	-1591.2 mm
Centroid Z	463.98 mm	463.96 mm
Moment of Inertia Ip1	1.553e+009 kg·mm ²	1.5531e+009 kg·mm ²
Moment of Inertia Ip2		1.0301e+009 kg·mm ²
Moment of Inertia Ip3	2.0683e+009 kg·mm ²	2.0684e+009 kg·mm ²
Statistics		
Nodes	6660	6900
Elements	5548	5776
Mesh Metric	None	

Coordinate Systems

TABLE 4
Model (B4) > Coordinate Systems > Coordinate System

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (B4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (B4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (B4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (B4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.776180 mm)
Max Face Size	Default (77.6180 mm)
Max Size	Default (155.240 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (0.698560 mm)

Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.388090 mm)
Statistics	
Nodes	13560
Elements	11324
Mesh Metric	None

Explicit Dynamics (B5)

TABLE 9
Model (B4) > Analysis

Object Name	<i>Explicit Dynamics (B5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (B4) > Explicit Dynamics (B5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (B4) > Explicit Dynamics (B5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (B4) > Explicit Dynamics (B5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No

Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No
On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
	Cycles

		1
Output Contact Forces		Off
Analysis Data Management		
Solver Files Directory	C:\Users\mech\Desktop\project\FINAL ANALYSIS_files\dp0\SYS-1\MECH\	
Scratch Solver Files Directory		

TABLE 13
Model (B4) > Explicit Dynamics (B5) > Loads

Object Name	Velocity	Velocity 2
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	1 Body	
Definition		
Type	Velocity	
Define By	Components	
Coordinate System	Global Coordinate System	
X Component	Free	
Y Component	-45000 mm/s (step applied)	45000 mm/s (step applied)
Z Component	Free	
Suppressed	No	

FIGURE 1
Model (B4) > Explicit Dynamics (B5) > Velocity

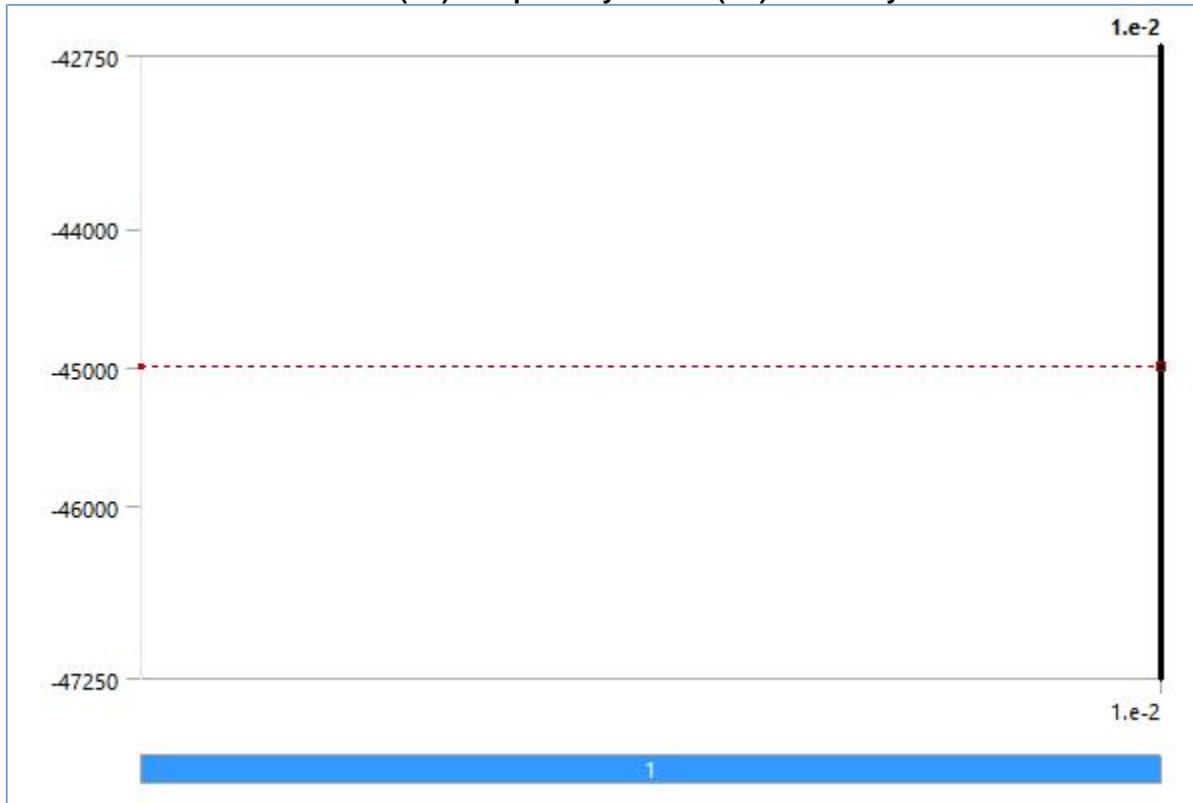
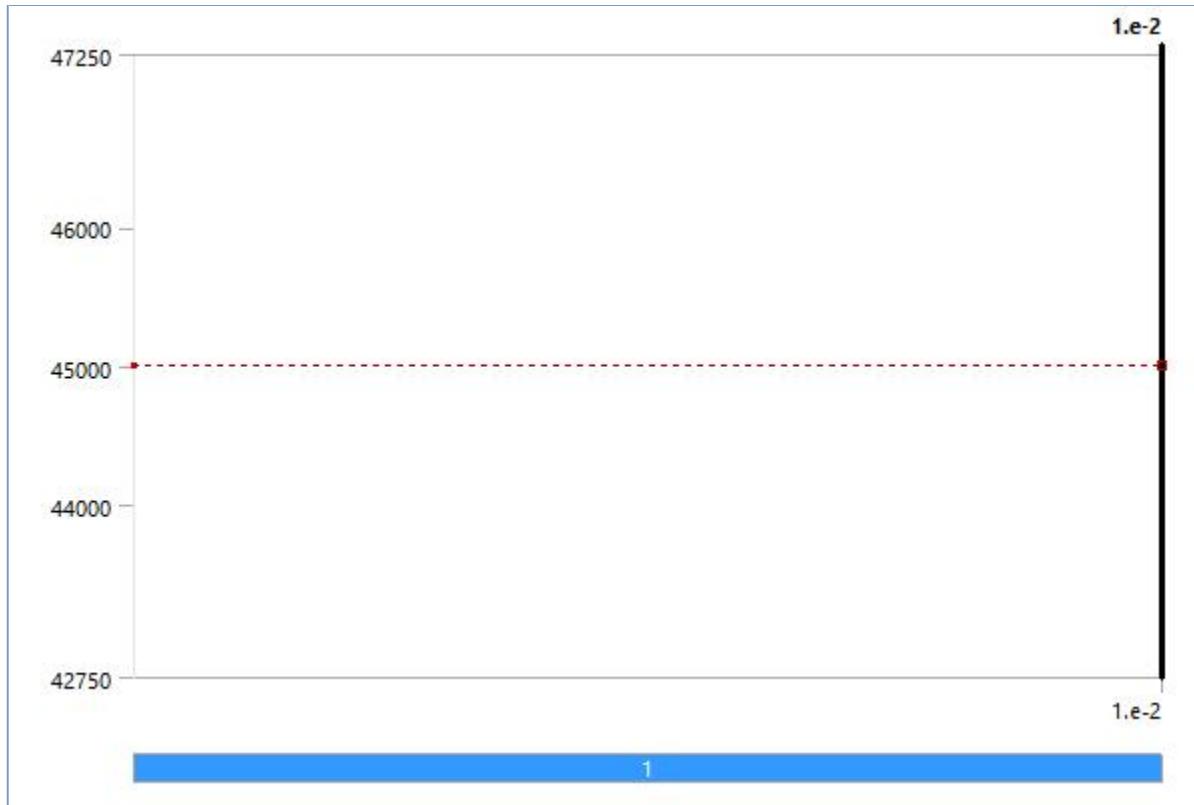


FIGURE 2
Model (B4) > Explicit Dynamics (B5) > Velocity 2



Solution (B6)

TABLE 14
Model (B4) > Explicit Dynamics (B5) > Solution

Object Name	<i>Solution (B6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	450.13 mm	4.2813e-004 mm/mm	0. MPa
Maximum	924.54 mm	0.12171 mm/mm	5348.9 MPa
Minimum Occurs On	PartBody		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	450.13 mm	4.2813e-004 mm/mm	8.7106 MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	924.54 mm	0.13626 mm/mm	5348.9 MPa
Information			
Time	1.0003e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 3
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Total Deformation

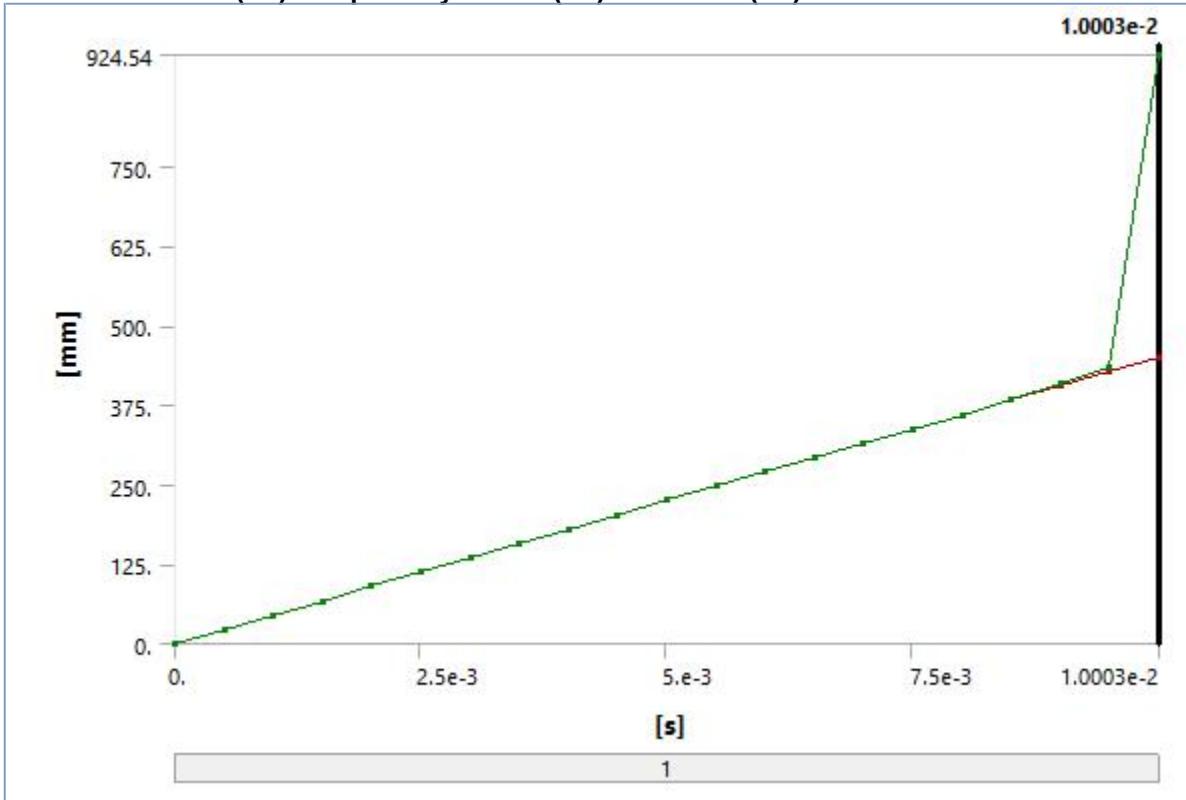


TABLE 17
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038	0.	0.

5.0369e-004	22.666	22.666
1.0008e-003	45.034	45.034
1.5015e-003	67.569	67.569
2.0023e-003	90.104	90.104
2.5031e-003	112.64	112.64
3.0002e-003	135.01	135.01
3.5009e-003	157.54	157.54
4.0017e-003	180.08	180.08
4.5025e-003	202.61	202.61
5.0033e-003	225.15	225.15
5.5003e-003	247.52	247.52
6.0011e-003	270.05	270.05
6.5019e-003	292.59	292.59
7.0027e-003	315.12	315.12
7.5034e-003	337.66	337.66
8.0005e-003	360.02	360.02
8.5011e-003	382.55	383.75
9.0009e-003	405.04	407.46
9.5014e-003	427.56	432.94
1.0003e-002	450.13	924.54

FIGURE 4
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Equivalent Elastic Strain

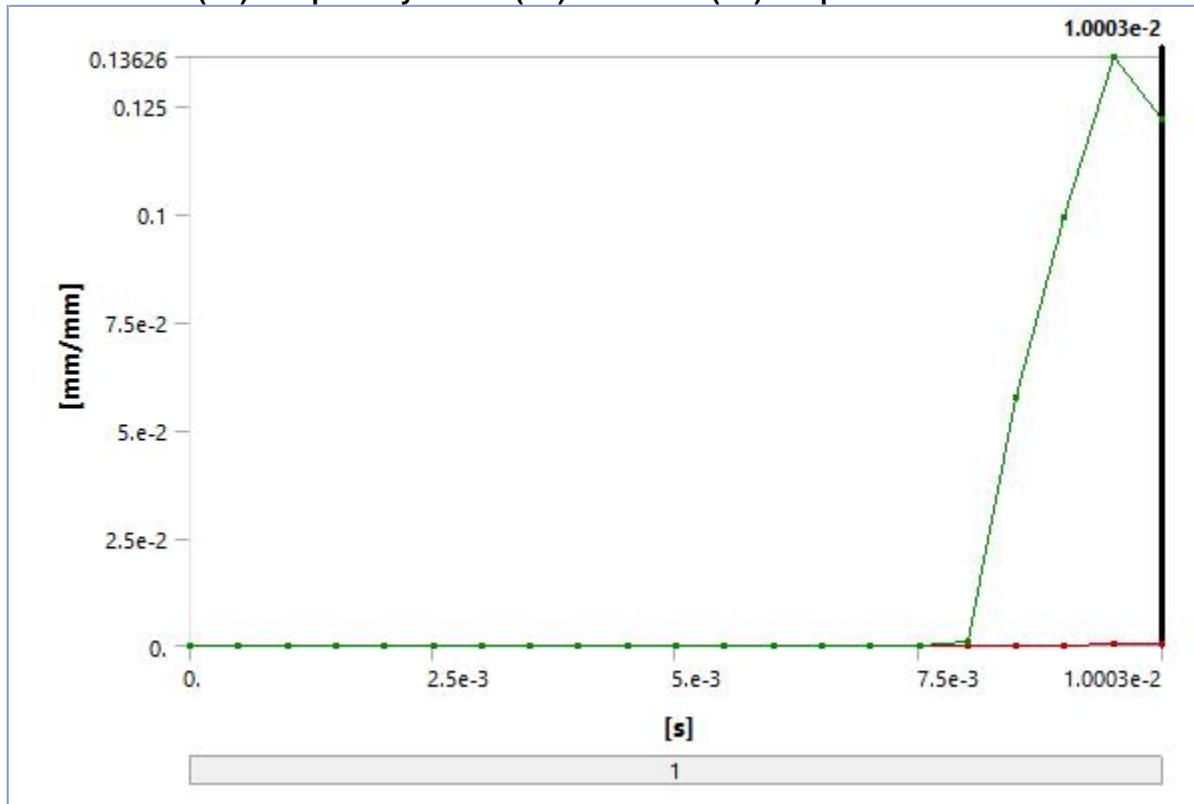


TABLE 18
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0369e-004		

1.0008e-003		
1.5015e-003		
2.0023e-003		
2.5031e-003		
3.0002e-003		
3.5009e-003		
4.0017e-003		
4.5025e-003		
5.0033e-003		
5.5003e-003		
6.0011e-003		
6.5019e-003		
7.0027e-003		
7.5034e-003		
8.0005e-003		1.1266e-003
8.5011e-003	1.6907e-008	5.7466e-002
9.0009e-003	1.0637e-004	9.9002e-002
9.5014e-003	2.4576e-004	0.13626
1.0003e-002	4.2813e-004	0.12171

FIGURE 5
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Equivalent Stress

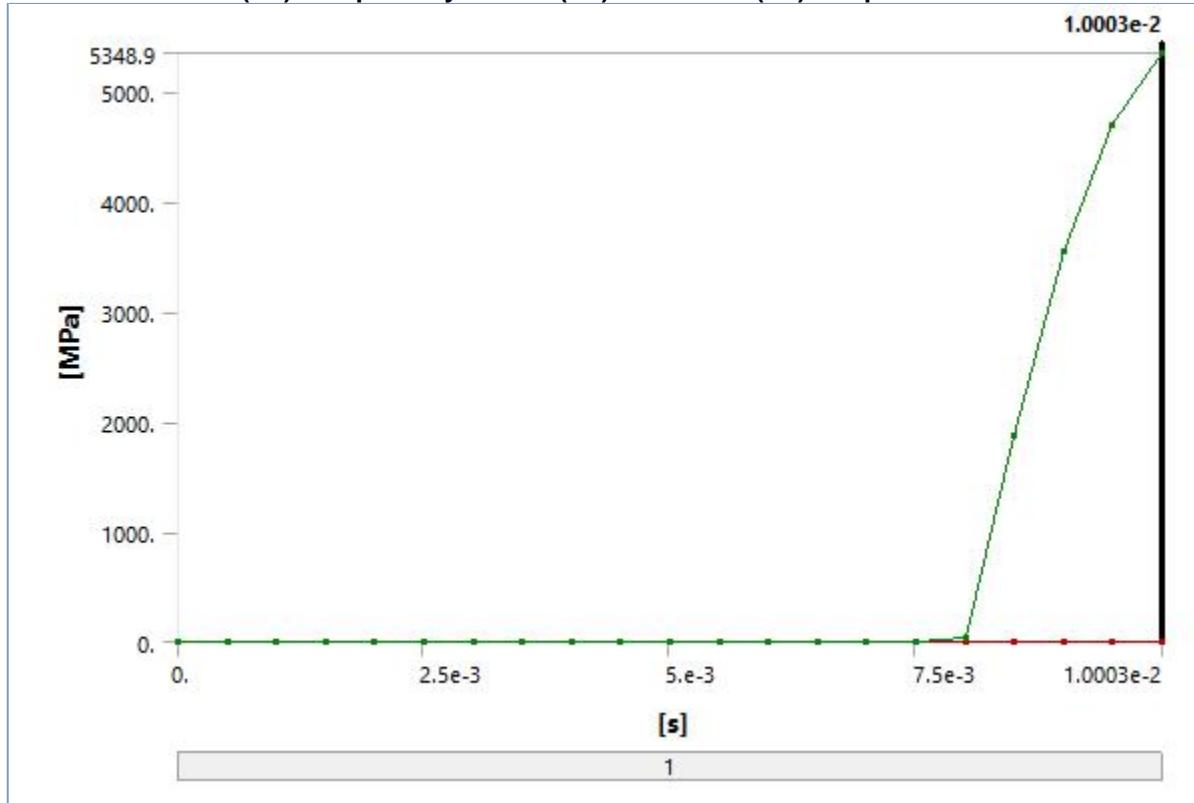


TABLE 19
Model (B4) > Explicit Dynamics (B5) > Solution (B6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0369e-004		
1.0008e-003		

1.5015e-003		
2.0023e-003		
2.5031e-003		
3.0002e-003		
3.5009e-003		
4.0017e-003		
4.5025e-003		
5.0033e-003		
5.5003e-003		
6.0011e-003		
6.5019e-003		
7.0027e-003		
7.5034e-003		
8.0005e-003		42.079
8.5011e-003	4.3156e-004	1868.
9.0009e-003	3.1244	3545.7
9.5014e-003	8.7106	4700.8
1.0003e-002	0.	5348.9

Material Data

Magnesium Alloy

TABLE 20
Magnesium Alloy > Constants

Density	1.8e-006 kg mm^-3
Coefficient of Thermal Expansion	2.6e-005 C^-1
Specific Heat	1.024e+006 mJ kg^-1 C^-1
Thermal Conductivity	0.156 W mm^-1 C^-1
Resistivity	7.7e-004 ohm mm

TABLE 21
Magnesium Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Magnesium Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
193

TABLE 23
Magnesium Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
193

TABLE 24
Magnesium Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
255

TABLE 25

Magnesium Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 26
Magnesium Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	45000	0.35	50000	16667

TABLE 27
Magnesium Alloy > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

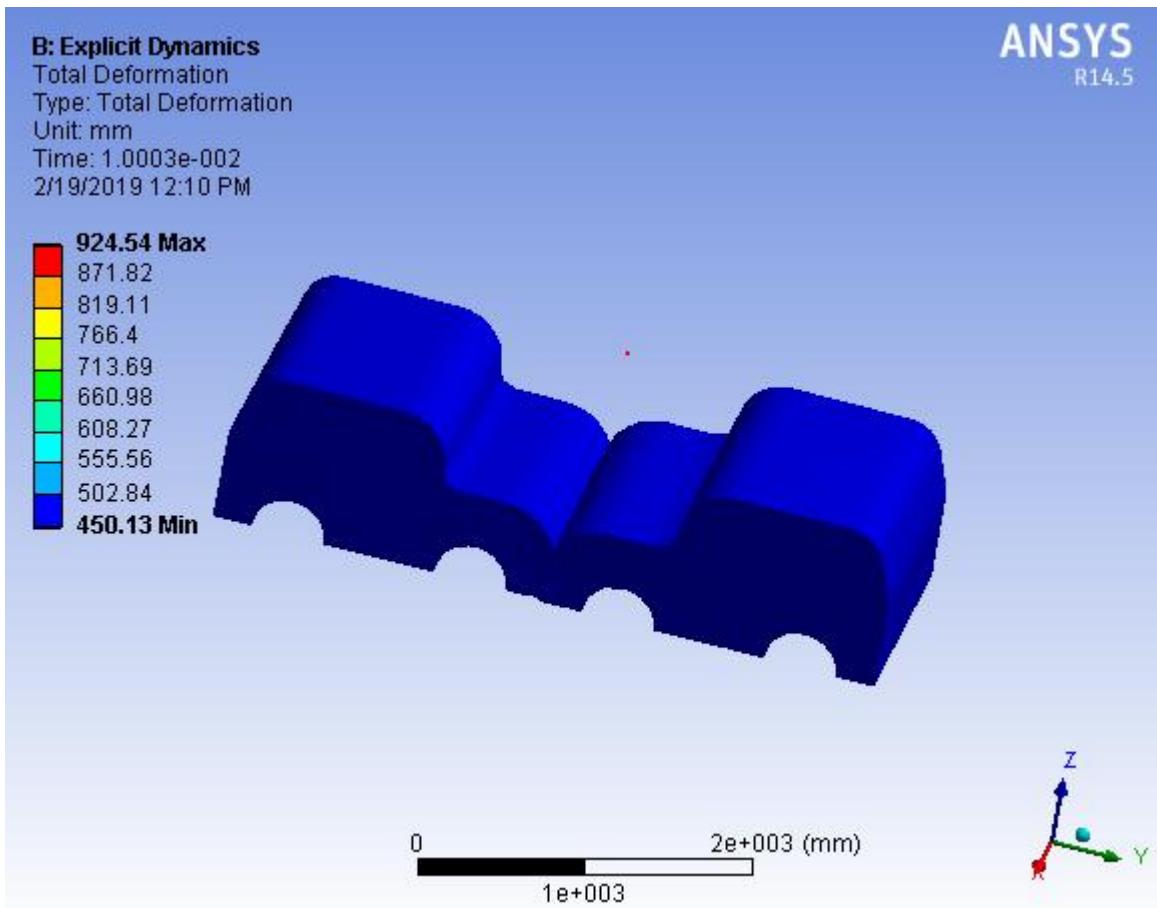
Subject: 45+MG+MG+F+DEFORMATION

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

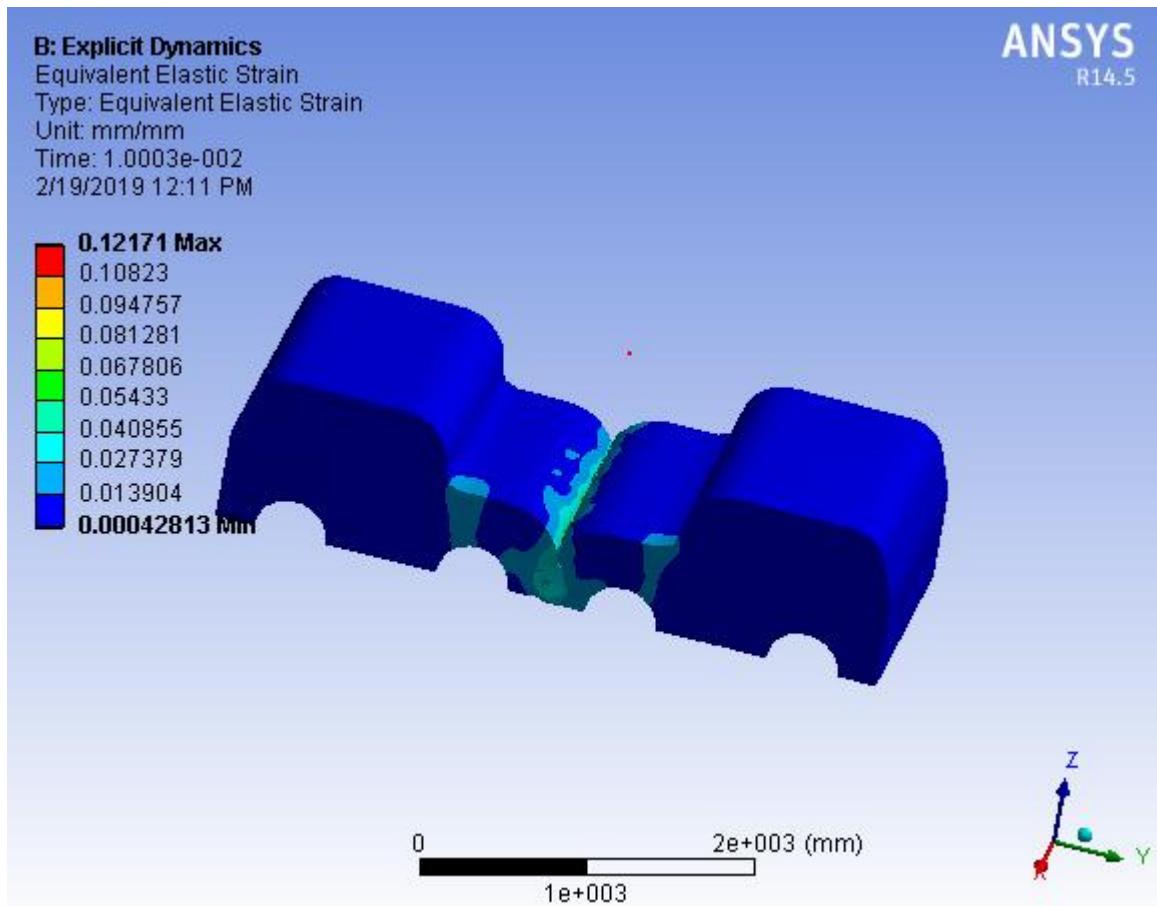
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Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

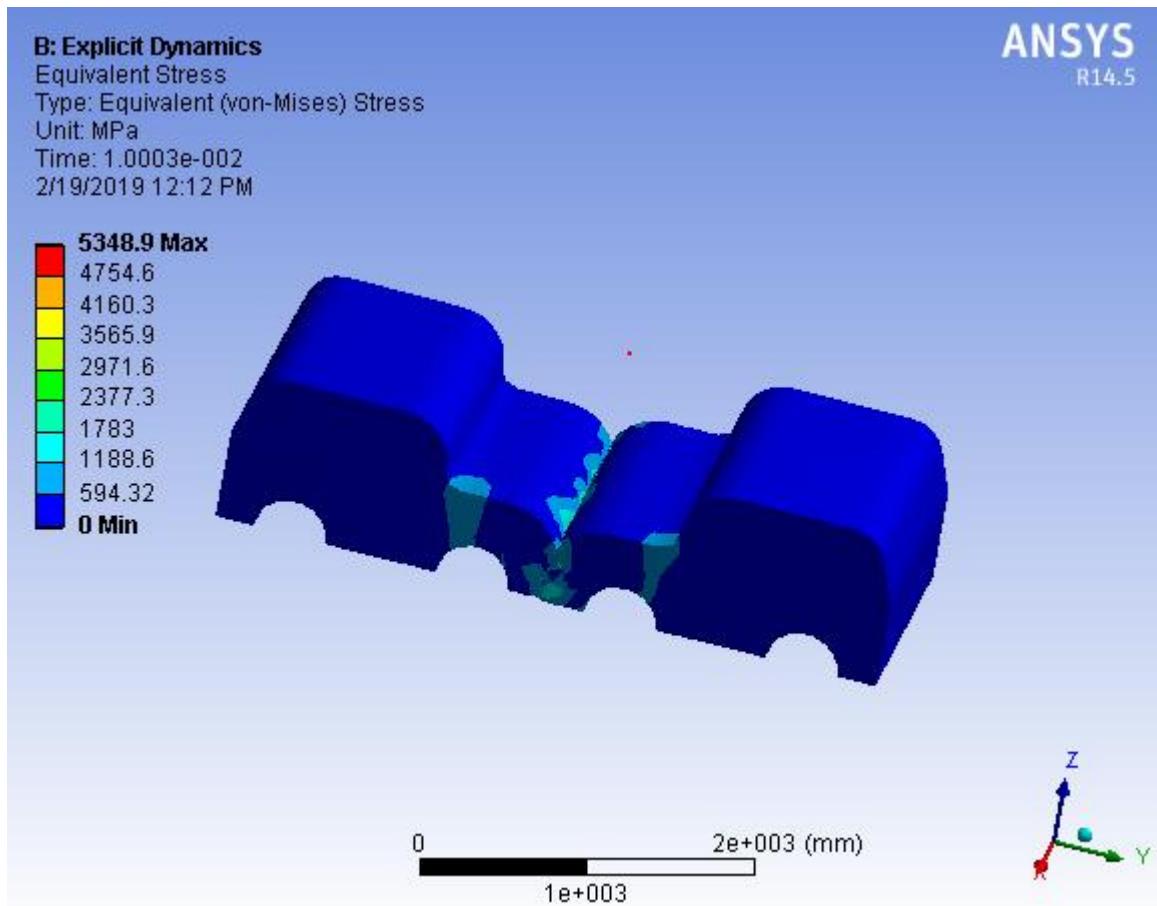
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Author:

Prepared For:

Date Tuesday, February 19, 2019

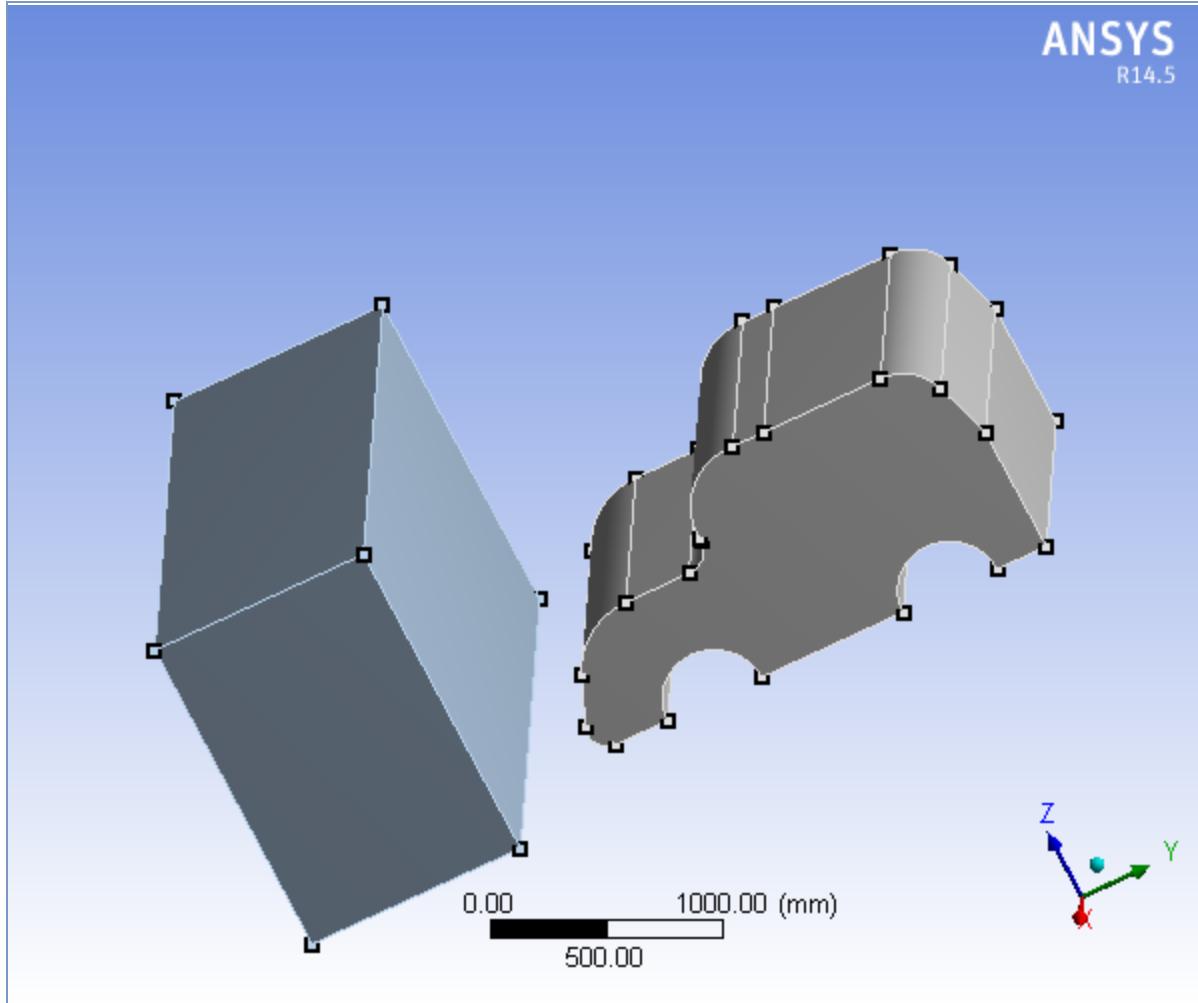
Comments:





Project

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Save Project Before Solution	No
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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\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	39446 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Magnesium Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	4121.3 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	1.5539e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.0302e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	2.0691e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Dynamics**(A5)**

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

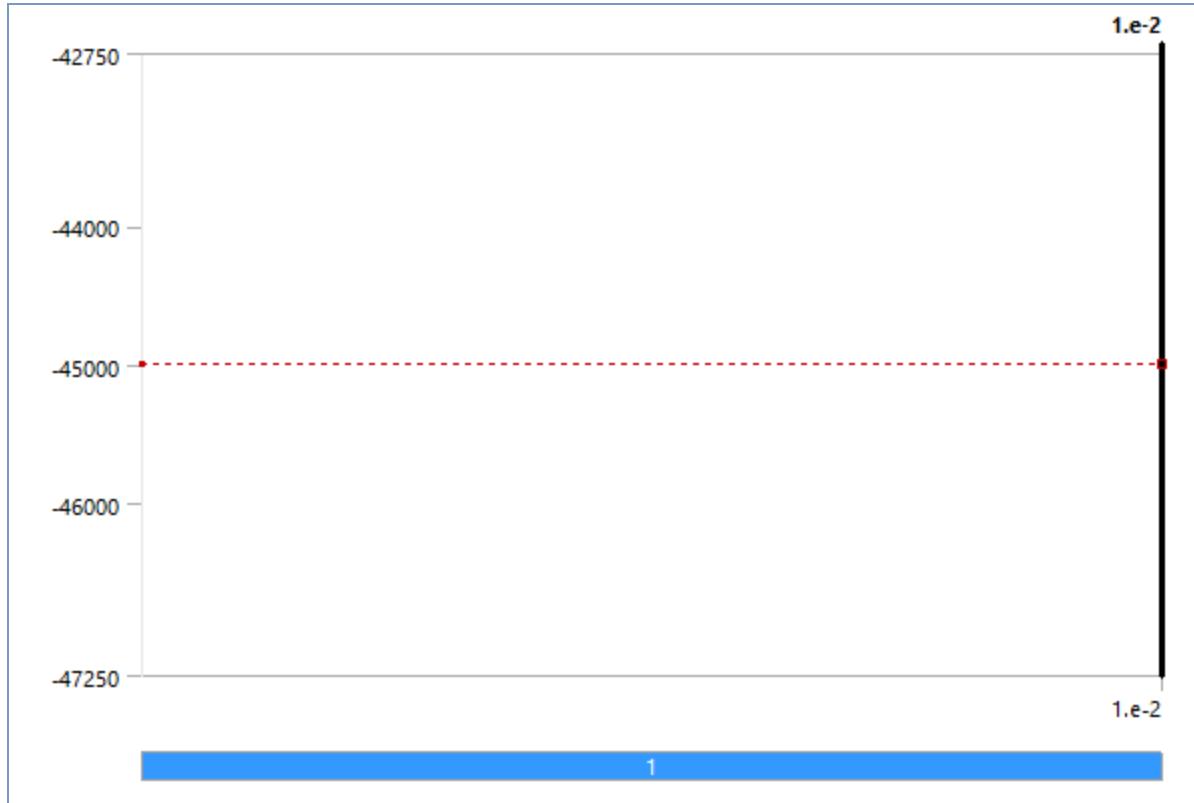
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-45000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	4.4444 mm	0. mm/mm	0. MPa
Maximum	451.13 mm	9.8514e-003 mm/mm	442.58 MPa
Minimum Occurs On	Solid		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	4.4444 mm	0. mm/mm	0. MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	451.13 mm	1.2972e-002 mm/mm	576.39 MPa
Information			
Time	1.0002e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

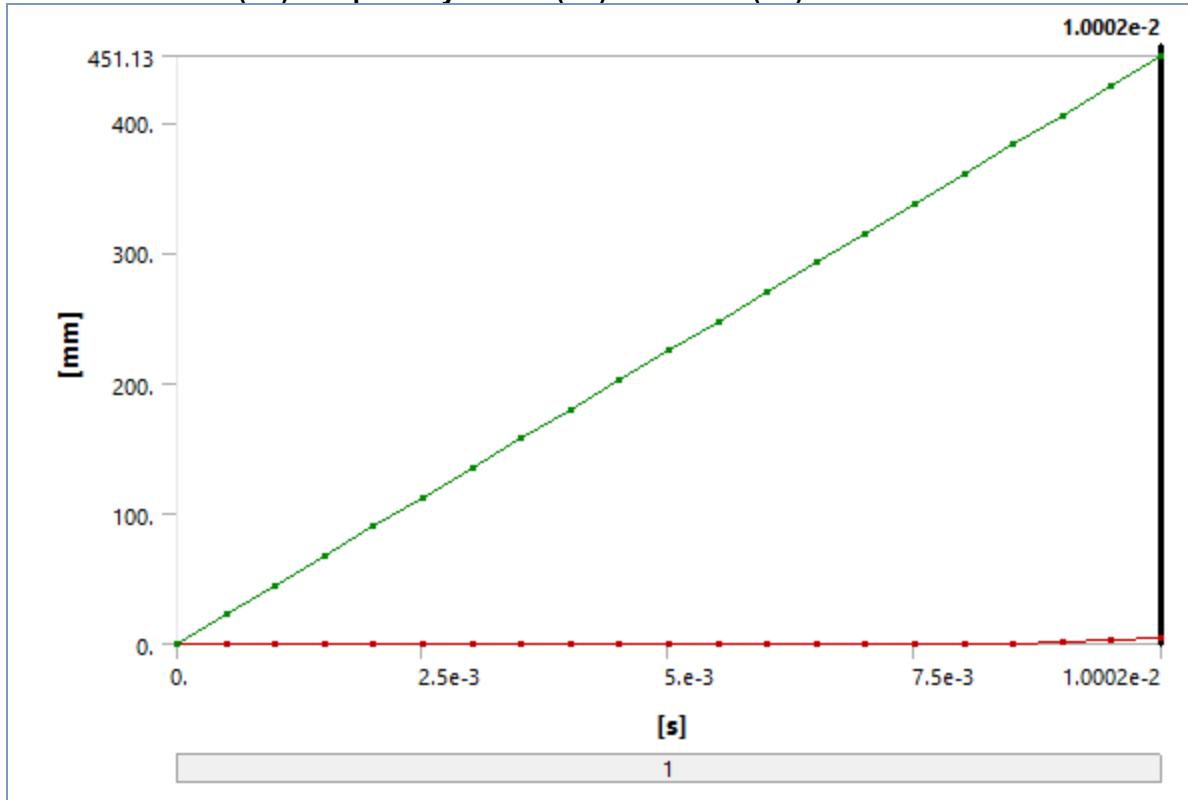


TABLE 17
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		0.

5.0217e-004		22.598
1.0009e-003		45.038
1.5025e-003		67.612
2.0012e-003		90.053
2.5028e-003		112.63
3.0015e-003		135.07
3.5002e-003		157.51
4.0018e-003		180.08
4.5005e-003		202.52
5.0021e-003		225.1
5.5008e-003		247.54
6.0024e-003		270.11
6.5011e-003		292.55
7.0027e-003		315.12
7.5014e-003		337.56
8.0002e-003	2.7937e-002	360.02
8.5008e-003	0.70022	382.86
9.0021e-003	1.8066	405.26
9.5002e-003	2.9561	427.84
1.0002e-002	4.4444	451.13

FIGURE
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

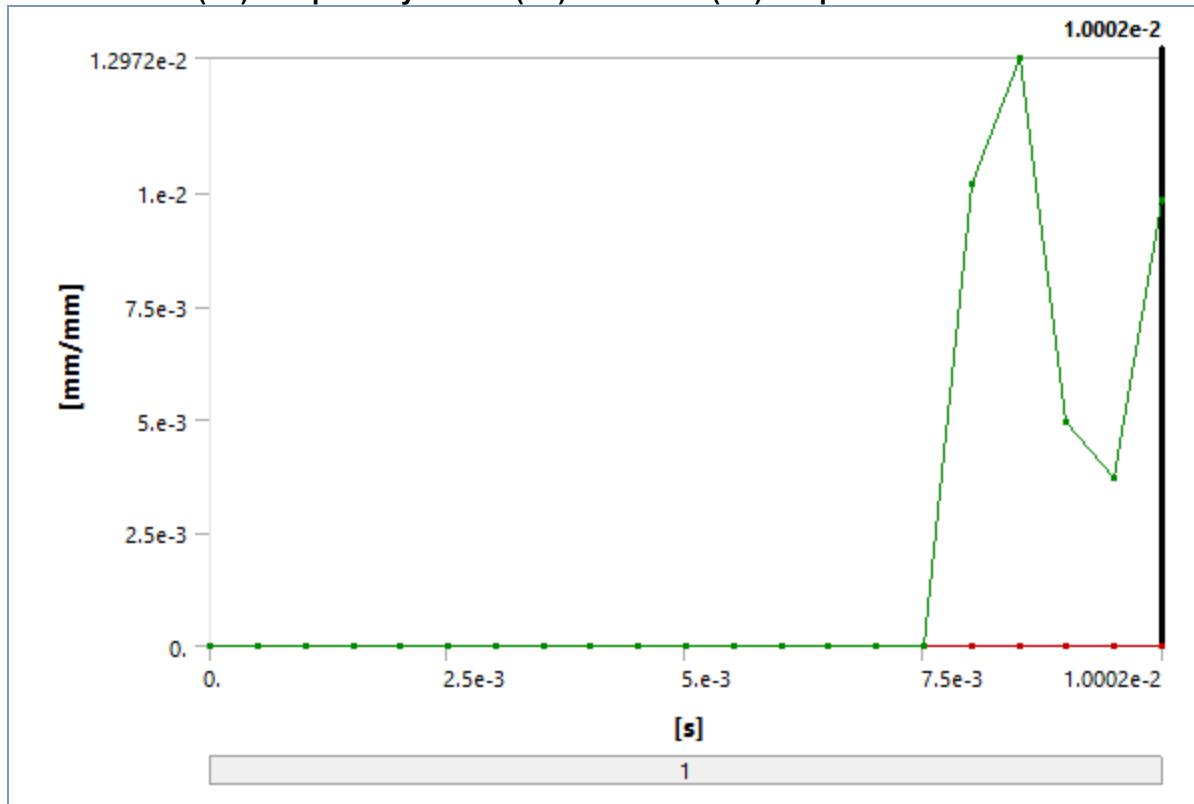


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0217e-004		

1.0009e-003	1.0002e-002
1.5025e-003	1.2972e-002
2.0012e-003	4.9596e-003
2.5028e-003	3.7152e-003
3.0015e-003	9.8514e-003
3.5002e-003	
4.0018e-003	
4.5005e-003	
5.0021e-003	
5.5008e-003	
6.0024e-003	
6.5011e-003	
7.0027e-003	
7.5014e-003	
8.0002e-003	
8.5008e-003	
9.0021e-003	
9.5002e-003	
1.0002e-002	

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

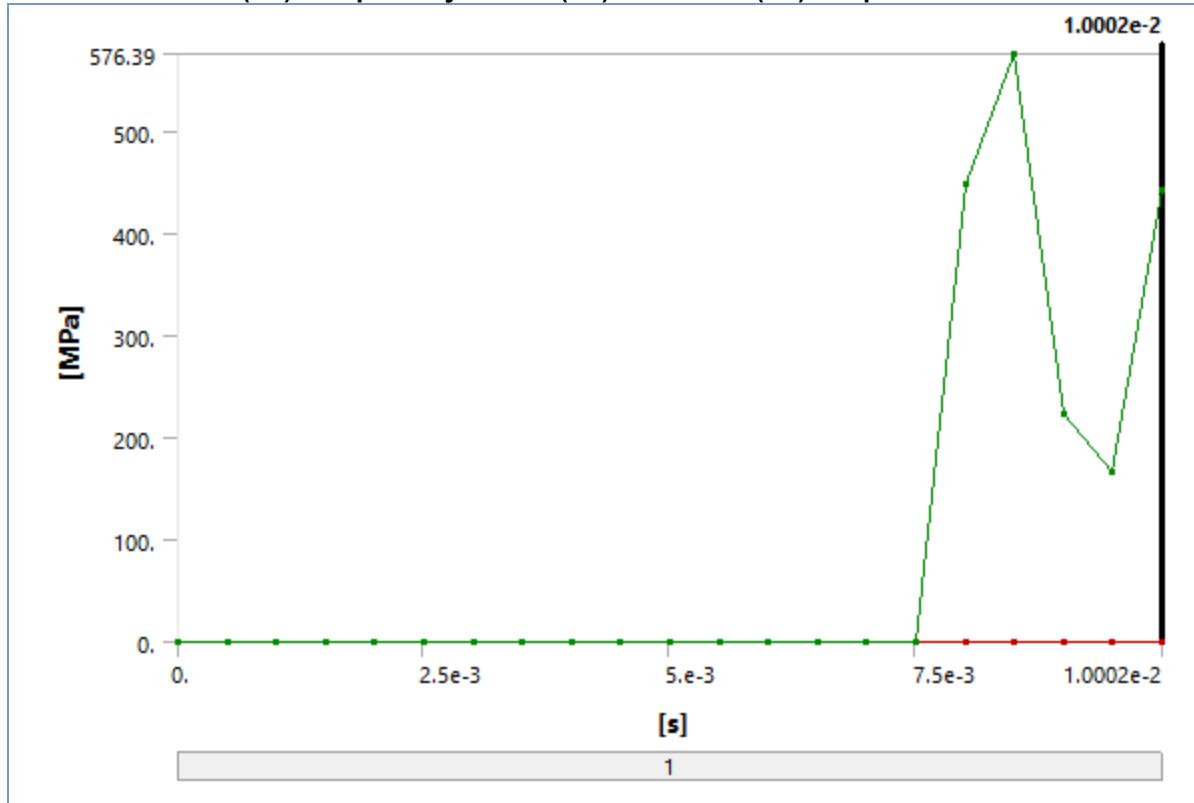


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0217e-004		
1.0009e-003		

1.5025e-003	
2.0012e-003	
2.5028e-003	
3.0015e-003	
3.5002e-003	
4.0018e-003	
4.5005e-003	
5.0021e-003	
5.5008e-003	
6.0024e-003	
6.5011e-003	
7.0027e-003	
7.5014e-003	
8.0002e-003	448.63
8.5008e-003	576.39
9.0021e-003	223.
9.5002e-003	167.18
1.0002e-002	442.58

Material Data

Magnesium Alloy

TABLE 20
Magnesium Alloy > Constants

Density	1.8e-006 kg mm^-3
Coefficient of Thermal Expansion	2.6e-005 C^-1
Specific Heat	1.024e+006 mJ kg^-1 C^-1
Thermal Conductivity	0.156 W mm^-1 C^-1
Resistivity	7.7e-004 ohm mm

TABLE 21
Magnesium Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Magnesium Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
193

TABLE 23
Magnesium Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
193

TABLE 24
Magnesium Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
255

TABLE 25

Magnesium Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 26
Magnesium Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	45000	0.35	50000	16667

TABLE 27
Magnesium Alloy > Isotropic Relative Permeability

Relative Permeability
10000

Structural Steel

TABLE 28
Structural Steel > Constants

Density	7.85e-006 kg mm ⁻³
Coefficient of Thermal Expansion	1.2e-005 C ⁻¹
Specific Heat	4.34e+005 mJ kg ⁻¹ C ⁻¹
Thermal Conductivity	6.05e-002 W mm ⁻¹ C ⁻¹
Resistivity	1.7e-004 ohm mm

TABLE 29
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 30
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 31
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 32
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 33
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 34
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0

2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 35
Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 36
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 37
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

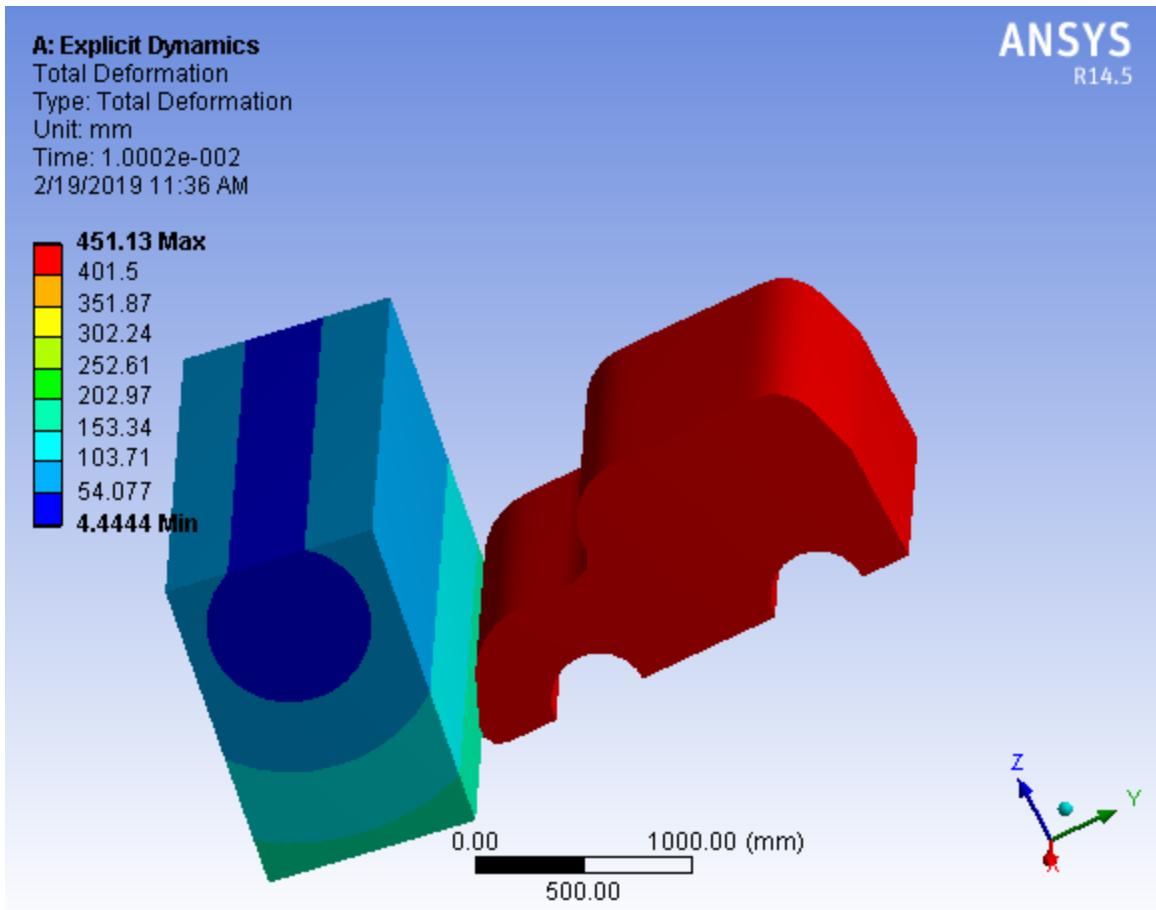
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Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

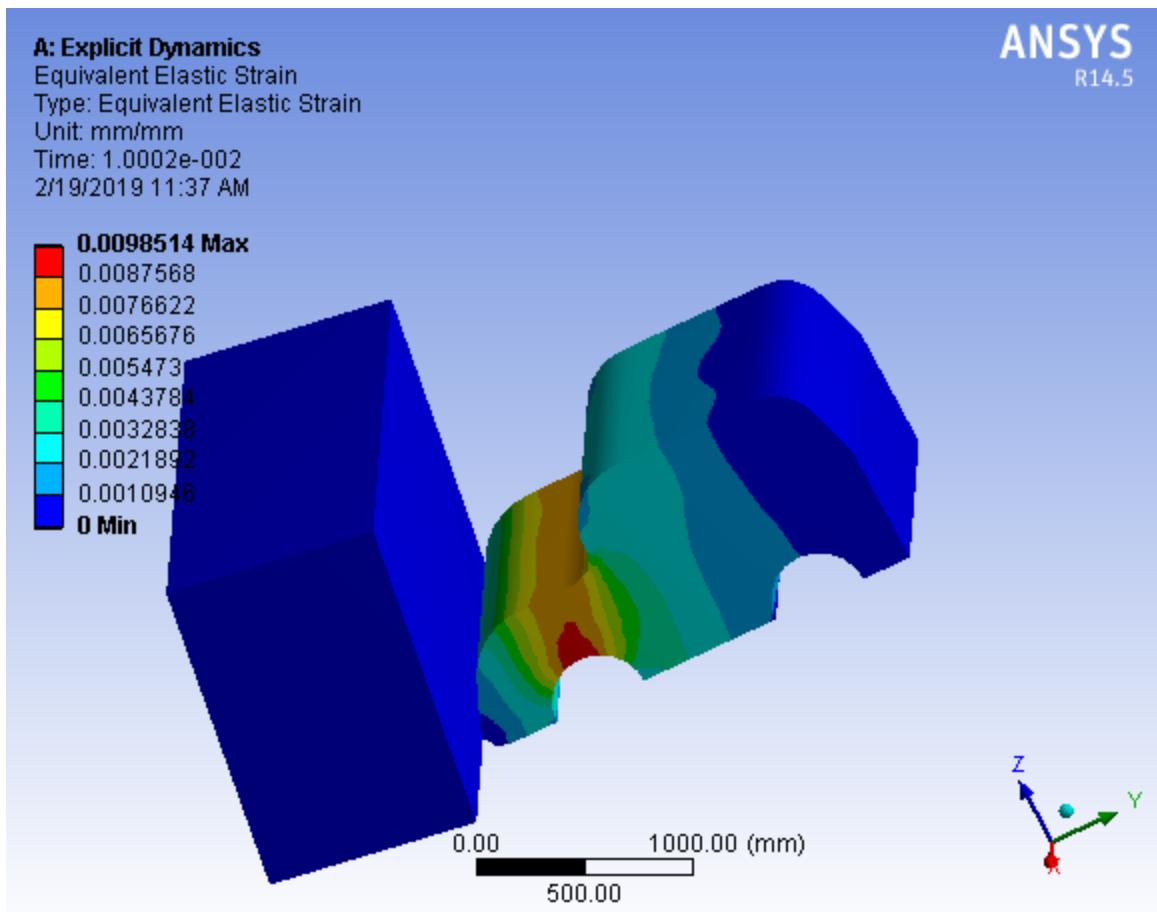
Subject: 45+MG+SS+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

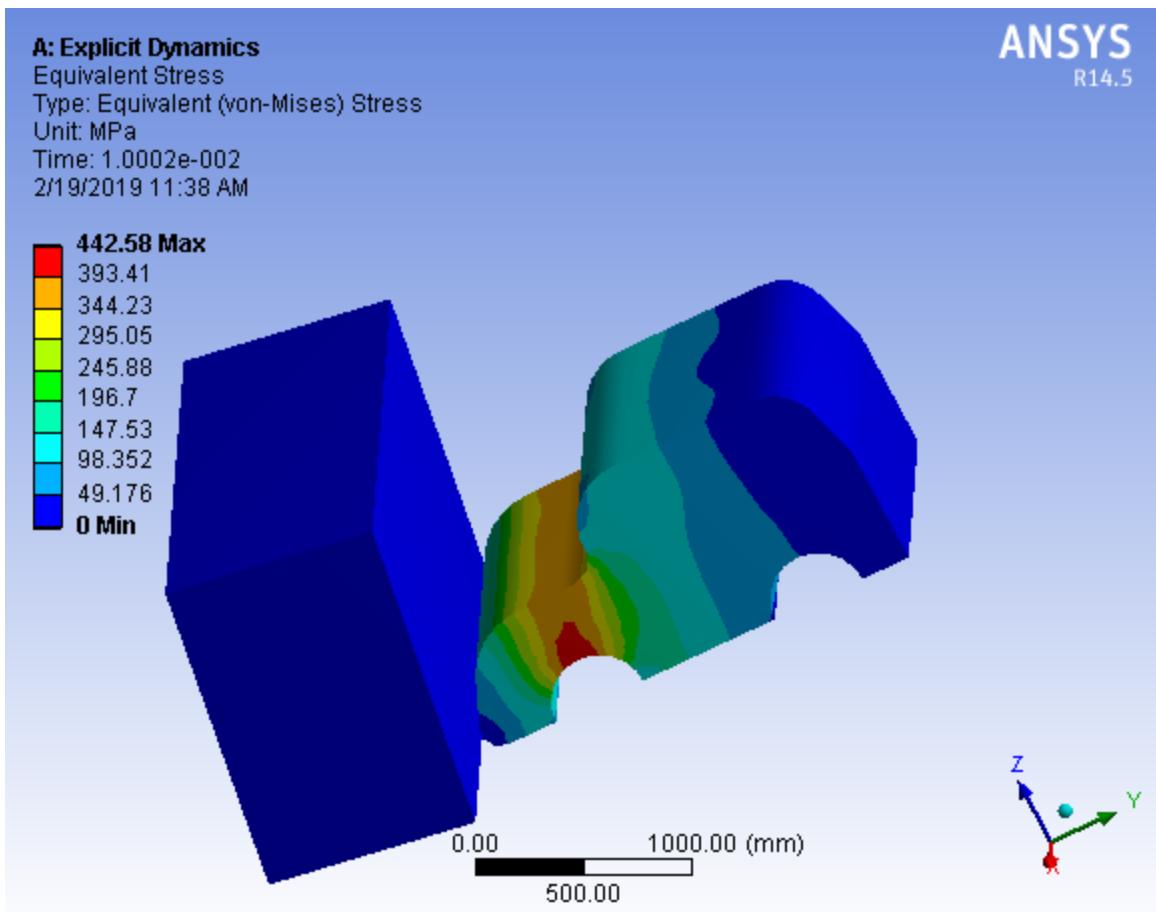
Subject: 45+MG+SS+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

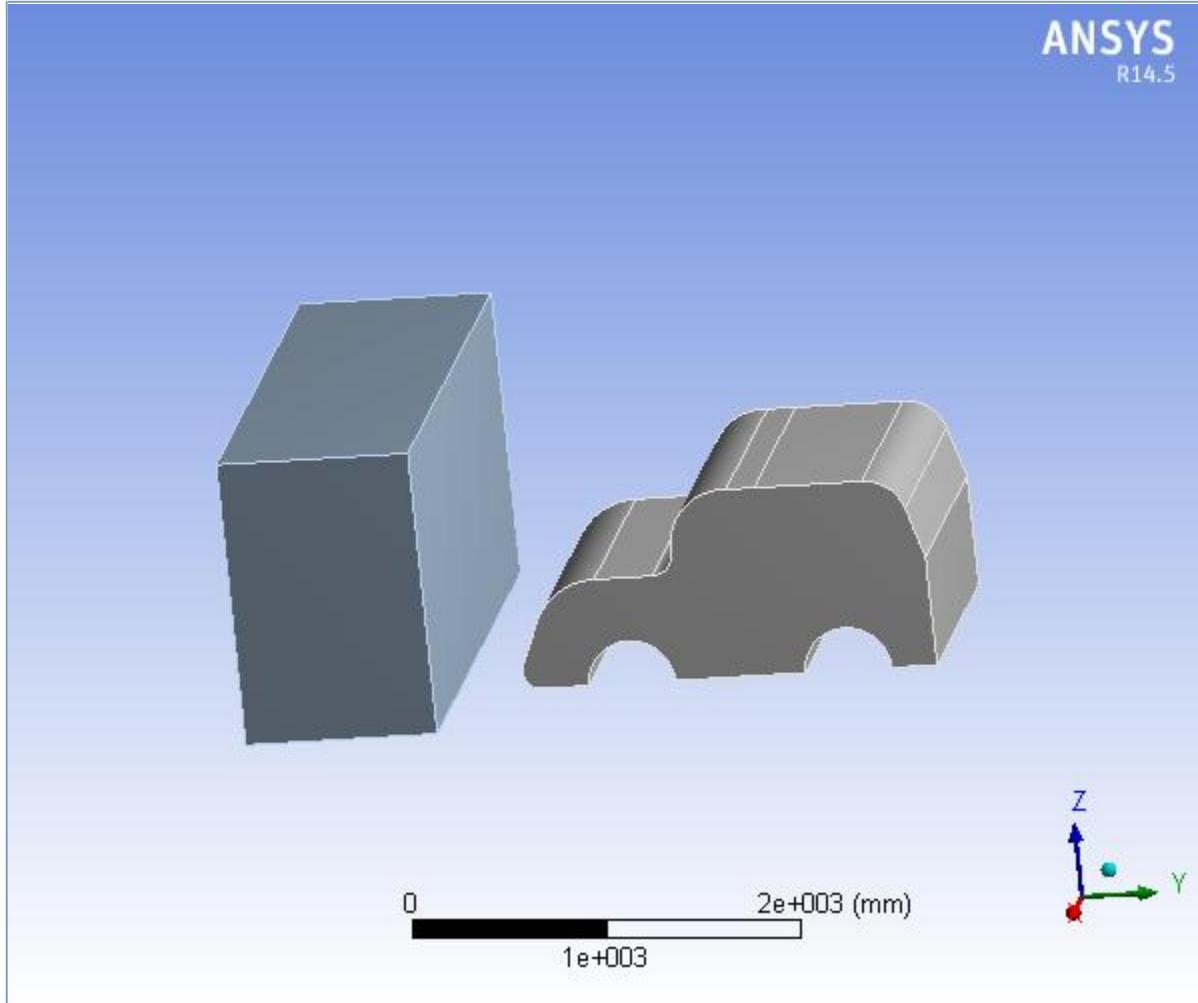
Comments:





Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
Product Version	14.5 Release
Save Project Before Solution	No
Save Project After Solution	No



Contents

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 - [Results](#)
- } [Material Data](#)
- » [Aluminum Alloy](#)
 - » [Structural Steel](#)

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\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	41667 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Aluminum Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	6342.2 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	2.3912e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.5854e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	3.1842e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Explicit Dynamics (A5)

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

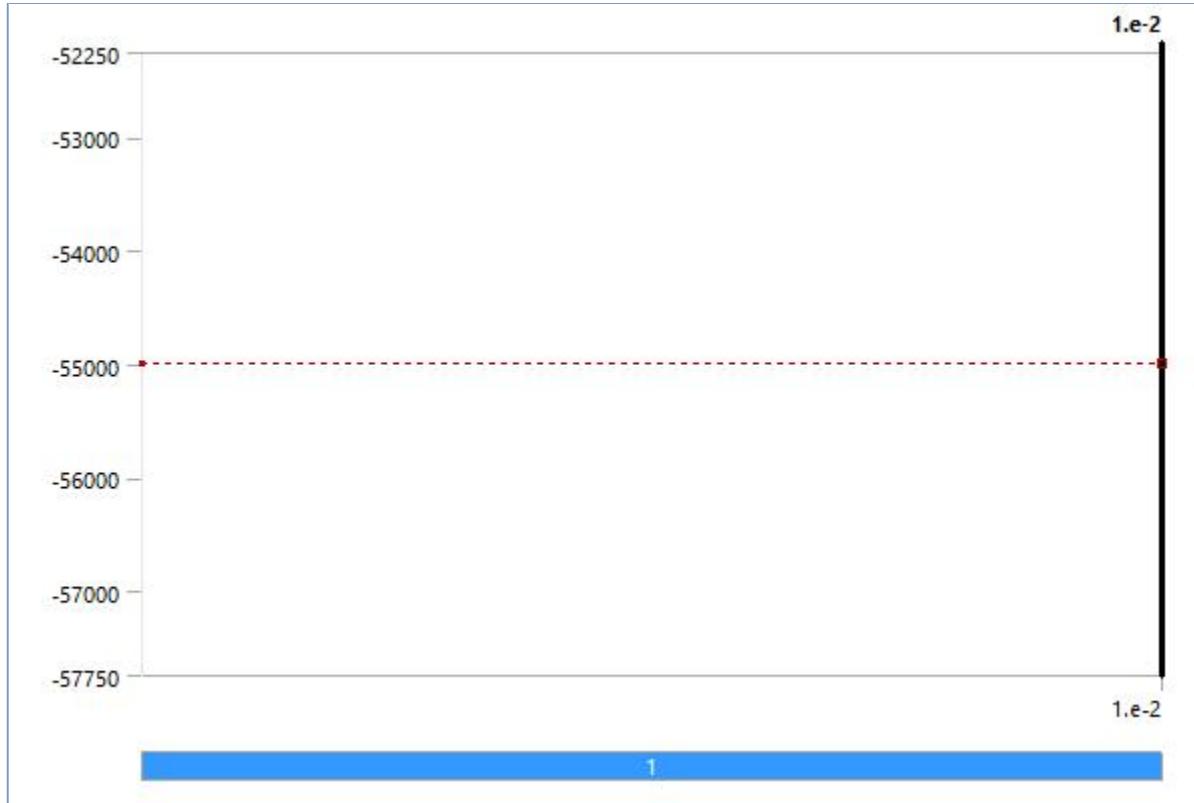
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_5400_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-55000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	11.875 mm	0. mm/mm	0. MPa
Maximum	551.35 mm	3.6422e-003 mm/mm	257.63 MPa
Minimum Occurs On	Solid		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	12.15 mm	0. mm/mm	0. MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	551.35 mm	1.1699e-002 mm/mm	829.03 MPa
Information			
Time	1.0001e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

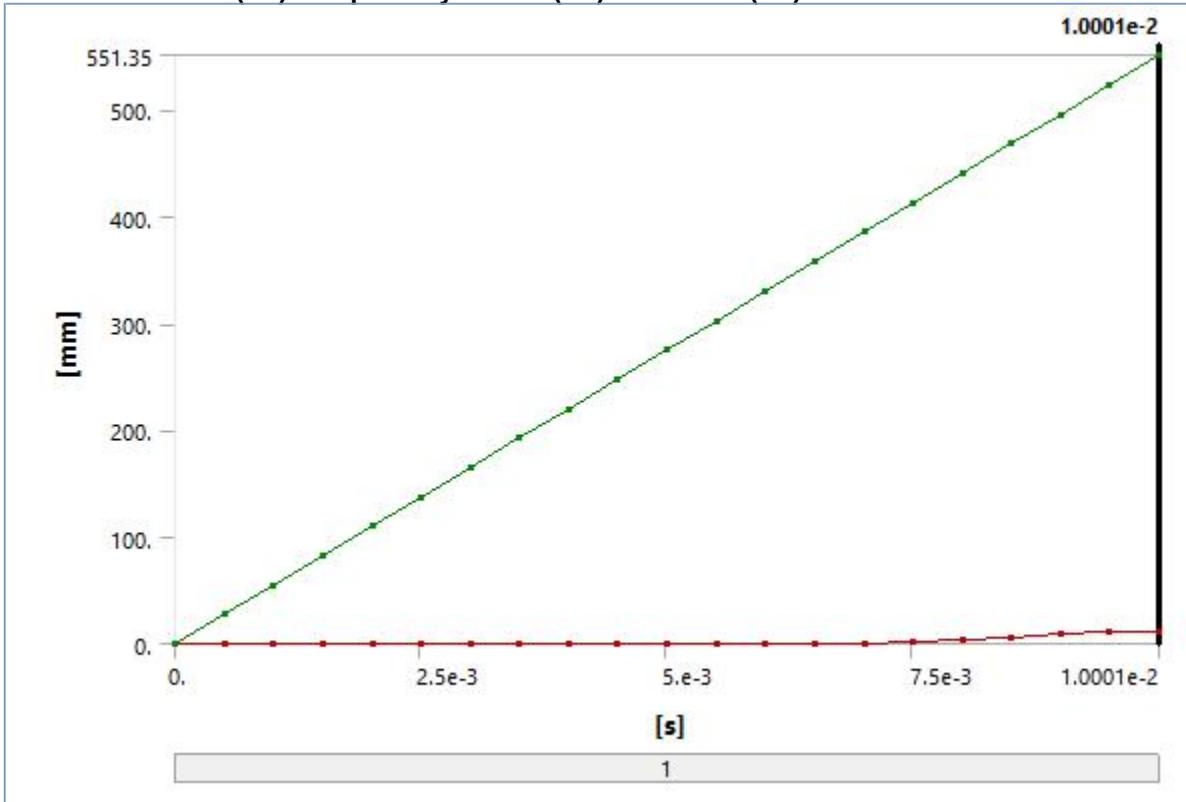


TABLE 17
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		0.

5.0097e-004		27.553
1.0014e-003		55.078
1.5019e-003		82.603
2.0023e-003		110.13
2.5028e-003		137.65
3.0002e-003		165.01
3.5006e-003		192.53
4.0011e-003		220.06
4.5015e-003		247.58
5.002e-003		275.11
5.5024e-003		302.63
6.0029e-003		330.16
6.5003e-003	1.3251e-002	357.52
7.0028e-003	0.87671	385.42
7.5029e-003	2.317	412.79
8.0028e-003	3.9071	440.39
8.5001e-003	6.0949	468.29
9.0002e-003	9.1774	495.82
9.5004e-003	12.15	523.79
1.0001e-002	11.875	551.35

FIGURE 3
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

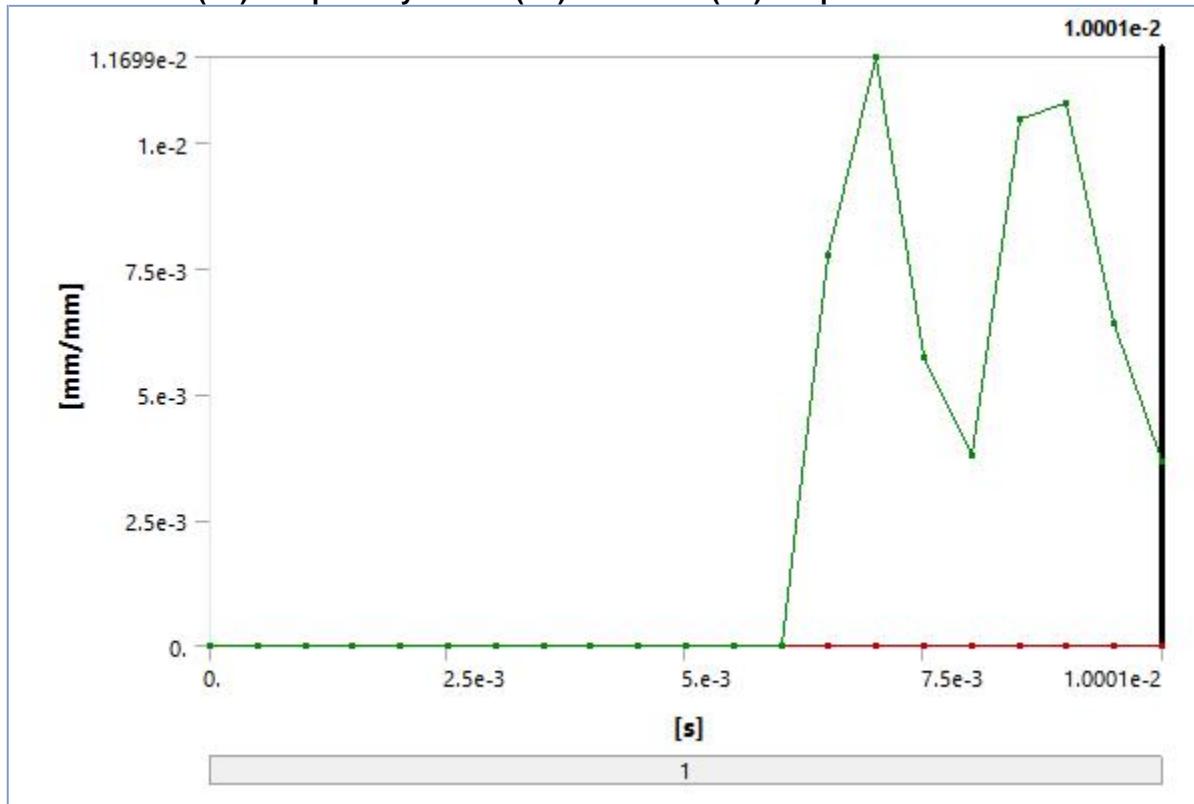


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0097e-004		

1.0014e-003	
1.5019e-003	
2.0023e-003	
2.5028e-003	
3.0002e-003	
3.5006e-003	
4.0011e-003	
4.5015e-003	
5.002e-003	
5.5024e-003	0.
6.0029e-003	0.
6.5003e-003	
7.0028e-003	
7.5029e-003	
8.0028e-003	
8.5001e-003	
9.0002e-003	
9.5004e-003	
1.0001e-002	

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

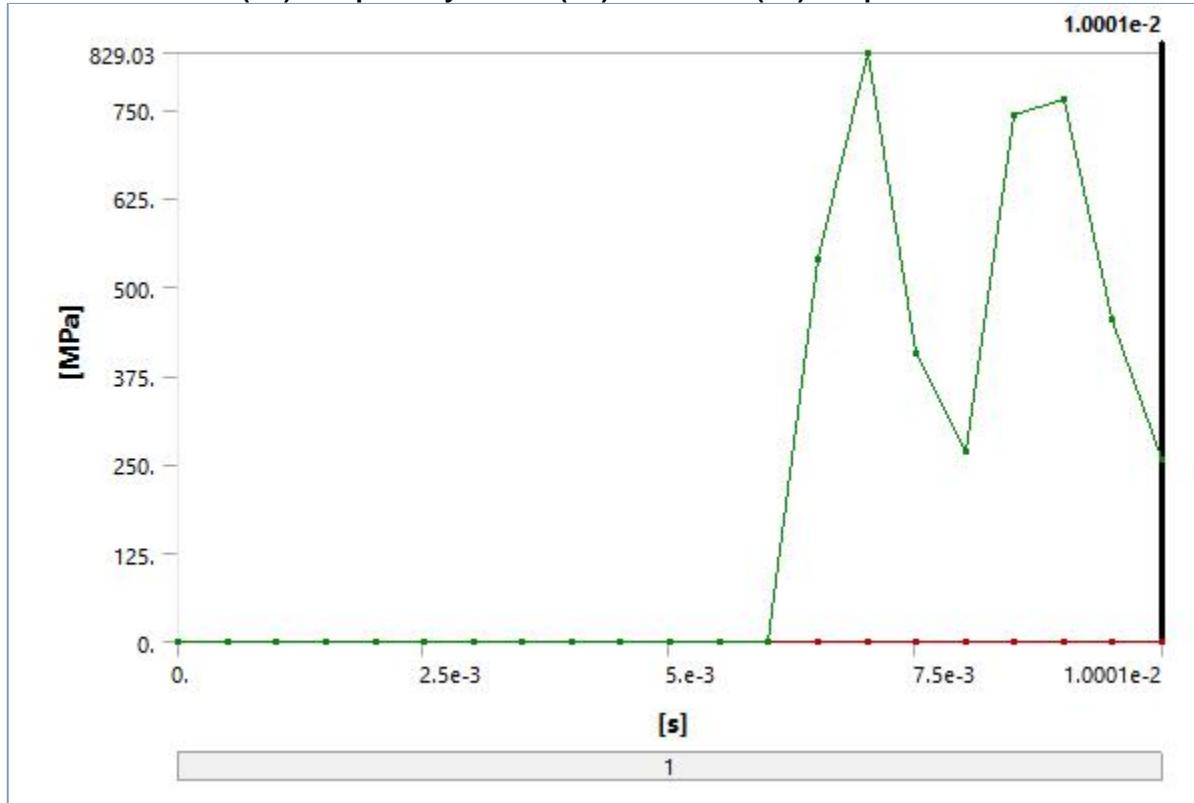


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0097e-004		
1.0014e-003		

1.5019e-003	
2.0023e-003	
2.5028e-003	
3.0002e-003	
3.5006e-003	
4.0011e-003	
4.5015e-003	
5.002e-003	
5.5024e-003	
6.0029e-003	
6.5003e-003	538.6
7.0028e-003	829.03
7.5029e-003	405.73
8.0028e-003	267.57
8.5001e-003	741.37
9.0002e-003	764.67
9.5004e-003	454.59
1.0001e-002	257.63

Material Data

Aluminum Alloy

TABLE 20
Aluminum Alloy > Constants

Density	2.77e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.3e-005 C ⁻¹
Specific Heat	8.75e+005 mJ kg ⁻¹ C ⁻¹

TABLE 21
Aluminum Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Aluminum Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 23
Aluminum Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 24
Aluminum Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
310

TABLE 25
Aluminum Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C

TABLE 26
Aluminum Alloy > Isotropic Thermal Conductivity

Thermal Conductivity W mm^-1 C^-1	Temperature C
0.114	-100
0.144	0
0.165	100
0.175	200

TABLE 27
Aluminum Alloy > Alternating Stress R-Ratio

Alternating Stress MPa	Cycles	R-Ratio
275.8	1700	-1
241.3	5000	-1
206.8	34000	-1
172.4	1.4e+005	-1
137.9	8.e+005	-1
117.2	2.4e+006	-1
89.63	5.5e+007	-1
82.74	1.e+008	-1
170.6	50000	-0.5
139.6	3.5e+005	-0.5
108.6	3.7e+006	-0.5
87.91	1.4e+007	-0.5
77.57	5.e+007	-0.5
72.39	1.e+008	-0.5
144.8	50000	0
120.7	1.9e+005	0
103.4	1.3e+006	0
93.08	4.4e+006	0
86.18	1.2e+007	0
72.39	1.e+008	0
74.12	3.e+005	0.5
70.67	1.5e+006	0.5
66.36	1.2e+007	0.5
62.05	1.e+008	0.5

TABLE 28
Aluminum Alloy > Isotropic Resistivity

Resistivity ohm mm	Temperature C
2.43e-005	0
2.67e-005	20
3.63e-005	100

TABLE 29
Aluminum Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

TABLE 30
Aluminum Alloy > Isotropic Relative Permeability

Relative Permeability

Structural Steel

TABLE 31
Structural Steel > Constants

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

TABLE 32
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 33
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 34
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 35
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 36
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 37
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 38

Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 39
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 40
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

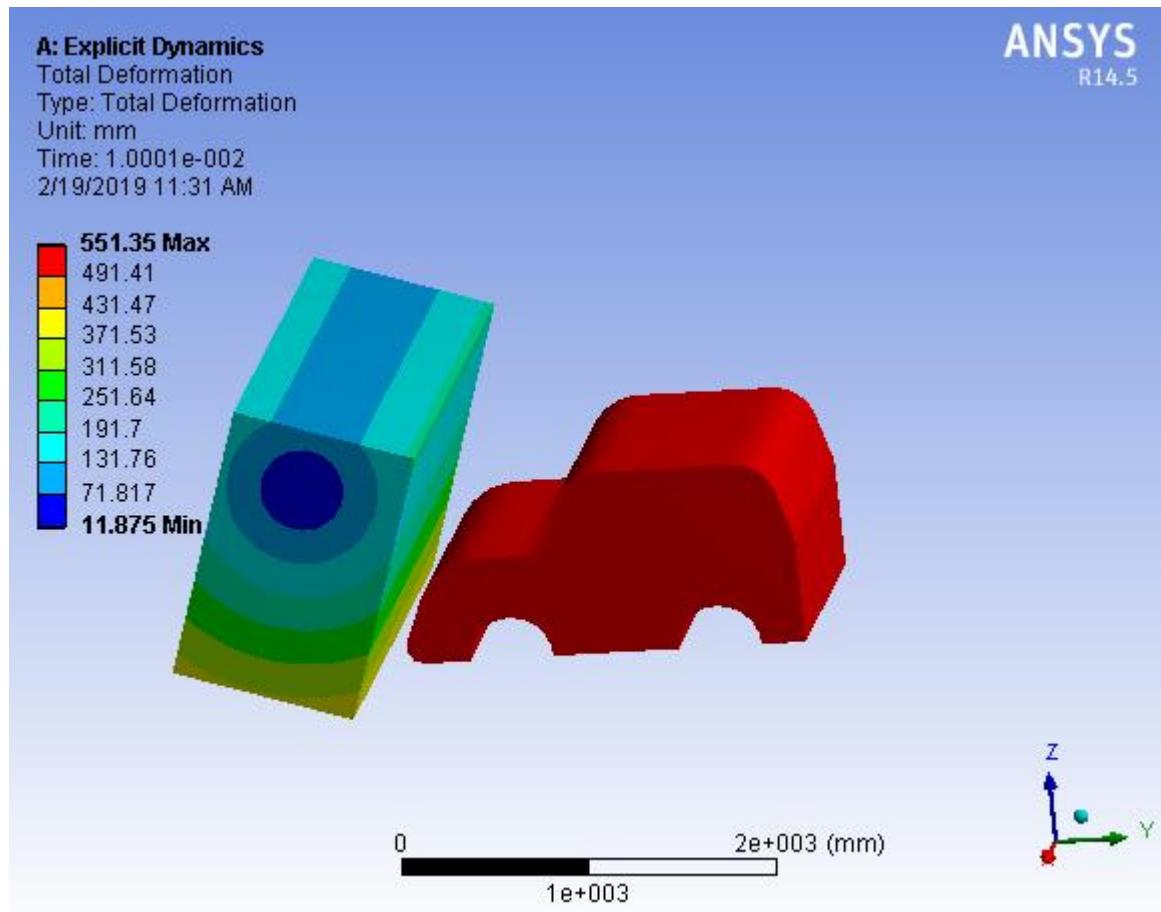
Subject: 55+AL+SS+F+DEFORMATION

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

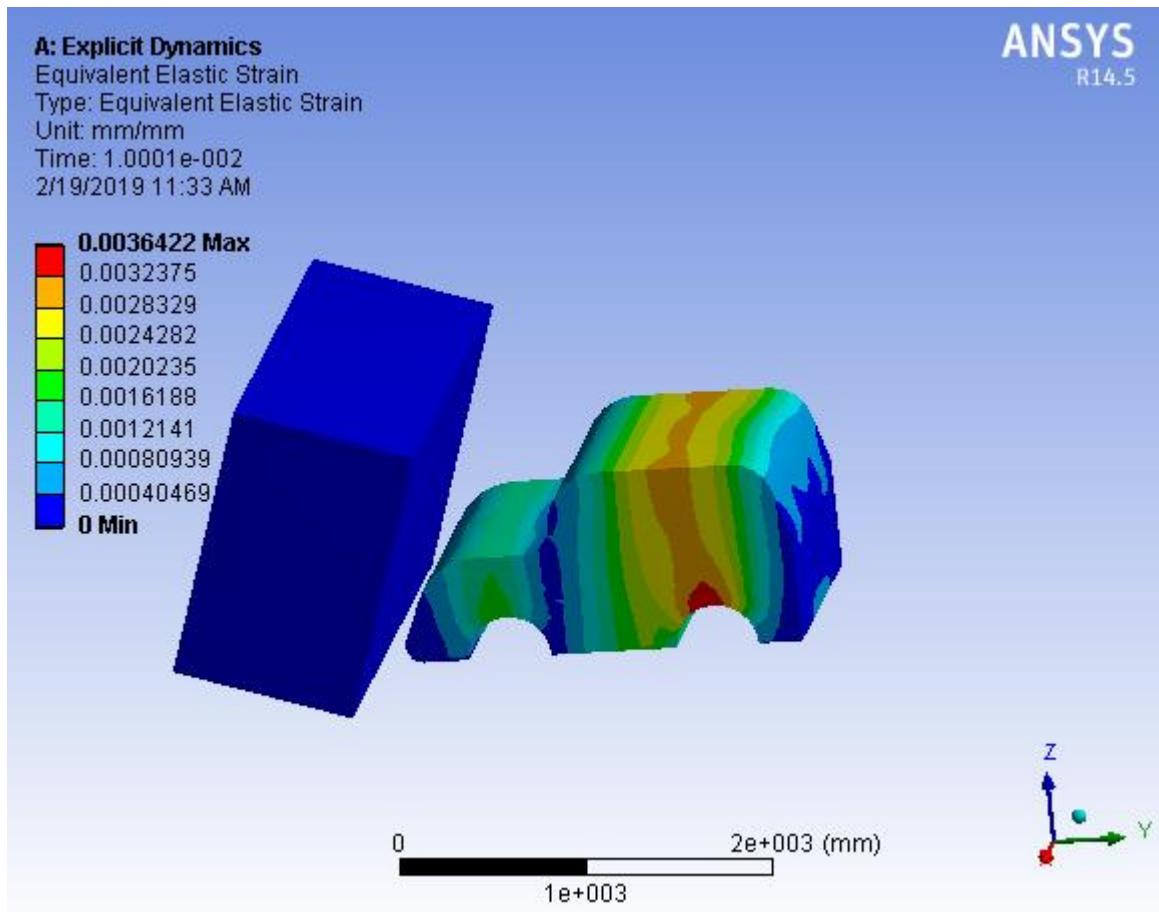
Subject: 55+AL+SS+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

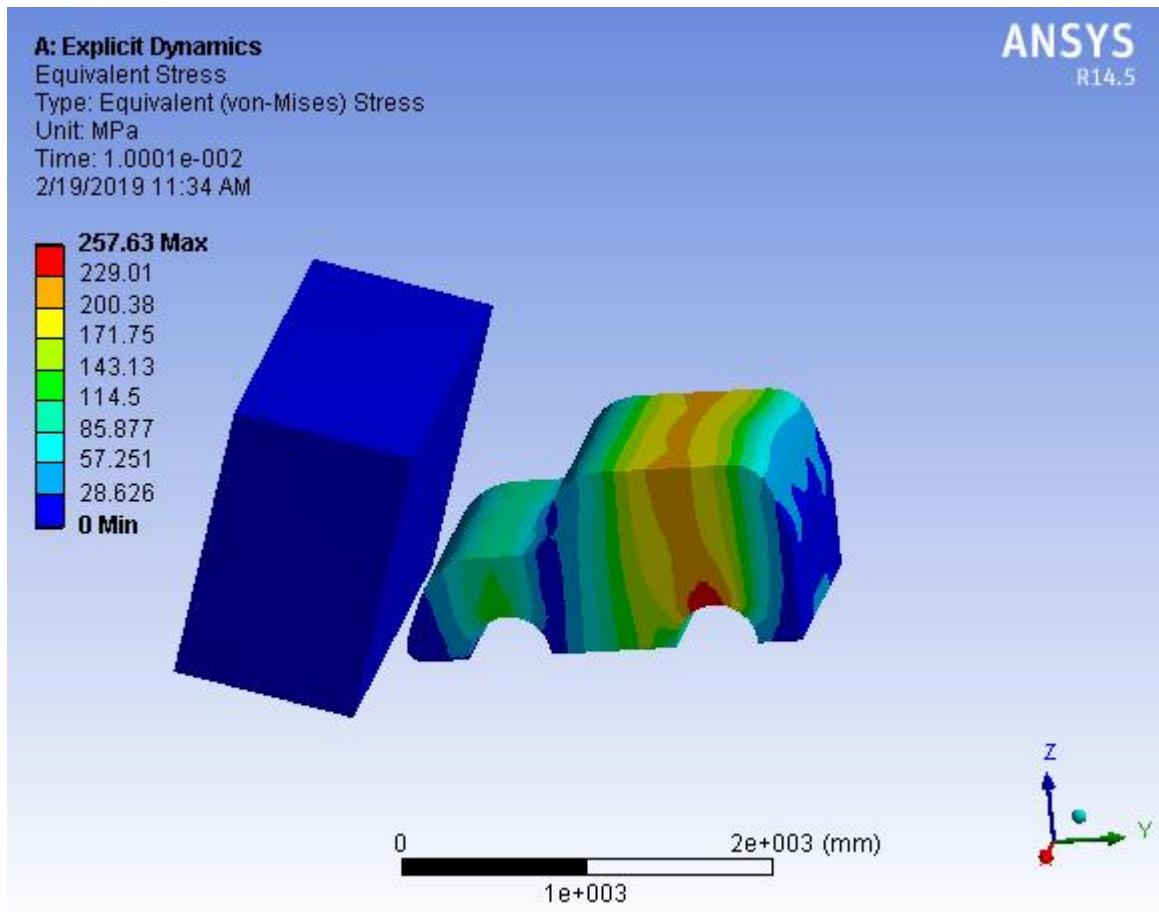
Subject: 55+AL+SS+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

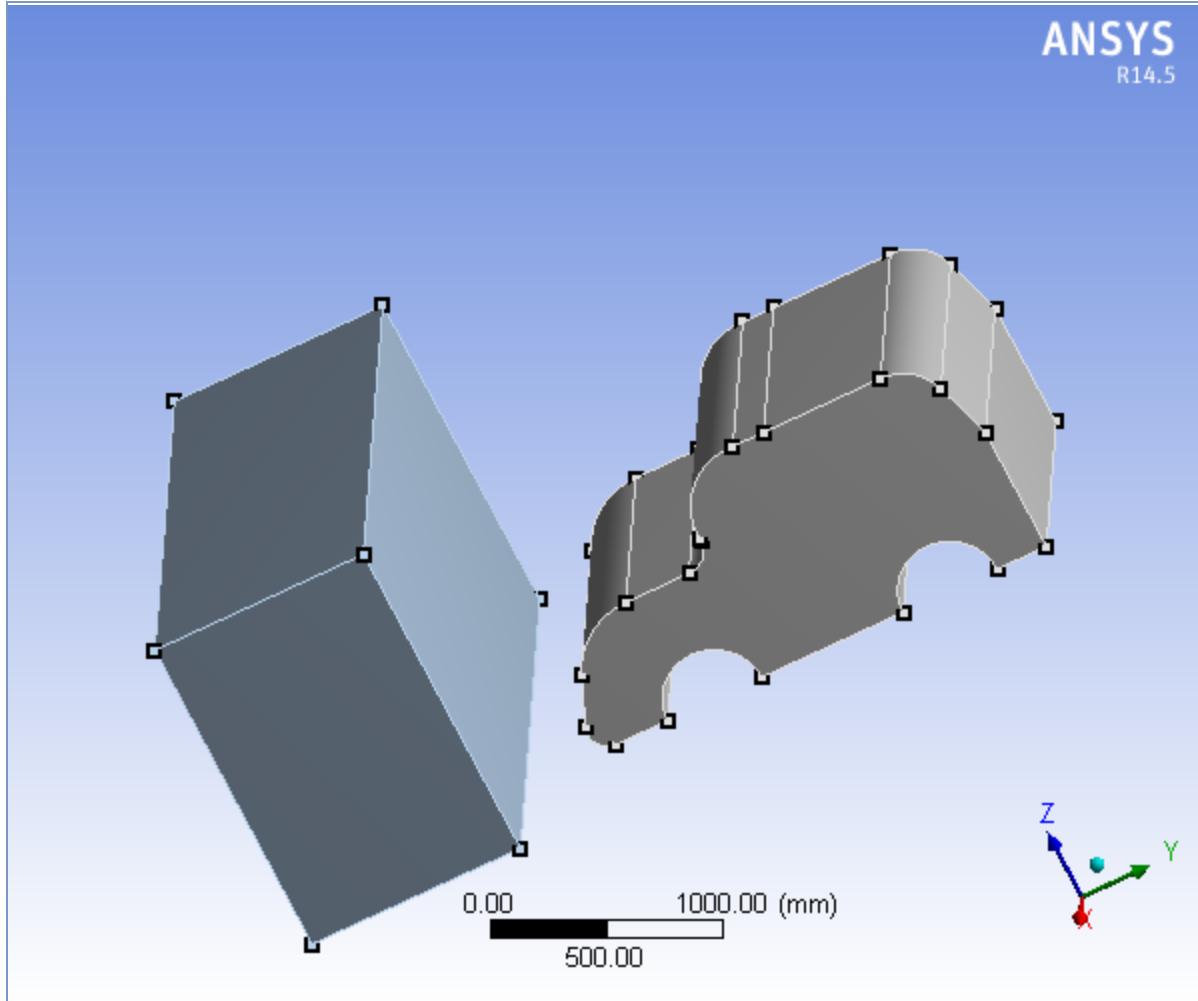
Comments:





Project

First Saved	Tuesday, February 19, 2019
Last Saved	Tuesday, February 19, 2019
Product Version	14.5 Release
Save Project Before Solution	No
Save Project After Solution	No



Contents

- [Units](#)
- [Model \(A4\)](#)
 - [Geometry](#)
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 - [Body Interaction](#)
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 - [Solution \(A6\)](#)
 - [Solution Information](#)
 - [Results](#)
- [Material Data](#)
 - [Magnesium Alloy](#)
 - [Structural Steel](#)

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\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Length Unit	Millimeters
Display Style	Body Color
Bounding Box	
Length X	3000. mm
Length Y	3499.9 mm

Length Z	1500. mm	
Properties		
Volume	6.7896e+009 mm ³	
Mass	39446 kg	
Scale Factor Value	1.	
Statistics		
Bodies	2	
Active Bodies	2	
Nodes	22792	
Elements	19614	
Mesh Metric	None	
Basic Geometry Options		
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	
Attach File Via Temp File	Yes	
Temporary Directory	C:\Users\mech\AppData\Local\Temp	
Analysis Type	3-D	
Decompose Disjoint Geometry	Yes	
Enclosure and Symmetry Processing	Yes	

TABLE 3
Model (A4) > Geometry > Parts

Object Name	PartBody	Solid
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	Rigid
Coordinate System	Default Coordinate System	
Reference Temperature	By Environment	
Reference Frame	Lagrangian	
Material		
Assignment	Magnesium Alloy	Structural Steel
Bounding Box		
Length X	1500. mm	3000. mm
Length Y	2154.4 mm	1000. mm
Length Z	1000.6 mm	1500. mm
Properties		
Volume	2.2896e+009 mm ³	4.5e+009 mm ³

Mass	4121.3 kg	35325 kg
Centroid X	-1.1612e-002 mm	-1.8084e-014 mm
Centroid Y	1591. mm	-499. mm
Centroid Z	464.24 mm	750. mm
Moment of Inertia Ip1	1.5539e+009 kg·mm ²	9.5672e+009 kg·mm ²
Moment of Inertia Ip2	1.0302e+009 kg·mm ²	3.3117e+010 kg·mm ²
Moment of Inertia Ip3	2.0691e+009 kg·mm ²	2.9437e+010 kg·mm ²
Statistics		
Nodes	8602	14190
Elements	7266	12348
Mesh Metric	None	

Coordinate Systems

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

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
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.]

Connections

TABLE 5
Model (A4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A4) > Connections > Body Interactions

Object Name	<i>Body Interactions</i>
State	Fully Defined
Advanced	
Contact Detection	Trajectory
Formulation	Penalty
Body Self Contact	Program Controlled
Element Self Contact	Program Controlled
Tolerance	0.2

TABLE 7

Model (A4) > Connections > Body Interactions > Body Interaction

Object Name	<i>Body Interaction</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Frictionless
Suppressed	No

Mesh

TABLE 8
Model (A4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Defaults	
Physics Preference	Explicit
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Coarse
Curvature Normal Angle	Default (70.3950 °)
Min Size	Default (0.707680 mm)
Max Face Size	Default (70.7680 mm)
Max Size	Default (141.540 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	14.9120 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
Advanced	
Shape Checking	Explicit
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Full Mesh
Rigid Face Mesh Type	Quad/Tri
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (0.636910 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.353840 mm)
Statistics	
Nodes	22792
Elements	19614
Mesh Metric	None

Dynamics**(A5)**

TABLE 9
Model (A4) > Analysis

Object Name	<i>Explicit Dynamics (A5)</i>
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Explicit Dynamics
Solver Target	AUTODYN
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 10
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	<i>Initial Conditions</i>
State	Fully Defined

TABLE 11
Model (A4) > Explicit Dynamics (A5) > Initial Conditions > Initial Condition

Object Name	<i>Pre-Stress (None)</i>
State	Fully Defined
Definition	
Pre-Stress Environment	None

TABLE 12
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Analysis Settings Preference	
Type	Program Controlled
Step Controls	
Resume From Cycle	0
Maximum Number of Cycles	1e+07
End Time	1.e-002 s
Maximum Energy Error	0.1
Reference Energy Cycle	0
Initial Time Step	Program Controlled
Minimum Time Step	Program Controlled
Maximum Time Step	Program Controlled
Time Step Safety Factor	0.9

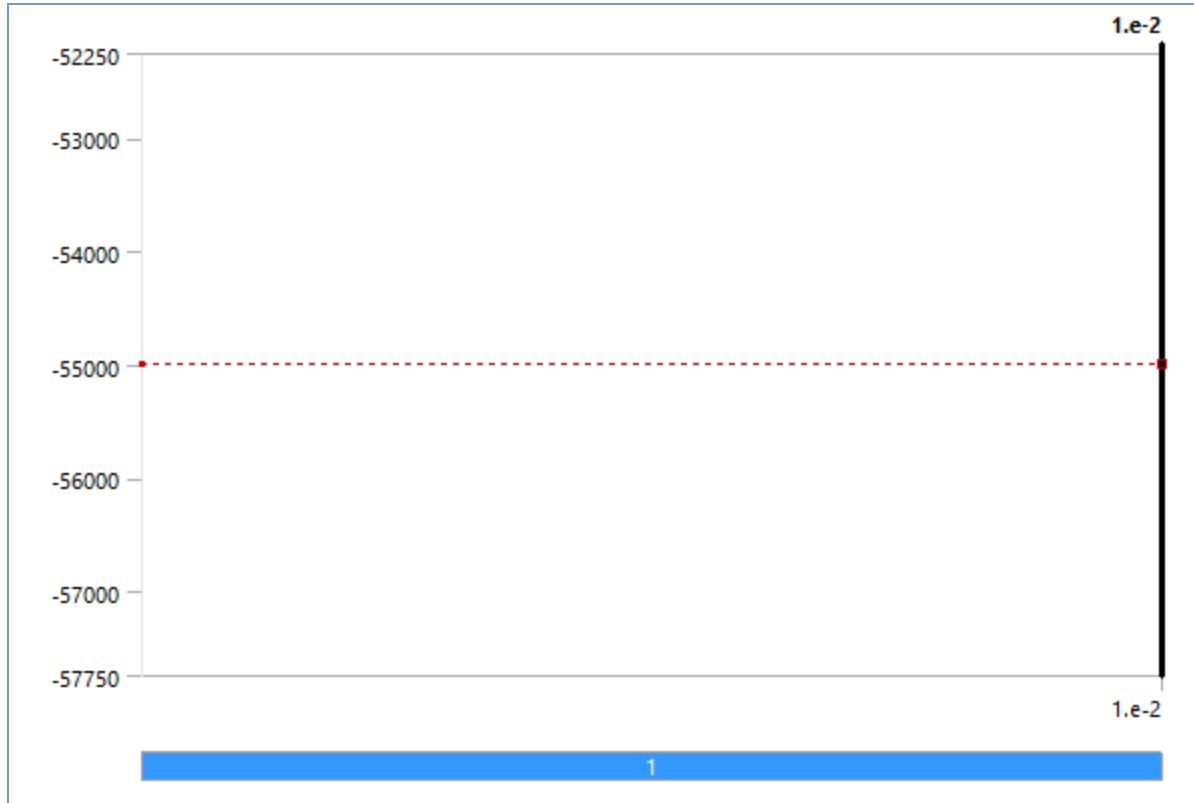
Characteristic Dimension	Diagonals
Automatic Mass Scaling	No
Solver Controls	
Precision	Double
Solve Units	mm, mg, ms
Beam Solution Type	Bending
Beam Time Step Safety Factor	0.5
Hex Integration Type	Exact
Shell Sublayers	3
Shell Shear Correction Factor	0.8333
Shell BWC Warp Correction	Yes
Shell Thickness Update	Nodal
Tet Integration	Average Nodal Pressure
Shell Inertia Update	Recompute
Density Update	Program Controlled
Minimum Velocity	1.e-003 mm s^-1
Maximum Velocity	1.e+013 mm s^-1
Radius Cutoff	1.e-003
Minimum Strain Rate Cutoff	1.e-010
Euler Domain Controls	
Domain Size Definition	Program Controlled
Display Euler Domain	Yes
Scope	All Bodies
X Scale factor	1.2
Y Scale factor	1.2
Z Scale factor	1.2
Domain Resolution Definition	Total Cells
Total Cells	2.5e+05
Lower X Face	Flow Out
Lower Y Face	Flow Out
Lower Z Face	Flow Out
Upper X Face	Flow Out
Upper Y Face	Flow Out
Upper Z Face	Flow Out
Euler Tracking	By Body
Damping Controls	
Linear Artificial Viscosity	0.2
Quadratic Artificial Viscosity	1.
Linear Viscosity in Expansion	No
Hourglass Damping	AUTODYN Standard
Viscous Coefficient	0.1
Static Damping	0.
Erosion Controls	
On Geometric Strain Limit	Yes
Geometric Strain Limit	1.5
On Material Failure	No

On Minimum Element Time Step	No
Retain Inertia of Eroded Material	Yes
Output Controls	
Save Results on	Equally Spaced Points
Number of points	20
Save Restart Files on	Equally Spaced Points
Number of points	5
Save Result Tracker Data on	Cycles
Cycles	1
Output Contact Forces	Off
Analysis Data Management	
Solver Files Directory	C:\Users\mech\AppData\Local\Temp\WB_RISE_4372_2\unsaved_project_files\dp0\SYS\MECH\
Scratch Solver Files Directory	

TABLE 13
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name	Velocity
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Velocity
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	-55000 mm/s (step applied)
Z Component	Free
Suppressed	No

FIGURE 1
Model (A4) > Explicit Dynamics (A5) > Velocity



Solution (A6)

TABLE 14
Model (A4) > Explicit Dynamics (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
Information	
Status	Done

TABLE 15
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
Display Filter During Solve	Yes

TABLE 16
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

Object Name	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent Stress</i>
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	<i>Total Deformation</i>	<i>Equivalent Elastic Strain</i>	<i>Equivalent (von-Mises) Stress</i>

By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	12.447 mm	0. mm/mm	0. MPa
Maximum	553.89 mm	6.4069e-003 mm/mm	288.13 MPa
Minimum Occurs On	Solid		
Maximum Occurs On	PartBody		
Minimum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	12.447 mm	0. mm/mm	0. MPa
Maximum Value Over Time			
Minimum	0. mm	0. mm/mm	0. MPa
Maximum	553.89 mm	1.9704e-002 mm/mm	879.99 MPa
Information			
Time	1.0003e-002 s		
Set	21		
Integration Point Results			
Display Option	Averaged		

FIGURE 2
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

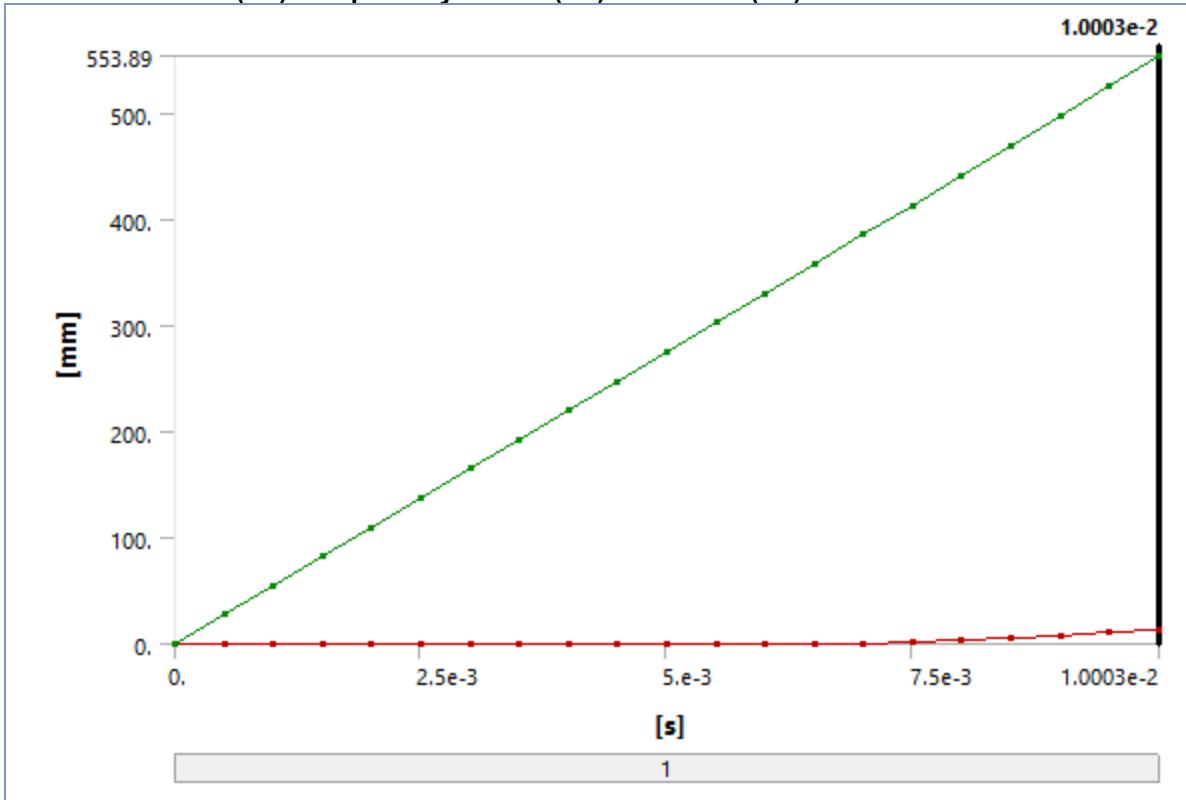


TABLE 17
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		0.

5.0214e-004		27.618
1.0008e-003		55.045
1.5025e-003		82.635
2.0011e-003		110.06
2.5028e-003		137.65
3.0015e-003		165.08
3.5001e-003		192.51
4.0018e-003		220.1
4.5005e-003		247.53
5.0021e-003		275.12
5.5008e-003		302.54
6.0024e-003		330.13
6.5011e-003	9.2855e-003	357.57
7.0003e-003	0.71222	385.59
7.5024e-003	2.157	412.85
8.0003e-003	3.6408	440.77
8.5016e-003	5.6267	469.69
9.0001e-003	8.4278	496.97
9.5012e-003	12.221	525.36
1.0003e-002	12.447	553.89

FIGURE
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

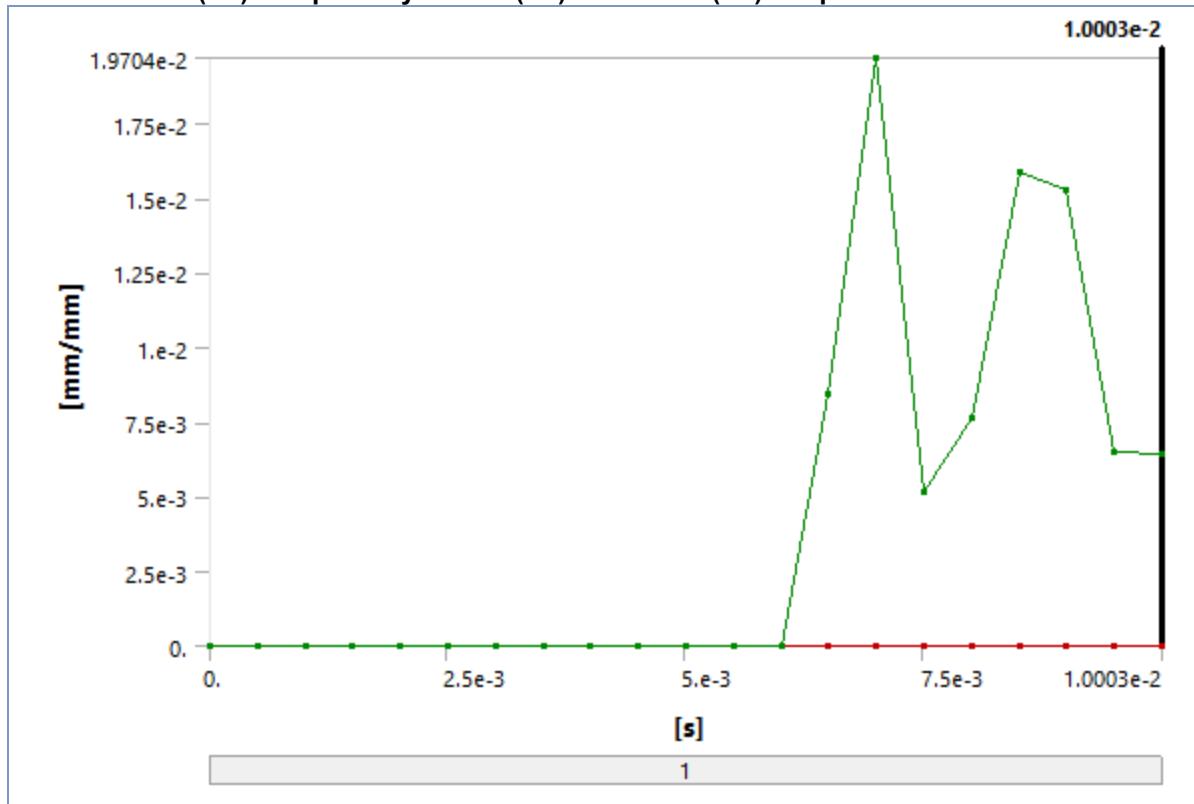


TABLE 18
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038		
5.0214e-004		

1.0008e-003	
1.5025e-003	
2.0011e-003	
2.5028e-003	
3.0015e-003	
3.5001e-003	
4.0018e-003	
4.5005e-003	
5.0021e-003	
5.5008e-003	
6.0024e-003	
6.5011e-003	
7.0003e-003	
7.5024e-003	
8.0003e-003	
8.5016e-003	
9.0001e-003	
9.5012e-003	
1.0003e-002	
	0.
	0.
	8.4543e-003
	1.9704e-002
	5.1882e-003
	7.6542e-003
	1.5872e-002
	1.5253e-002
	6.4806e-003
	6.4069e-003

FIGURE 4
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

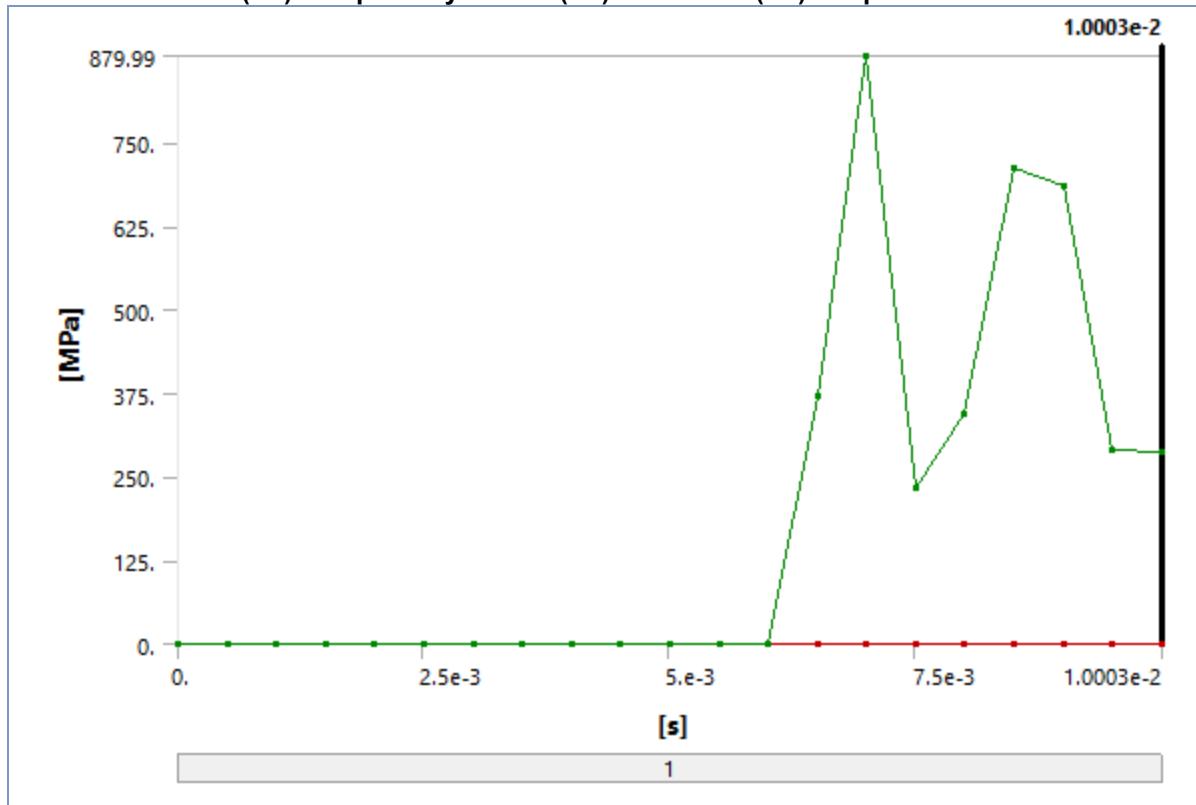


TABLE 19
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.1755e-038		
5.0214e-004		
1.0008e-003		

1.5025e-003	0.
2.0011e-003	
2.5028e-003	
3.0015e-003	
3.5001e-003	
4.0018e-003	
4.5005e-003	
5.0021e-003	
5.5008e-003	
6.0024e-003	
6.5011e-003	372.57
7.0003e-003	879.99
7.5024e-003	232.71
8.0003e-003	343.57
8.5016e-003	712.93
9.0001e-003	684.92
9.5012e-003	291.12
1.0003e-002	288.13

Material Data

Magnesium Alloy

TABLE 20
Magnesium Alloy > Constants

Density	1.8e-006 kg mm ⁻³
Coefficient of Thermal Expansion	2.6e-005 C ⁻¹
Specific Heat	1.024e+006 mJ kg ⁻¹ C ⁻¹
Thermal Conductivity	0.156 W mm ⁻¹ C ⁻¹
Resistivity	7.7e-004 ohm mm

TABLE 21
Magnesium Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 22
Magnesium Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
193

TABLE 23
Magnesium Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
193

TABLE 24
Magnesium Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
255

TABLE 25

Magnesium Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 26
Magnesium Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	45000	0.35	50000	16667

TABLE 27
Magnesium Alloy > Isotropic Relative Permeability

Relative Permeability
10000

Structural Steel

TABLE 28
Structural Steel > Constants

Density	7.85e-006 kg mm ⁻³
Coefficient of Thermal Expansion	1.2e-005 C ⁻¹
Specific Heat	4.34e+005 mJ kg ⁻¹ C ⁻¹
Thermal Conductivity	6.05e-002 W mm ⁻¹ C ⁻¹
Resistivity	1.7e-004 ohm mm

TABLE 29
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 30
Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 31
Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 32
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 33
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 34
Structural Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0

2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 35
Structural Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 36
Structural Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 37
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000

Total Deformation

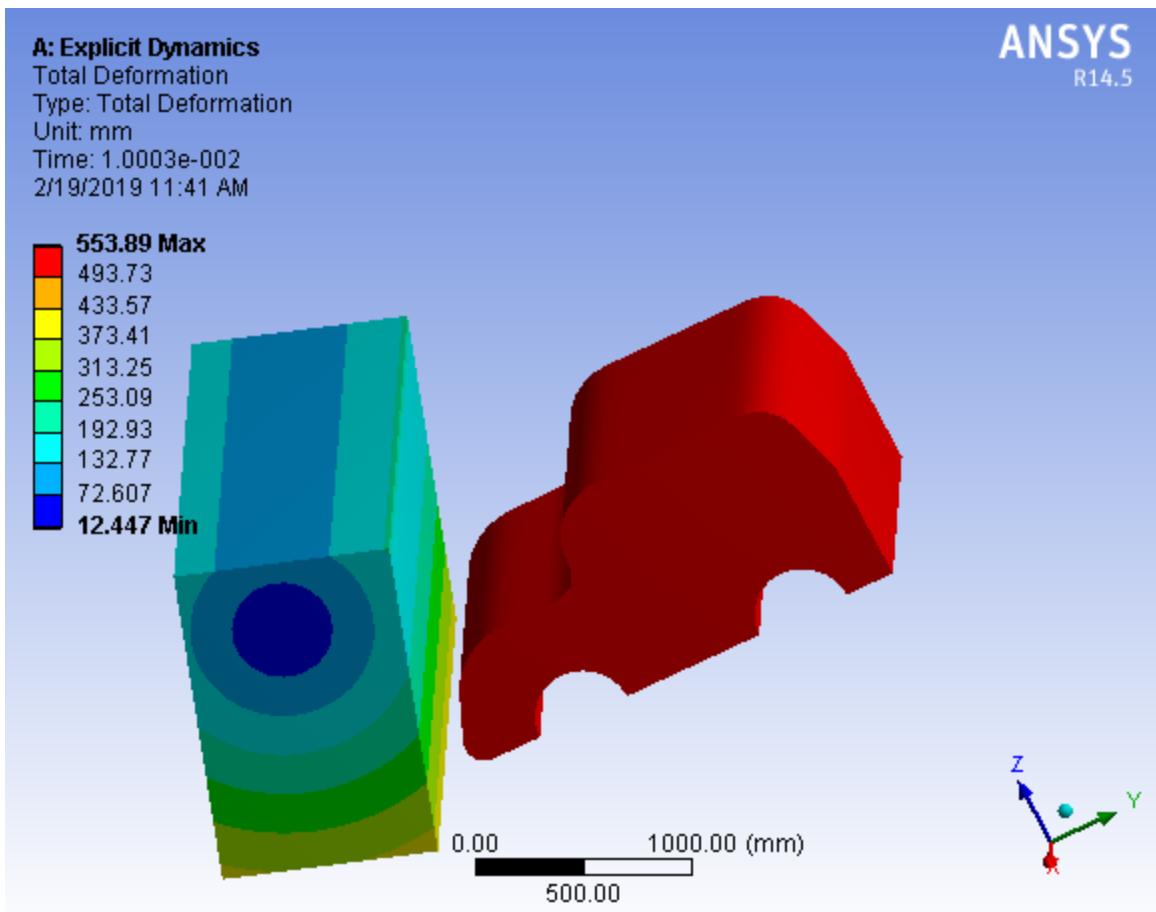
Subject: 55+MG+SS+F+DEFORMATION

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Elastic Strain

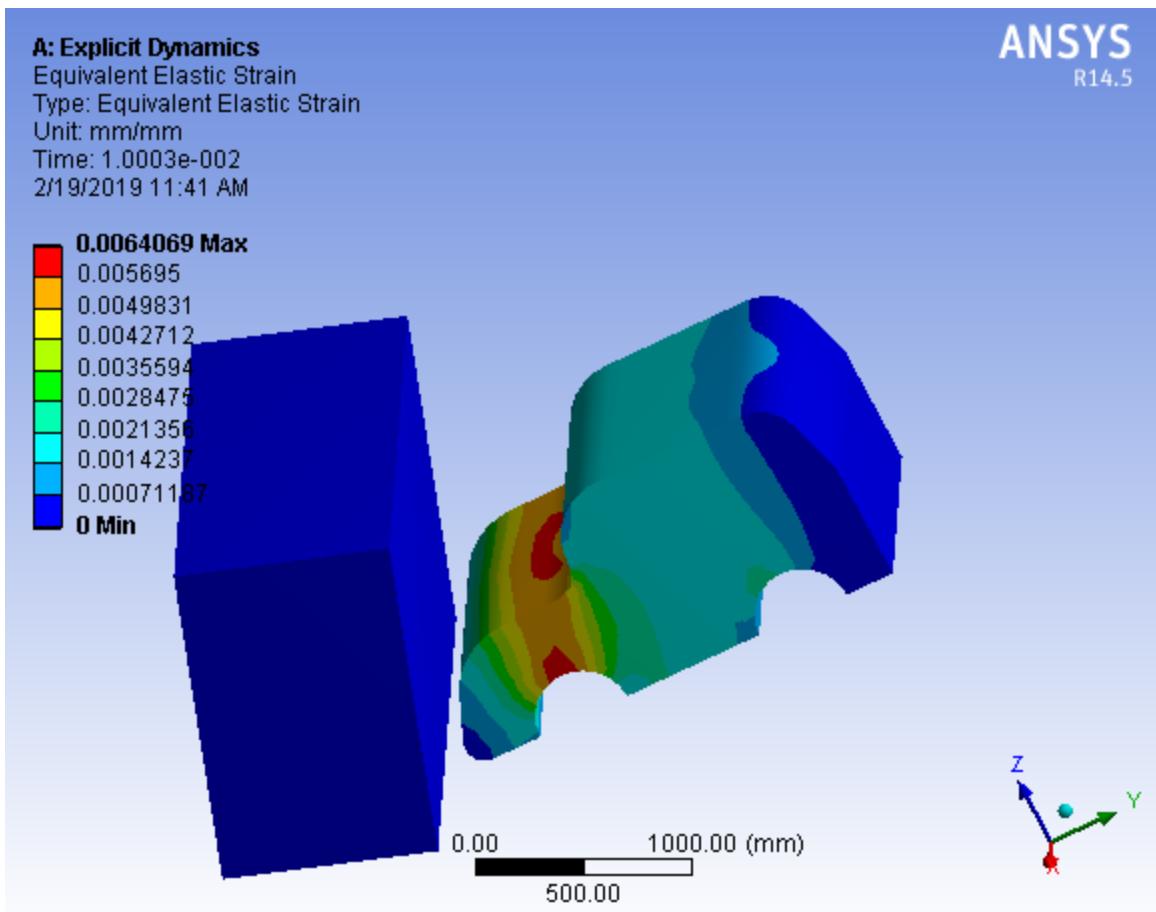
Subject: 55+MG+SS+F+STRAIN

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:



Equivalent Stress

Subject: 55+MG+SS+F+STRESS

Author:

Prepared For:

Date Tuesday, February 19, 2019

Comments:

