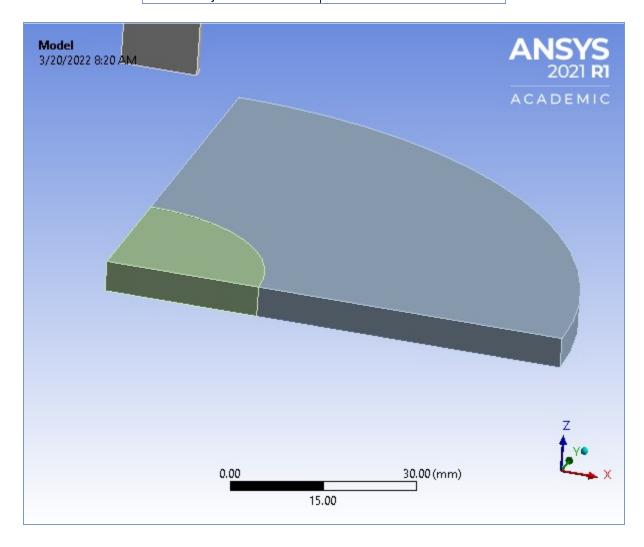
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Project*

First Saved	Saturday, December 25, 2021	
Last Saved	Saturday, December 25, 2021	
Product Version	2021 R1	
Save Project Before Solution	No	
Save Project After Solution	No	



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Contents

- Units
- Model (A4)
 - o **Geometry**
 - Cylinder
 - Plate
 - Parts
 - o Materials
 - COPPER Assignment
 - o Coordinate Systems
 - o Symmetry
 - Symmetry Region
 - o Connections
 - Body Interactions
 - Body Interaction
 - o Mesh
 - Mesh Controls
 - o Named Selections
 - o Explicit Dynamics (A5)
 - Initial Conditions
 - Initial Condition
 - Analysis Settings
 - Loads
 - Solution (A6)
 - Solution Information
 - Results
- Material Data
 - o COPPER
 - o AL 2024-T4

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		

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	Definition
Cauras	C:\Users\Neeraj Singh\Desktop\Work\ANSYS\Cylinder Impact\Cylinder
Source Impact_files\dp0\SYS\DM\SYS.agdb	
Туре	DesignModeler
Length Unit	Meters
Display Style	Body Color
	Bounding Box
Length X	76.2 mm
Length Y	76.2 mm
Length Z	90.322 mm
	Properties
Volume	29602 mm³
Mass	0.12179 kg
Scale Factor Value	1.
	Statistics
Bodies	3
Active Bodies	3
Nodes	8755
Elements	6760
Mesh Metric	None
	Update Options
Assign Default Material	No
	Basic Geometry Options
Parameters	Independent
Parameter Key	·
Attributes	Yes
Attribute Key	
Named Selections	Yes
Named Selection Key	
Material Properties	Yes
,	Advanced Geometry Options
Use Associativity	Yes
Coordinate Systems	Yes
Coordinate System Key	
Reader Mode Saves	No
Updated File	UVI
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
Analysis Type	3-D
Import Facet Quality	Source
Clean Bodies On Import	No
Stitch Surfaces On Import	None
Decompose Disjoint	Yes
Geometry	1 55
Enclosure and Symmetry	Yes
Processing	

TABLE 3 Model (A4) > Geometry > Parts

woder (A4) > Geometry > 1 arts				
Object Name Cylinder				
State	Meshed			
Graphics Properties				

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Visible Yes			
Transparency	1		
Definition			
Suppressed	No		
Stiffness Behavior	Flexible		
Coordinate System	Default Coordinate System		
Reference Temperature	By Environment		
Reference Frame	Lagrangian		
Ma	aterial		
Assignment	COPPER		
Bound	ding Box		
Length X 12.7 mm			
Length Y	12.7 mm		
Length Z	50.8 mm		
Pro	perties		
Volume	6435.2 mm³		
Mass	5.7273e-002 kg		
Centroid X 5.3764 mm			
Centroid Y	5.3764 mm		
Centroid Z	64.922 mm		
Moment of Inertia lp1	13.085 kg·mm²		
Moment of Inertia Ip2	12.702 kg·mm²		
Moment of Inertia lp3	1.2779 kg·mm²		
Statistics			
Nodes	4375		
Elements	3468		
Mesh Metric	None		

TABLE 4 Model (A4) > Geometry > Body Groups

widder (A4) / Gedirietry / Body Groups			
Object Name Plate			
State	Meshed		
Graphics Properties			
Visible Yes			
De	efinition		
Suppressed	No		
Assignment	AL 2024-T4		
Coordinate System Default Coordinate System			
Bounding Box			
Length X	76.2 mm		
Length Y	76.2 mm		
Length Z 5.08 mm			
Properties			
Volume	23167 mm³		
Mass 6.4519e-002 kg			
Centroid X	32.308 mm		
Centroid Y	32.308 mm		
Centroid Z	2.54 mm		
Moment of Inertia Ip1	34.062 kg·mm²		
Moment of Inertia Ip2	18.428 kg·mm²		
Moment of Inertia Ip3	52.214 kg·mm²		
Statistics			
* Committee of the comm			

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Nodes	4380
Elements	3292
Mesh Metric	None

TABLE 5 Model (A4) > Geometry > Plate > Parts

Model (A4) > Geometry > Plate > Parts					
Object Name					
State	State Meshed				
	ics Properties				
Visible	Y	'es			
Transparency		1			
I	Definition				
Suppressed	1	No			
Stiffness Behavior		xible			
Coordinate System	Default Coor	dinate System			
Reference Temperature	By Env	ironment			
Reference Frame	Lagra	angian			
	Material				
Assignment AL 2024-T4					
Во	unding Box				
Length X	76.2 mm	25.4 mm			
Length Y	76.2 mm	25.4 mm			
Length Z	5.08	3 mm			
	Properties				
Volume	20593 mm ³	2574.1 mm³			
Mass	5.735e-002 kg	7.1688e-003 kg			
Centroid X	35.001 mm	10.758 mm			
Centroid Y	35.001 mm	10.758 mm			
Centroid Z	2.54	4 mm			
Moment of Inertia Ip1	33.63 kg·mm²	0.43208 kg·mm²			
Moment of Inertia Ip2	10.698 kg·mm²				
Moment of Inertia lp3	44.082 kg·mm²	0.64105 kg·mm²			
Statistics					
Nodes	3190	1335			
Elements	2352	940			
Mesh Metric None					

FIGURE 1 Model (A4) > Geometry > CylinderImpactGeometry

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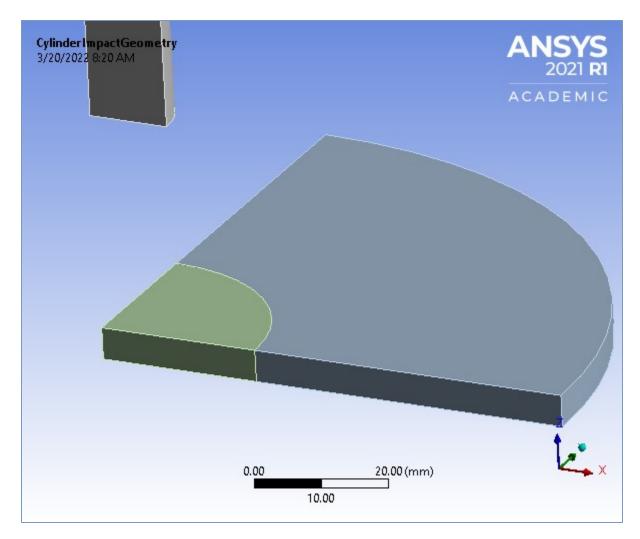


TABLE 6
Model (A4) > Materials

model (714) - materiale			
Object Name Materials			
State Fully Defined			
Statistics			
Materials 3			
Material Assignments	2		

TABLE 7
Model (A4) > Materials > COPPER Assignment

Object Name	COPPER Assignment	AL 2024-T4 Assignment
State	Fully Defined	

Coordinate Systems

TABLE 8

Model (A4) > Coordinate Systems > Coordinate System

Model (A4) > Coordinate Systems > Coordinate System				
Object Name	Global Coordinate System	ZXPlane	YZPlane	
State	State Fully Defined			
Definition				
Туре	Cartesian			
Suppressed	Suppressed No		lo	

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Origin		
Origin X	Origin X 0. mm	
Origin Y	0. mm	
Origin Z	0. mm	
Define By		Global Coordinates
Location		Defined
Directional Vectors		
X Axis Data	[1. 0. 0.]	[0. 0. 1.] [0. 1. 0.]
Y Axis Data	[0. 1. 0.]	[1. 0. 0.] [0. 0. 1.]
Z Axis Data	[0. 0. 1.]	[0. 1. 0.] [1. 0. 0.]
Principal Axis		
Axis		X
Define By		Fixed Vector
Orientation About Principal Axis		
Axis		Υ
Define By		Fixed Vector
Transformations		
Base Configuration		Absolute
Transformed Configuration		[0. 0. 0.]

Symmetry

TABLE 9 Model (A4) > Symmetry

	- J J
Object Name	Symmetry
State	Fully Defined

TABLE 10 Model (A4) > Symmetry > Symmetry Region

Object Name	Symmetry Region	Symmetry Region 2
State	Fully [Defined
	Scope	
Scoping Method	Named	Selection
Named Selection	Symmetry:ZXPlane	Symmetry:YZPlane
Definition		
Scope Mode	Automatic	
Туре	Symmetric	
Coordinate System	ZXPlane	YZPlane
Symmetry Normal	Z	Axis
Suppressed	N	l o

Connections

TABLE 11
Model (A4) > Connections

woder (A4) > Connections		
Object Name	Connections	
State	Fully Defined	
Auto Detection		
Generate Automatic Connection On Refresh	Yes	
Transparency		
Enabled	Yes	

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TABLE 12 Model (A4) > Connections > Body Interactions

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

TABLE 13 Model (A4) > Connections > Body Interactions > Body Interaction

Mesh

TABLE 14 Model (A4) > Mesh

iviodei (A4) > iviesti	
Object Name	Mesh
State	Solved
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Explicit
Element Order	Linear
Element Size	2.54 mm
Sizing	
Use Adaptive Sizing	Yes
Resolution	Default (4)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Slow
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Diagonal	140.61 mm
Average Surface Area	840.47 mm ²
Minimum Edge Length	5.08 mm
Quality	
Check Mesh Quality	Yes, Errors
Target Quality	Default (0.050000)
Smoothing	High

Mesh Metric	None
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
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Straight Sided Elements	
Rigid Body Behavior	Full Mesh
Triangle Surface Mesher	Program Controlled
Topology Checking	Yes
Pinch Tolerance	Please Define
Generate Pinch on Refresh	No
Statistics	
Nodes	8755
Elements	6760

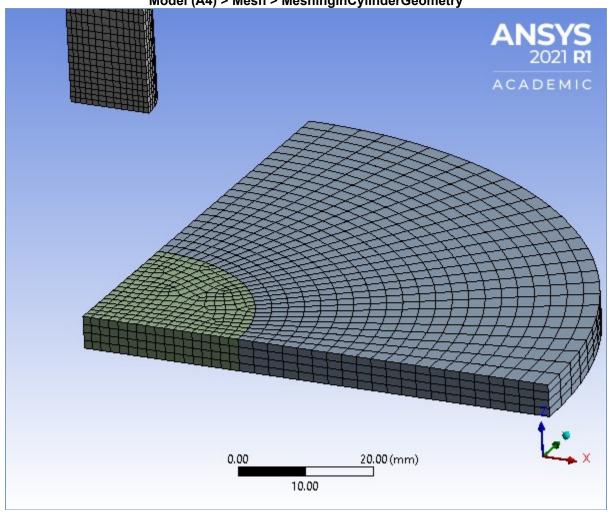
TABLE 15
Model (A4) > Mesh > Mesh Controls

	M	odel (A4) > Mesh > I	Mesh Controls		
Object Name	Body Sizing	Edge Sizing	Edge Sizing 2	Edge Sizing 3	MultiZone
State	Fully Defined				
Scope					
Scoping Method		G	Seometry Select	ion	
Geometry	2 Bodies	1 Edge	е	2 Edges	3 Bodies
		Definitio	n		
Suppressed			No		
Туре	Element Size	Number of Divisions	Eleme	nt Size	
Element Size	1.524 mm		1.524	l mm	
Number of Divisions		4			
Method					MultiZone
Mapped Mesh Type					Hexa
Surface Mesh Method					Program Controlled
Free Mesh Type					Not Allowed
Element Order					Use Global Setting
Src/Trg Selection					Automatic
Source Scoping Method					Program Controlled
Source					Program Controlled
Sweep Size Behavior			Sweep Element Size		
Sweep Element Size					Default
		Advance	d		
Defeature Size	Default				
Behavior		Soft			
Bias Type		No Bias			
Bias Option			Bias F	actor	
Bias Factor			3.		
Reverse Bias			No Se	ection	
			•		

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Preserve Boundaries	Protected
Mesh Based Defeaturing	Off
Minimum Edge Length	5.08 mm
Write ICEM CFD Files	No

FIGURE 2
Model (A4) > Mesh > MeshingInCylinderGeometry



Named Selections

TABLE 16
Model (A4) > Named Selections > Named Selections

Model (A4) > Named Ocicetions > Named Ocicetions		
Object Name	Symmetry:ZXPlane	Symmetry:YZPlane
State	Fully Defined	
Scope		
Scoping Method	Geometry	Selection
Geometry	3 Fa	aces
Definition		
Send to Solver	N	lo
Protected	Program	Controlled
Visible	Y	es
Program Controlled Inflation	Exc	lude

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Statistics	
Type Imported	
Total Selection	3 Faces
Surface Area	1032.3 mm²
Suppressed	0
Used by Mesh Worksheet	No

Explicit Dynamics (A5)

TABLE 17 Model (A4) > Analysis

Model (A4) > Allalysis				
Object Name	Explicit Dynamics (A5)			
State	Solved			
Definition				
Physics Type	Structural			
Analysis Type	Explicit Dynamics			
Solver Target	AUTODYN			
Options				
Environment Temperature	22. °C			
Generate Input Only	No			

TABLE 18
Model (A4) > Explicit Dynamics (A5) > Initial Conditions

Object Name	Initial Conditions	
State	Fully Defined	

TABLE 19
Model (A4) > Explicit Dynamics (A5) > Initial Condition

iics (A3) / iiiiliai coile		
Pre-Stress (None)	Velocity	
Fully De	efined	
Definition		
None Av	ailable	
From Deformed State		
	Velocity	
	Vector	
	5.08e+005 mm/s	
	Defined	
	No	
Scope		
	Geometry Selection	
	1 Body	
	Pre-Stress (None) Fully De Definition None Av From Deformed State	

TABLE 20
Model (A4) > Explicit Dynamics (A5) > Analysis Settings

model (11) = April 2 Jilanii 2 (11) 7 mai joi 2 datii ga				
Object Name	Analysis Settings			
State	Fully Defined			
	Analysis Settings Preference			
Туре	Type Custom			
Step Controls				
Number Of Steps	1			
Current Step Number	Current Step Number 1			
Load Step Type	Load Step Type Explicit Time Integration			

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End Time	1.e-004	
Resume From Cycle	0	
Maximum Number of Cycles	1e+07	
Maximum Energy Error	0.1	
Reference Energy Cycle	0.1	
Initial Time Step	Program Controlled	
Minimum Time Step	Program Controlled	
Maximum Time Step	Program Controlled	
Time Step Safety Factor	0.9	
Characteristic Dimension	0.9 Diagonals	
Automatic Mass Scaling	No	
Automatic Mass Scaling	Solver Controls	
Solve Units	mm, mg, ms	
Beam Solution Type	Bending	
Beam Time Step Safety	<u> </u>	
Factor	0.5	
Hex Integration Type	Exact	
Shell Sublayers	3	
Shell Shear Correction	0.8333	
Factor		
Shell BWC Warp Correction	Yes	
Shell Thickness Update	Nodal	
Tet Integration	Average Nodal Pressure	
Shell Inertia Update	Recompute	
Density Update	Program Controlled	
Minimum Timestep for SPH	1.e-010 s	
Minimum Density Factor for SPH	0.2	
Maximum Density Factor for SPH	3.	
Density Cutoff Option For SPH	Limit Density	
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	
9	Damping Controls	
Т	· •	

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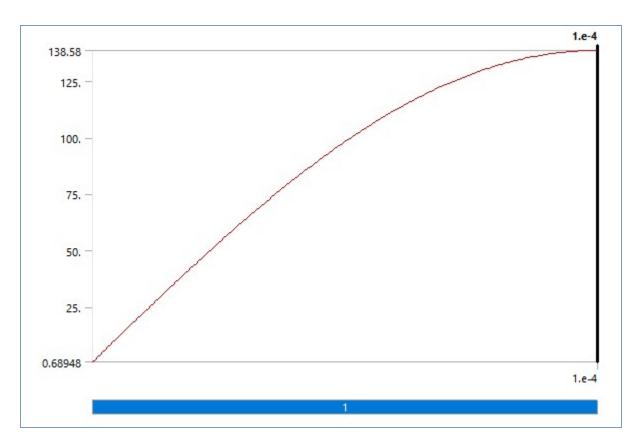
Linnan Antificial Vianacit	0.0	
Linear Artificial Viscosity	0.2	
Quadratic Artificial Viscosity	1.	
Linear Viscosity in Expansion	No	
Artificial Viscosity For Shells	Yes	
Linear Artificial Viscosity for SPH	1.	
Quadratic Artificial Viscosity for SPH	1.	
Hourglass Damping	AUTODYN Standard	
Viscous Coefficient	0.1	
Static Damping	0.	
	Erosion Controls	
On Geometric Strain Limit	No	
On Material Failure	Yes	
On Minimum Element Time Step	No	
Retain Inertia of Eroded Material	Yes	
	Output Controls	
Step-aware Output Controls	No	
Save Results on	Equally Spaced Points	
Result Number Of Points	80	
Save Restart Files on	Equally Spaced Points	
Restart Number Of Points	5	
Save Result Tracker Data on	Cycles	
Tracker Cycles	1	
Output Contact Forces	Off	
	Analysis Data Management	
Solver Files Directory	C:\Users\Neeraj Singh\Desktop\Work\ANSYS\Cylinder Impact\Cylinder Impact files\dp0\SYS\MECH\	
Scratch Solver Files Directory		

TABLE 21
Model (A4) > Explicit Dynamics (A5) > Loads

Object Name F			
Object Name r	Fixed Support	Pressure	
State	Fully Defined		
		Scope	
Scoping Method		Geometry Selection	
Geometry		1 Face	
	Definition		
Type F	Fixed Support Pressure		
Suppressed	No		
Define By		Normal To	
Magnitude	= 20000*sin(90*time/0.0001)+100		
	Function		
Unit System		U.S. Customary (in, lbm, lbf, °F, s, V, A) Degrees rad/s Fahrenheit	
Angular Measure	Degrees		
Graph Controls			
Number Of Segments	200.		

FIGURE 3
Model (A4) > Explicit Dynamics (A5) > Pressure

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Solution (A6)

TABLE 22 Model (A4) > Explicit Dynamics (A5) > Solution

_	. (211) = xp.1010 = y .10111100 (210)			
		Object Name	Solution (A6)	
		State	Solved	
	Information			
Ī		Status	Done	
Ī	Post Processing			
ſ	Beam S	Section Results	No	

TABLE 23
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Solution Information

formation			
ed			
Solution Information			
Output			
S			
S			

TABLE 24
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Results

model (717) - Explicit Bylianiles (716) - Testation (716) - Testation			
Object Name	Equivalent Plastic Strain Normal Stress		
State	State Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	1 Body All Bodies		

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	Definition	
Туре	Equivalent Plastic Strain	Normal Stress
Ву	T	me
Display Time	L	ast
Calculate Time History	Υ	'es
Identifier		
Suppressed	١	No
Orientation		Z Axis
Coordinate System		Global Coordinate System
	Integration Point Resul	ts
Display Option	Ave	raged
Average Across Bodies	ſ	No
	Results	
Minimum	2.4855e-002 mm/mm	-632.74 MPa
Maximum	0.94311 mm/mm	391.36 MPa
Average	0.14139 mm/mm	-81.007 MPa
Minimum Occurs On		Cylinder
Maximum Occurs On		Cylinder
	Minimum Value Over Tir	ne
Minimum	0. mm/mm	-6049.1 MPa
Maximum	2.4855e-002 mm/mm	0. MPa
	Maximum Value Over Ti	me
Minimum	0. mm/mm	0. MPa
Maximum	0.94311 mm/mm	5454.1 MPa
	Information	
Time	1.0001e-004 s	
Set	81	
Cycle Number	2885	

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

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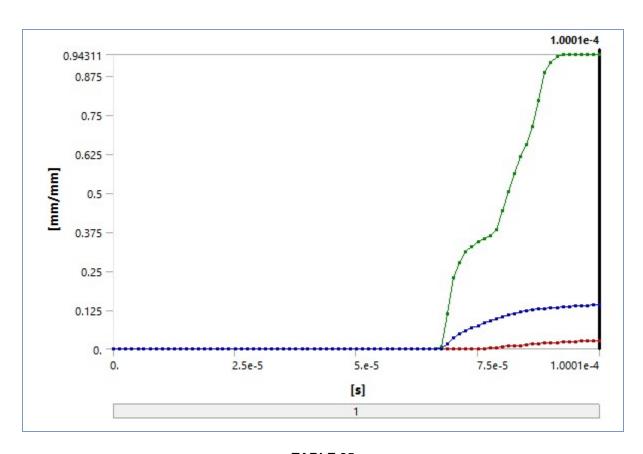


TABLE 25
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Plastic Strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1.1755e-038		-	
1.2621e-006			
2.541e-006			
3.7668e-006			
5.0458e-006			
6.2716e-006			
7.5508e-006			
8.7766e-006			
1.0003e-005			
1.1282e-005			
1.2508e-005			
1.3787e-005			
1.5013e-005			
1.6292e-005			
1.7518e-005			
1.8797e-005			
2.0024e-005			
2.1303e-005			
2.2529e-005			
2.3755e-005			
2.5035e-005			
2.6261e-005			
2.754e-005			
2.8767e-005			
3.0046e-005			

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to the second se				
3.1272e-005				
3.2552e-005				
3.3778e-005				
3.5005e-005				
3.6284e-005				
3.7511e-005				
3.8791e-005				
4.0017e-005				
4.1297e-005				
4.2523e-005				
4.3803e-005				
4.503e-005				
4.6256e-005				
4.7536e-005				
4.8763e-005		0.	0.	
5.0042e-005	0.			
5.1269e-005	-			
5.2549e-005				
5.3776e-005				
5.5002e-005				
5.6282e-005				
5.7509e-005				
5.8789e-005				
6.0016e-005				
6.1296e-005				
6.2523e-005				
6.3803e-005				
6.5029e-005				
6.6256e-005				
6.7536e-005		7.2759e-003	4.6881e-004	
6.8763e-005				
		0.11183	1.7603e-002	
7.0043e-005		0.11183 0.22898	<u> </u>	
7.0043e-005 7.1257e-005	1.1073e-004	0.22898	3.5095e-002	
7.1257e-005	1.1073e-004 7.4325e-004	0.22898 0.2763	3.5095e-002 4.7148e-002	
7.1257e-005 7.2512e-005	7.4325e-004	0.22898 0.2763 0.31026	3.5095e-002 4.7148e-002 5.7996e-002	
7.1257e-005 7.2512e-005 7.3767e-005		0.22898 0.2763 0.31026 0.32838	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005	7.4325e-004 1.1111e-003	0.22898 0.2763 0.31026 0.32838 0.34175	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005	7.4325e-004 1.1111e-003 1.0262e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 7.8751e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 7.8751e-005 8.0015e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 7.8751e-005 8.0015e-005 8.1259e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 7.8751e-005 8.0015e-005 8.1259e-005 8.2516e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.5001e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002 1.2358e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 7.8751e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002 1.2358e-002 1.4511e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005 8.7508e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.5001e-005 8.7508e-005 8.8755e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.5001e-005 8.6256e-005 8.7508e-005 9.0003e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 9.8922e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002 1.9764e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696 0.91843	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983 0.13096	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005 8.7508e-005 8.7508e-005 9.0003e-005 9.1273e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002 1.9764e-002 2.0203e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696 0.91843 0.936	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983 0.13096 0.13249	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.5016e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005 8.7508e-005 8.8755e-005 9.0003e-005 9.1273e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002 1.9764e-002 2.0203e-002 2.1398e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696 0.91843 0.936 0.94298	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983 0.13096 0.13249 0.13382	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.627e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005 8.7508e-005 8.8755e-005 9.0003e-005 9.1273e-005 9.3757e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.8922e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002 1.9764e-002 2.0203e-002 2.1398e-002 2.1962e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696 0.91843 0.936 0.94298 0.94303	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983 0.13096 0.13249 0.13507	
7.1257e-005 7.2512e-005 7.3767e-005 7.5016e-005 7.5016e-005 7.7518e-005 8.0015e-005 8.1259e-005 8.2516e-005 8.3762e-005 8.6256e-005 8.7508e-005 8.8755e-005 9.0003e-005 9.1273e-005	7.4325e-004 1.1111e-003 1.0262e-003 2.0584e-003 4.3816e-003 7.1964e-003 9.3585e-003 1.0655e-002 1.2358e-002 1.4511e-002 1.6758e-002 1.8739e-002 1.9764e-002 2.0203e-002 2.1398e-002	0.22898 0.2763 0.31026 0.32838 0.34175 0.35419 0.36266 0.38186 0.44329 0.50215 0.5598 0.61508 0.65281 0.71249 0.7953 0.88696 0.91843 0.936 0.94298	3.5095e-002 4.7148e-002 5.7996e-002 6.6981e-002 7.5008e-002 8.2861e-002 9.0826e-002 9.6492e-002 0.10252 0.10809 0.11319 0.11754 0.12104 0.125 0.12815 0.12983 0.13096 0.13249 0.13382	

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9.6265e-005	Se-005 2.4143e-002 0.94306		0.13784	
9.751e-005	2.4344e-002	0.94308	0.13902	
9.8762e-005	2.4507e-002	0.94309	0.1403	
1.0001e-004	2.4855e-002	0.94311	0.14139	

FIGURE 5
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Equivalent Plastic Strain > EquivalentPlasticStrain

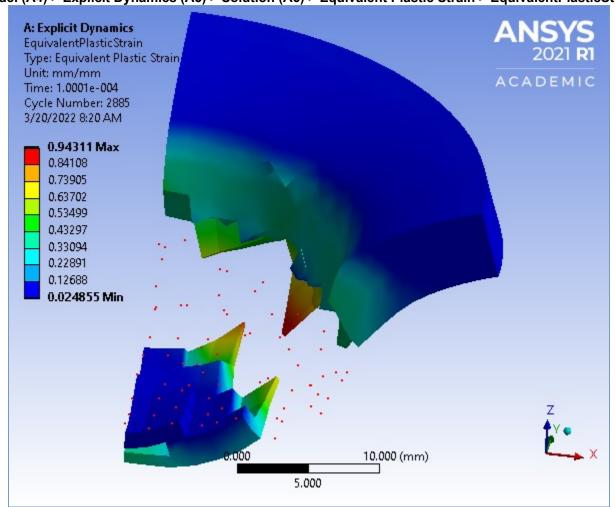


FIGURE 6
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Normal Stress

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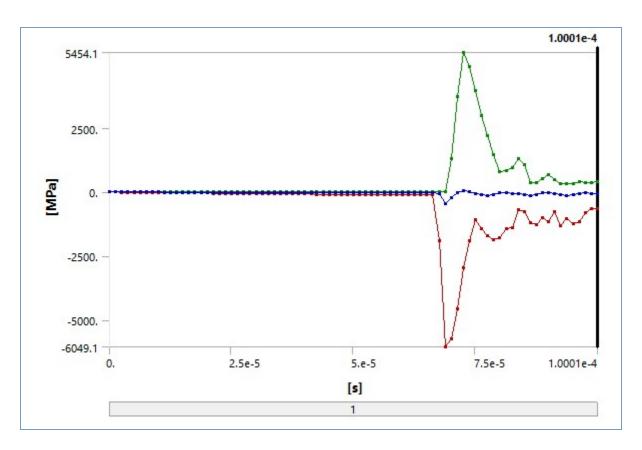


TABLE 26
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Normal Stress

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.1755e-038	0.		0.
1.2621e-006	-2.8106		-7.3864e-002
2.541e-006	-5.2852		-0.23762
3.7668e-006	-7.8546		-0.47148
5.0458e-006	-10.618		-0.7967
6.2716e-006	-13.342		-1.197
7.5508e-006	-16.185		-1.7332
8.7766e-006	-18.828		-2.3789
1.0003e-005	-21.492		-3.1604
1.1282e-005	-24.181		-4.0828
1.2508e-005	-26.704		-5.0432
1.3787e-005	-29.439		-6.084
1.5013e-005	-32.063		-7.0709
1.6292e-005	-34.718		-8.0918
1.7518e-005	-37.262		-9.0332
1.8797e-005	-40.08		-9.916
2.0024e-005	-42.758		-10.595
2.1303e-005	-45.355		-11.062
2.2529e-005	-47.706		-11.286
2.3755e-005	-49.978		-11.404
2.5035e-005	-52.531		-11.533
2.6261e-005	-54.822		-11.636
2.754e-005	-57.101		-11.684
2.8767e-005	-59.229		-11.731
3.0046e-005	-61.604		-11.845

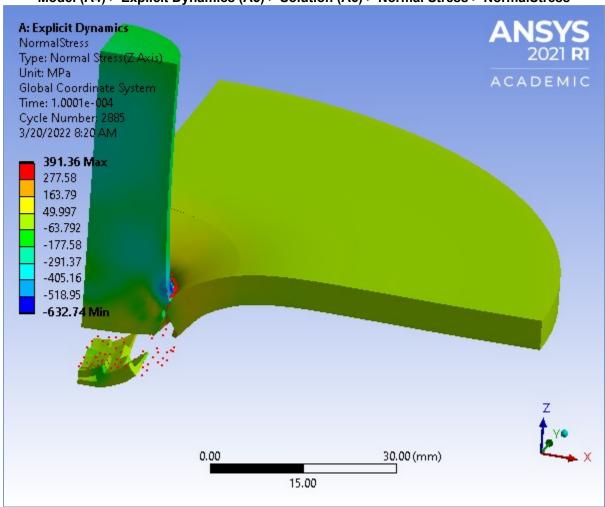
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3.1272e-005				
3.3778e-005 -68.25 3.5005e-005 -70.377 3.6284e-005 -72.607 3.7511e-005 -74.899 3.8791e-005 -77.361 4.0017e-005 -79.789 4.1297e-005 -82.114 4.2523e-005 -84.344 4.3803e-005 -86.663 4.503e-005 -98.564 4.503e-005 -98.564 4.7536e-005 -90.247 4.7536e-005 -92.188 4.8763e-005 -94.062 5.0042e-005 -95.944 5.1269e-005 -97.79 5.2549e-005 -99.722 5.3776e-005 -101.56 5.60282e-005 -104.91 5.6282e-005 -109.08 6.1296e-005 -110.47 6.2523e-005 -111.47 6.2523e-005 -111.47 6.2523e-005 -110.47 6.2523e-005 -110.47 6.2523e-005 -110.47 6.2523e-005 -110.47 6.2523e-005 -114.94	3.1272e-005	-63.905		-12.041
3.5005e-005 -70.377 -13.107 3.6284e-005 -72.607 -13.649 3.7511e-005 -74.899 -14.283 3.8791e-005 -77.361 -15.072 4.0017e-005 -79.789 -15.932 4.1297e-005 -82.114 -16.888 4.2523e-005 -84.344 -17.819 4.3803e-005 -86.663 -18.751 4.503e-005 -90.247 -20.251 4.6256e-005 -90.247 -20.251 4.7536e-005 -92.188 -20.826 4.8763e-005 -94.062 0. -21.215 5.0042e-005 -99.729 -21.505 5.2549e-005 -99.722 -21.519 5.5002e-005 -103.36 -21.435 5.602e-005 -104.91 -21.228 5.7509e-005 -106.3 -21.14 5.8789e-005 -104.74 -21.14 6.0365e-005 -110.47 -21.34 6.2526e-005 -114.94 -22.721 6.8256e-005 -116.57	3.2552e-005	-66.144		-12.331
3.6284e-005 -72.607 3.7511e-005 -74.899 3.8791e-005 -77.361 4.0017e-005 -79.789 4.1297e-005 -82.114 4.2523e-005 -84.344 4.3803e-005 -86.663 4.503e-005 -88.564 4.6256e-005 -90.247 4.7536e-005 -94.062 6.0042e-005 -95.944 5.1269e-005 -97.79 5.2549e-005 -90.722 5.3776e-005 -101.56 5.5002e-005 -103.36 5.6282e-005 -104.91 5.7509e-005 -106.3 5.8789e-005 -107.74 6.0016e-005 -109.08 6.1296e-005 -111.87 6.8252e-005 -111.87 6.8256e-005 -111.87 6.8256e-005 -114.94 6.8256e-005 -114.94 6.8256e-005 -114.94 6.8256e-005 -114.94 6.8256e-005 -16.89 7.7518e-005 -864.2 <	3.3778e-005	-68.25		-12.683
3.7511e-005 -74.899 3.8791e-005 -77.361 4.0017e-005 -79.789 4.1297e-005 -82.114 4.2523e-005 -84.344 4.3803e-005 -86.663 4.503e-005 -88.564 4.8763e-005 -92.47 4.7536e-005 -92.188 4.8763e-005 -94.062 5.0042e-005 -95.944 5.1269e-005 -97.79 5.2549e-005 -99.722 5.3776e-005 -101.56 5.6282e-005 -104.91 5.7509e-005 -103.36 5.6282e-005 -104.91 5.7509e-005 -107.74 6.016e-005 -109.08 6.1296e-005 -111.87 6.3803e-005 -111.87 6.3803e-005 -111.87 6.5029e-005 -116.57 6.6256e-005 -116.57 6.8763e-005 -149.4 7.227th -22.159 6.8763e-005 -149.2 7.332 1294.4	3.5005e-005	-70.377		-13.107
3.8791e-005	3.6284e-005	-72.607		-13.649
4.0017e-005 -79.789 -15.932 4.1297e-005 -82.114 -16.888 4.2523e-005 -84.344 -17.819 4.3803e-005 -86.663 -18.751 4.6256e-005 -90.247 -20.251 4.7536e-005 -92.188 -20.826 4.8763e-005 -94.062 0. -21.215 5.0042e-005 -95.944 -21.444 -21.519 5.2549e-005 -99.722 -21.5519 -21.505 5.3776e-005 -101.56 -21.435 -21.338 5.6282e-005 -104.91 -21.228 -21.228 5.7509e-005 -106.3 -21.14 -21.14 5.8789e-005 -107.74 -21.14 -21.34 6.1296e-005 -110.47 -21.34 -22.159 6.2523e-005 -111.87 -21.671 -23.33 6.7536e-005 -192.0 0.56298 -77.943 6.8763e-005 -6049.1 2.9046 -40.46 7.0043e-005 -5733.2 1294.4 -204.1 </td <td>3.7511e-005</td> <td>-74.899</td> <td></td> <td>-14.283</td>	3.7511e-005	-74.899		-14.283
4.1297e-005 -82.114 4.2523e-005 -84.344 4.3803e-005 -86.663 4.503e-005 -86.663 4.503e-005 -90.247 4.6256e-005 -90.247 4.7536e-005 -92.188 4.8763e-005 -94.062 5.0042e-005 -95.944 5.1269e-005 -97.79 5.2549e-005 -99.722 5.3776e-005 -101.56 5.5002e-005 -103.36 5.6282e-005 -104.91 5.7509e-005 -106.3 5.7899e-005 -106.3 5.7899e-005 -107.74 6.016e-005 -109.08 6.1296e-005 -111.87 6.5229e-005 -111.87 6.5229e-005 -114.94 6.5229e-005 -114.94 6.6256e-005 -116.57 6.8763e-005 -1920 0.56298 -77.943 6.8763e-005 -99.72 2.159 -66256e-005 -14.94 -22.159 <td< td=""><td>3.8791e-005</td><td>-77.361</td><td></td><td>-15.072</td></td<>	3.8791e-005	-77.361		-15.072
4.2523e-005 -84.344 -17.819 4.3803e-005 -86.663 -18.751 4.503e-005 -88.564 -19.559 4.6256e-005 -90.247 -20.251 4.7536e-005 -92.188 -20.826 4.8763e-005 -94.062 0. -21.215 5.0042e-005 -95.944 -21.444 5.1269e-005 -97.79 -21.519 5.2549e-005 -99.722 -21.505 5.3776e-005 -101.56 -21.435 5.5002e-005 -103.36 -21.338 -21.338 5.6282e-005 -104.91 -21.228 5.7509e-005 -106.3 -21.14 6.0216e-005 -109.08 -21.151 6.1296e-005 -110.47 -21.34 6.529ae-005 -111.87 -21.671 6.5029e-005 -113.4 -22.721 6.60256e-005 -116.57 -23.333 6.7536e-005 -1920 0.56298 -77.943 6.8763e-005 -99.73 129.44 -204.1 7.2512e-005	4.0017e-005	-79.789		-15.932
4.2523e-005 -84.344 -17.819 4.3803e-005 -86.663 -18.751 4.503e-005 -88.564 -19.559 4.6256e-005 -90.247 -20.251 4.7536e-005 -92.188 -20.826 4.8763e-005 -94.062 0. -21.215 5.0042e-005 -95.944 -21.444 5.1269e-005 -97.79 -21.519 5.2549e-005 -99.722 -21.505 5.3776e-005 -101.56 -21.435 5.5002e-005 -103.36 -21.338 -21.338 5.6282e-005 -104.91 -21.228 5.7509e-005 -106.3 -21.14 6.0216e-005 -109.08 -21.151 6.1296e-005 -110.47 -21.34 6.529ae-005 -111.87 -21.671 6.5029e-005 -113.4 -22.721 6.60256e-005 -116.57 -23.333 6.7536e-005 -1920 0.56298 -77.943 6.8763e-005 -99.73 129.44 -204.1 7.2512e-005	4.1297e-005	-82.114		-16.888
4.503e-005 -88.564 4.6256e-005 -90.247 4.7536e-005 -92.188 4.8763e-005 -94.062 5.0042e-005 -95.944 5.1269e-005 -97.79 5.2549e-005 -99.722 5.3776e-005 -101.56 5.5002e-005 -103.36 5.6282e-005 -104.91 5.7509e-005 -106.3 5.8789e-005 -107.74 6.0016e-005 -109.08 6.1296e-005 -111.87 6.3803e-005 -111.87 6.5029e-005 -116.57 6.3803e-005 -114.94 6.5029e-005 -116.57 6.7536e-005 -1920. 0.56298 -77.943 6.8763e-005 -1920. 0.56298 -77.943 6.87536e-005 -190.0 0.56298 -77.943 6.8763e-005 -9049.1 2.9046 -440.46 7.0043e-005 -5733.2 1296.8 5454.1 42.693<	4.2523e-005			-17.819
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9.0003e-005 -1177. 664.31 -23.715 9.1273e-005 -753.1 491.93 -50.651 9.2507e-005 -1302.4 327.06 -117.55 9.3757e-005 -1041.7 341.5 -123.12	8.7508e-005	-1270.5	382.22	-89.501
9.1273e-005 -753.1 491.93 -50.651 9.2507e-005 -1302.4 327.06 -117.55 9.3757e-005 -1041.7 341.5 -123.12	8.8755e-005	-1018.	519.69	-39.465
9.2507e-005 -1302.4 327.06 -117.55 9.3757e-005 -1041.7 341.5 -123.12	9.0003e-005	-1177.	664.31	-23.715
9.3757e-005 -1041.7 341.5 -123.12	9.1273e-005	-753.1	491.93	-50.651
	9.2507e-005	-1302.4	327.06	-117.55
	9.3757e-005	-1041.7	341.5	-123.12
			345.18	

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9.6265e-005	-1145.1	387.63	-48.318	
9.751e-005	-794.04	380.54	-38.367	
9.8762e-005	-631.82	373.13	-67.397	
1.0001e-004	-632.74	391.36	-81.007	

FIGURE 7
Model (A4) > Explicit Dynamics (A5) > Solution (A6) > Normal Stress > NormalStress



Material Data

COPPER

TABLE 27
COPPER > Constants

Density	8.9e-006 kg mm^-3		
Specific Heat	1.e-009 mJ kg^-1 C^-1		

TABLE 28
COPPER > Shock EOS Linear

Gruneisen Coefficient	Parameter C1 mm s^-1	Parameter S1	Parameter Quadratic S2 s mm^-1
2	3.958e+006	1.497	0

TABLE 29

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COPPER > Shear Modulus

Shear Modulus MPa 46400

TABLE 30
COPPER > Multilinear Isotropic Hardening

Stress MPa	Plastic Strain mm mm^-1	Temperature C
120	0	0
450	0.3	0
450	1.e+020	0

TABLE 31 COPPER > Color

Red	Green	Blue
181	155	130

AL 2024-T4

TABLE 32 AL 2024-T4 > Constants

Density	2.785e-006 kg mm^-3
Specific Heat	8.63e+005 mJ kg^-1 C^-1

TABLE 33 AL 2024-T4 > Shock EOS Linear

Gruneisen Coefficient	Parameter C1 mm s^-1	Parameter S1	Parameter Quadratic S2 s mm^-1
2	5.328e+006	1.338	0

TABLE 34 AL 2024-T4 > Steinberg Guinan Strength

Initial Yield Stress Y MPa	Maximum Yield Stress Ymax MPa	Hardening Constant B	5	Derivative dG/dP G'P	Derivative dG/dT G'T MPa C^-1	Derivative dY/dP Y'P	Melting Temperature Tmelt C
260	760	310	0.185	1.8647	-17.62	1.695e-002	946.85

TABLE 35 AL 2024-T4 > Shear Modulus

Shea	r Modulus MPa
28600	

TABLE 36 AL 2024-T4 > Color

Red	Green	Blue
182	229	228

TABLE 37 AL 2024-T4 > Principal Stress Failure

Maximum Tensile Stress MPa	Maximum Shear Stress MPa	
1000	1000	