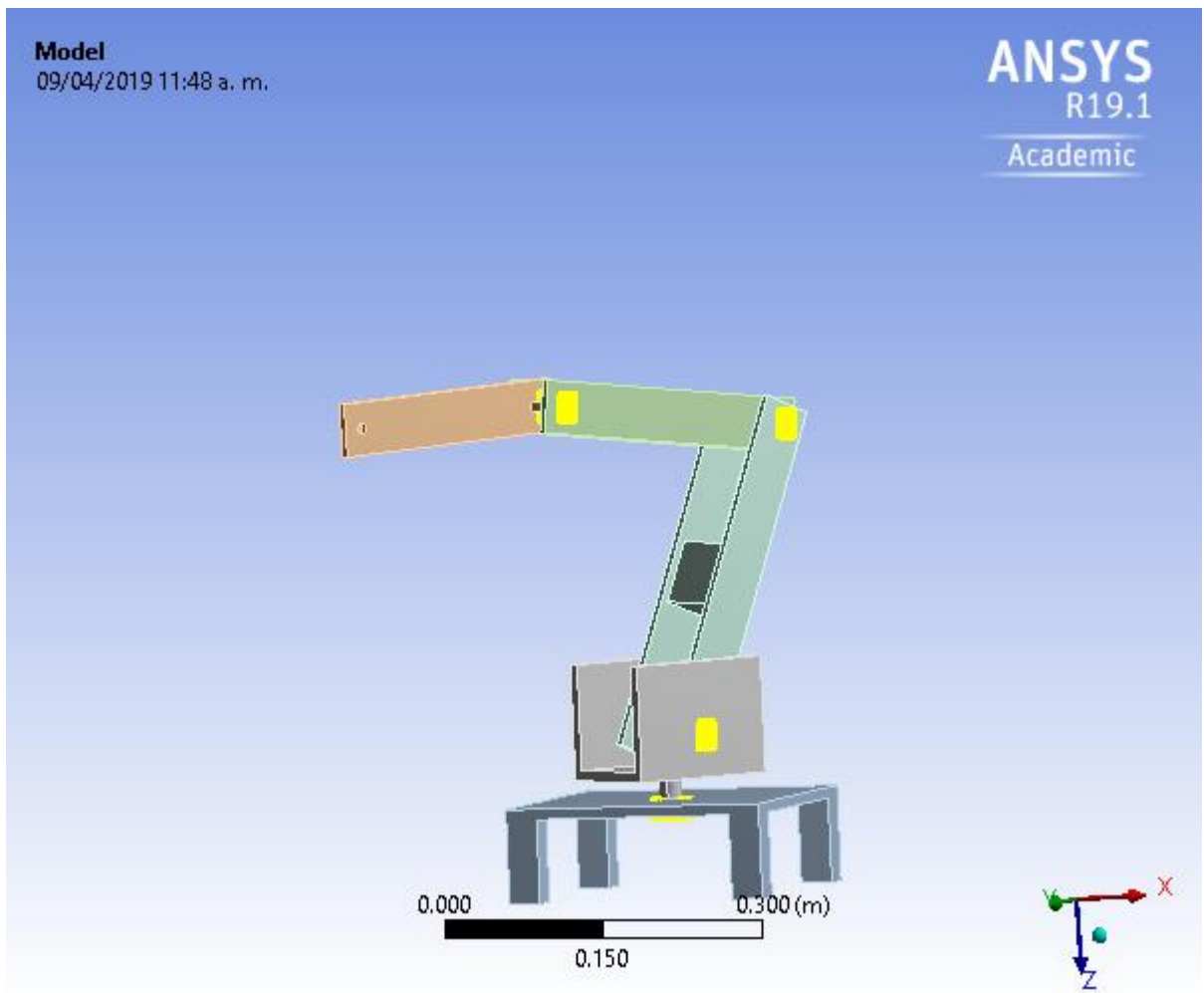




Project

First Saved	Tuesday, April 9, 2019
Last Saved	Tuesday, April 9, 2019
Product Version	19.1 Release
Save Project Before Solution	No
Save Project After Solution	No



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Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) 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\Raul Garcia\Desktop\Proyecto\Ensamblaje1.IGS
Type	Iges
Length Unit	Millimeters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	

Length X	0.31846 m
Length Y	0.46519 m
Length Z	0.50401 m
Properties	
Volume	2.1281e-003 m³
Mass	16.705 kg
Scale Factor Value	1.
Statistics	
Bodies	9
Active Bodies	9
Nodes	24602
Elements	8969
Mesh Metric	None
Update Options	
Assign Default Material	No
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Independent
Parameter Key	ANS;DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	Yes
Coordinate System Key	DS
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
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	base del brazo	basedelabasegarabo	Eslabon 2	Eslabon 3	eslabon1robotgarabo	Perno 3	Perno 4	Perno 5	Prtno 2
State	Meshed								
Graphics Properties									
Visible	Yes								
Transparency	1								
Definition									
Suppressed	No								
Stiffness Behavior	Flexible								

Coordinate System	Default Coordinate System								
Reference Temperature	By Environment								
Behavior	None								
Material									
Assignment	Structural Steel								
Nonlinear Effects	Yes								
Thermal Strain Effects	Yes								
Bounding Box									
Length X	0.16524 m	0.2688 m	0.20092 m	0.13232 m	0.17057 m	5.3966e-002 m	2.1992e-002 m	9.2807e-002 m	7.4299e-002 m
Length Y	0.18039 m	0.26637 m	0.29111 m	0.22124 m	0.19661 m	3.6982e-002 m	2.085e-002 m	6.1302e-002 m	4.9218e-002 m
Length Z	0.11497 m	9.9822e-002 m	9.3969e-002 m	5.3974e-002 m	0.34296 m	1.224e-002 m	4.0751e-002 m	1.5976e-002 m	1.2897e-002 m
Properties									
Volume	4.4532e-004 m³	9.0988e-004 m³	2.7018e-004 m³	8.6407e-005 m³	3.8537e-004 m³	4.37e-006 m³	1.2486e-005 m³	7.8036e-006 m³	6.2429e-006 m³
Mass	3.4957 kg	7.1425 kg	2.1209 kg	0.6783 kg	3.0252 kg	3.4305e-002 kg	9.8013e-002 kg	6.1258e-002 kg	4.9007e-002 kg
Centroid X	5.6153e-002 m	5.3451e-002 m	6.5485e-002 m	- 6.5308e-002 m	9.1055e-002 m	2.4564e-003 m	5.4425e-002 m	5.6089e-002 m	0.12602 m
Centroid Y	0.33379 m	0.33344 m	0.34626 m	0.53841 m	0.28214 m	0.45632 m	0.33356 m	0.33378 m	0.2305 m
Centroid Z	0.18026 m	0.26139 m	-0.12025 m	-0.13747 m	4.0291e-002 m	-0.13852 m	0.23216 m	0.18219 m	-0.10161 m
Moment of Inertia Ip1	1.0058e-002 kg·m²	5.7453e-002 kg·m²	1.3257e-002 kg·m²	3.4856e-003 kg·m²	2.251e-002 kg·m²	9.178e-006 kg·m²	1.5503e-005 kg·m²	5.1429e-005 kg·m²	2.6441e-005 kg·m²
Moment of Inertia Ip2	1.0936e-002 kg·m²	5.7453e-002 kg·m²	1.4379e-003 kg·m²	1.4582e-004 kg·m²	3.4748e-003 kg·m²	4.2606e-007 kg·m²	4.8693e-006 kg·m²	5.1429e-005 kg·m²	6.0866e-007 kg·m²
Moment of Inertia Ip3	1.2367e-002 kg·m²	0.10616 kg·m²	1.2579e-002 kg·m²	3.6259e-003 kg·m²	2.0078e-002 kg·m²	9.178e-006 kg·m²	1.5503e-005 kg·m²	7.6083e-007 kg·m²	2.6441e-005 kg·m²
Statistics									
Nodes	4164	2674	3054	1245	4571	2289	2027	2289	
Elements	2075	1237	1532	154	2235	448	392	448	
Mesh Metric	None								

Coordinate Systems

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

Object Name	Global Coordinate System
State	Fully Defined
Definition	

Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. m
Origin Y	0. m
Origin Z	0. m
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 > Contacts

Object Name	<i>Contacts</i>
State	Fully Defined
Definition	
Connection Type	Contact
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Auto Detection	
Tolerance Type	Slider
Tolerance Slider	0.
Tolerance Value	1.8905e-003 m
Use Range	No
Face/Face	Yes
Face Overlap Tolerance	Off
Cylindrical Faces	Include
Face/Edge	No
Edge/Edge	No
Priority	Include All
Group By	Bodies
Search Across	Bodies
Statistics	
Connections	11
Active Connections	11

TABLE 7
Model (B4) > Connections > Contacts > Contact Regions

ect me	Contact Region	Contact Region 2	Contact Region 3	Contact Region 4	Contact Region 5	Contact Region 6	Contact Region 7	Contact Region 8	Contact Region 9	Contact Region 10	
ate	Fully Defined										
	Scope										
ing nod	Geometry Selection										
act	2 Faces		4 Faces	2 Faces		1 Face		4 Faces		2 Faces	4 Faces
get	2 Faces				1 Face			2 Faces			
act lies	base del brazo			basedelabasegarabo		Eslabon 2				Eslabon 3	eslabon1robotgarabo
get lies	eslabon1robotgarabo	Perno 4	Perno 5	Perno 4		Eslabon 3	eslabon1robotgarabo	Perno 3	Prtno 2	Perno 3	Perno 5
ted	No										
	Definition										
ype	Bonded										
ppe ode	Automatic										
avior	Program Controlled										
rim act	Program Controlled										
rim nce	1.8905e-003 m										
sed	No										
	Advanced										
ion	Program Controlled										
nal ling	Program Controlled										
ion nod	Program Controlled										
ion nce	Program Controlled										
Slip nce	Program Controlled										
mal ess	Program Controlled										
ate ess	Program Controlled										
ball ion	Program Controlled										
	Geometric Modification										
act etry ion	None										
get etry ion	None										

Mesh

TABLE 8
Model (B4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Use Adaptive Sizing	Yes
Resolution	Default (2)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Fast
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Diagonal	0.7562 m
Average Surface Area	4.3329e-003 m ²
Minimum Edge Length	9.7253e-004 m
Quality	
Check Mesh Quality	Yes, Errors
Error Limits	Standard Mechanical
Target Quality	Default (0.050000)
Smoothing	Medium
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	No
Number of Retries	Default (4)
Rigid Body Behavior	Dimensionally Reduced
Triangle Surface Mesher	Program Controlled
Topology Checking	Yes
Pinch Tolerance	Please Define
Generate Pinch on Refresh	No
Statistics	
Nodes	24602
Elements	8969

Static Structural (B5)

TABLE 9
Model (B4) > Analysis

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

TABLE 10
Model (B4) > Static Structural (B5) > Analysis Settings

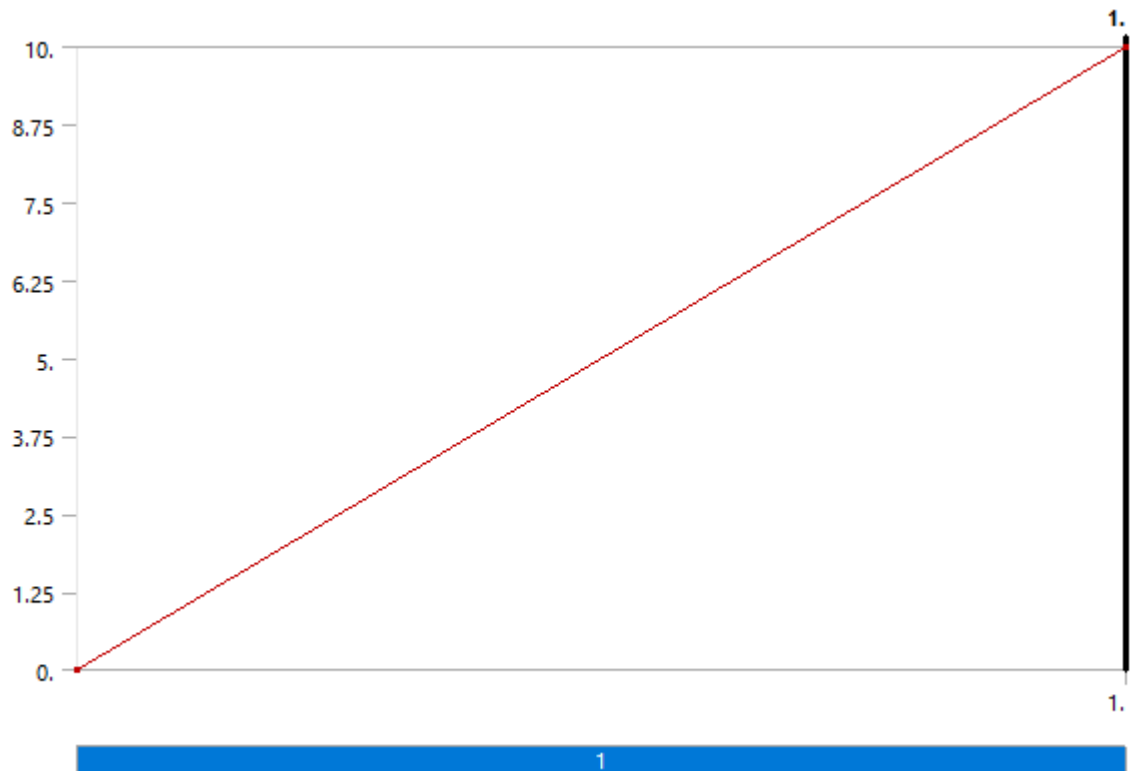
Object Name	<i>Analysis Settings</i>
State	Fully Defined
Step Controls	
Number Of Steps	1.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Program Controlled
Solver Controls	
Solver Type	Program Controlled
Weak Springs	Off
Solver Pivot Checking	Program Controlled
Large Deflection	Off
Inertia Relief	Off
Rotordynamics Controls	
Coriolis Effect	Off
Restart Controls	
Generate Restart Points	Program Controlled
Retain Files After Full Solve	No
Combine Restart Files	Program Controlled
Nonlinear Controls	
Newton-Raphson Option	Program Controlled
Force Convergence	Program Controlled
Moment Convergence	Program Controlled
Displacement Convergence	Program Controlled

Rotation Convergence	Program Controlled
Line Search	Program Controlled
Stabilization	Off
Output Controls	
Stress	Yes
Strain	Yes
Nodal Forces	No
Contact Miscellaneous	No
General Miscellaneous	No
Store Results At	All Time Points
Analysis Data Management	
Solver Files Directory	C:\Users\Raul Garcia\AppData\Local\Temp\WB_DESKTOP-JHJS8R7_Raul Garcia_7412_2\unsaved_project_files\dp0\SYS\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Contact Summary	Program Controlled
Delete Unneeded Files	Yes
Nonlinear Solution	No
Solver Units	Active System
Solver Unit System	mks

TABLE 11
Model (B4) > Static Structural (B5) > Loads

Model (B7) - Static Structural (B6) - Loads		
Object Name	Fixed Support	Force
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	4 Faces	1 Face
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Vector
Magnitude		10. N (ramped)
Direction		Defined

FIGURE 1
Model (B4) > Static Structural (B5) > Force



Solution (B6)

TABLE 12
Model (B4) > Static Structural (B5) > Solution

Object Name	<i>Solution (B6)</i>
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	
Status	Done
MAPDL Elapsed Time	27. s
MAPDL Memory Used	505. MB
MAPDL Result File Size	10.375 MB
Post Processing	
Beam Section Results	No
On Demand Stress/Strain	No

TABLE 13
Model (B4) > Static Structural (B5) > Solution (B6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Newton-Raphson Residuals	0

Identify Element Violations	0
Update Interval	2.5 s
Display Points	All
FE Connection Visibility	
Activate Visibility	Yes
Display	All FE Connectors
Draw Connections Attached To	All Nodes
Line Color	Connection Type
Visible on Results	No
Line Thickness	Single
Display Type	Lines

TABLE 14
Model (B4) > Static Structural (B5) > Solution (B6) > Results

Object Name	Total Deformation	Equivalent Elastic Strain
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent Elastic Strain
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. m	1.6382e-008 m/m
Maximum	1.0776e-004 m	3.2168e-005 m/m
Average	2.7715e-005 m	2.6383e-006 m/m
Minimum Occurs On	basedelabasegarabo	Perno 5
Maximum Occurs On	Eslabon 3	basedelabasegarabo
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

FIGURE 2
Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation

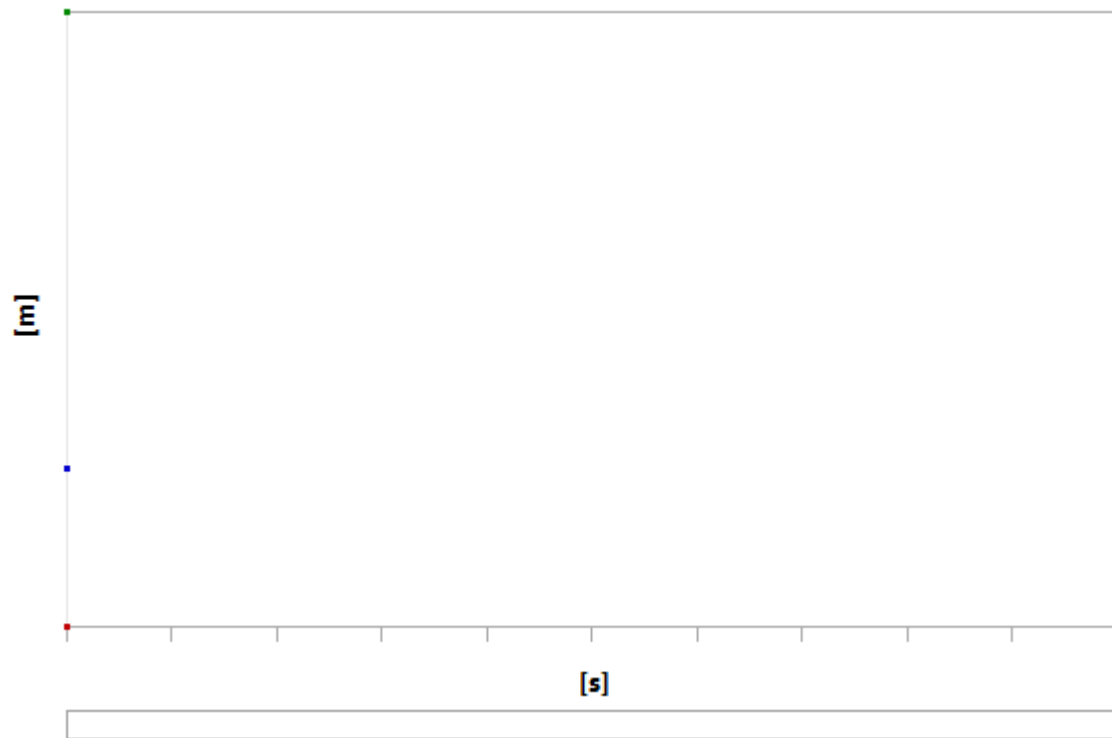


TABLE 15
Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]	Average [m]
1.	0.	1.0776e-004	2.7715e-005

FIGURE 3
Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation > Figure

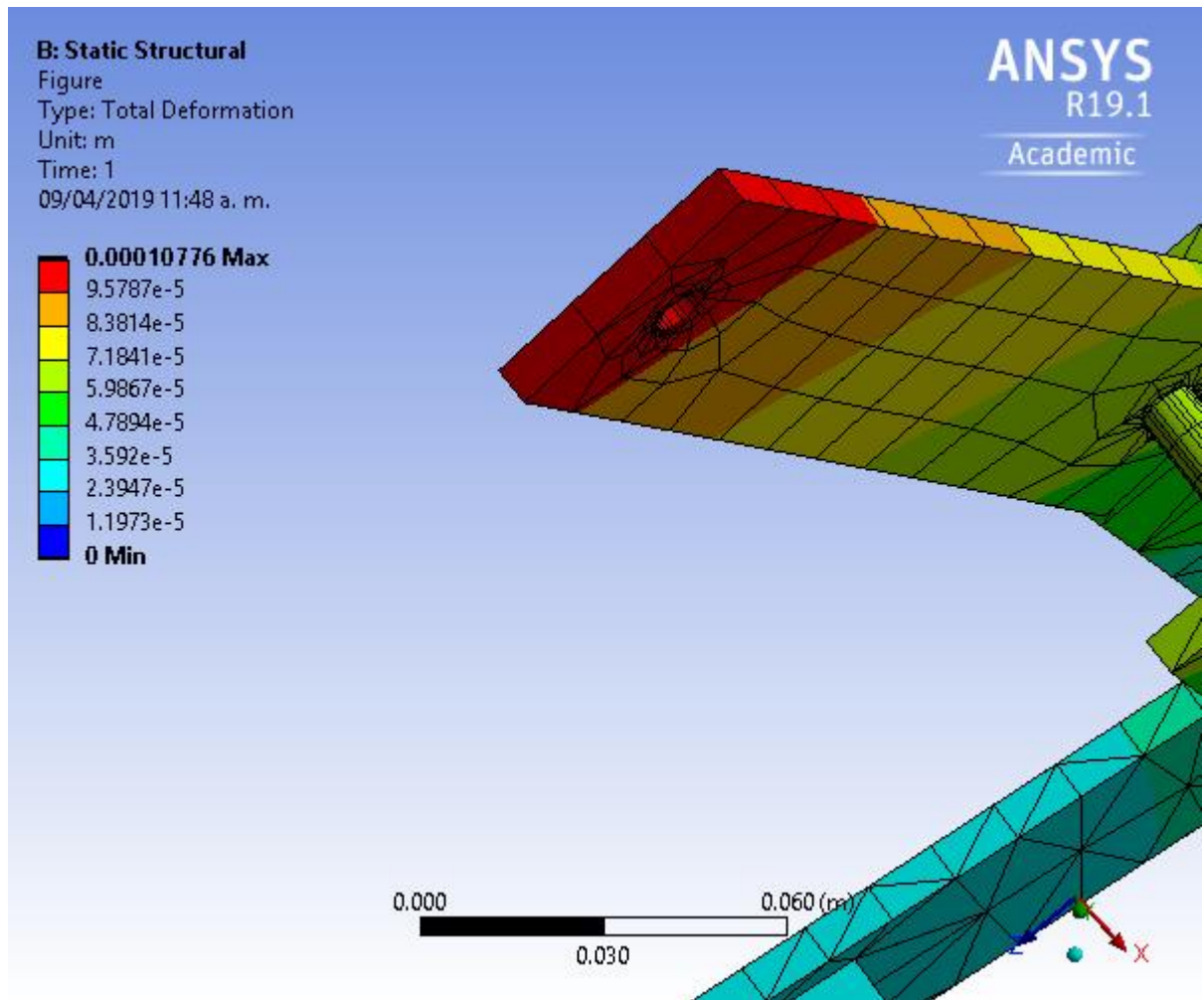


FIGURE 4
Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation > Figure 2

B: Static Structural

Figure 2

Type: Total Deformation

Unit: m

Time: 1

09/04/2019 11:48 a. m.

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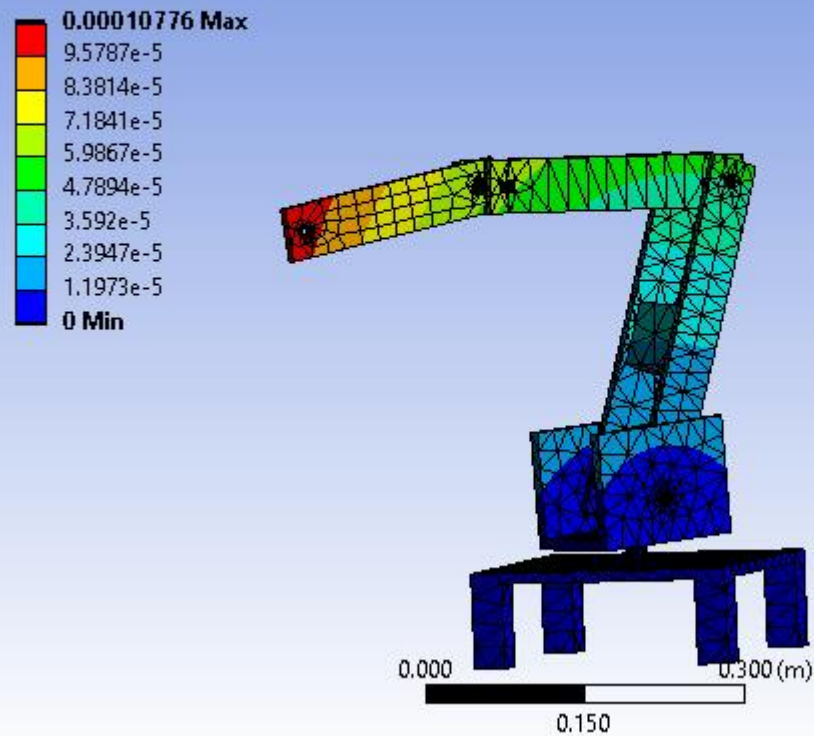


FIGURE 5
Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Elastic Strain

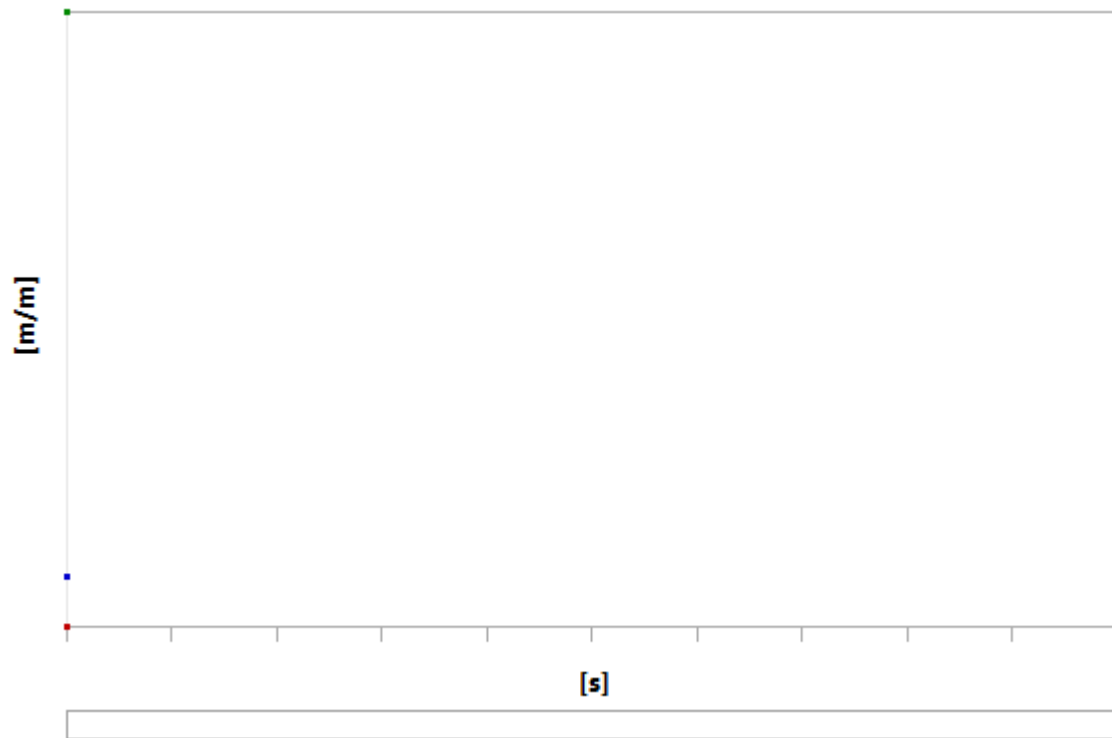


TABLE 16
Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Elastic Strain

Time [s]	Minimum [m/m]	Maximum [m/m]	Average [m/m]
1.	1.6382e-008	3.2168e-005	2.6383e-006

FIGURE 6
Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Elastic Strain > Figure

B: Static Structural

Figure

Type: Equivalent Elastic Strain

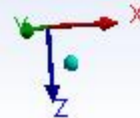
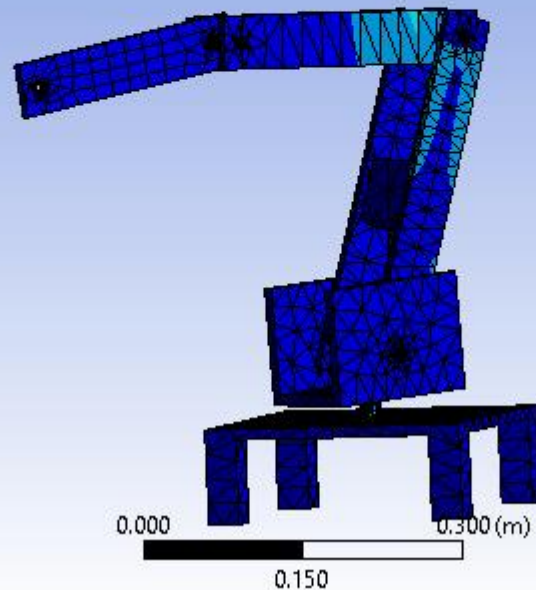
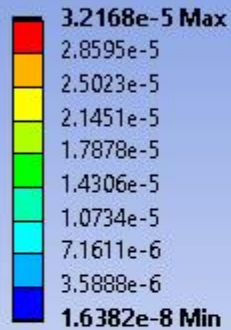
Unit: m/m

Time: 1

09/04/2019 11:49 a. m.

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Material Data

Structural Steel

TABLE 17
Structural Steel > Constants

Density	7850 kg m ⁻³
Coefficient of Thermal Expansion	1.2e-005 C ⁻¹
Specific Heat	434 J kg ⁻¹ C ⁻¹
Thermal Conductivity	60.5 W m ⁻¹ C ⁻¹
Resistivity	1.7e-007 ohm m

TABLE 18
Structural Steel > Color

Red	Green	Blue
132	139	179

TABLE 19
Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength Pa
0

TABLE 20
Structural Steel > Compressive Yield Strength

Compressive Yield Strength Pa
2.5e+008

TABLE 21
Structural Steel > Tensile Yield Strength

Tensile Yield Strength Pa
2.5e+008

TABLE 22
Structural Steel > Tensile Ultimate Strength

Tensile Ultimate Strength Pa
4.6e+008

TABLE 23
Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Zero-Thermal-Strain Reference Temperature C
22

TABLE 24
Structural Steel > S-N Curve

Alternating Stress Pa	Cycles	Mean Stress Pa
3.999e+009	10	0
2.827e+009	20	0
1.896e+009	50	0
1.413e+009	100	0
1.069e+009	200	0
4.41e+008	2000	0
2.62e+008	10000	0
2.14e+008	20000	0
1.38e+008	1.e+005	0
1.14e+008	2.e+005	0
8.62e+007	1.e+006	0

TABLE 25
Structural Steel > Strain-Life Parameters

Strength Coefficient Pa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient Pa	Cyclic Strain Hardening Exponent
9.2e+008	-0.106	0.213	-0.47	1.e+009	0.2

TABLE 26
Structural Steel > Isotropic Elasticity

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
2.e+011	0.3	1.6667e+011	7.6923e+010	

TABLE 27
Structural Steel > Isotropic Relative Permeability

Relative Permeability
10000