Thermal bending, sector supported

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1. Introduction

Flex along the width of the ladder.
1 cm sector support
20 deg. C temperature increase

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2. File Information

Model name:	A ladder

Model location:	C:\Documents and Settings\Howard Wieman\My Documents\aps project\mechanical\ladder thermal thin\A ladder.SLDASM
Results location:	C:\Program Files\SolidWorks\COSMOS\work
Study name:	thermal deformation 2 (-Default-)

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3. Materials

No.	Part Name	Material	Mass	Volume
1	A carbon ladder floor-1	[SW]ladder carbon corrected	8.86643e-006 kg	5.72e-009 m^3
2	cable-1	[SW]cable mix	3.61734e-005 lb	0.000709281 in^3
3	chip-1	[SW]silicon D	4.41771e-006 kg	1.9e-009 m^3
4	sector piece-1	[SW]ladder carbon corrected	6.2003e-006 kg	4e-009 m^3

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4. Load & Restraint Information

Restraint	
Restraint-1 <sector piece-1>	on **1 Face(s)** fixed.
Description:	
Restraint-2 <sector piece-1>	on **1 Face(s)** with respect to reference geometry **Face< 1 >** with displacement **0 m** normal to reference plane

Description:	
Restraint-3 <chip-1, cable-1, A carbon ladder floor-1, sector piece-1>	on **8 Face(s)** symmetry
Description:	

Load	
Temperature-1 <cable-1, A carbon ladder floor-1, chip-1, sector piece-1>	on **4 Component(s)** with temperature **320 Kelvin**
Description:	

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5. Study Property

Mesh Information	
Mesh Type:	Solid mesh
Mesher Used:	Standard
Automatic Transition:	Off
Smooth Surface:	On
Jacobian Check:	4 Points
Element Size:	0.28555 mm
Tolerance:	0.014278 mm
Quality:	High
Number of elements:	11954
Number of nodes:	19380
Time to complete mesh(hh;mm;ss):	00:00:05
Computer name:	WIEMAN-M90

Solver Information	
Quality:	High

Solver Type:	FFEPlus
Option:	Include Thermal Effects
Thermal Option:	Input Temperature
Thermal Option:	Reference Temperature at zero strain: 300 Kelvin

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6. Contact

Contact state: Touching faces - Bonded

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7. Results

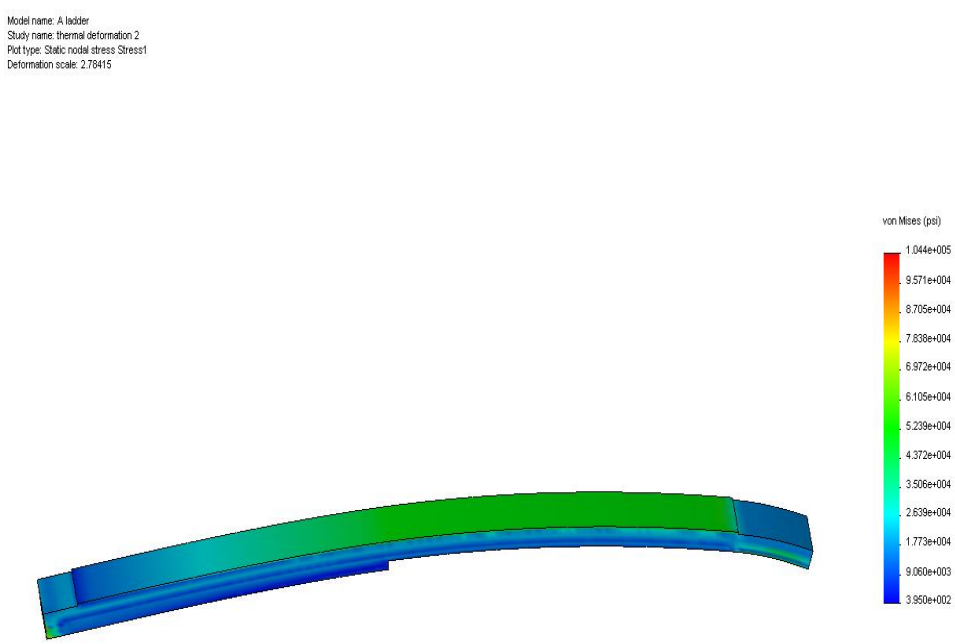
7a. Default Results

Name	Type	Min	Location	Max	Location
Stress1	VON: von Mises stress	394.989 psi Node: 19194	(93.1429 mm, 0.66 mm, -4.78571 mm)	104379 psi Node: 19279	(93.1429 mm, 0.66 mm, 1 mm)

Displacement2	UY: Y Displacement	-3.92199e-005 m Node: 9229	(93.8571 mm, 0.06584 mm, -4.82089 mm)	0.000790188 m Node: 548	(95 mm, 0.33 mm, -21 mm)

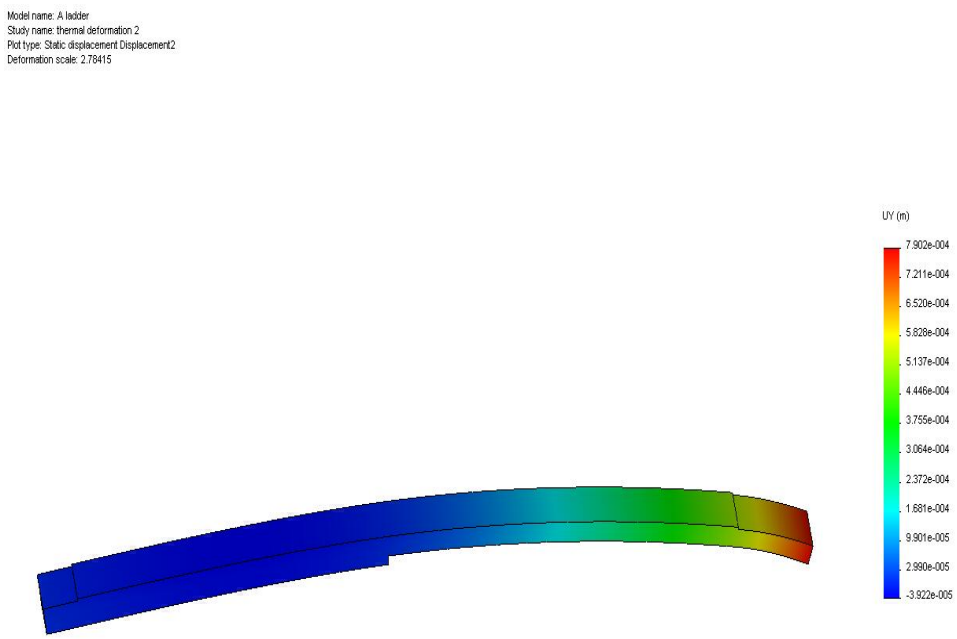
A ladder-thermal deformation 2-Stress-Stress1

JPEG



A ladder-thermal deformation 2-Displacement-Displacement2

JPEG



8. Design Scenario Results

9. Conclusion

500 microns deformation with stiff connection

10. Appendix

Material name: [SW]ladder carbon corrected

Description:

Material Source: Used SolidWorks material

Material Library Name: carbon composite tube

Material Model Type: Linear Elastic Isotropic

Property Name	Value	Units	Value Type
Elastic modulus	1.3996e+011	N/m^2	Constant
Poisson's ratio	0.33	NA	Constant
Shear modulus	7.0396e+010	N/m^2	Constant
Mass density	1550.1	kg/m^3	Constant
Tensile strength	1.8961e+009	N/m^2	Constant
Yield strength	1.2273e+009	N/m^2	Constant
Thermal expansion coefficient	1e-006	/Kelvin	Constant
Thermal conductivity	46	W/(m.K)	Constant
Specific heat	920	J/(kg.K)	Constant

Material name: [SW]cable mix

Description:

Material Source: Used SolidWorks material

Material Library Name:

Material Model Type: Linear Elastic Isotropic

Property Name	Value	Units	Value Type
Elastic modulus	1.55e+006	psi	Constant
Poisson's ratio	0.34	NA	Constant
Shear modulus	1.55e+006	psi	Constant
Mass density	0.051	lb/in^3	Constant
Tensile strength	51	psi	Constant
Yield strength	51	psi	Constant
Thermal expansion coefficient	0.00027333	/Fahrenheit	Constant
Thermal conductivity	0.00030762	BTU/(in.s.F)	Constant
Specific heat	0.31701	Btu/(lb.F)	Constant

Material name: [SW]silicon D

Description:

Material Source: Used SolidWorks material

Material Library Name: carbon composite tube

Material Model Type: Linear Elastic Isotropic

Property Name	Value	Units	Value Type
Elastic modulus	1.1032e+011	N/m^2	Constant
Poisson's ratio	0.28	NA	Constant
Shear modulus	4.8953e+010	N/m^2	Constant
Mass density	2325.1	kg/m^3	Constant
Tensile strength	1.1997e+008	N/m^2	Constant

Yield strength	1.1997e+008	N/m^2	Constant
Thermal expansion coefficient	3e-006	/Kelvin	Constant
Thermal conductivity	124	W/(m.K)	Constant
Specific heat	700	J/(kg.K)	Constant