Determination of shear stress imposed by ladder

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1. Introduction

A section of ladder is raised in temperature to determine the shear load imposed on the sector support beam.

Note:

Do not base your design decisions solely on the data presented in this report. Use this information in conjunction with experimental data and practical experience. Field testing is mandatory to validate your final design. COSMOSWorks helps you reduce your time-to-market by reducing but not eliminating field tests.

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2. Description

20 deg C20 deg C temperature rise
layers:
1. Silicon, 50 microns
2. acrylic 3M 467 MP, 50.8 microns
3. aluminum kapton flex cable, 137 microns
4. acrylic 3M 467 MP, 50.8 microns

Layer 4 is fixed on the bottom surface and the shear stress on the surface is determined.

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3. File Information

Model name:	ladder section
Model location:	C:\Documents and Settings\Howard Wieman\My Documents\aps project\mechanical\ladder thermal thin 3\ladder section.SLDASM
Results location:	C:\Program Files\SolidWorks\COSMOS\work
Study name:	full width (-full width-)

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4. Materials

No.	Part Name	Material	Mass	Volume

1	Silicon Ladder us-1	[SW]silicon D	6.39406e-005 kg	2.75e-008 m^3
2	acrylic us-1	[SW]acrylic adhesive	3.24818e-005 kg	2.794e-008 m^3
3	acrylic us-2	[SW]acrylic adhesive	3.24818e-005 kg	2.794e-008 m^3
4	cable us-1	[SW]cable mix no adhesive	0.000125287 kg	7.5438e-008 m^3

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5. Load & Restraint Information

Restraint	
Restraint-1 <acrylic us-1>	on **1 Face(s)** fixed.
Description:	
Restraint-2 <Silicon Ladder us-1, acrylic us-2, cable us-1, acrylic us-1>	on **8 Face(s)** symmetry
Description:	

Load	
Temperature-1 <acrylic us-1, cable us-1, acrylic us-2, Silicon Ladder us-1>	on **4 Component(s)** with temperature **320 Kelvin**
Description:	

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6. Study Property

Mesh Information	
Mesh Type:	Solid mesh
Mesher Used:	Standard
Automatic Transition:	Off
Smooth Surface:	On
Jacobian Check:	4 Points
Element Size:	0.054183 cm
Tolerance:	0.0027091 cm
Quality:	High
Number of elements:	48393
Number of nodes:	74002
Time to complete mesh(hh;mm;ss):	00:00:46
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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7. Contact

Contact state: Touching faces - Bonded

8. Results

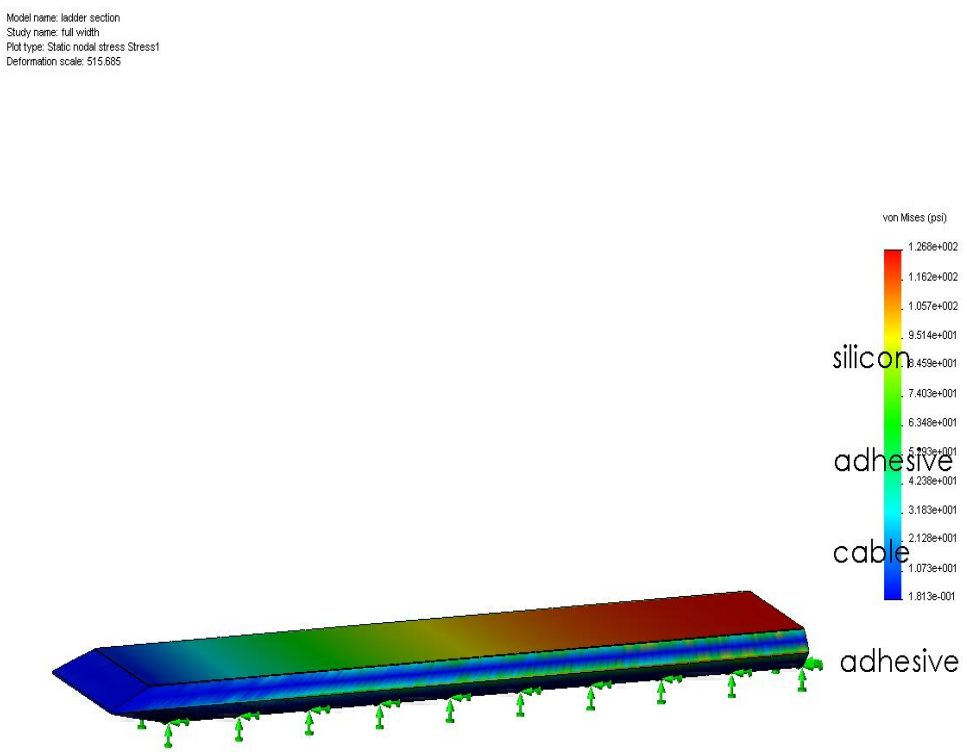
8a. Default Results

Name	Type	Min	Location	Max	Location
Stress1	VON: von Mises stress	0.181333 psi Node: 63490	(-0.537115 cm, 0.912963 cm, -4.49296 cm)	126.787 psi Node: 24487	(0.484005 cm, 0.918099 cm, -4.48924 cm)
Displacement1	URES: Resultant displacement	0 m Node: 24500	(-0.55 cm, 0.892905 cm, 0.49171 cm)	1.02172e-005 m Node: 49055	(0.55 cm, 0.911701 cm, 0.49171 cm)
Strain1	ESTRN: Equivalent strain	1.66403e-008 Element: 11338	(0.536905 cm, 0.920531 cm, 0.464828 cm)	0.118608 Element: 17290	(0.464583 cm, 0.894775 cm, 0.481563 cm)
Stress2	TYZ: Shear in Z dir. on XZ plane	-0.646803 psi Node: 23027	(0.55 cm, 0.919281 cm, -0.180333 cm)	0.702074 psi Node: 22533	(0.55 cm, 0.921781 cm, -4.21259 cm)
Stress3	SY: Y Normal stress	-0.62681 psi	(-0.197056 cm,	0.706736 psi	(0.11 cm, 0.921781

		Node: 7090	0.918129 cm, 0.350687 cm)	Node: 16322	cm, 0.330419 cm)

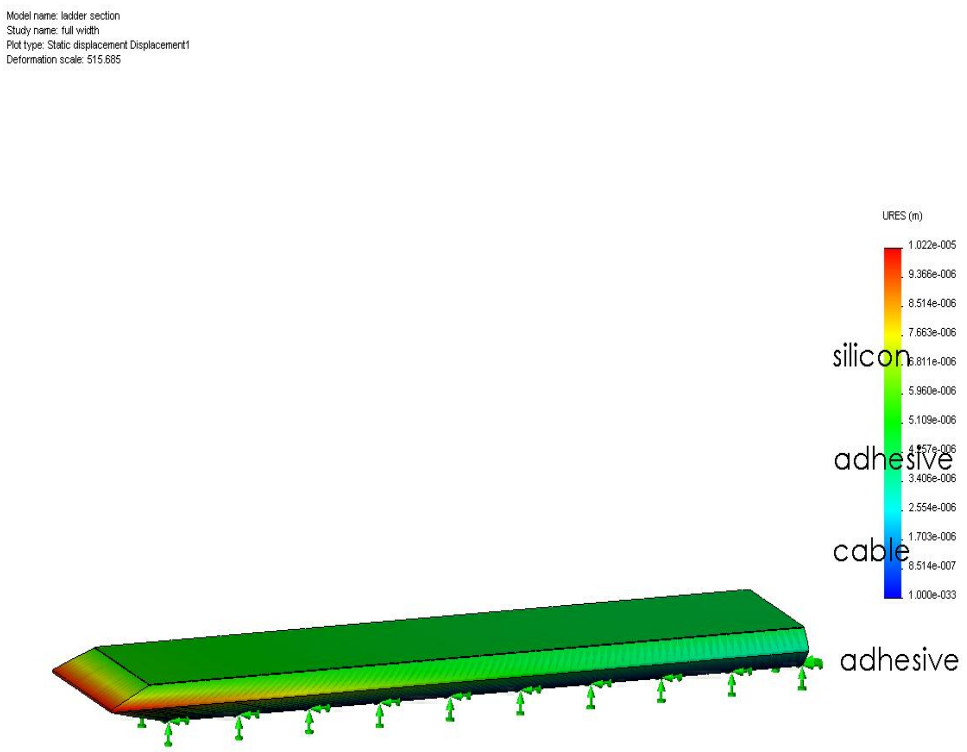
ladder section-full width-Stress-Stress1

JPEG



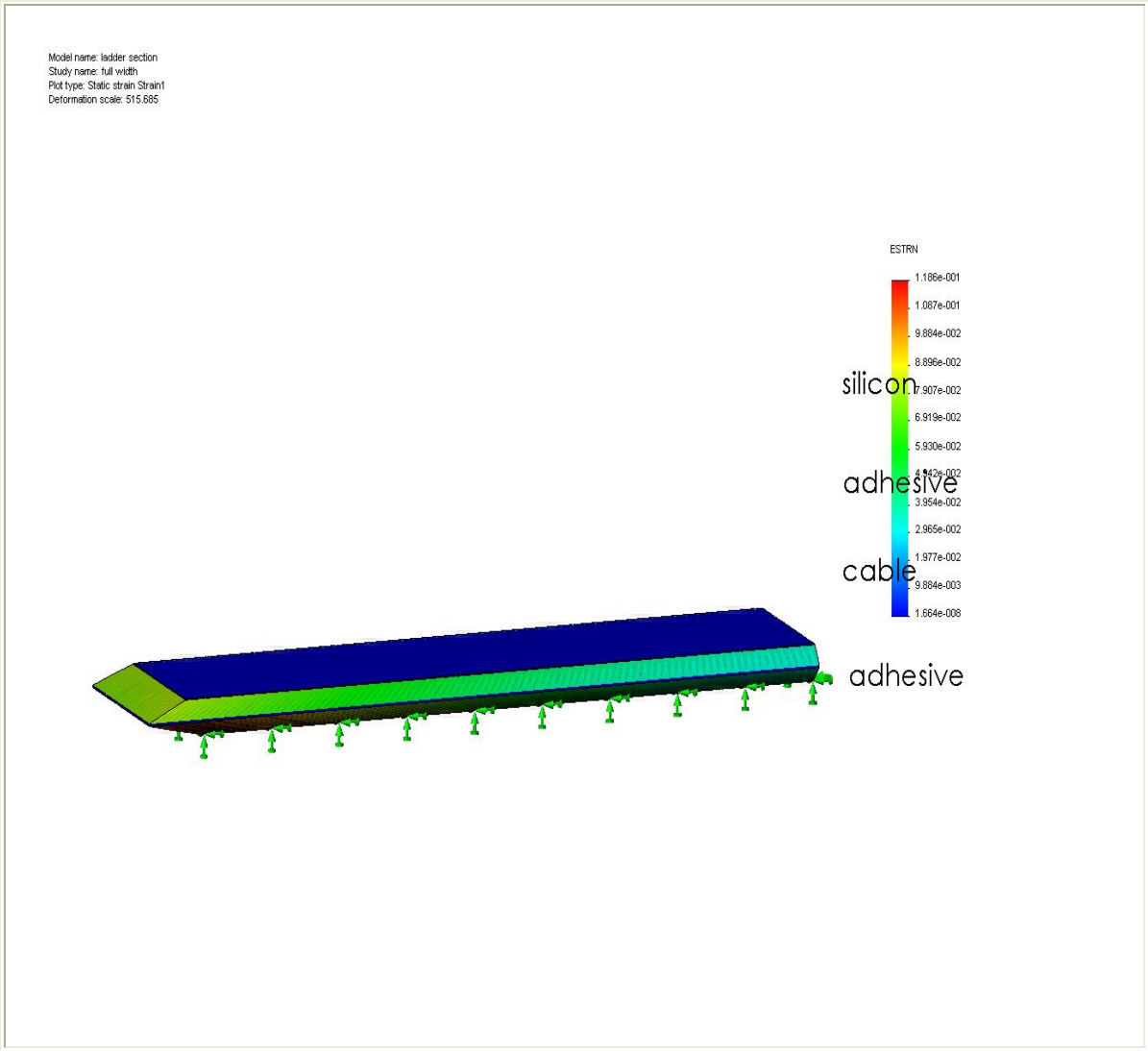
ladder section-full width-Displacement-Displacement1

JPEG



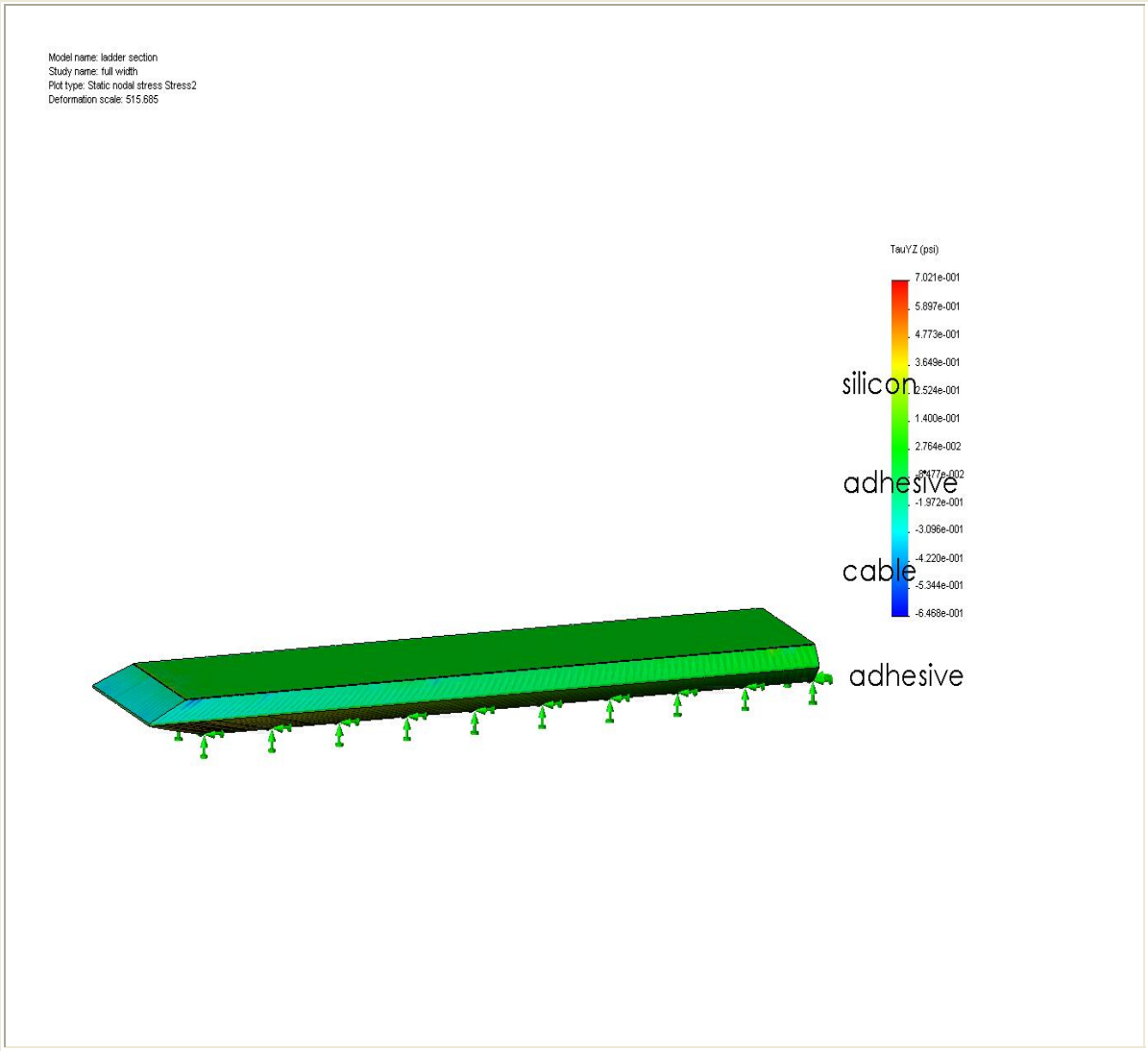
ladder section-full width-Strain-Strain1

JPEG



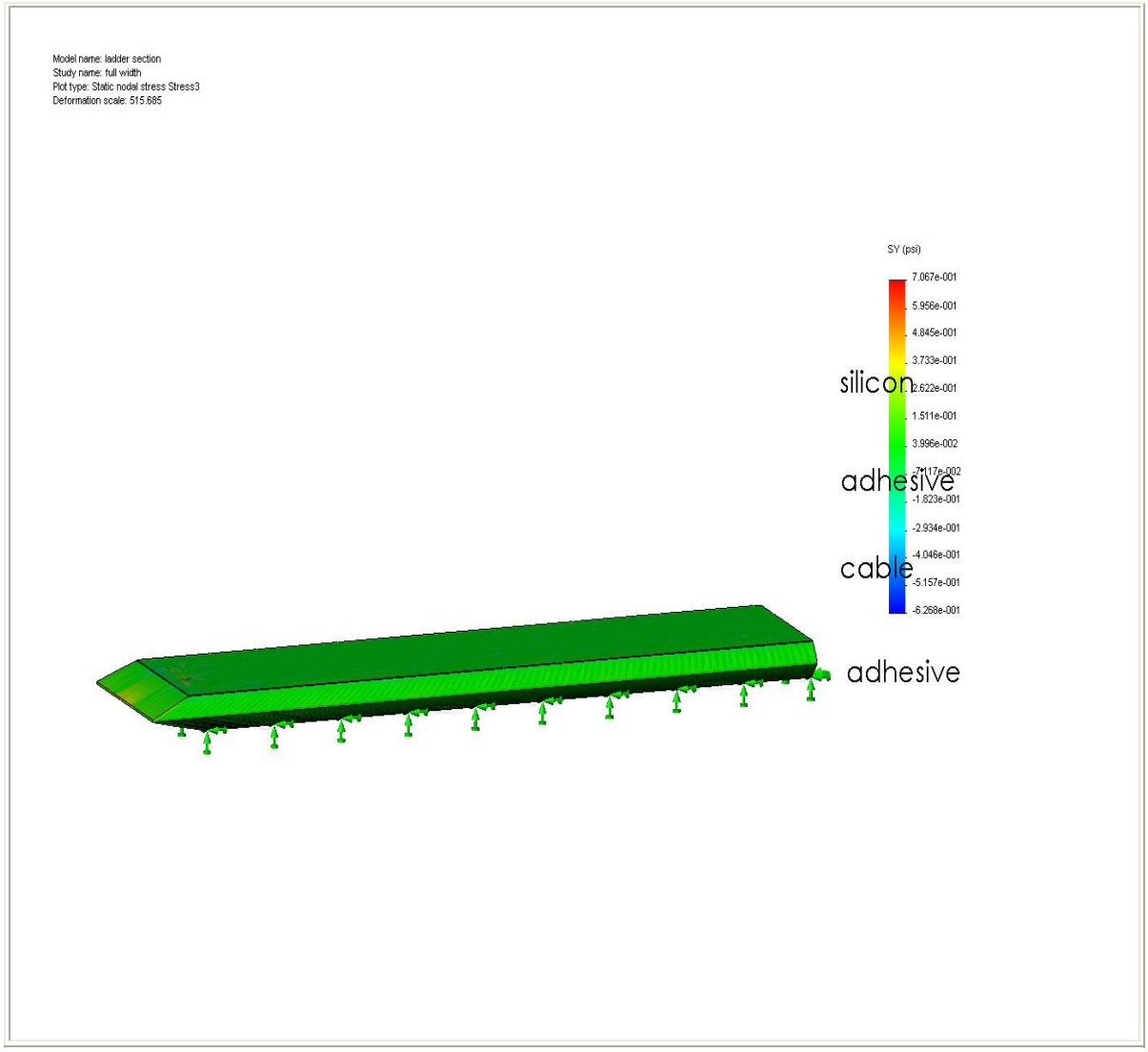
ladder section-full width-Stress-Stress2

JPEG



ladder section-full width-Stress-Stress3

JPEG



9. Conclusion

The shear is close to uniform across the width of the ladder and has a linear dependence along the length.

10. Appendix

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

Material name: [SW]acrylic adhesive

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	44816	N/m^2	Constant
Poisson's ratio	0.49	NA	Constant
Shear modulus	15169	N/m^2	Constant

Mass density	1162.6	kg/m^3	Constant
Tensile strength	3.5163e+005	N/m^2	Constant
Yield strength	3.5163e+005	N/m^2	Constant
Thermal expansion coefficient	0.00072	/Kelvin	Constant
Thermal conductivity	0.17	W/(m.K)	Constant
Specific heat	1400	J/(kg.K)	Constant

Material name: [SW]cable mix no adhesive

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	2.0684e+010	N/m^2	Constant
Poisson's ratio	0.34	NA	Constant
Shear modulus	1.1032e+010	N/m^2	Constant
Mass density	1660.8	kg/m^3	Constant
Tensile strength	8.2392e+008	N/m^2	Constant
Yield strength	4.7367e+008	N/m^2	Constant
Thermal expansion coefficient	1.1e-005	/Kelvin	Constant
Thermal conductivity	0.2	W/(m.K)	Constant
Specific heat	1175	J/(kg.K)	Constant