

# Simulation of Main Frame

Date: Wednesday, January 22, 2014  
Designer: Carter Mealey, Ben Holleran  
Study name: Center Load  
Analysis type: Static

## Table of Contents

Description .....1

Assumptions .....2

Model Information .....2

Study Properties .....5

Units .....5

Material Properties .....6

Loads and Fixtures.....7

Connector Definitions .....7

Contact Information.....7

Mesh Information .....8

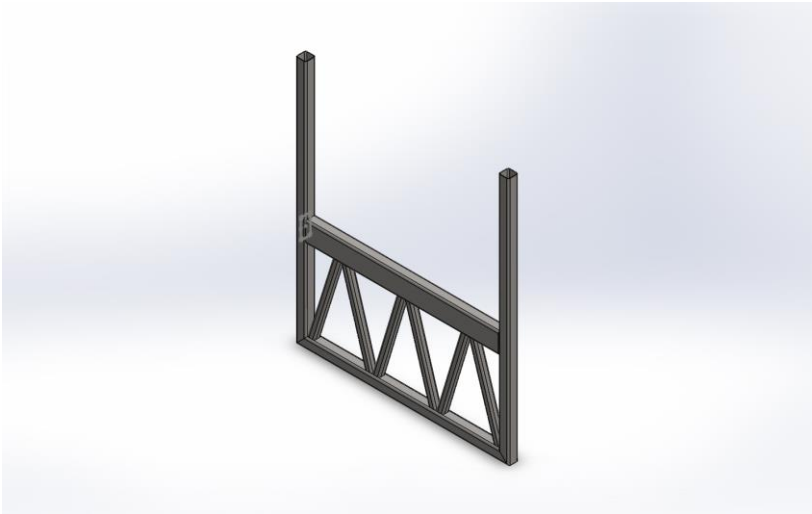
Sensor Details .....9

Resultant Forces .....9

Beams ..... 10

Study Results ..... 13

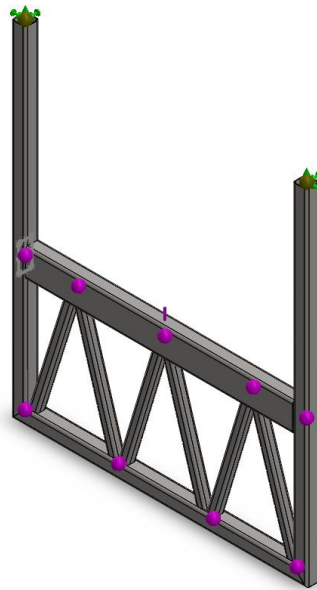
Conclusion ..... 16



Description  
No Data

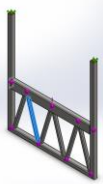
## Assumptions

## Model Information

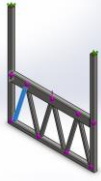
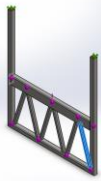
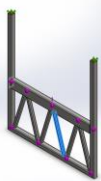



Model name: Main Frame  
Current Configuration: Default<As Machined>

### Beam Bodies:

Document Name and Reference	Formulation	Properties	Document Path/Date Modified
Beam-1(Truss Trim[2]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:636.35mm Volume:0.000346335m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.70141kg Weight:26.4738N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Frame Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014

Beam-2(Bottom miter 2[2]) 	Beam - Uniform C/S	Section Standard-ansi inch/square tube/3 x 3 x 0.25 Section Area: 866.845in <sup>2</sup> Length:1828.8mm Volume:0.00158529m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:12.3652kg Weight:121.179N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-3(Bottom miter 2[1]) 	Beam - Uniform C/S	Section Standard-ansi inch/square tube/3 x 3 x 0.25 Section Area: 1670.35in <sup>2</sup> Length:1524mm Volume:0.00254566m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:19.8561kg Weight:194.59N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-4(Deck trim) 	Beam - Uniform C/S	Section Standard-ansi inch/rectangular tube/3 x 2 x 0.25 Section Area: 1350.71in <sup>2</sup> Length:1447.8mm Volume:0.00195556m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:15.2534kg Weight:149.483N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-5(Truss Trim[5]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:636.35mm Volume:0.000346335m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.70141kg Weight:26.4738N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-6(Truss Trim[3]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:636.35mm Volume:0.000346335m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.70141kg Weight:26.4738N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014

Beam-7(Truss Trim[1]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:638.672mm Volume:0.000347599m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.71127kg Weight:26.5704N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-8(Truss Trim[6]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:638.672mm Volume:0.000347599m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.71127kg Weight:26.5704N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-9(Truss Trim[4]) 	Beam - Uniform C/S	Section Standard- Section Area: 544.265in <sup>2</sup> Length:636.35mm Volume:0.000346335m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:2.70141kg Weight:26.4738N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014
Beam-10(Bottom miter 1[2]) 	Beam - Uniform C/S	Section Standard-ansi inch/square tube/3 x 3 x 0.25 Section Area: 866.845in <sup>2</sup> Length:1828.8mm Volume:0.00158529m <sup>3</sup> Mass Density:7800kg/m <sup>3</sup> Mass:12.3652kg Weight:121.179N	\\vtcfiles\shared\ELM\ELM 4701\Bridge Tester\Design\Solidworks Models\Fram Optimization REV 2\Main Frame.SLDPRT Jan 22 00:54:07 2014

## Study Properties


Study name	Center Load
Analysis type	Static
Mesh type	Beam Mesh
Solver type	Direct sparse solver
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Result folder	SolidWorks document (\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Fram e Optimization REV 2)

## Units

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m <sup>2</sup>

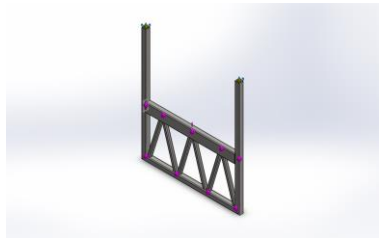


## Material Properties

Model Reference	Properties	Components
	<b>Name:</b> Plain Carbon Steel <b>Model type:</b> Linear Elastic Isotropic <b>Default failure criterion:</b> Unknown <b>Yield strength:</b> 2.20594e+008 N/m <sup>2</sup> <b>Tensile strength:</b> 3.99826e+008 N/m <sup>2</sup> <b>Elastic modulus:</b> 2.1e+011 N/m <sup>2</sup> <b>Poisson's ratio:</b> 0.28 <b>Mass density:</b> 7800 kg/m <sup>3</sup> <b>Shear modulus:</b> 7.9e+010 N/m <sup>2</sup> <b>Thermal expansion coefficient:</b> 1.3e-005 / Kelvin	SolidBody 1(Truss Trim[2])(Main Frame), SolidBody 2(Bottom miter 2[2])(Main Frame), SolidBody 3(Bottom miter 2[1])(Main Frame), SolidBody 4(Deck trim)(Main Frame), SolidBody 5(Truss Trim[5])(Main Frame), SolidBody 6(Truss Trim[3])(Main Frame), SolidBody 7(Truss Trim[1])(Main Frame), SolidBody 8(Truss Trim[6])(Main Frame), SolidBody 9(Truss Trim[4])(Main Frame), SolidBody 10(Bottom miter 1[2])(Main Frame)
Curve Data:N/A		



## Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		<b>Entities:</b> 2 Joint(s) <b>Type:</b> Fixed Geometry

Load name	Load Image	Load Details
Force-1		<b>Entities:</b> 1 Joint(s) <b>Reference:</b> Face< 1 > <b>Type:</b> Apply force <b>Values:</b> ---, ---, 20000 lbf <b>Moments:</b> ---, ---, --- lbf·in

## Connector Definitions

No Data

## Contact Information

No Data

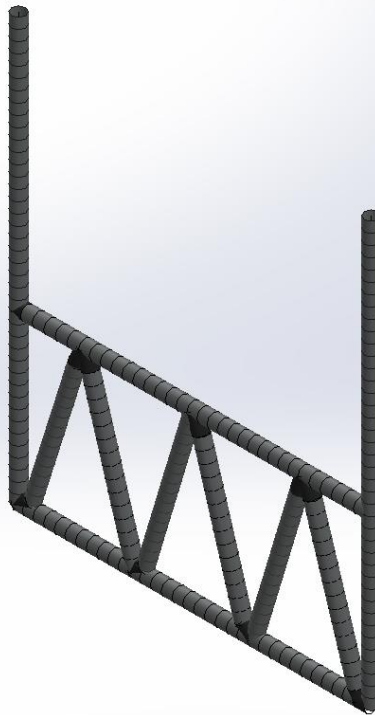
## Mesh Information

Mesh type	Beam Mesh
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## Mesh Information - Details

Total Nodes	247
Total Elements	243
Time to complete mesh(hh:mm:ss):	00:00:02
Computer name:	DRACOLYTH

Model name: Main Frame  
Study name: Center Load  
Mesh type:





## Sensor Details

No Data

## Resultant Forces

### Reaction Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	0	88964.4	1.00571e-015	88964.4

### Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N·m	-2.60671e-012	9.61975e-012	9.82266	9.82266

## Beams

### Beam Forces

Beam Name	Joints	Axial(N)	Shear1(N)	Shear2(N)	Moment1(N·m)	Moment2(N·m)	Torque(N·m)
Beam-1(Truss Trim[2])	1	35684.5	0.00285653	-1151.89	-358.37	-0.000888705	-8.21433e-014
	2	-35684.5	-0.00196842	1151.91	-420.459	-0.000718492	8.21438e-014
Beam-2(Bottom miter 2[2])	1	44824.6	-6.32148e-012	-989.513	-362.248	2.60767e-012	4.85129e-012
	2	-34512.5	-9.03141e-013	3572.53	-1257.57	-1.8386e-013	-1.87233e-013
	3	34512.5	9.03141e-013	-3572.53	-1328.59	-4.69924e-013	1.87233e-013
Beam-3(Bottom miter 2[1])	1	15702.1	-592.01	-2.90471e-014	-5.78065e-013	257.328	1.99826e-013
	2	-15702.1	592.01	1.24046e-011	1.08368e-013	14.5242	-2.05585e-013
	3	37652.5	-208.95	2.94847e-013	-8.84075e-014	1021.94	-5.44194e-014
	4	15293.7	730.015	-5.7622e-013	3.19106e-013	17.7887	6.66246e-013
Beam-4(Deck trim)	1	-2583.02	-10312.1	5.39609e-012	-2.64853e-012	913.636	3.5299e-012
	2	2583.02	10312.1	-5.39609e-012	3.99879e-012	1666.76	-3.5299e-012
	3	-25710.2	9142.05	7.83309e-012	2.77223e-012	255.892	1.19263e-012
	4	-26053.7	-10378.6	4.87719e-012	-2.39271e-014	5014.47	2.67068e-012
	5	-2432.68	10235.5	6.88297e-012	4.31096e-012	-1969.56	9.68686e-013
Beam-5(Truss Trim[5])	1	-36099.5	-0.00735709	1095.46	-339.817	-0.00228221	-3.9553e-014
	2	0	0	0	0	0	0
Beam-6(Truss Trim[3])	1	35841.5	-0.00184985	-341.046	173.333	-0.000940165	1.10032e-013
	2	-35841.5	-0.00122092	341.054	70.8359	0.000253582	-1.10029e-013
Beam-7(Truss Trim[1])	1	-35994.4	-0.00331255	1459.84	483.596	0.00109734	-1.2082e-013
	2	35994.4	0.00129905	-1459.85	448.768	0.000399337	1.2082e-013
Beam-8(Truss Trim[6])	1	-35205.2	3.14319e-013	1436.05	445.132	3.52209e-014	-1.53492e-013
	2	35205.2	0.000309931	-1436.06	472.036	0.000101875	1.53492e-013
Beam-9(Truss	1	-36869	-	391.901	180.165	0.000257918	-2.31192e-013

Trim[4])	2	36869	0.00345061	-391.948	69.2249	0.000609439	2.31192e-013
Beam-10(Bottom miter 1[2])	1	-33904.3	7.45638e-013	-3422.2	1229.01	-4.12376e-013	-4.57497e-013
	2	44139.8	0.0209319	989.398	372.071	-0.0078716	4.76845e-012
	3	33904.3	-7.45639e-013	3422.2	1093.49	9.18409e-013	4.57497e-013

## Beam Stresses

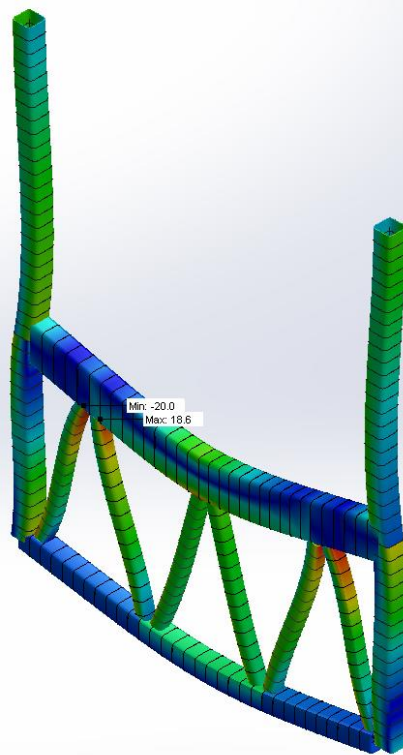
Beam Name	Joints	Axial(N/m^2)	Bending Dir1(N/m^2)	Bending Dir2(N/m^2)	Torsional (N/m^2)	Worst Case(N/m^2)
Beam-1(Truss Trim[2])	1	6.55646e+007	-4.78852e+007	118.748	-4.37233e-009	1.1345e+008
	2	6.55646e+007	5.61814e+007	-96.0044	4.37236e-009	1.21746e+008
Beam-2(Bottom miter 2[2])	1	5.17101e+007	-1.87295e+007	-1.34825e-007	1.04953e-007	7.04395e+007
	2	3.98139e+007	6.50206e+007	-9.50619e-009	-4.05061e-009	1.04835e+008
	3	3.98139e+007	-6.86925e+007	2.42967e-008	4.05061e-009	1.08506e+008
Beam-3(Bottom miter 2[1])	1	9.40051e+006	-1.67665e-008	-7.46369e+006	4.32304e-009	1.68642e+007
	2	9.40051e+006	-3.14317e-009	421267	-4.44762e-009	9.82178e+006
	3	2.25417e+007	-2.56422e-009	-2.9641e+007	-1.17731e-009	5.21826e+007
	4	9.156e+006	9.25554e-009	-515953	1.44136e-008	9.67195e+006
Beam-4(Deck trim)	1	-1.91233e+006	-7.29966e-008	-1.74554e+007	4.53783e-008	1.93677e+007
	2	-1.91233e+006	-1.10211e-007	3.18441e+007	-4.53783e-008	3.37564e+007
	3	-1.90345e+007	7.64058e-008	-4.88893e+006	1.53318e-008	2.39234e+007
	4	-1.92888e+007	-6.59458e-010	-9.58034e+007	3.43328e-008	1.15092e+008
	5	-1.80103e+006	1.18815e-007	3.76293e+007	1.24529e-008	3.94303e+007
Beam-5(Truss Trim[5])	1	6.63272e+007	4.54061e+007	-304.948	-2.10533e-009	1.11734e+008
	2	0	0	0	0	0
Beam-6(Truss Trim[3])	1	-6.58532e+007	-2.31607e+007	-125.624	5.85678e-009	8.9014e+007
	2	-6.58532e+007	9.46506e+006	-33.8834	-5.85664e-009	7.53183e+007
Beam-7(Truss Trim[1])	1	-6.6134e+007	6.46178e+007	-146.626	-6.43101e-009	1.30752e+008
	2	-6.6134e+007	-5.99641e+007	53.3592	6.43101e-009	1.26098e+008
Beam-8(Truss Trim[6])	1	-6.4684e+007	5.94783e+007	-4.70619e-009	-8.17007e-009	1.24162e+008
	2	-6.4684e+007	-6.30732e+007	13.6125	8.17006e-009	1.27757e+008
Beam-9(Truss Trim[4])	1	-6.7741e+007	2.40736e+007	-34.4629	-1.23059e-008	9.18146e+007
	2	-6.7741e+007	-9.24978e+006	81.4328	1.23059e-008	7.69908e+007
Beam-10(Bottom miter 1[2])	1	3.91124e+007	-6.35441e+007	-2.13213e-008	-9.89751e-009	1.02656e+008
	2	5.09201e+007	1.92373e+007	406.989	1.03161e-007	7.01579e+007
	3	3.91124e+007	5.65371e+007	-4.74849e-008	9.89751e-009	9.56495e+007



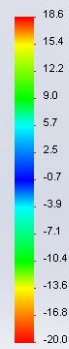
## Study Results

Name	Type	Min	Max
Stress1	TXY: Shear in Y Dir. on YZ Plane	0 ksi Element: 233	18.964 ksi Element: 164

Model name: Main Frame  
Study name: Center Load  
Plot type: Axial and bending Stress1  
Deformation scale: 149.256  
Global value: 0 to 0 ksi



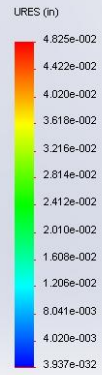
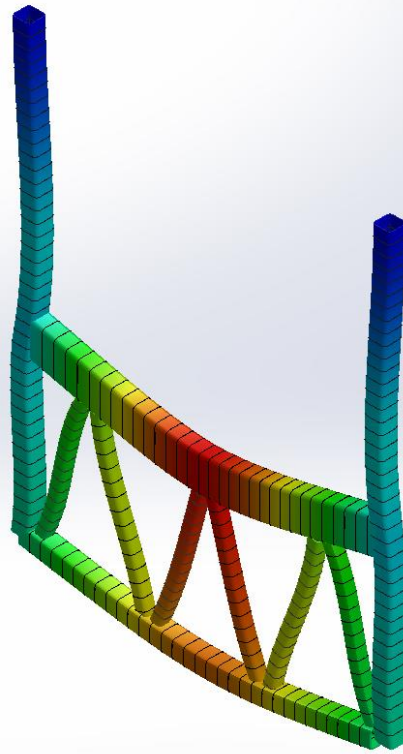
Axial and bending (ksi)



Main Frame-Center Load-Stress-Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 in Node: 57	0.0482452 in Node: 104

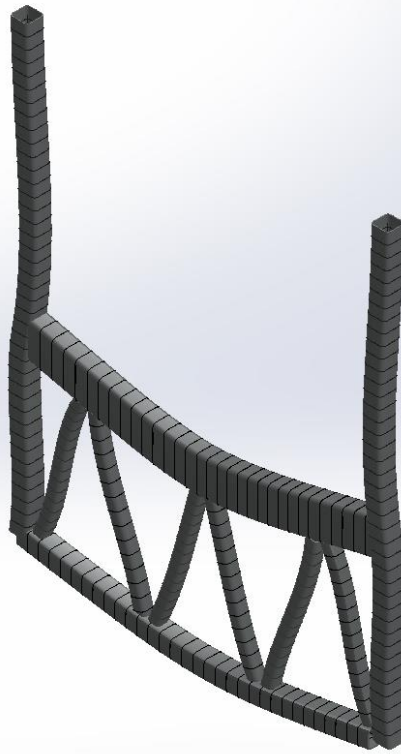
Model name: Main Frame  
Study name: Center Load  
Plot type: Static displacement Displacement1  
Deformation scale: 149.256



Main Frame-Center Load-Displacement-Displacement1

Name	Type
Displacement1{1}	URES: Resultant Displacement

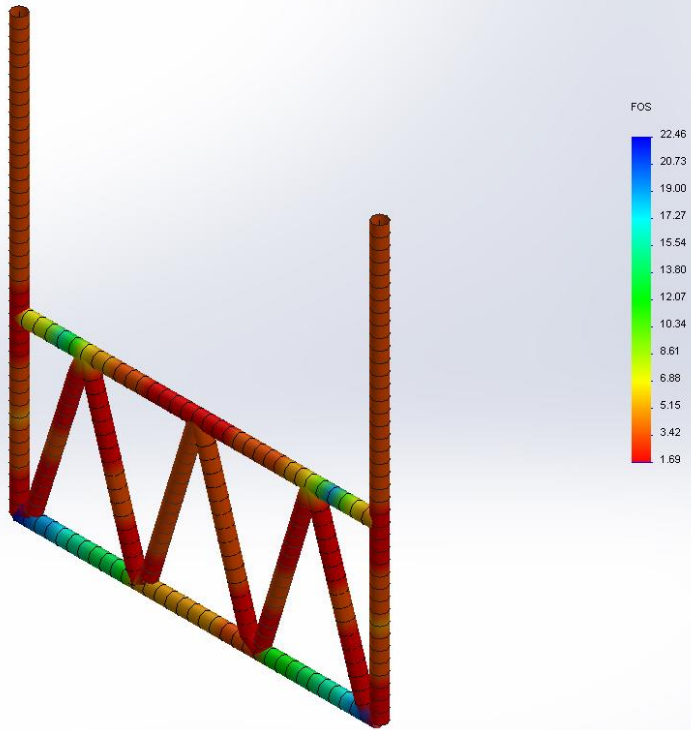
Model name: Main Frame  
Study name: Center Load  
Plot type: Static displacement Displacement1{1}  
Deformation scale: 149.256



Main Frame-Center Load-Displacement-Displacement1{1}

Name	Type	Min	Max
Factor of Safety1	Automatic	1.68712 Node: 166	22.4597 Node: 17

Model name: Main Frame  
Study name: Center Load  
Plot type: Factor of Safety Factor of Safety1  
Criterion: Automatic  
Factor of safety distribution: Min FOS = 1.7



Main Frame-Center Load-Factor of Safety-Factor of Safety1

## Conclusion