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|  | |  | | --- | | **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](#_Toc378115569)  [Assumptions 2](#_Toc378115570)  [Model Information 2](#_Toc378115571)  [Study Properties 5](#_Toc378115572)  [Units 5](#_Toc378115573)  [Material Properties 6](#_Toc378115574)  [Loads and Fixtures 7](#_Toc378115575)  [Connector Definitions 7](#_Toc378115576)  [Contact Information 7](#_Toc378115577)  [Mesh Information 8](#_Toc378115578)  [Sensor Details 9](#_Toc378115579)  [Resultant Forces 9](#_Toc378115580)  [Beams 10](#_Toc378115581)  [Study Results 13](#_Toc378115582)  [Conclusion 16](#_Toc378115583) | |
| Description No Data |

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| Assumptions |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 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^2****  ****Length:636.35mm****  ****Volume:0.000346335m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.70141kg****  ****Weight:26.4738N**** | ****\\vtcfiles\shared\ELM\ELM4701\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^2****  ****Length:1828.8mm****  ****Volume:0.00158529m^3****  ****Mass Density:7800kg/m^3****  ****Mass:12.3652kg****  ****Weight:121.179N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:1524mm****  ****Volume:0.00254566m^3****  ****Mass Density:7800kg/m^3****  ****Mass:19.8561kg****  ****Weight:194.59N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:1447.8mm****  ****Volume:0.00195556m^3****  ****Mass Density:7800kg/m^3****  ****Mass:15.2534kg****  ****Weight:149.483N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:636.35mm****  ****Volume:0.000346335m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.70141kg****  ****Weight:26.4738N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:636.35mm****  ****Volume:0.000346335m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.70141kg****  ****Weight:26.4738N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:638.672mm****  ****Volume:0.000347599m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.71127kg****  ****Weight:26.5704N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:638.672mm****  ****Volume:0.000347599m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.71127kg****  ****Weight:26.5704N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:636.35mm****  ****Volume:0.000346335m^3****  ****Mass Density:7800kg/m^3****  ****Mass:2.70141kg****  ****Weight:26.4738N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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^2****  ****Length:1828.8mm****  ****Volume:0.00158529m^3****  ****Mass Density:7800kg/m^3****  ****Mass:12.3652kg****  ****Weight:121.179N**** | ****\\vtcfiles\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame Optimization REV 2\Main Frame.SLDPRT****  **Jan 22 00:54:07 2014** | |

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| 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\Frame Optimization REV 2) | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Units  |  |  | | --- | --- | | Unit system: | SI (MKS) | | Length/Displacement | mm | | Temperature | Kelvin | | Angular velocity | Rad/sec | | Pressure/Stress | N/m^2 | |

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| Material Properties  |  |  |  | | --- | --- | --- | | ****Model Reference**** | ****Properties**** | ****Components**** | |  | |  |  | | --- | --- | | ****Name:**** | **Plain Carbon Steel** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Yield strength:**** | **2.20594e+008 N/m^2** | | ****Tensile strength:**** | **3.99826e+008 N/m^2** | | ****Elastic modulus:**** | **2.1e+011 N/m^2** | | ****Poisson's ratio:**** | **0.28** | | ****Mass density:**** | **7800 kg/m^3** | | ****Shear modulus:**** | **7.9e+010 N/m^2** | | ****Thermal expansion coefficient:**** | **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** | | | |

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| **Loads and Fixtures**  | ****Fixture name**** | ****Fixture Image**** | ****Fixture Details**** | | --- | --- | --- | | **Fixed-1** |  | |  |  | | --- | --- | | Entities: | **2 Joint(s)** | | Type: | **Fixed Geometry** | |  | ****Load name**** | ****Load Image**** | ****Load Details**** | | --- | --- | --- | | **Force-1** |  | |  |  | | --- | --- | | Entities: | **1 Joint(s)** | | Reference: | **Face< 1 >** | | Type: | **Apply force** | | Values: | **---, ---, 20000 lbf** | | Moments: | **---, ---, --- lbf·in** | | |

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| Connector Definitions No Data |

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| Contact Information No Data |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mesh Information  |  |  | | --- | --- | | Mesh type | Beam Mesh |  Mesh Information - Details  |  |  | | --- | --- | | Total Nodes | 247 | | Total Elements | 243 | | Time to complete mesh(hh;mm;ss): | 00:00:02 | | Computer name: | DRACOLYTH | |  | | |

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| Sensor Details No Data |

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| Resultant ForcesReaction 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 | |
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| BeamsBeam 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 Trim[4]) | 1 | -36869 | -0.000561031 | 391.901 | 180.165 | 0.000257918 | -2.31192e-013 | | 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 | |

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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Stress1 | TXY: Shear in Y Dir. on YZ Plane | 0 ksi  Element: 233 | 18.964 ksi  Element: 164 | | **Main Frame-Center Load-Stress-Stress1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Displacement1 | URES: Resultant Displacement | 0 in  Node: 57 | 0.0482452 in  Node: 104 | | **Main Frame-Center Load-Displacement-Displacement1** | | | |  | Name | Type | | --- | --- | | Displacement1{1} | URES: Resultant Displacement | | **Main Frame-Center Load-Displacement-Displacement1{1}** | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Factor of Safety1 | Automatic | 1.68712  Node: 166 | 22.4597  Node: 17 | | **Main Frame-Center Load-Factor of Safety-Factor of Safety1** | | | | |

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| Conclusion |