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|  | |  | | --- | | **Simulation of Main Frame**  **Date: Tuesday, January 21, 2014 Designer: Solidworks**  **Study name: double point study**  **Analysis type: Static** | | Table of Contents  [Description 1](#_Toc378106665)  [Assumptions 2](#_Toc378106666)  [Model Information 2](#_Toc378106667)  [Study Properties 5](#_Toc378106668)  [Units 5](#_Toc378106669)  [Material Properties 6](#_Toc378106670)  [Loads and Fixtures 7](#_Toc378106671)  [Connector Definitions 7](#_Toc378106672)  [Contact Information 8](#_Toc378106673)  [Mesh Information 8](#_Toc378106674)  [Sensor Details 8](#_Toc378106675)  [Resultant Forces 9](#_Toc378106676)  [Beams 10](#_Toc378106677)  [Study Results 14](#_Toc378106678)  [Conclusion 16](#_Toc378106679) | |
| Description Double point force |

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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(Structural Member5[2])** | **Beam – Uniform C/S** | ****Section Standard-ansi inch/square tube/3 x 3 x 0.25****  ****Section Area: 1670.35in^2****  ****Length:1600.2mm****  ****Volume:0.0026729m^3****  ****Mass Density:7800kg/m^3****  ****Mass:20.8486kg****  ****Weight:204.316N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-2(Trim/Extend9[1])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1670.35in^2****  ****Length:1761.1mm****  ****Volume:0.00293589m^3****  ****Mass Density:7800kg/m^3****  ****Mass:22.8999kg****  ****Weight:224.419N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-3(Structural Member5[1])** | **Beam – Uniform C/S** | ****Section Standard-ansi inch/square tube/3 x 3 x 0.25****  ****Section Area: 1670.35in^2****  ****Length:1600.2mm****  ****Volume:0.0026729m^3****  ****Mass Density:7800kg/m^3****  ****Mass:20.8486kg****  ****Weight:204.316N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-4(Trim/Extend9[2])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1670.35in^2****  ****Length:1761.1mm****  ****Volume:0.00293589m^3****  ****Mass Density:7800kg/m^3****  ****Mass:22.8999kg****  ****Weight:224.419N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-5(Trim/Extend6)** | **Beam – Uniform C/S** | ****Section Standard-ansi inch/rectangular tube/3 x 2 x 0.25****  ****Section Area: 2638.09in^2****  ****Length:1458.43mm****  ****Volume:0.00383757m^3****  ****Mass Density:7800kg/m^3****  ****Mass:29.9331kg****  ****Weight:293.344N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-6(Trim/Extend7[1])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1025.19in^2****  ****Length:638.672mm****  ****Volume:0.000654745m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.10701kg****  ****Weight:50.0487N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-7(Trim/Extend7[2])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1025.19in^2****  ****Length:636.35mm****  ****Volume:0.000652364m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.08844kg****  ****Weight:49.8667N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-8(Trim/Extend7[3])** | **Beam – Uniform C/S** | ****Section Standard-ansi inch/square tube/2 x 2 x 0.25****  ****Section Area: 1025.19in^2****  ****Length:636.35mm****  ****Volume:0.000652364m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.08844kg****  ****Weight:49.8667N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-9(Trim/Extend7[4])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1025.19in^2****  ****Length:636.35mm****  ****Volume:0.000652364m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.08844kg****  ****Weight:49.8667N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-10(Trim/Extend7[5])** | **Beam – Uniform C/S** | ****Section Standard-ansi inch/square tube/2 x 2 x 0.25****  ****Section Area: 1025.19in^2****  ****Length:636.35mm****  ****Volume:0.000652364m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.08844kg****  ****Weight:49.8667N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | | **Beam-11(Trim/Extend7[6])** | **Beam – Uniform C/S** | ****Section Standard-****  ****Section Area: 1025.19in^2****  ****Length:638.672mm****  ****Volume:0.000654745m^3****  ****Mass Density:7800kg/m^3****  ****Mass:5.10701kg****  ****Weight:50.0487N**** | ****\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame REV 2\Main Frame.SLDPRT****  **Jan 21 11:22:21 2014** | |

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| Study Properties  |  |  | | --- | --- | | Study name | double point study | | 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 (\\vtcfiles1.vtc.vsc.edu\shared\ELM\ELM4701\Bridge Tester\Design\Solidworks Models\Frame 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(Structural Member5[2])(Main Frame),**  **SolidBody 2(Trim/Extend9[1])(Main Frame),**  **SolidBody 3(Structural Member5[1])(Main Frame),**  **SolidBody 4(Trim/Extend9[2])(Main Frame),**  **SolidBody 5(Trim/Extend6)(Main Frame),**  **SolidBody 6(Trim/Extend7[1])(Main Frame),**  **SolidBody 7(Trim/Extend7[2])(Main Frame),**  **SolidBody 8(Trim/Extend7[3])(Main Frame),**  **SolidBody 9(Trim/Extend7[4])(Main Frame),**  **SolidBody 10(Trim/Extend7[5])(Main Frame),**  **SolidBody 11(Trim/Extend7[6])(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: | **---, ---, 10000 lbf** | | Moments: | **---, ---, --- lbf·in** | | | **Force-2** |  | |  |  | | --- | --- | | Entities: | **1 Joint(s)** | | Reference: | **Face< 1 >** | | Type: | **Apply force** | | Values: | **---, ---, 10000 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 | 268 | | Total Elements | 264 | | Time to complete mesh(hh;mm;ss): | 00:00:09 | | Computer name: | CARTER-PC | |  | | |

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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 | -2.38768e-016 | 88964.4 |  Reaction Moments  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N·m | 3.20633e-012 | -6.11552e-014 | 0.815094 | 0.815094 | |
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| BeamsBeam Forces  | Beam NameBeam-1(Structural Member5[2]) | Joints | Axial(N) | Shear1(N) | Shear2(N) | Moment1(N·m) | Moment2(N·m) | Torque(N·m) | | --- | --- | --- | --- | --- | --- | --- | --- | | Beam-2(Trim/Extend9[1]) | 1 | 28295.3 | 2904.09 | 3.02108e-013 | 4.57642e-013 | -1051.14 | -4.81387e-014 | | Beam-3(Structural Member5[1]) | 1 | 0 | -1.81899e-011 | -8.04562e-025 | -1.37325e-026 | 4.09273e-012 | 8.40105e-026 | | 2 | 16203.9 | 18.3565 | -1.19596e-013 | 8.05862e-014 | 152.684 | 4.61847e-014 | | 3 | 12494.6 | -119.978 | -1.59539e-013 | 8.38395e-014 | 195.104 | 2.00856e-014 | | Beam-4(Trim/Extend9[2]) | 1 | -28023.3 | 2893.99 | 2.40975e-014 | -4.97788e-013 | 947.985 | 4.55416e-014 | | 2 | 28023.3 | -2893.85 | -2.40951e-014 | 4.8116e-013 | 1048.96 | -4.5544e-014 | | Beam-5(Trim/Extend6) | 1 | 2084.02 | 15880.5 | -2.62398e-013 | -1.51111e-016 | 1114.94 | -7.46047e-013 | | 2 | -2073.85 | 16765.3 | -1.58555e-014 | 8.0058e-014 | -1082.96 | -5.23914e-013 | | 3 | -13686.8 | -4986.4 | 5.87049e-014 | 2.61515e-013 | 2534.07 | -1.59684e-014 | | 4 | -13750.5 | 5462.45 | 1.60834e-013 | 3.19933e-013 | 77.0197 | 3.18627e-013 | | 5 | -2084.02 | -15880.5 | 2.62398e-013 | 6.72053e-014 | 2943.22 | 7.46047e-013 | | Beam-6(Trim/Extend7[1]) | 1 | -29433.4 | 0.00539227 | -744.382 | -240.371 | -0.00174124 | 5.90202e-015 | | 2 | 29433.4 | -0.00715321 | 744.32 | -235.029 | -0.00225872 | -5.90431e-015 | | Beam-7(Trim/Extend7[2]) | 1 | -5534.11 | 0.00473458 | -559.061 | 149.669 | 0.00126752 | 1.67331e-014 | | 2 | 5534.11 | -0.00496052 | 559.075 | 206.094 | 0.00182861 | -1.67346e-014 | | Beam-8(Trim/Extend7[3]) | 1 | -5539.63 | -6.69289e-005 | -112.447 | -50.643 | 3.01429e-005 | -1.62643e-014 | | 2 | 5539.63 | 0.000112348 | 112.448 | -20.9128 | 2.08943e-005 | 1.62648e-014 | | Beam-9(Trim/Extend7[4]) | 1 | 5425.42 | -4.77339e-005 | 80.1976 | -39.3843 | -2.34417e-005 | 1.63189e-014 | | 2 | -5425.42 | 0.000194937 | -80.1986 | -11.6493 | -2.83158e-005 | -1.63183e-014 | | Beam-10(Trim/Extend7[5]) | 1 | 5419.88 | -6.55816e-005 | 543.891 | 142.299 | 1.71582e-005 | -1.71484e-014 | | 2 | -5419.88 | -0.000543409 | -543.892 | 203.806 | -0.000203625 | 1.71484e-014 | | Beam-11(Trim/Extend7[6]) | 1 | -29753.4 | 0.00146817 | -749.959 | -236.756 | -0.000463491 | -2.22649e-014 | |  |  |  |  |  |  |  |  |  Beam Stresses  | Beam NameBeam-1(Structural Member5[2]) | 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-2(Trim/Extend9[1]) | 1 | 1.69397e+007 | 1.32737e-008 | 3.04878e+007 | -1.04144e-009 | 4.74276e+007 | | Beam-3(Structural Member5[1]) | 1 | 0 | 3.98305e-022 | 1.18708e-007 | 1.81749e-021 | 1.18708e-007 | | 2 | 9.70088e+006 | 2.33737e-009 | -4.42852e+006 | 9.9916e-010 | 1.41294e+007 | | 3 | 7.48023e+006 | 2.43173e-009 | -5.65891e+006 | 4.34533e-010 | 1.31391e+007 | | Beam-4(Trim/Extend9[2]) | 1 | 1.67769e+007 | 1.44381e-008 | 2.74959e+007 | 9.85248e-010 | 4.42728e+007 | | 2 | 1.67769e+007 | 1.39559e-008 | -3.04247e+007 | -9.85299e-010 | 4.72016e+007 | | Beam-5(Trim/Extend6) | 1 | -789974 | 2.30547e-012 | 1.13802e+007 | -9.59075e-009 | 1.21701e+007 | | 2 | -786117 | 1.22143e-009 | 1.10537e+007 | -6.73513e-009 | 1.18398e+007 | | 3 | -5.18815e+006 | 3.98989e-009 | -2.58652e+007 | -2.05281e-010 | 3.10533e+007 | | 4 | -5.21228e+006 | 4.88116e-009 | -786137 | 4.09608e-009 | 5.99842e+006 | | 5 | -789974 | 1.02534e-009 | -3.00413e+007 | 9.59075e-009 | 3.08313e+007 | | Beam-6(Trim/Extend7[1]) | 1 | -2.87102e+007 | -1.91443e+007 | 138.68 | 3.14153e-010 | 4.78546e+007 | | 2 | -2.87102e+007 | 1.87188e+007 | -179.895 | -3.14275e-010 | 4.74292e+007 | | Beam-7(Trim/Extend7[2]) | 1 | 5.39813e+006 | -1.19204e+007 | 100.951 | 8.90669e-010 | 1.73186e+007 | | 2 | 5.39813e+006 | 1.64143e+007 | -145.64 | -8.90751e-010 | 2.18126e+007 | | Beam-8(Trim/Extend7[3]) | 1 | -5.40351e+006 | -4.03346e+006 | -2.40073 | -8.65716e-010 | 9.43697e+006 | | 2 | -5.40351e+006 | 1.6656e+006 | 1.66412 | 8.65745e-010 | 7.06911e+006 | | Beam-9(Trim/Extend7[4]) | 1 | -5.29211e+006 | 3.13676e+006 | -1.86701 | 8.68624e-010 | 8.42887e+006 | | 2 | -5.29211e+006 | -927809 | 2.2552 | -8.68593e-010 | 6.21992e+006 | | Beam-10(Trim/Extend7[5]) | 1 | 5.28671e+006 | 1.13334e+007 | -1.36656 | -9.12775e-010 | 1.66201e+007 | | 2 | 5.28671e+006 | -1.62321e+007 | -16.2177 | 9.12776e-010 | 2.15189e+007 | | Beam-11(Trim/Extend7[6]) | 1 | -2.90223e+007 | -1.88564e+007 | 36.9146 | -1.18512e-009 | 4.78787e+007 | |  |  |  |  |  |  |  | |

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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Stress1 | TXY: Shear in Y Dir. on YZ Plane | 0 ksi  Element: 1 | 7.00731 ksi  Element: 234 | | **Main Frame-double point study-Stress-Stress1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Displacement1 | URES: Resultant Displacement | 0 mm  Node: 1 | 0.375669 mm  Node: 155 | | **Main Frame-double point study-Displacement-Displacement1** | | | |  | Name | Type | | --- | --- | | Displacement1{1} | Deformed Shape | | **Main Frame-double point study-Displacement-Displacement1{1}** | |  |  | | --- | |  | | **Image-1** | |

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| Conclusion |