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|  | |  | | --- | | **Simulation of lhc-101**  **Date: Wednesday, June 20, 2018 Designer: Eugene Zeleny**  **Study name: Static 1**  **Analysis type: Static** | | Table of Contents  [Description 1](#_Toc517261708)  [Assumptions 2](#_Toc517261709)  [Model Information 2](#_Toc517261710)  [Study Properties 5](#_Toc517261711)  [Units 6](#_Toc517261712)  [Material Properties 7](#_Toc517261713)  [Loads and Fixtures 8](#_Toc517261714)  [Connector Definitions 8](#_Toc517261715)  [Contact Information 9](#_Toc517261716)  [Mesh information 10](#_Toc517261717)  [Sensor Details 11](#_Toc517261718)  [Resultant Forces 11](#_Toc517261719)  [Beams 12](#_Toc517261720)  [Study Results 13](#_Toc517261721)  [Conclusion 16](#_Toc517261722) | |
| Description Static loading of Large Hazelnut Computer |

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| Assumptions |

# Simulation is run without horizontal support beams (which do not affect vertical load analysis)

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| Model Information  |  |  |  |  |  | | --- | --- | --- | --- | --- | | |  | | --- | |  |   ****Model name:** lhc-101**  ****Current Configuration:** 5 - Simulation Only** | | | | | ****Solid Bodies**** | | | | | ****Document Name and Reference**** | ****Treated As**** | ****Volumetric Properties**** | ****Document Path/Date Modified**** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:44 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:44 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:45 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:45 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:46 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:46 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:46 2018** | | **Cut-Extrude2** | **Solid Body** | ****Mass:102.563 kg****  ****Volume:0.0131492 m^3****  ****Density:7800 kg/m^3****  ****Weight:1005.12 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-002.SLDPRT****  **Jun 20 12:38:47 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:76.3971 kg****  ****Volume:0.0097945 m^3****  ****Density:7800 kg/m^3****  ****Weight:748.692 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-003.SLDPRT****  **Jun 20 12:38:47 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:76.3971 kg****  ****Volume:0.0097945 m^3****  ****Density:7800 kg/m^3****  ****Weight:748.692 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-003.SLDPRT****  **Jun 20 12:38:48 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:76.3971 kg****  ****Volume:0.0097945 m^3****  ****Density:7800 kg/m^3****  ****Weight:748.692 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-003.SLDPRT****  **Jun 20 12:38:48 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:76.3971 kg****  ****Volume:0.0097945 m^3****  ****Density:7800 kg/m^3****  ****Weight:748.692 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-003.SLDPRT****  **Jun 20 12:38:49 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:75.5389 kg****  ****Volume:0.00968448 m^3****  ****Density:7800 kg/m^3****  ****Weight:740.281 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-004.SLDPRT****  **Jun 20 12:38:50 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:75.5389 kg****  ****Volume:0.00968448 m^3****  ****Density:7800 kg/m^3****  ****Weight:740.281 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-004.SLDPRT****  **Jun 20 12:38:50 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:75.5389 kg****  ****Volume:0.00968448 m^3****  ****Density:7800 kg/m^3****  ****Weight:740.281 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-004.SLDPRT****  **Jun 20 12:38:51 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:75.5389 kg****  ****Volume:0.00968448 m^3****  ****Density:7800 kg/m^3****  ****Weight:740.281 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-004.SLDPRT****  **Jun 20 12:38:51 2018** | | **Boss-Extrude1** | **Solid Body** | ****Mass:75.5389 kg****  ****Volume:0.00968448 m^3****  ****Density:7800 kg/m^3****  ****Weight:740.281 N**** | ****C:\Users\Open AG\Desktop\lhc-001\lhc-004.SLDPRT****  **Jun 20 12:38:52 2018** | |

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| Study Properties  |  |  | | --- | --- | | Study name | Static 1 | | Analysis type | Static | | Mesh type | Solid Mesh | | Thermal Effect: | On | | Thermal option | Include temperature loads | | Zero strain temperature | 298 Kelvin | | Include fluid pressure effects from SOLIDWORKS Flow Simulation | Off | | Solver type | FFEPlus | | Inplane Effect: | Off | | Soft Spring: | Off | | Inertial Relief: | Off | | Incompatible bonding options | Automatic | | Large displacement | Off | | Compute free body forces | On | | Friction | Off | | Use Adaptive Method: | Off | | Result folder | SOLIDWORKS document (C:\Users\Open AG\Desktop\lhc-001) | |

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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+08 N/m^2** | | ****Tensile strength:**** | **3.99826e+08 N/m^2** | | ****Elastic modulus:**** | **2.1e+11 N/m^2** | | ****Poisson's ratio:**** | **0.28** | | ****Mass density:**** | **7800 kg/m^3** | | ****Shear modulus:**** | **7.9e+10 N/m^2** | | ****Thermal expansion coefficient:**** | **1.3e-05 /Kelvin** | | **SolidBody 1(Cut-Extrude2)(lhc-002-1),**  **SolidBody 1(Cut-Extrude2)(lhc-002-10),**  **SolidBody 1(Cut-Extrude2)(lhc-002-11),**  **SolidBody 1(Cut-Extrude2)(lhc-002-13),**  **SolidBody 1(Cut-Extrude2)(lhc-002-14),**  **SolidBody 1(Cut-Extrude2)(lhc-002-15),**  **SolidBody 1(Cut-Extrude2)(lhc-002-2),**  **SolidBody 1(Cut-Extrude2)(lhc-002-9),**  **SolidBody 1(Boss-Extrude1)(lhc-003-1),**  **SolidBody 1(Boss-Extrude1)(lhc-003-5),**  **SolidBody 1(Boss-Extrude1)(lhc-003-6),**  **SolidBody 1(Boss-Extrude1)(lhc-003-7),**  **SolidBody 1(Boss-Extrude1)(lhc-004-1),**  **SolidBody 1(Boss-Extrude1)(lhc-004-10),**  **SolidBody 1(Boss-Extrude1)(lhc-004-11),**  **SolidBody 1(Boss-Extrude1)(lhc-004-2),**  **SolidBody 1(Boss-Extrude1)(lhc-004-9)** | | **Curve Data:N/A** | | | |

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| **Loads and Fixtures**  | ****Fixture name**** | ****Fixture Image**** | ****Fixture Details**** | | --- | --- | --- | | **Fixed-1** |  | |  |  | | --- | --- | | Entities: | **8 face(s)** | | Type: | **Fixed Geometry** | | | ****Resultant Forces****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Reaction force(N)** | **3.1449** | **21902.7** | **1645.24** | **21964.4** | | **Reaction Moment(N.m)** | **0** | **0** | **0** | **0** | | | |  | ****Load name**** | ****Load Image**** | ****Load Details**** | | --- | --- | --- | | **Force-2** |  | |  |  | | --- | --- | | Entities: | **5 face(s)** | | Type: | **Apply normal force** | | Value: | **22000 N** | | |

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The value of 22000 N is derived from an assumed load of 2400 lbs. (1100 kg) on top of the super structure with a safety factor of 2.

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| Contact Information  | Contact | Contact Image | Contact Properties | | --- | --- | --- | | Global Contact |  | |  |  | | --- | --- | | Type: | **Bonded** | | Components: | **1 component(s)** | | Options: | **Compatible mesh** | | |

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| Mesh information  |  |  | | --- | --- | | Mesh type | Solid Mesh | | Mesher Used: | Standard mesh | | Automatic Transition: | Off | | Include Mesh Auto Loops: | Off | | Jacobian points | 4 Points | | Element Size | 2.70494 in | | Tolerance | 0.135247 in | | Mesh Quality Plot | High | | Remesh failed parts with incompatible mesh | Off |  Mesh information - Details  |  |  | | --- | --- | | Total Nodes | 197957 | | Total Elements | 97427 | | Maximum Aspect Ratio | 71.799 | | % of elements with Aspect Ratio < 3 | 14.6 | | % of elements with Aspect Ratio > 10 | 36.7 | | % of distorted elements(Jacobian) | 0.00205 | | Time to complete mesh(hh;mm;ss): | 00:00:30 | | Computer name: |  | |  | | |

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| Resultant ForcesReaction forces  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N | 3.1449 | 21902.7 | 1645.24 | 21964.4 |  Reaction Moments  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N.m | 0 | 0 | 0 | 0 | | |
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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Stress1 | VON: von Mises Stress | 0.000e+00 N/m^2  Node: 189730 | 1.192e+08 N/m^2  Node: 148465 | | C:\Users\Open AG\AppData\Local\Microsoft\Windows\INetCache\Content.Word\lhc-101-Static 1-Stress-Stress1.jpg  **lhc-101-Static 1-Stress-Stress1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Displacement1 | URES: Resultant Displacement | 0.000e+00 mm  Node: 320 | 1.977e+01 mm  Node: 190895 | | C:\Users\Open AG\AppData\Local\Microsoft\Windows\INetCache\Content.Word\lhc-101-Static 1-Displacement-Displacement1.jpg  **lhc-101-Static 1-Displacement-Displacement1** | | | | | |
| Conclusion |

Based on the above simulations, using an S4 x 9.5 plain carbon steel I-beam in this super structure design will result in a 20mm (0.8”) maximum deflection, and a maximum beam stress that is half of the yield strength of the material, making this a sufficiently designed structure for the purposes of this project.