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|  | |  | | --- | | **Simulation of finger\_joint\_assembly\_v4.2**  **Date: Tuesday, May 18, 2021 Designer: Solidworks**  **Study name: finger\_joint\_bend**  **Analysis type: Static** | | Table of Contents  [Description 1](#_Toc72227789)  [Assumptions 2](#_Toc72227790)  [Model Information 2](#_Toc72227791)  [Study Properties 5](#_Toc72227792)  [Units 6](#_Toc72227793)  [Material Properties 7](#_Toc72227794)  [Loads and Fixtures 9](#_Toc72227795)  [Connector Definitions 9](#_Toc72227796)  [Contact Information 10](#_Toc72227797)  [Mesh information 13](#_Toc72227798)  [Sensor Details 14](#_Toc72227799)  [Resultant Forces 15](#_Toc72227800)  [Beams 15](#_Toc72227801)  [Study Results 16](#_Toc72227802)  [Conclusion 18](#_Toc72227803) | |
| Description No Data |

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| Assumptions |

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| Model Information  |  |  |  |  |  | | --- | --- | --- | --- | --- | | |  | | --- | |  |   ****Model name:** finger\_joint\_assembly\_v4.2**  ****Current Configuration:** Default** | | | | | ****Solid Bodies**** | | | | | ****Document Name and Reference**** | ****Treated As**** | ****Volumetric Properties**** | ****Document Path/Date Modified**** | | **Boss-Extrude1** | **Solid Body** | ****Mass:1.24335e-05 kg****  ****Volume:5.67741e-09 m^3****  ****Density:2,190 kg/m^3****  ****Weight:0.000121849 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\adhesive\_strip\_connector.SLDPRT****  **May 18 10:14:32 2021** | | **Fillet5** | **Solid Body** | ****Mass:0.000325912 kg****  ****Volume:1.48818e-07 m^3****  ****Density:2,190 kg/m^3****  ****Weight:0.00319394 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\adhesive\_strip\_finger\_joint\_cap.SLDPRT****  **May 18 10:14:32 2021** | | **Boss-Extrude1** | **Solid Body** | ****Mass:1.45635e-05 kg****  ****Volume:6.65e-09 m^3****  ****Density:2,190 kg/m^3****  ****Weight:0.000142722 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\adhesive\_strip\_magnet\_v2.SLDPRT****  **May 18 10:14:32 2021** | | **Split Line1** | **Solid Body** | ****Mass:0.00562533 kg****  ****Volume:2.23227e-06 m^3****  ****Density:2,520 kg/m^3****  ****Weight:0.0551282 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\finger\_joint\_cap.SLDPRT****  **May 18 10:16:09 2021** | | **Split Line1** | **Solid Body** | ****Mass:0.0327861 kg****  ****Volume:1.30103e-05 m^3****  ****Density:2,520 kg/m^3****  ****Weight:0.321303 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\finger\_joint\_v4.2.SLDPRT****  **May 18 10:19:06 2021** | | **Boss-Extrude1** | **Solid Body** | ****Mass:0.0021604 kg****  ****Volume:2.88054e-07 m^3****  ****Density:7,500 kg/m^3****  ****Weight:0.021172 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\magnet\_connector\_v2.SLDPRT****  **May 18 10:14:32 2021** | | **Hole1** | **Solid Body** | ****Mass:0.00015137 kg****  ****Volume:1.78454e-08 m^3****  ****Density:8,482.3 kg/m^3****  ****Weight:0.00148343 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\mill-max-824-22-005-00-001000\_0933.sldprt****  **May 15 09:00:49 2021** | | **Hole1** | **Solid Body** | ****Mass:0.00015137 kg****  ****Volume:1.78454e-08 m^3****  ****Density:8,482.3 kg/m^3****  ****Weight:0.00148343 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\mill-max-824-22-005-00-001000\_0933.sldprt****  **May 15 09:00:49 2021** | | **Hole1** | **Solid Body** | ****Mass:0.00015137 kg****  ****Volume:1.78454e-08 m^3****  ****Density:8,482.3 kg/m^3****  ****Weight:0.00148343 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\mill-max-824-22-005-00-001000\_0933.sldprt****  **May 15 09:00:49 2021** | | **Hole1** | **Solid Body** | ****Mass:0.00015137 kg****  ****Volume:1.78454e-08 m^3****  ****Density:8,482.3 kg/m^3****  ****Weight:0.00148343 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\mill-max-824-22-005-00-001000\_0933.sldprt****  **May 15 09:00:49 2021** | | **LPattern2** | **Solid Body** | ****Mass:6.35487e-05 kg****  ****Volume:4.53919e-08 m^3****  ****Density:1,400 kg/m^3****  ****Weight:0.000622778 N**** | ****C:\Users\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\Connectors\mill-max-824-22-005-00-001000\_P3XX-18-010-00-090000.sldprt****  **May 15 09:00:49 2021** | |

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| Study Properties  |  |  | | --- | --- | | Study name | finger\_joint\_bend | | 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\Natha\Desktop\Caltech 2020-2024\NASA\_Big\_Idea\_Challenge\GrabCAD\Current\Mechanical\v4\_Eggdee\Parts\5.18\_Finger\_Joint\_Bend) | |

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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:**** | **STYCAST 2850FT/Catalyst 23LV** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Tensile strength:**** | **1.0549e+08 N/m^2** | | ****Compressive strength:**** | **1.19969e+08 N/m^2** | | ****Elastic modulus:**** | **6.413e+09 N/m^2** | | ****Mass density:**** | **2,190 kg/m^3** | | **SolidBody 1(Boss-Extrude1)(adhesive\_strip\_connector-1),**  **SolidBody 1(Fillet5)(adhesive\_strip\_finger\_joint\_cap-1),**  **SolidBody 1(Boss-Extrude1)(adhesive\_strip\_magnet\_v2-2)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **Macor** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Yield strength:**** | **3.3e+07 N/m^2** | | ****Tensile strength:**** | **3.3e+07 N/m^2** | | ****Compressive strength:**** | **3.45e+08 N/m^2** | | ****Elastic modulus:**** | **6.69e+10 N/m^2** | | ****Poisson's ratio:**** | **0.29** | | ****Mass density:**** | **2,520 kg/m^3** | | ****Shear modulus:**** | **2.55e+10 N/m^2** | | ****Thermal expansion coefficient:**** | **8e-06 /Kelvin** | | **SolidBody 1(Split Line1)(finger\_joint\_cap-1),**  **SolidBody 1(Split Line1)(finger\_joint\_v4.2-1)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **N38SH Neodymium Magnet** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Tensile strength:**** | **2.85e+08 N/m^2** | | ****Elastic modulus:**** | **4.14e+10 N/m^2** | | ****Mass density:**** | **7,500 kg/m^3** | | **SolidBody 1(Boss-Extrude1)(magnet\_connector\_v2-1)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **Brass Alloy 385** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Yield strength:**** | **2.39689e+08 N/m^2** | | ****Tensile strength:**** | **4.78413e+08 N/m^2** | | ****Elastic modulus:**** | **1e+11 N/m^2** | | ****Poisson's ratio:**** | **0.33** | | ****Mass density:**** | **8,482.3 kg/m^3** | | ****Shear modulus:**** | **3.7e+10 N/m^2** | | ****Thermal expansion coefficient:**** | **1.8e-05 /Kelvin** | | **SolidBody 1(Hole1)(mill-max-824-22-005-00-001000\_MALE-1/mill-max-824-22-005-00-001000\_0933-1),**  **SolidBody 1(Hole1)(mill-max-824-22-005-00-001000\_MALE-1/mill-max-824-22-005-00-001000\_0933-2),**  **SolidBody 1(Hole1)(mill-max-824-22-005-00-001000\_MALE-1/mill-max-824-22-005-00-001000\_0933-3),**  **SolidBody 1(Hole1)(mill-max-824-22-005-00-001000\_MALE-1/mill-max-824-22-005-00-001000\_0933-4)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **Nylon 46** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Yield strength:**** | **1.39043e+08 N/m^2** | | ****Tensile strength:**** | **1.42559e+08 N/m^2** | | ****Elastic modulus:**** | **8.3e+09 N/m^2** | | ****Poisson's ratio:**** | **0.28** | | ****Mass density:**** | **1,400 kg/m^3** | | ****Shear modulus:**** | **3.2e+09 N/m^2** | | ****Thermal expansion coefficient:**** | **3e-05 /Kelvin** | | **SolidBody 1(LPattern2)(mill-max-824-22-005-00-001000\_MALE-1/mill-max-824-22-005-00-001000\_P3XX-18-010-00-090000-1)** | | **Curve Data:N/A** | | | |

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| **Loads and Fixtures**  | ****Fixture name**** | ****Fixture Image**** | ****Fixture Details**** | | --- | --- | --- | | **Fixed-1** |  | |  |  | | --- | --- | | Entities: | **1 face(s)** | | Type: | **Fixed Geometry** | | | ****Resultant Forces****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Reaction force(N)** | **-2.6226e-06** | **243** | **2.38419e-06** | **243** | | **Reaction Moment(N.m)** | **0** | **0** | **0** | **0** | | | |  | ****Load name**** | ****Load Image**** | ****Load Details**** | | --- | --- | --- | | **Force-1** |  | |  |  | | --- | --- | | Entities: | **1 face(s)** | | Type: | **Apply normal force** | | Value: | **243 N** | | |

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| Connector Definitions No Data |

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| Contact Information  | Contact | Contact Image | Contact Properties | | --- | --- | --- | | Contact Set-1 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **2 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **-0.052507** | **0.89239** | **-0.00071939** | **0.89393** | | | | | Contact Set-2 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **3 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **-0.11702** | **3.1636** | **-0.0015648** | **3.1657** | | | | | Contact Set-3 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **2 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **0.0001076** | **0.030752** | **0.00019563** | **0.030753** | | | | | Contact Set-4 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **3 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **0.034545** | **-0.09099** | **0.00060994** | **0.097328** | | | | | Contact Set-5 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **2 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **-5.2521E-05** | **0.52404** | **-0.004034** | **0.52405** | | | | | Contact Set-6 |  | |  |  | | --- | --- | | Type: | **Bonded contact pair** | | Entities: | **2 face(s)** | | | ****Contact/Friction force****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Contact Force(N)** | **0** | **-0.18865** | **0.0051333** | **0.18872** | | | | | Component Contact-1 |  | |  |  | | --- | --- | | Type: | **No penetration (Surface to surface)** | | Components: | **11 component(s)** | | |

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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 | 0.508 cm | | Tolerance | 0.0254 cm | | Mesh Quality Plot | High | | Remesh failed parts with incompatible mesh | Off |  Mesh information - Details  |  |  | | --- | --- | | Total Nodes | 6972 | | Total Elements | 3406 | | Maximum Aspect Ratio | 95.155 | | % of elements with Aspect Ratio < 3 | 59.4 | | % of elements with Aspect Ratio > 10 | 7.6 | | % of distorted elements(Jacobian) | 0 | | Time to complete mesh(hh;mm;ss): | 00:00:03 | | Computer name: | THICCO | |  | |  Mesh Control Information:  | **Mesh Control Name** | **Mesh Control Image** | **Mesh Control Details** | | --- | --- | --- | | **Control-1** |  | |  |  | | --- | --- | | Entities: | **3 Solid Body (s)** | | Units: | **in** | | Size: | **0.15** | | Ratio: | **0.15** | | |

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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 | -2.6226e-06 | 243 | 2.38419e-06 | 243 |  Reaction Moments  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N.m | 0 | 0 | 0 | 0 | |
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| Beams No Data |

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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Stress1 | VON: von Mises Stress | 8.044e+00 N/m^2  Node: 5092 | 6.915e+06 N/m^2  Node: 2237 | | **finger\_joint\_assembly\_v4.2-finger\_joint\_bend-Stress-Stress1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Displacement1 | URES: Resultant Displacement | 0.000e+00 mm  Node: 1027 | 3.601e-03 mm  Node: 6117 | | **finger\_joint\_assembly\_v4.2-finger\_joint\_bend-Displacement-Displacement1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Strain1 | ESTRN: Equivalent Strain | 6.688e-11  Element: 2299 | 2.547e-04  Element: 60 | | **finger\_joint\_assembly\_v4.2-finger\_joint\_bend-Strain-Strain1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Factor of Safety1 | Mohr-Coulomb Stress | 3.000e+00  Node: 1 | 3.000e+00  Node: 1 | | **finger\_joint\_assembly\_v4.2-finger\_joint\_bend-Factor of Safety-Factor of Safety1** | | | | |

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| Conclusion |