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|  | |  | | --- | | **Simulation of tract chassis**  **Date: Tuesday, March 1, 2022 Designer: JIBEBE PROJECT**  **Study name: Frequency 1**  **Analysis type: Frequency** | | Table of Contents  [Description 1](#_Toc97069037)  [Assumptions 2](#_Toc97069038)  [Model Information 2](#_Toc97069039)  [Study Properties 4](#_Toc97069040)  [Units 5](#_Toc97069041)  [Material Properties 5](#_Toc97069042)  [Loads and Fixtures 6](#_Toc97069043)  [Connector Definitions 7](#_Toc97069044)  [Contact Information 7](#_Toc97069045)  [Mesh information 8](#_Toc97069046)  [Sensor Details 10](#_Toc97069047)  [Study Results 11](#_Toc97069048)  [Conclusion 16](#_Toc97069049) | |
| Description No Data |

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| Assumptions  |  |  | | --- | --- | | Original Model | Model Analyzed | |

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| Model Information  |  |  |  |  |  | | --- | --- | --- | --- | --- | | |  | | --- | |  |   ****Model name:** tract chassis**  ****Current Configuration:** with c channel<As Machined>** | | | | | ****Solid Bodies**** | | | | | ****Document Name and Reference**** | ****Treated As**** | ****Volumetric Properties**** | ****Document Path/Date Modified**** | | **C channel 75X50(1)[3]** | **Solid Body** | ****Mass:3.87693 kg****  ****Volume:0.000490751 m^3****  ****Density:7900 kg/m^3****  ****Weight:37.9939 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **Split Line2[1]** | **Solid Body** | ****Mass:3.17204 kg****  ****Volume:0.000401523 m^3****  ****Density:7900 kg/m^3****  ****Weight:31.0859 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **Split Line1[2]** | **Solid Body** | ****Mass:4.58183 kg****  ****Volume:0.000579978 m^3****  ****Density:7900 kg/m^3****  ****Weight:44.9019 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **C channel 50X50X4(1)** | **Solid Body** | ****Mass:2.63766 kg****  ****Volume:0.000333882 m^3****  ****Density:7900 kg/m^3****  ****Weight:25.8491 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **C channel 75X50(1)[8]** | **Solid Body** | ****Mass:2.11469 kg****  ****Volume:0.000267682 m^3****  ****Density:7900 kg/m^3****  ****Weight:20.724 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **Split Line2[2]** | **Solid Body** | ****Mass:3.17204 kg****  ****Volume:0.000401523 m^3****  ****Density:7900 kg/m^3****  ****Weight:31.0859 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **Split Line1[1]** | **Solid Body** | ****Mass:4.58183 kg****  ****Volume:0.000579978 m^3****  ****Density:7900 kg/m^3****  ****Weight:44.9019 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **C channel 75X50(1)[1]** | **Solid Body** | ****Mass:1.62126 kg****  ****Volume:0.000205223 m^3****  ****Density:7900 kg/m^3****  ****Weight:15.8884 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **C channel 75X50(1)[2]** | **Solid Body** | ****Mass:3.87693 kg****  ****Volume:0.000490751 m^3****  ****Density:7900 kg/m^3****  ****Weight:37.9939 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | | **C channel 75X50(1)[9]** | **Solid Body** | ****Mass:2.11469 kg****  ****Volume:0.000267682 m^3****  ****Density:7900 kg/m^3****  ****Weight:20.724 N**** | ****C:\Users\pc\Desktop\Electric vehicle\Chassis\tract chassis.SLDPRT****  **Mar 01 22:56:51 2022** | |

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| Study Properties  |  |  | | --- | --- | | Study name | Frequency 1 | | Analysis type | Frequency | | Mesh type | Solid Mesh | | Number of frequencies | 5 | | Solver type | Direct sparse solver | | Soft Spring: | Off | | Incompatible bonding options | Automatic | | Thermal option | Include temperature loads | | Zero strain temperature | 298 Kelvin | | Include fluid pressure effects from SOLIDWORKS Flow Simulation | Off | | Result folder | SOLIDWORKS document (C:\Users\pc\Desktop\Electric vehicle\Chassis) | |

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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:**** | **AISI 1020** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Unknown** | | ****Yield strength:**** | **3.51571e+008 N/m^2** | | ****Tensile strength:**** | **4.20507e+008 N/m^2** | | ****Mass density:**** | **7900 kg/m^3** | | ****Elastic modulus:**** | **2e+011 N/m^2** | | ****Poisson's ratio:**** | **0.29** | | ****Thermal expansion coefficient:**** | **1.5e-005 /Kelvin** | | **SolidBody 1(C channel 75X50(1)[3])(tract chassis),**  **SolidBody 2(Split Line2[1])(tract chassis),**  **SolidBody 3(Split Line1[2])(tract chassis),**  **SolidBody 4(C channel 50X50X4(1))(tract chassis),**  **SolidBody 5(C channel 75X50(1)[8])(tract chassis),**  **SolidBody 6(Split Line2[2])(tract chassis),**  **SolidBody 7(Split Line1[1])(tract chassis),**  **SolidBody 8(C channel 75X50(1)[1])(tract chassis),**  **SolidBody 9(C channel 75X50(1)[2])(tract chassis),**  **SolidBody 10(C channel 75X50(1)[9])(tract chassis)** | | **Curve Data:N/A** | | | |

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| **Loads and Fixtures**  | ****Fixture name**** | ****Fixture Image**** | ****Fixture Details**** | | --- | --- | --- | | **Fixed-1** |  | |  |  | | --- | --- | | Entities: | **4 face(s)** | | Type: | **Fixed Geometry** | |  | ****Load name**** | ****Load Image**** | ****Load Details**** | | --- | --- | --- | | **Gravity-1** |  | |  |  | | --- | --- | | Reference: | **Top Plane** | | Values: | **0 0 -9.81** | | Units: | **SI** | | | **Remote Load/Mass (Rigid connection)-1** |  | |  |  | | --- | --- | | Entities: | **11 face(s)** | | Type: | **Load/Mass (Rigid connection)** | | Coordinate System: | **Global cartesian coordinates** | | Force Values: | **---, -3000, --- N** | | Moment Values: | **---, ---, --- N.m** | | Reference coordinates: | **1345 0 0 mm** | | Components transferred: | **Force** | | | **Remote Load/Mass (Rigid connection)-2** |  | |  |  | | --- | --- | | Entities: | **7 face(s)** | | Type: | **Load/Mass (Rigid connection)** | | Coordinate System: | **Global cartesian coordinates** | | Force Values: | **---, -3500, --- N** | | Moment Values: | **---, ---, --- N.m** | | Reference coordinates: | **350 0 0 mm** | | Components transferred: | **Force** | | |

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| Connector Definitions No Data |

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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 | 46.7245 mm | | Tolerance | 1.26282 mm | | Mesh Quality Plot | High |  Mesh information - Details  |  |  | | --- | --- | | Total Nodes | 51500 | | Total Elements | 26062 | | Maximum Aspect Ratio | 50.575 | | % of elements with Aspect Ratio < 3 | 56.5 | | % of elements with Aspect Ratio > 10 | 5.02 | | % of distorted elements(Jacobian) | 0 | | Time to complete mesh(hh;mm;ss): | 00:00:04 | | Computer name: | SIR\_ALECS | |  | |  Mesh Control Information:  | **Mesh Control Name** | **Mesh Control Image** | **Mesh Control Details** | | --- | --- | --- | | **Control-1** |  | |  |  | | --- | --- | | Entities: | **3 face(s)** | | Units: | **mm** | | Size: | **19.6499** | | Ratio: | **1.5** | | | **Control-2** |  | |  |  | | --- | --- | | Entities: | **1 Solid Body (s)** | | Units: | **mm** | | Size: | **21.1523** | | Ratio: | **1.5** | | | **Control-3** |  | |  |  | | --- | --- | | Entities: | **1 Solid Body (s)** | | Units: | **mm** | | Size: | **19.5738** | | Ratio: | **1.5** | | | **Control-4** |  | |  |  | | --- | --- | | Entities: | **1 Solid Body (s)** | | Units: | **mm** | | Size: | **18.6266** | | Ratio: | **1.5** | | |

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| Sensor Details No Data |

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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Amplitude1 | AMPRES: Resultant Amplitude Plot for Mode Shape: 1(Value = 475.34 Hz) | 0.000e+000  Node: 2002 | 3.262e-001  Node: 1310 | | **tract chassis-Frequency 1-Amplitude-Amplitude1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Amplitude2 | AMPRES: Resultant Amplitude Plot for Mode Shape: 2(Value = 881.856 Hz) | 0.000e+000  Node: 2002 | 2.318e-001  Node: 7493 | | **tract chassis-Frequency 1-Amplitude-Amplitude2** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Amplitude3 | AMPRES: Resultant Amplitude Plot for Mode Shape: 3(Value = 1811.7 Hz) | 0.000e+000  Node: 2002 | 4.426e-001  Node: 17720 | | **tract chassis-Frequency 1-Amplitude-Amplitude3** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Amplitude4 | AMPRES: Resultant Amplitude Plot for Mode Shape: 4(Value = 2090.87 Hz) | 0.000e+000  Node: 2002 | 2.256e+000  Node: 25069 | | **tract chassis-Frequency 1-Amplitude-Amplitude4** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Amplitude5 | AMPRES: Resultant Amplitude Plot for Mode Shape: 5(Value = 2121.08 Hz) | 0.000e+000  Node: 2002 | 2.739e+000  Node: 17853 | | **tract chassis-Frequency 1-Amplitude-Amplitude5** | | | |   **Mode List**   | ****Frequency Number**** | ****Rad/sec**** | ****Hertz**** | ****Seconds**** | | --- | --- | --- | --- | | **1** | **2986.7** | **475.34** | **0.0021038** | | **2** | **5540.9** | **881.86** | **0.001134** | | **3** | **11383** | **1811.7** | **0.00055197** | | **4** | **13137** | **2090.9** | **0.00047827** | | **5** | **13327** | **2121.1** | **0.00047146** |   **Mass Participation (Normalized)**   | ****Mode Number**** | ****Frequency(Hertz)**** | ****X direction**** | ****Y direction**** | ****Z direction**** | | --- | --- | --- | --- | --- | | **1** | **475.34** | **2.4296e-005** | **0.34868** | **2.6782e-006** | | **2** | **881.86** | **1.5693e-007** | **9.4623e-009** | **0.85807** | | **3** | **1811.7** | **1.0973e-008** | **7.1014e-007** | **0.033538** | | **4** | **2090.9** | **0.084195** | **4.0801e-005** | **1.1462e-005** | | **5** | **2121.1** | **0.0015483** | **1.5984e-006** | **0.00030601** | |  |  | **Sum X = 0.085767** | **Sum Y = 0.34873** | **Sum Z = 0.89193** | |

**Discussion**

The battery packs, motor and the gearbox are all to be carried by the chassis. Of these the components that rotate are the motor and the gearbox. Since the motor rotates at very high speeds its operating frequency is calculated as illustrated below.

Hence for a top speed of 3500rpm

Using the formulas shown above then the operating frequency of the motor is 58.33Hz (366.52rad/s)

For safe operation of the chassis and avoiding resonance the operating frequency of the motor should never coincide with the natural frequency of the chassis.

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