

DESIGN and ANALYSIS of the ROAM Collision System

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BACKGROUND

Remotely Operated Acceleration Monitor (ROAM) is a ground robot used to monitor accelerator enclosures while the beam line is active

Houses multiple data acquisition sensors to monitor:

- Radiation levels
- Temperature fluctuations
- Thermal imaging
- Sensor and gauge inspections

The collision system must be handled with great care as any collision with any part of the accelerator poses a great risk

If for any reason the operator loses control of the robot, a bumper system is in place to prevent significant force from being transferred from the robot to the object

GOALS

- Model current design of robot bumpers in CAD and perform impact failure analysis
- Redesign of the robot's bumper sensors for more robust components, smoother operation, and enhanced collision detection and perform impact failure analysis
- 3D print new parts, assembly, and perform field tests

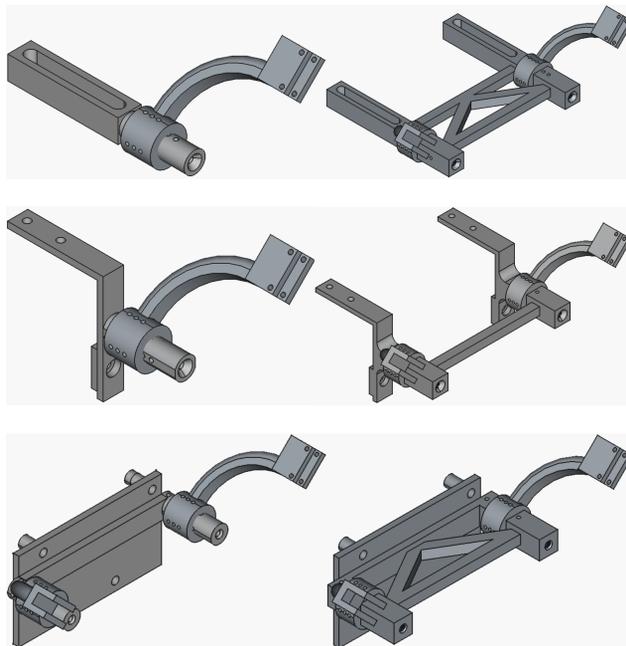
DETERMINING PART FAILURE

Max von Mises Stress > Allowable Stress = Part Failure

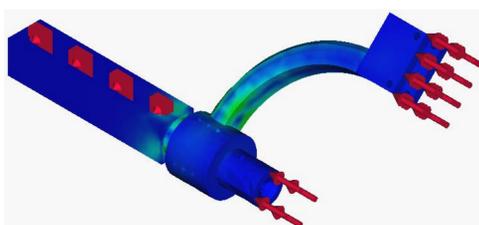
The force analysis looks at the parts right before it experiences failure, or in other words, when the maximum von Mises stress of the part equals the allowable stress of the material

Given PLA material with 30 MPa of allowable stress, calculate the magnitude of force needed to reach 30 MPa of stress to determine part failure

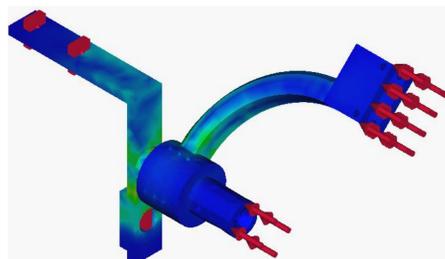
OVERVIEW OF PARTS



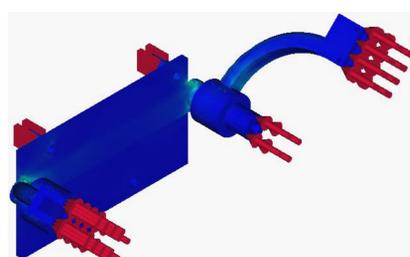
FEM FORCE ANALYSIS



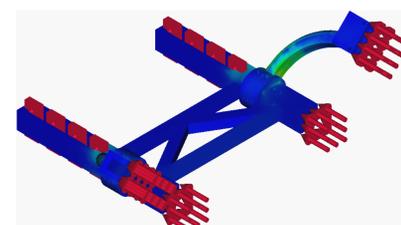
157.99 N | 35.52 lbs



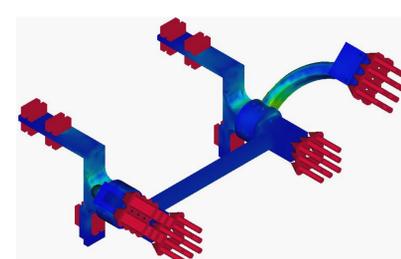
154.00 N | 34.62 lbs



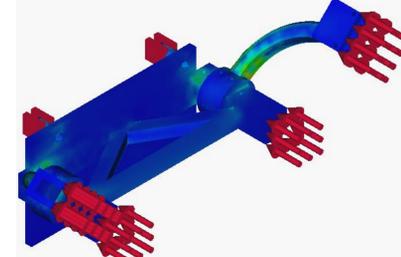
138.10 N | 31.05 lbs



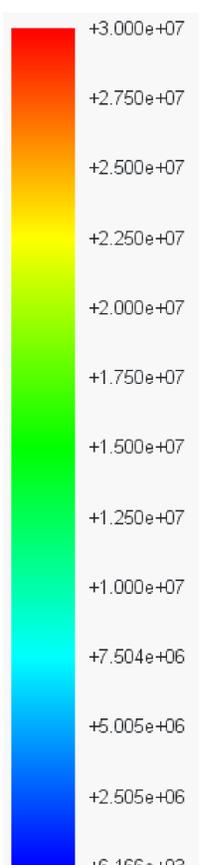
522.83 N | 117.54 lbs



537.25 N | 120.78 lbs



608.52 N | 136.80 lbs



THERMOPLASTIC MATERIALS IN RADIATION

Thermoplastic materials experiences cross linking and chain scission under certain amounts of radiation, changing the material's mechanical properties (Young's modulus, stress, strain, shear)

PLA, PBT, and PC have shown a decrease in their mechanical properties under high doses

PCTG and ABS have shown no significant difference in all mechanical properties under varying doses

3D PRINTING

All parts are made of PLA material, as it is the only available material, and fastened using 18-8 stainless steel screws

3D printing is done using Bambu Lab X1C and UltiMaker S series printers

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- Thank you to the internship coordinators for their support and guidance to not only me but the rest of the interns this summer

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