TRITON ROBOTICS

Roller Bracket v2 Analysis

Robomaster 2021-2022

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Abstract

This analysis is to determine if the roller brackets designed in version 2 of the protector would be able to withstand a collision against the playing field. After a couple of design changes, the roller bracket was analyzed to be able to survive a collision of 707 Newtons.

Calculations

Collisions against the playing field are much more likely and this was verified during 2021 RMUL. Robots sparingly collided into one another and when they did, it was usually at low speeds and close distances; collisions were mostly into the barriers and walls of the field. The strategy during the competition was to be either power or HP focused depending on which robots we faced. The calculations will assume a direct collision between the playing field in worst case scenarios i.e. max weight and max speed, but it is assumed that no field buffs have been applied.

Constants

Maximum Weight of Infantry in RMUL 2021	25 kg
Maximum Chassis Power Consumption at Level 3 for Power Focus	100 W

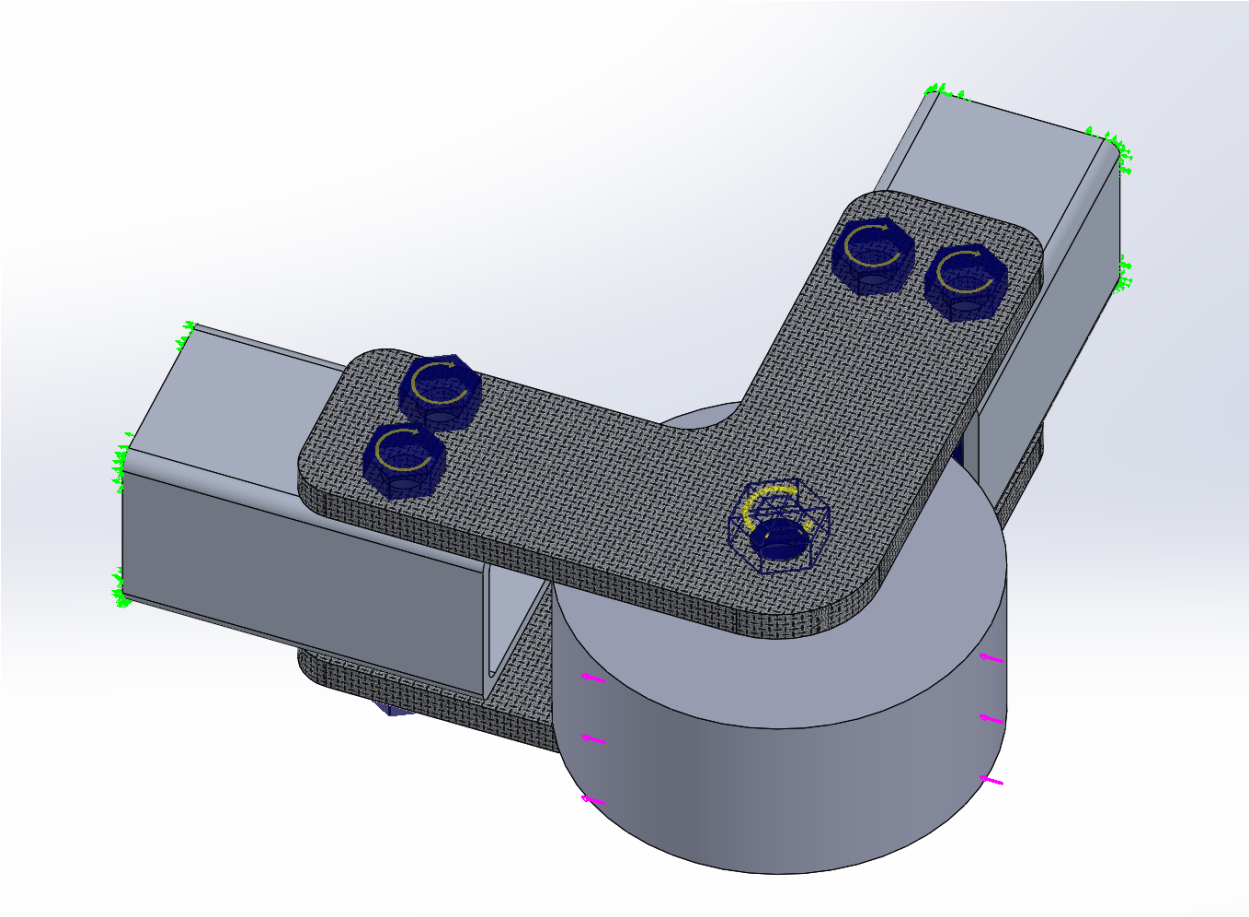
Assuming that all the power goes into the chassis in one second, the energy provided is 100 Joules using $P = E/t$.

Provided that all 100 Joules goes into translational movement, this means that the speed of the infantry, using the equation $E = \frac{1}{2}mv^2$, is 2.83 meters per second.

If the robot is going at 2.83 meters per second and collides into the playing field at a complete stop, the magnitude of the change in momentum or impulse is 70.71 Newton-seconds using the equation $J = \Delta p = |0 - mv_o|$.

The force of the collision can be found by assuming a duration of 0.1 seconds and constant force using $J = F\Delta t$. This gives us a force of 707 Newtons.

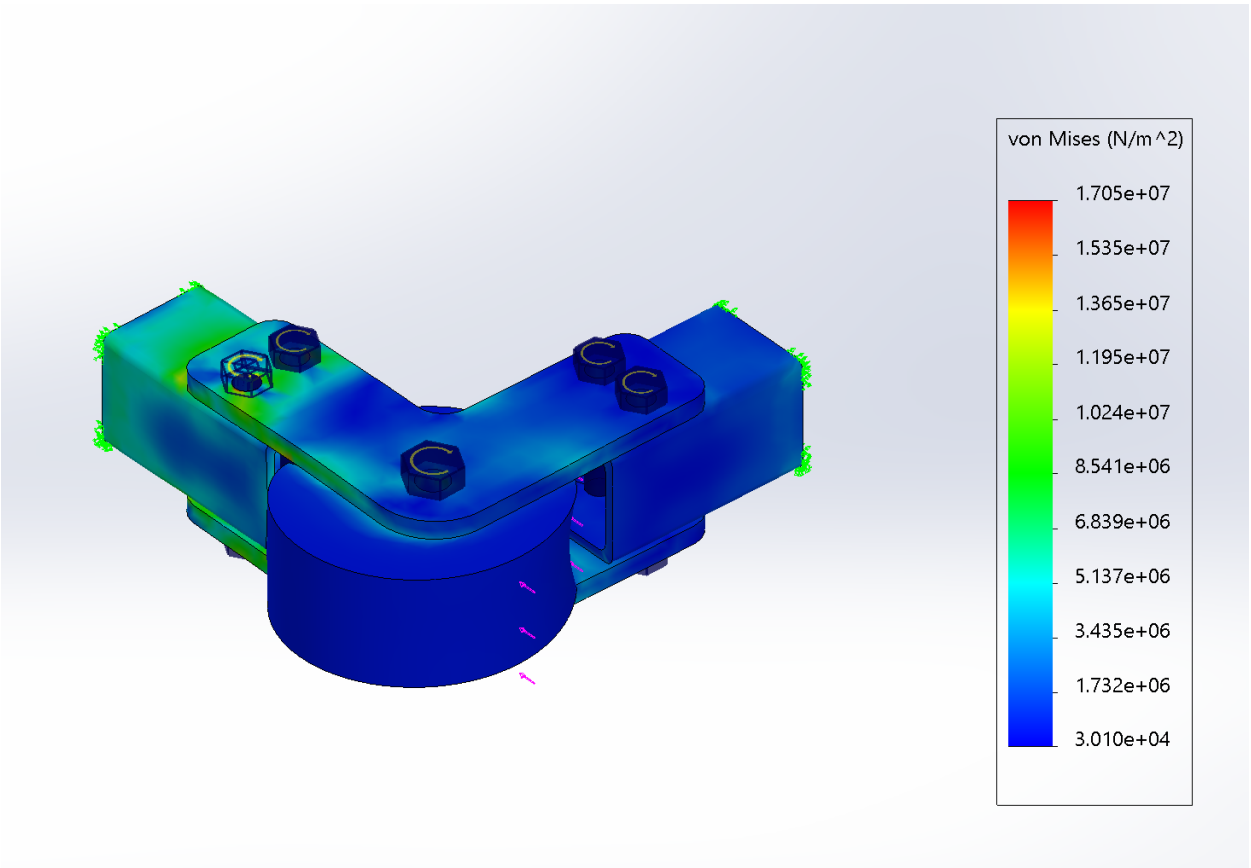
FEA 1

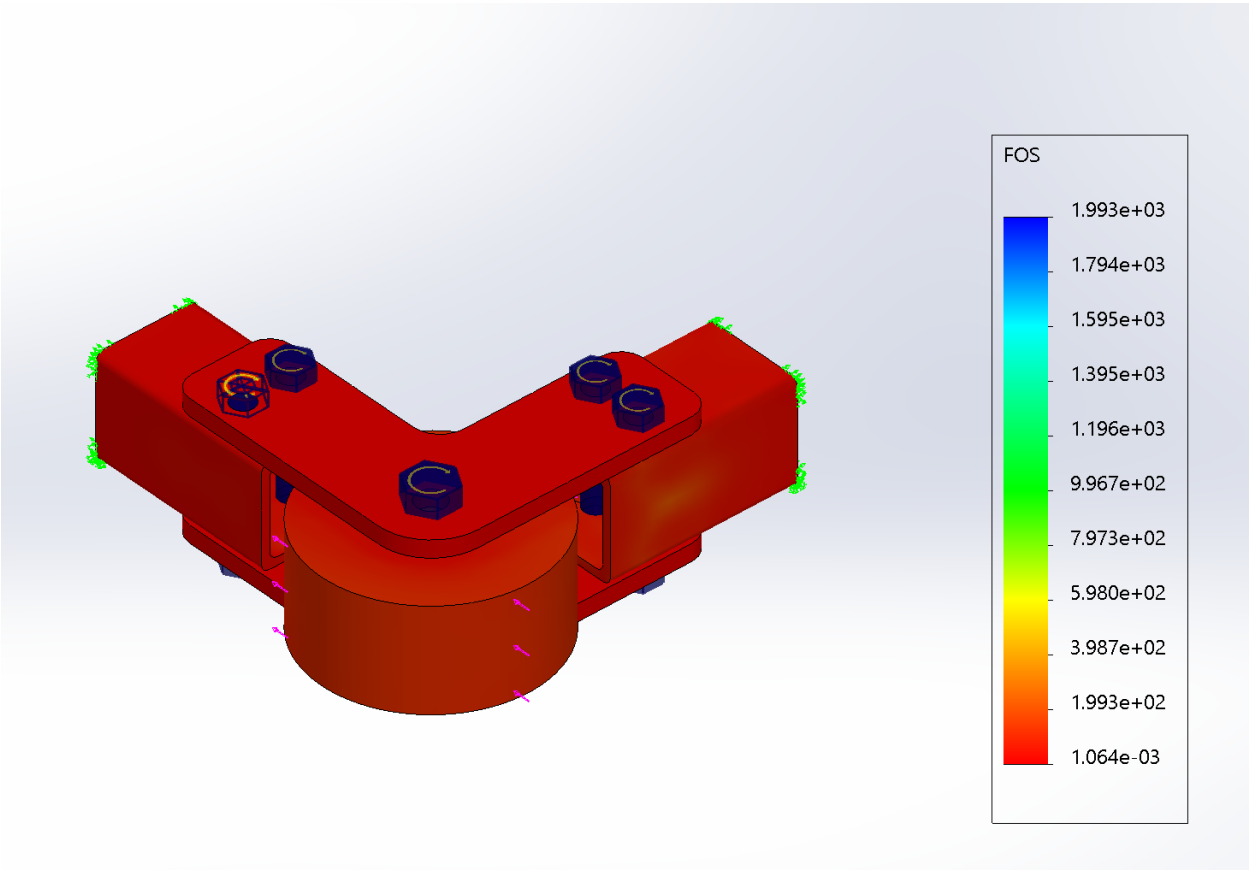


- For the square tubing, I used aluminum 6061. For the bracket, I used zoltek panex 33 but some values might be slightly different. For the roller, I used nylon 101 which is close to what the roller from McMaster is made of. The roller from McMaster has a durometer of 75, while nylon 101 has a durometer of 80.
- Course meshes will be used for all FEA analysis and will be run only once because this analysis acts as a simple check for whether or not it will work.

Preload

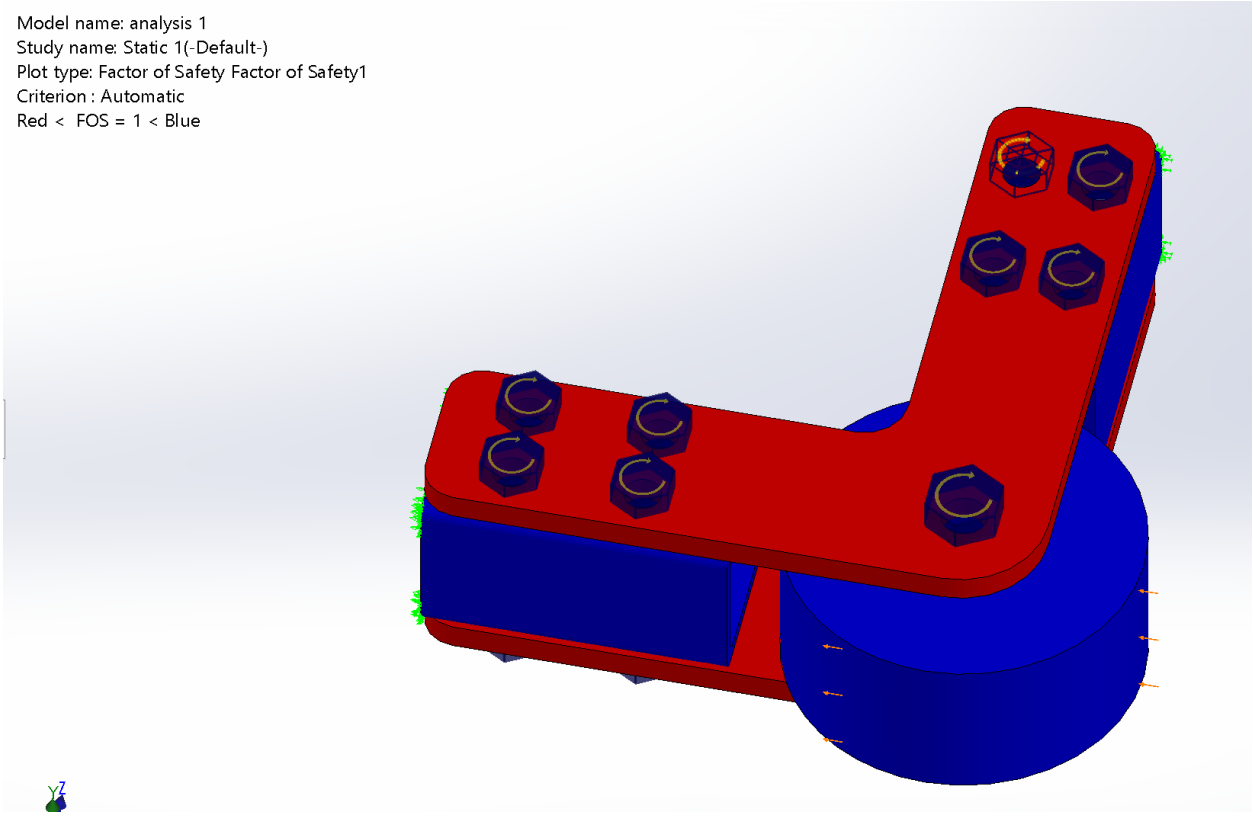
- Using the equation for preload $F_P = Kd$, the preload for a M4 screw is 0.00448 N-m and for a M5 screw, it is 0.00915 N-m.


von Mises (N/m^2)
1.705e+07
1.535e+07
1.365e+07
1.195e+07
1.024e+07
8.541e+06
6.839e+06
5.137e+06
3.435e+06
1.732e+06
3.010e+04



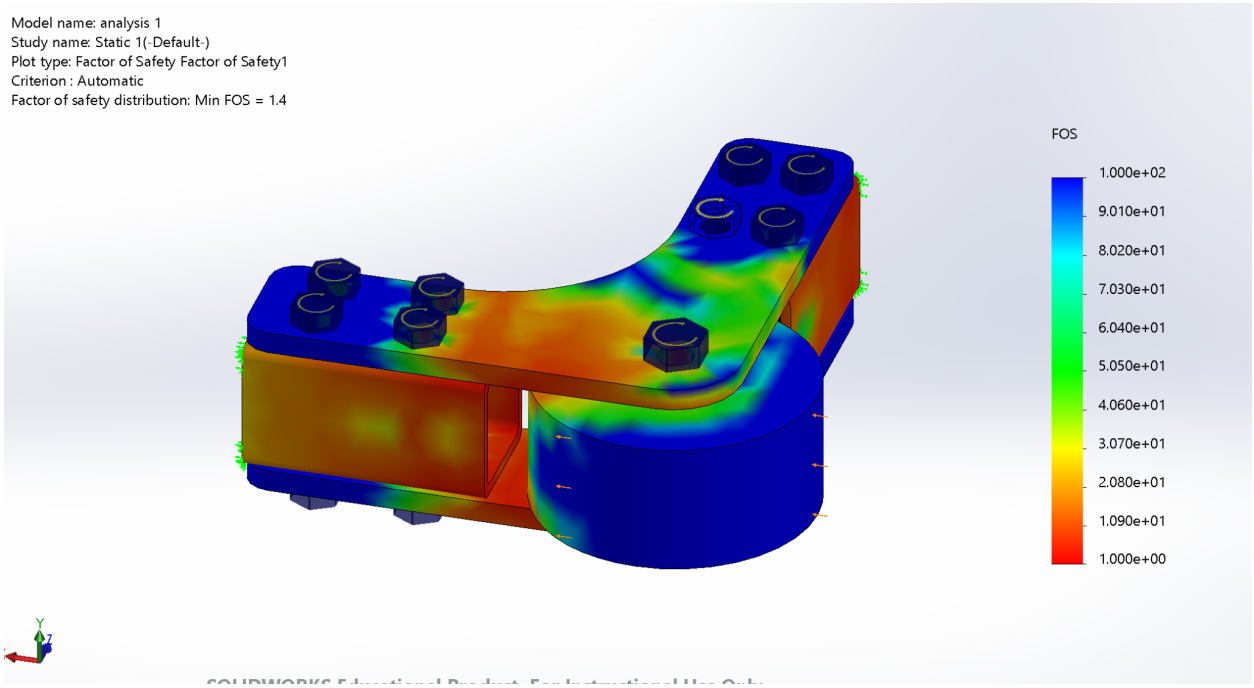
- The bracket needs to be designed since it will break.

FEA 2



- Even with more holes added, the bracket will still break

FEA 3



- I increased the inner fillet and changed the material to impact acrylic because I was getting such a low factor of safety (like 0.0088) when using my custom carbon fiber material. Once I changed the material, the result was a minimum factor of safety of 1.4.
- The problem was with the values for the material properties I was using for the carbon fiber plates. I decided to change to impact acrylic because it resembled the material that was expected to be used, which was carbon fiber.

References

http://www.matweb.com/search/datasheettext.aspx?matid=3108
https://zoltek.com/products/px30/
https://roymech.org/Useful_Tables/Screws/Preloading.html
https://www.trfastenings.com/products/knowledgebase/stainless-steel-fasteners/pre-load-and-tightening-torques-coarse-metric-threads