SIMULATION PRESENTATION

SENIOR DESIGN

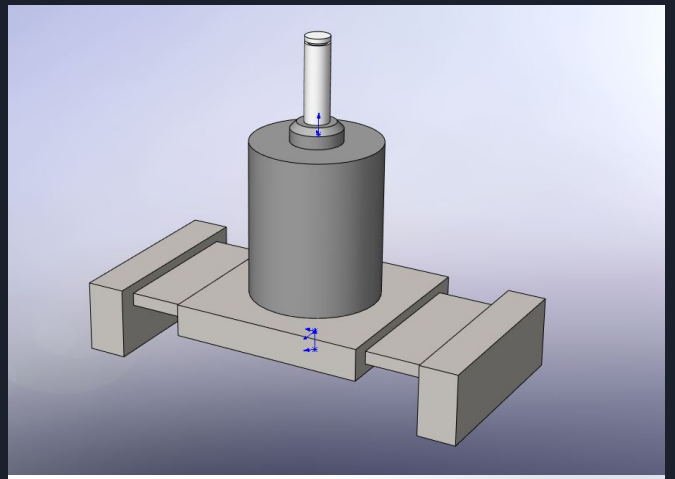
Bryan Moy, Do-Gon Kim, Isaac Zhang, Rifah Tasnim, Samman Sajjad Chaudhry, Zixuan Liu

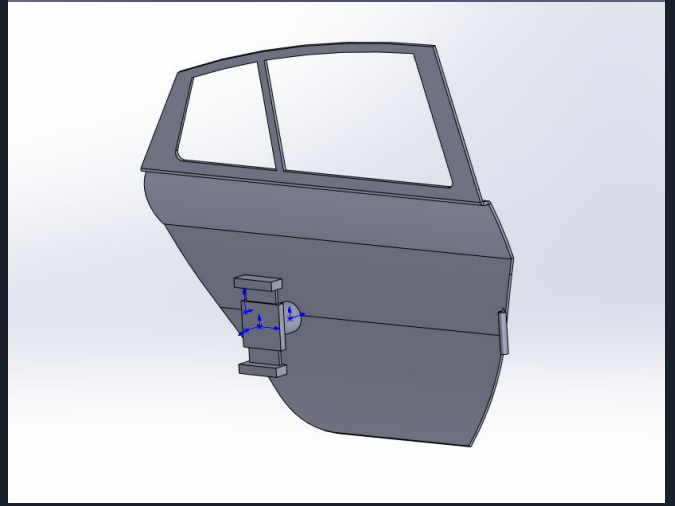
INTRODUCTION

- Number of flooding cases annually increasing
- Design device to assist escape from flooded cars

DEVICE CONCEPT

- Mechanical system powered by hydraulics
- Will exert certain amount of force on car door
  - Fixed to car seat with bracket holder
  - Oil pressure builds up in cylinder, pushing piston
  - Piston then pushes car door

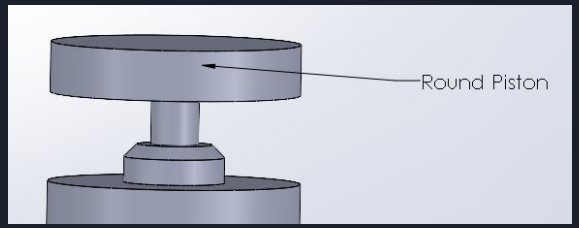


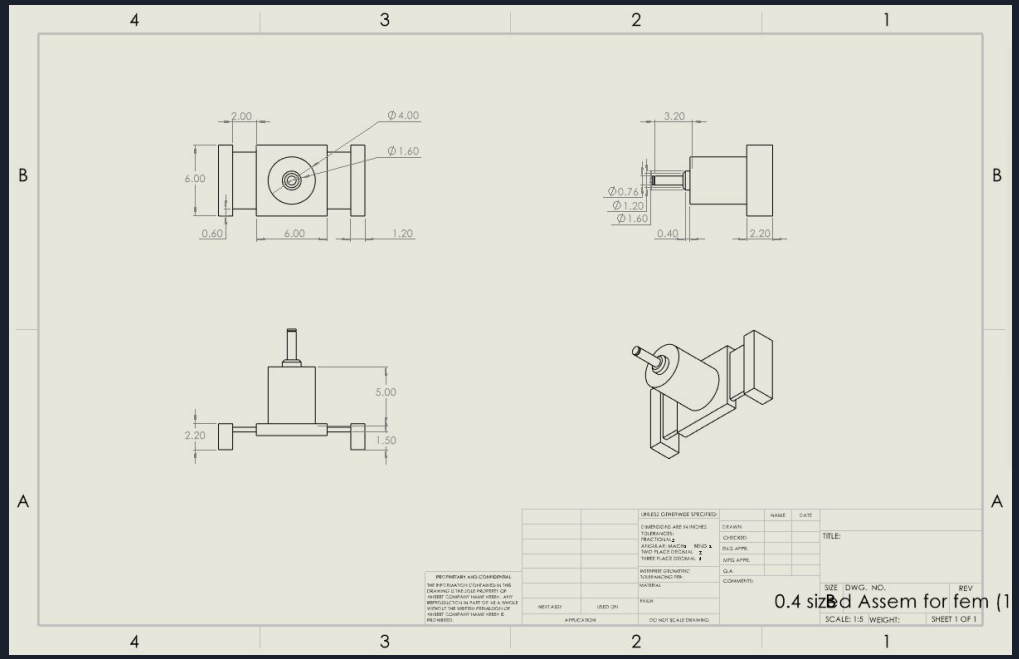


LAYOUT

Changes made:

- Size adjustment (downsized)
- Piston shape change
  - Old design below



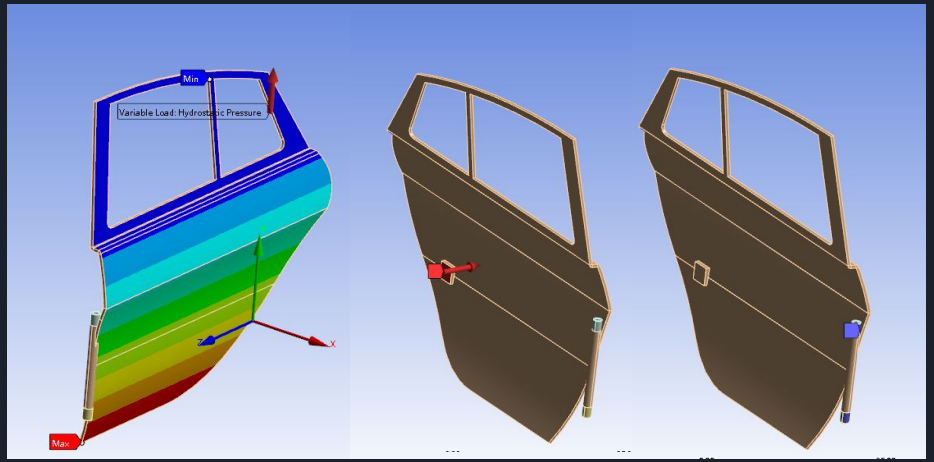


SIMULATIONS

Simulations conducted on 3 parts

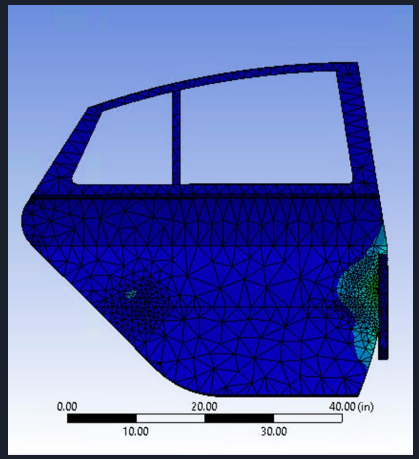
- Car door
  - Should deform outwards even when not moving outwards.
- Piston
  - Shrink less than 0.1in to not hinder performance
  - Avoid reaching harmonic frequencies to avoid breaking
- Cylinder:
  - Expand less than 0.01in to prevent oil leak

SIMULATION-1: CAR DOOR SETUP

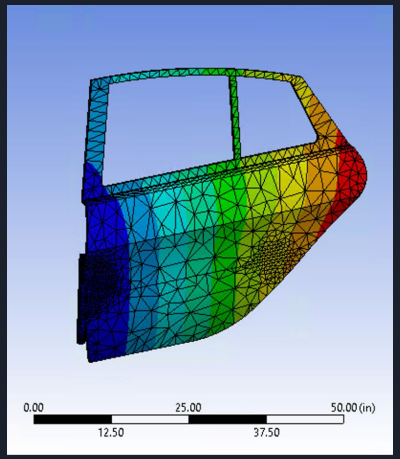


- Hinge simulated by fixed cylinders & joint connection
- 550 lbs force to the door
- Hydrostatic pressure outside
  - 30in Water level
- Assumptions:
  - Made of structural steel
  - Static water

SIMULATION-1: CAR DOOR RESULTS



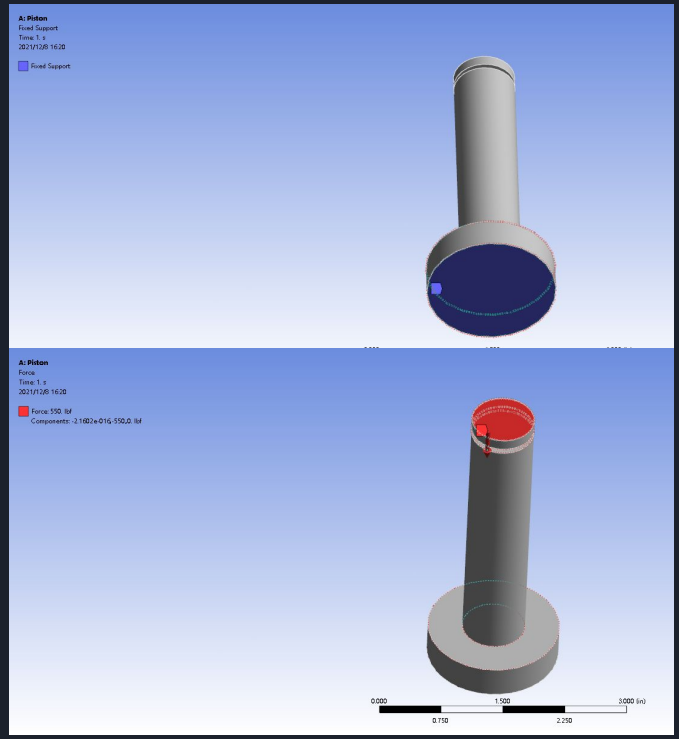
- Stress:
  - Max (32164 psi) at hinge
  - Min (0.070433 psi)



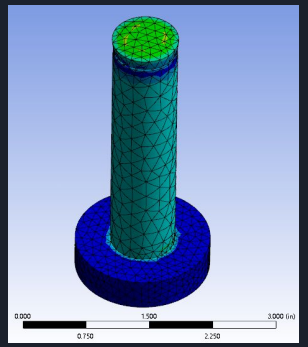
- Deformation:
  - Max (0.36586 in) outwards
  - Min (0 in) at hinge

SIMULATION-2: PISTON SETUP

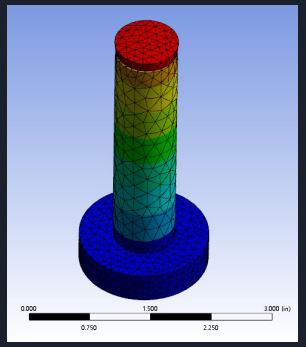
- Calculated force (550 lbf) from door to piston
- This force is coming from the car door due to pressure of water
- Assumptions:
  - The piston is fully extended from the jack
  - The piston only moves through the inner cylinder



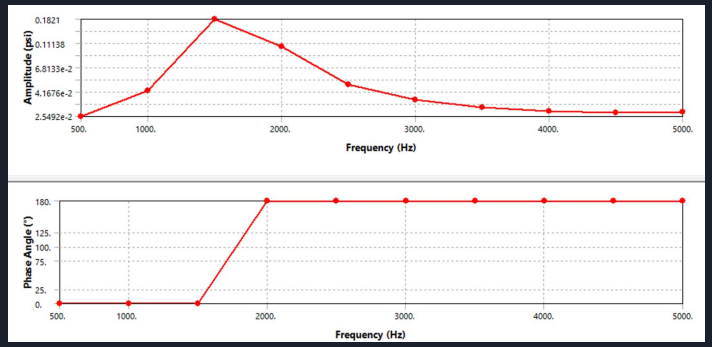
SIMULATION-2: PISTON RESULTS



- Stress:
  - Max (4074.3 psi) at top
  - Min (29.404 psi) at bottom

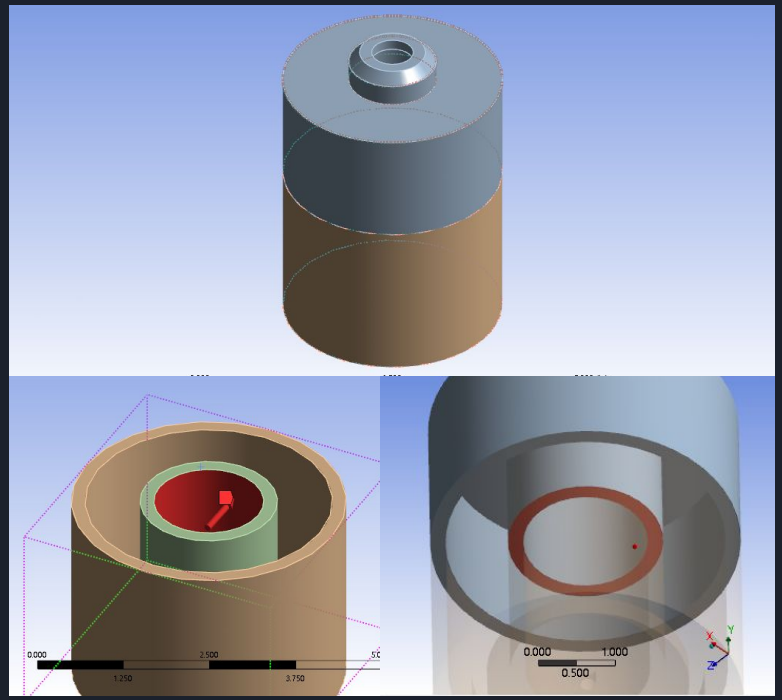


- Deformation:
  - Max (0.0001694 in) at top
  - Min (0 in) at bottom



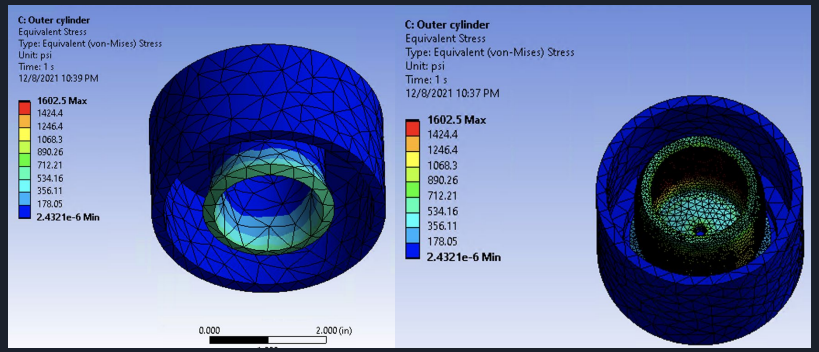
- Frequency
  - Phase angle stays at 180 degree
  - The piston is not stable around 2000 Hz

SIMULATION-3: CYLINDER SETUP

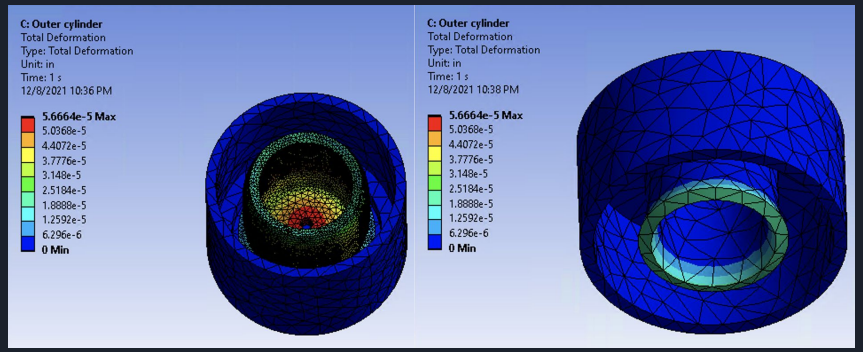


- Cut in half for analysis
- Only part below piston base subjected to oil pressure
- Use bonded contact to simulate as one part
- Assumptions:
  - The piston is exerted a certain distance.
  - The cylinder is sealed well.

SIMULATION-3: CYLINDER RESULTS



- Stress:
  - Max (1602.5 psi) at bottom
  - Min (2.4321e-6 psi) at side



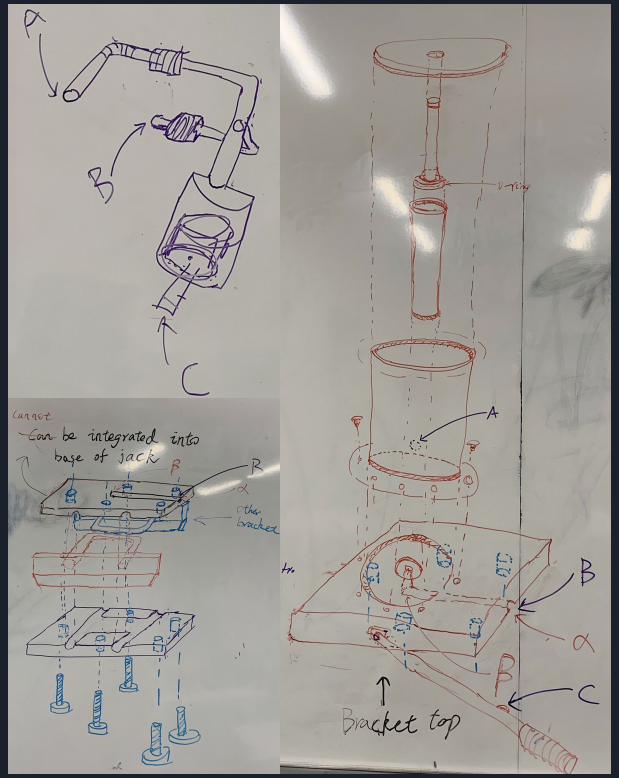
- Deformation
  - Max (5.6664e-5 in) at bottom
  - Min (0 in) on outer shell

CONCLUSIONS

- Car door
  - Confirmed that force is able to bend door outwards
- Piston
  - Deformation significantly less than 0.1in
  - Harm in performance is likely to be insignificant
- Cylinder:
  - Expanded significantly less than 0.01in
  - Leak is unlikely

OPEN ITEMS

- Further updates on layout
  - yet to be applied to model & drawing
- Parts considering purchase
  - Piston
  - Cylinder case
  - Jack handle



BILL OF MATERIALS

Quantity	Item	Unit Cost	Shipping costs	Total Price
ISO Viscosity Grade 150 Hydraulic Oil	1	$36.52	15.52	$52.04
Sheet Metal	10	$12.52	Information not available at the moment	$125.2
Ball bearing	100 Comes in a set	$12	Information not available at the moment	$12
Cylinder Case	1	$100	10	$110
Piston	1	$80	0	$80
Jack handle	1	$15.60	0	$15.60
Sealing tape	10	$0.8	0	$8
				$402.84 (Previously $189.24)

CITATIONS

- Car door model:
  - https://grabcad.com/library/car-door-54
- Flooded car image:
  - www.northjersey.com