



# Penstocks Design

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**Project Advisor: Dr. Emad Tanbour**

**A Design Project Submitted in Partial Fulfillment  
of the Requirements for the Course**

**Assessment III: Graduation Project**



# Statement of Purpose

- To design a Penstocks that can be manufactured using locally available resources and manufacturing techniques.
- Design the project using the SolidWorks program.



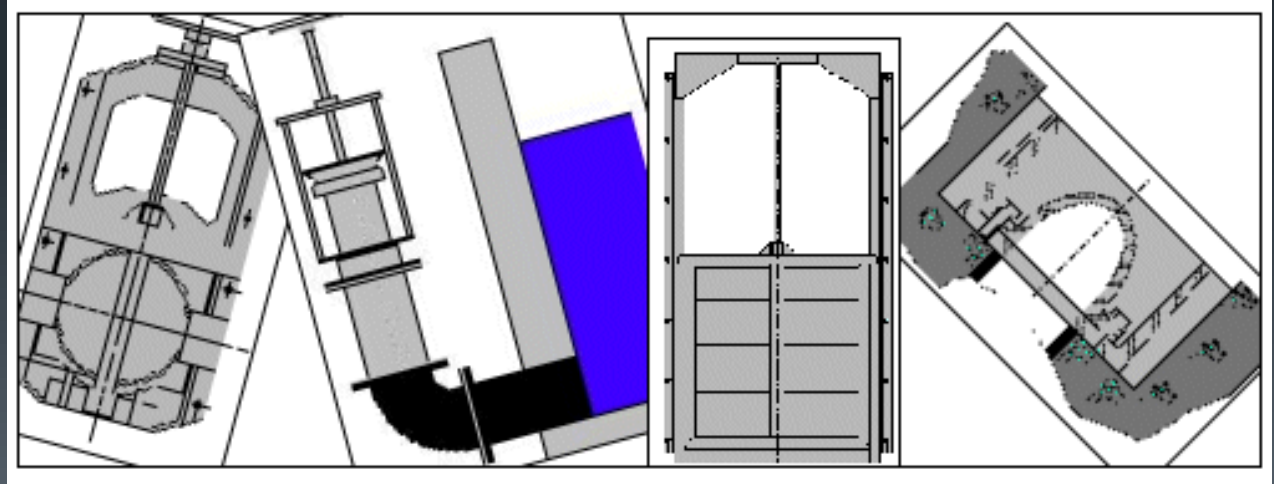
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# Introduction

- A **penstock** is a sluice or gate or intake structure that controls water flow, or an enclosed pipe that delivers water to hydraulic turbines and sewerage systems.
- Penstocks may be used where water level control, flow isolation or diversion is required. This may include dams, rivers and weirs, water treatment, sewage treatment, storm water, irrigation flood control gate applications.





# Design GANTT Chart

Perstocks Design

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Project Timeline

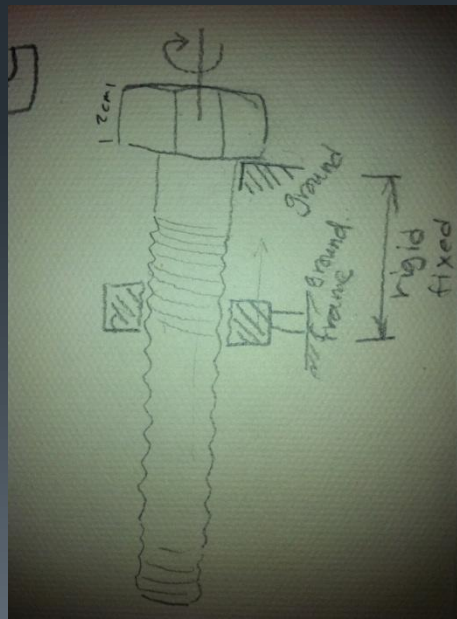
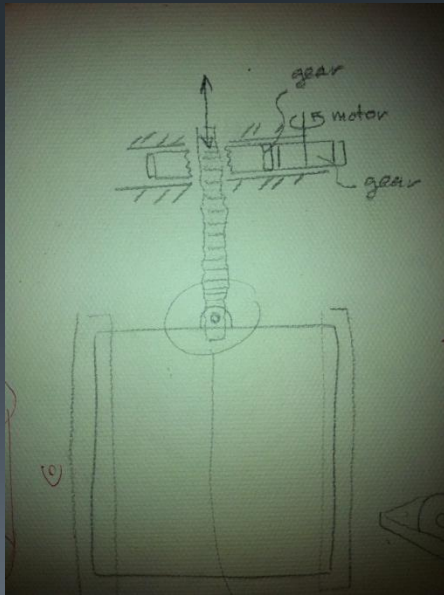
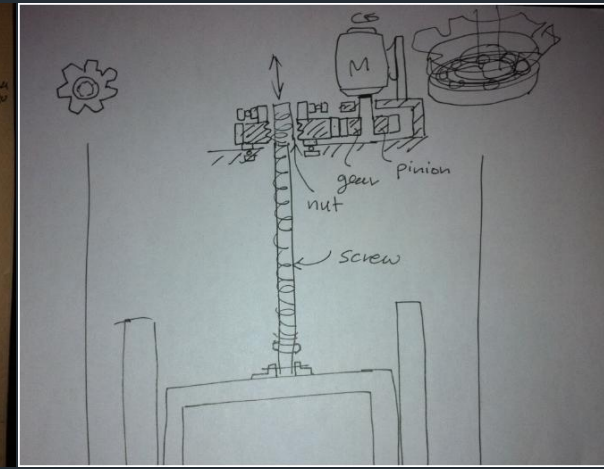
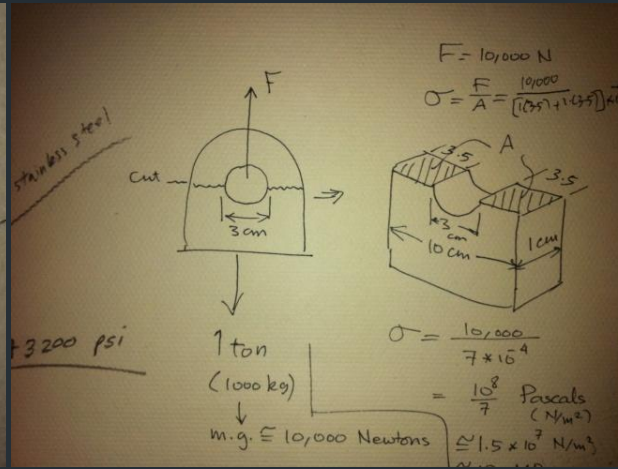
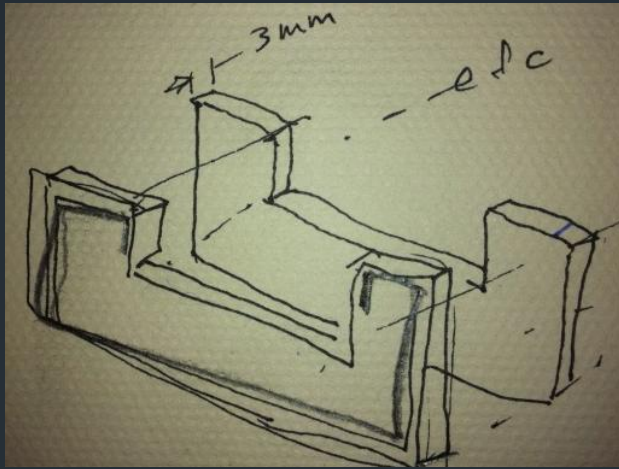
## GANTT Chart



Done  
Under proses



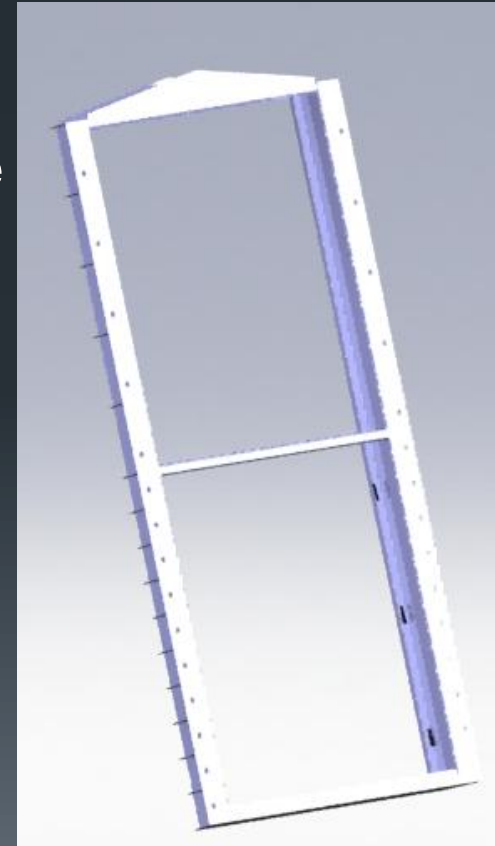
# Sketches





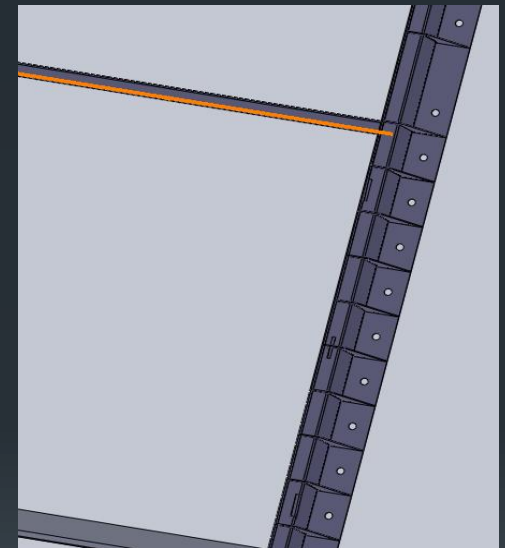
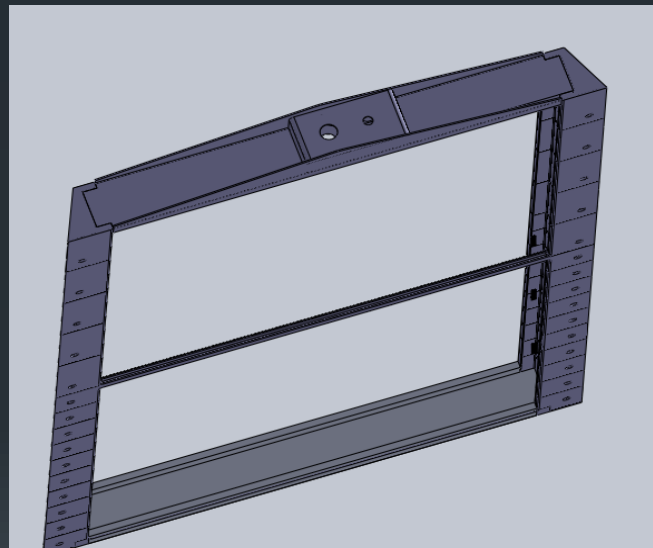
## Frame Design

- Gate Frame will be installed on a concrete wall. It has height of 4.17 m and width of 2.26 m.
- The frame is made of steels steel.
- We have installed 14 thrusts on each side of the Frame to distribute the lode on it and provide More strength to the starchier of the frame.
- We have installed 6 pushers inside to provide perfect selling when the gate is closed.





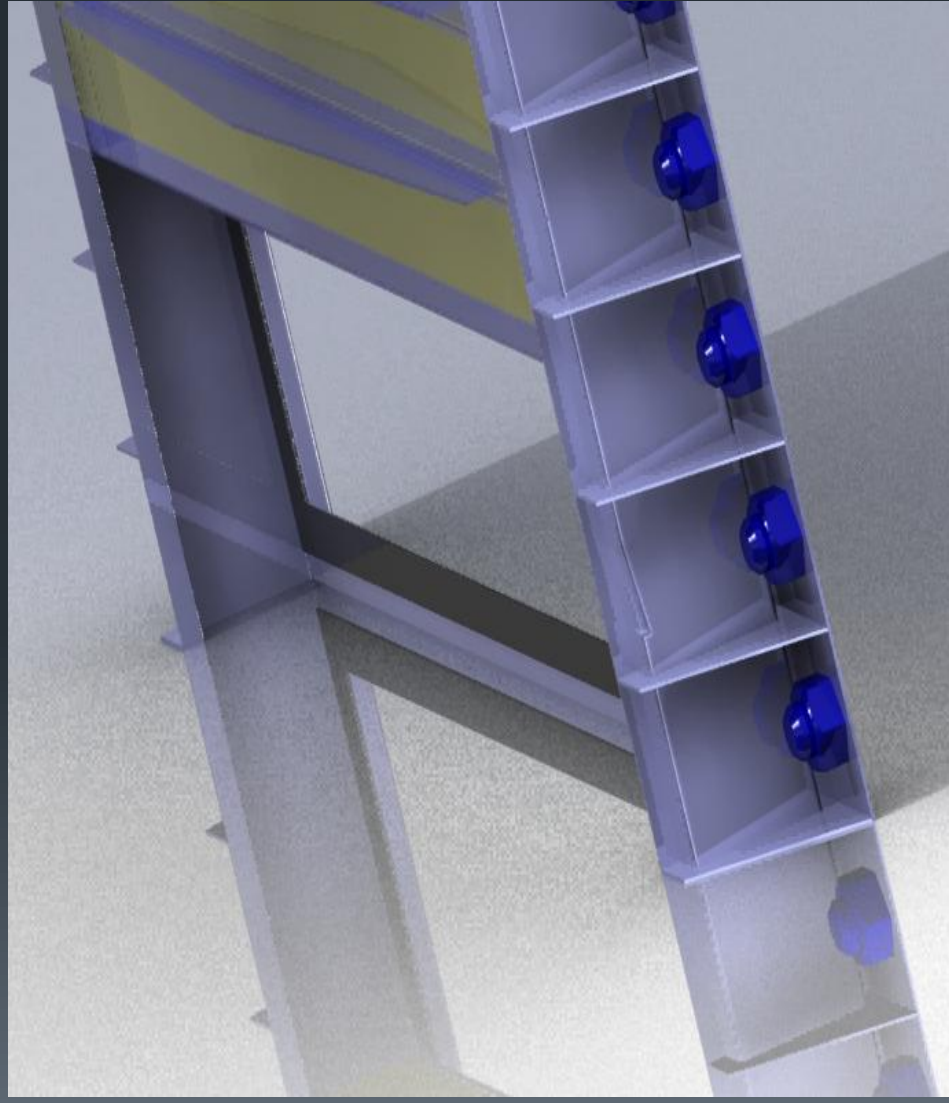
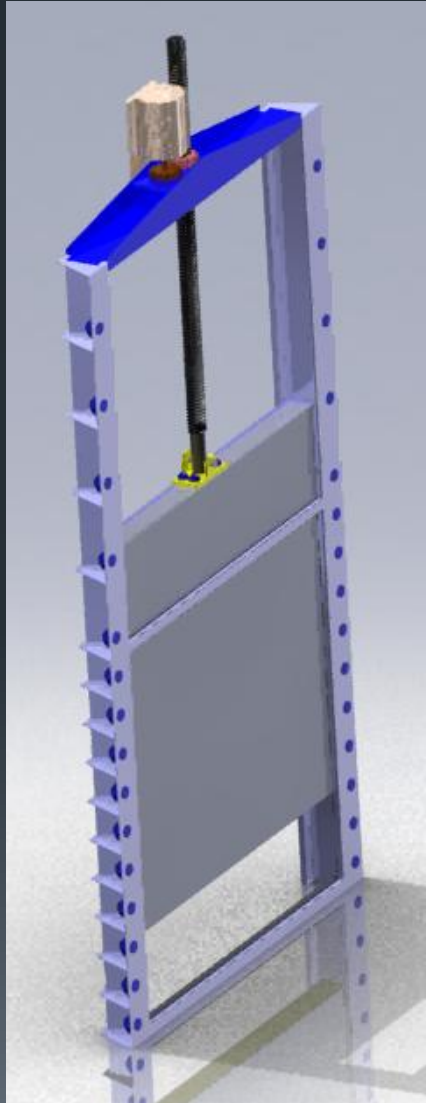
# Frame Design



# Frame Design



<b>Frame:</b>	
<b>THICKNES:</b>	inner =
17.13 cm	
	outer=
23.13	
<b>Length:</b>	
	400 cm
<b>WIDTH:</b>	
	200cm



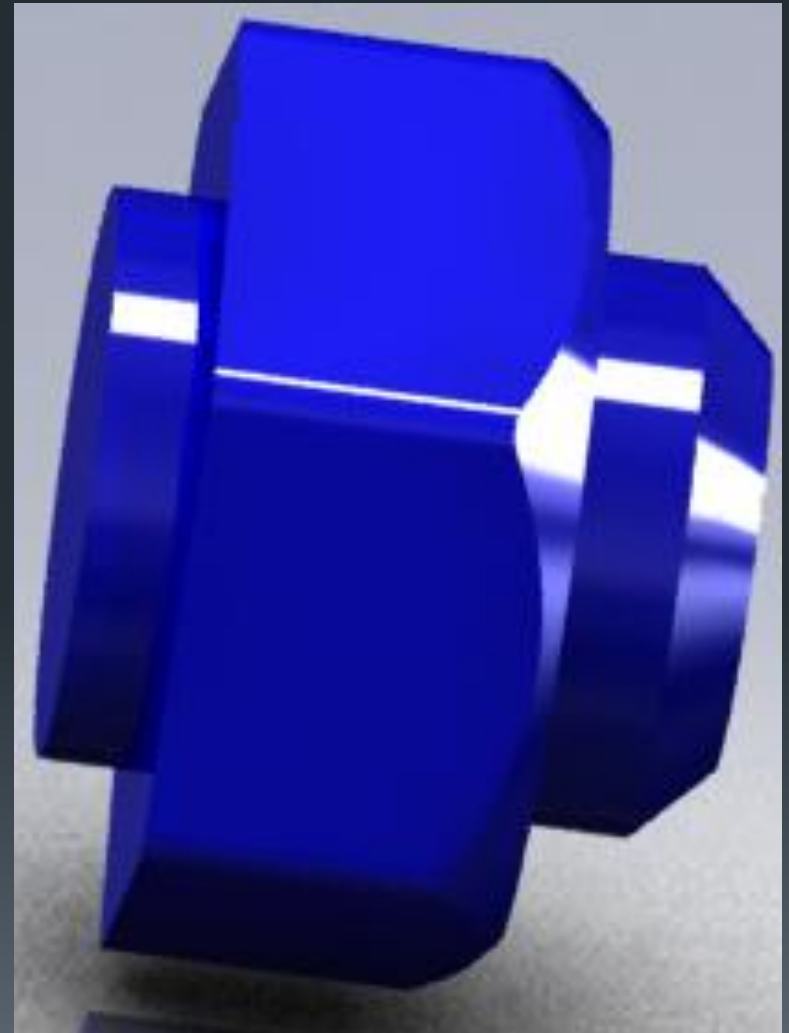
# Frame Dead Bolts

6 cm diameter

7 cm tall

Chamfer 0.8 cm with 45 degree

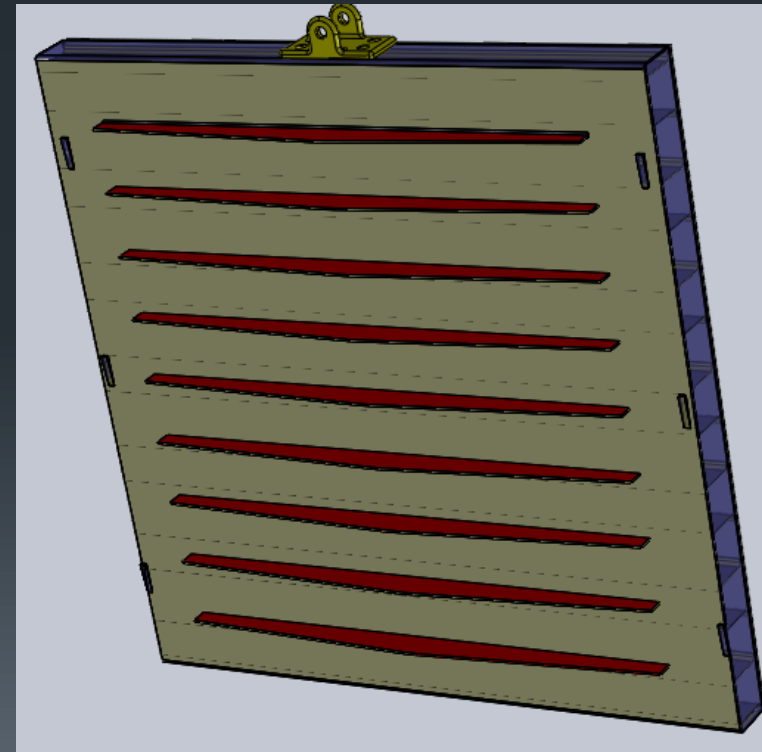
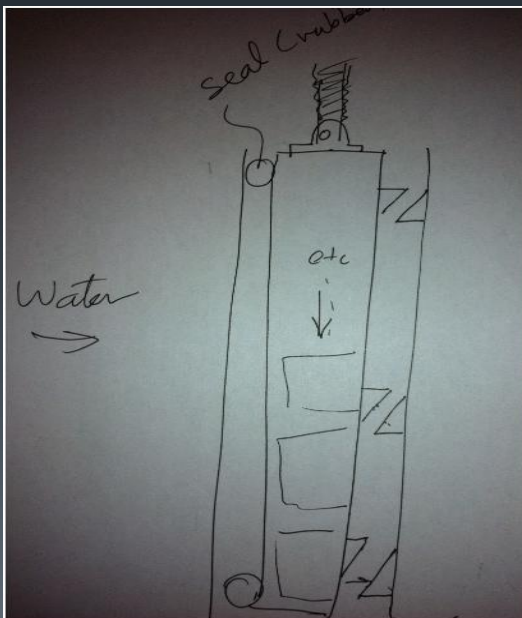
Sixfold with diameter 4.5 cm, and 4cm long



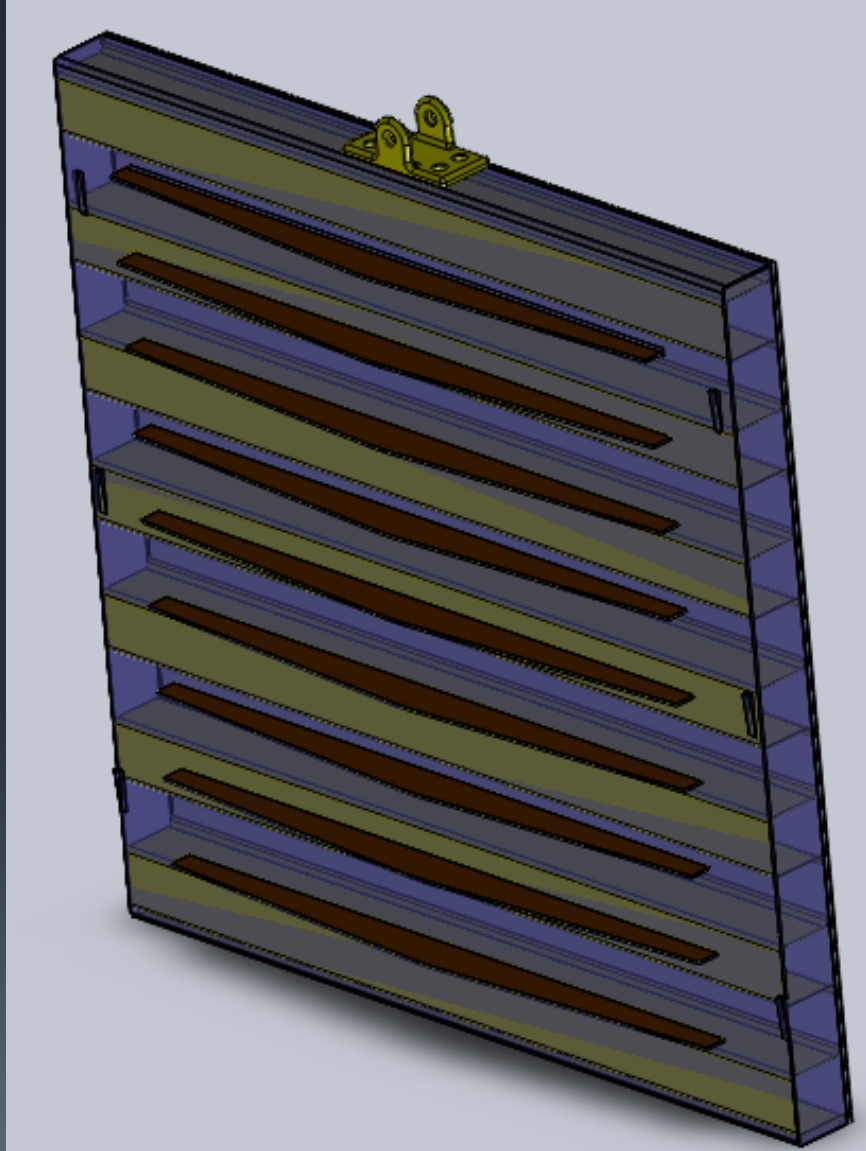
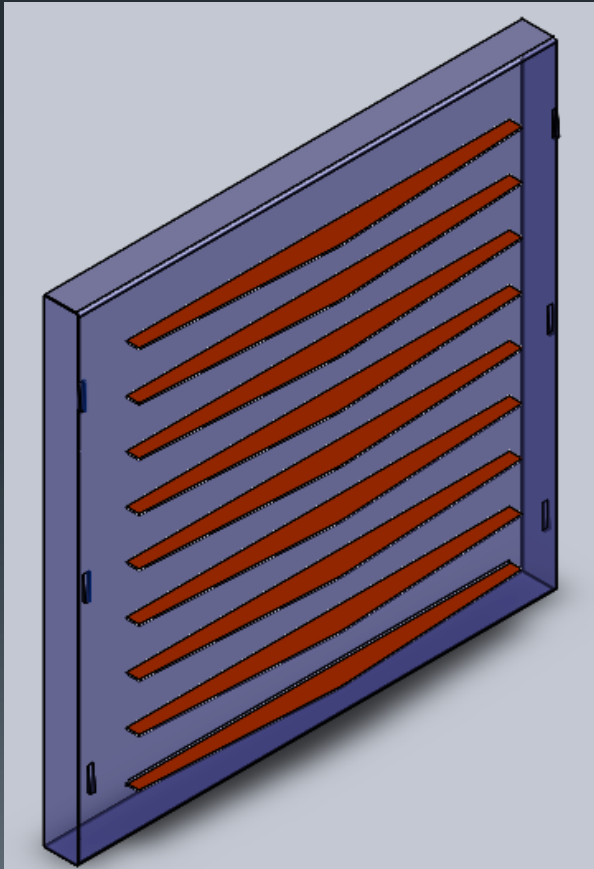


# Parts Design

- Gate: In our design the gate was 2 m X 2m and it consist of four major parts:
  - a) Front wall (facing the water).
  - b) Back wall.
  - c) Supporting metal sheets.
  - d) HENCH (Gate Holder).
  - e) Supporting pushing's.



Thickness of the assembly of the wall	15.6 cm
The wall will face the water	plate thickness 1 cm
the other side of the door	plate thickness 0.3 cm



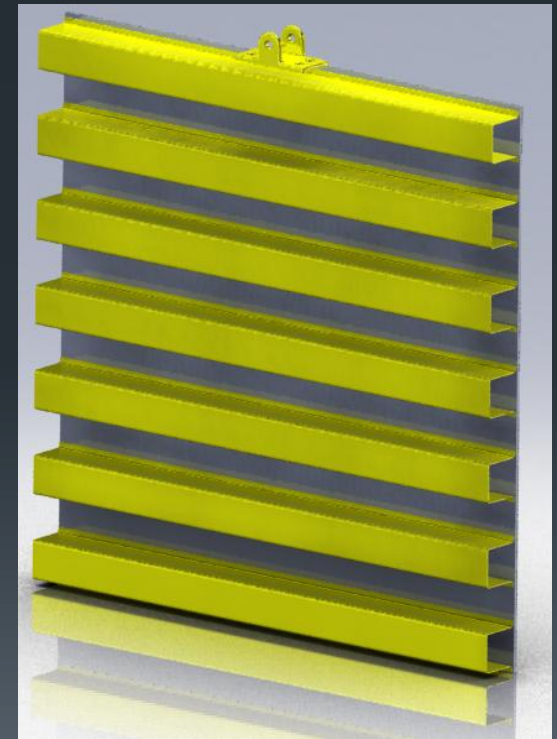
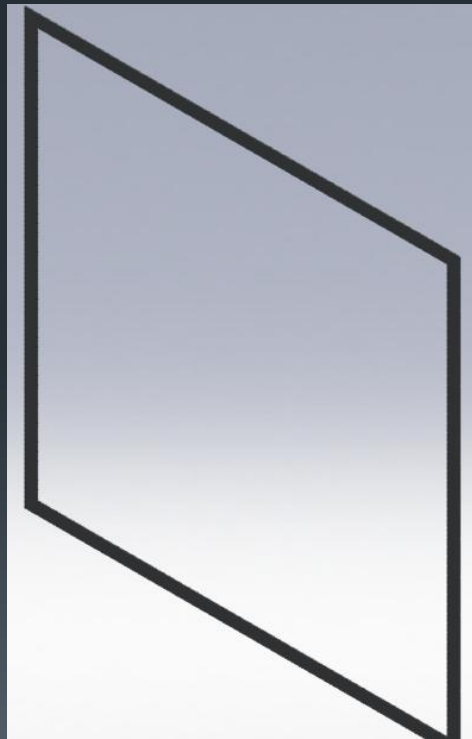
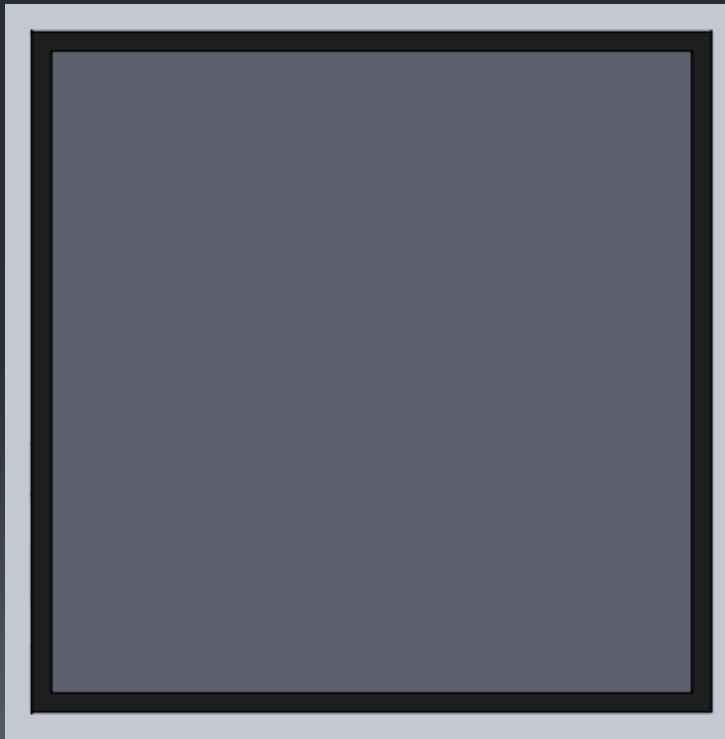
# Front Wall

It is 2x2

Thickness 1 cm

There is a rubber surrounded the front door that will face the water, it has a width 6cm and the thickness is 0.5cm  
To prevent leakage.

From the other side of the wall there will be sheets to support the wall



Number of the supporting sheets in the door assembly

7

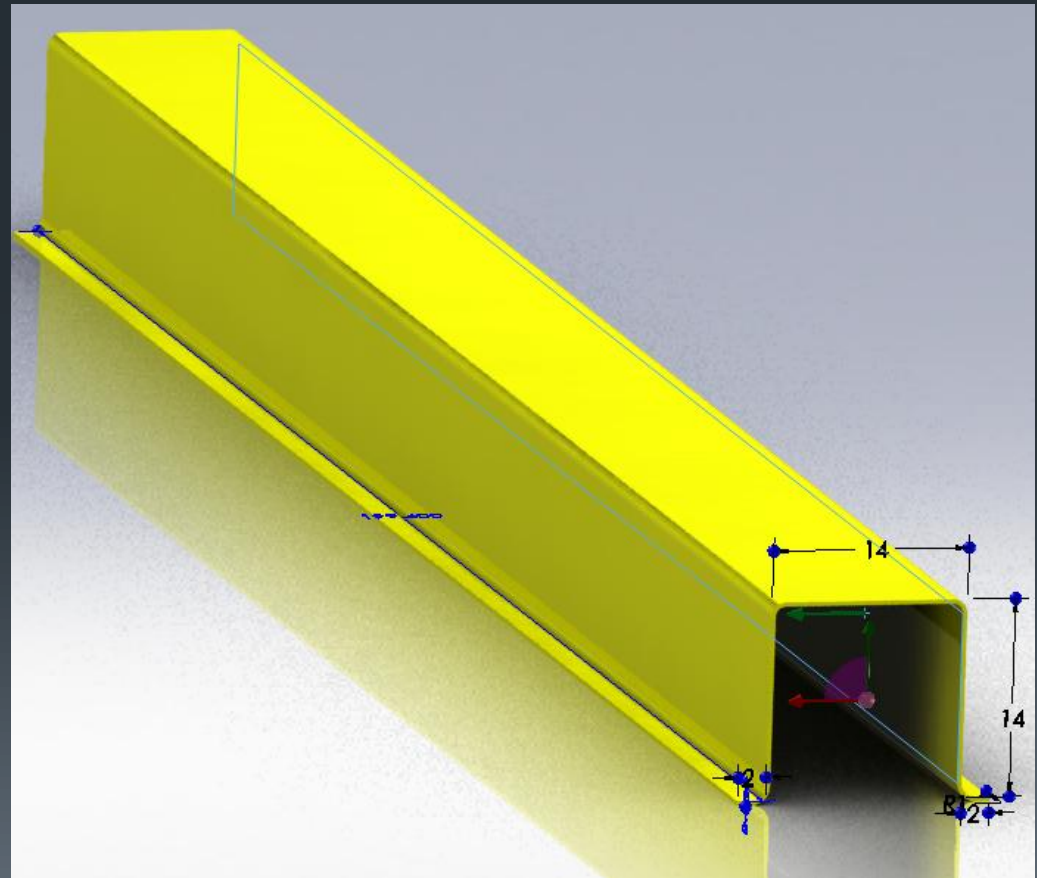
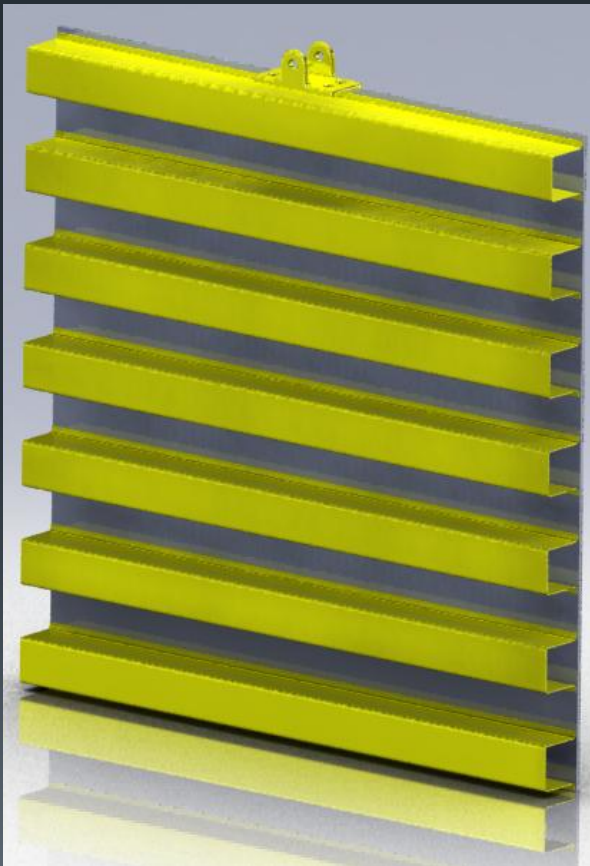
The sheet **14x14 cm**

Thickness of the sheet **3mm**

Between every sheet **4 cm**

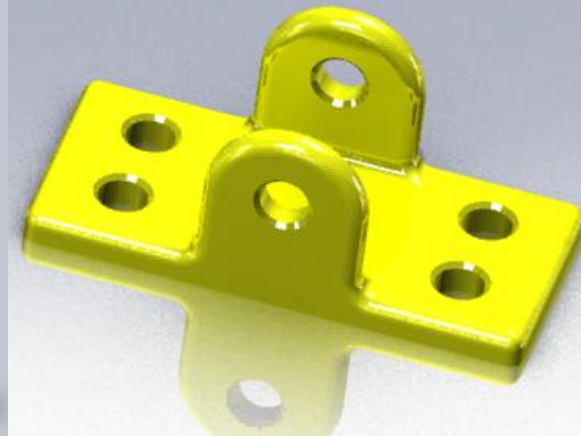
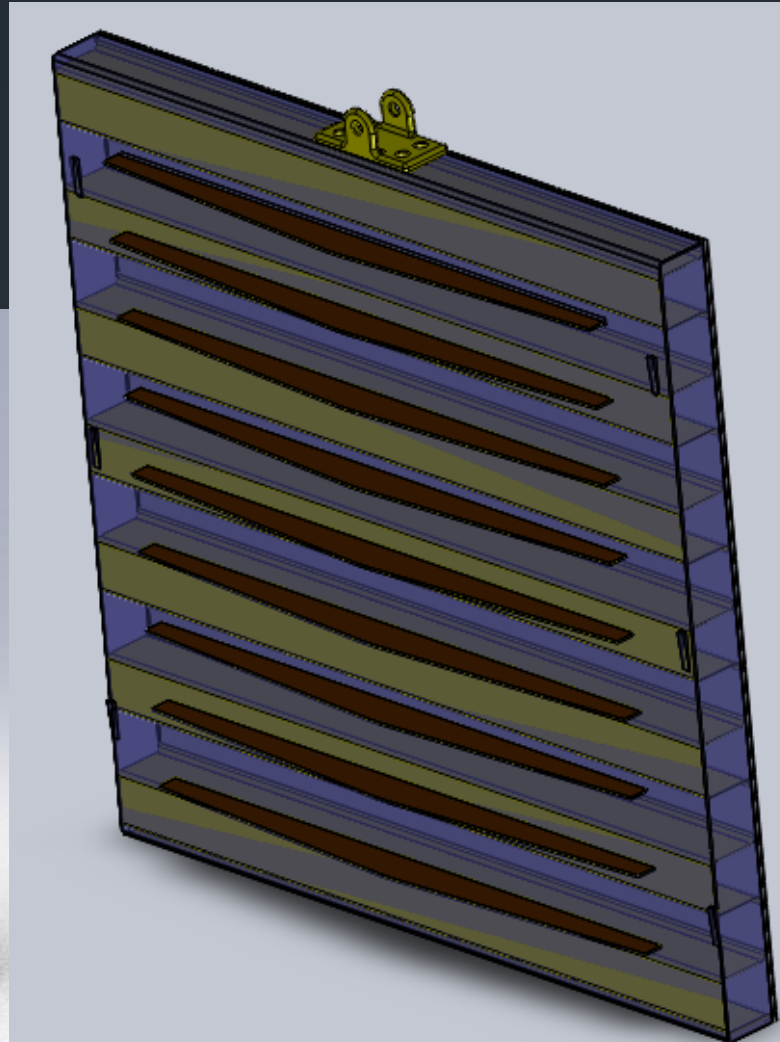
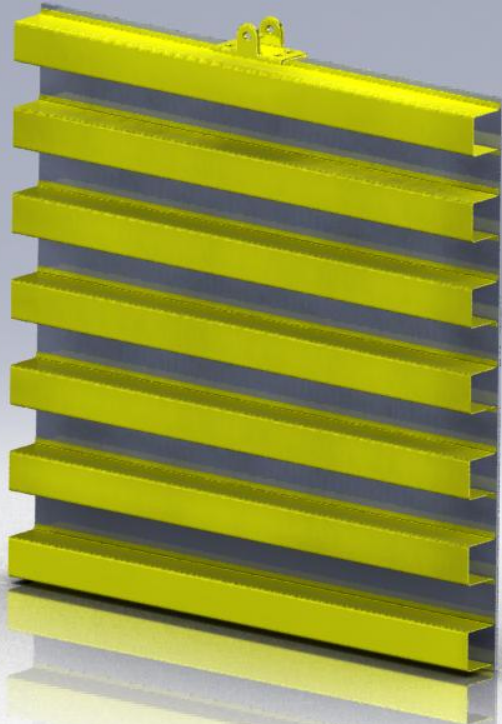


To support the door and let it to handle more pressure and forces.





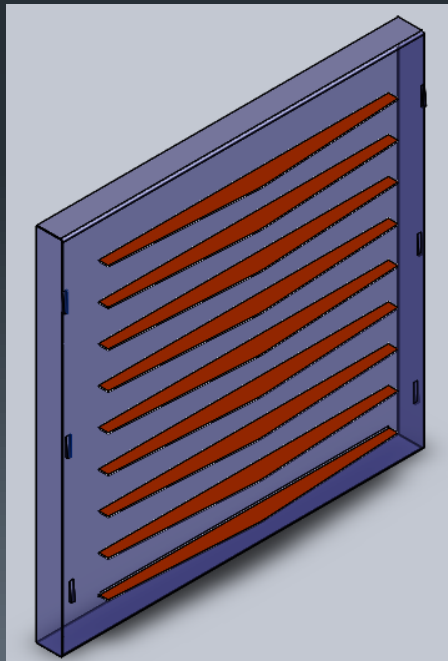
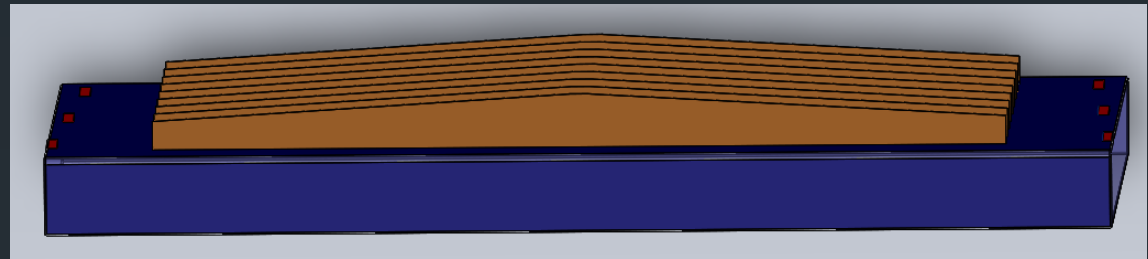
# Gate Assembly



# Back Wall



thickness 0.3 cm



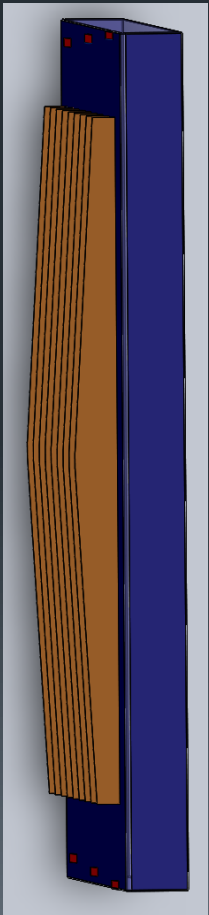
# Plates



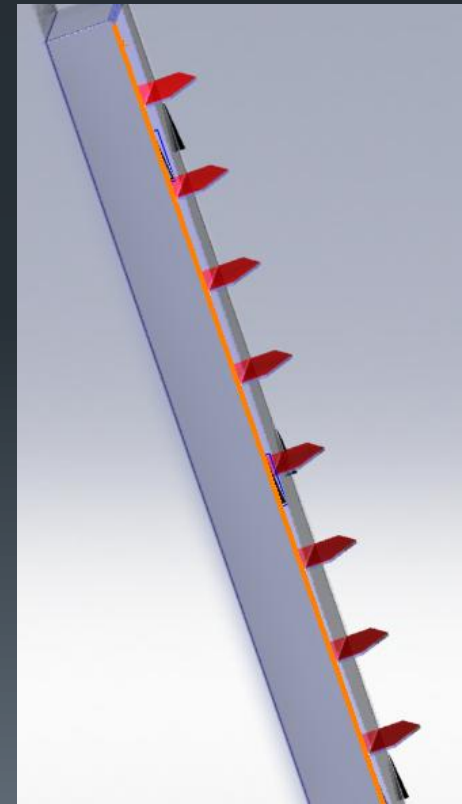
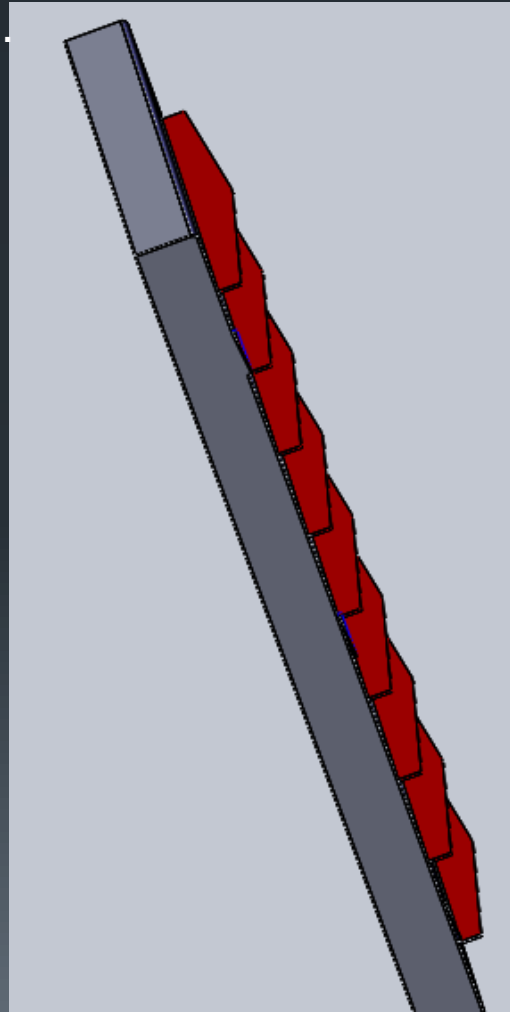
There is 9 plates

In 160cm long distance, 10cm width, and 0.6cm thickness.

It has distance between each other 20cm.



- To disrepute the forces in the door and give it the ability to handle high loads.

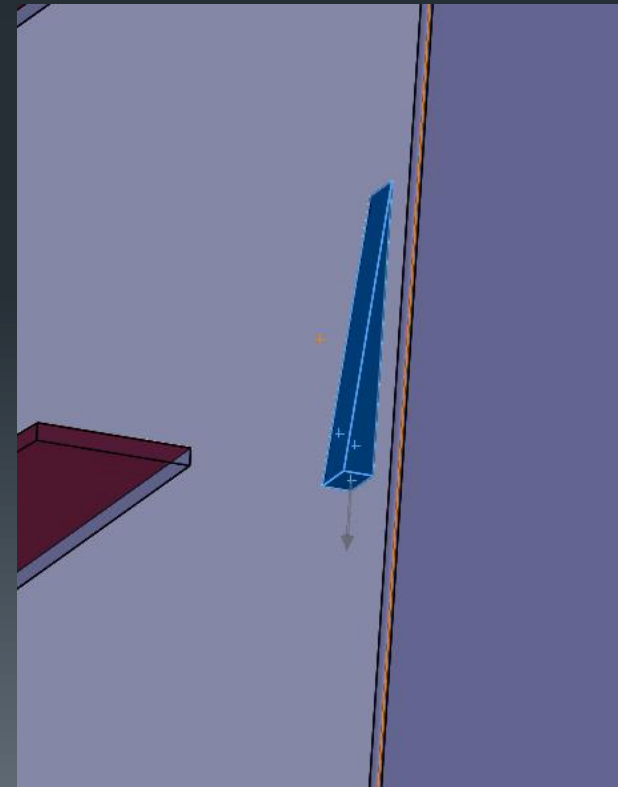
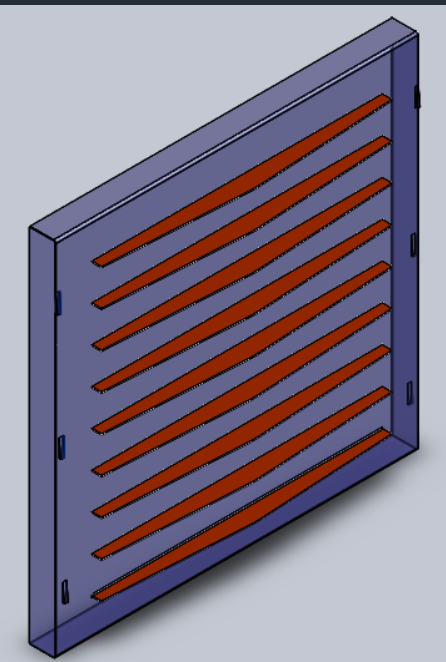


# Pushing's



- Triangle shape
- Height 1cm
- 10 cm long
- 2 cm width
- The first one is 23.7 cm from the top of the back door
- The distance between them is 60cm
- The shift is 2 cm between them

- To push the door to the other side and to prevent leakage when it is fully closed.



# Hinge

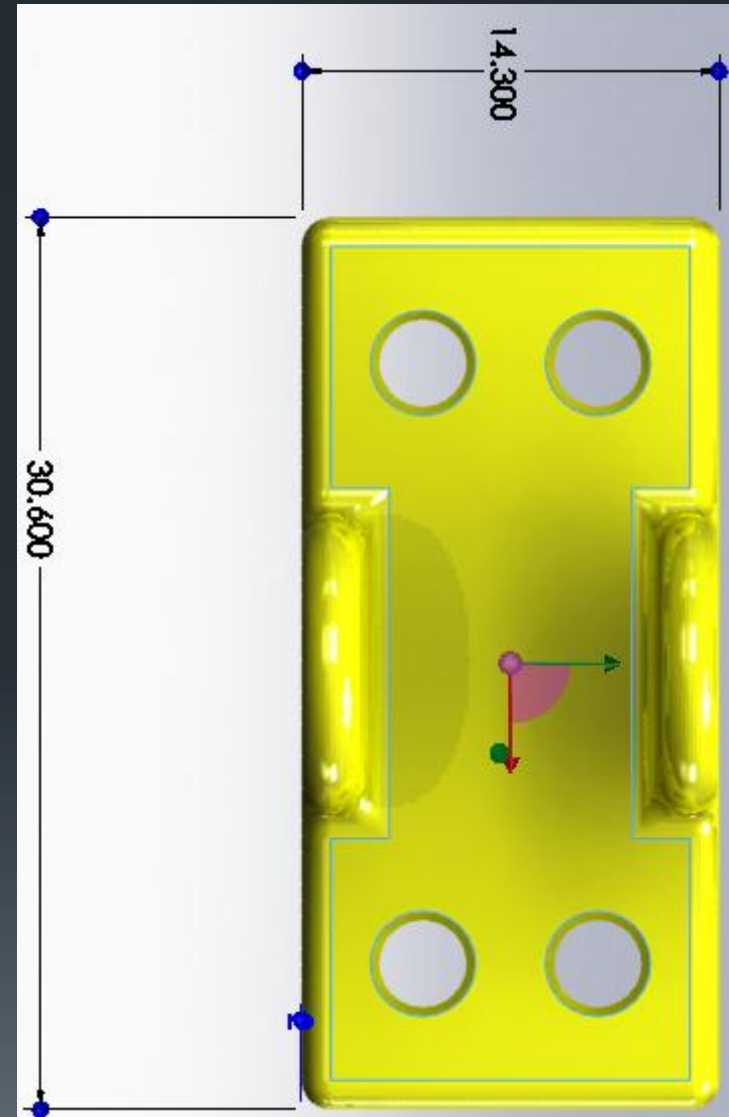
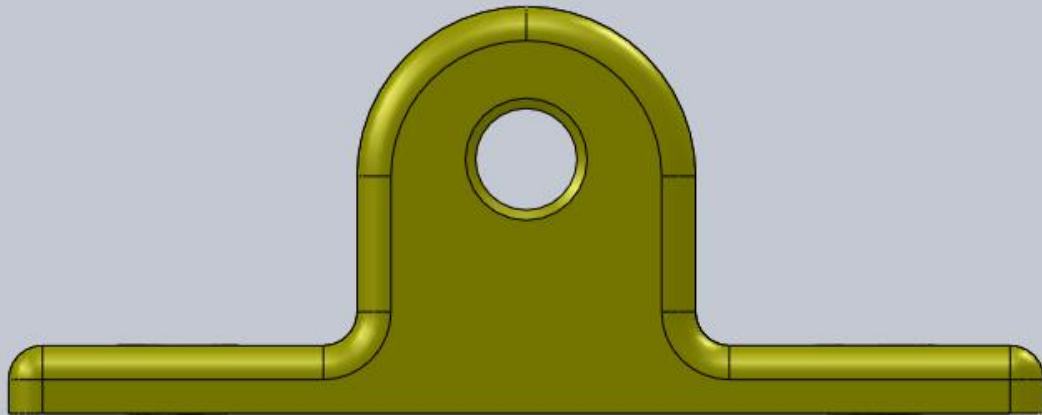
30.6 cm long

14.3 cm width

2 cm depth

3 cm diameter for the holes

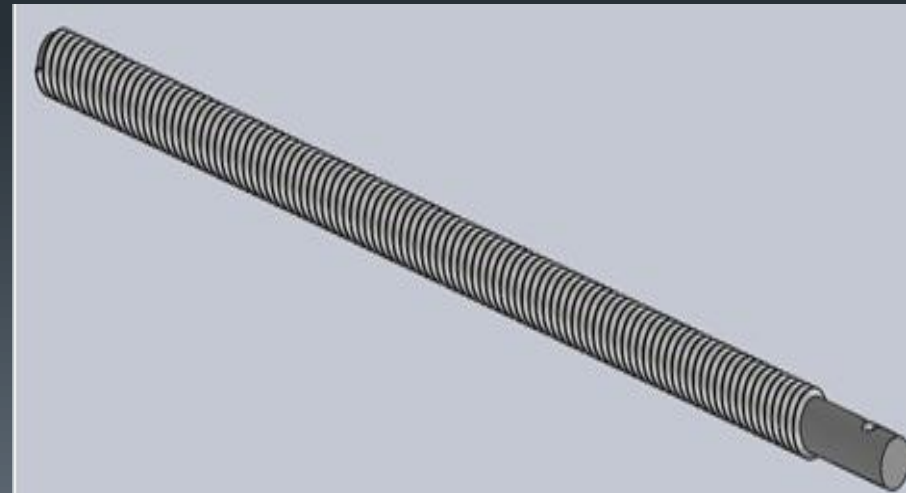
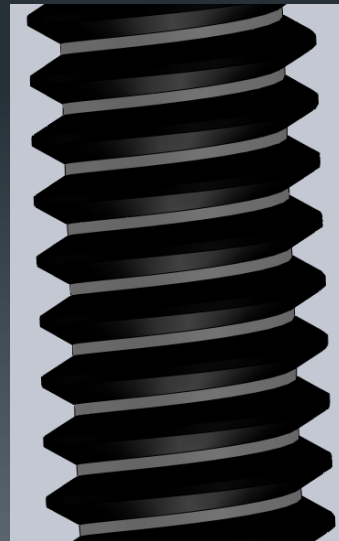
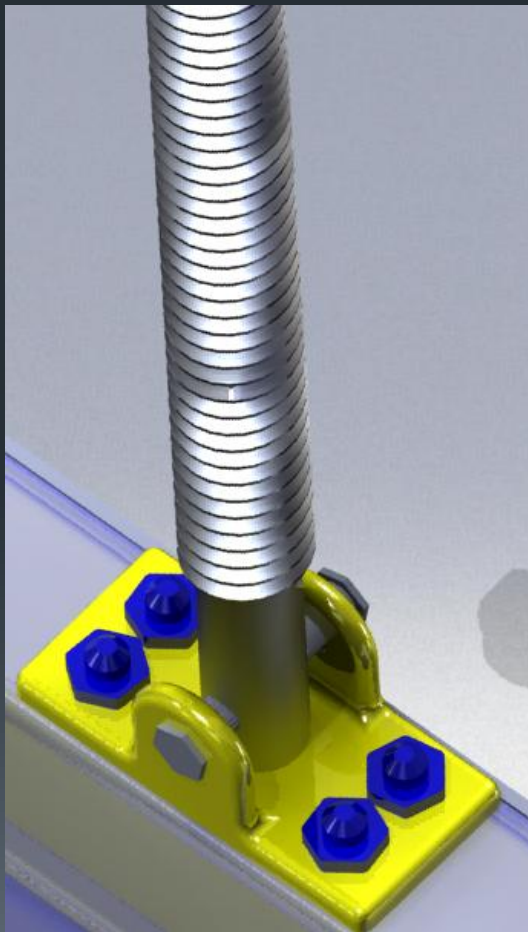
It will be fixed to the door, to let the pin have the ability to open and close the door in the frame.



# Power Screw

Screw length	225 cm
Screw nominal diameter	7 cm
Threaded length	200 cm

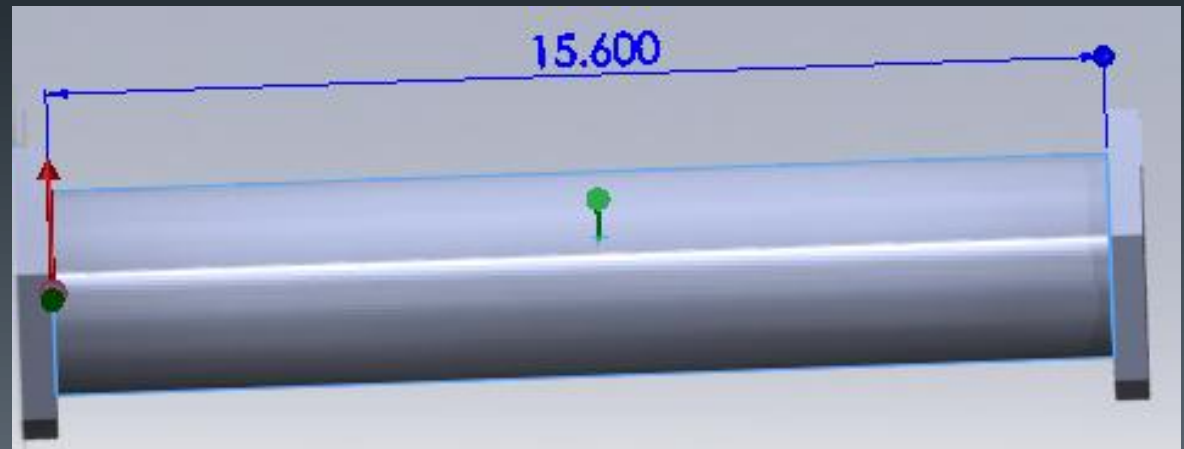
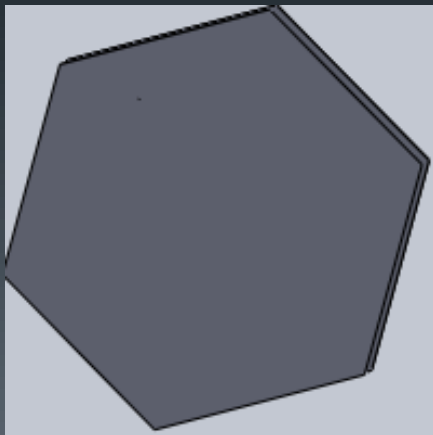
- It will be connected with the hench by a small pin.
- It will connect the pin with the gears to open and close the door.
- It will rotate inside the gear the will allow the pin to move upward and downward .



# Connector between Hinge and Power crew

It has a six fold from the both sides.  
The diameter for six folds is 4cm  
Its thickness is 0.5cm  
The cylindrical shape it is in the middle between the six folds.  
It has a diameter with 3cm, and extruded 15.6cm

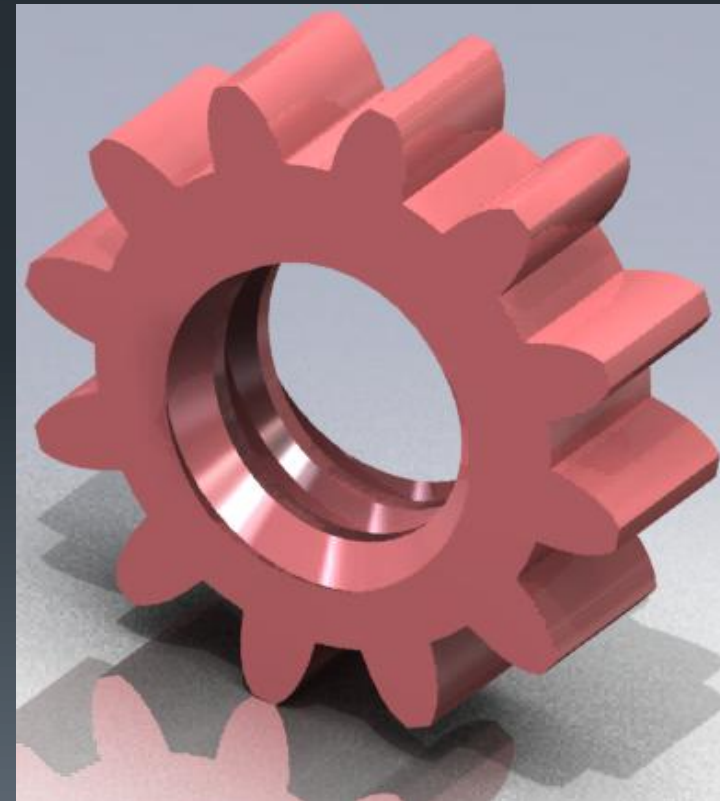
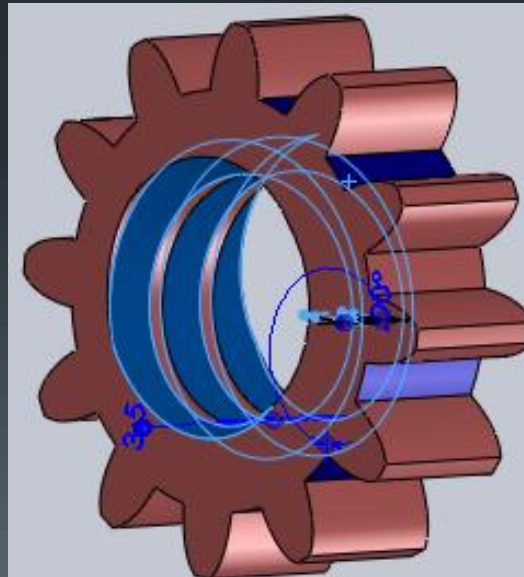
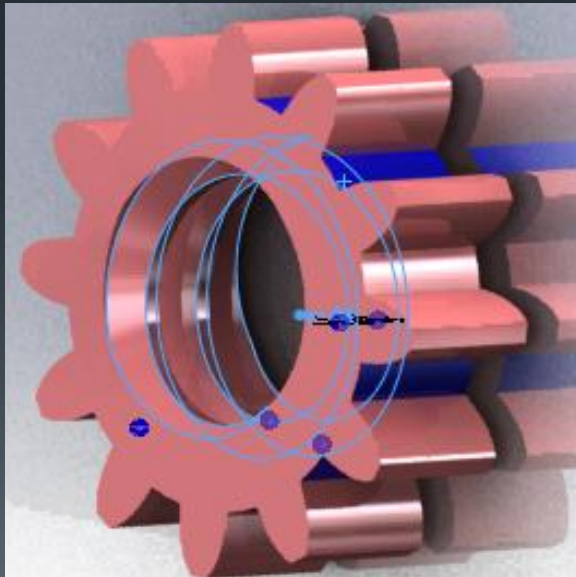
- It will connect the power screw with the hinge.



# Pinion Gear

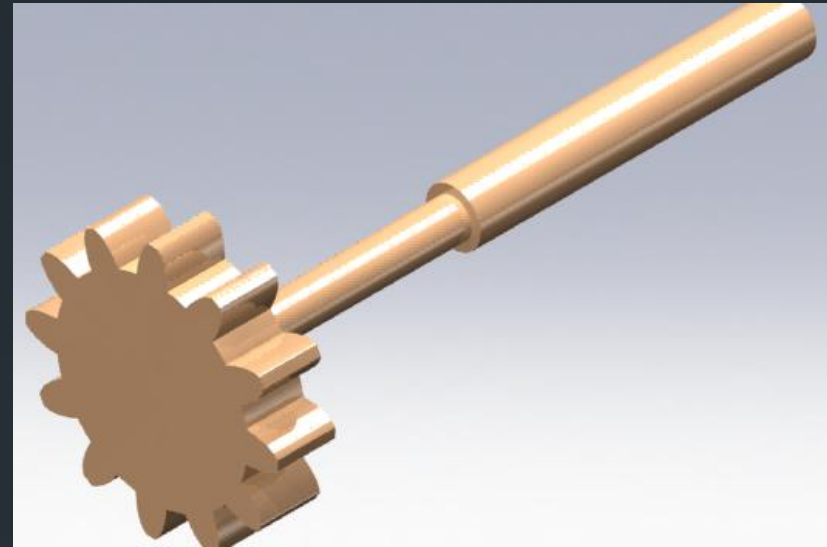
Diameter of the gear	12 cm
Thickness of the gear	4.6 cm
Number of Teeth	12

- It will rotate to move the pin upward and downward.
- It will rotate from other gear that supported with a motor.



Diameter of the gear	12 cm
Thickness of the gear	4.6 cm

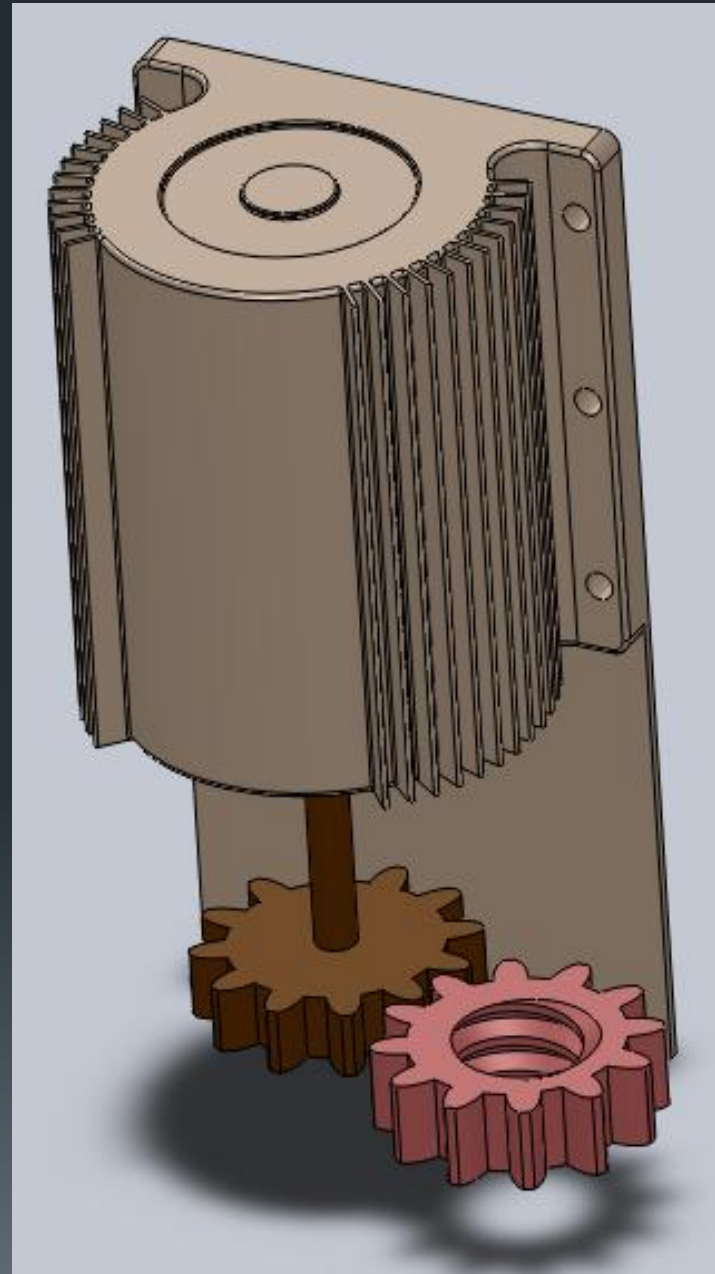
- This gear is connected with a shaft.
- The shaft is connected with a motor, the motor will rotate the stick shaft and the gear to rotate the other gear that is connected with the power screw, that will let the power screw move, by that rotation it will let the door open and close.





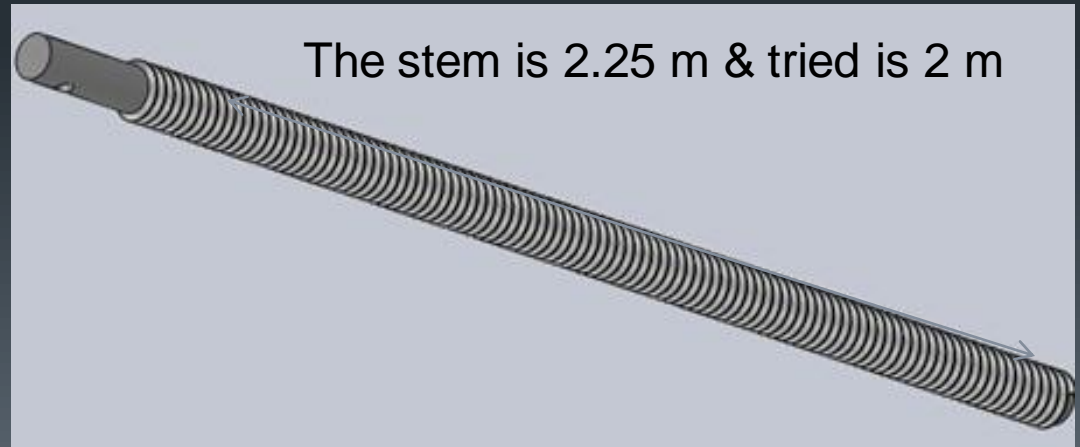
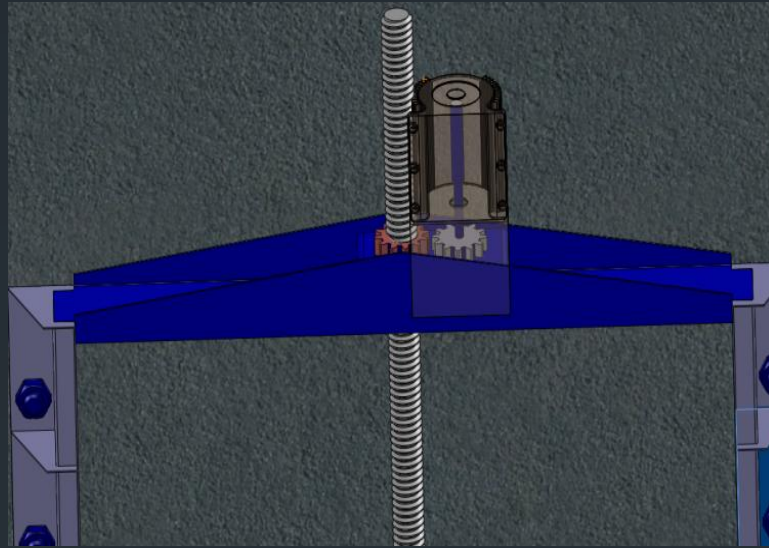
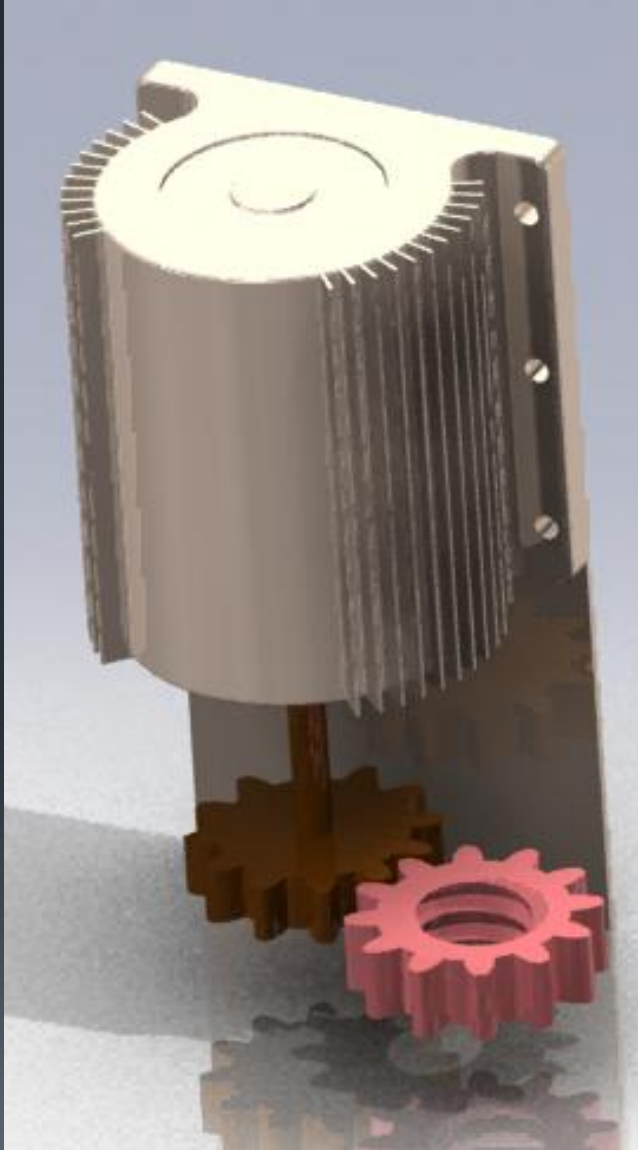
## College of Engineering Department of Mechanical Engineering

- Motor is been installed to provide the required force to open and close the gate.
- The motion will be transferred through two gears. One of the gears will have a thread surface inside that the stem will move in it, the other gear will be attached to the motor.
- The stem length is 2.25 m and has 109 rev with  
An angle of 90
- the motor shaft is 50 cm length and 2.5 cm Diameter.





# College of Engineering Department of Mechanical Engineering

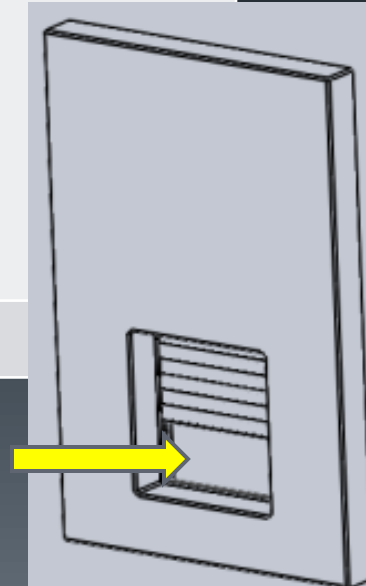
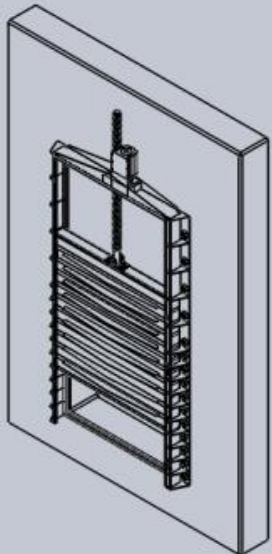




# College of Engineering

## Department of Mechanical Engineering

Fluid:	Water
<p><b>Operating force, force acting on the door:</b></p> <p style="text-align: center;"><b>P=100kN</b></p>	<p><math>P = 0.5 (F)</math>  <math>P = 0.5 (200)</math></p>
<p><b>Discharge Flow Rate:</b>  <b>Flow through the opening of the weir penstock at 2m by 2m</b></p> <p style="text-align: center;"><b>662m<sup>3</sup>/min</b></p>	<p style="text-align: center;"><b><math>q = 1.73 (W) (H) (1.5)</math></b></p> <p>Where:  <math>q</math> = discharge flow rate, m<sup>3</sup>/s  <math>W</math> = width, m, <math>H</math> = height, m</p> <p><math>q = 1.73 (2) (2) (1.5)</math>  <math>q = 10.4 \text{ m}^3/\text{sec} = 662 \text{ m}^3/\text{min}</math></p>





<p><b>Torque on the Drive Gear:</b></p> $T = (P) (5252)/\text{rpm}$ <p>Where: Constant = 5252 T = torque P = power of motor, assumed at 750 Watts = 1.00536 Hp RPM = rotational speed, rpm</p> $T = (1.00536) (5252)/1800$ $T = 2.93 \text{ ft-lbs} = 0.40 \text{ m-kg}$	<p><b>0.40 m-kg</b></p>
<p><b>Torque on the Driven Gear:</b></p> $T = (Ft) (D2)/2$ $T = (4) (0.16)/2$ $T = 0.32 \text{ m-kg}$	<p><b>0.32 m-kg</b></p>





## Calculations

- Hydraulic force acting on the penstock:

$$F = 10(H) (A)$$

Where:

$F$  = force, kN

$H$  = max. differential head, 5 m

$A$  = door area,  $m^2$

$$F = 10 (5) (4)$$

$$F = 200 \text{ kN}$$



# Design Approach

- **Group Brainstorming**
- **Gather Literatures from the web**
- **Sketches.**
- **Design Conceptualization**
- **Identification of Critical Components**
- **Sizing and Strength Calculations**
- **Prototyping by CAD SolidWorks**

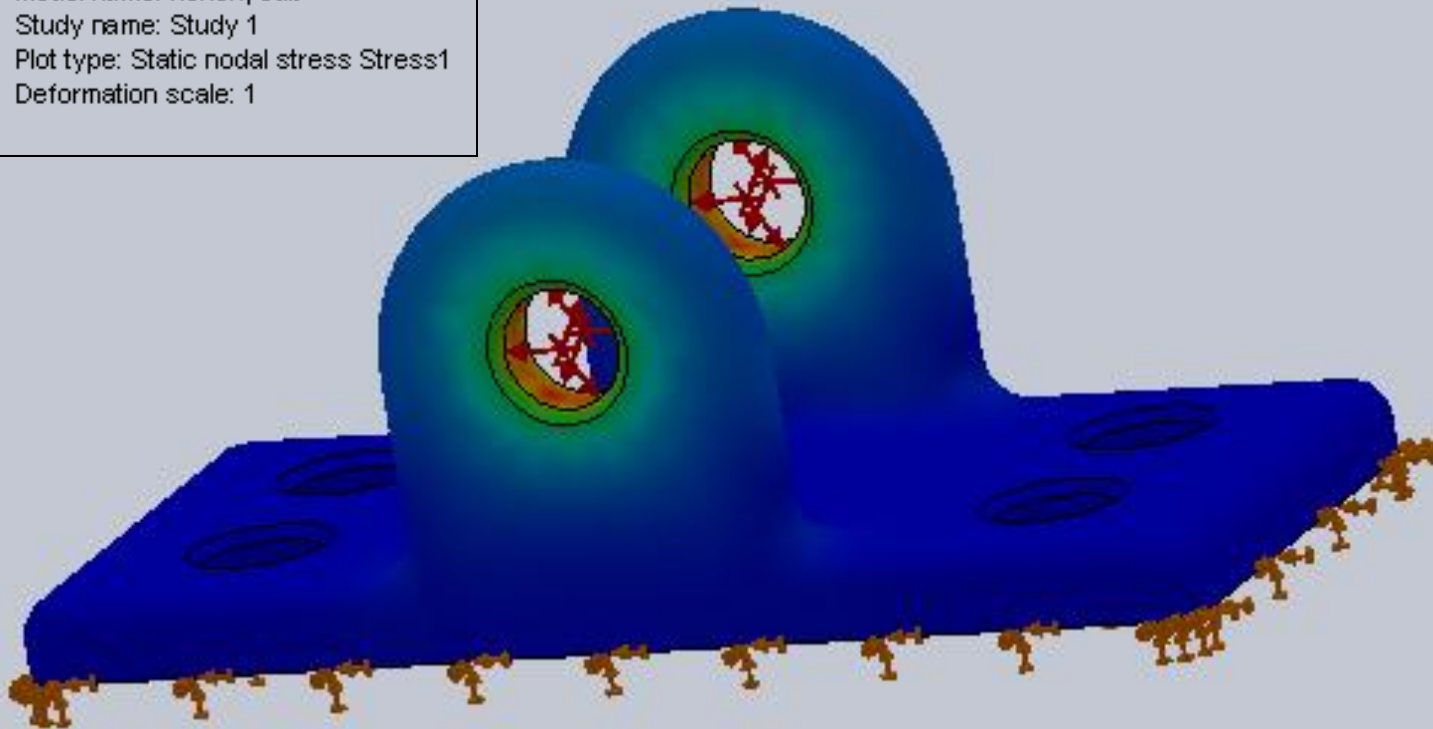


## Positives

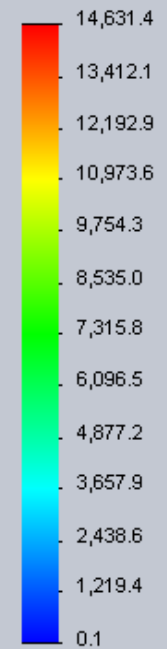
- Reliability
- Can hold resistance high force stresses.
- Light weight comparison of other models.
- Low production cost
- Low maintenance

# Stress Analyses

Model name: hench, edit  
Study name: Study 1  
Plot type: Static nodal stress Stress1  
Deformation scale: 1

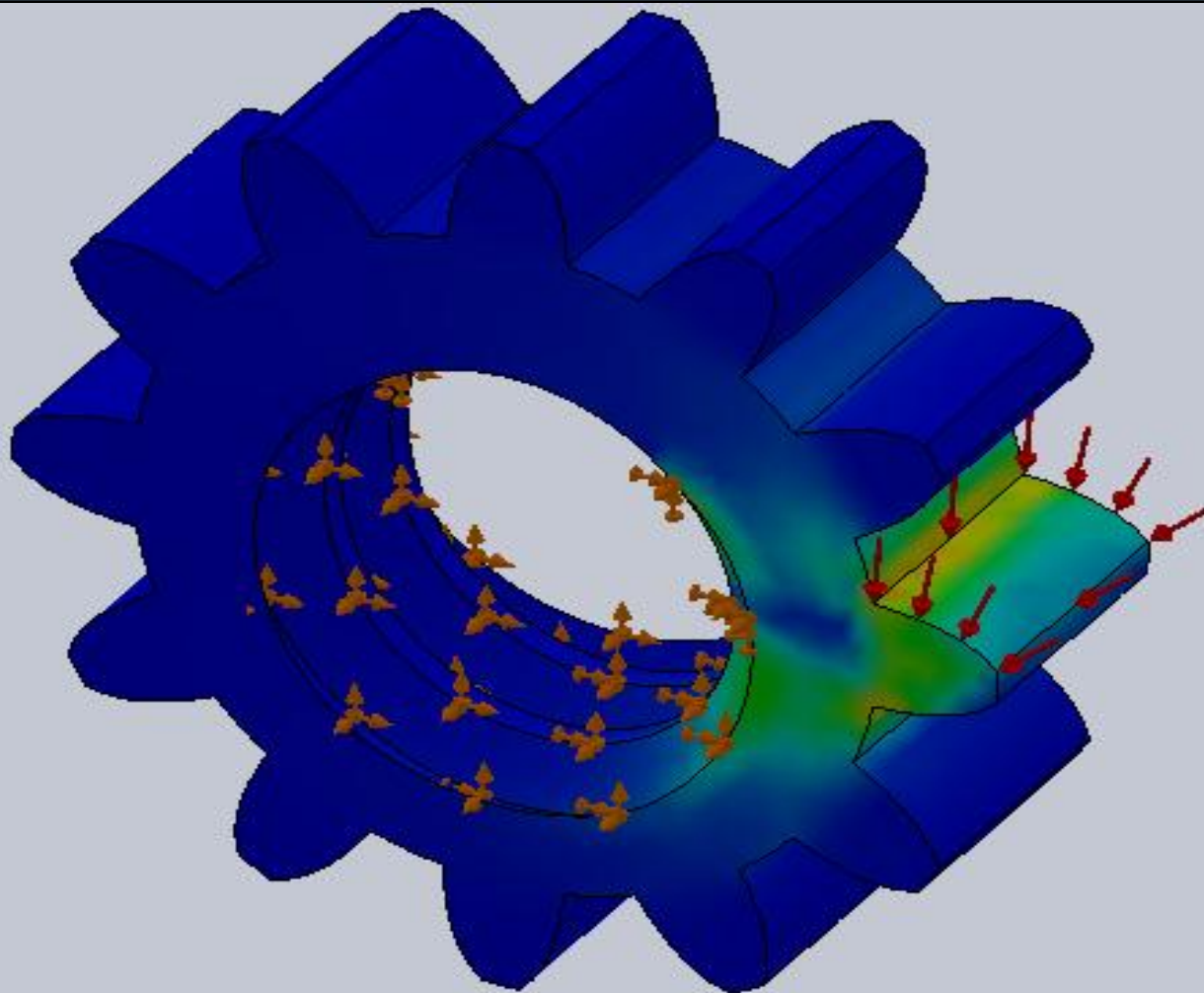


von Mises (N/m<sup>2</sup>)

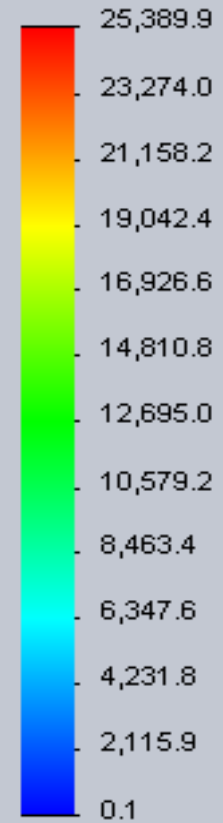


→ Yield strength: 351571000.0

Model name: gear2  
Study name: Study 1  
Plot type: Static nodal stress Stress1  
Deformation scale: 1

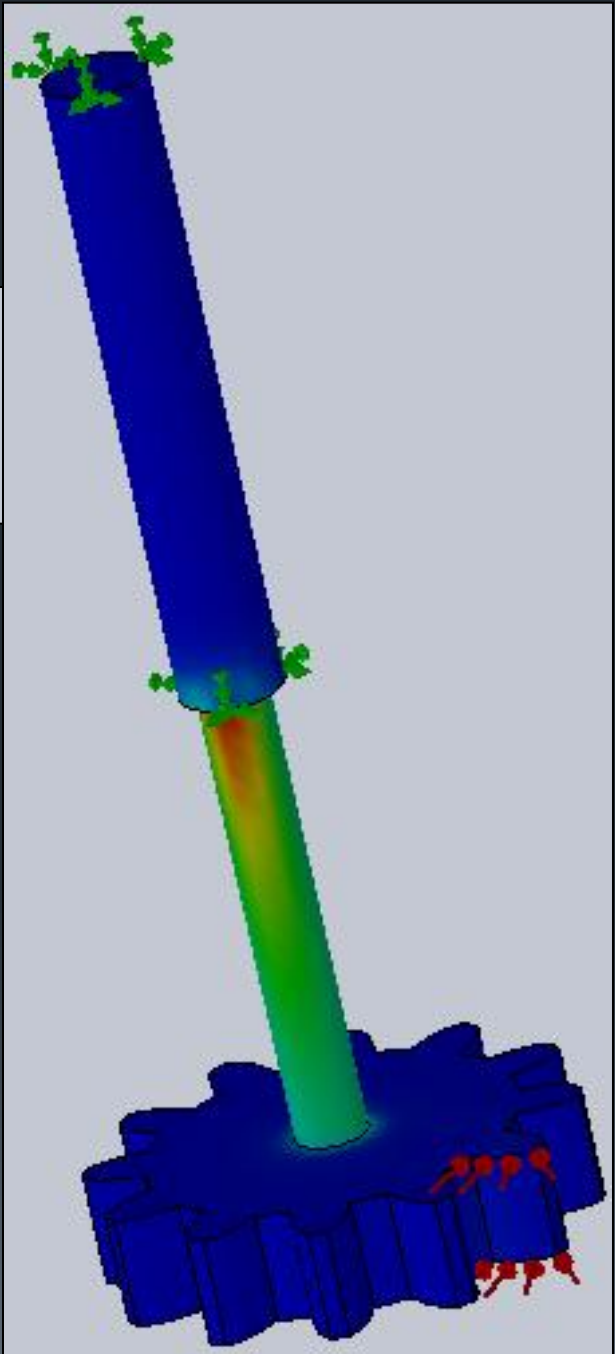


von Mises (N/m<sup>2</sup>)

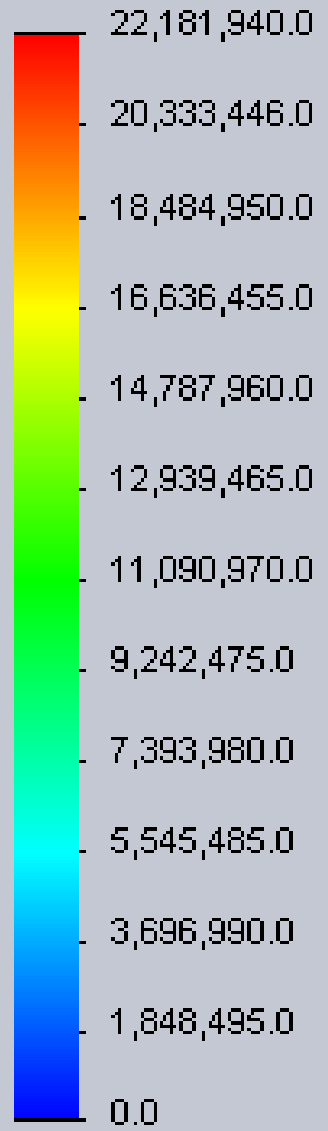


→ Yield strength: 620422000.0

Model name: gear  
Study name: Study 2  
Plot type: Static nodal stress Stress1  
Deformation scale: 1



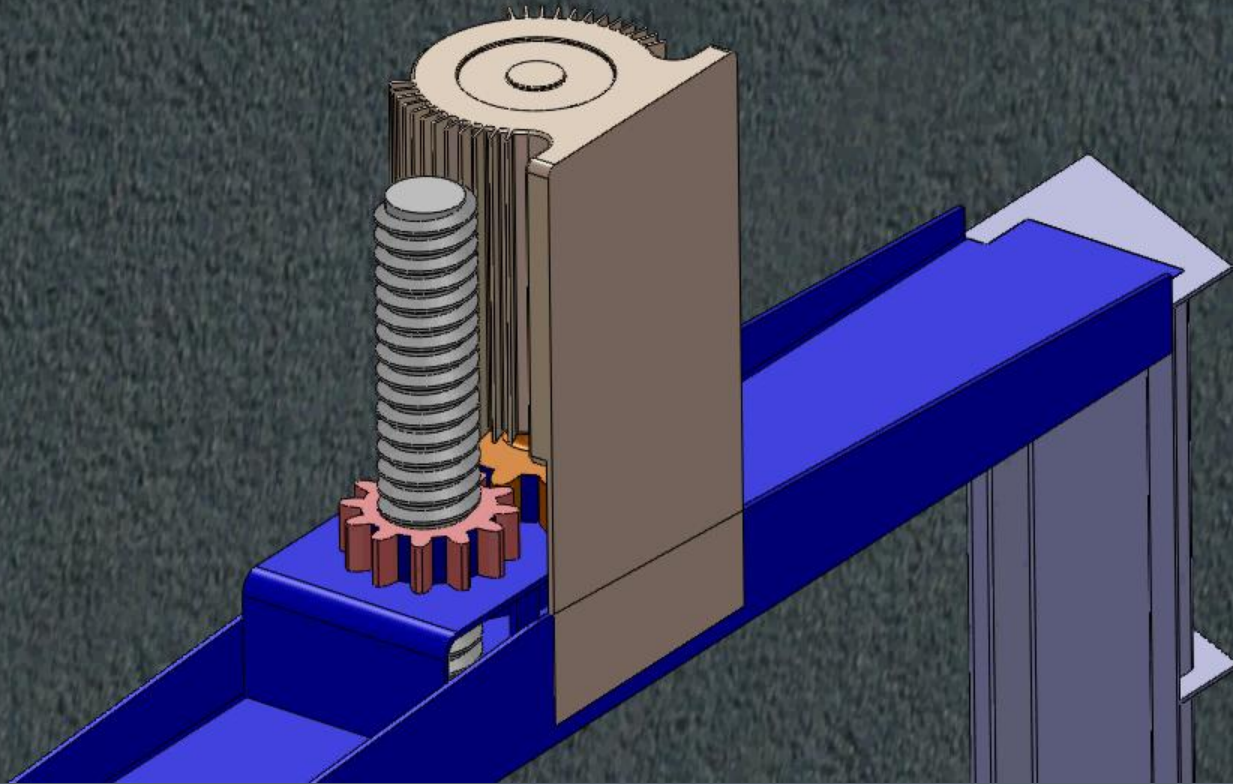
von Mises (N/m<sup>2</sup>)



→ Yield strength: 351571000.0

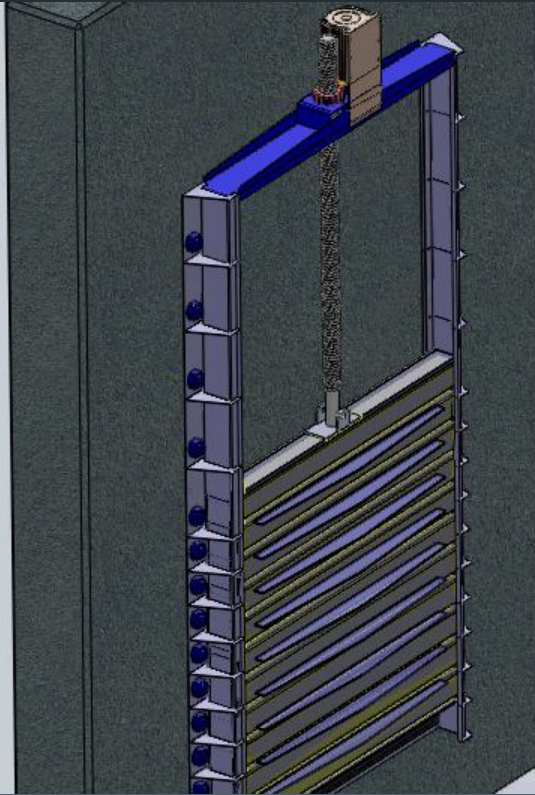


# Motor and Gear Mechanism





# Video clip





**Thank you**