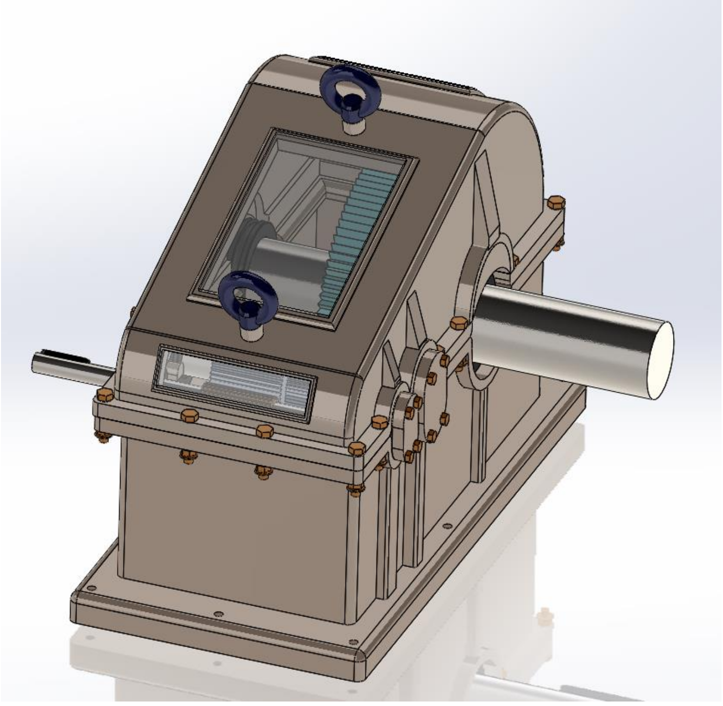

Design of a Gearbox System

Mechanical Engineering

Emrah Gökhan Çolak

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INTRODUCTION

In this project, we will determine first gear's and shaft's spesifications.We will determine gears spesifications according to the reduction ratio and module number.Reduction ratio will provide to determine gears torques and number revolutions per minute and number of teeths.And then we will determine pitch diamaters from module number.For the determining shafts minimum diameters, we will use as a reference gear torques because shafts are exposed same torque and torsion.

Secondly, we will design a gearbox system according to the calculated and decided values.We will draw gears, shafts, case, bolts, nuts, key and case, respectively.We will assembly whole parts together and we will be careful to provide the same reduction ratio in gear assemblies and calculations.

CALCULATIONS AND REFERENCE VALUES FOR GEARBOX

Given;

Reduction Ratio: 20
Motor Power: 30 kW
Input Torque : 4000

→First of all, I will choose a reduction ratio of 5 and 4 in stage 1 and stage 2, respectively.

P= $\frac{T_1.n_1}{9550}$, 30=$\frac{T_1.4000}{9550}$ → $\boxed{T_1\text{=71,6 N.m}}$ → <u>Input Torque</u>

Reduction Ratio=$\frac{Input\ Rpm}{Output\ Rpm}$

<u>Stage 1:</u> (Reduction ratio:5)

$\frac{T_1}{T_2} = \frac{n_2}{n_1} = \frac{1}{5}$ ($\frac{n_1}{n_2}$ = 5)

5.T_1= T_2

5.(71,6) = T_2 → $\boxed{T_2\text{=358 N.m}}$

<u>Stage 2:</u> (Reduction ratio:4)

$\frac{T_2}{T_3} = \frac{n_3}{n_2} = \frac{1}{4}$ ($\frac{n_2}{n_3}$ = 4)

4.T_2 = T_3

4.(358) = T_3 → $\boxed{T_3\text{ = 1432 N.m}}$ → Output Torque

$\frac{n_1}{n_2}$ = 5, $\frac{n_2}{n_3}$ = 4, → $\frac{n_1}{n_3}$ = 20

$\frac{n_1}{n_3}$ = 20, $\frac{4000}{n_3}$ = 20 → $\boxed{n_3 = 200 \text{ rpm}}$ →Output Rpm

→ $\boxed{N_1 = 20 \text{ Teeth}}$ (Decided)

$\frac{N_1}{N_2} = \frac{n_2}{n_1} = \frac{1}{5}$

$5.N_1 = N_2$
$5.(20) = N_2$ → $\boxed{N_2 = 100 \text{ Teeth}}$

$\frac{N_2}{N_3} = \frac{n_2}{n_2} = \frac{1}{4}$

$4.N_2 = N_3$
$4.(100) = N_3$ → $\boxed{N_3 = 400 \text{ Teeth}}$

→Pitch Diameters for Gears; (Required for Solidworks Design)
Module number, m = 1 mm/Teeth

m = $\frac{d}{N}$

$\frac{d_1}{20}$ = 1 → d_1 = 20 mm,

$\frac{d_2}{100}$ = 1 → d_2 = 100 mm,

$\frac{d_3}{100}$ = 1 → d_3 = 400 mm

→ <u>Thicknesses of the Gears</u>;

t_1 = 50 mm

t_2 = 110 mm

t_3 = 60 mm

→ <u>Lenghts of the Shafts</u>;

L_1 = 180 mm

L_2 = 150 mm

L_3 = 200 mm

→<u>Minimum diameters of the shafts</u>;

→***We will assume torques are the maximum forces acting on the shafts, So;*** $\boxed{\tau = S_y}$

$$\rightarrow \tau = \frac{T.c}{J} = \frac{16.T}{\pi.d^3}$$

Shaft Made from AISI 1010 Hot Rolled Steel
$(S_y = 180\ \mathrm{MPa})$

$$\tau_1 = \frac{16.T_1}{\pi.(d_1)^3} = \frac{16.(71,6)}{\pi.(d_1)^3} = 180\ \text{MPa}$$ $\boxed{d_1 = 12{,}6\ \text{mm}}$

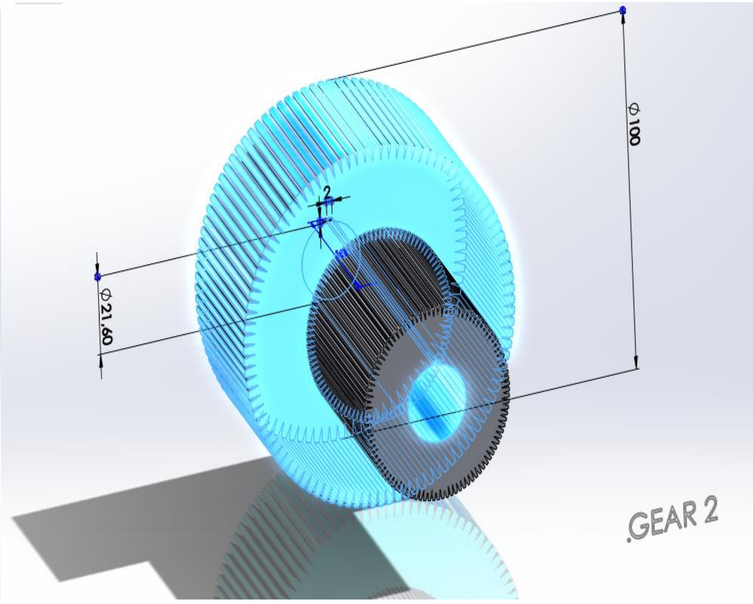
$$\tau_2 = \frac{16.T_2}{\pi.(d_2)^3} = \frac{16.(358)}{\pi.(d_2)^3} = 180\ \text{MPa}$$ $\boxed{d_2 = 21.6\ \text{mm}}$

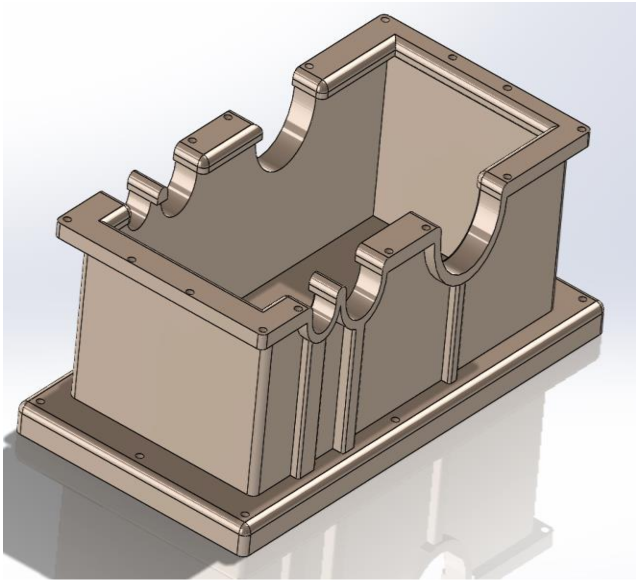
$$\tau_3 = \frac{16.T_3}{\pi.(d_3)^3} = \frac{16.(1432)}{\pi.(d_3)^3} = 180\ \text{MPa}$$ $\boxed{d_3 = 34.3\ \text{mm}}$

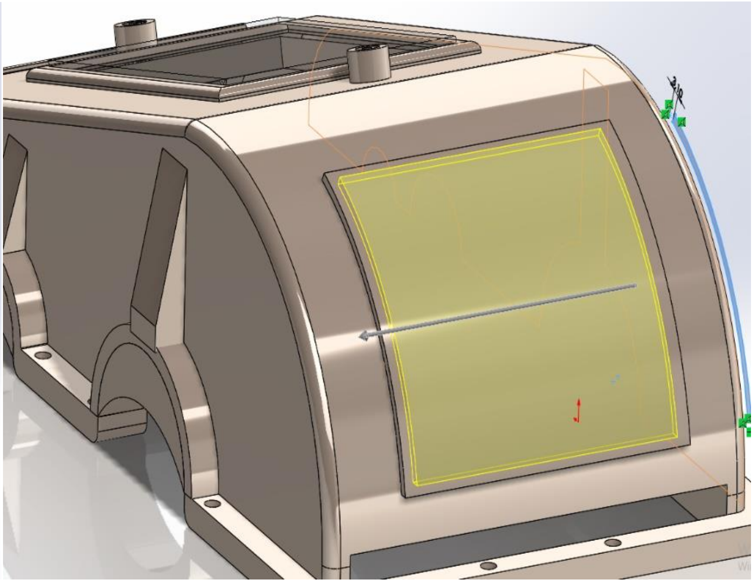
SOLIDWORKS DESIGN

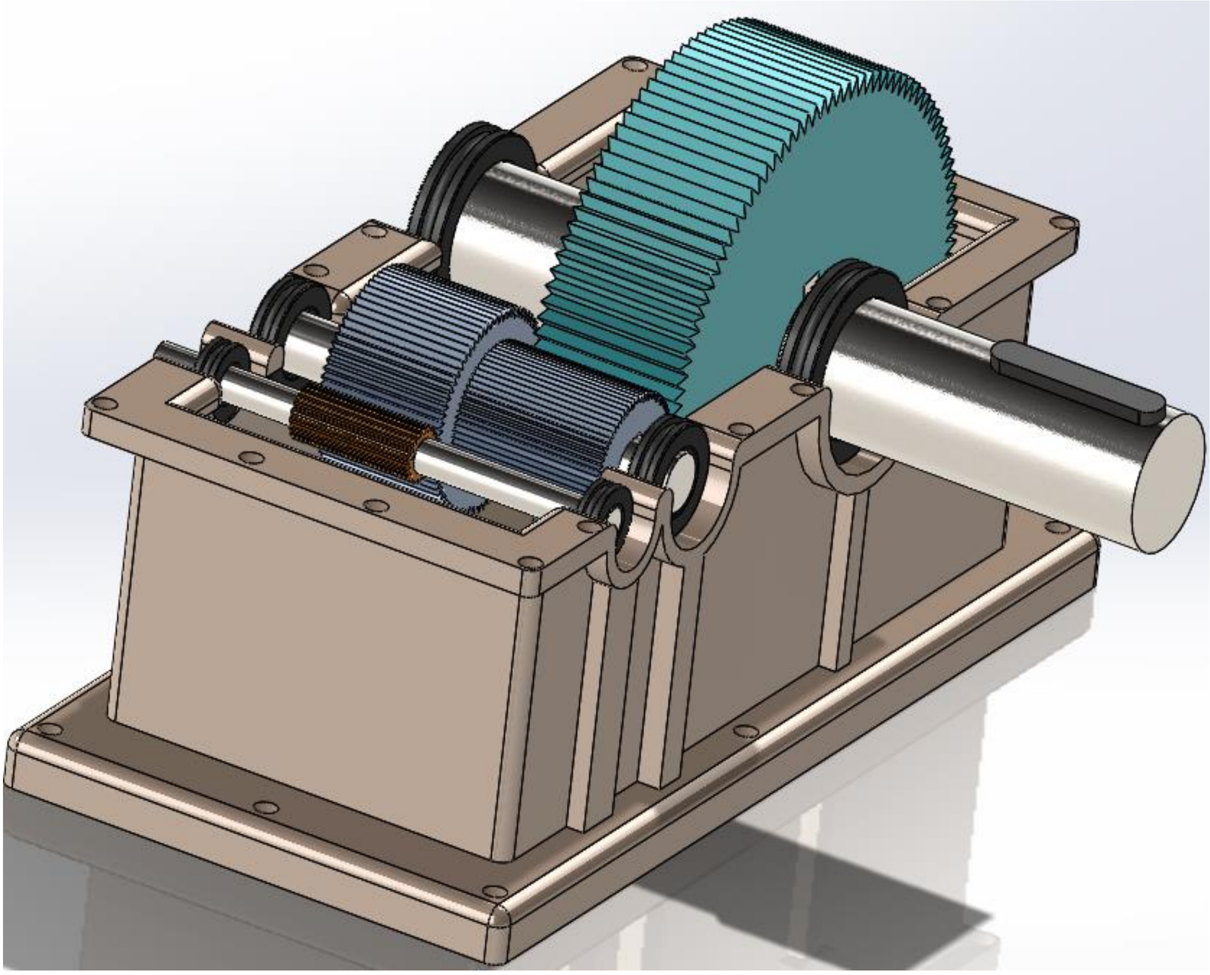
Design Stages

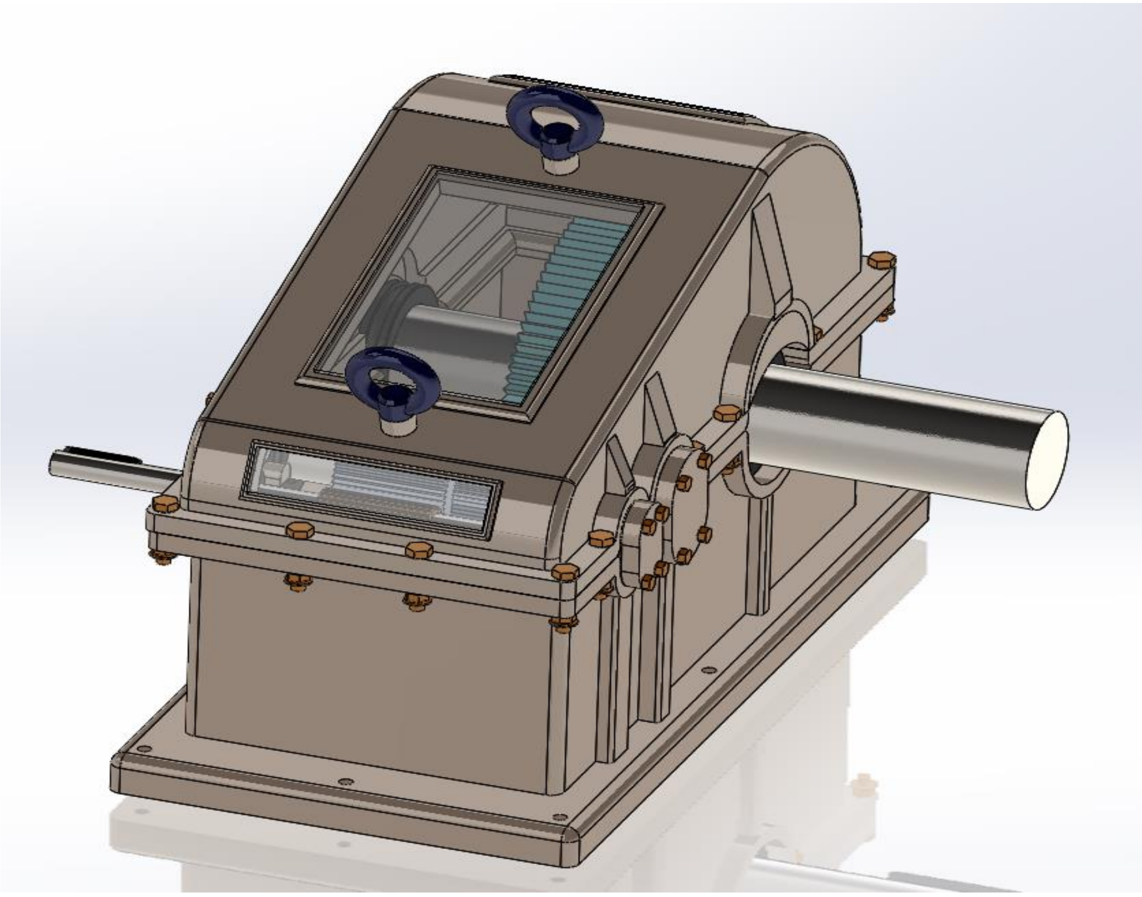
According to the shafts, I have drawed gears, bolts and nuts, case and keys.I have took only bearings from library.You can see design stages here:

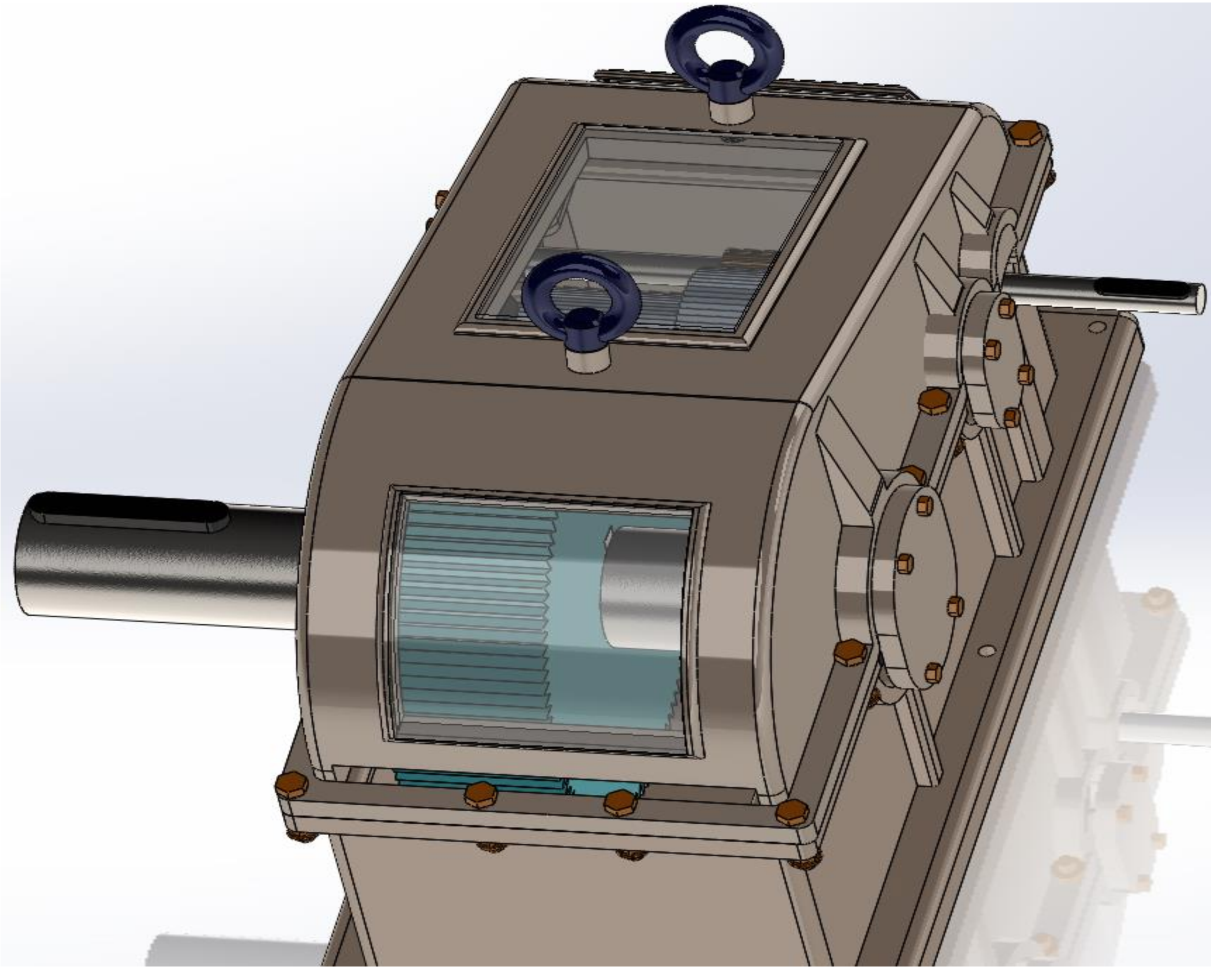


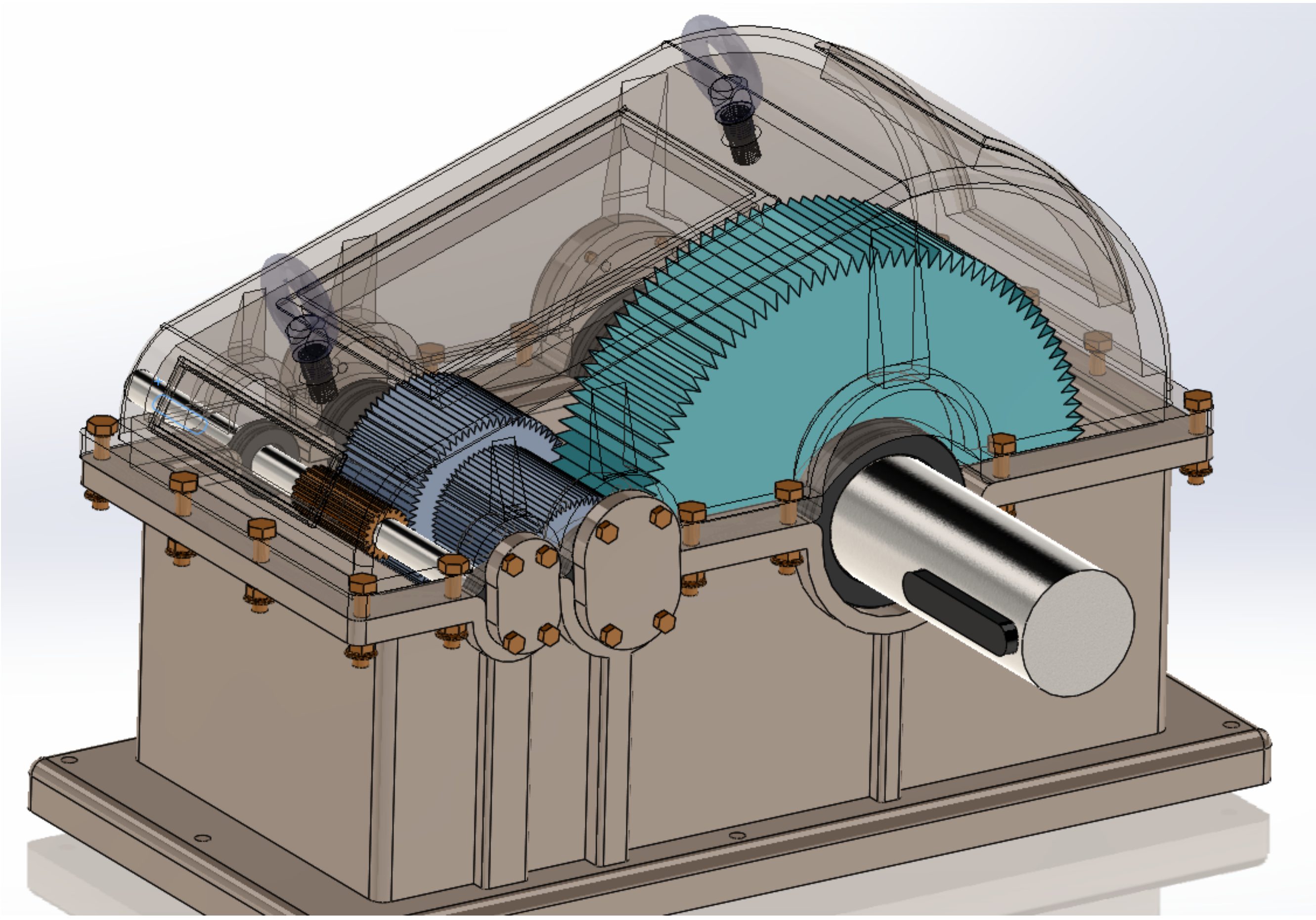












CONCLUSION

In this project, first of all we have determined gears and shafts spesifications.We have decided reduction ratios of stage 1 and stage 2 as 5 and 4,respectively.According to reduction ratio of 5, we have determined second gears torque, rpm and number of teeths.We did same calculations for stage 2 too with reduction ratio of 4. We have calculated minimum shaft diameters according to the different torsion values.

In the solidwork process we have drawed shaft and gears according to the determined values.After then we have drawed suitable case, bolts and nuts.And we have assemblied whole parts together.We have made gear mate $gear_1$-$gear_2$ and $gear_2$-$gear_3$ with reduction ratio 5 and 4 ,respectively.

We have seen how input rpm and reduction ratio effects the output torque and output rpm in the motion simulation.