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Design and Analysis of Differential Gear box for Commercial Vehicle

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Abstract -The main aim of this project work is to perform mechanical design & analysis of differential gear box. Differential is used when a vehicle takes a turn, the outer wheel on a longer radius than the inner wheel. The outer wheel turns faster than the inner wheel that is when there is a relative movement between the two rear wheels. If the two rear wheels are rigidly fixed to a rear axle the inner wheel will slip which cause rapid tire wear, steering difficulties and poor load holding. We have taken grey cast iron and aluminium 7475 alloy materials for conducting the analysis. Presently used materials for gears and gears shafts is Cast Iron, Cast Steel. So, in this paper we are checking as the aluminum 7475 can be the other material for the differential gear box for light utility vehicles so, we can reduce the weight. We had developed this project work as our semester project with a view to get familiar with the technologies as well as application of theories into practical work done by industries. This project contains the design and material selection of the gearbox for different type of vehicles also. For better efficiency, improvement of power transmit rate is important phenomenon.

***Key Words*: Differential Gearbox, Commercial Vehicle**

1. INTRODUCTION

Gearboxes are used in almost every industry right from power to marine, and also include agriculture, textile, automobiles, aerospace, shipping etc. There are different types of gearboxes available for varying uses. These gearboxes are constructed from a variety of materials depending on their end use and the kind of industry they are being used in. The product has numerous industrial applications for providing high torque and smooth speed reductions. These gearboxes are also manufactured keeping certain specifications in mind, which will also vary depending on the application. A transmission or gearbox provides speed and torque conversions from a rotating power source to another device using gear ratios. In British English the term transmission refers to the whole drive train, including gearbox, clutch, prop shaft (for rear-wheel drive), differential and final drive shafts. In American English, however, the distinction is made that a gearbox is any device which converts speed and torque, whereas a transmission is a type of gearbox that can be "shifted" to dynamically change the speed: torque ratio, such as in a vehicle. The mostCommon use is in motor vehicles, where the transmission adapts the output of the internal combustion engine to the drive wheels. Such engines need to operate at a relatively high rotational speed, which is inappropriate for starting, stopping, and slower travel. The transmission reduces the higher engine speed to the slower wheel speed, increasing torque in the process. Transmissions are also used on pedal bicycles, fixed machines, and anywhere else rotational speed and torque needs to be adapted.

Fig -1: Differential Gear Box

A differential is a device, usually but not necessarily employing gears, capable of transmitting torque and rotation through three shafts, almost always used in one of two ways: in one way, it receives one input and provides two outputs this is found in most automobiles and in the other way, it combines two inputs to create an output that is the sum, difference, or average, of the inputs. In automobiles and other wheeled vehicles, the differential allows each of the driving road wheels to rotate at different speeds, while for most vehicles supplying equal torque to each of them. The Differential is a mechanism that differentiates the power transmission ratio to the wheels. The final drive is also integrated with differential. The Final drive is the last stage in power transmission from the engine to the powered wheel. It reduces the gearbox's output shaft speed for harmonizing with the powered wheels.

As you can see below in the figure, the differential gear hub is located in the rear axle. Basically, the differential gear consists of three shafts. One shaft is the power input shaft that is connected with the propeller shaft. Another two shafts are the output shafts that transfers motion to the powered wheel. These shafts are connected with the bevel gears assembly in the housing.

The differential allows higher rpm to the outside wheel and reduces the inside wheel's speed during turning the vehicle. Without a differential, it is not possible to take a quick turn at a higher speed.

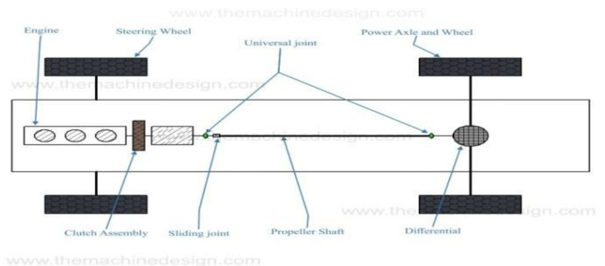

Fig -2: The differential in Automobile: Vehicle Layout

OBJECTIVES:

1. To design and to verify the best material for the gears in the gear box at higher speeds by analyzing stress, displacement and also by considering weight reduction thereby increasing its efficiency.
2. To find out the stress and torque gererated in gear box under different conditions.
3. To analyze the materials used for the gears and make the best choice out of it.
4. To improve the assembly by changing the materials for weight reduction.
5. To analyze the materials in SOLIDWORK which use for assembly.
6. Analysis is also conducted by varying the materials for gears, Grey Cast Iron, and Aluminum 7475 Alloy.

2. Construction of Differential

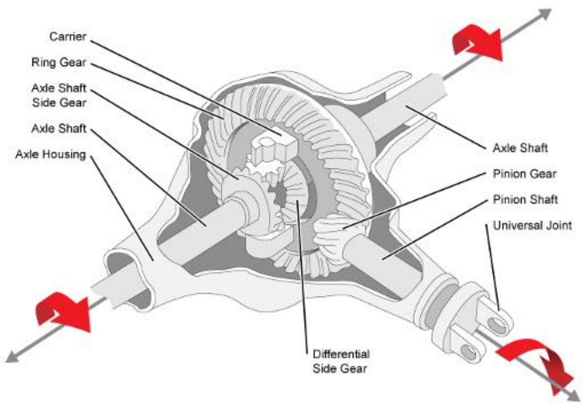

Fig -3: Construction of Differential gear box

As shown in the above figure, there are various parts in this differential unit. This is an open differential. A pinion gear is mounted on the pinion shaft. Actually, this pinion shaft is a propeller shaft. This pinion gear rotates the big ring gear. A Carrier unit mounted on the ring gear. It consists of two bevel pinions (planet pinions) and two bevels (sun) gears. The sun bevel gears are connected with the half shaft of the rear axle. A differential housing covers this whole assembly. And axle housing covers the half shaft.

2.1 Need of Differentilal Gear Box

Car wheels spin at different speeds, especially when turning. Each wheel travels a different distance through the turn, and that the inside wheels travel a shorter distance than the outside wheels. Since speed is equal to the distance travelled divided by the time it takes to go that distance, the wheels that travel a shorter distance travel at a lower speed. Also note that the front wheels travel a different distance than the rear wheels. For the non-driven wheels on your car --the front wheels on a rear-wheel drive car, the back wheels on a front-wheel drive car this is not an issue. There is no connection between them, so they spin independently. But the driven wheels are linked together so that a single engine and transmission can turn both wheels. If your car did not have a differential, the wheels would have to be locked together, forced to spin at the same speed. This would make turning difficult and hard on your car: For the car to be able to turn, one tire would have to slip. With modern tires and concrete roads, a great deal of force is required to make a tire slip. That force would have to be transmitted through the axle from one wheel to another, putting a heavy strain on the axle components.

3. SELECTION OF MATERIAL

In our project work we have taken grey cast iron and aluminium 7475 material to check as the aluminum7475 can be the other material for the differential gear box for light utility vehicles so, we can reduce the weight.

3.1 Aluminium Alloy 7475

Aluminum and other materials are used more widely with the improvement of car's weight reduction requirements and the high speed development of new materials. Differential housing is one of the important parts of automobiles drive axle; it is still heavy despite many optimization and improvement because that it is produced by ductile iron. Aluminum alloy material used in the differential housing are studied with Ansys.

Table -1: Material properties of alluminium alloy 7475

Sr. No	Properties	Metric
1	Density	2.6-2.8 g/cm3
2	Melting point	546 °C
3	Elastic modulus	70-80 GPa
4	Poisson's ratio	0.33
5	Thermal conductivity	177 W/m-K
6	Ultimate Tensile Strength	531 MPa
7	Elongation at Break	12 %
8	Modulus of Elasticity	71.7 GPa

3.2 Grey cast iron

Gray cast iron has graphite material, which can play a certain role in the work of lubrication and greatly reduce the friction. At the same time, gray cast iron has low cost and good processing performance, so it has been widely used to produce gears. The gray cast iron gears are often used in some gear system structure with low load capacity, low transmission speed and low impact resistance, but with very compact design. Ductile iron gears can be used for closed drive system. Ductile iron is an excellent material for manufacturing gears because of its good comprehensive mechanical properties, good technological properties and low price

Table -2: Material properties of Grey cast iron

Sr. No	Properties	Metric
1	Tensile Strength	250 Mpa
2	Young Modulus	105 Gpa
3	Fatigue Resistence	110 Mpa
4	Hardness	179-102
5	Thermal conductivity	48 W/m-K

4. DESIGN OF DIFFERENTIAL GEAR BOX

Differential is a part of ineer axle housing assembly, which includes the differential rear axles, wheels and bearings. The differential consisits of gears arranged in such way that connects the propeller shaft with the rear axles.

The following components consists the differential

1. Crown wheel and pinion
2. Sun gears
3. Differential casing

The main aim of the projects is to focus on the mechanical design and contact analysis on assembly of gears in gear box when they transmit power at different speeds at 2400RPM & 5000 RPM. Presently used materials are gray cast iron and aluminium alloy 7475. For validating design structural analysis is also conducted by varying the materials for gear, grey cast iron and aluminium 7475 allloy.

4.1 Design calculations of Differential Gear Box

A. ALUMINIUM ALLOY 7475 (2400 RPM)

a) Crown Wheel

Diameter of crown wheel = D_G= 475mm
Number of teeth on gear= T_G= 50
Number of teeth on Pinion = T_p= 8
Module =m=D_o/T_G= 475/50 = 9.5 = 10 = (accordign to standards)
Diameter of pinion = D_p= m × T_p = 10*8 = 80mm
Material used for both pinion and gear is aluminium alloy 7475
Brinell hardness number (BHN) = 140
Pressure angle of teeth is 20º involute system Φ=20º
Tooth form factor for the pinion
Y^1p = 0.154- 0.912/T_{EP}, for 20º full depth involute system
= 0.154 – 0.912/8
= 0.04
And tooth form factor for gear
Y^1G = 0.154- 0.912/T_{EG}
= 0.154 – 0.912 / 319.622
= 0.151
Since the allowable stastic stresses (σo) for both pinion and gear is same (i.e. σo = 172.33 Mpa) and y^1p is less than $y^1{}_G$, therfore the pinion is weaker. Thus the design should be based upon the pinion
Allowable static stress (σ_o) = σ_u / 3 = 517/3 = 172.33Mpa
σ_u = ultimate tensile strength = 517 Mpa

Load acting on crown wheel:

1. Tangential tooth load (W_T)

$$W_T = (172.33 * 0.229) * 95 * \pi * 10 * 0.04 \left(\frac{240.844-95}{240.844}\right)$$
= 2922.51N

2. Dynamic load (W_D)

$$W_D = 2922.51 + \frac{21*10.048(95*90+2922.51}{21*10.048+\sqrt{95}*90+2922.5}$$
W_D = 10532.23N

3. Static tooth load (W_s)

$$W_s = 245 * 95 * \pi * 10 * 0.041\left(\frac{240.844-95}{240.844}\right)$$
W_s = 18145N

For saftey against tooth breakage the
$W_s \geq 1.25$ W_d = 13165.2875

4. Wear load (W_w)

Axial Force
W_{RH} = $W_T$tanΦsinΘ_{p1}
= 14968.733tan20sin9
= 850.010N
Radial force acting on the pinion shaft
W_{RH} = $W_T$tanΦcosΘ_{p1}
= 14968.733tan20cos9
= 5366.752N

b) Sun Gear

Diameter ofcrown wheel = D_G = 150mm
Diameter of pinion = D_P = 70mm
Number of teeth on gear = T_G = 18
Number of teeth on pinion = T_P= 15
D = D_G+ D_P = 220
T = T_G + T_P= 33
Module = m=D/T 220/33 = 6.66 =7 (according to stds)
Materials used gor both pinion and gear is aluminium alloy 7475
Brinell hardness number (BHN) = 140
Pressure angle of teeth is 20ºinvolute system Φ = 20º
P =162BHP = 162 * 745.7 w = 120803.4w
We know that velocity ratio
V.R = T_G/ T_p = D_G/D_p = N_p/N_G
V.R = D_G/D_p = 150/70 = 2.142
V.R = N_p/N_G
2.142 = 2400 / N_G
N_G = 1120.448 rpm
Since the shafts are at right angles therfore pitch angle for the pinion
Θ_{P1}= $\tan^{-1}$ (1/v.r)
= $\tan^{-1}$(1/2.142)
= 25.025
Pitch angle of gear Θ_{P2}= 90º-25.025 = 64.974
We know that formative number of teeth for pnion
T_{EP} = $T_P$sec Θ_{P1} = 15sec25.025 = 16.554
And formative number of teeth for gear
T_{EG} = $T_G$sec Θ_{P2} = 18sec64.974 = 42.55
Tooth form factor for the pinion
$y^1{}_p$= 0.154-0.912/ T_{EP} for 20º full depth involute system
= 0.154 – 0.912/16.554
= 0.099
And tooth form factor for gear
$y^1{}_G$ = 0.154 – 0.912/ T_{EG}
= 0.154 – 0.912/42.55
= 0.132

Load acting on sun gear:

1. Tangential tooth load (W_T)

$$W_T = (196 * 0.254) * 66.5 * \pi * 7 * 0.099 \left(\frac{82.764-66.5}{82.764}\right)$$
= 1244.7N

2. Dynamic load (W_D)

$$W_D = 2922.51 + \frac{21*8.792(66.5*72.57+1244.7}{21*8.792+\sqrt{66.5}*72.57+1244.7}$$
W_D = 5513.77N

3. Static tooth load (W_s)

$$W_s = 245 * 66.5 * \pi * 7 * 0.099\left(\frac{82.764-66.5}{82.764}\right)$$
W_s = 6966.47N

For saftey against tooth breakage the $W_s \geq 1.25$,
W_d = 6892.2125 $W_s > W_d$

4. Wear load (W_w)

Axial Force
W_{RH} = $W_T$tanΦsinΘ_{p1}
= 22949.818tan20sin25.0259
= 3533.340N
Radial force acting on the pinion shaft
W_{RH} = $W_T$tanΦcosΘ_{p1}
= 22949.818tan20cos25.025
= 7567.863N

B. AlUMINIUM ALLOY 7475 (5000 RPM)

Load acting on crown wheel:

1. Tangential tooth load (W_T)

$$W_T = (172.33 * 0.125) * 95 * \pi * 10 * 0.04 \left(\frac{240.844-95}{240.844}\right)$$
= 1595.225N

2. Dynamic load (W_D)

$$W_D = 1595.225 + \frac{21*20.933(95*90+1595.225}{21*20.933+\sqrt{95}*90+1595.225}$$

W_D = 9830.39N

3. Static tooth load (W_s)

W_s = 14145N

For saftey against tooth breakage the $W_s \geq 1.25$,

W_d = 12287.9875

$W_s > W_d$

4. Wear load (W_w)

Axial Force

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

= 22961.480tan20sin25.025

= 3535.424N

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

= 22961.480tan20cos25.025

= 7551.525N

Load acting on sun gear:

1. Tangential tooth load (W_T)

$W_T = (172.33 * 0.140) * 66.5 * \pi * 7 * 0.099 \left(\frac{82.764-66.5}{82.764}\right)$

= 686N

2. Dynamic load (W_n)

$W_D = 1595.225 + \frac{21*18.316(66.5*72.57+686)}{21*18.316+\sqrt{66.5*72.57+686}}$

W_D = 4620.13N

3. Static tooth load (W_s)

W_s = 6966.47N

For saftey against tooth breakage the $W_s \geq 1.25$,

W_d = 5775.162 $W_s > W_d$

4. Wear load (W_w)

Axial Force

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

= 22961.480tan20sin25.025

= 3535.424N

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

= 22961.480tan20cos25.025

= 7551.525N

C. GREY CAST IRON (2400 RPM)

a) Crown Wheel

Diameter of crown wheel = D_G= 475mm

Number of teeth on gear= T_G= 50

Number of teeth on Pinion = T_p= 8

Module =m=D_o/T_G= 475/50 = 9.5 = 10 = (accordign to standards)

Diameter of pinion = D_p= m × T_p = 10*8 = 80mm

Material used for both pinion and gear is grey Cast Iron

Brinell hardness number (BHN) = 300

Pressure angle of teeth is 20° involute system Φ=20°

Tooth form factor for the pinion

$Y^1p = 0.154 - 0.912/T_{EP}$, for 20° full depth involute system

= 0.154 – 0.912/8

= 0.04

And tooth form factor for gear

$Y^1G = 0.154 - 0.912/T_{EG}$

= 0.154 – 0.912 / 319.622

= 0.151

Since the allowable stastic stresses (σo) for both pinion and gear is same (i.e. σo = 196Mpa) and y^1p is less than y^1_G, therfore the pinion is weaker. Thus the design should be based upon the pinion

Allowable static stress (σ_o) = 196Mpa

Load acting on crown wheel:

1. Tangential tooth load (W_T)

$WT = (196 * 0.229) * 95 * \pi * 10 * 0.04 \left(\frac{240.844-95}{240.844}\right)$

= 3243.079N

2. Dynamic load (W_n)

$W_D = 3243.079 + \frac{21*10.048(95*131.479+3243.079)}{21*10.048+\sqrt{95}*131.479+3243.079}$

W_D = 13110.818N

3. Static tooth load (W_s)

W_s = 37933.706N

For saftey against tooth breakage the $W_s \geq 1.25$,

W_d = 16388.522 $W_s > W_d$

4. Wear load (W_w)

Axial Force

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

= 14968.733tan20sin9

= 850.010N

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

= 14968.733tan20cos9

= 5366.752N

b) Sun Gear

Diameter ofcrown wheel = D_G = 150mm

Diameter of pinion = D_P = 70mm

Number of teeth on gear = T_G = 18

Number of teeth on pinion = T_P= 15

D = D_G+ D_P = 220

T = T_G + T_P= 33

Module = m=D/T 220/33 = 6.66 =7 (according to stds)

Materials used gor both pinion and gear is aluminium alloy 7475

Brinell hardness number (BHN) = 300

Pressure angle of teeth is 20°involute system Φ = 20°

P =162BHP = 162 * 745.7 w = 120803.4w

We know that velocity ratio

$V.R = T_G/T_p = D_G/D_p = N_p/N_G$

$V.R = D_G/D_p$ = 150/70 = 2.142

$V.R = N_p/N_G$

2.142 = 2400 / N_G

N_G = 1120.448 rpm

Since the shafts are at right angles therfore pitch angle for the pinion

$\Theta_{P1} = \tan^{-1}$ (1/v.r)

= $\tan^{-1}$(1/2.142)

= 25.025

Pitch angle of gear Θ_{P2}= 90°-25.025 = 64.974

We know that formative number of teeth for pnion

$T_{EP} = T_P \sec \Theta_{P1}$ = 15sec25.025 = 16.554

And formative number of teeth for gear

$T_{EG} = T_G \sec \Theta_{P2}$ = 18sec64.974 = 42.55

Tooth form factor for the pinion

$y^1_p = 0.154 - 0.912/T_{EP}$ for 20° full depth involute system

= 0.154 – 0.912/16.554

= 0.099

And tooth form factor for gear

$y^1_G = 0.154 - 0.912/T_{EG}$

= 0.154 – 0.912/42.55

= 0.132

Since the allowablr static (σ_O) for both pinion and gear is same (i.e σ_O=126.66Mpa) and y^1_p is less than y^1_G therfore the pinion is weaker. Thus the design should be based upon the pinion

Allowable static stress (σ_O) =196Mpa

Load acting on sun gear:

1. Tangential tooth load (W_T)

$$WT = (196*0.254)*66.5*\pi*7*0.099(\frac{82.764-66.5}{82.764})$$

$$= 1415.587N$$

2. Dynamic load (W_D)

$$W_D = 1415.587+ \frac{21*8.792(66.5*106.3269+1415.587}{21*8.792+\sqrt{66.5}*106.3269+1415.587}$$

$$W_D = 1883.579N$$

3. Static tooth load (W_s)

$$W_s = 14928.16N$$

For saftey against tooth breakage the $W_s \geq 1.25$,

$W_d = 2354.39$ $W_s > W_d$

4. Wear load (W_w)

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

$= 22949.818\tan20\sin25.025$

$= 3533.340N$

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

$= 22949.818\tan20\cos25.025$

$= 7567.863N$

D. GREY CAST IRON (5000 RPM)

Load acting on crown wheel:

1. Tangential tooth load (W_T)

$$W_T = (196*0.125)*95*\pi*10 *0.04 (\frac{240.844-95}{240.844})$$

$$= 1770.24N$$

2. Dynamic load (W_D)

$$W_D = 1770.24+ \frac{21*20.933(95*131.479+1770.24)}{21*20.933+\sqrt{95}*131.479+1770.24}$$

$$W_D = 11214.311N$$

3. Static tooth load (W_s)

$$W_s = 37933.706N$$

For saftey against tooth breakage the $W_s \geq 1.25$,

$W_d = 14017.88$ $W_s > W_d$

4. Wear load (W_w)

Axial Force

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

$= 22961.480\tan20\sin25.025$

$= 3535.424N$

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

$= 22961.480\tan20\cos25.025$

$= 7551.525N$

Load acting on sun gear:

1. Tangential tooth load (W_T)

$$W_T = (196*0.140)*66.5*\pi*7 *0.099 (\frac{82.764-66.5}{82.764})$$

$$= 780.245N$$

2. Dynamic load (W_D)

$$W_D = 780.245+ \frac{21*18.316(66.5*106.3269+780.245}{21*18.316+\sqrt{66.5}*106.3269+780.245}$$

$$W_D = 7161.239N$$

3. Static tooth load (W_s)

$$W_s = 14928.16N$$

For saftey against tooth breakage the $W_s \geq 1.25$,

$W_d = 8951.548$ $W_s > W_d$

4. Wear load (W_w)

Axial Force

$W_{RH} = W_T \tan\Phi \sin\Theta_{p1}$

$= 22961.480\tan20\sin25.025$

$= 3535.424N$

Radial force acting on the pinion shaft

$W_{RH} = W_T \tan\Phi \cos\Theta_{p1}$

$= 22961.480\tan20\cos25.025$

$= 7551.525N$

5. MODELING AND ANALYSIS

5.1 Modeling of model

Design is done by using software's such as CATIA-V5, Solidworks, Creo-2, and Ansys. The design and analysis were done on different materials like aluminium alloy and grey cast iron using these software's and by analytical method we have found some final results

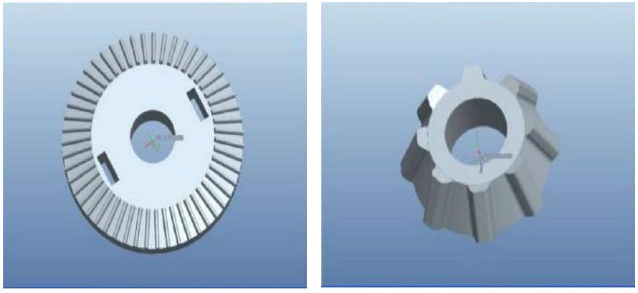

Fig -4: (a) Crown (b) Pinion

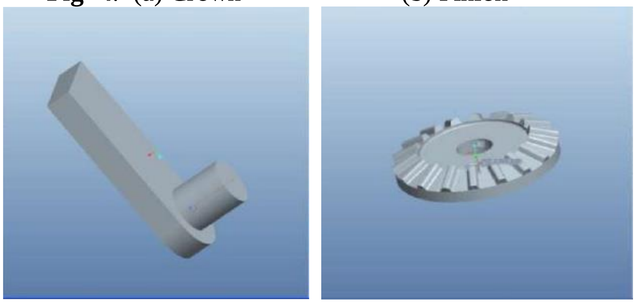

Fig -5: (a) Planet (b) Sun Gear

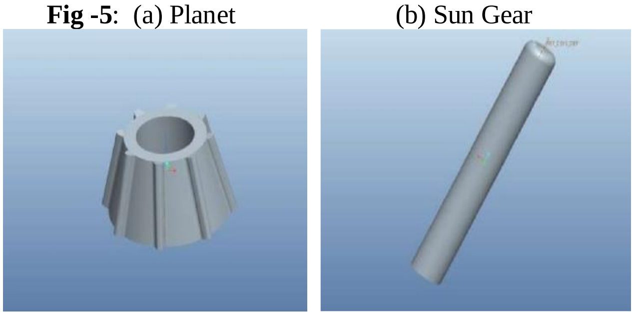

Fig -6: (a) Main shaft Pinion (b) Main Shaft

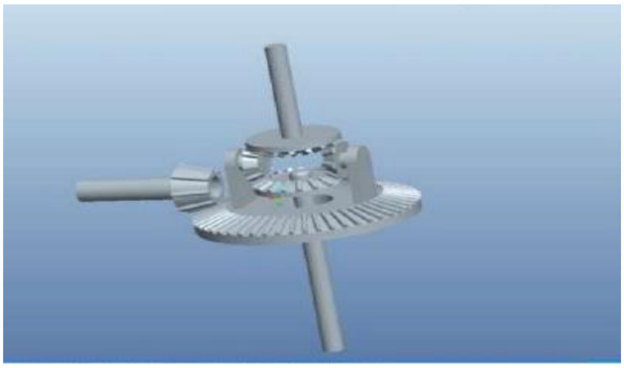

Fig -7: Crown Assembly

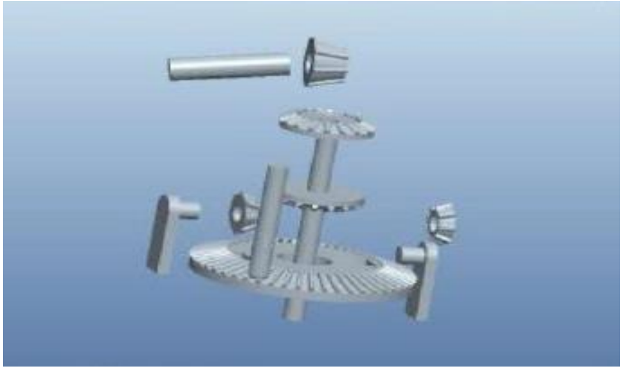

Fig -8: Crown Assembly Explode View

5.2 Analysis of Differential Gear Box

The modelling done in solidworks is saved in stp format and is imported in ansys software.

Meshing

Mesh generation is one of the most critical aspects of engineering simulation. ANSYS Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible

A. ALUMINIUM ALLOY 7475 (2400 RPM)

1. Tangential load

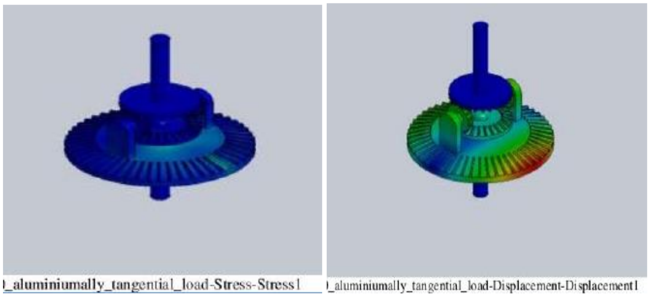

Fig -9: (a) Stress (b) Displacement

B. ALUMINIUM ALLOY 7475 (5000 RPM)

1. Tangential load

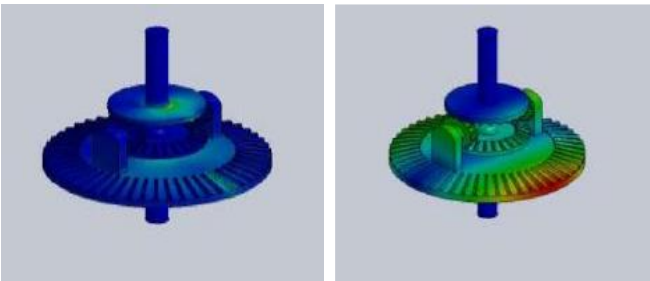

Fig -10: (a) Stress (b) Displacement

C. GREY CAST IRON (2400 RPM)

1. Tangential load

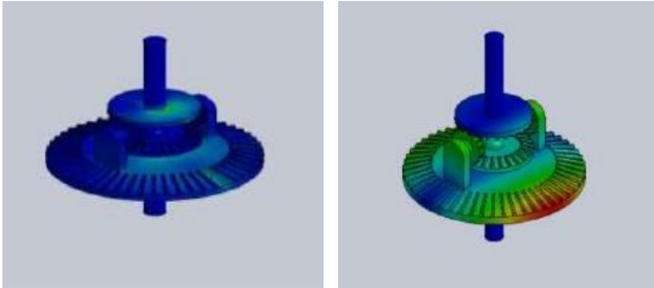

Fig -11: (a) Stress (b) Displacement

D. GREY CAST IRON (5000 RPM)

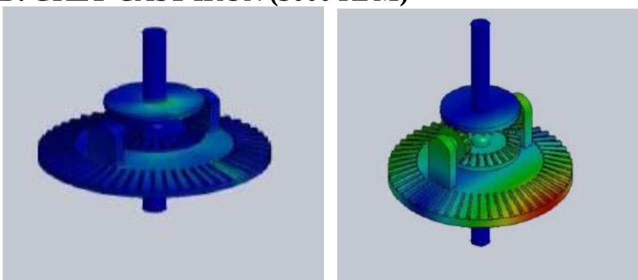

Fig -12: (a) Stress (b) Displacement

6. RESULT AND DISCUSSION

Total Deformation, Von-Mises Stresses and strain of Grey Cast Iron & Aluminium alloy7475 is shown in table

1. 2400 [RPM]

Table -2: Obtained Result

PARAMETER	ALUMINIUM ALLOY 7475	GRAY CAST IRON
Tangential load	2922.51	3243.08
Displacement (mm)	0.0241696	0.0100566
Stress N/mm^2	3.19018	3.57544
Strain	4.1593e^{-5}	1.69558e^{-5}
Static Load	18143.3	37933.7
Displacement (mm)	0.150063	0.11763
Stress N/mm^2	19.8068	41.8212
Strain	0.000258239	0.000198329

2. 5000 [RPM]

PARAMETER	ALUMINIUM ALLOY 7475	GRAY CAST IRON
Tangential load	1595.22	1770.24
Displacement (mm)	0.0131944	0.00548866
Stress N/mm^2	1.70369	2.01579
Strain	2.2558e^{-5}	9.32532e^{-6}
Static Load	18143.3	37933.7
Displacement (mm)	0.150063	0.117614
Stress N/mm^2	22.6949	43.1949
Strain	0.000274774	0.000199826

6.1 Discussion

The material used for differential gearbox should be aluminium alloy7475 as it reduces the weight and the gear should be made up of steel due to its strength. In the development of modified differential gearbox different system can be used. Till now the differential used to take one input and two outputs but by modifying and adding one extra bevel gear adjustment on crown wheel we can take one input and three outputs. And by analyzing using different materials we can modify differential gearbox having three outputs. Also, there are various special purpose differential gearboxes but individually they cannot overcome all the limitations so we can use the combinations of these special purpose differential gearboxes and reduce the limitations to some extent.

7. CONCLUSION

1. In our project we have designed a differential gear box for Ashok Leyland 2516M. Loads are calculated when the gears are transmitting different speeds 2400rpm, 5000rpm and different materials aluminium alloy 7475 and grey cast iron.
2. Structural analyses are done on the differential gear box to verify the best material by taking in to account stresses, displacements, weight etc.
3. By observing the structural analysis results using Aluminum alloy 7475 the stress values are within the permissible stress value. So using Aluminum Alloy 7475 is safe for differential gear. When comparing the stress values of the two materials for all speeds 2400rpm and 5000rpm the values are less for Aluminum alloy 7475 than grey Cast Iron.
4. By observing analysis results, the weight of Aluminum Alloy reduces almost 3 times with grey cast iron since its density is very less, thereby mechanical efficiency will be increased.
5. By observing analysis results, Aluminium alloy7475 is best material for Differential.

8. REFERENCES

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