

Input Torque (Nm)	1632.9
Large Gear Diameter (mm)	300
Input Speed (rpm)	37.8
Gear Ratio	12.7
Shoulder height	10
Shaft density	7850
Gear density	7850
g (m/s^2)	9.81
Helix Angle	15
Pressure Angle	15
Sut	1.77E+09
Sy	1.64E+09
Preload	4956.23

- Points to consider
- 1-2 shoulder
  - 2 keyway
  - 2-3 shoulder
  - 3-4 large shoulder
  - 5 keyway

Input Shaft	
Ft (N)	21772.0
Fa	7924.4
Fr	7924.4
Fw	
Fpre	0

Se	3.68E+08
Cor. Mean	3.20E+08
Cor. Amp	9.71E+07
OZ	3.34E+08
ZS	2.00E+08
Cor. Mean @S	3.60E+08
Cor. Amp@S	2.93E+08
Safety Factor	1.60

Se	3.68E+08
Cor. Mean	2.72E+08
Cor. Amp	5.68E+07
OZ	2.78E+08
ZS	2.50E+08
Cor. Mean @S	3.23E+08
Cor. Amp@S	3.01E+08
Safety Factor	1.90

Se	3.68E+08
Cor. Mean	1.98E+08
Cor. Amp	3.60E+04
OZ	1.98E+08
ZS	3.20E+08
Cor. Mean @S	2.63E+08
Cor. Amp@S	3.14E+08
Safety Factor	2.62

Se	3.68E+08
Cor. Mean	3.75E+08
Cor. Amp	7.51E+07
OZ	3.83E+08
ZS	2.11E+08
Cor. Mean @S	4.18E+08
Cor. Amp@S	2.81E+08
Safety Factor	1.55

Se	3.68E+08
Cor. Mean	6.14E+08
Cor. Amp	1.16E+04
OZ	6.14E+08
ZS	2.36E+08
Cor. Mean @S	6.62E+08
Cor. Amp@S	2.31E+08
Safety Factor	1.38

Bearing Weight (N):	58.86
Weight Gear	135.152

Section	1	2	3	4	5
Side view	bearing	gear		bearing	turbine
Feature	shoulder	keyway	shoulder	shoulder	Input Keyway
Diameter (mm)	35	45	45	55	35
Length (mm)	25.4	25.4	0	10	25.4
Cutouts (mm^2)		63		169.65	40
Cutouts (mm^3)		1280.16		169.65	812.8
I of section (mm^4)	73662	177002	201289	449180	73662
Volume (mm^3)	24438	39117	0	23589	24438
External vertical forces (N) ( assumed applied)	13374	-22971	0	0	9600
Weight + forces (N)	13375.60	-22967.99	0.00	1.82	9601.5
Moments - Equivalent weight moments at center	-1	0	0	0	0
Moments - Equivalent weight moments at End	-234	-218	-218	-218	122
Total Weight (N)		12.7			

DShaft1	Axial	Bending
Cor. Se:	2.64E+08	3.77E+08
Cload	0.70	1.00
Csize	0.84	0.84
Csurf	0.62	0.62
Ctemp	1.00	1.00
Creliab	0.81	0.81
Se'	8.86E+08	8.86E+08

DShaft2	Axial	Bending
Cor. Se:	2.58E+08	3.68E+08
Cload	0.70	1.00
Csize	0.82	0.82
Csurf	0.62	0.62
Ctemp	1.00	1.00
Creliab	0.81	0.81
Se	8.86E+08	8.86E+08

DShaft3	Axial	Bending
Cor. Se:	2.53E+08	3.61E+08
Cload	0.70	1.00
Csize	0.81	0.81
Csurf	0.62	0.62
Ctemp	1.00	1.00
Creliab	0.81	0.81
Se	8.86E+08	8.86E+08

Point 1: Bearing to Shoulder			
Kt Axial	2.08	Tension	0.00E+00
Kt Moment	1.81	Torsion	1.63E+03
kt Torsional	1.65	Shear	0.00E+00
D/d:	1.29	Moment	-2.34E+02
r/d:	0.06	I (m^4)	7.37E-08
r:	2.00 <- different	J	1.47E-07
q:	0.92	Area (m^2)	9.62E-04
Kf Axial:	2.08 <- Kf = Kt		
Kf Moment:	1.75	shoulder	
Kf Torsional:	1.65 <- Kf = Kt		

σ Bending nom	-5.56E+07	σ Bending Cor	-9.71E+07
σ Axial nom	0.00E+00	σ Axial Cor.	0.00E+00
τ Torsion Nom	1.94E+08	τ Torsion Cor.	3.20E+08
σ Mean Vd	3.20E+08		
σ Alternat	9.71E+07		

Point 2: keyway			
Kt Axial	1.00 assumed	Tension	0.00E+00
Kt Moment	2.14 p.607	Torsion	1.63E+03
kt Torsional	2.62 p.607	Shear	
D/d:	1.29	Moment	-2.18E+02
r/d:	0.02	I (m^4)	1.77E-07
r:	1.00	J	3.54E-07
q:	0.92	Area (m^2)	1.59E-03
Kf Axial:	1.00 <- Kf = Kt		
Kf Moment:	2.05		
Kf Torsional:	2.62 <- Kf = Kt		

σ Bending nom	-2.77E+07	σ Bending Cor	-5.68E+07
σ Axial nom	0.00E+00	σ Axial Cor.	0.00E+00
τ Torsion Nom	1.04E+08	τ Torsion Cor.	2.72E+08
σ Mean Vd	2.72E+08		
σ Alternat	5.68E+07		

Point 3: Gear to Shoulder			
Kt Axial	2.54	Tension	7.92E+03
Kt Moment	2.23	Torsion	1.63E+03
kt Torsional	1.90	Shear	
D/d:	1.22	Moment	-1.33E-01
r/d:	0.02	I (m^4)	1.77E-07
r:	1.00	J	3.54E-07
q:	0.92	Area (m^2)	1.59E-03
Kf Axial:	2.54 <- Kf = Kt		
Kf Moment:	2.13		
Kf Torsional:	1.90 <- Kf = Kt		

σ Bending nom	-1.69E+04	σ Bending Cor	-3.60E+04
σ Axial nom	4.98E+06	σ Axial Cor.	1.27E+07
τ Torsion Nom	1.04E+08	τ Torsion Cor.	1.97E+08
σ Mean Vd	1.98E+08		
σ Alternat	3.60E+04		

Point 4: Large Shoulder to Bearing			
Kt Axial	2.49	Tension	7.92E+03
Kt Moment	2.11	Torsion	1.63E+03
kt Torsional	1.93	Shear	
D/d:	1.29	Moment	1.22E+02
r/d:	0.03	I (m^4)	7.37E-08
r:	1.00	J	1.47E-07
q:	0.92	Area (m^2)	1.59E-03
Kf Axial:	2.49 <- Kf = Kt		
Kf Moment:	2.02		
Kf Torsional:	1.93 <- Kf = Kt		

σ Bending nom	3.72E+07	σ Bending Cor	7.51E+07
σ Axial nom	4.98E+06	σ Axial Cor.	1.24E+07
τ Torsion Nom	1.94E+08	τ Torsion Cor.	3.75E+08
σ Mean Vd	3.75E+08		
σ Alternat	7.51E+07		

Point 5: Coupling to turbine (keyway)			
Kt Axial	1.00 assumed	Tension	0.00E+00
Kt Moment	1.95 p.607	Torsion	1.63E+03
kt Torsional	2.80 p.607	Shear	
D/d:	1.29	Moment	2.31E-02
r/d:	0.03	I (m^4)	6.51E-08
r:	1.00	J	1.30E-07
q:	0.92	Area (m^2)	9.62E-04
Kf Axial:	1.00 <- Kf = Kt		
Kf Moment:	1.87		
Kf Torsional:	2.80 <- Kf = Kt		

σ Bending nom	6.21E+03	σ Bending Cor	1.16E+04
σ Axial nom	0.00E+00	σ Axial Cor.	0.00E+00
τ Torsion Nom	2.19E+08	τ Torsion Cor.	6.14E+08
σ Mean Vd	6.14E+08		
σ Alternat	1.16E+04		

0.612261

Forces from FBD	Name	Distance	Force	x	y	z
	B1G	95	Fg1	0.00	0.00	10886.00
	B1B2	135	Fg1a	2916.89	0.00	0.00
	B1s	0	Fg1r	0.00	2916.89	0.00
			Fws	0.00	0.00	0.00
			Frb2	0.00	5293.62	7565.41
			Frb1	0.00	-2376.73	3185.44

Torque (Nm)	458.20
Gear Diameter(mm)	300
Speed (rpm)	134.71
Pinion Diameter(mm)	84.18
Shaft density	7850
Gear density	7850
g (m/s^2)	9.81
Helix Angle	15
Pressure Angle	15
Sut	1.77E+09
Sy	1.64E+09
Preload	2460.56

Dshaft1	35
Shoulder height	30
Dpinion	84.2

Weight Pinion	7.78
Weight Gear	135.15
Bearing Weight (N)	58.86

Intermediate Shaft Weight						
Section	1	2	3	4	5	6
Side view	bearing 1				gear 2	bearing 2
Features	shoulder	keyway	shoulder	compression?	shoulder	keyway
Diameter (mm) (Dshaft1,Dshaft2,Dshaft3)	35	45	45	55	45	45
Length (mm)	25.4	25.4	0	55	0	25.4
Cutouts area (mm^2)	63					63
Cutouts volume (mm^3)		1280.16				
I of section (mm^4)	73662	177002	201289	449180	201289	177002
Volume (mm^3)	24438	39117	0	130671	0	39117
External Forces (N) (vertical) (assumed applied at centre of section)	8603.93	11270.02	0.00	0.00	0.00	3162.44
Weight (N)	1.88	3.01	0.00	10.06	0.00	3.01
Weight + Forces (N)	8605.82	11273.03	0.00	10.06	0.00	3165.46
Moments - Equivalent weight moments at centre of section (N*m)	-786	-168	779	1447	2503	3680
Moments - Equivalent weight moments at Edge POI(N*m) (z-axis)	-151	-471	-471	-1018	-1564	-2110
Total Weight (N)		19.85				

Lengths from FBD		Forces from FBD			
Name	Distance	Force	x	y	z
B1G1	25.4	Reaction B1	0.00	2510.7	8229.5
B1G2	105.8	Reaction B2	0.00	1224.7	-235.4
B1B2	131.2	Gear 1	2916.89	2916.9	10886.0
		Gear 2	818.50	818.5	3054.7
		Weight G1	0.00	0.0	7.8
		Weight G2	0.00	0.0	135.2
		Weight Shaft	0.00	0	19.85

- Points to consider
- 1-2 shoulder
- 2 keyway
- 2-3 shoulder
- 3 compression?
- 3-4 shoulder
- 4 keyway
- 4-5 shoulder

Dshaft1	
Cor. Se:	2.64E+08
Cload	0.70
Csize	0.84
Csurf	0.62
Ctemp	1.00
Creliab	0.81
Se	8.86E+08

Dshaft2	
Cor. Se:	2.58E+08
Cload	0.70
Csize	0.82
Csurf	0.62
Ctemp	1.00
Creliab	0.81
Se	8.86E+08

Dshaft3	
Cor. Se:	2.53E+08
Cload	0.70
Csize	0.81
Csurf	0.62
Ctemp	1.00
Creliab	0.81
Se	8.86E+08

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	2.64E+08
Cor. Mean	0.00E+00
Cor. Amp	5.57E+07
OZ	5.57E+07
ZS	2.06E+08
Cor. Mean @S	3.04E+07
Cor. Amp@S	2.60E+08
Safety Factor	4.70

Point 1: Left Bearing to Gear Shoulder			
Kt Axial	2.50	Tension	0.00E+00
Kt Moment	2.11	Torsion	0.00E+00
kt Torsional	1.93	Shear	
D/d:	1.29	Moment	1.09E+02
r/d:	0.03	I (m^4)	7.37E-08
r:	1.00	J	1.47E-07
q:	0.92	Area (m^2)	9.62E-04
Kf Axial:	2.50		
Kf Moment:	2.02		
Kf Torsional:	1.93		

Loading	
Mz1	3.19E+01
My1	1.05E+02
σ Bending Max 1	2.60E+07
σ Bending Cor 1	5.57E+07
τ Torsion Nom 1	0.00E+00
τ Torsion Cor. 1	0.00E+00
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	0.00E+00
σ Amplitude Von Mises	5.57E+07

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	3.68E+08
Cor. Mean	1.32E+08
Cor. Amp	4.33E+07
OZ	1.39E+08
ZS	2.91E+08
Cor. Mean @S	1.91E+08
Cor. Amp@S	3.29E+08
Safety Factor	3.09

Point 2 (left keyway)			
Kt Axial	1.00	Tension	0.00E+00
Kt Moment	2.14	Torsion	4.58E+02
kt Torsional	2.62	Shear	
D/d:	1.33	Moment	2.17E+02
r/d:	0.02	I (m^4)	1.77E-07
r:	1.00	J	3.54E-07
q:	0.50	Area (m^2)	1.59E-03
Kf Axial:	1.00		
Kf Moment:	1.57		
Kf Torsional:	2.62		

Loading	
Mz2	-5.90E+01
My2	-2.09E+02
σ Bending Max 2	2.76E+07
σ Bending Cor 2	4.33E+07
τ Torsion Nom 2	2.91E+07
τ Torsion Cor. 2	7.63E+07
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	1.32E+08
σ Amplitude Von Mises	4.33E+07

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	3.68E+08
Cor. Mean	9.09E+07
Cor. Amp	3.80E+07
OZ	9.85E+07
ZS	3.05E+08
Cor. Mean @S	1.53E+08
Cor. Amp@S	3.37E+08
Safety Factor	4.09

Point 3 (inner left shoulder)			
Kt Axial	2.66	Tension	0.00E+00
Kt Moment	2.23	Torsion	4.58E+02
kt Torsional	2.05	Shear	
D/d:	1.44	Moment	1.60E+02
r/d:	0.02	I (m^4)	2.01E-07
r:	1.00	J	4.03E-07
q:	0.92	Area (m^2)	1.59E-03
Kf Axial:	2.66		
Kf Moment:	2.13		
Kf Torsional:	2.05		

Loading	
Mz3	1.54E+02
My3	4.27E+01
σ Bending Max 3	1.78E+07
σ Bending Cor 3	3.80E+07
τ Torsion Nom 3	2.56E+07
τ Torsion Cor. 3	5.25E+07
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	9.09E+07
σ Amplitude Von Mises	3.80E+07

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	3.61E+08
Cor. Mean	2.43E+07
Cor. Amp	7.76E+06
OZ	2.55E+07
ZS	3.41E+08
Cor. Mean @S	9.25E+07
Cor. Amp@S	3.42E+08
Safety Factor	14.38

Point 4 (compression? unlikely)			
Kt Axial	1.00	Tension	0.00E+00
Kt Moment	1.00	Torsion	4.58E+02
kt Torsional	1.00	Shear	
D/d:	1.00	Moment	1.27E+02
r/d:		I (m^4)	4.49E-07
r:	0.00	J	8.98E-07
q:	1.00	Area (m^2)	2.38E-03
Kf Axial:	1.00		
Kf Moment:	1.00		
Kf Torsional:	1.00		

Loading	
Mz4	-7.53E+01
My4	-1.02E+02
σ Bending Max 4	7.76E+06
σ Bending Cor 4	7.76E+06
τ Torsion Nom 4	1.40E+07
τ Torsion Cor. 4	1.40E+07
σ Axial nom	1.04E+06
σ Axial Cor.	1.04E+06
σ Mean Von Mises	2.43E+07
σ Amplitude Von Mises	7.76E+06

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	3.68E+08
Cor. Mean	9.09E+07
Cor. Amp	2.16E+07
OZ	9.35E+07
ZS	3.21E+08
Cor. Mean @S	1.56E+08
Cor. Amp@S	3.36E+08
Safety Factor	4.43

Point 5 (inner right shoulder)			
Kt Axial	2.66	Tension	0.00E+00
Kt Moment	2.23	Torsion	4.58E+02
kt Torsional	2.05	Shear	
D/d:	1.44	Moment	9.10E+01
r/d:	0.02	I (m^4)	2.01E-07
r:	1.00	J	4.03E-07
q:	0.92	Area (m^2)	1.59E-03
Kf Axial:	2.66		
Kf Moment:	2.13		
Kf Torsional:	2.05		

Loading	
Mz5	8.65E+01
My5	2.81E+01
σ Bending Max 5	1.02E+07
σ Bending Cor 5	2.16E+07
τ Torsion Nom 5	2.56E+07
τ Torsion Cor. 5	5.25E+07
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	9.09E+07
σ Amplitude Von Mises	2.16E+07

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	3.68E+08
Cor. Mean	1.32E+08
Cor. Amp	1.83E+07
OZ	1.33E+08
ZS	3.16E+08
Cor. Mean @S	1.96E+08
Cor. Amp@S	3.27E+08
Safety Factor	3.37

Point 6 (keyway)			
Kt Axial	1.00	Tension	0.00E+00
Kt Moment	2.14	Torsion	4.58E+02
kt Torsional	2.62	Shear	
D/d:	1.29	Moment	9.19E+01
r/d:	0.02	I (m^4)	1.77E-07
r:	1.00	J	3.54E-07
q:	0.50	Area (m^2)	1.59E-03
Kf Axial:	1.00		
Kf Moment:	1.57		
Kf Torsional:	2.62		

Loading	
Mz6	9.17E+01
My6	-5.98E+00
σ Bending Max 6	1.17E+07
σ Bending Cor 6	1.83E+07
τ Torsion Nom 6	2.91E+07
τ Torsion Cor. 6	7.63E+07
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	1.32E+08
σ Amplitude Von Mises	1.83E+07

- Se
- Cor. Mean
- Cor. Amp
- OZ
- ZS
- Cor. Mean @S
- Cor. Amp@S
- Safety Factor

Se	2.64E+08
Cor. Mean	0.00E+00
Cor. Amp	7.60E+06
OZ	7.60E+06
ZS	2.54E+08
Cor. Mean @S	3.74E+07
Cor. Amp@S	2.59E+08
Safety Factor	34.41

Point 7 (right gear to bearing shoulder)			
Kt Axial	2.50	Tension	0.00E+00
Kt Moment	2.11	Torsion	0.00E+00
kt Torsional	1.93	Shear	
D/d:	1.29	Moment	1.58E+01
r/d:	0.03	I (m^4)	7.37E-08
r:	1.00	J	1.47E-07
q:	0.92	Area (m^2)	9.62E-04
Kf Axial:	2.50		
Kf Moment:	2.02		
Kf Torsional:	1.93		

Loading	
Mz7	-1.56E+01
My7	-2.99E+00
σ Bending Max 7	3.76E+06
σ Bending Cor 7	7.60E+06
τ Torsion Nom 7	0.00E+00
τ Torsion Cor. 7	0.00E+00
σ Axial nom	0.00E+00
σ Axial Cor.	0.00E+00
σ Mean Von Mises	0.00E+00
σ Amplitude Von Mises	7.60E+06

## Output Shaft

Input Torque (Nm)	<b>117.12282</b>
Large Gear Diameter (mm)	<b>300</b>
Speed (rpm)	<b>480.06</b>
Gear Ratio	<b>12.7</b>
Shaft density	<b>7850</b>
Gear density	<b>7850</b>
g (m/s^2)	<b>9.81</b>
Helix Angle	<b>15</b>
Pressure Angle	<b>15</b>
Sut	<b>1.77E+09</b>
Sy	<b>1.64E+09</b>
Weight Pinion	<b>7.78</b>
Pinion Diameter(mm)	<b>84.18</b>
Preload	<b>277.61</b>

## Lengths from FBD

Name	Distance
B1G	80
B1B2	115
B1s	0

## Forces from FBD

Force	x	y	z
Fg1	0.00	0.00	<b>1391.30</b>
Fg1a	<b>372.80</b>	0.00	0.00
Fg1r	0.00	<b>372.80</b>	0.00
Fws	0.00	0.00	0.00
Frb1	0.00	<b>395.79</b>	<b>962.45</b>
Frb2	0.00	<b>22.99</b>	<b>421.07</b>

Slot for FBD

Gear Specifications	Number of Teeth	Module	Addendum	Dedendum	Contact Ratio	Gear Quantity	Pitch Radius	Pressure angle	Face Width	Length of action(Z)
Gear	125	2.4	2.40	3	5.70778	12	150	15	25.4	41.569
Pinion	35		2.4	3		12	42.09101499		25.4	

125

Number of Cycles: 1.00E+10 **<--- Each gear cycles a different amount of times, need to take this into account.**  
 Material: Carburized and case hardened 64HRC  
 Number of Cycles(Gear 1): 60000

Input Gear

General Data	Bending	Surface
Face Width	25.4	
Modulus	2.4	
Geometry Factor(J, I)	0.5	5.54E-01
Dynamic Factor(Kv, Cv)	1	1
Load Distribution(Km, Cm)	1.6	1.6
Application Factor(Ka, Ca)	1	1
Size Factor(Ks, Cs)	1	1
Rim Thickness Factor(Kb)	1	NA
Idler factor(Ki)	1	NA
Elastic Coefficient (Cp)	NA	185.8463
Surface Finish Factor(Cf)	NA	1
Wt	10886	
Stress	571.4435696	712.66

ro(g):	38.82285677
ro(p):	10.89395631

A:	106
B:	0
Vt:	66.125

v (Poisson)	0.28
Modulus of Elasticit	2.00E+05

A:	106
B:	0
Vt:	66.125

Variables for I:	
Axial contact ratio(mf)	0.902661781
na	0.902661781
nr	0.707784727
Lmin	144.1509813
theta,n	14.5108187
phi,b	14.5108187
mn	0.176204142

Service Intervals(hr):	
Gear 1:	2.65E+01
Pinion 1:	1.24E+06
Gear 2:	1.24E+06
Pinion 2:	3.47E+05

Safety factors	Bending	Surface
Fatigue Strength (uncorrected)	520	1300
Life Factor(Kl,Ci)	1.657365672	1.331731
Temperature Factor(Kt,Ct)	1	1
Reliability Factor(Kr,Cr)	1	1
Hardness Ratio Factor(Ch)	NA	1
Corrected Fatigue Strength	861.8301493	1731.251
Safety Factor	1.508163177	5.901401

First Pinion

General Data	Bending	Surface
Face Width	25.4	
Modulus	2.4	
Geometry Factor(J,I)	0.47	0.55396
Dynamic Factor(Kv, Cv)	1	1
Load Distribution(Km, Cm)	1.6	1.6
Application Factor(Ka, Ca)	1	1
Size Factor(Ks, Cs)	1	1
Rim Thickness Factor(Kb)	1	NA
Idler factor(Ki)	1	NA
Elastic Coefficient (Cp)	NA	185.8463
Surface Finish Factor(Cf)	NA	1
Wt	2916.894909	
Stress	162.8913223	195.4149

A:	106
B:	0
Vt:	66.125

v (Poisson)	0.28
Modulus of Elasticit	2.00E+05

A:	106
B:	0
Vt:	66.125

Safety factors	Bending	Surface
Fatigue Strength (uncorrected)	520	1300
Life Factor(Kl,Ci)	0.899902855	0.679193
Temperature Factor(Kt,Ct)	1	1
Reliability Factor(Kr,Cr)	1	1
Hardness Ratio Factor(Ch)	NA	1
Corrected Fatigue Strength	467.9494845	882.9506
Safety Factor	2.872771108	20.41538

Second Gear

General Data	Bending	Surface
Face Width	25.4	
Modulus	2.4	
Geometry Factor(J,I)	0.5	0.155445
Dynamic Factor(Kv, Cv)	1	1
Load Distribution(Km, Cm)	1.6	1.6
Application Factor(Ka, Ca)	1	1
Size Factor(Ks)	1	1
Rim Thickness Factor(Kb)	1	NA
Idler factor(Ki)	1	NA
Elastic Coefficient (Cp)	NA	185.8463
Surface Finish Factor(Cf)	NA	1
Wt	3054.685262	
Stress	160.3509324	377.5126

ro(g):	38.82285677
ro(p):	10.89395631

A:	106
B:	0
Vt:	66.125

v (Poisson)	0.28
Modulus of Elasticit	2.00E+05

A:	106
B:	0
Vt:	66.125

Safety factors	Bending	Surface
Fatigue Strength (uncorrected)	520	1300
Life Factor(Kl,Ci)	0.899902855	0.679193
Temperature Factor(Kt,Ct)	1	1
Reliability Factor(Kr,Cr)	1	1
Hardness Ratio Factor(Ch)	NA	1
Corrected Fatigue Strength	467.9494845	882.9506
Safety Factor	2.918283527	5.470285

## Bearings

Bearing Preload Input	<b>4956.23</b>
Bearing Preload Intermediate	<b>2460.56</b>
Bearing Preload output	<b>277.61</b>
C	81200
X	0.4
Y	1.6
V	1
e	0.37
Kr	0.21

Input shaft speed	<b>37.8</b>
Secondary shaft speed	<b>134.71</b>
Output shaft	<b>480.06</b>

Bearing summaries	Fy	Fz	Fr	Fa	Internal axial force	Required Preload	Fa/VFr	P	L10	Lp	Service interval (hr)
1	-2376.73	7565.41	<b>7929.961963</b>	0	<b>4956.23</b>	<b>4956.23</b>	0	<b>7929.962</b>	<b>2331.39799</b>	<b>489.5936</b>	<b>2.16E+05</b>
2	5293.62	7565.41	<b>9233.52106</b>	2916.89	<b>5770.95</b>	<b>2854.06</b>	<b>0.315903</b>	<b>9233.521</b>	<b>1403.7689</b>	<b>294.7915</b>	<b>1.30E+05</b>
3	2510.651	8229.478	<b>8603.934221</b>	2916.89	<b>5377.46</b>	<b>2460.56</b>	<b>0.339019</b>	<b>8603.934</b>	<b>1776.35526</b>	<b>373.0346</b>	<b>4.62E+04</b>
4	1224.744	-235.385	<b>1247.158831</b>	818.50	<b>779.47</b>	<b>39.03</b>	<b>0.656292</b>	<b>1808.464</b>	<b>321726.625</b>	<b>67562.59</b>	<b>8.36E+06</b>
5	395.786	962.4546	<b>1040.65622</b>	372.7989	<b>650.41</b>	<b>277.61</b>	<b>6.77E-05</b>	<b>1040.656</b>	<b>2029998.96</b>	<b>426299.8</b>	<b>1.48E+07</b>
6	-22.9872	421.0739	<b>421.7008594</b>	0	<b>263.56</b>	<b>263.56</b>	0	<b>421.7009</b>	<b>41226058.1</b>	<b>8657472</b>	<b>3.01E+08</b>

## Fasteners

### Input/Output shaft end cap(4 bolts)

Bolt diameter	5
Threaded length (Lthd)	16
Total length of the bolt (Lbolt)	40
Shank length (Ls)	24
Length of thread (Lt)	16
Total length of material (L)	40
Tensile stress Area (At)	14.18

MoE	2E+11
Stiffness of the bolt (kb')	75628885751
Material stiffness(km)	2.77018E+11
Joint's Stiffness constant (C)	0.214460675
j	0.125
r	0.345
po	0.4389
p1	-0.9197
p2	0.8901
p3	-0.3187

#### Forces:

Preload(Fi)	4849.56
X-dir force/ # bolts(P)	1239.05656
Pb	265.728906
Pm	973.327651
Fb	5115.28891
Fm	3876.23235
Po	6173.54198

#### Strengths:

Class	5.8
Proof (Sp)	3.80E+08
Yield (Sy)	4.20E+08
Tensile(Sut)	5.20E+08

#### Safety Factors:

Tensile stress bolt (sigma,b)	360739697
Safety factor(SF)	1.1642744
Safety factor separation(Nsep)	4.9824537

### Intermediate shaft end cap(5 bolts,input side)

Bolt diameter	6
Threaded length (Lthd)	12.5
Total length of the bolt (Lbolt)	40
Shank length (Ls)	27.5
Length of thread (Lt)	12.5
Total length of material (L)	40
Tensile stress Area (At)	20.12

MoE	2E+11
Stiffness of the bolt (kb')	50297276331
Material stiffness(km)	1.84232E+11
Joint's Stiffness constant (C)	0.214460675
j	0.15
r	0.345
po	0.4389
p1	-0.9197
p2	0.8901
p3	-0.3187

#### Forces:

Preload(Fi)	6881.04
X-dir force/ # bolts(P)	492.112796
Pb	105.538842
Pm	386.573953
Fb	6986.57884
Fm	6494.46605
Po	8759.63785

#### Strengths:

Class	5.8
Proof (Sp)	3.80E+08
Yield (Sy)	4.20E+08
Tensile(Sut)	5.20E+08

#### Safety Factors:

Tensile stress bolt (sigma,b)	347245469
Safety factor(SF)	1.209519
Safety factor separation(Nsep)	17.800061

### Intermediate shaft end cap(4 bolts, output side)

Bolt diameter	5
Threaded length (Lthd)	16
Total length of the bolt (Lbolt)	40
Shank length (Ls)	24
Length of thread (Lt)	16
Total length of material (L)	40
Tensile stress Area (At)	14.18

MoE	2E+11
Stiffness of the bolt (kb')	30994908243
Material stiffness(km)	1.1353E+11
Joint's Stiffness constant (C)	0.214460675
j	0.125
r	0.345
po	0.4389
p1	-0.9197
p2	0.8901
p3	-0.3187

#### Forces:

Preload(Fi)	4849.56
X-dir force/ # bolts(P)	9.75654494
Pb	2.09239522
Pm	7.66414973
Fb	4851.6524
Fm	4841.89585
Po	6173.54198

#### Strengths:

Class	5.8
Proof (Sp)	3.80E+08
Yield (Sy)	4.20E+08
Tensile(Sut)	5.20E+08

#### Safety Factors:

Tensile stress bolt (sigma,b)	342147560
Safety factor(SF)	1.2275405
Safety factor separation(Nsep)	632.75904

### Case Cap(14 bolts)

Bolt diameter	4
Threaded length (Lthd)	14
Total length of the bolt (Lbolt)	20
Shank length (Ls)	6
Length of thread (Lt)	14
Total length of material (L)	20
Tensile stress Area (At)	8.78

MoE	2E+11
Stiffness of the bolt (kb')	24311036360
Material stiffness(km)	51319816509
Joint's Stiffness constant (C)	0.321443372
j	0.2
r	0.345
po	0.6118
p1	-1.1715
p2	1.0875
p3	-0.3806

#### Forces:

Preload(Fi)	3002.76
X-dir force/ # bolts(P)	0
Pb	0
Pm	0
Fb	3002.76
Fm	3002.76
Po	4425.21652

#### Strengths:

Class	5.8
Proof (Sp)	3.80E+08
Yield (Sy)	4.20E+08
Tensile(Sut)	5.20E+08

#### Safety Factors:

Tensile stress bolt (sigma,b)	342000000
Safety factor(SF)	1.2280702
Safety factor separation(Nsep)	N/A

## Key Failure

	Input key	First pinion key
Sy (Yield strength)	1.64E+09	1.64E+09
Width (mm)	10	14
Height (mm)	8	9
Length (mm)	25.4	25.4
Applied force (N)	9.33E+04	2.04E+04
A <sub>shear</sub> (m <sup>2</sup> )	2.54E-04	3.56E-04
A <sub>bearing</sub> (m <sup>2</sup> )	1.02E-04	1.14E-04
τ (Shear)	3.67E+08	5.73E+07
σ (Bearing stress)	9.18E+08	1.78E+08
SF <sub>shear</sub>	2.23	14.33
SF <sub>bearing</sub>	1.79	9.21

Material: 4140 Steel Q&T at 400°F  
9

## Lowest SF of input shaft

1.38

### Options for materials

4140 Steel Q&T at 400°F (same as shafts)  
4130 Steel Q&T at 800°F  
1095 Carbon Steel Q&T at 800°F  
1095 Carbon Steel Q&T at 600°F

Sy	Lowest SF	SF key <= SF for shaft?
1.64E+09	1.79	FALSE
1.19E+09	1.30	TRUE
1.21E+09	1.32	TRUE
1.26E+09	1.37	TRUE

# COLOUR SCHEME

Input  
Calculation  
Linked Cell

1.00
<b>2.00</b>
<b>12.7</b>