BAJA TUTOR
A Knowledge Base for BAJA ATV Enthusiasts

SAMPLE CALCULATIONS FOR FNR GEAR BOX AND CVT COMBINATION

Gear Reduction Selection

Power Requirements against:

Fr: Wheel Resistance
F_L : Air resistance
Fs: Gradient resistance
Fa: Acceleration resistance

Wheel Resistance= Rolling resistance + Slip Resistance + Road Resistance
Tr: Brake Torque

Assumption taken

Unmade road coefficient of friction fr= .16
mass of vehicle being=Mf

CALCULATIONS

Fr=fr*Mf*g*Cosαst where $\alpha st=30^{\circ}$

Fr=0.16*200*9.81*Cos 30
Fr=280N

Total Load R=113kg(driver)+200kg (vehicle)
R=313*9.81=3070.50N

Static Resistance=µR
=0.65*3070.5=1995.84N

Vmax=60kmph
Wheel Radius r=221.875mm
= .221m
Air Resistance

F_L:$0.5\rho C w A v^2$
P=Air Density

Cw=Drag Coefficient
A=Area
V=velocity

F_L =0.5*1.99*0.0315*$(16.66)^2$
=0.52N

Gradient Resistance:
Fst=Mf*g *Sinαst

Putting the corresponding value
Fst=131.725N

Acceleration resistance:
Fa=m*a
=956N
Ftotal=2662.247

Power Required: Ftotal*v/(Nrpm*η)

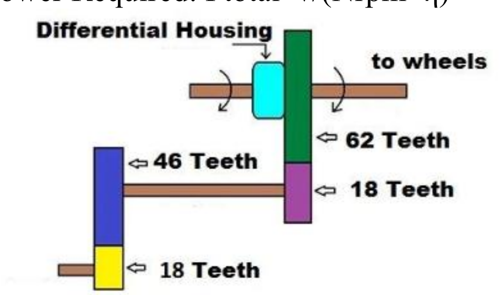


Fig62: Gear Train Layout

=10Kw
Engine Torque Te=60000*7.084/(2Π*3800)
=17.81Nm
For low end gear=8.6*.85*17.81=130.2Nm
Tractive Effort=Tw/r=465.9N

Gear reduction requirement

Ia max; r*Mf*g(frCosαst+Sinαst)/Tmax*ηtot
Putting the values: 24.5
Ia min:2.77
Ioverall:24.5/2.77=8.68

Proposed gear layout
Velocity At Lower And Higher end Gear ratio:V=16.28*(D/G)

V for High torque=14.37kmph
V for low torque=80kmph (theoretical)
<u>Calculation for module and strength</u>

Step1:Estimation of module based on beam strength

Zp=18
Zg=iZp=3.33*(18)
=60
$Mt=60X10^6 *7.08/(2\Pi*3600)$
=18.7Nm
Lewis form factor is 0.308 for 18 teeths
Therefore Y=0.308
Cs=Starting torque/rated Torque=1.5

Assuming a trial velocity value=5m/s
Cv=3/3+v=3/8

Assuming b/m=10

$$m=\frac{\{60X10^6[7.08*1.5*1.5*720*0.308]^{1/3}\}}{\{\Pi[18*3600*(3/8)*10*3]\}}$$
=2.5
=3mm

Step2 m=3mm
Dp'=m*Zp=3(18)=54mm
Dg'=m*Zg=180mm
b=10m=30mm

Checking the design
2Mt/Dp'=695.5N
$V=\Pi Dp*np/(60X10^3)$=10m/s   Cv=3/3+V=.2307

Peff=Cs/Cv*(Pt)
=4522.49N
From Lewis Equation, $Sb=m*b*\sigma_b*Y$
=6642.8N
FOS=Sb/Peff=1.5

Step 3 Surface hardness for the pinion

Q=2Zg/Zg+Zp=1.5 , Sw=bQDp'K=30(1.5)(54)(0.16)$(BHN/100)^2$
Sw=Peff(1.5)
=4522.5*1.5=6783.75=388.8$(BHN/100)^2$
Or BHN=417

Now Centre to Centre Distance

a=m(Zp+Zg)/2=117mm $\alpha=20^\circ$
m=3mm, Addendum=m=3mm
Deddendum=1.25m=3.75mm
Clearance=0.25m=0.75mm
Working Depth=2m=6mm
Whole Depth=6.75mm
Tooth thickness=1.5m=4.712mm

SHAFT ANALYSIS(input/intermediate)

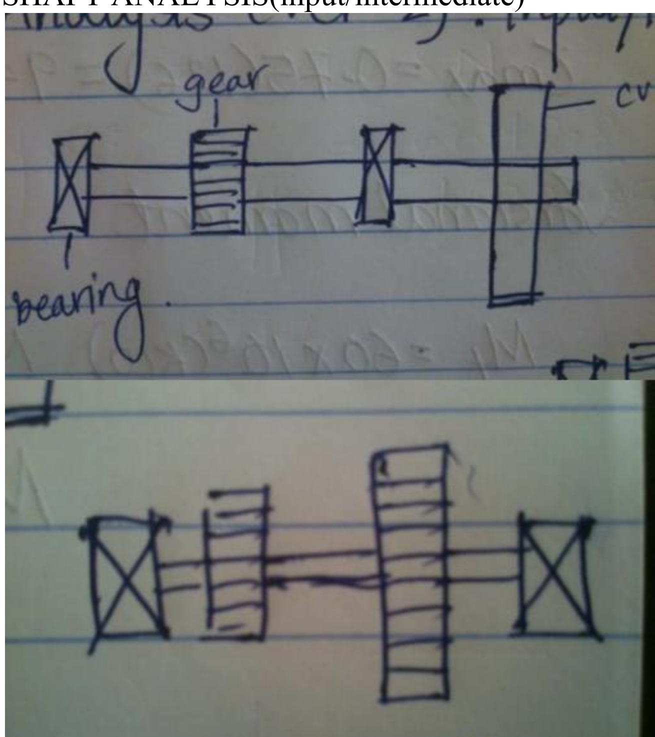


Fig 63:Shaft Analysis

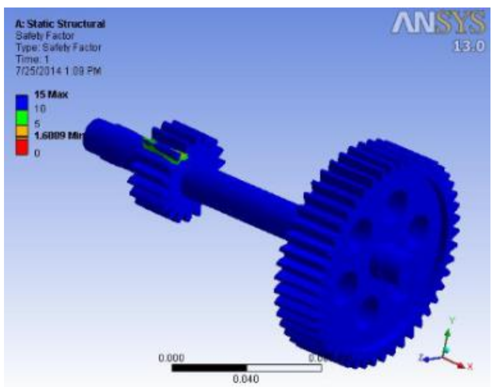
Outer Diameter=19mm
Syt=460N/mm^2 FOS=3

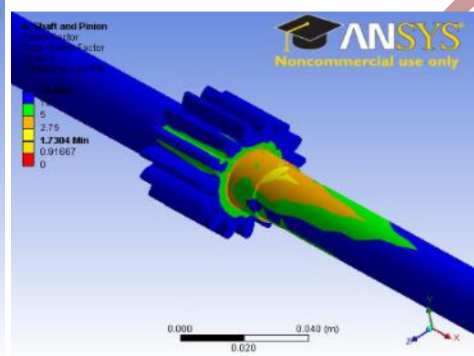
Centre to Centre=200mm Engagement Load=0.850KN, Maximum Load=1.2KN
$\mu=0.3$ $\Theta=180^\circ$ P=7.084KW N=3600rpm
D=198mm Dp=54mm Kb=Kt=1.5

Step1 Permissible Shear Stress

0.30(Syt)=138N/mm2

0.18(Sut)=0.18*700=126N/mm^2 the lower of the two is 126N/mm2 τ_{max} =0.75(126)=94.5N/mm^2





Step 2:Torsion Moment

Mt=60X10^6/2ΠN=18660.91N or 44881.693N@1800rpm

Step 3: Bending Moment

Pulley Diameter =198mm

Pr=Pt*tan(20)

(P_1-P_2)X198/2=44881.693N

(P_1-P_2)=453.35N

And $P_1=3P_2$

Therefore $2P_2$=188.49N

P_2=226.67N

P_1=680.02N