GANPAT UNIVERSITY
॥ विद्या समाजोत्कर्षः ॥
U V PATEL COLLEGE OF ENGINEERING

DESIGN OF MACHINE ELEMENTS

"DESIGN OF SINGLE PLATE CLUTCH"

B.TECH 6TH MECHANICAL

Batch:-E1

Year:-2019-2020

Guided by: - Dr. B. P. Patel

DEPARTMENT OF MECHANICAL ENGINEERING

U. V. PATEL COLLEGE OF ENGINEERING

GANPAT UNIVERSITY

KHERVA-382711

CERTIFICATE

This is to certify that Subhashis Hansda of roll no 17012031044 of 6^{th} Mechanical Engineering has satisfactorily completed the course work in “Design of Single Plate Clutch” within four walls of U.V. Patel College of Engineering, Kherva in the year of 2020.

Date of Submission: Staff In charge

Head of Department:

U.V. Patel College of Engineering

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Kherva-382711

Design a single plate clutch which transmits 7kW power operated with electric motor running at 1400rpm. Use following data for single plate clutch. Assume the data is required.

- Spline shaft material:-C15Mn75 IS 6967 Steel
- Yield shear strength for IS 6967 Steel =190N/mm^2
- Factor of safety for spline shaft=3.0
- Stress concentration factor for spline shaft=2.0
- Rivet material:-Low carbon steel
- Shear stress for rivet material:-42 N/mm^2
- No of rivets:-4
- Intensity of pressure for friction lining:- 0.06N/mm^2
- Coefficient of friction for friction lining:- 0.15
- Spring Material:- Spring Steel(Stainless Steel)
- Spring Index:-6
- Allowable shear stress for the spring wire:-437.5 N/mm^2
- Deflection of spring limited to 6.03 mm
- Modulus of rigidity for spring:-84 x 10^3 N/mm^2
- Angle of pressure plate support:-45^0
- Bearing type:-Deep groove ball bearing
- Bearing size:-SKF(60 series)
- Bolt material for driving shaft flange:-M.S
- Allowable shear strength for bolt of driving shaft flange=40N/mm^2
- Stud & Nut for spring attachment material:-Mild Steel
- Bush material: Brass
- Clutch plate material: Steel
- Pressure plate material: Steel
- Sleeve assembly material: Steel
- Flywheel material: Steel

- Driving shaft material: Steel

NOTATIONS:-

SPLINE SHAFT

- P=Power to be transmitted=7kW
- N=Speed of the driving& driven shaft=1400rpm
- T_y=Yield shear strength for
- FOS=Factor of safety
- K_{ts}=Stress concentration factor
- n=no of splines
- k=Type of fit
- d=Minor diameter of the spline shaft
- D=Major diameter of the spline shaft
- T_a=Allowable shear strength for spline shaft
- T=Average torque transmitted
- b= width of spline
- h=height of spline
- l=length of spline
- F=Shear force in spline shaft
- D_{ssb}=dia of spline shaft for bearing seating
- L_s=total length of spline shaft

HUB FOR SPLINE SHAFT

- d_{ho}=Outer dia of hub , mm
- b_h=Width of hub ,mm
- d_{hf}=diameter of hub flange , mm
- L_H= length of hub, mm
- F_{ahf}=Axial force for hub flange , N

- t_{hf}=thickness of hub flange, mm
- P_{CDfr}=Pitch circle diameter of flange rivet , mm

HUB FLANGE RIVET

- T_{fr}=Shear stress for hub material , N/mm^2
- n_r=no of rivets
- F_{hfr}=shear force for hub flange rivet ,mm
- d_{frh}=Head diameter of flange rivet, mm
- t_{frh}=Thickness of head flange rivet, mm
- l_r=Standard length of rivet, mm

FRICTION LINING

- r_{mfl}=Mean radius of friction lining
- b_{fl}=Face width of friction lining
- A_{ff}=Area of friction faces
- W_a=Axial force acting on the friction faces
- P_l=Intensity of pressure
- μ=Coefficient of friction
- n_{fs}=no of friction surfaces
- t_{fl}=Thickness of friction liner

CLUTCH PLATE

- r_1=Outer radius of clutch plate
- r_2=Inner radius of clutch plate
- r_{mfl}=mean radius of clutch plate
- d_1=Outer dia of clutch plate
- d_2=Inner dia of clutch plate

- t_{cp}=Thickness of clutch plate

SPRING

- D_m=Mean dia. of spring
- d_{sw}=Dia. of spring wire
- W_{tas}=Total load on spring
- n_s=No of springs required for axial load
- W_s=Max. Load on spring
- K=Wahl's stress factor
- C=spring index
- T_s=Allowable shear stress for the spring wire
- n_a=No of active turns to the spring
- G=Modulus of rigidity
- Δ=Deflection/Compression of spring
- n_f=Total No. of turns
- L_f=free length of spring
- p_{sc}=pitch of spring coil
- d_{is}=Inside dia. of spring

BRASS-BUSH

- L_B=length of bush
- D=Outer dia. of spline shaft
- D_b=Outer dia. of brass bush

STUD & NUT

- l_{st}=length of stud

- D_{st}=dia. of stud
- P_{st}=Pitch of stud ,mm

PRESSURE PLATE

- t_{pp}=Thickness of pressure plate
- d_{opp}=Outer dia. of pressure plate

ENGAGEMENT AND DISENGAGEMENT SLEEVE

- t_{es}=Thickness of engagement sleeve
- t_{ds}=Thickness of disengagement sleeve
- b_{ls}=width of lever slot
- d_{oes}=Outer dia. of engagement sleeve
- d_{ds}=Inner dia. of disengagement sleeve
- d_{is}=Inner dia. of sleeve

FLYWHEEL

- t_f=Thickness of flywheel
- d_{of}=Outer dia. of flywheel
- d_{inf}=Intermediate dia. of flywheel
- d_{if}=Inner dia. of flywheel
- t_{fb}=Thickness of flywheel near bearing
- t_{gf}=groove depth inside flywheel

DRIVING SHAFT FLANGE

- D_{ds}=driving shaft dia.(D_{ds}=D)
- t_{dsf}=Thickness of driving shaft flange
- d_{gsdf}=dia. of groove inside driving shaft
- t_{gsdf}=linear depth of groove inside driving shaft flange
- θ_c=Angle of cone inside driving shaft flange

BOLTS FOR DRIVING SHAFT FLANGE

- n_b=No of bolts required
- d_b=dia. of bolt
- d_{PCDb}=pitch circle dia. of bolt
- T_{max}=max torque transmitted
- T_b=Allowable shear strength for bolt

NUT FOR BOLT OF DRIVING SHAFT FLANGE

- d_n=dia of nut

BEARING

- d_{ob}=Outer dia. of bearing
- D^*=Diameter(Reference)
- B=width of bearing
- r^*=radius(reference)

- r_1^*=radius(reference)

(1) DESIGN OF SPLINE SHAFT AND HUB

Power P=7kW=7000W

Speed N=1400rpm

Spline Shaft Material =C15Mn75 (IS 6967) Steel

Yield Shear Strength of IS 6967, τ_y=190N/mm^2

Assuming Factor of Safety =3.0 and

Approximate value of stress concentration factor =2

No. of Splines	Width (b)	Height , h		
		Fitting A	Fitting B	Fitting C
4	0.241D	0.075D	0.125D	-
6	0.25D	0.05D	0.075D	0.1D
10	0.15D	0.045D	0.07D	0.095D
16	0.098D	0.045D	0.07D	0.095D

According to BIS splines are specified by four characters

nk x d x D (IS: 2327-1963)

Where

n=no of splines

k=type of fit

=A for permanent fit, P=21 N/mm^2

=B for hub which is to slide when not under load P=14N/mm^2

=C for hub which is to slide when not under load P=7N/mm^2

Let

d is minor diameter of the spline shaft

D is major diameter of the spline shaft

The allowable shear strength $T_a = \frac{\tau_y}{FOS*K_{ts}} = \frac{190}{3*2} = 31.667$N/mm^2

Average torque transmitted T= $\frac{60P}{2\pi N} = \frac{60*7*10^3}{2\pi 1400} = 47.770Nm$

Let us assume a shaft having 6 splines with class C fitting (where the hub can slide under the load). The permissible bearing pressure is 7N/mm^2.The standard proportions of splines are

Width b=0.25D

Height h=0.1D

The torque transmitting capacity of the hub is given by following relation

$$\boxed{T = \frac{1}{2} phln(D - h)}$$

Where n=no of splines

And assuming length of hub l=1.5D

So $47.770 * 10^3 = \frac{1}{2} * 7 * 0.1D * 1.5D * 6 * (D - 0.1D)$

D=25.62 mm

Standard Major Diameter of shaft,

Now $\boxed{D=28mm}$ (As per design data book)

Minor diameter of shaft

d= (D-2 $\frac{D}{10}$)=28-2x$\frac{28}{10}$ =22.4mm

Standard Minor diameter of shaft

$\boxed{d=23mm}$ (As per design data book)

Height, h=0.1D=0.1x28 h=2.8mm

Width of spline (key) b=$\frac{D}{4} = \frac{28}{4} = 7mm$

$\boxed{b=6mm}$ (As per design data book)

Length of spline L=1.5D

=1.5*28=42mm

Now checking for the shear failure of the shaft

$T = \frac{\pi}{16} d^3 \tau_y$=$16 * 47.77 * \frac{10^3}{\pi * 23^3}$

$$= 20.00 \ \frac{N}{mm^2}$$

Here,

$\boxed{\mathbf{20.00\ N/mm^2 < 31.667 N/mm^2}}$

- The value of the induced shear stress is less than the allowable shear Strength; hence the shaft is **safe in shear.**

- Now, Shear stress in Splines:-
  - Shear force,

$F = \frac{2T}{d}$

$= 2 * 47.770 * \frac{10^3}{23}$

$=4153.91$ N

Induced Shear stress in Splines,

$$\tau = \frac{F}{bln}$$

$$= \frac{4153.91}{6*42*6}$$

$= 2.747 \mathbf{N/mm^2}$

Here,

$\boxed{\mathbf{2.747\ N/mm^2 < 31.6 N/mm^2}}$

Which is also within the allowable limit.Hence**, the design is safe.**

- **Design specification of the spline: 6C x 23 x 28**

- Outer diameter of hub(d_{ho}) =1.75D

  =1.75*28=49 mm

- Width of hub (b_h)= 1.25D

  =1.25x28

  =35 mm

- Diameter of hub flange (d_{hf})=3D

  =3x28 =84mm

- Axial force for hub flange $F_{dhf} = 2d_{ho}*P*(\frac{d_{hf}-d_{ho}}{2})$

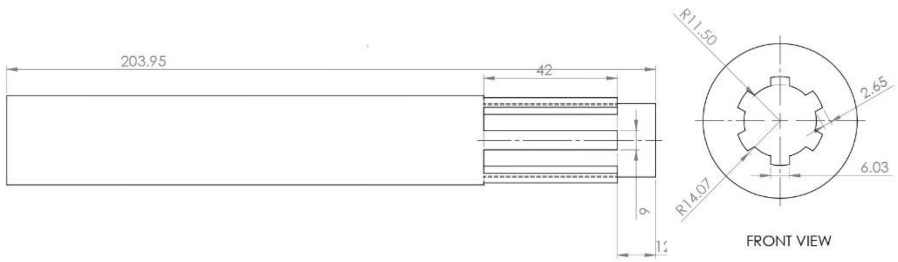
$=2*49*7*\frac{84-49}{2}$

$=12005$ N

- Pitch circle diameter of flange $P_{cdfr}= (\frac{d_{hf}-d_{ho}}{2}) + d_{ho}$

$= \frac{84-49}{2} + 49$

$P_{cdfr} = 66.5$ mm



(2) RIVET

- Material: Low Carbon Steel
- Shear stress $\tau_{th} = 42\ N/mm^2$
- No of rivets = 4
- Shear force for hub flange rivet

$$F_{hfr}= \frac{2T}{P_{CDfr}} = \frac{2*47.77*1000}{66.5}$$

$=1436.69$ N

- Also , shear force for hub flange rivet

$F_{hfr}=n_f \times \frac{\pi}{4} \times d_{fr}^2 \times \tau_{fr}$

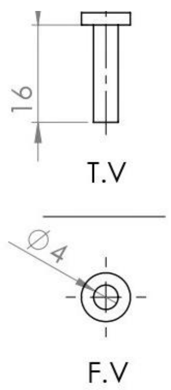
$1436.69 = 4 \times (3.14/4) \times d_{fr}^2 \times 42$

$d_{fr}=3.30$ mm

d_{fr}~4 mm

- Head diameter of flange rivet d_{hfr}=2 x d_{fr}
  = 2 x 4
  = 8 mm

- Thickness of head of flange of rivet $t_{hfr}=\frac{d_{fr}}{2}=\frac{4}{2}=2\ mm$
- Standard length of rivet =20 mm



(3) Mean radius and face width of the friction lining

Let, $r_{m_{fl}}$ = Mean radius of the friction lining

b_{fl} = Face width of the friction lining

$= \frac{r_{m_{fl}}}{4}$

- We know that the area of the friction faces,

  $A_{ff} = 2\,\pi r_{m_{fl}} \cdot b_{fl}$

- Normal or the axial force acting on the friction lining.

  $W_a = A_{ff} \times P_i$

$= 2\,\pi r_{m_{fl}} \cdot b_{fl} \cdot P_i$

And torque transmitted,

$$T = \mu W_a r_{m_{fl}} \cdot n_{fs}$$

$$= \mu \, (2\, r_{m_{fl}} \cdot b_{fl} \cdot P_i\,) r_{m_{fl}} \cdot n_{fs}$$

Here, $b_{fl} = \frac{r_{m_{fl}}}{4}$, n_{fs} = no. of friction lining = 2

$$\boxed{\mathbf{T = \frac{\pi}{2} \cdot \mu \cdot r_{mfl}^3 \cdot P_i \cdot n_{fs}}}$$

- The intensity of pressure (P_i) as 0.06N/mm^2 and Co-efficient of friction (μ) as 0.15, we have

$$\therefore 47.77 * 10^3 \ * 2 = \ 3.14 * 0.15 * r_{mf1}^3 * 0.06 * 2$$

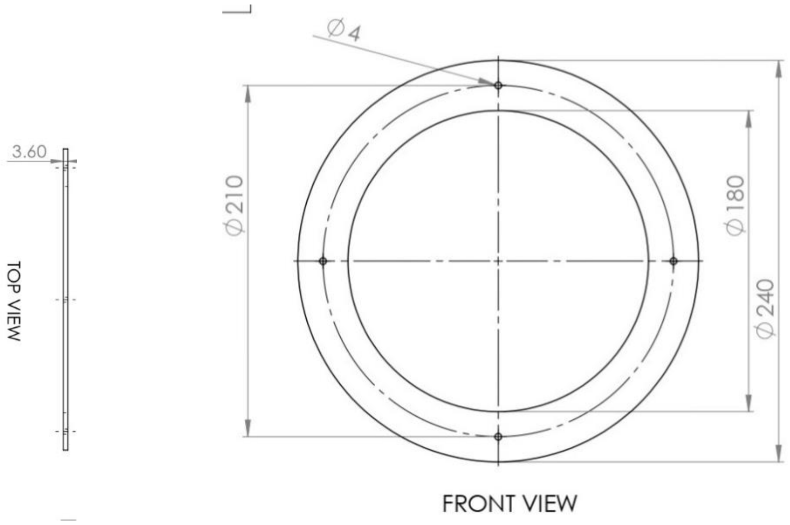
$$r_{mf1} = 118.55\, mm$$

$$= 120\, mm(approx)$$

$$\boxed{\mathbf{r_{m_{fl}} \cong 120mm}}$$

And, $b_{fl} = \frac{r_{m_{fl}}}{4} = \frac{120}{4}$

$$\boxed{\mathbf{b_{fl} = 30\ mm}}$$



(4) Outer and Inner radii of clutch Plate

Let,
r_1 and r_2 = Outer and inner radii of the clutch plate respectively.

- Since the face width (or radial width) of the plate is equal to the difference of the Outer and inner radii, therefore

  $b_{fl} = r_1 - r_2$

  OR

  $\boldsymbol{r_1 - r_2 = 30}$ **………… (1)**

- We know that for uniform Wear, mean radius of the clutch plate,

$$r_{m_{fl}} = \frac{r_1 + r_2}{2}$$

OR

$r_1 + r_2 = 2\, r_{m_{fl}}$

$= 2 \times 120$

$\boldsymbol{r_1 + r_2 = 240}$ **…………… (2)**

- By solving eq^n (1) and (2) we get,

$\boldsymbol{r_1}$ **= 140 mm** $\boldsymbol{d_1}$ **= 280 mm**
$\boldsymbol{r_2}$ **= 105 mm** $\boldsymbol{d_2}$ **= 210 mm**

Preferred outside diameter (mm): 120,125,130,135,140,145,150,155,160,170,180,190, 200,210,220,230,240,250,260,270,280,290,300,325 and 350
Preferred inside diameter (mm): 80,85,90,95,100,105,110,120,130,140,150,175, and 200
Preferred thickness (mm): 3, 3.5 and 4
Rivet holding land: Net less than 1.45 mm and greater than half the thickness of facing.

(Table-2.Preferred dimensions for clutch facings for an automotive transmission.)

- Standardize the Outer and inner dia. Of the clutch plate. (Ref. Table (2))

$\boldsymbol{r_1}$ **= 142.5 mm** $\boldsymbol{d_1}$ **= 285mm**	$\boldsymbol{r_2}$ **= 100 mm** $\boldsymbol{d_2}$ **= 200 mm**

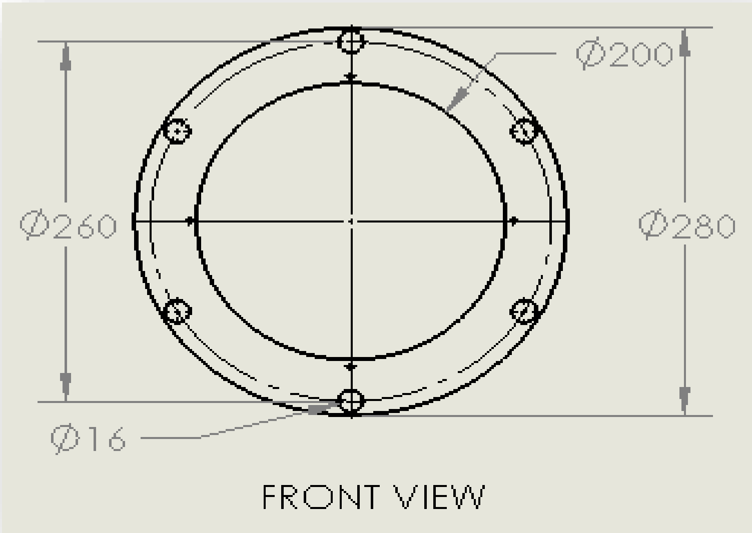
- Thickness of the clutch plate (Ref. Table(2))

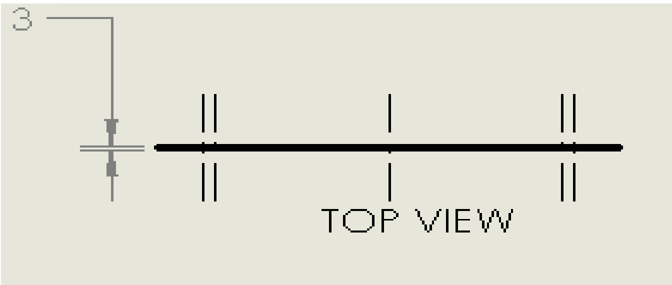
$\boldsymbol{t_{cp}}$ **= 3 mm**

- Thickness of friction lines,

t_{fl} = 1.2 t_{cp}
= 1.2×3
= 3.6mm

$\boldsymbol{t_{fl}}$**=3.6mm**





(5) Dimensions of Spring

Let, D_m = Mean diameter of the spring.
d_{sw} = Diameter of the spring Wire.

- Spring material : Spring Steel(Stainless Steel)

- We know that the axial force on the friction faces,

$W_a = 2\,\pi r_{m_{fl}} \cdot b_{fl} \cdot P_i$
$= 2\pi*120*30*0.06$
$\boldsymbol{W_a}$ **= 1356.48 N**

In Order to allow for adjustment and for maximum engine torque the spring is designed for an overload of 30%.

∴ Total load on the springs,

W_{tas} = 1.3W_a

= 1.3×1356.48

= 1763.424 N

$\boldsymbol{W_{tas}}$ **≅1770 N**

- No. of spring req. for given axial load**,**

n_s = 0.04D + 5

= 0.04× 28 + 5

= 6.12

$\boxed{\boldsymbol{n_s \cong 6}}$

- Since there are 6 Spring, therefore Max. load on each spring,

$W_s = \frac{W_{tas}}{n_s} = \frac{1770}{6}$

$\boxed{\boldsymbol{W_s} = \textbf{295 N}}$

- We know that Wahl's Stress factor,

$$\mathbf{k} = \frac{\mathbf{4c-1}}{\mathbf{4c-4}} + \frac{\mathbf{0.615}}{\mathbf{c}}$$

where c = spring index = 6 (given)

$$k = \frac{4\times6-1}{4\times6-4} + \frac{0.615}{6}$$

k = 1.2525

- We also know that maximum Shear Stress induced in the wire. (τ_s).

Let, τ_s = allowable shear stress for the spring wire

τ_s =437.5N/mm^2

$\tau_s \quad = \text{k} \times \frac{8W_s c}{\pi \times (d_{sw})^2}$

$$\therefore 437.5 = (1.2525 * 8 * 295 * 6)/(\pi * d_{sw}^2)$$

$$\boxed{\boldsymbol{d_{sw}} = \mathbf{3.5930\ mm}}$$

We shall take a standard wire of size SWG9 diameter

$$\therefore \boldsymbol{d_{sw} \cong 3.658mm}$$

And mean diameter of the spring.

D_m = C· d_{sw}

= 6 ×3.658

= 21.948mm

$\boldsymbol{D_m}$**= 22 mm**

- Deflection of spring is limited to 6.03 mm. (given)

∴ Let, n_a = no. of active turns of the spring.

G = 84× 10^3N/mm^2(given)

∴Deflection of the spring or compression of the spring,

$\delta = \frac{8W_s c^3 n_a}{G \cdot d_{sw}}$

$$\therefore 6.03 = \frac{(8 * 295 * 6^3 * n_a)}{84 * 10^3 * 3.658}$$
$$= 3.634$$

$n_a \cong 4$

- No. of active turn of spring

$$\boxed{\boldsymbol{n_a} \cong \mathbf{4}}$$

- Assuming squared and ground ends,

  Total No. of turns, $n_t = n_a + 2$

  $n_t = 4 + 2$ $\boxed{\boldsymbol{n_t} \mathbf{= 6}}$

- Free length of the spring,

  $L_f = n_t \cdot d_{sw} + \delta + 0.15\,\delta$

  $= (6\times3.658) + 6.03+(0.15\times6.03)$

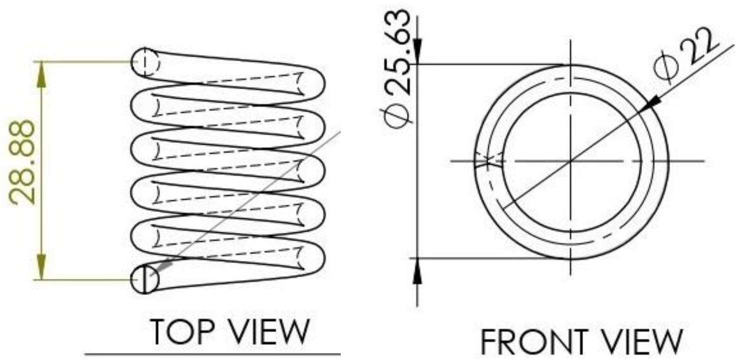
$$\boxed{\boldsymbol{L_f} \mathbf{= 28.88mm \cong 28.88mm}}$$

- Pitch of the spring coils,

$p_{sc} = \frac{L_f}{n_t - 1}$

$$= \frac{28.88}{5}$$

$$\boxed{\boldsymbol{p_{sc}} \mathbf{= 5.776\ mm \cong 5.776mm}}$$



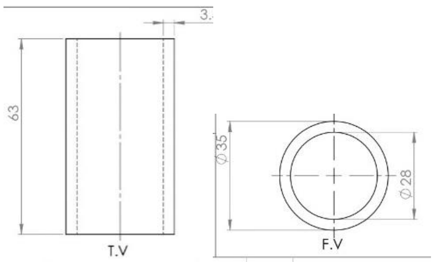
(6) Brass-Bush for spline shaft

Let, l_b = length of bush

D = Outer diameter of spline shaft.

- Outer diameter of brass bush,
  d_b =1.25 D = 1.25 ×28
  d_b =35 mm

  - Length of brass- bush
  l_b = 2.25 D = 2.25×28
  l_b = 63 mm



(7) Stud & Nut

Stud & Nut material :- Mild Steel (M.S)

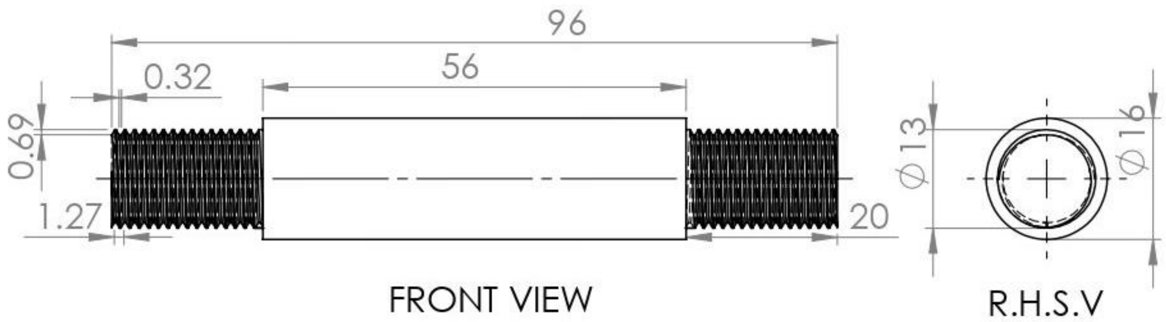
Inside diameter of spring $d_{is}=D_m - d_{sw}$
=22-3.658 =18.342 mm

Based on inside diameter of spring, selected size of stud is

M16 x 10 mm

Calculated length of stud= 95 mm

Selected length of stud = 96 mm



(8) Pressure Plate

- Angle of pressure plate support with horizontal = 45°

- Thickness of pressure plate,

t_{pp} = 1.5 × t_{cp}

= 1.5 ×3

t_{pp} = 4.5 mm

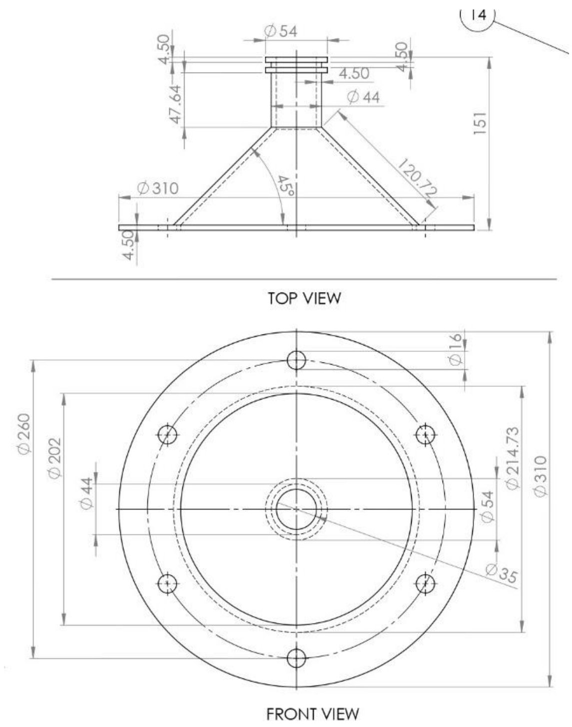
- Outer dia. Of pressure plate ($d_{o_{pp}}$):-

$d_{o_{pp}}$ = 1.15 d_1

= 1.15 ×270

∴ $d_{o_{pp}}$ = 310.5 mm

$$\boxed{\boldsymbol{d_{o_{pp}}} \cong \textbf{230 mm}}$$



(9) Engagement & Disengagement Sleeve

- Thickness of Engagement sleeve,

t_{es} = 1.5 t_{pp}

= 1.5 ×4.5

$\boldsymbol{t_{es}}$ **= 6.75 mm**

- Thickness of disengagement sleeve,

$\boldsymbol{t_{ds}}$**=** $\boldsymbol{t_{es}}$ **= 6.75 mm**

- Width of lever slot,

b_{ls} = $2t_{pp}$ = 2×4.5

$\boldsymbol{b_{ls}}$ **= 9 mm**

- Outer dia. Of engagement sleeve,

$d_{o_{es}}$ = 2.5D

= 2.5 ×28

$\boldsymbol{d_{o_{es}}}$ **= 70 mm**

- Outer dia. Of disengagement sleeve,

$$\boxed{\boldsymbol{d_{o_{es}}} = \boldsymbol{d_{ds}} = \textbf{70 mm}}$$

- Inner dia. Of sleeve,

d_{is}= 1.75D

= 1.75 ×28

$$\boxed{\boldsymbol{d_{is}} = \textbf{49 mm}}$$

(10) Flywheel

- Thickness of flywheel.

t_f = 0.5D

= 0.5 × 28

$$\boxed{\boldsymbol{t_f} = \textbf{14 mm}}$$

- Outer dia. Of flywheel,

d_{of} = 1.15 d_1

= 1.15 ×270

= 310.5 mm

$$\boxed{\boldsymbol{d_{of}} \cong \textbf{310 mm}}$$

- Intermediate dia. Of flywheel,

$d_{i_{nf}}$ = 0.75 d_1

= 0.75 ×270

$$\boxed{\boldsymbol{d_{i_{nf}}} = \textbf{202.5 mm}}$$

- Inner dia. Of flywheel(∴based on bearing outer dia.d_{ob} = d_{i_f} = 42 mm)

$$\boxed{\boldsymbol{d_{i_{nf}}} = \textbf{42 mm}}$$

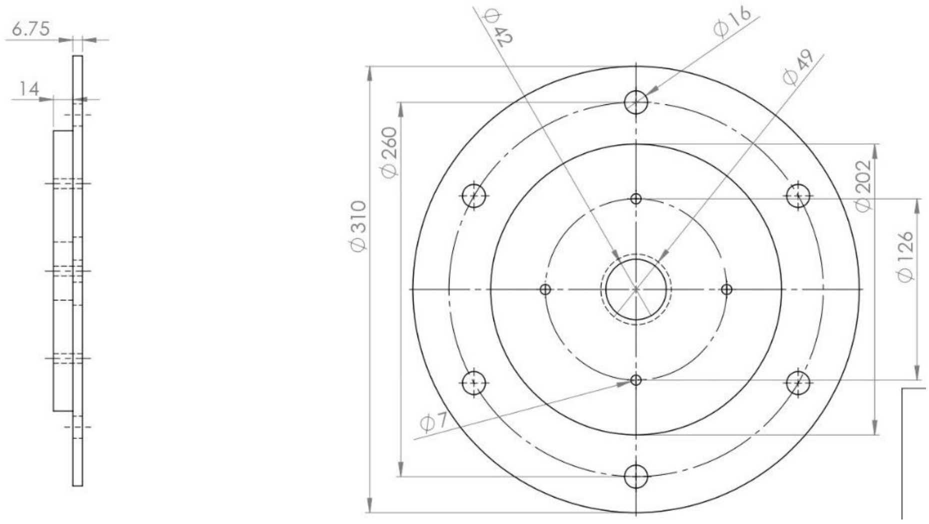
➢ Thickness of flywheel near bearing,

$\boxed{t_{fb} = \text{B} = 14 \text{ mm}}$ where, B = bearing width

Bearing No: SKF 6004 (Given)
(Ref. DDB Pg. no. 4.12)

➢ Groove depth inside flywheel approximate,

$\boxed{t_{gf} = 0.5 \text{ mm}}$



(11) Driving Shaft Flange

Now,

➢ Driving shaft dia.

$\boxed{D_{ds} = \text{D} = 28 \text{ mm}}$

- Thickness of driving shaft flange,

$$\boxed{t_{dsf} = t_f = \textbf{14 mm}}$$

- Outer dia. Of driving shaft flange ,

D_{ods} = 7.5 D_{ds}

= 7.5×28

$$\boxed{D_{ods} = \textbf{210 mm}}$$

- Dia. Of groove inside during shaft flange:

d_{gdsf} = 1.25 D_{ds}

= 1.25×28

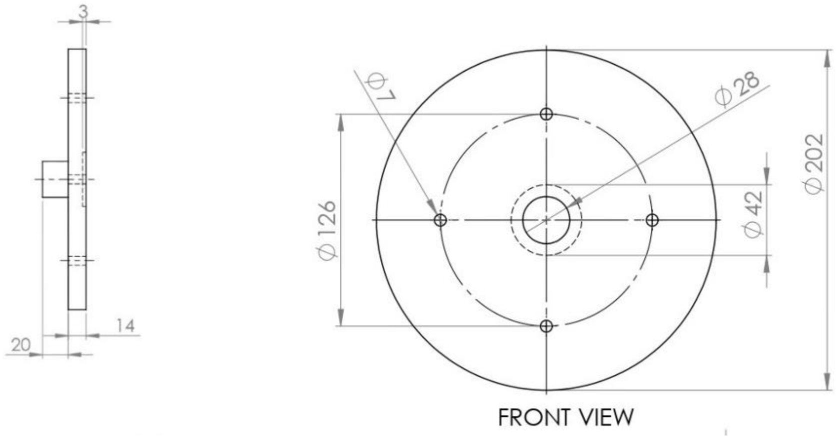
$$\boxed{d_{gdsf} = \textbf{35 mm}}$$

- Linear depth of groove inside driving shaft flange,

t_{gdsf} = **3** mm (Approx.)

- Angle of cone inside driving shaft flange,

$$\boxed{\theta_s = \textbf{45}°}$$



(12) Bolts for driving shaft flange

- No. of bolts required,

$$n_b = \frac{D_{ds}}{50} + 3$$
$$= \frac{38}{50} + 3$$
$$= 3.56$$

$$\boxed{\boldsymbol{n_b} = \mathbf{4}}$$

- Dia. Of bolt,

$$d_b = \frac{0.5\,D_{ds}}{\sqrt{n_b}}$$
$$= \frac{0.5*28}{2}$$
$$= 7\text{ mm}$$

$$\boxed{\boldsymbol{d_b} = \mathbf{8\ mm}}$$ (std. dia. Of bolt)

- Pitch circle dia. Of bolt,

$d_{PCD_b} = 4.5\ D_{ds}$

$= 4.5 \times 28$

$$\boxed{\boldsymbol{d_{PCD_b}} = \mathbf{126\ mm}}$$

- We know that average torque transmitted,

$$T = 47.77 \times 10^3 \text{N.mm}$$

∴For safer design the max. torque transmitted is 25% more than average torque transmitted,

T_{max} = 1.25×T = 1.25 ×47.77 x10^3
T_{max} = 59.68 x10^3N. mm

- Material of bolt : M.S (Given)
  - The allowable shear strength for bolt is 40 N/mm^2

    ∴ $\tau_{b_{all}}$= 40 N/mm^2

- Checking of bolt for shear stress.

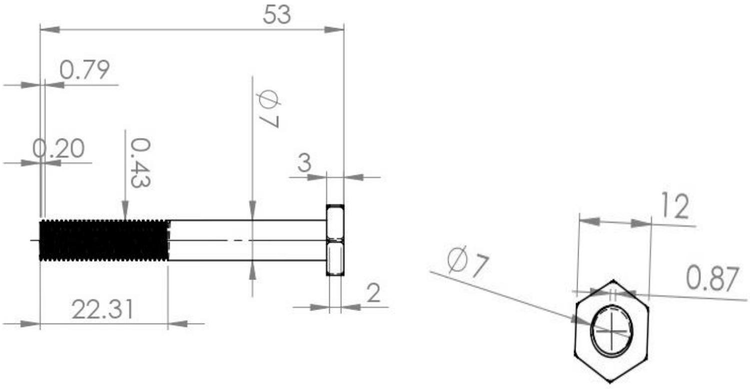
  ∴ $T_{max} = n_b \times \frac{\pi}{4} \times d_b^2 \cdot \tau_b \cdot \frac{d_{PCD_b}}{2}$

$$59.68 * 10^3 = 4 * \frac{\pi}{4} * 8^2 * \tau_b * \frac{126}{2}$$

∴ τ_b = 2.70 N/mm^2

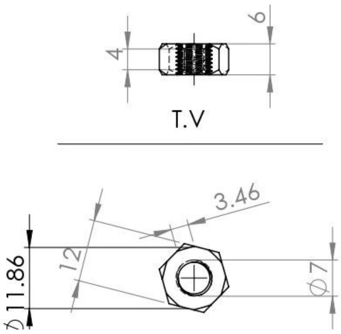
- **τ_b = 2.70N/mm^2<$\tau_{b_{all}}$ = 40 N/mm^2**

∴The design is safe for bolt in shear.



(`13) Nut for bolt of Driving Shaft Flange

Selected nut : M16



14 Bearing

- **Selected bearing: SKF 6004 (From DDB1: - Deep groove ball bearing)**

- Diameter of spline shaft, D = 28 mm
- Diameter of spline shaft for bearing seating, D_{ss_b} = 23 mm
- Outer dia. Of bearing d_{ob} = 42 mm
- Diameter, D^* = 36 mm
- Width of bearing, B = 12 mm
- Radius, r^* = 1 mm
- Radius, r_1^* = 0.6 mm
- Total length of spline shaft L=150 mm
- Deep groove ball bearing is selected because there are max no of ball fitted in the race. Therefore, the load carrying capacity and running speed is increase.
- The load carrying capacity is depend on ball size and no of ball
- SKF is a group of US bearing maker.