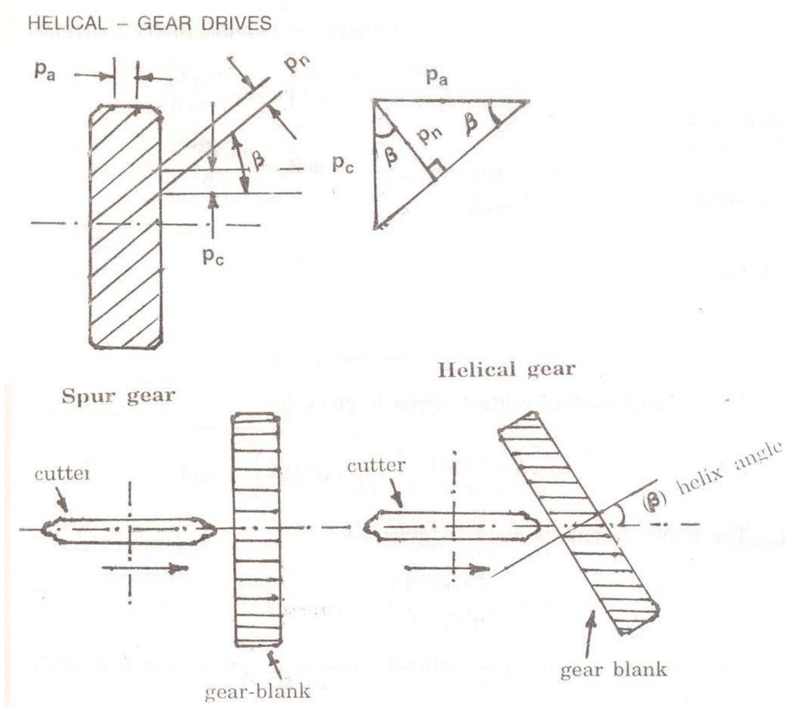
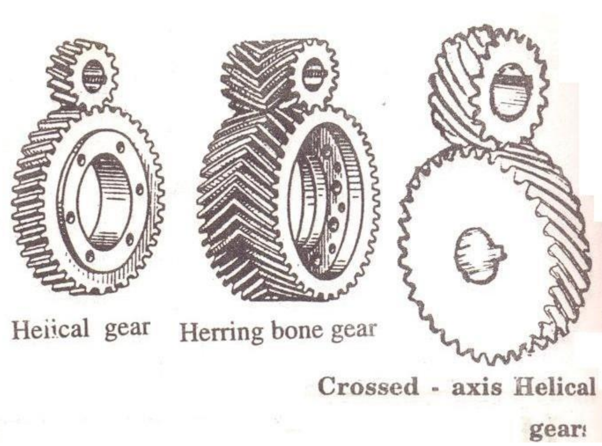
2.7 HELICAL GEAR DRIVES

Helical gears are the developed form of spur gears. In which all the teeth are cut at a constant angle known as helix angle to the axis of the gear, whereas in spur gear, teeth cut are parallel to the axis. Because of the inclined structure of the teeth more than one pair of the teeth will be in engagement and hence operation may be smooth due to their gradual contact and more power can be transmitted at higher speeds than spur gear drive.





DESIGN PROCEDURE

STEP-1

From the given problem find the amount of power to be transmitted, pinion speed, gear ratio, life of gear drive and determine their design stresses and young's modulus.

STEP-2

Calculate minimum centre distance **(PSG 8.13)**

STEP-3

Calculate the minimum normal module **(PSG 8.13a)**

$\geq 1.15o\beta^{3} \sqrt{\frac{[\ \ ]}{[\ _1]}}\psi_m$ from **(PSG 8.14)**

Select next nearest standard module **(PSG 8.2)**

STEP-4

Correct the number of teeth of pinion **(PSG 8.22)**

STEP-5

Determine the pitch circle diameters **(PSG 8.22)**

STEP-6

Decide the corrected centre distance

STEP-7

Determine the face width of gear teeth

$b = \psi.a$ or $b = \psi_{m.}m$

STEP-8

Correct the load correction factor and dynamic factor.

STEP-9

Check the induced stresses.

STEP-10

Find out the essential parameters of gear drive.

Example.Design a pair of helical gears to transmit 10 kW at 1000 rpm .The pinion reduction ratio of 5 is required.

Given

Power P =10 kW

Pinion speed n_1 = 1000 rpm

Speed ratio i = 5

Gear speed n_2 = 1000 / 5 = 200 rpm

Helix angle = 15 ° (assumed)

STEP-1

Select the material for pinion and gear as 40Ni2Cr1Mo28 steel **(PSG 8.5)**

$[\sigma_c]$ = 11000 kgf/cm^2

$[\sigma_b]$ = 400 kgf/cm^2

E = 2.15x 10^6 kgf/cm^2

I = 5

Ψ = b/a = 0.5 **(PSG 8.14)**

STEP-2

Minimum centre distance $\geq (+1)\sqrt[3]{\left(\frac{0.7}{[\ \ ]}\right)^2 \frac{[\ \ ]}{}}$ **(PSG 8.15)**

$[M_t] = M_t.k.k_d$ = 97420 x $\frac{10}{1000}$ x 1.3 = 1266.46 kgf-cm

$$\geq (5+1)\sqrt[3]{\left(\frac{0.7}{[11000]}\right)^2 \frac{2.15 10^6 1266}{50.5}} \geq 9.84 \text{ cm}$$

STEP-3

Minimum module $m_n \geq 1.15\cos\beta$ x $\sqrt{\frac{[\ \ ]}{[\ \ ]^1}}$ **(PSG 8.13)**

Let z_1 =20 ψ_m = b/m = 10

$Z_v = z_1/\cos^2\beta$ = 20 / $\cos^2 15$ = 22.2 **(PSG 8.22)**

y_v = 0.402 for z_v=22 **(PSG 8.18)**

$m_n \geq 1.15\cos 15 \times \sqrt{\frac{1266}{0.40240001020}} \geq 0.175$cm = 1.75 mm

m_n=2mm = 0.2 cm

Next standard module m_n=2 mm =0.2 cm

STEP-4

Number of teeth corrected **(PSG 8.22)**

Number of teeth of pinion $z_1 = \frac{2o\beta}{(+1)} = \frac{29.84o15}{0.2(5+1)}$ = 15.84 = 16

$z_2 = i \times z_1$ = 5 x 16 = 80

STEP-5

Pitch circle diameters

Pitch circle diameter of pinion $d_1 = \frac{}{o\beta}1$ = 02x16/cos15 = 3.3 cm **(PSG 8.22)**

$d_2 = i \times d_1$ =5x3.3 = 16.5 cm

STEP-6

Corrected centre distance

$a = \frac{3.3+16.5}{2}$ = 19.8 / 2 = 9.9cm

STEP-7

Face width b = 0.5x9.84 = 4.95 mm.

STEP-8

Checking the induced stresses

Surface compressive stress

$$= 0.7\sqrt{\frac{(\ +1)}{\ }\ [\ \ ]}$$

$$= 0.7\sqrt{\frac{(5+1)}{55}2.1510^{6}1266} = 10843 < [\sigma_c] = 11000 kgf/cm^2$$ **(PSG 8.13)**

So our design is safe

Bending stress $= \frac{0.7(+1)}{...}[\ ]$

$$= \frac{0.7(5+1)1266}{9.950.20.402} = 1336\ kgf/cm^2 < [\sigma_b] = 4000\ kgf/cm^2$$

So our design is safe

STEP-9

Other parameters

Addendum = m_n = 2 mm

Dedendum = 1.25 x m_n =1.25 x 2 =2.5 mm

Tip circle diameter of pinion = d_1+2xaddemdum = 33 + (2x2) = 37 mm

Tip circle diameter of gear = d_2+2xaddemdum = 165 + (2x2) =169 mm

Root circle diameter of pinion = d_1-(2xdedemdum) = 33 – 2x2.5 = 28 mm

Root circle diameter of gear = d_2-(2xdedemdum) = 165 – 2x2.5 =160 mm

Ex.Design a helical gear drive to transmit the power of 20 h.p. speed ratio 6, pinion speed 1200 rpm, helix angle is 25°.Select suitable materials and design the gear.

<u>PROBLEMS FROM ANNA UNIVERSITY EXAMS</u>

A pair of helical gears subjected to moderate shock loading is to transmit 37.8kW at 1750r.p.m of the pinion.The speed reduction ratio is 4.25 and the helix angle is 15^0.The service is continuous and the teeth are 20^0FD in the normal plane.Design the gears,assuming a life of 10,000 hours.[April/may2010]

Design a pair of helical gear to transmit 30 kW power at a speed reduction ratio of 4:1.The input shaft rotates at 2000 rpm. Take helix and pressure angles equal to 25^0 and 20^0 respectively. The number of teeth on the pinion may be taken as 30. [April/may2010]