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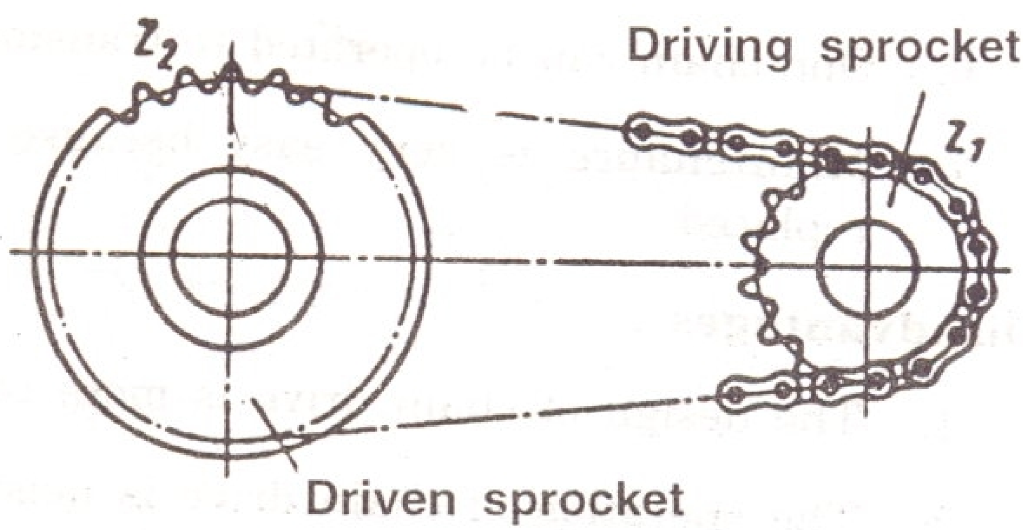
1.15 CHAIN DRIVES

A chain drive is a mechanical device which belongs to the category of drives with intermediate link is obtained by chains. It may also be considered to be intermediate between belt and gear drives, in that it has features in common with both.

Chains are suitable for long as well as short centre distance drives and give a more compact drive than is possible with belt.



APPLICATION

Modern chain drives are employed in these places where we require velocity ratios upto 10, chainvelocities upto 20 m/s and power ratios upto 150 kN.

Chain drives are quite extensively used in transportation machineries like motor cycles, bicycles, automobiles and conveyors. And technological machines like agricultural machinery, oil well drilling rigs, machine tools.

ADVANTAGES

1. The chain drives are having more power transmitting capacities compared with belt drives when the centre distance between the shafts is large(i.e.5 to 8 meters).
2. Their efficiency if higher (85 %)
3. Their small size compared with V-belt for particular power transmission provides a compact set up.

4. The chain drives exert less load on the shaft since no initial tension is required as compared with belt drives.
5. They can be operated for wide range of centre distances of power transmitting sprockets.
6. One chain can be operated to transmit power to several numbers of sprockets.
7. Maintenance is very easy because the chains can easily be repaired or replaced.

DISADVANTAGES

1. Design of chain drive is more complicated.
2. The operation of chain drive is noisy.
3. Their production cost is high.
4. They need carful maintenance by providing housing to the chains to save them from dirst.
5. They require more accurate assembly of shafts than belt drives.

CLASSIFICATION

1. POWER TRANSMITTING CHAINS
   Treated fortransmitting mechanical energy from one shaft to another.
2. HAULING CHAINS
   Used for carrying loads in conveying machinery.
3. LOADING OF LIFTING CHAINS
   Served for suspending, hoisting and lowering loads, mainly in material handling machineries.

CLASSIFICATION OF POWER TRANSMITTING CHAINS

a. BASED ON THE TYPES OF CHAINS EMPLOYED
   1. Roller chain
   2. Bush chain
   3. Silent chain
b. BASED ON THE NO OF CHAINS REQUIRED
   1. Single row chain
   2. Multi row chain
c. BASED ON THE NO OF DRIVEN SPROCKETS
   1. Normal type drive (i.e. one driven sprocket)
   2. Special type drive(i.e. several driven sprocket)

DESIGN PROCEDURE

STEP 1

Depending upon the amount of power to be transmitted and other working conditions such as available space, chain speed, position of chain drive etc. select the type of chain like bush or roller chain.

STEP2

Assuming centre distance between the sprockets in terms of pitches (usually from 30 to 50 p), determine the pitch of the chain and adopt its standard value. **(PSG 7.74)**

STEP3

Calculate the developed load for breaking the chain using the expression

$$Q = \frac{P.K_S.n'}{V}$$ **(PSG 7.77)**

v= chain velocity in m/s = $\frac{Z_1 n_1 p}{60x1000}$ or $\frac{Z_2 n_2 p}{60x1000}$

z_1 ,z_2= No of teeth of sprocket pinion and sprocket wheel.

STEP4

For the determined pitch, choose a suitable chain drive ,whichshould have more breaking

(i.e resisting) strength than the above calculated breaking load.

STEP5

Find out the actual factor of safety for this selected chain using

$$\sum P = P_t+P_c+P_s$$ **(PSG 7.78)**

$$[n]=Q/\sum P$$

This actual factor of safety is checked with the adapted value.

STEP6

Determine the induced stress over the projected area of chain using

$$\sigma = PK_s/Axv \quad N/mm^2$$ **(PSG 7.77)**

Check this allowable stress with induced stress.

STEP7

Find the length of chain **(PSG 7.75)**

STEP8

Evaluate the pitch diameter of pinion sprocket (d_1) and wheel sprocket (d_2)**(PSG 7.78)**

Example.1.6. Design a chain drive to actuate a compressor from 10 kW electric motor at 960 rpm. The compressor speed is to be 350rpm. Minimum centre distance should be 0.5 m. motor is mounted on an auxiliary bed. Compressor is to work for 8 hours/day.

Given:

Power to be transmitted P=10Kw

Motor speed n_1=960rpm

Compressor speed n_2=350rpm

Minimum centre distance a=0.5 m = 500 mm

Service = 8 hours/day

STEP -1-SELECTION OF CHAIN

Let us select roller chain.

STEP-2-DETERMINE THE PITCH

Assuming a=35p where p=Pitch of chain

p = a/35 =500/35 = 14.3 mm

Next standard value p = 15.875 mm **(PSG 7.72)**

Transmission ratio $i = \frac{n_1}{n_2} = \frac{960}{350} = 2.74$

For i = 2.74 ,

The number teeth on pinion sprocket z_1=25 **(PSG 7.74)**

The number of teeth on wheel sprocket z_2=i x z_1 = 2.74 x 25 = 69

STEP-3-BREAKING LOAD

$Q = \frac{P.K_S.n'}{V}$ **(PSG 7.77)**

P=Power = 10kW = 10,000 W

Q=Minimum breaking load in N

v = Chain velocity in m/s

n' = Factor safety to be assumed

K_s= Service factor

$K_s=K_1 \times K_2 \times K_3 \times K_4 \times K_5 \times K_6$ **(PSG 7.77)**

K_1=1.5 (Load with heavy shock) **(PSG 7.76)**

K_2=1(Adjustable supports)

K_3 = 1 (a_p=30 to 50 p)

K_4= 1

K_5 =1 (Drop lubrication assumed)

K_6=1 (8 Hours per day)

K_s=1.5x1x1x1 x 1 x 1 = 1.5

Let the minimum factor of safety n' = 11 for K_s=1 and z_1=25 **(PSG 7.77)**

n' = 11 x 1.5 =16.5 for K_s=1.5 and z_1=25

Chain velocity v= $= \frac{Z_1 n_1 p}{60x1000} = \frac{25x960x15.875}{60x1000}$ = 6.35 m/s

Minimum breaking load $Q = \frac{P.K_S.n'}{V} = \frac{10000x16.5x1.5}{6.35}$ = 38976 N

STEP-4-SELECTION OF CHAIN DRIVE

Since the minimum breaking load (i.e. developed tangential force to break the chain) is 38976 N. We should select a chain having higher breaking strength than the calculated value.

For pitch value of 15.875 mm, DR50 Rolon chain may be selected whose breaking strength 44400 N **(PSG 7.72)**

STEP-5-ACTUAL FACTOR OF SAFETY

Actual factor of safety $[n]=Q/\sum P$ **(PSG 7.78)**

$\sum P = P_t+P_c+P_s$

P_t = Tangential force due to power transmission = P/v (or) = N/v = 10000/6.35 = 1575N

P_c=Centrifugal tension = $\omega v^2/g = 17.8 \times 6.35^2/9.81 = 73.2$N **(PSG 7.72)**

P_s=Tension due to sagging of chain in N = K.ω.a

K= 4 (Position of chain drive inclined upto 40°) **(PSG 7.78)**

a =0.5 m

P_s=4x17.8x0.5 = 35.6 N

$\sum P$ =1575+73.2+35.6 = 1684 N

[n]= 444000/1684 = 26.4

Since the actual factor of safety is more than the adopted minimum value, chain selection is correct.

STEP-6-INDUCED STRESS

$\sigma = PK_s/Axv$ N/mm^2 **(PSG 7.77)**

A= Bearing area = 140 mm^2 **(PSG 7.72)**

σ = 10,000x1.5/140x6.35 = 17 N/mm^2< 33 N/mm^2

This is less than the allowable bearing stress whose value (For K_s=1.5,z_1=25 and n = 960rom) is

33 N/mm^2

STEP-7-LENGTH OF CHAIN

$L_p = 2a_p + \frac{(z_1+z_2)}{2} + \frac{\left\{\frac{z_1-z_2}{2\pi}\right\}^2}{a_p}$ **(PSG 7.75)**