Chain Drives Module-5

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- It transmit rotational Motion & torque from one shaft to another.
- It consist endless chain wrapped around two sprockets (sprocket wheels)
- Chain Made up of No. of Rigid link, which are hinged together by pin joint.
- power transmitted parallel shaft only.

Advantages

① Transmission efficiency is high
② It occupy less space
③ Transmit More power than belt drives
④ Permit high speed ratio 8 to 10
⑤ No slip, perfect Velocity ratio
⑥ Long service life
⑦ Suitable for shorter center distance

Disadvantages

① Require lubrication (Metal-Metal contact)
② Noise higher than belt or gears
③ chain drive elongates due to wearing of link & sprocket
④ Manufacturing cost high
⑤ It need accurate Mounting & careful Maintance.

Application ⇒ Rolling Mills, bicycles, conveying Machinery

Classification of chains

- Driving (power transmitting chain)
  - Block chain
  - Roller chain
  - Silent chain
- Crane (Hoisting) chain
  - chain with oval link
  - Square link chain
- pulling / conveyor chain
  - Dectachable (Hook Joint) type
  - Closed joint type

Driving chain ⇒ power transmitting with Max speed 900 m/min

Crane chain ⇒ Hoisting & hawling chain used for suspending hoisting (lifting) loads at Max speed of 150 m/min

Tractive chain ⇒ Conveyor chain moving loads in elevators, conveyors, These are called tractive chain at Max speed of 120 m/min

Velocity Ratio of chain

Z_1 = No. of teeth on smaller sprocket
Z_2 = No. of teeth on larger sprocket
N_1 = speed of smaller sprocket
N_2 = " larger "

$$V.R \Rightarrow i = \frac{N_1}{N_2} = \frac{Z_2}{Z_1}$$

i varies 1-7 [page 399, Table 14.36 (a)]

Average speed $\Rightarrow v = \frac{PZn}{1000}$ eq 14.22(a) → page 300

Empirical Formula for pitch $P \leq 10\left[\frac{60.67}{n_1}\right]^{2/3}$ [page 300, eq 14.22(b)]

Minimum Number of teeth on sprocket

It given in Table 14.36(a) → page 339

Space problem ⇒ $z_1 = 7$, $z_2 = i z_1$

Min: of teeth on smaller sprocket always be odd (17, 19 or 21)

$z_1 = 17$, Smooth operation at Moderate speed

$z_2 = 19$, durability & noise consideration

$z_3 = 21$, high speed

CENTRE DISTANCE

$C_{min} = k_1 C_1$ [page 301, eq 14.22(j)]

where $C_1 = \frac{D_{01} + D_{02}}{2}$, k_1 = constant [Table 14.36(b)]

Optimum centre distance $C_p = (30 \text{ to } 50)$ where $C = pC_p$ [page 301 eq 14.22(i)]

Chain Length

$$L_p = 2C_p \cos\alpha + \frac{1}{2}(z_1+z_2) + \alpha\left(\frac{z_2 - z_1}{180}\right) \quad \text{[page 301, eq 14.22(k)]}$$

$$= 2C_p + 0.5(z_1+z_2) + \frac{0.026(z_2-z_1)^2}{C_p} \quad \text{[page 301, eq 14.22(l)]}$$

Terms Refer data book

pitch dia of sprocket ⇒ $D = \frac{p}{\sin(180/z)}$ [page 301, eq 14.22(n)]

power Transmitted

Tangential Force ⇒ $F = \frac{1000P}{v}$ [page 300, eq 14.22(c)]

Min: No: of Strands in a chain

$n = \frac{F}{F_w}$ [page 301, eq 14.22(h)]

Allowable working load/strand ⇒ $F_w = \frac{F_u}{FS\, k_s}$ [page 300, eq 14.22(e)]

where k_s [Table 14.35]

FS [Table 14.37]

According AGMA Formula for allowable working load/strand $F_w = \frac{98.07A}{v + 3.05}$ [page 300 eq 14.22(f)]

Module-5

Actual Factor of Safety

$$F_S = \frac{F_u}{F + F_c + F_s}$$ [page 301, eq 14.22(c)] } Terms refer Databook

Definitions

Pitch

Linear distance b/w axes of adjacent rollers

Pitch circle diameter (PCD)

PCD of sprocket is the diameter of imaginary circle that passes through the centers of link pins when the chain is wrapped round the sprocket

Breaking Load

Refer to the Maximum load at which the chain undergoes failure.

208A or 208B

208 = chain Number
A = Americal Standard ANSI Series
B = British Standard series

Power rating of Roller chains

power transmitting by roller chain

$F = \frac{1000P}{v}$ (page 300, eq 14.22(c))

$\boxed{P = \frac{F \times v}{1000}}$ where F = Tangential force (N)
v = average velocity of chain

⇒ Allowable Tension in chain depend upon No: of factors
⇒ Such as type of chain, pitch of chain link, No: of teeth on the smaller sprocket, chain velocity, type of power source & driven Machinery & system of Lubrication.
→ power rating of the roller chain is obtained on the basis of 4 criteria

(I) Wear
* It caused by articulation of pin in bushing.
• wear result elongation of chain, hence chain pitch increased.
• To Make the chain 'ride out' on the sprocket teeth resulting faculty engagement.
• Elongation excessive → replace chain ⇒ permissible elongation = 1.5 to 2.5%
• chain properly lubricated, layer of oil film between the contacting surface of pin & bushing reduces wear.

(II) Fatigue
• Chain pass around sprocket wheel, it subjected to tensile force while Varies from Maximum on tight side to minimum on loose side.
• Chain drive subjected to one complete cycle of fluctuating stresses during every revolution of sprocket wheel.
• This result Fatigue failure on side link plate
• For infinite life, tensile stress should be less than endurance limit to link plate.

(III) Impact
• Engagement of rollers with the teeth of sprocket result in impact.
• when it excessive, this may lead to breakage of roller/bushing
• Increasing No: of teeth on sprocket or reducing chain tension & speed reduce magnitude of impact force.

V.imp

Galling in Roller chain

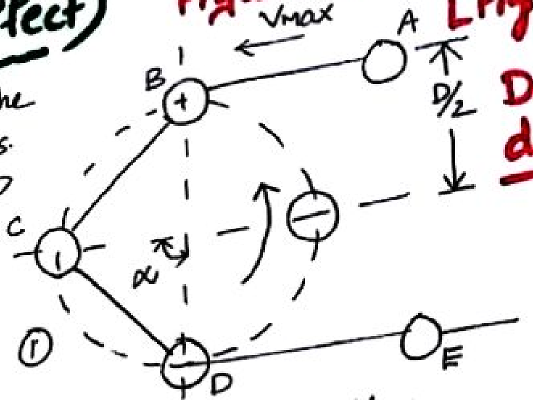
• Galling is stick-slip phenomenon b/w pin & bushing
• when chain tension high, weld are formed at high spot of contacting area
• Microscopic weld are immediately broken due to relative motion of contacting surfaces, lead to excessive wear, even presence of lubricant.

kw rating of chain = $\frac{\text{kw to be transmitted} \times k_s}{k_1 \times k_2}$ | k_s = Service Factor
k_1 = Multiple Strand Factor

Polygonal Action (or) chordal Action (polygonal Effect)

Figure → page 300 [Fig 14.17 (a)] Design data book

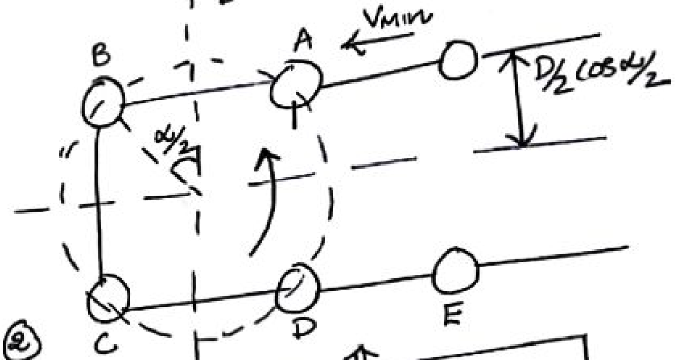
- In chain drive, chain passes around the sprocket as a series of chordal links.
- which similar to that of non slipping belt wrapped around rotating polygon. This action of chaindrive termed as polygon Action (chordal Action)



- Figure shows sprocket with 4 teeth rotating N rpm
- Link AB at distance $\frac{D}{2}$ from centre of sprocket wheel

$$V_{max} = \frac{\pi D N}{60 \times 10^3} \text{ m/s}$$

- when sprocket rotates through $\frac{\alpha}{2}$ position of link AB in fig ② at distance $\frac{D}{2}\cos\frac{\alpha}{2}$ from centre of sprocket



polygon action of chain

$$V_{min} = \frac{\pi D N \cos\frac{\alpha}{2}}{60 \times 10^3} \text{ m/s}$$

- Linear Velocity of chain not uniform $V_{max} - V_{min}$ during every cycle of tooth engagement. It lead pulsating & Jerky Motion

$$V_{max} - V_{min} = \frac{\pi D N}{60 \times 10^3}\left[1 - \cos\frac{\alpha}{2}\right] \quad \text{or} \quad V_{max} - V_{min} = \frac{\pi D N}{60 \times 10^3}\left[1 - \cos\left(\frac{180}{z}\right)\right]$$

$\boxed{z = \text{No: of teeth}}$

- when No: of teeth $\infty \Rightarrow \cos\left(\frac{180}{\infty}\right) = \cos 0 = 1$

$\therefore V_{max} \,\&\, V_{min} = 0 \Rightarrow$ pulsating Jerky motion avoided by increasing No: of teeth of sprocket

Chordal Action of Roller Chain

→ Sprocket with less no: of teeth affect smooth running of chaindrive. → Sprocket with less no: of teeth affect smooth running of chain drive, termed as → chordal Action
→ unsmooth running condition termed as → chordal Action

$R > R_c$. | R = roller radius
R_c = Radius when chain roller approach sprocket = chordal radius

(chord)onal rise → $\Delta R = R - R_c$

$$= R - R\cos\frac{\alpha}{2} = R\left[1 - \cos\frac{\alpha}{2}\right]$$

$$\alpha = \frac{360^\circ}{z}$$