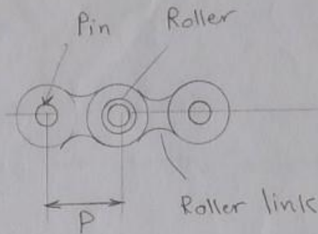
Roller Chain:

Roller chains and sprockets are standarized by ANSI.

Pitch: Center distance between Rollers

width: space between inner links plates.



Chain manufactured in:
Single, double or triple Strands.

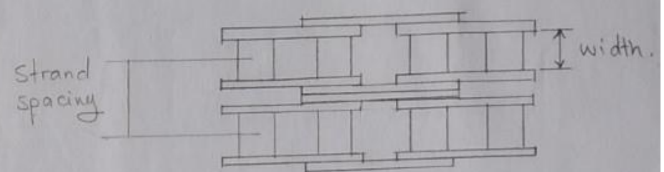


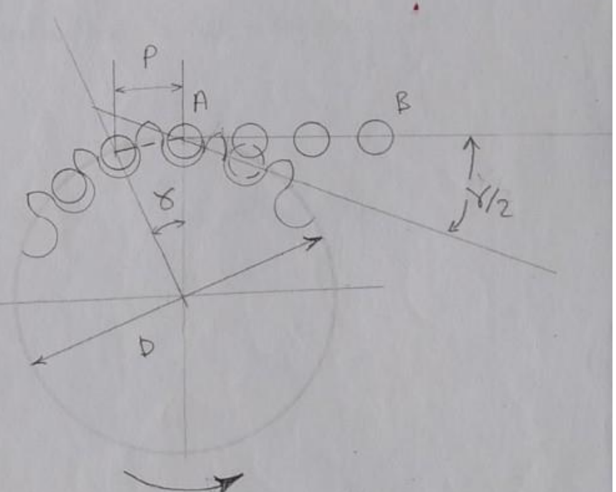
Table [17-13]. ANSI chains,
pitch, width, Min. Tesile strength, weight/length
Roller diameter, Multiple strand spacing

D = pitch dia. of Sprocket.
γ = pitch angle.
P = chain pitch.

$$\sin\frac{\gamma}{2} = \frac{P/2}{D/2}, \quad D = \frac{P}{\sin(\gamma/2)}$$

$$\gamma = \frac{360}{N}$$, N = no. of sprocket teeth.

$$D = \frac{P}{\sin(180/N)}$$

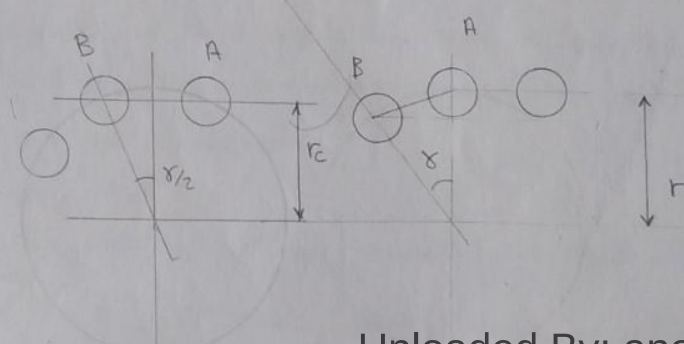


Angle of articulation ($\gamma/2$):
is the angle through which the link switch as it enters in contact.
Rotation of this angle → causes wear in chain Joints, impact between rollers and sprocket.

$\frac{\gamma}{2}$ ↑ → wear & surface fatigue ↑ ⇒ $\left(\frac{\gamma}{2}\right)$ must be reduced.

Chordal action:

First roller A comes in contact with sprocket.
Chain centerline at the chordal radius (r_c).



when sprocket rotates $\theta = \frac{\gamma}{2}$:

Chain Center line rises to distance r = Sprocket pitch radius.

Displacement of chain center line [chain rise or fall]

$$\Delta r = r - r_c = r\left[1-\cos(\gamma/2)\right] = r\left[1-\cos\left(\frac{180}{N}\right)\right]$$

Chordal action ⟶ Nonuniform speed ratio [sprocket radius varies between r_c → r].

If number of Rollers is large → Chordal action insignificant.

Chain velocity:

$$V = \frac{Npn}{12} \quad [ft/min].$$

N = Number of sprocket Teeth.

p = chain pitch, [in]

n = Sprocket speed. [rev/min]

max. chain velocity: occurs chain center line is at distance $= r$

$$V_{max} = \frac{\pi D n}{12} = \frac{\pi n p}{12 \sin(\gamma/2)}$$

min. chain velocity: occurs at distance $= r_c$ ⇒ $d = 2r_c$

$$d = D\cos\frac{\gamma}{2} = p\,\frac{\cos(\gamma/2)}{\sin(\gamma/2)}$$

$$\Rightarrow V_{min.} = \frac{\pi d n}{12} = \frac{\pi n p}{12}\,\frac{\cos(\gamma/2)}{\sin(\gamma/2)}$$

$$\frac{\gamma}{2} = \frac{180}{N}$$

speed variation: Chordal speed variation.

$$\frac{\Delta V}{V} = \frac{V_{max} - V_{min}}{V} = \frac{\pi}{N}\left[\frac{1}{\sin(180/N)} - \frac{1}{\tan(180/N)}\right]$$

Chordal speed variation must be as low as possible for precission drive.

It is desirable to obtain a small sprocket → sprocket with small no. of teeth.

For smooth operation at moderate and high speeds → min. number of sprocket teeth 17, using $N = 19, 21$ will give better performance and less noise.

sprocket size > 120 teeth are not standard.

Satisfactory performance ⇒ Velocity ratio < 6:1

Velocity ratio > 6:1 ⇒ reduce life of chain.

If space is limited you can use $N < 17$, but the chain life will be reduced.

Chain rollers failure due to wear of rollers on the pins or surface fatigue of rollers.

Table [17-14], [17-15] Chain roller (hp) capacity for 17- tooth sprocket correspond to life (15 kh) at various sprocket speeds, (single strand)

Roller chain Selection:

Extra chain capacity is required for the following.

1- Small sprocket, with $N<9$ for low speeds
$N<17$ for high speeds.

2- large sprockets, $N>120$

3- Shock loading, reverse loading is frequent.

4- Three or more sprockets.

5- Poor lubrication.

6- Chain operating under dust or dirty conditions.

To account for these operation conditions use the following correction factors.

a- Tooth correction factors: accounts for the fact that $N \neq 17$

Table [17-16] $\rightarrow K_1$

b- Multiple strand factor: accounts for the fact that rating is not proportional to no. of strands.

Table [17-17] $\rightarrow K_2$ for no. of strands.

c- Service factor: $K_s \rightarrow$ Table [17-11]

$$H = \frac{K_1 K_2 H_R}{K_s}$$

Chain length:

It is prefered to have an even number of pitches $\Rightarrow$ otherwise offset link is required.

approximated length:

$$\frac{L}{P} = \frac{2C}{P} + \frac{N_1 + N_2}{2} + \frac{(N_2 - N_1)^2}{4\pi^2 (C/P)}$$, Center distance: $C < 80P$
Better value: $C = (30-50)P$

L = chain length, C = Center distance., P = pitch of chain.

N_1 = no. of teeth of small sprocket, N_2 = teeth of large sprocket.

Lubrication of Roller Chains:

- Drip feed or shallow bath with a medium and light oil lubricant.
- heavy oil and greases are not recommended.

2020/4/26 16:30

Example:

Douple strand, No. 60 - roller chain

Driving sprocket, $N_d = 13$, $n = 300$ rpm

Driven sprocket, $N_D = 52$

a) Rated horse power?

b) Center distance if $L = 82\,(P)$.

Solution:

Table [17-14], No. 60 at 300 rpm - $H_r = 6.2$ hp.

$K_1 = 0.7$, $N_d = 13 \rightarrow$ Table [17-16].

Double strand, $K_2 = 1.7 \rightarrow$ Table [17-17].

Service factor: $K_s = 1.0$.

$$H = \frac{K_1 K_2 H_r}{K_s} = \frac{0.7 \times 1.7 \times 6.2}{1.0} = 7.38 \text{ hp} \leftarrow$$

b)
$$\frac{L}{P} = \frac{2C}{P} + \frac{N_1 + N_2}{2} + \frac{(N_2 - N_1)^2}{4\pi^2 (C/P)}$$

$$\frac{L}{P} - \frac{N_1 + N_2}{2} = \frac{2C}{P} + \frac{(N_2 - N_1)^2}{4\pi^2 (C/P)}$$

let $x = \frac{L}{P} - \frac{N_1 + N_2}{2}$, $\Rightarrow$ $\frac{C}{P} = \frac{1}{4}\left[-x \mp \sqrt{x^2 - 8\left(\frac{N_2 - N_1}{2\pi}\right)^2}\right]$

From table [17-13] No. 60 chain $\rightarrow P = 0.75$

$\frac{L}{P} = 82$, $N_1 = 13$, $N_2 = 52 \Rightarrow \frac{C}{P} = 23.95$ in $\rightarrow C = 17.96$ in

Take $C = 18$ in $\leftarrow$

(c) If the actual power transmitted [30%] less than calculated hp.
Find the Torque, and bending force on driving shaft.

$H' = 0.7\,H = 0.7 \times 7.38 = 5.17$ hp.

$T = \frac{63000\,(5.17)}{300} = 1086$ lb.in, $\quad H = \frac{T\omega}{63000}$

Sprocket pitch dia. $d = \frac{P}{\sin(\gamma/2)}$, $\gamma = \frac{360}{N}$, $\frac{\gamma}{2} = \frac{180}{N}$

$$d = \frac{0.75}{\sin\left(\frac{180}{13}\right)} = 3.13 \text{ in}$$

$F = \frac{T}{r} = \frac{1086}{(3.13/2)} = 694$ lb. $\leftarrow$