CHAIN DRIVES

In order to avoid slipping as in belt drives; steel chains are used. The chains are made up of number of rigid links which are hinged together by pin joints in order to provide the necessary flexibility for wrapping round the driving and driven wheels (sprockets). These sprockets have projecting teeth of special profile and fit into the corresponding recesses in the links of the chain as shown in Figure1.

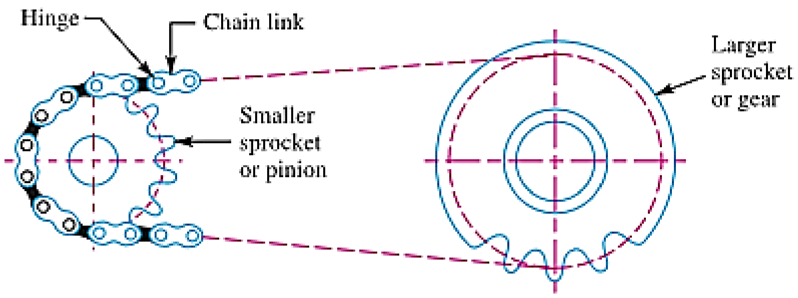

Figure 1:Sprockets and chain

The sprockets and the chain are thus constrained to move together without slipping and ensures perfect velocity ratio.
Following are the advantages and disadvantages of chain drive over belt or rope drive:

Advantages:

1. As no slip takes place during chain drive, hence perfect velocity ratio is obtained.
2. Since the chains are made of metal, therefore they occupy less space in width than a belt or rope drive.
3. It may be used for both long as well as short distances.
4. It gives a high transmission efficiency (upto 98 percent).
5. It gives less load on the shafts.
6. It has the ability to transmit motion to several shafts by one chain only.
7. It transmits more power than belts.
8. It permits high speed ratio of 8 to 10 in one step.
9. It can be operated under adverse temperature and atmospheric conditions.

Disadvantages:

1. The production cost of chains is relatively high.
2. The chain drive needs accurate mounting and careful maintenance, particularly lubrication and slack adjustment.
3. The chain drive has velocity fluctuations especially when unduly stretched.

Classification of Chains :
The chains, on the basis of their use, are classified into the following three groups:

1. Hoisting and hauling (or crane) chains
2. Conveyor (or tractive) chains
3. Power transmitting (or driving) chains.

Power Transmitting Chains

These chains are used for transmission of power, when the distance between the centers of shafts is short. These chains have provision for efficient lubrication. The power transmitting chains are of the following three types:

1. **Block or bush chain**. A block or bush chain is shown in Figure 2. This type of chain was used in the early stages of development in the power transmission. It produces noise when approaching or leaving the teeth of the sprocket because of rubbing between the teeth and the links. Such type of chains are used to some extent as conveyor chain at small speed.

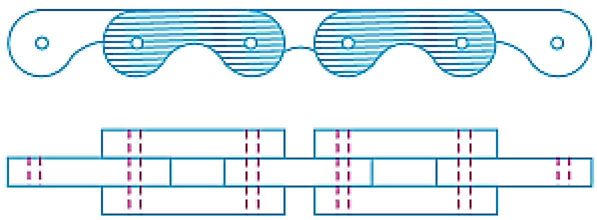

Figure 2: Block or bush chain.

2. **Bush roller chain**. A bush roller chain as shown in Figure3. It consists of outer plates or pin link plates, inner plates or roller link plates, pins, bushes and rollers. A pin passes through the bush which is secured in the holes of the roller between the two sides of the chain. The rollers are free to rotate on the bush which protect the sprocket wheel teeth against wear. The pins, bushes and rollers are made of alloy steel.

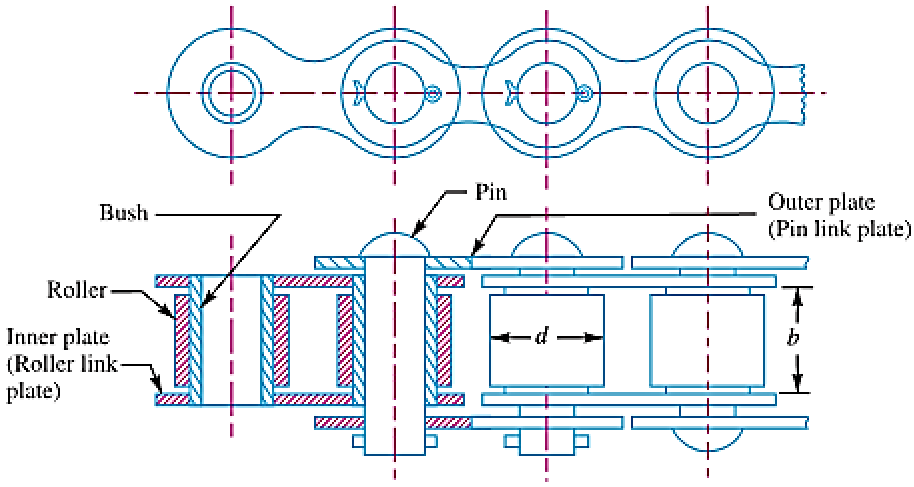

Figure 3: Bush roller chain.

A bush roller chain is extremely strong and simple in construction. It gives good service under severe conditions. There is a little noise with this chain which is due to impact of the rollers on the sprocket wheel teeth. This chain may be used where there is a little lubrication. When one of these chains elongates slightly due to wear and stretching of the parts, then the extended chain is of greater pitch than the pitch of the sprocket wheel teeth. The rollers then fit unequally into the cavities of the wheel. The result is that the total load falls on one teeth or on a few teeth. The stretching of the parts increase wear of the surfaces of the roller and of the sprocket wheel teeth.

The roller chains are standardized and manufactured on the basis of pitch. These chains are available in single-row or multi-row roller chains such as simple, duplex or triplex strands, as shown in Figure4.

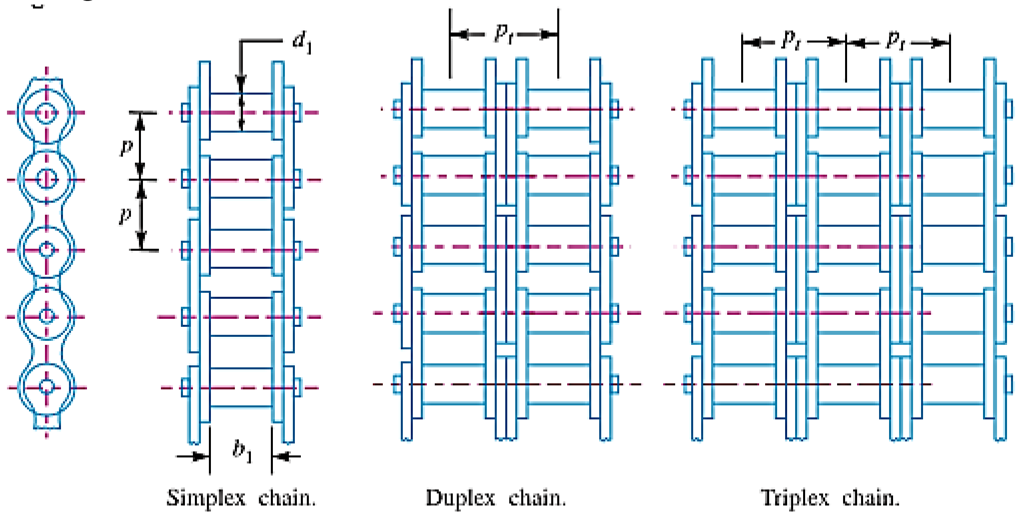

Figure 4: Types of roller chain.

3. Silent chain. A silent chain (also known as inverted tooth chain) is shown in Figure 5. It is designed to eliminate the evil effects caused by stretching and to produce noiseless running. When the chain stretches and the pitch of the chain increases, the links ride on the teeth of the sprocket wheel at a slightly increased radius. This automatically corrects the small change in the pitch. There is no relative sliding between the teeth of the inverted tooth chain and the sprocket wheel teeth. When properly lubricated, this chain gives durable service and runs very smoothly and quietly.

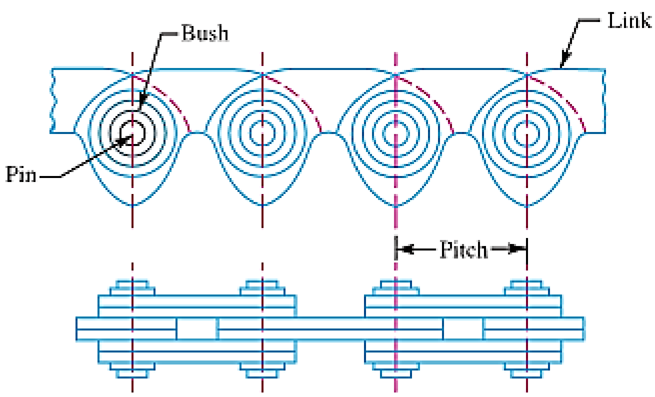

Figure 5: Silent chain.

Design Procedure of Chain Drive :

The chain drive is designed as discussed below:

1. First of all, determine the velocity ratio of the chain drive.

The maximum allowable speed for the roller and silent chains, depending upon the number of teeth on the smaller sprocket or pinion and the chain pitch is shown in table 21.6.

2. Select the minimum number of teeth on the smaller sprocket or pinion from Table 21.5.

The velocity ratio must be approximated to the closest integer greater than the ratio. This ratio is used for the selection of minimum number of teeth.

The approximated velocity ratio is used for the teeth number selection only and the real velocity ratio must be used elsewhere.

3. Find the number of teeth on the larger sprocket.

4. Determine the design power by using the service factor, such that

Design power = Rated power × Service factor

The service factor (K_S) is the product of various factors, such as load factor (K_1), lubrication factor (K_2) and rating factor (K_3). The values of these factors are taken as follows:

1. Load factor (K_1) = 1, for constant load
   = 1.25, for variable load with mild shock
   = 1.5, for heavy shock loads
2. Lubrication factor (K_2)= 0.8, for continuous lubrication
   = 1, for drop lubrication
   = 1.5, for periodic lubrication
3. Rating factor (K_3) = 1, for 8 hours per day
   = 1.25, for 16 hours per day
   = 1.5, for continuous service

When there is no information about the conditions of the above factors, the designer should suppose the worst case.

5. Choose the type of chain, number of strands for the design power and r.p.m. of the smaller sprocket from Table 21.4.

The designer should not use interpolations if the speed or load are not mentioned exactly. The selection must be for the closest speed less than the operating speed and so for the working load.

6. Note down the parameters of the chain, such as pitch, roller diameter, minimum width of roller etc. from Table 21.1.

7. Find pitch circle diameters and pitch line velocity of the smaller sprocket.

8. Determine the load (W) on the chain by using the following relation, i.e.

W = Rated power / Pitch line velocity

9. Calculate the factor of safety by dividing the breaking load (W_B) to the load on the chain (W). This value of factor of safety <u>should be greater than</u> the value given in Table 21.2.

10. Fix the center distance between the sprockets (*x*).
<u>When there is no restricts on the center distance, and for best results, the minimum center distance should be 30 to 50 times the pitch.</u>

11. Calculate the number of chain links (*K*) from the following

$$K = \frac{T_1 + T_2}{2} + \frac{2x}{p} + \left[\frac{T_2 - T_1}{2\pi}\right]^2 \frac{p}{x}$$

<u>The value of *K* as obtained from the above expression must be approximated to the nearest even number.</u>
After approximation of *K* , the value of (*x*) must be re calculated from the following

$$x = \frac{p}{4}\left[K - \frac{T_1 + T_2}{2} + \sqrt{\left(K - \frac{T_1 + T_2}{2}\right)^2 - 8\left(\frac{T_2 - T_1}{2\pi}\right)^2}\right]$$

<u>In order to accommodate initial sag in the chain, the value of the center distance obtained from the above equation should be decreased by 2 to 5 mm</u>

12. Determine the length of the chain.
$L = p * K$

REFERENCES

A Textbook of Machine Design by R.S. KHURMI & J.K. GUPTA, Eurasia Publishing House (PVT.) LTD. 2005