



CHAIN - PART 3: Chain Drive Design PA NOTE

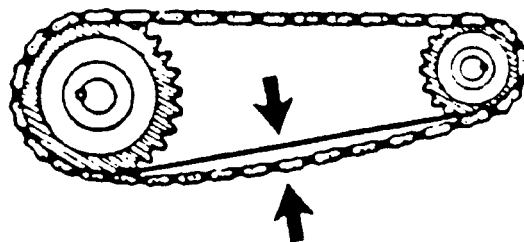
The information needed to design a chain drive is basically the same as that needed for a belt drive design. The load requirements, driveR/driveN speeds, and description of driveR/driveN units are necessary, along with center distance, peak load, and operating conditions. Service factors are also used for chain drives, ranging up to 1.7 for high shock loads. The proper pitch is selected using pitch selection tables in a method similar to that used for synchronous belts. Once the sprocket sizes have been chosen, rating tables are consulted to determine the correct number of strands required.

The chain industry generally admits that most chain drives are improperly designed. Comparison of chain to belt drives is usually difficult, if not pointless, due to most chain users' disregard for rating tables and service factors. Because of this, Poly Chain belt drives should not be designed using only the chain rating information without having all the basic drive data.

We will now review some additional design factors that are taken into consideration when designing a new chain drive. In practical, Type I (Drip or Manual) lubricated drives are most ideal, based on hardware cost, design, and performance. Slow speed drives (small sprocket less than 10 RPM) are designed on the basis of 10% of the chain's average tensile strength, while extremely slow speed drives operating at 25 feet/min. or less may use 20% of the chain's average tensile strength. Most manufacturers recommend that speed ratios should not exceed 6 or 7 to 1 in order to maintain the chain's full load capacity. This is synonymous to the recommended 6 teeth-in-mesh for synchronous belts.

Chain drives are similar to belt drives in that proper tension is essential for satisfactory performance. The amount of tension in chain can be related to chain sag. This sag is called the "catenary effect." The catenary is a curve made by a cord (chain or cable) of uniform weight suspended between two points. As a rule of thumb, sag of 2 to 3% of the center distance is sufficient to insure proper tensioning. An overtensioned chain will wear faster due to high pressure loading between the roller and pin and high pressure between the roller and sprocket. Overtensioning will also result in higher bearing and shaft loads.

Figure 1



2-3% Sag

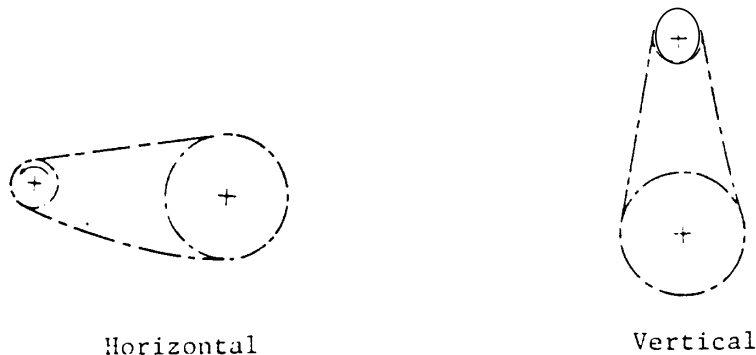
Undertensioning is also detrimental to chain performance. Insufficient tensioning can result in the chain ratcheting. Rapid wear of the roller outside diameter and roller-bushing bearing area will result due to the chain riding out of the



sprocket. The sprocket teeth will also experience abnormal wear. Shock loading can also result in the chain whipping or riding out of the sprocket.

Horizontal drives are recommended for optimum performance. Vertical drives can cause difficulties since less slack can be tolerated in order to insure proper chain/sprocket engagement. While a carefully designed silent chain drive can operate on vertical shafts, chain literature implies that such geometry should be avoided for other types of chain. In a vertical shaft drive, the link plates will ride on the side of the sprocket teeth causing accelerated chain and sprocket wear.

Figure 2



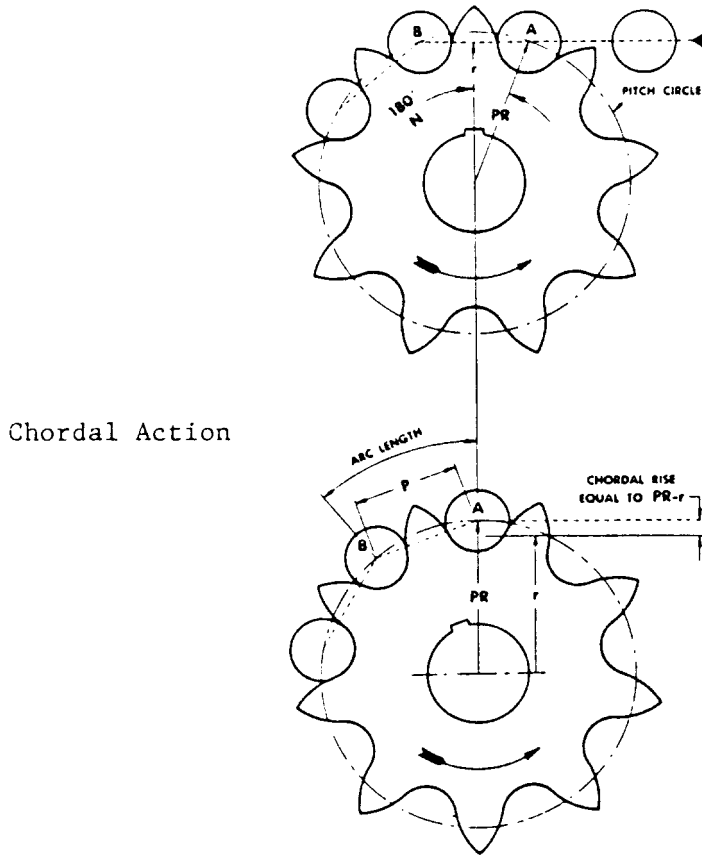
The total tension in chain should always be considerably less than the chain's yield strength. The total tension can be composed of up to four different types of tensions:

- 1) Working tension - pull required for power transmission.
- 2) Centrifugal tension - significant over 3000 feet/min. chain speed.
- 3) Weight between spans - on large center distance drives, sag between spans on the slack side becomes a factor.
- 4) Chordal action - pulsations are generated in following links by the dynamic affects of chordal action.

When a chain engages a sprocket, the centers of the chain joints lie on the pitch circle of the sprocket. The center line of each link forms a chord of this circle. As the trailing roller enters the sprocket, it wants to follow the leading roller along the chordal line. However, since the trailing roller is forced to follow the pitch circle of the sprocket, it is raised relative to its entry position. This chordal action initiates pulsations in the following links. While synchronous belts, such as the Poly Chain belt, exhibit chordal action characteristics, it is to a much smaller degree due to their greater flexibility, thus providing smoother performance on the drive.



Figure 3



NEMA (National Electrical Manufacturers Association) has established multipliers to modify V-belt minimum sheave diameters. These multipliers are an indication of relative tension in various types of drives. For example, the tension in a timing belt is higher than in chain, but less than in a V-belt or flat belt. Examples of the multipliers are shown below:

<u>Drive</u>	<u>Multiplier</u>
V-belt	1.0
Flat belt	1.33
Timing belt	.9
Chain	.7
Spur gear	.75
Helical gear	.85

The fourth part of this five part series will deal with maintenance and lubrication of chain drives.