DIFFERENCES IN SYNCHRONOUS BELTS

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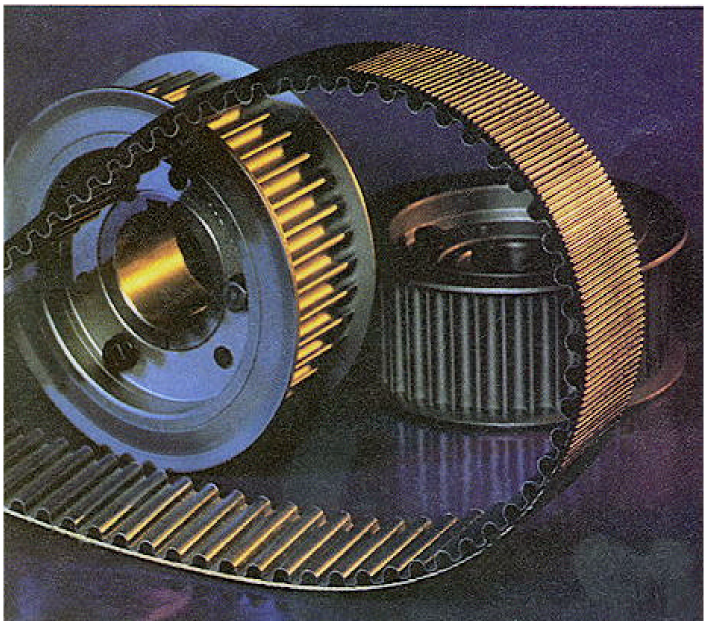
All toothed belts are not the same; subtle differences in tooth profiles and construction affect performance.



Synchronous belt drives operate on the tooth grip principle. The belt resembles a flat belt with evenly spaced teeth on the inside surface. Molded belt teeth are designed to make positive engagement with mating grooves on a pulley or sprocket.

Toothed belts do not rely on friction to transmit power, and they should not be confused with molded-notch V-belts which transmit power by wedging action of the V-shape. Because synchronous belts have positive engagement between belt teeth and sprocket grooves, there is relatively little motion between the belt and sprocket and no slip. Synchronous belts are up to 98% efficient in transmitting power.

The no-slip characteristic provides exact synchronization between a power source and a driveN unit. Synchronous belt drives are extremely useful in applications where indexing, positioning, or a constant speed ratio is required.

Types

Trapezoidal. The major characteristic of these belts, also called timing belts, is the trapezoidal tooth profile, Fig. 1a. Today the trapezoidal tooth is the most common profile.

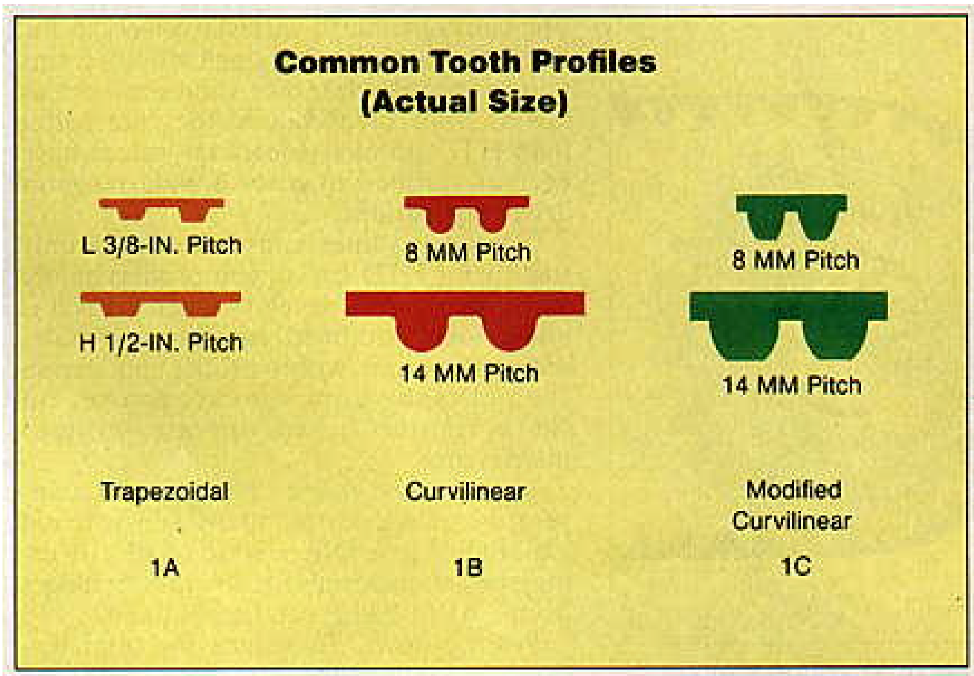


Fig. 1. Synchronous belt tooth profiles are not compatible with each other. Mixing belt and sprocket profiles reduces overall belt service life.

Pitches ranges from mini extra light (MXL-0.080 in.) for fractional horsepower drives to double extra heavy (XXH-1.25 in.) with a load capacity of more than 100 hp. Several of these timing belt pitches are available with double-sided teeth (teeth on both sides of the belt).

Over the years, many nonstandard timing belt pitches have been developed for specialized industrial applications.

Curvilinear. The curvilinear or rounded-tooth profile, Fig 1b, was developed in the early 1970s. Called high torque drive (HTD), these synchronous belts have teeth that are fully rounded, deeper, and more closely spaced than trapezoidal timing belts. HTD belt pitches range from 3 to 20 mm. Many of these belt pitches are available with double-sided teeth.

Modified Curvilinear. Several modified curvilinear tooth designs have emerged recently, Fig. 1c. These belts have high tooth flank angles and shallow depth teeth that provide enhanced performance characteristics over the HTD profile.

Some of these modified belts have small ribs on the back to reduce bending stresses. Others have a recess in the tip of the belt tooth.

Synchronous

There are four basic parts of a synchronous belt, Fig. 2. All of these components are integrally molded with specially compounded adhesion gums to ensure all parts work together as a unit.

Tooth and body. The teeth on a synchronous belt are spaced so the root lies at the pitch line. The tooth shear strength is greater than the strength of the tensile member when at least six belt teeth are in mesh with sprocket grooves.

This curvilinear tooth design improves stress distribution, and overall loading on many belt drives can be higher in comparison to trapezoidal tooth profiles.

Most synchronous belts are made of premium oil and heat-resistant neoprene stocks. Special materials can be specified to provide high oil resistance, static resistance, static conductance, and nonmarking characteristics.

Fabric tooth facing. Most synchronous belts have wear-resistant fabric for a tooth facing material. The material

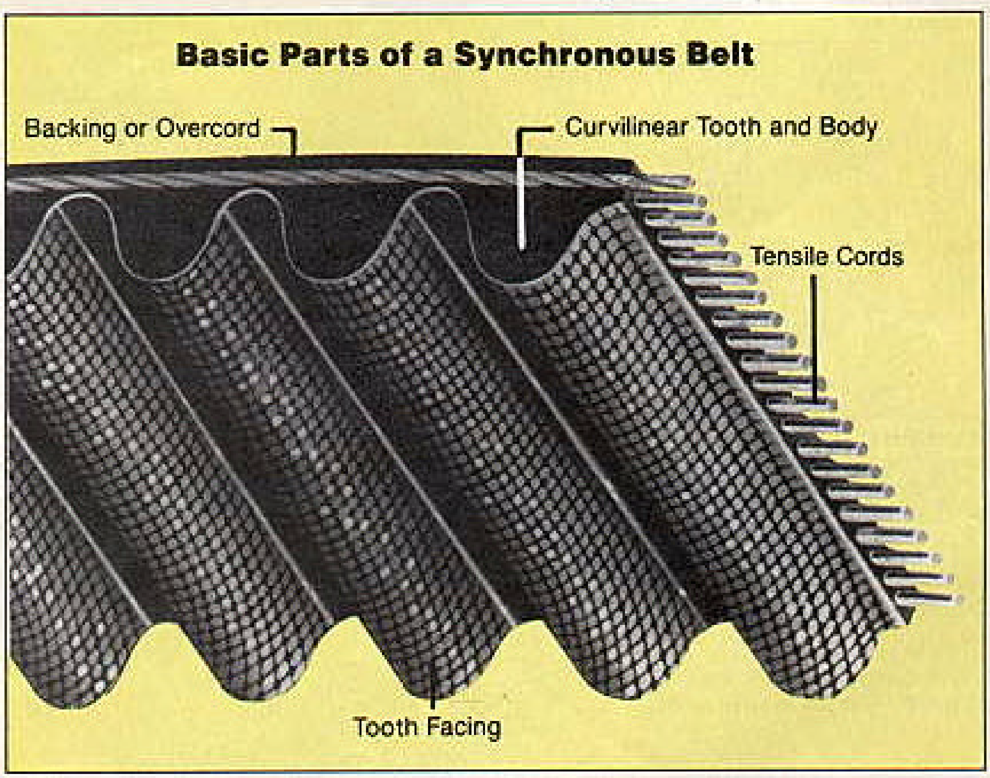


Fig. 2. Basic parts of a synchronous belt are molded together to form a a single unit. Materials of construction can be tailored for specific performance characteristics.

has a low coefficient of friction. The purpose of the facing is to cover and protect tooth surfaces for long belt life.

Backing or overcord. Overcord is bonded to the tensile member and provides protection against grime, oil, and moisture. The overcord protects from frictional wear if a backside idler is used or if power is transmitted from the backside of the belt.

Tensile member. The tensile cord is the belt muscle. Fiber glass is the most commonly used material. Its high-modulus, low-stretch characteristics make it excellent for a wide range of general applications.

Care must be exercised in handling, storing, and installing synchronous belts. Tightly crimping or bending the belt may cause invisible damage to the cord, substantially reducing belt service life.

Alternate cord materials, used where high shock or reversing loads are likely to occur, are aramid fiber, steel, or polyester in smaller pitch belts. Tensile cords are typically made up of several filaments twisted around each other.

Performance Characteristics

The table compares performance of trapezoidal, curvilinear, and modified curvilinear synchronous belts. It can be used to compare performance characteristics such as belt width, speed ratio, horsepower rating, and positioning accuracy.

Stock widths. As with trapezoidal pitches, belt widths are expressed in inches. Curvilinear and modified curvilinear

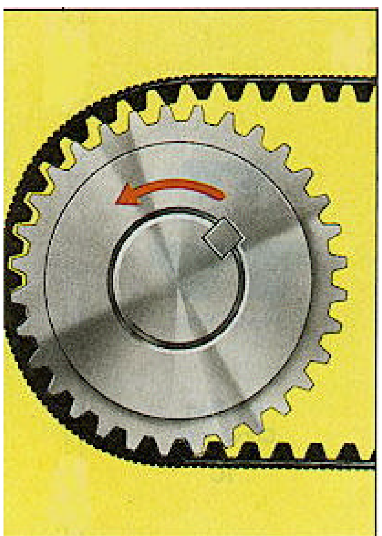


***Fig. 3. Ratcheting** in a synchronous belt drive occurs when the drive is undertensioned. The belt pitch begins to mismatch the driven sprocket pitch. Ratcheting is a major cause of belt wear and shortened service life.*

belts are cut to millimeter widths. Special made-to-order widths usually can be obtained for special applications.

Maximum speed ratio. The selection of various sprocket combinations can be used to obtain different speed ratios. It is possible to obtain higher speed ratios with custom-made sprockets or by using two or more drive stages. Making sprockets smaller than shown in catalogs usually leads to shorter belt service life.

Maximum horsepower rating per inch of width. Belt horsepower ratings may differ between manufacturers. One way of looking at a rating could be per inch of width, as shown in the table. As with all ratings, they may be misleading when comparing one manufacturer to another since an equal horsepower rating may have a different belt performance on specific drives.

Positioning accuracy (clearance values). The clearance between belt teeth and matching sprocket grooves is the principal indication of backlash in a drive. In drives requiring a high degree of precision indexing or registration, trapezoidal belts are normally used. As smaller diameter sprockets are used, the amount of clearance required to operate properly is increased. The clearance range varies inversely to the number of grooves. Although modified curvilinear profile clearance values are not as low as trapezoidal values, they are better than HTD profiles. Clearance values have been established to cover a wide range of drive applications.

Clearance values can be reduced only slightly for HTD curvilinear profiles before tooth interference develops when the belt is under load. Modified curvilinear profiles reduce clearance, within proper application allowances, by using sprocket grooves cut for a tighter fit to operate without interference.

Temperature range. The normal temperature range for standard construction materials is generally -30 to 185 F. By using special materials, temperature ranges from -65 to 230 F can be obtained.

Bearing loads. To reduce the total tension on a drive for a given torque, the sprocket diameter must be increased. Attempting to reduce tension by increasing belt width actually causes greater loads on bearings. Pull is concentrated farther away from the bearing and there is more sprocket weight due to increased width of the drive. As shown in the table, higher load capacities of curvilinear belts allow narrow widths, which reduces bearing loads.

Abrasion resistance. Large industrial drives operating in very clean environments often require belts with a high degree of abrasion resistance. Abrasion resistance reduces the amount of rubber or urethane dust produced by a drive. It has been found, through field testing, that urethane belts have higher abrasion resistance than neoprene belts.

Chemical resistance. When dealing with neoprene stocks, there are only a few compounds that can provide some chemical and oil resistance. There is usually a reduction in belt life when exposed to chemicals. The degree of reduction in life is difficult to predict due to the number of chemicals, degree of concentration of the chemical, type of exposure (vapor, mist, or immersion).

Urethane belts provide good resistance to most chemicals, including some acids, alkalis, and petroleum distillates.

Noise. Like any other power transmission drive system, synchronous drives produce certain noise levels. Through laboratory testing, it has been determined that pitch, number of grooves, rotational speed, horsepower, and belt width affect noise levels.

Two of the variables that reduce drive noise levels are higher capacity rating with small sprockets and narrower belt width. In drive applications where noise levels cannot be reduced by altering sprocket size or belt width, other approaches to reducing noise are acoustical guards, belts with a rough tooth fabric, special split belts, drive alignment, and correct belt tension.

Antiratcheting. As might be expected, the deeper the tooth and steeper the side of the tooth, the less tendency there is for belt teeth to jump out of sprocket grooves (ratcheting), Fig. 3.

Modified curvilinear tooth profiles have better antiratcheting characteristics compared to trapezoidal tooth profiles. The use of urethane in modified curvilinear tooth profiles adds resistance to tooth deflection, thus providing a greater antiratcheting characteristic than neoprene belts.

Synchronous Belts

Belt Type	Pitch	Stock Widths	Max. Speed Ratio	Max. Rating, hp/in of width (except as noted)	Clearance Value
Trapezoidal					
MXL	0.080 in.	1/8, 3/16, 1/4 in.	7.20	9.6 lb in.	N/A
XL	0.200*	1/4, 3/8	7.20	3.4	0.0040-0.0050
L	0.375*	1/2, 3/4, 1	12.00	6.4	0.0055
H	0.500*	3/4, 1, 1 1/2, 2, 3	11.14	22.4	0.0055
XH	0.875	2, 3, 4	6.67	27.2	0.0055
XXH	1.250	2, 3, 4, 5	5.00	33.5	N/A
Curvilinear					
HTD	3 mm*	6, 9, 15 mm	7.20	N/A	0.0065-0.0094
	5*	9, 15, 25	8.00	12.3	0.0080-0.0140
	8*	20, 30, 50, 85	8.73	37.2	0.0150-0.0200
	14*	40, 55, 85, 115, 170	7.71	43.9	0.0290
	20	115, 170, 230, 290, 340	6.35	90.1	N/A
Modified Curvilinear					
Type A	8 mm	12, 21, 36, 62 mm	10.18	68.3	0.0085
	14	20, 37, 68, 90, 125	8.00	163.6	0.0150
Type B	8 mm	20, 30, 50, 85	8.73	37.2	N/A
	14	40, 55, 85, 115, 170	7.71	48.6	N/A

* Available in double-sided teeth

Belt designations:
Type A — small ribs on back
Type B — recess in tip of tooth