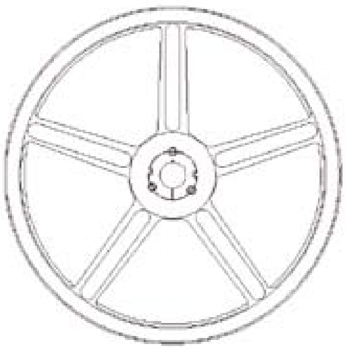
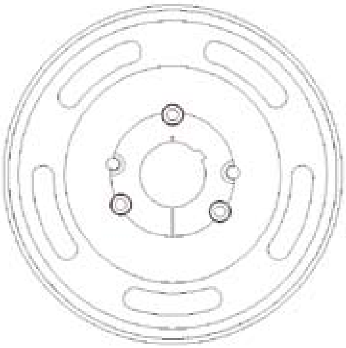
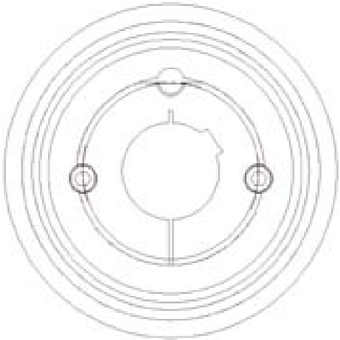
DESIGN AND MATERIAL CONSIDERATIONS FOR BELT DRIVE HARDWARE



Arm Style



Web Style



Block Style

Figure 1 - Common Styles of Sprockets and Sheaves

Contents

Introduction

Selecting the right material for a belt hardware application involves many factors, including the cost effectiveness of the number of parts needed, as well as the material performance required. Gates offers industrial sheaves, sprockets, bushings and related components in a variety of materials to meet the needs of each application. Most Gates stock products are made out of gray and ductile iron or sintered steel.

Sprockets and sheaves are made with different body styles, such as arm, web or block (See Figure 1). For any application requiring rim speeds above 6,500 feet per minute (fpm), Gates recommends that sprockets or sheaves are special ordered with appropriate materials and are dynamically balanced to ensure safe drive operation.

Gray Iron

The most popular casting material used today, gray iron contains a large amount of carbon in the form of gray graphite flakes, which lends to its name. Properties of common varieties of gray iron are described in Figure 2.

Available Grades and Maximum Allowable Rim Speeds		
Gray Iron	Yield Tensile Strength (psi)	Max. Allowable Rim Speed (fpm)
Class 30B, ASTM A-48	30,000	6,500
Class 40B, ASTM A-48	40,000	7,500

Figure 2 - Gray Iron Material Properties

Gray iron's widespread use is due to the following characteristics:

- Machinability
- Wear resistance
- Dampening capacity
- Heat dissipation
- Low modulus of elasticity
- Casts into most shapes

Common products that use gray iron castings include:

- Automotive components
- Agricultural equipment
- Construction equipment
- Machine tools
- Lawn and garden equipment
- Heavy equipment

Ductile Iron

Ductile iron is the second most popular material used for castings. Ductile iron contains graphite modules, which improve strength and ductility over gray iron of comparable composition. Ductile iron is sometimes referred to as nodular iron because the graphite is in the shape of spheres or nodules. Properties of common varieties of ductile iron are listed in Figure 3.

Available Grades and Maximum Allowable Rim Speeds		
Ductile Iron	Yield Tensile Strength (psi)	Max. Allowable Rim Speed (fpm)
65-45-12, ASTM A-536	45,000	8,000
80-55-06, ASTM A-536	55,000	9,000

Figure 3 - Ductile Iron Material Properties

Ductile Iron has the following desirable characteristics:

- High tensile strength and toughness
- Good machinability (equal to gray iron of the same hardness)
- High modulus of elasticity – good shock resistance
- Wear resistance
- Excellent ductility
- Casts into most shapes

Ductile iron castings are used in:

- Automotive components
- Agricultural equipment
- Construction equipment
- Lawn and garden equipment
- Heavy equipment
- Railroad equipment

Steel

Steels are alloys of iron and carbon, with the exception of stainless steels, which are alloys of iron, chromium and nickel. Steel is classified by its composition. The American Iron and Steel Institute (AISI) and the Society of Automotive Engineers (SAE) assign alloy designations. Most "general use" steels fall into three categories:

1. Carbon steels
2. Alloy steels
3. Stainless steels

Carbon steel contains small but specific amounts of manganese and silicon and is generally classified based on carbon content. Three broad classifications are referred to as low, medium and high carbon steels. Free cutting steels are carbon steels with sulfur, lead or phosphorous added.

Alloy steels are carbon steels with other elements added to increase hardness. These elements make alloy steels easier to heat treat for greater strength. The most commonly added alloys are nickel, chromium and molybdenum. Steels with certain amounts of manganese are also considered alloys.

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Material characteristics and mechanical properties of different types of steels vary widely. All common steel types may be used to produce component parts to custom specifications or specialized part requirements. Several common steels used today are listed in Figure 4 with their associated rim speed capabilities for sheave or sprocket applications.

Available Grades and Maximum Allowable Rim Speeds		
Steel	Yield Tensile Strength (psi)	Max. Allowable Rim Speed (fps)
1018 Steel	53,700	9,000
1144 Steel	89,900	12,000
304L Stainless Steel	30,500	7,000
416 Stainless Steel	84,800	11,000

Figure 4 - Steel Material Properties

Sintered Steel

Sintered steel can be used effectively in applications that have traditionally used other fabrication methods such as steel stampings, cast (gray or ductile) iron, die casting and screw machining. A wide variety of materials lend themselves to the sintering process. Sintering may be selected for the following reasons:

- Reduced secondary operations/scrap
- Ability to maintain close tolerances
- Good surface finish
- Complex shapes
- Low cost for moderate to high production quantities
- Wide range of mechanical properties
- Parts are recyclable

Available Grades and Maximum Allowable Rim Speeds		
Sintered Steel	Yield Tensile Strength (psi)	Max. Allowable Rim Speed (fps)
FC-0208-50	55,000	9,000
F-0008-30	35,000	7,000

Figure 5 - Sintered Steel Material Properties

Sintered parts are used in:

- Power tools
- Appliances
- Firearm components
- Automotive components
- Office equipment
- Computers
- Lawn and garden equipment

Generally, the higher the sintered steel tensile strength grades, the higher the cost. Although there are many material options to choose from, two common grades are generally suitable for most powdered metal power transmission components. Material properties for sintered steel are listed in Figure 5.

Aluminum

Available Grades and Maximum Allowable Rim Speeds		
Aluminum	Yield Tensile Strength (psi)	Max. Allowable Rim Speed (fps)
2024-T3	50,000	12,000
6061-T6	40,000	11,000
7075-T6	73,000	15,000

Figure 6 - Aluminum Properties

Aluminum offers many advantages over other materials. Some of these include:

- Light weight (~2/3 the weight of steel)
- Machinability
- High strength-to-weight ratio
- Non-oxidizing when exposed to air
- Excellent heat dissipation
- High electrical conductivity
- Can be cast by all common casting methods
- Heat treatable for higher strength and hardness

Many power transmission components made of various aluminum alloys and finishes provide excellent service. Aluminum components are used in:

- Office equipment
- Household appliances
- Home and commercial laundry equipment
- Computer hardware
- Power hand tools
- Lawn and garden equipment
- Light-duty machine tools
- Die-cast motorcycle rear wheel sprockets

When selecting aluminum materials for sheaves, pulleys and sprockets, it is important to consider the service life of the drive along with the desired performance characteristics of the application. Heavily loaded drives and drives running in abrasive or contaminated environments often require long industrial service life. Plain aluminum sheaves or sprockets will not likely meet the performance expectations of drives operating in long life or under severe conditions. Heat-treated, hard anodized and plated aluminum parts may perform satisfactorily but should be evaluated for suitability and tested on the actual application if possible.

Aluminum is often selected because of its light weight. If applications are lightly loaded or see limited or seasonal use, aluminum may be ideally suited for power transmission components.

Many different grades and types of aluminum are available for power transmission components. Figure 6 outlines three grades of aluminum along with their associated maximum rim speeds.

Plastic

Plastic materials are very versatile and offer many advantages when used for pulleys and sprockets. Some of these are:

- Light weight
- Non-corrosive (will not rust)
- Can conduct electricity (if required)
- Low cost, particularly in high volumes
- Wide variety of filled and non-filled materials
- Pulley and sprockets can be molded around a metal insert

It is possible to manufacture plastic power transmission components by conventional machining methods. However, injection molding is preferred, especially for high volumes, because most parts are ready for use after molding. Plastic part cost is typically much lower in high volumes than that of a comparable machined part. Plastic components are commonly used in a variety of applications such as:

- Office equipment
- Appliances
- Lawn and garden equipment
- Power tools
- Computer peripherals

Plastic components have a wide range of properties. These properties vary depending on the material selected and also by adding reinforcements such as fiberglass.

Common materials for plastic power transmission components are:

- Polycarbonate (Lexan®), fiberglass reinforcement optional
- Acetal (Delrin®), fiberglass reinforcement optional
- Nylon
- Nylatron®

Like aluminum parts, plastic parts may not be suitable for heavily loaded drives, or drives that run in abrasive or contaminated environments and that require long industrial service life. The service life of the drive needs to be carefully evaluated with the performance characteristics, such as heat dissipation of the application, before plastic parts are chosen.

Conclusion

In conclusion, there are multiple materials from which belt drive components are manufactured. While stock materials and components are acceptable for a wide variety of drive systems, some systems require special materials to ensure desired performance. Special application requirements can be discussed with Gates Product Application Engineers.

Additional Resources

Made-To-Order Metals

Gates Made-To-Order Metals service specializes in providing prototype and production pulleys, sheaves and sprockets for non-standard power transmission application.

Visit www.gates.com/mtometals for additional information or contact them at 800-709-6001.

Product Application Engineering

Gates has the largest and most experienced group of industrial product application engineers in its industry. These representatives will respond to your specific engineering inquiries regarding design, selection, maintenance and safety issues as they relate to Gates Industrial Power Transmission products.

Contact them at 303-744-5800 or at ptpasupport@gates.com.

Online Drawings and Information

Visit Gates online catalog PartView™ at www.gates.com/partview for CAD models, 2D specification sheets and more.

Belt Failure Analysis

Worn components can contribute to belt failure and increase downtime as well as replacement and maintenance costs. Learn more about identifying the source of failed synchonous and v-belts at www.gates.com/analysis.

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