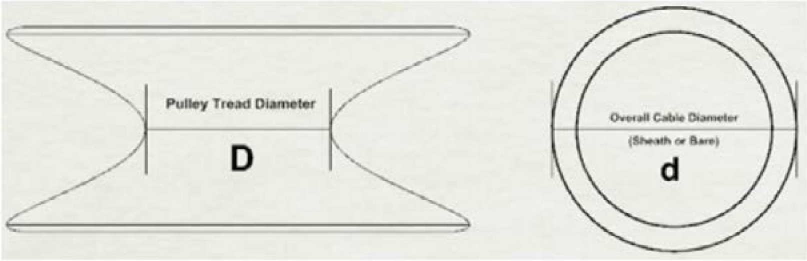
INTRODUCING PULLEYS INTO CABLE SYSTEMS

KEY FACTORS TO CONSIDER FOR YOUR DESIGN

Primary Design Factors For Pulleys in Cable Systems

Assuming all loads have been properly calculated and a suitable cable has been selected, design requirements for pulleys can be summarized as the following:



In the pulley selection process, the highest possible pulley tread diameter should be used in a design. If the tread diameter is too small to properly mate with the cable's overall diameter, then individual wire strands within that cable will experience greater amounts of fatigue. The D:d ratio is a general rule, as one must also consider all other relevant forces being exerted on the system. Outside tests have shown that if the pulley tread diameter is doubled, cable bending life can increase up to 13 times its original value.

In the chart below, we identify the preferred and absolute minimum D:d ratios that should be used in accordance with CMA cable construction sizes:

Pulley Diameter to Cable Diameter Ratio

Cable Construction	Preferred Minimum (D:d)	Absolute Minimum (D:d)	Absolute Minimum (D:d) for Aircraft
3x7	50:1	40:1	Not Recommended
7x7	42:1	30:1	40:1
7x19	24:1	18:1	35:1

D = Pulley Tread or Root Diameter
d = Nominal Bare or Coated Cable Diameter

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Pulley Groove Sizing for Proper Cable Mating

When the cable mates against the pulley, it rests along the pulley's groove. If the groove is too small to accommodate the cable's outer diameter, than pinching occurs, thereby affecting performance and service life. If the groove is too large, than the cable could be subjected to flattening since the groove's walls are not properly mated to the cable's outer surface.

In either case, improper groove design leads to additional stress and can reduce the cable's bending life by as much as 10%, resulting in accelerated wear. Determining the diameter of this groove depends on the following calculation:

1.5 x Diameter Tolerance	+	Maximum Cable Diameter
(Plus tolerance of bare cable or coating)		(Bare or coated diameter for either)

Pulley grooves, whether machined or molded, must be manufactured to be as smooth as possible along the entire surface. Imperfections or unchecked surface friction can affect service life and performance. If the groove radius changes from contoured to flat, cable life expectancy can also be affected. Two general design rules for groove sizing should be considered:

- The groove should be 150% of the maximum tolerance of the wire rope. This value is then added to the maximum diameter of either bare or coated cable types.
- The groove should make contact with at least 1/3 of the cable's outer circumference.

Cable Jacketing and Lubrication

Cable assemblies are available in a wide range of options with various jacketing and lubrication features. If a cable assembly requires jacketing, then a smooth and durable material is necessary in order to ensure optimal performance between the cable and pulley when subjected to loads. If the material causes friction or experiences degradation and cracking, then power transmission may be reduced.

In addition to jacketing, lubricated cables offer smoother operation and help to increase cycle life. Lubrication ensures that individual cable strands within a cable assembly can withstand the perpetual flexing caused by the back and forth motion over the pulley's groove. Depending on the system's operational environment, lubrication can also help to protect against corrosion.

In static systems, if the cable and pulley do not require repeated flexing, than dry cable is perfectly fine to use with a pulley for most applications.

Pulley Construction: A pulley's overall material and construction quality are vital to anticipating your system's performance needs. Pulleys are available in a variety of types and sizes. They're typically made from metals such as aluminum and steel. They can also be constructed from injection molded Nylon, Acetal, and other thermoplastic resins. Material specifications such as corrosion resistance and mechanical properties must also be considered.

Pulley/Bearing Description	Features	Typical Uses
1. Plain metallic or thermoplastic pulleys	Lowest cost, light loads, low RPM, intermittent operation.	Low frequency drive cable and lift cable applications.
2. Metallic or plastic pulleys with sintered bronze bearings	Self-lubricated bearings, cost-effective, durable, higher load, shock resistant.	Higher RPM, medium load drive, index & lift systems.
3. With open free turning or precision closed & lubricated ball bearings	Minimum friction, precise tracking, medium load, high RPM.	High speed drive, and index cable systems.

For axial and radial load capacities and maximum recommended RPMs, consult individual bearing and pulley manufacturers' literature.

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Pulley and Cable Installation

For maximum performance between the cable and pulley, attention to the overall installation process is critical. Along every stage of the design and selection for both cable and pulley, consider these factors:

- Operational environment: Exposure to corrosion, humidity, temperature, wind forces, UV degradation, chemical substances, and moisture.
- Proper Alignment: Optimal alignment between the mounting area and pulley, the pulley and cable, the cable and the load. In addition, extenuating forces which may affect the ability for the cable to seamlessly travel along the pulley's groove. Make sure to design the pulley system within acceptable fleet angles in order to reduce crushing, abrasion, and cable stacking.
- Load Capacity: Avoiding overloading of the pulley mount, pulley, cable, and cargo in order to prevent failure.
- Cable Life Expectancy: Proper selection of cabling and its installation with the pulley will help increase life expectancy.
- Bearing Life Expectancy: Anticipate all possible scenarios which could affect the pulley's bearing system.
- Proper Handling of Cable Assembly: To avoid premature failure, installations should be conducted that prevent the assembly from being twisted or rotated. If cable strands become unwound or overwound due to twisting, this will have an effect on mating with the pulley and could lead to accelerated fatigue or failure.
- Proper Cable to Pulley Operation: Operational factors such as nicking, kinking, or bending can also create improper groove-to-cable mating, resulting in reduced service life and the potential for system failure.

Contact CMA:

If you have questions or are interested in speaking with us about the proper selection of a pulley for our line of cable assemblies, we are happy to help. Contact us today!

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