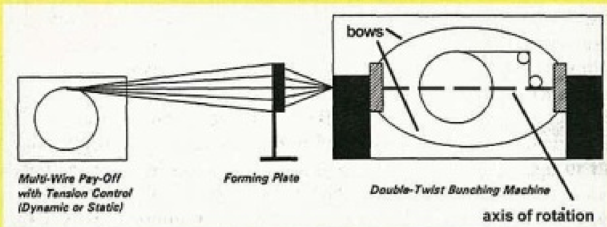
Spotlight On Bows

Michael McNulty, Editor
ire & Cable Technology International

Rotating machines such as stranders, bunchers, twinners and cablers use flyer bows to produce helically twisted wires, conductors and cables. All products being processed on these machines come in contact with the bow. More than half of the power required to run the corresponding machine goes towards rotating the bows. In addition, a good amount of the noise generated by a rotating machine comes from the bow—less aerodynamic bows usually make more noise. Consequently, these bows are pretty important, and they are a main factor in determining the level of success in your rotating equipment operations.

Depending on the machine style, one or two curved bows are attached to the rotating element of the machine. Bows get their name from the way they "bow" out in a curved path when installed—similar to the shapes of bows for hunting or playing musical instruments (violin, cello, etc.). Wire and cable bows, however, rotate at very high speeds, and wires or cables to be twisted travel along the path of the bow before being guided to the pulling capstan and/or take-up reel. The wires or cables are guided along the bow by varying means: eyelets, tubes, strips, rollers, bushings and grooves. With the exception of rollers, all other guiding devices are stationary. For machines that use two bows, the active bow processes the product and the other bow is only used for balance purposes. In a single bow machine, balance is achieved in other ways.



Bows need to stand up to the rigors of stranding, bunching, twinning and cabling. There are multiple forces being placed on the bows during wire and cable processing. These include the following:

- Centrifugal force generated from the rotating bows.
- The force of the wires or cables being pulled through the bow.
- Frictional force on guiding surfaces (eyelets, strips, etc.).
- Forces generated from air resistance.

These forces are fairly complex and vary at different points on the bow. For example, centrifugal force is highest at the center of the bow, and it approaches zero at the points where the bow is attached to the machine body. This is evident when looking at the corresponding formula for centrifugal force:

$$F = mV^2 / r$$

where m is mass, V is velocity and r is the distance from the rotation axis to the bow edge.

Friction changes depending on the materials being processes, the guidance systems employed and the amount of surface contact. Air stream forces are obviously a function of speed and bow design (profile/cross section, for example). Heat is also generated by friction and air resistance. All of this complexity not only means that resources and attention need to be spent on bows, but that many opportunities exist to differentiate operations and levels of performance. For example, power consumption can drop or rise dramatically, depending on the bow used. Because of this, a good amount of research and development is devoted to bow design and manufacture.

There is a wide array of wire and cable designs, sizes and applications as well as the many different types and manufacturers of stranders, bunchers, twinners and cables. Because of this, bow design and constructions is very diverse. This means that selection is not simple, but suppliers of bows can help you sort through the options. Major design variations can be grouped in three categories: bow materials, cross sections and guidance methods.

Bow Materials

In selecting a bow material, a balance between weight, strength, flexibility, durability and cost must be struck. Obviously, weight and cost are desired to be low while the factors need to be as high as possible. The resulting balance point will likely be dependent on many factors including product type and quality level, machine style and performance and manufacturing capabilities.

I have heard of the use of wooden bows on older machines, but in general, bows today are made either from metal or a composite material, and some designs combine the use of both. Common metals used are steel, titanium and aluminum. These are well known materials, each with its own distinct advantages and drawbacks that are well documented. Developments in special alloys include increasing strength while reducing weight. Composite materials are an area of extreme developments over the last few decades. Driven by the aerospace industry and other high attention areas like sports (golf, skiing, biking and car racing, for example), high performance composites are widely available and used extensively in bows.

Composites are defined as engineering materials made from two or more components. One component is often a strong fiber such as carbon fiber, fiber glass or kevlar which gives the material its tensile strength, while another component (matrix) is usually a plastic or expoy

Spotlight On Bows

resin that binds the fibers together. In terms of stresses, the fibers serve to resist tension, the matrix serves to resist shear and all materials together serve to resist compression. There are different methods for assembling the composite materials that are used in bow construction. Examples include braiding, weaving, molding, laminating and layering. Another technique is to use a strength member—a steel core, for example—within a carbon fiber composite to increase strength. A main goal of using a composite is to reduce weight and increase strength at the same time.

Cross Sections

If you take a bow and cut it in a direction perpendicular to the wire path on the bow and look at the end, then you would see the bow cross section. The options range from a simple rectangle with rounded corners to an engineered profile that resembles an aircraft wing. Several designs are patented. Some bows are open—the wires and cables and related guiding hardware are exposed to the air stream—others are closed—the wires or cables are shielded completely—and still other bows employ a channel so that the wires or cables are mostly or partially enclosed and out of the path of air flow. Once again, selection is dependent on many factors, but bow suppliers often have experimental data related to power consumption, friction drag, noise levels and expected speed that can help direct your choice. In addition, internal experimentation is common at wire and cable manufacturing operations, and customized bow sections can be developed.

Guidance Methods

As the ultimate bow would never come in contact with the wire or cable as it was being processed, it is no surprise that there are many different methods for guiding the material along the bow. Low coefficient of friction materials like ceramics, carbides and hardened or coated metals are used to make the eyelets, tubes, rollers, wear strips and bushings that are used in bows. Hardware should be easy-to-install, last long and not harm the surface of the wire or cable. In addition, drag should be kept to a low and string-up should be easy.

Bow Failure

Bows can fail for a variety of reasons including wire breaks, improper balance, tools or other foreign objects left in the machine, poor tension control, wrong size bow, machine problems and improper string-up. Breaking a bow is not desired, but if it happens, then it may break something else. This point should be considered when selecting a bow.

There are many good bow suppliers, and some interesting product development and research is under way. Stay in touch with the experts and improve the performance of bows in your operations. **WCTI**

Article references:
www.enwikipedia.org;
Wire & Cable Technology International, Nov. 2004 issue, pp. 65-69;
websites listing in the Spotlight Ads in this article

Next Spotlight Article:

Reels

November 2005 Issue