FLEXIBILITY VS FLEX LIFE

Key Engineering Considerations

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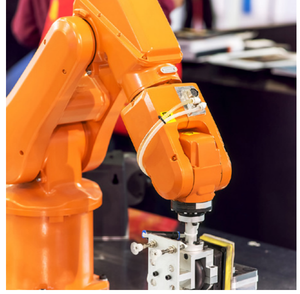
  

While the terminology sounds similar, when it comes to wire and cable design, 'flexibility' and 'flex life' could not be more different.

While cable designers know the truth about the differences between these two performance characteristics, unfortunately, many cable users have made the mistake of assuming these attributes are similar and interchangeable.

Flexibility can be defined as "The quality of a cable that allows for bending under the influence of an outside force". (Often among cable users, the concepts of flexibility and 'limpness' are confused. The characteristic of 'limpness' is often defined as the cable's ability to bend when acted on by its own weight as opposed to an external force.) Flex life, on the other hand, refers to "The measurement of the ability of a cable to withstand repeated bending." The major difference here, and the one which drives design considerations, is the focus around the intended use. Products requiring flex life, by definition, will be used in an abusive environment where the cable will be bent, twisted, or rolled repeatedly. Flexible products, however, are often used in static environments, where they are installed and left undisturbed, or in environments where any movement of the cable is minimal and non-destructive. As such, the design criteria and considerations for each type of cable are quite different.

When the term "high flex life" is applied to a cable, it generally implies that the cable can function for a minimum of 10 million cycles in the use for which it was designed. Applications where a high flex life cable may be required present different challenges for design engineers. For example, the design requirements for torsional flex, where the cable is twisted in a 'wringing' type motion, are quite different from the requirements for 'tick tock' flex, where the cable is bent back and forth at a repeated angle and frequency. The popular C-Track units, where the cable is cycled from a straight orientation to a "C" shape, present yet another set of design considerations. Through all of this, the cable's overall OD (Outside Diameter) also must be taken into account as part of the design calculations.

In addressing the mechanical challenges of a cable product requiring significant flex life, the design engineer will also look to the following areas for the correct solution set:

- Conductor: The copper conductor from the perspective of copper type and stranding play a critical role. The conductor stranding is directly related to the flex life of the product. An improper choice can reduce the cable's flex life significantly.

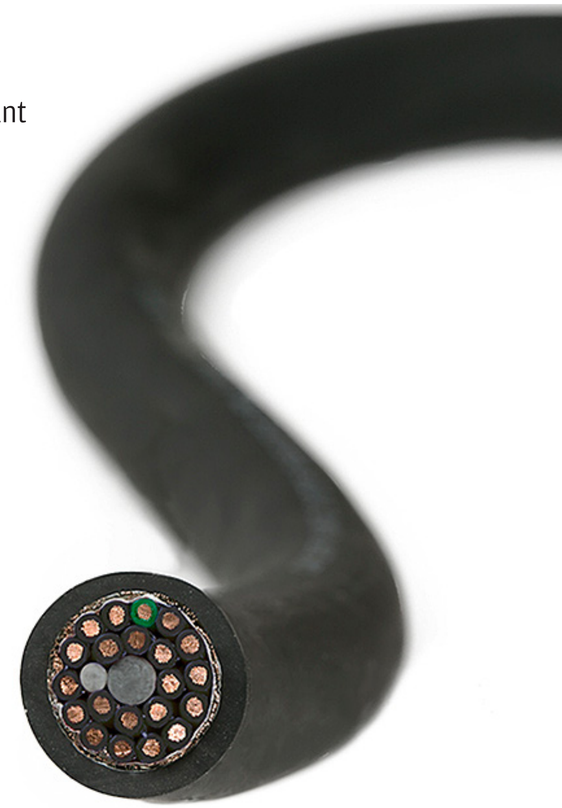
- Insulation materials: This applies to both for the inner primary wires and the overall cable jacket. While the inner insulations must be evaluated for hardness and coefficient of friction based on the application, the overall jacket selection must be able to withstand the challenges of the operating environment.

- Cabling: The choice of the cabling equipment and design configuration of the individual conductors as part of the cable core are important considerations relative to overall cable size, proper internal cable lay, and the minimization of any internal stresses caused by the cabling process.

- Binder Tapes: For static or minimal flexing, standard mylar or thread type binders are proven choices. However, for high flex applications, the binder tapes, specifically specialty tapes comprised of materials with a specific co-efficient of friction, are often utilized.

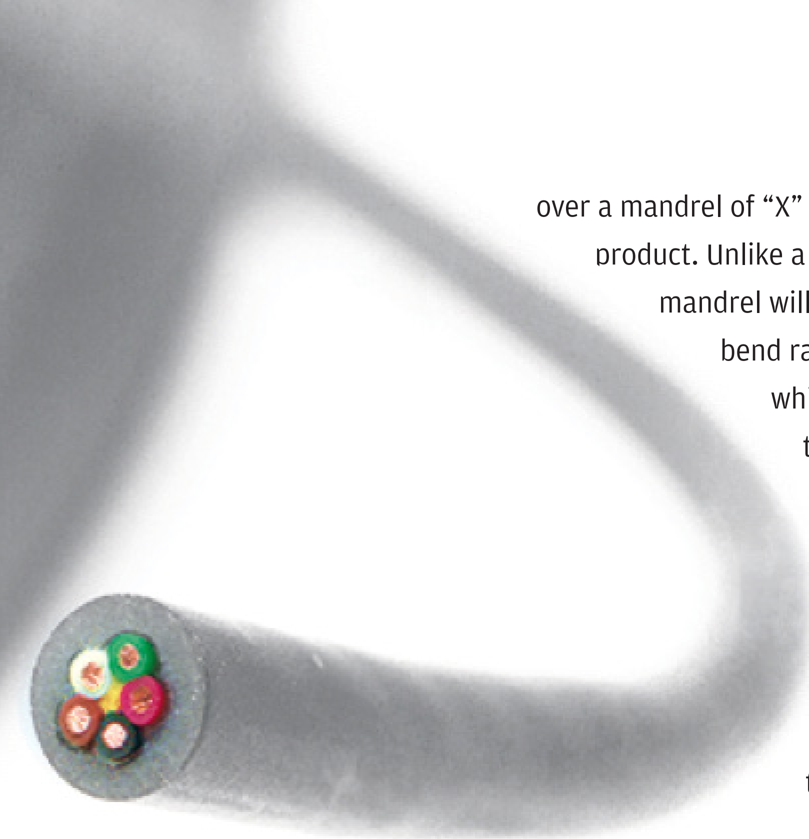
- Shielding: As a general rule, shields of any type do not support either flex life or flexibility. However, in many industrial settings, where cables designed for maximum flex life are often used, shields are required in order to combat the electromagnetic interference ("noise") generated by the environment. When shields are required, their construction in relation the application and the other design choices cannot be underestimated. A signal transmission distorted by environmental interference can create as much down time as a cable that has failed physically in the application.

- Lubricants: If deemed necessary, a powdered or liquid lubricant can be added to increase cable performance. Some lubricant types, while effective, can produce issues during cable termination. For that reason consideration must be given to whether or not lubricants are a necessary part of the design equation.



Regardless of the choice of materials or manufacturing methods, the goal of the design engineer around high flex cables is usually the same: Minimize mechanical stresses within the cable while reducing internal friction to the lowest possible degree.

In looking at the need for flexibility, the design engineer must consider a somewhat different set of variables. While flex life is usually measured in total cycles, flexibility is usually evaluated by its bend radius. That is to say the cables ability to bend



over a mandrel of "X" times the cable's diameter without damage to the product. Unlike a flex life product, the need to bend over the chosen mandrel will not be required on a repeated basis. Often the bend radius is determined by the requirements under which the cable will be installed. For example, a cable that has a functional bend radius of 5 times its cable OD should not necessarily be routed within a piece of equipment where it will be bent at an angle that is only 3 times its OD as it may damage the internal wires or create a "kink" in the cable which could negatively affect overall performance and, more importantly, the cable's usable life.

From a materials and design perspective, the requirement of flexibility presents some of, but not all of, the same challenges as a cable designed for flex life. When evaluating the product from a materials perspective, the designer will be more focused on the material choices around the conductor, insulating materials, cabling equipment and configuration of the cable core, and the shielding materials and constructions. Unlike flex life cables where many cable components carry a similar weight from the design perspective, the greatest effect on flexibility rests with the insulating materials and conductor construction. For example, it is not uncommon for cables to lose flexibility when there is a mis-match between the insulating materials and the environmental conditions.

Occasionally, a composite cable will require design as a high flex life product. A composite cable consists of two or more different types or sizes of wires. For example, instead of 4 conductors of 18 AWG, a composite construction may require 2 individual 18 AWG wires and a twisted pair of 16 AWG. Composite cables can be described as a 'wildcard' in design and a high degree of cable expertise is required to marry the different components into a single high flex life cable product.

The characteristics of flex life and flexibility are two very different concepts and require two different approaches to design. When contemplating what characteristics your cable may require, it is a sound approach to fully understand the application, and then discuss that information with a wire and cable design engineer.

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