To Flex or Not to Flex:
How to Specify a Cable for Flexing Applications

A cable that is intended to be deployed in flexing applications is, by its very nature, a flexible cable—or is it? Actually this is not necessarily true and although many readers may just see this as a simple case of semantics, the truth is that many flexible cables are not actually suited to environments that subject them to constant bending and flexing cycles.

In today's competitive world of highly complex electronics, the possibility of cable failure, or any equipment failure, is never an option. There is no acceptable level of downtime and no one can afford to replace expensive machinery years before its predicted lifespan - not when profit margins are razor thin and competition is breathing down your neck from all four corners of the world.

Still, cables fail and systems go down. Why?

In this article, we discuss the differences between a flexible cable and one that is designed for constant flexing. He also looks at why making the simple assumption that a flexible cable will perform in an extreme flexing application could be a costly mistake.

Flexible or flexing?

Far from being a matter of semantics, there is a big difference between flexible and flexing cables. The ability of a cable to be bent and routed in order to create a clean and tidy dressed installation is, of course, crucial. A flexible quality in a cable allows for much easier installation in applications that require the cable to follow a pre-determined path. It also simplifies troubleshooting in the cabinet and/or cable tray. It should also be noted that a round-geometry cable provides a greater reliability when it comes to bending cables as it does not incline itself to preferential axis bending. With this in mind, routing concerns should lead you to select a cable with the correct level of “bendability” assuming that once routed and installed, the cable will then be static during the life span of its service. If this is the case, then it would be safe to say that a standard cable with a good degree of “bendability” would suffice in this environment.

However, in many manufacturing and material handling applications cables are exposed to constant flexing during their operation. The ability to withstand millions of flex cycles is something far more complex than simple flexibility and comes with its own set of unique considerations.

Multiaxis robots test the flexing mettle of cables

So, how do you specify the correct flexing cable?

The first stage is to consider the type of flexing likely to be encountered by the cable. Is it single axis, torsional or multi axis? Each requires a specific set of cable attributes. For example, single axis control cables, demanding the most extreme performance (up to 14 million flex life cycles); require a flexible cable construction rated for continuous flex operation and may also require continuous flex shielding. In less demanding single axis environments, look for a cable that has a minimum of 1 million flex life cycles and flexing style constructions.

There are four common types of cable flexing movements to consider when designing and applying a high-flexing cable and they are:

- Rolling flex
- Bending flex or “tic-toc”
- Torsional flex
- Variable/random motion flex

Different cable construction methods and materials are used depending on the cable flexing movement. For example: torsional cables will have a different lay length and cabling method from a rolling flex cable. The performance of a cable is evaluated using physical test data and statistical analysis to produce what is known as “flex life” and overall system reliability.

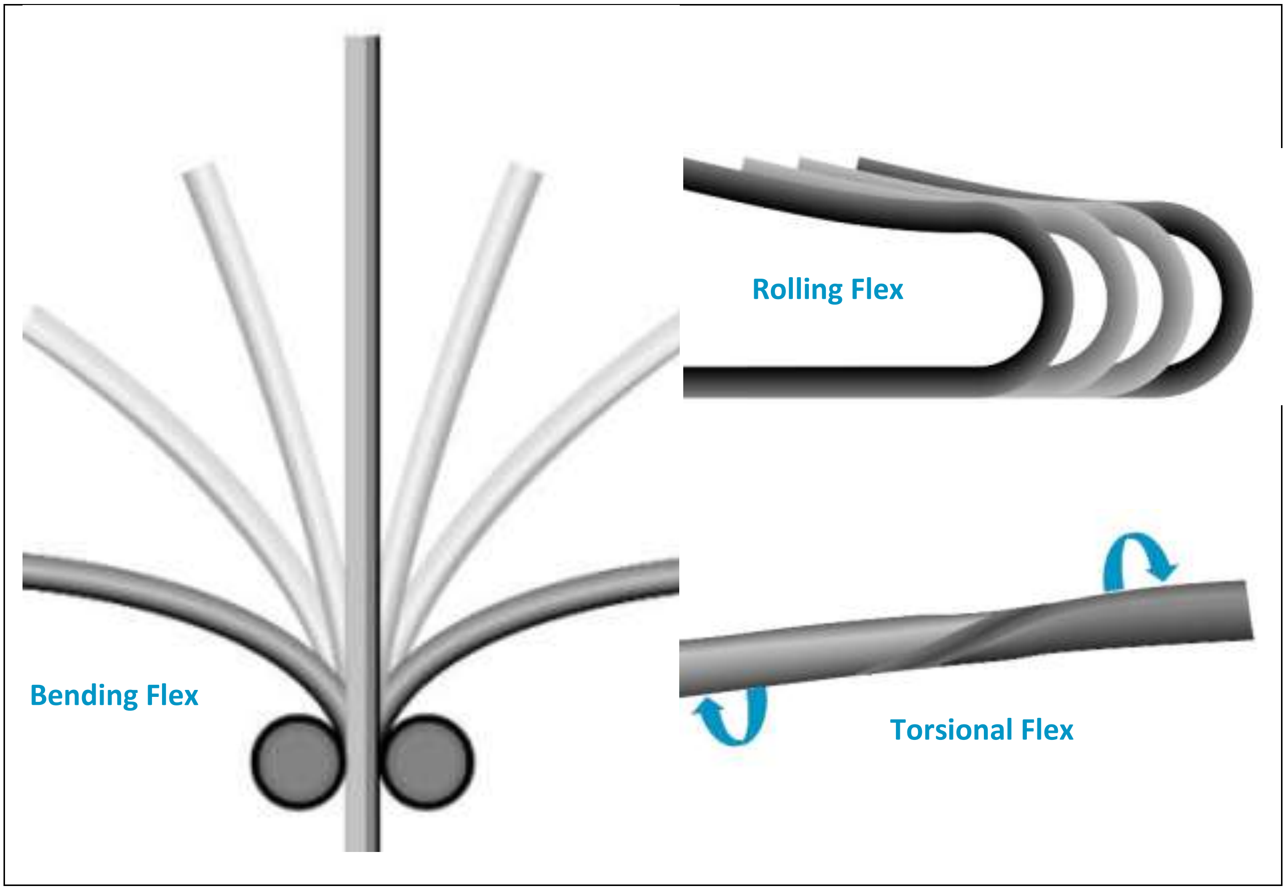
An understanding of the cable's application will allow the designer to choose the correct cable and reliably predict the product's lifespan and performance. In applications where the cables will be subject to torsional or variable flexing (such as can be found in robotics), it is essential to specify sophisticated cables capable of twisting and random robotic flexing operation of ±360 degrees per meter.

Cables today are often required to perform under incredibly severe flexing situations. One such situation is cable or C track installations which experience continuous flexing - linear motion.

Cables that are designed to withstand this type of arduous life employ unique manufacturing properties and materials. This is because one of the key factors in cable failure in flexing environments is the breakdown of the jacket materials, and particularly the shielding, as it is exposed to the differences in bend radiuses on the inner and outer surfaces. As there were no readily available flex test machines that would adequately quantify cable performance under accelerated conditions of continuous flexing-linear motion, Alpha Wire developed and built their own testing machine which is still in use ensuring that its cables are able to meet the rigors of harsh flexing environments.

This machine is capable of providing accelerated cable track motion for a protracted period of time and has been used to test numerous continuous flexing-linear motion cables. Operating at a fixed 17 cycles per minute, or 1,836,000 cycles per month, the only variable is the bend radius of the C tracks in which the cables are installed. It has four tracks into which cable is installed. Two tracks use a 4.5-inch radius while the remaining two have a 6-inch radius. Under test, the conductors within each cable are electrically interconnected to each other, in series, and to a counter that registers a single count for each completed cable flex cycle. This continues until one of the conductors in the cable breaks. This constitutes a failure and causes the counter for the sample to cease counting. A cable is also deemed to have failed if there is any visible cracking or splitting of the outer jacket.

While there is no way, at this time, to relate flex test performance to cable life, Alpha Wire believes that its test protocol is significantly more severe than most real-world C track installations seen today.



The type of flexing influences cable choice

Perhaps the best way to illustrate the importance of correctly specifying the correct cable is to use a real-life customer application as an example.

The customer was a well-established automobile assembly plant that had just purchased a number of paint-robots to automate the paint spraying process. When the robots were first put into service during the engineering performance and validate performance runs, the robots were failing during the first few days. Following several attempts and closer inspection, the failures were attributed to repeated cabling failures (they were not Alpha Wire cables!). At this stage, Alpha Wire was called in to look at the issues surrounding the installation and discuss the situation. The engineers analyzed the failures, reviewed the robots' movements and consulted with the plant personnel who were involved with the equipment to determine the exact problems and thus what would be required from a cable to prevent these problems from re-occurring.

There were a number of problems that could be identified, but by far the most problematic was their use of a cable recommended, but obviously not tested, by the robot manufacturer . . . a basic flexible cable!

The cable had done a fine job of contouring easily around cabinet corners and dress-out in an installation which always looked clean and aesthetically pleasing. However the cable was not able to continually flex in any plane, meaning that it simply failed after a short while. The problem was solved by designing and building a tailor-made flexing cable to meet the very specific system requirements of the customer's extreme application. The new cable was installed on a single robot to test and then rolled out across the rest of the systems. The net result is that the robots have now been running for nearly two and a half years with no cable replacements required.

Conclusions

Understanding exactly what will be required from a cable during its lifespan enables designers and system builders to be sure that any system failures will not be caused by the cable. However, knowing which cable is right for any given application is not always as straightforward as it seems. Cable companies need to address this by making the process of specifying the correct cable type from the outset as easy as possible. In order to facilitate the complexities of finding the correct cable, Alpha Wire offers interactive online parametric selection at www.alphawire.com. In this area users are able to enter environmental parameter requirements, in terms of operating temperatures, chemical resistance, abrasion resistance, flex requirements and so on. The guide then recommends the exact cable type to match the application's extreme environment.

In summary, specifying the correct cable from the outset reduces the risk of cable failure and ensures that productivity and performance are protected. With this in mind, the question “to flex or not to flex” becomes a critical decision!

GLOBAL HEADQUARTERS
711 Lidgerwood Avenue
Elizabeth, NJ 07207-0711 USA
Toll Free: 1-800-52 ALPHA
Tel: 1-908-925-8000
Fax: 1-908-925-5411
E-mail: info@alphawire.com

EUROPE
Alpha Wire International
Sunbury Int’l Business Centre,
Brooklands Close Windmill Road,
Sunbury-on-Thames, Middlesex
United Kingdom TW16 7DX
Tel: +44 (0) 800 288 8809
Fax: +44 (0) 800 288 8810
E-mail: europe@alphawire.com

ASIA PACIFIC
Alpha Wire
Silver Center, Suite 1708
North Shanxi Road 1388
Shanghai, China
Tel: +86-21-61498201/61498205
Fax:+86-21-61498001
E-mail: apac@alphawire.com

Lit. No: ToFlex-WP-1011
Supersedes: ToFlex-WP-0905