Flexible Drives

flexible shafts

The truly flexible alternative to couplings and universal joints and shafts

General Product Information

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A flexible shaft makes it possible to
- **transmit power**
- **between two points**
- **regardless of their relative positions.**

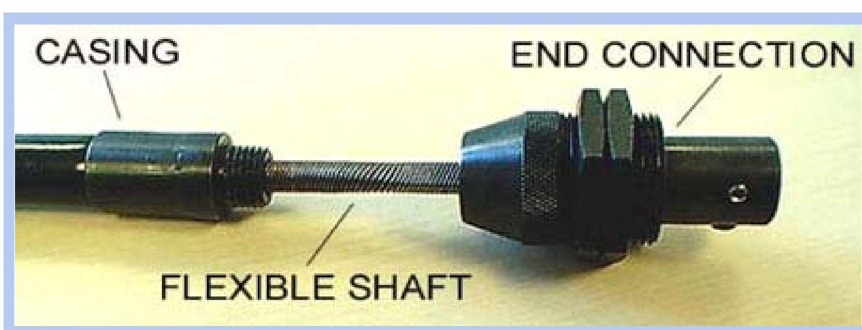
Use flexible shaft to transmit rotary power around a curve!

- **Advantages**

Design freedom	Design your system and place your driving and driven elements in the preferred position.
Design simplicity	No need to spend precious time ensuring tight drive system tolerances. Flexible shaft take up large misalignments by design
Moving parts	Ideal for hand tools or situations which involve constantly changing positions.
Dampens vibration	Tolerates vibration
Reliable	Minimum moving parts ensures reliability through simplicity
Bi-directional	Designed to deal with the most complex design requirements
Safe	Supplied as a self-contained drive the system is fully contained
Simple installation	Flexible to allow installation in the smallest of spaces.

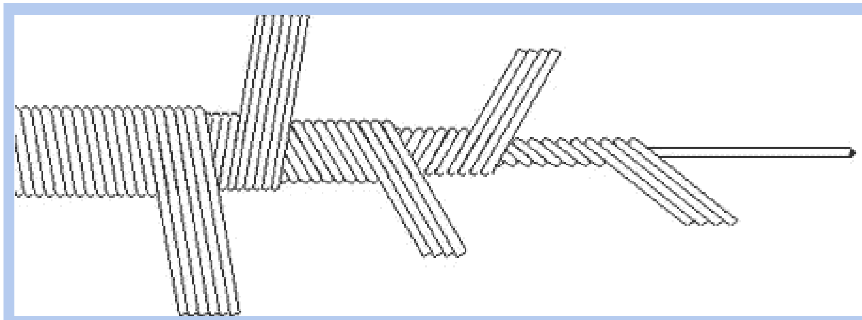
- **Basic structure**

A complete flexible drive will usually be made up of:



- A flexible shaft. This is the part that does the work and transmits the rotary motion.
- A flexible casing. This contains the flexible shaft and prevents excessive twisting under load.
- End connections. These are usually required to connect to the driving (e.g. motor/hand wheel) and driven (e.g. gearbox, valve) elements of the system.

Flexible shaft is built by winding one layer wire over another with a single wire or 'mandrel' in the centre. Successive layers alternate in pitch and direction.



Typical combinations are:

- The shaft only – with machined shaft ends attached or a squared formed onto the end of the shaft.
- The shaft and casing only – as above but with the addition of a casing to restrict shaft twisting.
- A complete flexible drive as described above.

MasterFlex® and LinkFlex® Industrial flexible Industrial shafts incorporate the latest advancements in flexible shaft design and construction and are manufactured using high tensile wires in carbon or stainless steel.

The characteristics of a flexible shaft are determined by the combination of the following factors:

- Grade of wire
- Number of layers
- Size of wire
- Number of wires in each layer
- Built-in tension

Varying the combination of these basic characteristics produces different types of shaft.

At one extreme is a shaft with maximum torsional stiffness, or resistance to twisting under load, giving minimum flexibility; at the other extreme is an

exceptionally flexible shaft which low torsional stiffness.
Between these extremes are many flexible shafts designed to meet our customer's requirements.
Factors that affect the design and application of a flexible shaft are discussed below:

- **Load (Torque)**

The load to be moved is normally expressed as the torque required to move the load.
The torque that a shaft must transmit is the principal factor in shaft selection. The torque requirement should be the maximum anticipated and, where possible, determined by direct measurement.
There is a distinct advantage in operating a flexible shaft at the highest speed conditions will permit, as the higher the speed the lower the torque on the shaft.
Other factors to consider are starting torque, reversing shocks and fluctuating loads all of which may constitute overloads on the shaft.
Where the overload strains on the shaft are not severe the factor of safety will generally be sufficient.
Where these factors are substantially more than normal running torque loads then a shaft capable of carrying these loads must be used.

- **Operating speeds**

Ordinarily, speeds of 1 – 3600 rpm are recommended as being well suited to flexible shaft operation.

Shafts of a larger diameter when run in a curved condition speeds should not exceed 152 surface metres per minute because of the possible excessive heating.

This maximum surface speed for any given shaft may be translated in r.p.m. by using the following formula:

$$\frac{152000}{3.14 \times d} = r.p.m \quad \text{(Where 'd' is the shaft diameter in mm)}$$

However, there are many applications where speed exceeds this guide and these figures represent a general rule for obtaining the best service life.

- **The use of gearing**

It is common practice, where standard motors are used, to introduce gearing to increase or decrease the ultimate speed of the operated device or tool.
Bearing in mind the desirability of always running a flexible shaft at the highest practical speed, it follows that in every case where gearing is used it should be located so that the flexible shaft operates at the higher speed.
Where gearing is introduced to reduce speed it should be placed at the driven end of the shaft; to increase speed place the gearing at the motor end.

- ## Curves in the shaft

Since the flexible shaft was developed primarily as a means of transmitting power under conditions that make it impossible to use a solid shaft, most applications involve curves.

These applications may be divided into two types:

1. Those in which the shaft operates in a given position and the curve or curves in the shaft remain fixed.
2. Those in which there are relative movement between the driving and the driven elements, and the curvature of the shaft is continually varied.

Each shaft has a recommended minimum operating radius. This is the radius of the smallest curve in which the shaft should be operated. It varies with the type of shaft and the shaft diameter. Figure quoted for MOR includes a suitable safety factor.

A shaft should not be bent in a curve of smaller radius than its recommended minimum. The main consideration with respect to curves is their effect on the torque capacity of a shaft and on its service life. The torque capacity and service life of any given flexible shaft decreases as the radius of the curve is reduced. Therefore in working out an application the rule is to design all curves with the largest possible radius the application will permit.
Where conditions impose more than one curve in the shaft the radius of the smallest curve should be used as the basis for selecting shaft.

- ## Direction of rotation

The pitch of the outer layer of wires determines the direction of rotation in which the shaft will give the best results. The shaft should be rotated in the direction that tends to tighten up its outer layer. When the shaft is operated in the opposite direction the torque capacity is generally reduced by 50%.
However, this reduction in torque capability is less severe in the range of the bi-directional shafts.

- ## Installation and care of flexible shafts and casings

1. Never bend a flexible shaft, or a casing with a shaft inside it, in a radius smaller than the ‘minimum operating radius’ of the particular shaft.
2. Do not subject the shaft or casing to unnecessary end pull or compression. Excessive tension on shaft or casing may cause permanent damage.
3. When installation is made, check for correct protrusion of shaft fittings to ensure proper engagement with mating parts.
4. After one end of a flexible shaft combination has been attached at the driving or driven end, be sure the shaft rotates freely before attaching the other end. Also, make certain that end fittings are properly engaged at both ends and that the shaft is not cramped in the casing.

5. Keep the flexible shaft and inside of casing free from dirt and grit.
6. Securing the casing with clamps at suitable intervals is desired in all fixed applications.
7. Frequent lubrication of flexible shafts is not always necessary except with large diameter shafts. Steel flexible shafts should always have a thin coating of grease to prevent corrosion.

- **Lubrication of flexible shafts**

Flexible shafts generally require periodic lubrication. The frequency of lubrication depends on the nature of the service. Where the shaft operates for long periods or is subjected to considerable flexing during operation, the lubrication should be more closely supervised.

General lubrication – the following procedure is recommended:

1. Remove the shaft from the casing. Clean both the shaft and inside the casing thoroughly by washing in a degreasing agent.
2. Drain the casing and dry the shaft.
3. Coat the entire shaft lightly with a good grade of grease. Contact our service department if you require details of the grease originally used. Grease as the shaft is assembled into the casing. Do not force grease into the casing with grease guns or pressure lubricators.

We can also supply a range of stainless steel flexible shafts which require, when used in our new flexible drive systems, no grease.

- **What next?**

If you are planning to use a flexible shaft in your application or now realize that our flexible shaft will solve your engineering problem then use the technical data of our **MasterFlex®**.
These drives are standard products that, if not suitable, can be adapted for your application.
If you require a more bespoke solution you can use the performance data quoted for the **MasterFlex®** drives as a guide to typical flexible shaft performance.

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