Flexible shafts

Flexible drive shafts are used in place of bevel gear units, chain couplings, universal joints, etc. in applications involving angle problems, confined spaces, free movement requirements and products which vibrate.

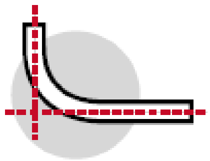
Examples of applications

Power transmission in machines (e.g. for grinding, drilling, milling machines, packaging machines, printing presses), also ideal for trimmers, concrete vibrators, etc.

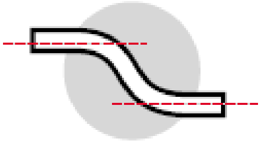
Introduction:

Flexible shafts are extremely rugged, high longevity components that permit continious work operations even in high speed ranges (up to 50 000rpm)

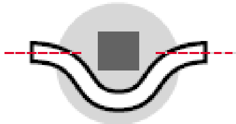
The following examples indicate a few of the possible uses:



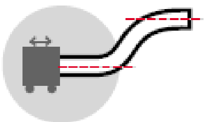
For substitution of unprotected or complex drive units, like (Angle gearboxes, chain hoists, universal joints, etc.)



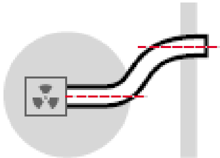
When there is little or no accurate alignment between the power source and the driven part.



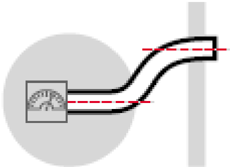
Transmission of mechanical rotary power where a straight line connection is not possible.



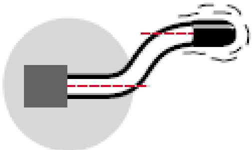
Connection or driving of components which have relative motions.



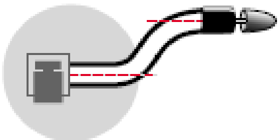
For operating machines at hazardous locations



For mechanical or manual operation of tools from a remote drive.



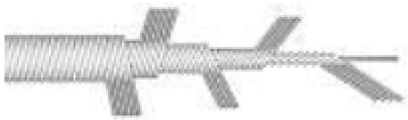
To dampen and absorb vibration from both the drive unit and the tool.



To reduce weight in case of handheld tools, etc.

Types of flexible shafts

Transmission and high-torque shafts



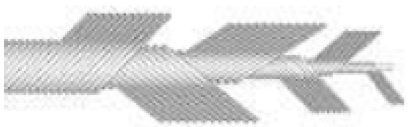
Applications:

Power transmission in machines (e.g. for grinding, drilling, and milling machines, packaging machines, printing presses). Also ideal for trimmers, concrete vibrators etc.

Features:

High flexibility, high rpm according to application, shock absorption.

Torsion shafts



Applications:

Remote control operation of valves, filling machines, adjustable seats etc. These shafts are used primarily for transmitting very high torques at relatively

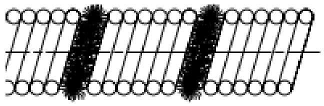
Speedometer shafts

Applications:

Driving speedometers and counters, general power transmission applications.

Features:
High flexibility, low in noise emissions and vibrations through precision winding with uniform distribution of wires, in conjunction with special heat treatment.

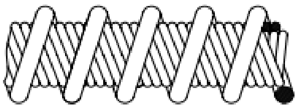
SU-Flock shafts



Applications:
Automotive and aircraft seat adjustment technology.

Features:
Very low noise emissions.

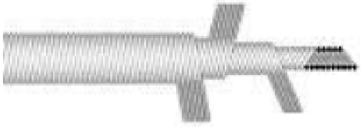
SU-Flex shafts



Applications:
For linearly controlled movements, e.g. of window lifters, for opening and closingsunroofs, but also for a diverse range of other industrial applications.

Features:
Suitable for both rotational and linear movement applications.

Hollow shafts



Applications:
Orthopedic equipment, transmission of rotary power with electrical or optical wires guided through the middle.

Features:
Hollow inside, very smooth rotation, very flexible.

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Design and selection of flexible shafts

Prerequisite to the selection of flexible shafts is a knowledge of the operational requirements, i. e. in particular the maximum torque and the power to be transmitted, as well as the operating speed.

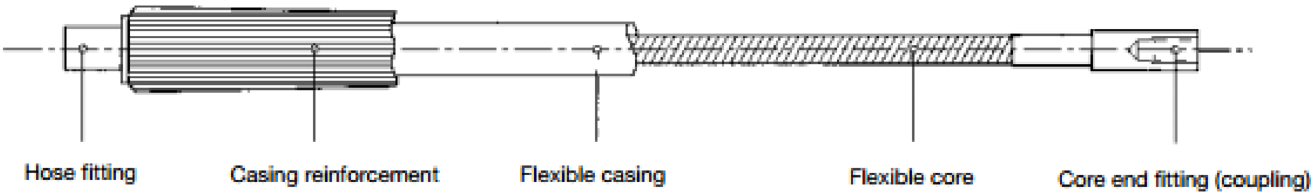
Selection sequence:

1. Clarify operational requirements.

2. Select flexible shafts using the tables and power transmission chart.

3. Select protective hose and end connections

Components of a flexible shaft



Torque

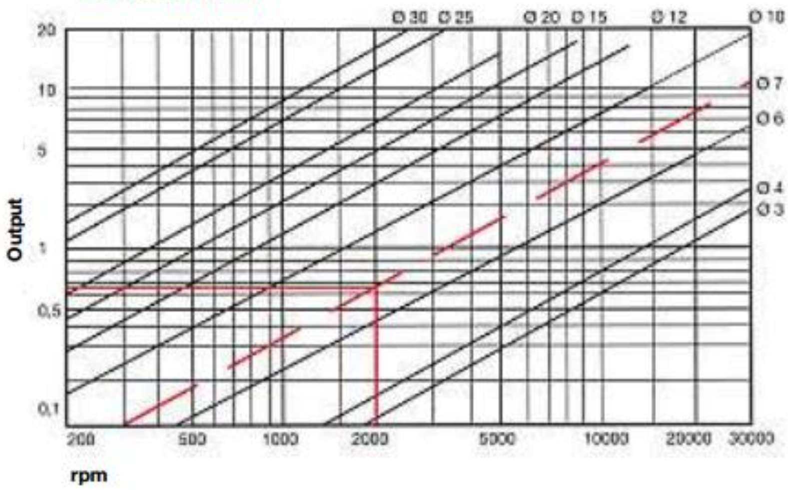
The torque to be transmitted and the matching shaft core size (and derived therefrom also the protective hose) can be determined on the basis of the power and the speed using the formula given below. The values indicated in the size tables apply for speeds of 20% of maximum speed and with straight installation conditions. At higher speeds the maximum torque decreases proportionally. The maximum admissible torque as specified in the table may not be exceeded, because it can cause permanent deformation of the shaft.

$$Md\ [Ncm] = \frac{P\ [kW] \cdot 955\,000}{n\ [min^{-1}]}$$

Power rating:

Each shaft has a maximum transmittable power rating which is shown in the chart below.

Core diameter [mm]



Example:
2000 rpm at 0,65 kW
Shaft Ø obtained: 7 mm

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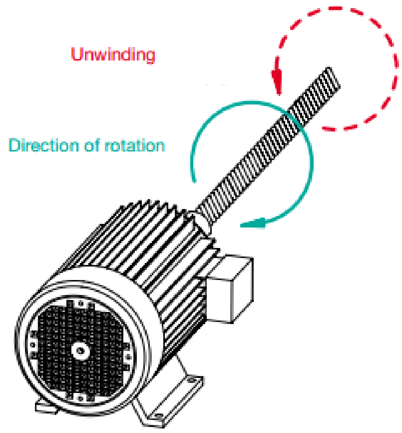
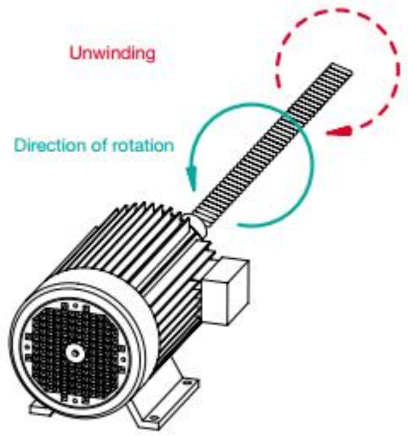
Design and selection of flexible shafts

Direction of rotation

Flexible shafts differ both in their construction and in their direction of winding. A left-wound shaft (related to its outermost layer) can transmit a higher torque in clockwise direction than in counterclockwise direction; a right-wound shaft can transmit a higher torque in counterclockwise direction. Depending on the shaft construction, the shaft can have approximately the same strength in both directions.



Outermost layer **left-wound** for operation in **clockwise** (right-hand) **direction**



Outermost layer **right-wound** for operation in **counter-clockwise** (left-hand) **direction**

In-service geometry

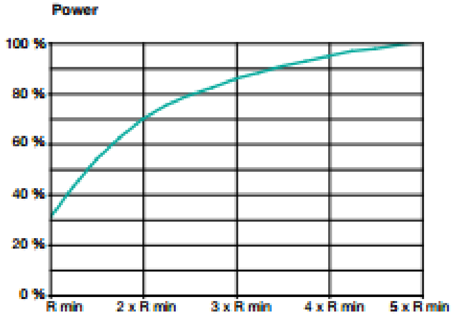
Since the in-service geometry affects the transmittable power, flexible shafts should be installed with as large radii as possible.

Influence of bend radius on transmittable power

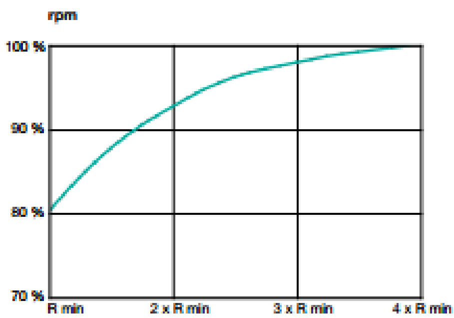
The torques and speeds indicated in the table are applicable for operation in a relatively unbent condition. If the shaft is operated strongly bent, the values will fall below those indicated. The diagrams given below show guideline values for the maximum admissible power transmission in function of operating radius.

Minimum bend radius

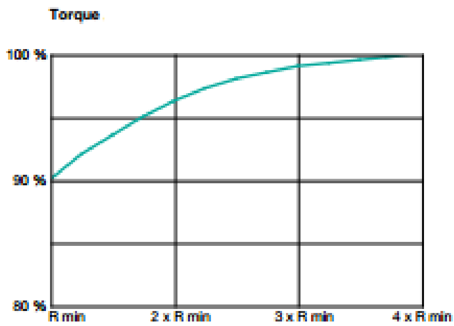
The maximum admissible operational shaft bend radius is designated the "Minimum bend radius".



Bend radius/power transmission ratio



Bend radius/rpm ratio



Bend radius/torque ratio

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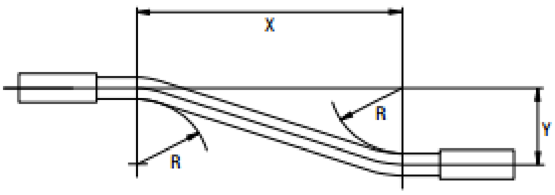
Design and selection of flexible shafts

In-service radius

Since flexible shafts lessen the need for exact alignment of motor and tool unit, simplification of the tool design is achieved. In the case of parallel misalignment of drive and tool unit the bend radius can be calculated as follows:



$$R\ [\text{mm}] = \frac{x^2 + y^2}{4y}$$

Special operating conditions

Attention must be paid to the environment in which the flexible shaft will be used. For example, extremely high or low temperatures, moisture, corrosive influences, dust, magnetic fields, vibrations, etc. Such factors can influence the choice of materials for core and casing and their fabrication. Our technical departments will gladly offer their advice.

Important criteria

- The following clarifications of choice of
- core, casing end coupling should also be
- made:
- Longevity
- Flexibility
- Continuous or intermittent operation
- Fast toolholder change
- Shaft related to coupling or slide length
- Difference in length of core and casing

Torsional deflection

Corresponds to the angle of torsional deflection of a shaft under load. The desired maximum degree of torsional deflection is one of the parameters governing the required diameter and type of the shaft. The angle of torsional deflection is proportional to the torque and the length of the shaft.

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Design and selection of flexible shafts

Reduction in degree of torsional deflection

The degree of torsional deflection in a flexible shaft varies proportionally with the torque. To keep the deflection, and the load as well, as low as possible, the flexible shaft should be operated at highest possible speed. If the speed is increased, the gearbox should be on the motor (drive) side; if it is reduced, it should be on the tool side.

Speed

The maximum speed of a flexible shaft is indicated in the table. The admissible speed is a function of the installation situation and of the torque to be transmitted.

Shaft guiding

As a rule of thumb: The shaft should be guided from 20 to 30 x ⍰. Not every protective casing is suitable for all applications
(e.g. friction heat). For the shaft diameter to casing inside diameter ratio, as a rule of thumb 1:1.2 can be assumed.

Length

In practice, depending on application and shaft diameter, flexible shafts with lengths of up to 15 m have proven successful.

Casings

In the case of high-speed rotary cores and cores longer than 5 to 8 cm, a protective casing is recommended to assure:

- Safety protection of personnel and equipment.
- Ability to handle shaft while running.
- Protection of the rotating core and retaining of shaft lubrication.
- Continuous guiding and support of the core. (Torsion shafts can be secured with guide rings.)
- Smooth operation.
- No “looping” of the rotating core during operation under torsional load.
- Shock absorption and absorption of push-pull forces.

Servicing

The service required depends on the prevailing working conditions. With normal use without adverse conditions (moisture, heat, dust, etc.), the core should be cleaned and greased after about 200 operating hours. Under extreme conditions, e. g. wetness, cleaning and greasing are recommended after 50 operating hours.

Power drive core

Construction
4 to 8 high tensile strength wires per layer.

Applications
Power transmission in machine-building and seat adjustment applications, hand tools, concrete vibrators, etc.

Features
Very flexible, high rpm operation, shock absorption, quiet and vibration-free operation.