# Overstressing your mill? Beware of the weakest link

*Universal joint upgrades are necessary for high-torque and high-speed operations*

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*Doing more with less is nothing new, but it takes a toll on the equipment. Getting more out of a tube or pipe mill stresses everything, and even if the motors, shafts, and gearboxes are up to the task, the universal joints are likely to suffer. Upgrading the universal joints can help in high-stress situations.*

A leveler shaft uses two universal joints to deliver torque from one level to another. This one is spring-loaded for fast installation or replacement. The spring-loaded feature eliminates the need to dismantle other portions of the drive system.

Manufacturing tube and pipe is relentlessly competitive, and it's common practice that tube and pipe producers coax from their mills every bit of productivity that they can. Often this means running at ever-higher line speeds, making products from higher-strength materials, and stretching the time between maintenance intervals. This takes a toll on the equipment and can result in accelerated wear throughout the system. It can also reveal weak links, and in some cases, these are the universal joints. Changing to a more robust universal joint becomes necessary when pushing the mill hard.

The two choices are pin-and-block joints, which are suited to high-torque situations or installations in which space is restricted, and needle-bearing joints, which are more suitable for high-speed applications, but require more space than the pin-and-block type (see **Figures 1** and **2**).

However, these are just guidelines. Every application needs a thorough evaluation to determine the best type and size.

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## Primary Factors

Several main factors determine the type of universal joints to be ordered and the extent of customization. The most crucial factors are the amount of torque the joint will have to tolerate, outside diameter (OD), revolutions per minute, the angle of mating shafts, and the space in which the component operates.

The amount of torque usually is the most important aspect of selecting a universal joint. For a given torque rating, a pin-and-block joint takes up less space than a needle-bearing joint, which is why the pin-and-block design is favored for high-torque applications when space is restricted. Pin-and-block joints are designed to maximize the yoke's OD, which increases the joint's breaking torque capacity while typically maintaining a smaller working envelope than a needle-bearing joint. For example, leveling processes are the highest-torque applications, requiring extremely robust universal joints with an OD as large as 8 inches. Additionally, roll size and material thickness determine the amount of torque applied to the component.

The available space for the universal joint is especially relevant today as machines are expected to occupy an increasingly smaller footprint. Even within those space limitations, for instance when multiple leveling rolls are present, components must be strong and robust. The joint should be as large as possible to maximize robustness, as long as the OD doesn't interfere with surrounding machine parts.

Universal joints are designed to offset various degrees of operational angles among mating shafts. Since small joints occupy less space, they can operate on greater angles than larger ones. Pin-and-block joints, however, tend to require a reduced angle for optimal operation. Specifically, the reinforced ear profile of the yoke increases the torque capacity but limits the angle of operation.

Line speed is another critical factor. High-speed applications generate friction and, thus, heat. Heat can become so excessive that even lubricants or oil drips cannot cool the parts adequately and may pose a considerable fire hazard.

Pin-and block-joints develop considerable surface friction so they can handle moderate rotational speeds. If space allows, lubricant-retaining boots can be added to offset friction and extend the joint's service life. Alternatively, oil baths, drips, and other lubrication systems are helpful.

Applications that run at high speeds and thereby generate significant friction and heat are better served by needle-bearing universal joints. Needle-bearing joints are equipped with roller bearings that minimize friction on the moving parts and reduce heat generation. Some types of needle-bearing universal joints are pre-lubricated and sealed for the life of the joint, requiring no maintenance in the field; others are equipped with grease fittings for lubrication at scheduled intervals.

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**Figure 1**
The design of a pin-and-block universal joint contributes to its robustness. It tends to be the best choice for high-torque applications.

## Related Factors

0ther factors also come into play. Usage pattern, for example, helps to determine the best type of product to install. Does the machine operate continuously or intermittently? If intermittently, does it use hard stops? Hard stops often apply high torque and aggressive force to the components, which would make pin-and-block joints a more suitable choice. Ideally, drive shafts subjected to such drastic force should incorporate a fail-safe solution. In the event that the application seriously exceeds the joint's rated torque capacity, imposing unforeseen failure, the drive shaft should be designed to fail and stop in a safe fashion. This is preferable to—that is, less expensive than—overtorquing the gear box and ruining the motor.

Many grades of steel are available for making universal joints. Higher grades of alloys make stronger components. For example, universal joints in demanding leveling applications typically require the highest grades of steel. In addition, components can be hardened, heat treated, and precision machined to close tolerances to further increase strength, durability, and performance. End bores can be customized to fit any application and can be "blind" to a specified bore depth, rather than through-machined, for additional strength and durability.

Ease of maintenance is a crucial but often forgotten aspect of part selection that should be considered in the design phase. If the operating environment is laden with abrasives or dust, ease of lubrication helps the maintenance technicians stick to the maintenance schedule. Lubricant-retaining boots help to extend the life of moving parts and reduce the joint replacement frequency. When replacement is necessary, drive shafts that compress and expand for easy-on and easy-off operation do not need tools and take less time to replace.

**Figure 2**
Although a needle-bearing type of universal joints has many more components than a pin-and-block style, friction isn't a problem. This style is preferred for high-speed applications.

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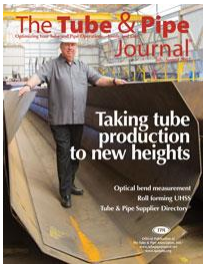


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