Products for Steel Production Equipment

Koyo

# Drive shafts for steel production/ industrial equipment

JTEKT

JTEKT CORPORATION

JTEKT

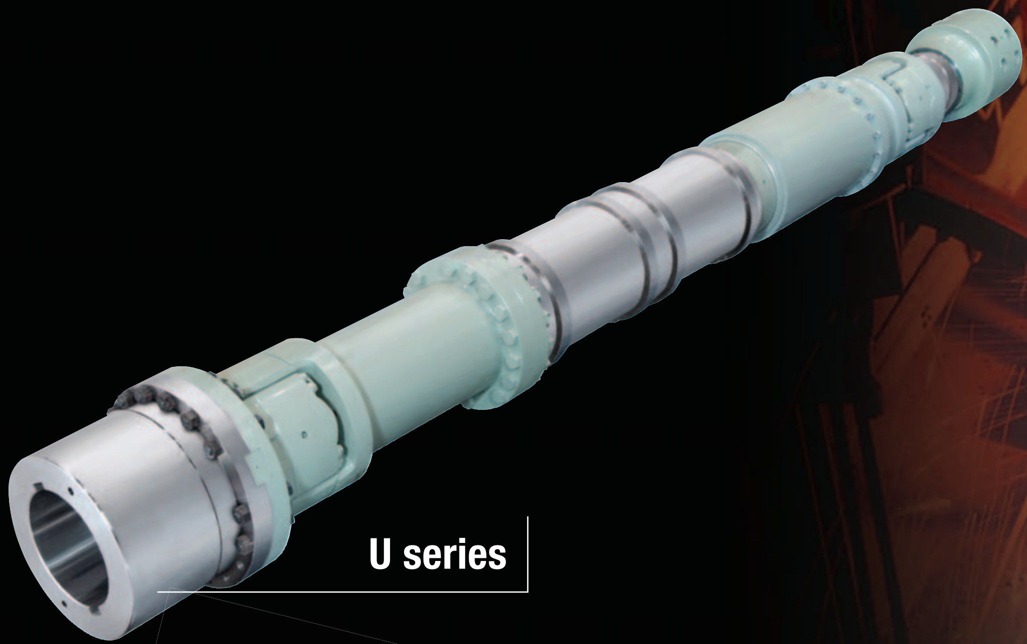
Koyo TOYODA

CAT.NO.B2021E

# Drive shafts for steel production/ industrial equipment

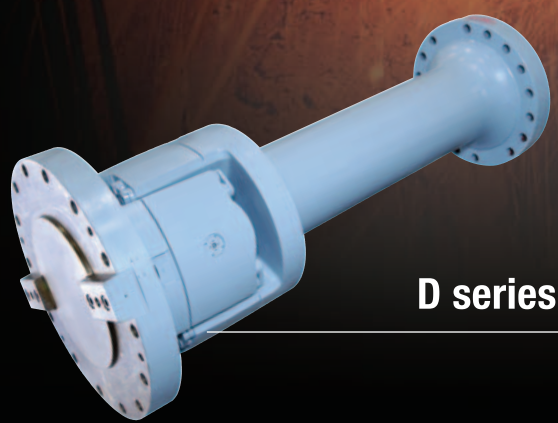
## Preface

Throughout the manufacturing industry the pursuit of greater power output at higher efficiency is a priority. Under such circumstances, highly sophisticated and economical drive shafts that fit in a limited space are in great demand for use in various equipment and machines.
Drive shaft lineup is certain to satisfy your requirements in various applications, including iron manufacturing machines, rolling mills, construction machines, and rolling stock.
We thank you in advance for your support of our drive shafts.



U series

EZ series



D series

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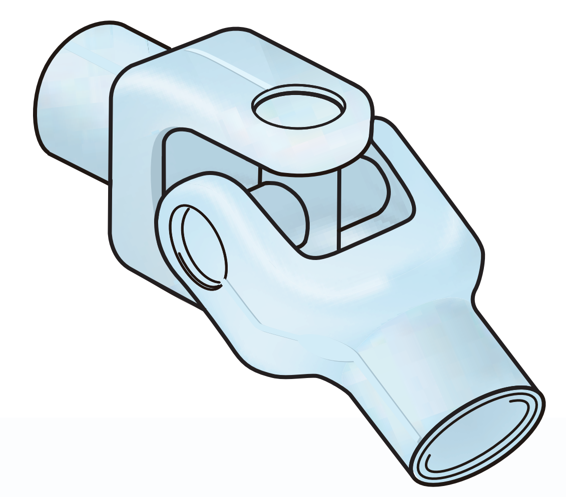
T series

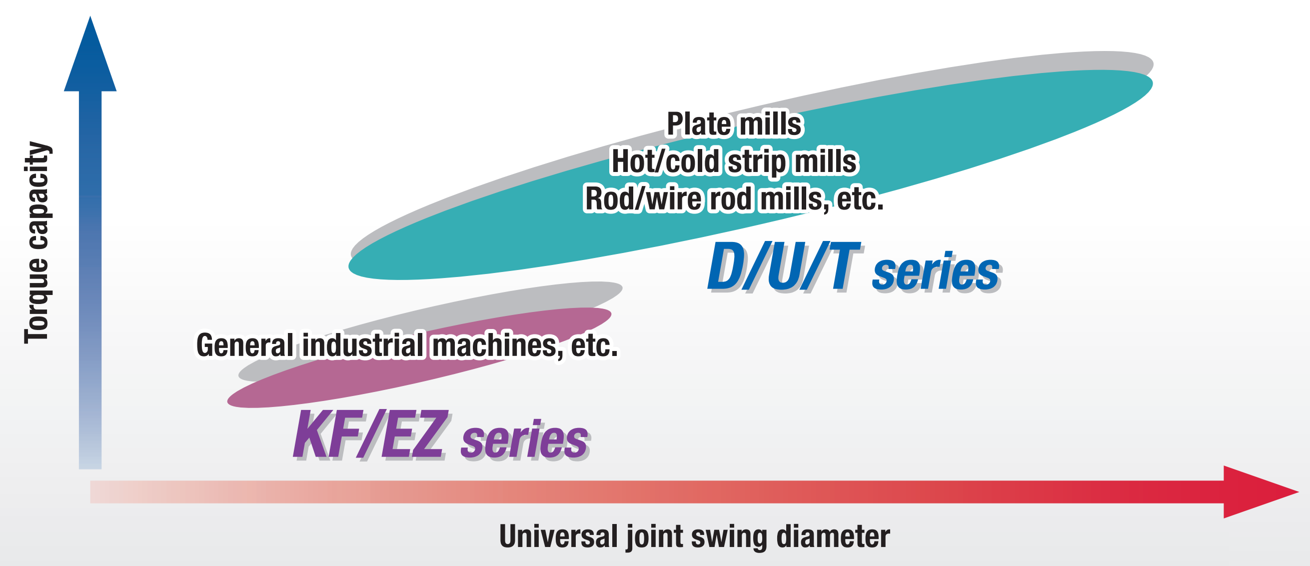
KF series

## Functions

A drive shaft is a revolving shaft used to transmit the power of a motor to a machine.
Since it is installed in a limited space, the axes are seldom aligned.
However, by using a universal joint, the input axis and the output axis can be flexibly connected even in a limited space, enabling smooth torque transmission.
Each universal joint has four rolling bearings (cross & bearing), realizing low friction and minimizing torque losses.


Universal joint

## Position of each series of universal joints




## Configuration of parts

1) Cross & bearings
The cross & bearings are the most critical components of a drive shaft.
A cross & bearing has a cross-shaped shaft and four rolling bearings that individually support each end of the shaft.

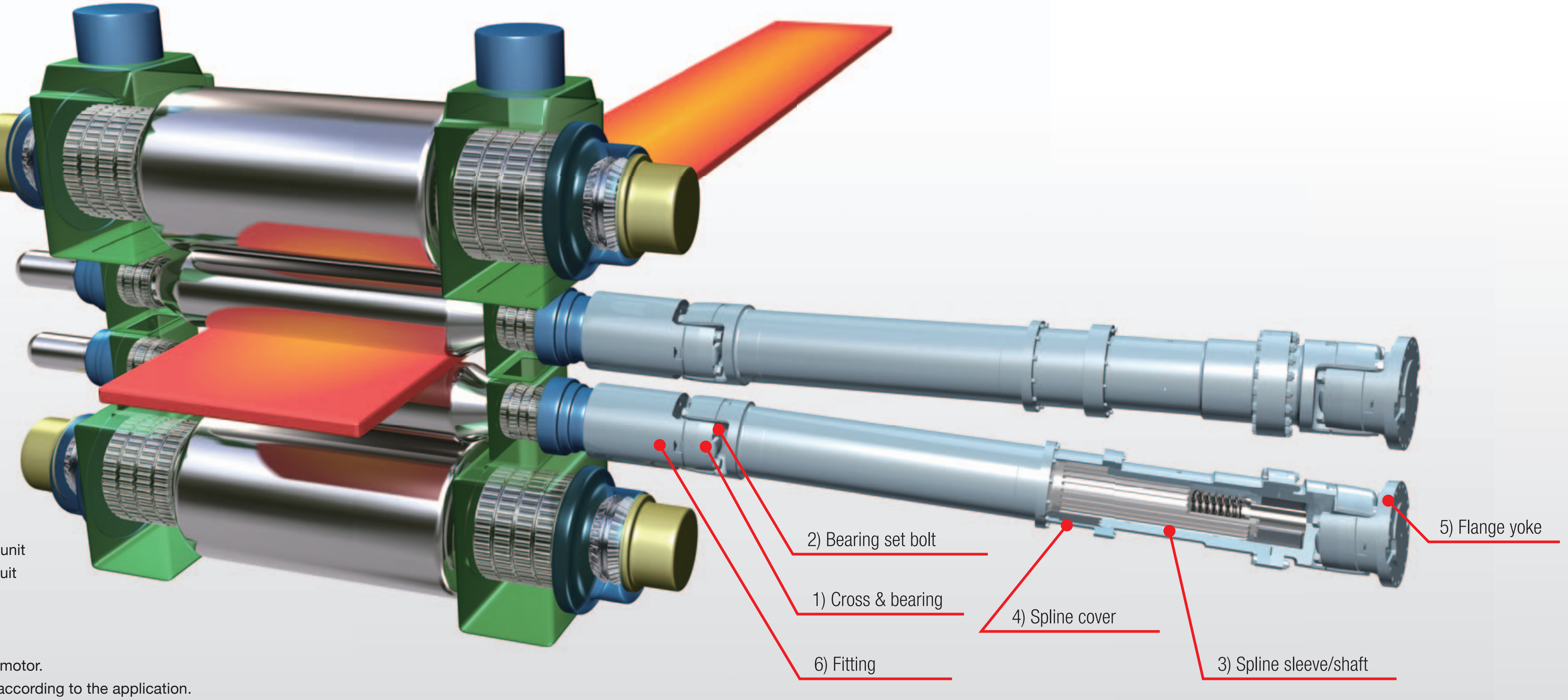
2) Bearing set bolt
Used to connect the cross bearing and its mating part.

3) Spline sleeve/shaft
There are a spline hole and shaft and the attaching length is adjustable.

4) Spline cover
Used to improve the dustproof and waterproof properties if the ambient environment is not good.

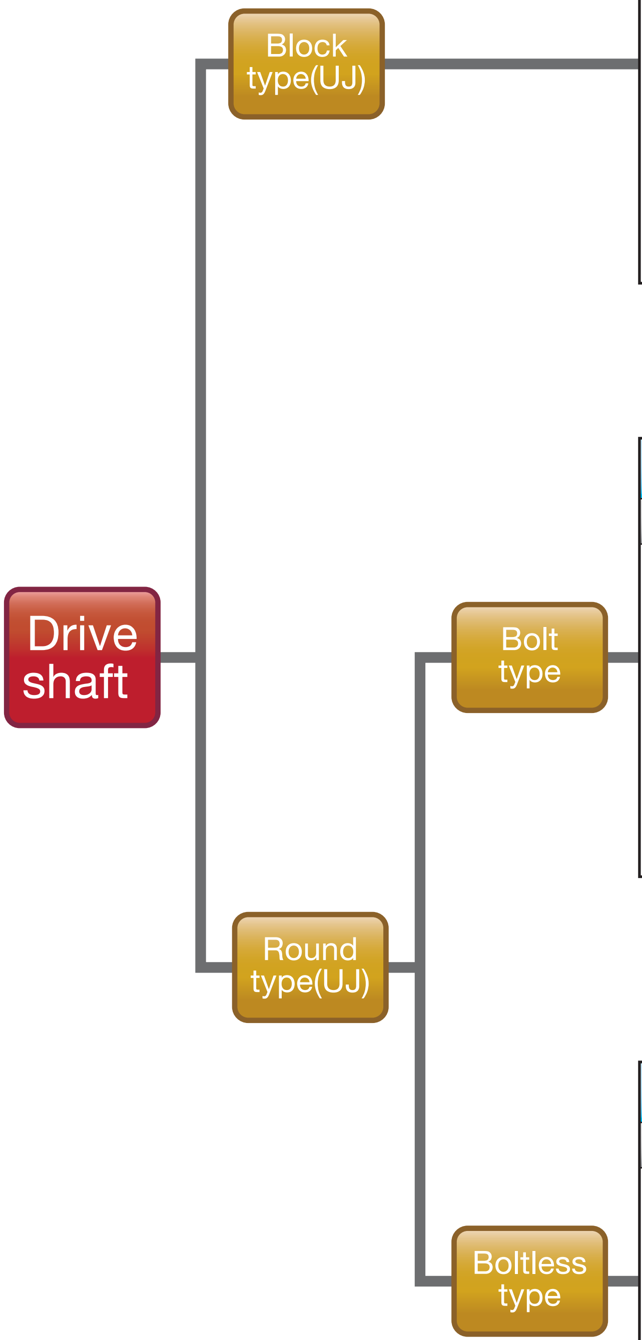
5) Flange yoke
The flange yoke is commonly used to connect a drive unit (such as a motor). A variety of joints are available to suit specifically desired applications.

6) Fitting
Used mainly for connection with the machine and the motor.
Various types of coupling arrangements are provided according to the application.



# Configurations of drive shafts

Drive shafts can be classified into two types in configuration, depending on the shape of the cross & bearings, which serve as universal joints: block type and round type.  The features and typical configuration of individual types are shown below.

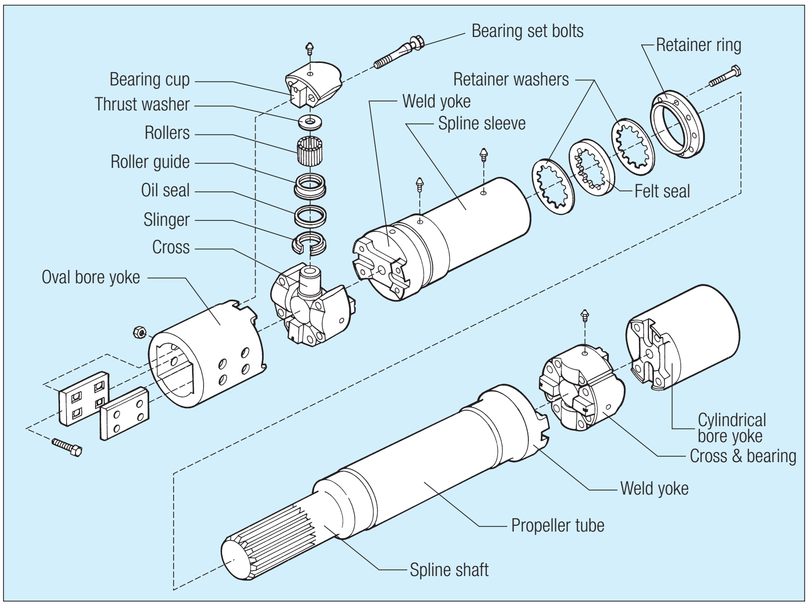


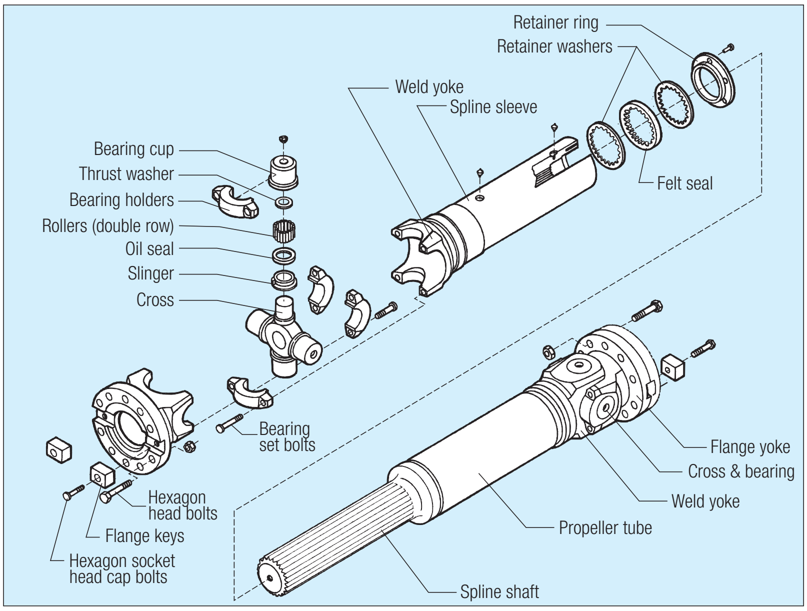

| D/U/T series | |
|---|---|
| **Features** | **Characteristics** |
| (1) These series are intended for use in extremely heavy duty applications.<br>(2) High dust resistance makes these series optimal for use under severe operating conditions such as in rolling mills. | (1) UJ swing diameter (mm) : 160 - 1230 |
| | (2) Torque $T_D$(kN·m) : 10.9 - 8970 |
| | (3) Torque $T_S$(kN·m) : 34.1 - 18800 |
| | (4) Maximum operating angle ( ° ) : 4 - 10 |

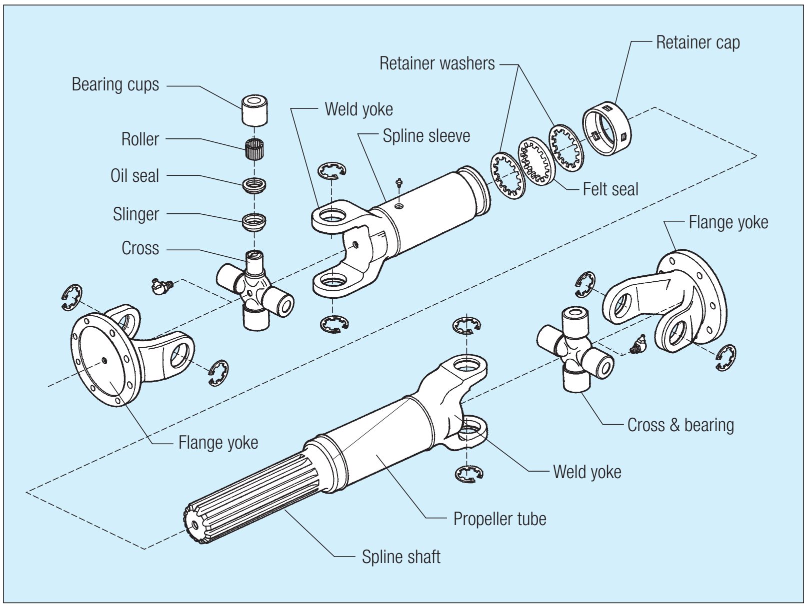
| EZ series | |
|---|---|
| **Features** | **Characteristics** |
| Series for heavy load with excellent balance between performance and price | (1) UJ swing diameter (mm) : 225 - 435 |
| | (2) Torque $T_D$(kN·m) : 19.5 - 149.2 |
| | (3) Torque $T_S$(kN·m) : 71.4 - 546 |
| | (4) Maximum operating angle ( ° ) : 15 |

| KF series | |
|---|---|
| **Features** | **Characteristics** |
| This cost efficient series is intended for light to medium duty applications. | (1) UJ swing diameter (mm) : 105 - 180 |
| | (2) Torque $T_D$(kN·m) : 1.56 - 9.89 |
| | (3) Torque $T_S$(kN·m) : 4.13 - 36.2 |
| | (4) Maximum operating angle ( ° ) : 18 - 30 |

## Representative configuration




## Structural features

With the cross & bearings fixed by bearing set bolts to the yokes, block type drive shafts transfer torque reliably through the key. The rollers, crosses, and bearing set bolts can be greater in size than those of the round type drive shafts, realizing high strength.

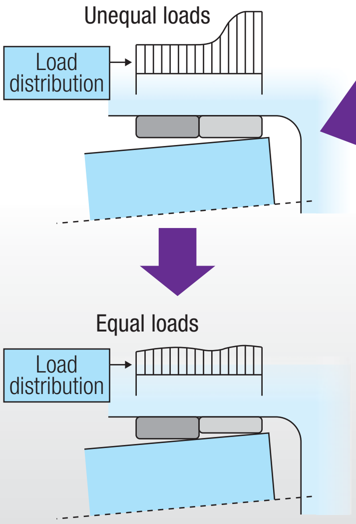
Compared with the block type, this type of drive shaft has cross & bearings of simpler construction and is more economical.

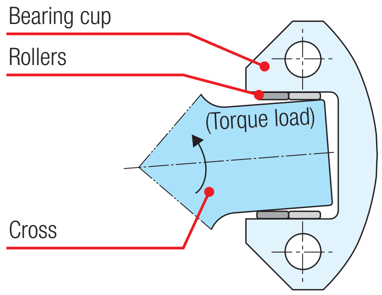
These drive shafts are connected to machines via a flange, enabling easy connection to a variety of machines.

# Measures to improve service life and strength

## Application of different diameter rollers for cross & bearing

Because the cross is an elastic cantilever beam and the bearing has some radial clearance, the load on the cross generally becomes heavier toward to the end of the cross.
In order to improve this phenomenon, load on the roller is made uniform by designing the roller to have a minutely smaller diameter at the very close end, which would improve flaking life. (figure on the right).
It is required that the detailed investigation takes into account multitude of JTEKT records and the technology of theoretical analysis by FEM, when this would be applied.



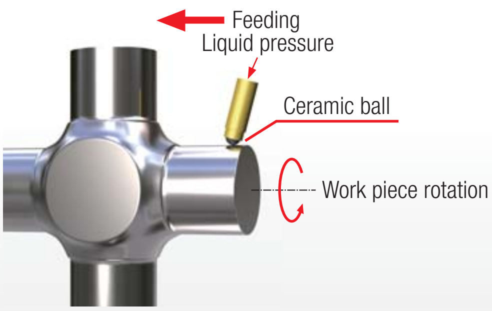
Effect of rollers different in diameter

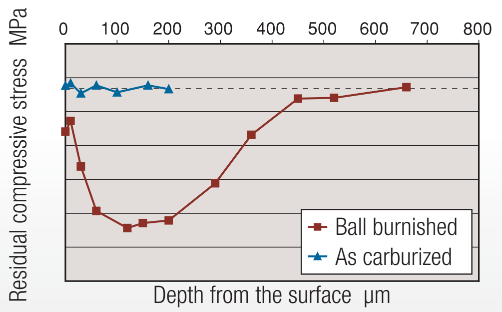

## Ball burnishing on cross shaft

The flaking life can be improved by the ball burnishing on cross raceway. This process is a type of plastic working process, which is applied by rolling contact of super-hard ball backed up hydraulically on the cross raceway surface.

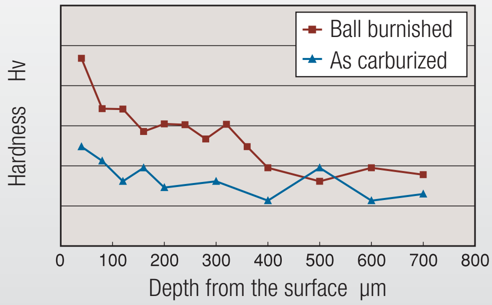
**Features**

(1) The hardness of the surface becomes higher than that of the carburized original material.
(2) Residual compressive stress at subsurface is larger than in the case of carburizing, and it can be applied deeply.
(3) Raceway roughness of the machined surface is improved. And no further finishing process is required after ball burnishing process.
(4) As the ball burnishing fixture can be used by attaching to lathe or other machine, there is actually no limitation in size of workpieces.



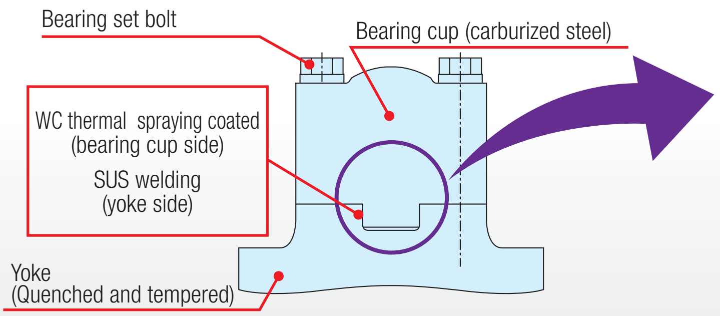
Measurement result of residual compressive stress

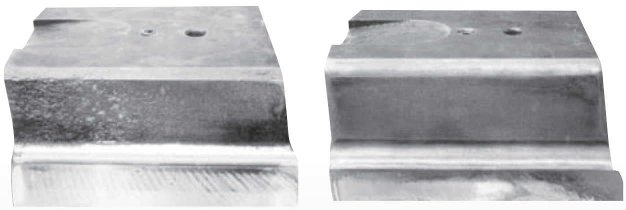


Measurement result of hardness

## Thermal spraying coat of tungsten carbide (WC) on bearing cup key

To avoid corrosion on the side face of bearing cup key applying carburizing heat treatment, one possible method is to apply thermal spraying coat of tungsten carbide (WC) on these surfaces.



Without WC coat (Corrosion wear after 13 months use)

WC coated product (No corrosion wear after 20 months use)

Effect of thermal spraying coat of tungsten carbide (WC)

**Effects**

The following effects are expected in case the generation of clearance due to corrosion at the key area is restrained.

(1) The bending stress of bolt can be alleviated, which leads to the restraint of strength reduction.

(2) The heavier load on raceways at the end of the cross can be restrained, which expects longer fatigue life for cross & bearing.

**【Improved corrosion resistance】**

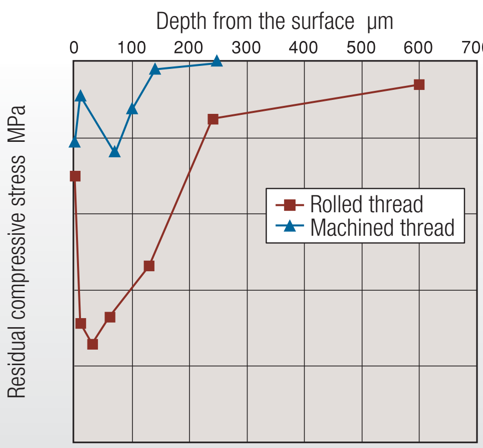

## Application of form rolling to bearing set bolt

The thread of the bearing set bolt has conventionally been machined after heat treatment. However, by switching this process to form rolling, allowable fatigue stress at the bottom radii of the thread increases significantly.

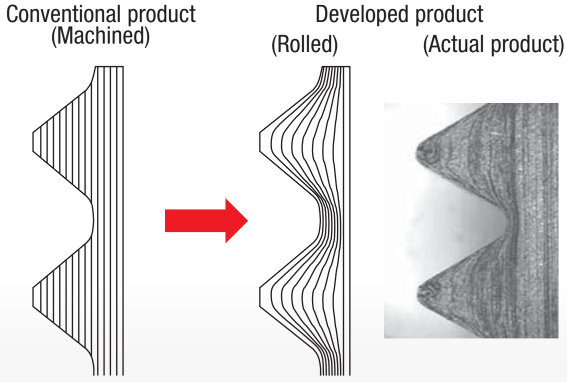
**Features**

(1) Fiber flow is formed along the shape of the thread. (figure on the right)

(2) Residual compressive stress at subsurface beneath the bottom radius of the thread increases. (figure below)




Residual compressive stress distribution of rolled thread




Fiber flow of rolled thread

**【Improved fatigue strength】**

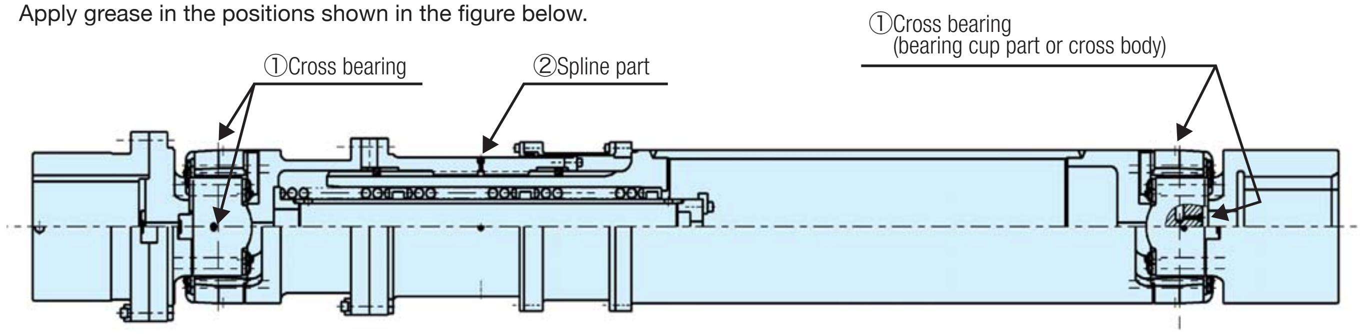
# Periodic inspection

## (1) Greasing

The greasing amount varies depending on the sizes of the cross & bearing and spline part.
Apply the amount of grease specified by JTEKT.

■ Greasing positions

Apply grease in the positions shown in the figure below.




■ Cycles of periodic greasing
- Hot strip mills: Once a month
- Cold strip mills: Every 3 months
- Others: Every 3 months

＊Be sure to apply grease with correct intervals and amount.
The grease to be applied should be the one specified in the drawing.
Use of insufficient or different grease may lead to early damage.

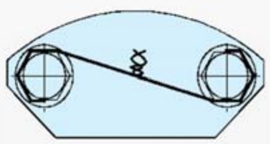
## (2) Tightening torque of bolts

The tightening torque of bolts is set according to the bolt size.
If the bolts are not tightened with the proper tightening torque, it may lead to their early damage.
Refer to the tightening torque of the bolts specified in the drawing.
In addition, a dimension table of torque wrenches is provided on page 28.

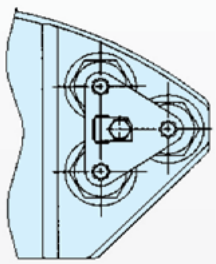
■ Periodic inspection of bolts

Conduct initial inspection of the bolts one week and one month after operation.
After that, conduct periodic inspection every six months.

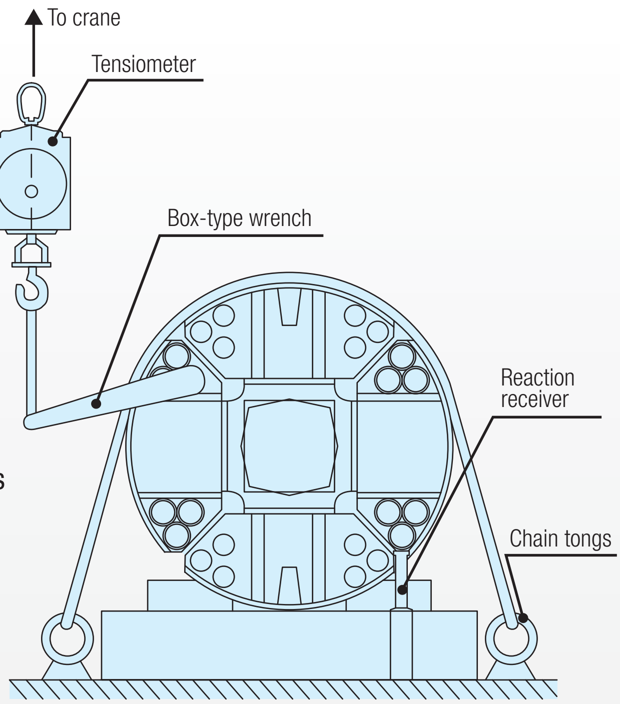
Inspection of the bolts includes the following.
- Check for looseness or damage of the whirl-stop
- Check the elongation by hammering or looking



Whirl-stop with one bolt



Whirl-stop with three bolts




■ How to loosen/tighten the bolts of the cross & bearing

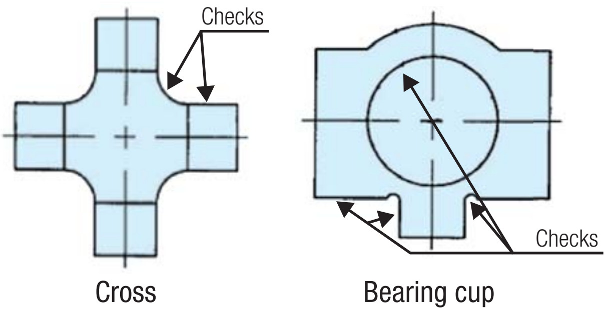
(1) As shown in the figure on the right, tighten the drive shaft with a jig such as chain tongs.

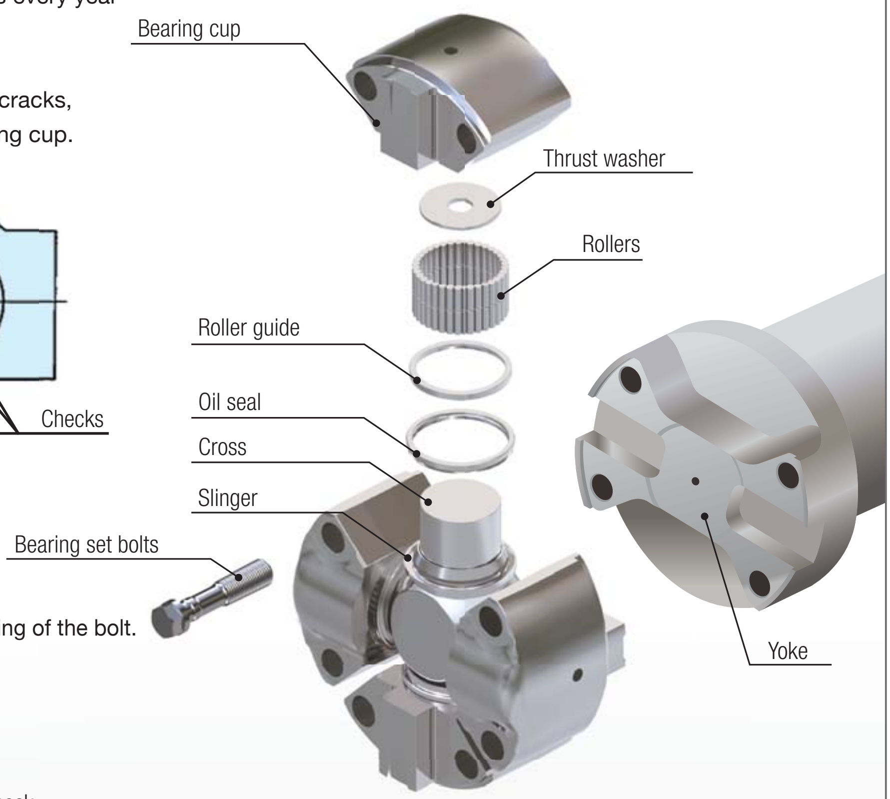
(2) Before tightening, apply a small amount of grease to the thread section and the head seat of the bolt.

(3) Tighten to the specified torque by using a wrench, tensiometer, etc.

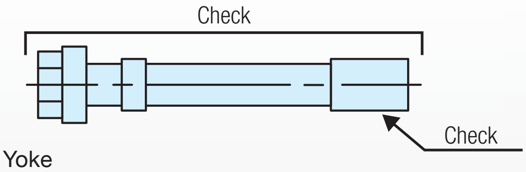
## Overhaul

- As a rule, conduct overhaul of the major parts every year after the start of operation.
- Cross & bearing
  - Check for brinelling, wear, flaking, seizure, cracks, nicks, or rusting, etc. of the cross and bearing cup.

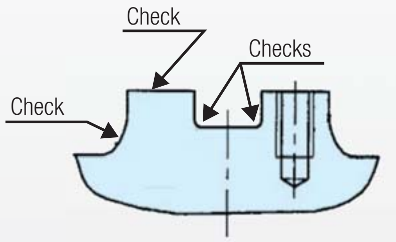



- Bearing set bolt
  - Check for bending, looseness, cracks, or rusting of the bolt.




- Yoke
  - Check for cracks, nicks, or rusting, etc. of each part.
  - Especially, check the cross & bearing attaching part and the flange attaching part for signs of the above.
- Others
  - Check for wear, scuffing, or cracking, etc. of the oval bore and spline.




∗Consult with JTEKT about the inspection result.
∗The next page shows some examples of failures of each part.

## Inspection/repair

- JTEKT undertakes inspection/repair of drive shafts. Long-term use leads to failure of the product, so consider periodic maintenance.
- The following are some examples of repairs JTEKT can undertake.
  - Re-grinding of the raceway surfaces of the cross and bearing cup
  - Overlying of the yoke key way and two planes of the oval bore
  - In addition, removal of slight wear and rust

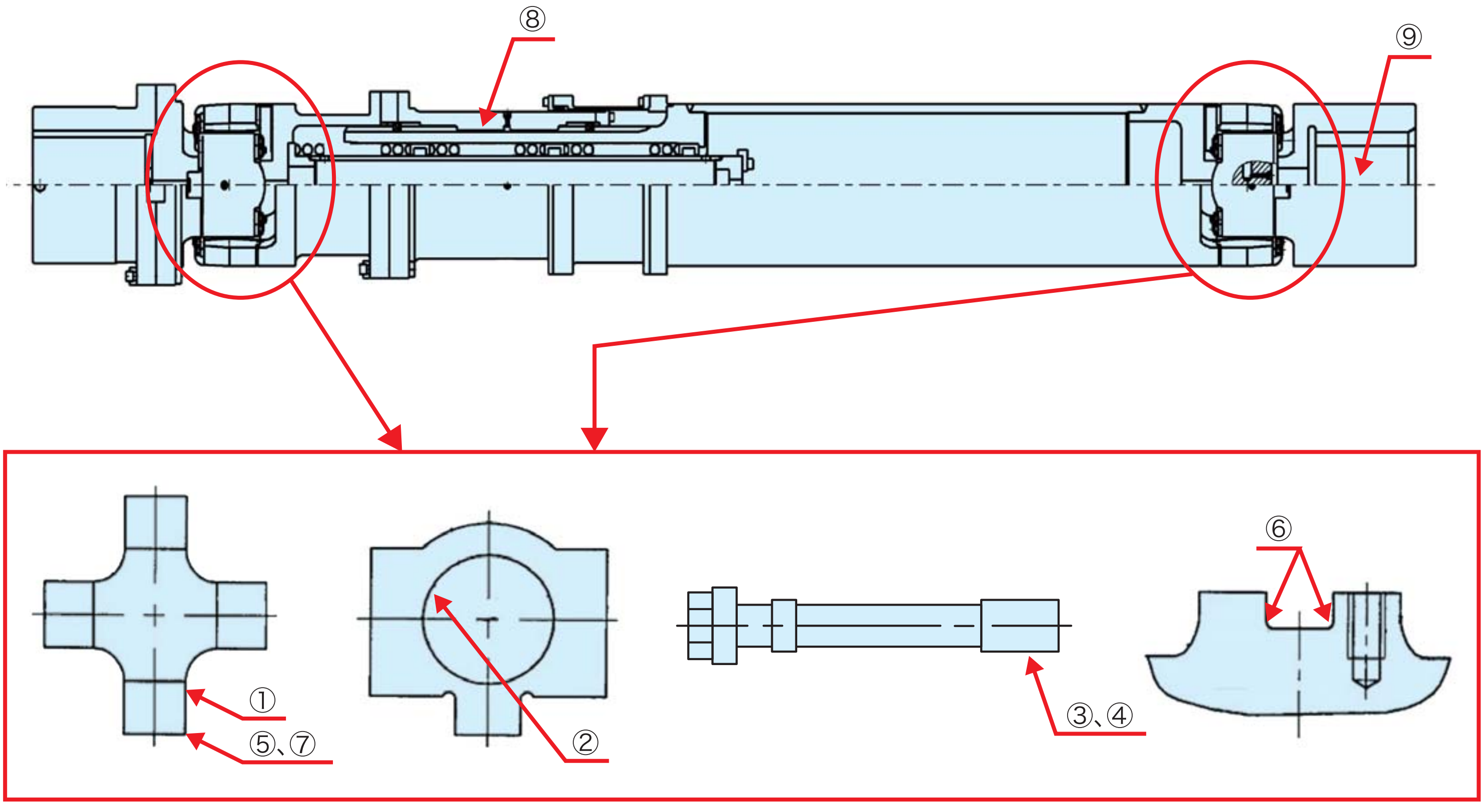
∗As a rule, repair is done for products with rotation diameter of ϕ400 or more.

## Management/storage

- When storing the product for a long period of time, take measures to prevent rusting.
- Before using a product stored for a long period of time, reapply grease to the cross & bearing, spline, etc.

# Cases of failures

Here are some examples of failure cases of drive shaft parts.




## (1) Insufficient greasing

### ① Flaking of cross raceway surface

**<Part>**
Cross
**<Cause>**
- Flaking occurred at the bottom of the cross due to insufficient lubrication

**<Measure>**
- Periodic greasing

**<Treatment>**
- Repair by re-grinding

### ② Flaking of bearing cup raceway surface

**<Part>**
Bearing cup
**<Cause>**
- Flaking occurred on the bearing cup inlet side due to insufficient lubrication

**<Measure>**
- Periodic greasing

**<Treatment>**
- Repair by re-grinding

## (2) Insufficient tightening torque

### ③ Breakage of bolt

**<Part>**
Bearing set bolt
**<Cause>**
- Flat fracture shape because the axial force did not act on the bolt

**<Measures>**
- Tighten with the proper tightening torque
- Maintenance of the attaching surfaces of the cup and yoke

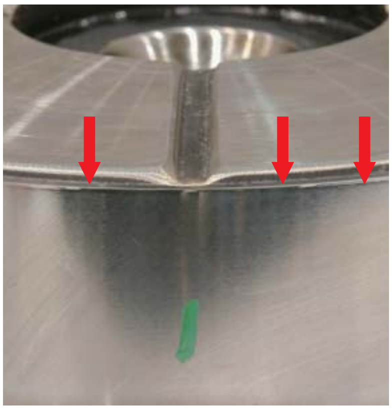
**<Treatment>**
- Replace with a new part

## (3) Excessive load

### ④ Breakage of bolt

**<Part>**
Bearing set bolt
**<Cause>**
- An excessive bending stress acted on the bolt
**<Measures>**
- Review the usage conditions
- Apply an appropriate load
- Reduce the bending stress acting on the bolt
**<Treatment>**
- Replace with a new part

### ⑤ Brinelling on raceway surface



**<Part>**
Cross
**<Cause>**
- An excessive load acted on the raceway surface
**<Measures>**
- Review the usage conditions
- Apply an appropriate load
**<Treatment>**
- Repair by re-grinding

### ⑥ Dent deformation of key

**<Part>**
Yoke key way
**<Cause>**
- An excessive load acted on the key way
**<Measures>**
- Review the usage conditions
- Apply an appropriate load
**<Treatment>**
- Repair by weld overlaying

## (4) Life

### ⑦ Flaking of raceway surface

**<Part>**
Cross
**<Cause>**
- Flaking occurred at the cross end due to long-term use
**<Treatment>**
- Repair by re-grinding
- Replace with a new part

### ⑧ Spline wear

**<Part>**
Sleeve yoke
**<Cause>**
- Wear of the torque transmission surface due to long-term use
**<Treatment>**
- Reusable in the case of slight wear
- Replace with a new part in the case of serious wear
(Repair by weld overlaying is impossible)

### ⑨ Oval bore wear

**<Part>**
Oval bore yoke
**<Causes>**
- Doglegged surface pressure
- Clearance of the torque transmission surface
- Wear of the torque transmission surface due to long-term use
**<Treatment>**
-Repair by weld overlaying

# General characteristics of universal joint

## Single universal joints

The driving shaft and driven shaft intermediated by a universal joint has the following relationship between their rotational angles:

$$\tan\phi_2 = \cos\theta \cdot \tan\phi_1 \quad \cdots(1)$$

where $\phi_1$ : Rotational angle of driving shaft
$\phi_2$ : Rotational angle of driven shaft
$\theta$ : Shaft operating angle (**Fig. 1**)

This means that, even if the rotational speed and torque of the driving shaft are constant, the driven shaft is subject to fluctuation in rotational speed and torque.
The speed ratio between the driving shaft and driven shaft can be obtained by differentiating equation (1) with respect to time ( t ), where $\phi_1$ is by $\omega_1 \cdot t$ and $\phi_2$ by $\omega_2 \cdot t$ :

$$\frac{\omega_2}{\omega_1} = \frac{\cos\theta}{1-\sin^2\phi_1 \cdot \sin^2\theta} \quad \cdots(2)$$

where $\omega_1$ : Rotational angular velocity of driving shaft (rad/s)
$\omega_2$ : Rotational angular velocity of driven shaft (rad/s)
$\omega_2/\omega_1$ : Angular velocity ratio

Equation (2) can be expressed in diagram form as shown in **Fig. 2**. The maximum value and minimum value of the angular velocity ratio can be expressed as follows:

$$(\omega_2/\omega_1)\ \text{max.} = 1/\cos\theta \quad \cdots\cdots \quad \phi_1 = 90°$$
$$(\omega_2/\omega_1)\ \text{min.} = \cos\theta \quad \cdots\cdots \quad \phi_1 = 0°$$

The maximum fluctuation rate of angular velocity in a universal joint can be expressed by the following equation:

$$\frac{(\omega_2\,\text{max.} - \omega_2\,\text{min.})}{\omega_1} = \frac{1}{\cos\theta} - \cos\theta$$

The torque ratio between input and output can be expressed by the diagram shown in **Fig. 3**. The maximum value and minimum value can be obtained as shown below, respectively:

$$(T_2/T_1)\ \text{max.} = 1/\cos\theta \quad \cdots\cdots \quad \phi_1 = 0°$$
$$(T_2/T_1)\ \text{min.} = \cos\theta \quad \cdots\cdots \quad \phi_1 = 90°$$

where $T_1$ : Input torque
$T_2$ : Output torque
$T_2/T_1$: Torque ratio

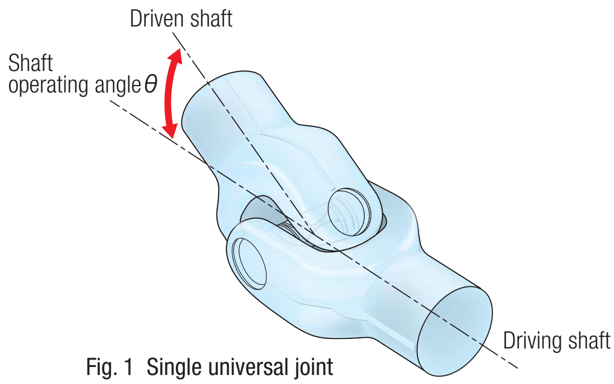



Fig. 1 Single universal joint

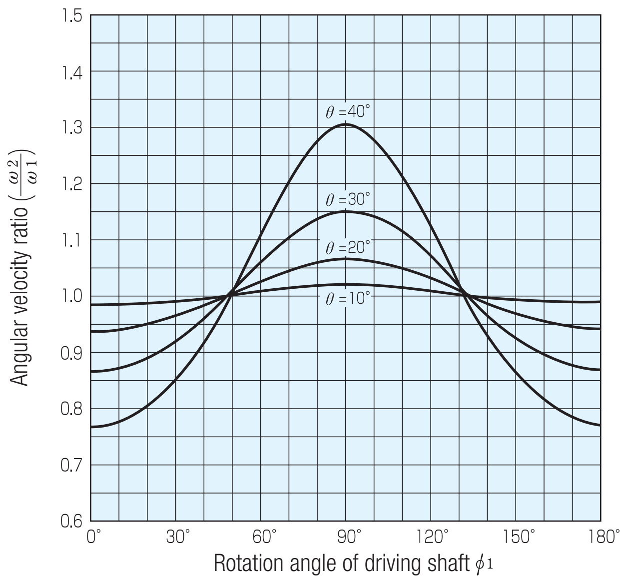



Fig. 2 Angular velocity fluctuation

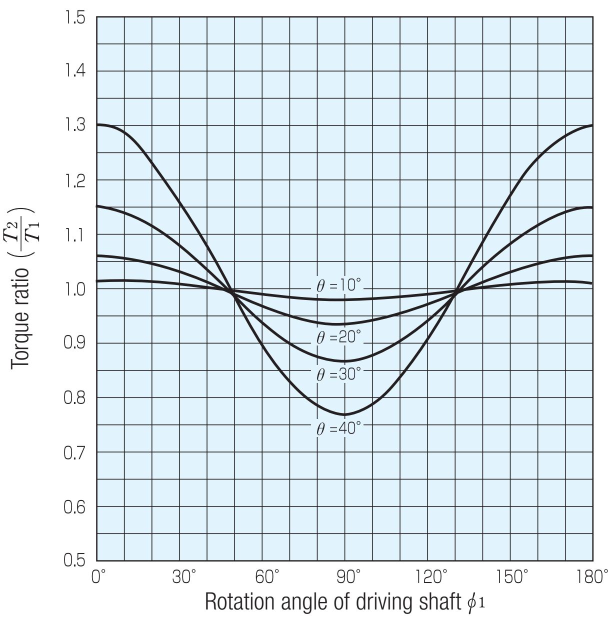



Fig. 3 Torque fluctuation

## Double universal joints

Universal joints are usually installed in pairs. When assembled as shown in **Fig. 4**, that is,

(1) With equal operating angles in both joints

(2) Yokes connected to the same shaft in line

(3) Central lines of all three shafts (driving shaft, intermediate shaft, and driven shaft) in the same plane, the driven shaft rotates exactly in the same way as the driving shaft.

Therefore, they should be attached as shown in the figure on the right as far as possible.

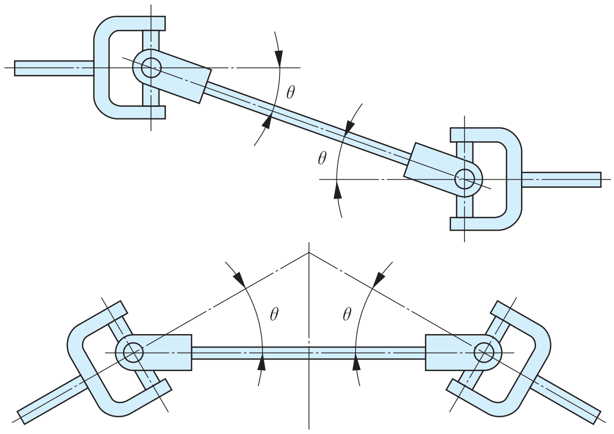



Fig. 4 Installation of double universal joints

## Secondary couple

It is often necessary to consider the secondary couples imposed by universal joints operating at an angle; especially under high angle or large torque. These couples must be taken into account in designing the shafts and supporting bearings.

The secondary couples in the universal joints are in the planes of the yoke. These couples are about the intersection of the shaft axis. They impose a load on the bearings and a bending stress in the shaft connecting the joints, and they fluctuate from maximum to zero every 90° of shaft revolution. The broken lines in **Fig. 5** indicate the effect of these secondary couples on the shafts and bearings.

The equation for maximum secondary couple is as follows:

$M_1$ max. $= T \tan\theta$ (for driving shaft)

$M_2$ max. $= T \sin\theta$ (for driven shaft)

where $M_1$: Secondary couple on driving shaft (N·m)

$M_2$: Secondary couple on driven shaft (N·m)

$T$ : Driving torque (N·m)

$\theta$ : Shaft operating angle

The ratio of the secondary couple to the driving torque is shown in **Fig. 6**.

The secondary couple $M_1$ and $M_2$ can be obtained by multiplying $M_1/T$ or $M_2/T$ by the driving torque $T$.

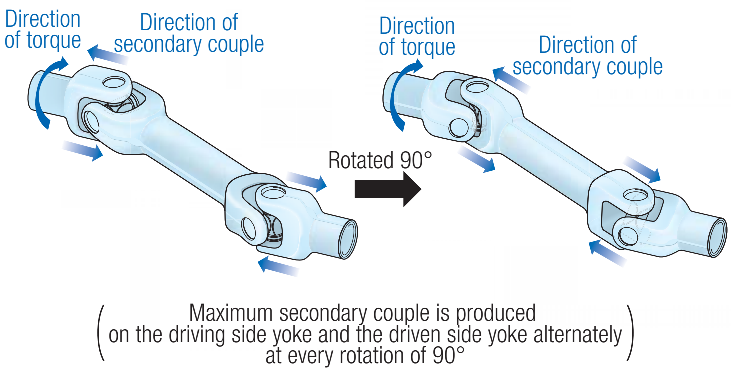



Fig. 5 Effect of secondary couple

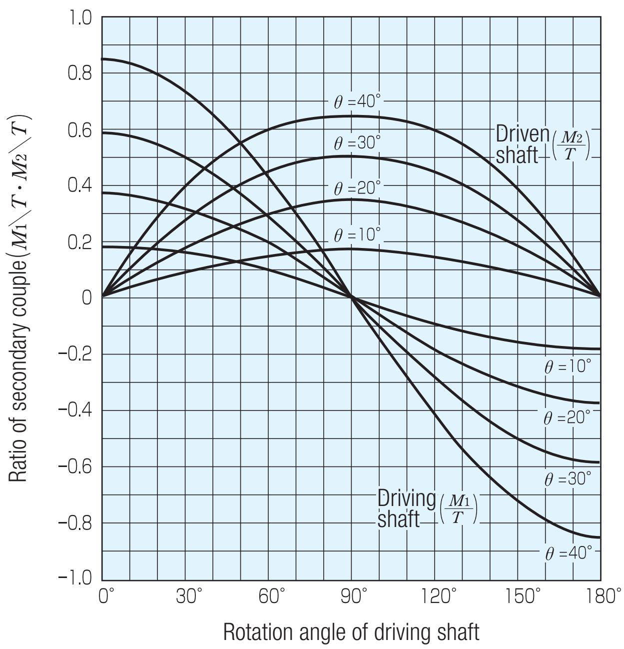



Fig. 6 Fluctuation of secondary couple to driving torque

# Drive shaft selection

A drive shaft should be selected so as to satisfy the required strength, service life, operating angle and dimensions necessitated by its purpose. Especially, a drive shaft can be selected if it meets conditions of both strength and life of the universal joint, except for special cases.

## Load torque of drive shaft

To decide the size of the drive shaft, it is necessary to grasp the load torque first.
A maximum torque including an impact torque and a mean torque should be known, and it is essential for selecting an appropriate drive shaft to understand the correct maximum torque and mean torque.

Maximum torque:
Value to determine if the strength of each part is sufficient.
Mean torque:
Value necessary to calculate the service life

## Mean torque

It is apparent that all kinds of machines are not operating thoroughly by their maximum torque. Therefore, if a drive shaft is selected according to a service life calculated from the maximum torque, it results in being uneconomically larger than necessary.
So, it is reasonable to set up a longer expected service life, if the application condition are severe; and shorter, if the conditions are easy.
If, for instance, a job is expressed as in the table below,

| Drive stage | 1 | 2 | 3 · · · · · Z |
|---|---|---|---|
| Torque (N · m) | $T_1$ | $T_2$ | $T_3 \cdots T_Z$ |
| Rotational speed ($\mathrm{min}^{-1}$) | $n_1$ | $n_2$ | $n_3 \cdots n_Z$ |
| Time ratio (%) | $t_1$ | $t_2$ | $t_3 \cdots t_Z$ |

the cube root of mean torque ($T_m$) and the arithmetical mean of rotational speed ( $n_m$ ) are yielded from the following equations.

$$T_m = \sqrt[3]{\frac{(T_1^3 \cdot n_1 \cdot t_1 + \cdots\cdots\cdots T_Z^3 \cdot n_Z \cdot t_Z)}{(n_1 \cdot t_1 + \cdots\cdots\cdots + n_Z \cdot t_Z)}}$$

$$n_m = \frac{(n_1 \cdot t_1 + \cdots\cdots\cdots + n_Z \cdot t_Z)}{(t_1 + \cdots\cdots\cdots + t_Z)}$$

## Strength of drive shaft

A drive shaft should be selected so that the normal maximum torque shall not exceed the " $T_D$ torque." However, it is difficult to determine the true maximum torque, and the engine capacity or motor capacity is used as the maximum torque in many cases. In consideration of the torque amplification factor (TAF) of the drive shaft and various imponderables, the safety factor ( $f_S$ ) of no less than 1.5 should be considered as the most desirable.

$f_D = T_D$ /maximum torque under normal operating conditions > 1.5

The maximum torque that may occur in an emergency should be determined using " $T_S$ torque." The safety factor ( $f_S$ ) of no less than 1.5 should be considered as desirable in this case as well.

$f_S = T_S$ /breaking torque under emergency conditions > 1.5

To select a drive shaft based on a safety factor of 1.5 or less, consult JTEKT as close examination is required in consideration of previous performance records.

## Life of drive shaft

There is no worldwide standard for service life calculation of universal joint bearings (cross & bearings) and the service life is calculated according to the unique method developed by each manufacturer.
JTEKT employs the following empirical equation based on extensive experimentation (conforming to SAE).
The service life $L_h$ is defined as the expected number of operating hours before a flaking occurs on the rolling contact surface of the bearing. The use of the bearings over the service life $L_h$ may be practical on a low speed machine such as a rolling mill.

$$L_h = 3000\, K_m \left( \frac{T_R \cdot K_n \cdot K_\theta}{T_m} \right)^{2.907}$$

Where, $L_h$: Average calculated bearing life (h)
$K_m$: Material factor = 1 to 3
$T_R$: Rated torque (N · m)
$T_m$: Mean torque (N · m)
$K_n$: Speed factor = $10.2/n^{0.336}$
$K_\theta$: Angle factor = $1.46/\theta^{0.344}$
$n$ : Rotational speed = ($\mathrm{min}^{-1}$)
$\theta$ : Shaft operating angle (° )

Note) A drive shaft should be selected by considering the type of the machine, peripheral equipment, particular operating conditions, and other factors. The method outlined in this catalog is a common rough guide. It is recommended to consult JTEKT for details.

# Selection criteria for each application

## (1) Rolling mills

(1) Feature

Based on our wealth of experience and achievement, JTEKT has established individual selection criteria according to the machine used, location of use, and usage conditions.

For example, with hot strip mills, drive shafts are used under severe conditions such as rolling mill water, and the roughing rolling mills are often applied with heavy reverse load constantly. Therefore, JTEKT makes design with emphasis on fatigue strength. As for finishing rolling mills, the front stand and rear stand of the line are considered a little differently. Since the front stand has a heavy pressure load and the load level is also high, design is made with emphasis on the fatigue strength. The load level of the rear stand is relatively low, however, the plate leaping speed is often increased toward the end of the rear stage, causing shock loading. Therefore, design is made with emphasis on the static strength.

(2) Examples of selection criteria

| Classification of rolling mill | | Reverse or non-reverse | Reference safety factor and bearing life | | |
|---|---|---|---|---|---|
| Machine used | Location of use | | Dynamic safety factor | Static safety factor | Bearing life $L(h)$ |
| Hot strip mills | Roughing rolling mill | Reverse | 4.2 | 7.0 | 20000 |
| | Edger rolling mill | Non reverse | 4.7 | 7.6 | 30000 |
| | Finishing rolling mill | Non reverse | 2.3 | 3.7 | 7000 |
| Shaped steel mills | BD/RU/FU/E rolling mills | Reverse | 4.8 | 8.0 | 30000 |
| | Tandem rolling mill | Non reverse | 2.8 | 4.7 | 20000 |
| Cold strip mills | Steel tandem rolling mill | Non reverse | 2.6 | 5.0 | 8000 |
| | Non-steel tandem rolling mill | Non reverse | 3.0 | 5.9 | 5000 |
| Rod/wire rod mills | tandem rolling mill | Non reverse | 2.4 | 4.2 | 30000 |

＊Dynamic safety factor: $f_D = T_D$ /motor rated torque
Static safety factor: $f_S = T_S$ /motor rated torque

## (2) Industrial equipment

(1) Features

Also for industrial equipment, we have established individual selection criteria according to the machine used and usage conditions based on our wealth of experience and achievement, as with rolling mills.

For example, in the case of a papermaking machine, shock torque seldom occurs because the material to be handled is basically paper. However, the rotational speed is high, and continuous operation for several months is often conducted. Therefore, lubrication of the cross bearing part is important. In the case of a failure, the entire equipment is stopped, so design is made with emphasis on the bearing life.

(2) Examples of selection criteria

| Machine used | Reverse or non-reverse | Reference safety factor and bearing life | | |
|---|---|---|---|---|
| | | Dynamic safety factor | Static safety factor | Bearing life $L(h)$ |
| Calender | Non reverse | 1.4 | 1.5 | 30000 |
| Papermaking | Non reverse | 1.5 | — | 100000 |

＊Dynamic safety factor: $f_D = T_D$ /normal maximum torque
Static safety factor: $f_S = T_S$ /emergency maximum torque

# Torque calculation from motor output

To obtain the load torque of a drive shaft, there is a method to calculate the torque from the motor output. The following is the calculation equation.

Horsepower → Torque (N·m)

$$T = \frac{HP}{N} \cdot 7122 \quad (\mathrm{N \cdot m}) \quad \cdots\cdots(1)$$

However, in the case of PS (CV in French) horsepower, the following equation is applied.

$$T = \frac{PS}{N} \cdot 7024 \quad (\mathrm{N \cdot m}) \quad \cdots\cdots(2)$$

Note) Check if the horsepower specified in the drawing provided means $HP$ horsepower or $PS$ horsepower.

$kW$ → Torque (N·m)

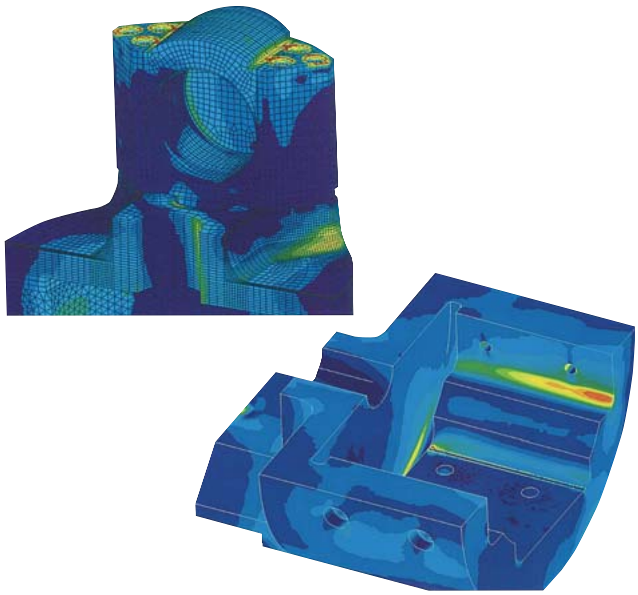
$$T = \frac{kW}{N} \cdot 9552 \quad (\mathrm{N \cdot m}) \quad \cdots\cdots(3)$$

In equations (1) to (3) above,

- $T$ : Torque (N·m)
- $N$ : Rotational speed (min$^{-1}$)
- $HP$ : Horsepower (English horsepower)
- $PS$ : Horsepower (French horse power)
- $kW$ : Kilowatt

# Evaluation/analysis

JTEKT conducts FEM analysis as one of the evaluation/analysis approaches to utilize for selection of a drive shaft.



Example of FEM analysis

# Balance quality of drive shaft

If a rotating drive shaft is unbalanced, it may adversely influence the equipment and ambient conditions, thus posing a problem. JTEKT designs and manufactures drive shafts to satisfy the balance quality requirements specified in JIS B 0905.

## Expression of balance quality

The balance quality is expressed by the following equation:

Balance quality $= e\omega$

or

Balance quality $= en/9.55$

where $e$: Amount of specific unbalance (mm)
This amount is the quotient of the static unbalance of a rigid rotor by the rotor mass. The amount is equal to the deviation of the center of the rotor mass from the center line of the shaft.

$\omega$: Maximum service angular velocity of the rotor (rad/s)

$n$: Rotational speed ($min^{-1}$)

## Balance quality grades

The JIS specifies the balance quality grades from G0.4 to G4000. Generally, the three grades described in Table 1 below are commonly used.
We apply grade G16 to high speed drive shafts unless otherwise specified.

## Correction of the unbalance of drive shafts

JTEKT corrects the unbalance of drive shafts to the optimal value by the two plane balancing method, using the latest balance system.
To correct the balance of a drive shaft, it is critical to correct the balance between two planes each near the two individual universal joints, instead of by the one plane balancing as used to balance car wheels.
Especially in the case of a long drive shaft, this two plane balancing method is the only way to acquire good results.

Table 1 Recommended balance quality grades (excerpt from JIS B 0905)

| Balance quality grade | Upper limit value of balance quality ($e\omega$) | Recommended applicable machines |
|---|---|---|
| G40 | 40 | Car wheels, wheel rims, wheel sets and drive shafts<br>Crankshaft systems of elastically mounted high speed four stroke engines (gasoline or diesel) with six or more cylinders<br>Crankshaft systems of the engines of automobiles, trucks and rolling stock |
| G16 | 16 | Drive shafts with special requirements (propeller shafts and diesel shafts)<br>Components of crushing machines<br>Components of agricultural machines<br>Components of the engines of automobiles, trucks and rolling stock (gasoline or diesel)<br>Crankshaft systems with six or more cylinders with special requirements |
| G 6.3 | 6.3 | Devices of processing plants<br>Ship engine turbine gears (for merchant ships)<br>Centrifugal drums<br>Papermaking rolls and printing rolls<br>Fans<br>Assembled aerial gas turbine rollers<br>Flywheels<br>Pump impellers<br>Components of machine tools and general industrial machines<br>Medium or large electric armatures (of electric motors having at least 80 mm in the shaft center height) without special requirements<br>Small electric armatures used in vibration insensitive applications and/or provided with vibration insulation (mainly mass produced models)<br>Components of engines with special requirements |

# Composition of drive shaft numbers

## (1) Block type

Model No.

D 56 100 123 4 CM

- D : Series code
- 56 : BRG No.
- 100 : Swing diameter No.
- 123 : Design serial No.
- 4 : Configuration code
- CM : Fitting code
- D 56 100 : Model No.

## (2) Round type

### ① KF series

2 F 180 001 5 CC

- 2 : Number of cross bearings
- F : Series code
- 180 : Swing diameter (unit: mm)
- 001 : Design serial No.
- 5 : Configuration code
- CC : Fitting code

### ② EZ series

EZ 26 045 001 3 CC

- EZ : Series code
- 26 : BRG No.
- 045 : Swing diameter No.
- 001 : Design serial No.
- 3 : Configuration code
- CC : Fitting code

## (3) Type with different model numbers on the right and left

T60120 D56100 234

- T60120 : (Model No.)
- D56100 : (Model No.)
- 234 : Design serial No.

The two model numbers are written side by side
If the rotation diameters are the same, the model numbers are written in order of T, D, and U
If the rotation diameters are different, the model number with larger rotation diameter is written first

## Supplementary explanation of items

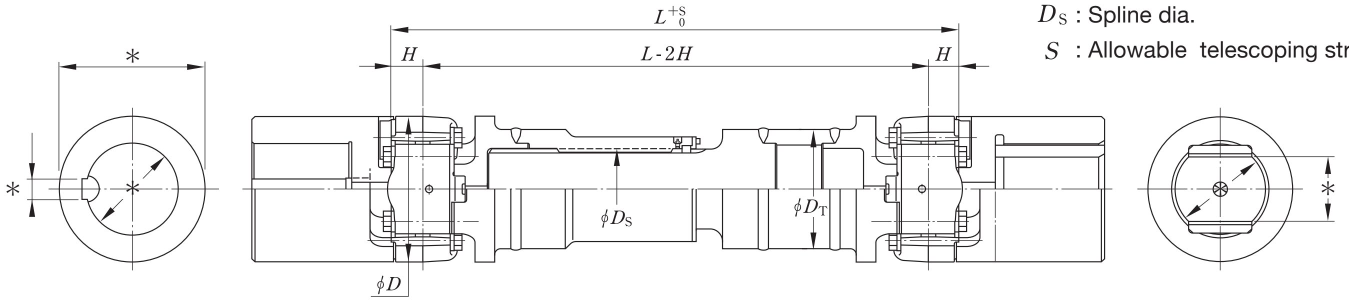
- **Series code** D : D series U : U series T : T series F(Z) : KF series EZ : EZ series
- **BRG. No. :** The raceway diameters of the cross are represented in two digits in order of size (e.g.: 56, 63)
- **Swing diameter No. :** The value is swing diameter of universal joint/5 and is represented in three digits (e.g.: $\phi$450 ㎜ → 090, $\phi$900 ㎜ → 180)
- **Design serial No. :** Represented in three digits for each model number (001 - 999)
- **Configuration code :** Decided according to the configuration of the drive shaft
- **Fitting code :** The following shape codes are added to the left, then to the right, according to the shape of the attaching parts at both ends.

  B : Cross bearing
  C : Cylindrical bore
  F : Flange
  M : Oval bore
  T : Tapered bore

# D series

## Telescoping type (with propeller tube)

$D_T$ : Propeller tube dia.
$D_S$ : Spline dia.
$S$ : Allowable telescoping stroke




Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

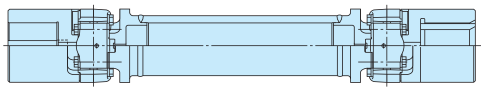
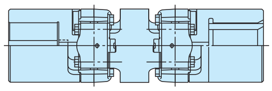
| Model No. | UJ swing dia. (mm) $D$ | Torque capacity (kN·m) | | | Max. operating angle (°) | Boundary dimensions (mm) | | | | | Bearing set bolts | | | | | Recommended wrench set 7) (bearing set bolt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $T_R$ 1) | $T_D$ 2) | $T_S$ 3) | | $L$ 4) (min.) | $H$ | $D_T$ | $D_S$ 5) | $S$ | Nominal thread size | Width across flats | Tightening torque (N·m) | Q'ty 6) | Type | Torque Wrench No. Socket No. Tensiometer No. Wrench No. |
| D22032 | 160 | 2.83 | 10.9 | 34.1 | 10 | 585 | 30 | 139.8 | 101.6 | 80 | M16×1.5 | 17 | 185± 20 | 8 | A | TW4200 HR17×4200 |
| D26038 | 190 | 5.33 | 22.5 | 54.7 | 10 | 677 | 38 | 159 | 114.3 ( 95) | 95 | M18×1.5 | 19 | 285± 20 | 8 | A | TW4200 HR19×4200 |
| D30044 | 220 | 8.54 | 35.3 | 73.1 | 10 | 760 | 45 | 177.8 | 127 (120) | 110 | M20× 2 | 22 | 370± 20 | 8 | A | TW4200 HR22×4200 |
| D34052 | 260 | 15.1 | 56.2 | 140 | 10 | 873 | 52 | 216.3 | 152.4 (140) | 125 | M24× 2 | 27 | 645± 30 | 8 | A | TW8500 HR27×8500 |
| D38060 | 300 | 22.7 | 89.9 | 260 | 10 | 965 | 60 | 244.5 | 177.8 (160) | 135 | M30× 2 | 32 | 1 180± 50 | 8 | C | TM500 WR32×500 |
| D44070 | 350 | 38.3 | 144 | 384 | 10 | 1080 | 70 | 298.5 | 203.2 (180) | 155 | M33× 2 | 36 | 1 720± 70 | 8 | C | TM500 WR36×500 |
| D48080 | 400 | 54.9 | 213 | 560 | 8 | 1220 | 80 | 339.7 | 225 (200) | 175 | M39× 3 | 50 | 3 040±200 | 8 | C | TM1000 WR50×500 |
| D50085 | 425 | 66.9 | 264 | 708 | 8 | 1284 | 86 | 355.6 | 250 | 185 | M42× 3 | 50 | 4 020±200 | 8 | C | TM1000 WR50×500 |
| D54090 | 450 | 80.4 | 333 | 739 | 8 | 1348 | 92 | 381 | 250 | 195 | M42× 3 | 50 | 4 020±200 | 8 | C | TM1000 WR50×500 |
| D56100 | 500 | 107 | 500 | 1 060 | 8 | 1503 | 107 | 410 | 275 | 205 | M48× 3 | 60 | 5 980±300 | 8 | C | TM2000 WR60×500 |
| D58110 | 550 | 146 | 747 | 1 460 | 6 | 1604 | 116 | 450 | 300 | 220 | M52× 3 | 65 | 7 650±300 | 8 | C | TM2000 WR65×800 |
| D60120 | 600 | 195 | 962 | 2 040 | 6 | 1730 | 125 | 490 | 325 | 235 | M58× 3 | 70 | 10 300±300 | 8 | C | TM2000 WR70×800 |
| D62130 | 650 | 249 | 1140 | 2 520 | 6 | 1849 | 136 | 530 | 350 | 250 | M62× 3 | 75 | 12 700±300 | 8 | C | TM2000 WR75×800 |
| D64140 | 700 | 293 | 1510 | 3 370 | 6 | 1949 | 146 | 580 | 375 | 265 | M68× 3 | 85 | 17 100±500 | 8 | C | TM3000 WR85×800 |

■ Features

This series is suitable for use under severe conditions, such as in driving rolling mill rolls.
Based on standardized cross & bearings, this series can be designed to suit a wide range of dimensions and a wide variety of fitting configurations.

■ Designs available to order

The fixed type can be designed to order, assembling components shown on the right.
For more details on these designs, consult JTEKT.

| | |
|---|---|
| With propeller tube |  |
| With coupling yoke |  |

| Model No. | UJ swing dia. (mm) $D$ | Torque capacity (kN·m) | | | Max. operating angle (°) | Boundary dimensions (mm) | | | | | Bearing set bolts | | | | Recommended wrench set [7] (bearing set bolt) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $T_R$ [1] | $T_D$ [2] | $T_S$ [3] | | $L$ [4] (min.) | $H$ | $D_T$ | $D_S$ [5] | $S$ | Nominal thread size | Width across flats | Tightening torque (N·m) | Q'ty [6] | Type | Torque Wrench No. Socket No. Tensiometer No. Wrench No. |
| D66150 | 750 | 371 | 1 730 | 3 870 | 6 | 2 090 | 155 | 620 | 400 | 290 | M72×4 | 90 | 20 400±500 | 8 | C | TM3000 WR90×800 |
| D68160 | 800 | 449 | 2 090 | 4 600 | 6 | 2 225 | 170 | 670 | 450 | 300 | M76×4 | 95 | 24 500±500 | 8 | C | TM3000 WR95×1000 |
| D71170 | 850 | 497 | 3 720 | 6 200 | 7 | 2 337 | 178 | 710 | 500 | 320 | M48×2 | 50 | 5 590±200 | 24 | D | TM2000 WB50×500 |
| D72180 | 900 | 591 | 4 070 | 6 610 | 7 | 2 445 | 190 | 750 | 500 | 335 | M48×2 | 50 | 5 590±200 | 24 | D | TM2000 WB50×500 |
| D7E184 | 920 | 621 | 4 360 | 8 050 | 7 | 2 495 | 190 | 780 | 550 | 340 | M52×2 | 50 | 7 350±300 | 24 | D | TM2000 WB50×500 |
| D74190 | 950 | 654 | 3 900 | 9 250 | 7 | 2 564 | 196 | 810 | 550 | 350 | M56×3 | 60 | 9 120±300 | 24 | D | TM2000 WB60×800 |
| D75194 | 970 | 697 | 4 600 | 10 400 | 7 | 2 594 | 196 | 830 | 550 | 370 | M56×3 | 60 | 9 120±300 | 24 | D | TM2000 WB60×800 |
| D76204 | 1 020 | 924 | 4 540 | 8 050 | 7 | 2 654 | 211 | 850 | 550 | 385 | M52×3 | 55 | 7 650±300 | 24 | D | TM2000 WB55×500 |
| D7J214 | 1 070 | 1 040 | 6 780 | 13 500 | 6 | 2 900 | 230 | 890 | 600* | 400* | M64×3 | 65 | 14 200±300 | 24 | D | TM2000 WB65×800 |
| D81220 | 1 100 | 1 100 | 7 970 | 13 300 | 6 | 2 970 | 250 | 920 | 600* | 415* | M64×3 | 65 | 14 200±300 | 24 | D | TM2000 WB65×800 |
| D8B226 | 1 130 | 1 210 | 7 550 | 15 200 | 6 | 3 070 | 260 | 950 | 650* | 430* | M68×3 | 70 | 17 100±500 | 24 | D | TM3000 WB70×800 |
| D8E246 | 1 230 | 1 540 | 8 970 | 18 800 | 6 | 3 165 | 260 | 1 030 | 650* | 450* | M72×4 | 75 | 20 400±500 | 24 | D | TM3000 WB75×800 |

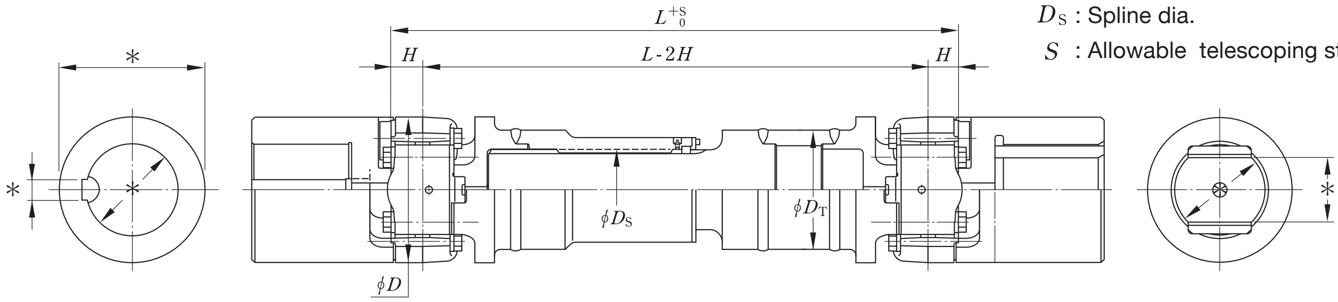
[Notes] 1) $T_R$ refers to the rated torque used for service life calculation (refer to page 15). The material factor $K_m$ is supposed to be 3 in this calculation.
2) $T_D$ refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions. $T_D$ divided by the maximum torque should preferably be greater than 1.5.
3) $T_S$ refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions. $T_S$ divided by the breaking torque should preferably be greater than 1.5.
4) $L$ refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) The parenthesized values refer to the involute spline diameter.
6) Represents the voltage used for one kit of cross & bearing.
7) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　　Type D: Tensiometer + Socket wrench

[Remarks] 1) The values with * mark are reference values.
2) The $T_D$ values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.

# U series

## Telescoping type (with propeller tube)

$D_T$ : Propeller tube dia.
$D_S$ : Spline dia.
$S$ : Allowable telescoping stroke




Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

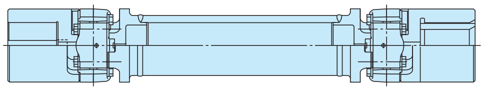
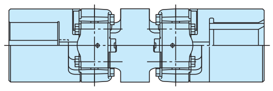
| Model No. | UJ swing dia. (mm) $D$ | Torque capacity (kN·m) $T_R$ [1] | Torque capacity (kN·m) $T_D$ [2] | Torque capacity (kN·m) $T_S$ [3] | Max. operating angle (°) | Boundary dimensions (mm) $L$ [4] (min.) | $H$ | $D_T$ | $D_S$ | $S$ | Bearing set bolts: Nominal thread size | Width across flats | Tightening torque (N·m) | Q'ty [5] | Recommended wrench set [6] (bearing set bolt): Type | Torque Wrench No. Socket No. Tensiometer No. Wrench No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U45073 | 365 | 45.5 | 284 | 497 | 4 | 1 185 | 75 | 339.7 | 225 | 170 | M39×2 | 41 | 2 840±150 | 8 | C | TM1000 WR41×500 |
| U4H078 | 390 | 53.3 | 315 | 545 | 4 | 1 240 | 80 | 355.6 | 250 | 180 | M42×2 | 46 | 3 820±200 | 8 | C | TM1000 WR46×500 |
| U49084 | 420 | 62.7 | 414 | 725 | 4 | 1 309 | 86 | 381 | 250 | 190 | M45×2 | 50 | 4 900±200 | 8 | C | TM2000 WR50×500A |
| U53088 | 440 | 77.1 | 466 | 855 | 4 | 1 388 | 92 | 406.4 | 275 | 205 | M45×2 | 55 | 5 050±200 | 8 | C | TM2000 WR55×500 |
| U5E095 | 475 | 94.1 | 650 | 1 170 | 4 | 1 465 | 100 | 420 | 275 | 210 | M48×2 | 55 | 5 880±200 | 8 | C | TM2000 WR55×500 |
| U55098 | 490 | 108 | 755 | 1 250 | 4 | 1 503 | 107 | 440 | 275 | 215 | M52×2 | 60 | 7 350±300 | 8 | C | TM2000 WR60×500 |
| U5G105 | 525 | 127 | 859 | 1 410 | 4 | 1 630 | 110 | 470 | 325 | 220 | M52×3 | 65 | 7 650±300 | 8 | C | TM2000 WR65×800 |
| U57108 | 540 | 140 | 1 160 | 1 780 | 4 | 1 674 | 116 | 485 | 350 | 230 | M56×2 | 60 | 9 120±300 | 8 | C | TM2000 WR60×500 |
| U59118 | 590 | 180 | 1 500 | 2 270 | 4 | 1 775 | 125 | 530 | 375 | 250 | M36×2 | 36 | 2 350±100 | 24 | D | TM1000 WB36×500 |
| U63128 | 640 | 229 | 2 120 | 2 920 | 4 | 1 899 | 136 | 580 | 400 | 265 | M39×2 | 36 | 2 940±150 | 24 | D | TM1000 WB36×500 |
| U6S132 | 660 | 255 | 2 230 | 3 030 | 4 | 1 963 | 142 | 600 | 400 | 275 | M39×2 | 36 | 2 940±150 | 24 | D | TM1000 WB36×500 |
| U6D138 | 690 | 285 | 2 660 | 3 710 | 4 | 2 049 | 146 | 620 | 450 | 285 | M42×2 | 41 | 4 270±200 | 24 | D | TM1000 WB41×500 |

## ■ Features

The U Series is mainly intended for non reversing mills, such as the finishing stand of a hot strip mill.

## ■ Designs available to order

The fixed type can be designed to order, assembling components are shown on the right.
For more details on these designs, consult JTEKT.

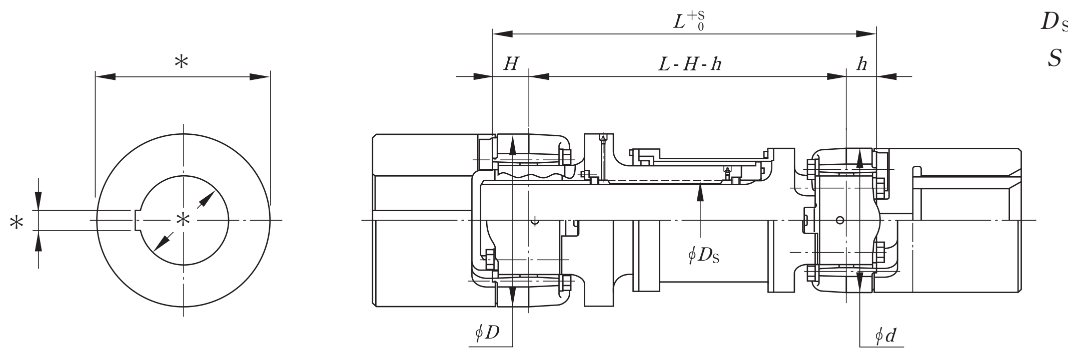
| | |
|---|---|
| With propeller tube |  |
| With coupling yoke |  |

| Model No. | UJ swing dia. (mm) $D$ | Torque capacity (kN·m) | | | Max. operating angle (°) | Boundary dimensions (mm) | | | | | Bearing set bolts | | | | Recommended wrench set [6] (bearing set bolt) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $T_R$ [1] | $T_D$ [2] | $T_S$ [3] | | $L$ [4] (min.) | $H$ | $D_T$ | $D_S$ | $S$ | Nominal thread size | Width across flats | Tightening torque (N·m) | Q'ty [5] | Type | Torque Wrench No. Socket No. Tensiometer No. Wrench No. |
| U65148 | 740 | 360 | 2 990 | 4 770 | 4 | 2 160 | 155 | 670 | 450 | 305 | M45×2 | 46 | 4 900±200 | 24 | D | TM2000 WB46×500 |
| U67152 | 760 | 398 | 3 440 | 4 840 | 4 | 2 195 | 160 | 685 | 450 | 310 | M45×2 | 46 | 4 900±200 | 24 | D | TM2000 WB46×500 |
| U6J156 | 780 | 416 | 3 770 | 5 700 | 4 | 2 235 | 165 | 705 | 500 | 315 | M48×2 | 50 | 5 590±200 | 24 | D | TM2000 WB50×500 |
| U69168 | 840 | 491 | 4 360 | 6 650 | 4 | 2 357 | 178 | 760 | 500 | 325 | M52×2 | 55 | 7 650±300 | 24 | D | TM2000 WB55×500 |

[Notes] 1) $T_R$ refers to the rated torque used for service life calculation (refer to page 15). The material factor $K_m$ is supposed to be 3 in this calculation.
2) $T_D$ refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions.
$T_D$ divided by the maximum torque should preferably be greater than 1.5.
3) $T_S$ refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions.
$T_S$ divided by the breaking torque should preferably be greater than 1.5.
4) $L$ refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) Represents the voltage used for one kit of cross & bearing.
6) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　　Type D: Tensiometer + Socket wrench

[Remarks] 1) The $T_D$ values in the table are values with pulsating load.
2) If you require U series with swing diameter of $\phi$285 to $\phi$345, contact JTEKT.

# T series




$D_S$ : Spline dia.
$S$ : Allowable telescoping stroke

Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

■ Features

The T Series is intended for such applications where telescoping function is required in a small space. Because one of the cross & bearings needs to be hollow to enable the required stroke, this series is applicable in such cases where the swing diameter has a given allowance on either the driving side or driven side.

| Model No. | UJ swing dia. (mm) D (d) | Torque capacity (kN·m) | | | Max. operating angle (°) | Boundary dimensions (mm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $T_R$ 1) | $T_D$ 2) | $T_S$ 3) | | $L$ 4) (min.) | $H$ ($h$) | $D_S$ | $S$ |
| T42065 (D30044) | 325 (220) | 16.9 | 35.3 | 73.1 | 10 | 699 | 67 (45) | 127 | 180 |
| T48080 (D38060) | 400 (300) | 30.8 | 89.9 | 260 | 10 | 870 | 80 (60) | 177.8 | 210 |
| T54090 (D44070) | 450 (350) | 45.0 | 144 | 384 | 10 | 969 | 92 (70) | 203.2 | 250 |
| TZ56100 (D48080) | 500 (400) | 74.1 | 209 | 551 | 8 | 1 080 | 107 (80) | 225 | 280 |
| T58110 (D54090) | 550 (450) | 82.5 | 333 | 739 | 8 | 1 196 | 116 (92) | 250 | 305 |
| T60120 (D56100) | 600 (500) | 111 | 500 | 1 060 | 8 | 1 319 | 125 (107) | 275 | 335 |
| T62130 (D58110) | 650 (550) | 142 | 747 | 1 460 | 6 | 1 414 | 136 (116) | 300 | 355 |
| T66150 (D62130) | 750 (650) | 212 | 1 140 | 2 520 | 6 | 1 617 | 155 (136) | 350 | 415 |

| Bearing set bolts | | | | Recommended wrench set 6) (bearing set bolt) | |
|---|---|---|---|---|---|
| Nominal thread size | Width across flats | Tightening torque (N·m) | Quantity 5) | Type | Torque Wrench No. Socket No. Tensiometer No. Wrench No. |
| M24×2 | 27 | 645± 30 | 8 | A | TM500 HR27×8500 |
| M30×2 | 32 | 1 180± 50 | 8 | C | TM500 WR32×500 |
| M33×2 | 36 | 1 720± 70 | 8 | C | TM500 WR36×500 |
| M39×3 | 50 | 3 030±200 | 8 | C | TM1000 WR50×500 |
| M42×3 | 50 | 4 020±200 | 8 | C | TM1000 WR50×500 |
| M48×3 | 60 | 5 980±300 | 8 | C | TM2000 WR60×500 |
| M52×3 | 65 | 7 650±300 | 8 | C | TM2000 WR65×800 |
| M62×3 | 75 | 12 700±300 | 8 | C | TM2000 WR75×800 |

[Notes] 1) $T_R$ refers to the rated torque used for service life calculation (refer to page 15). The material factor $K_m$ is supposed to be 3 in this calculation.
2) $T_D$ refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions.
$T_D$ divided by the maximum torque should preferably be greater than 1.5.
3) $T_S$ refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions.
$T_S$ divided by the breaking torque should preferably be greater than 1.5.
4) $L$ refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) Represents the voltage used for one kit of cross & bearing.
6) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　　Type D: Tensiometer + Socket wrench

[Remarks] 1) The $T_D$ values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.
2) Specifications in parentheses are recommended model numbers and dimensions for combination.

# KF/EZ series

$D_T$ : Propeller tube dia.
$D_S$ : Spline dia.
$S$ : Allowable telescoping stroke

## Telescoping type (with propeller tube)

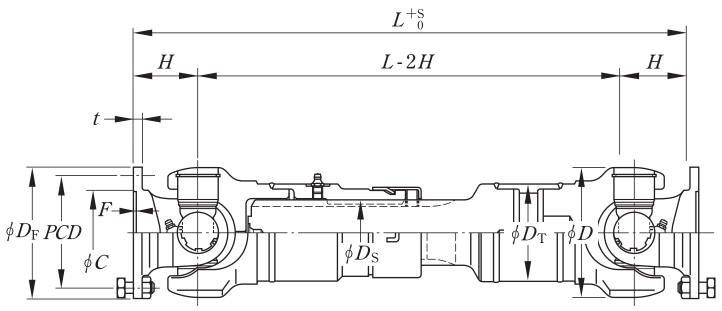


Fig. 1

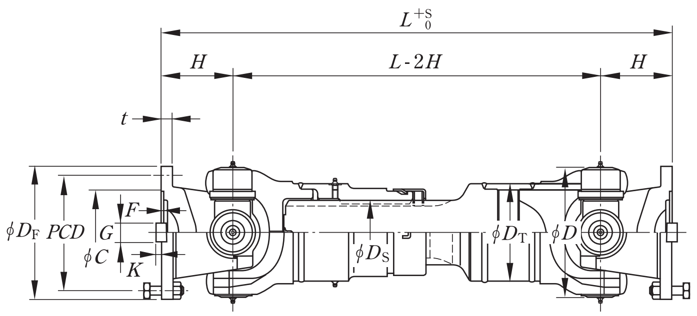


Fig. 2

| Model No. | Fig. | UJ swing dia. (mm) $D$ | Torque capacity (kN·m) | | | Max. operating angle (° ) | Boundary dimensions (mm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Telescoping type | | | | Fixed type with propeller tube |
| | | | $T_R$ 1) | $T_D$ 2) | $T_S$ 3) | | $H$ | $D_T$ | Propeller tube dia. $L$ 4) | With propeller tube $L$(min.) 4) | $S$ | $D_S$ | $L$(min.) 4) |
| KFZ100 | 1 | 105 | 735 | 1 560 | 4 130 | 30 | 70<br>— | 73 | 510<br>— | 550<br>— | 60 | 45 | 320<br>— |
| KF120 | 1 | 120 | 882 | 2 870 | 10 500 | 20 | 60<br>62 | 89.1 | 495<br>499 | 535<br>539 | 70 | 58 | 310<br>314 |
| KF150 | 1 | 150 | 1 860 | 5 890 | 21 600 | 20 | 72<br>74 | 114.3 | 577<br>581 | 617<br>621 | 70 | 70 | 354<br>358 |
| KF180 | 1 | 180 | 3 280 | 9 890 | 36 200 | 18 | 82<br>90 | 127 | 664<br>680 | 714<br>730 | 90 | 82 | 404<br>420 |
| EZ26045 | 2 | 225 | 6 370 | 19 500 | 71 400 | 15 | 123<br>128 | 165.2 | 845<br>855 | 895<br>905 | 90 | 105 | 536<br>546 |
| EZ28050 | 2 | 250 | 8 820 | 32 900 | 115 000 | 15 | 128<br>130 | 203 | 920<br>924 | 980<br>984 | 110 | 120 | 586<br>590 |
| EZ32057 | 2 | 285 | 13 700 | 41 400 | 152 000 | 15 | 143<br>148 | 216.3 | 1 015<br>1 025 | 1 075<br>1 085 | 110 | 140 | 666<br>676 |
| EZ34063 | 2 | 315 | 18 900 | 54 300 | 199 000 | 15 | 163<br>166 | 244.5 | 1 131<br>1 137 | 1 201<br>1 207 | 135 | 160 | 726<br>732 |
| KFZ350 | 2 | 350 | 25 500 | 77 200 | 283 000 | 15 | 175<br>180 | 244.5 | 1 195<br>1 205 | 1 265<br>1 275 | 135 | 180 | 780<br>790 |
| KFZ390 | 2 | 390 | 32 300 | 107 000 | 390 000 | 15 | 195<br>— | 273.1 | 1 335<br>— | 1 425<br>— | 140 | 200 | 880<br>— |
| KFZ435 | 2 | 435 | 51 000 | 149 200 | 546 000 | 15 | 220<br>— | 318.5 | 1 470<br>— | 1 570<br>— | 140 | 200 | 1 010<br>— |

[Notes] 1) $T_R$ refers to the rated torque used for service life calculation (refer to page 15). The material factor $K_m$ is supposed to be 1 for the drive shafts whose swing diameter is 180 mm or less, and to be 3 for those whose swing diameter is between 225 mm and 435 mm in this calculation.
2) $T_D$ refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions. $T_D$ divided by the maximum torque should preferably be greater than 1.5.
3) $T_S$ refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions. $T_S$ divided by the breaking torque should preferably be greater than 1.5.
4) $L$ refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
[Remarks] 1) The $T_D$ values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.

## Fixed type (with propeller tube)

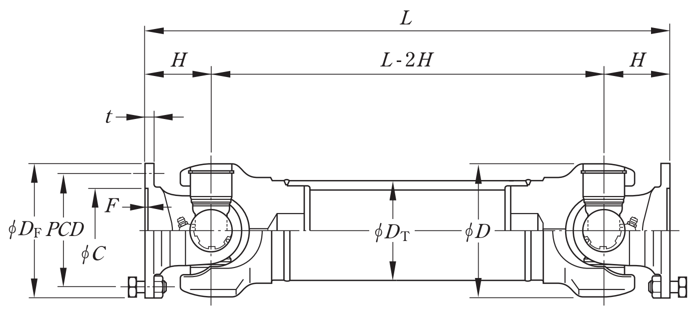


Fig. 1

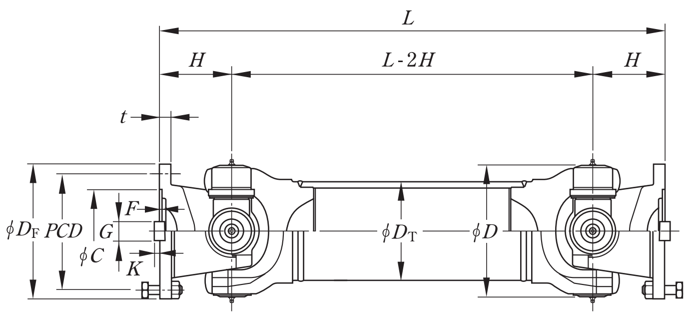


Fig. 2

| Bearing set bolts | | | Flange outside dia. (mm) |
|---|---|---|---|
| Nominal thread size | Width across flats | Tightening torque (N·m) | |
| — | — | — | 120<br>— |
| — | — | — | 120<br>150 |
| — | — | — | 150<br>180 |
| — | — | — | 180<br>225 |
| M16×1.5 | 14 | 185±10 | 225<br>250 |
| M18×2 | 14 | 240±20 | 250<br>285 |
| M18×2 | 14 | 240±20 | 285<br>315 |
| M20×2 | 17 | 360±20 | 315<br>350 |
| M22×1.5 | 17 | 745±40 | 350<br>390 |
| M27×1.5 | 19 | 1 460±80 | 390<br>— |
| M27×1.5 | 19 | 1 460±80 | 435<br>— |

## Fixed type (with double flange)

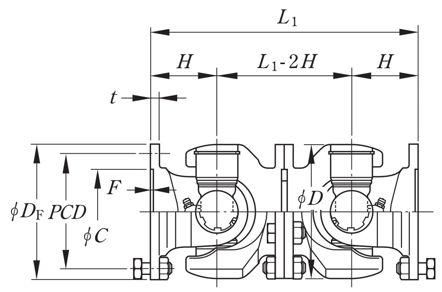


Fig. 1

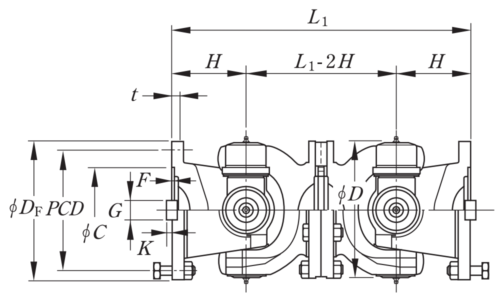


Fig. 2

For the flange dimensions ($PCD, C, F, G, K$ and $t$) that suit the individual flange outside diameter ($D_F$) and for the flange bolt hole details, refer to KF/EZ series flange coupling with cylindrical bore on page 27.

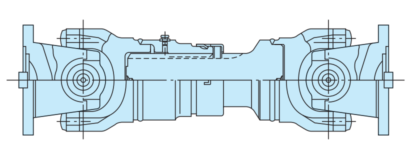
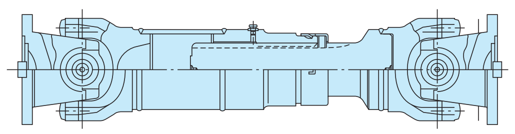
■ Features

The KF/EZ Series products have the following features depending on the swing diameter.

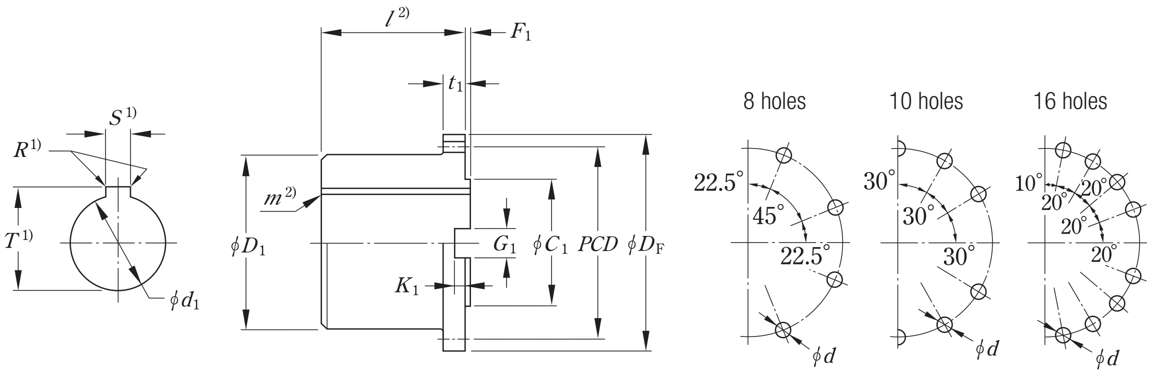
- Swing diameter: 180 mm or less
  The products are suitable for applications where the maximum operating angle is between 18° to 30°. They are suited to light load applications.These products are compatible with a wide variety of equipment. In addition they are economical, with the yokes being integrated.
- Swing diameter: 225 to 435 mm
  The products are suitable for applications where the maximum operating angle is no more than 15°. They are suited to medium load applications.
  Their yokes can be disassembled, so that their cross bearings can be replaced easily.

■ Designs available to order

When installation space is limited or when a stroke needs to be long, this series can be designed to order. Assembling components are shown below.
For more details on these designs, consult JTEKT.

| | |
|---|---|
| Telescoping type without propeller tube |  |
| Long telescoping type |  |

# KF/EZ series flange coupling with cylindrical bore




(Arrangement of bolt holes on the flange)

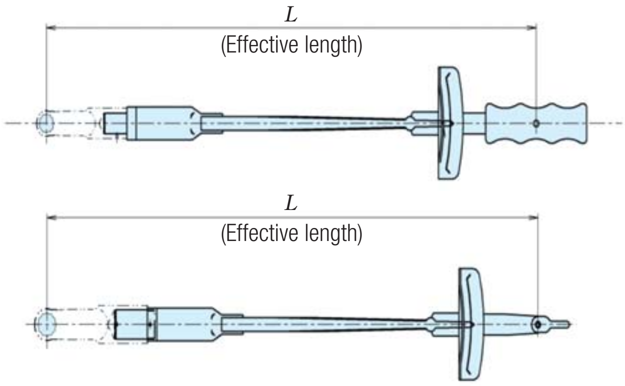
| Flange outside dia. $D_F$ (mm) | Boundary dimensions[3] (mm) | | | | | | | Flange bolt holes | | | Flange set bolts | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $D_1$ (max.) | $d_1$[4] (max.) | $C$ / $C_1$ | $F$ / $F_1$ | $G$(e9) / $G_1$(JS9) | $K$ / $K_1$ | $t$ / $t_1$ | $PCD$ (mm) ±0.1 | Dia. $d$ (mm) | Number | Nominal thread size | Tightening torque (N・m) |
| 120 | 84 | 52 | 75 H7/h7 | 2.5 / 2 | — | — | 8 | 101.5 | 10 (C12) | 8 | M10×1.25 | 64± 5 |
| 150 | 110.5 | 69 | 90 H7/h7 | 2.5 / 2 | — | — | 10 | 130 | 12 (C12) | 8 | M12×1.25 | 110± 5 |
| 180 | 133 | 83 | 110 H7/h7 | 2.5 / 2 | — | — | 12 | 155.5 | 14 (C12) | 8 | M14×1.5 | 175± 10 |
| 200 | 150 | 94 | 140 H7/f8 | 5 / 4.5 | 32 | 9 | 18 | 172 | 15 (drilled) | 8 | M14×1.5 | 175± 10 |
| 225 | 172 | 107 | 140 H7/f8 | 5 / 4.5 | 32 | 9 | 20 | 196 | 17 (drilled) | 8 | M16×1.5 | 265± 20 |
| 250 | 191 | 119 | 140 H7/f8 | 6 / 5 | 40 | 12.5 | 25 | 218 | 19 (drilled) | 8 | M18×2.0 | 360± 20 |
| 285 | 215 | 134 | 175 H7/f8 | 7 / 6 | 40 | 15 | 27 | 245 | 21 (drilled) | 8 | M20×2.0 | 500± 30 |
| 315 | 248 | 155 | 175 H7/f8 | 8 / 7 | 40 | 15 | 32 | 280 | 23 (drilled) | 10 | M22×2.0 | 675± 40 |
| 350 | 278 | 173 | 220 H7/f8 | 8 / 7 | 50 | 16 | 35 | 310 | 23 (drilled) | 10 | M22×2.0 | 675± 40 |
| 390 | 309 | 193 | 220 H7/f8 | 8 / 7 | 70 | 18 | 40 | 345 | 25 (drilled) | 10 | M24×2.0 | 900± 50 |
| 435 | 344 | 215 | 250 H7/f8 | 10 / 9 | 80 | 20 | 42 | 385 | 28 (drilled) | 16 | M27×2.0 | 1 320± 70 |
| 480 | 379 | 235 | 250 H7/f8 | 12 / 11 | 90 | 22.5 | 47 | 425 | 31 (drilled) | 16 | M30×2.0 | 1 810±100 |
| 550 | 446 | 278 | 295 H7/f8 | 12 / 11 | 100 | 22.5 | 50 | 492 | 31 (drilled) | 16 | M30×2.0 | 1 810±100 |

[Notes] 1) The keyway dimensions ( $S$, $T$ and $R$) shall be determined in conformity with JIS B 1301.
2) The dimensions $l$ and $m$ are determined according to customer specifications. (When not specified, $l$ is recommended to be $d_1$ multiplied by between 1.2 and 1.5 and $m$ to be $d_1$ multiplied by about 0.02.)
3) The upper line value in each cell is a dimension for the drive shaft end and the lower line value is a dimension for the cylindrical bore flange coupling end.
4) The $d_1$ max. dimensions are approximately $D_1$ divided by 1.6.

# Torque wrench set for bolt tightening

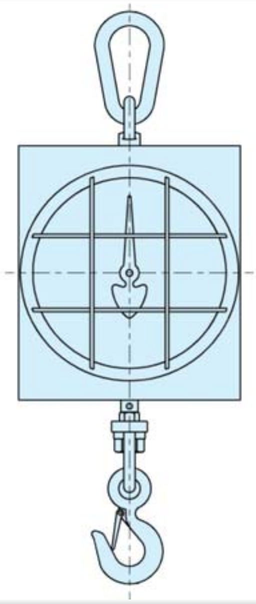
JTEKT provides tool sets suitable for bolt tightening of the drive shaft.
The following are representative tools and their specifications. For details, contact JTEKT.

## Torque wrench




| No. | L (mm) | Scale range (same on the right and left) (N·m) | Minimum scale (N·m) |
|---|---|---|---|
| TW4200 | 750 | 70～420 | 10 |
| TW8500 | 1310 | 100～850 | 20 |
| TW28000 | 1240 | 300～2800 | 50 |
| TW42000 | 1400 | 400～4200 | 100 |

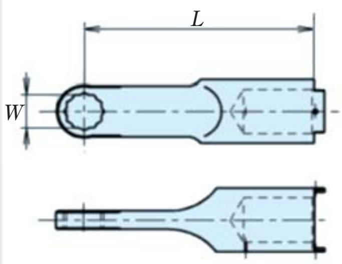
## Tensiometer



| No. | Weighing (kN) |
|---|---|
| TM500 | 5 |
| TM1000 | 10 |
| TM2000 | 20 |
| TM3000 | 30 |

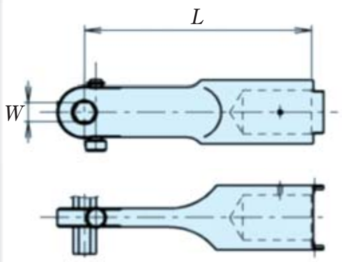
## Sockets

(1) Ring head




| No. | L (mm) | Width across flat W (mm) |
|---|---|---|
| HR17X4200 | 100 | 17 |
| HR19X4200 | 100 | 19 |
| HR22X4200 | 100 | 22 |
| HR24X8500 | 160 | 24 |
| HR27X8500 | 160 | 27 |
| HR30X8500 | 160 | 30 |
| HR32X8500 | 160 | 32 |
| HR36X8500 | 160 | 36 |
| HR41X8500 | 160 | 41 |

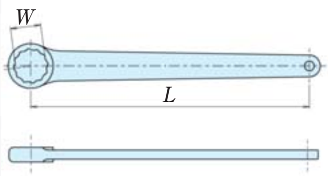
(2) Hexagonal bar head




| No. | L (mm) | Width across flat W (mm) |
|---|---|---|
| HH12X8500 | 160 | 12 |
| HH14X8500 | 160 | 14 |
| HH17X8500 | 160 | 17 |
| HH19X8500 | 160 | 19 |

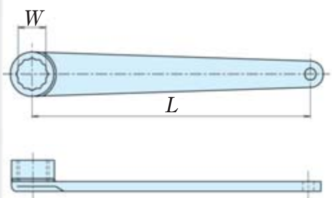
## Wrenches

(1) Ring wrench




| No. | L (mm) | Width across flat W (mm) |
|---|---|---|
| WR32X500 | 500 | 32 |
| WR36X500 | 500 | 36 |
| WR41X500 | 500 | 41 |
| WR46X500 | 500 | 46 |
| WR50X500 | 500 | 50 |
| WR50X500A | 500 | 50 |
| WR55X500 | 500 | 55 |
| WR60X500 | 500 | 60 |
| WR65X800 | 800 | 65 |
| WR70X800 | 800 | 70 |
| WR75X800 | 800 | 75 |
| WR80X800 | 800 | 80 |
| WR85X800 | 800 | 85 |
| WR90X800 | 800 | 90 |
| WR95X1000 | 1000 | 95 |

(2) Socket wrench



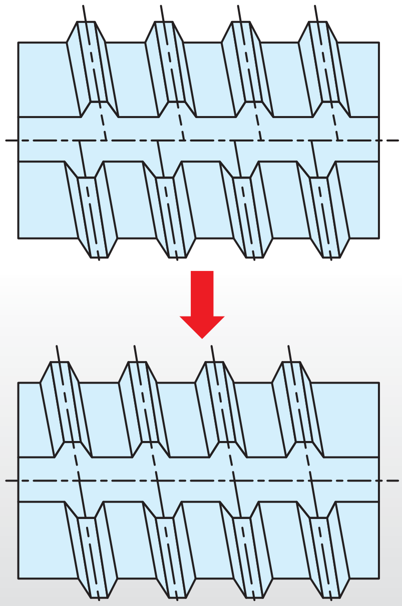

| No. | L (mm) | Width across flat W (mm) |
|---|---|---|
| WB36X500 | 500 | 36 |
| WB41X500 | 500 | 41 |
| WB46X500 | 500 | 46 |
| WB50X500 | 500 | 50 |
| WB55X500 | 500 | 55 |
| WB60X800 | 800 | 60 |
| WB65X800 | 800 | 65 |
| WB70X800 | 800 | 70 |
| WB75X800 | 800 | 75 |

# Product introduction

# Drive shaft with roll phase adjustment device for bar and rod mill

## Applications

Used to adjust the rotation direction phase of the upper and lower rolling mill rolls arbitrarily when forming a continuous thread shape in manufacturing of bar and rod steel for building material (screw reinforcing bar) in bar and rod mills.



### Reasons for increase of needs of screw reinforcing bar

(1) To simplify operations, the connection method of bar steel was increasingly changed from previous "welding method" to "screw connection method."

(2) By forming continuous convex in the periphery of bar steel, adhesion with concrete is increased.

### Necessity of phase adjustment of rotation direction of rolls

For roll forming of continuous convex screw thread on the surface of bar steel, the rotation direction phase of the upper and lower rolls with concavity spiral groove formed should be adjusted to an arbitrary position.

## Features

(1) The rotation phase can be adjusted almost steplessly, which improves the accuracy of products.

(2) The phase can be adjusted in a short time, which improves the efficiency of the work.

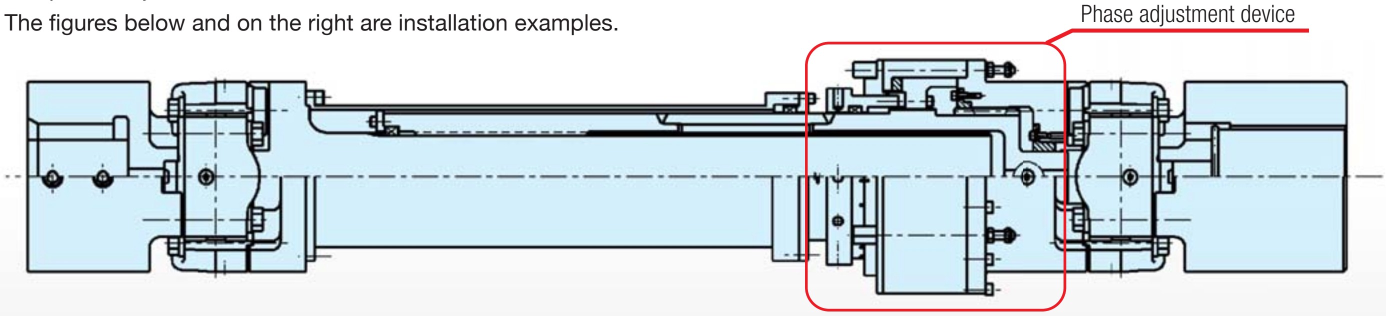
(3) With its unique configuration, the space can be saved in the directions of diameter and shaft.

(4) The lineup of equipment has been enriched to suit most of the bar steel sizes.

(5) On-line work can be conducted without removing the drive shaft.

## Installation examples

The phase adjustment device can be attached to both horizontal stand and vertical stand.
The figures below and on the right are installation examples.




For vertical stand

## Work procedure

(1) Phase adjustment work should be conducted with the rolls of the rolling mill inserted to the drive shaft. First, measure the adjustment amount.

(2) Decide the number of adjustment scales from the following equation.

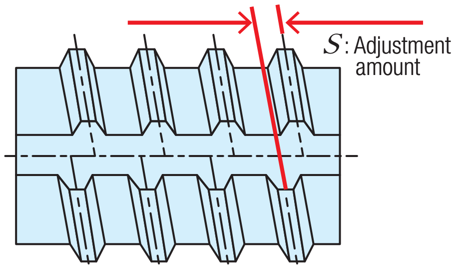
$$N = \frac{18 \cdot P \cdot S}{D \cdot L \cdot \tan\theta}$$

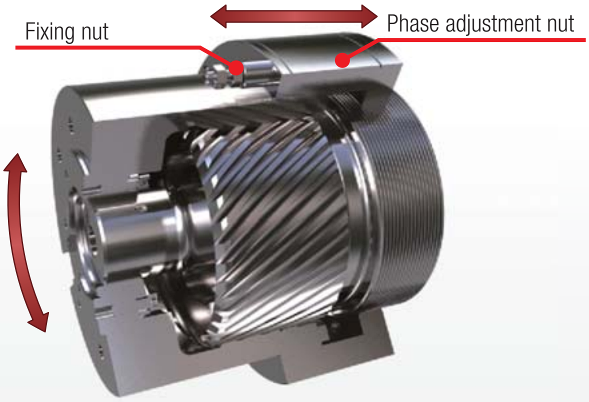
$N$ : Number of adjustment scales
$P$ : Helical spline PCD*
$S$ : Adjustment amount (mm) (Measure the dimension in the figure on the right)
$D$ : Roll diameter (mm) (customer dimension)
$L$ : Adjustment nut pitch*
$\theta$ : Helical spline helix angle*
For items with *, contact JTEKT.

(3) Loosen the fixing nuts in three positions so that the adjustment nut should be able to rotate.

(4) Proceed with adjustment by rotating the phase adjustment nut. When the adjustment nut is rotated, the helical spline slides. With sliding of the helical spline, the rolls rotate slightly. Adjust them to an arbitrary phase.

(5) When the work is complete, tighten the fixing nuts for whirl-stop so that the adjustment unit should not move. It is fixed to this phase.

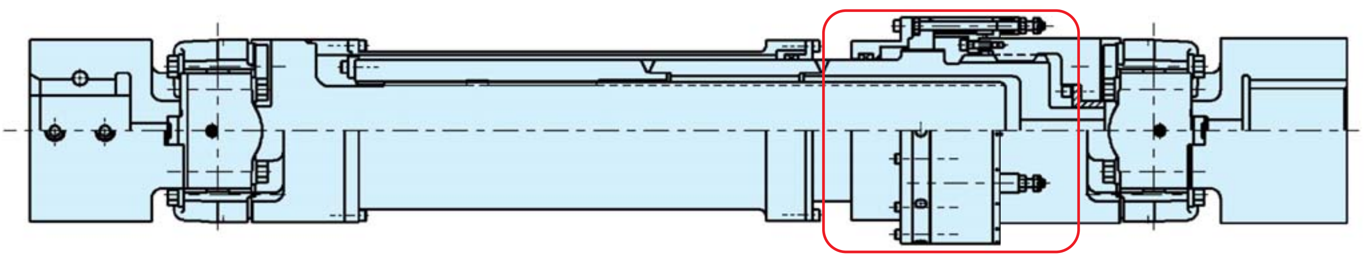


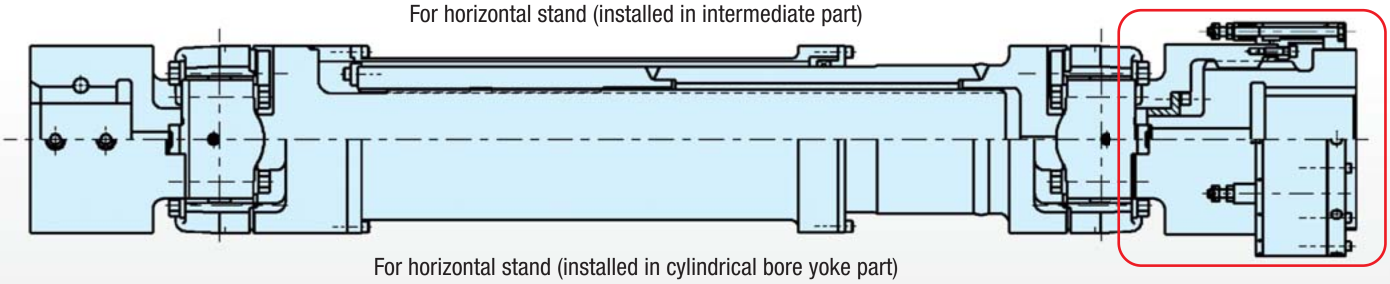

## For design of phase adjustment device

Provide JTEKT with the following information for design of the optimal phase adjustment device.
Provide them along with the selection sheet of the drive shaft.

- Stand status (horizontal stand or vertical stand)
- Roll rotation direction (seen from the pinion stand)
- Roll diameter (disposal diameter)
- Pinion PCD
- Pitch in the case of screw reinforcing bar and intercalary dimension in the case of bar steel with different diameters



For horizontal stand (installed in intermediate part)



For horizontal stand (installed in cylindrical bore yoke part)

# Product introduction

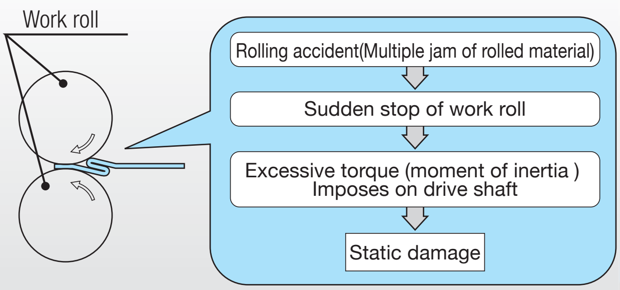
# Hyper coupling (1)

## Applications

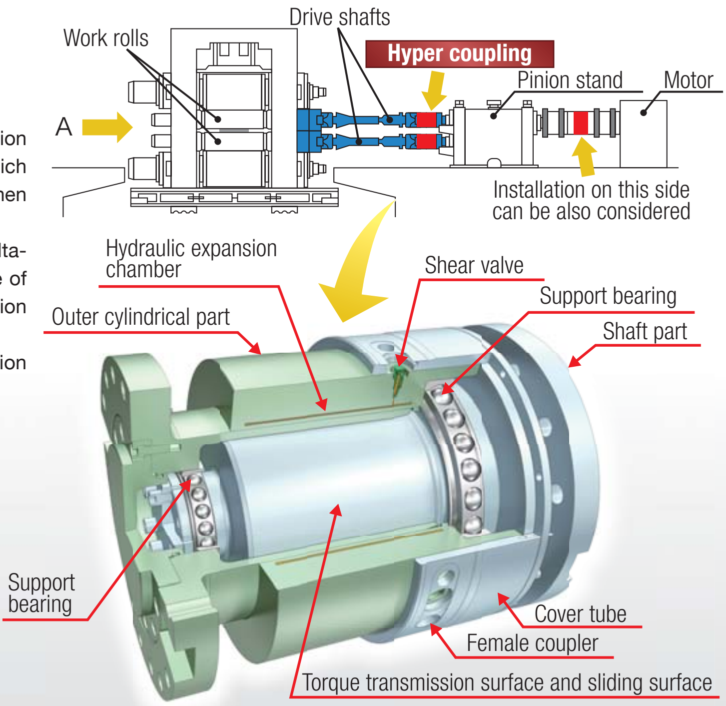
Used to protect peripheral devices of rolling mills against excessive torque.

## Structure and working principle

The hydraulic expansion type torque limiter transmits torque by the friction between the shaft components and the welded coupling assemble, which is generated by the bore shrinkage of the welded coupling assemble when oil is filled and pressurized in the hydraulic expansion chamber.
The torque can be set in proportion to hydraulic pressure, which is simultaneously released by the decompression of oil, thanks to the breakage of the shear valve coming concurrently with slipping of torque transmission surface, if the excessive torque beyond set value is generated.
The following illustration shows an example of the hydraulic expansion type torque limiter applied to a rolling mill.



View A (Example of abnormal rolling)



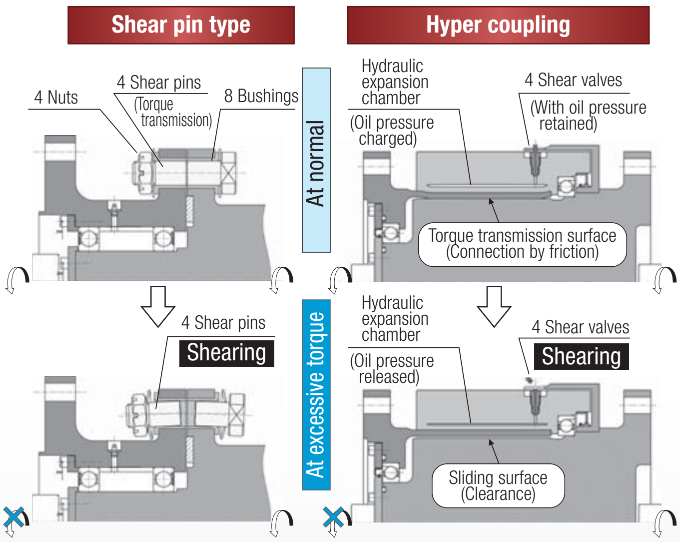
Installation position and structure of hyper coupling

## Comparison of Conventional Product

The shear pin type torque limiter has been used as the implement to release torque, however, the maintenance of surrounding parts of the shear pin is required in case the shear pin is broken, which leads to a lot of time consuming for replacement. Furthermore, the pin needs to be periodically replaced in the overhaul in order to prevent the accumulated metal fatigue of the pin. Compared with the share pin type torque limiter, the hydraulic expansion type torque limiter requires only share valve replacement for repair. Since it is not required to replace the shear valves during periodical inspection, it will improve the overhaul time.

| | | Shear pin type | Hyper coupling |
|---|---|---|---|
| At the time of recovery | Replacement part | ◆Shear pin : 4 pieces<br>◆Nut : 4 pieces<br>◆Bushe : 8 pieces | ◆Shear valves : 4 pieces |
| | Ratio of required man-hours for part replacement | 1 | 1/4 |
| At the regular inspection time | | Periodic replacement of shear pins is required due to accumulated fatigue | Periodic replacement of shear valves is not required |

Merits of hyper coupling



## Features

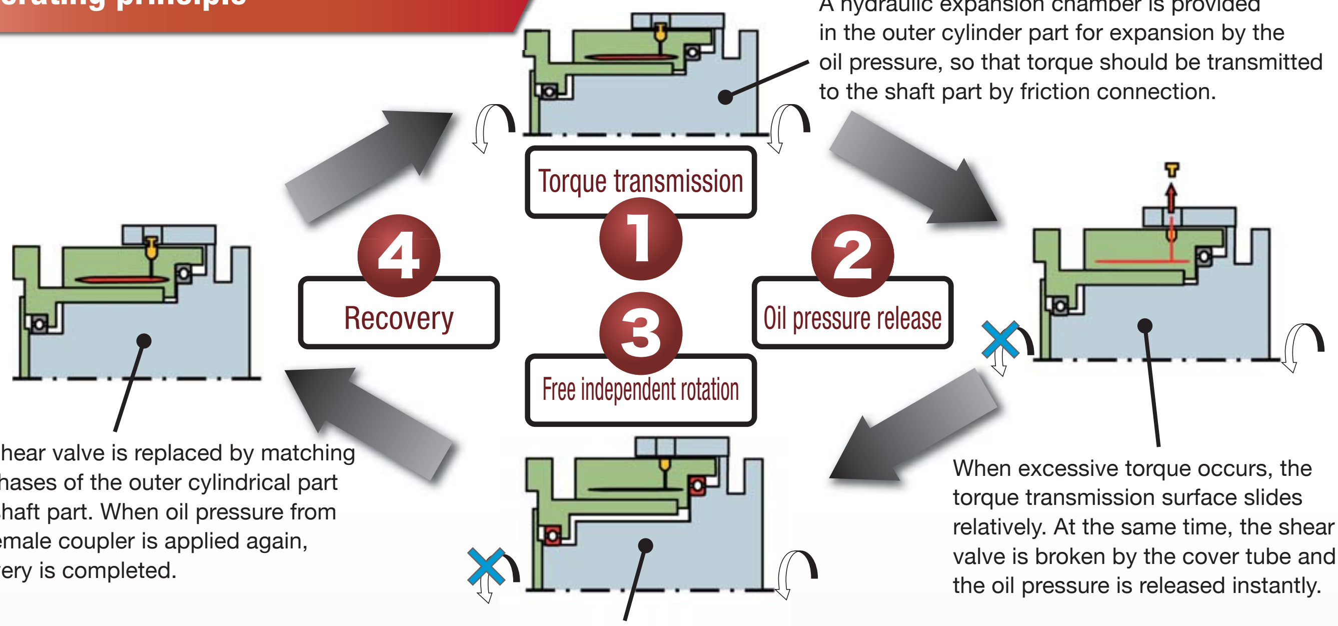
(1) The recovery time after operation (oil pressure release) is significantly shortened.

(2) High operation accuracy.
- The operation torque accuracy is high. The variation of the operation torque is within ±10 %.
- The operation torque is validated by using a large-sized torsion testing machine to improve reliability.

(3) The operation torque can be easily set.

(4) High durability performance.
- A high degree of free independen rotation performance after the release of the oil pressure is secured by utilizing our know-how as a bearing manufacturer.
- Special surface treatment is applied to the operating surface to improve durability.
- The oil pressure release-performance is improved by establishing an analysis method of the oil pressure release time.

## Operating principle



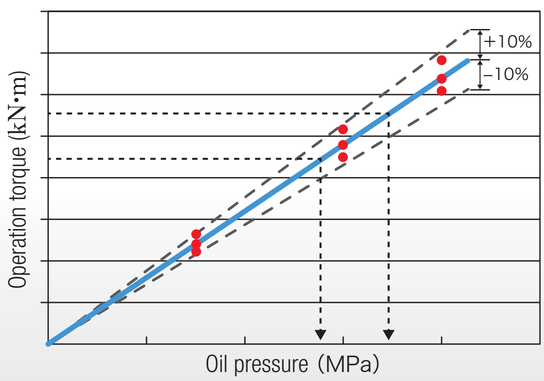

A hydraulic expansion chamber is provided in the outer cylinder part for expansion by the oil pressure, so that torque should be transmitted to the shaft part by friction connection.

When excessive torque occurs, the torque transmission surface slides relatively. At the same time, the shear valve is broken by the cover tube and the oil pressure is released instantly.

The outer cylindrical part and the shaft part are free to rotate independently and smoothly on the bearings that support both ends of the torque transmission surface.

The shear valve is replaced by matching the phases of the outer cylindrical part and shaft part. When oil pressure from the female coupler is applied again, recovery is completed.

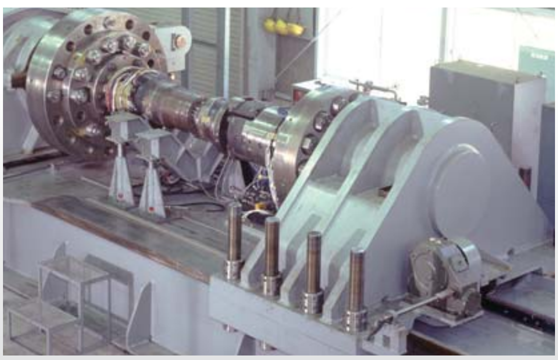
## Operation torque




Oil pressure-operation torque diagram (image)

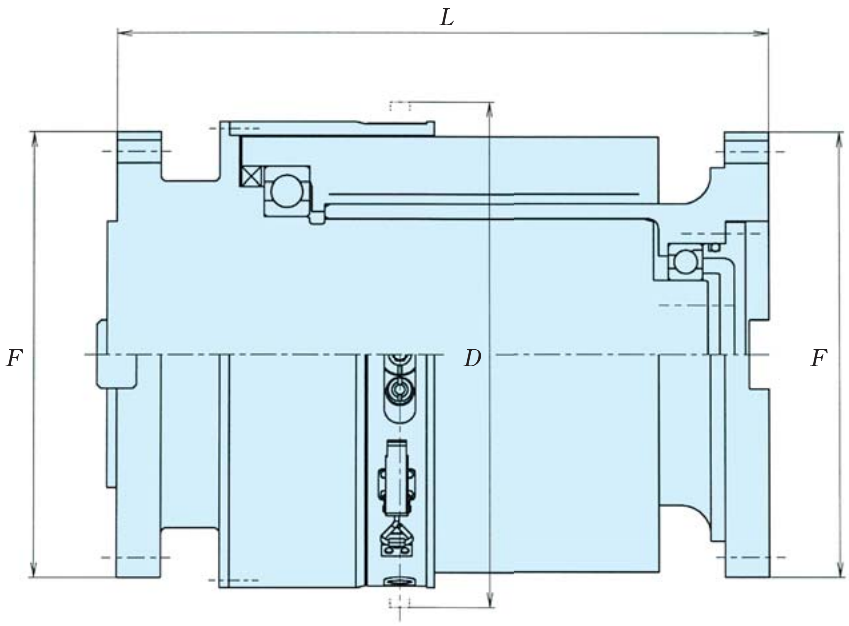
The setting of operation torque can be changed easily by adjusting the oil pressure value.

Before shipping, a large-sized torsion testing machine is used with the actual machine to calculate the relationship between each oil pressure and operation torque.
We set the oil pressure value for the requested operation torque.
The accuracy of the operation torque with each oil pressure value is high: within ±10 %.



Large-sized torsion testing machine

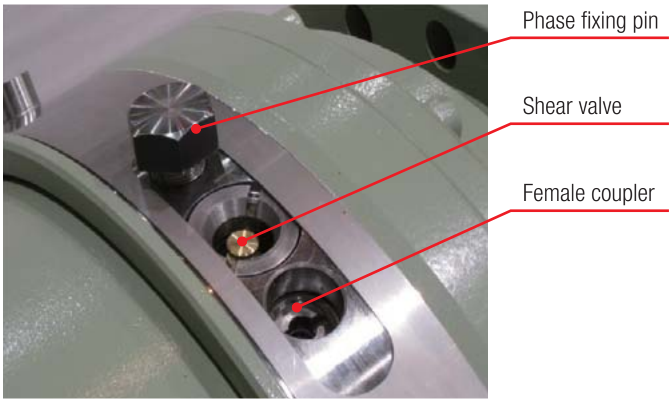
## Dimension tables




| Highper coupling No. | Operation torque (kN·m) | Full length *L* (mm) | Outside diameter *D* (mm) | Flange outside dia. *F* (mm) | Corresponding model No. | |
|---|---|---|---|---|---|---|
| | | | | | D series | U series |
| TL070 | 80～150 | 550 | 420 | 330 | D34052 | — |
| TL088 | 160～280 | 650 | 510 | 430 | D44070 | — |
| TL104 | 200～510 | 750 | 590 | 525 | D50085 | U49084 |
| TL120 | 400～800 | 850 | 670 | 610 | D56100 | U53088 |
| TL134 | 600～110 | 950 | 740 | 675 | D58110 | U5G105 |
| TL148 | 800～1300 | 1000 | 810 | 735 | D60120 | U57108 |
| TL160 | 1000～1800 | 1100 | 870 | 800 | D62130 | U59118 |
| TL176 | 1400～2300 | 1200 | 950 | 860 | D64140 | U6S132 |
| TL188 | 2100～2900 | 1300 | 1010 | 920 | D66150 | U6D138 |
| TL204 | 2500～3600 | 1400 | 1090 | 980 | D68160 | U67152 |
| TL218 | 3200～4300 | 1500 | 1160 | 1050 | D71170 | U69168 |

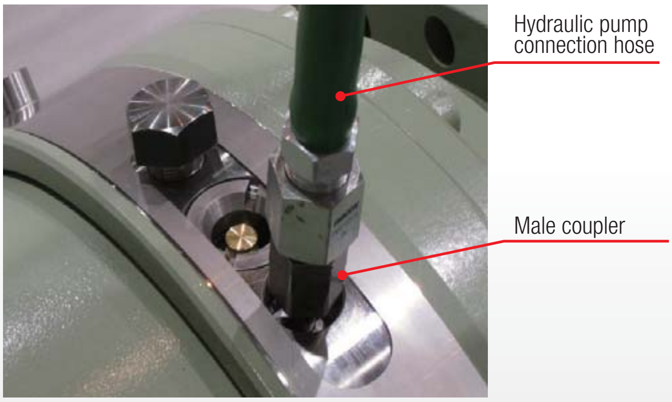
## Recovery method after operation

(1) After the drive system (drive shaft) is stopped completely, clean its surroundings.




(2) Match the phases of the outer cylinder part and shaft part and fix the cover tube and the outer cylinder part by using the phase fixing pin.
Remove the shear valve that has been cut off and replace with a new shear valve after cleaning.
(figure on the upper right)

(3) Insert the connection hose of the hydraulic pump with a male coupler to the female coupler and fill the hydraulic expansion chamber with oil and pressurize to the set pressure. (figure on the middle right)




(4) The oil pressure is retained by tightening the shear valve with specified torque. (figure on the lower right)


(5) Check for oil leakage of the shear valve.

(6) After removing the residual pressure of the hydraulic pump, remove the connection hose. The recovery is completed.

For details, refer to the operation manual attached to the product to conduct work.

## Examples of main tools (attached)

(1) Hydraulic pump
Used to fill the hydraulic expansion chamber with oil and pressurize.

(2) Torque wrench
Used to attach and remove the shear valve assembly, coupler assembly, and phase fixing pin.

(3) Phase fixing pin
Used for whirl-stop at the time of recovery of the hyper coupling.

(4) Male coupler
Attached to the end of the hose attached to the hydraulic pump.
It is inserted to the female coupler of the hyper coupling to pressurize and depressurize the hydraulic expansion chamber.

# Recommended tightening torque for flange bolts

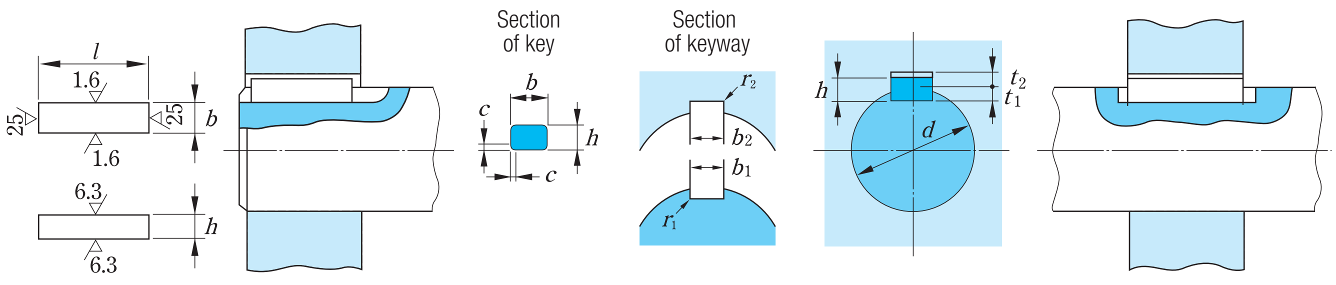
| | Designation | Pitch (mm) | Width across flats (mm) | Tightening torque (N・m) | Tightening force (N) |
|---|---|---|---|---|---|
| Coarse screw thread | M 6 | 1 | 10 | 12±1 | 11 500 |
| | M 8 | 1.25 | 13 | 29±2 | 21 100 |
| | M10 | 1.5 | 17 | 59±5 | 33 500 |
| | M12 | 1.75 | 19 | 98±5 | 47 400 |
| | M14 | 2 | 22 | 155±10 | 65 400 |
| | M16 | 2 | 24 | 245±20 | 91 800 |
| | M18 | 2.5 | 27 | 345±20 | 114 000 |
| | M20 | 2.5 | 30 | 480±30 | 144 000 |
| | M22 | 2.5 | 32 | 645±40 | 179 000 |
| | M24 | 3 | 36 | 825±50 | 207 000 |
| | M27 | 3 | 41 | 1 230±70 | 276 000 |
| | M30 | 3.5 | 46 | 1 670±100 | 334 000 |
| | M33 | 3.5 | 50 | 2 260±150 | 417 000 |
| | M36 | 4 | 55 | 2 840±150 | 479 000 |
| | M39 | 4 | 60 | 3 730±200 | 582 000 |
| | M42 | 4.5 | 65 | 4 610±300 | 665 000 |
| | M45 | 4.5 | 70 | 5 790±300 | 783 000 |
| | M48 | 5 | 75 | 6 960±400 | 876 000 |
| | M52 | 5 | 80 | 9 020±500 | 1 060 000 |
| | M56 | 5.5 | 85 | 11 300±600 | 1 240 000 |
| | M60 | 5.5 | 90 | 13 700±700 | 1 410 000 |
| | M64 | 6 | 95 | 16 700±900 | 1 610 000 |
| | M68 | 6 | 100 | 20 100±1000 | 1 840 000 |

| | Designation | Pitch (mm) | Width across flats (mm) | Tightening torque (N・m) | Tightening force (N) |
|---|---|---|---|---|---|
| Fine screw thread | M 6 | 0.75 | 10 | 14±1 | 12 900 |
| | M 8 | 1 | 13 | 31±2 | 23 000 |
| | M10 | 1.25 | 17 | 64±5 | 37 200 |
| | M12 | 1.25 | 19 | 105±5 | 54 400 |
| | M12 | 1.5 | 19 | 105±5 | 52 800 |
| | M14 | 1.5 | 22 | 175±10 | 75 400 |
| | M16 | 1.5 | 24 | 265±20 | 102 000 |
| | M18 | 2 | 27 | 360±20 | 123 000 |
| | M20 | 2 | 30 | 500±30 | 153 000 |
| | M22 | 2 | 32 | 675±40 | 191 000 |
| | M24 | 2 | 36 | 900±50 | 233 000 |
| | M27 | 2 | 41 | 1 320±70 | 305 000 |
| | M30 | 2 | 46 | 1 810±100 | 378 000 |
| | M33 | 2 | 50 | 2 450±150 | 468 000 |
| | M36 | 3 | 55 | 3 040±150 | 523 000 |
| | M39 | 3 | 60 | 3 920±200 | 624 000 |
| | M42 | 3 | 65 | 5 000±300 | 740 000 |
| | M45 | 3 | 70 | 6 180±300 | 855 000 |
| | M48 | 3 | 75 | 7 550±400 | 979 000 |
| | M52 | 3 | 80 | 9 610±500 | 1 160 000 |
| | M56 | 3 | 85 | 12 300±700 | 1 380 000 |
| | M60 | 3 | 90 | 14 700±800 | 1 560 000 |
| | M64 | 3 | 95 | 18 100±1000 | 1 810 000 |
| | M68 | 3 | 100 | 21 600±1000 | 2 040 000 |

[Remarks] 1) The recommended values are applicable to the following bolts.
Hexagon head bolts of JIS strength class 10.9 (bolt holes is JIS class 1)
Non treated (including blackening), grease lubrication ($\mu$ = 0.125 to 0.14)

2) The values are also applicable to class 2 bolt holes and reamer bolt holes as well as hexagon socket head cap screws as far as the designation and pitch are identical.

# Shape and dimensions of parallel key and keyway (JIS B 1301)




unit : mm

| Nominal size of key b×h | Dimension of key: b Basic dimension | b Tolerance (h9) | h Basic dimension | h Tolerance | | c | l [1] | Dimension of keyway: Basic dimension of $b_1$ and $b_2$ | Close grade $b_1$ and $b_2$ Tolerance (P9) | Normal grade $b_1$ Tolerance (N9) | Normal grade $b_2$ Tolerance (JS9) | $r_1$ and $r_2$ | Basic dimension of $t_1$ | Basic dimension of $t_2$ | Tolerance of $t_1$ and $t_2$ | Informative note: Applicable shaft dia. d [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2× 2 | 2 | 0<br>−0.025 | 2 | 0<br>−0.025 | h9 | 0.16<br>~0.25 | 6~ 20 | 2 | −0.006<br>−0.031 | −0.004<br>−0.029 | ±0.0125 | 0.08<br>~0.16 | 1.2 | 1.0 | +0.1<br>0 | 6~ 8 |
| 3× 3 | 3 | | 3 | | | | 6~ 36 | 3 | | | | | 1.8 | 1.4 | | 8~ 10 |
| 4× 4 | 4 | 0<br>−0.030 | 4 | 0<br>−0.030 | | | 8~ 45 | 4 | −0.012<br>−0.042 | 0<br>−0.030 | ±0.0150 | | 2.5 | 1.8 | | 10~ 12 |
| 5× 5 | 5 | | 5 | | | 0.25<br>~0.40 | 10~ 56 | 5 | | | | 0.16<br>~0.25 | 3.0 | 2.3 | | 12~ 17 |
| 6× 6 | 6 | | 6 | | | | 14~ 70 | 6 | | | | | 3.5 | 2.8 | | 17~ 22 |
| (7× 7) | 7 | 0<br>−0.036 | 7 | 0<br>−0.036 | | | 16~ 80 | 7 | −0.015<br>−0.051 | 0<br>−0.036 | ±0.0180 | | 4.0 | 3.0 | +0.2<br>0 | 20~ 25 |
| 8× 7 | 8 | | 7 | 0<br>−0.090 | h11 | | 18~ 90 | 8 | | | | | 4.0 | 3.3 | | 22~ 30 |
| 10× 8 | 10 | | 8 | | | 0.40<br>~0.60 | 22~110 | 10 | | | | 0.25<br>~0.40 | 5.0 | 3.3 | | 30~ 38 |
| 12× 8 | 12 | 0<br>−0.043 | 8 | | | | 28~140 | 12 | −0.018<br>−0.061 | 0<br>−0.043 | ±0.0215 | | 5.0 | 3.3 | | 38~ 44 |
| 14× 9 | 14 | | 9 | | | | 36~160 | 14 | | | | | 5.5 | 3.8 | | 44~ 50 |
| (15×10) | 15 | | 10 | | | | 40~180 | 15 | | | | | 5.0 | 5.0 | | 50~ 55 |
| 16×10 | 16 | | 10 | | | | 45~180 | 16 | | | | | 6.0 | 4.3 | | 50~ 58 |
| 18×11 | 18 | | 11 | 0<br>−0.110 | | | 50~200 | 18 | | | | | 7.0 | 4.4 | | 58~ 65 |
| 20×12 | 20 | 0<br>−0.052 | 12 | | | 0.60<br>~0.80 | 56~220 | 20 | −0.022<br>−0.074 | 0<br>−0.052 | ±0.0260 | 0.40<br>~0.60 | 7.5 | 4.9 | | 65~ 75 |
| 22×14 | 22 | | 14 | | | | 63~250 | 22 | | | | | 9.0 | 5.4 | | 75~ 85 |
| (24×16) | 24 | | 16 | | | | 70~280 | 24 | | | | | 8.0 | 8.0 | | 80~ 90 |
| 25×14 | 25 | | 14 | | | | 70~280 | 25 | | | | | 9.0 | 5.4 | | 85~ 95 |
| 28×16 | 28 | | 16 | | | | 80~320 | 28 | | | | | 10.0 | 6.4 | | 95~110 |
| 32×18 | 32 | 0<br>−0.062 | 18 | | | | 99~360 | 32 | −0.026<br>−0.088 | 0<br>−0.062 | ±0.0310 | | 11.0 | 7.4 | | 110~130 |
| (35×22) | 35 | | 22 | 0<br>−0.130 | | 1.00<br>~1.20 | 100~400 | 35 | | | | 0.70<br>~1.00 | 11.0 | 11.0 | +0.3<br>0 | 125~140 |
| 36×20 | 36 | | 20 | | | | — | 36 | | | | | 12.0 | 8.4 | | 130~150 |
| (38×24) | 38 | | 24 | | | | — | 38 | | | | | 12.0 | 12.0 | | 140~160 |
| 40×22 | 40 | | 22 | | | | — | 40 | | | | | 13.0 | 9.4 | | 150~170 |
| (42×26) | 42 | | 26 | | | | — | 42 | | | | | 13.0 | 13.0 | | 160~180 |
| 45×25 | 45 | | 25 | | | | — | 45 | | | | | 15.0 | 10.4 | | 170~200 |
| 50×28 | 50 | | 28 | | | | — | 50 | | | | | 17.0 | 11.4 | | 200~230 |
| 56×32 | 56 | 0<br>−0.074 | 32 | 0<br>−0.160 | | 1.60<br>~2.00 | — | 56 | −0.032<br>−0.106 | 0<br>−0.074 | ±0.0370 | 1.20<br>~1.60 | 20.0 | 12.4 | | 230~260 |
| 63×32 | 63 | | 32 | | | | — | 63 | | | | | 20.0 | 12.4 | | 260~290 |
| 70×36 | 70 | | 36 | | | | — | 70 | | | | | 22.0 | 14.4 | | 290~330 |
| 80×40 | 80 | | 40 | | | 2.50<br>~3.00 | — | 80 | | | | 2.00<br>~2.50 | 25.0 | 15.4 | | 330~380 |
| 90×45 | 90 | 0<br>−0.087 | 45 | | | | — | 90 | −0.037<br>−0.124 | 0<br>−0.087 | ±0.0435 | | 28.0 | 17.4 | | 380~440 |
| 100×50 | 100 | | 50 | | | | — | 100 | | | | | 31.0 | 19.5 | | 440~500 |

[Notes] 1) Dimension *l* shall be selected among the following within the range given in Table.
The dimensional tolerance on *l* shall be generally h12 in JIS B0401.
6 , 8 , 10 , 12 , 14 , 16 , 18 , 20 , 22 , 25 , 28 , 32 , 36 , 40 , 45 , 50 , 56 , 63 , 70 , 80 , 90 , 100 , 110 , 125 , 140 , 160 , 180 , 200 , 220 , 250 , 280 , 320 , 360 , 400

2) The applicable shaft diameter is appropriate to the torque corresponding to the strength of the key.

[Remark] The nominal sizes given in parentheses should be avoided from use, as possible.

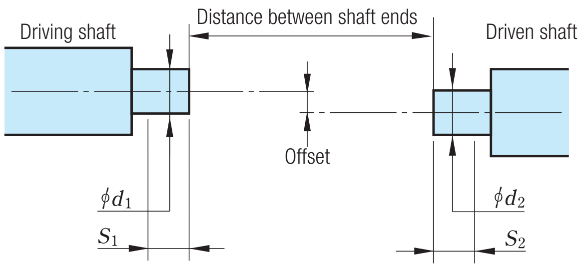
[Reference] Where the key of the smaller tolerance than that specified in this standard is needed, the tolerance on width *b* of the key shall be h7.
In this case, the tolerance on height *h* shall be h7 for the key 7× 7 or less in nominal size and h11 for the key of 8 × 7 or more.

# Drive shaft selection sheet

| Item | Necessity | Description | Remarks |
|---|---|---|---|
| Name of the machine | | | |
| Location of installation | | | |
| (1) Rated motor output (kW) | ○ | | |
| (2) Motor speed ($min^{-1}$) | ○ | Min. Max. | |
| (3) Reduction ratio | ○ | | |
| Drive shaft | | | |
| (4) Number of drive shafts per motor | ○ | | |
| (5) Torque transmission (kN·m) | ○ | Normal Normal max. Emergency max. | |
| (6) Rotational speed ($min^{-1}$) | ○ | Min. Max. | Unnecessary if (2) and (3) are filled in |
| (7) Direction(s) of rotation (Circle one of the two listed on the right.) | ○ | Non reversing Reversing | |
| (8) Limit swing dia. (mm) | △ | | |
| (9) Required stroke (mm) | ○ | | |
| (10) Pinion PCD (mm) | △ | | Enter when the shaft is used for reduction rolls as an example. |
| (11) Roll minimum dia. (mm) | △ | | |
| (12) Paint color | △ | | Black if not specified |
| (13) Ambient temperature (℃) | △ | | |
| (14) Special environmental conditions | △ | | Water, steam, etc. |

(15) Installation dimensions (Must be filled out.)

○ : Must be filled in.
△ : Should be filled in as appropriate.



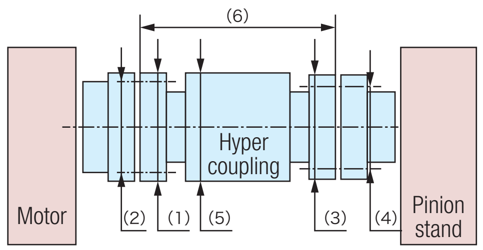

| | | |
|---|---|---|
| Distance between shaft ends (mm) | | |
| Offset | | |
| | Horizontal (mm) | |
| | Vertical (mm) | |
| Fit | | |
| Driving shaft | $\phi d_1$ (mm) | |
| | $S_1$ (mm) | |
| Driven shaft | $\phi d_2$ (mm) | |
| | $S_2$ (mm) | |

# Hyper coupling selection sheet

| Item | Necessity | Description | Remarks |
|---|---|---|---|
| Name of the machine | | | |
| Location of installation | ○ | | |
| (1) Rated motor output (kW) | ○ | | |
| (2) Motor speed | ○ | | |
| (3) Reduction ratio | ○ | | |
| Existing overload prevention device | | Yes No | |
| If "Yes" | | | |
| (4) Installation position (refer to (11)) | ○ | A B | |
| (5) Type | | Shear pin Hydraulic Others | |
| Installation position (refer to (11)) | | | |
| (6) (1) - (7) in the figure below | ○ | | |
| Transmission torque (kN·m) | | | |
| (7) Normal | ○ | | |
| (8) Max. | ○ | | |
| (9) Emergency max. | ○ | | |
| (10) Operation torque | ○ | | |
| Rotational speed $(min^{-1})$ | ○ | | |
| Paint color | | | |
| Ambient temperature (℃) | △ | | |
| Special environmental conditions | △ | | |

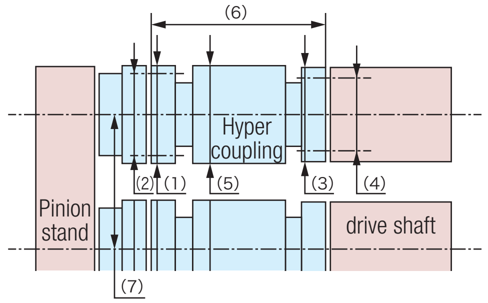
(11) Installation dimensions (Must be filled out.)

○ : Must be filled in.
△ : Should be filled in as appropriate.




A. When installed between the motor and the pinion stand

| | |
|---|---|
| (1) Flange outside diameter | |
| (2) Mounting hole PCD x quantity | |
| (3) Flange outside diameter | |
| (4) Mounting hole PCD x quantity | |
| (5) Hyper coupling outside diameter | |
| (6) Full length | |




B. When installed between the pinion stand and the drive shaft

| | |
|---|---|
| (1) Flange outside diameter | |
| (2) Mounting hole PCD x quantity | |
| (3) Flange outside diameter | |
| (4) Mounting hole PCD x quantity | |
| (5) Hyper coupling outside diameter | |
| (6) Full length | |
| (7) Pinion PCD | |

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## OFFICES

**KOYO CANADA INC.**
5324 South Service Road, Burilngton, Ontario L7L 5H5, CANADA
TEL : 1-905-681-1121
FAX : 1-905-681-1392

**JTEKT NORTH AMERICA CORPORATION**
**-Main Office-**
47771 Halyard Drive, Plymouth, MI 48170, U.S.A.
TEL : 1-734-454-1500
FAX : 1-734-454-7059
**-Cleveland Office-**
29570 Clemens Road, P.O.Box 45028, Westlake, OH 44145, U.S.A
TEL : 1-440-835-1000
FAX : 1-440-835-9347

**KOYO MEXICANA, S.A. DE C.V.**
Av. Insurgentes Sur 2376-505, Col. Chimalistac, Del. Álvaro Obregón, C.P.01070, México, D.F.
TEL : 52-55-5207-3860
FAX : 52-55-5207-3873

**KOYO LATIN AMERICA, S.A.**
Edificio Banco del Pacifico Planta Baja, Calle Aquilino de la Guardia y Calle 52, Panama, REPUBLICA DE PANAMA
TEL : 507-208-5900
FAX : 507-264-2782/507-269-7578

**KOYO ROLAMENTOS DO BRASIL LTDA.**
Avenida Brigadeiro Faria Lima, 1744 - 1st Floor - CJ.11 São Paulo - SP - Brazil CEP 01451-001
TEL : 55-11-3372-7500
FAX : 55-11-3887-3039

**KOYO MIDDLE EAST FZE**
6EA 601, Dubai Airport Free Zone, P.O.Box 54816, Dubai, U.A.E.
TEL : 97-1-4299-3600
FAX : 97-1-4299-3700

**KOYO BEARINGS INDIA PVT. LTD.**
C/o Stylus Commercial Services PVT LTD, Ground Floor, The Beech, E-1, Manyata Embassy Business Park, Outer Ring Road, Bengaluru-560045, INDIA
TEL : 91-80-4276-4567 (Reception Desk of Service Office)
FAX : 91-80-4276-4568

**JTEKT (THAILAND) CO., LTD.**
172/1 Moo 12 Tambol Bangwua, Amphur Bangpakong, Chachoengsao 24180, THAILAND
TEL : 66-38-533-310~7
FAX : 66-38-532-776

**PT. JTEKT INDONESIA**
Jl. Surya Madya Plot I-27b, Kawasan Industri Surya Cipta, Kutanegara, Ciampel, Karawang Jawa Barat, 41363 INDONESIA
TEL : 62-267-8610-270
FAX : 62-267-8610-271

**KOYO SINGAPORE BEARING (PTE.) LTD.**
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TEL : 65-6274-2200
FAX : 65-6862-1623

**PHILIPPINE KOYO BEARING CORPORATION**
6th Floor, One World Square Building, #10 Upper McKinley Road, McKinley Town Center Fort Bonifacio, 1634 Taguig City, PHILIPPINES
TEL : 63-2-856-5046/5047
FAX : 63-2-856-5045

**JTEKT KOREA CO., LTD.**
Seong-do Bldg 13F, 207, Dosan-Dearo, Gangnam-Gu, Seoul, KOREA
TEL : 82-2-549-7922
FAX : 82-2-549-7923

**JTEKT (CHINA) CO., LTD.**
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TEL : 86-21-5178-1000
FAX : 86-21-5178-1008

**KOYO AUSTRALIA PTY. LTD.**
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FAX : 61-2-8719-5333

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TEL : 31-184-606800
FAX : 31-184-606857
**-Sosnowiec Branch Office-**
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TEL : 48-32-720-1444
FAX : 48-32-746-7746

**KOYO KULLAGER SCANDINAVIA A.B.**
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TEL : 46-8-594-212-10
FAX : 46-8-594-212-29

**KOYO (U.K.) LIMITED**
Whitehall Avenue, Kingston, Milton Keynes MK10 0AX, UNITED KINGDOM
TEL : 44-1908-289300
FAX : 44-1908-289333

**KOYO DEUTSCHLAND GMBH**
Bargkoppelweg 4, D-22145 Hamburg, GERMANY
TEL : 49-40-67-9090-0
FAX : 49-40-67-9203-0

**KOYO FRANCE S.A.**
6 Avenue du Marais BP20189, 95105 Argenteuil Cedex, FRANCE
TEL : 33-1-3998-4202
FAX : 33-1-3998-4244/4249

**KOYO IBERICA, S.L.**
Avda. de la Industria, 52-2 izda 28820 Coslada Madrid, SPAIN
TEL : 34-91-329-0818
FAX : 34-91-747-1194

**KOYO ITALIA S.R.L.**
Via Stephenson 43/a 20157 Milano, ITALY
TEL : 39-02-2951-0844
FAX : 39-02-2951-0954
**-Romanian Representative Office-**
24, Lister Street, ap. 1, sector 5, Bucharest, ROMANIA
TEL : 40-21-410-4182
FAX : 40-21-410-1178

## PUBLISHER

**JTEKT CORPORATION NAGOYA HEAD OFFICE**
No.7-1, Meieki 4-chome, Nakamura-ku, Nagoya, Aichi 450-8515, JAPAN —— TEL : 81-52-527-1900 FAX : 81-52-527-1911

**JTEKT CORPORATION OSAKA HEAD OFFICE**
No.5-8, Minamisemba 3-chome, Chuo-ku, Osaka 542-8502, JAPAN —— TEL : 81-6-6271-8451 FAX : 81-6-6245-3712

**Sales & Marketing Headquarters**
No.5-8, Minamisemba 3-chome, Chuo-ku, Osaka 542-8502, JAPAN —— TEL : 81-6-6245-6087 FAX : 81-6-6244-9007

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CAT.NO.B2021E
Printed in Japan '16.01-1CM