ONE! JTEKT

Koyo, TOYODA, and JTEKT
unified all brands into JTEKT.

JTEKT Corporation WEB site
https://www.jtekt.co.jp/e/

JTEKT Bearing WEB site
https://koyo.jtekt.co.jp/en/

JTEKT Overseas hubs
https://www.jtekt.co.jp/e/company/global.html

JTEKT CORPORATION

www.jtekt.co.jp

CAT.NO.UA002EN-1MY
Printed in Japan '23.03('16.1)

JTEKT

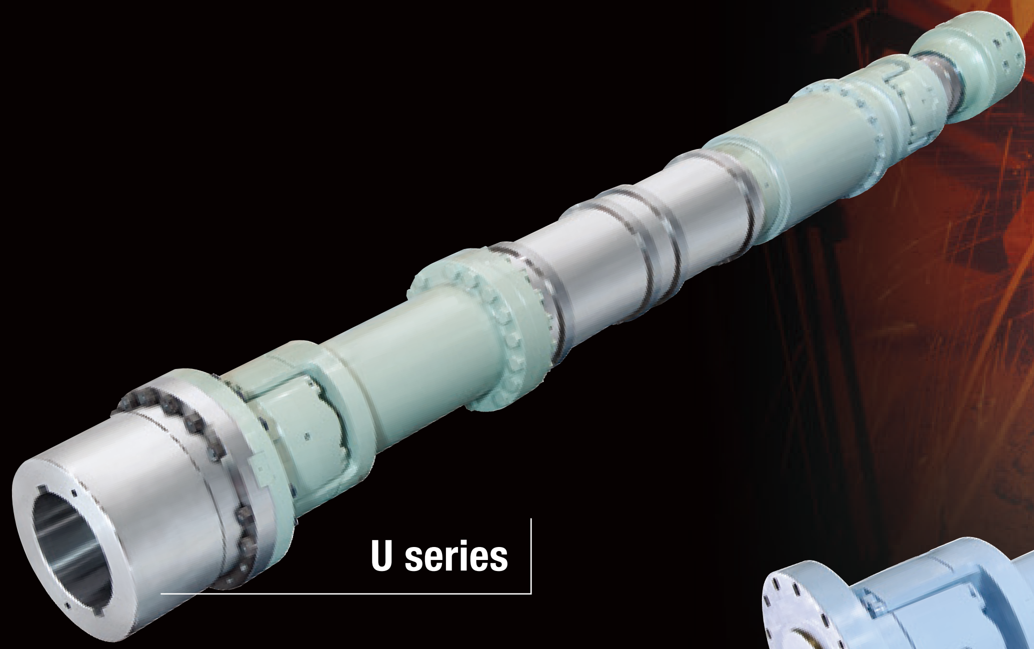
Drive shafts for steel production/ industrial equipment

CAT.NO.UA002EN-1MY

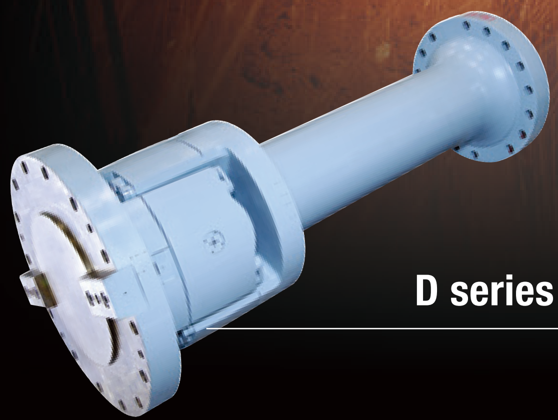
Drive shafts for steel production/ industrial equipment

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



D series

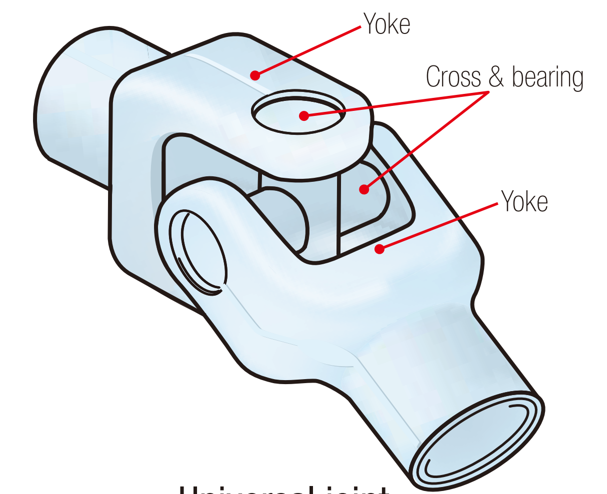
T series

CONTENTS

Drive shaft overview and configuration

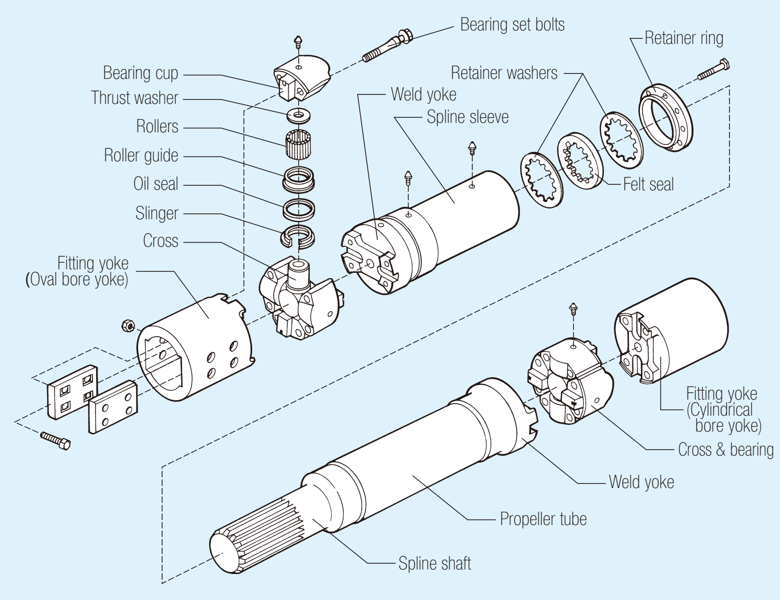
Functions

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
(Cross-type universal joint)

Drive shaft configuration



Features	Characteristics
(1) Used for extra-heavy duty applications. (2) High dust resistance makes these series optimal for use under severe operating conditions such as in rolling mills.	(1) Swing diameter (mm) : ϕ160 - 1230
	(2) Torque T_D(kN·m) : 10.9 - 8970
	(3) Torque T_S(kN·m) : 34.1 - 18800
	(4) Maximum operating angle (°) : 4 - 15

・T_D refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions.
・T_S refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions.

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.

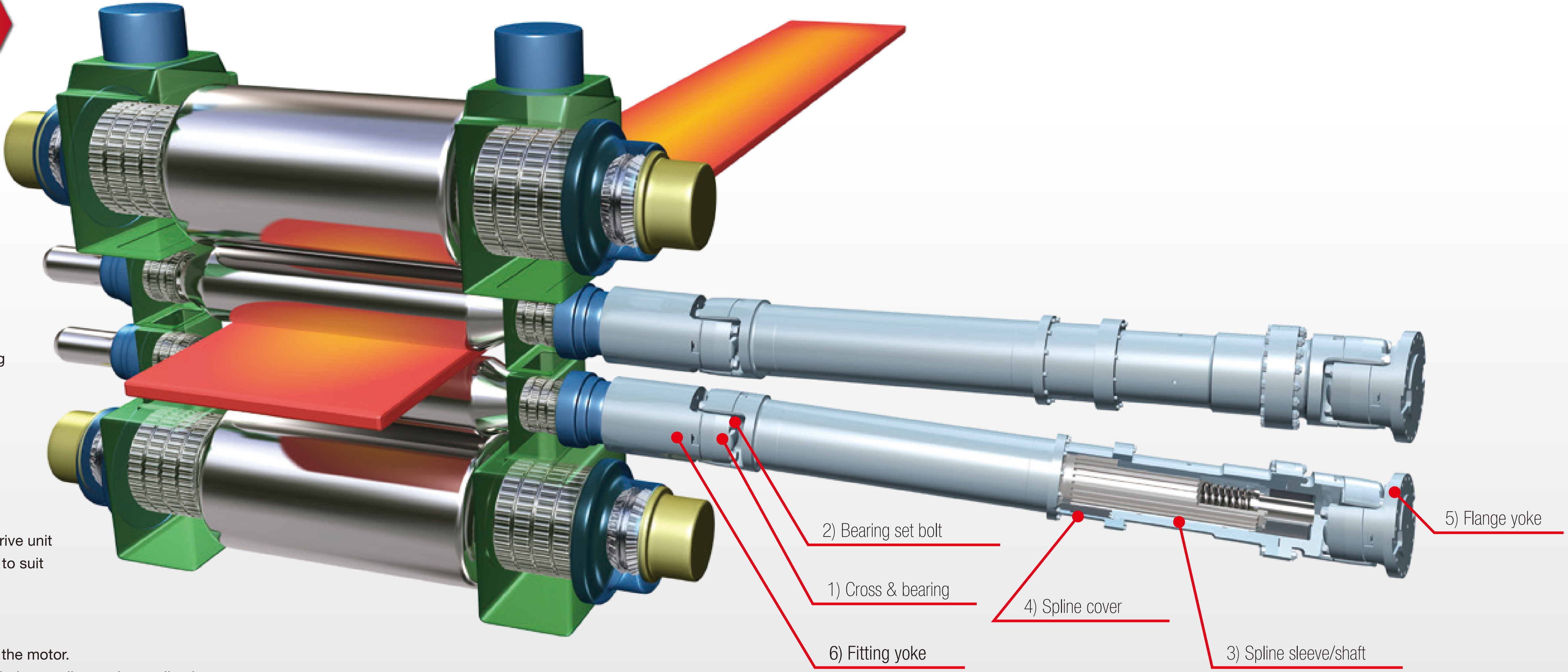
2) Bearing set bolt
Used to connect the cross & bearing and its mating part.

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



Composition of drive shaft numbers

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

*When model numbers are different on the right and left

T60120 D56100 234

(Model No.) (Model No.) 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

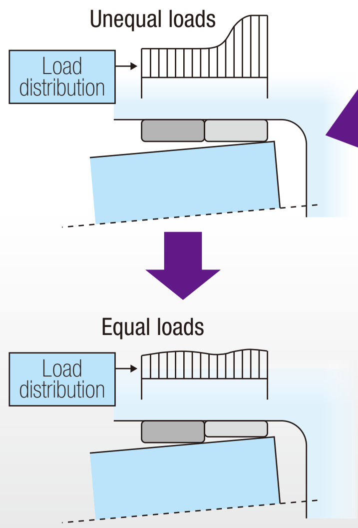
- Series code D : D series U : U series T : T series
- BRG. No. : The raceway diameters of the cross are represented in two digits in order of size (e.g.: 56, 63)
- Swing diameter No. : The value is swing diameter of cross & bearing /5 and is represented in three digits (e.g.: ϕ450 mm → 090, ϕ900 mm → 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

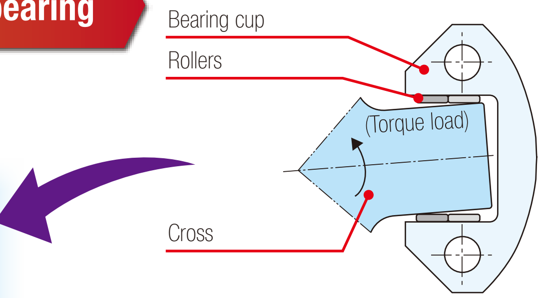
Measures to improve service life and strength

Below are optional specifications for use under severe conditions in which further strength and/or longer life are required.

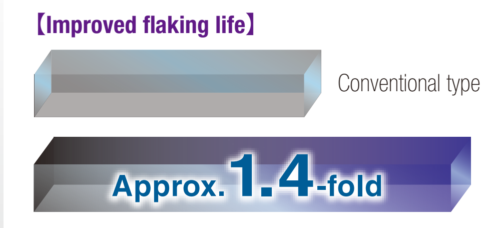
Application of different diameter rollers for cross & bearing

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.
(Rollers with different diameters can be used in a three-row structure.)





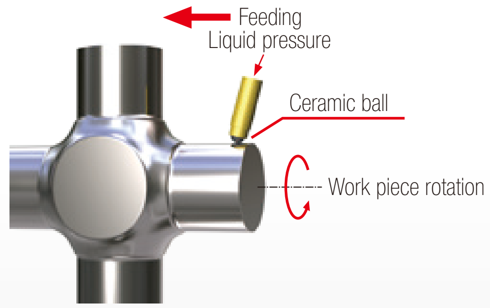
Effect of rollers different in diameter

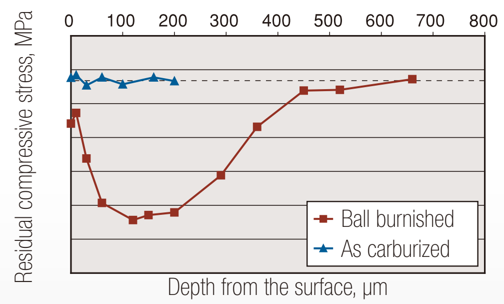


Ball burnishing on cross shaft

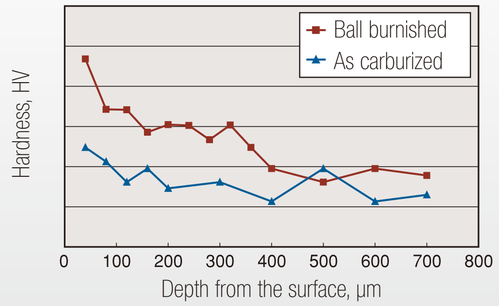
The flaking life can be improved by the ball burnishing on cross raceway. This process is a type of plastic working process, which is applied by rolling contact of super-hard ball backed up hydraulically on the cross raceway surface.

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

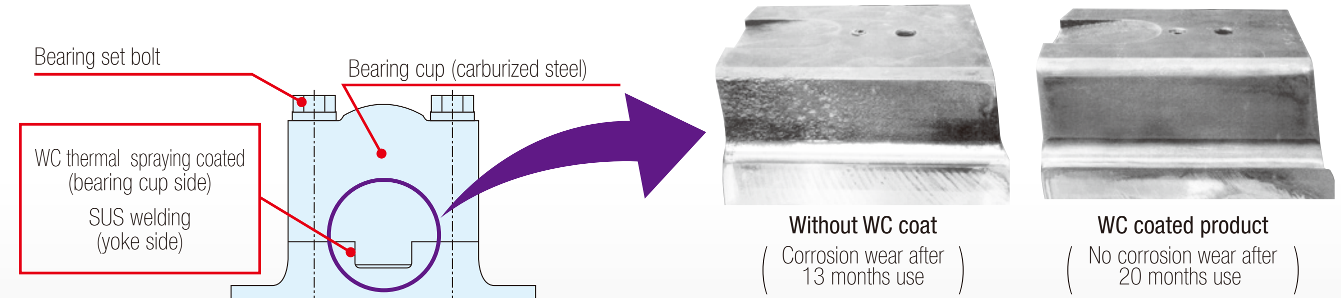


Measurement result of hardness

Measures to improve service life and strength

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

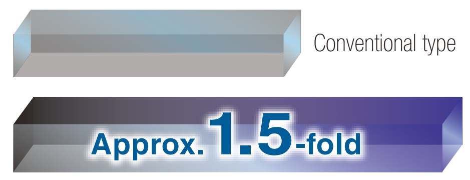
To avoid corrosion on the side face of bearing cup key applying carburizing heat treatment, one possible method is to apply thermal spraying coat of tungsten carbide (WC) on these surfaces.



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.

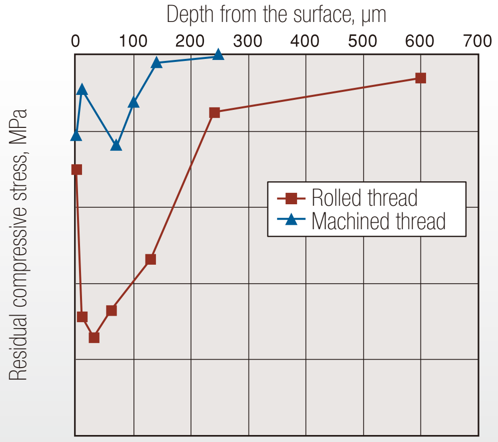
【Improved corrosion resistance】



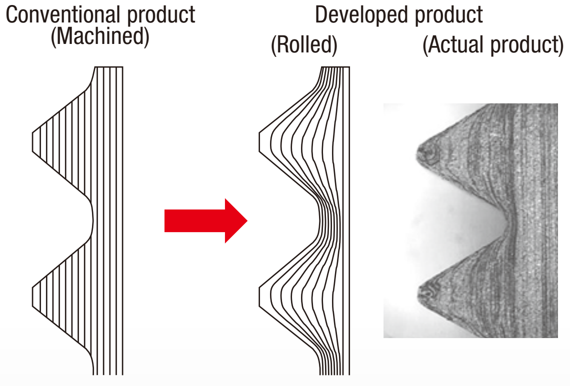
Application of form rolling to bearing set bolt

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)

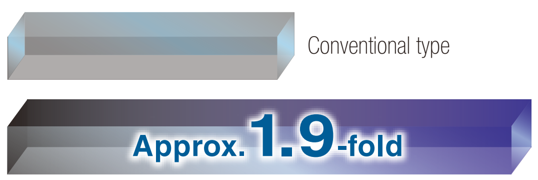


Residual compressive stress distribution of rolled thread

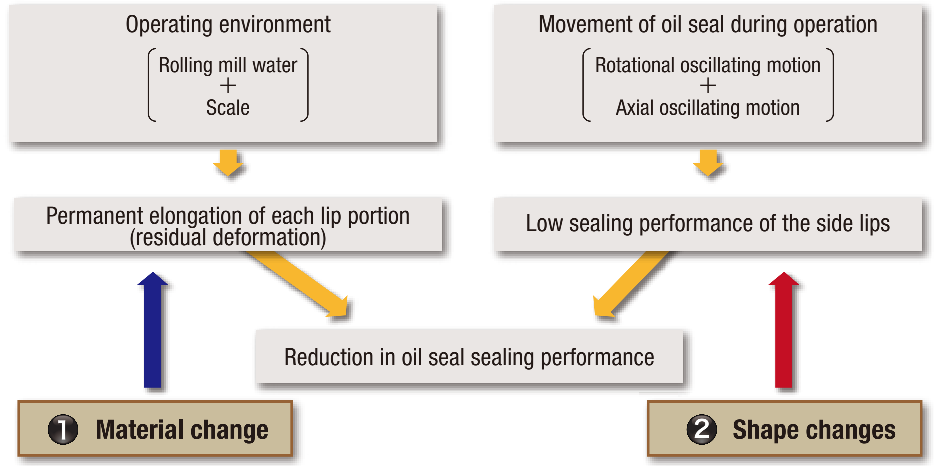


Fiber flow of rolled thread

【Improved fatigue strength】



Development of a high-sealing oil seal

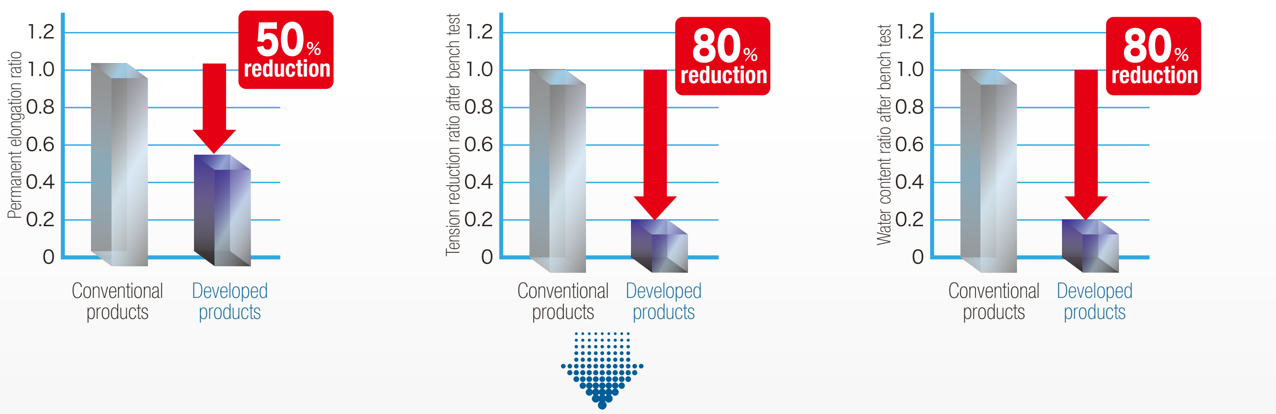


Features

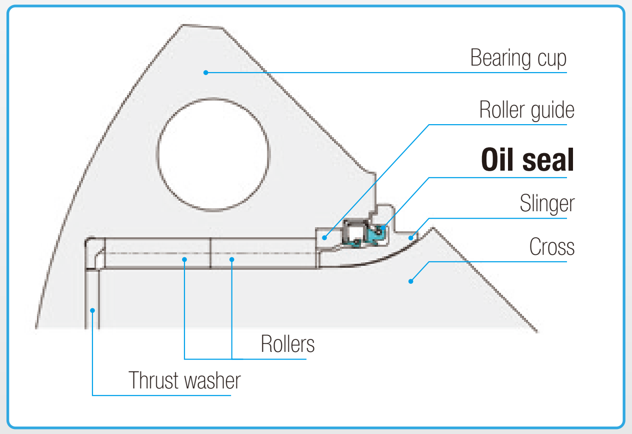
❶ Improved sealing performance through material change
・By changing from nitrile rubber to high nitrile rubber, permanent elongation under rolling mill water and high temperature (90°C) environment is reduced by 50% compared to conventional products.

❷ Improved sealing performance through shape change
・By changing from side lip seal thrust contact to radial contact, sealing performance relative to axial oscillating motion has improved
・Reduced decline in lip tension by 80% compared to conventional
・Reduced intrusion of rolling mill water by 80% compared to conventional products

① 【Confirmation of permanent elongation】 ② 【Confirmation of lip tension】 ③ 【Confirmation of sealing performance】



These changes suppress sudden damage to the cross bearing caused by deterioration in lubricating ability, thus contributing to reduced maintenance costs and improved productivity for customers.



Maintenance and inspection method of drive shaft

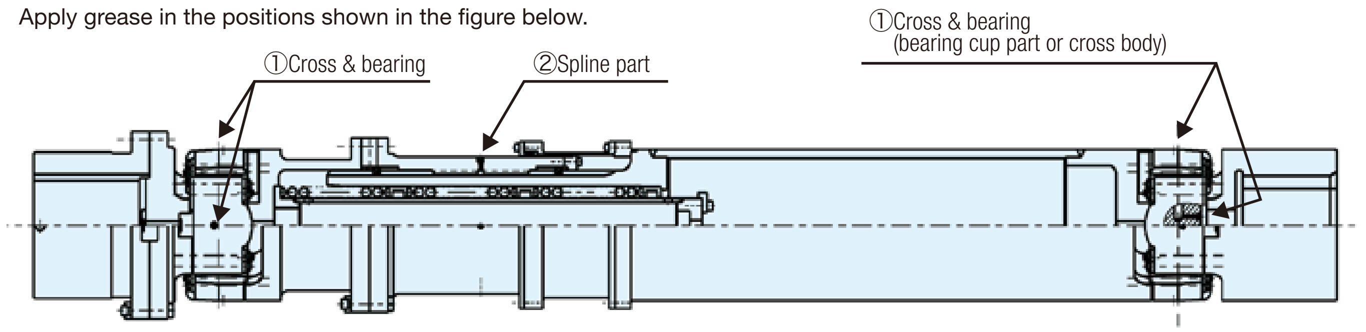
To use drive shafts safely for a long time, periodic inspection is required. Below is the periodic inspection procedure.
We can repair JTEKT products with a swing diameter of 500 mm or more as a guide. Please do not hesitate to contact JTEKT if you need more information.
<Examples of repair>
- Repair by grinding of raceway surfaces of cross and bearing cup
- Repair by overlay welding of yoke key way and oval bore
- Repair of slight wear and removal of rust

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: Once a month
- Others: Every 3 months

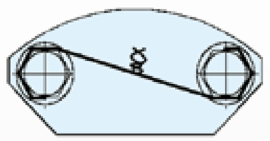
*Be sure to apply grease with correct intervals and amount.
The grease to be applied should be the one specified in the drawing.
Use of insufficient or different grease may lead to early damage.

(2) Tightening torque of bolts

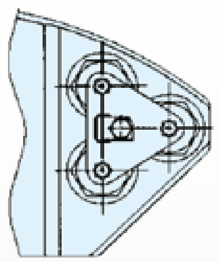
The tightening torque of bolts is set according to the bolt size.
If the bolts are not tightened with the proper tightening torque, it may lead to their early damage.
Refer to the tightening torque of the bolts specified in the drawing.
In addition, a dimension table of torque wrenches is provided on page 18.

■ 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

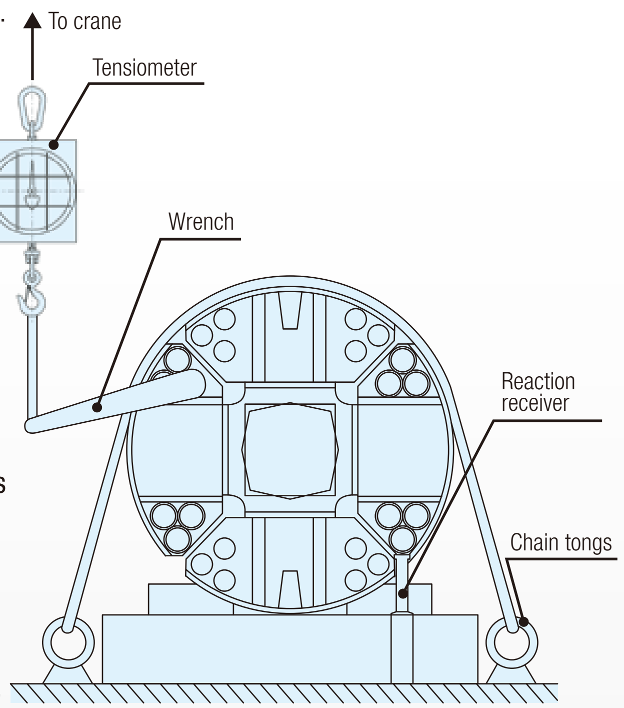


Whirl-stop with one bolt



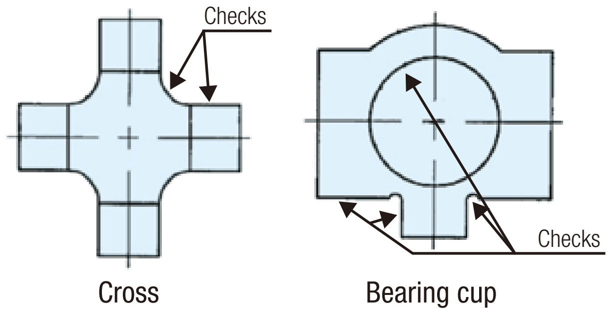
Whirl-stop with three bolts

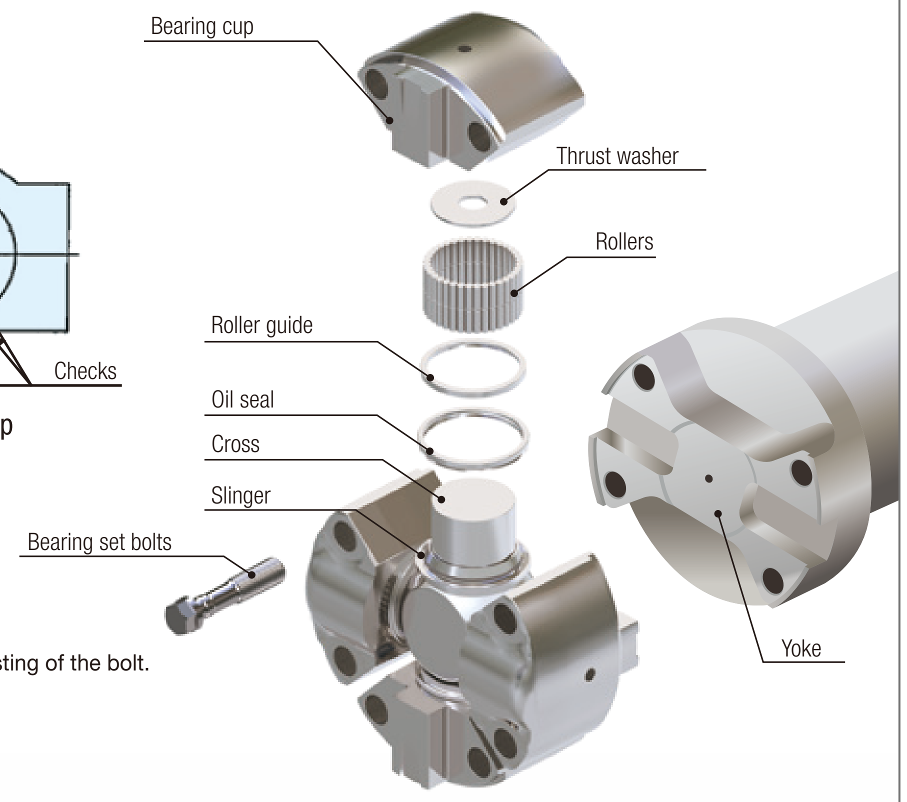
■ How to loosen/tighten the bolts of the cross & bearing
(1) As shown in the figure on the right, tighten the drive shaft with a jig such as chain tongs.
(2) Before tightening, apply a small amount of grease to the thread section and the head seat of the bolt.
(3) Tighten to the specified torque by using a wrench, tensiometer, etc.



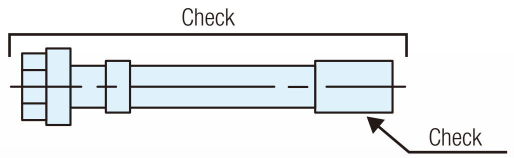
Overhaul

■ 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 the bearing cup.



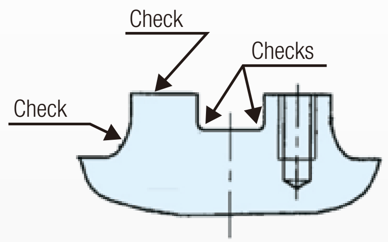


■ Bearing set bolt
- Check for bending, looseness, cracks, or rusting of the bolt.



■ 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.

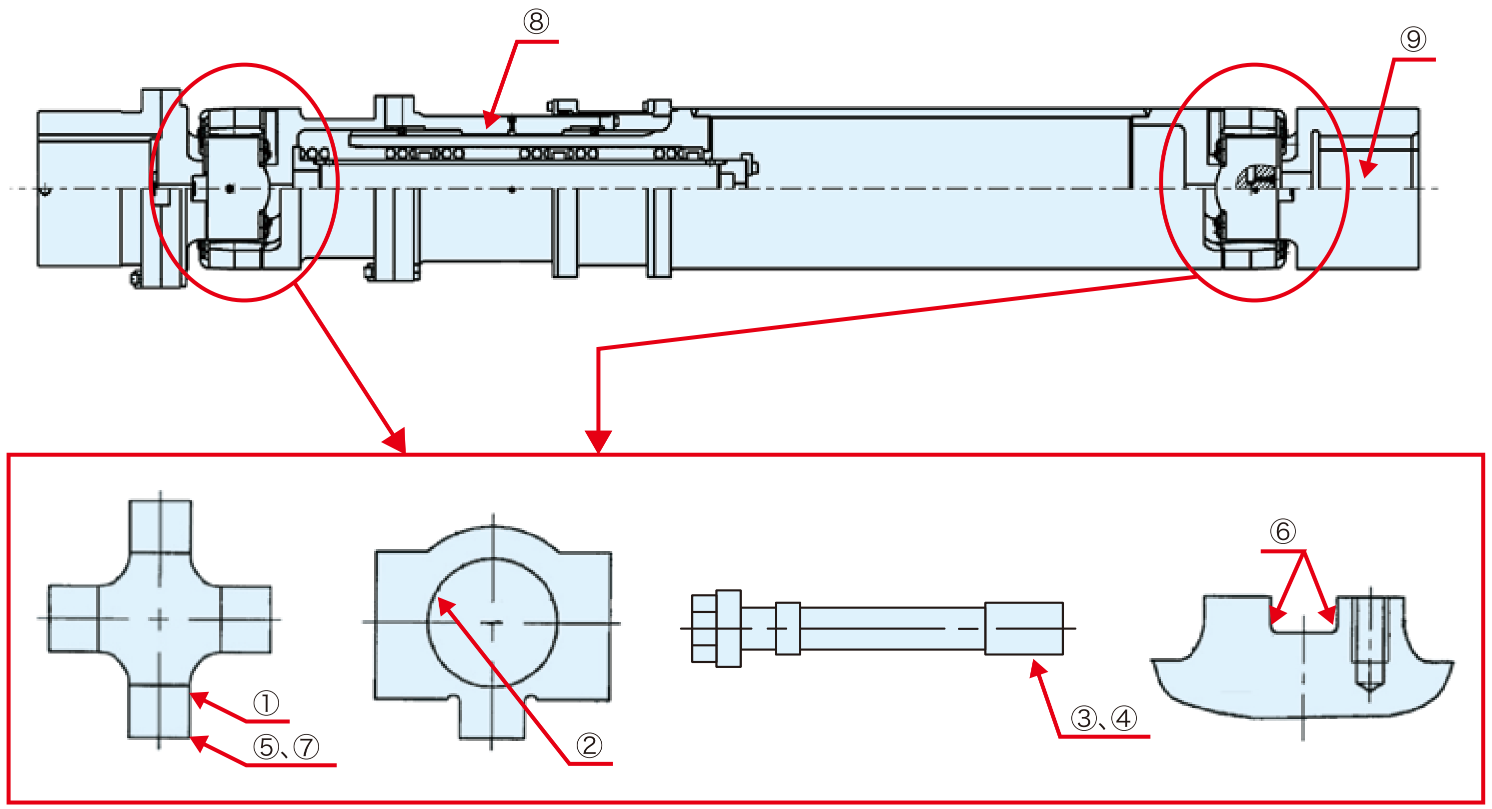
Management/storage

■ 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

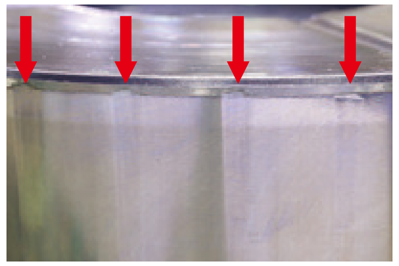
<Part>
Bearing set bolt
<Cause>
- Flat fracture shape because the axial force did not act on the bolt
<Measures>
- Tighten with the proper tightening torque
- Maintenance of the attaching surfaces of the cup and yoke
<Treatment>
- Replace with a new part

(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

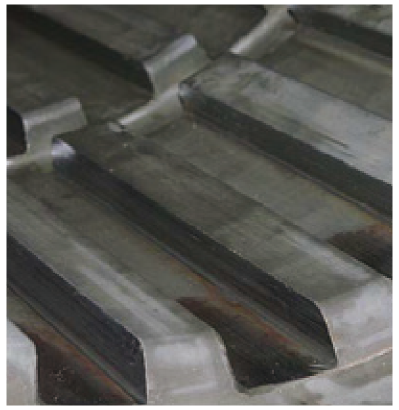
<Part>
Yoke key way
<Cause>
- An excessive load acted on the key way
<Measures>
- Review the usage conditions
- Apply an appropriate load
<Treatment>
- Repair by weld overlaying

(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>
Spline sleeve
<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 (Cross-type 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 ϕ_1 : Rotational angle of driving shaft
ϕ_2 : Rotational angle of driven shaft
θ : Shaft operating angle (**Fig. 1**)

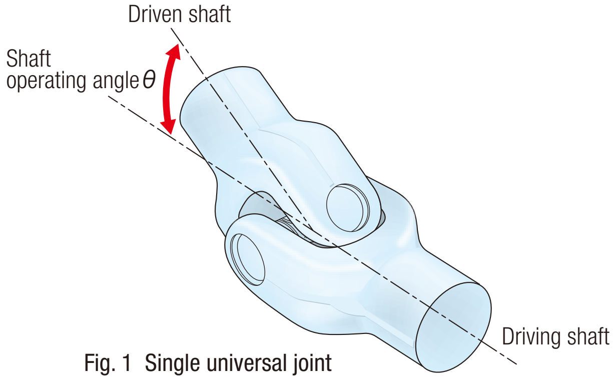


Fig. 1 Single universal joint

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 ϕ_1 is by $\omega_1 \cdot t$ and ϕ_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 ω_1 : Rotational angular velocity of driving shaft $(\mathrm{rad/s})$
ω_2 : Rotational angular velocity of driven shaft $(\mathrm{rad/s})$
ω_2/ω_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:

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

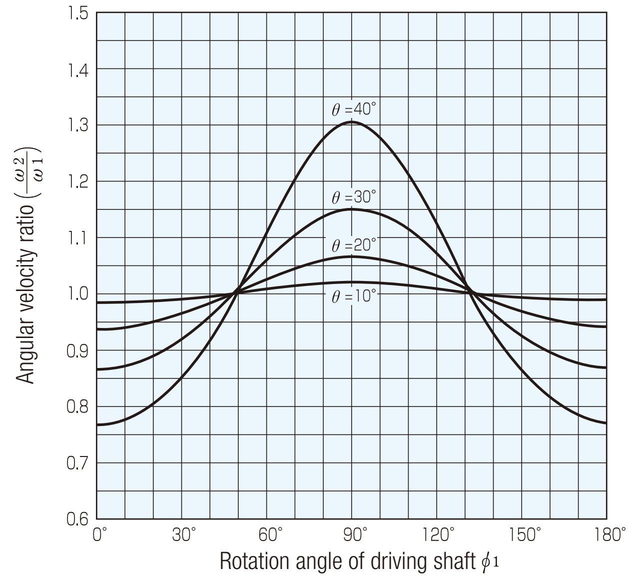


Fig. 2 Angular velocity fluctuation

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

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

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:

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

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

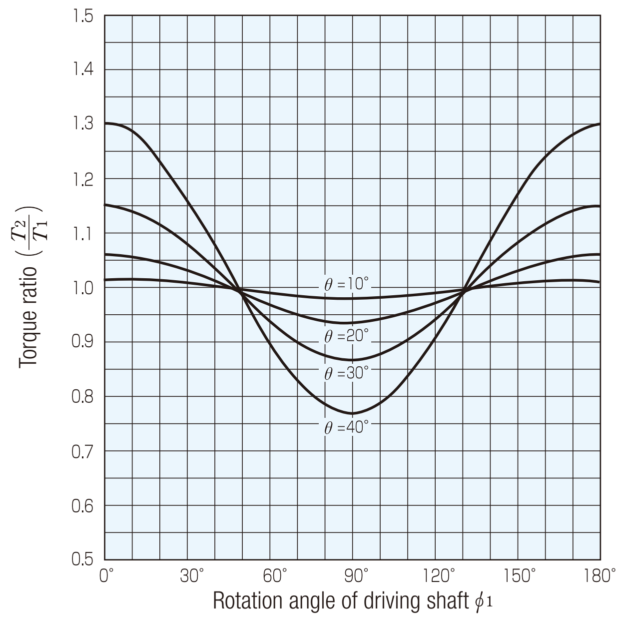


Fig. 3 Torque fluctuation

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.

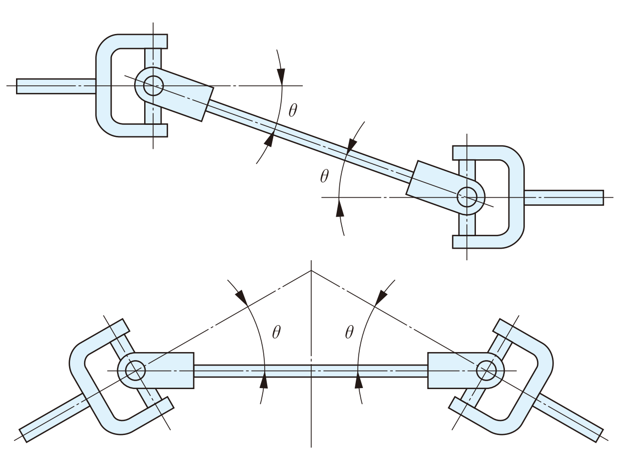


Fig. 4 Installation of double universal joints

Secondary couple

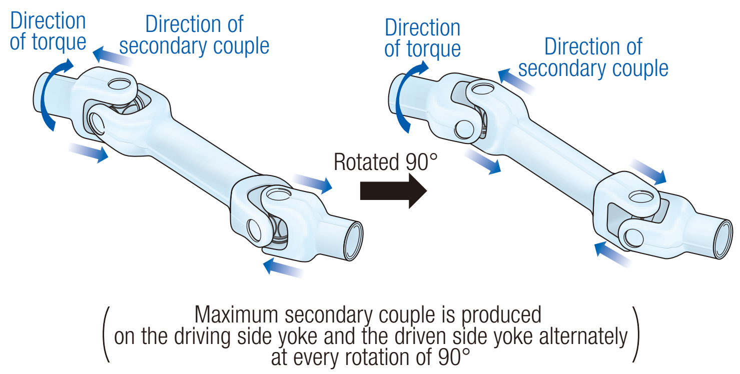
It is often necessary to consider the secondary couples imposed by universal joints operating at an angle; especially under high angle or large torque. These couples must be taken into account in designing the shafts and supporting bearings.

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:

$$M_1\ \mathrm{max.} = T\tan\theta \quad \text{(for driving shaft)}$$
$$M_2\ \mathrm{max.} = T\sin\theta \quad \text{(for driven shaft)}$$

where M_1: Secondary couple on driving shaft $(\mathrm{N \cdot m})$
M_2: Secondary couple on driven shaft $(\mathrm{N \cdot m})$
T : Driving torque $(\mathrm{N \cdot m})$
θ : Shaft operating angle



(Maximum secondary couple is produced on the driving side yoke and the driven side yoke alternately at every rotation of 90°)

Fig. 5 Effect of secondary couple

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.

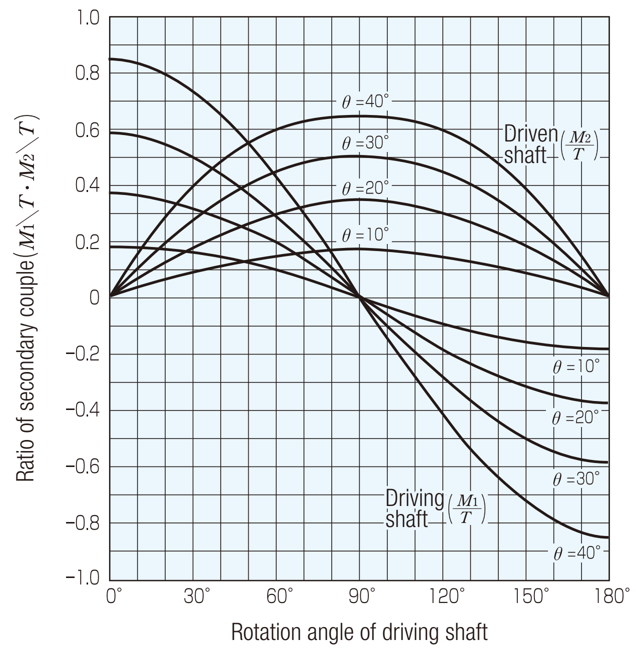


Fig. 6 Fluctuation of secondary couple to driving torque

Technical data (2)

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 cross & bearings, 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 (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 global standard for the method of calculating the service life of cross & bearings, and this method is based on the results of research performed 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_θ: Angle factor = $1.46/\theta^{0.344}$
n : Rotational speed = (min^{-1})
θ : 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.

Critical number of rotation

When the rotation speed approaches the critical number of rotations of a drive shaft (bending natural frequency), the powertrain may be affected by resonance, and thus when a drive shaft is designed, the rotational flexural rigidity of the drive shaft needs to be considered.
If you need to increase the rotation speed through equipment alteration etc., please contact JTEKT.

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.

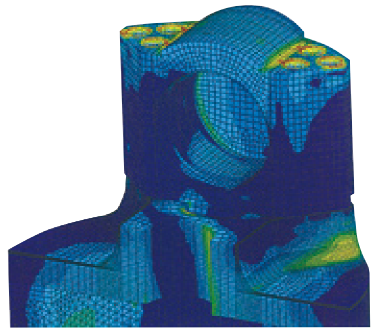
kW → Torque (N·m)

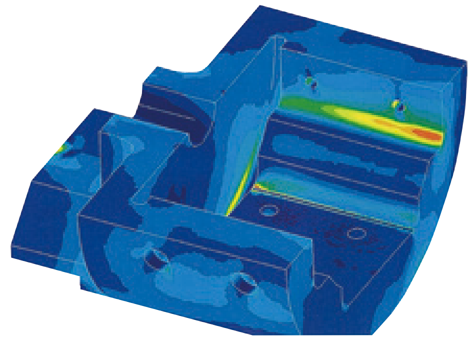
$$T = \frac{kW}{N} \cdot 9552 \quad (\mathrm{N \cdot m}) \quad \cdots\cdots(3)$$

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.

ω: 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.

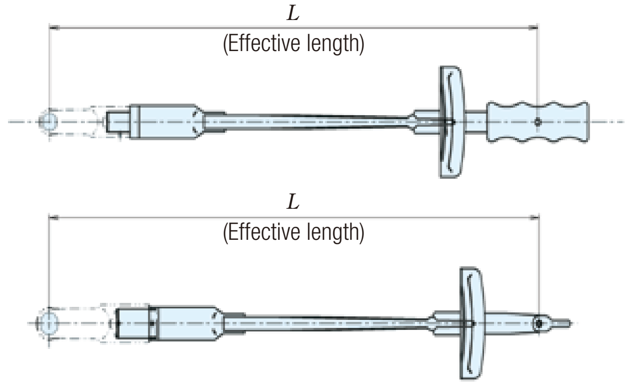
Table 1 Recommended balance quality grades (excerpt from JIS B 0905)

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 Crankshaft systems of elastically mounted high speed four stroke engines (gasoline or diesel) with six or more cylinders Crankshaft systems of the engines of automobiles, trucks and rolling stock
G16	16	Drive shafts with special requirements (propeller shafts and diesel shafts) Components of crushing machines Components of agricultural machines Components of the engines of automobiles, trucks and rolling stock (gasoline or diesel) Crankshaft systems with six or more cylinders with special requirements
G 6.3	6.3	Devices of processing plants Ship engine turbine gears (for merchant ships) Centrifugal drums Papermaking rolls and printing rolls Fans Assembled aerial gas turbine rollers Flywheels Pump impellers Components of machine tools and general industrial machines Medium or large electric armatures (of electric motors having at least 80 mm in the shaft center height) without special requirements Small electric armatures used in vibration insensitive applications and/or provided with vibration insulation (mainly mass produced models) Components of engines with special requirements

Torque wrench set for bolt tightening

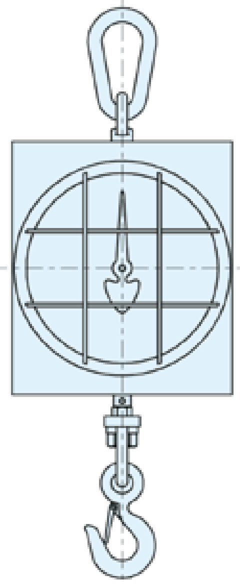
JTEKT provides torque wrench sets suitable for bolt tightening of the drive shaft.
The following are torque wrenches and related tools and their specifications. For details, contact JTEKT.

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

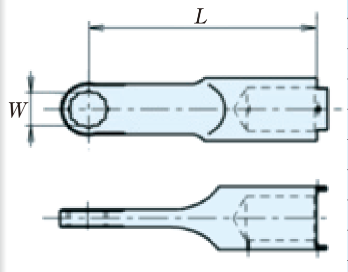
Tensiometer



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

Sockets

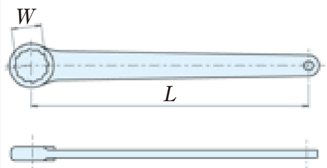
(1) Ring head



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

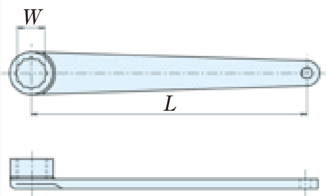
Wrenches

(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
WR55X500A	500	55
WR60X500	500	60
WR60X800A	800	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

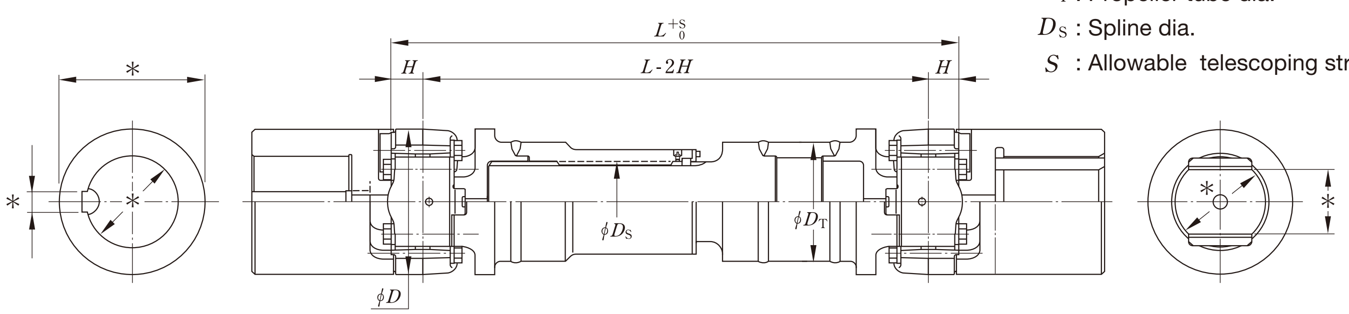


No.	L (mm)	Width across flat W (mm)
WB36X500	500	36
WB41X500	500	41
WB46X500	500	46
WB50X500	500	50
WB55X500	500	55
WB60X800	800	60
WB65X800	800	65
WB70X800	800	70
WB75X800	800	75

D series

Telescoping type (with propeller tube)

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

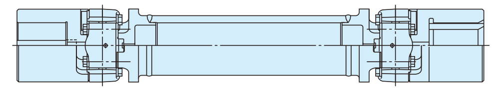
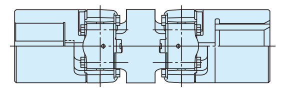


Dimensions marked with an asterisk (∗) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

Model No.	Swing dia. (mm) D	Torque capacity (kN·m) T_R 1)	T_D 2)	T_S 3)	Max. operating angle (°)	Boundary dimensions (mm) L 4) (min.)	H	D_T	D_S 5)	S	Bearing set bolts: Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty 6)	Type	Recommended wrench set (bearing set bolt) 7) Torque Wrench No. Socket No. Tensiometer No. Wrench No.
D22032	160	2.83	10.9	34.1	9	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	9.5	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	7.5	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	8	965	60	244.5	177.8 (160)	135	M30×2	32	1180± 50	8	B	TM500 WR32×500
D44070	350	38.3	144	384	9	1080	70	298.5	203.2 (180)	155	M33×2	36	1720± 70	8	B	TM500 WR36×500
D48080	400	54.9	213	560	8	1220	80	339.7	225 (200)	175	M39×3	50	3040±200	8	B	TM1000 WR50×500
D50085	425	66.9	264	708	8	1284	86	355.6	250	185	M42×3	50	4020±200	8	B	TM1000 WR50×500
D54090	450	80.4	333	739	8	1348	92	381	250	195	M42×3	50	4020±200	8	B	TM1000 WR50×500
D56100	500	107	500	1060	8	1503	107	410	275	205	M48×3	60	5980±300	8	B	TM2000 WR60×500
D58110	550	146	747	1460	6	1604	116	450	300	220	M52×3	65	7650±300	8	B	TM2000 WR65×800
D60118	590	191	939	1990	4.5	1730	125	490	325	235	M58×3	70	10300±300	8	B	TM2000 WR70×800
D60126	630	209	993	2180	15	1776	125	490	325	235	M58×3	70	10300±300	8	B	TM2000 WR70×800
D62134	670	260	1170	2640	9	1859	136	530	350	250	M62×3	75	12700±300	8	B	TM2000 WR75×800
D64140	700	293	1510	3370	6	1949	146	580	375	265	M68×3	85	17100±500	8	B	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	

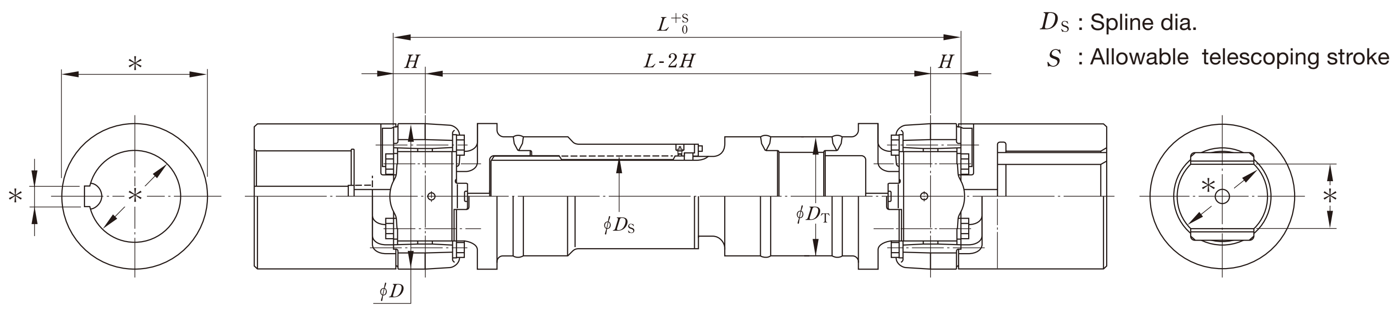
Model No.	Swing dia. (mm) D	Torque capacity (kN·m) T_R 1)	T_D 2)	T_S 3)	Max. operating angle (°)	Boundary dimensions (mm) L 4) (min.)	H	D_T	D_S 5)	S	Bearing set bolts: Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty 6)	Type	Recommended wrench set (bearing set bolt) 7) Torque Wrench No. Socket No. Tensiometer No. Wrench No.
D66150	750	371	1730	3870	6	2090	155	620	400	290	M72×4	90	20400±500	8	B	TM3000 WR90×800
D68160	800	449	2090	4600	6	2225	170	670	450	300	M76×4	95	24500±500	8	B	TM3000 WR95×1000
D71170	850	497	3720	6200	7	2337	178	710	500	320	M48×2	50	5590±200	24	C	TM2000 WB50×500
D72180	900	591	4070	6610	7	2445	190	750	500	335	M48×2	50	5590±200	24	C	TM2000 WB50×500
D7E184	920	621	4360	8050	7	2495	190	780	550	340	M52×2	50	7350±300	24	C	TM2000 WB50×500
D74190	950	654	3900	9250	7	2564	196	810	550	350	M56×3	60	9120±300	24	C	TM2000 WB60×800
D75194	970	697	4600	10400	7	2594	196	830	550	370	M56×3	60	9120±300	24	C	TM2000 WB60×800
D76204	1020	924	4540	8050	7	2654	211	850	550	385	M52×3	55	7650±300	24	C	TM2000 WB55×500
D7J216	1080	1040	6780	13500	6	2890	230	890	600※	400※	M64×3	65	14200±300	24	C	TM2000 WB65×800
D81220	1100	1100	7970	13300	6	2970	250	920	600※	415※	M64×3	65	14200±300	24	C	TM2000 WB65×800
D8B226	1130	1210	7550	15200	6	3070	260	950	650※	430※	M68×3	70	17100±500	24	C	TM3000 WB70×800
D8E246	1230	1540	8970	18800	6	3165	260	1030	650※	450※	M72×4	75	20400±500	24	C	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 bolt quantity 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 18.
Type A: Torque wrench + Ring head Type B: Tensiometer + Ring wrench
Type C: 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

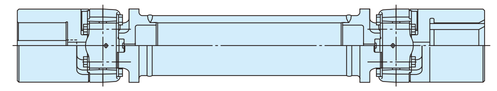
Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

Model No.	Swing dia. (mm) D	Torque capacity (kN·m) T_R 1)	T_D 2)	T_S 3)	Max. operating angle (°)	Boundary dimensions (mm) L 4) (min.)	H	D_T	D_S 5)	S	Bearing set bolts Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty 6)	Type	Recommended wrench set 7) (bearing set bolt) Torque Wrench No. Socket No. Tensiometer No. Wrench No.
U36057	285	19.6	115	230	4	943	57	244.5	177.8 (160)	135	M30×2	32	1320± 50	8	B	TM500 WR32×500
U38059	295	20.8	121	244	4	975	60	244.5	177.8 (160)	135	M32×2	32	1470± 70	8	B	TM500 WR32×500
U43069	345	34.5	217	430	4	1155	70	339.7	225 (200)	165	M36×2	41	2550±150	8	B	TM1000 WR41×500
U45073	365	45.5	284	497	4	1185	75	339.7	225 (200)	170	M39×2	41	2840±150	8	B	TM1000 WR41×500
U4H078	390	53.3	313	745	4	1240	80	355.6	250	180	M42×2	46	3820±200	8	B	TM1000 WR46×500
U49084	420	62.7	414	725	4	1309	86	381	250	190	M45×2	50	4900±200	8	B	TM2000 WR50×500A
U53088	440	77.1	504	855	4	1388	92	406.4	275	205	M45×2	55	5050±200	8	B	TM2000 WR55×500
U5E095	475	94.1	650	1170	4	1465	100	420	275	210	M48×2	55	5880±200	8	B	TM2000 WR55×500A
U55098	490	108	755	1252	4	1503	107	440	275	215	M52×2	60	7350±300	8	B	TM2000 WR60×800A
U5G105	525	127	859	1410	4	1630	110	470	325	220	M52×3	65	7650±300	8	B	TM2000 WR65×800
U57108	540	140	1160	1780	4	1674	116	485	350	230	M56×2	60	9120±300	8	B	TM2000 WR60×800A
U59118	590	180	1500	2270	4	1775	125	530	375	250	M36×2	36	2350±100	24	C	TM1000 WB36×500
U63128	640	229	2120	2920	4	1899	136	580	400	265	M39×2	36	2940±150	24	C	TM1000 WB36×500
U6S132	660	255	2230	3030	4	1963	142	600	400	275	M39×2	36	2940±150	24	C	TM1000 WB36×500
U6D138	690	285	2660	3710	4	2049	146	620	450	285	M42×2	41	4270±200	24	C	TM1000 WB41×500

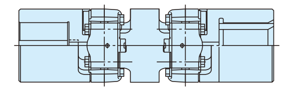
■ Features
The U Series is mainly intended for non reversing mills, such as the finishing stand of a hot strip mill.

■ 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

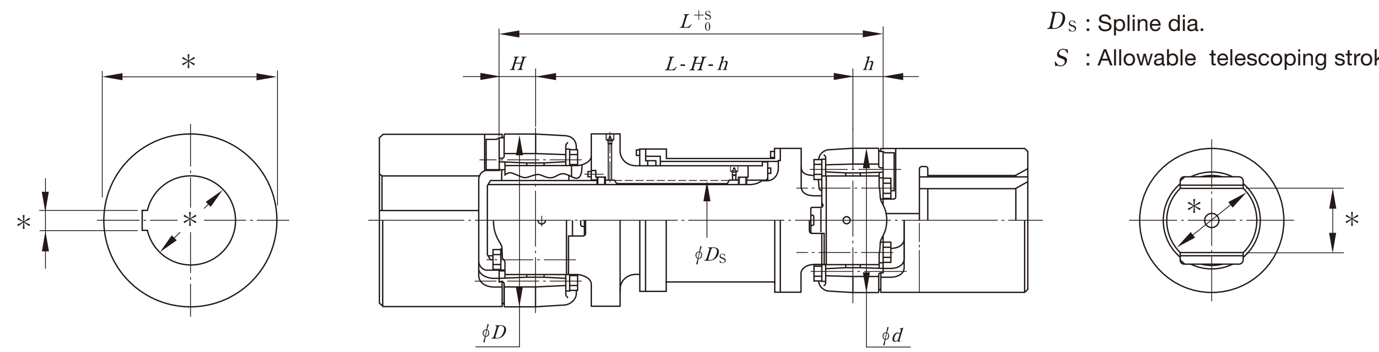


Model No.	Swing dia. (mm) D	Torque capacity (kN·m) T_R 1)	T_D 2)	T_S 3)	Max. operating angle (°)	Boundary dimensions (mm) L 4) (min.)	H	D_T	D_S 5)	S	Bearing set bolts Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty 6)	Type	Recommended wrench set 7) (bearing set bolt) Torque Wrench No. Socket No. Tensiometer No. Wrench No.
U65146	730	344	2920	5050	4	2160	155	670	450	305	M45×2	46	4900±200	24	C	TM2000 WR46×500
U67152	760	398	3440	4840	4	2195	160	685	450	310	M45×2	46	4900±200	24	C	TM2000 WB46×500
U6J156	780	416	3770	5700	4	2235	165	705	500	315	M48×2	50	5590±200	24	C	TM2000 WB50×500
U69168	840	491	4360	6650	4	2357	178	760	500	325	M52×2	55	7650±300	24	C	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) The value within parentheses indicates the spline diameter of the involute splines.
6) Represents the bolt quantity 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 18.
Type A: Torque wrench + Ring head   Type B: Tensiometer + Ring wrench
Type C: Tensiometer + Socket wrench

[Remarks] 1) The T_D values in the table are values with pulsating load.

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.	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	8	870	80 (60)	177.8	210
T54090 (D44070)	450 (350)	45.0	144	384	9	969	92 (70)	203.2	250
TZ56100 (D48080)	500 (400)	74.1	213	560	8	1080	107 (80)	225	280
T58110 (D54090)	550 (450)	82.5	333	739	8	1196	116 (92)	250	305
T60120 (D56100)	600 (500)	111	500	1060	8	1319	125 (107)	275	335
T62130 (D58110)	650 (550)	142	747	1460	6	1414	136 (116)	300	355
T66150 (D62130)	750 (650)	212	1140	2520	6	1617	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	1180± 50	8	B	TM500 WR32×500
M33×2	36	1720± 70	8	B	TM500 WR36×500
M39×3	50	3030±200	8	B	TM1000 WR50×500
M42×3	50	4020±200	8	B	TM1000 WR50×500
M48×3	60	5980±300	8	B	TM2000 WR60×500
M52×3	65	7650±300	8	B	TM2000 WR65×800
M62×3	75	12700±300	8	B	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 bolt quantity 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 18.
Type A: Torque wrench + Ring head   Type B: Tensiometer + Ring wrench
Type C: Tensiometer + Socket wrench

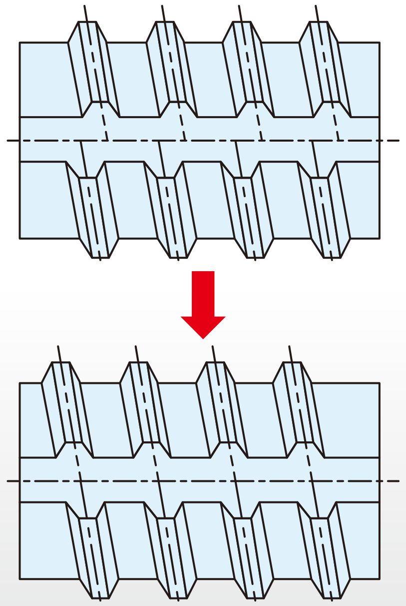
[Remarks] 1) The T_D values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.
2) Specifications in parentheses are recommended model numbers and dimensions for combination.

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

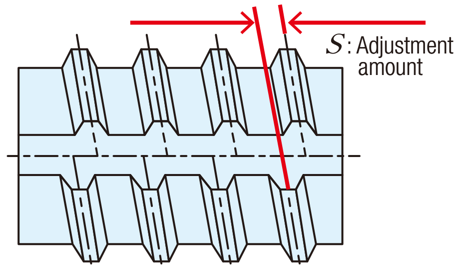
For roll forming of continuous convex screw thread on the surface of bar steel, the rotation direction phase of the upper and lower rolls with concavity spiral groove formed should be adjusted to an arbitrary position.

Work procedure

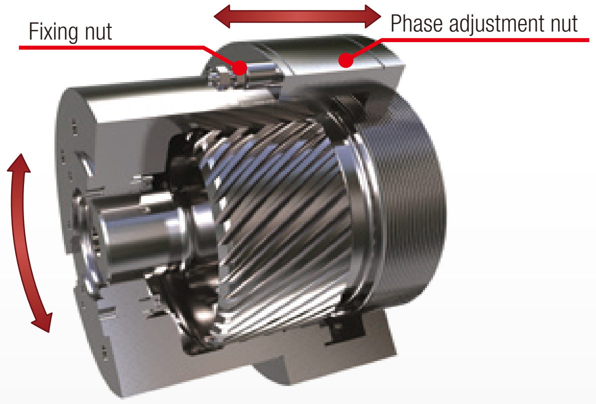
(1) Phase adjustment work should be conducted with the rolls of the rolling mill inserted to the drive shaft. First, measure the adjustment amount.
(2) Decide the number of adjustment scales from the following equation.

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

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*
θ : 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.



Features

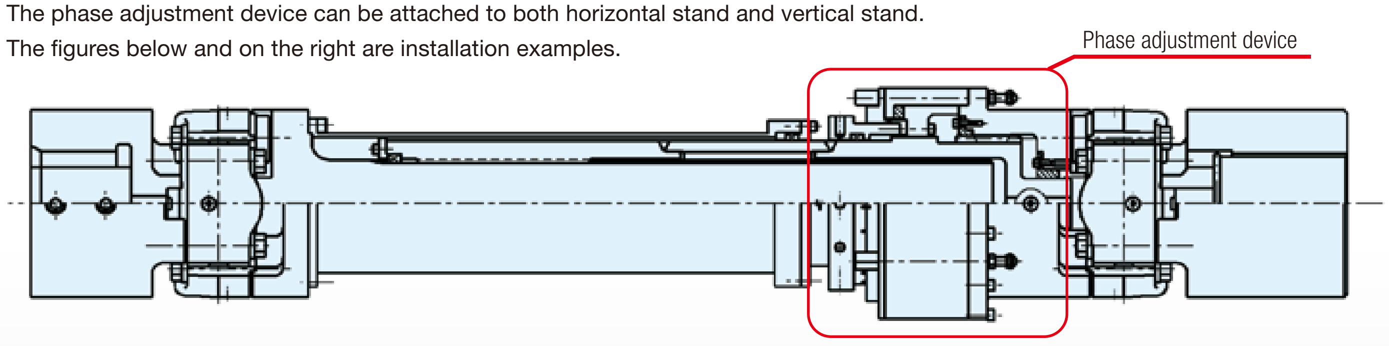
(1) The rotation phase can be adjusted almost steplessly, which improves the accuracy of products.
(2) The phase can be adjusted in a short time, which improves the efficiency of the work.
(3) With its unique configuration, the space can be saved in the directions of diameter and shaft.
(4) The lineup 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.

For design of phase adjustment device

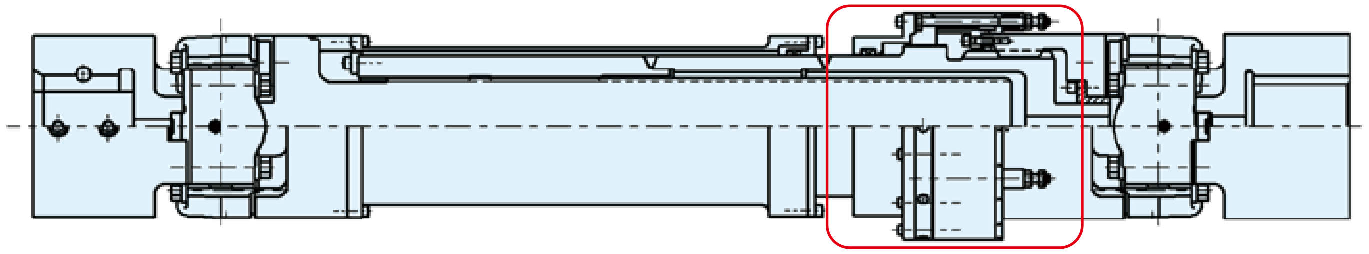
Provide JTEKT with the following information for design of the optimal phase adjustment device.
Provide them along with the selection sheet of the drive shaft.
- Stand status (horizontal stand or vertical stand)
- Roll rotation direction (seen from the pinion stand)
- Roll diameter (disposal diameter)
- Pinion PCD
- Pitch in the case of screw reinforcing bar and intercalary dimension in the case of deformed steel bar.

Installation examples

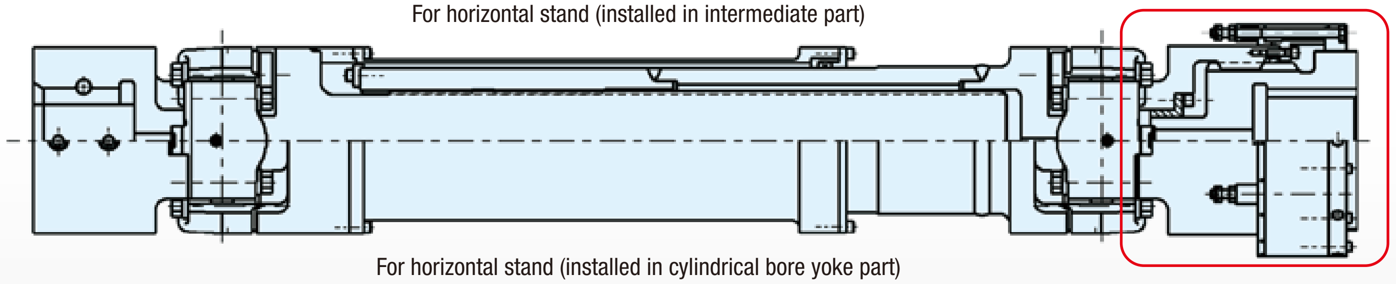
The phase adjustment device can be attached to both horizontal stand and vertical stand.
The figures below and on the right are installation examples.



For vertical stand



For horizontal stand (installed in intermediate part)



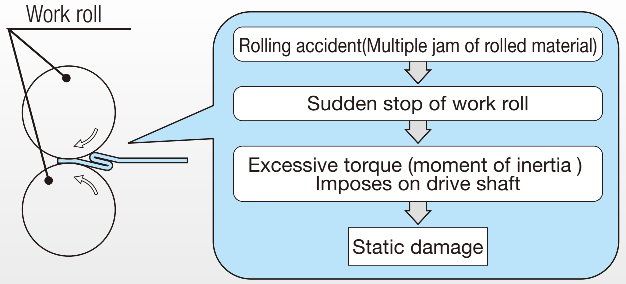
For horizontal stand (installed in cylindrical bore yoke part)

Applications

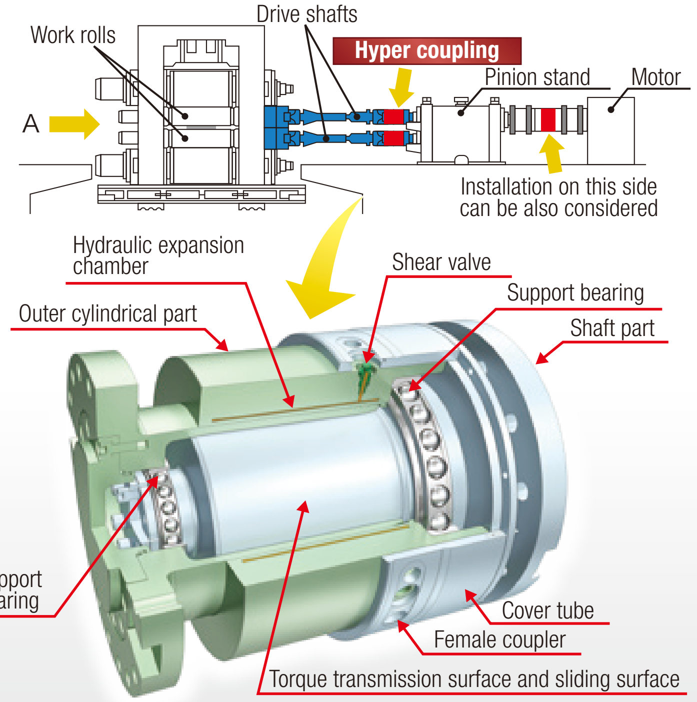
Used to protect peripheral devices of rolling mills against excessive torque.

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)



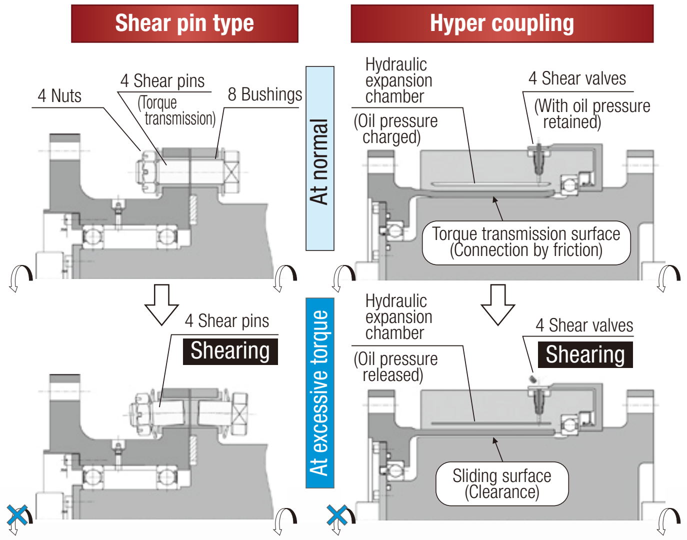
Installation position and structure of hyper coupling

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 ◆Nut : 4 pieces ◆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

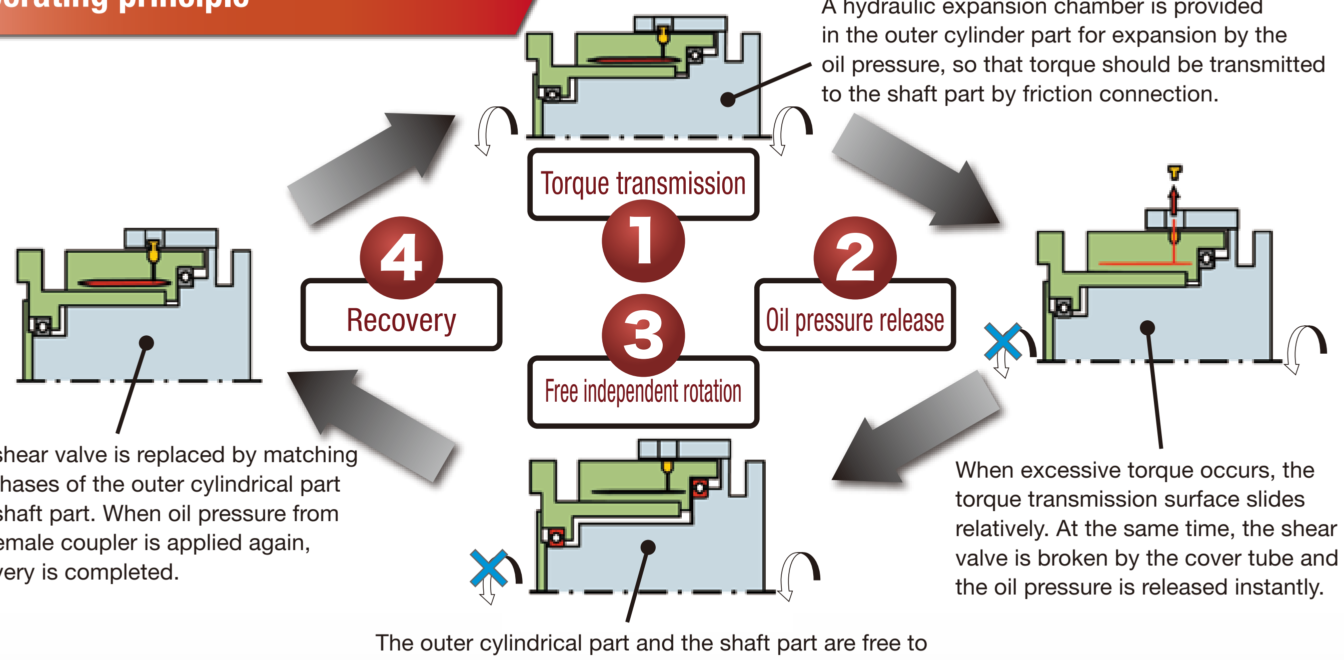


Features

(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



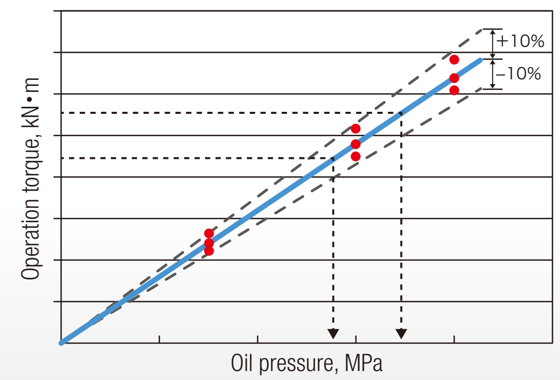
A hydraulic expansion chamber is provided in the outer cylinder part for expansion by the oil pressure, so that torque should be transmitted to the shaft part by friction connection.

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.

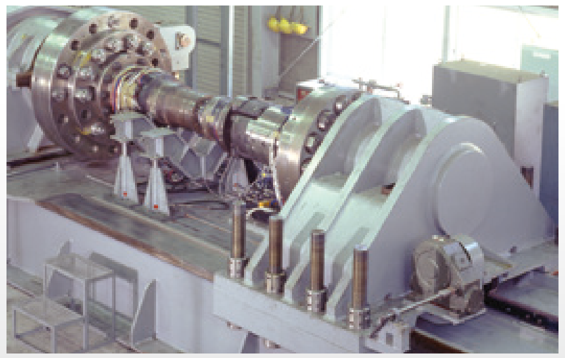
Operation torque



Oil pressure-operation torque diagram (image)

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

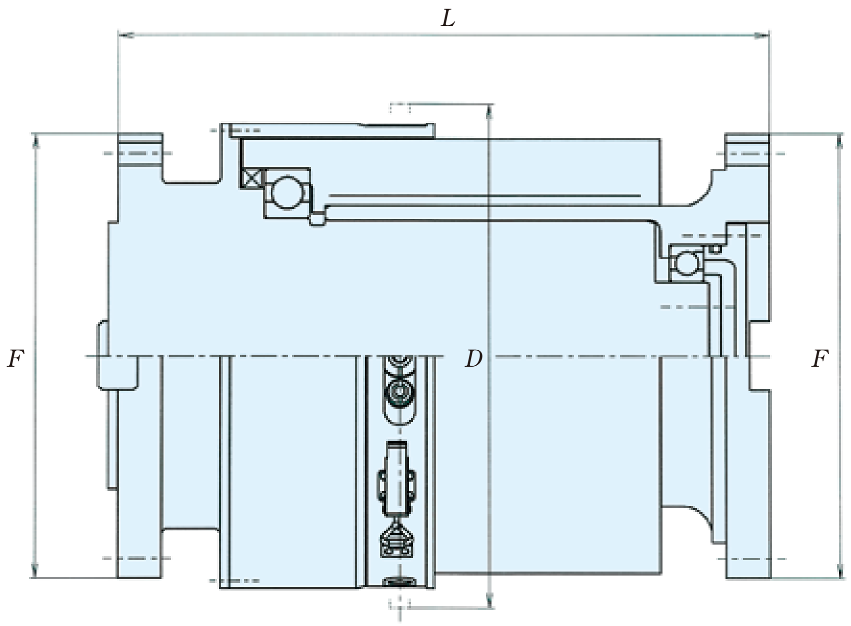
Before shipping, a large-sized torsion testing machine is used with the actual machine to calculate the relationship between each oil pressure and operation torque.
We set the oil pressure value for the requested operation torque.
The accuracy of the operation torque with each oil pressure value is high: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



Large-sized torsion testing machine

Product introduction
Hyper coupling (2)

Dimension tables

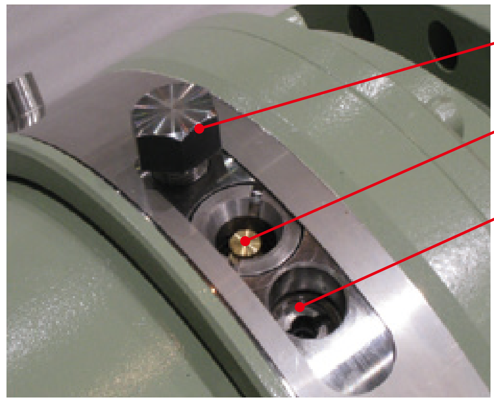


Highper coupling No.	Operation torque (kN·m)	Full length L (mm)	Outside diameter D (mm)	Flange outside dia. F (mm)	Corresponding model No.	
					D series	U series
TL070	80～ 150	550	420	330	D34052	–
TL088	160～ 280	650	510	430	D44070	–
TL104	200～ 510	750	590	525	D50085	U49084
TL120	400～ 800	850	670	610	D56100	U53088
TL134	600～1100	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

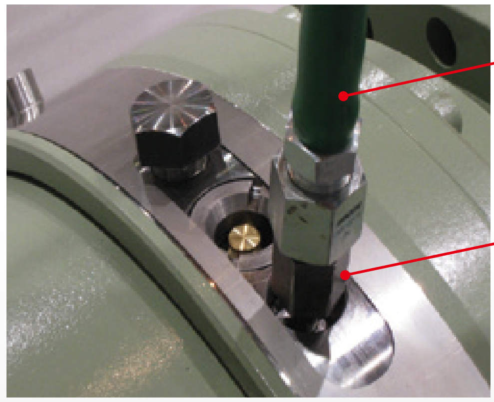
Recovery method after operation

(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)

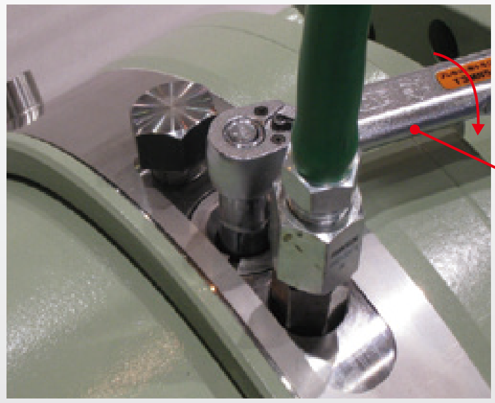


(4) The oil pressure is retained by tightening the shear valve with specified torque. (figure on the lower right)

(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.



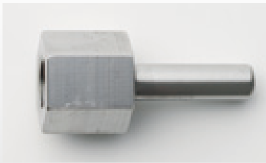
Examples of main tools (attached)

(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.



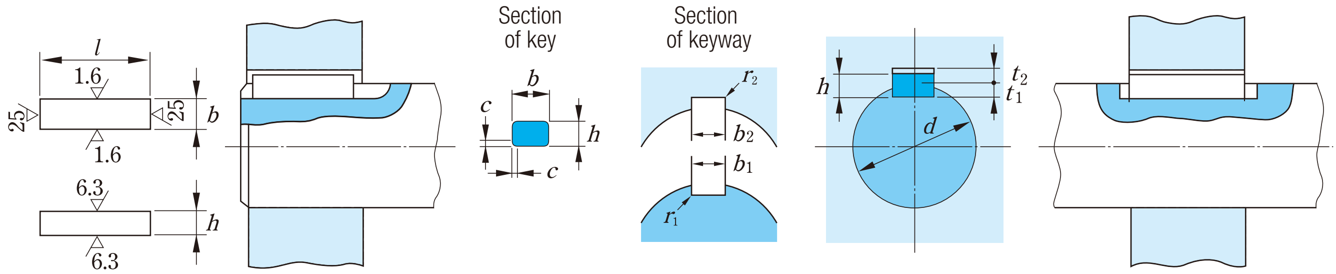
Recommended tightening torque for flange bolts

	Designation	Pitch (mm)	Width across flats (mm)	Tightening torque (N·m)	Tightening force (N)
Coarse screw thread	M 6	1	10	12±1	11500
	M 8	1.25	13	29±2	21100
	M10	1.5	17	59±5	33500
	M12	1.75	19	98±5	47400
	M14	2	22	155±10	65400
	M16	2	24	245±20	91800
	M18	2.5	27	345±20	114000
	M20	2.5	30	480±30	144000
	M22	2.5	32	645±40	179000
	M24	3	36	825±50	207000
	M27	3	41	1230±70	276000
	M30	3.5	46	1670±100	334000
	M33	3.5	50	2260±150	417000
	M36	4	55	2840±150	479000
	M39	4	60	3730±200	582000
	M42	4.5	65	4610±300	665000
	M45	4.5	70	5790±300	783000
	M48	5	75	6960±400	876000
	M52	5	80	9020±500	1060000
	M56	5.5	85	11300±600	1240000
	M60	5.5	90	13700±700	1410000
	M64	6	95	16700±900	1610000
	M68	6	100	20100±1000	1840000

	Designation	Pitch (mm)	Width across flats (mm)	Tightening torque (N·m)	Tightening force (N)
Fine screw thread	M 6	0.75	10	14±1	12900
	M 8	1	13	31±2	23000
	M10	1.25	17	64±5	37200
	M12	1.25	19	105±5	54400
	M12	1.5	19	105±5	52800
	M14	1.5	22	175±10	75400
	M16	1.5	24	265±20	102000
	M18	2	27	360±20	123000
	M20	2	30	500±30	153000
	M22	2	32	675±40	191000
	M24	2	36	900±50	233000
	M27	2	41	1320±70	305000
	M30	2	46	1810±100	378000
	M33	2	50	2450±150	468000
	M36	3	55	3040±150	523000
	M39	3	60	3920±200	624000
	M42	3	65	5000±300	740000
	M45	3	70	6180±300	855000
	M48	3	75	7550±400	979000
	M52	3	80	9610±500	1160000
	M56	3	85	12300±700	1380000
	M60	3	90	14700±800	1560000
	M64	3	95	18100±1000	1810000
	M68	3	100	21600±1000	2040000

[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 (μ = 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 $b \times h$	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	Sliding type b_1 Tolerance (H9)	Sliding type b_2 Tolerance (D10)	Normal type b_1 Tolerance (N9)	Normal type b_2 Tolerance (JS9)	Fastening type b_1 and b_2 Tolerance (P9)	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 −0.025	2	0 −0.025	h9	0.16～0.25	6～20	2	+0.025 0	+0.060 +0.020	−0.004 −0.029	±0.0125	−0.006 −0.031	0.08～0.16	1.2	1.0	+0.1 0	6～8
3×3	3		3				6～36	3							1.8	1.4		8～10
4×4	4	0 −0.030	4	0 −0.030			8～45	4	+0.030 0	+0.078 +0.030	0 −0.030	±0.0150	−0.012 −0.042		2.5	1.8		10～12
5×5	5		5			0.25～0.40	10～56	5						0.16～0.25	3.0	2.3		12～17
6×6	6		6				14～70	6							3.5	2.8		17～22
(7×7)	7	0 −0.036	7	0 −0.036			16～80	7	+0.036 0	+0.098 +0.040	0 −0.036	±0.0180	−0.015 −0.051		4.0	3.3	+0.2 0	20～25
8×7	8		7	0 −0.090	h11		18～90	8							4.0	3.3		22～30
10×8	10		8			0.40～0.60	22～110	10						0.25～0.40	5.0	3.3		30～38
12×8	12	0 −0.043	8				28～140	12	+0.043 0	+0.120 +0.050	0 −0.043	±0.0215	−0.018 −0.061		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	5.3		50～55
16×10	16		10				45～180	16							6.0	4.3		50～58
18×11	18		11	0 −0.110			50～200	18							7.0	4.4		58～65
20×12	20	0 −0.052	12			0.60～0.80	56～220	20	+0.052 0	+0.149 +0.065	0 −0.052	±0.0260	−0.022 −0.074	0.40～0.60	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	8.4		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 −0.062	18				90～360	32	+0.062 0	+0.180 +0.080	0 −0.062	±0.0310	−0.026 −0.088		11.0	7.4		110～130
(35×22)	35		22	0 −0.130		1.00～1.20	100～400	35						0.70～1.00	11.0	11.4	+0.3 0	125～140
36×20	36		20				—	36							12.0	8.4		130～150
(38×24)	38		24				—	38							12.0	12.4		140～160
40×22	40		22				—	40							13.0	9.4		150～170
(42×26)	42		26				—	42							13.0	13.4		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 −0.074	32	0 −0.160		1.60～2.00	—	56	+0.074 0	+0.220 +0.100	0 −0.074	±0.0370	−0.032 −0.106	1.20～1.60	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			2.50～3.00	—	80						2.00～2.50	25.0	15.4		330～380
90×45	90	0 −0.087	45				—	90	+0.087 0	+0.260 +0.120	0 −0.087	±0.0435	−0.037 −0.124		28.0	17.4		380～440
100×50	100		50				—	100							31.0	19.5		440～500

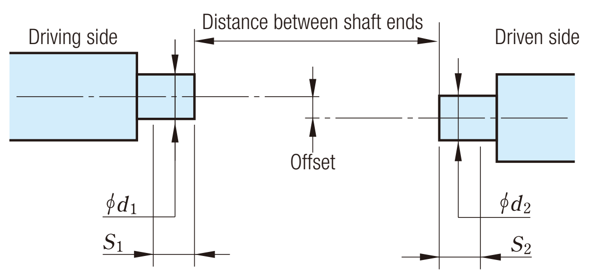
[Notes] 1) Dimension l shall be selected among the following within the range given in Table.
The dimensional tolerance on l shall be generally h12 in JIS B0401.
6 , 8 , 10 , 12 , 14 , 16 , 18 , 20 , 22 , 25 , 28 , 32 , 36 , 40 , 45 , 50 , 56 , 63 , 70 , 80 , 90 , 100 , 110 , 125 , 140 , 160 , 180 ,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

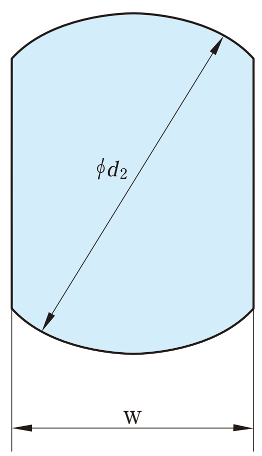
Item	Necessity	Description	Remarks
Name of the machine			
Location of installation			
(1) Rated motor output (kW)	○		
(2) Motor speed (min-1)	○	Min. Max.	
(3) Reduction ratio	○		
Drive shaft			
(4) Number of drive shafts per motor	○		
(5) Torque transmission (kN·m)	○	Normal Normal max. Emergency max.	
(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 side	ϕd_1 (mm)	
	S_1 (mm)	
Driven side *In the case of cylindrical shaft	ϕd_2 (mm)	
	S_2 (mm)	
Driven side *In the case of oval shaft	ϕd_2 (mm)	
	W (mm)	
	S_2 (mm)	



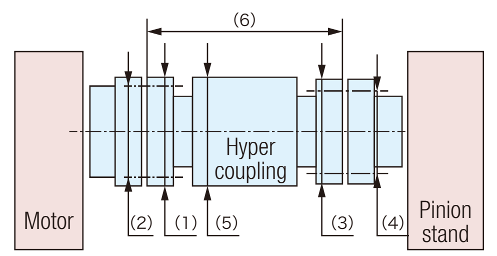
In the case of oval shaft

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))	○	A B	
(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	△		

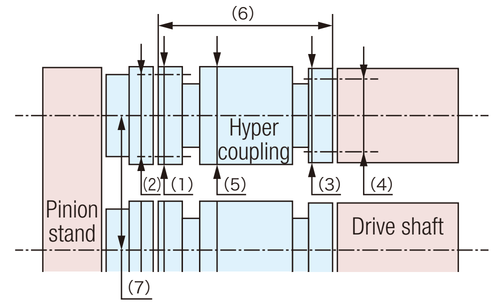
(11) Installation dimensions (Must be filled out.)

○ : 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	