



Spline Nut

THK General Catalog

A Technical Descriptions of the Products

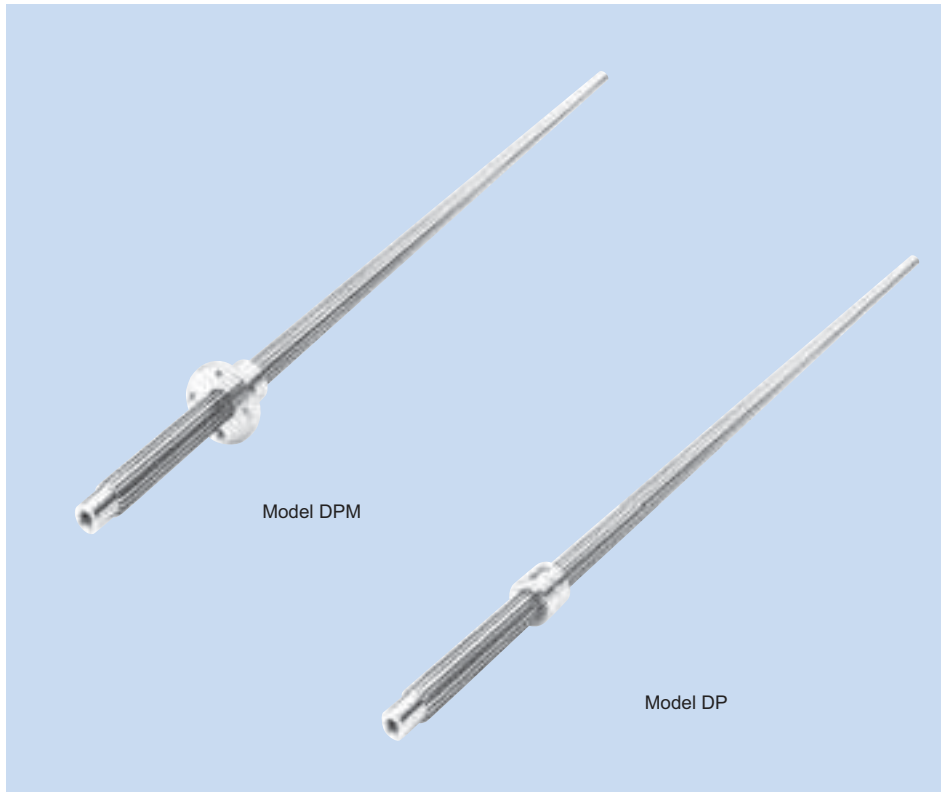
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* Please see the separate "B Product Specifications".

Features of the Spline Nut



Structure and Features

Spline Nut models DPM and DP are low price bearings that are made of a special alloy (see A-515) formed by die casting and use highly accurate spline shafts as the core. Unlike conventional machined spline nuts, the sliding surface of these models maintains a chill layer formed in the rolling process, thus achieving high wear resistance.

The surface of the spline shafts to be used in combination with the nuts is hardened through rolling and is mirror-finished. Accordingly, smooth sliding motion is achieved.

The specially designed teeth of the spline have large contact areas, as well as concentricity, which enable the shaft to automatically establish the center as a torque is applied. Therefore, the teeth demonstrate stable performance in transmitting a torque.

Features of the Special Rolled Shafts

Dedicated rolled shafts with standardized lengths are available for the Spline Nut.

[Increased Wear Resistance]

The shaft teeth are formed by cold gear rolling, and the surface of the tooth surface is hardened to over 250 HV and mirror-finished. As a result, the shafts are highly wear resistant and achieve significantly smooth motion when used in combination with nuts.

[Improved Mechanical Properties]

Inside the teeth of the rolled shaft, a fiber flow occurs along the contour of the tooth surface of the shaft, making the structure around the teeth roots dense. As a result, the fatigue strength is increased.

[Additional Machining of the Shaft End Support]

Since each shaft is rolled, additional machining of the support bearing of the shaft end can easily be performed by lathing or milling.

High Strength Zinc Alloy

The high strength zinc alloy used in the spline nuts is a material that is highly resistant to seizure and wear and has a high load carrying capacity. Its composition, mechanical properties, physical properties and wear resistance are given below.

[Composition]

Table1 Composition of the High Strength Zinc Alloy

Unit: %

Item	Description
Al	3 to 4
Cu	3 to 4
Mg	0.03 to 0.06
Be	0.02 to 0.06
Ti	0.04 to 0.12
Zn	Remaining portion

[Mechanical Properties]

Item	Description
Tensile strength	275 to 314 N/mm ²
Tensile yield strength (0.2%)	216 to 245 N/mm ²
Compressive strength	539 to 686 N/mm ²
Compressive yield strength (0.2%)	294 to 343 N/mm ²
Fatigue strength	132 N/mm ² × 10 ⁷ (Schenk bending test)
Charpy impact	0.098 to 0.49 N-m/mm ²
Elongation	1 to 5 %
Hardness	120 to 145 HV

[Physical Properties]

Item	Description
Specific gravity	6.8
Specific heat	460 J / (kg · K)
Melting point	390 °C
Thermal expansion coefficient	24 × 10 ⁻⁶

[Wear Resistance]

[Test conditions: Amsler wear-tester]

Item	Description
Test piece rotational speed	185 min ⁻¹
Load	392 N
Lubricant	Dynamo oil

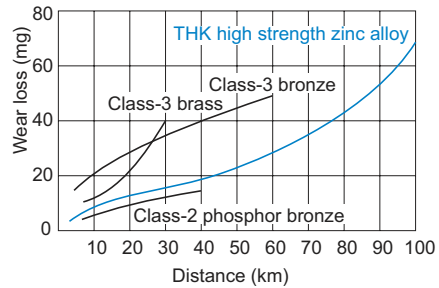


Fig.1 Wear Resistance of the High Strength Zinc Alloy

Clearance in the Rotation Direction

Clearance in the rotational direction: $\alpha \leq 20'$ MAX

Selecting a Spline Nut

[Dynamic Permissible Torque T and Dynamic Permissible Thrust F]

The dynamic permissible torque (T) and the dynamic permissible thrust (F) are the torque and the thrust at which the contact surface pressure on the tooth surface of the bearing is 9.8 N/mm². These values are used as a measuring stick for the strength of the spline nut.

[pV Value]

With a sliding bearing, a pV value, which is the product of the contact surface pressure (p) and the sliding speed (V), is used as a measuring stick to judge whether the assumed model can be used. Use the corresponding pV value indicated in Fig.1 as a guide for selecting a spline nut. The pV value also varies according to the lubrication conditions.

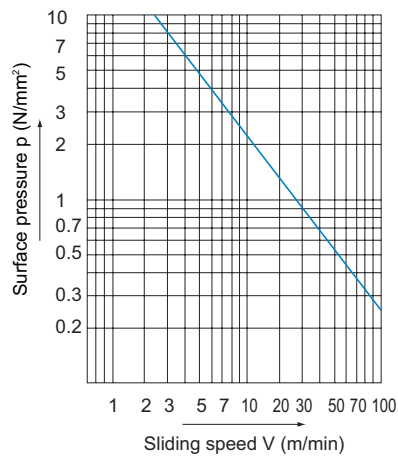


Fig.1 pV Value

Table1 Safety Factor (f_s)

Type of load	Lower limit of f _s
For a static load less frequently used	1 to 2
For an ordinary single-directional load	2 to 3
For a load accompanied by vibrations/impact	4 or greater

● f_s: Safety Factor

To calculate a load applied to the spline nut, it is necessary to accurately obtain the effect of the inertia that changes with the weight and dynamic speed of an object. In general, with reciprocating or rotating machines, it is not easy to accurately obtain all the factors such as the effect of the start and stop, which are always repeated. Therefore, if the actual load cannot be obtained, it is necessary to select a bearing while taking into account the empirically obtained safety factors (f_s) shown in Table1.

● **f_r:Temperature Factor**

If the temperature of the spline nut exceeds the normal temperature range, the seizure resistance of the nut and the strength of the material will decrease. Therefore, it is necessary to multiply the dynamic permissible torque (T) and the dynamic permissible thrust (F) by the corresponding temperature factor indicated in Fig.2. Accordingly, when selecting a spline nut, the following equations need to be met in terms of its strength.

Dynamic permissible torque (T)

$$f_s \leq \frac{f_r \cdot T}{P_T}$$

Static permissible thrust (F)

$$f_s \leq \frac{f_r \cdot F}{P_F}$$

- f_s : Static safety factor
(see Table1 on A-517)
- f_r : Temperature factor (see Fig.2)
- T : Dynamic permissible torque (N-m)
- P_T : Applied torque (N-m)
- F : Dynamic permissible thrust (N)
- P_F : Axial load (N)

● **Hardness of the Surface and Wear Resistance**

The hardness of the shaft significantly affects the wear resistance of the spline nut. If the hardness is equal to or less than 250 HV, the abrasion loss increases as indicated in Fig.3. The roughness of the surface should preferably be 0.80a or less.

A specially rolled shaft achieves surface hardness of 250 HV or greater, through hardening as a result of rolling, and a surface roughness of 0.20a or less. Thus, the dedicated rolled shaft is highly wear resistant.

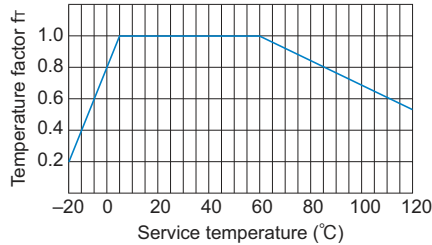


Fig.2 Temperature factor

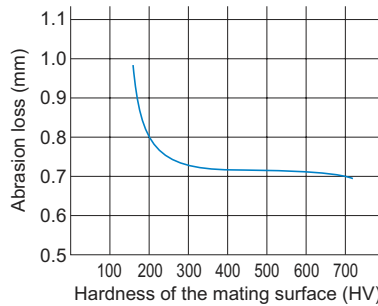


Fig.3 Hardness of the Surface and Wear Resistance

[Calculating the Contact Surface Pressure p]

$$p = \frac{P_T}{T} \times 9.8$$

- p : Contact surface pressure on the tooth under a load torque (P_T) (N/mm²)
- T : Dynamic permissible torque (N-m)
- P_T : Applied torque (N-m)

Point of Selection

Selecting a Spline Nut

[Calculating the Sliding Speed]

With splines, the sliding speed of the tooth surface is equal to the feeding speed.

V : Sliding speed of the tooth (m/min)

[Example of calculation]

Use Spline Nut DPM and reciprocate it at a speed in the axial direction of 5 m/min while transmitting a load torque of 78 N-m. Since the applied torque is not consistent in direction, it is important to select a spline nut that can be used in locations accompanied by vibrations and impact.

First, select a nut that has a dynamic permissible torque (T) at which it can be used.

$$T \geq \frac{f_s \cdot P_T}{f_T} = \frac{4 \times 78}{1} = 312 \text{ N} \cdot \text{m}$$

Safety factor (f_s) = 4
Temperature factor (f_T) = 1
Applied torque (P_T) = 78 N-m

Select Spline Nut model DPM3560 (dynamic permissible torque $T = 443$ N-m), which satisfies the dynamic permissible torque (T) above.

Obtain the pV value.

Obtain the contact surface pressure (p).

$$p = \frac{P_T}{T} \times 9.8 = \frac{78}{443} \times 9.8 \doteq 1.73 \text{ N/mm}^2$$

Obtain the sliding speed (V).

$$V = 5 \text{ m/min}$$

From the diagram of pV values (see Fig.1 on A-517), it is judged that there will be no abnormal wear if the sliding speed (V) is 13.5 m/min or below against the " p " value of 1.73 N/mm². Therefore, it is appropriate to select model DPM3560.

Fit

For the fitting between the spline nut circumference and the housing, we recommend loose fitting or tight fitting.

Housing inner-diameter tolerance: H8 or J8

Installation

[About Chamfer of the Housing's Mouth]

To increase the strength of the root of the flange of the spline nut, the corner is machined to have an R shape. Therefore, it is necessary to chamfer the inner edge of the housing's mouth.

Table1 Chamfer of the Housing's Mouth

Unit: mm

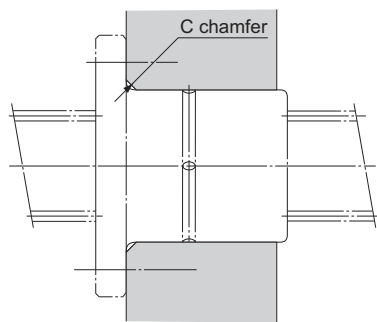


Fig.1

Model No.	Chamfer of the mouth C (Min.)
DPM	
12	2
15	
17	
20	
25	2.5
30	
35	3
40	
45	
50	

Spline Nut

Lubrication

Select a lubrication method according to the conditions of the spline nut.

[Oil Lubrication]

For the lubrication of the spline nut, oil lubrication is recommended. Specifically, oil-bath lubrication or drop lubrication is particularly effective. Oil-bath lubrication is the most appropriate method since it meets harsh conditions such as high speed, heavy load or external heat transmission, and it cools the spline nut. Drop lubrication suits low to medium speed and a light to medium load. Select a lubricant according to the conditions as indicated in Table2.

Table2 Selection of a Lubricant

Condition	Types of Lubricants
Low speed, high load, high temperature	High-viscosity sliding surface oil or turbine oil
Low speed, light load, low temperature	Low-viscosity sliding surface oil or turbine oil

[Grease Lubrication]

In low-speed feed, which occurs less frequently, the user can lubricate the slide system by manually applying grease to the shaft on a regular basis or using the greasing hole on the spline nut. We recommend using lithium-soap group grease No. 2.

