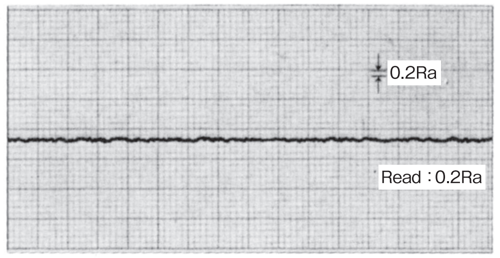
TSK Linear Shafts

Features of TSK Linear Motion Shaft

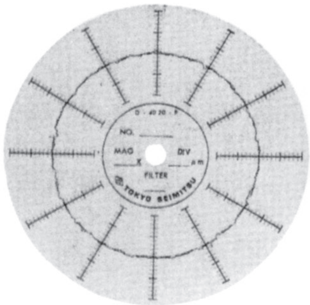
Accuracy

TSK linear motion shafts are guaranteed with a maximum of precision in its degrees of roundness, straightness, cylindricity and surface roughness via the strict quality control.

<Example of surface roughness measurements>



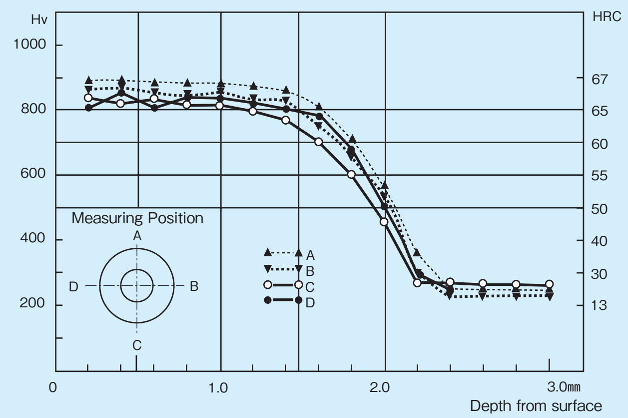
<Example of degree of roundness measurements>



Heat Treatment

TSK linear motion shafts are guaranteed with the even hardness and appropriate thickness of hardened layers to retain the durability and rigidity via the heat treatment by the high-frequency hardening with the original equipment.

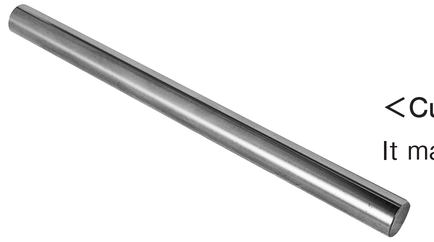
<Sectional Hardness Distributions (ϕ 13mm)>



Shaft Diameter	Hardness Depth	Hardness Layer
ϕ1～ϕ5	Over 0.5mm	
ϕ6～ϕ12	Over 1.0mm	
ϕ13～ϕ50	Over 1.5mm	

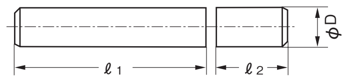
Special Treatment

We also design and make such specially treated linear shafts as with stages, screws, taps and mill machinings. If hurried, machining standard linear motion shafts may also be possible. Though its surface is hardend more than HRC60, the following treatments are possible.



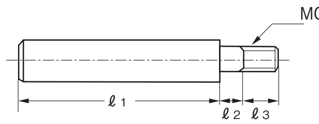
<Cutting>

It may be cut easily with a circular sawing grinder.



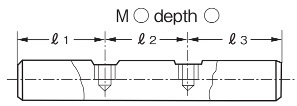
<Stage Machining>

Be sure to chuck it with soft jaws when machining.



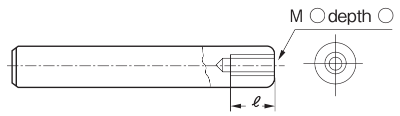
<Vertical tapping>

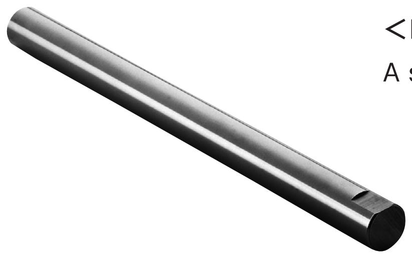
A conventional drill tap may be used after cutting with a solid-end mill or countersinking with a jet drill.



<Horizontal tapping>

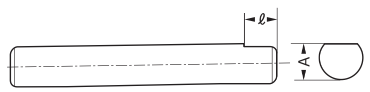
As it is hardened for 1-1.5mm in depth from its circumference, a conventional drill tap may be used on its shaft core.





<Plain Milling>

A super-hard solid mill may be used for milling.



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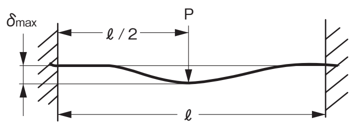
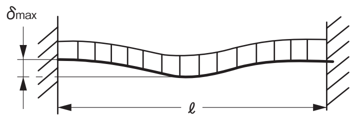
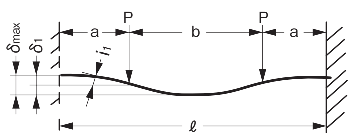
Calculating Deflection and Slope Angles

The deflection and slope angles of a shaft should be calculated under specific conditions. The following is its formula:

Supports	Conditions of usage	Deflection Formula	Slope Formula
Fixed at Both Ends		$\delta_{max} = \frac{P\ell^3}{192EI} = \frac{1}{4}P\ell^3C$	$i_1 = 0$ $i_2 = 0$
Fixed at Both Ends	Equally Distributed Load 	$\delta_{max} = \frac{P\ell^4}{384EI} = \frac{1}{8}P\ell^4C$	$i_2 = 0$
Fixed at Both Ends		$\delta_1 = \frac{Pa^3}{6EI}\left(2-\frac{3a}{\ell}\right) = 8Pa^3\left(2-\frac{3a}{\ell}\right)C$ $\delta_{max} = \frac{Pa^3}{24EI}\left(2+\frac{3b}{a}\right) = 2Pa^3\left(2+\frac{3b}{a}\right)C$	$i_1 = \frac{Pa^2b}{2EI\cdot\ell} = \frac{24Pa^2bc}{\ell}$ $i_2 = 0$

δ_1 : Deflection at Load Work Point (mm)
δ_{max} : Maximum Deflection (mm)
i_1 : Slope at Load Work Point (rad)
i_2 : Slope at Support Point (rad)
M_0 : Moment
P : Concentrated Load (kg)
P : Equally Distributed Load (kgf/mm)
a,b : Load Working Distance (mm)
ℓ : Span (mm)
I : Moment of Inertia of Area (mm^4)
E : Mudulus of Longitudinal Elasticity (2.1×10^4) (kgf/mm^2)
C : 1/48EI ($1/kgfmm^2$)

The following formula is used for calculating the moment of inertia of area.

<LS type Solid Shaft>

$$I = \frac{\pi D^4}{64}\ (mm^4)$$

<LPS type Pipe Shaft>

$$I = \frac{\pi}{64}(d_2^4 - d_1^4)\ (mm^4)$$

D, d_2 : Outer diameter d_1 : Inner diameter

Moment of Inertia of Area and C Value (=1/48EI) of Standard Shaft

D (mm)	2nd Moment of Inertia I (mm^4)	C=1/48EI ($1/kgfmm^2$)
3	3.98	2.49×10^{-7}
4	1.26×10	7.87×10^{-8}
5	3.07×10	3.23×10^{-8}
6	6.36×10	1.56×10^{-8}
8	2.01×10^{2}	4.94×10^{-9}
10	4.91×10^{2}	2.02×10^{-9}
12	1.02×10^{3}	9.73×10^{-10}
13	1.04×10^{3}	7.09×10^{-10}
15	2.49×10^{3}	3.98×10^{-10}
16	3.22×10^{3}	3.08×10^{-10}
20	7.85×10^{3}	1.26×10^{-10}
25	1.92×10^{4}	5.17×10^{-11}
30	3.98×10^{4}	2.49×10^{-11}
35	7.37×10^{4}	1.35×10^{-11}
38	1.02×10^{5}	9.73×10^{-12}
40	1.26×10^{5}	7.83×10^{-12}
50	3.07×10^{5}	3.23×10^{-12}
60	6.36×10^{5}	1.56×10^{-12}
80	2.01×10^{6}	4.94×10^{-13}
100	4.91×10^{6}	2.02×10^{-13}
120	1.02×10^{7}	9.73×10^{-14}
150	2.49×10^{7}	3.98×10^{-14}

O.D. d_2 (mm)	I.D. d_1 (mm)	2nd Moment of Inertia I (mm^4)	C=1/48EI ($1/kgfmm^2$)
13	7	1.34×10^{3}	7.40×10^{-10}
16	10	3.01×10^{3}	3.30×10^{-10}
20	14	7.36×10^{3}	1.35×10^{-10}
25	16	1.67×10^{4}	5.94×10^{-11}
30	17	3.65×10^{4}	2.72×10^{-11}
35	19	6.73×10^{4}	1.47×10^{-11}
40	20	1.18×10^{5}	8.41×10^{-12}
50	26	2.84×10^{5}	3.49×10^{-12}
60	30	5.85×10^{5}	1.70×10^{-12}
80	48	1.75×10^{6}	5.67×10^{-13}
100	60	4.27×10^{6}	2.32×10^{-13}