The following tables give a complete information of materials used for the production of Precision Shafts and their chemical-phisical characteristics.

Used Material Typology

W ,WZ,WB	WRA	WRB	WH	WV	BAC	WS	WSA
a) Ck60 (1.1221) b) Cf53 (1.1213)	X90CrMoV18 (1.4112)	X46Cr13 (1.4034)	a)100Cr6 (1.3505) b) Ck60 (1.2221)	a) Ck60 (1.1221) b) Cf53 (1.1213)	C45 UNI EN 10083/1	100Cr6 (1.3505)	42 CrMo 4 UNI EN 10083/1

Tensile Strength [N/mm^2]

W,WZ,WB	WRA	WRB	WH	WV	BAC	WS	WSA
550-750	750-900	650-800	600-750	**	**	600-750	850-1100

Materials chemical composition [%]

W,WZ,WB	WRA	WRB	WH	WV	BAC	WS	WSA
a) C 0.57-0.65 Si 0.15-0.35 Mn 0.6-0.9 b) C 0.50-0.57 Si 0.15-0.35 Mn 0.4-0.7	C 0.85-0.95 Si 0.70-1.00 Mn 0.70-1.00 Cr 17.0-19.0 Mo 0.90-1.30 V 0.07-0.12	C 0.42-0.5 Si 0.7-1.00 Mn 0.7-1.0 Cr 12.5-14.5	a) C 0.95-1.05 Si 0.15-0.35 Mn 0.2-0.4 Cr 1.3-1.65 b) C 0.57-0.65 Si 0.15-0.35 Mn 0.6-0.90	a) C 0.57-0.65 Si 0.15-0.35 Mn 0.6-0.9 b) C 0.50-0.57 Si 0.15-0.35 Mn 0.4-0.7	C 0.42-0.50 Si max 0.40 Mn 0.5 - 0.8	a) C 0.95-1.05 Si 0.15-0.35 Mn 0.2-0.4 Cr 1.3-1.65	C 0.38-0.45 Si max 0.40 Mn 0.6-0.9 Cr 0.9-1.20 Mo 0.15-0.3

Surface hardness

W,WZ,WB	WRA	WRB	WH	WV	BAC	WS	WSA
62±2 HRc	57±2 HRc	55±2 HRc	62±2 HRc	800-1100 HV (Cromo)	800-1100 HV (Cromo)	62±2 HRc	60±2 HRc

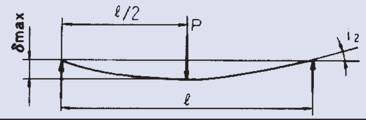
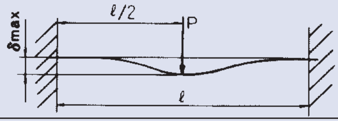
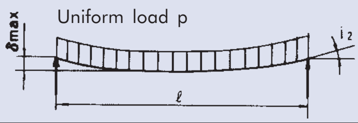
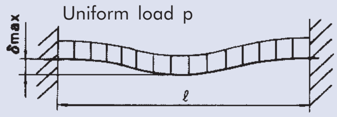
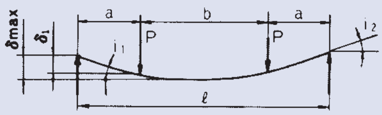
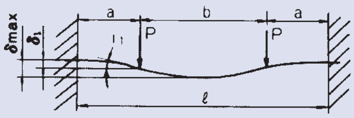
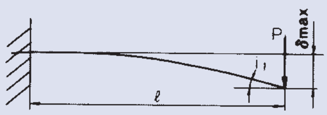
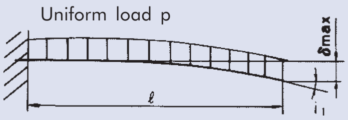
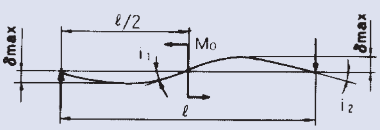
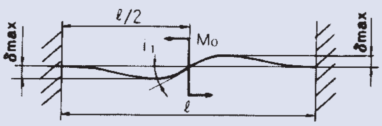
Applications

W,WZ,WB	WRA	WRB	WH	WV	BAC	WS	WSA
It is the most commonly used as a ball bushing race flow; it is hard on surface and cheap.	Material used for its resistance to corrosion. Its hardness is medium high.	Similar to WRA type, with a lower chemical resistence to corrosion. Cheap.	Used for tubular shafts, where a lightness perfect for the liquid, cables and air passing through is requested.	Characteristics similar to W type ,but particularly resistent to atmospheric agents corrosion thanks to a chrome coating.	Limited loading capability, perfect if compled with sliding sleeves. Good corrosion resistence.	Characteristics similar to WH type. Full shaft.	Used for shafts with geometrical characteristics of W type. Great strain resistence and average hardness surface.

Precision Shaft

Shaft deflections and deflection angles

To obtain the Shaft deflection and the deflection angle, select the calculation appropriate to the conditions. The table below shows typical conditions and calculation.

Supporting method		Load conditions	Deflection Formula	Deflection angle Formula
1	Free at both ends		$\delta_{max} = \frac{P\ell^3}{48EI} = P\ell^3 C$	$i_1 = 0$ $i_2 = \frac{P\ell^2}{16EI} = 3P\ell^2 C$
2	Fixed at both ends		$\delta_{max} = \frac{P\ell^3}{192EI} = \frac{1}{4} P\ell^3 C$	$i_1 = 0$ $i_2 = 0$
3	Free at both ends		$\delta_{max} = \frac{5p\ell^4}{384EI} = \frac{5}{8} p\ell^4 C$	$i_2 = \frac{p\ell^3}{24EI} = 2p\ell^3 C$
4	Fixed at both ends		$\delta_{max} = \frac{p\ell^4}{384EI} = \frac{1}{8} p\ell^4 C$	$i_2 = 0$
5	Free at both ends		$\delta_1 = \frac{Pa^3}{6EI}\left(2+\frac{3b}{a}\right)C = 8Pa^3\left(2+\frac{3b}{a}\right)C$ $\delta_{max} = \frac{Pa^3}{24EI}\left(\frac{3\ell^2}{a^2}-4\right) = 2Pa^3\left(\frac{3\ell^2}{a^2}-4\right)C$	$i_1 = \frac{Pab}{2EI} = 24PabC$ $i_2 = \frac{Pa(a+b)}{2EI} = 24Pa(a+b)C$
6	Fixed at both ends		$\delta_1 = \frac{Pa^3}{6EI}\left(2-\frac{3a}{\ell}\right)C = 8Pa^3\left(2-\frac{3a}{\ell}\right)C$ $\delta_{max} = \frac{Pa^3}{24EI}\left(2+\frac{3b}{a}\right) = 2Pa^3\left(2+\frac{3b}{a}\right)C$	$i_1 = \frac{Pa^2 b}{2EI\ell} = \frac{24Pa^2 bC}{\ell}$ $i_2 = 0$
7	Fixed at one end		$\delta_{max} = \frac{P\ell^3}{3EI} = 16P\ell^3 C$	$i_1 = \frac{P\ell^2}{2EI} = 24P\ell^2 C$ $i_2 = 0$
8	Fixed at one end		$\delta_{max} = \frac{p\ell^4}{8EI} = 6p\ell^4 C$	$i_1 = \frac{p\ell^3}{6EI} = 8p\ell^3 C$ $i_2 = 0$
9	Free at both ends		$\delta_{max} = \frac{\sqrt{3}M_0\ell^2}{216EI} = \frac{2\sqrt{3}}{9} M_0\ell^2 C$	$i_1 = \frac{M_0\ell}{12EI} = 4M_0\ell C$ $i_2 = \frac{M_0\ell}{24EI} = 2M_0\ell C$
10	Fixed at both ends		$\delta_{max} = \frac{M_0\ell^2}{216EI} = \frac{2}{9} M_0\ell^2 C$	$i_1 = \frac{M_0\ell}{16EI} = 3M_0\ell C$ $i_2 = 0$

Legenda

δ_1	= Deflection at loaded point (mm)	i_2	=Deflection angle at supporting point
p	=uniform load (kgf/mm)	I	=Geometrical moment of inertia (mm^4)
δ_{max}	=Maximum deflection (mm)	M_o	=Moment (kgf mm)
a,b	=Loading point distance (mm)	E	=Young's module $2.1x10^4$ (kgf / mm^2)
P	=Concentrated load (kgf)	i_1	=Deflection angle at loading point
ℓ	= Shaft lenght (mm)	C	=1/48EI (1/kgf mm^2)

The following formula gives the geometrical moment of inertia I:

Solid core shaft: $I=\pi D^4/64$ (mm^4)
Hollow shaft: $I=\pi(d_2^4-d_1^4)/64$ (mm^4)
where D,d_2=outer diameter d_1=inner diameter

Tables 2 and 4 below show the geometrical moment of inertia and the value of C=1/48 EI of each standard shaft:

Table 2 W,WRA,WRB,WS Types

Outer diameter D (mm)	Geometrical moment of inertia I (mm^4)	C=1/48 EI (1/kgf mm^2)
8	$2.01x10^2$	$4.94x10^{-9}$
10	$4.91x10^2$	$2.02x10^{-9}$
12	$1.02x10^3$	$9.73x10^{-10}$
13	$1.40x10^3$	$7.09x10^{-10}$
15	$2.49x10^3$	$3.98x10^{-10}$
16	$3.22x10^3$	$3.08x10^{-10}$
20	$7.85x10^3$	$1.26x10^{-10}$
25	$1.92x10^4$	$5.17x10^{-11}$
30	$3.98x10^4$	$2.49x10^{-11}$
35	$7.37x10^4$	$1.35x10^{-11}$
38	$1.02x10^5$	$9.73x10^{-12}$
40	$1.26x10^5$	$7.87x10^{-12}$
50	$3.07x10^5$	$3.23x10^{-12}$
60	$6.36x10^5$	$1.56x10^{-12}$
80	$2.01x10^6$	$4.94x10^{-13}$
100	$4.91x10^6$	$2.02x10^{-13}$
120	$1.02x10^7$	$9.73x10^{-14}$

Table 3 WZ Type

Shaft number	Geometrical moment of Inertia I (mm^4)	C=1/48EI (1/kgf mm^2)
WZ 6	7.98x10	$1.24x10^{-8}$
WZ 9	$4.04x10^2$	$2.46x10^{-9}$
WZ 12	$1.28x10^3$	$7.75x10^{-10}$
WZ 15	$3.12x10^3$	$3.18x10^{-10}$
WZ 19	$6.46x10^3$	$1.54x10^{-10}$
WZ 25	$2.04x10^4$	$4.86x10^{-11}$
WZ 31	$4.99x10^4$	$1.99x10^{-11}$
WZ 38	$1.03x10^5$	$9.63x10^{-12}$
WZ 50	$3.27x10^5$	$3.03x10^{-12}$

Calculation examples
1. Calculate the maximum deflection when a concentrated load of 100 kgf is applied in the center of a shaft of 30 mm diameter and 500 mm of length. (Ignore the shaft weight)

- When both ends are free:
From above data: P=100 kgf, l=500 mm
From table 2: for d=30 mm, $C=2.49x10^{-11}$ (1/kgf mm^2)
With these values in the formula 1 of Table 1: $\delta_{max}=Pl^3C=0.31$ mm

- When both ends are fixed:
With above values in the formula 2 of Table 1:
$\delta_{max}=1/4Pl^3C=0.08$ mm

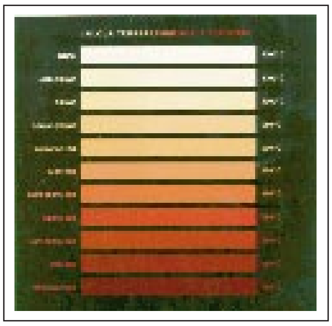
2. Calculate the maximum deflection of an hollow shaft with 60 mm of outer diameter and 32 mm of inner diameter; with length of 2000 mm

- When both ends are free:
The weight per lenght unit of the hollow shaft, with 60 mm of outer diameter and 32 mm of inner diameter, is 15.9 kgf/m.
Therefore p=15.9 kgf/m=$15.9x10^{-3}$ kgf/mm
Uniformly distributed load on the lenght l=2000 mm
Constant $C=1.70x10^{-12}$ (1/kgfmm^2)
From Table 4 and above listed values in the formula 3 of Table 1: $\delta_{max}=5/8\ Pl^4C=0.27$ mm

- When both ends are fixed:
With above values in the formula 4 of Table 1:
$\delta_{max}=1/8\ Pl^4C=0.05$ m

Table 4 WH Type

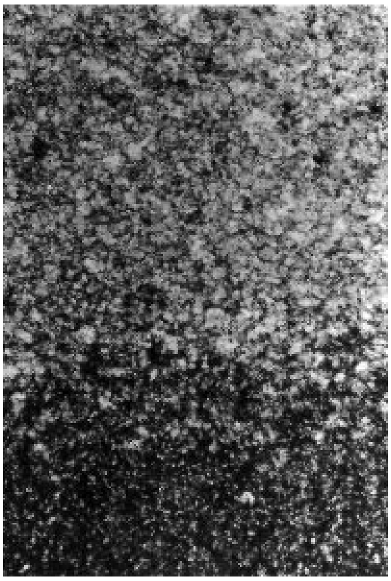
d_2 (mm)	d_1 (mm)	Geometrical moment of Inertia (mm^4)	C=1/48 EI (1/kgf mm^2)
12	4.0	$1.01x10^3$	$9.82x10^{-10}$
16	7.0	$3.10x10^3$	$3.20x10^{-10}$
20	14.0	$5.97x10^3$	$1.66x10^{-10}$
25	15.6	$1.63x10^4$	$6.09x10^{-11}$
30	18.3	$3.43x10^4$	$2.89x10^{-11}$
35	19.0	$6.73x10^4$	$1.47x10^{-11}$
40	28.0	$9.55x10^4$	$1.03x10^{-11}$
50	29.7	$2.69x10^5$	$3.69x10^{-12}$
60	36.0	$5.54x10^5$	$1.79x10^{-12}$
80	57.0	$1.49x10^6$	$6.66x10^{-13}$



Heat treatment

Precision Shaft are induction hardened; this treatment ensures a uniform surface hardness of HV 697 (HRc 60) both in radial and axial direction.
The Stainless steels are subjected to sophisticated treatments to avoid tensions and to ensures a surface hardness of HV 653 (HRc 58).

Micrography of the shaft trasversal section

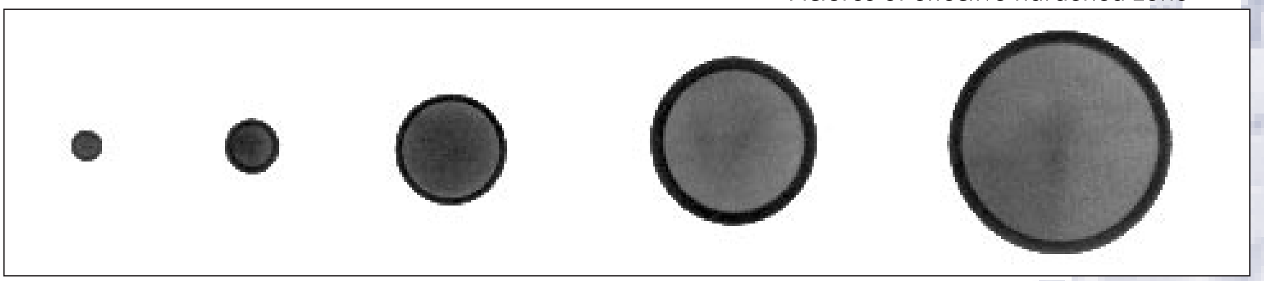


Induction hardened external surface
Martensite structure HRc 62±2

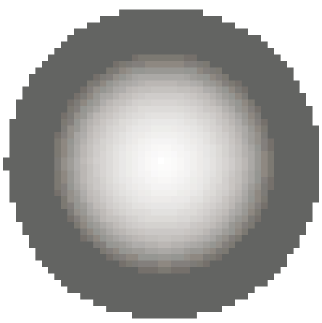
Transition structure:
Martensite
Troostite
Perlite

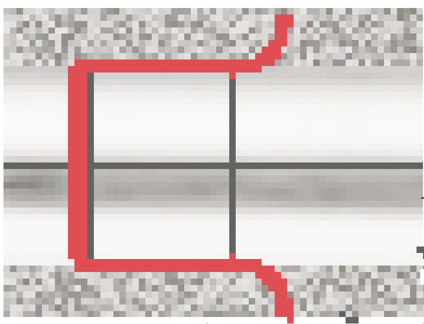
Core Structure:
Perlite
Ferrite

Pictures of effective hardened zone



The diagram values represent hardness depth minimum values.





Shaft surface hardness:
from 60 to 64 HRc
At hardness depth, the hardness is still of 80 % of surface hardness

Shaft Diameter (mm)	da 3 a 10	> 10 a 18	> 18 a 30	> 30 a 50	> 50 a 80
Hardness (mm)	0.4	0.6	0.9	1.5	2.2

Proceeding of hardness depth inside a shaft

Precision

The precision shafts are produced in a very reliable way, with high accuracy to their roundness, cylindricity, and surface roughness. The dimensional precision is expressed in the chart concerning the typology. The shafts subjected to annealing to be worked again can have different values if compared to the tolerated ones. The tolerances applied to the length of special shafts produced on customer's drawing refer to the UNI 5307 norm with "MEDIUM" precision degree.
Figures 1 and 2 show examples of roundness and surface roughness check.

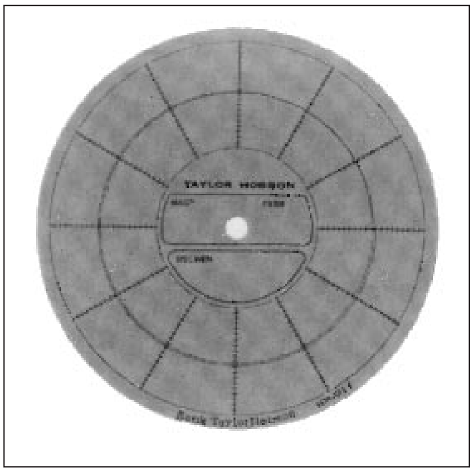
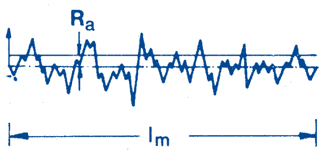


Fig.1: Roundness check

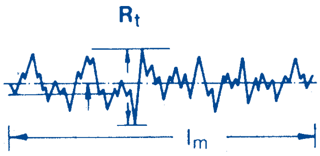
Roughness

Roughness can be expressed in three different ways:

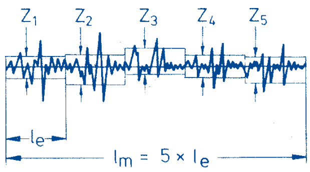
1) Ra = average roughness value
   It identifies a mean arithmetic value of all distances of the roughness diagram points, referred to a mean line and referred to a given lenght.



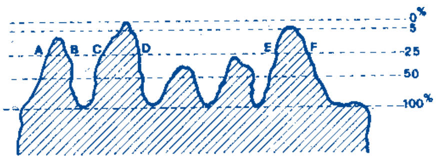
2) Rt = maximum roughness depth
   It is the distance amount the highest and lowest points of the roughness diagram referred to the total measured length.



3) Rz = average roughness depth
   It is the average value of roughness depth found on five lenghts measured in sequence.



4) tp = supporting surface
   It's a ratio between the actual contact area of the surface examined and a perfectly smooth surface, and the ideal contact area we could reach if the two surfaces were perfectly smooth.



Thanks to the accurate finishing of our surface, the supporting surface described at point 4 is average similar to the 93% at 1 micron depth. The effect of the above description is that the balls of ball bushing have a bigger contact surface, to its endurance advantage.

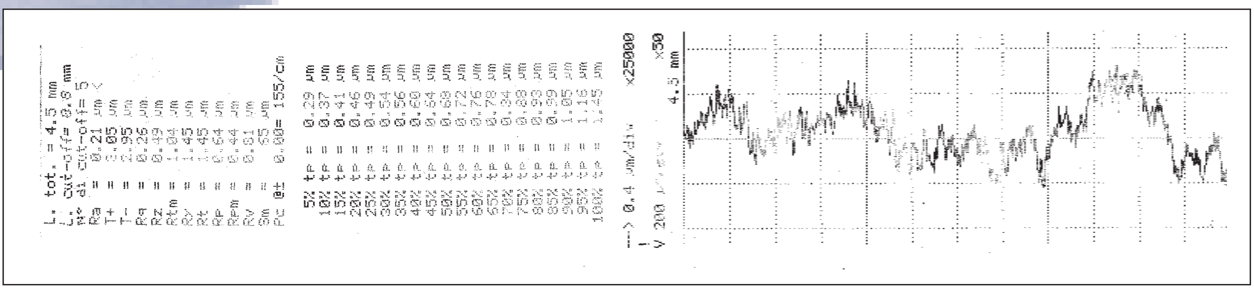


Fig.2: Surface roughness check

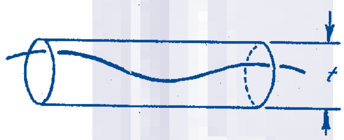
Geometrical tolerance

The dimensional tolerances often include also the geometrical one, since errors in shape and position of the used machine tools usually are not so important.
The geometrical tolerance besides some particulare cases, has an individual meaning to express straightness, parallelity and rectangularity errors,etc..
The geometrical tolerances contain the shape and the position accuracies: they locate the maximum possible displacement referred to an estabilished condition.

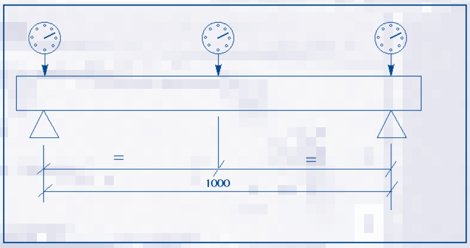
Principal geometrical tolerances:

Shape errors

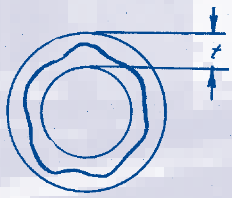
— STRAIGHTNESS
is defined by the cilinder diameter within which there must lay a straight line.



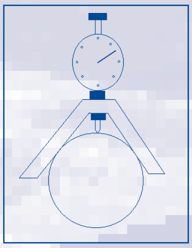
Straightness proof scheme



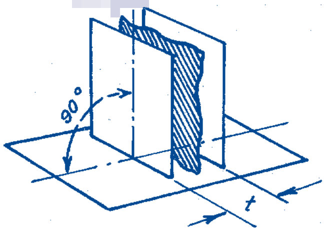
○ ROUNDNESS
is defined by the difference of the radius of two coaxial cylinders within which there must be contained a nominal cilindric surface.



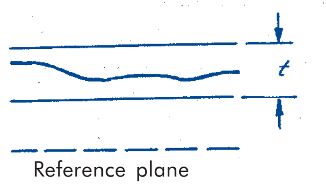
Roundness proof scheme



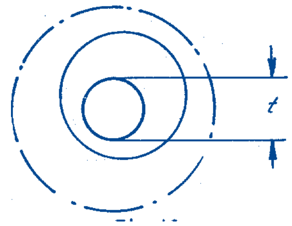
⊥ RECTANGULARITY
of a surface referred to a plane: it is defined by the distance between two parallel planes and perpendicular to the reference plane within which there must be the above mentioned surface.



PARALLELITY
of a line or a surface compared to a reference plane is the distance of two parallel planes between them and the reference plane, within which the line and the surface must be contained.



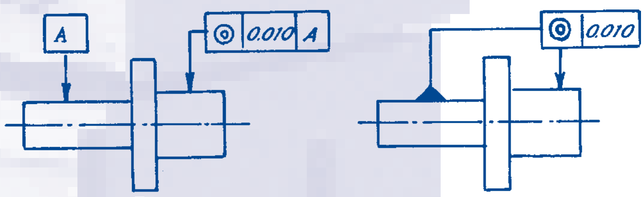
CONCENTRICITY
is defined by the circle diameter concentric with a reference circumference, within which there must be the centre of a circumference concentric with the reference one.



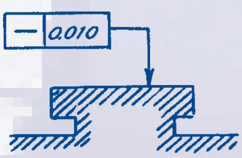
Example of geometrical tolerance

The geometrical tolerances are graphically expressed by rectangles divided into 2 or 3 sections respectively meaning:
- Tolerance symbol
- Tolerance value
- reference element consisting of a letter

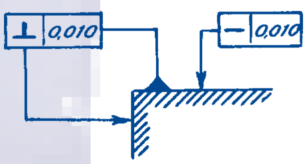
Example: | ⊥ | 0.010 | A | means that the surface marked by the symbol can show a maximum rectangularity error of 0.010 mm referred to surface A.



Coaxiality tolerance referred to a given surface.



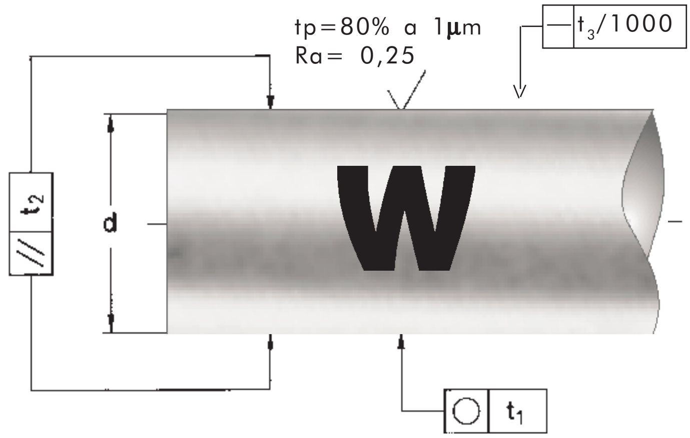
Straightness Tolerance



Rectangularity and straightness tolerance

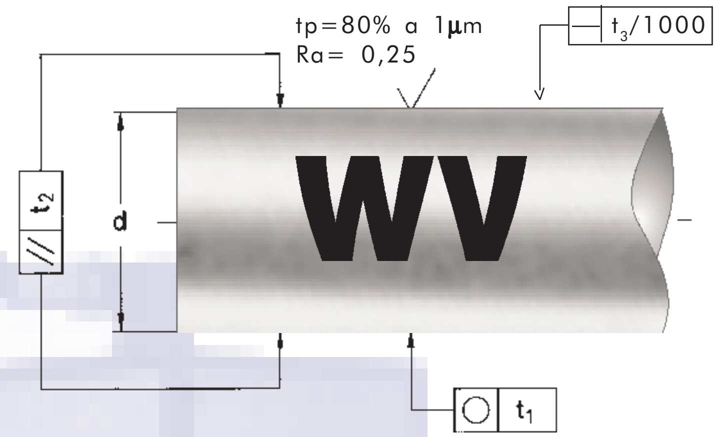
Dimensional Tables

Contents



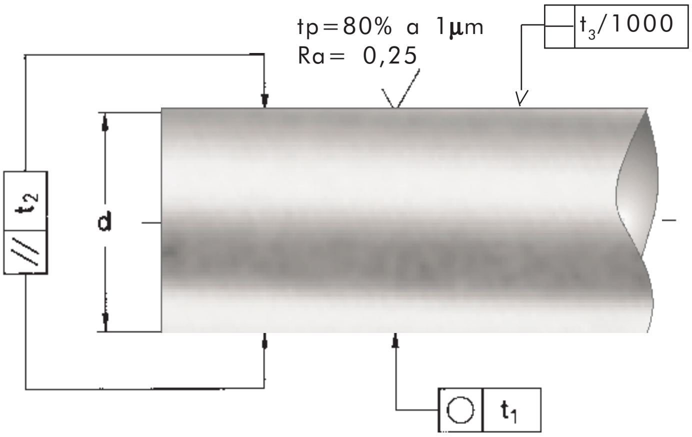
Shaft Diameter d	Weigth pro meter length	Shaft code number	Standard length	Hardening depth Rht (max) DIN 6773	Standard tolerance ISO h6	Special Tolerance ISO j6	Special Tolerance ISO g6	Roundness (circular) t_1	Parallelism (cylindric) t_2	Straightness t_3
mm	kg		mm	mm	µm	µm	µm	µm	µm	µm
3	0.06	**W 3**	400	0.5	0 -6	+4 -2	-2 -8	3	4	300
5	0.15	**W 5**	2,000	0.8	0 -8	+6 -2	-4 -12	4	6	300
6	0.22	**W 6**	3,000	0.8	0 -8	+6 -2	-4 -12	4	6	300
8	0.39	**W 8**	3,000	1.0	0 -9	+7 -2	-5 -14	4	6	300
10	0.61	**W 10**	4,500	1.0	0 -9	+7 -2	-5 -14	4	6	300
12	0.89	**W 12**	6,000	1.3	0 -11	+8 -3	-6 -17	5	8	200
14	1.21	**W 14**	6,000	1.3	0 -11	+8 -3	-6 -17	5	8	200
15	1.37	**W 15**	6,000	1.3	0 -11	+8 -3	-6 -17	5	8	200
16	1.57	**W 16**	6,000	1.6	0 -11	+8 -3	-6 -17	5	8	200
18	1.98	**W 18**	6,000	1.6	0 -11	+8 -3	-6 -17	5	8	200
20	2.45	**W 20**	6,000	1.6	0 -13	+9 -4	-7 -20	6	9	100
24	3.55	**W 24**	6,000	1.8	0 -13	+9 -4	-7 -20	6	9	100
25	3.83	**W 25**	6,000	1.8	0 -13	+9 -4	-7 -20	6	9	100
30	5.51	**W 30**	6,000	2.0	0 -13	+9 -4	-7 -20	6	9	100
32	6.30	**W 32**	6,000	2.0	0 -16	+11-5	-9 -25	7	11	100
35	7.55	**W 35**	6,000	2.5	0 -16	+11-5	-9 -25	7	11	100
40	9.80	**W 40**	6,000	2.5	0 -16	+11-5	-9 -25	7	11	100
50	15.3	**W 50**	6,000	3.0	0 -16	+11-5	-9 -25	7	11	100
60	22.1	**W 60**	6,000	3.0	0 -19	+12-7	-10-29	8	13	100
70	30.2	**W 70**	6,000	3.0	0 -19	+12-7	-10-29	8	13	100
80	39.2	**W 80**	6,000	3.0	0 -19	+12-7	-10 -29	8	13	100
90	49.9	**W 90**	6,000	3.0	0 -22	+13-9	-12 -34	10	16	100
100	61.7	**W 100**	6,000	3.3	0 -22	+13-9	-12 -34	10	16	100
110	74.6	**W 110**	6,000	3.3	0 -22	+13-9	-12 -34	10	16	100

On request we can supply Shaft diameters in no listed dimensions with special lengths and tolerances.



Shaft Diameter d	Weigth pro meter length	Shaft code number	Standard length	Hardening depth Rht (max) DIN6773	Standard tolerance ISO h7	Special Tolerance ISO h6	Roundness (circular) t_1	Parellelism (cylindric) t_2	Straight-ness t_3
mm	kg		mm	mm	µm	µm	µm	µm	µm
3	0.06	**WV 3**	400	0.5	0 -10	0 -6	6	10	300
5	0.16	**WV 5**	2,000	0.8	0 -12	0 -8	6	10	300
6	0.23	**WV 6**	3,000	0.8	0 -12	0 -8	6	10	300
8	0.40	**WV 8**	3,000	1.0	0 -15	0 -9	6	10	300
10	0.62	**WV 10**	3,500	1.0	0 -15	0 -9	6	10	300
12	0.89	**WV 12**	3,500	1.3	0 -18	0 -11	8	12	200
14	1.21	**WV 14**	3,500	1.3	0 -18	0 -11	8	12	200
15	1.39	**WV 15**	3,500	1.3	0 -18	0 -11	8	12	200
16	1.58	**WV 16**	3,500	1.6	0 -18	0 -11	8	12	200
18	1.98	**WV 18**	6,000	1.6	0 -18	0 -11	8	12	200
20	2.47	**WV 20**	6,000	1.6	0 -21	0 -13	9	12	100
24	3.55	**WV 24**	6,000	1.8	0 -21	0 -13	9	12	100
25	3.85	**WV 25**	6,000	1.8	0 -21	0 -13	9	12	100
30	5.55	**WV 30**	6,000	2.0	0 -21	0 -13	9	12	100
32	6.30	**WV 32**	6,000	2.0	0 -25	0 -16	11	15	100
35	7.55	**WV 35**	6,000	2.5	0 -25	0 -16	11	15	100
40	9.87	**WV 40**	6,000	2.5	0 -25	0 -16	11	15	100
50	15.4	**WV 50**	6,000	3.0	0 -25	0 -16	11	15	100
60	22.2	**WV 60**	6,000	3.0	0 -30	0 -19	12	15	100
70	30.2	**WV 70**	6,000	3.0	0 -30	0 -19	12	15	100
80	39.5	**WV 80**	6,000	3.0	0 -30	0 -19	12	15	100
90	49.9	**WV 90**	6,000	3.0	0 -35	0 -22	14	17	100
100	61.7	**WV 100**	6,000	3.3	0 -35	0 -22	14	17	100
110	74.6	**WV 110**	6,000	3.3	0 -35	0 -22	14	17	100

On request we can supply shaft diameters in no listed dimensions, with special length and tolerances.
Chromium plating: 5 - 20 µm.

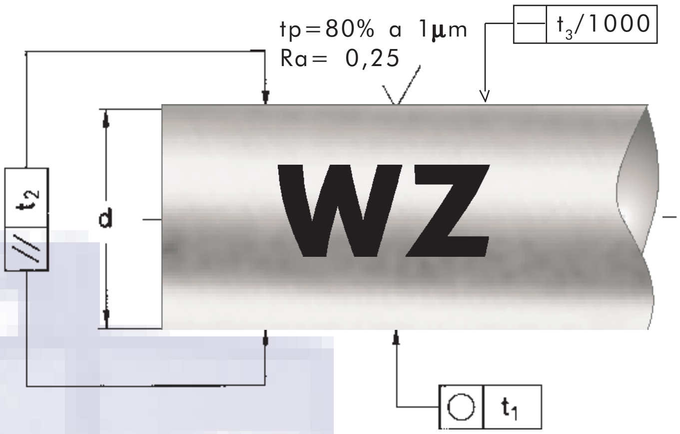


WRA HRc 57±2
WRB HRc 55±2

Shaft diameter d	Weigth pro meter length	Shaft code number	Standard length	Hardening depth DIN 50190 (max)	Standard tolerance ISO h6	Roundness (circular) t_1	Parallelism (cylindric) t_2	Straight-ness t_3
mm	kg		mm	mm	µm	µm	µm	µm
5	0.15	**WRA 5**	700	0.7	0 -8	4	5	300
	0.15	**WRB 5**	700	0.7	0 -8	4	5	300
6	0.22	**WRA 6**	1,500	0.7	0 -8	4	6	300
	0.22	**WRB 6**	1,500	0.7	0 -8	4	6	300
8	0.40	**WRA 8**	2,700	0.9	0 -9	4	6	300
	0.40	**WRB 8**	2,700	0.9	0 -9	4	6	300
10	0.62	**WRA 10**	2,700	1.1	0 -9	4	6	300
	0.62	**WRB 10**	2,700	1.1	0 -9	4	6	300
12	0.89	**WRA 12**	4,900	1.3	0 -11	5	8	200
	0.89	**WRB 12**	4,900	1.3	0 -11	5	8	200
14	1.21	**WRA 14**	4,900	1.5	0 -11	5	8	200
	1.21	**WRB 14**	4,900	1.5	0 -11	5	8	200
15	1.39	**WRA 15**	4,900	1.6	0 -11	5	8	200
	1.39	**WRB 15**	4,900	1.6	0 -11	5	8	200
16	1.58	**WRA 16**	4,900	1.6	0 -11	5	8	200
	1.58	**WRB 16**	4,900	1.6	0 -11	5	8	200
20	2.47	**WRA 20**	4,900	1.8	0 -13	6	9	100
	2.47	**WRB 20**	4,900	1.8	0 -13	6	9	100
25	3.85	**WRA 25**	4,900	2.0	0 -13	6	9	100
	3.85	**WRB 25**	4,900	2.0	0 -13	6	9	100
30	5.55	**WRA 30**	4,900	2.4	0 -13	6	9	100
	5.55	**WRB 30**	4,900	2.4	0 -13	6	9	100
40	9.87	**WRA 40**	4,900	2.6	0 -16	7	11	100
	9.87	**WRB 40**	4,900	2.6	0 -16	7	11	100
50	15.41	**WRA 50**	4,900	2.9	0 -16	7	11	100
	15.41	**WRB 50**	4,900	2.9	0 -16	7	11	100
60	22.20	**WRA 60**	4,900	3.0	0 -19	8	13	100
	22.20	**WRB 60**	4,900	3.0	0 -19	8	13	100

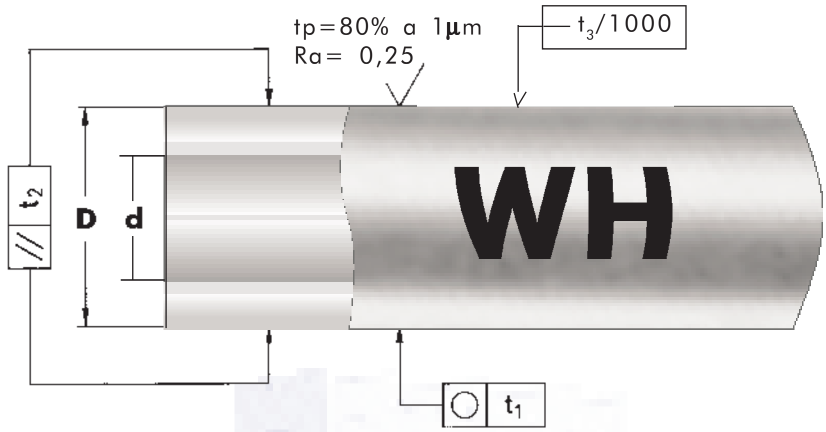
On request we can supply Shaft diameters in no listed dimensions with special lengths and tolerances.

Precision Shaft



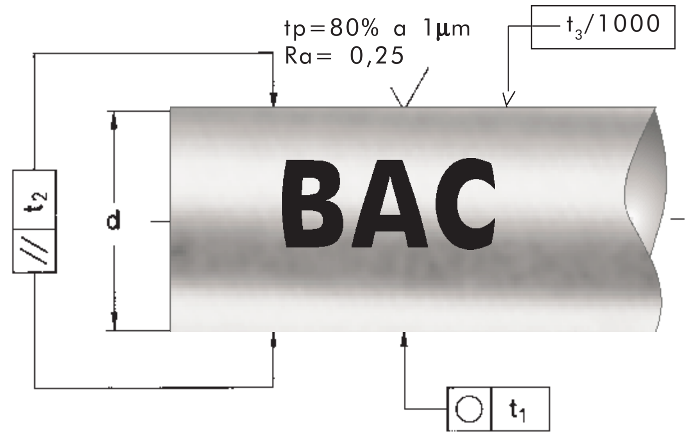
Shaft diameter d		Shaft code number	Standard length	Hardening depth Rht (max) DIN6773	Tolerance Class " L "	Standard Tolerance ISO h6	Weigth pro meter length	Round-ness (circular) t_1	Paralle-lism (cylindric) t_2	Straight-ness t_3
mm	inch		mm	mm	µm	µm	kg	µm	µm	µm
6.350	1/4	**WZ 6**	1,500	0.8	-13 -25	0 -9	0.25	4	5	300
9.525	3/8	**WZ 9**	3,000	1.0	-13 -25	0 -9	0.56	4	6	300
12.700	1/2	**WZ 12**	6,000	1.3	-13 -25	0 -12	0.99	5	8	200
15.875	5/8	**WZ 15**	6,000	1.3	-13 -25	0 -12	1.55	5	8	200
19.050	3/4	**WZ 19**	6,000	1.6	-13 -25	0 -13	2.24	6	9	200
25.400	1	**WZ 25**	6,000	1.8	-13 -25	0 -13	3.97	6	9	100
31.750	1 1/4	**WZ 31**	6,000	2.0	-13 -25	0 -16	6.22	7	11	100
38.100	1 1/2	**WZ 38**	6,000	2.5	-15 -28	0 -16	8.95	7	11	100
50.800	2	**WZ 50**	6,000	3.0	-15 -33	0 -19	15.91	7	11	100

HARDENED AND GROUND HOLLOW SHAFTS



Diameter outer D	Diameter inner d	Shaft code number	Standard length	Hardening depth Rht (max) DIN6773	Tolerance ISO h6	Weigth pro meter length	Roundness (circular) t_1	Parallelism (cylindrical) t_2	Straight-ness t_3
mm	mm		mm	mm	µm	kg	µm	µm	µm
12	4	**WH 12**	4,200	1.3	0-11	0.79	5	8	200
16	7	**WH 16**	4,200	1.6	0-11	1.28	5	8	200
20	14	**WH 20**	5,500	1.8	0-13	1.25	6	9	100
25	15.6	**WH 25**	5,500	2.0	0-13	2.35	6	9	100
30	18.3	**WH 30**	6,000	2.4	0-13	3.50	6	9	100
40	28	**WH 40**	6,000	2.6	0-16	4.99	7	11	100
50	29.7	**WH 50**	6,000	2.9	0-16	9.91	7	11	100
60	36	**WH 60**	6,000	3.0	0-19	14.20	8	13	100
80	57	**WH 80**	6,000	3.2	0-19	19.43	8	13	100
100	65	**WH 100**	6,000	3.3	0-22	35.61	10	16	100

On request we can supply Shaft diameters in no listed dimensions with special lengths and tolerances.

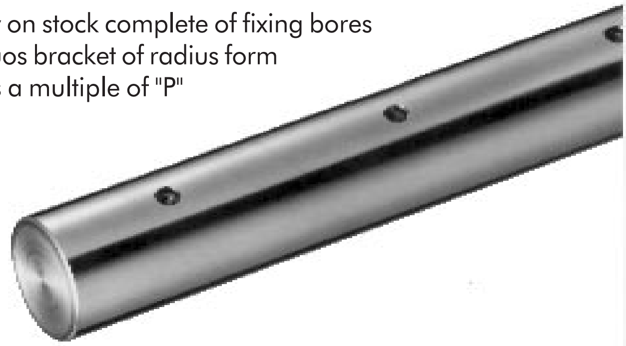


Shaft diameter d	Weigth pro meter length	Shaft code number	Standard length	Standard tollerance ISO f7	Roundness (circular) t_1	Parallelism (cylindrical) t_2	Straightness t_3
mm	kg		mm	µm	µm	µm	µm
3	0.06	**BAC 3**	400	-6 -16	3	4	300
4	0.10	**BAC 4**	400	-10 -22	3	4	300
5	0.16	**BAC 5**	3,500	-10 -22	4	6	300
6	0.23	**BAC 6**	3,500	-10 -22	4	6	300
8	0.40	**BAC 8**	3,500	-13 -28	4	6	300
10	0.62	**BAC 10**	3,500	-13 -28	4	6	300
12	0.89	**BAC 12**	3,500	-16 -34	5	8	200
14	1.21	**BAC 14**	3,500	-16 -34	5	8	200
15	1.39	**BAC 15**	3,500	-16 -34	5	8	200
16	1.58	**BAC 16**	3,500	-16 -34	5	8	200
18	1.98	**BAC 18**	6,000	-16 -34	5	8	200
20	2.47	**BAC 20**	6,000	-20 -41	6	10	100
24	3.55	**BAC 24**	6,000	-20 -41	6	10	100
25	3.85	**BAC 25**	6,000	-20 -41	6	10	100
30	5.55	**BAC 30**	6,000	-20 -41	6	10	100
32	6.30	**BAC 32**	6,000	-25 -50	8	12	100
35	7.55	**BAC 35**	6,000	-25 -50	8	12	100
40	9.87	**BAC 40**	6,000	-25 -50	8	12	100
50	15.4	**BAC 50**	6,000	-25 -50	8	12	100
60	22.2	**BAC 60**	6,000	-30 -60	9	14	100
70	30.2	**BAC 70**	6,000	-30 -60	9	14	100
80	39.5	**BAC 80**	6,000	-36 -71	9	14	100
90	49.9	**BAC 90**	6,000	-36 -71	10	16	100
100	61.7	**BAC 100**	6,000	-36 -71	10	16	100
110	74.6	**BAC 110**	6,000	-36 -71	10	16	100

On request we can supply shafts diameters with no listed dimensions with special length and tolerance.
Chromium plating: 20 ± 5 µm.

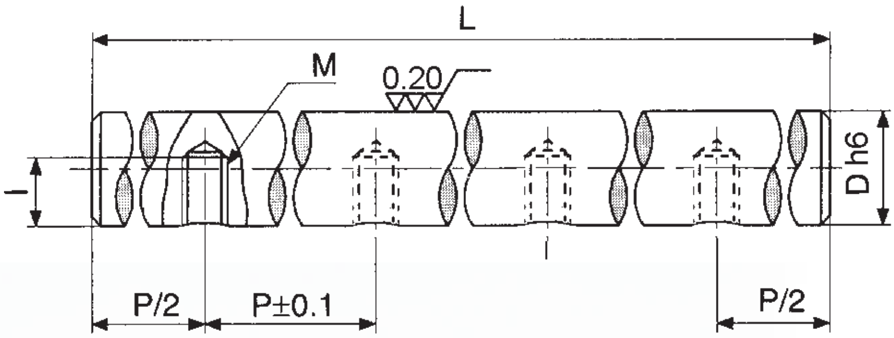
WB SHAFT - HARDENED, GROUND COMPLETE OF FIXING BORES

These Precision Shafts are ready on stock complete of fixing bores suitable for mounting on continuos bracket of radius form and dimension. The "L" length is a multiple of "P" pitch.



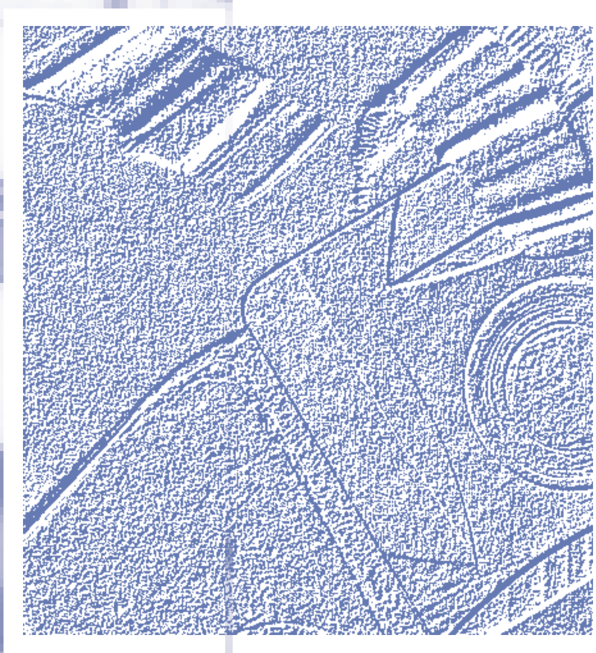
Therefore it is possible starting from standard lenght shafts obtaining different lengths by simple cutting process.

Shaft Diameter D m m	Shaft code number	Pitch P mm	P/2 mm	Nominal screw size	Thread Depth l mm	Standard lenght L mm	N° of holes for standard lenght
12	**WB 12 A**	75	37.5	M 4	8	3600	47
12	**WB 12 B**	120	60	M 4	8	3600	29
12	**WB 12 C**	150	75	M 4	8	3600	23
16	**WB 16 A**	75	37.5	M 5	9	3600	47
16	**WB 16 B**	100	50	M 5	9	3600	35
16	**WB 16 C**	150	75	M 5	9	3600	23
16	**WB 16 D**	150	75	M 5	9	3600	23
20	**WB 20 A**	50	25	M 6	11	6000	119
20	**WB 20 B**	75	37.5	M 6	11	6000	79
20	**WB 20 C**	100	50	M 6	11	6000	59
20	**WB 20 D**	150	75	M 6	11	6000	39
20	**WB 20 E**	150	75	M 5	11	6000	39
25	**WB 25 A**	60	30	M 8	15	6000	99
25	**WB 25 B**	75	37.5	M 8	15	6000	79
25	**WB 25 C**	120	60	M 6	15	6000	49
25	**WB 25 D**	120	60	M 8	15	6000	49
25	**WB 25 E**	150	75	M 6	15	6000	39
25	**WB 25 F**	200	100	M 6	15	6000	29
30	**WB 30 A**	60	30	M 10	17	6000	99
30	**WB 30 B**	75	37.5	M 10	17	6000	79
30	**WB 30 C**	100	50	M 10	17	6000	59
30	**WB 30 D**	150	75	M 6	15	6000	39
30	**WB 30 E**	150	75	M 8	15	6000	39
30	**WB 30 F**	150	75	M 10	15	6000	39
30	**WB 30 G**	200	100	M 8	15	6000	29
40	**WB 40 A**	75	37.5	M 12	21	6000	79
40	**WB 40 B**	100	50	M 12	21	6000	59
40	**WB 40 C**	150	75	M 10	19	6000	39
40	**WB 40 D**	150	75	M 8	21	6000	39
40	**WB 40 E**	200	100	M 10	19	6000	29
40	**WB 40 F**	200	100	M 8	17	6000	29
40	**WB 40 G**	300	150	M 8	17	6000	19
50	**WB 50 A**	100	50	M 16	27	6000	59
50	**WB 50 B**	100	50	M 14	25	6000	59
50	**WB 50 C**	150	75	M 10	22	6000	39
50	**WB 50 D**	150	75	M 10	21	6000	39
50	**WB 50 E**	200	100	M 10	21	6000	29
50	**WB 50 F**	200	100	M 12	21	6000	29
50	**WB 50 G**	300	150	M 12	21	6000	19
50	**WB 50 H**	300	150	M 10	21	6000	19



Shaft code number	Shaft support code						
WB 12 A	TSU TSWA	TSN		1050-112-00	1050-612-00		LRCB
WB 12 B	TSW			1050-212-00	1050-712-00		
WB 12 C						LRAB 11	
WB 16 A	TSU						
WB 16 B	TSN	TSWA		1050-116-00	1050-616-00		LRCB
WB 16 C	TSW			1050-216-00	1050-716-00		
WB 16 D	TSP					LRAB 12	
WB 20 A	TSS						
WB 20 B	TSU	TSC		1051-120-00		LRCU 20	
WB 20 C	TSN	TSWA		1050-120-00	1050-620-00	1051-220-00	LRCB
WB 20 D	TSP			1050-220-00	1050-720-00	LRAB 13	
WB 20 E	TSW						
WB 25 A	TSS						
WB 25 B	TSU	TSC		1051-125-00		LRCU 25	
WB 25 C				1050-125-00			LRCB
WB 25 D	TSN	TSWA		1051-225-00			
WB 25 E	TSW	TSP				LRAB 13	
WB 25 F				1050-225-00			
WB 30 A				1019-030-00			
WB 30 B	TSS						
WB 30 C	TSU	TSC		1051-130-00		LRCU 30	
WB 30 D	TSW					LRAB 13	
WB 30 E	TSP			1050-130-00	1050-630-00		LRCB
WB 30 F	TSN	TSWA					
WB 30 G				1050-230-00	1050-730-00		
WB 40 A				1019-040-00			
WB 40 B	TSU	TSC	TSS	1051-140-00		LRCU 40	
WB 40 C	TSW	TSP		1051-240-00			
WB 40 D						LRAB 21	
WB 40 E	TSN	TSWA		1051-240-00			
WB 40 F				1050-140-00	1050-640-00		LRCB
WB 40 G				1050-240-00	1050-740-00		
WB 50 A				1019-050-00		LRCU 50	
WB 50 B	TSU	TSS	TSC	1051-150-00			
WB 50 C						LRAB 21	
WB 50 D	TSW						
WB 50 E	TSP						
WB 50 F				1050-150-00	1050-650-00		LRCB
WB 50 G	TSN	TSWA		1051-250-00			
WB 50 H				1050-250-00	1050-750-00		

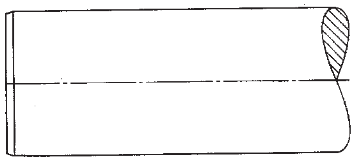
Mechanical working processes



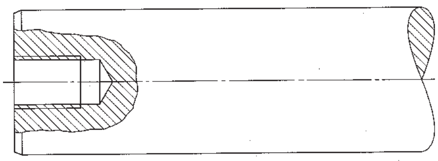
Contents

We are giving you an overview of the most commonly carried out working and standardization tables.

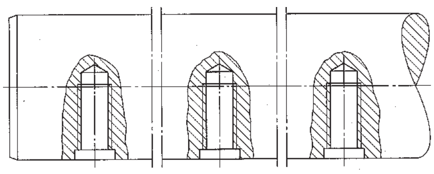
LENGTH CUT AND BURRING



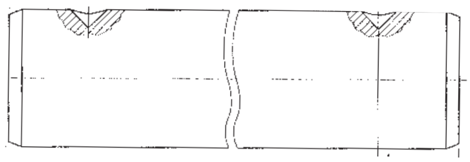
AXIAL BORING



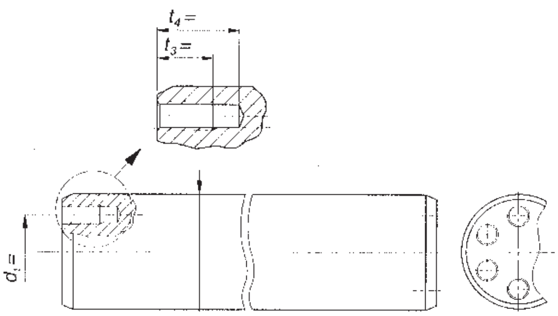
RADIAL BORING

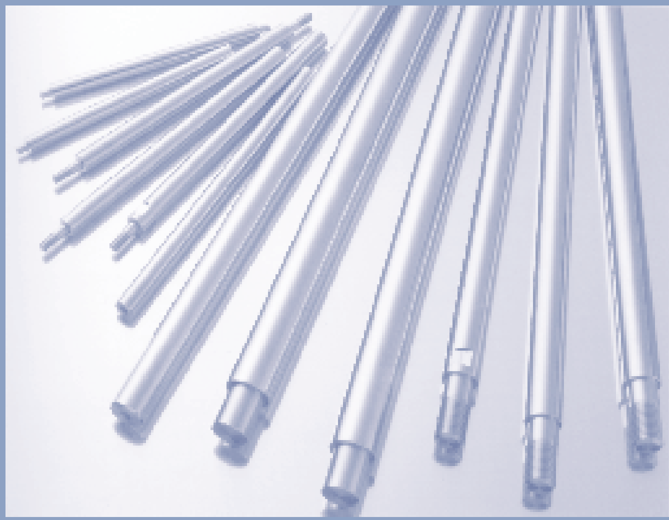


SCREW SEATS

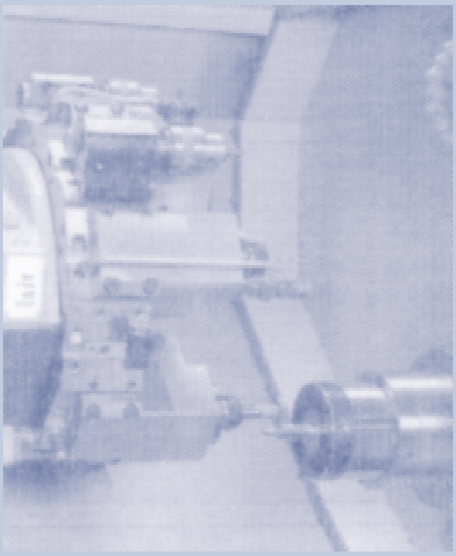


CIRCUMFERENCE AXIAL BORES

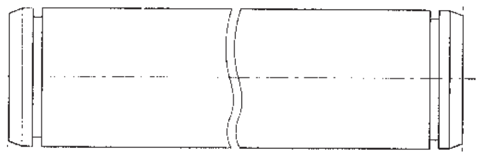




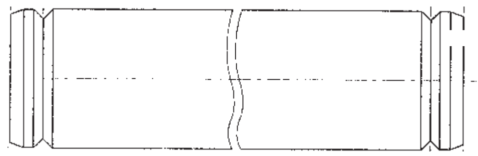
Precision Shafts may be worked in standard mill lengths or according to Customer's requirements.
For this purpose our workshop has been equipped and it's able to supply Precision Shafts according to customer drawings, in a short time.



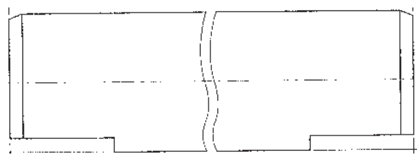
SNAP RING GROOVES



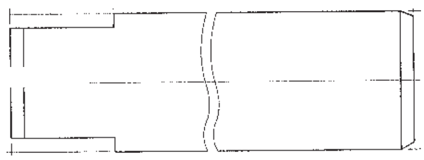
CIRCUMFERENCE GROOVE



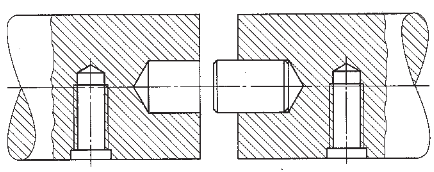
MILLED PLANES



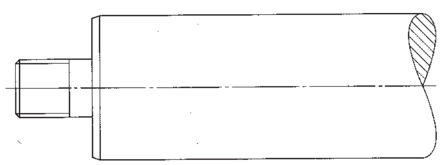
MILLED PLANES (FOR KEY)

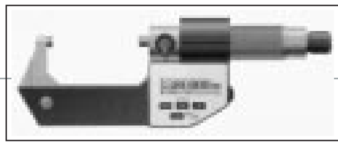


MORESHAFTS COUPLING



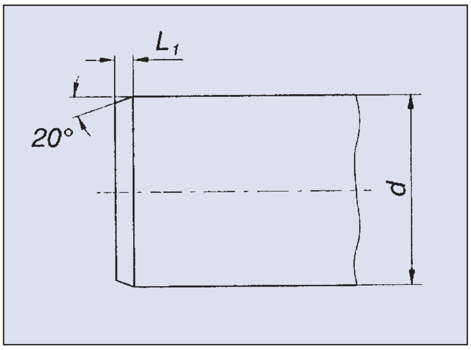
THREADED SMALL ENDS





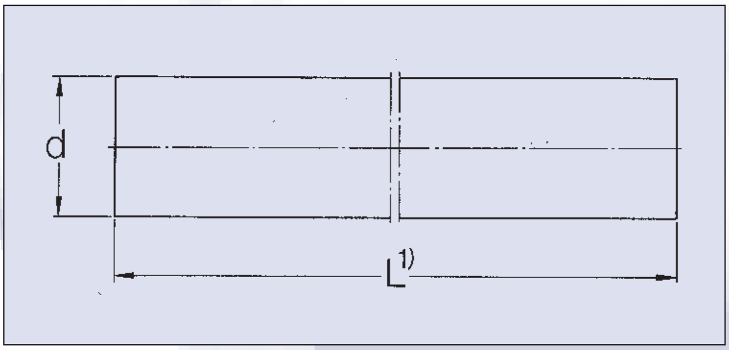
• CHAMFERS

Shaft diameter d (mm)	Chamfer width L_1 (mm)
5	1.5
8	1.5
10	1.5
12	2.0
16	2.0
20	2.0
25	2.0
30	2.0
40	3.0
50	3.0
60	3.0
80	3.0



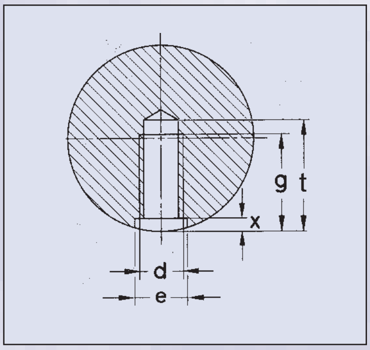
• CUT IN LENGTH SHAFTS TOLERANCE

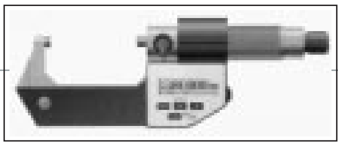
Length L1) (mm)	Tolerance (mm)
< 400	±0.5
400 - 1000	±0.8
1000 - 2000	±1.2
2000 - 4000	±2.0
4000 - 6000	±3.0



• RADIAL BORINGS

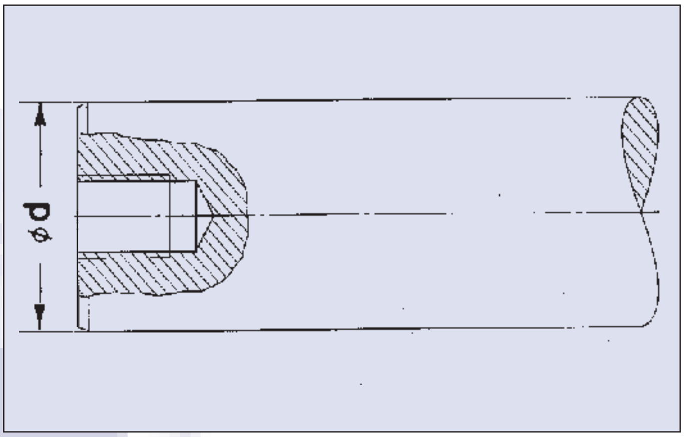
Shaft diameter d (mm)	Thread Bore	d min (mm)	d max (mm)	t (mm)	g (mm)	x (mm)	e (mm)
12	M4	4	4	9	8	2.5	d+1
16	M5	5	5	11	9.5	2.5	d+1
20	M6	5	6	15	13	3.0	d+1
25	M8	5	8	15	14	3.0	d+1
30	M10	6	10	22	18	4.0	d+1
40	M10	6	12	22	20	4.0	d+1
50	M12	6	12	26	23	4.0	d+1
60	M14	8	14	35	28	4.5	d+1
80	M16	10	16	45	33	5.5	d+1
100	M16	12	20	55	40	6.5	d+1





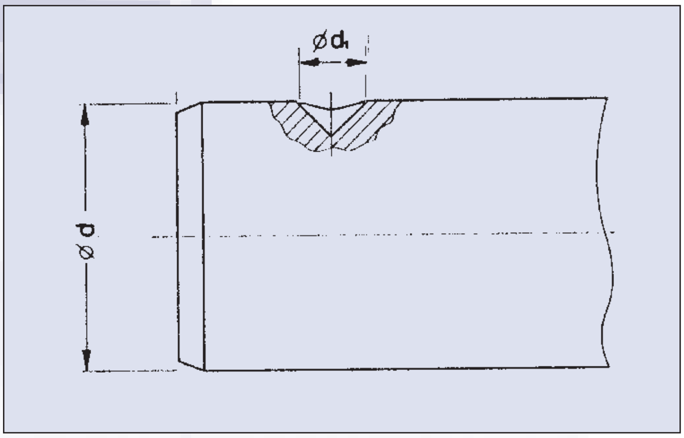
• AXIAL BORING

Shaft diameter d (mm)	Thread bore
8 - 15	M4 - M5
16 - 22	M5 - M8
25 - 32	M10 - M12
35 - 45	M10 - M16
46 - 60	M16 - M20
61 - 80	M16 - M24
81 -110	M20 - M30



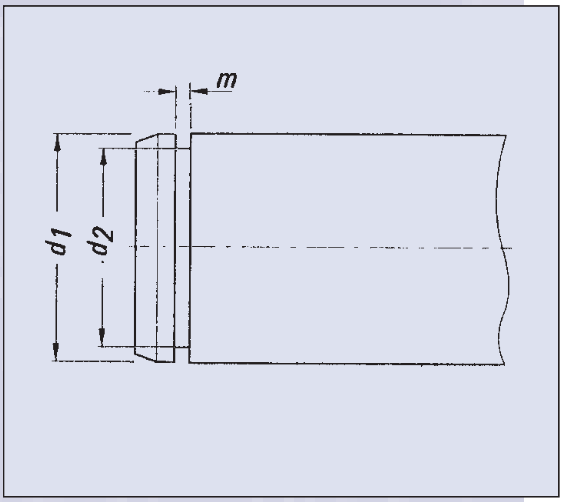
• SEATS SCREWS

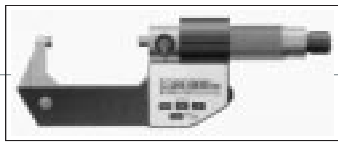
Shaft diameter d (mm)	d_1 (mm)
10 - 16	4
18 - 25	6
26 - 40	8
41 - 60	10
61 -100	12



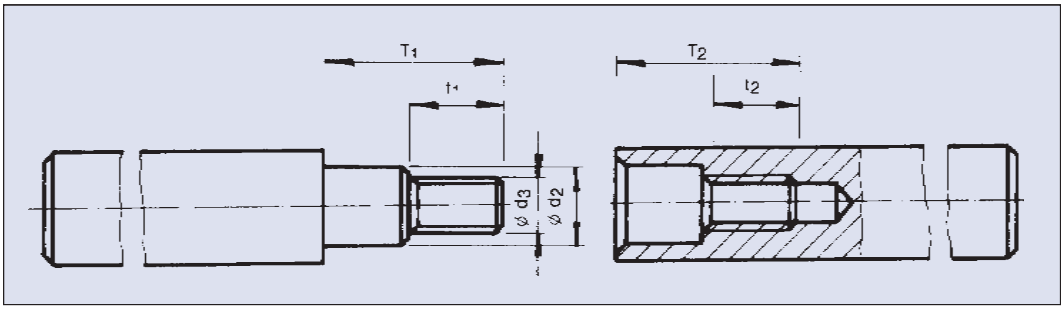
• GROOVES FOR SNAP RINGS (DIN 471)

Shaft diameter d_1 (mm)	m h11	m h13	d_2
8	0.8	0.9	7.6
10	1.0	1.1	9.6
12	1.0	1.1	11.5
14	1.0	1.1	13.4
15	1.0	1.1	14.3
16	1.0	1.1	15.2
18	1.2	1.3	17
20	1.2	1.3	19
24	1.2	1.3	22.9
25	1.2	1.3	23.9
30	1.5	1.6	28.6
32	1.5	1.6	30.3
35	1.5	1.6	33
40	1.75	1.85	37.5
50	2.0	2.15	47
60	2.0	2.15	57
70	2.5	2.65	67
80	2.5	2.65	76.5
90	3.0	3.15	86.5
100	3.0	3.15	96.5
110	4.0	4.15	106



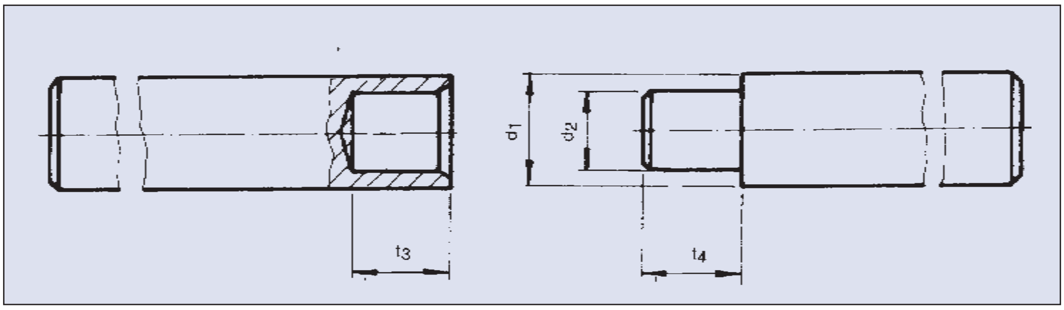


• SCREW TYPE SHAFT COUPLING

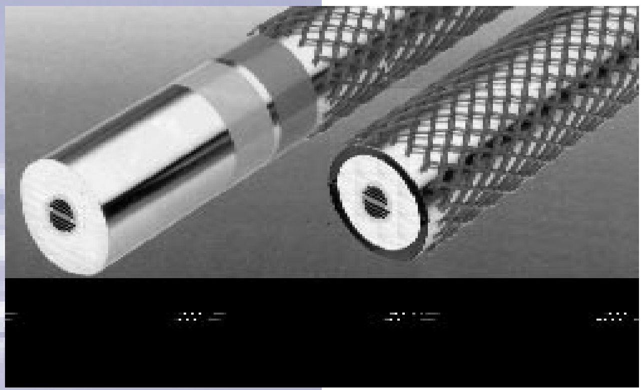


Shaft diameter d_1 (mm)	d_2 (mm)	d_3	T_1 (mm)	T_2 (mm)	t_1 (mm)	t_2 (mm)
12	7	M6	16	19	9	8
16	10	M8	20	25	12	10
20	12	M10	20	25	12	10
25	15	M12	35	41	18	20
30	15	M12	39	45	22	20
40	20	M16	48	55	26	25
50	25	M20	60	67	33	30
60	25	M20	60	67	33	30
80	40	M30	71	81	35	40

• SHAFTS LINKED IN A PIN-BORE TYPE SHAFT COUPLING



Shaft diameter d_1 (mm)	d_2 (mm)	t_3 (mm)	t_4 (mm)
12	7	11	10
16	10	14	12
20	12	14	12
25	15	20	17
30	15	24	21
40	20	28	25
50	25	35	32
60	25	35	32
80	40	38	33



We take particular care in packaging of our Precision Shaft in order to preserve them from oxidation and possible damages coming from transport and handling.
For above reason we have chosen special surface protection and dewatering oils and other products like Branorost paper which can garantee long storage.
Our Precision Shaft are preferably delivered in wood boxes or in case of small quantities, wrapped in compound materials like Lamiflex.
All products used are preferably ecological or recyclable in order to satisfy the concerned European standardizations.
The heavy load shipments are performed with a proper transport in order to avoid to transfer the Shaft among several carriers.