

## Induction Hardened and Hard Chrome Plated Linear Shafts product overview

Series	Description
NI-WV metric sizes	Induction hardened and hard chrome plated linear shafts steel grade: Cf53, C55E / $\phi 4 - 100$ mm

### Steel grades correspondents

EN	Werkstoff	DIN	B.S.	UNI	JIS	GOST	AISI SAE ASTM
C53	1.1213	Cf53 (C53G)	070M55	C53	S50C	50	1050
C55E	1.1203	Ck55	060A57, 070M55	C55	S55C, S55CM	55	1055
C45E	1.1191	Ck45	080M46	C45	S45C	45	1045
C60E	1.1221	Ck60	060A62, 070M60	C60	S58C	60, 60G, 60GA	1064

### Chemical composition - % by weight

Steel grade	Norm	C	Si	Mn	P	S	Cr	Ni.	Mo	V
Cf53	DIN 17212	0.50 ÷ 0.57	0.15 ÷ 0.35	0.40 ÷ 0.70	max. 0.025	max. 0.035	-	-	-	-
C55E	EN 10083-2	0.52 ÷ 0.60	max. 0.4	0.60 ÷ 0.90	max. 0.030	max. 0.035	max. 0.40	max. 0.40	max. 0.1	-
C45E	EN 10083-2	0.42 ÷ 0.50	max. 0.4	0.50 ÷ 0.80	max. 0.030	max. 0.035	max. 0.40	max. 0.40	max. 0.1	-
C60E	EN 10083-2	0.57 ÷ 0.65	max. 0.4	0.60 ÷ 0.90	max. 0.030	max. 0.035	max. 0.40	max. 0.40	max. 0.1	-

### Mechanical properties for steel bars

Steel grade	Diameter $\phi$ mm	Tensile strength $R_m$ N/mm <sup>2</sup>	Yield strength $R_{p0.2}$ N/mm <sup>2</sup>	Elongation $A_5$ %	Hardness Brinell HB
Cf53+N	$\phi \leq 16$	610 - 760	min. 340	min. 16	min. 183
	$16 < \phi \leq 100$	610 - 760	min. 340	min. 16	-
C55E+N	$\phi \leq 16$	min. 680	min. 370	min. 11	min. 208
	$16 < \phi \leq 100$	min. 640	min. 330	min. 12	min. 198
C45E+N	$\phi \leq 16$	min. 620	min. 340	min. 14	min. 190
	$16 < \phi \leq 100$	min. 580	min. 305	min. 16	min. 172
C60E+N	$\phi \leq 16$	min. 710	min. 380	min. 10	min. 218
	$16 < \phi \leq 100$	min. 670	min. 340	min. 11	min. 203

N=normalized

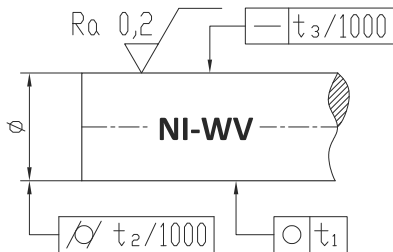


## NI-WV

metric sizes

Induction Hardened and Hard Chrome Plated Linear Shafts

steel grade: Cf53, C55E



Shaft Diameter $\varnothing$	Weight	Series	Standard length	Surface hardening depth SHD	Roundness (circularity) t1 max. $\mu\text{m}$	Parallelism (cylindricity) t2 max. $\mu\text{m}$	Straightness t3 max. mm/m	Standard tolerance ISO h7 $\mu\text{m}$
mm	kg/m		mm	mm				
4	0.10	NI-WV 4	4000	0.4 + 0.4	5	10	0.30	0 / -12
5	0.15	NI-WV 5	4000	0.4 + 0.4	5	10	0.25	0 / -12
6	0.22	NI-WV 6	6000	0.4 + 0.4	5	10	0.25	0 / -12
8	0.39	NI-WV 8	6000	0.4 + 0.4	6	10	0.20	0 / -15
10	0.62	NI-WV 10	6000	0.4 + 0.4	6	10	0.20	0 / -15
12	0.89	NI-WV 12	6000	0.6 + 0.6	8	12	0.20	0 / -18
16	1.58	NI-WV 16	6000	0.6 + 0.6	8	12	0.20	0 / -18
20	2.46	NI-WV 20	6000	0.9 + 0.8	9	12	0.20	0 / -21
25	3.85	NI-WV 25	6000	0.9 + 0.8	9	12	0.15	0 / -21
30	5.55	NI-WV 30	6000	0.9 + 0.8	9	12	0.15	0 / -21
35	7.55	NI-WV 35	6000	1.5 + 1.3	11	15	0.15	0 / -25
40	9.86	NI-WV 40	6000	1.5 + 1.3	11	15	0.15	0 / -25
45	12.48	NI-WV 45	6000	1.5 + 1.3	11	15	0.15	0 / -25
50	15.41	NI-WV 50	6000	1.5 + 1.3	11	15	0.15	0 / -25
60	22.20	NI-WV 60	6000	2.2 + 1.6	13	15	0.15	0 / -30
80	39.44	NI-WV 80	6000	2.2 + 1.6	13	15	0.15	0 / -30

- Surface hardness:  $62\pm 2$  HRC
- Chrome layer thickness:  $12\pm 5$   $\mu\text{m}$
- Chrome layer microhardness: 900-1100HV0.1
- Surface roughness: Ra: max. 0.20  $\mu\text{m}$
- Length tolerance:  $\pm 200$  mm
- Steel grades: Cf53, C55E, alternative C45E, C60E
- Surface hardening depth, SHD: according to EN ISO 15787
- On request: special lengths, tolerances and dimensions

- The hardening depth (SHD according to EN ISO 15787 or  $R_{ht}$  according to DIN 6773) is defined as the distance from the steel surface up to the point where the hardness value is 80% of the minimum guaranteed value of the surface hardness and it is established in accordance with ISO 13012, depending on the shaft's size.
- The minimum guaranteed value of the surface hardness varies between the steel grade.

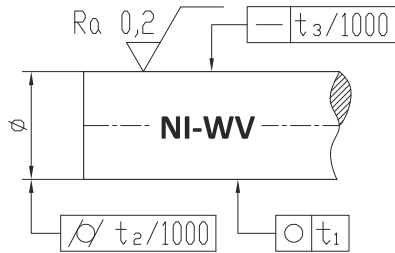


## Induction Hardened and Hard Chrome Plated Linear Shafts

steel grade: Cf53, C55E

## NI-WV

imperial sizes



فقط سایز ۱۲.۷ در انبار موجود است بقیه سایزها به سفارش مشتری قابل تحویل می باشد

Shaft Diameter Ø		Weight kg/m	Series	Standard length inch	Surface hardening depth SHD inch	Roundness (circularity)		Parallelism (cylindricity)		Straightness t3 max. in/ft	Standard tolerance Class "L" inch
mm	inch					t1 max. inch	t2 max. inch	t3 max. in/ft			
6.35	1/4	0.25	NI-WV 6.35	236.22	0.016 + 0.016	0.00020	0.00039	0.00308	-0.0005 / -0.001		
9.525	3/8	0.56	NI-WV 9.525	236.22	0.016 + 0.016	0.00024	0.00039	0.00246	-0.0005 / -0.001		
12.7	1/2	0.99	NI-WV 12.7	236.22	0.024 + 0.024	0.00031	0.00047	0.00246	-0.0005 / -0.001		
15.875	5/8	1.55	NI-WV 15.875	236.22	0.024 + 0.024	0.00031	0.00047	0.00246	-0.0005 / -0.001		
19.05	3/4	2.24	NI-WV 19.05	236.22	0.035 + 0.032	0.00035	0.00047	0.00246	-0.0005 / -0.001		
22.225	7/8	3.04	NI-WV 22.225	236.22	0.035 + 0.032	0.00035	0.00047	0.00185	-0.0005 / -0.001		
25.4	1	3.98	NI-WV 25.4	236.22	0.035 + 0.032	0.00035	0.00047	0.00185	-0.0005 / -0.001		
28.575	1 1/8	5.03	NI-WV 28.575	236.22	0.035 + 0.032	0.00035	0.00047	0.00185	-0.0005 / -0.001		
31.75	1 1/4	6.21	NI-WV 31.75	236.22	0.059 + 0.051	0.00043	0.00059	0.00185	-0.0005 / -0.001		
34.925	1 3/8	7.52	NI-WV 34.925	236.22	0.059 + 0.051	0.00043	0.00059	0.00185	-0.0005 / -0.001		
38.1	1 1/2	8.94	NI-WV 38.1	236.22	0.059 + 0.051	0.00043	0.00059	0.00185	-0.0006 / -0.0011		
44.45	1 3/4	12.17	NI-WV 44.45	236.22	0.059 + 0.051	0.00043	0.00059	0.00185	-0.0006 / -0.0011		
50.8	2	15.90	NI-WV 50.8	236.22	0.087 + 0.063	0.00043	0.00059	0.00185	-0.0006 / -0.0013		
57.15	2 1/4	20.13	NI-WV 57.15	236.22	0.087 + 0.063	0.00051	0.00059	0.00185	-0.0007 / -0.0015		
63.5	2 1/2	24.85	NI-WV 63.5	236.22	0.087 + 0.063	0.00051	0.00059	0.00185	-0.0007 / -0.0015		
76.2	3	35.78	NI-WV 76.2	236.22	0.087 + 0.063	0.00051	0.00059	0.00185	-0.0008 / -0.0017		
88.9	3 1/2	48.70	NI-WV 88.9	236.22	0.087 + 0.063	0.00059	0.00070	0.00185	-0.0010 / -0.0020		
101.6	4	63.61	NI-WV 101.6	236.22	0.126 + 0.079	0.00059	0.00070	0.00185	-0.0012 / -0.0024		

- Surface hardness: 62±2 HRC
- Chrome layer thickness: 12±5 µm
- Chrome layer microhardness: 900-1100HV0.1
- Surface roughness: Ra: max. 0.20 µm
- Length tolerance: ±200 mm
- Steel grades: Cf53, C55E, alternative C45E, C60E
- Surface hardening depth, SHD: according to EN ISO 15787
- On request: special lengths, tolerances and dimensions

□ The hardening depth (SHD according to EN ISO 15787 or Rht according to DIN 6773) is defined as the distance from the steel surface up to the point where the hardness value is 80% of the minimum guaranteed value of the surface hardness and it is established in accordance with ISO 13012, depending on the shaft's size.

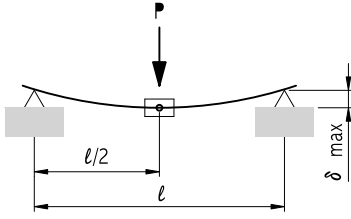
□ The minimum guaranteed value of the surface hardness varies between the steel grade.



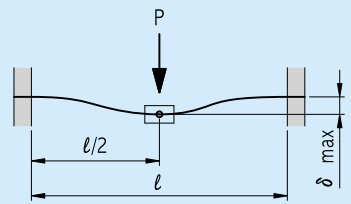
## Equations for shaft deflection amount calculation

### Variations of support and Load

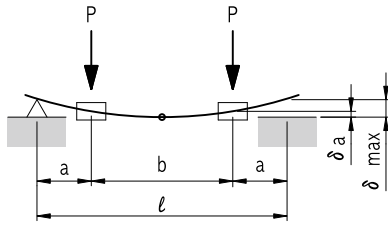
### Equation for Deflection Amount



$$\delta_{\max} = \frac{P \cdot l^3}{48 \cdot E \cdot I} = 2,021 \times 10^{-5} \frac{P \cdot l^3}{d^4}$$

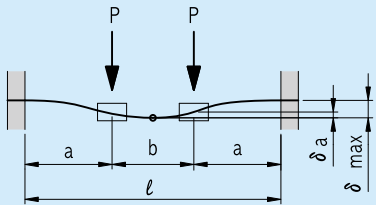


$$\delta_{\max} = \frac{P \cdot l^3}{192 \cdot E \cdot I} = 5,053 \times 10^{-6} \frac{P \cdot l^3}{d^4}$$



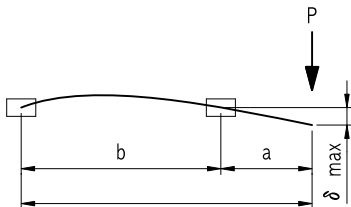
$$\delta_a = \frac{P \cdot a^2}{6 \cdot E \cdot I} (2a+3b) = 1,617 \times 10^{-4} \frac{P \cdot a^2 (2a+3b)}{d^4}$$

$$\delta_{\max} = \frac{P \cdot a^2}{24 \cdot E \cdot I} (3l^2 - 4a^2) = 4,042 \times 10^{-5} \frac{P \cdot a \cdot (3l^2 + 4a^2)}{d^4}$$



$$\delta_a = \frac{P \cdot a^3}{6 \cdot E \cdot I} (2 - \frac{3a}{l}) = 1,617 \times 10^{-4} \frac{P \cdot a^3}{d^4} (2 - \frac{3a}{l})$$

$$\delta_{\max} = \frac{P \cdot a^2}{24 \cdot E \cdot I} (2a+3b) = 4,042 \times 10^{-5} \frac{P \cdot a^2 \cdot (2a+3b)}{d^4}$$



$$\delta_{\max} = \frac{P \cdot a^2 l}{3 \cdot E \cdot I} = 3,234 \times 10^{-4} \frac{P \cdot a^2 l}{d^4}$$

E : Modulus of Longitudinal elasticity  $2.1 \times 10^4$  (kgf/mm<sup>2</sup>)

P : Applying Load(kgf)

I : Geometrical Moment of Inertia(mm<sup>4</sup>) ; I =  $\pi d^4/64$ , Hollow shaft : I =  $\pi(d^4 - d_i^4)/64$

d<sub>i</sub> : Shaft inner-diameter(mm), d : Shaft Outer-diameter(mm)

