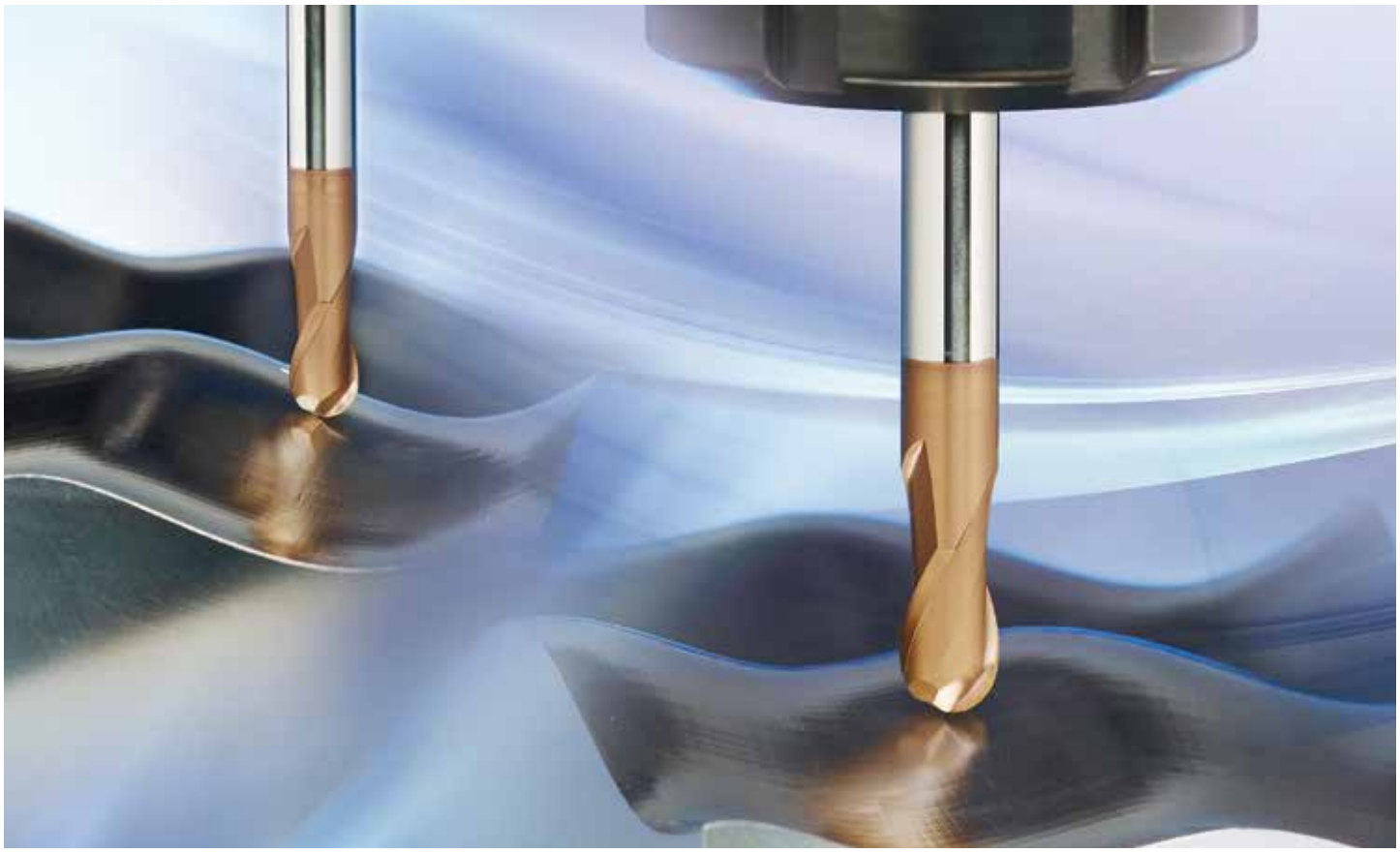
KORLOY
TECH-NEWS

H Endmill

Endmill Series for High Hardened Steel Machining at High Speeds

- **Increased Wear Resistance**
  The new coating technology improves wear resistance
- **Improved Cutting Performance and Productivity**
  The new shape boosts productivity due to high speed and high precision machining



KORLOY

H Endmill
For high hardened steel
in high speed machining

Endmill Series for High Hardened Steel Machining at High Speeds

H Endmill

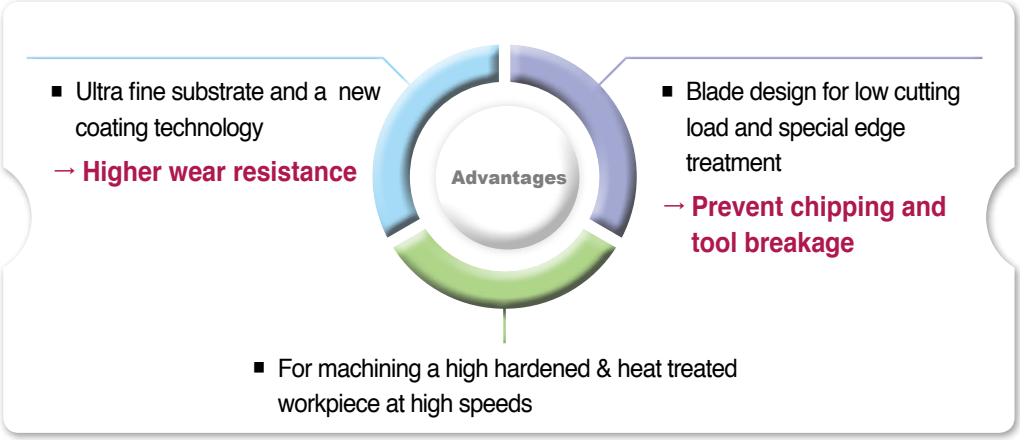
High hardened & heat treated steels (HRC 45~70) used in parts for automobiles and molds offer excellent durability and effective wear resistance.

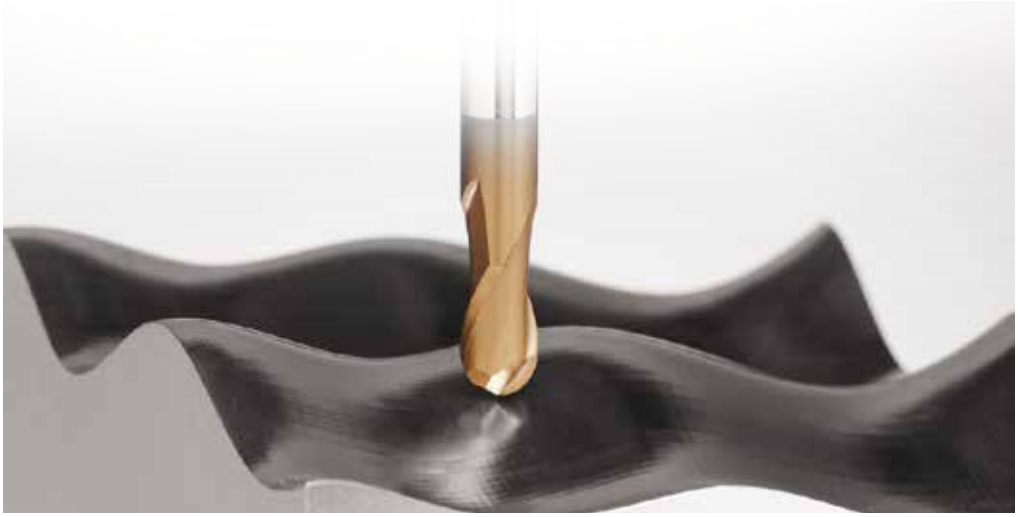
This hardened steel material apparently causes massive tool wear on relief surface involving high temperatures in high speed and dry machining. Additionally, large impact during machining results in chipping and tool breakage.

The H Endmill is specifically designed for machining high hardened & heat treated workpieces, complemented with an ultra fine substrate and a newly invented AlTiSiN coating layer. It features good adhesion on coating layer and excellent resistance to wear at high temperatures. As a result it improves tool life by delaying coating flaking at high speed and dry cutting conditions.

Thanks to the negative rake angle, blade design for low cutting load and special edge treatment, chipping resistance has significantly been improved to enable stable machining without edge breakage.

The H Endmill boosts tool life by more than 20% compared to previous products, delivering higher wear resistance and optimum tool geometries that suit machining high hardened & heat treated materials.

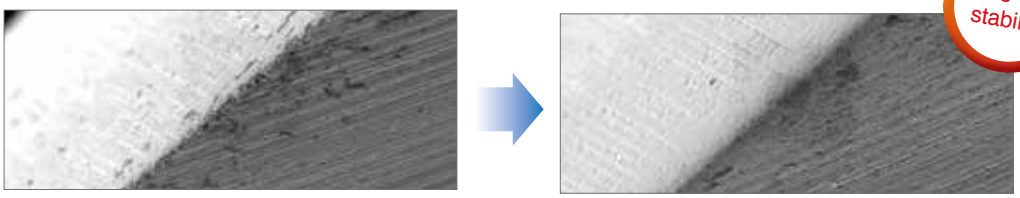




Features

- **New grades applied (PC303S, PC310U)**
  - Ultra fine substrate + AlTiSiN coating layer for excellent wear resistance
- **High accuracy with tolerance**
  - h5 – High quality production system enables tolerance-h5 through the whole series
- **Special edge treatment**
  - Prevents chipping and enables continued stable machining

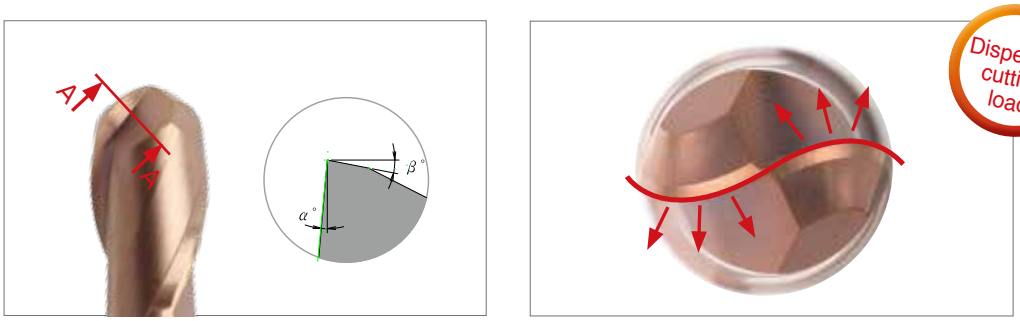
Cutting edge



[Before edge treatment] [After edge treatment]

- Negative rake angle suited for machining high hardness steel materials
- **The S-shaped ball disperses cutting resistance**

PBE Series (Ball)



[SECTION A-A] [S-shaped ball]

- **The new corner R shape improves form/ firm accuracy**
- The corner R tolerance is under ±0.005 for high accuracy

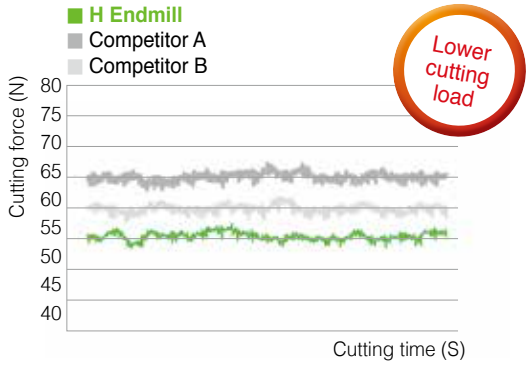
PRE Series (Radius)

[H Endmill radius] [New corner R shape] [Measurement result of corner R tolerance]

- Special edge treatment and new shapes **reduce cutting load**

Cutting load

- **Workpiece** X100CrMoV5 1(DIN) (HRC60)
- **Cutting conditions** Diameter = Ø8.0,
  n(min^{-1}) = 4,000
  vc(m/min) = 100
  vf(mm/min) = 800
  fz(mm/t) = 0.05
  ap(mm) = 8.0
  ae(mm) = 0.25, dry
- **Tool** PRE4080-100-R05



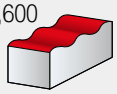
Cutting Performance

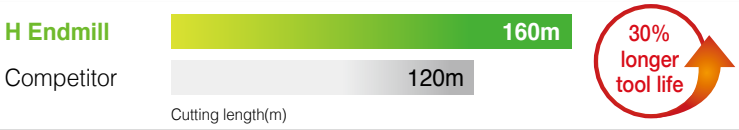
[H Endmill]


[Competitor]

High Hardened Steel (X100CrMoV5 1* heat treated, HRC60)

- Cutting conditions: Diameter(mm) = Ø8.0, n(min-1) = 8,000, vc(m/min) = 200, vf(mm/min) = 1,600, fz(mm/t) = 0.1, ap(mm) = 0.2, ae(mm) = 0.8, wet
- Tools: PBE2080-100





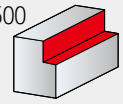
The new grades improve wear resistance

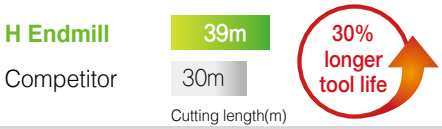
[H Endmill]


[Competitor]

High Hardened Steel (X100CrMoV5 1* heat treated, HRC60)

- Cutting conditions: Diameter(mm) = Ø8.0, n(min-1) = 4,000, vc(m/min) = 100, vf(mm/min) = 500, fz(mm/t) = 0.03, ap(mm) = 8.0, ae(mm) = 0.25, dry
- Tools: PRE4080-100-R05





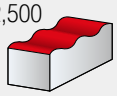
Cutting edge treatment for less chipping

[H Endmill]


[Competitor]

High Hardened Steel (STAVAX, heat treated, HRC50)

- Cutting conditions: Diameter(mm) = Ø8.0, n(min-1) = 10,000, vc(m/min) = 250, vf(mm/min) = 2,500, fz(mm/t) = 0.125, ap(mm) = 0.1, ae(mm) = 0.2, wet
- Tools: PBE2080-100



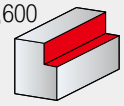
The new grades improve wear resistance

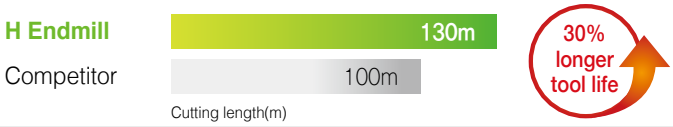
[H Endmill]


[Competitor]

High Hardened Steel (STAVAX, heat treated, HRC50)

- Cutting conditions: Diameter(mm) = Ø8.0, n(min-1) = 8,000, vc(m/min) = 200, vf(mm/min) = 1,600, fz(mm/t) = 0.05, ap(mm) = 8.0, ae(mm) = 0.4, wet
- Tools: PRE4080-100-R05





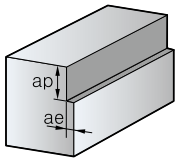
Cutting edge treatment for less chipping

* Germany [DIN]

Recommended Cutting Conditions (PRE4000 Radius)

Workpiece / Conditions / Diameter(Ø)	Pre hardened steel (≥HRC40)		High hardened steel (≤HRC55)		High hardened steel (HRC55~HRC70)	
	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)
3	17,300	1,250	11,500	840	7,500	256
4	13,200	1,300	8,800	880	5,600	268
5	12,500	1,500	8,300	1,000	5,100	296
6	10,350	1,400	6,900	950	4,200	280
8	7,800	1,350	5,200	900	3,200	264
10	6,150	1,260	4,100	840	2,550	248
12	5,250	1,260	3,500	840	2,100	240

■ Application tip

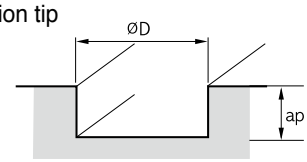


■ Shouldering depth(ap) and radial depth(ae)
- ap = 0.1D
- ae = 0.03D
- Workpiece should be clamped rigidly.
  In case of vibration, reduce R.P.M and feed rate by the same ratio

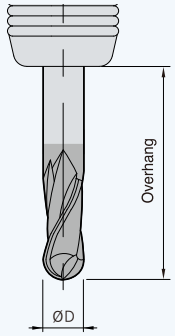
Recommended Cutting Conditions (PRE4000 Radius)

Workpiece / Conditions / Diameter(Ø)	Pre hardened steel (≥HRC40)		High hardened steel (≤HRC55)		High hardened steel (HRC55~HRC70)	
	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)
3	17,300	544	11,500	336	7,500	128
4	13,200	560	8,800	352	5,600	136
5	12,500	644	8,300	400	5,100	144
6	10,350	616	6,900	384	4,200	144
8	7,800	576	5,200	356	3,200	132
10	6,150	544	4,100	332	2,550	124
12	5,250	544	3,500	332	2,100	124

■ Application tip



■ Slotting depth(ap)
- ap = 0.05D
- ae = 1.0D
- Workpiece should be clamped rigidly.
  In case of vibration, reduce R.P.M and feed rate by the same ratio



∗Cutting condition by overhang

■ Adjust conditions according to the overhang.
→ E.g) When the overhang is 3D and is increased by 1D, decrease R.P.M and feed 10%.

∗Notice

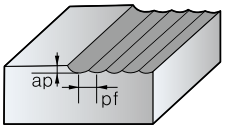
■ Cutting conditions are up to the machine's condition and the shape of cutting.

■ Use cutting fluid that is suited in order to reduce temperature reaction

Recommended Cutting Conditions (PBE2000 Ball)

Workpiece / Conditions / Diameter(Ø)	Pre hardened steel (HRC35~HRC45)		High hardened steel (HRC45~HRC55)		High hardened steel (HRC55~HRC70)	
	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)	R.P.M, n(min-1)	Feed, vf(mm/min)
0.5	35,000	1,470	31,500	1,330	28,000	1,050
1	35,000	2,940	31,500	2,660	28,000	2,000
1.2	33,600	3,010	30,100	2,695	26,600	2,100
1.5	33,600	3,150	30,100	2,800	25,900	2,150
2	33,460	3,360	28,000	2,800	24,500	2,200
2.5	25,900	3,710	22,400	2,800	17,500	2,200
3	22,260	3,710	18,550	2,800	16,500	2,200
4	16,730	3,710	14,000	2,800	13,000	2,200
5	17,800	4,900	15,000	3,750	12,500	2,100
6	13,400	4,100	11,000	3,100	10,000	2,500
8	10,700	3,500	9,000	2,700	8,000	2,150
10	8,900	3,100	7,500	2,400	6,600	1,900
12	6,680	2,500	5,600	1,900	5,000	1,550

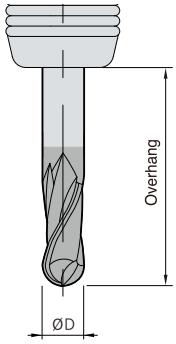
■ Application tip



- ap = 0.02D
- pf = 0.05D
- Workpiece should be clamped rigidly.
  In case of vibration, reduce RPM and feed rate by the same ratio

∗Cutting condition by overhang

■ Adjust conditions according to the overhang.
→ E.g) When the overhang is 3D and is increased by 1D, decrease R.P.M and feed 10%.



∗Notice

■ Cutting conditions are up to the machine's condition and the shape of cutting.

■ Use cutting fluid that is suited in order to reduce temperature reaction

∗Effective Cutting Speed Formulas (Ball Endmills)

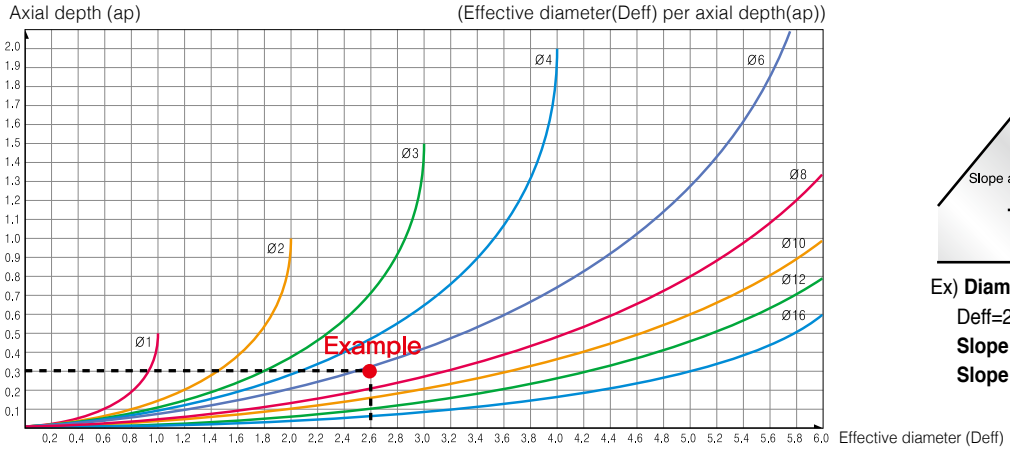
■ Effective cutting speed, Veff = (π×Deff×n)/1000 (n = min-1)

■ Effective diameter, Deff = $(2\sqrt{ap(D-ap)}\times\alpha)$
D=Ø(Tool diameter), Deff=Effective diameter

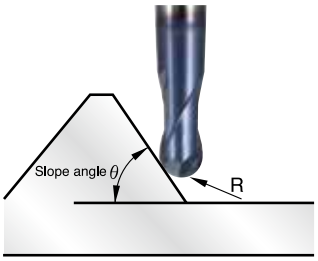
■ Examine the machining efficiency by applying the effective cutting speed(Veff) according to axial depth(ap) per effective diameter(Deff)

α : α=1 (Slope angle θ=0°)
α=1.2 (Slope angle θ=7°)
α=1.5 (Slope angle θ=15°)
α=1.7 (Slope angle θ=30°)
α=2.17 (Slope angle θ=45°)
α=2.3 (Slope angle θ=60°)

∗Effective diameter formulas (Ball Endmills, Slope angle = 0°)

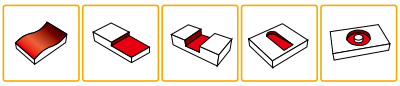


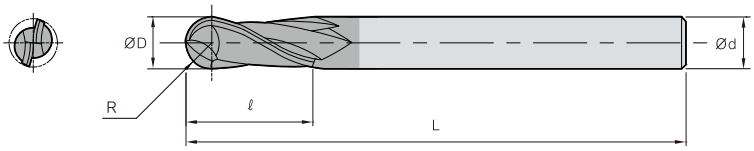
※ This graph shows effective diameters and axial depths of Ø1~Ø16 ball endmills in 0° slope angle



Ex) **Diameter** : 6mm, ap=0.3mm,
Deff=2.6mm, RPM, n=14,000(min-1)
Slope angle 0° : Veff = 113.7(m/min)
Slope angle 15° : Veff = 113.7 x 1.5 = 170.6(m/min)

PBE2000 (Standard Ball)





2	Helix Angle 30°	Grade PC303S	h5 shank

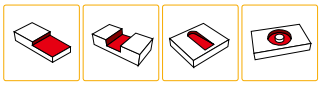
ØD	Tolerance
~ Ø5.9	0.00 ~ -0.015
Ø6.0 ~	0.00 ~ -0.025

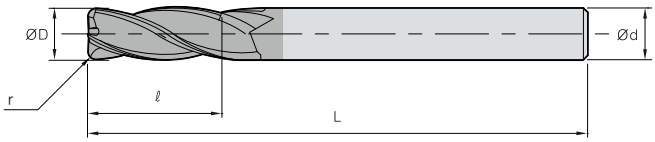
Hardness of workpiece			Workpiece		
~HRC40	~HRC55	~HRC70	HPM1 KP4M	NAK55 NAK80 STAVAX	X100CrMoV5 1 (DIN) X40CrMoV5-1
○	◎	◎	○	◎	◎

(mm)

Designation		R	ØD	Ød	ℓ	L
PBE 2	PBE2005-040	0.25	0.5	6	1	40
	PBE2010-050	0.5	1	6	2.5	50
	PBE2012-050	0.6	1.2	6	3	50
	PBE2015-050	0.75	1.5	6	4	50
	PBE2020-050	1	2	6	5	50
	PBE2025-060	1.25	2.5	6	7	60
	PBE2030-060	1.5	3	6	8	60
	PBE2040-070	2	4	6	8	70
	PBE2050-080	2.5	5	6	10	80
	PBE2060-090	3	6	6	12	90
	PBE2080-100	4	8	8	14	100
	PBE2100-100	5	10	10	18	100
	PBE2120-110	6	12	12	22	110

PRE4000 (Standard Radius)





4	Helix Angle 30°	Grade PC310U	h5 shank

ØD	Tolerance
~ Ø5.9	0.00 ~ -0.015
Ø6.0 ~	0.00 ~ -0.025

Hardness of workpiece			Workpiece		
~H_RC40	~H_RC55	~H_RC70	HPM1 KP4M	NAK55 NAK80 STAVAX	X100CrMoV5 1 (DIN) X40CrMoV5-1
○	◎	◎	○	◎	◎

(mm)

Designation		ØD	Ød	ℓ	L	r
PRE 4	PRE4030-060-R01	3	6	8	60	0.1
	PRE4030-060-R02	3	6	8	60	0.2
	PRE4030-060-R03	3	6	8	60	0.3
	PRE4030-060-R05	3	6	8	60	0.5
	PRE4040-070-R01	4	6	10	70	0.1
	PRE4040-070-R02	4	6	10	70	0.2
	PRE4040-070-R03	4	6	10	70	0.3
	PRE4040-070-R05	4	6	10	70	0.5
	PRE4040-070-R10	4	6	10	70	1
	PRE4060-090-R02	6	6	15	90	0.2
	PRE4060-090-R03	6	6	15	90	0.3
	PRE4060-090-R05	6	6	15	90	0.5
	PRE4060-090-R10	6	6	15	90	1
	PRE4080-100-R02	8	8	20	100	0.2
	PRE4080-100-R03	8	8	20	100	0.3
	PRE4080-100-R05	8	8	20	100	0.5
	PRE4080-100-R10	8	8	20	100	1
	PRE4100-100-R03	10	10	25	100	0.3
	PRE4100-100-R05	10	10	25	100	0.5
	PRE4100-100-R10	10	10	25	100	1
	PRE4120-110-R03	12	12	30	110	0.3
	PRE4120-110-R05	12	12	30	110	0.5
	PRE4120-110-R10	12	12	30	110	1

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