



Alro Steel

Metals • Industrial Supplies • Plastics

Toolox[®] 44

Pre-hardened Steel 45 HRC with ESR Properties

Toolox[®] 44 is a highly engineered quench & tempered pre-hardened tool and machine steel with measured and guaranteed mechanical properties. Toolox[®] 44 is delivered ready to use, no heat treating required, saving you valuable production time, reducing risks and lowering overall costs.



Product Features

- Quench and tempered steel
- Ready to use, no additional heat treatment required
- Easy to machine with good dimensional stability
- High strength and toughness at elevated temperatures
- Double the toughness of comparable steels at the same hardness
- Excellent for etching, polishing and EDM
- Low residual stress, no stress relieving required
- Excellent substrate for surface treatments
- Supplied as (HR) plate, thickness 1" to 5-1/8"

Applications

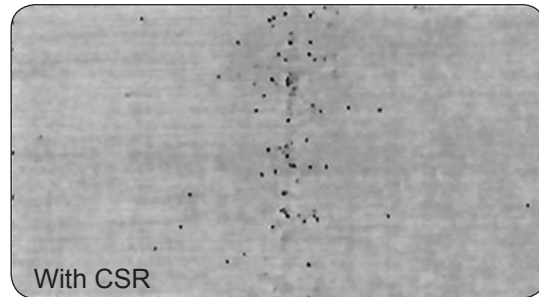
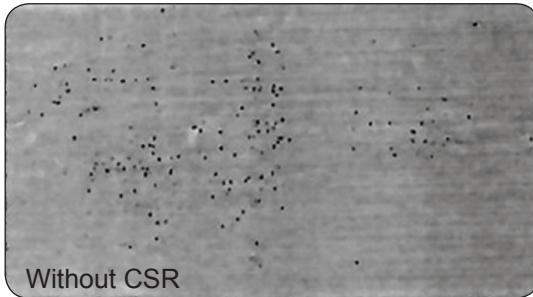
- Cold Work Tooling
- Machine Components
- Wear Components
- Guide Rails
- Plastic Molds
- Rubber Molds
- Press Forming
- Forging Dies
- Die Cast Dies

TOOLOX[®]
ENGINEERING & TOOL STEEL

Characteristics & Advantages

Toolox is a steel with ESR properties. The CSR casting process along with the low carbon concept gives a high degree of cleanliness and a homogenous structure. Fundamental factors that provide an excellent substrate for machining, polishing, texturing and EDM.

Homogeneity & low levels of inclusions

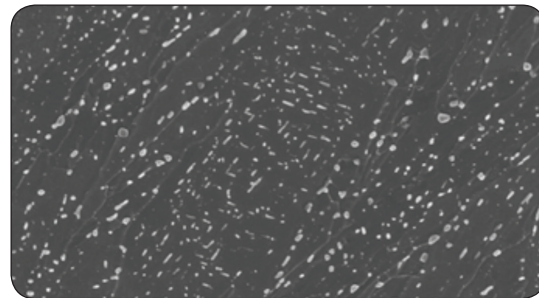
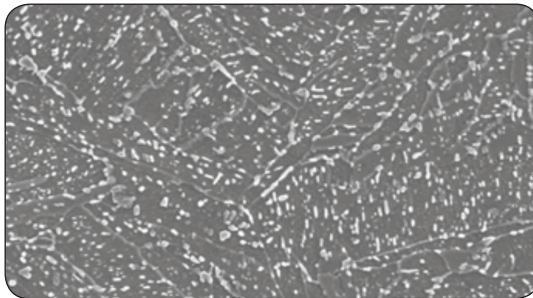


The fundamental idea behind Toolox is to deliver a steel that is hardened and ready for use, with tested and guaranteed physical properties. The CSR method of casting achieves the homogeneity and cleanliness at the same level as in ESR re-melted material. Every plate is uniquely produced.

Toughness

By utilizing a low carbon concept and a very high cooling rate, we have produced a steel that is two to three times tougher than comparable steels of similar hardness. The high hardness, in combination with excellent toughness, ensures lower tool wear and longer tool life.

Modified Carbide Morphology



The high cooling rate during quenching and a low carbide concept we have been able to modify the carbide morphology. Which is the basis for the high toughness.

Fatigue

Toolox has unique toughness and fatigue properties that remarkably increases the lifespan of the tool or machine component. Given the ultra-high cleanliness, the surface and not the steel is the critical consideration for the fatigue properties.

High Temperature Properties

Toolox 44 has high strength and toughness at elevated temperatures, even with extended contact times. This heat resistance makes Toolox 44 excellent for tools and components working at high temperature.

Physical Properties	+20°C / 68°F	200°C / 392°F	300°C / 572°F	400°C / 752°F	500°C / 932°F
Heat conductivity (W/m*K)	34	32		31	
Thermal expansion coefficient (10 ⁻⁵ /K)	13.5	13.5		13.5	

Characteristics & Advantages

Low Residual Stress

Toolox is a quenched and tempered material. The high tempering temperature produces very low residual stress levels. Even after heavy machining stress relieving is not required.

Etching, Polishing & EDM

The advanced CSR casting technology effectively produces a superior product free of segregation with very high levels of cleanliness. Toolox is excellent for etching, polishing and the EDM process.

Chemical composition	Toolox® 44
C	0.32%
Si	0.6 - 1.1%
Mn	0.8%
P	Max 0.010%
S	Max 0.002%
Cr	1.35%
Mo	0.80%
V	0.14%
Ni	Max 1.0%

Welding & Gas Cutting

The quenching process used when producing Toolox offers the opportunity to use a lower alloy content compared to conventional grades, allowing better weldability and easier cutting.

Mechanical Properties	+20°C (68°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)
Hardness (HBW)	450				
Hardness (HRC)	~45				
Yield Strength $R_{p0.2}$ (MPa)	1,300	1,150	1,120	1,060	930
Yield Strength $R_{p0.2}$ (psi)	188,550	166,800	162,400	153,700	134,900
Tensile Strength R_M (MPa)	1,450	1,380			
Tensile Strength R_M (psi)	210,300	200,150			
Elongation, A_5 , (%)	13	10			
Impact toughness, Charpy-V (J)	30	60	80	80	

Inclusions	Toolox® 44
Inclusion size (equivalent dia.)	6 micron
Area fraction	0.015%
Aspect ratio	1.2



Machining Recommendations

Despite a hardness of 45 HRC, Toolox 44 is easily machined. Toolox is based on a low carbon concept, with low carbide content. Carbides are hard to machine, the low carbide content offers excellent machinability.

Clamping

Toolox has a very low level of residual stresses. To maximize the benefits deformation-free clamping is recommended. If material is gas cut, mill off 5-10mm (0.196" - 0.393") from the gas-cut edge to get a blank free from residual stresses. We have modified the carbide morphology as compared to traditional tool steels, using less carbon in Toolox. Therefore, the heat generated during milling is transferred into the chip and not into the cutting edge/workpiece producing a very blue chip.

Machining Recommendations

Solid End Milling

Application	Tool	First Choice	Size	ap x Dc	ae x Dc	Speed (sfm)	Speed n (rpm)	Feed fz (ipt)	Feed Rate Vf (in/min)
Slot Milling	Niagra Cutter™ Stabilizer 2.0 STR430.2	All Cutting Data are Start Values							
		STR430.2-0.125-D2-R010.0-Z4	1/8	1.00	1.00	350	10,696	0.0006	26.7
		STR430.2-0.188-D2-R010.0-Z4	3/16	1.00	1.00	350	7,131	0.0009	26.7
		STR430.2-0.250-D2-R020.0-Z4	1/4	1.00	1.00	350	5,348	0.0013	26.7
		STR430.2-0.313-D2-R020.0-Z4	5/16	1.00	1.00	350	4,278	0.0016	26.7
		STR430.2-0.375-D2-R020.3-Z4	3/8	1.00	1.00	350	3,565	0.0019	26.7
Side Milling	Niagra Cutter™ Stabilizer 2.0 STR430.2	All Cutting Data are Start Values							
		STR430.2-0.125-D2-R010.0-Z4	1/8	1.00	0.25	350	10,696	0.0008	32.1
		STR430.2-0.188-D2-R010.0-Z4	3/16	1.00	0.25	350	7,131	0.0011	32.1
		STR430.2-0.250-D2-R020.0-Z4	1/4	1.00	0.25	350	5,348	0.0015	32.1
		STR430.2-0.313-D2-R020.0-Z4	5/16	1.00	0.25	350	4,278	0.0019	32.1
		STR430.2-0.375-D2-R020.3-Z4	3/8	1.00	0.25	350	3,565	0.0023	32.1
Optimized Roughing	Niagra Cutter™ Multi Flute 638R	All Cutting Data are Start Values							
		S638R-0.125-F3-R010.0-Z6	1/8	2.00	0.10	525	16,044	0.0008	78.0
		S638R-0.188-F3-R010.0-Z6	3/16	2.00	0.10	525	10,696	0.0012	78.0
		S638R-0.250-D3-R015.0-Z6	1/4	2.00	0.10	525	8,022	0.0016	78.0
		S638R-0.313-D2-R015.0-Z6	5/16	2.00	0.10	525	6,418	0.0020	78.0
		S638R-0.375-D1-R015.0-Z6	3/8	2.00	0.10	525	5,348	0.0024	78.0
		S638R-0.500-D1-R015.0-Z6	1/2	2.00	0.10	525	4,011	0.0033	78.0

Tips & Tricks

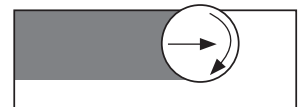
For optimal tool life and surface finish, run-out should not exceed .0004"



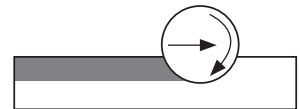
Indexable Milling

Application	First Choice	Unstable Conditions	Grade / Groove	Speed (sfm)	Feed fz (ipt)	APMX / Depth
Facing	R220.53 Quattro Mill	---	MP1500 / M15	480	0.0075	0.160
	---	R220.53 Quattro Mill	MP3000 / MD19	420	0.0075	0.160
Copy Milling	R218.19 -160	---	MP1500 / M11	480	0.0350	0.050
	---	R218.19 -160	MP2500 / M11	420	0.0400	0.040
Square Shoulder Facing						
Diameter > 50%	R220.69 - Turbo 12	---	MP1500 / MD13	480	0.0051	0.180
	---	R220.69 - Turbo 12	MP3000 / MD13	420	0.0051	0.180
Square Shoulder Profiling						
20% or Less Engagement	R220.69 - Turbo 12	---	MP1500 / MD13	648	0.0070	0.310
	---	R220.69 - Turbo 12	MP3000 / MD13	570	0.0070	0.310
Square Shoulder Profiling						
10% or Less Engagement	R220.69 - Turbo 12	---	MP1500 / MD13	672	0.0097	0.310
	---	R220.69 - Turbo 12	MP3000 / MD13	590	0.0097	0.310
Square Shoulder Profiling						
5% or Less Engagement	R220.69 - Turbo 12	---	MP1500 / MD13	720	0.0135	0.310
	---	R220.69 - Turbo 12	MP3000 / MD13	630	0.0135	0.310

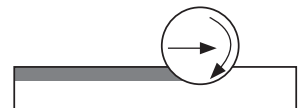
Tips & Tricks for Side Milling



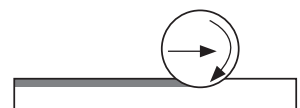
> 50% Engagement



20% Engagement
+ 37% feed



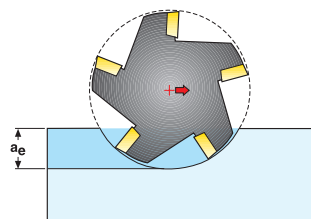
10% Engagement
+ 90% feed



5% Engagement
+ 165% feed



Side Milling - Technical Info



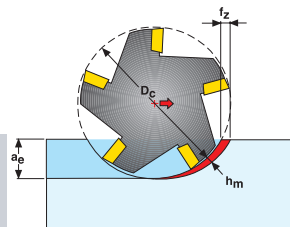
Formula for calculating if $a_e/D_c < 30\%$

a_e = radial width of cut

D_c = Tool Diameter

$$h_m = f_z \cdot \sqrt{\frac{a_e}{D_c}}$$

$$f_z = h_m \cdot \sqrt{\frac{D_c}{a_e}}$$



Drilling & Tapping Recommendations

HSS drills recommended when you have unstable machine conditions. If the machine conditions are good you can use solid/brazed cemented carbide drill or drills with exchangeable heads.

HSS-Co



HSS
HSS-E
HSS-Co



Use an HSS-Co drill (8% Co) with a low helix angle and a robust core that can withstand high torques.

Individual holes can be drilled with an ordinary HSS drill. For a rational production, either a microalloyed (HSS-E) or a Cobalt alloyed (HSS-Co) drill is recommended.

Sizes: mm (inches)		Toolox 44	
V _c m/min (sf./min)		~7	
Dc mm (sfm in)		Feed rate (mm/min) & speed (rpm)	Feed rate (in./min) & speed (rpm)
5	(16.5)	0.05 / 445	.0019 / 445
10	(33.0)	0.09 / 220	.0035 / 220
15	(49.5)	0.15 / 150	.0059 / 150
20	(66.0)	0.20 / 110	.0078 / 110
25	(82.5)	0.25 / 90	.0098 / 90
30	(99.0)	0.30 / 75	.0118 / 75
*35	(115.5)	0.35 / 63	.0137 / 63
*40	(132.0)	0.40 / 55	.0157 / 55


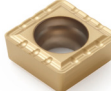
Drilling

First Choice	Diameter	Speed (sfm)	Feed Rate (ipr)	Tips & Tricks
Niagra Cutter™ Universal™ Drill ND110X	Ø 8.0 mm	266	0.0055	For chip breaking issues increase feedrate.



Tool	First Choice	Second Choice	Diameter	Speed (sfm)	Feed fz (ipt)	Tips & Tricks
FEEDMAX™	SD20X-P	---	Ø 8.0 mm	209	0.0071	Decrease feedrate 20% for lengths over 7XD. For chip breaking issues increase feedrate.
	---	SD20X-M	Ø 8.0 mm	251	0.0063	



Tool / Insert	First Choice	Second Choice	Diameter	Speed (sfm)	Feed Rate (ipr)	Tips & Tricks
PERFOMAX™ T400D (center insert)	 DP3000 (peripheral insert)	 T250D (peripheral insert)	Ø 25 mm	623	0.0043	Use P1 chip-breaker and for chip breaking issues increase feedrate



Countersinking and counterboring are best performed using tools that have replaceable inserts. Always use a revolving pilot and use coolant.



Toolox® 44 - Countersink & Counterbore Recommendations			
C-bore Dia.	Speed m/min	RPM	Feedrate
19 (0.748)	20 - 50 m/min 66 - 165 sf/min	335 - 840	.10 - .20 mm/rev. .0039 - .0078 in/rev.
24 (0.945)	20 - 50 m/min 66 - 165 sf/min	265 - 665	.10 - .20 mm/rev. .0039 - .0078 in/rev.
34 (1.339)	20 - 50 m/min 66 - 165 sf/min	185 - 470	.10 - .20 mm/rev. .0039 - .0078 in/rev.
42 (1.654)	20 - 50 m/min 66 - 165 sf/min	150 - 380	.10 - .20 mm/rev. .0039 - .0078 in/rev.
57 (2.244)	20 - 50 m/min 66 - 165 sf/min	110 - 280	.10 - .20 mm/rev. .0039 - .0078 in/rev.

Drilling & Tapping Recommendations

With the correct tools you can perform all tapping/thread milling operations using all Toolox grades. We recommend four-flute taps, which can withstand the very high torque that occurs during tapping in hard materials. If is not critical, the drilled hole can be 3% larger than standard. This will increase the lifetime of the tap.

- * Thread oil or thread paste is recommended as lubricant.
- * We recommend thread milling for thread below M5



Tap for blind holes.



Tap for through holes.

Metric (mm)	Toolox® 44
V _c (m/min)	3 - 5
Size	Speed (rpm)
M5	190 - 320
M6	160 - 265
M8	120 - 200
M10	95 - 160
M12	80 - 130
M16	60 - 100
M20	45 - 80

Tapping

Tool	First Choice	Speed (sfm)	Tips & Tricks
Threadmaster™ Tap	Metric		Not mandatory, the drill hole can be 3% larger than the standard, this will increase the tool life of the tap.
	M5	90	
	M6	90	
	M7	90	
	M8	90	
	M10	90	
	M12	90	
	M16	90	
	M20	90	
	Inch		
	10-32	90	
	1/4-20	90	
	3/8-16	90	
1/2-13	90		
NPT			
27	26		
18	26		
14	26		
11.5	26		



Spiral Tap



Straight Tap



NPT Tapered Tap

Turning

Insert	Optimized	Stable Conditions	Unstable Conditions	Tips & Tricks						
CNMG432-MF2	TH1500-Duratonic®	TP0501-Duratonic® Chrome	TP1501-Duratonic® Chrome	For optimum efficiency, utilize wiper inserts whenever possible. This allows for better surface finish, and increased metal removal rates.						
	f (in/rev)									
	0.004	0.008	0.012		0.004	0.008	0.012	0.004	0.008	0.012
	SFM				SFM			SFM		
760	570	450	675	500	395	635	395	300		

