TOOLOX®
PREHARDENED TOOL STEEL

# Moulds and dies application album

SSAB

# Short summary

# What is Toolox®?

Toolox is a different steel concept for production of mould and dies. The basic idea is to deliver steel ready to use with guaranteed and measured mechanical properties.

## Toolox is

a pre-hardened quenched and tempered steel
a steel with ESR properties
a steel suitable to nitriding

## What is the point?

**Toolox is delivered in two different hardness levels;**
- Toolox 33, 300 HBW, $R_{p0.2}$ ~ 850 MPa.
- Toolox 44, 450 HBW, $R_{p0.2}$ ~ 1300 MPa.

Both grades possess excellent toughness and fatigue properties. Furthermore, Toolox 44 has very good mechanical properties at elevated temperatures.

**Toolox is designed to be machined;**
delivered as stress relieved with extremely low residual stresses. The steel homogeneity gives excellent machinability. Toolox has good weldability and is perfect for etching, polishing and EDM.

**Toolox has an extra option;**
it is very suitable for nitriding. With nitriding it is possible to reach surface hardness of 58-65 HRC. If required, component service life length can be increased using surface engineering such as nitriding, or nitriding followed by PVD-coating.

## Guaranteed properties

- Impact toughness
- Hardness
- Thickness
- Flatness
- Surface condition

## Strong steel delivered ready to use

# Application areas

- PLASTIC AND RUBBER MOULDS.
- PRESSURE DIE CASTING.
- SHEET METAL FORMING.
- CERAMIC MOULDS.

**NOTE!**

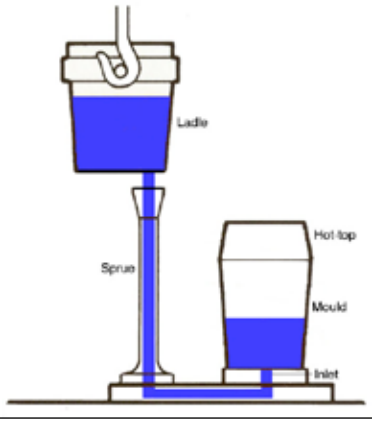
all application cases were controlled in January 2009
For a current update please contact respective contact person.

Generally, the German W.Nr. designations have been
used to denominate the steels replaced.

# Continuous soft reduction casting (CSR)

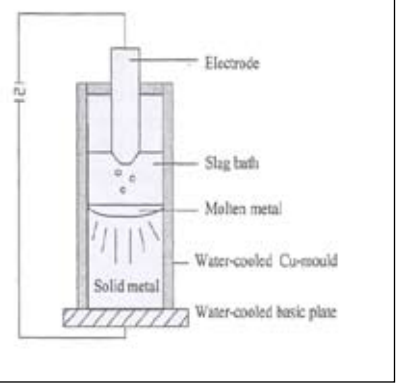
Secondary metallurgy

Ingot casting



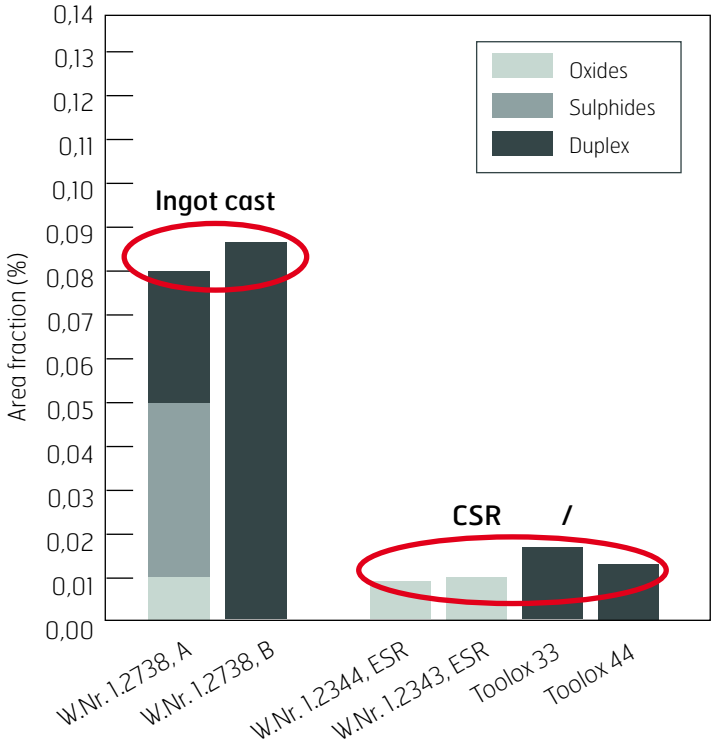

CSR-casting

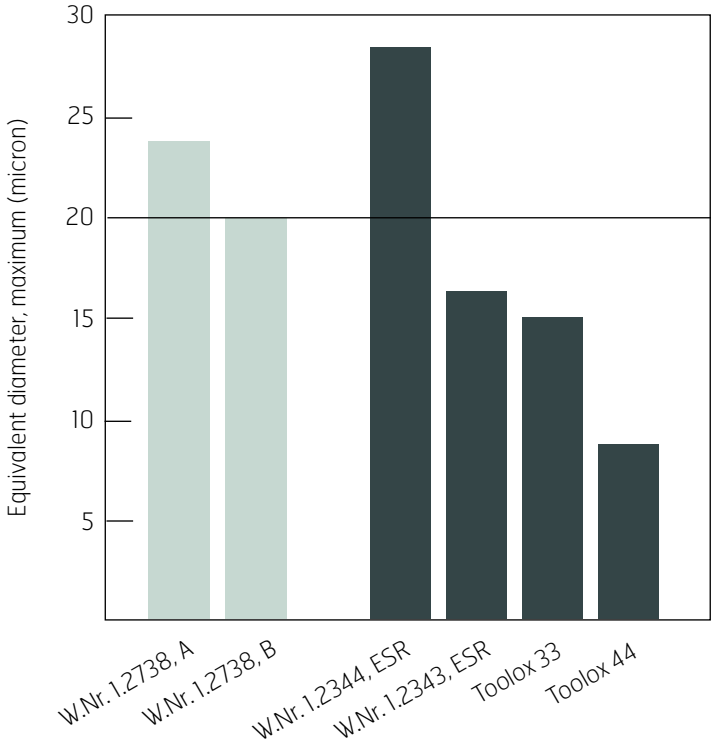
ESR-remelting




High quality slabs/ingots

# CSR quality means clean steel

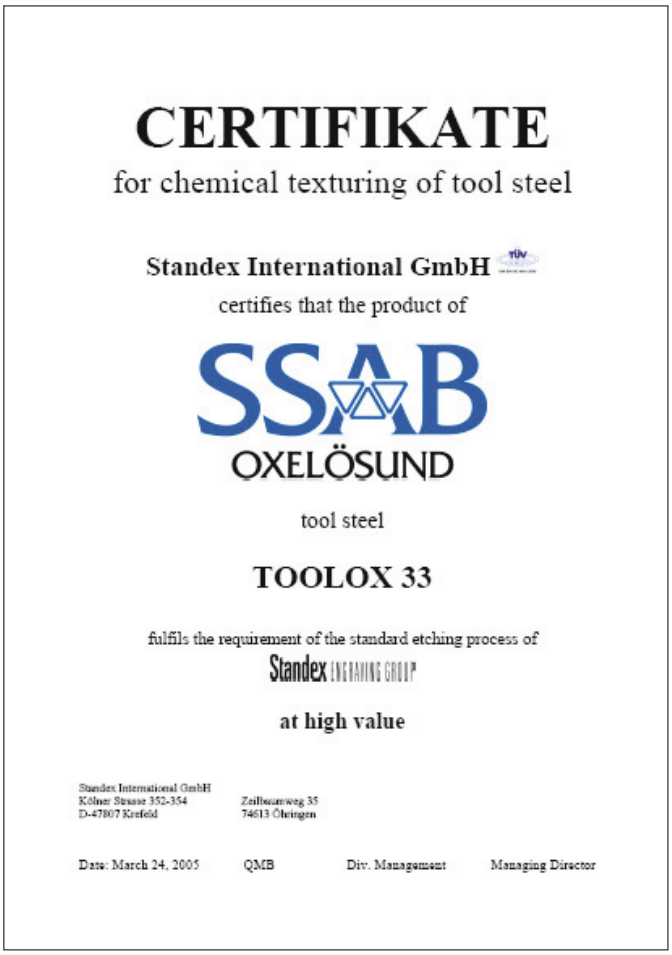


# CSR quality means clean steel

Toolox can be polished to extremely high optical demands!

# CSR quality means clean steel



# CERTIFIKATE

for chemical texturing of tool steel

**Standex International GmbH**

certifies that the product of

SSAB
OXELÖSUND

tool steel

**TOOLOX 33**

fulfils the requirement of the standard etching process of

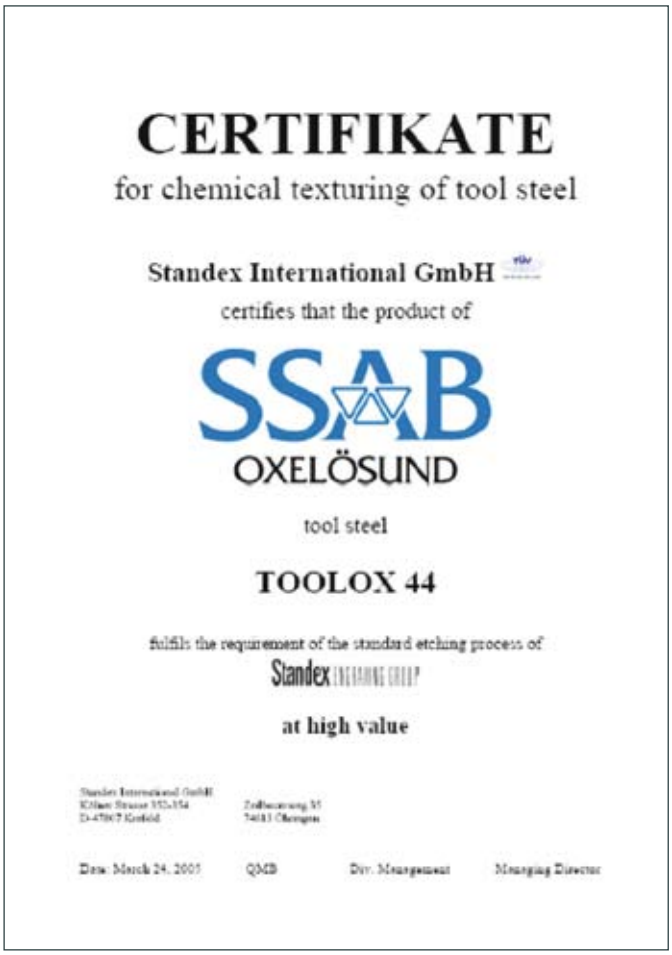
Standex ENGRAVING GROUP

**at high value**

Standex International GmbH
Kölner Strasse 352-354
D-47807 Krefeld

Zeilbaumweg 35
74613 Öhringen

Date: March 24, 2005 QMB Div. Management Managing Director



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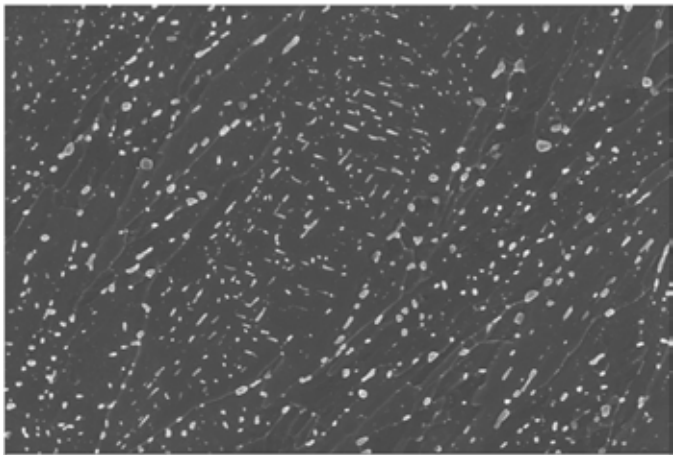
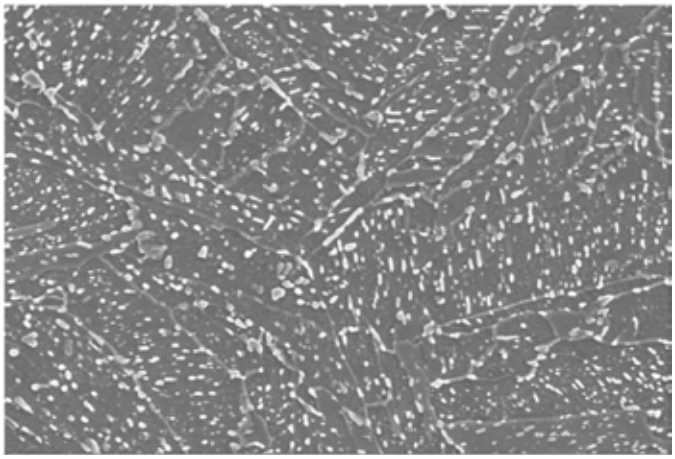
# Modified Carbide Morphology

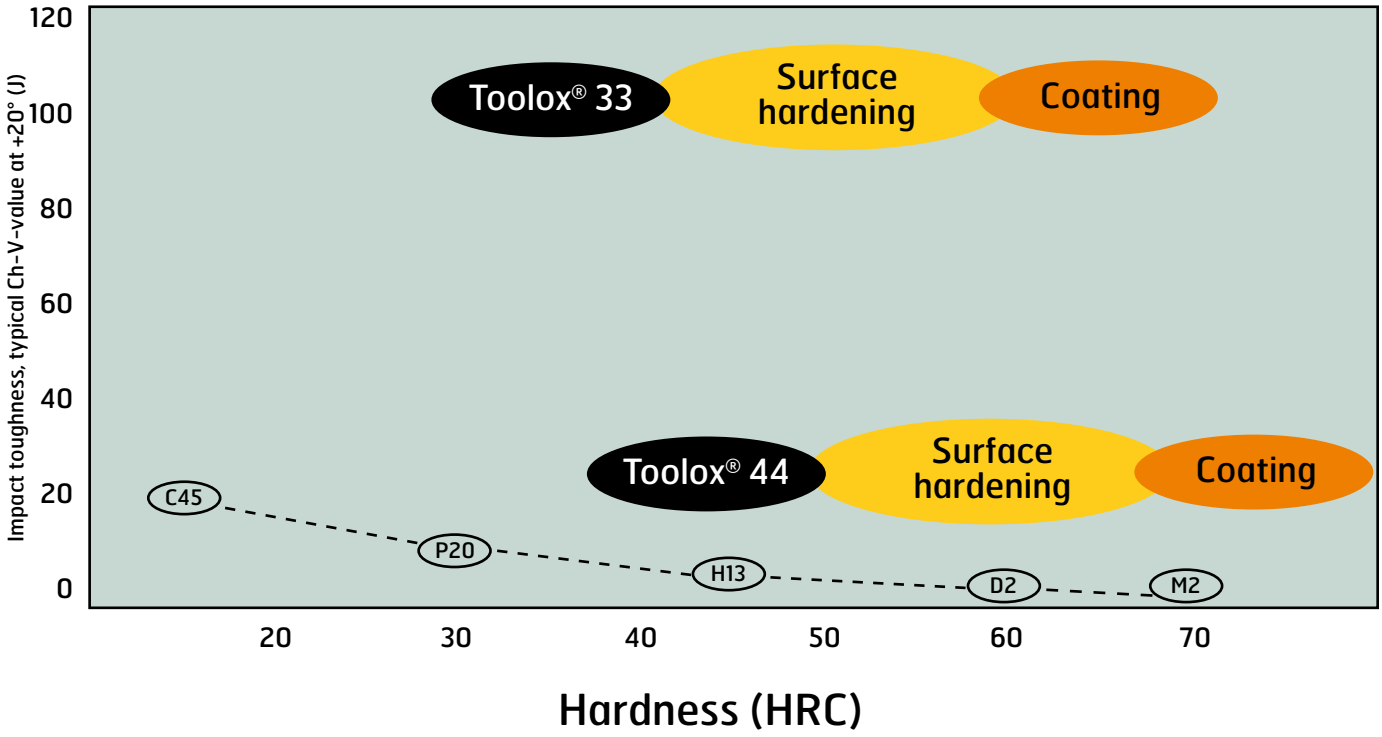


Toolox 33
Area of carbides 6.4 %



W.Nr. 1.2311 (P20)
Area of carbides 10.0%

# Superior crack resistance

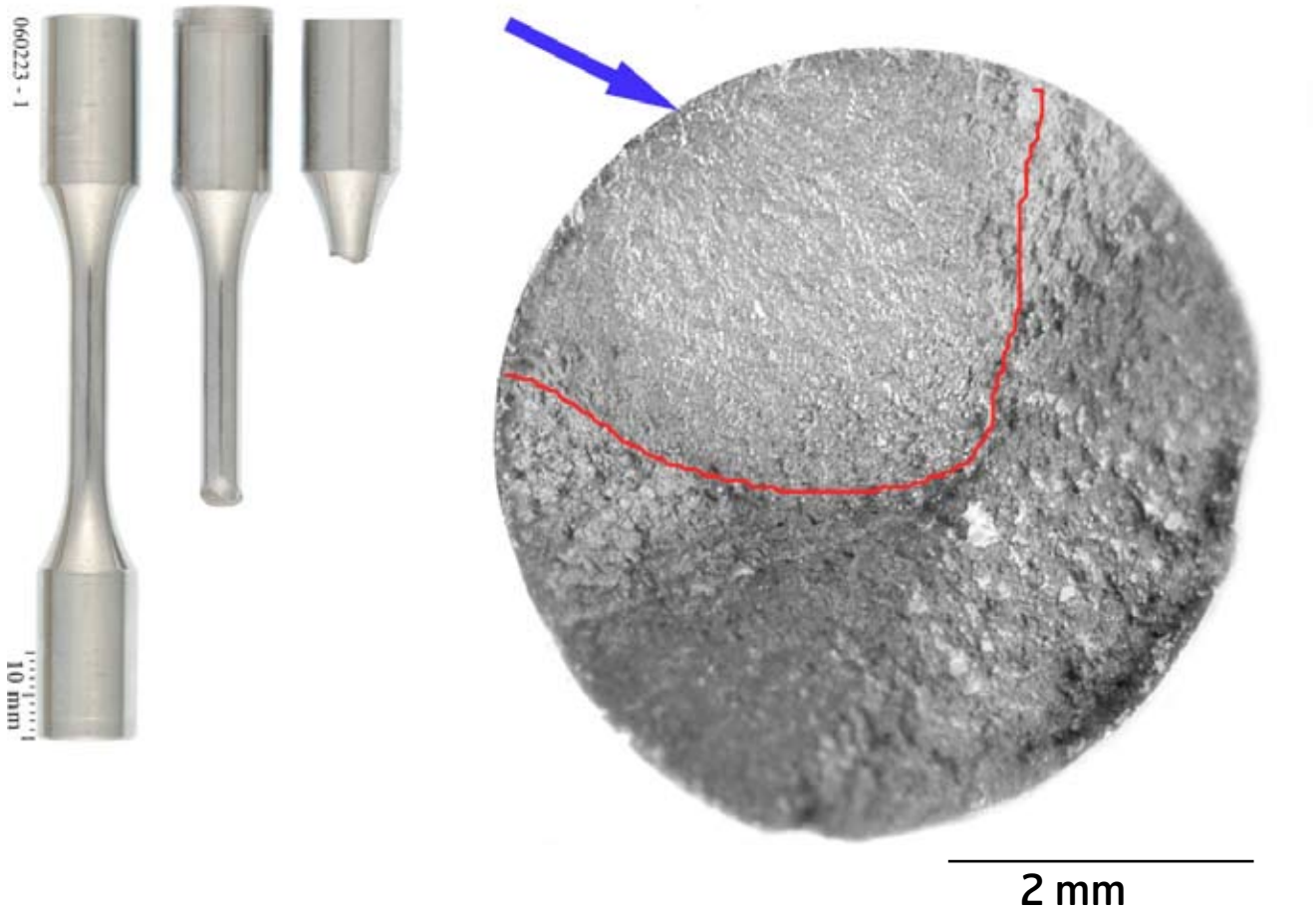



P20=W.Nr. 1.2311

H13=W.Nr. 1.2344

D2=W.Nr. 1.2379

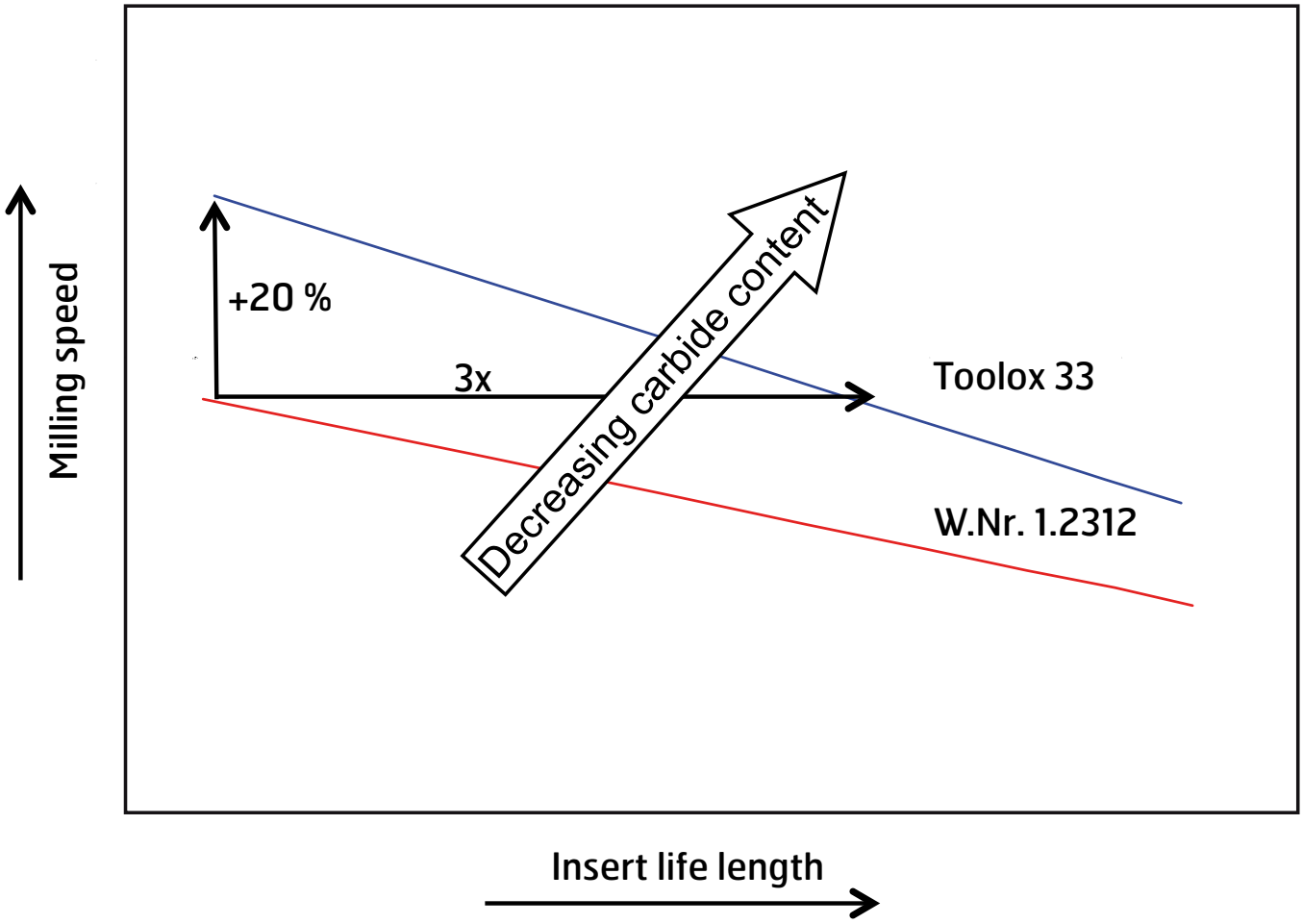
# Good fatigue properties




The ultra high cleanliness of Toolox implies that when performing fatigue tests special care must be taken to polish the test specimen surfaces to a very high quality. In the test shown above part of the test specimen surface was not good enough and the fatigue was initiated in this area.

**This means that in common fatigue of a component, made in Toolox, is the fatigue life length governed by its surface quality and not the steel matrix cleanliness.**

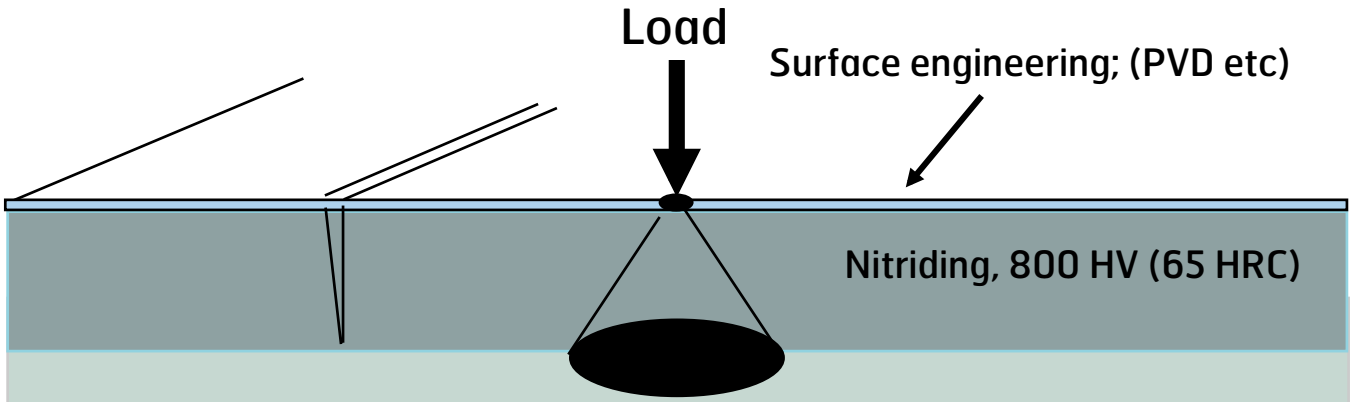
# Improved machining properties




Toolox 33 shows 20 % proved higher milling speed than W.Nr. 1.2312.

Less carbides in Toolox 33 than in W.Nr. 1.2311/2312/2738
gives lower cutting tool wear.

# Excellent for surface engineering

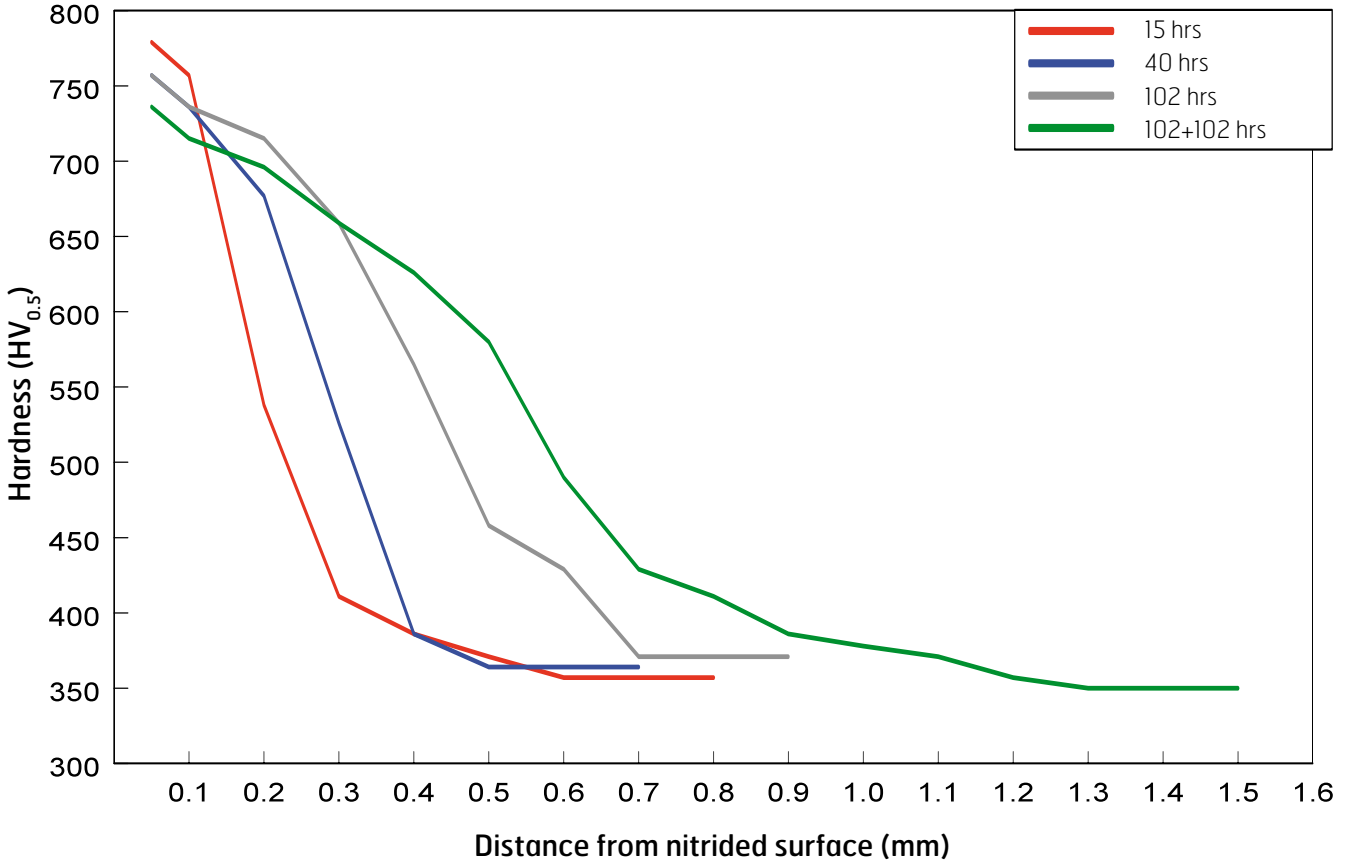



Unique combination of strong and tough matrix means a perfect steel for surface engineering!

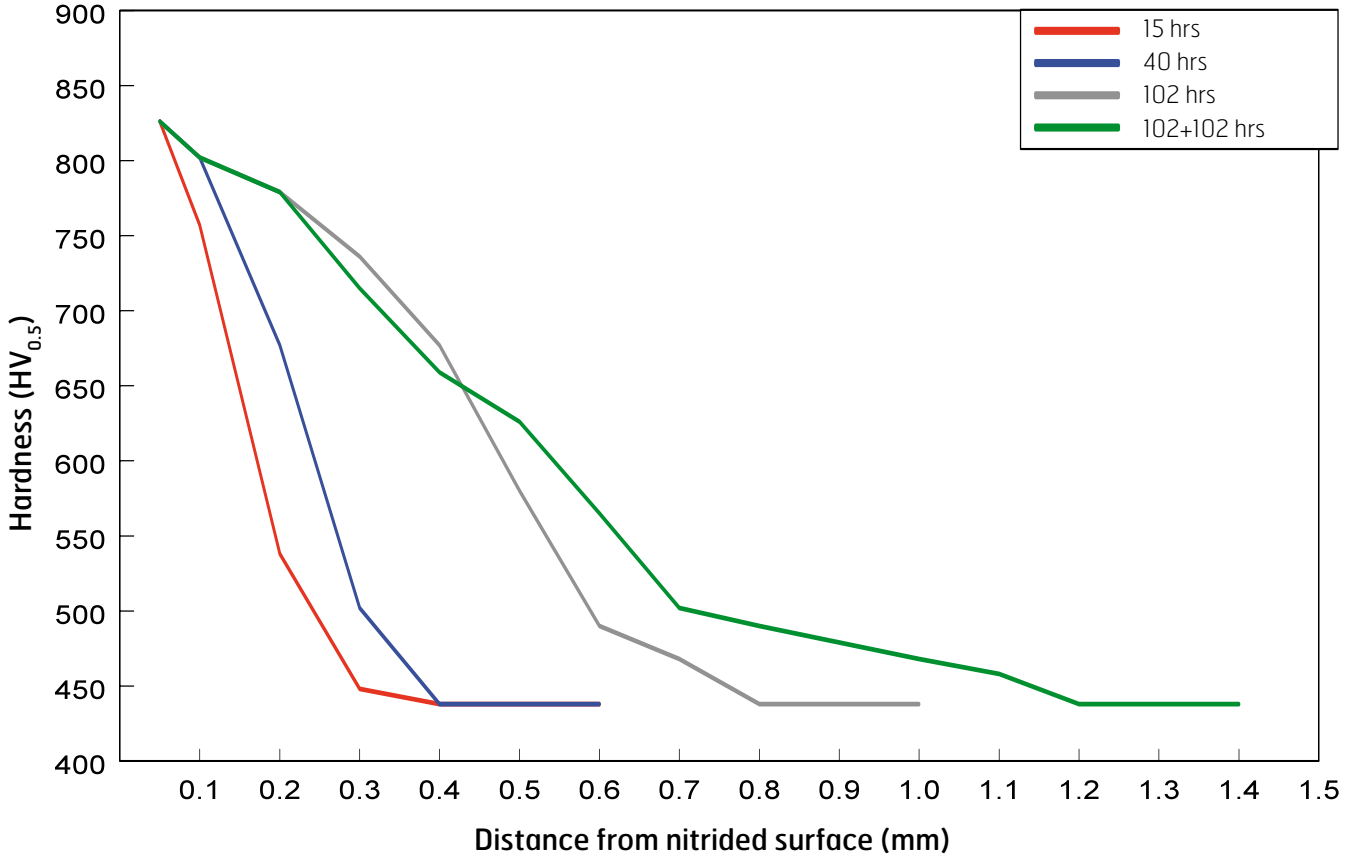
**Toolox 44**;

| | |
|---|---|
| Compressive yield strength, $R_{c0.2}$ | 1250 MPa, typical value |
| Impact toughness, Charpy-V | 30 J @ +20 °C, typical value |

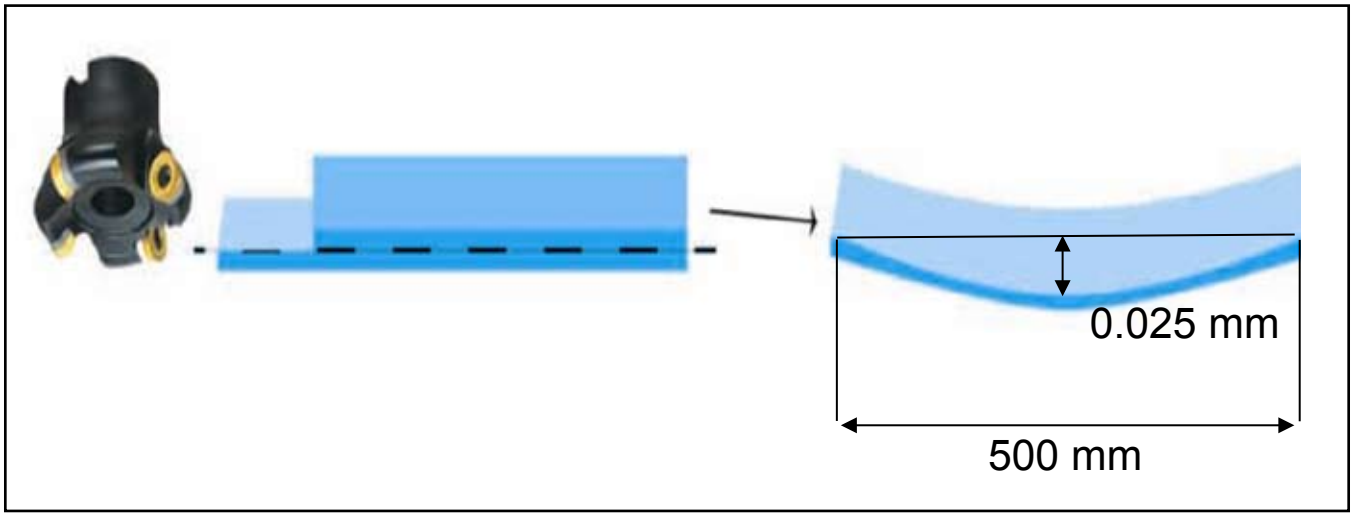
# Gas nitriding of Toolox 33




# Gas nitriding of Toolox 44



# Heat treatment gives high dimensional stability



| | Toolox 33 | W.Nr. 1.2311 | W.Nr. 1.2728 |
|---|---|---|---|
| **Hardness (HBW)** | 275-325 | 280-325 | 280-325 |
| **$R_{p0.2}$(MPa)** | ~ 850 | ~ 850 | ~ 850 |
| **$R_m$(MPa)** | ~ 1100 | ~ 1100 | ~ 1100 |
| **$A_5$(%)** | ~ 16 | ? | ? |
| **Toughness** | Min 35 J @ RT | Not guaranteed | Not guaranteed |
| **ESR-properties** | Yes | No | No |
| | | | |
| **C** | 0.21-0.26 | 0.35-0.45 | 0.35-0.45 |
| **Si** | 1.0-1.2 | 0.20-0.40 | 0.20-0.40 |
| **Mn** | 0.7-0.9 | 1.30-1.60 | 1.30-1.60 |
| **P** | Max 0.010 | Max 0.035 | Max 0.035 |
| **S** | Max 0.003 | Max 0.035 | Max 0.035 |
| **Cr** | 1.0-1.3 | 1.80-2.10 | 1.80-2.10 |
| **Ni** | - | - | 0.90-1.20 |
| **Mo** | 0.15-0.40 | 0.15-0.25 | 0.15-0.25 |

| | Toolox 44 | W.Nr. 1.2379 | W.Nr. 1.2344 |
|---|---|---|---|
| **Hardness (HBW)** | 410-475 | Acc. to Q&T | Acc. to Q&T |
| **$R_{p0.2}$(MPa)** | ~ 1300 | - " - | - " - |
| **$R_m$(MPa)** | ~ 1450 | - " - | - " - |
| **$A_5$(%)** | ~ 13 | - " - | - " - |
| **Toughness** | Min 18 J @ RT | - " - | - " - |
| **ESR-properties** | Yes | Optional | Optional |
| | | | |
| **C** | 0.30-0.34 | 1.50-1.60 | 0.37-0.43 |
| **Si** | 1.0-1.2 | 0.10-0.40 | 0.90-1.20 |
| **Mn** | 0.7-0.9 | 0.15-0.45 | 0.30-0.50 |
| **P** | Max 0.010 | Max 0.030 | Max 0.030 |
| **S** | Max 0.003 | Max 0.030 | Max 0.030 |
| **Cr** | 1.3-1.4 | 11.0-12.0 | 4.80-5.50 |
| **Mo** | 0.75-0.85 | 0.60-0.80 | 1.20-1.50 |
| **V** | 0.13-0.15 | 0.90-1.10 | 0.90-1.10 |

Note that the mechanical properties obtained in W.Nr. 1.2379 and W.Nr. 1.2344 depend on the actual heat treatment carried out.
If a heat treater guarantees such properties, how are these verified?

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| Inspection certificate A02 | Issuing department A05 | Purchaser order no A07 | Our order no A08 | Certificate no and date A03 |
|---|---|---|---|---|
| EN 10 204 - 3.1 | Quality inspection | Toolox 33 | 10067814 | 12685085 2009-06-17 |

| Consignee A06 | Product B01 | Marking (Stamping) B06 | Standard/rules OX B02 |
|---|---|---|---|
| SSAB Oxelösund AB<br>613 80 Oxelösund<br>Sweden | Tool steel | Trade mark, PLATE ID NO | Steel grade TOOLOX 44 |

| Dimensions [mm] B10-B12 | Weight [kg] B13 | PLATE ID NO B07 | Deliv. Cond. B04 | Internal code B16 |
|---|---|---|---|---|
| T 6 W 2090 L 4560 | 485 | 088968-646164 | Q | 20829 |

| Purchaser A11 | Customer marks B15 |
|---|---|
| SSAB Oxelösund AB C/O Bvba Thor Shipping & Transport Quay | |

Chemical composition C71-C92

| Heat no | C | Si | Mn | P | S | Cr | Ni | Mo | V | Ti | Cu | Al | Nb | B | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 088968 | .32 | 1.11 | .78 | .008 | .001 | 1.32 | .08 | .777 | .138 | .015 | .01 | .012 | .017 | .002 | .005 |

Carbon equivalent etc C93-C99

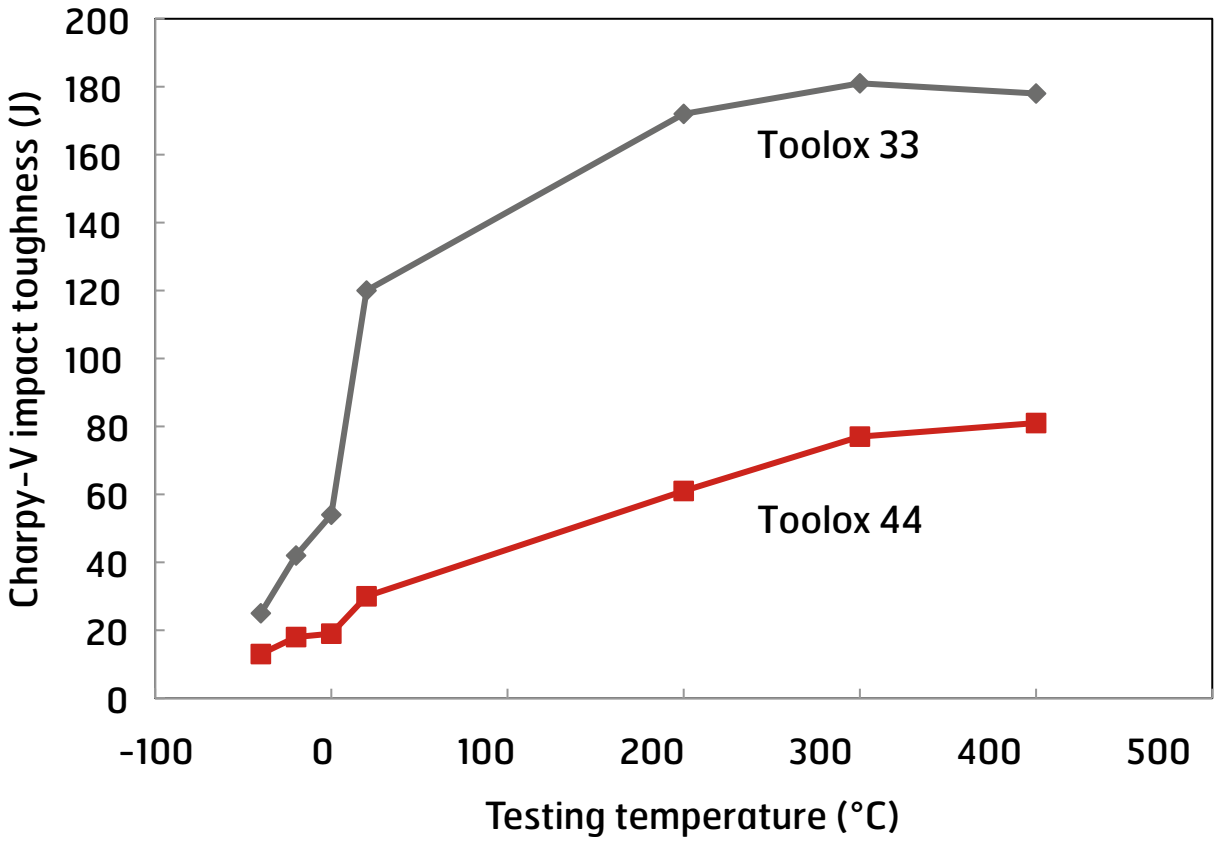
| C04 Testtype | C00 Millcode | C01 Specimen position | C02 Direc-tion | B05 Treat-ment | C10 Specimen type | C03 Temp [degr C] | Test results | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tensile Test | 728740 | Top end | Transvers | Delivery condition | Rectangular | | C11 Rp0,2 [MPa] | C12 Rm [MPa] | C13 A5 [%] | |
| | | | | | | | 1340 | 1437 | 11 | |
| Impact test | 728740 | Top end | Transvers | Delivery condition | Charpy-V 5x10 | 20 | C42 E [J] | C42 E [J] | C42 E [J] | C43 Ave [J] |
| | | | | | | | 13 | 17 | 14 | 15 |
| Hardness test (HBW) | 728795 | Top end | | Delivery condition | | | C32 Ave | | | |
| | | | | | | | 451 | | | |

Ultrasonic testing: Satisfactory results according to:

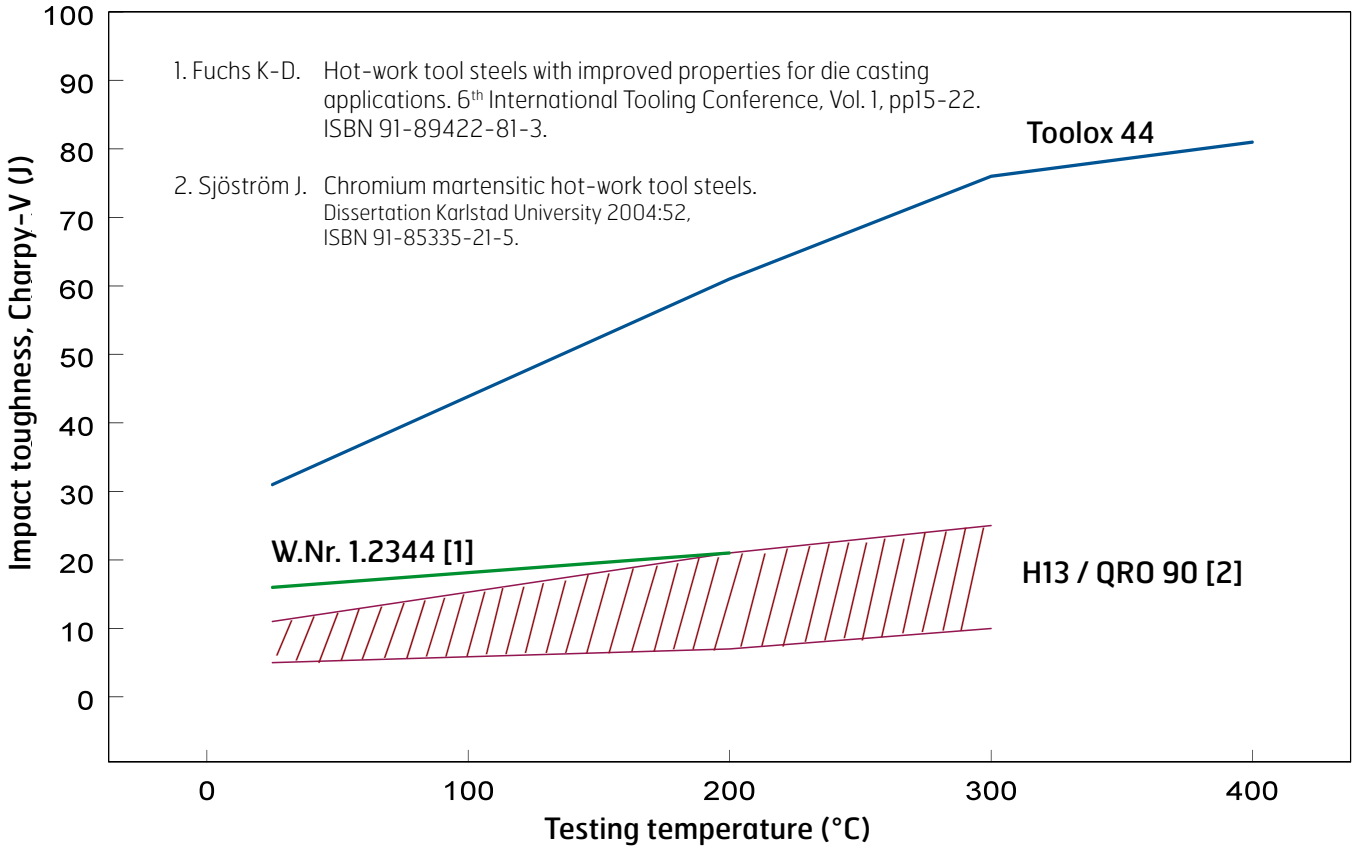
TOOLSTEEL

| Z02 | | Z01 | A04 |
|---|---|---|---|
| It is hereby certified that the material described above complies with the requirements of the order. | | This certificate is produced with EDP and valid without signature<br><br>Quality Inspection Department/ I Ivarsson / R Persson | |

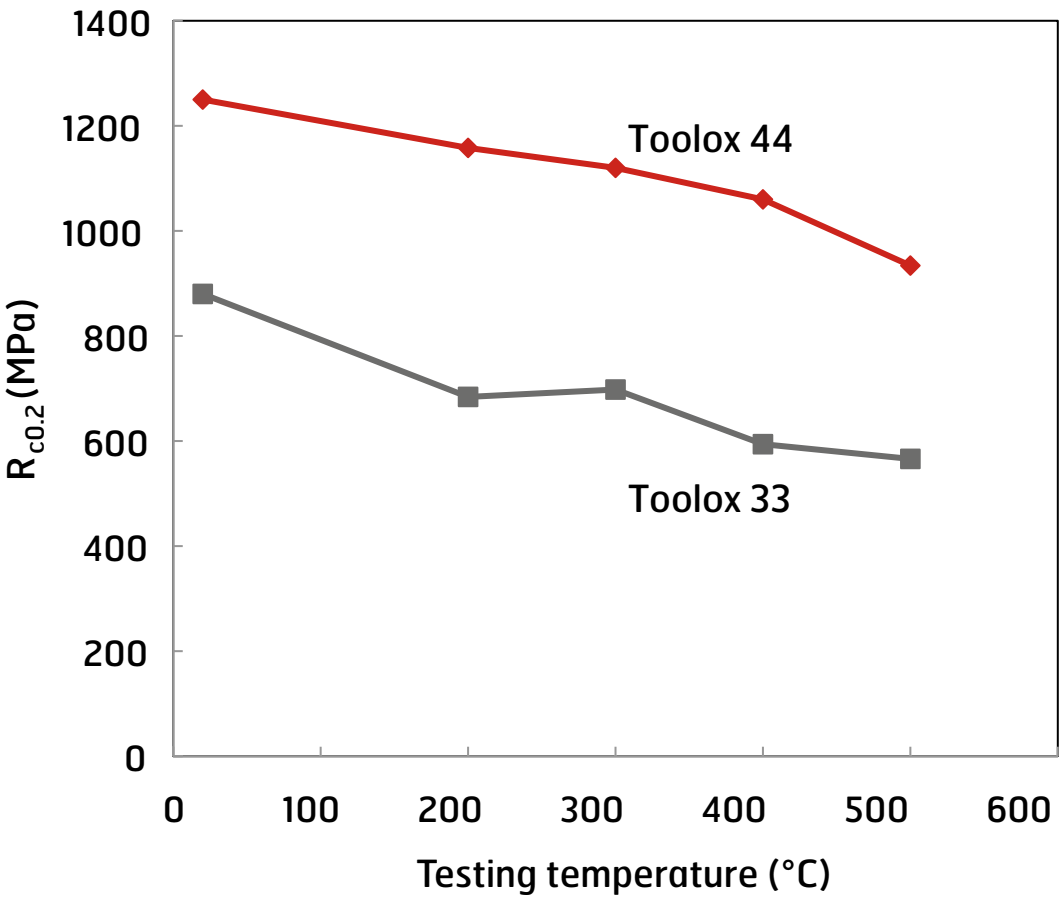
# Impact toughness of Toolox



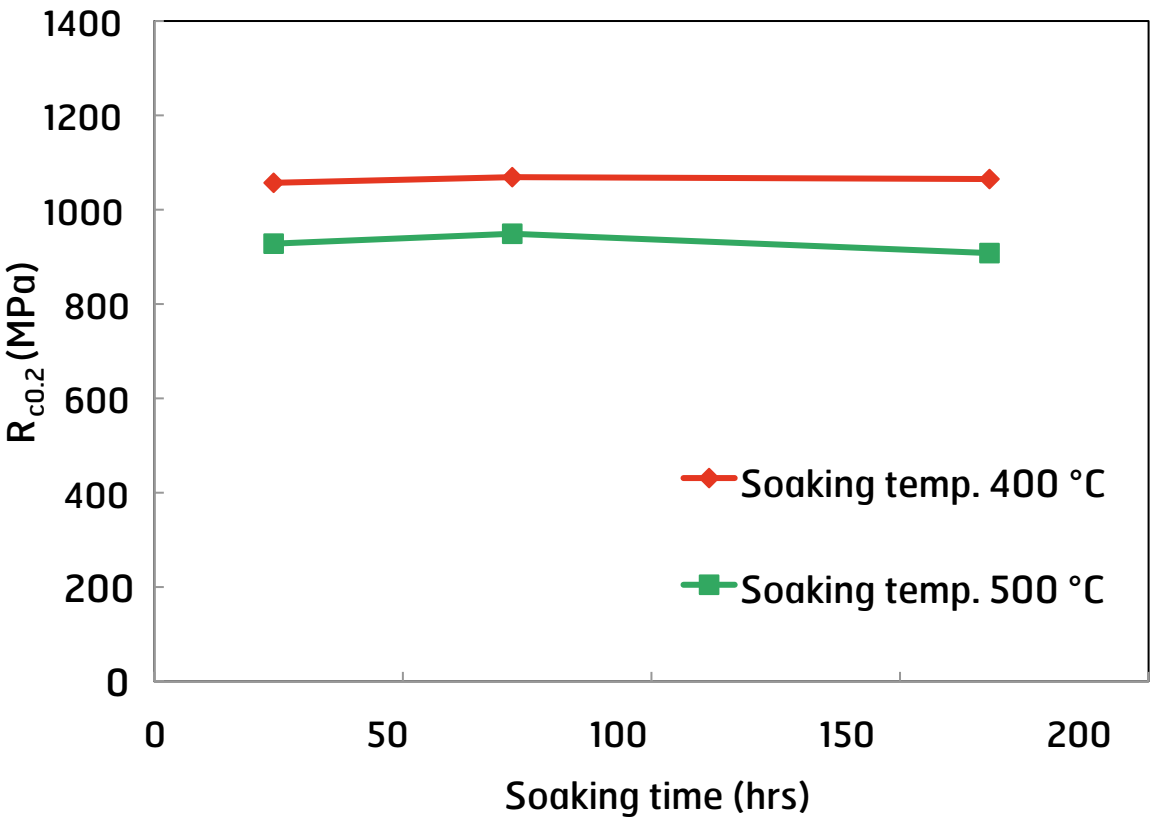
# Impact toughness of Toolox 44 when compared with W.Nr. 1.2344 (45 HRC)



# Compressive yield strength of Toolox at elevated temperatures

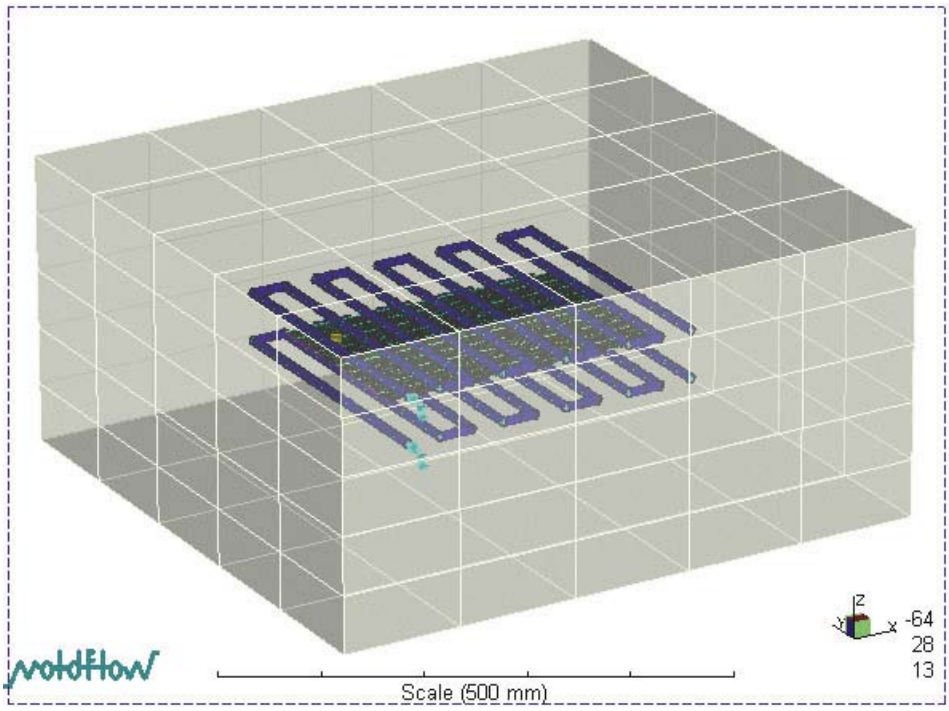


# Compressive yield strength of Toolox 44 after prolonged soaking times at elevated temperatures



# Moulding 2

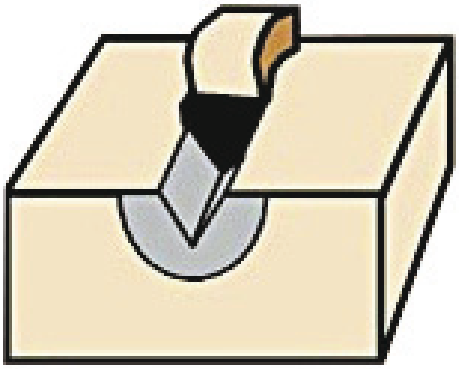
# Heat conductivity




Higher mould thermal conductivity of Toolox 44 as when compared with W.Nr. 1.2344 (45 HRC) will shorten the cooling time.

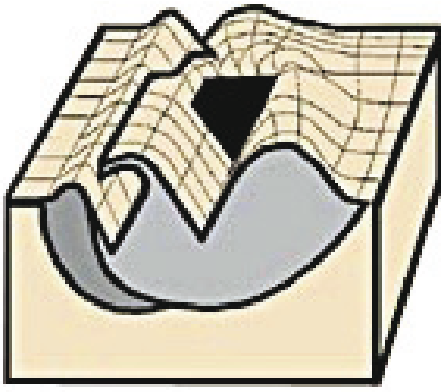
An analysis shows that 3-4.5 % shorter cooling time is possible to reach with Toolox 44 when compared to W.Nr. 1.2344.

# Abrasive wear, two main mechanisms



## Cutting

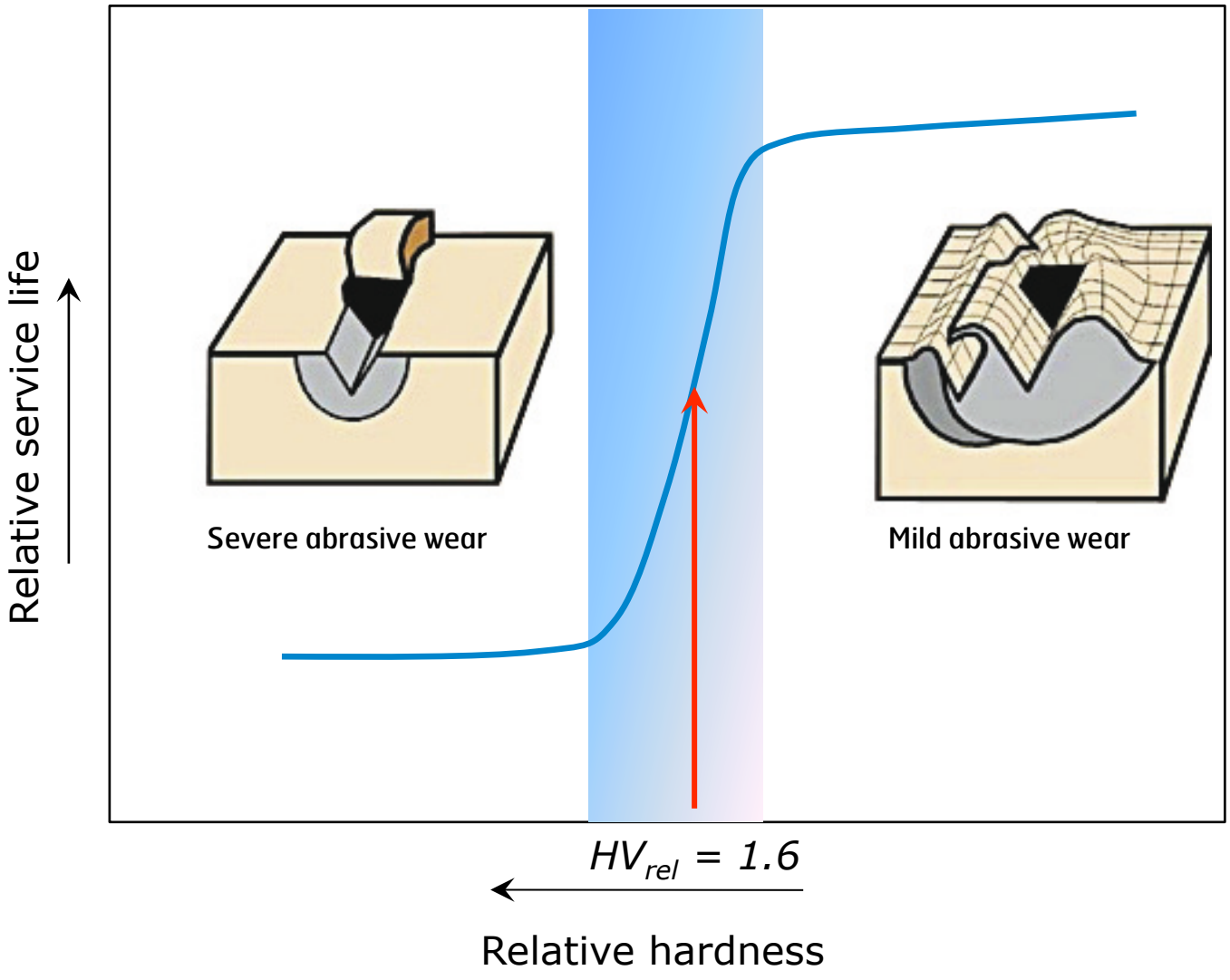
Dominates when the ratio between abrasive particle hardness and parent material hardness is larger than 1.6.



## Ploughing

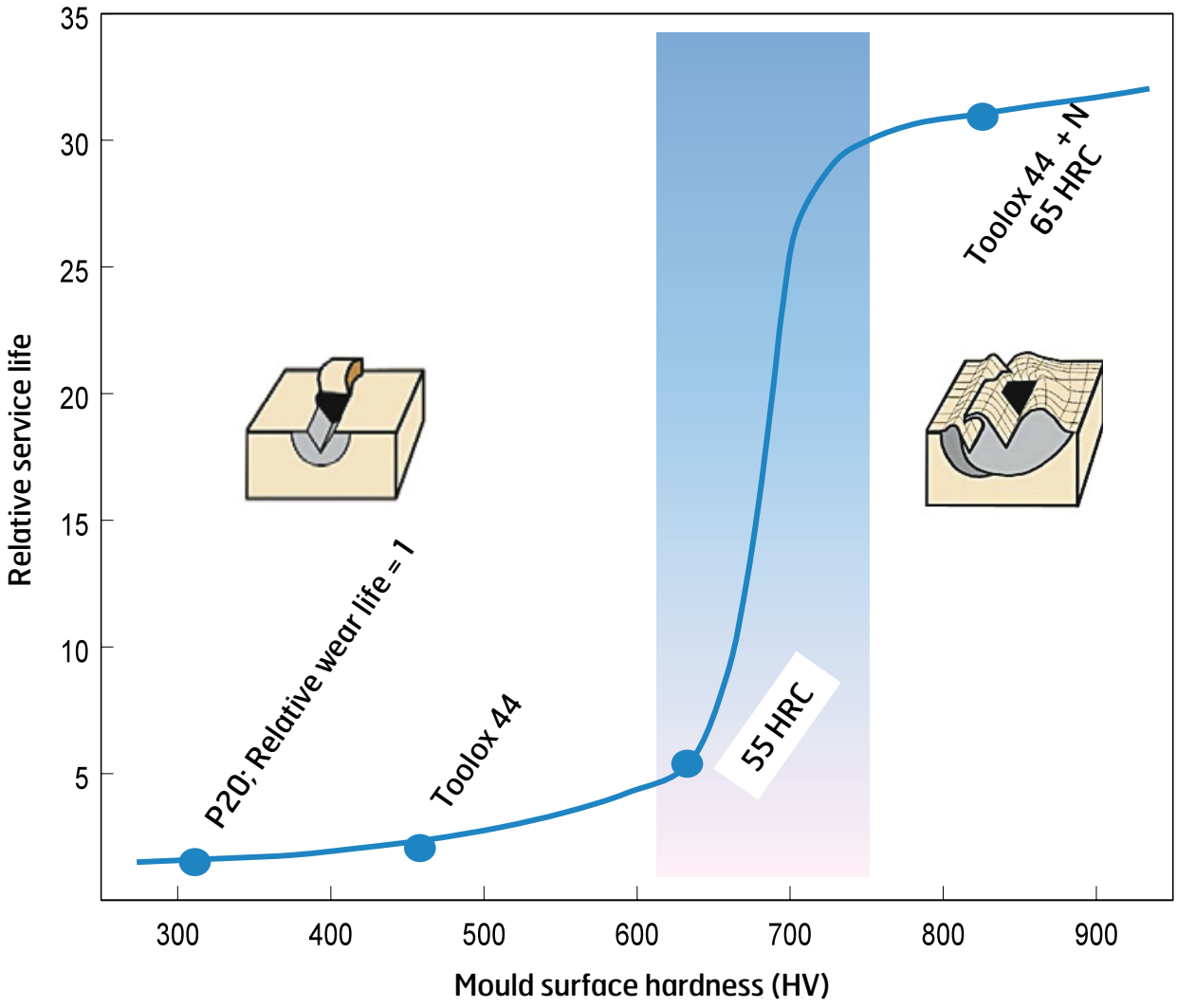
Dominates when the ratio between abrasive particle hardness and parent material hardness is lower than 1.6.

# Relative wear




($HV_{rel}$ = $HV_{abrasive\ medium}$ / $HV_{mould\ surface}$)

# Relative wear life,
## of plastic moulds worn by glass fibre, 1070 HV




P20=W.Nr. 1.2311

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# Toolox 44 in plastic injection mould

## Function
Tap to cover cables.

## Plastic
Nylon (PA) with 15 % glass fibre.

## Previous steel
Customer used in the past W.Nr. 1.2343 quenched and tempered, and thereafter nitrided the surface.

## Manufacturing
This is a two parts mould with direct injection. The forming parts of the mould are in Toolox 44. The try-out of the mould has been done with standard hardness of 45 HRC. Later on, before production, the mould has received Ionic Nitriding to 61 - 62 HRC .

## Experience
Monthly, around 10,000 pieces were made until a total number of 50,000 were produced. Thereafter, the production stopped as the total volume aimed for was reached. The mould was still fully operative. The customer has since then bought Toolox 44 again.

## Contact person
Ludger Weichert, SSAB Plate.

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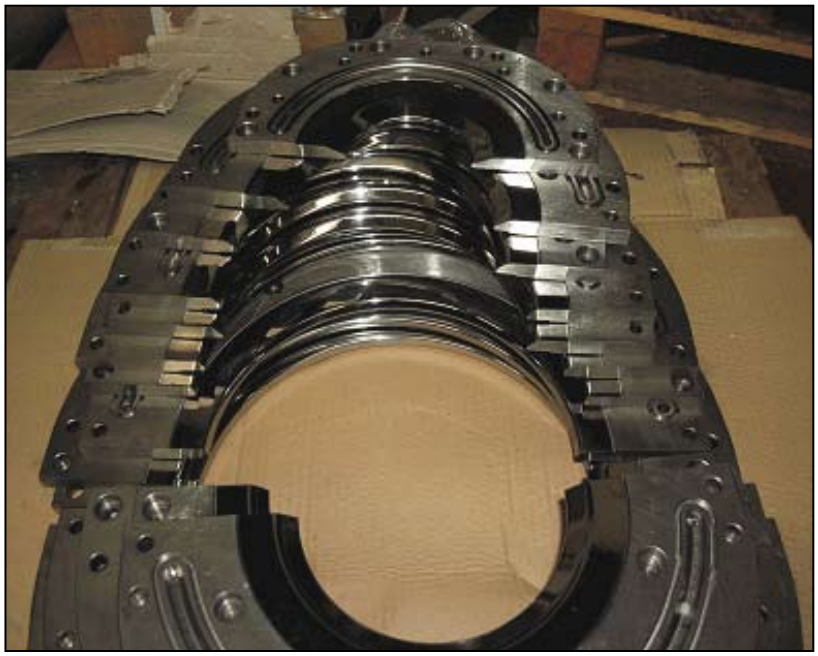
PREHARDENED TOOL STEEL

# Plastic mould in Toolox 33



## Function
Plastic mould for production of a head-light glass. As the cover is transparent, the surface quality of the mould is very important.
The mould has two parts, one is seen in the picture to the right, the other in the top left.

## Plastic
Polycarbonate (PC).

## Previous steel
For the internal thicker part was W.Nr. 1.2738 used. The thinner pieces were made in W.Nr. 1.2311. The customer had significant problems to obtain a good flatness of the thinner pieces.

## Manufacturing
Blanks, 250x12 mm, were made in Toolox 33. The customer was very satisfied with the dimensional stability. A very good surface quality could be obtained.

## Experience
The mould was put into use in June 2005. Since then more than 100,000 pieces have been made with fully satisfactorily result.

## Contact person
Ludger Weichert, SSAB Plate.

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# Toolox 33 in rubber mould for sealing

## Function
Prototype moulds made by Hutchinson France. Toolox 33 is used in the moulding parts of the mould. The rubber piece manufactured is used as sealing in car engines.

## Previous steel
For the internal thicker part was W.Nr. 1.2738 used. The thinner pieces were made in W.Nr. 1.2311. The customer had significant problems to obtain a good flatness of the thinner pieces.

## Manufacturing
Machining, polishing and rectification went well. Same parameters as with W.Nr. 1.2311 were used. The surface quality was considered better using Toolox. Also, the dimensional stability was satisfactorily. No surface treatment such as nitriding was carried out.

## Experience
The manufactured moulds are used within the Hutchinson factory. Since 2006, several moulds have been used with fully satisfying result.
A mould for the subsequent serial production has also been manufactured and will be put into use during first half of 2007.

## Contact person
Håkan Engström, SSAB Plate.

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# Toolox 44 in plastic mould for cellular phone cover

## Function
Mobile phone cover.

## Plastic
Polycarbonate (PC).

## Manufacturing
Toolox 44 is used in the moveable part of the mould. W.Nr. 1.2344 heat treated to 52-54 HRC is used in the fixed part.
High speed milling, etching, polishing worked well. Polishing is made to the most demanding surface quality. No problems with carbide spots as is often the case with regular tool steels. The only complication with Toolox 44 has been threading.

## Experience
The first mould for the phone was made in 2002. Since then 10-12 more moulds have been made. Each mould have a lifetime of around 600,000 pieces. An estimation is that totally 3 - 4 million pieces have been made with good result. In January 2007 the phone model went out of production.
During service the mould was regularly welded
and inserts were filled in where the mould was too worn. These maintenance procedures were also successfully carried out.

## Contact person
Tomas Berglund, SSAB Plate.

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# Toolox 44 in a plastic mould for a head-lamp lens

## Function
Mould for manufacturing of a lens to a motorcycle head lamp. The lens is made in Polycarbonate (PC), crystal quality.

## Previous steel solution
W.Nr. 1.2344 in ESR-quality. Heat treated to 45 - 48 HRC. This solution was used due to high demands on polishability. The time to manufacture the mould is typically eight weeks.

## Manufacturing
Toolox 44 is used in the moveable part of the mould. The mould was made by the company Fabrilcar, in Oliveira de Azemeis. All parts of the mould were made in Toolox 44. Starting with 125 mm thick blanks of approximately 500x300 mm in size. Milling was found to be similar to W.Nr. 1.2344 in heat treated condition. Polishing went well with a high surface quality obtained. The only complication was drilling. Besides lowering the cost significantly as heat treatment could be avoided, the manufacturing time was reduced with more than one week.

## Experience
The mould will be put into use at the factory during the first part of 2007. The annual production is estimated to be 600,000 components. If possible, maintenance of the mould will be avoided.

## Contact person
Håkan Engström, SSAB Plate.

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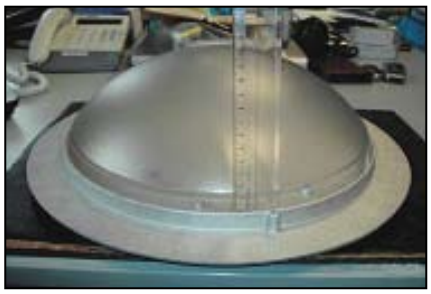
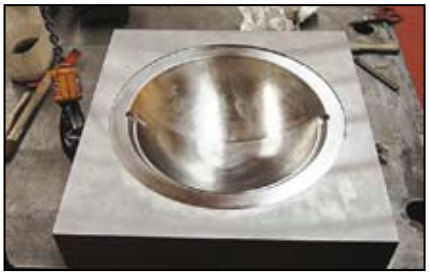
# Toolox 44 for lamp manufacturing





## Function
Moulds for lamp manufacturing. The lamp also contains an aluminium part, made via aluminium die casting as well as a transparent plastic part.

## Material
Aluminium and Polycarbonate plastic.

## Previous steel solution
W.Nr. 1.2343. in ESR-quality, heat treated to around 46 - 48 HRC was used in the aluminium mould as well as in the plastic mould.

## Manufacturing
Toolox 44 was used in both moulds. For the plastic mould it was crucial to obtain a good polished surface. Extensive milling was carried out. The Toolox 44 blank of 130 mm thickness was milled off until only 20 mm remained in the thinnest part of the mould. Manufacturing went well with a satisfying surface obtained. No surface hardening was carried out on the moulds produced.

## Experience
25,000 pieces have been made with fully satisfactorily result both in the aluminium die casting mould as well as in the plastic mould. The surface quality of the plastic parts is still after 25,000 components produced very good.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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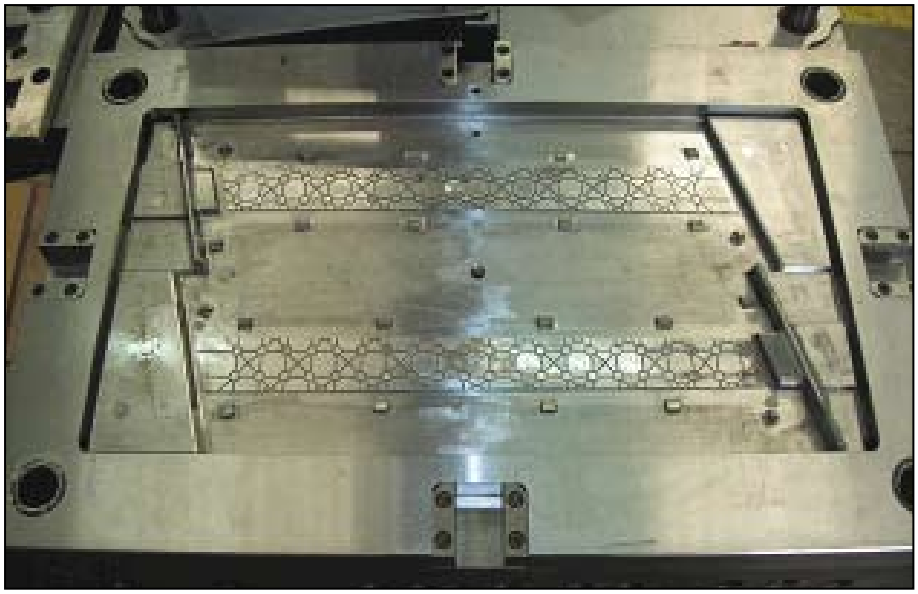
# Toolox 44 in an injection mould



## Function
Mould for injection moulding of an automotive security belt guide. The temperature of the molten plastic during injection is estimated to 220°C. This gives an estimated mould surface temperature of 80°C.

## Previous steel solution
Tool steel with subsequent heat treatment after machining of the mould.

## Manufacturing
A 600x400x110 mm Toolox 44 blank was used. Due to elimination of heat treatment in mould production, manufacturing time was reduced by 25-30 %. The total mould cost was decreased with around 2.5 €/kg. The mould maker experienced slightly more difficulties during machining as compared to the previously material used. EDM was carried out with good result and very small deformations.
No surface hardening was carried out.

## Experience
The mould was put into use in July 2006 and is, so far, running with good result.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Plastic mould in Toolox 44


## Function
The component is a fixture for an electrical box, used in electrical installations.

## Plastic
Plastic PA 6 ("nylon plastic"). No filler material.

## Previous steel solution
Stavax (AISI 420 mod.).

## Manufacturing
Manufacturing has worked well. The only problem has been threading. Using machine taps there were difficulties in removing the chips from the holes.
Changing to taps having straight threads pushing the chips forward solved the problem.

## Experience
The mould has, since commissioning in 2001, been used for an annual production of up to 50,000 pieces, giving a total of around 200,000 details which is fully satisfactorily. Toolox 44 has also been used for the inserts in several other moulds. The major benefit with Toolox 44 is to save time in mould production as heat treatment and adjustment of the mould are eliminated. Today, the customer more and more buys manufactured moulds. When moulds need to be repaired or modified, Toolox is always used.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 in plastic injection mould

## Function
Mould for injection moulding of rear door handle for the Fiat Grande Punto car.

## Plastic
Low abrasive standard plastic.

## Previous steel solution
W.Nr. 1.2343 hardened and tempered. That steel was chosen as the number of components produced is high and high production reliability was demanded.

## Manufacturing
No major complications during manufacture of the moulds were reported. No surface hardening was carried out. Significant reduction in tool manufacturing time was obtained as, using Toolox 44, the need of heat treatment was eliminated.

## Experience
The mould was made in May 2006 and put into service in June 2006.
So far the result is fully satisfactorily.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 in plastic mould for a Campari bottle gadget

## Function
Small gadget placed on Campari bottles.

## Plastic
Polycarbonate (PC).

## Previous steel
W.Nr. 1.2343 heat treated to around 46-48 HRC.

## Manufacturing
A lot of small holes in the product make the machining tolerances very severe. In each mould six components are made in a single shot. No major complications during manufacturing were reported. No surface hardening was carried out.

## Experience
The mould has been taken out of production as the total series of 100,000 pieces has been produced with fully satisfactorily result.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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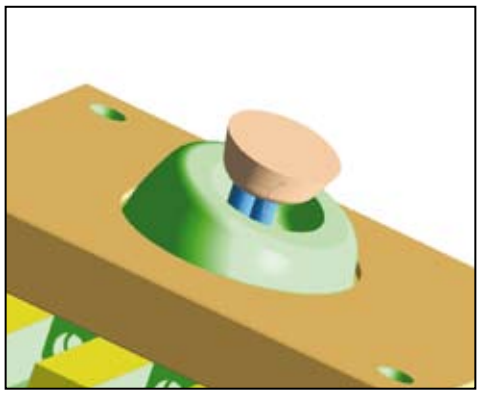
# Plastic injection mould in Toolox 44



## Function
Core to be inserted into a two shot injection mould tool.
The moulder wanted a materal harder than P20, but was not specific about the hardness. Normally, W.Nr. 1.2344 would have been used. Rough machined, hardened and finish machined. But using W.Nr. 1.2344 the customer felt it would be difficult to reach the flat shape on the back side of the tool.
Therefore Toolox 44 was chosen.

## Plastic
Polypropylene TPE.

## Manufacturing
By using Toolox 44 at least five days were saved in the manufacture of this core. Two to three days in heat treatment and two days extra wire erosion and machining. Using tungsten carbide tooling on high speed machining centres, the customer has reported no machining problems using similar speeds and feeds to P20. Drilling was no problem using TiN coated drills. 8 mm holes 15 mm deep were drilled and thereafter EDM spiral tapped. The core was given a light polish.

## Experience
The mould has been used since summer 2003 with no negative feedback.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 in plastic injection mould

## Function
Tap to cover cables.

## Plastic
Nylon (PA) with 15 % glass fibre.

## Previous steel solution
Customer used in the past W.Nr. 1.2343 quenched and tempered, and thereafter nitrided the surface.

## Manufacturing
This is a two parts mould with direct injection. The forming parts of the mould are in Toolox 44. The try-out of the mould has been done with standard hardness of 45 HRC. Later on, before production, the mould has received Ionic Nitriding to 61 - 62 HRC .

## Experience
Monthly, around 10,000 pieces were made until a total number of 50,000 were produced. Thereafter, the production stopped as the total volume aimed for was reached. The mould was still fully operative. The customer has since then bought Toolox 44 again.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 in plastic injection mould

## Function
Plastic mould for production of pump impellers.

## Plastic
Glass fibre reinforced Nylon (PA)

## Previous steel solution
W.Nr. 1.2343 heat treated to 46 - 48 HRC. After heat treatment, nitriding was done to increase wear resistance.

## Manufacturing
Toolox 44 was used to reduce the manufacturing time of the mould. Time savings related to eliminating heat treatment are estimated to 50 % of the manufacturing time. Furthermore, the estimated total manufacturing cost has been reduced with around 30%. No complications reported during manufacture. Nitriding was carried out as with the previous steel used.

## Experience
The mould went into service in the end of 2006. So far, with a satisfactorily result.

## Contact person
Ludger Weichert, SSAB Plate.

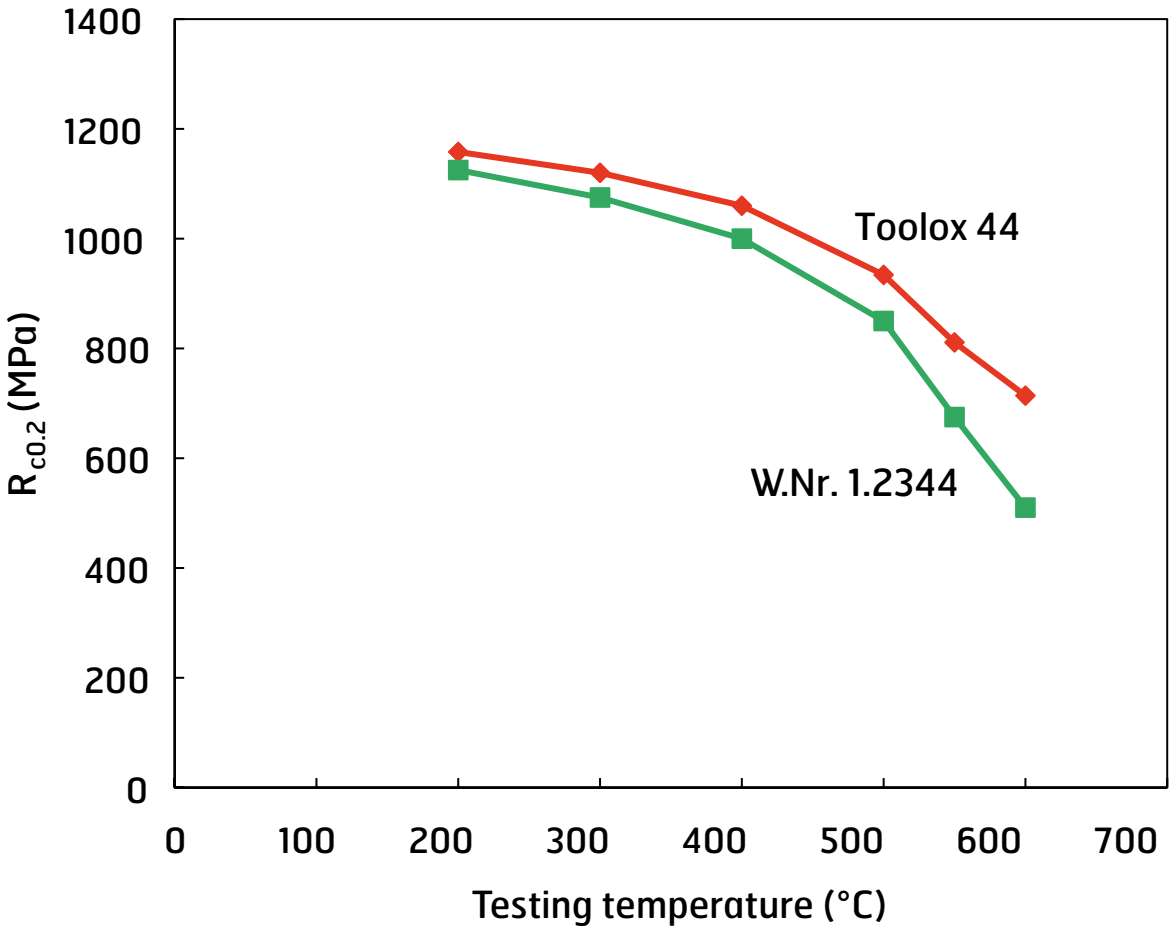
SSAB

# Which grade to choose in moulding?

| Plastic | Choose |
|---|---|
| PP | Toolox 33 |
| PA6 (nylon) | Toolox 44 |
| PA66 | Toolox 44 + Nitriding |
| PC | Toolox 44 + Nitriding |
| ABS | Toolox 44 |
| PMMA (Styrene) | Toolox 33 + Nitriding or Toolox 44 |
| PCPBT | Toolox 44 + Nitriding |
| With filler (glass-fibre) | Toolox 44 + Nitriding |

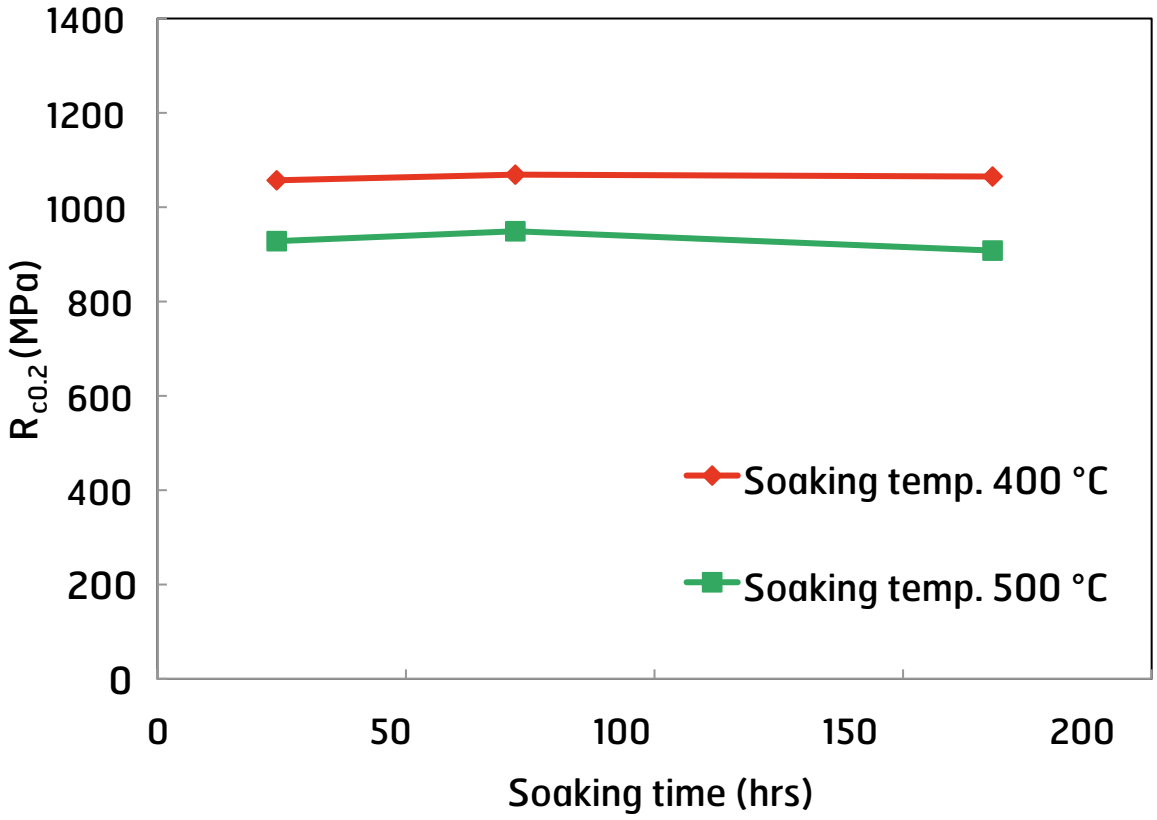
# Die-casting 3

# Compressive yield strength of Toolox 44 at elevated temperatures

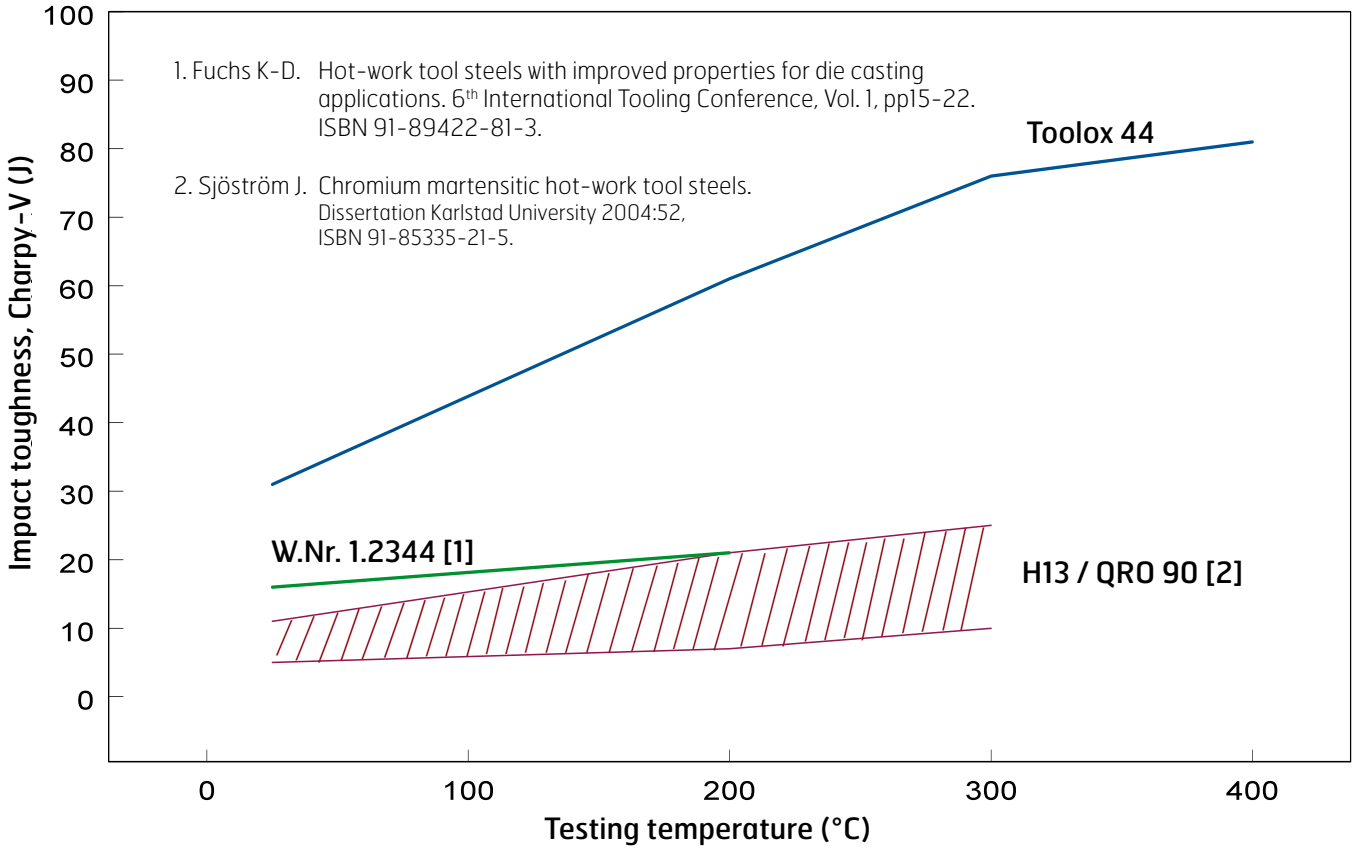



The strength of Toolox 44 at elevated temperatures is equal to the strength of W.Nr. 1.2344 Q&T to 45 HRC!

# Compressive yield strength of Toolox 44 after prolonged soaking times at elevated temperatures



# Impact toughness at elevated temperatures




# Thermal fatigue

- Simulation of aluminium die casting, $T_{peak}$ = 710 °C.
- No differences when compared to ESR-remelted W.Nr. 1.2344, heat treated to 45 HRC, i.e no cracks could be detected after finished testing!

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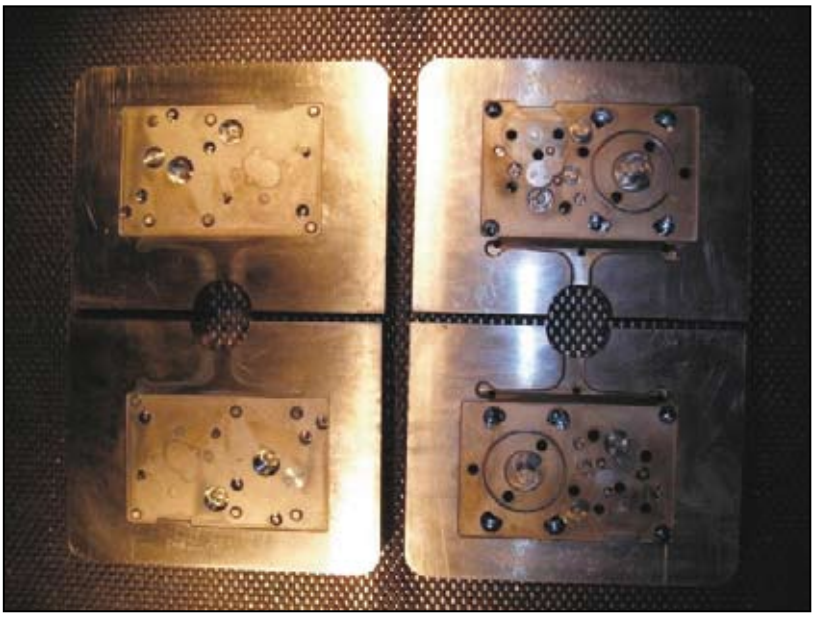
# Toolox 44 in Zamak die casting



## Function
Die casting of components in Zamak. The parts are mechanical components in electronic valve actuators. Toolox 44 is used for the inserts in the die casting mould.

## Previous steel solution
The mould is a new design. For similar previous moulds, W.Nr. 1.2344 heat treated to 44-47 HRC has been used. Probably ESR-quality.

## Manufacturing
The moulds are made by the Barcelona based company GARME. They say that after initial work in finding the right tooling, they don't experience such a difference in the machining as compared to working with non heat-treated W.Nr. 1.2344. They see large economical benefits with Toolox. Besides, giving a lower purchase cost they also see large benefits in manufacturing time. The normal time to manufacture the mould in W.Nr. 1.2344 is 300 hours. Using Toolox 44 a reduction by 50-100 hours was achieved due to elimination of heat treatment.

## Experience
The customer is a manufacturer of electronic equipment. The inserts were made in the end of 2005. Until January 2007 around 15,000 pieces have been made. The result has been at least as good as when using W.Nr. 1.2344. The final series will probably be 200,000 details.

## Contact person
Håkan Engström, SSAB Plate.

SSAB

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# Toolox 44 in Zamak die casting

## Function
Mould for manufacturing of Zamak pieces used for a coffin decoration. For aestethical reasons, the must to have a very good surface quality.

## Previous steel solution
W.Nr. 1.2343 hardened and tempered.

## Manufacturing
Machining went well. The necessary surface quality was obtained without any reported complications. Significant cost and time savings were obtained due to the elimination of heat treatment in mould manufacturing.

## Experience
The die has been in use since the end of 2005. So far with good result.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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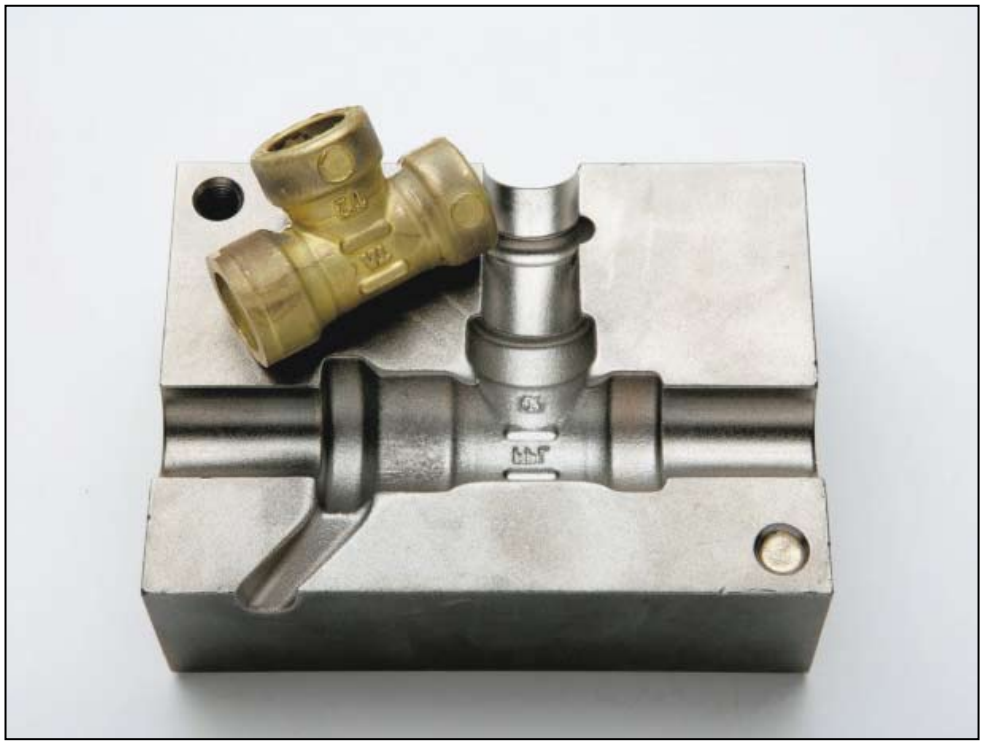
# Toolox 44 in brass die casting



## Function
Mould for die casting of brass components.

## Material
Brass.

## Previous steel solution
QRO 90 heat treated to around 48 HRC. Technically a well working, but expensive, solution.

## Manufacturing
It was possible to reach better surface on Toolox 44 after polishing than with the previous steel. This was considered important by the customer. Machining of the mould went well.

## Experience
Toolox 44 was used in a parallel test to QRO 90. In the mould as well as in the cores. In the cores, Toolox 44 was worn out faster than QRO 90. The mould itself was run to the full series of 45,000 pieces. Almost no difference could be seen between the Toolox 44 and the QRO 90 moulds. The only difference was slightly better surfaces on the QRO 90 part. The customer has decided to introduce Toolox 44 as standard for the application and also initiate a test with larger moulds.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 in aluminium die casting of automotive engine cover

## Function
Aluminium die casting mould to manufacture covers used in car engines. The moulds are made in a series of 80. To make covers in different diameters up to around 300 mm. Each mould makes two covers in one shot.

## Previous steel solution
W.Nr. 1.2343 heat treated to 46 - 48 HRC.

## Manufacturing
No major complications reported during manufacturing. Significant savings in time and cost due to that heat treatment was eliminated when using Toolox 44.

## Experience
Initially, the customer made two moulds in Toolox 44 (= making four details at the time). These moulds were made in early 2005. Since then, the moulds have been in production, parallel with the moulds made in the previous steel. Two years later, the Toolox moulds still work well. The customer has decided to use only Toolox 44 for a new series of 80 moulds they plan to make, thereby leaving the previous solution. The change will represent a significant increase in the productivity at the customer.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 for aluminium die casting

## Function
Piston for a Piaggio Vespa scooter.

## Previous steel solution
W.Nr. 1.2343 ESR-quality heat treated to 46 - 48 HRC. Technically, the solution worked well at the customer.

## Manufacturing
The piston is made in ten different sizes. Therefore a series of ten moulds were made. Toolox 44 blanks with 130 mm thickness were used in the manufacturing. Usually, a mould like this is manufactured in four weeks. Using Toolox 44 , one week manufacturing time can be saved due to heat treatment can be eliminated. No surface engineering was made.

## Experience
The mould went into production early 2006. So far it works fully satisfactorily.
The customer has also used Toolox 44 in a significant number of other projects.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 in aluminium die casting

## Function
The piece is used for locking moveable ladders systems.

## Previous steel solution
W.Nr. 1.2343 ESR-quality heat treated to 46-48 HRC. Heat-checking typically appears after 6,000 cycles. Stress relieving after each 10,000 cycle interval was normally always carried out.

## Manufacturing
With Toolox 44 no heat treatment had to be carried out and the mould manufacturing time could be halved. The total cost of the tool was reduced by 20 % as compared with the previous solution.

## Experience
The die went into service in March 2005. Since then at least 80,000 production cycles have been made. The mould is still running.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 in aluminium die casting

## Function
Die casting of an aluminium fixture for furniture.

## Previous steel solution
W.Nr. 1.2343 ESR-quality. The manufacturing time with this solution was around 30 days. Twelve days for machining, seven days for heat treatment and another eleven days for adjustments after heat treatment.

## Manufacturing
A Toolox 44 blank with dimensions of 90x250x330 mm was used. The blank was delivered on 20th of February 2006. The mould was finished on 10th of March 2006, and tested on the 11th. The total manufacturing time was 16 days, including four days waiting for the base mould to be delivered. The time savings correspond to eliminate heat treatment and the following adjustment of the mould to its final shape. Very small deformations were reported during machining in Toolox 44.

## Experience
The mould went into production in March 2006. So far production it works well.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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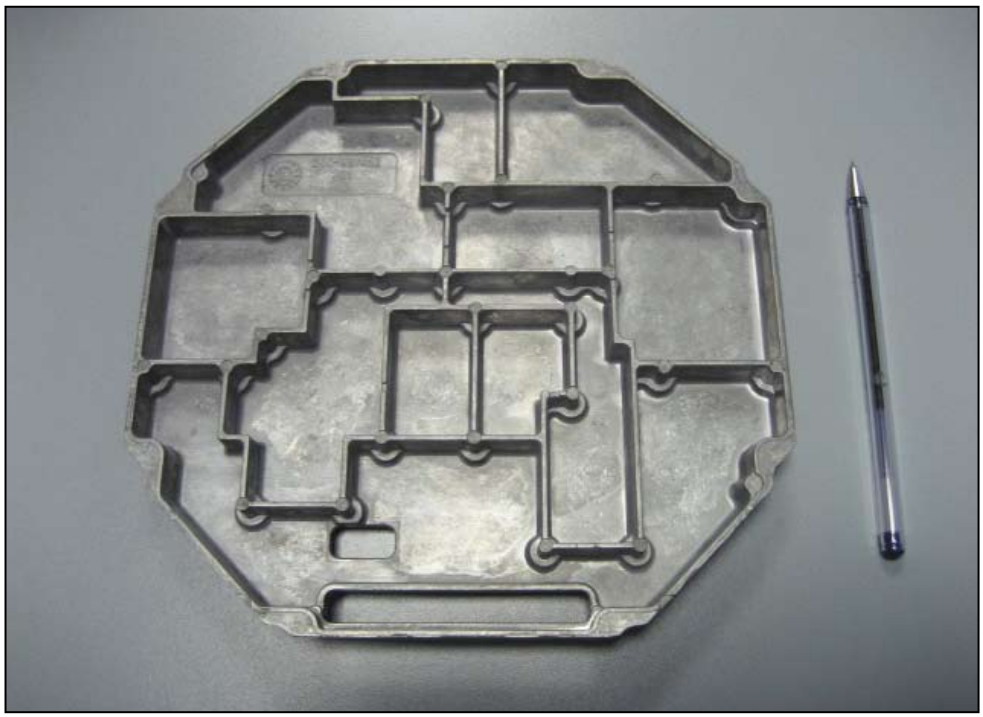
# Toolox 44 for aluminium die casting



## Function
Die casting of components covering the cutting blade in a lawn mover.

## Previous steel solution
W.Nr. 1.2343 hardened and tempered.

## Manufacturing
No major complications reported during manufacturing. The mould is not surface engineered.

## Experience
The die went into production in 2006. An annual production of 100,000 components is estimated. So far running production works well.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 for aluminium die casting


## Function
Mould for die casting of aluminium component.

## Previous steel solution
W.Nr. 1.2343 ESR-quality, hardened and tempered. A well working solution.

## Manufacturing
The entire mould is made in Toolox 44. Starting from 130 mm blanks. Each blank weight is approximately 10 kg. Besides some problems with threading, machining went well. No surface engineering was carried out.

## Experience
The mould went into use in the beginning of 2005. So far no backlashes.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

# Forging 4

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# Toolox 44 for Brass forging die

## Function
Pressing of brass door handles

## Previous steel solution
Different steel grades were used for the application; W.Nr. 1.2343/1.2344/1.2365.

## Manufacturing
The die manufacturer experienced some problems during drilling. No similar problems reported during milling. Significant reductions in mould manufacturing time as heat treatment could be eliminated.

## Experience
The brass handles are pressed in one stroke at 730-750°C. After each stroke the die is cooled to 150-200°C and excess material is removed. Surprisingly, the end user has reported that the die does not oxidise was the case with the tool steels previously used. The Toolox 44 surface remains in the original polished shape. Due to this, the finished pieces do not stick on to the die surface. The need for maintenance is thereby reduced improving both quality and volumes of the components produced.
The die manufacturer has after these initial results ordered Toolox 44 for a large series of dies.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Steel hot forging die in Toolox 44

## Function
The chain link is used in high-quality ship and offshore steel chains. One chain can have thousands of links. Toolox 44 is used in a hot forging die in the chain production. The chain steel is heated to around 890°C before forging. Thereby the die works continuously at an estimated temperature of 400-500°C. Sometimes as long as several months without any interruptions. The forces which act on the die are small, approximately 1-2 tons.

## Chain material
Steel grade W.Nr. 1.7218

## Previous steel solution
Before Toolox 44, different steels were tested. The best result was obtained using W.Nr. 1.2343/1.2344. The die was manufactured in soft annealed condition, thereafter heat treated to 45 HRC. Typical die life time was around 10,000-11,000 forging strokes. The end failure was, typically, surface cracks.

## Manufacturing
Using the SSAB recommendations, there were no problems with machining of Toolox 44.
No surface engineering was carried out.

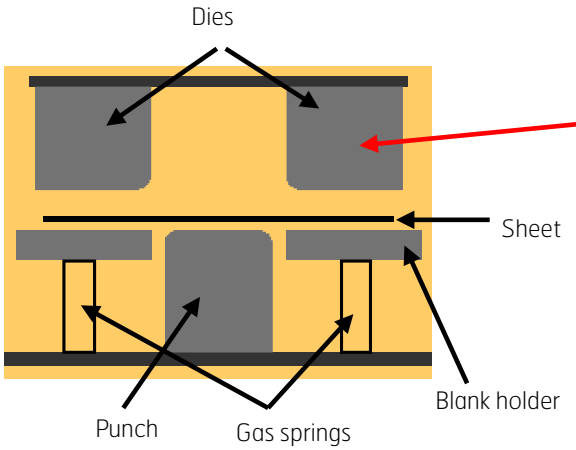
## Experience
The first Toolox 44 die went into service around 2002. That die has been used in approximately 50,000 strokes and, after refurbishing, still works well. The customer makes, since then introduction of Toolox 44, this new grade in all their forging dies. Up till today totally 10-12 tools. Besides the enhanced life time, another advantage using Toolox 44 is that a worn die can easily be re-used in a die with smaller dimensions.

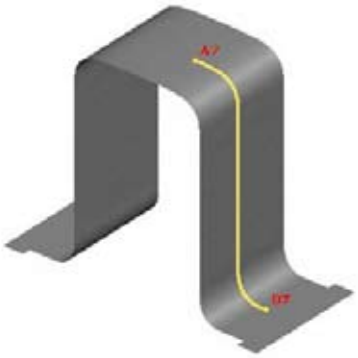
## Contact person
Tomas Berglund, SSAB Plate.

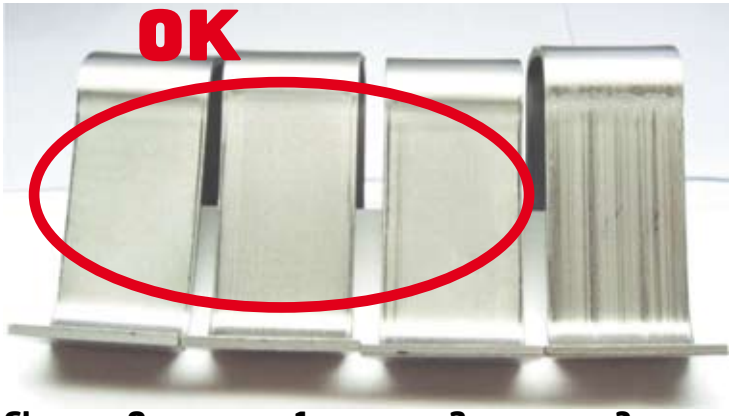
SSAB

# Sheet forming 5

# Adhesive wear






| Class | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| | Good part Not for outer panels | Incipient scratches/ galling | | Scratches cover the entire part: interruption of the test run |

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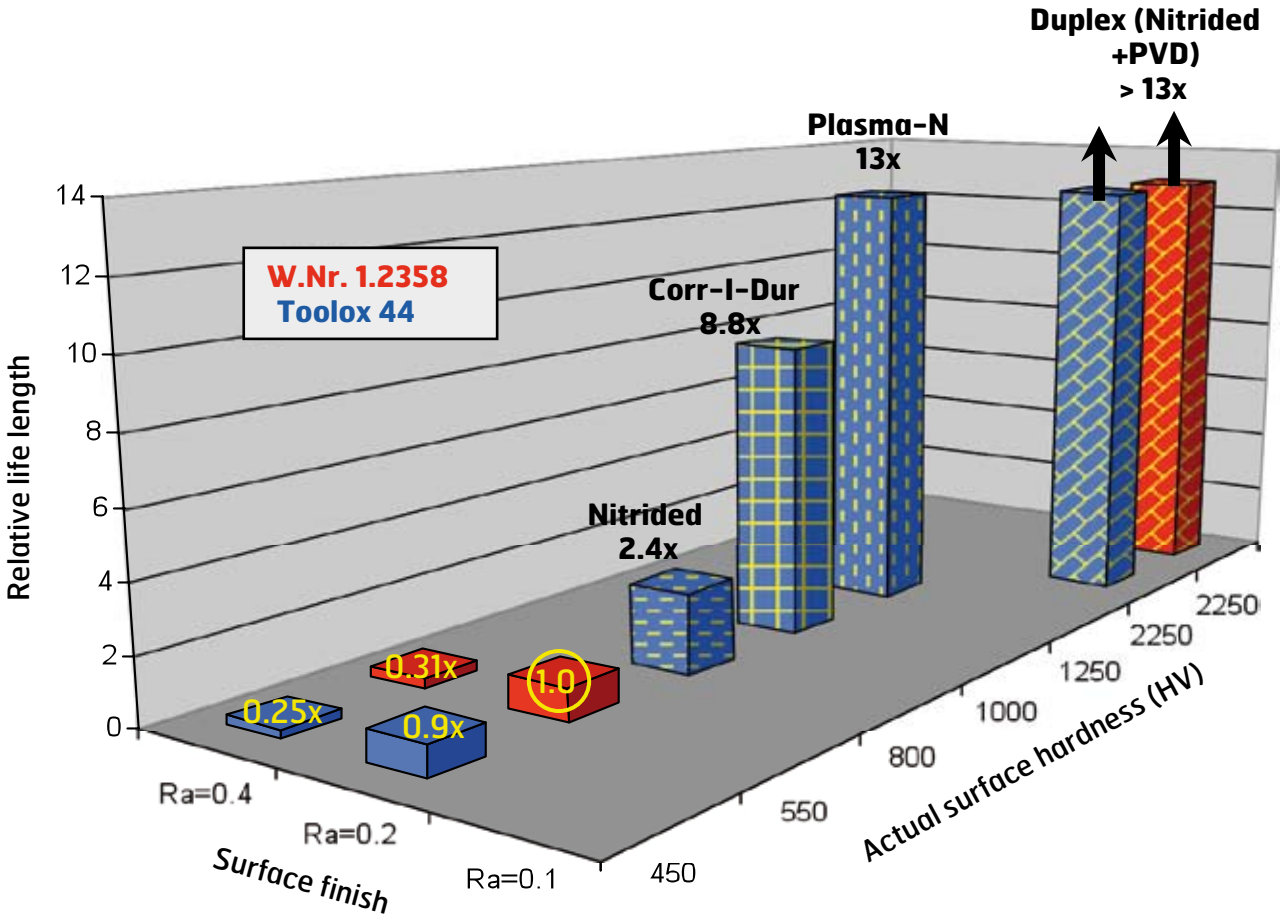
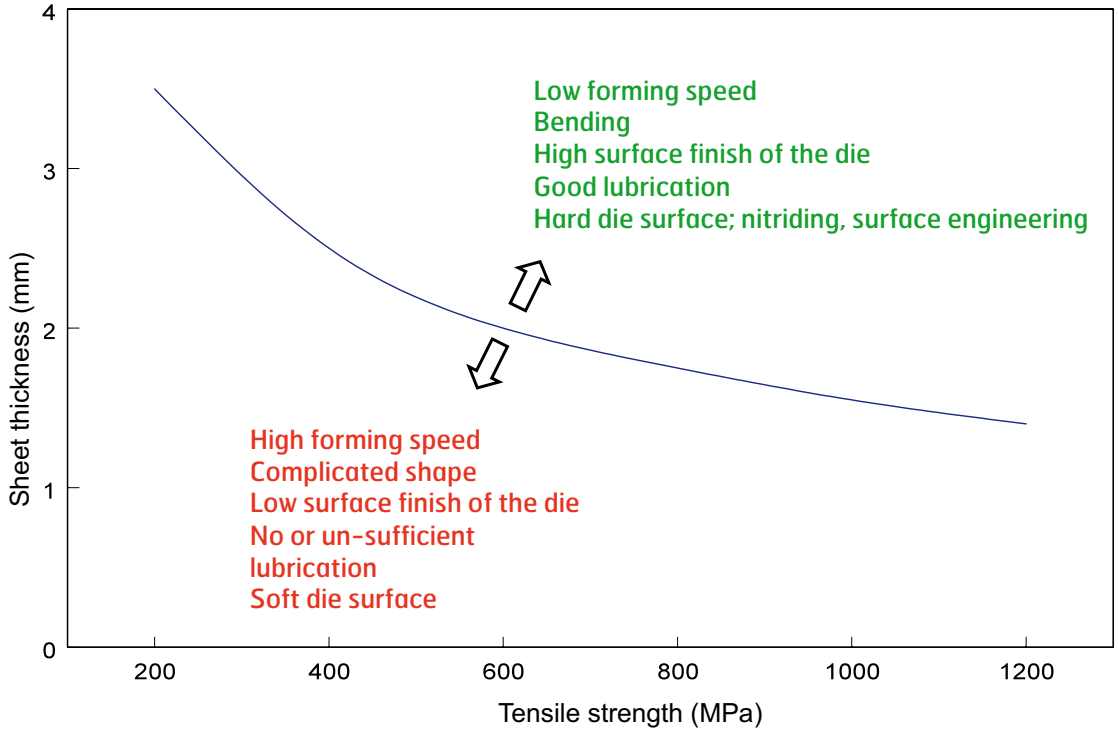
AUTOMOTIVE STAMPING

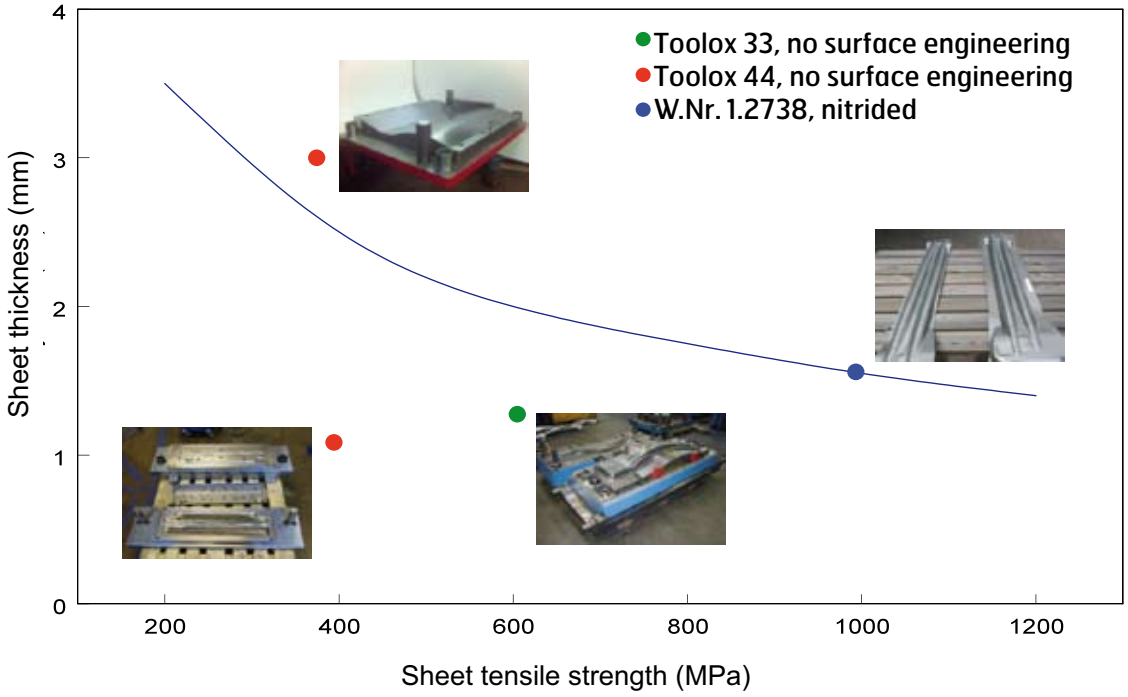
# Test of different surfaces, worn by a 1.95 mm thick Docol 600




OLOFSTRÖM SCHOOL OF
AUTOMOTIVE STAMPING

# Toolox in sheet forming



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# Toolox 44 in a cold forming die

## Function
Toolox 44 is used in a part of the die making the final forming operation. The component made is used as support in floor assembly. The die has a work pace of 42 strokes/minute. There are very high demands on the geometry of the produced component.

## Material in the component produced
Steel grade P 13, Italian standard, with a thickness of 1.8 mm.

## Previous steel solution
W.Nr. 1.2379 heat treated to 58 - 60 HRC. Toolox 44 was used as the previous mould failed after only 3,500 pieces produced. The failure was probably fatigue cracking due to the high stamping forces. A new die had to be made urgently.

## Manufacturing
No complications were reported during manufacture.

## Experience
The die was put into use end 2006. With a surface hardness of 45 HRC 65,000 details were produced. Thereafter was the die nitrided to a surface hardness of about 60 HRC, and another 127,000 components were manufactured. The total service life of the die made of Toolox is 1.5-2 times the life of the previous dies (W.Nr. 1.2379).

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

TOOLOX®
PREHARDENED TOOL STEEL

# Toolox 44 in a set of progressive dies for production of refrigerator parts

## Function
Progressive dies for manufacture of bottom plate for the compressor of a refrigerator. It is the first time in 10 years that the design of the bottom plate is changed.

## Material
Low strength strip steel.

## Manufacturing
Previous steel was W.Nr. 1.2363 hardened to 60 HRC. Toolox 44 was chosen to save time, to avoid the difficulties in heat treatment of long parts and to be able to do final adjustments easier. Manufacturing of the dies went well. More than three days could be saved in die-making. Elimination of the common adjustment after heat treatment as was the case with previous material solution was also appreciated.

## Experience
The die went into service in 2003. The die was inspected after 150,000 details produced. No visible wear could be detected. Control measurements of the die were OK. In early 2007 the die is still in use and approximately 1.6 million pieces have been produced without any noticeable wear.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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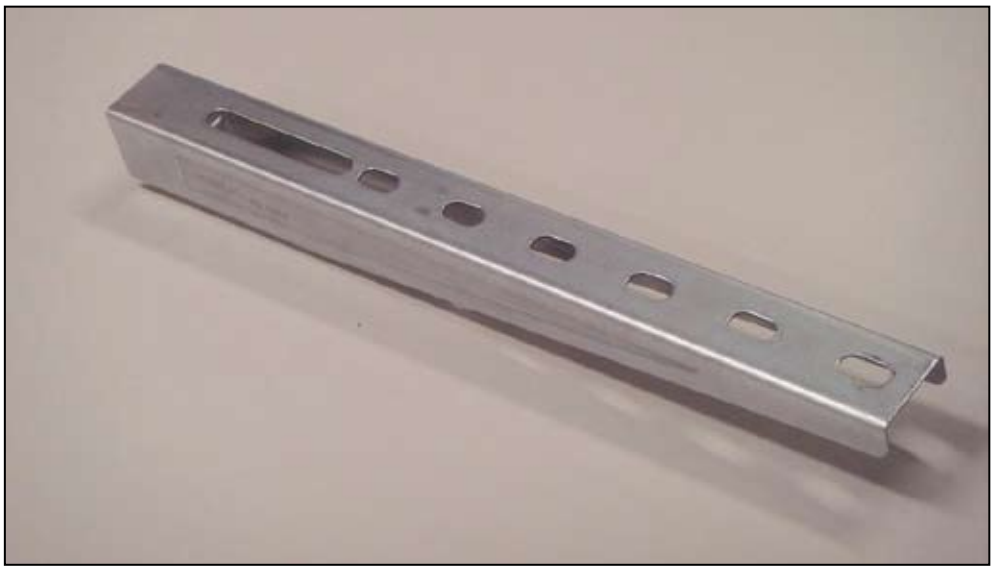
# Toolox 44 in forming of galvanized sheet



## Function
Tool set for forming, cutting and trimming of 2 mm galvanized mild steel

## Manufacturing
Previous steel was W.Nr. 1.2379 heat treated to 58/60 HRC used. Toolox 44 was chosen to save time, to avoid the time necessary for heat treatment.

Manufacturing of the die made of Toolox went without any known disturbances.

## Experience
The die made of Toolox is reported to last twice as long as W.Nr. 1.2379-material before requiring any maintenance.

## Contact person
Giancarlo Moglia, SSAB Plate.

SSAB

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# Toolox 44 for cold forming of a truck engine protection sheet

## Function
Die for production of a steel protection plate for the bottom side of a truck engine.
Toolox 44 was used for both sides of the die.

## Manufacturing
Normally, cold forming steels of the W.Nr. 1.2363 are used. To avoid heat treatment a change to Toolox 44 was made. The mould manufacturing went well. Initially, there were some problems to find the right tooling. There were quite a lot of milling since the die is quite large. The protection plates are powder coated so although the demands on surface quality are high, they are not extreme.

## Material
2 mm DOGAL 350 YP galvanized strip steel.

## Experience
The expected yearly production in these dies is 10,000 pieces during the truck model lifetime which is 7-10 years. The die is in production since early 2005, so far with fully satisfactorily result.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 nitrided, in a blanking die

## Function
Blanking die for manufacturing automotive components.

## Material
Sheet, 3.8 mm thickness, 270 MPa.

## Manufacturing
Die manufacturing went without any difficulties.

## Experience
The die made of Toolox has produced more that 254,000 components. Earlier was W.Nr. 1.2379 (58/60 HRC) used which last about 10,000 components. DC-53 (58/60 HRC) showed a service life of 15,000 components.

## Contact person
Keith Nicholls, SSAB Plate.

SSAB

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# Toolox 44 in cold forming of airport seats

## Function
Tool for manufacturing of airport lounge seats.

## Material
Mild steel, 3 mm thickness.

## Manufacturing
Two blanks of 80mm x 600mm x 600mm each were CNC-machined. The machining went well.

## Experience
Eliminating the need for heat treatment resulted in:
- Cost savings for the heat treatment.
- Improved dimensional stability.
- Improved appearance.
- Cost savings in machining time.

Thousands of details have, so far, been supplied with no negative feedback.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

TOOLOX®
PREHARDENED TOOL STEEL

# Toolox 44 in die for stamping car parts

## Function
Punching die for manufacture of non-original spare parts to cars. About 95 % of the die production is for export. An example is spare parts to the Volkswagen "Beetle".

## Material
Coil in 0.8 mm sheet thickness. An approximately annual coil consumption is 2,700 tons.

## Manufacturing
Machined and ground 20 mm thick Toolox 44 plate was used. The parts were cut out using wire cutting. No surface treatment such as nitriding was carried out.

## Previous steel solution
Steel grade used was W.Nr. 2311. A typical service life of a die was about 200,000 details produced.

## Experience
In June 2006, the Toolox die had been used to cut 60,000 pieces. The die was still running with good result in January 2007. The customer aims at 300,000 pieces.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 in a cold forming die producing heat protection shields


## Function
The die is used in stamping of a heat protection shield for truck engines.
The forming speed is relatively low as bolting holes are deep drawn in the same process step.

## Material
Stainless steel grade 18/8.

## Manufacturing
No reported complications. The final shield is approximately 500x800 mm in size.

## Experience
The die was manufactured in 2006 and so far it works well. The aim is to make approximately 60,000 shields/year during seven years.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44 in cold forming die for heat exchangers

## Function
The die is used for pressing of pieces used in heat exchangers.

## Material
Stainless steel.

## Previous solution
W.Nr. 1.2344. Bought in soft-annealed condition. After manufacturing of the die, the steel was quenched to around 50 HRC. The final die is made using a modular system consisting of many parts.

## Manufacturing
The die was milled out from one Toolox 44 plate. Representing a big improvement in cost and time compared to the previous solution.

## Experience
Around 600,000 pieces have been made with good result. The die is still running. The customer is very happy with the new solution, which he considers much more efficient especially for low series dies

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

TOOLOX®
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# Toolox 44 in a shearing die

## Function
Shearing dies for deep draw stamping.

## Material
1.25 mm soft aluminium grade 1100-0.

## Manufacturing
The 70 mm thick die consists of two parts. One mild steel part making up the body of the die. On top of the mild steel, a part of 10 mm thick Toolox 44 is mounted to be used for the actual shearing operation. The Toolox piece was laser cut to its final shape. A much faster solution than wire EDM. The quality after laser cutting gave a good edge quality of the finished product. No further finish work was needed.

## Experience
After around 4,000 components produced the result is quite good. Still, the sheared edges of the manufactured piece are of good quality. The customer has decided to continue to use Toolox 44 for further projects.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 44 for cold forming of stainless steel parts

## Function
Industrial furnace bottom piece.

## Material
Stainless steel, grade 430, in 1.0 mm thickness.

## Previous steel solution
Special casting supposed to be especially suitable for shaping stainless steel. The surface of the casting should increase strength with usage. The customer had used same castings before, with good result, but this time quite soon the produced pieces showed scratches on the surface.

## Manufacturing
Manufacturing went well with no problems reported. Polishing was made with abrasive paper since a not too good surface was wanted. The customer decided to nitride the surface to be extra confident in wear resistance.

## Experience
Commissioned during summer of 2006. The die is used in the die manufacturer factory. The lifetime is expected to be seven years. In January 2007, around 20,000 pieces have been produced in the new tool with good result. No scratches have been found. No maintenance of the Toolox die has been necessary. In running production only a limited amount of oil is used for lubrication.

## Contact person
Håkan Engström, SSAB Plate.

SSAB

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# Toolox 44 in cold forming of automotive exhaust pipes


## Function
Cold forming of exhaust pipes for German cars.

## Material
1.0 mm stainless steel strip plate.
Probably grade AISI 304.

## Manufacturing
Milling was made at higher speed than previously used. No surface hardening was carried out.

## Experience
Toolox 44 was made for the prototype tool. It has been in production since 2004. The tool was originally estimated to produce 4,000 pieces. In September 2005 5,000-6,000 pieces have been made, and the tool was still in running production. No known problems.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 44
# in a die cold forming menu covers


## Function
The end customer is a restaurant chain, present all over Middle East. They make their menu covers by cold formed aluminium.

## Previous steel solution
Tool steel with subsequent heat treatment. The distortions gave problems obtaining the necessary geometry. Quite common, also problems with cracking after heat treatment occurred.

## Material
Aluminium sheet, 1.5 mm thick.304.

## Manufacturing
No complications during machining.
The die was nitrided.

## Experience
In January 2007, the die had been running around one year and produced 2,000 pieces. The result is fully satisfactorily.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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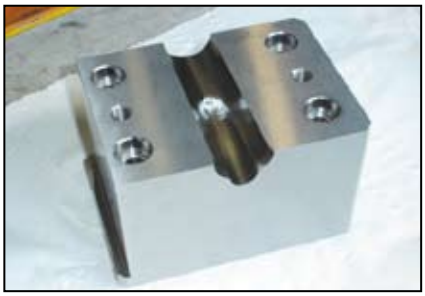
# Toolox 44 in a hydroforming tool



## Function
Part of mould for hydro-forming. The mould consists of three parts subject to very high pressures. As a first step Toolox 44 is used in the two smaller end pieces. The left bottom picture shows the Toolox 44 die. The tube to be hydro-formed will be placed to half the length of the piece.

## Previous solution
W.Nr. 1.2343 heat treated to 45 HRC.

## Manufacturing
Slightly more tool wear in the machining of Toolox 44 . An advantage was the possibility to avoid the additional machining for W.Nr. 1.2343 necessary after heat treatment. The same machining parameters as for hardened W.Nr. 1.2343 was used. Elimination of heat treatment saved 3.5 days in the die manufacturing.

## Experience
A parallel test with W.Nr. 1.2343 and Toolox 44 was made. Up to around 50,000 cycles; both solutions showed similar wear. Thereafter the wear of the Toolox 44 dies increased slightly more.
However, the benefits in die manufacturing make the end customer satisfied with Toolox 44 and they plan to use Toolox 44 in further projects.

## Contact person
Ludger Weichert, SSAB Plate.

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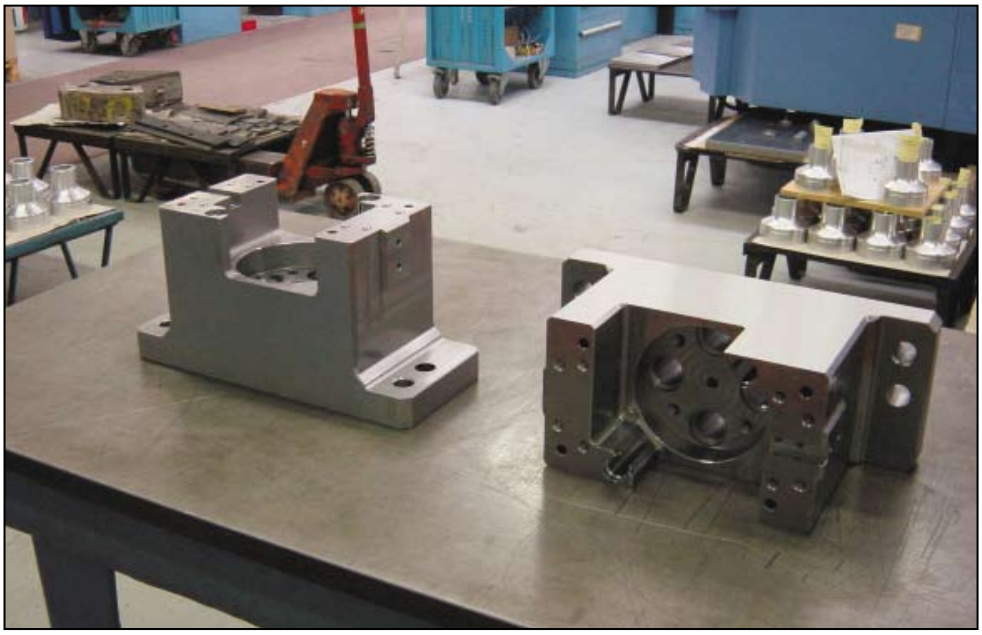
# Toolox 33 in a progressive die



## Function
The detail is part of a progressive die for production of thin steel seals for oil drums. The die is designed for a production pace of 40 seals/minute.

## Manufacturing
The customer needs very good dimensional stability, in the magnitude of 0/-0.005 mm after machining. A 615x320x1100 mm Toolox 33 blank was used to produce the part. Machining went well and the die manufacturer was very satisfied with the dimensional stability.

## Previous steel solution
Cast iron with extra low level of residual stresses.

## Experience
Put into service in 2006. The die is designed to a life-length of at least 20 years.

## Contact person
Ludger Weichert, SSAB Plate.

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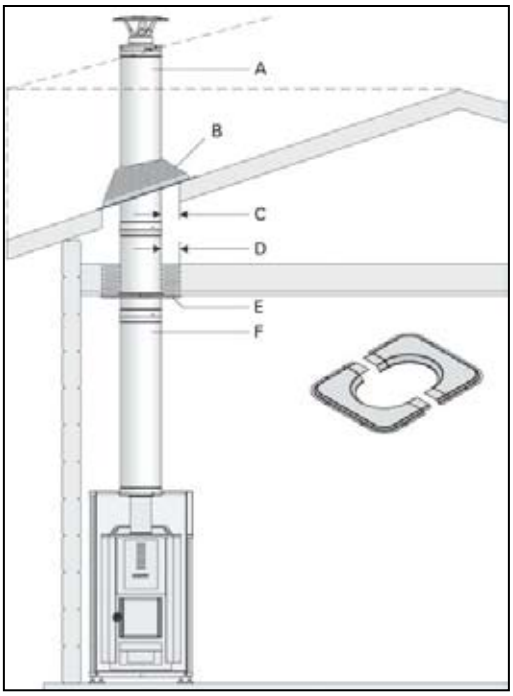
# Toolox 33 for cold forming a component in a sauna heating system




## Function
Collar for usage in a sauna heating system, see drawing above right.

## Material
AISI 430 BA sheet steel in 0.6 mm thickness with protective plastic film on one side.

## Previous steel solution
Several hardened segments of W.Nr. 1.2510 or W.Nr. 1.2767 were used.

## Manufacturing
By using a 110 mm Toolox 33 plate, the die could be made in one piece. Toolox combines the good machinability and shape stability requested.

## Experience
The die is in use. After producing between 10,000 and 20,000 pieces, the results are fully satisfactorily, The planned annual production is 30,000 components.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

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# Toolox 33 for tool for manufacturing of an automotive B-pillar

## Function
The tool is used in manufacturing of B pillars for a German car manufacturer. New tool was necessary due to new crash test requirements.

## Manufacturing
Forged Toolox 33 in size 300x600x3000 mm was used. The previous steel, W.Nr. 1.2379, was replaced due to delivery time. The lead time in die manufacturing could be reduced by two weeks as heat treatment could be avoided. Milling went well with a fine surface and a very small shape deviation, 0.01 mm on 1700 mm length. Only cemented carbide tools were used.

## Experience
The mould went into service early 2005 and has been running without any known problems since then. The average daily production of these components is 80 pillars. The mould is designed to manufacture totally 80,000 components.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

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# Toolox 33 in a die for production of aluminium elements for engine coolers

## Function
Tool for cold stamping of aluminium parts for an engine cooler.

## Material
Silicon alloyed aluminium sheet, 0.8 mm thickness.

## Manufacturing
Finish milling could be made without subsequent stress relieve tempering. To increase die surface strength, gas nitriding was carried out.

## Experience
The die has been running since 2003 and had until January 2007 produced 300,000 parts. The customer is fully satisfied with the result and has used Toolox in a new project. For the new application Toolox 44 was chosen.

## Contact person
Tomas Berglund, SSAB Plate.

SSAB

# Miscellaneous 6

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# Toolox 44 in a mould producing ceramic tiles

## Function
The press tool is used in production of ceramic tiles.

## Previous steel solution
W.Nr. 1.2080 machined and then hardened to approximately 60 HRC. Besides being a time consuming solution, the high hardness made the edges brittle.

## Manufacturing
To lower the cost of the die Toolox 44 was used in the shaping part of the tool thereby excluding heat treatment.
A blank of Toolox 160 x 160 x 35 mm was used. Nitriding was carried out.

## Experience
The tool worked quite well with nitriding. To further decrease cost and save tool manufacturing time, a new tool was made without surface nitriding. This gives a shorter die service time but a more total economical solution.

## Contact person
Ludger Weichert, SSAB Plate.

SSAB

# Data sheets 7

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# Product sheet:
## Toolox® 33, 300 HBW with ESR properties

## Specification

| | | | |
|---|---|---|---|
| **Hardness** | HBW<br>275 - 325 | | |
| **Impact toughness** | Test temperature<br>20 °C | Impact energy, Charpy-V-test for plate, transverse direction; min J<br>≤ 130 mm<br>35 | Impact energy, Charpy-V-test for forged bar, thickness direction; min J<br>> 130 mm<br>35 |
| **Ultrasonic inspection** | Ultrasonic inspection is carried out according to:<br>EN 10 160 (rolled plates)<br>EN 10228-3 (forged bars)<br>with extra demands according to specification SSAB V6. | | |
| **Etching** | Toolox 33 fulfils the etching requirements of NADCA # 207-2006. | | |
| **Dimensions** | Toolox 33 is supplied as plate in thicknesses between 5 - 130 mm, or as forged bars in thicknesses between 150 - 300 mm. | | |
| **Delivery condition** | Quenched and tempered at a minimum temperature of 590 °C. | | |
| **Heat treatment** | Toolox 33 is not intended for further heat treatment. If Toolox 33 is heated above 590 °C after delivery from SSAB Plate no guarantees for the properties of the steel are given. | | |
| **Nitriding/coating** | Nitriding or surface coating may be carried out if the temperature is below 590 °C. | | |
| **Testing** | Testing according to EN 10 025 and EN ISO 6506-1.<br>Hardness is measured on a milled surface 0.5 - 2 mm below the original surface. | | |
| **Tolerances** | Thickness, length, width and flatness tolerances according to "Dimension program and tolerances for new rolling of tool steel plates from SSAB Plate".<br>Forged bars; According to DIN 7527. | | |
| **Surface finish** | On delivery from SSAB Plate the plate meets the following specifications:<br>- free from mill scale<br>- not repair welded<br>- surface defects below the nominal ordered thickness are not permitted.<br>Forged bars according to DIN 7527. | | |

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PREHARDENED TOOL STEEL

2009-05-14

# Technical information

## Toolox® 33

## Usage

Toolox 33 is a new steel delivered quenched and tempered with high impact toughness and very low residual stresses to get good dimensional stability. Toolox 33 has a low carbide content, and is therefore excellent to machine. Toolox 33 is suitable for plastic moulding, for rubber moulding and machine components. With proper surface treatment, the service life of the tool/component can be prolonged.

## Typical Values

| CHEMICAL COMPOSITION | |
|---|---|
| C | 0.22-0.24% |
| Si | 0.6-1.1% |
| Mn | 0.8% |
| P | max 0.010% |
| S | max 0.003% |
| Cr | 1.0-1.2% |
| Mo | 0.30% |
| V | 0.10-0.11% |
| Ni | max 1% |
| $CE_{IIW}$ | 0.62-0.71 |
| CET | 0.40-0.44 |

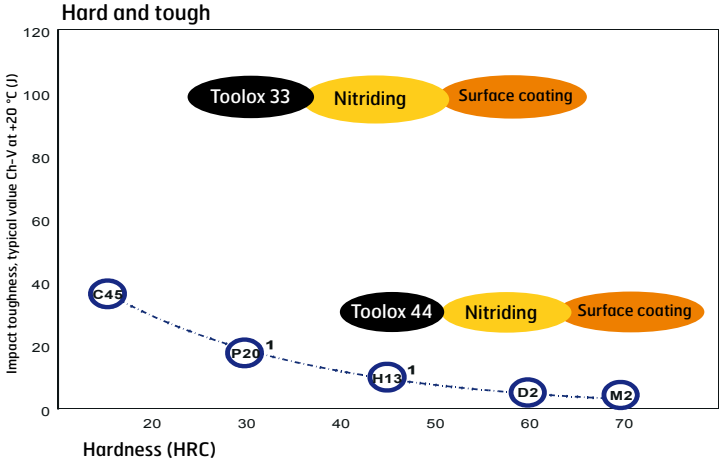
| MECHANICAL PROPERTIES | +20°C | +200°C | +300°C | +400°C | +500°C |
|---|---|---|---|---|---|
| Tensile strength, $R_m$ [MPa] | 980 | 900 | | | |
| Yield strength, $R_{p0,2}$ [MPa] | 850 | 800 | | | |
| Elongation, $A_5$ [%] | 16 | 12 | | | |
| Compressive yield strength, $R_{c0,2}$ [MPa] | 800 | 750 | 700 | 590 | 560 |
| Impact toughness [J] | 100 | 170 | 180 | 180 | |
| Hardness [HBW] | 300 | | | | |
| Hardness [HRC] | 29 | | | | |

| INCLUSIONS | |
|---|---|
| Inclusion size (equiv. diam) | 6 µm |
| Area fraction | 0.015% |
| Aspect ratio | 1.2 |

| PHYSICAL PROPERTIES | +20°C | +200°C | +400°C |
|---|---|---|---|
| Heat conductivity [W/m • K] | 35 | 35 | 30 |
| Thermal expansion coefficient, [10-6/K] | 13.1 | 13.1 | |

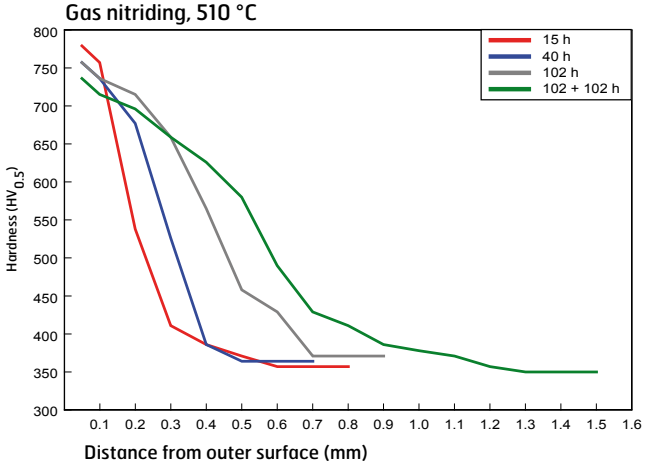
## Surface technology

Hard and tough




Footnote 1: P20 = W.Nr. 1.2311 and H13 = W.Nr. 1.2344

Gas nitriding, 510 °C

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2009-05-14

# Machining
## Toolox® 33

Toolox 33 can be machined using conventional machines. It is important that sharp tools are used, with a positive cutting angle and that vibration is avoided. Use the following recommendations as guidelines and the starting point for your own evaluation of best practice.

## Milling

**Cemented carbide cutter ISO class P 20**

Always use a positive cutting angle

Cutting speed $V_c$ = 150-250 m/min

Feed f = 0.10-0.20 mm/tooth

Speed (rpm) $n = \frac{V_c \times 1000}{\pi \times D}$

**Roughing**
Use milling cutters with circular inserts

**Finishing**
Use milling cutters with a 45° setting angle

## Drilling

**Carbide**

Cutting speed $V_c$ = 40-50 m/min

f = 0.10-0.18 mm/revolution

Feed (f ) and speed (rpm) (n)

are dependent on the drill bit

diameter D

Use coolant

**High speed steel HSS-Co**

Cutting speed $V_c$ = 13-15 m/min

Speed (rpm)

$n = \frac{V_c \times 1000}{\pi \times D}$

Use coolant

| D [mm] | FEED, f [mm/rev] |
|---|---|
| 5 | 0.10 |
| 10 | 0.10 |
| 15 | 0.16 |
| 20 | 0.23 |
| 25 | 0.30 |
| 30 | 0.35 |

## Threading

**Thread milling**

Cutting speed $V_c$ = 30 m/min

Feed (f) = 0.03 mm/tooth

**Threading HSS-Co**

Cutting speed

$V_c$ = 7-9 m/min

| DIMENSION | SPEED |
|---|---|
| M6 | 450 |
| M8 | 300 |
| M10 | 250 |
| M12 | 200 |
| M16 | 150 |

## Gas cutting / Welding

Recommended preheat temperature when gas cutting and welding. **Min. 175°C**

Recommended stress relief annealing (after slow cooling to room temperature).
after gas cutting and welding. **580 °C**

For further information see Best Practice or please contact SSAB Plate.

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# Standard dimensions

## Toolox® 33

| THICKNESS MM | WIDTH AND LENGTH |
|---|---|
| 8<br>9.5<br>11.5<br>14<br>18<br>22<br>28<br>35<br>40<br>43<br>50<br>53<br>60<br>66<br>80<br>84 | The standard width is 2100 mm and lengths between 4 and 5.8 m. Plates are delivered with mill edges. If necessary, the plates can be divided. |
| **THICKNESS MM** | **WIDTH AND LENGTH** |
| 104<br>120<br>130 | The standard width is 1700 mm and lengths between 4 and 5.8 m. Plates are delivered with mill edges. If necessary, the plates can be divided. |
| **THICKNESS MM** | **WIDTH AND LENGTH** |
| 180<br>220<br>270<br>320 | Forged bars in widths of 600 -1200 mm, dependent on thickness, and lengths of approximately 2.8 m. Please contact SSAB Plate or representatives for further information. |

If you require smaller sizes than those offered in the stock list please contact your Approved Toolox Dealer.
If larger formats are required, please contact SSAB Plate.

Toolox is the registered trademark for tool steels produced by SSAB Plate.
For more information about Toolox 33, contact SSAB Plate.

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# Product sheet:
## Toolox® 44, 450 HBW (~45 HRC) with ESR properties

## Specification

| | | | |
|---|---|---|---|
| **Hardness** | HBW<br>410 - 475 | | |
| **Impact toughness** | Test temperature<br>20 °C | Impact energy, Charpy-V-test for plate, transverse direction; min J<br>≤ 130 mm<br>18 | Impact energy, Charpy-V-test for forged bar, thickness direction; min J<br>> 130 mm<br>11 |
| **Ultrasonic inspection** | Ultrasonic inspection is carried out according to:<br>EN 10 160 (rolled plates)<br>EN 10228-3 (forged bars)<br>with extra demands according to specification SSAB V6 | | |
| **Etching** | Toolox 44 fulfils the etching requirements of NADCA # 207-2006. | | |
| **Dimensions** | Toolox 44 is supplied as plate in thicknesses between 5 - 130 mm, or as forged bars in thicknesses between 150 - 300 mm. | | |
| **Delivery condition** | Quenched and tempered at a minimum temperature of 590 °C. | | |
| **Heat treatment** | Toolox 44 is not intended for further heat treatment. If Toolox 44 is heated above 590 °C after delivery from SSAB Plate no guarantees for the properties of the steel are given. | | |
| **Nitriding/coating** | Nitriding or surface coating may be carried out if the temperature is below 590 °C. | | |
| **Testing** | Testing according to EN 10 025 and EN ISO 6506-1.<br>Hardness is measured on a milled surface 0.5 - 2 mm below the original surface. | | |
| **Tolerances** | Thickness, length, width and flatness tolerances according to "Dimension program and tolerances for new rolling of tool steel plates from SSAB Plate".<br>Forged bars; According to DIN 7527. | | |
| **Surface finish** | On delivery from SSAB Plate the plate meets the following specifications:<br>- free from mill scale<br>- not repair welded<br>- surface defects below the nominal ordered thickness are not permitted.<br>Forged bars according to DIN 7527. | | |

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# Technical information

## Toolox® 44

## Usage

Toolox 44 is a new steel delivered quenched and tempered with high impact toughness and very low residual stresses to get good dimensional stability. Despite its hardness of 450 HBW (~45 HRC), Toolox 44 is easily machined. Toolox 44 has high strength at elevated temperature and is suitable for dies and tools such as plastic, rubber, die casting, bending and sheet forming tools. Toolox 44 is also well suited as machine components such as wear parts, guide rails, hot applications. With proper surface treatment, the service life of the tool/component can be prolonged.

## Typical Values

| CHEMICAL COMPOSITION | |
|---|---|
| C | 0.32% |
| Si | 0.6-1.1% |
| Mn | 0.8% |
| P | max 0.010% |
| S | max 0.003% |
| Cr | 1.35% |
| Mo | 0.80% |
| V | 0.14% |
| Ni | max 1% |
| CEIIW | 0.92-0.96 |
| CET | 0.55-0.57 |

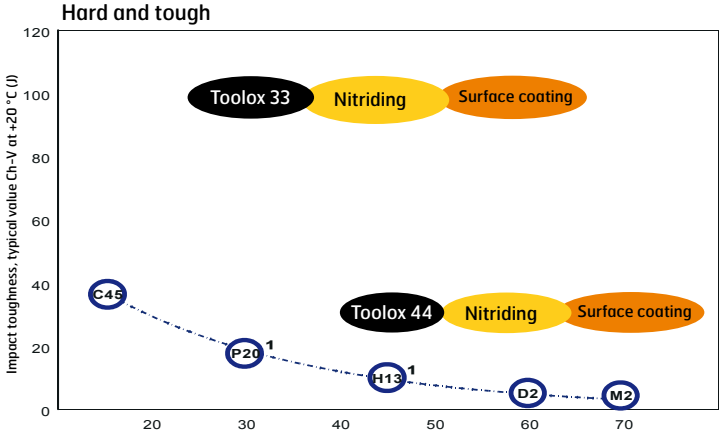
| MECHANICAL PROPERTIES | +20°C | +200°C | +300°C | +400°C | +500°C |
|---|---|---|---|---|---|
| Tensile strength, $R_m$ [MPa] | 1450 | 1380 | | | |
| Yield strength, $R_{p0,2}$[MPa] | 1300 | 1200 | | | |
| Elongation, $A_5$ [%] | 13 | 10 | | | |
| Compressive yield strength, $R_{c0,2}$ [MPa]<br>- after 170 h soaking time | 1250 | 1120 | 1120 | 1060<br>1060 | 930<br>910 |
| Impact toughness [J] | 30 | 60 | 80 | 80 | |
| Hardness [HBW] | 450 | | | | |
| Hardness [HRC] | 45 | | | | |

| INCLUSIONS | |
|---|---|
| Inclusion size (equiv. diam) | 6 µm |
| Area fraction | 0.015% |
| Aspect ratio | 1.2 |

| PHYSICAL PROPERTIES | +20°C | +200°C | +400°C |
|---|---|---|---|
| Heat conductivity [W/m • K] | 34 | 32 | 31 |
| Thermal expansion coefficient, [10-6/K] | 13.5 | 13.5 | 13.5 |

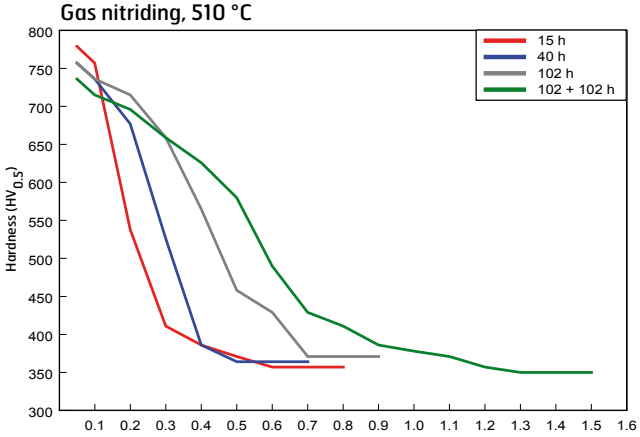
## Surface technology

Hard and tough




Footnote 1: P20 = W.Nr. 1.2311 and H13 = W.Nr. 1.2344

Gas nitriding, 510 °C

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# Machining
## Toolox® 44

Toolox 44 can be machined using conventional machines. It is important that sharp tools are used, with a positive cutting angle and that vibration is avoided. Use the following recommendations as guidelines and the starting point for your own evaluation of best practice.

## Milling

**Cemented carbide cutter ISO class P 20**

Always use a positive cutting angle

Cutting speed $V_c$ = 100-150 m/min

Feed f = 0.10-0.15 mm/tooth

Speed (rpm) $n = \frac{V_c \times 1000}{\pi \times D}$

**Roughing**
Use milling cutters with circular inserts

**Finishing**
Use milling cutters with a 45˚setting angle

## Drilling

**Carbide**

Cutting speed $V_c$ = 30-40 m/min

f = 0.10-0.15 mm/revolution

Feed (f ) and speed (rpm) (n)

are dependent on the drill bit

diameter D

Use coolant

**High speed steel HSS-Co**

Cutting speed $V_c$ = 6-8 m/min

Speed (rpm)

$n = \frac{V_c \times 1000}{\pi \times D}$

Use coolant

| D [mm] | FEED, f [mm/rev] |
|---|---|
| 5 | 0.05 |
| 10 | 0.09 |
| 15 | 0.15 |
| 20 | 0.20 |
| 25 | 0.25 |
| 30 | 0.30 |

## Threading

**Thread milling**

Cutting speed $V_c$ = 30 m/min

Feed (f) = 0.03 mm/tooth

**Threading HSS-Co**

Cutting speed

$V_c$ = 2.5-4 m/min

| DIMENSION | SPEED |
|---|---|
| M6 | 160 |
| M8 | 120 |
| M10 | 95 |
| M12 | 80 |
| M16 | 60 |
| M20 | 50 |

## Gas cutting / Welding

Recommended preheat temperature when gas cutting and welding. **Min. 250˚C**

Recommended stress relief annealing (after slow cooling to room temperature).
after gas cutting and welding. **580 ˚C**

For further information see Best Practice or please contact SSAB Plate.

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# Standard dimensions

## Toolox® 44

| THICKNESS MM | WIDTH AND LENGTH |
|---|---|
| 8<br>9.5<br>11.5<br>14<br>18<br>22<br>28<br>35<br>40<br>43<br>50<br>53<br>60<br>66<br>80<br>84 | The standard width is 2100 mm and lengths between 4 and 5.8 m. Plates are delivered with mill edges. If necessary, the plates can be divided. |
| **THICKNESS MM** | **WIDTH AND LENGTH** |
| 104<br>120<br>130 | The standard width is 1700 mm and lengths between 4 and 5.8 m. Plates are delivered with mill edges. If necessary, the plates can be divided. |
| **THICKNESS MM** | **WIDTH AND LENGTH** |
| 180<br>220<br>270<br>320 | Forged bars in widths of 600 -1200 mm, dependent on thickness, and lengths of approximately 2.8 m. Please contact SSAB Plate or representatives for further information. |

If you require smaller sizes than those offered in the stock list please contact your Approved Toolox Dealer.
If larger formats are required, please contact SSAB Plate.

Toolox is the registered trademark for tool steels produced by SSAB Plate.
For more information about Toolox 44, contact SSAB Plate.

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# Best Practice
## Flamecutting of Toolox® 33

# Recommended flame cutting procedure

1. When flame cutting Toolox 33 preheat both sides of the kerf, approximately 100-150 mm on each side.
   The preheat temperature shall be reached in the plate centre. Maintain the preheat temperature throughout the entire cutting operation.
   **The preheat temperature for Toolox 33 is 150-200 °C**

2. Cut.

3. Apply a post-cut heat treatment of 560-580 °C for the whole cut piece or, if large sizes are cut, 100 – 150 mm from the cutting edge. The post-cut heat treatment shall start within a limited time after the pieces have been cut. The soaking time shall be 5 min/mm thickness or at least 60 min. The soaking time to be counted from when the centre part has reached the aimed heat treatment temperature. Normally, 2 hours soaking time is sufficient.
   **Maximum time to elapse before starting heat treatment after flame cutting is 9 hours.**

4. The plate/part shall cool in open air to room temperature.

5. From the gas-cut edge:
   *5 mm shall be milled off to remove the heat affected zone generated by the cutting operation.
   *Another 5 mm shall be milled off if a shape stable material is necessary for further machining/sawing etcetera.

6. Calibrate your post heat treatment procedure by hardness control of the base material and of the heat affected zone. The base material shall show no hardness deterioration. Theheat affected zone shall have the same, or almost the same hardness as the un-affected base material.

**Before flame cutting in Toolox 44 please contact SSAB Plate.**

**Flame cut blanks for a bearing house.**

**Final product.**

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# Best Practice
## Welding of Toolox®

# Recommended welding procedure

1. Preheat both sides of the weld groove, approximately 100-150 mm on each side. The preheat temperature shall be reached in the plate centre. Maintain the preheat temperature throughout the entire welding operation, especially during tack welding.
   The preheat temperature:
   ***170-200 °C for Toolox 33**
   ***225-275 °C for Toolox 44**

2. Use as soft electrodes as possible, or stainless electrodes. The electrodes must be dry with a maximum hydrogen content of 5 ml/100g weld deposit. For best texturing quality use TIG-welding with a fi ller wire of the same chemical composition as the base material. The easiest way is then to saw a rod from a spare part of the base material.

3. Weld with a heat input giving $\Delta t_{8/5}$ between 10 and 20 s.

4. During welding:
   **Maintain a minimum interpass temperature of:**
   ***170 °C for Toolox 33**
   ***225 °C for Toolox 44**

5. Apply a post-weld heat treatment approximately 100-150 mm from each side of the weld. The soaking time shall be 5 min/mm plate thickness or minimum 60 minutes. Normally, 2 hours soaking time is suffi cient. The soaking time shall be counted from when the temperature has been reached in the entire tempering volume.

   ***Use a post-weld heat treatment temperature of 150-200 °C if low demands are put on shape stability.**

   ***Use a post-weld heat treatment temperature of 560-580 °C if high demands are put on shape stability and to minimize the infl uence from the weld on the texturing result.**

6. After the post-weld heat treatment the component shall cool in open air to room temperature.

**Welded and textured Toolox.**

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# Best Practice
## Machining of Toolox®

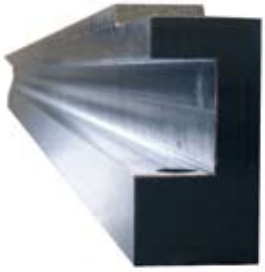
**SSAB Plate is neither an expert in machining nor a cutting tool supplier. We do not claim to have optimum solutions in machining, but we happily share our experience with you as suggestions for your machining optimization. Cutting tool suppliers are experts to contact regarding machining.**

## Machining

Normally, machining in Toolox is no problem when using positive cutting angles. As Toolox has a tendency to deformation hardening, the window for optimal cutting conditions is a bit smaller. It is important to keep the feed, and reduce cutting speed if cutting edge wear is too high. Our recommendations are published on **www.toolox.com**.

## Blue chips

The machinability of Toolox has been improved. During milling you will notice it as the chips produced are very bluish. We have modified the carbide morphology as compared to traditional tool steels, using less carbon in Toolox. Thereby the heat generated during milling is transferred into the chip and not into the cutting edge.



## Clamping

Toolox has very low level of residual stresses. To get the full effect make sure to use deformation free clamping. If blanks are gas cut, mill off 5-10 mm from the gas cut edge to get a blank free from residual stresses.

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# Best Practice
## Machining of Toolox®

## Drilling of cooling channels
### 20-30 times the drill diameter

The latest technology is cemented carbide drills with internal cooling. A new internal cooled cemented carbide drill which works extremely well has been presented by Wirth and is marketed by Hoffmann, see www.hoffmann.com, item No. 123695 for further information.

When using high speed drills we suggest use of cobalt alloyed grades, plenty of coolant and "wood pecker drilling". Use of mechanical feed is important. A re-shaping of the tip angle to 110-118° prolongs the service life by 2-3 times as compared to a standard tip angle of 130°. The explanation for this increase in service life is a change in wear pattern from peripheral wear to tip wear. Further information is given on **www.guehring.de**.

## Deep hole drilling
### 10-12 times the drill diameter

When drilling deep holes with high demands on surface tolerances, straight fluted internal cooled cemented carbide drills have been successfully used. The surface quality of these holes is as they were reamed. The drill used, Futura Coated M2612 12xD, is made by Miller. Further information is given on **www.miller-tools.de**.

## Tapping

The most critical machining operation in Toolox 44 is tapping. A good alternative, when possible, is thread milling. When using thread taps it is crucial to find the correct tap. Very good results have been achieved with taps from Emuge-Franken, see www.emuge-franken.de, with their:

- **M5 Rekord 1A-Z-TiCN**
- **M6 Rekord 1A-Z-TiCN**

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# Best Practice
## Polishing Toolox®

**SSAB Plate is neither an expert nor a supplier of polishing.**
**We by no means claim to have found the optimum solutions, but we are happy to share the experience from our partner.**

# When polishing Toolox

1. Honing with coarse honing stone, for instance grain size 120. All marks of milling or EDM is here worked off completely. The work is preferably done with a flat side of the honing stone to achieve as flat an even surface as possible. Vary the directions of the honing (in X-shape). This helps when it comes to get an even surface, and at the same time more efficient and thereby time saving work is done.

2. Honing acc. to above, but with fine grain, for instance grain size 320. All remaining marks left by the previous honing (in step 1) are here completely removed.

3. Rough polishing with diamond paste on a brass piece. Grain size 45 microns (µm). This is continues until all remaining traces of the previous honing in step 2 are completely removed.

4. Acc. to step 3, but with 15 µm diamond paste. Continue until all remaining traces from step 3 are removed.

5. Acc. to step 4, but with 7 µm diamond paste. Continue until all remaining traces from step 4 are removed.

6. Polishing with 7 µm diamond paste on fibre or plastic element. Continue until all remaining traces from step 5 are removed.

7. Polishing with 3 µm diamond paste on fibre or plastic element. Continue until all remaining "nuance differences" from step 6 are completely removed. (We here use the term "nuance" since the surface by now is so fine that one hardly can talk about any, for the naked eye, visible scratches anymore).

8. Polishing with 3 µm diamond paste on felt element. Continue until all nuance differences from step 7 are removed.

9. Final polishing with 3 µm diamond paste and cotton. This is manual work, and now the final gloss is given.

   Continue until an even gloss is achieved over the entire surface.

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# Best Practice
## Polishing and texturing Toolox®

# To consider when polishing Toolox

**Be thoughtful!**
As every step is performed, remaining marks and scratches from the previous step must be completely removed.
For example: Say that step 3 above is not done good enough, and you in the following step (4) see scratches remaining from step 2, attempts to remove them will fail. The only thing to do is to go back to step 3 and to this step again until it is completed. There are no short cuts!

**Keep clean!**
Between every step the work piece, and everything that comes in contact with it, must be completely cleaned so that no coarse particles prom the previous step comes in contact with the surface. For example: If diamond paste from step 4 (15 micron) remains as the polishing in step 5 begins (with 7 micron paste), the coarser grains from the 15 micron paste will give scratches no matter how much polishing is done with the finer paste.

**Don't over-polish!**
Excess polishing with a soft material (felt, for example) can easily cause an "orange peel" surface. It is often tempting to polish "a little extra" on areas where perhaps remaining scratches from previous steps are seen in order to get rid of them, but this can easily create an orange peel surface in this area. Furthermore, also the finest diamond paste works of some material, and that means that a local - more intensive - polishing, will give waviness on the surface.

**Half the central part is re prepared after claim of "orange surface".**

# Texturing Toolox

**Standex certificate Toolox 33 and Toolox 44**
Toolox is a homogenous material, with properties as ESR remelted material. Because of its homogeneity Toolox is well suited for texturing. We have acceptance from different texturing companies like Standex, Surface etching cooperation group etc.

SVENSK INDUSTRIGRAVYR
www.industrigravyr.se


CERTIFIKATE
for chemical texturing of tool steel
SSAB
OXELÖSUND
TOOLOX 33


CERTIFIKATE
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Title .....

Photo

Function .....

Experience .....

Previous solution .....

Contact Person .....

Manufacturing .....

SSAB

SSAB is a global leader in value added high strength steel. SSAB offers products developed in close cooperation with its customers to reach a stronger, lighter and more sustainable world.

SSAB employs over 9 200 people in over 45 countries around the world and operates production facilities in Sweden and the US. SSAB is listed on the NASDAQ OMX Nordic Exchange, Stockholm.

For more information, contact us or visit **www.ssab.com**

021-Toolox application album Moulds & Dies -UK-V1-2009. Österbergs & Sörmlandstryck, Nyköping

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