# Welcome to Workshop-Automotive Tooling

## Uddeholm Swedish Rally 2008

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# Workshop program

## Program proposal

- New generation of cold work tool steels for blanking and forming of AHSS
- Numerical simulation of sheet forming to aid selection of anti-galling tool steels
- Questions, discussions.....



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# Tooling solutions for Advanced High Strength Steels

Börje Johansson, Product Manager Uddeholm Tooling

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# Automotive trends

## Demands on presslines

- **New work materials with high strength**
- **Higher press speeds**
- **Less number of work stations**
- **Less use of chlorinated lubricants**
- **High demands on productivity**



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# Environment & safety


**Reduce $CO_2$ emissions in EU from 166 g/km 2003 to 140 g/km 2008**

**Reach 5 stars in EuroNCAP and USNCAP crash tests**

***Reduction of vehicle weight by use of thinner but stronger sheet materials***



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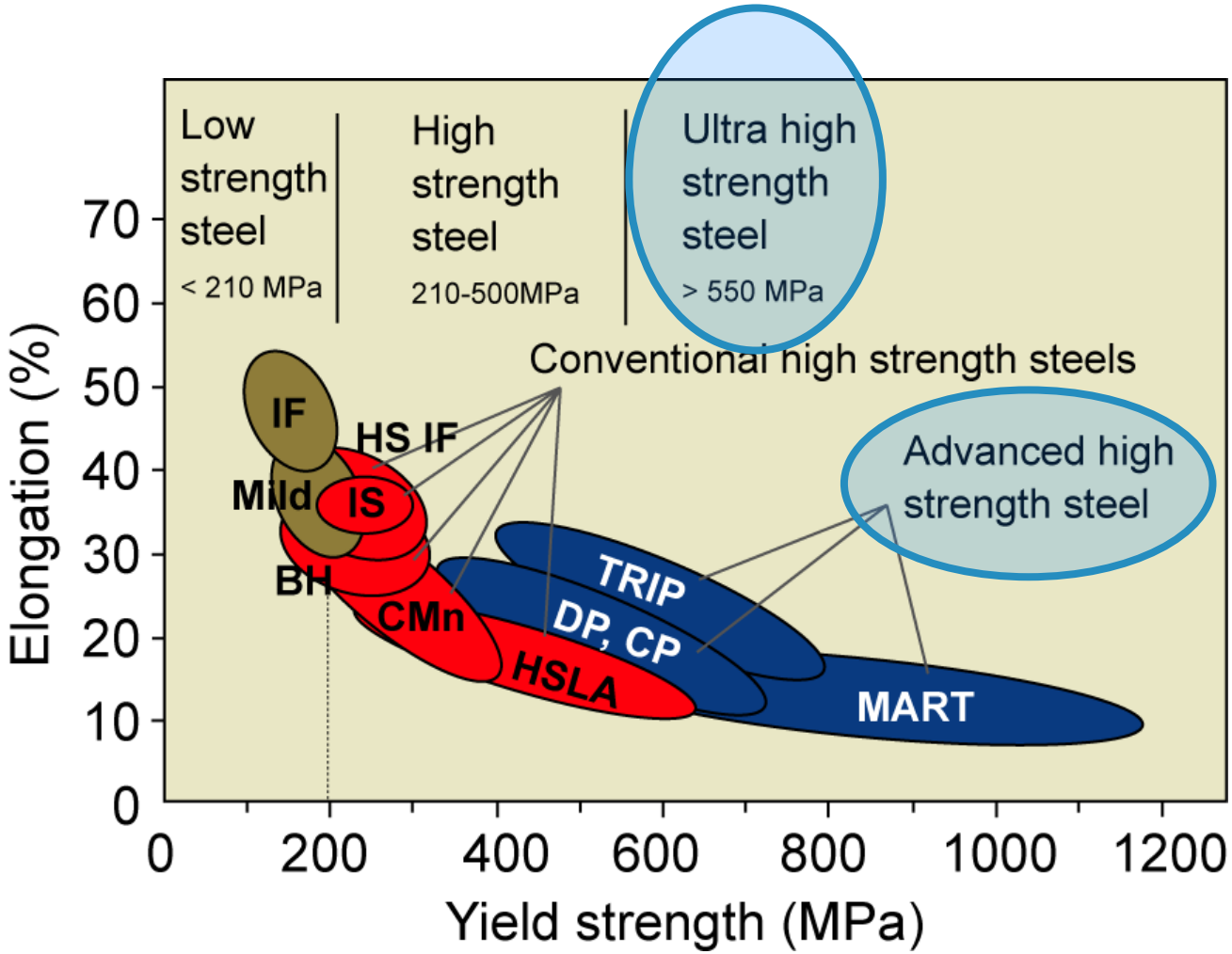
# What are Advanced High Strength Steels?



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# The automotive tooling environment

## Blanking and Forming AHSS Sheet

**In blanking**

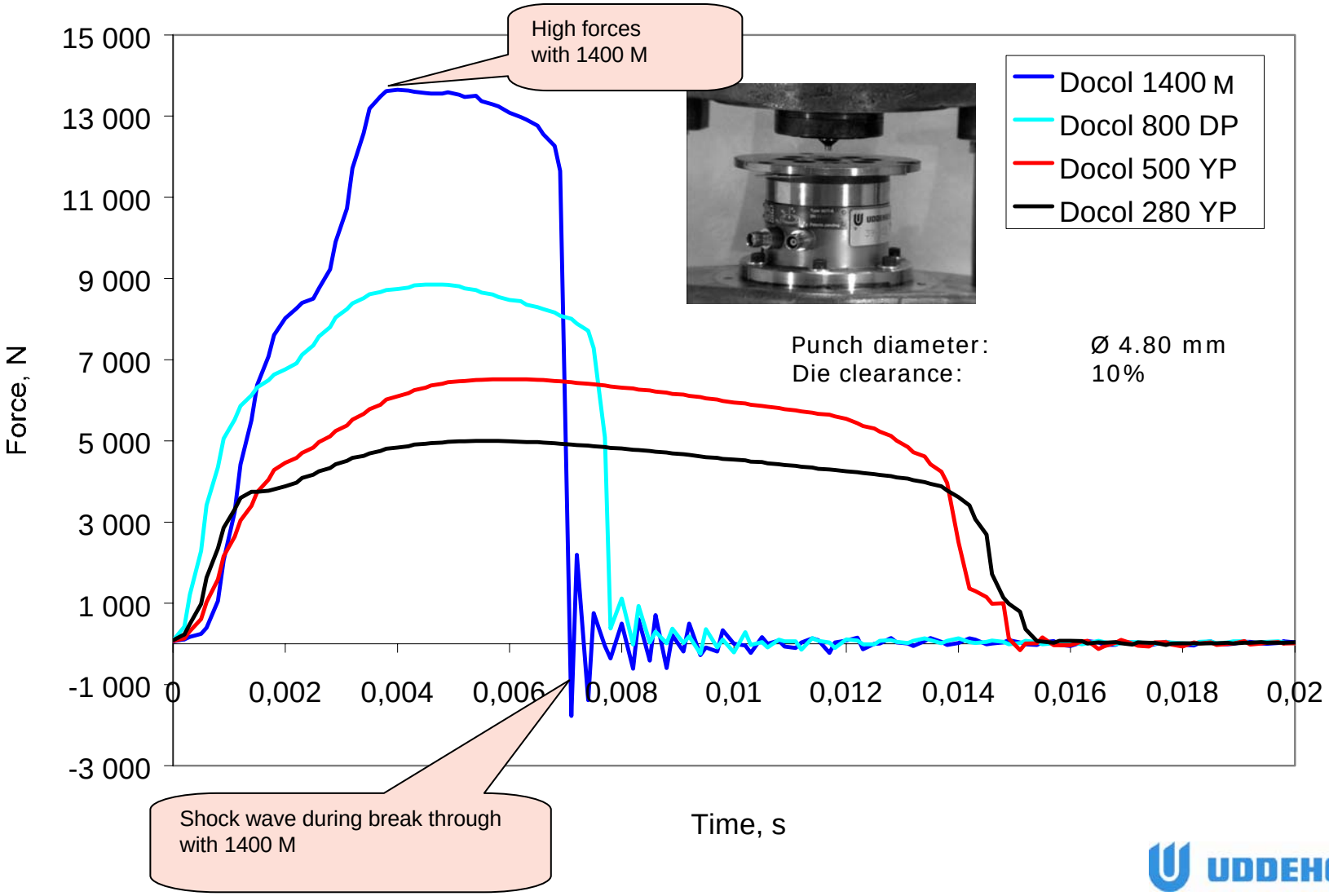
Shear strength of sheet material must be exceeded

**In forming**

Yield strength of sheet material must be exceeded

# The presswork tooling environment

## Influence of sheet material strength on blanking force



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# The presswork tooling environment

## Influence of increasing sheet strength (hardness)

Blanking and Forming

| Type of sheet | Strength $R_m$ (MPa) | Blanking | | Forming | |
|---|---|---|---|---|---|
| | | Tool failure | Note | Tool failure | Note |
| Soft -mild | < 330 | •Increased wear | • Changed die clearance | •Increased wear | •Reduced formability |
| High strength | 330-570 | •Increased chipping-cracking | • Reduced burr formation | •Increased galling | •Increased spring back |
| Extra high strength | 570-800 | •Increased plastic deformation | | | •Increased wrinkling problems |
| Ultra high strength | > 800 | | •Shock waves | | |



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# The presswork tooling environment

**The most used tool steels for blanking, trim, forming and calibration dies:**

| | | |
|---|---|---|
| 5%Cr-steel | AISI A2 | W.-Nr. 1.2363 |
| 12% cr-steel | AISI D2 | W.-Nr. 1.2379 |

**These grades are not always suitable for demanding presswork applications especially for higher strength sheet materials**



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# The new generation press work tool steels from Uddeholm Tooling

| Uddeholm grade | Type of metallurgy | AISI/ W.-Nr. | % C | % Si | % Mn | % Cr | % Mo | % W | % V |
|---|---|---|---|---|---|---|---|---|---|
| UNIMAX | ESR | - | 0,50 | 0,20 | 0,50 | 5,0 | 2,30 | - | 0,5 |
| CALDIE | ESR | - | 0,70 | 0,20 | 0,50 | 5,0 | 2,30 | - | 0,5 |
| SLEIPNER | Conventional | - | 0,90 | 0,90 | 0,50 | 7,80 | 2,50 | - | 0,5 |
| VANADIS 4 EXTRA | PM Superclean[3] | - | 1,40 | 0,40 | 0,40 | 4,70 | 3,50 | - | 3,70 |
| WEARTEC SF | Spray forming | - | 2,80 | 0,80 | 0,70 | 7,00 | 2,30 | - | 7,20 |
| VANCRON 40 | PM Superclean [3] + nitrogenation | - | 3,00* | 0,50 | 0,40 | 4,50 | 3,20 | 3,70 | 8,50 |
| * C+N= 3 % | | | | | | | | | |
| **Reference: Old generation presswork tool steels** | | | | | | | | | |
| RIGOR | Conventional | A2/ 1.2363 | 1,00 | 0,30 | 0,80 | 5,30 | 1,10 | - | 0,20 |
| SVERKER 21 | Conventional | D2/ 1.2379 | 1,55 | 0,30 | 0,40 | 11,80 | 0,80 | - | 0,80 |
| CARMO/ CALMAX | Conventional | - / 1.2358 | 0,60 | 0,35 | 0,80 | 4,50 | 0,50 | - | 0,20 |



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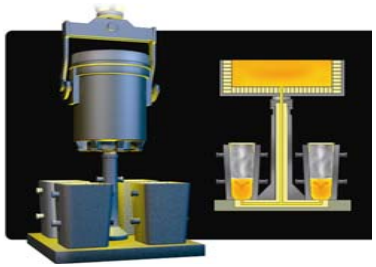
# CALDIE



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| UDDEHOLM grade | Abrasive wear resistance | Adhesive wear resistance | Cracking resistance | | Plastic deformation resistance |
|---|---|---|---|---|---|
| | | | Chipping | Total breakage | |
| RIGOR | | | | | |
| SVERKER 21 | | | | | |
| CARMO/CALMAX | | | | | |
| | | | | | |
| CALDIE | | | | | |
| UNIMAX | | | | | |
| SLEIPNER | | | | | |
| | | | | | |
| WEARTEC SF | | | | | |
| | | | | | |
| VANADIS 4 Extra | | | | | |
| | | | | | |
| VANCRON 40 | | | | | |

- Very good combination of chipping resistance and compressive strength which make Caldie very useful for blanking and forming of AHSS
- Very good through hardening properties and can reach 62 HRC after high temperature tempering
- A perfect substrate steel for all types of surface coatings



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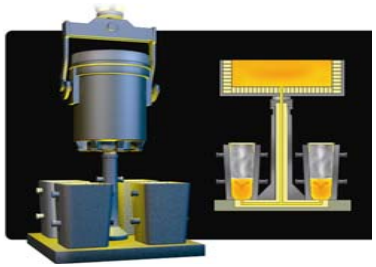
# UNIMAX



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|---|---|---|---|---|---|
| | | | Chipping | Total breakage | |
| RIGOR | | | | | |
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| UNIMAX | | | | | |
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| WEARTEC SF | | | | | |
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| VANADIS 4 Extra | | | | | |
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| VANCRON 40 | | | | | |

- **An extremely good chipping resistance at 58 HRC makes Unimax to the best problem solver at premature tool failures caused by chipping and cracking**
- **Very good through hardening properties and can reach 58 HRC after high temperature tempering**
- **A very good substrate steel for surface coatings if 58 HRC gives enough compressive strength to support the layer.**



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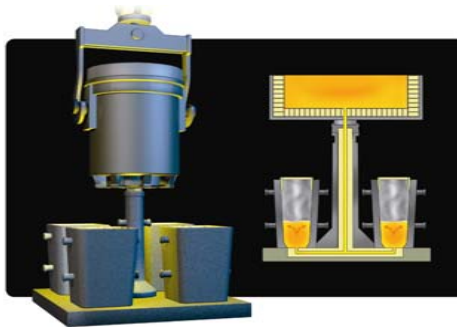
# SLEIPNER



| UDDEHOLM grade | Abrasive wear resistance | Adhesive wear resistance | Cracking resistance | | Plastic deformation resistance |
|---|---|---|---|---|---|
| | | | Chipping | Total breakage | |
| RIGOR | | | | | |
| SVERKER 21 | | | | | |
| CARMO/CALMAX | | | | | |
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| VANADIS 4 Extra | | | | | |
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| VANCRON 40 | | | | | |

- **Sleipner is a universal presswork tool steel with the potential to replace AISI D2/ W.-Nr. 1.2379 as the standard steel for presswork tooling**
- **Smaller volume of carbides as well as smaller size of the carbides are balanced with a broader hardness range compared to D2 which gives a tool steel with a very wide properties profile**
- **Sleipner can be hardened up to 64 HRC after high temperature tempering. Sleipner is also a very good substrate steel for surface coatings.**



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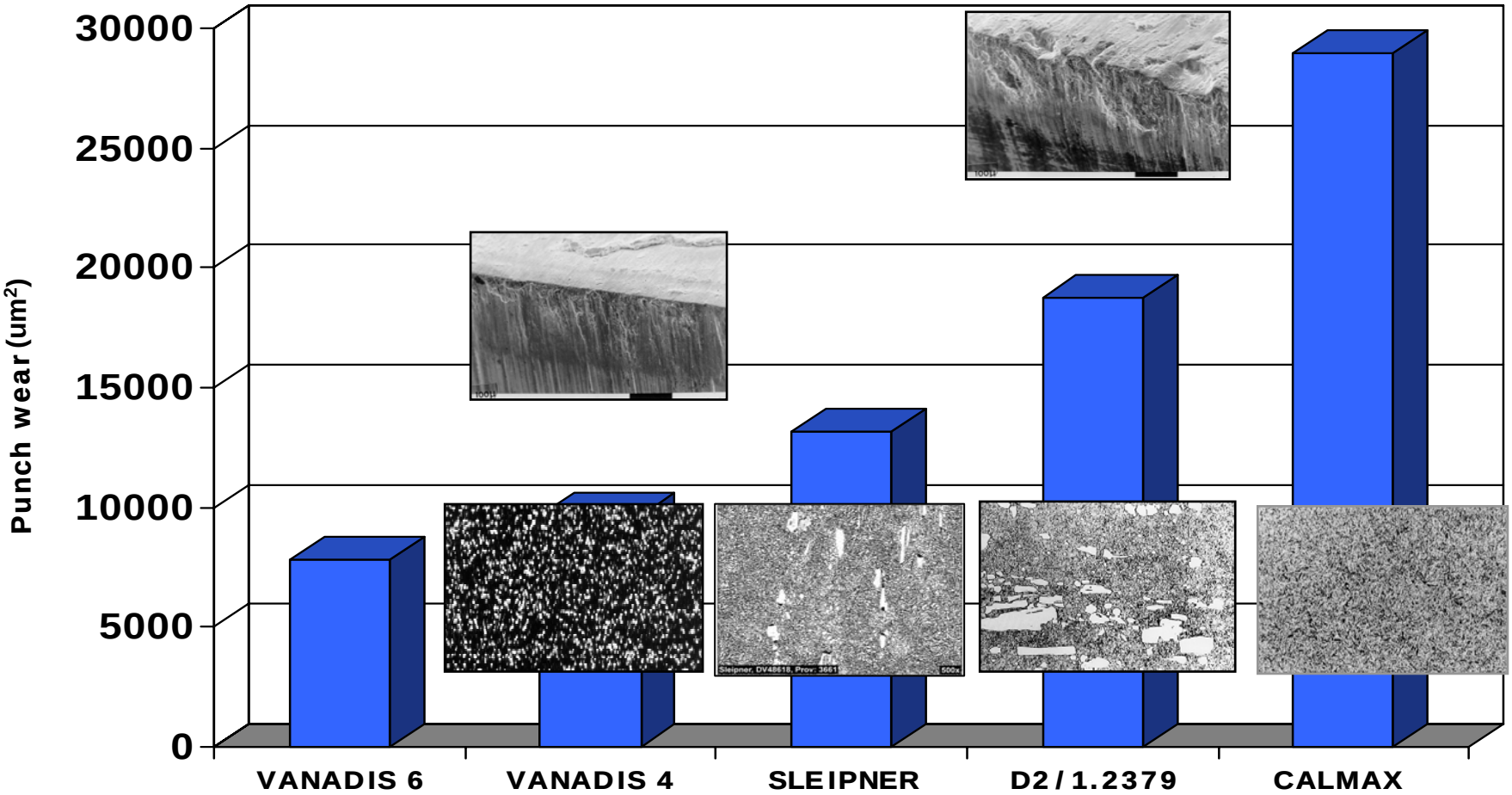
# Blanking of Docol 1400 M, t= 1mm

## Punch wear after 200 000 strokes

**Tool hardness:60 HRC; CALMAX 58 HRC**



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# VANADIS 4 EXTRA

| UDDEHOLM grade | Abrasive wear resistance | Adhesive wear resistance | Cracking resistance | | Plastic deformation resistance |
|---|---|---|---|---|---|
| | | | Chipping | Total breakage | |
| RIGOR | | | | | |
| SVERKER 21 | | | | | |
| CARMO/CALMAX | | | | | |
| | | | | | |
| CALDIE | | | | | |
| UNIMAX | | | | | |
| SLEIPNER | | | | | |
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| WEARTEC SF | | | | | |
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| VANADIS 4 Extra | | | | | |
| | | | | | |
| VANCRON 40 | | | | | |

- Vanadis 4, the first PM tool steel from Uddeholm Tooling is now replaced by Vanadis 4 Extra
- The carbides in Vanadis 4 have been exchanged with harder and smaller carbides in Vanadis 4 Extra, giving an improved chipping resistance while maintaining wear resistance
- The steel can reach 64 HRC. The properties profile make Vanadis 4 Extra to a very good substrate for surface coatings

- Vanadis 4 Extra has the best combination of wear resistance and chipping resistance



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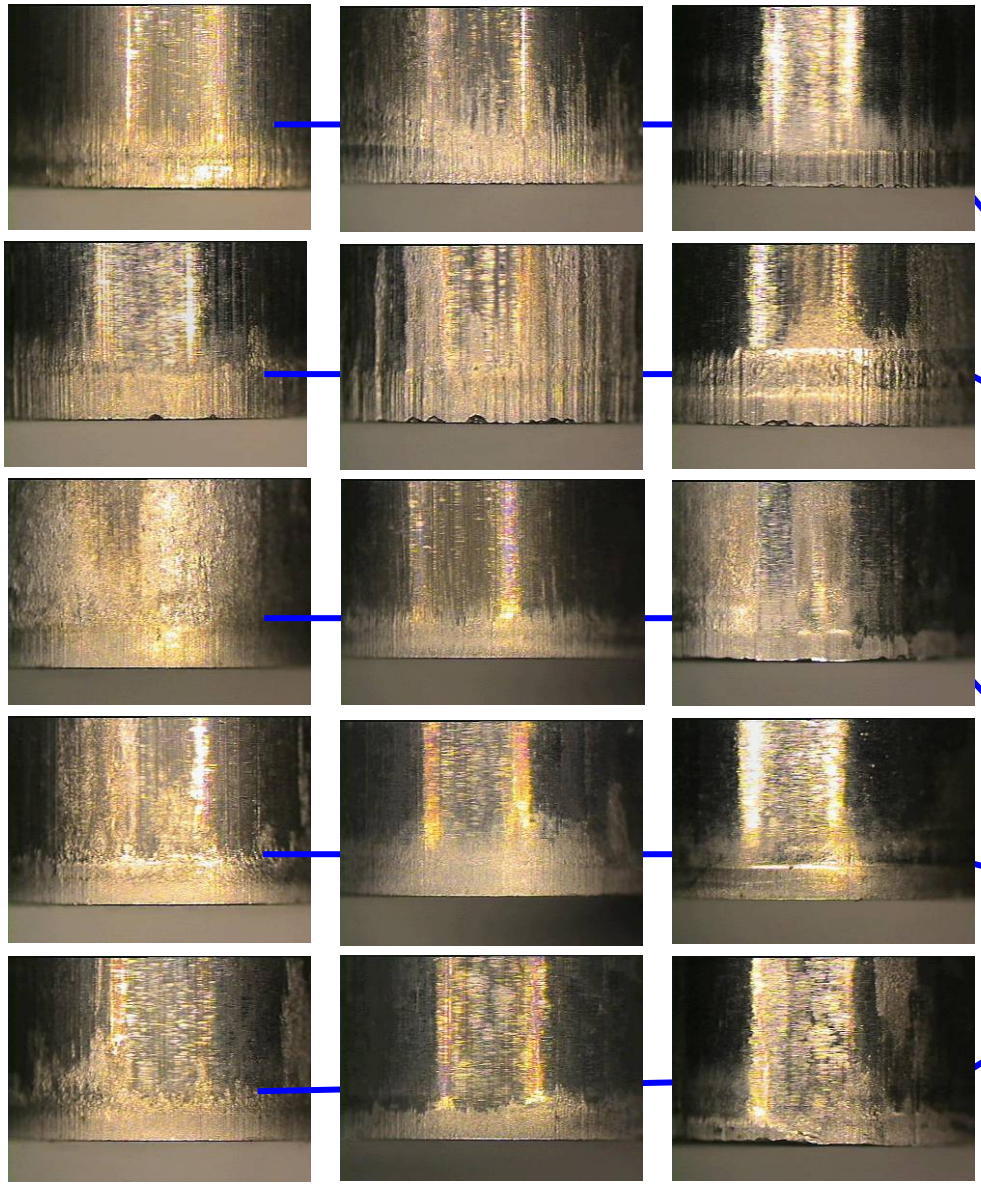
# Tool steel development

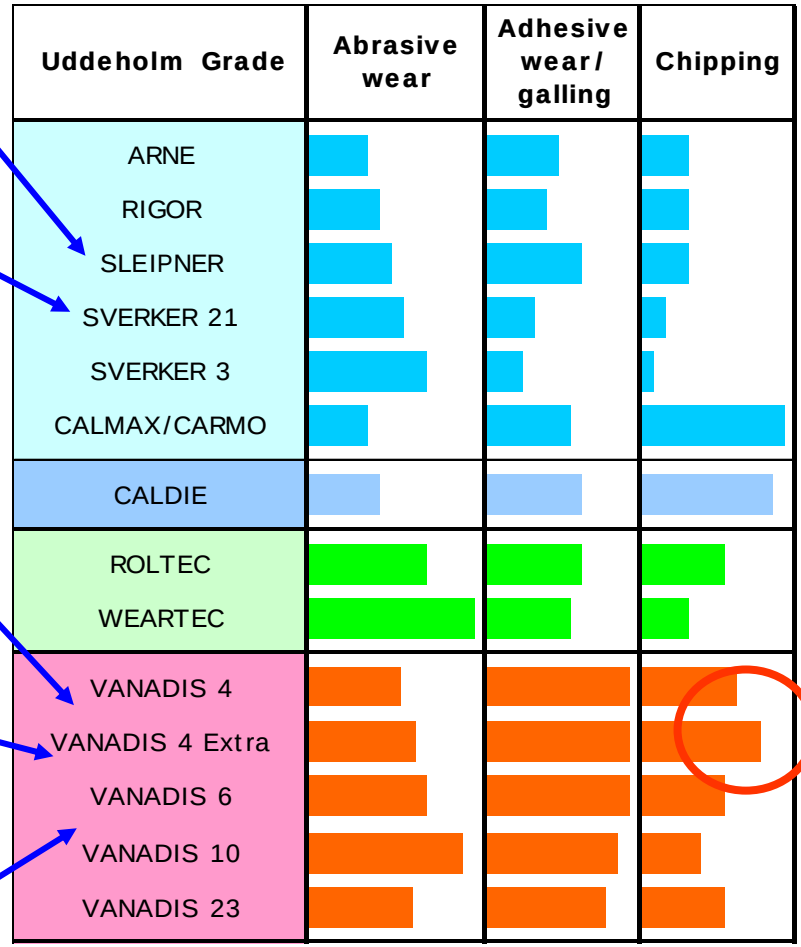
Trip 700 | CP-W 800 | MS-W 1200



**Blanking of AHSS, t=1,8 mm**

**Edge appearance after 50 000 strokes**

**Limiting tool steel failure mechanisms**

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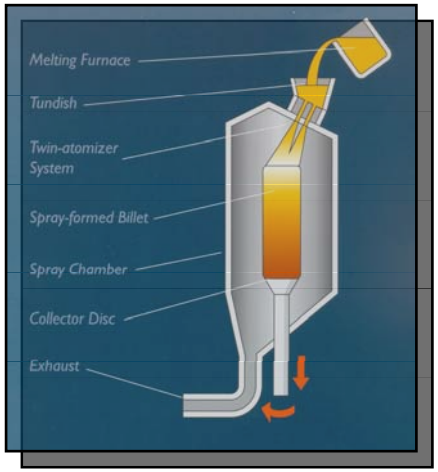
# WEARTEC SF




| UDDEHOLM grade | Abrasive wear resistance | Adhesive wear resistance | Cracking resistance | | Plastic deformation resistance |
|---|---|---|---|---|---|
| | | | Chipping | Total breakage | |
| RIGOR | | | | | |
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| SLEIPNER | | | | | |
| | | | | | |
| WEARTEC SF | | | | | |
| | | | | | |
| VANADIS 4 Extra | | | | | |
| | | | | | |
| VANCRON 40 | | | | | |

- **Weartec SF represents a totally new process route to produce tool steels giving properties between ESR and PM**
- **Weartec SF is a very highly alloyed steel and the big advantage with spray forming is that no carbide networks are created as for conventional ingot metallurgy**
- **Weartec SF is the most wear resistant tool steel on the market.The wear resistance is not far away from cemented carbides and with a fairly good chipping resistance**
- **A hardness level of 64 HRC can be reached after hardening**



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# VANCRON 40

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|---|---|---|---|---|---|
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| | | | | | |
| VANCRON 40 | | | | | |

- **The development of Vancron 40 is a real innovation in the world of tooling. It is probably the start of a paradigm shift as it has the potential to totally change the way of thinking around the solutions of tribological problems connected with tooling**

- **The galling and adhesive wear resistance is extremely good while the abrasive wear resistance is moderate**
- **At galling and adhesive wear tool failures Vancron 40 gives a performance similar to surface coated tool steels. For the highest sheet strength levels surface coatings give better result to date. But the development has just started!**



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# Tooling Requirements for Forming of AHSS Sheet

## Forming operation is concerned with:

- high wear & galling resistance
- compressive strength
- cracking resistance due to contact fatigue

**Cracking problems can also be aggravated by galling / adhesive wear due to the ongoing surface deterioration**

# Tooling Requirements for Forming of AHSS Sheet

## Galling resistance

**For uncoated AHSS sheet uncoated forming tools will normally not be suitable**

**Coated tool steels will normally be necessary but there is an exception – VANCRON 40**



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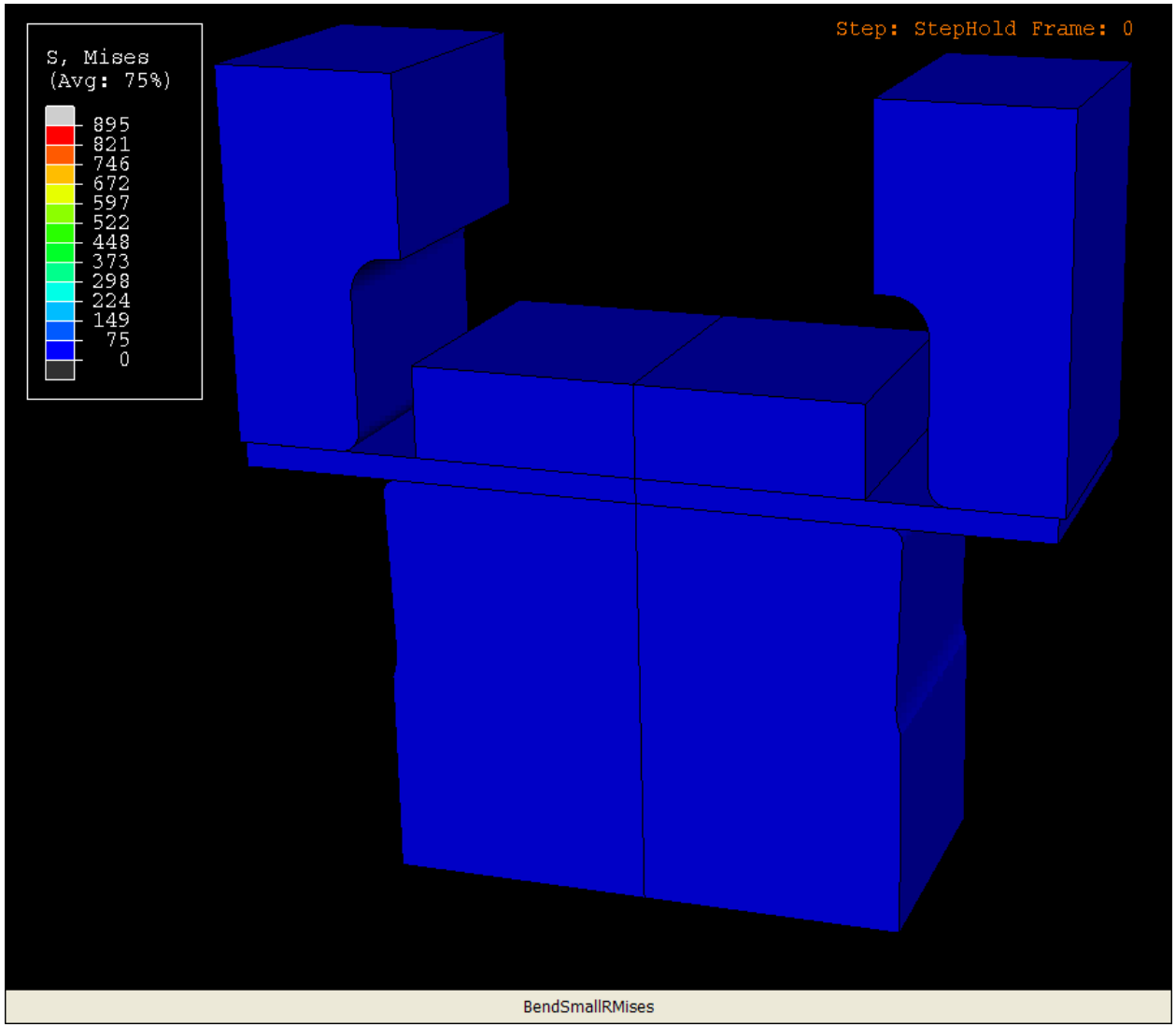
# Tooling Requirements for Forming of AHSS Sheet



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# Tooling Requirements for Forming of AHSS Sheet

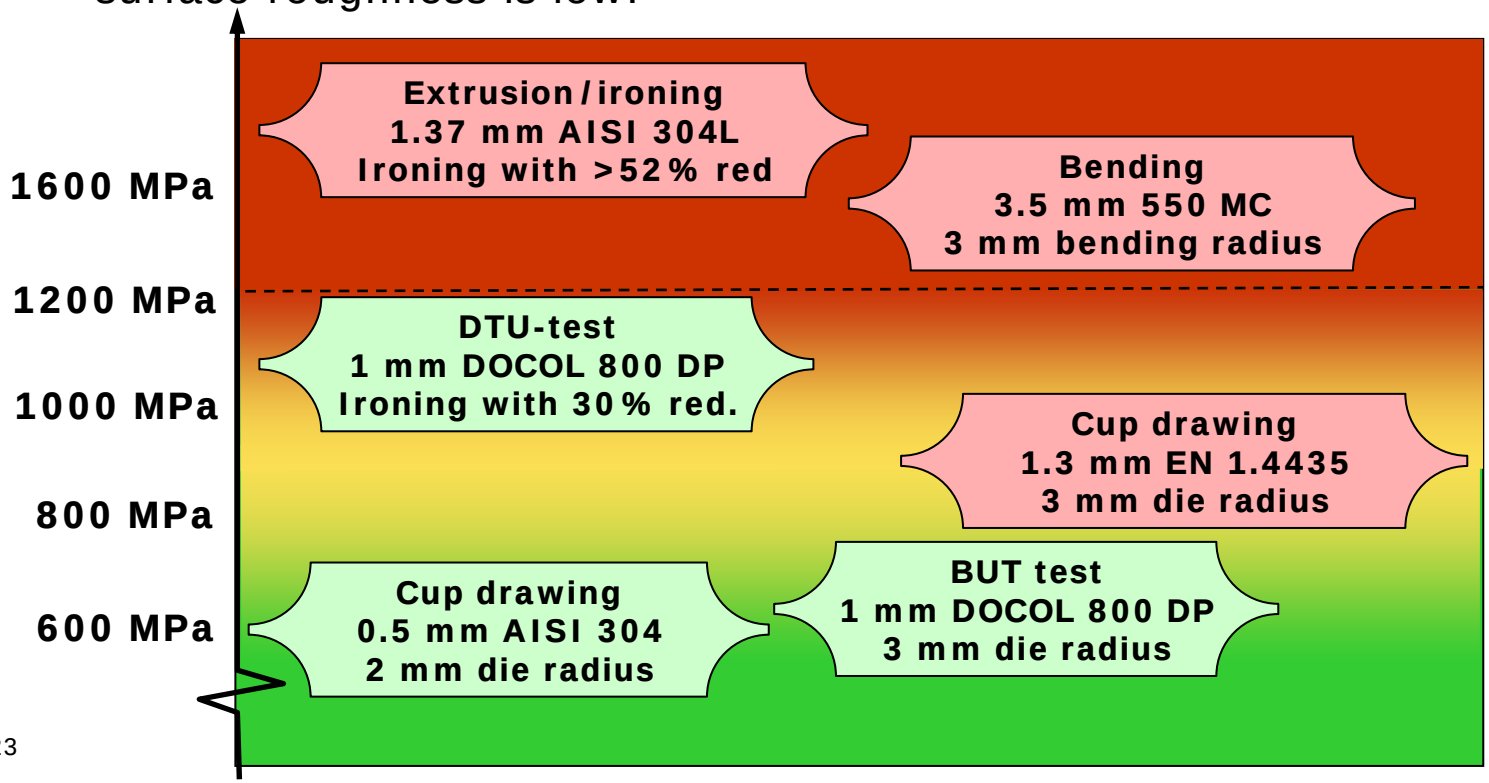
**Recommendations** (from experience up to now)

**Vancron 40 (uncoated)**

… works fine at contact pressure up to 600 MPa.

… should not be recommended at contact pressure above 1200 MPa.

… can be used between 600 and 1200 MPa if lubrication conditions are good and surface roughness is low.



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# Tooling Requirements for Forming of AHSS Sheet

## Galling resistance

**Forming tool segment**

**Production material 1200-1450 MPa steel sheet 2.5mm$^t$**

**W.-Nr. 1.2379 10 parts then galling**

**WEARTEC SF 4000 parts then galling**

**VANCRON 40 178000 parts (to date)**



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