



**Docol<sup>®</sup>**

**Docol range  
of cold-reduced  
steel sheet  
products**

**SSAB**  
SWEDISH STEEL





Docol is the brand name of SSAB Tunnpåt cold-reduced steel sheet products spanning the whole range from mild steels intended for pressing and bending, right up to ultra-high strength steels.

Technical development continually leads to new materials. The Docol cold-reduced high strength steels from SSAB Tunnpåt are good examples of this trend. The high strength steels are available with many different properties.

This brochure is designed to assist you in selecting the right grade of steel – the one that is best suited for your specific product.

## C O N T E N T S

|       |  |
|-------|--|
| 4–5   | <b>Docol cold-reduced steel sheet</b><br>Product range |
| 6–7   | <b>Mild steels</b>                                     |
| 8–17  | <b>High strength steels</b>                            |
| 18–19 | <b>Hardenable steels</b>                               |
| 20–21 | <b>Surface finish</b>                                  |
| 22–23 | <b>Tolerances</b>                                      |
| 24–25 | <b>Other technical information</b>                     |
| 26–27 | <b>Knowledge Service Center and information</b>        |

# Docol cold-reduced steel sheet

Docol is the product name of cold-reduced steel sheet from SSAB Tunnpålt. The raw material for producing cold-reduced steel sheet is hot rolled strip rolled in our hot-strip rolling mill. The strip is then pickled, following which it is cold reduced to produce thinner sheet to close thickness tolerances. Finally, the material is annealed and skin-pass rolled to achieve the required mechanical properties, flatness and surface finish.

Cold-reduced steel sheet is used for a wide variety of applications, including those in which the products are to be painted or otherwise surface treated. Vehicle parts, refrigerators, light fittings, electric radiators and water radiators are typical products that are made of cold-reduced steel sheet. Cold-reduced steel sheet can rightfully be claimed to be today's most widely used material. It is easy to form and join, and its surfaces are suitable for surface treatment.

## Most important steps in the cold-reducing process

*Pickling:* After steel strip has been hot rolled, its surface is covered with an iron oxide film known as millscale. To prevent this millscale from damaging the surface during subsequent cold rolling, it is removed by pickling.

*Cold Rolling:* Cold Rolling reduces the material to its final thickness. Careful process control during cold rolling enables the production parameters to be controlled with great accuracy. Thickness and flatness can therefore be maintained within very close tolerances.

*Heat treatment and skin-pass rolling:* This is where the material is given the required mechanical properties and the final surface finish. At the same time, it is inspected against the customer's specific requirements.

## Range of steels

The product range comprises three main groups. In addition to the *standardized mild steels* intended for various forming operations such as bending and pressing, the range also includes *high strength steels and hardenable steels*.

## Mild steels



DC01 – radiator



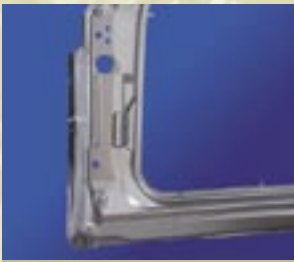
DC03 – electrical distribution cubicle



DC04 – fire extinguisher



DC05 – gusset plate



DC06 – door frame



Docol 4D – oil pump

## High strength steels



Docol YP – micro-alloyed steels



Docol DP/DL – dual-phase steels



Docol M – martensitic steels



Docol RP/BH – rephosphorized steels



Docol wear – abrasion resistant steel



Docol strap – packing straps



Socol W – corrosion resistant steels

## Hardenable steels



Docol quenching and tempering steels, high-carbon steels and boron steels

## Mild steels

### DC01

Steel grade for general applications involving relatively simple pressing, bending and folding operations.

### DC03

Steel grade intended for fairly complex pressing operations.

### DC04

Steel grade for applications in which strict demands are made on pressing properties.

### DC05

Steel grade for advanced forming, with optimum performance in drawing operations.



### DC06

Steel grade for advanced forming, with optimum suitability for drawing and stretch forming.

### Docol 4D

Steel grade for very advanced forming, with best conceivable properties in both drawing and stretch forming operations.

### Hot-dip galvanizing

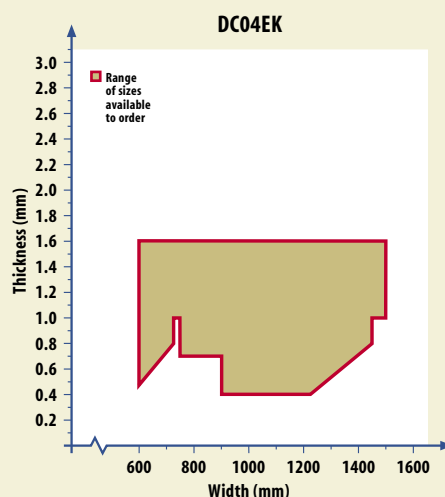
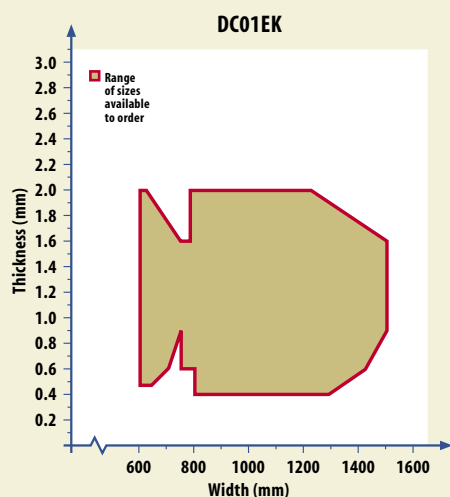
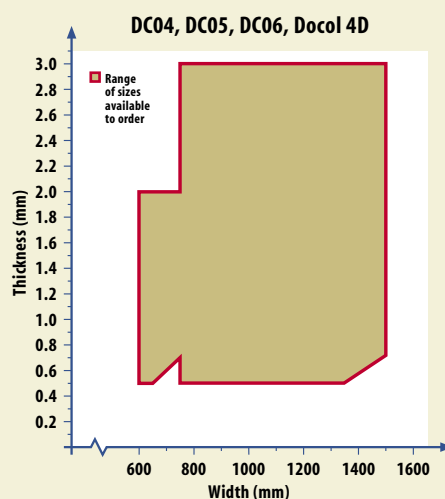
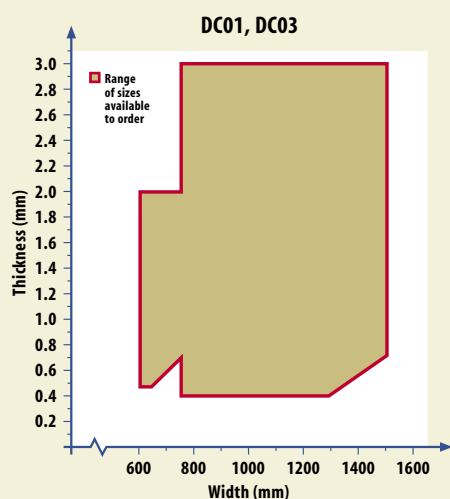
The range of mild steels, with the exception of DC06 and Docol 4D, can be supplied with chemical compositions that make the steels especially suited for hot-dip galvanizing.

### Enamelling steels

Steels to European standards EN 10209. Steels DC01EK and DC04EK have the properties necessary for conventional two-coat enamelling and for direct enamelling with grip coat.

The mechanical properties of DC01EK and DC04EK are the same as those of DC01 and DC04 respectively.

### Dimensions of strip in coils







This three-wheeler is a good example of the application of Docol 280 YP selected for its low weight, strength and formability.

#### Cut-to-length sheet sizes

| Thickness mm | Length, mm |      |
|--------------|------------|------|
|              | min.       | max. |
| 0.40–3.00    | 1000       | 8000 |

Note: The width is always taken to be  $\leq$  length

#### Mechanical properties\*

| Steel grade | Yield strength<br>$R_{p0.2}$ N/mm <sup>2</sup><br>max. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min.–max. | Elongation<br>$A_{80}$ % | $r_{90^\circ}$<br>min. | $n_{90^\circ}$<br>min. |
|-------------|--|--|--------------------------|------------------------|------------------------|
| DC01        | 280  | 270–410  | 28                       | –                      | –                      |
| DC03        | 240  | 270–370  | 34                       | 1.3                    | –                      |
| DC04        | 210  | 270–350  | 38                       | 1.6                    | 0.18                   |
| DC05        | 180  | 270–330  | 40                       | 1.9                    | 0.20                   |
|             |  |  |                          | $r_{\min}$             | $\bar{n}_{\min}$       |
| DC06        | 180  | 270–350  | 38                       | 1.8                    | 0.22                   |
| Docol 4D    | 140  | 250–330  | 40                       | 2.0                    | 0.24                   |

\*) Test piece taken at 90° to the direction of rolling

#### Chemical composition (typical values)

| Steel grade   | C (%) | Mn (%) | P (%) | S (%) | N (%) | Al (%) | Ti (%) |
|---------------|-------|--------|-------|-------|-------|--------|--------|
| DC01          | 0.05  | 0.20   | 0.01  | 0.01  | 0.003 | 0.04   | –      |
| DC03          | 0.05  | 0.20   | 0.01  | 0.01  | 0.003 | 0.04   | –      |
| DC04          | 0.02  | 0.20   | 0.01  | 0.01  | 0.003 | 0.04   | –      |
| DC05          | 0.02  | 0.20   | 0.01  | 0.01  | 0.005 | 0.05   | –      |
| DC06/Docol 4D | 0.002 | 0.15   | 0.01  | 0.01  | 0.003 | 0.04   | 0.065  |

## High strength steels

The grades in the Docol high strength steel group have many different properties. Grades can be selected to offer properties such as

- excellent formability in relation to their high strength
- good weathering properties (corrosion resistance)
- good resistance to abrasion
- good resistance to impact and shocks

High strength Docol materials are often used for lowering the weight of a product without impairing its strength, or for increasing the strength without increasing the weight.

### Docol YP/LA

Docol YP are high strength, low-alloy steels intended for pressing. YP steels are characterized by high yield strength combined with good formability. At higher strength levels, this is achieved by the addition of small quantities of niobium.

The consistency of the mechanical properties of Docol



YP steels is guaranteed within the specified minimum and maximum values.

The designations of the steel grades are based on the guaranteed minimum yield strengths.

If required, we can also supply customers with equivalent micro-alloyed steels known as Docol LA and conforming to the provisions of EN 10268.

Docol LA has guaranteed yield strengths between the minimum and maximum limits, whereas only the minimum value of tensile strength is guaranteed.

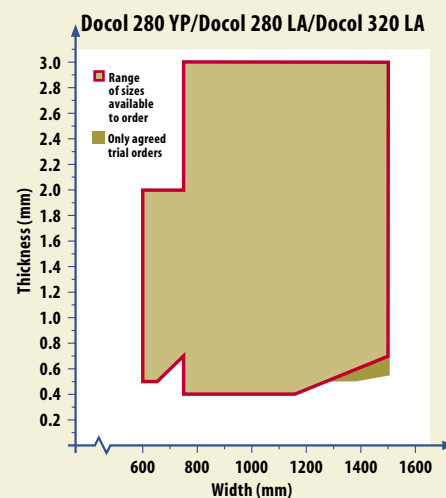
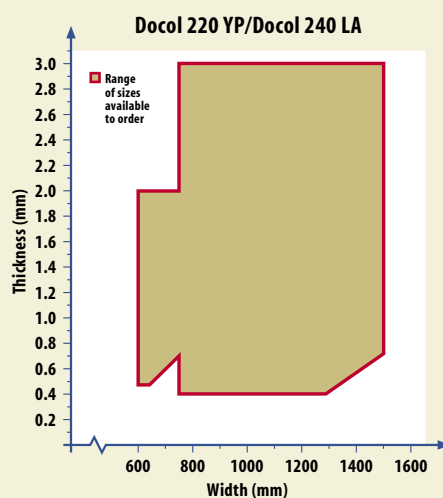
### YP steels for hot-dip galvanizing

Docol 220 YP, Docol 280 YP and Docol 350 YP can be supplied with a modified chemical composition to suit hot-dip galvanizing.

### Cut-to-length sizes

| Thickness, mm | Length, mm |
|---------------|------------|
| 0.40–3.00     | 1000–8000  |

### Dimensions of strip in coils





### Mechanical properties\*

| Steel grade  | Yield strength<br>$R_{e1}$ N/mm <sup>2</sup><br>min.–max. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min.–max. | Elongation<br>$A_{80}$ %<br>min. | Bending radius,<br>180° bend |
|--------------|---|--|----------------------------------|------------------------------|
| Docol 220 YP | 220–290   | 330–400  | 30                               | 0xt                          |
| Docol 260 YP | 260–340   | 350–450  | 24                               | 0xt                          |
| Docol 280 YP | 280–350   | 370–450  | 26                               | 0xt                          |
| Docol 300 YP | 300–380   | 380–480  | 22                               | 0xt                          |
| Docol 340 YP | 340–440   | 410–530  | 20                               | 0xt                          |
| Docol 350 YP | 350–440   | 410–510  | 22                               | 0xt                          |
| Docol 380 YP | 380–500   | 460–650  | 18                               | 0.5xt                        |
| Docol 420 YP | 420–540   | 480–620  | 16                               | 0.25xt                       |
| Docol 500 YP | 500–620   | 570–710  | 12                               | 0.5xt                        |

t=sheet thickness

\*) Test piece taken at 90° to the direction of rolling

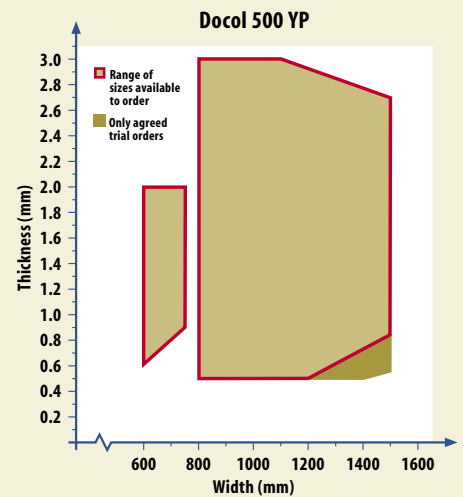
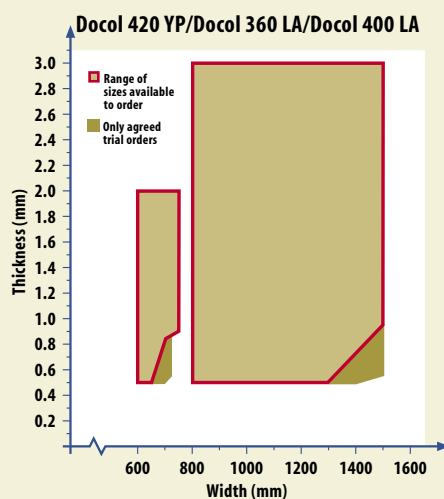
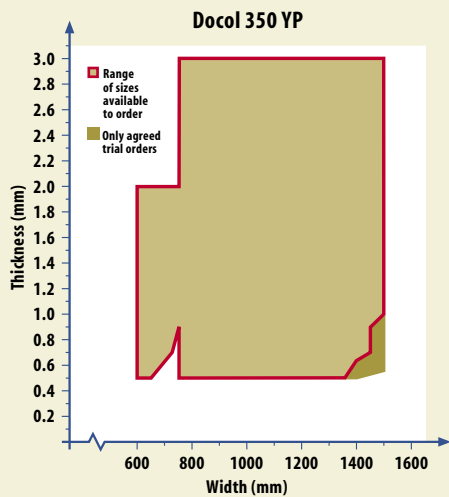
### Chemical composition (typical values)

| Steel grade  | C<br>(%) | Si<br>(%) | Mn<br>(%) | P<br>(%) | S<br>(%) | Al<br>(%) | Nb<br>(%) |
|--------------|----------|-----------|-----------|----------|----------|-----------|-----------|
| Docol 220 YP | 0.05     | 0.01      | 0.20      | 0.01     | 0.01     | 0.05      | –         |
| Docol 260 YP | 0.05     | 0.01      | 0.40      | 0.01     | 0.01     | 0.04      | 0.01      |
| Docol 280 YP | 0.05     | 0.01      | 0.40      | 0.01     | 0.01     | 0.04      | 0.01      |
| Docol 300 YP | 0.05     | 0.01      | 0.40      | 0.01     | 0.01     | 0.04      | 0.01      |
| Docol 340 YP | 0.05     | 0.01      | 0.40      | 0.01     | 0.01     | 0.04      | 0.03      |
| Docol 350 YP | 0.05     | 0.01      | 0.40      | 0.01     | 0.01     | 0.04      | 0.03      |
| Docol 380 YP | 0.05     | 0.01      | 0.50      | 0.01     | 0.01     | 0.04      | 0.05      |
| Docol 420 YP | 0.05     | 0.20      | 0.60      | 0.01     | 0.01     | 0.04      | 0.04      |
| Docol 500 YP | 0.06     | 0.40      | 1.20      | 0.01     | 0.005    | 0.04      | 0.05      |

### Mechanical properties\*\*

| Steel grade | Yield strength<br>$R_{e1}$ N/mm <sup>2</sup><br>min.–max. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min. | Elongation<br>$A_{80}$ %<br>min. | Bending radius,<br>180° bend |
|-------------|---|---|----------------------------------|------------------------------|
| H 240 LA    | 240–310   | 340   | 27                               | 0xt                          |
| H 280 LA    | 280–360   | 370   | 24                               | 0xt                          |
| H 320 LA    | 320–410   | 400   | 22                               | 0xt                          |
| H 360 LA    | 360–460   | 430   | 20                               | 0.25xt                       |
| H 400 LA    | 400–500   | 460   | 18                               | 0.25xt                       |

\*\*) Test piece taken in rolling direction



### Docol DP/DL

Docol DP and Docol DL are dual-phase steels. The steels are subjected to special heat treatment in the continuous annealing line, which produces a two-phase structure in which the ferrite that imparts unique forming properties is one of the phases, and martensite that accounts for the strength is the other. The strength increases with increasing proportion of the hard martensite phase.

Docol DP/DL steels are characterized by low yield strength in relation to the tensile strength, so that they have good ability to distribute the plastic deformation during working. In DL steels, the difference between the yield strength and the tensile strength is greater than in DP steels, and DL steels thus have even better formability than DP steels. The final strength of the finished part is achieved by strain hardening during pressing and by bake hardening in conjunction with painting.

The figures in the steel designations specify the minimum tensile strengths.

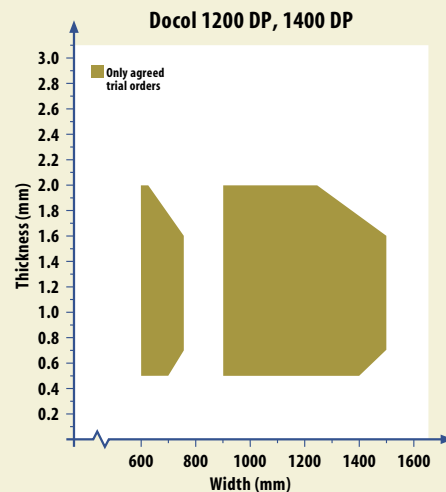
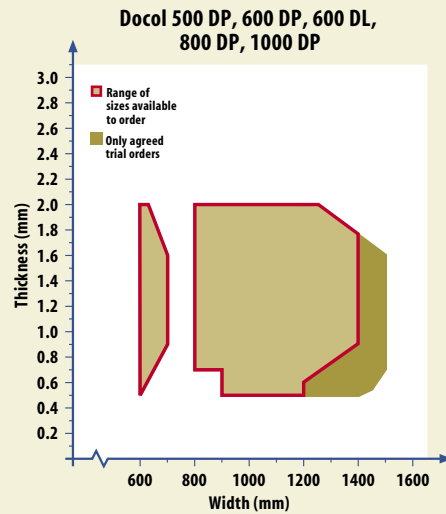
### Docol M

Docol is a fully martensitic steels (one phase steels). The cold rolled products which are fully martensitic are those with tensile strength of 1200 N/mm<sup>2</sup> and above. The strength is produced by extremely fast water quenching from an elevated austenitic temperature range.

### Electrogalvanized steels

The steel grades Docol 1000DP, 1200M and 1400M are available with zinc electroplated finish, with zinc thicknesses of between 2.5 and 10 µm per side.

### Dimensions of strip in coils



### Cut-to-length sizes

| Thickness, mm | Length, mm |
|---------------|------------|
| 0.50–3.00     | 1000–8000  |

| Mechanical properties* |   |   |  |                                  |
|------------------------|---|---|--|----------------------------------|
| Steel grade            | Yield strength<br>$R_{p0.2}$ N/mm <sup>2</sup><br>min.–max. | Yield strength after<br>strain hardening and<br>bake hardening<br>$R_{p2.0}+BH^{**}$ N/mm <sup>2</sup> min. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min.–max. | Elongation<br>$A_{80}$ %<br>min. |
| Docol 500 DP           | 290–370   | 400   | 500–600  | 20                               |
| Docol 500 DL***        | 230–  | –   | 500–600  | 25                               |
| Docol 600 DP           | 350–450   | 500   | 600–700  | 16                               |
| Docol 600 DL           | 280–360   | 420   | 600–700  | 20                               |
| Docol 800 DP           | 500–650   | 650   | 800–950  | 8                                |
| Docol 800 DL***        | 390–  | –   | 800–950  | 13                               |
| Docol 1000 DP          | 700–950   | 850   | 1000–1200  | 5                                |
| Docol 1200 M           | 950–(1200)  | 1150  | 1200–1400  | 4                                |
| Docol 1400 M           | 1150–(1400)   | 1350  | 1400–1600  | 3                                |

\*) Test piece taken at 90° to the direction of rolling

\*\*) BH = Bake hardening after 2% plastic deformation and heated to 170°C for 20 min

\*\*\*)) Development grade

| Chemical composition (typical values) |          |           |           |          |          |           |           |
|---------------------------------------|----------|-----------|-----------|----------|----------|-----------|-----------|
| Steel grade                           | C<br>(%) | Si<br>(%) | Mn<br>(%) | P<br>(%) | S<br>(%) | Al<br>(%) | Nb<br>(%) |
| Docol 500 DP                          | 0.08     | 0.30      | 0.65      | 0.015    | 0.01     | 0.04      | –         |
| Docol 500 DL***                       | 0.07     | 0.20      | 1.80      | 0.015    | 0.002    | 0.04      | –         |
| Docol 600 DP                          | 0.11     | 0.40      | 0.90      | 0.015    | 0.005    | 0.04      | –         |
| Docol 600 DL                          | 0.10     | 0.40      | 1.50      | 0.015    | 0.002    | 0.04      | –         |
| Docol 800 DP                          | 0.13     | 0.20      | 1.50      | 0.015    | 0.002    | 0.04      | 0.015     |
| Docol 800 DL***                       | 0.14     | 0.20      | 1.70      | 0.015    | 0.002    | 0.04      | 0.015     |
| Docol 1000 DP                         | 0.15     | 0.20      | 1.50      | 0.015    | 0.002    | 0.04      | 0.015     |
| Docol 1200 M                          | 0.11     | 0.20      | 1.60      | 0.015    | 0.002    | 0.04      | 0.015     |
| Docol 1400 M                          | 0.17     | 0.50      | 1.60      | 0.015    | 0.002    | 0.04      | 0.015     |



A new chassis design for Emmaljunga's most comfortable pram. Extra high-strength tubing providing a high degree of elasticity makes the pram more comfortable and streamlined production.





#### **Docol RP/BH**

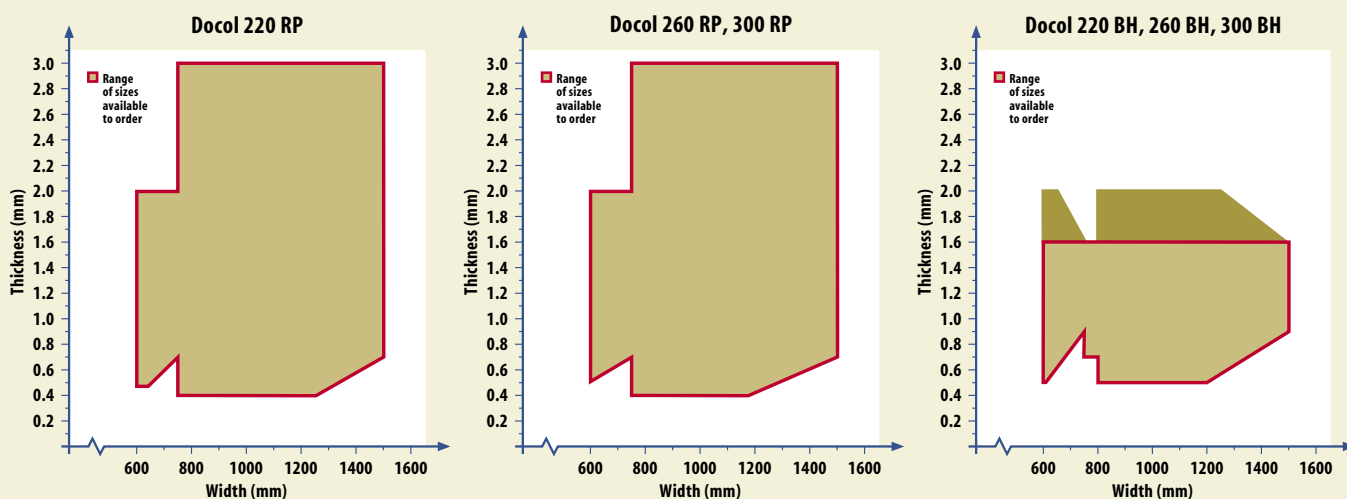
Docol RP is a phosphorus-alloyed high strength steel, known as rephosphorized steel and intended for pressing. Docol RP is characterized by excellent formability combined with high strength. The final strength of the finished part is achieved by strain hardening during pressing.

Docol BH is also a rephosphorized steel with excellent formability, but the difference is that the final strength of the finished part is due to a combination of strain hardening during pressing and bake hardening following painting.

The figures in the steel grade designations specify the minimum guaranteed yield strengths.

**The determination to achieve safer and more fuel-efficient cars has led to the growing use of high strength steels. High strength Docol steels are widely used in today's cars.**

### Dimensions of strip in coils



### Cut-to-length sizes

| Thickness, mm | Length, mm<br>min.–max. |
|---------------|-------------------------|
| 0.40–3.00     | 1000–8000               |

Note: The width is always taken to be  $\leq$  length

### Mechanical properties\*

| Steel grade  | Yield strength<br>$R_{p0.2}$ or $R_{el}$<br>min.–max. | Yield strength after strain<br>hardening and bake hardening<br>$R_{p2.0} + BH^{**}$ N/mm <sup>2</sup><br>min. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min.–max. | Elongation<br>$A_{80}$ %<br>min. |
|--------------|---|---|--|----------------------------------|
| Docol 220 RP | 220–280   | –   | 340–420  | 30                               |
| Docol 260 RP | 260–320   | –   | 380–460  | 28                               |
| Docol 300 RP | 300–360   | –   | 420–500  | 26                               |
| Docol 220 BH | 220–280   | 270   | 340–420  | 30                               |
| Docol 260 BH | 260–320   | 310   | 380–460  | 28                               |
| Docol 300 BH | 300–360   | 360   | 420–500  | 26                               |

\*) Test piece taken at 90° to the direction of rolling

\*\*) BH = Bake hardening after 2% plastic deformation and heated to 170°C for 20 min

### Chemical composition (typical values)

| Steel grade     | C<br>% | Si<br>(%) | Mn<br>(%) | P<br>(%) | S<br>(%) | Al<br>(%) |
|-----------------|--------|-----------|-----------|----------|----------|-----------|
| Docol 220 RP/BH | 0.04   | 0.01      | 0.30      | 0.06     | 0.01     | 0.04      |
| Docol 260 RP/BH | 0.04   | 0.01      | 0.50      | 0.09     | 0.01     | 0.04      |
| Docol 300 RP/BH | 0.05   | 0.20      | 0.60      | 0.11     | 0.01     | 0.04      |



### Docol Wear

Docol Wear is a cold-reduced, abrasion resistant steel. The material is annealed, hardened by quenching and then tempered in a continuous annealing line. Docol Wear can be used for components subjected to abrasive wear by hard particles such as stones, sand and grain.

The figures in the steel designations specify typical hardness values (Vickers).

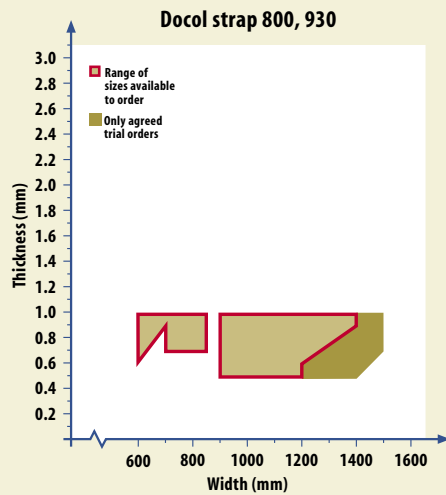
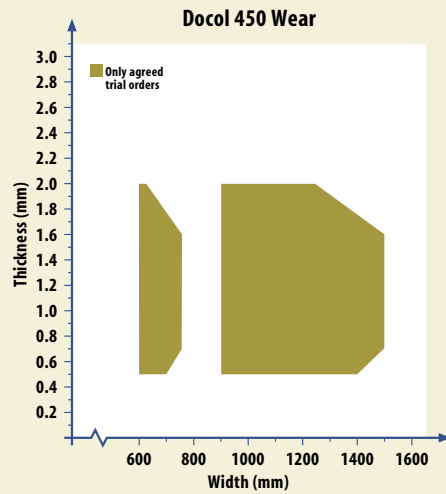


### Docol Strap

Docol packaging strap – designated Docol Strap 800 and Docol Strap 930 – is delivered in quenched and tempered condition. Docol strap is characterized by high strength, combined with good formability and bendability.



## Dimensions of strip in coils



## Cut-to-length sizes

|                | Thickness, mm | Length, mm |
|----------------|---------------|------------|
| Docol Wear 450 | 0.50–2.0      | 1000–8000  |





Docol Wear is suitable for the many agricultural machine parts that are subjected to heavy wear.

| Hardness (typical values) |          |          |         |
|---------------------------|----------|----------|---------|
| Steel grade               | Hardness |          |         |
|                           | Brinell  | Rockwell | Vickers |
| Docol Wear 450            | 440      | 43       | 456     |

| Chemical composition (typical values) |       |        |        |       |       |        |        |
|---------------------------------------|-------|--------|--------|-------|-------|--------|--------|
| Steel grade                           | C (%) | Si (%) | Mn (%) | P (%) | S (%) | Al (%) | Nb (%) |
| Docol Wear 450                        | 0.17  | 0.50   | 1.60   | 0.015 | 0.002 | 0.04   | 0.015  |

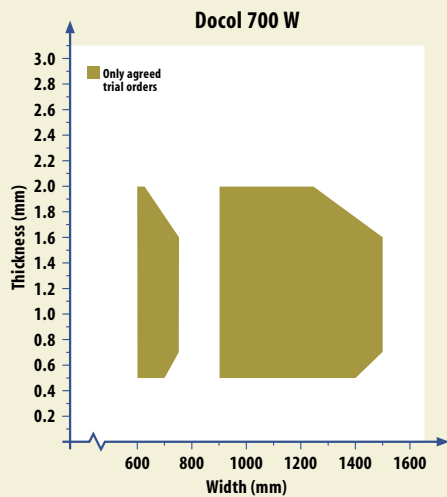
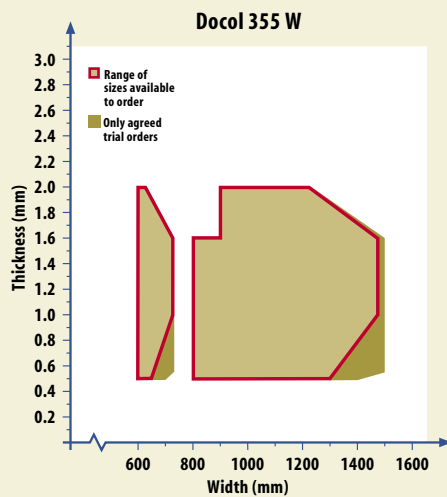
| Mechanical properties* (typical values) |                              |                           |                       |
|---|------------------------------|---------------------------|-----------------------|
| Steel grade                             | Yield strength<br>$R_{p0.2}$ | Tensile strength<br>$R_m$ | Elongation<br>$A_5$ % |
| Docol Strap 800                         | 660                          | 850                       | 20                    |
| Docol Strap 930                         | 890                          | 1070                      | 14                    |

\*) Test piece taken along the direction of rolling

| Chemical composition (typical values) |       |        |        |       |       |        |
|---------------------------------------|-------|--------|--------|-------|-------|--------|
| Steel grade                           | C (%) | Si (%) | Mn (%) | P (%) | S (%) | Al (%) |
| Docol Strap 800/<br>Docol Strap 930   | 0.15  | 0.50   | 1.50   | 0.015 | 0.005 | 0.04   |



### Dimensions of strip in coils



### Docol W

Docol W are corrosion-resistant steels. Such steels initially corrode in exactly the same way as ordinary carbon steels. But after some time, a uniform, dense oxide film (patina) will form on the steel surface. This property is promoted by appropriate contents of Cu, Cr, P and Si in the steel. The oxide film remains firmly in place and prevents moisture from penetrating through it and causing corrosion of the steel. In addition to having good corrosion resistance, Docol W is also characterized by good formability and impact resistance.

Docol W is available in two strength levels, with minimum guaranteed yield strengths of 355 N/mm<sup>2</sup> and 700 N/mm<sup>2</sup>.

### Cut-to-length sizes

| Thickness, mm | Length, mm               |
|---------------|--------------------------|
|               | Docol 355W<br>Docol 700W |
| 0.50–2.00     | 400–4000                 |

### Mechanical properties\*

| Steel grade | Yield strength<br>$R_{p0.2}/R_{eL}$ N/mm <sup>2</sup><br>min. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>min. | Elongation<br>$A_{80}$ %<br>min. |
|-------------|---|---|----------------------------------|
| Docol 355W  | 355   | 450**   | 20                               |
| Docol 700W  | 700   | 800   | 5                                |

\*) Test piece taken at 90° to the direction of rolling

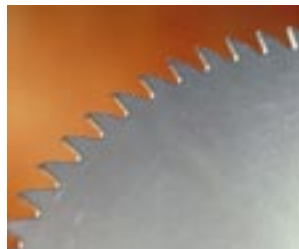
\*\*) The tensile strength does not conform to EN 101055

### Chemical composition (typical values)

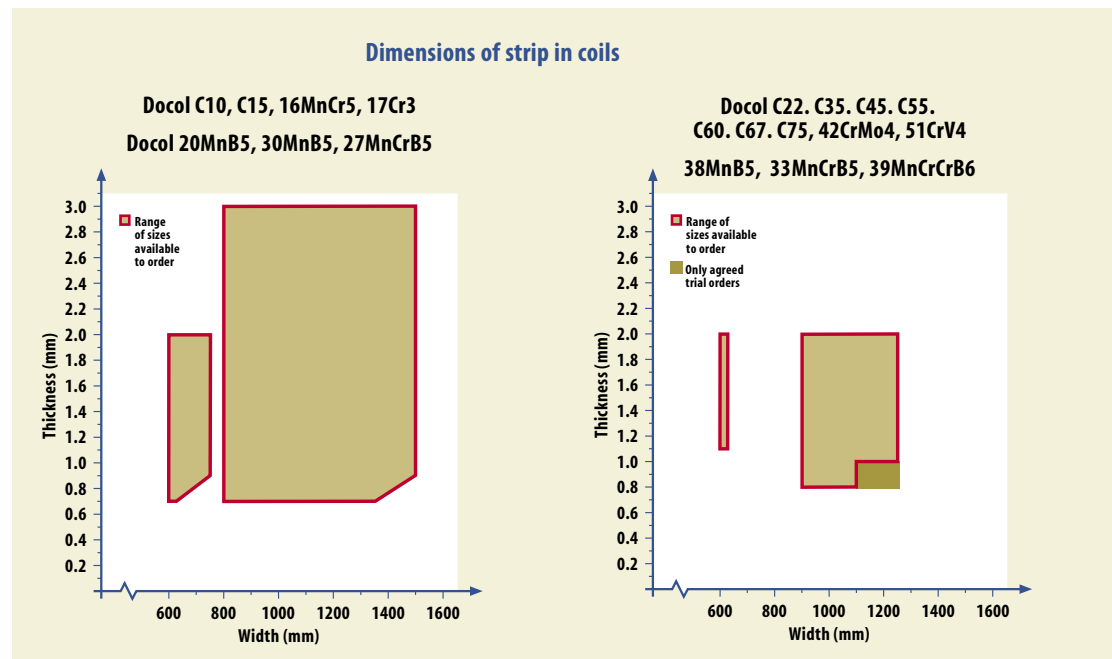
| Steel grade | C (%) | Si (%) | Mn (%) | P (%) | S (%) | Cu (%) | Cr (%) | Al (%) | Nb (%) |
|-------------|-------|--------|--------|-------|-------|--------|--------|--------|--------|
| Docol 355W  | 0.05  | 0.30   | 0.35   | 0.08  | 0.01  | 0.30   | 0.60   | 0.04   | —      |
| Docol 700W  | 0.13  | 0.50   | 1.20   | 0.015 | 0.002 | 0.40   | 0.50   | 0.04   | 0.015  |



## Hardenable steels



Hardened high-carbon steel enables ladies' shoes to retain their shape.



The grades in the Docol hardenable steels group are characterized by good formability and by the fact that the very high strength and hardness are achieved by hardening the finished part.

### Docol case hardening steels

Docol case hardening steels are available in versions conforming to EN 10132-2. The steels are characterized by good formability and the opportunities available for providing the finished part with a hard surface by case hardening, whilst the core of the part will retain its toughness.

| Mechanical properties (in annealed condition) |  |   |                                  |                        |
|---|--|---|----------------------------------|------------------------|
| Steel grade                                   | Yield strength<br>$R_{p0.2}$ N/mm <sup>2</sup><br>max. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>max. | Elongation<br>$A_{80}$ %<br>min. | Hardness<br>HV<br>max. |
| Docol C10                                     | 345  | 430   | 26                               | 135                    |
| Docol C15                                     | 360  | 450   | 25                               | 140                    |
| Docol 16MnCr5                                 | 420  | 550   | 21                               | 170                    |
| Docol 17Cr3                                   | 420  | 550   | 21                               | 170                    |

| Chemical composition (typical values) |                  |                   |                   |              |              |                   |
|---------------------------------------|------------------|-------------------|-------------------|--------------|--------------|-------------------|
| Steel grade                           | C (%)<br>min-max | Si (%)<br>min-max | Mn (%)<br>min-max | P (%)<br>max | S (%)<br>max | Cr (%)<br>min-max |
| Docol C10                             | 0.07-0.13        | 0.15-0.35         | 0.30-0.60         | 0.025        | 0.025        | max 0.40          |
| Docol C15                             | 0.12-0.18        | 0.15-0.35         | 0.30-0.60         | 0.025        | 0.025        | max 0.40          |
| Docol 16MnCr5                         | 0.14-0.19        | 0.15-0.35         | 1.00-1.30         | 0.025        | 0.025        | 0.80-1.00         |
| Docol 17Cr3                           | 0.14-0.20        | 0.15-0.35         | 0.60-0.90         | 0.025        | 0.025        | 0.70-1.00         |



### Docol high-carbon steels

Docol high-carbon steels are available in versions that conform to EN 10132. The steels are characterized by good formability and scope for achieving very high hardness by quenching and tempering.

| Mechanical properties (in annealed condition) |  |   |                                  |                        |
|---|--|---|----------------------------------|------------------------|
| Steel grade                                   | Yield strength<br>$R_{p0.2}$ N/mm <sup>2</sup><br>max. | Tensile strength<br>$R_m$ N/mm <sup>2</sup><br>max. | Elongation<br>$A_{80}$ %<br>min. | Hardness<br>HV<br>max. |
| Docol C22                                     | 400  | 500   | 22                               | 155                    |
| Docol C35                                     | 430  | 540   | 19                               | 170                    |
| Docol C45                                     | 455  | 570   | 18                               | 180                    |
| Docol C55                                     | 480  | 600   | 17                               | 185                    |
| Docol C60                                     | 495  | 620   | 17                               | 195                    |
| Docol C67                                     | 510  | 640   | 16                               | 200                    |
| Docol C75                                     | 510  | 640   | 15                               | 200                    |
| Docol 42CrMo4                                 | 480  | 620   | 15                               | 195                    |
| Docol 51CrV4                                  | 550  | 700   | 13                               | 220                    |

| Chemical composition (typical values) |                    |                     |                     |               |               |                     |
|---------------------------------------|--------------------|---------------------|---------------------|---------------|---------------|---------------------|
| Steel grade                           | C (%)<br>min.–max. | Si (%)<br>min.–max. | Mn (%)<br>min.–max. | P (%)<br>max. | S (%)<br>max. | Cr (%)<br>min.–max. |
| Docol C22                             | 0.17–0.24          | 0.15–0.35           | 0.40–0.70           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C35                             | 0.32–0.39          | 0.15–0.35           | 0.50–0.80           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C45                             | 0.42–0.50          | 0.15–0.35           | 0.50–0.80           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C55                             | 0.52–0.60          | 0.15–0.35           | 0.60–0.90           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C60                             | 0.57–0.65          | 0.15–0.35           | 0.60–0.90           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C67                             | 0.65–0.73          | 0.15–0.35           | 0.60–0.90           | 0.025         | 0.025         | 0.20–0.40           |
| Docol C75                             | 0.70–0.80          | 0.15–0.35           | 0.60–0.90           | 0.025         | 0.025         | 0.20–0.40           |
| Docol 42CrMo4                         | 0.38–0.45          | 0.15–0.35           | 0.60–0.90           | 0.025         | 0.025         | 0.90–1.20           |
| Docol 51CrV4                          | 0.47–0.55          | 0.15–0.35           | 0.70–1.10           | 0.025         | 0.025         | 0.90–1.20           |

### Docol Boron steels

Docol Boron steels are available in versions conforming to EN 10083-3. The steels are characterized by good formability and weldability. They can easily be hardened, and tempering is often unnecessary.

| Mechanical properties (typical values) |                   |  |   |                          |                 |
|--|-------------------|--|---|--------------------------|-----------------|
| Steel grade                            | Condition         | Yield strength<br>$R_{p0.2}$ N/mm <sup>2</sup> | Tensile strength<br>$R_m$ N/mm <sup>2</sup> | Elongation<br>$A_{80}$ % | Hardness<br>HRC |
| Docol 20MnB5                           | Annealed          | 350  | 500   | 28                       | 46<br>43        |
|  | Quenched in water |  | 1480  |                          |                 |
|  | Quenched in oil   |  | 1360  |                          |                 |
| Docol 30MnB5                           | Annealed          | 350  | 500   | 28                       | 53<br>50        |
|  | Quenched in water |  | 1845  |                          |                 |
|  | Quenched in oil   |  | 1675  |                          |                 |
| Docol 38MnB5                           | Annealed          | 350  | 500   | 28                       | 56<br>53        |
|  | Quenched in water |  | 2050  |                          |                 |
|  | Quenched in oil   |  | 1845  |                          |                 |
| Docol 27MnCrB5                         | Annealed          | 400  | 550   | 25                       | 51<br>48        |
|  | Quenched in water |  | 1735  |                          |                 |
|  | Quenched in oil   |  | 1575  |                          |                 |
| Docol 33MnCrB5                         | Annealed          | 400  | 550   | 25                       | 53<br>50        |
|  | Quenched in water |  | 1845  |                          |                 |
|  | Quenched in oil   |  | 1675  |                          |                 |
| Docol 39MnCrB6                         | Annealed          | 400  | 550   | 25                       | 55<br>52        |
|  | Quenched in water |  | 1980  |                          |                 |
|  | Quenched in oil   |  | 1795  |                          |                 |

| Chemical composition |                    |                |                     |               |               |                     |                    |
|----------------------|--------------------|----------------|---------------------|---------------|---------------|---------------------|--------------------|
| Steel grade          | C (%)<br>min.–max. | Si (%)<br>max. | Mn (%)<br>min.–max. | P (%)<br>max. | S (%)<br>max. | Cr (%)<br>min.–max. | B (%)<br>min.–max. |
| Docol 20MnB5         | 0.17–0.23          | 0.40           | 1.10–1.40           | 0.030         | 0.015         | 0.10–0.30           | 0.0008–0.0050      |
| Docol 30MnB5         | 0.27–0.33          | 0.40           | 1.15–1.45           | 0.030         | 0.015         | 0.10–0.30           | 0.0008–0.0050      |
| Docol 38MnB5         | 0.36–0.42          | 0.40           | 1.15–1.45           | 0.030         | 0.015         | 0.10–0.30           | 0.0008–0.0050      |
| Docol 27MnCrB5       | 0.24–0.30          | 0.40           | 1.10–1.40           | 0.030         | 0.015         | 0.30–0.60           | 0.0008–0.0050      |
| Docol 33MnCrB5       | 0.30–0.36          | 0.40           | 1.20–1.50           | 0.030         | 0.015         | 0.30–0.60           | 0.0008–0.0050      |
| Docol 39MnCrB6       | 0.36–0.42          | 0.40           | 1.40–1.70           | 0.030         | 0.015         | 0.30–0.60           | 0.0008–0.0050      |

## Surface finish

### Surface quality A

Defects such as pores, indentations, small marks, minor scratches and light discoloration that do not affect the formability or the scope for surface coating are permissible.

### Surface quality B

The best side should have a surface which is free from defects that would affect the appearance of a quality painted or electro-

lytically coated surface. The other side must at least meet the demands for surface quality A. If the product is delivered as coils or slit strip, the proportion of defects may be greater than if cut-to-size sheet or finished blanks are delivered.

### Surface appearance

The surface appearance of cold-reduced steel sheet is closely linked to the surface topography of the sheet. The surface topo-

graphy affects the frictional properties when cold-reduced sheet is worked, and is also important for the subsequent surface treatment process. The surface appearance can be classified into bright, semi-bright, normal or rough. If no particular surface appearance requirements are specified when order is placed, the products will be delivered with normal surface appearance.

| Surface appearance | Symbol | Surface roughness                            |
|--------------------|--------|--|
| Bright             | b      | $R_a \leq 0.4 \mu\text{m}$                   |
| Semi-bright        | g      | $R_a \leq 0.9 \mu\text{m}$                   |
| Normal             | m      | $0.6 \mu\text{m} < R_a \leq 1.9 \mu\text{m}$ |
| Rough              | r      | $R_a > 1.6 \mu\text{m}$                      |







Various products, such as white goods and light fittings, demand a high standard of surface finish of the steel to ensure that the subsequent surface treatment process will produce good and consistent end results.



# Tolerances

The advanced equipment and control systems at SSAB enable close and consistent tolerances to be maintained. This is beneficial to customers whose automated equipment demands close tolerances, and to customers who want to obtain the largest possible sheet area from every tonne of sheet.

## Tolerances according to EN 10131

### Tolerances on width

*Normal tolerance*

+4/-0 (≤1200 mm wide)

+5/-0 (>1200 mm – ≤1500 mm wide)

Applies unless otherwise specified.

*Closer tolerances*

+2/-0 (600 – ≤1500 mm wide)

### Tolerances on length

**(cut-to-length sheet)**

<2000 mm +6/-0 mm

≥2000 mm +0.3% of nominal length/-0 mm

### Perpendicularity

**(cut-to-length sheet)**

Up to 1% of the nominal width of the sheet.

### Tolerances on flatness

The table specifies the maximum permissible deviation (vertical height) in accordance with EN 10131 when the sheet rests freely on a flat horizontal surface.

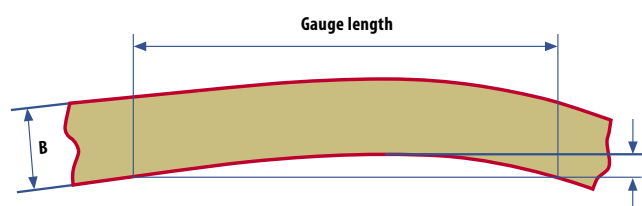
The values in the column headed “Normal flatness” apply if the user cuts the sheet to length and carries out straightening competently and in suitable straightening equipment.

Unless otherwise specified, the sheet is delivered with normal flatness.

## Straightness

| Gauge length, mm | t <sub>max</sub> |
|------------------|------------------|
| 5000             | 15               |
| 1000             | 2                |

t<sub>max</sub> applies to both gauge lengths located at random on the strip.



Up to 0.2% of the sheet length applies to cut-to-length sheet

## Tolerances on thickness

| Nominal thickness, mm | Normal tolerance for nominal width, mm |             |
|-----------------------|--|-------------|
|                       | ≤1200                                  | >1200 ≤1500 |
| >0.35 ≤0.40           | ±0.04                                  | ±0.05       |
| >0.40 ≤0.60           | ±0.05                                  | ±0.06       |
| >0.60 ≤0.80           | ±0.06                                  | ±0.07       |
| >0.80 ≤1.00           | ±0.07                                  | ±0.08       |
| >1.00 ≤1.20           | ±0.08                                  | ±0.09       |
| >1.20 ≤1.60           | ±0.10                                  | ±0.11       |
| >1.60 ≤2.00           | ±0.12                                  | ±0.13       |
| >2.00 ≤2.50           | ±0.14                                  | ±0.15       |
| >2.50 ≤3.00           | ±0.16                                  | ±0.17       |

Delivered with normal tolerances unless otherwise specified. The thickness is measured at a distance of at least 40 mm from the edge of the sheet.

## Flatness

| Thickness, mm | Width, mm   | Max. deviation, mm |                   |
|---------------|-------------|--------------------|-------------------|
|               |             | Normal flatness    | Improved flatness |
| -0.70         | -1200       | 12                 | 5                 |
|               | (1200)–1500 | 15                 | 6                 |
| (-0.70)–1.20  | -1200       | 10                 | 4                 |
|               | (1200)–1500 | 12                 | 5                 |
| (1.20)–3.00   | -1200       | 8                  | 3                 |
|               | (1200)–1500 | 10                 | 4                 |

Flatness tolerances for steel sheet with yield strength < 280 N/mm<sup>2</sup>.

| Thickness, mm | Width, mm   | Max. deviation, mm |                   |
|---------------|-------------|--------------------|-------------------|
|               |             | Normal flatness    | Improved flatness |
| -0.70         | -1200       | 15                 | 8                 |
|               | (1200)–1500 | 18                 | 9                 |
| (-0.70)–1.20  | -1200       | 13                 | 6                 |
|               | (1200)–1500 | 15                 | 8                 |
| (1.20)–3.00   | -1200       | 10                 | 5                 |
|               | (1200)–1500 | 13                 | 6                 |

Flatness tolerances for steel sheet with specified minimum yield strengths equal to or over 280 N/mm<sup>2</sup> and less than 360 N/mm<sup>2</sup>.





## Other technical information

### Ageing

The pressing properties of cold-reduced mild steel grades decline with time. The risk then increases of stretcher strain marks occurring during forming. Cold-reduced steel sheet used for pressing should therefore not be stored for longer than necessary before it is worked. Steel grades DC06 and Docol 4D are alloyed with small quantities of titanium, which results in a non-ageing material that retains its good pressing properties for a long period of time.

### Weldability

All steel grades described in this brochure have good weldability. Resistance welding, such as spot welding and seam welding, can be carried out without dif-

ficulty. All except the very thin sheet can be fusion welded. Gas-shielded arc welding (short-arc welding) is beneficial due to its low heat input, and can be used on sheet down to about 0.7 mm thick.

Manual arc welding with basic or rutile electrodes can be used on sheet down to around 1 mm thick.

### Oiling

Sheet is normally protected by a coat of anti-corrosion oil before delivery. An anti-corrosion press oil can be used instead, if specified by the customer.

If agreed, sheet can be delivered in dry condition, i.e. entirely without anti-corrosion oil.

### Coil weights

As agreed, but not exceeding 24 tonnes

### Coil diameters

Inside diameter = 610 mm

Outside diameter = up to 2000 mm

### Bundle weights

Up to 4 tonnes

### Packaging

See our Packaging brochure

**Every delivery is carefully inspected for dimensions and weights before it is loaded onto a railway wagon or truck.**





| Mild steels     |                         |                        |                         |                          |                       |                      |                        |       |
|-----------------|-------------------------|------------------------|-------------------------|--------------------------|-----------------------|----------------------|------------------------|-------|
| New designation | Former designation      |                        |                         |                          |                       |                      |                        |       |
| EN 10130        | Sweden<br>SS<br>14 XXXX | Germany<br>DIN<br>1623 | Great Br.<br>BS<br>1449 | France<br>NF A<br>36-401 | Finland<br>SFS<br>600 | Italy<br>UNI<br>5866 | Spain<br>UNI<br>36-086 | Japan |
| DC01            | 1142                    | St 12                  | CR4                     | TC                       | CR 2                  | Fe P01               | AP 01                  | SPCD  |
| DC03            | 1146                    | St 13                  | CR2                     | E                        | CR 3                  | 0                    | AP 03                  | SPCE  |
| DC04            | 1147                    | St 14                  | CR1                     | ES                       | CR 4                  | Fe P04               | AP 04                  | SPCEN |
| DC05            | —                       | St 14                  | —                       | —                        | —                     | —                    | —                      | —     |
| DC06            | —                       | —                      | —                       | —                        | —                     | —                    | —                      | —     |
| Docol 4D        | —                       | —                      | —                       | —                        | —                     | —                    | —                      | —     |

| Surface quality |    |   |    |   |    |    |   |    |    |
|-----------------|----|---|----|---|----|----|---|----|----|
| A               | 32 | 3 | GP | X | 11 | MA | X | GP |    |
| B               | 42 | 5 | FF | Z | 12 | MB | X | FF | FF |

| Surface appearance |        |  |
|--------------------|--------|--|
| Designation        | Symbol | Surface roughness                            |
| Bright             | b      | $R_a \leq 0.4 \mu\text{m}$                   |
| Semi-bright        | g      | $R_a \leq 0.9 \mu\text{m}$                   |
| Normal             | m      | $0,6 \mu\text{m} < R_a \leq 1.9 \mu\text{m}$ |
| Rough              | r      | $R_a > 1.6 \mu\text{m}$                      |

| High strength steels         |             |            |            |             |            |          |          |
|------------------------------|-------------|------------|------------|-------------|------------|----------|----------|
| SSAB Tunnpått<br>steel grade | SS<br>14xxx | BS<br>1449 | SEW<br>093 | 094         | NF A36-203 | EN 10268 | EN 10155 |
| Docol 220 RP                 | —           | —          | —          | ZStE 220 P  | —          | —        | —        |
| Docol 260 RP                 | —           | —          | —          | ZStE 260 P  | —          | —        | —        |
| Docol 300 RP                 | —           | —          | —          | ZStE 300 P  | —          | —        | —        |
| Docol 220 BH                 | —           | —          | —          | ZStE 220 BH | —          | —        | —        |
| Docol 260 BH                 | —           | —          | —          | ZStE 260 BH | —          | —        | —        |
| Docol 300 BH                 | —           | —          | —          | ZStE 300 BH | —          | —        | —        |
| Docol 220 YP                 | 1316        | CR37/23    | —          | —           | —          | —        | —        |
| Docol 240 YP                 | —           | —          | —          | —           | —          | —        | —        |
| Docol 240 LA                 | —           | —          | —          | —           | —          | H 240 LA | —        |
| Docol 260 YP                 | —           | —          | ZStE 260   | —           | —          | —        | —        |
| Docol 280 YP                 | 1426        | —          | —          | —           | E 275 D    | —        | —        |
| Docol 280 LA                 | —           | —          | —          | —           | —          | H 280 LA | —        |
| Docol 300 YP                 | —           | CR40/30    | ZStE 300   | —           | —          | —        | —        |
| Docol 320 LA                 | —           | —          | —          | —           | —          | H 320 LA | —        |
| Docol 340 YP                 | —           | —          | ZStE 340   | —           | E 335 D    | —        | —        |
| Docol 350 YP                 | 2136        | CR43/35    | —          | —           | —          | —        | —        |
| Docol 360 LA                 | —           | —          | —          | —           | —          | H 360 LA | —        |
| Docol 380 YP                 | —           | —          | ZStE 380   | —           | —          | —        | —        |
| Docol 400 LA                 | —           | —          | —          | —           | —          | H 400 LA | —        |
| Docol 420 YP                 | —           | —          | ZStE 420   | —           | E 430 D    | —        | —        |
| Docol 500 YP                 | —           | —          | —          | —           | E 490 D    | —        | —        |
| Docol 355 W                  | —           | —          | —          | —           | —          | —        | JOWP     |

Other high strength steels in the SSAB Tunnpått product range are not covered by standards.

## Knowledge Service Center and information

The many SSAB Tunnplåt experts with long practical experience of cold-reduced steel are at the disposal of our customers.

Our experts at Knowledge Service Center have the broad expertise in materials and production engineering. They will give you immediate answers to questions in technical matters on +46 243 72929 or by e-mail at [help@ssab.com](mailto:help@ssab.com).

*Our Applications Engineers* have spearhead expertise in sizing, forming, joining and surface treatment.

### Put our modern analysis tools to use

We use the very latest tools for assisting our customers in selecting the right grade of steel and the right design, including:

*Finite Element Method (FEM)* analysis can be used for simulating all stages in the development of a part, such as selection of steel grade, shape of the blank, method of working and final design of the part. FEM

analysis can also be used for calculating the energy absorption of an automotive part in the event of a crash. Many conceivable variants of tool design, radii, design, thickness and steel grade can be simulated in a computer environment in order to find the optimum solution.

*ASAME* is an item of equipment that enables us to check quickly that a customer has selected the right combination of steel grade and design. ASAME measures the distribution of elongation in pressed parts. The information is processed in a powerful computer program and immediately produces information on how the tools, production methods and design affect the material. ASAME can handle very detailed analyses of complicated forming operations.

### Courses and seminars

SSAB Tunnplåt regularly arranges courses and seminars on how the many opportunities offered by cold-reduced steels can be put to use, such as:



The FEM analysis shows that the stresses in the material are too high in several places.



After a number of relatively simple modifications to the design and the planned production, the analysis shows that the bracket for the tow lug meets all of the demands.



Our courses and seminars attract many participants. Lars Ståhlberg has clearly gained the attention of the group.

*Steel sheet course* that provides fundamental knowledge of the production of steel, and the properties and applications of the various steel grades.

*Seminars that provide more detailed knowledge* of sizing, design, working, forming and jointing of ultra-high strength steels.

Seminars that are tailored to the needs of individual companies.

### Handbooks

In-depth knowledge of the many opportunities offered by cold-reduced steels are included in our handbooks:

The Sheet Steel Handbook provides information on sizing and design, as well as production engineering advice.

The Sheet Steel Forming Handbook provides expanded information on plastic forming and machining.

The Sheet Steel Joining Handbook deals with various types of joining methods for high strength steels.

### Trial steel sheets

Order sheets from our Trial Sheet Stores if you are interested in finding out how a new grade of steel would perform in your production equipment or in the intended product.

### Product information

Further information on all of our high strength steel grades and how they can be used and worked is presented in our brochures entitled High Strength and Extra-High Strength and Ultra-High Strength Steels.

### Certification

SSAB Tunnplåt has gained environmental certification in

accordance with ISO 14001 and quality certification in accordance with ISO 9001:2000 and ISO/TS 16949:2002. You find them at [www.ssabdirect.com](http://www.ssabdirect.com)

**Visit our home pages.**

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[www.businesssteel.com](http://www.businesssteel.com)  
[www.steelprize.com](http://www.steelprize.com)



## Ordering recommendations

Every item in an order should usually be in multiples of 18 kg per mm of strip width.

When placing your order, always remember to specify your demands or requirements on:

- steel grade (description, EN number, our designation, standard number, etc.)
- suitability for hot-dip galvanizing
- suitability for enamelling
- surface quality
- surface appearance
- surface roughness
- dimensions, including tolerances
- edge trimming
- quantity
- delivery time
- oiled or dry
- max. and/or min. bundle weight
- max. and/or min. coil size (weight and/or diameter)
- packaging

SSAB Tunnpåt AB is the largest Scandinavian sheet steel manufacturer and a leader in Europe in the development of high strength, extra-high strength and ultra-high strength steels.

SSAB Tunnpåt is a member of the SSAB Swedish Steel Group, has a turnover of SEK 10 billion, and has around 4000 employees in Sweden. The company produces about 2.5 million tonnes of sheet steel annually.

Our environmental policy involves continual improvements to the efficiency of production processes and environmental care plants, and development of the environmental properties of our products from the life cycle perspective.

We produce the following steels in our modern, high-efficiency production lines and rolling mills for strip products:

**DOMEX**  
hot-rolled steel sheet

**DOCOL**  
cold-reduced steel sheet

**DOGAL**  
metal-coated steel sheet

**PRELAQ**  
prepainted steel sheet

Registered trademarks of SSAB  
Tunnpåt.

We assist our customers in selecting the steels that are best suited for improving their competitiveness. Our strength lies in the quality of our products, our reliability of supply, and our flexible technical customer service.

ssabdirect.com

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