

# Docol M

## Cold reduced martensitic steels

### Product

Docol M are cold reduced fully martensitic steels. These steels are manufactured using special heat treatment in a continuous annealing line. The ultra high strength is produced by extremely fast water quenching from an elevated austenitic temperature range.

Docol M grades are characterized by good formability at these high strength levels combined with good weldability. All conventional welding methods can be used due to the lean chemical composition.

Some of the advantages of using Docol M are:

- Weight reduction
- Very high strength levels
- Simplified manufacturing
- Increased safety
- Improved environment
- Longer lifecycle
- Increased payload
- Reduced total cost

### Applications

Typical applications for Docol M are

- Safety components in cars
- door beams
- bumper reinforcements.
- Safety shoe toe-caps and soles
- Cutting tools
- Clutch discs

### Mechanical properties

Steel grade	Yield strength $R_{el}$ (N/mm <sup>2</sup> )		Yield strength after bake hardening <sup>1)</sup> min	Tensile strength $R_m$ (N/mm <sup>2</sup> )		Elongation $A_{80}$ % min	Min. bending radius 90° bend
	min	max		min	max		
Docol 900M	700	-	900	900	1100	3	3,0 xt
Docol 1200M	950	-	1150	1200	1400	3	3,0 xt
Docol 1400M	1150	-	1350	1400	1600	3	3,0 xt
Docol 1500 <sup>2)</sup>	1200	-	-	1500	1700	3	3,0 xt

The mechanical properties are valid in transverse direction of rolling  
t = Sheet thickness

1) BH = bake hardening after 2% plastic deformation and heated to 170° C.

2) Can be achieved at request

### Dimension range

Thickness: 0.5 - 2.10 mm

Width: 800 - 1500 mm, depending on steel grade and thickness

### Tolerances

Docol M are supplied to tolerances in accordance with EN 10131.

### Chemical composition

(typical values)

Steel grade	C (%)	Si (%)	Mn (%)	P (%)	S (%)	Al <sub>tot</sub> (%)	Nb (%)	Ti (%)
Docol 900M	0,05	0,20	2,00	0,010	0,002	0,040	-	-
Docol 1200M	0,11	0,20	1,70	0,010	0,002	0,040	0,015	0,025
Docol 1400M	0,17	0,20	1,40	0,010	0,002	0,040	0,015	0,025
Docol 1500M	0,21	0,20	1,10	0,010	0,002	0,040	0,015	0,025

### Forming

Docol M is designed for conventional cold forming techniques such as stamping, roll forming and tube making.

### Bending

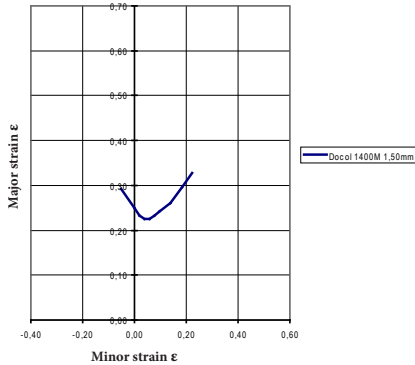
The bendability of M steels is good. At tight bend radii it is important if possible to do the bending transverse to the rolling direction where the bendability is somewhat better than in the longitudinal direction.

### Roll forming

Roll forming is widely used for M steels and this also permits smaller radii compared to those achieved when bending.

## Pressing

The high work hardening of M steels results in good stretchability and drawability. Usual consideration when designing details in Docol is to make the radii slightly larger and optimize the blank shape to help the material "flow" in the tool. The forming limit curves below, for Docol 1400 M in thickness 1,50 mm, show a material that can withstand at least 14% deformation at forming.



## Shearing and punching

When shearing and punching Docol M steels it is particularly important to use the right cutting clearances. Factors ruling this are sheet thickness, strength and the demand on the cut surface appearance. We recommend a cutting clearance of 10-12% of the sheet thickness for Docol M steels.

## Welding

The weldability of Docol M is very good. The reason for this is that Docol M steels have very low contents of alloying elements in relation to the high strength of the steels.

When Docol M is fusion welded all the common welding methods can be used as e.g. gas metal arc welding (GMAW), manual metal arc welding (MMA), TIG-welding, plasma wel-

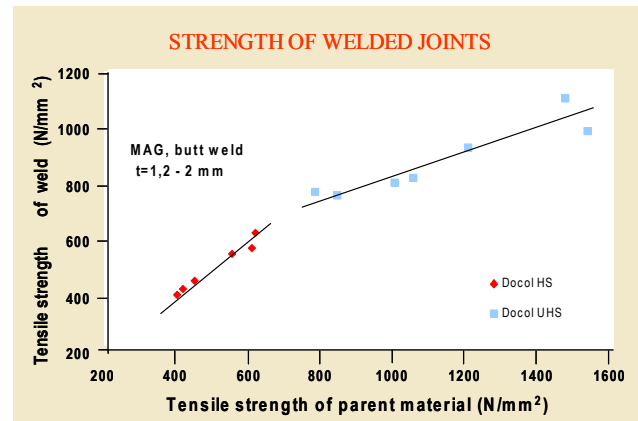
The particulars in this data sheet are correct at the time of going to print and are intended to give general guidance for the use of the product. Subject to changes arising from continual product development. The information and data must not be regarded as guaranteed values, unless specially confirmed in writing.

ding and laser welding. The recommended filler metals for Docol M are shown in table 1. If the weldments can be placed in areas of low stresses, then filler metals of lower strength than in table 1 can be used.

GMAW (MAG) Gas metal arc welding	MMA Manual metal arc welding
AWS: A5.28 ER 10XS-X AWS: A5.28 ER 11XS-X AWS: A5.28 ER 12XS-X	AWS: A5.5 E10X18 AWS: A5.5 E11X18 AWS: A5.5 E12X18

Tabell 1: Rekommenderade tillsatsmaterial

The strength of welded joints with Docol M is higher than when conventional high strength steels are welded.



Another welding method, which can be used for Docol M, is electrical resistance welding. Spot welding is the most common welding method for Docol M. When Docol M is spot welded to another soft steel it is recommended that the electrode force is increased by 20-30%. To ensure good welding results when Docol M is spot welded to itself it is recommended that the electrode force is increased by 40-50% and that the welding time is slightly increased.

## Teknisk service och information

Knowledge Service Center will be pleased to assist with additional information concerning this product from SSAB Tunnpålat.

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