Steel

CP-W® and CP-K®

Product information for complex-phase steels

thyssenkrupp

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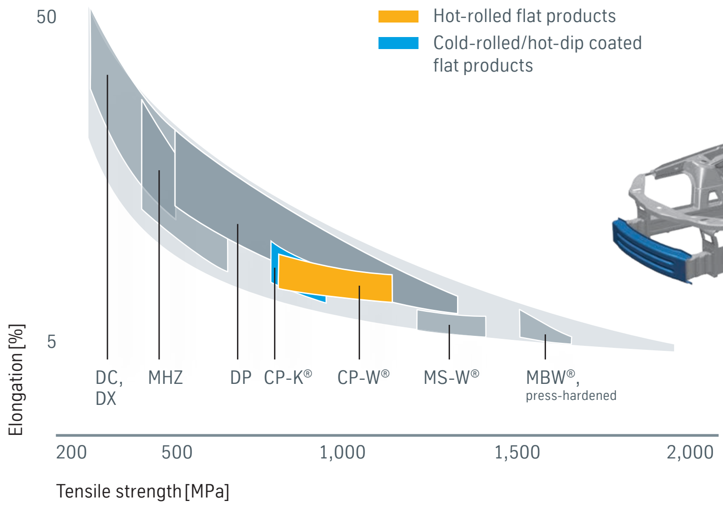
Overview of steel grades



Content

Areas of application

Complex-phase steels CP-W® and CP-K® by thyssenkrupp offer very high strengths and yield points. They are particularly suitable for weight-saving production of cold-formed, crash-relevant automotive components such as side impact intrusion beams, B-pillar reinforcements, profiles, cross members, body reinforcements, bumper bars and chassis parts. The use of complex-phase steels in B-pillar reinforcements can double the strength, for example, compared to with conventional micro-alloyed steels. The hot-rolled and cold-rolled grades which are currently available are characterized by strong strain hardening even with only minor deformation forces.

Available steel grades

thyssenkrupp supplies the following steel grades as per the product information or the reference steel grades in accordance with the respective standards.

Steel grade designations and surface refinements

			Surface refinements					
			UC	EG	GI	GA	ZM	AS
Complex-phase steel								
Steel grade	Reference grade DIN EN 10152, 10338, 10346	Reference grade VDA 239-100						
● (orange) CP-W® 660Y760T	HDT760C	HR660Y760T-CP	●	●	●			
● (orange) CP-W® 800	–	–	●	●	●			
● (orange) CP-W® 1000	–	–	●	●				
● (blue) CP-K® 570Y780T	HCT780C	CR570Y780T-CP	●	●				
● (blue) CP-K® 900Y1180T	–	CR900Y1180T-CP	●		●			

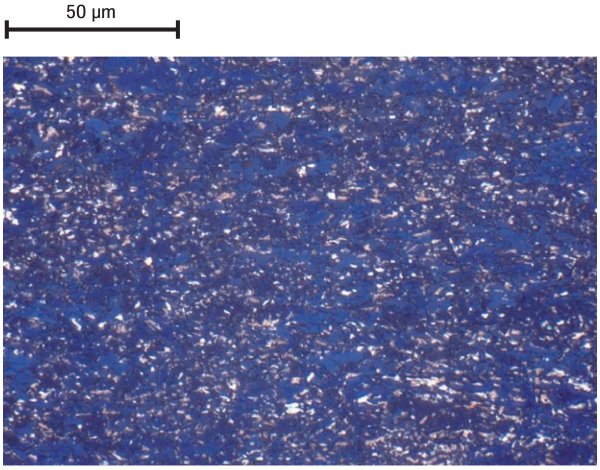
● (orange) Hot-rolled flat products
● (blue) Cold-rolled/hot-dip coated flat products
● (grey) Serial production for unexposed applications

UC Uncoated
EG Electrogalvanized zinc coating
GI Hot-dip zinc coating
GA Galvannealed
ZM ZM Ecoprotect®
AS Aluminum-silicon coating

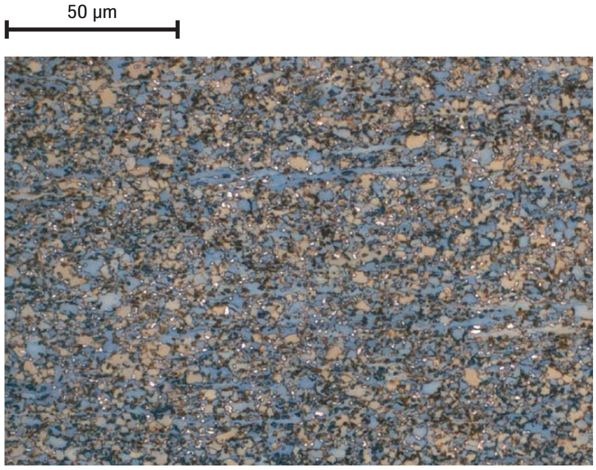
Material characteristics

Due to its selected chemical composition and special hot-rolling process, complex-phase steel has an extremely fine microstructure. In the complex interaction of matching micro-structure components and precipitation hardening, this results in a particularly attractive combination of properties: high strength and wear resistance with good cold formability and weldability.

Micrograph of CP-W® 660Y760T and CP-K® 570Y780T



Microstructure of complex-phase steel CP-W® 660Y760T.
Microstructural contrasting with color etching according to Klemm.



Microstructure of complex-phase steel CP-K® 570Y780T.
Microstructural contrasting with color etching according to Klemm.

Technical features

Chemical composition

Mass fractions in ladle analysis	C [%] max.	Si [%] max.	Mn [%] max.	P [%] max.	S [%] max.	Al [%] total	Ti + Nb [%] max.	Cr + Mo [%] max.	V [%] max.	B [%] max.
Steel grade										
● CP-W® 660Y760T	0.14	1.00	2.20	0.080	0.015	0.015 – 2.0	0.25	1.00	0.20	0.005
● CP-W® 800	0.14	1.00	2.20	0.080	0.015	0.015 – 2.0	0.25	1.00	0.20	0.005
● CP-W® 1000	0.19	1.00	2.20	0.080	0.015	0.015 – 2.0	0.25	1.20	0.20	0.005
● CP-K® 570Y780T	0.14	1.00	2.20	0.080	0.015	0.015 – 2.0	0.15	1.00	0.20	0.005
● CP-K® 900X1180T	0.20	0.80	2.60	0.080	0.015	0.015 – 2.0	0.15	1.40	0.20	0.005

Mechanical properties

Test direction in rolling direction	Yield strength	Tensile strength	Elongation	
	$R_{p0.2}$ [MPa]	R_m [MPa] min.	A [%] min.	A_{80} [%] min.
Steel grade				
● CP-W® 660Y760T	660 – 830	760	12	10
● CP-K® 570Y780T	570 – 720	780	–	10
● CP-K® 900Y1180T	900 – 1,070	1,180	–	6

Mechanical properties

Test direction transverse to rolling direction	Yield strength	Tensile strength	Elongation	
	$R_{p0.2}$ [MPa]	R_m [MPa] min.	A [%] min.	A_{80} [%] min.
Steel grade				
● CP-W® 800	680 – 830	780	12	10
● CP-W® 1000	720 – 920	950	12	9

● (orange) Hot-rolled flat products
● (blue) Cold-rolled/hot-dip coated flat products

$R_{p0,2}$ Proof strength at 0.2% plastic elongation
R_m Tensile strength
A Percentage elongation after fracture using a proportional specimen with $L_0 = 5.65 \sqrt{S_0}$ for sheet thicknesses ≥ 3.0 mm
A_{80} Percentage elongation after fracture using a specimen with gauge length L_0 = 80 mm for sheet thicknesses < 3.0 mm

Heat treatment of hot-rolled complex-phase steels at temperatures from 500 to 700°C can be used to increase the yield strength by up to 100 MPa (e.g., 680°C, dwell time 0.7 min/mm sheet thickness in saline bath). In addition, forming in the temperature range from 550°C to 650°C enables complex parts to be produced without compromising the component properties.

Surfaces

Surface refinements, electrogalvanized zinc coating

	Specification	Nominal coating on each side of single spot sample		Coating on each side of single spot sample	
		Mass [g/m²]	Thickness [μm]	Mass [g/m²]	Thickness [μm]
Electrogalvanized zinc coating					
Designation					
EG 25/25	DIN EN	18	2.5	≥ 12	≥ 1.7
EG 18	VDA 239-100	–	–	18–38	2.5–5.4
EG 50/50	DIN EN	36	5.0	≥ 29	≥ 4.1
EG 29	VDA 239-100	–	–	29–49	4.1–6.9
EG 75/75	DIN EN	54	7.5	≥ 47	≥ 6.6
EG 53	VDA 239-100	–	–	53–73	7.5–10
EG 100/100	DIN EN	72	10	≥ 65	≥ 9.1
EG 70	VDA 239-100	–	–	70–90	9.9–13

Surface refinements, hot-dip galvanized

	Specification	Minimum coating mass on both sides [g/m²]		Coating on each side of single spot sample		Informative
		Triple spot sample	Single spot sample	Mass [g/m²]	Thickness [μm]	Typical thickness [μm]
Hot-dip zinc coating						
Designation						
GI 100	DIN EN	100	85	–	5–12	7
GI 40	VDA 239-100	–	–	40–60	5.6–8.5	–
GI 140	DIN EN	140	120	–	7–15	10
GI 60	VDA 239-100	–	–	60–90	8.5–13	–
GI 200	DIN EN	200	170	–	10–20	14
GI 85	VDA 239-100	–	–	85–115	12–16	–

Further coatings on request.

Surface finishes and surface qualities

	Finish type	Surface quality
Products		
Cold-rolled flat products	Uncoated	A Normal surface
		U Unexposed (interior parts)
Electrolytically zinc coated flat products	Electrogalvanized zinc coating	A Normal surface
		U Unexposed (interior parts)
Hot-dip coated flat products	Hot-dip zinc coating	B Improved surface
		U Unexposed (interior parts)

A / B as per DIN EN
U as per VDA 239-100

Surface treatments

		UC	EG	GI	GA	ZM	AS
Type of surface treatment							
O	Oiled	●	●	●			

● Serial production

UC Uncoated
EG Electrogalvanized zinc coating
GA Galvannealed
GI Hot-dip zinc coating
ZM ZM Ecoprotect®
AS Aluminum-silicon coating

Notes on applications and processing

Forming

Complex-phase steels are particularly suitable for crash-relevant parts such as pillars, side impact intrusion beams and bumper bars. Hot-rolled complex-phase steels are also used in the vehicle chassis area. Cold-rolled complex-phase steels have a higher minimum yield strength in comparison with dual-phase steels of identical tensile strength. Complex-phase steels can be worked in crash forming operations, that is, without a blank holder in a single forming step. Calibration should be integrated to enable specific, localized plasticization, in order to improve the dimensional accuracy of the worked components. Folding or bending operations are also customary, as are deep-drawing and stretch-forming operations up to the B-pillar geometry. Suitability for roll forming is guaranteed. This is where cold-rolled complex-phase steels offer an interesting alternative to equal-strength dual-phase steels on account of their strain-hardening characteristics and bending ability. Due to their extremely fine microstructure, complex-phase steels also exhibit good hole expansion properties.

Particular attention must be paid to the design of the cutting and forming tools. Tool requirements are exacting, especially in cutting. In addition to a sufficient hardness of > 60 HRC, it is important to select suitable tool materials to simultaneously ensure high ductility, thus preventing premature breaking of the cutting edges. Specific rounding of the cutting edge in the dimension of about 50 microns helps to optimize the edge stability of the tools. The cutting gap must be designed to taking the material thickness into account and should be taking ≥ 10% of the sheet thickness.

A sufficient supporting hardness must be achieved for the forming tools. A segmented structure of the forming tools is common today. In highly stressed areas, the use of high speed steels may be necessary. These include 1,3343 or corresponding sintered tool materials. In addition, tool coatings such as CVD (TiC-TiN coating) can minimize tool wear.

The presses should have high pressing and hold-down force potentials. As a guideline, the tensile strength level should be considered here, compared with known materials.

Processing instructions for joining

Complex-phase steels are suitable for welding both same-grade joints and hybrid joints with other common steel grades. The precondition is welding parameters matched to the material.

Resistance spot welding

For spot welding complex-phase steels, the same equipment can basically be used as for welding unalloyed deep-drawing steels. However, the electrode forces should be increased compared to these steel grades in order to achieve a large welding zone. Stable and rigid welding rods with large power reserves are therefore recommended for spot welding of complex-phase steels; this may also offer advantages in case of engineering fit issues. Extending the welding time has a positive effect on the welding zone; for this reason, medium to long welding times are recommended for spot welding.

Typical properties of a resistance spot weld [1)]

	Sheet thickness t [mm]	Welding zone ΔI [kA]	Cross tensile strength $d_{w\,min}$ [kN]	Shear tensile strength $d_{w\,min}$ [kN]	Mean hardness HV 0.1 Base material	Weld nugget
Steel grade						
● HX340LAD+Z	1.5	2.0	9.9	13.7	165	330
● CP-W® 660Y760T	1.5	1.4	6.7	17.3	280	390
● CP-W® 1000	1.5	1.5	6.2	18.9	330	460
● CP-K® 570Y780T	1.5	1.6	8.1	17.2	290	395

1) Test results as per SEP 1220-2.

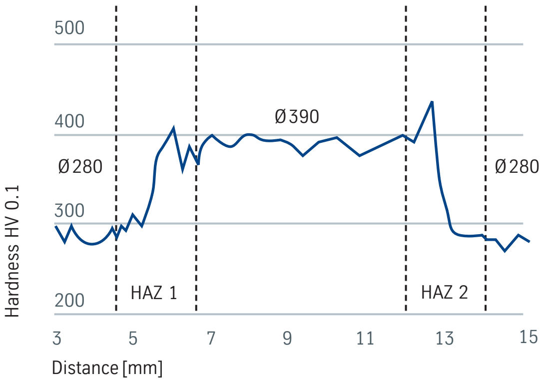
● Hot-rolled flat products
● Cold-rolled/hot-dip coated flat products
t Sheet thickness of test specimens
$d_{w\,min}$ Welding spot diameter of $4\sqrt{t}$

CP-W® 660Y760T

CP-W® 1000

Good weld nugget formation.

Hardness profile of the weld nugget on a CP-W® 660Y760T



Relatively low hardening compared to the base material.

Compared to lower-strength steels, complex-phase steels have a lower electrical conductivity; lower welding currents are thus required for in spot welding electrodes with the same force. In resistance spot welding of galvanized sheets, the welding currents must be increased due to the higher conductivity of the coating compared with the base material (substrate). In addition to the sheet type, surface and thickness combination, other factors e.g., the type of electrode used, play an important role in determining optimum joining parameters.

MIG arc brazing

Information sheet DVS 0938-2 “Arc brazing” describes brazing of steels up to a tensile strength of approximately 500 MPa. As the material described here is above this tensile strength, it is advisable to check the component-specific suitability for brazing.

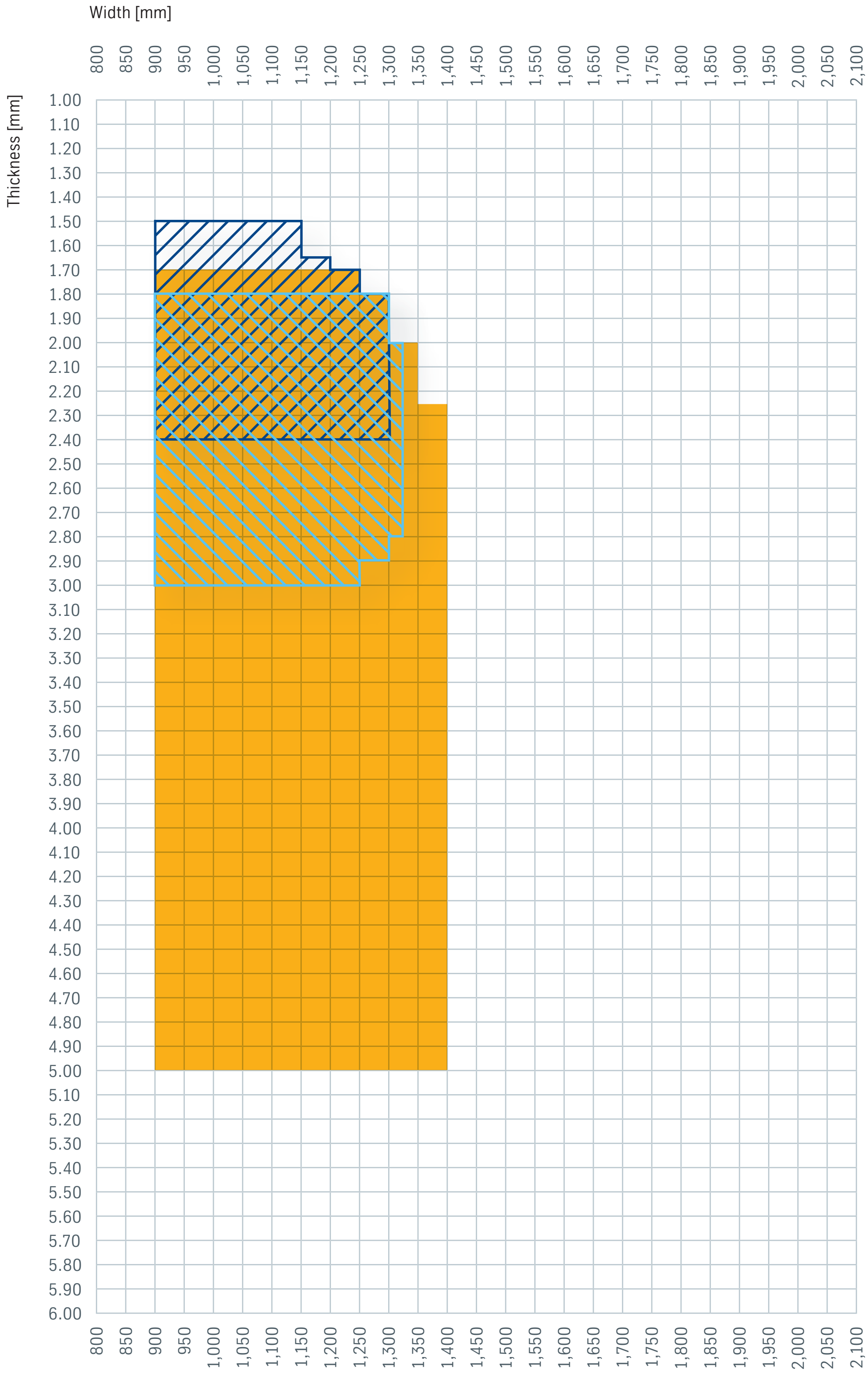
Fatigue strength and crash performance

Complex-phase steels exhibit high structural durability. In terms of stress-strain curve characteristics the steels are superior to dual-phase and retained-austenite steels. However, in case of excessive elongation, that is, in case of misuse load, their behavior is more sensitive.

High resistance to crash deformation is assured due to the high yield point, without compromising elongation at break values. This group of materials is thus suitable, for example, for A-pillar and B-pillar reinforcement parts, which are designed in particular to prevent a component group buckling under crash load.

Available dimensions

CP-W® 660Y760T, CP-W® 800



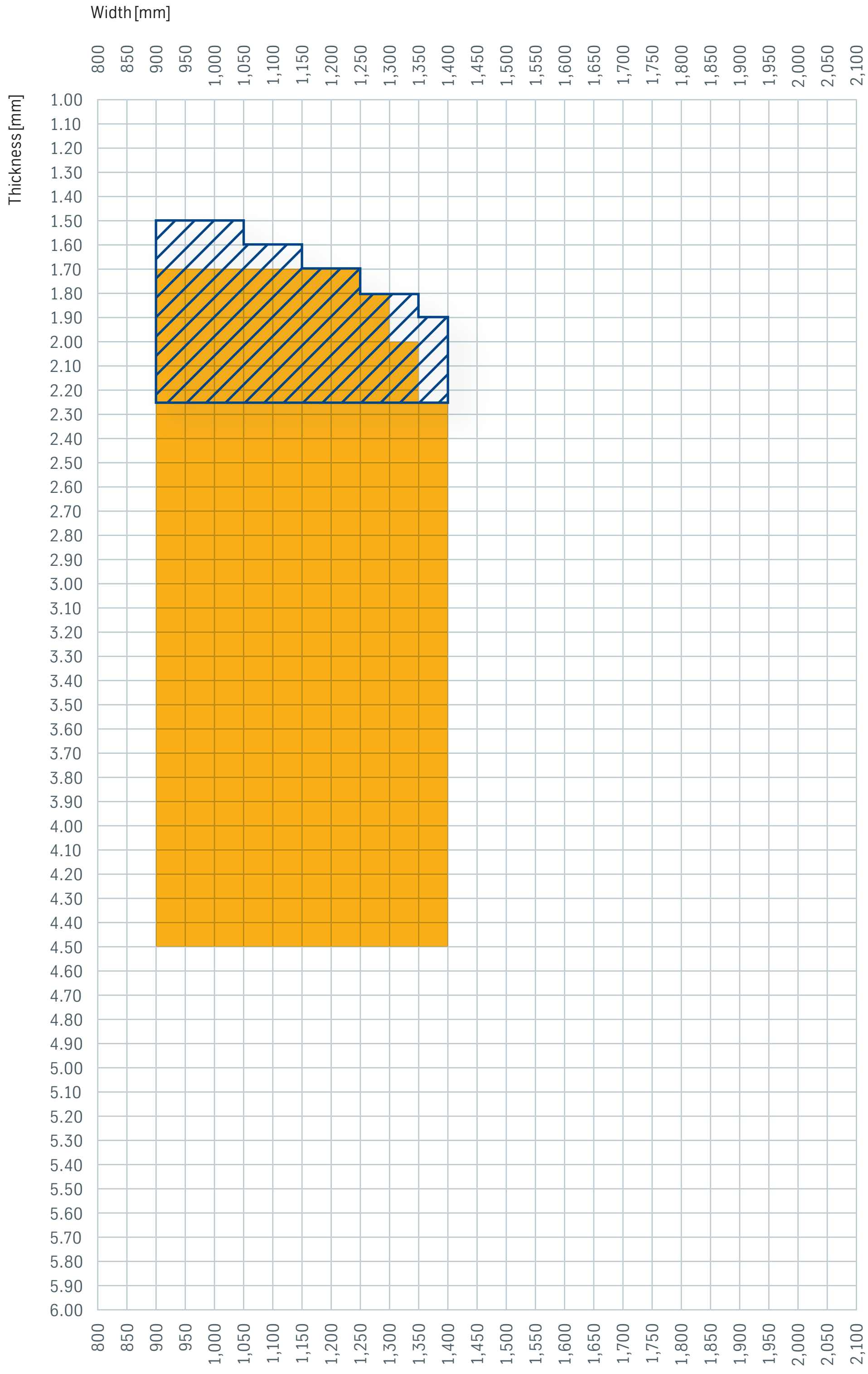
EG Electrogalvanized zinc coating
GI Hot-dip zinc coating

GI trimmed
EG trimmed
Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

Further dimensions on request.

CP-W® 1000



EG Electrogalvanized zinc coating

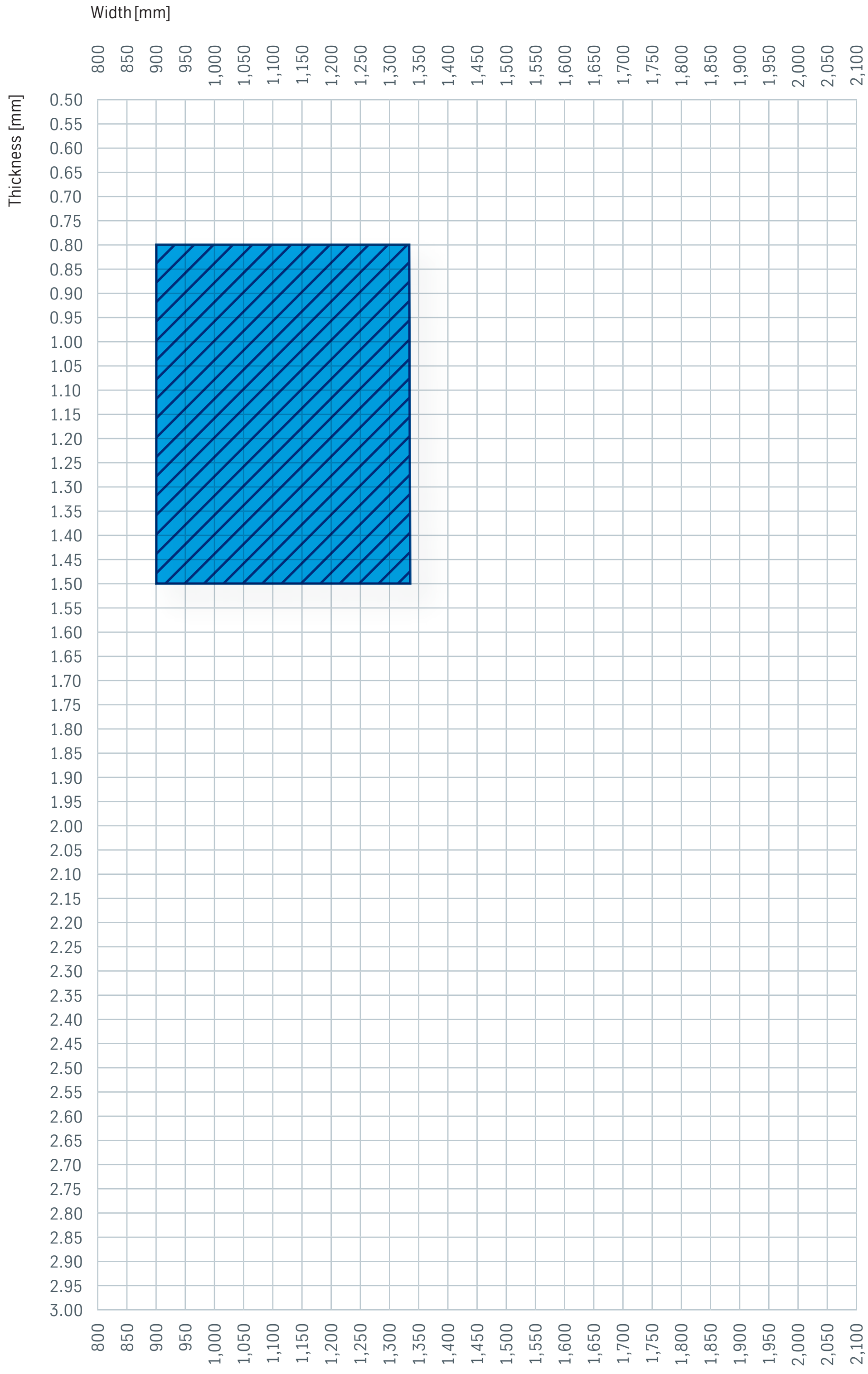
EG trimmed

Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers.

Further dimensions on request.

CP-K® 570Y780T



EG Electrogalvanized zinc coating

EG trimmed

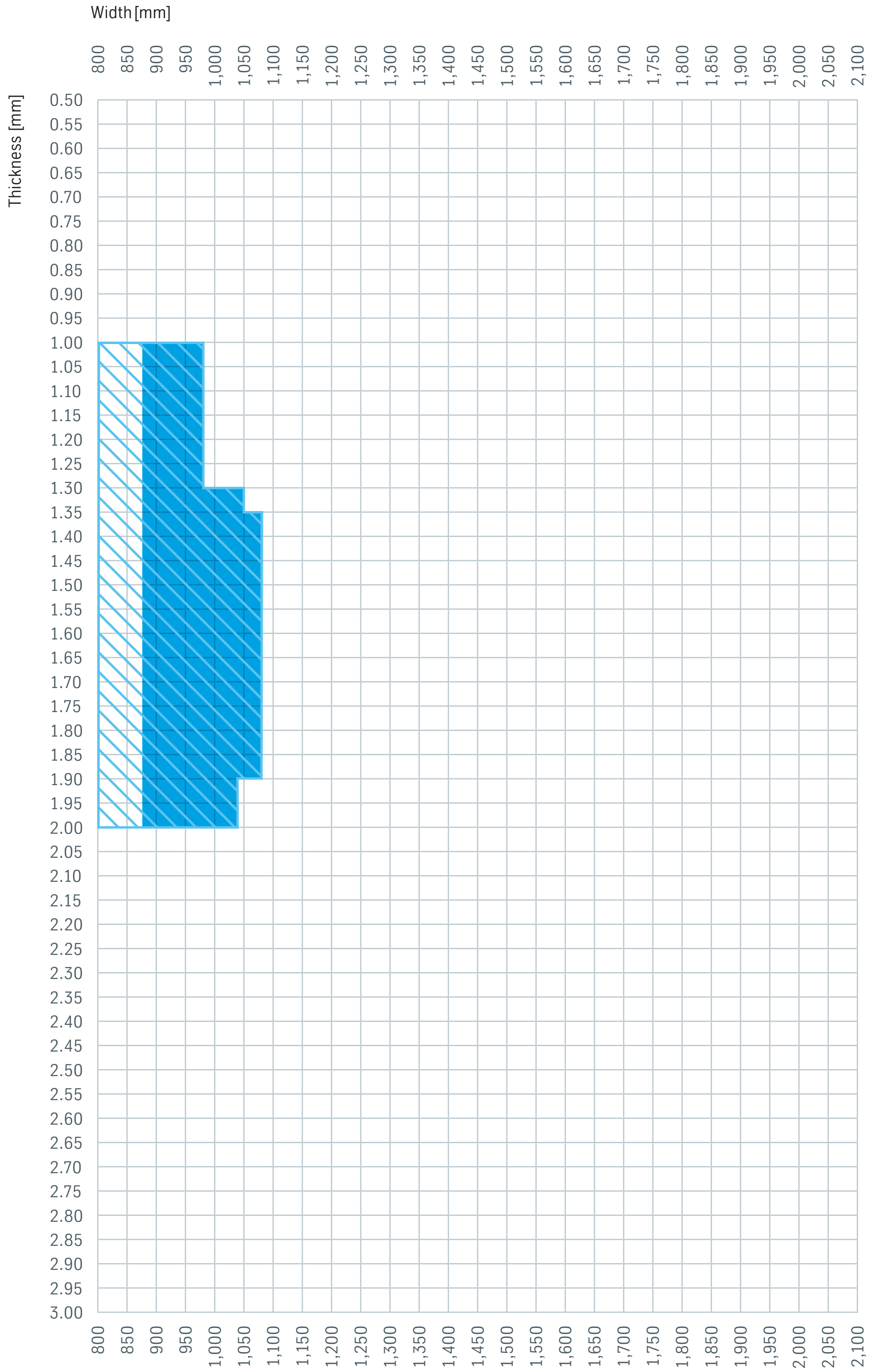
Uncoated with mill edge

For interior parts

Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

Further dimensions on request.

CP-K® 900Y1180T



GI Hot-dip zinc coating

GI trimmed
Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

Further dimensions on request.

Sample applications

B-pillar made of CP-W® 660Y760T.

Rear axle torsion tube made of CP-W® 660Y760T.

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