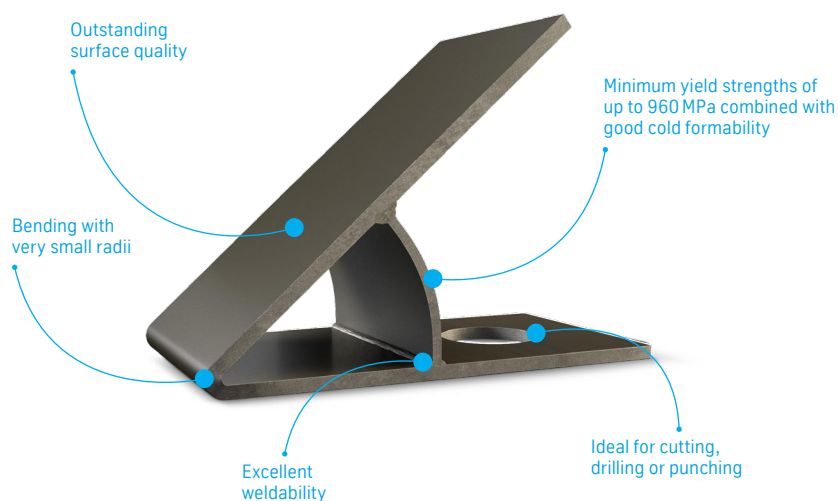




Issue: January 22, 2019, version 0 / WB 660

Brief profile



perform[®] from thyssenkrupp is a microalloyed steel which is thermomechanically rolled and available as uncoated wide hot strip and cut-to-length plate in the sizes listed in the section “Available dimensions”.

perform[®] steels are characterized by a very low levels of sulfur and a low carbon content, microalloying with niobium, vanadium, titanium as well as their combination.

The combination of microalloying and the special thermomechanical rolling process gives perform[®] steels outstanding cold formability and weldability. The extremely fine-grain microstructure additionally results in very good toughness levels with a low risk of cold cracking. thyssenkrupp supplies perform[®] steels in various yield strengths from 300 to 960 MPa.

perform[®] steels are primarily used for complex part geometries such as vehicle frames, axle structures, BIW beams and pillars, special profiles and shaped parts in car and commercial vehicle construction.

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Available steel grades

perform® is available as uncoated wide hot strip with yield strengths from 300 to 700 MPa and cut-to-length plate with yield strengths from 500 to 960 MPa in the sizes listed in the section “Available dimensions”.

Steel grade	Reference grade DIN EN 10149-2	Material No.
perform® 300	–	–
perform® 315	S315MC	1.0972
perform® 340	–	–
perform® 355	S355MC	1.0976
perform® 380	–	1.0978
perform® 420	S420MC	1.0980
perform® 460	S460MC	1.0982
perform® 500	S500MC	1.0984
perform® 550	S550MC	1.0986
perform® 600	S600MC	1.8969
perform® 650	S650MC	1.8976
perform® 700	S700MC	1.8974
perform® 900	S900MC	1.8798
perform® 960	S960MC	1.8799

Comments

By arrangement the grades perform® 300 to 700 can be also supplied with category A galvanizing properties based on DIN EN 10149-2.

Wide hot strip and cut-to-length plate can be ordered in pickled or non-pickled condition and with mill or trimmed edges. For surface quality requirements of cut-to-length plates DIN EN 10163 is applicable.

Cut-to-length plate is supplied with a maximum flatness tolerance in accordance with DIN EN 10029, table 4. Lower flatness tolerances in accordance with DIN EN 10029, table 5 can be agreed separately when ordering.

By special arrangement, cut-to-length plate can be supplied in blasted and primed condition.

The admissible tolerances are based on DIN EN 10051 for wide hot strip and cut-to-length plates.

Unless otherwise agreed upon in the order, the delivery will be governed by the conditions outlined in DIN EN 10021.

Orders can also be placed for microalloyed steels to DIN EN 10149-2.

Technical characteristics

Mechanical properties – test direction parallel to rolling direction, state of delivery: thermomechanically rolled

Steel grade	Yield strength	Tensile strength	Elongation		Notch impact energy		Bend test, mandrel diameter ⁴⁾
	R _{eh} [MPa] min.	R _m [MPa]	A [%] min. L ₀ = 80 mm Nominal thickness < 3.0 mm	L ₀ = 5,65 · √S ₀ ≥ 3.0 mm	KV [J] at a test temperature of -20 °C	KV [J] at a test temperature of -40 °C	D [t = specimen thickness]
perform® 300	300	380–500	21	25	40	27	0 t
perform® 315	315	390–510	20	24	40	27	0 t
perform® 340	340	420–540	19	23	40	27	0.5 t
perform® 355	355	430–550	19	23	40	27	0.5 t
perform® 380	380	450–590	17	21	40	27 ³⁾	0.5 t
perform® 420	420	480–620	16	19	40	27 ³⁾	0.5 t
perform® 460	460	520–670	14	17	40	27 ³⁾	1.0 t
perform® 500	500	550–700	12	14	40	27 ³⁾	1.0 t
perform® 550	550	600–760	12	14	40	27 ⁴⁾	1.5 t
perform® 600	600	650–820	11	13	40	27 ⁴⁾	1.5 t
perform® 650 ¹⁾	650 ²⁾	700–880	10	12	40	27 ⁴⁾	2.0 t
perform® 700 ¹⁾	700 ²⁾	750–950	10	12	40	27 ⁴⁾	2.0 t
perform® 900 ^{1), 6)}	900	940–1.200	–	10	60	30	8,0 t
perform® 960 ^{1), 6)}	960	980–1,200	–	10	60	30	8.0 t

¹⁾ State of delivery: Possibly additionally tempered.

²⁾ For thicknesses > 8 mm yield strengths may be 20 MPa lower.

³⁾ For wide hot strip: For thicknesses > 12 mm on request.

⁴⁾ For wide hot strip: Notch impact energy at a test temperature of -40 °C on request.

⁵⁾ Bend test in accordance with ISO 7438 is performed by using transverse specimens.

⁶⁾ Values for test direction transverse to rolling direction: R_{eh} min. and R_m min., KV at -20 °C min. 30 J, KV at -40 °C min. 27 J.

Number of tests

Wide hot strip

Unless otherwise agreed upon in the order, for the inspection certificate 3.1 to DIN EN 10204 the scope of testing applies in accordance with DIN EN 10149-1 and 2. The notch impact energy is optional. The test temperature, -20 °C or -40 °C, has to be agreed when ordering.

Cut-to-length plate

Unless otherwise agreed upon in the order, the tests listed below will be performed during inspection:

Test	Scope of testing
1 tensile test	1 specimen per 40 t from each heat
1 notched bar impact test ⁶⁾	1 set (3 specimens) per 40 t from each heat
1 bend test	1 specimen per 40 t from each heat

⁶⁾ The notched bar impact tests in accordance to EN ISO 148 are carried out by using longitudinal specimens. The values for the impact energy are minimum values obtained as the average of three specimens, no single value being less than 70% of the value stated in the table. The values apply to plate thicknesses from 10 to 20 mm. For thicknesses below 10 mm the required minimum impact value is reduced proportionally to the specimen width (product thickness). No impact test is performed on products below 6 mm in thickness.

The notched bar impact test will be carried out at a test temperature of -20 °C by default. By special arrangement the notched bar impact test can be carried out at a test temperature of -40 °C.

Chemical composition

Mass fractions in ladle analysis	C [%] max.	Si [%] ¹⁾ max.	Mn [%] max.	P [%] max.	S [%] max.	Al [%] min.	Nb [%] ³⁾ max.	V [%] ³⁾ max.	Ti [%] ³⁾ max.	Mo [%] max.	B [%] max.
Steel grade											
perform® 300	0.10	0.10	1.30	0.025	0.010 ²⁾	0,015	0.050	0.08	0.100	–	–
perform® 315	0.10	0.10	1.30	0.025	0.010 ²⁾	0,015	0.050	0.08	0.100	–	–
perform® 340	0.10	0.10	1.50	0.025	0.010 ²⁾	0,015	0.060	0.08	0.100	–	–
perform® 355	0.10	0.10	1.50	0.025	0.010 ²⁾	0,015	0.060	0.08	0.100	–	–
perform® 380	0.10	0.10	1.50	0.025	0.010 ²⁾	0,015	0.065	0.08	0.100	–	–
perform® 420	0.10	0.10	1.60	0.025	0.010 ²⁾	0,015	0.070	0.10	0.100	–	–
perform® 460	0.10	0.10	1.60	0.025	0.010 ²⁾	0,015	0.080	0.15	0.100	–	–
perform® 500	0.10	0.10	1.70	0.025	0.006	0,015	0.080	0.15	0.100	–	–
perform® 550	0.10	0.10	1.80	0.025	0.006	0,015	0.080	0.15	0.100	–	–
perform® 600	0.10	0.10	1.90	0.025	0.006	0,015	0.080	0.20	0.200	0.50	0.0050
perform® 650	0.10	0.30	2.00	0.025	0.006	0,015	0.080	0.20	0.200	0.50	0.0050
perform® 700	0.10	0.30	2.00	0.025	0.006	0,015	0.080	0.20	0.200	0.50	0.0050
perform® 900	0.12	0.30	1.70	0.020	0.006	0.015	0.060	0.12	0.050	0.70	0.0050
perform® 960	0.12	0.30	1.70	0.020	0.006	0.015	0.060	0.12	0.050	0.70	0.0050

¹⁾ By arrangement the grades perform® 300 to 700 can be supplied with category A galvanizing properties based on DIN EN 10149-2, i.e. reduced Si content.

²⁾ A sulfur content of max. 0.006% can be agreed when ordering.

³⁾ For perform® 300 to 700: The sum of the alloying components Nb, V and Ti must not exceed 0.22%.

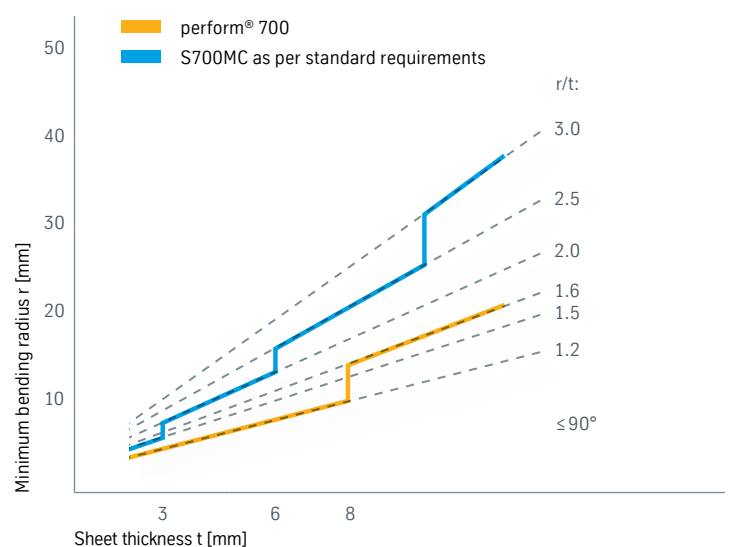
Information on use and processing

Forming

Microalloyed steels are particularly suitable for structural and crash-relevant parts, e.g. beams. The choice of grade for a particular strength level should take into account the anticipated forming loads so that individual advantages can be optimally exploited and the steels can also be used for difficult forming operations.

The typical r- and n-values for microalloyed steels do not make them suitable for a particular kind of forming operation. They are equally suitable for stretch-forming and deep-drawing.

Graphic 1: Press brake bending radii



perform® 700 is significantly better for press brake bending compared to the comparative grade according to DIN EN 10149-2.

Bending and press braking

With their particularly fine-grain microstructure and high cleanliness levels, perform® steels offer optimum forming behavior. They are also suitable for multi-stage forming processes. The drawing limit ratios differ very little from those of mild steels.

The predominant forming technique for cold forming steels is press brake bending. In most cases, bending with a defined inside radius in a die is limited by the rigid design of the die. The higher the strength of the steel, the greater the minimum press brake bending radius.

Graphic 1 on page 4 shows the press brake bending radii for perform® 700 compared with grade S700MC as per standard requirements independent of direction.

Minimum bending radii during cold forming

Recommended smallest bend radius for nominal thicknesses t in [mm]¹⁾

$t \leq 3$ $3 < t \leq 6$ $6 < t < 8$ $8 \leq t \leq 10$ $t > 10$

Thermo-mechanically rolled steel for cold forming

Steel grade

perform® 700	1.2 t	1.2 t	1.2 t	1.6 t	1.6 t
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Reference grade DIN EN 10149-2

S700MC	1.5 t	2.0 t	2.5 t	2.5 t	3.0 t
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¹⁾ Values for bending angles $\leq 90^\circ$.

Shearing, blanking, machining

perform® steels can be sheared and blanked. In general the quality of the cut edges and consequently the cutting process are of great importance. Defect-free cut edges are essential to achieve the stated inside bending radii.

To achieve smooth material flow, grinding the cut edges in the bending zone and measures such as lubrication have proven effective.

The behavior of perform® steels during drilling, turning and milling is similar to that of conventional cold forming steels. Normal tools can be used for high-strength grades provided the cutting parameters are adapted accordingly.

Thermal cutting

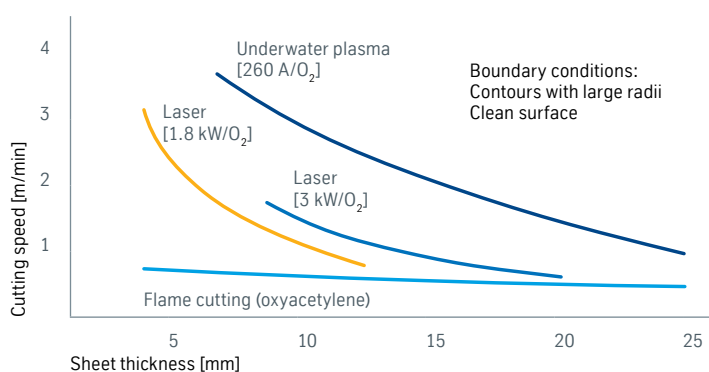
The following thermal cutting processes can be used with perform® steels:

- Plasma cutting
- Laser beam cutting
- Flame cutting

The plasma and laser beam techniques offer major advantages in terms of cost-efficiency and workpiece distortion. Plasma cutting permits the highest cutting speeds, as shown in Graphic 2, albeit with certain limitations with regard to cut edge quality.

Depending on sheet thickness and laser power, laser beam cutting offers significantly higher cutting speeds than flame cutting. Other advantages include a very narrow heat-affected zone, low distortion and high dimensional accuracy. Graphic 2 shows thermal cutting speeds for ferritic steels.

Graphic 2: Cutting speed



Joining

Microalloyed steels display good weldability for both similar and dissimilar joints with other common steel grades on condition that the welding parameters are matched to the material.

Welding

For welding follow DIN EN 10149-2 chapter 7.5 “Technological Properties” and STAHL-EISEN-Werkstoffblatt 088.

Recommendations for welding are also given in DIN EN 1011 part 1 and part 2. For those, who process this steel for the first time it is recommended to consult the steel supplier to take advantage of the experiences gathered so far.

Resistance spot welding

Resistance spot welding is widely used in automotive body making. Sheets in thicknesses of less than 3 mm in particular can be joined cost-efficiently and reliably by this method in mass production, although in general this calls for adjustments to welding current, welding time and electrode force. Particularly important is the influence of electrode force and welding time on the welding range. With increasing sheet thickness and strength, higher electrode forces and longer current flow times are generally required to achieve an adequate welding range. Alternatively the use of multiple-pulse welding based on SEP12202 can have a favorable effect on the welding range.

The welding range depends not only on the grade, surface and thickness of the sheet; process parameters such as current type (AC 50 Hz / DC 1,000 Hz) and electrode geometry are also important. The welding ranges of conventional high-strength steels largely overlap. In addition to the good weldability of the individual steel grades, by setting similar parameters it is thus also possible to achieve good weldability for combinations of a broad range of materials available from the steel industry.

MIG arc brazing

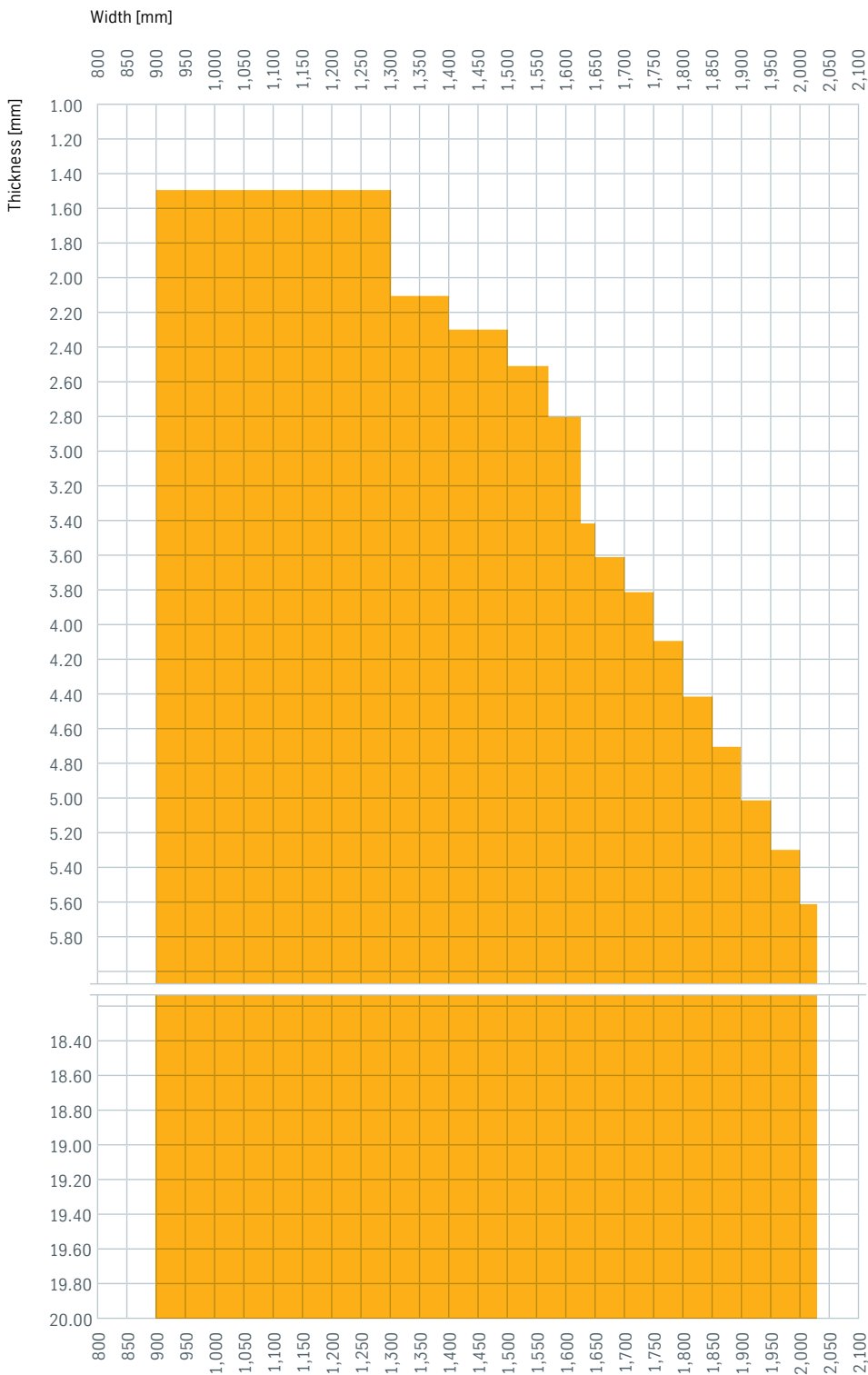
The data sheet DVS 09382 “Arc brazing” describes the brazing of steels with tensile strengths up to approx. 500 MPa. As the material described has a higher tensile strength, it is advisable to check the suitability of parts for brazing.

Fatigue strength and crash behavior

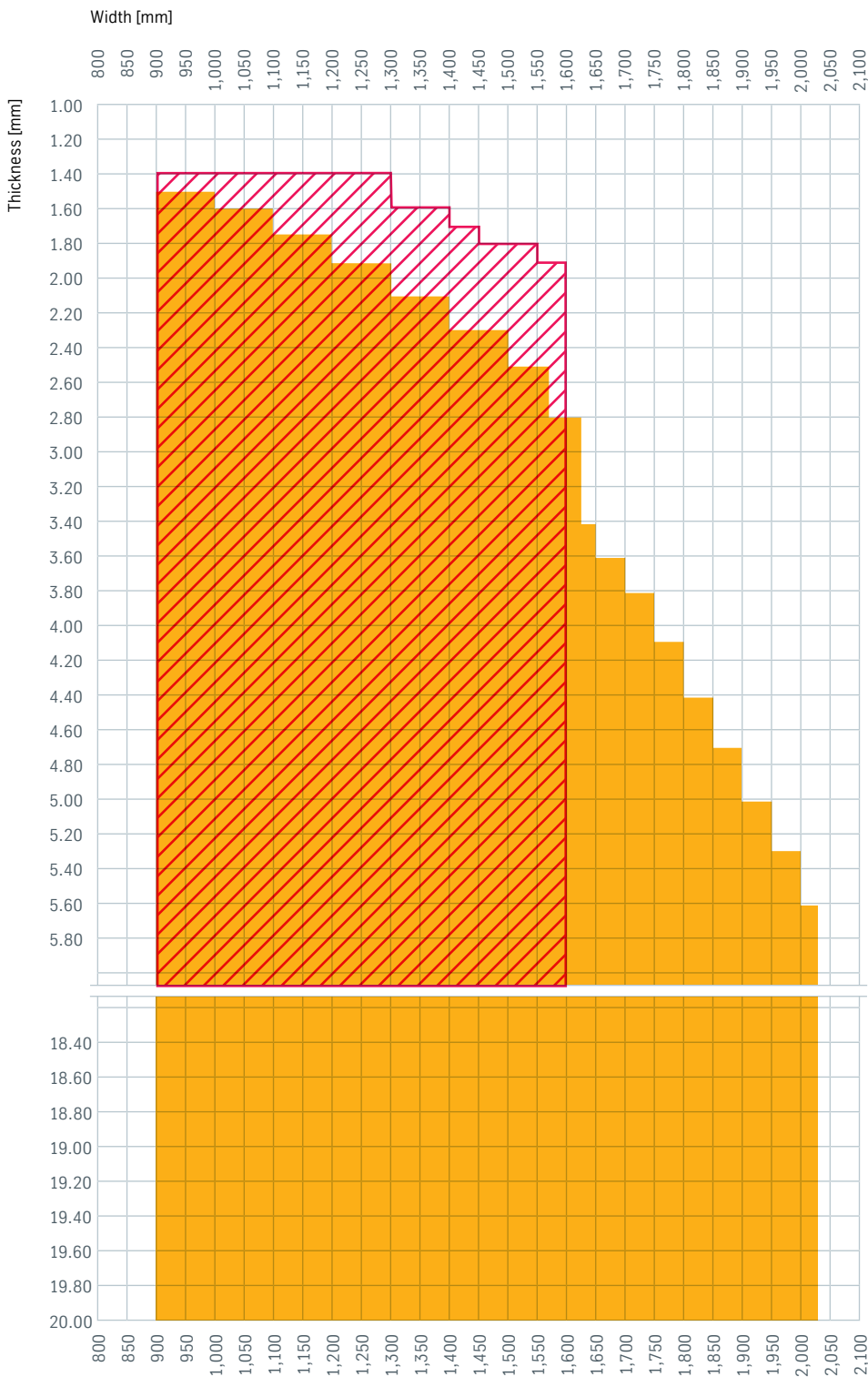
Microalloyed steels guarantee higher minimum yield and tensile strengths than deep-drawing steels. These parameters allow reliable and practical evaluation of fatigue strength. Microalloyed steels are available in various strengths. The higher the yield strength and tensile strength, the higher the fatigue strength. Formability tends to decrease with increasing strength, so designers and production planners need to find the optimum solution. Microalloyed steels are traditionally used for stamped and welded parts and structural components. Thanks to their high residual elongation they demonstrate very robust crash behavior. However, compared with dual-phase and retained-austenite grades they display lower work hardening and possibly lower yield strength, which reduces their energy absorption capacity.

Available dimensions

Wide hot strip perform® 300



Wide hot strip
perform® 315



- uncoated
- Product version scalur®¹⁾

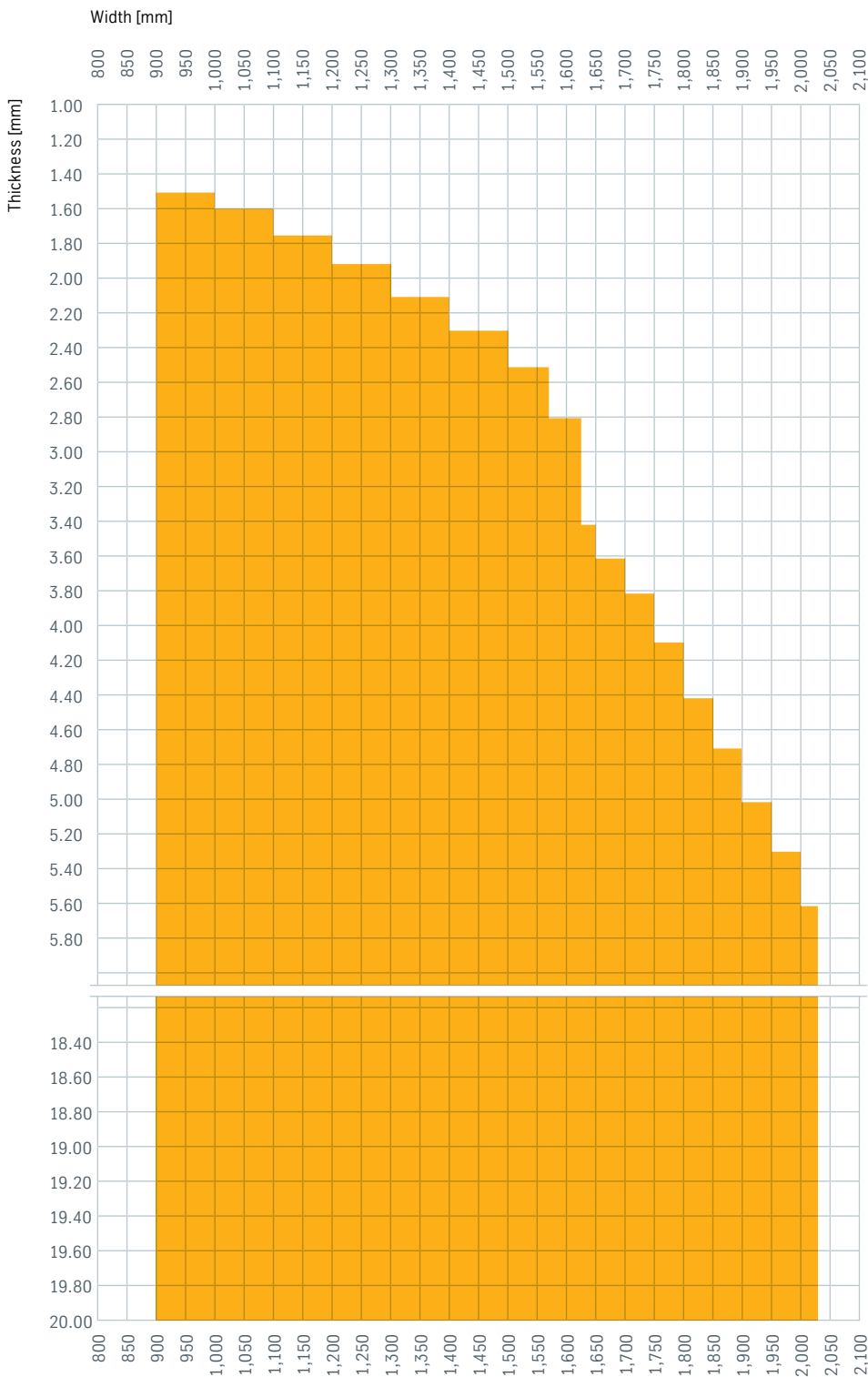
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹⁾ Max. width:
1,600 mm for thicknesses up to 8.99 mm

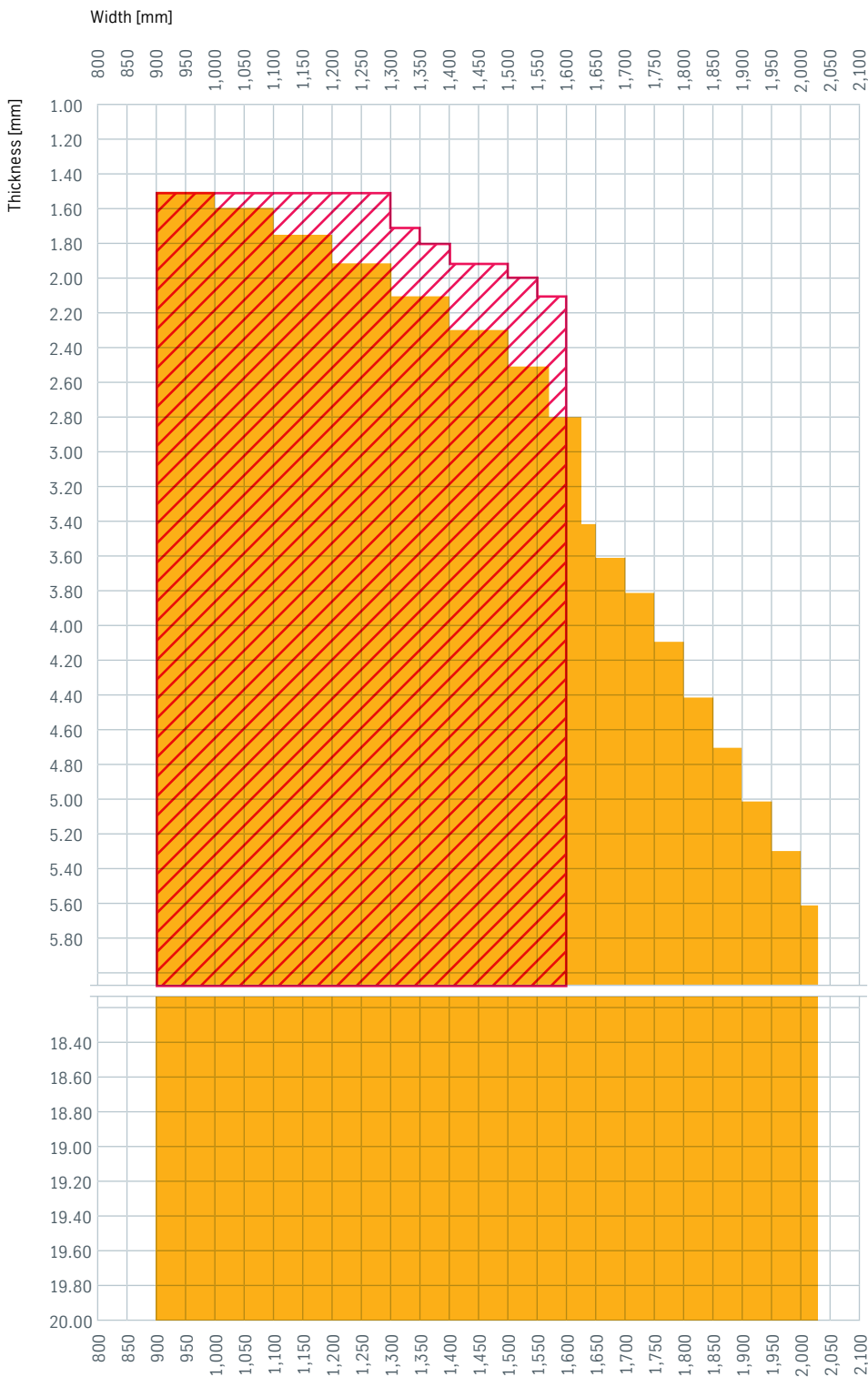
Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 340



Wide hot strip
perform® 355



- uncoated
- Product version scalur®¹⁾

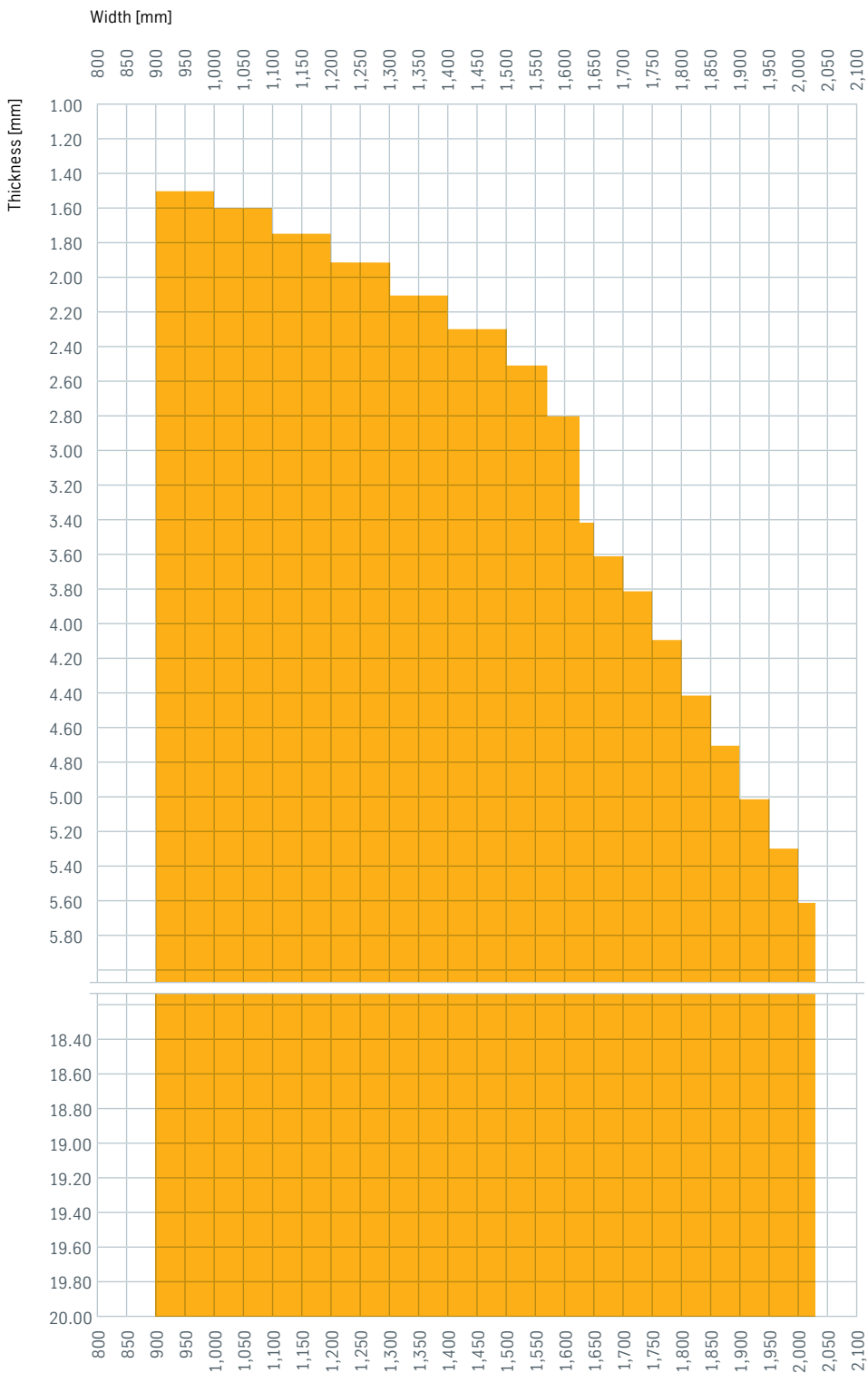
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹⁾ Max. width: 1,600 mm for thicknesses up to 8.99 mm

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 380

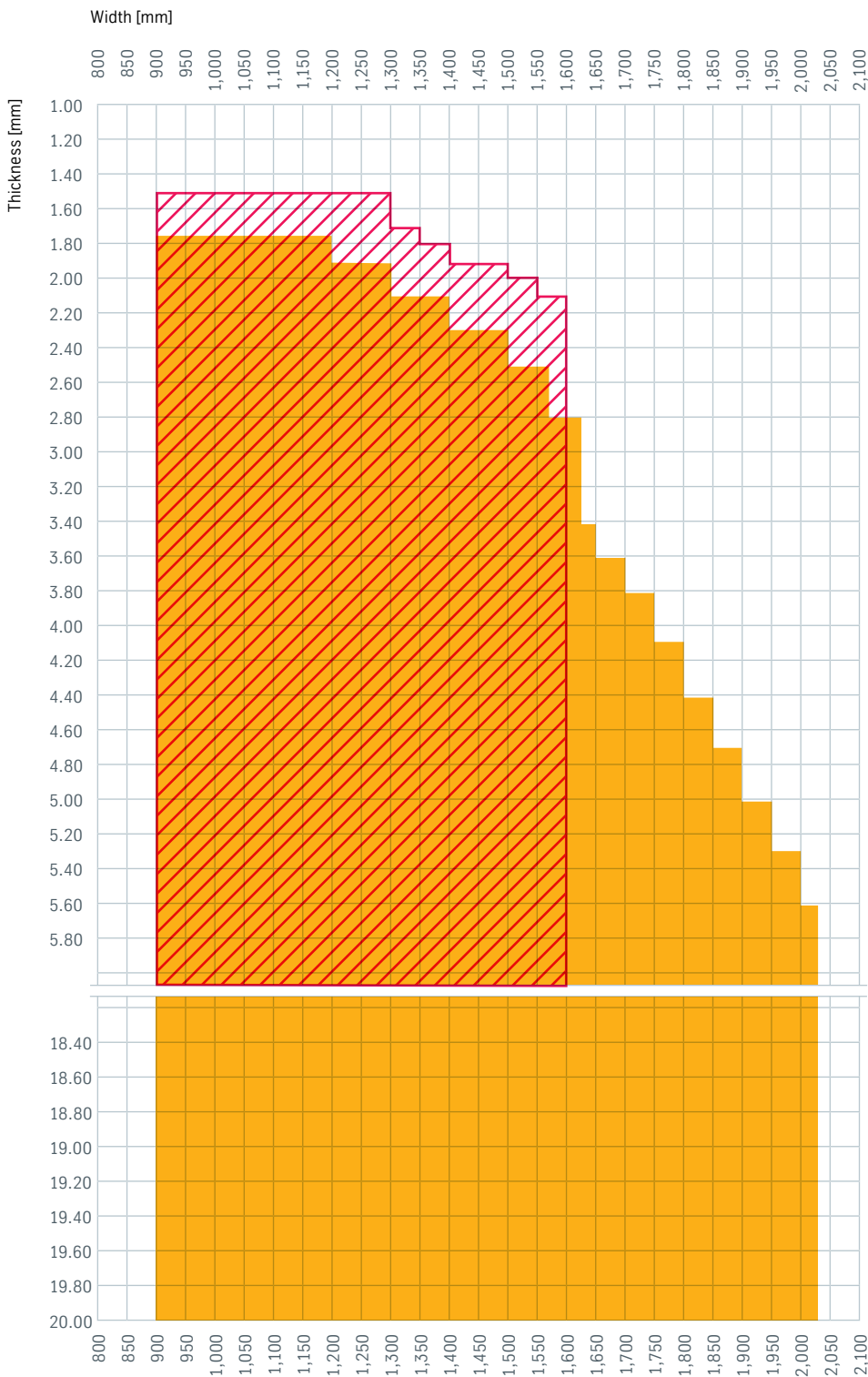


uncoated

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 420



- uncoated
- Product version scalur®¹)

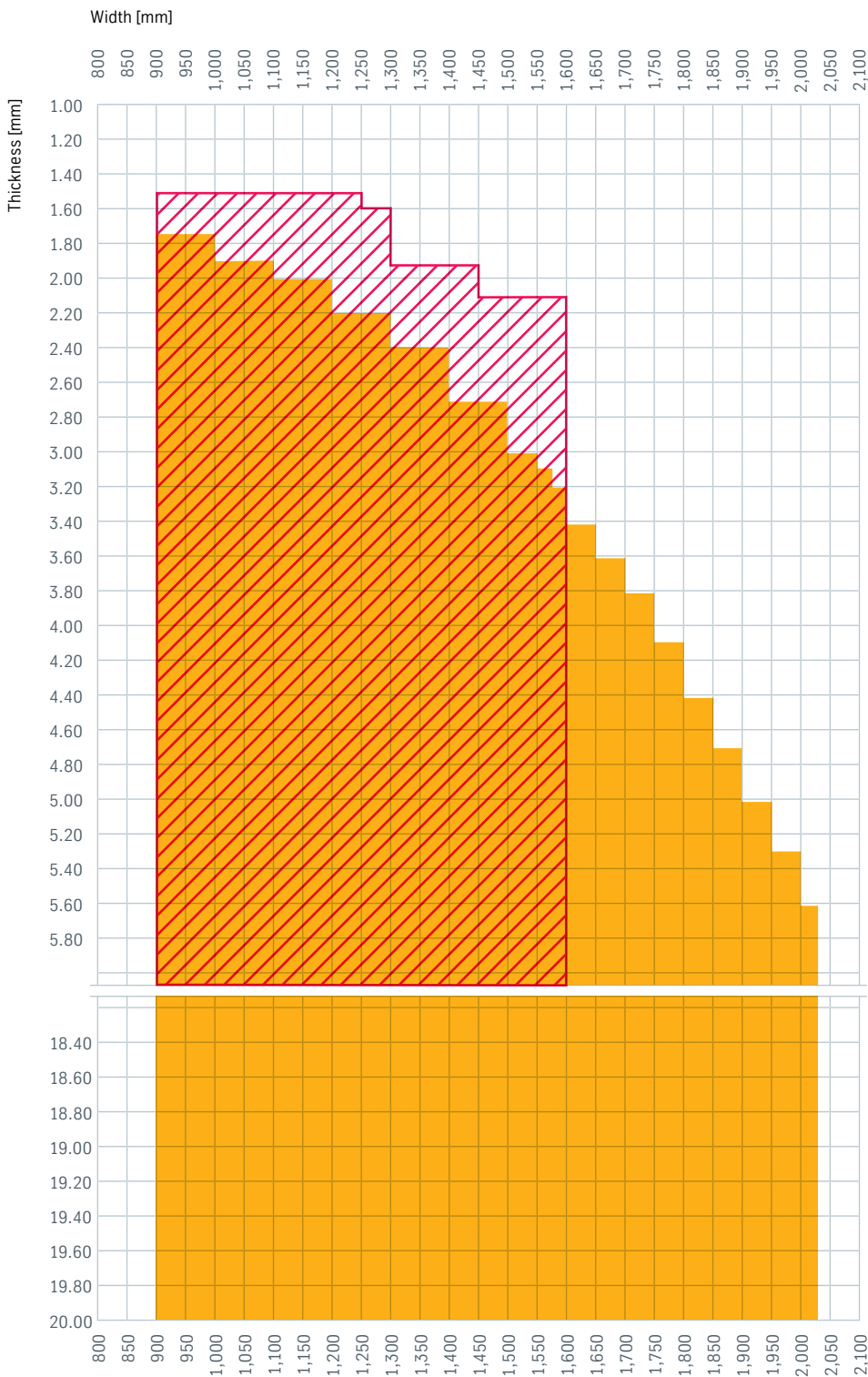
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹) Max. width:
1,600 mm for thicknesses up to 8.99 mm

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 460



- uncoated
- Product version scalur®¹¹

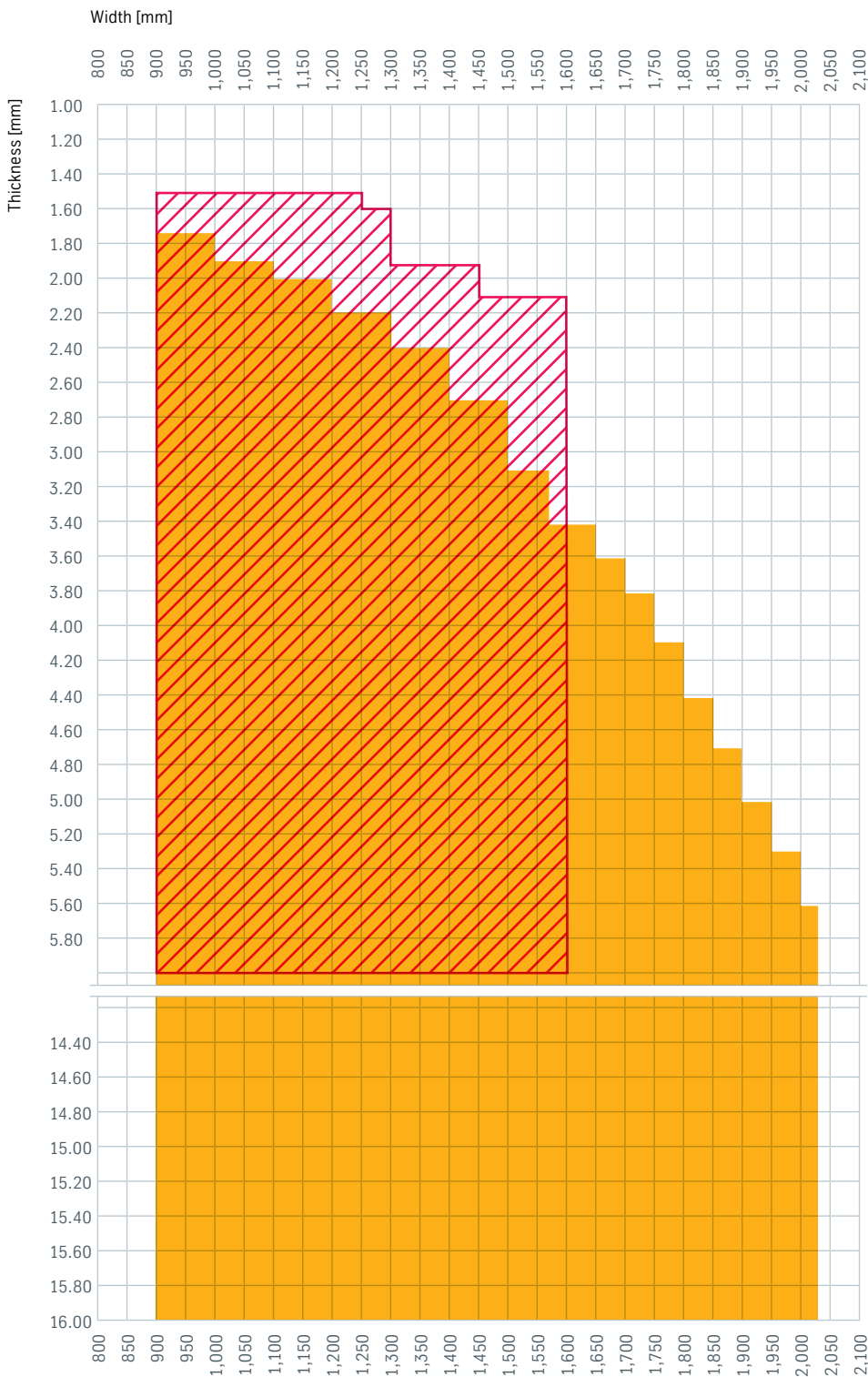
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹¹ Max. width:
1,600 mm for thicknesses up to 8.99 mm

Widths < 900 mm and other sizes
on request.

Tolerances to DIN EN 10051 or narrower
by arrangement.

Wide hot strip
perform® 500



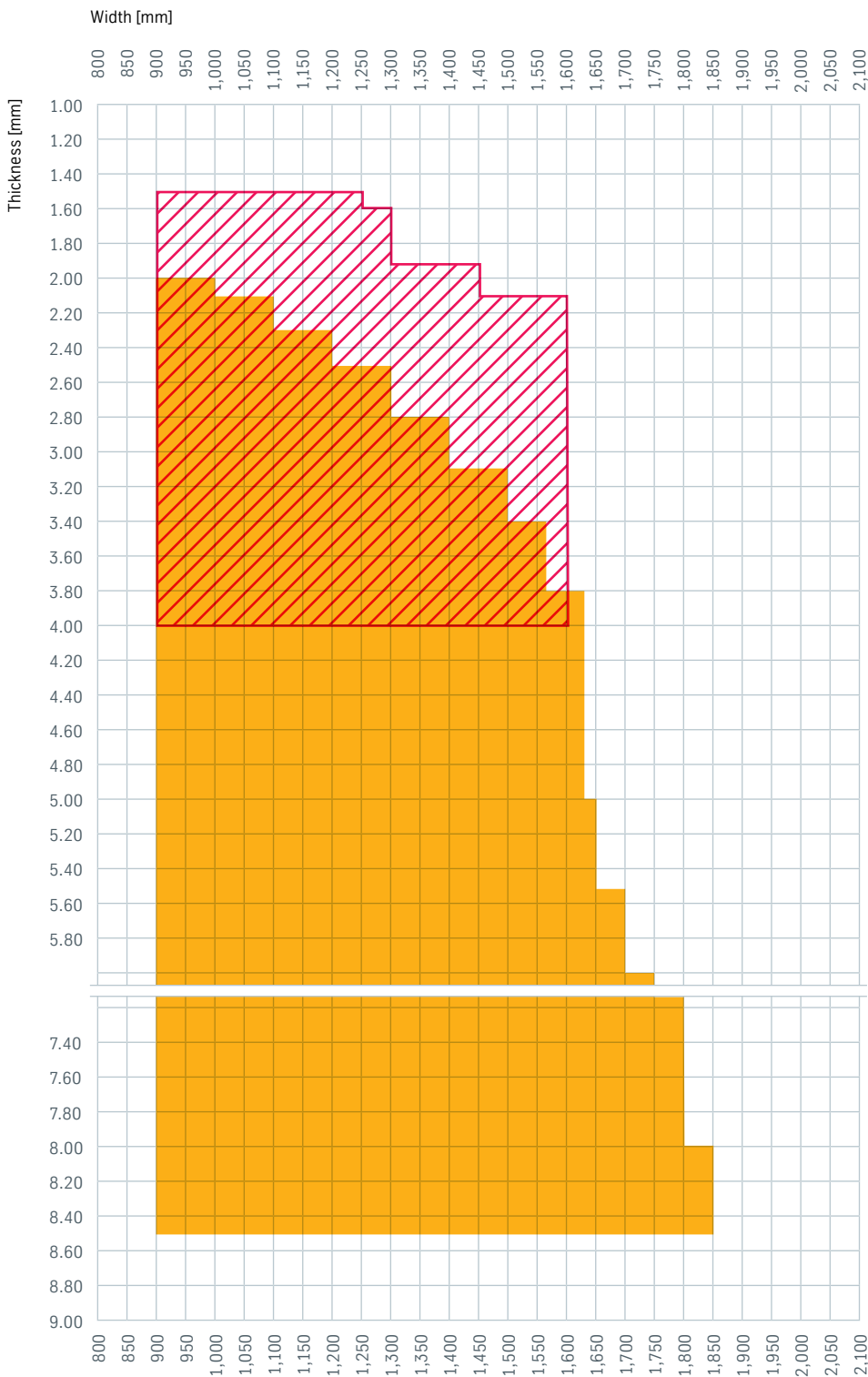
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹) Max. width:
1,600 mm for thicknesses up to 8.99 mm

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 550



scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 600



- uncoated¹⁾
- Product version scalur®

scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹⁾ Max. width: 1,620 mm for thicknesses up to 7.99 mm

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 650



uncoated¹⁾
 Product version scalur®

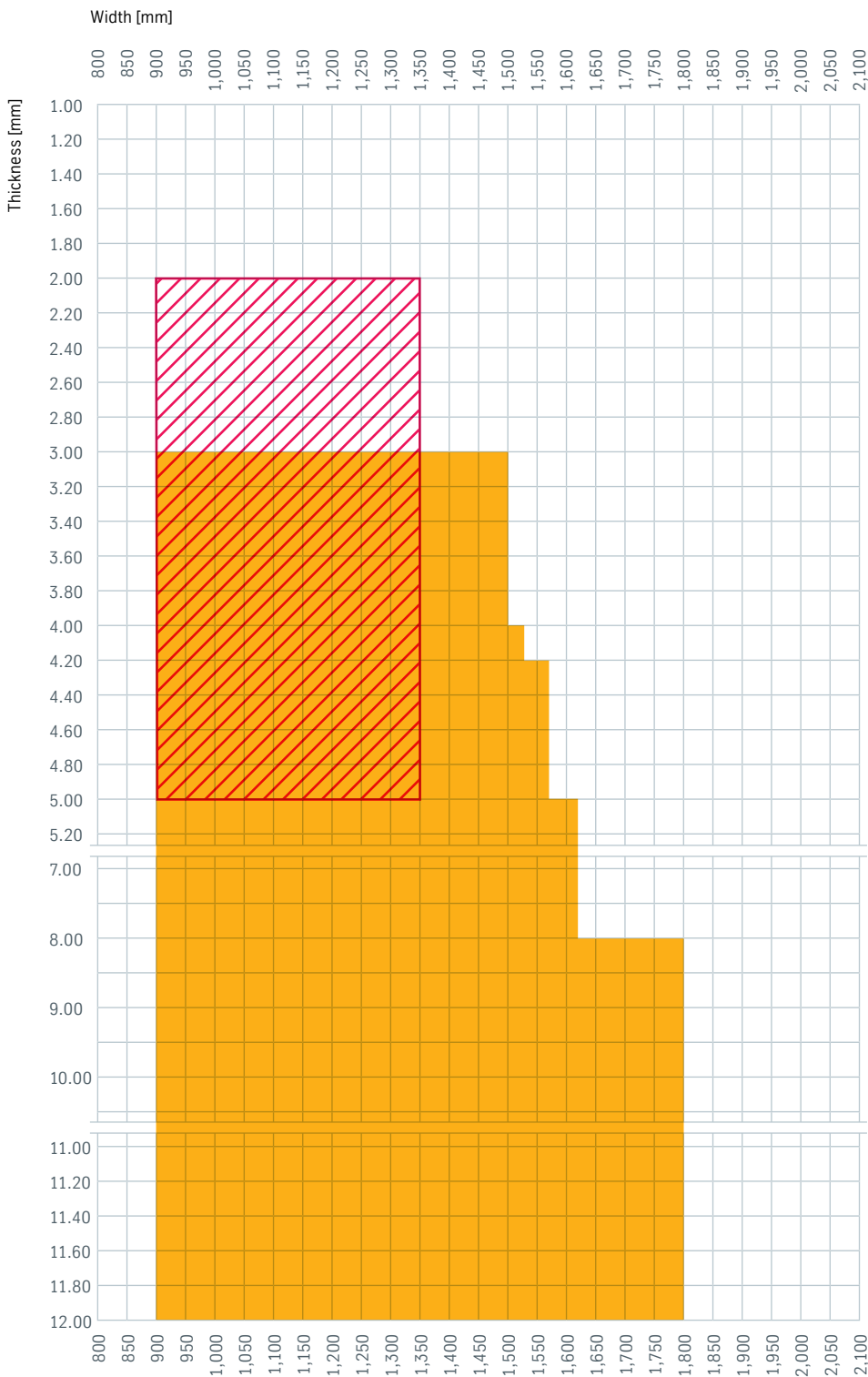
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

¹⁾ Max. width: 1,620 mm for thicknesses up to 7.99 mm

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Wide hot strip
perform® 700



scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

Widths < 900 mm and other sizes on request.

Tolerances to DIN EN 10051 or narrower by arrangement.

Cut-to-length plate

perform® 500, perform® 550, perform® 600, perform® 650, perform® 700, perform® 900, perform® 960

	Thickness* [mm]	Width* [mm]
	from_to	max.
Steel grade		
perform® 500	3.00–3.39	≤ 1,620
	3.40–3.99	≤ 1,720
	4.00–4.59	≤ 1,870
	4.60–15.00	≤ 2,000
	15.01–20.00	≤ 1,700

	Thickness* [mm]	Width* [mm]
	from_to	from_to/max.
Steel grade		
perform® 600	2.00–2.99	1,000–1,250
	3.00–3.79	≤ 1,500
	3.80–4.19	≤ 1,530
	4.20–4.99	≤ 1,570
	5.00–7.99	≤ 1,620
perform® 700	8.00–12.00	≤ 1,800

	Thickness* [mm]	Width* [mm]
	from_to	max.
Steel grade		
perform® 550	3.00–3.39	≤ 1,270
	3.40–3.59	≤ 1,380
	3.60–3.79	≤ 1,430
	3.80–3.99	≤ 1,480
	4.00–4.99	≤ 1,530
	5.00–12.00	≤ 1,630

	Thickness* [mm]	Width* [mm]
	from_to	from_to
Steel grade		
perform® 900	4.00–5.99	1,000–1,320
perform® 960	6.00–8.00	1,000–1,520

Minimum width: 820 mm, trimmed
Length: 1,000 to 16,000 mm

Other sizes on request.

* Not all thickness and width combinations are possible.

Sample applications



Axle structures and wheel rims in truck manufacturing.



Lifting and working platforms for special-purpose vehicles.

Special mill grades are supplied subject to the special conditions of thyssenkrupp. Other delivery conditions not specified here will be based on the applicable specifications. The specifications used will be those valid on the date of issue of this product information brochure.

General information

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