

Ramior protection steels



SSAB





No other steel manufacturer in the world has the same knowledge and expertise in terms of armor steel production as SSAB.

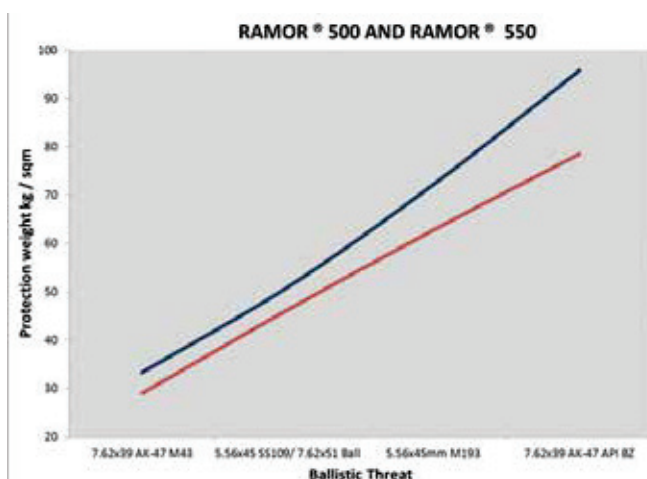
From our long experience, we understand the needs of our users and the demands that are required of our products. With our unique manufacturing capability, knowledge and expertise we can create the properties necessary to meet these demands.

With tailor made properties, tight thickness tolerances and excellent surface quality, these steels have protected lives and kept property safe for over a decade.

Reduce weight but not standards. Upgrade to Ramor 550.

Ramor armor steel is extremely strong and tough. By using optimized alloy content in combination with patented direct quenching process, high hardness and toughness can be achieved.

Ramor offers excellent ballistic properties in combination with high hardness and strength. Ramor is developed for applications where blast protection or high ballistic resistance is required, such as armored vehicles, doors, window frames and systems for transport of valuables. Shooting range equipment is another application for which the product has been developed in cooperation with customers.



Save weight by upgrading to Ramor 550

The weight of armouring in a passenger compartment can be reduced by up to 10 to 20 percent when upgrading from Ramor 500 to Ramor 550.

Type of threat	Weight saving potential
Mild threats (3.0 - 6.5 mm)	10-15%
High threats (8.0 - 14 mm)	15-20%

The weight saving will;

- ▶ increase payload
- ▶ give better off-road capability
- ▶ reduce fuel consumption
- ▶ extend the vehicle life-time

For more details and technical advice, please contact your local sales man or visit www.ssab.com

Passenger compartment manufactured from Ramor 500 or Ramor 550: Bent and welded componenets.

- ▶ Typical vehicle parts are
 - ▶ A-, B- and C-pillars
 - ▶ All four sides, roof, fire wall, etc.
- ▶ The thickness 3.0 - 13 mm is chosen based on the protection class
- ▶ You can save the weight equivalent of 2-3 persons by shifting from 500 to 550 grade



Floor Structures: Ramor 400, Ramor 450 or Ramor 500.



Understanding your needs. Understanding Ramor steel.

Protect product range*	Thickness (mm)
Ramor 300	3.0-6.0
Ramor 400	3.0 - 30.0
Ramor 450	8.0 - 16.0
Ramor 500	2.0 - 30.0
Ramor 550	3.0-15.0

* For more product information check datasheets at www.ssab.com

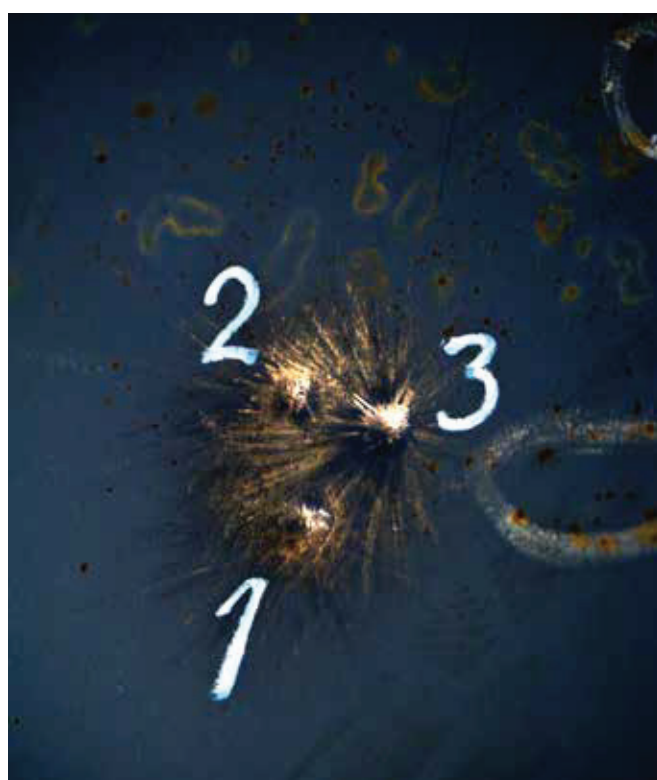


Plate thickness requirements vs protection levels

EN 1522

Protection level	Threat	Velocity (m/s)	Range (m)	Ramor 500 (mm)	Ramor 550 (mm)
FB2	9mm Luger FJ/CB/SC	415±10	5	2.0	
FB3	357 Magnum	430±10	5	2.3	
FB4	.44 Mag FJ/FN/SC	440±10	5	2.5	
FB4+	7,62x39 AK47(M43)	700±10	10	4.0	3.7
FB6	5,56x45 SS109	950±10	10	6.5	5.9
	7,62x51 NATO Ball	830±10			
FB7	7,62x51 NATO AP	820±10	10	14.5	13.0

NIJ 0108.01

Protection level	Threat	Velocity (m/s)	Range (m)	Ramor 500 (mm)	Ramor 550 (mm)
II	9mm FMJ	358±12	5	2.2	
	.357 Magnum JSP	425±15			
IIIA	9mm FMJ	426±15	5	2.5	
	.44 Magnum SWC	436±15			
III	7,62x51 FMJ	838±15	15	6.0	5.0

VPAM PM 2007

Protection level	Threat	Velocity (m/s)	Range (m)	Ramor 500 (mm)	Ramor 550 (mm)
VPAM6	7,62x39 Ball	720±10	10	4.25	3.7
VPAM7	5,56x45 SS109	950±10	10	6.5	5.9
	7,62x51 NATO Ball	830±10			
VPAM8	7,62x39 API BZ	740±10	10	12.2	10.1
VPAM9	7,62x51 NATO AP	820±10	10	14.5	13.0

GOST R

Protection level	Threat	Velocity (m/s)	Range (m)	Ramor 500 (mm)	Ramor 550 (mm)
II	5.45 mm 7H7	310-335	5	2.2	-
	7.62 mm H-134C	415-445	5	2.2	-
III	AK-74 7H6	900±10	10	4.7	3.9
	AKM 57-H-231	725±15			

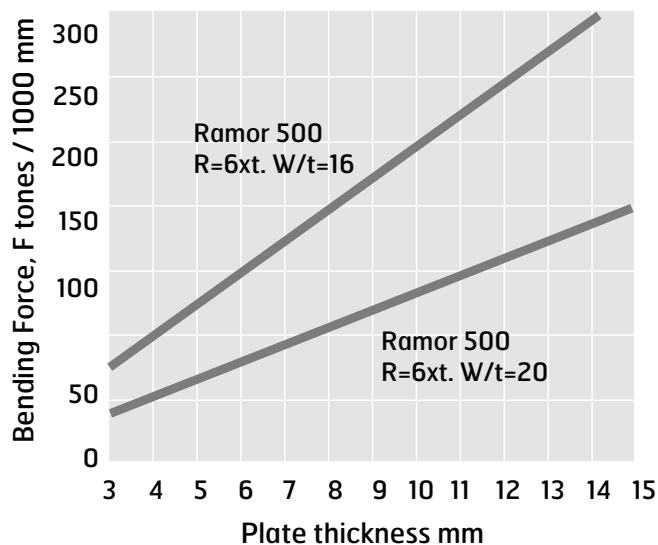
"All statements as to the properties and utilization of materials and products mentioned in this sheet are for the purpose of description only. Guarantees in respect of existence of certain properties or utilization of material mentioned are valid only if agreed upon writing. This version is only valid until a new version is available, SSAB reserve the right to not inform when a new version is available and valid"

Ramor Workshop Recommendations

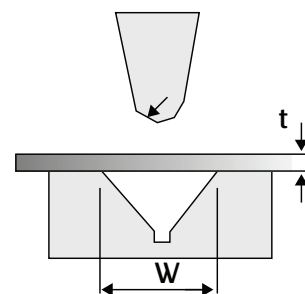
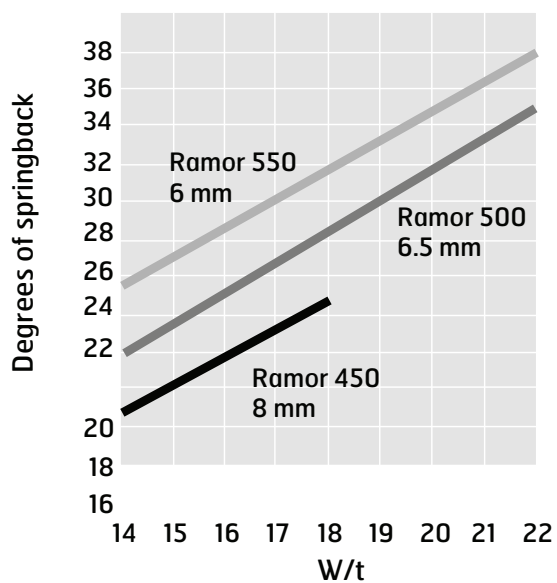
TYPICAL MECHANICAL PROPERTIES

Ramor	Yield strength R _e MPa	Tensile Strength R _m MPa	Elongation A ₅ %	Hardness HBW	Impact strength t °C	all directions Chapy V J
Ramor 300	820	940	8	260-320	-40°C	60 J
Ramor 400	1100	1300	8	360-460	-40°C	20 J
Ramor 450	1200	1400	10	400-480	-40°C	35 J
Ramor 500	1450	1700	7	490-560	-40°C	20 J
Ramor 550	1550	1850	7	540-600	-40°C	16 J

Bending force for Ramor 500 (for Ramor 550 add +10 %)



Springback after bending $R/t = 6$



R = minimum bending radius
 t = plate thickness
 W = die opening width (mm)

Ramor	400	450	500	550
Minimum bending radius R both directions	5xt	4xt	6xt	6xt
Recommended gap width W/t	14 - 18	12 - 16	16 - 20	16 - 20

RECOMMENDED AUSTENITIC WELDING CONSUMABLES

Welding method	EN Classification	AWS Classification	Consumables (Esab)	Type
GMAW, solid wire	EN 12072 G 18 8 Mn	AWS 5.9 ER307	OK Autrod 16.95	Austenitic
SMAW, electrode	EN 1600 E 18 8 Mn B 4 2	AWS 5.4 E307-15	OK 67.45	Austenitic

RECOMMENDED UNDERMATCHING FERRITIC CONSUMABLES

Welding method	EN Classification	AWS Classification	Consumables (Esab)	Type
GMAW, Solid wire	EN 440 G3Si1	AWS A5.18 ER70S-6	OK Autrod 12.51	Ferritic
SMAW, electrode	EN 499 E 42 4 B 42 H5	AWS A5.1 E7018	OK 48.00	Ferritic

PREHEATING / WORKING TEMPERATURE UNDERMATCHING FERRITIC CONSUMABLES

Plate thickness mm				
	10		20	30
Ramor 400	+20°C			Austenitic +20°C
Ramor 500		+100°C	+150°C	Austenitic +20°C
Ramor 450, 550	Austenitic +20°C			

THICKNESS TOLERANCES (LOWER TOLERANCES = 0.00)

Thickness mm	Cut to length	Cut to length Special tolerance*	Heavy plates
2.00 – 3.00	+0.32 mm	+0.20 mm*	
3.01 – 4.00	+0.36 mm	+0.24 mm*	
4.01 – 5.00	+0.40 mm	+0.24 mm*	
5.01 – 6.00	+0.42 mm	+0.28 mm*	+0.74 mm
6.01 – 6.50	+0.44 mm	+0.30 mm*	+0.74 mm
6.51 – 6.99			+0.74 mm
7.00 – 7.99			+0.76 mm
8.00 – 9.99			+0.80 mm
10.00 – 11.99			+0.90 mm
12.00 – 14.99			+1.00 mm
15.00 – 19.99			+1.10 mm

* Special tolerance by separate agreement only. Typical plate thickness is middle of 0 mm and upper tolerance.

SSAB is a Nordic and US-based steel company. SSAB offers value added products and services developed in close cooperation with its customers to create a stronger, lighter and more sustainable world. SSAB has employees in over 50 countries. SSAB has production facilities in Sweden, Finland and the US. SSAB is listed on the Nasdaq OMX Nordic Exchange in Stockholm and has a secondary listing on the Nasdaq OMX in Helsinki.

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SSAB



RAMOR 300

General Product Description

The low-alloy protection plate.

Ramor™ 300 is a low-alloy protection plate, available as sheet in thicknesses of 3-6 mm (0.118-0.236") and delivering a hardness of 260-320 HBW.

Ramor 300 is not intended for further heat treatment.

Dimension Range

Ramor 300 is available as cut-to-length sheet in thickness between 3.0-6.0 mm.

Mechanical Properties

Thickness (mm)	Hardness (HBW)
3.0- 6.0	260- 320

Mechanical Testing

Brinell hardness test according to EN ISO 6506-1 on each heat treatment individual/coil.

Hardness is measured on a milled surface 0.3-2 mm below plate surface.

Chemical Composition (ladle analysis)

C (max %)	Si (max %)	Mn (max %)	P (max %)	S (max %)	Cr (max %)	Mo (max %)	B (max %)
0.20	0.50	2.0	0.030	0.010	0.80	0.30	0.005

The steel is grain-refined. Phosphorous and sulphur are not intentionally alloying elements.

Tolerances

More details are given on www.ssab.com

RAMOR 300

Thickness

Cut Length Product Type	Thickness (mm)	Tolerance (Min / Max)
Cut Length	3.00- 4.00	- 0.0 / + 0.36
Cut Length	4.01- 5.00	- 0.0 / + 0.40
Cut Length	5.01- 6.00	- 0.0 / + 0.42

Length and Width

Tolerances according to EN 10051. Sheets are delivered with mill edges cut as standard.

Flatness

Tolerances according to SSAB's flatness tolerances.

Cut Length Product Type	Thickness (mm)	1000 ruler (mm)
Cut Length	3.00- 4.00	6
Cut Length	4.01- 5.00	6
Cut Length	5.01- 6.00	6

Shape

Tolerances according to EN 10051.

Surface Properties

According to EN 10163-2 Class B subclass 3.

Delivery Conditions

Ramor 300 is delivered in quenched condition.

Fabrication and Other Recommendations

Welding, bending and machining

For information concerning welding and fabrication, see SSAB's brochures on www.ssab.com or consult Tech Support, techsupport@ssab.com.

Ramor 300 is not intended for further heat treatment. If Ramor 300 is heated above 150 °C after delivery from SSAB no guarantees for the properties are given.

Appropriate health and safety precautions must be taken when cutting, welding, grinding or otherwise working on the product. Grinding, especially of primer coated plates, may produce dust with high particle concentration.

RAMOR 300



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RAMOR 400

General Product Description

The steel for blast protection.

Ramor™ 400 is a medium-hard steel for blast protection, available in thicknesses of 3-30 mm (0.118-1.18") and delivering a hardness of 360-460 HBW.

Ramor 400 is available as cut-to-length sheet in thicknesses of 3-6.5 mm (0.118-0.256") and as plate in thicknesses of 6-30 mm (0.236-1.18"). It is not intended for further heat treatment.

Dimension Range

Ramor 400 is available as cut-to-length sheet in thickness between 2.0- 12.0 mm, and as plate in thickness between 6.0- 30.0 mm.

Mechanical Properties

Thickness (mm)	Hardness (HBW)
2.0- 30.0	360- 460

Mechanical Testing

Brinell hardness test according to EN ISO 6506-1 on each heat treatment individual/coil.

Hardness is measured on a milled surface 0.3-2 mm below plate surface.

Chemical Composition (ladle analysis)

C (max %)	Si (max %)	Mn (max %)	P (max %)	S (max %)	Cr (max %)	Ni (max %)	Mo (max %)	B (max %)
0.20	0.70	1.5	0.020	0.010	1.00	0.50	0.50	0.005

The steel is grain-refined. Phosphorous and sulphur are not intentionally alloying elements.

Tolerances

More details are given on www.ssab.com

RAMOR 400

Thickness

Cut Length Product Type	Thickness (mm)	Tolerance (Min / Max)
Cut Length	2.00- 3.00	- 0.0 / + 0.32
Cut Length	3.01- 4.00	- 0.0 / + 0.36
Cut Length	4.01- 5.00	- 0.0 / + 0.40
Cut Length	5.01- 6.00	- 0.0 / + 0.42
Cut Length	6.01- 6.50	- 0.0 / + 0.44
Cut Length	6.51- 8.00	- 0.0 / + 0.50
Cut Length	8.01- 10.0	- 0.0 / + 0.57
Cut Length	10.01- 12.00	- 0.0 / + 0.61

Heavy Plate Product Type	Thickness (mm)	Tolerance (Min / Max)
Heavy Plate	6.0- 7.9	- 0.0 / + 0.8
Heavy Plate	8.0- 14.9	- 0.0 / + 1.0
Heavy Plate	15.0- 24.9	- 0.0 / + 1.2
Heavy Plate	25.0- 30.0	- 0.0 / + 1.4

Length and Width

Sheets are delivered with mill edges cut as standard.

- Tolerances conform to EN 10 051 or to SSAB's standard after agreement.

Plate delivered according to SSAB's dimension program.

- Tolerances conform to EN 10 029 or to SSAB's standard after agreement.
- Dimensional tolerances for plate with mill edge according to special agreement.

Flatness

Tolerances according to SSAB's flatness tolerances which are more restrictive than EN 10029 Class N (steel type L)

Cut Length Product Type	Thickness (mm)	1000 ruler (mm)
Cut Length	2.00- 3.00	6
Cut Length	3.01- 4.00	6
Cut Length	4.01- 5.00	6
Cut Length	5.01- 6.00	6
Cut Length	6.01- 6.50	6
Cut Length	6.51- 8.00	6
Cut Length	8.01- 10.0	6
Cut Length	10.01- 12.00	6

RAMOR 400

Heavy Plate Product Type	Thickness (mm)	1000 ruler (mm)
Heavy Plate	6.0- 7.9	6
Heavy Plate	8.0- 14.9	6
Heavy Plate	15.0- 24.9	6
Heavy Plate	25.0- 30.0	6

Shape

Tolerances for plate according to EN 10 029. Tolerances for Sheet according to EN 10 051.

Surface Properties

According to EN 10 163-2 Class B subclass 3.

Delivery Conditions

Ramor 400 is delivered in quenched condition.

Fabrication and Other Recommendations

Welding, bending and machining

For information concerning welding and fabrication, see SSAB's brochures on www.ssab.com or consult Tech Support, techsupport@ssab.com.

Ramor 400 is not intended for further heat treatment. If Ramor 400 is heated above 180 °C after delivery from SSAB no guarantees for the properties are given.

Appropriate health and safety precautions must be taken when cutting, welding, grinding or otherwise working on the product.

Grinding, especially of primer coated plates, may produce dust with high particle concentration.



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RAMOR 450

General Product Description

Combines ballistic properties with impact toughness.

Ramor™ 450 is a medium-hard protection plate combining ballistic properties with impact toughness, at 8-16 mm (0.315-0.630") thick and 400-480 HBW.

Ramor 450 is not intended for further heat treatment.

Dimension Range

Ramor 450 is available as plate in thickness between 8.0- 16.0 mm.

Mechanical Properties

Thickness (mm)	Hardness Min - Max (HBW)	Yield Strength Min (min MPa)	Tensile Strength Min (MPa)	Elongation A ₅ Min (min %)
8- 16	400- 480	1000	1150	8

Impact Properties

Test temperature	Min. impact energy test Charpy-V 10x10 mm test specimens ¹⁾
-40 °C	20 J

¹⁾ Impact testing transverse to rolling direction, average value of three tests. Single value min. 70% of specified average.

Mechanical Testing

Brinell hardness test according to EN ISO 6506-1 on each heat treatment individual/coil.

Hardness is measured on a milled surface 0.3-2 mm below plate surface.

Charpy impact test according to EN ISO 148, 1 test/20 ton.

Tensile test according to EN ISO 6892 on each plate and thickness <19.9 mm.

RAMOR 450

Chemical Composition (ladle analysis)

C (max %)	Si (max %)	Mn (max %)	P (max %)	S (max %)	Cr (max %)	Ni (max %)	Mo (max %)	B (max %)
0.25	0.70	1.50	0.015	0.010	1.0	2.0	0.70	0.005

The steel is grain-refined. Phosphorous and sulphur are not intentionally alloying elements.

Tolerances

More details are given on www.ssab.com

Thickness

Heavy Plate Thickness (mm)	Tolerance (Min / Max)
8.0- 14.9	- 0.0 / + 1.0
15- 16	- 0.0 / + 1.1

Length and Width

According to SSAB's dimension program.

- Tolerances conform to EN 10029 or to SSAB's standard after agreement
- Dimensional tolerances for plate with mill edge according to special agreement.

Shape

Tolerances according to EN 10029

Flatness

Tolerances according to SSAB's flatness tolerances which are more restrictive than EN 10029 Class N (steel type L)

Surface Properties

According to EN 10163-2 Class B Subclass 3.

Delivery Conditions

Ramor 450 is delivered in quenched condition.

Fabrication and Other Recommendations

Welding, bending and machining

For information concerning welding and fabrication, see SSAB's brochures on www.ssab.com or consult Tech Support, techsupport@ssab.com.

Ramor 450 is not intended for further heat treatment. If Ramor 450 is heated above 180 °C after delivery from SSAB no guarantees for the properties are given.

Appropriate health and safety precautions must be taken when cutting, welding, grinding or otherwise working on the product.

Grinding, especially of primer coated plates, may produce dust with high particle concentration.

RAMOR 450



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RAMOR 500

General Product Description

The ballistic protection steel with high hardness.

Ramor™ 500 is a ballistic protection steel of high hardness, available in thicknesses of 2-30 mm (0.079-1.18") and hardnesses of 490-560 HBW.

Ramor 500 is available as cut-to-length sheet in thicknesses of 2-6.5 mm (0.079-0.256") and as plate in thicknesses of 6-30 mm (0.236-1.18"). Delivered in quenched condition, Ramor 500 is not intended for further heat treatment.

Dimension Range

Ramor 500 is available as cut-to-length sheet in thickness between 2.0- 6.50 mm, and as plate in thickness 6.0- 30.0 mm.

Mechanical Properties

Thickness (mm)	Hardness (HBW)
2.0- 30	490- 560

Mechanical Testing

Brinell hardness test according to EN ISO 6506-1 on each heat treatment individual/coil.

Hardness is measured on a milled surface 0.3-2 mm below plate surface.

Chemical Composition (ladle analysis)

C (max %)	Si (max %)	Mn (max %)	P (max %)	S (max %)	Cr (max %)	Ni (max %)	Mo (max %)	B (max %)
0.35	0.70	1.50	0.015	0.010	1.0	2.0	0.70	0.005

The steel is grain-refined. Phosphorous and sulphur are not intentionally alloying elements.

Tolerances

More details are given on www.ssab.com

RAMOR 500

Thickness

Cut Length Product Type	Thickness (mm)	Tolerance (Min / Max)
Cut Length	2.00- 4.00	- 0.0 / + 0.36
Cut Length	4.01- 5.00	- 0.0 / + 0.40
Cut Length	5.01- 6.00	- 0.0 / + 0.42
Cut Length	6.01- 6.50	- 0.0 / + 0.44

Heavy Plate Product Type	Thickness (mm)	Tolerance (Min / Max)
Heavy Plate	6.0- 7.9	- 0.0 / + 0.8
Heavy Plate	8.0- 14.9	- 0.0 / + 1.0
Heavy Plate	15.0- 24.9	- 0.0 / + 1.2
Heavy Plate	25.5- 30.0	- 0.0 / + 1.4

Length and Width

Sheets are delivered with mill edges cut as standard.

- Tolerances conform to EN 10051 or to SSAB's standard after agreement.

Plate delivered according to SSAB's dimension program.

- Tolerances conform to EN 10029 or to SSAB's standard after agreement
- Dimensional tolerances for plate with mill edge according to special agreement.

Flatness

Tolerances according to SSAB's flatness tolerances which are more restrictive than EN 10029 Class N (steel type L).

Cut Length Product Type	Thickness (mm)	1000 ruler (mm)
Cut Length	2.00- 4.00	6
Cut Length	4.01- 5.00	6
Cut Length	5.01- 6.00	6
Cut Length	6.01- 6.50	6

Heavy Plate Product Type	Thickness (mm)	1000 ruler (mm)
Heavy Plate	6.0- 7.9	6
Heavy Plate	8.0- 14.9	6
Heavy Plate	15.0- 24.9	6
Heavy Plate	25.5- 30.0	6

Shape

For Plate tolerances according to EN 10029. For Sheet tolerances according to EN 10051.

RAMOR 500

Surface Properties

According to EN 10 163-2 Class B Subclass 3.

Delivery Conditions

Ramor 500 is delivered in quenched condition.

Fabrication and Other Recommendations

Welding, bending and machining

For information concerning welding and fabrication, see SSAB's brochures on www.ssab.com or consult Tech Support, techsupport@ssab.com.

Ramor 500 is not intended for further heat treatment. If Ramor 500 is heated above 180 °C after delivery from SSAB no guarantees for the properties are given.

Appropriate health and safety precautions must be taken when cutting, welding, grinding or otherwise working on the product.

Grinding, especially of primer coated plates, may produce dust with high particle concentration.



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RAMOR 550

General Product Description

The ballistic protection steel with extra-high hardness.

Ramor™ 550 is a ballistic protection steel of extra-high hardness, available in thicknesses of 3-15 mm (0.118-0.591") and hardnesses of 540-600 HBW.

Ramor 550 is available as cut-to-length sheet in thicknesses of 3-6 mm (0.118-0.236") and as plate in thicknesses of 6-15 mm (0.236-0.591"). Delivered in quenched condition, Ramor 550 is not intended for further heat treatment.

Dimension Range

Ramor 550 is available as cut-to-length sheet in thickness between 3.0-6.0 mm, and as plate in thickness between 6.0- 15.0 mm.

Mechanical Properties

Thickness (mm)	Hardness (HBW)
3.0- 15.0	540- 600

Mechanical Testing

Brinell hardness test according to EN ISO 6506-1 on each heat treatment individual/coil.

Hardness is measured on a milled surface 0.3-2 mm below plate surface.

Chemical Composition (ladle analysis)

C (max %)	Si (max %)	Mn (max %)	P (max %)	S (max %)	Cr (max %)	Ni (max %)	Mo (max %)	B (max %)
0.36	0.70	1.50	0.015	0.010	1.50	2.50	0.8	0.005

The steel is grain-refined. Phosphorous and sulphur are not intentionally alloying elements.

Tolerances

More details are given on www.ssab.com

RAMOR 550

Thickness

Cut Length Product Type	Thickness (mm)	Tolerance (Min / Max)
Cut Length	3.00- 4.00	- 0.0 / + 0.36
Cut Length	4.01- 5.00	- 0.0 / + 0.40
Cut Length	5.01- 6.00	- 0.0 / + 0.42
Heavy Plate Product Type	Thickness (mm)	Tolerance (Min / Max)
Heavy Plate	6.0- 7.9	- 0.0 / + 0.8
Heavy Plate	8.0- 15.0	- 0.0 / + 1.0

Length and Width

Sheets are delivered with mill edges cut as standard.

- Tolerances conform to EN 10 051 or to SSAB's standard after agreement.

Plate delivered according to SSAB's dimension program.

- Tolerances conform to EN 10 029 or to SSAB's standard after agreement
- Dimensional tolerances for plate with mill edge according to special agreement.

Flatness

Tolerances according to SSAB's flatness tolerances which are more restrictive than EN 10029 Class N (steel type L)

Cut Length Product Type	Thickness (mm)	1000 ruler (mm)
Cut Length	3.00- 4.00	6
Cut Length	4.01- 5.00	6
Cut Length	5.01- 6.00	6
Heavy Plate Product Type	Thickness (mm)	1000 ruler (mm)
Heavy Plate	6.0- 7.9	6
Heavy Plate	8.0- 15.0	6

Shape

For Plate tolerances according to EN 10029. For Sheet tolerances according to EN 10051.

Surface Properties

According to EN 10163-2 Class B Subclass 3

RAMOR 550

Delivery Conditions

Ramor 550 is delivered in quenched condition.

Fabrication and Other Recommendations

Welding, bending and machining

For information concerning welding and fabrication, see SSAB's brochures on www.ssab.com or consult Tech Support, techsupport@ssab.com.

Ramor 550 is not intended for further heat treatment. If Ramor 550 is heated above 180 °C after delivery from SSAB no guarantees for the properties are given.

Appropriate health and safety precautions must be taken when cutting, welding, grinding or otherwise working on the product. Grinding, especially of primer coated plates, may produce dust with high particle concentration.



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