

Extra High Strength Structural Steel

Quend 700



1 Steel description and applications

Quend 700 is extra high strength structural steel produced as quenched and tempered with a minimum yield strength of 700 MPa. Quend 700 complies with the requirements corresponding to the S690QL given in the EN 10025-6 standard, where a minimum impact toughness of 27 J is guaranteed at -40°C.

Quend 700 is recommended for the following applications:

- truck chassis
- lifting and hoisting equipment
- handling equipment
- trailers ...

2 Technical characteristics

Tensile properties

| TRANSVERSE TESTING | | |
|--------------------------|------------------------|------------------|
| Yield strength Rp 0.2 | Tensile Strength Rm | Elongation A5 |
| 700 MPa min | 780 - 930 MPa | 14% min |

Impact toughness

| Minimum values at | | |
|-------------------|--------|--------|
| 0 °C | -20 °C | -40 °C |
| 35 J | 30 J | 27 J |

Transverse testing according to EN 10025 option 30.

Thickness < 12 mm subsize Charpy V specimen have been used.

Testing according to EN 10025.

Chemical composition The steel is fine grain treated.

| Max ladle analysis, % | | | | | | | | | | | | | |
|-----------------------|------|------|-------|-------|-------|------|-------|-------|------|-------|------|-------|-------|
| C | Si | Mn | P | S | Nb | Cr | V | Ti | Ni | Al | Mo | N | B |
| 0,20 | 0,60 | 1,50 | 0,020 | 0,010 | 0,040 | 0,60 | 0,070 | 0,040 | 1,00 | 0,070 | 0,50 | 0,014 | 0,005 |

| Carbon equivalent, typical values, % | | |
|--------------------------------------|--------------------|--------------------|
| Plate thickness | CEV ⁽¹⁾ | CET ⁽²⁾ |
| 6 - 15 mm | 0,45 | 0,29 |
| 15,01 - 25 mm | 0,44 | 0,30 |
| 25,01 - 50 mm | 0,45 | 0,30 |

(1) CEV = C+Mn/6+ (Ni+Cu)/15+ (Cr+Mo+V)/5

(2) CET = C+(Mn+Mo)/10+Ni/40 +(Cr+Cu)/20

3 Dimensions

Quend 700 is currently supplied in the following range:

- thickness: 6 - 50 mm
- width: 1500 - 3100 mm

NLMK Clabecq is continuing the extension of its dimensional program in order to offer as soon as possible a thickness range from 3 to 60 mm. For more information, please check our website or contact your local NLMK Clabecq representative.

4 Flatness, tolerances & surface properties

Quend 700 is delivered with a unique combination of excellent flatness, tight thickness tolerances and superior surface finish.

| Feature | Norm | |
|---------------------------------|---|-------------|
| FLATNESS | - EN 10029: . Class N (standard) & . Class S | PLUS |
| THICKNESS tolerance | - meets and exceeds EN 10029 Class A - tighter tolerances upon request | PLUS |
| Shape, length, width tolerances | meets EN 10029 | |
| SURFACE properties | exceeds the usual market standards, EN 10163-2 Class B3 | PLUS |

5 Delivery conditions

Quend 700 is delivered as quenched and tempered. Our Quend plates are supplied as standard in the **shotblasted and painted** condition. In order to maintain a good weldability and laser cutting performance, a low zinc silicate primer is applied. Plates can also be delivered unpainted.

6 Heat treatment

The mechanical properties of Quend 700 has been obtained by quenching and tempering. For not losing the guaranteed properties of Quend 700, the plate should not be used in applications requiring hot working and service temperatures above 550 °C.



7 Ultrasonic testing

Ultra sonic testing (UT), is applied to secure the plate from discontinuities like inclusions, cracks and porosity. In thickness from 8 mm and up, all plates are UT tested and controlled against class S2, E2, according to EN 10160.

8 General processing recommendations

To obtain optimal work shop productivity when processing Quend 700, it is essential to use the recommended procedures and tools given below.

Thermal cutting

Quend 700 may be cut either by oxygen fuel, plasma and laser cutting without any restrictions.

Subsequent to cutting, let the cut parts slowly cool down to room temperature. Do never accelerate the cooling of the parts. A slow cooling rate will reduce the risk of cut edge cracking.

Cold forming

Quend 700 is very well suited for cold forming operations. Quend 700 complies with the S690QL bending requirements but offer even closer R/t ratios:

Minimum recommended R/t ratio when bending of Quend 700

| Thickness (mm) | Transverse to rolling (R/t) | Longitudinal to rolling (R/t) | Width (W/t) |
|----------------|-----------------------------|-------------------------------|-------------|
| t ≤ 8.0 | 1.5 | 2.0 | 8 – 10 |
| 8 < t < 20 mm | 2.0 | 3.0 | 8 – 10 |
| t ≥ 20.0 mm | 3.0 | 4.0 | 10 – 12 |

R = Recommended punch radius (mm), t = Plate thickness (mm) , W – Die opening width (mm)
(bending angle ≤ 90°)

Due to the homogeneous properties and narrow thickness tolerances of Quend 700, variations in springback are kept at a low level. Grinding of flame cut or a sheared edge in the bending area is recommended to further prevent cracking during bending.

Welding

Welding of Quend 700 can be performed using any of the conventional welding methods available both as manual or automatic.

In the thickness range up to 30 mm, preheating prior to welding is normally not needed, if a heat input of 1,7 kJ/mm is used.

Welding of Quend 700 is recommended to be performed at ambient temperature not lower than +5 °C. Subsequent to welding, let the welded parts slowly cool down to room temperature. Do never accelerate the cooling process of the weld.

It is always recommended to use low hydrogen electrodes when welding Quend 700.

Machining

Quend 700 provides a very good machinability and can be drilled, counter sunked and milled in the same way as any other 700MPa or S690QL Q&T steel.

For more information regarding welding, cold forming and machining, please consult the respective manuals with technical recommendations on www.quend.me

Extra High Strength Structural Steel

Quend 960



1 Steel description and applications

Quend 960 is extra high strength structural steel produced as quenched and tempered with a minimum yield strength of 960 MPa. Quend 960 complies with the requirements corresponding to the S960QL given in the EN 10025-6 standard, where a minimum impact toughness of 27 J is guaranteed at -40°C.

Quend 960 is recommended for the following applications:

- crane booms
- lifting equipment
- stabilising support
- undercarriage ...

2 Technical characteristics

Tensile properties

| TRANSVERSE TESTING | | |
|--------------------------|------------------------|------------------|
| Yield strength Rp 0.2 | Tensile Strength Rm | Elongation A5 |
| 960 MPa min | 980 - 1150 MPa | 12% min |

Impact toughness

| Minimum values at | | |
|-------------------|--------|--------|
| 0 °C | -20 °C | -40 °C |
| 35 J | 30 J | 27 J |

Transverse testing according to EN 10025 option 30.
Thickness < 12 mm subsize Charpy V specimen have been used.

Testing according to EN 10025.

Chemical composition

The steel is fine grain treated

| Max ladle analysis, % | | | | | | | | | | | | | |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| C | Si | Mn | P | S | Nb | Cr | V | Ti | Ni | Al | Mo | N | B |
| 0,20 | 0,50 | 1,50 | 0,02 | 0,01 | 0,04 | 0,70 | 0,06 | 0,01 | 1,50 | 0,06 | 0,70 | 0,005 | 0,005 |

| Carbon equivalent, typical values, % | |
|--------------------------------------|--------------------|
| CEV ⁽¹⁾ | CET ⁽²⁾ |
| 0,57 | 0,36 |

(1) CEV = C+Mn/6+ (Ni+Cu)/15+ (Cr+Mo+V)/5
(2) CET = C+(Mn+Mo)/10+Ni/40 +(Cr+Cu)/20

3 Dimensions

Quend 960 is currently supplied in the following range:

- thickness: 4 - 15 mm
- width: 1500 - 3100 mm

NLMK Clabecq is continuing the extension of its dimensional program in order to offer quickly a thickness range from 4 up to 25 mm. For more information, please check our website or contact your local NLMK Clabecq representative.

4 Flatness, tolerances & surface properties

Quend 960 is delivered with a unique combination of excellent flatness, tight thickness tolerances and superior surface finish.

| Feature | Norm | |
|---------------------------------|---|-------------|
| FLATNESS | - EN 10029: . Class N (standard) & . Class S | PLUS |
| THICKNESS tolerance | - meets and exceeds EN 10029 Class A - tighter tolerances upon request | PLUS |
| Shape, length, width tolerances | meets EN 10029 | |
| SURFACE properties | exceeds the usual market standards, EN 10163-2 Class B3 | PLUS |

5 Delivery conditions

Quend 960 is delivered as quenched and tempered. Our Quend plates are supplied as standard in the **shotblasted and painted** condition. In order to maintain a good weldability and laser cutting performance, a low zinc silicate primer is applied. Plates can also be delivered unpainted.

6 Heat treatment

The mechanical properties of Quend 960 has been obtained by quenching and tempering. For not losing the guaranteed properties of Quend 960, the plate should not be used in applications requiring hot working and service temperatures above 550 °C.



7 Ultrasonic testing

Ultra sonic testing (UT), is applied to secure the plate from discontinuities like inclusions, cracks and porosity. In thickness from 8 mm and up, all plates are UT tested and controlled against class S2, E2, according to EN 10160.

8 General processing recommendations

To obtain optimal work shop productivity when processing Quend 960, it is essential to use the recommended procedures and tools given below.

Thermal cutting

Quend 960 may be cut either by oxygen fuel, plasma and laser cutting without any restrictions.

Subsequent to cutting, let the cut parts slowly cool down to room temperature. Do never accelerate the cooling of the parts. A slow cooling rate will reduce the risk of cut edge cracking.

Cold forming

Quend 960 is very well suited for cold forming operations. Quend 960 complies with the S960QL bending requirements but offer even closer R/t ratios:

Minimum recommended R/t ratio when bending of Quend 700

| Thickness (mm) | Transverse to rolling (R/t) | Longitudinal to rolling (R/t) | Width (W/t) |
|----------------|-----------------------------|-------------------------------|-------------|
| t ≤ 8.0 | 2.5 | 3.0 | 10 - 12 |
| 8 < t < 20 mm | 3.0 | 4.0 | 10 - 12 |

R = Recommended punch radius (mm), t = Plate thickness (mm) , W – Die opening width (mm) (bending angle ≤ 90°)

Due to the homogeneous properties and narrow thickness tolerances of Quend 960, variations in springback are kept at a low level. Grinding of flame cut or a sheared edge in the bending area is recommended to further prevent cracking during bending.

Welding

Welding of Quend 960 can be performed using any of the conventional welding methods available both as manual or automatic.

In the thickness range up to 12 mm, preheating prior to welding is normally not needed, if a heat input of 1,7 kJ/mm is used.

Welding of Quend 960 is recommended to be performed at ambient temperature not lower than +5 °C. Subsequent to welding, let the welded parts slowly cool down to room temperature. Do never accelerate the cooling process of the weld.

It is always recommended to use low hydrogen electrodes when welding Quend 960.

Machining

Quend 960 provides a very good machinability and can be drilled, counter sunked and milled in the same way as any other 960MPa or S960QL Q&T steel.

For more information regarding welding, cold forming and machining, please consult the respective manuals with technical recommendations on www.quend.me

Abrasion Resistant steel Quard 400



Quard[®]
ABRASION RESISTANT STEEL

1 Steel description and applications

Quard 400 is a martensitic abrasion resistant steel with an average hardness of 400 HBW. Due to its versatility in terms of high toughness, good cold formability and excellent weldability, Quard 400 combines an outstanding work shop performance and a long lasting wear resistance.

Quard 400 is recommended for the following applications:

- mining and earthmoving machinery
- crushing and pulverizing equipment
- buckets, knives, crushers, feeders
- presses
- skips
- excavators
- slurry pipe systems
- screw conveyors

2 Technical characteristics

Hardness guarantee

| Hardness | Brinell hardness test, HBW according to EN ISO 6506-1, is performed 1 - 2 mm below the plate surface once per heat and 40 tonnes. |
|-----------------|---|
| HBW = 370 - 430 | |

Other mechanical properties (typical values)

| Charpy-V notch impact test | Yield Strength (MPa) | Tensile Strength - Transverse - (MPa) | Elongation A5 (%) |
|---------------------------------|----------------------|---------------------------------------|-------------------|
| 40J (longitudinal at -40 °C) | 1050 | 1250 | 10 |

Chemical composition

The steel is grain refined.

| | Max ladle analysis, % | | | | | | | | |
|------------|-----------------------|------|------|-------|-------|------|------|------|-------|
| | C | Si | Mn | P | S | Cr | Ni | Mo | B |
| 3 - 25,4 | 0,16 | 0,60 | 1,40 | 0,025 | 0,010 | 0,55 | 0,10 | 0,25 | 0,005 |
| 25,41 - 40 | 0,17 | 0,60 | 1,60 | 0,025 | 0,010 | 1,15 | 0,10 | 0,25 | 0,005 |

| Carbon equivalent, typical values, % | | |
|--------------------------------------|--------------------|--------------------|
| Plate thickness | CEV ⁽¹⁾ | CET ⁽²⁾ |
| 3 - 4 mm | 0,35 | 0,24 |
| 4,01 - 8 mm | 0,36 | 0,25 |
| 8,01 - 20 mm | 0,40 | 0,28 |
| 20,01 - 25,4 mm | 0,45 | 0,29 |
| 25,41 - 40 mm | 0,57 | 0,33 |

(1) CEV = C+Mn/6+ (Ni+Cu)/15+ (Cr+Mo+V)/5

(2) CET = C+(Mn+Mo)/10+Ni/40 +(Cr+Cu)/20

3 Dimensions

Quard 400 at present is supplied in the following range:

- thickness: 4 - 40 mm
- width: 1500 - 3100 mm

NLMK Clabecq carries on the extension of its dimensional program in order to propose as soon as possible a thickness range from 3 to 50 mm. For more information, please check our website or contact your local NLMK Clabecq representative.

4 Flatness, tolerances & surface properties

Quard 400 is delivered with a unique combination of excellent flatness, tight thickness tolerances and superior surface finish.

| Feature | Norm | |
|---------------------------------|---|-------------|
| FLATNESS | - EN 10029: . Class N (standard) & . Class S | PLUS |
| THICKNESS tolerance | - meets and exceeds EN 10029 Class A - tighter tolerances upon request | PLUS |
| Shape, length, width tolerances | meets EN 10029 | |
| SURFACE properties | exceeds the usual market standards, EN 10163-2 Class B3 | PLUS |

5 Delivery conditions

Our Quard plates are supplied as standard in the **shotblasted and primed** condition. In order to maintain a good weldability and laser cutting performance, a low zinc silicate primer is applied. Plates can also be delivered unpainted.

6 Heat treatment

Quard 400 receives its properties by quenching and when applicable by subsequent tempering. The properties of the delivery condition can not be retained after exposure at service or preheating temperatures above 250 °C. Quard 400 is not intended for any further heat treatment.



7 Ultrasonic testing

Ultrasonic testing (UT), is applied to secure the plate from discontinuities like inclusions, cracks and porosity. In thickness from 8 mm and up, all plates are UT tested and controlled against class S2, E2, according to EN 10160.

8 General processing recommendations

To obtain optimal work shop productivity when processing Quard 400, it is essential to use the recommended procedures and tools given below.

Thermal cutting

Plasma and flame cutting can be performed without the need for preheating in thicknesses up to 40 mm, provided the ambient temperature is above 0 °C.

Subsequent to cutting, let the cut parts slowly cool down to room temperature. A slow cooling rate will reduce the risk of cut edge cracking (never accelerate the cooling of the parts).

Cold forming

Quard 400 is very well suited for cold forming operations. The minimum recommended R/t ratio when bending of Quard 400 is given in the table below:

| Thickness (mm) | Transverse to rolling (R/t) | Longitudinal to rolling (R/t) | Width (W/t) |
|----------------|-----------------------------|-------------------------------|-------------|
| t ≤ 8.0 | 2.5 | 3.0 | 8 – 12 |
| 8 < t < 20 | 3.0 | 4.0 | 10 – 12 |
| t ≥ 20.0 | 4.5 | 5.0 | 12 – 14 |

R = Recommended punch radius (mm), t = Plate thickness (mm) , W – Die opening width (mm) (bending angle ≤ 90°)

Due to the homogeneous properties and narrow thickness tolerances of Quard 400, variations in springback is kept at a low level. Grinding of flame cut or a sheared edge in the bending area is recommended to further prevent cracking during bending.

Welding

Quard 400 has a very good weldability, granted by the low carbon equivalent of the steel. It can be welded using any of the conventional welding methods, both as manual or automatic.

Welding of Quard 400 is recommended to be performed at ambient temperature not lower than +5°C. Subsequent to welding, let the welded parts slowly cool down to room temperature (never accelerate the cooling process of the weld).

If welding using a heat input of 1.7 kJ/mm, preheating is not required in single plate thickness up to 20 mm. The interpass temperature used should not exceed 225 °C.

Soft weld consumables, giving low hydrogen weld deposits (<= 5 ml/100g), are recommended. The consumable strength should be as soft as the design and wear mode allows.

In general, the welding recommendation of Quard 400 should be in the accordance to EN-1011.

Machining

Quard 400 offers good machinability with HSS and HSS-Co alloyed drills. The feed rate and cutting speed have to be adjusted to the high hardness of the material.

Face milling, counter boring and countersinking are best performed using tools with replaceable cemented carbide inserts.

For more information regarding welding, cold forming and machining, please consult the respective manuals with technical recommendations on www.quard.me

Abrasion Resistant steels

Quard 450



1 Steel description and applications

Quard 450 is a martensitic abrasion resistant steels, with an average hardness of 450 HBW. The steel offers very high resistance to abrasive wear and impact granting a longer service life. The combination of very good cold forming properties and excellent weldability makes Quard 450 an optimal choice for most wear applications.

Quard 450 is mainly recommended for the following applications:

- on road tipper and dumper bodies
- cement drum mixer barrels,
- refuse haulers, scrap containers
- buckets, knives
- feeders, skips, screw conveyors
- mining and earthmoving machinery

2 Technical characteristics

Hardness guarantee

| Hardness |
|-----------------|
| HBW = 420 - 480 |

Brinell hardness test, HBW according to EN ISO 6506-1, is performed 1 - 2 mm below the plate surface once per heat and 40 tonnes.

Other mechanical properties (typical values)

| Charpy-V notch impact test | Yield Strength (MPa) | Tensile Strength - Transverse - (MPa) | Elongation A5 (%) |
|------------------------------|----------------------|---------------------------------------|-------------------|
| 35 J (longitudinal at -40°C) | 1100 | 1400 | 10 |

Chemical composition

The steel is grain refined.

| | Max ladle analysis, % | | | | | | | | | |
|------------|-----------------------|------|------|-------|-------|------|------|------|-------|--|
| | C | Si | Mn | P | S | Cr | Ni | Mo | B | |
| 3 - 20 | 0,20 | 0,60 | 1,40 | 0,025 | 0,010 | 0,20 | 0,10 | 0,25 | 0,005 | |
| 20,01 - 40 | 0,21 | 0,60 | 1,60 | 0,025 | 0,010 | 0,75 | 0,10 | 0,25 | 0,005 | |

| Carbon equivalent, typical values, % | | |
|--------------------------------------|--------------------|--------------------|
| Plate thickness | CEV ⁽¹⁾ | CET ⁽²⁾ |
| 3 - 4 mm | 0,38 | 0,29 |
| 4,01 - 7,99 mm | 0,41 | 0,30 |
| 8 - 20 mm | 0,41 | 0,32 |
| 20,01 - 40 mm | 0,56 | 0,37 |

(1) CEV = C+Mn/6+ (Ni+Cu)/15+ (Cr+Mo+V)/5

(2) CET = C+(Mn+Mo)/10+Ni/40 +(Cr+Cu)/20

3 Dimensions

Quard 450 at present is supplied in the following range:

- thickness: 4 - 40 mm
- width: 1500 - 3100 mm

NLMK Clabecq carries on the extension of its dimensional program in order to propose as soon as possible a thickness range from 3 to 50 mm. For more information, please check our website or contact your local NLMK Clabecq representative.

4 Flatness, tolerances & surface properties

Quard 450 is delivered with a unique combination of excellent flatness, tight thickness tolerances and superior surface finish.

| Feature | Norm | |
|---------------------------------|---|-------------|
| FLATNESS | - EN 10029: . Class N (standard) & . Class S | PLUS |
| THICKNESS tolerance | - meets and exceeds EN 10029 Class A - tighter tolerances upon request | PLUS |
| Shape, length, width tolerances | meets EN 10029 | |
| SURFACE properties | exceeds the usual market standards, EN 10163-2 Class B3 | PLUS |

5 Delivery conditions

Our Quard plates are supplied as standard in the **shotblasted and primed** condition. In order to maintain a good weldability and laser cutting performance, a low zinc silicate primer is applied. Plates can also be delivered unpainted.

6 Heat treatment

Quard 450 receives its properties by quenching and when applicable by subsequent tempering. The properties of the delivery condition can not be retained after exposure at service or preheating temperatures above 250 °C. Quard 450 is not intended for any further heat treatment.



7 Ultrasonic testing

Ultrasonic testing (UT), is applied to secure the plate from discontinuities like inclusions, cracks and porosity. In thickness from 8 mm and up, all plates are UT tested and controlled against class S2, E2, according to EN 10160.

8 General processing recommendations

To obtain optimal work shop productivity when processing Quard 450, it is essential to use the recommended procedures and tools given below.

Thermal cutting

Plasma and flame cutting can be performed without the need for preheating in thicknesses up to 40 mm, provided the ambient temperature is above 0 °C.

Subsequent to cutting, let the cut parts slowly cool down to room temperature. A slow cooling rate will reduce the risk of cut edge cracking (never accelerate the cooling of the parts).

Cold forming

Quard 450 is very well suited for cold forming operations.

The minimum recommended R/t ratio when bending of Quard 450 is given in the table below:

| Thickness (mm) | Transverse to rolling (R/t) | Longitudinal to rolling (R/t) | Width (W/t) |
|----------------|-----------------------------|-------------------------------|-------------|
| t ≤ 8.0 | 3.5 | 4.0 | 10 – 12 |
| 8 < t < 20 | 4.0 | 5.0 | 10 – 14 |
| t ≥ 20.00 | 5.0 | 6.0 | 12 – 16 |

R = Recommended punch radius (mm), t = Plate thickness (mm), W – Die opening width (mm) (bending angle ≤ 90°)

Due to the homogeneous properties and narrow thickness tolerances of Quard 450, variations in springback is kept at a low level. Grinding of flame cut or a sheared edge in the bending area is recommended to further prevent cracking during bending.

Welding

Quard 450 has a very good weldability, granted by the low carbon equivalent of the steel. It can be welded using any of the conventional welding methods, both as manual or automatic.

Welding of Quard 450 is recommended to be performed at ambient temperature not lower than +5°C. Subsequent to welding, let the welded parts slowly cool down to room temperature (never accelerate the cooling process of the weld).

If welding using a heat input of 1.7 kJ/mm, preheating is not required in single plate thickness up to 20 mm. The interpass temperature used should not exceed 225 °C.

Soft weld consumables, giving low hydrogen weld deposits (<= 5 ml/100g), are recommended. The consumable strength should be as soft as the design and wear mode allows.

In general, the welding recommendation of Quard 450 should be in the accordance to EN-1011.

Machining

Quard 450 offers good machinability with HSS and HSS-Co alloyed drills. The feed rate and cutting speed have to be adjusted to the high hardness of the material.

Face milling, counter boring and countersinking are best performed using tools with replaceable cemented carbide inserts.

For more information regarding welding, cold forming and machining, please consult the respective manuals with technical recommendations on www.quard.me

Abrasion Resistant steels

Quard 500



Quard®

ABRASION RESISTANT STEEL

1 Steel description and applications

Quard 500 is a martensitic abrasion resistant steels, with an average hardness of 500 HBW. Its very high resistance to abrasive wear and impact makes it ideal where long service life is required. With the combination of superior hardness and strength, Quard 500 an optimal choice for the recycling and mining industry.

Quard 500 is mainly recommended for the following applications:

- screeners
- crushing and pulverizing equipment
- conveyors belts
- grapples
- scrap presses

2 Technical characteristics

Hardness guarantee

| Hardness | Brinell hardness test, HBW according to EN ISO 6506-1, is performed 1 - 2 mm below the plate surface once per heat and 40 tonnes. |
|-----------------|---|
| HBW = 470 - 530 | |

Other mechanical properties (typical values)

| Yield Strength (MPa) | Tensile Strength - Transverse - (MPa) | Elongation A5 (%) |
|----------------------|---------------------------------------|-------------------|
| 1250 | 1600 | 8 |

Chemical composition

The steel is grain refined.

| Max ladle analysis, % | | | | | | | | | |
|-----------------------|------|------|-------|------|------|------|------|-------|--|
| C | Si | Mn | P | S | Cr | Ni | Mo | B | |
| 0,30 | 0,80 | 1,60 | 0,025 | 0,01 | 1,00 | 1,00 | 0,50 | 0,005 | |

| Carbon equivalent, typical values, % | |
|--------------------------------------|--------------------|
| CEV ⁽¹⁾ | CET ⁽²⁾ |
| 0,57 | 0,40 |

(1) CEV = C+Mn/6+ (Ni+Cu)/15+ (Cr+Mo+V)/5

(2) CET = C+(Mn+Mo)/10+Ni/40 +(Cr+Cu)/20

3 Dimensions

Quard 500 at present is supplied in the following range:

- thickness: 4 - 20 mm
- width: 1500 - 3100 mm

NLMK Clabecq carries on the extension of its dimensional program of Quard 500 in order to propose quickly a thickness range from 4 to 40 mm. For more information, please check our website or contact your local NLMK Clabecq representative.

4 Flatness, tolerances & surface properties

Quard 500 is delivered with a unique combination of excellent flatness, tight thickness tolerances and superior surface finish.

| Feature | Norm | |
|---------------------------------|---|-------------|
| FLATNESS | - EN 10029: . Class N (standard) & . Class S | PLUS |
| THICKNESS tolerance | - meets and exceeds EN 10029 Class A - tighter tolerances upon request | PLUS |
| Shape, length, width tolerances | meets EN 10029 | |
| SURFACE properties | exceeds the usual market standards, EN 10163-2 Class B3 | PLUS |

5 Delivery conditions

Our Quard plates are supplied as standard in the **shotblasted and primed** condition. In order to maintain a good weldability and laser cutting performance, a low zinc silicate primer is applied. Plates can also be delivered unpainted.

6 Heat treatment

Quard 500 receives its properties by quenching and when applicable by subsequent tempering. The properties of the delivery condition can not be retained after exposure at service or preheating temperatures above 250 °C.

Quard 500 is not intended for any further heat treatment.



7 Ultrasonic testing

Ultrasonic testing (UT), is applied to secure the plate from discontinuities like inclusions, cracks and porosity. In thickness from 8 mm and up, all plates are UT tested and controlled against class S2, E2, according to EN 10160.

8 General processing recommendations

To obtain optimal work shop productivity when processing Quard 500, it is essential to use the recommended procedures and tools given below.

Thermal cutting

Plasma and flame cutting can be performed without the need for preheating in thicknesses up to 20 mm, provided the ambient temperature is above 0 °C.

Subsequent to cutting, let the cut parts slowly cool down to room temperature. A slow cooling rate will reduce the risk of cut edge cracking (never accelerate the cooling of the parts).

Cold forming

Quard 500 is very well suited for cold forming operations.

The minimum recommended R/t ratio when bending of Quard 500 is given in the table below:

| Thickness (mm) | Transverse to rolling (R/t) | Longitudinal to rolling (R/t) |
|----------------|-----------------------------|-------------------------------|
| t ≤ 8.0 | 3.5 | 4.5 |
| 8 < t < 20 | 4.5 | 5 |
| t > 20 | 6 | 7 |

R = Recommended punch radius (mm), t = Plate thickness (mm), W - Die opening width (mm) (bending angle ≤ 90°)

Due to the homogeneous properties and narrow thickness tolerances of Quard 500, variations in springback is kept at a low level. Grinding of flame cut or a sheared edge in the bending area is recommended to further prevent cracking during bending.

Welding

Quard 500 has a very good weldability, granted by the optimal carbon equivalent of the steel. It can be welded using any of the conventional welding methods, both as manual or automatic.

Welding of Quard 500 is recommended to be performed at ambient temperature not lower than +5°C. Subsequent to welding, let the welded parts slowly cool down to room temperature (never accelerate the cooling process of the weld).

If welding using a heat input of 1.7 kJ/mm, preheating is not required in single plate thickness up to 10 mm. The interpass temperature used should not exceed 225 °C.

Soft weld consumables, giving low hydrogen weld deposits (<= 5 ml/100g), are recommended. The consumable strength should be as soft as the design and wear mode allows.

In general, the welding recommendation of Quard 500 should be in the accordance to EN-1011.

Machining

Quard 500 offers good machinability with HSS and HSS-Co alloyed drills. The feed rate and cutting speed have to be adjusted to the high hardness of the material.

Face milling, counter boring and countersinking are best performed using tools with replaceable cemented carbide inserts.

For more information regarding welding, cold forming and machining, please consult the respective manuals with technical recommendations on www.quard.me