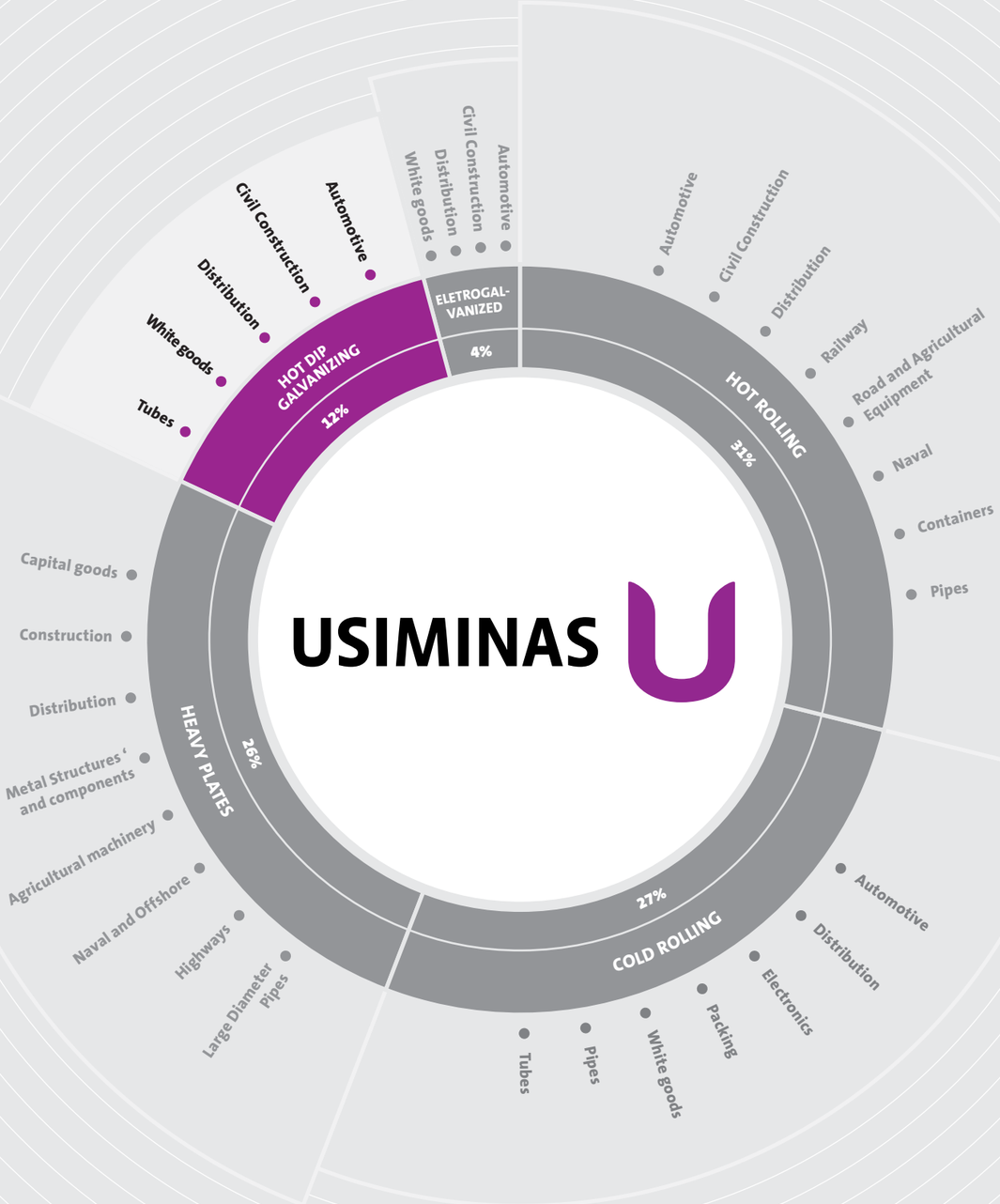
# *HOT-DIP GALVANIZED*

USIMINAS

USIMINAS

# INDEX




# COMPLETE SOLUTIONS IN STEEL

## WHEN THE STEEL IS FROM USIMINAS, QUALITY COMES FIRST.

Usiminas is a leading producer of flat steel in the Americas. There are units in six states of the country working on an integrated basis to deliver differentiated products and services.

A broad portfolio – from plates to coated steel - adds value to various strategic sectors of the economy, such as automotive, marine, oil and gas, civil construction, machinery and equipment, white goods, distribution, among others.

They are innovative steels, developed in line with market trends, from Usiminas' historical vocation to technological research.

In the segment of Heavy Plates, Usiminas has production lines with the use of controlled rolling and thermal treatment, and of controlled rolling and accelerated cooling. These combinations produce quality steel at different levels of mechanical strength

As the base of everything, a team trained to make steel more than a product, a solution.



# **HOT-DIP GALVANIZED** STEEL (HDG)

Hot-dip galvanized steels, also known as HDG, are produced in partnership with Unigal Usiminas, a joint venture created in 1999 between Usiminas and the Japanese company Nippon Steel & Sumitomo Metal Corporation. These products are characterized by their excellent atmospheric corrosion resistance. The coating types available are:

- **Usigal-GI®** – pure zinc coating;
- **Usigal-GA®** – zinc-iron coating.

HDG pure zinc-coated coils and plates, Usigal-GI®, and the zinc-iron coated alloys, Usigal-GA®, may be supplied with coating according to domestic and international standards. Usigal-GI® steels may be supplied with metallic coating mass, the sum of both sides, ranging from 80 g/m2 to 600 g/m2. These products can also be supplied with differentiated zinc coating per side, subject to prior consultation to Usiminas. Usigal-GA® steels are supplied with metallic coating weight, the sum of both sides, ranging from 60 g/m2 to 140 g/m².

HDG material are available with product thickness ranging from 0.40 mm to 3.00 mm and widths from 750 mm to 1,830 mm.

HDG steels, due to their excellent surface characteristics, are used in several segments, mainly the automotive one. These products are used for applications requiring high drawability, good weldability and pre-painting surface treatment.




# POST TREATMENT

Usiminas sells HDG steels with three types of treatment:

## CHEMICAL TREATMENT

Hot-dip galvanized steel, regardless of the type of coating, can be supplied with conventional chemical treatment, which increases its atmospheric corrosion resistance. Chemically treated Usigal-GI® is preferably indicated for those applications in which the material is used without painting. Such products are normally supplied without oiling, but can be supplied oiled, subject to prior consultation.

## "L" TREATMENT

"L" treatment is the application of a lubricant film especially developed for use in the production process of automotive parts. The product is only supplied oiled, and indicated for manufacture of external panels, internal door panels, wheel wells and floorings of vehicles. The L-treated steels have benefits such as excellent drawability, facility of removal with acid phosphatizing solution, and possibility of expansion of the forming range.

## PHOSPHATIZATION

Similar to the L treatment, the process of phosphatization is also indicated in parts with critical drawing, such as external sides, panels, wheel wells, and car floors.

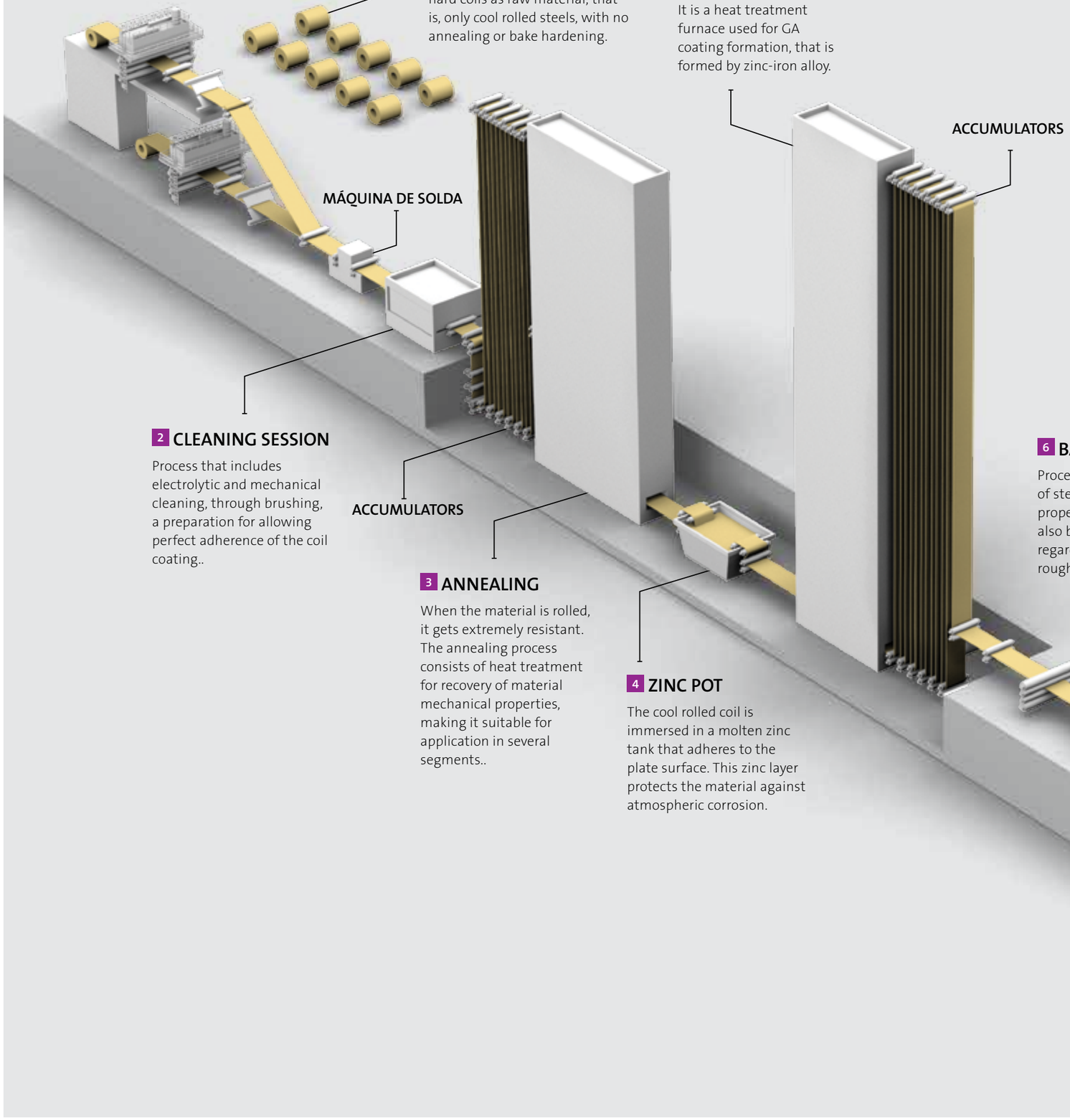
## STANDARDS AND SPECIFICATIONS

Usiminas supplies materials in accordance with international or specific standards for each customer, with the most commercialized one being:

- Usiminas
- American Society for Testing and Materials
- European Standard
- Japanese Industrial Standard
- Brazilian Standard
- Society of Automotive Engineers

This catalogue describes hot-dip electrogalvanized (galvanized) steel with its chemical and mechanical characteristics, produced according to Usiminas' specifications, and national and international standards. However, the catalogue brings only basic information of the standards, which are not sufficient to completely describe the product. Thus, Customer detailing is necessary when opting for one of them.

# PRODUCTION
# FLOW – HOT-DIP GALVANIZED STEEL




**1 FULL HARD COILS**

Hot-dip galvanization uses full hard coils as raw material, that is, only cool rolled steels, with no annealing or bake hardening.

**2 CLEANING SESSION**

Process that includes electrolytic and mechanical cleaning, through brushing, a preparation for allowing perfect adherence of the coil coating..

**3 ANNEALING**

When the material is rolled, it gets extremely resistant. The annealing process consists of heat treatment for recovery of material mechanical properties, making it suitable for application in several segments..

**4 ZINC POT**

The cool rolled coil is immersed in a molten zinc tank that adheres to the plate surface. This zinc layer protects the material against atmospheric corrosion.

**5 GALVANNEALING FURNACE**

It is a heat treatment furnace used for GA coating formation, that is formed by zinc-iron alloy.

**6 BAKE HARDENING**

Process providing adequacy of steel mechanical properties. In addition, it also brings improvement regarding shape and gives roughness to the band.

**7 POST-TREATMENT**

In this process, there is the possibility of applying a layer of L treatment or phosphate over the zinc layer that helps in the stages of stamping and painting, or chemical treatment, which enhances the resistance against atmospheric corrosion.

**8 SHEARS**

They trim the edges and sections the coil to reach the dimensions requested by the customer.

**9 ONLINE INSPECTION**

In this stage, the inspection and checking of the requests made by the customer are performed.

**FINAL PRODUCT**

**HOT-DIP GALVANIZED COIL**

Hot-dip galvanized coil: it has great resistance against atmospheric corrosion. Its dimensions are defined according to the customer request. This steel is much used by automobile manufacturers.

# **COMMERCIAL QUALITY** STEEL

HDG commercial quality steel is supplied with guarantee of chemical composition, with other guarantees being met on prior request. Such materials are indicated for general folding, being used in structural parts of low formation requirements in the sectors of civil construction, pipes, white goods, and general use.

| Standard | Grade | Coatin | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Propertie | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Others | Tensile Test Direction | YS (MPa) | LR (MPa) | Elongation | | | Hardness (HRB) |
| | | | | | | | | | | | | | Thickness (mm) | GL (mm) | % min. | |
| Usiminas (USI) | USIGAL-GI-CF01<br>USIGAL-GA-CF01<br>USIGAL-GI-QC45<br>USIGAL-GA-QC45 | GI<br>GA<br>GI<br>GA | 0.40 ~ 3.00 | 0.12 max. | 0.60 max. | 0.005 min. | 0.060 max. | 0.035 max. | - | - | - | - | - | - | - | -<br>45 ~ 60 |
| ASTM A653 | CS-A (1) (2) (7)<br>CS-B (1) (7)<br>CS-C (1) (2) (7) | GI / GA | 0.40 ~ 3.00 | 0.10 max.<br>0.02 ~ 0.015<br>0.08 max. | 0.60 max. | (3) | 0.030 max.<br>0.100 max. | 0.035 max. | Cu: 0.25 max.<br>Ni: 0.20 max.<br>Cr: 0.15 max.<br>Mo: 0.06 max.<br>V: 0.008 max.<br>Nb: 0.008 max.<br>Ti: 0.025 max. (4) | Longitudinal | 170 ~ 380<br>205 ~ 380<br>170 ~ 410 | - | - | 50 | 20<br>15 | - |
| EN 10346 | DX51D+Z<br>DX51D+ZF | GI<br>GA | 0.40 ~ 3.00 | 0.18 max. | 1.20 max. | - | 0.120 max. | 0.045 max. | Si: 0.50 max.<br>Ti: 0.300 max. | Transversal | - | 270 ~ 500 | (8) | 80 | (8) | - |
| JIS G 3302 | SGCC | GI / GA | 0.40 ~ 3.00 | 0.15 max. | 0.80 max. | - | 0.050 max. | 0.050 max. | - | - | - | - | (8) | 80 | (8) | - |
| SAE J2329 | CR1 | GI / GA | 0.40 ~ 3.00 | 0.13 max. | 0.60 max. | - | 0.035 max. | 0.035 max. | - | - | - | - | - | - | - | - |
| NBR 7008 | ZC | GI / GA | 0.40 ~ 3.00 | 0.15 max. | 0.60 max. | (5) | 0.040 max. | 0.040 max. | - | - | - | - | - | - | - | - |

(1) There is no specification for the Al, N, and B elements; however, their results may be reported.
(2) For C contents ≤ 0.02% p/p, V, Nb, or Ti, or combinations of these, can be used as stabilizing elements. In these cases, the maximum limit for the V and Nb content sum is 0.100% p/p and for Ti, 0.150% p/p.
(3) When the application requires aluminum-killed steel, the grade may be manufactured with a minimum 0.010% p/p Al content.
(4) For steels with C equal to or greater than 0.02% p/p, the maximum Ti content must be the lower value of 0.025% p/p or calculated by the formula 3.4N + 1.5S.
(5) No specified value. However, the values found must appear on the certificate of analysis.
(6) For products with thickness lower than 0.70mm and/or special flatness, the elongation value can reach two units below the table value.
(7) For the ASTMA 653 standard, the mechanical properties shown are not mandatory. The values are provided to guide the customer in specifying the suitable steel for a given application. Values outside these ranges may occur. The customer can, if necessary for the application, negotiate with Usiminas a narrower range.
(8) For thicknesses ≤ 0.50mm, a 18% minimum elongation. Thicknesses between 0.50 < AND ≤ 0.70mm, a 20% minimum elongation. Thicknesses greater than 0.70mm, a 22% minimum elongation.

# **DRAWING** STEEL

HDG drawing steel carries the guarantee of mechanical properties, with the yield strength (YS), tensile strength (TS) and elongation (E) being specified. For steel with greater drawing requirements, minimum anisotropy (r) and strain hardening coefficient (n) values are specified.

The application of this steel is indicated for medium to extra-critical drawing processes, where the characteristics of strength, rigidity and ductility are required. Normally, they are used by the automotive, white goods, and civil construction industries. They may be supplied with low or ultra-low carbon.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Other | Tensile Test Direction | YS (MPa) | TS (MPa) | Elongation | | | r | n |
| | | | | | | | | | | | | | Thickness (mm) | MB (mm) | % mln. | | |
| Usiminas (USI) | USIGAL-GI-ST02 | GI | 0.40 ~ 2.30 | 0.12 max. | 0.50 max. | | 0.040 max. | 0.030 max. | - | Transversal | 140 ~ 300 | 270 ~ 420 | - | 50 | 32 | (13) | (13) |
| | USIGAL-GA-ST02 | GA | | | | | | | | | | | | | -32 | | |
| | USIGAL-GI-ST03 | GI | | 0.08 max. | 0.45 max. | 0.005 min. | 0.030 max. | | | | 140 ~ 220 | 270 ~ 370 | | | -34 | | |
| | USIGAL-GA-ST03 | GA | | | | | | | | | | | | | -34 | | |
| | USIGAL-GI-ST04 | GI | 0.60 ~ 2.30 | 0.06 max. | | | 0.025 max. | | Ti: 0.600 max.<br>Nb: 0.500 max. | | 120 ~ 200 | 270 ~ 350 | | | 37 | | |
| | USIGAL-GA-ST04 | GA | | | 0.35 max. | | | 0.020 max. | | | | | | | | | |
| | USIGAL-GI-ST05 | GI | | 0.02 max. | | | 0.020 max. | | | | 120 ~ 180 | 270 ~ 350 | | | 39 | | |
| | USIGAL-GA-ST05 | GA | | | | | | | | | | | | | | | |
| ASTM A653 | FS-A (1) (12) | GI / GA | 0.40 ~ 2.30 | 0.10 max. | 0.50 max. | (14) | 0.020 max. | 0.035 max. | Cu: 0.25 max.<br>Ni: 0.20 max.<br>Cr: 0.15 max.<br>Mo: 0.06 max.<br>V: 0.008 max.<br>Nb: 0.008 max.<br>Ti: 0.025 max. (2) | Longitudinal | 170 ~ 310 | - | - | 50 | 26 | 1.0 ~ 1.4 (4) | 0.17 ~ 0.21 (4) |
| | FS-B (1) (12) | | | 0.02 ~ 0.10 | | | | 0.030 max. | | | | | | | | | |
| | DDS-A (1) (12) | | | 0.06 max. | | | | 0.025 max. | | | 140 ~ 240 | | | | 32 | 1.0 ~ 1.8 (4) | 0.19 ~ 0.24 (4) |
| | DDS-C (1) (12) | | 0.60 ~ 2.30 | 0.02 max. | | 0.010 min. | 0.020 ~ 0.100 | 0.025 max. | (3) | | 170 ~ 280 | | | | 32 | 1.2 ~ 1.8 (4) | 0.17 ~ 0.24 (4) |
| | EDDS (1) (12) | | | | 0.40 max. | | 0.020 max. | 0.020 max. | | | 105 ~ 170 | | | | 40 | 1.6 ~ 2.1 (4) | 0.22 ~ 0.27 (4) |

CONTINUA

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Other | Tensile Test Direction | YS (MPa) | TS (MPa) | Elongation | | | r | n |
| | | | | | | | | | | | | | Thickness (mm) | MB (mm) | % mIn. | | |
| EN 10346 | DX52+Z | GI | 0.40 ~ 2.30 | 0.12 max. | 0.60 max. | - | 0.100 max. | 0.045 max. | Si: 0.500 max.<br>Ti: 0.300 max. | Transversal | 140 ~ 300 | 270 ~ 420 | (5) | 80 | 26 | - | - |
| | DX52+ZF | GA | | | | | | | | | | | | | | | |
| | DX53+Z | GI | | | | | | | | | 140 ~ 260 | 270 ~ 380 | | | 30 | | |
| | DX53+ZF | GA | | | | | | | | | | | | | | | |
| | DX54+Z | GI | | | | | | | | | | | | | 36 | 1.6 min. (6) (7) | 0.18 min. (6) |
| | DX54+ZF | GA | 0.60 ~ 2.30 | | | | | | | | 120 ~ 220 | 260 ~ 350 | | | 34 | 1.4 min. (6) (7) | 0.18 min. (6) |
| | DX56+Z | GI | | | | | | | | | | | | | 39 | 1.9 min. (6) (7) | 0.21 min. (6) |
| | DX56+ZF | GA | | | | | | | | | 120 ~ 180 | 260 ~ 350 | | | 37 | 1.7 min. (6) (7) (8) | 0.20 min. (6) (8) |
| JIS G3302 | SGCD1 | GI / GA | 0.40 ~ 2.30 | 0.12 max. | 0.60 max. | - | 0.040 max. | 0.040 max. | - | Longitudinal | - | 270 min. | 0.40 ≤ E < 0.60 | 50 | 34 | - | - |
| | | | | | | | | | | | | | 0.60 ≤ E < 1.00 | | 36 | | |
| | | | | | | | | | | | | | 1.00 ≤ E < 1.60 | | 37 | | |
| | | | | | | | | | | | | | 1.60 ≤ E < 2.30 | | 38 | | |
| | SGCD2 | | | 0.10 max. | | | | | | | | | 0.60 ≤ E < 1.00 | | 38 | | |
| | | | | | | | | | | | | | 1.00 ≤ E < 1.60 | | 39 | | |
| | | | | | | | | | | | | | 1.60 ≤ E < 2.30 | | 40 | | |
| | SGCD3 | | 0.60 ~ 2.30 | 0.08 max. | 0.45 max. | | 0.030 max. | 0.030 max. | | | | | 0.60 ≤ E < 1.00 | | 40 | | |
| | | | | | | | | | | | | | 1.00 ≤ E < 1.60 | | 41 | | |
| | | | | | | | | | | | | | 1.60 ≤ E < 2.30 | | 42 | | |
| | SGCD4 | | | 0.06 max. | | | | | | | | | 0.60 ≤ E < 100 | | 42 | | |
| | | | | | | | | | | | | | 1.00 ≤ E < 160 | | 43 | | |
| | | | | | | | | | | | | | 1.60 ≤ E < 2.30 | | 44 | | |
| NBR 7008 | ZE | GI / GA | 0.40 ~ 2.30 | 0.10 max. | 0.45 max. | (9) | 0.030 max. | 0.030 max. | - | Transversal | 140 ~ 300 | 420 max. | (11) | 50 | 26 | - | - |
| | ZEE Grau 1 | | 0.60 ~ 2.30 | 0.08 max. | | 0.010 min. | | | (10) | | 140 ~ 260 | 380 max. | | | 31 | | |
| | ZEE Grau 2 | | | 0.08 max. | | | | 0.020 max. | | | 140 ~ 220 | 350 max. | | | 37 | | |
| | ZEE Grau 3 | | | 0.01 max. | 0.30 max. | | 0.020 max. | | | | 140 ~ 200 | 350 max. | | | 40 | | |
| | ZEE Grau 4 | | | 0.01 max. | | | | | | | 120 ~ 180 | 350 max. | | | 40 | | |

(1) There is no specification for the N and B elements; however, their results may be reported.
(2) For steels with C equal to or greater than 0.02% p/p, the maximum Ti content must be the lower value of 0.025% p/p or calculated by the formula 3.4N + 1.5S.
(3) Maximum specified contents (% p/p): Cu: 0,25/ Ni: 0,20/ Cr: 0.15/ Mo: 0,06/ V: 0.10/ Nb: 0.10/ Ti: 0,15.
(4) Average value performed in three directions.
(5) For materials with a thickness between 0.50 < AND ≤ 0.70mm, the minimum elongation must be reduced by 2 units. For a thickness ≤ 0.50mm, the reduction shall be by 4 units.
(6) Value measured in the transverse direction.
(7) For thicknesses > 1.50mm, the r value must be reduced by 0.2 unit.
(8) For a thickness ≤ 0.70mm, the r value must be reduced by 0.2 unit and the n value, by 0.01 unit.
(9) No specified value. However, the value found must appear on the certificate of analysis.
(10) Such chemical elements as P, Nb, Ti, and V can be added alone or in combination.
(11) For products with thickness lower than 0.70mm and/or special flatness, the elongation value can reach two units below the table value.
(12) For the ASTMA 653 standard, the mechanical properties shown are not mandatory. The values are provided to guide the customer in specifying the suitable steel for a given application. Values outside these ranges may occur. The customer can, if necessary for the application, negotiate with Usiminas a narrower range.
(13) It can be guaranteed upon request.
(14) There is no specification for the Al chemical element; however, its result must be reported.

# BAKE HARDENING
## STEEL

This class of steel has as its main characteristics the increased mechanical strength obtained after paint baking (range from 100°C to 200°C), due to strain hardening. It also has a medium to deep drawing characteristics.

Bake hardening steel is applied in the automotive industry, mainly in closing panels, such as hood, doors, trunk lid and for fenders, providing good indenting resistance to those panels, even when submitted to low drawing levels, which is one of the characteristics of these parts.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Other | Tensile Test Direction | YS (MPa) | TS (MPa) | Elongation | | | r | n | Min. value BH (MPa) |
| | | | | | | | | | | | | | Thickness (mm) | MB (mm) | % mln. | | | |
| Usiminas (USI) | USIGAL-GI-BH180 | GI | 0.60 ~ 2.30 | 0.05 max. | 0.80 min. | 0.05min. | 0.060 max. | 0.025 max. | Nb: 0.500 max.<br>Ti: 0.600 max. | Transversal | 180 ~ 240 | 300 ~ 380 | - | 50 | 32 | (8) | (8) | 30 |
| | USIGAL-GA-BH180 | GA | | | | | | | | | | | | | -32 | | | |
| | USIGAL-GI-BH220 | GI | | 0.10 max. | 0.70 max. | 0.120 max. | 0.080 max. | | Nb: 0.090 max.<br>Ti: 0.120 max. | | 220 ~ 280 | 320 ~ 400 | - | | -30 | | | |
| | USIGAL-GA-BH220 | GA | | | | | | | | | | | | | -30 | | | |
| ASTM A 653 | BHS 180 (1) | GI / GA | 0.60 ~ 2.30 | 0.12 max. | 150 max. | - | 0.120 max. | 0.030 max. | Cu: 0.200 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max.<br>V: 0.008 max. (2)<br>Nb: 0.008 max. (2)<br>Ti: 0.008 max. (2) (3) | Longitudinal | 180 min. | 300 min. | - | 50 | 30 | - | - | 20 |
| | BHS 210 (1) | | | | | | | | | | 210 min. | 320 min. | | | 28 | | | |
| | BHS 240 (1) | | | | | | | | | | 240 min. | 340 min. | | | 24 | | | |
| EN 10346 | HX180BD+Z | GI | 0.60 ~ 2.30 | 0.10 max. | 0.70 max. | 0.100 max. | 0.060 max. | 0.025 max. | Si: 0.50 max.<br>Nb: 0.090 max.<br>Ti: 0.120 max. | Transversal | 180 ~ 240 | 290 ~ 360 | (4) | 80 | 34 | 1.5 min. (5) (6) | 0.16 min. (5) | 35 |
| | HX180BD+ZF | GA | | | | | | | | | | | | | 32 | 1.3 min. (5) (6) | | |
| | HX220BD+Z | GI | | | | | 0.080 max. | | | | 220 ~ 280 | 320 ~ 400 | | | 32 | 1.2 min. (5) (6) | 0.15min. (5) | |
| | HX220BD+ZF | GA | | | | | | | | | | | | | 30 | 1.0 min. (5) (6) | | |
| SAE J 2340 | 180B | GI / GA | 0.60 ~ 2.30 | 0.01 max. | - | - | 0.050 max. | 0.015 max. | B: 0.0010 max.<br>Cu: 0.200 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max. | Longitudinal | 180 min. | 300 min. | - | 50 | - | - | 0.19 min. (7) | 245 (9) |
| | 210B | | | | | | 0.100 max. | | | | 210 min. | 320 min. | | | | | 0.17min. (7) | 275 (9) |

(1) There is no specification for the Al, Si, and N elements; however, their contents must be reported.
(2) For C contents ≤ 0.02% p/p, V, Nb, or Ti, or combinations of these, can be used as stabilizing elements. In these cases, the maximum limit for V and Nb is 0.100% p/p and for Ti, 0.150% p/p.
(3) For steels with a C content ≥ 0.02% p/p, the maximum Ti content must be the lower value of 0.025% p/p or calculated by the formula 3.4N + 1.5S or 0.025%.
(4) For materials with a thickness between 0.60mm < AND ≤ 0.70mm, the minimum elongation can be reduced by 2 units.
(5) Value measured in the transverse direction.
(6) For a thickness > 1.50mm, the r value must be reduced by 0.2 unit.
(7) Average value of test performed in three directions.
(8) It can be guaranteed upon request.
(9) Measurement method: LE + ΔW + BH after a 2% deformation and a 175 °C heat treatment during 30 minutes.

# **MEDIUM-STRENGTH** STEEL

This series include products that have high mechanical strength and good formability as their main characteristics. High mechanical strength is especially due to the hardening mechanism of solid solution and carbides precipitation obtained by the addition of carbon and manganese. Medium-strength steels are used by the automotive industry and, mainly, in civil construction.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Others | Tensile Test Direction | LE (MPa) | LR (MPa) | Elongation | | |
| | | | | | | | | | | | | | Thickness (mm) | BM (mm) | % min. |
| Usiminas (USI)(6) | USIGAL-GI-ZAR230 | GI | 0.40 ~ 3.00 | 0.12 max. | 0.70 max. | 0.010 min. | 0.060 max. | 0,040 max. | - | Transversal | 230 min. | 340 min. | - | 50 | 16 |
| | USIGAL-GA-ZAR230 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-ZAR250 | GI | 0.60 ~ 3.00 | 0.15 max. | | | | | | | 250 min. | 360 min. | | | |
| | USIGAL-GA-ZAR250 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-ZAR280 | GI | | 0.20 max. | 0.80 max. | | | | | | 280 min. | 400 min. | | | |
| | USIGAL-GA-ZAR280 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-ZAR320 | GI | 0.70 ~ 3.00 | 0.23 max. | 1.00 max. | | | | | | 320 min. | 390 min. | | | 14 |
| | USIGAL-GA-ZAR320 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-ZAR345 | GI | | | | | | | | | 345 min. | 430 min. | | | |
| | USIGAL-GA-ZAR345 | GA | | | | | | | | | | | | | |
| ASTM A653 | SS 230 (1) | GI / GA | 0.40 ~ 3.00 | 0.20 max. | 1.35 max. | - | 0.100 max. | 0.040 max. | Cu: 0.250 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max.<br>V: 0.008 max. (2)<br>Nb: 0.008 max. (2)<br>Ti: 0.025 max. (2) (3) | Longitudinal | 230 min. | 310 min. | | | 20 |
| | SS 255 (1) | GI / GA | 0.60 ~ 3.00 | | | | | | | | 255 min. | 360 min. | | | 18 |
| | SS 275 (1) | GI / GA | | 0.25 max. | | | | | | | 275 min. | 380 min. | | | 16 |
| EN 10346 (4) | S220GD+Z | GI | 0.40 ~ 3.00 | 0.20 max. | 1.70 max. | - | 0.100 max. | 0.045 max. | Si: 0.60 max. | Longitudinal | 220 min. | 300 min. | (5) | 80 | 20 |
| | S220GD+ZF | GA | | | | | | | | | | | | | |
| | S250GD+Z | GI | 0.60 ~ 3.00 | | | | | | | | 250 min. | 330 min. | | | 19 |
| | S250GD+ZF | GA | | | | | | | | | | | | | |
| | S280GD+Z | GI | | | | | | | | | 280 min. | 360 min. | | | 18 |
| | S280GD+ZF | GA | | | | | | | | | | | | | |
| | S320GD+Z | GI | 0.70 ~ 3.00 | | | | | | | | 320 min. | 390 min. | | | 17 |
| | S320GD+ZF | GA | | | | | | | | | | | | | |
| | S350GD+Z | GI | | | | | | | | | 350 min. | 420 min. | | | 16 |
| | S350GD+ZF | GA | | | | | | | | | | | | | |
| JIS G3302 | SGC340 | GI / GA | 0.60 ~ 3.00 | 0.25 max. | 1.70 max. | - | 0.200 max. | 0.050 max. | - | Transversal | 245 min. | 340 min. | - | 50 | 20 |
| | SGC400 | | | | | | | | | | 295 min. | 400 min. | | | 18 |
| | SGC440 | | | | 2.00 max. | | | | | | 335 min. | 440 min. | | | 18 |
| SAE J2340 | 300S | GI / GA | 0.60 ~ 3.00 | 0.13 max. | - | - | 0.100 max. | 0.020 max. | Cu: 0.200 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max. | Longitudinal | 300 ~ 400 | 390 min. | - | 50 | 24 |
| | 340S | | | | | | | | | | 340 ~ 440 | 440 min. | | | 22 |

(1) There is no specification for the Al and N elements; however, their contents must be reported.
(2) For C levels equal to or less than 0.02%, V, Nb, or Ti, or a combination of these, is allowed for element stabilization. In these cases, the maximum limits for V and Nb shall be 0.100% and for Ti, 0.150%.
(3) For steels with C > 0.02% content, the maximum Ti content is to be less than can be 3.4N + 1.5s or 0.025%.
(4) For all grades applied to semi-finished products for Resistance Limit a range of 140 MPa is expected.

(5) For materials with thickness 0.50 < E ≤ 0,70, the minimum elongation can be reduced in 2 units. Thickness ≤ 0.50mm - reduction of 4 units.
(6) Depending on the requested size, the material can be manufactured with addition of Nb and/or Ti elements, the material having microalloyed medium resistance steel characteristics.

# **REPHOSPHORIZED MEDIUM-STRENGTH** STEEL

The main characteristic of the steels in this series is high mechanical strength and good drawability. Its high mechanical strength is especially due to the mechanism of hardening by solid solution obtained through the addition of phosphorus and manganese. Medium-strength steel is mainly used by the automotive industry.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Other | Tensile Test Direction | YS (MPa) | TS (MPa) | Elongation | | | r | n |
| | | | | | | | | | | | | | Thickness (mm) | MB (mm) | % mln. | | |
| Usiminas (USI) | USIGAL-GI-IFAR340 | GI | 0.60 ~ 2.30 | 0.01 max. | 0.90 max. | 0.100 max. | 0.08 max. | 0.025 max. | Nb: 0.09 max.<br>Ti: 0.12 max. | Transversal | 160 min. | 340 min. | - | 50 | 31 | (8) | (8) |
| | USIGAL-GA-IFAR340 | GA | | | | | | | | | | | | | 31 | | |
| ASTM A653 | SHS 180 (1) | GI / GA | 0.60 ~ 2.30 | 0.12 max. | 1.50 max. | - | 0.120 max. | 0.030 max. | Cu: 0.200 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max.<br>V: 0.008 max. (2)<br>Nb: 0.008 max. (2)<br>Ti: 0.025 max. (2) (3) | Longitudinal | 180 min. | 300 min. | - | 50 | 32 | - | - |
| | SHS 210 (1) | | | | | | | | | | 210 min. | 320 min. | | | 30 | | |
| | SHS 240 (1) | | | | | | | | | | 240 min. | 340 min. | | | 26 | | |
| | SHS 280 (1) | | | | | | | | | | 280 min. | 370 min. | | | 24 | | |
| | SHS 300 (1) | | | | | | | | | | 300 min. | 390 min. | | | 22 | | |
| EN 10346 | HX160YD | GI | 0.60 ~ 2.30 | 0.01 max. | 0.70 max. | 0.100 max. | 0.06 max. | 0.025 max. | Si: 0.20 max. (4)<br>Nb: 0.09 max.<br>Ti: 0.12 max. | Transversal | 160 a 220 | 300 a 360 | (5) | 80 | 37 | 1.9 (7) | 0.20 (7) |
| | | GA | | | | | | | | | | | | | 35 | 1.7 (7) | |
| | HX180YD | GI | | | | | | | | | 180 a 240 | 330 a 390 | | | 34 | 1.7 (7) | 0.18 (7) |
| | | GA | | | | | | | | | | | | | 32 | 1.5 (7) | |
| | HX220YD | GI | | | 0.90 max. | | 0.08 max. | | | | 220 a 280 | 340 a 420 | | | 34 | 1.5 (7) | 0.17 (7) |
| | | GA | | | | | | | | | | | | | 32 | 1.3 (7) | |

(1) There is no specification for the Si, Al, and N elements; however, their results may be reported.
(2) For C contents ≤ 0.02% p/p, V, Nb, or Ti, or combinations of these, can be used as stabilizing elements. In these cases, the maximum limit for V and Nb is 0.100% p/p and for Ti, 0.150% p/p.
(3) For steels with a C content ≥ 0.02% p/p, the maximum Ti content must be the lower value of 0.025% p/p or calculated by the formula 3.4N + 1.5S or 0.025%.
(5) For materials with a thickness between 0.50mm < AND ≤ 0.70mm, the minimum elongation may be reduced by 2 units. For a thickness ≤ 0.50mm, the reduction may be by 4 units.
(6) For materials with a thickness > 1.5 mm, the minimum r value must be reduced by 0.2 unit.
(7) Value measured in the transverse direction.
(8) They can be guaranteed upon request.

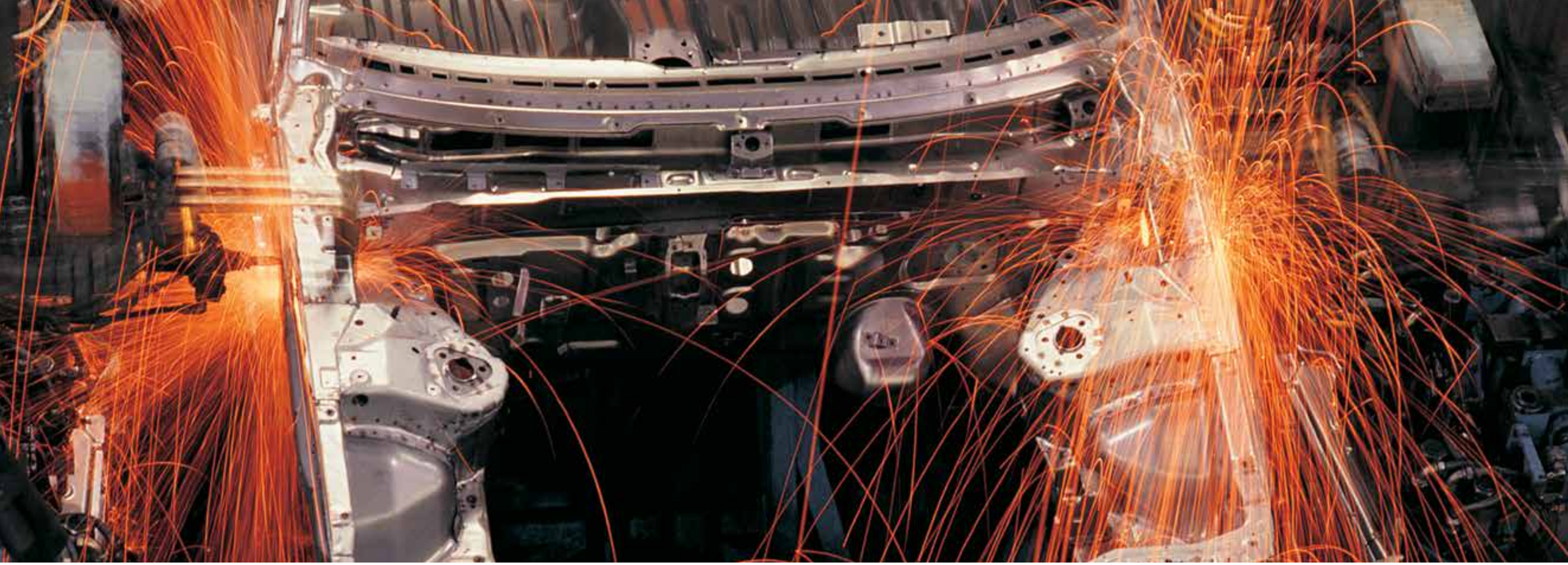
# MEDIUM-AND HIGH-STRENGTH MICRO ALLOYED STEEL

This steel shows high mechanical strength associated with good ductility. Its high strength is obtained by the addition of alloy elements, such as titanium and/or niobium, which provide hardening due to the ferrite grain refinement.

This group of steel is applied in vehicle parts that do not require high drawability, such as structural or reinforcement parts. The high mechanical strength and low alloy can replace lower strength steels, allowing thickness reduction and/or strength gain of vehicle parts. On request, thicknesses of up to 3.00 mm.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Others | Tensile Test Direction | LE (MPa) | LR (MPa) | Elongation | | |
| | | | | | | | | | | | | | Thickness (mm) | BM (mm) | % min. |
| Usiminas | USIGAL-GI-ZAR420 | GI | 0.70 ~ 3.00 | 0.20 max. | 1.70 max. | 0.10 max. | 0.20 max. | 0.040 max. | - | Transversal | 420 min. | 460 min. | - | 50 | 16 |
| | USIGAL-GA-ZAR420 | GA | | | | | | | | | 450 min. | 470 min. | | | 15 |
| | USIGAL-GI-ZAR450 | GI | | | | | | | | | 500 min. | 530 min. | | | 13 |
| | USIGAL-GI-ZAR450 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-ZAR500 | GI | | 0.23 max. | 2.00 max. | | | | | | | | | | |
| | USIGAL-GA-ZAR500 | GA | | | | | | | | | | | | | |
| ASTM A653 | HSLAS275 (1) | GI / GA | 0.70 ~ 3.00 | 0.20 max. | 1.20 max. | - | - | 0.035 max. | Cu: 0.200 max. (2)<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.160 max.<br>V: 0.010 min. (3)<br>Nb: 0.005 min. (3)<br>Ti: 0.010 min. (3) (7): | Longitudinal | 275 min. | 340 min. | - | 50 | 22 |
| | HSLAS340 (1) | GI / GA | | | | | | | | | 340 min. | 410 min. | | | 20 |
| | HSLAS380 (1) | GI / GA | | 0.15 max. | | | | | | | 380 min. | 450 min. | | | 18 |
| | HSLAS410 (1) | GI / GA | | 0.20 max. | 1.35 max. | | | | | | 410 min. | 480 min. | | | 16 |
| EN 10346 | HX260LAD+Z (4) | GI | 0.70 ~ 3.00 | 0.11 max. | 0.60 max. | 0.015 min. | 0.030 max. | 0.025 max. | Si: 0.50 max.<br>Nb: 0.090 max.<br>Ti: 0.150 max. | Transversal | 260 ~ 330 | 350 ~ 430 | (5) | 80 | 26 |
| | HX260LAD+ZF (4) | GA | | | | | | | | | | | | | 24 |
| | HX300LAD+Z | GI | | | 1.00 max. | 0.100 max. | | | | | 300 ~ 380 | 380 ~ 480 | | | 23 |
| | HX300LAD+ZF | GA | | | | | | | | | | | | | 21 |
| | HX340LAD+Z | GI | | | | | | | | | 340 ~ 420 | 410 ~ 510 | | | 21 |
| | HX340LAD+ZF | GA | | | | | | | | | | | | | 19 |
| | HX380LAD+Z | GI | | | 1.40 max. | 0.015 min. | | | | | 380 ~ 480 | 440 ~ 560 | | | 19 |
| | HX380LAD+ZF | GA | | | | | | | | | | | | | 17 |
| | HX420LAD+Z | GI | | | | | | | | | 420 ~ 520 | 470 ~ 590 | | | 17 |
| | HX420LAD+ZF | GA | | | | | | | | | | | | | 15 |
| SAE J2340 | 300Y (6) | GI / GA | 0.70 ~ 3.00 | 0.13 max. | - | - | 0.060 max. | 0.015 max. | Cu: 0.200 max.<br>Ni: 0.200 max.<br>Cr: 0.150 max.<br>Mo: 0.060 max. | Longitudinal | 300 ~ 400 | 400 min. | - | 50 | 21 |
| | 340Y (6) | GI / GA | | | | | | | | | 340 ~ 440 | 440 min. | | | 20 |
| | 380Y (6) | GI / GA | | | | | | | | | 380 ~ 480 | 480 min. | | | 18 |
| | 420Y (6) | GI / GA | | | | | | | | | 420 ~ 520 | 520 min. | | | 16 |

(1) There is no specification for the P and N elements; however, their contents must be reported.
(2) For HSLAS275 grade, there is no Cu content specification. However, its result must be reported.
(3) For C contents less than or equal to 0.02% p/p, V, Nb or Ti, or a combination of these, can be used as stabilizing elements. In these cases, the maximum limit for V and Nb is 0.100% p/p and for Ti is 0.150% p/p.
(4) For HX260LAD+Z and HX260LAD+ZF grades, the maximum titanium content is 0.120% p/p.
(5) For materials with thickness of 0.50mm < E ≤ 0,70mm, the minimum elongation must be reduced in 2 units.
(6) A minimum content of at least one of Nb, Ti or V elements of 0,005% p/p is specified.
For steels with C content ≥ 0.02% p/p, the maximum Ti content must be the lower of 0.025% p/p or calculated by the formula 3.4N + 1.5S or 0.025%. (7)



# **DUAL PHASE** STEEL

Dual phase is a name related to the steel's microstructure, which is predominantly made up of martensite islands (hard phase), dispersed in a soft ferrite matrix. The presence of these components and their respective volumetric fractions in the microstructure directly influences the mechanical properties of this class of steel. Such structure provides excellent ductility, allowing high strain hardening behavior and high strain ageing behavior (bake hardening effect).

Hot-dip galvanized dual phase steels are especially recommended for the automotive industry for structural and reinforcement parts, providing weight reduction through thickness reduction. They have exceptional impact absorption capacity due to their high ductility. Dual phase steels of lower strength can be used in the automotive industry for manufacturing closing panels, aiming higher indentation resistance.

| Standard | Grade | Coating | Thickness Range (mm) | Chemical Composition (% p/p) | | | | | | Mechanical Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Mn | Al | P | S | Others | Tensile Test Direction | LE (MPa) | LR (MPa) | Elongation | | |
| | | | | | | | | | | | | | Thickness (mm) | BM (mm) | % min. |
| Usiminas (USI) | USIGAL-GI-DP590 | GI | 0.80 ~ 2.30 | 0.23 max. | 3.30 max. | 0.010 min. | 0.090 max. | 0.015 max. | Si: 0.20 max.<br>B: 0.006 max.<br>Cu: 0.200 max. | Transversal | 340 ~ 440 | 590 ~ 780 | - | 50 | 20 |
| | USIGAL-GA-DP590 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-DP780 | GI | | | | | | | | | 380 ~ 580 | 780 ~ 900 | | | |
| | USIGAL-GA-DP780 | GA | | | | | | | | | | | | | |
| | USIGAL-GI-DP980 (1) | GI | 1.00 ~ 2.30 | | | | | | | | 550 ~ 780 | 980 ~ 1130 | - | | 10 |
| | USIGAL-GA-DP980 (1) | GA | | | | | | | | | | | | | |

(1) Fornecimento sob consulta

# COMPLEMENTARY INFORMATION **ON SALE ORDER**

## SURFACE QUALITY

The surface quality of HDG products are defined by NBR 7008. In general, the following applications can be exemplified:

**SURFACE 1:** adequate for applications in exposed parts that have high surface aspect requirements.

**SURFACE 2:** adequate for less demanding applications as surface 1, also for exposed parts

**SURFACE 3:** normally indicated for applications with lower requirement of the steel, such as in non-exposed parts and general applications, depending on the application requirement of the product.

## TYPE OF OILING

HDG steels are supplied oiled with conventional temporary protection oil, or with temporary pre-lubricant protective oil, which helps in the process of formation/stamping. According to the customer's application/need, different amounts of oil can be applied.

## EDGE FINISHING

Products can be supplied with or without sheared edges.

## PACKING

The type of packing for HDG products shall be defined according to the customers' needs.

## DIMENSIONAL TOLERANCES

Usiminas can offer HDG products with dimensional tolerance under NBR7013, international standards, or according to customer's specific requests. Consult the sales team for further information.

## COIL INTERNAL DIAMETER

The coils can be supplied with an internal diameter of 610 mm or 508 mm, on request.

# USEFUL INFORMATION **ON** USAGE

## AGING

Long storage time associated with elevated temperatures can alter the mechanical properties of certain products.

## STORAGE AND SHIPPING

- Storage of coils or plate bundles should be made in proper locations, with the use of cradles or pallets in good condition, thus avoiding indenting that damage the coils and plates.
- Contact with water, especially sea water, during storage or transportation, can cause white and/or red rust in hot-dip galvanized products. Thus, one should always avoid handling of these products in the rain, and under conditions that may cause condensation. Preferably, the storage location should have low relative humidity (less than 60% is recommended), with good air circulation.
- If contact with water occurs, the products should immediately be dried and used.
- Damaged packing should be immediately repaired.

## HANDLING DURING DRAWING OPERATIONS

- The plates should be carefully handled in such a way as to avoid occurrence of surface damage that impedes their application.
- The use of proper gloves is recommended when handling the plates.

**USIMINAS**

**PLEASE CONTACT US**

## SALES OFFICE


**Belo Horizonte – MG**
3011 Professor José Vieira de Mendonça Street
Engenho Nogueira - Zip Code 31310-260
Phone: (31) 3499-8232 / (31) 3499-8500

**São Paulo - SP**
277 Do Café Avenue, tower A and 9º floor
Ed. Centro Empresarial do Aço
Vila Guarani - Zip Code 04311-900
Phone: (11) 5591-5200

**Porto Alegre - RS**
2350 Dos Estados Avenue
Humaitá - Zip Code 90200-001
Phone: (51) 2125-5801

**Cabo de Santo Agostinho - PE**
Tronco Distribuidor Rodoviário Norte Avenue, ZI3
Complexo Industrial Suape - Zip Code 54590-000
Phone: (81) 3527-5400

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