



PLATES



Plates

BHILAI STEEL PLANT

Rationalised sizes of Plates from Plate Mill

| Thickness (mm) \ Width (mm) | Length (mm) | | | | | | | | |
|-----------------------------|---------------------------------------|--|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---|------|------|
| | 1600 | 1800 | 2000 | 2200 | 2500 | 2600 | 2800 | 3000 | 3200 |
| 8 | | | | | | 7000 9000 9300 | | | |
| 10 | | | | | 6300 9300 12500 | 6300 7000 9000 9300 12500 | | | |
| 12 | | | | | 6300 8000 9000 12500 | 6300 8000 9000 12500 | 6300 7000 9000 9300 12500 | | |
| 14 | | | | 9300 | 6300 7000 9000 9300 12500 | 6300 7000 9000 9300 12500 | 5600 6300 7100 8000 9000 12500 | | |
| 16 | | | 7000 9300 | 6300 7000 9000 9300 12500 | 6300 8000 9000 12500 | 6300 8000 9000 12500 | 5600 7100 8000 10000 | | |
| 18 | | 5600 7100 9300 12500 9300 12500 | 6300 7000 8000 9000 12500 | 6300 8000 9000 12500 | 5600 7100 8000 10000 | 5600 6300 7100 9300 10000 | 6300 9000 9300 10000 | | |
| 20 | 7000 9300 | 6300 7000 8000 9000 9300 12500 | 5600 6300 8000 9000 12500 | 5600 7100 8000 10000 | 6300 7100 9000 9300 10000 | 6300 9000 9300 10000 | 5600 6300 8000 9000 9300 | | |
| 22 | 6300 7000 9000 9300 12500 | 6300 8000 9000 12500 | 7100 8000 10000 | 6300 7100 9300 10000 | 5600 6300 8000 9000 9300 | 5600 6300 8000 9000 9300 | 5600 7100 8000 | | |

| Thickness (mm) \ Width (mm) | Length (mm) | | | | | | | | |
|-----------------------------|-------------|------|------|------|------|------|------|------|------|
| | 1600 | 1800 | 2000 | 2200 | 2500 | 2600 | 2800 | 3000 | 3200 |
| 75 | 7100 | 6300 | 5600 | 5000 | 4500 | 4500 | 4500 | 4500 | |
| | 8000 | 7100 | 6300 | 5600 | 5000 | 5000 | | | |
| 80 | 6300 | 5600 | 5000 | 4500 | 4500 | | | | |
| | 7100 | 6300 | 5600 | 5000 | 5000 | | | | |
| | 8000 | 7100 | 6300 | 5600 | | | | | |
| 90 | 5600 | 5000 | 5000 | 5000 | | | | | |
| | 6300 | 5600 | 5600 | | | | | | |
| | | 6300 | | | | | | | |
| 100 | 5000 | 5000 | 5000 | | | | | | |
| | 5600 | 5600 | | | | | | | |
| | 6300 | | | | | | | | |
| 110 | 5000 | 5000 | | | | | | | |
| | 5600 | | | | | | | | |
| 120 | 4500 | | | | | | | | |
| | 5000 | | | | | | | | |

Note :

- 1) Plates above 40 mm will be flame cut.
- 2) Plates up to 13.5 metre length can also be rolled from slabs of new slab caster.

ROURKELA STEEL PLANT

Rationalised sizes of Plates from Plate Mill (From old Mill)

| Thickness (mm) | Width (mm) | | Length (mm) | |
|-------------------------------|---|---|---|--|
| | 1600 | 2000 | 2500 | |
| 8 | – | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000 | |
| 10 | – | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | |
| 12, 14, 16, 18, 20, 22, 25 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | |
| 28, 32 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000 | |
| 36, 40 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11000, 12000 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000 | 4500, 5000, 5600, 6300, 7100, 8000 | |
| 45 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, | 4500, 5000, 5600, 6300, 7100, 8000 | 4500, 5000, 5600, 6300 | |
| 50 | 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000 | 4500, 5000, 5600, 6300 | 4500, 5000, 5600, 6300 | |
| 56 | 4500, 5000, 5600, 6300, 7100, 8000 | 4500, 5000, 5600, 6300 | 4500, 5000, 5600 | |
| 63 | 4500, 5000, 5600, 6300, 7100, 8000 | 4500, 5000, 5600 | 4500 | |

Note :

1. For 8 mm order acceptable is with mutual agreement.
2. For normalised plates minimum length to be 6300 mm.
3. Plates can be supplied with ultrasonic testing (offline) up to maximum 50 mm thickness.
4. Plates in other sizes can be supplied as per mutual agreement.

Supply Condition

Plates are supplied in bare packaging condition. Plates are normalised as per the requirements of specification. Thickness wise supply conditions are mentioned here :

| Thickness (mm) | Supply Condition |
|----------------|--------------------|
| 8 -20 mm | Sheared condition |
| >20-63 mm | With gas cut edges |

ROURKELA STEEL PLANT

Rationalised sizes of Plates from Hot Strip Mill

| Thickness (mm) | Width (mm) | Length (mm) |
|----------------|------------|-------------------------|
| 5, 6, 8, 10 | 1250 | 5000, 6300, 8000, 10000 |

Sizes of Chequered Plates of RSP

| | | |
|-------------------|------|-------------------------|
| 4, 5, 6, 7, 8, 10 | 1250 | 5000, 6300, 8000, 10000 |
|-------------------|------|-------------------------|

Note :

1. Plates are supplied in Mill Edge conditions (Width +20 to +50 mm)
2. Chequered plates are supplied with tear drop pattern

BOKARO STEEL PLANT

Rationalised sizes of HR Plates

| Thickness (mm) | Width (mm) | Length (mm) |
|----------------|--|-----------------------------|
| 5 | 1000, 1100, 1250, 1400, 1500, 1600, 1700, 1800 | 4500, 5000 5600, 6300, 8000 |
| 6 | 1000, 1100, 1250, 1400, 1500, 1600, 1700, 1800 | 4500, 5000 5600, 6300, 8000 |
| 7 | 1000, 1100, 1250, 1400, 1500, 1600, 1700, 1800 | 4500, 5000 5600, 6300, 8000 |
| 8 | 1000, 1100, 1250, 1400, 1500, 1600, 1700, 1800 | 4500, 5000 5600, 6300, 8000 |
| 10 | 1000, 1100, 1250, 1400, 1500, 1600, 1700, 1800 | 4500, 5000 5600, 6300, 8000 |
| 12 | 1250, 1400, 1500 | 5000, 6300 |

Applications

| Specification | Application |
|--|---|
| IS: 2062/2011 ASTM-A-36 | General structurals |
| IS: 5986/2011 | Flanging and forming operations |
| SAILCOR (IRS M-41) HCRS (Cu+P), ASTM-A-588M, IS: 2062 with Copper | Atmospheric corrosion resistance |
| SAIL Boiler IS: 2002/2009, ASTM-A-285 (Grade C), ASTM-A-515, ASTM-A-516, ASTM-A-537 (Class 1), ASTM-A-204 (Grade B), DIN 17155 (Grade H1), EN 10028, BS 1501 | Boilers and pressure vessels |
| ASTM-A-517 (Grade F) | Penstock |
| SAILHARD | Abrasion Resistant |
| SAILMA 300, 350, 410, 450, 550, 550 HI, 600, as per IS: 2062/2011, IS: 5986/2011, IS: 2062/2011: E300, E350, E410, E450 | High Tensile |
| SAIL Marine IS: 3039, Lloyds Grade A, B, ABS Grade A, NCD 1431, LR Grade E&D, ABS Grade AH/DH/EH-32, 36, NV Grade AB&D | Ship Building |
| API 5L, Grade A, B, X42, X46, X52, X56, X60, X65 | Oil and gas pipeline manufacturing |
| Chequered Plates conforming to IS: 3502/2009* | Industrial Flooring |
| Dead Soft Quality | Galvanising Pots and special engineering application |
| HSFQ 250/350 (Thickness < 8 mm) | Auto Components & Pre Engineered Building (PEB) Sections (For forming at ambient temperature) |
| SAIL FORMING 250/350 Thickness: 8 - 14 mm | Auto Components (For forming at high temperature - Hot Forming) |
| SAIL Form 34/38/46 SAIL Super Form 45 (SAPH 440) | Fabrication of long & cross members in auto sector |
| SAIL HITEN 690 AR | ATM Safe, Earth Moving Equipment |
| SAIL SPP 400/700 (Hardox 400/Weldox 700) SAIL-FRS | Earth Moving Equipment Fire Resistant Plates |

* Base material as per IS: 2062/2011

Plates manufactured by different steel plants as per following specifications

Bhilai Steel Plant

Mild

IS: 2062 E 250 Quality A
IS: 2062 E 250 Quality BR/B0
IS: 2062 E 250 Quality C
IS: 5986 (2011), various grades
ASTM A/SA 36
ASTM A/SA 238 Gr. A, B, C, D
ASTM A/SA 573 Gr. 58, 65
EN 10025 S 235 JR+AR, 275 JR+AR
EN 10025 S 235 JR+N, 275 JR+N
EN 10025 S 235 JO+N, 275 JO+N
EN 10025 S 235 J2+N, 275 J2+N
BS 4360 Gr. 43A, B
BS 4360 Gr. 43C
BS 4360 Gr. 43D
JIS G 3101 SS 400, 490
IRS/LRS/ABS/GL/DNV Gr. A
LRS/ABS/GL/DNV Gr. B
LRS/ABS/GL/DNV Gr. D
Dead Soft Quality
NES 791 PART 1

API

API 5L Gr. A, B
API 5L X 42, 46, 52, 56
APL 5L X 60, 65, 70

High Tensile

IS: 2062 E 300
IS: 2062 E 350
IS: 2062 E 410
IS: 2062 E 450
IS: 5986 (2011) higher grades
SAIL MA 300
SAIL A 300 HI, 350 HI
SAIL A 410
SAIL MA 410 HI
SAIL MA 450
SAIL MA 450 HI
ASTM A/SA 572, Gr. 42, 50, 55
ASTM A/SA 573, Gr. 70
BS 4360, Gr. 50B

EN 10025 S355 JR+N
EN 10025 S355 JO+N
EN 10025 S355 J2+N
GOST 09G25, 10G2S1-Cat 1
GOST 09G25, 10G2S1-Cat 2
GOST 09G25, 10G2S1-Cat 3
GOST 521, Gr. 10 KhsND
JIS G 3106 SM 490A
JIS G 3106 SM 490B
ABS AH32, AH36, DH32, DH36
ABS AH36, EH36
NCD 1431

Boiler Quality

IS: 2002 Gr. 1
IS: 2002 Gr. 1 (For fire box)
IS: 2002 Gr. 2
IS: 2002 Gr. 3
ASTM A/SA 515 Gr. 60, 65, 70
ASTM A/SA 516 Gr. 55, 60, 65, 70
ASTM A/SA 285 Gr. A, B, C
BS 1501/1/224 Gr. 400A, 430A
DIN 17155H1
EN 10028-2 P235GH, 265GH
EN 10028-3 P275N, P355NL1
ASTM A/SA 537 C1 1
BS 1501-1-224 Gr. 460A, 490A
EN 10028-3 P355 N, P355 NL1

Special Steel

SAIL HARD
SAIL HITEN AR 690
HOT SAW DISC
IRS M 41
ASTM A/SA 588 Gr. A
ASTM A/SA 204, Gr. A, B, C
DIN 17155 Gr. 15 Mo3
DMR 249 Gr. A
SAIL MA 550
SAIL MA 550 HI
SAIL MA 600
SAIL MA 600 HI
SAIL -FRS

Rourkela Steel Plant

IS: 2062/2011
ASTM-A-36
SAILMA
300HI/350HI/410HI/
450HI
Lloyds Grades A, B, D
IS: 2002/2009
ASTM-A-285 M
Grade C
Dead Soft Quality
LO-Pearl
IS: 5986/2011
IS: 3502/2009
ASTM-A-517 Gr. F
IS: 3039/1988
SAPH 440
ASTM-A-537 Cl I
ASTM-A-515/ 516
Grades- 60/65/70
BSK-46
API 5L grade
A, B, X 42,
X46, X52, X56
X60, X65
SAIL SPP 400/700

Bokaro Steel Plant

IS: 2062/2011
SAILMA 300HI/350HI
E38/ E34
SAILCOR/ HCRS
IRSM-41
BSK-46/E-46
SAPH-45
IS: 2002/2009
IRS Gr. A
E-550, E-500, E-450
ASTM A 36
JIS 3101 SS 400
IS: 5986/2011
IS: 6240/2008

Rolling and cutting tolerance for plates (as per IS 1852/2003)

Width

The tolerances on width of plate shall be as follows

| Length (mm) | Width (mm) | Thickness (mm) | Tolerance on Width |
|--------------------------|--------------------------|------------------------|-----------------------|
| Up to and including 8000 | Up to and including 2000 | Up to and including 20 | - 0, + 10 mm |
| | | Over 20 | -0, + 15 mm |
| Up to and including 8000 | Over 2000 | Up to and including 20 | - 0, + 0.5% of width |
| | | Over 20 | -0, + 20 mm |
| Over 8000 | All widths | Up to and including 20 | - 0, + 0.2% of length |
| | | Over 20 | -0, + 0.3% of length |

Note 1 : Plates over 20 mm in thickness may be supplied with either as rolled or gas-cut edges. In case of Bhilai plates, above 40 mm thick plates shall be supplied with flame cut edges. The tolerances on width in such cases shall be subject to arrangement between the purchaser and the supplier.

Note 2 : In case plates below 20 mm in thickness are supplied in as-rolled condition the tolerances shall be mutually agreed to between the purchaser and the supplier.

Note 3 : Plates from BSP is supplied in trimmed condition. For untrimmed plates, width tolerance will be (+) 100 mm, (-) 0 mm.

Thickness

The tolerances on thickness shall be as follows :

| Thickness | Tolerance in percentage of nominal Thickness |
|-----------------------------------|--|
| Less than 8 mm | + 12.5, - 5.0 |
| From 8 mm up to & including 12 mm | + 7.5, - 5.0 |
| Over 12 mm | ± 5.0 |

The thickness shall be measured at the following points

- One at each corner of the plate.
- One in the middle of the width, and
- One in the middle of the length.

These measurements shall be 25 mm away from the edge and at points randomly chosen. The thickness measured at each of these points shall satisfy the tolerances specified above.

Length (mm)

| Length (mm) | | Thickness (mm) | Tolerance on length |
|-------------|---------------------|-----------------------------------|------------------------------|
| Over | Up to and including | | |
| — | 2200 | Up to and including 20 Over 20 | - 0, + 10 mm - 0, + 15 mm |
| 2200 | 3000 | Up to and including 20 Over 20 | - 0, + 0.5% - 0, + 15 mm |
| 3000 | 6300 | Up to and including 20 Over 20 | - 0, + 0.5 % - 0, + 0.5 % |
| 6300 | 8000 | Up to and including 20 Over 20 | - 0, + 35 mm - 0, + 0.5 % |
| 8000 | — | Up to and including 20 Over 20 | - 0, + 35 mm - 0, + 40 mm |

The tolerance for length of plates from 5 to 10 mm thickness when produced in continuous mill shall be as follows

| Length (mm) | Tolerance |
|--------------------------|---|
| Up to and including 2500 | + 25 mm, - 0 mm |
| Over 2500 | + 1 percent of the length subject to a maximum of 70 mm, - 0 mm |

Note : Plates over 20 mm in thickness may be supplied with either as-rolled or gas-cut edges. In case of Bhilai plates, above 40 mm thick plates shall be supplied with flame cut edges. The length tolerance in such cases shall be subject to agreement between the purchaser and the supplier.

Chemical Composition IS: 2062/2011

| Grade | Quality | Ladle Analysis, wt % Max | | | | | Carbon Equivalent, Max | Mode of Deoxidation |
|-------|-----------|--------------------------|------|-------|-------|------|------------------------|---------------------|
| | | C | Mn | S | P | Si | | |
| E 250 | A | 0.23 | 1.50 | 0.045 | 0.045 | 0.40 | 0.42 | Semi Killed/Killed |
| | BR, B0 | 0.22 | 1.50 | 0.045 | 0.045 | 0.40 | 0.41 | Semi Killed/Killed |
| | C | 0.20 | 1.50 | 0.040 | 0.040 | 0.40 | 0.39 | Killed |
| E 275 | A | 0.23 | 1.50 | 0.045 | 0.045 | 0.40 | 0.43 | Semi Killed/Killed |
| | BR, B0 | 0.22 | 1.50 | 0.045 | 0.045 | 0.40 | 0.42 | Semi Killed/Killed |
| | C | 0.20 | 1.50 | 0.040 | 0.040 | 0.40 | 0.41 | Killed |
| E 300 | A, BR, B0 | 0.20 | 1.50 | 0.045 | 0.045 | 0.45 | 0.44 | Semi Killed/Killed |
| | C | 0.20 | 1.50 | 0.040 | 0.040 | 0.45 | 0.44 | Killed |
| E 350 | A, BR, B0 | 0.20 | 1.55 | 0.045 | 0.045 | 0.45 | 0.47 | Semi Killed/Killed |
| | C | 0.20 | 1.55 | 0.040 | 0.040 | 0.45 | 0.45 | Killed |
| E 410 | A, BR, B0 | 0.20 | 1.60 | 0.045 | 0.045 | 0.45 | 0.50 | Semi Killed/Killed |
| | C | 0.20 | 1.60 | 0.040 | 0.040 | 0.45 | 0.50 | Killed |
| E 450 | A, BR | 0.22 | 1.65 | 0.045 | 0.045 | 0.45 | 0.52 | Semi Killed/Killed |
| E 550 | A, BR | 0.22 | 1.65 | 0.020 | 0.025 | 0.50 | 0.54 | Semi Killed/Killed |
| E 600 | A, BR | 0.22 | 1.70 | 0.020 | 0.025 | 0.50 | 0.54 | Semi Killed/Killed |

Notes:

1. New grade designation system based on minimum yield stress has been adopted.
2. For semi-killed steel, silicon shall be less than 0.10 percent. For killed steel, when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 percent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 percent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.
3. Steels of qualities A, BR, B0 and C are generally suitable for welding processes. The weldability increases from quality A to C for grade designation E 250 and E 275.
4. Carbon equivalent (CE) would be calculated based on ladle analysis, only

$$CE = C + \frac{Mn}{6} + \frac{(C + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$$
5. Micro-alloying elements like Nb, V and Ti may be added singly or in combination. Total micro-alloying elements shall not be more than 0.25 percent.

Chemical Composition IS: 2062/2011

6. Alloying elements such as Cr, Ni, Mo and B may be added under agreement between the purchaser and the manufacturer. In case of E 600 and E 650 the limit of Cr and Ni either singly or in combination, shall not exceed 0.50 percent and 0.60 percent respectively.
7. Copper may be present between 0.20 to 0.35 percent as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example E 250 Cu. In case of product analysis the copper content shall be between 0.17 and 0.38 percent.
8. Incidental element - Elements not quoted in Table 1 shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacturer of such elements which affect the hardenability, mechanical properties and applicability.
9. Nitrogen content of steel shall not exceed 0.012 percent which shall be ensured by the manufacturer by occasional check analysis.
10. The steel, if required, may be treated with calcium based compound or rare earth element for better formability.
11. Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.

Mechanical Properties : 2062/2011

| Grade Designation | Quality | Tensile Strength R _m Min MPa | Yield Stress Min MPa | | | Percentage Elongation A, at Gauge Length, L=5.65 √S ₀ Min | Internal Bend Diameter Min | | Charpy Impact Test | |
|-------------------|---------|---|-------------------------|-------|-----|---|----------------------------------|-----|--------------------------|-----------|
| | | | <20 | 20-40 | >40 | | ≤ 25 | >25 | Temp °C | J, Min |
| E-250 | A | 410 | 250 | 240 | 230 | 23 | 2t | 3t | - | - |
| | BR | | | | | | | | RT | 27 |
| | B0 | | | | | | | | 0 | 27 |
| | C | | | | | | | | (-) 20 | 27 |
| E-275 | A | 430 | 275 | 265 | 255 | 22 | 2t | 3t | - | - |
| | BR | | | | | | | | RT | 27 |
| | B0 | | | | | | | | 0 | 27 |
| | C | | | | | | | | (-) 20 | 27 |
| E-300 | A | 440 | 300 | 290 | 280 | 22 | 2t | - | - | - |
| | BR | | | | | | | | RT | 27 |
| | B0 | | | | | | | | 0 | 27 |
| | C | | | | | | | | (-) 20 | 27 |
| E-350 | A | 490 | 350 | 330 | 320 | 22 | 2t | - | - | - |
| | BR | | | | | | | | RT | 27 |
| | B0 | | | | | | | | 0 | 27 |
| | C | | | | | | | | (-) 20 | 27 |
| E-410 | A | 540 | 410 | 390 | 380 | 20 | 2t | - | - | - |
| | BR | | | | | | | | RT | 25 |
| | B0 | | | | | | | | 0 | 25 |
| | C | | | | | | | | (-) 20 | 25 |
| E-450 | A | 570 | 450 | 430 | 420 | 20 | 2.5t | - | - | - |
| | BR | | | | | | | | RT | 20 |
| E-550 | A | 650 | 550 | 530 | 520 | 12 | 3.0t | - | - | - |
| | BR | | | | | | | | RT | 15 |
| E-600 | A | 730 | 600 | 580 | 570 | 12 | 3.5t | - | - | - |
| | BR | | | | | | | | RT | 15 |

- In case of product thickness/diameter more than 100 mm, lower minimum limit of tensile strength may be mutually agreed to between the purchaser and the manufacturer/supplier

Chemical Composition : SAILMA Grades

| Grade | C max. | Mn max. | S max. | P max. | Al min. | Si max. | CE max. | MAE (Nb+V+Ti) max. |
|---------------|--------|---------|--------|--------|---------|---------|---------|--------------------|
| SAILMA 300 | 0.20 | 1.50 | 0.045 | 0.045 | 0.02 | 0.45 | 0.44 | 0.25 |
| SAILMA 300 HI | 0.20 | 1.50 | 0.040 | 0.040 | 0.02 | 0.45 | 0.43 | 0.25 |
| SAILMA 350 | 0.20 | 1.55 | 0.045 | 0.045 | 0.02 | 0.45 | 0.46 | 0.25 |
| SAILMA 350 HI | 0.20 | 1.55 | 0.040 | 0.040 | 0.02 | 0.45 | 0.45 | 0.25 |
| SAILMA 410 | 0.20 | 1.60 | 0.045 | 0.045 | 0.02 | 0.45 | 0.48 | 0.25 |
| SAILMA 410 HI | 0.20 | 1.60 | 0.040 | 0.040 | 0.02 | 0.45 | 0.48 | 0.25 |
| SAILMA 450 | 0.20 | 1.65 | 0.045 | 0.045 | 0.02 | 0.45 | 0.50 | 0.25 |
| SAILMA 450 HI | 0.20 | 1.65 | 0.040 | 0.040 | 0.02 | 0.45 | 0.50 | 0.25 |
| SAILMA 550 | 0.20 | 1.65 | 0.020 | 0.025 | 0.02 | 0.50 | 0.54 | 0.25 |
| SAILMA 550 HI | 0.20 | 1.65 | 0.015 | 0.025 | 0.02 | 0.50 | 0.54 | 0.25 |
| SAILMA 600 | 0.22 | 1.70 | 0.015 | 0.025 | 0.02 | 0.50 | 0.54 | 0.25 |

For Hot Rolled coils, S is maintained below 0.030%

Mechanical Properties : SAILMA Grades

| Grade | YS, MPa min | | | UTS Mpa, min | % El min Std GL | Internal Bend Diameter, min | | Charpy Impact Test | |
|---------------|-------------|----------|--------|--------------|-----------------|-----------------------------|--------|---------------------|----------|
| | <25 mm | 25-40 mm | >40 mm | | | ≤25mm | >25 mm | Temp ^o C | J, min |
| SAILMA 300 | 300 | 290 | 280 | 440 | 24 | 2t | - | - | - |
| SAILMA 300 HI | 300 | 290 | 280 | 440 | 24 | 2t | - | 0 | 40 |
| SAILMA 350 | 350 | 330 | 320 | 490 | 24 | 2t | - | - | - |
| SAILMA 350 HI | 350 | 330 | 320 | 490 | 24 | 2t | - | 0 -20 | 40 30 |
| SAILMA 410 | 410 | 390 | 380 | 540 | 22 | 2t | - | - | - |
| SAILMA 410 HI | 410 | 390 | 380 | 540 | 22 | 2t | - | 0 -20 | 35 25 |
| SAILMA 450 | 450 | 430 | 420 | 570 | 22 | 2.5t | - | - | - |
| SAILMA 450 HI | 450 | 430 | 420 | 570 | 22 | 2.5t | - | 0 -20 | 30 20 |
| SAILMA 550 | 550 | 530 | 520 | 650 | 14 | 3t | - | - | - |
| SAILMA 450 HI | 550 | 530 | 520 | 650 | 14 | 3t | - | 0 -20 | 25 15 |
| SAILMA 600 | 600 | 580 | 570 | 730 | 14 | 3.5t | - | - | - |

Impact will be given for any one temperature. For 450 HI & above impact is for > 10 mm. For < 12 mm impact to be given only if specified.

Chemical Composition : IS 5986/2011

| Grade | Constituents, Percent, Max | | | | |
|-------|----------------------------|-----------|------------|---------|--------------------|
| | Carbon | Manganese | Phosphorus | Sulphur | Carbon Equivalents |
| 165 | 0.12 | 0.60 | 0.040 | 0.040 | – |
| 205 | 0.15 | 0.80 | 0.040 | 0.040 | – |
| 235 | 0.17 | 1.00 | 0.040 | 0.040 | – |
| 255 | 0.20 | 1.30 | 0.040 | 0.040 | 0.42 |
| 325 | 0.20 | 1.30 | 0.040 | 0.040 | 0.42 |
| 355 | 0.20 | 1.50 | 0.035 | 0.035 | 0.45 |
| 420 | 0.20 | 1.50 | 0.035 | 0.035 | 0.45 |
| 490 | 0.20 | 1.50 | 0.035 | 0.030 | 0.45 |
| 560 | 0.20 | 1.50 | 0.035 | 0.030 | 0.45 |

Notes:

1. The nitrogen content of the steel shall not be more than 0.009 percent. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012 percent. This shall be ensured by occasional checking.
2. When the steel is killed by aluminium the total aluminium content should not be less than 0.02 percent. When steel is silicon killed the silicon content shall not be less than 0.1 percent. When the steel is aluminium silicon killed the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.
3. The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20 and 0.35 percent on analysis.
4. The steel can be made with micro-alloying element like Nb, V, Ti and B either individually or in combination on mutual agreement. In which case the total micro-alloying elements should not exceed 0.2 percent in ladle analysis. However, in case of boron, the limit shall be 0.001 percent.
5. As the form of sulphide inclusions may have certain influence on the cold forming properties, steel may be treated with elements like Ce or Ca, if agreed to between the manufacturer and purchaser.

$$\text{Carbon equivalent (CE) based on ladle analysis} = C + \frac{\text{Mn}}{6} + \frac{(\text{Cr} + \text{Mo} + \text{V})}{5} + \frac{(\text{Ni} + \text{Cu})}{15}$$

Mechanical Properties: IS 5986/2011

| Specification | Grade | Yield Strength MPa, Min | Ultimate Tensile Strength, MPa, Min | Elongation% min GL5.65 $\sqrt{S_0}$ | Internal Diameter of bend | |
|---------------|-------|----------------------------|--|--|------------------------------|-----------|
| | | | | | ≤ 12 mm | > 12 mm |
| | | | | > 3 mm | | |
| IS:5986:2011 | 165 | 165 | 290-400 | 30 | Close | t |
| | 205 | 205 | 330-440 | 28 | t | 2t |
| | 235 | 235 | 360-470 | 26 | t | 2t |
| | 255 | 255 | 410-520 | 24 | t | 2t |
| | 325 | 325 | 420-530 | 19 | 2t | 3t |
| | 355 | 355 | 420-530 | 18 | 2t | 3t |
| | 420 | 420 | 480-590 | 15 | 2t | 3t |
| | 490 | 490 | 540-650 | 12 | 2t | 3t |
| | 560 | 560 | 610-720 | 10 | 2t | 3t |

Grade 165 may be supplied based on chemical composition only, if agreed to

Chemical Composition : SAILCOR

| Specification | Grade | C % max | Mn % max | P % max | S % max | Si % max |
|---|----------|---------|-----------|------------|---------|-----------|
| IRSM 41 | SAIL COR | 0.10 | 0.25-0.45 | 0.75-0.140 | 0.030 | 0.28-0.72 |
| Cr 0.35-0.60, Ni 0.20-0.47, Cu 0.30-0.60, Al 0.08 max | | | | | | |

Mechanical Properties : SAILCOR

| Specification | Grade | Yield Strength MPa min | Ultimate Tensile Strength MPa min | Elongation% Std GL | Internal Diameter of bend |
|---------------|-------|------------------------------|---|-----------------------|------------------------------|
| SAILCOR | HR | 340 | 480 | 22 | t |

Chemical Composition

| Grade | C % max | Mn % max | P % max | S % max | Others% | |
|----------|---------|----------|---------|---------|----------------|-----------------------|
| SAIL-FRS | 0.20 | 1.5 | 0.040 | 0.040 | Cr+Mo =1.00 | Nb+V+Ti = 0.12 max |

Note: Micro alloying elements like Nb, V, Ti or B shall be added singly or in combination and total micro alloying shall be as indicated or as per mutual agreement between SAIL & Purchaser.

IS: 2041-2009 - Chemical Composition (wt %)

(Steel Plates for pressure vessels used at moderate and low temperature)

| Grade | C max | Si | Mn | P max | S max | Al (total) min | N max | Nb max | V max | Ti max | Nb+V+Ti min | Cr max | Cu max | Mo max | Ni max |
|-------|-------|-----------|-----------|-------|-------|-------------------|-------|--------|-------|--------|----------------|--------|--------|--------|--------|
| R 220 | 0.21 | 0.15-0.35 | 0.60-1.50 | 0.035 | 0.035 | 0.020 | 0.012 | — | — | — | — | — | — | — | — |
| R 260 | 0.25 | 0.15-0.35 | 0.85-1.50 | 0.035 | 0.035 | 0.020 | 0.012 | — | — | — | — | — | — | — | — |
| R 275 | 0.16 | 0.40 max | 0.80-1.50 | 0.025 | 0.015 | 0.020 | 0.012 | 0.05 | 0.05 | 0.03 | 0.05 | 0.30 | 0.30 | 0.08 | 0.50 |
| R 355 | 0.18 | 0.50 max | 1.10-1.70 | 0.025 | 0.015 | 0.020 | 0.012 | 0.05 | 0.10 | 0.03 | 0.12 | 0.30 | 0.30 | 0.08 | 0.50 |
| H 235 | 0.16 | 0.35 max | 0.60-1.20 | 0.025 | 0.015 | 0.020 | 0.012 | 0.02 | 0.02 | 0.03 | 0.06 | 0.30 | 0.30 | 0.08 | 0.30 |
| H 265 | 0.2 | 0.40 max | 0.80-1.40 | 0.025 | 0.015 | 0.020 | 0.012 | 0.02 | 0.02 | 0.03 | 0.06 | 0.30 | 0.30 | 0.08 | 0.30 |
| H 295 | 0.2 | 0.40 max | 0.90-1.50 | 0.025 | 0.015 | 0.020 | 0.012 | 0.02 | 0.02 | 0.03 | 0.06 | 0.30 | 0.30 | 0.08 | 0.30 |
| H 355 | 0.22 | 0.60 max | 1.10-1.70 | 0.025 | 0.015 | 0.020 | 0.012 | 0.02 | 0.02 | 0.03 | 0.06 | 0.30 | 0.30 | 0.08 | 0.30 |

NOTES :

- For Grades R220, R 260, R275, R355 Carbon content over the maximum specified shall be increased by 0.03 percent for plates over 12 mm thickness.
- Microalloying elements Nb and V may be added to Grades R220 & R260, subject to mutual agreement between purchaser and manufacturer/supplier.
- For product thicknesses ≤ 6 mm, a minimum Mn of 0.6 percent is permitted.
- The minimum Al (total) content may not be applicable, if Nb, Ti or V either singly or in combination are additionally used for Nitrogen binding.
- If only Al is used for nitrogen binding, a ratio $Al/N > = 2$ shall apply.
- $Cr + Cu + Mo$ shall not exceed 0.45 percent.
- Elements not listed in the table shall not be intentionally added to the steel without agreement of the purchaser.
- Closer limits of composition may be agreed to between the supplier and the purchaser.
- Whenever micro alloying elements are added for achieving the strength, maximum carbon equivalent shall not exceed 0.50 for steels used for welding.
- Carbon equivalent (CE) based on ladle analysis = $C + Mn/6 + \sqrt{Cr + Mo + V}/5 + (Ni + Cu)/15$.

IS: 2041- 2009 Mechanical Properties

(Steel Plates for pressure vessels used at moderate and low temperature)

| Grade | Yield Stress MPa, min | | | | Tensile Strength MPa | Elongation % on Gauge Length 5.65 $\sqrt{S_0}$, min | Impact Energy (J) min at a temperature in °C | | | 0.2% proof stress at 300° C MPa, min | |
|-------|-----------------------|---------------|---------------|----------------|----------------------|--|--|----|-----|--------------------------------------|-----|
| | <=16 | > 16 to 40 mm | > 40 to 60 mm | > 60 to 100 mm | | | 20 | 0 | -20 | | -40 |
| R 220 | 220 | 220 | 220 | 220 | 415-540 | 21 | 50 | 40 | 27 | 20 | — |
| R 260 | 260 | 260 | 260 | 260 | 490-620 | 21 | 50 | 40 | 27 | 20 | — |
| R 275 | 275 | 265 | 255 | 235 | 390-510 | 23 | 80 | 70 | 50 | 40 | — |
| R 355 | 355 | 345 | 335 | 315 | 490-640 | 21 | 80 | 70 | 50 | 40 | — |
| H 235 | 235 | 225 | 215 | 200 | 360-480 | 24 | 40 | 34 | 27 | — | 153 |
| H 265 | 265 | 255 | 245 | 215 | 410-530 | 22 | 40 | 34 | 27 | — | 173 |
| H 295 | 295 | 290 | 285 | 260 | 460-580 | 21 | 40 | 34 | 27 | — | 192 |
| H 355 | 355 | 345 | 335 | 315 | 510-650 | 20 | 40 | 34 | 27 | — | 232 |

NOTES :

1. Impact test shall be at any one temperature as mutually agreed.
2. Impact test is optional for Grades R220 and R260.
3. The orientation of Impact test specimen shall be longitudinal to the rolling direction for R220, R260, R275, R355 grades and transverse to the rolling direction for H235, H265, H295 and H355 grades.
4. Stringent impact test temperature and values can be mutually agreed.
5. For thickness > 100 mm, Yield stress to be mutually agreed.

Chemical Composition

| Specification | Grade | C % | Mn % | P % max | S % max | Si % | CE |
|---|---|-----------|-----------|------------|------------|-----------|--|
| ASTM-A-36 | – | 0.25 max | 0.80-1.20 | 0.04 | 0.05 | 0.15-0.40 | |
| ASTM-A-588 | – | 0.19 max | 0.80-1.25 | 0.040 | 0.050 | 0.30-0.65 | |
| | Al 0.02 min, Cr 0.40-0.65, Ni 0.40 max, Cu 0.25-0.40, V 0.02-0.10 | | | | | | |
| HCRS (Cu+P) | | 0.15 max | 0.25-0.80 | 0.07-0.15 | 0.03 | 0.28-0.50 | Cu 0.2 min |
| | Al 0.03 max, Cr 0.35-0.60, Ni 0.20-0.47, V 0.05 max | | | | | | |
| IS: 2002/2009 | 1 | 0.18 max | 0.50-1.20 | 0.035 | 0.040 | 0.15-0.35 | 0.44 max Cu 0.10% max (residual) |
| | 2 | 0.20 max | 0.50-1.20 | 0.035 | 0.040 | 0.15-0.35 | 0.44 (max) Al 0.020% max |
| | 3 | 0.22 max | 0.50-1.20 | 0.035 | 0.040 | 0.15-0.35 | 0.44 max |
| ASTM-A-285 | C | 0.28 max | 0.90 | 0.035 | 0.035 | | |
| ASTM-A- 515 | 60 | 0.24-0.27 | 0.90 | 0.035 | 0.035 | 0.15-0.40 | Al 0.02% max |
| | 65 | 0.28-0.31 | 0.90 | 0.035 | 0.035 | 0.15-0.40 | |
| | 70 | 0.31-0.33 | 1.20 | 0.035 | 0.035 | 0.15-0.40 | |
| ASTM-A-516 | 55 | 0.18-0.22 | 0.60-0.90 | 0.035 | 0.035 | | |
| | 65 | 0.24-0.28 | 0.85-1.20 | 0.035 | 0.035 | | |
| | 70 | 0.27-0.30 | 0.85-1.20 | 0.035 | 0.035 | | |
| <p>– For each reduction of 0.10% of C below the specified max, an increase of 0.60% of Mn above the specified max is permitted up to 1.50%.</p> <p>– Grade 60 plates, Mn 0.85-1.20 for thickness ≤= 12.5 mm</p> <p>– Heats will be micro alloyed for orders requiring impact test</p> | | | | | | | |
| ASTM-A-537 | Cl 1 | 0.24 max | 0.7-1.60 | 0.035 | 0.035 | 0.15-0.50 | Micro alloyed with Nb/V, if required |
| | Al 0.02 min, Cr 0.25 max, Ni 0.25 max, Cu 0.35 max, Mo 0.08 max | | | | | | |
| DIN 17155 | HI | 0.16 | 0.40-1.20 | 0.035 | 0.030 | 0.35 | |
| | Al 0.02% min, Cr 0.25% max, Ni 0.30% max, Cu 0.30% max, Nb 0.01% max, V 0.03% max, Ti 0.03% max, Mo 0.10% max | | | | | | |

Mechanical Properties

| Specification | Grade | Yield Strength, MPa, min | Ultimate Tensile Strength, MPa, min | Elongation % min GL 5.65 √S ₀ | | Internal diameter of bend | | |
|---------------|-------|--------------------------|-------------------------------------|---|----------------|---------------------------|--------------------|------------------|
| ASTM-A-36 | | 250 | 400-550 | 200 mm GL -18 50 mm GL-21 | | | | |
| ASTM-A-588 | | 345 | 485 min | 200 mm GL 16 | 50 mm GL 19 | ≤ 20 1t | >20 <25 1.5t | >25 <40 2t |

| Specification | Grade | Yield Strength MPa, min | | | UTS MPa min | El% min GL 5.65 √S ₀ | Internal diameter of bend |
|---------------|-------|-------------------------|----------|----------|-------------|------------------------------------|---------------------------|
| | | <16 mm | 16-40 mm | 40-60 mm | | | |
| IS 2002/2009 | 1 | 235 | 225 | 215 | 360-480 | 24 | 2T |
| | 2 | 265 | 255 | 245 | 410-530 | 22 | 2T |
| | 3 | 290 | 285 | 280 | 460-580 | 21 | 3T |

| Specification | Grade | Yield Strength, MPa, min | Ultimate Tensile Strength, MPa, min | Elongation % min | | |
|--|---------|---------------------------------|-------------------------------------|------------------|----------|----|
| | | | | 200 mm GL | 50 mm GL | |
| ASTM-A-285 | C | 205 | 385-515 | 23 | 27 | |
| ASTM-A-515 | 60 | 220 | 415-550 | 21 | 25 | |
| | 65 | 240 | 450-585 | 19 | 23 | |
| | 70 | 260 | 485-620 | 17 | 21 | |
| ASTM-A516 | 55 | 205 | 380-515 | 23 | 27 | |
| | 60 | 220 | 415-550 | 21 | 25 | |
| | 65 | 240 | 450-585 | 19 | 23 | |
| | 70 | 260 | 485-620 | 17 | 21 | |
| Charpy Impact energy 18J for Gr 60 & 65 at – 51°C and 20J for Gr 70 at – 46°C for upto 25 mm: 18J for Gr 60 & 65 at – 46°C and 20J for Gr 70 at – 40°C for >25 <50 | | | | | | |
| ASTM-A-537 | Class I | 345 | | 485-620 | 18 | 22 |
| DIN 17155 | HI | 235 for <16mm | 225 for 16-40 mm | 360-480 | 24 | |
| | | Charpy Impact energy 31J at 0°C | | | | |

For ASTM-A-588/285/204/ 515/ 516/ 537

Bend Test is a supplementary requirement

Chemical Composition

| Specification | Grade | C % max | Mn % max | P % max | S % max | Si % max | CE |
|---------------|-------|---|-------------|------------|------------|-------------|----|
| ASTM-A-204 | B | 0.20-0.23 | 0.90 | 0.035 | 0.035 | 0.15-0.40 | |
| | | Mo 0.45 - 0.60% | | | | | |
| ASTM-A -517 | F | 0.1-0.2 | 0.6-1.0 | 0.035 | 0.035 | 0.15-0.35 | |
| | | Ni 0.7-1.0, Cr 0.4-0.65, Mo 0.4-0.6, V 0.03-0.08, Cu 0.15- 0.50, B 0.0005-0.006 | | | | | |

| Specification | Steel grade | % ^{a, g} | | | | | | |
|-----------------|-------------|-----------------------|------------------------|----------|----------|----------|-----------|-----------|
| | | C ^b max | Mn ^b max | P max | S max | V max | Nb max | Ti max |
| API 5 L PSL1 | A | 0.22 | 0.90 | 0.030 | 0.030 | — | — | — |
| | B | 0.26 | 1.20 | 0.030 | 0.030 | c,d | c,d | d |
| | X42 | 0.26 | 1.30 | 0.030 | 0.030 | d | d | d |
| | X46 | 0.26 | 1.40 | 0.030 | 0.030 | d | d | d |
| | X52 | 0.26 | 1.40 | 0.030 | 0.030 | d | d | d |
| | X56 | 0.26 | 1.40 | 0.030 | 0.030 | d | d | d |
| | X60 | 0.26 ^e | 1.40 ^e | 0.030 | 0.030 | f | f | f |
| | X65 | 0.26 ^e | 1.45 ^e | 0.030 | 0.030 | f | f | f |
| | X70 | 0.26 ^e | 1.65 ^c | 0.030 | 0.030 | f | f | f |

^a Cu ≤ 0.50%; Ni ≤ 0.50%; Cr ≤ 0.50% and Mo ≤ 0.15%

^b For each reduction of 0.01% below the specified maximum concentration for carbon, an increase of 0.05% above the specified maximum concentration for Mn is permissible, up to a maximum of 1.65% for grades ≤ B, but ≤ X52; up to a maximum of 1.75% for grades > X52, but < X70; and up to a maximum of 2.00% for grade X70

^c Unless otherwise agreed, Nb + V ≤ 0.06%

^d Nb + V + Ti ≤ 0.15%

^e Unless otherwise agreed

^f Unless otherwise agreed, Nb + V + Ti ≤ 0.15%

^g No deliberate addition of B is permitted and the residual B ≤ 0.001%

| Speci- fication | Steel grade | % maximum | | | | | | | | | Carbon equivalent ^a % maximum | |
|--------------------|----------------|-------------------|-------------------|-------------------|-------|-------|------|------|------|-------|--|-------------------|
| | | C ^b | Si | Mn ^b | P | S | V | Nb | Ti | Other | CE _{IW} | CE _{Pcm} |
| API 5 L PSL2 | | Welded Pipe | | | | | | | | | | |
| | BM | 0.22 | 0.45 | 1.20 | 0.025 | 0.015 | 0.05 | 0.05 | 0.04 | d,h | 0.43 | 0.25 |
| | X42M | 0.22 | 0.45 | 1.30 | 0.025 | 0.015 | 0.05 | 0.05 | 0.04 | d,h | 0.43 | 0.25 |
| | X46M | 0.22 | 0.45 | 1.30 | 0.025 | 0.015 | 0.05 | 0.05 | 0.04 | d,h | 0.43 | 0.25 |
| | X52M | 0.22 | 0.45 | 1.30 | 0.025 | 0.015 | c | c | c | d,h | 0.43 | 0.25 |
| | X56M | 0.22 | 0.45 | 1.30 | 0.025 | 0.015 | c | c | c | d,h | 0.43 | 0.25 |
| | X60M | 0.12 ^e | 0.45 ^e | 1.60 ^e | 0.025 | 0.015 | f | f | f | g,h | 0.43 | 0.25 |
| | X65M | 0.12 ^e | 0.45 ^e | 1.60 ^e | 0.025 | 0.015 | f | f | f | g,h | 0.43 | 0.25 |
| | X70M | 0.12 ^e | 0.45 ^e | 1.70 ^e | 0.025 | 0.015 | f | f | f | g,h | 0.43 | 0.25 |

- ^a Based upon product analysis. The CE_{IW} limits apply if C > 0.12% and the CE_{Pcm} limits apply if C ≤ 0.12%
- ^b For each reduction of 0.01% below the specified maximum for C, an increase of 0.05% above the specified maximum for Mn is permissible, up to a maximum of 1.65% for grades ≤ B, but ≤ X52; up to a maximum of 1.75% for grades < X52, but < X70; up to a maximum of 2.00% for grade X70
- ^c Nb + V + Ti ≤ 0.15%
- ^d Unless otherwise agreed, Cu ≤ 0.50%; Ni ≤ 0.30%; Cr ≤ 0.30% and Mo ≤ 0.15%
- ^e Unless otherwise agreed
- ^f Unless otherwise agreed, Nb + V + Ti ≤ 0.15%
- ^g Unless otherwise agreed, Cu ≤ 0.50%; Ni ≤ 0.50%; Cr ≤ 0.50% and Mo ≤ 0.50%
- ^h Unless otherwise agreed no intentional addition of B is permitted and residual B ≤ 0.001%

Chemical Composition

| Specification | Grade | C % max | Mn % max | P % max | S % max | Si % max | CE | |
|---------------|---|------------|---------------|------------|------------|-------------|------|-----|
| IS: 3039/1988 | I | 0.23 | * | 0.040 | 0.040 | ** | 0.42 | *** |
| | * Mn content not less than 2.5 times Carbon content if thickness > 12.5 mm. ** Si 0.10-0.35% if killed quality. *** Al min 0.01% | | | | | | | |
| | II | 0.21 | 0.70-1.4 | 0.040 | 0.040 | 0.10-0.35 | | |
| | III | 0.18 | 0.70-1.5 | 0.040 | 0.040 | 0.19-0.50 | # | |
| | # Al min 0.015% for grade III | | | | | | | |
| Lloyds Grade | A | 0.21 | 2.5xC% min | 0.035 | 0.035 | 0.50 | | |
| | B | 0.21 | 0.80min | 0.035 | 0.035 | 0.35 | | |
| | For Gr B Mn 0.60% min if impact tested. | | | | | | | |
| SAILHARD | | 0.23 | 1.6 | 0.050 | 0.050 | 0.50 | | |
| | Al 0.10 max, Cr 0.65 max, Nb+V+Ti 0.15 max | | | | | | | |
| GOST 19282 | 09G2S | 0.12 | 1.3-1.7 | 0.035 | 0.040 | 0.5-0.8 | | |
| | 10G2S1 | 0.12 | 1.3-1.65 | 0.035 | 0.040 | 0.8-1.1 | | |
| | Al 0.050 max, Cr 0.30 max, Ni 0.30 max, Cu 0.30 max, Ti 0.03 max, N 0.008 max | | | | | | | |

| Specification | Grade | C % max | Mn % max | P % max | S % max | Si % | Others |
|----------------------|----------------|------------|-------------|------------|------------|---------------|---|
| SAIL SPP 400 | Hardox 400 | 0.22 | 1.60 | 0.02 | 0.01 | 0.10- 0.70 | Cr : 1.40 max Mo : 0.60 max Ni : 0.50 max B : 40 ppm max |
| SAIL SPP 700 | Weldox 700E | 0.20 | 1.60 | 0.02 | 0.01 | 0.60 max | Cr : 0.70 Mo : 0.70 V : 0.08 |
| SAIL HITEN 690 AR | | 0.22 | 1.60 | 0.025 | 0.015 | 0.60 | Al - 0.02 max V - 0.20 max Ti - 0.02 max Nb - 0.050 max |

Mechanical Properties

| Specification | Grade | Yield Strength MPa Min | | Ultimate Tensile Strength MPa Min | Elongation % min GL $5.65 \sqrt{S_0}$ | | Internal diameter of bend | |
|-------------------|-----------------------------|---------------------------|-----------------|---|---|------------------|---------------------------------|----------------|
| | | | | | 200 mm | 50 mm | <25 mm | >25 < 40 mm |
| ASTM-A-204 M | B | 275 | | 485-620 | 17 | 21 | 1.5T | 2T |
| ASTM-A-517 | F | 690 | | 795-930 | 16 | | | |
| IS 3039/1988 | | ≤ 25 mm | > 25 < 50 mm | | | | | |
| | I | 230 | 220 | 400-490 | 22 | | | |
| | II | 235 | 235 | 400-490 | 22 | | | |
| | III | 235 | 235 | 400-490 | 22 | | | |
| Lloyds Grade | A | 235 | | 400-520 | 22 | | | |
| | B | 235 | | 400-520 | 22 | CE : 27 J at 0°C | | |
| | Impact 27J at 0°C for >25mm | | | | | | | |
| API 5L (PSL-1) | A | 210 | | 335 | % elongation $1940A^{0.2}/U^{0.9}$ (GL: 50.8 mm) for all API Grades A: Cross sectional area in mm ² U: Minimum UTS in MPa | | | |
| | B | 245 | | 415 | | | | |
| | X-42 | 290 | | 415 | | | | |
| | X-46 | 320 | | 435 | | | | |
| | X-52 | 360 | | 460 | | | | |
| | X-56 | 390 | | 490 | | | | |
| | X-60 | 415 | | 520 | | | | |
| | X-65 | 450 | | 535 | | | | |
| | X-70 | 485 | | 570 | | | | |

Mechanical Properties

| Steel grade API 5L PSL-2 | Yield strength ^a R _{t0.5} MPa | | Tensile strength ^a R _m MPa | | Ration ^{a,b} R _{t0.5} /R _m | Elongation (on 50) A _f % |
|--------------------------------|---|------------------|--|---------|--|---|
| | minimum | maximum | minimum | maximum | maximum | minimum |
| BM | 245 | 450 ^c | 415 | 655 | 0.93 | d |
| X42M | 290 | 495 | 415 | 655 | 0.93 | d |
| X46M | 320 | 525 | 435 | 655 | 0.93 | d |
| X52M | 360 | 530 | 460 | 760 | 0.93 | d |
| X56M | 390 | 545 | 490 | 760 | 0.93 | d |
| X60M | 415 | 565 | 520 | 760 | 0.93 | d |
| X65M | 450 | 600 | 535 | 760 | 0.93 | d |
| X70M | 485 | 635 | 570 | 760 | 0.93 | d |

- ^a For intermediate grades, the difference between the specified maximum yield strength and the specified minimum yield strength shall be as given in the table for the next higher grade, and the difference between the specified minimum tensile strength and the specified minimum yield strength shall be as given in the table for the next higher grade. For intermediate grades up to grade X46M, the tensile strength shall be ≤ 655 MPa. For intermediate grades greater than grade X46M and lower than grade X70M, the tensile strength shall be ≤ 760 MPa. The calculated value shall be rounded to the nearest 5 MPa.
- ^b This limit applies for pipe with $D > 323.9$ mm (12.750 in).
- ^c For pipe requiring longitudinal testing, the maximum yield strength shall be ≤ 495 MPa.
- ^d The specified minimum elongation, A_f shall be as determined using the following equation:

$$A_f = C \frac{A_{xc}^{0.2}}{U^{0.9}}$$

where C is 1940 for calculations; A_{xc} is the applicable tensile test piece cross-sectional area, expressed in square millimetres as follows:

- for circular cross-section test pieces, 130 mm² for 12.7 mm and 8.9 mm diameter test pieces; and 65 mm² for 6.4 mm diameter test pieces;
- for full-section test pieces, the lesser of (a) 485 mm² and (b) the cross-sectional area of the test piece, derived using the specified outside diameter and the specified wall thickness of the pipe, rounded to the nearest 10 mm²;
- for strip test pieces, the lesser of (a) 485 mm² and (b) the cross-sectional area of the test piece, derived using the specified width of the test piece and the specified wall thickness of the pipe, rounded to the nearest 10 mm²;

U is the specified minimum tensile strength, expressed in megapascals.

Note : The mechanical properties specified in API Grades are for pipes only. HRC/Plate properties are to be mutually agreed upon by the producers & pipe manufacturers.

Mechanical Properties

| Specification | Grade | Yield Strength (MPa min) | Ultimate Tensile Strength (MPa min) | %Elongation (min) | Bend | Hardness |
|---------------|-------------|---|---|-------------------|------|----------|
| SAILHARD | | | | | | 200 BHN |
| DSQ LO-PEARL | | 245 | 375 | 25 | 37 | |
| SAIL SPP 400 | HARDOX 400 | 900 | 1100 | 10 | | |
| SAIL SPP 700 | WELDOX 700E | 620 | 725-860 | 16 | | |
| SAIL HITEN | | 550 | 690 | 15 | 3.5T | |
| GOST 19282 | 09G2S | 345 (t:8-10) 325 (t:10-20) 305 (t:20-32) 285 (t:32-40) | 490 (t:8-10) 470 (t:10-20) 460 (t:20-32) 450 (t:32-40) | 21 | 2T | |
| | 10G2S1 | 345 (t:8-10) 335 (t:10-20) 325 (t:20-32) 325 (t:32-40) | 490 (t:8-10) 480 (t:10-20) 470 (t:20-32) 450 (t:32-40) | 21 | 2T | |

ABS Steel Plates

| Grade | Chemistry | Tensile Strength |
|-------------------------|---|--|
| A | C 0.21, Mn 2.5 x C% min S, P 0.035, Si : 0.50 max Al 0.02 min, CE 0.40 | YS 235 MPa, % EL : 22 (50 GL) UTS 400-520 MPa Impact 34J/RT (> 50 mm) |
| B | C 0.21, Mn 0.80 min S, P 0.035, Si : 0.35 max Al 0.02 min, CE 0.40 | YS 235 MPa UTS 400-520 MPa Impact 27J/0° (> 25 mm) |
| C | C 0.21, Mn 0.60 min S, P 0.035 Al 0.03 min, CE 0.040 | YS 315 MPa UTS 400-520 MPa Impact 27J/-20°C for all thicknesses |
| AH 32 DH 32 EH 32 | C 0.18, Mn 0.90-1.60 Nb 0.02-0.05, Si : 0.50 max S 0.035, P 0.035 V 0.05-0.10, Ti 0.02 max | YS 315 MPa, UTS : 440-590 MPa Imp AH 32 34 J min at 0°C DH 32 34 J min at -20°C EH 32 34 J min at -40°C |
| AH 36 DH 36 EH 36 | C 0.18, Mn 0.90-1.60 Si : 0.50 max S 0.035, P 0.035, Nb 0.02-0.05 V 0.05-0.10, Ti 0.02 max | YS 355 MPa UTS 490-620 MPa Imp AH 36 34 J min at 0°C DH 36 34 J min at -20°C EH 36 34 J min at -40°C |

Mechanical Properties

Processing of plate orders for Home Sales through Vacuum Degassing (VD)/Isothermal/normal route as per customer requirements.

| Requirement | | | Process | | |
|-----------------------|--|--|---|---|-----------------------|
| Category | Grade | Specifications/ Sub Grades | Vacuum Degassing (VD) (Ref. A20/A20 M:07 CI 5.3.4 & S1) | Isothermal (Ref. A20/A20 M:07 CI 5.3.4) | Normal |
| UT | Mild | IS 2062 E 250 A, B, C, A/SA 283 A/SA 36, BS4360 Gr 43A, BS/DIN EN 10025 S235, 275 JIS G 3101 SS 400, DIN 17100 RSt 37.2, 44.2 Other Equivalent grades | ≥ 50 mm All grades with UT | 40 to <50 mm All grades with UT | < 40 mm All grades |
| | Boiler Quality (Normal strength) | IS 2002/1,2,3, IS2041/1,2 A/SA 515 & 516 Grades A/SA 285 | ≥ 50 mm | 40 to <50 mm | < 40 mm |
| | | DIN 17155 HI, EN 10028 2-P 235 GH, P265GH, EN 10028-2-P275 | All thickness | – | – |
| | Boiler Quality (High Strength) | BS 1501-1 BS EN 10028-2-P295GH & 355GH BS EN 10028-3-P355 | All thickness | – | – |
| | | A/SA 537 Class 1, IS2041/3 | ≥ 50 mm | 40 to <50 mm | < 40 mm |
| | Boiler Qty. (Spl) | A/SA 204, SAIL FRS | All thickness | – | – |
| | High Tensile | IS 2062 E 300, 350, 410 Sailma 300, 300HI/350, 350HI/410, 410HI ASTM A 572 Gr 42, 50, DIN 17100 St 52.3 BS/DIN EN S355 JO, JR, J2, NL GOST 9G2S, 10G2S1, BS4360 Gr 50 | ≥ 50 mm | 40 to <50 mm | < 40 mm |
| Special | API, DMR, SAIL HITEN, SAILHARD, SAILMA 450 550, 600 SAILMA 450HI 550HI, 600HI, HT 750 IS 2062 E 450 D, E A 588, A 242, GOST5521 Hot Saw Disc | All thickness | | | |
| UT | All grades | All specifications/ Sub grades | ≥ 50 mm | 40 to <50 mm | < 40 mm |
| IMPACT | All grades | All specifications/ Sub grades | Impact test tempe- rature lower than (–) 20°C | | |
| SPL TDC | All grades | All specifications/ sub grades | As per Customer's requirement or agreement | | |
| Normalised Plate | As per mandatory requirement of the specification or as per agreed TDC | | | | |
| Normalised Rolling | As per requirement of the customer | | | | |