HOT STRIP MILL : BOKARO STEEL PLANT

Rationalized sizes for Hot Rolled Coils

Thickness (mm)	Width (mm)
2	1030, 1070, 1250, 1270, 1310, 1400
2.1, 2.2	1030, 1070, 1250, 1270, 1310, 1400
2.3, 2.37	1030, 1250, 1270, 1305, 1400
2.5	1030, 1070, 1130, 1250, 1270 ,1310, 1400, 1420
2.6	1030, 1100, 1250, 1270, 1310, 1400, 1420
2.7, 2.8	1030, 1070, 1250, 1270, 1310, 1400, 1420
2.9	1030, 1090, 1130, 1150, 1155, 1160, 1250, 1270, 1280,1310, 1400, 1420, 1680, 1685
2.95, 3.0, 3.1, 3.15, 3.2	1030, 1130, 1250, 1270, 1310, 1400, 1420
3.35	1030, 1250, 1270, 1310, 1385, 1400, 1420, 1500, 1550
3.5, 3.55, 3.6	1030, 1250, 1270, 1310, 1360, 1400, 1420, 1500, 1550
3.65	1030, 1250, 1270, 1310, 1385, 1400, 1420, 1500, 1550
3.8, 3.9, 3.95	1030, 1250, 1270, 1310, 1400, 1420, 1500, 1550
4.0	1030, 1250, 1270, 1310, 1400, 1420, 1500, 1550
4.1	1030, 1250, 1270, 1310, 1385, 1400, 1420, 1500, 1550
4.3	1030, 1250, 1270, 1310, 1350, 1360, 1400, 1420, 1500, 1550, 1730
4.5	1030, 1100, 1250, 1270, 1310, 1360, 1400, 1420, 1500, 1550, 1730
4.8, 4.9	1030, 1250, 1270, 1310, 1360, 1385, 1400, 1420, 1500, 1550, 1730
5.0	1030, 1250, 1310, 1400, 1420, 1500, 1550, 1730, 1830
5.3, 5.4, 5.6	1030, 1060, 1310, 1360, 1400, 1420, 1500, 1550, 1730
5.8	1030, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730
6.0	1030, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730, 1830
6.3, 6.6	1030, 1130, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730
7.0	1030, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730, 1830
7.2, 7.3, 7.5, 7.8	1030, 1130, 1150, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730
8.0, 8.7	1030, 1250, 1310, 1360, 1400, 1420, 1500, 1550, 1730, 1830
9.2, 9.8, 10, 11.8, 12	1030, 1150, 1250, 1310, 1400, 1420, 1500, 1550, 1730, 1830
16	1250, 1310, 1400, 1420, 1500, 1550, 1730, 1830

Physical attributes of HR Coils from BSL

Inner diameter of coils	850 mm
Outer diameter of coils	2300 mm (max.)
Coil weight	15 - 32 Tonne

HOT ROLLED COILS

Grade wise size mix of Hot Rolled Coils produced at BSL

Quality / Grade	Thickness (mm)		Width (mm)	
	Min	Max	Min	Max
IS 10748 GR 1 Si Al (K)	2	6	1000	1440
IS 10748 GR 1 Si Al (K)	3	6	1000	1580
IS 10748 GR 2 Si Al (K)	2	12	1000	1440
IS 10748 GR 2 Si Al (K)	3	12	1000	1580
IS 10748 GR 3 Si Al (K)	2.5	10	1000	1440
IS 10748 GR 3 Si Al (K)	3.2	10	1000	1580
IS 10748 GR 3 Si Al (K)	4.5	10	1000	1830
IS 10748 GR 4 Si Al (K)	2.8	10	1220	1440
IS 10748 GR 4 Si Al (K)	4	10	1220	1580
IS 10748 GR 5 Si Al (K)	3.2	10	1220	1440
IS 10748 GR 5 Si Al (K)	4	10	1220	1580
IS 5986 ISH 290S / 330S Si Al (K)	2	6	1000	1310
IS 5986 ISH 290S / 330S Si Al (K)	2.5	6	1000	1440
IS 5986 ISH 290S / 330S Si Al (K)	3	6	1000	1500
IS 5986 ISH 290S / 330S Si Al (K)	4	6	1000	1830
IS 5986 ISH 360S / 410S Si Al (K)	2	6	1000	1310
IS 5986 ISH 360S / 410S Si Al (K)	2.5	6	1000	1440
IS 5986 ISH 360S / 410S Si Al (K)	3	6	1000	1500
IS 5986 ISH 360S / 410S Si Al (K)	4.5	6	1000	1830
IS 5986 ISH 320LA / 360LA / 390LA / 430LA / 450LA / 480LA / 500LA	4.8	10	1220	1310
IS 5986 ISH 320LA / 360LA / 390LA / 430LA / 450LA / 480LA / 500LA	4.8	10	1500	1580
IS 5986 ISH 540 R FRM410/450	6	16	1220	1335
IS 5986 ISH 540 R FRM410/450	6	16	1500	1580
IS 2062 E250 BR / B0 / C Si Al (K)	4	16	1000	1500
IS 2062 E250 BR / B0 / C Si Al (K)	4.5	16	1000	1830
IS 2062 E350 BR / B0 / C Si Al (K)	3	16	1220	1310
IS 2062 E350 BR / B0 / C Si Al (K)	4	16	1220	1580
IS 2062 E410 BR / B0 / C Si Al (K)	4	16	1220	1310
IS 2062 E410 BR / B0 / C Si Al (K)	4.8	16	1220	1580
IS 2062 E450 BR / B0 / C Si Al (K)	4	16	1220	1310
IS 2062 E450 BR / B0 / C Si Al (K)	4.8	16	1220	1580
IS 11513 CR4 Al (K)	2	6	1000	1440
IS 1079 HR 1/ HR 2 Si Al (K)	2	6	1000	1440
IS 1079 HR 2 Si (K)	2.5	6	1220	1310

Quality / Grade	Thickness (mm)		Width (mm)	
	Min	Max	Min	Max
IS 10748 Gr 1 / Gr 2 Si (K)	2.3	10	1220	1310
IS 10748 Gr 2 Al (K)	2	6	1220	1440
SAILMC 40	2.6	6	1040	1100
SAILMC 45	2.8	6	1040	1100
SAILMC 50	3	6	1040	1100
SAILMC 55	3	6	1040	1100
SAILBR	2.5	6	1220	1440
IS 6240 Al (K)	2.2	6	1155	1250
IS 6240 Al (K)	2.9	6	1155	1685
EN 10120 P 265	2.2	6	1000	1260
EN 10120 P 310	2.2	4	1000	1070
EN 10120 P 310	2.3	4	1000	1260
JISG 3116 SG 255/ SG 295	2.5	4	1000	1070
JISG 3116 SG 255/ SG 295	2.8	4	1000	1260
E 34 SS4012 Si Al (K)	4	16	1180	1250
E 34 SS4012 Si Al (K)	4	16	1500	1550
E 38 SS4012 Si Al (K)	4	16	1180	1250
E 38 SS4012 Si Al (K)	4	16	1500	1550
E 46 SS4012 Si Al (K)	4	16	1180	1250
E 46 SS4012 Si Al (K)	4	16	1500	1550
IS 11587 / IRSM 41 (SAILCOR)	3.15	10	1220	1420
IRSM 41 (SAILCOR)	3.6	10	1220	1550
IS 2041 R 220/ R 260	4	16	1220	1280
	4	16	1500	1580

* If required some of the above grades can be supplied with Cu also.

** In addition Hot Rolled Coils in the following specifications can also be supplied.

Specification	Grade	Specification	Grade
API 5L PSL 1	A	API 5L PSL 2	BM
	B		X42M
	X42		X46M
	X46		X52M
	X52		X56M
	X56		X60M
	X60		X65M
	X65		

HOT STRIP MILL - II : ROURKELA STEEL PLANT

KEY FEATURES :

- **Capacity : 3.0 MTPA** • **Thickness Range : 1.2 mm - 25.4 mm**
- **Width Range : 900 mm - 2100 mm**

- Seven Stand Four High Continuous Mill • Roll Force : F1-F4 50,000 KN AND F5-F7 40,000 KN
- Motor Rating : 9.5 MW each • Pair Cross Mill with Stabilizer in F1 – F4
- Work Roll Shift (WRS) in F5 – F7 stand • Automatic gauge Control (AGC) in all stands
- Positive Roll Bending in all stands • High Speed Rolling Mill (21.2 m/s max strip speed).

Automation:

- Level 2 operated AGC control, roll gap setting , mill speed, looper control
- Auto Position Control (APC) in AGC, Side guides and loopers ensure proper process variables all the time
- Multi function gauge, Flatness and Width measurement system, Strip Top and **Bottom Surface Inspection System.**

Parameters	HSM - II
Width (For > 95.4% of measured strip width)	-0/ + 8 mm
Thickness (For > 95.4% of measured strip thickness)	±27µ to 60µ
Profile	±15µ to ±40µ
Flatness	34 to 28 I-unit
Finishing temperature	± 10^0C
Coiling temperature	± 10^0C
Telescopicity	15 mm

Rationalized Sizes of HR Coils from Hot Strip Mill - II of RSP

Thickness (mm)	Width (mm)
1.6, 1.7, 1.8, 1.9, 2, 2.1	910, 930, 940, 1020, 1030, 1040, 1050, 1220, 1230, 1250
2.2, 2.3, 2.4, 2.5,2.6 ,2.7, 2.8	910, 930, 940, 1020, 1030, 1040, 1050, 1220, 1230, 1250, 1270, 1280, 1290, 1300, 1310, 1320, 1380, 1390, 1400, 1410, 1420, 1430, 1500, 1550
2.9	910, 930, 940, 1020, 1030, 1040, 1050, 1155, 1220, 1230, 1250, 1270, 1280, 1290, 1300, 1310, 1380, 1390, 1400, 1410, 1420, 1500, 1550, 1680
3, 3.1, 3.2, 3.5, 3.8, 3.9, 4, 4.1, 4.2, 4.3, 4.5, 4.8	910, 930, 940, 1020, 1030, 1040, 1050, 1220, 1230, 1250, 1270, 1280, 1290, 1300, 1310, 1380, 1390, 1400, 1410, 1420, 1500, 1550, 1800, 1830
5, 5.3, 5.4, 5.5, 5.6, 5.8, 6, 6.5	1020, 1030, 1040, 1050, 1220, 1230, 1250, 1270, 1280, 1290, 1300, 1310, 1380, 1390, 1400, 1410, 1420, 1500, 1550, 1800, 1830, 2000, 2100
7.8, 8, 9.8, 10, 11.8, 12, 16, 20, 25	1250, 1270, 1280, 1290, 1300, 1310, 1380, 1390, 1400, 1410, 1420, 1500, 1550, 1800, 1830, 2000, 2100

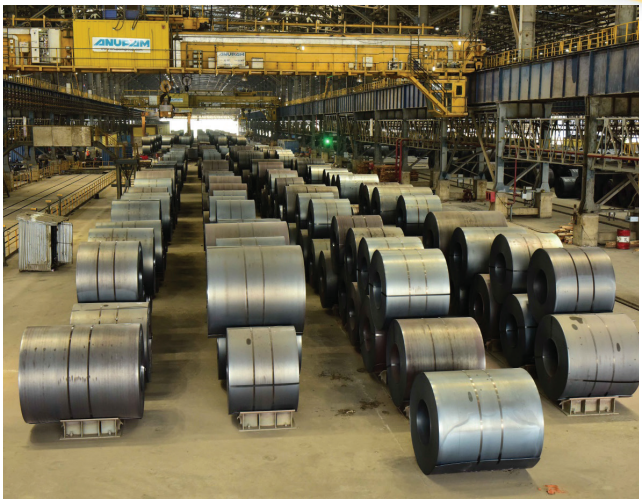
Grade wise size mix of Hot Rolled Coils produced Hot Strip Mill - II of RSP

Quality / Grade	Thickness (mm)		Width (mm)	
	Min	Max	Min	Max
IS 10748 GR 1 Si Al (K)	1.6	6	1000	1250
IS 10748 GR 1 Si Al (K)	2.5	6	1300	1850
IS 10748 GR 2 Si Al (K)	2	12	1000	1250
IS 10748 GR 2 Si Al (K)	2.5	12	1300	1500
IS 10748 GR 2 Si Al (K)	3.0	12	1400	1850
IS 10748 GR 3 Si Al (K)	2.5	10	1000	1440
IS 10748 GR 3 Si Al (K)	3.5	10	1000	1850
IS 10748 GR 3 Si Al (K)	4.5	10	1000	1830
IS 2062 E250 BR / B0 / C Si Al (K)	2.5	16	1000	1500
IS 2062 E250 BR / B0 / C Si Al (K)	4.0	16	1000	2000
IS 2062 E350 BR / B0 / C Si Al (K)	3	16	1220	1310
IS 2062 E350 BR / B0 / C Si Al (K)	4	16	1220	1500
IS 6240 Al (K)	2.2	6	1155	1250
IS 6240 Al (K)	2.9	6	1155	1680

- *If required some of the above grades can be supplied with Cu also.
- Above product mix is based on present supplies. HSM - II is under ramp-up and stabilization. Other grades and sizes will be added soon.

Physical attributes

Inner diameter of coils	760 mm
Outer diameter of coils	2300 mm (max.)
Coil weight	15 - 34 Tonne

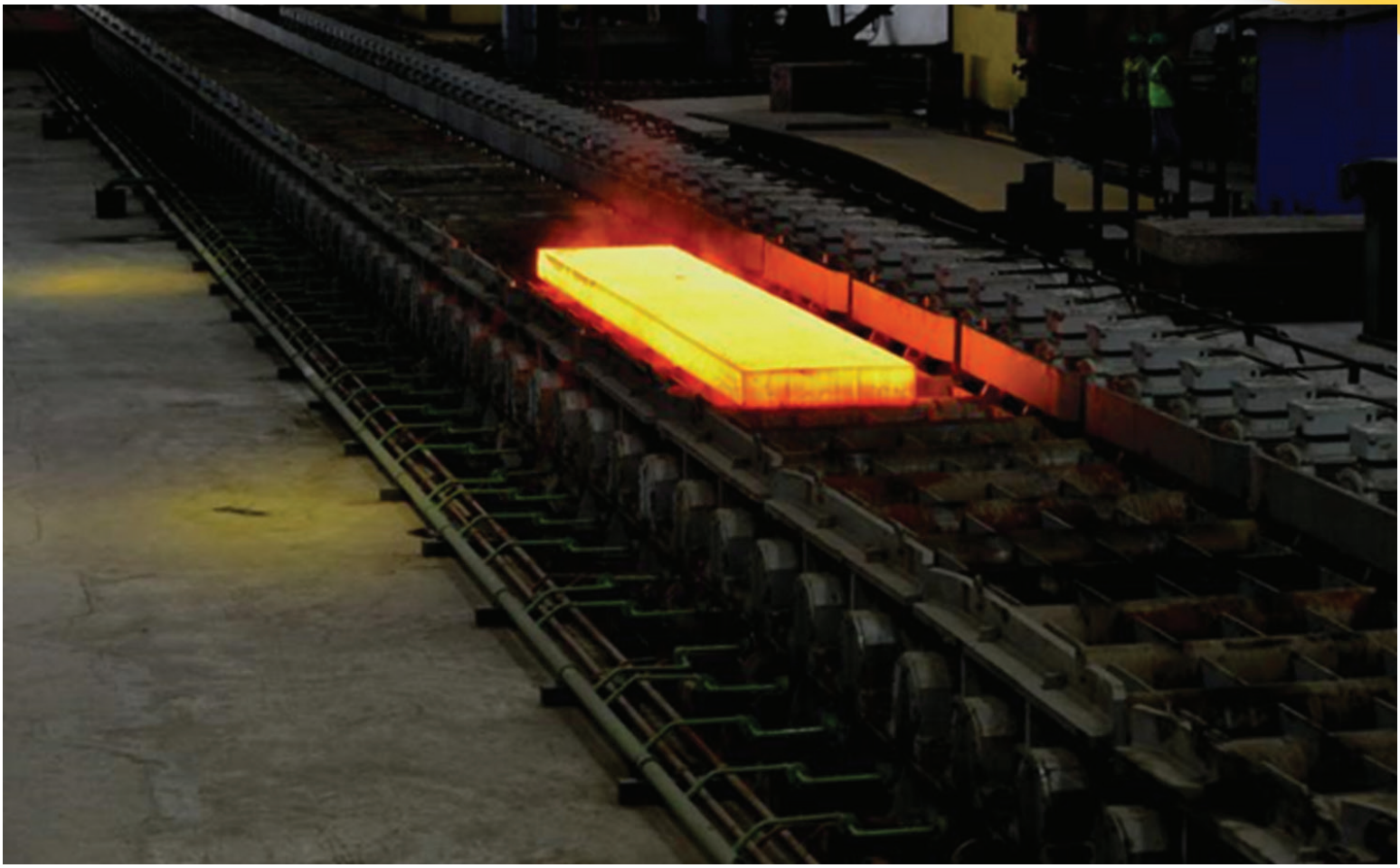


Rationalized Sizes of HR Coils from Hot Strip Mill - I of RSP

Thickness (mm)	Width (mm)
2.0, 2.1, 2.2, 2.3	910, 920, 930, 1010, 1025, 1030, 1040, 1060
2.5, 2.6	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130
2.7, 2.8	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1250
2.9	1025, 1150, 1155, 1160, 1220
3.1, 3.5	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1250, 1310
3.7	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1250, 1310, 1410
3.8	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1250, 1310, 1400, 1410
4.0	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1220, 1250, 1310, 1400, 1410
4.1, 4.3, 4.5, 4.6, 4.8, 5, 5.6, 5.8, 6, 6.6, 7.0, 7.4, 7.8, 8, 9, 9.0, 9.8, 10	910, 920, 930, 1010, 1020, 1025, 1030, 1040, 1060, 1130, 1220, 1250, 1310, 1400, 1410, 1420

Grade wise size mix of Hot Rolled Coils produced Hot Strip Mill - I of RSP

Quality / Grade	Thickness (mm)		Width (mm)	
	Min	Max	Min	Max
IS 10748 Gr. 1 /2 Si Al (K)	2.2	12	930	1250
IS 10748 Gr. 1 /2 Si Al (K)	2.8	10	1250	1420
IS 10748 Gr. 1 /2 Si Al (K)	3.1	10	1310	1420
IS 10748 Gr. 1/2 Si Al (K)	4.0	10	1380	1420
IS 6240 Al (K)	2.9		1160	
IS 2062 E250 BR	5.0	10	1050	1400
IS 3502 (Chequered Coil) - for 3 mm & 4 mm base will be confirming to IS 10748 Gr. 2	3.0	10	1050	1250



Salem Steel Plant (SSP)

At Salem, SAIL has Special Steel Plant which manufactures Hot Rolled and Cold Rolled Stainless Steel Coils & Sheets. Here we are also rolling range of Hot Rolled Coils in Mild Steel also.

Thickness : 1.60 - 12.7 mm
Width : 1000 - 1275 mm
ID (for coil) : 762 / 610 mm
Edge : As rolled (Mill Edge)

Thickness Tolerances :

Width (mm)	Thickness range (mm)					
	1.6-2.0	>2.0-3.0	>3.0-5.0	>5.0-8.0	>8.0-10.0	>10.0-12.7
1000-1250	+0.18	+0.20	+0.25	+0.30	+0.35	+0.50
>1250-1275	+0.20	+0.25	+0.30	+0.35	+0.40	+0.50

Thickness measurements are taken at 25 mm from the edges.
Width tolerance : +30 mm, -0 mm (for all width ranges).

HOT ROLLED SHEETS - BSL

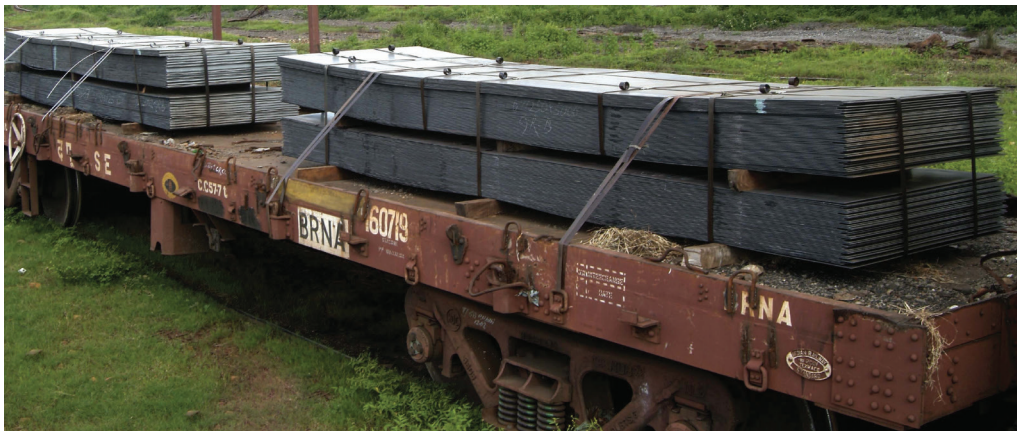
Rationalized sizes of Hot Rolled Sheets (HRS)

Thickness (mm)	Width (mm)	Length (mm)
2	930, 1000, 1030, 1100, 1130, 1250, 1310	2500
2.5	930, 1000, 1030, 1100, 1130, 1250, 1310, 1400	2500
2.9	1000, 1100, 1250,1400	2500, 4000, 4500
3.15	1000, 1100, 1250,1400	2500, 4000, 4500
3.55	1000, 1100, 1250,1400	2500, 4000, 4500
4	1000, 1100, 1250,1400	2500, 4000, 4500

HOT STRIP MILL PLATES - BSL

Rationalized sizes of Hot Strip Mill Plates (HSMP)

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
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



Thickness and width tolerances are as per IS: 1852 / 2003. Closer tolerances can also be supplied on demand.

Packaging: Bare bundles with cross-wise steel strip. Packet weight: 5 - 18 tonnes.

Marking: Paint marked on the top sheet of the bundle or Sticker / label on top sheet of bundle with required details. Laser marking on each and every piece of Hot Strip Mill plate.

Common grades for Hot Rolled Sheets are IS 1079, IS 5986, IS 6240 etc. and for Hot Strip Mill Plates are IS 12062, SAILCOR, IS 2002, IRS etc. Certain other grades can also be supplied in which HR Coils are produced at BSL.

Other non standard sizes can be serviced depending on order quantity.

Rourkela Steel Plant

Rationalized sizes of Hot Strip Mill Plates (HSMP) from HSM - I

Thickness (mm)	Width (mm)	Length (mm)
Hot Strip Mill Plates		
5, 6, 8, 10	1250	5000, 6300, 8000, 10000

Rationalized sizes of Chequred Plates from HSM - I

Thickness (mm)	Width (mm)	Length (mm)
Chequered Plates		
4, 5, 6, 8, 10	1250	5000, 6300, 8000, 10000

Note:

- Plate are supplied in Mill edge condition
- Chequered plates are supplied with tear drop pattern
- Other non standard sizes can be serviced depending on order quantity.

Chemical Composition: IS 2062/2011

Grade Designation	Quality	Ladle Analysis %, max					Carbon Equivalent (CE), max	Method of Deoxidation
		C	Mn	S	P	Si		
E 250	A	0.23	1.50	0.045	0.045	0.40	0.42	Killed
	BR, B0	0.22	1.50	0.045	0.045	0.40	0.41	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	Killed
	BR, B0	0.22	1.50	0.045	0.045	0.40	0.42	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	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	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	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%. For killed steel, when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02%. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10%. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.01%.
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%.
6. Alloying elements such as Cr, Ni, Mo and B may be added under agreement between the purchaser and the manufacturer.
7. Copper may be present between 0.20% to 0.35% 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%.
8. Incidental element - Elements not quoted in Table 1 shall not be intentionally added to steel without the agrement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be takent 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% 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.

Chemical Composition : IS 10748/2004

Grade	C% max	Mn% max	P% max	S% max
I	0.10	0.50	0.040	0.040
II	0.12	0.60	0.040	0.040
III	0.16	1.20	0.040	0.040
IV	0.20	1.30	0.040	0.040
V	0.25	1.30	0.040	0.040
CE: 0.45 max for grades IV and V				

Notes:

1. CE based on ladle analysis $= C + \frac{Mn}{6} + \frac{(C + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$
2. For semi-killed quality silicon content shall be 0.08%, maximum.
3. When the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02%. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10%. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.01%.
4. Micro-alloying may be allowed subject to mutual agreement between the purchaser and the supplier. Micro-alloying elements like Nb, V or Ti, when used individually or in combination, the total content shall not exceed 0.20%.
5. Nitrogen content of steel shall not exceed 0.012%, which shall be ensured by the manufacturer by occasional check analysis.
6. Closer limits of composition may be agreed to between the supplier and the purchaser.

Chemical Composition: IS 1079 / 2017

Grade	C% max	Mn% max	P% max	S% max
HR0	0.25	2.00	0.080	0.045
HR1	0.15	0.60	0.050	0.035
HR2	0.10	0.45	0.040	0.035

Notes:

1. Steel of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination and shall not exceed 0.2%. However, Boron addition shall be restricted to 0.006% maximum.
2. The Nitrogen content of the steel shall not be more than 0.007%. For Aluminium killed or Aluminium-Silicon killed, the Nitrogen content shall not exceed 0.012%. This has to be ensured by the manufacturer by occasional check analysis.
4. When the steel is Aluminium killed, the total Aluminium content shall not be less than 0.02%. However, Aluminium less than 0.02% can be mutually agreed between the purchaser and the supplier for Aluminium killed steel. When the steel is Silicon killed, the

Silicon content shall not be less than 0.10%. When the steel is Aluminium - Silicon killed, the Silicon content shall not be less than 0.03% and total Aluminium content shall not be less than 0.01%.

5. When Copper bearing steel is required the Copper content shall be between 0.20% and 0.35%. In case of product analysis, the Copper content shall be between 0.17% and 0.38%.
6. Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.

Chemical Composition : IS 5986 / 2017

Grade	C% max	Mn% max	Si% max	P% max	S% max	Micro-alloy	CE max
ISH 290S	0.12	0.60	0.50	0.040	0.040	0.15	-
ISH 330S	0.15	0.80	0.50	0.040	0.040	0.15	–
ISH 360S	0.17	1.20	0.50	0.040	0.040	0.15	–
ISH 410S	0.20	1.30	0.50	0.040	0.040	0.15	0.42
ISH 490S	0.24	1.60	0.50	0.040	0.040	0.15	0.50
IS 5986 ISH320LA	0.12	1.20	0.50	0.025	0.020	0.22	-
IS 5986 ISH360LA	0.12	1.20	0.50	0.025	0.020	0.22	-
IS 5986 ISH390LA	0.12	1.30	0.50	0.025	0.020	0.22	-
IS 5986 ISH410LA / HSFQ 350	0.12	1.40	0.50	0.025	0.020	0.22	-
IS 5986 ISH430LA / SAILFORM 350	0.12	1.50	0.50	0.025	0.020	0.22	-
IS 5986 ISH450LA	0.12	1.50	0.50	0.025	0.020	0.22	-
IS 5986 ISH480LA	0.12	1.50	0.50	0.025	0.020	0.22	-
IS 5986 ISH500LA / SAILFORM 450 / HSFQ 450	0.12	1.60	0.50	0.025	0.020	0.22	-
IS 5986 ISH540R / SAILFORM 410	0.20	1.70	0.50	0.030	0.020	0.20	-

Notes:

1. Steel of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination and shall not exceed 0.2%. However, Boron addition shall be restricted to 0.006% maximum.
2. The nitrogen content of the steel shall not be more than 0.009%. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012%. This shall be ensured by occasional checking.
3. When the steel is killed by aluminium the total aluminium content should not be less than 0.02%. When steel is silicon killed the silicon content shall not be less than 0.1%. When the steel is aluminium silicon killed the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.01%.
4. The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20% and 0.35% on analysis.
5. The elements (for example Cr, Mo, Ni, etc.) not mentioned in above table can be added upto 1.0% maximum either singly or in combination.
6. Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.
7. Carbon equivalent (CE) based on ladle analysis = $C + \frac{Mn}{6} + \frac{(C + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$

Chemical Composition : IS 11513 / 2017

Designation	Quality	C% max	Mn% max	P% max	S% max
CR0	Hard	0.25	1.70	0.050	0.045
CR1	Commercial	0.15	0.60	0.040	0.040
CR2	Drawing	0.12	0.50	0.035	0.035
CR3	Deep Drawing	0.10	0.45	0.030	0.030
CR4	Extra Deep Drawing (Al Killed)	0.08	0.40	0.025	0.025

Notes:

1. Steels of these grades can be supplied with the addition of micro-alloy elements like boron, titanium, niobium and vanadiumeither singly or in combination and shall not exceed 0.25%. However boron addition will be restricted to 0.006%. The elements (for example Cr, Mo, Ni, etc) not mentioned in above table can be added either singly or in combination.
2. The nitrogen content of the steel shall not be more than 0.007%. For aluminium killed or silicon-aluminium killed, the nitrogen content shall not exceed 0.012%. This shall be ensured by the manufacturer by occasional check analysis.
3. Micro-alloyed grade shall be supplied in fully aluminium killed condition or aluminium with stabilizing elements.
4. When the steel is aluminium killed, the total aluminium content shall not be less than 0.02%. When the steel is silicon killed the silicon content shall not be less than 0.10%. When the steel is aluminium silicon killed, the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.01%.
5. When copper bearing steel is required the copper content shall be between 0.20% and 0.35%.
6. Restricted chemistry may be mutually agreed to between the purchaser and the supplier.

Chemical Composition

Specification	Grade	C% max	Mn% max	P% max	S% max	Si%max	Al% min
IS 11587:1986 IRSM 41	GrA SAILCOR	0.10	0.25-0.45	0.75-0.140	0.030	0.28-0.72	0.08 max
		MAE: Cr 0.35-0.60, Ni 0.20-0.47, Cu 0.30-0.60					
Medium Carbon Grades	SAILMC 40	0.36-0.45	0.60-0.90	0.040	0.040	0.15-0.35	0.02
	SAILMC 45	0.41-0.50	0.60-0.90	0.040	0.040	0.15-0.35	0.02
	SAILMC 50	0.46-0.55	0.60-0.90	0.040	0.040	0.15-0.35	0.02
	SAILMC 55	0.51-0.60	0.60-0.90	0.040	0.040	0.15-0.35	0.02
	SAILMC 60	0.56-0.65	0.60-0.90	0.040	0.040	0.15-0.35	0.02
IS 6240		0.16	0.30 min	0.025	0.025	0.25	0.02
	MAE, 0.1% (Nb, Ti, B) N<90 ppm						
High Strength LPG							
IS 15914:2011	HS 235	0.16	0.30	0.25	0.025	0.25	0.015
	HS 265	0.18	0.40	0.30	0.025	0.25	0.015
	HS 295	0.19	0.50	0.35	0.025	0.25	0.015
	HS 345	0.20	0.70	0.45	0.025	0.25	0.015
	MAE, 0.1% (Nb, Ti, V, B) N<90 ppm						
JISG 3116	SG 255	0.20	0.30 min	0.040	0.040	-	-
	SG 295	0.20	1.00	0.040	0.040	0.35	-

Specification	Grade/Brand Name	C% max	Mn% max	P% max	S% max	Si%max	Al% min
EN 10120	P245NB	0.16	0.30 min	0.025	0.015	0.25	0.020
	P265NB	0.19	0.40 min	0.025	0.015	0.25	0.020
	P310NB	0.20	0.70 min	0.025	0.015	0.50	0.020
	Nb 0.05 max Ti 0.03 max for EN 10120						

Specification	C% max	Mn% max	P% max	S% max	Si% max	Nb% max	V% max	Ti% max	Al% min
E-34	0.10	0.70	0.030	0.030	0.20	0.055	0.095	0.045	0.02-0.06
E-38	0.10	1.00	0.030	0.030	0.40	0.055	0.095	0.045	0.02-0.06
E-46	0.12	1.00	0.025	0.025	0.40	0.060	0.095	0.045	0.02

Chemical Composition of Seismic Resistant Structural Steel IS 15962:2012

Grade	C% max	Mn% max	P % max	S% max	Si% max	CE max	Mode of Deoxidation
E250S	0.20	1.50	0.035	0.045	0.40	0.39	Semi-killed/Killed
E300S	0.20	1.50	0.035	0.045	0.45	0.40	Semi-killed/Killed
E350S	0.20	1.60	0.035	0.045	0.45	0.42	Semi-killed/Killed
E450S	0.22	1.60	0.035	0.045	0.45	0.47	Semi-killed/Killed

- Microalloying elements (MAE) like Nb, V and Ti may be added singly or in combination. Total MAE shall not be more than 0.15%.
- Cr, Ni, Mo may be added but not more then 0.60% singly or in combination.
- Cu may be present between 0.20 and 0.35%.
- Nitrogen content shall not be more then 0.012%.

Chemical Composition: IRS (Normal Strength Steels for Ship Structures)

Designation	C% max	Mn% max	S% max	P% max	Si% max
A	0.21	2.5 x C	0.035	0.035	0.50
B	0.21	0.80	0.035	0.035	0.35
Carbon + 1/6 of the manganese content is not to exceed 0.40 per cent					

1. The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0.020%.
2. For grade B, when the silicon content is 0.10% or more (killed steel), the minimum manganesecontent may be reduced to 0.60%.
3. IRS may limit the amount of residual/trace elements which may have an adverse effect on theworking and use of the steel, e.g. copper and tin.
4. Where additions of any other element have been made as part of the steelmaking practice, thecontent is to be specified.
5. When any grade of steel is supplied in the thermo-mechanically rolled condition, variation in thespecified chemical composition may be allowed or required by IRS.

Mechanical Properties : IS 10748/2004

Grade	Yield Strength (MPa) min	Ultimate Tensile Strength (MPa) min	Elongation% GL=5.65 $\sqrt{S_o}$	Internal Diameter of bend
1	170	290	30	t
2	210	330	28	2t
3	240	410	25	2t
4	275	430	20	3t
5	310	490	15	3t

* Supplied on basis of chemical composition

1. t = Nominal thickness of the test piece.
2. Mechanical properties other than those specified in this table may be as per agreement between the purchaser and the manufacturer for specific applications.

Mechanical Properties : 2062 / 2011

Grade Designation	Quality	Tensile Strength (MPa) Min	Yield Stress (MPa) Min			%age Elongation A, at Gaug Length, L=5.65 √SoMin	Internal Bend Diameter Min		Charpy Impact Test	
			<20	20-40	>40		25	>25	Temp ºC	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

1. 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.

Mechanical Properties : IS 1079 / 2009

Grade	Tensile Strength (MPa) max	%age Elongation after FractureA, min			
		t≤3 mm		t>3 mm	
		Gauge length L_o=80 mm	Gauge length L_o=50 mm	Gauge length L_o=5.65√So	Gauge length Lo=50 mm
HR0	Properties on mutual agreement between the purchaser and the manufacturer				
HR1	440	23	24	28	20
HR2	420	25	26	30	31

Notes:

1. Minimum tensile strength for qualities HR1 & HR2 would normally be expected to be 270 MPa. Where minimum tensile is required, the value of 270 MPa may be specified. All tensile strength values are determined to the nearest 10 MPa.
2. The non proportional test with a fixed original gauge length (50 mm) up to 6 mm thick sheet can be used in conjunction with a conversion table. In case of dispute, however, only the results obtained on a proportional test piece will be valid for material 3 mm and over in thickness.
3. Where, 't' is thickness, GL= Gauge Length, So – Original cross-sectional area gauge length.
4. The yield stress values apply to 0.2% proof stress, if the yield is not clearly distinctive, otherwise the values apply to the lower yield stress.
5. Tensile testing is not mandatory for HR1, unless agreed to between the purchaser and manufacturer.

Mechanical Properties : IS:5986/2011

Grade	YS (MPa) Min	UTS (MPa) Min	%age Elongation after fracture A, min	
			GL= 80mm (t ≤ 3mm)	GL=5.65√So (t > 3mm)
ISH 290S	165	290-400	22	30
ISH 330S	205	330-440	20	28
ISH 360S	235	360-470	19	26
ISH 410S	255	410-520	17	23
ISH 490S	355	490-630	16	20
IS 5986 ISH320LA	255	320-420	25	27
IS 5986 ISH360LA	300	360-460	23	25
IS 5986 ISH390LA	315	390-510	20	24
IS 5986 ISH410LA / HSFQ 350	340	410-520	20	23
IS 5986 ISH430LA / SAILFORM 350	355	430-550	19	23
IS 5986 ISH450LA	380	450-570	18	21
IS 5986 ISH480LA	420	480-620	16	19
IS 5986 ISH500LA / SAILFORM 450/ HSFQ 450	450	500-670	14	18

Grade	Yield Strength MPa				Tensile Strength (MPa)	%age Elongation after fracture A, min					
	t<2	2≤t< 3.2	3.2≤t < 6.3	t≥6.3		t<2	2≤t< 3.2	3.2≤t <6.3	t≥6.3	t≤3	t>3
						GL= 50mm				GL= 80mm	GL = 5.65√So
ISH 540R / SAILFORM 410	430 - 570	420 - 560	410 - 550	400 min	540 min	19	20	21	22	(2)	19

Mechanical Properties

Specification	YieldStrength (MPa) min	Ultimate Tensile Strength (MPa)	Elongation %	Internal dia Meter of bend
SAILCOR Gr A	340	480	22	t
IS 6240/2008	240	350-450	25 (GL=5.65√S_o)	
JISG 3116 SG 295	295	440	26	
EN 10120 P245NB	245	360-450	26 34 24 32 21 28 Up to 3 mm, GL= 80 mm GL=5.65√S_o	
EN 10120 P265NB	265	410-500		
EN 10120 P310NB	310	460-550		
E 34	330-410	390-490	27 min	0.5t- close
E 38	370-460	440-560	25 min	0.5t- close
E 46	450-530	490-610	21 min	0.5t- close

Mechanical Properties of Seismic Resistant Structural Steel (IS 15962:2012)

Grade	UTS (MPa) min	Yield Strength (MPa) min			% El min. GL=5.65√A_0	Charpy Impact (J at 0°C) min	YS/UTS max
		<20 mm	20-40 mm	>40 mm			
E250S	410	250	240	230	23	27	0.80
E300S	440	300	290	280	22	27	0.80
E350S	490	350	330	320	22	27	0.85
E450S	570	450	430	420	20	27	0.88

Mechanical Properties of high tensile flat rolled steel for lighter cylinder (IS 15914:2011)

Grade	Tensile Strength (MPa)	Yield Stress (MPa) Min	%age ElongationMin at Gauge Length (under revision) min 80 mm 5.65√S_o		Referenc Heat Treatment Austenitizing Temperature °C
			<3 mm	3 to 6 mm	
HS 235	360-460	235	25	32	920-960
HS 265	410-510	265	22	30	890-930
HS 295	450-560	295	20	28	890-930
HS 345	490-610	345	18	24	880-920

The above properties are specified for cold formed and normalized cylinder. However tensile properties of hot rolled plate/sheet/strip are to be mutually agreed upon by the producer and by the cylinder manufacturer.

Mechanical Properties: IRS (Normal Strength Steels for Ship Structures)

Grade	Tensile Strength R_{eH} (N/mm^2), min	Yield Stress R_m (N/mm^2), min	Elongation $5.65\sqrt{S_o}$ A5 (%), min	Avg Impact Energy (J), min*		
				Test Temp °C	T ≤ 50mm	
					Long	Trans
A	235	400-520	22	+20	-	-
B				0	27	20

* Charpy V-notch impact tests are generally not required for grade B steel with thickness ≤ 25mm.

Rolling and Cutting Tolerance as per IS:1852 - 1985 (Reaffirmed 2003)

Tolerance on Width of Strip Supplied with as Rolled Edges

Width (mm)	Tolerance (mm)
>900 to 1250	+ 30, - 0
> 1250 to 1550	+ 35, - 0
> 1550 to 1850	+ 40, - 0

Tolerance on Thickness for Strip above 500 mm width

Width (mm)	Tolerance on thickness (mm)				
	> 1.6 to 2	> 2 to 3	> 3 to 5	> 5 to 8	> 8 to 10
>500 >X ≥ 1250	± 0.18	± 0.20	± 0.25	± 0.30	± 0.35
1250 >X ≥1550	± 0.20	± 0.25	± 0.30	± 0.35	± 0.40
1550 >X ≥1850	± 0.22	± 0.28	± 0.35	± 0.40	± 0.40

Rolling and Cutting Tolerance for HR Sheets

as per IS: 1852 - 1985 (Reaffirmed 2003)

Width (mm)	Tolerance (mm)	Length (mm)	Tolerance
Up to 1250	+ 6 , - 0	Up to 2500	+ 25 mm, - 0 mm
> 1250 to 1550	+ 0.5%, - 0	Over 2500	+ 1% of the length (max 70 mm), - 0 mm

Thickness tolerance for sheets as per table of HR Coils.

Note : Cutting tolerance for all lengths for all products except plate, strip and sheet shall be + 100 mm, - 0 mm.

Closer tolerances can be supplied on mutual agreement.