सेल SAIL

PIG IRON

Pig Iron

The mass of each pig pallet shall be either 45 kg having two notches or 22.5 kg having one notch, subject to mutual agreement between the purchaser and manufacturer.

Specifications

Specification	Grade	Designation	Si %	Mn %	P %	S % max
IS: 13502:2005	Steel-making	PG Si X Mn 1 P40	See Note 1	<0.5	<0.4	0.06

Note :

1. When ordering the integer given below shall be substituted for the symbol 'X' in the designation to the specific silicon range :

Integer No.	Steelmaking Pig Iron
1	≤0.75
2	>0.75 but ≤1.25
3	>1.25 but ≤1.75

2. Other elements such as Cr, Mo, Ni, Ti, V etc. may be present in traces (total not exceeding 10%). The contents of these elements shall not be used in classification of pig iron. Pig Iron is available in SAIL grade with silicon content of 1 - 1.5%.

Standard Grades

Chemical Composition: IS 1079/2017

Quality		Constituent, Percent, Max			
Grade	Designation	Carbon	Manganese	Phosphorus	Sulphur
HR0	Ordinary	0.25	2.00	0.080	0.050
HR1	Commercial	0.15	0.60	0.050	0.035
HR2	General Purpose	0.10	0.45	0.040	0.035
HR3		0.08	0.40	0.035	0.030
HR4		0.08	0.35	0.030	0.030
ISH270C	Drawing Quality	0.08	0.45	0.035	0.035
ISH270D		0.06	0.40	0.030	0.030
ISH270E		0.06	0.35	0.025	0.025

Notes:

1. Steel of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium. The micro-alloying elements shall not exceed 0.006 percent in case of Boron and 0.20 percent in case of other elements.
2. The Nitrogen content of the steel shall not be more than 0.007 percent. For Aluminium killed or Silicon-Aluminium killed, the Nitrogen content shall not exceed 0.012 percent. This has to be ensured by the manufacturer by occasional check analysis.
3. Grade HR4 and HR5 shall be supplied in fully Aluminium killed condition or Aluminium with stabilising elements.
4. When the steel is Aluminium killed, the total Aluminium content shall not be less than 0.02 percent. When the steel is Silicon killed, the Silicon content shall not be less than 0.10 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.
5. When Copper bearing steel is required the Copper content shall be between 0.20 and 0.35 percent. In case of product analysis, the Copper content shall be between 0.17 and 0.38 percent.
6. Restricted chemistry may be mutually agreed to between the purchaser and the supplier.

Mechanical Properties : IS 1079/2017

Grade	Quality Designation	Tensile Strength max MPa	Percentage Elongation after Fracture A, min			
			t≤3		t>3	
			Gauge length Lo=80	Gauge length Lo=50	Gauge length Lo=5.65 √So	Gauge length Lo=50
HRO	Ordinary	*	*	*	*	*
HR1	Commercial	440	23	24	28	29
HR2	General Purpose	420	25	26	30	31
HR3		400	28	29	33	34
HR4		380	31	32	36	37

Grade	Designation	Quality Yield Strength (Yield Point/Proof Stress)** MPa			Tensile Strength MPa	Percentage Elongation after Fracture A, min Min**				
		t<2	2≤t<3.2	t≥3.2		t<2	2≤t<3.2	t≥3.2	t≤3	t>3
						GL Lo=50 mm			GL Lo=80 mm	GL Lo=5.65 pSo
ISH270C	Drawing Quality	170, Min			270-420	26	26	31	25	30
ISH270D		170, Min		165,	270-400 Min	29	29	34	28	33
ISH270E		165, Min	155, Min	145, Min	270-380	32	32	37	31	36

Notes:

1. 1 MPa = 1 N/mm^2
2. Minimum tensile strength for qualities HR1, HR2, HR3 and HR4 would normally be expected to be 270 MPa. Where minimum tensile strength is required, the value of 270 MPa may be specified. All tensile strength values are determined to the nearest 10 MPa.
3. The non-proportional test piece with a fixed original gauge length (50 mm) up to 5 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.
4. Where "t" is thickness of steel sheet, in mm.
5. Tensile testing is not mandatory for HR1, unless agreed to between the purchaser and manufacturer.

* Properties on mutual agreement between the purchaser and manufacturer.

** Maximum values on yield strength and elongation and/or restricted properties may be agreed to between the purchaser and the manufacturer.

Chemical Composition IS: 2062/2011

Grade	Quality	Ladle Aaalysis, wt % Max					Carbon Equi-valent, 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, BO	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, BO	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, BO	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, BO	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, BO	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 nto 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, BO 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 No. 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 Ci, Ni, Mo and B may be added under agrement between the purchaser and the manufacturer. In case of E 600 and E 650 the limit of Ci 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 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 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 rate 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, $L=5.65\sqrt{S_0}$ Min	Internal Bend Diameter Min		Charpy Impact Test	
			≤ 20	20-40	>40		<25	>25	Temp ^{0}C	J, Min
E-250	A	410	250	240	230	23	2t	3t	-	-
	BR								RT	27
	BO								0	27
	C								(-) 20	27
E-275	A	430	275	265	256	22	2t	3t	-	-
	BR								RT	27
	BO								0	27
	C								(-) 20	27
E-300	A	440	300	290	280	22	2t	-	-	-
	BR								RT	27
	BO								0	27
	C								(-) 20	27
E-350	A	490	350	330	320	22	2t	-	-	-
	BR								RT	27
	BO								0	27
	C								(-) 20	27
E-410	A	540	410	390	380	20	2t	-	-	-
	BR								RT	25
	BO								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

Notes

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.
2. Bend test not required for thickness > 25 mm for grades E 300 to E 600. 't' is the thickness of the test piece.
3. For sub-quality BR, impact test is optional; if required, at room temperature (25 ± 2°C).
4. Impact test shall normally be carried out on products having thickness/diameter greater than or equal to 12 mm.

Chemical Composition : SAILMA Grades

Grade	C max.	Mn max.	S max.	P max.	AI 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	% EI min Std GL	Internal Bend Diameter, min		Charpy Impact Test	
						≤25mm	>25 mm	Temp ^{0}C	J, min
	<25 mm	25-40 mm	>40 mm						
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 5986/2017

Grade	C, max	Mn, max	Si, max	P, max	S, max	Micro alloy, max	CE, max
IS 5986 ISH290S	0.12	0.60	0.50	0.040	0.040	0.15	-
IS 5986 ISH310S	0.15	0.80	0.50	0.040	0.030	0.15	-
IS 5986 ISH330S	0.15	0.80	0.50	0.040	0.040	0.15	-
IS 5986 ISH360S	0.17	1.20	0.50	0.040	0.040	0.15	-
IS 5986 ISH370S	0.17	1.20	0.50	0.040	0.030	0.15	-
IS 5986 ISH400S	0.20	1.30	0.50	0.040	0.030	0.15	0.42
IS 5986 ISH410S	0.20	1.30	0.50	0.040	0.040	0.15	0.42
IS 5986 ISH440S	0.24	1.50(1)	0.50	0.040	0.030	0.15	0.45
IS 5986 ISH490S	0.24	1.60(1)	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	0.12	1.40	0.50	0.025	0.020	0.22	-
IS 5986 ISH430LA	0.12	1.50(1)	0.50	0.025	0.020	0.22	-
IS 5986 ISH450LA	0.12	1.50(1)	0.50	0.025	0.020	0.22	-
IS 5986 ISH480LA	0.12	1.50(1)	0.50	0.025	0.015	0.22	-
IS 5986 ISH500LA	0.12	1.60(1)	0.50	0.025	0.015	0.22	(2)
IS 5986 ISH550LA	0.12	1.70	0.50	0.025	0.015	0.22	(2)
IS 5986 ISH600LA	0.12	1.80	0.50	0.025	0.015	0.22	(2)
IS 5986 ISH440R	0.20	1.50(1)	0.50	0.030	0.020	0.20	(2)
IS 5986 ISH490R	0.20	1.60(1)	0.50	0.030	0.020	0.20	(2)
IS 5986 ISH540R	0.20	1.70	0.50	0.030	0.020	0.20	(2)
IS 5986 ISH590R	0.20	1.80	(2)	0.030	0.020	0.20	(2)

Notes:

1. Steels of these grades can be supplied with the addition of micro-alloying elements like Boron.Titanium, Niobium and Vanadium either singly or in combination as per above table. However, Boron addition will be restricted to 0.006 percent maximum.
2. 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 ensured by occasional checking.
3. When the steel is killed by aluminium the total aluminium content should not be less than 0.02 percent. However, aluminium less than 0.02 percent can be mutually agreed to between the purchaser and the supplier for aluminium killed steel. 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.
4. The material may be supplied in the copper bearing quality in which case the coper shall be between 0.20 and 0.35 percent on analysis.
5. The elements (for example Cr, Mo, Ni, etc) not mentioned in above table can be added upto 1.0 percent 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 $= C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$

Mechanical Properties : IS 5986/2017

Grade	YS, MPa (min)	UTS, Mpa	%EI		Bend	
			GL=80 mm (t≤3 mm)	GL=5.65√So (t≤3 mm)	t≤12 mm	t>12 mm
IS 5986 ISH290S	165	290-400	22	30	close	1t
IS 5986 ISH330S	205	330-440	20	28	1t	2t
IS 5986 ISH360S	235	360-470	19	26	1t	2t
IS 5986 ISH410S	255	410-520	17	23	1t	2t
IS 5986 ISH490S	355	490-630	16	20	2t	3t
IS 5986 ISH320LA	255	320-420	25	27	close	1t
IS 5986 ISH360LA	300	360-460	23	25	close	1t
IS 5986 ISH390LA	315	390-510	20	24	close	1t
IS 5986 ISH410LA	340	410-520	20	23	0.5t	2t
IS 5986 ISH430LA	355	430-550	19	23	1t	2t
IS 5986 ISH450LA	380	450-570	18	21	1t	2t
IS 5986 ISH480LA	420	480-620	16	19	1t	2t
IS 5986 ISH500LA	450	500-670	14	18	1t	2t
IS 5986 ISH550LA	500	550-700	12	14	1.5t	2t
IS 5986 ISH600LA	550	600-760	12	14	1.5t	2t

Grade	YS, MPa (min)				UTS, Mpa	%EI				Bend	
						GL 50 mm				t≥6.3	t≥6.3
	t≤2	2≤t <3.2	3.2≤t <6.3	t≥6.3	(min)	t≤2	2≤t <3.2	3.2≤t <6.3	t≥6.3	(min)	(min)
IS 5986 ISH310S	195	185	175	165	310	33	34	38	40	1t	2t
IS 5986 ISH370S	225	215	205	195	370	32	33	36	38	1t	2t
IS 5986 ISH400S	245-375	235-355	225-345	215	400	31	33	35	37	1t	2t
IS 5986 ISH440S	285-400	275-390	265-380	255	440	29	30	33	34	1t	2t
IS 5986 ISH440R	305-450	305-440	305-430	295	440	26	27	28	29	1t	2t
IS 5986 ISH490R	375-500	365-490	355-480	345	490	22	23	24	25	1.5t	2.5t
IS 5986 ISH540R	430-570	420-560	410-550	400	540	19	20	21	22	1.5t	2.5t
IS 5986 ISH590R	480-630	470-620	450-610	450	590	17	18	19	20	1.5t	2.5t

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 $= C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$
2. For semi-killed quality silicon content shall be 0.08 percent, maximum.
3. 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 nto be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.
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 percent.
5. Nitrogen content of steel shall not exceed 0.012 percent, 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.

Mechanical Properties : IS 10748/2004

Grade	Yield Strength	Ultimate Tensile Strength	Elongation% GL=5.65 √So	Internal Diameter of bend
	MPa min	MPa min		
I	170	290	30	T
II	210	330	28	2T
III	240	410	25	2T
IV	275	430	20	3T
V	310	490	15	3T

* Supplied on basis of chemical composition for IS10748

Chemical Composition : IS 11513/2011

Sl. No.	Designation	Grade	Name	Constituent, Percent, Max				
				Carbon	Manganese	Sulphur	Phosphorus	MA
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(i)	CR0	H	Hard	0.25	1.70	0.045	0.050	–
(ii)	CR1	O	Commercial	0.15	0.60	0.040	0.040	–
(iii)	CR2	D	Drawing	0.12	0.50	0.035	0.035	–
(iv)	CR3	DD	Deep Drawing	0.10	0.45	0.030	0.030	–
(v)	CR4	EDD	Extra deep drawing aluminium killed (non-ageing)	0.08	0.40	0.025	0.025	–

Notes:

1. Steels of these grades can be supplied with the addition of MA (micro-alloying) elements like boron, titanium, niobium and vanadium. The micro-alloying elements shall not exceed 0.008 percent in case of boron and 0.20 percent in case of other elements.
2. The mitrogen content of the steel shall not be more than 0.007 percent. For aluminium killed or silicon-aluminium killed, the nitrogen content shall not exceed 0.012 percent. 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 percent. When the steel is silicon killed the silicon content shall not be less than 0.10 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.
5. When copper bearing steel is required the copper content shall be between 0.20 and 0.35 percent. In case of product analysis, the copper content shall be between 0.17 and 0.38 percent.
6. Restricted chemistry may be mutually agreed to between the purchaser and the supplier.

* Supplied on basis of chemical composition

Chemical Composition : SAILCOR

Specification	Grade	C % max	Mn % max	P % max	S % max	Si % max	Al % min
IS:11513 CR 4	SAIL SOFT	0.06	0.25	0.025	0.025	0.04	0.020

Chemical Composition : SAILCOR

Specification	Grade	C % max	Mn % max	P % max	S % max	Si % max
SAIL COR	IRSM 41	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 0.03 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