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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Grade</th>
<th>Designation</th>
<th>Si %</th>
<th>Mn %</th>
<th>P %</th>
<th>S % max</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS: 13502:2005</td>
<td>Steel-making</td>
<td>PG Si X Mn 1 P40</td>
<td>See Note 1</td>
<td>&lt;0.5</td>
<td>&lt;0.4</td>
<td>0.06</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Integer No.</th>
<th>Steelmaking Pig Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≤0.75</td>
</tr>
<tr>
<td>2</td>
<td>&gt;0.75 but ≤1.25</td>
</tr>
<tr>
<td>3</td>
<td>&gt;1.25 but ≤1.75</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Quality</th>
<th>Constituent, Percent, Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Carbon</td>
</tr>
<tr>
<td>HR0</td>
<td>0.25</td>
</tr>
<tr>
<td>HR1</td>
<td>0.15</td>
</tr>
<tr>
<td>HR2</td>
<td>0.10</td>
</tr>
<tr>
<td>HR3</td>
<td>0.08</td>
</tr>
<tr>
<td>HR4</td>
<td>0.08</td>
</tr>
<tr>
<td>ISH270C</td>
<td>0.08</td>
</tr>
<tr>
<td>ISH270D</td>
<td>0.06</td>
</tr>
<tr>
<td>ISH270E</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Designation</th>
<th>Tensile Strength max MPa</th>
<th>Percentage Elongation after Fracture A, min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>t≤3</td>
<td>t&gt;3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gauge length Lo = 80</td>
<td>Gauge length Lo = 50</td>
</tr>
<tr>
<td>HRO</td>
<td>Ordinary</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>HR1</td>
<td>Commercial</td>
<td>440</td>
<td>23</td>
</tr>
<tr>
<td>HR2</td>
<td>General Purpose</td>
<td>420</td>
<td>25</td>
</tr>
<tr>
<td>HR3</td>
<td></td>
<td>400</td>
<td>28</td>
</tr>
<tr>
<td>HR4</td>
<td></td>
<td>380</td>
<td>31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality</th>
<th>Yield Strength (Yield Point/Proof Stress)** MPa</th>
<th>Tensile Strength MPa</th>
<th>Percentage Elongation after Fracture A, min**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Designation</td>
<td>t≤2</td>
<td>t&gt;2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2st&lt;3.2</td>
<td>t≥3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gl. Lo = 50 mm</td>
<td>Gl. Lo = 80 mm</td>
</tr>
<tr>
<td>ISH270C</td>
<td>170, Min</td>
<td>270-420</td>
<td>26</td>
</tr>
<tr>
<td>ISH270D</td>
<td>Drawing Quality</td>
<td>170, Min</td>
<td>165, Min</td>
</tr>
<tr>
<td>ISH270E</td>
<td>165, Min</td>
<td>155, Min</td>
<td>145, Min</td>
</tr>
</tbody>
</table>

**Notes:**

1. 1 MPa = 1 N/mm²

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>Ladle Analysis, wt % Max</th>
<th>Carbon Equivalent, Max</th>
<th>Mode of Deoxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Mn</td>
<td>S</td>
</tr>
<tr>
<td>E 250</td>
<td>A</td>
<td>0.23</td>
<td>1.50</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>BR, BO</td>
<td>0.22</td>
<td>1.50</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.20</td>
<td>1.50</td>
<td>0.040</td>
</tr>
<tr>
<td>E 275</td>
<td>A</td>
<td>0.23</td>
<td>1.50</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>BR, BO</td>
<td>0.22</td>
<td>1.50</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.20</td>
<td>1.50</td>
<td>0.040</td>
</tr>
<tr>
<td>E 300</td>
<td>A, BR, BO</td>
<td>0.20</td>
<td>1.50</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.20</td>
<td>1.50</td>
<td>0.040</td>
</tr>
<tr>
<td>E 350</td>
<td>A, BR, BO</td>
<td>0.20</td>
<td>1.55</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.20</td>
<td>1.55</td>
<td>0.040</td>
</tr>
<tr>
<td>E 410</td>
<td>A, BR, BO</td>
<td>0.20</td>
<td>1.60</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.20</td>
<td>1.60</td>
<td>0.040</td>
</tr>
<tr>
<td>E 450</td>
<td>A, BR</td>
<td>0.22</td>
<td>1.65</td>
<td>0.045</td>
</tr>
<tr>
<td>E 550</td>
<td>A, BR</td>
<td>0.22</td>
<td>1.65</td>
<td>0.020</td>
</tr>
<tr>
<td>E 600</td>
<td>A, BR</td>
<td>0.22</td>
<td>1.70</td>
<td>0.020</td>
</tr>
</tbody>
</table>

**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.
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 C, 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 C, 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

<table>
<thead>
<tr>
<th>Grade Designation</th>
<th>Quality</th>
<th>Tensile Strength $R_{e, min}$ MPa</th>
<th>Yield Stress $R_{p, 0, 2}$ MPa</th>
<th>Percentage Elongation $A_{%, min}$</th>
<th>Internal Bend Diameter $Min$</th>
<th>Charpy Impact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\leq 20$</td>
<td>$20-40$</td>
<td>$&gt;40$</td>
<td>$&lt;25$</td>
<td>$&gt;25$</td>
</tr>
<tr>
<td>E-250</td>
<td>A</td>
<td>410</td>
<td>250</td>
<td>240</td>
<td>230</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BO</td>
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</tr>
<tr>
<td></td>
<td>C</td>
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</tr>
<tr>
<td>E-275</td>
<td>A</td>
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<td>275</td>
<td>265</td>
<td>256</td>
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</tr>
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<td></td>
<td>BR</td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>C</td>
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</tr>
<tr>
<td>E-300</td>
<td>A</td>
<td>440</td>
<td>300</td>
<td>290</td>
<td>280</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-350</td>
<td>A</td>
<td>490</td>
<td>350</td>
<td>330</td>
<td>320</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BO</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-410</td>
<td>A</td>
<td>540</td>
<td>410</td>
<td>390</td>
<td>380</td>
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</tr>
<tr>
<td></td>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-450</td>
<td>A</td>
<td>570</td>
<td>450</td>
<td>430</td>
<td>420</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>E-550</td>
<td>BR</td>
<td>650</td>
<td>550</td>
<td>530</td>
<td>520</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-600</td>
<td>BR</td>
<td>730</td>
<td>600</td>
<td>580</td>
<td>570</td>
<td>12</td>
</tr>
</tbody>
</table>

**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 $\pm$ 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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SAILMA 300</td>
<td>0.20</td>
<td>1.50</td>
<td>0.045</td>
<td>0.045</td>
<td>0.02</td>
<td>0.45</td>
<td>0.44</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 300 HI</td>
<td>0.20</td>
<td>1.50</td>
<td>0.040</td>
<td>0.040</td>
<td>0.02</td>
<td>0.45</td>
<td>0.43</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 350</td>
<td>0.20</td>
<td>1.55</td>
<td>0.045</td>
<td>0.045</td>
<td>0.02</td>
<td>0.45</td>
<td>0.46</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 350 HI</td>
<td>0.20</td>
<td>1.55</td>
<td>0.040</td>
<td>0.040</td>
<td>0.02</td>
<td>0.45</td>
<td>0.45</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 410</td>
<td>0.20</td>
<td>1.60</td>
<td>0.045</td>
<td>0.045</td>
<td>0.02</td>
<td>0.45</td>
<td>0.48</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 410 HI</td>
<td>0.20</td>
<td>1.60</td>
<td>0.040</td>
<td>0.040</td>
<td>0.02</td>
<td>0.45</td>
<td>0.48</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 450</td>
<td>0.20</td>
<td>1.65</td>
<td>0.045</td>
<td>0.045</td>
<td>0.02</td>
<td>0.45</td>
<td>0.50</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 450 HI</td>
<td>0.20</td>
<td>1.65</td>
<td>0.040</td>
<td>0.040</td>
<td>0.02</td>
<td>0.45</td>
<td>0.50</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 550</td>
<td>0.20</td>
<td>1.65</td>
<td>0.020</td>
<td>0.025</td>
<td>0.02</td>
<td>0.50</td>
<td>0.54</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 550 HI</td>
<td>0.20</td>
<td>1.65</td>
<td>0.015</td>
<td>0.025</td>
<td>0.02</td>
<td>0.50</td>
<td>0.54</td>
<td>≤ 0.25</td>
</tr>
<tr>
<td>SAILMA 600</td>
<td>0.22</td>
<td>1.70</td>
<td>0.015</td>
<td>0.025</td>
<td>0.02</td>
<td>0.50</td>
<td>0.54</td>
<td>≤ 0.25</td>
</tr>
</tbody>
</table>

For Hot Rolled coils, S is maintained below 0.030%.

### Mechanical Properties: SAILMA Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>YS, MPa  min</th>
<th>UTS Mpa, min</th>
<th>% El Std GL</th>
<th>Internal Bend Diameter, min</th>
<th>Charpy Impact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤25 mm 25-40 mm</td>
<td>&gt;40 mm</td>
<td></td>
<td>≤25 mm &gt;25 mm</td>
<td>Temp °C</td>
</tr>
<tr>
<td>SAILMA 300</td>
<td>300</td>
<td>290</td>
<td>280</td>
<td>440</td>
<td>24</td>
</tr>
<tr>
<td>SAILMA 300 HI</td>
<td>300</td>
<td>290</td>
<td>280</td>
<td>440</td>
<td>24</td>
</tr>
<tr>
<td>SAILMA 350</td>
<td>350</td>
<td>350</td>
<td>320</td>
<td>490</td>
<td>24</td>
</tr>
<tr>
<td>SAILMA 350 HI</td>
<td>350</td>
<td>350</td>
<td>320</td>
<td>490</td>
<td>24</td>
</tr>
<tr>
<td>SAILMA 410</td>
<td>410</td>
<td>390</td>
<td>380</td>
<td>540</td>
<td>22</td>
</tr>
<tr>
<td>SAILMA 410 HI</td>
<td>410</td>
<td>390</td>
<td>380</td>
<td>540</td>
<td>22</td>
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<tr>
<td>SAILMA 450</td>
<td>450</td>
<td>430</td>
<td>420</td>
<td>570</td>
<td>22</td>
</tr>
<tr>
<td>SAILMA 450 HI</td>
<td>450</td>
<td>430</td>
<td>420</td>
<td>570</td>
<td>22</td>
</tr>
<tr>
<td>SAILMA 550</td>
<td>550</td>
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<td>520</td>
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</tr>
<tr>
<td>SAILMA 550 HI</td>
<td>550</td>
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<td>600</td>
<td>580</td>
<td>570</td>
<td>730</td>
<td>14</td>
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</table>

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>C, max</th>
<th>Mn, max</th>
<th>Si, max</th>
<th>P, max</th>
<th>S, max</th>
<th>Micro alloy, max</th>
<th>CE, max</th>
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<tr>
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<td>0.040</td>
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<tr>
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<td>0.80</td>
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<td>0.040</td>
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<td>0.15</td>
<td>-</td>
</tr>
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</tr>
<tr>
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<td>0.040</td>
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<td>0.030</td>
<td>0.15</td>
<td>0.42</td>
</tr>
<tr>
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<td>0.040</td>
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<td>0.42</td>
</tr>
<tr>
<td>IS 5986 ISH440S</td>
<td>0.24</td>
<td>1.50(1)</td>
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<td>0.040</td>
<td>0.030</td>
<td>0.15</td>
<td>0.45</td>
</tr>
<tr>
<td>IS 5986 ISH490S</td>
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<td>1.60(1)</td>
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<td>0.040</td>
<td>0.040</td>
<td>0.15</td>
<td>0.50</td>
</tr>
<tr>
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<td>0.020</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>IS 5986 ISH390LA</td>
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<td>0.020</td>
<td>0.22</td>
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</tr>
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<td>IS 5986 ISH410LA</td>
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<td>1.40</td>
<td>0.50</td>
<td>0.025</td>
<td>0.020</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>IS 5986 ISH450LA</td>
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<td>0.50</td>
<td>0.025</td>
<td>0.020</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>IS 5986 ISH450LA</td>
<td>0.12</td>
<td>1.50(1)</td>
<td>0.50</td>
<td>0.025</td>
<td>0.020</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>IS 5986 ISH500LA</td>
<td>0.12</td>
<td>1.60(1)</td>
<td>0.50</td>
<td>0.025</td>
<td>0.015</td>
<td>0.22</td>
<td>(2)</td>
</tr>
<tr>
<td>IS 5986 ISH500LA</td>
<td>0.12</td>
<td>1.60(1)</td>
<td>0.50</td>
<td>0.025</td>
<td>0.015</td>
<td>0.22</td>
<td>(2)</td>
</tr>
<tr>
<td>IS 5986 ISH600LA</td>
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<td>1.80</td>
<td>0.50</td>
<td>0.025</td>
<td>0.015</td>
<td>0.22</td>
<td>(2)</td>
</tr>
<tr>
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<td>1.50(1)</td>
<td>0.50</td>
<td>0.030</td>
<td>0.020</td>
<td>0.20</td>
<td>(2)</td>
</tr>
<tr>
<td>IS 5986 ISH490R</td>
<td>0.20</td>
<td>1.60(1)</td>
<td>0.50</td>
<td>0.030</td>
<td>0.020</td>
<td>0.20</td>
<td>(2)</td>
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<tr>
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<td>1.70</td>
<td>0.50</td>
<td>0.030</td>
<td>0.020</td>
<td>0.20</td>
<td>(2)</td>
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<tr>
<td>IS 5986 ISH550R</td>
<td>0.20</td>
<td>1.80</td>
<td>(2)</td>
<td>0.030</td>
<td>0.020</td>
<td>0.20</td>
<td>(2)</td>
</tr>
</tbody>
</table>

### 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 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 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 copper 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 up to 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

<table>
<thead>
<tr>
<th>Grade</th>
<th>YS, MPa (min)</th>
<th>UTS, Mpa</th>
<th>%EI GL=80 mm (ts≤3 mm)</th>
<th>%EI GL=5.65y/So (ts≤3 mm)</th>
<th>Bend ts≤12 mm</th>
<th>Bend ts&gt;12 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 5986 ISH30S</td>
<td>165</td>
<td>290-400</td>
<td>22</td>
<td>30</td>
<td>close</td>
<td>1t</td>
</tr>
<tr>
<td>IS 5986 ISH29S</td>
<td>205</td>
<td>330-440</td>
<td>20</td>
<td>28</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH360S</td>
<td>255</td>
<td>360-470</td>
<td>19</td>
<td>26</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH410S</td>
<td>255</td>
<td>410-520</td>
<td>17</td>
<td>23</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH490S</td>
<td>355</td>
<td>490-630</td>
<td>16</td>
<td>20</td>
<td>2t</td>
<td>3t</td>
</tr>
<tr>
<td>IS 5986 ISH320LA</td>
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<td>320-420</td>
<td>25</td>
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<td>1t</td>
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<td>360-460</td>
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<td>25</td>
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</tr>
<tr>
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<td>390-510</td>
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<td>24</td>
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<td>1t</td>
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<td>IS 5986 ISH410LA</td>
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<td>23</td>
<td>0.5t</td>
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</tr>
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<td>430-550</td>
<td>19</td>
<td>23</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH450LA</td>
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<td>450-570</td>
<td>18</td>
<td>21</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH480LA</td>
<td>420</td>
<td>480-620</td>
<td>16</td>
<td>19</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH500LA</td>
<td>450</td>
<td>500-670</td>
<td>14</td>
<td>18</td>
<td>1t</td>
<td>2t</td>
</tr>
<tr>
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<td>550-700</td>
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<td>14</td>
<td>1.5t</td>
<td>2t</td>
</tr>
<tr>
<td>IS 5986 ISH600LA</td>
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<td>600-760</td>
<td>12</td>
<td>14</td>
<td>1.5t</td>
<td>2t</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>YS, MPa (min)</th>
<th>UTS, Mpa</th>
<th>%EI GL=50 mm</th>
<th>%EI GL=6.3 mm</th>
<th>Bend ts≤6.3 mm</th>
<th>Bend ts≥6.3 mm</th>
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<tbody>
<tr>
<td></td>
<td>ts≤2</td>
<td>2σt&lt;3.2</td>
<td>3.2σt&lt;6.3</td>
<td>t≥6.3</td>
<td>ts≤2</td>
<td>2σt&lt;3.2</td>
</tr>
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<td>185</td>
<td>175</td>
<td>165</td>
<td>310</td>
<td>33</td>
</tr>
<tr>
<td>IS 5986 ISH30S</td>
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<td>215</td>
<td>205</td>
<td>195</td>
<td>370</td>
<td>32</td>
</tr>
<tr>
<td>IS 5986 ISH240S</td>
<td>245-375</td>
<td>235-355</td>
<td>225-345</td>
<td>215</td>
<td>400</td>
<td>31</td>
</tr>
<tr>
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<td>275-390</td>
<td>265-380</td>
<td>255</td>
<td>440</td>
<td>29</td>
</tr>
<tr>
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<td>305-440</td>
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<td>295</td>
<td>440</td>
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<td>355-480</td>
<td>345</td>
<td>490</td>
<td>22</td>
</tr>
<tr>
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<td>430-570</td>
<td>420-560</td>
<td>410-550</td>
<td>400</td>
<td>540</td>
<td>19</td>
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<td>450-610</td>
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### Chemical Composition: IS 10748/2004

<table>
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<th>C % max</th>
<th>Mn % max</th>
<th>P % max</th>
<th>S % max</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
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<td>0.50</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>II</td>
<td>0.12</td>
<td>0.60</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>III</td>
<td>0.16</td>
<td>1.20</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>IV</td>
<td>0.20</td>
<td>1.30</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>V</td>
<td>0.25</td>
<td>1.30</td>
<td>0.040</td>
<td>0.040</td>
</tr>
</tbody>
</table>

*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 not 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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Yield Strength</th>
<th>Ultimate Tensile Strength</th>
<th>Elongation% GL=5.65 Vs0</th>
<th>Internal Diameter of bend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPa min</td>
<td>MPa min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>170</td>
<td>290</td>
<td>30</td>
<td>T</td>
</tr>
<tr>
<td>II</td>
<td>210</td>
<td>330</td>
<td>28</td>
<td>2T</td>
</tr>
<tr>
<td>III</td>
<td>240</td>
<td>410</td>
<td>25</td>
<td>2T</td>
</tr>
<tr>
<td>IV</td>
<td>275</td>
<td>450</td>
<td>20</td>
<td>3T</td>
</tr>
<tr>
<td>V</td>
<td>310</td>
<td>490</td>
<td>15</td>
<td>3T</td>
</tr>
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</table>

* Supplied on basis of chemical composition for IS10748
### Chemical Composition : IS 11513/2011

<table>
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<th>Designation</th>
<th>Grade</th>
<th>Name</th>
<th>Carbon</th>
<th>Manganese</th>
<th>Sulphur</th>
<th>Phosphorus</th>
<th>MA</th>
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</thead>
<tbody>
<tr>
<td>(i)</td>
<td>CR0</td>
<td>H</td>
<td>Hard</td>
<td>0.25</td>
<td>1.70</td>
<td>0.045</td>
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<td>(ii)</td>
<td>CR1</td>
<td>O</td>
<td>Commercial</td>
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<td>0.040</td>
<td>0.040</td>
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<td>(iii)</td>
<td>CR2</td>
<td>D</td>
<td>Drawing</td>
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<td>(iv)</td>
<td>CR3</td>
<td>DD</td>
<td>Deep Drawing</td>
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</tr>
<tr>
<td>(v)</td>
<td>CR4</td>
<td>EDD</td>
<td>Extra deep drawing aluminium killed (non-ageing)</td>
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<td>0.40</td>
<td>0.025</td>
<td>0.025</td>
<td>—</td>
</tr>
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</table>

**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 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 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 0.05 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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Grade</th>
<th>C % max</th>
<th>Mn % max</th>
<th>P % max</th>
<th>S % max</th>
<th>Si % max</th>
<th>Al % min</th>
</tr>
</thead>
<tbody>
<tr>
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<td>SAIL SOFT</td>
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<td>0.25</td>
<td>0.025</td>
<td>0.025</td>
<td>0.04</td>
<td>0.020</td>
</tr>
</tbody>
</table>

### Chemical Composition : SAILCOR

<table>
<thead>
<tr>
<th>Specification</th>
<th>Grade</th>
<th>C % max</th>
<th>Mn % max</th>
<th>P % max</th>
<th>S % max</th>
<th>Si % max</th>
</tr>
</thead>
<tbody>
<tr>
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<td>ISRM 41</td>
<td>0.10</td>
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<td>0.75-0.140</td>
<td>0.030</td>
<td>0.28-0.72</td>
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</tbody>
</table>

Cr 0.35-0.60, Ni 0.20-0.47, Cu 0.30-0.60, Al 0.03 max

### Mechanical Properties : SAILCOR

<table>
<thead>
<tr>
<th>Specification</th>
<th>Grade</th>
<th>Yield Strength MPa min</th>
<th>Ultimate Tensile Strength MPa min</th>
<th>Elongation% Std GL</th>
<th>Internal Diameter of bend</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAIL COR</td>
<td>HR</td>
<td>340</td>
<td>480</td>
<td>22</td>
<td>t</td>
</tr>
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</table>