LRPC STRANDS-CONSTRUCTION PRODUCTS

Usha Martin's continued investment in technology and equipment consistently push products to the highest quality standards. Years of engineering excellence, demonstrates our commitment to our customers in the construction industry. To keep pace with new concepts and constructional revolutions, Usha Martin product basket encompasses a comprehensive range of LRPC strands, namely:

- Bright Low relaxation (LRPC)/Normal relaxation (NRPC) Strand
- Galvanized LRPC Strand
- Polymer Coated*/Galvanized*/Bright LRPC Strand
  - Grease/Wax Filled - Un-bonded LRPC Strand.
  - Bonded LRPC Strand
- Plain, Indented & Ribbed high tensile steel wire for Prestressed concrete.

*LRPC Strands of all available sizes and grades can be polymer sheathed & galvanized in conformance to all national and international specifications.
NATIONAL PRESENCE

- Sale Offices
  1. Bangalore
  2. Chandigarh
  3. Chennai
  4. Delhi
  5. Faridabad
  6. Ghaziabad
  7. Indore
  8. Jaipur
  9. Kolkata
  10. Ludhiana
  11. Madurai
  12. Mumbai
  13. Nagpur
  14. Pune
  15. Rajkot

- Manufacturing Facilities
  1. Hoshiarpur
  2. Jamshedpur
  3. Ranchi
  4. Silvasa

- Head Office
  Kolkata

OUR VALUED CLIENTS

NATIONAL
- NATIONAL HIGHWAY AUTHORITY OF INDIA (NHA)
- PUBLIC WORKS DIVISION (PWD)
- NUCLEAR POWER CORPORATION
- DELHI METRO RAILWAY CORPORATION
- KOLKATA METRO RAILWAYS
- NATIONAL THERMAL POWER CORPORATION
- IT PARKS & MULTISTORIED COMPLEX BY PRIVATE CONTRACTORS

INTERNATIONAL OVERSEAS CUSTOMERS SPREAD OVER
- GULF & MIDDLE EAST COUNTRIES
- PAPUA NEW GUINEA
- BANGLADESH
- SOUTH AFRICA
- AUSTRALIA

ISO 9001:2008

DELI METRO RAIL CORPORATION LTD.
HIGH TENSILE STEEL STRANDS

for Prestressed Concrete (Low Relaxation)

Why Low Relaxation Strands?

A steel member that is prestressed and embedded in concrete, loses the initially applied stress exponentially with the passage of time. The utmost important factor attributing to this loss in stress is the stress relaxation property of the steel itself. By treating the steel through a thermomechanical process known as stabilising, the propensity of the steel to "relax" under a stressed condition is controlled to a great extent. Some of the main advantages that our customers derive by using low relaxation strands are listed below:

- Upto 10% reduction in steel requirement is possible.
- Saving in number of anchorages, ducts, sheathings, wedges and labour resulting in overall reduction of project cost.
- Reduction in concrete requirement due to reduced size of structural members.
- Thermo-mechanical processing during manufacture of LRPC Strands produces a nearly straight strand, thereby eliminating necessity for extra post straightening treatment.

### Product Specifications

#### Bright (Unalvanized LRPC Strands)

#### INDIAN SPECIFICATIONS : IS-14268/1995

<table>
<thead>
<tr>
<th>Class</th>
<th>Nominal Diameter of Strand</th>
<th>Tolerance</th>
<th>Nominal area of Strand</th>
<th>Minimum Breaking Strength of Strand</th>
<th>0.2 Proof load of Breaking Strength</th>
<th>0.2% Elongation (GL=600mm)</th>
<th>Nominal Weight of Strand</th>
<th>Relaxation Loss</th>
<th>Chemical Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm²)</td>
<td>(kN)</td>
<td>(kg)</td>
<td>(kg/km)</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>9.5</td>
<td>+0.66 -0.15</td>
<td>54.8</td>
<td>102.3</td>
<td>10434</td>
<td>92.1</td>
<td>9394</td>
<td>432</td>
<td>2.5 max. at 70% of specified min. breaking load after 1000 hours OR 1.8 max. at 70% of specified min. breaking load after 100 hours</td>
</tr>
<tr>
<td>11.1</td>
<td>+0.66 -0.15</td>
<td>74.2</td>
<td>137.9</td>
<td>14065</td>
<td>124.1</td>
<td>12658</td>
<td>582</td>
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<td></td>
</tr>
<tr>
<td>12.7</td>
<td>+0.66 -0.15</td>
<td>98.7</td>
<td>183.7</td>
<td>18737</td>
<td>165.3</td>
<td>16860</td>
<td>775</td>
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</tr>
<tr>
<td>15.2</td>
<td>+0.66 -0.15</td>
<td>140.0</td>
<td>260.7</td>
<td>26592</td>
<td>234.6</td>
<td>23929</td>
<td>1102</td>
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#### BRITISH SPECIFICATIONS : BS-5896 : 1980

<table>
<thead>
<tr>
<th>Type of Strand</th>
<th>Nominal Diameter</th>
<th>Tolerance</th>
<th>Tensile strength</th>
<th>Specified Characteristic breaking strength</th>
<th>Load at 1% Elongation</th>
<th>Relaxation</th>
<th>Initial load (% of actual breaking load)</th>
<th>Maximum 1000 hrs Class 1 Class 2</th>
<th>Minimum Elastic at max load</th>
<th>Nominal Mass (kg/1000m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Wire Standard</td>
<td>9.3 11.0 12.5 15.2</td>
<td>±0.30 -0.15 ±0.40 -0.20</td>
<td>52 71 93 139</td>
<td>1770 1770 1770 1670</td>
<td>92 125 164 232</td>
<td>81 110 144 204</td>
<td>60% 70% 80% 120%</td>
<td>4.5% 8.0% 2.5% 4.5%</td>
<td>408 557 730 1090</td>
<td></td>
</tr>
<tr>
<td>7 Wire Super</td>
<td>9.6 11.3 12.9 15.7</td>
<td>±0.30 -0.15 ±0.40 -0.20</td>
<td>55 75 100 150</td>
<td>1860 1860 1860 1770</td>
<td>102 139 186 265</td>
<td>90 122 163 233</td>
<td>70% 80% 120%</td>
<td>10% 2.5% 4.5%</td>
<td>432 590 785 1180</td>
<td></td>
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</tbody>
</table>

#### ASTM SPECIFICATIONS : A416

<table>
<thead>
<tr>
<th>Grade</th>
<th>Nominal Diameter of Strand</th>
<th>Tolerance</th>
<th>Nominal area of Strand</th>
<th>Minimum Breaking Strength of Strand</th>
<th>Minimum load at 1% Extension</th>
<th>Nominal Weight of Strand</th>
<th>1000 hrs Relaxation</th>
<th>Minimum % Extension GL 600 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(inch)</td>
<td>(mm)</td>
<td>(inch²)</td>
<td>(lb)</td>
<td>(lb/1000ft)</td>
<td>(kg)</td>
<td>(%)</td>
<td>(%)</td>
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<tr>
<td>270</td>
<td>3/8</td>
<td>9.53</td>
<td>+0.026 -0.15</td>
<td>54.84</td>
<td>23000</td>
<td>102.3</td>
<td>20700</td>
<td>92.1</td>
</tr>
<tr>
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<td>7/16</td>
<td>11.1</td>
<td>+0.026 -0.15</td>
<td>54.84</td>
<td>23000</td>
<td>102.3</td>
<td>20700</td>
<td>92.1</td>
</tr>
<tr>
<td></td>
<td>1/2</td>
<td>12.7</td>
<td>-0.06 -0.15</td>
<td>54.84</td>
<td>23000</td>
<td>102.3</td>
<td>20700</td>
<td>92.1</td>
</tr>
<tr>
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<td>6/10</td>
<td>15.2</td>
<td>-0.06 -0.15</td>
<td>54.84</td>
<td>23000</td>
<td>102.3</td>
<td>20700</td>
<td>92.1</td>
</tr>
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### SPEC – prEN10138 – 3: Dimension & Properties of Strands

<table>
<thead>
<tr>
<th>Class</th>
<th>Steel Designation</th>
<th>Steel Name</th>
<th>Steel Number</th>
<th>Diameter (mm)</th>
<th>Tensile Strength Rm (MPa)</th>
<th>Cross-Sectional Area A (mm²)</th>
<th>Mass (g/m)</th>
<th>Permitted Deviation on Nominal Mass (%)</th>
<th>Characteristic Value of Maximum Force f_m (kN)</th>
<th>Maximum Value of Maximum Force f_max (kN)</th>
<th>Characteristic Value of 0.2% Proof Force f_p,0.2 (kN)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Y186057</td>
<td>11366</td>
<td>9.0</td>
<td>11.0</td>
<td>12.5</td>
<td>13.0</td>
<td>15.2</td>
<td>16.0</td>
<td>1860</td>
<td>93</td>
<td>106</td>
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<td>50</td>
<td>93</td>
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<td>150</td>
<td>±2</td>
<td>75</td>
<td>140</td>
<td>160</td>
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<td></td>
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<td></td>
<td>390</td>
<td>726</td>
<td>781</td>
<td>1095</td>
<td>1170</td>
<td>±2</td>
<td>586</td>
<td>173</td>
<td>198</td>
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<td></td>
<td></td>
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<td>120</td>
<td>279</td>
<td>319</td>
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<td></td>
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<td>149</td>
<td>240</td>
<td>224</td>
</tr>
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<td></td>
<td></td>
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<td>160</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>228</td>
<td></td>
<td>240</td>
</tr>
</tbody>
</table>

Notes:

- **a** The Nominal Modulus of Elasticity may be taken to be 195 GPa (kN/mm²).
- **b** The Nominal Tensile Strength is calculated from the Nominal Cross-Sectional Area and the specified characteristic Maximum Force, rounded to the nearest 10 MPa.
- **c** The Cross-Sectional Area is calculated from the Nominal Mass and Density of 7.81 kg/dm³.
- **d** The specified characteristics 0.2% Proof Force is approximately 86% of the specified characteristic Maximum Force.

### SPEC – AS – 1311: Dimension, Masses and Minimum Breaking Force of 7 Wire Strand

<table>
<thead>
<tr>
<th>Nominal Diameter of strand (mm)</th>
<th>Nominal area (mm²)</th>
<th>Calculated mass (kg/1000 m)</th>
<th>Minimum Breaking Force (kN)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.3</td>
<td>52</td>
<td>410</td>
<td>94</td>
<td>REGULAR</td>
</tr>
<tr>
<td>10.9</td>
<td>71</td>
<td>555</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>12.7</td>
<td>94</td>
<td>740</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>139</td>
<td>1090</td>
<td>227</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>55</td>
<td>430</td>
<td>102</td>
<td>SUPER</td>
</tr>
<tr>
<td>10.9</td>
<td>75</td>
<td>590</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>12.7</td>
<td>100</td>
<td>785</td>
<td>184</td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>143</td>
<td>1125</td>
<td>250</td>
<td>EXTRA – HIGH TENSILE</td>
</tr>
<tr>
<td>15.2</td>
<td>143</td>
<td>1125</td>
<td>261</td>
<td></td>
</tr>
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</table>
**SPEC - ISO 6934 - 4 : 1991 (E) : Dimension, Masses and Tensile Properties of 7 Wire Strand**

<table>
<thead>
<tr>
<th>Type of Strand</th>
<th>Nominal Stand Diameter</th>
<th>Nominal Tensile Strength</th>
<th>Nominal Cross-Sectional Area</th>
<th>Mass Per Length</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mm)</td>
<td>(mm^2)</td>
<td>(mm^2)</td>
<td>(g/m)</td>
<td>Permissible Deviation</td>
</tr>
<tr>
<td>7-Wire Ordinary</td>
<td>9.5</td>
<td>1860</td>
<td>54.8</td>
<td>432.0</td>
<td>+4 -2</td>
</tr>
<tr>
<td></td>
<td>10.8</td>
<td>1720</td>
<td>69.7</td>
<td>546.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.1</td>
<td>1860</td>
<td>74.2</td>
<td>580.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.4</td>
<td>1720</td>
<td>92.9</td>
<td>729.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.7</td>
<td>1860</td>
<td>95.7</td>
<td>774.0</td>
<td></td>
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<tr>
<td></td>
<td>15.2</td>
<td>1720</td>
<td>139.0</td>
<td>1101.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.2</td>
<td>1860</td>
<td>139.0</td>
<td>1101.0</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1* The type of Strand, Nominal Diameter and Nominal Tensile Strength are for designation purposes only.

2* The nominal Tensile Strength is calculated from the nominal cross-sectional area and the specified characteristic maximum force (see footnote 5*).

3* No single test result shall be less than 85% of the specified characteristic value.

4* Considering the small tolerance on mass per length, characteristic forces have been specified rather than stresses.

5* The 0.1% Proof Force is mandatory and the 0.2% Proof Force is for information only (see ISO 6934-1), except when otherwise agreed.

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**Additional Specifications**

- PC strands as per following can also be supplied in case of specific demands:
  - IS4268, Class 1
  - ASTM A416, Grade 250
  - JIS G 3536, Grade SW P7AL, SWPR7BL
  - Normal Relaxation PC Strands as per IS6006
INTRODUCING FOR THE FIRST TIME IN INDIA

Galvanised LRPC Strands:
Apart from Bright LRPC Strands, for some application, particularly in the case of extreme corrosive environment, Usha Martin's Galvanized LRPC Strands provides the additional protection required, and can be manufactured to customer requirements. The physical and mechanical properties of the galvanized strands manufactured from hot - dip galvanized wires are at par with the bright strands for that particular diameter. Galvanization increases the resistance to corrosion led fatigue thereby resulting in enhanced service life.

Zinc coating weight can be supplied as per the customer requirements, varying from 190 - 340 gm/sq m.

Polymer Coated Galvanized / Bright LRPC Strand:
The extruded thermoplastic coating becomes an integral part of the strand and is highly recommended for construction industry. The coating seals out contaminants, cushions the strands, resists abrasion and increases the life cycle capability of the structure.

Usha Martin's extensive background in cable sheathing technology and extrusion capability facilitates products with smooth, uniform and concentric coating of Polymer with premium quality. Usha Martin offers a selection of choices of types (family), thickness and colours (UV stabilized) of Polymers suitable for LRPC strand sheathing.
Grease Filled - Un-bonded LRPC Strand-For Post Tensioning

This speciality LRPC Strand may be bright or galvanized depending upon the environment, is coated with a corrosion resistant / water repellent - high temperature grease / wax to fill the interstices between the wires followed by a co-extrusion of an UV stabilized Polymer layer with thickness (min 0.5 mm, max as per customer's requirement). Usha Martin's Galvanized Un-bonded LRPC strands has an excellent durability and provides perfect protection against corrosion through tri-complimentary nested barrier formed by (1) galvanization followed by (2) anti-corrosive, water repellent - grease / wax coating in the interstices (3) UV stabilized polymer sheath. This particular arrangement also enables monitoring of strands, by replacing a post-tensioned strand at regular interval.

Bonded LRPC Strand (Galvanized/Bright) - For Stay Cables

Bonding implies adhesion of the polymer sheath with the steel surface of the LRPC Strand. Bonded LRPC Strands exhibits a strong bonding strength and conforms to the requirement of the customers. The state of art sheathing lines and stringent control parameters during manufacture, particularly with regard to diametrical concentricity of sheathing, consents Bridge Designers to bundle Usha Martin strands with confidence.

Properties of Sheathed Galvanized/Bright LRPC Strand Post Tensioning /Stay Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>LRPC Variants</th>
<th>Sheathing Thickness (mm)</th>
<th>Polymer Type (UV Stabilized)**</th>
<th>Zinc Coating weight g/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Tensioning</td>
<td>Unbonded (Grease Filled)</td>
<td>0.5</td>
<td>As per Customer's Requirement</td>
<td>PP: Standard Colour Orange OR PE: Standard Colour Black</td>
</tr>
<tr>
<td>Stay Cables</td>
<td>Bonded</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
PP : POLYPROPYLENE, PE : POLYETHYLENE

** Apart from the standard colours shown in the table, other colours can also be supplied as per customers requirement
# HIGH TENSILE STEEL WIRES

for Pre-stressed Concrete (Plain, Indented, Ribbed)

Applications: Concrete poles, Railway sleepers, Hume pipes, Bridges.

BRITISH SPECIFICATIONS: BS-5896:1980

<table>
<thead>
<tr>
<th>Nominal Diameter (mm)</th>
<th>Tolerance (mm)</th>
<th>Nominal UTS (kg/mm²)</th>
<th>Minimum Spec. Characteristics 0.1% Proof Load (kN)</th>
<th>Minimum load at 1% Elongation (kN)</th>
<th>Minimum Elongation % GL 200 mm (%)</th>
<th>Reverse Bend</th>
<th>Minimum Number of Bend Loops</th>
<th>Radius of Bend (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>0.05</td>
<td>160</td>
<td>50.1</td>
<td>51.3</td>
<td>3.5</td>
<td>4 for smooth</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>6.0</td>
<td>0.05</td>
<td>170</td>
<td>39.3</td>
<td>40.2</td>
<td>do</td>
<td>3 for indented</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>6.0</td>
<td>0.05</td>
<td>180</td>
<td>41.6</td>
<td>42.6</td>
<td>do</td>
<td>3</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>5.0</td>
<td>0.05</td>
<td>170</td>
<td>27.2</td>
<td>21.8</td>
<td>do</td>
<td>3</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>5.0</td>
<td>0.05</td>
<td>180</td>
<td>28.8</td>
<td>29.5</td>
<td>do</td>
<td>3</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>4.5</td>
<td>0.05</td>
<td>165</td>
<td>21.4</td>
<td>21.9</td>
<td>do</td>
<td>3</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>4.0</td>
<td>0.04</td>
<td>170</td>
<td>17.5</td>
<td>17.9</td>
<td>do</td>
<td>3</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4.0</td>
<td>0.04</td>
<td>180</td>
<td>18.5</td>
<td>19.0</td>
<td>do</td>
<td>3</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Notes:
- Maximum relaxation values after 100 hrs. as per Class 1 of BS specification
- Coli weights and IDs shall be as per table below

INDIAN SPECIFICATIONS: IS-1785 Part-1 (Stress Relieved)

<table>
<thead>
<tr>
<th>Nominal Diameter (mm)</th>
<th>Tolerance (mm)</th>
<th>Nominal UTS (kg/mm²)</th>
<th>Minimum Elongation GL=200 mm (%)</th>
<th>Bend Minimum Value</th>
<th>Bend Radius (mm)</th>
<th>Minimum 0.2% Proof Stress</th>
<th>Col DDS</th>
<th>Coll weights for stress relieved wires (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>0.025</td>
<td>205</td>
<td>2.5</td>
<td>3</td>
<td>7.5</td>
<td>85% of min. Tensile Strength for all wires.</td>
<td>1.5</td>
<td>200-300</td>
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<tr>
<td>3.0</td>
<td>0.04</td>
<td>190</td>
<td>2.5</td>
<td>3</td>
<td>10.0</td>
<td>1.5</td>
<td>200-300</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>0.05</td>
<td>175</td>
<td>3.0</td>
<td>3</td>
<td>12.5</td>
<td>1.5</td>
<td>300-500</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>0.05</td>
<td>160</td>
<td>4.0</td>
<td>3</td>
<td>15.0</td>
<td>1.5</td>
<td>300-500</td>
<td></td>
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<tr>
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<td>150</td>
<td>4.0</td>
<td>3</td>
<td>20.0</td>
<td>2.0</td>
<td>300-600</td>
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<td>140</td>
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<td>25.0</td>
<td>2.0</td>
<td>300-600</td>
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</tbody>
</table>
### INDIAN SPECIFICATIONS : IS-6003 (Stress Relieved & indented)

<table>
<thead>
<tr>
<th>Nominal Diameter (mm)</th>
<th>Tolerance (mm)</th>
<th>Nominal UTS (kg/mm²)</th>
<th>Minimum Elongation (GL=200 mm) (%)</th>
<th>Bend Minimum Value (nos.)</th>
<th>Bend Radius (mm)</th>
<th>Minimum 0.2% Proof Stress % of Minimum specified UTS for all wires.</th>
<th>Coil I.D. (metre)</th>
<th>Coil weights for stress relieved wires (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>0.05</td>
<td>190</td>
<td>2.5</td>
<td>3</td>
<td>10.0</td>
<td>85% of minimum for all wires.</td>
<td>1.5</td>
<td>200-300</td>
</tr>
<tr>
<td>4.0</td>
<td>0.05</td>
<td>175</td>
<td>3.0</td>
<td>3</td>
<td>12.5</td>
<td>1.5 - 2.0</td>
<td>300-500</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>0.05</td>
<td>160</td>
<td>4.0</td>
<td>3</td>
<td>15.0</td>
<td>1.5 - 2.0</td>
<td>300-500</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- Apart from plain wires, we can also produce two side/ indented wires and ribbed wires.
- In sizes 7.00 and 8.00mm stress relieved wire we can also manufacture 160 kg/mm² minimum tensile.
- Relaxation values at initial stress 70% of min. UTS for all wires are 5% max. after 1000 hrs. or 3.5% max. after 100 hrs.
- Wires can be supplied in uncoiled condition or can be coated with water soluble rust preventive oil.
- We can also produce wires in higher sizes conforming to the above specifications.
- We can also manufacture High tensile Steel Wires as per other standards.
- Wires of higher diameters can also be produced as per customers requirement.

**Packing:**

In coils wrapped with Polythene and Hessian or Polycoated Hessian or as per customer’s requirement.
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