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WELDING  
CONSUMABLES  
PRODUCT CATALOGUE

# Introduction

Weldfast Electrodes Pvt. Ltd., an ISO 9001 certified company, has well established state-of-the-art plants to manufacture high quality welding consumables for joining, fabrication, repairs and maintenance purposes since the year 1985.

Quality Control and well-established Quality Assurance Policy are integral features of the Weldfast manufacturing process. The company has been manufacturing & marketing "WELDFAST" series of SMAW Electrodes, MIG/ TIG & SAW wires for process, engineering & core sector industries to spectrum of industries. Our welding consumables conform to the requirements of BIS, ASME, BS, DIN and ISO specifications.

Weldfast Electrodes Pvt. Ltd. believes in improving relations with customer, based on mutual cooperation and consistent exchange of experience. The company has capacity to develop, test and manufacture new products as per the specific or exceptional requirements by the customer.

Through this brochure, in addition to providing information about the products, an attempt is made to incorporate information frequently required by the shop floor personnel, which may not be readily available to them.



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### Caution

*Due care has been taken to provide the accurate information in this manual. However, we do not assume any responsibility / liability arising out of adoption of any practice / information. Please contact us before adopting any information.*

*The pictures / photographs shown in this manual are indicative and do not necessarily purport to be the part of standard product/ product design. Weldfast Electrodes Pvt Ltd reserves the right to withdraw, change, alter any product, product packing without any notice.*

## 01 | MILD STEEL ELECTRODES

| No. | Product                                                                                                 | Characteristics                                                                                                                                                                                                                                                                                                                                                           |
|-----|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | <b>WELDFAST SUPER</b><br><br>AWS A / SFA - 5.1 E 6013<br>IS 814 / ER 4211X<br>DIN 1913 / E 4322R322     | <p>The electrode burns with smooth arc and least spatter. The welds are of radiographic quality.</p> <p>Re-drying temperature 120°C for ½ hr.</p> <p>Approvals : BHEL Trichy, NTPC, LRS Gr 1, ABS Gr 1, DNV Gr 1, IRS Gr 1, BV Gr 1, BIS, CIB (Maharashtra), MAHAGENCO, Thermax.</p>                                                                                      |
| 2   | <b>WELDFAST QUALITY</b><br><br>AWS A/ SFA - 5.1 E 6013<br>IS 814 / ER 4222X<br>DIN 1913 / E 4322R322    | <p>A medium coated rutile electrode suitable for all position welding. The electrode burns with smooth arc and least spatter. The strong protective gas shield ensures good X-ray quality deposit.</p> <p>Re-drying temperature 120°C for ½ hr.</p> <p><b>Approvals :</b> LRS Gr 2, ABS Gr 2, DNV Gr 2, IRS Gr 2, BV Gr2, BIS, CIB (Maharashtra), Thermax, MAHAGENCO.</p> |
| 3   | <b>WELDFAST SUPREME</b><br><br>AWS A / SFA - 5.1 E 6013<br>IS 814 / ERR 4222X<br>DIN 1913 / E 4322RR622 | <p>A heavy coated rutile electrode for very smooth bead appearance of the filling and capping runs. It produces smooth arc, clean and radiographic weld deposit, little spatter and slag is easy to remove.</p> <p>Re-drying temperature 120°C for ½ hr.</p> <p><b>Approvals :</b> BIS, CIB (Maharashtra), MAHAGENCO.</p>                                                 |





| Weld Analysis (%)                                                                                                 | Mechanical Properties                                                                                                                                                             | Application                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.60 (max)<br><b>Si</b> 0.40 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>UTS</b> 480-530 N/mm <sup>2</sup><br><b>YS</b> 380-490N/mm <sup>2</sup><br><b>Elongation %</b> 22-26<br><b>CVN Impact at 0°C</b> 55-60 J<br><b>Current</b> AC/DC <sup>+</sup>  | Steel structures and tanks, truck frames and bodies, machinery construction, auto body frames, railway wagons, ships, pipelines, bridges etc.                                                                                                                                   |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.60 (max)<br><b>Si</b> 0.40 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>UTS</b> 480-540 N/mm <sup>2</sup><br><b>YS</b> 370-500 N/mm <sup>2</sup><br><b>Elongation %</b> 23-27<br><b>CVN Impact at 0°C</b> 55-60 J<br><b>Current</b> AC/DC <sup>+</sup> | The electrode has wide application in fabrication of pressure vessels, tanks, rail wagons, ship building, pressure pipelines, steel furniture, auto bodies etc. suitable for joining steels conforming to ASTM. Specifications : SA-36/SA-36M, SA-285/SA-285M & SA-414/SA-414M. |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.60 (max)<br><b>Si</b> 0.40 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>UTS</b> 480-550 N/mm <sup>2</sup><br><b>YS</b> 370-500 N/mm <sup>2</sup><br><b>Elongation %</b> 23-27<br><b>CVN Impact at 0°C</b> 60-70 J<br><b>Current</b> AC/DC <sup>+</sup> | Storage tanks, railway wagons, automobile frames and bodies, boilers, rail coaches, ships, locomotive, fiber boxes etc.                                                                                                                                                         |

## 02 | LOW HYDROGEN ELECTRODES

| No. | Product                                                                                                                     | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4   | <b>WELDFAST LH 16</b><br><br>AWS A/SFA - 5.1 E 7016<br>IS 814 / EB 5426H <sub>3</sub> X<br>DIN 1913 / E 5144B1026           | <p>A medium coated, all position, basic type hydrogen controlled electrode for welding Mild Steel, Medium &amp; High Tensile Low Alloy steels, for depositing buffer layer before hard facing and for joining cast steel to mild steel. The weld deposit is of excellent X-ray quality. The electrode produces stable &amp; smooth arc, smooth uniform weld deposit and is easy in slag removal.</p> <p>Re-drying temperature 300°C for 1 hr.</p> <p><b>Approvals :</b> Indian Railways - CLASS A3/B1</p>             |
| 5   | <b>WELDFAST LH 18</b><br><br>AWS A/SFA - 5.1 E 7018<br>IS 814 / EB 5426H <sub>3</sub> JX<br>DIN 1913 / E5144B1026           | <p>A basic coated low hydrogen all position welding electrode with metal recovery of 110% approximately. The weld deposit has good toughness and excellent X- ray quality. It gives excellent arc stability, smooth arc and is very easy in slag removal.</p> <p>Re-drying temperature 300°C for 1 hr.</p> <p><b>Approvals :</b> BHEL Trichy, NTPC, LRS 3YH5, ABS 3YH5, DNV 3YH5, IRS 3YH5, BV, BIS, CIB (Maharashtra), Thermax, MAHAGENCO., Indian Railways - CLASS A4/B2.</p>                                       |
| 6   | <b>WELDFAST LH 18 - 1</b><br><br>AWS A/SFA - 5.1 E 7018-1<br>IS 814 / EB 5526H <sub>3</sub> JX<br>DIN 1913 / E 5155B1029    | <p>A basic coated low hydrogen all position welding electrode with deposition efficiency of approximately 110%. The weld metal has excellent toughness even at -50°C and satisfies X-ray, ultrasonic and radiographic requirements. Electrode gives smooth and stable arc, easy slag removal and is suitable for welding of pipes in 1G, 2G, 5G &amp; 6G positions.</p> <p>Re-drying temperature 300°C for 1 hr.</p> <p><b>Approvals :</b> LRS 4Y40H5, DNV 4Y40H5, BV 4Y40H5.</p>                                     |
| 7   | <b>WELDFAST LH 18 (NACE)</b><br><br>AWS A/SFA - 5.1 E 7018-1<br>IS 814 / EB 5629H <sub>3</sub> JX<br>DIN 1913 / E 5155B1029 | <p>A basic coated extra- low- hydrogen all position welding electrode with deposition efficiency of approximately 110%. The weld metal has excellent toughness even at -50°C and satisfies X-ray, ultrasonic and radiographic requirements. Electrode gives smooth and stable arc, with easy slag removal even from first pass in a vee groove. The weld metal which contain about 1.2% Mn, is extremely resistant to cold and hot cracking and tri-axial stressing.</p> <p>Re-drying temperature 300°C for 1 hr.</p> |



| Weld Analysis (%)                                                                                                   | Mechanical Properties                                                                                                                                                                      | Application                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.60 (max)<br><b>Si</b> 0.75 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)   | <b>UTS</b> 550-610 N/mm <sup>2</sup><br><b>YS</b> 430-540 N/mm <sup>2</sup><br><b>Elongation %</b> 24-28<br><b>CVN Impact at -30°C</b> 50-60 J<br><b>Current</b> AC/DC <sup>-</sup>        | Suitable for cast steels, difficult steels of unknown composition and for non machinable deposits on cast iron. Typical applications include coaches, ships, heavy duty structures, earth moving machinery, rotary kiln shells, boilers and pressure vessels. Used as Buffer layer before depositing hard facing electrodes.                                        |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.60 (max)<br><b>Si</b> 0.75 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)   | <b>UTS</b> 550-610 N/mm <sup>2</sup><br><b>YS</b> 430-540 N/mm <sup>2</sup><br><b>Elongation %</b> 24-28<br><b>CVN Impact at -30°C</b> 50-60 J<br><b>Current</b> AC/DC <sup>-</sup>        | Boiler and pressure vessels, penstocks, storage tanks, bridges, heavy structures subjected to dynamic loading and under restrained conditions.                                                                                                                                                                                                                      |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.60 (max)<br><b>Si</b> 0.75 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)   | <b>UTS</b> 550-610 N/mm <sup>2</sup><br><b>YS</b> 440-530 N/mm <sup>2</sup><br><b>Elongation %</b> 24-28<br><b>CVN Impact at -45°C</b> 55-65J<br><b>Current</b> AC/DC <sup>+</sup>         | Welding of pressure vessels & boilers, pipelines, power plants, penstocks, earth moving equipments, bridges, low alloy steels and heavy thick plates of carbon steel. Suitable for steels conforming to ASTM. Specification : Gr. 60, Gr. 65 steels of SA-515/SA-515(P. No. 1) and Gr. 60, Gr. 65 steels of SA-516/SA-516M (P. No.1).                               |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.40 (max)<br><b>Si</b> 0.60 (max)<br><b>S</b> 0.015 (max)<br><b>P</b> 0.018 (max) | <b>UTS</b> 520-600 N/mm <sup>2</sup><br><b>YS</b> 430-530 N/mm <sup>2</sup><br><b>Elongation %</b> 24-28<br><b>CVN Impact at -46°C</b> 40 J<br><b>Current</b> AC (70 OCV) /DC <sup>+</sup> | Welding of medium high tensile steels, heavy sections and restrained joints in high tensile steel. Welding of carbon steel and low alloy steel fabrications where severe service conditions exist. It meets corrosion test as per NACE Standard TM- 01-77 and TM-02-84. Suitable for joining steels like ASTM 106Gr.B (NACE quality), Gr60, Gr65 of SA-515/SA-515M. |

## 03 | LOW ALLOY HIGH TENSILE STEEL ELECTRODES

| No. | Product                                                                                                        | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8   | <b>WELDFAST CROMO 0500</b><br><br>AWS A/SFA - 5.5 E 7018-A1<br>IS 1395 / E 49B-A1-26Fe<br>DIN 8575 / E MoB20+  | <p>A medium heavy basic coated, hydrogen controlled, iron powder electrode, gives weld deposit containing 0.5% Mo. The weld deposit is of radiographic quality. Suitable for welding carbon-moly creep resistant steels in all position.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> <p><b>Approvals :</b> NTPC, BHEL, CIB (Maharashtra)</p>                                                                                  |
| 9   | <b>WELDFAST CROMO 1500</b><br><br>AWS A/SFA - 5.5 E 8018-B2<br>IS 1395 / E 55BB226Fe<br>DIN 8575 / E CrMo1B20+ | <p>A medium heavy coated, low hydrogen iron powder type electrode gives weld deposit of 1.3% Cr and 0.5% Mo steel. The weld deposit is of radiographic quality. The electrode burns with smooth arc, low spatter and is easy in slag removal. Suitable for welding chrome - moly creep resistant steels in all positions.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> <p><b>Approvals :</b> NTPC, BHEL, CIB (Maharashtra)</p> |
| 10  | <b>WELDFAST CROMO 2251</b><br><br>AWS A/SFA - 5.5 E 9018-B3<br>IS 1395 / E 55BB326Fe<br>DIN 8575 / E CrMo2B26  | <p>A medium heavy coated, low hydrogen, iron powder type, all position electrode with weld deposit of approximately 2.30% Cr and 1% Mo steel. The weld deposit is of radiographic quality and creep resistant up to 600°C.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> <p><b>Approvals :</b> NTPC, BHEL, CIB (Maharashtra)</p>                                                                                                |
| 11  | <b>WELDFAST CROMO 5500</b><br><br>AWS A/SFA - 5.5 E 8018-B6<br>IS 1395 / E 41BB626Fe<br>DIN 8575 / E KCrMo 526 | <p>It is basic coated electrode for welding Chrome-Moly creep resistant steels suitable for welding in all position. Weld deposit is of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                                                     |
| 12  | <b>WELDFAST CROMO 9100</b><br><br>AWS A/SFA-5.5 E 8018-B8<br>DIN 8575/ E CrMo526                               | <p>A basic coated electrode for welding Chrome Moly creep resistant steels in all positions. The weld deposit contains approximately 9% Cr is air hardenable and requires preheat &amp; post heat treatment. Weld deposit is of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                             |



| Weld Analysis (%) |            | Mechanical Properties      |                             | Application                                                                                                                                                                                                                                                                 |
|-------------------|------------|----------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b>          | 0.06-0.09  | <b>UTS</b>                 | 490 N/mm <sup>2</sup> (min) | For welding of 0.5% Mo and 1% Cr-0.5% Mo steels. Suitable in welding of flange, forged fittings, valves, seamless tubes and pipes for high temperature applications in power plants, refinery, petro-chemical and fertilizer units                                          |
| <b>Mn</b>         | 0.90 (max) | <b>YS</b>                  | 390 N/mm <sup>2</sup> (min) |                                                                                                                                                                                                                                                                             |
| <b>Mo</b>         | 0.40-0.65  | <b>Elongation %</b>        | 22 (min)                    |                                                                                                                                                                                                                                                                             |
| <b>Si</b>         | 0.80 (max) | <b>CVN Impact at +27°C</b> | 90 -120 J                   |                                                                                                                                                                                                                                                                             |
| <b>S</b>          | 0.03 (max) | <b>Current</b>             | AC/DC <sup>+</sup>          |                                                                                                                                                                                                                                                                             |
| <b>P</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>C</b>          | 0.05-0.12  | <b>UTS</b>                 | 550 N/mm <sup>2</sup> (min) | For welding 1Cr/0.5Mo and similar creep resistant steels. Suitable in welding of flange, forged fittings, valves, seamless tubes and pipes for high temperature applications in power plants, refinery, petro-chemical and fertilizer units and P11 and P12 type of steels. |
| <b>Mn</b>         | 0.90 (max) | <b>YS</b>                  | 460 N/mm <sup>2</sup> (min) |                                                                                                                                                                                                                                                                             |
| <b>Si</b>         | 0.80 (max) | <b>Elongation %</b>        | 19 (min)                    |                                                                                                                                                                                                                                                                             |
| <b>Cr</b>         | 1.00-1.50  | <b>CVN Impact at +27°C</b> | 50-90 J                     |                                                                                                                                                                                                                                                                             |
| <b>Mo</b>         | 0.40-0.65  | <b>Current</b>             | AC/DC <sup>+</sup>          |                                                                                                                                                                                                                                                                             |
| <b>S</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>P</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>C</b>          | 0.05-0.12  | <b>UTS</b>                 | 620 N/mm <sup>2</sup> (min) | For welding 2Cr/1Mo and similar creep resistant steels. Suitable in welding of flange, forged fittings, valves, seamless tubes and pipes for high temperature applications in power plants, refinery, petro-chemical and fertilizer units and P22 type of steels.           |
| <b>Mn</b>         | 0.90 (max) | <b>YS</b>                  | 530 N/mm <sup>2</sup> (min) |                                                                                                                                                                                                                                                                             |
| <b>Si</b>         | 0.80 (max) | <b>Elongation %</b>        | 17 (min)                    |                                                                                                                                                                                                                                                                             |
| <b>Cr</b>         | 2.00-2.50  | <b>CVN Impact at +27°C</b> | 50-100 J                    |                                                                                                                                                                                                                                                                             |
| <b>Mo</b>         | 0.90-1.20  | <b>Current</b>             | AC/DC <sup>+</sup>          |                                                                                                                                                                                                                                                                             |
| <b>S</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>P</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>C</b>          | 0.05-0.10  | <b>UTS</b>                 | 550 N/mm <sup>2</sup> (min) | For welding cast or forged fitting, flanges, valves, seamless tubes or pipes used for high temperature applications in power plants, refinery, petrochemical and fertilizer units.                                                                                          |
| <b>Mn</b>         | 1.00 (max) | <b>YS</b>                  | 460 N/mm <sup>2</sup> (min) |                                                                                                                                                                                                                                                                             |
| <b>Si</b>         | 0.90 (max) | <b>Elongation %</b>        | 19 (min)                    |                                                                                                                                                                                                                                                                             |
| <b>Cr</b>         | 4.00-6.00  | <b>Current</b>             | AC/DC <sup>+</sup>          |                                                                                                                                                                                                                                                                             |
| <b>Mo</b>         | 0.45-0.65  |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>S</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>P</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>Ni</b>         | 0.40 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>C</b>          | 0.05-0.10  | <b>UTS</b>                 | 550 N/mm <sup>2</sup> (min) | For Welding cast or forged fitting, flanges, valves, seamless tubes or pipes used for high temperature applications in power plants, refinery, petrochemical and fertilizer units.                                                                                          |
| <b>Mn</b>         | 1.00 (max) | <b>YS</b>                  | 460 N/mm <sup>2</sup> (min) |                                                                                                                                                                                                                                                                             |
| <b>Si</b>         | 0.90 (max) | <b>Elongation %</b>        | 19 (min)                    |                                                                                                                                                                                                                                                                             |
| <b>Cr</b>         | 8.00-10.50 | <b>Current</b>             | AC/DC <sup>+</sup>          |                                                                                                                                                                                                                                                                             |
| <b>Mo</b>         | 0.85-1.20  |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>S</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>P</b>          | 0.03 (max) |                            |                             |                                                                                                                                                                                                                                                                             |
| <b>Ni</b>         | 0.40 (max) |                            |                             |                                                                                                                                                                                                                                                                             |



| No. | Product                                                                  | Characteristics                                                                                                                                                                                                                                                                                                                            |
|-----|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13  | <b>WELDFAST TENSAL 60</b><br>AWS A/SFA-5.5 E8018G<br>IS 1395/ E55BG129Fe | A basic coated all position electrode for welding fine grained high tensile steels. It gives a very smooth arc, medium penetration, low spatter and easy operation in all position. The welds are of radiographic quality.<br>Re-drying temperature is 300°C for 1 hr.                                                                     |
| 14  | <b>WELDFAST TENSAL 100 G</b><br>AWS A/ SFA-5.5 E10018G                   | A basic coated low hydrogen iron powder electrode for welding of low alloy and high tensile steels. The weld metal is Ni-Cr-Mo type having good toughness properties at sub-zero temperature. It gives smooth and excellent arc stability, easy removal of slag and radiographic quality weld.<br>Re-drying temperature is 300°C for 1 hr. |
| 15  | <b>WELDFAST TENSAL 100 D2</b><br>AWS A/ SFA-5.5 E10018-D2                | A low alloy, low hydrogen, iron-powder electrode for welding of high tensile steels. Weld metal is of Mn-Mo type. It gives smooth arc and easy slag removal. Welds are of radiographic quality.<br>Re-drying temperature is 300°C for 1 hr.                                                                                                |
| 16  | <b>WELDFAST TENSAL 100 M</b><br>AWS A/SFA-5.5 E10018M                    | Low hydrogen, iron-powder electrode for welding of high tensile steels. Weld metal is of Mn-Mo type. It gives smooth arc and easy slag removal. Welds are of radiographic quality.<br>Re-drying temperature is 300°C for 1 hr.                                                                                                             |
| 17  | <b>WELDFAST TENSAL 80</b><br>AWS A/SFA - 5.5 E 11018G                    | A basic coated all position electrode for welding fine grained high tensile steels. It gives smooth arc, little spatter with easy removal of slag and fine rippled bead. Welds are of radiographic quality.<br>Re-drying temperature is 300°C for 1 hr.                                                                                    |

| Weld Analysis (%)                                                                                                                                                                        | Mechanical Properties                                                                                                                                                                         | Application                                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.06-0.10<br><b>Mn</b> 0.90-1.40<br><b>Si</b> 0.50 (max)<br><b>Ni</b> 0.70-1.00<br><b>Mo</b> 0.30-0.50<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                            | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>YS</b> 460 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 19 (min)<br><b>CVN Impact at +27°C</b> 50 -150 J<br><b>Current</b> AC/ DC <sup>+</sup> | For construction of heavy duty mining and earth moving equipments. It is ideal for steels subjected to dynamic loading conditions like bridge girders, penstocks etc.                       |
| <b>C</b> 0.06 (max)<br><b>Mn</b> 1.50 (max)<br><b>Si</b> 0.60 (max)<br><b>Ni</b> 0.50-1.00<br><b>Mo</b> 0.50 (max)<br><b>Cr</b> 0.50 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>UTS</b> 690 N/mm <sup>2</sup> (min)<br><b>YS</b> 600 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 16 (min)<br><b>CVN Impact at +27°C</b> 50-100 J<br><b>Current</b> AC/ DC <sup>+</sup>  | Welding of high tensile steels, fabrication of penstocks, pressure vessels, boilers, pipelines and other machinery parts.                                                                   |
| <b>C</b> 0.15 (max)<br><b>Mn</b> 1.65-2.00<br><b>Mo</b> 0.25-0.45<br><b>Ni</b> 0.90 (max)<br><b>Si</b> 0.80 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                          | <b>UTS</b> 690 N/mm <sup>2</sup> (min)<br><b>YS</b> 600 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 16 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)<br><b>Current</b> AC/DC <sup>+</sup> | For welding of high tensile steels used for fabrication of penstocks, earth moving equipments and heavy structures subjected to dynamic loading and mechanical restraint.                   |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.75-1.70<br><b>Mo</b> 0.25-0.50<br><b>Cr</b> 0.35 (max)<br><b>Ni</b> 1.40-2.10<br><b>Si</b> 0.60 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)   | <b>UTS</b> 690 N/mm <sup>2</sup> (min)<br><b>YS</b> 610 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 20 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)<br><b>Current</b> DC <sup>+</sup>    | Welding of earth moving equipments, high tensile steels e.g. USS T-1, N-A-XTRA 70, Bh65.                                                                                                    |
| <b>C</b> 0.05-0.10<br><b>Mn</b> 1.00-1.50<br><b>Si</b> 0.80 (max)<br><b>Ni</b> 3.00-3.60<br><b>Mo</b> 0.50 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                           | <b>UTS</b> 760 N/mm <sup>2</sup> (min)<br><b>YS</b> 670 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 15 (min)<br><b>Current</b> AC/DC <sup>+</sup>                                          | For construction of heavy duty mining and earth moving equipments. It is ideal for steels like T1, HY80, HSD70 grade used in dynamic loading conditions like bridge girders, penstocks etc. |

| No. | Product                                           | Characteristics                                                                                                                                                                                                                                                                                                                                                             |
|-----|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18  | <b>WELDFAST W2</b><br>AWS A/SFA -5.5 E8018-W2     | <p>A low alloy, low hydrogen, iron-powder electrode for welding of low alloy steels. Weld metal exhibits excellent atmospheric corrosion resistance. It gives excellent arc stability, arc smoothness and easy slag removal. Welds are of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                         |
| 19  | <b>WELDFAST 90G</b><br>AWS A/SFA- 5.5 E9018G      | <p>Low hydrogen, Iron powder electrode for welding medium, high tensile structural steels, heavy sections. Weld metal is of x-ray quality. It gives excellent arc stability, arc smoothness and easy slag removal</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                       |
| 20  | <b>WELDFAST 9018M</b><br>AWS A/SFA- 5.5 E 9018M   | <p>A basic coated low hydrogen, iron powder electrode for welding of high tensile, low-alloy steels. Weld metal is Ni-Cr-Mo type and exhibits good toughness at sub-zero temperatures. It gives excellent arc stability, arc smoothness and very easy slag removal. Weld metal is of X-ray quality.</p> <p>Re-drying temperature 300 °C for 1 hr.</p>                       |
| 21  | <b>WELDFAST 11018M</b><br>AWS A/SFA- 5.5 E 11018M | <p>It is an extra low hydrogen low alloy high tensile steel electrode, designed to deposit weld metal of 1.25 - 2 .5 % Ni with good impact strength at - 50°C. The all position electrode gives very smooth arc, medium penetration, low spatter, easy operation &amp; easy slag removal and radiographic quality weld.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> |
| 22  | <b>WELDFAST 12018M</b><br>AWS A/SFA- 5.5 E12018M  | <p>A medium basic coated low alloy, hydrogen controlled electrode specially designed for repair of hot working die, forging dies, earth moving equipment, automotive parts and chemical plants.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                         |

| Weld Analysis (%)                                                                                                                                                                                                | Mechanical Properties                                                                                                                                                                         | Application                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.12 (max)<br><b>Mn</b> 0.50-1.30<br><b>Si</b> 0.35-0.80<br><b>Ni</b> 0.40-0.80<br><b>Cr</b> 0.45-0.70<br><b>Cu</b> 0.30-0.75<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                             | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>YS</b> 460 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 19% (min)<br><b>CVN Impact at -20°C</b> 27 J (min)                                     | <p>It is extra low hydrogen electrode specially designed for welding of high strength structural steels including quenched and tempered steels. Welding of weathering steels e.g. Corten-A, Corten-B &amp; their equivalents. Weld metal has high notch toughness at low temperature. Extra low level of diffusible hydrogen prevents hydrogen induced cracking.</p> |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.25 (max)<br><b>Si</b> 0.80 (max)<br><b>Ni</b> 1.40-1.80<br><b>Cr</b> 0.20 (max)<br><b>Mo</b> 0.35 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                         | <b>UTS</b> 620 N/mm <sup>2</sup> (min)<br><b>YS</b> 530 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 17 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)<br><b>Current</b> AC/DC <sup>+</sup> | <p>Weld metal is Ni-Cr-Mo type and exhibits good toughness at sub-zero temperatures. Boiler and pressure vessels, penstock, pipelines, machinery parts. Suitable for joining N-A-XTRA 60 steels</p>                                                                                                                                                                  |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.60-1.25<br><b>Si</b> 0.80 (max)<br><b>Cr</b> 0.15 (max)<br><b>Ni</b> 1.40-1.80<br><b>Mo</b> 0.35 (max)<br><b>V</b> 0.05 (max)<br><b>S</b> 0.030 (max)<br><b>P</b> 0.030 (max) | <b>UTS</b> 620 N/mm <sup>2</sup> min<br><b>YS</b> 540-620 N/mm <sup>2</sup><br><b>Elongation %</b> 24 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)                                          | <p>Boiler and pressure vessels, penstock, pipelines, machinery parts. Suitable for joining N-A-XTRA 60 steels.</p>                                                                                                                                                                                                                                                   |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.30-1.80<br><b>Si</b> 0.60 (max)<br><b>Ni</b> 1.25-2.50<br><b>Cr</b> 0.40 (max)<br><b>Mo</b> 0.25-0.50<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)<br><b>V</b> 0.05 (max)    | <b>UTS</b> 760 N/mm <sup>2</sup><br><b>YS</b> 680-760 N/mm <sup>2</sup><br><b>Elongation %</b> 20 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)                                              | <p>It is extra low hydrogen electrode specially designed for welding of high strength structural steels including quenched and tempered steels. Weld metal has high notch toughness at low temperature. Extra low level of diffusible hydrogen prevent hydrogen induced cracking.</p>                                                                                |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 1.30 - 2.25<br><b>Si</b> 0.60 (max)<br><b>Ni</b> 1.75 - 2.50<br><b>Cr</b> 0.30 - 1.50<br><b>Mo</b> 0.30 - 0.55<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                    | <b>UTS</b> 830 N/mm <sup>2</sup> (min)<br><b>YS</b> 745 - 830 N/mm <sup>2</sup><br><b>Elongation %</b> 18 (min)<br><b>CVN Impact at -50°C</b> 27 J (min)<br><b>Current</b> AC/DC <sup>+</sup> | <p>The electrode is used for machinery parts made of high tensile steels and specially developed for the repair of hot working dies, forging dies, earth moving equipments, automotive parts, and chemical plants.</p>                                                                                                                                               |

## 04 | STAINLESS STEEL ELECTRODES

| No. | Product                                                                      | Characteristics                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 23  | <b>WELDFAST 308</b><br><br>AWS A/SFA - 5.4 E 308-16<br>IS 5206 / E19.9R26    | <p>A rutile basic coated all position electrode. Smooth arc, excellent slag removal, smooth uniform bead and easy striking are the characteristics of this electrode.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                           |
| 24  | <b>WELDFAST 308L</b><br><br>AWS A/SFA - 5.4 E 308L-16<br>IS 5206 / E19.9LR26 | <p>A rutile basic coated all position electrode. Excellent slag removal, smooth &amp; uniform bead and easy striking are the characteristics. Extra low carbon content gives added resistance to inter granular corrosion.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                      |
| 25  | <b>WELDFAST 347</b><br><br>AWS A/SFA - 5.4 E 347-16<br>IS 5206 / E19.9NbR26  | <p>A rutile basic coated all position electrode for welding stabilized version of corrosion resistant Cr-Ni Steels. Weld beads are smooth, uniform and excellent in appearance.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                 |
| 26  | <b>WELDFAST 316</b><br><br>AWS A/SFA - 5.4 E 316-16<br>IS 5206 / E19.12.2R26 | <p>A rutile basic coated all position electrode, 18/12 Mo Stainless Steel weld deposit. The weld metal has excellent creep strength and resistance to cracking, corrosion at high temperature up to 850°C. The electrode has smooth arc &amp; excellent arc stability, low spatter loss, easy removal of slag and smooth, uniform weld deposit.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> |





| Weld Analysis (%)                                                                                                                                                                         | Mechanical Properties                                                                                                               | Application                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.08 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 9.00-11.00<br><b>Cr</b> 18.00-21.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                         | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 3-7<br><b>Current</b> AC/DC <sup>+</sup> | For welding of corrosion resistant Cr-Ni steels of AISI grades 301, 302, 304, 308 used in dairy, food processing and chemical industries.                                                           |
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 9.00-11.00<br><b>Cr</b> 18.00-21.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                         | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 3-7<br><b>Current</b> AC/DC <sup>+</sup> | For welding of Cr-Ni steels of AISI grades 301, 302, 304, 308 equipments used in chemical processing, dairy & food industry.                                                                        |
| <b>C</b> 0.08 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 9.00-11.00<br><b>Cr</b> 18.00-21.00<br><b>Cb</b> 1.00 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 6-9<br><b>Current</b> AC/DC <sup>+</sup> | For welding of AISI grades 301, 302, 304, 308, 321 and 347. A wide range of application in the manufacture of equipments for chemical, food, aircraft industries, gas turbines and soap industries. |
| <b>C</b> 0.08 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 11.00-14.00<br><b>Cr</b> 17.00-20.00<br><b>Mo</b> 2.00-3.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 3-8<br><b>Current</b> AC/DC <sup>+</sup> | For welding of corrosion resistant Cr-Ni-Mo Steels of AISI grades 316, 316H, 317 used in chemical industries, handling organic assets and other corrosion chemicals etc.                            |

| No. | Product                                                                          | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27  | <b>WELDFAST 316L</b><br><br>AWS A/SFA - 5.4 E 316L-16<br>IS 5206 / E19.12.2LR26  | <p>A rutile basic coated all position electrode having extra low carbon with weld deposit of 18Cr/13Ni/2.5Mo stainless steel. Resistant to stress corrosion cracking, chemical corrosion cracking at temperature up to 850°C. The weld metal deposit has excellent creep strength and is of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                    |
| 28  | <b>WELDFAST 317L</b><br><br>AWS A/SFA - 5.4 E317L-16                             | <p>A rutile basic coated all position electrode having extra low carbon with weld deposit of 19Cr/12Ni/3.5 Mo and controlled Ferrite content of 3-8 for maximum resistance to cracking. Weld Metal is resistant to stress corrosion cracking, hot cracking, chemical corrosion at high temp. Higher moly reduces susceptibility to pitting. Excellent arc stability and low spatter loss. The weld metal is of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> |
| 29  | <b>WELDFAST 309</b><br><br>AWS A/SFA - 5.4 E 309-16<br>IS 5206 / E23.12R26       | <p>A rutile basic coated all position electrode giving 25/12, Cr-Ni deposit which has excellent corrosion and oxidation resistance in continuous service up to 1100°C. It gives smooth arc and has self - removing slag, least spatter and uniform weld bead.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                        |
| 30  | <b>WELDFAST 309L</b><br><br>AWS A/SFA - 5.4 E 309L-16<br>IS 5206 / E23.12LR26    | <p>A rutile basic coated all position electrode giving 25/12, Cr-Ni deposit which has excellent corrosion and oxidation resistance in continuous service up to 1100°C. It gives smooth arc, self removal of slag, least spatter and uniform weld bead. The extra low carbon gives added resistance to inter-granular corrosion.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> <p><b>Approvals :</b> Thermax, IBR</p>                                                               |
| 31  | <b>WELDFAST 309Mo</b><br><br>AWS A/SFA - 5.4 E 309Mo-16<br>IS 5206 / E23.12.2R26 | <p>A rutile basic coated all position electrodes giving 25/12/2.5 Mo weld deposit. It gives a smooth arc, low spatter, easy removal of slag and uniform bead.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                                                                                                        |

| Weld Analysis (%)                                                                                                                                                                         | Mechanical Properties                                                                                                               | Application                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 11.00-14.00<br><b>Cr</b> 17.00-20.00<br><b>Mo</b> 2.00-3.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 490 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 3-8<br><b>Current</b> AC/DC <sup>+</sup> | For welding of stainless steels such as AISI 316, 316L, 316H, 317 and 317L, in chemical plants, paint industries and dye industries.                                                                                                                                                                           |
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.50-2.50<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 12.00-14.00<br><b>Cr</b> 18.00-21.00<br><b>Mo</b> 3.00-4.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Ferrite %</b> 3-8<br><b>Current</b> AC/DC <sup>+</sup> | For welding of stainless steels such as AISI 316L/317 and for welding of equipments in chemical industries especially for sulphuric and sulfurous acids and their salts, paper and pulp industry, paint and dye industries.                                                                                    |
| <b>C</b> 0.10 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 12.00-14.00<br><b>Cr</b> 22.00-25.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                        | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Current</b> AC/DC <sup>+</sup>                         | For welding of corrosion and heat resistant Cr-Ni steels to themselves or to mild steel. The weld deposit offers higher temperature oxidation resistance than 18/8 Cr-Ni grade stainless steel. It is used for overlays of ferritic steel, dissimilar steels and difficult to weld steels.                     |
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 12.00-14.00<br><b>Cr</b> 22.00-25.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                        | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Current</b> AC/DC <sup>+</sup>                         | For welding of corrosion and heat resistant Cr-Ni steels to themselves or to mild steel. The weld deposit offers higher temperature oxidation resistance than 18/8 Cr-Ni grade stainless steel. Useful in welding of clad steel.                                                                               |
| <b>C</b> 0.12 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 12.00-14.00<br><b>Cr</b> 22.00-25.00<br><b>Mo</b> 2.00-3.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Current</b> AC/DC <sup>+</sup>                         | For welding of corrosion and heat resistant Cr-Ni steels to themselves or to mild steel. The electrode is useful in welding clad steel and for building corrosion and heat resistant layer on mild or low alloy steels. Also suitable for dissimilar joints of carbon steels with 316 type of stainless steel. |

| No. | Product                                                                             | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 32  | <b>WELDFAST 309MoL</b><br><br>AWS A/SFA - 5.4 E 309LMo-16<br>IS 5206 / E23.12.2LR26 | <p>A rutile basic coated all position electrode giving 25/12/2.5 Mo weld deposit. It gives a smooth arc, low spatter, easy removal of slag and uniform bead. Excellent resistance to chemical corrosion and heat.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                                         |
| 33  | <b>WELDFAST 310</b><br><br>AWS A/SFA - 5.4 E 310-16<br>IS 5206 / E25.20R26X         | <p>A basic coated austenitic all position electrode and deposit 25/20 SS which has excellent stability and oxidation resistance in continuous service upto 1100°C. Smooth arc, easy slag removal, low spatter and uniform bead are characteristics of this electrode.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                     |
| 34  | <b>WELDFAST 410</b><br><br>AWS A/SFA - 5.4 E 410-15                                 | <p>A basic coated electrode with ER410 core wire for welding of 13% Cr Steels for producing straight chrome stainless steel deposit on austenitic stainless steels and carbon steels. The weld deposit is of air hardening type and requires preheat and post heat treatment to achieve optimum ductility and toughness to resist cavitation-erosion, abrasion and moderate corrosion.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                    |
| 35  | <b>WELDFAST 410Ni-Mo (SPL)</b><br><br>AWS A/SFA - 5.4<br>E 410NiMo-15 (Nearest)     | <p>A basic coated all position electrode. It gives smooth arc, easy removal of slag and uniform weld bead. The weld deposit is of radiographic quality.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                                                                                                   |
| 36  | <b>WELDFAST 2209</b><br><br>AWS A/SFA- 5.4 E 2209-16                                | <p>It is a rutile basic coated duplex electrode giving 22.5Cr, 3.00 Mo, 0.12 N which has excellent corrosion resistant. It gives smooth arc, self removal of slag, least spatter and uniform weld bead. These electrodes give increased tensile strength with improved resistance to pitting corrosive attack and to stress corrosion cracking. This electrode is specially designed for ferritic-austenitic stainless steels or the so called "Duplex stainless steels".</p> |

| Weld Analysis (%)                                                                                                                                                                                                                        | Mechanical Properties                                                                                                                                                                                                                                                                                                              | Application                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 12.00-14.00<br><b>Cr</b> 22.00-25.00<br><b>Mo</b> 2.00-3.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                                                | <b>UTS</b> 520 N/mm <sup>2</sup> min<br><b>Elongation %</b> 30 min<br><b>Current</b> AC/DC <sup>+</sup>                                                                                                                                                                                                                            | For welding of corrosion and heat resistant Cr-Ni steels to themselves or to mild steel. The electrode is useful in welding clad steel and for building corrosion heat resistant layer on mild or low alloy steels.                                                                                                             |
| <b>C</b> 0.08-0.20<br><b>Mn</b> 1.00-2.50<br><b>Si</b> 0.75 (max)<br><b>Ni</b> 20.00-22.50<br><b>Cr</b> 25.00-28.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                                                                        | <b>UTS</b> 550 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Current</b> AC/DC <sup>+</sup>                                                                                                                                                                                                                        | Welding of AISI 310 type, German steels 4762, 4828, 4841, 4846 and 4848 welding of stainless clad steels, straight chrome steels, dissimilar steels, hydrogenation and polymerisation plant, gas turbine combustion chamber parts, high temp. furnace parts etc.                                                                |
| <b>C</b> 0.12 (max)<br><b>Mn</b> 1.00 (max)<br><b>Si</b> 0.90 (max)<br><b>Cr</b> 11.00-13.50<br><b>Ni</b> 0.70 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                                                                       | <b>UTS</b> 520 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 20 (min)<br><b>Current</b> DC <sup>+</sup>                                                                                                                                                                                                                           | Very much suitable for refiner plug and socket, sleeves, turbine runners, valve seats etc.                                                                                                                                                                                                                                      |
| <b>C</b> 0.05 (max)<br><b>Mn</b> 0.60-0.90<br><b>Si</b> 0.30-0.60<br><b>Cr</b> 11.5-14.0<br><b>Mo</b> 0.40-0.60<br><b>Ni</b> 3.80-5.50<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                                                     | <b>UTS</b> 790 N/mm <sup>2</sup> (min)<br><b>YS</b> 590 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 14 (min)<br><b>CVN Impact at 23±5°C</b> 50 J (min)<br><b>CVN Impact at 0°C</b> 45 J (min)<br><b>Current</b> DC <sup>+</sup><br><b>Hardness</b> 260 BHN<br>PWHT @ 600°C for 8 hrs is necessary to achieve desired properties | For welding ASTM CA6NM (CA-6NM) castings or similar materials as well as type 410, 410S and 405 base metals.                                                                                                                                                                                                                    |
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.50-2.00<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 8.50-10.50<br><b>Cr</b> 21.50-23.50<br><b>Mo</b> 2.50 - 3.50<br><b>N</b> 0.08-0.20<br><b>Cu</b> 0.75 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max) | <b>UTS</b> 690 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 20 (min)                                                                                                                                                                                                                                                             | Electrodes of this composition are used primarily to weld duplex stainless steel which contains approximately 22 percent of chromium. It finds extensive use in welding duplex steels which needs high resistance to stress corrosion cracking and high yield strength e.g. In ship building industry, chemical industries etc. |

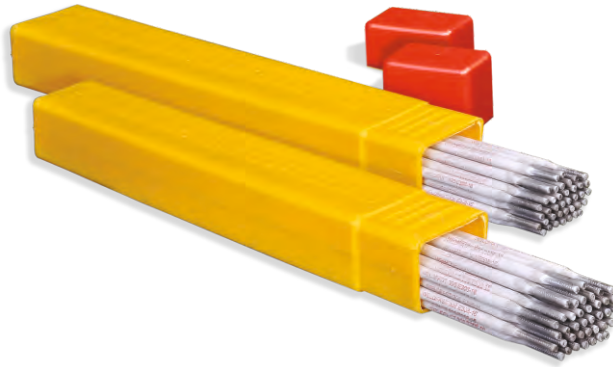
| No. | Product                                                                   | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 37  | <b>WELDFAST 2594</b><br><br>AWS A/SFA-5.4 E 2594-16                       | <p>It is super duplex stainless steel all position electrode giving 25.5 Cr,10.0 Ni, 4.0 Mo &amp; 0.25N deposit gives smooth arc, self removal of slag, least spatter and uniform weld bead.</p> <p>Re-drying temperature is 300°C for 1 hr</p>                                                                                                                                                                                                     |
| 38  | <b>WELDFAST 2595</b><br><br>AWS A/SFA-5.4 E 2595-16                       | <p>Super Duplex stainless steel electrode giving 25.5Cr, 9 Ni, 3.8 Mo, 0.7 Cu, 0.7W, deposit gives smooth arc, self removal of slag, least spatter and uniform weld bead.</p> <p>Re-drying temperature is 300°C for 1 hr</p>                                                                                                                                                                                                                        |
| 39  | <b>WELDFAST 2553</b><br><br>AWS A/SFA- 5.4 E 2553-16                      | <p>Rutile coated electrode for welding duplex austenitic ferritic steels. Weldmetal deposited by these electrode combine increased tensile strength with improve resistance to pitting corrosive attack and stress corrosion. The electrode deposits weld metal having uniform and fine ripples. Slag removal is very easy and spatter loss is extremely low. Electrode works in all positions.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> |
| 40  | <b>WELDFAST 307S</b><br><br>AWS A/SFA 5.4 E307-16<br>IS 5206 / E18.8MnR26 | <p>A high deposition efficiency electrode for depositing extremely tough buffer layer prior to hardfacing or joining of dissimilar sections of almost any composition of steel.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                                                 |

| Weld Analysis (%)                                                                                                                                                                                                                                               | Mechanical Properties                                                                                                                                                                                   | Application                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.04 (max)<br><b>Mn</b> 0.50-2.00<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 8.00-10.50<br><b>Cr</b> 24.0-27.0<br><b>Mo</b> 3.50 - 4.50<br><b>N</b> 0.20 - 0.30<br><b>Cu</b> 0.75 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                        | <b>UTS</b> 760 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 15 (min)                                                                                                                                  | <p>It is designed for welding of type 2507 super duplex stainless steels and similar composition. It can also be used for the welding of carbon and low alloy steels to duplex stainless steels as well as to weld standard duplex stainless steels such as type 2205.</p>                        |
| <b>C</b> 0.04 (max)<br><b>Mn</b> 2.50 (max)<br><b>Si</b> 1.20 (max)<br><b>Ni</b> 8.00-10.50<br><b>Cr</b> 24.0-27.0<br><b>Mo</b> 2.50 - 4.50<br><b>N</b> 0.20 - 0.30<br><b>Cu</b> 0.40-1.50<br><b>W</b> 0.40-1.00<br><b>S</b> 0.025 (max)<br><b>P</b> 0.03 (max) | <b>UTS</b> 760 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 15 (min)                                                                                                                                  | <p>It is designed for welding of super duplex stainless steels UNS S32550, S32750 and similar composition. It can also be used for the welding of carbon and low alloy steels to duplex stainless steels as well as to weld standard duplex stainless steels such as type UNS E31803, E32205.</p> |
| <b>C</b> 0.06 (max)<br><b>Mn</b> 0.50-1.50<br><b>Si</b> 1.00 (max)<br><b>Ni</b> 6.50-8.50<br><b>Cr</b> 24.00-27.00<br><b>Mo</b> 2.90-3.90<br><b>N</b> 0.10-0.25<br><b>Cu</b> 1.50-2.50<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)                            | <b>UTS</b> 760 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 15 (min)                                                                                                                                  | <p>It is designed for welding of type 2553 super duplex stainless steels and similar composition. Welding of super duplex austenitic ferritic stainless steels. Used for piping in gas or oil, offshore platforms.</p>                                                                            |
| <b>C</b> 0.06-0.14<br><b>Mn</b> 3.30-4.75<br><b>Si</b> 0.50-0.80<br><b>Cr</b> 18.0-21.5<br><b>Ni</b> 9.00-10.70<br><b>S</b> 0.03 (max)<br><b>P</b> 0.04 (max)<br><b>Mo</b> 0.50-1.50                                                                            | <b>UTS</b> 590 N/mm <sup>2</sup> (min)<br><b>Elongation %</b> 30 (min)<br><b>Hardness</b> 180-220 BHN (As welded)<br><b>Hardness (Work hardened)</b> 500 - 550 BHN<br><b>Current</b> AC/DC <sup>+</sup> | <p>Rebuilding of austenitic manganese parts, over laying on cast steels, carbon &amp; alloy steels, diamond crossings, forging hammer and anvil repair. The deposit can stand heavy impact loading work hardens in service.</p>                                                                   |



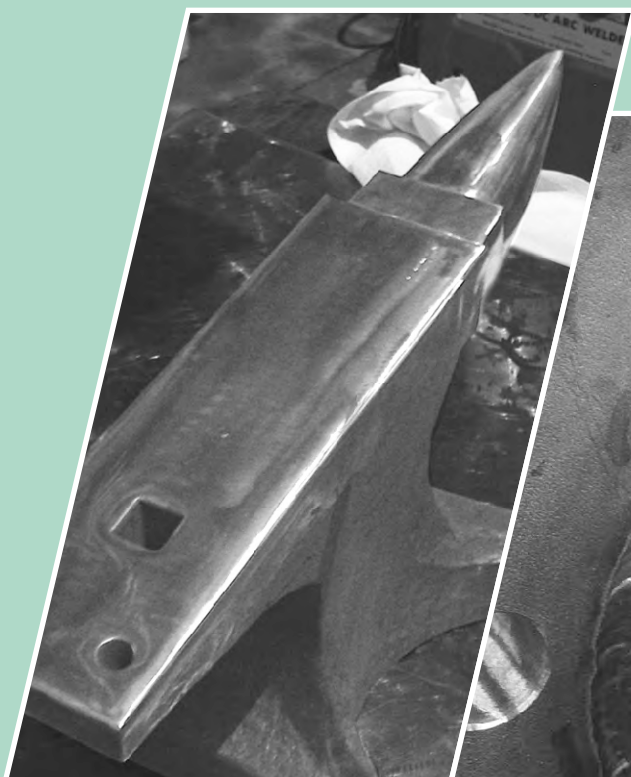
## 05 | **HARDFACING ELECTRODES**

| No. | Product                                        | Characteristics                                                                                                                                                                                                                                                                                                                                                                   |
|-----|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 41  | <b>WELDFAST HARDEX II</b>                      | <p>A low hydrogen type electrode deposits wear resistant material with excellent resistance to moderately heavy shocks and wear caused by heavy sliding or rolling friction.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                  |
| 42  | <b>WELDFAST HARDEX IIR</b><br>IS 7303 EFe-B314 | <p>It is a medium-heavy coated rutile, air hardening type electrode for hardfacing on mild steel, carbon steel and low alloy steels. In hard base materials it is advisable to use buffer layer of Weldfast LH-16. Weld deposit is machinable with good cutting tools.</p> <p>Re-drying temperature is 120°C for 1/2 hr.</p> <p><b>Approvals :</b> Indian Railway - Class H4B</p> |
| 43  | <b>WELDFAST HARDEX III</b>                     | <p>A low hydrogen type electrode and deposits are wear resistant with excellent resistance to abrasion even under moderate shocks.</p> <p>Re-drying temperature is 300°C for 1 hr.</p>                                                                                                                                                                                            |
| 44  | <b>WELDFAST HARDEX IIIR</b>                    | <p>A medium heavy coated rutile type electrode for hard facing on mild steel, carbon steel and low alloy steels, where approx 600 Brinell hardness is required. Weld is non-machinable and can only be ground. When used on austenitic manganese steel parts, give a buffer layer of Weldfast 307.</p> <p>Re-drying temperature is 120°C for 1/2 hr.</p>                          |



| Weld Analysis (%)                                                                                                                                                                  | Mechanical Properties                                                                              | Application                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 0.15-0.25<br><b>Mn</b> 3.00-3.50<br><b>Si</b> 0.50-0.80<br><b>Cr</b> 0.30-0.70<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                                              | <b>As welded</b> 350- 450 BHN<br><b>(Three layer deposit)</b><br><b>Current</b> AC/DC <sup>+</sup> | For pneumatic equipments, anvils, wheels flanges, sprockets, bucket chain links, bucket bases, guide rollers, actuating cams, bucket ladle tumblers. The electrode can be used on carbon, low alloy steels and on various grades of cast iron.                                    |
| <b>C</b> 0.05-0.15<br><b>Mn</b> 0.50-1.00<br><b>Si</b> 0.30-0.50<br><b>Cr</b> 2.00-4.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                                              | <b>As welded</b> 350- 450 BHN<br><b>(Three layer deposit)</b><br><b>Current</b> AC/DC <sup>+</sup> | For shear blades, cold-punching dies, conveyer parts, crawler parts, axle, sprockets, latch bars, pulleys, brake shoes, large cog wheels and other steel castings, where resistance to abrasion combined with toughness is required.                                              |
| <b>C</b> 0.40-0.60<br><b>Mn</b> 0.60-1.20<br><b>Si</b> 0.50-0.80<br><b>Cr</b> 5.00-7.00<br><b>Mo</b> 0.50-1.00<br><b>V</b> 0.40-0.80<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>As welded</b> 600- 650 BHN<br><b>(Three layer deposit)</b><br><b>Current</b> AC/DC <sup>+</sup> | It is very much suitable for hardfacing on carbon steels, low alloy steels and on cast irons. The applications include industrial knife edges, mill hammers, dredging bucket rims, shovel jaws and parts of agricultural and earth moving machinery.                              |
| <b>C</b> 0.50-0.80<br><b>Mn</b> 0.30-0.60<br><b>Si</b> 0.30-0.60<br><b>Cr</b> 7.00-8.00<br><b>Mo</b> 0.50-1.00<br><b>V</b> 0.40-0.80<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>As welded</b> 600- 650 BHN<br><b>(Three layer deposit)</b><br><b>Current</b> AC/DC <sup>+</sup> | The electrode is suitable for abrasion, impact or a combination of both, such as metal cutting and forming tools, hot and cold punching dies, drill bits, shears and croppers, oil expeller, crusher hammers, cane and bamboo cutting knives, crane wheels, conveyor buckets etc. |

| No. | Product                   | Characteristics                                                                                                                                                                                                                                                                               |
|-----|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45  | <b>WELDFAST HARDEX IV</b> | <p>A low hydrogen type electrode which deposits wear resistant material with excellent resistance to abrasion. The deposit can withstand very heavy compression without crumbling.</p> <p>Re-drying temperature is 120°C for 1/2 hr.</p>                                                      |
| 46  | <b>WELDFAST MANGAN</b>    | <p>A highly alloyed austenitic electrode, depositing wear resistant material with excellent resistance under heavy impact loads. The deposit rapidly work hardens and provides a fairly high hardness with a tough core to absorb shocks.</p> <p>Re-drying temperature is 300°C for 1 hr.</p> |



| Weld Analysis (%)                                                                                                                     | Mechanical Properties                                                                                                                               | Application                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C</b> 2.00-4.00<br><b>Mn</b> 0.50-2.50<br><b>Si</b> 1.50-4.00<br><b>Cr</b> 4.00-7.00<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max) | <b>As welded</b> 580- 660 BHN<br><b>(Three layer deposit)</b><br><b>Current</b> AC/DC <sup>+</sup>                                                  | For oil expeller worms, ploughshears, sand gravel, coal conveyor parts etc.                                                                                                                               |
| <b>C</b> 0.50-1.00<br><b>Mn</b> 12.00-14.00<br><b>Ni</b> 3.00 (max)<br><b>S</b> 0.03 (max)<br><b>P</b> 0.03 (max)                     | <b>Hardness</b> 240-260 BHN<br><b>( As welded )</b><br><b>Hardness</b> 500-550 BHN<br><b>( Work hardened )</b><br><b>Current</b> AC/DC <sup>+</sup> | Ideal for deposit on mild, carbon or low alloy steels and manganese steel. It is also used to resurface roll crusher, jaw crusher, shovel and excavator bucket tooth points, rail switch over points etc. |



## 06 | CAST IRON ELECTRODES

| No. | Product                                           | Characteristics                                                                                                                                                                                                                                                        |
|-----|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47  | <b>WELDFAST CI</b>                                | <p>Weldfast CI is electrode for depositing non machinable layer on various cast irons. It deposits weldmetal with exceptional colour match.</p> <p>Re-drying temperature is 120°C for 1/2 hr.</p>                                                                      |
| 48  | <b>WELDFAST CIMAC</b><br>AWS A/SFA 5.15 E NiFe-CI | <p>A nickel based alloy depositing very dense and highly crack resistant weld metal. The deposit is machinable and offers a reasonable colour match. It can weld all grades of cast irons to itself or to steel.</p> <p>Re-drying temperature is 120°C for 1/2 hr.</p> |

## 07 | CUTTING & GOUGING ELECTRODES

| No. | Product                   | Characteristics                                                                                                              |
|-----|---------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 49  | <b>WELDFAST GROOVECUT</b> | <p>A medium heavy coated electrode for cutting and piercing ferrous and non ferrous metals.</p>                              |
| 50  | <b>WELLGOUGE</b>          | <p>Wellgouge has a special coating to produce high blowing effects and a hot exothermic arc to remove metal efficiently.</p> |

| Weld Analysis (%)                                                                                                                                                                                                  | Mechanical Properties                                                                                                                                                              | Application                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div><div>C</div>2.00 (max)<div>Mn</div>1.20 (max)<div>Si</div>3.00 (max)<div>Cr</div>0.40 (max)<div>Ni</div>0.30 (max)<div>S</div>0.03 (max)<div>P</div>0.03 (max)<div>Fe</div>Bal.</div>                         | <div><div>Current</div>AC/DC<sup>+</sup></div>                                                                                                                                     | The electrode is ideal for filling casting defects and also for sealing runs in repairing old contaminated, oil/grease soaked castings. The deposit in first run is generally not machinable. |
| <div><div>C</div>2.00 (max)<div>Mn</div>2.50 (max)<div>Si</div>4.00 (max)<div>Ni</div>45.00-60.00<div>Cu</div>2.50 (max)<div>Al</div>1.00 (max)<div>S</div>0.03 (max)<div>P</div>0.03 (max)<div>Fe</div>Bal.</div> | <div><div>UTS</div>400-580 N/mm<sup>2</sup><div>YS</div>300-400 N/mm<sup>2</sup><div>Elongation %</div>6-18<div>Hardness</div>165-218 BHN<div>Current</div>AC/DC<sup>+</sup></div> | Useful in repairing wornout gears, cams, impeller rings, cracked bearing blocks, cast iron frames etc.                                                                                        |

| Weld Analysis (%)                       | Mechanical Properties                          | Application                                                                                                                                                                                                                  |
|-----------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div><div>---</div><div>---</div></div> | <div><div>Current</div>AC/DC<sup>+</sup></div> | Useful in cutting operation on carbon steels, low alloy steels, stainless steels, cast irons and non ferrous alloys. Hold the electrodes at 45° to the job and use sawing motion to cut.                                     |
| <div><div>---</div><div>---</div></div> | <div><div>Current</div>AC/DC<sup>+</sup></div> | The electrodes is useful in chamfering, gouging and grooving all metals commonly used in industry. It is useful for gouging out old/ defective weldmetal, bevelling cracks, removing unwanted sections, flashes, risers etc. |





## 08 | MIGFAST - 1

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

**Approvals :** CE Certification ( TUV : SUD), BHEL, IRS, IBR, Thermax

#### Classification

AWS/SFA -5.18 ER 70S-6

#### Characteristics

A copper coated solid Steel wire for MIG/MAG welding of carbon steels. Normally recommended with CO<sub>2</sub> Shielding, also can be used with Ar-CO<sub>2</sub> mixtures. Uniform copper coating, smooth feeding, stable arc and minimum spatter under optimum welding conditions are the speciality of MIGFAST-1.

#### Applications

Multiple applications in Automobile Industry, Construction and Mining Equipment, Railway Wagon and Coaches, Storage tanks, Pressure Vessels, Steel Furniture, Pipes, LPG cylinders and Structural fabrications.

#### Welding current

DCEP

#### Wire Chemistry (%)

| C           | Mn          | Si          | S           | P           | Cu         |
|-------------|-------------|-------------|-------------|-------------|------------|
| 0.06 - 0.15 | 1.40 - 1.85 | 0.80 - 1.15 | 0.035 (max) | 0.025 (max) | 0.50 (max) |

#### All-Weld Mechanical Properties ( CO<sub>2</sub> Shield )

| UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) -(l = 4 x d) | CVN Impact values at                 |
|-----------------------|----------------------|-----------------------------|--------------------------------------|
| 490 (min)             | 400 (min)            | 22 (min)                    | 0°C 50 J ( min)<br>-30°C 27 J ( min) |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

CO<sub>2</sub> Consumption rate 10-12 lpm

#### Welding Position

Down hand/ Horizontal/ Vertical

#### Sizes (mm)

0.80, 1.00, 1.20, 1.60

#### Packing Specification

**Spools :** Net 15kg approx.

**Drums :** Net 100kg, 250kg

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.





## 09 | MIGFAST - 2

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

#### Classification

AWS/ SFA 5.28 ER 90S-D2

**Approvals :** Indian Railways : Class III

#### Characteristics

A copper coated MIG wire for MIG/MAG welding of high tensile steels. Uniform copper coating, smooth feeding, stable arc and minimum spatter under optimum welding conditions. Normally recommended with Ar/O<sub>2</sub> Shielding, CO<sub>2</sub> shielding can also be used.

#### Applications

Welding of SAILMA 450/450H1 steel used in CONCOR wagons is typical application for this wire. Is used for welding of high tensile steels like IS 8500 Grades 540 B, 570 B and 590B; IS 2002 Gr. III, IS 1875 Cl.

#### Welding current

DCEP

#### Wire Chemistry (%)

| C           | Mn          | Si          | Mo          | S           | P           | Ni         | Cu         |
|-------------|-------------|-------------|-------------|-------------|-------------|------------|------------|
| 0.07 - 0.12 | 1.60 - 2.10 | 0.50 - 0.80 | 0.40 - 0.60 | 0.025 (max) | 0.025 (max) | 0.15 (max) | 0.50 (max) |

#### All-Weld Mechanical Properties

|                                 | UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) - (l= 4 x d) | CVN Impact values at |
|---------------------------------|-----------------------|----------------------|-----------------------------|----------------------|
| Ar + 1-5%O <sub>2</sub> Gas Mix | 620 (min)             | 540 (min)            | 17 (min)                    | -30°C 27J (min)      |

Values obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

Ar + O<sub>2</sub>

#### Welding Position

F, H, V-up, V-down, OH

#### Sizes (mm)

1.00, 1.20, 1.60

#### Packing Specification

**Spools :** Net 12.500/ 15 kg approx.

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.



## 10 | MIGFAST - 3

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

#### Classification

AWS/SFA 5.18 ER 70S-2

#### Characteristics

Deoxidized copper coated mild steel wire. It gives stable arc, smooth flow and minimum spatter under Optimum welding conditions. Welds are of radiographic quality.

#### Applications

Structural, pressure vessels and boilers involving unalloyed and micro-alloyed structural steels. It meets HIC & SSCC test as per NACE specification.

#### Welding current

DCEP

#### Wire Chemistry (%)

| C          | Mn        | Si        | S          | P           | Ti        | Zr        | Al        | Cu         |
|------------|-----------|-----------|------------|-------------|-----------|-----------|-----------|------------|
| 0.07 (max) | 0.90-1.40 | 0.40-0.70 | 0.03 (max) | 0.025 (max) | 0.05-0.15 | 0.02-0.12 | 0.05-0.15 | 0.50 (max) |

#### All-Weld Mechanical Properties (Argon Shield)

| UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) -(l = 4 x d) | CVN Impact values at -30°C |
|-----------------------|----------------------|-----------------------------|----------------------------|
| 490 (min)             | 400 (min)            | 22 (min)                    | 27J (min)                  |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

Argon

#### Welding Position

All positions

#### Sizes (mm)

0.80, 1.20, 1.60

#### Packing Specification

Spools : Net 12.500/ 15 kg approx.

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.



## 11 | MIGFAST - 4

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

#### Classification

AWS/SFA 5.28 ER 80S-D2

#### Characteristics

A copper-coated, low-alloy, molybdenum (0.5% Mo), solid wire for the GMAW of creep-resistant steels of the same type, such as pipes in pressure vessels and boilers with a working temperature of up to 500°C. It can also be used for welding low-alloy high tensile strength steels. MIGFAST-4 is usually welded with CO<sub>2</sub> as the shielding gas. The

mechanical properties are given in the stress-relieved condition.

#### Applications

Suitable for welding of Mn and 0.50 % Mo steels

#### Welding current

DCEP

#### Wire Chemistry (%)

| C           | Mn          | Si          | Mo          | Ni         | S           | P           | Cu         |
|-------------|-------------|-------------|-------------|------------|-------------|-------------|------------|
| 0.07 - 0.12 | 1.60 - 2.10 | 0.50 - 0.80 | 0.40 - 0.60 | 0.15 (max) | 0.025 (max) | 0.025 (max) | 0.50 (max) |

#### All-Weld Mechanical Properties 100% CO<sub>2</sub>

| UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) -(l = 4 x d) | CVN Impact values at -30°C |
|-----------------------|----------------------|-----------------------------|----------------------------|
| 550 (min)             | 470 (min)            | 17 (min)                    | 27J (min)                  |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

CO<sub>2</sub>

#### Welding Position

F, H, V-up, V-down, OH

Note : The properties may vary with CO<sub>2</sub> shielding.

#### Sizes (mm)

1.00 1.20, 1.60

#### Packing Specification

Spools : Net 12.500/ 15 kg approx.

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.



## 12 | MIGFAST - 5

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

#### Classification

AWS/SFA 5.28 ER 90SG

#### Characteristics

A copper-coated low-alloy steel gas-shielded welding wire. It has excellent all position welding performance.

#### Applications

It is use for welding of high tensile strength steel, such as steel construction, pressure vessels, vehicles and bridges.

#### Welding current

DCEP

#### Wire Chemistry (%)

| C         | Mn        | Si        | Mo        | Ni         | S           | P           | Cu         |
|-----------|-----------|-----------|-----------|------------|-------------|-------------|------------|
| 0.07-0.12 | 1.60-2.15 | 0.50-0.85 | 0.40-0.65 | 0.15 (max) | 0.025 (max) | 0.025 (max) | 0.50 (max) |

#### All-Weld Mechanical Properties ( 100% Ar )

| UTS-N/mm <sup>2</sup> | YS -N/mm <sup>2</sup> | Elongation (%) -(l = 4 x d) | CVN Impact values at                 |
|-----------------------|-----------------------|-----------------------------|--------------------------------------|
| 620(min)              | 540(min)              | 17 (min)                    | -30°C 50J ( min)<br>-46°C 27J ( min) |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

Argon

#### Welding Position

F,H, V-up, V-down, OH

#### Sizes (mm)

1.20, 1.60, 2.00

#### Packing Specification

Spools : Net 12.500/ 15 kg approx.

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.



## 13 | MIGFAST - 6

### Copper Coated Continuous Solid Wire for MIG/ MAG Welding

#### Classification

AWS/SFA 5.28 ER 80SG

#### Characteristics

A copper-coated low-alloy steel gas-shielded welding wire. It has excellent all position welding performance.

#### Applications

It is use for welding of high tensile strength steel, such as steel construction, pressure vessels, vehicles and bridges.

#### Welding current

DCEP

#### Wire Chemistry (%)

| C         | Mn        | Si        | Mo        | Ni         | S           | P           | Cu         |
|-----------|-----------|-----------|-----------|------------|-------------|-------------|------------|
| 0.07-0.12 | 1.60-2.15 | 0.50-0.85 | 0.40-0.65 | 0.15 (max) | 0.025 (max) | 0.025 (max) | 0.50 (max) |

#### All-Weld Mechanical Properties ( 100% Ar )

| UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) -(l= 4 x d) | CVN Impact values at                 |
|-----------------------|----------------------|----------------------------|--------------------------------------|
| 550 (min)             | 470 (min)            | 17 (min)                   | -30°C 50J ( min)<br>-46°C 27J ( min) |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

Argon

#### Welding Position

F,H, V-up, V-down, OH

#### Sizes (mm)

1.20, 1.60, 2.00

#### Packing Specification

Spools : Net 12.500/ 15 kg approx.

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.



## 14 | TIGFAST - 3

### Copper coated wire for GTAW/ TIG welding

**Approvals :** IBR

#### Characteristics

Deoxidized copper coated mild steel wire. It gives stable arc, smooth flow and minimum spatter under Optimum welding conditions. Welds are of radiographic quality.

#### Applications

Structural, pressure vessels and boilers involving unalloyed and micro-alloyed structural steels. It meets HIC & SSCC test as per NACE specification.

#### Welding current

DCEP

#### Classification

AWS/SFA 5.18 ER 70S-2

#### Wire Chemistry (%)

| C          | Mn        | Si        | S          | P           | Ti        | Zr        | Al        | Cu         |
|------------|-----------|-----------|------------|-------------|-----------|-----------|-----------|------------|
| 0.07 (max) | 0.90-1.40 | 0.40-0.70 | 0.03 (max) | 0.025 (max) | 0.05-0.15 | 0.02-0.12 | 0.05-0.15 | 0.50 (max) |

#### All-Weld Mechanical Properties (Argon Shield)

| UTS-N/mm <sup>2</sup> | YS-N/mm <sup>2</sup> | Elongation (%) -(l = 4 x d) | CVN Impact values at -30°C |
|-----------------------|----------------------|-----------------------------|----------------------------|
| 490 (min)             | 400 (min)            | 22 (min)                    | 27J (min)                  |

Obtained with normal welding parameters. The values may change if parameters are changed markedly.

#### Shielding Gas

Argon

#### Welding Position

All positions

#### Sizes (mm)

Dia : 1.60, 2.00, 2.40, 3.15, 4.00  
Length : 1000 mm

#### Packing Specification

Net 5kg in Telescopic Plastic Tube.  
4 Such Tubes are Packed in Cardboard Box

#### Packing

Each spool is sealed in an airtight polythene bag and then packed in a corrugated box, which is again shrink-packed for better protection.

## 15 | MIGFAST / TIGFAST (STAINLESS STEEL WIRES)

### Solid Stainless Steel Wires For MIG / TIG Welding

| Brand Name                                     | AWS Classification (AWS/SFA-5.9) | WIRE CHEMISTRY (%) |             |             |           |           |           |           | Mechanical Properties of All Weld Metal in As welded condition |            | Sizes (Dia. mm)                                                                                              |
|------------------------------------------------|----------------------------------|--------------------|-------------|-------------|-----------|-----------|-----------|-----------|----------------------------------------------------------------|------------|--------------------------------------------------------------------------------------------------------------|
|                                                |                                  | C                  | Cr          | Ni          | Mn        | Si        | Mo        | Nb        | UTS Mpa                                                        | Elongation |                                                                                                              |
| <b>MIGFAST 308</b><br><b>TIGFAST 308</b>       | ER 308                           | 0.08 Max           | 19.50-22.00 | 9.00-11.00  | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 550 Min                                                        | 30% Min    | MIGFAST in Spools of 12.5 or 15.0kgs.<br>TIGFAST in 1.60, 2.00, 2.50, 3.15, 4.00mm sizes (in 1000 mm length) |
| <b>MIGFAST 308L</b><br><b>TIGFAST 308L</b>     | ER 308L                          | 0.03 Max           | 19.50-22.00 | 9.00-11.00  | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 520 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 347</b><br><b>TIGFAST 347</b>       | ER 347                           | 0.08 Max           | 19.00-21.50 | 9.00-11.00  | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | 0.20-1.00 | 520 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 316</b><br><b>TIGFAST 316</b>       | ER 316                           | 0.08 Max           | 18.00-20.00 | 11.00-14.00 | 1.00-2.50 | 0.30-0.65 | 2.00-3.00 | —         | 520 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 316 L</b><br><b>TIGFAST 316 L</b>   | ER 316L                          | 0.03 Max           | 18.00-20.00 | 11.00-14.00 | 1.00-2.50 | 0.30-0.65 | 2.00-3.00 | —         | 490 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 309</b><br><b>TIGFAST 309</b>       | ER 309                           | 0.12 Max           | 23.00-25.00 | 12.00-14.00 | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 550 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 309L</b><br><b>TIGFAST 309L #</b>   | ER 309L                          | 0.03 Max           | 23.00-25.00 | 12.00-14.00 | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 520 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 309 Mo</b><br><b>TIGFAST 309 Mo</b> | ER 309Mo                         | 0.12 Max           | 23.00-25.00 | 12.00-14.00 | 1.00-2.50 | 0.30-0.65 | 2.00-3.00 | —         | 550 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 310</b><br><b>TIGFAST 310</b>       | ER 310                           | 0.08-0.15          | 25.00-28.00 | 20.00-22.50 | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 550 Min                                                        | 30% Min    |                                                                                                              |
| <b>MIGFAST 312</b><br><b>TIGFAST 312</b>       | ER 312                           | 0.15 Max           | 28.00-32.00 | 8.00-10.50  | 1.00-2.50 | 0.30-0.65 | 0.75 Max  | —         | 660 Min                                                        | 22% Min    |                                                                                                              |
| <b>MIGFAST 410</b><br><b>TIGFAST 410</b>       | ER 410                           | 0.12 Max           | 11.50-13.50 | 0.60 Max    | 0.60 Max  | 0.50 Max  | —         | —         | 520 Min *                                                      | 20% Min *  |                                                                                                              |
| <b>MIGFAST 430</b><br><b>TIGFAST 430</b>       | ER 430                           | 0.10 Max           | 15.50-17.00 | 0.60 Max    | 0.60 Max  | 0.50 Max  | —         | —         | 450 Min**                                                      | 20% Min**  |                                                                                                              |

**Note :** Weld metal properties with 100 % Ar gas shielding.

\* After PWHT at 750° C for 1 Hr, furnace cooled to 315° C and then air cooled to ambient.

\*\* After PWHT at 770° C for 2 Hr, furnace cooled to 595° C and then air cooled to ambient.

Single value shown are maximum %

# Approved by Thermax Ltd.



## 16 | SOLID WIRES FOR SUBMERGED ARC WELDING (SAW)

| No. | Product                                        | Application                                                                                                                                                                                                                                                                                     |
|-----|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01  | <b>WELDFAST EL 8</b><br>AWS/ SFA 5.17 EL8      | Low Manganese-Silicon copper coated wire is suitable for welding of Mild steel, medium, high tensile steel and unalloyed steels in combination with agglomerated SAW flux. Typical applications are LPG cylinders, long seam welded pipes, butt and fillet welds in general structural welding. |
| 02  | <b>WELDFAST EL 12</b><br>AWS/ SFA 5.17 EL12    | Suitable for continuously welded pipes, wind mill towers, high speed welding pressure vessels and structures with high thickness etc. Could be used with suitable flux for obtaining good sub-zero impact properties.                                                                           |
| 03  | <b>WELDFAST EM 12K</b><br>AWS/ SFA 5.17 EM12K  | Medium Manganese killed steel wire better radiographic quality & tough deposit. Suitable for H- SAW pipes, L-SAW Pipes, Conventional pipes and structural fabrication.                                                                                                                          |
| 04  | <b>WELDFAST EH 14</b><br>AWS/ SFA 5.17 EH 14   | High Manganese killed steel wire for thick joints which requires PWHT Suitable for manufacture of pressure vessels, heat exchangers, boilers etc.                                                                                                                                               |
| 05  | <b>WELDFAST EH 10K</b><br>AWS/ SFA 5.17 EH 10K | Typical applications include manufacture of API pipes, High pressure pipelines, Pen-stocks, Nuclear reactors. Could be used for cryogenic applications by using suitable flux.                                                                                                                  |
| 06  | <b>WELDFAST EA2</b><br>AWS/ SFA 5.23 EA2       | Medium manganese wire with moly gives higher strength and toughness of weld deposit can be used where PWHT is relatively long Suitable for Pressure vessels, Heat exchangers, Welding of steel with 0.5% Mo and low alloy steels.                                                               |



### NOTE

In addition to the SAW wires described here, stainless steel SAW wires are also available. The detailed information on these wires could be provided on request.

|  | C          | Mn        | Si         | S           | P           | Cu         | Mo        |
|--|------------|-----------|------------|-------------|-------------|------------|-----------|
|  | 0.10 (max) | 0.25-0.60 | 0.07 (max) | 0.03 (max)  | 0.03 (max)  | 0.35 (max) | –         |
|  | 0.04-0.14  | 0.25-0.60 | 0.10 (max) | 0.03 (max)  | 0.03 (max)  | 0.35 (max) | –         |
|  | 0.05-0.15  | 0.80-1.25 | 0.10-0.35  | 0.03 (max)  | 0.03 (max)  | 0.35 (max) | –         |
|  | 0.10-0.20  | 1.70-2.20 | 0.10 (max) | 0.03 (max)  | 0.03 (max)  | 0.35 (max) | –         |
|  | 0.07-0.15  | 1.30-1.70 | 0.05-0.25  | 0.025 (max) | 0.025 (max) | 0.35 (max) | –         |
|  | 0.05-0.17  | 0.95-1.35 | 0.20 (max) | 0.025 (max) | 0.025 (max) | 0.35 (max) | 0.45-0.65 |

## 17 | STORAGE AND DRYING OF ELECTRODES

The most ideal storing conditions are well ventilated dry stores where electrode cases or packets are stored on pallets or racks off the floor. The store temperature should be minimum 2°C above the ambient and relative humidity 50% max. Wherever it is possible and when-ever optimum results from electrodes are desired, following storing, holding and redrying temperatures are recommended :

| Type of Electrodes                                               | Storing Conditions                                 | Redrying Conditions        | Holding Conditions              |
|------------------------------------------------------------------|----------------------------------------------------|----------------------------|---------------------------------|
| M. S. General Purpose<br>Super, Quality and Supreme              | 30° ± 10°C, RH 50% max.                            | 120° ± 10°C                | Same as storage                 |
| Low Hydrogen<br>LH 16, LH 18, LH 18-1                            | 30° ± 10°C, RH 50% max.                            | 300° ± 20°C                | 120° - 150°C                    |
| Low Alloy & High Tensile<br>Cromo & Tensal Series                | 30° ± 10°C, RH 50% max.                            | 300° ± 20°C                | 120° - 150°C                    |
| Hardfacing Electrodes<br>Hardex II, III & IV<br>Hardex IIR, IIIR | 30° ± 10°C, RH 50% max.<br>30° ± 10°C, RH 50% max. | 300° ± 20°C<br>120° ± 10°C | 120° - 150°C<br>Same as storage |
| All Stainless Steel Electrodes                                   | 30° ± 10°C, RH 50% max.                            | 300° ± 20°C                | 120° - 150°C                    |
| Cast Iron Machinable                                             | 30° ± 10°C, RH 50% max.                            | 120° ± 10°C                | Same as storage                 |

**Note :** Under site working conditions, it is recommended that the electrodes for welding are drawn from hot cannisters and the balance electrodes at the end of the working day are returned to drying oven.

## 18 | COMMON PROBLEMS IN WELDING & THEIR REMEDIES

### Possible Reasons

### CRACKING - WELD METAL

### Possible Remedies

- |                                                       |                                                                                                            |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| 1. High rigidity of joint                             | 1. Preheat, use peening, change welding sequence, increase cross section or bead                           |
| 2. Unsound welds                                      | 2. Check for porosity and inclusions.                                                                      |
| 3. Defective electrodes                               | 3. Change electrode, control moisture by proper storage. (high or low moisture in coating, poor core wire) |
| 4. Poor fit up.                                       | 4. Improve edge preparation and fit up Reduce root gap.                                                    |
| 5. Small or shallow bead.                             | 5. Increase cross selection of bead. Change electrode type/size.                                           |
| 6. Excessive carbon or alloy pick up from base metal. | 6. Reduce penetration by low current and increase travel speed. Change to low penetration electrode.       |
| 7. Angular distortion, causing tension at root run.   | 7. Balance welding on both sides, use peening.                                                             |
| 8. Excessive sulphur in base metal.                   | 8. Use EXX16 electrodes.                                                                                   |

### CRACKING - BASE METAL

- |                                     |                                                                                                                         |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1. Under bead or hydrogen cracking. | 1. Use low hydrogen EXX16 or EXX18 electrode.                                                                           |
| 2. High harden ability.             | 2. Preheat, increase welding heat input, post heat immediately after welding, use lower carbon or alloy content steel.  |
| 3. High strength.                   | 3. Use annealed or normalised metal.                                                                                    |
| 4. High transition temperature.     | 4. Examine preheat, post heat procedure, use material in tough condition, examine possibility of using different alloy. |
| 5. Brittle phase.                   | 5. Heat treat before welding to bring brittle phase in solution.                                                        |
| 6. Excessive stresses               | 6. Redesign, change sequences of welding use intermediate stress relief/anneal.                                         |

### POROSITY

- |                                                                            |                                                                 |
|----------------------------------------------------------------------------|-----------------------------------------------------------------|
| 1. Excessive hydrogen, oxygen, nitrogen or moisture in welding atmosphere. | 1. Change electrode, protect arc from excessive drafts.         |
| 2. High rate of weld freezing.                                             | 2. Increase heat input, preheat.                                |
| 3. High sulphur base metal.                                                | 3. Use EXX16 electrodes or low sulphur steels.                  |
| 4. Oil, paint or rust on steel.                                            | 4. Clean joint surfaces.                                        |
| 5. Improper arc length, current or electrode manipulation.                 | 5. Use proper arc length and control/correct welding technique. |
| 6. Excessive moisture in electrode or joint.                               | 6. Use dry electrodes and material.                             |

### INCLUSIONS

- |                                                  |                                                                       |
|--------------------------------------------------|-----------------------------------------------------------------------|
| 1. Failure to remove slag from previous deposit. | 1. Clean surface and previous beads properly.                         |
| 2. Improper joint design.                        | 2. Examine joint design. Examine selection of type/size of electrode. |
| 3. Inefficient arc shielding.                    | 3. Observe proper arc length and manipulations.                       |

# 19 | CHOICE OF WELDFAST ELECTRODES FOR INDIAN & VARIOUS INTERNATIONAL SPECIFICATIONS OF STEEL

## M. S. General Purpose Electrodes

| Weldfast Electrodes | Indian Standard IS                                 | British Standard BS | German Standard DIN | American Standard SAE/AISI | ASTM        |
|---------------------|----------------------------------------------------|---------------------|---------------------|----------------------------|-------------|
| Weldfast Super      | IS2062 plates, angles, tees, beams, channels flats | BS 970-1955         | DIN 1654 1954       | SAE 1005                   | A-36        |
|                     | IS 432-1966, MS Gr I & II                          | EN 2, ABCDE, 132A   | CQ 15               | SAE 1006                   | A-283       |
|                     | IS 1875 - IS 1878-1A                               | BS 1970-1972        | CQ 22               | SAE 1008                   | Gr A,B,C,D, |
|                     | IS 1977-1975                                       | BS 015A03,          | DIN 17210-1969      | SAE 1010                   | A-181       |
| Weldfast Quality    | Fe 310 - 0 ( St 32 )                               | BS 030A04           | C10                 | SAE 1011                   | Gr 60,70    |
|                     | Fe 410 - 0 ( St 42 )                               | BS 040A04           | C15                 | SAE 1012                   | A-21-6ECA   |
| Weldfast Supreme    | IS 2073 - 1970 - C 14                              | BS 050A04,          | CK10                | SAE 1013                   |             |
|                     | IS 2830 - 1975                                     | BS 040A10           | CK 15               | SAE 1015                   |             |
|                     | Gr 1 Fe 410 SB 1                                   | BS 050A12           | CM15                |                            |             |
|                     | Gr 2 Fe 410 SB 2                                   | BS 050A12           |                     |                            |             |
|                     | Gr 3 Fe 410 SB 3                                   | BS 040A15           |                     |                            |             |
|                     | IS 4432 - 1967 C10, C14                            | BS 050A15           |                     |                            |             |
|                     | IS 5489 - 1975 -14C6                               | BS 040A17,          |                     |                            |             |
|                     |                                                    | BS 050A17           |                     |                            |             |
|                     |                                                    | 45 M10              |                     |                            |             |

## Low Hydrogen Electrodes

| Weldfast Electrodes | Indian Standard IS          | British Standard BS | German Standard DIN | American Standard SAE/AISI | ASTM              |
|---------------------|-----------------------------|---------------------|---------------------|----------------------------|-------------------|
| Weldfast LH 16      | IS 2062, IS 2002, IS 432    |                     |                     | SAE-1970                   | A-105,            |
|                     | MS Grs, I & II              |                     |                     | 1005, 1006,                | A-106, Gr.A,B,C,  |
|                     | Medium tensile steel,       |                     | DIN                 | 1008, 1010,                | A-210 Gr.A1,      |
|                     | IS 961 Fe570HT,             |                     | 1645-1954           | 1011,1012,                 | Gr, C,            |
| Weldfast LH 18      | ST58 HT, Fe540 WHT          |                     | CQ 15, CQ 22,       | 1013, 1015                 | A-350, Gr, LF 1&2 |
|                     | ST 55WHT                    |                     | CQ 35,              | 1016, 1017                 | A-182, Gr, F1,    |
| Weldfast LH 18-1    | IS 1875-1978                |                     | DIN                 | 1018, 1019                 | A-333-Gr, 186     |
|                     | 15C8C11A,                   |                     | 17210-1969          | 1020, 1021                 | A-691 CMSH70      |
| Weldfast LH 28      | 20C8C12/2A                  | BS 970-1955         | C10, C15            | 1022, 1023                 | A-334-Gr.146      |
|                     | 30C8C13/3A                  | EN1A, 1B,           | C35, C45,           | 1025, 1026                 | A-515             |
|                     | IS 2073-1970-C 20           | 3ABCD, 4, 5,        | CK15, CD22,         | 1028, 1030                 | A-537 Gr.2        |
|                     | C 30, C 40 14 Mn1           | 7A, 8A,B,C,D,       | CK35,               | 1035, 1024                 | A-266,            |
|                     | IS 14, 13S25                | AM, BM, CM, DM,     | CK45,               | 1027, 1036                 | Gr,1,2,3,4        |
|                     | IS 2830-1975-Gr I, II & III | 201, 202            | 40 Mn4,             | 1109, 1110                 | A-216-WCBB        |
|                     | IS 2831-1975-Fe310          |                     | 28 Mn6,             | 1116, 1211                 | WCC               |
|                     | OB Fe 410 OB,               |                     | CM 15, CM35,        | 12L13, 12L14               | A-181-Gr.60-70    |
|                     | IS 3930-30CB (C30),         |                     | CM 45, 21 Mn6       | 1513, 1518                 | A-234-WPA,        |
|                     | 35CB (C35Mn75)              |                     |                     | 1522, 1525                 | WPB, WPC          |
|                     | IS 4368-20Mn2               |                     |                     | 1526                       | A-285             |
|                     | IS 4431-10C8S10,            |                     |                     |                            | Gr.A, B & C       |
|                     | 14C14S14,                   |                     |                     |                            |                   |
|                     | 25C12S14,                   |                     |                     |                            |                   |
|                     | 11C10S25,                   |                     |                     |                            |                   |
|                     | 40C15S12, C15Mn15,          |                     |                     |                            |                   |
|                     | 10S11, IS 5489-28C6         |                     |                     |                            |                   |

| Weldfast Electrodes    | Indian Standard<br>IS                                                                                        | British Standard<br>BS                   | German Standard<br>DIN                                                                                              | American Standard<br>SAE/AISI     | ASTM                                                                                                                           |
|------------------------|--------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Weldfast<br>CROMO 0500 | IS39030-1977-47 Mn6<br>40Mn 15S12,<br>35Mn6 Mo3<br>35 Mn6 Mo4                                                |                                          | 15Mo3, 16Mo5                                                                                                        | 4012, 4023<br>4024, 4027,<br>4419 | A-209 Gr. TI<br>A-161 TI,<br>A-182F1<br>A-691-CM65,70,75<br>A-234-WP1                                                          |
| Weldfast<br>CROMO 1500 | IS1570-07Cr 90 Mo55<br>15Cr 90Mo55,<br>13CrMo44,<br>25CrMo 44, 40Cr 4,<br>50 Cr4V2<br>40 Cr4Mo3,<br>17Mn5Cr4 | BS970-<br>1955-En20A,<br>En206<br>En 207 | DIN 1654-1954<br>-34Cr4,<br>41Cr4, 40CrMo4,<br>25 Cr Mo4,<br>34CrMo4, 42CrMo 4,<br>30CrMoV9,<br>34CrS4,<br>34CrMoS4 | AISI 4118                         | A-234-WP11,WP12<br>A-335, Gr. P1, P2<br>A-182 F11, F12, F1<br>A-200 T11,<br>A-369 FP2, FP11,<br>FP12,<br>A-381F12,<br>A-387B,C |
| Weldfast<br>CROMO 2251 | 10Cr 2 Mo1                                                                                                   |                                          |                                                                                                                     |                                   | A-182 Gr. F21, F22,<br>A-199 T22,<br>A-200 & A-213 T22,<br>A-336 F22,<br>A-369 FP22                                            |
| Weldfast<br>CROMO 5500 | IS1570-10Cr5 Mo55,<br>20CrMo55<br>IS5517-1978-15Cr<br>13Mo6, 25 Cr13Mo6,<br>40CrMo10V2                       | BS1508-625,<br>BS1628 GrB<br>BS1731 GrB  |                                                                                                                     |                                   | A-182F5, F54,<br>A-199T5,<br>A-200T5, A-213T5<br>A-335P5, F5,<br>A-369 FP5                                                     |
| Weldfast<br>CROMO 9100 |                                                                                                              |                                          |                                                                                                                     |                                   | A-182 F7 F9<br>A-691-CMS-70                                                                                                    |
| Weldfast Tensal 80     | 40 Ni14, 35Ni5Cr2,<br>40Ni6CrMo2,<br>31Ni10Cr3 Mo6,<br>20Ni7Mo2<br>20NiCr2Mo2                                | En15, 325, 351                           | DIN17210-<br>15CrNi6,<br>16CrNiMo6,<br>36CrNiMo4,<br>34CrNiMo6,<br>30CRNiMo8                                        | AISI 4320,<br>4340,<br>4615       | A-202 Gr A&B<br>A-299                                                                                                          |
| Weldfast 410           | IS6529-04Cr12                                                                                                | En56 A, B, C                             | X15Cr13                                                                                                             |                                   | A-182-F6<br>A-473-405, 410S                                                                                                    |
| Weldfast 13            | 12Cr13, 20Cr13,<br>30Cr13                                                                                    | BS1503-713                               | X07Cr13                                                                                                             | AISI 1405,<br>410                 | A-268-TP405,<br>A-176,A240 Gr 405,<br>410,A-336F6                                                                              |

| Weldfast Electrodes | Indian Standard IS                                             | British Standard BS      | German Standard DIN          | American Standard SAE/AISI                                               | ASTM                                                                                                            |
|---------------------|----------------------------------------------------------------|--------------------------|------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Weldfast 430        | IS 6529-05CR17                                                 | EN60                     | X8Cr17                       |                                                                          | A-176,276 & 473<br>Gr.430                                                                                       |
| Weldfast 308        | IS 1570-02Cr18Ni11<br>04Cr18 Ni10,<br>07CR18Ni9,<br>10Cr17 Ni7 | EN 58 A,B,C,<br>D,E,F    | X5CrNi 189,<br>X5CrNi 199    | AISI 304/<br>SAE 303,304<br>AISI 4201, 202<br>305, 308, 301,<br>302, 304 | A-167,240,270,276<br>& 314 Type 304<br>182F304<br>A-213, 376, 249, 271<br>GrTP 304H, A-351-<br>CF8, CF8A, CF 8C |
| Weldfast 308L       | 02Cr18Ni11                                                     |                          | X2CrNi189                    | AISI 302,<br>304,<br>304L                                                | A-213, 249, 312<br>TP304L & H<br>A-351, CF3,CF3A                                                                |
| Weldfast 347        | 04Cr19NiTi20<br>04CR10Ni9Nb40                                  | BS3014 Gr3<br>BS3014 Gr5 | X10CrNiTi189<br>X10CrNiNb189 | SAE30321,<br>AISI321,<br>SAE30347,<br>AISI347                            | A-213-TP321-321H<br>347,347H &<br>348H                                                                          |
| Weldfast 316        | 05Cr18Ni11Mo3<br>04Cr17Ni12Mo2                                 | EN58H                    | X5CrNiMo1812                 | SAE30316,<br>AISI316                                                     | A-167,240,276<br>473 Type 31<br>A-213,249,269,<br>312, 376 409<br>Gr.TP316, TP31'6H                             |
| Weldfast 316L       | 02Cr17Ni12Mo2                                                  | EN58H                    | X2CrNiMo1812<br>X5CrNiMo1910 | SAE30316L,<br>AISI316L                                                   | A-167,240, 473<br>Type316L, A213,<br>249, 269, 312, Gr.<br>TP A-351 CF8M,<br>CF10 MC,CF3M,<br>CF3MA             |
| Weldfast 318        | 07Cr19Ni9Mo2Ti28                                               | EN58H                    |                              | SAE30316,<br>AISI316                                                     | A-213-Tp316,316H                                                                                                |
| Weldfast 309        |                                                                |                          |                              |                                                                          | A-351-CH8,CH10,CH20                                                                                             |
| Weldfast 310        | 10Cr25Ni18                                                     |                          | X12CrNi2520                  | SAE 30310S,<br>AISI 310S                                                 | A-213-TP310,<br>F310 CN7M<br>A-312-TP310,<br>A-351-CK20,<br>HK20, 40                                            |



# 20 | COMPOSITION OF COMMONLY USED GRADES OF STEELS UNDER VARIOUS SPECIFICATIONS & RECOMMENDED WELDFAST MAKE ELECTRODES

| Specification | Grade              | Usage                                               | Common Section                                                      | Composition in Wt. % |      |      |      |      |      |              | Recommended Electrode                                | Remarks                                                                          |
|---------------|--------------------|-----------------------------------------------------|---------------------------------------------------------------------|----------------------|------|------|------|------|------|--------------|------------------------------------------------------|----------------------------------------------------------------------------------|
|               |                    |                                                     |                                                                     | C                    | Mn   | Si   | Cr   | Ni   | Mo   | Other        |                                                      |                                                                                  |
| IS226         |                    | Structural Steel                                    | Plates, angles tee, beams, channels, round, square & hexagonal bars | 0.25                 | -    | -    | -    | -    | -    | -            | Weldfast Super Quality, Supreme, Contact             | For Joint thickness up to 20 mm<br><br>Beyond 20 mm, use low H <sub>2</sub> type |
|               |                    |                                                     |                                                                     | -                    | -    | -    | -    | -    | -    | -            |                                                      |                                                                                  |
|               |                    |                                                     |                                                                     | -                    | -    | -    | -    | -    | -    | -            |                                                      |                                                                                  |
|               |                    |                                                     |                                                                     | -                    | -    | -    | -    | -    | -    | -            |                                                      |                                                                                  |
|               |                    |                                                     |                                                                     | -                    | -    | -    | -    | -    | -    | -            |                                                      |                                                                                  |
| IS432         | MS Gr.I            | Steel for concrete                                  | Bars & Wires 0.25                                                   | -                    | -    | -    | -    | -    | -    | -do-         | -do-                                                 |                                                                                  |
|               | MS GR.II           |                                                     |                                                                     | 0.17                 | -    | -    | -    | -    | -    | -            |                                                      |                                                                                  |
| IS 961        | Fe570HT (St.58HT)  | Structural steel, high Strength                     | Merchant sections                                                   | 0.27                 | -    | -    | -    | -    | -    | -            | Weldfast LH16-LH18                                   | Post Weld HT recommended                                                         |
|               | FE540WHT (St55HTw) |                                                     |                                                                     | 0.20                 | -    | -    | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
| IS 1875       | 1A,15C8            | Carbon steel for                                    | Billets, blooms slabs, bars, forging                                | 0.20                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast Supr., Qua., Sup.                           | Post Weld HT recommended                                                         |
|               | 2,20C8             |                                                     |                                                                     | 0.25                 | 0.90 | .035 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | 2A,25C8            |                                                     |                                                                     | 0.30                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | 3,30C8             |                                                     |                                                                     | 0.35                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | 3A,25C8            |                                                     |                                                                     | 0.40                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast Tensal 60                                   |                                                                                  |
|               | 4,45C8             |                                                     |                                                                     | 0.50                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast Tensal 60                                   |                                                                                  |
|               | 5,55C8             |                                                     |                                                                     | 0.60                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast 309                                         |                                                                                  |
|               | 6,66C8             |                                                     |                                                                     | 0.70                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast 309/312                                     |                                                                                  |
| IS2073        | C-14               | Carbon steel                                        | Bars                                                                | 0.18                 | 0.70 | -    | -    | -    | -    | -            | Weldfast Super, Quality,                             | Upto 20 mm thick joint, otherwise LH                                             |
|               | C-20               | for production                                      |                                                                     | 0.25                 | 0.90 | 0.35 | -    | -    | -    | -            | Supreme, Contact                                     |                                                                                  |
|               | C-30               | of machined parts for general engineering purpose   |                                                                     | 0.35                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | C-40               |                                                     |                                                                     | 0.45                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | C-45               |                                                     |                                                                     | 0.50                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | C-55Mn-75          |                                                     |                                                                     | 0.60                 | 0.90 | 0.35 | -    | -    | -    | -            | Weldfast 309/312                                     |                                                                                  |
|               | C-65               | Free cutting steels                                 | Bars                                                                | 0.70                 | 0.80 | 0.35 | -    | -    | -    | -            | Weldfast 309/312                                     |                                                                                  |
|               | 14Mn1S14           |                                                     |                                                                     | 0.18                 | 1.50 | 0.30 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
|               | 13S25              |                                                     |                                                                     | 0.18                 | 1.20 | 0.10 | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
| IS2830        | Gr1,Fe410SB1       | Carbon steel for re-rolling                         | Billets, blooms, slabs, bars                                        | 0.16                 | 0.90 | -    | -    | -    | -    | -            | Weldfast Super, Supreme                              | upto 20 mm thick joint, otherwise LH                                             |
|               | Gr2,Fe410SB2       | in to structural                                    |                                                                     | 0.23                 | 0.90 | -    | -    | -    | -    | -            | Quality, Contact                                     |                                                                                  |
|               | Gr3,Fe410SB3       | section                                             |                                                                     | 0.23                 | 0.90 | -    | -    | -    | -    | -            |                                                      |                                                                                  |
| IS2831        | Fe3100B            | Carbon steel for re-rolling into structural section | Billets, blooms, slabs, bars                                        | 0.15                 | 1.20 | -    | -    | -    | -    | -            | Weldfast Super, Supreme, Quality, Contact            | upto 20 mm thick joint, otherwise LH                                             |
|               | Fe4100B            |                                                     |                                                                     | 0.30                 | 1.20 | -    | -    | -    | -    | -            | Weldfast LH16/LH18                                   |                                                                                  |
| IS 3195       | 98C6               | Steel for valve, helical springs                    | Cast, rolled, 1.05 forged products                                  | 0.80                 | 0.35 | -    | -    | -    | -    | Weldfast 312 | Pre/post weld Weldfast 312 Weldfast 312 Weldfast 312 | HT recommended                                                                   |
|               | 113C6              |                                                     |                                                                     | 1.20                 | 0.80 | 0.35 | -    | -    | -    |              |                                                      |                                                                                  |
|               | 50Cr4V2            |                                                     |                                                                     | 0.56                 | 0.80 | 0.35 | 1.20 | -    | -    | 0.3V         |                                                      |                                                                                  |
|               | 60Cr4V2            |                                                     |                                                                     | 0.65                 | 1.00 | 0.35 | 1.20 | -    | -    | 0.15VMin     |                                                      |                                                                                  |
| IS 4368       | 20Mn2              | Alloy steel or general engineering purposes         | Billets, blooms slab                                                | 0.24                 | 1.70 | 0.35 | -    | -    | -    | -            | Weldfast LH16/Tensal60                               | Pre/post weld HT recommended                                                     |
|               | 15Cr65             |                                                     |                                                                     | 0.18                 | 0.60 | 0.35 | 0.80 | -    | -    | -            | Weldfast CROMO1500                                   |                                                                                  |
|               | 17Mn1Cr95          |                                                     |                                                                     | 0.19                 | 1.30 | 0.35 | 1.10 | -    | -    | -            | Weldfast CROMO1500                                   |                                                                                  |
|               | 20MnCr1            |                                                     |                                                                     | 0.22                 | 1.40 | 0.35 | 1.30 | -    | -    | -            | Weldfast CROMO1500                                   |                                                                                  |
|               | 21Cr1Mo28          |                                                     |                                                                     | 0.26                 | 0.80 | 0.35 | 1.20 | -    | 0.35 | -            | Weldfast CROMO1500                                   |                                                                                  |
|               | 07CR90Mo55         |                                                     |                                                                     | 0.12                 | 0.70 | 0.60 | 1.10 | 0.30 | 0.65 | -            | Weldfast CROMO1500                                   |                                                                                  |
|               | 10Cr2Mo1           |                                                     |                                                                     | 0.15                 | 0.70 | 0.50 | 2.50 | -    | 1.10 | -            | Weldfast CROMO2251                                   |                                                                                  |
|               | 15NiCr1Mo12        |                                                     |                                                                     | 0.18                 | 1.00 | 0.35 | 1.25 | 1.50 | 0.15 | -            | Weldfast Tensal 60                                   |                                                                                  |
|               | 15NiC2Cr1Mo15      |                                                     |                                                                     | 0.18                 | 1.00 | 0.35 | 1.25 | 2.00 | 0.20 | -            | Weldfast Tensal 80                                   |                                                                                  |
|               | 16NiCr2Mo20        |                                                     |                                                                     | 0.20                 | 0.70 | .035 | 1.70 | 2.20 | 0.25 | -            | Weldfast Tensal 80                                   |                                                                                  |
|               |                    |                                                     |                                                                     |                      |      |      |      |      |      |              |                                                      |                                                                                  |
|               |                    |                                                     |                                                                     |                      |      |      |      |      |      |              |                                                      |                                                                                  |

■ HT Stand for Heat Treatment.

■ Single value to be considered as max,value

| Specification | Grade               | Usage                                                               | Common Section                    | Composition in Wt. % |      |      |       |       |      |           | Recommended Electrode                       | Remarks                       |
|---------------|---------------------|---------------------------------------------------------------------|-----------------------------------|----------------------|------|------|-------|-------|------|-----------|---------------------------------------------|-------------------------------|
|               |                     |                                                                     |                                   | C                    | Mn   | Si   | Cr    | Ni    | Mo   | Other     |                                             |                               |
| IS 6529       | 04Cr13,12Cr13       | Stainless steels for corrosion oxidation & high temperature service | All cast, rolled, forged sections | 0.35                 | 1.00 | 1.00 | 14.50 | 1.00  | -    | -         | Weldfast 410/Weldfast13                     | Post weld HT Recommended      |
|               | 20Cr13, 30Cr13      |                                                                     |                                   | 0.10                 | 1.00 | 1.00 | 18.00 | -     | -    | -         | Weldfast 430                                |                               |
|               | 05Cr17              |                                                                     |                                   | 0.03                 | 2.00 | 1.00 | 20.00 | 13.00 | -    | -         | Weldfast 308 L                              |                               |
|               | 02Cr18Ni11          |                                                                     |                                   |                      |      |      |       |       |      |           |                                             |                               |
|               | 04Cr18Ni10          |                                                                     |                                   |                      |      |      |       |       |      |           |                                             |                               |
|               | 07Cr18Ni9           |                                                                     |                                   |                      |      |      |       |       |      |           |                                             |                               |
|               | 10Cr17Ni7           |                                                                     |                                   | 0.15                 | 2.00 | 1.00 | 20.00 | 12.00 | -    | -         | Weldfast 308                                |                               |
|               | 04Cr18Ni10Ti20      |                                                                     |                                   | 0.08                 | 2.00 | 1.00 | 19.00 | 12.00 | -    | Ti5C/0.8  | Weldfast 347                                |                               |
|               | 04Cr18Ni10Nb40      |                                                                     |                                   | 0.08                 | 2.00 | 1.00 | 19.00 | 12.00 | -    | Nb10C/10  | Weldfast 347                                |                               |
|               | 02Cr17Ni12Mo2       |                                                                     |                                   | 0.03                 | 2.00 | 1.00 | 18.5  | 14.00 | 3.00 |           | Weldfast 316L                               |                               |
|               | 04Cr17Ni12Mo2       |                                                                     |                                   | 0.08                 | 2.00 | 1.00 | 18.5  | 14.00 | 3.00 |           | Weldfast 316                                |                               |
|               | 04Cr17Ni12Mo2Ti20   |                                                                     |                                   | 0.08                 | 2.00 | 1.00 | 18.5  | 14.00 | 3.00 | Ti5C/0.80 | Weldfast 318                                |                               |
|               | 10Cr17Mn6Ni4        |                                                                     |                                   | 0.15                 | 7.50 | 1.00 | 18.0  | 4.50  |      | (N2) 0.25 | Weldfast 307S                               |                               |
| BS 970        | EN1A,7,7A           | Free Cutting                                                        | Bars                              | 0.15                 | 1.20 | 0.10 | -     | -     | -    | (S) 0.3M. | Weldfast LH16                               | Pre/ Post weld HT Recommended |
|               | EN2,2A, 2B, 2E      | Cold Forming                                                        | Bars                              | 0.20                 | 0.80 | -    | -     | -     | -    | -         | Weldfast Supreme/ Super/Quality             |                               |
|               | EN2C,2D             | Cold forming                                                        | Bars                              | 0.30                 | 0.70 | -    | -     | -     | -    | -         | Weldfast /Suprer, LH16,                     |                               |
|               | EN3, 3A, 3B, 3C, 3D |                                                                     |                                   | 0.25                 | 1.00 | 0.35 | -     | -     | -    | -         | Weldfast Super, Quality Supreme, LH16/LH18  |                               |
|               | EN5,5A,5B, 5C,5D,   | General Engg. application                                           | Bars                              | 0.35                 | 1.00 | 0.35 | -     | -     | -    | -         | Weldfast LH16/LH18                          |                               |
|               | EN6,6K,6A,          |                                                                     |                                   | 0.45                 | 1.00 | 0.35 | -     | -     | -    | -         | Weldfast LH16/LH18                          |                               |
|               | EN8,8A,8B, 8C,8D,8E | Machine tools                                                       | Bars                              | 0.60                 | 0.80 | 0.35 | -     | -     | -    | -         | Weldfast LH16/309                           |                               |
|               | EN9,9K              |                                                                     |                                   | 0.70                 | 0.80 | 0.35 | 0.80  | 0.80  | -    | -         | Weldfast 309/312                            |                               |
|               | EN10,EN11           | Hardenable Steel for axles, shafts                                  | Bars                              | 0.45                 | 0.90 | 0.35 | -     | 1.00  | -    | -         | Weldfast Tensal 60                          |                               |
|               | EN12,12A            |                                                                     |                                   | 0.25                 | 1.80 | 0.35 | 0.30  | 0.40  | -    | -         | Weldfast Tensal 60                          |                               |
|               | 12B,12C,            | connecting rods, crank shaft etc.                                   | Billets                           | 0.45                 | 0.80 | 0.35 | 1.50  | -     | 0.40 | -         | Weldfast Cromo 1500                         |                               |
|               | EN14,14A,           |                                                                     |                                   | 0.45                 | 0.80 | 0.35 | 1.50  | -     | 0.40 | -         | Tensal 60/309/312                           |                               |
|               | EN218,19,20         | Low alloy                                                           | Rounds                            | 0.45                 | 0.70 | 0.35 | 1.40  | 3.50  | 0.40 | -         | Weldfast Tensal 80                          |                               |
|               | EN23, 24            |                                                                     |                                   |                      |      |      |       |       |      |           | Weldfast 309/312                            |                               |
|               | EN31                | Wear resistant Steel                                                |                                   | 1.20                 | 0.75 | 0.35 | 1.60  | -     | -    | -         | Weldfast 312                                |                               |
|               | EN32                |                                                                     |                                   | 0.15                 | 1.00 | 0.35 | -     | -     | -    | -         | Weldfast Super, Quality Supreme, LH16, LH18 |                               |
| BS 970        | EN34,35             | High tensile steel                                                  |                                   | 0.20                 | 0.60 | 0.35 | -     | 2.00  | 0.30 | -         | Weldfast Tensal 80                          | Pre/ Post weld HT Recommended |
|               | EN56                | High Chromium Steel for turbine, pumps                              |                                   | 0.12                 | 1.00 | 1.00 | 14.0  | 1.00  | -    | -         | Weldfast 410/Weldfast 13                    |                               |
|               | EN57,EN60           | Corrosion heat resistant steel                                      |                                   | 0.20                 | 1.00 | 1.00 | 20.0  | 3.00  | -    | -         | Weldfast 430                                |                               |
|               | EN58 B,C,D,E,F,G,H  |                                                                     |                                   | 0.15                 | 2.00 | 0.20 | 20.0  | 12.0  | -    | -         | Weldfast 308/308L                           |                               |
|               | EN58 J,             | Case hardening steel                                                |                                   | 0.12                 | 2.00 | 0.20 | 20.0  | 12.0  | 3.00 | -         | Weldfast 308 Mo                             |                               |
|               | EN206, 207          |                                                                     |                                   | 0.20                 | 0.80 | 0.35 | 0.80  | -     | -    | -         | Weldfast 316/316L<br>Weldfast CROMO 1500    |                               |
| AISI/SAE      | 1005 to 1020        | Plain carbon steel &                                                |                                   | 0.20                 | 0.90 | -    | -     | -     | -    | -         | Weldfast Super, Quality Supreme             | Pre/ Post weld HT Recommended |
|               | Up to 1050          | Medium carbon steel for general engg.                               |                                   | 0.55                 | 1.00 | -    | -     | -     | -    | -         | Weldfast LH16/LH18                          |                               |
|               | 1108, 09, 10        | Free cutting steel                                                  |                                   | 0.20                 | 1.20 | -    | -     | -     | -    | (S) 0.15  | Weldfast LH16/LH18                          |                               |
|               | 17,18,19,1211       |                                                                     |                                   |                      |      |      |       |       |      |           |                                             |                               |
|               | 4012                | Alloy steel                                                         |                                   | 0.14                 | 1.00 | -    | -     | -     | 0.25 | -         | Weldfast CROMO 1500                         |                               |
|               | 4118, 4419          |                                                                     |                                   | 0.23                 | 0.90 | -    | -     | -     | 0.60 | -         | Weldfast CROMO 1500                         |                               |

■ HT Stand for Heat Treatment.

■ Single value to be considered as max,value

| Specification | Grade                                                  | Usage                                                                     | Common Section                            | Composition in Wt. % |      |      |       |      |      |               | Recommended Electrode    | Remarks                        |
|---------------|--------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------|----------------------|------|------|-------|------|------|---------------|--------------------------|--------------------------------|
|               |                                                        |                                                                           |                                           | C                    | Mn   | Si   | Cr    | Ni   | Mo   | Other         |                          |                                |
| AISI/SAE      | 4320, 4615, 4621<br>4718, 4720                         | Alloy steel                                                               |                                           | 0.22                 | 0.90 | 0.30 | 0.50  | 200  | 0.30 | -             | Weldfast Tensal 80,      | Post weld<br>HT<br>Recommended |
|               | 5115, 5120, 6118                                       |                                                                           |                                           | 0.22                 | 0.90 | 0.30 | 0.90  | -    | -    | -             | Weldfast CROMO1500       |                                |
|               | 8615, 8617, 8720                                       |                                                                           |                                           | 0.22                 | 0.90 | 0.30 | 0.60  | 0.70 | 0.25 | -             | Weldfast Tensal 60       |                                |
| AISI /SAE     | 201                                                    | Corrosion/<br>oxidation<br>resistance<br>& high<br>temperature<br>service | All rolled,<br>forged and<br>case section | 0.15                 | 7.50 | 1.00 | 18.0  | 5.50 | -    | (N)0.25       | Weldfast 307/308         |                                |
|               | 301                                                    |                                                                           |                                           | 0.15                 | 2.00 | 1.00 | 18.0  | 8.00 | -    | -             | Weldfast 308             |                                |
|               | 302                                                    |                                                                           |                                           | 0.15                 | 2.00 | 1.00 | 19.0  | 10.0 | -    | -             | Weldfast 308             |                                |
|               | 304                                                    |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 20.0  | 10.5 | -    | -             | Weldfast 308             |                                |
|               | 304L                                                   |                                                                           |                                           | 0.03                 | 2.00 | 1.00 | 20.2  | 12.0 | -    | -             | Weldfast 308L            |                                |
|               | 305                                                    |                                                                           |                                           | 0.12                 | 2.00 | 1.00 | 19.0  | 13.0 | -    | -             | Weldfast 308             |                                |
|               | 308                                                    |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 21.0  | 12.0 | -    | -             | Weldfast 308             |                                |
|               | 309                                                    |                                                                           |                                           | 0.20                 | 2.00 | 1.00 | 24.0  | 15.0 | -    | -             | Weldfast 309             |                                |
|               | 309L                                                   |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 24.0  | 15.0 | -    | -             | Weldfast 309 L           |                                |
|               | 310                                                    |                                                                           |                                           | 0.25                 | 2.00 | 1.50 | 26.0  | 22.0 | -    | -             | Weldfast 310             |                                |
|               | 310S                                                   |                                                                           |                                           | 0.08                 | 2.00 | 1.50 | 26.0  | 22.0 | -    | -             | Weldfast 310             |                                |
|               | 316                                                    |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 18.0  | 12.0 | 3.00 | -             | Weldfast 316             |                                |
|               | 316L                                                   |                                                                           |                                           | 0.03                 | 2.00 | 1.00 | 18.0  | 12.0 | 3.00 | -             | Weldfast 316L            |                                |
|               | 317                                                    |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 20.0  | 15.0 | 4.00 | T6x0min       | Weldfast 317             |                                |
|               | 321                                                    |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 19.0  | 12.0 | -    | -             | Weldfast 347             |                                |
|               | 330                                                    |                                                                           |                                           | 0.15                 | 2.00 | 1.50 | 17.0  | 37.0 | -    | -             | Weldfast 330             |                                |
|               | 347/348                                                |                                                                           |                                           | 0.08                 | 2.00 | 1.00 | 19.0  | 13.0 | -    | Cb-Ta 10xCmin | Weldfast 347             |                                |
|               | 403/405/409/410                                        |                                                                           |                                           | 0.15                 | 1.00 | 1.00 | 13.0  | -    | -    | -             | Weldfast 13/410          |                                |
| AISI/SAE      | 414                                                    |                                                                           |                                           | 0.15                 | 1.00 | 1.00 | 5.540 | 2.50 | -    | -             | Weldfast 13/410          |                                |
|               | 420                                                    |                                                                           |                                           | 0.15                 | 12.5 | 1.00 | 14.0  | -    | -    | -             | Weldfast 13/410          |                                |
|               | 430                                                    |                                                                           |                                           | 0.12                 | 1.00 | 1.00 | 18.0  | -    | -    | -             | Weldfast 430             |                                |
|               | 501/502                                                |                                                                           |                                           | 0.10                 | 1.00 | 1.00 | 6.00  | -    | 0.65 | -             | Weldfast CROMO 5500      |                                |
| ASTM          | A 105, 106, Gr A,B,C,<br>A210GrA1,C,<br>A350 GrLF1,LF2 | Tubes, Flanges, Bolts                                                     |                                           | 0.35                 | 1.10 | 0.30 | -     | -    | -    | -             | Weldfast LH16/LH18       |                                |
|               | A335GrP12                                              |                                                                           |                                           | 0.15                 | 0.60 | 0.50 | 12.5  | -    | 0.60 | -             | Weldfast CROMO 1500      |                                |
|               | A209 GrT1, A182GrF1                                    |                                                                           |                                           | 0.25                 | 0.90 | 0.35 | -     | -    | 0.60 | -             | Weldfast CROMO 0500      |                                |
|               | A200 GrT11,<br>A182Gr,F11,F12                          |                                                                           |                                           | 0.15                 | 0.60 | 1.00 | 1.50  | -    | 0.60 | -             | Weldfast 1500            |                                |
|               | A200 Gr T22, A182 GrF22                                |                                                                           |                                           | 0.15                 | 0.60 | 0.50 | 2.60  | -    | 1.10 | -             | Weldfast CROMO 2251      |                                |
|               | A182 Gr F5                                             |                                                                           |                                           | 0.15                 | 0.60 | 0.50 | 6.00  | 0.50 | 0.60 | -             | Weldfast CROMO 5500      |                                |
|               | A182 Gr F6(a)                                          |                                                                           |                                           | 0.15                 | 1.00 | 1.00 | 13.0  | 0.50 | -    | -             | Weldfast 13/410          |                                |
|               | A182 GrF9                                              |                                                                           |                                           | 0.15                 | 0.60 | 1.00 | 10.0  | 0.50 | 1.00 | -             | Weldfast CROMO9100       |                                |
|               | A213T2                                                 |                                                                           |                                           | 0.15                 | 0.60 | 0.30 | 0.80  | -    | 0.60 | -             | Weldfast CROMO 1500      |                                |
|               | A213 GrT3(b)                                           |                                                                           |                                           | 0.15                 | 0.60 | 0.50 | 2.50  | -    | 0.60 | -             | Weldfast CROMO 2251      |                                |
|               | A213 GrT5                                              |                                                                           |                                           | 0.15                 | 0.60 | 0.50 | 6.00  | -    | 0.60 | -             | Weldfast CROMO 5500      |                                |
|               | A213GrT9                                               |                                                                           |                                           | 0.15                 | 0.60 | 3.00 | 10.0  | -    | 1.00 | -             | Weldfast CROMO 9100      |                                |
| DIN1654       | CQ15                                                   | Draw steel for                                                            |                                           | 0.15                 | 0.50 | 0.35 | -     | -    | -    | -             | Weldfast Super, Quality, |                                |
| DIN17200      | C22,CK22 Q&T                                           | cold pressing                                                             |                                           | 0.25                 | 0.60 | 0.35 | -     | -    | -    | -             | Supreme                  |                                |
| DIN7200       | C35,CK35                                               |                                                                           |                                           | 0.40                 | 0.80 | 0.35 | -     | -    | -    | -             | Weldfast LH16, LH18      |                                |
| DIN17210      | C10,CK10                                               | Case hardening                                                            |                                           | 0.13                 | 0.60 | 0.35 | -     | -    | -    | -             | Weldfast Super,          | PWHT                           |
|               | C15,CK15,CM15                                          |                                                                           |                                           | 0.18                 | 0.60 | 0.35 | -     | -    | -    | -             | Quality, Supreme         |                                |
|               | 20MoCr4                                                |                                                                           |                                           | 0.22                 | 0.90 | 0.40 | 0.60  | -    | -    | 0.50          | Weldfast CROMO 1500      |                                |

■ HT Stand for Heat Treatment.

■ Single value to be considered as max.value

## 21 | SELECTION OF WELDFAST ELECTRODES FOR WELDING SIMILAR MATERIALS

|                                 |            | Materials to be welded Spec.               | AWS Classification | AWS Electrodes   | Weldfast Brand                                           |
|---------------------------------|------------|--------------------------------------------|--------------------|------------------|----------------------------------------------------------|
| Carbon Steels                   |            | UTS under 510 N/mm2<br>UTS under 610 N/mm2 | A5.1<br>A5.1       | E 60XX<br>E 70XX | Super, Quality, Supreme,<br>Contact, LH-16, LH-18, LH-28 |
| Low Chromium<br>Ferritic Alloys |            | ½ Cr - ½ Mo                                | A5.5               | E80XXB2          | CROMO 1500                                               |
|                                 |            | 1 Cr - ½ Mo                                |                    |                  |                                                          |
|                                 |            | 1¼ Cr - ½ Mo                               | A5.5               | E90XXB3          | CROMO 2251                                               |
|                                 |            | 2¼ Cr - 1 Mo                               | A5.5               | E8018B6          | CROMO 5500                                               |
|                                 |            | 5 Cr - ½ Mo<br>9 Cr - 1 Mo                 | A5.5               | E8018B8          | CROMO 9100                                               |
| STAINLESS STEEL                 | Ferritic   | AISI Type 405                              | A5.4               | E410-15          | Weldfast 13/410                                          |
|                                 |            | AISI Type 410 S                            |                    |                  |                                                          |
|                                 |            | AISI Type 410                              |                    |                  |                                                          |
|                                 |            | AISI Type 430                              | A5.4               | E-430-15         | Weldfast 430                                             |
|                                 | Austenitic | AISI Type 304 and 304 H                    | A5.4               | E308-16          | Weldfast 308                                             |
|                                 |            | AISI Type 304 L                            | A5.4               | E308L -16        | Weldfast 308L                                            |
|                                 |            | AISI Type 321 and 321 H                    |                    |                  |                                                          |
|                                 |            | AISI Type 347 and 347 H                    | A5.4               | E347-16          | Weldfast 347                                             |
|                                 |            | AISI Type 316 and 316 H                    | A5.4               | E316-16          | Weldfast 316/308Mo*                                      |
|                                 |            | AISI Type 316 L                            | A5.4               | E316L-16         | Weldfast 316L                                            |
|                                 |            | AISI Type 309                              | A5.4               | E309-16          | Weldfast 309 L                                           |
|                                 |            | AISI Type 310                              | A5.4               | E310-16          | Weldfast 310                                             |

■ When operating temperature is over 400°C and when thickness is over 20 mm for types 321 and 347, the recommended electrode is Weldfast 308 Mo. This electrode may also be used for type 316 in service over 400°C.

## 22 | WELDFAST MILD STEEL ELECTRODE SELECTION CHART

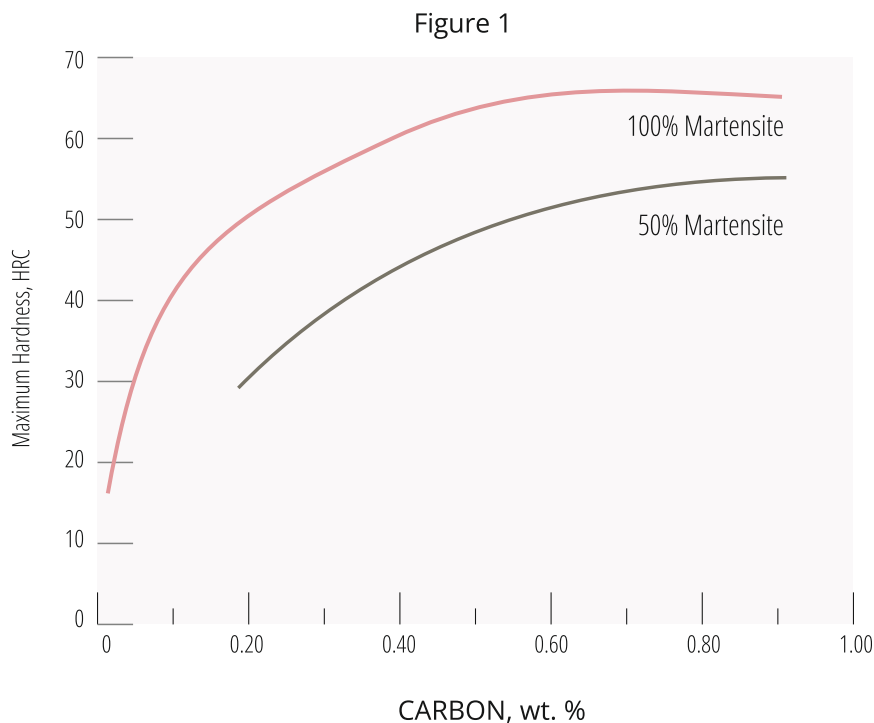
| Weldfast Electrode<br>AWS Classification | Super<br>E6013 | Quality<br>E6013 | Supreme<br>E6013 | LH-16<br>E7016 | LH-18<br>E7018 |
|------------------------------------------|----------------|------------------|------------------|----------------|----------------|
| Groove butt welds, flat (>6mm)           | 6              | 7                | 8                | 7              | 9              |
| Positional groove butt (>6mm)            | 8              | 8                | 5                | 10             | 10             |
| Fillet welds, flat or horizontal         | 7              | 8                | 10               | 5              | 7              |
| Positional fillet welds                  | 9              | 9                | 6                | 10             | 9              |
| Thin material (<6 mm)                    | 8              | 7                | 10               | 2              | 2              |
| Heavy Plate or highly restrained joint   | 7              | 7                | 6                | 10             | 9              |
| High sulphur or off-analysis steel       | 3              | 3                | 5                | 10             | 10             |
| Deposition rate                          | 4              | 5                | 5                | 5              | 6              |
| Depth of penetration                     | 6              | 7                | 5                | 7              | 7              |
| Appearance, absence from undercut        | 8              | 8                | 9                | 7              | 8              |
| Radiographic soundness                   | 6              | 7                | 7                | 10             | 9              |
| Ductility                                | 5              | 6                | 6                | 10             | 10             |
| Low temperature impact strength          | 4              | 4                | 4                | 10             | 10             |
| Low spatter loss                         | 6              | 6                | 7                | 6              | 8              |
| Poor fit up                              | 8              | 7                | 6                | 7              | 7              |
| Welder appeal                            | 9              | 8                | 10               | 6              | 8              |
| Slag removal                             | 7              | 7                | 8                | 6              | 6              |
| Current                                  | AC/DC          | AC/DC            | AC/DCS           | AC/DCR         | AC/DC          |

◆ Rating is on comparative basis of same size of electrode with 10 as the highest value, relative rating may change with size of electrode. ◆ NR-Not recommended.  
◆ DCR-Direct current reverse, electrode positive. ◆ DCS-Direct current straight, electrode negative. AC-Alternative current. DC-Direct current, either polarity.

## 23 | CARBON EQUIVALENT

The Heat of welding, thermal cutting causes changes in the microstructure and mechanical properties in a region of the heated steel that is referred to as the heat-affected zone (or HAZ). The resulting microstructure in the HAZ will depend upon the composition of the steel and the rate at which the steel is heated and cooled. With some steels, the thermal cycle may result in the formation of martensite in the weld metal and HAZ. The amount of martensite formed and the hardness of the steel depend upon carbon content, as well as the time at elevated temperature and the cooling

rates. Figure 1 gives the relationship between hardness and carbon content for steels that are 50 or 100% martensite after quenching. Martensitic transformation and the resulting high hardness can lead to cracking in the weld or HAZ if the metal cannot yield to relieve welding stresses. The degree of hardening in the HAZ is an important consideration determining the weldability of a carbon or low-alloy steel. Weldability and resistance to hydrogen cracking generally decreases with increasing carbon or martensite in the weld metal or the HAZ, or both.



Relationship between Carbon Content and Maximum Hardness of Steels  
with Microstructures of 50% and 100% Martensite

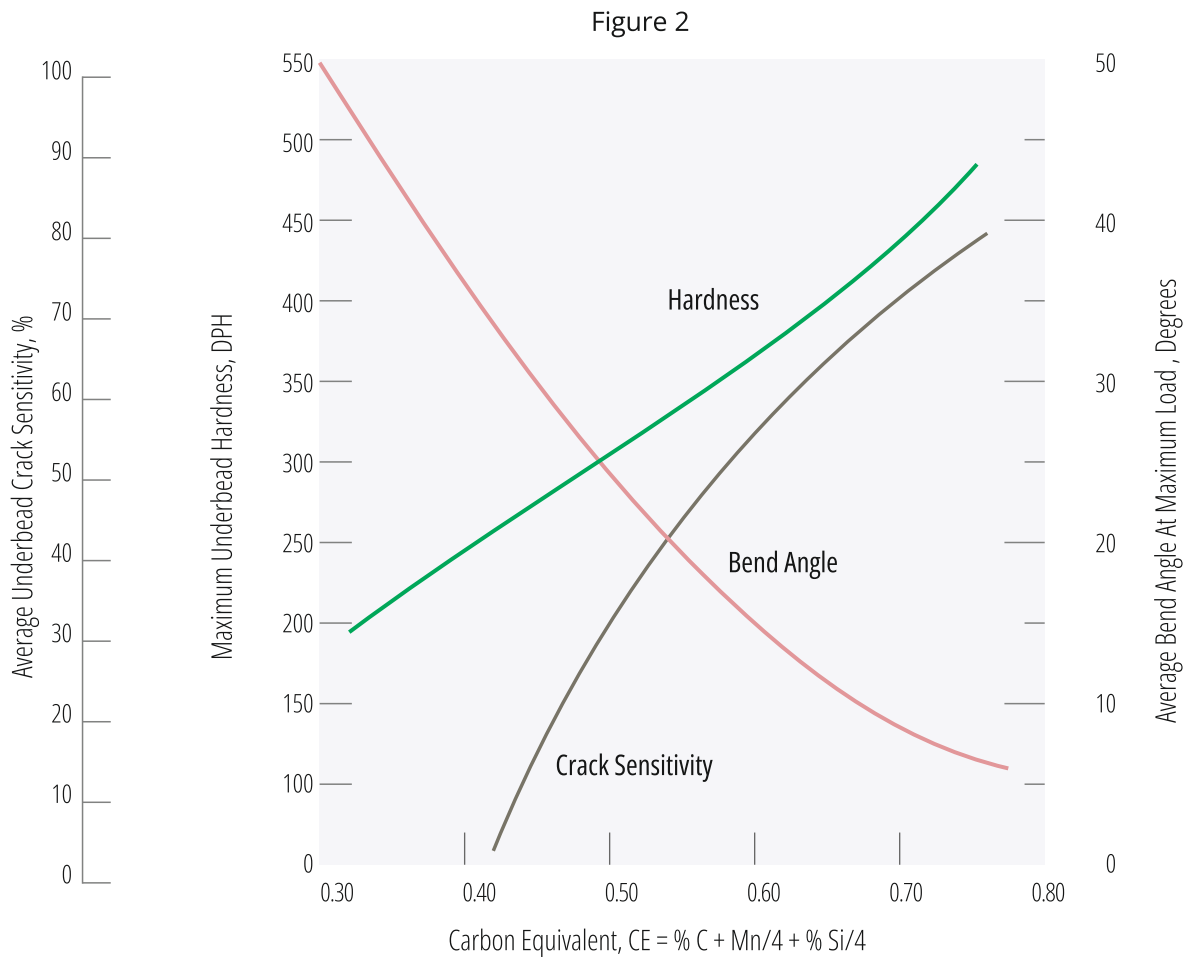
Although carbon is the most significant alloying element affecting weldability, the effects of other elements can be estimated by equating them to an equivalent amount of carbon. Thus, the effect of total alloy content can be

expressed in terms of a carbon equivalent (CE). One empirical formula that may be used for judging the risk of underbead cracking in carbon steels is:-

$$CE = C + (Mn/6) + [(Cr+Mo+V)/5] + [(Ni+Cu)/15]$$

Figure 2 shows the general relationships between carbon steel composition (CE) and hardness, underbead cracking sensitivity, or weldability based upon slow-bend capability of notched-weld-bead test bars. Generally, steels with low CE values (e.g., 0.2 to 0.3) have excellent weldability; however,

the susceptibility to underbead cracking from hydrogen increases when the CE exceeds 0.40. A steel with only 0.20% C and 1.60% Mn will have a CE of 0.60, indicating relatively high crack sensitivity.



Relationship between Composition and Underbead Hardness Crack Sensitivity, and Notched-Weld-Bead Bend Angle for 1 in. (25.4 mm) Thick C-Mn Steel Plate Welded with E6010 Covered Electrodes

## 24 | HYDROGEN INDUCED CRACKING

Hydrogen induced cracking (also known as under-bead, cold, or delayed cracking), can occur when welding carbon and low-alloy steels. The potential for hydrogen cracking in the weld metal, the heat affected zone (HAZ), or both depends on their composition, hydrogen content, and stress level. It generally occurs at temperature below 150 °C immediately cooling or after a period of several hours. This time depends upon the type of steel, the magnitude of welding stresses, and the hydrogen content of the weld metal and HAZ.

Hydrogen cracking or cold cracking results when both hydrogen and tensile stresses are present in crack-susceptible microstructure of the weld metal & HAZ. Sometimes cracking may occur in the weld metal particularly when the yield strength is over 90 Ksi (620 MPa); in general, however, alloy steels are most likely to crack in the HAZ. Diffusion of hydrogen in the HAZ from the weld metal during welding contributes to cracking in this zone. Microstructure of the steel and tensile stresses are also contributing factors.

To summarize, hydrogen cracking in welded joints associated with the combined presence of four conditions, namely:

- 1) The presence of atomic (diffusible) hydrogen in the steel
- (2) A susceptible microstructure, to be partly or wholly martensitic generally accepted to be partly or wholly martensitic
- (3) A tensile stress at the sensitive location
- (4) A temperature below 300 °F (150 °C)

Hydrogen cracking will not take place if one or more of these conditions is absent. Further discussion on the conditions for hydrogen cracking is provided in the following subsections.

### Hydrogen Sources.

Molten steel has a high solubility for atomic (diffusible) hydrogen, which may be present due to the dissociation of water vapor or hydro carbons in the welding

arc. The diffusion rate of atomic hydrogen in steel at or near its melting temperature is high. Therefore, the molten weld metal can rapidly pick up atomic hydrogen from the hot gas in the arc. Once in the weld metal, hydrogen atoms can diffuse rapidly into the HAZ of the base metal. The absorbed hydrogen is rejected from the steel during cooling and phase transformation, whereupon it tends to concentrate at microstructural dislocations and voids in the matrix. The driving force to form diatomic or molecular hydrogen in the voids is very great, and a high pressure can occur. This induces localized tensile stresses that add to residual tensile stresses.

There are several possible sources of moisture and other hydrogenous compounds that can dissociate in the welding arc and introduce diffusible hydrogen in the weld metal. Sources include the filler metal, moisture in the electrode covering, welding flux, shielding gas, or contaminants on the filler or base metal

### Avoiding Cracking.

When the carbon or alloy content of steel is increased to achieve higher strength, the hardness of the martensite in the microstructure is increased as well, and this tends to reduce the steel's tolerance for hydrogen. Residual stresses tend to increase with strength also. Higher-strength quenched-and-tempered steels such as HY-130, on the other hand, must be welded with covered electrodes that contain no more than 0.1% moisture in the covering. Moisture or hydrogen limitations for covered electrodes vary between these two levels, depending upon the steel being welded.

Hydrogen cracking can be controlled by several means. A welding process or an electrode that produces little diffusible hydrogen can be selected. A combination of welding and thermal treatments that drives off the hydrogen, or produces a microstructure that is less sensitive to such cracking, can be used. Another alternative is simply to apply welding procedures that result in low welding stresses.



## Welding Process.

Available hydrogen during welding can be limited by using a low-hydrogen process. Primary sources of hydrogen are cellulose, moisture, or both, in the electrode covering with shielded metal arc welding; moisture in the flux with submerged arc welding; moisture in core ingredients of the flux with flux cored arc welding; and moisture in core ingredients of metal cored electrodes with gas metal arc welding. Other sources of hydrogen are adsorbed moisture, rust, or hydrocarbon contaminants (oil, grease, drawing lubricants, or paint) on the filler metal or the base metal. Shielding gas contaminated with humid air or moisture is yet another source of hydrogen.

The use of low-hydrogen electrodes is recommended for shielded metal arc welding of steels that are susceptible to hydrogen cracking. However, the moisture content of the electrodes must be maintained below the limits stated in the applicable filler metal specification.

Electrodes are manufactured to be within acceptable moisture limits consistent with the type of covering and strength of the weld metal. Low-hydrogen electrodes are packaged in containers that provide the moisture protection necessary for the type of covering and the application. Such electrodes can be maintained for many months in these containers when stored at room temperature with the relative humidity at 50% or less. Unpackaged, they can be stored in electrode-holding ovens for short times. However, if the containers are removed or damaged and the electrodes are improperly stored, the coverings may absorb excessive moisture.

### Thermal Treatments. Preheating and Post heating

Preheating and Post heating at or just above the preheat temperature should be considered when there is danger of hydrogen cracking in the welded joint.

Preheating involves raising the temperature of the weldment prior to welding and maintaining an elevated interpass temperature during the entire welding operation in order to:

- (1) Reduce cooling rates and reduce the hardness of HAZs
- (2) Increase the rate at which hydrogen diffuses away from the weld and HAZ
- (3) Reduce stresses near the weld

Preheat may be applied to the entire weldment, only to the vicinity of the weld joint. Selection of pre heat temperature and the degree to which preheat must be applied involves a number of considerations. In general, preheat temperatures must increase with increasing carbon equivalent, plate thickness, restraint and hydrogen levels. High arc energy levels, low hydrogen consumables and heating of the entire part rather than only a local area may permit the use of a lower preheat temperature. Recommendations for minimum pre heat temperatures for carbon and low alloy steels can be found in a number of documents.

Post heating should be performed immediately after welding, while the weldment is still at the preheat temperature. The post heat temperature may be the same used for preheating [200 to 600 °F (93 to 316 °C)]. T holding time at post heat temperature depends upon joint thickness, because the length of the path of which the hydrogen must diffuse to the surface is a controlling factor. Raising the temperature modestly help reduce the time needed for hydrogen removal.

Weldments of steels that are quenched and temperature to achieve desired properties require special treatment. Either they must be welded with a low-hydrogen practices, or they must be post weld heat-treated prior to hardening treatment.



## 25 | **USEFUL INFORMATION FOR WELDING TECHNICIANS**

### 1. Striking the arc

To avoid short circuiting, strike the electrode quickly against the base-metal surface and lift gently to obtain a proper arc-length (2 mm).

### 2. Positioning of the electrode

#### Fillet welds :

The angle of 60o-90o towards welding direction (Fig. 1).

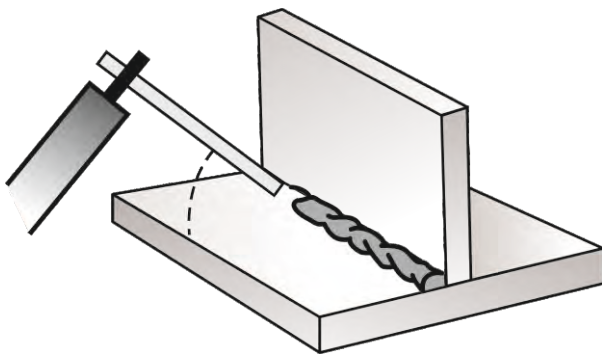


Fig. 1

#### Butt welds :

The electrode shall be held at a 60o-90o angle towards welding direction (Fig. 2).

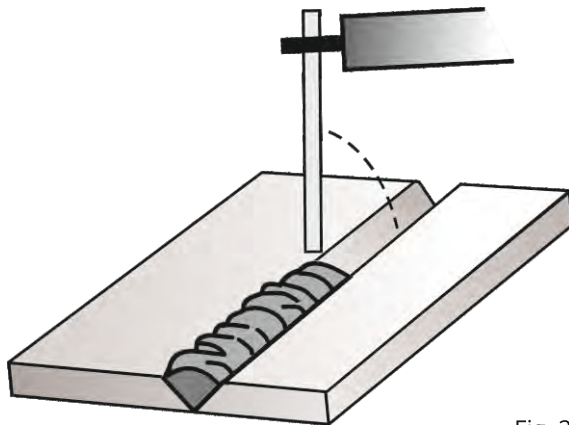


Fig. 2

### 3. Ending the weld run

Weld metals contract while solidifying. It is therefore better, especially on root runs, to add extra weld metal when ending the weld. This is done by going back over the weld run just 2 cm before ending.

### 4. Weld Preparation

#### AJ Preparation of surface :

Normally the first run will not hold the desired properties, due to mixing with base material. It is often beneficial to make the seating for the weld metal big enough to hold two layers of surfacing material. As a rule of thumb, assume that one weld layer is 3 mm thick.

#### BJ Tacking :

It is necessary to fix parts together before joining. Fillet joints shall be fixed as tight as possible. Butt joints shall be fixed with a gap when the plate thickness is over 2 mm.

One should maintain the same gap width along the whole joint. To achieve this, use a gauge when tack-welding. Normally the grip-end of the root electrode (max 3.25 mm) provides a good gauge, but for thin plates a piece of the plate itself will be better.

#### CJ Joining :

F Confirm if the joint can be welded only from one side or from both sides.

F Choose the right joint preparation depending on the plate thickness.

F Fillet welds shall have a throat thickness of half the plate thickness of the thinner plate.

F Butt welds have a slightly convex surface both on the root and on the top side of the weld.

### 5. Hardfacing / Surface building

The following should be considered when surfacing.

- ◆ Choose the electrode most suitable to stop the wear.
- ◆ It is properties of parent metal that decides if one has to go for buffer layer or to directly & apply the hard surfacing electrode on base plate. One should get the as much information on parent metal.

## 6. Setting the correct current for welding

Currents are given in ranges for each size. The lower limit gives the minimum amperage to maintain a stable arc. The upper limit gives the maximum amperage to avoid damage on the coating components. When welding, use the information in the current conditions mentioned in manufactures manual or on the packing of the electrode.

### Current level basically influence :

- ◆ **Bead appearance**
- ◆ **Hardness (through cooling rate and dilution)**
- ◆ **Fluidity**

## Effect of different current conditions on various properties of weldmetal

|                                 |                                                                                     |                                                                                       |
|---------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>A) Fluidity of Weldmetal</b> | Too High Current<br>Burn through & undercut                                         | Too Low Current<br>Inadequate Fusion                                                  |
| <b>B) Bead Shape</b>            |  |  |
| <b>C) Hardness</b>              | Low cooling rate resulting<br>in low hardness                                       | High cooling rate gives higher<br>hardness                                            |

## 7. OCV (Open Circuit Voltage)

The welder has to take care that the selected electrode operates on the power source available with him e.g. Low hydrogen electrodes require higher OCV than required for striking rutile type electrodes.

## 8. Electrode care

Electrodes should be stored in a dry place and they should be allowed to reach the same temperature as the operating environment before opening.

Electrodes in unsealed boxes pick up moisture from the air. For this reason electrodes should be redried according to the information on each box before use on critical applications.



## Notes

[illegible]

## Notes







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