
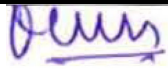





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## Welding Specification of Bogie


|          |             |              |   |
|----------|-------------|--------------|---|
| Approved | 12.03.2020  | Sudarshan M  |  |
| Reviewed | 12.03.2020  | Dhananjaya B |  |
| Prepared | 12.03.2020  | Jayanth C    |  |
|          | <b>Date</b> | <b>Name</b>  | <b>Signature</b>  |




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## 1. INTRODUCTION


This document is to describe the welding specification of bogie for Driving Motor car (DMC), Trailer car (TC) and Motor car (MC) proposed for Mumbai Metro (MRS1) project.

## 2. SCOPE

This document is according to criteria specified in the Employer's Requirement Technical Specification (ERTS. clause No.14.3)

## 3. APPLICABLE STANDARDS & NORMS

| No. | ERTS Standard | Equivalent Standard          | Title   |
|-----|---------------|------------------------------|---|
| 1   | ISO 2553      | ISO 2553-1992                | Welded, brazed and soldered joints-symbolic representation on drawings.   |
| 2   | -             | ISO 4063-1998                | Welding and allied processes-Nomenclature of processes and reference numbers.   |
| 3   | -             | ISO 5817-2007                | Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections |
| 4   | BS EN 287-1   | BS EN 287-2004<br>ISO 9606-1 | Approval testing of welders for fusion welding.   |
| 5   | BS EN 288-3   | BS EN ISO-15614-1 :2004      | Specifications and Approval of welding procedures for metallic materials- Welding procedure tests for the arc welding of steels.      |
| 6   | JIS G 3114    | JIS G 3114-2004              | Hot-Rolled Atmospheric Corrosion Resisting Steels for welded structure.   |
| 7   | -             | IS 309-2005                  | Compressed Oxygen gas - Specification.  |
| 8   | -             | IS 5760-1998                 | Argon, Compressed and liquid - Specification.   |
| 9   | -             | AWS A5.18-2005               | Specification for Carbon steel electrodes and rods for Gas shielded Arc Welding.  |
| 10  | -             | AWS A5.12-2009               | Specification for Tungsten and Tungsten alloy electrodes for arc welding and cutting.   |
| 11  | -             | BS EN 15085-2 :2007          | Railway applications- Welding of railway vehicles and components- Quality requirements & certification of welding manufacturer        |
| 12  | -             | BS EN 15085-3 :2007          | Railway applications- Welding of railway vehicles and components- Design requirements   |
| 13  | -             | BS EN ISO 6947 :2011         | Welding & allied processes - Welding positions  |


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#### 4. ABBREVIATIONS

|      |  |
|------|--|
| ERTS | : Employer's Requirement Technical Specification |
| ISO  | : International Organization for Standardization |
| JIS  | : Japanese Industrial Standard                   |
| IS   | : Indian Standard                                |
| BS   | : British Standard                               |
| EN   | : European Standard                              |
| MIG  | : Metal Inert Gas                                |
| MAG  | : Metal Active Gas                               |
| TIG  | : Tungsten Inert Gas                             |
| SMAW | : Shielded Metal Arc Welding                     |
| SMA  | : Shape Memory Alloy                             |
| AWS  | : American Welding Society                       |
| ER   | : Electric Rod (Filler Material)                 |
| W/D  | : Welding  |
| NDT  | : Non destructive Test                           |
| MPT  | : Magnetic particle Test                         |
| LPT  | : Liquid Penetrate Test                          |
| DPT  | :Dye Penetrate Test                              |
| RT   | : Radiographic Test                              |
| PQR  | : Product Quality Report                         |
| PFDR | : Pre-final Design review                        |

#### 5. REFERENCE DOCUMENTS


| No. | Doc. No.   | Title                                      | Remarks |
|-----|------------|--|---------|
| 1   | GR/TD/4997 | NDT Test Specification of Bogie frame      |         |
| 2   | GR/TD/4999 | Stress relieving procedure for Metro Bogie |         |
| 3   | GR/TD/4565 | Welding Inspection Of Bogie                |         |
| 4   | GR/TD/4658 | ITP of Bogie                               |         |

|   |   |          |                         |
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## 6. TECHNICAL REQUIREMENTS (ERTS)

| ERTS Clause no. | ERTS Requirements   | Compliance statement                     | Para No. for compliance reference | Remarks |
|-----------------|---|--|-----------------------------------|---------|
| <b>14.3</b>     | <b>Welding</b>  |  |                                   |         |
| 14.3.1          | All welding procedure shall be documented by the Contractor for each sub and major assemblies. Approval of the welding procedure shall be required by BS EN 288-3: Specification of Approval Testing of Welding Procedures or equivalent. All welding procedure shall be proven to avoid/ control distortion of sub and major assemblies. | Complied                                 | Covered in WPS & Drawings         |         |
| 14.3.2          | Approval of welder shall be as required by BS EN 287-1: Specification for Approval Testing of Welders Working to Approved Welding Procedures, or equivalent.  | Complied                                 | Section 4.4                       |         |
| 14.3.3          | Arc welding shall be performed by the MIG/TIG process and in all cases complete and adequate fusion with the base material shall be ensured. All consumables for welding like gas, electrode shall conform to International Standards. The welding symbols shall be as per ISO 2553 or any other relevant International Standards.        | Complied                                 | Section 3.2.2, 3.2.3, 3.3         |         |
| 14.3.4          | The Contractor shall provide details of all preparatory and post-welding procedures to be undertaken during the process of spot welding. Spot welding of components which carry structural loads shall be performed using equipment fitted with time, current and pressure control.   | Not Applicable for Bogie frame structure | -                                 |         |
| 14.3.5          | The Engineers or Inspector reserves the right to verify the quality of the technique / technology employed for joining the modular element of shell.  | Complied                                 | Section 5.0                       |         |



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## 7. GENERAL

### 7.1. Introduction

This specification defines the minimum requirements applicable for welding of carbon steel. This specification is formulated to cover all joints associated with the product. The parts of the bogie frame are joined mainly by: MIG & MAG welding processes.

### 7.2. Definitions

Symbolic representation of welds will be as per EN ISO 2553 and welding processes applied will be as per BS EN ISO 4063. Any special conditions or requirements will be fully explained by adding notes or details. If necessary, full and complete information regarding welding technique, process etc. will be clearly shown in the drawing.

#### 7.2.1. Manufacturer

Manufacturer of parts to the project refers normally to one specific manufacturing unit within the company. The quality control of manufacturing parts of sub-contracts will be done in accordance with BEML quality procedure.


## 8. WELDING MATERIAL

### 8.1. Base Metal

The base metal used in Bogie will be in accordance with the specification as given in Table 1.

**Table 1** Carbon steel Base metal

| Sl. No. | Description  | Standard                                 |
|---------|--|--|
| 1       | Hot - Rolled Atmospheric Corrosion Resisting Steels for Welded Structure | SMA 490 BW, JIS G 3114                   |
| 2       | Seamless steel tube - Ø190.7 mm & Ø93 mm                                 | ASTM A618, Gr. 1a / STKM 18B, JIS G 3445 |
| 3       | Structural Steel Rod - Ø30mm   | ASTM A588 Gr. A                          |
| 4       | Square structural steel bar - 85mm                                       | ASTM A588 Gr. A                          |
| 5       | Forgings   | S355 J2W+N, BS EN 10025-5                |

|   |   |          |                         |
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## 8.2. Preparation of Base Metal

Surfaces & edges to be welded and surfaces adjacent to a weld shall be even, smooth, uniform and free from fins, tears, cracks, spatter, loose / thick oxide scale, oil, slag, rust, moisture, primer, grease and any other foreign material / other discontinuities that would prevent proper welding / produce objectionable fumes which would adversely affect the quality or strength of the weld.

## 8.3. Edge Preparation and Fitting

All edge preparation or cutting of the material will be done by laser cutting, shearing, chipping, grinding, machining, plasma cutting, gas cutting and carbon arc gouging. In cases where the edge preparation is performed by any other method other than grinding or machining, the cut surface will be grinded in order to remove oxide scale, rust, etc. Grinding of the welded-on layer will be performed in order to ensure a smooth and even edge. Any layer of rust surface if formed after edge preparation will be removed by buffing or by rubbing using emery paper.

# 9. WELDING PROCESS

## 9.1. General Requirements

Welding process in BEML will be carried out as per BS EN ISO 4063 & EN 15085-3 standard .

## 9.2. Welding Consumable


All welding consumables (Electrodes, Filler Rods, Wires, and Shielding Gases etc.) will conform to EN ISO:14175 standard.

Consumables will be stored in a dried environment and used in accordance with the manufacturer's instructions.

### 9.2.1. Filler Metal Requirements

The Filler metal for welding will be selected considering the requirements of the product, regarding the mechanical characteristics of the parent material with the lowest demands of yield stress and impact strength as well as taking into consideration the welding position, weld appearance and welding method.

The filler metal will be kept clean, free from oil, dirt, rust and any other pollution.

|   |   |          |                         |
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Unidentified, damaged or rusty filler metals will be removed from the manufacturing premises.

The qualification tests for the welding rod will be as per the respective welding rod specification standards.

### 9.2.2. The Filler Metal for carbon steel - Bogie Frame

The filler metals of carbon steel to be applied in this specification are shown in the Table 2 & all test certificates will be provided at the inspection stage.

**Table 2** Filler metal for carbon steel

| Item        | Standard                     | Description   |
|-------------|------------------------------|---|
| Welding Rod | ER 70 S-6, AWS<br>A5.18:2005 | Specification for Carbon steel electrodes and rods for Gas shielded Arc Welding |
| Welding Gas | EN ISO 14175                 | Argon (100%) - MIG  |
|             |                              | Argon (80%) + CO <sub>2</sub> (20%) - MAG                                       |
|             |                              | Argon (98%) + O <sub>2</sub> (2%) - MAG   |

### 9.3. Welding Process Control


The non destructive Test examination will be carried out at critical areas to verify the completeness and adequate fusion with the base material without loss of structural thickness. Proper Records & reports will be maintained for the same.

#### 9.3.1. General


Welding will be under the control of a suitable experienced and qualified welding engineer. Where subcontract undertakes welding, the firm will deploy only certified welders for welding and submit the certificates of welders to BEML.

The following will be taken care of during welding process:

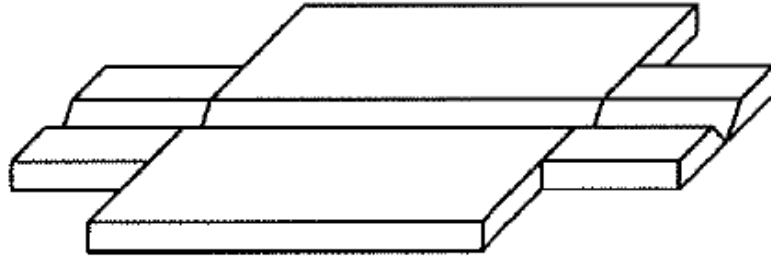
- Protection from the weather.
- Surfaces to be welded will be dry.
- In any case, no welding will be carried out on parent metal below 0° C.
- Pre-Heat Temperature:

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- a. The preheating temperature is the temperature of the parent metal measured immediately before welding commences.
  - b. If necessary the preheat and inter-pass temperature of the weld area should be specified depending on the material, the thickness and the component to be welded. The required temperature is followed as per EN 1011-2 and EN 1011-4, guidance on measurement is followed as per EN ISO 13916.
  - c. Preheat and inter-pass temperature shall be maintained during tacking and welding within the limits specified and checked using infrared thermometer.
  - d. If the temperature of the work piece is below 5 °C, preheating is necessary in any case.
  - e. The welding is carried out inside the factory. It will not have any outdoor welding. With the exception of tack welding and the allowed procedures, the heating should be performed along the whole groove, that is to be welded (in order to avoid deformation of certain parts it might be advisable to use multi-stage welding) and to be maintained until the whole joint is welded.
  - f. When gas heating is used, it is convenient to measure the temperature on the opposite side of the edge than that which is pre-heated
- Grinding of Plate Edge:  
The exposed edge of the welded joint (termination) and the adjacent parent material will be dressed smooth by machining or grinding. The marks produced by machining or grinding will lie parallel to the plate surface.
  - Run-on & Run-off:  
Run-on and run-off plates shall be used according to EN 15085-3, 7.3.11. For  $t \geq 8\text{mm}$  they shall have the same joint preparation as the actual weld. The run-on and run-off plates shall be made so as to enable the welding to be started or stopped beyond its necessary length.  
The parts to be assembled and the plates, which are "integrated" into the design or implanted as small plates to the parts to be welded, are homogenous. The penetration of these plates shall be the same as that used on the joints to be made.  
The plates shall either be fixed by mechanical or magnetic means and can also be welded. After having completed the joint, the plates can either be mechanically removed or cut using a blowpipe or plasma. A longitudinal grinding shall be made after the removal of the plates. Any rupture caused by shock is prohibited.

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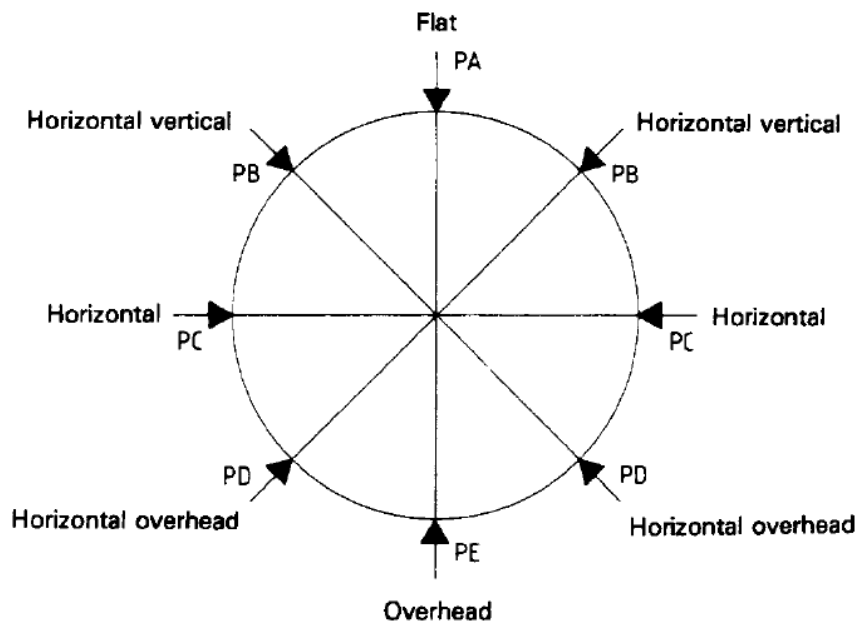
Run-on & Run-off plates shall be used at the beginning and at the end of welds, see Figure 1.




**Figure 1** Run-on and Run-off plates for butt welds.

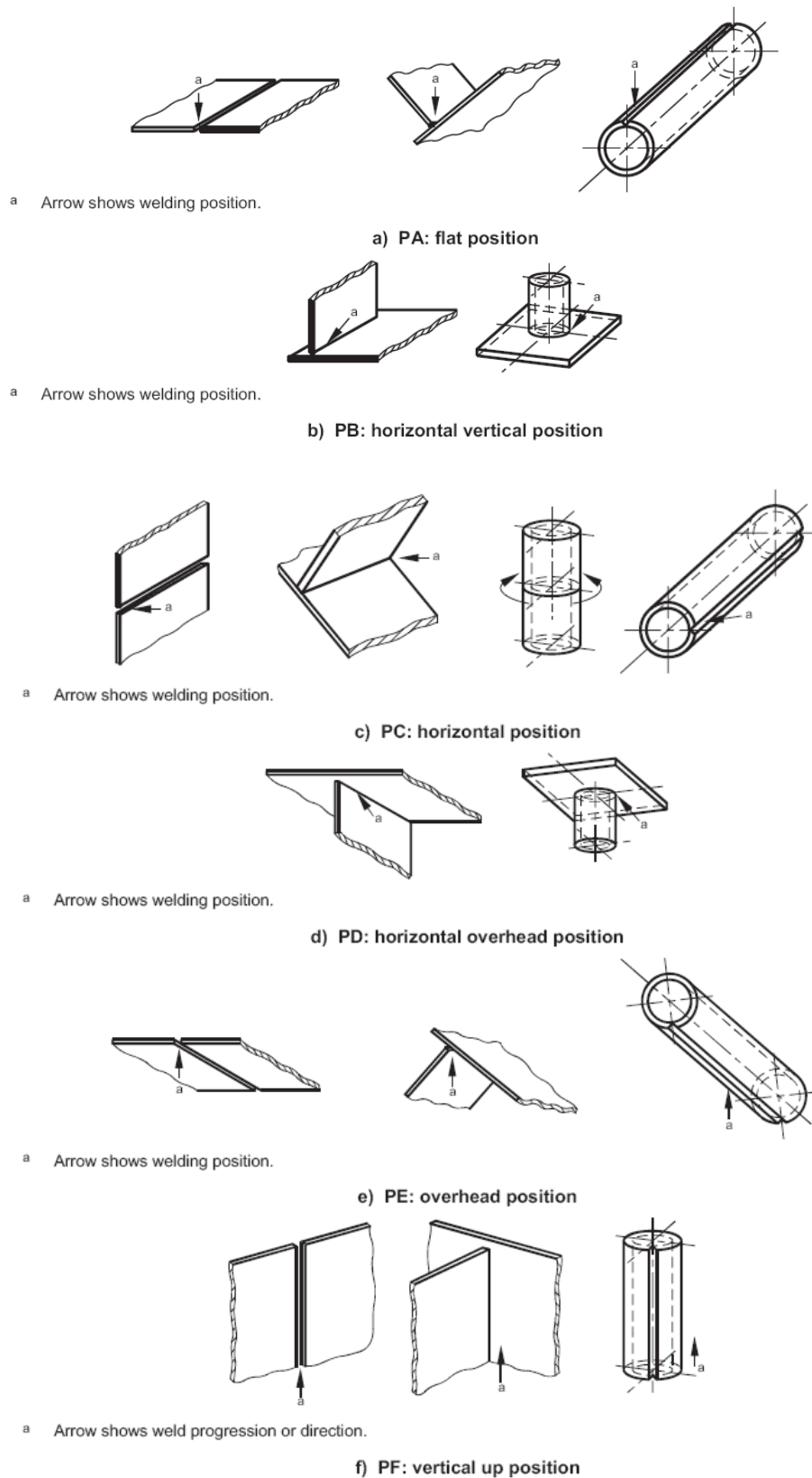
- **Weld Positions:**

The main weld positions, defined by slope and rotation, are given in table 3 and illustrated in Figure 2. For the sake of clarity, symbols for the main working positions are given from the co-ordinate origin; the working direction is outwards. All the welding is done in position PA or PB as per standard ISO 6947. If necessary rotating equipment will be used. Main positions for butt and fillet welds are illustrated in Figure 3.




**Figure 2** Weld positions (Simplified view)

|   |   |          |                         |
|---|---|----------|-------------------------|
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**Figure 3** Weld positions for butt and fillet welds

|   |   |          |                         |
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**Table 3** Terms and symbols for Weld Positions

| Terms   | Description   | Symbol | Slope<br><i>S</i>        | Rotation<br><i>R</i>         |
|---|---|--------|--------------------------|------------------------------|
| Flat position   | Horizontal working, centreline of weld vertical, capping layer on capping           | PA     | 0°<br>180°               | 90°<br>90°                   |
| Horizontal vertical position  | Horizontal working, capping layer towards the capping                               | PB     | 0°<br>0°<br>180°<br>180° | 45°<br>135°<br>45°<br>135°   |
| Horizontal position   | Horizontal working, centreline of weld horizontal                                   | PC     | 0°<br>0°<br>180°<br>180° | 0°<br>180°<br>0°<br>180°     |
| Horizontal overhead position  | Horizontal working, overhead, capping layer towards the bottom                      | PD     | 0°<br>0°<br>180°<br>180° | 225°<br>315°<br>225°<br>315° |
| Overhead position   | Horizontal working, overhead, centreline of weld vertical, capping layer underneath | PE     | 0°<br>180°               | 270°<br>270°                 |
| Vertical up position  | Working upwards   | PF     | 90°                      | —                            |
| Vertical down position  | Working downwards   | PG     | 270°                     | —                            |
| <b>NOTES</b><br>1 To avoid confusion with existing abbreviations, e.g. F for flat, in principle the letter “P” (for position) has been placed in front of the symbol to indicate “main position”.<br>2 Tolerances for the main positions are not specified in this International Standard because they depend on the different welding procedures used. |   |        |                          |                              |


### 9.3.2. Butt Welded Joints

The details of all butt welds, form of joints, angle between fusion faces and gap between parts will be arranged to permit the use of a satisfactory welding procedure. The combination of weld detail and welding procedure will be such that the resultant joint will comply with the requirements of the design.

Where there is access, the reverse side of the joint will be back-gouged to sound weld metal and sealing run deposited. Back gouging into sound weld metal may require confirmation by the appropriate NDT (Non-Destructive Test) method.


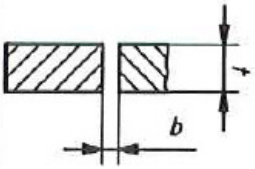

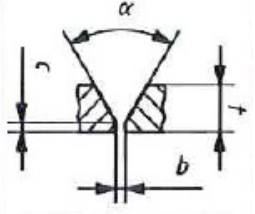

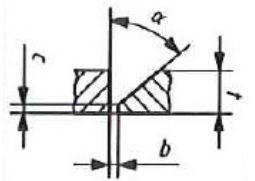

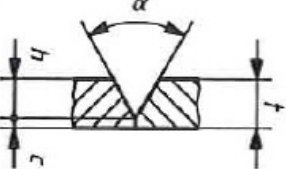

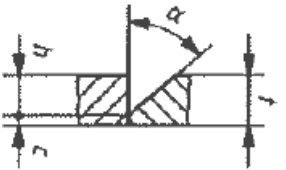
Where the access to the reverse side of the joint does not allow back gouging but access for welding, then sealing run will be deposited.

All the root gap & root face for butt welded joint is followed as per Annex B, Table B.1 of EN 15085-3 standard. The shape and dimension of the butt welded joint in manual Arc welding

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will be as shown in Table 4.


**Table 4** The shape and dimension of the butt-welding in manual Arc Welding

| Weld Type            | Symbol  | Base Metal Thickness-<br>t (mm) | Angle $\alpha$ (°) | Root gap- b (mm) | Root Face - c (mm) | Figure  |
|----------------------|---|---------------------------------|--------------------|------------------|--------------------|---|
| Plain Butt Weld      |    | $\leq 4$                        | -                  | 0-3              | -                  |    |
| Butt weld in V Joint |   | 3-15                            | 50-60              | 0-3              | 0-2                |   |
| HV weld              |  | 3-15                            | 40-60              | 1-3              | 1-2                |  |
| Y weld               |  | 3-15                            | 50-60              | -                | $\leq 0.2 t$       |  |
| HY weld              |  | 3-15                            | 40-60              | -                | $\leq 0.2 t$       |  |

### 9.3.3. Fillet Welded Joints


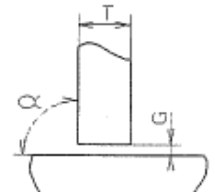

- The effective area will be the effective weld length multiplied by the effective throat. Stress in a fillet welds will be considered as applied to this effective area for any direction of applied load.



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- The effective length of a fillet weld will be the overall length of the full-size fillet, including end returns. No reduction in effective length will be made for either the start or crater of the weld if the weld is full size throughout its length.
- The minimum effective length of a fillet weld will be at least four times the nominal size or the size of the weld will be considered not to exceed one- fourth its effective length.
- When the butt welding is carried out together with fillet welding, the joint condition should follow the butt welding.
- In case of welding a different thickness of base metal, it should be based on the thinner part.
- The detail of partial joint of penetration fillet weld will be as shown in Table 5.

**Table 5** Partial joint penetration for fillet weld


| Weld Type   | Symbol  | Base Metal Thickness T (mm) | Intersection angle $\alpha$ (°) | Root Gap G (mm) | Root Face R (mm) | Figure  |
|-------------|---|-----------------------------|---------------------------------|-----------------|------------------|---|
| Single Side |  | 3 ~ 6                       | 60 ~ 120                        | 2 below         | -                |  |
| Double Side |  | 5 ~ 12                      |                                 |                 |                  |   |

#### 9.3.4. Allowable stress Arc Welded Joints

The allowable stress in Arc welded joints will be as shown in Table 6.

**Table 6** Allowable stress of Arc welded joints (JIS E 4049-1990)

| Welded Joints                   | Allowable Stress                                  |
|---------------------------------|---|
| Groove welded Joints            | Allowable stress of base metal to be welded       |
| Other than groove welded joints | Allowable shear stress of base metal to be welded |

|   |   |          |                         |
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### 9.3.5. The Allowable Stress of Base Metal

The allowable stress of base metal will be as shown in the Table 7.

**Table 7** Allowable Stress of Base metal

| Material Standard                       | Strength, (N/mm <sup>2</sup> ) |                |
|---|--------------------------------|----------------|
|   | Yield Stress                   | Tensile Stress |
| SMA490BW, JIS G 3114                    | 335 ~ 365                      | 490 ~ 610      |
| ASTM A618 Gr. 1a / STKM 18B, JIS G 3445 | 345                            | 485            |
| ASTM A588 Gr. A                         | 345                            | 485            |
| S355 J2W+N, BS EN 10025-5,              | 315 ~ 355                      | 470 ~ 630      |

### 9.3.6. Shielded Metal Arc Welding (SMAW)

- Technique for shield metal Arc welding will be in accordance with AWS recommended practice for manual Arc welding.
- The shield metal Arc welding is not applied in normal condition.
- This welding will be applied repair and modification etc in the area of not to supply the welding gas.


### 9.3.7. MAG Welding

- Technique for MAG welding will be in accordance with the AWS recommended practice for semi-automatic Arc welding.

## 10. WELDING WORKMANSHIP

### 10.1. Tack Welding

Tack welds are made to hold parts of a weldment in proper position until the final welds are carried out. Tack welds, which are incorporated into final weld, will be made with electrodes meeting the requirements of the final welds and will be cleaned thoroughly. Tack welds not incorporated into final welds will be removed, except those that are required for holding the parts in position for further processes.

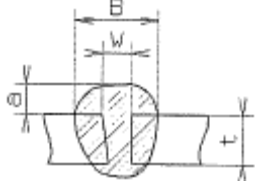
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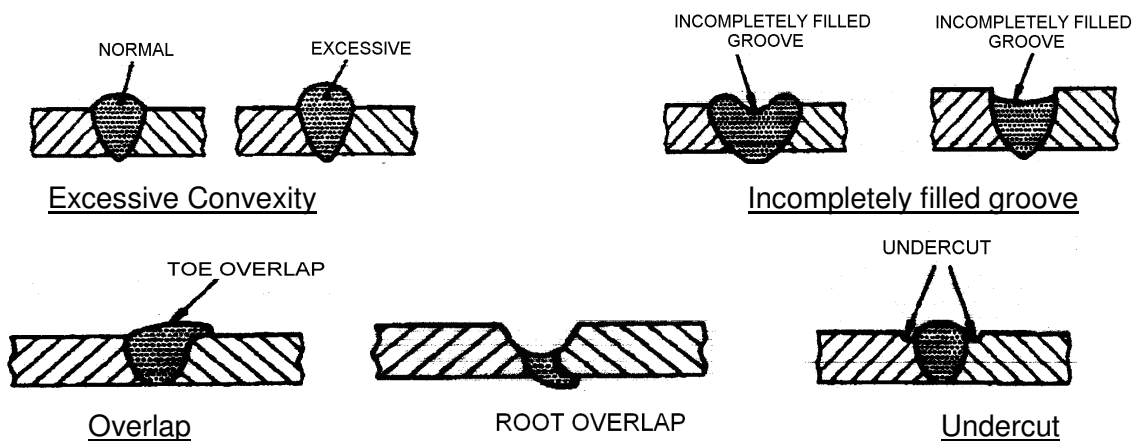
## 10.2. Weld Profiles

### 10.2.1. The Weld Profiles of Groove Welds


Groove welds will preferably be made with slight or minimum excess except as may be otherwise agreed. In case of butt and corner joints, the excess will not exceed 2 mm in height and will have gradual transition to the plane of the base metal surfaces see Table 8. They will be free of the discontinuities shown for butt joints in Figure 4.

**Table 8** Bead width and dimensions of the butt welding

| Groove         | Plate Thickness               | Bead (B)          | Excess (a) | Shape  |
|----------------|-------------------------------|-------------------|------------|--|
| Without Groove | 2.3 below                     | 5-7               | $\leq 2$   |  |
|                | 3.2                           | 6-8               |            |  |
|                | 4.5                           | 7-9               |            |  |
|                | 6.0                           | 8-10              |            |  |
| With Groove    | Including All Plate Thickness | +2<br>(W+2)<br>-0 | $\leq 2$   |  |

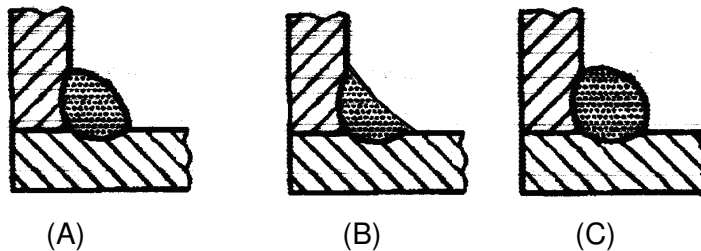


**Figure 4** Unacceptable weld profiles of groove joint.

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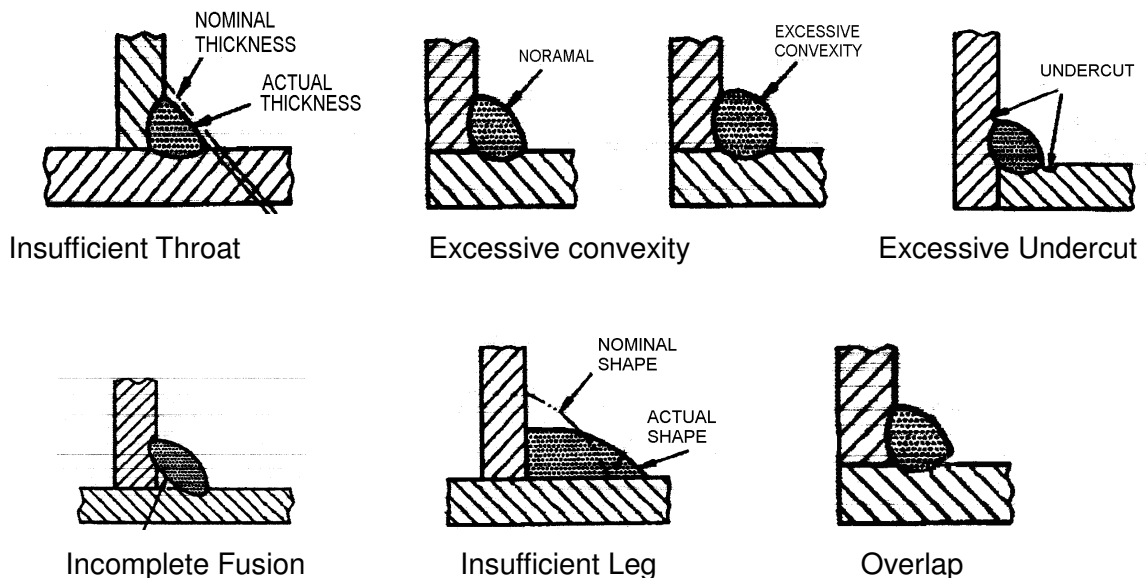
### 10.2.2. The Weld Profiles of Fillet Welds

The faces of fillet welds may be slightly convex, flat, or slightly concave as shown in Figure 5(A) and (B) with none of the unacceptable profiles in Figure 5.



**Figure 5** Weld profiles of fillet joint.

Note: Convexity, C, of a weld or individual surface bead will not exceed 0.07 times the actual face width of the weld or individual bead, respectively, plus 0.06 in. (1.5 mm).




**Figure 6** Unacceptable fillet weld profiles.

## 10.3. Repairs

### 10.3.1. General Requirements

The removal of weld metal or portions of the base metal may be done by machining, grinding, chipping or air carbon arc gouging. It will be done in such a manner that the remaining weld

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metal or base metal is not nicked or undercut. Unacceptable portions of the weld will be removed without substantial removal of the base metal.

Additional weld metal to compensate for any deficiency in size will be deposited using an electrode preferably smaller than that used for making the original welds. The surfaces will be cleaned thoroughly before welding.

These procedures are to contain details about methods for removal, preparation of welding area, etc. The Main Supplier may in certain circumstances demand that the repair procedure is approved according to the same routines as welding procedures for welding and testing. Any major repair will have the approval of MRS1 or MRS1's representative before repairing..

### **10.3.2. Repair Preparation**

Defects that are detected and found unacceptable and which are to be repaired will be removed by means of machining, grinding or carbon arc grooving. After thermal cutting the repair area has to be ground free from slag and carburized material. The groove or the repair area shall be even and without notches, and in addition the area shall be free from oil, rust, fat and other contaminants. The repair area is to be examined by magnet particle testing or penetrating liquid to guarantee the removal of all defects prior to repair welding.


NDT (Non-Destructive Testing) will be done after the removal of weld and after repair. NDT is to be performed by qualified operators. Along with NDT, Visual check will also be carried out.

### **10.3.3. Repair Working**

The manufacturer is to do his utmost to reduce the stresses originating from the welding in the area.


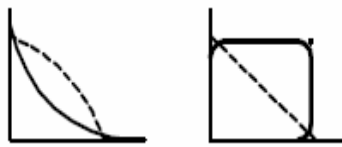



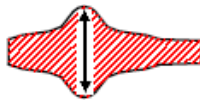



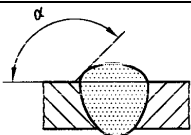
All repair work is to be performed by qualified welders. The repaired area will be checked and examined according to the requirements for the original weld. If at a further check more defects are found, the weld must be re-examined once again.


The repair of welds will not be required more than 3 times for carbon steel. Any major repair will have the approval of MRS1 or MRS1's representative before repairing.

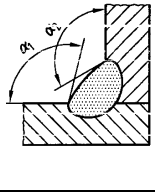
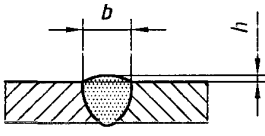

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The Main Supplier has to be informed in writing before further repair is performed. Non-destructive testing (NDT) will be done after the removal of weld and after repair.

**Table 9** Extent of allowance and repair method of the flaw

| Flaw                               | Shape   | Extent of Allowance   | Repair                          |
|------------------------------------|---|---|---------------------------------|
| Fillet Welding, Lack of Leg Length |    | Standard Scale<br>* 30~0%   | Adding Bead                     |
| Fillet welding Bead Shape Badness  |    | Surface Flat  | Adding Bead and Grinding        |
| Undercut                           |   | The Depth is over<br>0.05 to 0.5 mm   | Fillet with Bead                |
| Overlap                            |  | Not Permissible   | Re-Welding                      |
| Roughness of Bead Surface          |  | Allowance,<br>$\Delta h=2.5\text{mm}$ Below   | Welding after Removing          |
| Uneven Bead Width                  |  | Allowance, Less than<br>5 mm  | Welding after Removing          |
| Bead Badness                       |  | Concavity Part is not<br>Permissible  | Re-Welding                      |
| Blow-Hole Pit                      |  | Critical welding zone:<br>Not permissible etc:<br>Dia. 1 mm below                             | Welding after removing          |
| Crack and lack of penetration      |  | Not Permissible   | Complete weld removal & welding |
| Toe angle                          |  | $\alpha \geq 100^\circ$ for class C<br>$\alpha \geq 150^\circ$ for class B<br>as per ISO 5817 | Grinding                        |

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|                 |   |  |                     |
|-----------------|---|--|---------------------|
|                 |  | $\alpha \geq 110^\circ$ for class B&C as per ISO 5817  | Grinding            |
| Built-up Height |  | $h \leq 1\text{mm} + 0.15 b$ , but max 7 mm for class C.<br>$h \leq 1\text{mm} + 0.1 b$ , but max 5 mm for class B as per ISO 5817 | Grinding            |
| Slag Adherence  |  | Invisible  | Completely removing |

#### 10.3.4. Allowable Stress of the Welding after Repair working

The allowable stress of the Arc Welding after repair working will be applied in accordance with section 9.3.5.

### 10.4. Approval of Welder


#### 10.4.1. Manual Welders

The Manufacturer is responsible for the approval of all Manual Welders, including tack welders and Welding Operations according to BS EN 287:2004. The approval test may be performed either on tubes or plates. The approval test should be on seamless tubes, since this will give the widest range of approval. It is necessary to wait for at least 24 to 48 hours after the welding of the approval tests for the visual examination and other tests.

Manual welder, who has not passed the approval test, must be trained further before a renewed test is allowed.

#### 10.4.2. Welding Operators

Welding Operators who only perform work with automatic welding equipment do not need to pass welder approval according to BS EN 287:2004.

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## **11. INSPECTION AND TESTING OF WELDING**

### **11.1. Welding Inspection**

The Inspection Plan will identify stages at which welding inspection will be carried out as per. Inspection stages will be pointed in the manufacture of the product where it is considered necessary that weld inspection be carried out prior to continuing manufacture. All weld preparations and fit-ups will be inspected and verified prior to welding and all welds will be subject to visual inspection (100%).

Details of all weld inspections will be recorded in the form of stage inspection sheets or defect report sheets. All welding machines will be calibrated. Records will be maintained and be available for examination by the Engineer.

The weld inspection, checking and monitoring will be carried out by the welding inspector and engineer periodically for the welding quality, welding equipment, welding consumables, welder, weld operator and welding test.

### **11.2. Inspection of Arc Welding**

ISO 5817-2007 will be followed for the inspection of Arc welding.

### **11.3. Arc Welding Test**

BS EN 288-3 will be followed for the Arc welding test.

### **11.4. NDT (Non-Destructive Testing)**

- NDT tests will be carried out as per ISO:17635.
- The type of NDTs: -
  - a. MPT (Magnetic particle Test - EN ISO:17638)
  - b. LPT (Liquid Penetrate Test - EN571-1)
  - c. RT (Radiographic Test - EN1435).
  - d. UT (Ultrasonic Testing - EN1714)
- NDT test will be carried out at the locations as specified in relevant drawings.