

## **PART 5**

### **WELDING**

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## WELDING

### Section 5.1 – General

- 5.1.1 Welding of structures and fabrications will generally be for mild steel and of either manual metal arc (MMA) or metal inert gas MIG/CO<sup>2</sup> types.
- 5.1.2 Details of the welding of main structural members are to be included for approval on structural drawings and should indicate the type and dimensions of weld. Alternatively, the Builders standard welding table may be submitted for approval. Details are to be provided of the proposed sequence of fabrication and welding, and identification of welds carried out by automatic processes where used.
- 5.1.3 Welding operators are to be qualified or coded to an approved standard and proficient for the type of work undertaken. The Surveyor may require the Builder to provide sample weld test pieces fabricated under similar conditions to the proposed construction.
- 5.1.4 All welding is to be carried out in accordance with the best practice. Wherever possible, the down hand welding method is to be employed, and in all cases full consideration is to be given to the access of welds and their locations.
- 5.1.5 Where welds are not suitably detailed on drawings, symbols will be required as shown in Section 5.7.
- 5.1.6 Care is to be taken when removing welded temporary fittings in order to avoid damage to the hull material. Bridges and dogs should not be hammered off. Tack welds, where utilised, are to be of a quality, equal to the finished weld. Strong backs and other methods for ensuring alignment are to be arranged for easy removal after assembly.

### Section 5.2 – Preparation

- 5.2.1 Plate edges and weld preparation may be produced by any of the approved established methods. Plate edges are to be properly prepared, and a back-sealing run is to be applied after suitable back seam gouging to all seams where the main welding is carried out from one side only. Plates are to be properly aligned with no excessive gaps, and excessive force is not to be used in fairing plates for welding.
- 5.2.2 Special care is to be taken to ensure cleanliness of edges and faces prior to welding. All edges are to be cleaned free of oil, rust, paint, zinc coatings and other contaminants.
- 5.2.3 When welding components with large cross-sectional areas, the sections are to be pre-heated in accordance with the requirements of the electrode manufacture.

- 5.2.4 All welding procedures must be carried out in controlled conditions without excessive humidity, or where the temperature of the steel is not below +2°C.

### **Section 5.3 – Dimension of welds**

- 5.3.1 The dimensions of fillet welds for structural connections are to be in accordance with Section 5.6. The length of intermittent welds is to be measured over the length of the correctly proportioned fillet. Intermittent welds are to be doubled at the ends of all stiffening members and continued around ends of brackets, etc.
- 5.3.2 At the design stage, consideration is to be given to the stress capabilities of the different types of welds to be used in construction.
- 5.3.3 Care is to be taken to ensure thorough penetration and fusion. Finished welds are to be sound, uniform and free from slag inclusions, porosity, undercutting or other defects.
- 5.3.4 Plug and slot welds are not to be used except where access to both sides is not possible. Such plug welds are to be 75mm long and spacing is to be in accordance with the requirements for intermittent welding as given in the Standards. Width of slot is to be not less than twice plate thickness and the ends of the slot are to be radiused. Plugs are not to be completely filled with weld metal.
- 5.3.5 Stiffening members, which pass over an uncompleted weld, are to be scalloped in way of same. Scallops are to have a minimum radius of 25mm.

### **Section 5.4 – Materials**

- 5.4.1 Electrodes are to be stored under approved conditions as indicated by the Manufacturer to avoid deterioration. Special consideration is to be given to the storage of low hydrogen electrodes.
- 5.4.2 Welding wires used with the MIG/CO<sup>2</sup> method are to be to BS 2901 Part 1, 1970, and electrodes used with the MMA method are to be to BS 639, 1976, or equivalent Standards. Add in flux cored mig.
- 5.4.3 The testing of welds is to be generally of the non-destructive type. Visual inspections may be augmented by a system of radiograph, ultrasonic, magnetic particle, or dye penetrant examination. Welds that are found to be defective are to be cut out and re-welded to the satisfaction of the Surveyor, and subject to re-testing.
- 5.4.4 Where higher tensile steel is used, details of the welding methods to be employed are to be submitted for approval.

## Section 5.5 – Aluminium alloys

5.5.1 Builders are to supply verification that welders employed by them in the fabrication of aluminium alloy structures are fully qualified and experienced in the requirements for the welding of aluminium alloys, relative to the welding process employed (Ref BS/DIN EN 287-1/ISO9606-2 or equivalent).

MIG: Qualified to manual weld with this process

MIG:(MACHINE): Qualified to machine weld in the down-hand position

TIG: Qualified to manual weld with this process in all positions.

5.5.2 Aluminium alloys are to be welded by either the gas tungsten arc (TIG), or gas metal arc (MIG), or other approved processes. Generally the welding dimensions of connections are to be as for steel. Where chain or intermittent welding is employed, the minimum length 'W' is to be not less than that required for steel measured clear of end craters.

5.5.3 Plate edges and weld preparations may be by any of the following methods:-

- a) Plasma arc cutting;
- b) Tungsten arc;
- c) Mechanical means (saw or shear).

5.5.4 All weld edges are to be prepared smooth and free from cutting tool scores, oils, and moisture. Fusion faces of weld joints are to be cleaned free of all foreign matter, i.e. grease, dirt, oxide film, and moisture.

5.5.5 Where cutting by mechanical means are used, care is to be taken to ensure that tools are not contaminated by other metals. Plates may be sheared provided this does not cause distortion of the plate edges.

5.5.6 Operatives, material, and structures are to be protected at all times to effectively prevent draughts destroying the gas shield. All welds are to be made on clean dry surfaces and carried out under cover.

## Section 5.6 – Welding details

### 5.6.1 Connections of structural members

Type of weld connection		
<b>Plating - bottom shell</b>	Bar keel, stem bar Centre girder to bar keel and floors Side girders and machinery seatings Floors in machinery spaces Frames and floors in fuel, fresh water and ballast tanks Tank tops and ends Watertight and oil-tight bulkheads	Full strength fillet (continuous)
	Frames and floors outside machinery spaces	Staggered intermittent or chain
<b>Plating - side shell</b>	Frames Longitudinals Stringers Non-watertight bulkheads	Staggered intermittent or chain
<b>Plating - deck</b>	Deck to shell plating Pillars Hatch coamings Bulwarks and stays to deck plating Beams and girders under machinery, bollards, masts and gallows	Full strength fillet (continuous)
	Beams Longitudinals Deck girders	Staggered intermittent or chain

**Note:-**

- 1) All seams and butts in shell, deck, and weathertight deckhouses and superstructures, shall be square butt or single vee butt, continuous welded both sides.

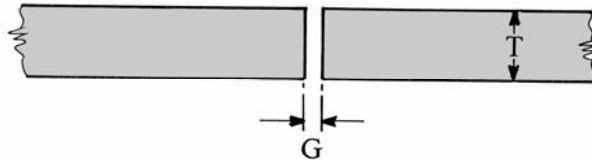
### 5.6.1 Connections of structural members *(continued)*

Type of weld connection		
<b>Bulkheads</b>	Bulkheads to shell and deck plating Brackets on longitudinals Tank sides and ends, to bulkhead plating	Full strength fillet (continuous)
	Stiffeners (Stiffeners in water tanks are to be fully welded)	Staggered intermittent or chain
<b>Side plating of engine room casings, deckhouses, wheelhouses and shelters</b>	Side plating to deck Side plating to rail	Full strength fillet (continuous)
	Stiffeners	Staggered intermittent or chain

**5.6.2 Details of weld connections**

(i) *Square butt joint*

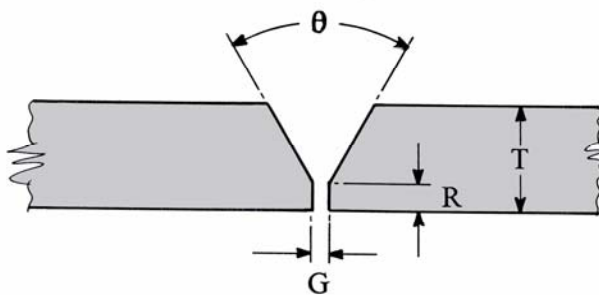
Recommended for use up to and including 6 mm plate - this method is economical in preparation and welding. A gap of more than that shown is not permitted



Up to 6 mm plate:

$$G = \frac{T}{2}$$

(ii) *Single V butt*



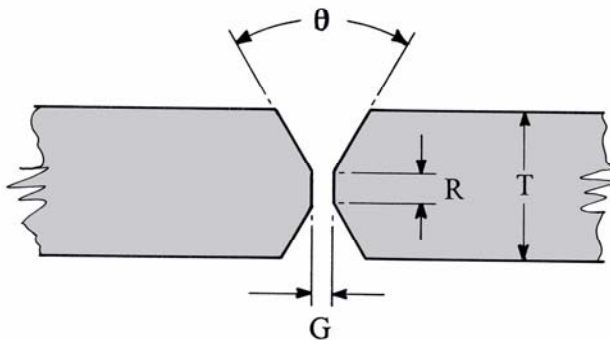
Over 6 mm up to 16 mm plate:

$$G = 0-3 \text{ mm}$$

$$R = 1.5 \text{ mm} - 3 \text{ mm}$$

$$\theta = 60^\circ - 70^\circ$$

(iii) *Double V butt*



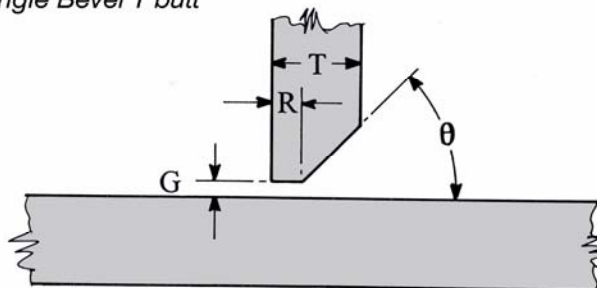
Over 16 mm plate:

$$G = 0-3 \text{ mm}$$

$$R = 1.5 \text{ mm} - 3 \text{ mm}$$

$$\theta = 60^\circ - 70^\circ$$

(iv) *Single Bevel T butt*



Over 6 mm up to 19 mm plate:

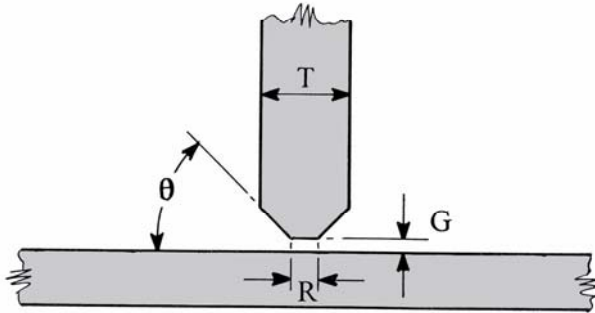
$$G = 0 - 1.5 \text{ mm}$$

$$R = 1.5 \text{ mm} - 3 \text{ mm}$$

$$\theta = 45^\circ \text{ minimum}$$

5.6.2 Details of weld connections (*continued*)

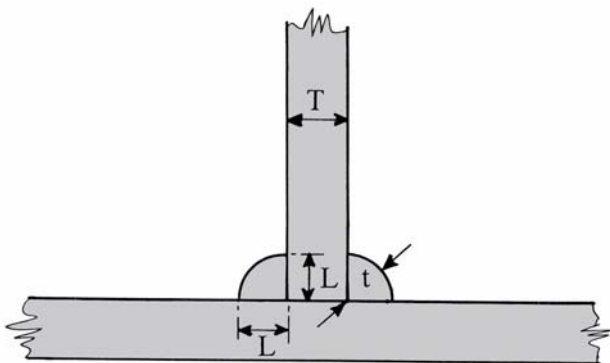
(v) *Double bevel T butt*



Over 19 mm up to 38 mm plate:

- G = 0 - 1.5 mm
- R = 0 - 5 mm
- $\theta = 45^\circ$

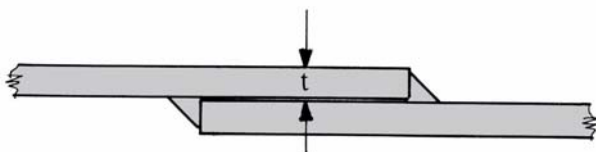
(vi) *Full strength (continuous) fillet weld*



12.5 mm plate and above:

- T = thickness of thinner part.
- L = leg length = 0.7T approx.
- t = throat thickness = 0.75L where plates are at right angles but is not to exceed 0.9L.
- For plates under 12.5 mm leg length is given in table 5.6.4.

(vii) *Fillet welded lap joint*  
(Recommended only for work of minor structural importance)



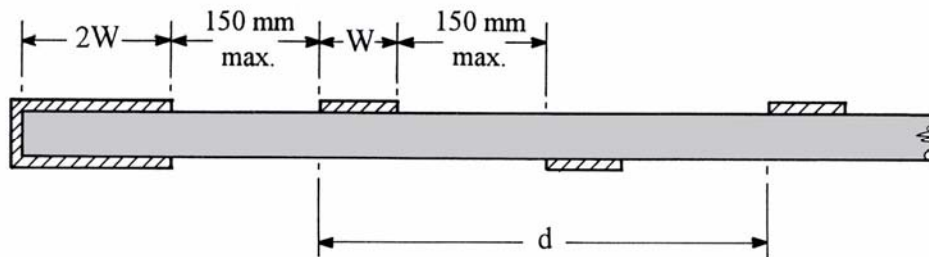
Length of overlap minimum 3t  
maximum 4t

### 5.6.2 Details of weld connections (*continued*)

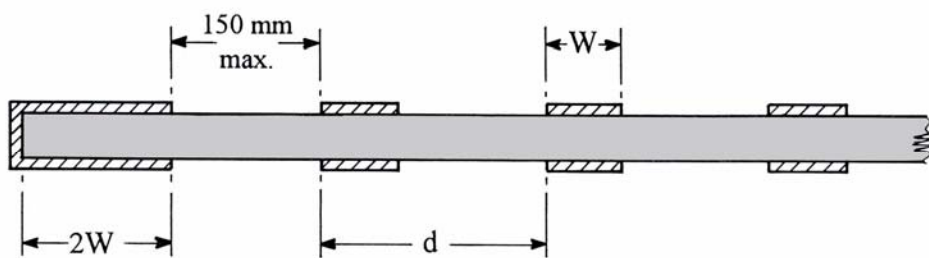
(viii) *Intermittent welds*

The minimum length of weld  $W$  is to be  $10 \times$  plate thickness or  $75 \text{ mm}$  whichever is the lesser. For values of ' $d$ ' in relation to  $W$  see Paragraph 5.6.3.

Staggered intermittent



Chain intermittent



*Note:*

Intermittent welds are to be doubled at the ends of all structural members and the welding to be carried round the ends.

### 5.6.3 Fillet welding

Maximum value of 'd' in relation to minimum 'W' values for staggered intermittent and chains intermittent welds.

Plate thickness mm	Minimum 'W' length mm	Maximum 'd' mm	
		Staggered intermittent	Chain intermittent
3	30	360	180
4	40	380	190
5	50	400	200
6	60	420	210
7	70	440	220
8	75	450	225
↓	75	450	225
16	75	450	225

### 5.6.4 Dimensions of fillet welds for light plate

Plate thickness mm	Weld type - double continuous Leg length mm
3	3.5
4	4
5	4.5
6	5
8	6
10	7

### 5.6.5 Throat thickness


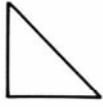






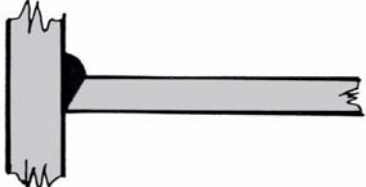

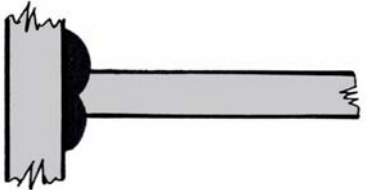

The minimum and maximum limits of throat thickness are to be as follows

- a) Intermittent (staggered or chain) fillets
  - Minimum throat thickness 't' = 'L' x 0.75
  - Maximum throat thickness 't' = 'L' x 0.90
  
- b) Double continuous fillets
  - Minimum throat thickness 't' = 'L' x 0.75
  - Maximum throat thickness 't' = 'L' x 0.90

subject to a minimum throat thickness of 3mm for intermittent fillets, and a minimum of 2.5mm for continuous fillets.

'L' = Leg length of weld, where plate thickness is less than 12.5mm leg lengths given in Table 5.6.4 are to be used.

**Section 5.7 – Symbols**

FORM OF WELD	SECTION REPRESENTATION	SYMBOL
Fillet		
Square butt		
Single V butt		
Double V butt		
Single bevel butt		
Double bevel butt		
Sealing run	