

## 9.2 Welds

### 9.2.1 AS 4100 Requirements

The general requirements for connections are set out in Clause 9.1 of AS 4100. Clause 9.7 of AS 4100 considers the requirements for the design of welds. Clause 9.8 of AS 4100 should be used for assessing the strength of a weld group.

### 9.2.2 Detailed Information on Welds and Welding

Reference [9.5] Design Guide 2 'Welding in Structural Steel Connections' contains detailed information on

- types of weld
- weldability of steel
- welding processes
- welding consumables
- welding procedures
- workmanship
- weld imperfections
- weld inspection

More detailed information may also be found in References [9.6] and [9.7]. Reference [9.2] Handbook 1 'Design of Structural Steel Connections' contains detailed information on design requirements for welds and for the design of fillet weld groups. This Part of this publication only includes the basic elements involved with the welding of steel structures.

### 9.2.3 Weld Quality and Capacity Factors

#### 9.2.3.1 Complete Penetration Butt Welds

**GP** (general purpose)  $\phi = 0.6$  (Table 3.4 of AS 4100)

Category GP may be selected where the weld is essentially statically loaded and is not loaded above 66.7% of the design capacity of a SP weld.

**SP** (structural purpose)  $\phi = 0.9$  (Table 3.4 of AS 4100)

Category SP shall be selected where a GP quality weld is not appropriate.

The cut-off value of 66.7% for this weld type is due to the ratio of GP to SP capacity factors ( $\phi$ ), i.e.

$$0.6/0.9 \times 100 = 66.7\%$$

#### 9.2.3.2 Fillet Weld / Incomplete Penetration Butt Weld / Plug or Slot Weld / Weld Group

**GP** (general purpose)  $\phi = 0.6$  (Table 3.4 of AS 4100)

Category GP may be selected where the weld is essentially statically loaded and is not loaded above 75% of the design capacity of a SP weld.

**SP** (structural purpose)  $\phi = 0.8$  (Table 3.4 of AS 4100)

Category SP shall be selected where a GP quality weld is not appropriate.

The cut-off value of 75% for these weld types is due to the ratio of GP to SP capacity factors ( $\phi$ ), i.e.

$$0.6/0.8 \times 100 = 75\%$$

## 9.2.4 Strength Limit State Assessment of Butt Welds

There are two types of butt weld, defined in Clause 9.7.2.1 as follows:

- (a) Complete penetration butt weld – a butt weld in which fusion exists between the weld and parent metal throughout the complete depth of the joint.
- (b) Incomplete penetration butt weld – a butt weld in which fusion exists over less than the complete depth of the joint.

The design capacity of each type of butt weld is determined as follows:

### Complete Penetration butt weld

AS 4100 Clause 9.7.2.7 requires that the design capacity is taken as equal to the nominal capacity of the weaker part of the parts joined multiplied by the capacity factor ( $\phi$ ) of:

0.90 – weld category SP

0.60 – weld category GP

provided that the weld procedure is qualified in accordance with AS 1554.1 [Ref.9.18].

To specify this type of weld on a drawing, the term 'complete penetration butt weld' or the appropriate symbol from AS 1101.3 is sufficient Ref [9.8]. The design throat thickness is then the size of the weld which is the minimum depth which the weld extends from its face into a joint – that is the thickness of the thinner part.

### Incomplete penetration butt weld

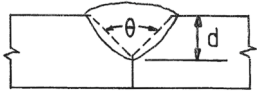
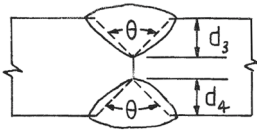
AS 4100 Clause 9.7.2.7 requires that the design capacity shall be calculated as for a fillet weld using a design throat thickness determined using Clause 9.7.2.3(b) of AS 4100.

The size of an incomplete penetration butt weld is a function of:

- (a) the required design throat thickness
- (b) the welding process
- (c) the details of the weld preparation

and rather than specifying the size of such a weld on the drawings it is usual to specify the required design throat thickness. This then allows the fabricator to produce the required weld by selecting the most advantageous combination of welding process, weld preparation and welding position. The whole procedure must be qualified in terms of AS 1554.1 [Ref.9.18] before fabrication commences.

**TABLE 9.7: Design Throat Thickness for Prequalified Preparations of Incomplete Penetration Butt Welds**

Joint Type	$\theta$ or $t_t$	Manual metal arc	Submerged arc	Flux-cored arc	Gas-shielded metal-arc
<b>Single-V butt weld</b> 	$\theta$ $t_t$	45,60 45:d-3 60:d	60 d	50,60 d-3	50,60 d-3
<b>Double-V butt weld</b> 	$\theta$ $t_t$	45,60 45:d <sub>3</sub> +d <sub>4</sub> -6	60 d <sub>3</sub> +d <sub>4</sub>	50,60 d <sub>3</sub> +d <sub>4</sub> -6	50,60 d <sub>3</sub> +d <sub>4</sub> -6

NOTE: 1)  $t_t$  = design throat thickness

2) For other types of incomplete penetration butt welds see Table 4.4(B), AS 1554.1 [Ref.9.18]