INTERNATIONAL UNIVERSITY OF AFRICA

CIVIL ENGINEERING DEPARTMENT

ANALYSIS AND DESIGN OF STEEL WORKS

8TH SEMESTER

Connections part 2 WELDENING

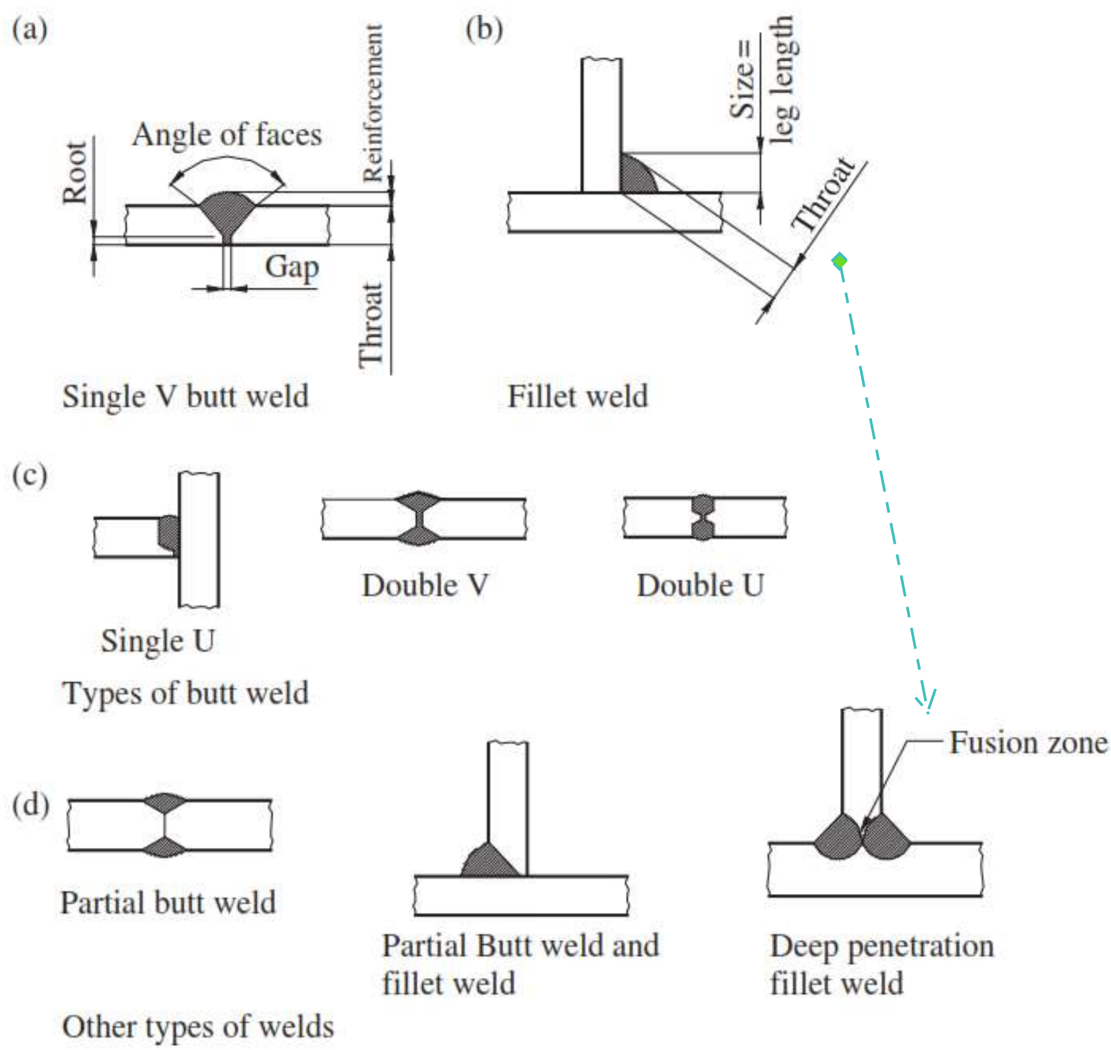
PREPARED BY DR TALAAT

Connections

Welded connections

Welding

Welding is the process of joining metal parts by fusing them and filling in with molten metal from the electrode. The method is used extensively to join parts and members, attach cleats, stiffeners, end plates, etc. and to fabricate complete elements such as plate girders. Welding produces neat, strong and more efficient joints than are possible with bolting. However, it should be carried out under close supervision, and this is possible in the fabrication shop.Site joints are usually bolted. انظر الترجمــه 1



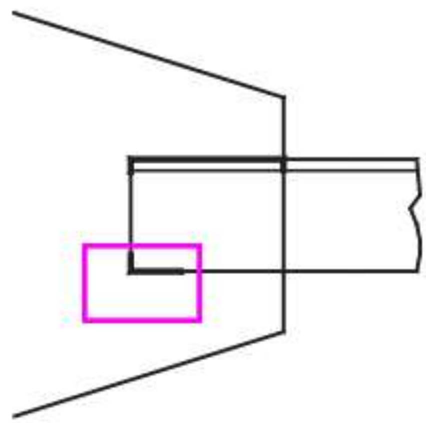
WELD TYPES: FILLET AND BUTT WELDS

Design of fillet welds

Important provisions regarding fillet welds are set out in Clause 6.7.2 of BS5950: Part 1. Some of these are listed below:

(1) End returns for fillet welds around corners should be at least twice the leg length. (a)

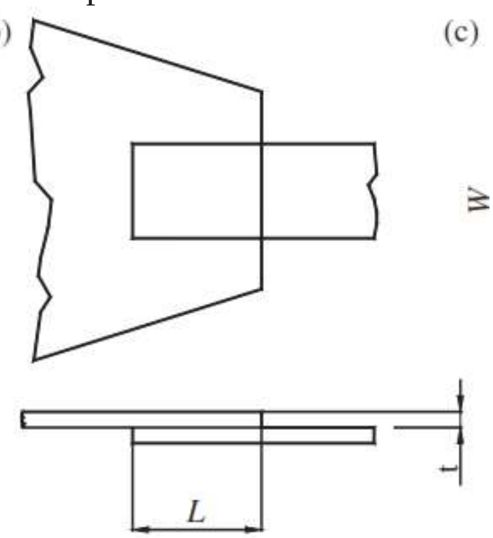
(a)



Return ends

(2) In lap joints the lap length should not be less than *four times* the thickness of the thinner plate.

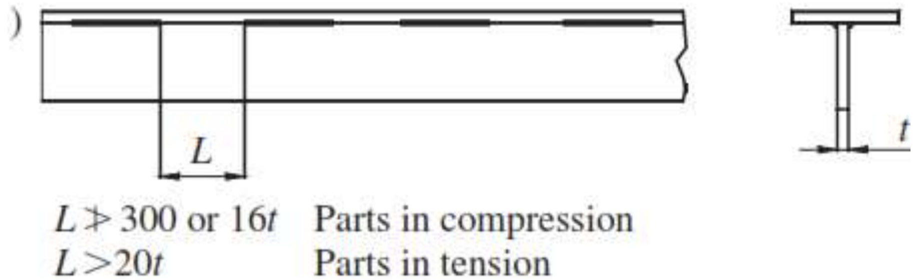
(b) (c)



$L \nless 4t$

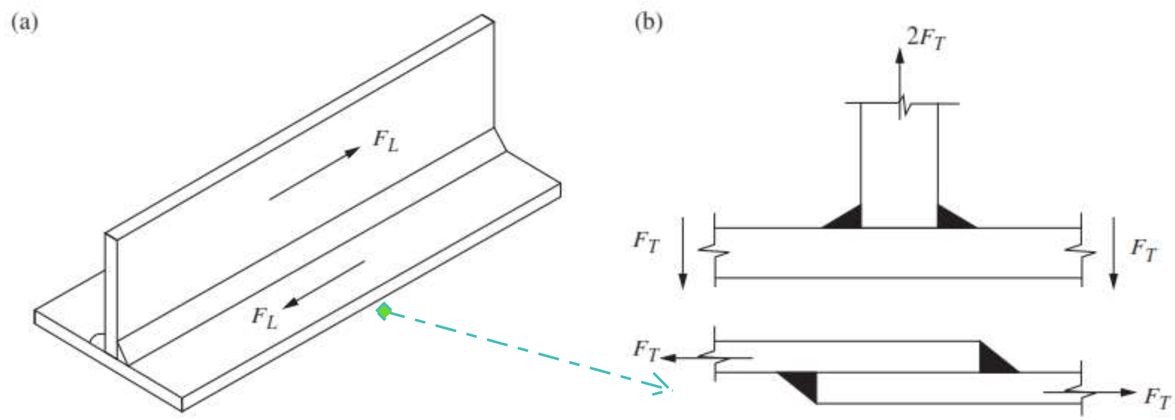
Lap length

(3) Intermittent welds should not be used under fatigue conditions. The spacing between intermittent welds should not exceed 300 mm or 16t for parts in compression or 24t for parts in tension, where t is the thickness of the thinner plate.



Intermittent fillet welds

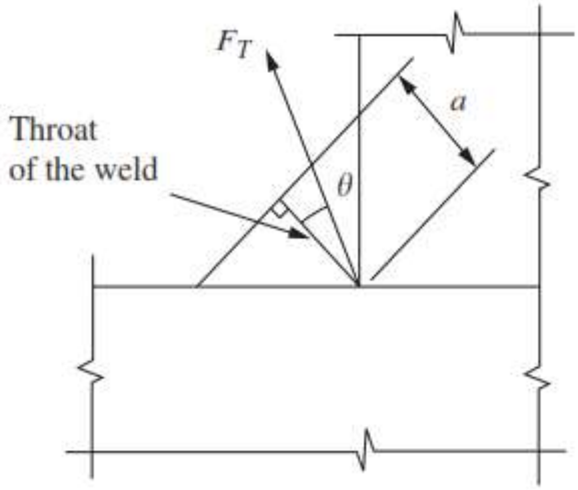
A key change is the recognition that the fillet weld is stronger in the transverse direction compared to its longitudinal direction,



Welds subject to longitudinal shear

Welds subject to transverse forces

Design of fillet weld



Resultant transverse force on weld

Design of fillet weld
Elect_rode *Electrode* are classified as
NO 35 , No 42 and No 50

(1) The weld strength is not less than that of the plate;
(2) The sum of the throat thicknesses of the weld is greater than the plate thickness; and
(3) The weld is principally in direct compression or tension.

Table 10.4 Design strength of fillet welds p_w (kN/mm^2)

Steel grade BS EN10025	*Electrode classification (BS EN499, BS EN440)*		
	35	*42*	*50*
S275	220	(220)	(220)
S355	(220)	250	(250)
S460	(220)	(250)	280

Note: bracket values are under or over matching electrodes

Summary

P_w = 220 kN /mm2 for S275 for all size of electrode
P_w = 250 kN /mm2 for S355 for all size of electrode
P_w = 280 kN /mm2 for S460 for all size of electrode

EXAMPLE

Get the strength of a fillet weld /meter run if you have the below data

INPUT

Assume Leg of fillet weld =5mm
Assume we used electrode 35
Steel used is 275 N/mm^2

OUT PUT

Equivalent size of throat 70% of Leg=0.7x5 = 0.35 mm
From table 10.4 above the strength of the electrode pw= 220 N/mm^2
Then
The strength of the weld /meter = .35x220= 770 kN/mm/meter run

OR

Strength of the weld kN/mm/mm run= 770/1000= 0.770 kN/mm run

The table below can be generated

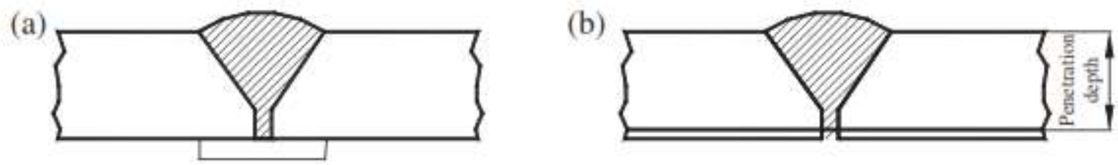
Table 10.5 Strength of fillet weld (kN/mm run)

<table>
<tr><th rowspan="2">Weld size or leg length</th><th colspan="5">Steel grade</th></tr>
<tr><th colspan="2">S275</th><th colspan="2">S355</th><th>S460</th></tr>
<tr><th></th><th colspan="5">Electrode classification</th></tr>
<tr><th></th><th>35</th><th>42</th><th>42</th><th>50</th><th>50</th></tr>
<tr><td>5</td><td colspan="2">0.77</td><td>0.88</td><td>0.88</td><td>0.98</td></tr>
<tr><td>6</td><td colspan="2">0.92</td><td>1.05</td><td>1.05</td><td>1.18</td></tr>
<tr><td>8</td><td colspan="2">1.23</td><td>1.40</td><td>1.40</td><td>1.57</td></tr>
<tr><td>10</td><td colspan="2">1.54</td><td>1.75</td><td>1.75</td><td>1.96</td></tr>
<tr><td>12</td><td colspan="2">1.85</td><td>2.10</td><td>2.10</td><td>2.35</td></tr>
</table>

Design of butt welds

The design of butt welds is covered in Clause 6.9 of BS 5950: Part 1. This clause states that the design strength should be taken as equal to that of the parent metal provided matching electrodes are used. A matching electrode should have specified tensile strength, yield strength, elongation at failure and Charpy impact value each equivalent to, or better, than those specified for the parent metal. 2 انظر الترجمـــه

Full penetration depth is ensured if the weld is made from both sides or if backings run is made on a butt weld made from one side (see Figures(a) and (b)).



Single V weld with backing plate

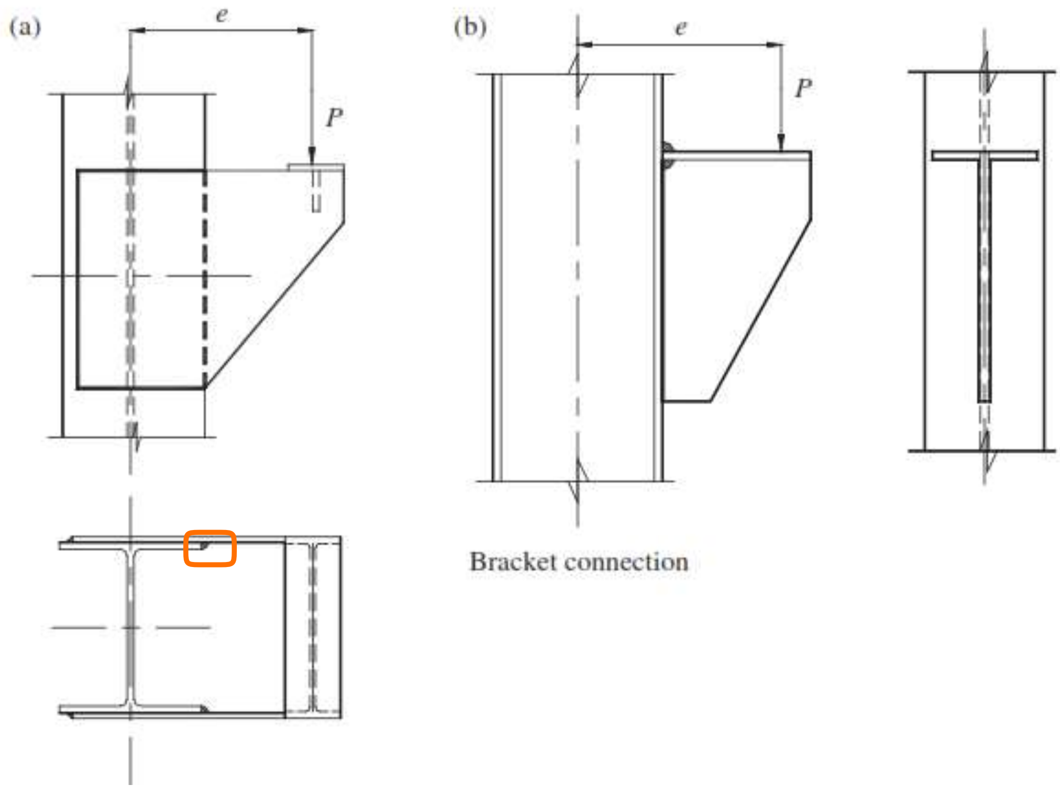
Single V weld made from one side

Eccentric connections

The two types of eccentrically loaded connections are shown in Figure below. These are:

(1) The torsion joints with the load in the plane of the weld; and

(2) The bracket connection.



Eccentrically loaded connections

(A) TORSION JOINTS

Calculation of weld strength in torsion loaded type

A rectangular weld group is shown in Figure 10.24(a), where the eccentric load P is taken on one plate. The weld is of unit leg length throughout:

$$\text{Direct shear } F_s = P/\text{length of weld}$$
$$= P/[2(x + y)].$$

Shear due to torsion

$$F_T = Per/I_p$$

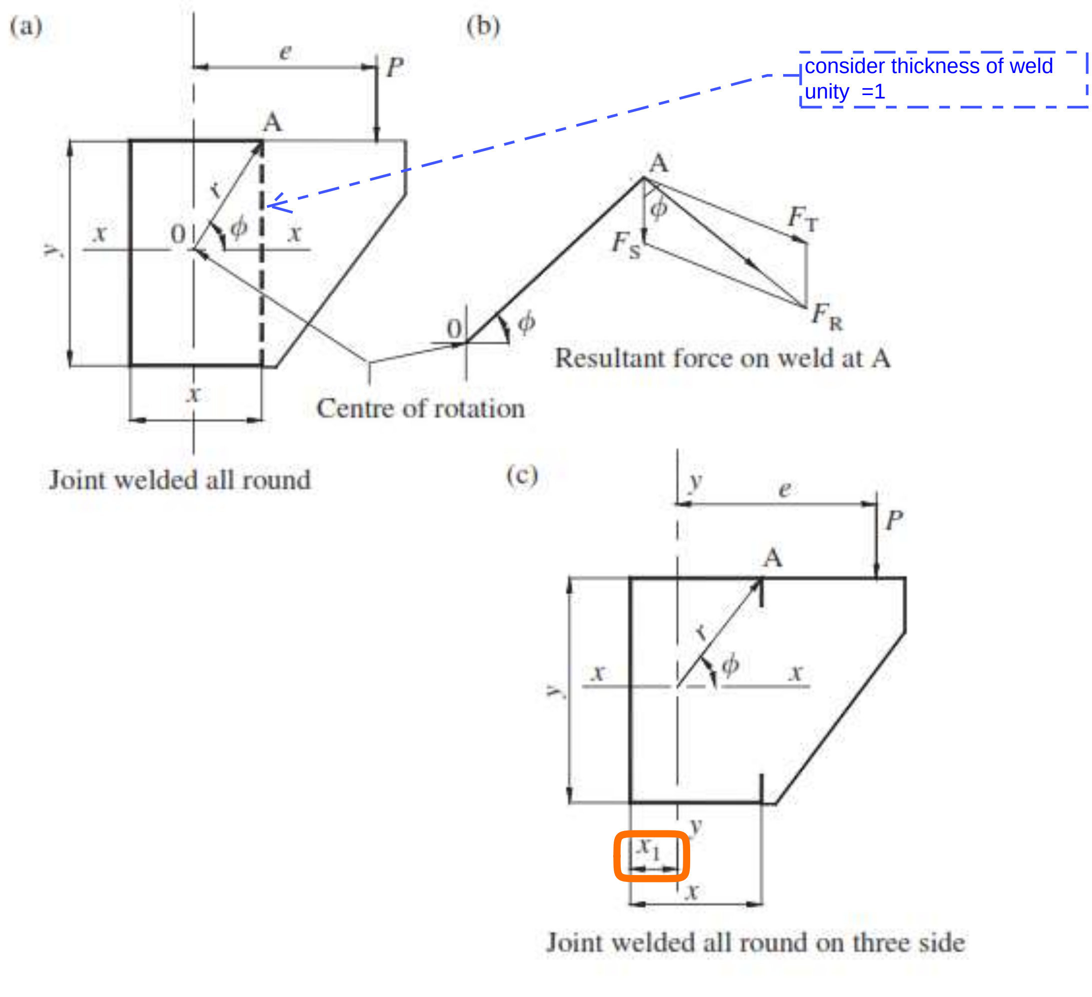


Figure 10.24 Torsion joints load in plane of weld

where,

I_p is the polar moment of inertia of the weld group $= I_x + I_y$,

$I_x = (y^3/6) + (xy^2/2)$, 2(1xY^3/12)+(1xXxY/2^2)x2

$I_y = (x^3/6) + (x^2y/2)$,

$r = 0.5(x^2 + y^2)^{0.5}$.

The heaviest loaded length of weld is that at A, furthest from the centre of rotation O. The resultant shear on a unit length of weld at A is given by:

$$F_R = [F_S^2 + F_T^2 + 2F_S F_T \cos\phi]^{0.5}$$

The resultant shear is shown on Figure 10.24(b). The weld size can be selected from Table 10.5.

If the weld is made on three sides only, as shown on Figure 10.24(c), the centre of gravity of the group is found first by taking moments about side BC:

$x_1 = x^2/(2x + y)$

$I_x = y^3/12 + xy^2/2$

$I_y = x^3/6 + 2x(x/2 - x_1)^2 + yx_1^2$

FT=Per/I_p

The above procedure can then be applied.

(B) BRACKET CONNECTION

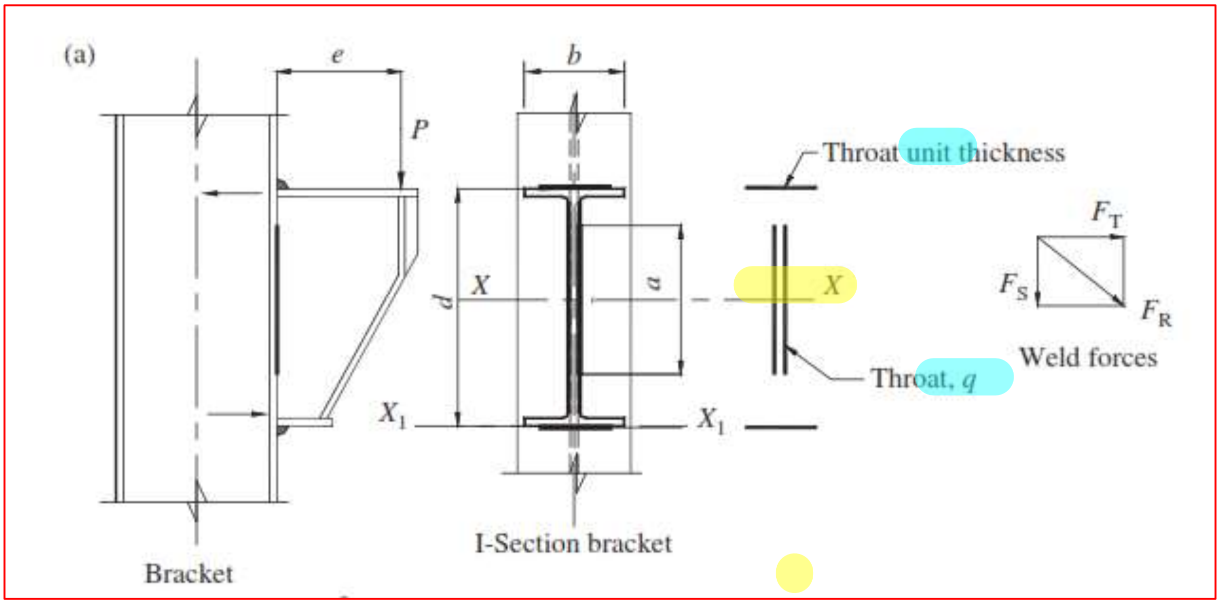


Figure 10.25 Bracket connections

Various assumptions are made for the analysis of forces in bracket connections. Consider the bracket shown in Figure 10.25(a), which is cut from a universal beam with a flange added to the web. The bracket is connected by fillet welds to the column flange. The flange welds have a throat thickness of unity and the web welds a throat thickness q, a fraction of unity. Assume rotation about the centroidal axis XX. Then:

Weld length	$L = 2b + 2aq$,
Moment of inertia	$I_x = bd^2/2 + qa^3/6$,
Direct shear	$F_s = P/L$,
Load due to moment	$F_T = Ped/2I_x$,
Resultant load	$F_R = (F_T^2 + F_S^2)^{0.5}$.

SECOND METHOD OF ANALYSIS

In a second assumption rotation takes place about the bottom flange X_1X_1. The flange welds resist moment and web welds shear. In this case:

$$F_T = Pe/db$$

$$F_s = P/2a.$$

اللحام هو عملية ربط الأجزاء المعدنية بصهرها وملؤها بالمعدن المنصهر من القطب الكهربائي.
تُستخدم هذه الطريقة على نطاق واسع لربط الأجزاء والأجزاء، وتثبيت المسامير، والمقويات، والصفائح الطرفية، وغيرها، ولتصنيع عناصر كاملة مثل عوارض الصفائح. يُنتج اللحام وصلات أنيقة وقوية وأكثر كفاءة من تلك التي تُنتج باستخدام البراغي. مع ذلك، يجب إجراؤه تحت إشراف دقيق، وهذا ممكن في ورشة التصنيع. عادةً ما تُثبت وصلات الموقع بالبراغي.

الترجمه 2

يتناول البند 6.9 من المواصفة البريطانية 5950: الجزء 1 تصميم اللحامات الطرفية. ينص هذا البند على أن قوة التصميم يجب أن تُعادل قوة المعدن الأصلي بشرط استخدام أقطاب كهربائية مطابقة. يجب أن يكون للقطب الكهربائي المطابق قوة شد محددة، وقوة خضوع، واستطالة عند الانهيار، وقيمة تأثير شاربي، بحيث تكون كل منها مساوية أو أفضل من تلك المحددة للمعدن الأصلي.