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	Job title*: Weld Design (Static)*		
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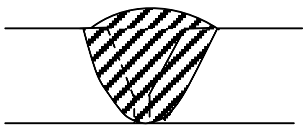
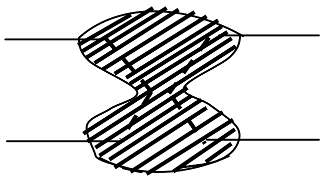
PROBLEM 1:

Two plates 14 mm thick are joined by (I) a double-V butt weld, (II) a single-V butt weld. Determine the strength of the welded joint in tension in each case. Effective length of the weld is 20 cm. Yield strength of steel = 250 N/mm^{2,} Partial safety factor for strength = 1.10.

Solution:



Single V butt weld



Double V butt weld

I. *In the case of double V butt weld, complete penetration of the weld would take place.*
Therefore effective throat thickness = 14 mm (thickness of the parent metal
Effective length of weld = 200 mm
Factored yield stress of the member = 250/1.10 = 227.3 N/mm^2
Design ultimate Strength of the
*Single V butt weld = (227.3 *14 * 200)/1000*
= 636.44 kN

II *For single V butt weld considering the penetration to be incomplete*
*Therefore effective throat thickness = 5/8 * 14 = 8.75 mm*
(IS: 816-1969)
Effective length of weld = 200 mm
Design ultimate Strength of the
*double V butt weld = (227.3 * 8.75 * 200)/1000*
= 397.78 kN

Note: The design ultimate strength of the welds are presented along with the factored strength and in no case these should be used with working loads.

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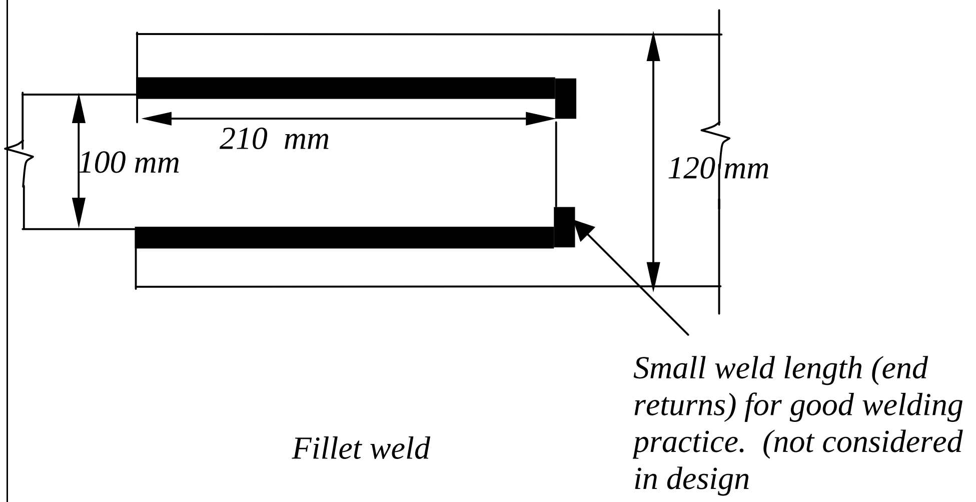
PROBLEM 2:

Design a suitable side fillet weld to connect two plates 100 mm × 10 mm and 120 mm × 12 mm, and to transmit tension equal to the full strength of the thin plate. Factored shear stress in the weld is 189.4 N/mm² and factored yield stress of the plate is 227.3 N/mm².



Solution:

Minimum size of the weld specified in IS:816(1969) for 12 mm thick plate is 5 mm.

Maximum size of fillet weld based on the thickness of the plate, i.e.,
$$= (10.0 - 1.5) = 8.5 \text{ mm}$$

A fillet weld of 6 mm may be suitable.

Tension transmitted by 1 mm of weld length $= 189.4 * 1 * 0.7 * 6$
$= 795.5$ *N*

Tensile strength based on the thinner plate $= 227.3 * 100 * 10$
$= 227.3$ *kN*

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Length of weld required = 227300 / 795.5
= 286 mm

Therefore, a weld length of 150 mm each on either longitudinal side can be provided.

<u>To ensure good fabrication practice the following checks are to be made</u>

- *The welds are to be checked for, a) whether sufficient weld lengths are provided on either side, b) This is greater than the width of the thinner plate. In this particular case 150 mm > 100 mm.*

- *The spacing of the longitudinal welds should be checked so as to be less than 16 times the thickness of the plate. In the present case 100 mm < 16 * 10 mm.*

- *It is also a good fabrication practice to take the weld round the corner for a small distance, normally twice the weld size (end return).*

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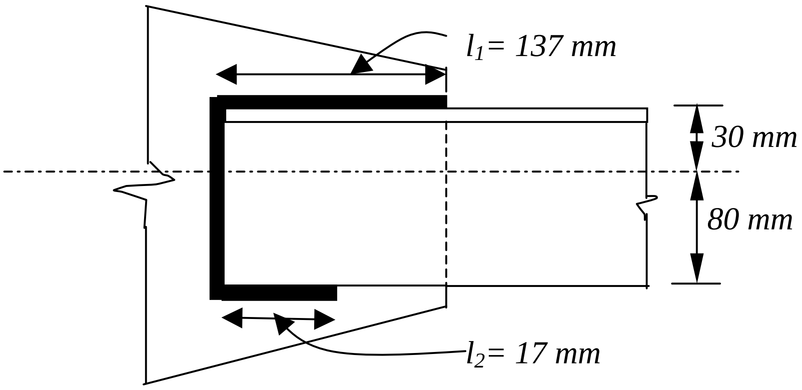
PROBLEM 3:

In a roof truss, a tie member ISA 110 mm x 110mm x 8 mm carries a factored tension of value 210 kN. The tie is connected to a gusset plate 8 mm thick. Design the welded joint. Factored yield strength of steel is 227.3 N/mm² and shear strength of weld is 189.4 N/mm².



Fillet weld for tie member of a roof truss

Solution:

For this problem we would provide a weld group consisting of transverse and longitudinal welds and ensure that the CG of the weld group coincides with the line of action of the externally applied load.

First we would decide about the weld size. This is decided by the thickness of the rolled section and the plate. Weld which are applied to rounded toe of rolled section should not be more than ¾ of its thickness or plate thickness and hence we get a weld size of 6mm (3/4 8). The maximum size of the end weld is also limited by the thickness of the plate, which is 8-1.5=6.5 mm. Hence 6 mm fillet welds are O.K.*

Transverse weld is provided equal to the size of the leg = 110 mm.

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Force transmitted by transverse weld = (189.4 0.7* 6* 110) /1000*
=87.50 kN

Remaining force to be transmitted by the longitudinal welds = 210 – 87. 50
=122.50 kN

We must ensure that the CG of the welds coincides with line of action of the external force. This could be ensured by providing longitudinal welds along the near and far side of the angle and also by ensuring that the moment of the all the forces about any of the line of the weld vanishes.

Let us assume that the lengths of the welds in the heel and toe sides are l_1 *and* l_2 *respectively.*

Total weld length required for 122.50 kN
*=122.50 * 1000 / ((189.4* 0.7*6))=154 mm*

Taking moment of all forces about the heel side longitudinal weld, we get

$87.50 * 1000 * 55 + l_1 * 0 + l_2 * (189.4. * 0.7 * 6) * 110$
$= 210 * 1000 * 30.$
Therefore l_2 $= 17$ *mm*

Hence we get the weld length l_2 *as say 17 mm. The bracketed term in the above expression represents the strength of the weld for 1 mm.*

Now we get the length l_1 *as 154 – 17 =137 mm*

Alternatively the longitudinal weld length l_1 *is obtained by taking moment of all the forces about the toe side weld line. Hence we have demonstrated as to how a weld group could be designed to have a CG coinciding with the externally applied load.*

It is also to be noted that in case it is desired to reduce the length of the joint then the heel side weld size can be increased.

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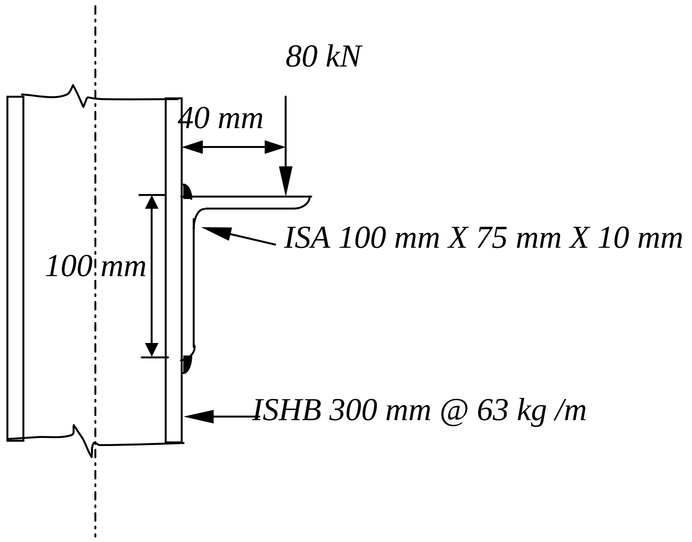
PROBLEM 4:

An ISA 100 mm X *75 mm* X *10 mm is welded with the flange of a column ISHB 300, @63 kg/mm. The bracket carries factored load of 80 kN at a distance of 40 mm from the face of the column. Design the bracket connection. Factored yield stress of steel is 227.3 N/mm*^{2}.



Welded bracket connection

Solution:
For the rolled section ISHB 300 @63 kg/ m

Flange width = 250 mm

We see that the external load not only causes shear but also a bending moment in the plane of the web. Hence it is necessary to provide two weld lines such that they produce a resisting couple to oppose the applied bending moment. In this particular case, as shown in the figure, we can provide weld at the top and bottom of the seating angle or bracket. Hence the top weld would be under tension and bottom weld would be under compression producing a couple whose lever arm would be 100 mm (length of the connected leg).

We also see that both welds share the shear force. Hence the welds are subjected to simultaneous action of shear and tension or compression.

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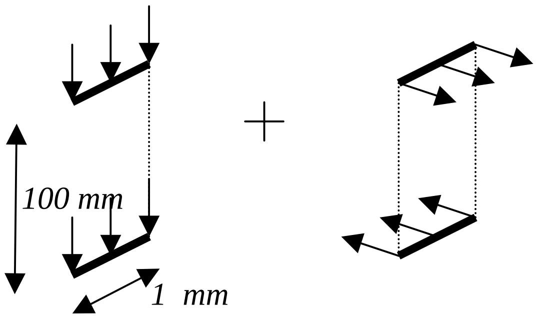
Having decided about the weld lengths (250 mm at top and bottom of the bracket) we can calculate the size of the weld 't'.

Shear force in 1mm length size of the weld. = 80000/(2 250)=160 N*



*Bending moment about the face of the column=40 * 80000*
$=32 * 10^5$ N-mm

Force in the weld per 1 mm length due to bending moment $= 32 * 10^5 / (250 * 100) = 128$ N

Resultant force due shear and bending = $\sqrt{160^2 + 128^2} = 205$ N
(For 1 mm weld length)

This resultant force should not exceed the design strength of the weld.

Therefore, $t * 0.7 * 189.4 \geq 205$

Solving for t,
$t \geq 1.55$ *mm*

Hence provide a weld size of 3 mm.