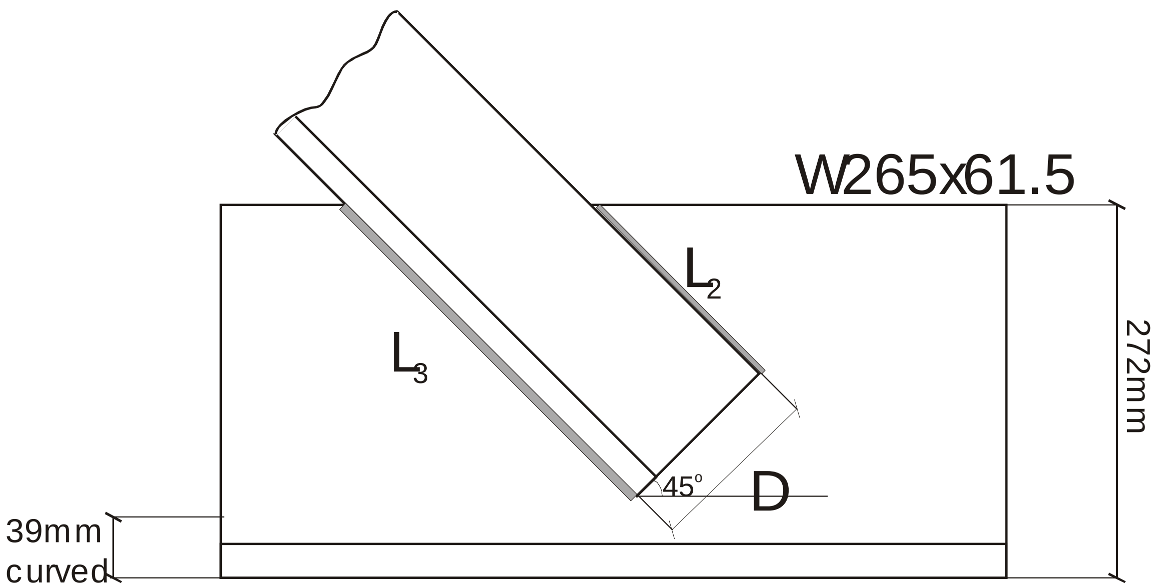
Solution for assignment on shear lag in welded connections

The shown member has a L127x127x9.5 cross-section and is inclined at 45 degrees with the horizontal. It is subject to a factored tensile force of 630 kN. The member is to be welded through two longitudinal welds L_2 and L_3 to the bottom chord of a truss with a WT265x61.5 cross section. The WT265x61.5 has a 39*mm* curved fillet dimension (see properties of WT 265x61.5 in your handbook). Also, it is good practice to leave an extra 20*mm* clearance from the end of the curved portion to the bottom point of the inclined member.



Connection

a) It is required to determine whether the proposed welded connection is suitable to resist the given force <u>based on a shear lag limit state</u>.

b) What is the efficiency of the proposed welding pattern? (i.e., the ratio of the effective net area reduced for shear lag to the total effective net area of the angle)

c) Propose a welding pattern that is a) more efficient and b) more economic

(a) Based on the above geometric constraints, we have

$$Max(L_3) = \frac{272-39-20}{\left(1/\sqrt{2}\right)} = 300mm$$

$$Max(L_2) = Max(L_3) - b = 300 - 127 = 173mm \approx 170mm$$

Take $L_2 = 170mm,\ L_3 = 300mm$

1. The A_{ne1} contribution:

The given detail does not have any elements with a transverse weld. Therefore, we have $A_{ne1} = 0$.

2. The A_{ne2} contribution:

The leg parallel to the stem is connected through two longitudinal welds L_2 and L_3 . The area of this leg is thus classified as A_{ne2} . The average weld length for this leg is

$$L = \frac{1}{2}\left(L_1 + L_2\right) = \frac{1}{2}\left(300 + 170\right) = 235mm$$

The width of the connected leg is $w = 127mm$. Thus,

$$2w = 2\left(127\right) = 254mm$$

$$254mm > L = 235mm > w = 127mm$$

And the corresponding equation is

$$A_{ne2} = 0.5wt + 0.25Lt = 0.5\times127\times9.5 + 0.25\times235\times9.5 = 1{,}161mm^2$$

3. The A_{ne3} contribution:

The outstanding leg (perpendicular to the stem) is connected through a single longitudinal L_3 at the base and is unconnected at the top. Thus, this area is classified as A_{ne3}. Since we have already accounted for the corner area (as part of the connected leg), we need not count it again as part of the outstanding leg. Thus, the width of the outstanding leg is $w = 127 - 9.5 = 117.5mm$ and $L = L_3 = 300mm$. The centroidal distance $\bar{x}$ from the centroid of the element to the weld to the shear plane is

$\bar{x} = 9.5 + 0.5 \times 117.5 = 68.3mm$.

For $L > w$, the corresponding equations is

$$A_{ne3} = \left(1 - \frac{\bar{x}}{L}\right) wt = \left(1 - \frac{68.25}{300}\right) 117.5 \times 9.5 = 862mm^2$$

4. Resistance of the member based on shear lag

$A_{ne} = A_{ne2} + A_{ne3} = 1161 + 862 = 2023mm^2$

$T_r = \phi_u A_{ne} F_u$

$= 0.75 \times 2,023 \times 450 \times 10^{-3} = 683kN$

(b) T he efficiency of he connection

The overall efficiency of the member is

$$\frac{A_{ne}}{A_n} = \frac{2,023}{2,330} = 87\%$$

Note:

For the connected leg, the efficiency is $\frac{1,161}{127 \times 9.5} = \frac{1,161}{1,207} = 96.2\%$

For the outstanding leg, the efficiency is $= \frac{862}{1207 - 9.5^2} = 77.2\%$

(c) Solution:

By replacing the weld L_2 by a transverse weld, the efficiency of connected leg increases to 100%. The transverse weld is 127mm long, which is less than the length of weld L_2 Thus, the transverse weld solution is both more economic (shorter) and more efficient.