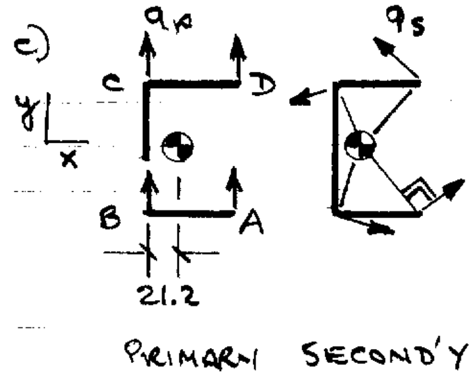
2 cond'd

c)



In-plane loading (torsion).

Geometric properties, from tables.

$b = 60 \quad d = 50 \quad L = 170$ mm

centroid at $b^2/L = 60^2/170 = 21.2$ mm

$J_{zz} = I_{xx} + I_{yy} = \frac{d^2}{12}(6b+d) + \frac{b^3}{3L}(b+2d)$

$= (85.42 + 67.76)e3 = 153.2e3$ mm^3

Centroidal moment, T

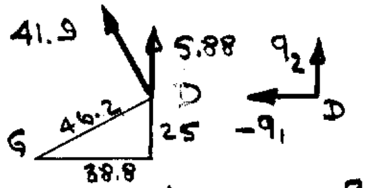
$T = 10^3(100+60-21.2) = 138.8e3$ Nmm

By inspection, the maximum intensity will occur at A and D – radius larger than that to B & C hence secondary intensity larger. Also directions of primary & secondary are more in correspondence.

Primary: $q_p = F/L = 10^3/170 = 5.88$ N/mm ↑

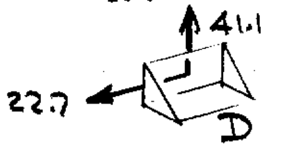
Second'y: $q_s = Tr/J$ and for A & D

$r = \sqrt{((60-21.2)^2 + 25^2)} = 46.2$ mm



$= 138.8e3 \times 46.2/153.2e3 = 41.9$ N/mm.

Combining the intensity at D, say (A will be the same).



$q_1 = -41.9 \times 25/46.2 = -22.7$ N/mm

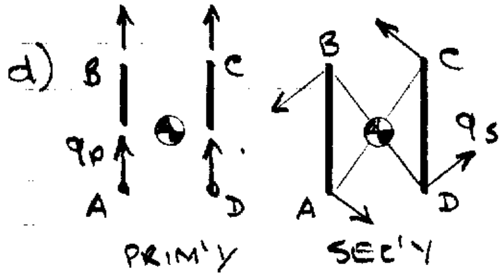
$q_2 = 41.9 \times 38.8/46.2 + 5.88 = 41.1$ N/mm

Applying (1) at D: $q_E = 49.6$ N/mm

$\sigma_E = 2q_E/w = 16.5$ MPa.

Thus, if 1kN → 16.5 MPa, then $240/16.5 = $ 14.5 kN leads to 240 MPa

d)



Similar approach to above – in-plane loading

Geometric properties, from tables.

Centroid by inspection (symm)

$J_{zz} = I_{xx} + I_{yy} = \frac{d}{2}(b^2 + d^2/3)$

$= 63e3$ mm^3 $\quad L = 120$ mm

Centroidal moment: $T = 10^3(100+15) = 115e3$ Nmm

Maximum intensity at C or D due to directional correspondence. $r = \sqrt{(30^2+15^2)} = 33.5$ mm

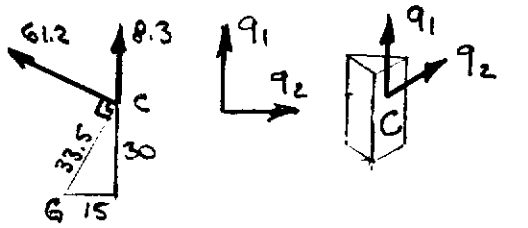
Primary $q_p = F/L = 10^3/120 = 8.3$ N/mm

Secondary $q_s = Tr/J = 115e3 \times 33.5/63e3 = 61.2$ N/mm

Resolving at C say:–

$q_1 = 61.2 \times 15/33.5 + 8.3 = 35.7$ N/mm

$q_2 = 61.2 \times 30/33.5 (-) = -54.8$ N/mm



From (1) $q_E = \sqrt{(1.5 \times 35.7^2 + 54.8^2)} = 70.1$

$\sigma_E = 2 \times 70.1/6 = 23.4$ MPa

So, for σ_E of 240 MPa, the load is $F = 1(\text{kN}) \times 240/23.4 = $ 10.3 kN