Path acg or fcb (three holes and two stagger) :

$$A_n = \left[230 - 3 \times 22 + \frac{50^2}{4 \times 50} + \frac{45^2}{4 \times 50}\right] \times 10$$

$$= 1866.25 \text{ mm}^2$$

The minimum net area is for path fcde.

$$\therefore \quad \mathbf{A_n = 1521.25 \text{ mm}^2}$$

- *Minimum net area occurs at a path which has the maximum number of holes and minimum number of staggers.*

Example–4 : Determine the design tensile strength of plate 160 × 8 mm connected to 10 mm thick gusset using M 16 bolts as shown in figure. The yield stress of steel is 250 MPa and ultimate stress is 410 MPa. **(May 2012)**

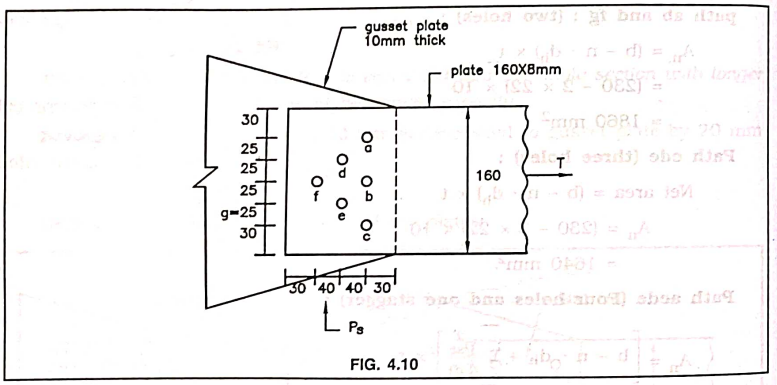

FIG. 4.10

Solution :

d = 16 mm

d_h = 16 + 2 = 18 mm

f_y = 250 MPa

f_u = 410 MPa

(1) Strength due to yielding of gross section :

$T_{dg} = A_g \cdot f_y/\gamma_{mo}$ | IS : 800

$= (160 \times 8) \times 250/1.10$ | cl. 6.2, P.32

$= 290909$ N

$= 290.91$ kN ... (1)

(2) Strength due to rupture of net section :

Calculation of net area :

Path abc (3 holes) :

$A_n = (b - n \cdot d_h) \times t$

$= (160 - 3 \times 18) \times 8$

$= 848 \text{ mm}^2$

Path adec (4 holes and 2 stagger) :

$$A_n = \left[b - n \cdot d_h + \frac{\Sigma p_{si}^2}{4gi}\right] \times t$$ | IS : 800

$$= \left[160 - 4 \times 18 + \frac{(2 \times 40^2)}{4 \times 25}\right] \times 8$$ | cl.6.3.1

$= 960 \text{ mm}^2$ | p.32

Path adfec (5 holes and 4 stagger) :

$$A_n = \left[160 - 5 \times 18 + \frac{(4 \times 40^2)}{4 \times 25}\right] \times 8$$

$= 1072 \text{ mm}^2$

Minimum value of An is 848 mm^2

$\therefore \quad T_{dn} = 0.9 \, A_n \cdot f_u/\gamma_{m1}$

$= 0.9 \times 848 \times 410/1.25$

$= 250329$ N

$= 250.33$ kN ... (2)

Therefore, the design tensile strength is the smaller of T_{dg} and T_{dn}.

$\therefore \quad \mathbf{T_d = 250.33 \text{ kN}}$

Example–5 : A plate of 100 × 10 mm is connected to the gusset plate by one M 20 bolt. Calculate net area for the plate subjected to tension, in case of,

(a) drilled holes

(b) Punched holes