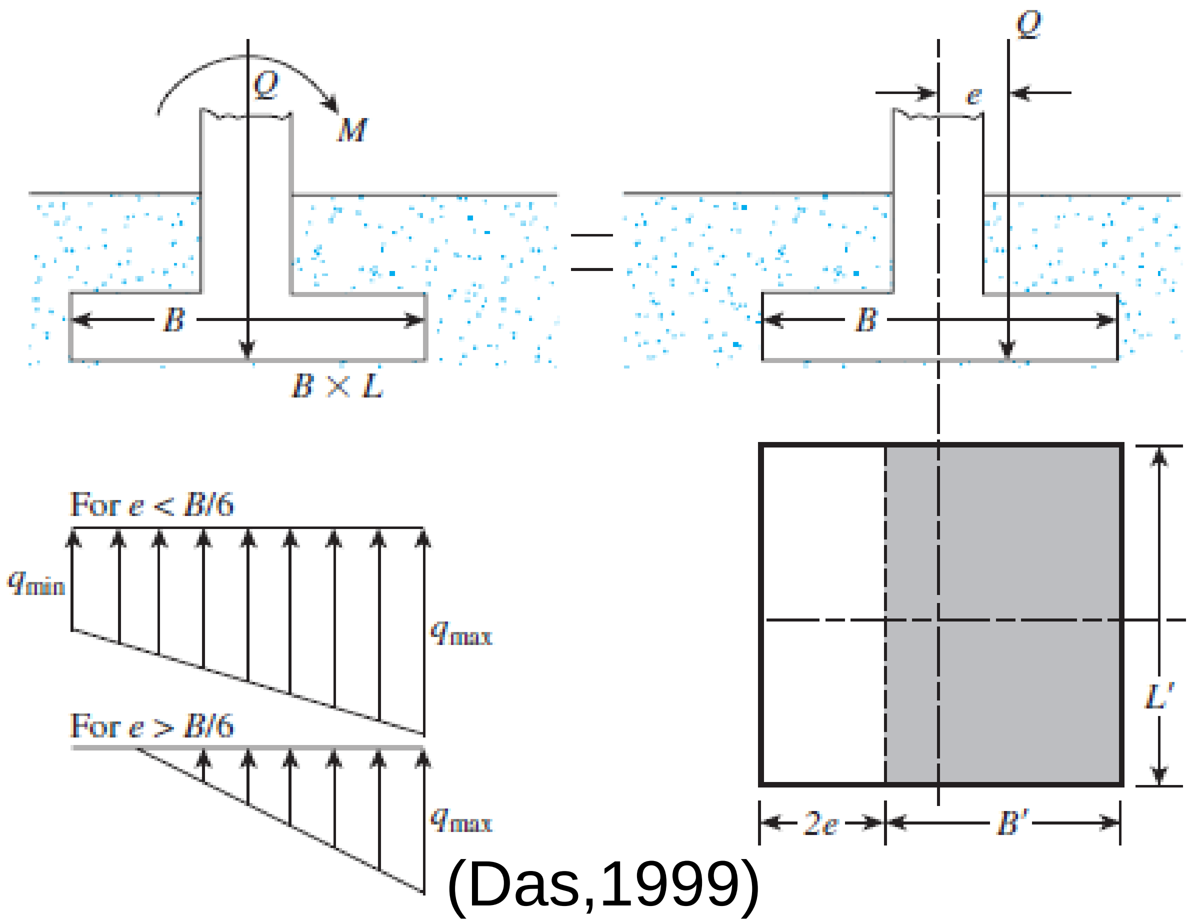
Eccentricity

$$q_{\max} = \frac{Q}{BL} + \frac{6M}{B^2L}$$

$$q_{\min} = \frac{Q}{BL} - \frac{6M}{B^2L}$$



(Das,1999)

one-way eccentricity

$\acute{A} = \acute{B} x \acute{L}$ *(the base area of foundation)*

$$\acute{B} = B - 2e$$

$$\acute{L} = L$$

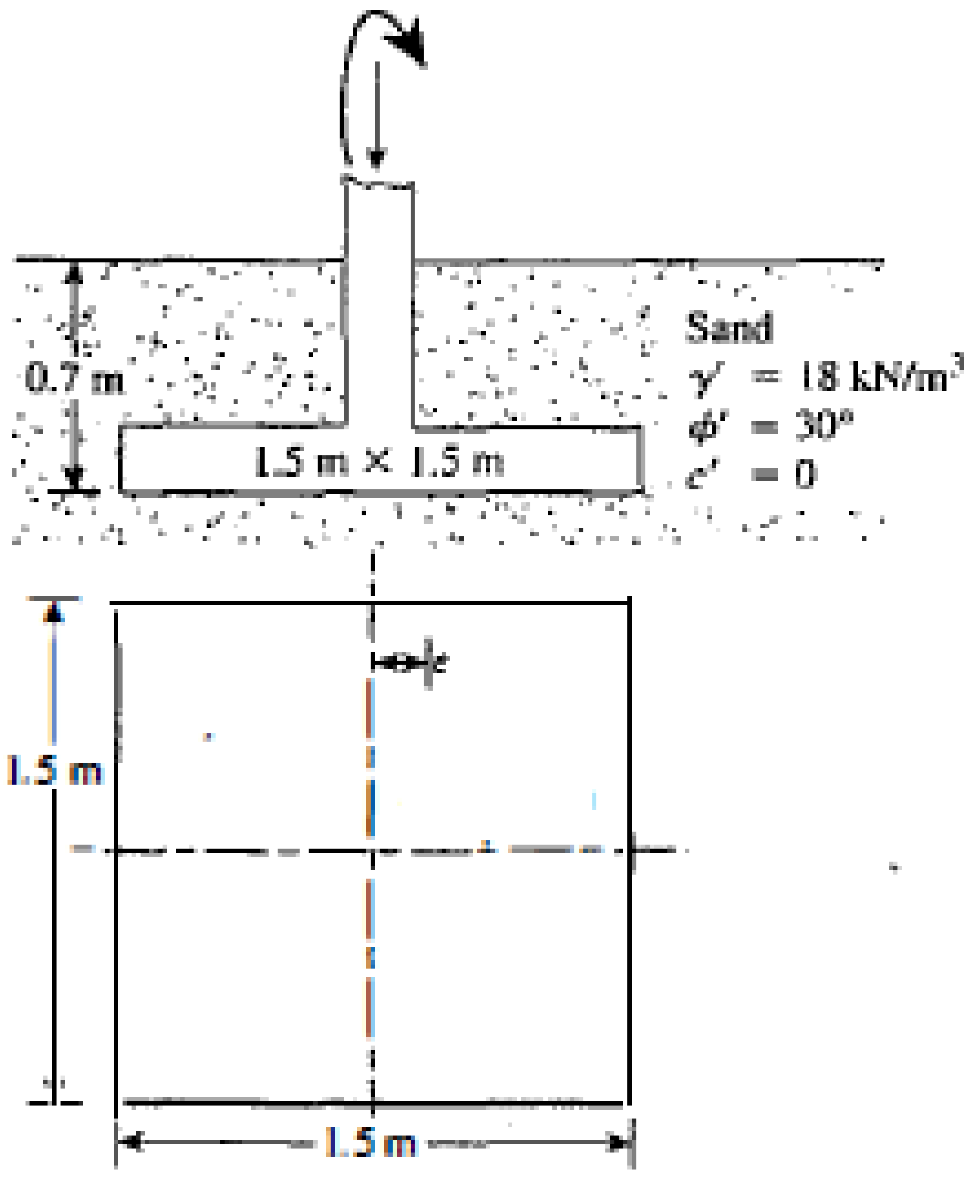
$$q_{ult} = \mathrm{c}N_c s_c d_c i_c g_c b_c + qN_q s_q d_q i_q g_q b_q + \frac{1}{2}\acute{B}\gamma N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma b_\gamma$$

$$Q_{ult} = q_{ult}\acute{A}$$

$$q_a = \frac{q_{ult}}{factor\ of\ safety} = \frac{Q_a}{\acute{B} x \acute{L}}$$

$$Q_a = q_a\acute{A} = q_a\acute{B}\acute{L}$$

$$e_B = 0.15, Qult = ?$$



(Das,1999)

$$q = (0.7)(18) = 12.6kPa$$

$$\acute{B} = 1.5 - 2(0.15) = 1.2m \qquad \acute{L} = L = 1.5m$$

$$s_q = 1 + (\frac{\acute{B}}{\acute{L}} tan\emptyset) = 1 + \frac{1.2m}{1.5m} tan30° = 1.462$$

$$d_q = 1 + [2tan\emptyset(1 - sin\emptyset)^2 \frac{D_f}{B}] = 1 + [2tan30(1 - sin30)^2 \frac{0.7m}{1.5m}] = 1.135$$

$$s_\gamma = 1 - 0.4\left(\frac{\acute{B}}{\acute{L}}\right) = 1 - 0.4\frac{1.2m}{1.5m} = 0.68 \qquad d_\gamma = 1$$

$$q_{ult} = qN_q s_q d_q + \frac{1}{2}\acute{B}\gamma N_\gamma s_\gamma d_\gamma = 549kPa$$

$$= (12.6)(18.4)(1.\bar{4}62)(1.135)$$

$$+(0.5)(18\frac{kN}{m^3})(1.2m)(22.4)(0.68)(1)$$

$$Q_{ult} = q_{ult}\acute{A} = 549kPa(1.2m)(1.5m) = 988kN$$

Two-way eccentricity

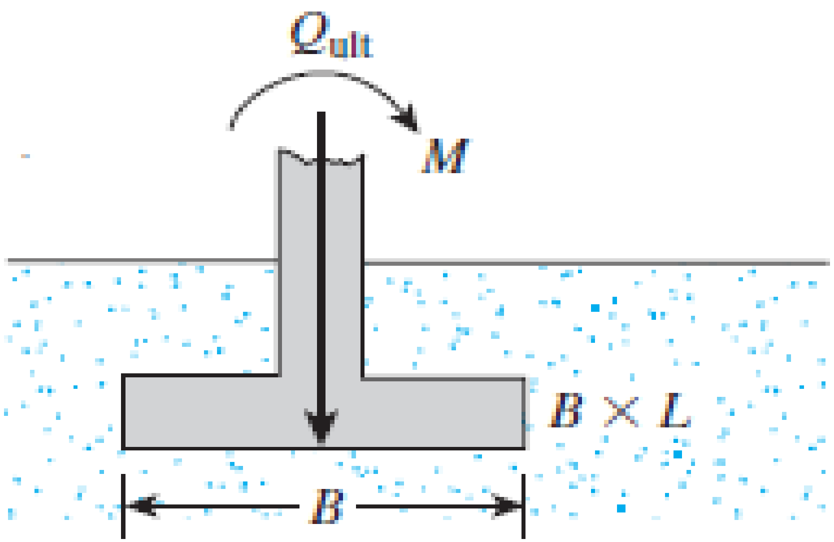
$\acute{A} = \acute{B} x \acute{L}$ *(the base area of foundation)*

$$q_{ult} = \mathrm{c} N_c s_c d_c i_c g_c b_c + q N_q s_q d_q i_q g_q b_q + \frac{1}{2} \acute{B} \gamma N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma b_\gamma$$

$$Q_{ult} = q_{ult} \acute{A}$$

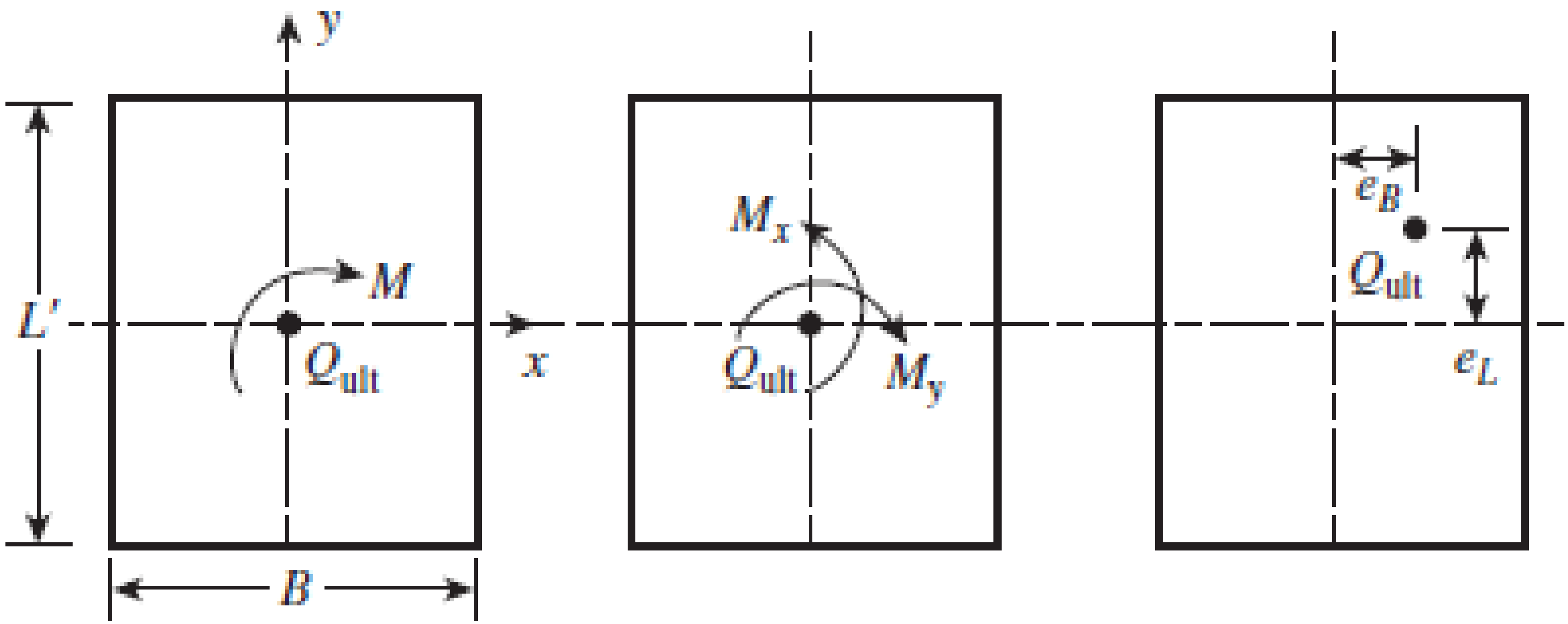
$$q_a = \frac{q_{ult}}{factor\ of\ safety} = \frac{Q_a}{\acute{B} x \acute{L}}$$

$$Q_a = q_a \acute{A} = q_a \acute{B} \acute{L}$$



$$A' = \text{effective area} = B'L'$$

$$Q_{ult} = q_{ult}\acute{A} = q_{ult}\acute{B}\acute{L}$$



(Das,1999)

Case I. $e_L/L \geq \frac{1}{6}$ and $e_B/B \geq \frac{1}{6}$.

$$A' = \tfrac{1}{2}B_1L_1$$

where

$$B_1 = B\left(1.5 - \frac{3e_B}{B}\right)$$

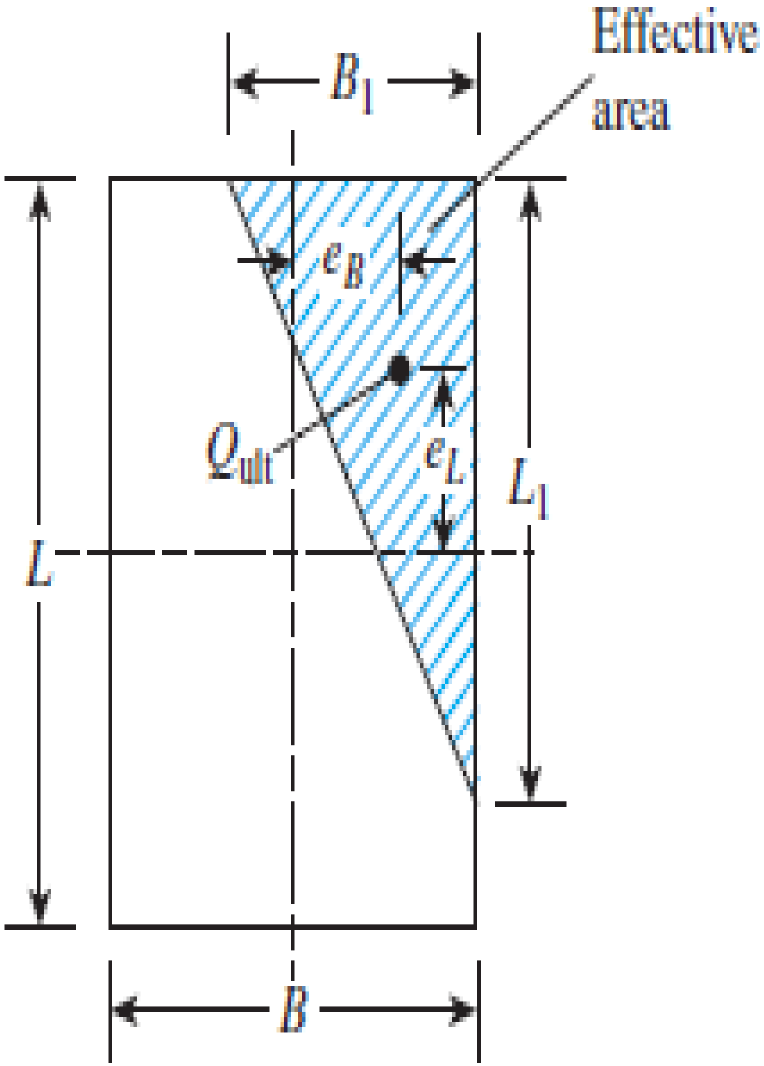
and

$$L_1 = L\left(1.5 - \frac{3e_L}{L}\right)$$

The effective length L' is the larger of the two dimensions B_1 and L_1. So the effective width is

$$B' = \frac{A'}{L'}$$

(Das,1999)



Effective area for the case of $e_L/L \geqslant \frac{1}{6}$ and $e_B/B \geqslant \frac{1}{6}$

(Das,1999)

Case II. $e_L/L < 0.5$ and $0 < e_B/B < \frac{1}{6}$.

$$A' = \tfrac{1}{2}(L_1 + L_2)B$$

The effective length is

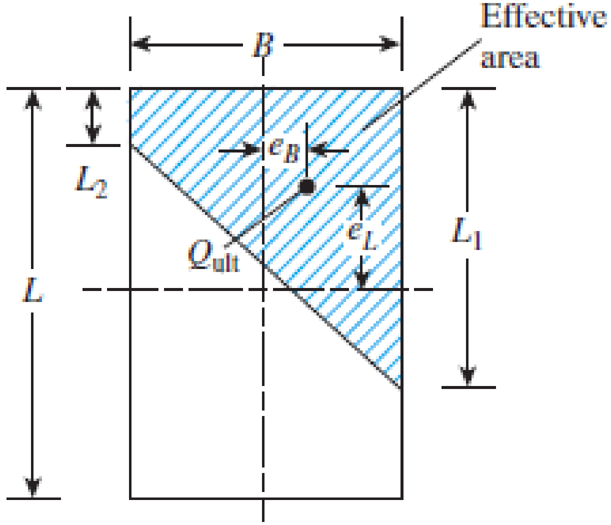
$$L' = L_1 \text{ or } L_2 \quad \text{(whichever is larger)}$$

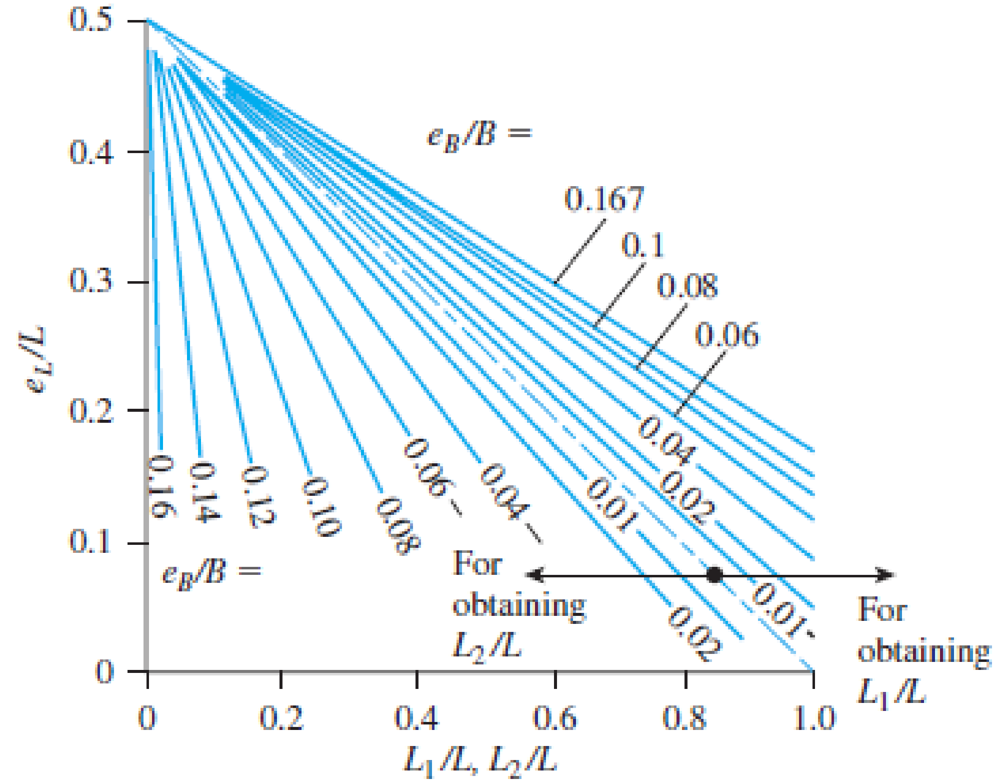
$$B' = \frac{A'}{L_1 \text{ or } L_2 \quad \text{(whichever is larger)}}$$

The effective length is

$$L' = L_1 \text{ or } L_2 \quad \text{(whichever is larger)}$$

(Das,1999)



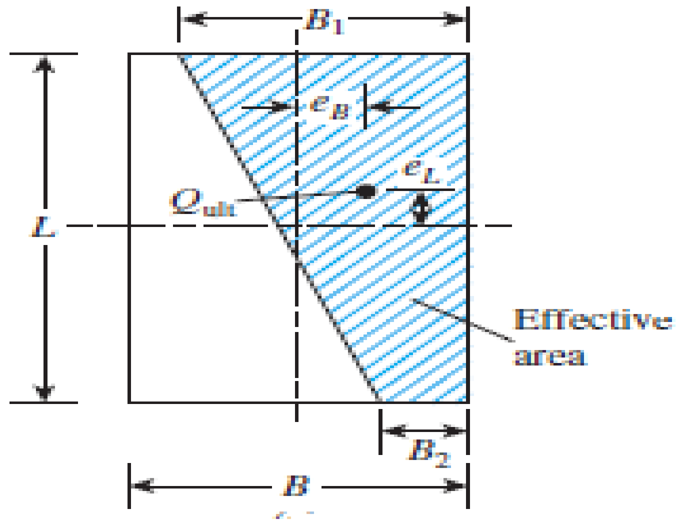


Effective area for the case of $e_L/L < 0.5$ and $0 < e_B/B < \frac{1}{6}$ (After Highter and Anders, 1985) (Highter, W. H. and Anders, J. C. (1985). "Dimensioning Footings Subjected to Eccentric Loads," *Journal of Geotechnical Engineering*, American Society of Civil Engineers, Vol. 111, No. GT5, pp. 659–665. With permission from ASCE.)

(Das,1999)

Case III. $e_L/L < \frac{1}{6}$ and $0 < e_B/B < 0.5.$

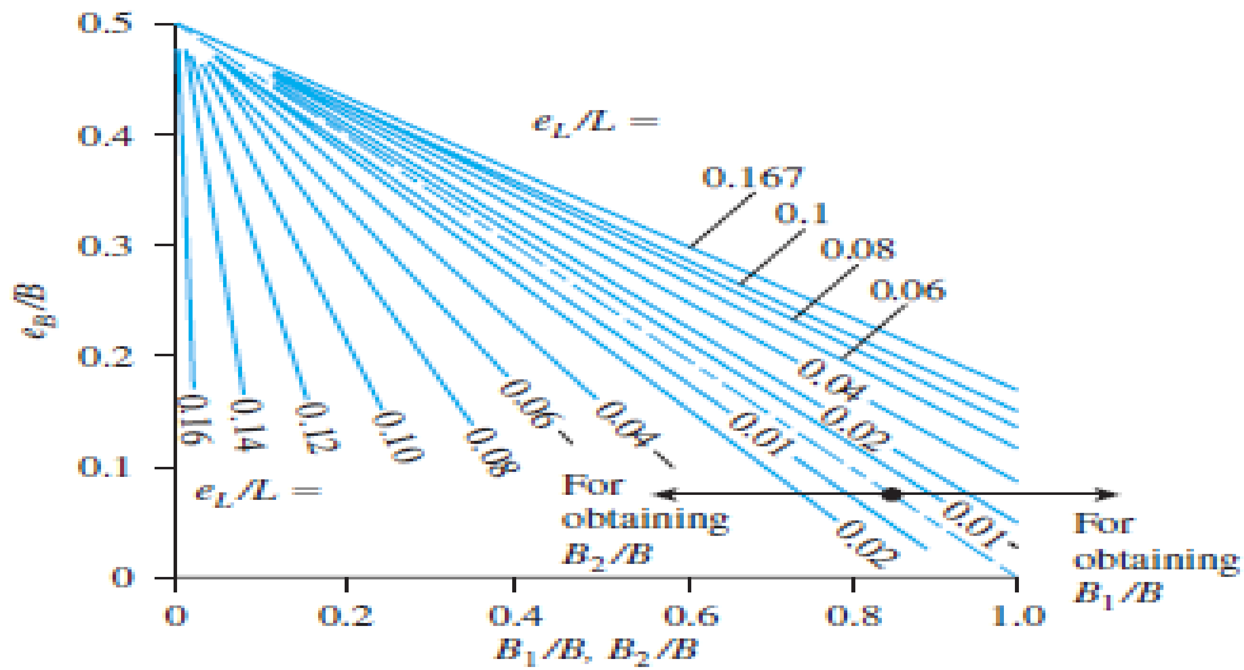
$$A' = \tfrac{1}{2}(B_1 + B_2)L$$



$$L' = L$$

$$B' = \frac{A'}{L}$$

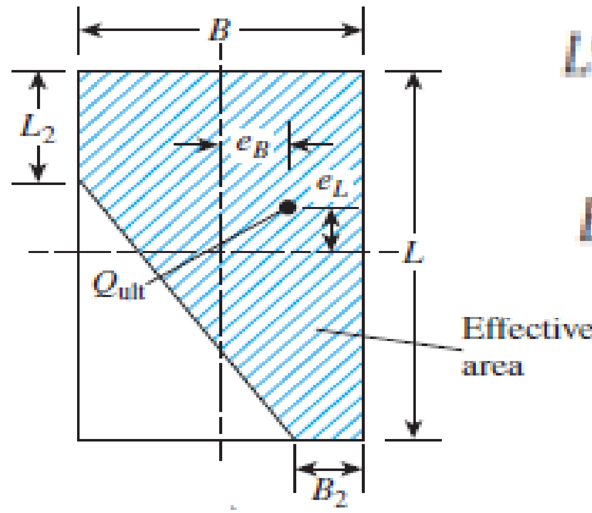
(Das,1999)



Effective area for the case of $e_L/L < \frac{1}{6}$ and $0 < e_B/B < 0.5$ (After Highter and Anders, 1985) Highter, W. H. and Anders, J. C. (1985). "Dimensioning Footings Subjected to Eccentric Loads," *Journal of Geotechnical Engineering*, American Society of Civil Engineers, Vol. 111, No. GT5, pp. 659–665. With permission from ASCE.)

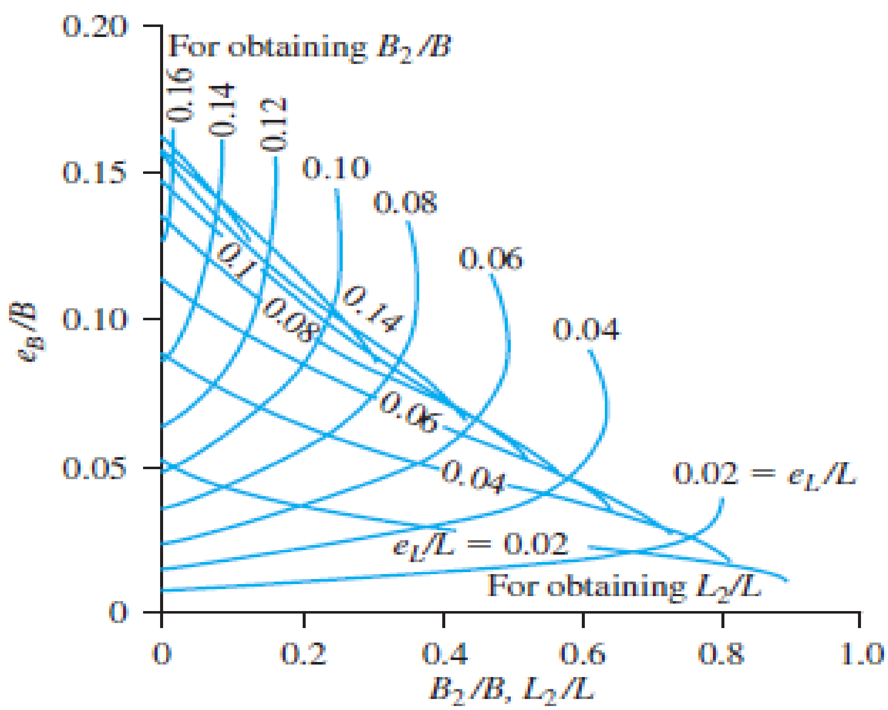
Case IV. $e_L/L < \frac{1}{6}$ and $e_B/B < \frac{1}{6}$.

$$A' = L_2 B + \frac{1}{2}(B + B_2)(L - L_2)$$



$$L' = L$$

$$B' = \frac{A'}{L}$$

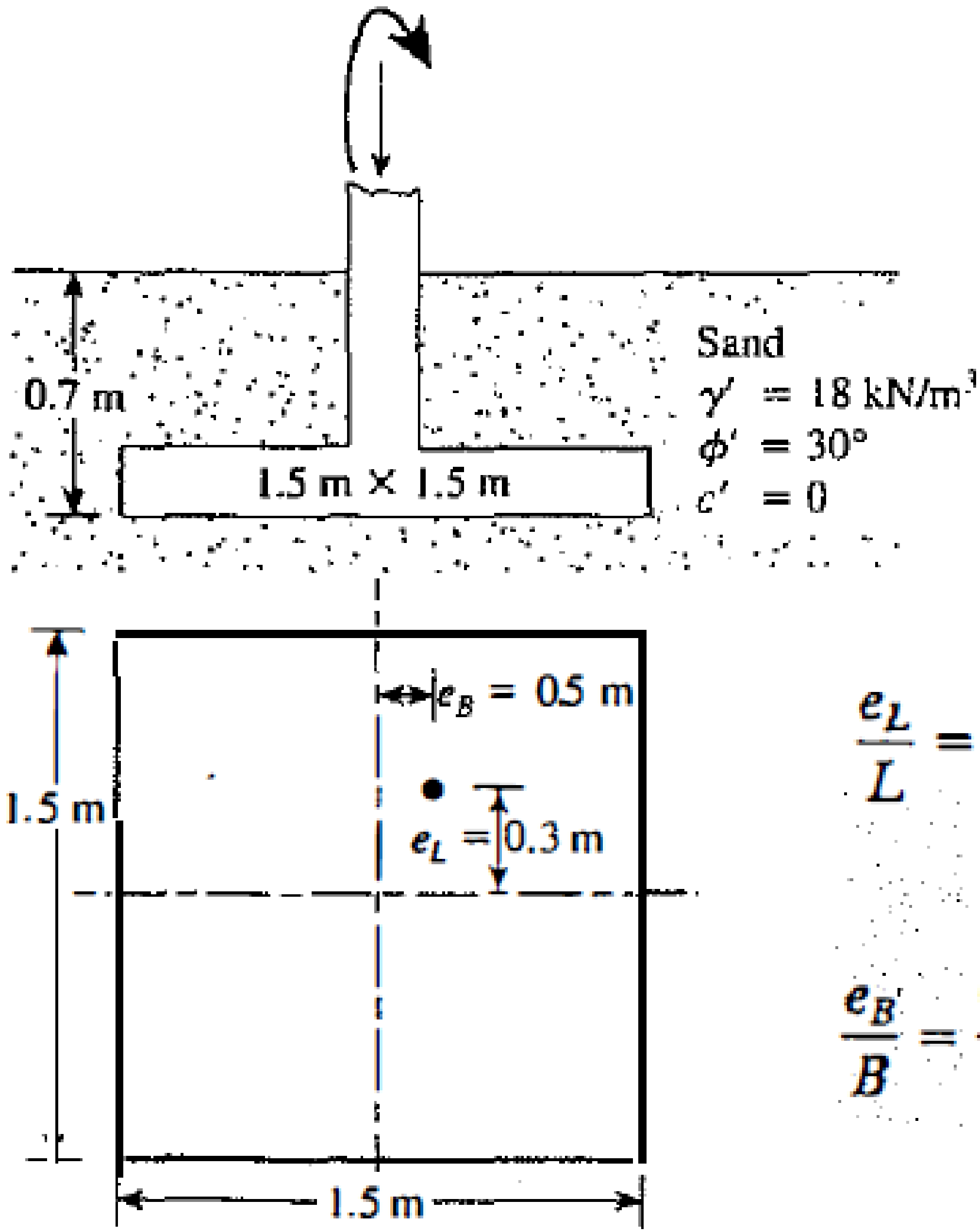


Effective area for the case of $e_L/L < \frac{1}{6}$ and $e_B/B < \frac{1}{6}$ (After Highter and Anders, 1985) (Highter, W. H. and Anders, J. C. (1985). "Dimensioning Footings Subjected to Eccentric Loads," *Journal of Geotechnical Engineering*, American Society of Civil Engineers, Vol. 111, No. GT5, pp. 659–665. With permission from ASCE.)

(Das,1999)

$$\boldsymbol{e_B = 0.15 \;\; and \; e_L = 0.3; \;\; Qult =?}$$

There is a two way-eccentricity



$$\frac{e_L}{L} = \frac{0.3}{1.5} = 0.2$$

Case II

$$\frac{e_B}{B} = \frac{0.15}{1.5} = 0.1$$

$\frac{L_1}{L} \approx 0.85;$ $L_1 = (0.85)(1.5) = 1.275$ m $\frac{L_2}{L} \approx 0.21;$ $L_2 = (0.21)(1.5) = 0.315$ m

(Das,1999)

$$A' = \tfrac{1}{2}(L_1 + L_2)B = \tfrac{1}{2}(1.275 + 0.315)(1.5) = 1.193\ \mathrm{m}^2$$

$$L' = L_1 = 1.275\ \mathrm{m} \qquad B' = \frac{A'}{L'} = \frac{1.193}{1.275} = 0.936\ \mathrm{m}$$

$$s_c = 1.0 + \frac{N_q}{N_c} \cdot \frac{B}{L}$$

$$s_q = 1.0 + \frac{B}{L}\tan\phi \quad = \quad 1 + \left(\frac{B'}{L'}\right)\tan\phi' = 1 + \left(\frac{0.936}{1.275}\right)\tan 30° = 1.424$$

$$s_\gamma = 1.0 - 0.4\frac{B}{L} \quad = \quad 1 - 0.4\left(\frac{B'}{L'}\right) = 1 - 0.4\left(\frac{0.936}{1.275}\right) = 0.706$$

$$d_q = 1 + 2\tan\phi(1 - \sin\phi)^2 k = 1 + 2\tan\phi'(1 - \sin\phi')^2 \frac{D_f}{B} = 1 + \frac{(0.289)(0.7)}{1.5}$$

$$d_\gamma = 1.00$$

$$\emptyset = 30° \Rightarrow N_c = 30.13;\ \ N_q = 18.4;\ N_\gamma = 22.4$$

(Das,1999)

$$q_{ult} = cN_c s_c d_c + qN_q s_q d_q + \frac{1}{2}\acute{B}\gamma N_\gamma s_\gamma d_\gamma$$

$$q_{ult} = 0 + (0.7x18)(18.4)(1.424)(1.135) + \frac{1}{2}(0.936)(18)(22.4)$$

$$Q_{ult} = q_{ult}\acute{A} = q_{ult}\acute{B}L' = q_{ult}(0.936x1.275) = 600kN$$

(Das,1999)