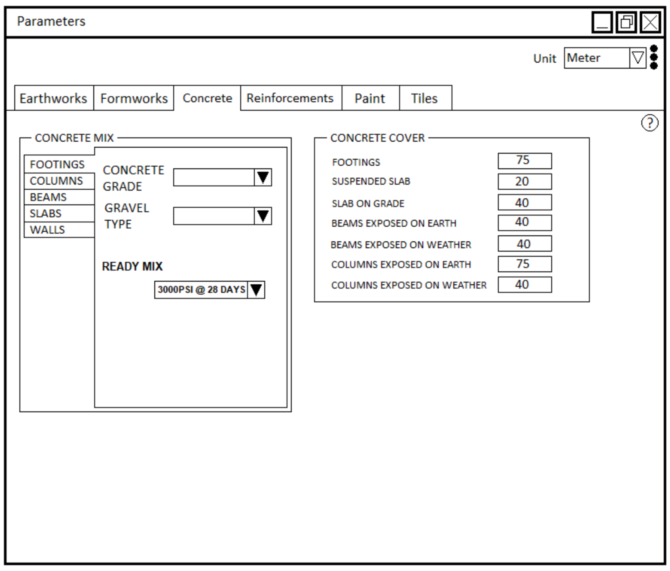
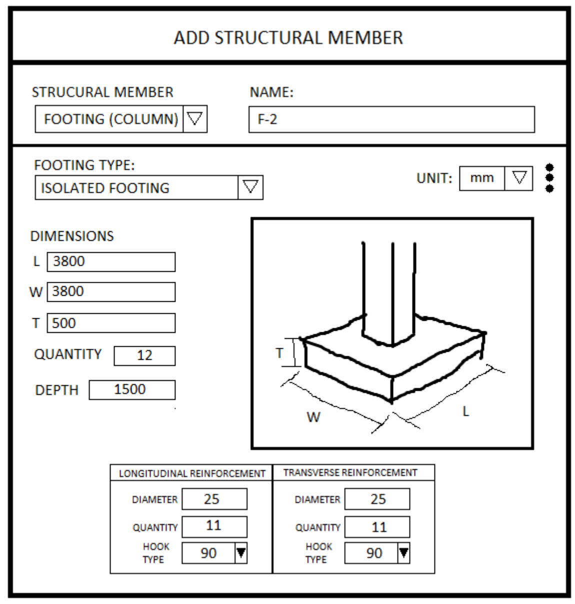
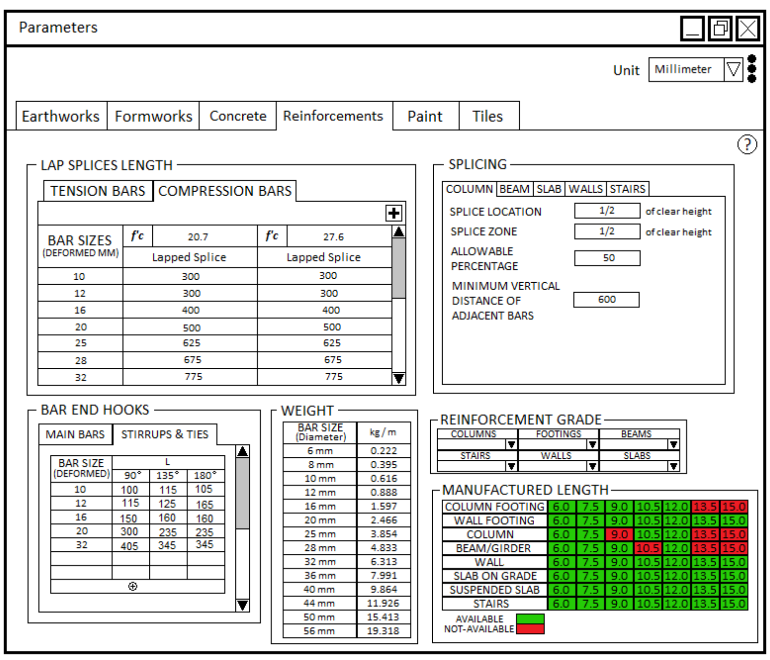
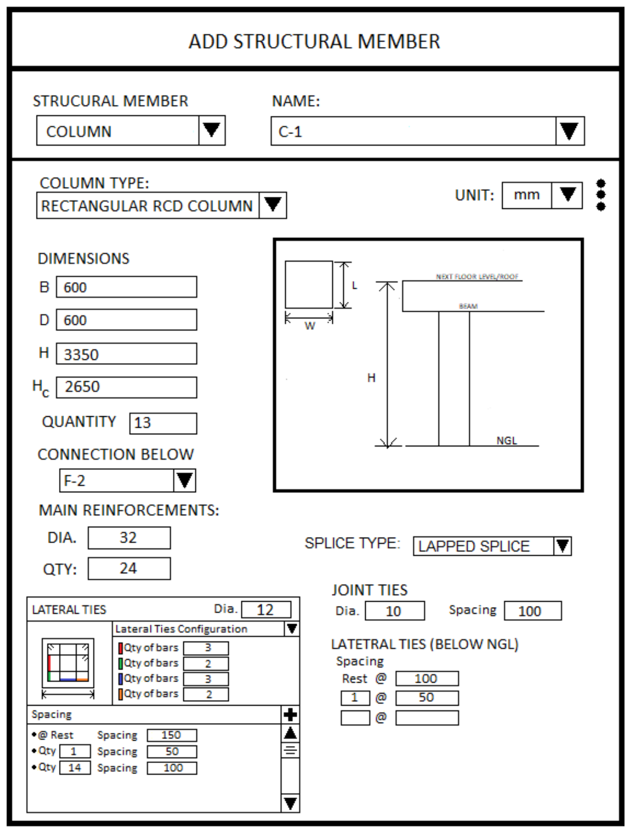
REFERENCE

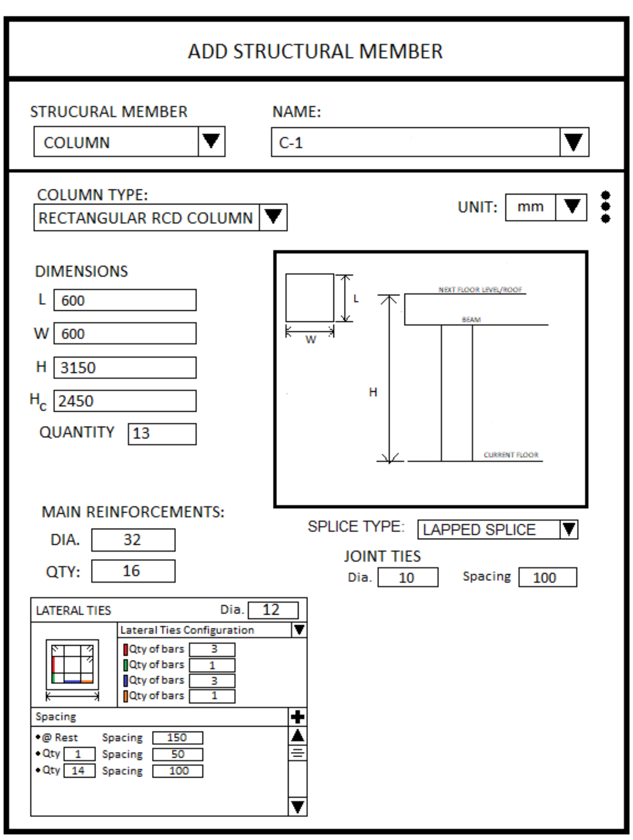




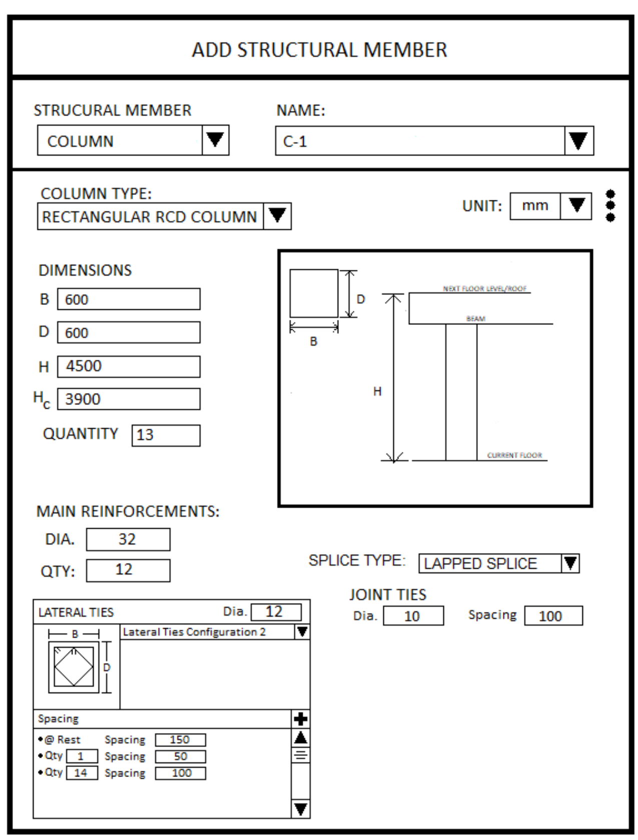




@ GROUND FLOOR



@ 2ND & 3RD FLOOR



@ 4TH FLOOR

1. The program will compute the required quantity of @rest lateral ties, lateral ties below NGL (if there is), and joint ties for each column.

LEGEND	
$CC_F = Footing\ Concrete\ Cover\ (based\ on\ parameters)$	
$d_{bLF} = diameter\ of\ longitudinal\ bars$	$d_{bTF} = diameter\ of\ transverse\ bars$
$Qty_{TE(x)} = Quantity\ of\ Lateral\ Ties\ below\ NGL$	$S_{E(x)} = Spacing\ of\ Lateral\ Ties\ below\ NGL$
$Qty_{T(@rest)} = Quantity\ of\ @\ rest\ Lateral\ Ties$	$S_{(@rest)} = Spacing\ of\ @rest\ Lateral\ Ties$
$Qty_{Tx} = Quantity\ of\ Lateral\ Ties\ @\ floor\ \boldsymbol{n}$	$S_{(x)} = Spacing\ of\ Lateral\ Ties\ @\ floor\ \boldsymbol{n}$

- For Ground Floor

a) If there are lateral ties (Below NGL)

$$Qty_{TE(1)} = \frac{D_F - \left(\sum_2^3 Qty_{TE(x)} S_{E(x)}\right) - CC_F - d_{bLF} - d_{bTF} - d_{bMR}}{S_{E(1)}}$$

Then,

$$Qty_{T(@rest)} = \frac{H_C + D_F - \left(\sum_1^3 Qty_{TE(x)} S_{E(x)}\right) - \left(\sum_1^x Qty_{T(x)} S_{(x)}\right) - CC_F - d_{bLF} - d_{bTF} - d_{bMR}}{S_{(@rest)}} + 1$$

And,

$$Qty_{TQ} = \frac{D_{B(n+1)} or\ D_{RB}}{S_{TJ}} - 1$$

b) If there are NO lateral ties (Below NGL)

$$Qty_{T(@rest)} = \frac{H_C - 2\left(\sum_1^x Qty_{T(x)} S_{(x)}\right) - CC_F - d_{bTF} - d_{bTF} - d_{bMR}}{S_{(@rest)}} + 1$$

And,

$$Qty_{TQ} = \frac{H - H_C}{S_{TJ}} - 1$$

- For the upper floors

$$Qty_{T(@rest)} = \frac{H_{Cn} - 2\left(\sum_1^x Qty_{T(x)} S_{(x)}\right)}{S_{(@rest)}} + 1$$

And

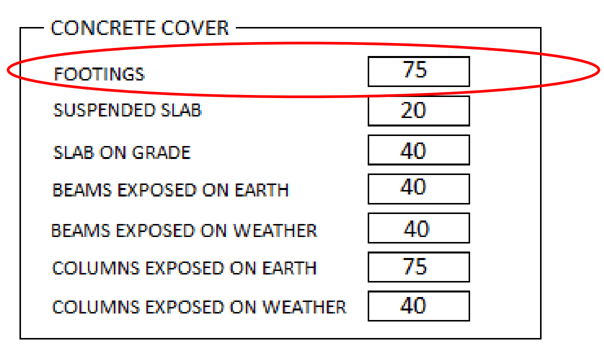
$$Qty_{TQ} = \frac{H - H_C}{S_{TJ}} - 1$$

Note:

If the $\boldsymbol{Answer} \geq \mathbf{0}$, then Round Up to whole number

If the $\boldsymbol{Answer} < \mathbf{0}$, then Round Down to whole number

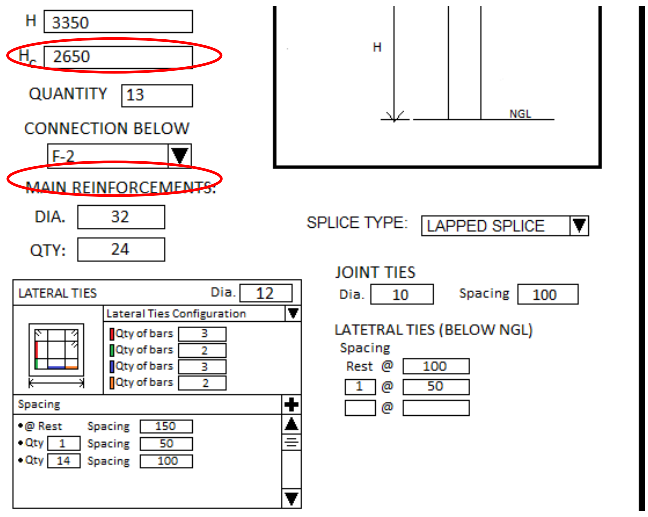
Example:



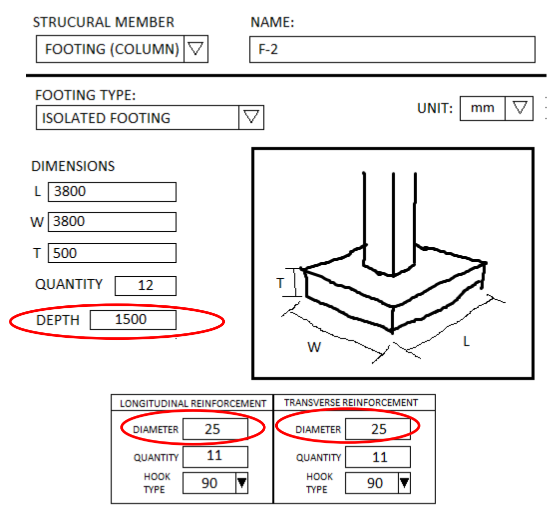
CONCRETE COVER	
FOOTINGS	75
SUSPENDED SLAB	20
SLAB ON GRADE	40
BEAMS EXPOSED ON EARTH	40
BEAMS EXPOSED ON WEATHER	40
COLUMNS EXPOSED ON EARTH	75
COLUMNS EXPOSED ON WEATHER	40

$$CC_F = 75$$

@ Ground Floor



$$H_C = 2650 \text{ and } d_{bMR} = 32$$



$$D_F = 1500, d_{bLF} = 25, \text{and } d_{bTF} = 25$$

Since there are Lateral Ties (Below NGL)

$$Qty_{TE(1)} = \frac{D_F - \left(\sum_2^3 Qty_{TE(x)} S_{E(x)}\right) - CC_F - d_{bLF} - d_{bTF} - d_{bMR}}{S_{E(1)}}$$

$$Qty_{TE(1)} = \frac{1500 - [1(50) + 0(0)] - 75 - 25 - 25 - 32}{100} = 12.93 \rightarrow 13$$

Then,

$$Qty_{T(@rest)} = \frac{H_C + D_F - \left(\sum_1^3 Qty_{TE(x)} S_{E(x)}\right) - \left(\sum_1^2 Qty_{T(x)} S_{(x)}\right) - CC_F - d_{bLF} - d_{bTF} - d_{bMR}}{S_{(@rest)}} + 1$$

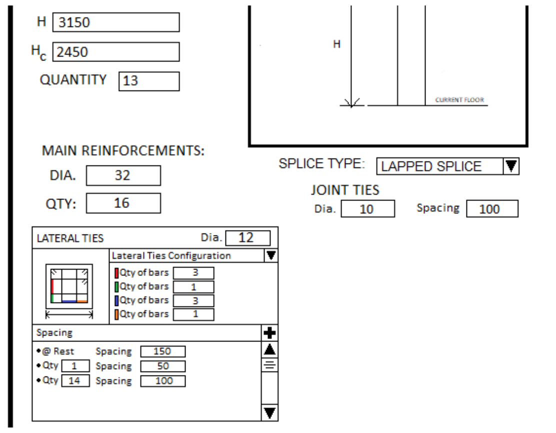
$$= \frac{2650 + 1500 - [13(100) + 1(50) + 0(0)] - [1(50) + 14(100)] - 75 - 25 - 25 - 32}{150} + 1$$

$$Qty_{T(@rest)} = 8.95 \rightarrow 9$$

And

$$Qty_{TQ} = \frac{H - H_C}{S_{TJ}} = \frac{3350 - 2650}{100} - 1 = 6$$

@ 2nd – 3rd Floor



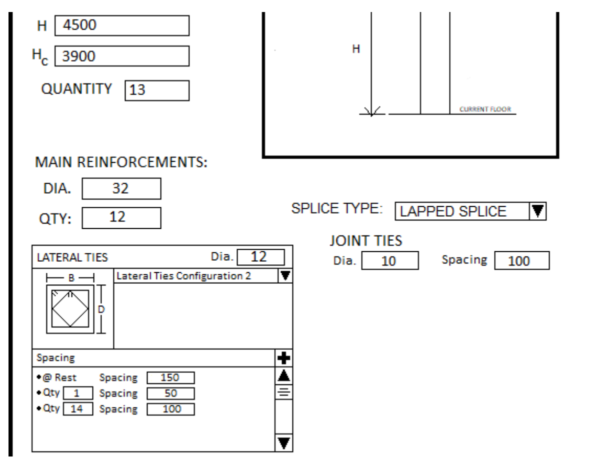
$$Qty_{T(@rest)} = \frac{H_{C2} - 2\left(\sum_1^2 Qty_{T(x)} S_{(x)}\right)}{S_{(@rest)}} + 1$$

$$Qty_{T(@rest)} = \frac{2450 - 2[1(50) + 14(100)]}{150} + 1 = -2$$

And,

$$Qty_{TQ} = \frac{H - H_C}{S_{TJ}} - 1 = \frac{3150 - 2450}{100} - 1 = 6$$

@ 4th Floor



$$Qty_{T(@rest)} = \frac{H_{C4} - 2\left(\sum_1^2 Qty_{T(x)} S_{(x)}\right)}{S_{(@rest)}} + 1$$

$$Qty_{T(@rest)} = \frac{3900 - 2[1(50) + 14(100)]}{150} + 1 = 7.667 \rightarrow 8$$

And,

$$Qty_{TQ} = \frac{H - H_C}{S_{TJ}} - 1 = \frac{4500 - 3900}{100} - 1 = 5$$

2. The program will compute the length of the lateral ties. Depending on what Lateral Ties configuration.

LEGEND:

$CC_C = Concrete\ Cover\ of\ the\ column (exposed\ to\ weather)$

$d_T = diameter\ of\ the\ lateral\ ties\ of\ the\ columns\ current\ floor$

$d_M = diameter\ of\ the\ main\ reinforcement\ of\ the\ columns\ current\ floor$

$H_{L(135)} = Hook\ length\ (depends\ on\ the\ table\ of\ 135\ degree\ hook\ in\ parameters)$

$S_W = Spacing\ @\ the\ width\ of\ the\ column$ $S_L = Spacing\ @\ the\ length\ of\ the\ column$

Note: (For R_L

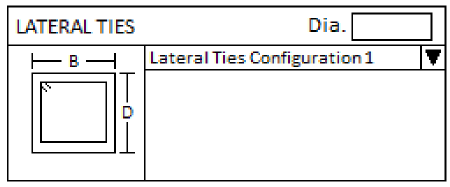
Case 1: $d_{Mb} = 10\ mm \rightarrow 16\ mm$

$$R_L = 2d_T$$

Case 2: $d_{Mb} = 20\ mm \rightarrow 25\ mm$

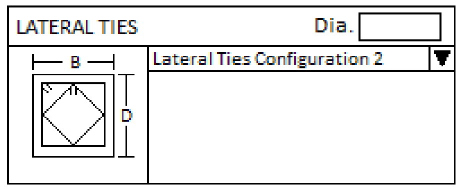
$$R_L = 2.5d_T$$

- For Lateral Ties Configuration 1



$$L_B = 2(B + D) - 8(CC_C) + 2H_{L(d)} - 3R_L$$

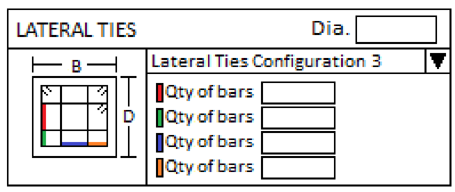
- For Lateral Ties Configuration 2



$$L_{B(a)} = 2(B + D) - 8(CC_C + d_T) + 2H_{L(135)} - 3R_L$$

$$L_{B(b)} = 4\sqrt{\left(\frac{B}{2} - CC_C\right)^2 + \left(\frac{D}{2} - CC_C\right)^2} + 2H_{L(135)} - 3R_L$$

- For Lateral Ties Configuration 3



$$S_B = \frac{B - 2(CC_C + d_T) - d_M(Qty_{BLUE} + 2Qty_{ORANGE})}{Qty_{BLUE} + 2Qty_{ORANGE} - 1}$$

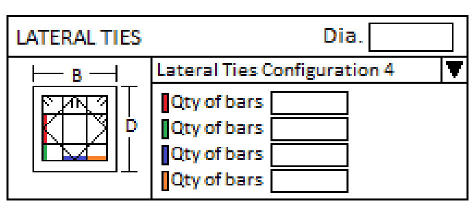
$$S_D = \frac{D - 2(CC_C + d_T) - d_M(Qty_{RED} + 2Qty_{GREEN})}{Qty_{RED} + 2Qty_{GREEN} - 1}$$

$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{B(b)} = 2D + 2[d_M Qty_{BLUE} + S_B(Qty_{BLUE} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{D(c)} = 2B + 2[d_M Qty_{RED} + S_D(Qty_{RED} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

- For Lateral Ties Configuration 4



$$S_B = \frac{B - 2(CC_C + d_T) - d_M(Qty_{BLUE} + 2Qty_{ORANGE})}{Qty_{BLUE} + 2Qty_{ORANGE} - 1}$$

$$S_D = \frac{D - 2(CC_C + d_T) - d_M(Qty_{RED} + 2Qty_{GREEN})}{Qty_{RED} + 2Qty_{GREEN} - 1}$$

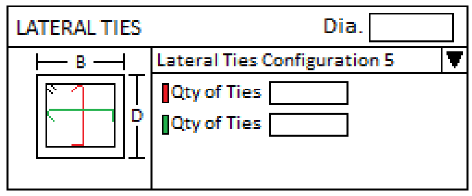
$$L_{B(a)} = 2(W + L) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{B(b)} = 4\sqrt{\left(\frac{W}{2} - CC_C\right)^2 + \left(\frac{L}{2} - CC_C\right)^2} + 2H_{L(135)} - 3R_L$$

$$L_{B(c)} = 2D + 2[d_M Qty_{BLUE} + S_B(Qty_{BLUE} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{B(d)} = 2B + 2[(d_M Qty_{RED} + S_D(Qty_{RED} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

- For Lateral Ties Configuration 5

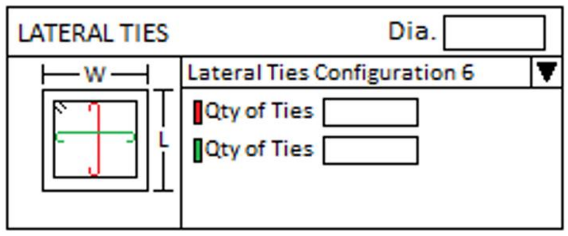


$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{B(b)} = B - 2(CC_C) + H_{L(135)} + H_{L(90)}$$

$$L_{B(c)} = D - 2(CC_C) + H_{L(135)} + H_{L(90)}$$

- For Lateral Ties Configuration 6



$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$L_{B(b)} = B - 2(CC_C) + 2H_{L(180)}$$

$$L_{B(c)} = D - 2(CC_C) + 2H_{L(180)}$$

Example:

CONCRETE COVER

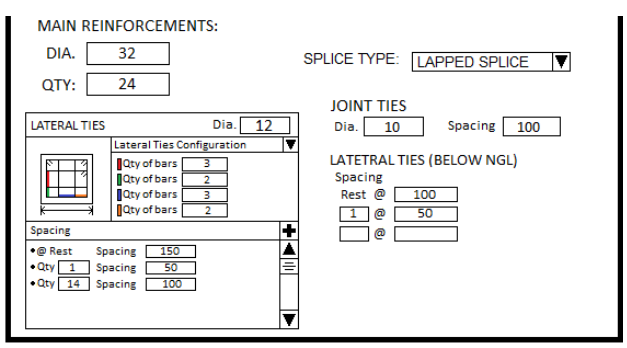
FOOTINGS	75
SUSPENDED SLAB	20
SLAB ON GRADE	40
BEAMS EXPOSED ON EARTH	40
BEAMS EXPOSED ON WEATHER	40
COLUMNS EXPOSED ON EARTH	75
COLUMNS EXPOSED ON WEATHER	40

BAR END HOOKS

MAIN BARS | STIRRUPS & TIES

BAR SIZE (DEFORMED)	L		
	90°	135°	180°
10	100	115	105
12	115	125	165
16	150	160	160
20	300	235	235
32	405	345	345

@ Ground Floor



Since the **Lateral Tie Configuration 3** is chosen. Thus,

$$S_D = \frac{B - 2(CC_C + d_T) - d_M(Qty_{BLUE} + 2Qty_{ORANGE})}{Qty_{BLUE} + 2Qty_{ORANGE} - 1} = \frac{600 - 2(40 + 12) - 32[3 + 2(2)]}{3 + 2(2) - 1}$$

$$S_D = 45.33333$$

$$S_D = \frac{D - 2(CC_C + d_T) - d_M(Qty_{RED} + 2Qty_{GREEN})}{Qty_{RED} + 2Qty_{GREEN} - 1} = \frac{600 - 2(40 + 12) - 32[3 + 2(2)]}{3 + 2(2) - 1}$$

$$S_D = 45.33333$$

Since $d_T = 12\ mm$ thus, $H_{L(135)} = 125\ mm$ & $R_L = 2d_T = 2(12) = 24$

$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600 + 600) - 8(40) + 2(125) - 3(24)$$

$$L_{B(a)} = \mathbf{2258\ mm}$$

$$L_{B(b)} = 2D + 2[d_M Qty_{BLUE} + S_B(Qty_{BLUE} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600) + 2[32(3) + 45.3333(3 - 1) + 2(12)] - 4(40) + 2(125) - 3(24)$$

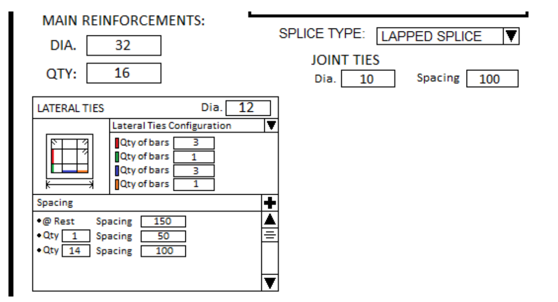
$$L_{B(b)} = 1639.333 \rightarrow round\ up\ to\ whole\ number \rightarrow \mathbf{1640\ mm}$$

$$L_{B(c)} = 2B + 2[d_M Qty_{RED} + S_D(Qty_{RED} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600) + 2[32(3) + 45.3333(3 - 1) + 2(12)] - 4(40) + 2(125) - 3(24)$$

$$L_{B(c)} = 1639.333 \rightarrow round\ up\ to\ whole\ number \rightarrow \mathbf{1640\ mm}$$

@ 2nd – 3rd Floor



Since the **Lateral Tie Configuration 3** is chosen. Thus,

$$S_B = \frac{W - 2(CC_C + d_T) - d_M(Qty_{BLUE} + 2Qty_{ORANGE})}{Qty_{BLUE} + 2Qty_{ORANGE} - 1} = \frac{600 - 2(40 + 12) - 32[3 + 2(1)]}{3 + 2(1) - 1}$$

$$S_B = 84$$

$$S_D = \frac{D - 2(CC_C + d_T) - d_M(Qty_{RED} + 2Qty_{GREEN})}{Qty_{RED} + 2Qty_{GREEN} - 1} = \frac{600 - 2(40 + 12) - 32[3 + 2(1)]}{3 + 2(1) - 1}$$

$$S_D = 84$$

Since $db_T = 12\ mm$ thus, $H_{L(135)} = 125\ mm$, $R_L = 2d_T = 2(12) = 24$

$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600 + 600) - 8(40) + 2(125) - 3(24)$$

$$L_{B(a)} = \mathbf{2258\ mm}$$

$$L_{B(b)} = 2D + 2[d_M Qty_{BLUE} + S_B(Qty_{BLUE} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600) + 2[32(3) + 84(3 - 1) + 2(12)] - 4(40) + 2(125) - 3(24)$$

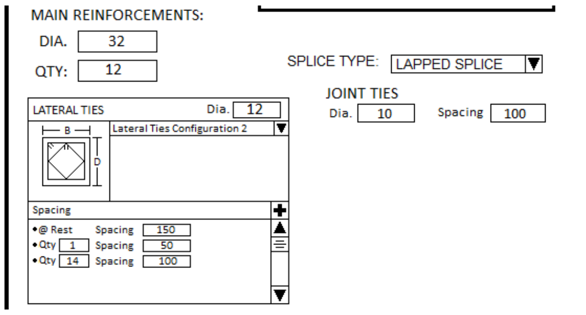
$$L_{B(b)} = \mathbf{1794\ mm}$$

$$L_{B(c)} = 2B + 2[d_M Qty_{RED} + S_D(Qty_{RED} - 1) + 2d_T] - 4(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600) + 2[32(3) + 84(3 - 1) + 2(12)] - 4(40) + 2(125) - 3(24)$$

$$L_{B(c)} = \mathbf{1794\ mm}$$

@ 4th Floor



Since the **Lateral Tie Configuration 2** is chosen. Thus,

$db_T = 12\,mm$ thus, $H_{L(135)} = 125\,mm$, $R_L = 2d_T = 2(12) = 24$

$$L_{B(a)} = 2(B + D) - 8(CC_C) + 2H_{L(135)} - 3R_L$$

$$= 2(600 + 600) - 8(40) + 2(125) - 3(24)$$

$$L_{B(a)} = \mathbf{2258\,mm}$$

$$L_{B(b)} = 4\sqrt{\left(\frac{B}{2} - CC_C\right)^2 + \left(\frac{D}{2} - CC_C\right)^2} + 2H_{L(135)} - 3R_L$$

$$= 4\sqrt{\left(\frac{600}{2} - 40\right)^2 + \left(\frac{600}{2} - 40\right)^2} + 2(125) - 3(24)$$

$$L_{B(b)} = 1648.78 \rightarrow round\ up\ to\ whole\ number \rightarrow \mathbf{1649\,mm}$$

3. The program will compute the length of the joint ties. Depending on what Lateral Ties configuration.
   - For Lateral Tie Configurations 1 – 4

$$L_{B(x)}\ of\ Qty_{TQ} = L_{B(x)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

   - For Lateral Tie Configuration 5

$$L_{B(a)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$L_{B(b)}\ of\ Qty_{TQ} = L_{B(b)}\ of\ Qty_T - \left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - \left(H_{L(90)}\ of\ Qty_T - H_{L(90)}\ of\ Qty_{TQ}\right)$$

$$L_{B(c)}\ of\ Qty_{TQ} = L_{B(c)}\ of\ Qty_T - \left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - \left(H_{L(90)}\ of\ Qty_T - H_{L(90)}\ of\ Qty_{TQ}\right)$$

   - For Lateral Tie Configuration 6

$$L_{B(a)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$L_{B(b)}\ of\ Qty_{TQ} = L_{B(b)}\ of\ Qty_T - 2\left(H_{L(180)}\ of\ Qty_T - H_{L(180)}\ of\ Qty_{TQ}\right)$$

$$L_{B(c)}\ of\ Qty_{TQ} = L_{B(c)}\ of\ Qty_T - 2\left(H_{L(180)}\ of\ Qty_T - H_{L(180)}\ of\ Qty_{TQ}\right)$$

Where: For R_V

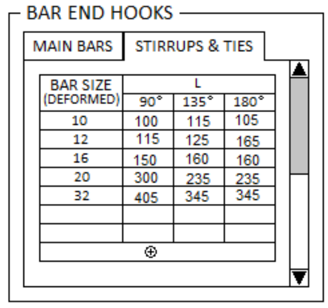
Case 1: $d_{TQ} = 10\,mm \rightarrow 16\,mm$

$$R_V = 2d_{TQ}$$

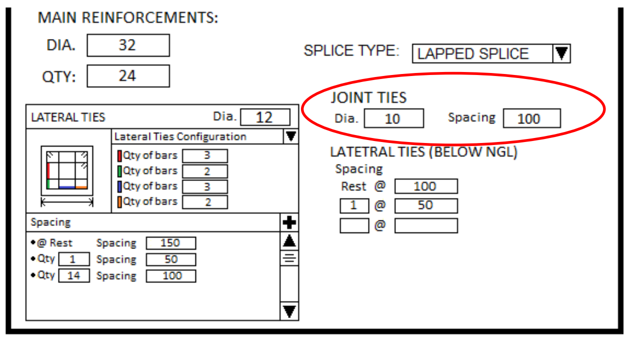
Case 2: $d_{TQ} = 20\,mm \rightarrow 25\,mm$

$$R_V = 2.5d_{TQ}$$

Example:



@ Ground Floor



Since the **Lateral Tie Configuration 3** is chosen. Thus,

Since $d_{TQ} = 10\ mm$ thus, $H_{L(135)}\ of\ \ Qty_{TQ} = 115\ mm, R_V = 2d_{TQ} = 2(10) = 20$

$$L_{B(a)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 2258 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(a)}\ of\ Qty_{TQ} = \mathbf{2250\ mm}$$

$$L_{B(b)}\ of\ Qty_{TQ} = L_{B(b)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 1640 - 2(125 - 115) - 3(20) + 3(24)$$

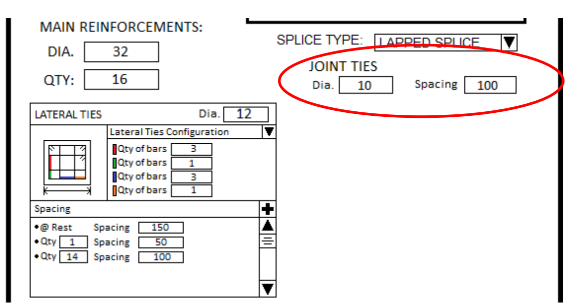
$$L_{B(b)}\ of\ Qty_{TQ} = \mathbf{1632\ mm}$$

$$L_{B(c)}\ of\ Qty_{TQ} = L_{B(b)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 1640 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(c)}\ of\ Qty_{TQ} = \mathbf{1632\ mm}$$

@ 2nd – 3rd Floor



Since the **Lateral Tie Configuration 3** is chosen. Thus,

Since $db_{TQ} = 10\ mm$ thus, $H_{L(135)}\ of\ \ Qty_{TQ} = 115\ mm,\ R_V = 2d_{TQ} = 2(10) = 20$

$$L_{B(a)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 2258 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(a)}\ of\ Qty_{TQ} = \mathbf{2250\ mm}$$

$$L_{B(b)}\ of\ Qty_{TQ} = L_{B(b)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 1794 - 2(125 - 115) - 3(20) + 3(24)$$

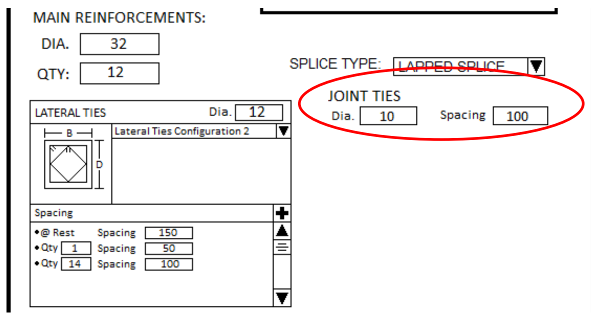
$$L_{B(b)} of\ Qty_{TQ} = \mathbf{1786\ mm}$$

$$L_{B(c)}\ of\ Qty_{TQ} = L_{B(c)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 1794 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(c)}\ of\ Qty_{TQ} = \mathbf{1786\ mm}$$

@ 4th Floor



Since the **Lateral Tie Configuration 3** is chosen. Thus,

Since $db_{TQ} = 10\ mm$ thus, $H_{L(135)}\ of\ Qty_{TQ} = 115\ mm$, $R_V = 2d_{TQ} = 2(10) = 20$

$$L_{B(a)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 2258 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(a)}\ of\ Qty_{TQ} = \mathbf{2250\ mm}$$

$$L_{B(b)}\ of\ Qty_{TQ} = L_{B(a)}\ of\ Qty_T - 2\left(H_{L(135)}\ of\ Qty_T - H_{L(135)}\ of\ Qty_{TQ}\right) - 3R_V + 3R_L$$

$$= 1649 - 2(125 - 115) - 3(20) + 3(24)$$

$$L_{B(b)}\ of\ Qty_{TQ} = \mathbf{1641\ mm}$$

4. The program will determine the respective manufactured bars and no. of manufactured pcs.

LEGEND:

$Qty_{Pn} = no. of\ pcs.\ produced$ $\quad$ $Qty_{Mn} = no. of\ manufactured\ pcs.$

$L_M = Available\ Manufactured\ Reinforcement\ Length$

$L_W = Wastage\ Length$ $\quad$ $L_E = Excess\ manufactured$ bar length

$L_{CBn} = Chosen\ Manufactured\ Bar\ Length$

$$Qty_{Pn} = \frac{L_M}{(L_B\ of\ Qty_T)\ or\ (L_B\ of\ Qty_{TQ})}$$

- For Ground Floor

  Note: If $\sum Qty_{TE(x)} = 0$ thus, $\sum Qty_{Tx}$ will replace $\sum Qty_{TE(x)}$.

  If the Lateral Ties Configuration 1-4

$$Qty_{Mn} = \frac{\left(\sum Qty_{TE(x)} + \sum Qty_{Tx} + Qty_{T(@rest)}\right)\ or\ Qty_{TQ}}{Qty_{Pn}} \cdot Qty_{Column}$$

  If the Lateral Ties Configuration 5 & 6

$$Qty_{Mn} = \frac{\left(\sum Qty_{TE(x)} + \sum Qty_{Tx} + Qty_{T(@rest)}\right)\ or\ Qty_{TQ}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\ for\ L_{B(a)}$$

$$Qty_{Mn} = \frac{[(\sum Qty_{TE(x)} + \sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}]Qty_{GREEN}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\, for\ L_{B(b)}$$

$$Qty_{Mn} = \frac{[(\sum Qty_{TE(x)} + \sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}]Qty_{RED}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\, for\ L_{B(c)}$$

- For Upper Floors

  If the Lateral Ties Configuration 1-4

$$Qty_{Mn} = \frac{(2\sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}}{Qty_{Pn}} \cdot Qty_{Column}$$

  If the Lateral Ties Configuration 5-6

$$Qty_{Mn} = \frac{(2\sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\, for\ L_{B(a)}$$

$$Qty_{Mn} = \frac{[(2\sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}]Qty_{GREEN}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\, for\ L_{B(b)}$$

$$Qty_{Mn} = \frac{[(2\sum Qty_{Tx} + Qty_{T(@rest)})\ or\ Qty_{TQ}]Qty_{RED}}{Qty_{Pn}} \cdot Qty_{Column} \quad \vdots\, for\ L_{B(c)}$$

Then,

$$L_W = [Qty_{Pn} - Qty_{Pn}\ (round\ down\ into\ whole\ number)] \times L_B$$

$$L_E\ (m) = [Qty_{Mn}(round\ up) - Qty_{Mn}] \times L_M$$

And

$$Total\ Wasage\ = L_E + L_W[Qty_{Mn}\ (round\ down\ into\ whole\ number)]$$

Example:

@ Ground Floor

- **For Lateral Ties**

$$\sum_{1}^{3} Qty_{TE(x)} = (13 + 1 + 0) = 14\ \ \&\ \ \sum_{1}^{2} Qty_{T(x)} + Qty_{T(@rest)} = (1 + 14) + 9 = 24$$

a) $L_{B(a)}$

L [M]	Qty [T]	Qty [TE]	Total	L [B(a)]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	24	14	38	2.258	13	2.66	2	240.5	241	1.484	3.00	359.160
7.5						3.32	3	160.3	161	0.726	5.00	121.160
10.5						4.65	4	120.3	121	1.468	7.88	184.035
12						5.31	5	96.2	97	0.710	9.60	77.760

Thus $L_{CM(a)} = 12$ and $Qty_{M(a)} = 97$

b) $L_{B(b)}$

L [M]	Qty [T]	Qty [TE]	Total	L [B(b)]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	24	14	38	1.64	13	3.66	3	164.67	165	1.080	2.00	179.12
7.5						4.57	4	123.50	124	0.940	3.75	119.37
10.5						6.40	6	82.33	83	0.660	7.00	61.12
12						7.32	7	70.57	71	0.520	5.14	41.54

Thus $L_{CM(b)} = 12$ and $Qty_{M(b)} = 71$

c) $L_{B(c)}$

L [M]	Qty [T]	Qty [TE]	Total	L [B(a)]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	24	14	38	1.64	13	3.66	3	164.67	165	1.080	2.00	179.12
7.5						4.57	4	123.50	124	0.940	3.75	119.37
10.5						6.40	6	82.33	83	0.660	7.00	61.12
12						7.32	7	70.57	71	0.520	5.14	41.54

Thus $L_{CM(c)} = 12$ and $Qty_{M(c)} = 71$

- **For Joint Ties**

$$Qty_{TQ} = 6$$

a) $L_{B(a)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	2.25	13	2.67	2	39	39	1.500	0	58.500
7.5				3.33	3	26	26	0.750	0	19.500
10.5				4.67	4	19.5	20	1.500	5.25	33.750
12				5.33	5	15.6	16	0.750	4.8	16.050

Thus $L_{CM(a)} = 12$ and $Qty_{M(a)} = 16$

b) $L_{B(b)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	1.632	13	3.68	3	26	26	1.104	0	28.704
7.5				4.60	4	19.5	20	0.972	3.75	22.218
10.5				6.43	6	13	13	0.708	0	9.204
12				7.35	7	11.14	12	0.576	10.2857	16.622

Thus $L_{CM(b)} = 10.5$ and $Qty_{M(b)} = 13$

c) $L_{B(c)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	1.632	13	3.68	3	26	26	1.104	0	28.704
7.5				4.60	4	19.5	20	0.972	3.75	22.218
10.5				6.43	6	13	13	0.708	0	9.204
12				7.35	7	11.14	12	0.576	10.2857	16.622

Thus $L_{CM(c)} = 10.5$ and $Qty_{M(c)} = 13$

@ 2nd Floor

- **For Lateral Ties**

Since there is no $Qty_{TE(x)}$ thus, $\sum Qty_{T(x)}$ will be multiply in 2

$$2\sum Qty_{T(x)} + Qty_{T(@rest)} = 2(1 + 14) + (-2) = 28$$

a) $L_{B(a)}$

L [M]	Qty [T]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	28	2.258	13	2.66	2	182	182	1.484	0	270.09
7.5				3.32	3	121.3	122	0.726	5	92.85
10.5				4.65	4	91	91	1.468	0	133.59
12				5.31	5	72.8	73	0.710	2.4	53.52

Thus $L_{CM(a)} = 12$ and $Qty_{M(c)} = 73$

b) $L_{B(b)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	28	1.794	13	3.34	3	121.3	122	0.618	4	78.78
7.5				4.18	4	91	91	0.324	0	29.48
10.5				5.85	5	72.8	73	1.530	2.1	112.26
12				6.69	6	60.67	61	1.236	4	78.16

Thus $L_{CM(b)} = 7.5$ and $Qty_{M(b)} = 91$

c) $L_{B(c)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	28	1.794	13	3.34	3	121.3	122	0.618	4	78.78
7.5				4.18	4	91	91	0.324	0	29.48
10.5				5.85	5	72.8	73	1.530	2.1	112.26
12				6.69	6	60.67	61	1.236	4	78.16

Thus $L_{CM(c)} = 7.5$ and $Qty_{M(c)} = 91$

- **For Joint Ties**

$$Qty_{TQ} = 6$$

a) $L_{B(a)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	2.25	13	2.67	2	39	39	1.500	0	58.500
7.5				3.33	3	26	26	0.750	0	19.500
10.5				4.67	4	19.5	20	1.500	5.25	33.750
12				5.33	5	15.6	16	0.750	4.8	16.050

Thus $L_{CM(a)} = 12$ and $Qty_{M(a)} = 16$

b) $L_{B(b)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	1.786	13	3.36	3	26	26	0.642	0	16.692
7.5				4.20	4	19.5	20	0.356	3.75	10.514
10.5				5.88	5	15.6	16	1.570	4.2	27.750
12				6.72	6	13	13	1.284	0	16.692

Thus $L_{CM(b)} = 7.5$ and $Qty_{M(b)} = 20$

c) $L_{B(c)}\ of\ Qty_{TQ}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	6	1.786	13	3.36	3	26	26	0.642	0	16.692
7.5				4.20	4	19.5	20	0.356	3.75	10.514
10.5				5.88	5	15.6	16	1.570	4.2	27.750
12				6.72	6	13	13	1.284	0	16.692

Thus $L_{CM(c)} = 7.5$ and $Qty_{M(c)} = 20$

@ 4th Floor

- For Lateral Ties

Since there is no $Qty_{TE(x)}$ thus, $\sum Qty_{T(x)}$ will be multiply in 2

$$2\sum Qty_{T(x)} + Qty_{T(@rest)} = 2(1 + 14) + 8 = 38$$

a) $L_{B(a)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	38	2.258	13	2.66	2	247	247	1.484	0	366.55
7.5				3.32	3	164.7	165	0.726	2.5	121.56
10.5				4.65	4	123.5	124	1.468	5.25	185.81
12				5.31	5	98.8	99	0.710	2.40	71.98

Thus $L_{CM(a)} = 12$ and $Qty_{M(a)} = 99$

b) $L_{B(b)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	38	1.649	13	3.64	3	164.7	165	1.053	2	174.692
7.5				4.55	4	123.5	124	0.904	3.75	114.942
10.5				6.37	6	82.33	83	0.606	7	56.692
12				7.28	7	70.57	71	0.457	5.14	37.133

Thus $L_{CM(b)} = 12$ and $Qty_{M(b)} = 71$

- For Joint Ties

$$Qty_{TQ} = 5$$

a) $L_{B(a)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	5	2.25	13	2.67	2	32.5	33	1.500	3	51.000
7.5				3.33	3	21.67	22	0.750	2.5	18.250
10.5				4.67	4	16.25	17	1.500	7.875	31.875
12				5.33	5	13	13	0.750	0	9.750

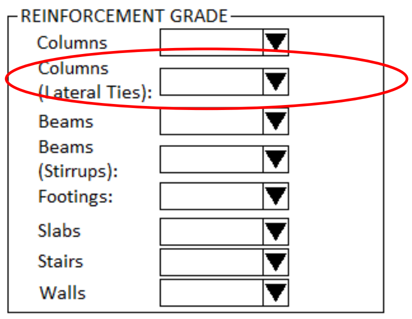
Thus $L_{CM(4a)} = 12$ and $Qty_{M(4a)} = 13$

b) $L_{B(a)}$

L [M]	Qty [TQ]	L [B]	Qty (Column)	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	5	1.641	13	3.66	3	21.67	22	1.077	2	24.617
7.5				4.57	4	16.25	17	0.936	5.625	20.601
10.5				**6.40**	**6**	**10.83**	**11**	**0.654**	**1.75**	**8.290**
12				7.31	7	9.286	10	0.513	8.57	13.188

Thus $L_{CM(4b)} = 10.5$ and $Qty_{M(4b)} = 11$

5. The program will compute the price of the Lateral Ties.



$$Price_{Total} = \sum Qty_{M(Lateral\ Ties)} Price_{M(Lateral\ Ties)} + \sum Qty_{M(Joint\ Ties)} Price_{M(Joint\ Ties)}$$

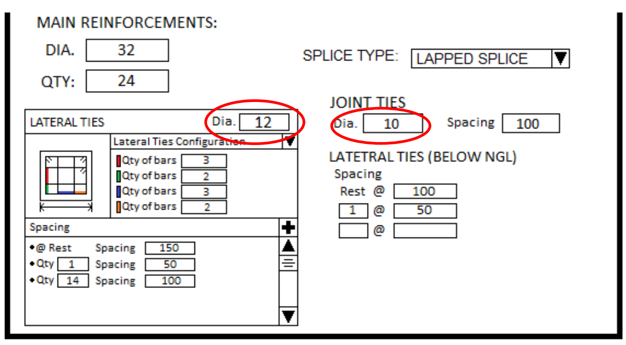
Where:

$$Price_M = Price\ of\ the\ steel\ reinforcement\ based\ on\ Pricing$$

$$= Sorted\ through\ Reinforcement\ Grade, diameter, and\ Manufactured\ Length$$

Example

@ Ground Floor



- Lateral Ties

$$d_{LT} = 12\ mm$$

Rebar GRADE 40 (⌀12mm) [6m]- **P 234.43**

Rebar GRADE 40 (⌀12mm) [7.5m]- **P 293.04**

Rebar GRADE 40 (⌀12mm) [9m]- **P 351.65**

Rebar GRADE 40 (⌀12mm) [10.5m]- **P 410.26**

Rebar GRADE 40 (⌀12mm) [12m]- **P 468.86**

$$Qty_{M(a)} = 97\ \&\ L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\ 468.86$$

$$Qty_{M(b)} = 71\ \&\ L_{CM(b)} = 12\ m \therefore Price_{M(b)} = ₱\ 468.86$$

$$Qty_{M(c)} = 71\ \&\ L_{CM(c)} = 12\ m \therefore Price_{M(c)} = ₱\ 468.86$$

$$\sum Qty_{M(LT)} Price_{M(LT)} = 97(468.86) + 71(468.86) + 71(468.86) = ₱\ 112{,}058.54$$

- Joint Ties

$$d_{JT} = 10\ mm$$

Rebar GRADE 40 (⌀10mm) [6m]- **P 162.62**

Rebar GRADE 40 (⌀10mm) [7.5m]- **P 203.28**

Rebar GRADE 40 (⌀10mm) [9m]- **P 243.94**

Rebar GRADE 40 (⌀10mm) [10.5m]- **P 284.59**

Rebar GRADE 40 (⌀10mm) [12m]- **P 325.25**

$$Qty_{M(a)} = 16\ \&\ L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\ 325.25$$

$$Qty_{M(b)} = 13 \,\&\, L_{CM(b)} = 10.5\ m \therefore Price_{M(b)} = ₱\ 284.59$$

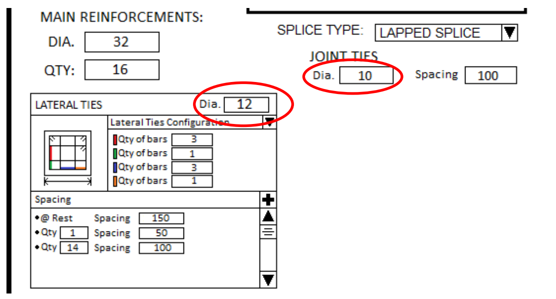
$$Qty_{M(c)} = 13 \,\&\, L_{CM(c)} = 10.5\ m \therefore Price_{M(c)} = ₱\ 284.59$$

$$\sum Qty_{M(JT)} Price_{M(JT)} = 16(325.25) + 13(284.59) + 13(284.59) = ₱\ 12{,}603.34$$

- Total

$$Price_{Total} = 112{,}058.54 + 12{,}603.34 = ₱\ \mathbf{124{,}660.88}$$

@ 2nd – 3rd Floor



- Lateral Ties

$$d_{LT} = 12\ mm$$

Rebar GRADE 40 (⌀12mm) [6m]- **P 234.43**

Rebar GRADE 40 (⌀12mm) [7.5m]- **P 293.04**

Rebar GRADE 40 (⌀12mm) [9m]- **P 351.65**

Rebar GRADE 40 (⌀12mm) [10.5m]- **P 410.26**

Rebar GRADE 40 (⌀12mm) [12m]- **P 468.86**

$$Qty_{M(a)} = 73 \,\&\, L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\ 468.86$$

$$Qty_{M(b)} = 91 \,\&\, L_{CM(b)} = 7.5\ m \therefore Price_{M(b)} = ₱\ 293.04$$

$$Qty_{M(c)} = 91 \,\&\, L_{CM(c)} = 7.5\ m \therefore Price_{M(c)} = ₱\ 293.04$$

$$\sum Qty_{M(LT)} Price_{M(LT)} = 73(468.86) + 91(293.04) + 91(293.04) = ₱\ 87{,}560.06$$

- Joint Ties

$$d_{JT} = 10\ mm$$

Rebar GRADE 40 (⌀10mm) [6m]- **P 162.62**

Rebar GRADE 40 (⌀10mm) [7.5m]- **P 203.28**

Rebar GRADE 40 (⌀10mm) [9m]- **P 243.94**

Rebar GRADE 40 (⌀10mm) [10.5m]- **P 284.59**

Rebar GRADE 40 (⌀10mm) [12m]- **P 325.25**

$$Qty_{M(a)} = 16 \,\&\, L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\ 325.25$$

$$Qty_{M(b)} = 20 \,\&\, L_{CM(b)} = 7.5\ m \therefore Price_{M(b)} = ₱\ 203.28$$

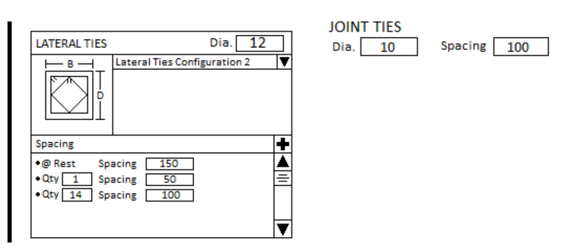
$$Qty_{M(c)} = 20 \,\&\, L_{CM(c)} = 7.5\ m \therefore Price_{M(c)} = ₱\ 203.28$$

$$\sum Qty_{M(JT)} Price_{M(JT)} = 16(325.25) + 20(203.28) + 20(203.28) = ₱\ 13{,}335.2$$

- Total

$$Price_{Total} = 87{,}560.06 + 13{,}335.2 = ₱\ \mathbf{100{,}895.26}$$

@ 4th Floor



- Lateral Ties

$$d_{LT} = 12\ mm$$

Rebar GRADE 40 (⌀12mm) [6m]- **P 234.43**

Rebar GRADE 40 (⌀12mm) [7.5m]- **P 293.04**

Rebar GRADE 40 (⌀12mm) [9m]- **P 351.65**

Rebar GRADE 40 (⌀12mm) [10.5m]- **P 410.26**

Rebar GRADE 40 (⌀12mm) [12m]- **P 468.86**

$$Qty_{M(a)} = 99 \;\&\; L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\,468.86$$

$$Qty_{M(b)} = 71 \& L_{CM(b)} = 12\ m \therefore Price_{M(b)} = ₱\,468.86$$

$$\sum Qty_{M(LT)} Price_{M(LT)} = 99(468.86) + 71(468.86) = ₱\,79{,}706.2$$

- Joint Ties

$$d_{JT} = 10\ mm$$

Rebar GRADE 40 (⌀10mm) [6m]- **P 162.62**

Rebar GRADE 40 (⌀10mm) [7.5m]- **P 203.28**

Rebar GRADE 40 (⌀10mm) [9m]- **P 243.94**

Rebar GRADE 40 (⌀10mm) [10.5m]- **P 284.59**

Rebar GRADE 40 (⌀10mm) [12m]- **P 325.25**

$$Qty_{M(a)} = 13 \;\&\; L_{CM(a)} = 12\ m \therefore Price_{M(a)} = ₱\,325.25$$

$$Qty_{M(b)} = 11 \;\&\; L_{CM(b)} = 10.5\ m \therefore Price_{M(b)} = ₱\,284.59$$

$$\sum Qty_{M(JT)} Price_{M(JT)} = 13(325.25) + 11(284.59) = ₱\,7{,}358.74$$

- Total

$$Price_{Total} = 79{,}706.2 + 7{,}358.74 = ₱\,\mathbf{87{,}064.94}$$

6. The program will compute the weight of the reinforcement.

$$W = \omega\left[\sum L_{CM} Qty_M\right] W_D$$

Where:

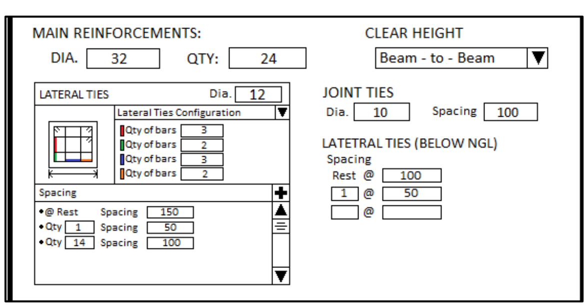
$$\omega = 1.0\ (for\ the\ mean\ time)$$

Example:

WEIGHT

BAR SIZE (Diameter)	kg / m
6 mm	0.222
8 mm	0.395
10 mm	0.616
12 mm	0.888
16 mm	1.597
20 mm	2.466
25 mm	3.854
28 mm	4.833
32 mm	6.313
36 mm	7.991
40 mm	9.864
44 mm	11.926
50 mm	15.413
56 mm	19.318

@Ground Floor



- Lateral Ties

  Since the diameter for lateral ties is **12 mm**. Thus, the $W_D = 0.888\ kg/m$

$$W_{LT} = \omega\left[\sum L_{CM} Qty_M\right] W_D = \omega\left[\sum_{a}^{c} L_{CM} Qty_M\right] W_D$$

$$W_{LT} = 1.0 \cdot [12(97) + 12(71) + 12(71)] \cdot 0.888 = 2546.78\ kg$$

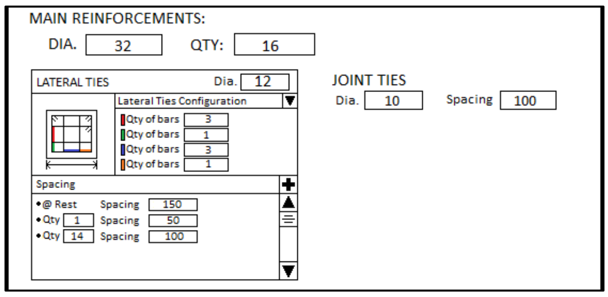
- Joint Ties

Since the diameter for lateral ties is **10 mm**. Thus, the $W_D = 0.616\ kg/m$

$$W_{JT} = \omega\left[\sum L_{CM}Qty_M\right]W_D = \omega\left[\sum_a^c L_{CM}Qty_M\right]W_D$$

$$W_{JT} = 1.0 \cdot [12(16) + 10.5(13) + 10.5(13)] \cdot 0.616 = 286.44\ kg$$

@ 2nd – 3rd Floor



- Lateral Ties

Since the diameter for lateral ties is **12 mm**. Thus, the $W_D = 0.888\ kg/m$

$$W_{LT} = \omega\left[\sum L_{CM}Qty_M\right]W_D = \omega\left[\sum_a^c L_{CM}Qty_M\right]W_D$$

$$W_{LT} = 1.0 \cdot [12(73) + 7.5(91) + 7.5(91)] \cdot 0.888 = 1990.008\ kg$$

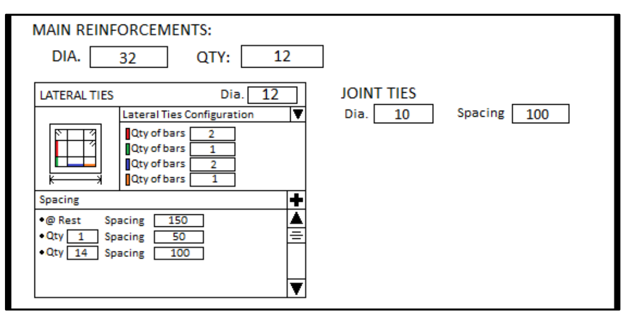
- Joint Ties

Since the diameter for lateral ties is **10 mm**. Thus, the $W_D = 0.616\ kg/m$

$$W_{JT} = \omega\left[\sum L_{CM}Qty_M\right]W_D = \omega\left[\sum_a^c L_{CM}Qty_M\right]W_D$$

$$W_{JT} = 1.0 \cdot [12(16) + 7.5(20) + 7.5(20)] \cdot 0.616 = 303.072\ kg$$

@ 4th Floor



- Lateral Ties

Since the diameter for lateral ties is **12 mm**. Thus, the $W_D = 0.888\ kg/m$

$$W_{LT} = \omega\left[\sum L_{CM}Qty_M\right]W_D = \omega\left[\sum_a^c L_{CM}Qty_M\right]W_D$$

$$W_{LT} = 1.0 \cdot [12(99) + 12(71)] \cdot 0.888 = 1811.52\ kg$$

- Joint Ties

Since the diameter for lateral ties is **10 mm**. Thus, the $W_D = 0.616\ kg/m$

$$W_{JT} = \omega\left[\sum L_{CM}Qty_M\right]W_D = \omega\left[\sum_a^c L_{CM}Qty_M\right]W_D$$

$$W_{JT} = 1.0 \cdot [12(13) + 10.5(11)] \cdot 0.616 = 167.244\ kg$$

7. The program will compute the total weight of the ties in the column.

$$W_{Total} = W_{LT} + W_{JT}$$

Example:

@ Ground Floor

$$W_{Total} = W_{LT} + W_{JT}$$
$$W_{Total} = 2546.78 + 286.44$$
$$W_{Total} = \mathbf{2,833.22\ kg}$$

@ 2nd – 3rd Floor

$$W_{Total} = W_{LT} + W_{JT}$$
$$W_{Total} = 1990.008 + 303.072$$
$$W_{Total} = \mathbf{2,293.08\ kg}$$

@ 4th Floor

$$W_{Total} = W_{LT} + W_{JT}$$
$$W_{Total} = 1811.52 + 167.244$$
$$W_{Total} = \mathbf{1,978.764\ kg}$$

8. The program will determine the Labor Price for the Lateral Ties of Columns

CATEGORY: LABOR RATE (REBAR **PER KG**) - 9 items

FOOTING [KG]**- P 17**
WALL FOOTING [KG]**- P 17**
COLUMN [KG]**- P 15**
STAIRS [KG]**- P 15**
BEAM [KG]**- P 16**
FOOTING TIE BEAM [KG] - **P 16**
SLAB ON GRADE [KG]- **P 17**
SUSPENDED SLAB [KG]**- P 18**
WALLS [KG]- **P 16**

$$Price_{Labor} = W \cdot L_R$$

Example:

$$L_R = ₱\,15$$

@ Ground Floor

$$Price_{Labor} = W \cdot L_R$$
$$Price_{Labor} = 2{,}833.22(15)$$
$$Price_{Labor} = ₱\,\mathbf{42,498.30}$$

@ 2nd – 3rd Floor

$$Price_{Labor} = W \cdot L_R$$
$$Price_{Labor} = 2{,}293.08(15)$$
$$Price_{Labor} = ₱\,\mathbf{34,396.20}$$

@ 4th Floor

$$Price_{Labor} = W \cdot L_R$$
$$Price_{Labor} = 1{,}978.764(15)$$
$$Price_{Labor} = ₱\,\mathbf{29,681.46}$$