REFERENCE

ADD STRUCTURAL MEMBER

STRUCURAL MEMBER: FOOTING (WALL)

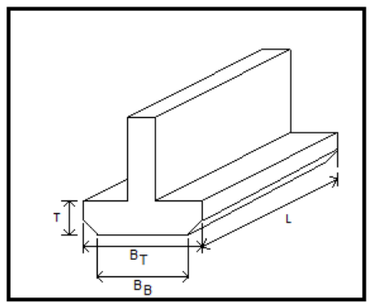
NAME: WF-1

FOOTING TYPE: WALL FOOTING (Trapezoidal)

UNIT: mm

DIMENSIONS

L	30440
L_{F-F}	22190
B_T	500
B_U	300
T	200
D	200
QUANTITY	1



LONGITUDINAL REINFORCEMENT		TRANSVERSE REINFORCEMENT	
DIAMETER	10	DIAMETER	10
QUANTITY	5	QUANTITY	
SPACING		SPACING	300
HOOK TYPE	0	HOOK TYPE	0

Parameters

Unit: Meter

Earthworks | Formworks | Concrete | Reinforcements | Paint | Tiles

CONCRETE MIX

FOOTINGS | COLUMNS | BEAMS | SLABS | WALLS

CONCRETE GRADE

GRAVEL TYPE

READY MIX: 4000 PSI @ 28 Days

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

Parameters

Unit: Millimeter

Earthworks | Formworks | Concrete | Reinforcements | Paint | Tiles

LAP SPLICES LENGTH

TENSION BARS | COMPRESSION BARS

BAR SIZES (DEFORMED MM)	f'c 20.7 Lapped Splice	f'c 27.6 Lapped Splice
10	300	300
12	300	300
16	400	400
20	550	500
25	800	750
28	1000	850
32	1300	1100

REINFORCEMENT GRADE

Columns	Grade 60
Columns (Lateral Ties):	Grade 40
Beams	Grade 60
Beams (Stirrups):	Grade 40
Footings:	Grade 60
Slabs	Grade 40
Stairs	
Walls	

BAR END HOOKS

MAIN BARS | STIRRUPS & TIES

BAR SIZE (DEFORMED)	L 90°	135°	180°
10	150		125
12	200		150
16	250		175
20	300		200
25	450		230
28	550		350
32	600		450

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

MANUFACTURED LENGTH

COLUMN FOOTING	6.0	7.5	9.0	10.5	12.0	13.5	15.0
WALL FOOTING	6.0	7.5	9.0	10.5	12.0	13.5	15.0
COLUMN	6.0	7.5	9.0	10.5	12.0	13.5	15.0
BEAM/GIRDER	6.0	7.5	9.0	10.5	12.0	13.5	15.0
WALL	6.0	7.5	9.0	10.5	12.0	13.5	15.0
SLAB ON GRADE	6.0	7.5	9.0	10.5	12.0	13.5	15.0
SUSPENDED SLAB	6.0	7.5	9.0	10.5	12.0	13.5	15.0
STAIRS	6.0	7.5	9.0	10.5	12.0	13.5	15.0

AVAILABLE

NOT-AVAILABLE

STEPS

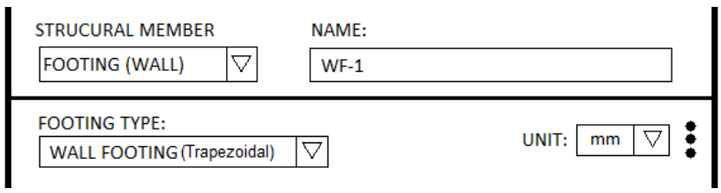
1. Determine the Concrete Cover of Wall Footing (CC_{WF})
   - Case 1: $Footing\ Type: Wall\ Footing\ (Trapezoidal)$

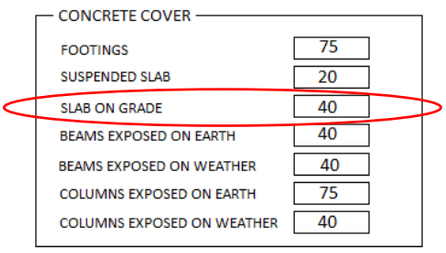
$$CC_{WF} = \text{SLAB ON GRADE} \quad 40$$

   - Case 2: $Footing\ Type: Wall\ Footing\ (Rectangular)$

$$CC_{WF} = \text{BEAMS EXPOSED ON EARTH} \quad 40$$

   Example





$$CC_{WF} = 40$$

2. Determine the quantity of bars of the footing.

   LEGEND:

   $Qty_F = Quantity\ of\ footing$

   $Qty_L = Quantity\ of\ Longitudinal\ Reinforcement$

   $Qty_T = Quantity\ of\ Transverse\ Reinforcement$

   $S_T = Spacing\ of\ Transverse\ Rebar$

   $F_{B_T} = Footing\ Top\ Base\ (Trapezoidal)$

   $F_L = Footing\ Length$

   $F_B = Footing\ Base\ (Regular)$

   $S_L = Spacing\ of\ Longitudinal\ Rebar$

If there is no input on the quantity box, but only on the spacing.

$$Qty_L = Qty_F \left[Round\ up\ to\ whole\ number \left(\frac{(F_B\ or\ F_{B_T}) - 2CC_F}{S_L} + 1 \right) \right]$$

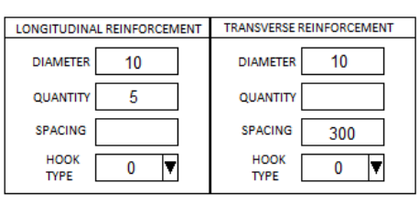
$$Qty_T = Qty_F \left[Round\ up\ to\ whole\ number \left(\frac{F_L - 2CC_F}{S_T} + 1 \right) \right]$$

If there is an input on the quantity box.

$$Qty_L = Qty_F \cdot Qty_{L(input)}$$

$$Qty_T = Qty_F \cdot Qty_{T(input)}$$

Example:



Since there is an input on the quantity box on the longitudinal reinforcement. Thus,

$$Qty_L = Qty_F \cdot Qty_{L(input)} = 1 \cdot 5 = 10\ pcs$$

Since there is no input on the quantity box on the transverse reinforcement. Thus,

$$Qty_T = Qty_F \left(\frac{F_L - 2CC_{WF}}{S_T} + 1 \right) = 1 \left(\frac{30440 - 2(40)}{300} + 1 \right) = 1(102.2) = 1(103) = 103\ pcs$$

3. The program will compute the required length of each quantity. (The answer must be converted to meters)

LEGEND:

$L_B\ of\ Qty_L = Bar\ length\ of\ longitudinal\ reinforcement$

$L_B\ of\ Qty_U = Bar\ length\ of\ upper\ reinforcement$

$L_B\ of\ Qty_T = Bar\ length\ of\ transverse\ reinforcement$

$H_L = Hook\ length\ (Use\ the\ what\ type\ of\ bar\ hook\ on\ the\ main\ bars)$

$$F_{B_B} = Footing\ Bottom\ Base\ (Trapezoidal)$$

Note:

If the hook type is 0 then, $H_L = 0$

For Longitudinal Reinforcement

$$L_B\ of\ Qty_L = F_L - 2CC_F + 2H_L$$

For Transverse Reinforcement

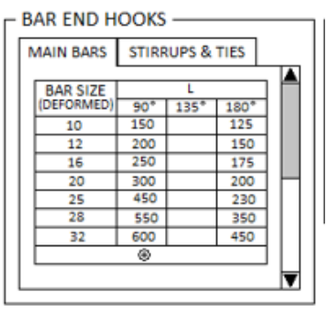
If the Wall Footing is Regular

$$L_B\ of\ Qty_T = F_W - 2CC_F + 2H_L$$

If the Wall Footing is Trapezoidal

$$L_B\ of\ Qty_T = \left[F_{B_B} - 2CC_F \tan(22.5)\right] + 600 + \frac{F_{B_T} - F_{B_B}}{\cos(45)} + 2H_L$$

Example:



$$L_B\ of\ Qty_L = F_L - 2CC_F + 2H_L$$
$$= 30440 - 2(40) + 2(0)$$
$$L_B\ of\ Qty_L = 30360\ mm = 30.36\ m$$

$$L_B\ of\ Qty_T = F_{B_B} + 2CC_F[\cos(45) - \tan(22.5)] + \frac{F_{B_T} - F_{B_B}}{\cos(45)} + 2H_L$$
$$= [300 - 2(40)\tan(22.5)] + 600 + \frac{500-300}{\cos(45)} + 2(0)$$
$$L_B\ of\ Qty_T = 1149.71\ mm = 1.14971\ m$$

4. The program will check the available manufactured bar lengths. And will compute the following equations to determine the manufactured bar length and its corresponding manufactured quantity.

LEGEND:

$Qty_P = Produced\ Quantity$ $\qquad$ $L_M = Available\ Manufactured\ Bar\ Length$

$Qty_M = Manufactured\ Quantity$ $\qquad$ $L_W = Wastage\ Length$

$Qty_M = Extra\ Quantity$ $\qquad$ $L_E = Excess\ Length$

$$S_L = Splice\ Length\ (Tension\ Table\ in\ the\ Parameters)$$

For Longitudinal Reinforcement

- If $L_B\ of\ \ Qty_L < Largest\ L_M$

$$Qty_P = \frac{L_M}{L_B\ of\ \ Qty_L}$$

$If\ \boldsymbol{Qty_P < 1}$

$$L_W = 0$$

$Else$

$$L_W = L_M - (L_B\ of\ Qty_L) \cdot Qty_P (round\ down\ into\ whole\ number)$$

$$Qty_M = \frac{Qty_L}{Qty_P (round\ down\ to\ whole\ number)}$$

$$L_E = [Qty_M (round\ up\ to\ whole\ number) - Qty_M] \cdot L_M$$

And

$$Total\ Wastage = L_E + L_W [Qty_M (round\ down\ to\ whole\ number)]$$

The manufactured bar length that has the smallest total wastage will be the chosen manufactured bar length and its corresponding manufactured quantity

- If $L_B\ of\ \ Qty_L > Largest\ L_M$

$$Qty_M = \frac{L_B\ of\ \ Qty_L}{L_M - S_L}$$

$$L_X = [Qty_M - Qty_M (round\ down\ into\ whole\ number)](L_M - S_L)$$

Note: Splice Length (S_L)

$$S_L = based\ on\ the\ table\ inside\ the\ parameters\ (Tension)$$

- If there is no Splice Length in the table. Thus,

$$S_L = 0\ m$$

$$L_E = L_M - L_X$$

And

$$Total\ Wastage = L_E \cdot Qty_L$$

The manufactured bar length that has the smallest total waste will be the chosen manufactured bar length and its corresponding manufactured quantity

$$Qty_{CM} = Qty_L \cdot Qty_M (round\ up\ into\ whole\ number)$$

For **Transverse Reinforcement**

$$Qty_P = \frac{L_M}{L_B\ of\ \ Qty_T}$$

$If\ \boldsymbol{Qty_P < 1}$

$$L_W = 0$$

$Else$

$$L_W =\cdot L_M - (L_B\ of\ \ Qty_T) \cdot Qty_P (round\ down\ into\ whole\ number)$$

$$Qty_M = \frac{Qty_T}{Qty_P (round\ down\ to\ whole\ number)}$$

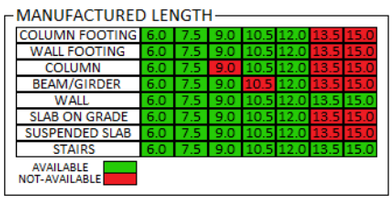
$$L_E = [Qty_M (round\ up\ to\ whole\ number) - Qty_M] \cdot L_M$$

And

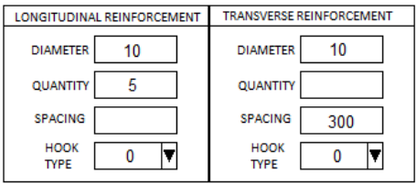
$$Total\ Wastage = L_E + L_W[Qty_M(round\ down\ to\ whole\ number)]$$

The manufactured bar length that has the smallest total wastage will be the chosen manufactured bar length and its corresponding manufactured quantity

Example:

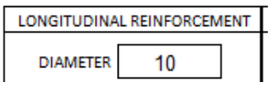


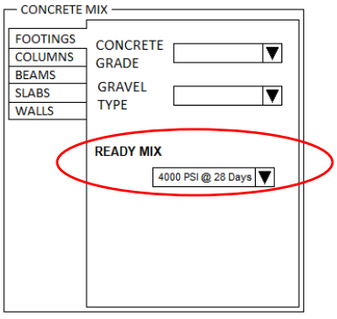
Based on the reference the available manufactured lengths are **6**, **7.5**, **9**, **10.5**, and **12** meters.

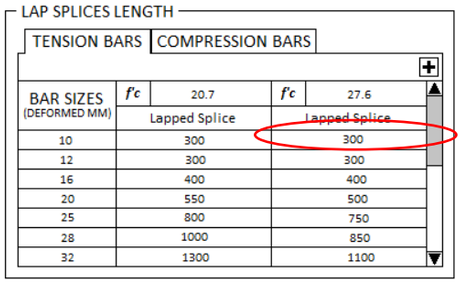


- For Longitudinal Reinforcement

  Since $(L_B\ of\ \ Qty_L = 30.29) > (Largest\ L_M = 15)$. Thus,







$$f'c = 4000\ psi \rightarrow 27.6$$

$$S_L = 300\ mm \rightarrow 0.3\ m$$

$@\ L_M = 6\ m$

$$Qty_M = \frac{L_B\ of\ \ Qty_L}{L_M - S_L} = \frac{30.36}{6 - 0.3} = 5.326$$

$$L_X = [Qty_M - Qty_M(round\ down\ into\ whole\ number)](L_M - S_L) = (5.326 - 5)(6 - 0.3) = 1.86\ m$$

$$L_E = L_M - L_X = 6 - 1.86 = 4.14\ m$$

$$Total\ Wastage = L_E \cdot Qty_L = 4.14 \cdot 5 = 20.7$$

$$Qty_{CM} = Qty_L \cdot Qty_M(round\ up\ into\ whole\ number) = 5 \cdot 6 = 30$$

The results of the computations of other L_M

L [M]	Qty [T]	L [B] of Qty [T]	Splice Length	Qty [M]		L [x]	L [E]	Qty [CM]	Total Waste
6	5	30.36	0.30	5.33	6	1.860	4.140	30	20.700
7.5				4.22	5	1.560	5.940	25	29.700
9				3.49	4	4.260	4.740	20	23.700
10.5				2.98	3	9.960	0.540	15	2.700
12				2.59	3	6.960	5.040	15	25.200

The smallest average is $L_M = 10.5\ m$. Thus, $\boldsymbol{L_{M(chosen)A} = 10.5\ m}$ and $\boldsymbol{Qty_{CM(chosen)A} = 15}$

- For Transverse Reinforcement

  @ $L_M = 6\ m$

$$Qty_P = \frac{L_M}{L_B\ of\ \ Qty_T} = \frac{6}{1.14971} = 5.219$$

Since $Qty_P > 1$. Thus,

$$L_W =\cdot L_M - (L_B\ of\ \ Qty_T) \cdot Qty_P(round\ down\ into\ whole\ number) = 6 - 1.14971(5) = 0.251\ m$$

$$Qty_M = \frac{Qty_T}{Qty_P(round\ down\ to\ whole\ number)} = \frac{103}{5} = 20.6$$

$$L_E = [Qty_M(round\ up\ to\ whole\ number) - Qty_M] \cdot L_M = [21 - 20.6] \cdot 6 = 2.4\ m$$

$$Total\ Wastage = L_E + L_W[Qty_M(round\ down\ to\ whole\ number)] = 2.4 + 0.251(20) = 7.42$$

The results of the computations of other L_M

L [M]	Qty [T]	L [B] of Qty [T]	Qty [P]		Qty [M]		L [W]	L [E]	Total Wastage
6	103	1.1497	5.22	5	20.60	21	0.251	2.400	7.429
7.5			6.52	6	17.17	18	0.602	6.250	16.480
9			7.83	7	14.71	15	0.952	2.571	15.900
10.5			9.13	9	11.44	12	0.153	5.833	7.512
12			10.44	10	10.30	11	0.503	8.400	13.429

The smallest Total Wastage is $L_M = 6\ m$. Thus, $\boldsymbol{L_{M(chosen)B} = 6\ m}$ and $\boldsymbol{Qty_{CM(chosen)B} = 21}$

5. The program will determine the Price of the Steel Rebar

$$Price_{Total} = \sum Qty_{CM(chosen)} Price_M$$

Where:

$$Price_M = Price\ of\ the\ steel\ reinforcement\ based\ on\ Pricing$$
$$= Sorted\ through\ Reinforcement\ Grade, diameter, and\ Manufactured\ Length$$

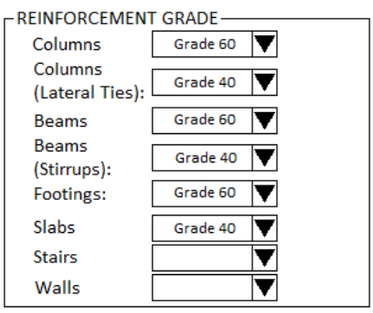
Case 1: $Footing\ Type: Wall\ Footing\ (Trapezoidal)$

$Price_M =$ Slabs

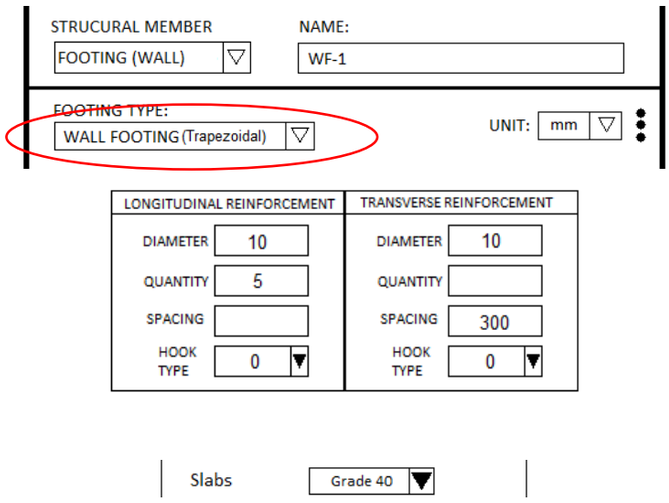
Case 2: $Footing\ Type: Wall\ Footing\ (Rectangular)$

$Price_M =$ Beams

Example



WF-1



- For Longitudinal Reinforcement

  $Qty_{CM(chosen)A} = 15$

  $L_{M(chosen)} = 10.5\ m$

  $d_b = 10\ mm$

  Rebar GRADE 40 (ø10mm) [6m]- **P 162.62**

  Rebar GRADE 40 (ø10mm) [7.5m]- **P 203.28**

  Rebar GRADE 40 (ø10mm) [9m]- **P 243.94**

  Rebar GRADE 40 (ø10mm) [10.5m]- **P 284.59**

  Rebar GRADE 40 (ø10mm) [12m]- **P 325.25**

  $$Price_{M(A)} = ₱\ 284.59$$

  $Qty_{CM(chosen)A} Price_{M(A)} = 15 \cdot 284.59 = ₱\ 4268.85$

- For Transverse Reinforcement

  $Qty_{CM(chosen)B} = 21$

  $L_{M(chosen)B} = 6\ m$

  $d_b = 10\ mm$

  Rebar GRADE 40 (ø10mm) [6m]- **P 162.62**

  Rebar GRADE 40 (ø10mm) [7.5m]- **P 203.28**

  Rebar GRADE 40 (ø10mm) [9m]- **P 243.94**

  Rebar GRADE 40 (ø10mm) [10.5m]- **P 284.59**

  Rebar GRADE 40 (ø10mm) [12m]- **P 325.25**

  $$Price_{M(B)} = ₱\ 162.62$$

  $Qty_{CM(chosen)B} Price_{M(B)} = 21 \cdot 162.62 = ₱\ 3415.02$

$$Price_{Total} = \sum Qty_{CM(chosen)} Price_M = 4268.85 + 3415.02 = ₱\ \mathbf{7683.87}$$

6. The program will compute the weight of the chosen manufactured bar length in transverse and longitudinal reinforcement of the footing.

$$Weight = L_{M(chosen)} \cdot Qty_{M(chosen)} \cdot W_D$$

Where:

$W_D = corresponding\ weight\ of\ the\ reinforcement\ diameter\ (Table\ in\ the\ Parameters)$

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

WF-1

@ Longitudinal Reinforcement: $diameter = 10\,mm$, thus $W_D = 0.616$

@ Transverse Reinforcement: $diameter = 10\,mm$, thus $W_D = 0.616$

For WF-1

@ Longitudinal Reinforcement

$$Weight_L = L_{M(chosen)} \cdot Qty_{M(chosen)} \cdot W_D = (10.5) \cdot (15) \cdot (0.616) = 97.02\,kg$$

@ Transverse Reinforcement

$$Weight_U = L_{M(chosen)} \cdot Qty_{M(chosen)} \cdot W_D = (6) \cdot (21) \cdot (0.616) = 77.616\,kg$$

7. The program will compute the total weight of reinforcements on each footing.

$$Weight_{TOTAL} = Weight_L + Weight_T$$

Example:

For WF-1

$$Weight_{TOTAL} = Weight_L + Weight_T = 97.02 + 77.616 = \mathbf{174.646\,kg}$$

8. The program will compute the Labor price of reinforcement in the Wall Footing.

$$Price_{Labor} = Weight_{TOTAL} \cdot L_R$$

Where:

$L_R = Labor\ Rate\ in\ Footing\ based\ in\ the\ Pricing$

Example:

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**

$$Price_{Labor} = Weight_{TOTAL} \cdot L_R$$
$$Price_{Labor} = 174.646 \cdot 17$$
$$Price_{Labor} = \mathbf{₱\,2968.812}$$