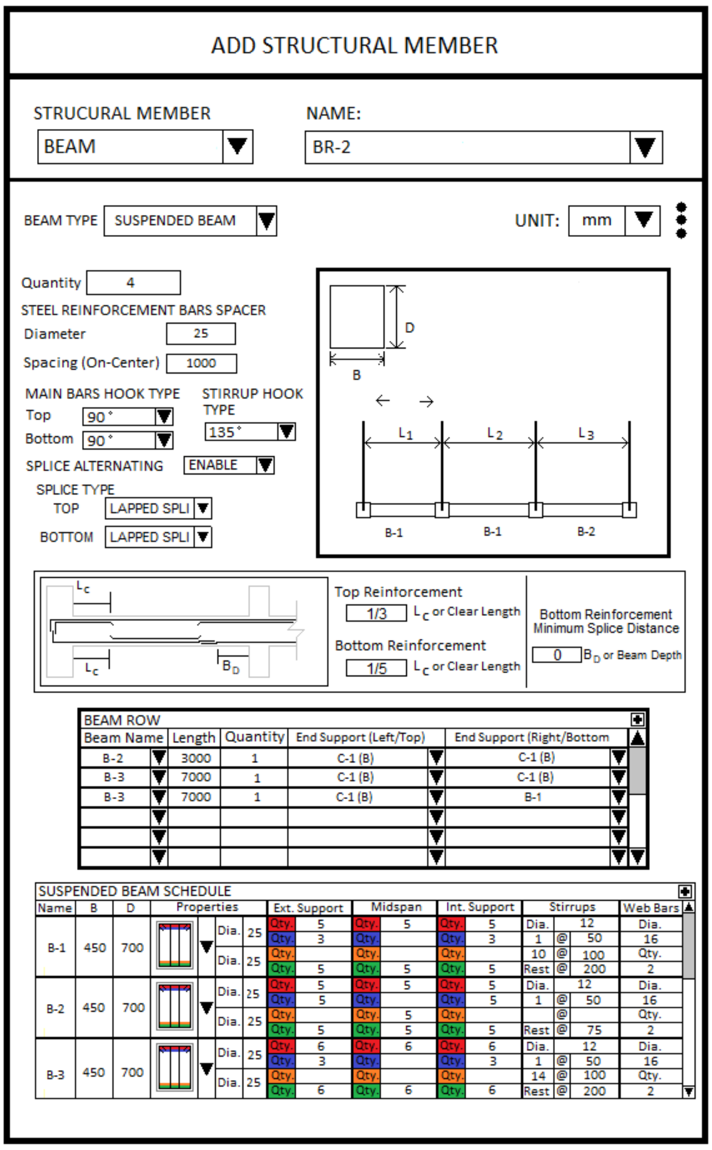
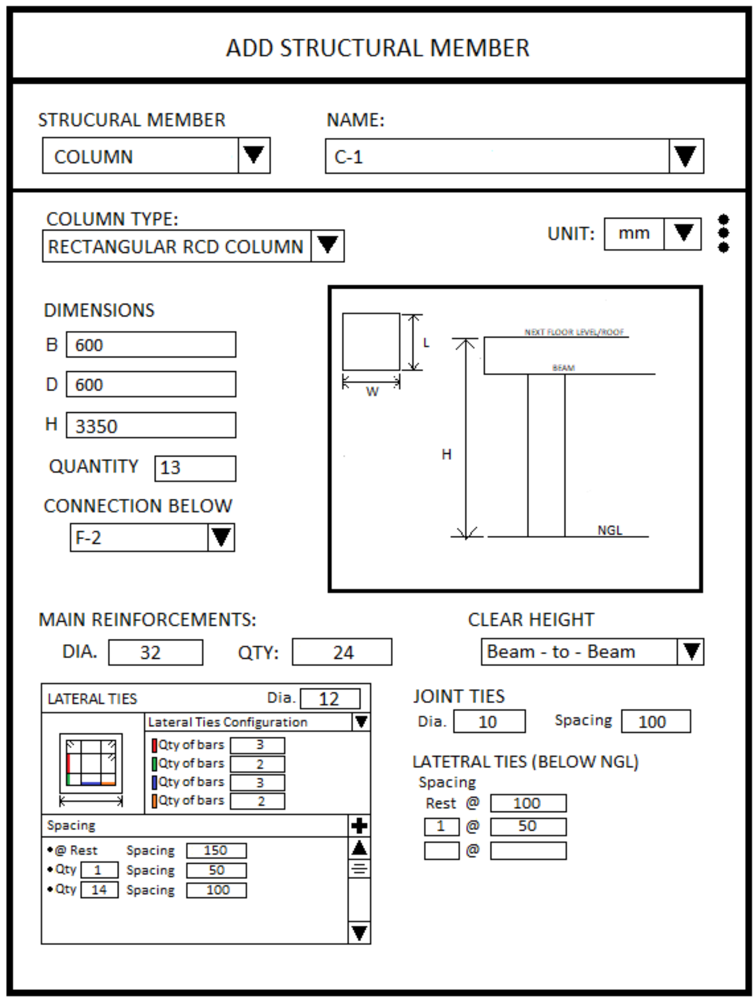
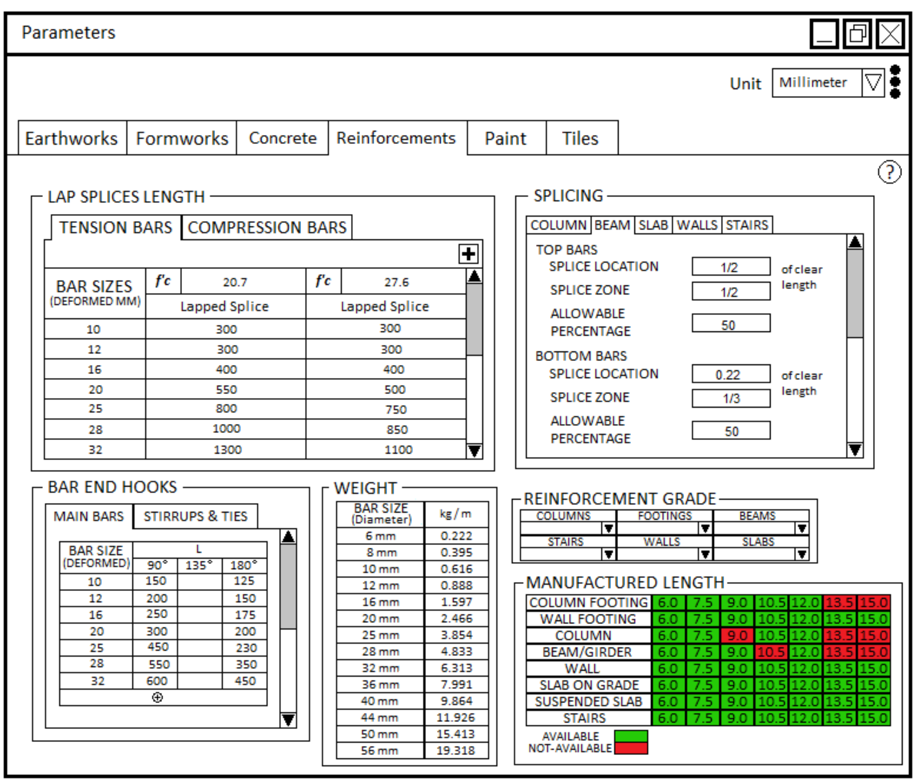
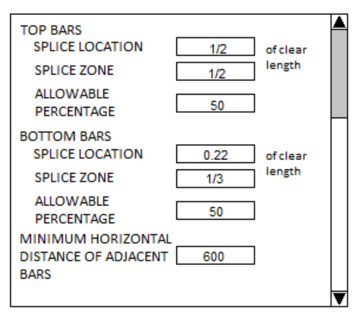
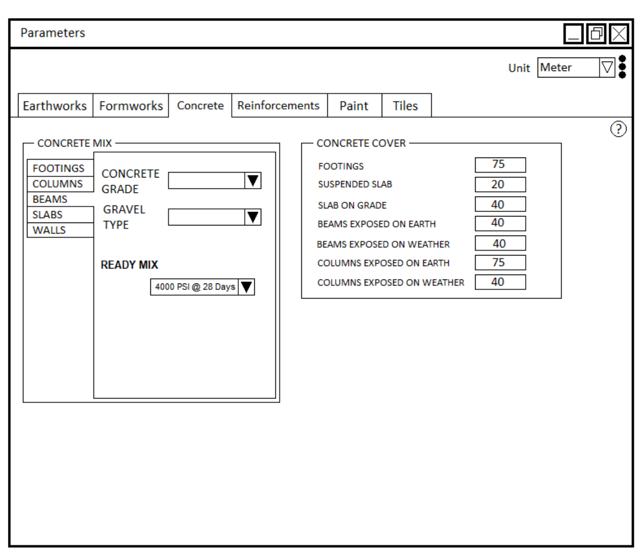
REFERENCE


ADD STRUCTURAL MEMBER
STRUCURAL MEMBER
BEAM
NAME:
BR-2
BEAM TYPE
SUSPENDED BEAM
UNIT:
mm
Quantity
4
STEEL REINFORCEMENT BARS SPACER
Diameter
25
Spacing (On-Center)
1000
MAIN BARS HOOK TYPE
Top
90°
Bottom
90°
STIRRUP HOOK TYPE
135°
SPLICE ALTERNATING
ENABLE
SPLICE TYPE
TOP
LAPPED SPLI
BOTTOM
LAPPED SPLI
D
B
L1
L2
L3
B-1
B-1
B-2
Top Reinforcement
1/3
Lc or Clear Length
Bottom Reinforcement
1/5
Lc or Clear Length
Bottom Reinforcement Minimum Splice Distance
0
BD or Beam Depth
BEAM ROW
Beam Name
Length
Quantity
End Support (Left/Top)
End Support (Right/Bottom
B-2
3000
1
C-1 (B)
C-1 (B)
B-3
7000
1
C-1 (B)
C-1 (B)
B-3
7000
1
C-1 (B)
B-1
SUSPENDED BEAM SCHEDULE
Name
B
D
Properties
Ext. Support
Midspan
Int. Support
Stirrups
Web Bars
B-1
450
700
B-2
450
700
B-3
450
700
Dia.
Qty.
Rest


ADD STRUCTURAL MEMBER
STRUCURAL MEMBER
COLUMN
NAME:
C-1
COLUMN TYPE:
RECTANGULAR RCD COLUMN
UNIT:
mm
DIMENSIONS
B
600
D
600
H
3350
QUANTITY
13
CONNECTION BELOW
F-2
L
W
H
NGL
MAIN REINFORCEMENTS:
DIA.
32
QTY:
24
CLEAR HEIGHT
Beam - to - Beam
LATERAL TIES
Dia.
12
Lateral Ties Configuration
Qty of bars
3
Qty of bars
2
Qty of bars
3
Qty of bars
2
Spacing
@ Rest
Spacing
150
Qty
1
Spacing
50
Qty
14
Spacing
100
JOINT TIES
Dia.
10
Spacing
100
LATETRAL TIES (BELOW NGL)
Spacing
Rest
@
100
1
@
50
@


Parameters
Unit
Millimeter
Earthworks
Formworks
Concrete
Reinforcements
Paint
Tiles
LAP SPLICES LENGTH
TENSION BARS
COMPRESSION BARS
BAR SIZES (DEFORMED MM)
f'c 20.7
f'c 27.6
Lapped Splice
Lapped Splice
10 300 300
12 300 300
16 400 400
20 550 500
25 800 750
28 1000 850
32 1300 1100
SPLICING
COLUMN
BEAM
SLAB
WALLS
STAIRS
TOP BARS
SPLICE LOCATION
1/2
of clear length
SPLICE ZONE
1/2
ALLOWABLE PERCENTAGE
50
BOTTOM BARS
SPLICE LOCATION
0.22
of clear length
SPLICE ZONE
1/3
ALLOWABLE PERCENTAGE
50
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
REINFORCEMENT GRADE
COLUMNS
FOOTINGS
BEAMS
STAIRS
WALLS
SLABS
MANUFACTURED LENGTH
COLUMN FOOTING
WALL FOOTING
COLUMN
BEAM/GIRDER
WALL
SLAB ON GRADE
SUSPENDED SLAB
STAIRS
6.0 7.5 9.0 10.5 12.0 13.5 15.0
AVAILABLE
NOT-AVAILABLE


TOP BARS
SPLICE LOCATION
1/2
of clear length
SPLICE ZONE
1/2
ALLOWABLE PERCENTAGE
50
BOTTOM BARS
SPLICE LOCATION
0.22
of clear length
SPLICE ZONE
1/3
ALLOWABLE PERCENTAGE
50
MINIMUM HORIZONTAL DISTANCE OF ADJACENT BARS
600


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

STEPS

1. The program will check the availability of the manufactured bar lengths.

   Example: The available manufactured bar lengths are 6, 7.5, 9, and 12 meters.

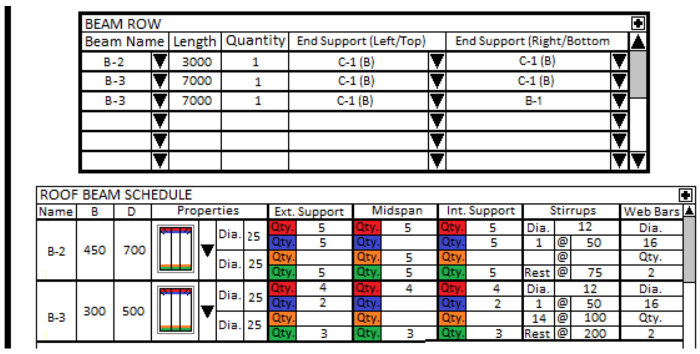
2. The program will determine the quantity of the total top bars of each beam section.

$$Qty_{Ext} = Qty_{RED} + Qty_{BLUE}$$

$$Qty_{Mid} = Qty_{RED} + Qty_{BLUE}$$

$$Qty_{Int} = Qty_{RED} + Qty_{BLUE}$$

Example:



BEAM ROW

Beam Name	Length	Quantity	End Support (Left/Top)	End Support (Right/Bottom
B-2	3000	1	C-1 (B)	C-1 (B)
B-3	7000	1	C-1 (B)	C-1 (B)
B-3	7000	1	C-1 (B)	B-1

ROOF BEAM SCHEDULE

Name	B	D	Properties		Ext. Support		Midspan		Int. Support		Stirrups			Web Bars
B-2	450	700	Dia.	25	Qty.	5	Qty.	5	Qty.	5	Dia.		12	Dia.
					Qty.	5	Qty.		Qty.	5	1	@	50	16
			Dia.	25	Qty.		Qty.	5	Qty.			@		Qty.
					Qty.	5	Qty.	5	Qty.	5	Rest	@	75	2
B-3	300	500	Dia.	25	Qty.	4	Qty.	4	Qty.	4	Dia.		12	Dia.
					Qty.	2	Qty.		Qty.	2	1	@	50	16
			Dia.	25	Qty.		Qty.		Qty.		14	@	100	Qty.
					Qty.	3	Qty.	3	Qty.	3	Rest	@	200	2

For Ref (1): B-2

$$Qty_{Ext(1)} = Qty_{RED} + Qty_{BLUE} = 5 + 5 = 10$$

$$Qty_{Mid(1)} = Qty_{RED} + Qty_{BLUE} = 5 + 0 = 5$$

$$Qty_{Int(1)} = Qty_{RED} + Qty_{BLUE} = 5 + 5 = 10$$

For Ref (2): B-3

$$Qty_{Ext(2)} = Qty_{RED} + Qty_{BLUE} = 4 + 2 = 6$$

$$Qty_{Mid(2)} = Qty_{RED} + Qty_{BLUE} = 4 + 0 = 4$$

$$Qty_{Int(2)} = Qty_{RED} + Qty_{BLUE} = 4 + 2 = 6$$

For Ref (2): B-3

$$Qty_{Ext(3)} = Qty_{RED} + Qty_{BLUE} = 4 + 2 = 6$$

$$Qty_{Mid(3)} = Qty_{RED} + Qty_{BLUE} = 4 + 0 = 4$$

$$Qty_{Int(3)} = Qty_{RED} + Qty_{BLUE} = 4 + 2 = 6$$

3. The program will determine the quantity of continuous reinforcement of each beam

$$Qty_{CR} = \frac{Allow(\%)}{100}\left[Smallest\ Qty_{Mid}\ between\ Ref_{(n-Z)},\ to\ Ref_{(n+Z-1)}\right]$$

Where Smallest Qty_{Mid} must not be equal or less than zero.

$$Z = \frac{100}{Allow(\%)}$$

If Z is Odd and the $Smallest\ Qty_{Mid}$ is Even

If n is Odd, Qty_{CR} must be round down to whole number

If n is Even, Qty_{CR} must be round up to whole number

Else,

If n is Odd, Qty_{CR} must be round up to whole number

If n is Even, Qty_{CR} must be round down to whole number

Example:

$$Z = \frac{100}{Allow(\%)} = \frac{100}{50} = 2$$

- For Ref (1)

Finding the smallest Qty_{Mid} $between\ Ref_{(-1)},\ to\ Ref_{(2)}$

$Ref_{(-1)}$: $Qty_{Mid} = 0$

$Ref_{(0)}$: $Qty_{Mid} = 0$

$Ref_{(1)}$: $Qty_{Mid} = 5$

$Ref_{(2)}$: $Qty_{Mid} = 4$

The smallest $Qty_{Mid} = 4$

$Qty_{CR(1)} = \frac{Allow(\%)}{100}\left[Smallest\ Qty_{Mid}\ between\ Ref_{(n-Z)},\ to\ Ref_{(n+Z-1)}\right]$

$Qty_{CR(1)} = \frac{50}{100}[4]$

$Qty_{CR(1)} = 2$

- For Ref (2)

Finding the smallest Qty_{Mid} $between\ Ref_{(0)},\ to\ Ref_{(3)}$

$Ref_{(0)}$: $Qty_{Mid} = 0$

$Ref_{(1)}$: $Qty_{Mid} = 5$

$Ref_{(2)}$: $Qty_{Mid} = 4$

$Ref_{(3)}$: $Qty_{Mid} = 4$

The smallest $Qty_{Mid} = 4$

$Qty_{CR(2)} = \frac{Allow(\%)}{100}\left[Smallest\ Qty_{Mid}\ between\ Ref_{(n-Z)},\ to\ Ref_{(n+Z-1)}\right]$

$Qty_{CR(2)} = \frac{50}{100}[4]$

$Qty_{CR(2)} = 2$

- For Ref (3)

Finding the smallest Qty_{Mid} $between\ Ref_{(0)},\ to\ Ref_{(3)}$

$Ref_{(1)}$: $Qty_{Mid} = 5$

$Ref_{(2)}$: $Qty_{Mid} = 4$

$Ref_{(3)}$: $Qty_{Mid} = 4$

$Ref_{(4)}$: $Qty_{Mid} = 0$

The smallest $Qty_{Mid} = 4$

$Qty_{CR(3)} = \frac{Allow(\%)}{100}\left[Smallest\ Qty_{Mid}\ between\ Ref_{(n-Z)},\ to\ Ref_{(n+Z-1)}\right]$

$Qty_{CR(3)} = \frac{50}{100}[4]$

$Qty_{CR(3)} = 2$

4. The program will compute the non-continuous bars

If $n < \left(n_{last} + 1 - Z\right)$

$$Qty_{NCR} = Qty_{Mid} - \sum_{n}^{n+Z-1} Qty_{CR}$$

If $n \geq \left(n_{last} + 1 - Z\right)$

$$Qty_{NCR} = Qty_{Mid} - \sum_{n_{last}+1-Z}^{n_{last}} Qty_{CR}$$

Example:

$$\left(n_{last} + 1 - Z\right) = (3 + 1 - 2) = 2$$

- For Ref (1): $1 < 2 \therefore n < \left(n_{last} + 1 - Z\right)$

$$Qty_{NCR(1)} = Qty_{Mid(1)} - \sum_{n}^{n+Z-1} Qty_{CR}$$

$$Qty_{NCR(1)} = Qty_{Mid(1)} - \sum_{1}^{1+2-1} Qty_{CR}$$

$$Qty_{NCR(1)} = Qty_{Mid(1)} - \left(Qty_{CR(1)} + Qty_{CR(2)}\right)$$

$$Qty_{NCR(1)} = 5 - (2 + 2) = 1$$

- For Ref (2): $2 = 2 \therefore n = \left(n_{last} + 1 - Z\right)$

$$Qty_{NCR(2)} = Qty_{Mid(2)} - \sum_{n_{last}+1-Z}^{n_{last}} Qty_{CR}$$

$$Qty_{NCR(2)} = Qty_{Mid(2)} - \sum_{3+1-Z}^{3} Qty_{CR}$$

$$Qty_{NCR(2)} = Qty_{Mid(2)} - \left(Qty_{CR(2)} + Qty_{CR(3)}\right)$$

$$Qty_{NCR(2)} = 4 - (2 + 2) = 0$$

- For Ref (3): $3 > 2 \therefore n > \left(n_{last} + 1 - Z\right)$

$$Qty_{NCR(2)} = Qty_{Mid(3)} - \sum_{n_{last}+1-Z}^{n_{last}} Qty_{CR}$$

$$Qty_{NCR(3)} = Qty_{Mid(3)} - \sum_{3+1-Z}^{3} Qty_{CR}$$

$$Qty_{NCR(3)} = Qty_{Mid(3)} - \left(Qty_{CR(2)} + Qty_{CR(3)}\right)$$

$$Qty_{NCR(3)} = 4 - (2 + 2) = 0$$

5. The program will compute the quantity of extra bars A and B.

Case 1: $n = 1$

$$Qty_{ER-A} = Qty_{Ext(n)} - Qty_{Mid(n)}$$

$$Qty_{ER-B} = Qty_{Int(n)} - Qty_{Mid(n)}$$

Case 2: $1 < n < n_{last}$

$$Qty_{ER-A} = Qty_{Int(n)} - Qty_{Mid(n)}$$

Case 3: $n = n_{last}$

$$Qty_{ER-A} = Qty_{Ext(n)} - Qty_{Mid(n)}$$

Example:

- Ref (1): $n = 1$

$$Qty_{ER-A(1)} = Qty_{Ext(1)} - Qty_{Mid(1)}$$

$$Qty_{ER-A(1)} = 10 - 5$$

$Qty_{ER-A(1)} = 5$

$Qty_{ER-B(1)} = Qty_{Int(1)} - Qty_{Mid(1)}$

$Qty_{ER-B(1)} = 10 - 5$

$Qty_{ER-B(1)} = 5$

- Ref (2): $n > 1$ and $n < n_{last}$

$Qty_{ER-A(2)} = Qty_{Int(2)} - Qty_{Mid(2)}$

$Qty_{ER-A(2)} = 6 - 4$

$Qty_{ER-A(2)} = 2$

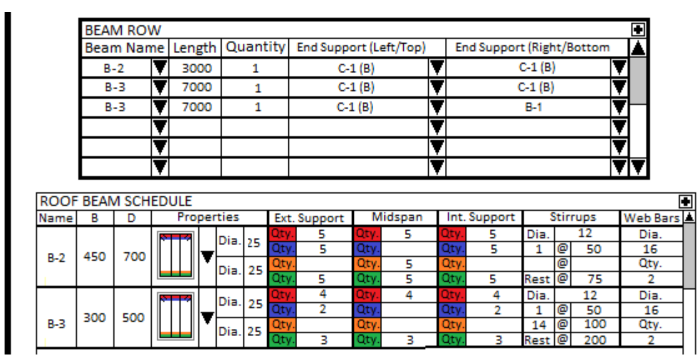
- Ref (3): $n = n_{last}$

$Qty_{ER-A(3)} = Qty_{Ext(3)} - Qty_{Mid(3)}$

$Qty_{ER-A(3)} = 6 - 4$

$Qty_{ER-A(3)} = 2$

6. The program then will check the supports that are connected to each beam.
   Example:



BEAM ROW

Beam Name	Length	Quantity	End Support (Left/Top)	End Support (Right/Bottom
B-2	3000	1	C-1 (B)	C-1 (B)
B-3	7000	1	C-1 (B)	C-1 (B)
B-3	7000	1	C-1 (B)	B-1

ROOF BEAM SCHEDULE

Name	B	D	Properties		Ext. Support		Midspan		Int. Support		Stirrups			Web Bars
B-2	450	700	Dia.	25	Qty.	5	Qty.	5	Qty.	5	Dia.	12		Dia.
					Qty.	5	Qty.		Qty.	5	1	@	50	16
			Dia.	25	Qty.		Qty.	5	Qty.			@		Qty.
					Qty.	5	Qty.	5	Qty.	5	Rest	@	75	2
B-3	300	500	Dia.	25	Qty.	4	Qty.	4	Qty.	4	Dia.	12		Dia.
					Qty.	2	Qty.		Qty.	2	1	@	50	16
			Dia.	25	Qty.		Qty.		Qty.		14	@	100	Qty.
					Qty.	3	Qty.	3	Qty.	3	Rest	@	200	2

- Ref (1)
  a) End Support (Left/Top): **C-1(B)**
  b) End Support (Right/Bottom): **C-1(B)**
- Ref (2)
  a) End Support (Left/Top): **C-1(B)**
  b) End Support (Right/Bottom): **C-1(B)**
- Ref (3)
  a) End Support (Left/Top): **C-1(B)**
  b) End Support (Right/Bottom): **B-1**

7. The program will determine the dimension of the support

LEGEND:

- If the support is a Column connected to its width **“Support Name(D)”** then
  a) Case 1: The Beam Type is “Footing Tie Beam” & “Grade Beam”

$$Dim_{S:Left/Top} = \frac{B_{column} + \left(CC_{EE} - CC_{EW}\right)}{2} \quad or \quad Dim_{S:Right/Bott} = \frac{B_{column} + \left(CC_{EE} - CC_{EW}\right)}{2}$$

  b) Case 2: The Beam Type is “Suspended Beam” & “Roof Beam”

$$Dim_{S:Left/Top} = \frac{B_{column}}{2} \quad or \quad Dim_{S:Right/Bott} = \frac{B_{column}}{2}$$

- If the support is a Column connected to its length **"Support Name(B)"** then

  a) Case 1: The Beam Type is "Footing Tie Beam" & "Grade Beam"

$$Dim_{S:Left/Top} = \frac{D_{column}+\left(CC_{EE}-CC_{EW}\right)}{2} \quad or \quad Dim_{S:Right/Bott} = \frac{D_{column}+\left(CC_{EE}-CC_{EW}\right)}{2}$$

  b) Case 2: The Beam Type is "Suspended Beam" & "Roof Beam"

$$Dim_{S:Left/Top} = \frac{D_{column}}{2} \quad or \quad Dim_{S:Right/Bott} = \frac{D_{column}}{2}$$

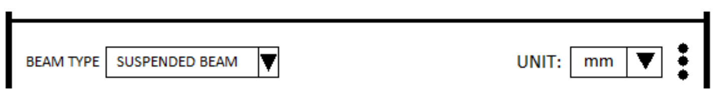
- If the support is a Beam, then

$$Dim_{S:Left/Top} = \frac{B_{beam}}{2} \quad or \quad Dim_{S:Right/Bott} = \frac{B_{beam}}{2}$$

- If there is No support, then

$$Dim_{S:Left/Top} = 0 \quad or \quad Dim_{S:Right/Bott} = 0$$

Example:



- Ref (1)

  a) End Support (Left/Top): **C-1(B)**

$$Dim_{S:Left/Top(1)} = \frac{D_{column}}{2} = \frac{600}{2} = 300$$

  b) End Support (Right/Bottom): **C-1(B)**

$$Dim_{S:Right/Bott(1)} = \frac{D_{column}}{2} = \frac{600}{2} = 300$$

- Ref (2)

  a) End Support (Left/Top): **C-1(B)**

$$Dim_{S:Left/Top(2)} = \frac{D_{column}}{2} = \frac{600}{2} = 300$$

  b) End Support (Right/Bottom): **C-1(B)**

$$Dim_{S:Right/Bott(2)} = \frac{D_{column}}{2} = \frac{600}{2} = 300$$

- Ref (3)

  a) End Support (Left/Top): **C-1(B)**

$$Dim_{S:Left/Top(2)} = \frac{D_{column}}{2} = \frac{600}{2} = 300$$

  b) End Support (Right/Bottom): **B-1**

$$Dim_{S:Right/Bott(2)} = \frac{B_{beam}}{2} = \frac{450}{2} = 225$$

8. The program will then compute the Clear Length of the respective beams

$$L_{Cn} = L_{n} - Dim_{S:Left/Top} - Dim_{S:Right/Bott}$$

Example:

- Ref (1)

$$L_{C(1)} = L_1 - Dim_{S:Left/Top(1)} - Dim_{S:Right/Bott(1)}$$

$$L_{C(1)} = 3000 - 300 - 300$$

$$L_{C(1)} = 2400$$

- Ref (2)

$$L_{C(2)} = L_2 - Dim_{S:Left/Top(2)} - Dim_{S:Right/Bott(2)}$$

$$L_{C(2)} = 7000 - 300 - 300$$

$$L_{C(2)} = 6400$$

- Ref (3)

$$L_{C(3)} = L_3 - Dim_{S:Left/Top(3)} - Dim_{S:Right/Bott(3)}$$

$$L_{C(3)} = 7000 - 300 - 225$$

$$L_{C(3)} = 6475$$

9. The program will determine the splice length of each beam, based on splice type.
   a) Case 1: Splice Type is Lapped Splice or Welded Splice (Lapped)

   $$S_L = Based\ on\ the\ table\ of\ splice\ length\ @\ Tension$$

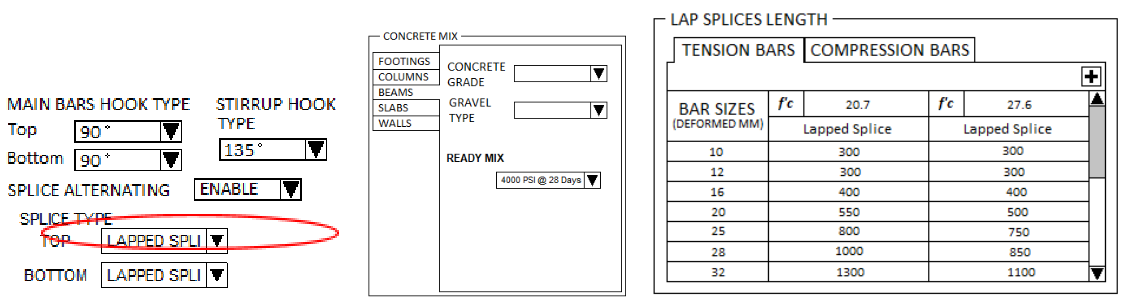
   b) Case 2: Splice Type is Mechanical Splice or Welded Splice (Butt)

   $$S_L = 0$$

   Example:

   Since the Splice Type is Lapped Splice, Then

   $$S_L = Based\ on\ the\ table\ of\ splice\ length\ @\ Tension$$



The concrete strength is $4000\ psi = 27.6$

- Ref (1): The diameter of the top reinforcement = 25 mm

$$S_{L(1)} = 750$$

- Ref (2) The diameter of the top reinforcement = 25 mm

$$S_{L(2)} = 750$$

- Ref (3) The diameter of the top reinforcement = 25 mm

$$S_{L(1)} = 750$$

10. The program will compute the effective distance of each beam
    - If the Splice Alternating is **Enable**

    $$E_{Dn} = \left(1 - S_{LOC}\right)L_{Cn} + \frac{S_{Ln}}{2}$$

    - If the Splice Alternating is **Disabled**

    $$E_{Dn} = \left(1 - S_{LOC}\right)L_{Cn} - \frac{D_{Min}}{2}$$

Example:

Since the Splice Alternating is **Enable**

For Ref (1)

$$E_{D(1)} = \left(1 - S_{LOC}\right)L_{C(1)} + \frac{S_{L(1)}}{2} = (1 - 0.5)(2400) + \frac{750}{2} = 1575$$

For Ref (2)

$$E_{D(2)} = \left(1 - S_{LOC}\right)L_{C(2)} + \frac{S_{L(2)}}{2} = (1 - 0.5)(6400) + \frac{750}{2} = 3575$$

For Ref (3)

$$E_{D(3)} = \left(1 - S_{LOC}\right)L_{C(2)} + \frac{S_{L(2)}}{2} = (1 - 0.5)(6475) + \frac{750}{2} = 3612.5$$

11. The program will compute the concrete cover of the support of the first and last beam in the beam row.

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

For Ref (n), where $n = 1$

- If the beam type is Grade Beam or Footing Tie Beam
  a) Case 1: If the *End Support (Left/Top)* is Column

$$CC_{S:L/T(n)} = Columns\ Exposed\ to\ Earth$$

  b) Case 2: If the *End Support (Left/Top)* is Beam

$$CC_{S:Left/Top(n)} = Beams\ Exposed\ to\ Earth$$

- If the beam type is Suspended Beam or Roof Beam
  a) Case 1: If the *End Support (Left/Top)* is Column

$$CC_{S:L/T(n)} = Columns\ Exposed\ to\ Weather$$

  b) Case 2: If the *End Support (Left/Top)* is Beam

$$CC_{S:L/T(n)} = Beams\ Exposed\ to\ Weather$$

For Ref (n), where $n = n_{last}$

- If the beam type is Grade Beam or Footing Tie Beam
  c) Case 1: If the *End Support (Right/Bottom)* is Column

$$CC_{S:R/B(n)} = Columns\ Exposed\ to\ Earth$$

  d) Case 2: If the *End Support (Right/Bottom)* is Beam

$$CC_{S:R/B(n)} = Beams\ Exposed\ to\ Earth$$

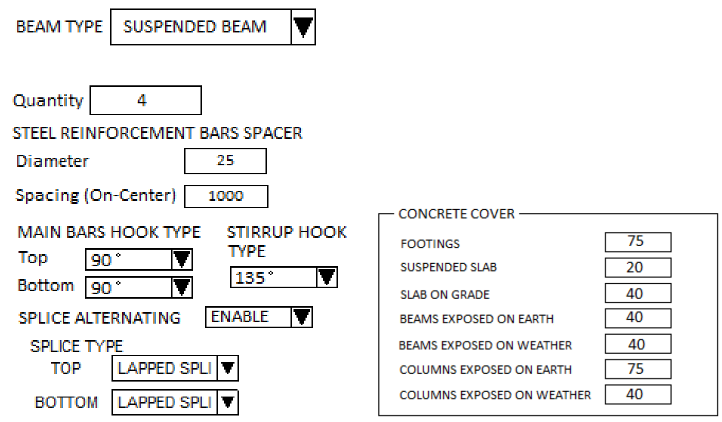
- If the beam type is Suspended Beam or Roof Beam
  c) Case 1: If the *End Support (Right/Bottom)* is Column

$$CC_{S:R/B(n)} = Columns\ Exposed\ to\ Weather$$

  d) Case 2: If the *End Support (Right/Bottom)* is Beam

$$CC_{S:R/B(n)} = Beams\ Exposed\ to\ Weather$$

Example:



$$n_{last} = 3$$

- For Ref (1)

  Since the *End Support (Left/Top)* is Column. Thus,

$$CC_{S:L/T(1)} = Columns\ Exposed\ to\ Weather = 40$$

- For Ref (3)

  Since the *End Support (Right/Bottom)* is Beam. Thus,

$$CC_{S:R/B(3)} = Beams\ Exposed\ to\ Weather = 40$$

12. The program will compute the length of the continuous reinforcement **(must be converted into meter)**

a) If the Splice Alternating is **Enabled**:

- Case 1: $n \leq Z$ and $n < \left(n_{last} - Z + 1\right)$

$$L_B\ of\ Qty_{CR} = \sum_{1}^{n} L_n + H_{L(°)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(n)} - Dim_{S:Right/Bott(n)} - E_{Dn}$$

- Case 2: $n \leq Z$ and $n \geq \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{1}^{n} L_n + H_{L(1)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(1)} - Dim_{S:Right/Bott(n)} - E_{Dn}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - CC_{S:R/B\left(n_{last}\right)}$$

And if $\left(L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_m$, Thus $L_{B(c)}\ of\ Qty_{CR}$ will replace $L_{B(a)}\ of\ Qty_{CR}$ and $L_{B(b)}\ of\ Qty_{CR}$

Where:

$$L_{B(c)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - S_{L(n)}$$

- Case 3: $n > Z$ and $n < \left(n_{last} - Z + 1\right)$

$$L_B\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n-Z)} - L_{C(n-Z)} - Dim_{S:Right/Bott(n)}$$

- Case 4: $n > Z$ and $n \geq \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n-Z)} - L_{Cn} - Dim_{S:Right/Bott(n)}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - CC_{S:R/B\left(n_{last}\right)}$$

And if $\left(L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_m$, Thus $L_{B(c)}\ of\ Qty_{CR}$ will replace $L_{B(a)}\ of\ Qty_{CR}$ and $L_{B(b)}\ of\ Qty_{CR}$

Where:

$$L_{B(c)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - S_{L(n)}$$

b) If the Splice Alternating is **Disable**:

- Case 1: $n \leq Z$ and $n < \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{1}^{n} L_n + H_{L(°)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(n)} - Dim_{S:Right/Bott(n)} - E_{Dn}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{1}^{n} L_n H_{L(°)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(n)} - Dim_{S:Right/Bott(n)} - E_{Dn} + D_{Min} + S_{Ln}$$

- Case 2: $n \leq Z$ and $n \geq \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{1}^{n} L_n + H_{L(°)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(1)} - Dim_{S:Right/Bott(n)} - E_{Dn}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{1}^{n} L_n H_{L(°)} + Dim_{S:Left/Top(1)} - CC_{S:L/T(1)} - Dim_{S:Right/Bott(n)} - E_{Dn} + D_{Min} + S_{Ln}$$

$$L_{B(c)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - CC_{S:R/B\left(n_{last}\right)}$$

$$L_{B(d)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - D_{Min} - S_{Ln} - CC_{S:R/B\left(n_{last}\right)}$$

And if $\left(L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_m$, Thus $L_{B(e)}\ of\ Qty_{CR}$ will replace $L_{B(a)}\ of\ Qty_{CR}$ and $L_{B(c)}\ of\ Qty_{CR}$

Where:

$$L_{B(e)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}$$

And if $\left(L_{B(b)}\ of\ Qty_{CR} + L_{B(d)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_m$, Thus $L_{B(f)}\ of\ Qty_{CR}$ will replace $L_{B(b)}\ of\ Qty_{CR}$ and $L_{B(d)}\ of\ Qty_{CR}$

Where:

$$L_{B(e)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}$$

- Case 3: $n > Z$ and $n < \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n)} - L_{C(n-Z)} - Dim_{S:Right/Bott\left(n_{last}\right)}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + S_{L(n-Z)} + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n)} - L_{C(n-Z)} - Dim_{S:Right/Bott\left(n_{last}\right)} - S_{L(n)}$$

- Case 4: $n > Z$ and $n \geq \left(n_{last} - Z + 1\right)$

$$L_{B(a)}\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n)} - L_{C(n-Z)} - Dim_{S:Right/Bott\left(n_{last}\right)}$$

$$L_{B(b)}\ of\ Qty_{CR} = \sum_{n-Z}^{n} L_n + S_{L(n-Z)} + E_{D(n-Z)} - E_{Dn} - Dim_{S:Left/Top(n)} - L_{C(n-Z)} - Dim_{S:Right/Bott\left(n_{last}\right)} - S_{L(n)}$$

$$L_{B(c)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - CC_{S:R/B\left(n_{last}\right)}$$

$$L_{B(d)}\ of\ Qty_{CR} = \sum_{n}^{n_{last}} L_n + H_{L\left(n_{last}\right)} + E_{Dn} + Dim_{S:Right/Bott\left(n_{last}\right)} - Dim_{S:Left/Top(n)} - L_{Cn} - D_{Min} - S_{Ln} - CC_{S:R/B\left(n_{last}\right)}$$

And if $\left(L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_m$, Thus $L_{B(e)}\ of\ Qty_{CR}$ will replace $L_{B(a)}\ of\ Qty_{CR}$ and $L_{B(c)}\ of\ Qty_{CR}$

Where:

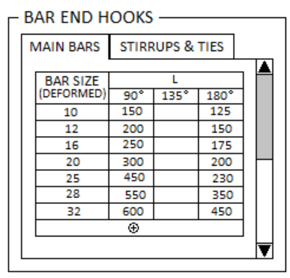
$$L_{B(e)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}$$

And if $\left(L_{B(b)}\ of\ Qty_{CR} + L_{B(d)}\ of\ Qty_{CR} - S_{L(n)}\right) < Largest\ L_{m}$, Thus $L_{B(f)}\ of\ Qty_{CR}$ will replace $L_{B(b)}\ of\ Qty_{CR}$ and $L_{B(d)}\ of\ Qty_{CR}$

Where:

$$L_{B(e)}\ of\ Qty_{CR} = L_{B(a)}\ of\ Qty_{CR} + L_{B(c)}\ of\ Qty_{CR} - S_{L(n)}$$

Example:



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
⊕			

The Splice Alternating is **Enable**, $Z = 2$, and $n_{last} - Z + 1 = 3 - 2 + 1 = 2$

- Ref (1): $n < Z$ & $n < \left(n_{last} - Z + 1\right)$, Thus Case 1

$$L_{B}\ of\ Qty_{CR(1)} = \sum_{1}^{1} L_{n} + H_{L(90)} + Dim_{S:Left/Top(1)} - CC_{S:Left/Top(1)} - Dim_{S:Right/Bott(1)} - E_{D(1)}$$

$$L_{B}\ of\ Qty_{CR(1)} = (3000) + 450 + 300 - 40 - 300 - 1575$$

$$L_{B}\ of\ Qty_{CR(1)} = 1835\ mm \rightarrow 1.835\ m$$

- Ref (2): $n = Z$ & $n = \left(n_{last} - Z + 1\right)$, Thus Case 2

$$L_{B(a)}\ of\ Qty_{CR(2)} = \sum_{1}^{2} L_{n} + H_{L(90)} + Dim_{S:Left/Top(1)} - CC_{S:Left/Top(1)} - Dim_{S:Right/Bott(2)} - E_{D(2)}$$

$$L_{B(a)}\ of\ Qty_{CR(2)} = (3000 + 7000) + 450 + 300 - 40 - 300 - 3575$$

$$L_{B(a)}\ of\ Qty_{CR(2)} = 6835\ mm \rightarrow 6.835\ m$$

$$L_{B(b)}\ of\ Qty_{CR(2)} = \sum_{2}^{3} L_{n} + H_{L(3)} + E_{D(2)} + Dim_{S:Right/Bott(3)} - Dim_{S:Left/Top(2)} - L_{C(2)} - CC_{S:R/B(3)}$$

$$L_{B(b)}\ of\ Qty_{CR(2)} = (7000 + 7000) + 450 + 3575 + 225 - 300 - 6400 - 40$$

$$L_{B(b)}\ of\ Qty_{CR(2)} = 11510\ mm \rightarrow 11.51\ m$$

$$\because Check\ \left(L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - 2S_{L(n)}\right) < Largest\ L_{m}$$

$$L_{B(a)}\ of\ Qty_{CR(2)} + L_{B(b)}\ of\ Qty_{CR(2)} - S_{L(2)} = 6.835 + 11.51 - (0.750) = 17.595\ m$$

$$Largest\ L_{m} = 12\ m$$

$17.595\ m > 12\ m$, Thus $L_{B(c)}\ of\ Qty_{CR(2)}$ will not replace $L_{B(a)}\ of\ Qty_{CR(2)}$ & $L_{B(b)}\ of\ Qty_{CR(2)}$

- Ref (3): $n > Z$ & $n > \left(n_{last} - Z + 1\right)$, Thus Case 4

$$L_{B(a)}\ of\ Qty_{CR(3)} = \sum_{3-2}^{3} L_{n} + E_{D(3-2)} - E_{D(3)} - Dim_{S:Left/Top(3-2)} - L_{C(3-2)} - Dim_{S:Right/Bott(3)}$$

$$L_{B(a)}\ of\ Qty_{CR(3)} = (3000 + 7000 + 7000) + 1575 - 3612.5 - 300 - 2400 - 225$$

$$L_{B(a)}\ of\ Qty_{CR(3)} = 12037.5\ mm \rightarrow 12.0375\ m$$

$$L_{B(b)}\ of\ Qty_{CR(3)} = \sum_{3}^{3} L_n + H_{L(3)} + E_{D(3)} + Dim_{S:Right/Bott(3)} - Dim_{S:Left/Top(3)} - L_{C(3)} - CC_{S:R/B(3)}$$

$$L_{B(b)}\ of\ Qty_{CR(3)} = (7000) + 450 + 3612.5 + 225 - 300 - 6475 - 40$$

$$L_{B(b)}\ of\ Qty_{CR(3)} = 4472.5\ mm \rightarrow 4.4725\ m$$

$$\therefore Check\ \left(L_{B(a)}\ of\ Qty_{CR} + L_{B(b)}\ of\ Qty_{CR} - 2S_{L(n)}\right) < Largest\ L_m$$

$$L_{B(a)}\ of\ Qty_{CR(3)} + L_{B(b)}\ of\ Qty_{CR(3)} - 2S_{L(3)} = 12.0375 + 4.4725 - (0.750) = 15.76\ m$$

$$Largest\ L_m = 12\ m$$

$15.76\ m > 12\ m$, Thus $L_{B(c)}\ of\ Qty_{CR(3)}$ will not replace $L_{B(a)}\ of\ Qty_{CR(3)}$ & $L_{B(b)}\ of\ Qty_{CR(3)}$

13. The program will compute the length of non-continuous reinforcement. (Must be converted into meter)

If the $Qty_{NCR(n)} = 0$. Then,

$$L_B\ of\ Qty_{NCR(n)} = 0\ mm \rightarrow 0\ m$$

If the $Qty_{NCR(n)} > 0$

- Case 1: $n = 1$ and $n = n_{last}$

$$L_B\ of\ Qty_{NCR(n)} = L_n + Dim_{S:Right/Bott(n)} + Dim_{S:Left/Top(n)} - CC_{S:L/T(1)} - CC_{S:R/B(n_{last})} + 2H_{L(n)}$$

- Case 2: $n = 1$ and $n < n_{last}$

$$L_B\ of\ Qty_{NCR(n)} = L_n + Dim_{S:Right/Bott(n)} + Dim_{S:Left/Top(n)} - CC_{S:L/T(1)} + H_{L(n)}$$

- Case 3: $n > 1$ and $n = n_{last}$

$$L_B\ of\ Qty_{NCR(n)} = L_n + Dim_{S:Right/Bott(n)} + Dim_{S:Left/Top(n)} - CC_{S:R/B(n_{last})} + H_{L(n)}$$

- Case 4: $n > 1$ and $n < n_{last}$

$$L_B\ of\ Qty_{NCR(n)} = L_n + Dim_{S:Right/Bott(n)} + Dim_{S:Left/Top(n)}$$

Example:

Ref (1): $Qty_{NCR(n)} = 1$, $n = 1$ and $n < n_{last}$. Thus Case 2

$$L_B\ of\ Qty_{NCR(1)} = L_n + Dim_{S:Right/Bott(n)} + Dim_{S:Left/Top(n)} - CC_{S:L/T(1)} + H_{L(n)}$$

$$L_B\ of\ Qty_{NCR(1)} = 3000 + 300 + 300 - 40 + 450$$

$$L_B\ of\ Qty_{NCR(1)} = 4010\ mm \rightarrow 4.01\ m$$

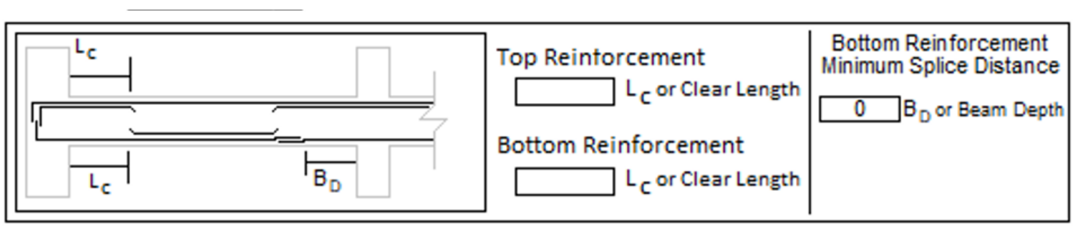
Ref (2): $Qty_{NCR(2)} = 0$. Thus,

$$L_B\ of\ Qty_{NCR(2)} = 0\ m$$

Ref (3): $Qty_{NCR(3)} = 0$. Thus,

$$L_B\ of\ Qty_{NCR(3)} = 0\ m$$

14. The program will compute the length of extra reinforcement. (Must be converted into meter)



If the $Qty_{ER(n)} = 0$. Then,

$$L_B\ of\ Qty_{ER(n)} = 0\ mm \rightarrow 0\ m$$

If the $Qty_{ER(n)} > 0$. Then,

- Case 1: $n = 1 = n_{last}$

$$L_B\ of\ Qty_{ER-A(n)} = xL_{C(n)} + 2Dim_{S:Left/Top(n)} + H_{L(1)} - CC_{S:L/T(1)}$$

$$L_B\ of\ Qty_{ER-B(n)} = xL_{C(n)} + 2Dim_{S:Right/Bott(n)} + H_{L(n_{last})} - CC_{S:R/B(n_{last})}$$

- Case 2: $n = 1$ and $n < n_{last}$

$$L_B\ of\ Qty_{ER-A(n)} = xL_{C(n)} + 2Dim_{S:Left/Top(n)} + H_{L(n)} - CC_{S:L/T(1)}$$

$$L_B\ of\ Qty_{ER-B(n)} = x\left(L_{C(n)} + L_{C(n+1)}\right) + 2Dim_{S:Right/Bott(n)}$$

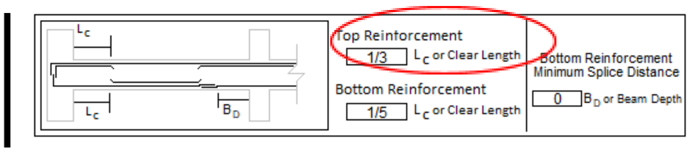
- Case 3: $n > 1$ and $n = n_{last}$

$$L_B\ of\ Qty_{ER-A(n)} = xL_{C(n)} + 2Dim_{S:Right/Bott(n)} + H_{L(n_{last})} - CC_{S:R/B(n_{last})}$$

- Case 4: $n > 1$ and $n < n_{last}$

$$L_B\ of\ Qty_{ER-A(n)} = x\left(L_{C(n)} + L_{C(n+1)}\right) + 2Dim_{S:Right/Bott(n)}$$

Example:



$$x = 1/3$$

Ref (1): $n = 1$ and $n < n_{last}$, thus Case 2

$$L_B\ of\ Qty_{ER-A(1)} = xL_{C(1)} + 2Dim_{S:Left/Top(1)} + H_{L(1)} - CC_{S:L/T(1)}$$

$$L_B\ of\ Qty_{ER-A(1)} = \frac{1}{3}(2400) + 2(300) + 450 - 40$$

$$L_B\ of\ Qty_{ER-A(1)} = 1810\ mm \rightarrow 1.81m$$

$$L_B\ of\ Qty_{ER-B(n)} = x\left(L_{C(1)} + L_{C(1+1)}\right) + 2Dim_{S:Right/Bott(1)}$$

$$L_B\ of\ Qty_{ER-B(n)} = \frac{1}{3}(2400 + 6400) + 2(300)$$

$$L_B\ of\ Qty_{ER-B(n)} = 3533.33\ mm \rightarrow 3.5333\ m$$

Ref (2): $n > 1$ and $n < n_{last}$, thus Case 4

$$L_B\ of\ Qty_{ER-A(2)} = x\left(L_{C(2)} + L_{C(2+1)}\right) + 2Dim_{S:Right/Bott(2)}$$

$$L_B\ of\ Qty_{ER-A(2)} = \frac{1}{3}(6400 + 6425) + 2(300)$$

$$L_B\ of\ Qty_{ER-A(2)} = 4875\ mm \rightarrow 4.875\ m$$

Ref (3): $n > 1$ and $n = n_{last}$, thus Case 3

$$L_B\ of\ Qty_{ER-A(3)} = xL_{C(n)} + 2Dim_{S:Right/Bott(n)} + H_{L(n_{last})} - CC_{S:R/B(n_{last})}$$

$$L_B\ of\ Qty_{ER-A(3)} = \frac{1}{3}(6425) + 2(225) + 450 - 40$$

$$L_B\ of\ Qty_{ER-A(3)} = 3001.67\ mm \rightarrow 3.00167\ m$$

15. After determining the quantities of main reinforcement and their respective required bar length, the program will determine their respective manufactured bars and no. of manufactured pcs

LEGEND:

NOTE:

- For $Qty_{CR(n)}$

    If $Qty_{CR(n)}$ $or\ its\ L_B\ is\ equal\ to\ ZERO\ then,$

$$Qty_{Pn} = 0\,pcs$$

$$L_{CBn} = 0\,m$$

    If $Difference = L_B - L_M \le \pm 150\ mm\ or\ 0.15\ m\ then,$

$$Qty_{Mn} = q\,Qty_{CR(n)}Qty_{BR}$$

$$L_{CBn} = L_M$$

    If $L_B > \left(Largest\ L_M + 0.15\right)$

$$Qty_{Mn} = q\,Qty_{CR(n)}Qty_{BR}$$

$$L_{CBn} = L_B$$

    Else, compute

$$Qty_{Pn} = \frac{L_M}{L_B\ of\ Qty_{CR(n)}}$$

$$Qty_{Mn} = q\frac{Qty_{CR(n)}}{Qty_{Pn}}Qty_{BR}$$

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

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

    And

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

    Then the program will choose the manufactured bar length with the lowest $Total\ Waste$, but the $Average\ L > 0$

- For $Qty_{NCR(n)}$ and $Qty_{ER(n)}$

    If $Qty_{CR(n)}$ $or\ its\ L_B\ is\ equal\ to\ ZERO\ then,$

$$Qty_{Pn} = 0\,pcs$$

$$L_{CBn} = 0\,m$$

    Else, compute

$$Qty_{Pn} = \frac{L_M}{L_B\ of\ Qty_{CR(n)}}$$

$$Qty_{Mn} = \frac{Qty_{CR(n)}}{Qty_{Pn}}Qty_{BR}$$

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

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

    And

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

Then the program will choose the manufactured bar length with the lowest $Total\ Waste$, but the $Average\ L > 0$

Example:

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

a) For Ref (1)

- $Qty_{CR(1)} = 2$ & $L_B\ of\ Qty_{CR(1)} = 1.835\ m$

L [m]	Difference
6	4.165
7.5	5.665
9	7.165
12	10.165

Since NO L_M has a $Difference \leq 0.15\ m$. Thus,

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	2	1.835	4	3.27	3	2.667	3	0.495	2	2.990
7.5				4.09	4	2	2	0.160	0	0.320
9				4.90	4	2	2	1.660	0	3.320
12				6.54	6	1.333	2	0.990	8	8.990

$Qty_{M(1a)} = 2$ & $L_{M(1a)} = 7.5\ m$

- $Qty_{NCR(1)} = 1$ & $L_B\ of\ Qty_{NCR(1)} = 4.01\ m$

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	1	4.01	4	1.50	1	4	4	1.990	0	7.960
7.5				1.87	1	4	4	3.490	0	13.960
9				2.24	2	2	2	0.980	0	1.960
12				2.99	2	2	2	3.980	0	7.960

$Qty_{M(1b)} = 2$ & $L_{M(1b)} = 9\ m$

- $Qty_{ER-A(1)} = 5$ & $L_B\ of\ Qty_{ER-A(1)} = 1.81\ m$

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	5	1.81	4	3.31	3	6.667	7	0.570	2	5.420
7.5				4.14	4	5	5	0.260	0	1.300
9				4.97	4	5	5	1.760	0	8.800

12				6.63	6	3.333	4	1.140	8	11.420

$Qty_{M(1c)} = 5 \& L_{M(1c)} = 7.5\, m$

- $Qty_{ER-B(1)} = 5 \& L_{B}\ of\ Qty_{ER-B(1)} = 3.533\, m$

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	5	3.5333	4	1.70	1	20	20	2.467	0	49.334
7.5				2.12	2	10	10	0.433	0	4.334
9				2.55	2	10	10	1.933	0	19.334
12				3.40	3	6.667	7	1.400	4	12.401

$Qty_{M(1d)} = 10 \& L_{M(1d)} = 7.5\, m$

b) For Ref (2)

- $Qty_{CR(2)} = 2 \& L_{B(a)}\ of\ Qty_{CR(2)} = 6.835\, m$

L [m]	Difference
6	0.835
7.5	0.665
9	2.165
12	5.165

Since NO L_M has a $Difference \leq 0.15\, m$. Thus,

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	2	6.835	4	0.88	0	####	####	0.000	#DIV/0!	#DIV/0!
7.5				1.10	1	8	8	0.665	0	5.320
9				1.32	1	8	8	2.165	0	17.320
12				1.76	1	8	8	5.165	0	41.320

$Qty_{M(2a)} = 8 \& L_{M(2a)} = 7.5\, m$

- $Qty_{CR(2)} = 2 \& L_{B(b)}\ of\ Qty_{NCR(2)} = 11.51\, m$

L [m]	Difference
6	5.510
7.5	4.010
9	2.510
12	0.490

Since NO L_M has a $Difference \leq 0.15\, m$. Thus,

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	2	11.51	4	0.52	0	####	####	0.000	#DIV/0!	#DIV/0!
7.5				0.65	0	####	####	0.000	#DIV/0!	#DIV/0!
9				0.78	0	####	####	0.000	#DIV/0!	#DIV/0!
10.5				0.91	0	####	####	0.000	#DIV/0!	#DIV/0!
12				1.04	1	8	8	0.490	0	3.920

$Qty_{M(2b)} = 8$ & $L_{M(2b)} = 12\ m$

- $Qty_{NCR(2)} = 0$ & $L_B\ of\ Qty_{NCR(2)} = 0\ m$

$Qty_{M(2c)} = 0$ & $L_{M(2c)} = 0\ m$

- $Qty_{ER-A(2)} = 4$ & $L_B\ of\ Qty_{ER-A(2)} = 4.875\ m$

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	4	4.875	4	1.23	1	16	16	1.125	0	18.000
7.5				1.54	1	16	16	2.625	0	42.000
9				1.85	1	16	16	4.125	0	66.000
12				2.46	2	8	8	2.250	0	18.000

$Qty_{M(2d)} = 16$ & $L_{M(2d)} = 6\ m$

c) For Ref (3)

- $Qty_{CR(3)} = 2$ & $L_{B(a)}\ of\ Qty_{CR(3)} = 12.0375\ m$

L [m]	Difference
6	6.038
7.5	4.538
9	3.038
12	0.037

$Qty_{M(3a)} = 8$ & $L_{M(3a)} = 12\ m$

- $Qty_{CR(3)} = 2$ & $L_{B(b)}\ of\ Qty_{NCR(3)} = 4.4725\ m$

L [m]	Difference
6	1.528
7.5	3.028
9	4.528
12	7.528

Since NO L_M has a $Difference \leq 0.15\ m$. Thus,

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	2	4.4725	4	1.34	1	8	8	1.528	0	12.220
7.5				1.68	1	8	8	3.028	0	24.220
9				2.01	2	4	4	0.055	0	0.220
12				2.68	2	4	4	3.055	0	12.220

$Qty_{M(3b)} = 4$ & $L_{CM(3b)} = 9\ m$

- $Qty_{NCR(3)} = 0$ & $L_B\ of\ Qty_{NCR(3)} = 0\ m$

$Qty_{M(3c)} = 0$ & $L_{CM(3c)} = 0\ m$

- $Qty_{ER-A(3)} = 4$ & $L_B\ of\ Qty_{ER-A(3)} = 3.00167\ m$

L [M]	Qty [Total]	L [B]	Qty (**B**eam**R**ow)	Qty [P]		Qty [M]		L [W]	L [E]	Total Waste
6	4	3.00167	4	2.00	1	16	16	2.998	0	47.973
7.5				2.50	2	8	8	1.497	0	11.973
9				3.00	2	8	8	2.997	0	23.973
12				4.00	3	5.333	6	2.995	8	22.975

$Qty_{M(3c)} = 8 \, \& \, L_{CM(3c)} = 7.5\,m$

16. The program will compute the weight of the production bars of that particular beam

If $L_{CM} \leq Largest\ L_M$

$$W_n = W_{Dn}\left(\sum L_{CMn} Qty_{Mn}\right)$$

If $L_{CM} > Largest\ L_M$

$$W_n = 1.005 W_{Dn}\left(\sum L_{CMn} Qty_{Mn}\right)$$

Where:

$W_{Dn} = Weight\ based\ on\ the\ diameter\ of\ the\ main\ reinforcement\ in\ that\ particular\ beam.$

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

Ref (1) Top Reinforcement diameter = 25 mm

$$W_1 = W_{D(1)}\left(\sum_{x=a}^{d} Qty_{M(1x)} L_{CM(1x)}\right)$$

$$W_1 = 3.854(2(7.5) + 2(9) ++ 5(7.5) + 10(7.5))$$

$$W_1 = 560.757\ kg$$

Ref (2)

$$W_2 = W_{D(2)}\left(\sum_{x=a}^{d} Qty_{M(2x)} L_{CM(2x)}\right)$$

$$W_2 = 3.854(8(7.5) + 8(12) + 0(0) + 16(6))$$

$$W_2 = 971.208\ kg$$

Ref (3)

$$W_3 = W_{D(3)}\left(\sum_{x=a}^{d} Qty_{M(3x)} L_{CM(3x)}\right)$$

$$W_3 = 3.854(8(12) + 4(9) ++ 0(0) + 8(7.5))$$

$$W_3 = 739.968\ kg$$

17. The program will then compute the total weight of the main reinforcement.

$$W_T = \sum W_n$$

Example:

$$W_T = \sum_{1}^{3} W_n = 560.757 + 971.208 + 739.968 = 2271.933\, kg$$