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Connection between Beam & Column.

Hinged Joint  

Rigid Joint

Connection exists if the moment B.M. of the applied load exists on the column

Joint if it exists on the B.M. column.  

Hinged or Rigid between the column and the column if it exists between both the column and the column Stiffness and that exists on the column.

\[
H = L \quad I_c = \frac{b t_c^3}{12} \quad I_b = \frac{b t_b^3}{12}
\]

\[
K_b = \frac{E I_b}{L} \quad K_c = \frac{E I_c}{H}
\]

Relative Stiffness.

\[
K_r = \frac{K_b}{K_c}
\]

If the connection is a Hinged Joint, its stiffness is much lower than the column stiffness.

If the connection is a Rigid Joint, its stiffness is equal to the column stiffness.

For calculating stiffness, it is assumed that:

\[
t_c \leq \frac{t_b}{2}
\]

and if it is assumed that:

\[
t_c \geq 0.8 t_b
\]

Systems Girders.
Girder’s Concrete Dimensions.

Simple Girder → For all types of soil.
Continuous Girder → For medium and hard soil.

Concrete Dimensions.

* Span of girders \( L = (4.0 \rightarrow 12.0 \text{ m}) \).

\[ \begin{align*}
  \text{Simple} & \quad t_G = \frac{L}{10} \\
  \text{Continuous} & \quad \frac{L}{12} \\
  \text{Cantilever} & \quad \frac{L_c}{5}
\end{align*} \]

* \( t_c \leq t_G \quad (t_c \approx 0.7 \rightarrow 0.9 \ t_G) \)

* \( b = \frac{0.30 \text{ m}}{\text{Spacing}} \) (largest)

\( \quad \)
**hinged support** بين الكمره و العمود عباره عن **Connection** و ذلك لان 
أي أنتنا أحملنا الـ $t_c \leq t_C$ بين الكمره و العمود. $Frame$ $action$ $wL^2/24$ من الكمره الى العمود و تعمله عند تصميم العمود.

---

**Frame** عن $-12 \leq m$ يتحول الى **Span** لانها لن تستطيع إهمال الـ $Frame$ $action$ حتى إذا كانت $t_c \leq t_C$

$L > 12.0 m$
RFT. of Girders.

Design on $P$ & $M_{add.}$

buckling

$\frac{wL^2}{24}$
Continuous Girder Two spans.

\[ \frac{w L^2}{24} \]

\[ \frac{w L^2}{9} \]

\[ \frac{w L^2}{11} \]

Stirrup Hangers \((0.1 \rightarrow 0.2) A_s\)

\[ A_s \text{ for } \frac{w L^2}{24} \]

\[ 0.5 A_s \]

\[ 0.5 A_s \]

\[ 0.5 A_s \]

\[ 0.5 A_s \]

Sec. \((3-3)\)  
Sec. \((2-2)\)  
Sec. \((1-1)\)
Beam with Cantilever.

$1.5 L_c \quad L_c$

$0.2 L \quad 400 \text{ mm}$

$0.10 L \quad L$

$0.15 L \quad L_c$

$A_s \text{ For } \frac{wL^2}{24}$

$A_s \text{ Cantilever}$

$0.5 A_s$

$0.5 A_s$

$A_s \text{ For } \frac{wL^2}{24}$

$\text{Stirrup Hangers } (0.1 \to 0.2) A_s$

$\text{Shrinkage bars } \text{ IF } t > 700 \text{ mm}$

$\text{Sec. (3–3)} \quad \text{Sec. (2–2)} \quad \text{Sec. (1–1)}$
Girder with variable depth.

Mekan 'ám 'l-kür 'l-ziyàdàh Variable depth 'Systemàr èl-làzàyàdàh Seàr àa l-ziyàdàh màqàmàh àl-kàbir.

$t \approx \frac{L}{12}$
**Continuous Girder**

Continuous Girders are preferred over indeterminate Girders because they distribute loads more efficiently. However, if we use Continuous Girders, we need an intermediate Hinge to accommodate the load.

---

**Continuous Girder (2 Spans)**

![Diagram of Continuous Girder with intermediate Hinge](image)

- Intermediate Hinge
- Span length: $L$
- Support
- Load: 2 cm.

---

*(Systems)* **Girders.**

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Continuous Girders (More than 2 Spans)

Floating Bay

Continuous Girders (More than 3 Spans)
* Design the Column.

\[ P = \text{Reaction of the girder.} \]

Check Buckling.

(1) In Plane.

\[ H_o = h \]

\[ \lambda_b = \frac{1.2 \times H_o}{t} \]

* IF \( \lambda_b \leq 10 \) Designed \( P \) only
* IF \( \lambda_b > 10 \) Designed \( P, M_{\text{add.}} \)

(2) Out of Plane

\[ H_o = \text{The bigger of } h_1, h_2 \]

\[ \lambda_b = \frac{1.2 \times H_o}{b} \]

* IF \( \lambda_b \leq 10 \) Designed \( P \) only
* IF \( \lambda_b > 10 \) Designed \( P, M_{\text{add.}} \)
Simple Girder with Sky Light
Girder with Sky Light.
Real Support

Neoprene Plate.

If the span is larger than 12 m, the support will not be a real support and it will be a girder support.

Real Hinge

It is a beam section between two parallel sections.

Roller support

It allows free rotation of the beam section.

Hinged support

It allows free rotation of the beam section.
Frame span عن - 12.0 م ينتقل العزم من الكرم إلى العمود فيتحول إلى Girder span عند زيادة

\[ L > 12.0 \text{ m} \]

\[ L < 12.0 \text{ m} \]

إذا ارتفعت أن تكون الأعمدة أكبر من - 12.0 م لا ينتقل العزم من الكرم إلى العمود Real support لا يتحول إلى girder أي يظل بين الكرم والعمود Frame يتحول إلى girder.

\[ t_c = \frac{L}{10} \]

\[ t_c = \frac{H}{8 \to 9} \]

when \[ L = (12.0 \to 20.0 \text{ m}) \]

when \[ L = (20.0 \to 40.0 \text{ m}) \]

و.o.w. يفضل لتخطيط الـ (Systems) Girders.
Systems 
خطوات مسألة الـ

1. اختيار الـ system
2. رسم elevation & Plan في ال concrete Dim.
3. Plan رسم تسليح البلاطة على نفس الـ
4. عمل لل블اطات و حساب الاعمال على ال Load distribution
5. حل ال B.M.D. & N.F.D. و رسم System
6. تصميم قطاعات ال M,N على System
7. رسم التسليح و التفريد في ال elevation
Example.

Sec. A–A

\[ F_{cu} = 25 \, N/mm^2 \quad , \quad F_y = 360 \, N/mm^2 \]

\[ L.L. = 1.50 \, kN/m^2 \quad , \quad F.C. = 2.0 \, kN/m^2 \]

Foundation Level. \( = -2.0 \, m \)

Req.
1. Draw concrete Dimensions in elevation.
2. Show the statical system For the main system.
3. Design the slabs & Draw its RFT. in plan.
4. Design the Main system and draw its RFT. in elevation & Cross–Sec.

Structural joint

2.0 cm 5.0 5.0 5.0 5.0

Key Plan

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Concrete Dimensions.

The shape of the beam at the top is a rectangle. It is not a system where it is assumed the shape of the beam is rectangular.

Foundation Level. = -2.0 m

It is preferable to assume the distances between the columns and the columns are one way until the distance is a small value, which is the case in the calculations.

The column does not buckle under the load as in the longitudinal direction.

This is because it will not buckle under the load in the plane.

The column will not increase the cross-sectional area by more than 3%.

\[ t_c = \frac{L}{12} = \frac{10}{12} = 0.833 = 0.85 \text{ m} \]

\[ b = 0.30 \text{ m} \quad \text{but For column } C_1 \quad b = 0.40 \text{ m} \]

\[ t_c \approx 0.7 \quad t_c = 0.65 \text{ m} \]

\[ t_{sec.B} = \frac{\text{spacing}}{12} = \frac{5.0}{12} = 0.416 \approx 0.45 \text{ m} \]
Girders Designed on $M$

Columns
Check Buckling
and Designed on $P, M_{add}$
Design of slabs.

\[ t_s = \frac{L_s}{30} = \frac{2000}{30} = 66.7 \text{ mm} \]

\[ \text{take } t_s = 120 \text{ mm} \]

\[ W_s = 1.4 (t_s \delta_c + F.C.) + 1.6 (L.L.) \]

\[ \left( W_s \right)_{U.L.} = 1.4 (0.12 \times 25 + 2.0) + 1.6 (1.50) = 9.40 \text{ kN/m}^2 \]

\[ W_s = 9.40 \text{ kN/m}^2 \]
$W_s = 9.40 \text{ kN/m}$

\[ \frac{wL^2}{24} = 1.57 \]
\[ \frac{wL^2}{10} = 3.76 \]
\[ \frac{wL^2}{12} = 3.13 \]

Sec. ①

$M_{U.L.} = 3.76 \text{ kN.m/m}$

$t_s = 120 \text{ mm}, \quad d = 100 \text{ mm}$

$100 = C_1 \sqrt{\frac{3.76 \times 10^6}{25 \times 1000}} \quad \rightarrow \quad C_1 = 8.15 \quad \rightarrow \quad J = 0.826$

$A_s = \frac{3.76 \times 10^6}{0.826 \times 360 \times 100} = 126.4 \text{ mm}^2/\text{m} \quad \textcircled{5 \phi 10 \text{ m}}$
RFT. of the Slabs.
Loads on Beams.
o.w. of Beams & Girder = 1.4 b t δ_c

Beams (250*450) o.w. = 1.4 (0.25) (0.45) (25) = 3.90 kN/m

Girder (300*850) o.w. = 1.4 (0.30) (0.85) (25) = 8.90 kN/m

\[ B_1 \]

\[ \omega_a = \omega_e = \text{o.w.} + w_s \frac{L_s}{2} \]

\[ = 3.90 + (9.40) \left( \frac{2.0}{2} \right) = 13.30 \text{ kN/m} \]

\[ R_1 = \omega_a \times \text{Spacing} = 13.30 \times 5.0 = 66.5 \text{ kN} \]

\[ R_1 = 66.5 \text{ kN} \]

\[ B_2 \]

\[ \omega_a = \omega_e = \text{o.w.} + 2 w_s \frac{L_s}{2} \]

\[ = 3.90 + 2 (9.40) \left( \frac{2.0}{2} \right) = 22.7 \text{ kN/m} \]

\[ R_2 = \omega_a \times \text{Spacing} = 22.7 \times 5.0 = 113.5 \text{ kN} \]

\[ R_2 = 113.5 \text{ kN} \]
Loads on the Girder.

**o.w. of Girder** (300 \* 850)

**o.w.** = 1.4 \( (0.30 \times 0.85 \times 25) \) = 8.90 kN/m

\[ W = \text{o.w.} + \frac{\Sigma P}{\text{span}} = 8.90 + \frac{4 \times 113.5}{10.0} = 54.3 \text{ kN/m} \]

66.5 kN

\[ R_1 = 0.4wL + 80.2 = 0.4 \times 54.3 \times 10 + 66.5 = 283.7 \text{ kN} \]

\[ R_2 = 1.2wL + 139 = 1.2 \times 54.3 \times 10 + 113.5 = 765.1 \text{ kN} \]

\[ \frac{wL^2}{24} = 226.25 \text{ kN.m} \]

\[ \frac{wL^2}{9} = 603.3 \text{ kN.m} \]

\[ \frac{wL^2}{11} = 493.6 \text{ kN.m} \]
Sec. 1 \[ M_{U.L.} = 603.3 \text{ kN.m} \quad R-\text{Sec.} \]

Take \[ d = 0.80 \text{ m} \quad (\text{as taken in the concrete dimensions}) \]

\[ 800 = C_1 \sqrt{\frac{603.3 \times 10^6}{25 \times 300}} \quad \rightarrow \quad C_1 = 2.82 \quad \rightarrow \quad J = 0.721 \]

\[ \therefore A_S = \frac{M_{U.L.}}{J \cdot F_y \cdot d} = \frac{603.3 \times 10^6}{0.721 \times 360 \times 800} = 2905.4 \text{ mm}^2 \]

Check \[ A_{s_{\text{min}}} \]

\[ A_{s_{\text{req.}}} = 2905.4 \text{ mm}^2 \]

\[ \mu_{\text{min.}} b d = (0.225 \times \frac{\sqrt{F_{cu}}}{F_y}) b d = (0.225 \times \frac{25}{360}) 300 \times 800 = 750 \text{ mm}^2 \]

\[ \therefore A_{s_{\text{req.}}} > \mu_{\text{min.}} b d \quad \therefore \text{Take } A_S = A_{s_{\text{req.}}} = 2905.4 \text{ mm}^2 \quad 8 \Phi 22 \]

\[ \therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{22 + 25} = 5.85 = 5.0 \text{ bars} \]

Sec. 2 \[ M_{U.L.} = 226.25 \text{ kN.m} \quad R-\text{Sec.} \]

\[ 800 = C_1 \sqrt{\frac{226.25 \times 10^6}{25 \times 300}} \quad \rightarrow \quad C_1 = 4.60 \quad \rightarrow \quad J = 0.82 \]

\[ \therefore A_S = \frac{M_{U.L.}}{J \cdot F_y \cdot d} = \frac{226.25 \times 10^6}{0.82 \times 360 \times 800} = 958.0 \text{ mm}^2 \]

Check \[ A_{s_{\text{min}}} \]

\[ A_{s_{\text{req.}}} = 958.0 \text{ mm}^2 \]

\[ \mu_{\text{min.}} b d = (0.225 \times \frac{\sqrt{F_{cu}}}{F_y}) b d = (0.225 \times \frac{25}{360}) 300 \times 800 = 750 \text{ mm}^2 \]

\[ \therefore A_{s_{\text{req.}}} > \mu_{\text{min.}} b d \quad \therefore \text{Take } A_S = A_{s_{\text{req.}}} = 958.0 \text{ mm}^2 \quad 3 \Phi 22 \]
Sec. 3 \[ M_{U.L.} = 493.6 \text{ kN.m} \quad T-Sec. \]

Take \( d = 0.80 \text{ m} \) (as taken in the concrete dimensions)

\[
B = \begin{cases} 
C.L. - C.L. = \text{Spacing} = 5.0 \text{ m} = 5000 \text{ mm} \\
16 t_s + b = 16 \times 120 + 300 = 2220 \text{ mm} \\
K \frac{L}{5} + b = 0.8 \times \frac{10000}{5} + 300 = 1900 \text{ mm} 
\end{cases}
\]

\[ B = 1900 \text{ mm} \]

\[
\therefore 800 = C_1 \sqrt{\frac{493.6 \times 10^6}{25 \times 1900}} \quad C_1 = 7.84 \quad \rightarrow J = 0.826
\]

\[
\therefore A_S = \frac{M_{U.L.}}{J F_y d} = \frac{493.6 \times 10^6}{0.826 \times 360 \times 800} = 2075 \text{ mm}^2
\]

Check \( A_{S_{min.}} \)

\[
A_{S_{req.}} = 2075 \text{ mm}^2
\]

\[
\mu_{min.} b d = \left( 0.225 \times \frac{F_{cu}}{F_y} \right) b d = \left( 0.225 \times \frac{25}{360} \right) 300 \times 800 = 750 \text{ mm}^2
\]

\[ A_{S_{req.}} > \mu_{min.} b d \quad \therefore \text{Take } A_S = A_{S_{req.}} = 2075 \text{ mm}^2 \]

\[ \text{Stirrup Hangers } = (0.1 \rightarrow 0.2) \quad A_S = (0.1 \rightarrow 0.2) \quad 2075 \quad 6 \# 22 \]

\[ \text{Stirrup Hangers } = (0.1 \rightarrow 0.2) \quad A_S = (0.1 \rightarrow 0.2) \quad 2075 \quad 3 \# 12 \]
Design of the Columns.

Column \( C_1 \)

\[ P = R_1 = 765.1 \text{ kN} \]

1. **In Plane.**

   Case 1

   \[ H_0 = 7.15 \text{ m} \]

   \[ \lambda_b = \frac{K \cdot H_o}{t} = \frac{1.2 \cdot 7.15}{0.65} = 13.2 > 10 \]

2. **Out of Plane.**

   Case 1

   \[ H_0 = 7.55 \text{ m} \]

   \[ \lambda_b = \frac{K \cdot H_o}{b} = \frac{1.2 \cdot 7.5}{0.40} = 22.65 < 23 \]

\[ \therefore \text{The column is long at out of plane direction.} \]

\[ \delta = \frac{(\lambda_b)^2 \cdot b}{2000} = \frac{22.65^2 \cdot 0.40}{2000} = 0.1026 \text{ m} \]

\[ M_{add} = P \cdot \delta = 765.1 \cdot 0.1026 = 78.50 \text{ kN.m} \]

\[ \begin{array}{c}
\text{78.50 kN.m} \\
765.1 \text{ kN}
\end{array} \]
\[ e = \frac{M}{P} = \frac{78.50}{765.1} = 0.101 \text{ m} \quad \therefore \quad \frac{e}{t} = \frac{0.1026}{0.40} = 0.256 \quad < 0.5 \quad \text{use} \quad \text{I.D.} \]

\[ \zeta = \frac{0.4 - 0.1}{0.4} = 0.75 = 0.7 \quad \text{use} \quad \text{ECCS Page 4–25} \]

\[
\begin{align*}
\frac{P_u}{F_{cu} b t} &= \frac{765.1 \times 10^3}{25 \times 650 \times 400} = 0.117 \\
\frac{M_u}{F_{cu} b t^2} &= \frac{78.50 \times 10^6}{25 \times 650 \times 400^2} = 0.030
\end{align*}
\]

\[ \rho < 1.0 \quad \text{Take} \quad \rho = 1.0 \]

\[ A_s = A_s^* = \mu b t = P_f F_{cu} \times 10^{-4} b t = 1.0 \times 25 \times 10^{-4} \times 650 \times 400 = 650 \text{ mm}^2 \]

\[ A_{s_{\text{total}}} = A_s + A_s^* = 1300 \text{ mm}^2 \]

\[ A_{s_{\text{min}}} = \frac{0.25 + 0.052 \lambda_{\text{max}}}{100} b t \]

\[ = \frac{0.25 + 0.052 (22.65)}{100} \times 650 \times 400 = 3712.28 \text{ mm}^2 > A_{s_{\text{total}}} \]

\[ A_s = A_s^* = \frac{3712.28}{2} = 1856.14 \text{ mm}^2 \quad 5 \phi 22 \]

\[ \text{Diagram:} \quad \text{5} \phi 22 \]

\[ \text{5} \phi 22 \]

\[ \text{5} \phi 22 \]

\[ \text{2} \phi 12 \]

\[ \text{5} \phi 22 \]

\[ \text{0.40} \]

\[ \text{0.65} \]
Column C2

\[ P = R_2 = 283.7 \text{ kN} \]

1. **In Plane.**

\[ H_o = 7.15 \text{ m} \]

\[ \lambda_b = \frac{K \cdot H_o}{t} = \frac{1.2 \cdot 7.15}{0.65} = 13.2 > 10 \]

\[ \delta = \left( \frac{\lambda_b}{2000} \right) \cdot t = \frac{13.2^2 \cdot 0.65}{2000} = 0.056 \text{ m} \]

\[ M_{add} = P \cdot \delta = 283.7 \cdot 0.056 = 15.88 \text{ kN.m} \]

\[ e = \frac{M}{P} = \frac{15.88}{283.7} = 0.056 \text{ m} \]

\[ \zeta = \frac{0.65 - 0.1}{0.65} = 0.8 \text{ use ECCS Page 4-24} \]

\[ \frac{P_U}{F_{cu} \cdot b \cdot t} = \frac{283.7 \cdot 10^3}{25 \cdot 300 \cdot 650} = 0.058 \]

\[ M_{U} \text{ is } \frac{15.88 \cdot 10^6}{25 \cdot 300 \cdot 650^2} = 0.0050 \]

\( \rho < 1.0 \), Take \( \rho = 1.0 \)

\[ A_S = A_S' = \mu \cdot b \cdot t = P \cdot F_{cu} \cdot 10^{-4} \cdot b \cdot t = 1.0 \cdot 25 \cdot 10^{-4} \cdot 300 \cdot 650 = 487.5 \text{ mm}^2 \]

\[ A_{S_{total}} = A_S + A_S' = 975 \text{ mm}^2 \]

\[ A_{S_{min}} = \frac{0.25 + 0.052 \lambda_{max}}{100} \cdot b \cdot t \]

\[ = \frac{0.25 + 0.052 \cdot 13.2}{100} \cdot 300 \cdot 650 = 1826 \text{ mm}^2 > A_{S_{total}} \]

\[ A_S = A_S' = \frac{1826}{2} = 913 \text{ mm}^2 \]

\[ \boxed{3 \neq 22} \]
Example.

14.0 m

10 \times 7.0 m = 70.0 m

(+ 5.00)

2.0 m 10.0 m 2.0 m
If the slab is Solid Slab

(+) 5.0
0.85
1.5
0.5
0.70
(+0.00)
(-2.00)

girders.

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RFT. of slabs

Load Distribution
If the slab is Hollow Blocks.

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IF the slab is Hollow Blocks.

2.0 5.0 5.0 2.0

RFT. of slabs

7.0

Load Distribution

7.0

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Example.

14.0 m

10 * 7.0 m = 70.0 m

(+ 5.00)

7.0 m 7.0 m
IF the slab is Solid Slab

+5.00

1.50

0.5

±0.00

-2.00

3.50  3.50  3.50  3.50

0.45  0.60

0.50

7.0  7.0
IF the slab is Solid Slab

KEY PLAN

 plan

Systems

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IF the slab is Solid Slab

RFT. of slabs

Load Distribution
IF the slab is Hollow Blocks.

(+5.00)

1.50

0.5

(±0.00)

(-2.00)

0.25

0.60

0.50

7.0

7.0
IF the slab is Hollow Blocks.

RFT. of slabs

Load Distribution

(Systems) Girders.
Example.

$F_{cu} = 25 \text{ N/mm}^2$, $F_y = 360 \text{ N/mm}^2$

$L.L. = 1.5 \text{ kN/m}^2$, $F.C. = 2.0 \text{ kN/m}^2$

Foundation Level. $= -2.0 \text{ m}$

**Reg.**

1. **Draw concrete Dimensions in plan & elevation.**
2. **Show the statical system For the main system.**
3. **Design the slabs & Draw its RFT. in plan.**
4. **Design the secondary beams and draw its RFT. in elevation & Cross-Sec.**
5. **Design the Main system and draw its RFT. in elevation & Cross-Sec.**

Key Plan
Plan concrete Dimensions.

Girder  (300*800)

Beam  (250*500)

3.13  2.61  2.61  2.61  2.61  2.61  2.61  2.61  3.13

5.0  5.0  5.0
Design of slabs.

Two way Slabs

\[ t_s = \frac{L_s}{40} = \frac{3130}{40} = 78.2 \text{ mm} \quad t_s = 120 \text{ mm} \]

\[ W_{S_i} = 1.4 \left( t_s \delta_c + F.C. \right) + 1.6 \left( L.L. \right) \cos \Theta \]

\[ W_{S_i} = 1.4 \left( 0.12 \times 25 + 2.0 \right) + 1.6 \left( 1.50 \right) \cos 16.7^\circ = 9.30 \text{ kN/m}^2 \]

\[ W_{S_i} = 9.30 \text{ kN/m}^2 \]
Strip (1)

\[ \alpha \, W_{si} \]

Strip (2)

\[ M \cdot \cos \theta \]

\[ \beta \, W_{si} \]
RFT. of the Slabs.
Loads on Beams.

o.w. of Beams & Girder $= 1.4 \, b \, t \, \delta_c$

**Beams** $(250 \times 500)$  
O.w. $= 1.4 \, (0.25) \, (0.5) \, (25) = 4.30 \, kN/m$

**Girder** $(300 \times 800)$  
O.w. $= 1.4 \, (0.30) \, (0.8) \, (25) = 8.40 \, kN/m$

---

$B_1$

\[ C_a = 1 - \frac{1}{2} \left( \frac{L_b}{L} \right) = 1 - \frac{1}{2} \left( \frac{3.13}{5} \right) = 0.68 \]

\[ C_e = 1 - \frac{1}{3} \left( \frac{L_b}{L} \right)^2 = 1 - \frac{1}{3} \left( \frac{3.13}{5} \right)^2 = 0.87 \]

\[ \omega_a = 0.\bar{W} + C_a \, \omega_{s_i} \, \frac{L_b}{2} = 4.30 + 0.68 \left( \frac{3.13}{2} \right) = 14.2 \, kN/m \]

\[ \omega_e = 0.\bar{W} + C_e \, \omega_{s_i} \, \frac{L_b}{2} = 4.30 + 0.87 \left( \frac{3.13}{2} \right) = 17.0 \, kN/m \]

\[ R_1 = \omega_a \times \text{Spacing} = 14.2 \times 5.0 = 71.0 \, kN \quad \boxed{R_1 = 71.0 \, kN} \]
\[ B_2 \]

**Trapezoid (1)**

\[
C_a = 1 - \frac{1}{2} \left( \frac{L_s}{L} \right) = 1 - \frac{1}{2} \left( \frac{3.13}{5} \right) = 0.68
\]

\[
C_e = 1 - \frac{1}{3} \left( \frac{L_s}{L} \right)^2 = 1 - \frac{1}{3} \left( \frac{3.13}{5} \right)^2 = 0.87
\]

**Trapezoid (2)**

\[
C_a = 1 - \frac{1}{2} \left( \frac{L_s}{L} \right) = 1 - \frac{1}{2} \left( \frac{2.61}{5} \right) = 0.74
\]

\[
C_e = 1 - \frac{1}{3} \left( \frac{L_s}{L} \right)^2 = 1 - \frac{1}{3} \left( \frac{2.61}{5} \right)^2 = 0.91
\]

\[
\omega_a = 0.\text{w.} + C_a \frac{w_{si}}{2} \left( \frac{L_s}{L} \right) + C_e \frac{w_{si}}{2} \left( \frac{L_s}{L} \right)^2 = 4.30 + 0.68 \left( \frac{9.30}{2} \right)^2 + 0.74 \left( \frac{9.30}{2} \right)^2 = 23.1 \text{ kN/m}
\]

\[
\omega_e = 0.\text{w.} + C_e \frac{w_{si}}{2} \left( \frac{L_s}{L} \right) + C_e \frac{w_{si}}{2} \left( \frac{L_s}{L} \right)^2 = 4.30 + 0.87 \left( \frac{9.30}{2} \right)^2 + 0.91 \left( \frac{9.30}{2} \right)^2 = 28.0 \text{ kN/m}
\]

\[ R_2 = \omega \cdot \text{Spacing} = 23.1 \cdot 5.0 = 115.5 \text{ kN} \quad \boxed{R_2 = 115.5 \text{ kN}} \]

\[ B_3 \]

**Trapezoid**

\[
C_a = 1 - \frac{1}{2} \left( \frac{L_s}{L} \right) = 1 - \frac{1}{2} \left( \frac{2.61}{5} \right) = 0.74
\]

\[
C_e = 1 - \frac{1}{3} \left( \frac{L_s}{L} \right)^2 = 1 - \frac{1}{3} \left( \frac{2.61}{5} \right)^2 = 0.91
\]

\[
\omega_a = 0.\text{w.} + 2C_a \frac{w_{si}}{2} \left( \frac{L_s}{L} \right) = 4.30 + 2 \left( 0.74 \right) \left( \frac{2.61}{2} \right) = 22.2 \text{ kN/m}
\]

\[
\omega_e = 0.\text{w.} + 2C_e \frac{w_{si}}{2} \left( \frac{L_s}{L} \right) = 4.30 + 2 \left( 0.91 \right) \left( \frac{2.61}{2} \right) = 26.3 \text{ kN/m}
\]

\[ R_3 = \omega \cdot \text{Spacing} = 22.2 \cdot 5.0 = 111 \text{ kN} \quad \boxed{R_3 = 111 \text{ kN}} \]
Girders

designed on $M$

Solved by 3 Moment eqn.

Columns

check buckling

and designed on $P, M_{add}$
Example.

Sec. A–A

Req.
1. Draw concrete Dimensions in plan & elevation.
2. Draw RFT. of slabs in plan.
Plan concrete Dimensions.

Plan

Girder (300*1000) Girder (300*1000)

Beam (250*500)

120

5.0

2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5

10.0

5.0

5.0

5.0

5.0

10.0
Columns

Check Buckling

and Designed on $P, M_{add}$
RFT. of the Slabs.
Example.

Req.
1- Draw concrete Dimensions in plan & elevation.
2- Draw RFT. of slabs in plan.

Key Plan
Girders

Desined on $M$

Column $C$

Check Buckling

and Desined on $P, M_{add}$
RFT. of the Slabs.
Example.

Row.

1 - Draw concrete Dimensions in plan & elevation.
2 - Draw RFT. of slabs in plan.

Plan
Girders
Designed on $M$

Columns
Check Buckling
and Designed on $P, M_{add}$
RFT. of the Slabs.