Note: - 1- Design followed ACI Code,
and 2- Assume any suitable values when required.

01)

Two-way Slabs

In a typical floor of a multi storey framed building, clear span between supports equal to 6.80m. Ultimate uniform distributed load on the slab is 12 kN/m^2, preliminary thickness of slab = 175mm, fc` = 28MPa, fy = 420 MPa for all types of reinforcement. Use DDM and consider all limitations satisfied.

1. **Determine the thickness and steel reinforcement required for the maximum negative moment in the column strip of an interior frame only. Consider the panels are supported by beams as shown in Fig.1.**
2. **Calculate the thickness and steel reinforcement required for the maximum negative moment in the column strip of an interior frame only. Consider the slab with drop panels(c=1) as shown in Fig.2.**
3. **Find the thickness and steel reinforcement required for the maximum negative moment in the column strip of an interior frame only. Consider the panels are without interior beams as shown in Fig.3.**

See Fig (1-a)

02)

Reinforced Concrete Two-way Slab

A two - way slab system shown in Fig. has the following given data :

- The building consist of five stories, height of each storey = 3.2 m.
- All columns are 400 x 400mm in dimension.
- Exterior Beams are 400 x 580 mm overall cross-section and α =(Ib / Is) = 4.0.
- Ultimate uniform distributed load = 12 kN/m^2.
- fc` = 25 MPa and fy = 414 MPa for all types of reinforcement.

1- Design the most critical panel (find amount of steel reinforcement and spacing).
2- Re-Design the same panel using YLT.
3- Compare the results and comment.

See Fig (1-b)

<u>03)</u>

A typical floor of two - way slab system shown in the attached figure and has the following given data:

- The building consist of six stories, height of each storey = 3.35 m.
- Use thickness of slab of 200mm.
- Consider superimposed dead load of 3.0 kN/m^2 (weight of finishing materials and additional loads).
- Live load = 3.0 kN/m^2.
- Use fc` = 24 MPa and fy = 420 MPa for all types of reinforcement.

1- **Calculate the maximum negative and positive moments in middle strip for an interior frame by the DDM (consider all limitations are satisfied).** Assume α = Ib / Is = 5 for all beams, torsional constant, C = 8.0 x 10^9 mm^4, and β = C / 2Is = 1.25 if required.

2- **Determine the maximum negative and positive moments in middle strip for an interior frame by the EFM.** Assume that the design negative moment at face of support is equal to 0.8 of the maximum negative at center of the column, k = 4 EI / L, COF = 0.5, M_{FEM} = 0.0833 Wu L_2 L_1^2, Kc = 11 x 10^4 kN.m,
Ksb = 6.0 x 10^4 kN.m and Kt = 4.5 x 10^4 kN.m when required.

3- **Find the maximum negative and positive moments for the maximum panel size by the Yield Line Theory (YLT),** assume m_{neg} = 2m_{pos}.

4- **Compare the negative and positive moments obtained from the different methods (DDM, EFM and YLT) and write your comments.**

5- **Calculate the amount of reinforcement required for the maximum negative moment determined by the YLT.**

See Fig (1-c)

<u>04)</u>

A typical floor of two - way slab system shown in the Fig. has the following given data:

- The building consist of four stories, height of each storey = 3.40 m.
- Preliminary thickness of slab of 175mm.
- Consider superimposed dead load of 4.0 kN/m^2 (weight of finishing materials and additional loads).
- Live load = 2.5 kN/m^2.
- Use fc` = 21 MPa and fy = 420 MPa for all types of reinforcement.
- Assume $\alpha = Ib / Is = 5$ for exterior beams, torsional constant, $C = 8.0 \times 10^9\ mm^4$, and $\beta = C / 2Is = 1.25$ if required.

1. **Determine the minimum thickness required for deflection control.**
2. **Check the punching shear strength of an interior column (critical one).**
3. **Calculate the maximum negative and positive moments in column and middle strips for an interior frame by the DDM (consider all limitations are satisfied).**

See Fig (1-d)

<u>05)</u>

The two - way slab system, its typical floor shown in the Figiure, has the following given data :

* The building consist of six stories, height of each storey = 3.4 m.
* Corner and edge columns are 400x400mm, and interior columns are 450 mm in diameter.
* Exterior beams are 400 x 550 mm overall cross-section.
* Interior beams are 400 x 550 mm overall cross-section.
* Preliminary thickness of the slab is 150mm.
* Ultimate uniform distributed load = 13.0 kN/m^2(7.7 kN/m^2 dead load and 5.3kN/m^2 live load)
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.
* Use $\alpha = Ib / Is = 5$ for interior and $\alpha = Ib / Is = 8$ for exterior beams, $\beta = C / 2Is = 0.85$.

1- Check minimum thickness required for deflection control for the slab system. 15 *Marks*

2- Find maximum negative and positive moments for an interior frame in the middle strip by DDM (consider that all limitations satisfied). 15 *Marks*

3- Calculate maximum negative and positive moments for an interior frame in the middle strip by EFM. Use k = 4 EI / L, COF = 0.5, $M_{FEM} = 0.0833\ Wu\ L_2\ L_1^2$, $Kc=4.2 \times 10^4$ kN.m, Ksb = 4.0×10^4 kN.m, torsional constant, $C = 7.7 \times 10^8\ mm^4$. *25 Marks*

4- Find the negative and positive moments for an interior panel by YLT, assume $m_{pos.} = 0.7\ m_{neg}$. *15 Marks*

5- Determine amount of steel reinforcement required for the maximum negative moment in the middle strip only. *15 Marks*

6- Compare the results obtained from DDM, EFM and YLT and comment. *15 Marks*

See Fig (2)

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06)

Reinforced Concrete Two-way Slab

A two - way slab system shown in Fig. has the following given data :

- The building consist of six stories, height of each storey = 3.5 m.
- All columns are 400 x 400mm in dimension.
- Exterior Beams are 400 x 560 mm overall cross-section and α =(Ib / Is) = 4.0.
- Ultimate uniform distributed load = 11 kN/m^2.
- fc` = 28 MPa and fy = 414 MPa for all types of reinforcement.

1. **Design the most critical panel (find amount of steel reinforcement and spacing).**
2. **Re-Design the same panel using YLT.**
3. **Compare the results and comment.**

See Fig (3)

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07)

Two-way slab (DDM)

A typical two - way slab floor system shown in Fig. and has the following given data :

* The building consists of three storey and the height of each = 3.5 m.
* Upper and lower columns size are 400 x 400 mm square.
* Beams cross-section are 400 x 550 mm overall.
* Thickness of the slab is 15cm.
* Ultimate uniform distributed load = 12 kN/m^2
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.

Design the middle strip for the maximum negative moment in long direction only.
Hint: Assume that limitations of DDM are satisfied.

08)

Two way slab(YLT)

A two - way slab shown in Fig. and has the following data :

* Slab thickness = 17 cm.
* Service live load 3 kN/m^2
* Column size φ40cm.
* Concrete compressive strength, fc` = 25 MPa and
* Steel yield strength, fy = 350 MPa for φ 12mm steel bar.

1- For the mode of failure drawn, calculate the negative and positive moments, amount of steel required and sketch the details.
2- Draw at least two other modes of failure.
Hint: 1- Dead load is based on the weight of the slab, tile and plastering.
2- Use $m = m_{neg}. = 1.8\, m_{pos}$.

See Fig (4)

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09)

A. Answer the followings briefly:

1. Write four differences between one –way and two - way slabs **or** write the limitations of the DDM?
2. Calculate the wind load in kN/m^2, consider the speed of the wind of 120km/hr?
3. Write the main differences between pretension and post tensioned prestressed concrete?

B. For the slabs shown in Fig.1. Draw at least two modes of failure without calculations? 15 Marks

See Fig (5)

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10)

A two - way flat slab system shown in Fig.1, has the following given data :

- The building consist of five stories, height of each storey = 3.3 m.
- Corner and edge columns are 400x400mm in dimension, and interior columns are 450 mm in diameter.
- Exterior beams are 400 x 600 mm overall cross-section and $\alpha = 5.0$.
- Lateral loads are resisted by the shear walls.
- Ultimate uniform distributed load = 12.0 kN/m^2(7.2 kN/m^2 dead load and 4.8kN/m^2 live load)
- Use fc` = 21 MPa and fy = 420 MPa for all types of reinforcement.

1- Check thickness of the slab within the drop panel only.

2- Design an interior column strip for the maximum negative moment only.

11)

1. **Draw at least two modes of failure (yield line patterns) for the slabs shown in Fig.**
2. **Calculate amount of steel reinforcement for the slab shown in Fig.2a, assume that:**

- Ultimate uniform distributed load, wu = 13 kN/m^2 , length of slab, L = 6m.
- Thickness of the slab = 17cm .
- Use fc` = 21MPa and fy = 420 MPa for all types of reinforcement.

See Fig (6)

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12)

A regular n-sided slab simply supported around the edges and has the following data:

- Ultimate uniform distributed load, wu = 12 kN/m^2.
- Thickness of the slab = 15cm.
- Length of each side = 5m.
- Use fc` = 21MPa and fy = 414 MPa for all types of reinforcement.

1. **Calculate the ultimate moment for the follwing cases:**
   a. n =3, b. n = 4, c. n = 6, d. n = ∞ (use r = 2.5m).
2. **Design the slab(calculate amount of reinforcement) for case <u>b</u> above.**

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13)

A. Answer three of the followings briefly:

4. Absolute safety impossible during design of concrete structures?
5. Write the design procedure of the reinforced concrete two way slabs by EFM?
6. Classify reinforced concrete water tanks under ground according to the applied load and indicate the critical case for design?
7. Write the steps of the internal force concept of prestressed concrete?

B. For the slab shown in Fig.1. Draw three modes of failure and calculate negative steel reinforcement required for one mode only?

- Ultimate uniform distributed load is 12 kN/m^2 .
- Concrete compressive strength, fc` = 21 MPa.
- Steel yield strength, fy = 414MPa for all types of reinforcement.
- Assume $m = m_{neg.} = 2m_{pos}$.

See Fig (7)

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14)

Two way slab system (EFM)

The two - way flat plate slab system, its typical interior floor shown in Fig. has the following data :

- The building consist of five stories, height of each storey = 3.40 m.
- Corner and edge columns are 400x400mm, and interior columns are 400 mm in diameter.
- Exterior beams are 400 x 580 mm overall cross-section.
- Preliminary thickness of the slab is 180mm.
- Ultimate uniform distributed load = 13.0 kN/m^2(8.2 kN/m^2 dead load and 4.8kN/m^2 live load)
- Use fc` = 21 MPa and fy = 420 MPa for all types of reinforcement.
- Use $\alpha = Ib / Is = 6$, torsional constant, $C = 7.8 \times 10^8$ mm^4, $\beta = C / 2Is = 1.25$.

1- Check minimum thickness required for deflection control.

2- Check punching shear strength at critical sections [Hint: only check two-way action for an interior column] .

3- Find maximum negative and positive moments for an interior frame by EFM. Use k = 4 EI / L, COF = 0.5, $M_{FEM} = 0.0833\ Wu\ L2\ L_1^2$, Kc = 4.2×10^4 kN.m,
Ksb = 4.0×10^4 kN.m.

15)

1. **Compute the moments require**d to resist a concentrated load P in addition to its own weight w_{dl} if a fan mechanism develops. Assume that the negative moment capacity is m_n and the positive moment capacity is m_p per unit width in all directions.
2. **Calculate the negative and positive** reinforcement for the applied loads. Use m_n = 2 m_p, P=50 kN, L = 3.0m, thickness, t = 170mm, fc` = 21 MPa and fy = 420 MPa.

See Fig (8)

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16)

A two - way slab system, its typical interior floor shown in attached figure, has the following given data :

- The building consist of five stories, height of each storey = 3.40 m.
- Consider superimposed dead load of 2.50 kN/m^2 (weight of finishing materials and additional loads) and a live load of 3.0kN/m^2 .
- Use fc` = 24 MPa and fy = 420 MPa for all types of reinforcement.
- Assume α = Ib / Is = 6 for all beams, torsional constant, C = 7.2 x 10^9 mm^4, and β = C / 2Is = 1.25 if required.
- Assume k = 4 EI / L, COF = 0.5, M_{FEM} = 0.0833 Wu L_2 L_1^2, Kc = 4.0 x 10^4 kN.m, Ksb = 5.0 x 10^4 kN.m when required.

1- Calculate minimum thickness required of panel 4 for deflection control for all three types (Slab supported by beams, flat plate and flat slab system).

2- Check punching shear strength in an interior column for the flat plate and flat slab at distance (d/2) from the face of the column.

3- Find maximum negative and positive moments in middle strip for only one type in an interior frame by either DDM (consider all limitations satisfied) or EFM.

17)

A slab panel with 8mx8m (center to center), supported by beams in all sides, 200mm in thickness and its made of normal weight concrete. Ultimate uniform distribute load of 15kN/m^2. fc`=21MPa and fy = 420 MPa for all types of reinforcement. Assume that the slab will be designed with isotropic top and bottom reinforcement and assume that m_{neg}. = 2 m_{pos}.

1. **Calculate the negative and positive moments.**
2. **Calculate the amount of steel reinforcement required for the negative and positive moments.**
3. **Draw the detail of reinforcement.**

See Fig (9)

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18)

The two – way slab system shown below has the following data :

- The building consist of only one story and its height = 5 m.
- Corner columns are 500 x 500 mm square, interior columns are 300 mm around and 300 x 500 mm rectangular for other exterior columns.
- Interior and spandral beams are 300 x 600 mm overall cross-section.
- Lateral loads are resisted by the shear walls.
- Service live load is 1.5 kN/m^2 and preliminary slab thickness = 150 mm.
- Use fc` = 21 Mpa and fy = 350 Mpa for all types of reinforcement.

1- Calculate minimum thickness required for deflection control and check for shear strength.

2- Apply limitations of the direct design method, calculate M_o for an interior frame as shown in the figure and then distribute to M_{neg} & M_{pos} for an interior panel.

3- Determine the negative and positive moments by the equivalent frame method.

4- Design the beam (B_1) for bending, shear and torsion if required.

5- Calculate the ultimate moment ($m = m_{neg} = 2m_{pos}$) for an interior panel (panel 4), use $\theta = 45^o$. Compare the results with the moments obtained in (1 and 3) above.

19)

The two - way flat slab system, its typical interior floor shown in Fig, has the following given data :

- The building consist of three stories, height of each storey = 3.35 m.
- Corner and edge columns are 400x400mm, and interior columns are 450 mm in diameter.
- Exterior beams are 400 x 580 mm overall cross-section.
- Preliminary thickness of the slab is 150mm.
- Preliminary thickness of the drop panel is 75mm.
- Size of drop panel is 2 x 2 m.
- Ultimate uniform distributed load = 13.0 kN/m^2.
- Use fc` = 24 MPa and fy = 420 MPa for all types of reinforcement.
- Use $\alpha = Ib / Is = 7$, torsional constant, $C = 6.8 \times 10^9 mm^4$, and $\beta = C / 2Is = 0.9$ if required.

1- Check minimum thickness required for deflection control and size of drop panels. 15 *Marks*

2- Check punching shear strength within the drop panel. 15 *Marks*

3- Calculate the maximum negative and positive resisting moments of the slab in the column strip only. 30 *Marks*

20)

A slab panel with $36m^2$ in area, 150mm in thickness and its made of normal weight concrete. The slab supported by beams around and will need to support a superimposed dead load of 2.0 kN/m^2 (in addition to its own weight) and a live load of $3.0kN/m^2$. Assume that the slab will be designed with isotropic top and bottom reinforcement and assume that $m_{neg.} = 2\ m_{pos}$.

4. **Calculate the moments consider a square slab.**
5. **Calculate the moments consider a circular slab.**
6. **Calculate the amount of steel reinforcement required (for the critical case in 1 or 2 above), use fc`=21MPa and fy = 420 MPa for all types of reinforcement.**

See Fig (10)

21)

Two-way slab(DDM)

A typical two - way slab floor system shown in Fig.and has the following given data :

* The building consists of three storey and the height of each = 3.5 m.
* Upper and lower columns size are 400 x 400 mm square.
* Beams cross-section are 400 x 550 mm overall.
* Thickness of the slab is 15cm.
* Ultimate uniform distributed load = 12 kN/m^2
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.

Design the middle strip for the maximum negative moment in long direction only.

Hint: Assume that limitations of DDM are satisfied.

22)

Two way slab(YLT)

A two - way slab shown in Fig. and has the following data :

* Slab thickness = 17 cm.
* Service live load 3 kN/m^2
* Column size φ40cm.
* Concrete compressive strength, fc` = 25 MPa and
* Steel yield strength, fy = 350 MPa for φ 12mm steel bar.

1- For the mode of failure drawn, calculate the negative and positive moments, amount of steel required and sketch the details.

2- Draw at least two other modes of failure.

Hint: 1- Dead load is based on the weight of the slab, tile and plastering.

3- Use $m = m_{neg.} = 1.8\ m_{pos}$.

See Fig (11)

23)

A two - way flat slab system shown in Fig. has the following given data :

- The building consist of five stories, height of each storey = 3.3 m.
- Corner and edge columns are 400x400mm in dimension, and interior columns are 450 mm in diameter.
- Exterior beams are 400 x 550 mm overall cross-section and α = 5.0.
- Lateral loads are resisted by the shear walls.
- Ultimate uniform distributed load = 11.0 kN/m^2(6.2 kN/m^2 dead load and 4.8kN/m^2 live load)
- Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.
- Use α = Ib / Is = 6, torsional constant, C = 7.8 x 10^9 mm^4, β = C / 2Is = 0.9.

1- Design an interior column strip for the maximum negative and positive moments.

2- Re-design the strip using flat – plate system [i.e. slab without drop panel].

See Fig (12)

<u>24)</u>

1- Draw at least two modes of failure for each slab shown in Fig.

2- Calculate negative and positive moments ***(for only one mode of failure)*** **for the slab shown in Fig.1a.** Ultimate uniform distributed load = 15.0 kN/m^2

<u>25)</u>

In a multi storey building, the two - way slab supported by beam (typical floor shown in the Fig.) and has the following given data:

- The building consist of three stories and height of each storey = 3.4 m.
- Columns are 400x400mm.
- Beams are 400 x 600 mm overall cross-section.
- Use thickness of the slab of 200mm
- Assume α =4 for all beams and panels.
- Ultimate uniform distributed load = 13.0 kN/m^2
- Use fc` = 24 MPa and fy = 414 MPa for all types of reinforcement.

1- Calculate amount of steel reinforcement required for the slab (bottom and top in both directions) using Direct Design Method*(Hint: The design based on the maximum negative and positive moments).*

2- Design an exterior beam for bending, shear and torsion *(Hint: Consider the following applied factored loads, Mu=196kN.m, Vu=170kN and Tu=11kNm).*

See Fig (13)

<u>26)</u>

A. Draw two modes of failure for each slab shown in Figure .

B. Calculate amount of steel required for the maximum negative moment *(select one slab only).*

Use fc` = 24MPa, fy = 420 MPa, thickness of the slab is 170 cm and ultimate uniform distributed load of about 13 kN per square meter.

See Fig (14)

<u>27)</u>

The two - way slab system, its typical floor shown in Figure, and has the following given data :

- The building consist of seven stories, height of each storey = 3.2 m.
- ALL columns are 400x400mm in dimension.

- All beams are 400 x 550 mm overall cross-section.
- Preliminary thickness of the slab is 150mm.
- Ultimate uniform distributed load = 12.0 kN/m^2(7.2 kN/m^2 dead load and 4.8kN/m^2 live load)
- Use fc` = 24 MPa and fy = 420 MPa for all types of reinforcement.
- Use $\alpha = Ib / Is = 6$ for all interior beams.

1. **Check thickness of an interior panel.**
2. **Find maximum negative and positive moments in column and middle strips for an interior frame by DDM, consider all limitations satisfy.**
3. **Calculate amount of steel reinforcement required for the maximum moment calculated in 2 above.**

See Fig (15)

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28)

A two - way slab system supported on beams shown in Fig, has the following given data :

* The building consist of five stories, height of each storey = 3.5 m.
* Corner columns are 400x400mm in dimension, exterior edge columns are 400 x 500 mm and interior columns are 450 mm in diameter.
* Beams are 400 x 550 mm overall cross-section.
* Lateral loads are resisted by the shear walls.
* Ultimate uniform distributed load = 12 kN/m^2
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.

1- Check punching shear strength for an interior column.

2- Design an interior middle strip for the maximum negative and positive moments and draw the detail.

See Fig (16)

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29)

1. **For the slabs shown in Fig. Draw at least two modes of failure for each slab.**
2. A typical polygonal slab with fixed edges. It has side distance (L=4m) and a perpendicular distance of side from central point is r. At collapse it develops yield lines, let m_{pos} be yield line moment per unit length in positive yield lines and m_{eng} in negative yield lines (assume $m_{neg} = 1.5\ m_{pos}$). Thickness of the slab is 200mm, superimposed dead loads = 3 kN/m^2 in addition to its own weight, live load = 2.5kN/m^2, fc`=24MPa, fy=414MPa for 12.7mm steel bar (As1 = 113mm^2).

Calculate amount of top and bottom reinforcement required and draw in a typical section.

See Fig (17)

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30)

Reinforced Concrete Slab

The reinforced concrete slab system shown in Fig. in an intermediate floor, has the following design data:

- Storey height = 4m.
- Column size 40 x 40cm.
- The floor system without edge beam.
- Lateral loads resisted by the shear walls.
- Service live load = 2 kN/m^2 and dead load = 1 kN/m^2 in addition to its own weight.
- Use fc` = 21MPa and fy = 414 MPa for all types of reinforcement.
   1. **Calculate the minimum thickness required for the slab** ***[Hint: check punching shear strength].***
   2. **Calculate the design (negative and positive) moments** ***[Hint: use k = 4, M_{FEM} = 0.083 Wu L_2 Ln^2 and Cof= 0.5] if required.***

31)

Reinforced Concrete Slab

3. **Draw at least two modes of failure (yield line pattern) for slabs shown in Fig.2.**
4. **Calculate amount of steel reinforcement for the slab shown in Fig.2a, assume that:**

- Ultimate uniform distributed load, wu = 12 kN/m^2 , length of slab, L = 5m.
- Thickness of the slab = 15cm .
- Use fc` = 21MPa, fy = 350 MPa for all types of reinforcement.

See Fig (18)

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32)

A two - way slab system supported on beams shown in Fig. has the following given data :

* The building consist of five stories, height of each storey = 3.5 m.
* Corner columns are 400x400mm in dimension, exterior edge columns are 400 x 400 mm and interior columns are 450 mm in diameter.
* Exterior beam cross-section are 400 x 550 mm overall.
* Lateral loads are resisted by the shear walls.
* Ultimate uniform distributed load = 12 kN/m^2
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.

1- Check punching shear strength for an interior column.

2- Design an interior middle strip for the maximum negative and positive moments and draw the detail.

See Fig (19)

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33)

A flat slab on a series of columns with column heads has the following dimensions:

- Column spacing 7.0mx6.0m in x and y directions respectively.
- Preliminary thickness of the slab is 180mm and thickness within drop panel is 260mm.
- Interior columns are circular with 750mm in diameter and exterior columns are 750mm square.

- Edge beams 750x750mm (overall).
- Superimposed dead loads = 3 kN/m^2 and live load = 2.75kN/m^2.
- Use fc`=21MPa, fy=420MPa.

1. **Calculate minimum thickness required for deflection control and check punching shear strength within the drop panel for an interior column.**
2. **Analyze an interior frame in x-direction by DDM and determine maximum design moments.**
3. **Calculate amount of top and bottom reinforcement required for the maximum design moments in column strip and draw in a typical section.**

See Fig (20)

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34)

A. For the slabs shown in Fig.1. Draw at least two modes of failure without calculations.

B. Calculate amount of reinforcement for the maximum negative moment for slab a, or b or c.

Use fc` = 21MPa, fy = 414 MPa, thickness of slab is 20 cm and ultimate uniform distributed load of about 12 kN per square meter.

See Fig (21)

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35)

The two - way flat-plate slab system, its typical interior floor shown in Fig. has the following data :

* The building consist of four stories, height of each storey = 3.2 m.
* Corner and edge columns are 400x400mm, and interior columns are 400 mm in diameter.
* Exterior beams are 400 x 550 mm overall cross-section.
* Thickness of the slab is 180mm.
* Ultimate uniform distributed load = 12.0 kN/m^2(7.2 kN/m^2 dead load and 4.8kN/m^2 live load)
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.
* Use $\alpha = Ib / Is = 6$, torsional constant, $C = 5.57 \times 10^8$ mm^4, $\beta = C / 2Is = 1.0$.

Find maximum negative and positive moments for an interior frame by EFM. Use k = 4 EI / L, COF = 0.5, $M_{FEM} = 0.0833\ Wu\ L2\ Ln^2$, Kc = 4.2×10^4 kN.m, Ksb = 4.0×10^4 kN.m.

See Fig (22)

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36)

Two way slab system

The two - way flat slab system, its typical interior floor shown in Fig. has the following data :

* The building consist of four stories, height of each storey = 3.2 m.
* Corner and edge columns are 400x400mm, and interior columns are 400 mm in diameter.
* Exterior beams are 400 x 550 mm overall cross-section.
* Preliminary thickness of the slab is 150mm.

* Preliminary thickness of the drop panel is 50mm.
* Size of drop panel is 2 x 2 m.
* Ultimate uniform distributed load = 12.0 kN/m^2(7.2 kN/m^2 dead load and 4.8kN/m^2 live load)
* Use fc` = 28 MPa and fy = 414 MPa for all types of reinforcement.
* Use α = Ib / Is = 5, torsional constant, C = 6.8 x 10^9 mm^4, β = C / 2Is = 0.9.

1- Check minimum thickness required for deflection control.

2- Check punching shear strength at critical sections.

3- Find maximum negative and positive moments for an interior frame by DDM if limitations satisfied.

**4- Find maximum negative and positive moments for an interior frame by EFM. Use k = 4 EI / L, COF = 0.5, M_{FEM} = 0.0833 Wu L2 Ln^2, Kc = 4.2 x 10^4 kN.m,
Ksb = 4.0 x 10^4 kN.m.**

5- Compare the results obtained from DDM and EFM and comment.

See Fig (23)

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37)

A. Answer the followings briefly:

1. Write four differences between one –way and two - way slabs **or** write the limitations of the DDM?
2. Calculate the wind load in kN/m^2, consider the speed of the wind of 120km/hr?
3. Write the main differences between pretension and post tensioned prestressed concrete?

B. For the slabs shown in Fig.1. Draw at least two modes of failure without calculations?

See Fig (24)

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38)

A two - way flat slab system shown in Fig. has the following given data :

- The building consist of five stories, height of each storey = 3.3 m.
- Corner and edge columns are 400x400mm in dimension, and interior columns are 450 mm in diameter.
- Exterior beams are 400 x 550 mm overall cross-section and α = 5.0.
- Lateral loads are resisted by the shear walls.
- Ultimate uniform distributed load = 12 kN/m^2
- Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.

1- Check punching shear strength within the drop panel for an interior column.

2- Design an interior column strip for the maximum negative and positive moments.

See Fig (25)

39)

The two - way flat-plate slab system, its typical interior floor shown in Fig. has the following data :

* The building consist of four stories, height of each storey = 3.2 m.
* Corner and edge columns are 400x400mm, and interior columns are 400 mm in diameter.
* Exterior beams are 400 x 550 mm overall cross-section.
* Thickness of the slab is 180mm.
* Ultimate uniform distributed load = 12.0 kN/m^2(7.2 kN/m^2 dead load and 4.8kN/m^2 live load)
* Use fc` = 21 MPa and fy = 414 MPa for all types of reinforcement.
* Use $\alpha = Ib / Is = 6$, torsional constant, $C = 5.57 \times 10^8 \ mm^4$, $\beta = C / 2Is = 1.0$.

Find maximum negative and positive moments for an interior frame by EFM. Use k = 4 EI / L, COF = 0.5, $M_{FEM} = 0.0833\ Wu\ L2\ Ln^2$, Kc = 4.2×10^4 kN.m, Ksb = 4.0×10^4 kN.m.

See Fig (26)

51) Shear wall

A shear wall of a multi storey framed building is shown in Fig. the building consists of five floors with the following design data:

- Vertical loads (service load):
    - Dead load at each floor, P_{DL} = 100 kN
    - Live load at each floor, PLL = 60 kN
- Horizontal loads (service load): Horizontal loads calculated and shown in the figure for each floor.
- Shear wall dimensions, length (height) = 20m, width =5.5m and thickness =0.40m.
- Use f`c = 28 MPa, fy = 420MPa for all types of steel bars, diameter of 25mm for flexural, 10mm for shear reinforcement and 40mm as clear cover.

Design the shear wall for:
1- Maximum bending moment.
2- Maximum shear force.

See Fig (37)

52)

Reinforced Concrete Shear wall

The shear wall in a typical floor of a multi storey framed building shown in Fig. the building consists of 10 floors. Height of each floor is 3.0m, the wind load uniformly distributed along all building height and its value equal to 1.20 kN/ m^2. Use fc` = 25MPa, fy = 414 MPa for all types of reinforcement. Each shear wall carry 12 kN/ storey as a vertical load (live load = 5 kN/storey and dead load = 7 kN/storey) in addition to its own weight.

Check the adequacy of the section of the shear with provided steel for :
1- Maximum bending moment at third floor.
2- Maximum shear force at third floor.

See Fig (38)

<u>53)</u>

Shear wall

The shear wall in a typical floor of a multi storey framed building shown in Fig, the building consists of 5 floors. Height of each floor is 3.2m, the wind load uniformly distributed along all building height and its value equal to 1.42 kN/ m^2. Assume that the total wind forces are resisted by the shear walls, slab-column framing resisting gravity loads only. Use fc` = 21MPa, d=0.80 l_w, fy = 420 MPa for all types of reinforcement. Vertical loads of 72 kN / storey (assume that live load = dead load) carried by shear walls in addition to the weight of shear walls.
Select shear reinforcement for shear wall-1.

See Fig (39)

<u>54)</u>

Shear wall

The shear wall in a typical floor of a multi storey framed building shown in Fig. the building consists of 10 floors. Height of each floor is 3.2m, the wind load uniformly distributed along all building height and its value equal to 1.00 kN/ m^2. Use fc` = 21MPa, fy= 420 MPa for all types of reinforcement. Each shear wall carry 14 kN/ storey as a vertical load (live load = 6 kN/storey and dead load = 8 kN/storey) in addition to its own weight.

Design the shear wall <u>only</u> for :
1- Maximum bending moment.
2- Maximum shear force.

See Fig (40)

<u>55)</u>

Shear wall

The shear wall in a typical floor of a multi storey framed building shown in Fig, the building consists of 8 floors. Height of each floor is 3.0m, the wind load uniformly distributed along all building height and its value equal to 1.30 kN/ m^2. Use fc` = 21MPa, fy = 414 MPa for all types of reinforcement. Each shear wall carry 16 kN/ storey as a vertical load (live load = 7 kN/storey and dead load = 9 kN/storey) in addition to its own weight.

Design the shear wall for :
1- Maximum bending moment at second floor.
2- Maximum shear force at second floor.

<u>56)</u>

Plan and section of a shear wall in a typical floor of a multi storey framed building shown in Figure . The building consists of seven floors. Height of each floor is 3.2m, the wind load uniformly distributed along all building height and its value equal to 1.3 kN/m^2. Each shear wall carry 20 kN/ storey as a vertical load (live load = 8 kN/storey and dead load = 12 kN/storey) in addition to its own weight. Use fc` = 30MPa and fy = 420 MPa for all types of reinforcement.
Design the interior shear wall for :
1- Maximum bending moment at base of the shear wall.
2- Maximum shear force at base of the shear wall.

See Fig (41)

<u>57)</u>

The shear wall in a typical floor of a multi storey framed building shown in Fig. the building consists of 10 floors. Height of each floor is 3.2m, the wind load uniformly distributed along all building height and its value equal to 1.4 kN/. Use fc` = 28MPa, fy = 414 MPa for all types of reinforcement. Each shear wall carry 20 kN/ storey as a vertical load (live load = 8 kN/storey and dead load = 12 kN/storey) in addition to its own weight.
Design the shear wall for :
1- Maximum bending moment at base of the shear wall.
2- Maximum shear force at base of the shear wall.

See Fig (42)

<u>58)</u>

Shear wall

A shear wall of a multi storey framed building is shown in Fig. the building consists of five floors with the following design data:
- Vertical loads (service load):
    - Dead load at each floor, P_{DL} = 100 kN
    - Live load at each floor, PLL = 60 kN
- Horizontal loads (service load): Horizontal loads calculated and shown in the figure for each floor.
- Shear wall dimensions, length (height) = 20m, width =5.5m and thickness =0.40m.
- Use f`c = 28 MPa, fy = 420MPa for all types of steel bars, diameter of 25mm for flexural,

10mm for shear reinforcement and 40mm as clear cover.

Design the shear wall for:
1- Maximum bending moment.
2- Maximum shear force.

See Fig (43)

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59)

The shear wall in a typical floor of a multi storey framed building shown in Fig. the building consists of 10 floors. Height of each floor is 3.6m, the wind load uniformly distributed along all building height and its value equal to 1.20 kN/ m^2. Use fc` = 21MPa, fy = 414 MPa for all types of reinforcement. Each shear wall carry 12 kN/ storey as a vertical load (live load = 5 kN/storey and dead load = 7 kN/storey) in addition to its own weight.
Design the shear wall for :
1- Maximum bending moment. 10 Marks
2- Maximum shear force. 15 Marks

See Fig (44)

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60)

Shear wall

Design a shear wall of length 4.0m and thickness 250mm subjected to the following design factored forces:

- Axial force, Nu = 1950 kN
- Moment, Mu = 5400 kN.m
- Shear, Vu = 720 kN
- Concrete compressive strength, f`c = 30 MPa.
- Steel yield stress, fy = 420MPa.
- Use clear cover 40mm, 25mm steel bars for bending and 10mm steel bars as shear reinforcement when required.