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Question NO: 01

Slab:

Slabs are constructed to provide flat surfaces, usually horizontal, in building floors, roofs, bridges, and other types of structures. The slab may be supported by walls, by reinforced concrete beams usually cast monolithically with the slab, by structural steel beams, by columns, or by the ground.

Slabs are classified into two types:

1. One Way Slab
2. Two Way Slab

One Way Slab:

One-way slab is a slab which is supported by beams on the two opposite sides to carry the load along one direction. The ratio of longer span (l) to shorter span (b) is equal or greater than 2, considered as One-way slab because this slab will bend in one direction i.e. in the direction along its shorter span

$$\frac{\text{Longer Span}}{\text{Short Span}} \geq 2$$

one-way slab and two-way slab equation

Due to the huge difference in lengths, the load is not transferred to the shorter beams. Main reinforcement is provided in shorter span and distribution reinforcement in a longer span.

Example: Generally, all the Cantilever slabs are one Way slab. Chajjas and verandahs are a practical example of one-way slab.



Two Way Slab:

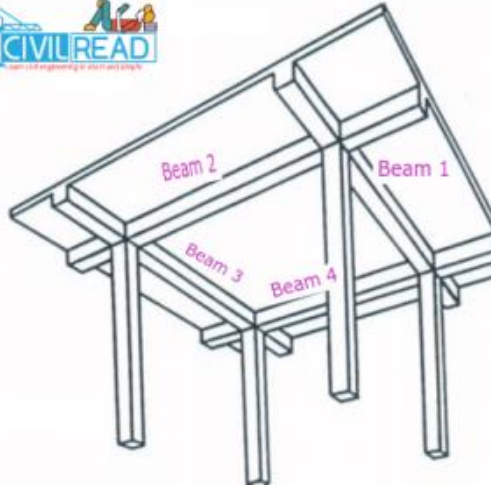
Two-way slab is a slab supported by beams on all the four sides and the loads are carried by the supports along with both directions, it is known as two-way slab. In two-way slab, the ratio of longer span (l) to shorter span (b) is less than 2.

$$\frac{\text{Longer Span}}{\text{Shorter Span}} = \frac{l}{b} < 2$$

one-way slab and two-way slab equation-1

In two way slabs, the load will be carried in both the directions. So, the main reinforcement is provided in both directions for two way slabs.

Example: These types of slabs are used in constructing floors of a multistoried building.



Question No: 02

Question No 02

Ans:-

Solution

1- Determine the effective depth d :

$$d = h - 3/4 \text{ in. (cover)} - \text{half bar diameter}$$

2- Determine the Average A_s provided per 1-ft width (12 in) of slab.

The area of no 6 bars is

$$A_b = 0.44 \text{ in}^2$$

$$A_s = \frac{12 A_b}{5} = \frac{12 (0.44)}{7}$$
$$\Rightarrow 0.754 \text{ in}^2 / \text{ft}$$

Area of bars in slabs are given in Appendix A.

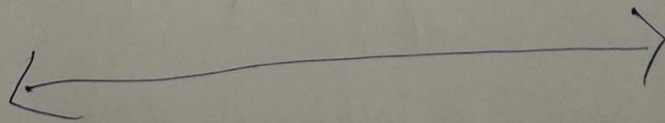
3- Compare the steel ratio used with ρ_{max} and ρ_{min} For $f'_c = 3 \text{ ksi}$ and $f_y = 60 \text{ ksi}$, $\rho_{max} = 0.01356$ and $\rho_{min} = 0.00333$. ρ (used) $= 0.754 (12 \times 5.875) = 0.0107$, which is adequate ($\phi = 0.9$).

4 - Calculate $\phi M_n = \phi A_s f_y (d - a/2)$

$$a = A_s f_y (0.85 f'_c b) = 0.754 (60) / (0.85 \times 3 \times 12) = 1.48 \text{ in}$$

$$\phi M_n = 0.9 (0.754) (60) (5.875 - 1.48/2)$$

$$\Rightarrow 209 \text{ k.in} = 17.42 \text{ k.ft}$$



Question No: 03

Question # 03

Ans:-

Solution

1- using eq: 10.9

$$P_u = \phi P_n = \phi k [0.85 f'_c A_g + A_{st} (f_y - 0.85 f'_c)]$$

For a tied column

$$\phi = 0.65, k = 0.8 \text{ and } A_{st} = 4.0 \text{ in}^2$$

$$P_u = \phi P_n = 0.65(0.8) [0.85(4) + (12)(12) + 4(60 - 0.85 \times 4)] = 372 \text{ k}$$

2- Check steel percentage

$$\rho_g = \frac{4}{144} = 0.02778 = 2.778\%$$

This is less than 8% and greater than 1%.

Question No: 04

. Plain concrete columns prohibited: possibility of bending is always present:

ACI 10.9: $0.01 \leq A_s/A_g \leq 0.08$

ACI 10.9.1:

whereas = Area of longitudinal reinforcement;

A_g = Total area of column cross section;

3.2.2. Possible column configuration

a. Tied - Deformed bars or wires placed normal to column axis

3. Spacing of Ties to Prevent Longitudinal Bar Buckling

A. Tied column may fail prior to steel yield if shell spalls and longitudinal bars buckle;

B. Insure that bar buckling load is greater than yield load. ($\sigma_{cr} > f_y$)

Assume that bar buckling load is greater than yield load - Assume a pin-pin bar between ties:

Assume that bar buckling load is greater than yield load - Assume a pin-pin bar between ties:

2

σ_{cr}^2

$E I P$

L

π

= (3.1)

The moment of inertia of a circular bar is:

4

64

$D^4 \pi$

= (3.2)

and for $\sigma_{cr} = P_{cr}/A = P_{cr}/(\pi D^2/4)$

2

$2 \cdot 16 \cdot (\pi) \cdot cr$

E

L D

π

$\sigma = (3.3)$

Example:

For $f_y = 40 \text{ ksi} = \sigma_{cr}$

2

2 2 40

$16(\rho) 16(\rho) cr$

E E

LD LD

$\pi \pi$

$\sigma = \rightarrow = (3.4)$

Solving for critical buckling condition

$L = 21 D$

So, to prevent buckling, space ties more closely than this.

ACI Code requires (ACI, Sect 7.10.5.2) that spacing not to be greater than

16 D (D = Diameter of longitudinal bar);

48 tie bar diameter;

Least member dimension.

Other Code requirements are given in ACI Sections 7.10.5.

Question No: 05

Footing is one of the most important parts of a structure which transfers loads of a structure to the underlying soil. The selection of footing depends on the following factors.

1 – The depth of the soil at which safe bearing strength exists.

2 – The type and condition of soil

3 The type of the superstructure

Types of footings:

1. Wall footing/strip footing
2. Spread Footings
3. Isolated footings
4. Stepped footings
5. Combined footings
6. Sloped footings
7. Mat or raft foundation
8. Strapped footings
9. Pile foundation

Strip footing:

This is a component of shallow foundation which distributes the weight of a load bearing wall across the area of the ground. It is also known as wall footing.

Strapped footing

In this type of footing, the outer and inner column is connected by a strap beam does not transfer any load to the soil.

Isolated footings:

It is square, circular or individually rectangular slab of uniform thickness, provided under each column.

Stepped footings:

The main purpose of using stepped footing is to keep the metal columns away from direct contact with soil to save them from corrosive effect. They are used to carry the load of metal columns and transmit this load to the below ground.

Combined footings:

When two or more columns are supported by a footing it is called combined footing. This footing may be of rectangular or trapezoidal in plan. Combined footing is provided under following situations.

1. When columns are close to each other and their individual footings overlap.
2. Soil having low bearing capacity and requires more area under individual footing.
3. The column end is situated near the property line and the footing cannot be extended.

Sloped footings:

The strapped footings having sloping top or side faces are known as sloped footings. This type of footing is useful in the construction of formwork.

Raft foundation:

This foundation covers the entire area under the structure. This foundation has only RCC slab covering the whole area or slab and beam together. Raft foundation is adopted when heavy structures are to be constructed on soft made-up ground or marshy sites with uncertain behavior. Raft foundation is also known as mat foundation.

Pile foundation:

A pile foundation is a long cylinder of strong material such as concrete that is pushed into the ground to act as steady support for structures built on top of it.