# DESIGN OF TWO WAY SLAB

**Definition :**

Slab is a thin flexural member used as a floor of structure to support the imposed load

**Loads on slab :**

Generally in design of horizontal slab two types of loads are considered.

- Dead load
- Imposed load

**Dead load :**

The dead load in slab comprises of the immovable partitions. Floor finishes weathering courses and primarily its weight .The dead loads are to be determined based on the weight of the materials .

**Imposed loads:**

Imposed load is the load induced by the intent use or occupancy of the building including the weight of movable partitions load due to impact vibrations.

**Basic rules for the design of the slab :**

The two main factors to be considered while designing the slab are:

- Strength of the slab against flexure, shear, twisted.
- Stiffness against deflection

**One way slab – codal requirements :**

When the ratio of the longer span to shorter span is greater than 2, it is called one way slab and bending takes place along one direction. The loads on the slab is transferred to the supports only on the main reinforcement. Hence main reinforcement is provided in the shorter span.

**Minimum requirement in slab :**

As per clause 26.5.2.1 of IS 456:2000, the reinforcement in either direction ,in slabs shall not be less than 0.12% of the total cross sectional area , when HYSD bars Fe415 are used.

**Maximum size of bars in slabs**

As per clause 26.5.2.2 of IS 456 :2000 , the reinforcing bars shall not exceed 1/8 of the total thickness of the slab.

**TWO WAY SLAB DESIGN**

Design a R.C Slab for a room measuring 6.5mx5m. The slab is cast monolithically over the beams with corners held down. The width of the supporting beam is 230 mm.The slab carries superimposed load of 4.5kN/m$^2$. Use M-20 concrete and Fe-500 Steel.

Since, the ratio of length to width of slab is less than 2 and slab is resting on beam, the slab is designed as two way restrained slab.

**Step: 1 Depth of slab and effective span**

Assume approximate depth d = l/30

= 5000/30 = 166mm

Assume D = 180 mm

& clear cover 15 mm for mild exposured d

= 180-20 = 160 mm.

Effective span is lesser of the two

i) ly = 6.5+0.23 = 6.73 m ,

lx = 5.0+0.23 = 5.23 m

ii) ly = 6.5+0.16 = 6.66 m,

lx = 5+0.16 = 5.16 m

ly = 6.66 m

lx = 5.16 m

$$\alpha = \frac{l_y}{l_x} = \frac{6.66}{5.16} = 1.3$$

Step 2: Load Calculation

Self-weight of slab = 0.18X25 = 4.50 kN/m$^2$

Super imposed load = 4.50

Total load = 9.0 kN/m$^2$

Ultimate load Wu = 9X1.5 = 13.5 kN/m$^2$

Step 3: Design bending moment and check for depth

The boundary condition of slab in all four edges discontinuous

(case 9, Table 9.5.2)

$$M_x = \propto_x W_u {l_x}^2$$

$$M_y = \propto_y W_u {l_x}^2$$

For $\frac{l_y}{l_x} = 1.3,$

$$\propto_x = 0.079$$

$$\propto_y = 0.056$$

Positive moment at mid span of short span $M_x$ $= 0.079 \times 13.5 \times 5.16^2$

$= 28.40$ kNm

Positive moment at mid span of longer span $M_x$ $= 0.056 \times 13.5 \times 5.16^2$

$= 20.13$ kNm

Minimum depth required from maximum BM consideration

$$d = \sqrt{\frac{M_u}{0.138\, f_{ck} b}}$$

$$= \sqrt{\frac{28.40 \times 10^6}{0.138 \times 20 \times 1000}}$$

$$d = 103 \text{ mm}$$

However, provide $d = 160$ mm

Step: 4 Area of Reinforcement

Area of steel is obtained using the following equation.

$$M_u = 0.87\, f_y\, Ast\, d\, (1 - \frac{f_y Ast}{f_{ck} bd})$$

Steel along shorter direction ($M_x$)

$$28.40 \times 10^6 = 0.87 \times 500 \times Ast \times 160\, (1 - \frac{500\, Ast}{20 \times 1000 \times 160})$$

$28.40 \times 10^6 = 69600\, Ast - 10.875\, Ast^2$

Solving Ast $= 438\ mm^2$

Provide 10 mm @ 175 C/C ($P_t = 0.27\%$)

Steel along shorter direction ($M_y$)

Since long span bars are placed above short span bars d = 160-10 = 150

$$20.13 \times 10^6 = 0.87 \times 500 \times Ast \times 150 \left(1 - \frac{500\ Ast}{20 \times 1000 \times 150}\right)$$

$20.13 \times 10^6 = 65250\, Ast - 10.875\, Ast^2$

Solving, Ast $= 327\ mm^2$

Spacing at 10 mm;

$$\frac{79}{327} \times 100 = 241$$

Provide 10 mm @ 240 mm C/C (<3d = 450)

Step: 5 Check for shear

$$\text{Design shear } V_u = \frac{W_u\, l}{2}$$

$$= \frac{13.5 \times 5.16}{2}$$

$$= 34.83\ kN$$

$$\tau_v = \frac{34.83 \times 10^3}{1000 \times 160}$$

$$= 0.217\ N/mm^2 \qquad (< \tau_{c\,max} = 28\ N/mm^2)$$

Shear resisted by concrete $\boldsymbol{\tau_c}$ = 0.42 for $\mathbf{p_t}$ = 0.37 (Table 19, IS 456-2000)

$$\boldsymbol{\tau_c > \tau_v}$$

Step: 6 Check for Deflection

$$\left(\frac{l}{d}\right)_{Allowable} = \left(\frac{l}{d}\right)_{Basic} \times k_1$$

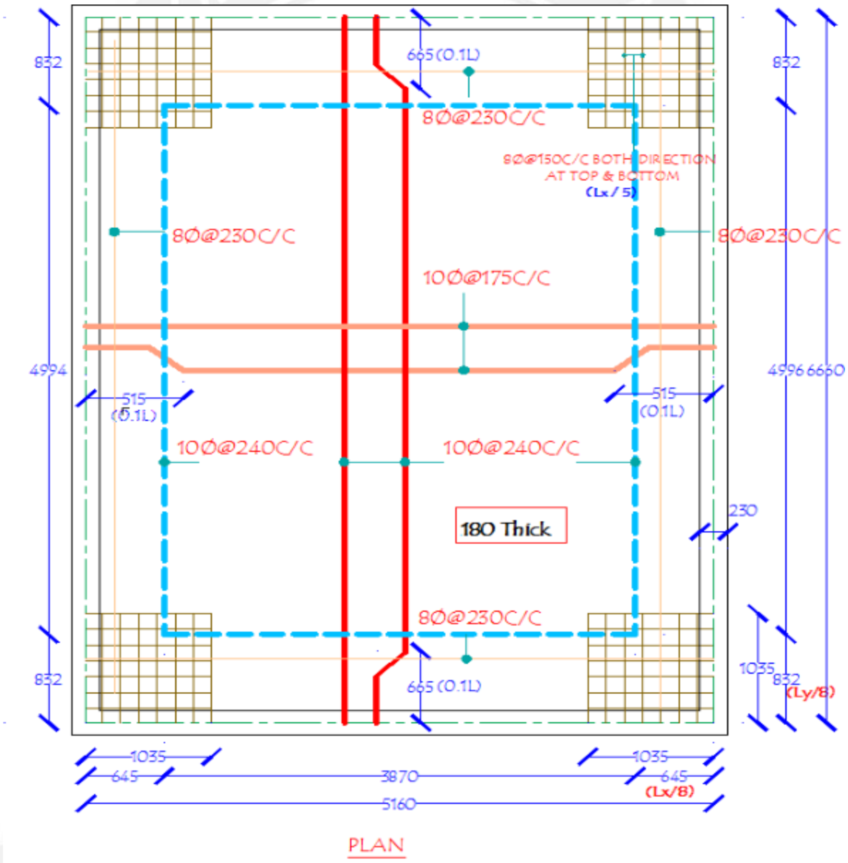
$\mathbf{k_1}$ = 1.5 for $\mathbf{p_t}$ = 0.27% & $f_s = 0.58 \times f_y = 240$

(Fig. 4, cl.32.2.1, IS 456-2000)

$\left(\frac{l}{d}\right)_{Allowable} = 26 \times 1.5 = 39$

$\left(\frac{l}{d}\right)_{Actual} = 5.16/0.16 = 32$

$\left(\frac{l}{d}\right)_{Actual} < \left(\frac{l}{d}\right)_{Allowable}$ (OK)




Reinforcement Detail of Two way Restrained slab