UNIT-IV

YIELD LINE THEORY.

Yield line :

The yield line is defined as the line in plane of slab across which reinforcing bar's have yielded, and about which excessive deformation under constant limit moment that is (i.e) ultimate moment, it is continuous to occur failure

Characteristic feature of yield line :

(i) Yield line end at slab boundary
(ii) They are straight
(iii) yield line produced and pass through intersection of axis of rotation of adjacent slab element
(iv) The axis of rotation generally lie along lines of supports and passes over any column.

Internal workdone = moment × rotation

External workdone = load × deformation

Principle of virtual work:

i) If deformationable structure is equilibrium under action of a system of external forces are subjected to a virtual deformation compactible with its support conditions, The work done by these force and the displacement associated with the virtual deformation is equal to the work done by the internal stresses or strain associated with this deformation.

(ii) Does the workdone during small motion of collapse mechanism is equal to work absorbed by the plastic hinge formed along the yield line

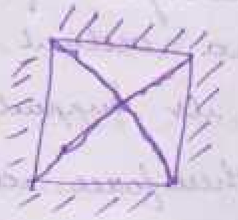
(iii) The segment of slab within the yield line go through rigid body displacement with the collapse load acting on the structure

workdone by external force = workdone by internal force (energy absorbed by hinges).

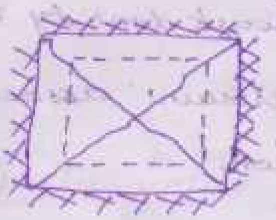
W.E = W.I

YIELD LINE PATTERNS:

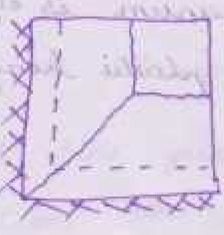
(i) Square Slab with Simply Supported edges.



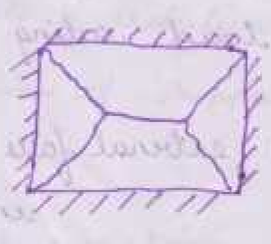
(ii) Square Slab with fixed ends



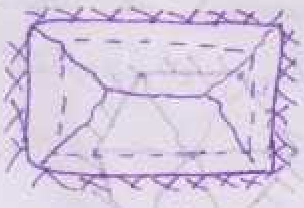
(iii) Square slab with continuous edges.



4) Rectangular Slab with Simply Supported edges



(v) Rectanglural with fixed ends.

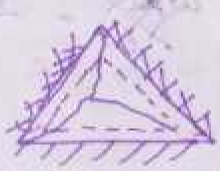


(vi) Rectangular with continuous two end fixed othe two are Simply Supported.

(vii) Rectangular Slab with three edge simply Supported: one end free.

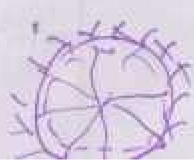
(viii) Triangular slab simply Supported edge

(ix) Triangular with fixed.



(x) Circular Slab:-

Fix



16 m

* Design a Simply Supported Square slab of 4.5 m side length to Support a service load of 4 KN/m² adopt M_{20} grade concrete + Fe 415 grade steel

Given:-

length = 4.5 m;

Service Load = 4 KN/m²

M_{20} + Fe 415 grade material

depth.
load
moment
Ast.

(i) Depth of slab:- (Page No: 39)

depth = Span / B.V.

$B.V = 35 \times 0.8$

$= 28$

$\Rightarrow d = 450/28 = 160.7 \text{ mm}$.

adopt cover (d') = 15

$\Rightarrow D = d + d' + 10/2 = 160.7 + 15 + 10/2$.

$= 180.7$

$D \simeq 185 \text{ mm}$.

Step 2 : Load Calculation

Dead load = 1×1×0.185×25

= 4.625 kN/m² ≈ 4.63

live load = 4 kN/m².

Total load = 8.635 kN/m²

factored load = 8.63 × 1.5

= 12.9 kN/m².

Step 3 : Moment & shear calculation

$M_u = w_u l^2 / 24$

$= \frac{12.9 \times 4.5^2}{24}$

$M_u = 10.98$ kNm.

Shear force $V_u = w_u l / 2$

$= 12.9 \times 4.5 / 2$

= 29.02 kN

Step 4 Limiting moment capacity of slab.

$M_{u\,lim} = 0.36 \frac{x_{umax}}{d}\left(1 - 0.42 \frac{x_{umax}}{d}\right) bd^2 f_{ck}.$

$$\Rightarrow M_{u,lim} = 0.36 \times 0.48\left(1-(0.42\times0.48)\right) 1000 \times 160.7^2 \times 20$$

$M_{u\,lim} = 71.26 \times 10^6$ Nmm.

$= 71.26$ KNm.

$M_{u\,lim} = 71.26$ KNm > 10.8 KNm.

∴ under reinf section

Step 5: Area of steel:

$$M_u = 0.87 f_y A_{st}\left(1 - \frac{A_{st} f_y}{b d f_{ck}}\right) d.$$

$$\Rightarrow (10.6\times10^6) = 0.87 \times 415 \times 160.7 \times A_{st}\left(1 - \frac{A_{st}\,415}{1000\times160.7\times20}\right)$$

$A_{st} = 190.84\ mm^2$.

Use 10mm ϕ bar:

$$\text{Spacing} = \frac{\pi/4 \times 10^2}{190.84} \times 1000$$

$= 411.54$ mm.

$\Rightarrow S = 400$ mm c/c.

Provide 10mm dia bar at 400mm c/c in both ways

—x—.

2. Design a simply supported slab of 3.75 m side length to support a live load of 3.5 KN/m² adopt M20 + FE415 grade material.

Given data.

Span = 3.75 m.

live load = 3.5 KN/m.

grade = M20 + Fe415.

Step 1 depth :-

depth = Span / Basic Value.

Basic Value = 35 × 0.8

= 28

d = 3750/28

= 133.9 ~~125~~ mm.

Overall depth = 133.9 ~~125~~ + 15 + 10/2

= 158.9 ~~145~~ mm.

≃ 160 mm.

ii, load calculation

Dead load = $1 \times 1 \cdot \times 0.180 \times 25$

$= 4\ kN/m$

live load = $3.5\ kN/m$

Total load = $7.5\ kN/m$.

factored load = 7.5×1.5

$= 11.25\ kN/m$.

iii, Moment calculation

$M_u = wl^2/24$

$= 11.25 \times 3.75^2/24$

$= 6.59\ kNm$.

shear, $V_u = wl/2$

$= 11.25 \times 3.75/2$

$= 21.09\ kN$

iv, limiting moment

$$M_{u,lim} = 0.36\ \frac{x_{umax}}{d}\left(1 - 0.42 \times \frac{x_{umax}}{d}\right) \times bd^2 f_{ck}$$

$$= 0.36 \times 0.48\left(1 - 0.42 \times 0.48\right) \times 100 \times 133.9^2 \times 20$$

$= 49.47 \times 10^6\ kNm > 6.59\ kNm$.

Area of steel:

$$\Rightarrow M_u = 0.87 f_y \, 415 \left[1 - \frac{A_{st} f_y}{b d f_{ck}}\right]$$

$$(46.59 \times 10^6) = 0.87 \times 415 \times A_{st} \left(1 - \frac{A_{st} \times 415}{100 \times 133.9 \times 20}\right) 133.9$$

$A_{st} = 139.32 \ mm^2$

Use 10 mm ϕ bar.

$$\text{Spacing} = \frac{\pi/4 \times 10^2}{139.32} \times 1000$$

$= 563.73$ mm

$\simeq 560$ mm c/c.

Provide 10 mm ϕ bars at 560 mm c/c. in both way.