23CE503:STRUCTURAL ENGINEERING - I (RCC)

Topic: Unit- III : SLABS

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Topic: Unit- III : SLABS

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- Types of Slabs
- Design Considerations for One Way Slab
- IS Codal Provisions
- Design Steps of One Way Slab
- Analysis One Way Slab
- Design of One Way Slab (Numerical Problems)

SLABS

- Slab
  - A slab is a plate element having depth (D), very small as compared to it's length and width.
  - Slabs form floors and roofs of buildings.
  - They are assumed to carry uniformly distributed loads.
- Usually slabs are horizontal except in the case of stair cases and ramps for car parks.

SLABS TYPE

- Simply supported slab
- Continues slabs
- Cantilever slabs

SLABS TYPE BASED ON SUPPORT CONDITIONS

- One way slabs
- Two way slabs
- Flat slabs

SLABS

- One way slabs
  - If the slab is supported on two opposite sides.
  - If the slab is supported on four sides, and $L_y/L_x \geq 2$.
  - Both of condition called one way slab.
  - In one way slab main reinforcement is provided along short span and distribution reinforcement provided along long span.
- Two way slabs
  - If the slab is supported on all four edge, and $Ly/Lx < 2$.
  - Above condition called two way slab.
  - In two way slabs main reinforcement is provided along both the direction.

L_y = longer span
L_x = shorter span

- Flat slabs
  - When slab is directly supported on columns, without beams.
  - It’s provided to increase the floor height and to permit large amount of light.
- Grid slab
  - When slab is supported on beams with columns only on the periphery of the hall.
- Continuous slab
  - In case of large halls, auditoriums, marriage halls, etc. the length is divided into equal bays by providing beams.
  - The slab provided over such area is called, continuous slab.

- Design considerations

→ Effective depth (d) (IS: 456-2000,Pg-37, cl 23.2.1)

— $\frac{L}{D} = 20 \times Modifocation\ Factor$ (IS: 456-2000, Pg-38, Fig.4)

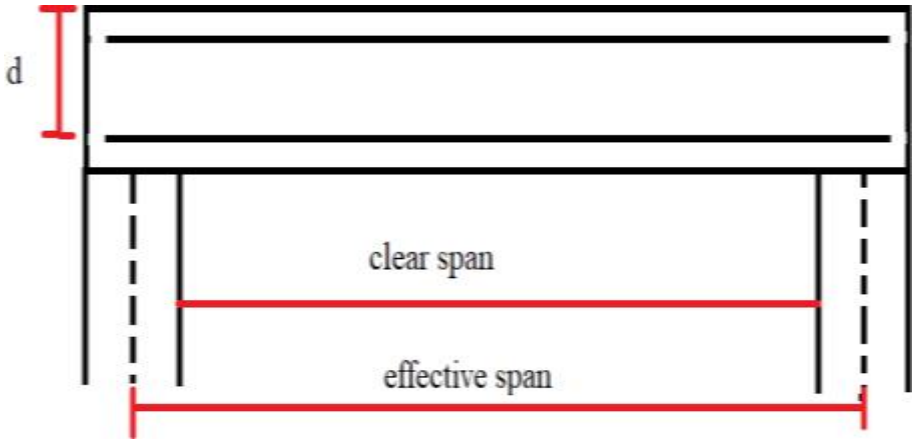
→ Effective span (l_e) (IS: 456-2000, Pg-34,cl 22.2)

— A) simply supported slab

i. Clear span + effective depth (d)

ii. Centre to centre of support

Which ever is smaller



– B) continuous slab

— If width of support < $\frac{1}{12}$ × clear span, then effective span is taken as per simply supported

— If width of support > $\frac{1}{12}$ × clear span (OR) width of support > 600 mm, then

i. For end span one end fixed and the other continuous OR for intermediate span: effective span = clear span

ii. For end span with one end free other continuous:

   a. Clear span + d/2

   b. Clear span +(½ x width of dis-continuous support)

Which ever is smaller

General design requirements for slabs as per IS 456 2000

1. Effective span

a) Clear span + effective depth of slab

b) Center to center distance between the supports

SS beam

Cantilever beam

length to the face of the support + half of the effective depth

2. (l/d) ratio For the spans not exceeding 10m, basic values should not exceed as per **clause 23.2**

For two way slab , shorter span is used for calculating the span to effective depth ratio

3. Minimum reinforcement : **0.12%** of gross sectional area (**clause 26.5.2.1**)

4. Maximum diameter of bars : shall not exceed (1/8)th. Of thickness of slab**(clause 26.5.2.2)**

5. Spacing of main reinforcement : not more than **3d (or) 300mm** (whichever is less)

6. Distribution reinforcement : area :**0.12%** gross area for HYSD else **0.15% gross area**

Spacing shall not be more than **5d (or) 450mm (**whichever is **less)**

7. Cover to reinforcement : not less than **25mm** (or) **2dia of bar**

Generally, **8mm** or **10mm dia** is assumed.

Design of one way slab

- If the ratio of longer side to shorter side is greater than 2, its one way slab
- One way slab bends in only one direction across the span and acts like a wide beam.
- The analysis and design of one way slab is similar to beam of 1m width (**b=1000mm**)

Step 1 : Select (l/d) ratio in range of **25-30** for Simply supported slabs and calculate the effective depth, $d_{provided}$=(span/(basic value * modification factor))

Step 2 :Calculation of M and V (l =shorter span length)

Step 3: Minimum depth required to resist the bending moment (M=Mulimit)

$d_{provided} > d_{required}$

Step 4 Calculate area of steel per meter width of slab (A_{st}

Step 5 Find spacing of bars

Step 6 Calculation of distribution steel

Step 7 Check for deflection

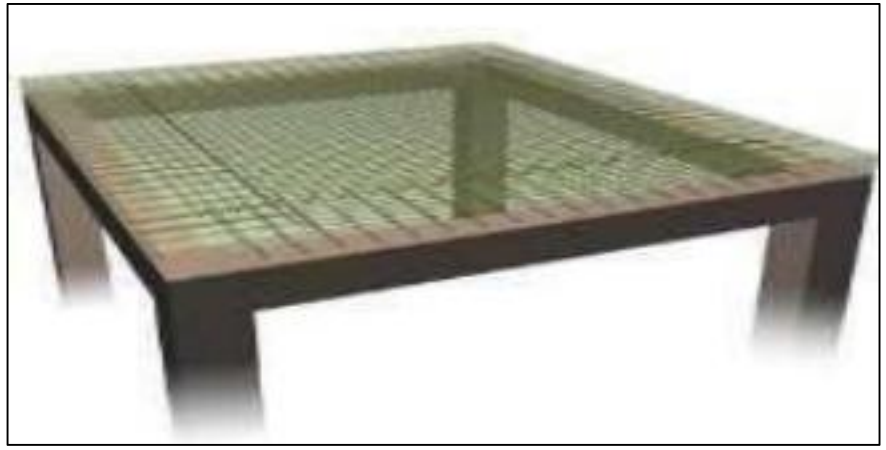
Step 8 Check for shear (Tc*k , k from **clause 40.2.1.1**)

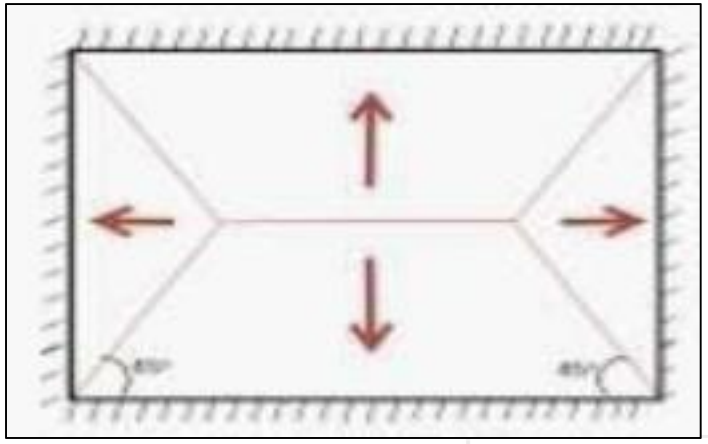
Step 9 Check for development length

TWO WAY SLAB

TWO WAY SLAB

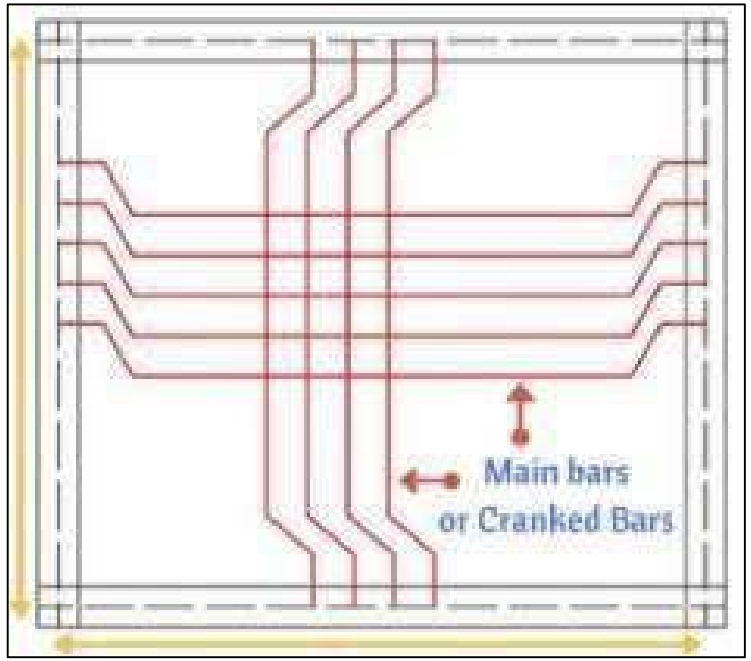
- If the slab is supported on all four edges and if $\frac{l_y}{l_x}$ **< 2, → Two way slab.**
- The tendency of slab is to bend in both directions. Such slabs are called **Two way slabs.**



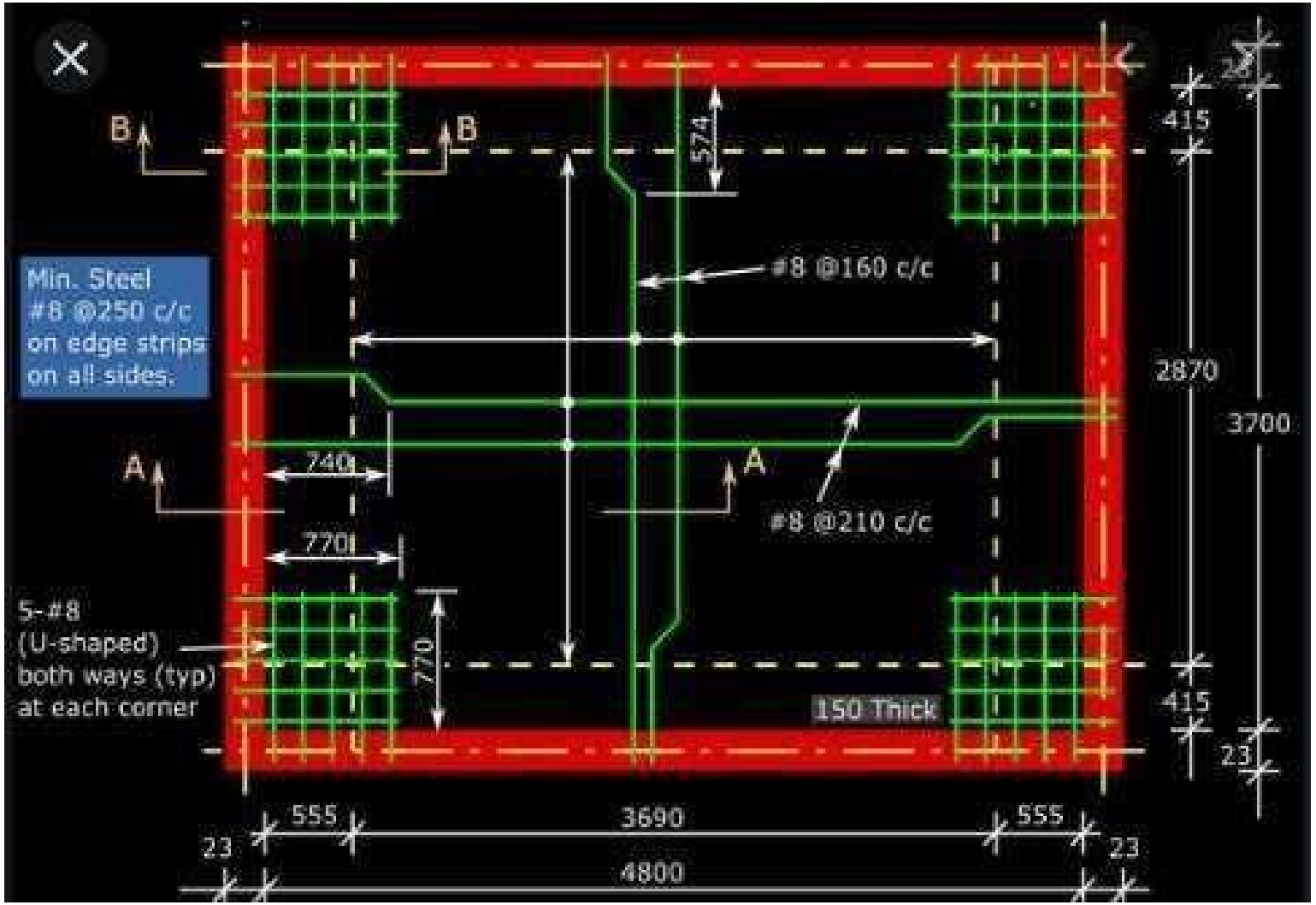


INTRODUCTION

- In two way slabs, Main reinforcement is provided along l_x (Short span) as well as l_y (long span).
- In case of two way slabs, Deflection and bending is less as compared to one way slabs. Therefore, B.M. is also reduced



REINFORCEMENT OF TWO WAY SLABS:



Thickness of two way slabs

Table 13.1: Minimum thickness for slabs without interior beams

f_y (MPa)	Without drop panels			With drop panels		
	Exterior panel		Internal panel	Exterior panel		Internal panel
	No edge beams	With edge beams		No edge beams	With edge beams	
300	$L_n / 33$	$L_n / 36$	$L_n / 36$	$L_n / 36$	$L_n / 40$	$L_n / 40$
420	$L_n / 30$	$L_n / 33$	$L_n / 33$	$L_n / 33$	$L_n / 36$	$L_n / 36$
520	$L_n / 28$	$L_n / 31$	$L_n / 31$	$L_n / 31$	$L_n / 34$	$L_n / 34$

L_n is the maximum clear length of the panel.

Linear interpolation must be performed for intermediate values of steel grade f_y.

The thickness of slabs with interior beams is given by equations to be seen later.

ACI, SBC and other codes of practice allow the use of simplified methods for the analysis and design of two way slabs. Among these is the Direct Design Method.

INTRODUCTION

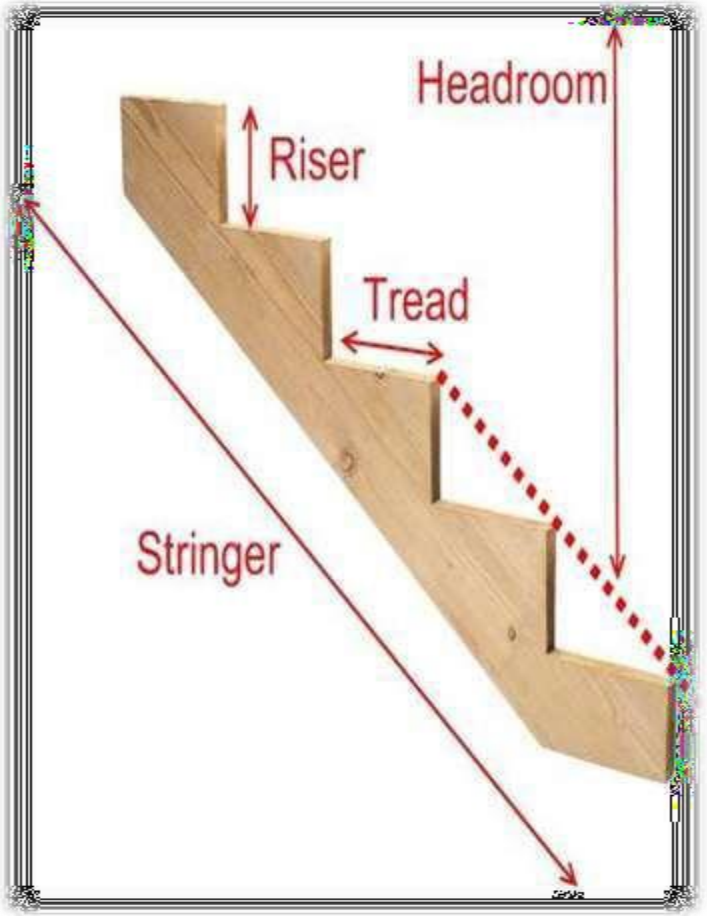
STAIRS CONSIST OF STEPS ARRANGED IN A SERIES FOR THE PURPOSE OF GIVING ACCESS TO DIFFERENT FLOORS OF BUILDING.SINCE STAIR IS OFTEN THE ONLY MEANS OF COMMUNICATION BETWEEN THE VARIOUS FLOORS OF BUILDING,THE LOCATION REQUIRES GOOD AND CAREFUL CONSIDERATION.

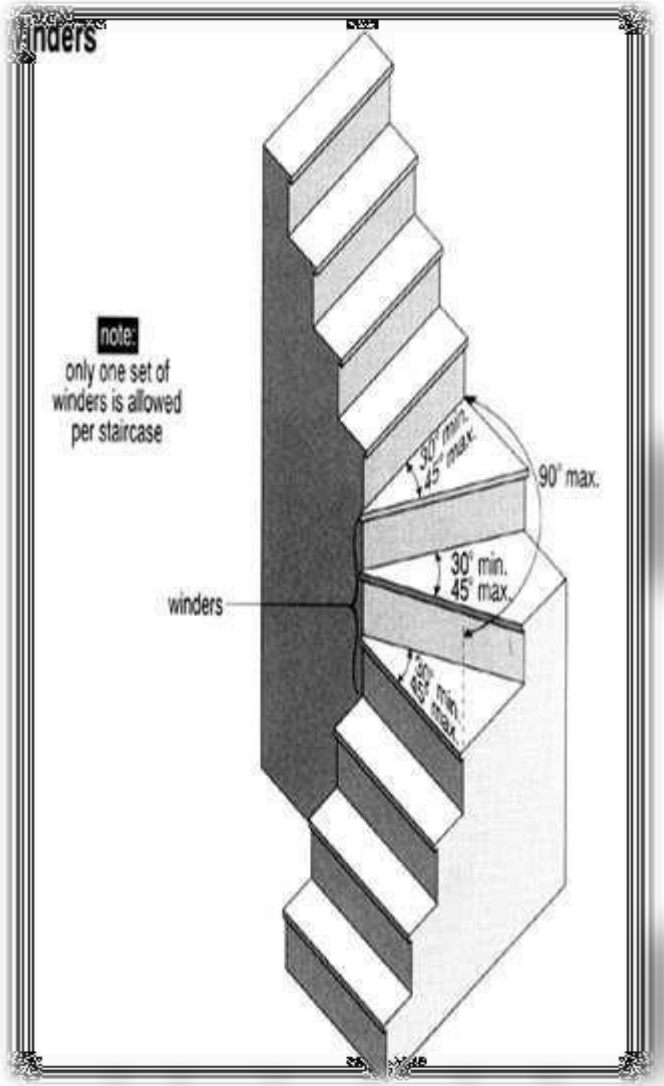
COMPONENTS OF STAIRCASES

TREAD:-THE UPPER HORIZONTAL PORTION OF STEP OVER WHICH FOOT IS PLACED DURING ASCENDING AND DESCENDING A STAIRWAY.

RISER:-THE VERTICAL MEMBER OF STEP.IT IS USED TO SUPPORT AND CONNECT SUCCESSIVE TREADS.

HEADROOM:-THE VERTICAL HEIGHT BETWEEN THE TREAD OF ONE FLIGHT AND CEILING OF OVERHEAD CONSTRUCTION.IT SHOULD BE SUFFICIENT SO AS NOT TO CAUSE ANY DIFFICULTY TO PERSON USING THE STAIRS.



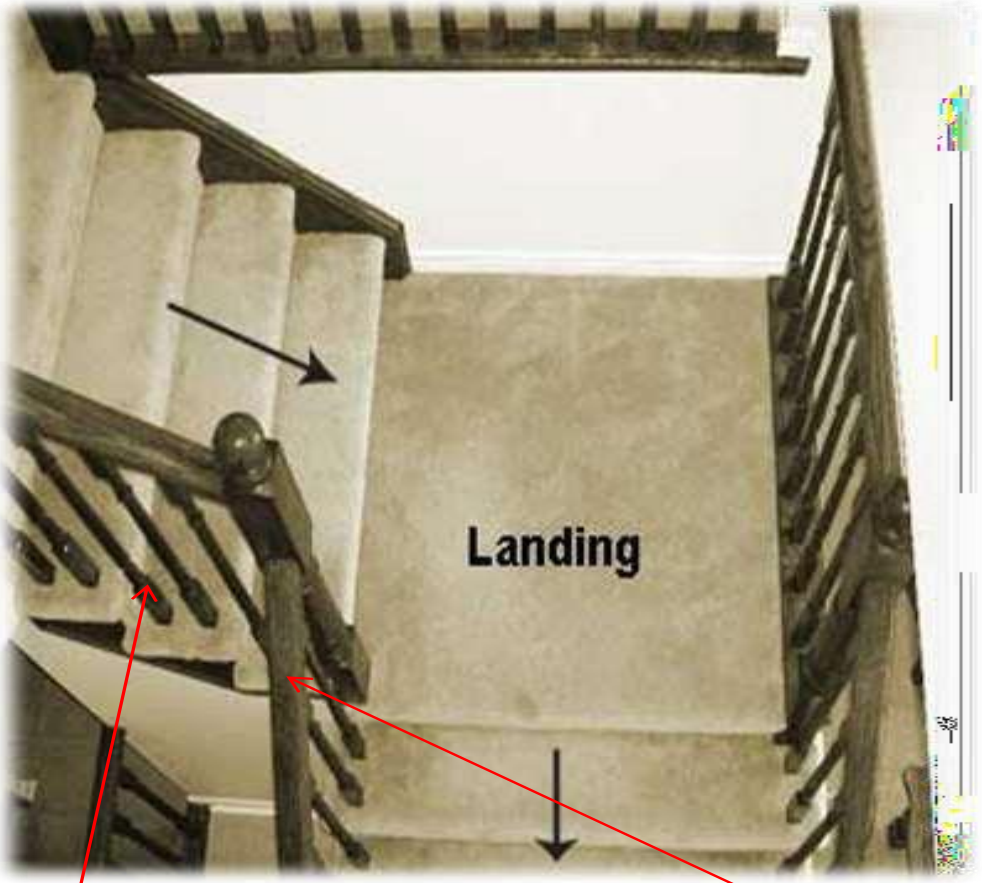


STRINGERS:-THESE ARE THE SLOPING MEMBERS OF THE STAIR,USED TO SUPPORT THE END OF STEPS

WINDERS:-THESE ARE THE STEPS USED FOR CHANGING THE DIRECTION OF STAIRS .THESE ARE USUALLY TRIANGULAR IN PLAN.

FLIGHT:-THIS CONSIST OF SERIES OF STEPS PROVIDED BETWEEN LANDINGS

RUN OR GOING:-TOTAL LENGTH OF STAIRS IN HORIZONTAL PLAIN INCLUDING LENGTH OF LANDINGS



BALUSTERS

HAND RAIL

LANDING:-THIS IS THE HORIZONTAL PLATFORM PROVIDED AT THE HEAD OF SERIES OF STEPS .IT IS USED AS A RESTING PLACE DURING USE OF STAIRS .IT FACILITATES CHANGE OF DIRECTION OF FLIGHT

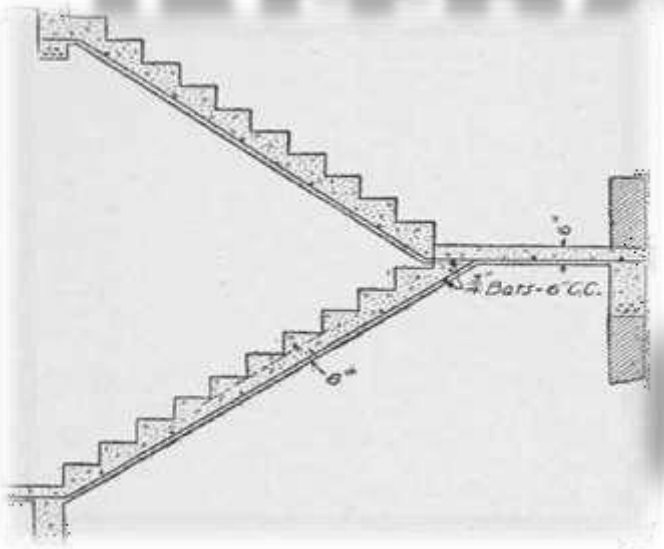
HAND RAIL:-IT IS AN INCLINED RAIL PROVIDED AT CONVINIENT HEIGHT OVER STEPS .IT SERVES AS GUARD RAIL AND PROVIDE ASSISTANCE TO USER OF STAIRS .

BALUSTERS:-IT IS INDIVIDUAL VERTICAL MEMBER MADE OF TIMBER,METAL OR MASONARY FIXED BETWEEN STRING AND HAND RAIL TO GIVE SUPPORT TO HAND RAIL.

TYPES OF STAIRCASES

STRAIGHT STAIRS:-

- ✓ALL STEPS LEAD IN ONE DIRECTION
- ✓THIS MAY BE CONTINUOUS WITH TWO FLIGHTS WITH AN INTERMIDIATE LANDING
- ✓ADOPTED WHEN STAIRCASE IS NARROW AND LONG
- ✓PROVIDED MOSTLY IN PORCH,ENTRANCE ETC



DOG-LEGGED STAIRS:-

- ✓CONSIST OF TWO STRAIGHT FLIGHTS RUNNING IN OPPOSITE DIRECTIONS
- ✓THERE IS NO SPACE BETWEEN THE FLIGHTS IN PLAN
- ✓LANDING IS PROVIDED AT LEVEL WHICH DIRECTION OF FLIGHT CHANGES

QUARTER TURN NEWEL:-

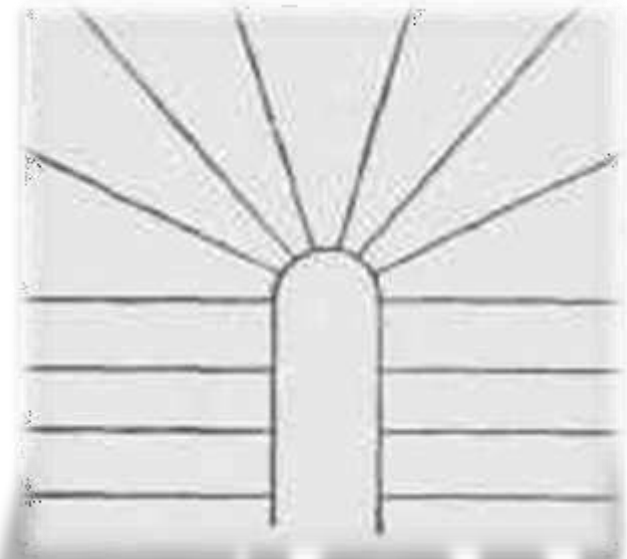
- ✓A STAIR TURNING THROUGH 90° WITH THE HELP OF LEVEL LANDING
- ✓USED IN SHOPS AND PUBLIC BUILDINGS

OPEN NEWEL STAIRS:-

- ✓POPULARLY KNOWN AS OPEN WELL STAIRS
- ✓A WELL OR OPENING IS LEFT BETWEEN FORWARD AND BACKWARD FLIGHT
- ✓THE OPENING IS GENERALLY USED FOR INSTALLATION OF LIFT
- ✓A SHORT FLIGHT MAY OR MAY NOT PROVIDED IN THESE STAIRS

GEOMETRICAL STAIRS :-

- ✓THESE STAIRS MAY HAVE ANY GEOMETRICAL SHAPE AND THEY REQUIRE NO NEWEL POST
- ✓THIS TYPE OF STAIR IS SIMILAR TO OPEN NEWEL STAIR EXCEPT THE WELL FORMED BETWEEN FORWARD AND BACKWARD FLIGHT IS CURVED
- ✓CHANGE OF DIRECTION IN SUCH STAIRS IS ACHIEVED BY WINDERS AND NOT BY LANDINGS



CIRCULAR STAIRS:-

- ✓ALL THE STEPS ARE RADIATE FROM A NEWI POST OR WELL HOLE
- ✓ ALL THE STEPS ARE WINDERS
- ✓THIS IS PROVIDED WHERE SPACE IS LIMITED AND TRAFFIC IS CASUAL
- ✓MOSTLY LOCATED AT REAR OF BUILDING

STRUCTURAL BEHAVIOR OF STAIRCASES

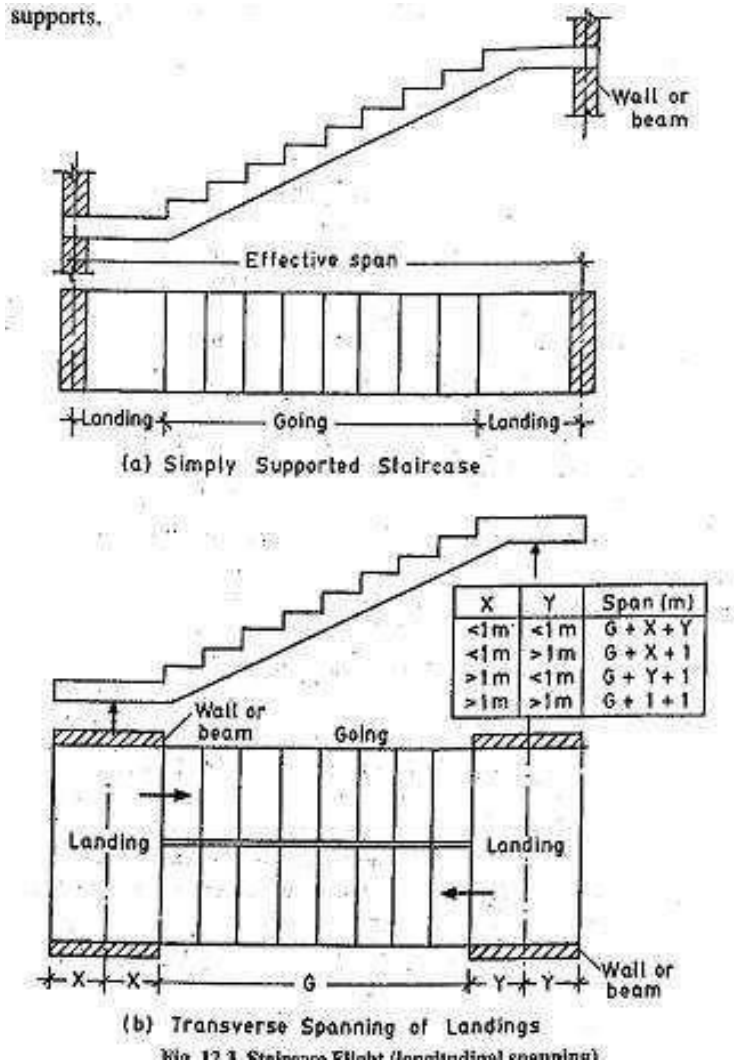
1)STAIRS SPANNING IN LONGITUDINAL DIRECTION:-

✓INCLINED STAIR FLIGHT TOGEATHER WITH LANDING ARE SUPPORTED ON WALL & BEAMS

✓IN FIG (a) THE EFFECTIVE SPAN IS CONSIDERED BETWEEN THE CENTRE TO CENTRE OF SUPPORTS

✓IN FIG (b) OF TRANSVERSE SPANNING OF LANDINGS SPAN IS TAKEN AS SSHOWN IN FIG

✓IN CASE OF OPEN WELL STAIRS WHERE SPAN PARTLY CROSS AT RIGHT ANGLES THE LOAD ON COMMEN AREA MAY DISTRIBUTED AS ONE HALF IN EACH DIRECTION IN FIG (C)



Thank You..