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Program : **B.Tech**

Subject Name: **Structural Design and Drawing (RCC-I)**

Subject Code: **CE-601**

Semester: **6th**

Unit – V

Staircases: Staircases with waist slab having equal and unequal flights with different support conditions, Slab less tread-riser staircase

Stairs

Stairs consist of steps arranged in a series for purpose of giving access to different floors of a building. Since a stair is often the only means of communication between the various floors of a building, the location of the stair requires good and careful consideration.

In a residential house, the staircase may be provided near the main entrance. In a public building, the stairs must be from the main entrance itself and located centrally, to provide quick accessibility to the principal apartments. All staircases should be adequately lighted and properly ventilated.

The staircase is an important component of a building, and often the only means of access between the various floors in the building. It consists of a flight of steps, usually with one or more intermediate landings provided between the floor levels. The horizontal top portion of a step is termed tread and the vertical projection of the step is called riser. Generally tread of 300 mm and Riser of 150 mm are ideally suited for public buildings. For residential and factory buildings lower values of tread up to 250 mm combined with higher values of riser up to 190 mm are preferred. The width of the stair is generally around 1.1 – 1.5m, and in any case, should normally not be less than 850 mm. The horizontal projection (plan) of an inclined flight of steps, between the first and last risers, is termed going of flight. Generally, risers in a flight should not exceed about 12 in number.

Types of stair cases

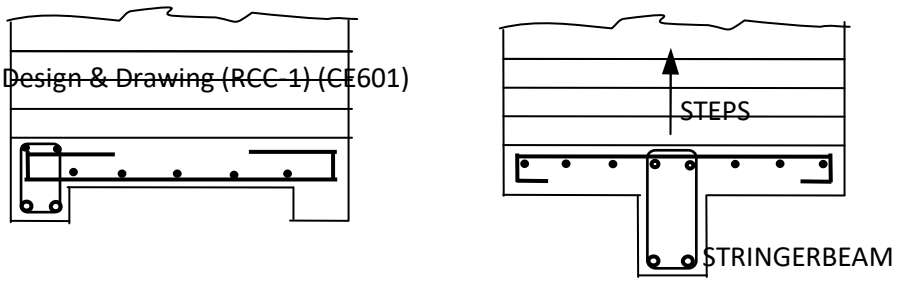
Geometric classification
Straight stairs (with or without intermediate landing)
Quarter-turn stairs
Dog-legged stairs
Open well stairs
Spiral stairs
Helicoidally stairs
Slab less stair case
Free standing stair case

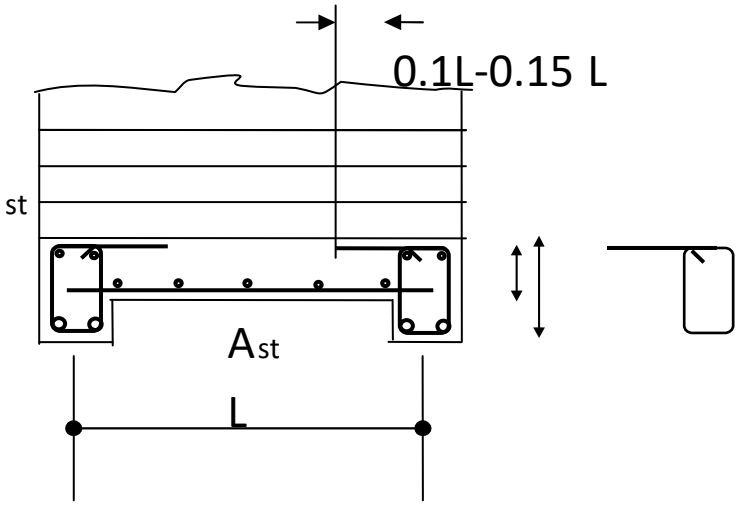
Structural Classification
Stairs with cantilever steps
Stair slab spanning transversely
(or horizontally between stringer beams or walls)
Stair slab spanning longitudinally
Slabless or raiser and tread type
Spiral stair case
Helicoidal slab stair case
3D or free standing stair slab

- **Classification based on span**

Based on type of span, following are the two types of stair cases;

Horizontally spanning or transversely spanning stairs. Figure 1
Longitudinally spanning stairs. For details refer IS: 456-2000 and SP (34).





Transversely spanning stair cases can be seen in figure 1. Here the main steel is provided transversely and the distribution steel is in the longitudinal direction.
STRINGER BEAMS
0.5 A
Transversely spanning stair cases

Longitudinally spanning stair cases:
Here the main steel in provided longitudinally and the distribution steel is in the transverse direction. Refer problem.

Effective span
The effective span is defined as follows based on the type of support.

Where flight supported at the ends of the landings in such a way that both landing and flight spans in the same direction, the effective span is the distance between the center to center of the supporting beams or wall. Refer Figure 2.

Where spanning on the edge of a landing slab which spans parallel with the riser, the effective span is the distance equal to the going of the stairs plus at each end either half the width of the landing or one meter, whichever is smaller. Refer Figure 3.

Where supported at top and bottom riser by beams spanning parallel with the riser, the distance center to center of the beams is the effective span. Refer Figure 4.

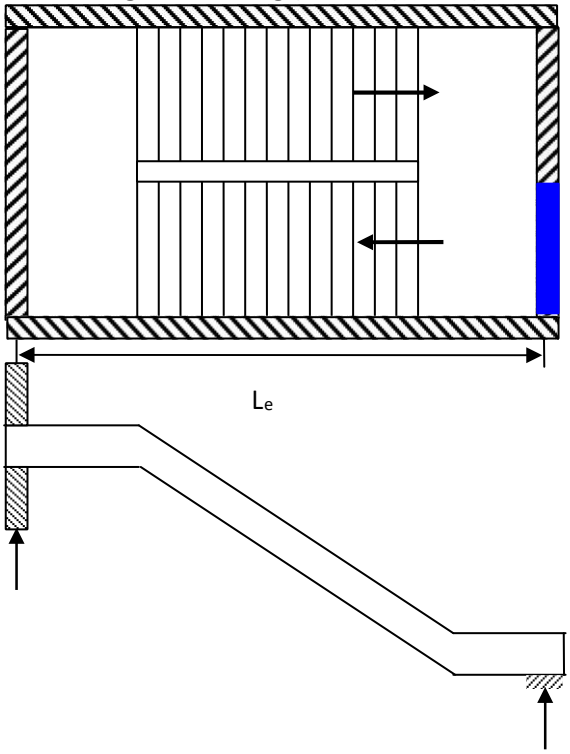
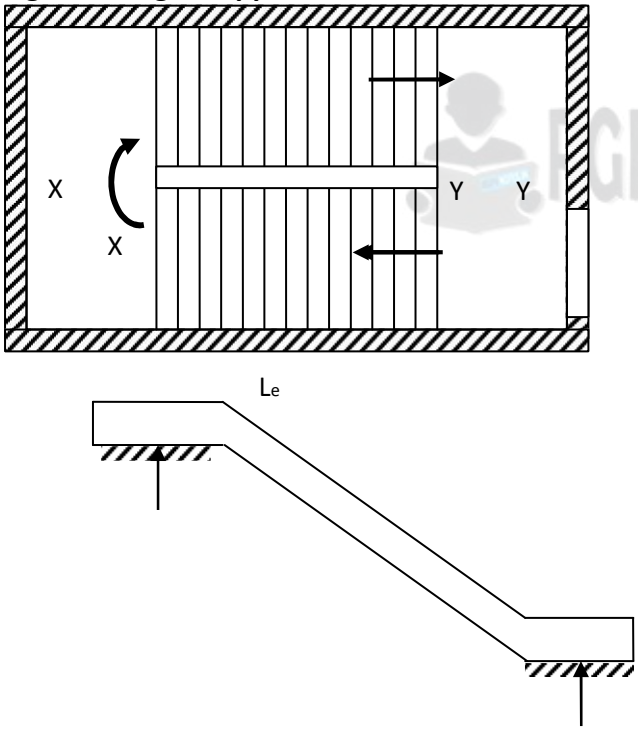
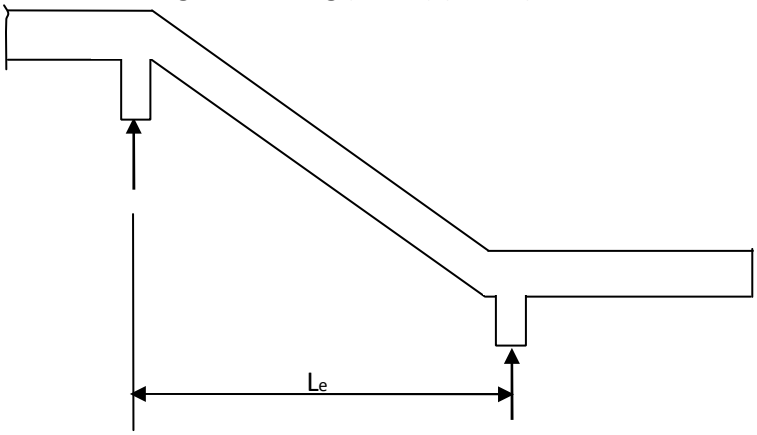


Figure 2. Flight supported at the ends of the landings on walls



Flight supported at the sides of the landings on walls



Flight supported on landing beams

Guide lines

Guide lines to be followed for fixing the dimensions of component parts of stair.

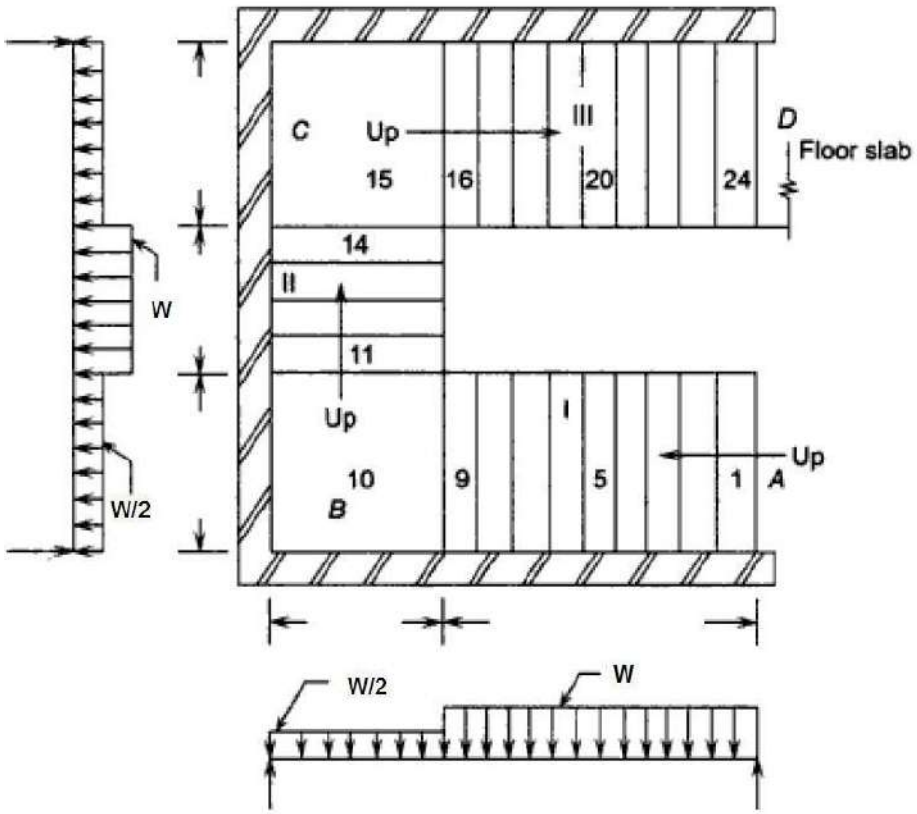
Rise (R) is 150mm to 180mm and tread (T) is 220 mm to 250 mm for a residential building.
For public building rise is kept between 120 to 150 mm and tread between 250 to 300 mm
Sum of tread (T) and twice the rise (2R) should be between 500 mm to 650 mm
The width of the stair is dependent on the usage and is between 0.8 m to 1 m for residential building and 1.8 m to 2 m for public building.
The width of the landing is equal to the width of stairs.
The number of steps in each flight should not be greater than 12
The pitch of the stair should not be more than 38 degrees.
The head room measured vertically above any step or below the mid landing shall not be less than 2.1 m.

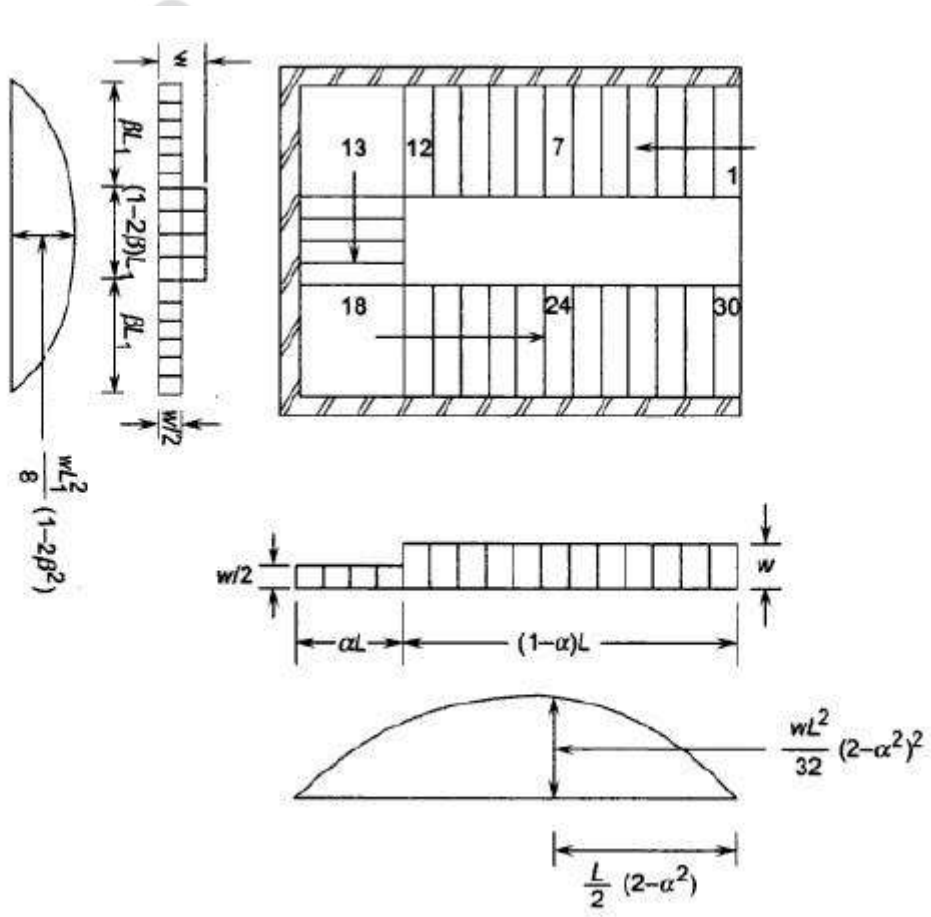
Distribution of Loading on Stairs

In the case of stairs with open wells, where spans partly crossing at right angles occur, the load on areas common to any two such spans may be taken as one half in each direction as shown in Fig. 5. Where flights or landings are embedded into walls for a length of not less than 110 mm and are designed to span in the direction of the flight, a 150 mm strip may be deducted from the loaded area and the effective breadth of the section increased by 75 mm for purposes of design (see Fig. 6).

Depth of Section

The depth of section shall be taken as the minimum thickness perpendicular to the soffit of the staircase.





Load distribution and bending moments

RCC design of a Dog-legged staircase

In this type of staircase, the succeeding flights rise in opposite directions. The two flights in plan are not separated by a well. A landing is provided corresponding to the level at which the direction of the flight changes.

Design of Dog-legged Stairs

Based on the direction along which a stair slab span, the stairs maybe classified into the following two types.

Stairs spanning horizontally

Stairs spanning vertically

Stairs spanning horizontally

These stairs are supported at each side by walls. Stringer beams or at one side by wall or at the other side by a beam.

Loads

Dead load of a step = ½ x T x R x 25

Dead load of waist slab = b x t x 25

Live load = LL (KN/m^2)

Floor finish = assume 0.5 kN/m

Stairs spanning longitudinally

In this, stairs spanning longitudinally, the beam is supported by top and at the bottom of flights.

Loads

Self-weight of a step = 1 x R/2 x 25

Self-weight of waist slab = 1 x t x 25

Self-weight of plan = 1 x t x 25[(R^2 + T^2)/T]

Live load = LL (KN/m^2)

Floor finish = assume 0.5 KN/m

For the efficient design of an RCC stair, we have to first analyse the various loads to be imposed on the stair.

The load calculations will help us determine, how much strength is required to carry the load. The strength bearing capacity of a staircase is determined on the amount of steel and concrete used.

The ratio of steel to concrete has to be as per standards. Steel in the staircase will take the tension imposed on it and the concrete takes up the compression

Design of RCC Stair case

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