Design of Stair-Cases

Stair Cases :-

A set of steps leading from one floor of a building to another, typically inside the building, is known as stair cases.
There are two main important components involved in stair cases -
i) Rise ii) Tread.

Rise : The vertical part of the stair step is known as Rise of stair case. → 150 mm to 180 mm

Tread :- The horizontal part of the stair step is known as tread of stair case.
210 mm to 230 mm

Requirements of Good stairs :-

1) **location :-** It should be so located ~~that~~ such that the sufficient light and ventilation to be ensured on the stair way.

2. ~~th~~ **Width of stair :-** The width of stair for Public building normally vary from ~~km~~ 1.5 m to 2m. and for the resedential building, the width of stair may vary from 900 mm to 1000 mm.

3. Length of flight :-

The no. of steps provided in the flight should be restricted to 12 and a minimum of 3.

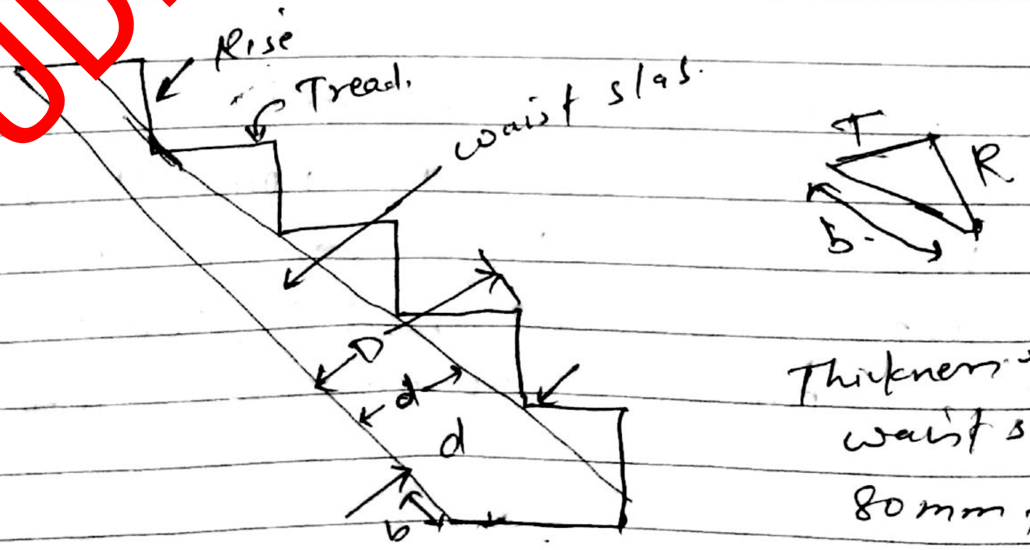
4. Head Room :

4. Pitch of stair :-

The slope of stair should never exceed 40° and should not be flatter than 25°.

5. materials :- The stair should be constructed of materials which posses fire resisting qualities.

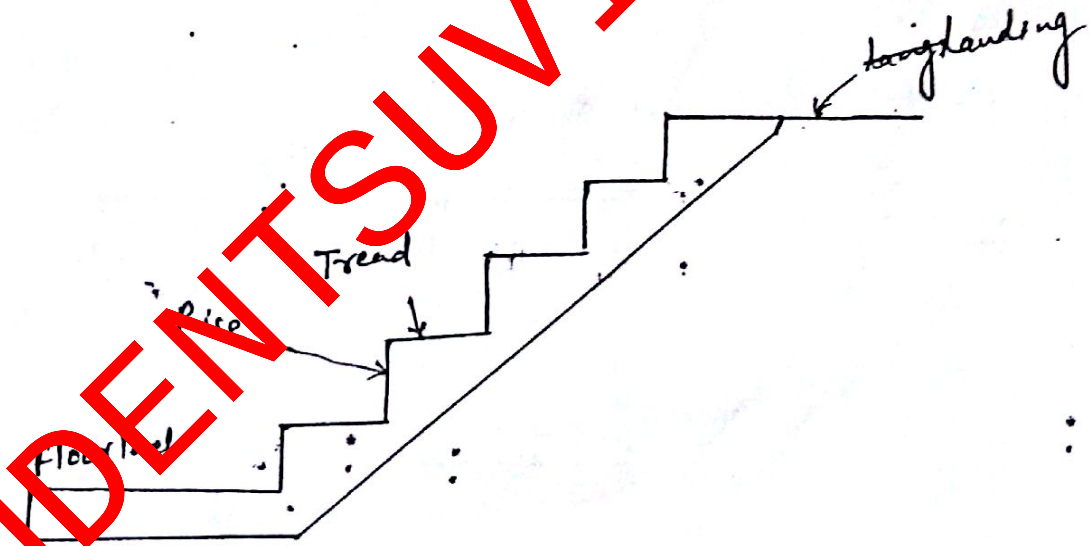
6. Landing :- The width of the landing should not be less than the width of the stair.



Thickness of waist slab = 80 mm to 100 mm

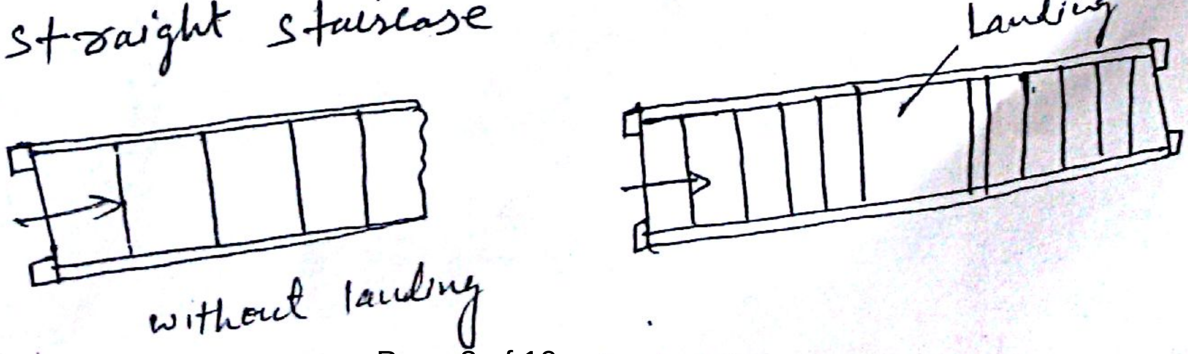
Stair Cases

A staircase consists of a number of steps arranged in a series for the purpose of to provide access to differ levels within a building. There are two main componant of a staircase: stairs and landing slab. The width of stair case may depend on the purpose for which it is prov and generally vary between 1m for residential buildi to 2m for public buildings. A flight is the length of the staircase situated between two landings. The number of steps in a flight may vary between 3 to

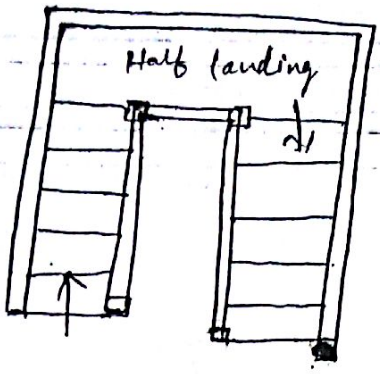


Types of staircase :-

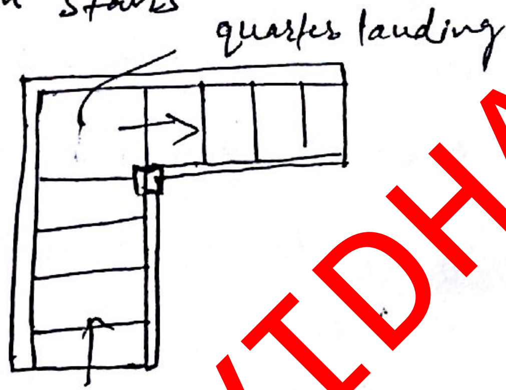
1. straight staircase



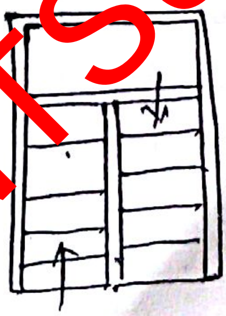
2. Half turn staircase (open well stair)



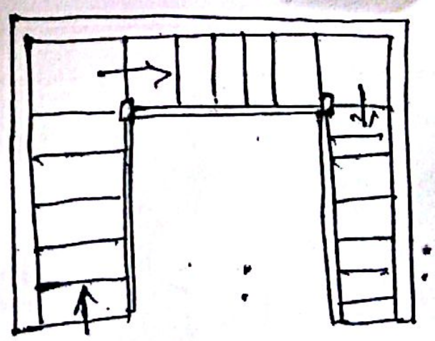
3. Quarter-turn stairs



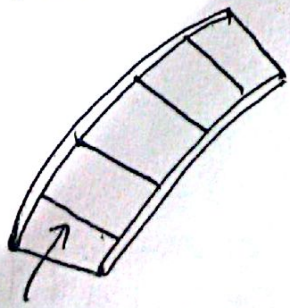
4. Dog-legged stairs



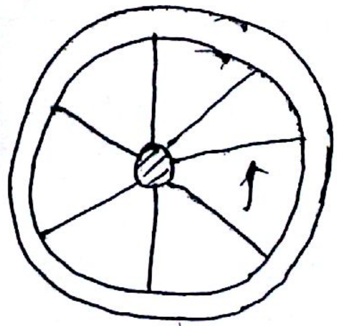
7. open newel stair with quarter space landi



5. Circular stairs



6. Spiral stairs

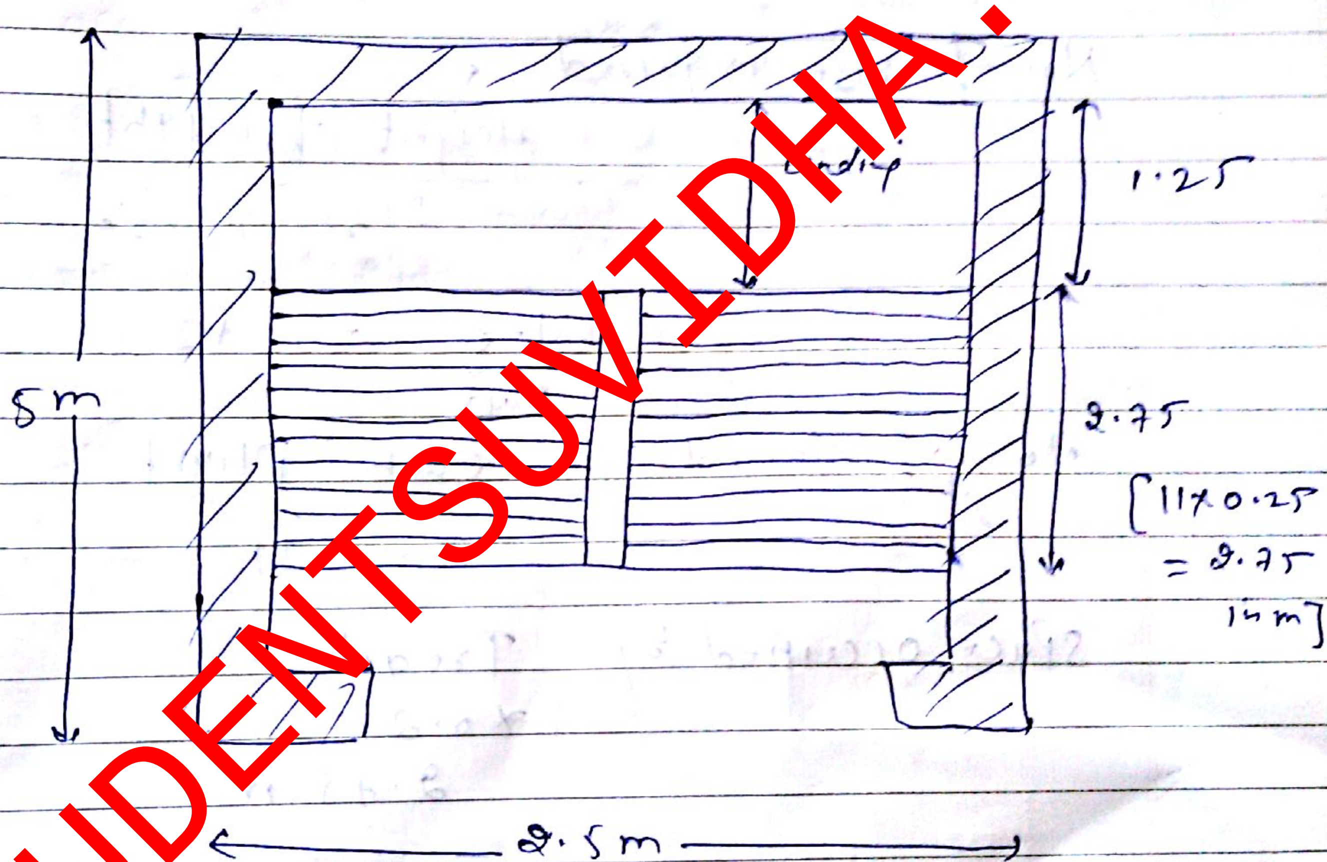


II : Dog-legged Stair

Que:-

Given vertical distance of floor = 3.6 m
Stair hall = 2.5 m x 5 m.
Live load = 2500 N/m²
Use m20 and fe 415 (HYSD)

Solⁿ:



Landing = 1.25 or 1.5 m.

No. of rise always greater than no. of tread by 1.

Step – I   ~~Design constant.~~
General Arrangement –

Let the rise be 150 mm
Tread = 250 mm

Height of each flight = $\frac{\text{vertical distance}}{2}$
$= \frac{3.6}{2} = 1.8$ m

No. of rise required = $\frac{\text{Height of flight}}{\text{Size of rise}}$

$= \frac{1.8}{0.15} = 12$

No. of tread in each flight
= 11

Space occupied by Tread =
$11 \times 0.25 =$
2.75 m

Space left for passage (width of landing)

$= 5.0 - 2.75 - 1.5$ (or 1.25)
$= 1$ m

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Step – II Design Constant.

$\sigma_{cbc} = 7\ N/mm^2$

$\sigma_{st} = 230\ N/mm^2$

$k = 0.289$

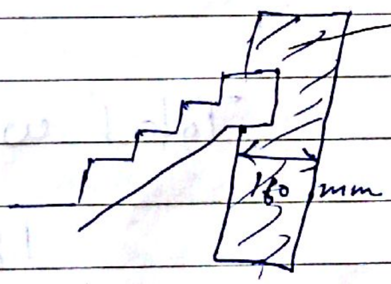
$j = 0.904$

$Q = 0.914$

Step – III — Design loads –

Loading on each flight

Let the bearing of landing slab wall = 160 mm



Effective span

$= 2.75 + 1.25 + \frac{0.160}{2}$

$= 4.1\ m.$

Thickness of waist slab = 200mm (for 40 to 50 mm per meter span)

Weight of slab (w') =

$0.2 \times 1 \times 25000$

$= 5{,}000\ N/m^2 \Rightarrow 5{,}000\ N$

Dead load of Horizontal area = w_1 =

$$w' \times \frac{\sqrt{R^2 + T^2}}{T}$$

$$5,000 \times \frac{\sqrt{(0.150)^2 + (0.250)^2}}{0.250}$$

$$= 5830 \ N/m^2$$

Dead weight of step -

$$w_2 = \frac{R}{2 \times 1000} \times 25000$$

$$= \frac{0.150}{2 \times 1000} \times 25000$$

$$\Rightarrow 1875 \ N/m^2 \Rightarrow 1875 N$$

Total weight per meter run -

$$1875 + 5830$$

$$\Rightarrow 7705 \ N/m^2 \rightarrow 7705 N.$$

weight of finishing - 100 N/m

live load = 2500 N/m² → 25

Total load = 10305 N/m

Step - IV

Design of waist slab -

$$m = \frac{wl^2}{8}$$

$$= \frac{10305 \times (4.11)^2}{8} \times 10^6$$

$$= 21.65 \times 10^6 \text{ N-mm}$$

Step - V

$$d = \sqrt{\frac{m}{Q.b}}$$

$$= \sqrt{\frac{21.65 \times 10^6}{0.914 \times 1000}}$$

$= 154$ mm

Overall depth using 16mm of bars with clear cover = 20mm

$= 154 + 20 + \frac{16}{2} = 182$ mm

⇒ Available effective depth

$= 154 - 20 - 16/2$

$= 154$ mm

Step - VI - Design of Reinforcement -

$$A_{st} = \frac{m}{\sigma_{st} \cdot j \cdot d} = \frac{21.65 \times 10^6}{230 \times 0.904 \times 154}$$

$= 216 \text{ mm}^2$

Using 8mm ϕ bars

$$\text{spacing} = \frac{50.3 \times 1000}{216}$$

$= 230$ mm c/c

Area of bar

$= \frac{\pi}{4} \times (8)^2$

$= 50.3 \text{ mm}^2$

Ans

use 10 mm ϕ bar @ 110 mm c/c as a main Reinforcement

Distribution Reinforcement :-

A_{sd} = 0.12 % of total gross-cross-sectional area

$= \frac{0.12}{100} \times 1000 \times 180$

$= 216 \text{ mm}^2$

use 8 mm ϕ bar for distribution reinforcement

$\therefore$ spacing $= 1000 \times \frac{\frac{\pi}{4} \times 8^2}{216}$

$= 232.6$ mm

use 8 mm ϕ bar @ 230 mm c/c as distribution reinforcement.