Elevators and Escalators Design
Lecture No.11
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The upward and downward movement of people in newly erected multistory buildings is principally achieved by lifts.

Fig. No. 1 Shows the multistory buildings upward and downward movement of people is achieved by elevators.

Location of Lifts
It is recommended that the walking distance between the entrance or office and the lift group should not be greater than 60m, preferably this should be kept to 45m maximum.
When lifts are arranged in a group it is recommended that all the lifts in that should serve the same floors

Designing and Planning Considerations:
• In larger, multistory buildings it is usual to locate the lifts at a central pedestrian circulation point.
• Lobbies in front of lift shaft entrances must be designed and arranged.
• For a lobby in front of a single lift, the available min depth between the wall of the lift shaft door and the opposite wall, measured in the direction of the lift car must be at least the same as the depth of the lift car itself.
• The building and its function dictate the basic type of lifts which need to be provided.
• Lifts are mechanical installations which are required to have a long service life.
**Grouping of Lifts**

The lifts should be positioned to: **Minimize** the walking distance between cars and hence the time taken to load passengers which will then improve overall **quality of service**. **For a two lift group:** side by side positioning is the most efficient but also the option having the lifts positioned opposite one another is also an efficient arrangement.

![Diagram of lift groups](image)

Fig.No.2 Shows the Lobbies in front of lift shaft entrances must be designed and arranged

**Basic Regulations of Choice the kind of Vertical Communication are:**
- Number of Storey.
- Distance between floors.
- Intensive use of elevator in each floor.
- Location of the building.
- Number of users in rush hours.
- Services in the building.

**Characteristics controls designing elevator are:**
- Speed of the Elevator.
- Dimensions of the car
- Loads
- Number of elevators.
- Location of entrances in the building.
- Location of the elevator area.
Fig. No.3 shows plan view of Shaft and Car dimensions

Fig No. 4 Shows the Structural Dimensions, Dimension of the basic element of the elevator

Elevators Types
There are three main applications for lifts namely:
Passenger, Goods and Service

- Residential
- Commercial
- Freight Elevators
- Bed Elevators
- Panoramic Elevators
- Library Elevators
- Food Elevators
• **Elevators Types**

  • Passenger Elevator (Traction)
    If your building has more than G + 5 floors you will probably want to consider an electric traction elevator. Traction elevators are better suited for taller buildings, since they are capable of much greater speeds and heights.

  • Hydraulic elevators
    Hydraulic elevators are used frequently and have a vast range of applications. Small buildings under G + 5 floors are typically where hydraulic units are found. Hydraulic units are limited by the number of floors that they can serve. Often these limitations are not due to the inability of the equipment, but reflect more on the cost of installation versus the long-term maintenance costs. Hydraulic elevators, which serve many floors in high traffic facilities, are not as cost efficient as are traction units, in regard to the units' performance and maintenance cost.

• **Hospital Elevators**
  These are passenger elevators but the cabin interior sizes are specially designed to allow stretchers to fit comfortably. Besides this, exceptionally smooth travel, exact matching with landing levels & minimum down-times are some of the features which classifies it as a Hospital Elevator.

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Fig. No.5 Shows the plan view of the lift for Hospital beds dimensions

Fig. No.6 Shows the several types of plan view of the Panoramic lifts dimensions
Operation types of the Lifts:

I. Traction Lift
II. Hydraulic Lift

**Drive Unit:**
- Electro Mechanical Drive.
- Electro Hydraulic Drive.

**Hydraulic Lifts**
- Hydraulic Lifts: Hydraulic lifts work by the action of a pumped fluid, normally oil. Within a cylinder driving a piston which is attached to the lift car.
- The hydraulic lift is used in applications where the maximum travel distance is about 20m.
- The maximum traveling speed of commercially available hydraulic lifts is limited to about 0.75m/s.
- This type of lift is suited to low intensity usage and is limited to around a maximum of 50 starts per hour.
- The hydraulic lift has the advantage of lower capital cost when compared with a traction lift.

![Fig.No.7 Shows the plan view of the Hydraulic passenger elevator.](image)

**Traction Lifts**
- This type of lift is driven by Wire ropes passing over a driving wheel or sheave and connected to the lift car and a counterweight.
- The speed of these lifts can range from 0.5 m/s up to a maximum of 10 m/s.
Basic Lift Components

- Entrances
- Brakes
- Lift Cars
- Indicators
- Guides
- Counterweights
- Shaft
- Lift motor room

Elevator Consist of:

- Gear (with speed 0.62-2.5m/s).
- Gearless (with speed 2.5-12m/s).
- Control Board.
- Doors: (manual-half-automatic-full auto.).
- Safety.

Entrances:
1- Two Panel center opening: This is considered the most efficient door configuration as passengers can pass through the entrance before the doors are fully.
2- Four panel centre opening: This arrangement is used on entrances of 1400mm wide and above.
3- Two panel side opening: This method is more space efficient but slower for passenger transfer and is used on non intensive applications.

Lift Cars
Lift cars are made up of Two Main component parts:

- The **car itself** and the **sling** which holds the car.
- The sling includes the **guide shoes** and **safety gear**.
- The internal height within the car must be at least 1980mm.
- On very **high speed lifts** the car requires special design to reduce noise levels and this is achieved by providing noise insulation to the car and **streamlining** the car to make the airflow around the car smoother.

Traction Lifts

- The sheave is connected to an electric motor.
- When the motor turns one way, the sheave raises the elevator; when the motor turns the other way, the sheave lowers the elevator.
- In **gearless elevators**, the motor rotates the sheaves directly

In **geared** elevators, the motor turns a **gear train** that rotates the sheave.

- Typically, the sheave, the motor and the **control system** are all housed in a **machine room** above the elevator shaft.
- The **counterweight** weights about the same as the car filled to **40-percent** capacity.
• Basically, the motor only has to overcome friction the weight on the other side does most of the work.
• Using up the potential energy in the elevator car (letting it descend to the ground) builds up the potential energy in the weight (the weight rises to the top of the shaft). .
• Both the elevator car and the counterweight ride on guide rails along the sides of the elevator shaft. The rails keep the car and counterweight from swaying back and forth, and they also work with the safety system to stop the car in an emergency.

**Lift Layout**
The lift machine is usually located above the lift shaft as this allows:
- The most economical and simplest roping system.
- Reduced power consumption and the loads on the overhead structure are usually lower than those with the lift machine below the lift shaft. Also lift motor rooms located at the bottom of the shaft increases the shaft dimensions and increases maintenance.

**Electric Traction Machine Above (1:1)**
This is an economical and efficient roping system applicable to many medium and high speed systems. The rope linear speed and car travel speed are the same.

**Electric Traction Machine Above (2:1)**
Rope linear speed is twice the car travel speed and the ropes pass over the sheave once.
This arrangement allows a machine to carry twice the lift car load.
This arrangement allows the higher speed and therefore smaller motor.
The 2:1 arrangement is generally used when loads exceed 1800 kg.
Also economical for speed from 1.5 to 2.5 m/s.

**Electric Traction Above-Double Wrap**
This arrangement the ropes pass over the sheaves twice and it is also 2:1 roped.
This method is used for high speed medium to heavy duty loads.
- Minimize rope wear.

**Electric Traction Machine Below**
The headroom required above the lift shaft is reduced.
The load imposed on the building structure by the car, passenger load and counterweight is double compared with other methods.
It is possible to limit the room above the lift shaft to about 1.5 high to house the pulleys and load bearing top sheave.

**Operation and Control**
1- Single Automatic Pushbutton Control
This is the basic system applicable only for light traffic and a maximum of about three floors.
This system the landing call buttons are non-directional. and while the lift is in use the landing calls are ignored.
This can result in unsatisfactory long waiting times.

2- Down Collective Control
Register all calls made while the lift is in motion or is stationary.
The lift car normally rests at the ground floor and when more than one landing call is registered the lift will travel to the highest call and stop at the other call on the way down.

Good for Hotels and Residential Towers. If Two Lifts one of the lifts will be returned to the ground floor and the other will remain on the last floor served, unless this is also the ground floor, in which case it will be automatically sent to stop at a midway floor.
When a landing call is registered the electronic control system will determine which car is nearest to the call.

3- Full Collective Control
Up and down call buttons.
The lift stops at all up calls during its upward journey and at all down call during its downward journey.
Lift stops at each call floor **in sequence** in the order that the floors are reached according to the direction of travel.

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**ESCALATORS**

**Escalator = Scala Elevator**

The escalator as we know it was later re-designed by Charles Seeberger in 1897, who created the name 'escalator' from the word 'scala', which is Latin for steps and the word 'elevator', which had already been invented.

An escalator is a conveyor type transport device that moves people. It is a moving staircase with steps that move up or down using a conveyor belt and tracks keeping each step horizontal for the passenger. However, the escalator began as an amusement and not as a practical transport.

- Escalators are required to provide continuous mass transport of people.
- Escalators in department stores rise at an angle of between (30°-35°). The 35° escalator is more economical, as it takes up less surface area.
- In accordance with a worldwide standard, the width of the step to be used is 60 cm (for one person width) 80 cm (for one- to two people width) and 100 cm (for two people width).
- According to current assessment, or average one escalator is installed for every **1500 m² of sales area**.

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**Fig. No.9 Shows the width of the step to be used is (60 -100 cm)**
Fig. No. 10 Shows the dimensions and performance for escalators with either 30° or 35° angle of ascent.

| step width | 600   | 800   | 1000
|------------|-------|-------|------
| A          | 605–620| 805–820| 1005–1020 |
| B          | 1170–1220| 1320–1420| 1570–1620 |
| C          | 1280  | 1480  | 1680
| transportation capacity/h | 5000–8000 persons | 7000–8000 persons | 8000–10000 persons |

Fig. No. 11 Shows the arrangement of escalators
TRAVELATORS

- Traveletor (Moving walks) for rapid horizontal or inclined transportation. You will find Schindler moving walks in some of the world's busiest airports, exhibition halls, subway systems and shopping complexes.
- Schindler 9500 moving walks combine comfort with safe, rapid, horizontal and inclined transportation and are ideal for use wherever the elimination of long walks is desired.
- Moving Walks are designed to carry people smoothly and comfortably.
- An Inclined Moving Walks offer ideal solutions for the needs of modern pedestrian traffic, in all types of commercial facilities from grocery stores to shopping malls.
- Travelators are a means of conveying people horizontally or up a slightly inclined plane (up to a max. angle of 12° or 21%).
- The average split of traffic that goes upstairs in a large departments store is:
  - Stairs 2% - Lifts 8% - Escalators 90%

Length in Plan is:
With 30° escalators = 1.732xstorey height.
With 35° escalators = 1.428 storey height.

Example
Storey height = 4.5m
Length in plan = 1.732x4.5 = 7.794m.
   = 1.428x4.5 = 6.426m

Fig. No. 12 Shows the plan and cross-section view