



Building Elevator Systems

An Online Continuing Education Course for Engineers

Course Number: BD-6001

Credit: 6 Hours / 6 PDH / 6 CPD

BUILDING ELEVATOR SYSTEMS

For most people residing in urban cities, elevators have become an integral part of their daily life. Simply stated, an elevator is a hoisting or lowering mechanism, designed to carry passengers or freight, and is equipped with a car and platform that typically moves in fixed guides and serves two or more landings. The elevators can be broadly classified as either electric traction type or hydraulic type.

- Traction elevators have an elevator car and counterweight attached to opposite ends of hoist ropes. The hoist ropes pass over a driving machine that raises and lowers the car. Traction elevators run on load-bearing rails in the elevator hoistway. Traction elevators are most often used in mid-rise and high-rise buildings with five or more floors.
- Hydraulic elevators, on the other hand, are raised by forcing pressurized oil through a valve into a steel cylinder located above ground or underground. The pressure forces a piston to rise, lifting the elevator platform and car enclosure mounted on it. The car is lowered by opening the valve and allowing the weight of the car to force oil from the cylinder in a controlled manner. When the valve is closed the car is stopped. Since the weight of hydraulic elevator cars is borne by the piston, there is no need for a structural framework or load-bearing rails. Hydraulic elevators are commonly found in low-rise buildings with two to five floors.

The main design considerations for choosing either electric traction drive or hydraulic for a particular project are the number of floors, the height of the building, the number of people to be transported, desired passenger waiting times and frequency of use.

The other mode of vertical building transportation is “Escalator”. It can be described as moving stairs typically used to carry large number of people at high volumes through a limited no of floors. These are commonly used in high density areas or where sudden traffic surges are expected at times; for example at discharge times from offices, railways underground stations, airport terminals, theaters, shopping malls and departmental stores. In such applications, escalators will provide shorter travel time than elevators because elevator cars are limited in size and passengers have to wait longer for the service.

In this course we will discuss the key notions pertaining to elevator systems.

SECTION - 1

GENERAL ELEVATOR PLANNING

Several factors combine to influence the cost of an elevator installation, including the passenger handling capacity, waiting interval, speed, location, finishes, intelligent group control safety, and reliability. There are also risks associated with the use of elevators. To ensure that persons are not stuck in elevators for longer periods of time, or worse that the elevator does not lose stability and plummet to the basement from a high floor, the engineers responsible for designing elevators must comply with all statutory codes and standards.

Typical parameters in design of elevators include:

Characteristic of the premises

- Type and use of building;
- Floor plate size and height of the building;
- Size of population and its distribution in the premises;
- Fire safety and regulations;
- The house keeping of the premises.

Circulation Efficiency

- Number of cars and their capacity;
- Location and configuration of elevators in entrance lobby;
- Travel length, number of stops and maximum acceptable waiting time;
- Arrangement with the combination of elevator, escalator and emergency stairs.

Characteristic of the equipment

- Type of transportation systems;
- Rated load and car dimensions;
- The speed of the lift/escalator system;

- The type of motor drive control system of the machine;
- Mode of group supervisory control and safety features;
- Cab enclosure and hoist way door finishes;
- Emergency power supplies and fire protection systems;
- Requirements of the local regulations on vertical transport system.

And so on. There could be over a hundred different possible configurations for your building's elevators, and each will have its advantages and disadvantages compared with the others.

DEVELOPMENT PROCESS

The design, installation, and use of an elevator system is dictated according to various standards (aka elevator codes), which may typically be international, national, state, regional or city based. Building codes, fire regulations, the American Disabilities Act (ADA) and other Uniform Federal Accessibility Standards (UFAS) are a few examples of these rules to which the engineers and architects must submit. As far as the specific rules governing the design of elevators; American Society of Mechanical Engineer's Standard A17.1 (ASME/ANSI A17.1), CAN/CSA B44 in Canada and EN81 (European standard) provide the detailed criteria.

Note that in most US Jurisdictions, ASME/ANSI A17.1, A17.2, A17.3, A17.5, A18.1 usually take precedence over all other codes unless specifically advised.

DESIGN ELEMENTS OF ELEVATOR SYSTEMS

Traffic Planning

Elevators' planning in building projects is dependant on the "traffic analysis" study which varies according to the type and usage of the building. For example, an office building typically requires more elevators than an apartment building due to heavier loads & traffic. Elevator professionals often use building type to assist in recommending solutions based on different types of building traffic.

Traffic analysis is the study of the population distribution and their predicted pattern of flow within the day. It helps in selecting:

- The correct number and type of transportation devices;
- The right sizes and speeds of the transportation devices;
- The proper control systems and features to optimize and synchronize traffic flow;
- The optimum layout for the transportation devices and correct positioning in the building and in relation to one another;
- Easy access to buildings and a smooth flow of people and goods.

The efficiency of an elevator system is defined in terms of the quantity of service (handling capacity) and quality of service (passenger waiting time).

Handling Capacity:

The handling capacity of elevator system is the total number of passengers that the system can transport within a certain period of time, (usually 5 minutes i.e. 300 seconds) during the peak traffic conditions (usually the morning up-peak*) with a specified average car loading (usually 80% of the rated capacity of the elevator). The handling capacity is usually expressed in percentage and is calculated as:

$$HC = 0.8 \times \frac{300 \times RC}{I \times P} = \frac{240 \times RC}{I \times P}$$

Where

- HC = Handling capacity (percent)
- RC = Rated capacity of the elevator (lbs)
- I = Interval (seconds)
- P = Number of passengers carried on a round trip [the number of passengers carried on a round trip is established by the designer for each project, and is typically obtained by dividing elevator capacity by 150 pounds per person].

Acceptable five-minute handling capacities during peak periods for general passenger elevator service can be taken as 10 to 16%. The criteria differs depending on the building type — residential apartments or offices. As a rough guide, the following is acceptable:

- Residential Apartments / buildings: 7 to 9%.
- Premises without specific distribution traffic, such as mixed-tenancy office buildings with different working hours: 12 to 16%.
- Premises with excessive distribution traffic, such as single tenancy office buildings with the same working hours: 16 to 25%.

*The up-peak mode is defined as the mode in which the lift is considered to be in operation during the up-peak period. The up-peak period is the time interval during which the maximum number of people arrive at the main terminal floor. The up-peak mode is considered to be the mode in which the lift is in operation during the up-peak period. The up-peak mode is considered to be the mode in which the lift is in operation during the up-peak period. The up-peak mode is considered to be the mode in which the lift is in operation during the up-peak period.

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Interval:

Interval or waiting interval is the average time, in seconds, between successive lift car arrivals at the main terminal floor with cars loaded to any level. The interval represents the theoretical longest time between elevator dispatches from the main lobby.

The interval is directly related to passenger waiting times and inversely related to the number of elevators in a group and is calculated by the following equation: