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User Requirements of Elevators

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Please note

As elevators are the primary means of vertical movement in many buildings, they should be built to satisfy the requirements of most users. This Digest discusses these requirements and the options available.

Basic Requirements

Most users require no more than a service that is comfortable, safe and relatively efficient. As comfort is determined by both environmental and psychological aspects, elevators should be ventilated and well maintained. Comfort is also determined by the number of people in the elevator, and a limiting density for most[1] is about 5 persons/m². Relative efficiency of service should relate to the type of building and is normally evaluated in terms of average waiting time. Table 1 indicates the waiting times assumed to be acceptable for various buildings.

Table 1. Recommended performance of elevators

Type of Building	Average Waiting Interval (sec)	Percentage of Total Population Handled in Peak 5 Min
Office buildings	25-30	12-15
Apartment buildings	50-80	5-8
Hostels and dormitories	50-70	10-15
Hotels	40-70	10-15

Efficiency of Elevators

Acceptable waiting time is a value judgment based in part on an estimate of the cost of the time lost in waiting. Consequently, in residential situations a longer waiting time is more acceptable than in a working environment. Pattern of use also varies and Table 1 indicates frequently assumed values for the percentage of total population using an elevator in the peak 5 minutes of the day. In some office buildings the implementation of staggered hours has

changed the pattern of demand from highest at the start and end of the day to highest at the lunch hour. Figure 1 is a graph of elevator demand for cases with and without staggered hours.

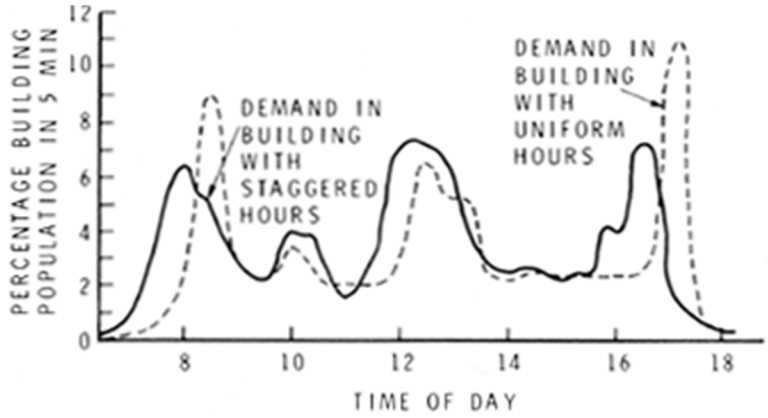

Figure 1. Elevator demand in an office building

Types of Elevator

Since the development in 1853 by E. G. Otis of the traction elevator a number of other types have appeared. The two main ones in service are the traction and the hydraulic. They satisfy almost completely different requirements and should be installed accordingly. The traction elevator lifts the car by cables, using counterweights to minimize energy expenditure. The hydraulic elevator pushes the car up on a shaft filled with compressed oil.

Hydraulic elevators are considerably slower than the traction type, having a speed of 30 to 50 mpm whereas traction elevators operate at faster than 70 mpm and even in excess of 300 mpm. Consequently, hydraulic elevators are suitable only in low-rise/low-demand situations such as small apartment buildings where they will cost about 15 per cent less than the traction type. Hydraulic elevators require less space for machine rooms, which can be remote from the hoistway. Figure 2 shows sections for comparable hydraulic and traction elevators.

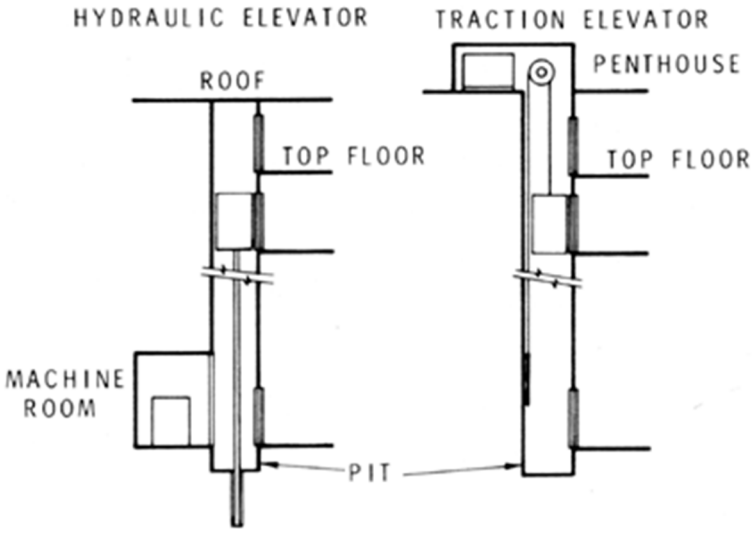

Figure 2. Sectional elevations of elevators

Car Size and Shape

Elevator cars are rated according to maximum allowable weight and number of passengers.[2] An elevator may therefore be referred to as 1150 kg or 16-person capacity (metric sizes have not been finalized). Usually, however, the maximum loading of an 1150 kg elevator will not exceed 13. A density of 5 persons/m^2 of clear platform area can be used to determine maximum

design loading rather than 6 persons/m^2 used in some safety regulations. The shape of cars is relatively uniform, depth being about two-thirds width. This minimizes the time taken to exit from a full car and reduces transfer time, but the entry and exit of wheelchairs and equipment may thus be made more difficult.

Novel Applications

Although traction elevators are not mechanically restricted with regard to the height to which they will operate, special arrangements must be made to maintain an adequate level of service in a high-rise building. High-speed elevators can be uncomfortable because of rapid acceleration and vibration. In buildings of more than twelve storeys, banks of elevators frequently serve one range of floors exclusively. This is most efficient if the range of floors is kept between five and ten. Some very tall buildings may have a "sky lobby" to which passengers can take an express elevator, then transfer to a local elevator to reach the desired floor. Occasionally, in high-demand situations a "tandem" arrangement may be employed where two cars are joined vertically one serving even-numbered floors, the other odd-numbered floors.

It is possible also to achieve a high degree of versatility by mixing escalators and elevators. A penthouse suite of offices or a basement car park can be served by a hydraulic lift. In buildings such as hotels it may be advisable to improve security by making passengers from a basement transfer at the lobby before going on to the upper floors. These arrangements can be confusing to users, however, and adequate signage will be required.

Requirements of Disabled

The physically handicapped are often dependent on elevators and care should be taken to ensure that their needs are met. Approximately 5 per cent of the adult population require special features, many of which would benefit the rest of the population as well.[3] Such features should be internationally standardized to allow manufacturers to produce uniform lines of elevators.

Most problems result from control operations. The blind can frequently not detect which of a bank of elevators is available or at which floor one has stopped; and floor selection buttons may be out of reach of those in wheelchairs. Recently some elevator companies have responded to this need by developing special features for the handicapped. The following recommendations include such features.

Signal: Advance warning of next car to depart by both auditory and visual signals; the amount of advance warning should be adequate to allow a person moving at 0.5 m/s to enter before the door closes.

Floor Number: The floor number, in relief, located on the door frame at 1500 mm.

Floor Alignment: Maximum vertical inaccuracy 12 mm; maximum horizontal gap 32 mm.

Floor Selection Panel: Maximum height of top button 1370 mm, with a minimum height for bottom button of 890 mm (a horizontal arrangement could be used if necessary); panel should be located on a side wall in 900-kg elevators or smaller. Again, the buttons indicating floor numbers should be in relief, preferably buttons that depress and remain depressed until the desired floor has been reached.

Call Buttons: Buttons should be 1065 mm from floor level.

Railing: Inside car perimeter should be equipped with a railing at a maximum height of 1050 mm from finished floor level.

Shelf for Packages: In the lobby a permanently fixed shelf should be installed at 1010 mm from finished floor level.

Door Safety Devices: Doors should be both bumper and photoelectric type.

Telephone Emergency Alarm: If a building has a concierge, there should be a telephone communication alarm for two-way information exchange, and for those with problems in communicating there should also be a normal button alarm with emergency power available.

Elevator Size: Figure 3 illustrates the minimum size required to accommodate a wheelchair.

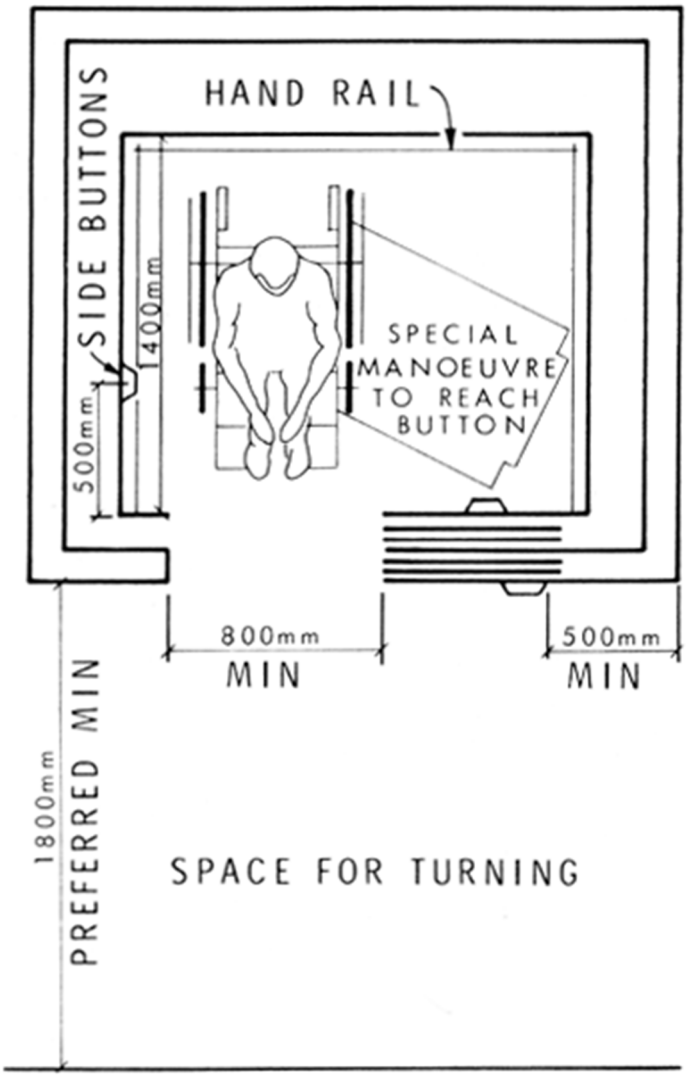

Figure 3. Dimensional requirements for use of wheelchairs

Requirements for Emergency Use

Ambulance attendants have specific requirements in moving a patient in an elevator. The standard stretcher cannot easily fit into an elevator of less than 1150 kg capacity, and in some cases a patient on a stretcher should not be tilted to allow entry into a smaller one. The consequence of delays in trying to manoeuvre patients into elevators or of tilting those who should remain horizontal have not yet been fully appraised. Current studies indicate that it is a problem serious enough to justify installing one 1150 kg elevator with a side-opening door in most buildings.

Another problem faced by ambulance attendants is the delay caused by not having an elevator immediately available. Where possible, a key-operated elevator that could be commanded to the entrance level would solve this problem; the building superintendent could keep the keys or make some other arrangement with the ambulance company.

Provision of a key-operated elevator is often mandatory for the use of fire departments. In new buildings over eight storeys in height a 900 kg elevator is required, and one with side-opening doors and a capacity of 1150 kg would be adequate for use with stretchers at an increased cost of about 5 per cent. It is a distinct advantage that fire fighters should have available as many elevators as possible for the evacuation of people unable to use stairs.

If elevators break down it may be necessary to remove passengers. Provision is often made for dropping an escape ladder through a trap door in the roof of the car; or in some cases it may be possible to force open the elevator doors if the car has stopped between floors.

Requirements for Furniture and Equipment Delivery

Sofas, pianos and large carpets can be extremely difficult to load on elevators of less than 1150 kg capacity. It may frequently be necessary to remove the ceiling panels of the car or to transport such loads by some other means. Office, computing, photocopying and other equipment may even need to be disassembled to be fitted into elevators with a capacity of less than 1150 kg.

Maintenance and Security

Elevators are among the most heavily vandalized parts of buildings. Features such as rubberized flooring or other easily cleaned surface and recessed baseboards are almost standard. Carpeting, if used, should be removable for cleaning but securely fixed otherwise. Fixtures should be of metal or some other unbreakable material, and light fixtures should be out of reach. Door glides should not allow doors to be jammed. As elevators are a relatively frequent location for assaults and robbery, consideration should be given to providing mirrors, cameras, etc., for increased supervision. Maintenance contracts are usually undertaken with elevator companies, and standard contracts have now been prepared by provincial authorities.

Elevator Lobbies

The number of elevators can determine the shape of a lobby. No more than three elevators should be banked to serve the same range of floors or boarding will take too long, but a facing row of three can serve the same range of floors. For silent hour security in office buildings it should be possible to close off the elevator lobby and stairs. Such separation will also aid recent fire control procedures, which recommend pressurizing the lobby and stairs after doors have been automatically closed. During regular operating hours the lobby, especially for residential situations, should be easily supervised.

Size and Number

Throughout this discussion recommendations have been made regarding the size of elevators. Often, however, the choice of both size and number is the result of a relatively complex analysis. Graphical methods can be used to give an estimate of requirements,[4] and computer programs are frequently used to find the most efficient elevator system. The following simplified example for elevators designed to cope at the peak 5 minutes of the day will demonstrate the basic method.

Given -- 12-storey apartment block
-- 3-m storey height
-- 30 bedrooms per floor
-- 10-sec elevator operating time per stop

Assume -- 1 1/2 people per bedroom gives 45 per floor and 495 above ground level
-- 8 per cent of population returns during peak 5 min, i.e., 40 people in 5 min (this assumption will be the largest source of error)
-- Each car travels 11 storeys (probabilistic formulae are available for more precise calculation)
-- Each car carries 12 people (formulae are available for calculation)

-- Each car stops at 6 floors, excluding entrance level

-- Each passenger takes 1.5 sec to transfer (i.e., boarding or deboarding)

Calculation

Round-Trip Time = Travel Time+Stopping Time+Transfer Time

Travel Time = Distance÷Velocity
=(2 x 11 ÷ 3)÷ 70 m/min ≈ 1 min

Stopping Time = Number of Stops + 1 x Operating Time (assumed to be 10 sec)
= 7 x 10 ≈ 70 sec

Transfer Time = Number of Transfers x Time
= 2 x 12 x 1.5 sec ≈ 36 sec

Round-Trip Time = 2 min 46 sec

During this period about 22 people will have arrived, indicating that two elevators with an average loading of 12 would be adequate. The average capacity is assumed to be 80 per cent of maximum capacity, so that these elevators should be 16-person or 1150-kg elevators.

The average waiting time is one-half the Round-Trip Time divided by the number of elevators: 40 sec.

Summary

Selection of elevators depends not only on cost but also on the requirements of users. Building form determines the type of elevator system, whether a traction or hydraulic system or an elaborate sky-lobby system. Use by the disabled requires certain size and features, and both ambulance attendants and fire departments have specific but compatible needs. The number and size of the elevators in any building depend, therefore, upon the pattern of use.

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