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BUILDING PRACTICE NOTE

ACCESSIBLE PEDESTRIAN SYSTEMS FOR THOSE WITH PHYSICAL DISABILITIES

by

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Division of Building Research, National Research Council of Canada

Ottawa, December 1979

FOREWORD

There is growing recognition today of the problems and needs of persons with various disabilities. This change in attitude has had a considerable influence on construction but unfortunately buildings that are not accessible to everyone are still being designed and built.

The information presented in this Building Practice Note is an attempt to bring to the attention of designers several suggested ways in which they can achieve a building whose design presents no limits to mobility.

This Note is based on the results of discussions with many interested persons. My thanks are added to those of the author to those mentioned in the Preface.

Comments relating to the information contained in this Note and its usefulness in the design process will be welcome.

Ottawa
December 1979

C.B. Crawford
Director, DBR/NRC

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by

B.M. Johnson

PREFACE

This Building Practice Note presents the general planning of pedestrian circulation systems and the design requirements for interior pedestrian facilities with an emphasis on the needs of the elderly or persons with physical disabilities. The first of seven sections that comprise this Note contains general information concerning planning; each of the others deals with a separate topic oriented to the needs of decision-makers at an identified step in the process.

The author wishes to thank Dave O'Malley, who prepared the illustrations and here acknowledge the contribution of a group of persons from other federal government agencies:

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Helen Morton, Treasury Board
Wilf Race, Employment and Immigration Canada

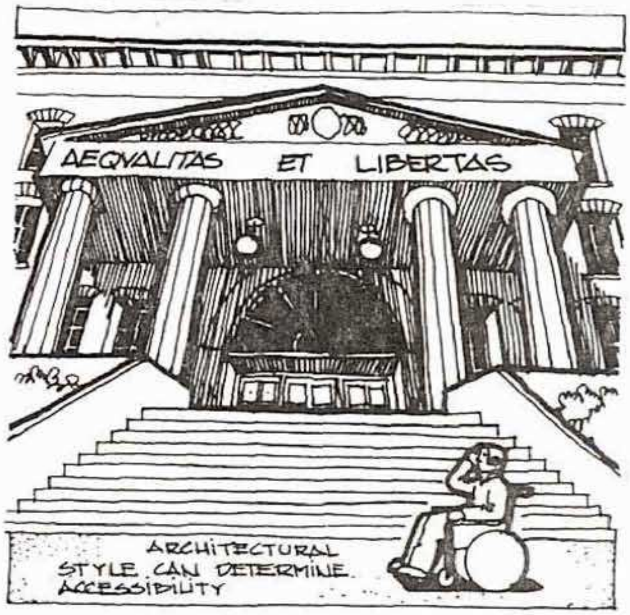
Comments on these notes will be welcomed. They should be sent to: C.B. Crawford, Director, Division of Building Research, National Research Council of Canada, Ottawa, Ontario K1A 0R6.

SECTION 1

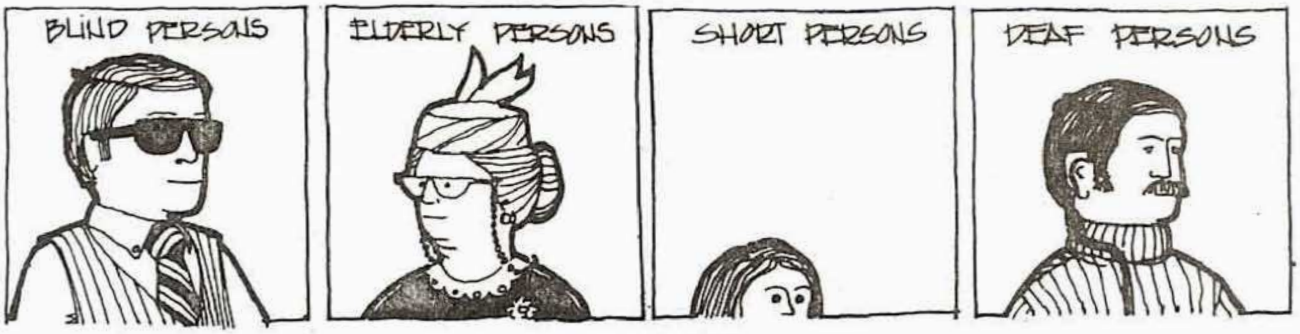
PLANNING FOR ACCESSIBILITY

Persons with disabilities should not be deprived of participating in the mainstream of society by man-made obstacles in their environment. In the past, buildings were made inaccessible by architectural barriers because designers failed to consider the problems and needs of persons with various disabilities. Today these problems and needs are recognized. This change in attitude assumes that certainly all new buildings will be accessible to everyone. Unfortunately, this is not always the case.

Certain traditional elements in design are insurmountable barriers to the disabled. For example, the practice of having the first floor above grade level, prevalent in monumental buildings, forces anyone wishing to enter the building to climb a series of steps. Frequently, even small buildings continue this tradition by having a single step at the front door. Other classical elements such as heavy doors, grand staircases and small changes in level are all barriers that can be avoided with careful planning.

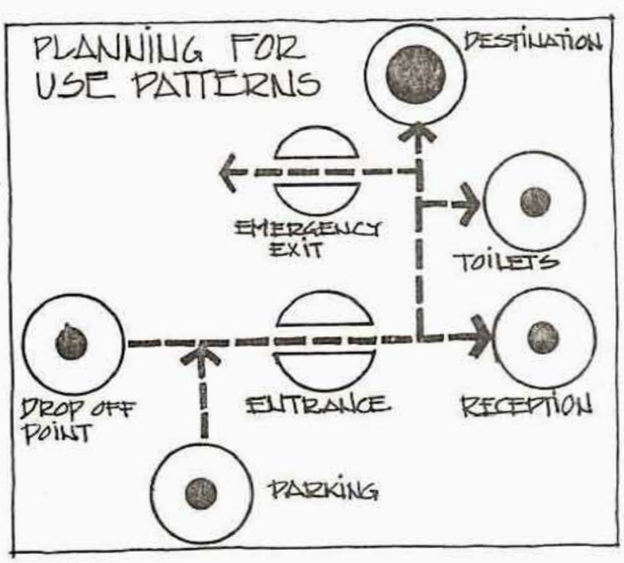


One very important need must be considered throughout the design process: persons with disabilities want to be able to use a building unaided. The designer must therefore be aware of the various user groups and understand their problems and abilities. Although a building may be accessible to someone in a wheelchair, it may still contain obstacles for people who are blind or deaf.



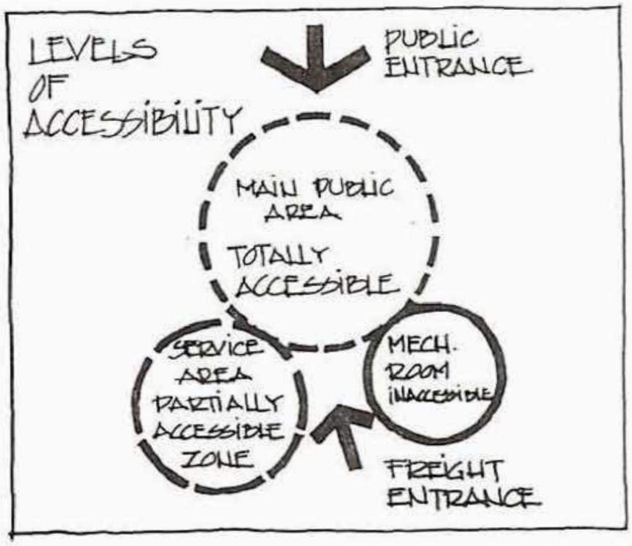
Those with physical disabilities are usually more susceptible to fatigue as are those who use canes, crutches, or walkers who can also have considerable problems maneuvering. The latter group includes the elderly, who may also have problems of impaired vision such as susceptibility to glare, reduced colour discrimination, and poor boundary recognition. Temporarily disabled persons and those not normally considered handicapped, such as a person trying to push a baby carriage through a revolving door, are often ignored. Children, too, can have problems using building facilities.

The designer must relate these considerations to all aspects of building use, i.e., arrival at the site, entrance into the building, orientation within the building, access to destination, use of auxiliary services, and emergency exiting.

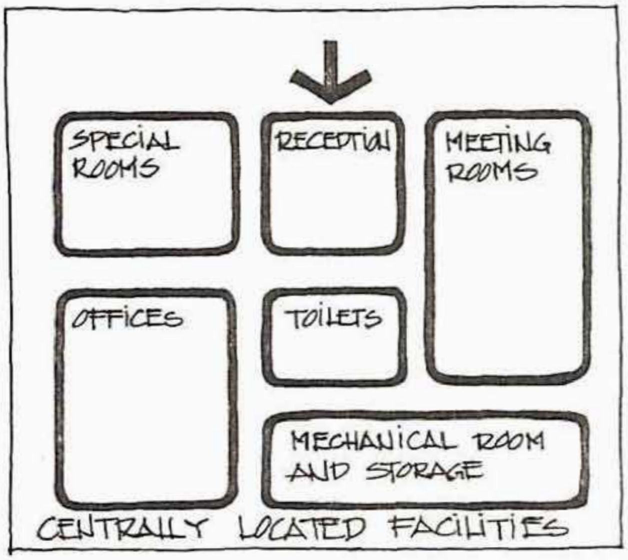


LEVELS OF ACCESSIBILITY

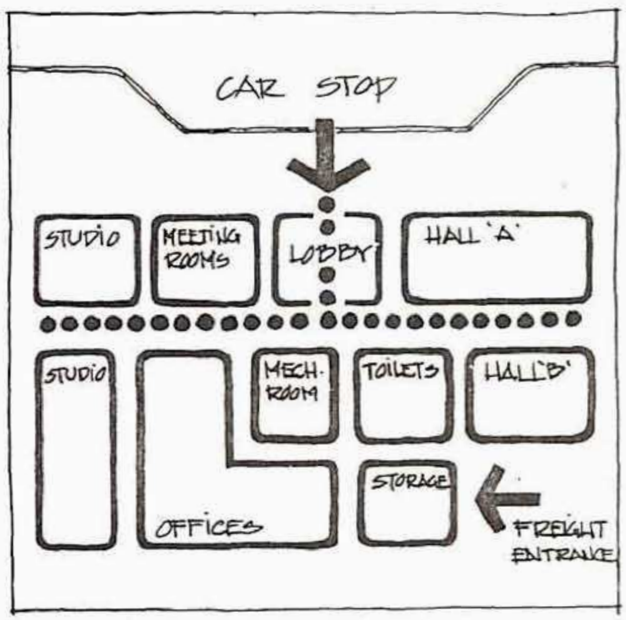
Ideally the entire building should be made accessible; this may add less than one per cent to the total cost if provisions are made at the design stage. It is sometimes economically impracticable to make existing buildings totally accessible to the disabled. In such cases, the management and design team must determine which areas should be made accessible.



All public areas should be completely accessible and barrier free. Service areas, such as storerooms, should be so designed that they can be made totally barrier-free if required. Mechanical rooms, dangerous zones and similar areas need not be accessible, but provisions should be made for persons with disabilities who may eventually be working there.

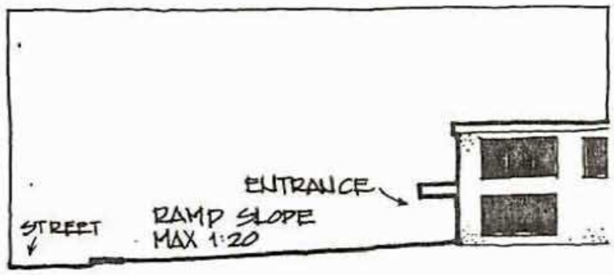


Facilities within a building, such as reception halls and washrooms, should be arranged to minimize travel distances. Distances from car drop-off points to the various facilities, to emergency exits, and other facilities should also be kept to a minimum.

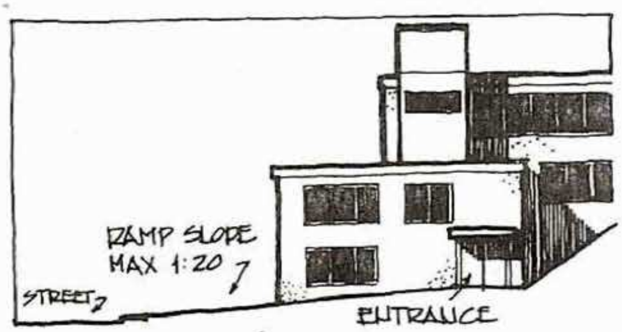


ACCESSIBILITY OF THE ENTRANCE

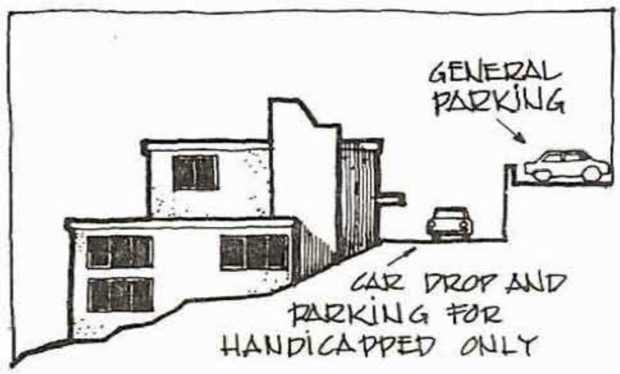
Accessibility of the entrance is determined by the distance and height differential between arrival areas and the building. A short route with a low ramp sloped 1:20 or less is desirable. However, if a long ramp is necessary, it should not be sloped more than 1:12 and should incorporate resting areas every 10 m.



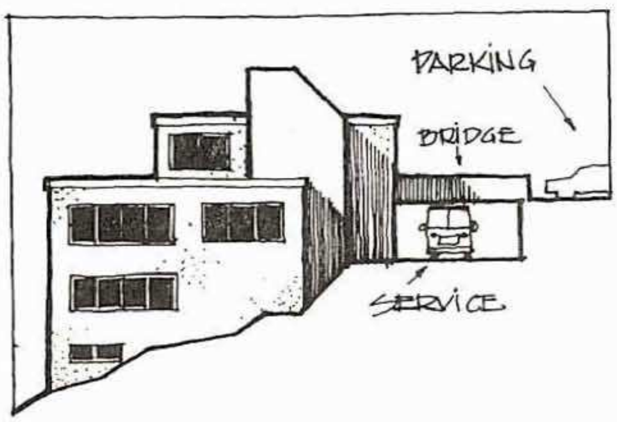
The entrance should be located near the elevators in buildings where elevator position is determined by a sloping site.



A special drop-off point or car parking should be located close to a building on a steeply sloping site to reduce travel distance.



An enclosed raised walkway or covered bridge would provide a protected horizontal access to the upper floors of a building.



CORRIDORS

If travel distances cannot be minimized, resting areas should be incorporated inside and outside a building at intervals of about 30 m along all paths. This is most important to persons using walking aids who tire quickly. Seating and space for wheelchairs to move out of the way of other pedestrians should be included.

The design of long straight corridors can be improved by recessing parts of the wall along the corridor to create alcoves, or by dividing the area into short or staggered corridors with offset resting places.

EMERGENCY EXITS

Some people will not be able to use emergency exits unaided, for example, those confined to wheelchairs who cannot manage stairs, those with walking difficulties, and the very old. A refuge area should be provided where these people can wait in relative safety until they can be moved under supervision. (See Section 7.)

SECTION 2

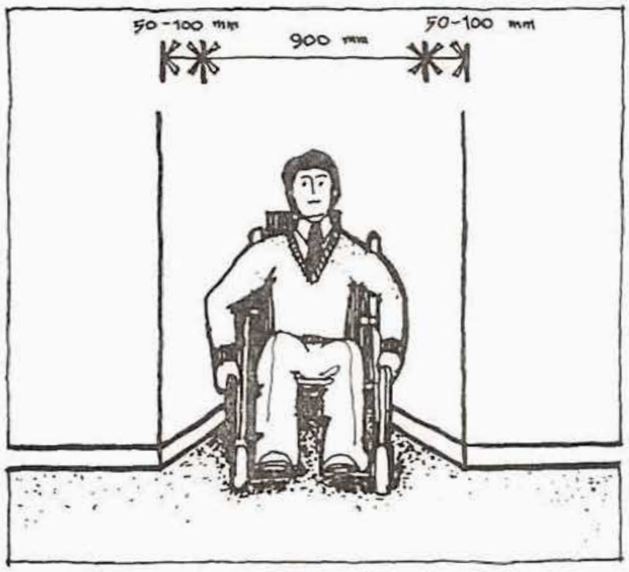
INTERIOR PEDESTRIAN SYSTEMS

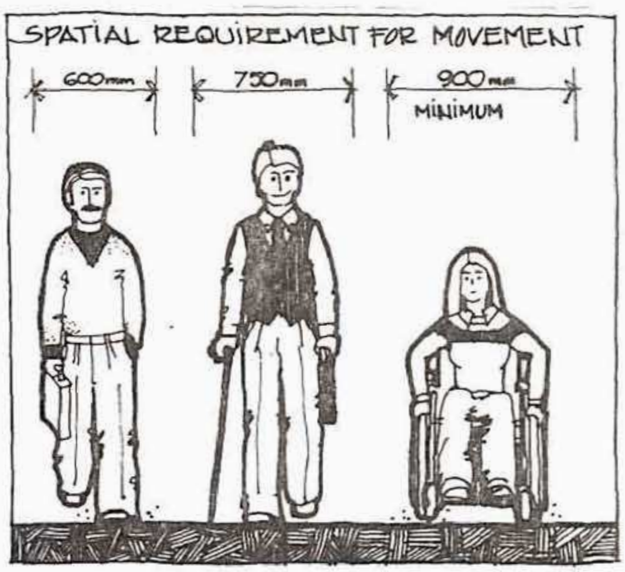
Whether designing a new building or upgrading an existing one, it is important to consider accessibility early in the design process. Designing accessible interior pedestrian systems is particularly important to ensure that people with disabilities have sufficient space to move in and convenient routes to reach their destinations.

CORRIDORS

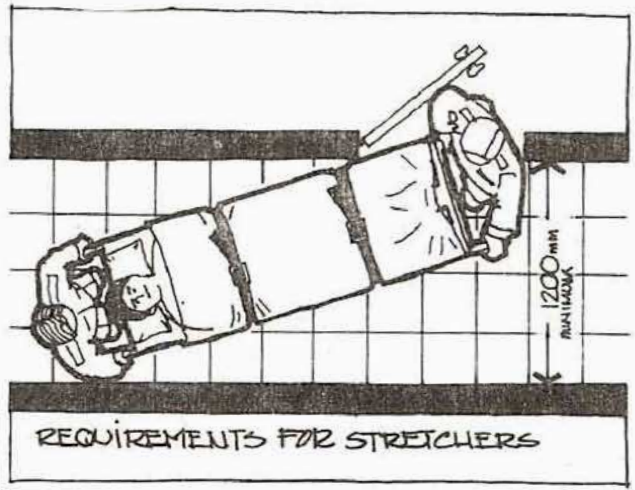
Most people moving in a straight line require a space 600 mm wide; someone with a cane may require 750 mm. The space for wheelchairs must accommodate the width of the chair and hands and arms to propel the wheelchair. Although 900 mm is adequate for most people in wheelchairs, they would have to move very slowly and accurately. Consequently, most authorities recommend a minimum corridor width of 1000 to 1200 mm. A width of 1200 mm enables someone to pass a wheelchair by turning sideways. A corridor width of 1800 mm allows two wheelchairs or a stretcher and wheelchair to pass.

A corridor width of about 1200 mm is required to allow a person using a wheelchair to turn from a corridor through a doorway. However, if the clear width of the doorway is less than 815 mm then the corridor should be widened about 75 mm for every 50 mm less of clear width.

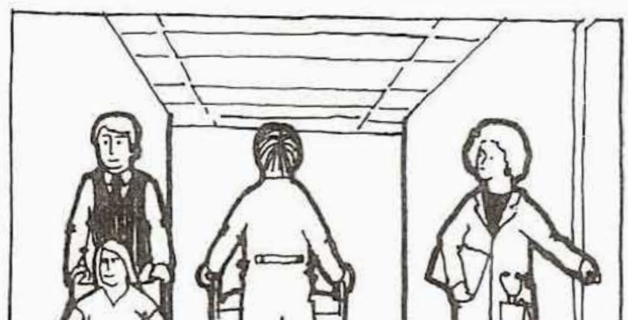




Special provision must be made for moving furniture or stretchers through doorways if a corridor is less than 1200 mm. The door will often need to be wider than usual or the corridor so shaped that large pieces of furniture can be maneuvered.

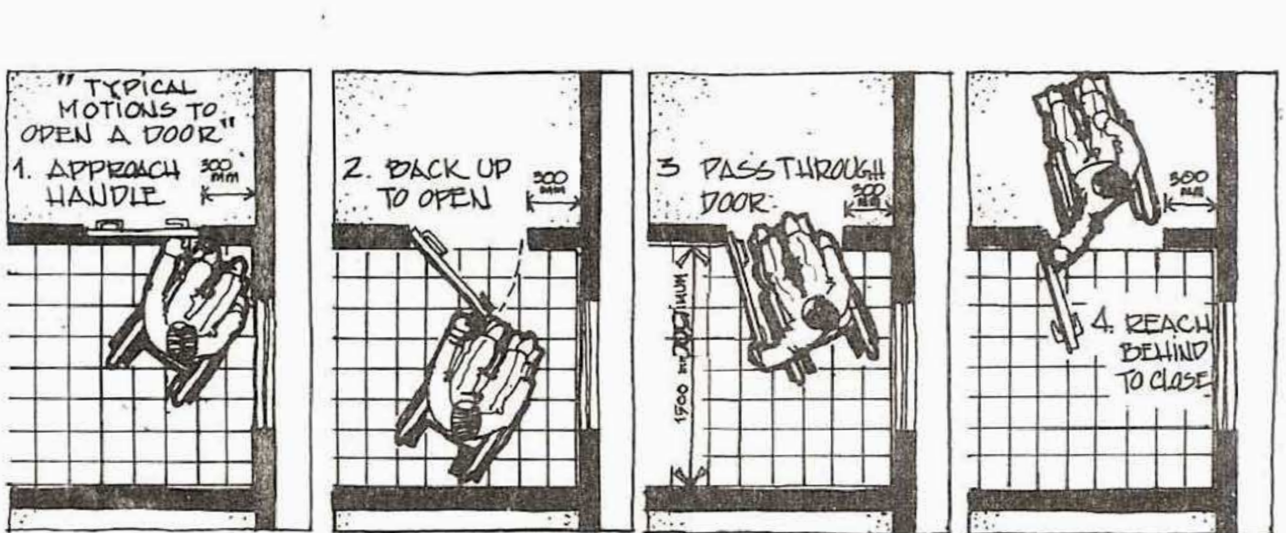


Corridor width should be determined by type of occupancy. For emergency exits or where there is considerable pedestrian traffic a flow of up to 6 persons/min/100 mm can be assumed to determine the width of level corridors.



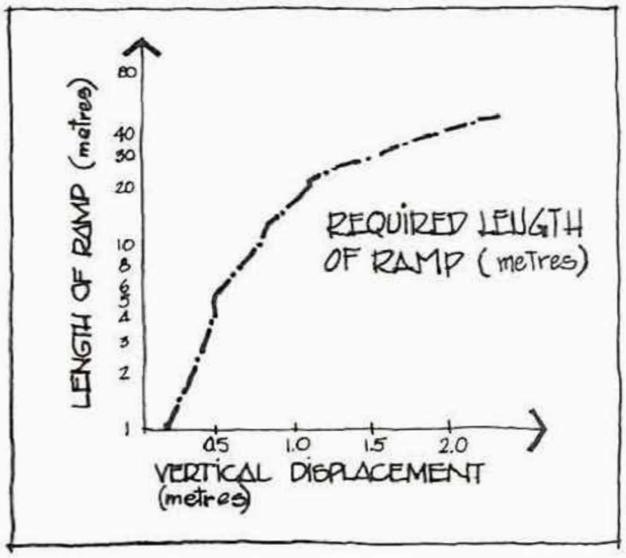
REQUIREMENTS FOR USING DOORS

A person in a wheelchair makes four movements to use most doors when the approach is from the side of the door swing. There must be adequate space for each maneuver. Generally a level floor area of about 1500 m^2 is required on the swing side of the door.



RAMPS

People using wheelchairs become fatigued quickly on steep or long ramps and their movements become less precise. A ramp 10 m or more long should be 1500 mm wide and very gently sloped. Although a large percentage of people in wheelchairs will be able to use short ramps of slope 1:12, some will not be able to use long ramps of slope of 1:20 and will require landings (for resting), which further increase ramp length. The graph presents approximate ramp length for different vertical displacements, assuming that the ramp is designed so that most people in wheelchairs can use it unassisted. (See Section 6.)



ENTRANCE HALLS

The entrance hall should allow easy maneuvering of large objects such as ambulance stretchers and wheelchairs. Revolving doors are often installed to help reduce air leakage but they present an obstacle to many people such as those with walking aids, baby carriages or large packages. An air lock or draught lobby is more convenient.

A canopy extending from the entrance to the vehicle access point would provide protected access for all users in inclement weather.

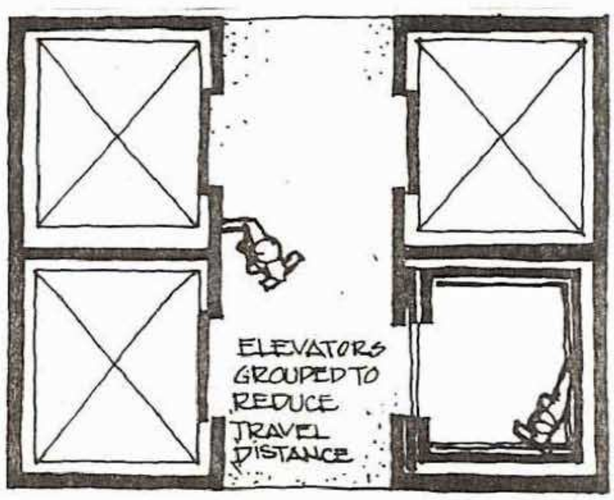
The distance between the two sets of doors in a draught lobby should be at least 1900 mm, but if the lobby is very narrow, 2300 mm may be required.

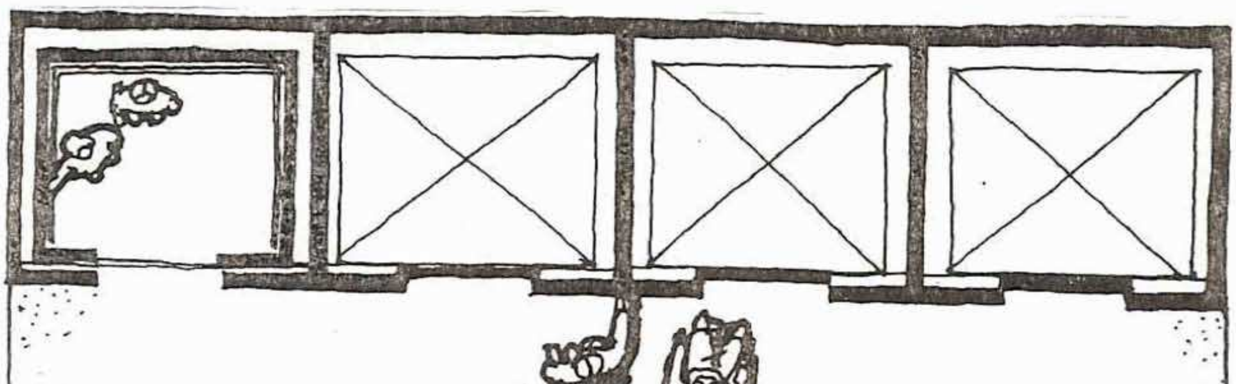
ELEVATORS

Although elevator size depends on several factors, an elevator with a rated capacity of approximately 1150 kg is the minimum recommended for people using wheelchairs. Elevators of 900 kg capacity can be used if special design features, such as buttons placed on a side panel, are implemented. However, these elevators are generally awkward to use and are too small for ambulance stretchers. (See Section 4.)

Because most elevator doors have a clear opening of 800 mm, there is seldom any difficulty maneuvering into the elevator from the lobby. Ambulance stretchers, however, require a minimum lobby width of about 1200 mm for elevators with side-opening doors and 1800 mm for elevators with centre-opening doors.

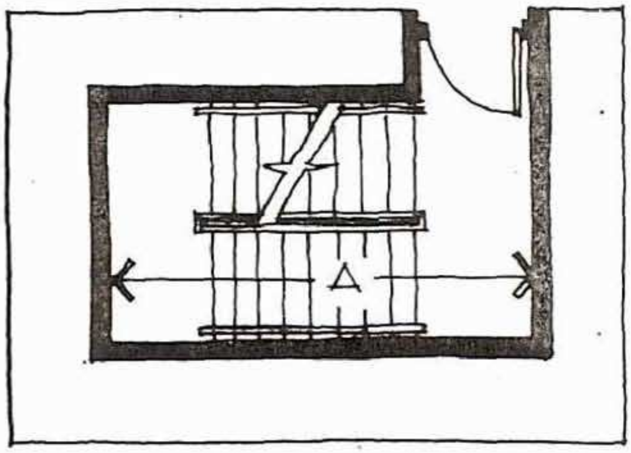
Elevators in rows of more than three serving the same floors do not allow sufficient time for most people to enter an elevator. Travel distance will be minimized if the elevators are arranged so that they face each other, thus enabling a person to reach any one elevator from a convenient midway point. Because many people with walking difficulties cannot move faster than 0.5 m/s, they also require special advanced warning signals (both auditory and visual) when more than two elevators serve the same floors.





STAIRWAYS

Required flow capacity, assuming 4 to 5 person/min/100 mm determines the width of the stair. If the stairs are not divided into lanes by handrails, however, they should not normally exceed 1750 mm in width. A stair width of 1400 mm seems optimum for both capacity and facility in reaching handrails. The minimum width of landings is about 2300 mm to maneuver stretchers, furniture or other large items.

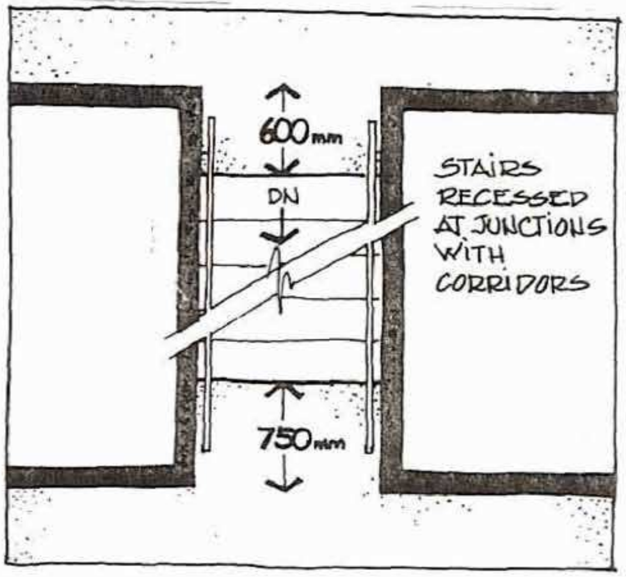


The convenient range for stair pitch is limited but varies according to nature of use. The table gives a range of lengths for stairs (including landings) suitable in most office buildings. Stair width is assumed to be 1400 mm and risers vary between 150 and 200 mm.

Required Length of 'A'

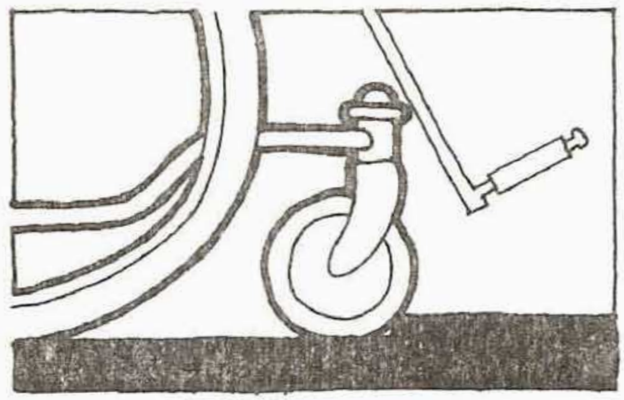
Floor to Floor Height, mm	Range for 'A', mm
2600	4600 - 5200
2800	4900 - 5500
3000	5200 - 5800
3200	5500 - 6100
3400	5800 - 6400

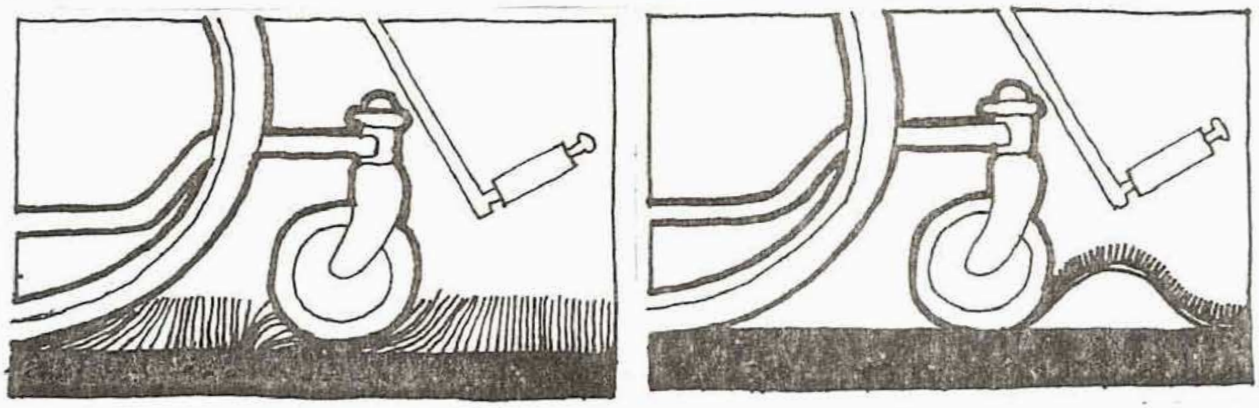
Stairs located off corridors should be recessed a minimum of 600 mm at the top and 750 mm at the bottom, to avoid possible collision between persons using the stair and corridor.



FLOOR SURFACE

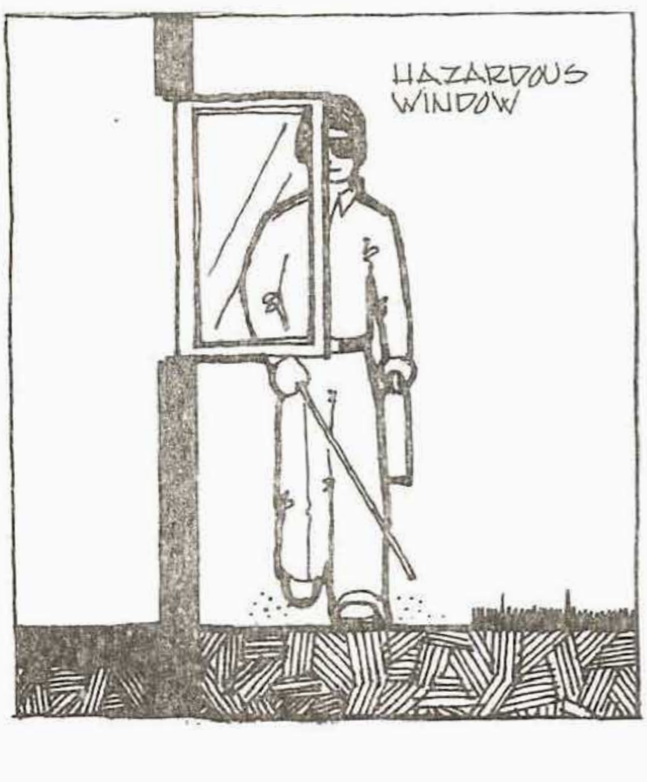
Floor surfaces must not be uneven, slippery, unstable, or in any way prevent the passage of a wheelchair or cause people to lose their balance. People using wheelchairs can negotiate abrupt changes in level of up to 15 mm depending on how complex a maneuver is required, but 10 mm is the preferred maximum. Thresholds can present extreme obstacles because of the maneuvering required to open doors.





HAZARDS

Objects constituting a hazard to those with impaired vision should be detectable with a cane or be recessed. Special attention should be given to windows and other fixtures that can protrude over walkways. The area under a staircase must be fenced off by a guardrail to prevent people with sight problems from walking into it. The clear space under the stairs should be at least 2200 mm high.



CHECKLIST

1. Is the building entrance accessible from the parking lot or garage to persons using wheelchairs?

2. Is the ground or floor surface level and is there sufficient space to maneuver a wheelchair (e.g., a minimum space of 900 mm on the push side and 1500 mm on the pull side of the doorway)?

3. Are the thresholds easy to negotiate, not exceeding 10 mm above floor level?

4. Is an alternative path available if turnstiles or revolving doors are used?

5. Is there sufficient room in a vestibule for a person in a wheelchair or on crutches to open both the inner and outer doors without difficulty?

6. Do floor coverings, pavings and gratings permit easy wheelchair movement?

7. Have resting areas been positioned on a ramp so that the distance between level areas is less than 10 m?

8. Do elevators serve all floors including garage level?

9. Are elevators that serve the same floors grouped to reduce travel distance?

SUGGESTED READING

Colter, S.R., and DeGraff, A.H., "Architectural Accessibility for the Disabled of College Campuses," State University Construction Fund, Albany, New York, 1976.

Corlett, E.N., Hutcheson, C., DeLugan, M.A., and Rogozenski, J., "Ramps or Stair, The Choice Using Physiological and Biometric Criteria," Applied Ergonomics, Vol. 3, No. 4., 1972, pp. 195-201.

Goldsmith, S., "Designing for the Disabled," 3rd ed., London, RIBA Publications, 1976, pp. 148-152.

Henning, D.N., "Considerations of the Physically Disabled," National Research Council, Division of Building Research, CBD 135, 1971.

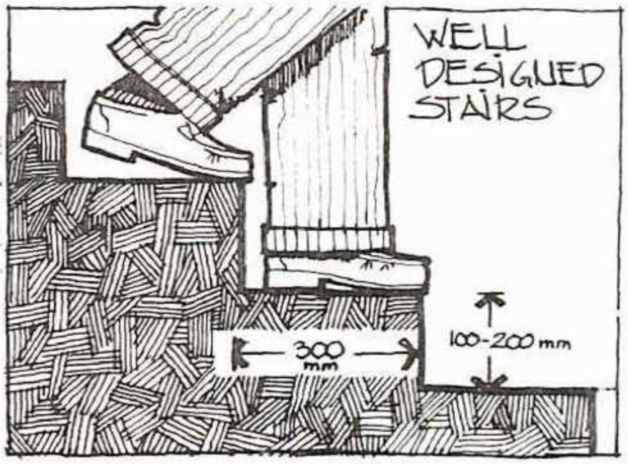
Johnson, B.M., "User Requirements of Elevators," National Research Council, Division of Building Research, CBD 190, 1977.

SECTION 3

STAIRS

Although stairs are a definite barrier to the non-ambulant person, they will be preferred by some semi-ambulant persons, such as those with arthritis or those using crutches who have difficulty on steep or slippery ramps. Some ambulant persons will also prefer stairs to escalators. However, stairs are a major source of personal injury, mainly because they are frequently poorly designed or maintained. The design of safe and convenient stairs requires consideration of the requirements of the users, the nature of use and location of the stair.

SIZE AND CONFIGURATION OF STEPS



Traditional stair design has been concerned primarily with the way people walk up the stairs which has been the basis for determining risers and runs. Shallow treads have been designed because most people place only the ball of the foot on the step, although some elderly do "clomp" up the stair with the whole foot. Stair design, however, should be based on the way people walk down the stairs, which is a more awkward and dangerous movement. It is estimated that 70% of serious falls occur in descent.

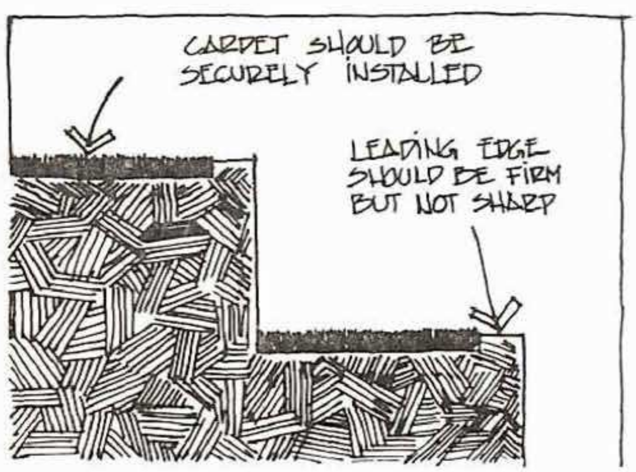
In descent a person tries to place both the ball and heel on the step. The angle of the foot on the step determines the safety of downward movement. If the angle is steep and little of a person's foot can be placed on the tread, there is a high probability of slipping.

Research has shown that there is no optimum ration between the run and rise of a stair. Elderly persons will find stairs more fatiguing if the run and rise are large. It has been found that runs of 300 mm result in fewer mis-steps and falls than shorter runs, without being fatiguing for those with short legs or walking difficulties, and allow people to "clomp" up or stand on the stairs comfortably.

Risers can vary between 100 and 200 mm, without making the stairs awkward to use. The preferred range is 150 to 175 mm. However, British research has found risers of 225 mm acceptable. For economy of space, 175 mm is appropriate for exit stairs.

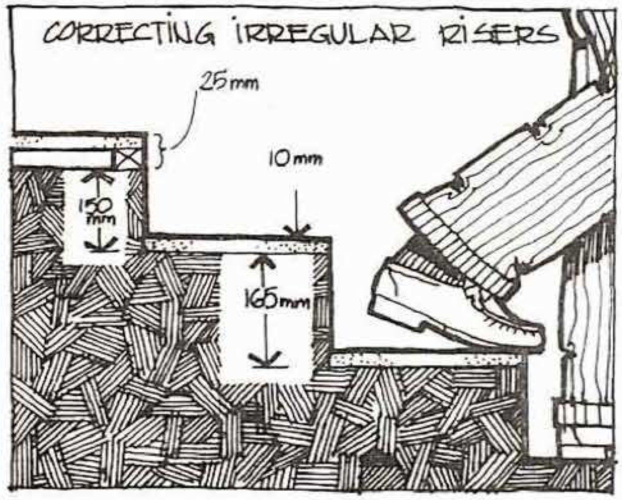
The leading edge should be designed so that it provides firm support in descent and does not catch toes or crutch or cane tips. Rounded edges can cause slipping and applied nosing pieces frequently come loose. Traditional stair design allowed the leading edge to overhang the tread by using nosings. Such nosings, however, decrease the percentage of the shoe placed on the tread, especially for women, and therefore increase the risk of falling. Unless skillfully detailed, nosings can also be a tripping hazard for persons ascending the stair. Consequently, if nosings are to be included on a stair, their overhang should be less than 15 mm and shaped so they will not catch toes or crutch tips. Considering the many difficulties of designing and constructing such nosings, it would be better not to have them at all.

Carpeting on stairs should always be installed with extra care and should not cover the leading edge of the steps because it does not always provide secure footing. Frequently, it is used to improve traction; however, if larger treads are used and highly polished surfaces avoided, traction should be sufficient.



Materials used for improving traction, such as special rubber grips, are generally unnecessary and will be hazardous if they come loose. Providing the stair is not steeply sloped, most commonly used flooring materials will have sufficient friction for most shoe soles.

Irregularities in stairs are a significant cause of mishaps. Failure at the design stage to consider finished floor levels may result in variation of riser height at either the top or bottom of a flight of stairs. If the steps have a different thickness of finishing than the floor, the top and bottom risers of the unfinished stair must be sized to allow for the difference in thickness. Irregularities as little as 5 mm can cause mis-steps. Ideally, there should be absolute uniformity in riser heights and tread depths on a stair.



These recommendations apply to all stairs, but especially to stairs exposed to ice and snow and those such as basement stairs which are often used in poorly lit situations by people carrying loads. These stairs are usually the most poorly designed.

STAIR SHAPE

Flights of stairs with a vertical displacement of approximately 3000 mm or higher are not advisable because they will be fatiguing for some people ascending the stairs and provide no place to rest. The dogleg stair is preferable: it is relatively compact and has short flights. Straight runs of stairs have the advantage that a stair-lift or inclinator can be added for those who find stairs a barrier. It should be noted that these mechanisms can make use of the stair inconvenient.

Because of people's tendency to keep to the right in public settings, stairs should be shaped so that persons descending on the right have the shortest distance to walk and can keep a continuous hold of the handrail.

The width of the stair is mainly determined by its required capacity but if it is very wide a person falling may not be able to reach the handrail. Stairs wider than 2100 mm should probably be divided into lanes of up to 1750 mm but not much less than 1050 mm. If the stair is less than 2100 mm wide, most people will be close enough to the handrail to reach it in the event of a fall. Division of the stair into lanes less than 1050 mm will reduce the capacity of the stairs.

HANDRAILS

Handrails on both sides of stairs are useful even on those less than 1050 mm wide because a person using the stairs may not have the use of both arms. This design feature is especially critical on wide stairs.

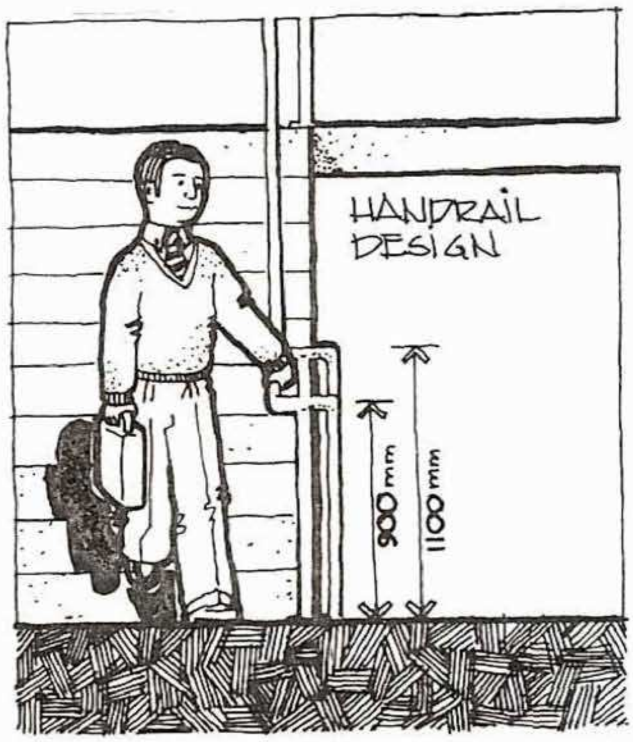
Handrails serve three separate purposes:

(1) support in ascent;

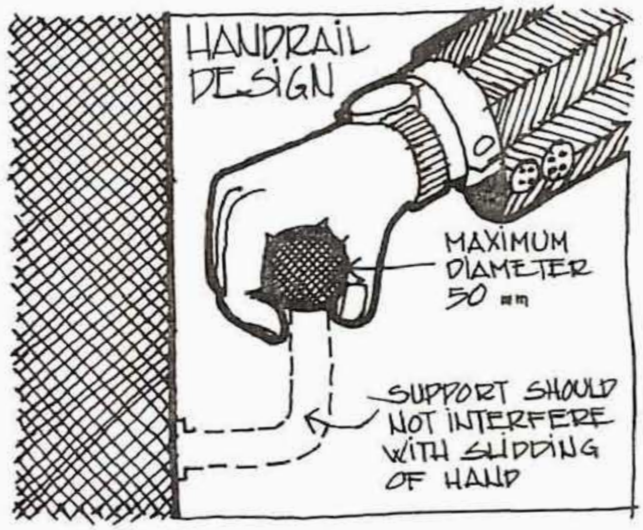
(2) guidance in descent; and

(3) support to check falls

The effectiveness of a handrail is related to the height of the person using the stair. A handrail located about 950 mm above the leading edge of the steps provides guidance and support to check falls in ascent, and guidance in descent, for about 95% of the population. A handrail about 1200 mm is needed, however, to provide support for a tall person falling forward down the stairs. Because a guardrail about 1100 mm high is needed for most people on any open side of the stairwell to prevent them from falling over, two rails, one 900 mm and the other 1100 mm high, could be installed. The higher rail could serve as both guardrail and handrail for taller persons. The one at 900 mm is suitable for most elderly persons and some children. Handrail heights should generally be lower in occupancies where there is a large proportion of children or the elderly.

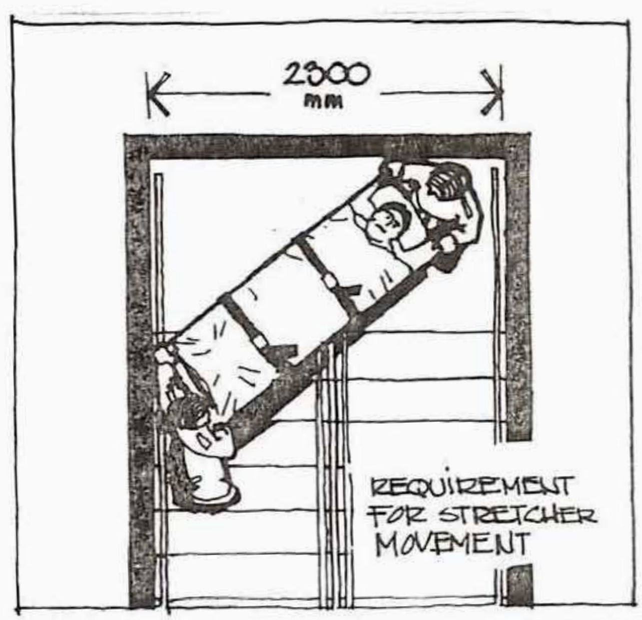


A handrail should be less than 50 mm in outside diameter, and preferably 40 mm, so it can be easily grasped. The supports should be designed to allow the hand to move freely along the rail, which should be at least 50 mm from rough surface walls and 35 mm from smooth surface walls. The handrail should continue about 300 mm past the stairs, and be turned in towards the wall. Some authorities recommend 450 mm. An extension of the handrail of about 600 mm at the top and bottom of the stairs can be useful to provide guidance for the blind.

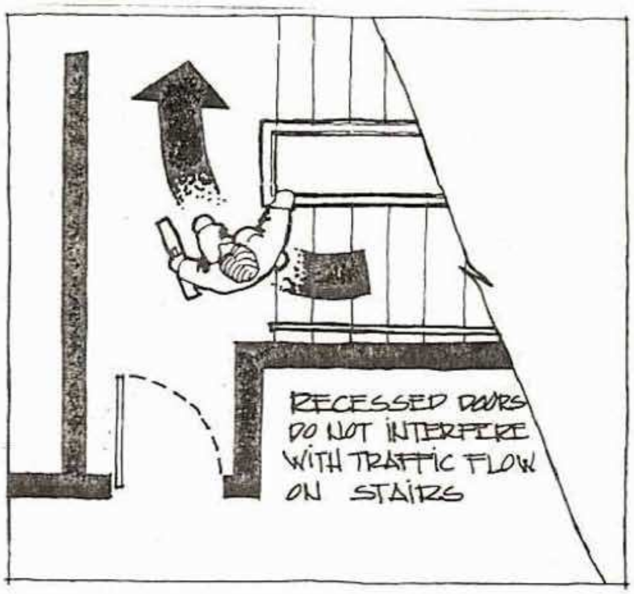


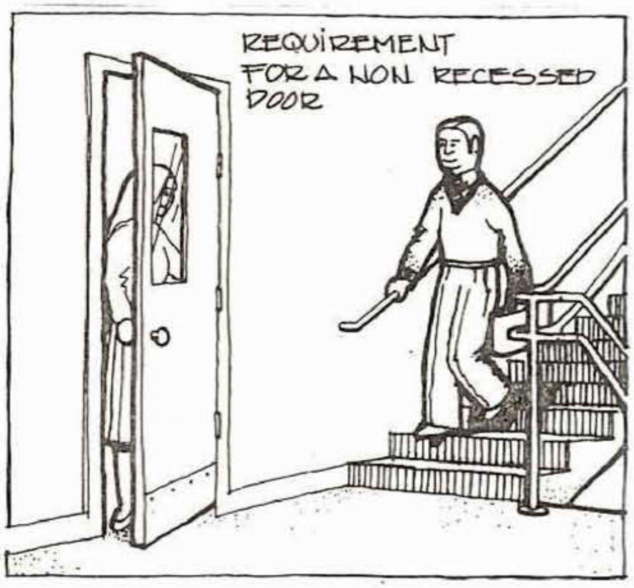
LANDINGS

The landing must be at least 2300 mm wide to be able to turn round large items such as beds, carpets and sofas, which require about the same space as an ambulance stretcher and patient being moved on the stair and turned through 180°. The clear width between handrails should be at least 2200 mm, measured across the landing.



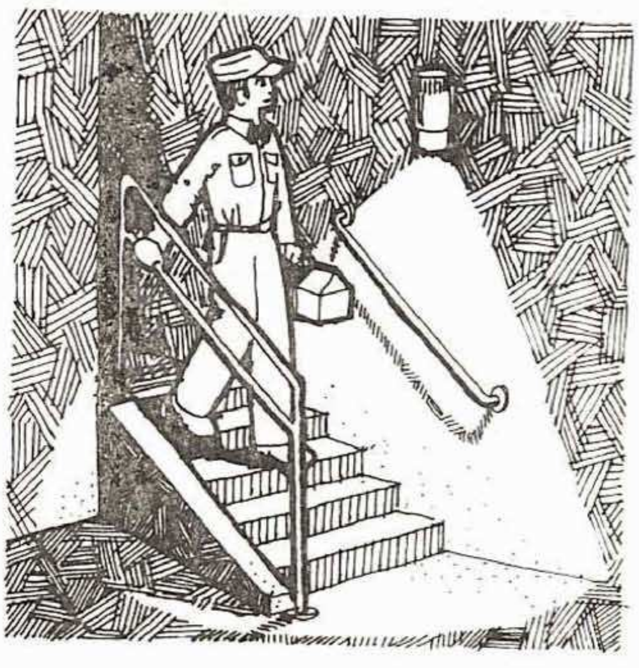
There must be adequate room to use a door. Doors leading to exit stairs opening into the stairwell, can be hazardous and should be recessed, if possible. If the door cannot be positioned to overcome this hazard, a wired glass or similar window should be installed to allow people to see the danger.





LIGHTING

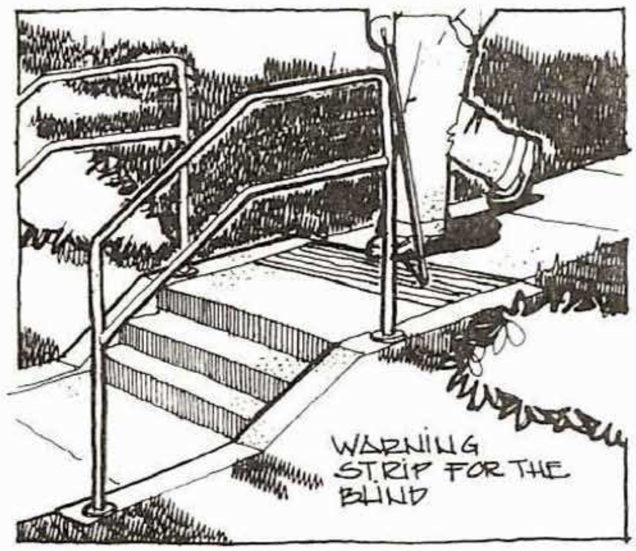
Stairs that are not enclosed should be lit as brightly as or brighter than surrounding areas. Windows will be a source of glare unless deep reveals are used or the walls around the window are a light colour. Artificial lighting should be diffused and designed to light the stair evenly, and so located as to help persons differentiate between risers and treads.



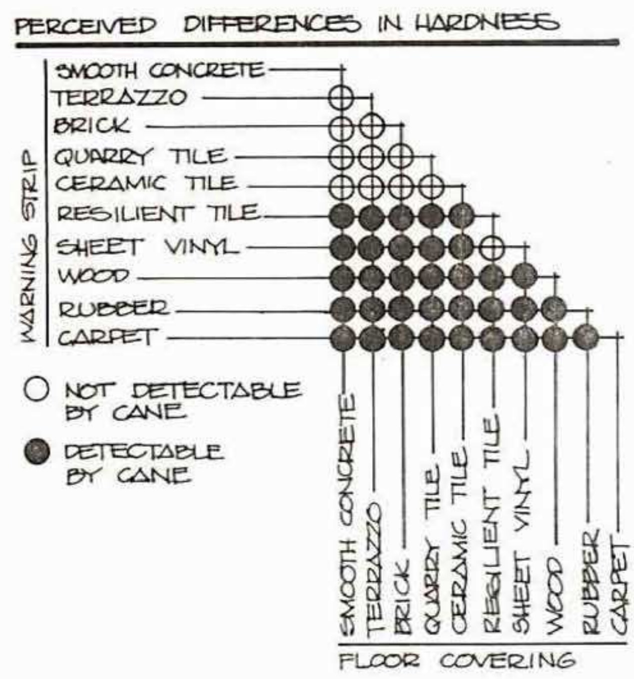
Emergency lighting is generally required to provide a luminance of at least 10 lux. However, in occupancies with a large proportion of elderly or visually impaired persons, a luminance of 50 lux is required for these persons to be able to see as well as younger occupants.

SENSORY CUES TO IDENTIFY STAIRS

Most blind persons are alerted to enclosed stairs by the stairwell's acoustical properties and because they have to pass through a doorway. To alert blind persons to stairs in unexpected locations, a warning strip should be installed on the floor at least 300 mm wide and one tread width from the top of the stair. The warning signal must be of a material that has a different hardness from the normal surface material, as shown in the chart, so that it can be detected by a cane.



Contrasting edging pieces on steps help in identifying the tread. Care should be taken to ensure that these pieces are neither slippery nor likely to come loose. Contrasting colours of treads and risers also aid people in ascent.



DISTRACTIONS

Distractions should be avoided especially at the top of stairs. For example, a sudden increase in the field of view can distract a person and cause him to lose his footing. This occurs at what is sometimes referred to as an "orientation edge." Some research has indicated that such distractions are a major cause of stair accidents. It can be avoided by allowing persons to view the scene several paces before the stair. Open riser stairs are usually visually distracting and should be avoided.

CHECKLIST

1. Are the treads of the stair 300 mm deep?
2. Are the risers 150 to 175 mm high?
3. Is the nosing non-existent or less than 15 mm?
4. Can persons easily identify the steps?
5. Are the finish materials securely fixed and not slippery?
6. Are the finish materials of the floors and stairs the same thickness?
7. Can persons use the handrail continuously in descent?
8. Are handrails provided on both sides at 950 mm?
9. Is the diameter of the handrails less than 50 mm and preferably 40 mm?
10. Is there at least 50 mm between the handrail and rough walls?
11. Are warning strips provided to warn the blind of stairs in unexpected locations?
12. Are persons using the stairs visually distracted?

SUGGESTED READING

Brill, M., Bonnie, S. and Collison, T., "The Hidden Epidemic; Home Accidents," Progressive Architecture, No. 4, 1974, pp. 76-81.

Fitch, J.M., Templar, J.M., and Corcoran, P., "The Dimensions of Stairs," Scientific American, Vol. 231, No. 4, 1974, pp. 82-90.

Ward, J.S. and Randall, P., "Optimum Dimensions for Domestic Stairways. A Preliminary Study," Architects' Journal, Vol. 146, No. 1, 1967, pp. 29-34; Vol. 151, No. 8, 1970, pp. 513-520.

Carson, D.H., Archea, J.C., Margulis, S.T. and Carson, F.E., "Safety on Stairs," National Bureau of Standards Science Series 108; U.S. Department of Commerce, Nov. 1978.

Templer, J.A., Mullet, G.M., and Archea, J.C., "An Analysis of the Behavior of Stair Users," National Bureau of Standards, NBSIR 78-1554, Nov. 1978.

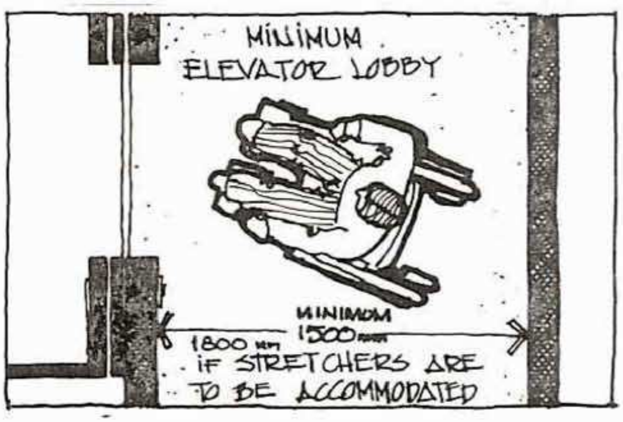
SECTION 4

ELEVATORS

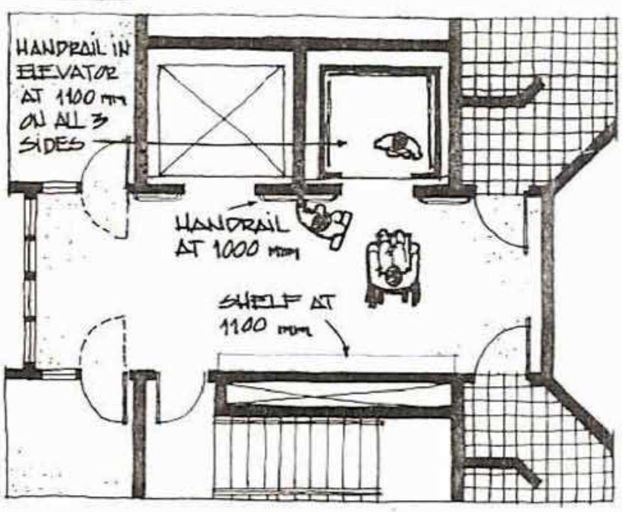
Elevators are necessary to make future and existing multi-storey buildings accessible. They should be comfortable, safe and relatively efficient, and include additional features for the physically disabled. These features, many of which benefit the rest of the population, can be incorporated in standard elevators and specially designed wheelchair lifts.

ELEVATOR LOBBIES

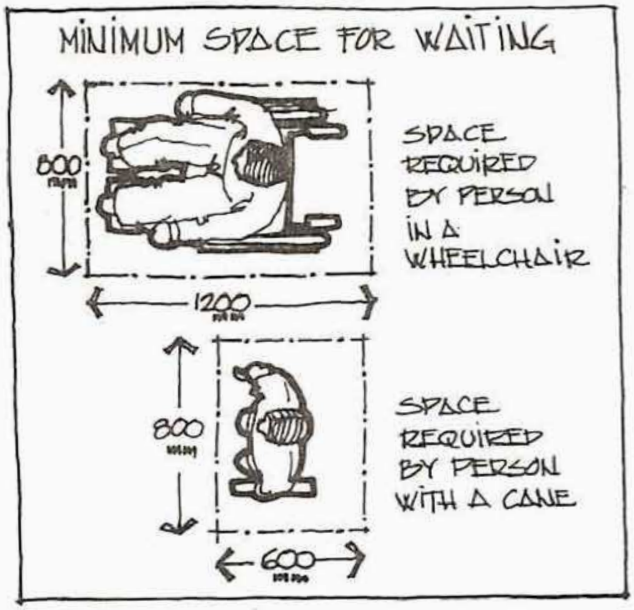
Only a limited number of elevators should serve the same range of floors to reduce the distance between waiting passengers and arriving cars. In residential buildings, the minimum dimension between the front of an elevator with centre-opening doors and the facing wall is preferably 1800 mm. In some cases where access for stretchers is not required, 1500 mm may be adequate but any less will impede wheelchair maneuvering. Lobbies 1200 mm deep are adequate for elevators with side-opening doors.



People frequently wait and gather in elevator lobbies. A shelf for storing parcels would be particularly useful in lobbies of residential buildings. It should be about 1100 mm high and 300 mm deep and as long as possible. The shelf could also serve as something to rest against, unless a rail is provided at approximately 1000 mm from the finished floor level.

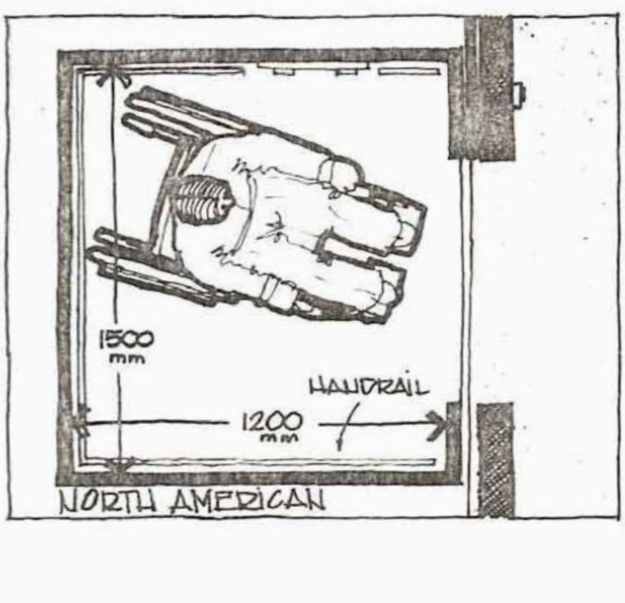


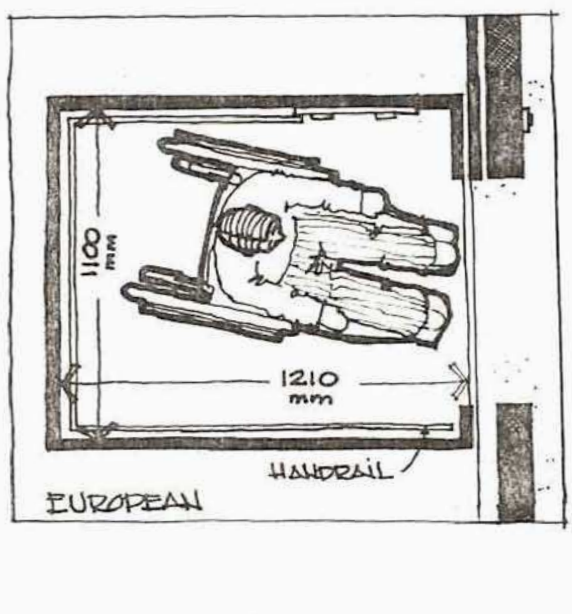
The lobby can also provide a space of refuge in emergency situations for people unable to use stairs. A wheelchair requires a space of about 1200 mm by 800 mm; a person standing with a cane requires about 600 mm by 800 mm. The size of such an area (i.e., the total number of people it can hold) depends on the occupant characteristics of the building and the number of people who can reach the lobby. A minimum space might be one that is adequate for a wheelchair and a person with a cane. The area should be protected from smoke and fire so that some assistance can reach the people who have taken refuge.



ELEVATOR SIZE AND SHAPE

The diagrams show the minimum sizes for two basic shapes of elevators. The standard North American elevator is about two-thirds as deep as it is wide to allow people to exit more quickly from the car. Unfortunately, this shape makes small elevators very awkward for people in wheelchairs and ambulance attendants transporting people in stretchers. Small size European elevators are less awkward to use because they are usually deeper than wide.

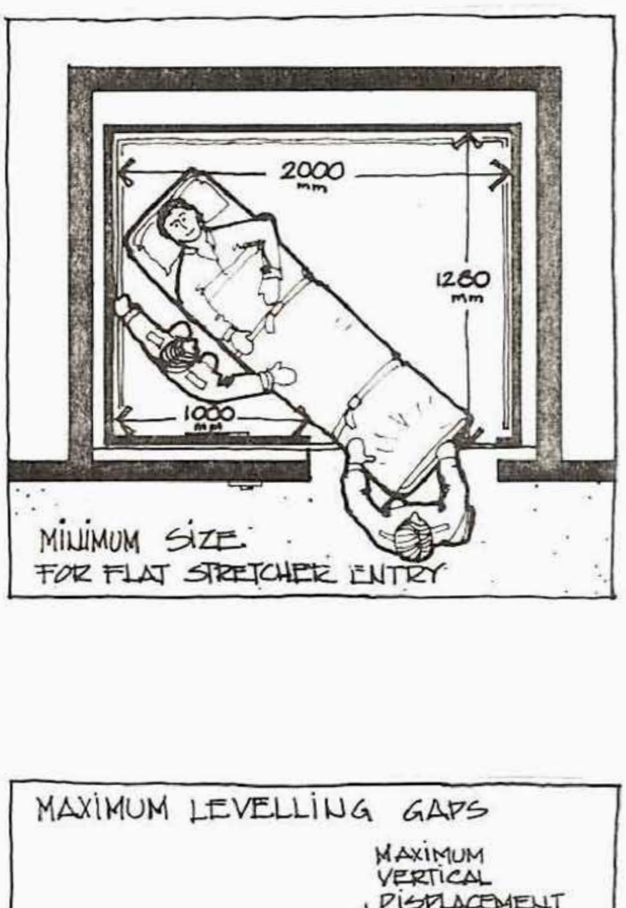




The following table gives approximate sizes and the degree of accessibility provided by an elevator. European type elevators are marked with an 'e'.

Capacity Load		Inside Dimensions, mm		Clear Door		Suitability for Use by	
Persons	kg	Width	Depth	Width, mm	Type of Door	Handicapped Persons	
4	300	1100	910	700	single panel	not large enough for use	(e)
6	450	1100	1210	700	single panel	for small wheelchairs	(e)
8	600	1100	1510	800	single panel	smallest suitable	(e)
8	600	1500	1200	750	single panel	for small wheelchairs only	
10	750	1300	1510	800	single panel	suitable for all wheelchairs	(e)
10	750	1300	1510	800	2 panel centre	awkward to use	(e)
10	750	1750	1200	910	single panel	awkward but usable	
12	900	1600	1510	800	single panel	convenient to use	(e)
12	900	1370	1300	815	single panel	convenient for wheelchairs	
12	900	1730	1300	915	single panel	stretchers partially raised	
16	1200	2000	1510	1100	2 panel centre	stretcher must be tilted	(e)
16	1150	2030	1300	1065	single panel	stretcher can enter flat	
20	1500	2030	1450	1065	2 panel centre	stretcher can enter flat	

In many buildings, the number of problems faced by ambulance attendants justifies the installation of at least one 1150 kg elevator with a side-opening door, which could be key controlled to descend to the lobby when required. Elevators of 1150 kg capacity with two-panel side-opening doors, or smaller elevators, force attendants to tilt the patient or raise a section of the stretcher.



Larger elevators are required to accommodate the larger wheelchairs and stretchers found in hospitals or other buildings with a high percentage of chair-bound or bedridden occupants. These elevators are usually deeper than wide and of 1600 kg capacity or larger.

ELEVATOR TYPE AND LEVELLING

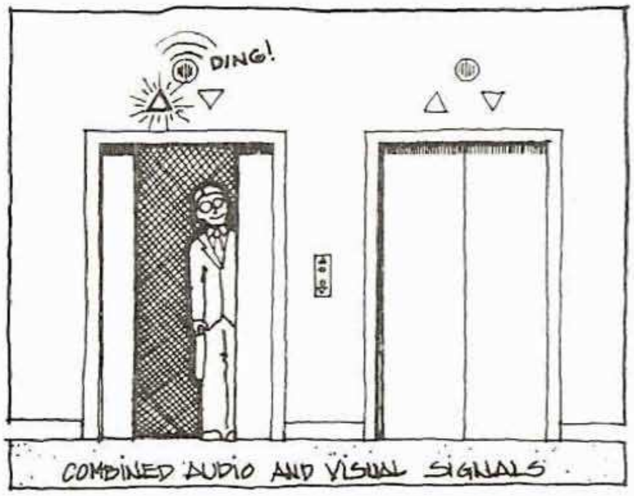
In general, the type of elevator does not greatly affect its performance. The hydraulic elevator will be slightly smoother than the usual one- or two-speed traction type, but variable speed traction elevators are as smooth as hydraulic ones. The levelling tolerances of 12 mm maximum for vertical displacement and 32 mm maximum for horizontal displacement can be met by both types of elevators.

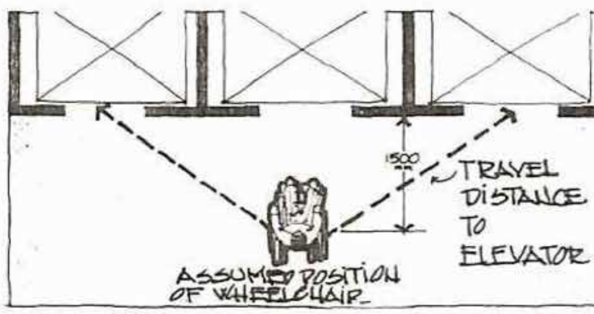
ARRIVAL SIGNALS

An advance signal indicating which elevator is about to arrive should be provided where a bank of elevators serve the same range of floors. It should be both audible and visual (i.e., a flashing indicator light). The signal should be activated far enough in advance to allow someone moving at 0.5 m/s to reach the door before it closes. Assuming that the door is open for 3 s, the time of the advance signal can be derived from the formula:

$$\frac{D}{0.5\ m/s} - 3\ s = \text{advance signal}$$

where D is the distance to the door from the most advantageous position. This will usually be about 1500 mm out from a point midway between elevators in a row.





ADDITIONAL INTERIOR FEATURES

A spring-loaded shelf near the floor selection panel of the elevator would be very useful but should be designed so that it can be easily pulled down.

A rail 1100 mm from the finished floor level should be installed inside the elevator to provide support for those unsteady on their feet.

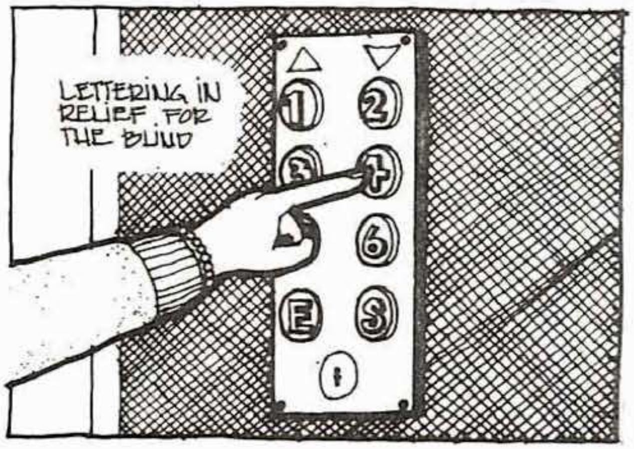
EMERGENCY COMMUNICATION

The elevator should be equipped with a telephone made as resistant as possible to vandalism and connected directly to the maintenance office of the building. The telephone should be placed at about 1200 mm from the finished floor level with a preferred cord length of 900 mm. Special features for voice or received signal amplifications could easily be incorporated with the unit. A push-button alarm could also be installed for off-hour emergencies. (See Section 7.)

Alarms that indicate an emergency or breakdown of the elevator system should be both auditory and visual. Someone inside an elevator must know that he has successfully signalled for assistance. An answering feature should be included.

ELEVATOR CONTROLS

The automatic push-button operation of most elevators causes problems to those who cannot see or reach the buttons for floor selection. Buttons with the lettering in relief help the blind, and buttons up to 1370 mm from the finished floor level can be reached by most people. During operation of the elevator the selected buttons should remain recessed until the desired floor is reached (metal buttons will be less vandalism prone). A plaque indicating the number of the floor level in relief should be applied on the doorframe 1500 mm from the finished floor level.



People in wheelchairs have difficulty reaching elevator controls, depending on how close they can get to the buttons. Small elevators of 900 kg or less will not allow the person to maneuver easily into a position to reach buttons above 1400 mm. If the buttons cannot be lowered they should be put on a side panel. In larger elevators, most adults in wheelchairs can reach buttons up to 1500 mm from the finished floor level. The call button should be at least 300 mm from the nearest wall and at most 1050 mm from the floor level.

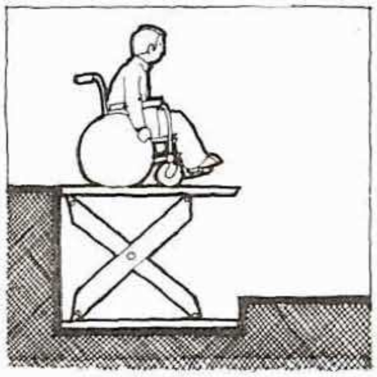
DOOR RE-OPENING DEVICES

Both types of re-opening devices, the photo-electric and bumper type, should be incorporated but, if only one is possible, the bumper type is preferred to the photo-electric. Two beams are recommended for the photo-electric devices: one to detect feet or foot rests, the other placed higher for the main part of the body. These devices can sometimes be activated accidently, or by smoke from fires. Consequently, they should be deactivated after about 20 s to allow the door to close.

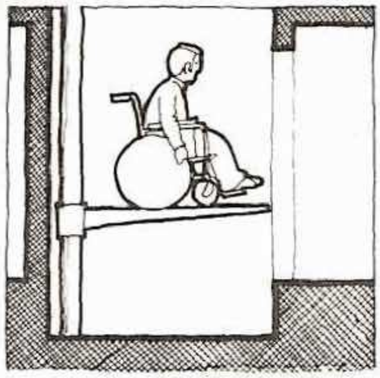
WHEELCHAIR LIFTS

Special wheelchair lifts are either platforms or enclosed cars designed so that continuous pressure on the buttons raises or lowers the lift. In these installations, special care must be taken to ensure that control devices are suitable for public buildings.

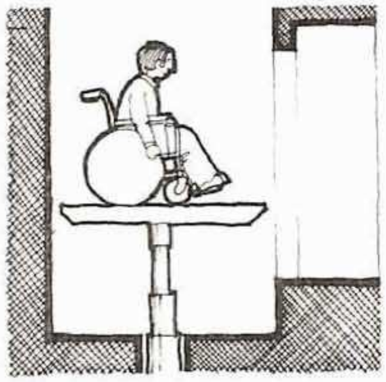
There is little information that the designer or building manager can consult to select a special wheelchair lift for a new or existing building. Basically, the special lifts incorporate a hydraulic power system and one of three types of lifting mechanisms to raise the platform, as shown.



"scissors" apparatus
car raised indirectly by pressure on the scissors



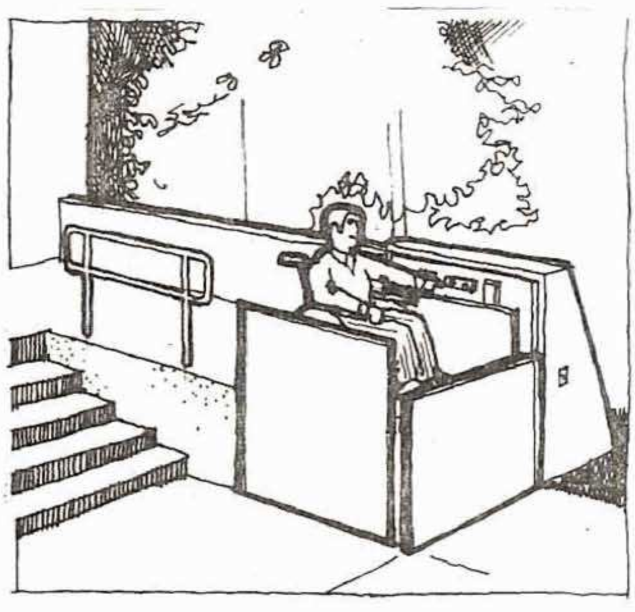
side plunger
car raised and lowered directly



bottom plunger
either fixed or telescoping

Enclosed devices operate without a gate on the cab; the entry doors are standard fire doors with electrical devices to deactivate the car if the doors are opened.

Several types of lift devices that are fixed to stairs have been used for several years primarily in housing. These generally require that the person in a wheelchair transfer to a special seat on the device; consequently someone must wait with a wheelchair at the other end of the stair. For this reason, they are generally unacceptable in public buildings.



CHECKLIST

1. Is the elevator lobby at least 1500 mm, preferably 1800 mm, deep?

2. Does the lobby provide a shelf for packages or a rail for resting, 1100 mm above the finished floor level?

3. Can the call and floor selection buttons be easily reached by someone in a wheelchair without being too low for those standing?

4. Is there adequate advance warning (both auditory and visual) (one second for each 0.5 m travel distance) for someone to reach the doors before they close?

5. Is a rail provided inside the cab, 1000 mm from the finished floor level?

SUGGESTED READING

Fruin, J.J., "Pedestrian Planning and Design," New York, Metropolitan Association of Urban Designers and Environmental Planners Inc., 1971.

Canadian Standards Association, "Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks," CSA B44 - 1971, Appendix E, 1977.

Goldsmith, S., "Designing for the Disabled," 3rd ed., London, RIBA Publications, 1976.

Johnson, B.M., "User Requirements of Elevators," National Research Council of Canada, Division of Building Research, CBD 190, 1977.

National Elevator Industry Inc., "Suggested Minimum Passenger Elevator Requirements for the Handicapped," New York, July 1976.

Steinfeld, E., Schroeder, S., and Bishop, M., "Accessible Buildings for People with Walking and Reaching Limitations," U.S. Dept of Housing and Urban Development, U.S. Government Printing Office, 1979.

SECTION 5

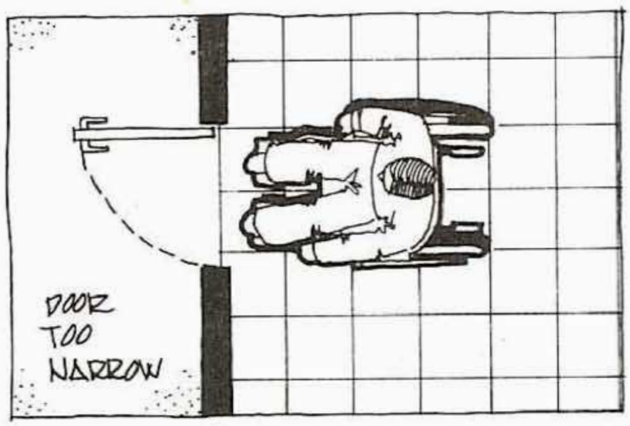
DOORWAYS

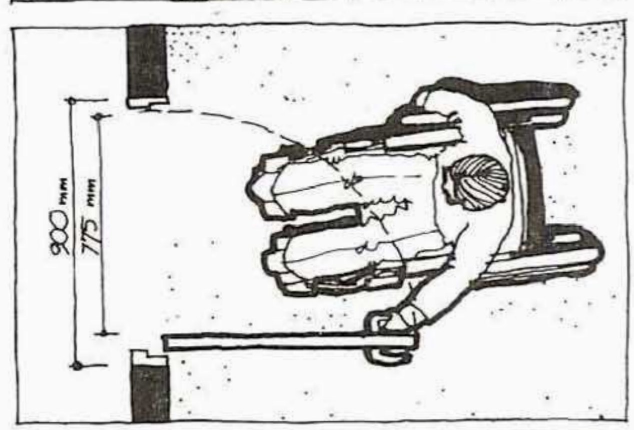
A person must make three maneuvers to use a door: open the door, pass through and usually close the door after use. This seemingly easy and unconscious procedure can be extremely awkward for persons with disabilities if the designer has not considered critical factors such as width, weight, direction of opening and position of the doors. It is possible to consider these factors and yet satisfy other requirements of door design such as security from illegal entry.

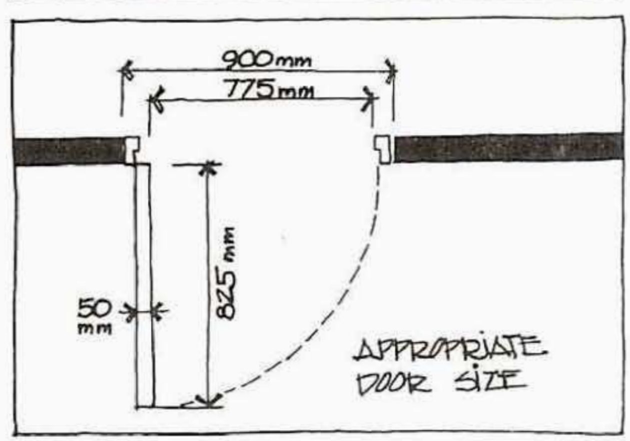
DIMENSIONS OF DOOR OPENINGS

Persons with disabilities should have adequate space to enter and move easily inside a building. Narrow doors are inconvenient or impossible for people who use mobility aids.

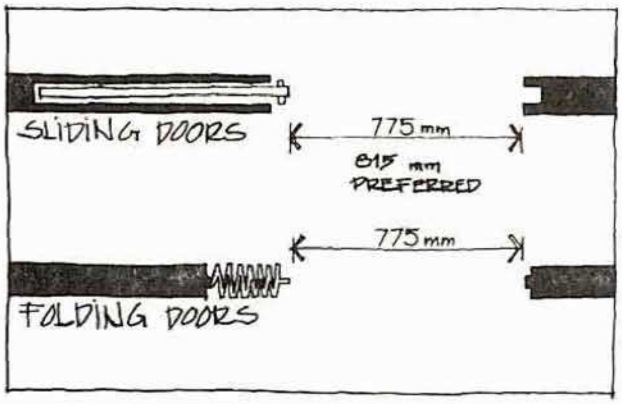
A door must accommodate the width of a wheelchair and the person's arms. Wheelchairs for adults vary in width from 600 to 800 mm. The usual size is 660 mm; larger wheelchairs are used in institutions. The minimum clear width is therefore 750 mm; the preferred minimum is 770 mm. If the clear width is 820 mm or greater, someone in a wheelchair will be able to go through the doorway more quickly and easily, and require less precision for turning or moving forward. A door opening of 860 mm is required to achieve the minimum clear width unless special hingeing devices are used. An appropriate modular dimension would be 900 mm; larger doors would take too much space, especially in small rooms such as bedrooms and bathrooms.







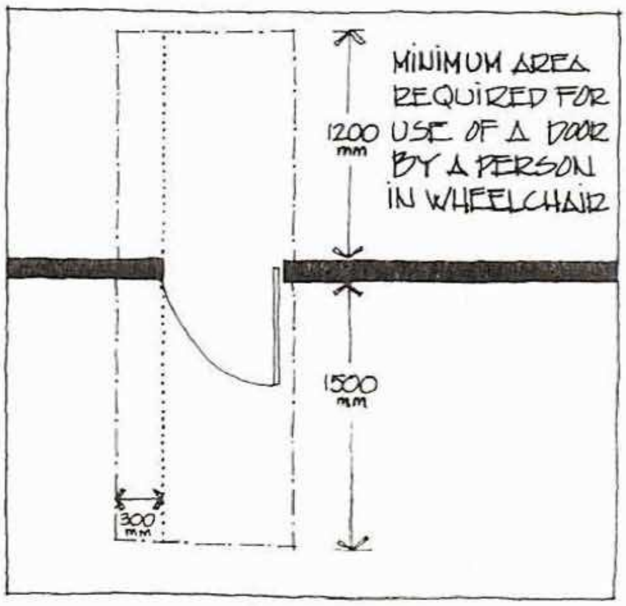
Sliding or folding doors can be less than 775 mm wide in some situations because they are easier to use. The preferred width, however, is 815 mm.



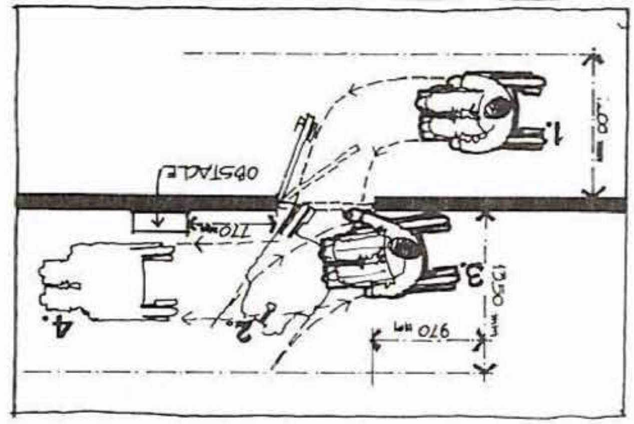
SPACES AROUND DOORS

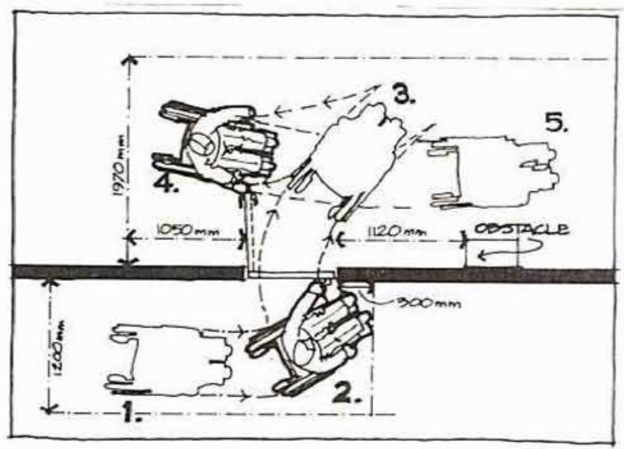
People using wheelchairs require more floor clearance at the side of the door between the handle and the nearest wall. This should not be less than 300 mm; 600 mm is preferred. They also require a clear level surface area on either side of the door - 1500 mm on the side of the door swing and 1200 mm on the other side.

When there are a series of doors, such as in a draught lobby or other vestibule, a space of 1900 mm between the doors, or more significantly, a clear space of 1100 mm between one door in the open position and the other door, is required. The space may vary according to the width of the draught lobby; generally the distance between the doors can be reduced if the lobby is widened. In wide lobbies of more than two doors across, 1500 mm may be adequate.

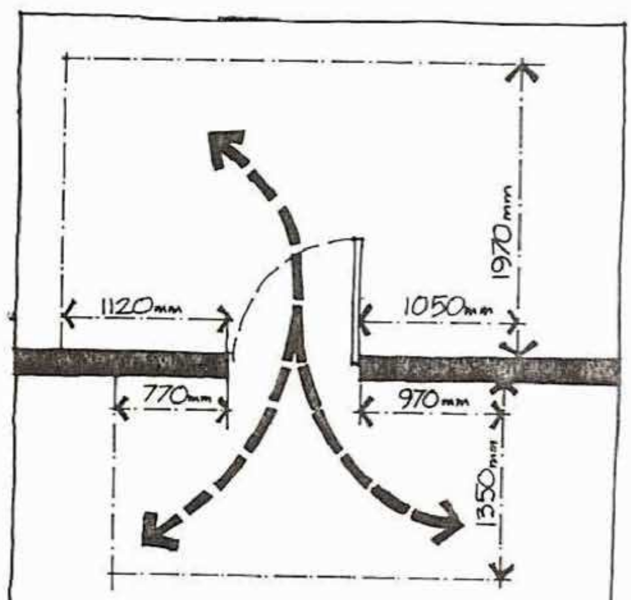


The area required to open, pass through, and close the door depends on the direction of approach, which must be considered for either side of the door. If a door can be approached from several directions, the space must be of optimum dimensions to accommodate any one of them. The space required for maneuvering can be reduced depending on the width of the door. For example, if the clear width of a door 870 mm wide is increased from 815 mm, the maneuvering area can be decreased by as much as 75 mm for every 50 mm increase.

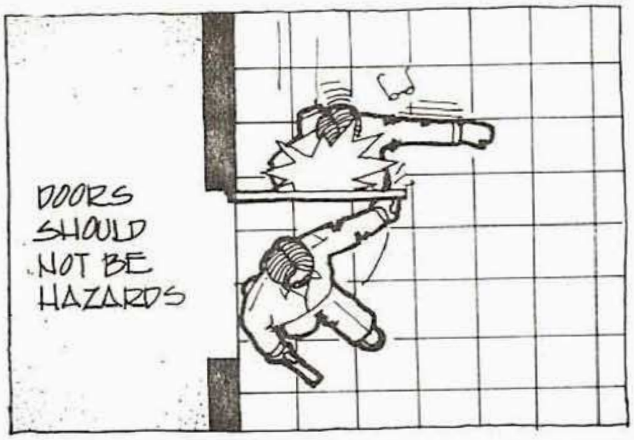




Whenever circulation spaces are reduced to the optimum dimensions around a door, the position of the handle and direction of door swing must be considered. A person in a wheelchair will require a large space to maneuver if he must close the door after passing through. The area can be reduced, however, by the provision of a closing handle near the hinge of the door, or the installation of an automatic mechanism to close the door.

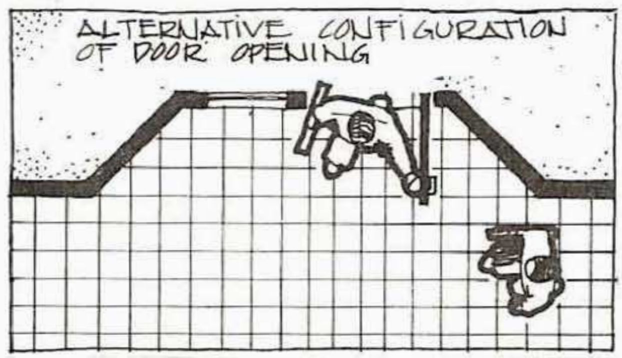


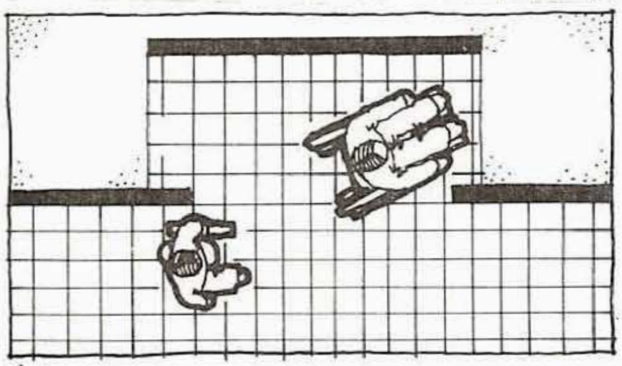
A door in a corner of a room should be positioned so that the hinges are near the corner and the door opens to the wall. This will allow easier maneuvering and reduce the chance of someone being struck by an opening door. Windows between 1200 and 1800 mm high in the door can prevent such an accident.



ALTERNATE ARRANGEMENTS FOR DOORS

Alternate arrangements for doors may improve accessibility and make maneuvering easier. For example, doors can be recessed from the main circulation paths. In certain rooms, baffle walls can replace doors. They are particularly useful in clinic or hospital rooms, such as examination rooms that require only visual privacy.



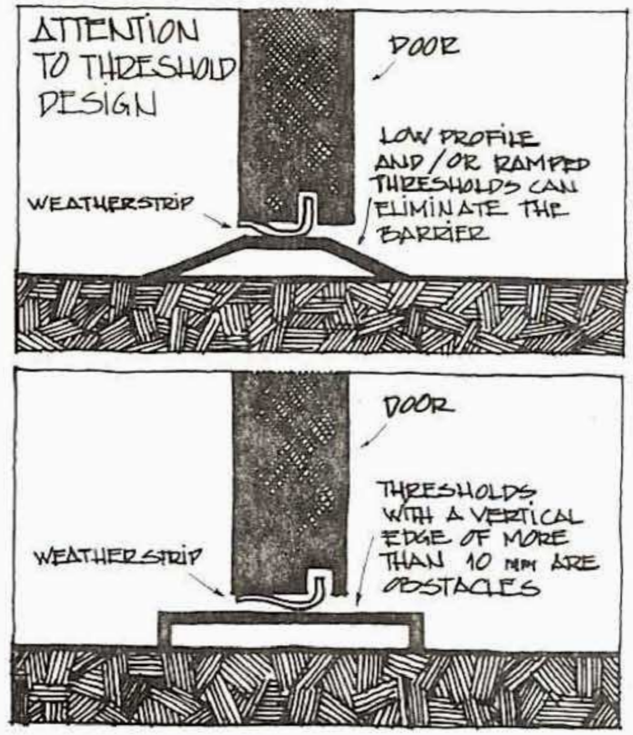


DOOR HANDLES

People with arthritis or others who have problems grasping or using their hands find door knobs difficult to grip unless knobs are elliptical in shape. Levers are easier to use but should be designed so they will not catch clothing or injure people. Locking devices are particularly difficult to use because the door must be unlocked and opened using two hands. If the dead bolt stays retracted once unlocked, however, it is easier to use. The height of the latches and locks should not exceed 1400 mm.

THRESHOLDS

Thresholds should be used as little as possible because physically disabled persons have difficulty maneuvering through doorways. A threshold 10 mm high, depending on surface drainage, is required for doors exposed to the weather. Although sections made of aluminum or similar materials can be used to smooth thresholds up to 15 mm high, 10 mm is the preferred maximum, especially in confined spaces.



CHECKLIST

1. Has adequate level space been provided about doors to enable someone in a wheelchair to maneuver easily?
2. Do the floor surfaces inside and outside the building remain non-slip when wet?
3. Are thresholds easy to negotiate, not exceeding a height of 10 mm?
4. Has the doorway an adequate clear width (at least 815 mm) depending on the space about the door?
5. Is there a space of at least 1900 mm between the doors in a draught lobby?
6. Have sliding doors been incorporated to improve accessibility?
7. Have large doors been placed on special hinges to make them easier to open?
8. Have lever handles been used instead of knobs or other opening devices that are difficult to grasp?
9. Can the door be unlocked using one hand?

SUGGESTED READING

Canadian Standards Association, "Electrically Activated Door Securing and Automatic Releasing Devices," CSA Standard B222.61.

Goldsmith, S., "Designing for the Disabled," 3rd ed., London, RIBA Publications, 1976, p. 181-192.

Johnson, B.M., "Crime Prevention through Building Design," Specification Associate, Vol. 20, No. 1, 1978, p. 8-9. (Available as NRCC 16612.)

Parkin, A., "Waiting for the Air Curtain: An Ergonomic Survey of Door Handles and Locks," Design, Vol. 241, January 1968, p. 50-54.

Steinfeld, E., Schroeder, S., and Bishop, M., "Accessible Buildings for People with Walking and Reaching Limitations," U.S. Dept. of Housing and Urban Development, U.S. Government Printing Office, 1979.

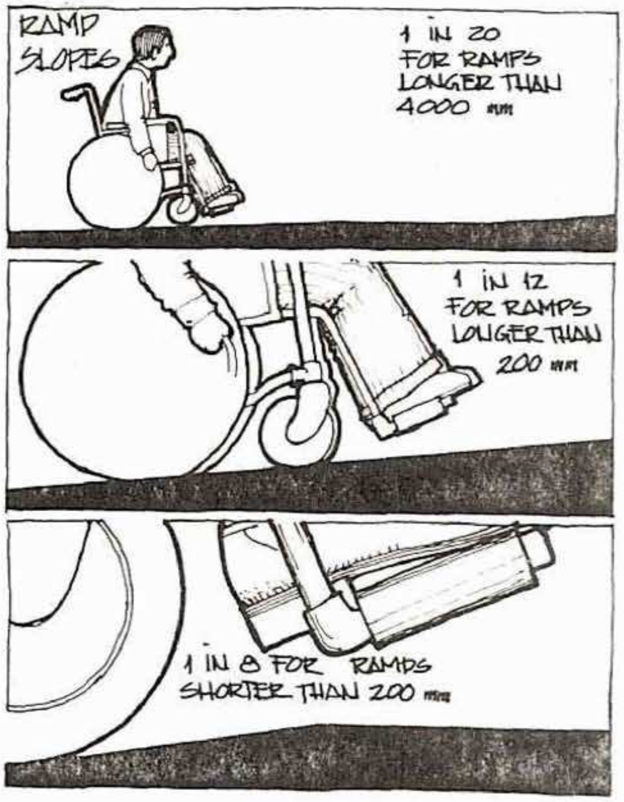
SECTION 6

RAMPS

Well designed ramps can overcome vertical displacements but are generally too costly when used for height changes of more than one metre. Exterior ramps also require adequate protection and considerable maintenance. However, in the renovation of buildings, it may be more economical to provide large ramps rather than elevators. Whenever possible, stairs should be provided as an alternative for many ambulant disabled, such as amputees or hemiplegics, who have difficulty using ramps.

RAMP LENGTH AND SLOPE

The relationship between ramp length, ramp slope and the ability of persons to use the ramp has not been clearly established. The appropriate ramp length will depend on the cost of construction and the nature of disabilities. Although most persons using wheelchairs will be able to go up relatively steep ramps for a short distance, they will have difficulty with long ramps unless the slope is very gentle. To ensure that people in wheelchairs can go up a ramp without assistance, the ramp should preferably be sloped according to its length, as follows.



1. 1:20 for ramps longer than 4000 mm (suitable for vertical displacements >200 mm); can be used unassisted by wheelchair users if rest areas are provided.

2. 1:12 for ramps less than 4000 mm (suitable for vertical displacements between 25 and 200 mm); can be used up to lengths of 4000 mm by approximately 70% of wheelchair users.

3. 1:8 for ramps shorter than 200 mm (suitable for vertical displacements <25 mm).

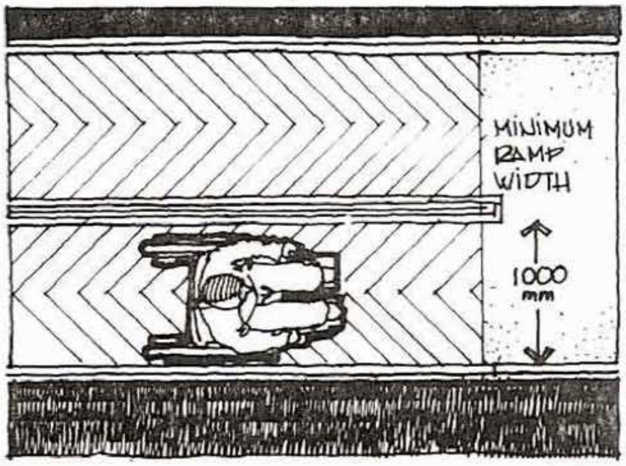
The results of British research (given in following table) indicate slightly steeper gradients depending on type of handicap (Goldsmith 1976).

	Length of Ramp		
	≤ 3 m	3 to 6 m	> 6 m
Ambulant disabled	1:9	1:12	1:12
Independent wheelchair users	1:10	1:16	1:20
Wheelchair with attendant	1:9	1:12	1:20
Electric wheelchair users	1:16	1:16	1:20

The general recommendation is that the slope of the ramp should be as gentle as possible within the space available. If a steep ramp is required because of space limitations, the designer and owner should be aware that some people will not be able to use the ramp without assistance.

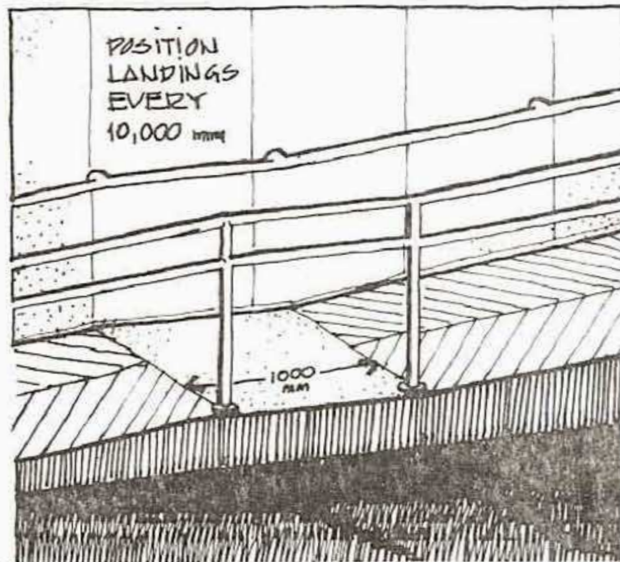
RAMP WIDTH

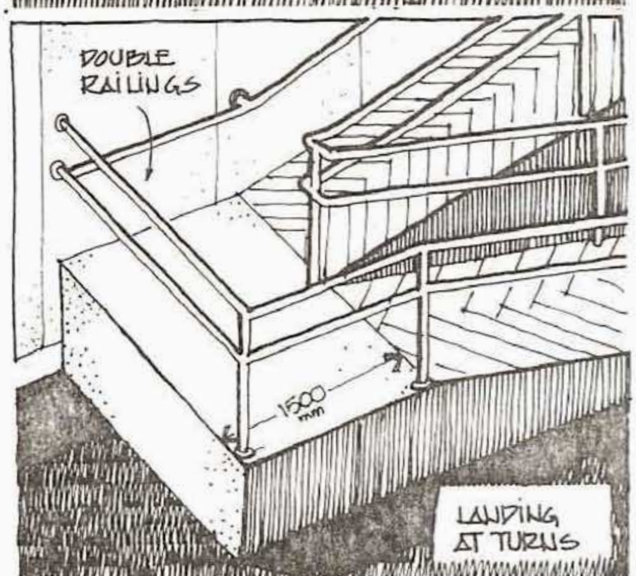
Ramps should be at least 1000 mm (preferably 1200 mm) wide to be used comfortably by people in wheelchairs. Long ramps should be wider, about 1500 mm, because someone in a wheelchair is less exact as he becomes fatigued and requires more room to maneuver. This width also allows pedestrians to pass a wheelchair.

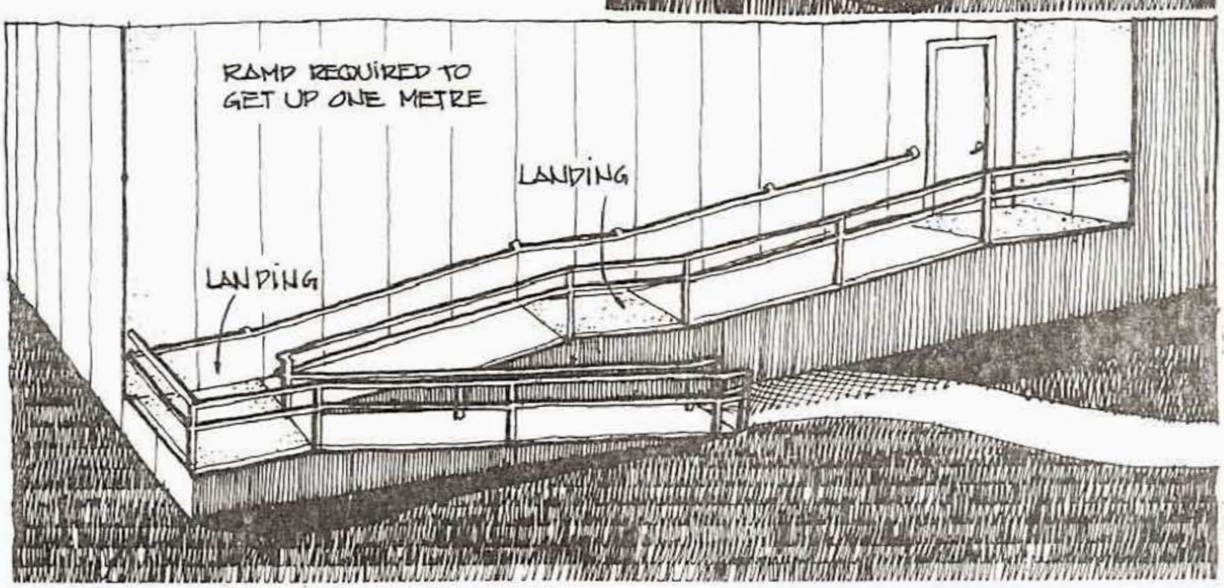


LANDINGS

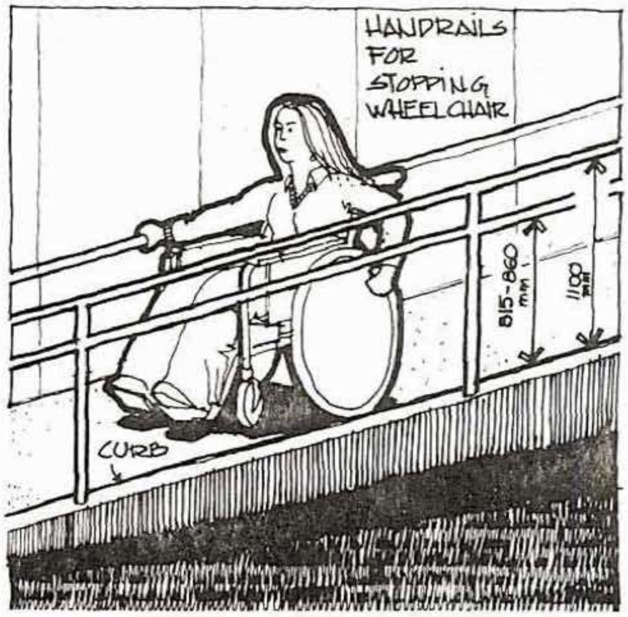
When the ramp exceeds 10 m in length, a landing or resting platform is required and should be positioned to equalize the lengths of sloped surfaces. This landing should be at least 1000 mm (preferably 1200 mm) in length if the ramp continues straight but 1500 mm if the ramp turns. The surface texture should change so that these landings are not disorienting to blind or poorly sighted people. A landing 1500 mm long will also be required at the top and bottom of the ramp. Where a door opens near the ramp, the landing must be designed to allow the appropriate maneuver for someone in a wheelchair to open the door. When the ramp intersects a pedestrian route, it should be set back to avoid possible collisions between people using the ramp and pedestrians.







HANDRAILS



Handrails should be provided on long ramps with a slope greater than 1:20, to give support to ambulant and semi-ambulant persons as well as wheelchair users. The rails should be about 815 to 860 mm from the surface of the ramp on each side, extending at least 300 mm beyond the ramp at the top and bottom. On open sides of ramps a top rail should be placed about 1100 mm high to function as a guardrail.

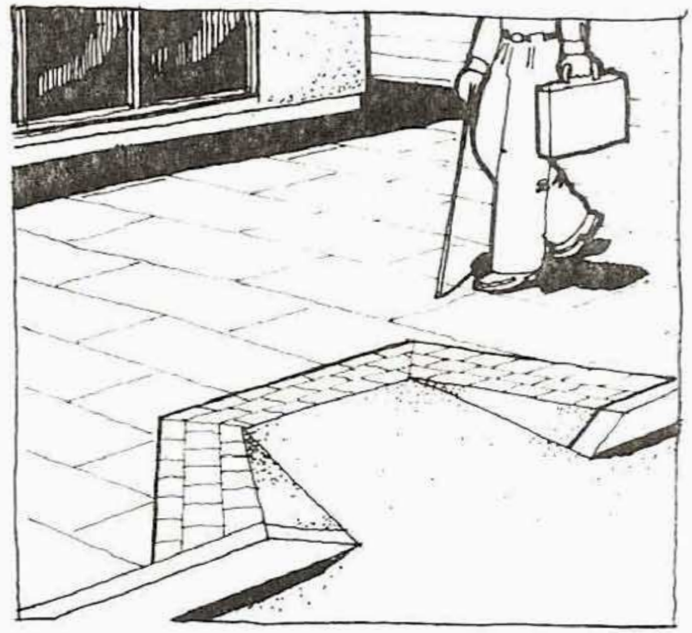
RAMP SURFACE

Ramps should have surfaces with frictional coefficients above 0.5 for normal conditions. Slip resistance is critical to prevent rubber heels or crutch/cane tips from slipping. A herringbone pattern, roughened surface, or coarse aggregate, could be used for exterior ramps. Interior ramps should have a grooved rubber tile or sheet applied with corrugations at right angles to the direction of travel. Any cross slope for drainage should be less than 1:20. The bottom end of a ramp should be tapered to eliminate any abrupt change in level greater than 10 mm; the top end should be smooth.

A curb should be provided on the exposed side of any ramp to check wheelchair wheels. This curb should not be less than 50 mm high where there is a rail or wall on that side or 75 mm otherwise.

If an exterior ramp cannot be covered, built-in electrical heaters should be considered as a means of keeping it free of ice. Electric cables could be laid directly over the concrete base and then covered by 50 mm of screed. A control, sensitive to ice, is also required in most circumstances. Besides the capital cost, the cost of energy required to melt snow or ice must be considered. Facilities for drainage must also be provided on landings and at the base of the ramp.

Curb cuts can be more easily detected by the blind if there is a change of surface texture surrounding the ramp or between the ramp and the sidewalk.



LIGHTING AND SIGNALS

All ramps and landings should have an illuminance at least as great as the surroundings and no less than 50 lux. In addition to warning strips, textured or coloured surfaces can be added to draw attention to the ramp.

PORTABLE AND TEMPORARY RAMPS

Both ends of portable or temporary ramps should be tapered to eliminate any abrupt edges greater than 10 mm. They should also have rails or side pieces at least 50 mm high to prevent the wheels from going off the edge of the ramp.

CHECKLIST

1. Is the ramp protected from rain and accumulation of snow and ice?

2. Is the surface of the ramp non-slip (with a high coefficient of friction)?

3. Is there a horizontal area at the top and bottom of any ramp leading to a doorway (1500 mm^2 with an extra width of 300 mm beyond the latch edge of the door)?

4. Have landings 1000 mm to 1200 mm long been positioned at 10 m intervals or less on any ramp longer than 10 m?

5. Are landings at least 1500 mm by 1800 mm provided at each turning point?

6. If the ramp is more than 10 m in length, is it at least 1200 mm wide?

7. Is the ramp slope 1:20 for any ramp longer than 4 m?

8. Are there handrails 815 to 860 mm along the full length of any ramp over 4 m long and do they extend 300 mm over level portions of the ramp?

SUGGESTED READING

Corlett, E.N., Hutcheson, C., DeLugan, M.A., and Rogozenski, J., "Ramps or Stairs: The Choice Using Physiological and Biometric Criteria," Applied Ergonomics, Vol. 3, No. 4, 1972, p. 195-201.

Fruin, J.J., "Designing for the Disadvantaged: Optimum Design Considers all Users, American Society of Civil Engineers, March 1975, p. 65-67.

Goldsmith, S., "Designing for the Disabled," 3rd ed., London, RIBA Publications, 1976, p. 168-173.

Steinfeld, E., Schroeder, S., and Bishop, M., "Accessible Buildings for People with Walking and Reaching Limitations," U.S. Dept. of Housing and Urban Development, U.S. Government Printing Office, 1979.

Templer, J. "Priorities for Elderly and Handicapped Pedestrians - A Manual for Developing a Priority Accessible Network," U.S. Dept. of Transportation, Federal Highway Administration, DOT-FH-11-8504, 1979.

Williams, G.P., "Design Heat Requirements for Snow Melting Systems," National Research Council of Canada, Division of Building Research, CBD 160, 1974.

SECTION 7

EMERGENCY EVACUATION OF BUILDINGS

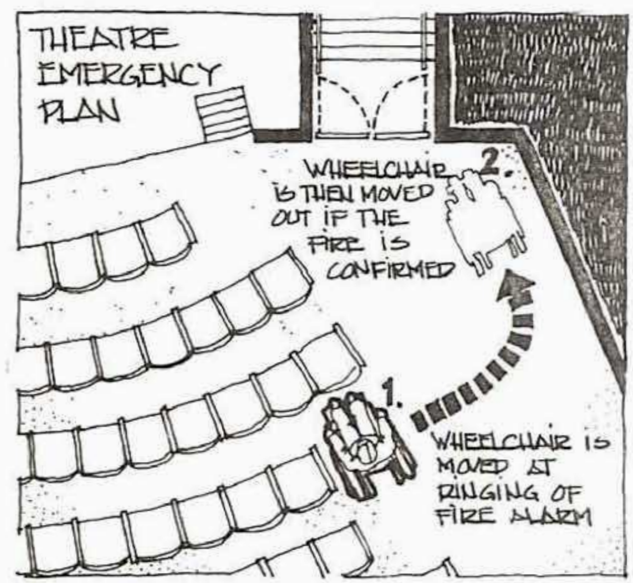
Emergency evacuation of persons with disabilities is in large measure the concern of management who must determine the abilities of persons in the building, plan for assistance and evacuation facilities, and ensure that appropriate procedures are carried out. The physically disabled must also accept their responsibility in notifying the building management of their location whenever convenient. Design features will improve the effectiveness of any emergency evacuation procedure; in most occupancies, only minor design or operational changes are required.

EMERGENCY PLAN

A plan for emergency situations should be devised for any building accessible to the non-ambulant. The nature of the plan will depend on the type of occupancy, the location and number of persons with disabilities, and the design of the building.

In certain types of occupancies, such as health care facilities, it is generally assumed that most patients are non-ambulant. In such occupancies, the usual departmentalized areas of activity (i.e., treatment areas) could provide temporary refuge areas to allow quick removal of the most threatened patients to a refuge area and later out of the building if required.

Some occupancies such as theatres or arenas have special locations set aside for people in wheelchairs. The building manager or operator and the fire department should be aware of these seating areas in case of emergency.



In many buildings, however, the location of non-ambulant or semi-ambulant persons is difficult to determine. Consequently, areas of refuge should be established at various locations throughout the building where these people can wait for assistance. Many would find such areas beneficial. The person with a coronary ailment, for example, could wait in a refuge area until the fire is confirmed, rather than risk using the stairs in a "false alarm" situation.

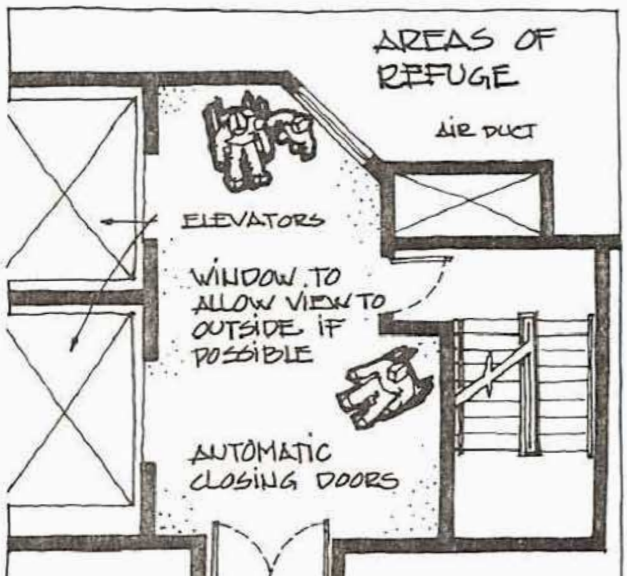
AREAS OF REFUGE

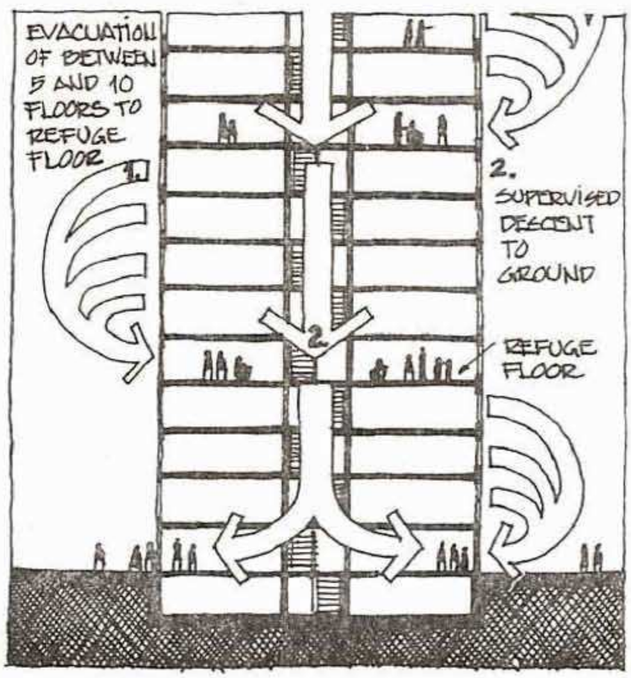
The concept "areas of refuge" is to provide areas where, in an emergency, people can wait temporarily and be evacuated later in relative safety. These areas require careful design to ensure that they are adequately fire resistant and smoke proof. Refuge areas can be incorporated into many existing buildings by enclosing parts of the building with automatic closing doors, which are activated by heat or smoke detectors or the fire alarm. It may be necessary to relocate garbage chutes or other potential hazards so that they do not reduce the safety of the refuge areas.

In housing, balconies can be used as refuge areas for later evacuation of the physically disabled but only if they can be reached from outside the building by the fire department. However, firemen's ladders seldom extend beyond seven storeys. The balcony must also be accessible from the inside, i.e., the door must be readily openable, wide enough, and without a significant threshold. In winter, the maintenance of the balcony may be so difficult that it will be impossible to use.

In multi-storey buildings, refuge areas on intermittent floors could be designed with sufficient protection for those who are only capable of descending a few flights. From these floors, the people could proceed under supervision to the ground if necessary.

The size of the refuge area will vary according to the anticipated number of physically disabled persons in the building. It should be based on an area of about 0.7 m^2 for each disabled person.





In office buildings, the number of people who have difficulty using stairs is approximately 8 per cent, about half of whom could successfully use the stairs at their own pace. Consequently, they could most safely proceed down the stairs at the end of the evacuation line. Less than 4 per cent of office personnel would find stairs a barrier, and these could evacuate via the elevators under the supervision of the fire department.

A number of disabled may be present in other occupancies, such as cinemas or theatres, especially those advertising accessibility. About 5 per cent of the occupants may have restricted walking abilities.

In some occupancies, such as education facilities, the number of persons with disabilities may be about 1 per cent. This value may become higher in future.

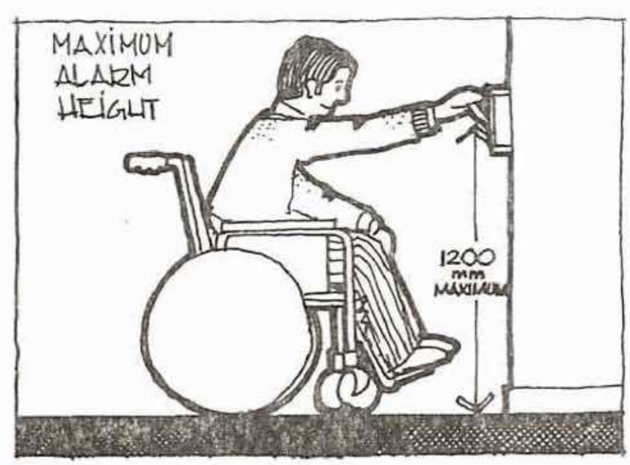
COMMUNICATIONS

There are four stages of communication in emergency situations. The following indicates possible measures for each of these stages.

1. Turning in Alarm:

    - all alarm boxes mounted 1200 mm or lower;

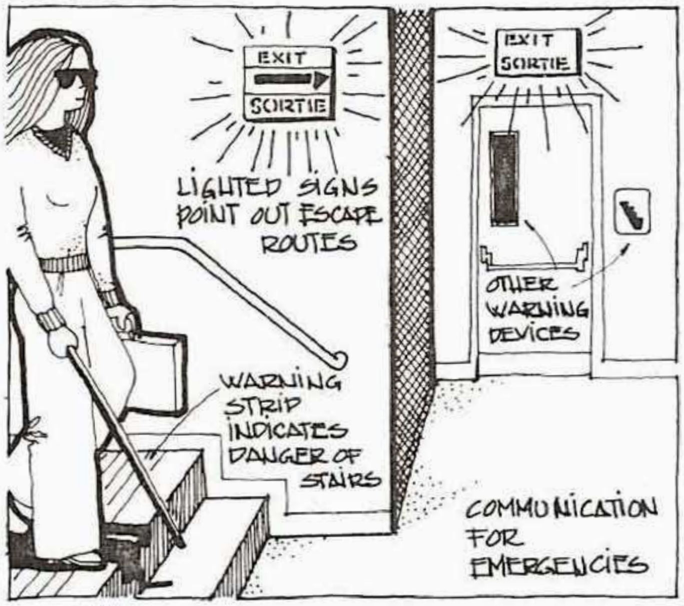
    - telephones used as mechanism for notifying authorities of emergency must be adapted to meet needs of users i.e., equipped with variable amplifying receivers and mounted less than 1200 mm from floor level.



2. Notification of Emergency:

   - siren and flashing lights;

   - special operations and procedures for those requiring communication assistance, probably on an individual basis.



3. Notification of Procedure:

   - auditory signal for immediate or phased evacuation;

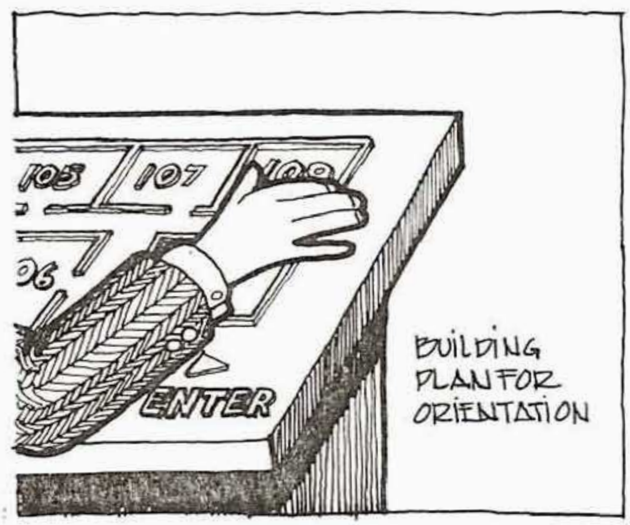
   - flashing of exit lights for exits that are to be used during phased or partial evacuations;

   - stand-by power for emergency lighting.

4. Choice of Escape Route:

   - signs indicating accessible escape routes;

   - warning of hazards such as stairs and other dangerous areas.



Emergency procedures will be affected by the occupants' knowledge of the building. Building plans in relief with raised lettering to describe rooms should be set up near the main entrance for the blind to orient themselves for normal usage of the building and thus be prepared in case of emergencies.

CHECKLIST

1. Can elevator lobbies be made smoke proof?

2. Are alarm boxes mounted 1200 mm or lower from the floor?

3. Are alarm signals both auditory and visual?

SUGGESTED READING

Pauls, J.L., "Movement of People in Building Evacuations." *In* "Human Response to Tall Buildings," Chapter 21, p. 281-292. Community Development Series, Vol. 34, 1977. (Available as NRCC 16253.)