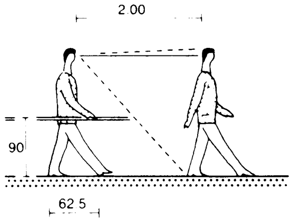
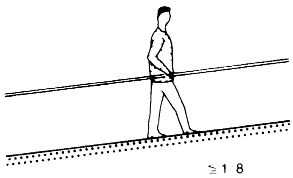
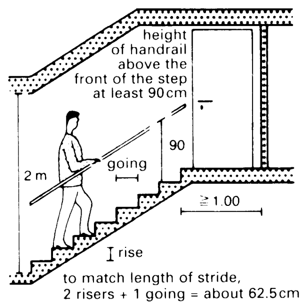
STAIRS



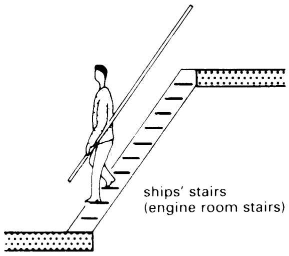
(1) **Standard stride of an adult on a horizontal plane**



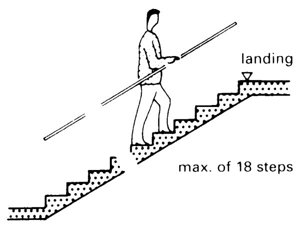
(2) **On a ramp the stride is reduced proportionately (desirable slope 1:10–1:8)**



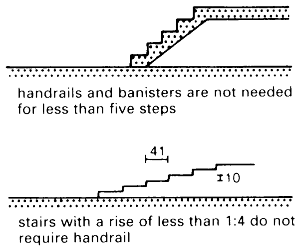
(3) **Optimum rise-to-tread ratio 17/29**



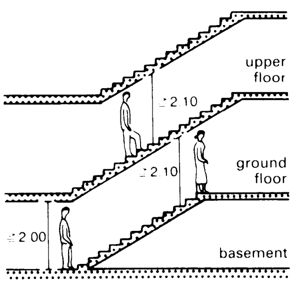
(4) **Ladder stairs with a handrail**



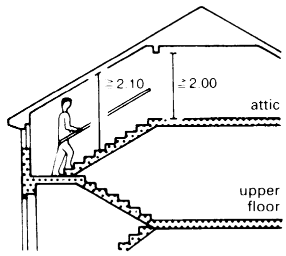
(5) **Normal stairs 17/29; landing after a max. of 18 steps**



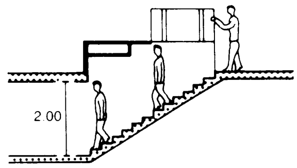
(6) **Steps without a handrail**



(7) **Superimposed stairs save space**



(8) **Laying the rafters and beams parallel to the stairs saves space and avoids the need for expensive alterations**

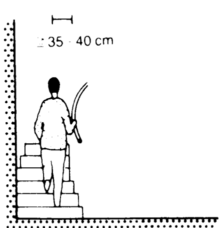


(9) **Covered entrances to cellars and trapdoors should be avoided. However, this combination has advantages and is safe**

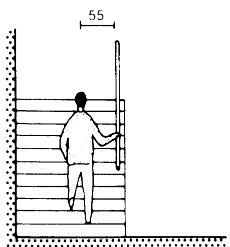
Calculations for the construction of stairs, ramps and guards are set out in various national building regulations. In the UK, British Standards and the Building Regulations should be consulted (see Approved Document K). The guidelines here are based on German standards.

Dwellings with no more than two flats must have an effective stair width of at least 0.80 m and 17/29 rise-to-tread ratio. Stairs which are not strictly covered by building regulations may be as little as 0.50 m wide and have a 21/21 ratio. Stairs governed by building regulations must have a width of 1.00 m and a ratio of 17/28. In high rise flats they must be 1.25 m wide. The length of stair runs from ≥3 steps up to ≤18 steps → (5). Landing length = *n* times the length of stride + 1 depth of step (e.g. with a rise-to-tread ratio of 17/29 = 1 × 63 + 29 = 92 cm or 2 × 63 + 29 = 1.55 m). Doors opening into the stairwell must not restrict the effective width.

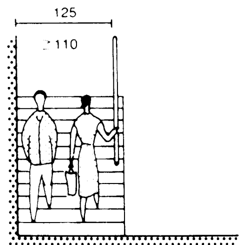
The time required for complete evacuation must be calculated for stair widths in public buildings or theatres. Such staircases or front entrance steps are climbed slowly, so they can have a more gradual ascent. A staircase at a side entrance or emergency stairs should make a rapid descent easy.



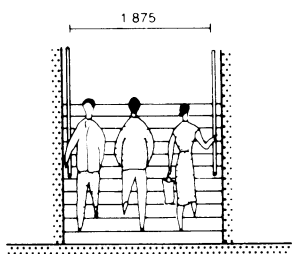
(10) **If stairs are narrow or curved the distance of the line of walk to the outer string should be 35–40 cm**



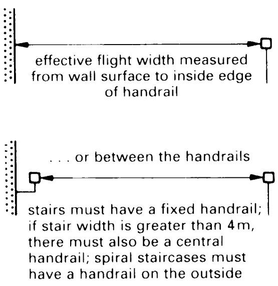
(11) **If stairs are straight and wide the distance of the line of walk to the handrails should be 55 cm**



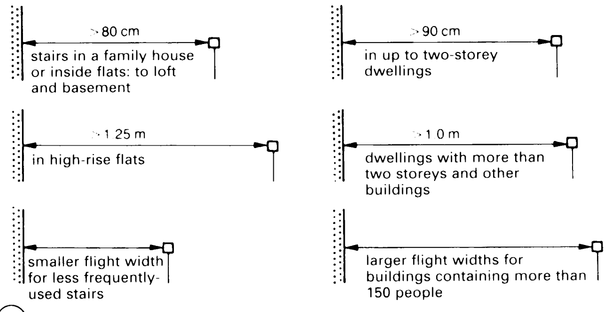
(12) **Stair width allowing two people to pass**



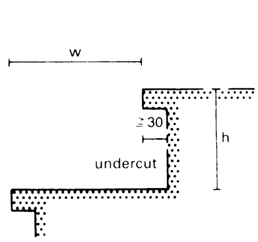
(13) **Stair width allowing three people to meet and pass**



(14) **Minimum dimensions for stairs**



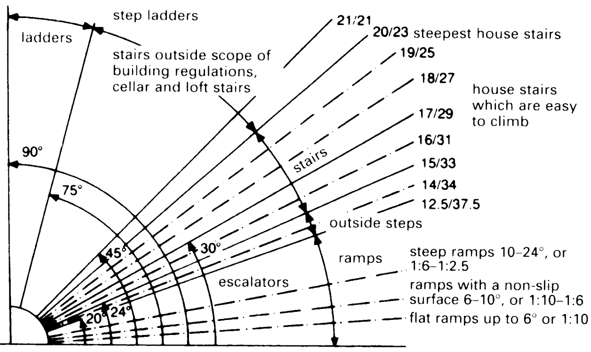
(15) **Measuring the effective flight width**



when tread (w) is less than 260 mm, the stairs must be undercut by ≥30 mm

(16) **The proportions of the stair rises must not change as you go up**

STAIRS



(1) **Incline for ramps, outside stairs, house stairs, machinery access steps and ladders**

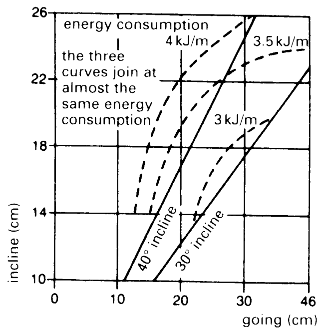
height of storey	two-way stairs		single, triple width and stairs in buildings	
	easy rise		easy rise	
	steps, no.	steps, height	steps, no.	steps, height
a	b	c	f	g
2250	–	–	13	173.0
2500	14	178.5	15	166.6
2625	–	–	15	175.0
2750	16	171.8	–	–
3000	18	166.6	17	176.4

(2) **Height of storey and step rise**

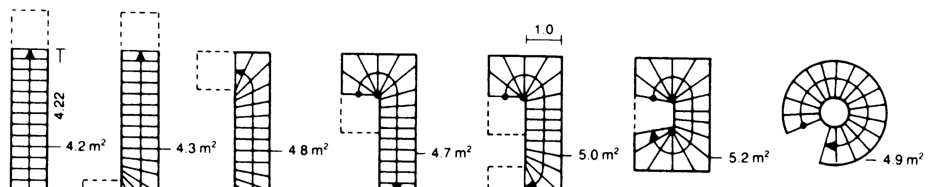
type of building	type of stairs		effective width of stairs	rise, $r^{2)}$	going, $g^{3)}$
residential building with no more than two flats[1]	essential stairs (building regulations)	stairs leading to habitable rooms, cellar and loft steps	≥ 80	17 ± 3	28^{+9}_{-5}
		which lead to non-habitable rooms	≥ 80	≤ 21	≥21
	stairs (additional) considered non-essential according to building regulations		≥ 50	≤ 21	≥21
stairs (additional) considered non-essential according to building regulations (flats)			≥ 50	no stipulations	
other buildings	essential stairs according to building regulations		≥ 100	17^{+2}_{-3}	28^{+9}_{-2}
	stairs (additional) considered non-essential according to building regulations		≥ 50	≤ 21	≥21

[1] Also includes maisonettes in buildings with more than two flats;
[2] but not <14 cm.; [3] but not >37 cm = stipulation of the ratio of rise r/g

(3) **Stairs in buildings**

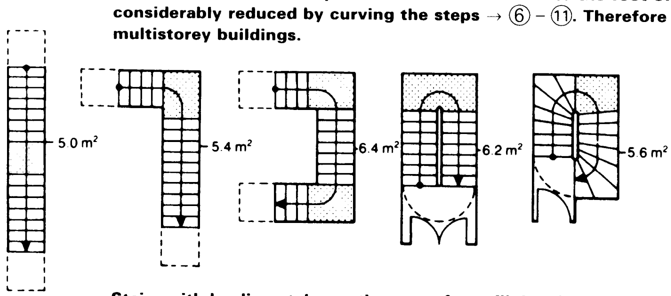


(4) **Energy consumption of an adult climbing stairs**

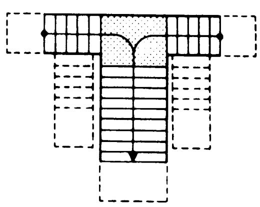


(5) – (16) 16 risers of 17/29, 17.2/28.1
height of storey 2.75 m; flight width 1 m

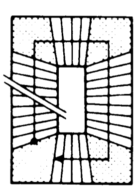
(5) - (11) **All stairs without landings, whatever the type, take up almost the same surface area. However, the distance from the top of the lower floor stairs to the foot of the next staircase can be considerably reduced by curving the steps → (6) – (11). Therefore curved steps are preferred for multistorey buildings.**



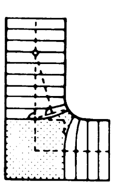
(12) - (16) **Stairs with landings take up the area of one flight of stairs + the surface area of landing – surface area of one step. For a height per storey of ≥2.75 m, stairs with landings are necessary. Width of landing ≥ stair flight width.**



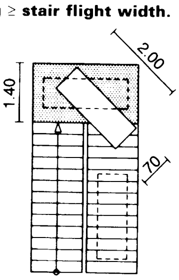
(17) **Three flight-width stairs are expensive and a waste of space**



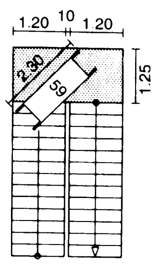
(18) **Winders save space**



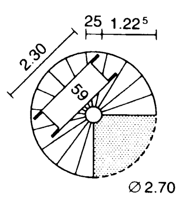
(19) **Curved steps at the landing on a narrow stairway save landing space**



(20) **Minimum space required for moving furniture**



(21) **Transporting a stretcher**



(22) **On a spiral staircase**

The experiences one has of ascending and descending stairs varies greatly with the stair design, for example there is a significant difference between an interior domestic design and a grand flight of entrance steps. Climbing stairs takes on average seven times as much energy as walking on the flat. From the physiological point of view, the best use of 'climbing effort' is with an angle of incline of 30° and a ratio of rise of:

$$\frac{\text{rise of step, } r}{\text{going of step, } g} = \frac{17}{29}$$

The angle of rise is determined by the length of an adult's stride (about 61–64 cm). To arrive at the optimum rise, which takes the least energy, the following formula can be applied:

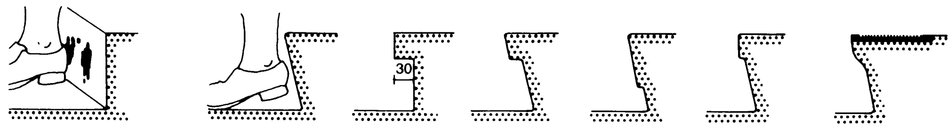
$$2r + g = 63\,\text{cm (1 stride)}$$

In the dimensioning and design of flights of stairs, the function and purpose of the staircase is of primary importance, taking in the factors mentioned above.

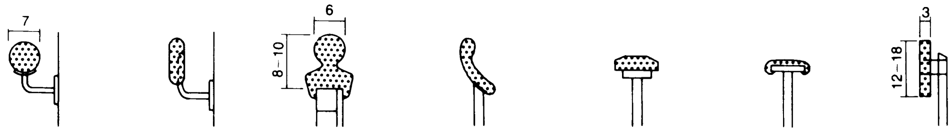
Not only is the gaining of height important, but also the way that the height is gained. For front door steps in frequent use, low steps of 16 × 30 cm are preferable. However, stairs in a workplace, or emergency stairs, should enable height to be gained rapidly. Every main staircase must be set in its own continuous stairwell, which together with its access routes and exit to the open air, should be designed and arranged so as to ensure its safe use as an emergency exit. The width of the exit should be ≥ the width of the staircase.

The stairwell of at least one of the emergency staircases or fire exits must be ≤ 35 m from every part of a habitable room or basement. When several staircases are necessary, they must be placed so as to afford the shortest possible escape route. Stairwell openings to the basement, unconverted lofts, workshops, shops, storerooms and similar rooms must be fitted with self-closing fire doors with a fire rating of 30 minutes.

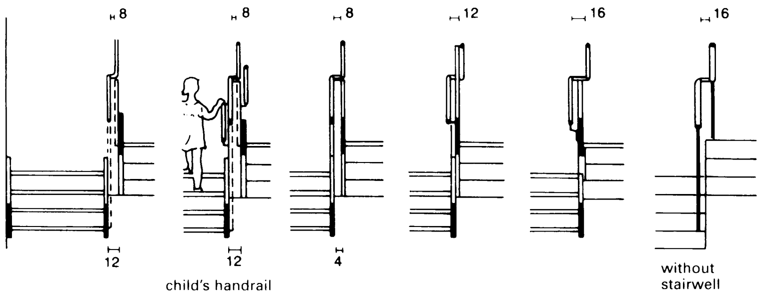
STAIRS



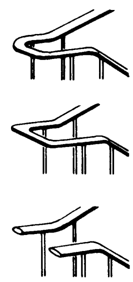
① **Step profiles**



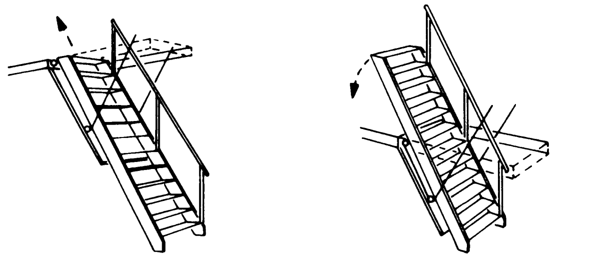
② **Handrail profiles**



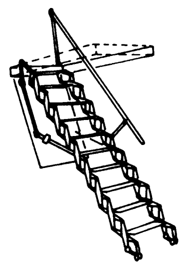
③ **Handrail and string details**



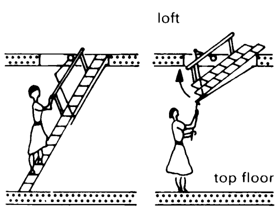
④ **Handrail on landing**



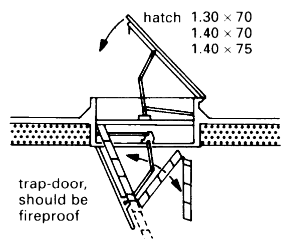
⑤ **Space-saving retractable stairs, in one, two or three sections → ⑦**



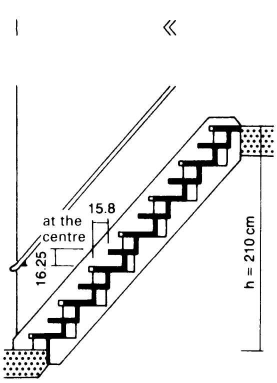
⑥ **Space-saving loft ladder (scissor frame) for rooms 2.0–3.8 m high**



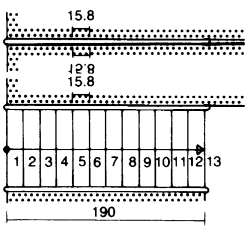
⑦ **Space-saving, telescopic aluminium or wooden ladders for lofts → ⑤ + ⑥**



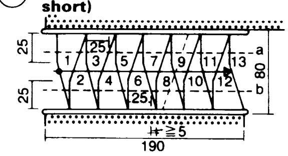
⑧ **Flat roof exit with loft steps**



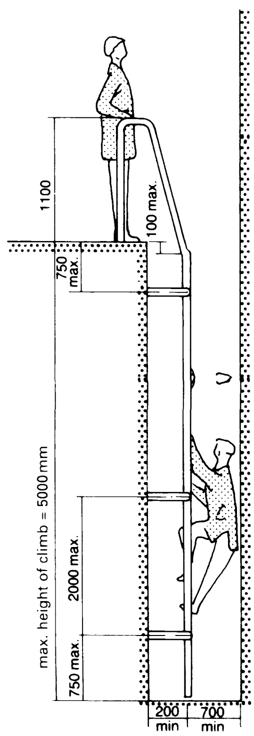
⑨ **Wooden alternating tread stair, section through centre**



⑩ **Normal stairs (goings too short)**



⑪ **Plan: goings at lines a and b are ≥20 cm**



⑫ **Fixed catladder**

To avoid marking risers with shoe polish from heels, use recessed profiles which have longer goings → ①.

Maximum space is required at hip (handrail) level, but at foot level considerably less is needed so the width at string level can be reduced, allowing more space for the stairwell.

Staggering the handrail and string allows better structural fixing. A good string and handrail arrangement with a 12 cm space between stairwell strings is shown in ③. An additional handrail for children (height about 60 cm) is also shown, along with some less popular string and handrail positions.

Circles in theatres, choir lofts, galleries and balconies must have a protective guard rail (height *h*). This is compulsory wherever there is a height difference in levels of 1 m or more.

For a drop of <12 m, *h* = 0.90 m

For a drop of >12 m, *h* = 1.10 m

Loft ladders have an angle of 45–55°. However, if user requirements stipulate a stair-like access (e.g. where loads are carried and available length is too short for a flight of normal stairs), then alternating tread stairs may be designed → ⑪. There should be a minimum number of risers for this type of stair (riser ≤ 20 cm). Here 'the sum of the goings + twice the rise = 630 mm' is achieved by shaping the treads; goings are measured (staggered) at the axes a and b → ⑫, of the right and left foot.

storey height,	size of loft ladder

storey height, FFL to underside of ceiling (cm)	size of loft ladder (cm)
220–280	100 × 60(70)
220–300	120 × 60(70)
220–300	130 × 60(70,80)
240–300	140 × 60(70,80)
frame width: W = 59, 69, 79 cm frame length: L = 120, 130, 140 cm frame height: H = 25 cm	

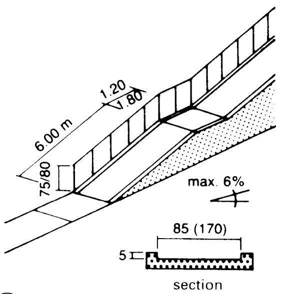
⑬ **Telescopic loft ladders → ⑤ - ⑧**

RAMPS AND SPIRAL STAIRCASES

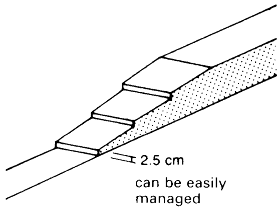
Ramps should be provided to allow wheelchair users and those with prams or trolleys to move easily from one level to another → ①-③.

Under building regulations, a main or 'essential' staircase with a ceiling aperture size of about 210cm diameter (with a minimum 80cm flight width) is permissible for family houses, and from 260cm for other buildings (with a minimum 1.00m flight width). Spiral stairs with less than 80cm effective flight width are only permitted as 'non-essential' stairs. Material used can be metal plate (with a plastic or carpet overlay if needed), marble, wood, concrete or stone → ⑥ - ⑨. Stairs in prefabricated steel sections, aluminium castings or wood for installation on site, are suitable as service stairs, emergency stairs and stairs between floors → ⑬. Stair railings can be fitted in steel, wood or Plexiglas → ⑭. Spiral staircases are space-saving and, with a pillar in their central axis, are of sturdy design → ⑤ - ⑥. They can, however, also be designed without a central pillar, giving an open winding staircase with a stairwell → ⑭ - ⑮.

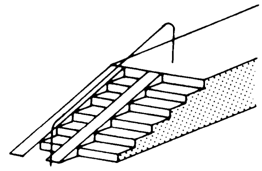
Spiral and helical stairs in the UK are usually designed in accordance with BS 5395: Part 2 to fulfil the recommendations of the Approved Document K (AD K).

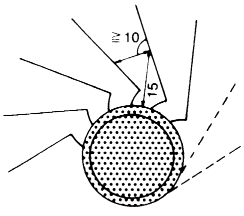


① **Ramp**



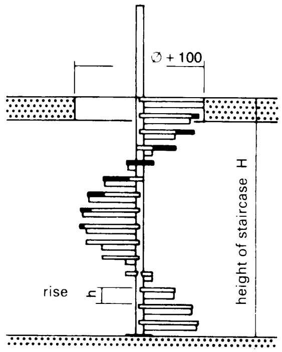
② **Stepped ramps**


③ **Stair ramp**

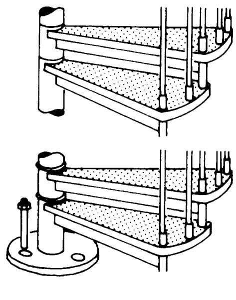


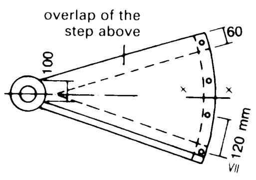
by setting the front edge of the step at a tangent to the newel post, the tread width is increased

④ **Step formation**

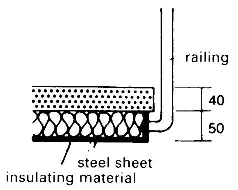


⑤ **Spiral staircase** → ⑬

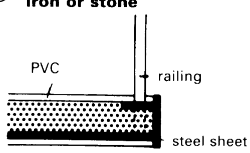

⑥ **Steps are in wood, wrought iron or stone**



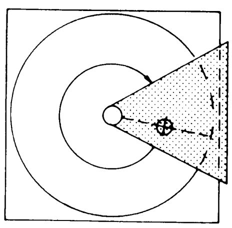
⑦ **Spiral stair treads**

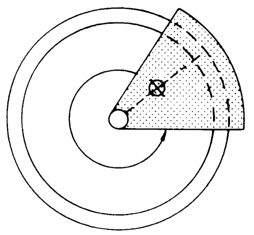


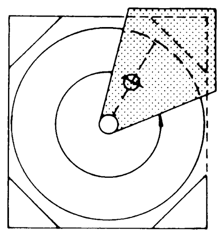
⑧ **Solid wooden step**



⑨ **PVC on cement screed**


⑩ **Square ceiling opening**

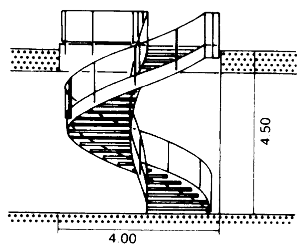

⑪ **Round ceiling opening**


⑫ **Angular opening**

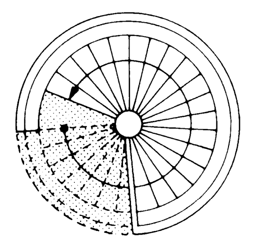
examples of uses with details

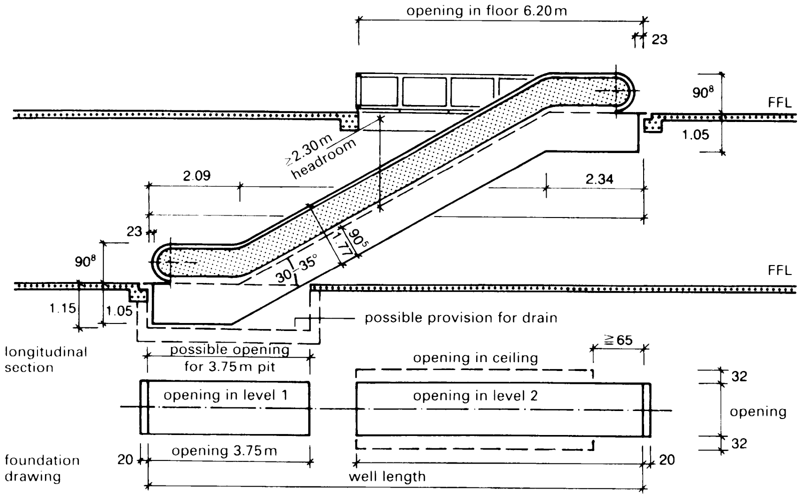
use	two-way traffic impossible								two-way traffic possible					two-way traffic easy					
	still passable					easy to pass			easy to pass				passable with comfort						
						small furniture can pass through			dismantled furniture can pass through				furniture can pass through		for heavy traffic				
secondary rooms																			
basements, lofts																			
home bar, hobby room																			
bedrooms, sauna																			
swimming pool, laboratory																			
workshop, garden																			
gallery, small store																			
salesroom																			
maisonette, boutique																			
office rooms, large storeroom																			
consulting/shop room																			
guest bedrooms																			
emergency stairs																			
main/'essential' domestic stairs																			
stairs dia. (nominal dimension)	1200	1250	1300	to	1500	1550	1600	1650	1700	1750	1800	1850	to	2050	2100	2150	2200	to	2400
flight width (mm)	516	541	566		653	678	703	728	753	778	625	650		750	775	800	825		925
	between the newel post and handrail										from 10cm depth of tread								

⑬ **Determination using minimum sizes for spiral stairs of all types**

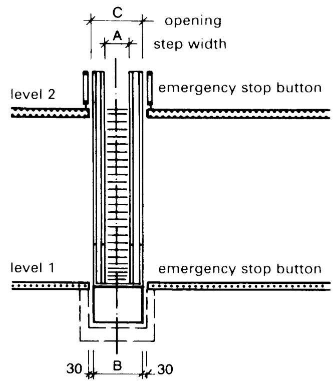


⑭ **Vertical section of spiral staircase**


⑮ **Plan view of** → ⑭



(1) **Cross-section/foundation diagram of an escalator**



(2) **Escalator width**

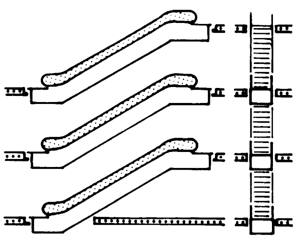
step width	600	800	1000
A	605–620	805–820	1005–1020
B	1170–1220	1320–1420	1570–1620
C	1280	1480	1680
transportation capacity/h	5000–6000 persons	7000–8000 persons	8000–10 000 persons

(3) **Dimensions and performance for escalators with either 30° or 35° angle of ascent**

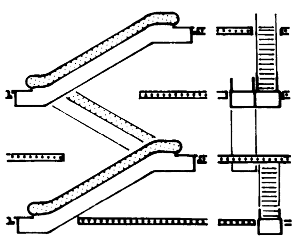
transportation capacity

$$Q = 3600 \times \frac{G_p \times v}{g} \times f \text{ (people/h)}$$

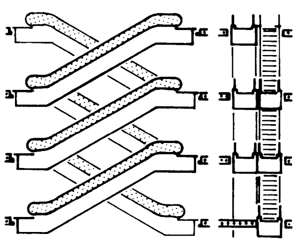
where
G_p = people per step (1, 1.5, 2)
v = conveyor speed (m/s)
g = going (m)
f = 0.5–0.8 escalator utilisation factor



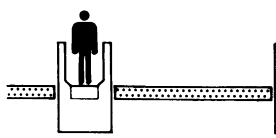
(4) **Superimposed**



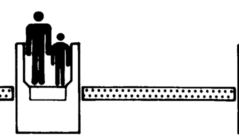
(5) **Crossover**



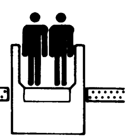
(6) **Double crossover**



(7) **Escalator 60cm wide**



(8) **80cm wide**



(9) **1.00m wide**

Length in plan → (1)

with 30° escalator = 1.732 × storey height
with 35° escalator = 1.428 × storey height
Example: storey height 4.50 m and angle 30° (note that 35° angle is not allowed in some countries)
length in plan: 1.732 × 4.5 = 7.794
Including landings top and bottom, total length is approximately 9m, allowing for about 20 people to stand in a row on the escalator.

speed	time per person	width sufficient for : 1 person	2 persons
0.5 m/s	~ 18 s	4000	8000
0.65 m/s	~ 14 s	5000	10 000
		people/h can be transported	

(10) **Performance data** → (1) – (3)

These guidelines are based on recommendations issued by the German Federations of Trade Associations. In the UK, reference is usually made to BS EN 115: 1995: *Safety rules for the construction and installation of escalators and passenger conveyors.*

Escalators → (1) – (3) are required to provide continuous mass transport of people. (They are not designated as 'stairs' in the provision of emergency escape.) Escalators, for example, in department stores rise at an angle of between 30° and 35°. The 35° escalator is more economical, as it takes up less surface area if viewed in plan but for large ascents, the 30° escalator is preferred both on psychological as well as safety grounds. The transportation capacity is about the same with both.

Escalators in public transport installations are subject to stringent safety requirements (for function, design and safety) and should have angles of ascent of 27–28°. The angle of rise is the ratio 3/16, which is that of a gentle staircase.

In accordance with a worldwide standard, the width of the step to be used is 60cm (for one-person width), 80cm (for one- to two-people width) and 100cm (for two-people width) → (7) – (9). A 100cm step width provides ample space for people carrying loads.

A flat section with a depth of ≥2.50m (minimum of two horizontal goings) should be provided at the access and exit points of the escalator.

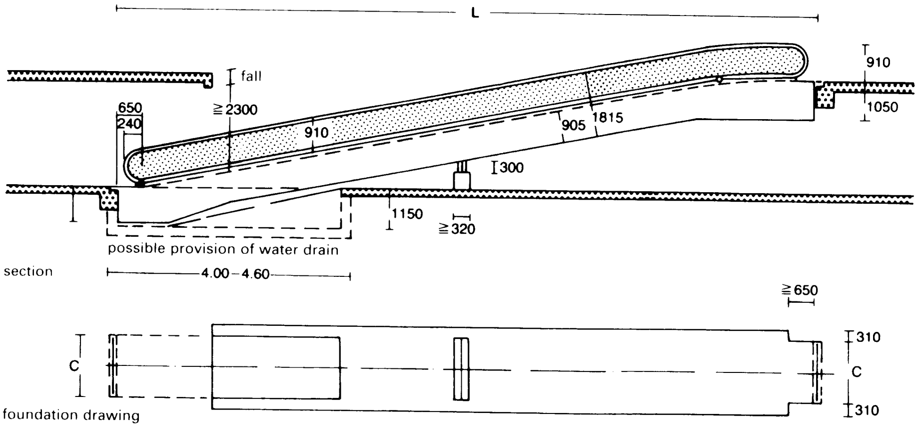
In department stores, office and administration buildings, exhibition halls and airports the speed of travel should, as a rule, be no greater than 0.5m/s, with a minimum of three horizontal exit goings. For underground stations and public transport facilities, 0.65m/s is preferred.

The average split of traffic that goes upstairs in a large department store is:

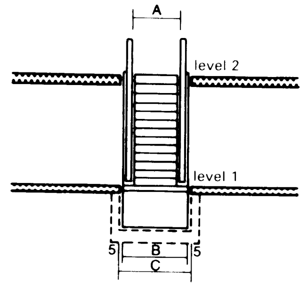
fixed stairs	2%
lifts	8%
escalators	90%

Coming down, about three-quarters of the traffic uses the escalators.

According to current assessments, on average one escalator is installed for every 1500 m^2 of sales area; but this average should be reduced to an optimum of 500–700 m^2.



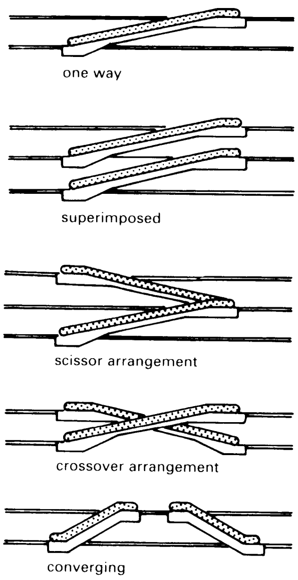
(1) **Travelator, cross-section and foundation diagram**



(2) **Cross-section** → (1)

type	60	80	100
A	600	800	1000
B	1220	1420	1620
C	1300	1500	1700

(3) **Dimensions** → (1) - (2)



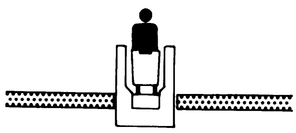
(4) **Arrangement of travelators**

The hourly capacity of a travelator is calculated according to the formula:

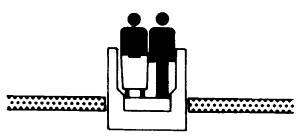
$$Q = \frac{3600\,K.w.v}{0.25} \text{ (persons/h)}$$

where
w = transportation width (m)
v = speed (m/s)
K = load factor

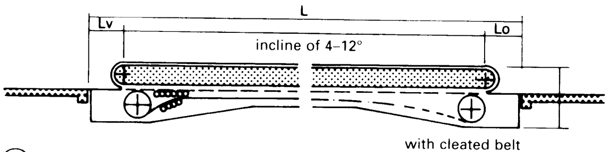
The load factor varies between 0.5 and 0.9 (average 0.7) according to the use. The 0.25 in the denominator represents a step area of 0.25 m²/person.



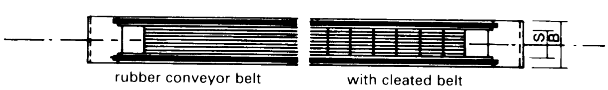
(5) **One person with 60 cm shopping trolley (width 80 cm)**



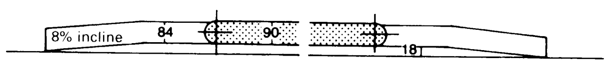
(6) **Two people; 1 m width**



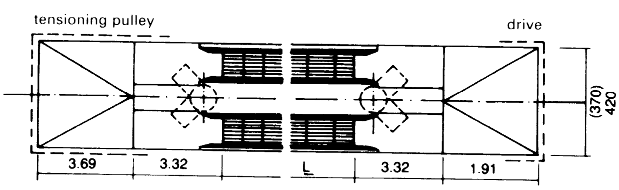
(7) **Section of travelator with rubber conveyor belt**



(8) **Plan view** → (7)



(9) **Section of a reversible travelator** → (10)



(10) **Plan view** → (9)

horizontal travelator	cleated belt	conveyor belt (rubber)	reversible travelator
effective width, S	800 ÷ 1000	750 ÷ 950	2 × 800 ÷ 2 × 1000
overall width, B	1370 ÷ 1570	1370 ÷ 1570	3700 ÷ 4200
design	flat construction with ≥4° incline		
length of a section	12–16 m		~ 10 m
inter-support distance	in accordance with structural requirements		
possible length, L	≥250 m		
capacity	40 m/min		11000 people/h

(11) **Dimensions and performance of horizontal travelator** → (7) - (8)

Travelators (or moving pavements) are a means of conveying people horizontally or up a slightly inclined plane (up to a maximum angle of 12°, or 21%). The big advantage of the travelator lies in its ability to transport prams, invalid chairs, shopping trolleys, bicycles and unwieldy packages with only a slight risk of accident. At the planning stage the expected traffic must be carefully calculated, so that the installation provides the best conveying capacity possible. This capacity depends on the clear width available, the speed of travel and the load factor.

The number of people transported can be as high as 6000–12 000 people/h. The speed of travel on inclined travelators is normally 0.5–0.6 m/s although where the inclination angle is less than 4° they can sometimes be run a little faster, up to 0.75 m/s. Long travelators can be up to 250 m in length but shorter runs (e.g. about 30 m long) are better because they allow people to access and exit to and from the sides. It is therefore sensible to plan a series of smaller travelators.

The advantage of the reversible travelators is their ability to offer both horizontal directions of travel → (9) - (10), in contrast to → (7) - (8). The low height required for construction (this being only 180 mm) allows these travelators to be fitted into existing buildings.

The cotangents of the travelator gradient are:

Gradient W (°)	10°	11°	12°
cot W	5.6713	5.1446	4.7036

Horizontal length L = cotan W × conveyor lift

Example: conveyor lift, 5 m; gradient 12°

$L = 4.7036 \times 5 = 23.52$ m

(to two decimal places).

LIFTS

The upward and downward movement of people in newly erected multistorey buildings is principally achieved by lifts. An architect will normally call in an expert engineer to plan lift installations. The guidelines given here are based on German standards. In the UK, lift installation is covered by BS 5655, which contains recommendations from CEN (Committee for European Normalisation) and the International Standards Organisation. It is anticipated that future standards relating to lifts will be fully international in their scope.

In larger, multistorey buildings it is usual to locate the lifts at a central pedestrian circulation point. Goods lifts should be kept separate from passenger lifts; though their use for carrying passengers at peak periods should be taken into account at the planning stage.

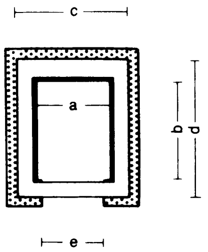
The following maximum loads are stipulated for passenger lifts in blocks of flats:

400 kg (small lift)	for use by passengers with hand baggage only
630 kg (medium lift)	for use by passengers with prams and wheelchairs
1000 kg (large lift)	can also accommodate stretchers, coffins, furniture and wheelchairs → ⑧

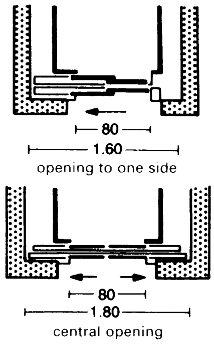
Lobbies in front of lift shaft entrances must be designed and arranged so that: (1) the users entering or exiting the lifts, even those carrying hand baggage, do not get in each other's way more than is absolutely necessary; and (2) the largest loads to be carried by the lift in question (e.g. prams, wheelchairs, stretchers, coffins and furniture) can be manoeuvred in and out without risk of injuring people or damaging the building and the lift itself. Other users should be not be obstructed by the loads more than is absolutely necessary.

For a lobby in front of a single lift: (1) the available minimum depth between the wall of the lift shaft door and the opposite wall, measured in the direction of the lift car, must be at least the same as the depth of the lift car itself; and (2) the minimum area available should be at least the same as the product of the depth of the lift car depth and the width of shaft.

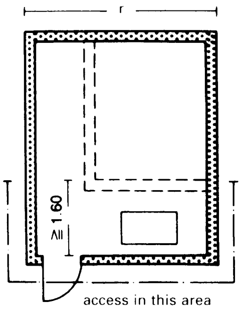
For a lobby in front of lifts with adjacent doors the available minimum depth between the shaft door wall and the opposite wall, measured in the direction of the lift car depth, should be at least the same as the depth of the deepest lift car.



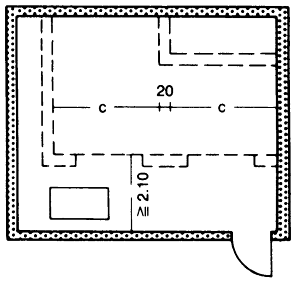
① **Plan view of lift shaft**



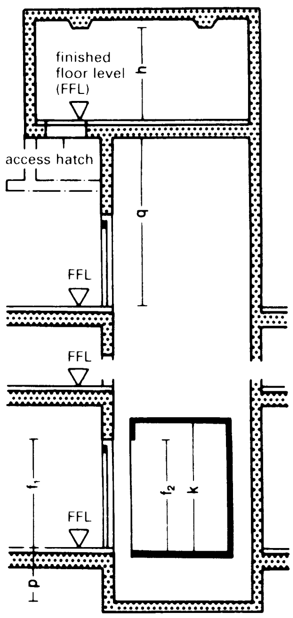
② **Doors**



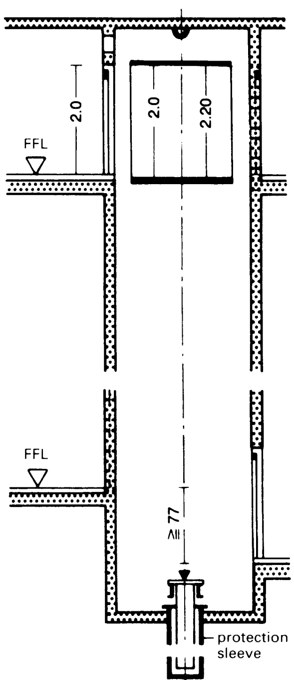
③ **Lift motor room**



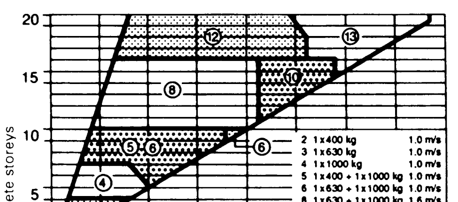
④ **Lift motor room (set of lifts)**



⑤ **Shaft and lift motor room**



⑥ **Shaft of hydraulic lift**



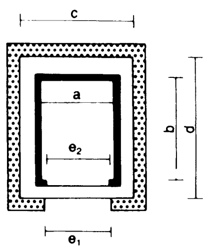
⑦ **Conveying capacity requirements for normal flats: finite elements method (FEM)**

		400			630				1000			
	load capacity (kg)	400			630				1000			
	operating speed (≤m/s)	0.63	1.00	1.60	0.63	1.00	1.60	2.50	0.63	1.00	1.60	2.50
shaft	minimum width, c (mm)	1800			1800				1800			
shaft	minimum depth, d (mm)	1500			2100				2600			
shaft	min. shaft pit depth, p (mm)	1400	1500	1700	1400	1500	1700	2800	1400	1500	1700	2800
shaft	min. shaft head height, q (mm)	3700	3800	4000	3700	3800	4000	5000	3700	3800	4000	5000
door	clear width lift door, c_2 (mm)	800			800				800			
door	clear width shaft door, s_2 (mm)	2000			2000				2000			
lift motor room	minimum area (m^2)	8	10		10	12	14		12	14	15	
lift motor room	minimum width, r (mm)	2400	2400		2700	2700	3000		2700	2700	3000	
lift motor room	minimum depth, s (mm)	3200	3200		3700	3700	3700		4200	4200	4200	
lift motor room	minimum height, h (mm)	2000	2200		2000	2200	2600		2000	2200	2600	
lift car	clear width, a (mm)	1100			1100				1100			
lift car	clear depth, b (mm)	950			1400				2100			
lift car	clear height, k (mm)	2200			2200				2200			
lift car	clear access width, e_2 (mm)	800			800				800			
lift car	clear access height, f_2 (mm)	2000			2000				2000			
	permitted no. passengers	5			8				13			

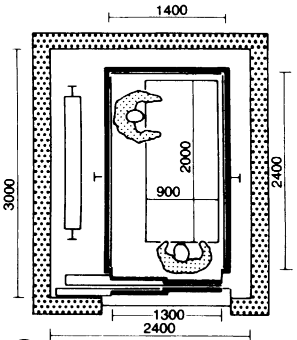
⑧ **Structural dimensions, dimensions of lift cars and doors**

LIFTS

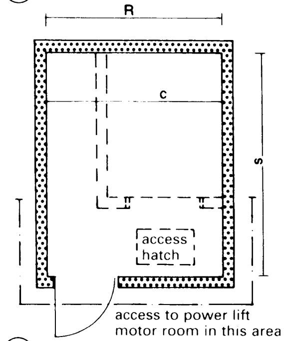
For Offices, Banks, Hotels etc. and Hospital Bed Lifts



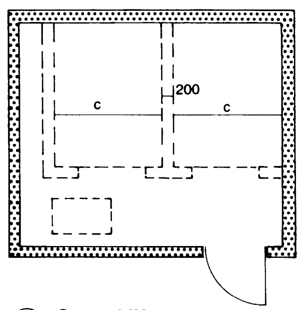
(1) **Plan of lift shaft**



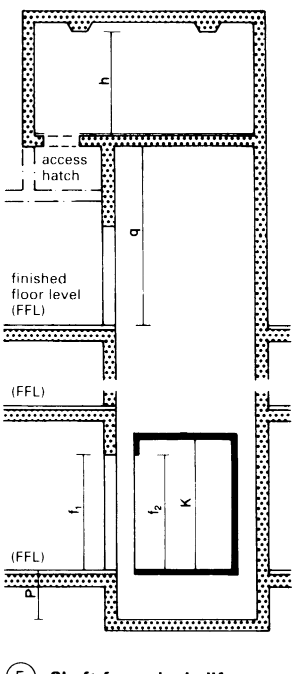
(2) **Lifts for hospital beds**



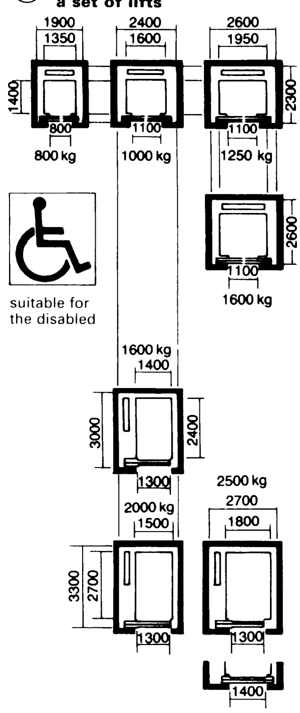
(3) **Lift motor room**



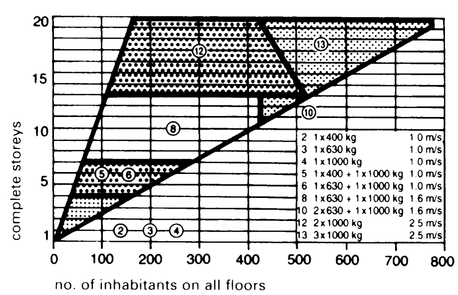
(4) **General lift motor room for a set of lifts**



(5) **Shaft for a single lift**



(6) **General overview of the lifts → (8) - (9)**



(7) **Transportation capacity requirements for flats with and without floors of offices: finite elements method (FEM)**

The building and its function dictate the basic type of lifts which need to be provided. They serve as a means of vertical transport for passengers and patients.

Lifts are mechanical installations which are required to have a long service life (anything from 25 to 40 years). They should therefore be planned in such a way that even after 10 years they are still capable of meeting the increased demand. Alterations to installations that have been badly or too-cheaply planned can be expensive or even completely impossible. During the planning stage the likely usage should be closely examined. Lift sets normally form part of the main stairwell.

Analysis of use: types and definitions

Turn-round time is a calculated value indicating the time which a lift requires to complete a cycle with a given type of traffic.

Average waiting time is the time between the button being pressed and the arrival of the lift car:

$$\text{average waiting time (s)} = \frac{\text{cycle time (s)}}{\text{number of lifts/set}}$$

Transportation capacity is the maximum achievable carrying capacity (in passengers) within a five minute (300 s) period:

$$\text{transportation capacity} = \frac{300\,(s) \times \text{car load (passengers)}}{\text{cycle time (s)} \times \text{no. of lifts}}$$

Transportation capacity expressed in percent:

$$\text{transportation capacity (\%)} = \frac{100 \times \text{transportation capacity}}{\text{number of occupants of building}}$$

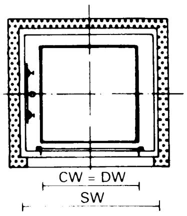
carrying capacity (kg)	800				1000 (1250)				1600			
nominal speed (m/s)	0.63	1.0	1.6	2.5	0.63	1.0	1.6	2.5	0.63	1.0	1.6	2.5
min. shaft width, c	1900				2400				2600			
min. shaft depth, d	2300				2300				2600			
min. shaft pit depth, p	1400	1500	1700	2800	1400	1700		2800	1400	1900		2800
min. shaft head height, q	3800		4000	5000	4200			5200	4400			5400
shaft door width, c_1	800				1100				1100			
shaft door height, f_1	2000				2100				2100			
min. area of lift motor room (m^2)	15			18	20				25			
min. width of lift motor room, r	2500			2800	3200				3200			
min. depth of lift motor room, s	3700			4900	4900				5500			
min. height of lift motor room, h	2200			2800	2400			2800	2800			
car width, a	1350				1500				1950			
car depth, b	1400				1400				1750			
car height, k	2200				2300				2300			
car door width, e_2	800				1100				1100			
car door height, f_2	2000				2100				2100			
no. of people permitted	10				13				21			

(8) **Structural dimensions (mm) → (1) - (6): lifts allow wheelchair access**

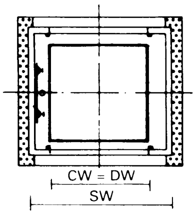
carrying capacity (kg)	1600				2000				2500			
nominal speed (m/s)	0.63	1.0	1.6	2.5	0.63	1.0	1.6	2.5	0.63	1.0	1.6	2.5
min. shaft width, c	2400								2700			
min. shaft depth, d	3000				3300							
min. shaft pit depth, p	1800	1700	1900	2800	1600	1700	1900	2800	1800	1900	2100	3000
min. shaft head height, q	4400			5400	4400			5400	4800			5600
shaft door width, c_1	1300								1300 (1400)			
shaft door height, f_1	2100											
min. area of lift motor room (m^2)	26				27				29			
min. width of lift motor room, r	3200								3500			
min. depth of lift motor room, s	5500				5800							
min. height of lift motor room, h	2800											
car width, a	1400				1500				1800			
car depth, b	2400				2700							
car height, k	2300											
car door width, e_2	1300								1300 (1400)			
car door height, f_2	2100											
no. of people permitted	21				26				33			

(9) **Structural dimensions of hospital bed lifts**

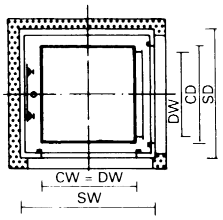
SMALL GOODS LIFTS



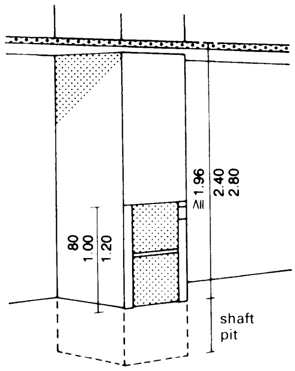
① **Small goods lift loaded only from one side**



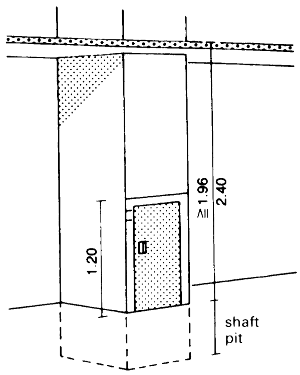
② **With loading from both sides**



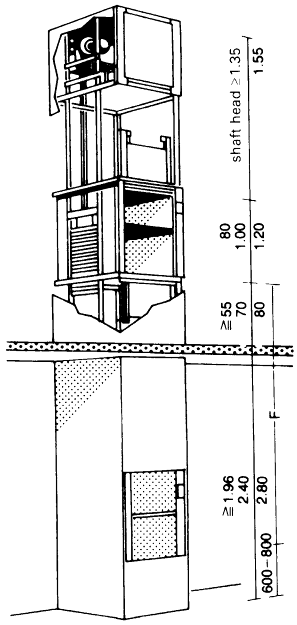
③ **With corner loading**



④ **Small goods lift with sliding doors opening vertically at floor level**



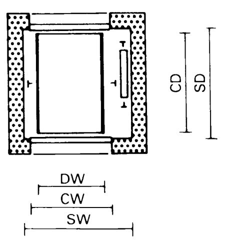
⑤ **Small goods lift with hinged door opening at floor level**



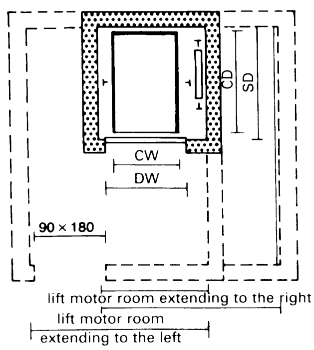
⑥ **Small goods lift and vertical sliding door opening at waist level**

loading arrangement	one side access and loading from both sides							corner access and loading				
payload, Q (kg)			100				300			100		
speed, v (m/s)			0.45				0.3			0.45		
car width = door width (CW = DW)	400	500	600	700	800	800	800	500	600	700	800	800
car depth (CD)	400	500	600	700	800	1000	1000	500	600	700	800	1000
car height = door height (CH = DH)			800			1200	1200		800			1200
door width, corner loading (DW)	–	–	–	–	–	–	–	350	450	550	650	850
shaft width (SW)	720	820	920	1020	1120		1120	820	920	1020	1120	1120
shaft depth (SD)	580	680	780	880	980	1180	1180	680	780	880	980	1180
min. shaft head height (SHH)			1990			2590	2590		2145			2745
lift motor room door width	500	500	600	700	800	800	800	500	600	700	800	800
lift motor room door height				600						600		
loading point clearance			1930			2730	2730		1930			2730
loading point clearance				700			450			700		
min. sill height at lowest stopping point, B			600			800	800		600			800

⑦ **Dimensions of small goods lifts**



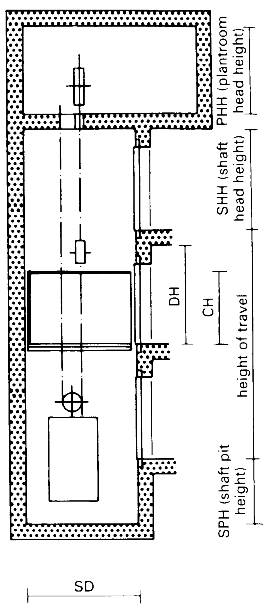
⑧ **Goods lift with loading from both sides**



⑨ **Goods lift with loading only from one side, and the lift motor room**

load carrying capacity (kg)	630	1000	1600	2000	2500	3200
nominal speed (m/s)	◄	0.40	0.63	1.00		►
lift car dimensions (mm)						
CW	1100	1300	1500	1500	1800	2000
CD	1570	1870	2470	2870	2870	3070
CH	2200	2200	2200	2200	2200	2200
door dimensions (mm)						
DW	1100	1300	1500	1500	1800	2000
DH	2200	2200	2200	2200	2200	2200
shaft dimensions (mm)						
SW	1800	2000	2200	2300	2600	2900
SD	1700	2000	2600	3000	3000	3200
SPH 0.4 and 0.63 (mm)	1200	1300	1300	1300	1300	1400
1.0 (mm)	1300	1300	1600	1600	1800	1900
SHH 0.4 and 0.63 (mm)	3700	3800	3900	4000	4100	4200
1.0 (mm)	3800	3900	4200	4200	4400	4400
PHH (mm)	1900	1900	1900	2100	1900	1900

⑩ **Structural dimensions – drive pulleys – goods lifts** → ⑧ – ⑨



⑪ **Cross-section** → ⑧ – ⑨

Small goods lifts: payload ≥300 kg; car floor area ≤0.8 m^2; for transporting small goods, documents, food etc.; not for use by passengers. The shaft framework is normally made of steel sections set in the shaft pit or on the floor, and clad on all sides by non-flammable building materials. → ① – ⑥ Dimensions and load-carrying capacity → ⑦.

The following formula is used to estimate the time, in seconds, of one transport cycle:

$$Z = \frac{2\,h}{v} + B_z + H\,(t_1 + t_2)$$

where

2 = constant factor for the round trip

h = height of the lift (m)

v = operating speed (m/s)

B_z = loading and unloading time (s)

H = number of stops

t_1 = time for acceleration and deceleration (s)

t_2 = time for opening and closing lift shaft doors (s)

With single doors t_2 = 6 s; with double doors, 10 s; with vertical sliding doors for small goods lifts, about 3 s.

The maximum transportation capacity in kg/min can be found from the time for one transport cycle, Z, and the maximum load the lift can carry:

$$\frac{\text{max. load (kg)} \times 60}{Z\ \text{(s)}}$$

Under building regulations, the lift motor room must be lockable, have sufficient illumination and be of a size such that maintenance can be carried out safely. The height of the area for the lift motor must be ≥1.8 m.

For food lifts in hospitals, the lift shafts must have washable smooth internal walls.

An external push-button control must be provided for calling and despatching the lift to/from each stopping point.

Larger goods lifts may be designed to convey goods and carry passengers employed by the operator of the installation.

Accuracy of stopping: for goods lifts without deceleration = ±20–40 mm; for passenger and goods lifts with deceleration = ±10–30 mm

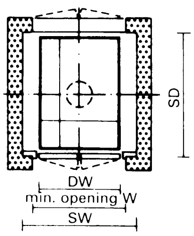
Speeds: 0.25, 0.4, 0.63 and 1.0 m/s.

HYDRAULIC LIFTS

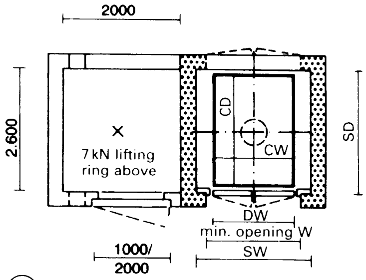
These meet the demand for transporting heavy loads economically up and down shorter lift heights and are best used for up to 12 m lift height. The lift motor room can be located remotely from the shaft itself.

Standard direct-acting piston lifts can be used to lift payloads of as much as 20 t up to a maximum height of 17 m → ① - ③, while standard indirect acting piston lifts can lift 7 t up to 34 m. The operating speed of hydraulic lifts is 0.2–0.8 m/s. A roof mounted lift motor room is not required. Several variations in hydraulics can be found → ⑥ - ⑨. The most commonly used is the centrally mounted ram → ① - ③.

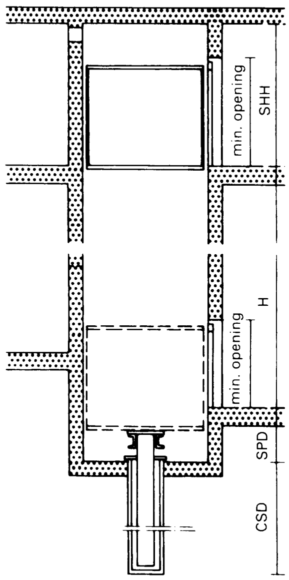
The ram retraction control tolerance, regardless of load, has to be kept within ±3 mm, so that a completely level entry into the lift car is obtained. Height clearance of the lift doors should be 50–100 mm. greater than other doors. Double swing doors or hinged sliding doors can be fitted – either hand-operated or fully automatic, with a central or side opening.



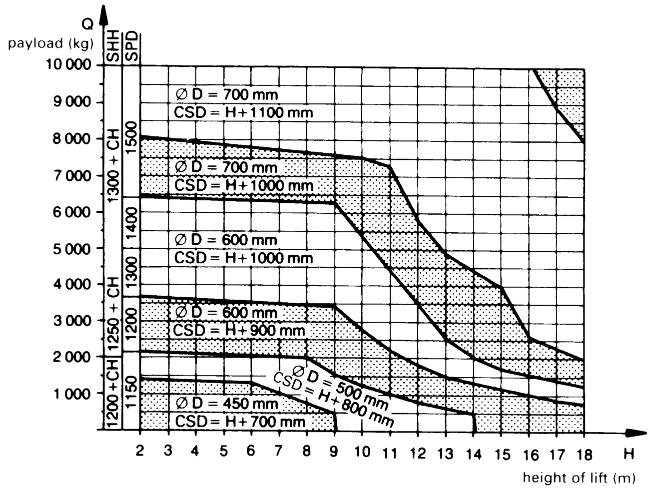
① Plan view of shaft



② Plan view of shaft with lift motor room



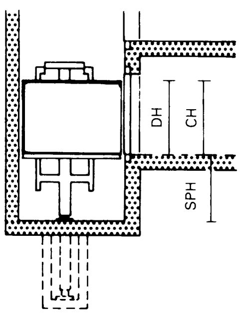
③ Vertical section of shaft



④ Graph to determine shaft head height SHH; shaft pit depth SPD; cylinder shaft depth CSD; cylinder shaft diameter D

payload		Q ≠ 5000 kg	Q ≠ 10 000 kg
shaft width	SW	CW + 500	CW + 550
shaft depth	SD	CD + 150 with one door CD + 100 with opposite doors	
approx. measurements for lift motor room (lift motor room should be within 5 m of the shaft but may be further away if absolutely necessary)	width	2000	2200
	depth	2600	2800
	height	2200	2700

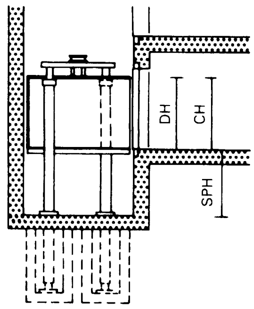
⑤ Technical data → ① - ③



⑥ Rucksack arrangement 1:1

capacity	(kg)	630	1000	1600
speed	(m/s)	0.30	0.18	0.23
		0.47	0.28	0.39
max. lift height	(m)	6.0	7.0	7.0
car dimensions (mm)	W	1100	1300	1500
	D	1500	1700	2200
	H	2200	2200	2200
door dimensions (mm)	W	1100	1300	1500
	H	2200	2200	2200
shaft dimensions (mm)	W	1650	1900	2150
	D	1600	1800	2300
	SPH min.	1200	1400	1600
	SHH min.	3200	3200	3200

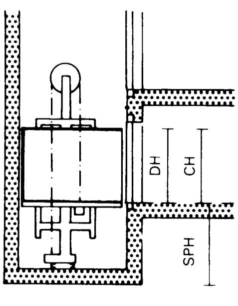
dimensions → ⑥



⑦ Tandem arrangement 1:1

capacity	(kg)	1600	2000	2500	3200
speed	(m/s)	0.15	0.18	0.24	0.20
		0.24	0.30	0.38	0.30
max. lift height	(m)	6.0	7.0	7.0	7.0
car dimensions (mm)	W	1500	1500	1800	2000
	D	2200	2200	2700	3500
	H	2200	2200	2200	2200
door dimensions (mm)	W	1500	1500	1800	2000
	H	2200	2200	2200	2200
shaft dimensions (mm)	W	2200	2200	2600	2800
	D	2300	2800	2800	3600
	SPH min.	1300	1300	1300	1300
	SHH min.	3450	3450	3450	3450

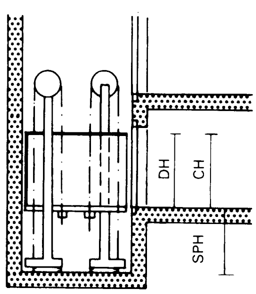
dimensions → ⑦



⑧ Rucksack arrangement 2:1

capacity	(kg)	630	1000	1600
speed	(m/s)	0.28	0.30	0.24
		0.46	0.50	0.42
		0.78	0.80	0.62
max. lift height	(m)	13.0	16.0	18.0
car dimensions (mm)	W	1100	1300	1500
	D	1500	1900	2200
	H	2200	2200	2200
door dimensions (mm)	W	1100	1300	1500
	H	2200	2200	2200
shaft dimensions (mm)	W	1650	1900	2150
	D	1600	2000	2300
	SPH min.	1200	1400	1600
	SHH min.	3200	3200	3200

dimensions → ⑧

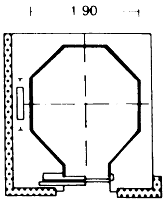


⑨ Tandem 2:1

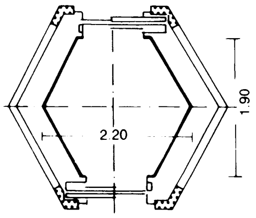
capacity	(kg)	1600	2000	2500	3200
speed	(m/s)	0.23	0.19	0.25	0.21
		0.39	0.32	0.39	0.31
		0.61	0.50	0.64	0.51
max. lift height	(m)	13.0	14.0	16.0	18.0
car dimensions (mm)	W	1500	1500	1800	2000
	D	2200	2200	2700	3500
	H	2200	2200	2200	2200
door dimensions (mm)	W	1500	1500	1800	2000
	H	2200	2200	2200	2200
shaft dimensions (mm)	W	2300	2300	2600	2900
	D	2300	2800	2800	3600
	SPH min.	1300	1300	1300	1300
	SHH min.	3400	3550	3650	3650

dimensions → ⑨

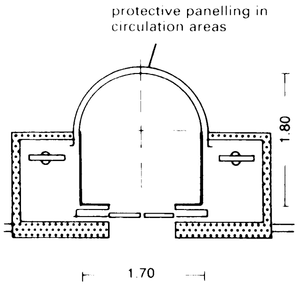
PANORAMIC GLASS LIFTS



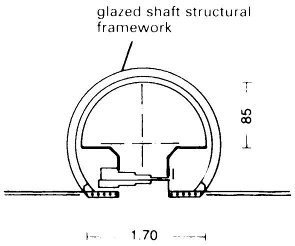
(1) **Octagonal car shape**



(1) **Hexagonal shape**



(3) **Semi-circular shape**



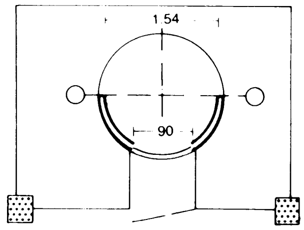
(4) **Circular shape**

Panoramic lifts are available in a variety of cabin shapes → (1) – (6) and a carrying capacity of 400–1500 kg (5–20 passengers). There are several possible drive systems and nominal speeds, depending on the height of the building and requirements for comfort: 0.4, 0.63, 1.0 m/s with a three-phase a.c. drive; and 0.25–1.0 m/s with a hydraulic drive. Construction materials used are glass and steel – polished, brushed or with high gloss finish – brass and bronze.

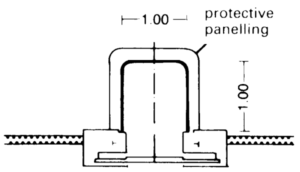
The panoramic lift enjoys great popularity. This applies both to external lifts on the façades of imposing business premises from which passengers can enjoy the view, and internal lifts in department stores or in foyers of large hotels where they look out on to the sales floors and displays. → (10) – (11)

Stairlifts

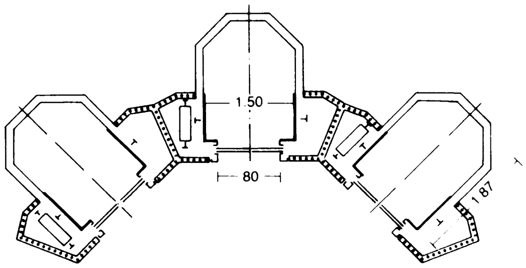
Stairlifts allow people with impaired mobility to move between floors with ease. They can be used on straight or curved stairways, and traverse landings. Aesthetics and maintenance of the rail mechanism must be given careful consideration during design and installation. In the UK, BS 5776: 1996 Powered stairlifts defines the requirements for such lift installations in domestic properties as well as in other buildings.



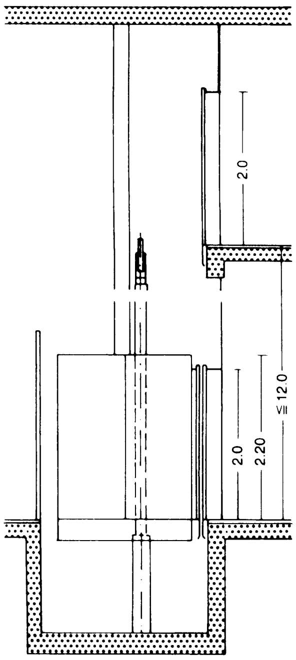
(5) **Circular car**



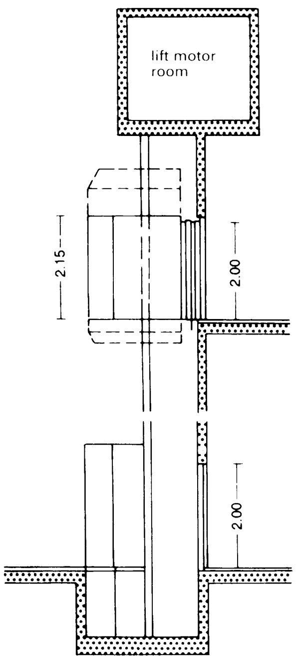
(6) **U-shape**



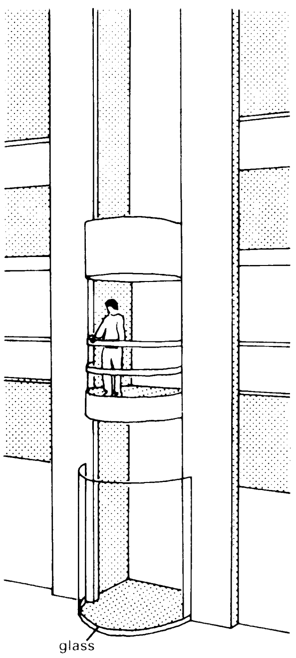
(9) **Group of panoramic glass lifts**



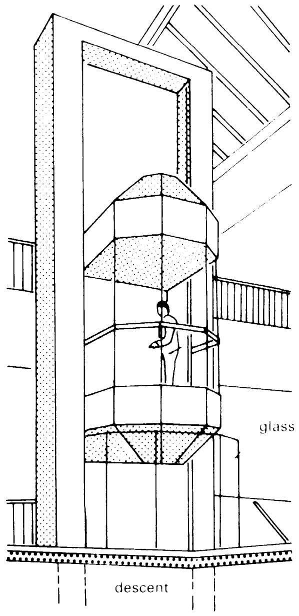
(7) **Cross-section of hydraulic lift** → (3)



(8) **Cross-section of cable lift**



(10) **Lift on the inside of a building** → (3)



(11) **Panoramic lift** → (9)