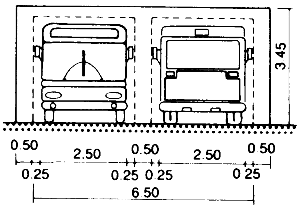
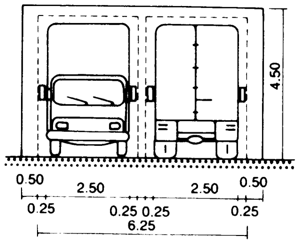
ROAD DIMENSIONS

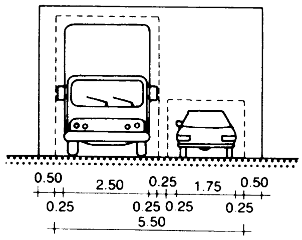
SPACE REQUIREMENT AT FULL SPEED (≥ 50km/h)



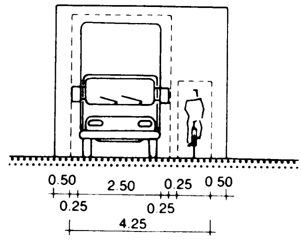
① **Bus/bus**



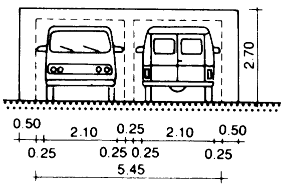
② **Lorry/lorry**



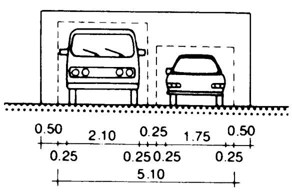
③ **Lorry/car**



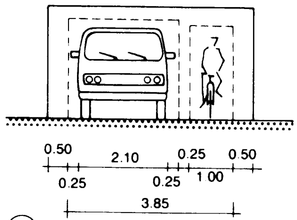
④ **Lorry/bicycle**



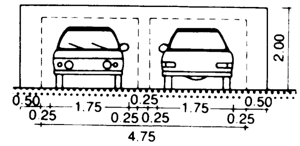
⑤ **Van/van**



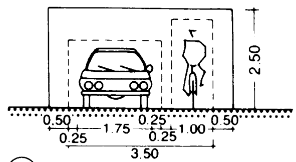
⑥ **Van/car**



⑦ **Van/bicycle**

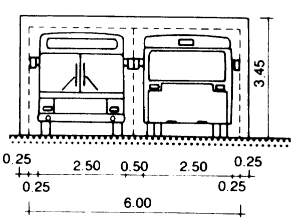


⑧ **Car/car**

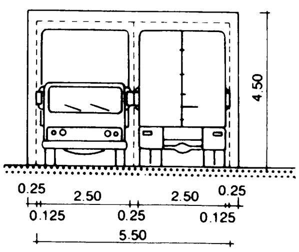


⑨ **Car/bicycle**

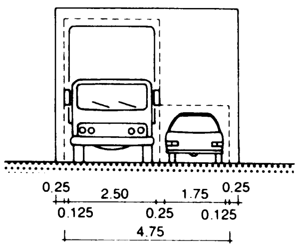
SPACE REQUIREMENT AT LOWER SPEED (≤ 40km/h)



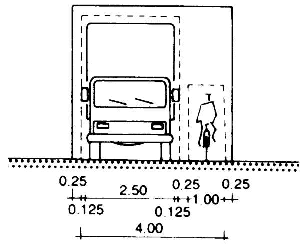
⑩ **Bus/bus**



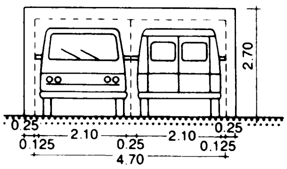
⑪ **Lorry/lorry**



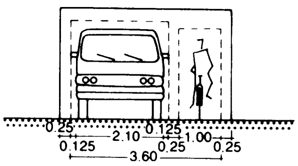
⑫ **Lorry/car**



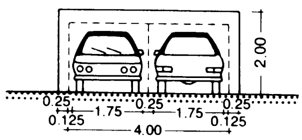
⑬ **Lorry/bicycle**



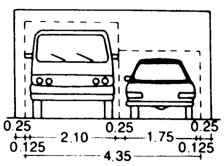
⑭ **Van/van**



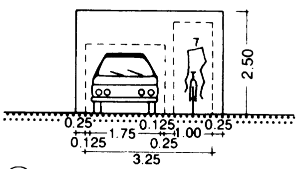
⑮ **Van/bicycle**



⑯ **Car/car**



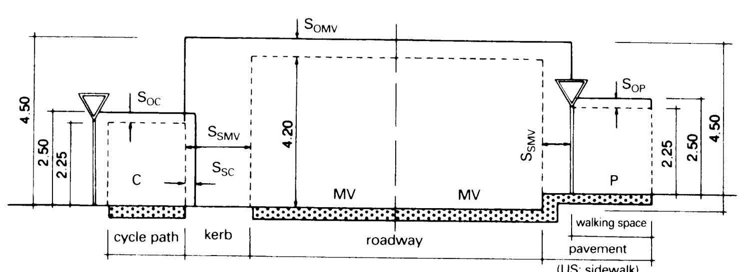
⑰ **Van/car**



⑱ **Car/bicycle**

——— clearance limit
- - - - - limit of space for traffic

Basic dimensions for traffic space and a selection of cases showing the clearance necessary for traffic passing in opposite directions both at full and lower speeds



S_S = safe side clearance
S_O = safe head room
P = pedestrians
= clearance limit
= limit of space for traffic
C = cyclist
MV = motor vehicle

⑲ **Clearance dimensions for motor vehicle traffic**

The road space necessary for the free movement of vehicles comprises vehicle size, → pp. 432–3, side and head clearances, an extra allowance for oncoming traffic, and space for verges, drainage gutters and hard shoulders. Based on a vehicle height of 4.20 m → ⑲, the safe clearance height is 4.50 m although it is better to allow 4.75 m to cater for repairs to the carriageway surface. The safe side clearance → ⑲ is dependent on the maximum speed limit for that area: ≥1.25 m for roads with ≥70 km/h limit; ≥0.75 m with a limit of ≤50 km/h.

The basic space required for cyclists is 1 m wide by 2.25 m high; for pedestrians it is 0.75 m by 2.25 m. For sufficient head clearance for foot- and cycle paths, 2.50 m should be allowed. The safe side clearance for cyclists is 0.25 m.

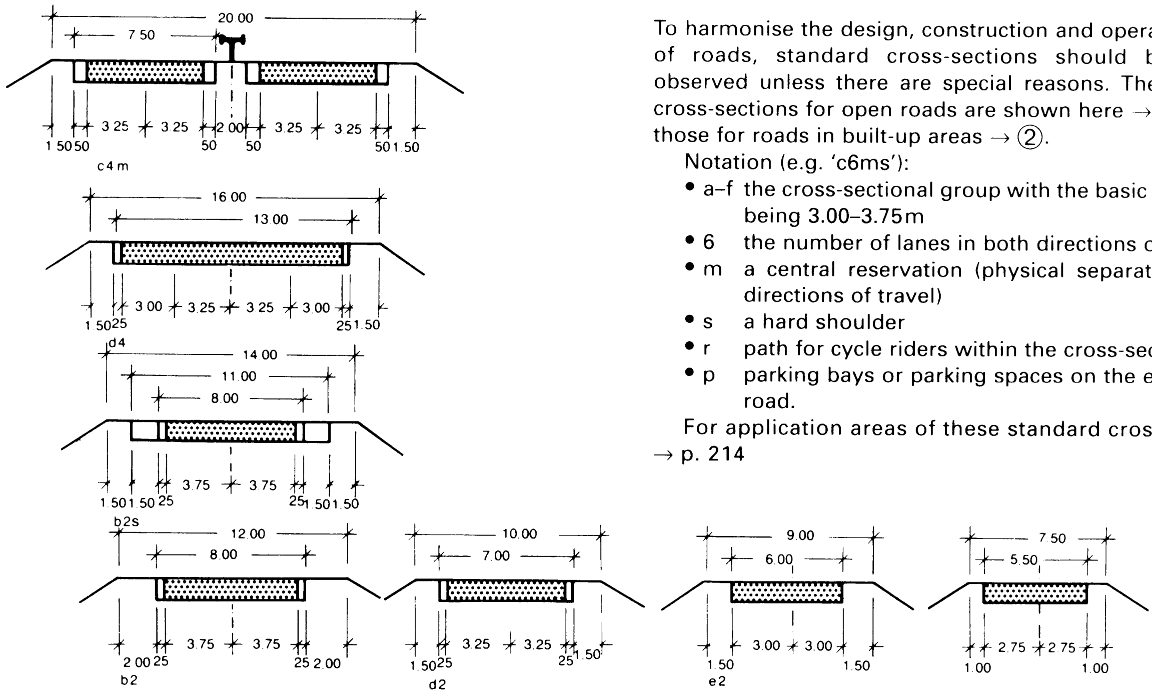
ROAD DESIGN

To harmonise the design, construction and operational use of roads, standard cross-sections should be strictly observed unless there are special reasons. The standard cross-sections for open roads are shown here → (1) as are those for roads in built-up areas → (2).

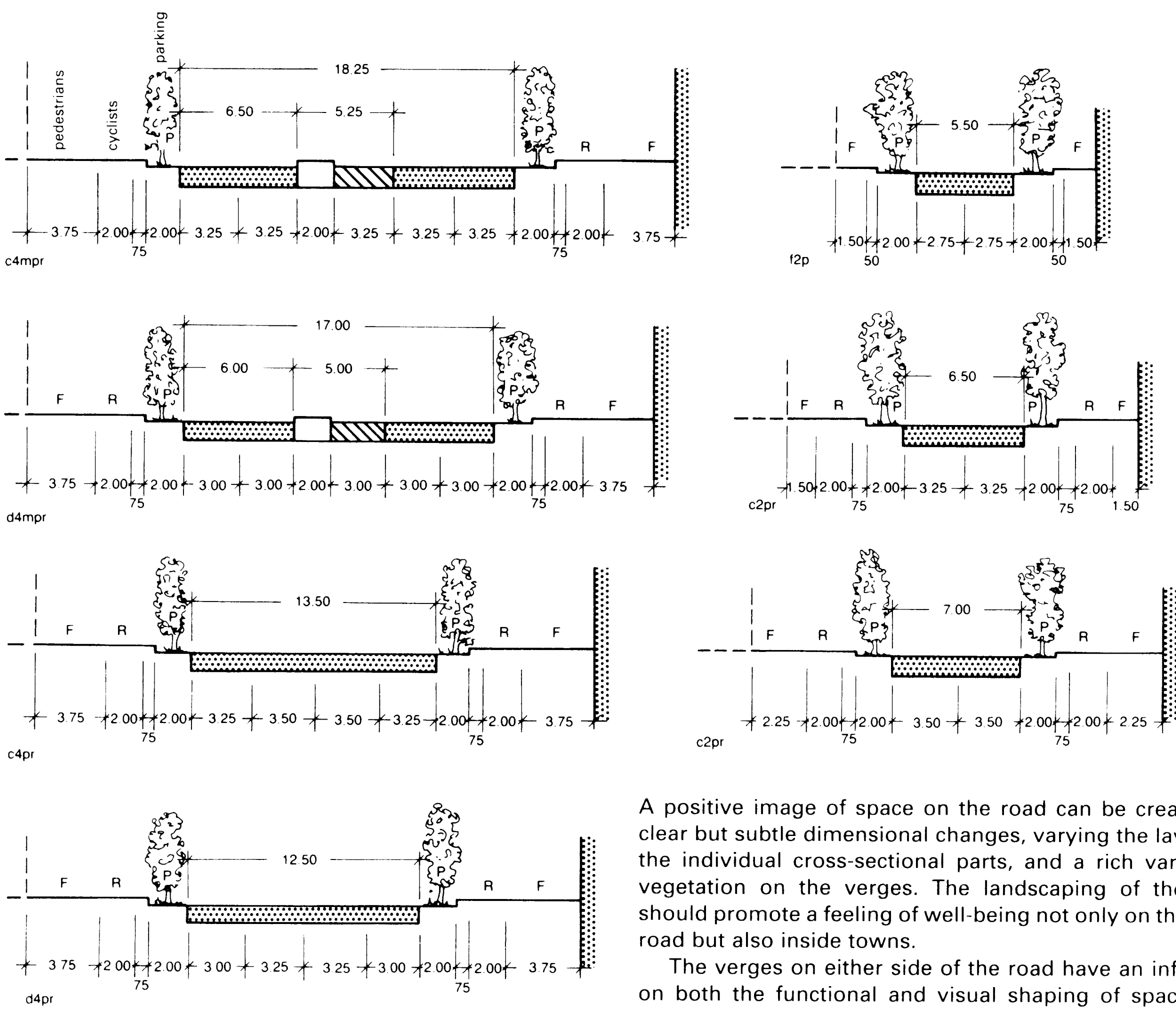
Notation (e.g. 'c6ms'):

- a–f the cross-sectional group with the basic lane width being 3.00–3.75m
- 6 the number of lanes in both directions of travel
- m a central reservation (physical separation of the directions of travel)
- s a hard shoulder
- r path for cycle riders within the cross-section
- p parking bays or parking spaces on the edge of the road.

For application areas of these standard cross-sections → p. 214



(1) **Standard cross-sections for open roads**



(2) **Standard cross-sections for roads in built-up areas**

A positive image of space on the road can be created by clear but subtle dimensional changes, varying the layout of the individual cross-sectional parts, and a rich variety of vegetation on the verges. The landscaping of the road should promote a feeling of well-being not only on the open road but also inside towns.

The verges on either side of the road have an influence on both the functional and visual shaping of space. The following items have to be co-ordinated: foot- and cycle paths alongside the roadway, areas for stationary vehicles, areas for public transport, residential areas and areas for manufacturing plants and commerce.

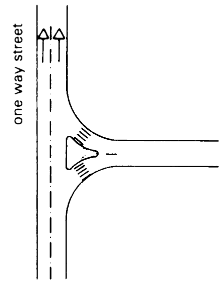
Field of application			Type of road				
Road category	Traffic loading (vehicles/hr and speed)	Special criteria of application	Standard cross-section	Type of traffic	Speed limit V_{perm} (km/h)	Junctions	Design speed V_e (km/h)
1	2	3	4	5	6	7	8
A I	≤ 3800 with V = 90 km/h ≤ 2800 with V = 110 km/h		a 6 ms	motor v	–	different level	120 100
	≤ 2400 with V = 90 km/h ≤ 1800 with V = 110 km/h		a 4 ms	motor v	–	different level	120 100
	≤ 2200 with V = 90 km/h ≤ 1800 with V = 100 km/h	With light lorry traffic or restricted conds.	b 4ms	motor v	–	different level	120 100
	≤ 1700 with V = 70 km/h ≤ 900 with V = 90 km/h		b 2 s	motor v	≤ 100 (120)	(diff. level) same level	100 90
	≤ 1300 with V = 70 km/h ≤ 900 with V = 80 km/h	With light lorry traffic	b 2	motor v	≤ 100	(diff. level) same level	100 90
A II	≤ 4100 with V = 70 km/h ≤ 3400 with V = 110 km/h		b 6ms	motor v	–	same level	100 90
	≤ 2600 with V = 70 km/h ≤ 2200 with V = 90 km/h		b 4ms	motor v	–	different level	100 90
	≤ 2300 with V = 70 km/h ≤ 2100 with V = 80 km/h	With light lorry traffic or restricted conditions.	c 4m	motor v	≤ 100(80)	(diff. level) same level	100 90 (80)
	≤ 1700 with V = 70 km/h ≤ 1400 with V = 80 km/h		b 2s	motor v	≤ 100	same level	100 90 80
	≤ 1600 with V = 60 km/h ≤ 900 with V = 80 km/h	With light lorry traffic	b 2	motor v	≤ 100	same level	100 90 80
	≤ 1700 with V = 60 km/h ≤ 900 with V = 80 km/h	With agricultural traffic > 10 veh/h	b 2s	general	≤ 100	same level	100 90 80
	≤ 1300 with V = 60 km/h ≤ 900 with V = 70 km/h		b 2	general	≤ 100	same level	100 90 80
	≤ 1000 with V = 60 km/h ≤ 700 with V = 70 km/h	With light lorry traffic	d 2	general	≤ 100	same level	100 90 80
A III	≤ 2600 with V = 60 km/h ≤ 2100 with V = 80 km/h		c 4m	motor v	≤ 80(100)	(diff. level) same level	(100) (90) 80
	≤ 2300 with V = 60 km/h ≤ 1800 with V = 80 km/h	With light lorry traffic or restricted conds.	d 4	motor v	≤ 80	same level	80 70
	≤ 1700 with V = 60 km/h ≤ 900 with V = 70 km/h	With agricultural traffic > 20 veh/h	b 2s	general	≤ 100	same level	80 70
	≤ 1600 with V = 50 km/h ≤ 900 with V = 70 km/h	With heavy lorry traffic	b 2	general	≤ 100	same level	80 70
	≤ 1300 with V = 50 km/h ≤ 700 with V = 70 km/h	With light lorry traffic	d 2	general	≤ 100	same level	80 70 60
	≤ 800 with V = 50 km/h ≤ 700 with V = 60 km/h		e 2	general	≤ 100	same level	80 70 60
A IV	≤ 1400 with V = 40 km/h ≤ 1000 with V = 60 km/h	With heavy lorry traffic	d 2	general	≤ 100	same level	80 70 60
	≤ 900 with V = 40 km/h ≤ 700 with V = 50 km/h		e 2	general	≤ 100	same level	80 70 60
	≤ 300	Measurement not tech. practical	f 2	general	≤ 100	same level	70 60
B II	≤ 2800 with V = 60 km/h ≤ 2400 with V = 80 km/h	With heavy lorry traffic	b 4ms	motor v	≤ 80	different level	80 70
	≤ 2600 with V = 60 km/h ≤ 2100 with V = 80 km/h		c 4m	motor v	≤ 80	diff. level (same level)	80 70 (60)
	≤ 2500 with V = 50 km/h ≤ 2100 with V = 70 km/h	With light lorry traffic or restricted conds.	d 4	motor v	≤ 70	same level	70 (60)
B III	≤ 2500 with V = 50 km/h ≤ 2100 with V = 60 km/h	With heavy lorry traffic	c 4m	general	≤ 70	same level	70 60
	≤ 2200 with V = 50 km/h ≤ 1800 with V = 60 km/h		d 4	general	≤ 70	same level	70 60 (50)
	≤ 1400 with V = 40 km/h ≤ 1000 with V = 50 km/h		d 2	general	≤70	same level	70 60 (50)
	≤ 900 with V = 40 km/h ≤ 700 with V = 50 km/h	With light lorry and limited bus traffic	e 2	general	≤ 60	same level	60 (50)
B IV	≤ 1400 with V = 40 km/h ≤ 1000 with V = 50 km/h		d 2	general	≤ 60	same level	60 50
	≤ 900 with V = 40 km/h ≤ 700 with V = 50 km/h	With light lorry and limited bus traffic	e 2	general	≤ 60	same level	60 50
C III	≤ 2100		c 4mpr	general	≤ 50	same level	(70) (60) 50
	≤ 2000	With light lorry traffic	d 4mpr	general	≤ 50	same level	(70) (60) 50
	≤ 1900	Special case of the c4mpr with restricted conditions	c 4pr	general	≤ 50	same level	(70) (60) 50
	≤ 1800	Special case of the d4mpr with restricted conds.	d 4pr	general	≤ 50	same level	(70) (60) 50
	≤ 1700		c 2pr	general	≤ 50	same level	(60) 50 (40)
	≤ 1500	With light lorry traffic	d 2pr	general	≤ 50	same level	(60) 50 (40)
C IV	≤ 1000	With light lorry traffic	c 2pr	general	≤ 50	same level	(60) 50 (40)
	≤ 1000		d 2pr	general	≤ 50	same level	(60) 50 (40)
	≤ 600	limited bus traffic	f 2p	general	≤ 50	same level	50 (40)

(1) **Fields of application and standard cross-sections** ▸ p. 213

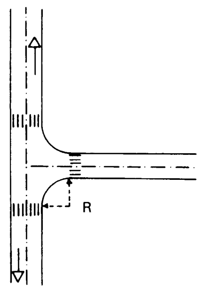
INTERSECTIONS

Junctions are where one road flows into another (directly) → ①-②; crossroads are where two roads cross each other at their point of intersection → ⑤-⑧. Junctions on single carriageways are usually in the same plane (and can be with or without traffic lights).

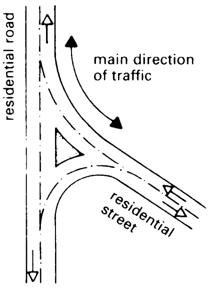
Roundabouts → ⑭-⑮ are a form of intersection popular in some countries (e.g. UK). They offer several advantages: reduced risk of serious accidents; traffic lights are rarely necessary; there is less noise generated and energy is conserved. The diameter of the roundabout depends on the available space and the acceptable length of the tailbacks caused by high volumes of oncoming traffic. An offset crossroads makes more room available; road intersections are visible at a glance and the road ends can be spacious. They are suitable for slow flowing traffic, as is found in residential districts → ⑯.



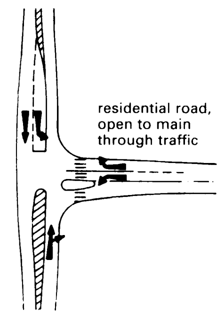
① **'T' junctions – roads on same level**



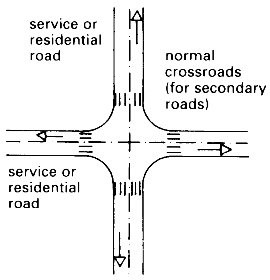
② **as** → ①



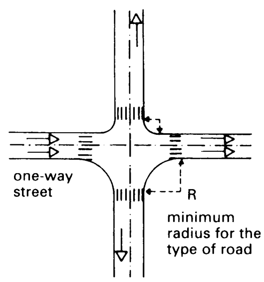
③ **'T' Junction main road in a built-up area**



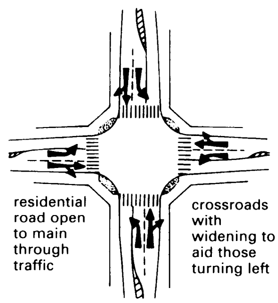
④ **With widening of the section and islands to aid those turning left**



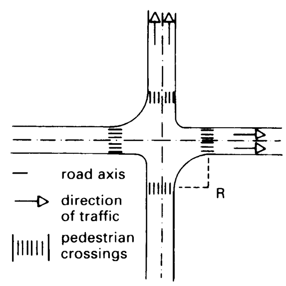
⑤ **Crossroads – on same level**



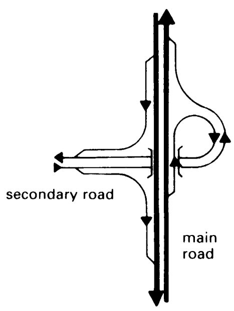
⑥ **as** → ⑤



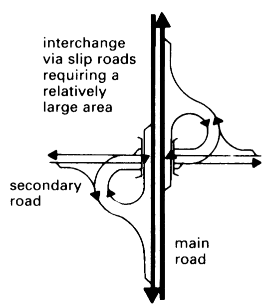
⑦ **as** → ⑤



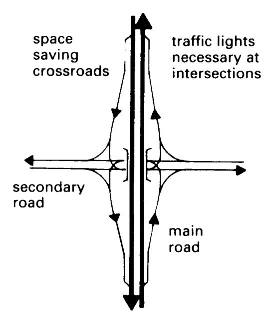
⑧ **as** → ⑤



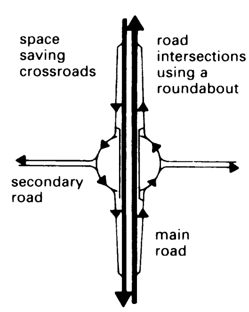
⑨ **Junctions/crossroads – at different levels**



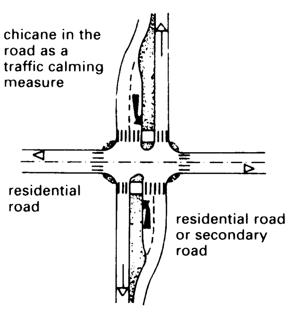
⑩ **as** → ⑨



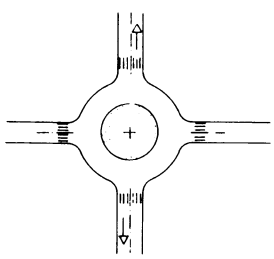
⑪ **as** → ⑨



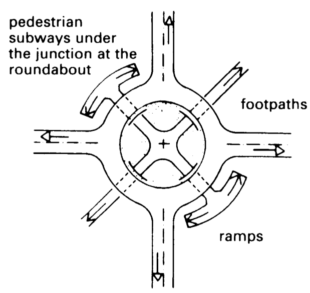
⑫ **as** → ⑨



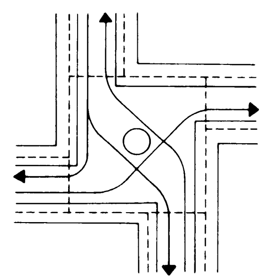
⑬ **Reduction in the width of the carriageway**



⑭ **Roundabout**



⑮ **Roundabout with pedestrian subways**



⑯ **Offset crossroads only for slow traffic**

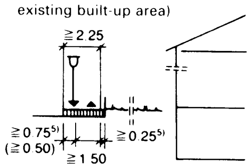
ROADSIDE PATHS

Footpaths ≥2m wide (1.50m minimum clear width plus a 0.50m strip between the path and the road); ≥3m in the vicinity of schools, shopping centres, leisure facilities etc.

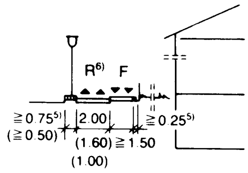
Cycle paths ≥1.00m wide for each lane, with 0.75m safety strips separating them from the road.

Combined use If the path is for both pedestrian and cycle riders' use, the width should be ≥2.50m.

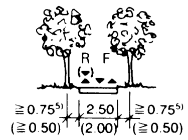
cross-sections[1] (values in brackets are minimum dimensions in existing built-up area)



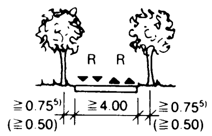
(1) **Footpath running alongside the road**



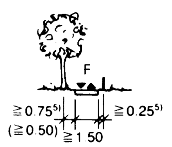
(2) **Cycle path running alongside the road**



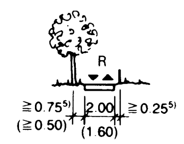
(3) **Common footpath and cycle path**



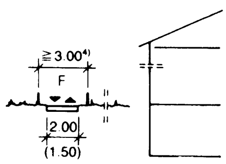
(4) **Cycle riding track**



(5) **Separate footpath**



(6) **Separate cycle riders' path**



(7) **Path serving housing; not suitable for vehicles**

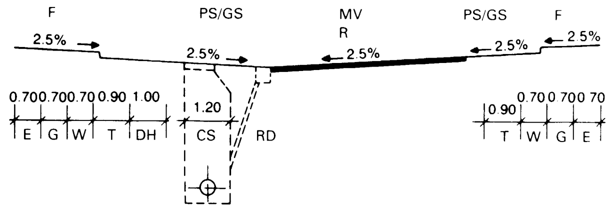
	values for design details				
	R_1 min [m]	S[2] max %	R_B min [m]	R_S min [m]	clear height min [m]
(1)		6 (12)[8]			2.50
(2)	10 (2)[7]	depending on type of street	30	10	2.50
(3)	10 (2)[7]	3 (4 in <250m)[8] (8 in < 30m)[8]	30	10	2.50
(4)	10 (2)[7]	3 (4 in 250m)[8] (8 in < 30m)[8]	30	10	2.50
(5)		6 (12)[8]			2.50
(6)	10 (2)[7]	3 (4 in <250m)[8] (8 in <30m)[8]	30	10	2.50
(7)		6 (12)[8]			3.50 (-2.50)

notes:

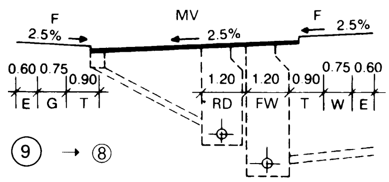
[1] Slight variances in the dimensions may be necessary due to the actual slab widths
[2] S_{min} = 0.5% (for drainage)
[3] Length of service paths unsuitable for vehicles
1 - 2 storeys ≥ 80m
3 storeys ≥ 60m
4 storeys and more ≥ 50m
[4] With partitioning drain 4 - 4.50m
[5] Other additions to the width: continuous rows of trees require a strip of at least 2.50m width for planting
[6] Traffic in both directions only allowed in exceptional cases
[7] Radiused out at junctions
[8] In exceptional cases

abbreviations → (1) - (7)
F = footpath
R = cycle riding
R_1 = radius of bends
S = longitudinal slope
R_B = rounded out radius of brow
R_S = rounded out radius of dips

(1) - (7) **Pedestrian and cycle riders' paths**

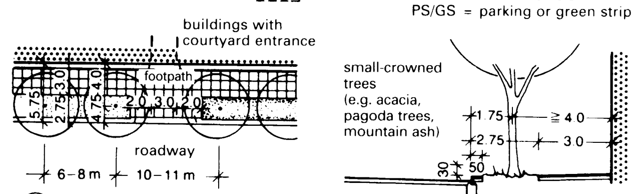


(8) **Basic widths for the supply and drainage pipework layout in the road space**

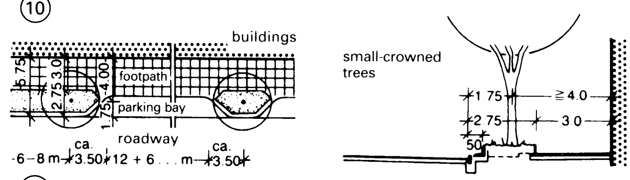


(9) → (8)

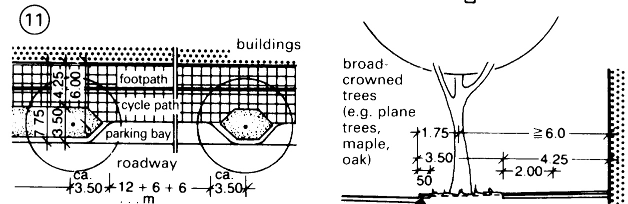
E = electricity
G = gas
W = water
DH = district heating
T = telephone cable
CS = combined sewer
FW = foul water drain
RD = rainwater drain
F = footpath
R = cycle riding
MV = motor vehicle
PS/GS = parking or green strip



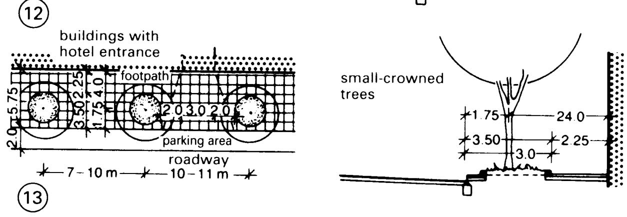
(10)



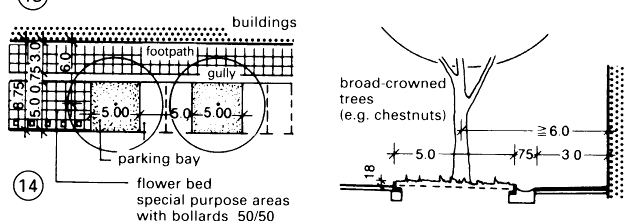
(11)



(12)

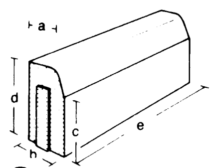


(13)

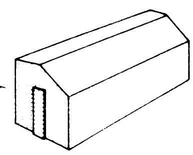


(14)

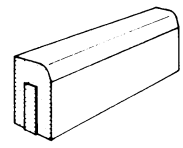
(10) - (14) **Examples of lay-out of road space in built-up areas**



(1) **High kerbstone**

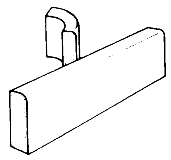


(2) **Flat kerbstone**

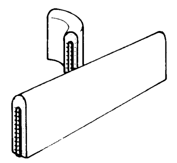


(3) **Rounded kerbstone**

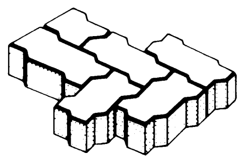
	a	b	c	d	e
high kerbstones (1)	12	15	25	13	(100 / 50)
flat kerbstones (2)	7 15	12 18	20 19	15 13	100 50
round kerbstones (3)	9	15	22	15	100 50
lawn kerbstones (4)	– –	8 8	– –	20 25	(100 / 50)
border kerbstones (5)	–	6	–	30	100



(4) **Lawn kerbstone**

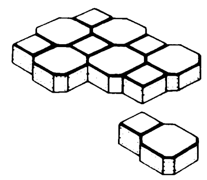


(5) **Border kerbstone**



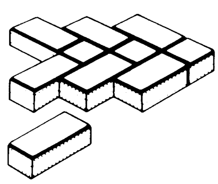
height (cm)	width (cm)	length (cm)	blocks/ m^2
6	11.25	22.5	39
8	11.25	22.5	39
10	11.25	22.5	39

(6) **Interlocking blocks**



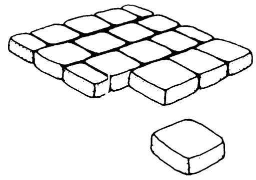
height (cm)	width (cm)	length (cm)	blocks/ m^2
6	14/9	23	38
8	14/9	23	38

(7) **Ornamental interlocking blocks**



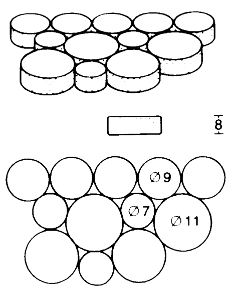
height (cm)	width (cm)	length (cm)	blocks/ m^2
6	10	10;20	48;96
8	10	10;20	48;96

(8) **System paving blocks**

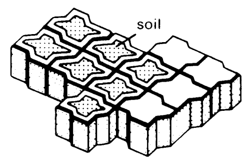


height (cm)	width (cm)	length (cm)	blocks/ m^2
8	7	21	68
8	14	14;21	51;34

(9) **Rustic paving blocks**



(10) **Round paving blocks**



height (cm)	width (cm)	length (cm)	blocks/ m^2
10	33	16.5	18
10	33	33	12
solid block has same dimensions			

(11) **Lawn blocks**

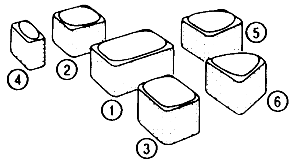
In addition to pavements, interlocking block paving can be used for pedestrianised roads, parking areas, hall floors, paving between rail tracks and on the beds and side slopes of water courses.

The dimensions of paving blocks (length/width in cm) that match standard road building widths include: 22.5/11.25; 20/10; 10/10; 12/6 etc. Kerb heights of 6, 8 and 10 cm are commonly used.

The depth and material of the substructure (e.g. gravel, crushed stone with grain sizes 0.1–35 mm), which acts as a filter or bearing layer, should be adapted to the ground conditions and the expected traffic load. If the ground is load bearing the bearing layer should be 15–25 cm deep, compacted until it is sufficiently stable. Pavement beds can be 4 cm of sand or 2–8 mm of chippings. After vibrating the overlay the pavement bed can be compressed by about 3 cm.

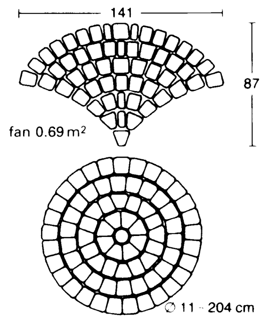
Wedge-shaped curved blocks can be used for circular paved areas or curved edges → (13). For farm track paving, parking areas, fire-service access roads, spur roads, reinforcing slopes against erosion damage or access routes in areas liable to flooding, multi-sided lawn blocks are available → (11). These are also useful in heavily landscaped areas, allowing a fast covering of stable greenery to be provided.

Composite and round palisades made of concrete → (14) – (16) are suitable for bordering planted areas to compensate for height differences and for slope revetment → (17). These are also available in pressure-impregnated wood.

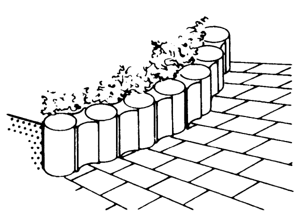


block	1½ (1)	normal (2)	¾ (3)	½ (4)	wedge -1 (5)	wedge -2 (6)
height	8	8	8	8	8	8
width	12	12	12	12	8/11	5/13
length	18	12	9	6	12	12
no./m^2	46	69	92	139	87	92

(12) **Concrete paving** → (13)

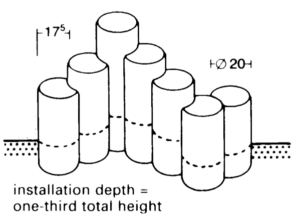


(13) **Circle** → (12)



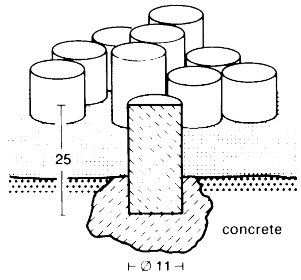
height (cm)	width (cm)	binder length (cm)	pieces/ m^2
40	9	12.5	8

(14) **Palisades/concrete**

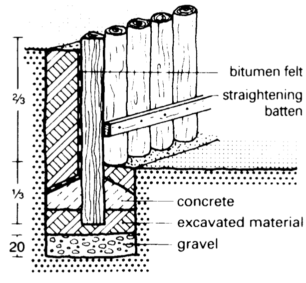


height (cm)	40; 60; 80; 100;
	120; 150; 180; 200

(15) **Composite palisades**

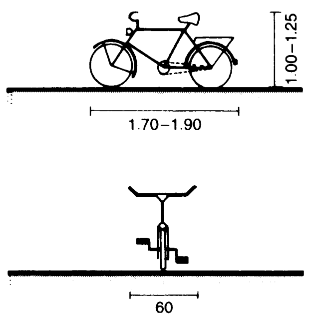


(16) **Concrete border blocks**

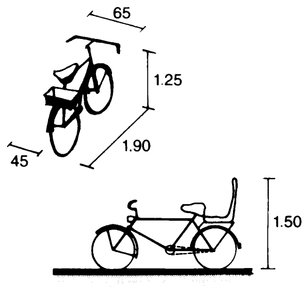


(17) **Wooden palisades**

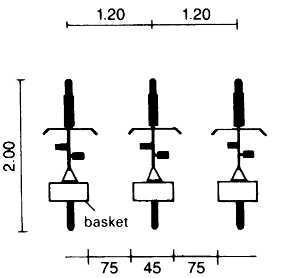
BICYCLE PARKING



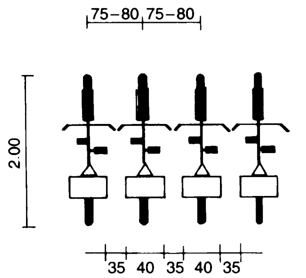
① **Basic bicycle dimensions**



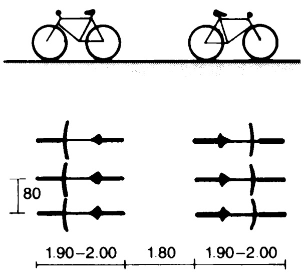
② **Bicycle with basket/child's seat**



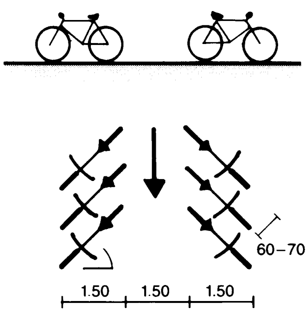
③ **Bicycle parking: ample space**



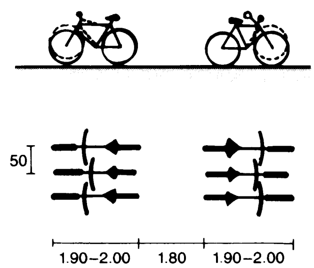
④ **Close packed**



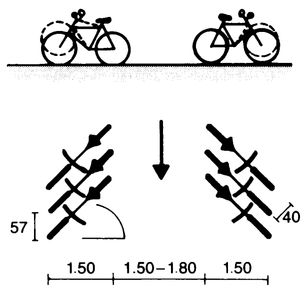
⑤ **Basic layout parallel in straight lines**



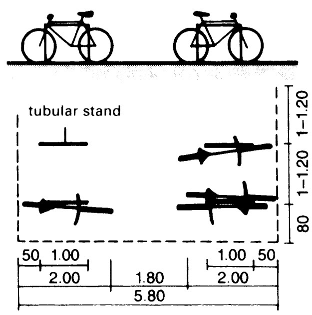
⑥ **Parallel, herringbone formation**



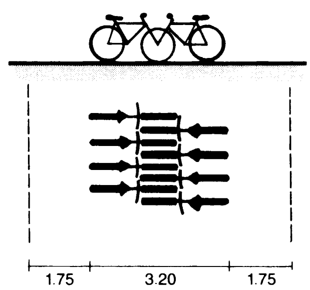
⑦ **Staggered, parallel straight formation**



⑧ **Staggered, herringbone formation**



⑨ **With tubular stands**



⑩ **Front wheel overlapping**

Dimensions of bicycles → ①–②. Note allowances for baskets and children's seats. Include space for special types: recumbent bikes up to 2.35m long; tandems up to 2.60m; bicycle trailers (with shaft) approx. 1.60m long, 1.00m wide; bikes adapted for disabled people and for delivering goods.

Offer comfortable parking → ③ wherever possible: narrow parking can cause injury, soiling and damage during locking/loading. Double rows with overlapping front wheels can save space.

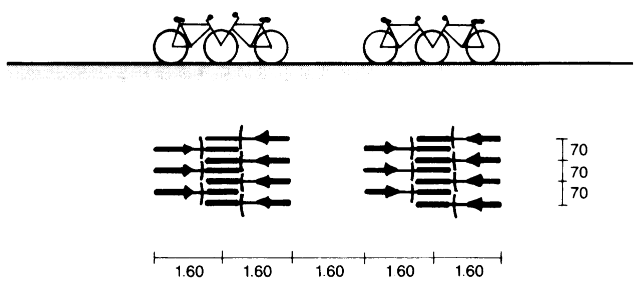
Cycle stands must give steady support, even when loading the bike. Locking should be possible using only one 'U' lock, securing the front wheel and the frame to the stand at the same time. Tubular stands are therefore suitable → ⑨. Provide an intermediate bar for children's bikes. Stands should be 1.20m apart with access lanes 1.50–1.80m wide → ⑦–⑨. Cycle stands which do not provide sensible locking opportunities only suitable for internal use in areas of restricted access.

General installation design should be clear and user-friendly: close to the destination, easy to find and approach. For long-term parking, consider roofing and lighting → p. 219. Supervision is advisable at railway stations, sports grounds, shopping centres etc.

apartments	1 per 30m² total living area
visitors to apartments	1 per 200m² total living area
student residential halls	1 per bed
secondary schools	0.7 per pupil place
colleges of further educ.	0.5 per student place
lecture theatres	0.7 per seat
libraries	1 per 40m
college canteens	0.3 per seat
places of work	0.3 per employee
shops for daily supplies	1 per 25m² sales area
shopping centres	1 per 80m² sales area
retail units for	1 per 35m² sales area
professional offices, doctors' practices	0.2 per client on premises
sports arenas, halls, indoor swimming pools	0.5 per clothes locker
regional gathering places	1 per 20 visitor places
other gathering places	1 per 7 visitor places
local restaurants	1 per 7 seats
beer gardens	1 per 2 seats

If several uses happen at the same time in a building, then the totals for the different uses should be added up.

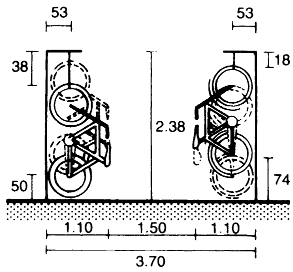
⑪ **Guide values for capacity of cycle parking**



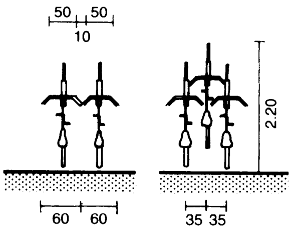
⑫ **Front wheel overlapping with central access**

BICYCLE PARKING AND CYCLE PATHS

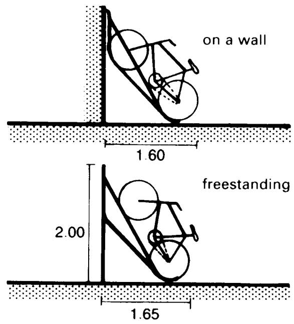
Basic space requirements for cyclists are made up of the bicycle width (0.60 m) and the height allowed for the rider → ⑤ plus the necessary room for manoeuvre under various conditions. Although the minimum width of a single-lane cycle path is 1.00 m, it is preferable to increase this to 1.40–1.60 m, particularly where riders could be travelling at higher speeds. Where traffic is two way, an ideal width of 1.60–2.00 m allows oncoming cyclists to pass each other safely as well as making it easy to overtake slower riders.



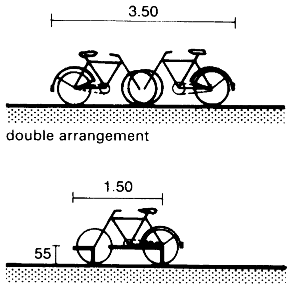
① Cycle racks



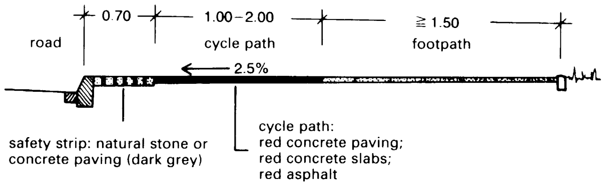
② Parallel Intermeshed

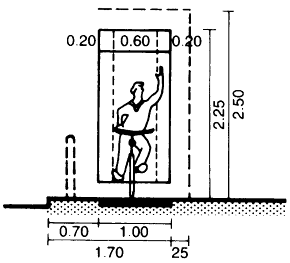


③ Tilted racks

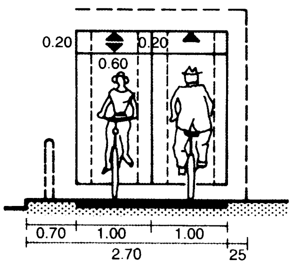


④ With frame holder

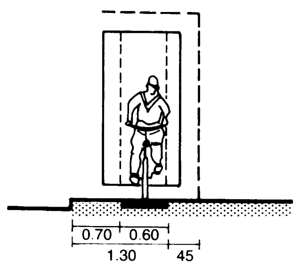




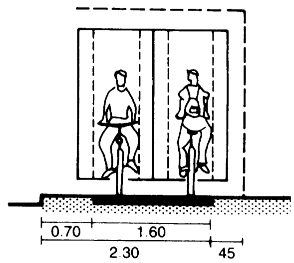
⑤ Normal cross-section for cycle path width



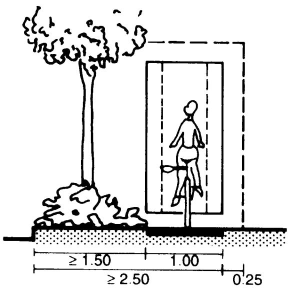
⑥ Two lane



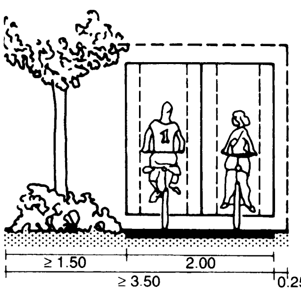
⑦ Where space is limited



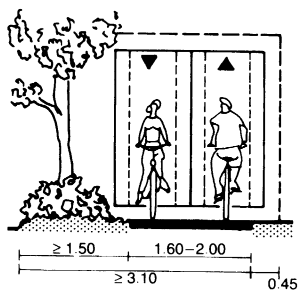
⑧ Minimum cross-section



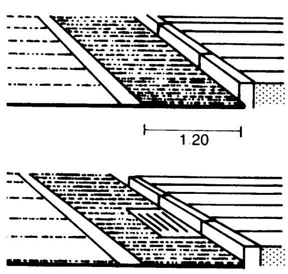
⑨ Grass strips between them and the road are a good solution



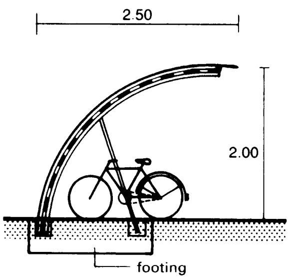
⑩ Most suitable arrangement



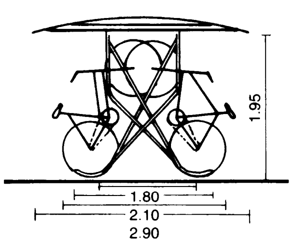
⑪ Grass strips are necessary with two-way traffic



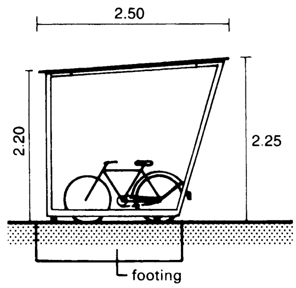
⑫ Cycle lanes avoiding drains and similar obstacles



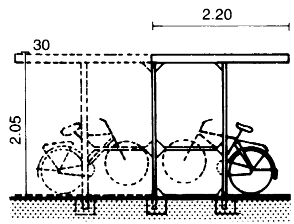
⑬ Weather protection roof – curved roof



⑭ Double racks with curved roof

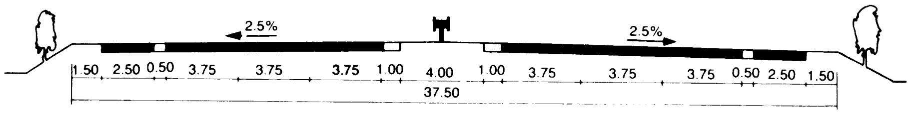


⑮ Tubular framed cycle shed

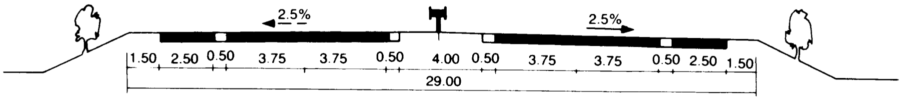


⑯ Cycle sheds

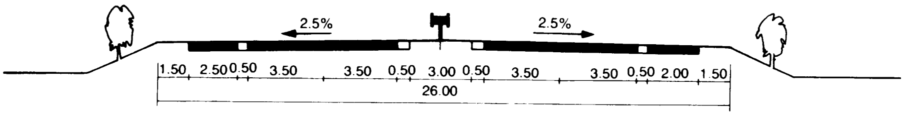
MOTORWAYS



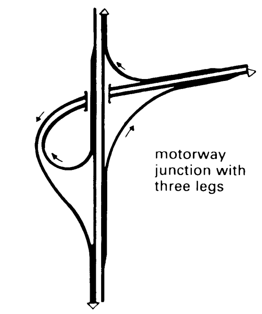
(1) **Standard cross-section for six-lane motorways 37.50 m wide**



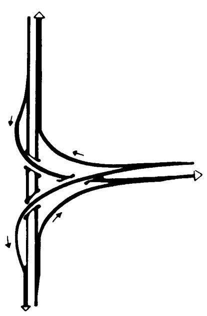
(2) **Standard cross-section for four-lane motorways 29 m wide**



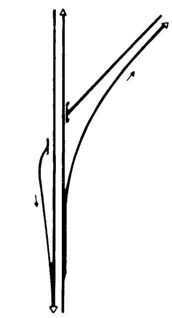
(3) **As above but 26 m wide**



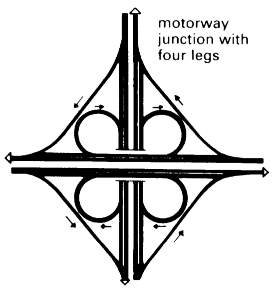
(4) **Trumpet intersection**



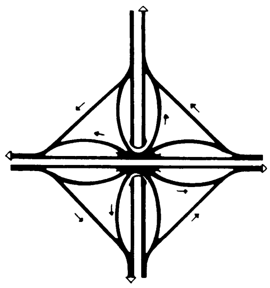
(5) **Triangle**



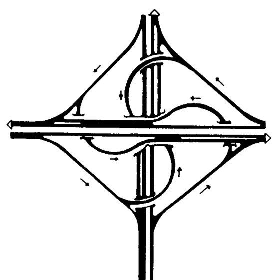
(6) **Fork**



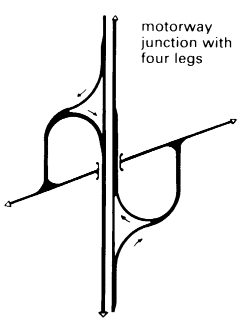
(7) **Clover leaf**



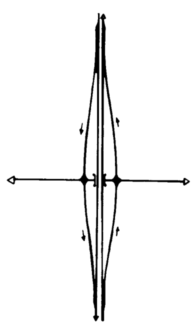
(8) **Maltese cross**



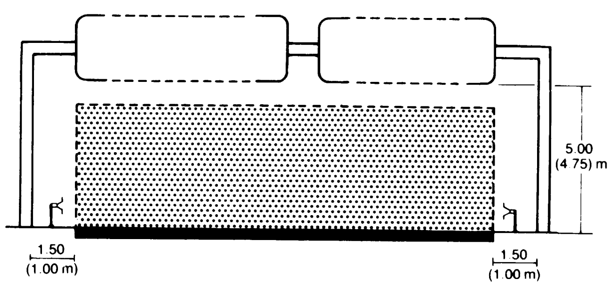
(9) **Windmill**



(10) **Half-clover leaf**



(11) **Lozenge**



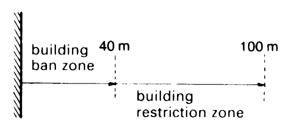
(12) **Sign gantry over carriageway**

Motorways are twin carriageway (each with two or more lanes and a hard shoulder, and separated by a central reservation) roads with no obstructions, designed for high-speed traffic → (1)–(3). They are the safest and most efficient roads. Environmental considerations have top priority in their planning and construction.

Motorway intersections are constructed using variations in levels of the carriageways → (4)–(9) with special entry and exit slip roads for junctions → (10)–(11).

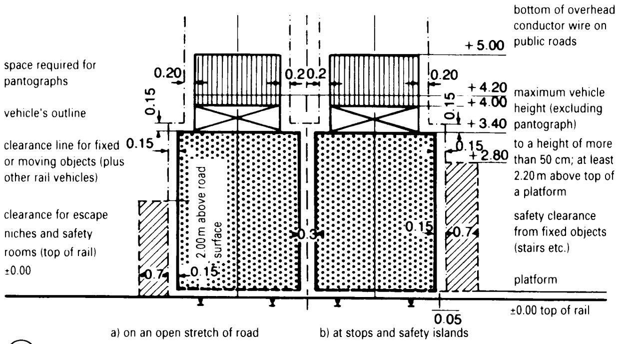
Direction signs should be positioned at least 1000 m before an exit for connecting roads and 2000 m before motorway intersections → (12).

Building restrictions (i.e. a requirement for special planning permission) apply to the construction or major alteration of structures 40–100 m from the outside edge of motorway carriageways; construction of high buildings within 40 m of motorways is banned.

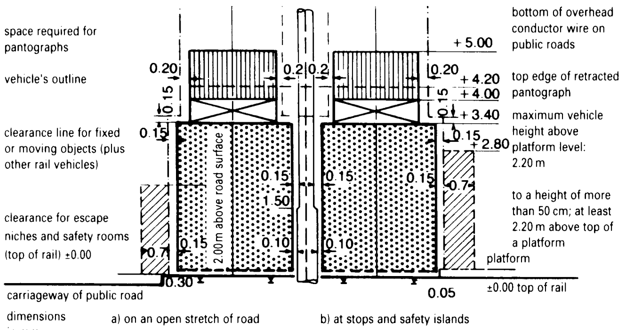


(13) **Building ban/restriction**

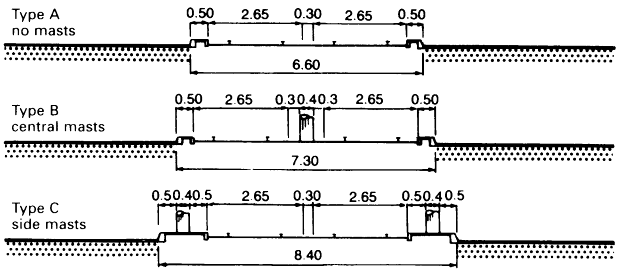
TRAMWAYS/URBAN LIGHT RAILWAYS



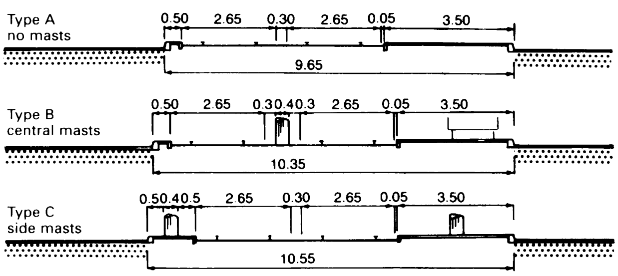
(1) **Minimum clearances for track laid in carriageway of public road**



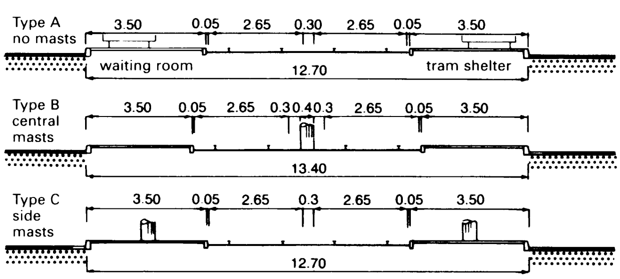
(2) **Minimum clearances for track on special segregated sections on a public road**



(3) **Standard widths for segregated sections of track in secondary roads**



(4) → (3) **Tram stops on one side**

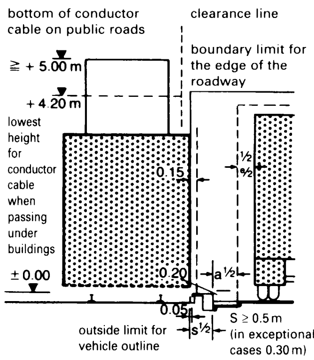


(5) **Tram stops on both sides of road** → (3)

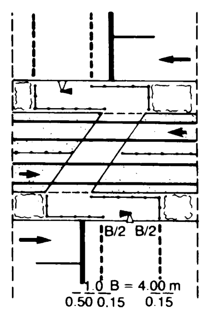
A tramway is controlled entirely by sight and shares the road with other general traffic; an urban light railway travels over stretches of track with standard train safety equipment, just like the underground (US: subway) or main line railways, as well as alongside roads on special track bed. (The underground travels only on defined, independent track beds, with no crossings, and does not mix with urban traffic.)

- **Track gauge** the standard gauge is 1.435m, or a metric gauge of 1.000m, and the clearance width is the carriage frame width (2.30–2.65m) plus extra to compensate for deflectional movement on curves and an extra allowance for the width on cambers plus sway (at least 2 × 0.15m)
- **Distance of kerbstone from carriage frame** for special track beds 0.50m; can be as little as 0.30m in exceptional cases
- **Carriage heights** the height of the carriage body should be ≤3.40 m; min. height allowance for safe passage under buildings is 4.20 m, and on roads should be 5.00 m
- **Safety clearance space** 0.85 m width from the outside limit of the vehicle outline on the door side of rail vehicles.

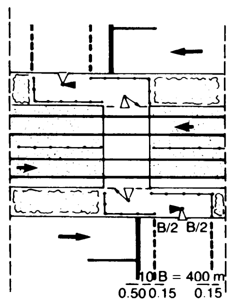
The width of street platforms should be at least 3.50 m (although 2 m can be regarded as an absolute minimum for platforms on the side of streets where space is limited). Where a waiting room is to be incorporated, the platform width should be at least 5.50 m. The platform length should exceed the train length by ≥5m to allow for inaccurate braking.



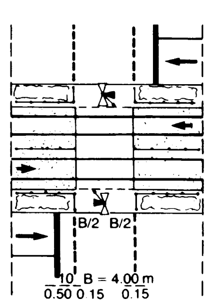
(6) **Clearance limits for the road and tramway**



(7) **Permanent pedestrian crossing without signals**



(8) **With signal control lights for crossing the track**



(9) → (8)

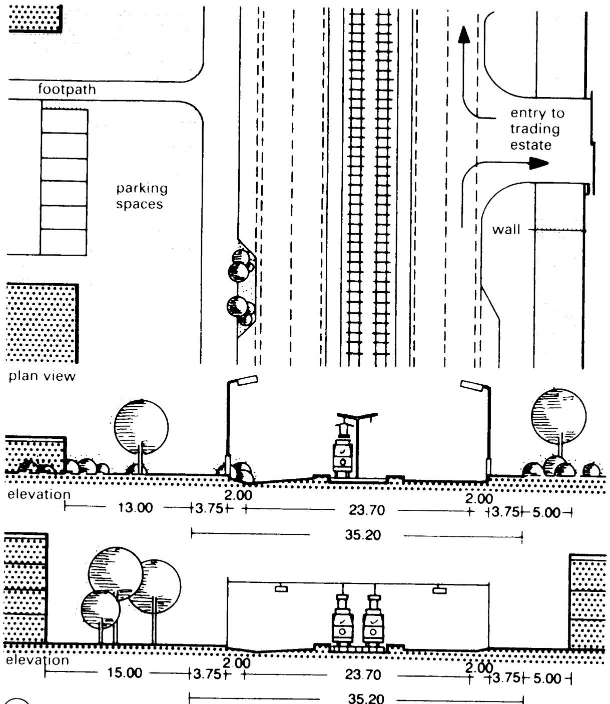
TRAFFIC LAYOUT

The layouts for traffic must take all the associated circumstances into account. We need to differentiate between the following classifications:

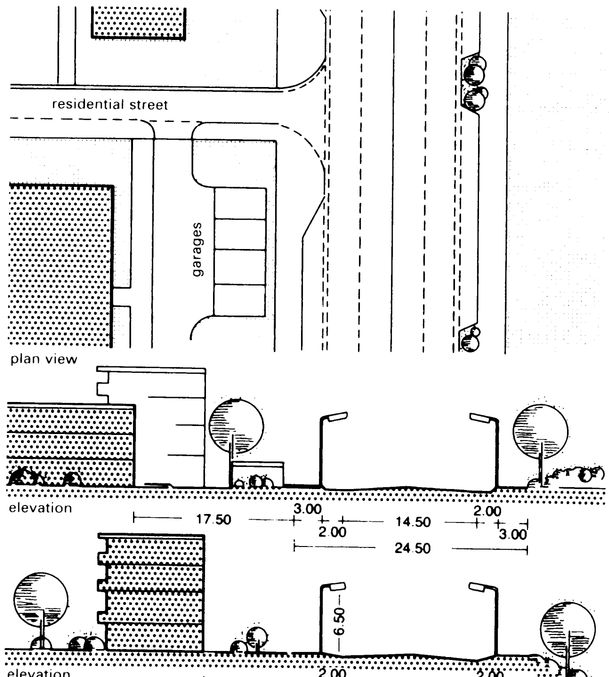
- I *Connecting traffic* – urban railways, motorways with ≤4 lanes
- II *Main roads* with or without sections of tram tracks → ①
- III *Secondary roads* with 2–4 lanes, some sections with parking at the side of the road → ②
- IV *Residential roads* having ≤2 lanes, and parking spaces in the road → ③ + ④.

Residential roads must have large parking areas → ⑤ + ⑥; alternatively, where necessary, parking spaces between blocks of flats → ⑦. Class IV roads offer wide scope for good layout design, with footpaths, squares and open areas.

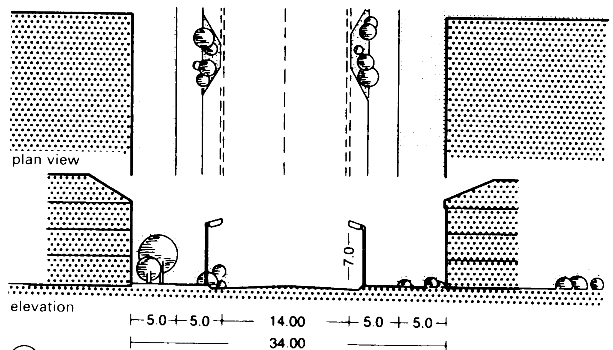
Local commuter rail traffic, where the urban railway is being extended, must be taken out of the road space and run on its own track bed → ① → p. 223 ①–⑤.



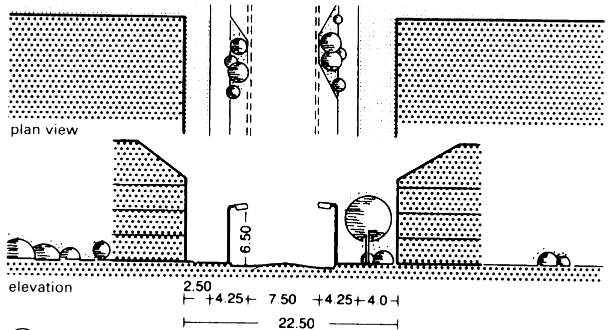
① **Class II roads with tram tracks**



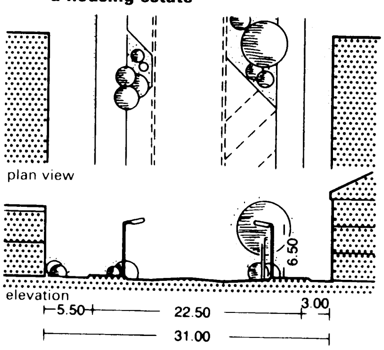
② **Traffic layout in a housing estate**



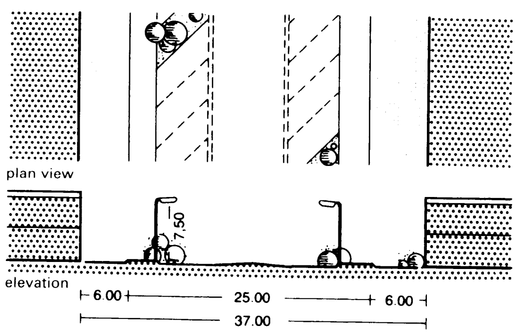
③ **Class III roads with four lanes**



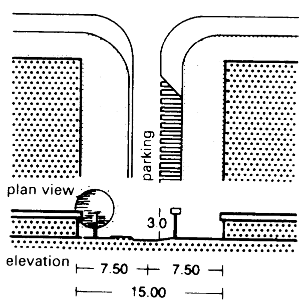
④ **Class III roads with two lanes**



⑤ **With parking on one side of the road**



⑥ **With parking on both sides of the road**



⑦ **Parking spaces between the houses**

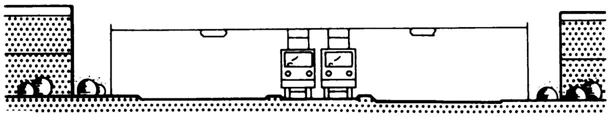
TRAFFIC LAYOUT

Urban railways with overhead conductor cables – or, even better, with conductor rails – work efficiently on their own tracks and can be separated by railings or hedges from the road traffic → ①+②. Elevated railways ③ allow traffic to move freely below and improve rail traffic circulation because trains are not affected by road signals; however they increase noise for residents. A better solution is to run railways in shallow or deep cuttings, or even underground → ④+⑤+⑪.

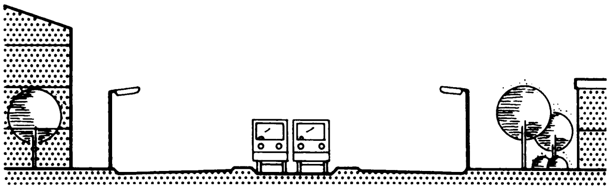
Road noise in flat terrain is reduced by uninhabited buildings (e.g. garages), which provide sound insulation, by planting trees or by using backfilled earth embankments planted with trees. Even more effective are roads partly in cuttings with planted earth slopes or sunk completely in a cutting → ⑧–⑩.

In general, it is only possible to put in noise suppressing walls with new roads, particularly when planning the layout of new areas where high-speed traffic (100–120km/h) can be segregated from residential buildings and run in cuttings with slip roads leading to the residential areas. These would be flanked by rows of garages, with parking places in front of them, and linked by wide footpaths leading to the houses/flats. Plenty of lawns and evergreen trees (i.e. conifers), improve the quiet, homely environment.

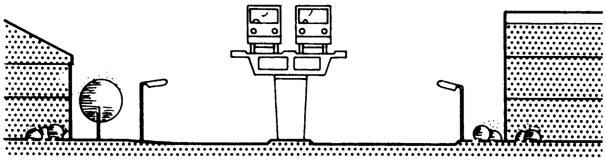
Elevated roads are only convenient for commercial and industrial estates, where the road noise causes less disturbance.



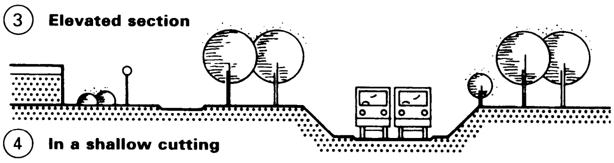
① **Urban railway with overhead conductor cable**



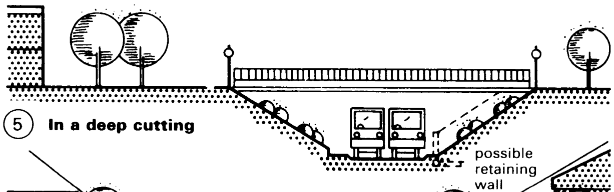
② **Urban railway**



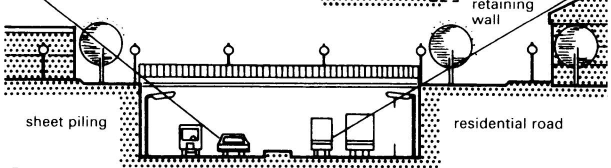
③ **Elevated section**



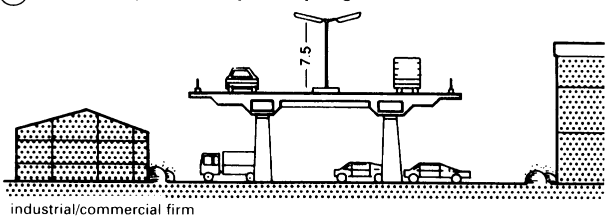
④ **In a shallow cutting**



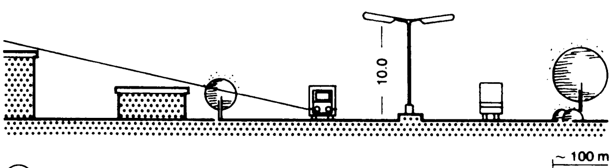
⑤ **In a deep cutting**



⑥ **In a cutting retained by sheet piling**

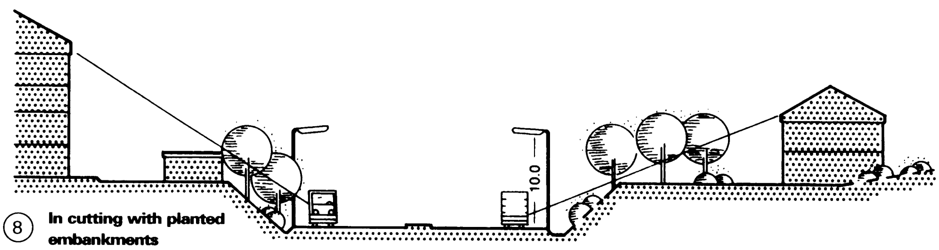


⑦ **Elevated section, with parking below**

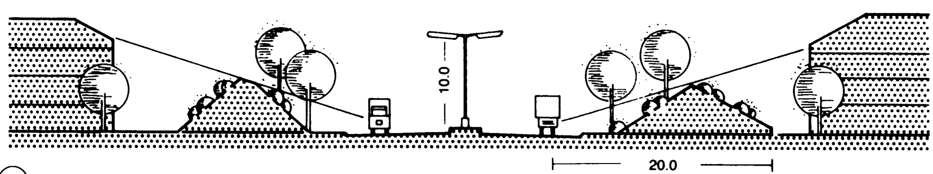


⑩ **Road in flat terrain**

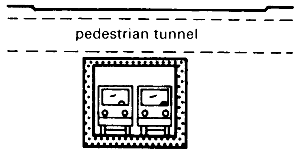
Tests have shown that a road sunk in a cutting with a tree planted bank is the best technical arrangement to contain sound. The main sound waves must not directly impact on the building



⑧ **In cutting with planted embankments**



⑨ **Sound protection is good with side embankments**

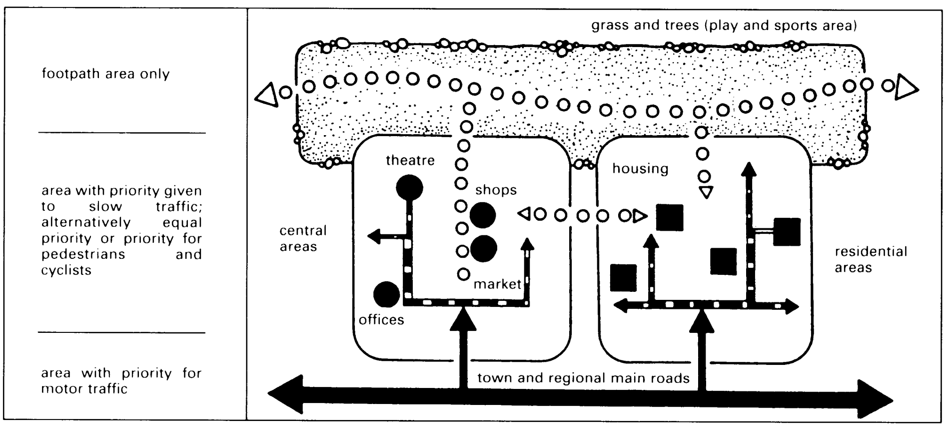


⑪ **In a tunnel**

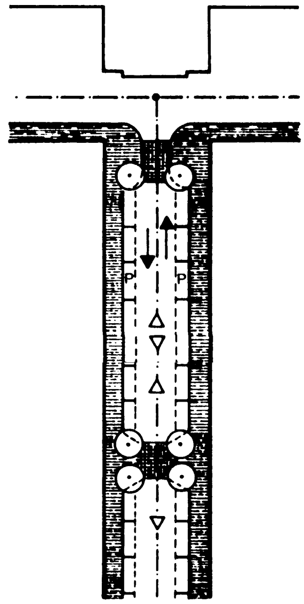
TRAFFIC LAYOUT

no.	measures (desired effects →)	suppression of outside traffic	speed reduction	emphasis on residential character	extra safety for pedestrians/children	extra space for pedestrian movement	reduction of traffic noise	enhanced consideration (positive motivation)	key to measures: A – traffic system; B – detailed layout; C – traffic control; ●● desired effect; ● probable effect; ○ possible effect
A 1	blind alleys cul de sacs	●●	○		○		●		
2	crescents	●					○		
3	one way ouɘ ʍɐʎ	●●				○○			
3	one way streets	●				○			
B 1	change of road surface material		●						
2	narrowing of road section	●	●●		●		●		
3	visual rearrangement of road space	●	●	●●	●		●	●	
4	dynamic obstacles (humps)	●	●●		●				
5	reorganisation of stationary traffic		●●		●				
6	raised paving	●	●●	●●	●	●●	●	●●	
C 1	sign: 'Residential area'	●	●	●●	●●		●	●	traffic signs
2	speed 30 km/h		●		●		●		30
3	change of priority for drivers	○	●		○				

(1) **Traffic calming measures and effects in residential roads**

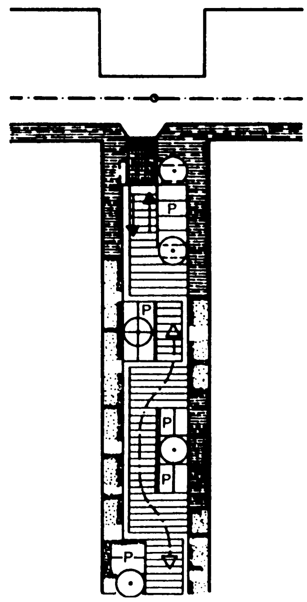


(2) **Outline diagram of the space allocation of traffic priorities**



individual measures:
B1 + B2 + B3 +
(where appropriate, B4 + B6) + C1 + C2;
driving and pedestrian areas separated, reduction in road size in favour of wider pavements, speed reduction by narrowing the road and partial use of raised paving;
this gives more space and greater safety for pedestrians – improved layout through space subdivision

(3) **Road layout: proposal 1** → (1)

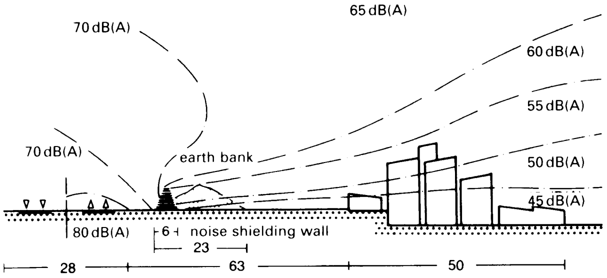


(A3) + B1 + B2 + B3 + B4 + B5 + B6 + C1;
layout for driving, parking and walking in a common (mixed) area so multiple use of the whole road area is possible;
speed is limited to 'walking pace' (or 20 km/h max.);
total reorganisation of the whole layout, taking into consideration the primarily residential needs

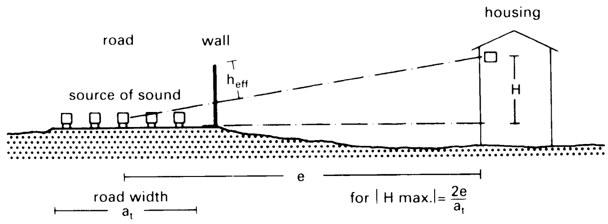
(4) **Road layout: proposal 2** → (1)

TRAFFIC NOISE

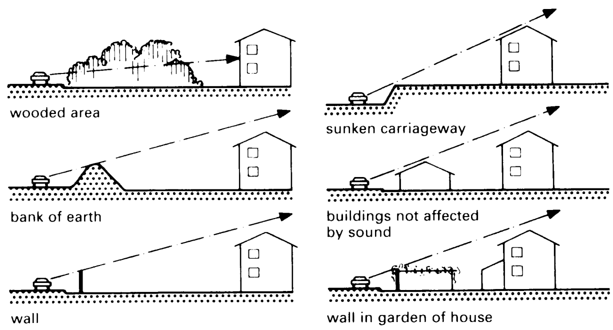
Guidelines for Road Noise Shielding



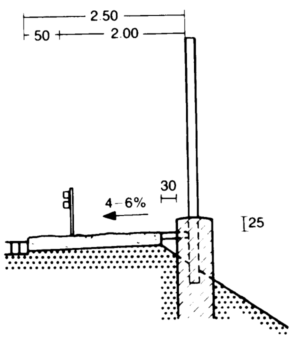
① **Isophonic map: effect of an earth bank or noise shielding wall on sound levels**



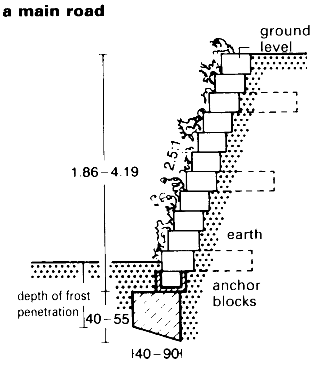
② **Determining the required height of a noise shielding wall**



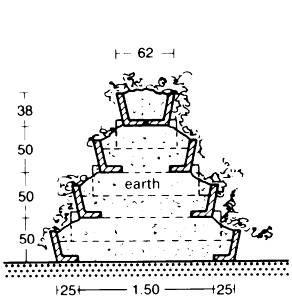
③ **Noise insulation measures on a main road**



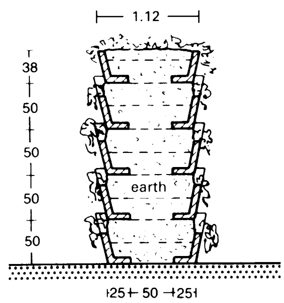
④ **Standard arrangement for noise shielding walls on roads**



⑤ **Noise insulating wall of concrete blocks**



⑥ **Noise insulating pyramid (pre-cast concrete components)**

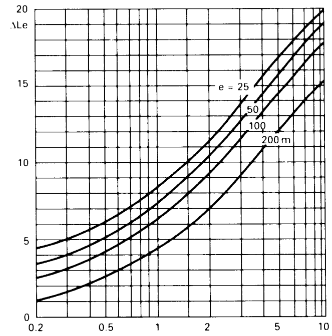


⑦ **Noise insulating modular wall**

Increased environmental concerns have made reduction of traffic noise a top priority. Effective measures include earth mounds and noise shielding walls and pyramids → ①–⑦. There are many suitable pre-cast concrete products on the market today as well as sound insulating walls made from glass, wood and steel.

The sound level of road traffic can be reduced by ≥25 dB(A) after passing through a noise shielding wall. (With a reduction of 10 dB(A), the sound seems half as loud.)

The shielding effect is dependent on the wall material but far more so on its height. This is because refraction bends the path of the sound waves so a small part of the sound energy arrives in the shadow area. The higher the wall the lower the amount of sound penetration, and the longer the detour for the refracted sound.



	day	night
residential zone, weekend homes	50	35
general residential area, small housing estate	35	40
village, mixed area	60	45
town centre, commercial area	65	50
industrial estate	70	70
special area	45–70	35–70

planned sound levels (dB(A))

⑧ **Reduction of sound level**

required reduction		10	15	20	25	30	35
necessary distance	meadows	75–125	125–250	225–400	375–555	–	–
	woods	50–75	75–100	100–125	125–175	175–225	200–250

⑨ **Sound reduction by distance**

wall or bank height (m)	1	2	3	4	5	6	7
reduction (dB(A))	6	10	14	16.5	18.5	20.5	23.5

⑩ **Rough estimate of anticipated traffic noise reduction**

traffic density, both directions (daytime vehicles/h)	classification of road types according to traffic density in urban areas	distance from noise emission point/centre of road (m)	noise level band
<10	residential road	–	0
10–50	residential road (2 lanes)	>35 26–35 11–25 ≤10	0 I II III
>50–200	residential main road (2 lanes)	>100 36–100 26–35 11–25 ≤10	0 I II III IV
>200–1000	country road within town area and main residential road (2 lanes)	101–300 36–100 11–35 <10	I II III IV
	country road outside town and on trading estates (2 lanes)	101–300 36–100 11–35 ≤10	II III IV V
>1000–3000	town high street and road on an industrial estate (2 lanes)	101–300 36–100 <35	IV IV V
>3000–5000	motorway feeder roads, main roads, motorway (4–6 lanes)	101–300 ≤100	IV V

⑪ **Rough estimate of anticipated road traffic noise**

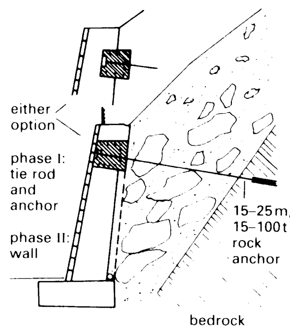
SECURING EMBANKMENTS

Long rounded banks with their faces planted as lawns or with shrubs and trees are aesthetically desirable but all steeply sloping surfaces must be secured. For a bank which is steeper than the natural angle of repose, turf, wattle, cobbles or retaining walls can be used for this purpose.

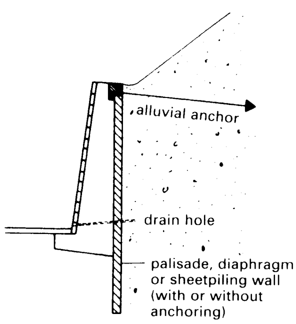
If the slope is more than 1:2 use grass turf fixed with wooden pegs or stepped turf for securing steeper slopes of 1:1.5 to 1:0.5 → p. 230. Wattle is suitable for fixing steep slopes on which it is difficult to establish plant growth → p. 230. It is necessary to distinguish between dead and live wattle: in the case of live wattle (willow cuttings) subsequent permanent planting with deciduous shrubs is called for because willow is only a pioneer plant.

Vegetation is not suitable for securing large bank cuttings, such as in road building or on sloping plots, so more expensive artificial forms of retention are necessary → (1) - (6).

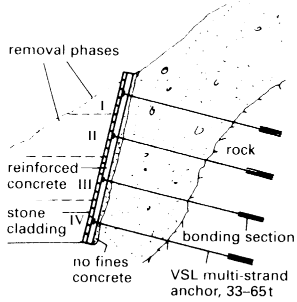
There are several types of anchored frameworks that can be used to create retaining walls. The simplest consists of horizontal, preanchored beams and vertical posts, with intermediate areas covered with reinforced sprayed concrete → (4). With planted supporting walls considerable height differences can be overcome to create ample space for roads or building plots in uneven terrain → (6) + (7). High walls can also be built with earth anchors, depending upon the system and the slope → (15).



(1) **Lined wall for banks of loose stone**

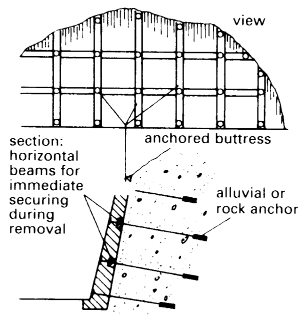


(2) **Lined wall; unconsolidated rock**



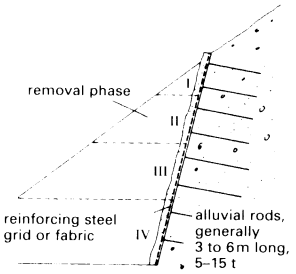
in steps, material removed from top to bottom and immediately shored with wall elements and alluvial anchors (Brenner motorway)

(3) **Bank retention; unconsolidated rock**



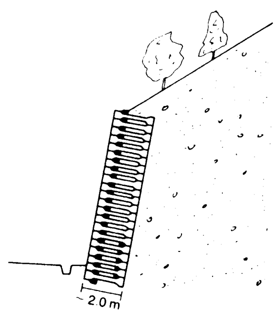
clay-bound or partially solidified unconsolidated mass

(4) **Primary bank retention using anchored framework**

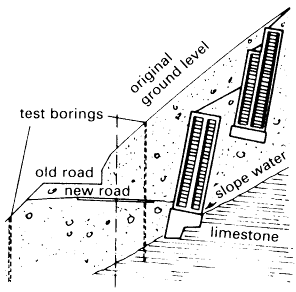


in steps, material removal from top to bottom, with immediate securing using sprayed concrete and reinforcing steel fabric and alluvial rods

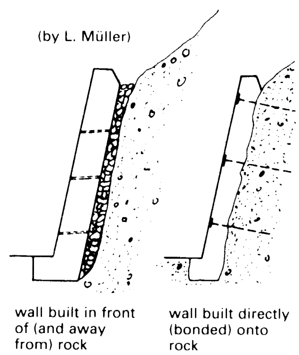
(5) **Bank retention; unconsolidated rock**



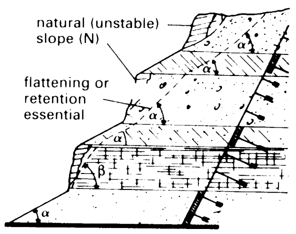
(6) **Lattice support wall (Krainer wall) made of concrete (Ebensee system)**



(7) **Staggered 'Krainer' walls give space for new road**

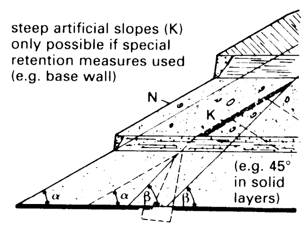


(8) **Rock facing, either as filled or solid walling**

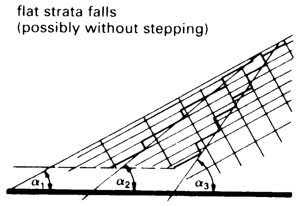


steep slopes only possible with retention (particularly for non-solid layers)

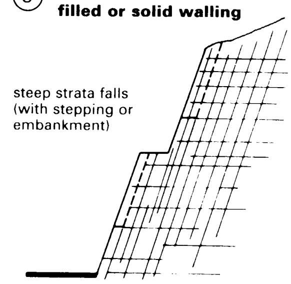
(9) **Retention considerations: multi-strata slope**



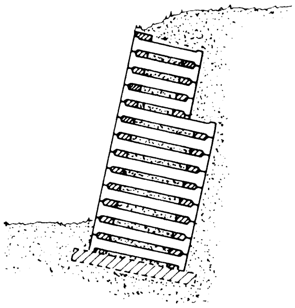
(10) **Retention considerations: multi-strata slope**



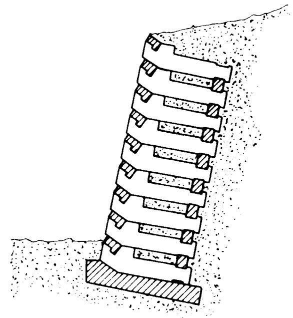
(11) **Geological influence on slope retention**



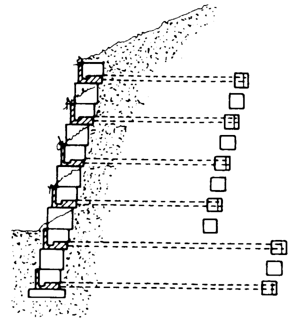
(12) **Geological influence on slope retention**



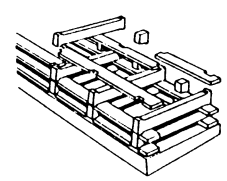
(13) **Krainer wall**



(14) **RGS 80 wall**



(15) **Wall with land anchors (Lüdenscheid example)**



(16) **The Ebensee Krainer wall** → (6) + (13)