MINISTRY OF TRANSPORT
SCOTTISH DEVELOPMENT DEPARTMENT
THE WELSH OFFICE

Roads in urban areas

LONDON
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Introduction

It is twenty years since the Minister of War Transport appointed a Committee under the chairmanship of Sir Frederick Cook, whose terms of reference were:

> 'To consider the design and layout most appropriate to various types of roads in built-up areas, with due regard to safety, the free flow of traffic, economy and the requirements of town planning, and to make recommendations.'

The Committee's report, embodied in the publication *Design and Layout of Roads in Built-up Areas*,[1] has served as a guide to highway engineers throughout the post-war period.

The past twenty years have seen a growth in population, car ownership and traffic volume far greater than was thought likely at the end of the war. For example, the Committee recommended that in designing new roads, provision should generally be made for a volume of traffic double that of 1939. By 1964 the pre-war figure of vehicle ownership had already more than trebled; by 1970 it will probably have multiplied more than five times and by 1980, eight times.

The Cook Committee recognised the need to design the road system of a town as part of the overall plan for the town as a whole. More recently the Buchanan Report (*Traffic in Towns*)[2] has shown in graphic terms what can happen to living and working conditions in urban areas if this concept of integrated town planning is lost sight of, or not properly understood.

This manual, covering much the same ground as its predecessor, brings into one volume the recommended standards of urban road design and layout which have been developed in the intervening years. It is, however, important to bear in mind that the manual does not purport to give guidance on the planning of future road requirements. It will help highway engineers to achieve good standards of design once conclusions have been reached about the purpose and location of the roads required and the capacity which is needed. The manual does not deal in any detail with the many factors which must be taken into account or the planning processes involved in arriving at such conclusions. These decisions will call for the study and forecasting of land uses and transport requirements in the detail appropriate to the size of the town concerned. Decisions will have to be made as to the balance to be arrived at between the use of public and private transport, and consequential parking and traffic management policies worked out. Above all, the plans will have to be developed in the context of the foreseeable scale of resources which can be devoted to urban road building.

The evolution of a practicable urban road network and its integration with the urban environment is a task demanding the closest collaboration between highway and traffic engineers, architects and town planners. Once the decision has been taken to build or improve a road in a given place, this manual shows how it can be designed to fulfil its stated traffic requirements safely, efficiently and economically.

1 Urban traffic

1.1 Design for safety and capacity

1.1.1 Urban roads and development

Urban roads should be designed to be safe and to permit the free flow of traffic at reasonable speed. Their traffic capacity should be balanced against the traffic requirements of the existing and proposed development they are expected to serve. This will necessitate the planning of the urban road network as a whole, and will involve forecasting future traffic volumes and appropriate controls of parking and development to ensure that the network will continue to function efficiently.

Much can be done to improve the safety and capacity of existing roads by traffic management and the control of street parking. But provision for the future growth of traffic and improvement of environmental standards will entail a continuing programme of major improvement and new construction, which will need to be carefully phased with other urban development and renewal.

The magnitude of the traffic accident figures in built-up areas highlights the importance of designing urban roads for safety. Design for safety will require appropriate degrees of traffic segregation to reduce the risk of conflict and protect the more vulnerable road users. These measures will in turn promote the smoother flow of traffic and improve road capacity.

1.1.2 Traffic accidents in built-up areas

Nearly three-quarters of all road casualties occur in built-up areas, i.e. areas where speed limits of 30 or 40 mph apply. The yearly total of casualties in built-up areas is now over 280,000 and includes over 65,000 killed or seriously injured.[3]

Thirteen out of fourteen pedestrian casualties occur on urban roads. A quarter of all casualties on such roads and a third of those killed or seriously injured are pedestrians. The groups of pedestrians most vulnerable to accidents are young children and elderly adults. The vulnerability of adults increases with age and that of children is greatest between the ages of 3 and 8. Of all road users, pedestrians incur the greatest risk of death relative to the risk of injury.

Pedestrian casualties in one-vehicle accidents were investigated during the period 1954–1957.[4] The investigations showed that on speed-restricted roads the actions of pedestrians prior to fatal or serious accidents were as follows:

	%
Crossing road masked by stationary vehicle	19
Crossing road masked by moving vehicle	4
Crossing road not masked by vehicle	46
Walking, standing or playing in road	9
Stepping, walking or running off footway or verge	16
On footway or refuge	4
Unknown	2
	100

Cyclists, moped riders and the riders and passengers of motor scooters and motor cycles are involved in about 40% of all casualties in built-up areas and make up 30% of those killed or seriously injured.

Casualty rates per million miles driven in built-up and non-built-up areas are compared in Table 1–1.[5] Although total casualty rates are higher in built-up areas it will be noted that fatality rates are generally lower, probably due to lower speeds. The table clearly shows the greater risks sustained by pedal cyclists and all types of motor cyclists as compared with other drivers. For the same distance travelled the risk of *death* for a motor cyclist is greater than that of *serious injury* for a car driver.

The peak times for casualties are:

(i) 5 pm to 6 pm on weekdays; Midday to 1 pm on Saturdays — these periods coincide with daily traffic peaks;

(ii) 10 pm to midnight on Saturdays; 10 pm to 11 pm on Sundays — these periods do not coincide with daily traffic peaks.

Table 1–1 Driver casualty rates, 1960

Class of road user	Casualties per million miles driven					
	Built-up areas			Non-built-up areas		
	Fatal	Fatal and serious	Total including slight	Fatal	Fatal and serious	Total including slight
Motor cyclists*	0.24	4.9	17.5	0.33	4.0	8.7
Scooter riders	0.14	3.6	17.9	0.20	3.0	8.3
Moped riders	0.14	2.4	9.4	0.11	1.6	3.9
Pedal cyclists	0.081	1.5	8.0	0.111	1.1	3.0
Car drivers	0.009	0.18	0.97	0.024	0.30	0.91
Other drivers	0.006	0.11	0.65	0.012	0.16	0.55

*Includes motor cycle combination riders

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*Includes motor cycle combination riders

1.1.3 Traffic segregation

Traffic segregation should be the keynote of modern road design and should be arranged to reduce the risk of conflict between one vehicle and another and between motor vehicles and slower-moving and more vulnerable road users such as pedestrians and pedal cyclists. Some examples of the application of segregation to the urban road system are outlined in Table 1–2.

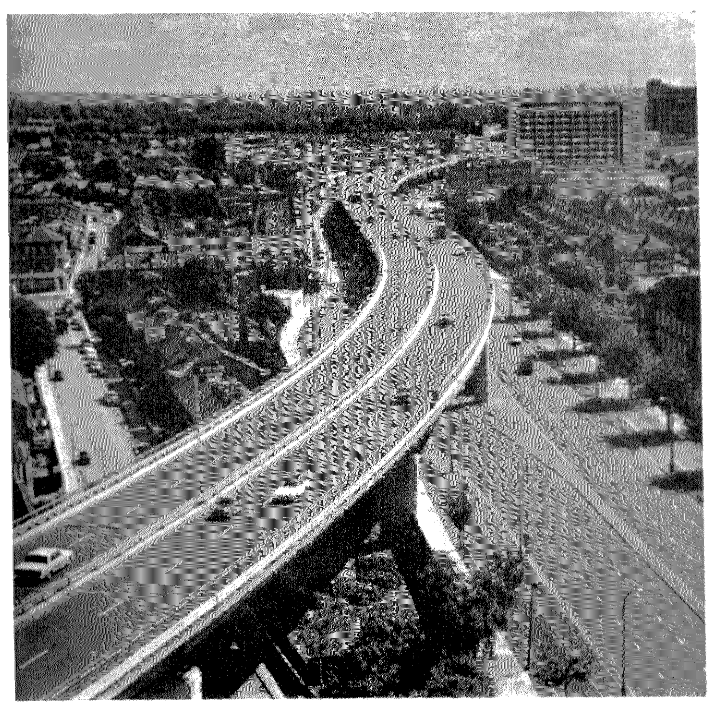
The principles of segregation should be applied as far as practicable or necessary to all traffic schemes and road improvements and in the planning of new towns and the redevelopment of existing ones. The means of segregation and the rate at which it can be introduced will depend upon a variety of circumstances such as the impetus of redevelopment and the availability of funds.

Table 1–2 Some methods of traffic segregation

Type of segregation	Method	Purpose
Segregation in relation to destination	By construction of by-passes	To separate through traffic from traffic requiring to enter the town and traffic circulating within it
	By provision of separate primary and distributory traffic networks	To separate longer-distance urban traffic from local traffic
Segregation of types of traffic	By construction of urban motorways	To provide fast, high-capacity routes solely for motor traffic and eliminate accidents involving pedestrians and pedal cyclists
	By cycle tracks and cycle ways	To separate pedal cyclists from faster motor vehicles and from pedestrians
	By pedestrian ways and elevated footways	To obviate conflicts with faster traffic and give easy, direct access to various parts of the town
	By construction of back streets	To give separate access for goods and service vehicles, with facilities for loading and off-loading
	By reserving some roads or traffic lanes for buses	To ensure rapid and direct public transport and reduce interference from other traffic
Segregation of traffic by grade separation	By construction of flyovers, underpasses and grade-separated junctions	To avoid conflicts between through and crossing or turning traffic streams
	By building special subways and bridges for pedestrians or cyclists	To eliminate conflicts with motor traffic
Segregation in relation to direction	By dual or divided carriageways and one-way streets	To reduce or eliminate the risk of conflict between opposing traffic streams
	By channelising islands at junctions	To separate traffic streams and points of possible conflict, thereby simplifying the driver's task
Segregation of moving vehicles from parked vehicles	By provision of off-street parking and prohibition of street parking	To increase street capacity and eliminate risks due to screening of pedestrians from view by stationary vehicles
Segregation by other controls	By traffic signals	Use of time segregation to eliminate or reduce traffic conflicts at junctions
	By banning right turns, closing side streets and limiting access points	To reduce the risk of conflict between through and turning or crossing traffic

System of linked roof-top car parks at Coventry

Motorway M.4, London: urban section on viaduct above Great West Road



1.2 Vehicles and road design

1.2.1 Vehicle dimensions and turning circles

The maximum permitted dimensions and weights of road vehicles are specified in Regulations made by the Minister of Transport.[6] Some provisions influencing road design are given below:

Maximum width of motor vehicles (including buses, but not locomotives and vehicles for abnormal loads)	8 ft. 2½ in. (2.5 metres)
Rigid vehicles:	
Maximum length (including buses)	36 ft. 1 in. (11 metres)
Gross weight:	
vehicles with 2 axles	16 tons (provided outer axles are at least 12 ft. apart)
vehicles with 3 axles	22 tons (provided outer axles are at least 18 ft. apart)
vehicles with 4 or more axles	28 tons (provided outer axles are at least 26 ft. apart)
Articulated vehicles:	
Maximum length	42 ft. 7¾ in. (13 metres)
Gross weight:	
vehicles with 3 axles	22 tons (provided outer axles are at least 18 ft. apart)
vehicles with 4 axles	32 tons (provided outer axles are at least 38 ft. apart)
vehicles with 5 or more axles	32 tons (provided outer axles are at least 32 ft. apart)
Road trains with one trailer:	
Maximum length	59 ft. 0¾ in. (18 metres)
Gross weight	32 tons

Turning circles of public service vehicles must have swept diameters no greater than 65 ft. for vehicles not exceeding 27 ft. in length and no greater than 71 ft. for longer vehicles. No such restrictions govern the turning circles of commercial vehicles; these range widely from 30 to over 80 ft. diameter, but lie mainly between 40 and 70 ft. diameter.

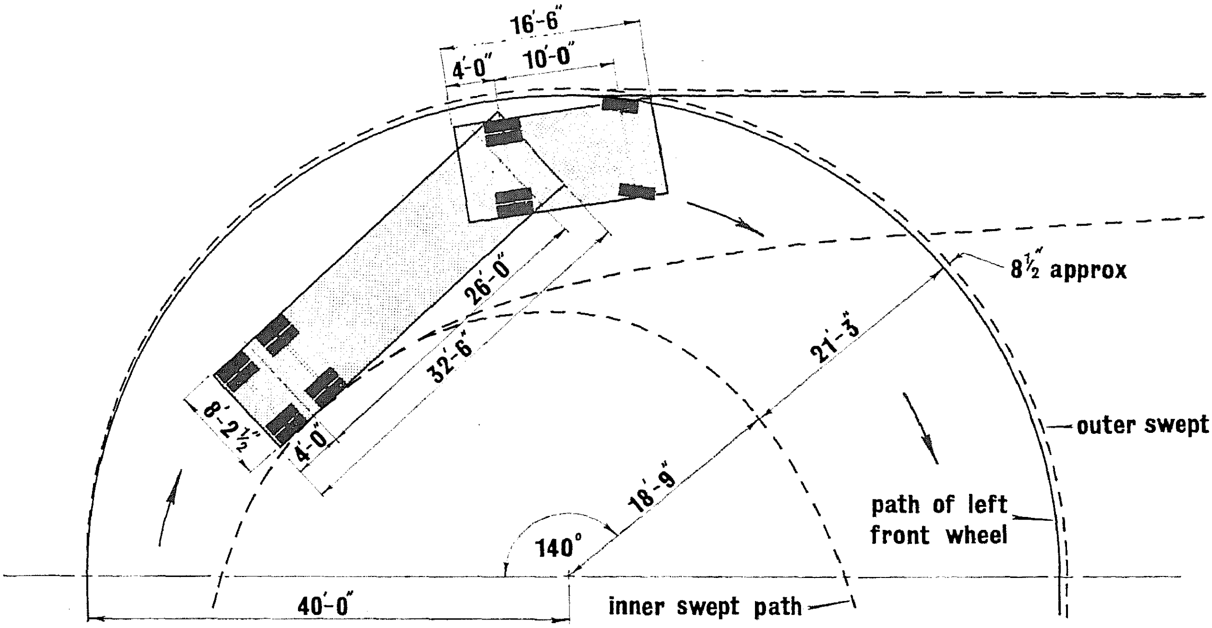
Loads should not normally be wider than 9 ft. 6 in., nor should they overhang the sides of a vehicle by more than 12 in.

Roads and junctions with dimensions adequate for commercial vehicles will also be suitable for private cars. Where commercial vehicles are few in number, such as on roads in residential areas, carriageway widths and junction radii may be reduced accordingly. Car dimensions normally lie within the ranges given below:

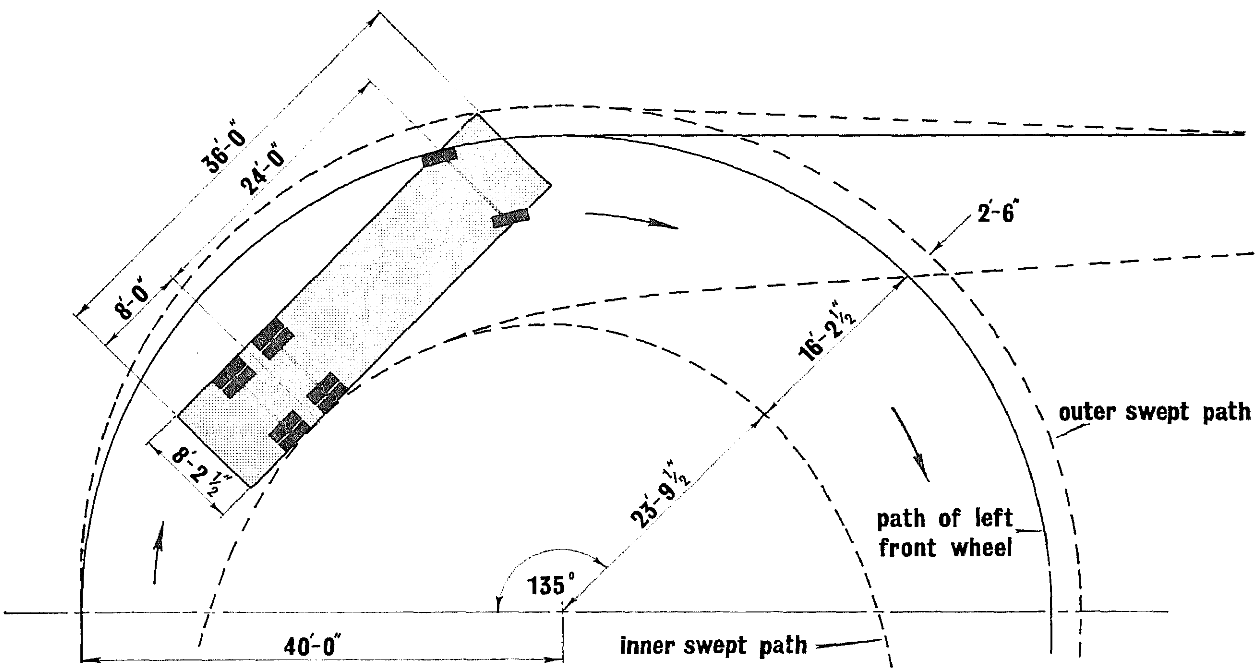
Width ....4 ft. 7½ in.–6 ft. 2 in.
Length.........................10 ft.–18 ft.
Turning circles ....25 ft.–45 ft. diameter

In designing junctions with sharp curves it should be remembered that a vehicle cannot be turned from a straight path directly over to full lock and that allowance must be made for the back wheels (especially of long articulated vehicles) cutting the corner.

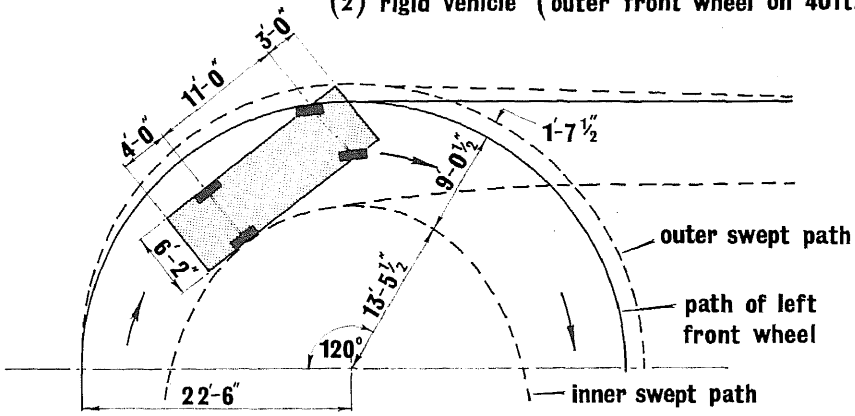
Typical swept paths for large commercial vehicles, both rigid and articulated, and for large cars are shown in Fig. 1–1.



(1) articulated vehicle (outer front wheel on 40ft. radius turn)



(2) rigid vehicle (outer front wheel on 40ft. radius turn)



(3) large car (outer front wheel on 22ft. 6in. radius turn.)

Fig. 1–1 Typical vehicular swept paths

1.2.2 Passenger car units

Vehicles of different types require different amounts of road space because of variations in size and performance. In order to allow for this in capacity measurements for roads and junctions, traffic volumes are expressed in passenger car units (pcu's). The basic unit is the car (taxis, light vans and three-wheeler vehicles also count as one unit). As different types of vehicles affect the capacity of rural roads, urban roads, roundabouts and traffic signals in varying degrees, the weighting for each class of vehicle has to be varied to suit the purpose for which it is to be used. For example, a heavy goods vehicle on a rural road is rated as equivalent to 3 cars, but on an urban road to only 2, and at traffic signals to 1.75. The appropriate values for different types of vehicles under varying conditions are given in Table 1–3.

Table 1–3 Passenger car units

Class of vehicle	Equivalent value in passenger car units (pcu's)			
	Urban standards	Rural standards	Round-about design	Traffic signal design
Private car, taxi, motor cycle combination, light goods vehicle (up to 30 cwt. unladen)	1.00	1.00	1.00	1.00
Motor cycle (solo), motor scooter, moped	0.75	1.00	0.75	0.33
Medium or heavy goods vehicle (over 30 cwt. unladen), horse-drawn vehicle	2.00	3.00	2.80	1.75
Bus, coach, trolley bus, tram	3.00	3.00	2.80	2.25
Pedal cycle ...	0.33	0.50	0.50	0.20

1.2.3 Carriageway capacity

The speed of traffic in towns will be lower than that on rural roads and there will be less overtaking; drivers are prepared for these conditions and higher traffic densities can therefore be allowed. The design of main traffic routes in built-up areas should be based on peak-hour demands and not, as in rural areas, on the average daily traffic during August. Due allowance should be made, especially in intersection design, for tidal flows during the morning and evening peaks and for any other peaks during the day—as, for example, at lunch time.

Approximate practical capacities of urban roads between junctions are given in Tables 1–4 and 1–5, which cover a wide range of carriageway widths typical of both new and existing roads. On two-way carriageways capacity is relatively independent of distribution by direction and designs can be based on two-way flows; on the other hand, on dual or divided carriageways capacity is dependent on distribution by direction and designs must therefore be based on peak-hour flows in the busier direction of travel. Recommended carriageway widths for various types of road and some typical cross-sections are given in Chapter 4.

To secure good environmental conditions, roads within environmental areas not acting as *local distributors* should desirably not be loaded to their practical capacity. All roads in environmental areas should be so designed with regard to route and junctions that they are unattractive to traffic as through routes or short cuts.

Table 1–4 Practical capacities of two-way urban roads

Effective width of carriageway in feet (excluding refuges or central reserve)	2-lane			3-lane		4-lane			6-lane			Remarks
	20′	22′	24′	30′	33′	40′	44′	48′	60′	66′	72′	
Description	Capacity in pcu's per hour for BOTH directions of flow					Capacity in pcu's per hour for ONE direction of flow						(for definitions of road types see Section 2.1)
Urban motorway with grade separation and no frontage access								3,000			4,500	Applicable to the highest category of *distributor*
All-purpose road with no frontage access, no standing vehicles permitted and negligible cross-traffic	1,200	1,350	1,500	2,000	2,200	2,000	2,200	2,400	3,000	3,300	3,600	Appropriate for all-purpose *distributors*
All-purpose street with high-capacity junctions and 'No Waiting' restrictions	800	1,000	1,200	1,600	1,800	1,200	1,350	1,500	2,000 2,200 for dual carriageways	2,250 2,450 for dual carriageways	2,500 2,700 for dual carriageways	Applicable to those *distributors* and *access roads* where access to development is frequent but capacity is not unduly restricted by junctions
All-purpose street with capacity restricted by waiting vehicles and junctions	300 to 500	450 to 600	600 to 750	900 to 1,100	1,100 to 1,300	800 to 900	900 to 1,000	1,000 to 1,200	1,300 to 1,700	1,500 to 2,000	1,600 to 2,200	Typical of existing roads where waiting vehicles and junctions with heavy cross traffic severely limit capacity

Table 1–5 Practical capacities of one-way urban roads

Effective width of carriageway in feet (excluding refuges)	20′	22′	24′	30′	33′	36′	40′	44′	48′	Remarks
Description	Capacity in pcu's per hour									(for definitions of road types see Section 2.1)
Urban motorway with grade separation and no frontage access			3,000			4,500			6,000	Applicable to the highest category of *distributor*
All-purpose road with no frontage access, no standing vehicles and negligible cross-traffic	2,000	2,200	2,400	3,000	3,300	3,600	4,000	4,400	4,800	Appropriate for all-purpose *distributors*
All-purpose street with high-capacity junctions and 'No Waiting' restrictions	1,300	1,450	1,600	2,150	2,400	2,650	3,000	3,350	3,700	Applicable to those *distributors* and *access roads* when access to development is frequent but capacity is not unduly restricted by junctions
All-purpose street with capacity restricted by waiting vehicles and junctions	800	950	1,100	1,650	1,900	2,150	2,500	2,800	3,200	Typical of existing roads where waiting vehicles and junctions with heavy cross traffic severely limit capacity

1.3 Existing and future traffic

1.3.1 Traffic censuses and surveys

For overall planning purposes, comprehensive land use/transport studies are likely to be required. They will provide information for planning the future transport requirements of the town, including the future road network, and for ensuring the adequacy of individual projects, whether large or small. The precise form and extent of any study will depend on the nature of the problems under consideration, the availability of existing information and the size of the town. Traffic censuses and surveys, either as part of the comprehensive study or taken separately, will provide information about specific road problems.

The main types of traffic study are:

Traffic censuses	To determine traffic volumes and composition on roads and at junctions.
Traffic surveys	To ascertain by home and/or roadside interviews the number, timing, and origin and destination of journeys.
Pedestrian censuses	To assess the adequacy of footways or the need for pedestrian crossings, subways, or pedestrian-operated traffic signals.
Pedestrian surveys	To locate and measure the main pedestrian flows, e.g. for a system of pedestrian ways.
Public transport surveys	To assess the use and adequacy of public transport services.
Parking surveys	To ascertain the availability and usage of on-street and off-street parking space and the duration of parking.
Speed and delay studies	To measure the adequacy of the road system; for the assignment of traffic to routes; for the preparation of economic assessments.
Accident studies	For the identification of points of special danger and of the causes of accidents.

Censuses and surveys should be kept up-to-date so that trends can be determined, changes in travel habits detected and any necessary amendments made to the overall plan. Information on the conduct of censuses and surveys and the analysis of the results may be obtained from *Urban Traffic Engineering Techniques*.[7]

1.3.2 Future traffic

Up to the present, forecasts of future traffic in towns have largely been based on the extrapolation of present trends, with allowances for growth ranging from 60% for very large towns to 150% for others. As survey and forecasting techniques are improved it will be possible to relate forecasts more closely to the needs of individual towns and to design road networks in relation to the varying requirements of different parts of the town. Each town will be able, by the traffic policies it pursues, to influence directly the volume of traffic circulating within it.

Some points to be considered initially and as roadworks and development proceed are:

(i) When a road is widened or a new road constructed in a built-up area further improvement may well be precluded for many years by erection of buildings alongside the road. It is important therefore that road projects should be adequate and compatible with longer-term development proposals for the town as a whole.

(ii) Where there are land acquisition or other difficulties, interim improvements of lesser capacity than that ultimately required may be economically justifiable. But as new development proceeds it may be necessary to fix building lines or limit the life of development alongside the road to allow for its eventual widening and the construction of higher capacity junctions.

(iii) To avoid overloading of the network, continuing control of parking will be necessary, together with positive action to avoid over-concentration of traffic-generating development, particularly in central areas.

(iv) As indicated in *Urban Traffic Engineering Techniques*,[7] cost-benefit analysis may be used to compare alternative schemes or to assess priorities, having regard to time lost through traffic delays and the cost to the community of accidents. But present methods are not sufficiently refined always to give full financial justification and do not make any allowance for possible effects on environment. As research is in progress on the development of techniques, the most up-to-date information should be sought before commencing a cost-benefit analysis.

2 The urban road system

2.1 Road types

In this manual reference is made to four main types of urban road:

(i) *Primary distributors* These roads form the primary network for the town as a whole. All longer-distance traffic movements to, from and within the town should be canalised on to the *primary distributors*.

(ii) *District distributors* These roads distribute traffic within the residential, industrial and principal business districts of the town. They form the link between the primary network and the roads within environmental areas (i.e. areas free from extraneous traffic in which considerations of environment predominate over the use of vehicles).

(iii) *Local distributors* These roads distribute traffic within environmental areas. They form the link between *district distributors* and *access roads*.

(iv) *Access roads* These roads give direct access to buildings and land within environmental areas.

For clarity these road types are referred to in italics throughout the manual. The relationship between them is illustrated in Fig. 2–1 and their role is discussed in Sections 2.3 to 2.5.

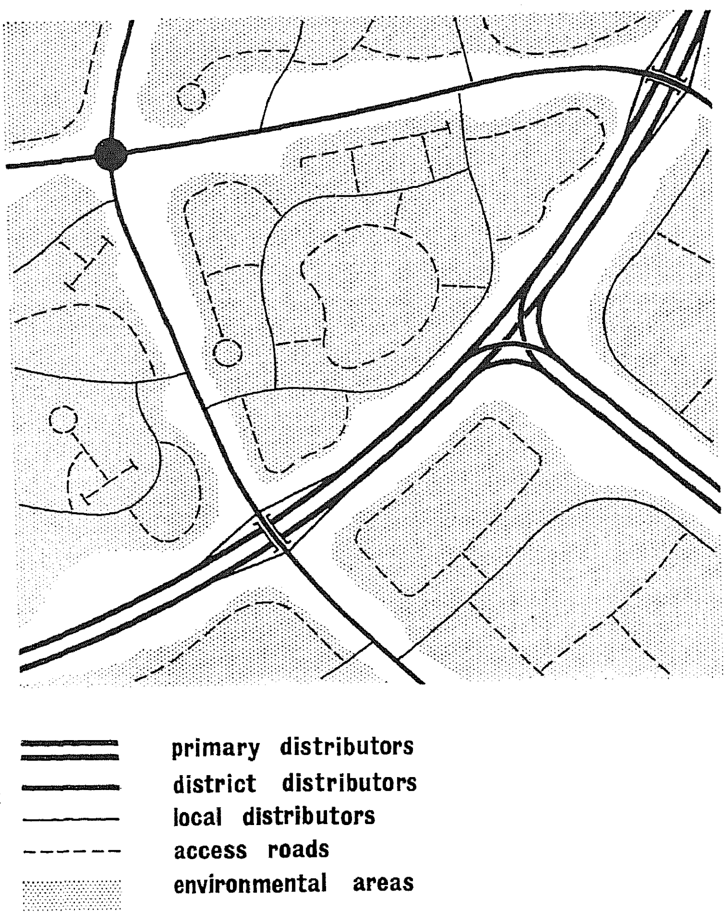


Fig. 2–1 Urban road types

2.2 Diversion of through traffic from urban streets

The existing road pattern in Great Britain still consists largely of a network of roads linking towns and passing through town centres ill-suited to handle the growing volume of through and local traffic. If the volume of through traffic is large enough, the best way of diverting it from a town on a major through route may be by providing an outer by-pass or (if a number of roads converge on the town) by constructing a partial or complete outer ring road. If, on the other hand, the amount of through traffic does not warrant an outer by-pass or ring road, or if its use would involve such a lengthy detour that drivers would take a short cut through the town, a better alternative may be to provide an internal relief road for both the through traffic and the longer-distance internal traffic. The relief road would then form part of the town's primary road network. When both an outer by-pass and an internal relief road are planned, quicker relief of congestion and greater economic benefit will sometimes result from the prior construction of the latter.

Such measures will not obviate the need to improve the efficiency of the existing road system by traffic management together with a programme of improvements to eliminate the worst trouble-spots.

To avoid overloading the primary network of very large towns it may be necessary to allocate separate routes for both through traffic and the longer-distance movements within the town. These routes (called regional distributors in the Buchanan Report[2]) would serve a wider area than the usual primary network. They would have a limited number of connections to the primary network and would normally be designed to the same standard.

Regional distributors will also be required to serve conurbations, where they should be linked by *primary distributors* to the main centres of development. Wherever possible, existing motorways or other major routes passing through conurbations should be utilized as regional distributors.

2.3 *Primary distributors*

An efficient road system will be needed to enable traffic to enter or leave the town rapidly and safely, or to circulate freely within it; the system should also accommodate any through traffic not diverted to outer by-passes or ring roads. This can be achieved by means of a network of *primary distributors* linking the business, industrial and residential districts, which should have separate *distributor* and *access road* systems to enable traffic to reach houses, factories, shops, vehicle parks, etc.

For maximum capacity and safety, *primary distributors* should ideally be designed with full restriction of frontage access. In large towns and cities where traffic flows are heavy, grade separation and motorway status will need to be considered. Where such standards are not economically justifiable or cannot be obtained it will be necessary to designate existing or proposed all-purpose roads as *primary distributors*, steps being taken to restrict frontage access, street parking and the number of turning and crossing movements to the maximum extent which is practicable.

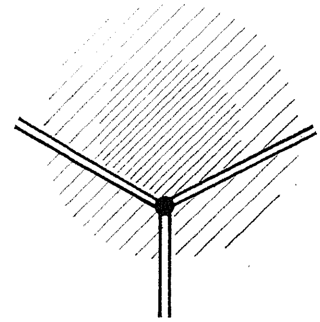
The shape of the primary network will be determined by the traffic requirements of the town, and these in turn will be influenced by topography and the pattern of development. Some typical network layouts are illustrated in Fig. 2–2. Probably the most widely used is the radial-ring pattern in which a number of radial roads are linked to one or more ring roads. But this layout will not always be the most suitable, and it is important that a whole range of designs should be considered and tested at the planning stage.

The design standards recommended for *primary distributors* may be unnecessarily high for smaller towns, and those recommended for *district distributors* should normally be adequate.

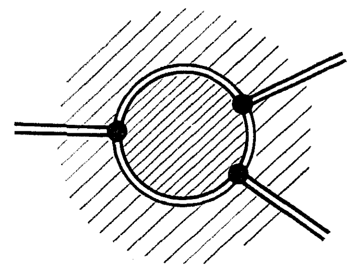
2.4 *District distributors*

In the same way that *primary distributors* serve the town as a whole, *district distributors* will serve specific localities comprised of groups of environmental areas, such as the town centre or large residential districts. *District distributors* will feed traffic from the primary network to these districts but will not traverse environmental areas. Although these roads may link adjoining districts they are not intended for the longer cross-town journeys, for which the primary network should provide a more attractive alternative. It is particularly important that drivers should not be able to use any *district distributors* in the town centre as through routes.

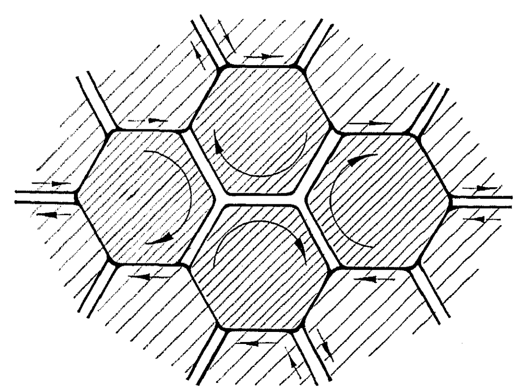
The prime function of *district distributors* will be to facilitate the safe and unhindered movement of traffic within the districts they serve. This function should be preserved by appropriate restrictions on frontage access and street parking. Although prohibition of access and parking may initially be impracticable on existing roads, an increasing degree of restriction should be applied as redevelopment takes place and alternative facilities become available. The immediate application of such restrictions to new roads should usually present no difficulty. Parking



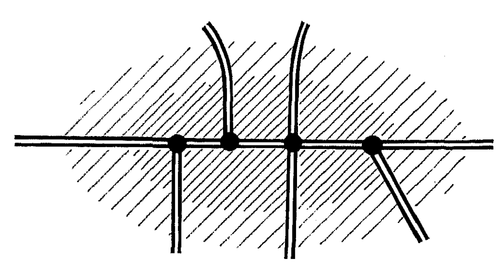
(1) inner tangents



(2) radial-ring



(3) linked hexagons



(4) spine and spurs

Fig. 2–2 Examples of network layouts

Distributor roads and interchanges at Cumbernauld (*reproduced by courtesy of the Cumbernauld Development Corporation*) provision and the nature and extent of development within districts should be related to the capacity of their road systems.

As indicated in Section 2.3 the design standards recommended for *district distributors* should usually be adequate for the primary network in smaller towns. In some cases a separate hierarchy of *district distributors* may be unnecessary, e.g., where the primary network surrounds a single environmental area such as the centre of a small town.

2.5 *Local distributors* and *Access roads*

Local distributors and *access roads* will serve and be located within environmental areas, which will be bounded but not crossed by *primary* or *district distributors*. Traffic from the major distributors will penetrate into environmental areas on the *local distributors* and will gain access to houses, shops, offices, factories and other development via *access roads*. As in the case of other distributors, the function of *local distributors* should be preserved by appropriate restrictions on frontage access and street parking.

In new towns and areas of extensive redevelopment, environmental areas will often be planned so that pedestrian and vehicular access to premises are separated, e.g. by means of:

- Radburn-type layouts for housing estates;
- pedestrian precincts;
- pedestrian ways separated horizontally or vertically from streets carrying vehicular traffic;
- back streets giving goods and service vehicle access to shops, offices, factories, etc.

However, the streets in many environmental areas, especially existing streets, will have to serve both vehicular and pedestrian traffic and can do so satisfactorily provided they are not unreasonably congested by parked and moving vehicles. Where necessary, environmental standards and safety should be improved by prohibiting or restricting street parking (with appropriate provision for off-street parking) and providing a system of back streets for servicing premises. It may be practicable to close some shopping streets to vehicular traffic for all or part of the day.

Many *access roads* will be culs-de-sac. It is important that there should be sufficient space for vehicles to turn around at the end of such culs-de-sac. Suggested designs for turning circles and bays in residential streets are given in Figure 2–3.

2.6 Stages of improvement

It will often be convenient to implement the planned improvement of the urban road system in the following sequence:

(i) Prohibit or restrict waiting on *primary* and *district distributors*. During peak traffic periods prohibit the loading and unloading of commercial vehicles and limit stopping to pick up or set down passengers as on urban clearways.

(ii) Take urgent action to provide off-street parking accommodation, consistent with a policy relating the availability of parking space to the capacity of the network. Site garages and car parks near the main centres of development, with easy access to distributor roads.

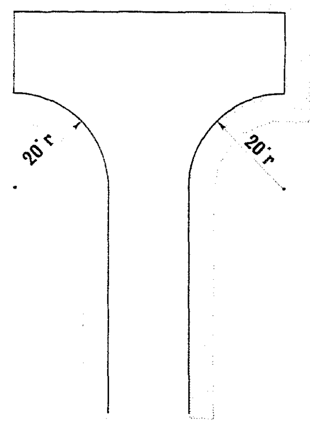
(iii) Construct secondary means of access to enable goods and service vehicles to load or unload at the rear of shops and other premises. Where it is not immediately possible to provide these to full vehicular width, the interim construction of rear alleyways wide enough for the operation of trolleys or fork-lift trucks should be considered. These alleyways should terminate at suitably sited loading bays on minor streets.

(iv) Prohibit or restrict street parking on *local distributors* and *access roads* in conjunction with the planned provision of car park spaces and the availability of back streets for servicing shops, etc.

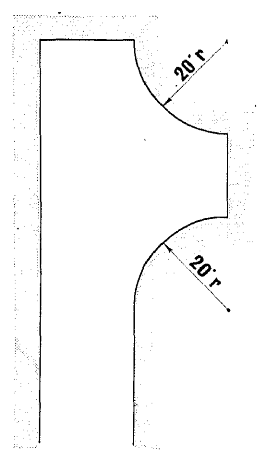
(v) Construct or improve *primary* and *district distributors* to the required standards. This work should be carried out concurrently with stages (i) to (iv) and programmed so that the most-needed sections are completed first.

(vi) As the primary network is developed, introduce traffic control to canalise cross-town journeys on to *primary distributors* instead of *district* and *local distributors*.

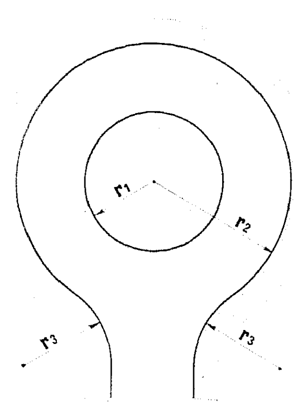
Fig. 2–3 Vehicle turning points for residential culs-de-sac



(1) 'T' turning bay



(2) side turning bay



radius	cars only	all vehicles
r_1	15'	30'
r_2	30'	50'
r_3	20'	35'

(3) turning circle

Shopping precinct, Coventry Town Centre

Entrance to underground garage beneath Hyde Park, London

Multi-storey car park adjoining Bull Ring Centre, Birmingham

3 Factors affecting alignment

3.1 The road and its surroundings

The urban road pattern will be influenced by the topography of the town, the position of the main business, shopping, industrial and residential districts, and the disposition of the major roads outside the town. The route and detailed alignment, both horizontal and vertical, of the individual town road will be affected not only by local topography and development but by the need to conform to the standards of curvature, gradient and visibility appropriate to its purpose.

Road design is an exercise in three-dimensional planning whose success will be measured not only by the efficiency of the road but by its appearance and impact upon the neighbourhood. The road and its associated structures should have a pleasing appearance from its surroundings as well as from the viewpoint of the road user. It should not adversely affect its environment by allowing the noise and fumes of traffic to become obtrusive. It should not sever communities or unduly restrict cross-movement. Meeting these requirements will present many problems in planning new towns or extensive areas of redevelopment, but will require even more ingenuity in areas of existing development. Some of the factors to be considered at an early stage in the planning of new roads or the improvement of existing ones are considered below.

3.1.1 Location and alignment

In towns there will usually be less scope for fitting the road to the landscape than in the countryside, but every effort should be made to do this so far as circumstances allow. Roads on gentle curves fitting the contours of the ground afford opportunities for attractive design and have the advantage of presenting the road-user with a continuously changing forward view. Provided it is not too long, a straight alignment can often be pleasing; it expresses directness of purpose and lends itself to the closing of the vista by a suitable terminal building. Opportunities should be taken of affording views of the surroundings and especially of buildings of architectural or historic interest, provided this can be done without detriment to amenity.

Where possible, horizontal and vertical curves should be phased to coincide or should be contiguous, with common tangent points. It will enhance the appearance of the road if curves are reasonably long and adjacent curves are similar in length. Small changes of direction are undesirable as they tend to give a disjointed appearance to the view of the road ahead.

Adjoining horizontal or vertical curves of the same or opposite sense which are visible from one another should not be connected by a short straight. It is better to introduce a flat curve between curves of the same sense or to extend curves of the opposite sense to a common point.

Sharp horizontal curves starting at a summit may be dangerous as drivers may not be able to see them in time. Sharply undulating profiles are undesirable as drivers may be tempted to overtake without realising that oncoming vehicles may be hidden from view in the dips.

3.1.2 Elevated and sunken roads

Where the need for grade separation on urban motorways and other important routes entails their construction as elevated or sunken roads, great care will obviously be needed in their location and planning to avoid destruction of amenity and disruption of local communications.

Sunken roads in tunnel can be planned so as not to interfere with surface roads or development, but the high cost of tunnels may inhibit their construction unless development is allowed above them. Sunken roads in cutting do not form a visual barrier but may restrict cross-traffic at surface level; they should usually be depressed about 20 ft. below the existing street system to ensure adequate headroom at bridges without having to regrade the streets on the bridge approaches. Unless the road is flanked by retaining walls, extra width will be required to accommodate side slopes, though these will help to give the road an open appearance and will afford opportunities for planting and landscaping. Building the road in cutting and planting the slopes will help to muffle traffic noises. The diversion of public utility services crossing the road and the drainage of surface and ground water in the cutting may present difficulties. Sunken roads can be linked to the existing street system more easily than elevated roads as the slip road gradients assist deceleration when leaving the sunken road and acceleration when joining it.

Elevated roads may be on embankment or viaduct and can be designed to cause little or no interference to cross-streets and underground services. They are easier to drain than sunken roads. Viaducts require less space than roads on embankment and will be more suitable in constricted areas; they have the advantage that supporting piers can be arranged and spaced to fit in with existing features or property. The space underneath elevated roads can sometimes be used for buildings or parking. Although elevated roads will be conspicuous because of their height and size, there is no reason why they should be detrimental to amenity provided they are well designed and properly sited. Their alignment may largely be governed by the location of interchanges, but where possible they should be sited well away from existing buildings, particularly in residential areas. To minimise interference to existing property it may sometimes be possible to route elevated roads above railways or through areas due for redevelopment.

3.2 Design speeds

The design speed of a highway is that chosen for the correlation of such features as sight distances, curvature and superelevation upon which the safe operation of vehicles depends. It is the maximum speed maintainable throughout the journey compatible with safety and comfort when weather and traffic conditions are favourable and the geometric features of the highway are the controlling factors.

Suggested design speeds for urban roads are as follows:

Primary distributor: urban motorway	50 mph
Primary distributor: all-purpose	40 mph
District distributor, local distributor, important *access road*	30 mph

These recommendations are intended only as a guide; it may sometimes be practicable to raise, or necessary to lower, the design speed for certain types of road or for parts of a road, though 30 mph should be regarded as the minimum value for all distributors. For example, physical restrictions on the alignment of an urban motorway may make it impracticable to achieve a design speed of 50 mph, and a standard of 40 mph may have to be accepted instead.

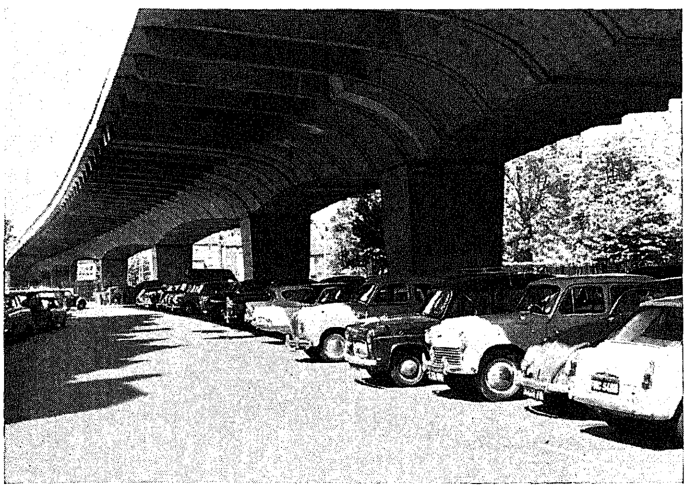
3.3 Sight distances

Sight distances, both vertical and horizontal, should be measured between points 3 ft. 6 in. above the carriageway along the centre lines of both the nearside and offside lanes of the carriageway. On dual-carriageway roads sight distances should be checked on both carriageways.

On single-carriageway roads sufficient visibility for safe overtaking should be provided on as much of the road as possible. It will often be impracticable to achieve this standard, especially in hilly districts or where there are buildings close to the road on the inside of a curve, but in no case should visibility be less than the minimum stopping distance given in Table 3–1. Particular care should be taken to ensure that on horizontal curves visibility is not restricted by shrubs, bridge piers or other obstructions at the side of the road or on the central reserve.

Table 3–1 Minimum sight distances

Design speed mph	Sight distances: Minimum overtaking distance (single carriageway) ft.	Sight distances: Minimum stopping distance (single and dual carriageways) ft.
50	1,200	425
40	950	300
30	700	190
20	480	110



Car park under Hammersmith Flyover

3.4 Gradients

A gradient of 1 in 25 should ordinarily be regarded as the maximum on the through carriageways of urban motorways and other *primary distributors*, but in hilly districts and other difficult locations gradients of up to 1 in 20 may have to be accepted on urban motorways and even steeper gradients on all-purpose roads. Steep gradients should be kept as short as possible.

It is impracticable to specify a maximum gradient for other urban roads, as these are more likely to be affected by the restrictions of topography and development than *primary distributors*. Although the same standards as for *primary distributors* should be used wherever possible, particularly for *district distributors*, the adoption of steeper gradients will sometimes be unavoidable despite their adverse influence on road capacity and safety. Junctions should preferably be located away from steep gradients, especially where the road is on a curve.

On steep sections of heavily trafficked roads the installation of road heating may be warranted to prevent the formation of ice on the road surface.

To avoid congestion on busy distributor roads with long, steep gradients the provision of a special climbing lane for the slower-moving commercial vehicles may be warranted. It is suggested that the economic case for providing a climbing lane should be examined where grade lengths exceed the values given in Table 3–2, which is based on American recommendations.[8] On a single three-lane carriageway a climbing lane may be obtained by providing an offset double white line, with permissive marking for downhill overtaking where visibility is adequate.

Table 3–2 Critical grade lengths

Gradient %	Critical grade length ft.
3	1,600
4	1,100
5	800
6	650

To facilitate the drainage of surface water, channel gradients steeper than 1 in 250 are desirable. If possible the general road gradient should be steeper than 1 in 250, but where flatter gradients have to be accepted it may be necessary to steepen the channel between gullies to obtain the required minimum fall.

3.5 Vertical curves

Vertical curves should be provided at all changes of gradient. In urban areas the restrictions imposed by topography and development may not permit correlation of horizontal and vertical curves to the same extent as in rural areas, but where possible this should be done.

To ensure reasonable standards of comfort and appearance and to secure appropriate visibility at summits, vertical curves should not be shorter than:

(i) indicated by the formula $L = KA$, where L is the curve length in feet, A is the algebraic difference in gradients (expressed as a percentage) and K has a value selected from Table 3–3, or
(ii) shown in the fourth column of the table if longer than (i).

Summit curves designed using the K values given in the second column of the table will have sight distances just adequate for overtaking on two-way roads with a single carriageway. The K values shown in the third column will ensure acceptable stopping sight distances at summits and a reasonable ride at both summits and valleys; these minimum standards will apply to dual-carriageway roads, one-way roads and those two-way single-carriageway roads where physical conditions preclude the achievement of better visibility.

Where K values of over 125 are used the channel gradients at summits and valleys will be flatter than 1 in 250 for more than 100 ft., and surface water drainage may require special attention.

Table 3–3 Minimum vertical curve lengths

Design speed mph	Minimum K value for overtaking	Minimum K value for stopping and comfort	Minimum vertical curve length ft.
50	—*	65	150
40	—*	35	120
30	175	20	90
20	85	10	60

*Values not quoted as dual-carriageway layouts will normally be appropriate for these design speeds.

3.6 Horizontal curves and superelevation

It is desirable that all-purpose roads in urban areas should not be superelevated too steeply, and superelevation should preferably not exceed 1 in 24 on roads with single-level junctions and little or no restriction of frontage access. In no case should superelevation be steeper than 1 in 14½ or flatter than the standard carriageway crossfall. Adverse camber should be eliminated or superelevation introduced where necessary.

As indicated in Ministry of Transport Memorandum No. 780[9] superelevation should normally be 1 in $\frac{37r}{V^2}$, where V is the design speed in mph and r the curve radius in feet. Values for design speeds of 30, 40 and 50 mph are shown in Fig. 3–1. The minimum radius for any given design speed and superelevation is governed by the formula $\frac{V^2}{15r} = s + f$, where s is the superelevation in feet per foot and f the side-friction factor. Table 3–4 compares normal and minimum radii for certain design speeds and rates of superelevation; the minimum values assume side-friction factors of 0.18 up to and including 30 mph and 0.15 at higher speeds.

Table 3–4 Normal and minimum radii for 1 in 24 and 1 in 14½ superelevation

Design speed mph	Normal radius (ft.) for superelevation of:		Minimum radius (ft.) for superelevation of:	
	1 in 24	1 in 14½	1 in 24	1 in 14½
50	1,620	980	870	760
40	1,040	630	560	490
30	590	360	270	240
20	260	160	120	110

On curves with radii below those given in the second column of Table 3–5 it is recommended that adverse crossfall or camber should be eliminated to give a uniform crossfall towards the inside of the curve. On curves with greater radii the elimination of adverse crossfall, though not essential, will sometimes be desirable on the grounds of appearance. Transition curves are desirable at the ends of curves with radii below those shown in the last column of the table; it will often be useful to provide transitions for curves of greater radius to improve their appearance and facilitate the introduction of superelevation or the elimination of adverse camber.

Table 3–5 Radii for elimination of adverse camber or provision of transition curves

Design speed mph	Eliminate adverse crossfall if radius is less than: ft.	Provide transition curves if radius is less than: ft.
50	6,000	4,000
40	4,000	2,000
30	2,000	1,000
20	1,000	500

Superelevation should not be introduced or adverse crossfall removed so gradually as to create large almost-flat areas of carriageway or so sharply as to cause discomfort or give the edges of the carriageway a kinked appearance. A satisfactory appearance can usually be achieved by ensuring that the carriageway edge profile does not vary in grade more than about 1% from that of the line about which the carriageway is pivoted and by ample rounding-off of all changes in edge profile. Where transition curves are provided, superelevation or removal of adverse crossfall should be effected along their length. In other cases about two-thirds of the cant should be introduced on the approach straight and the remainder at the beginning of the curve.

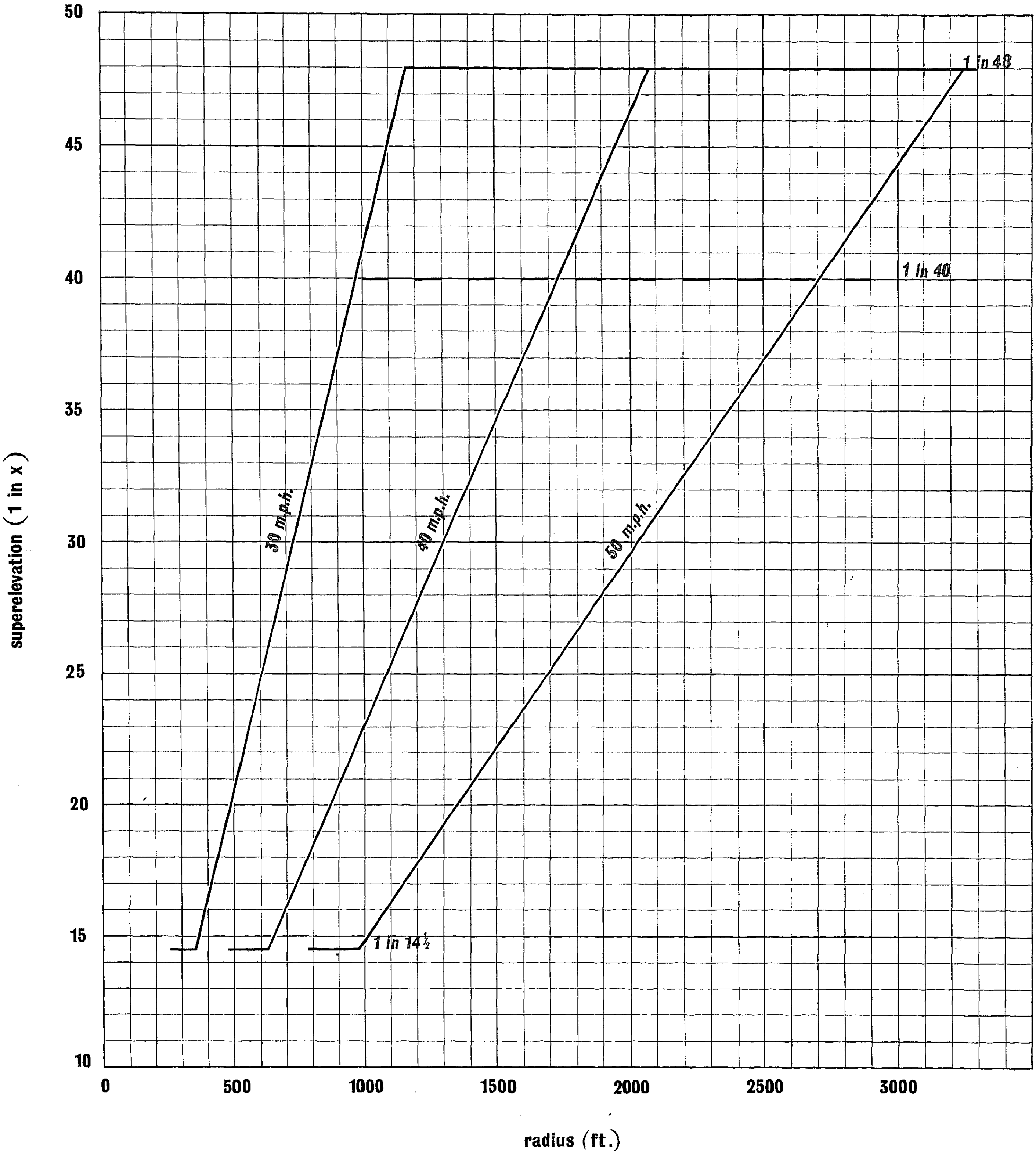


Fig. 3–1 Superelevation values for various radii

4 The road in cross-section

The width and layout of a road will depend largely upon the type, volume and speed of the traffic it will carry. The design of the various components of the road for the accommodation and safety of vehicular and pedestrian traffic is considered below.

4.1 Carriageways

4.1.1 Traffic lanes

Lane widths should be chosen with particular regard to the type, volume and speed of traffic using the road. Recommended lane widths for various types of road are given in Table 4–1.

Table 4–1 Recommended lane widths

Road type	Recommended lane widths	
	Single two-lane carriageway	Dual or divided carriageway with at least four lanes
Primary distributor	—	12 ft.
District distributor	12 ft.	12 ft. normally 11 ft. if the proportion of heavy commercial traffic is fairly low
Local distributor	12 ft. in industrial districts 11 ft. in principal business districts 10 ft. in residential districts	—
Access road	Principal means of access: 12 ft. in industrial districts 11 ft. in principal business districts 9 ft. normally in residential districts	—
	Secondary means of access: 10 ft. in industrial and principal business districts On back roads in residential districts a *two-lane* width of 13 ft. will suffice if use is limited to cars	—

A nearside lane width of 14 ft. may be desirable on roads carrying large numbers of cyclists.

At single-level junctions where additional lanes are required for turning traffic but where space is restricted it may be necessary to reduce the normal lane width to 9 ft. or exceptionally even to 8 ft. 6 in.

4.1.2 Lane widening on curves

An appropriate amount of lane widening on sharp curves is desirable on all roads. On roads with 12 ft. traffic lanes the carriageways on curves of less than 500 ft. radius should be widened by 1 ft. per lane. For lane widths of less than 12 ft. the added width should be 1 ft. per lane on curves of less than 1,500 ft. radius, increasing to 1 ft. 6 in. per lane on curves of less than 1,000 ft. radius and to 2 ft. per lane on curves of less than 500 ft. radius. The recommendations apply to curves of 300 ft. radius and over; recommended lane widths for sharper curves such as on connecting carriageways in junctions are given in Table 10–2.

No lane widening is required on three-lane carriageways marked as two lanes on curves.

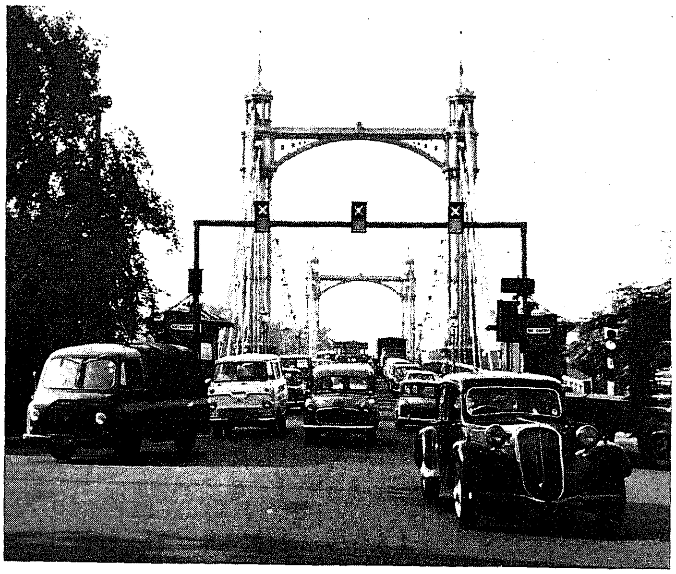
4.1.3 Carriageway widths

Roads should be planned with sufficient width for the estimated future traffic. This should be done even where land acquisition and provision of the full capacity required is to be carried out in stages. Where necessary, provision should be made for additional lanes on the approaches to junctions to accommodate right- or left-turning traffic.

Except possibly in tidal-flow systems, carriageways for two-way traffic should normally have an even number of lanes. Three-lane carriageways with a central overtaking lane are not appropriate for urban traffic conditions and, if future traffic volumes exceed two-lane capacity, at least four lanes should be provided where practicable. Where the opposing traffic streams are separated by a chain of refuges or a continuous central reserve the overall width should be increased to accommodate that of the refuges or reserve.

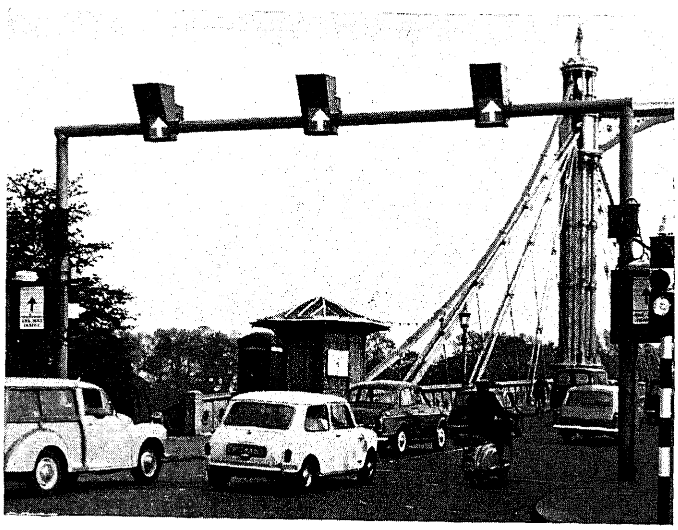
If suitable arrangements can be made to indicate the direction of travel in each lane the introduction of a tidal flow system may allow some economy in the number of lanes required. Except possibly on short lengths, two-way tidal flow is unlikely to be satisfactory on three- or four-lane carriageways (i.e. where only one lane would be available for the lighter flow and might easily be blocked by a waiting or broken-down vehicle) but may be suitable for wider roads where at least two lanes are available for the lighter flow. Arrangements for tidal flow are more difficult on roads where opposing traffic streams are separated by a dividing island, but may be warranted on certain heavily trafficked routes, e.g. on radials with heavy flows inwards in the morning and outwards in the evening. In such cases provision for tidal flow may be made by construction of three carriageways instead of two, thereby allowing for reversal of flow on the centre carriageway. A tidal flow system for a three-carriageway urban motorway is shown in Fig. 4–1.

On urban motorways the opposing traffic streams should always be separated. Separation will usually be effected by means of a central reserve but can also be achieved by one-way road systems



One-way tidal flow on Albert Bridge: morning flow into Central London

One-way tidal flow on Albert Bridge: evening exodus from London



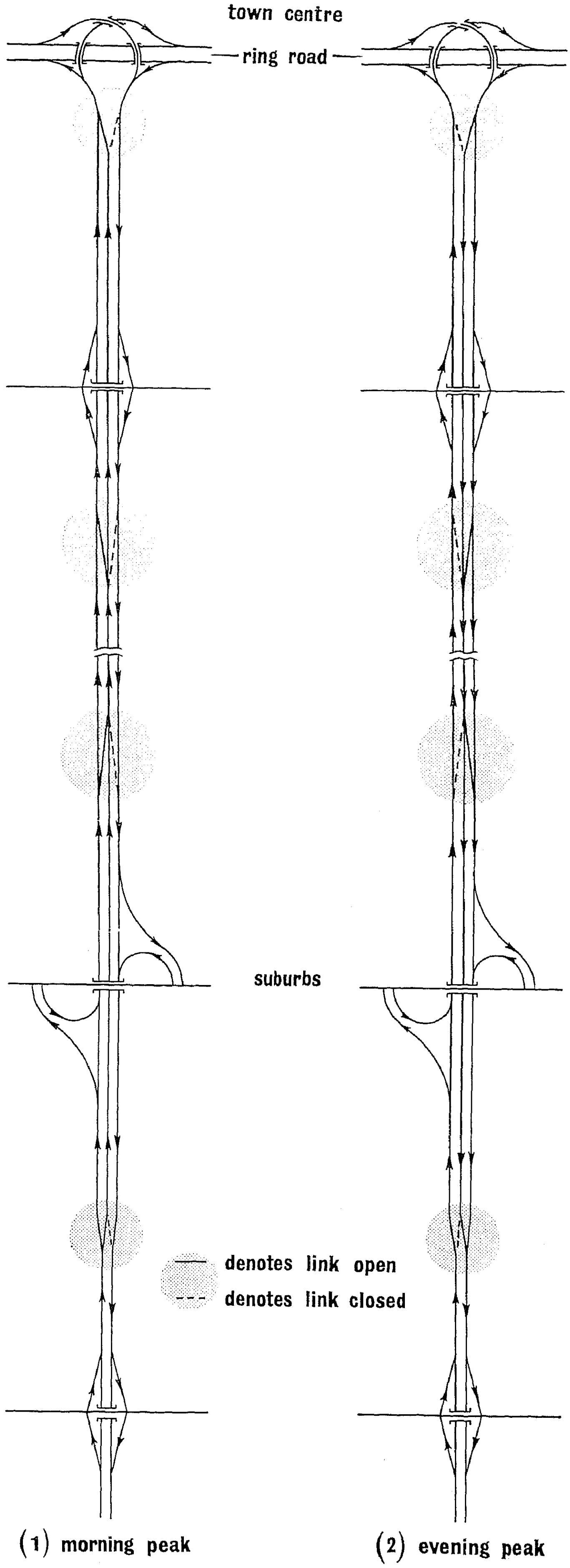


Fig. 4–1 Tidal flow on three-carriageway urban motorway

or by building one carriageway above the other. Dual-carriageway layouts or other methods of separation will also be appropriate for other *primary distributors* and for *district distributors* carrying large volumes of traffic, such as those serving business and industrial areas. The number of lanes in each direction will depend upon the estimated future traffic but should not be less than two and will rarely need to be more than four.

4.1.4 Camber and crossfall

Except on curves where superelevation or elimination of adverse crossfall or camber is required, carriageways should normally have a crossfall neither steeper than 1 in 40 nor flatter than 1 in 48 from the crown or central reserve downwards towards the side of the road. Excessive camber is a source of danger to drivers and cyclists and should be eliminated. Not only does it reduce the traffic capacity of the road but it may cause loads to be displaced or lead to vehicles side-slipping in icy conditions.

At the junction of a side street with a major road the carriageway of the side street should be graded into the channels of the major road, which should retain its normal cross-section throughout the junction.

Where new or improved roads with dual carriageways have to be fitted to existing features, varying the level of the two carriageways may be helpful. Even on roads with only a single carriageway a difference in kerb levels may be useful, provided due care is taken in the treatment of the camber and crossfalls.

4.1.5 Kerbs

Kerbs should normally be light-coloured and should be clearly distinguishable from other parts of the road by day or night and in wet or dry weather.

As shown in Fig. 4–2 raised kerbs with vertical or half-batter faces about 4 in. high should be provided where footways or cycle tracks lie within about 10 ft. of the carriageway or where obstructions such as bridge piers and lighting columns are less than 5 ft. from the carriageway. 45° splayed kerbs may be installed instead where greater clearances are available or safety fences are provided.

On roads without footways or cycle tracks, or where these are on embankment above the road or separated from it by safety fencing, lip or flush kerbs or marginal strip markings may be used, provided obstructions such as bridge piers and lighting columns are at least 5 ft. clear of the carriageway and the face of any safety fence is at least 4 ft. from the carriageway. Flush kerbs or marginal strips are not suitable where positive control of drainage is required at the edge of the carriageway. The provision of a slight ripple or corrugation on the face of a flush kerb (not enough to cause danger to two-wheeled vehicles) may help to prevent overrunning by setting up an audible vibration in an encroaching vehicle but should not be regarded as an alternative to making the kerb adequately visible.

Where footways are much used by perambulators or wheelchairs, kerb heights should be reduced to about 1 in. above channel level adjoining pedestrian crossings and other suitable crossing points. The footway should be ramped down in an easy slope towards the lowered kerb.

4.1.6 Central reserves

On urban roads requiring more than two traffic lanes it will usually be desirable to separate the opposing traffic streams by a central reserve unless tidal flow operation is envisaged.

Although central reserves will often be narrow because space is restricted, the adoption of a greater width where conditions permit will enhance the appearance and safety of the road. A reserve width of at least 6 ft. is desirable, especially at points where pedestrians have to cross the road, but a minimum width of 4 ft. may have to be adopted at pinch points. Where there are bridge piers, lighting columns, etc. on the reserve the minimum width will depend upon the width of the obstructions and the clearances needed between them and the carriageways; minimum clearances are given in Table 4–2.

Reserves 6 ft. wide or less should normally be paved and bordered by raised kerbs. The type of kerb should be chosen in accordance with Sub-Section 4.1.5. The paving should be either slightly cambered or dished for ease of drainage and should preferably contrast with the carriageways in colour and texture. Where conditions are suitable for the growth of grass, reserves over 6 ft. wide may be grassed, provided there are no fences or other obstructions along the reserve which would interfere with grass-cutting operations. Special consideration should be given to the drainage of surface water from wide reserves; the adoption of a slightly dished cross-section will ensure that water does not run across the carriageways.

On curves the central reserve should normally have the same cross-section as on straights. Where, however, the method of superelevation involves the tilting of the reserve its crossfall should not be dangerously steep. Unless safety fencing is installed to protect traffic the crossfall should not usually be steeper than 1 in 6.

Obstructions on the reserve are a potential danger to traffic and their number should be kept to a minimum. Care should be taken to ensure that they do not unreasonably restrict visibility on bends or at junctions; widening of the reserve may be necessary to give the required minimum sight distances. On urban motorways and other heavily trafficked roads where speeds are high, safety fencing erected in advance of obstructions will be needed for the protection of vehicles; if the reserve is narrow the erection of continuous safety fencing may be warranted not only to screen obstructions but to prevent accidents due to vehicles crossing the reserve.

On the approaches to an intersection the central reserve may have to be widened to accommodate a lane for right-turning traffic. Care should be taken to ensure that these local widenings do not spoil the general alignment of the carriageways.

Low kerb at pedestrian crossing

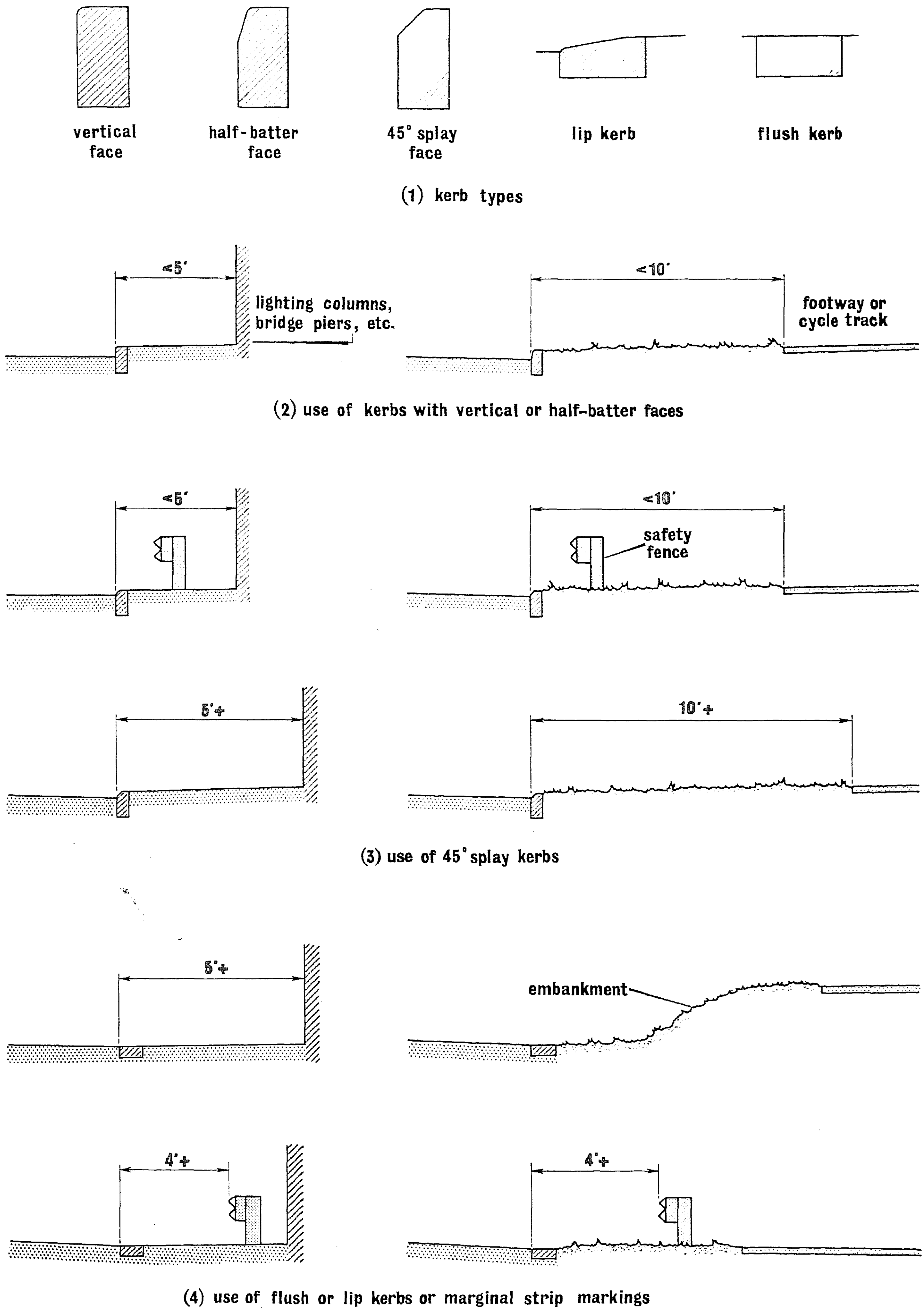

vertical face
half-batter face
45° splay face
lip kerb
flush kerb
(1) kerb types
<5'
lighting columns, bridge piers, etc.
<10'
footway or cycle track
(2) use of kerbs with vertical or half-batter faces
<5'
<10'
safety fence
5'+
10'+
(3) use of 45° splay kerbs
5'+
embankment
4'+
4'+
(4) use of flush or lip kerbs or marginal strip markings

Fig. 4–2 Kerbs

4.1.7 Central reserve crossings

On urban motorways central reserve crossings will be needed to enable traffic to be diverted from one carriageway to the other in the event of an emergency or to enable maintenance and repairs to be carried out. A typical crossing is shown in Fig. 4–3.

Crossings should normally be provided in the following positions along urban motorways:

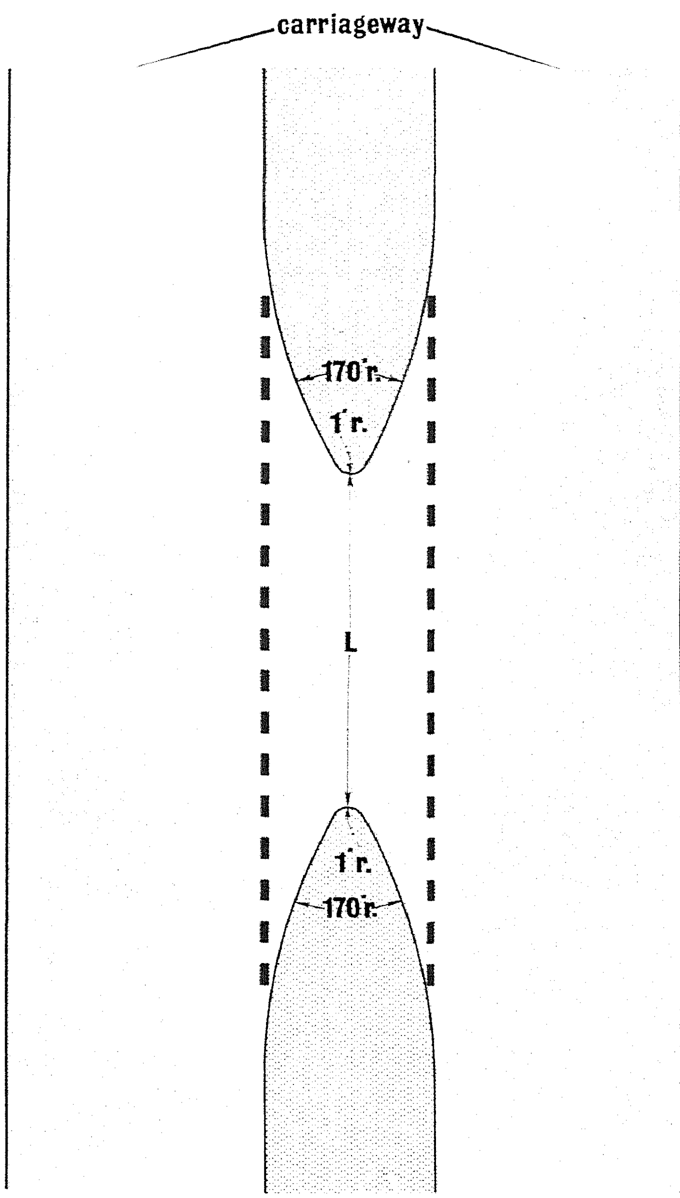
(i) near to all terminal junctions;

(ii) at other junctions approximately opposite the mid-point of all acceleration and deceleration lanes (where speed change lanes are arranged in pairs on either side of the motorway one crossing will suffice for each pair);

(iii) at intervals of approximately one mile between all junctions.

When not in use, crossings should be closed to traffic by means of light, easily-removable barriers.

On all-purpose roads with dual carriageways and single-level junctions it will not usually be necessary or desirable to provide crossing places other than those that may be needed at major junctions. Crossings should not normally be provided opposite culs-de-sac or other minor roads or opposite the accesses to petrol filling stations, public houses, factories, etc.



central reserve width (ft.)	4	6	8	10	15	20
crossing length L (ft.)	75	65	60	55	50	45

Fig. 4–3 Central reserve crossings

4.1.8 Divided carriageways

On roads where traffic speeds are restricted to 30 mph the separation of traffic streams by a chain of refuges instead of a continuous central reserve may have to be accepted. Refuges along divided carriageways should preferably be not more than 100 yds. apart and should be inter-visible. Where possible the normal lane width should be maintained past refuges; if the street width is limited the clearances between a refuge and the kerbs may have to be reduced slightly but should not be less than 18 ft.

To enable refuges to be seen easily they should have internally illuminated bollards at each end and an indicator lamp about 16 ft. high in between. The indicator lamp should be sufficiently well illuminated to be clearly visible at night but should not be so brightly lit as to cause distraction to drivers or become a substitute for the normal street lighting. The lamp standard should be positioned to minimise obstruction to pedestrians. It may sometimes be necessary to site a street lighting column at a refuge instead of an indicator lamp.

Refuges should normally be 6 ft. wide and never less than 4 ft. wide. They should have openings in the centre at carriageway level for the convenience of pedestrians, especially of those with perambulators. Both ends of the refuge should be tapered and not semicircular in plan, and should be formed by kerbs about 4 in. high with light-coloured vertical or near-vertical faces. White warning lines should be painted on the carriageway on the approaches to the refuge.

4.1.9 Clearances

Recommended minimum clearances between the edge of the carriageway and obstructions on the footway, verge or central reserve are specified in Table 4–2 and illustrated in Fig. 4–4. The clearances allow for overhanging loads and the tilting of vehicles towards the obstruction by the crossfall or super-elevation of the carriageway. To encourage the correct placement of vehicles on the carriageway, greater clearances should be provided where possible, especially on roads with design speeds above 30 mph. Where an obstruction is located on the inside of a bend a greater clearance than that specified may be required to ensure that the sight distance is not less than the minimum stopping distance.

Table 4–2 Clearances from the carriageway

		Minimum clearance where carriageway crossfall is:		
Design speed mph	Height of object on footway, verge or central reserve	away from object, or towards object but not steeper than 1 in 40	towards object but not steeper than 1 in 24	towards object and steeper than 1 in 24
30	Less than 10′ 0″	1′ 6″	1′ 9″	2′ 0″
	10′ 0″ and above	1′ 6″	2′ 0″	2′ 6″
40 or 50	Less than 10′ 0″	Minimum in all cases ... ... 2′ 0″ Desirable where conditions permit 4′ 0″		
	10′ 0″ and above	Minimum in all cases ... ... 3′ 0″ Desirable where conditions permit 5′ 0″		

Six-lane divided carriageway

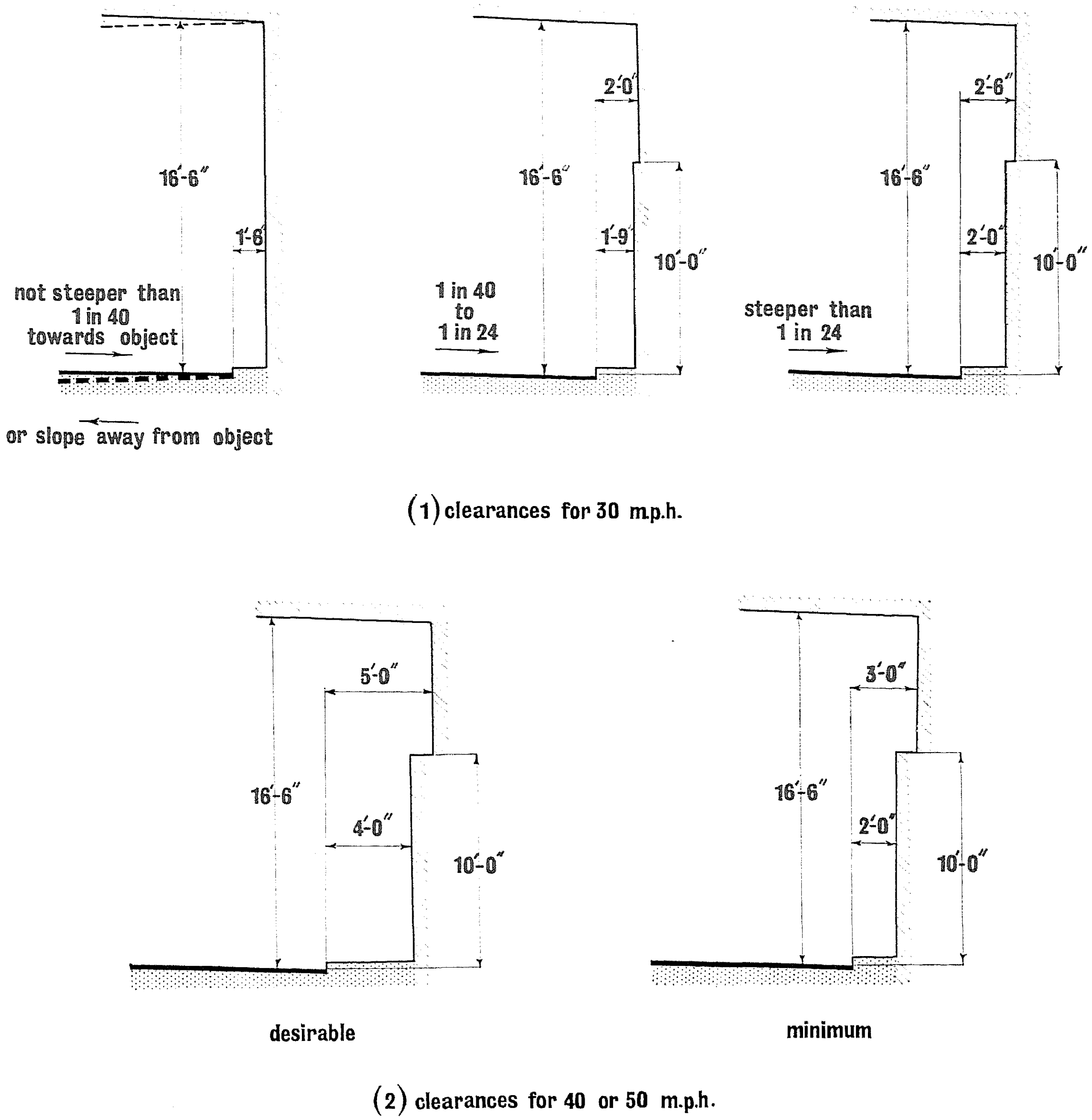


Fig. 4–4 Minimum clearance profiles

4.1.10 Lay-bys

On existing *district* and *local distributors* there will seldom be room for the construction of lay-bys, though their provision should be considered as part of the measures to relieve congestion at those bottlenecks where it has been necessary to tolerate some waiting despite obstruction to the flow of traffic. As proposals for future development should include adequate arrangements for off-street parking and service access to premises, lay-bys should rarely be needed on new or extensively improved streets in these categories.

On all-purpose *primary distributors* (which are intended primarily for the rapid movement of large volumes of traffic) the provision of lay-bys at regular intervals will help to maintain steady flow by enabling a driver to stop clear of the carriageway if, for example, he needs to consult a map, check the loading or functioning of his vehicle or visit a nearby convenience. The presence of lay-bys at fairly frequent intervals should also help to reduce the number of breakdowns on the carriageway. It is accordingly recommended that lay-bys should be spaced at intervals of not more than one mile on each side of these roads. They should also be provided on those lengths of urban motorway without paved verges, where they should be spaced at intervals of not more than half a mile along each carriageway. They should not be sited where their use might unduly restrict visibility or interfere with the movement of traffic, as, for example, on the inside of a bend or on the approaches to a junction.

Typical layouts for lay-bys are shown in Fig. 4–5. To enable vehicles to leave or rejoin the carriageway smoothly, lay-bys should have tapered ends. They should normally be 10 ft. wide and at least 100 ft. long excluding the end tapers. Lesser widths may have to be accepted where space is restricted, but where possible lay-bys should be at least 8 ft. wide. Suitable arrangements should be made for the drainage of surface water from lay-bys; a crossfall outwards from the kerb towards the carriageway will reduce the risk of splashing.

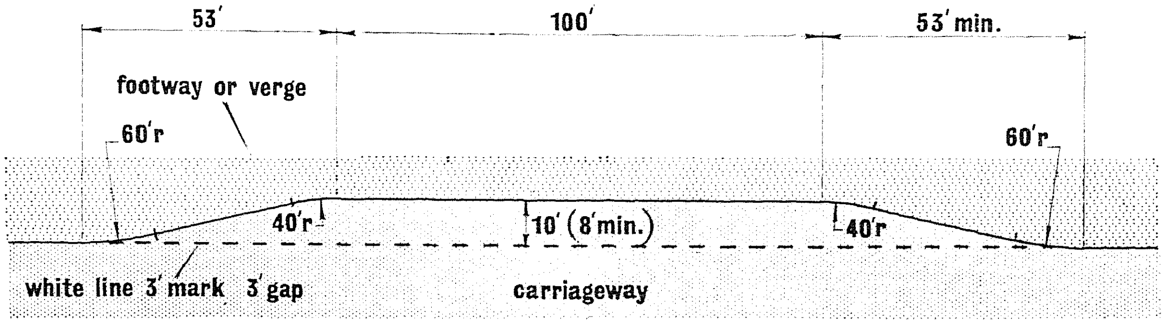
It will often be convenient to site lay-bys and bus bays together. As shown in Fig. 4–5 a combined lay-by and bus bay should be at least 150 ft. long excluding end tapers and between 9 ft. and 10 ft. 9 in. wide.

On roads linked to the national motorway network, lay-bys should be installed at convenient points near the interchanges to enable drivers to check their vehicles or consult maps before entering or after leaving the motorway.

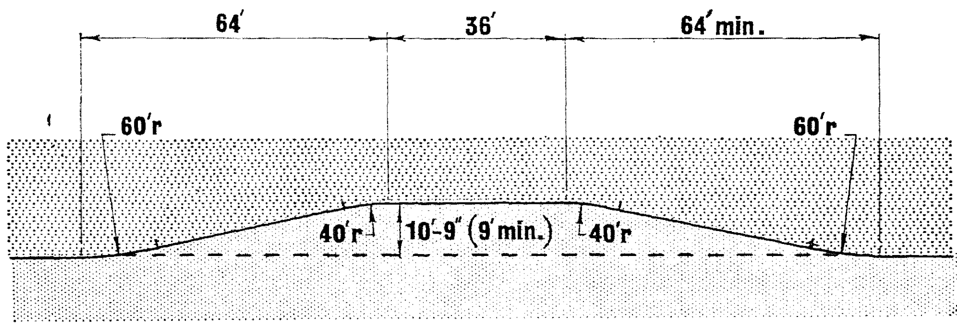
4.2 Footways

4.2.1 Footway widths and construction

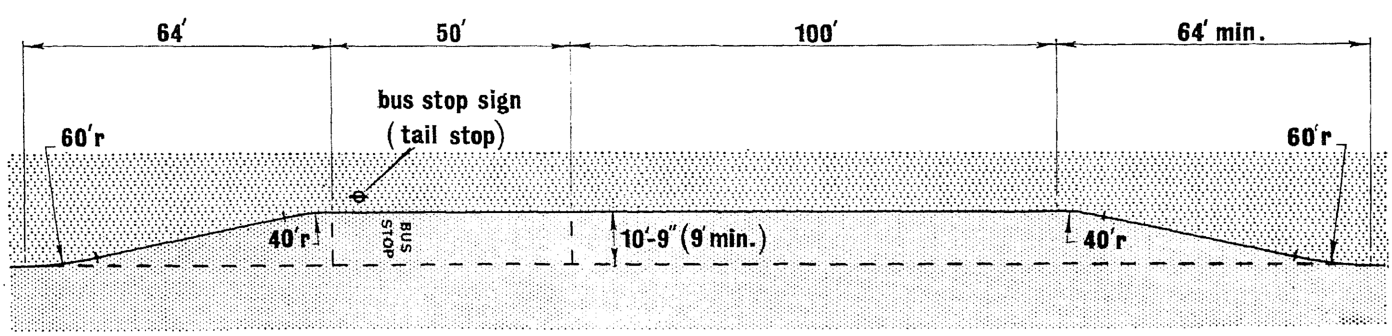
When designing new roads or improving existing ones in urban areas, it should be considered whether alternative arrangements should be made for pedestrians which would dispense with the need for footways alongside the carriageway. If, however, footways are provided they should be amply wide and comfortable to walk upon, so as to minimize any tendency for pedestrians to walk along the carriageway. They should have well-maintained surfaces with crossfalls neither so flat as to be difficult to drain nor so steep as to be dangerous to walk upon. Crossfalls within the range 1 in 40 to 1 in 30 should meet these requirements. Surfaces should not be slippery and should be carefully graded to avoid ponding. Paving slabs should be firmly bedded, with close, flush joints; bituminous surfacings should be free from loose chippings.



(1) lay-by



(2) standard bus bay



(3) combined lay-by and bus bay

Notes:

1. The run-out length should be increased where difficulties of visibility or exit make this desirable.

2. At bus bays the bus stop sign should be erected at the point where passengers enter and alight.

3. Where provision has to be made to accommodate more than one vehicle in a bus bay at the same time, the length of the widest section should be increased to allow at least 3 ft. between standing vehicles.

4. Where carriageway markings are necessary they should conform to the appropriate regulations for white line markings and lettering.

Fig. 4–5 Layouts of lay-bys and bus bays

Those parts of the footway immediately adjoining buildings, fences, trees and other obstructions will not be available for the free movement of pedestrians and should be disregarded when calculating the width required. Minimum clearances between the edge of the carriageway and obstructions on the footway are specified in Table 4–2. The capacity of open footways may be taken as 10 to 15 persons per foot width of pavement per minute after deducting approximately 3 ft. 'dead width' in shopping areas and 1 ft. 6 in. elsewhere.

Recommended footway widths for various types of road are given in Table 4–3. Greater widths may be necessary where pedestrian traffic is heavy or additional space is required for underground services.

Table 4–3 Recommended footway widths

Type of road	Recommended minimum footway widths
Primary distributor:	
Urban motorway	No footways
All-purpose road	9 ft.*
District distributor	9 ft. in principal business and industrial districts* 8 ft. in residential districts*
Local distributor	9 ft. in principal business and industrial districts* 6 ft. in residential districts*
Access road	Principal means of access: 9 ft. in principal business districts.* 6 ft. in industrial districts* 6 ft. normally in residential districts* 12–15 ft. adjoining shopping frontages
	Secondary means of access: 3 ft. verge instead of footway on roads in principal business and industrial districts 2 ft. verge instead of footway on roads in residential districts

*If no footway is required provide verge at least 3 ft. wide

Footways adjoining short shopping frontages (e.g. in residential streets) should be at least 12 ft. wide; a minimum of 15 ft. is desirable adjoining longer shopping frontages such as those in the town centre. These footways will usually have to accommodate more pedestrians and perambulators than any others, and it is important that they should be wide enough for free movement and for shop window gazing without risk of being jostled.

At points of possible congestion such as bus stops and the entrances to large shops and public buildings it may be necessary to widen the footway by setting back the frontage line or arcading the buildings. It will often be useful to design bus queue shelters so that pedestrians can walk through them when there are no people waiting. Passenger shelters with seats should usually be located at the back of the footway or behind the highway boundary.

Where space is available for a more generous layout the provision of a verge between the footway and the carriageway will add to the safety of pedestrians by increasing their separation from moving vehicles. Verge widths and construction are considered in Section 4.4. When deciding the width required for footways and verges, that needed to accommodate underground services clear of the carriageways should also be taken into account (see Section 7.3).

The erection of pedestrian guard rails along the edge of the verge or footway will give effective segregation but may lead to access difficulties, especially where premises have no secondary means of access. Possibly the most useful function of guard rails is the guidance and protection of pedestrians at points of special danger such as busy road junctions. Pedestrian guard rails should be neat and simple in appearance; their height and construction should deter children from climbing through or over them.

4.2.2 Elevated footways

Elevated footways offer opportunities for imaginative architectural design and are being included in a number of important development projects. They ensure complete segregation of pedestrians from vehicles and enable wider carriageways to be constructed at ground level. Their width should be calculated in the same way as for those at ground level, and the same minimum standards should apply; care should be taken to avoid giving pedestrians any sense of restriction. If elevated footways are located above the carriageway there must be at least 16 ft. 6 in. headroom for vehicles, and the appropriate clearances must be maintained between the carriageway and any supports for the footway. Where elevated footways are situated outside the highway boundary (e.g. on the podium of a building) they may be at some other level, provided adequate headroom is available at any vehicular access to the building. Even though no footways may be needed at ground level, kerbed and paved margins at least 3 ft. wide should be constructed alongside the carriageway to protect buildings abutting the road and for the use of police and maintenance staff.

Appropriate arrangements will be needed for the drainage of elevated footways to ensure that water does not run on to the vehicles below. Parapets should be high enough and so constructed as to deter children from climbing through or over them. For safety, parapets need to be at least 3 ft. 3 in. high, but to avoid an unduly heavy appearance they should preferably not be higher than 4 ft.

Elevated footways should be inter-connected by bridges across the road at suitable intervals. Access to ground level should be provided at bus stops and other convenient points by means of ramps, stairs or escalators.

4.2.3 Arcading over footways

The upper storeys of buildings may be allowed to project forward over the public footway provided daylighting and sunlighting standards can be maintained, minimum headroom of 16 ft. 6 in. can be obtained over the full highway width and no supporting columns or piers are required within this width.

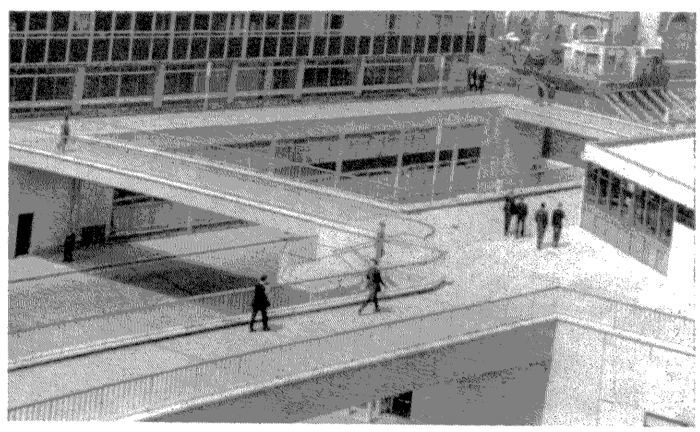
It will sometimes be possible to recess shop fronts behind the highway boundary, thereby increasing the width of the footway and protecting shoppers in bad weather. Alternatively, protection can be given by canopies projecting over the footway; these should be cantilevered from the buildings to avoid the need for supports obstructing the footway. Canopies should have adequate clearance from the edge of the carriageway in accordance with Table 4–2.

4.2.4 Pedestrian arcades

Arcades have the advantages of enabling people to do their shopping under cover and of keeping them away from moving vehicles. Arcades should preferably be at least 20 ft. wide and, for maximum effectiveness, should be sited on or between main

Walk-through queue shelters

. . . Pedestrian guard rails should be neat and simple in appearance; their height and construction should deter children from climbing through or over them



Elevated footway system with linking bridges, London Wall

Buildings cantilevered over the footway provide weather protection for shoppers

Subway with ramped approaches as well as steps

Shops can help to make subways more attractive

It is often useful to site pedestrian subways in conjunction with bus stops

pedestrian routes. They should be served by back streets for goods delivery and should have car parks near at hand for the convenience of customers and to avoid congestion in nearby streets.

4.2.5 Pedestrian ways

These should be planned as a secondary network of streets for pedestrians only, thereby ensuring that those who use them are segregated from vehicular traffic. They will be useful not only in shopping and business precincts but also in residential areas, where they should be planned to give direct and convenient access from houses to shops, schools, open spaces, etc. independently of the general road system. They should be linked to coach and bus stops and railway stations.

It is important that pedestrian ways should be suitably wide, especially at points where pedestrians are likely to congregate. In business areas they should usually be at least 20 ft. wide and in residential areas at least 6 ft. wide. Where necessary they should be carried over or under any roads which they cross.

4.2.6 Pedestrian bridges and subways

Bridges or subways solely for the use of pedestrians will be required as part of a pedestrian way system and at busy junctions and other points where pedestrians need to cross the road in large numbers. As pedestrian bridges and subways are usually fairly short and are intended solely for movement they can reasonably be assumed to have a higher acceptable capacity than ordinary footways, but flows should not exceed 27 persons per foot width per minute on the level and 19 persons per foot width per minute on stairs or ramps. A 'dead width' of about 2 ft. 6 in. is usually allowed adjoining any display windows in subways.

Where possible, bridges and subways should have ramped approaches as well as steps. Continuous ramps should preferably not be steeper than 1 in 10. Consideration should be given to the possible need for a surface-heating system to obviate hazards due to snow and ice where steeper gradients are necessary. Bridges should have clear headroom of 16 ft. 6 in. above the carriageway and in the case of permanent structures a deck width of at least 6 ft. Subways should have a minimum width of 7 ft. 6 in. and at least 7 ft. headroom for pedestrians. They should be attractive in appearance and, for public confidence and safety, should have straight and well-lit passageways free from recesses.

To ensure the maximum effectiveness of these expensive facilities their use should not involve long detours or unnecessary climbing. Bridges are generally cheaper than subways but usually require more climbing. Construction of subways across existing streets may involve heavy expenditure on the diversion and regrading of services; underground services in new roads should be located so that proposed subways can be kept as shallow as possible.

It may sometimes be possible to minimise interference to services and reduce the number of steps to be climbed by raising the level of the carriageway over a subway.

Where possible, pedestrian subways or bridges should be sited in conjunction with bus stops.

4.2.7 Crossing the carriageway

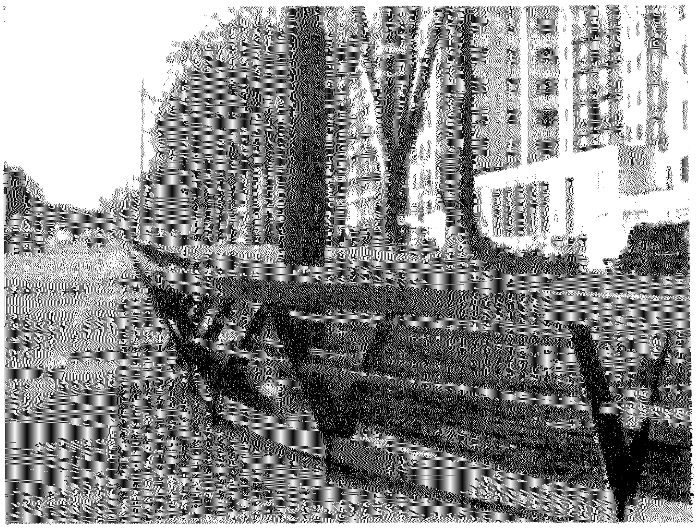
Pedestrians who cross the carriageway at random are in far more danger than those who do so at recognised crossing places. If the construction of special bridges or subways across busy streets is impracticable or cannot be justified, pedestrians should be guided and encouraged to cross the carriageway at a limited number of clearly recognisable points where they can do so in safety and with the least possible interference to other traffic. Pedestrian crossings, either controlled or uncontrolled, or refuges should be provided at appropriate points to assist pedestrians in crossing the road. The greatest need to cross the carriageway is likely to occur at junctions; the siting of refuges and ways of simplifying traffic movements at junctions are considered in Chapter 10.

Although the safest place to cross the carriageway is at signal-controlled or zebra crossings there is evidence that the risk of crossing within 50 yards or so of these points is exceptionally high. To encourage the safe and proper use of crossings it will often be helpful to erect pedestrian guard rails on the approaches.

Although guard rails have great value at points of special danger it is not considered that there is sufficient justification for their universal erection, which might be unduly confining and would create difficulties on narrow footways and at shops, bus stops and vehicular accesses. Control by less obvious means can often be exercised by the planting of hedges and shrubs along the verges and central reserve, or by the erection of a suitably deterring fence or wall along the reserve. It is important that these features should not restrict visibility on bends or at junctions or conceal pedestrians at crossing places.

Guard rails are particularly useful for preventing heedless walking or running into the carriageway from passageways, school exits, etc.

A low fence, suitably designed, can effectively deter pedestrians from crossing the central reserve at random



Fences should not restrict visibility at bends or junctions, or conceal pedestrians at crossing places

4.3 Cycle tracks and cycle ways

The volume of cycle traffic is declining in many parts of the country, but in some towns cyclists are still present in sufficient numbers to have an important influence on highway requirements.

Provision of cycle tracks will not be appropriate on *district* and *local distributors* and *access roads* where the speed of traffic is relatively low, though the widening of the nearside traffic lanes to 14 ft. may be warranted where cycle traffic is heavy. Widening of the nearside lanes may also be required on all-purpose *primary distributors*, but in view of the vulnerability of cyclists arrangements should be made where possible to route them along quieter roads. Where no alternative routes are available and the number of cyclists exceeds 1,500 in a 16-hour period or where heavy cycle traffic may be expected at certain times of the day (as, for example, near an industrial estate) consideration should be given to the provision of cycle tracks or cycle ways.

Cycle tracks should normally be designed for one-way traffic, though two-way operation may sometimes be necessary. For one-way traffic the standard width is 9 ft. and the minimum 6 ft. If cycle traffic warrants a width in excess of 9 ft. the increase should be by units of 3 ft. For two-way operation the normal minimum should be 12 ft., but lesser widths will be acceptable when flows are light.

Cycle tracks should have a well-maintained and carefully graded surface. Their profile should continue without interruption across intersecting vehicular entrances; gently sloping ramps and lowered kerbs should be provided where they join the carriageway. To ensure the rapid dispersal of surface water they should have a crossfall of about 1 in 40 and should be equipped with gullies at appropriate intervals. A cycle track should desirably be separated from the carriageway by a verge about 6 ft. wide and from the footway by one at least 3 ft. wide. Where space is limited any modification of width should first be effected between the cycle track and footway; if this verge has to be omitted a low kerb may be used as a delineator. The verge between the cycle track and the carriageway should not be narrower than 3 ft.

At busy single-level junctions with a high proportion of cycle traffic (especially right-turning traffic) the construction of cycle subways may be warranted. These should have at least 7 ft. 6 in. headroom and a minimum width of 10 ft. 6 in. for one-way working or 13 ft. 6 in. for two-way working. Maximum ramp gradients should be 1 in 20 upwards and 1 in 15 downwards.

Consideration should be given to the possible need for subways for the combined use of pedestrians and cyclists. Combined subways should have at least 7 ft. 6 in. headroom and a minimum width of 16 ft. 6 in. for one-way cycle traffic or 19 ft. 6 in. for two-way traffic; these widths include a single 6 ft. footway.

Where cycle traffic is heavy or concentrations of cyclists occur (as, for example, between a housing estate and a factory or school) it may sometimes be desirable to construct cycle ways. These should be wide enough for two-way traffic. They should be separate from the general road system and should cross other roads at a different level. It may be possible to combine cycle ways with the pedestrian way system.

4.4 Verges

4.4.1 On all-purpose roads

On all-purpose roads in principal business and industrial districts the full width between the carriageway and the highway boundary will usually be paved and used as a footway. Where, however, restrictions on space are less severe the inclusion of verges will not only increase the separation of vehicles from pedestrians but may improve the appearance of the road.

Verges less than 6 ft. wide should normally have an attractively coloured and textured stone surface with a cobbled, surface-dressed or other suitably bound finish. A crossfall of about 1 in 30 will usually suffice for verges of this type. Wider verges may be grassed, provided their width is sufficient for the establishment and maintenance of grass cover. Grass verges may require a crossfall of about 1 in 20 for adequate drainage; they should be suitably levelled and trimmed, and should be free from concealed grips and similar hazards.

On roads without footways and cycle tracks, verges will be required between the carriageway and the highway boundaries, not only to accommodate lighting columns, traffic signs, underground services, etc., but to provide appropriate clearance to ensure proper vehicle placement and development of full carriageway capacity. On all-purpose roads the normal minimum width should be 3 ft., but this may be reduced to 2 ft. on secondary access roads in residential areas. The clearance between the carriageway and any obstruction on the verge should be in accordance with Table 4–2.

Cuttings and embankments within the highway limits will normally be grass covered. The appearance and stability of the slopes will be improved by rounding them at the top and bottom and by planting them with suitable shrubs. Where the carriageway is on an embankment above footways or cycle tracks, safety fencing may be needed at the top of the embankment.

4.4.2 On urban motorways

In view of the higher speed of traffic on urban motorways, wider verges are desirable:

(i) to obtain maximum capacity by increasing the lateral clearances to fixed obstructions, and

(ii) to provide at least partial shelter for broken-down vehicles without interfering with the stable flow in lanes past them.

Where space is restricted and costs of acquisition and construction are high a minimum width of 5 ft. can be tolerated, but where conditions are easier the widening of the verge to 8 ft. will ensure greater safety and allow more adequately for maintenance functions and the siting of drains and services.

Verges should be paved and flush with the carriageways. To ensure that the verges are clearly distinguishable they should be separated from the carriageways by white marginal strip markings 1 ft. wide and should preferably have a contrasting colour and texture. The full width of paved verges should remain unobstructed by street furniture.

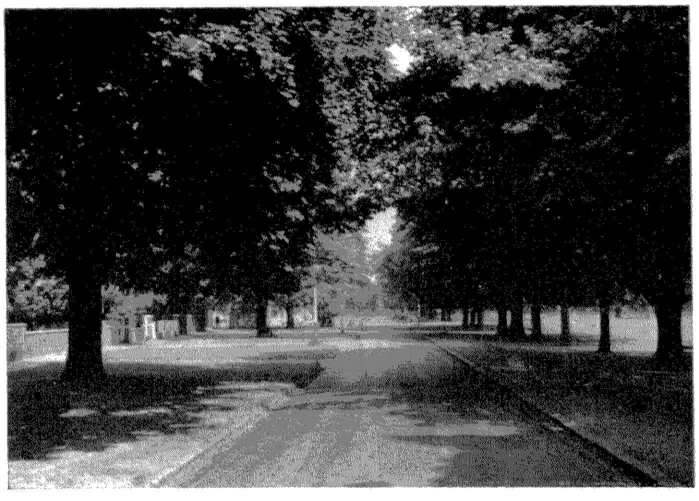
As indicated in Sub-Section 4.1.10, lay-bys will be required at intervals of not more than half a mile along each carriageway on those lengths of urban motorway where it is impracticable even to provide paved verges 5 ft. wide. Where lesser clearances are unavoidable they should be in accordance with Table 4–2, and raised kerbs should be used instead of flush marginal strips.

4.5 Use of suitable materials

The materials used in road construction should harmonise with their surroundings, local materials being used wherever possible. Variations of colour and texture in the surfacing of the carriageways, cycle tracks and footways can add to the appearance and safety of the road. Providing their wearing quality and skid resistance are adequate, there is considerable advantage in using light-coloured rather than dark aggregates for the road surface; they reveal obstructions more readily and aid visibility at night. The colour and texture of the road surface should be uniform over as long a length as possible. To avoid the creation of ugly scars, repairs should be carried out with materials matching those originally used.

Part of the 14-mile system of cycle and pedestrian ways at Stevenage

Subway for cyclists and pedestrians under roundabout

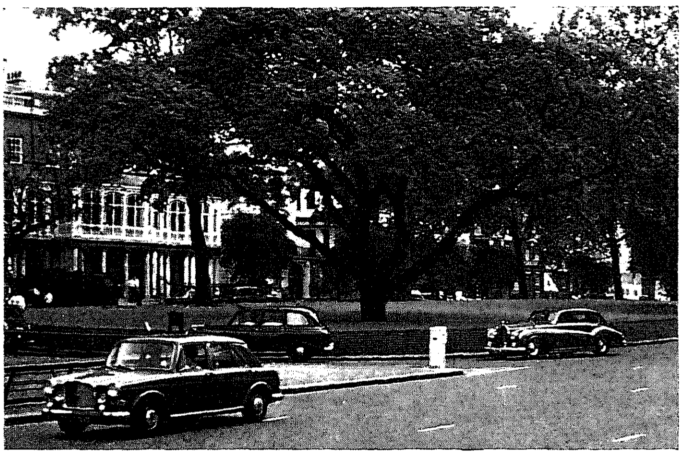


Where space permits, wide verges can be an attractive feature of the urban scene

Boundary walls, fences and hedges provided in the course of roadworks should have a good appearance and be in keeping with the locality. They should be designed to give the required degree of physical separation without creating a tunnel effect or preventing the integration of the road into its surroundings. Low walls and light, open fences or railings will often suffice, but on urban motorways more-substantial barriers may be required to deter trespassers.

4.6 Variation of layout

In built-up areas the various paved components of the road have, within narrow limits, to be parallel to one another, but where some variation can be made a pleasing effect may result. For example, it may be possible to vary the position and level of the footway, provided the alterations do not induce pedestrians to take undesirable short cuts. Variation of the verge width may sometimes give scope for the planting of trees and shrubs, but care should be taken to prevent or discourage the use of the verge by pedestrians, and it should never be so narrow as to make maintenance difficult. It may sometimes be possible to save a line of trees or other attractive features by slight variations of alignment or layout, e.g. by placing the footway behind the trees. On sidelong ground it may be advantageous for both appearance and economy to have the carriageways, footways and cycle tracks (if any) at different levels.



Trees saved by means of wide, raised central reserve

4.7 Typical cross-sections

4.7.1 *Primary distributors*—urban motorways

Typical cross-sections	Fig. 4–6.
Design speed	50 mph normally; 40 mph where alignment is restricted.
Carriageways	Normally dual two- or three-lane layout with 12 ft. traffic lanes.
Central reserve	10 ft. standard and 6 ft. minimum width with central safety fence 2 ft. wide. Increase width as necessary at other obstructions to provide clearances in accordance with Table 4–2 and appropriate visibility on inside of bends.
Marginal strip markings	Standard width 12 in.
Verges	Paved, flush with carriageways and not less than 5 ft. wide. Desirable width 8 ft. where conditions permit. For alternative arrangements where width is severely restricted, see Sub-Section 4.4.2.

4.7.2 *Primary distributors*—all-purpose

Typical cross-sections	Fig. 4–7.
Design speed	40 mph normally.
Carriageways	Normally dual two- or three-lane layout with 12 ft. traffic lanes. A single-carriageway layout will be appropriate if one-way operation is envisaged.
Central reserve	6 ft. standard and 4 ft. minimum width if unobstructed. 11 ft. standard and 7 ft. absolute minimum width with lighting columns. 16 ft. desirable minimum to accommodate lane for right-turning traffic approaching an intersection.
Footways	Consider possible routeing away from road. 9 ft. minimum width where essential.
Cycle tracks	9 ft. standard and 6 ft. minimum for one-way operation. 12 ft. normal minimum for two-way operation.
Verges	3 ft. minimum if provided instead of footway, but consider width needed for traffic signs, underground services, etc. and clearances in accordance with Table 4–2. 6 ft. desirable minimum and 3 ft. absolute minimum between carriageway and cycle track. 3 ft. desirable minimum between cycle track and footway, but use low kerb where space is restricted.

4.7.3 *District distributors*

Typical cross-sections	Fig. 4–8.
Carriageway lane widths	12 ft. standard. 11 ft. on roads with four or more lanes if proportion of heavy commercial traffic is fairly low.
Carriageway layout	Residential districts: single two-lane layout where practicable, but traffic volumes will often warrant dual carriageways. Principal business and industrial districts: dual two-lane carriageways normally. In all districts one-way systems with single carriageways will sometimes be appropriate.
Central reserve	6 ft. standard and 4 ft. minimum width. Increase clearances to lighting columns, etc. as indicated in Table 4–2 where carriageways are superelevated. 15–16 ft. desirable minimum to accommodate lane for right-turning traffic approaching an intersection.
Footways	9 ft. minimum in principal business and industrial districts. 8 ft. minimum in residential districts.
Verges	3 ft. minimum if provided instead of footway, but consider width needed for traffic signs, underground services, etc. and clearances in accordance with Table 4–2.

4.7.4 *Local distributors*

Typical cross-section	Fig. 4–9.
Carriageway lane widths	12 ft. in industrial districts. 11 ft. in principal business districts. 10 ft. in residential districts.
Carriageway layout	Single two-lane.
Footways	9 ft. minimum in principal business and industrial districts. 6 ft. minimum in residential districts.
Verges	3 ft. minimum if provided instead of footway, but consider width needed for traffic signs, underground services, etc. and clearances in accordance with Table 4–2.

4.7.5 *Access roads*

Typical cross-sections	Fig. 4–10.
Carriageway lane widths	9 ft. to 12 ft. normally (for details see Table 4–1).
Carriageway layout	Single two-lane.
Footways	6 ft. to 15 ft. (for details see Table 4–3).
Verges	3 ft. minimum if provided instead of footway (2 ft. on secondary *access roads* in residential districts), but consider width needed for traffic signs, underground services, etc. and clearances in accordance with Table 4–2.

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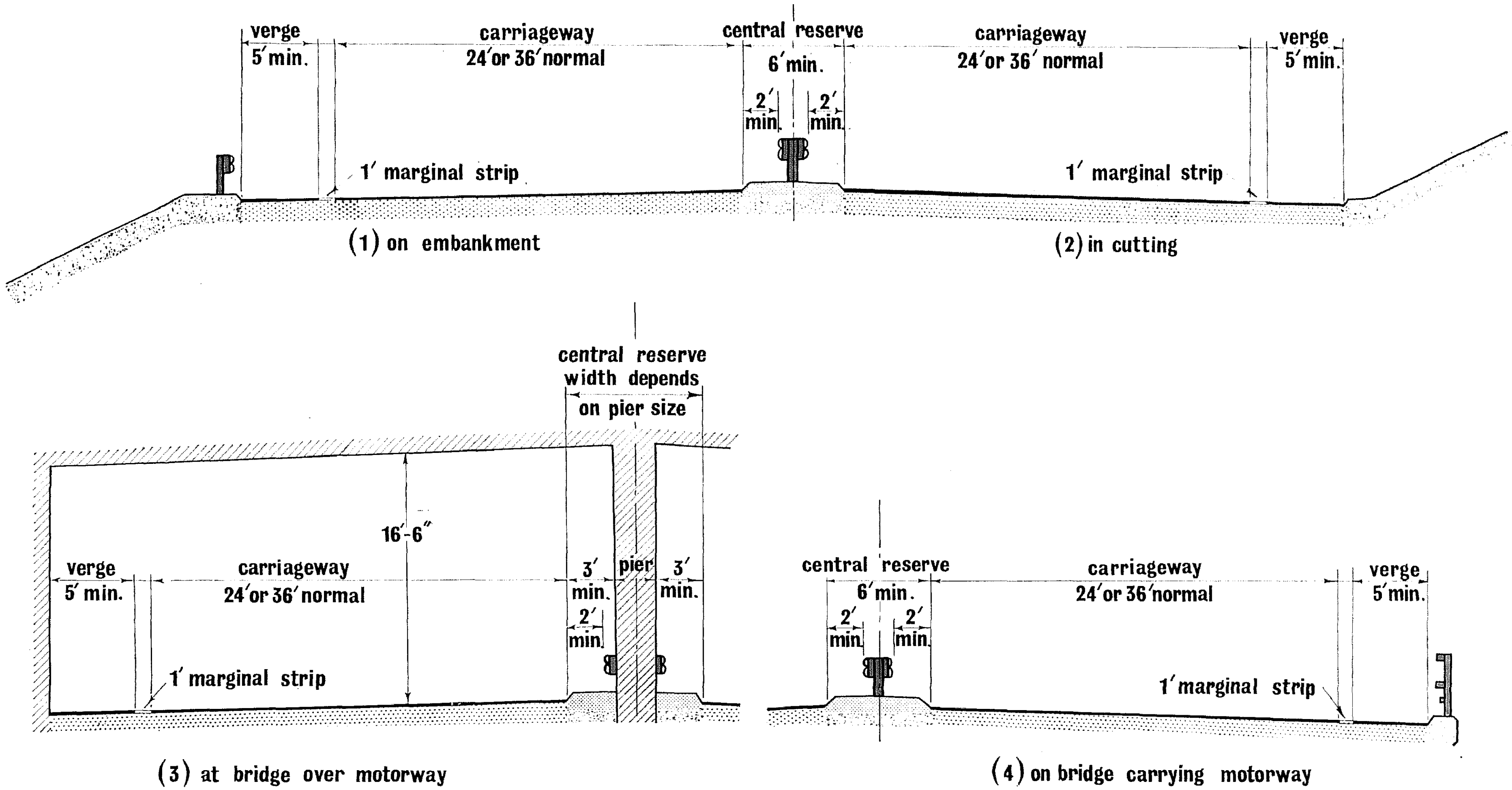


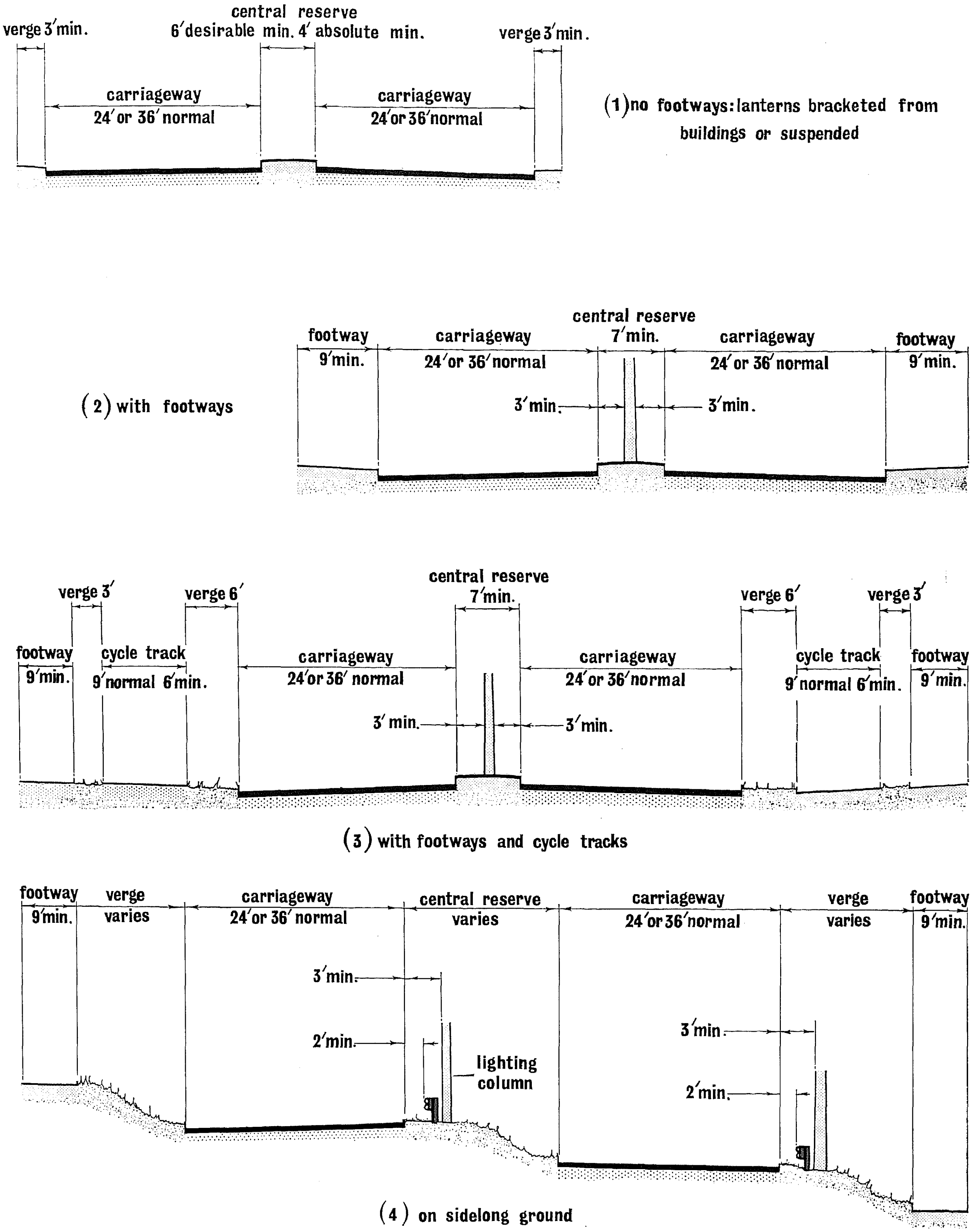
Notes:

1. The central reserve should be bordered by raised kerbs where it is 6 ft. wide or less, or where the face of any safety fence is less than 4 ft. from the adjoining carriageway. Where greater widths are available, flush marginal strips 1 ft. wide may be used instead of kerbs.

2. On lengths of motorway without paved verges the nearside edge of each carriageway should be bordered by raised kerbs and should be at least 2 ft. clear of the face of any safety fence on the verge and at least 3 ft. clear of bridge piers, retaining walls, lighting columns, etc.

3. The clearance between the carriageways and any fixed obstructions on the inside of bends at the sides of the road or on the central reserve should be increased where necessary to ensure the requisite visibility standards.

Fig. 4–6. Primary distributors—urban motorways. Typical cross-sections



The clearances shown above are suitable for speeds above 30 mph. As indicated in Table 4–2 lesser clearances may be used on roads designed for 30 mph.

Fig. 4–7 ***Primary distributors*—all-purpose roads. Typical cross-sections**

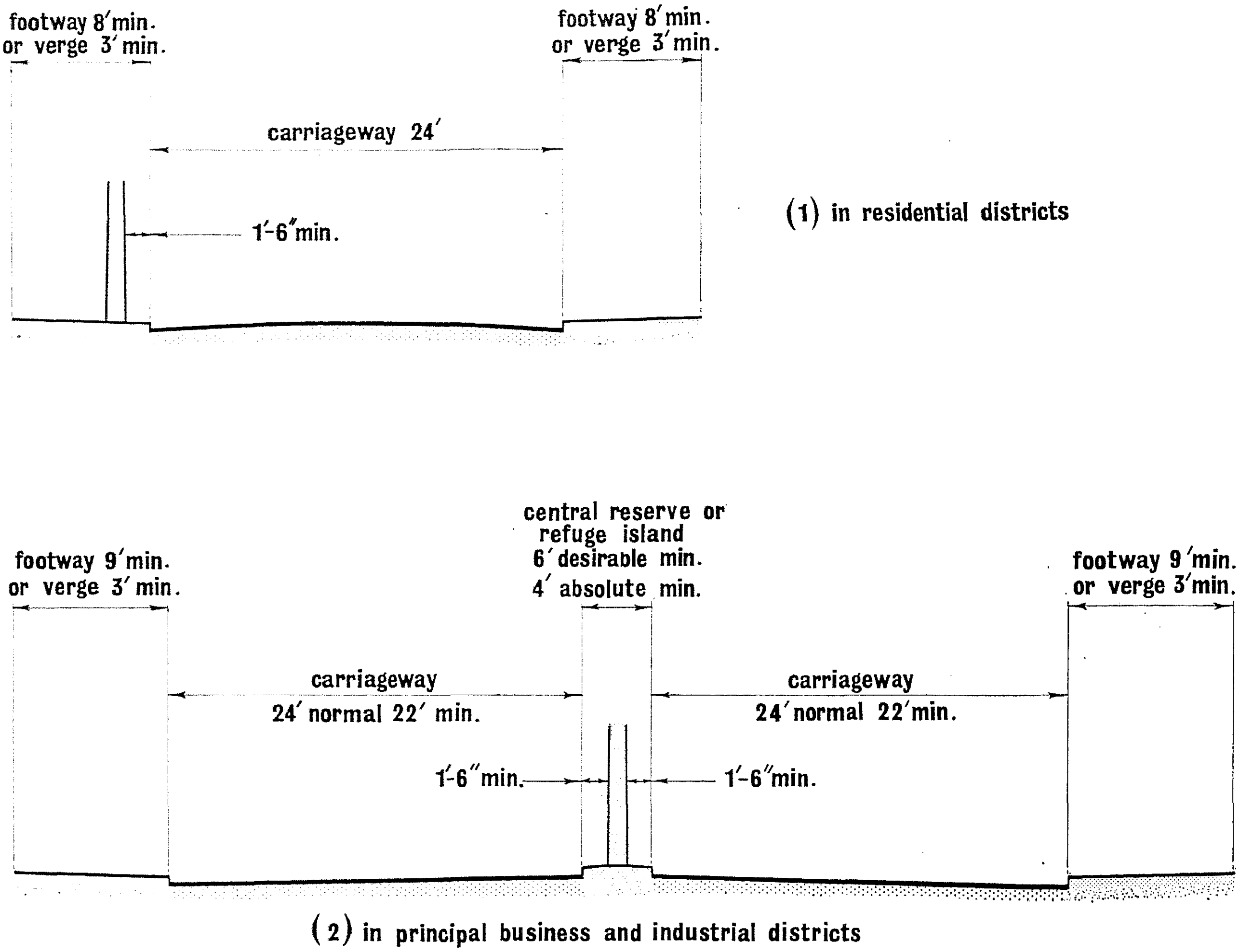


Fig. 4–8 *District distributors.* Typical cross-sections

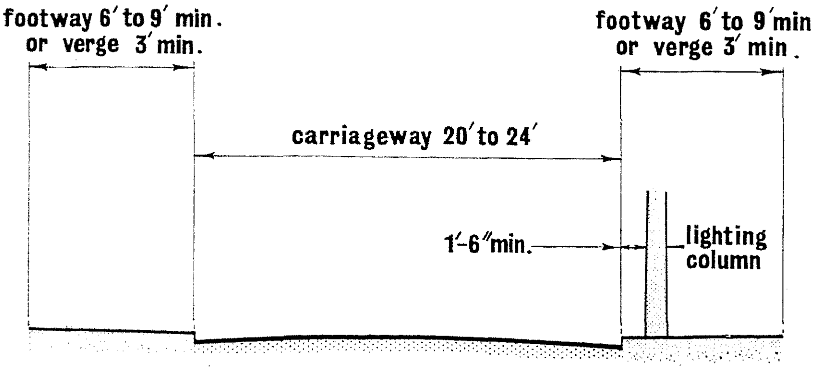
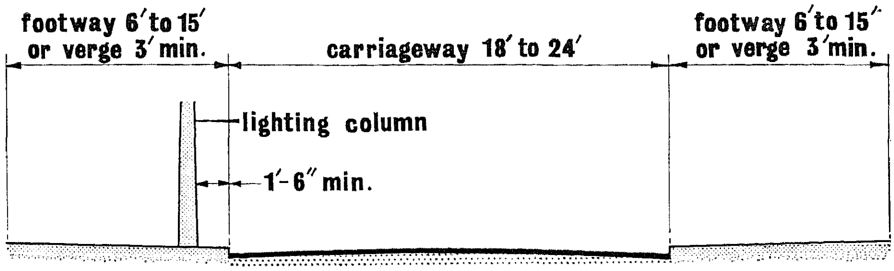
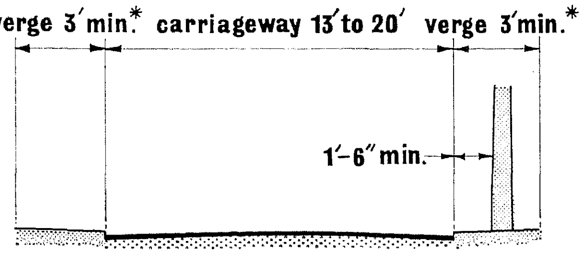


Fig. 4–9 *Local distributors.* Typical cross-section



(1) principal means of access



*2′ min. on residential roads

(2) secondary means of access

Fig. 4–10 *Access roads.* Typical cross-sections

5 Road equipment and other features

5.1 Street lighting

Recommendations on the design of street lighting installations are given in British Standard Code of Practice C.P.1004, which is at present being revised. Parts 1 and 2 of the revised version were published in 1963[10]; Part 1 describes the general principles of lighting and Part 2 the lighting of traffic routes. Further parts will be published later dealing with the lighting of roads carrying only local traffic, roundabouts and complex junctions, bridges and flyovers, tunnels and underpasses, roads with special requirements, and town centres.

Lighting installations must be efficient by night and should look well by day. No hard-and-fast rules can be given to ensure aesthetically satisfactory design and layout; every town and village has its own character, but it should be possible to meet most requirements within the general principles and tolerances of the Code. The design of lighting installations for streets bordered by buildings of architectural or historic interest will require particular care.

Useful guidance on the design and siting of lighting columns is given in the Code. As well as being arranged to give satisfactory light distribution, columns should be sited to minimise obstruction of the footway, protect sight lines and ensure the necessary clearances from the carriageway. The minimum width of the central reserve and footways may be affected by the presence of lighting columns and the clearances from the carriageway recommended in Table 4–2.

The texture and colour of the road surface will influence the effectiveness of a lighting installation, and where cost, durability and skid resistance permit it is an advantage to the lighting to use a light-coloured road surface.

On distributor roads of all types, lighting will be required primarily to facilitate the safe movement of traffic (including pedestrians and cyclists on all-purpose roads). The recommendations given in Part 2 of the Code will be widely applicable to these roads and their adoption should make for uniformity of standard and quality. On any given traffic route the lighting should be of uniform standard and frequent changes in the type of lighting should be avoided.

On *access roads*, lighting will usually be required more for amenity and security purposes than for traffic movement. The standard of lighting will depend on the type of street; a standard lower than that needed for traffic routes will suffice for quiet streets in residential areas, but for the busy streets of shopping and business districts a high standard of lighting will be necessary.

5.2 Traffic signs

On busy urban roads clear signposting is essential to prevent indecision, confusion and danger. Signposting requirements may present special problems where space is restricted and should always be considered at an early stage in planning road improvements or new roads.

Traffic signs should conform to the appropriate statutory instruments and Departmental recommendations.[11] They should be clearly visible, and the letter sizes should be appropriate to the speed of traffic and the displacement of the signs from the driver's path. They should be located so as to allow ample opportunity for any necessary action or manoeuvre. Their number should be kept to the minimum required for the proper guidance and control of traffic.

With the exception of waiting restriction signs and certain other prescribed types, all warning, mandatory, prohibitory and advance direction signs should be illuminated by direct lighting where they are located within 50 yards of a street lamp; if further away they may be either illuminated by direct lighting or reflectorised. Many informatory signs do not warrant the expense of direct lighting (e.g. toilet and parking signs) but should be placed where they can be seen after dark by the light from nearby street lamps. To ensure efficient operation and reduce cable and duct costs, sign and street lighting installations should be designed together wherever possible. The control system should enable lighting to be switched on quickly if daytime visibility deteriorates. It may be desirable for some signs and bollards to remain lighted throughout the day.

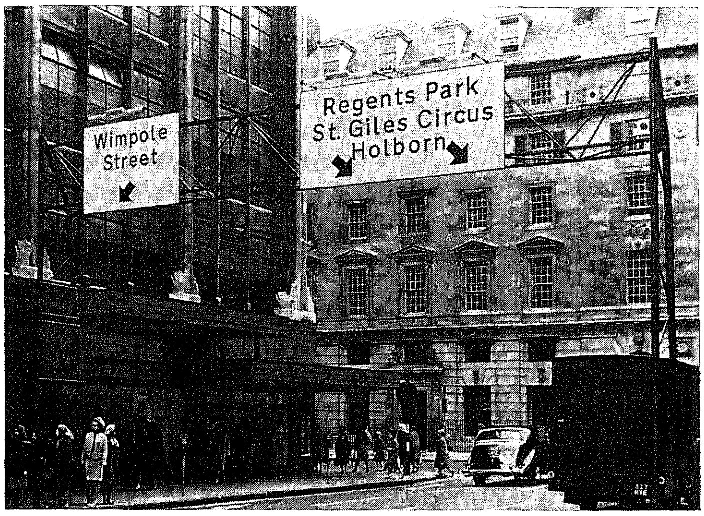
It may sometimes be necessary to erect signs on the central reserve, duplicating those at the side of the road. On roads where traffic is so heavy that there is a risk of roadside signs being hidden from view, illuminated overhead signs may be more suitable. Special gantries will be required to support these signs, though it may sometimes be possible to mount them on bridges over the road. Overhead signs are especially useful to indicate lane positions on the approaches to busy junctions.

To avoid congestion and danger on heavily trafficked urban motorways, special arrangements may be required to give advance warning of accidents, weather hazards, and road or lane closures. Warning may be given by means of a system of overhead illuminated signs spaced at intervals of not more than one mile; as indicated in Section 5.4 it may be convenient for the signs to be switched on and off from the emergency telephone control point. Where bridges are conveniently located, it may be preferable to mount warning signs on bridge parapets rather than to erect special gantries. At the site of an accident additional guidance to traffic should be given as quickly as possible by the erection of portable warning signs in accordance with Departmental requirements.

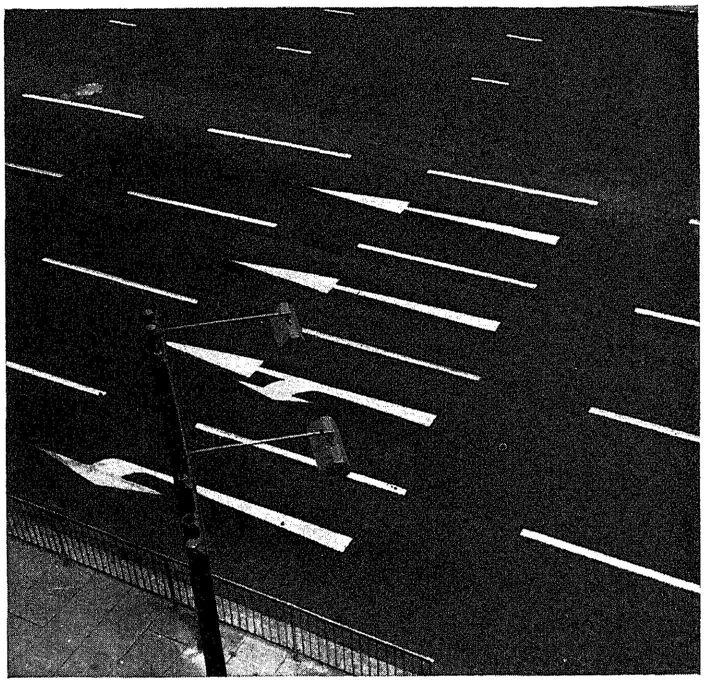
5.3 Carriageway markings

Safe and orderly use of the carriageway should be encouraged by the provision of carriageway markings in accordance with the appropriate statutory instruments and Departmental regulations.[11] Markings should be used not only to define traffic lanes but to guide vehicles at junctions and indicate the positions of bus stops, taxi ranks, waiting lanes and parking bays. To reduce the number of traffic signs, yellow markings may now be used at the edge of the carriageway to denote waiting restrictions.

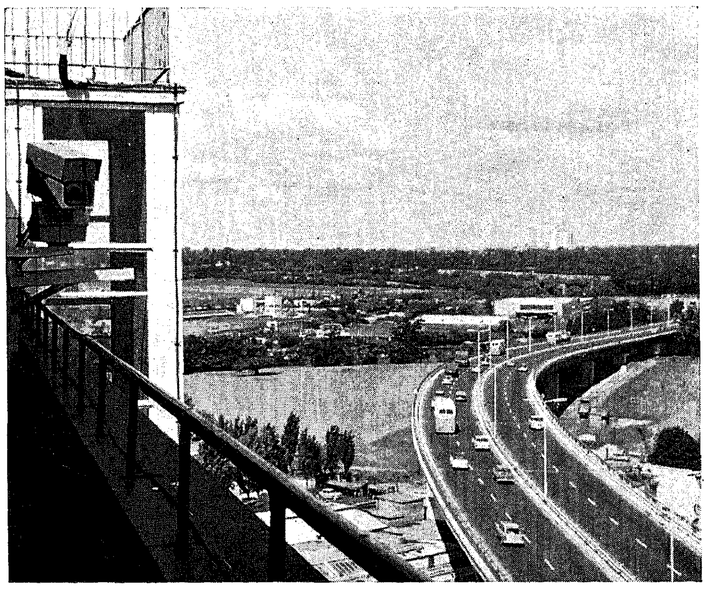
Carriageway markings should be skid-resistant in both wet and dry weather conditions. Adequate skid resistance is particularly important where the camber or crossfall is steep and at junctions where turning traffic includes an appreciable number of two-wheeled vehicles.



Sign gantries can often be of relatively light construction



Clear carriageway markings are particularly helpful on the approaches to junctions



Television surveillance by remote control of Motorway M.4, London

Double white lines should not be needed on properly designed new roads in towns. They are not regarded as suitable for general use on existing urban roads because of the possibility of standing vehicles, but there may be sites with restricted visibility where their use is justified. They should not be used merely to displace standing vehicles; 'No Waiting' Orders will be appropriate in such circumstances.

Reflecting studs will not usually be required on urban roads in addition to carriageway markings. In certain areas, however, the risk of fog or poor visibility may be high enough to justify their installation, even though the street lighting may be adequate for normal conditions.

5.4 Emergency telephones

These are only appropriate on motorways, where segregation from the ordinary road system makes it difficult for a driver to summon aid in the event of an accident or breakdown. To enable aid to be obtained quickly, emergency telephones should be provided on both sides of the road at intervals of not more than half a mile, or at each lay-by on lengths without paved verges. Telephones should be solely for emergency use and should be connected to a central control point.

It will usually be convenient for the emergency warning signs to be actuated from the same central control. This will enable the appropriate signs to be switched on as soon as details of the emergency are received by telephone.

5.5 Safety fences

In towns the main need for safety fences for the protection of vehicles will arise on urban motorways and other *primary distributors* where speeds are high. Except at points of special danger, safety fences will not usually be required on all-purpose roads subject to a 30 mph speed limit.

On urban motorways and where necessary on all-purpose *primary distributors* safety fences should be erected:

(i) on both sides of the road on embankments 20 ft. high or more;
(ii) on the outer edge of the road where the radius is 2,600 ft. or less and the embankment height 10 ft. or more.

These minimum heights do not preclude the placing of continuous lengths of safety fencing along embankments whose height is slightly less than these figures at certain points.

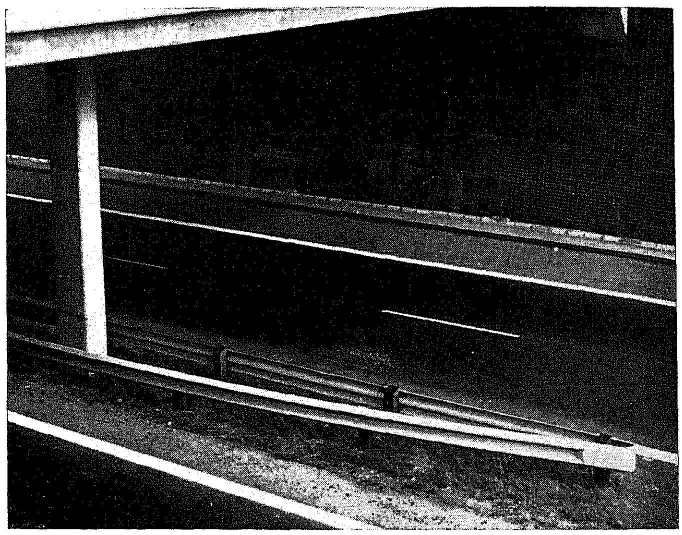
Safety fences may also be needed at other danger points, e.g. where there is a road, railway or river at the foot of an embankment, where the road is supported by high retaining walls, on bridges with lightly built parapets, or in advance of bridge piers or other obstructions on the central reserve or verges.

In advance of obstructions on the verges or central reserve, safety fences should be aligned at a narrow angle to the road so as to deflect vehicles away from the obstruction. Where reserves are narrow and speeds high, continuous safety fencing may be required both to screen obstructions and to prevent accidents due to vehicles crossing the reserve.

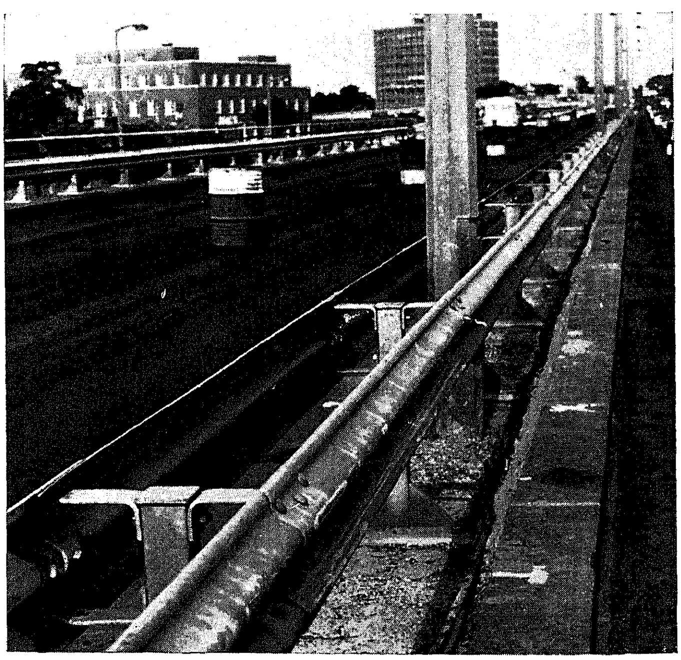
Safety fences should normally be unobtrusive in appearance, but at points where attention needs to be drawn to special dangers, e.g. on the outside of a sharp curve, it may be helpful to paint black and white bands 3 ft. wide on the fenders.

5.6 Street furniture

The choice of street furniture requires discrimination and care. Useful guidance may be obtained from the Council of Industrial Design publication *Street Furniture from Design Index* 1965/66.[12]



Safety fence on central reserve in advance of bridge piers



Double safety fence under construction on the narrow central reserve of an urban motorway

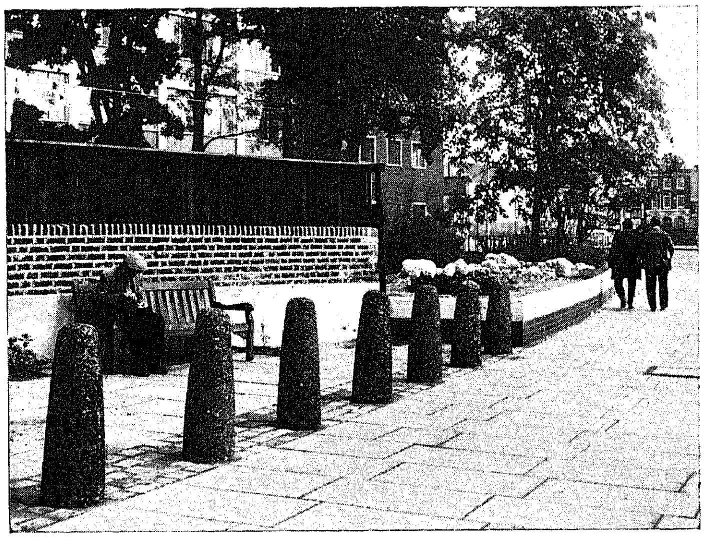
Street furniture should not be allowed to obstruct sight lines or encroach on carriageway clearances. If placed too near the carriageway street furniture may lead to accidents by restricting the view of pedestrians about to cross the road. Obstruction of the footway should be avoided wherever possible by siting equipment behind it or on the verge (provided the verge is wide enough).

Seats placed by the roadside constitute a welcome amenity for pedestrians but should not be allowed to obstruct the footway. They should preferably be placed on the verge (if wide enough) or in recesses along the boundary line. The ground in front of the seats should of course be suitably hardened and drained.

Bins for the storage of sand and grit should not be sited where they obstruct the footway or where loading operations may interfere with the flow of traffic. If possible they should be sited on the verge at lay-bys or in well-lighted positions on *local distributors* or *access roads*.

To encourage the public to keep the streets clean and tidy, plenty of litter baskets or bins should be provided. Many attractive designs are now available which keep litter hidden from view and protected from the wind and rain. Bins should be attached to lamp standards or sited where they do not obstruct the footway but can easily be seen.

Telephone kiosks, pillar boxes and police call boxes must necessarily be placed where they are conspicuous, but they should neither restrict the movement of pedestrians nor limit visibility at junctions or on bends. It will often be possible to site them behind the footway or on wide verges. Where possible, telephone kiosks and post boxes should be sited adjoining lay-bys. Fire alarms in boxes fixed to boundary walls will cause less obstruction than those mounted on posts.



Irregularities in the boundary line will enable seats to be placed clear of the footway

Public conveniences should not be located on roundabouts or traffic islands unless access is obtained solely by subway. Conveniences will be more easily accessible if placed above ground with entrances at the back of the footway.

Street name plates should be well designed and clearly lettered. To ensure that they can easily be seen by all road users they should be placed not more than 10 ft. from street corners. They should be placed on both sides of side streets to facilitate identification from the main road. On long roads they should be placed at all intersections and at intervals of not more than 200 yards in between. The lower they are fixed the more easily they can usually be seen, but in busy streets they will need to be at least 6 ft. 6 in. above the ground to avoid being obscured by vehicles and pedestrians. Elsewhere a lower mounting height may be suitable and should enable name plates to be seen from vehicles with side-lights or dipped headlights. Name plates should not be less than 2 ft. from the ground and should preferably be fixed so that they will be illuminated by street lamps. Street names can also be conveniently indicated on the side panels of bollards.

All houses, offices, business establishments and other premises should be numbered, and their numbers should be displayed on their gates or doors so as to be clearly visible from the street. Numbers should be arranged so that when travelling away from the centre of a town the odd numbers are on the left and the even numbers on the right. Succeeding numbers should be approximately opposite one another, even though this may require the omission of certain numbers or the use of suffix letters where frontages vary.

5.7 Trees and shrubs

When improving existing roads or building new ones, existing trees and shrubs should be retained wherever possible. Where space is restricted the only possible form of planting may be the