

DESIGN AND LAYOUT OF
ROADS IN BUILT-UP AREAS

DESIGN AND LAYOUT OF ROADS IN BUILT-UP AREAS

Report of the
Departmental Committee set up by
the Minister of War Transport

LONDON: HIS MAJESTY'S STATIONERY OFFICE
1946

Appointment and Terms of Reference of the Committee

The Committee was appointed in April, 1943, by the Minister of War Transport, with the concurrence of the Minister of Town and Country Planning and the Secretary of State for Scotland

“ 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 road traffic, economy and the requirements of town planning, and to make recommendations.”

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Constitution of Committee

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Mr. THOS. S. SINCLAIR, Assoc.M.Inst.C.E., A.M.I.Struct.E., A.M.T.P.I., Ministry of War Transport (Secretary).

Mr. Sinclair succeeded Mr. R. S. F. Edwards, Assoc.M.Inst.C.E., Barrister-at-law, as secretary to the Committee in August, 1943, on the latter's promotion within another branch of the Ministry.

The total expenditure incurred by the Committee up to the date of publication of this Report is estimated at \$1220 of which £690 represents the estimated cost of printing.

PART I

Introduction

1. Full inquiry into the matters covered by our terms of reference would, in normal times have justified investigations of a wide-spread nature and, in certain directions, prolonged experimental work ; but we realize that our Report should be in the hands of local authorities as early as possible so that its recommendations may be available for their guidance in the preparation of the many schemes of reconstruction which are now in contemplation or in hand. In many respects we should have liked to extend our investigations and to have put forward our recommendations in greater detail, but the pressure upon the time of the members of the Committee and of the technical officers of the department in connection with the war effort has precluded our doing so. We have, however, taken care to give our reasons for the conclusions we have reached, and where necessary to illustrate the methods which we suggest should be applied in giving effect to them.

2. We have held twenty-two meetings, and have visited certain towns for the purpose of examining on the site proposals for large-scale improvement schemes which presented features of special interest. In addition to information collated by our own members and officers of the Ministry we have had the advantage of considering memoranda prepared by various organizations and individuals concerned with particular aspects of the problems under discussion and in many cases have heard oral evidence in their amplification. We have given full consideration to the points they have raised and desire to record our sincere thanks for their assistance.

3. The following is a list of the organizations which have helped us in this way :—

- *The Automobile Association.
- *British Road Federation.
- *Chief Constables Association (Cities and Boroughs—England and Wales).
- *County Chief Constables Conference.
- *Cyclists' Touring Club.
- Mansion House Association on Transport.
- *Metropolitan Police.
- *Municipal Passenger Transport Association.
- The Institution of Municipal and County Engineers.

The National Horse Association of Great Britain.

- *The Pedestrians Association.
- *The Public Transport Association (Inc.).
- *Railway Companies Association.
- *Retailers Advisory Committee on Town Planning.
- *The Roads Improvement Association (Inc.).
- *The Royal Automobile Club.
- Royal Scottish Automobile Club.
- Scottish Carriers and Haulage Contractors Association.
- Scottish Road Passenger Transport Association.

4. We also desire to record our indebtedness to the members of the staffs of some of our colleagues for valuable assistance in the preparation of drawings and diagrams to illustrate our Report particularly Messrs. A. E. Martin, G. O. Cunnah, H. M. Casson and N. P. Brand. We also owe our thanks to Mr. D. G. Bevan, M.Inst.C.E., M.Inst.M. & Cy.E. for his help and advice in certain directions, and we appreciate the interest which has been evinced by many persons who have provided us with photographs and other matter of which, in many cases, we have been unable to make use owing to lack of space.

Nomenclature of Classes of Roads

5. We consider it desirable that there should be uniformity of practice in the terms used to designate the various classes of roads in relation to built-up areas and that these terms should be based on the predominant traffic function of each class. We recognise that in urban road systems as they at present exist one class of road has, to a greater or less extent, also to serve the purpose of a road of another class, but we are of opinion that every new road should be designed on the basis of its main purpose in a planned road pattern and that, to the fullest possible extent, a similar course should be followed when existing roads are reconstructed.

6. In this Report we have adopted, in relation to the road pattern in built-up areas, the following

* Memoranda supplemented by oral evidence.

nomenclature for classes of roads the predominant function of which is as stated :—

Arterial Roads

Roads serving the country as a whole, or a region of the country, and linking up the main centres of population or the various regions.

Through Roads

Roads carrying traffic having its origin outside the town, and its destination inside the town, or *vice versa*.

Local Through Roads

Roads carrying traffic having its origin in one area of the town and its destination in another area.

Local Roads

All other roads in the town except development roads.

Development Roads

Roads the primary function of which is to provide frontage for the development of land.

7. Where we refer to "arterial traffic," "through traffic," etc., we mean traffic for which "arterial roads," "through traffic roads," etc., are designed respectively to provide: the term "town roads" is used to describe inclusively the urban system of through, local through and local roads.

Definition of Terms

8. We have used other terms in the Report as follows :—

Single Purpose Road

A road designed for, and restricted to, the use of one class of traffic, e.g., mechanically propelled vehicles, pedal cyclists or pedestrians.

Motorway

A single purpose road restricted to the use of mechanically propelled vehicles.

Intersections and Junctions

The term "intersection" is used to cover all types of intersections and junctions. "Junction" refers only to a single connection of one road with another, i.e., a "T" junction, a "Y" junction or an acute angle junction.

Grade Separation

Such vertical alignment of a highway or highways as enables one stream of traffic to be carried over or under another.

Footway

That part of the highway exclusively reserved for the use of foot passengers; generally parallel with the carriageway and separated therefrom by a kerb or verge.

Footpath

A path solely for foot passengers generally crossing fields or other open spaces and not associated with a carriageway.

Vehicles

All wheeled vehicles other than pedal cycles unless the latter are specifically mentioned.

Public Service Vehicles

All passenger vehicles for the use of which a fare is paid, but not including taxicabs.

Means of Access

Includes (a) points of connection with other roads and (b) points of access to adjacent land or buildings (which we refer to as "frontage access") for pedestrians and vehicles or both.

Inapplicability of Common Standards

9. We have found it impossible to make all our recommendations applicable to towns irrespective of their character, topography and size. This is especially true of London and other such conurbations, each of which may well present problems which demand special treatment, though many of our recommendations will be found capable of general adoption. We have kept in mind not only areas ripe for immediate reconstruction (either as the result of enemy action or by obsolescence), but also areas in which the redevelopment of the road system must be a lengthy process extending over many years, as well as new towns which may be brought into being. We appreciate that opportunities of comprehensive reconstruction as a short-term operation are relatively few, but we wish to emphasize the need of a long term master plan to which all schemes of reconstruction will be related, and the desirability that each section must be capable of functioning as a unit, making its own contribution to the requirements of traffic, safety and amenity, until it becomes an integral part of the complete scheme.

It will perhaps be helpful if in the first place we summarize the interpretation we have placed on our terms of reference. We have made no attempt in this introductory note to go beyond

this point and have dealt later with the various aspects which demanded investigation under the headings appropriate to each. We have refrained from making a summary of recommendations since we feel that they should not be considered apart from their context. We have, however, drawn attention to the salient features of the Report by sub-headings of the sections into which it is divided, and a detailed index has been compiled.

OBSERVATIONS ON TERMS OF REFERENCE

" Design and Layout "

10. We have taken the term " design and layout " to include the general pattern of the road system in urban areas and have considered it in relation to location, alignment, width and arrangement, so as best to meet social and industrial requirements and to ensure the movement of all classes of road users, vehicular, cyclist and pedestrian, with the maximum degree of freedom compatible with safety.

11. We have made no reference to materials or methods of construction except those which relate more particularly to the use which can be made of them in special circumstances, and to their influence on amenity. These matters directly concern the Ministry of War Transport, in association with the Road Research Board of the Department of Scientific and Industrial Research, and memoranda, drawings and specifications have been published from time to time for the information and guidance of highway authorities. The latest of such memoranda, entitled " The Lay-out and Construction of Roads " (Memorandum No. 575), was issued by the Ministry of War Transport in October, 1943. Its recommendations, which cover a wide field, relate mainly to roads in rural areas ; but in many respects they are of general application and we have kept them in mind throughout our deliberations.

" Built-up Areas "

12. We have assumed the term " built-up areas " to include areas which, though at present undeveloped, may later form part of an urban community, whether by building on vacant land within the confines of the town as it now exists or by an extension of building beyond the present developed area. In this country the work of the planner is governed to no small extent by the

heritage of the past, whether owing to events which have found their place in history or to the march of industry within more recent years. In the former, public sentiment demands, and properly demands, that every care should be exercised to preserve the best of that which is of traditional or historical interest. In the latter, advantage should be taken of all reconstruction schemes to ensure that adequate provision is made for the requirements of traffic. There is little need to emphasize the opportunities of replanning which are now presented as the result of enemy action, and of the importance of turning them to the best account.

13. In the past, local street improvements have sometimes been carried out with insufficient consideration of their effect on the circulation of traffic within the area, and of the interdependence of the traffic facilities of the town and those afforded by the arterial road system. There should be clear appreciation of the functions of each, though there is bound to be some overlapping, and there will be roads which for the time being at least may have to serve a dual purpose. Three should be adequate and convenient means of connection between arterial and town roads ; but in our view the main purpose of the former (even when unavoidably traversing urban areas) is to provide for the uninterrupted and speedy flow of long distance traffic unhampered by and imposing no undue restraint on the life of the local community. On the other hand we think it no hardship that within built-up areas motor and other vehicles should proceed at such speed as will have due regard to the reasonable requirements and convenience of the local inhabitants. It follows, therefore, that the two classes of road require different treatment.

" Safety "

14. The problem of road accidents is common to all roads, though not in the same degree, and the need of measures for the promotion of safety applies to town and country alike. Town roads in general must accommodate vehicles, cycles and pedestrians, and the avoidance of accidents depends to a large extent on the prudence and consideration shown by all classes of road users. In accordance with our terms of reference we have considered the accident problem mainly in relation to developed areas, where it is specially acute. There are obvious reasons why this should be so. Traffic in

busy town streets is subject to many more hazards than on the open road by reason of the density of population and the necessity of permitting the local inhabitants such freedom of movement as will not unduly hamper them in following their lawful avocations ; this is an aspect which must be carefully borne in mind in dealing with urban conditions, where special regard must be had to the social, commercial and other requirements of the local community.

15. Road accidents are due in the main to the human element, and this view is emphasized by the marked success achieved by a carefully organized system of motor patrols inaugurated in Lancashire in 1938, which, coupled with education and propaganda, and special efforts directed to the safeguarding of children, resulted in a reduction of road accidents by 44 per cent. within a period of twelve months. Nevertheless, it cannot be disputed that the character of the road has a direct bearing on road safety, and that much more can be done by good design and layout to lessen the likelihood of accidents due to faulty judgment or carelessness on the part of road users. These aspects have been constantly in our minds throughout our deliberations and have been given full weight in our recommendations.

" Traffic "

16. If a road is properly to fulfil its functions it must afford adequate accommodation by way of width and layout and thus enable the traffic using it, vehicular, cyclist and pedestrian, to do so with the maximum speed and convenience consistent with safety. In built-up areas maximum speed is of less account than free flow, and facilities must be afforded—often at the expense of other considerations—for business and shopping and the pursuit of recreation and amusement.

17. There is some ground for the criticism that in the past the overall width of roads, and the dimensions of their component parts, have been determined on stereotyped lines without sufficient regard to the purpose they will serve and the volume and character of the traffic likely to use them. By-laws relating to new streets are helpful in maintaining a minimum standard, but the minimum too often becomes the maximum and they sometimes tend to a degree of uniformity which is to be deprecated.

18. A traffic survey is the first essential of a road plan, whether for national or local purposes,

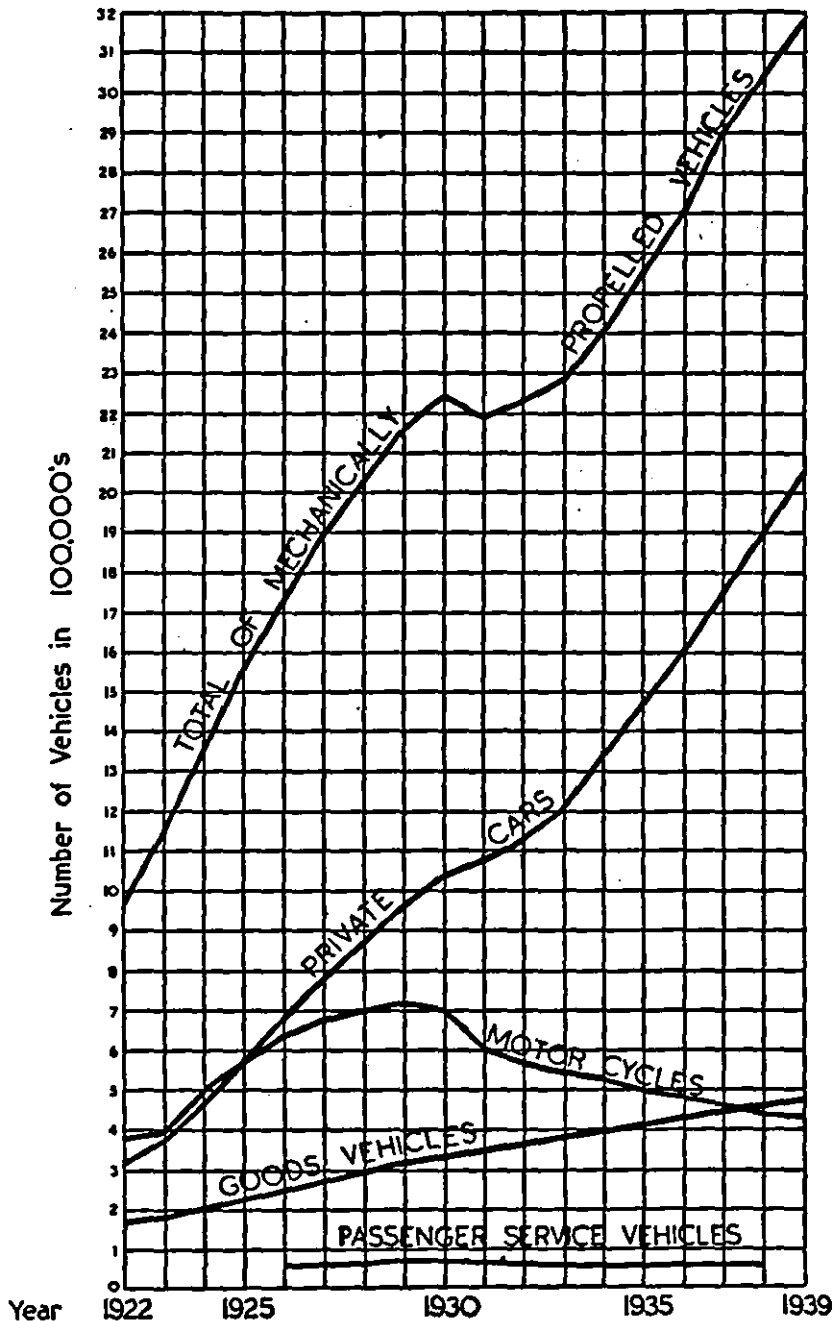
and should cover the whole area under review. The survey will provide information on origin and destination, type, volume and hourly flow under existing conditions, but regard must be had to future tendencies and this may well prove the most difficult phase of the problem. The graph, Fig. 1, shows the increase in the number of vehicles registered in the years 1922-1939. There are conflicting views as to the likely volume and character of road traffic in the post-war years. The possibility of a greater or less rate of increase than that which obtained in the 10 years prior to 1939 depends on undeterminable factors, such as general economic conditions, the purchasing power of the individual, trend of population, use of other forms of conveyances than those now available, and the potentialities of air transport. Any forecast must therefore be conjectural.

19. It does not follow that the rate of growth of traffic throughout the whole country can be taken as a reliable index of what may be expected in a particular area. Industrial and other local conditions and tendencies, variations in daily movements of the population, routing of public service vehicles, and co-ordination with other forms of transport are important considerations which have a material bearing on the traffic in a town and must be given due weight in estimating future requirements.

" Economy "

20. No design, whether of a road system or of a particular road, can be termed satisfactory unless due regard is paid to considerations of economy. Extravagance must not be countenanced, but avoidance of capital expenditure or cheapness in design and construction is not always synonymous with economy—a word which is too frequently misused. It is uneconomical (as it is deplorable) that lives should be lost on the roads, or that, as the result of street accidents members of the public should be permanently incapacitated or temporarily prevented from performing their normal service to the community. It is uneconomical that time and money should be wasted by the delay of vehicles on roads inadequate for the traffic using them, or that roads designed for free flow should have their traffic capacity impaired by uncontrolled frontage development. It is on the other hand sound economy to spend money with a view to future saving. The cost of delay due to traffic congestion in large centres of population is difficult

GROWTH OF NUMBER OF MECHANICALLY PROPELLED VEHICLES



NOTE: The graphs indicate the approximate number of vehicles licensed each year. The "total" number graph includes the following classes in addition to those shown separately:- Tractors, Taxicabs, Agricultural Class 5/-, Exempt Vehicles & Trade Licences. P.S.Vs include omnibuses, trolleybuses, tramcars and motor coaches. No records are available for P.S.Vs during 1922-5 & 1939.

FIGURE 1

to assess but it is undoubtedly serious, as is the inconvenience caused to all sections of the public. In London alone the loss due to traffic delays has been estimated at several millions of pounds a year. Diminution in the number of accidents which may be expected to follow the execution of a well-designed road improvement constitutes a direct saving to the community.

"The Requirements of Town Planning"

21. The road system is one of the most important features of the town plan and when properly designed in relation to other requirements will form its framework. Apart from traffic considerations it is the means of linking up the areas zoned for civic, commercial, industrial, residential or recreational purposes. Advice to local authorities on town planning, and its application to specific areas, is the function in England and Wales of the Minister of Town and Country Planning, and in Scotland of the Secretary of State: but, as has

been indicated, the layout of roads and all other elements of the town plan, including consideration of amenity, should be considered together. With this object in view close liaison exists between the Minister of War Transport, the Minister of Town and Country Planning and the Secretary of State for Scotland.

22. If the provisions for road communications incorporated in the town plan are to be adequate in scope and satisfactory in practice prior consultation should take place with those whose responsibility it will be to ensure the smooth working of traffic under the designed conditions, and this applies with special force to the police. Full co-operation should be sought with the railway companies and public service vehicle operators, whilst nothing but good can result from ascertaining the views and endeavouring to meet the reasonable requirements of responsible trading and other organizations concerned with various aspects of the life of the community.

PART II

Road Safety

The responsibility of the individual

23. We have drawn attention, in paras. 14 and 15, to the primary responsibility of the individual in accident causation. But we cannot leave it at that; nor should we accept the view that the problem approaches the insoluble, for we can be encouraged by the reduction in fatal road accidents from 7,153 in 1934 to 6,440 in 1938, despite an increase of some 700,000 in the number of vehicles then in use (see Fig. 2). Opinions differ on the extent to which road conditions are contributory to accidents, but there is no doubt of the importance of so designing our roads as to minimize risk due to carelessness or faulty judgment whilst dispensing, as far as possible, with restrictive measures. The proper planning and design of

roads can make a substantial contribution to road safety. A layout of such form as will promote the harmonious flow of traffic, and automatically lead road users to follow the right path, is an essential feature of a well designed road.

The problem in built-up areas

24. The special seriousness of the accident problem in built-up areas was emphasized in a Report on road accidents issued by the Ministry of Transport relating to the year 1936/7. The Report gives separately statistics of accidents which occurred on roads on which the 30 miles per hour speed limit was in operation, *i.e.*, 40,350 miles, or 22 per cent. of the total road mileage of

NUMBER OF FATAL ROAD ACCIDENTS AND LICENSED VEHICLES

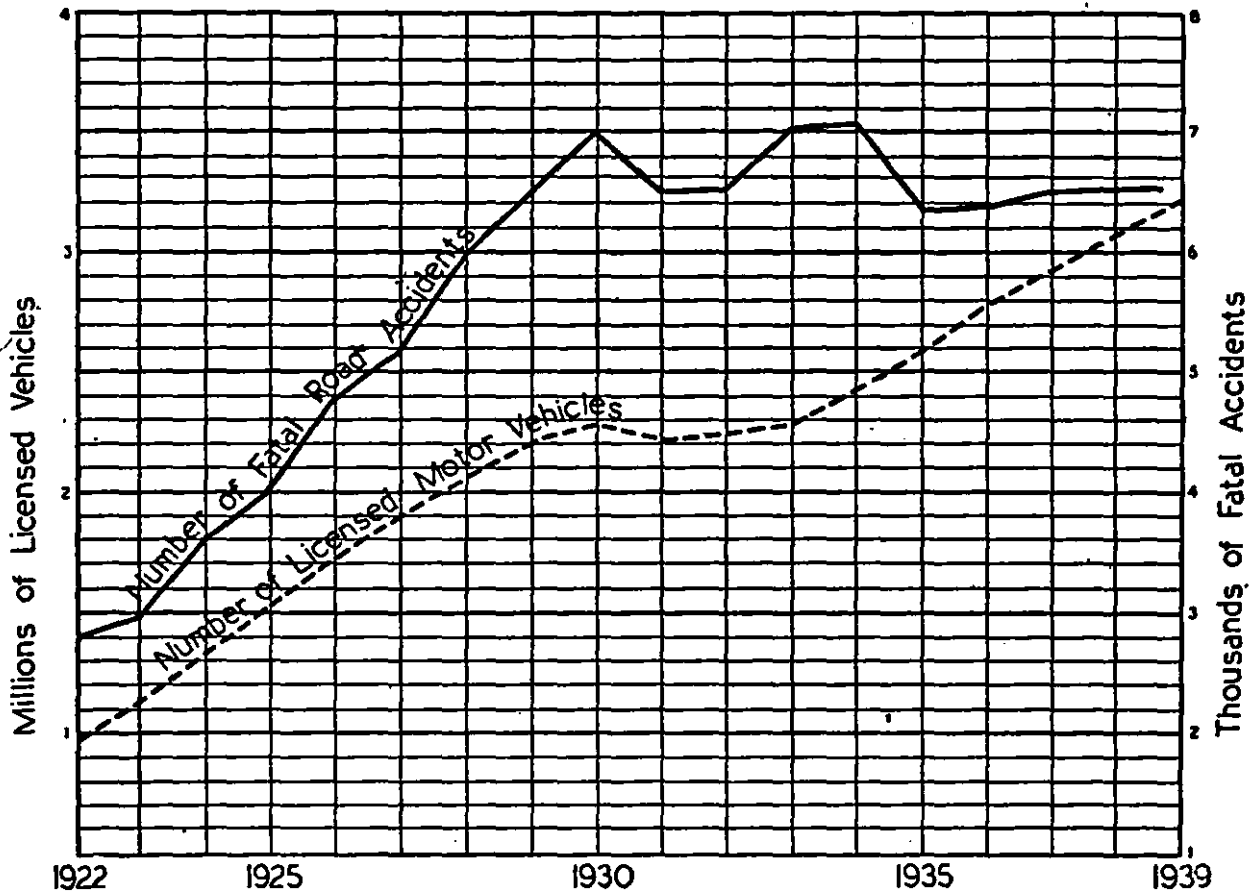


FIGURE 2

the country. Approximately 60 per cent. of the persons killed on all roads in Great Britain and 76 per cent. of the persons injured were involved in accidents in built-up areas. They were as follows :—

	Number of persons		Percentage of total	
	Killed	Injured	Killed	Injured
Pedestrians	2,465	67,169	60.5	39.4
Pedal Cyclists	825	55,060	20.2	32.3
Motor Cyclists	376	15,076	9.2	8.9
Drivers of vehicles	103	9,466	2.5	5.6
Passengers (including side car and pillion)	311	23,503	7.6	13.8
	4,080	170,274	100	100

These are illustrated in Fig. 3 overleaf.

25. The police attributed the cause of fatal and non-fatal accidents to the following classes of road users :—

	Fatal % of total	Non-fatal % of total
Pedestrians	50.8	35.6
Pedal Cyclists	15.3	23.5
Drivers of motor vehicles (including motor cycles)	25.0	29.0
Others	2.5	3.4
	93.6	91.5
Causes other than personal	6.4	8.5
	100.0	100.0

Other facts which emerge from a study of the voluminous statistics given in the Report are :—

Children under 7 years of age accounted for 19 per cent. of the pedestrians killed. Of pedestrians

ROADS IN BUILT-UP AREAS

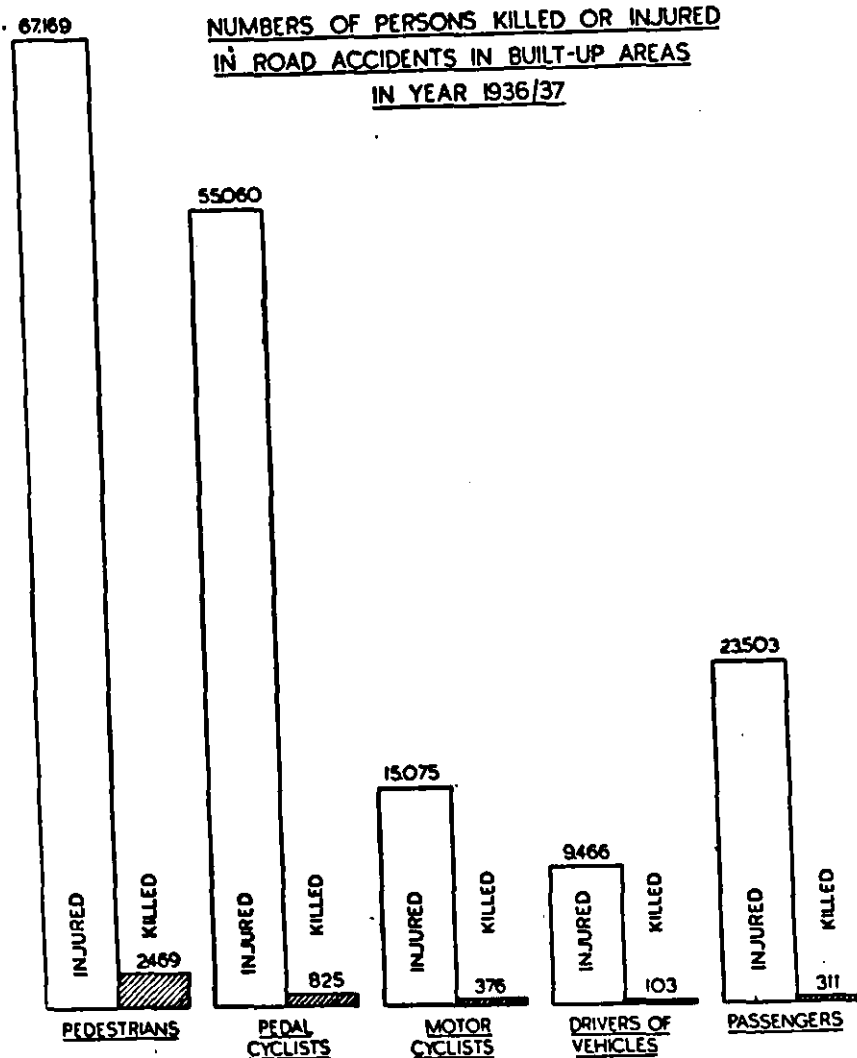


FIGURE 3

70 per cent. of those killed and 60 per cent. of those injured were crossing the carriageway.

Of all fatal accidents 39 per cent. occurred at road junctions and intersections; 25 per cent. were due to collisions between moving vehicles (including pedal cycles); 43 per cent. occurred at dusk or during hours of darkness. Of all fatal accidents attributed to drivers and pedal cyclists in turning from one road into another, 80 per cent. occurred in making a right-hand turn.

The importance of segregation

26. These figures point to the vulnerability of pedestrians (particularly when crossing the carriageway) and of pedal cyclists, and stress the importance of the segregation of vehicular, pedestrian and cycle traffic as a means of accident prevention.

We must, however, bear in mind that complete segregation can be achieved only by physical means, and that there is a limit to what the public will stand in the way of restrictive measures.

27. So far as mechanically propelled vehicles are concerned the fullest possible measure of segregation would, of course, be attained by confining them exclusively to single purpose roads, e.g., motor roads, but such a course is impracticable as a general measure even when planning a completely new town. In Part V(i) of our Report, we examine the place of the single purpose road in the urban road system and reach the conclusion that this type of road should be provided in a built-up area only in certain exceptional circumstances, though we recognize that in suitable case the use of by-passes may advantageously be con

fined to motor vehicles. On town roads generally, segregation has to be achieved by other methods than by the isolation of mechanically propelled vehicles on roads reserved for their sole use.

The analogy between road and rail

28. It is often stated that the road is the permanent way of the motor vehicle, just as the rail is the permanent way of the railway train, but the analogy between the railway and the road should not be carried too far. The railway train runs at pre-determined speeds, which are carefully adjusted to meet conditions of gradient, curvature and so on, upon a track of unvarying width to which it is rigidly confined and from which all other moving units are excluded. The mechanically propelled road vehicle runs at speeds governed (within certain limits) only by the discretion of its driver, on a track which varies in character, allows ample room for lateral movement, is used at one and the same time by other types of vehicles of varying speed and stability and which affords free access to pedestrians, except on the relatively small lengths of carriageway from which they are excluded by physical means.

The safety aspect of motorways

29. The value of motorways as a safety measure must depend upon their length as a whole in comparison with the total mileage of roads and the extent to which they will attract traffic from all-purpose roads following an approximately parallel route. So far as built-up areas are concerned their value in this respect would be more immediately and less expensively achieved by means of a by-pass or outer ring road provided these are designed with due regard to road safety—in suitable cases as motorways.

30. We have referred later in our Report to cases in which there may be no alternative to motorways, or roads forming part of the arterial system and carrying heavy traffic, passing through congested areas, and have expressed the view that they should be so designed as to be independent of the urban road system. Ability to travel at high speeds under safe conditions is the main purpose of a motorway, and this is obviously impossible of attainment on roads which are used by all classes of road users. It is on this account that 40,350 miles of roads and streets in built-up areas are subject to a speed limit of 30 m.p.h. At this speed, allowing the driver a reaction time of

one second (a fair average for all classes of drivers) and a braking efficiency of 50 per cent. (rather above the average) a car will travel 44 ft. before the driver can take effective action to apply his brakes or alter his course, and a further 61 ft. before his vehicle is brought to rest. By reason of the varied nature of the traffic in built-up areas it is specially important that the driver should observe the rule that the speed of his vehicle should not exceed that which will permit him to take effective action within the limit of vision open to him. On the other hand, it is only fair to the driver that the layout of roads—particularly at intersections, bends and summits—should be such that he may within the critical distance reduce the speed or alter the course of his vehicle without undue strain on his part.

Methods of construction

31. Methods of construction have a direct bearing on road safety but they are not within our terms of reference. They have been dealt with in the Memorandum No. 575, "The Layout and Construction of Roads" issued by the Ministry of War Transport in 1943. We are in general agreement with the principles relating to methods of construction set out in that Memorandum, and recommend that they should be applied in built-up areas so far as conditions permit.

Consideration of safety measures

32. We have given full consideration to the dominating claims of road safety throughout our deliberations, and have carefully borne them in mind in preparing our Report. It may be helpful briefly to enumerate our principal recommendations here :—

- (i) Arterial traffic should be deflected from built-up areas to the utmost practicable extent. (Para. 117.)
- (ii) Where there is a heavy stream of arterial traffic which cannot be diverted from a densely built-up area, consideration should be given to the practicability of the construction of an elevated or sub-surface road. (Para. 130.)
- (iii) On important traffic routes, mechanically propelled, pedal cyclist and pedestrian traffic should be segregated on separate tracks. (Paras. 230 to 246.)

- (iv) The restriction of frontage access and the reduction of the number of side road connections should be related to the function of the particular road and the volume and speed of traffic using it. (Part VI.)
- (v) Service roads, if properly designed, provide in certain cases a suitable means of restricting frontage access and of limiting the number of side road connections; but outside the central area, buildings should be grouped, as far as possible, on subsidiary development roads. (Part VI.)
- (vi) Business premises directly fronting busy streets should be provided with means of loading and unloading vehicles at the rear of, or within the curtilage of the premises. (Paras. 172, 408, 426 and 427.)
- (vii) Buildings likely to attract large numbers of vehicles should be provided with space in which vehicles can wait elsewhere than on the highway. (Para. 427.)
- (viii) Where traffic is heavy and continuous, intersections should be so planned as to enable opposing streams of traffic to cross at different levels. (Part VII, Section (c).)
- (ix) Where considerable streams of traffic cross on the level provision should be made for the elimination of direct cuts, or right hand turns, preferably by a roundabout, or alternatively for control by traffic light signals. (Part VII, Section (c).)
- (x) Ample sight distances should be provided at intersections, and vehicles from minor roads should be led to enter major roads at reduced speeds. (Part VII, Section (c).)
- (xi) Where vehicular and pedestrian traffic are alike heavy, subways or overbridges, with ramped approaches, should if possible be constructed for pedestrians, and where necessary for cyclists. Otherwise, pedestrian crossings should be provided with refuges at suitable points and barriers erected to prevent crossing elsewhere in their vicinity. (Part VII, Section (d).)
- (xii) Footways should be of adequate width, and equipment such as lamp standards, telephone boxes, pillar boxes and traffic signs, erected so as not to obstruct the use of the footway or impair the line of sight of vehicle drivers. (Para. 395.)
- (xiii) Schools, playing fields, and places of public resort likely to be visited by large numbers of people at rush hours should be so located that access to them is not derived directly from through traffic roads. (Para. 221.)
- (xiv) Public conveniences, etc., should not be located on the central islands of roundabouts, unless it is possible to give the public access to them by way of a subway. (Para. 378.)
- (xv) Where it is essential for the convenience of the public that vehicles shall wait on the public highway specific provision should be made in the design of the road. (Para. 404.)
- (xvi) Full regard should be paid to the requirements and effective operation of public service vehicles, to the provision of loading stations, and to suitable means of interchange with railway and other forms of transport. (Paras. 75 and 414.)
- (xvii) Road signs and street name plates should be conspicuous, of standard design, and sited on uniform principles, in accordance with the recommendations of the Departmental Committee on Traffic Signs. (Paras. 370 and 393.)
- (xviii) There should be adequate and uniform lighting of traffic routes presenting similar characteristics, and the adoption of such standard of lighting on important routes as will enable vehicles to be driven without the use of headlights. (See Report of the Departmental Committee on Street Lighting, 1937.)
- (xix) Unimportant streets—particularly *culs de sac*—should be set aside, for so long as may be necessary, as “playing streets” for children where open spaces are not readily accessible or cannot be provided short of complete redevelopment. (Para. 106.)
- (xx) Houses, shops and other buildings should be systematically numbered so that they can be readily identified without leading to obstruction and delay. (Para. 393.)
- (xxi) Roadside advertisements which tend to distract the attention of drivers of vehicles or obstruct their line of sight should be strictly controlled. (Paras. 445-449.)



PLATE 1. WAITING BAY FOR BUSES AT WINDSOR.



PLATE 2. BUS QUEUE BARRIERS BELOW CANOPY—BIRMINGHAM.



PLATE 3. TURNING PLACE FOR PUBLIC SERVICE VEHICLES—GOLDERS GREEN.



PLATE 4. A PLAY STREET IN SALFORD.



PLATE 5. SKETCH OF PROPOSED NEW ROUTE THROUGH AREA TO BE RE-DEVELOPED—BIRMINGHAM.



PLATE 6. BACK ACCESS LANE WITH LOADING BAYS IN BUILDING—LEEDS.



PLATE 7. SHOP WINDOWS RECESSED BEHIND BACK OF FOOTWAY—LEEDS.



PLATE 8. CANOPIES CANTILEVERED FROM BUILDINGS—LEEDS.

Importance of maps and records

33. Administrative matters are not our concern, but we desire to stress the importance of the systematic investigation of road accidents by qualified officers. Accident maps should be maintained by the Divisional Road Engineers of the Ministry of War Transport, the Highway Authorities, and the Police in collaboration, and should be studied in the light of police reports and such other information as is available. The compilation of maps and of accident statistics is not an end in itself, and is of little use unless trained minds are

brought to bear on their interpretation and immediate steps taken to carry out such remedial measures as knowledge of the circumstances may show to be necessary.

Education and propaganda

34. We desire also to emphasize the effectiveness of education (more particularly in schools), and propaganda. We regard these measures (especially the first) as of special importance in urban areas by reason of the large number of children concerned and the additional risks of accident to which they are exposed.

PART III

General Traffic Considerations

Section (a)—Traffic Surveys.

35. The main purpose of a traffic survey is to ascertain by observation and subsequent analysis the volume, direction, type and characteristics of traffic, whether over an area as a whole, some part of it, or a particular thoroughfare, and to apply the results to the consideration of the nature and scope of the proposals under review.

36. The traffic census, which before the war was taken triennially by enumerators stationed at selected points (approximately at 3 mile intervals) mainly outside built-up areas on Class I and Class II roads, was primarily a volumetric one and aimed at ascertaining the number of vehicles of various types passing the census points in both directions during 16 hours from 6 a.m. to 10 p.m. on 7 consecutive days in the month of August. Assumed weights were allocated to each type of vehicle and the results tabulated in numbers and tonnage. In the census taken on Class I roads in 1938 the count at several hundred census points was continued throughout the 24 hours in order to record hourly variations in flow and the incidence of night traffic.

37. For the design or redesign of the urban road system an "origin and destination" census is of primary importance. The results will indicate not only the total volume of traffic to be dealt with, but the proportion which can be diverted from the town, or from that part of it under immediate review.

38. There are various methods by which this information can be obtained:—

(a) BY DIRECT INTERVIEW

Vehicles are stopped and drivers asked the starting point of their journeys and their destination and such further information as may be desired, including in some cases the purpose of the trip, what route is being taken, and the stops proposed to be made. This method gives the fullest accurate information and is particularly useful where personnel is limited, as it is not necessary to operate all the stations utilized in the census on the same day.

(b) BY OBSERVATION OF REGISTRATION NUMBERS

As each vehicle passes a census station its registration number is observed and recorded and a comparison of the record cards from all stations shows which stations each vehicle has passed. For the purpose of this study the origin is the place where the car was first observed and the destination the place where it was last observed. This method is especially suitable where traffic is heavy, since vehicles are not stopped. It is, however, necessary to take the census at all stations on the same day, and every exit from the area or route under observation must be covered, so that a large number of observers may be required. The subsequent statistical work is heavy.

(c) BY THE USE OF POST CARDS

A post card, setting out in tabular form the information required, is handed to every driver as he passes the census point, to be filled in by him and posted at his journey's end.

This is a simple method and specially useful when traffic is heavy and more information is desired than can be obtained from the registration plates, but its success depends on the driver's willingness to co-operate by correctly answering the questions asked on the postcard. Advance publicity is essential to the success of this method in order to secure a representative return—which may be taken as at least 20 per cent. of the cards issued.

(d) BY TAGS ON VEHICLES

In this method a precoded card is handed to the driver or (in the form of a tag) it may be fastened to his vehicle, marked with the time it enters the area under study. When the vehicle leaves the area the card is handed back by the driver or the tag is removed, the time noted and any other readily observable information recorded on it. The driver should be informed of the purpose of the survey and asked to hand the card to the observer as he leaves the survey area.

This method can be used for studying movements in a small area where the traffic is dense and there is a reasonable continuity of movement. It gives information only of the points of entry and exit and the time taken to traverse the area. It is useful in determining the number of vehicles likely to use a by-pass, on the assumption that any vehicle taking less than one and a half times the minimum time required to traverse the area is a "through" vehicle.

Avoidance of traffic delay

39. In busy streets serious congestion may be caused by the stopping of vehicles in order to question drivers. In this connection, however, it may be of interest to note that in a survey covering the movements of upwards of 30,000 vehicles it was found that the average time occupied in questioning each driver was only 10 seconds throughout the whole survey. Where unreasonable delay may be anticipated a typical cross section of the traffic—say, not less than 20 per cent.—should suffice, always provided that it is really typical and that a volumetric census is taken concurrently. In the "Registration Number"

method it is usual to record every vehicle, but since the traffic need not be stopped for this purpose the possibility of causing delay does not arise.

Other traffic information required

40. In addition to a volumetric and origin and destination census there are circumstances in which information on the following matters may be relevant :—

- (a) The extent and direction of the daily movement of people by road into and out of the town or area under observation.
- (b) The routes used by, and the picking-up and setting-down points of, public service vehicles, both for long distance and local traffic.
- (c) The extent, and points of interchange, of goods and passenger traffic between road, rail and waterway systems.
- (d) The extent of delivery and collection of goods and parcels by railway operators, and the routes followed.
- (e) In manufacturing towns, movements of goods by road within the town during the process of, and after manufacture.
- (f) Traffic to recreational, amusement and other centres, which may be of considerable density on special occasions.
- (g) The location and nature of obstacles which impose delay to the free passage of traffic.
- (h) The accommodation available for parking vehicles of all descriptions, their location, whether on or off the highway, and whether publicly or privately owned. (The parking of vehicles is further dealt with in Part VIII of the Report.)

41. Prior publicity should always be given to the purpose and the proposed date of a census which is likely to make demands on the goodwill of road users. The co-operation of the police is, of course, essential. It will also be advantageous to obtain from railway companies, public service vehicle and other large road operators, particulars of journeys to be undertaken by their vehicles during the census period, so as to ease congestion by obviating the necessity of stopping them.

Examples of origin and destination surveys

42. Examples of origin and destination surveys are given in Appendixes 1, 2 and 3 and special regard should be had to the remarks and suggestions included under the heading "Observations."

Automatic traffic recorders

43. Where the object of the census is to ascertain the volume of traffic and variations of traffic flow, greater use than is the case at present might be made of automatic methods of recording. An apparatus was designed and installed at the Road Research Laboratory to give a continuous record of traffic passing over experimental road materials laid on the Colnbrook By-pass. A detector pad, such as is used for automatic traffic control signals, was installed on each half width of the carriageway, and impulses set up by the impact of wheels of vehicles passing over the pad operating a counter through an electric relay. Each detector pad was connected to 12 counters brought into operation in succession every two hours by a clock mechanism, thus recording the volume of traffic in each direction in each consecutive period of two hours throughout the day. This equipment which was described and illustrated in the report of the Road Research Board for the year ended 31st March, 1938, and in "Engineering" of the 25th November, 1938, records axles, and it is desirable to make occasional checks by enumerators to correct for the number of multi-axle vehicles.

44. Another type of fixed installation was developed by the U.S. Bureau of Public Roads in 1935 and was described in "Public Roads," Vol. 19, No. 1, March, 1938. It is understood that 500 are now in operation. The detector equipment consists of two photo-electric cells which record the interruption of two parallel beams of light by passing vehicles, and operate a counting mechanism through an electric relay. A record of the cumulative total of vehicles travelling in both directions every hour is made automatically. Errors are said not to exceed 2 per cent. and they arise mainly from vehicles travelling in opposite directions crossing the light beams simultaneously, and from the double-recording of vehicles with trailers. This equipment records the number of passing vehicles irrespective of the number of axles. A modified and cheaper form of this apparatus, using only one photo-electric cell, has been developed as portable equipment for making special traffic studies.

45. Two cheap portable axle counting instruments have also been used extensively in the United States for short counts. Both are operated by an impulse given by vehicle wheels passing over a rubber tube laid on the carriageway. The tube may easily be damaged and the device is therefore

not suitable for prolonged heavy duty, but, as it can be quickly replaced at small cost, its short life is not a serious disadvantage for counts lasting a few days on lightly trafficked roads. In the simpler of these instruments the impulse from a vehicle passing over the rubber tube moves a diaphragm against which rests a lever which actuates the escapement of a watch mechanism and records the number of impulses on the watch dial. It is necessary for an operator to read the instrument periodically and ensure that the rubber tube has not been displaced or fractured; but one operator can supervise a number of counters. Errors are said to be not more than 4 per cent. In the other instrument the recording apparatus is operated electrically. It is stated to give, on the whole, results of similar accuracy but with occasional errors as much as 7 per cent. A number of modifications in these instruments have been made, including the substitution of an electrical contact detector for the rubber tube, and the use of a number of short detectors to record the distribution of traffic across the width of a carriageway. Both types may be adapted to give a printed photographic hourly record.

Investigation recommended

46. Automatic records have obvious limitations but we recommend that the Ministry of War Transport should cause an investigation to be made of their potential usefulness in recording traffic flow, in order that advice may be given to highway authorities of the merits and demerits of various types and their suitability for the various purposes for which they can be used.

Section (b)—Growth of Traffic*Growth of traffic in recent years*

47. Fig. 1 shows the number of licenced motor vehicles in each of the four main classes, *i.e.*, (1) Private cars, (2) Motor cycles, (3) Goods vehicles, and (4) Public service vehicles (excluding taxis) from 1922 to 1939. The increase in the total number of motor vehicles during the seven years 1923-29 averaged 179,000 per annum, and during the seven years 1933-39, 166,000 per annum. It will be noticed that the annual increase was reasonably uniform before and after the economic depression of 1931. The increase is chiefly attributable to private motor cars, which in 1939 constituted practically two-thirds of the total of

all licenced motor vehicles. The steady decrease in the number of motor cycles from 1930 is noteworthy.

48. Comparison of the average daily number of vehicles passing the census points on the Class I roads in 1935 and 1938 with the licensing figures for the same years discloses that before the war road traffic in the country as a whole was increasing at a rather greater rate than that of the number of licenced vehicles. The relative figures of the average annual increase are 6.8 and 6.0 per cent. and indicate that the growth of road traffic is due not only to additional vehicles licensed but to an increase in the mileage run.

Numbers of pedal cycles

49. In the absence of a system of registration, it is impossible to state with any accuracy the number of pedal cyclists in this country, but it has been variously estimated at between 8 and 10 millions. The average daily number of pedal cycles and motor vehicles (including motor cycles) disclosed by the census taken at all comparable points on Class I roads (including trunk roads) in 1938 was as follows:—

Year	Motor vehicles (including motor cycles)	Pedal cycles	Percentage of pedal cycles to motor vehicles
1931 ...	1355	330	24
1935 ...	1827	645	35
1938 ...	2198	595	27

50. These figures indicate a reduction in the number of pedal cyclists during the last three years covered by the census returns, and a noteworthy drop in relation to motor vehicles, though the latter may be due, in part, to increased car mileage as mentioned in para. 48. A considerable fillip has been given to pedal cycling as the result of wartime restrictions on travel by car, and it may well be that conditions obtaining in early post-war years will tend still further to popularize the cycling habit. This possibility emphasizes the necessity of making ample road provision for pedal cyclists.

Estimation of future growth of traffic

51. As has been pointed out in para. 18, there are many indeterminable factors governing the future growth of traffic, but if vehicular traffic (excluding pedal cycles) increases after the war at the same rate as in the 10 preceding years it will rather more than double itself in 20 years.

52. The traffic capacity to be provided on the carriageways of a road, including its intersections, should be based on the estimated number of vehicles (including pedal cycles if these have to be accommodated on the carriageway) to be carried at peak hours. This estimate will for some years at least have to take as its basis the volume of traffic as it existed prior to the war. Adjustments may however be required because of alterations in the distribution or volume of traffic which will result from the replanning of the road system or from any anticipated abnormal variation of population. Account must also be taken of the particular local factors referred to in para. 19. Subject to the adjustments mentioned we recommend that provision should be made for a volume of traffic double that which obtained prior to the war. In making this recommendation we have borne in mind that in the lane capacities of carriageways which in para. 58 and 59 we propose for adoption in calculating highway widths, allowance is made for a reasonable margin of safety. We suggest, however, that where there is a foreseeable possibility of the need for further widening in the distant future which may be precluded by the erection of important buildings having a long life, it will be prudent to design the road to carry traffic greater than double the pre-war volume.

53. The following comparative figures relating to the year 1939 are of interest:—

	Motor Vehicles per thousand of Population	Motor Vehicles per mile of Road
U.S.A. ...	221	9.7
New Zealand ...	164	3.0
Canada ...	131	2.3
Australia ...	106	1.6
Great Britain ...	61	14.5
France ...	54	5.7
Belgium ...	28	11.6

Section (c)—Road Capacity

Capacity of carriageways

54. When applied to built-up areas theoretical calculations of the capacity of an unobstructed traffic lane are of little more than academic interest, for such conditions cannot be attained in busy city streets. Regard must be had to the many obstructive features which, to a greater or less extent, are unavoidable, such as the mixed character and

varying speed of the traffic, intersections with cross streets, the presence of standing vehicles, stoppages to permit the crossing of pedestrians and the stopping and starting of public service and other vehicles. In considering road capacity a bicycle is regarded as one vehicle where cycles and mechanically propelled vehicles use the same carriageway.

55. On an unobstructed carriageway permitting free movement of traffic, the theoretical capacity in number of vehicles per hour of a single traffic lane varies with the speed of the vehicle. An empirical formula taking into account such considerations as stopping distance, drivers' reaction time and so on, the constants of which have been determined from observations made under practical conditions, gives a figure of 1,000 vehicles per traffic lane per hour at 4 miles per hour, 1,600 vehicles per hour at 10 m.p.h., and a maximum of 1,800 vehicles per hour at 20 m.p.h. The capacity falls away as speed increases beyond 20 m.p.h., due to the need of maintaining a greater distance between each vehicle. American authorities quote lower capacities for speeds up to 25 m.p.h., but give a maximum of 2,000 vehicles per hour at a speed of 30 m.p.h. No one formula will meet all conditions, and different results will be obtained with vehicles and drivers having different characteristics. Variations in road conditions, *e.g.*, whether the surface is wet or dry, will also affect results.

56. The above figures relate to a single free-flow unobstructed traffic lane, but it must not be assumed that additional traffic lanes will provide for a proportionate increase in traffic capacity. Increased width tends to promiscuous movement and overtaking, and observations have shown that if the first lane is considered as carrying 100 per cent. of its capacity, the second lane will contribute about 75 per cent. additional capacity and the third lane about another 50 per cent. more.

57. Actual counts of maximum traffic densities were made before the war at many points in and around London. At holiday times short bursts of traffic approaching 2,000 vehicles per hour per traffic lane were counted on some of the main roads on the outskirts. At many points in central London counts up to 1,200 vehicles per hour per traffic lane (following delays due to temporary stoppages) were not unusual, but traffic was unduly congested and the resulting conditions were dangerous.

58. As a result of observations extending over many years, the Ministry of War Transport came to the conclusion that, under normal town conditions, with mixed traffic and street intersections, the maximum admissible capacity of a road with two lanes in each direction averaged 550 vehicles per hour per traffic lane, but that on thoroughfares further obstructed by standing vehicles this latter figure was too high, and that a lower figure, of from 300 to 400 vehicles per hour per traffic lane, depending on circumstances, was all that could reasonably be expected. On a motor-way, sub-surface or elevated road where there are no streams of traffic crossing on the level and frontage access is barred, we are of opinion that the reasonable capacity for a two-lane unidirectional unobstructed carriageway may be safely taken at 1,000 vehicles per hour per traffic lane, and for a three-lane unidirectional unobstructed carriageway, 900 vehicles per hour per lane.

59. We recommend that the figures in the preceding paragraph be adopted as the basis of calculation of carriageway space required in built-up areas, and that where, as in some shopping streets, a lane is provided specifically for waiting vehicles, this space should be ignored in determining the number of lanes required for moving vehicles, and that the average capacity of these lanes should be taken as 500 vehicles per hour per traffic lane.

Capacity of footways

60. There should be little need to emphasize the desirability of footways being of such ample width as will make for the comfort and convenience of pedestrians, and so obviate any tendency to walk along the carriageway. There are, of course, other factors than the number of persons actually on the move which influence the width of footways: for example, undue congestion is often found at bus and tram stops and at entrances to places of public resort, perambulators hamper free movement, and in shopping streets part of the footway is occupied by "shop gazers."

61. Those portions of the footway immediately adjacent to buildings and fences, or to trees, traffic signs, lamp-posts, etc., are not available for the movement of pedestrians and must be regarded as "dead" width. It has been found that in central shopping areas the "dead" width may be as much as 3 ft., but where the footway is flanked by a verge it is reduced to about 1 ft. 6 in.

62. As a result of investigations into pedestrian movement made in London, Birmingham, Leeds and Edinburgh, it was ascertained that if the number of pedestrians per 24 in. width (after deducting the "dead" width) is less than 20 per minute, the footways can be regarded as having adequate capacity. If the number is between 20 and 30 per minute free passage becomes inconvenient, and if higher than 30 per minute the footway is unduly congested.

63. According to American authorities,* pedestrian traffic at the rate of 33 pedestrians per 22 in. lane a minute can be moved satisfactorily on special occasions such as sporting events, but the density is too high in the vicinity of shops where comfort and convenience are vital to business. In such conditions 18 to 27 people per 22 in. lane per minute is considered a reasonable maximum. These figures confirm the results obtained from the investigations made in this country.

PART IV

Traffic Components

Section (a)—Public Service Vehicles

Numbers and Types

64. According to the latest returns prior to the outbreak of war the number of public service vehicles in use in Great Britain was 61,995. This number was made up of 50,282 motor buses and coaches, 2,725 trolley-buses and 8,988 tramcars. Within the previous ten years motor and trolley-buses had increased by 6,709 whilst tramcars decreased by 5,353. Fig. 1 shows the increase in number of mechanically propelled vehicles and indicates that the number of public service vehicles licensed yearly since 1926 has remained almost constant.

65. An indication of the types of public service vehicles in built-up areas was given to us by the Municipal Passenger Transport Association (Inc.). This organisation operates principally in built-up areas and, with the exception of two comparatively small municipal undertakings, comprises within its membership all road passenger transport undertakings in Great Britain and Northern Ireland owned and operated by local authorities. (The London Passenger Transport Board does not come within this category.)

66. The vehicles owned by constituent members of the Association at the end of 1941 were:

(1) Motor Buses	9,875	operated by	93	undertakings
(2) Trolley	1,811	"	30	"
(3) Tramcars	5,991	"	30	"
				<u>17,677</u>

In 1941/42 the mileage travelled by these vehicles approximated to 467,163,000, and the passengers carried to 5,574,724,000, averaging 11.9 passengers per vehicle mile. These figures are the latest obtainable, and in considering them allowance must be made for war-time conditions.

67. We are not primarily concerned with the relative merits of the three types of public service vehicles mentioned in the preceding paragraph, but rather with the provision which should be made to accommodate them on the highway in such a manner as will best meet transport needs without detriment to road safety or the operation of other vehicles.

68. Public service vehicles are an indispensable means of road transport for all sections of the community and the great majority of people possess no alternative to their use. Considered as traffic units they are more obstructive than private cars, both by reason of their size and the frequency of their stops, but they possess a marked advantage from the point of view of road space occupied per passenger.

* Traffic Engineering Handbook (a joint publication of The Institute of Traffic Engineers and the National Conservation Bureau, New York).

Prior consultation with appropriate authorities

69. We wish to emphasize the necessity of consultation with the authorities responsible for the operation of public service vehicles, and with the appropriate Regional Transport Commissioner, when schemes are being prepared for the construction or widening of streets likely to be used by them. This is particularly necessary when the future road pattern of a town is being determined, for no urban road system will adequately serve the public if it does not provide for the convenient circulation of public service vehicles. Such consultation should take place in the initial stages of the preparation of the scheme, and should cover the provision to be made for services to, and in, areas of potential development, as well as the siting, etc., of bus and tram stations and of picking-up and setting-down points.

Motor and trolley buses

70. Flexibility, both in manoeuvring and routing, and ability to pick up and set down passengers at the kerbside are the principal factors which contribute to the popularity of buses as compared with tramcars, though trolley buses have less freedom than motor buses in this respect because they are tied to defined routes by overhead trolley wires, whilst a further disadvantage lies in the necessity of a large turning circle at each terminal point. Regulations restrict the overall width of omnibuses to 7 ft. 6 ins., but a number of vehicles 8 ft. in width, built for use in the Dominions, are now running in certain parts of the country as a war measure. Although an increase in the overall width of buses to 8 ft. would doubtless add to the convenience and comfort of passengers, an extra 6 ins. would be likely to involve an additional risk of accident on carriageways already used to capacity, and would have to be taken into account in determining the width and layout of new or widened streets likely to be used by such vehicles. We are of opinion that in considering this matter due regard should be had to the safety factor, as well as to the effect on the free movement of other vehicles, and on the cost of road widening and construction.

Effect of excessive camber

71. It has been found that when travelling on roads of more than medium camber, especially at road junctions, double-deck buses (which number more than 90 per cent. of all buses on the road), tend to keep more than the usual distance from

the kerb. For this reason, and when clearance on the offside is also taken into account, buses on excessively cambered roads will be found to occupy a width of carriageway in excess of the normal traffic lane. Every opportunity should therefore be taken to eliminate excessive crossfall and an average camber of 1 in 40 between the crown of the road and the channel should be regarded as a maximum.

Waiting bays or lanes

72. A "waiting lane" which forms part of the layout of the road will afford the carriageway accommodation necessary for picking-up and setting-down bus passengers at the kerbside without obstructing vehicular traffic. On other roads, where the whole width of the carriageway is fully utilized by moving vehicles, such accommodation can be afforded in waiting bays which should be 9 ft. in width and of a length dependent on the number of buses requiring to use them at the same time, but not less than 100 ft. (See Plate 1.) Waiting bays for public service vehicles should be reserved exclusively for their use. We do not, however, regard waiting bays for buses as suitable in streets such as shopping streets, and consider that in these the width of carriageway should be sufficient to enable the outer lanes to be utilised by public service and other vehicles when stationary for short periods.

Queue barriers and shelters

73. At picking-up and setting-down points, provision should be made for the orderly waiting of passengers in queues and for their adequate protection from the weather while so doing. Double-line queue barriers having such means of protection will not be less than 4 ft. in clear width, and, as they should be set back 18 ins. from the face of the kerb, they will occupy about 5 ft. 6 ins. of width. Except where verges of this width are provided they will encroach on available footway space unless arrangements are made to prevent it. Some mitigation of the obstruction to pedestrians will be afforded if the barriers are so designed that, when they are not occupied by passengers, pedestrians can walk freely through them; alternatively, the full width of the footway may be roofed at the barriers, provided this does not interfere with the use or amenity of adjacent buildings. (See Plate 2.) If the footways are not of sufficient width to permit the construction of queue barriers without undue inconvenience, it may sometimes be practicable to

increase the width of the footways at the barriers by setting back the frontage line or arcading the buildings.

74. The specific provision which may have to be made in the design of carriageways and footways for waiting bays and queue barriers emphasizes the need for prior consultation with the appropriate authorities on the location of the points of picking-up and setting-down of bus and tram services.

Bus stations

75. Location of bus stations is an important factor to be taken into account in planning the road system. Conditions in different towns are so varied that no general rule can be laid down to govern their position, but in any event there should be provision for the interchange of passengers at principal railway stations, and they should be conveniently located for shopping centres, and markets. Where services radiate from central points, bus stations should be provided. Their use should not be confined to a single undertaking, but, where desirable and practicable, should serve the purpose of other undertakings calling at the town, or over long distances having the town as their starting place or destination.

Provision for housing estates, etc.

76. It is essential that in determining the situation and layout of housing estates or satellite towns full regard shall be had to the facilities required for mass transportation, and that, where convenience demands that public service vehicles shall traverse a housing estate or satellite town, the necessary provision for doing so shall be made in the road plan. Instances have been brought to our notice of large housing estates where subsequent provision had to be made for bus services the need for which had not been foreseen, with the result that they have had to operate on roads unsuitable in alignment and width.

Terminal points

77. Accommodation should be provided off the highway for buses which are stationary at terminal points during quiet periods between rush hours, (See Plate 3) and buses used for conveying operatives to and from specific works or factories should be given facilities for loading and unloading within the curtilage of the premises they serve and provided with easy means of ingress and egress.

Buses in shopping streets

78. We discuss in Part V, Section (e) of our Report, the question of restricting the use by public

service vehicles of shopping streets, particularly those within the inner ring road.

Tramways

79. It has been said that tramways constitute a serious source of danger, but any tendency to this effect can be materially minimized if the track is properly maintained. There is no conclusive evidence to show that tramcars themselves constitute a higher potential cause of accidents than other types of public service vehicles. Passengers are, however, exposed to additional risk of accident when entering or leaving a tramcar when, as is usually the case, the track runs along the middle of the carriageway.

80. There can be no doubt that tramcars running on fixed tracks obstruct the free flow of traffic, especially when the tracks are provided with passing loops. In the general interest of the free flow of road traffic, we welcome the tendency to replace tramcars by vehicles of greater flexibility, particularly in the central areas of towns; but we accept the position that tramways may have a proper place in road passenger transport, e.g., on routes serving heavy tidal traffic to or from housing or industrial estates or important places of public resort.

81. The presence of tramways introduces serious complications in the safe and effective layout of roads, and in particular of road intersections, and so long as they remain it may be impossible to adopt the type of layout best suited to the majority of road users. We are of opinion that, taking the long view, there are few towns in which the existence of tramways at surface level should be allowed to determine the future pattern of the road system and the design of its intersections.

82. Where tramways are to be retained every opportunity should be taken to locate them within their own fenced reservations which, preferably, should be outside the limits of the highway.

Section (b)—Goods Vehicles

Numbers and dimensions

83. Of the half million goods vehicles licensed for use in this country immediately before the war 62 per cent. were vehicles with an unladen weight of two tons or under, while those up to and including 2½ tons unladen weight constituted 85 per cent. of the whole.

84. Maximum dimensions are laid down by Act and Regulations, and (excluding vehicles for abnormal loads and special dimensions for steam locomotives) are as follows :—

Maximum Length :—

Vehicles with 4 wheels	27 ft. 6 ins.
Vehicles with more than 4 wheels	30 ft.
Articulated Vehicles	33 ft.
Vehicle with Trailer	60 ft.

Maximum Width : All types, 7 ft. 6 ins. (except locomotives, which may be 9ft.)

Although a maximum width is prescribed for vehicles the width of the load is not controlled, and in considering the road space required for goods vehicles regard must be had to the overhang of the load.

Turning circles

85. Although the maximum diameter of the turning circle of public service vehicles is laid down in regulations no legislative restriction governs that of commercial vehicles. Large vehicles of this class, such as rigid or articulated six or eight-wheelers, have turning circles up to 80 ft. diameter or, in one type, as much as 84 ft. 6 ins. diameter. In considering the relation of the vehicle turning circle to road layout it must be borne in mind that a vehicle cannot be turned from a straight path directly over to full lock ; also that when approaching a road intersection at which he desires to turn, a driver must steer his vehicle at a distance from the kerb to allow the rear wheels to clear it.

86. It has been recommended in Memorandum 575 that roads likely to be used by a large number of heavy industrial vehicles should be laid out with a dimension of 70 ft. between the outer kerbs of dual carriageways, to permit all but the largest vehicles to turn from one carriageway to the other without reversing. We endorse this recommendation, the adoption of which will, incidentally, result in a central reservation of sufficient width to enable adequate amenity treatment to be afforded. We feel, however, that the turning of large vehicles from one side of the road to the other, except at intersections laid out to facilitate such movement, should be discouraged in the central areas of towns, though specific provision for it is necessary in factory and warehouse areas in and the vicinity of docks and railway good stations.

Slow-moving vehicles

87. Slow-moving, horse-drawn goods vehicles are productive of obstruction and delay, and have

to be taken into account in estimating traffic capacity ; this has been referred to in Section (d) of this Part of our Report. In other respects, however, they do not influence the dimensions of road layout.

Parking and unloading

88. We refer in para. 419 to the provision of parking places for goods vehicles, in paras. 172, 408 and 426 to the facilities required for their loading and unloading, and in para. 253 to the influence of large goods vehicles on the design of service roads.

Section (c)—Private Cars

Numbers and dimensions

89. Of approximately two million private cars licensed for use in Great Britain prior to the commencement of the war, about 50 per cent. were of 8 and 10 h.p., and 72 per cent. up to and including 12 h.p. It will be observed from Fig. 1 that immediately before the war private cars comprised 61 per cent. of all vehicular traffic on roads in this country, excepting pedal cycles. Whereas goods vehicles are limited by regulation to maximum permissible speeds in accordance with their weights, types of tyres, and other characteristics, the only restriction applying to private cars is the maximum speed limit of 30 m.p.h. which, with few exceptions, is imposed on all traffic in built-up areas.

90. The maximum permissible dimensions for cars are similar to those of goods vehicles, with 3 tons maximum unladen weight. The length of the largest cars of the higher ratings—i.e., over 30 h.p.—in use before the war was 19 ft. 3 ins., and widths ranged up to 6 ft. 4½ ins. The turning circle of these cars is up to 52 ft. in diameter while that of cars up to and including 12 h.p. seldom exceeds 40 ft.

Influence on road design

91. A road laid out to dimensions adequate for the convenient movement of goods and public service vehicles will make the necessary provision for private cars so far as widths and radii of curves are concerned, and in respect of superelevation within the 30 m.p.h. speed limits. The special demand by private cars is for waiting and parking spaces and we have referred to this in Part VIII, Sections (a) and (b) of our Report.

Section (d)—Horse-drawn Vehicles

92. Horse-drawn vehicles constitute a very small proportion of road traffic in this country under normal conditions—the traffic census of 1938 gave a percentage of 0.62 for Class I roads, and the census of 1936 a percentage of 1.24 for Class II roads, of all road vehicles other than pedal cycles. Horse-drawn vehicles of the commercial class vary from slow-moving heavy drays or lorries to light vans which may move at trotting speed, whilst there is still a number of horsed vehicles in private use.

93. There is a considerable diversity of opinion on the comparative merits and demerits of horse-drawn and mechanically propelled vehicles for short journeys, more particularly for door to door delivery. Representatives of the Railway Companies' Association expressed to us a strong preference for horse-drawn vehicles for this purpose, and it is evident that for some time to come they will remain a factor to be taken into account.

Congestion by slow-moving vehicles

94. The presence of slow-moving vehicles constitutes a serious obstruction to the flow of traffic in busy streets. They may reduce the speed of the traffic lane upon which they travel to about walking pace, and, during peak hours, may go far to creating severe congestion. Low acceleration on the part of horse-drawn vehicles is an added cause of delay, particularly at traffic control signals. It is impracticable to provide separate traffic lanes for their accommodation, and they are thus specially obstructive where there is no second lane available for overtaking. Recourse may have to be had to an Order under Section 46 of the Road Traffic Act, 1930, providing, *inter alia*, for the specification of routes to be followed by vehicles of any class or description, and their prohibition or restriction on specified roads, either generally or during particular hours.

Provision for horse-riding

95. Our attention has been drawn to what is said to have been the growing popularity of horse-riding in pre-war days and the probability that the habit will continue and is likely to increase. It is generally out of the question to make special provision for equestrians in closely-built-up areas, but where the demand exists and circumstances permit, advantage should be taken of wide verges,

and reservations on parkways, to provide tracks for horse-riders. We are also of opinion that where horse-riding is extensively practised the provision and effective maintenance of bridle tracks for horsemen would be a distinct asset to those concerned, and tend to the relief of traffic and consequent enhancement of safety on the public highway.

Non-slip surfaces

96. Methods of road construction are not within our terms of reference, but we endorse the recommendations contained in the memoranda issued from time to time by the Ministry of War Transport on the maintenance of non-slippery surfaces—a matter of importance to horse-riders as to all road users.

Driving of cattle

97. In many of our old towns cattle markets occupy central positions which, by reason of unsatisfactory means of approach and the growth and altered character of traffic, are now entirely unsuitable. Similar objections in regard to access apply to abattoirs, and ports where cattle arrive or leave by ship. Wherever practicable, cattle markets should be removed to situations to which cattle can be taken without causing obstruction to other traffic; but if existing sites have necessarily to be retained, cattle should be conveyed to and fro by suitable vehicles, or the driving of them should be confined within specified hours.

Section (e)—Pedal Cyclists

Factors governing use in built-up areas

98. The extent to which pedal cycles are used is largely governed by topographical features. Examination of the census returns from five towns of comparable size in hilly country and five of similar size in flat country disclosed that pedal cycle traffic in the former was only 35 per cent. of that in the latter. In both cases the volume decreased from the centre of the town outwards, but while in hilly country the count of pedal cycles at census points between 2 and 3 miles out was only 10 per cent. of that in the town centres, in flat country it was 26 per cent. As a general rule pedal cycle traffic increases as the town centre is approached, and the difficulty of providing adequate facilities for it becomes correspondingly greater; but this observation does not apply to large towns such as Glasgow, Birmingham and Manchester, where the intensity of traffic in the city centre discourages cycling.

Accidents to pedal cyclists

99. In Part II of our Report dealing with Road Safety we pointed out that in built-up areas one-fifth of the persons killed and one-third of those injured were pedal cyclists. In the Report of the Ministry of Transport on Road Accidents in 1936/37 accidents to pedal cyclists in built-up areas were attributed to the following causes:—

	Percentage of total of such accidents	
	Fatal	Non-fatal
(i) Emerging or turning from one road into another ...	24.4	21.2
(ii) Skidding	5.6	9.6
(iii) Overtaking improperly or cutting in	4.3	3.9
(iv) Inattention, misjudging clearance, etc.	9.2	22.3
(v) Swerving	10.8	8.8
(vi) Losing control	10.1	6.9
(vii) Others	35.6	27.3
	100	100

Of the fatal accidents attributed to pedal cyclists in turning from one road into another, 70 per cent. occurred while the pedal cyclist was making a right-hand turn.

Importance of segregation

100. Careful consideration of these and other figures which are available in official Reports, as well as of evidence given to us, leads us to the inevitable conclusion that by far the best preventive of accidents to pedal cyclists lies in their segregation from motor traffic, for it is clearly unsound that a running surface should be used at one and the same time by heavy motor-driven vehicles capable of developing high speed and by light and unstable vehicles such as pedal cycles.

101. We see no difference in principle between the desirability of the segregation of motor, pedal cycle, and pedestrian traffic respectively, and in view of the contribution which the provision of cycle tracks is capable of making to the safety of all classes of traffic—and to pedal cyclists in particular—we regard it as unfortunate that attempts should be made in any quarter to discourage cyclists from using them.

Cycle tracks

102. On the question of standards to be adopted for cycle tracks, we endorse the recommendations of Memorandum No. 575 that the

width should normally be 9 ft. and should in no case be reduced to less than 6 ft. If the traffic warrants a width in excess of 9 ft. the increase should be by units of 3 ft. We are of the opinion that the separation of cycle tracks from carriageways or footways by physical barriers such as fencing, or high kerbing adjacent to the cycle tracks, is not in the best interests of safety. The width of the verge between the track and the near-side kerb of the carriageway should not be less than 6 ft., and a similar width should be given if possible between the track and the footway. There may be places, however, where lack of space necessitates narrow verges, and in these cases any modification of width should first be effected between the cycle track and the footway, or it may be necessary to omit the verge altogether. In the latter event, the division between the track and footway could be delineated by a kerb which should not project above the level of the cycle track to such an extent as to be dangerous; but such an arrangement should not be adopted if it can be avoided.

Use of service roads by cyclists

103. Where continuous service roads suitable for the purpose form part of the layout we see no reason why they should not be used by cyclists in lieu of special cycle tracks. Further aspects of the segregation of cyclists on special tracks are discussed in Part VII, Section (a) and in para. 208.

Section (f)—Pedestrians

Vulnerability to accidents

104. Throughout our deliberations the high vulnerability of pedestrians to road accidents has been constantly in our minds, and in all our recommendations we have had regard to the measures which can best be taken to ensure their safety, with the minimum of personal inconvenience. It is evident, however, that under modern conditions of traffic pedestrians must forego certain of their traditional rights as users of the King's Highway and accept the necessity of such restrictions as are essential to their own safety and that of other road users.

105. It was made evident in para. 25 that the main danger to pedestrians arises in crossing the road. It is a difficult task, especially in built-up areas, to strike the right balance between the promotion of safety by controlling physically the points at which pedestrians may cross the carriageway and the preservation of their freedom of movement.

In Part VII, Section (d) of our Report we have referred at length to various means by which they can be enabled to do so, and have made a number of recommendations the adoption of which should result in a material diminution in road accidents. It is unfortunate that the use of subways and footbridges—the safest of all the means of crossing busy streets—entails some additional physical effort, to which elderly people in particular are naturally averse. This, however, can be overcome by the raising or lowering of the carriageway as topography permits to enable the subway or bridge to be constructed at ground level. Suggestions have been made that access to subways and footbridges should be by escalators, but except in very special cases we cannot think that they offer a practical solution.

Safety of Children

106. We pointed out in para. 25 that of the pedestrians killed in 1936-37 in built-up areas, 19 per cent. were children under seven years of age. The loss of life and liability to accidents amongst children is particularly distressing. Much has been done in the way of education and propaganda by the co-operation of the education authorities and the police, and in the years immediately prior to the war there was a small but steady decline in road accidents to children. Experience shows that methods of safety inculcated into the minds of

children of school age are likely to continue in later years and much can be hoped for in this direction as time goes on. An excellent example of what can be accomplished is given by results achieved in Salford, a county borough with a population of close upon 224,000 and a gross density as high as 43 persons per acre. As a result of education and demonstrations by police officers and other competent persons, coupled with the provision of a large number of "play" streets (See Plate 4), the erection of barriers at school entrances and other safety measures, there was an entire absence of fatalities amongst school children in the streets during the twelve months ending September, 1936. It must be admitted, however, that the need for play streets is evidence of lack of planning in the past, and their elimination in due course is an essential objective.

Importance of adequate footways

107. In the appropriate sections of our Report we have stressed the importance of making the footway—which should be regarded as their own haven—convenient and attractive to pedestrians. It should be of ample width, comfortable to walk upon and free from obstructions. Pedestrian "ways" remote from busy traffic routes should be encouraged, and we refer to them in paras. 206 and 207.

PART V

The Road Pattern

Section (a)—General Considerations

108. In a country such as ours opportunities of planning new towns are few and far between, for we are usually concerned with the far more difficult task of adapting existing conditions to meet new requirements.

Types of road pattern

109. Broadly speaking, there are three principal types of urban road pattern, (1) Radial, (2) Gridiron, and (3) Linear, of which the first is the predominant type in this country, however unsymmetrical its outline may be. The tendency has been for centres of population to grow up at road intersections and, as these centres extend outwards, for

new routes to develop from the hub. Even coastal towns conform in greater or less degree to the radial pattern.

110. The gridiron type favoured by the Romans has been adopted extensively in the U.S.A. One objection to this pattern is the extra distance involved in travelling in a diagonal direction; this has been remedied in many towns by the addition of diagonal routes, though these have an unfortunate effect on the architectural development of adjoining frontages, producing acute angled plots and awkward street intersections. There are very few examples of towns in this country laid out on the gridiron plan, though individual estates have often been so developed particularly after the

introduction of the By-law Street in the last quarter of the 19th century which tended to produce a dreary monotony.

111. The linear type of development arises mainly from topographical features and is frequently found in towns which have grown up along the principal roads through valleys, e.g., in such regions as South Wales and the West Riding of Yorkshire. A typical example near London is High Wycombe.

112. In towns not of radial pattern, no general solution can be put forward for the relief of traffic congestion and the by-passing of arterial traffic,

and care must therefore be exercised in applying the principles set out in this Report. Each town, whether it be radial or not, will have attendant circumstances which will have a marked bearing on the future planning of the area. The radial, therefore, is the type we have had principally in mind. Our recommendations on the design and layout of the streets constituting the road pattern can, however, be applied to each of the three types of towns described in the para. 109 so that suitable conditions may be created in each case for facilitating the free flow of traffic.

113. These three types may be illustrated diagrammatically:—

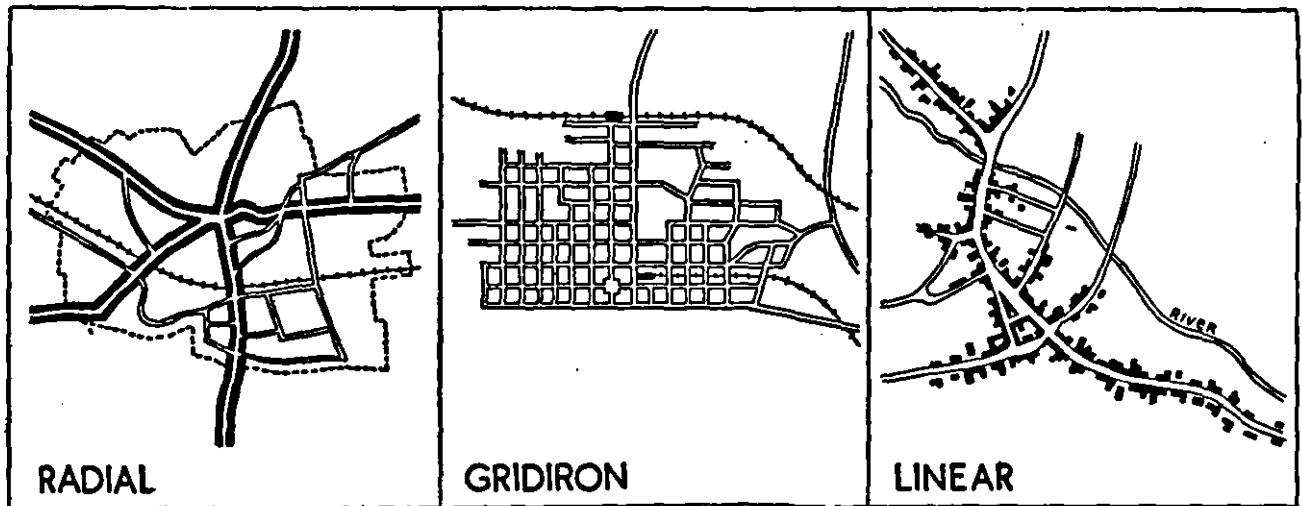


FIGURE 4

Distribution of urban population

114. It will be useful to state how the urban population in Great Britain is distributed in towns of various sizes, since the population of a town is obviously one of the most important factors to be considered in replanning or improving its road system. There are, outside of the County of London, 1,159 urban authorities, 964 County Boroughs, Municipal Boroughs and Urban Districts in England and Wales, and 195 Large Burghs and Small Burghs in Scotland. They can be classified as follows:—

Population	No. of Urban Authorities	
	England and Wales.	Scotland.
Less than 10,000	... 368	154
10,000—50,000	... 454	34
50,000—100,000	... 98	3
100,000—250,000	... 30	2
250,000—500,000	... 11	1
500,000—1 million	... 2	—
Over 1 million 1	1

Many of these towns—including some of the largest—form conurbations such as those of London, Glasgow, Birmingham and Manchester. They present special problems on that account and point to the need of co-ordinated planning in each region, particularly of their communications.

Varying character of traffic

115. In large towns and conurbations arterial traffic is generally a much smaller proportion of the total traffic than in smaller towns, and the predominantly local character of the traffic of large cities has an important bearing on the design of their road systems. On the other hand, arterial traffic in this country is largely inter-urban, and much of it has its point of origin or destination in the large towns or conurbations where it is what we have described as through traffic.

116. Special treatment may be required in coastal towns or ports, where a predominant point of traffic origin and destination, such as docks or harbours, may necessitate a direct through traffic

route connected with the arterial road system and segregated from shopping and residential areas.

Traffic function of roads

117. In the majority of towns radial and ring roads form the principal routes for through and local-through traffic. Where there is a substantial volume of arterial traffic passing through a town provision should be made for a by-pass. If, however, the volume of arterial traffic does not justify a by-pass, provision for it should be made on the outer ring road or on such part of it as is used by arterial traffic, the design of which should then more nearly approach that of an arterial route. The main radials are the connecting links with the arterial road system and should be regarded primarily as through traffic routes. As they are part of the urban road pattern a reasonable balance must be struck in their design and layout between their through traffic function and more local interests. Nevertheless, considerations of safety and free flow demand that to the fullest possible extent they should be progressively converted to through traffic routes.

118. We cannot agree that local interests should be entirely subordinated to arterial traffic so long as the latter continues to pass through a town. Statistics show that eighty per cent. of the population of the country live in areas which are designated as urban for local government purposes. We have said that provision for arterial traffic should be made by means of a by-pass outside the limits of urban development, but until this can be achieved it should not be regarded as a hardship that, in passing through built-up areas, arterial traffic should be subject to restrictions on speed, and perhaps in other respects, which would be unnecessary on roads specifically designed to accommodate it.

119. Where circumstances make it desirable to provide for a large volume of high-speed traffic having its origin or destination in a large town or conurbation, or where, by reason of topography or prior development, a by-pass cannot be located outside built-up areas, consideration should be given to the construction of a sub-surface or elevated road rather than to attempt to mould a high-speed highway at ground level into the existing road pattern.

120. In a new town, the separation of arterial from local traffic should present no difficulty; but our main problem consists in the re-modelling of

an existing urban road system. Replanning on a scale which entails widespread demolitions may take many years to materialize, except in the comparatively few towns where war damage has been widespread or where there are large obsolescent areas ripe for reconstruction. The essential requirement is that a long-term policy should be pursued in the form of a master plan, to which all projects should be made to conform.

Factors to be considered in layout and design

121. Roads in built-up areas fall to be considered in relation to both (1) their location and (2) their design. Within (1) the main factors to be considered are:—

- (a) The points of origin and destination of arterial traffic, with due regard to future developments, such as re-location of railway termini, or the provision of airports.
- (b) The present or proposed use-zoning of the area.
- (c) The principal movements of traffic from one part of the town to another, including daily movement of population.
- (d) Alignment which will facilitate satisfactory treatment of road intersections.

Within (2) the main factors to be considered are:—

- (i) The volume, type and variation of vehicular, cycle and pedestrian traffic.
- (ii) The use to be made of road frontages.

122. The objectives to be aimed at on through and local through roads in order to provide for the maximum measure of free flow compatible with safety are:—

- (a) Reduction to a minimum of the number of road intersections and the effective design of such as are essential.
- (b) Limitation of frontage development having direct access to the road.
- (c) Segregation of motor, pedal cyclist and pedestrian traffic, and of opposing streams of traffic.
- (d) Prevention of obstruction by standing vehicles.
- (e) Abolition of railway level crossings.
- (f) Reduction to a minimum of points of pedestrian crossing of carriageways on the level, and the effective layout of such as are essential.
- (g) Regulation of horse-drawn vehicles.

With the exception of roads which have been constructed primarily as by-passes, few if any roads in built-up areas even approximate to these standards, but the ideal should be kept in view and every endeavour made to achieve it.

123. Such matters as the design of intersections, road widths, traffic segregation, pedestrian crossings, parkways, provision for public service vehicles, parking accommodation and so on, are, for the most part, governed by considerations which are not necessarily peculiar to roads of a particular class and are discussed in the appropriate sections of our Report. The observations which follow on by-passes, radial and ring roads are confined to those aspects which more particularly concern their special functions.

Railway level crossings

124. There are many towns in which the existence of railway level crossings constitutes a serious cause of obstruction and delay. They are always potential sources of danger, but the demand for their elimination is justified more by their interference with the free flow of traffic than by considerations of road safety. A railway level crossing should never be incorporated in a new road, and on existing roads every opportunity should be taken of substituting a bridge, although it is obvious that because of the property involved the cost of so doing will be exceptionally heavy in built-up areas. Failing a vehicular bridge, a foot-bridge or subway should be provided for pedestrians and cyclists, the use of which in suitable cases should be made compulsory.

Section (b)—Relation of the By-Pass to the Urban Road System

125. The function of a by-pass is to provide an attractive alternative route for traffic which has no valid reason to pass through the busy streets of a built-up area, thereby alleviating conditions which, on existing routes, contribute to danger, congestion and delay.

Estimating by-passable traffic

126. Data from traffic surveys made in this country, and deductions from census returns lead to the following assumptions:—

In towns up to 10,000 population 80 per cent. of the entering traffic is by-passable.

In towns of 10,000 to 50,000 population 65 per cent. of the entering traffic is by-passable.

In towns of 50,000 to 100,000 population 45 per cent. of the entering traffic is by-passable.

In towns of 100,000 to 250,000 population 20 per cent. of the entering traffic is by-passable.

In towns of 250,000 to 500,000 population 15 per cent. of the entering traffic is by-passable.

In towns of 500,000 to 1,000,000 population less than 10 per cent. of the entering traffic is by-passable.

127. These figures show that, generally speaking, the larger the town the smaller is the proportion of by-passable (*i.e.*, arterial) traffic, and this conclusion is largely confirmed by a Report issued in January, 1944, by the National Inter-regional Highway Committee appointed by the President of the United States. The Report shows that in the United States small townships of 2,500 population or less have roughly 50 per cent. traffic which is by-passable, while those of half to 1 million population have only about 5 per cent. traffic which has no reason for entering the city. In considering these figures it should be borne in mind that in the United States the distances between towns and villages are much greater than in this country and that the use of the motor-car is far more extensive.

128. The figures given in para. 126 must, however, be regarded as generalizations and they are likely to be very much affected by particular circumstances, especially in smaller towns. The volume of traffic by-passable from small towns on a principal arterial route will be much greater than from a town of the same size on a less important route, but which serves as the cultural and shopping centre for a large area. It was found that in a certain town with a population of about 12,000 and of special attraction to tourists, only 22 per cent. of the incoming traffic was by-passable, whereas in a town with approximately the same population, in another part of the country, but with no similar attraction, 70 per cent. of the incoming traffic was shown to be by-passable.

129. Although in large towns and cities the percentage of by-passable traffic may be a relatively small proportion of the whole, it may numerically be considerable and include many of the larger vehicles. The construction of a by-pass might well permit the deferment of the widening and improvement of radial roads into the town, or a reduction in the scale of the work otherwise necessary.

By-passes should be made attractive to traffic

130. Where there is justification for a by-pass, but the route selected materially increases the distance to be travelled, or imposes undesirable gradients, there is reluctance on the part of drivers to deviate from the shortest road, and the new route must be so planned on free flow principles as regards terminal points, alignment, gradient, freedom from frontage access, intersections at surface level and speed restrictions as to compensate for any additional length. Where these conditions cannot be achieved (particularly in large towns) consideration should be given to the provision of a sub-surface or elevated road for the purpose of taking traffic through the built-up area. (See Part V, Section (h) of our Report.)

Necessity of obtaining data by census

131. It is necessary again to emphasize the importance of ascertaining by means of a detailed traffic survey including an origin and destination census, the justification for a by-pass and the facilities required for interchange with other routes as it may be found that there is no need for connection even with some of the radial roads.

Section (c)—Radial Roads

132. The point of convergence of radial roads constitutes in most towns the crux of the traffic problem. Main radials serve primarily the needs of through traffic and minor radials the needs of local-through traffic. The qualification that one class of road may be used by more than one class of traffic and thus also serve the functions of another class, applies with special force to radials.

133. While the planner has a relatively free hand in the location of the outer ring road, and perhaps, as the result of enemy action, or by reason of a slum or other clearance scheme, may have been given some freedom of action in locating inner and, in a less degree, intermediate ring roads, he is, in the treatment of radials, faced to the maximum extent with the fact of existing development, sometimes along the greater part of their length, and the ideal and the attainable are thus particularly difficult to reconcile.

134. On these parts of radial roads which are in relatively open country (as in the outer areas of a town) there will be few, if any, obstacles in the way of attaining the standards enumerated in para. 122, and opportunity may present itself of develop-

ment on parkway lines. The problem, however, becomes increasingly difficult as the radial road approaches the town centre. Unless the width between buildings is sufficient to permit the construction of waiting lanes or service roads the elimination of standing vehicles is almost impossible and the segregation of cycle traffic is out of the question.

135. The improvement of the radial roads of existing towns so that they may be brought into conformity with reasonable standards of free flow and safety must be by a continuous, though it may be slow, process of widening associated with the reconstruction of adjacent buildings. This assumption emphasizes the importance of providing an outer ring road designed to attract traffic which has no real need to enter the inner part of the town. The existence of old-established shopping centres on main radial roads constitutes a major problem. (See also Part V, Section (e)—Shopping Streets.) If there is no likelihood of the transfer of the shopping centre elsewhere, consideration should be given to the construction of a new road, or the adaptation of an existing parallel road as a traffic route, leaving the existing road as a local shopping street.

Connections with other roads

136. Provision must be made for convenient and safe connections between the radial and ring roads. Broadly speaking, three types of design are available: (a) The fly-over, (b) the roundabout, either of the double-deck type or at surface level, and (c) intersections controlled by traffic signals. The first-named is the ideal, but considerations of cost, the large area of land required and the complexity of design for an all-purpose road may preclude its adoption, except perhaps at connections with outer ring roads where the traffic is exceptionally heavy.

137. Vehicular connection with subsidiary roads should be restricted as far as practicable. Advantage should be taken of topography, or occasions of redevelopment, to carry subsidiary roads over or under main radials without connections, to link up subsidiary roads before they enter main radials, or to intercept them by means of service roads.

Specimen cross sections

138. The cross sections of roads shown in Part V, Section (d) will be suitable in width and layout for radial roads, depending on the circumstances

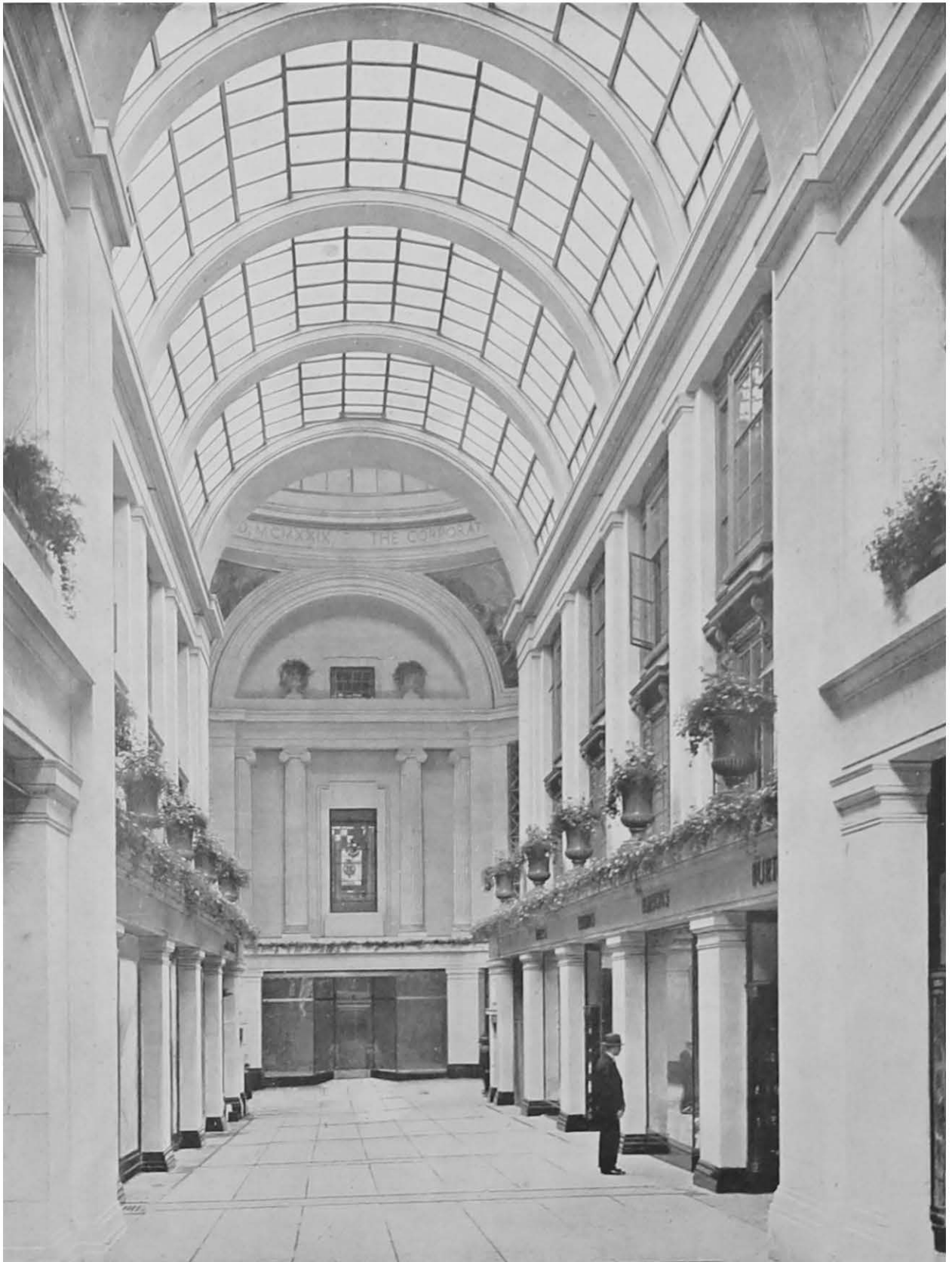


PLATE 9. SHOPPING ARCADE—NOTTINGHAM.



PLATE 10. PEDESTRIAN WAY WITH SHOPS—NORWICH.



PLATE 11. INFORMAL TREE PLANTING—MANCHESTER.



PLATE 12. SUB-SURFACE ROAD—DETROIT, U.S.A.



PLATE 13. ELEVATED HIGHWAY WITH CAR PARK ACCOMMODATION BELOW—NEW YORK.

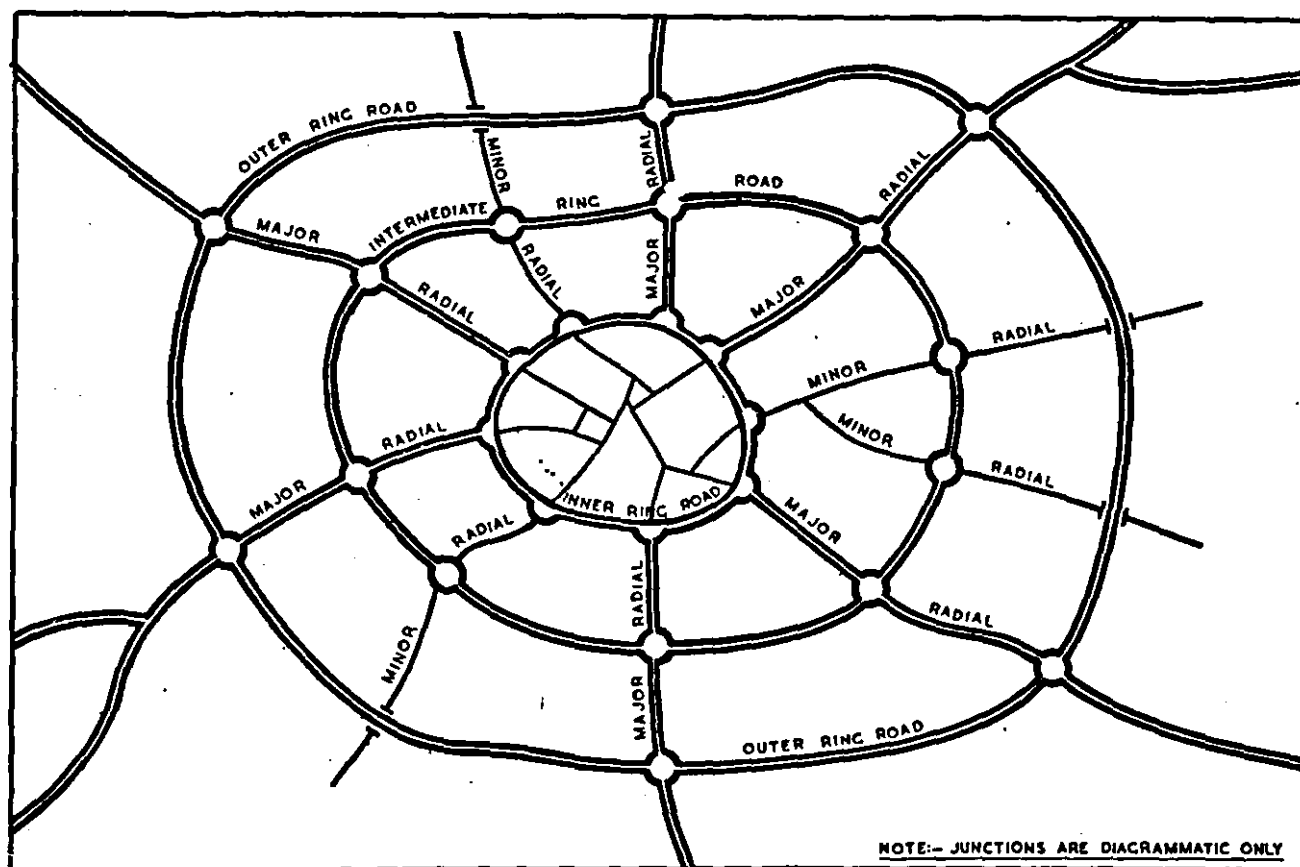


FIGURE 5

obtaining on these roads and on the location of each section of radial road in relation to the centre of the town.

Section (d)—Ring Roads

139. Ring roads can be divided into three classes, inner, outer and intermediate, as illustrated in Fig. 5.

The number and character of ring roads necessary for traffic requirements will depend mainly upon the population and spread of urban development. Towns with a population of say 20,000 may need but a single ring road, whereas a town with 100,000 or so may require both an inner and an outer ring, and a still larger town, or conurbation, one or more intermediate rings in addition.

OUTER RING ROADS

140. The first step is to determine to what extent, if at all, the outer ring road will be required to function as a route for arterial traffic, for this will have an important bearing on its location and design. We have made it clear that arterial traffic

should be deflected from the urban road system, but there may be topographical, economic or other reasons why this cannot be done, and use may then have to be made of the outer ring road, or some part of it, for both arterial and local traffic. In such a case the location and design of the road must be governed by the main purpose it will serve, and if arterial traffic predominates on any part, that part should be located outside the planned limits of development with its lay-out and construction based on the principles appropriate to an arterial route.

141. In most towns, however, the primary function of an outer ring road is to serve the traffic of the town itself by linking up the outer communities and acting as a distributor between the radials. On this assumption it should be located not outside the limits of the town but within the outer fringe of present and potential urban development.

Principles of location and design

142. The location and design of an outer ring road should, except as noted in para. 140, be based on the following principles:—

- (a) Its predominant function is to serve the needs of local through traffic.
- (b) For this purpose it should not be all-circumscribing but located within the outer fringe of present and potential development.
- (c) It should be so designed as to compensate for the detour involved in its use by facilities for higher speed, added convenience, safety and amenity.
- (d) Provision should be made upon it for all classes of traffic, i.e., vehicular, pedal cyclist and pedestrian.
- (e) Frontage development entailing direct means of access should not be permitted.

143. Reconciliation of the provision of free-flow facilities with the requirements of the com-

munity in the immediate vicinity must not be effected by making the outer ring road a development road, otherwise its main purpose will be defeated. Every effort should be made to secure that means of access should not be derived from the ring road itself. The objections to frontage development can be minimized to some extent by means of service roads, preferably without direct connection with the ring road. Outer ring roads may well lend themselves to treatment as parkways, to which we refer later in our Report. Connections with radial roads and access from subsidiary roads should be on the lines suggested under para. 136 and more fully detailed in Part VII, Section (c), though it may be expected that with outer ring roads there will be fewer difficulties concerning land acquisition.

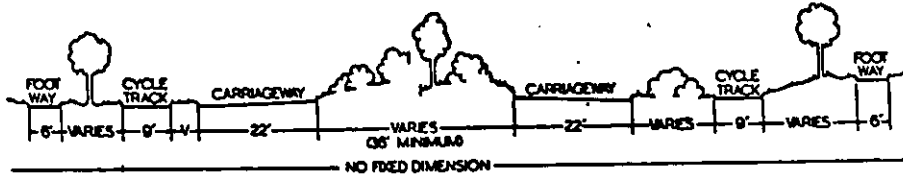


FIGURE 6

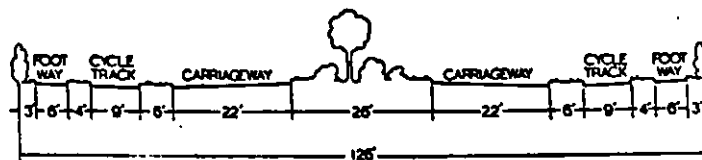


FIGURE 7



FIGURE 8

Specimen cross sections

Specimen cross sections, which show possible arrangements of the component units which go to make up various classes of highway, are given in this Report. They should not be regarded as typical examples for adoption in all cases, irrespective of location or traffic density.

For parkways (Fig. 6), no general maximum dimension can be given, but, as indicated in para. 186, a minimum of about 300 ft. should be aimed at while in no circumstances should the widths of any of the component units be less than the minimum specified in the various sections of the Report. The verges should be in excess of these minima in "parkway" layout.

Fig. 7 shows a layout with an overall effective width of 126 ft., suitable where space is limited. The 26 ft. central reservation will permit of the dual carriageways each being widened to 30 ft., when necessary, leaving a 10 ft. central reservation. In showing this cross section which incorporates various minimum dimensions set out in this Report, we have no wish to see these dimensions adopted concurrently. Imagination should be applied in designing roads and applying these minima.

Fig. 8 shows a cross section designed to suit the ground, but in cases such as this, the elevation and disposition of the various component units will require careful study to enable full economy to be effected.

INTERMEDIATE RING ROADS

144. Intermediate ring roads serve primarily the needs of traffic whether from a distance or of local origin desiring to reach points between the outer and inner ring roads. They will normally be located in areas already partially developed and, to a larger extent than outer ring roads, will incorporate existing roads with all the diversity of use to which the latter are subject. Limitation of interconnection with subsidiary roads and of frontage access should be aimed at, but anything approaching complete restriction is likely to be out of the question, except where an entirely new section of

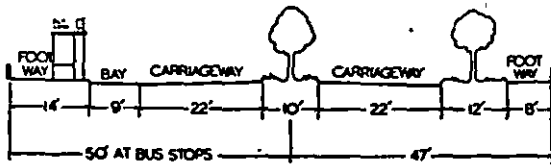


FIGURE 9

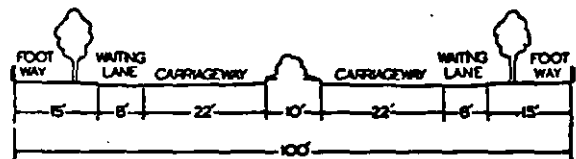


FIGURE 10

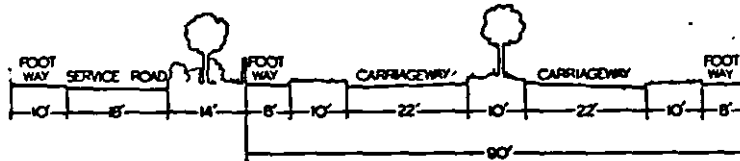


FIGURE 11

Specimen cross sections

The layout on Fig. 9 would be suitable where traffic is not heavy, and where ample room for amenity treatment and planting is desired. The effective width is 94 ft., but this overall dimension can be adjusted. At bus stops 9 ft. wide stopping bays are provided and adequate footway room obtained by a local increase of 3 ft.

Fig. 10 shows a layout suitable where traffic is heavy and service roads cannot be obtained. Buses can stop on the nearside lane (which should be widened to 9 ft. in these circumstances) and room for passenger queue barriers and shelters can be provided and adequate footway width obtained by suitable recesses in the boundary.

Fig. 11 shows a cross section with a 90 ft. effective width between boundaries. It may be adopted in an area where traffic is heavy, provision being made for a free-flow highway by the construction of service roads outside the highway boundary, and the enforcement of complete restriction of access.

road is constructed or extensive redevelopment takes place. Where frontage development exists, or is inevitable, it should, wherever possible, be provided for by means of parallel service roads.

Connections with other roads

145. Fly-over connections of the intermediate ring road with the main or minor radials will rarely be practicable, and roundabouts should in general be adopted. Connections with subsidiary roads should be treated in accordance with the principles and examples set out in Part VII, Section (c).

INNER RING ROADS

146. Except in the special cases to which we refer in para. 158, the inner ring road should not be regarded as a route for through traffic other than that having its points of origin or destination in the central area. Its traffic function is to serve the needs of local-through and local traffic, and its purpose to promote the convenient use and the amenity of the central area by deflecting from it all vehicles which have no need to traverse it, whilst affording convenient means of entry to those for which access is essential. Its location and design is therefore closely bound up with the size, layout and use of the central area.

Area enclosed by inner ring road

147. Generally, the central area will contain the public buildings and the principal shopping centre which has grown up around the hub of the radial roads. In larger towns public service vehicles constitute a substantial proportion of vehicular traffic reaching the centre and no adequate alleviation of congestion and danger is likely to be

attained unless public service vehicles can, in whole or part, be diverted from the central area. Nevertheless the prosperity of this area depends to a large extent on its accessibility to the users of mass transport, and if public service vehicles are to be wholly excluded the inner ring road should be so located that passengers do not have to walk more than 300 yards to reach the principal shopping centre. It follows that the area enclosed by the inner ring road should approximate to that of a circle having a diameter not greater than 600 yards. It will be understood that the word "diameter" is not used in a strictly geometrical sense, but is intended to define a mean transverse measurement across the central area confined by the inner ring road.

Use of central area by public service vehicles

148. Where the activities to be provided for within the central area cannot be contained within this space—nearly 60 acres—or where physical or other conditions make it essential that the inner ring road shall have a diameter greater than 600 yards, arrangements should be made for a limited number of public service vehicles to enter the central area. For this purpose it is necessary for one or more picking-up and setting-down stations for public service vehicles to be established within the central area. These stations should be so located that the roads leading to them from the inner ring road do not form direct routes across the central area, otherwise they will militate against the primary function of the inner ring road.

149. An alternative is to provide routes across the central area for a limited number of public service vehicles. In this case the roads they use will inevitably attract other traffic, which properly should follow the inner ring road. These transverse routes will have to be constructed or improved to a standard sufficient for the traffic using them, and in design and layout may need to be almost as spacious as the inner ring road. The result of adopting the alternative will be, in effect, to divide the central area into several units or precincts, and to this extent to defeat the purpose for which an inner ring road is provided. To obtain the maximum advantage of an inner ring road, the size of the central area should, therefore, not be greater than that referred to in para. 147.

Traffic requirements of inner ring road

150. If all or most public service vehicles are to be excluded from the central area, the inner ring

road will become a more or less continuous picking-up and setting-down circuit for them. Provision for this purpose must be made in its design and layout; its overall width should be sufficient to allow for a waiting lane on each side of the divided carriageway and for footways. If, therefore, the volume of moving traffic estimated to use the inner ring road is such as to require two lanes in each direction in order to maintain free flow, the overall width will be of the order of 100 ft. made up of two footways each 15 ft. wide, carriageways each 30 ft. or 31 ft. wide, and a continuous central reservation of not less than, and preferably greater than, 6 ft. We regard the provision of dual carriageways on an inner ring as essential to the free flow of traffic and to the safety of pedestrians while they cross from one side of the road to the other. (See also para. 157.)

Specimen cross sections

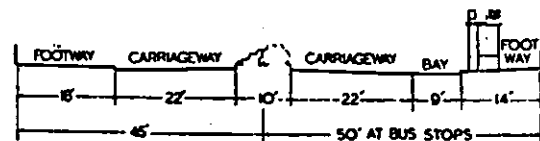


FIGURE 12

Fig. 12. The 90 ft. effective width might be suitable in an area where traffic is not heavy, and the 18 ft. footways provide ample width for pedestrian movement, this latter width being paved because of the difficulty of maintaining grass verges in densely built-up areas.

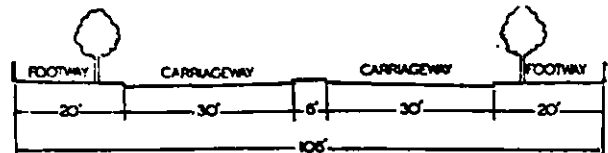


FIGURE 13

Fig. 13. Shows a layout suitable of adoption on a heavily trafficked route where the volume demands the provision of 30 ft. carriageways and pedestrian movement requires 20 ft. wide footways.

Frontage development on inner ring roads

151. Safety and free flow alike require that frontage access to the inner ring road should be restricted. We are, however, of opinion that complete prohibition of frontage access is both unnecessary and undesirable if, as we have suggested above, waiting lanes are provided primarily for the use of

public service vehicles. Prohibition of access, on a road constructed at ground level encircling the centre of a town, would in our view impose such a break on the continuity of development as seriously to prejudice the life of the town and, in particular, the prosperity of the central area. Nevertheless, we recommend that places of public resort should not derive their means of access from the inner ring road, and that as far as practicable all premises fronting it should derive their means of vehicular access from the rear.

152. We are strongly of opinion that the inner ring road should not be developed as a shopping centre though we see no objection to display windows of shops which have their main frontage and their entrances elsewhere. It is appreciated that where the shopping centre extends beyond the inner ring road it may be unavoidable that portions of the frontages to the ring road will have to accommodate shops, but where these shops are of types which attract crowds, e.g., large stores, the entrances should not front the ring road. In this connection, we wish to emphasize the consideration to which we have referred in para. 161 (Shopping Streets and Arcades), and to point out that the width of an inner ring road providing the facilities referred to in para. 150 is substantially in excess of that which in para. 166 we have recommended as the ideal width for a principal shopping street.

Connections with adjacent street system

153. The treatment of the intersections on the inner ring road should be determined in the light of three main principles, (1) discouragement of passage through the central area of traffic having no business there, (2) maintenance of free flow on the ring, and (3) provision for safe and convenient movement of vehicular traffic and pedestrians between the central area and the rest of the town.

154. Part of the vehicular traffic, and practically all pedestrian traffic, approaching the central area on the main and minor radials will require to enter it, though not necessarily at the point of intersection of the particular radial on which they are travelling. A substantial proportion of the vehicular traffic should, however, make use of the inner ring road, either to avoid the central area or to reach its most convenient point of entry. Traffic conditions on each of the radials will need individual study. Generally, the intersections with the radials should be laid out as roundabouts, enabling traffic to enter and circulate on the inner ring, and effectively

breaking the continuity of traffic movement on the radial inwards towards the central area.

155. Where continuity is necessary local roads should be carried over or under the ring road without interconnection, provided this will not result in the creation of a route encouraging passage of unessential traffic through the central area. Minor roads should be stopped up before they enter the inner ring road, but full use should be made of subways or over-bridges to maintain free passage for pedestrians between the central area and elsewhere.

Provision for pedestrians at intersections

156. In view of the concentration of pedestrians at intersections there would be substantial advantages in making provision for pedestrians, and possibly for cyclists, under the roundabouts. Where junctions of radials with the inner ring road are numerous, the free flow on the inner ring might be prejudiced by a multiplicity of level roundabouts and a two-level layout may in certain cases be necessary.

One-way working

157. Although one-way working on the inner ring road would substantially assist in breaking the traffic continuity of the radials the disadvantages attaching to a restriction of this kind on an inner ring road are such that it should be adopted only as a last resort. Where one-way working is to be operated the intersection of the radials with the inner ring road could be laid out with islands specially designed to deflect traffic on to the inner ring road.

Sub-surface or elevated construction on inner ring roads

158. Where, in exceptional cases, the provision of a ring road more distant from the centre of the town than the inner ring road is impracticable by reason of topography or of intensity of existing development, the inner ring road may have to be used to a considerable extent as a through traffic route. In such cases consideration should be given to its construction as a sub-surface or elevated road. (See Section (h).) Such a course may also be necessary in very large cities where a free-flow road at surface level would prejudice the inter-passage of traffic between the central area and the outer areas, or where the provision of the necessary means of inter-passage would so prejudice the

free-flow functions of the inner ring road as to defeat its purpose of relieving congestion in the central area.

Section (e)—Shopping Streets and Arcades

159. The principal shopping areas of most of our towns and cities have grown up on the main traffic routes; many of them are at the convergence of the radial roads and extend outwards along these roads for a considerable distance. Even in suburban areas the tendency has been for the shops to be grouped around the intersections of the principal roads. The juxtaposition on these roads of the local traffic attracted to the shops, and in particular the concentration of pedestrians, with traffic passing through the town, or moving from one part of the town to another, creates conditions of congestion and danger which constitute the most serious and intractable element of the urban traffic problem.

Traffic on shopping streets

160. Representatives of retail traders have strongly urged that the public prefers to shop in areas where there is a large volume of traffic with a resultant atmosphere of stir and bustle. We regard this view as a statement of conditions as they exist rather than an indication of what the public would choose were other types of shopping areas available to them; for the fact remains that there are in this country few examples of areas which by design or redevelopment have been laid out in the predominant interest of the shopping public. The experience which has been gained from the construction of by-passes with the object of diverting from a town or village arterial traffic which has no occasion to call there, clearly indicates that the popularity and prosperity of a local shopping centre is enhanced by the exclusion of unessential vehicular traffic, and we have no doubt that the application of the same principle to shopping areas generally would in time be appreciated by the public and therefore benefit the trading community.

161. We are of opinion that safety and convenience require that shopping centres should be divorced from principal traffic routes, either by altering the traffic function of these routes so that they may be appropriated to the service of the shops or, where this is impracticable, by the progressive elimination from them of the shopping centres. We are therefore wholly in sympathy with the conception of the shopping precinct in which

the interests of the pedestrian are predominant, though we do not suggest that all vehicular traffic should be excluded from the precinct. We recognize that a lengthy period must elapse before many of the shopping centres which have grown up on the radial roads can be converted or transferred to traffic-quiet areas of this kind, and that in the meantime it will be necessary to take such remedial measures as are practicable in order to make these centres safer and less obstructive on their present sites.

Shops at intersections

162. We regard development for shopping purposes at busy street intersections as objectionable, unless they can be so designed as (a) to effect complete segregation of pedestrian from vehicular traffic by making provision for the former to cross at different levels, and (b) to prevent waiting along the main road frontage and making provision for parking and the loading and unloading of vehicles at the rear of the premises. The ideal course is that pedestrians should be enabled to pass and repass at ground level and vehicular traffic to circulate in an elevated or a sunken roundabout. Where this is impracticable segregation may have to be effected by the provision of service roads around a surface level roundabout with subways for pedestrians, the use of which is enforced by guard rails at the kerb side, which should be continuous except at the entries to the subways and service roads.

163. We have examined the attractive designs prepared by a Committee of the Royal Academy for the development as shopping centres of the principal intersections on the proposed "A" Ring Road of London. We regard the principle of segregation at three levels, which these designs involve, as too costly of attainment to warrant consideration in other than metropolitan conditions. We are of opinion that the balance of advantage lies in locating shopping centres elsewhere than at principal intersections rather than in being driven to adopt elaborate measures of segregation in the interests of the safety and convenience of the pedestrian.

Shops in the central area

164. The construction of an inner ring road will in many towns be the best means of converting to a precinct the area occupied not only by the principal shopping centre, but also by markets, places of amusement, civic buildings, banks, hotels and so on. We have therefore regarded the central

area enclosed by an inner ring road as the typical precinct shopping centre and the recommendations which follow as to the design and layout of shopping streets relate principally to this area ; they are, however, applicable in varying degrees to all shopping centres.

Layout of shopping streets

165. Our observations and enquiries, as well as the evidence put before us, suggest that the desirable characteristics of the ideal shopping street are :—

- (a) Facilities by which the pedestrian may, in comfort and safety (i) move along the street, (ii) cross the street and (iii) view the goods displayed in the shop windows.
- (b) Absence of vehicular traffic other than that serving the shops.
- (c) Easy accessibility to public service vehicle routes.
- (d) Space in the street in which vehicles may wait for a limited period while their occupants do business in the shops.
- (e) Adjacency of car parks.
- (f) Provision, other than on the street itself, for loading and unloading goods.
- (g) Continuity of shopping frontage on both sides of the street.
- (h) Limitation of carriageway width to the minimum required for the service of the shops.
- (i) Ample footway width.

166. The requirements of through and local-through traffic are clearly incompatible with the conditions which should obtain in shopping streets where convenient and safe crossing of streets is essential. Had provision not also to be made for adequate means of approach for vehicular traffic, and in particular for waiting vehicles, the consideration of the safety of the pedestrian would suggest that shops could best be located in arcades or other purely pedestrian ways. Many shoppers, however, become pedestrians only when they have been brought to or near the shopping area by private cars or public service vehicles, and the layout of the shopping centre must provide for this vehicular traffic. We regard the ideal carriageway width for a shopping street as 44 ft., laid out with a divided carriageway, having one lane 11 ft. wide for moving vehicles and one lane 9 ft. wide for

waiting vehicles, on each side of the 4 ft. central refuges

Accommodation for pedestrians

167. Facilities for convenient movement of pedestrians along the street, and for opportunity to stand and gaze at the shop windows, presuppose footways of substantial widths. The width of the footways of many shopping streets has been reduced to enable the carriageways, carrying traffic not essential to the shopping functions of these streets, to be widened, and this practice is to be deprecated. Inadequacy of the footways is a major defect of many shopping streets, productive of accidents due to pedestrians stepping into the carriageway because of congestion on the footways. In principal shopping streets we regard a width of 15 ft. for the footways as the minimum ; where the streets are traversed by public service vehicles and provision has to be made for queue barriers, an appropriate additional width should be made available on the footways. In a new street where the positions of the queue barriers can be predetermined, this extra width could be obtained by setting back the frontage of new buildings for the length of the barriers ; this should prove more economical than adding to the width of each footway for the whole length of the street.

Specimen cross sections

Fig. 14. This cross section incorporates a 44 ft. carriageway divided by 4 ft. central refuges, and 15ft. footways. It is in accordance with the specific recommendation made in para. 166.



FIGURE 14

Fig. 15. shows the same street where provision is to be made at bus stops for waiting passengers.

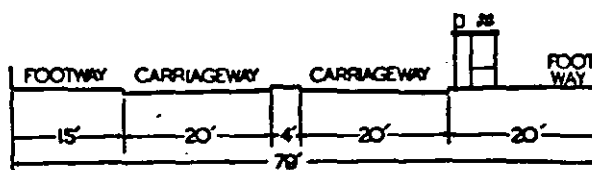


FIGURE 15

Fig. 16. By increasing the footway width to, say, 20 ft. room can be obtained for the planting of trees, or other amenity treatment, on shopping streets.

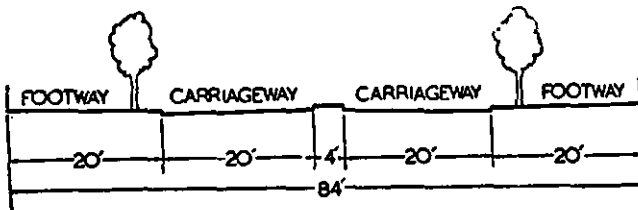


FIGURE 16

Fig. 17. shows a suitable layout for a shopping street of minor character where there is very little vehicular traffic excepting that of cars belonging to shoppers. Only on such minor streets do we consider that a single carriageway of 30 ft. width may be suitable.

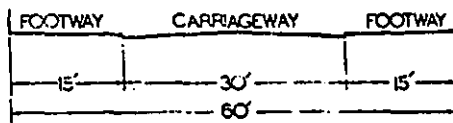


FIGURE 17

The views of retailers

168. We understand that the retailers attach importance to continuity of shopping frontages and to their existence on both sides of the street. Also that they deprecate very wide shopping streets because these do not provide the atmosphere of intimacy popular with shoppers. Nevertheless, the interests of amenity may make it desirable, in certain circumstances, to provide a width greater than the minimum required for traffic purposes. The development as shopping streets of roads carrying, or likely to carry, traffic of a volume requiring more than one lane in each direction for moving vehicles should be discouraged. Where shopping centres exist on roads of this character, and it is impracticable to divert from them traffic not essential to the purposes of the shops, it will be necessary to prohibit the stopping of vehicles other than for picking-up and setting-down, thus leaving the full width of the carriageway available for moving traffic. In the interests of the safety of the pedestrian, it will be desirable to erect barriers at the kerbside with openings to give access to pedestrian crossings provided the shops fronting these streets have access at the rear for loading and unloading.

Public service vehicles on shopping streets

169. A difficult and debatable question is the extent to which shopping precincts, such as the area within an inner ring road, should be traversed by public service vehicles. The representatives of the retail traders attach great importance to ready access to shops for bus passengers. We agree that, so far as conditions permit, bus passengers should be placed in no less favourable position than persons who own or can hire a car, and we have visualized that accommodation for private cars waiting outside shops will be provided. A bus, however, can pull up only at an authorized stopping place so that, except in the immediate proximity of a bus stop, passengers desiring to call at a particular shop are obliged to walk some distance. While we consider it is essential that shopping areas should be conveniently served by public service vehicles we do not regard it as unreasonable that such vehicles should be excluded from a shopping precinct, whether within an inner ring road or elsewhere, provided that this does not entail a journey on foot in excess of, say, 300 yards from the public service vehicle route to the principal shopping streets. The balance of evidence given to us confirms this view.

170. If public service vehicles are to be excluded from a shopping street or centre it is essential that control under planning powers should be exercised to prevent the transfer of shops to the route to be used by the public service vehicles, or its subsequent development as a shopping street with the consequent recurrence of conditions of danger and congestion.

Waiting vehicles on shopping streets

171. We have suggested that facilities by which cars can wait outside shops while their occupants are making purchases are desirable in shopping streets, and recommend that for this purpose the traffic lane adjacent to the kerb on each side of the street should be regarded as a "waiting lane." If these waiting lanes were used as car parks their purpose would be defeated, and we contemplate that a time limit will have to be set to the period that a car may be left stationary in the street. The length of this period will be influenced by the number of cars desiring to wait in a particular street, but we have in mind that it should not exceed twenty minutes. If it is necessary for a car to be left for a longer period it should be accommodated in a car park. The provision of car parks is dealt with in Part VIII.

Rear access roads

172. Unless the loading and unloading of vehicles can be limited to periods of the day when the waiting lanes are not occupied by customers' vehicles, provision for this service should be made on roads located at the rear of the premises; these roads should be of sufficient width to permit the passing of two large vehicles (see Plate 6); if they are culs-de-sac adequate space for turning at the closed end is essential. Instances have been brought to our notice where these rear access roads have become subsidiary shopping streets; this should be prevented by the exercise of planning control.

Two-level shopping streets

173. It has been suggested that a two-level road with the shops and footways at first floor level, is the solution of the problem of the shopping street. This appears to us to be impracticable in existing shopping areas and unnecessary in areas to be developed as precincts. Complete reconstruction of existing buildings would be necessary together with ramps, staircases or escalators to give access to the footways, and foot-bridges across the street would be required at frequent intervals. To afford clearance for vehicular traffic the surface of the foot-bridges would have to be about 20 ft. above road level and thus necessitate the footways being at a height exceeding that of the first floor of most existing buildings.

Arcading over footways in streets

174. We regard it as generally undesirable that the upper stories of buildings, whether used as shops or for other purposes, shall project forward over the public footway, and be supported by columns or piers which cause obstruction on the footway. The recessing of shop fronts behind the back of the public footway, thus providing additional space in front of the shop windows, is open to no objection and gives opportunity for attractive architectural treatment. (See Plate 7.) This method has the further advantage of protecting shop gazers from the weather. A similar measure of protection is afforded by canopies projecting over the footway; they should be cantilevered from the building and form part of its architectural design. (See Plate 8.) Supporting columns or piers on the footway should be avoided and care should be taken to ensure adequate clearance between the edge of the canopy and the overhang of vehicles.

Pedestrian arcades

175. Pedestrian arcades possess the obvious advantages of enabling shopping to be carried out entirely under cover and affording some relief to traffic (See Plate 9), provided that the cars of persons visiting the arcades are accommodated in car parks and not left in adjoining streets. For this reason car parks should be near at hand and arcades should have secondary means of access for goods delivery. If arcades are to be successful in attracting shoppers it is important that they should be of ample width (not less than 20 ft.) and so sited as to furnish a convenient through route for pedestrians from one main road to another. These conditions also apply to what may be called "uncovered pedestrian ways." (See Plate 10.)

Section (f)—Local Roads

176. The design and layout of local roads depends primarily on the topography and zoning of the area, and the character and intensity of the traffic. It is impossible to lay down standards applicable to all possible combinations of these varying conditions but, in addition to what we have said elsewhere in this Report, there are certain other aspects on which we desire to comment; these relate mainly to those local roads which primarily have a traffic function even though, so far as existing roads are concerned, they may also serve the purpose of development. We do not propose to make recommendations on the layout and design of development roads, *i.e.*, of roads the primary function of which is to afford frontage access to land or buildings. The standards to be observed on such roads are governed by by-laws and town planning requirements, and, in our opinion, the varying regulations which govern the layout of such roads are in urgent need of codification.

177. We desire to urge that in the planning of local roads, including development roads, a sufficient overall width should be provided to permit of the introduction of grass verges, with trees and shrubs, wherever this will be consistent with the character of the adjacent development.

Roads in neighbourhood units

178. We welcome the increasing recognition of the conception of the neighbourhood unit and the precinct; development of this kind will materially

assist in the promotion of road safety by avoiding the combination in one and the same road of traffic and development functions. We have already considered the precinct constituted by the area enclosed by the inner ring road. Among other advantages, the residential neighbourhood unit has that valuable amenity, absence of traffic noise.

179. In the design of the road system of the neighbourhood unit or the precinct two undesirable features must be avoided: first, that the local roads within the unit or precinct may provide a short cut for traffic which should be excluded; second, that entrance to and circulation within the unit or precinct of traffic (including public service vehicles) which has business therein, may be unduly limited or hampered. That these are real dangers has already become manifest. The road system of the neighbourhood unit or precinct should be planned as a whole, and in relation to the system comprised by the through, local-through and more important local roads which will circulate traffic around, and divert it from, the unit or precinct.

Roads adjacent to markets

180. Vehicular traffic to, from and between retail and wholesale markets, and markets and the railway station, in combination with the concentration of pedestrians attracted by the retail market, constitutes a major traffic problem in many large towns. Retail markets often spread over public highways, and vehicles serving them obstruct the passage of other traffic. Street markets in old towns are often protected by charter, but there are many cases in which their removal elsewhere would be to the public advantage. In the design of markets, whether wholesale or retail, provision should be made off the highway for standing vehicles, and entrances and exits should be planned so as to minimize obstruction. Wholesale markets at which the bulk of the commodities arrive or leave by rail should be located immediately adjacent to railway goods stations, and wherever practicable the inter-passage of goods between railhead and the wholesale markets should be effected otherwise than by crossing public highways on the level.

Shopping streets

181. We have considered and put forward recommendations about the design and layout of shopping streets. (Section (e).) Such streets will

the better serve their primary function the more they are truly "local" roads.

Roads in industrial areas

182. In the design and layout of roads in industrial areas regard must be had to the tidal character of the traffic resulting from the movements of the workpeople, as well as the character and the volume of the goods traffic, though it may not be economical to design the roads to a capacity which would avoid every element of congestion or delay during the short peak periods where the traffic is flowing in one direction only. The siting of works entrances should receive special consideration in relation to free flow and safety, and their design should, in general, conform to that of a side road junction of corresponding traffic importance. Where large numbers of workpeople enter or leave premises at the same time, arrangements should be made by the management for the use of an appropriate number of entrances, so as to minimize congestion at any one part.

Roads in commercial and office areas

183. The primary road traffic requirements of commercial and office areas are the reasonable proximity of public service vehicle routes and the provision of adequate facilities for waiting and parked vehicles. No reliable information is available on the relation between the cubic capacity of large buildings of the office type and the road traffic requirements of the occupants of and callers at such buildings. We are of opinion that further investigation into this matter should be made jointly by the Ministries of War Transport and Town and Country Planning.

Culs-de-sac.

184. The cul-de-sac, which may be regarded as a precinct in miniature, finds an appropriate place in residential, and occasionally in industrial and commercial areas. From the traffic standpoint the primary requirement of the cul-de-sac is an adequate turning space at the closed end.

Section (g)—Boulevards and Parkways

185. The Boulevard is associated in most people's minds with the work of Baron Haussmann in Paris, and may be defined as "a wide road or street planted with trees." While it may be said

to be the product of an age when formality in town planning was much in vogue, its possibilities as a processional highway were doubtless borne in mind, and it continues to serve an essential function in this respect. In these older conceptions, carriageways of 50 ft. to 60 ft. were thought ideal, irrespective of the traffic using them (in the Avenue Des Champs Elysees, Paris, for example, the central carriageway is 114 ft. in width, and The Mall, London, has one carriageway 60 ft. in width); while the alignment of trees, and the layout generally, followed rigid lines.

Parkways

186. Thomas Adams described a parkway as a "road through a park, and therefore a road normally without building frontages." A parkway, as the term is now understood in this country, is not so much a road running through a park—as, for example, The Mall and Constitutional Hill in London—as a park bordering a highway. The highway would be constructed because traffic required it, and the treatment applied to its layout would be parkway treatment. The object of this treatment should be to provide amenities in the neighbourhood of the road, rather than to develop land adjoining heavily trafficked carriageways for recreational purposes. Although the road is constructed on parkway lines, the park need not be of public park dimensions; it should for preference be varied in width, but seldom less than 300 ft. across including the road. In our opinion the cost of acquiring additional land for the provision of reasonable amenity treatment of the highway might properly be included as part of the cost of the road and so qualify for appropriate assistance from government funds. Reservation of land for parkway treatment can be made in town planning schemes, or under Section 13 of the Restriction of Ribbon Development Act, 1935.

187. One of the main essentials in which the parkway differs from the boulevard is in the freedom of the former from frontage development. Higher speeds than those normal in built-up areas will be obtainable, so that the segregation of opposing traffic streams and of different types of traffic is of first importance. In the interest of pedestrians, particularly of children, some form of continuous protection (*e.g.*, a hedge or shrubbery) should be provided to restrain them from crossing the carriageways elsewhere than at prescribed points.

Parkway layout and treatment

188. Since the whole conception of parkway treatment is informality there is no reason why the layout should conform to a uniform cross-section. The carriageways, cycle tracks and footways can be separated one from the other by suitably planted grass verges, or by reservations of varying width and level. Every opportunity should be taken of aligning the units which go to make up the highway in such a manner as to preserve shrubs and trees which are worthy of preservation, and to retain natural features which will tend to give the parkway just that additional amenity that other types of layout too frequently lack. In areas closer to the centre of the town it may be necessary, on account of the prohibitive cost of land, to adopt a less generous width and perhaps a more rigid cross-section, but a parkway effect can be obtained by avoiding formality in the planting of trees and shrubs and in the treatment of verges. (See Plate 11.) (See also Part IX—Amenity.)

189. Fig. 18 (see pages 38 and 39) shows what has been accomplished in New York in the provision of a parkway through the back blocks of an existing built-up area, where minor streets have been cut off by a continuous service road and access confined to occasional main intersections. This treatment could be well applied to new main radial routes in existing towns, thus providing valuable amenity and an attractive entrance to the town. Parkway might also be used for linking up parks in an open space system, and be made to serve the purpose of a belt separating industrial from residential areas.

Limitations on use

190. In America it is frequently the practice to limit the use of parkways to private vehicles. We understand that American parkways do not necessarily form part of the general highway system but in our judgment it is both inexpedient and unnecessary to apply such restrictions to parkways as we conceive them in this country.

Section (h)—Sub-Surface and Elevated Roads

191. While in the smaller built-up areas adequate traffic facilities can generally be provided by widening existing roads or constructing new roads at ground level, it may be necessary in highly developed parts of large towns or conurbations, where traffic is heavy, to have recourse to the

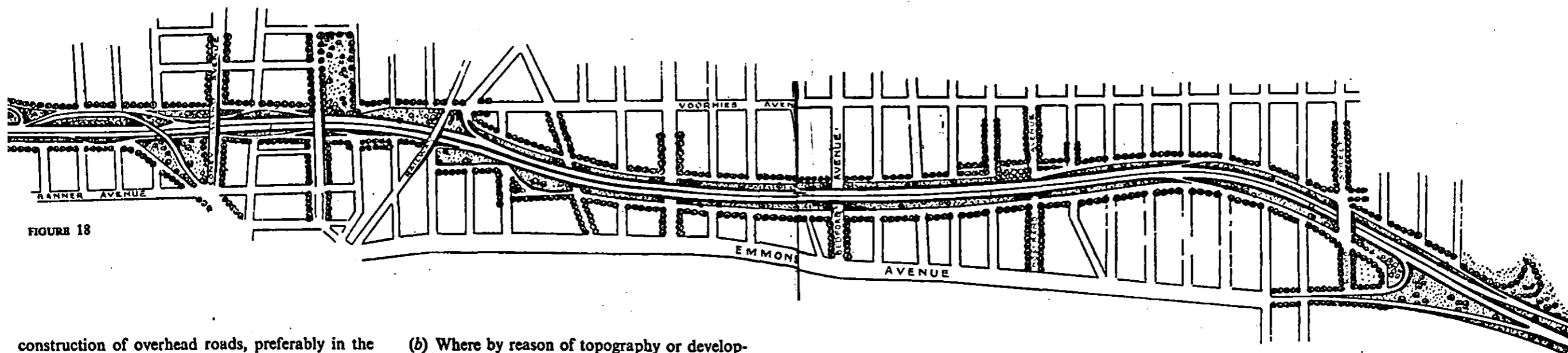


FIGURE 18

construction of overhead roads, preferably in the form of viaducts, or of sub-surface roads either in open cut or in tunnel. Such highways should have no frontage development or intersections with minor roads, and the limited number of points of inter-connection with major roads should be designed as fly-overs or under-passes. As they will be free from obstructions caused by waiting vehicles, frontage access and intersections on the level, they will have a traffic carrying capacity very much in excess of that of a surface road of the normal type and similar width.

Advantages over roads at ground level

192. In a highly developed area, a road at ground level with equivalent free-flow facilities would constitute such a barrier between the districts on either side of it as to be detrimental to the convenient circulation of local traffic, and might tend to isolate one part of the town from another. The construction of a sub-surface or elevated highway would avoid these disadvantages and so enable the continuity of the local road system to be maintained.

Factors affecting choice of type of road

193. Sub-surface or elevated roads are costly to construct but in heavily-built-up areas may be justified, *inter alia*, in the following circumstances:

- (a) Where it is necessary to relieve traffic in, or circulate traffic around, a central area, and the required free-flow facilities cannot be provided at ground level without unduly hampering reasonable interpassage between the central area and the adjacent areas.

- (b) Where by reason of topography or development a by-pass has to be located passing through a heavily-built-up area.
- (c) Where high-speed connection is required from a point near the centre of a large built-up area to the arterial road system.
- (d) Where there is a large volume of point-to-point traffic in a particular direction, e.g., to a special objective such as an airport or docks, or an important river crossing.

Minimum dimensions

194. The construction of such roads will tend to canalize the flow of main traffic and may enable substantial economies to be effected by obviating the widening of the surface roads which they will relieve. Unless there are good reasons to the contrary, their use should be confined to mechanically-propelled vehicles, and they should provide at least two traffic lanes in each direction, divided by a central strip, and a narrow footway for inspection purposes on each side. The road will therefore have a minimum effective width approaching 60 ft. Provision for three traffic lanes in each direction may be necessary especially where traffic is largely tidal in character. On roads of this type higher speeds than the maximum of 30 m.p.h. normally permissible in built-up areas can obviously be operated with safety.

195. Apart from conditions arising from the topography of the district the height of an elevated road or depth of a sub-surface road is governed by the headroom of 16 ft. 6 ins. required for clearance over or under existing or proposed streets. The level of a sub-surface road may have to be

adjusted to avoid undue interference with large underground mains and services, but a longitudinal switchback effect should be avoided.

Effect on amenity

196. Full consideration must be given to the effect of a sub-surface or elevated road on the amenity of the districts through which it passes, as well as to the design of the structure itself. There has been a prejudice against viaducts, which may have arisen from the existence of railway viaducts closely bordered by unrelated building development and with arches unattractively used for purposes for which they were not designed. Provided that full regard is paid to aesthetics in the design of the structure, there is no reason why a properly sited highway viaduct should be detrimental to amenity, whether it takes the form of a spacious separate structure or is designed as part of the redevelopment of adjacent areas. There is no objection on aesthetic grounds to sub-surface roads in open cutting, and if laid out with sloping banks they lend themselves to attractive treatment. It need hardly be added that where tunnels are constructed skilled architectural treatment is required in the design of the entrances and of any buildings required for their ventilation or other related purposes.

Sub-surface roads

197. Sub-surface roads in open cutting have the advantage that they do not necessitate heavy constructional works above ground level. (Plate 12.) On the other hand, difficulties may arise from

waterlogged ground or owing to the presence of underground services. Except when flanked by retaining walls they occupy a considerably greater width of land than a viaduct with equivalent facilities. It may be found desirable to construct on each side a surface level road to intercept the side roads, thus enabling the number of bridges over the sub-surface road to be reduced and the development of the parallel frontages facilitated. The standard clearance required under the bridges spanning an open-cut sub-surface road may sometimes be obtained by raising the level of the upper road, thus enabling the amount of excavation required for the free-flow highway to be reduced.

Elevated roads

198. Viaducts may be sited (a) above existing highways, or (b) on new alignments through back areas. The former has the advantage that it conforms to the pattern of existing development, but presupposes that the route required for the free-flow highway is coincident with that of existing roads, is of sufficient width, and has frontage buildings set back so far as to enable a high-level road to be superimposed without unduly encroaching on the existing highway or unduly prejudicing the interests of frontagers. In such a case it may be found practicable to construct the viaduct as a double-cantilevered structure deriving its support from piers or columns in a central reservation.

199. The location of the elevated road through back areas would make for greater freedom in the determination of the route and may be the only practicable course. The points at which inter-

connection with roads at ground level is required will be a determining factor in its location; wherever possible, however, the elevated road should be aligned through areas to be redeveloped in order to minimize interference with existing buildings.

200. Where a viaduct is to be constructed through areas used for industrial or commercial purposes it may be thought desirable to take advantage for these purposes of the space beneath the structure (see Plate 13), and the use to be made of the sub-structure must be taken into account in the design of the viaduct so that this may appropriately reflect its dual function. Roads laid at ground level parallel to highway viaducts give an air of spaciousness to the structure and its surroundings and present opportunities for attractive design.

Tunnels

201. Vehicular tunnels are expensive to construct and maintain; they have to be lighted and, unless of short length, to be ventilated. The adequate ventilation of road tunnels presents many difficulties and constitutes a substantial part of the cost of their construction and subsequent maintenance. In certain circumstances, however, they may be the only practicable alternative to a road at ground level.

General recommendations

202. It is not possible to lay down any universally applicable rules to determine whether a road which is not at surface level should take the form of a viaduct, an open cutting or a tunnel. Reference has been made above to factors which must be taken into account when coming to a decision on this point. If the road is of substantial length it may be that conditions will necessitate adoption of each of these forms of construction for various parts of its length, but any of them is bound to involve considerable expenditure, and they need the most careful consideration from the point of view of general town development.

Section (i)—The Single Purpose Road

Classes of traffic to be provided for

203. In this country traffic in built-up areas is made up of pedestrians and of many types of vehicles, ranging from the motor-bus, tramcar and heavy lorry to the light car, horse-drawn vehicle,

bicycle and perambulator. Up to the present, all these (with the exception noted below) have had to make use of the same highway, though occasionally segregated tracks for some classes of road users have been provided within its limits. Segregation in its most complete form is attained when a highway is provided for the sole use of one class of road user, *e.g.*, the motorist, the pedal cyclist or the pedestrian. Highways to meet the needs of pedestrians exist in the form of footpaths through open spaces as distinct from footways bordering a carriageway, and it is necessary to consider whether other forms of segregated highways should find their place in the urban road system.

The motorway

204. It is the essence of the motorway that it shall be dissociated from building and other development in the area through which it passes, that there shall be no means of access from fronting lands (other than such buildings as petrol filling stations); that the points of connection with the general road system shall be strictly limited in number and that there shall be no crossing on the level of opposing streams of traffic. These factors have only to be stated to make evident the substantial difficulties of constructing motorways at ground level in areas which have already been built up.

205. As has been indicated in para. 192 (Sub-surface and Elevated Roads), a surface road of the motorway type constructed in a built-up area would form a barrier detrimental to the convenient movement of traffic and the continuity of interest of the urban community. We are of opinion that where in fully-built-up areas traffic conditions are such that free-flow highways of this character are necessary, they should be constructed otherwise than at ground level. We visualize that, save in exceptional cases, motorways to serve the requirements of arterial traffic will be located outside, but reasonably adjacent to, the larger towns and cities, which will be connected to the motorway system by spur roads.

Pedestrian ways

206. In the section of this Report dealing with shopping streets we have drawn attention to the possibilities of single-purpose pedestrian ways, the frontages of which are utilized for shops. We are of opinion that more extended provision could

advantageously be made for pedestrian ways in other parts of the urban area, thus attracting pedestrians who otherwise would have to make use of the footways which form part of the streets. This form of single-purpose way would be particularly appropriate in residential areas where pedestrian ways could be planned as an integral part of the park system, linking up individual open spaces, recreational areas and playgrounds, and giving at the same time direct access from the houses to community buildings, shopping centres, and schools. (See Plate 14.)

207. The planning of residential areas as neighbourhood units will give an opportunity of so siting public buildings and open spaces in relation to houses that pedestrian ways may become a safe and pleasant means of access throughout the area, independent of traffic routes. They should be designed to conform to the natural direction and flow of pedestrian traffic and prefer-

ably be carried over or under the principal highways which they intersect. (See Plates 15 and 16.)

Cycle ways

208. The principles underlying the provision of pedestrian ways could advantageously be applied to well-surfaced "cycle ways" for the exclusive use of pedal cyclists, separate from the general road system and of width sufficient for two-way traffic. In towns where pedal cycle traffic is intense, a material contribution could thus be made to safety and the relief of congestion on public highways.

Police supervision

209. Police supervision would be necessary to ensure that pedestrian or cycle ways are not used by other classes of traffic or otherwise abused, but from this standpoint they present problems differing only in degree from those arising in connection with existing footpaths.

PART VI

The Road in Relation to Development

Control of means of access

210. The relationship between the use to which the land is put and the location, design and layout of the road, is of primary importance to the social and commercial interests of the community which the road exists to serve, as well as to the traffic capacity of the road and the safety of every individual. It has to be considered both with regard to "development" (*i.e.*, change of use) and to the existing use of land. It is therefore more complex in areas already built-up than in the open country or the parts of a town to be planned for future development. In determining the measure of control to be exercised, or the physical means to be adopted, to promote free flow and safety on an urban road system or on a particular street in a town it must never be forgotten that a town is a living organism and that facilities for ready intercourse between all its parts are essential to its unity and prosperity. It is from this standpoint, no less than from that of the requirements of traffic and safety, that we have approached the

question of control of means of access to roads in built-up areas.

211. The expression "means of access," used in its broadest sense, includes (*a*) the points of connection with other roads, and (*b*) the points of access to adjacent land, which we refer to as "frontage access." The degree of control to be exercised over means of access of both these kinds has to be related to the traffic function of the various classes of roads and to the local conditions on any particular road. We recommend that on roads forming part of the arterial system, there should be complete prohibition of frontage access and elimination of crossing on the level of traffic streams. At the other end of the scale are the development roads, *i.e.*, roads the function of which is to afford access to land or buildings. Level intersections and individual means of frontage access are appropriate to this class of road and control will normally be limited to ensuring the proper relation of the road junctions to each other,

and of the entrances to the level and alignment of the road, as well as adequate lines of sight.

212. Control of access will rarely be necessary on local roads, but is essential in differing degrees on roads forming part of through or local-through routes, e.g., on ring and radial roads.

213. Public opinion has been slow in accepting the necessity for restriction of access, even to arterial roads. This is probably due to failure to appreciate the extent to which unrestricted access results in road accidents, congestion and delay, as well as to apprehension that an adequate measure of restriction will be costly to achieve. Experience has, however, shown that, in comparison with the cost of road construction or widening, the cost of restriction is relatively small where the land to which it relates is either undeveloped or in process of redevelopment, and further, that the value of expensive works of road construction or reconstruction may largely be vitiated by subsequent uncontrolled frontage development. We are of opinion that expenditure on restricting access, whether this be effected under planning or highway powers, should be regarded as an integral part of the construction or improvement of the roads, and as such should rank for the same measure of assistance from central funds. We visualize, moreover, that implementation by the Government of the policy outlined in the White Paper on "The Control of Land Use" will materially facilitate the economical application by local authorities of the necessary measure of restriction.

Limitation of points of connection

214. We have referred in para. 25 (Road Safety) to the large proportion of road accidents which occur at intersections, and in para. 54 (Road Capacity) to the detrimental effect of intersections on road capacity. Intersections designed to preserve free flow and safety are costly both in respect of land and construction. We are strongly of opinion that in areas to be developed or redeveloped, the local road system of the neighbourhood units should be so designed that connections to through and local-through roads are kept to the minimum consistent with adequate means of entry to or exit from the unit, and, wherever physical conditions permit, local roads connecting one unit with another should be carried over or under through routes.

Methods of effecting limitation

215. In areas which are already developed, the physical means by which the number of minor road connections can be limited are:—

- (a) Stopping up the minor road before it enters the more important road ;
- (b) Carrying the minor road over or under the more important road by a bridge, without interconnection ;
- (c) Providing a service road on the more important road to intercept the minor roads.

216. The first method, (a), may be facilitated by linking up two or more minor roads so that they have only one point of connection to the through or local-through road. If the stopping up converts part of the minor road into a cul-de-sac, a turning circle may have to be formed. As a rule it will not be necessary to close the minor road connection to pedestrians (or to pedal cyclists, if they dismount to cross the footway) and the elimination of the side road junction may be effected by placing a barrier across the carriageway of the minor road and making the footway of the major road continuous. We are of opinion that less cumbersome and more expeditious powers than those under the Highways Act 1835, the Roads and Bridges (Scotland) Act 1878 and operative planning schemes should be made available to enable redundant side road junctions to be stopped up.

217. Method (b), that of carrying the minor road over or under the through or local-through road, will frequently involve interference with existing premises and may entail expensive constructional work, including alterations to mains and sewers. It may, therefore, be practicable only when redevelopment is undertaken, unless advantage can be taken of opportunities afforded by difference of ground level.

218. Method (c), the provision of a service road alongside the more important road, postulates that the width between buildings on the latter is—or by setting back of buildings can be made—sufficiently great to enable a service road to be constructed on one or both sides. Where several minor roads discharge into the service road the latter will in effect become a parallel local road. If the intercepted minor roads serve an appreciable number of premises or substantial area of back land, traffic on the parallel road will be considerable and it will have to be laid out to adequate dimensions ; a



PLATE 14. PEDESTRIAN WAY IN LEICEST. E.



**PLATES 15 AND 16. PEDESTRIAN WAYS
IN HAMPSTEAD GARDEN SUBURB.**



PLATE 17. DEVELOPMENT, HAVING NO ACCESS TO RING ROAD, SCREENED BY SHRUBS AND TREES—LEEDS.



PLATE 18. TRAMWAY IN FENCED RESERVATION—BIRMINGHAM.



PLATE 19. TRAMWAY IN RESERVATION OFF THE HIGHWAY—LEEDS.



PLATE 20. DUAL CARRIAGEWAY ROAD WITH CYCLE TRACKS—BIRMINGHAM.



PLATE 21. SERVICE ROAD SEPARATED FROM DUAL CARRIAGEWAY ROAD BY SHRUBBERY AND LOW WALL—WOOLWICH,



PLATE 22. SERVICE ROAD SEPARATED FROM MAIN ROUTE BY SHRUBBERY AND RAILINGS—EDINBURGH.

carriageway of not less than 20 ft. is likely to be required, together with a footway on one side. A continuous barrier should be provided except at the points where the service road discharges into the main carriageway. Further reference to the design of service roads is made in Part VII, Section (b).

Restriction of frontage access

219. Restriction of frontage access, whether vehicular or pedestrian, on through or local-through roads, is necessary for the following reasons :—

- (i) Inconvenience and delay to traffic by reason of vehicles standing on the carriageway at or near the means of access, or turning in to and out of the vehicular means of access ;
- (ii) Danger to vehicular, pedal cyclist and pedestrian traffic using the road, by reason of standing vehicles, or vehicles entering or emerging from the vehicular means of access, and to persons heedlessly entering the road ;
- (iii) Difficulty of making the level of the means of access conform to that of the footway or cycle track without impairing the continuity of level of these tracks.

220. We do not propose to attempt to lay down arbitrary and universally applicable rules to determine the precise degree to which frontage access to through or local-through routes in built-up areas should be restricted. The powers by which restriction can be enforced require that the specific circumstances of each case should be taken into account ; what is practicable will be determined to no small extent by the scale of the development which has already taken place, and regard must be had to the volume and character of the traffic on the particular road. Nevertheless the necessity for a high standard of restriction is indisputable, and on the undeveloped length of main radial roads and on outer ring roads the standard should be complete absence of frontage access.

Advantages of group development

221. In areas at present undeveloped, or capable of being redeveloped, adoption of the principle of the neighbourhood or community unit will greatly assist in freeing through and local-through routes from the harmful conditions inevitably

attaching to frontage access. It is in the promotion of group development off principal traffic routes that town planning can make one of its most substantial contributions to the safety and convenience of the road system, as also in ensuring that premises such as schools, cinemas, theatres, markets or shops and the like which attract concentrations of vehicles and pedestrians do not derive their direct means of access from heavily trafficked roads.

222. Where houses front an internal road of a group development unit and have their backs, with their gardens, to the through or local-through route, the amenity of the latter may be preserved by due attention to the design of rear elevations and by the planting of belts of trees and shrubs along the sides of the traffic route. An example of this is shown in Plate 17.

The service road as a means of reducing points of access

223. Apart from redevelopment of the land, the service road is the only available means of reducing the number of points of access to roads the frontages of which have already been wholly developed and, as noted in para. 218, a service road can be provided only where the adjacent buildings are sufficiently set back. If it is fully to serve its purpose the service road must be separated from the through or local-through route by a continuous barrier, otherwise drivers or passengers calling at fronting premises will be likely to leave their vehicles stationary on the main carriageway and occupiers, children in particular, may emerge on to the carriageway without due care and thus expose themselves to risk of accident.

224. We are of opinion that the provision of parallel service roads as a means of limiting frontage access should only be used where other methods are impracticable because of existing conditions which are incapable of being otherwise rectified. Where service roads are necessarily adopted they may have to be constructed in sections until the complete scheme is capable of fulfilment ; until then consent may have to be given to the formation, as a temporary measure, of a direct means of access, which should be closed when the service road has been constructed.

Waiting lanes on through roads a palliative

225. The provision as part of the highway lay-

out of waiting lanes adjacent to the kerb, which we have recommended for streets such as shopping streets, should, on through or local-through roads be regarded as a palliative to be used only where fully developed frontages render it necessary to afford specific accommodation for waiting vehicles and where a service road cannot be provided.

Frontage access at major intersections

226. The special problems arising in connection with frontage access at major intersections of the various types likely to be met with on through and local-through routes are considered in Part VII, Section (c) of the Report, dealing with the design and layout of intersections.

PART VII

Road Design and Layout

Section (a)—Traffic Segregation

227. Segregation, which may be defined as separation of traffic in the interests of safety and free flow, should be the key-note of modern road design. It has several aspects and can be applied in diverse ways. Examples of these in the urban road system are :—

- (a) Segregation in relation to destination, e.g., by a ring road or by-pass.
- (b) Segregation of classes of road users, e.g., by motorway, cycle track or footway.
- (c) Segregation in relation to direction, e.g., by dual carriageways or refuges, and by one-way streets.
- (d) Segregation of traffic by grade separation, e.g., by flyover or under-pass.
- (e) Time segregation, e.g., by traffic light signals;

228. Another aspect of segregation is the separation of slow from fast-moving vehicles. Except to the extent that slow moving vehicles may be excluded by regulation from particular roads, either completely or during specified hours, or that they may make use of service roads, we are of opinion that their segregation from other vehicular traffic is impracticable on all-purpose roads in built-up areas.

229. In other parts of this Report (Part V, Sections (b), (d), (g) and (h)), we have considered certain aspects of segregation and propose now to refer to the directional segregation of vehicular traffic, to the segregation of pedal cyclists and pedestrians, and to the special case of tramways.

Directional segregation of vehicular traffic (excluding tramcars).

230. The separation by physical means of streams of vehicles travelling in opposite directions has to be considered in relation not only to the free flow and safety of vehicular traffic, but also to the safety and convenience of pedestrians crossing from one side of the road to the other.

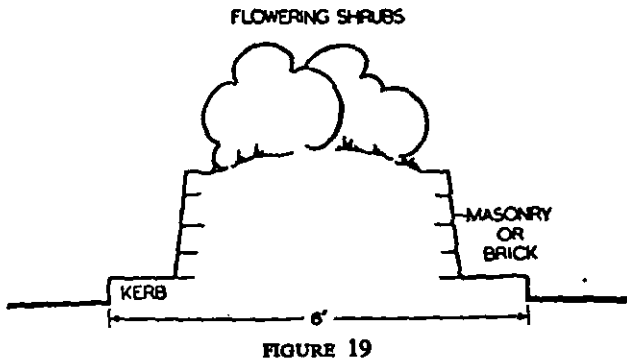
231. Save in exceptional circumstances, the following are the only methods by which directional segregation of vehicular traffic can be achieved ; by (1) inducing segregation by means of a traffic line, painted or in permanent materials, and (2) effecting segregation by a central reservation, generally continuous, or by a series of refuges.

232. The use of the first method in built-up areas as a means of inducing directional segregation should be confined to two-lane carriageways, normally 22 ft. wide, on which the risk to pedestrians in crossing is not so serious as to warrant the provision of refuges, except at the more frequented intersections. We do not regard three-lane carriageways, with a central overtaking lane, as suitable for fully-built-up areas, and are of opinion, that where they exist they should be marked with a central traffic line.

Central reservations

233. We are of opinion that dual-carriageway layout promotes safety of vehicular traffic, and that a central strip or reservation provides a greater degree of safety than any other form of longitudinal division of the carriageway and should be adopted on roads carrying through or local-through traffic, where there is need for more than one traffic lane in each direction. It has, however, the dis-

advantage of tending to encourage the indiscriminate crossing of the carriageway by pedestrians, though this objection can be met by erecting a barrier along the whole of its length, with openings at necessary points of connection between the carriageways. Barriers should also be erected along the footways opposite to the openings on the central reservation and they should overlap the openings by 20 yds. on each side. The width of the central reservation should never be less than 4 ft., but, where conditions permit, it should be 15 ft., or more, and turfed, planted with trees and shrubs, or otherwise treated to break up the expanse of paved surfaces. Fig. 19 shows a suggested method of treatment of a comparatively narrow reservation which, while forming an effective barrier, is attractive in appearance.



234. Where a width of carriageway in excess of two lanes is required we are of the opinion that the safety of pedestrians demands that it should be of four (or more) lanes, physically divided into two (or more) traffic lanes on each side of the centre line. It is on these carriageways that it becomes necessary to decide whether the division should be made by a chain of refuges or by a central reservation, continuous except at intersections or where provision has to be made for vehicles turning from one side of the road to the other. The character of the frontage development (particularly in shopping streets) may be such as to demand facilities for vehicles readily to turn from one side of the road to the other, and in such streets provisions should be made for refuges, spaced at such distance apart as may be requisite.

Central refuges

235. It has been represented to us that refuges constitute dangerous obstructions because of the risk of vehicles colliding with them, particularly in foggy weather, or of their existence being masked

by other vehicles. This objection seems to us to have some force in relation to isolated refuges, but to be inapplicable to a chain of central refuges, if proper precautions are taken to render their presence conspicuous. In this connection we endorse the recommendation of the Departmental Committee on Street Lighting to the effect that there should be on each refuge a central post with a light source at a height of about 16 ft., surrounded by a diffusing globe, together with a self-luminous guard post or bollard at each end of the refuge. The kerb of the refuge (as of a central reservation) should be of light-coloured material or painted white periodically. For reasons of safety at pedestrian refuges, or points where pedestrians congregate, the kerb should be vertical, but where these conditions do not apply the kerbs should be rounded or splayed to reduce resistance to vehicles in an emergency. For the safety of pedestrians it is desirable that the kerb should be not less than 4 to 5 ins. in height.

236. The width of refuges should be a minimum of 4 ft. and where possible 6 ft. Openings should be provided in the centre at carriageway level for the convenient crossing of persons in charge of perambulators or other hand-propelled vehicles, and for their protection during periods of waiting. The distance between a chain of refuges and the kerb should normally be a minimum of 20 ft., though in built-up areas the clearance may occasionally have to be reduced to 18 ft. The ends of the refuges should be tapered and not semi-circular in plan, in order to reduce the impact of vehicles which may come into collision with them.

One-way streets

237. Some relief from traffic congestion can be afforded by the adoption of a system of one-way working, which is most effective when the streets in question are closely parallel. Such a system involves additional vehicle mileage, is often a source of irritation to road users, and, because of the change from the normal flow of vehicular traffic, may be dangerous to pedestrians. In our opinion one-way working should be regarded merely as a palliative, pending the execution of necessary street improvements.

Tramways

238. We have referred to the segregation of tramways in para. 82 of Part IV, Section (a), of our Report. Objections to tramway tracks are at a minimum where the track is in a reservation fenced

off from the carriageway and provided with openings at stopping places. Where conditions permit, longitudinal refuges not less than 4 ft. in width and of sufficient length to accommodate waiting passengers, should be provided on both sides of the tramway track at stopping places to facilitate the safe crossing of the carriageway. On roads carrying fast traffic isolated refuges may, however, give rise to danger and this factor must be taken into account. The location of the refuges also must be carefully chosen to avoid such narrowing of the carriageway as might create dangerous conditions, and they should be approached by properly defined pedestrian crossings. Whether tramway reservations should be located between dual carriageways or on the side is a matter for decision according to local circumstances, although in the latter case additional complications may ensue at junctions and roundabouts and at points where the track takes a left or right-hand turn.

Tramway subways

239. Where in large cities it is essential that tramways should traverse the central area there are obvious advantages in making provision for them in subways or tunnels under the carriageway, as was done in Kingsway, London. Streets would not only be relieved of obstruction attributable to this type of traffic, but a material reduction in width might be effected in projected improvement schemes.

Cyclists

240. It is impracticable to lay down rules capable of general application to govern the volume of pedal cycle traffic (relative to vehicular traffic as a whole), which calls for the provision of segregated tracks for cyclists, but on arterial, through and local-through routes where land is available they should be provided as a matter of course. This applies with special force to by-passes and outer ring roads.

241. Pedal cycle traffic is heaviest in fully developed areas, where the difficulty of providing effective segregation is at its highest, for it will rarely be feasible to construct cycle tracks in built-up streets, though every effort should be made for their provision when conditions admit. We have referred to the provision of "cycle ways" in para. 208.

Central tracks for cyclists

242. The suggestion has been made that cyclists could be accommodated in a single track along the central reservation where the latter is sufficiently wide for the purpose, but we feel that such an arrangement would be a danger to cyclists, who would have to cross a stream of vehicular traffic to gain access to the track, even if at intersections it was carried below the level of the carriageway.

Cycle strips on carriageway

243. It has also been suggested that strips of the carriageway adjacent to the kerb might be regarded as primarily for the use of pedal cyclists. We disagree with this suggestion. Whatever methods were adopted for indicating the reserved strips, whether by special colour or other means, they would have to be used by vehicles drawing alongside the kerb. Apart from this objection we feel that in cases of emergency other road users could not be relied upon, nor indeed expected to regard them as sacrosanct to pedal cyclists, and the latter would then have been led into a false sense of security.

Condition of cycle tracks

244. Objections to cycle tracks have been stimulated by the indifferent surfaces with which some of the early tracks were laid, but this condition has since been largely remedied. The profile of the tracks should be unbroken across intersecting vehicular entrances, and they should approach side roads with an easy ramp. Projecting or uneven joints (such as sometimes occur in concrete construction) should be avoided, and the surface is best formed by materials of pleasingly distinctive colour. Except where a subway is available there will always be the objection of having to cross traffic streams on the surface at all intersecting roads, but if effect is given to other recommendations in our Report intersections should be fewer in number than in the past. We do not consider that this admitted disadvantage outweighs the merits which cycle tracks possess.

Pedestrians

245. A high measure of pedestrian safety would be achieved if pedestrian and vehicular traffic were completely segregated, but (except on motorways) this could be made possible only by the universal erection of continuous and impenetrable barriers to prevent access from the footway to the carriageway (except at points where pedestrian traffic is

under complete control), coupled with the use of overbridges or subways where full protection at surface level is not possible. A measure of so revolutionary a character is unlikely to secure acceptance, and would be inimical to the general interests of the community.

246. Footways of adequate capacity make an important contribution to road safety and we have dealt with standards of width in Part III, Section (c) of our Report. Provided a footway is sufficiently spacious to accommodate the people using it, there should be no need to adopt other measures for their protection whilst they are moving along it in a direction parallel to the kerb line; but the overwhelming majority of accidents to pedestrians occur on the carriageway, either in crossing the road from one side to the other or in boarding or leaving a vehicle. We discuss the measures which should be adopted for the protection of pedestrians whilst necessarily crossing the carriageway in Section (d) of this part of our Report.

Section (b)—Service Roads

247. We have discussed the general question of restricting means of access in Part VI, and the circumstances in which it may be necessary to make provision for service roads, parallel and contiguous to through or local-through roads, are referred to in para. 224.

Widths

248. Where a service road gives access only to domestic premises fronting it we recommend a minimum carriageway width of 16 ft. This will suffice for two streams of slow moving vehicles. Where, however, the service road also intercepts minor side roads, thus reducing the number of intersections with the main highway, or where the frontages are developed for commercial or industrial purposes, more ample dimensions will be required and the carriageway of the service road should have a width of not less than 20 ft. A width greater than 16 ft. will also be required if the service road is to be used as the cycle track of the main highway. A single footway not less than 6 ft. wide may suffice on the service road if there is a continuous footway on the main highway. Where, however, the service road is fronted by commercial or industrial buildings or intercepts side roads a wider footway, usually not less than 10 ft., should be provided.

Separation from the main highway

249. It is essential on safety grounds that the service road shall be effectively separated from the main highway, except at the points of connection. The means of separation may advantageously take the form of an impenetrable hedge or an attractively designed low wall. Where there is a verge between the boundary of the main highway and the service road, it may be planted with shrubs in such a manner as to constitute the necessary barrier.

Connections with main highway

250. Conditions of danger may result from faulty siting of the points of connection of the service road in relation to intersections on the main highway. Generally, they should be not less than 70 yds. away from the intersections, but if an intersection is controlled by a roundabout the point of connection should be closer to it, so that traffic enters and leaves the service road at a point where vehicles on the main highway are travelling at reduced speed. The position and form recommended for the connection in such circumstances is shown in Fig. 20. Where the intersection is of the multi-level type, the connection should be where shown in the figures reproduced in Section (c) of this part of the Report.

251. The number of the points of connection will largely be determined by the length of the service road; they should be infrequent, and, if possible, at intervals of not less than 440 yards. On roads such as main radials it is desirable there should be no points of connection, except those at intersections on the main highway. There should, however, be a connection at each end of the service road, even though its length may be relatively small, in order to avoid a dead end which would necessitate the provision of a turning circle.

Should not be unidirectional

252. Service roads should not be unidirectional since, with the limited number of points of connection, such a restriction would necessitate long detours. The points of connection should be by means of right-angled junctions, so that traffic from the service road is compelled to enter the main highway at reduced speed.

Provision for large vehicles

253. The provision which it is necessary to make for large vehicles turning into and out of the service

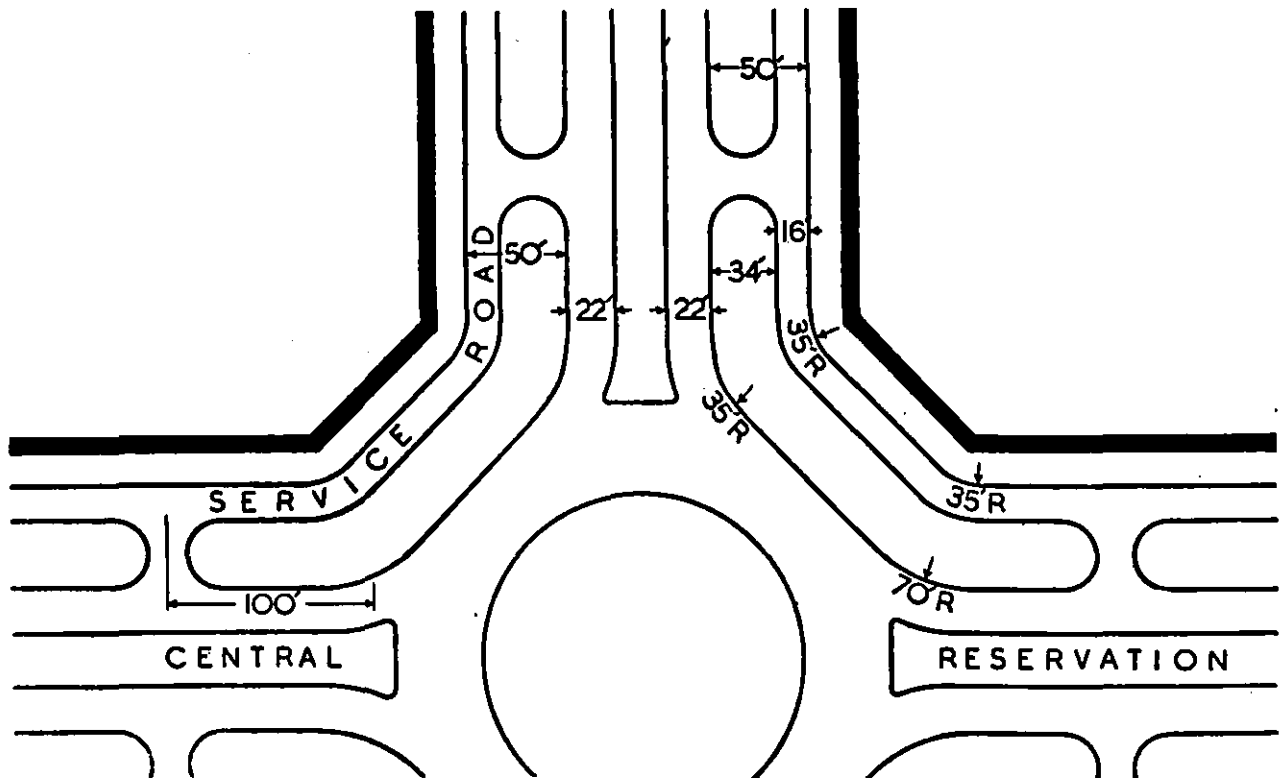


FIGURE 20

road without obstructing the flow of traffic on the main highway will determine the setback of the carriageway of the service road, at least at the points of connection. A distance of 50 ft. between the nearside kerb of the service road and the nearside kerb of the main carriageway will enable the majority of large vehicles to turn conveniently. Where the carriageway of a service road is 16 ft. wide the adjacent kerbs of the main carriageway and of the service road will be 34 ft. apart. This dimension will be required only at the points of connection, but the adoption of a smaller width elsewhere would not generally lead to pleasing development. Moreover, when the width of 34 ft. is divided into its component parts (*i.e.*, verges, cycle tracks, if required, and footway on the main highway and barrier and verge on the service road), it will not be found excessive. Plate 21 illustrates a suitable layout with shrubbery, barrier, main road footway and verge.

Section (c)—Road Intersections

254. In this Report we use the term "intersection" to cover all types of intersections and junctions. Where the term "junction" is used it

refers only to a single connection of one road with another, *i.e.*, to a T junction, a Y junction, or an acute angled junction.

255. The principal factor militating against the free flow of traffic in built-up areas is the congestion and delay resulting from inadequate or faulty layout of road intersections, and particularly from their multiplicity. We have mentioned in Part II that 39 per cent. of fatal road accidents and 47 per cent. of non-fatal accidents in built-up areas occur at road intersections, and we have pointed out that of the accidents attributed to drivers of vehicles and to pedal cyclists, four-fifths occurred while a right-hand turn was being made.

256. The design of road intersections is, therefore, a matter of prime importance in relation to both traffic and safety; it is, moreover, relevant to the amenity of towns and cities, for well laid out intersections give scope for worthy architectural treatment of adjacent buildings, while the multiplicity of traffic signs, signals, etc., which have to be provided to palliate conditions of congestion and danger at many existing intersections tend to detract from the appearance of the street.

257. The improvement of principal intersections may be one of the most costly items in the reconstruction of the road system of an existing town, but no part of the scheme is more essential. We recognize that, save in complete redevelopment, the re-design of the intersections may have to be spread over a considerable period, but we wish to emphasize the need for taking a long view when premises at or adjacent to a road intersection are due for rebuilding, so as to ensure that the new buildings shall conform to the plan for its ultimate layout.

258. An ideal road system would not necessitate manual control of traffic at intersections nor the use of traffic light signals and the aim should be to reduce the need for either to a minimum. Traffic light signals are, however, frequently indispensable under existing conditions and it may be necessary to visualize the continued use of manual control at intersections where the occurrence of a large volume of traffic is periodic or at infrequent intervals.

Tramways at intersections

259. We have referred in paras. 81 and 238 to the serious difficulty of providing the layout most suitable for the majority of road users at intersections traversed by surface tramways. In our view this is a factor to which full weight should be given when an intersection at present traversed by tramways is to be reconstructed.

Pedestrians at intersections

260. The difficulty of reconciling the interests of pedestrians with those of other road users is at its maximum at intersections, since at such points the movement of vehicular traffic is most complex and the attention of drivers is primarily directed to the control of their vehicles, sometimes to the prejudice of the safety of pedestrians unless the latter can be provided with means of crossing at a different level. This involves structures which are costly by reason of the space they occupy and the works they comprise, but it is impossible to overstate the importance of such provision in areas where large concentrations of pedestrians are juxtaposed with heavy streams of vehicular traffic. This consideration emphasizes the recommendation we have made that the road plan should to the fullest possible extent provide for the segregation from shopping or other areas where pedestrians congregate of all vehicular traffic other than that

having business in those areas. In the recommendations we make on the design of intersections we have kept the needs of pedestrians prominently in mind.

Elimination of side road junctions

261. It is impracticable to adopt at all the numerous intersections of minor roads with major roads a type of layout which will avoid obstruction to traffic on the latter while vehicles are entering or leaving the minor roads. The best means of eliminating obstruction is to eliminate the intersection and we refer to what has been said in paras. 214 and 215 of this Report as to the reduction of the number of side road junctions.

Development at intersections

262. Street intersections afford opportunity for comprehensive architectural treatment, and at junctions of major importance it is particularly appropriate that there should be co-ordinated design of the buildings fronting them. In this connection we have in mind office buildings, flats, hotels and so on, but in a later paragraph (273) we refer to the necessity of avoiding direct access to such buildings at or near a major intersection. We are advised that in future it is likely that the taller buildings will be located in the centre of blocks rather than at intersections, where traffic conditions make it desirable strictly to limit the concentration of pedestrians and to avoid standing traffic. This does not, however, minimize the need for some uniformity in the architectural treatment of each intersection.

Need for early consideration of intersection design

263. When the line of a new road is being considered in its initial stages designs of its intersections should be prepared in sufficient detail to avoid the need for any subsequent variation of the line. Failure to take such precaution has in certain instances made it necessary to amend the line of a proposed road after its route has been safeguarded—because it was later found impossible to provide on the original location for satisfactory treatment of the intersections.

Location of intersections

264. Intersections should not be located at a bend, in a deep cutting or in such close proximity to a summit or over-bridge that the line of sight may be obstructed by the vertical rise or near to an under-bridge, the abutments of which may restrict

the view of the road user. An intersection is undesirable on the crest of a steep hill unless it is to be laid out as a roundabout.

265. It is in the interests of both traffic flow and safety that intersections should be located on level ground. To facilitate the starting and deceleration of vehicles, particularly in frosty weather, up or down gradients should be eased at the immediate approach to intersections. These considerations should be kept in mind in determining the location of the points of connection of side roads.

Angle of intersection

266. Roads should join or intersect as nearly as possible at right angles, save in the case of the link roads of multi-level layouts which are one-way and are specially designed with deceleration and cross-over lanes. Acute angle junctions are undesirable from the standpoint of traffic and do not lend themselves to the satisfactory use of the fronting lands. Where a side road joins an existing road at an acute angle its alignment should be varied, so that the carriageways may be connected by a square junction. Care must, however, be taken not to introduce into the side road a reverse bend with sharp curves which would create conditions of danger for the driver of a vehicle when he has to change from one lock to another in entering or leaving the main carriageway.

Kerb radii

267. The turning circle of vehicles of various types is a determining factor in the layout of intersections. Generally, intersections should be so designed that drivers do not have to go over to full lock while negotiating them. In view, however, of the relatively small proportion of vehicles which have a turning circle in excess of 60 ft. diameter, and the substantial increase in cost which would be involved in basing designs on a larger turning circle, we are of opinion that, save in special cases, intersections should be designed to enable a vehicle with a turning circle not greater than 60 ft. to traverse them without going over to full lock.

268. The radius of kerbs at intersections should normally be 35 feet in order to enable large vehicles to keep close to the kerb when turning. In residential streets used mainly by light cars a kerb radius of 15 ft. should be regarded as the minimum. A greater kerb radius than 35 ft. may be necessary at roundabouts; we agree with the recommendation

of Memorandum No. 575 that the radius at entry should be 60 ft., and the radius at exit 150 ft., in the case of roundabouts in the outer parts of built-up areas, but are of opinion that at roundabouts in fully-built-up streets the radius of kerb at entry should not be greater than 35 ft., or at exit 70 ft.

Number of roads at intersections

269. It is undesirable that more than four roads should meet at a common point, unless it is practicable to layout the intersection as a roundabout with a central island of sufficient size to provide the necessary weaving distance. Where there is to be a roundabout full advantage should be taken of the facilities it affords by making it serve four roads, since the space occupied by a roundabout at a T junction is practically the same as for a roundabout accommodating four roads. The design of interconnecting flyovers where provision has to be made for more than four roads is very complicated and the number of roads to be connected at one point by means of a flyover should be limited to four.

Control of right-hand turn

270. We have referred to the fact that four-fifths of the accidents attributed to drivers of vehicles, and to pedal cyclists, occurred while a right-hand turn was being made. In existing street systems it may be necessary (but strictly as a palliative) to prohibit a right-hand turn at a particular T junction on a major road; such prohibition may relate to vehicles turning out of the side road, into the side road, or to both movements. The opportunities for making a right-hand turn may be reduced to the point of elimination by the institution of one-way working on the major road, on the side road or on both; the extent of the reduction is dependent on the direction of the one-way working in relation to the position of the T junction.

271. The existence of a heavy stream of right-hand turning traffic at an intersection is *prima facie* evidence of the desirability of roundabout treatment. Where it is proposed to adopt one of the measures referred to above the alternative route to be used by diverted traffic should preferably be such that the traffic will enter the major road at a roundabout.

Sight lines

272. Save where vehicular traffic is unidirectional at roundabouts and flyovers the boundaries

of the highway should be set back at all intersections in a manner sufficient to afford to drivers adequate view of approaching vehicles. Detailed reference is made below to the dimensions and form of the set back at the various types of intersections. We are of opinion that, notwithstanding the power available in Section 4 of the Roads Improvement Act, 1925, the whole of the space required for visibility should be incorporated within the limits of the highway so that no restrictions need be placed on the height of fences or structures on private property adjacent to an intersection.

Means of access at intersections

273. The efficiency of an intersection layout is closely related to the use to be made of its frontages, and in particular to the means of access—vehicular or pedestrian—at, and in the vicinity of, the intersection. The need for vehicles to halt or wait arises from the existence of means of access, except where traffic is held up by congestion or obstruction. Control of vehicular access at intersections is essential, but the degree to which this should be restricted has to be determined in relation to the function of the road, the nature of the intersection and the use of fronting land. The objective to be aimed at is the maintenance of free flow and the mitigation of conditions of danger by the elimination of stationary vehicles from intersections and by diverting from the immediate proximity of major intersections heavy streams of pedestrians, unless they are provided with means of crossing otherwise than at surface level. It follows that places of public resort attracting large numbers of people should not have their means of access, whether vehicular or pedestrian, at or close to a major intersection.

Lighting of intersections

274. Adequate lighting of intersections is

essential ; we wish to draw particular attention to para. 94 of the Final Report of the Departmental Committee on Street Lighting on the need for gradation of lighting between routes illuminated to different standards. Lighting of intersections will also include the illumination of central islands, refuges, etc., in a manner sufficient to render them visible to drivers even in foggy conditions. Reference to the illumination of refuges and bollards is made in para. 235.

Investigation recommended

275. We recommend that, in the interests of traffic, safety and economy, the Ministry of War Transport should undertake a detailed study of the movement of vehicles at, and in the vicinity of existing intersections of different types under various traffic conditions. Also that, in the light of the information thus obtained, experimental intersections should be laid out to test the efficiency of their design. We suggest that prior attention should be given to the design of roundabouts.

T JUNCTIONS

Sight distance

276. It is of first importance in the interest of road safety that drivers should have full view of approaching vehicles at a T junction. Fig. 21 shows the sight distance required when drivers approaching the junction would not normally travel at a speed in excess of about 20 m.p.h. This is based on the time taken by a driver on the road forming the leg of the T to decelerate to a stop at the rate of eleven feet per sec. per sec. with a reaction time of half a second.

Fig. 22 shows the sight distance required when the driver on the through road of the T maintains a speed of 30 m.p.h. We recommend that, with the

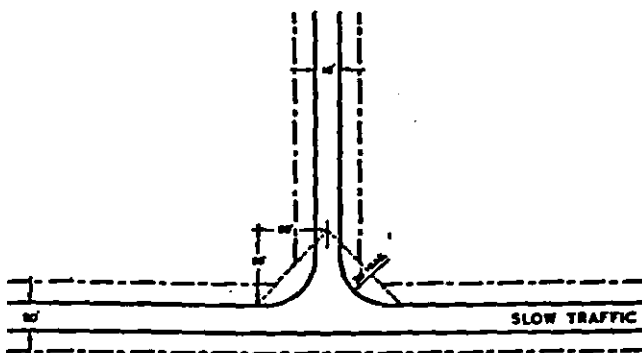


FIGURE 21

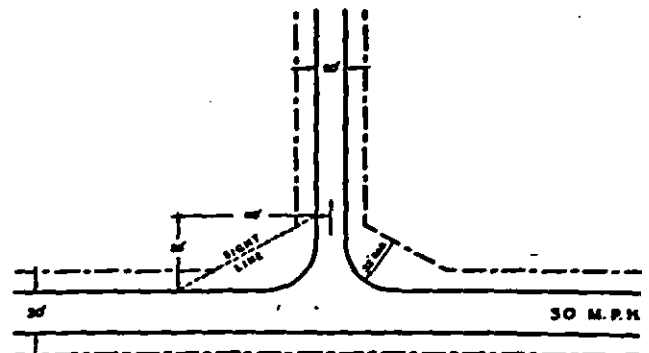


FIGURE 22

proviso mentioned in the next paragraph, the sight distance shown on the latter drawing should be provided unless the character of the through road is such that a speed of 30 m.p.h. is unlikely to be attained on it.

277. In streets where the building line is coincident with the back of the footpath, the cost involved in setting back sufficiently to provide the sight distance shown on Fig. 22 may be prohibitive. Moreover, a 45 degrees splay is to be preferred from an architectural standpoint. We recommend that, in such cases, the buildings at the corners should be splayed to a line joining points 15 ft. back each way from the junction of the building lines. Such a splay will, if the footpaths are 15 ft. in width, yield sight distances similar to those shown in Fig. 21. Where footways are narrower the splay should be increased proportionately.

T junctions on four-lane and dual carriageway roads

278. A suitable layout in streets such as shopping streets for the T junction of a three-lane with a four-lane carriageway is shown in Fig. 23.

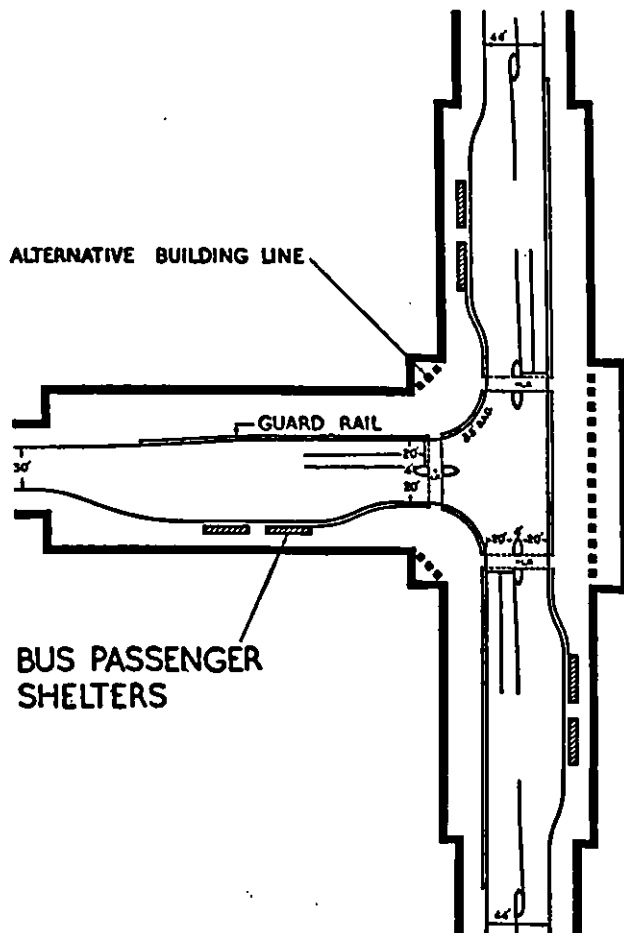


FIGURE 23

Provision has been made for bus services on both the roads, and with the object of facilitating convenient interchange between the different bus services the picking-up and setting-down points are located in draw-ins, which, though adjacent to the intersection, allow free movement of other vehicles. The layout is such as would enable traffic light signals to be installed should conditions so require, without modification of the design.

279. It was at one time considered that where a minor road with an undivided carriageway joined a dual carriageway road by a T junction, the central reservation of the latter should be continued across the mouth of the minor road, the openings in the central reservation being sited on each side of and a short distance from the junction. Such a layout requires that drivers entering or emerging from the minor road shall go over rapidly from one lock to another, and encourages them to make a right turn against the traffic flow instead of turning left and weaving into the traffic on the major road. We are of opinion that, provided sight distances are adequate at a T junction of this type the opening in the central reservation should be opposite the minor road, the intersection being laid out on the same principles as apply to one in which there are refuges in the carriageways of both roads. It is desirable that the central reservation at this point should be wide enough to permit a turning vehicle to halt in safety.

280. A T junction of one road with a width between the outside kerbs (excluding waiting lanes) in excess of about 55 ft. with another of similar dimension should preferably be controlled by a roundabout, as the area of carriageway at such a junction would, if uncontrolled, permit of turning at a speed and in a manner incompatible with safety and, if controlled by traffic light signals, would involve an unduly long traverse. In this connection we refer to what has been said in paras. 269 and 271.

Acute angle and Y junctions

281. It is undesirable that roads shall join each other at an acute angle and in the planning of new roads right-angled junctions should as a rule be provided. Where an existing minor road enters a major road at an acute angle the layout should, wherever possible, be amended so that the carriageway of the minor road may form a right-angled junction with that of the major road. Figs. 24 and 25 show alternative methods of treating such

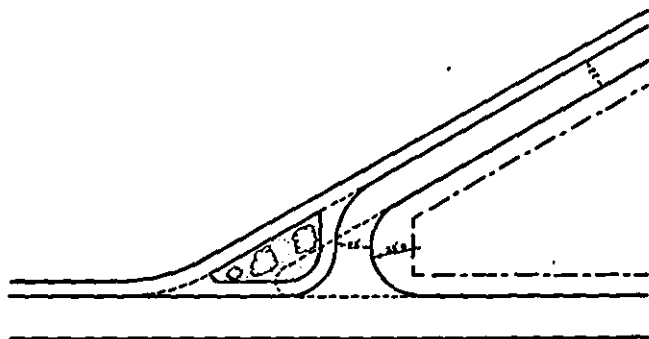


FIGURE 24

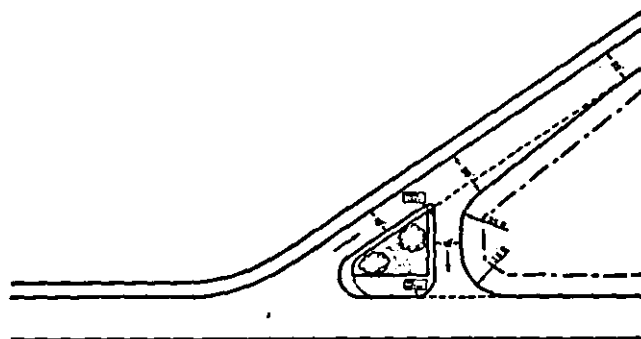


FIGURE 25

a junction, the choice depending upon the volume of traffic and other circumstances. In both these forms of layout the shrubs should be set back behind the required sight lines.

282. In realigning the carriageway of the minor road the creation of sharp reverse bends should be avoided, as these would produce conditions of danger. It is, moreover, important that the portion of the existing carriageway which has been thrown into disuse, shall be obliterated by the formation of a turfed area in the form of a mound, or by the planting of shrubs so that drivers unaware of the altered alignment may not at night or during fog run over the kerb on the disused highway. Reflecting discs should be fixed along the new line of the kerb. Failure to observe these precautions has resulted in accidents.

283. Where two roads of substantial and approximately equal importance join at an acute angle or Y junction; consideration should be given to the construction of a roundabout. Otherwise one of the roads should be treated as if it were a minor road and the layout amended on the lines indicated in paras. 281 and 282.

REFUGES

284. Refuges may be required at a T junction either to guide the movement of vehicles or to lessen the danger to which pedestrians are exposed when crossing carriageways. The same refuge is usually made to serve both purposes, though its most advantageous position for the one purpose may not be identical with that required for the other, since a refuge sited in the position best suited for guidance of vehicular traffic will usually encourage pedestrians to cross the carriageway at a point where, to their detriment, the attention of a driver is directed principally to the movement of other vehicles.

285. Where a refuge serves the dual purposes of guiding vehicular traffic and providing an intermediate place of rest for pedestrians, it should normally be sited so that its end nearer the intersection is not less than 10 ft. behind the line of the kerb on the major road. (See Figs. 26 and 27.) In siting refuges in existing junctions it will not always be possible to obtain such a dimension, but endeavour should be made to do so. The refuges in the major road should be placed as near to the intersection as possible consistent with the safe turning of large vehicles.

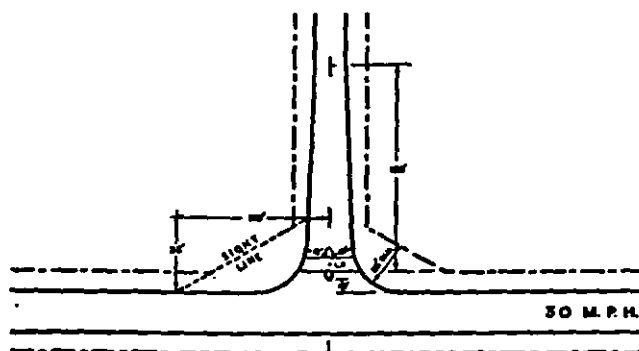


FIGURE 26

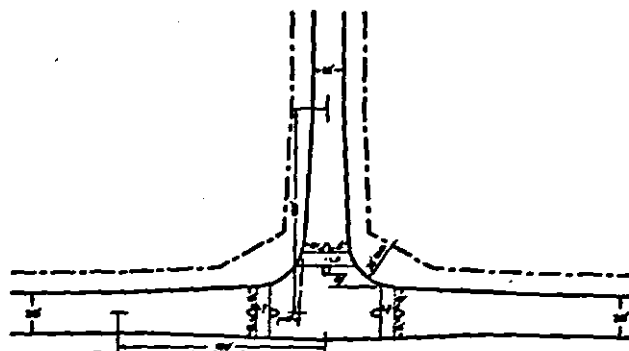


FIGURE 27

Width of carriageways at refuges

286. The aggregate width of carriageway on the two sides of a refuge at an intersection should preferably be equal to the ruling width between the kerbs of the road in which it is placed. On roads having a carriageway width of 30 ft. or more, the minimum width on either side of the refuge should be 18 ft. On two lane carriageways refuges will not normally be required except at an intersection where there is a heavy pedestrian flow, in which case a dimension of not less than 12 ft. should be provided.

287. The provision of the widths referred to in the preceding paragraph will frequently involve the widening of the carriageways approaching the intersection. The additional width should be obtained by tapering in the manner shown on Figs. 26 and 27.

Refuges at bends

288. We have referred in para. 235 to the danger which may result when the view of a refuge is obscured to a driver by a vehicle ahead of him. Experience has shown that this is particularly liable to occur when an intersection at which a refuge has been introduced is approached by a left-hand curve. In such a case a vehicle keeping to its near side may mask the view of the refuge to a driver desiring to overtake, with the result that, if he misjudges the speed of the vehicle ahead he may collide with the refuge. In the design of new roads the introduction of a left-hand curve approaching an intersection should be avoided; but if this is not possible the distance between the nearside kerb of the carriageway and the kerb of the refuge should be increased by, say, 4 ft. in excess of the dimensions recommended above.

Experimental siting

289. When a refuge is to be introduced at an existing intersection, the precaution should be taken of testing its siting in temporary materials, in order to ascertain the precise position best suited to serve traffic flow and safety.

290. Reference to the position of pedestrian crossings in the vicinity of road intersections is made in Part VII, Section (d), to the width of refuges in para. 236 and to their illumination in para. 235.

CROSS-ROADS

291. Where a road which forms parts of a defined route used by a substantial volume of traffic

intersects another road of similar character it is preferable that they should form a direct rather than a staggered crossing, as the former lends itself better to control by roundabout or flyover, or, if circumstances so require, by traffic light signals. Staggered crossings have their place where, in outer areas, a defined though relatively lightly trafficked route crosses another of similar character. In such circumstances they should be laid out as recommended in Memorandum No. 575.

292. In the planning of the road system of neighbourhood units, housing, and industrial estates, it is generally desirable that the minor roads should be so located that their junction with the more important roads of these units and estates do not form direct cross-roads.

293. Fig. 28 shows a layout which may be adopted for the cross-roads formed by two streets with four-lane carriageways used by public service vehicles where the space available does not permit the construction of a roundabout. In comparing this layout with that of the T junction (Fig. 23) it will be noted that provision has been made in the former for three traffic lanes on each side of the refuges in order to cope with a large volume of turning traffic. At an intersection of this type control by traffic light signals will normally be required. The traffic lines shown on this and other drawings of intersections are in accordance with the recommendations made in the recently published report of the Departmental Committee on Traffic Signs.

ROUNDBABOUTS

294. No universally applicable rules can be laid down to determine where the adoption of roundabout layout is justifiable and will prove adequate. Factors to be taken into account are the volume, character, direction and periodicity of vehicular traffic and the extent of pedestrian traffic, as well as the physical conditions. As a general rule, however, it may be taken that where there is a cross roads on a heavily trafficked route at which the volume of traffic entering from both the minor roads is, in total, more than 25 per cent. of all the traffic entering the intersection, or where there is a heavy right-hand turn, there is a *prima facie* case for control by a roundabout or flyover. Where conditions permit, the intersection of two four-lane streets (excluding waiting lanes) each carrying a large volume of traffic, should be laid out with a

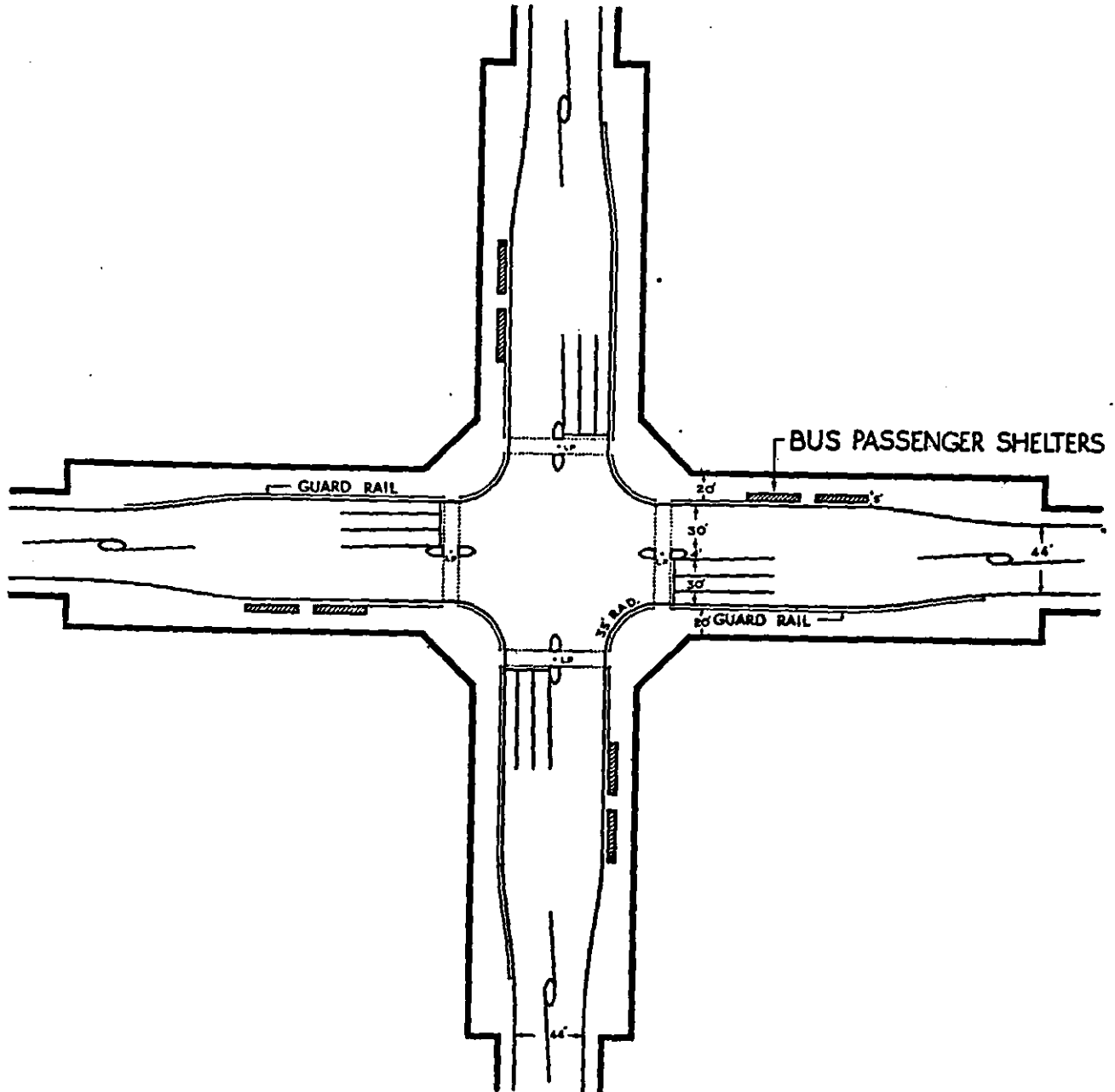


FIGURE 28

roundabout and pedestrian subways or with a flyover.

295. The flyover and the roundabout offer the best form of control with continuous traffic movement, and, when of adequate size, can deal with much more traffic than light signals or halt signs.

296. The design of a roundabout depends on the distribution of the traffic at the intersection, the peak hour load, the lay-out and widths of the converging roads, and in built-up areas limits may be

imposed by reason of the difficulty and cost of acquiring land. The shape of the island should be circular, or as nearly circular as possible, so that smooth flow at even speed is obtained.

Size of central island

297. The radius of the central island must be such as will enable a vehicle to travel at a speed at which it can keep close to the inner kerb. An island of not less than 100 ft. diameter should be aimed at.

This will enable a vehicle to travel round it at a speed approaching 15 miles per hour.

298. The ability of traffic to weave depends on the length of road in which the movement is carried out. The greater the "weaving length," or the smaller the angle of approach of weaving traffic streams, the greater the capacity of the gyratory system. The radius of the central island should be such that sufficient weaving length is afforded between any two entering streets. This again indicates the desirability of a minimum diameter of 100 ft. On the other hand, if, at irregular shaped roundabouts, the volume of traffic between any two points of entry is small, the weaving length between these points is of relative unimportance.

299. The smoothest flow is obtained when the converging traffic lanes become tangential in the weaving length. This, however, requires a comparatively large roundabout, and experience shows that equally efficient weaving is provided for when the angle of the converging lanes does not exceed 30 degrees (see Appendix 5). The angle of convergence bears an inverse relationship to the diameter of the central island, the angle decreasing as the diameter is increased, so that the diameter of the central island should be as large as practicable.

Angle of entry

300. Entering roads should be introduced to the gyratory system as nearly at right angles as possible to ensure that approaching traffic enters at uniform speed. The kerb radius of the entering streets should be such that drivers can keep to their proper lane in entering and leaving the roundabout. (See also para. 268.)

Alignment of kerbs

301. The outer kerb of the roundabout should be straight between the kerbs of the adjacent entering streets. Experience has shown that when the outer kerb is concentric with the kerb of the central island, vehicles entering at one street and leaving at the next do not follow the reverse curves, but proceed in a straight line between the points of entrance and exit. In such layouts it has been found that some 20 per cent. of the carriageway surface is not used.

Width of carriageway

302. The width of carriageway in the roundabout is important. Too wide a carriageway is con-

fusing, and one which is too narrow hinders movement. It is not desirable to have a width less than 30 ft., and, generally, smooth flow is not achieved if it is greater than for four lanes of traffic. There may, however, be exceptional circumstances where five lanes require to be dealt with, but in such cases the size of the central island must be proportionately increased. At the intersection of a four-way crossing the number of traffic lanes in the carriageway round the roundabout should be approximately one-quarter of the total number of traffic lanes of all intersecting carriageways; but it is essential also to have regard to the anticipated maximum traffic volumes, the periodicity and the direction of flow.

Capacity of system

303. There are, however, irregularities of traffic movement at a roundabout, and at peak hours the traffic on one side may be greater than on the other, so that the total traffic within the gyratory system will be slightly less than twice the volume carried by the carriageway on one side. We suggest an upper limit of 3,000 vehicles per hour on any one side, making a total of 6,000 vehicles per hour for the whole of the intersection controlled by a roundabout. In this connection it is of interest to note that before the war, the peak volume of traffic on the west side of Hyde Park Corner was approximately 3,600 vehicles per hour, the width of the carriageway being 58 ft.

304. When the traffic at an existing roundabout is approaching 75 per cent. of its maximum capacity consideration should be given to increasing the size of the roundabout, or to the provision of an under or overpass. This does not mean that a flyover should not be considered until a roundabout has nearly reached its full capacity. The need for obtaining continuity of flow on major highways will sometimes necessitate flyover construction even when the traffic volume does not approach that which would overtax a roundabout. In planning roundabouts and their approaches at very heavily trafficked intersections the layout should be such as to facilitate the construction of a flyover if one should be required in the future.

305. As the result of investigation under working conditions, methods of calculation have been devised for estimating the maximum capacity of roundabouts of varying shapes and sizes. The

following table gives the minimum size of circular roundabouts for maximum traffic capacities, with an allowance for tidal traffic. These data are applicable only to the crossing of two roads at right angles, with carriageway widths not greater than 50 ft. between outer kerbs, but the method can be applied to any shape of roundabout. The maximum converging angle is indicated in this Table. An example of the design of a gyratory traffic system is given in Appendix 5.

1	2	3	4	5	6
Diameter of island	Width of carriage-way round island	Total width between outer kerbs	Maximum converging angle	Peak capacity in V/P/H (inc. cycles)	Remarks
feet	feet	feet	degrees	Up to	
60	30	120	85	2,500	
75	30	135	59	3,000	
100	30	160	55	3,500	
105	40	185	59	4,000	Alternative layouts of which the larger island is to be preferred
150	30	210	40	4,000	
140	50	240	53	5,000	
180	40	260	40	5,000	
240	50	340	40	6,000	

Note.—The capacity figures in Column 5 are *maximum volumes*. When designing a roundabout 33½ per cent. over the future estimated volume should be taken so that the system will not be taxed beyond 75 per cent. of its ultimate capacity.

Small roundabouts

306. We have previously stated that we regard 100 ft. as the minimum diameter of a roundabout, but there may be cases where space does not permit the construction of a roundabout of this dimension, although a gyratory traffic system is considered essential as a safety measure. We have seen examples of smaller roundabouts serving a useful purpose in built-up areas under conditions of light traffic, but the central island should never be less than 60 ft., which will permit its negotiation by public service vehicles. We have included diameters of 60 and 75 ft. in the table in order to make the information complete.

Pedestrians at roundabouts

307. Pedestrian traffic is always a difficulty at a roundabout. If a roundabout is to handle the vehicular traffic satisfactorily there must be continuous movement, both at the inlets and the outlets. This operates adversely for the pedestrian, who has to wait until there is a gap in the traffic sufficient to enable him to cross the carriageway. At the less busy intersections there may be little objection to this course, but guard rails should be erected with openings at such places as will limit the crossing of the carriageways to defined pedestrian crossings. Where traffic is dense, pedestrian subways should be provided crossing under each carriageway, or alternatively taken into the centre of the central gyratory island, where they can be interconnected. Plate 23 shows what has been done at the roundabout at the northern end of Caterham By-Pass, Surrey. Where there are no guard rails, pedestrians are apt to take short cuts across the island. Such tendency may be prevented by planting it with shrubs or forming a mound (Plate 24). It may also be necessary to erect light railings round the island, but in no circumstances should footways be constructed across or round it at surface level.

Provision for heavy pedestrian or cycle traffic

308. Where pedestrian or cycle movement is heavy, and would, if introduced to the traffic streams at the intersection, be dangerous and cause congestion, it has been found advantageous either to raise the carriageways of the roundabout 10 ft. above ground level and enable pedestrians and cyclists to circulate at ground level (as shown in Fig. 29), or to carry the footways and cycle tracks under the carriageways by means of subways. This latter method will prove the less costly of the two, although in built-up areas there may be difficulties in doing so because of the existence of sewers and other underground services.

Dimensions of subways and overbridges

309. A memorandum recently issued by the Ministry of War Transport (No. 577 Roads) suggests the following minimum dimensions for pedestrian and cyclist overbridges and subways:—

- (a) Pedestrian subways: a clear headroom of 7 ft. and a clear width of 7 ft. 6 in.
- (b) Cycle subways: a clear headroom of 7 ft. 6 in. and a clear width of 10 ft. 6 in. for

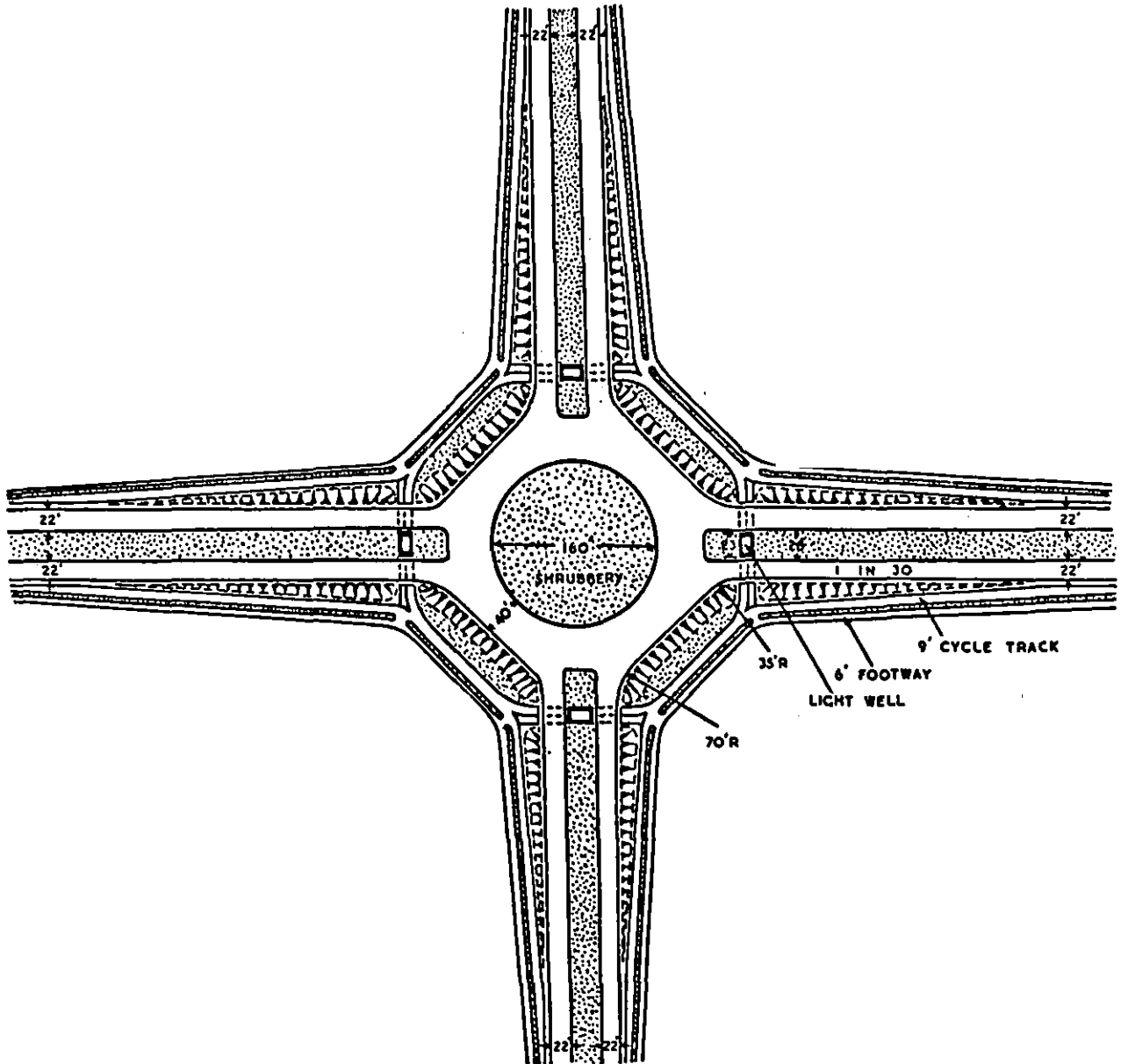


FIGURE 29

unidirectional traffic, and 15 ft. 6 in. for traffic in both directions.

- (c) Combined pedestrian and cycle subways: a headroom of 7 ft. 6 in. over the cycle track and a width of 16 ft. 6 in. where cycle traffic is unidirectional, increased to 21 ft. 6 in. for two directional cycle traffic. In each case the footway should be not less than 6 ft. 6 in.

- (d) Pedestrian footbridge: a width of 6 ft.

The maximum gradient for the ramps of pedestrian subways or bridges should be 1 in 10. For

unidirectional cycle ramps the maximum gradients should be 1 in 20 for the up and 1 in 15 for the down grade.

Tramways at roundabouts

310. There are many places on built-up areas, and particularly in the centres of towns, where tramway tracks present a special problem. Where possible, the tramway should be taken round the central island to enable other traffic to weave with the trams. This layout has proved satisfactory where the roundabout is not working to full capacity.



PLATE 23. TWO-LEVEL ROUNDABOUT WITH PEDESTRIAN SUBWAYS—CATERHAM, SURREY.



PLATE 24. ROUNDABOUT PLANTED WITH SHRUBS—BIRMINGHAM.

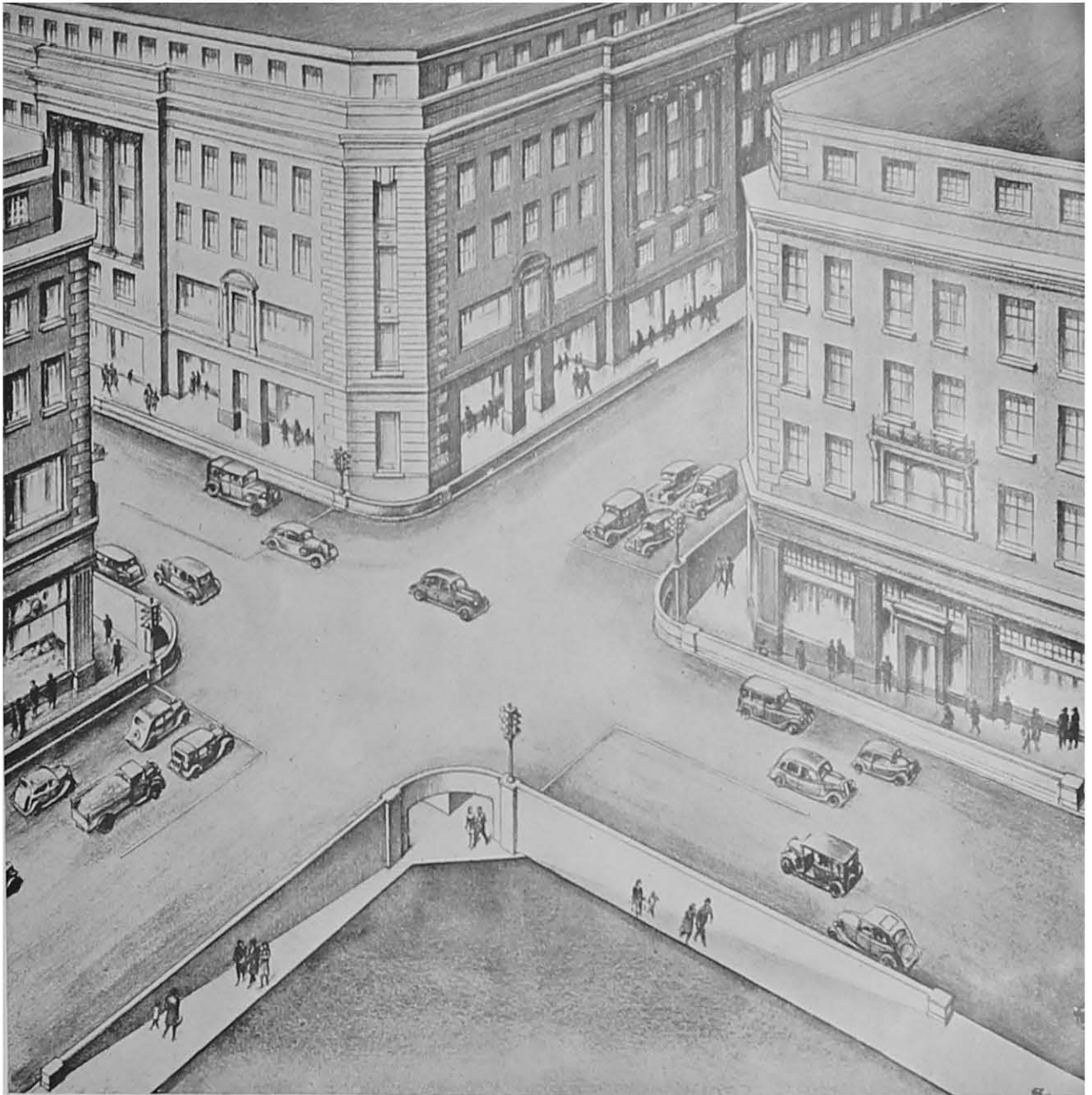


PLATE 25. SKETCH OF PEDESTRIAN SUBWAY WITH RAMPED APPROACHES.



PLATE 26. LAMP STANDARD—BIRMINGHAM.



PLATE 27. LAMP STANDARDS—LEEDS.



PLATE 28. P.S.V. PASSENGER SHELTER—L.P.T.B.

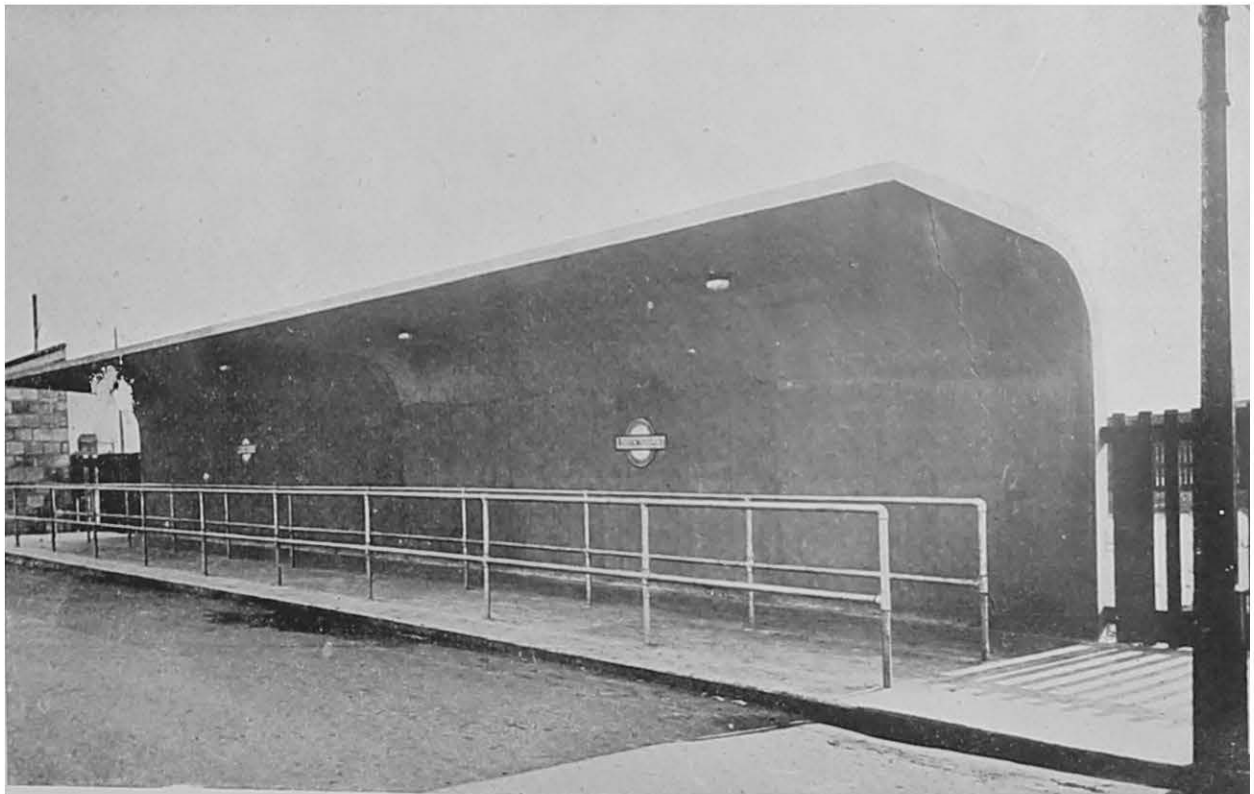


PLATE 29. P.S.V. QUEUE SHELTER—EAST HAM.



PLATES 30 AND 31. SEATS IN SUBURBAN AREA—HAMPSTEAD GARDEN SUBURB.



PLATE 32. . ELECTRICITY BOX SITED IN HEDGE—FINCHLEY.



PLATE 33. WALL TYPE FIRE ALARM—GLASGOW.



PLATE 34. TELEPHONE BOXES BUILT INTO WALL OF BUILDING—LONDON.



PLATE 35. LETTER BOX BUILT INTO WALL—WESTMINSTER.



PLATES 36 AND 37. MULTI-STOREY CAR PARK BUILDING—BLACKPOOL.

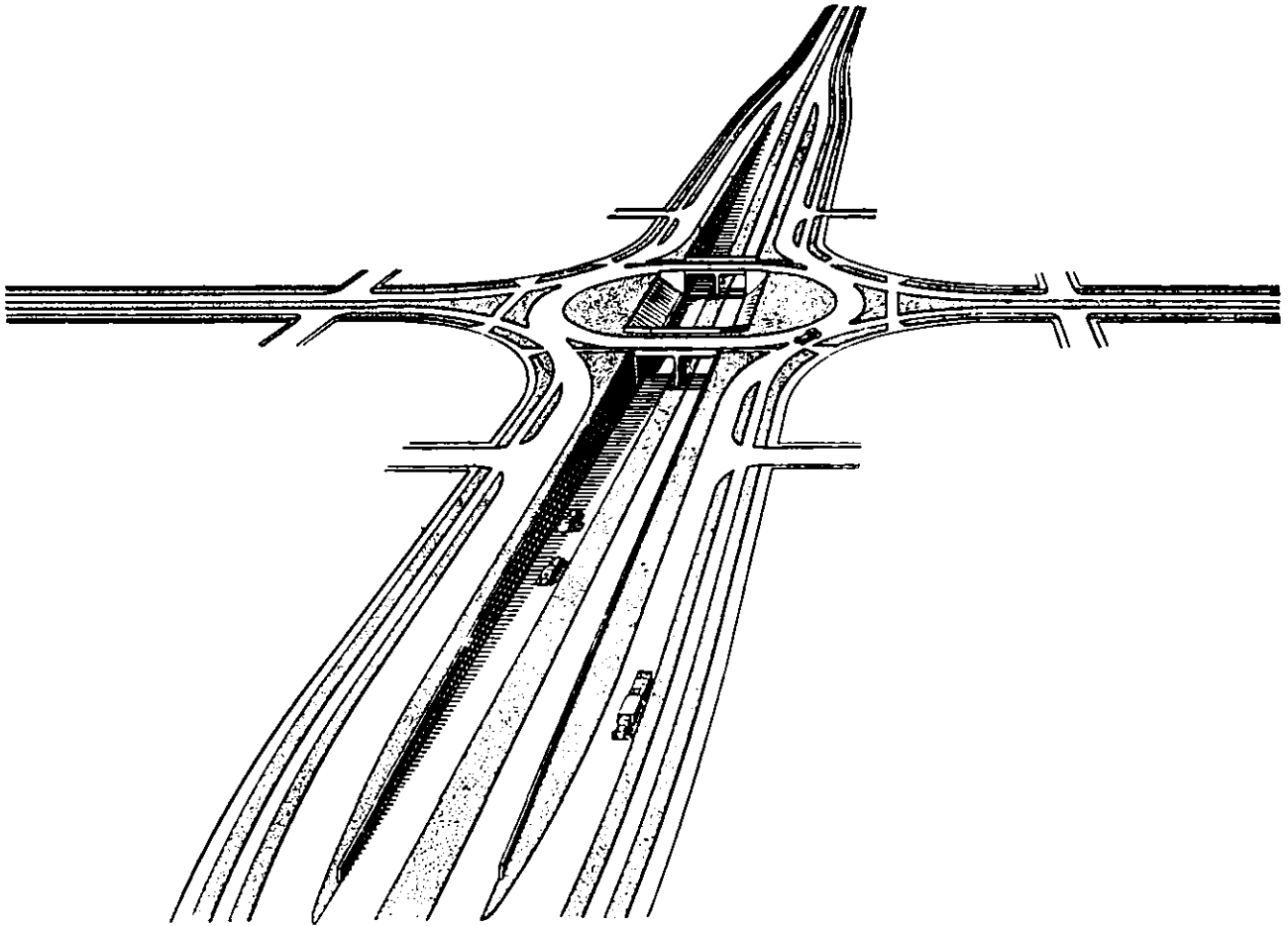


FIGURE 30

Development on central islands

311. Our attention has been drawn to intersections where the central island has been used as a site for a petrol filling station, but we are of the opinion that no form of development should be permitted on gyratory traffic islands with a diameter less than 200 ft. unless access thereto is otherwise than at ground level. Roundabout sites afford opportunity for the construction of underground subway systems similar to that in Piccadilly Circus, or for treatment as suggested in para. 307, which could be developed to good purpose and would encourage the general use of subways.

MULTI-LEVEL INTERSECTIONS

312. Where (i) the volume of traffic in an intersection is, in normal circumstances, sufficient to warrant roundabout treatment, (ii) a small percentage only turns to right or left, and (iii) the major volume is travelling on a free-flow highway (or in the circumstances instanced in para. 304),

there would be justification for a multi-level crossing. The topography of the surroundings will influence the decision on the adoption of a flyover as against an under-pass. Figs. 30 to 35 illustrate suitable means of crossing at different levels.

313. A flyover imposes minimum restraint on the flow of traffic, but if the layout is of the clover-leaf type, turning traffic must make considerable detours. Moreover, the space occupied by a clover leaf on an all-purpose road is so great (24 acres or so) that the adoption of this form of intersection will rarely be practicable in built-up areas. A roundabout, though minimizing detours, imposes speed restraint on the flow of both direct and turning traffic. The layouts shown on Figs. 30 to 35 have been designed to allow free flow of through traffic, while exercising only such restraint on turning traffic as would be imposed by a normal roundabout. These layouts should be modified as may be necessary to suit local conditions. The

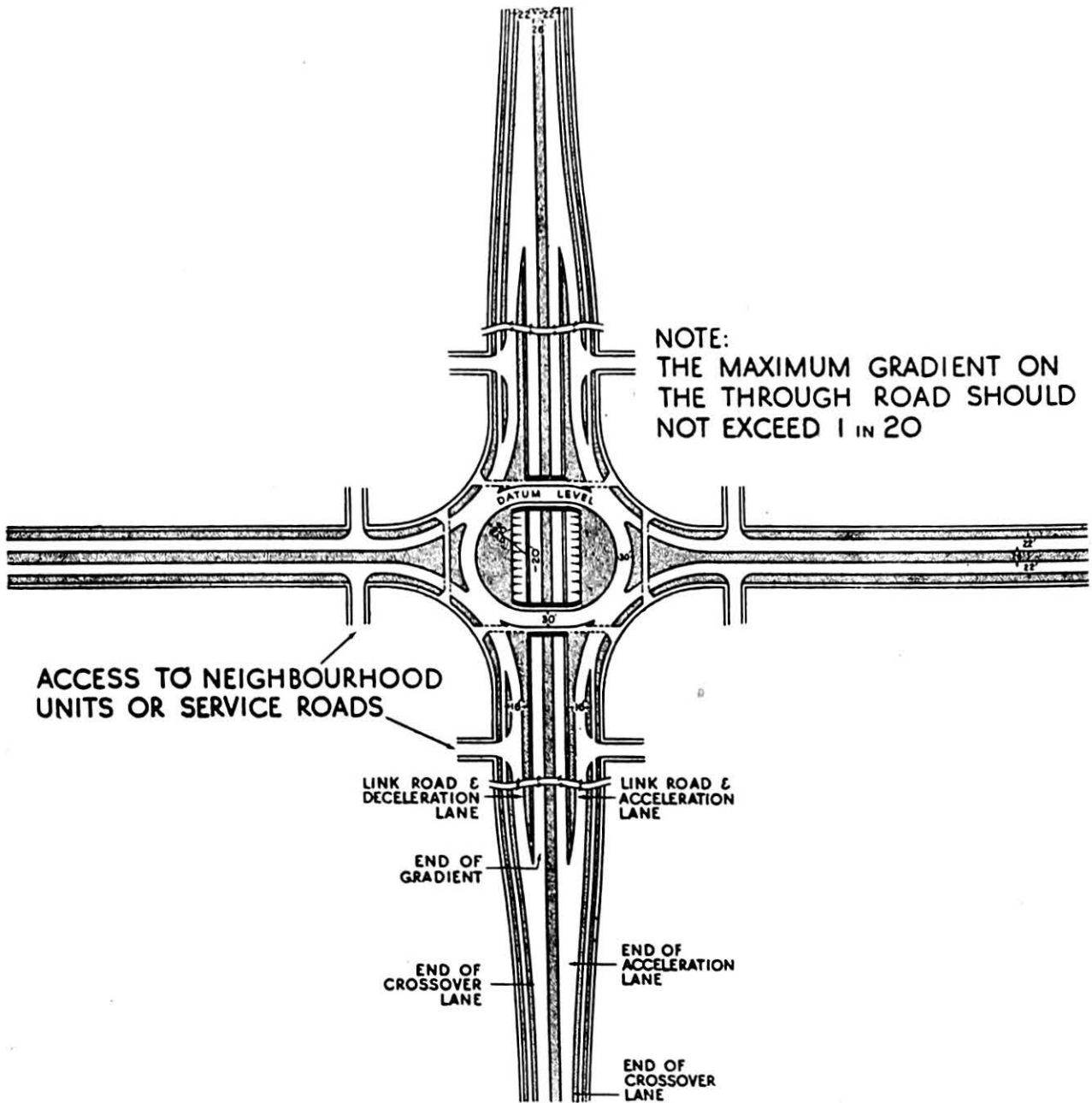


FIGURE 31

data on which the designs are based are given in Appendix 6.

314. The layout shown in Figs. 30 and 31 for the crossing of two important routes has been designed for a speed of 30 m.p.h. The length of the link roads is determined by the lengths of the approach ramps which have been shown with gradients of 1 in 30. On the east-west road the roundabout and link roads are kept at ground level as this arrangement is the most economical. The north-south road may pass over or under the

roundabout, but here it is shown depressed, a form of construction which is preferable on the grounds of amenity. When the roundabout is working to maximum capacity traffic on the east-west road is forced to reduce speed to approximately 12 m.p.h., but if it is considered that this reduction is too great the size of the roundabout should be increased. The drawings show the arrangement of component units where cycle tracks and footways are incorporated in the layout of the north-south road. Cyclists are introduced into the traffic stream circulating at

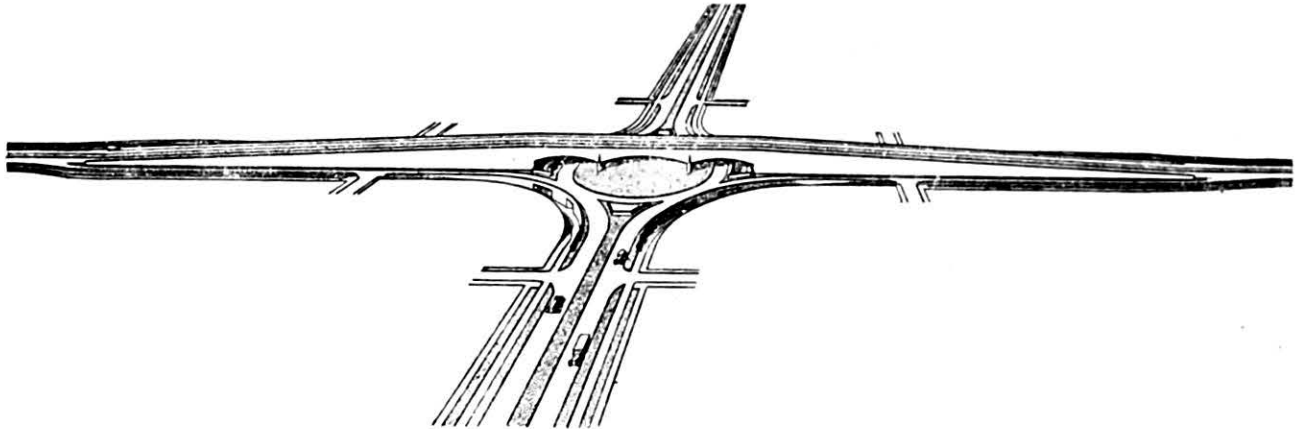


FIGURE 32

the roundabout at a point where the low speed of vehicles would tend to minimize danger due to collision. It has been assumed that on the east-west road no cycle tracks are necessary. The suggested sites for connections to service roads, or access roads to the neighbourhood units are also shown.

example the east-west road is designed for a speed of 50 m.p.h. and the north-south road for a speed of 30 m.p.h. To segregate traffic, the east-west route has been raised, which permits the cycle tracks and footways to be sunk 10 ft. below ground level, as shown on the detail. The positions for connections to service roads or access roads to the neighbourhood units are also shown and are so sited as to avoid interference with the subway ramps.

315. The design in Figs. 32 and 33 is on similar lines to that shown in Figs. 30 and 31, but in this

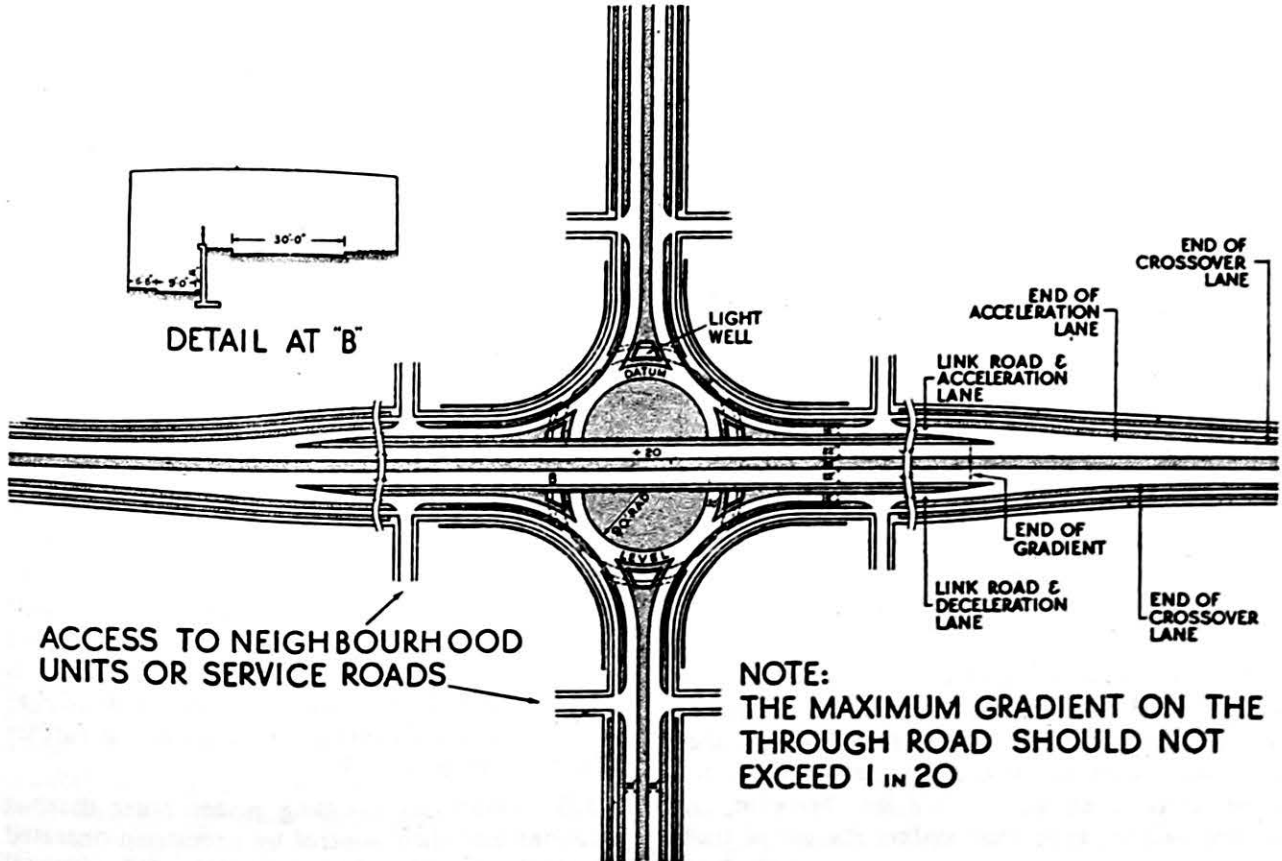


FIGURE 33

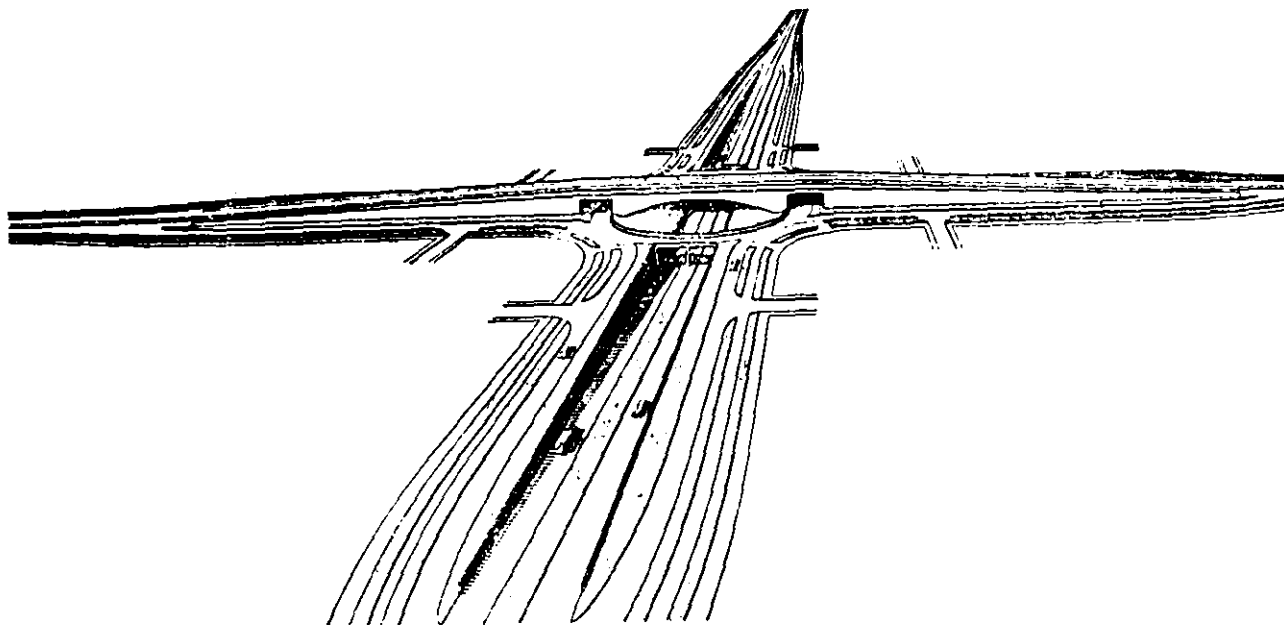


FIGURE 34

316. The design in Figs. 34 and 35 is suitable where two major routes carrying large volumes of traffic cross in an area not subject to a speed limit. The link roads and roundabout are at ground level, one through road being constructed above the roundabout, and the other below. The link roads are shown as near as possible to the main routes, in order to save space, and their length is determined by the length of the approach ramps. The drawings show the arrangement where cycle tracks and footways are incorporated in the layout of both roads, and also indicate possible positions for connections to service roads or access roads to neighbourhood units. Local traffic would circulate at ground level in the roundabout, joining the main routes via the link roads. The surface of the acceleration and cross-over lanes where they abut on the main carriageways should differ in colour from the latter. They will then be easily distinguishable.

TRAFFIC SIGNALS

317. Control of traffic at intersections by coloured light signals has been found of marked value in the automatic control of traffic, and there are many situations where this method must continue to be relied upon. We feel, however, that in any well-designed road system the use of traffic control signals should not be necessary outside the busy central area.

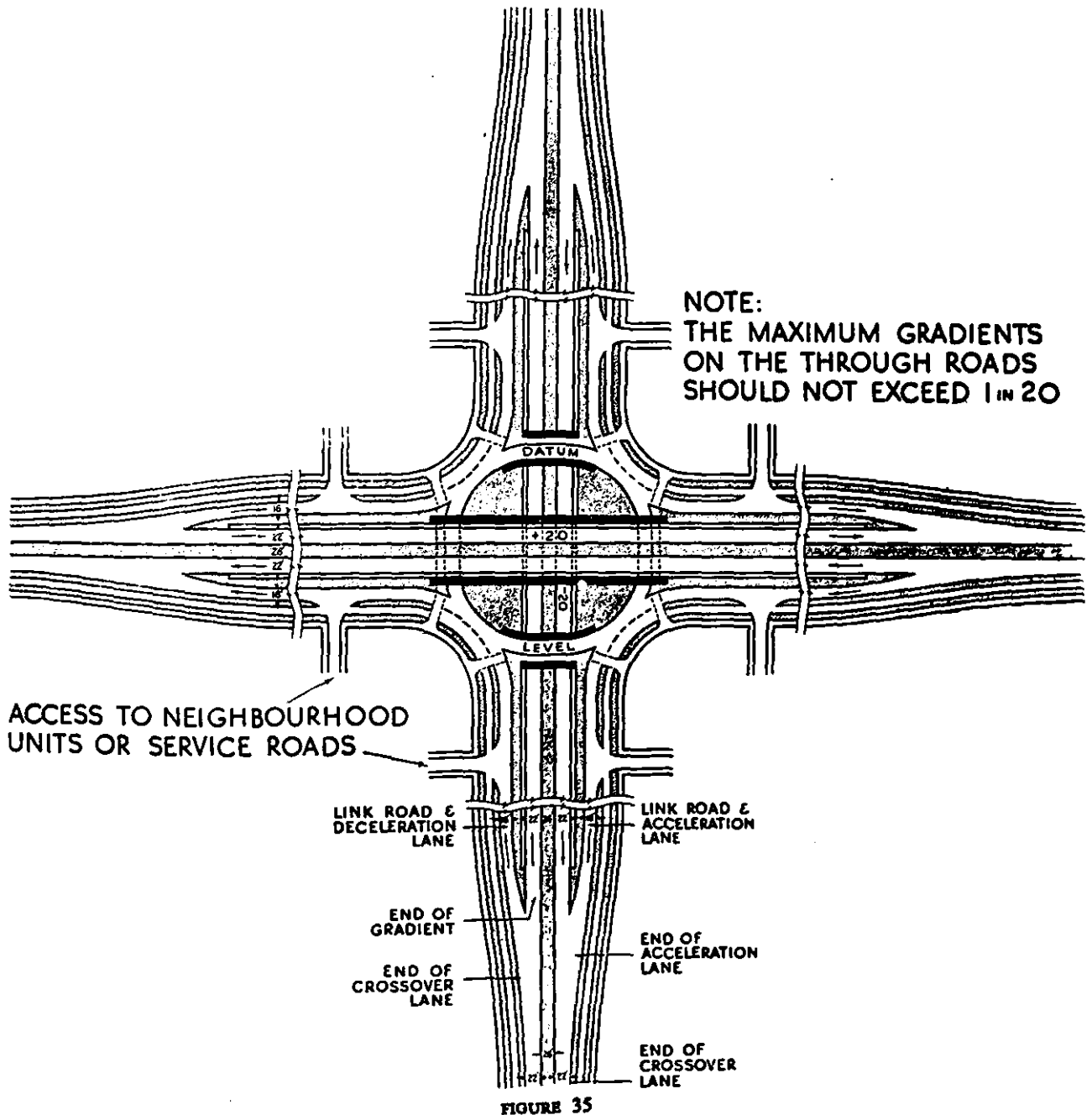
Prior consideration of alternatives

318. Careful study of the accident statistics of an intersection may show that by some simple readjustments, such as diverting heavy turning movements to alternative routes, by the erection of a "Halt" sign on certain entry or entries, or even by an alteration of kerb lines, the situation can be satisfactorily dealt with and signal control found to be unnecessary. In these cases consideration should first be given to the possibilities of effective modification of the layout of the road.

Provision for pedestrians

319. As indicated previously, roundabout treatment provides continuity of vehicular movement, a feature not obtained where there is signal control, but it does not assist pedestrians in crossing the carriageways where subways are not provided. In signal controlled special facilities can be designed to aid pedestrian movement by the inclusion of an all-red period in the light sequence. Pedestrians are thus enabled to cross the road with greater freedom and safety, but the time in each cycle in which vehicular traffic is at a complete standstill may be a serious disadvantage. The subject is further referred to in para. 339.

320. Pedestrian crossing places other than at junctions and their control by pedestrian-operated signals are considered in para. 339 of Section (d) of this part of our Report.



Type of control

321. In the installation of traffic signals it is essential that the control should be "vehicle actuated," and where intersections, which are signal controlled, are sited close together they should be linked. Flexible progressive operation is often valuable in maintaining maximum permissible traffic flow on the controlled roads.

Capacity of controlled intersections

322. The installation with the largest capacity

is that which can be worked on a straight two-phase system; additional complications—all-red periods, pedestrian periods, special periods for heavy right-hand turns, etc.—tend to reduce the capacity of the intersection.

323. The following figures show the approximate capacities of two typical straight cross-road intersections with different phasing; the first with one traffic lane entering the junction from each direction, the second with two. It is assumed that the approaches are not obstructed by bus stops,

standing vehicles, etc., and that traffic densities in opposite directions on the same phase are equal.

Phasing	Approximate Traffic Capacity of Intersections, each approach road having	
	One traffic lane entering intersection.	Two traffic lanes entering intersection.
	Vehicles per Hour	Vehicles per Hour
Simple 2-phase ..	2,200	4,400
2-phase with 3 sec. all-red clearing period	2,100	4,200
2-phase with 10 secs. pedestrian period	1,900	3,800
3-phase (assuming equal density on all phases) ..	1,200	2,400

If traffic densities in opposite directions are unequal the capacity will be less than stated above, but will not be less than half these figures. The figures have been worked out by theoretical methods based on observations made of traffic flow at existing signal installations.

Section (d)—Crossing of Carriageway by Pedestrians

324. In the section of our Report dealing with Road Safety we pointed out that in the year 1936/37, 2,465 pedestrians were killed and 67,169 injured in built-up areas, and that nearly 70 per cent. of the fatalities occurred in crossing the carriageway. The alleviation of the risks to which pedestrians are exposed—or expose themselves—in crossing streets is therefore of primary importance. Much might be done by strict attention to the provisions of the Highway Code relating to the conduct of pedestrians—as of all classes of road users—but this alone would not suffice. The well-designed town plan and the proper layout of the street can make an important contribution to the safety of the pedestrian, and the problem has to be approached from both these angles.

325. It is necessary in the first instance that the road system be so designed as to ensure that, to the fullest possible extent, streets which are extensively used by pedestrians have not to be traversed by traffic other than that having business in them; also that shops, markets, public buildings, amuse-

ment centres, and other places attracting a large number of pedestrians shall be located elsewhere than on through and local-through traffic routes.

326. Provision must of necessity be made for the crossing of streets by pedestrians, but they should be prevented from gaining access to the carriageway at unsuitable points, and where they cross they should be enabled to do so in safety. Factors to be taken into account are the speed and volume of traffic, turning movements at intersections and elsewhere, and interference with visibility owing to stationary vehicles and other obstructions.

Limitation of crossing places

327. In streets where vehicular traffic is heavy, crossing of the carriageway by pedestrians should be concentrated at a limited number of points, and should be by way of subways or bridges, or by properly defined pedestrian crossing places. In streets of minor traffic importance the restriction of points of crossing by physical barriers can only reasonably be applied at major intersections. Experience has shown that where necessary complete physical restriction can best be accomplished by barriers or guard rails coupled with subways or overbridges, spaced at such intervals as will enable pedestrians to pass without undue inconvenience from one side of the road to the other.

328. The indiscriminate erection of guard rails or barriers (whether at the edge of the footway or along the central reservation) would give rise to an unpleasant feeling of restraint, and in considering their adoption regard should be had to particular circumstances relating to the character of the street and the type and volume of traffic which it carries. There is, however, no reason why guard rails should be unsightly, and we have included in Appendix 9 of this Report illustrations of well-designed guard rails, as well as of other types of barriers to serve the same purpose.

Compulsory use of pedestrian crossings

329. In our opinion the safety of pedestrians would be materially enhanced—and, incidentally, the erection of guard rails could be largely dispensed with—if regulations were made under Section 18(2) of the Road Traffic Act, 1934, prohibiting foot passenger traffic on the carriageway within 100 yards of a pedestrian crossing. We are, however, given to understand that the police regard such regulations as too difficult of enforcement to make them worth while.

Outer ring roads

330. We have expressed the view that on outer ring roads, free flow of vehicular traffic should be the main consideration, and have visualized that dual carriageways will be provided. If the frontages are undeveloped there will be little need for pedestrians to cross the carriageways elsewhere than at intersections with radials, but there is always the possibility that they will do so. The safety of pedestrians (children in particular) would best be safeguarded by a barrier, preferably in the form of an impenetrable dwarf hedge between the footway and the outer kerb. A less satisfactory alternative is to plant such a hedge on the central reservation, though this has the advantage of mitigating the glare of headlights of vehicles using the dual carriageways. Pedestrian crossings may be required at intervals, but where a large number of pedestrians require to cross the outer ring road, as at its intersections with the more important radials, provision should be made by which they may do so at a different level from that of the carriageways.

Intermediate ring roads

331. Intermediate ring roads will usually incorporate existing roads and streets to a larger extent than outer ring roads, and elimination of direct frontage access is not likely to be practicable. Entry by pedestrians to the carriageways can be controlled by means of service roads, provided they are separated by an effective barrier with openings at convenient intervals. As a rule, crossings of the main carriageways will be on the surface, and pedestrian crossings should be provided.

Inner ring roads

332. The inner ring road will be extensively used by pedestrians making for the central area, and may be expected to serve as an important bus route. It is essential that the large number of pedestrians requiring to cross it shall be enabled to do so with a minimum of risk. As the road will normally be of the dual carriageway type, limitation of the points of pedestrian crossing can best be effected by a suitable barrier along the central reservation. The alternative of erecting barriers along the footways has the disadvantage of necessitating frequent openings at bus stops and in order to afford access to abutting premises, and these openings would largely defeat the object desired. At the intersections of the main radials with the inner ring road, a layout is desirable which will

afford pedestrians access to the central area at a different level from that of vehicular traffic.

Radial roads

333. Mention has previously been made of the varying character of radial roads along their length (Part V, Section (c)); conditions at their outer ends may approximate to those obtaining on outer ring roads, whilst towards the city centre they will more closely resemble inner ring roads. Such provision should be made for the crossing of pedestrians on the lines already indicated as will best meet the local circumstances.

Shopping Areas

334. In shopping areas the interests of the pedestrian should predominate, and it is for this reason we have urged that vehicular traffic in shopping streets should, as far as possible, be restricted to that which cannot be diverted elsewhere. Provision of convenient means for crossing the carriageway at frequent intervals is an essential feature of shopping streets, and the special circumstances demand that, in general, the crossings should be on the surface. The use of guard rails should be avoided, except where their erection is desirable to prevent the crossing of the road at intersections otherwise than by the use of defined pedestrian crossings.

Access to places of public resort

335. Provision for pedestrian access from important traffic routes to places of public resort such as schools, theatres, cinemas, football grounds and race tracks constitutes a special problem. Pedestrian traffic to such places is usually intermittent, but intense. Control by the police, or (especially at schools) by traffic officers, probably furnishes the best means of promoting safety. Pedestrian crossings with or without traffic light signals under police supervision will be helpful, but if vehicular traffic is heavy and entrance by pedestrians is desired over long periods, e.g., to exhibition buildings, the construction of a bridge or subway (preferably the latter) may be justified. Space for the accommodation of queues at theatres and other such buildings should be provided off the highway.

School entrances

336. If possible, entrances to schools should be located in side roads, but if this is out of the question reliance must be placed on guard rails at the

edge of the footway. They should overlap the entrance by not less than 10 ft. on each side, and should be of such design that children cannot climb through them or over them. If the traffic is heavy, and other satisfactory measures cannot be taken to ensure the safety of children, consideration should be given to the construction of a subway.

Means of crossing at surface level.

337. There are three principal means of mitigating danger to pedestrians whilst crossing on the surface: by pedestrian crossings, by pedestrian crossings in conjunction with traffic light signals, and by a central reservation or chain of refuges in the carriageway.

Siting of pedestrian crossings

338. The provision and siting of pedestrian crossings should be in accordance with the recommendations set out in Circular No. 414 (Roads) dated January 14th, 1935, issued by the Ministry of Transport and repeated in Appendix 7. In determining their position, at road intersections in relation to footways, of which they virtually form an extension, regard should be had to the observations in Section (c) of this Part of our Report, and to the explanatory diagrams.

339. The safety of foot-passengers at pedestrian crossings is further enhanced by traffic light signals, particularly at busy intersections. In many cases traffic conditions demand that a signal installation should comprise measures for the additional protection of pedestrians and these are given in Circular No. 544 (Roads) issued by the Ministry of Transport on February 21st, 1940, a copy of which appears in our Report as Appendix 8. At intersections controlled by traffic light signals, opportunities for the safe crossing of pedestrians can be afforded by the inclusion of an all-red period. An all-red, or pedestrian phase can also be introduced in the cycle by a call from a pedestrian-operated push-button, which, once called, is introduced at the appropriate time in the cycle and must complete its period of operation. Experience has shown that pedestrians are apt to ignore the push-button, or to cross the road before the pedestrian period is signalled, with the result that vehicular traffic is stopped without apparent reason and the installation is brought into disrepute. Pedestrian-operated signals may have their advantages under conditions of medium traffic, but we are of opinion they should not be encouraged since they tend to stop

the flow of vehicular traffic for longer periods than may be necessary.

Division of carriageways in the interests of pedestrians

340. The relative advantages and disadvantages of the two means of dividing the carriageway longitudinally, *i.e.*, by a continuous reservation or a chain of refuges, are discussed in Section (a) of this Part of the Report dealing with segregation of traffic. A two-lane carriageway pre-supposes a limited volume of vehicular traffic and pedestrians should not therefore be exposed to an appreciable risk in crossing. There will, however, be cases where, primarily for the control of turning vehicular traffic, it will be desirable to widen a two-lane carriageway at an intersection and to introduce a refuge.

Means of crossing otherwise than at surface level

341. The use of a bridge or subway for pedestrians eliminates all the risks attendant on crossing on the surface; but where the need for them is greatest, *i.e.*, in fully-built-up areas, constructional difficulties are at a maximum, and in the main their provision must be confined to major intersections. As we have pointed out in para. 105, there is noticeable objection to making use of a subway or footbridge, probably because of the additional physical effort which is involved. The provision of ramped approaches instead of stairways will go some way to meet this reluctance, and will facilitate their use by perambulators and other hand-propelled vehicles. (Plate 25.) Objections are also raised to the use of subways which serve as a means of access to public conveniences, but this is surely carrying feelings of delicacy too far. In the absence of physical means to prevent surface crossing in the vicinity it is unlikely that either subways or footbridges will be largely used, and consideration should be given to the erection of barriers along the footway so as to preclude crossing at surface level for some considerable distance—50 yds. or so—on either side of the entrance.

Relative advantages of subways and footbridges

342. Subways are more costly than footbridges, though they involve a descent of only about 10 ft. instead of a rise of about 18 ft. in the case of the latter. Their construction may give rise to special difficulties of drainage, and by reason of interference with underground mains and services. They

also require lighting, and precautions must be taken to prevent risk of misconduct. Footbridges over streets may appear unsightly though this is largely a question of architectural treatment. Objections to both subways and overbridges lie in the space occupied on the footway by their approaches and the obstruction thus caused, especially in the case of ramps. Information on the desirable dimensions of subways and overbridges has been given in para. 309.

Section (e)—Underground Services

Necessity for planning by undertakers

343. Public utility services are essential to the life of the community, and statutory authority for the use of the public highway for their accommodation has existed for close upon a hundred years. Little difficulty was experienced in the days of horse-drawn vehicles when underground services consisted almost entirely of sewers and water and gas mains, but to these must now be added telephone and electricity cables. In some streets in large towns, room for additional underground mains can be found only by tunnelling under those already in existence. Furthermore, the rapid growth of mechanized transport has made more serious the problem of hindrance to traffic, in addition to deterioration of the road crust every time the road has to be opened.

344. Any attempt to rationalize the positions of existing mains in busy thoroughfares is out of the question, by reason of both cost and interruption of traffic, but it is important to ensure that the positions of underground mains shall be accurately recorded so that new or reconstructed highways shall not, in the course of years, be brought to the same condition as are many existing streets. It is fortunate that a large number of public utilities are now controlled by either local authorities or large public companies, who should have sufficient foresight and resources to enable a long view to be taken of future requirements and so avoid the subsequent duplication of mains which too often have been laid with the object of meeting only the needs of the immediate future.

Position of mains and sewers in the highway

345. In urban areas, trunk mains and sewers should as far as practicable be routed through open spaces, or streets of minor traffic importance.

Wide central reservations may be utilized for the location of underground mains, provided that before the carriageways are constructed pipes or ducts are laid at street junctions and other points where it may become necessary to provide for branch connections.

346. In wide streets it is advantageous from the traffic standpoint, and will often prove economical to the undertakers, to lay distribution mains in duplicate, one on each side. They should be located as near as practicable to the premises to be served, and for this a wide footway is of marked advantage. Their lateral disposition and depth should be such that service connections will be clear of intervening mains, and the lengths of the most expensive types of connections kept as short as possible. Fig. 36 shows the position adopted for distribution mains in one of our large cities, but it is not necessarily exhaustive.

CROSS SECTION SHOWING POSITION OF MAINS UNDER FOOTWAY

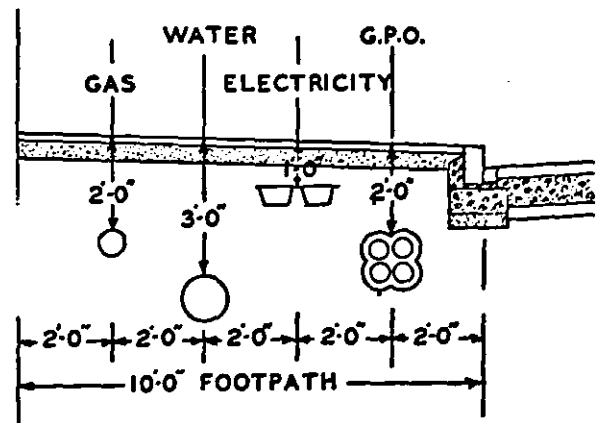


FIGURE 36

Use of vacant land

347. Where there is vacant land alongside the highway, which the highway authority has acquired or intends to acquire for road widening, endeavour should be made to give the undertakers facilities for laying their mains in advance of widening operations, care being taken to locate the mains on such alignment and at such depth as will accord with the final layout.

Pipe subways

348. In the construction of new or in the improvement of existing streets, where traffic is heavy

* Since the original publication of this report the Joint Committee of the Institution of Civil Engineers and the Institution of Municipal (and County) Engineers has published recommendations on the layout of mains and services in the highway which differ slightly from Figure 36.

and continuous, particularly in the town centre, consideration should be given to the provision of subways, to accommodate distribution mains under the carriageway. They are costly to construct, but have the advantage of giving ready access to the mains they accommodate, of providing for additional mains, of facilitating repairs, and, to some extent of reducing the number of road openings. Very few towns in this country outside the metropolitan area have adopted subways, owing in part to their heavy cost and to reluctance on the part of some undertakings (particularly gas) to make use of them; but where in existence, they have proved successful in operation.

Co-operation between highway authorities and public utility undertakers

349. The possession by public utility undertakers of statutory rights to lay their mains in the public highway, subject to a measure of control by highway authorities points to the desirability of such effective co-operation as will best promote mutual interests. It is of importance to ensure that the subsoil, as well as the surface, of roads and streets shall be utilized to the best public advantage. In towns where the highway authorities and public undertakers are one and the same there should be no difficulty in reaching agreement on the positioning of mains and services and the manner in which the work shall be carried out, and we entertain no doubt that similarly satisfactory agreements can be reached by mutual collaboration in the case of undertakings which are privately owned.

Breaking up of streets

350. The question of breaking up of streets by statutory undertakers and their subsequent reinstatement has formed the subject of inquiry by a Joint Committee of the House of Lords and the House of Commons, and their conclusions were embodied in a Report issued in 1939, by His Majesty's Stationery Office. The subject is of interest in dealing with road conditions in built-up areas but cannot be said to have a direct bearing on the matters we are charged to consider.

Section (f)—Other aspects of Road Design

Introductory

351. If free flow and safety are to be promoted to the fullest practicable extent regard must be had to them in the planning and alignment of the road

system and its relation to development, as well as in the more detailed design and layout of the particular road. Various aspects of design and layout have already formed the subject of recommendations we have made earlier in this Report, but there are other features to which attention must be directed. Many of these have been dealt with in Memorandum No. 575 published by the Ministry of War Transport in 1943. This Memorandum was primarily concerned with roads in the open country and, while many of its recommendations are equally applicable to urban roads, there are certain matters on which we think it necessary to comment from the standpoint of traffic and safety requirements in built-up areas.

Width of traffic lanes for moving vehicles

352. The normal width of a lane for moving traffic should be 11 ft. On undivided carriageways with more than two lanes for moving traffic, or on divided carriageways with more than two lanes for moving traffic in each direction the width of each lane should be 10 ft. Where the anticipated volume of traffic is not so great as to require the provision of a carriageway with two lanes each 11 ft. in width, we are of opinion that, subject to the qualification made below, the ruling width of the carriageway should not be less than 16 ft. even on service roads or on link roads where traffic on the road is unidirectional. This recommendation does not apply to subsidiary development roads of relatively short lengths. The width of such roads should conform to any regulations or provisions made for inclusion in a planning scheme.

Width of waiting lanes

353. Where waiting lanes are required on roads not used by public service vehicles, their width should be 8 ft., but where a waiting lane has also to serve as the picking-up and setting-down place for public service vehicles its width should be 9 ft.

Horizontal curvature

354. We endorse the recommendations made in Section 8(b) of Memorandum No. 575 for through and local-through roads in the outer or less developed portions of built-up areas. In the more densely developed parts, and where speed is restricted to 30 m.p.h., we are of opinion that curves with radii of not less than 1,000 ft. for roads of this character and not less than 500 ft. for local roads, may safely be adopted; and also, that

transition curves need be introduced only where the radius of curvature is less than 1,000 ft. On reverse curves a short length of straight should be introduced between the two curves. We appreciate that conditions of topography may necessitate the use of curves of radii less than the minimum suggested above. We do not consider it necessary to recommend a minimum curve radius, either horizontal or vertical, for development roads. On roads subject to the 30 m.p.h. speed limit we are of opinion that the increase over normal width of each traffic lane, where the radius is less than 1,500 ft. but greater than 1,000 ft. need not be more than 1 ft. ; and, where 1,000 ft. or less, not more than $1\frac{1}{4}$ ft.

Vertical curvature

355. We are in agreement with what is said in Section 10 of Memorandum No. 575, for through and local-through traffic roads not subject to the 30 m.p.h. speed limit. Roads subject to the speed limit may have been so restricted by reason of existing development that it may be impracticable to attain the standards laid down in Memorandum No. 575. Nevertheless, as large and slow-moving vehicles are likely to overtake on such roads we recommend that the maximum possible line of sight should be provided and that 1,000 ft. on single carriageway roads and 500 ft. on dual carriageway roads should be regarded as the desirable minimum. Where it is necessary simultaneously to incorporate horizontal and vertical curves the recommended sight distances may have to be increased to permit of safe overtaking. There will be places where, on a single two-way carriageway, safety can be obtained more economically by widening the carriageway throughout the length represented by the sighting distance and introducing a physical division, rather than by lowering the summit.

Visibility at corners

356. The minimum line of sight desirable at intersections and junctions is shown in the various drawings embodied in Section (c) of this Part of our Report.

Superelevation

357. For roads not subject to 30 m.p.h. speed limit we recommend that the standards set out in Section 8(c) of Memorandum No. 575 should be complied with. On roads in built-up areas, subject to a speed limit of 30 m.p.h. superelevation should be provided, if practicable, of 1 in 40 on curves of

800 ft. and over, of 1 in 30 on curves of 600 ft., and 1 in 25 on curves of 500 ft. Adverse camber should always be eliminated.

Gradients

358. We appreciate that by reason of topography it is impracticable to lay down universally applicable standards of desirable gradient in built-up areas and that what would rightly be considered excessive in the eastern counties of England would be normal in the hills and valleys of the west and north. In locating new roads due regard must, however, be given to the additional cost of vehicle operation and the strain imposed while ascending and descending unduly steep gradients. We agree that, for adequate drainage, 1 in 250 is the minimum desirable gradient.

Cross fall and camber

(a) On carriageways

359. We desire to draw attention to the detrimental effect of the excessive camber which still characterizes many roads in built-up areas. The objection to this from the standpoint of safety—and particularly the safety of pedal cyclists—is obvious, but its effect on carriageway capacity is not generally recognized. Elimination of excessive camber has enabled carriageways to accommodate an increased volume of traffic as well as more conveniently to provide for the traffic already using them.

360. It is frequently impossible to eliminate excessive camber by raising the haunches of the carriageway and footways because the level of the latter must conform to the threshold or step levels of adjacent properties, with the result that the more costly work of lowering the level of the crown of the carriageway, involving the provision of new foundations, has to be undertaken. This is one of the considerations leading us to recommend that powers should be made available to all highway authorities to control the level of the entrances to premises fronting the roads for which they are responsible.

361. The practice of grading the crown of the carriageway of minor roads into the crown of the major road produces a series of undulations in each traffic lane of the major road, particularly near the kerbs, resulting in discomfort and an element of danger, and preventing the full use of the carriage-

way. The carriageway of the minor road should be graded into the channels of the major road, the latter retaining a uniform section throughout the intersection.

(b) On draw-in for public service vehicles and on waiting lanes

362. Where the draw-in or waiting bay is of short length, we recommend that its cross fall should be outwards from the kerb toward the carriageway of which it forms an extension, the channel of the carriageway being continued across the draw-in or bay by a line of setts or other means of definition for the guidance of traffic. Where, however, the length of the bay or lane is such that a gully would be required on the line of demarcation, we suggest that the balance of advantage lies in continuing the normal crossfall of the carriageway to the kerb.

(c) On service roads

363. For ease of construction and for economical drainage, service roads are best laid with a straight cross fall, the direction of the fall being governed by site conditions.

(d) Footways

364. While it is necessary that footways should be self-cleansing, the crossfall should be the minimum required to attain this object, as excessive crossfall is prejudicial to the comfort and safety of pedestrians. A paved forecourt physically continuous with the footway should have a crossfall similar to that of the footway.

365. The surface level of the footway should be continuous across vehicular entrances to adjacent premises. On footways extensively used by perambulators or other hand-propelled vehicles, the kerb should be depressed at junctions, intersections and pedestrian crossings, the footway being ramped down in an easy slope to a kerb the upper surface of which is about 1 in. above the level of the channel.

Gullies

366. While we agree that gullies should be placed at the back of the kerb, with side entrance gratings, we recognize that in certain cases gully gratings in the channels may be necessary, either because the space under the footway adjacent to the kerb is occupied by mains or other services, or because the steepness of the gradient may render

effective drainage by recessed or weir-type gullies impossible. Nevertheless, every effort should be made to keep the surface of the carriageway clear of gully gratings, and where they cannot be dispensed with they should be flat, and set to the level of the channel.

Kerbing

367. We endorse the recommendations of Section 24 of Memorandum No. 575 in so far as they relate to built-up areas. The functions of a raised kerb, apart from the support it affords to the road structure, include, in relation to a particular road, one or more of the following :—

- (a) To protect the pedestrian—or the pedal cyclist where a cycle track is provided—from the incursion of motor or other vehicles on to their segregated tracks.
- (b) To facilitate passage of the surface water falling on the carriageway to gullies or other outlets.
- (c) To render visible to road users the boundaries of the carriageway.
- (d) To prevent the wheels of vehicles from cutting into the verges adjacent to the carriageway, thus endangering the stability of its haunches.

Where in the outer parts of built-up areas, as on outer ring roads, or parkways, these functions can effectively be discharged by other means, we are of opinion that, in the interests of amenity, raised kerbing should be omitted.

Section (g)—Road Equipment

368. The expression “road equipment” or “road furniture” if interpreted strictly, might refer only to equipment placed on the road for the proper functioning of the road or of the traffic using the road. It will be convenient, however, to regard it as including also fittings placed on the road by statutory undertakers and others for purposes not primarily related to the road or road traffic. Road equipment should be considered in relation to both efficiency for its purpose and degree of obstruction to traffic.

369. Road equipment above the surface includes :—

- (a) Traffic signs and signals, beacons, etc.
- (b) Street lighting standards.
- (c) Bollards.

- (d) Tramway overhead equipment.
- (e) Guard rails and other physical barriers.
- (f) Bus and tram passenger shelters and queue barriers.
- (g) Public conveniences.
- (h) Cabmen's shelters.
- (i) Seats.
- (j) Water troughs, wells and drinking fountains.
- (k) Storage bins for road materials.
- (l) Litter baskets and bins.
- (m) Trees and shrubs.
- (n) Telegraph and telephone poles.
- (o) Electricity transmission poles.
- (p) Electricity plant.
- (q) Telephone call boxes and police boxes.
- (r) Postal pillar boxes.
- (s) Fire alarm posts.
- (t) Statues and memorials.
- (u) Street name plates and street numbers.

Many of the items mentioned above are erected in positions on the footway where they constitute an obstruction to the free movement of pedestrians, and to the line of sight of the drivers of vehicles. Taking each of the items enumerated above we have :—

(a) *Traffic signs and signals*

370. The efficiency of a traffic sign depends on its being placed in such a position that it is easily visible to road users, and in particular to the drivers of vehicles and to cyclists. As a general rule it may be taken that the best site for this purpose is immediately behind the kerb line, with sufficient clearance (say 18 ins.) to obviate fouling by road vehicles, but in certain circumstances it may be necessary to place it on an island or central reservation.

371. Traffic control signals must also be erected close to the carriageway. The traffic signal controller, however, need not be placed on the footway, and its installation off the highway will afford better working room when repairs and adjustments are necessary. If a flexible progressive system is installed the master controller may be of considerable size, and if located on the footway would constitute a major obstruction to free flow. The whole question of traffic signs has been dealt with by a Departmental Committee appointed for that specific purpose.

(b) *Street lighting standards*

372. The Report of the Departmental Committee on Street Lighting, published in 1937, states that the maximum distance between the two rows of light sources should not exceed about 30 ft. if a dark centre to the road is to be avoided, and that the maximum overhang which can be provided without causing visibility at the kerbs to suffer unduly is about 6 ft. These considerations suggest that, for the effective lighting of the highway, lighting standards must usually be placed adjacent to the kerb, though in suitable cases consideration should be given to the alternative of siting them on any unpaved space at the back of the footway or, where there is no such space, in a recess in the boundary fence. Where the standards are to be at the kerbside care should be taken to ensure that on bends and at road junctions they do not obstruct vision, and that on narrow footways standards should not have wide bases.

(c) *Bollards*

373. As a rule bollards are erected on island refuges and it is essential that they should be easily seen by vehicle drivers. If the refuges are correctly located and the dimensions of the adjacent carriageway accord with the recommendations we have made in Section (c) of this Part of the Report, they cannot be held to impede the flow of traffic. We endorse the recommendations on the visibility and illumination of bollards made by the Departmental Committee on Traffic Signs, and recommend that bollards should be painted white and illuminated by a white light only. The positioning of bollards is further dealt with in para. 235.

(d) *Tramway overhead equipment*

374. In many towns tramways are disappearing, but evidence given to the Committee indicates that in some localities they are likely to be retained for many years. Even when tramways are abandoned the poles and wires may be used for trolley-buses ; such poles, are as a rule, erected along the kerb line, and, like lamp standards, constitute an obstruction on the footway. Endeavour should be made to secure the erection of tramway poles behind the footway, and where buildings flank the streets consideration should be given to the possibility of the wires being supported from the walls of such buildings.

(e) Guard rails and barriers

375. In Section (d) of this Part of the Report, dealing with the crossing of carriageways by pedestrians, we refer to the use of guard rails and to the relative advantages of siting them on dual carriageway roads, elsewhere than at intersections, on the central reservation, or at the kerbside. Guard rails should be placed not less than 18 ins. behind the face of the kerb so as to obviate the possibility of contact with passing vehicles, and they therefore reduce the available width of the footway to this extent. They should be so designed that pedestrians, particularly children, cannot crawl through them. The tubular railings generally in use are deficient in this respect unless supplemented by a wire mesh and, as a rule, they are also unattractive in appearance. We have given consideration to the design of railings which will be both effective and sightly and sketches of suitable types are given in Appendix 9.

376. It has been suggested that walls of brickwork or masonry might be used instead of railings. They have the advantage of affording additional scope for aesthetic treatment, and prevent splashing of pedestrians by passing vehicles. On the other hand, they tend to collect dust and dirt and would to some extent obstruct visibility, particularly of children. They would also occupy additional space and can therefore most appropriately be used on continuous central reservations or where footways are of ample width. Sketches of types of barriers are given in Appendix 9.

(f) Bus and tram passenger shelters and queue barriers

377. Passenger shelters and queue barriers are generally erected immediately behind the kerb line. With barriers this is unavoidable, although, when not combined with barriers and other circumstances permit, the shelters can be placed behind the footway. Where the shelters are in exposed situations provision should be made for the adequate protection of the passengers from wind and rain.

(g) Public conveniences

378. From the considerations of both accessibility and economy public conveniences are best placed above ground so that entrance to them can be given at surface level at the back of the footway. In no circumstances should they be placed on roundabouts or traffic islands, unless access is

obtained from a subway. As we have said in para. 341, reluctance to make use of a pedestrian subway is sometimes attributed to its use also as an approach to a public convenience, but this cannot be considered a serious deterrent.

(h) Cabmen's shelters

379. The provision of shelters is most desirable for the comfort of taxi drivers, but they should be sited so that they do not form objectionable obstructions on the footway or carriageway. Section 40 of the Public Health Acts, Amendment Act, 1890 (extended in Local Government Act, 1929, Sections 30 and 31), authorizes the local authority to provide, maintain or remove cabmen's shelters "in or near any street in their district," and authorities should have regard to the term "near any street" in making such provision as may be necessary.

(i) Seats

380. In many cases, local authorities have provided wayside seats for the use of the public, and in others they have been the gift of local residents. We feel that more attention should be given to their provision. They should not be placed on footways but on verges, on open spaces, or in recesses along the boundary line. The surrounding area should always be paved to prevent its becoming muddy in inclement weather.

(j) Water troughs

381. Horse troughs have largely fallen into disuse. Sometimes they are badly maintained and cases have been reported in which they have become fouled to such an extent that horse owners have issued instructions to their drivers not to water horses from them. Except where their retention is justified by use, they should be removed.

382. There are also drinking water fountains in public highways, some of which are not maintained as they should be. Where possible, they should be removed to any suitable open space which may be available.

(k) Storage bins for road materials

383. Bins for the storage of sand and grit should not be placed, as they so often are, on the footway at the edge of the carriageway (unless fixed on a verge or placed underground), for despite the advantage this position offers in obviating double handling, the capacity of the footway is thus

materially reduced and the safety of pedestrians endangered. They should preferably be sited in a side road in a well-lighted spot.

(l) Litter baskets and bins

384. Receptacles for litter have been most effective in helping to keep the streets clear of odds and ends dropped by the public, but they should be less unsightly and untidy than they usually are. They should be protected from rain, should not expose their contents, and should be made readily detachable for the purpose of being easily emptied. They should be attached to lamp standards or other such equipment so as not to constitute further obstructions to the use of the footways. Advertising on them should be prohibited.

(m) Trees and shrubs

385. The provision, siting and maintenance of trees and shrubs is dealt with in Part IX—Amenity.

(n) Telegraph and telephone poles

386. Under the Telegraph Acts the Postmaster-General has power to erect telephone or telegraph poles in the highway, but it is understood that it is the policy of his Department to look with disfavour on the erection of poles in built-up areas. It is to be hoped that underground distribution will be rapidly extended, especially in built-up areas, so as to reduce obstruction of footways and the possibility of accidents.

(o) Electricity transmission poles

387. We are strongly of opinion that in built-up areas the proper place for electricity cables of all descriptions is underground. If, however, they are overhead the poles should be erected outside the boundary of the highway.

(p) Electricity plant

388. Feeder pillars, junction boxes and transformer kiosks or chambers are necessary for the purpose of housing electric equipment, but in many cases form major obstructions to the use of the highway. Feeder pillars, junction boxes and the like should be sited in recesses off the highway or built into boundary walls. In built-up areas this may not always be practicable, in which case chambers should be constructed below ground level and access to them obtained in such a manner as will not interfere with pedestrian traffic. Transformers, whether in the form of sub-stations, kiosks or chambers, should be erected on land outside

the limits of the highway. Provision for housing electrical plant of this character is essential to the conduct of the undertaking, and we are of opinion that facilities should be made available to enable electricity undertakings to acquire suitable sites so that effect can be given to the above-mentioned recommendations.

(q) Telephone call boxes and police boxes

389. We realize that the authorities do their best to obviate obstruction in the erection of telephone and police boxes. We feel, however, that structures of this description should be placed behind the footway as some are, or, at any rate, in such a position as not to obstruct the use of the highway or the view of the road users. Police boxes and pillars need not be sited on the footway provided that the signal lights are in a conspicuous position.

(r) Postal pillar boxes

390. Post Office pillar boxes constitute an obstruction on many footways and we are of opinion that where a verge or other open space is not available for their accommodation, they should take the form of letter boxes built into boundary walls.

(s) Fire alarm posts

391. There is no uniformity of practice in the placing of fire alarms. In some towns alarm posts are erected on the footway while others use the "box" type fitted on the boundary walls. This latter type projects about 4 ins. and does not constitute a serious obstruction to the footway, while being reasonably conspicuous. We suggest that a uniform practice should be adopted which will obviate the erection of fire alarms on posts on the footway.

(t) Statues and memorials

392. In central areas the placing of statuary and memorials is important from the point of view of safety, of amenity, and civic design, and this aspect of the matter should not be forgotten when considering their future location.

(u) Street name plates and street numbers

393. The Ministry of War Transport Departmental Committee on Traffic Signs has recently made recommendations on the design and positioning of street name plates and street numbers. We endorse these recommendations and desire to stress

the importance of maintaining uniformity of practice in this connection in the interest of the safety and convenience of all road users.

Provision of verges

394. The provision of a grass (or other) verge upon which trees, lamp-posts, etc., can be placed enables footways to be kept clear of such obstructions. There are, however, comparatively few streets in towns where grass and other verges exist and in these some other solution must be sought.

Obstructions on footways

395. In view of the repeatedly stressed opinion that footways generally are of inadequate width, a primary step would be to remove from them as much street equipment as can be located elsewhere. There may be no alternative to kerb-line siting for such equipment as street lamps, traffic control signals, road signs and so on, but a very large number of permanent obstructions have been placed on the highway—probably by reason of the

ease with which facilities for so doing have been available—and every endeavour should be made to secure their removal where they obstruct the view of road users, or interfere with the comfort of pedestrians.

General

396. In the foregoing paragraphs we confine the term “footway” to that part of the highway which is normally used by pedestrians. We are of opinion that consideration should be given to the acquisition of suitable sites at intervals with a view to enabling local authorities to arrange with the various undertakers to erect their apparatus at these points. Police boxes, telephone boxes, pillar boxes, fire alarms, grit bins, stamp machines, etc., could be so accommodated, and in certain circumstances waiting space for tram and bus passengers and sites for public conveniences could be included. A sketch is given in Appendix 10 showing how such facilities could be accommodated in specially designed units.

PART VIII

The Stationary Vehicle

Section (a)—Vehicles on the Public Highway

397. No road system in a built-up area will effectively serve public requirements unless adequate provision is made to accommodate vehicles which remain stationary for shorter or longer periods. Such provision will vary with the different circumstances in which it is necessary for vehicles to stand, and, apart from involuntary stops due to obstruction or breakdown, they may be classified as follows :—

- (a) Picking-up and setting-down passengers from
 - (i) public service, or
 - (ii) other passenger vehicles.
- (b) Waiting while calls of short duration are being made by the occupants of passenger vehicles, or goods are loaded or unloaded at nearby premises.
- (c) Parking when passenger or goods vehicles are left by their drivers for longer periods elsewhere than in a garage.

398. Whether a vehicle is to be considered as picking-up or setting-down, waiting or parked, depends in the main on the length of time for which it is stationary. It is impossible to lay down universally applicable limits of time to differentiate between the three different sets of circumstances, but we have considered separately their requirements in the design and layout of the urban road system.

Picking-up and setting-down

399. Although the primary purpose of the public highway is to afford passage, it will be accepted that persons desiring to alight from or board a passenger vehicle should be permitted to do so while the vehicle is momentarily halted on the carriageway. Except for public service vehicles, no special provision is required in the layout of a street to accommodate vehicles picking-up or setting-down. Buses and tramcars differ from



PLATE 38. / STRAIGHT STREET WITH TERMINAL FEATURE—EDINBURGH.



PLATE 39. CURVED STREET, HIGH STREET, OXFORD.



PLATE 40. DUAL CARRIAGEWAY LAYOUT ON SIDELONG GROUND—BIRMINGHAM.



PLATE 41. LAYOUT ADAPTED TO PRESERVE TREES—BIRMINGHAM.



PLATE 42. CENTRAL RESERVATION PLANTED WITH SHRUBS—LEEDS.



PLATE 43. CARRIAGEWAY ON HOUSING ESTATE ROAD DIVIDED TO PRESERVE WELL ESTABLISHED TREES—BIRMINGHAM.



PLATE 44. FOOTWAY WIDTH VARIED TO PRESERVE TREES AND SHRUBBERY—BIRMINGHAM.

other passenger vehicles in that they stop on the highway only at specified points. Where at such places there is a large number of buses requiring to pick-up and set-down at the kerbside it will be necessary to make special provision in the layout of the street to ensure that moving vehicles are not impeded, and that persons waiting to board the buses do not obstruct pedestrians, but are marshalled conveniently and in safety, and are protected from the weather.

400. A tramcar has not the same freedom of movement as an omnibus and, while halting to pick-up and set-down, remains on its track, which is usually in the middle of the carriageway. Facilities are required, e.g., in the form of a refuge, on which persons leaving or entering the tramcar may pause in safety before they cross the carriageway or while they are waiting to mount. The sites of the refuges must be carefully chosen to avoid such narrowing of the carriageway as would create dangerous conditions. (See also para. 238.) At the more frequented tram stopping places, provision for marshalling passengers and for their protection from the weather will also be necessary, as for buses. We refer in detail in Part IV Section (a) of this Report to the accommodation required at stopping places of public service vehicles.

Waiting

401. We consider it would be unreasonable to require that a vehicle should in no circumstances be permitted to remain stationary on the carriageway for a period longer than is necessary for picking-up and setting-down passengers. A restriction of this kind would be unnecessary if applied to relatively lightly trafficked roads—which constitute the greater part of the road system of most built-up areas—as on such roads a vehicle left stationary at the kerbside, other than in the immediate proximity of a road intersection, would be neither obstructive to traffic nor prejudicial to safety.

402. We have carefully considered whether the waiting of vehicles on the carriageways of principal traffic routes should be prohibited. Whilst the presence of standing vehicles constitutes a temporary obstruction to moving vehicular traffic and on occasion may be a potential source of danger to pedestrians requiring to cross the carriageway, we are of opinion that a universal prohibition of waiting in built-up areas would be inconsistent with that

measure of facility of access to fronting premises which both the public and the occupiers of these premises have a right to expect. The circumstances of each case should be carefully considered and, where essential in the interest of traffic and safety, highway authorities should make use of the powers available for prohibition of waiting.

403. We have recommended that shops and other premises attracting large numbers of waiting vehicles and pedestrians should be located in areas not traversed by the main stream of through and local-through traffic, but we recognize that a long period must elapse before old established shopping centres on radial roads and roads of similar traffic characteristics can be converted, or transferred to traffic-quiet areas. It is in centres where traffic having business at adjacent premises is intermixed with through and local-through traffic, that the problem of the waiting vehicle is most acute. Where the carriageway is already inadequate, and the whole of the available space is required for the free flow of moving vehicles, the measure of facility for access to fronting premises to which we have referred above cannot be afforded and prohibition of waiting may be the only course to adopt.

Provision of waiting lanes

404. Where, however, shopping and similar centres are, as we are of opinion they should be, situated in traffic-quiet areas, such as those within the inner ring road or other precincts, we recommend that the layout of the streets in these areas should make specific provision for waiting vehicles by the reservation of a width of 8 ft. of the carriageway adjacent to each kerb, or of 9 ft. if it is intended that public service vehicles shall use the lane as a stopping place. The strip should be clearly differentiated from the remainder of the carriageway by variation in colour or texture, or divided from it by a well defined line.

Limitation of waiting time

405. It is obvious that if waiting for an unlimited period were permitted in a busy shopping street, the carriageway would be so fully occupied that vehicles could not draw up at the kerbside and that few only of the persons desiring to leave their vehicles stationary while they made purchases in the shops, or delivered goods, would be able to do so. We recognize therefore that a limit must be set to the time a vehicle is allowed to wait on the carriage-

way while its occupants do business in adjacent premises, or while goods are collected or delivered. The length of this period has to be determined in the light of local conditions and in relation to the volume of moving and waiting traffic and the carriageway space available in the particular street. We visualize that generally it will not be less than ten and not more than twenty minutes, and we regard it as reasonable that vehicles which are required to remain stationary for a longer period should be left in car parks.

406. We recognize that a restriction on the period of waiting will be of no avail unless it can be enforced, and that enforcement will impose an arduous duty on the police; but we regard prohibition of waiting in traffic-quiet areas as an unreasonable restraint on public convenience, and, on the other hand, unlimited waiting as an unjustifiable use of road space. We see no alternative therefore to the imposition and enforcement of a limit to the waiting period.

Unilateral waiting

407. Unilateral waiting may have to be resorted to where shopping and other streets on which waiting is permitted are too narrow to accommodate two lines of standing vehicles in addition to the necessary provision for moving vehicles. As in the case of one-way working we regard unilateral waiting as a temporary measure pending the provision of adequate road space.

Loading and unloading of goods

408. The loading and unloading of goods from vehicles stationary on the carriageway may cause obstruction, not only to vehicular traffic, but also to foot passengers, and where pedestrian traffic is heavy it would be reasonable to limit the hours during which these operations are permitted. We are of opinion that the owners of premises which front busy streets, or at which goods have frequently to be loaded or unloaded, should be required to provide facilities for this purpose on their own premises, preferably with access from the side or rear.

Parking

409. The increasing number of motor vehicles and the limits to be set to the period during which vehicles may wait at the kerbside in built-up areas will accentuate the need, already apparent, for

adequate and conveniently located parking places where motorists may leave their vehicles for a longer period than that which comes within our definition of "waiting."

410. No generally applicable formula can be devised to determine the number of cars for which, in any particular town, car parking facilities should be provided. Neither population nor number of cars owned by the residents afford a reliable criterion, since the parking space required is to a large degree dependent on the number of persons coming into a town from districts outside. It is therefore necessary for a count to be made of the cars left (for other than short periods of waiting) on the streets, and in public and private car parks, at a time when the number is at its maximum, otherwise an allowance will have to be made for peak periods in addition to that for estimated growth of demand. The count should be made in conjunction with a survey of the facilities already available, or proposed to be made available, in existing public car parks, commercial car parks and garages, or on the street, if there are suitably located streets where cars can be parked without creating nuisance or causing unreasonable obstruction.

Parking on the highway

411. In many towns public highways have been appropriated for the parking of cars to supplement the accommodation available in public or private car parks, or in commercial garages. This practice has been legalized in England and Wales (outside the London Traffic Area) by the Public Health Act 1925 (Sec. 68) and in Scotland by the Road Traffic Act 1930 (Sec. 120). These Acts recognize that the leaving of vehicles unattended in a street may be to the detriment of the residents or other persons using the street: they provide that the allocation of road space for the purpose of parking must be carried out in accordance with a prescribed procedure (which includes a right of appeal by persons aggrieved) and that the parking must not unreasonably obstruct the use of the street or the access to adjoining premises, or cause a nuisance. Special provisions are in force in the London Traffic Area.

412. There may be public squares, side streets and culs de sac of such width and character that cars may be parked in them without causing nuisance or unreasonable obstruction, and there may be no immediate alternative to the facilities

they afford. Nevertheless we regard the use of the surface of the public highway for this purpose as an expedient to be adopted only as a temporary measure, pending the provision of adequate accommodation off the highway for parked vehicles.

Parking for Shoppers

413. The convenience of the shopping public is only one (though perhaps the principal) of the reasons leading to the waiting of vehicles at the kerbside. An investigation has recently been carried out by the Retailers Advisory Committee on Town Planning, following an interview we had with their representatives, to ascertain whether it is possible to lay down any broadly applicable standards of accommodation required for the purpose of car parking. The investigators examined conditions in ten provincial towns and found that the capacity of the parking facilities, either in car parks or on streets, available to shoppers was related to the frontage of main shopping streets in the average of nine car parking spaces to each 100 ft. of frontage; there was, however, wide variation between towns, and the investigators came to the conclusion that for the adequate accommodation of the parked cars of the shopping public it might be desirable to provide as many as 20 parking spaces for each 100 ft. of main shopping frontage. These figures must, however, be used with some reserve, for much will depend upon the class of shops concerned.

Buses and coaches

414. Buses and coaches which require to stand for periods longer than is necessary for the picking-up and discharging of passengers should do so within the curtilage of a bus station or other premises, and in no case should the public highway be used for this purpose.

Taxicabs

415. Taxicabs should be discouraged from cruising because of the unnecessary obstruction to traffic which this practice entails, and there is no reasonable alternative to the provision of hackney carriage stands on the public highway for their accommodation when awaiting hire. As far as possible they should be located in backwaters off the main thoroughfares.

Section (b)—Car Parks

416. In speaking of car parks we have chiefly in mind those provided by a local authority,

whether above or below ground, for the accommodation of cars whose owners desire to leave them in safe custody for varying periods of the day, generally on payment of a small fee. We appreciate that there is a large number of privately-owned garages fulfilling a very useful purpose in temporarily housing cars; but, as a rule, they have other functions, such as the carrying out of repairs, sale of petrol, and so on. Their existence (as of parking places on the public highway) should be taken into account in assessing the number, location and capacity of public car parks, to which this Section mainly refers.

Powers covering the provision of car parks

417. Powers given to local authorities under the Public Health Act, 1925, and the Restriction of Ribbon Development Act, 1935, for the provision of parking places, permit the provision and maintenance of buildings for underground car parks, and of cloakrooms and other conveniences. They also permit the provision of approaches to and from car parks and the adaptation of existing streets for the purpose, as also the letting for use, as a parking place, of any parking place which is not part of a street.

Disposition of car parks

418. The adequacy of car parking facilities clearly depends not only on the number of parking places available but also on their disposition. The public may reasonably expect that, if limitations are to be imposed on the periods during which cars may be left stationary at the kerbside, accommodation will be available in car parks within a short distance of shopping or other centres. As a general rule it will be preferable to provide a greater number of small car parks dispersed about these centres rather than a few large ones, despite increased difficulties in administration. In this connection we desire to draw attention to the useful field of employment as car park attendants thus offered to disabled ex-service men.

419. In towns on or near routes extensively used by long-distance goods vehicles which may remain for lengthy periods and perhaps overnight, the requirements of this type of traffic should be kept in mind in the location of car parks. If possible they should be approached otherwise than through residential or shopping streets, and they should preferably be within easy reach of, or combined with establishments where the drivers can obtain food and sleeping accommodation.

Types of car park

420. Up to the present the general practice has been to provide car parks at ground level on such open land as may be available for the purpose. Leaving cost out of the question, this is generally the easiest and most economical course to adopt, but, except as a temporary measure it may well be considered that land in or near the centre of a city should be put to better use. We think it desirable that full consideration should be given to the construction of car parks in buildings and beneath open squares, gardens and the like rather than at surface level. We refer to possibilities in this direction in a later paragraph.

Design of car parks

421. The shape of the site has an obvious bearing on the layout of a car park. The number of cars which can be parked within a given length increases the more nearly the angle of parking of the vehicle approaches a right angle, although a greater width of manoeuvring space in the aisles is then required. In practice the angle of parking has little effect on the gross area required per car. It is found that in general the aisles take up rather more than one-third of the space available for parking, and, together with approach roads, account for approximately 45 per cent. of the site. Some saving can be made if small cars are segregated, but it will be found that with the open access system a gross area approaching 200 sq. ft. should be allowed for each car, if due allowance is made for access roads, irregularities in manoeuvring, and opening of doors.

422. In estimating the total accommodation afforded by a car park regard must be had to the number of times a bay will be used each day. The figures vary according to the accommodation afforded in relation to the demand and the periods for which cars are parked. In Birmingham there is an exceptionally large car park in the centre of the city, with a capacity of 750 vehicles. The average number of cars parked per day is 1,550, which gives a use-ratio of 2.07. In other towns the user is less frequent, but it is clearly a matter in which local conditions are the determining factor.

423. Car parks often present an appearance of confusion and desolation and much could be done to improve their appearance by the judicious planting of trees, hedges or shrubs.

Car parks above and below ground

424. We have said that more might be done in the way of providing public car parks otherwise than at ground level. Public parks and other open spaces may lend themselves to the purpose of underground car parks, provided that constructional difficulties are not too serious. Advantage might be taken of incorporating a car park in such a structure as a promenade (which has been successfully done at Hastings) or other public works or buildings, and there is no valid objection to the basements of buildings being used as car parks, provided due precautions are taken against fire and explosion. Where possible, access to car parks should be from lightly trafficked streets, and the immediate approaches should be laid out with such easy curves and gradients as will facilitate entrance and exit.

Mechanical car parks

425. Mechanical methods have been adopted to some extent in connection with the parking of vehicles in closely-built-up areas, and it is claimed that by these means it is possible to use up to 90 per cent. of the floor space for the storage of vehicles, as compared with about 55 per cent. in open access car parks. Lifts, turntables and rotary floors are used, sometimes in conjunction with multi-storey buildings, but these methods are expensive and depend upon a high use-ratio if they are to be financially successful. Up to the present parking places of this character are practically all the result of private enterprise.

Provision for parking in buildings

426. Something has been done in the way of relieving congestion of the streets by the operation of Section 17 of the Restriction of Ribbon Development Act, 1935, which empowers a local authority in certain circumstances (after consultation with the highway authority and the police) to require that, in the case of new buildings of various classes (including those containing a space of not less than 250,000 cubic feet, places of public resort, refreshment houses, stations for public service vehicles, petrol filling stations or garages used in connection with any trade or business), provision shall be made for the loading and unloading of vehicles, picking-up and setting-down passengers, and the fuelling of vehicles in such manner as will limit interference with traffic on adjacent roads.

427. We consider it reasonable that persons responsible for the erection of new buildings of such character as attract large numbers of vehicles which are likely to remain stationary for a considerable period should provide the necessary accommodation for them off the highway and we recommend the matter should be examined by the appropriate Government departments with a view to local authorities being given such powers as will enable them to take effective action in this direction. There are many cinemas at which parking accommodation is now made available and we understand that certain large departmental stores provide similar facilities for their customers' cars. We should like to see the practice extended, and suggest that the owners of smaller premises might combine for a similar purpose.

The importance of provision of car parks

428. We have alluded briefly to various methods in vogue for the temporary storage of cars in public car parks whether at, above, or below ground level. We regard the whole question as one of first importance by reason of the ever-increasing difficulty of finding suitable sites in large towns to meet probable post war requirements. In many places the use of "blitzed" sites has helped to meet immediate needs, and small towns may be able to meet their requirements by providing open car parks; but in the larger towns the difficulty is likely to become more acute as time goes on, and we do not look to open car parks as being the final solution. The provision of car parks, whether on the surface, above or below ground, will help to relieve congestion in adjacent streets, and there may well be circumstances in which the cost of their provision and maintenance may be offset to some extent by a saving in street widening.

Investigation recommended

429. We strongly recommend that the Minister of War Transport should cause mechanical and other methods of parking, and all questions concerning the layout of car parks, to be investigated in order that he may be in a position to give appropriate advice on the subject to local authorities.

Parking of pedal cycles

430. Insufficient attention has been given in this country to the provision of parking places for pedal cycles while their riders go about their business. Cycles left stationary, often precariously, at the kerbside or against a wall or fence, are obstructive to vehicular and pedestrian traffic and may be a source of danger. For this reason, as also to minimize risk of theft or damage, consideration should be given to the allocation of sites equipped with stands or racks, preferably protected from the weather. Such sites may be found on the private forecourts of shops, or in squares or public gardens, and part of a car park could suitably be utilized for this purpose. Accommodation for stationary pedal cycles has been extensively made in certain continental countries, notably in Switzerland and Holland. There are in the City of Oxford five cycle parks which take 520 machines in all, some of which are fitted with metal racks, and others with concrete blocks having a slot for the cycle wheel. To overcome the danger of cycles being stolen from parks not controlled by an attendant, a locking device may be embodied in the design of the racks on the same lines as those which are widely used in Germany; particulars of this device are given in Appendix 4.

PART IX

Amenity

431. The term "amenity" is frequently mis-used. As applied to the layout of roads it has too often been confined to the planting of trees and shrubs (not always of a suitable kind or in suitable positions) and the provision of strips or plots of grass, the ineffective maintenance of which has tended to detract from, rather than add to, the pleasantness of the surroundings. The layout of streets in built-up areas must of necessity be governed to a considerable extent by utilitarian considerations, but from the point of view of amenity their treatment, including alignment and dimensions, should be considered in relation to the buildings which will abut upon them, and the general requirements of the town plan. The best results can only be obtained by whole-hearted co-operation from the earliest stage between the Planner, the Engineer and the Architect.

432. From the point of view of road planning "amenity" can be taken to include:—

- (a) Alignment and setting in relation to buildings.
- (b) Proportion and balance.
- (c) General landscaping including preservation and planting of trees and shrubs, and suitable areas of turf.
- (d) Use of suitable materials.
- (e) Design of road equipment.
- (f) Control of advertisements.

Alignment

433. A straight alignment is often pleasing of itself as expressing directness of purpose, and lends itself to the closing of the vista by a well-designed terminal building. If unduly long, however, it becomes monotonous and should generally be avoided where the road leads over the crest of a hill, unless, to prevent the feeling of driving into space, the view can be intercepted by a suitable feature on the sky line. A road on a gentle curve which fits the contour of the ground has its own attractions and presents the road user, as he passes along, with a continuously changing prospect of the buildings that border it.

434. Where there are buildings of architectural or historic interest the road system should be so arranged as to open them up to view, and opportunity should be afforded for glimpses of the natural features of the surrounding country.

435. Road planning is three dimensional, and layouts which look well on paper may present anything but a pleasing aspect when applied to the varying levels of the ground. The man in the street gets a foreshortened view not always evident to the designer, and particular care is necessary in the association of changes in horizontal alignment with changes in vertical alignment. Symmetry of plan, or mere pattern making, is, of itself, no advantage unless its purpose is apparent on the ground. It will add nothing to the pleasure or convenience of a road user to know that the layout of the town within his immediate view has its exact counterpart half a mile or more away.

Proportion and balance

436. In built-up areas the various paved units which go to make up the traffic facilities of a street have, within narrow limits, to be parallel with one another, but a pleasing effect may sometimes be obtained by variation in the multiplicity of parallel lines. The location of the footway between the edge of the carriageway and the boundary fence can often be varied with advantage, both vertically and horizontally, provided deviations are not of such extent or character as to induce pedestrians to take undesirable short cuts. A variation of the width of verge will sometimes lend itself to satisfactory treatment by turfing, or 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.

437. The dimensions of carriageways, footways and cycle tracks, depend primarily on the volume of traffic to be carried, but their proportions and disposition should be such that the street as a whole in relation to the frontage development presents an harmonious appearance. By reason of their location or development, streets may require a wide footway on one side only, or it may be possible to save a line of trees, or other pleasing feature, by a slight variation of layout on each side of the central axis. Such an arrangement is specially suitable on sidelong ground where the need of securing a good foundation for the carriageway may result in the provision of a wide bank which can be suitably

planted. Where the level of the ground lends itself to this course the carriageways, footways and cycle tracks may, with benefit to economy and safety as well as to amenity, be at different levels.

Trees and Shrubs

438. There is little need to draw attention to the desirability of preserving suitable trees and shrubs already in existence. In new planting undue formality should be avoided unless (e.g., in the case of a civic centre), strictly formal treatment is called for. Where margins are narrow the only possible form of tree planting is the avenue, though its uniformity can sometimes be modified by taking advantage of such irregularities in the fence line as will make it possible to plant in groups. A spacious appearance can be given to a road by planting the trees and shrubs between the footway and the boundary, and a pleasing effect can be obtained by the growth of hedges as boundary fences and by the planting of trees behind the fence. As a rule this should be possible on approach roads leading to a town, and invariably so on housing estates in the ownership of local authorities. The trees should be of a species which will not grow to such size as to overshadow the adjoining houses.

439. Trees and shrubs should never be planted where they interfere with the vision of road users to such an extent as to be inimical to safety. Care should also be taken to set them back a sufficient distance from the edge of the carriageway to avoid the likelihood of contact with passing vehicles, or the subsequent distortion of the trees by excessive pruning in order to prevent this happening. The possibility of further widening should also be borne in mind, and where this is likely the trees should be so sited as to avoid destruction.

440. The whole subject of tree planting on roads is dealt with in an excellent publication of the Roads Beautifying Association entitled "Roadside Planting." The Association are always willing to give helpful advice on the selection of species of trees and shrubs suitable for various locations and purposes, and we recommend that they should be freely consulted by highway authorities.

Use of suitable materials

441. As far as practicable materials used in road construction should harmonize with their surroundings, and the best use should be made of those which are produced locally. Some variation in

colour or texture, however slight, is often worth while, whilst verges (especially if narrow) can be tar surfaced and blinded with suitable chippings, crushed brick or other material the colour of which is not in disharmony with the surroundings. The practice of varying the aggregate and surface finish used in concrete footways, whether in-situ or pre-fabricated, having regard to the character of the locality has much to commend it; but it is a matter which requires careful handling and should not be introduced merely for the sake of variety.

442. Subject to the wearing qualities being equal, there is great advantage in using light coloured rather than dark aggregates for road surfaces: they show up obstructions on the highway more readily and are advantageous from the point of view of road safety by aiding visibility at night. As far as practicable repairs should be carried out with materials to match those originally used in order to avoid ugly scars on the road surface, and it is desirable to maintain a road surface which is uniform in material and colour throughout as long a length as possible.

Boundary fences

443. The war-time removal of iron fencing from squares, open spaces, and even gardens of private residences, has in many areas resulted in the enhancement of amenities. A dwarf wall with a hedge planted behind it—a form of fencing which town planners have long advocated—has been found in practice to meet essential requirements, with advantage to the appearance of residential areas.

Design of road equipment

444. Prior to the war the Royal Fine Art Commission for England and Wales was in consultation with the Ministry of Transport and a number of manufacturers regarding the design of reinforced concrete lighting columns. Some designs were approved by the Commission, but the outbreak of war put a temporary stop to these activities. We strongly recommend that collaboration should be resumed between the Ministry of War Transport and the Royal Fine Art Commission, and extended to cover the design of other items of road equipment, not on the score of uniformity or with a view to standardization (though both have their advantages), but to ensure that the amenities of the surroundings are interfered with as little as possible whatever is erected on the public highway. In

referring to the Royal Fine Art Commission we include both that of England and Wales and of Scotland.

Roadside advertisements and signs

445. We recognize that the advertising of goods and events by means of posters and other outdoor displays is of service to the public and appreciate that effective advertising is essential to commercial interests. But the fact remains, that roadside advertising has, in many areas both urban and rural, been one of the chief causes of disfigurement, and not an unimportant factor contributing to road accidents.

446. The conditions obtaining during the war have automatically restricted roadside advertising to a substantial extent and there is now an opportunity for enforcing adequate control which, if it is missed, may not recur for many years. We therefore urge that the Government should immediately make available to all local authorities adequate and readily applicable powers to regulate the number, siting and form of all kinds of outdoor advertising displays likely to be prejudicial to the safety and amenity of a public highway, including signs indicating the nature of the business carried on at the premises to which they are attached, whether or not the signs project over the public highway.

447. While a general prohibition of roadside advertising in built-up areas could not be justified,

the appropriate authorities should be enabled to, and should, effect the removal of existing, and prohibit new outdoor advertising displays in the vicinity of roads of the parkway or boulevard type and exercise strict control over displays adjacent to any road.

448. It is unnecessary for us to examine in detail the powers at present available in the Advertisement Regulations Acts, the Town Planning Acts, or other general or local acts, but we wish to refer to the exclusion from control under the Advertisement Regulation Act 1925 of property belonging to railway companies and other statutory undertakers. The exemption thus given has in our view militated against the objects of the relevant legislation and tended to discourage local authorities from exercising their powers of control over other advertisements. We urge that this exemption should no longer be continued.

449. We wish to emphasize the danger arising from the distracting effect on drivers of vehicles of roadside advertisements and signs and particularly of those which embody flashing, illuminated or reflecting devices; also from advertisements or signs which interfere with the visibility or effectiveness of traffic signs or signals or have the guise of traffic signs. We urge that full attention be given to this aspect of road safety when a decision is reached on the new powers of control which, in our view, should not be adoptive, but of universal application.

PART X

Legislation

450. In our opinion the legislative powers at present available need, in certain respects, to be supplemented in order that the road system in built-up areas may be brought into conformity with the standards of safety and free flow recommended in our Report. The general character of these supplementary powers may be summarized as follows :—

Dual Carriageway Roads

To provide that carriageways separated by a central reservation or a succession of islands shall be uni-directional.

Guard Rails and Barriers

To facilitate the erection of guard rails or barriers on the footway or on the central reservation of dual carriageways.

Accommodation on Premises for Stationary Vehicles

To enable the provision of accommodation for waiting and parked vehicles to be made a condition of consent to the erection of premises irrespective of their cubic contents, which are likely to attract large numbers of vehicles. (Paras. 426-427.)

Roadside Advertisements and Signs

To enable effective control to be exercised over all outdoor advertising likely to be prejudicial to road safety and amenity. (Paras. 445 to 449.)

Stopping-up Streets

To provide wider and more expeditious powers for the stopping-up of redundant road junctions, and for the construction of incidental works. (Para. 216.)

Single-purpose Roads

To enable highways to be constructed for and

limited to the use of a particular class of traffic. (Paras. 203 to 209.)

Standard Widths

To apply the powers now available under Section 1 of the Restriction of Ribbon Development Act, 1935, to the area of land required for the purpose of the road, irrespective of arbitrary dimensions.

Waiting Space for Public Service Vehicles

To ensure that space provided on the highway for picking-up and setting-down by public service vehicles may be reserved for this purpose. (Para. 72.)

It is a pleasant duty to record our appreciation of the work of our Secretary, Mr. Thos. S. Sinclair. He has discharged his task with whole-hearted enthusiasm, his knowledge of the subject has been exceedingly helpful to everybody concerned and his tact is unflinching. We desire to associate Mr. T. P. Murray, M.Sc., Assoc.M.Inst.C.E., who for some time has acted as Assistant to Mr. Sinclair, with this expression of thanks.

F. C. COOK (*Chairman*)
 H. E. ALDINGTON
 S. L. G. BEAUFAY
 W. S. CAMERON
 W. R. DAVIDGE
 C. V. GODFREY

REGINALD A. KIDD
 W. A. MACARTNEY
 A. J. MCINTOSH
 HERBERT J. MANZONI
 R. H. MATTHEW
 T. G. NEWCOMEN.

THOS. S. SINCLAIR (*Secretary*).

January, 1945.

APPENDIX 1

Notes on Special Traffic Survey carried out on London-Birmingham Trunk Road

General

The survey was carried out to ascertain what through traffic used the road, the points at which other traffic joined or left the road, and the need of by-passing certain built-up areas along its length. There were 7 points selected as survey stations, as follows :—

- (1) Bedfordshire, south of Dunstable.
- (2) Northamptonshire, south of Towcester.
- (3) Northamptonshire, south of Daventry.
- (4) Warwickshire, south of Coventry.
- (5) Warwickshire, near Packington Park on east side of junction with A.452.
- (6) Warwickshire, Birmingham City boundary near Elmdon.
- (7) Warwickshire, south of junction of A.452 with A.446.

The survey began at 6 a.m. on 13th October, 1938, and was completed, at point No. 1, at 6 a.m. on 14th October, while the completion time for the other stations was extended progressively northwards up to 12 noon on the latter date at point 7. This time lag was necessary to cover the vehicles passing through the most southerly census point at or about 6 a.m. on the 14th instant and give them ample time to pass through the whole section.

Of the 45,831 entries recorded, 41,506 related to vehicles which began their journey on the road during the 24 hours from 6 a.m. on the 13th to 6 a.m. on the following day, and were analysed as follows :—

Northward bound

Recorded at Point 1	...	3,342	
" " Points 2 to 7 inclusive...	19,965		
Less entries in respect of vehicles which were first observed after 6 a.m. on 14th October	...	2,663	17,302
			<hr/>
Total	...		20,644

Southward bound

Recorded at Points 6 and 7...	...	5,788	
" " Points 1 to 5 inclusive	16,736		
Less entries in respect of vehicles which were first observed after 6 a.m. on 14th October	...	1,662	15,074
			<hr/>
Total	...		20,862
			<hr/>
Grand Total	...		41,506

Details of operation

The records of the count were taken on green forms for northbound traffic and yellow forms for southbound traffic. The form heading was as follows :—

- (a) Census Point No.
- (b) Direction of Traffic.
- (c) Date.
- (d) Time : from to
- (e) Sheet No.

while the remainder of the sheet was divided into columns with room for records of the following vehicles :—

- A. Passenger vehicles sub-divided :—motor-cycles (1 column), motor-cars (2 columns), motor-omnibuses and coaches (1 column), and
- B. Goods vehicles sub-divided :—light vehicles (1 column), heavy vehicles (2 columns), heavy vehicles with trailer (1 column).

Each enumerator recorded the registration numbers of vehicles passing in the specified direction and a new sheet was taken each hour. If more than one sheet was required in any hour the sheets for that hour were numbered 1, 2, 3 and so on.

The general arrangement was to have two teams of men, each comprising an enumerator and a man to call out the registration numbers, with a third to slow down traffic, making six men in all at each point per eight-hour shift, one team recording the traffic northbound and the other southbound.

At the census points a barrier 50 yards in length was placed centrally in the carriageway so that vehicles approached the enumerators in single file.

Observations

It was found advantageous to have a constable on duty at the census points as his signals to drivers to slow down were better observed than those given by the enumerators.

Many drivers stopped to enquire what was taking place and some seemed apprehensive as to why their registration numbers were being taken. It would be of advantage to have a notice-board, "Traffic Census Ahead," sited some distance from the enumerators, with another closer to the control point indicating "Census Point—Drive Slowly" in reflecting letters.

The compass direction of directional counts should be shown on the forms—not left to the enumerators, who frequently use descriptions which are found to be confusing when the forms are analysed.

Considerable difficulty was experienced by those compiling the statistics owing to faulty recording of registration numbers, e.g., "S", "X" and "F" were frequently misinterpreted, as were the letters "E", "D", "C", "B" and "G," owing no doubt to faulty enunciation on the part of the "readers," while the last digit of the numerals was often omitted. Some of this faulty recording may, however, have been due to number plates being dirty and to the fact that they are difficult to read at night time.

This type of survey demands the employment of intelligent enumerators who should be carefully trained in their duties, and extreme care is necessary in classifying the vehicles. It was frequently found that vehicles at a point classed as "Heavy" were at the next point classed as "Light."

APPENDIX 2

Notes on Special Traffic Survey carried out at Lewes in East Sussex

General

The survey was taken to ascertain the justification for a by-pass to Lewes, to show whether two were needed, and, if so, which should have priority. It extended over seven days from August 15th to 21st, 1938, and covered 16 hours each day, *i.e.*, from 6 a.m. till 10 p.m. The weather was mainly fine.

The point selected for the census was on Route A.26, Lewes—Brighton Road, about one mile west of the built-up area of Lewes.

In all 32,701 vehicles were stopped. Only 0.3% of the drivers refused to answer the questions put to them. The following data were obtained:—

Number of vehicles stopping or calling at Lewes... ..	10,020	30.6%
Number of vehicles which could have used a northern by-pass... ..	13,355	40.8%
Number of vehicles which could have used a southern by-pass	8,197	25.0%
Information indefinite, <i>e.g.</i> , evening tour	1,033	3.3%
Refusals to answer	106	0.3%
	<hr/>	<hr/>
	32,701	100.0%

Details of Operation

In charge of the census were three assistants from the H.Q. office; throughout the census a police officer was in attendance.

Each day, between 8 a.m. and 8 p.m., 20 enumerators were on duty, and from 6 a.m. to 8 a.m. and from 8 p.m. to 10 p.m., ten were on duty.

During each period two enumerators were normally engaged in checking and totalling enumeration sheets. One-half the remainder were on duty in half-hour shifts, while the other half, though resting, were prepared to deal with any accumulation of traffic. Ten shelters were used by the enumerators.

A straight section of road was selected and a barrier was erected along the centre line for a distance of 200 yards.

Notice-boards were erected as follows:—

200 yards from barrier—"E.S.C.C. Please drive slowly. Traffic Control Ahead."

100 yards from barrier—"Caution."

Near Control—"E.S.C.C. Prompt replies will avoid delay."

At Control—"Stop."

Vehicles entered this 200 yards lane in single file and were stopped at the far end, where the questions were put to the drivers by the enumerators. Shelters were erected for the enumerators' use, about 20 ft. apart, so that the drivers of four vehicles could be questioned simultaneously.

On the cars being stopped the drivers were shown a card 16 in. by 12½ in. on which was printed in ½ in. letters, "Please answer these three questions":—

1. Where did you start your present journey?
2. Where are you going?
3. Have you any reason, either business or pleasure, for calling at Lewes?

The answers were entered on census sheets on which was also recorded the direction of travel, date and hour, observer's name and the sheet number.

The form made provision for particulars of 40 vehicles under the following heads:—

Column 1 "Type of vehicle" sub-divided as follows: "Private car, motor-cycle, motor-bus or coach, commercial vehicle."

" 2 "Travelling from....."

" 3 "Travelling to....."

" 4 "Whether reason for calling at Lewes," sub-divided "Yes" and "No."

" 5 "Special remarks."

" 6 "For office use," divided into two sections headed "North By-pass" and "South By-pass," and each of these was further sub-divided as in column 1.

Observations

Enumerators recording East-West traffic used blue forms, and those recording West-East traffic used red. Ambulances, hearses, horse-drawn vehicles and cycles were not recorded.

Time was saved by the prior preparation of cards relating to journeys of the buses belonging to the Southdown Motor Services, which were handed to the enumerators without stopping in passing through the control.

The fact that the County Council had no legal power to stop vehicles and question drivers was pointed out to each enumerator and the necessity for exercising courtesy in dealing with the public was stressed.

It was originally estimated that the questioning would take somewhere between 45 and 50 seconds per vehicle, but in actual fact it was found that an average of ten seconds sufficed. The maximum delay in any one case was under two minutes.

Motorists were inclined to stop at the beginning of the barrier opposite the rear of the "Stop" sign intended for traffic on the opposite stream. The addition of a "Go Slowly" sign to the back of this "Stop" sign overcame this difficulty.

The specific wording to the questions was very carefully considered, for it was realised that the language used should be both simple and explicit. Despite the care taken in drafting them, many drivers had to be further questioned to enable the enumerator to complete the forms.

In their instructions the enumerators were told that should traffic be blocked to such an extent as to cause extensive delay, they were to let it through until the jam was cleared before recommencing duties. In such an event the enumerators had to record merely the type of vehicle, so that their volumetric census would be complete. Recourse to this procedure proved unnecessary. Experience showed the necessity of protecting the enumeration forms during wet weather.

In general the public reacted favourably to the census though towards the end of the period, some drivers who passed daily through the check points became tired of answering the same questions, though few refused to do so.

APPENDIX 3

Notes on Special Traffic Survey carried out at Stratford-on-Avon

General

The survey was taken to ascertain the necessity for a by-pass to Stratford-on-Avon and, if one was found to be required, whether it should be sited to the east or west of the town. The survey was carried out on Sunday the 1st and Monday the 2nd of May, 1938 (during Whit. week-end), and covered 16 hours each day—that is, from 6 a.m. until 10 p.m.

The points selected for the census were one on each of the classified roads leading into the town, and were sited roughly at the borough boundary.

The following table shows the traffic, expressed both in number of vehicles and as a percentage of the total traffic which would probably have used a by-pass had one been available:—

Western By-pass

Route No.	Town Served	Total No. of Vehicles	Traffic which would probably use by-pass	
			No. of Vehicles	%
A.34	Oxford ...	4296	1613	37.6
A.46	Cheltenham	2428	375	15.5
A.439	Evesham ...	2877	279	9.7
A.422	Alcester ...	3512	516	14.6
A.34	Birmingham	6002	1677	28.0
Totals ...		19115	4460	23.4

Eastern By-pass

Route No.	Town Served	Total No. of Vehicles	Traffic which would probably use by-pass	
			No. of Vehicles	%
A.34	Oxford ...	4296	1378	32.1
A.422	Banbury ...	2117	368	17.4
B.4086	Wellesbourne	2163	313	14.5
A.46	Warwick ...	6030	420	7.0
A.34	Birmingham	6002	1631	27.2
Totals ...		20608	4110	20.0

Details of operation

The records of the count were entered on foolscap sheets which recorded the vehicle's registration number and time of passing the census point. Vehicles passing between one census point and another within 15 minutes were regarded as having passed straight through the town.

Four men were stationed at each census point, two recording in-going and two out-going traffic, and vehicles were controlled by a line of red flags down the middle of each road which assured their passing the recording stations in single file. As in the London-Birmingham Trunk Road survey, one man read out the registration number while the second man kept the record.

APPENDIX 4

Extracts from article by Engineer-Admiral E. O. Hefford, O.B.E., in "Cycling" issue of February, 14th, 1940.

"In Germany, workers who live up-country cycle to the suburban terminal stations, store their cycles at the stations, and come to the city in cheap trains. In Berlin, Leipzig, and other big cities, they have developed a remarkable method of parking bicycles and of defeating the bicycle thief.

They erect bicycle racks similar to those provided in many works in Britain, together with an ingenious automatic locking device for securing the cycle.

This automatic locking device consists of a steel box about 7 ins. square and 2 ins. thick, with a chain for securing the cycle as shown in the sketch, and an internal mechanism similar to that in the "Home Safes" issued by our banks here.

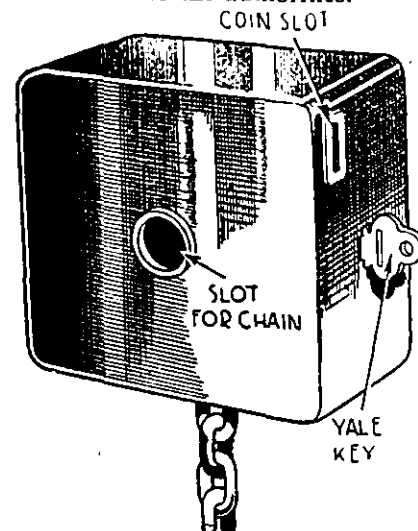
The insertion of a five pfennig ($\frac{1}{4}$ d.) coin releases one end of the chain from its socket and at the same time delivers a Yale-type key which the cyclist puts in his pocket. The chain is then rove through the wheel or frame of the cycle and the loose end is snapped into the central socket on the face of the box, thus securing the bicycle until the owner's return.

The insertion of the key releases the chain again and the bicycle is set free, the key itself remaining fixed in the lock in readiness for the next customer.

This $\frac{1}{4}$ d. charge not only permits the securing of the bicycle and its protection from the elements, but also

insures the cycle for £5 against theft—a really economical proposition for the cyclist.

As regards reliability, the Berlin Police Headquarters Advisory Bureau on Burglary and Theft, after applying very severe tests, expressed its approval of the device and recommended it to the authorities."



APPENDIX 5

The design of a roundabout in a built-up area

An actual example has been chosen to demonstrate the method recommended for use in designing roundabouts in built-up areas. In the example shown, the streets to the north, east and west are existing and that on the south is a proposed street.

In the case of a new road this will have to be estimated. Allowance was then made for anticipated future increases of traffic. (See Part III, Section (b)), and a further adjustment by increasing the estimated volumes by 33½%. (See Part VII, Section (c), Paras. 304 and 305.) The adjusted volumes were plotted to a convenient scale on a diagram as in Fig. A from which Fig. B was prepared showing to the same traffic scale the anticipated movement at the proposed roundabout.

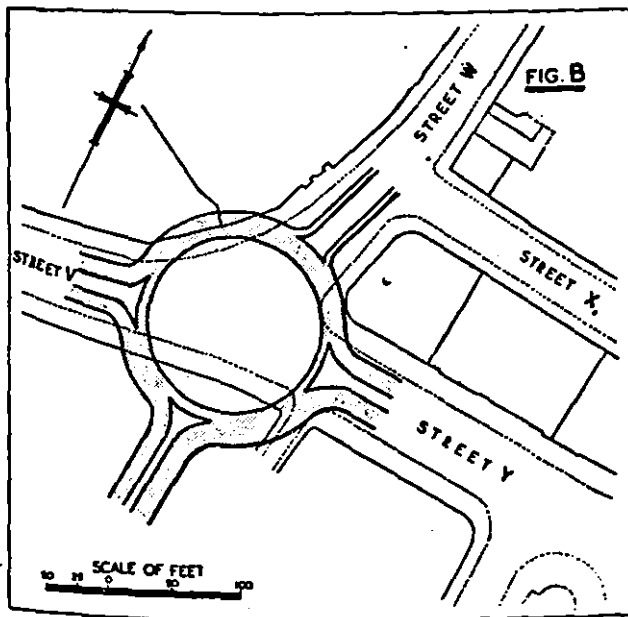
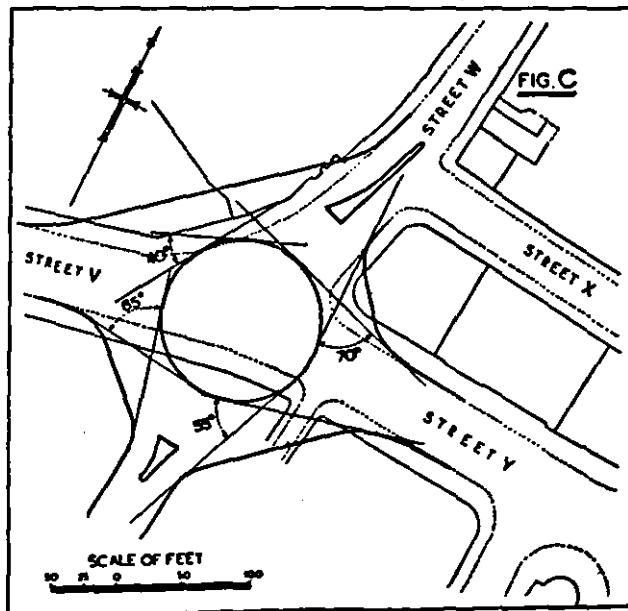
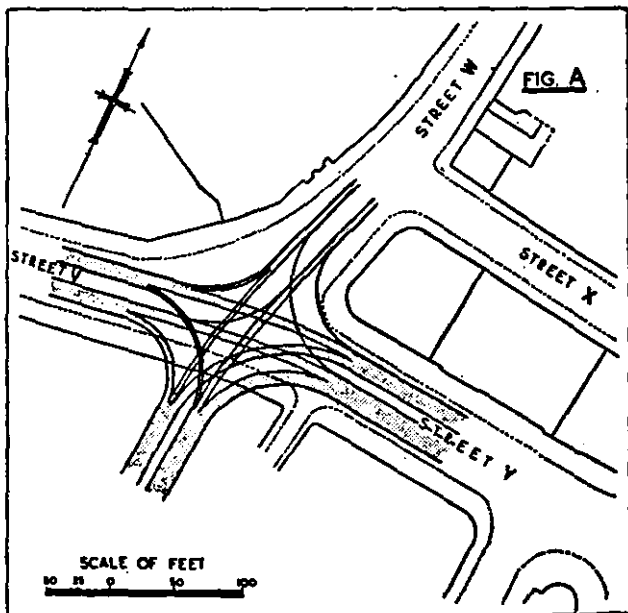
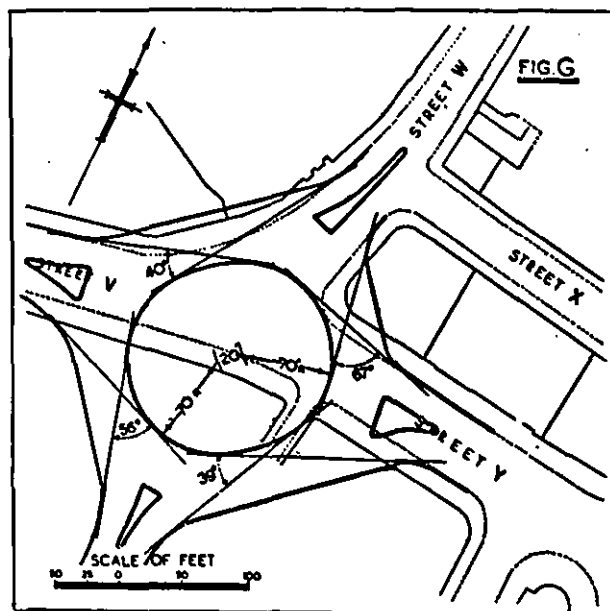
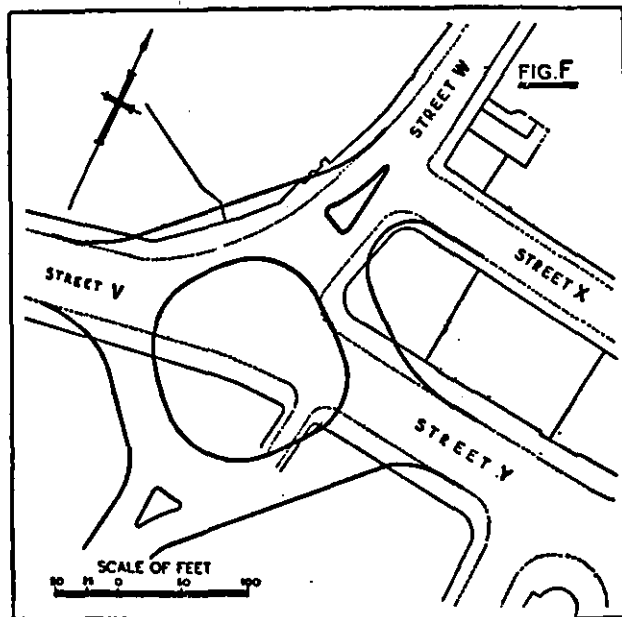
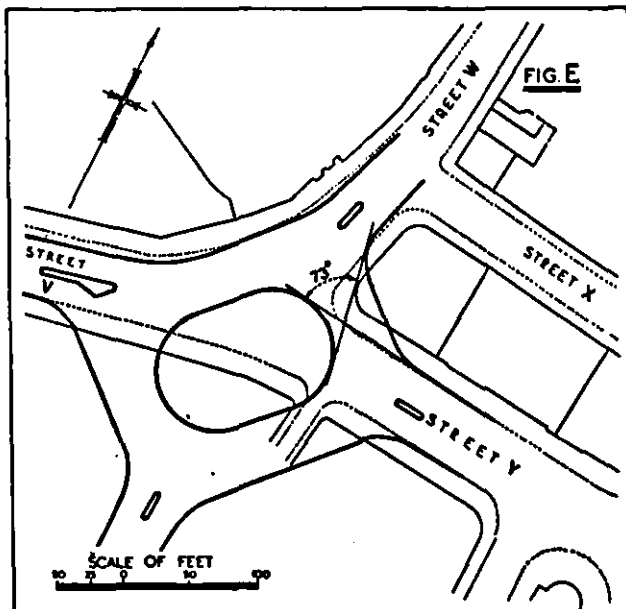


Fig. D shows a graph which was prepared from data obtained by the Ministry of War Transport under working conditions at various intersections controlled by roundabouts. This shows the "weave angles" referred to in para. 299 of the Report, and the corresponding numbers of vehicles per traffic lane per hour for circumscribing carriageways of three, four or five lanes.

The layout Fig. C was checked for traffic capacity by measuring the weave angles, as shown, and from the graph, the theoretical capacity of the roundabout was obtained as follows:—

	Measured Angle of Weave	No. of Vehicles per hour per traffic lane	No. of Vehicles per hour on 40 ft. carriage-way	Anticipated No. of Vehicles per hour
East Side	70°	575	2,300	2,130
West Side	65°	620	2,480	2,230
South Side	55°	700	2,800	2,630
North Side	40°	840	3,360	2,230

The first step was to ascertain by means of a traffic census the volume and distribution of the flow of traffic through the intersection during the peak period.



These figures proved that the roundabout was capable of handling the anticipated traffic; but the layout of Fig. C necessitated the acquisition of a considerable area of costly land on the northern frontage.

A further design, Fig. E, was evolved, which reduced the property acquisition on the northern frontage. On checking for traffic capacity, however, it was found that on the east side insufficient provision was made for the anticipated traffic, the weave angle being too large.

Modification of the layout, reducing the weave angle of the east side, was made as shown in Fig. F. This

provided amply for traffic on all sides of the island, but did not permit satisfactory architectural treatment.

To rectify this the design was further modified as shown in Fig. G. This was found to meet all the requirements of traffic, to permit satisfactory architectural treatment and to effect economy of land acquisition on the northern frontage.

In the northern entry, a long baffle island was introduced to obviate danger from northbound traffic on street W turning right into street X across southbound traffic on street W.

RELATION BETWEEN MAXIMUM WEAVING ANGLE AND DENSITY

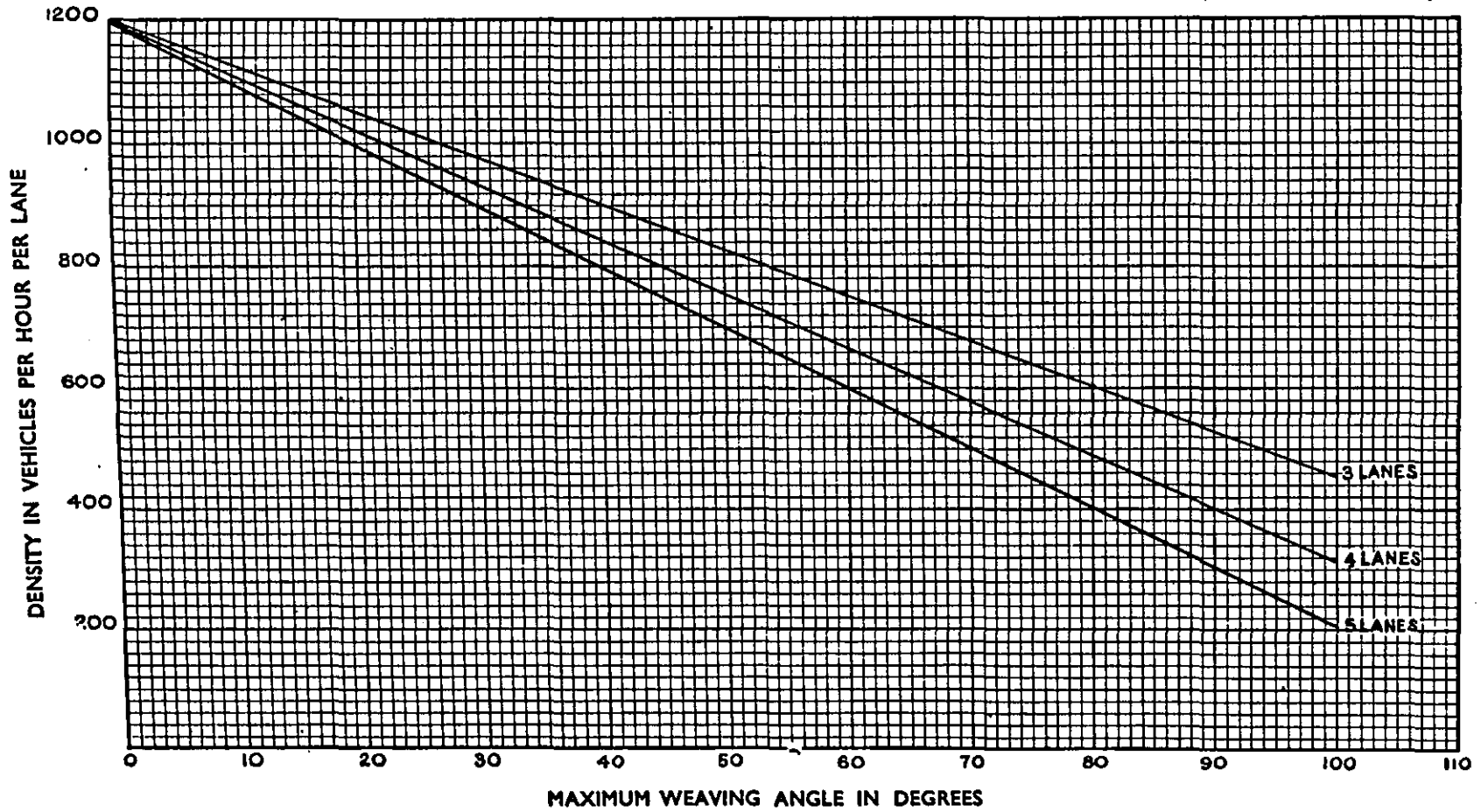


FIGURE D

APPENDIX 6

The designs in Figs. 30 to 35 are based on the following assumptions:—

(a) *Circular arcs*

A centrifugal ratio on circular arcs of 0.25.

Centrifugal ratio, $\frac{P}{W}$, is defined as the ratio of P (the centrifugal force acting on a vehicle moving on a curved path), to W (the weight of the vehicle).

P is derived from the formula,

$$\frac{P}{W} = \frac{V^2}{15r}$$

where, V = Speed in miles per hour,
r = Radius of curve in feet.

(b) *Transition curves*

A rate of change of radial acceleration for a vehicle of one foot per second per second in a second.

(c) *Flyovers*

Carriageways constructed above ground will be carried on viaducts, as these require less space than embankments and are therefore better suited to built-up areas.

(d) *Gradients*

Figs. 31, 33 and 35 are shown with gradients on ramps of 1 in 30—the limiting gradient is 1 in 20.

(e) *Speeds*

A working speed of two-thirds the maximum safe speed at peak flow is assumed.

(f) *Acceleration and deceleration lanes*

An acceleration lane permitting drivers to attain a speed of 70 per cent. of the design speed of the highway before they enter the main highway. It is reasonable to assume that most drivers travel at a speed not greater than 70 per cent. of the design speed of the main road when entering a deceleration lane.

The layouts are designed on the foregoing assumptions, the rate of acceleration being taken as 1.5 ft. per second per second, and the rate of deceleration as 5 ft. per second per second. Acceleration and deceleration lanes are incorporated in the link roads. The lengths of link roads have been adjusted to coincide with the ramped approaches and in consequence the link road in certain layouts is shorter than the length of acceleration lane required and provision of this extra length required is made alongside the main carriageway.

(g) *Cross-over distance*

To enable vehicles to enter or leave the traffic stream on the through roads, tapered cross-over lanes are incorporated in the designs. The lengths of these lanes have been determined by the distance a vehicle will travel in four seconds, this being considered to be the time taken to cross from one lane to the next when travelling at 70 per cent. of the design speed of the main road.

APPENDIX 7

Circular No. 414 (Roads).

MINISTRY OF TRANSPORT,

County Councils ; Whitehall Gardens,
County Borough Councils ; London, S.W.1.
Town Councils, 14th January, 1935.
Urban District Councils,
in England and Wales, other than
Councils whose areas are situated
wholly within the London Traffic
Area.

County Councils ;
Town Councils,
in Scotland.

Sir,

Road Traffic Act, 1934—Section 18

(1) I am directed by the Minister of Transport to refer to Circular No. 404 (Roads), dated 20th August, 1934, in which the local authorities concerned were invited to take preliminary action with a view to the early formulation of schemes containing proposals for the establishment of foot passenger crossings on roads in accordance with the provisions of Section 18 of the Road Traffic Act, 1934, a copy of which was appended to the Circular.

(2) Mr. Hore-Belisha desires that, with a view to reducing the number of accidents on roads, pedestrian crossing places should be provided where necessary throughout the country at the earliest possible date.

(3) He has made an Order under sub-section (4) of the section appointing 15th March, 1935, as the date by which schemes (or statements of the reasons why a local authority considers the establishment of crossings in their area unnecessary) must, in accordance with the terms of the section, be submitted to him.

(4) Local authorities are reminded that public notice of their intention must be given whatever the intention may be. A convenient form of notice of intention to submit a scheme was attached to Circular No. 404 (Roads); a form of notice of intention to submit a statement of reasons why crossings are considered unnecessary is appended to this Circular (see Appendix 2).

(5) Local authorities who do not consider crossings necessary should give the reasons for their decision in as detailed a manner as possible; a mere statement that crossings are not considered necessary is not sufficient.

(6) Copies are attached of regulations and directions respecting the signs and markings on the carriageway which are to be used for pedestrian crossings and of regulations dealing with the movement of pedestrian and vehicular traffic at and in the vicinity of the crossings. The latter regulations apply, at present, only to the London Traffic Area, but regulations to the same general effect applicable to the rest of the country will be made without delay and a copy will be forwarded to you as soon as possible. It will be noted that the markings to be used on the carriageway to indicate the limits of the crossings are studs, circular or square in shape, with an area of not less than 12 square inches, flush edges and a maximum projection above the carriageway of $\frac{1}{4}$ inch. The studs are to be spaced at distances of not less than $10\frac{1}{2}$ and not more than 14 inches between centres. Normally the distance should be about 13 inches.

(7) In future foot passenger crossings must be marked in accordance with the regulations and no experiments should be made with other forms of markings without the express authorisation of the Minister, which he will be quite prepared to give in suitable cases. Apart from legal difficulties it would be confusing to pedestrians and to drivers to have several forms of marking in use.

(8) Councils of boroughs and urban districts are under the provisions of the Act responsible for all crossings in their areas on every class of road whether maintained by the borough or urban district as the case may be or by any other authority. The county council is responsible only for the establishment of crossings in rural districts. It is, however, clearly desirable that the highway authority should be consulted at all stages and kept informed of any council's intention to establish crossings on roads in respect of which they are not the highway authority.

(9) Local authorities are reminded that under subsection (4) of the Section, they are required to consult with the chief officer of police concerned before submitting a scheme or statement under the section to the Minister.

(10) While the formulation of schemes for crossings rests primarily with the local authorities concerned after consultation with the chief officer of police, it is desirable in the interests of pedestrians and of drivers of vehicles that the same general principles with regard to the location of crossings should so far as possible be adopted throughout the country. As a guide to this end, your Council is requested to observe, so far as practicable, the general principles set out in Appendix I.

(11) "Please Cross Here" signs—These signs will be superseded by those to be used for foot passenger crossings and they should accordingly be removed.

(12) Grants—The Minister will be prepared to accept the grant at the rate of 60 per cent. approved expenditure incurred in the execution of any works (including the placing, erection, maintenance and removal of marks and traffic signs) required in connection with the establishment of pedestrian crossings on both classified and unclassified roads in non-county boroughs, urban districts and rural districts in England and Wales and in small burghs and county districts in Scotland in accordance with any scheme approved by him under the provisions of section 18 of the Road Traffic Act, 1934.

To enable grants to be made, the schemes when submitted to the Minister should be accompanied by a detailed estimate of the expenditure to be incurred. No grant will be issued until the Minister has given his approval to the scheme as required under the above-mentioned provisions.

Expenditure incurred by the councils of county boroughs in England and Wales and the councils of large burghs in Scotland on the establishment of pedestrian crossings must be regarded as covered by the general Exchequer contributions under the Local Government Act, 1929, and the Minister will not be in a position to make specific grants in respect of it.

(13) This Circular does not apply to the London Traffic area. A separate Circular will be sent to the local authorities whose areas are wholly or partly within the London Traffic Area.

I am, Sir,

Your obedient Servant,
CYRIL HURCOMB,
Secretary.

The Clerk of the Council.
The Town Clerk.

APPENDIX I (to Circular No. 414)

It must be borne in mind that the object of the system of pedestrian crossings is to afford every inducement to the pedestrian to use them in preference to other parts of the carriageway. They must therefore be conveniently sited and spaced, at intervals of sufficient but not excessive frequency, to meet the reasonable needs of pedestrians.

(a) When a system of pedestrian crossings is being planned, thoroughfares should be considered as a whole. Where a thoroughfare extends beyond the area of a single authority, the system should be planned by the authorities in consultation.

(b) Pedestrian crossings should not be provided at isolated intersections unless traffic is at all times controlled by police or by light signals, or the crossings are sited at a roundabout.

(c) Crossings may be provided over minor side roads in continuation of footpaths carrying heavy pedestrian traffic, if the vehicular traffic in and out of the minor road is substantial.

(d) Crossings should normally be provided only at road intersections. Where crossings are provided elsewhere, it will frequently be desirable that the vehicular traffic should be controlled by pedestrian actuated signals.

(e) Where pedestrian crossings are provided at controlled intersections, all streams of traffic entering the intersection which pass over a crossing should be stopped at intervals.

Siting of Crossings

(f) The siting of pedestrian crossings should be carefully considered to secure the maximum degree of safety for pedestrians, and the least possible interference with other traffic.

(g) The number of crossings at an intersection should be the minimum which will enable pedestrians to cross the main streams of traffic.

(h) Crossings at an intersection should normally be sited as nearly as possible in line with the footpaths and so as to make use of any existing refuges. If the refuge is in an unsuitable position it should, where practicable, be moved.

(i) At a normal intersection there should be four pedestrian crossings, except where it is clear there is no need for all four. In particular, at the intersection of a major and a minor

road it should, as a rule, be unnecessary to provide crossings over the major road on each side of the minor road.

(j) At a T junction, it should not normally be necessary to provide crossings across the head of the T in continuation of the footpaths on both sides of the stem of the T.

(k) Where there is a choice of position, the crossing should be placed where the least volume of turning traffic will pass over it. For example, at a T junction with most of the traffic turning left from the stem of the T the crossing should be in continuation of the footpath on the right-hand side.

(l) The minimum width of a crossing is 8 ft. In deciding upon the actual width to be provided, the volume of pedestrian traffic and other factors should be borne in mind. Excessive width of crossings is undesirable.

(m) Crossings should normally be at right angles to the directions of vehicular traffic.

(n) At complicated intersections and roundabouts, pedestrian crossings should take the pedestrians round the outside of the intersection and not across any part of it unless it is necessary for pedestrians to cross the intersection in order to reach omnibus stopping places, lavatories, etc.

(o) At an intersection controlled by light signals the line defining the pedestrian crossing on the side of the approach-

ing traffic will normally coincide with the continuous "stop" line, but in special cases, e.g., where it is necessary to provide room for traffic to turn round a sharp corner, the "stop" line may have to be put further back.

(p) It is important that stationary omnibuses or trams should not obscure the view of drivers or other vehicles approaching a crossing. It may accordingly be necessary for omnibuses and tram-car stopping places to be moved to allow the crossing to be placed in the most suitable position.

APPENDIX II (to Circular No. 414)

FORM OF NOTICE.

NOTICE is hereby given that the Council does not propose to submit to the Minister of Transport a scheme for the establishment of pedestrian crossings in their area. The Council will submit to the Minister a statement of the reasons why it does not consider the establishment of crossing necessary.

Details of the statement will be available for inspection at the office of the Council at _____ between the hours of 10 a.m. and 4 p.m. from _____ to _____ and any representations in regard thereto should be sent to the Clerk to the Council not later than _____

APPENDIX 8

Circular No. 544 (Roads)

MINISTRY OF TRANSPORT,
Metropole Buildings,
Northumberland Avenue
London, W.C.2.
21st February, 1940.

County Councils,
County Borough Councils,
Town Councils,
The Common Council of the City of London,
Metropolitan Borough Councils,
Urban District Councils, in England and Wales,
County Councils,
Town Councils in Scotland.

Sir,

Traffic Light Signals

I am directed by the Minister of Transport to state that in the light of the experience gained in the control of traffic by light signals he has come to the conclusion that additional protection to pedestrians is desirable at many road junctions where traffic signals operate. The Minister therefore asks authorities to review all existing installations in their area in consultation with police authorities (in the Metropolitan Police district, the Commissioner of Police) with a view to making additions to existing installations for the benefit of pedestrians wherever such additions are practicable and warranted by traffic conditions.

In some exceptional circumstances special "CROSS NOW" signal indications, usually operated by push buttons, may be justified; but it should be borne in mind that arrangements of this kind cause increased delay to traffic and unless there is a considerable volume of pedestrian traffic the disadvantages of such special installations are likely to outweigh the advantages.

In other circumstances it may be desirable to provide additional three-light signals to existing installations so that a pedestrian can see at least one signal immediately facing him when crossing a road at a signal-controlled junction. In some cases, however, it may be found that signals of this type would be either misleading to drivers (e.g. by showing contradictory indications) or dangerous to pedestrians by encouraging them to cross at a time when a substantial volume of turning traffic will flow across their path.

Where the signal control is not of the normal two-phase type or where heavy turning movements might present special danger to pedestrians the Divisional Road Engineer should be consulted at an early stage; and his prior approval should be obtained in all cases where it is proposed to provide additional signal faces.

The Minister will be prepared to accept for grant approved expenditure incurred on authorised modifications of existing equipment as part of the maintenance costs of the signals; and in all new signal installations submitted for his approval, he will require to be satisfied that provision has been made, where necessary, for the protection and guidance of pedestrians.

I am, Sir,

Your obedient Servant,
LEONARD BROWETT,
Secretary.

The Clerk of the Council.
The Town Clerk.

Copies of this circular letter are transmitted for the information of the Surveyor and the Accounting Officer to your Council, and in the case of Scottish Councils an additional copy is forwarded for the information of the Auditor.

APPENDIX 9

Pedestrian Guard Rails

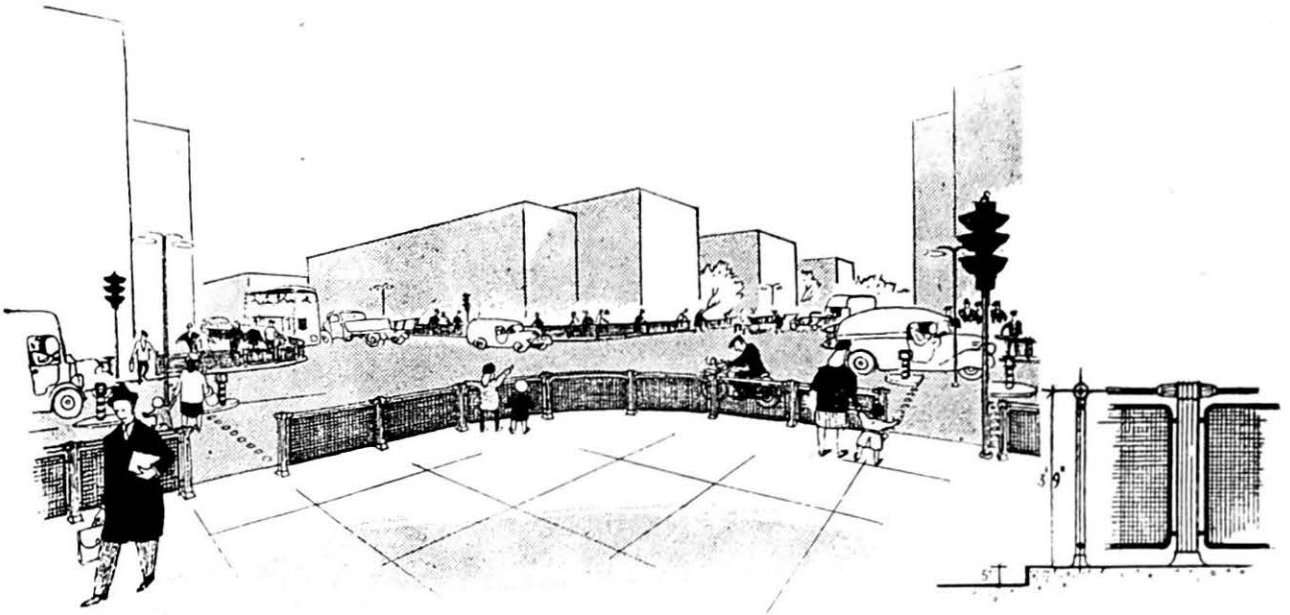


FIGURE I

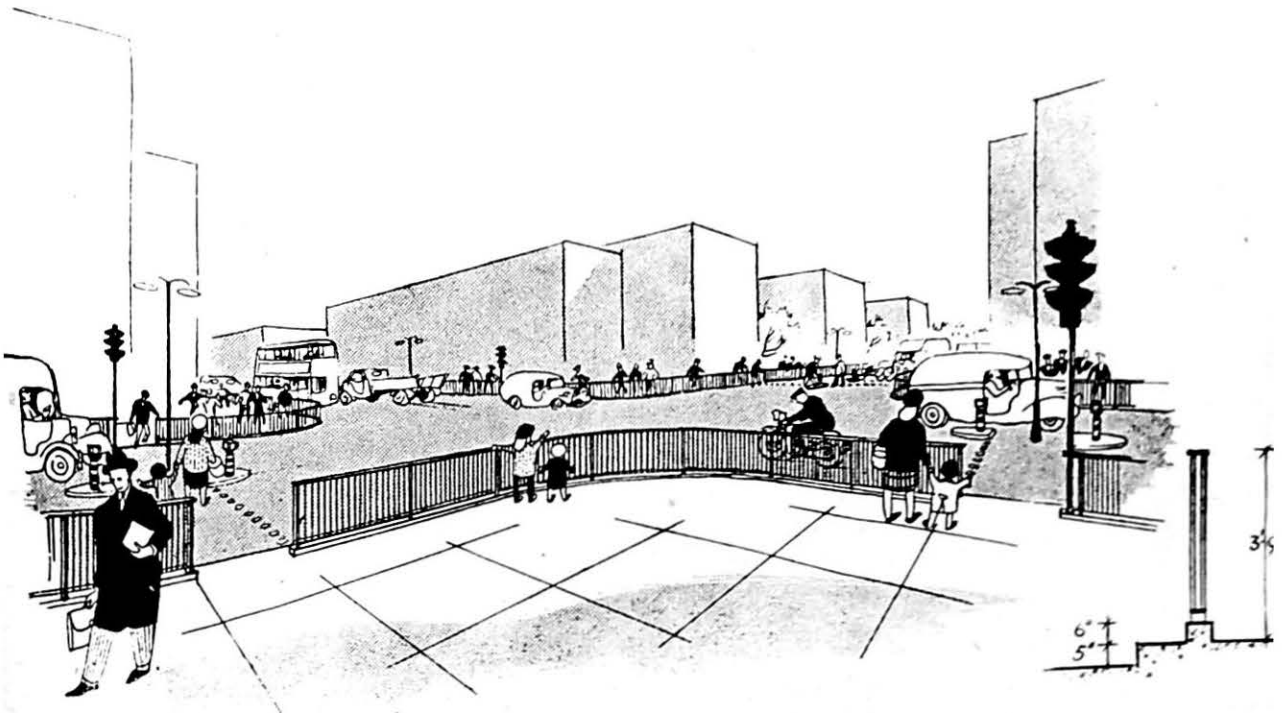


FIGURE II

Pedestrian Barriers

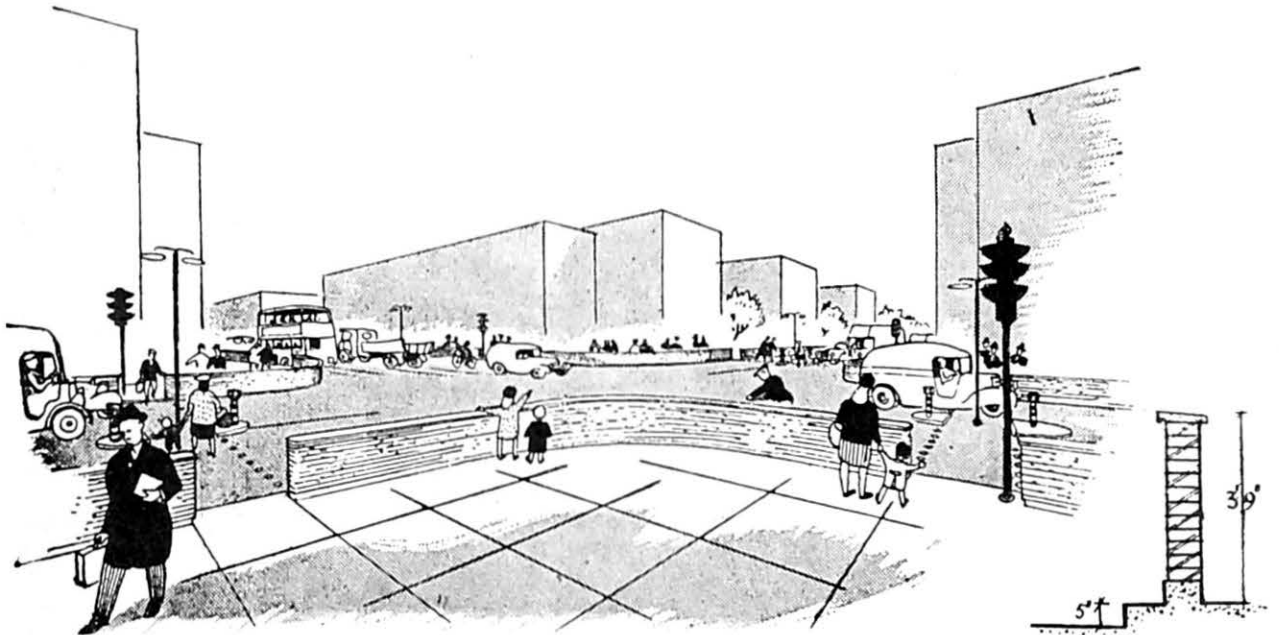


FIGURE III

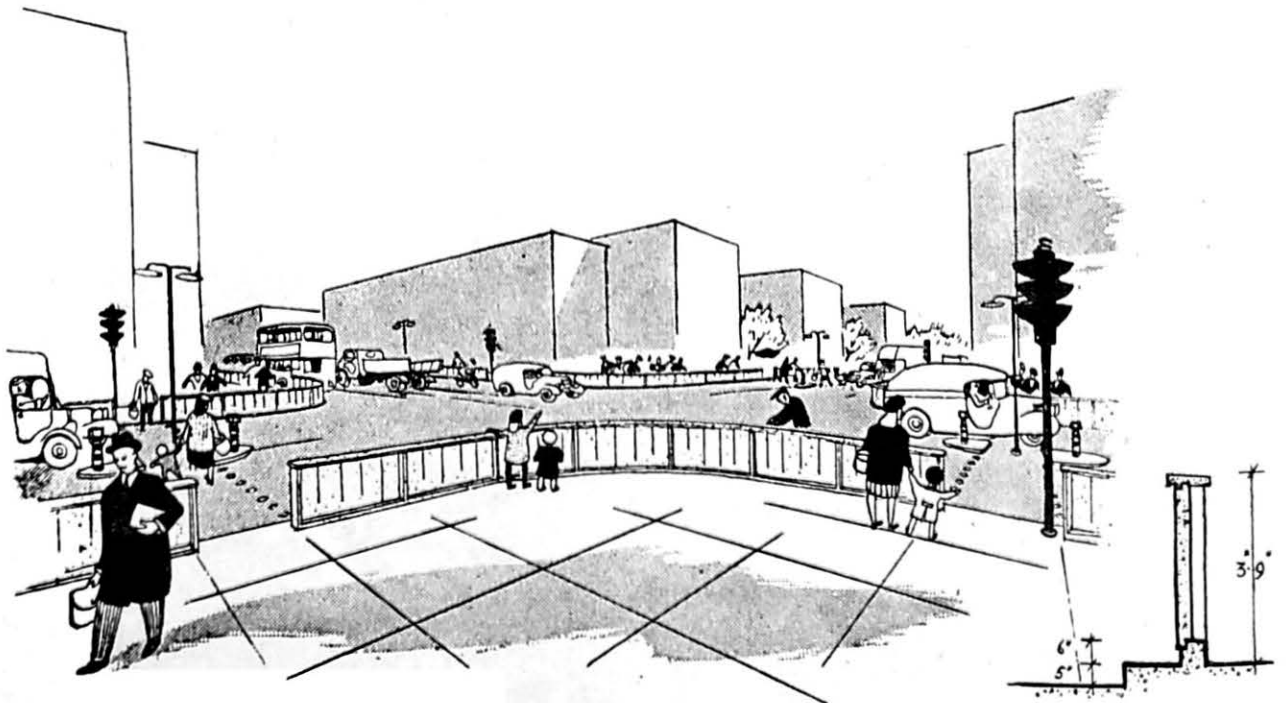
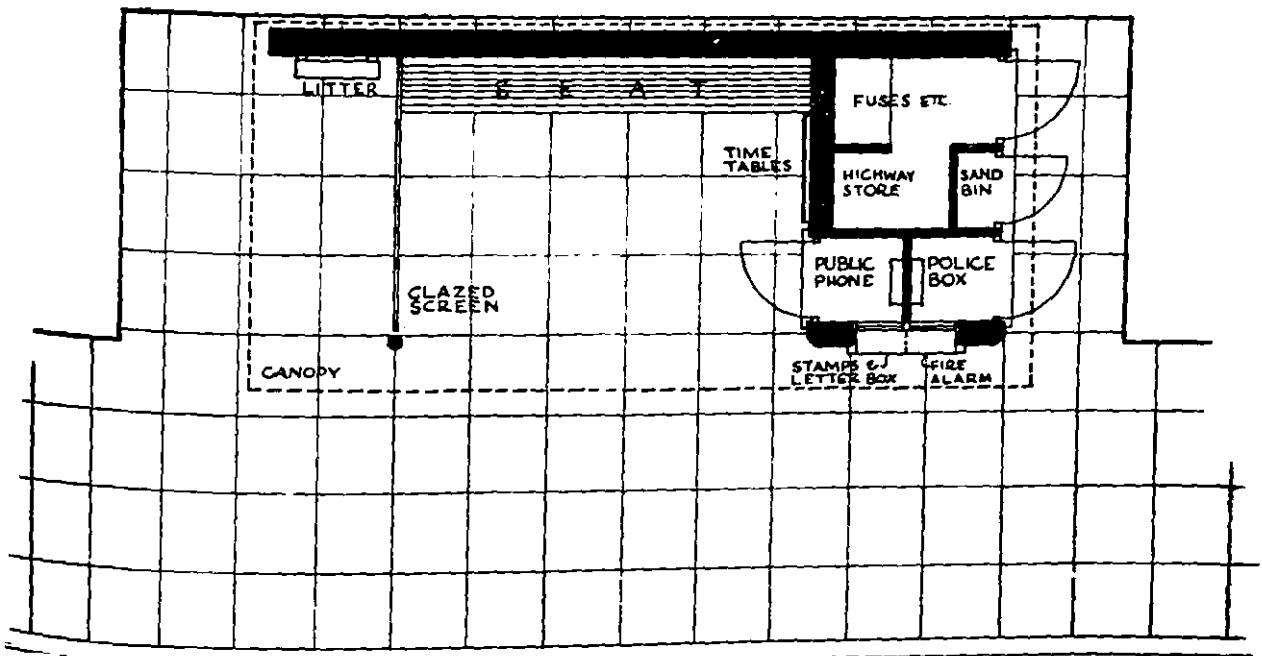
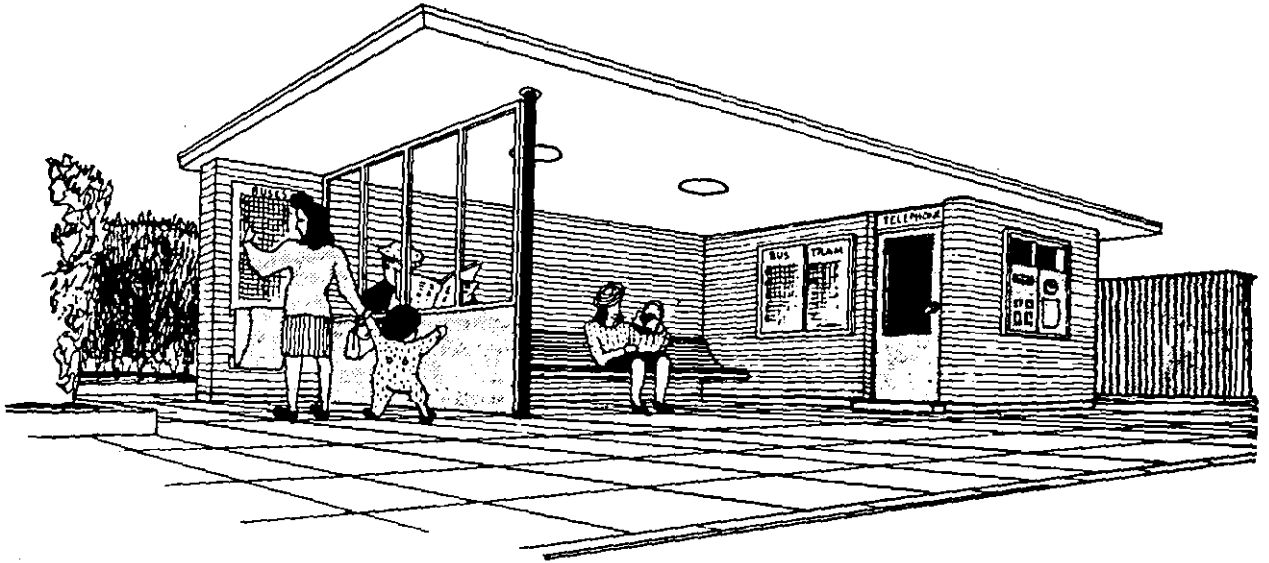


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