HIGHWAY RESEARCH BOARD

Bulletin No. 25

Controlled Access Expressways in Urban Areas

A SYMPOSIUM

1950

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*REPORT OF COMMITTEE ON
CONTROLLED ACCESS EXPRESSWAYS
IN URBAN AREAS*

**HIGHWAY RESEARCH BOARD
DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH
NATIONAL RESEARCH COUNCIL**

Washington 25, D. C.

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FOREWORD

Urban traffic congestion rates high on a list of the Nation's serious domestic problems. Its influence on the economy, safety, tempers and the American way of life is tremendous.

Far and wide, City and State officials, encouraged and aided by substantial grants of Federal funds, are making plans for relieving and correcting the intolerable conditions existing on the streets of every city. The controlled access expressway is the corner-stone of most of these plans for solving urban traffic congestion.

The impact of a controlled access expressway on an urban area can be far-reaching. Even the simplest application of the expressway principle will bring about change, for that is its purpose. Just what these changes will be, however, is not well-enough known. A new field, largely unexplored and unmeasured, has been created.

The field is so large the Committee realized its work would necessarily be limited to the general features of the problem if the report was to be made available within a reasonable time, consequently this material serves an an introduction to a broad subject. It is hoped the report will suggest and stimulate definitive research in order that more effective tools will be made available in this important field.

CONTROLLED ACCESS EXPRESSWAYS IN URBAN AREAS

A SYMPOSIUM

In discussing the influence of controlled access expressways on urban areas, it is helpful to understand the economic forces unleashed by the automotive vehicle. This understanding includes the potentialities for beneficial exploitation of these forces.

Historically, the city was formed when men drew together for mutual protection. The city was the citadel and trade and commerce gravitated naturally to this protected place. Progress toward civilized society and government unfolded in ratio to the means available for communication and transportation. Urban life evolved and with it arts and crafts developed on an organized basis. The age of specialization began and it was inevitable that mechanical devices would be developed to lessen the fatigue of human effort thus increasing the productiveness of the individual and improving the economic status of the producer.

So long as man was chained to animal power, the opportunities for expanded community and industrial development were limited. Modern industrial, agricultural, commercial and community development began with the advent of the railway, which substituted mechanical motive power for animal power. The community became the hub of this development. The products of the mine, forest and soil were gathered from great distances and delivered rapidly with economy to centers where labor was available for further processing into finished products. Thus industry and commerce gravitated to the city where raw materials and labor met. The development and economy of the country evolved around rail and water transportation.

By 1900 settlement of the United States was virtually complete and the rail and waterway systems very nearly stabilized as to location. But local commerce and retail trade were confined to areas within walking or horse and buggy distance of the customer and worker. The range of the farmer's market was limited to a half day's journey by team and wagon. This period at the turn of the century represented the culmination of the horse and buggy-railway economy. It was geared to the fixed rails of the iron horse.

The road evolved as a corollary of the invention of the wheel. For thousands of years, however, its concept remained unchanged, static and crude because the speed of the vehicle using it was constant. Suddenly, the revolution of the automotive age burst upon the world and a vista of more rapid free wheel transportation began to unfold. It has taken about fifty years for the human mind to adjust itself to this revolution and begin to grasp the significance of the automotive vehicle and the highway transportation system to economic, industrial and community life. The automotive vehicle injected an entirely new principle into transportation - flexibility. In addition, increased speed, size and weight has forced a new concept of the physical and geometric characteristics of the highway structure and compels a utilization of the laws of motion in its design as well as recognition of human psychology and behavior.

The first twenty years of the century were devoted to perfecting the mechanical design of the vehicle so it would be dependable and economical to operate; and to developing efficient manufacturing processes to bring its selling price within reach of the average citizen. During this period few people recognized the potentialities of the motor car or anticipated the revolution it would cause in American economy, culture and social values.

After the close of World War I, the

automotive era began in earnest and within the period between the two wars a highway construction program in the United States was accomplished without parallel in the history of the world. This effort, in the short span of twenty years, provided a network of all-weather highways from the Atlantic to the Pacific and from the Canadian border to Mexico. Without this system the automotive era would have withered and died.

But the greater part of this highway development was in rural areas to make such areas accessible to the city. Little was done to adjust the horse-and-buggy city street system to the changed requirements of the automotive era. Now realization has come that the economy brought about by this revolution is bogging down in urban areas and a shift in emphasis in highway planning is necessary in order to bring the economy of the nation back into healthful balance. Therefore highway development in urban areas assumes national as well as local, regional and state interest.

The automotive vehicle has broken down individual transportation barriers. Never before in history has it been possible for man to move so freely, so flexibly, so swiftly, so far and with such economy along the face of the earth. The highlights of this new service to modern economy may be summarized as follows:

a. The motor car is ready instantly at all times at the door to carry the individual or his family along a personally selected route, arriving at a convenient predetermined time. It renders complete door-to-door service without added expense or vexing delays in changing from one form of transportation to another.

b. The farmer can travel with ease and comfort protected from the weather a greater distance in a half-hour than formerly in one-half day. This widens the economical radius of productive lands. It gives the farm population more time to devote to crops, the business of disposing of crops, social life, leisure, recreation and the pursuit of cultural occupations.

c. It brings children to schools instead of schools to the children. This increases the efficiency, economy and quality of education.

d. The worker is brought to the industrial plant and not the plant to the worker, permitting more economical and logically zoned plant location. It offers more space for plant layout and design with improved working and recreational facilities, and it opens up additional sites for industry, thus developing tax ratables and employment over greater areas. This will result in a more logical, efficient and widespread utilization of land.

e. The motor bus provides semi-personalized, at-the-curb mass transportation facilities with opportunity for adjustment of routes to follow trends of shifting population and the establishment of new industrial areas as well as a flexible rural service not hitherto available.

f. Motor transportation expands shopping opportunities encouraging economical large-unit merchandising and the cash-and-carry principle. This increases the annual national sales volume and gives the mass of the people more of everything for less expenditure.

g. It opens recreation areas and facilities to all the people improving the national health and morale and promotes the prosperity of regions whose sole natural resource consists of recreational terrain or water.

h. It provides store-door delivery, resulting in more economical transportation and handling costs, lower inventories, greater turnover with the capital employed, less storage space and fresher merchandise for the consuming public.

i. It provides rapid direct farm-to-market or processing plant delivery service with economy and without rehandling expense or delay. This results in extensive milk pick-up services, field loading of crops, over-night delivery of fresh vegetables, poultry, eggs and live stock up to distances of 300 miles, with forty-eight hour delivery up to 1,000 miles, greatly improving the quality, quantity and variety of fresh foods, thus promoting the standard of living and health of the American people.

j. It supplements other forms of transportation and reduces the necessity of constructing or maintaining uneconomical fixed plant.

k. It promotes greater and more economical utilization of the land and thus develops the country and induces expanding tax ratables.

l. It will promote and make possible the eventual elimination of slum areas when planning agencies grasp the significance and opportunities of the automotive age.

m. It spreads the economy of travel and the transport of commodities to all classes of people and to all sections of the nation's economy, thus affording the great mass of the people the opportunity of healthful, educational and recreational travel resulting in welding the nation more closely together and the reduction of the cost of commodities and manufactured products, therefore promoting a higher standard of living in America.

n. It enables a concept of distance to be based on time rather than miles, i. e., one often hears the expression that a certain place is so many minutes away or so many hours away.

o. It promotes the development of off-street (highway) service centers with adequate parking facilities which offer convenient, safe and economical shopping facilities to the public.

p. Because of greater flexibility for expanded service with economy the automotive age generates an expanding economy and creates wealth at the national, state and local level.

Some of the services and trends outlined above are fully established and recognized generally; others, in initial stages of development and exploitation, are recognized less generally; still others in their infancy are understood but dimly.

Flexibility and utility of the motor car are recognized universally. But the economic benefits it bestows are not so well understood. Nor are the implications of further beneficial effects from wise community and facility planning. More careful zoning is a case in point. It is a sad commentary on the ability to plan affairs when, (after a public body has constructed an excellently designed and adequate highway facility at public expense for the use and comfort of all the people) within a short span of years indiscriminate and unregulated development by abutting owners transforms a once community asset into a roadside slum with greatly decreased traffic efficiency and increased accident potential. Controlled access expressways prevent this deterioration and preserve transportation efficiency.

Planning must recognize the nature of the automotive revolution and the principles required to further the beneficial affects of the automotive age; and utilize such principles in the practical affairs of rebuilding America. Automotive age planning must look forward not backward.

The impact of the automotive revolution caught the cities and communities of America unaware. These communities developed and matured during the horse and buggy and railway economies. In general, they are wholly unsuited to the efficient use of the motor car. As a consequence many cities are experiencing distress, losing population and suffering a decline in taxable ratables. These cities represent an investment of funds of some billions of dollars, and it is only wise conservation that this investment be safeguarded by adjusting conditions so that urban areas will continue to serve the public in the years ahead.

This can be prevented only if urban areas are revitalized. Bold farseeing community planning and action that recognizes the needs of the automotive age will be required to save many cities from continued retrogression and make the city accessible and suited to automotive traffic. These potentialities so far are dimly seen, and the ways and means to arrest the retrogression by eliminating undesirable features while preserving and strengthening the desirable ones are not too clearly recognized.

The general public does not fully appreciate the significance of the motor truck. If motor transport came to a stop overnight, the American way of life as we understand it would cease abruptly. In fact, the population, particularly in urban areas, would face starvation. Trucks transport significant portions of all vegetables, milk and fresh foods from farm to market and practically all foodstuffs are trucked from wholesaler to retailer. Without motor transport, essential and critical materials could not be delivered to industrial plants, and the wheels of industry would stop. Widespread unemployment, distress and economic paralysis would result. The importance of truck transport is a vital factor in urban area economy and merits careful consideration in planning controlled access highways.

In broad terms, the highway transportation system is composed of three general groups:

1. The feeder system
2. The ordinary trunk highway system
3. Controlled access highways

The feeder system primarily serves the land directly. The land must be accessible to be useful. The group includes urban streets that provide access to property and do not serve as through-traffic arteries.

The ordinary trunk highway system collects traffic from feeder roads and carries the great burden of traffic between centers of population. It is a town-to-town system. In addition it serves the land along its borders since free access is permitted adjacent land owners.

Controlled access highways do not serve the land directly because free access to them is denied abutting property owners except at specially designed traffic interchange facilities. They are justified by intolerable congestion on land-service highways where traffic density with costly, nerve-racking delays from red lights, intersections at grade, left turns and disturbances caused by vehicles entering and leaving the highway at will greatly reduce freedom of movement and increase accidents. The most pressing application of the controlled access principle is in highly developed and industrialized urban areas where traffic congestion is strangling further development.

If cities are to be rejuvenated and geared to the possibilities of the automotive age, it will be necessary to restore facility of movement and provide for greatly enlarged traffic capacity. Consequently, judicious planning and construction of an economic system of controlled access highways is a must in many communities.

The location and design of express type facilities, therefore, present a grave and challenging problem. It is essential that the best engineering skill and judgement be applied, particularly in the more heavily built up and industrialized areas. It is important that all available engineering techniques are brought to bear on the problem. And of these techniques, the origin-and-destination survey is a potent tool. It is necessary to provide sufficient traffic capacity and to locate arteries along paths desired by the motorist, close-in to destinations, with due regard to available or potential parking facilities.

In some instances, it is possible to combine slum clearance with the construction of new traffic arteries. But the desire for such clearance should not locate the highway disadvantageously for traffic. Nor should a sacrifice be made in acceptable geometric design. Possibly no other highway location problem requires so much engineering skill, study and time as the location of an expressway in an urban area. In the location of the highway and traffic interchange facilities, the ability of the street system to carry traffic in the terminal areas is fundamental.

Plans for the future city, the location of population and industry, the efficient use of the land are important contributing considerations. In developing a controlled access system in urban areas it is often wise to carry appreciable flows of through-traffic around the congested areas with express beltlines or by-passes, and to provide the "in city" expressways for the sole purpose of handling traffic destined for the heart of the city itself and for local movement. Only in this way can sufficient capacity be provided in areas subject to heavy traffic.

The mileage of the express type highway will constitute only a small percentage of the total road mileage in America But it is an important mileage. It will carry a significantly large proportion of the traffic in the areas it serves. It is the leaven in the dough constituting the difference between meeting the challenge of the automotive age or allowing the automotive revolution to master and overwhelm many mature and declining urban centers.

Responsibility for meeting the challenge of the automotive revolution and of making full use of benefits that can flow from the automotive age is not borne by the engineer alone. It extends through all levels of government from top to bottom and to administrative, political, industrial, commercial and civic leaders throughout the nation. No small part of this responsibility is informing the people of the issues involved and securing a full measure of public support. But the engineer must assume leadership and at the same time establish sound principles for the proper design and development of controlled access highways in urban areas.

This report is an approach to the general features of the subject. The success of the controlled access expressway in urban areas is dependent on skillful utilization of many factors and adaptation to each specific problem. These factors and the techniques involved are outlined generally in this report. It is hoped that subsequent committees will further develop specific techniques by additional research.

LOCATION CONSIDERATIONS

The location of an urban expressway should be governed by its ability to coordinate and improve travel on the existing street system and to provide an effective facility for the movement of all traffic. Properly located, an expressway can integrate Inter-city, Metropolitan, State and Federal routes, thereby relieving traffic congestion on major city streets and county highways. The removal of this overload from the local system will eliminate the necessity for many street extensions and widenings.

In sound and efficient highway planning, mass transportation and private transportation must be complementary, not competitive. Therefore, the coordination of express automobile and truck movement over the facility must be considered in the final location of an expressway if the public is to derive the full benefit of such improvement.

Expressways provide an excellent opportunity for express bus service, both urban and interurban. Express service by bus for the outlying districts of a metropolitan area and its suburban districts may use the expressways as efficiently as private rights-of-way. These buses can use the local streets for picking up passengers in the outlying districts and deliver them to destinations within the city. Where intermediate stops are desired on the express highway portion of these routes, such stops and convenient loading may be provided at street grade by means of the interchange lanes and ramps without interfering with traffic upon the expressway.

Access from the expressway to industrial areas is another factor for consideration if complete utility of the improvement is to be realized. This is important for freight transport as trucks take over more and more of the haulage of raw materials and finished products. Also, employees destined to these areas will receive the benefits of this convenience. The removal of motor freight trucks from the local street system will provide faster and safer trips for the traffic still using the existing facilities.

An expressway should not be considered merely as a highway for carrying vehicular traffic faster and farther out from the central area, as some have assumed, concluding that the system would accelerate decentralization of population. On the contrary, by concentrating through traffic on relatively few arteries, the improvement will aid materially in the appropriate conversion and redevelopment of the central residential areas. These areas are now blighted, or being blighted, by unwanted traffic congestion as well as other factors, and are consequently being abandoned for "greener pastures" in the suburbs They can regain the order, quiet and safety of local streets, competing in this respect with the suburbs, by confining through traffic to roadways specifically designed for the purpose.

The route of a proposed expressway should be determined with the thought to preserve the unity of neighborhoods and for the redevelopment and conservation of central residential areas. Adequately landscaped and planted, the expressway will serve as attractive and logical boundaries for communities and good location for certain recreational facilities. They are viewed as an essential measure in the checking of wasteful decentralization and the restoration of older areas to economic health.

Several theories have been advanced relative to the best location for an expressway. Each has its advantages and disadvantages. The authorities who prefer between-block locations claim a cheaper right-of-way cost on the basis that this method, in the majority of cases: (1) will preserve the buildings facing the street by using the back yards of the property required; (2) through preservation of the houses and small retail neighborhood establishments cause the least disturbance and dislocation to the immediate area; (3) remove from the tax books taxable property of lesser value; and, (4) cause less disturbance to existing underground utilities thus reflecting a tremendous saving in construction costs.

The proponents of the center of street location claim; (1), a wider right-of-way can be obtained by the acquisition of entire lot depths; (2), the economy in acquiring the rear portions of city lots is not as great as appears; (It has been the experience of right-of-way negotiators that the ultimate cost of a portion of a parcel of land represents nearly the total value of the entire parcel in most cases) (3), with a wider right-of-way, a better opportunity is afforded to design flatter slopes and attractively landscape the area; (These two erosion control devices will reflect a lower maintenance cost for years in addition to their beautification abilities) and, (4), the existing local streets flanking the improvement will serve as feeders and collecting arteries.

WIDTH CONSIDERATIONS

It is generally agreed by highway engineers that generous right-of-way widths should be provided for expressways. Some advocate right-of-way widths of three hundred feet or greater, if possible. A wide right-of-way properly landscaped is a guarantee against damages to the abutting property values. Fumes, noise, and dirt, the objectionable by-products of arterial highways, are effectively eliminated where ample space is provided between the pavement and dwelling units. On wide rights-of-way, medians between pavements can be of generous widths to provide proper planting which provides more safety to the driving public.

An improvement of generous width will allow for future expansion, should it be needed, without entailing acquisition of additional land for widening purposes. Subsequent widening is a costly procedure and should be precluded in the original purchase.

DESIGN CONSIDERATIONS

In order to function as intended, an expressway cannot usually intersect other traffic arteries at grade, although conditions may be such that the highway economically may be at grade between intersections. This is generally possible in the open country, but it is more difficult in cities or towns, where railroads, waterways, and particularly city streets, may be so close together as to make impracticable the construction of an expressway at grade In certain cases however, it may be possible to construct it essentially as a surface road, for example where it can be located parallel and adjacent to an existing railroad or waterway, or to a hillside, swamp, park or other natural man-made barrier.

The vertical location of an expressway in relation to the ground or street surface will depend on the specific characteristics of the terrain and the street system, and possibly to some degree on the likes and dislikes of the communities through which it will pass. It may depend also on the relative cost of right-of-way and construction. Generally speaking, the following types of structures can be used:

(a) Above ground (embankments with earth slopes or between retaining walls; viaducts of steel or concrete).

(b) At ground level (surface highway with over- or under-passes at traffic crossings).

(c) Below ground (open cut with earth slopes or retaining walls; cut-and-cover subway type; tunnel).

The engineering problems and economics involved in the construction of any of the types of structures mentioned above will usually follow the same patterns as those of similar structures used for other purposes. The following comments, however, may be noted as applicable to expressway structures.

Where the soil on which an embankment is to be placed is soft, the height should be limited so that undue settlement will not occur. Otherwise, the settlements may be costly, not only on account of damage to the expressway proper but also to adjacent properties. It may be possible to increase the permissable height of the embankment by excavating the soft material and replacing it with firmer soil, but in either case consideration must be given to this matter in order to obtain the proper economic picture.

The slopes of embankments and cuts should be quite easy, preferably not less than 2-1/2 to 1. This, together with suitable planting of the slopes, will protect their integrity and reduce the cost of maintenance, but in the economic study, consideration must be given the additional cost of right-of-way and material required for the easy slopes.

Where the width of right-of-way is limited, the earth slopes can be replaced with retaining walls, or steel or concrete viaduct structures may be used, but the cost of the structure will generally be greater then for embankments with earth slopes, although the cost of right-of-way may be less.

Public utility subsurface structures in existing streets, including gas and water mains, sewers, electric conduits, large water conduits, rapid transit subways, and others, will affect or make prohibitive the use of embankments or open cuts. Even the cost of foundations for viaduct structures may be materially increased on account of the presence of subsurface structures.

A characteristic of a viaduct structure is that there are open spaces below the deck and between the supports. Under certain conditions this open space can be useful for parking purposes, but it should not be used for storage in such a manner that it will interfere with inspection and maintenance of the structure. If not properly lighted and policed, the space may readily become a serious public nuisance or danger.

Advantage should be taken of any means to bring daylight under viaducts and bridges, and this should be supplemented with adequate artificial lighting. Arrangements for the lighting should be carefully made in the early design stage and should not be an afterthought.

Expressways in open cuts are sometimes felt, by the communities they pass through, to be less objectional barriers than would be embankment structures. They may involve extensive reconstruction of existing structures and consideration must be given to the elevation of the groundwater level, in its relation to the structure as well as to the methods and cost of removing water and snow from the roadway.

Where the right-of-way width is limited, retaining walls can be used in open cuts in place of slopes. As high unbroken vertical retaining walls on both sides of the expressway may have a depressing effect on the users of the road, a terraced design giving an opportunity for planting and landscaping will be worth considering.

Where additional surface street area is needed the open cut can be covered over part of the width of the expressway, and used for street purposes.

Subway construction should have the roof below the general depth of sub-surface structures. Ample means of ventilation as well as for pumping and lighting must be provided. Owing to the high cost and the want of scenic possibilities, the use of subways for expressways is not indicated except for short lengths, or where other suitable means are not available.

In hilly areas the use of tunnels may be found of economic advantage. They may shorten the length and time of travel, and cause improved traffic conditions in foggy and wintery weather. If the tunnels are short, artificial ventilation may be unnecessary if the cross section of the tunnel is sufficiently large. For longer tunnels, ventilation may be provided by properly spaced ventilating shafts, or longitudinal ventilation. Suitable fan equipment is required for both.

The principal purpose of an expressway in a city is to improve travel conditions. A common obstruction to travel is a vehicle which has become disabled on the road. If it remains on the regular travel lanes it becomes an accident menace and may seriously delay the traffic. Therefore, whatever the type of structure may be, the expressway should, throughout its length, be provided with a shoulder strip outside of the land area, preferably as wide as a lane, but at least wide enough to permit continuous traffic when a disabled vehicle is using the shoulder strip for refuge.

LOCATION OF TRAFFIC INTERCHANGES

The primary function of controlled-access urban expressways is the provision of an adequate artery to serve the vehicular traffic needs within the urban area. In the designation, "controlled-access" is the connotation of the restriction of immediate entrance and exit between the expressway and properties fronting on the expressway. Access is provided only at designated points. Thus, spacing of the accesses becomes one of the most vital aspects in the planning and design of urban expressways.

The term, "traffic interchange", as used in this discussion, means literally any point where there is an interchange of traffic between the expressway and other highway or street, even though the interchange may not be necessary or possible for all direction flow of traffic. The term, "interchange" is used to designate the turning facilities at the intersection or junction of two or more main highways in conjunction with grade separation.

An expressway is a highway which provides express service for vehicular traffic. As in railroads, a highway which "makes all the stops" is not an expressway. However, a "non-stop" highway through a city in similar manner to a by-pass, would serve only through traffic and benefit the city only by removing the through traffic from the city streets. The urban expressway is usually planned to serve various types of traffic. For through traffic it should provide a relatively uninterrupted flow. However, its greatest service is in facilitating the flow of traffic between the business district, or districts, and outlying residential areas or other points outside the city. The pattern of spacing of interchanges must conform to this principal function.

It follows, therefore, that access should generally be more frequent in these terminal areas, that is, in the outlying residential districts and in the central business district with access somewhat less frequent in the intervening areas. Access at a distance from the business district would not conform to this function. Ordinarily such traffic can be best served by the existing streets.

No exact or fixed criteria for the spacing of interchanges have been developed. For instance, no rule has been, nor can be, developed which states that access should be provided at regular intervals such as one thousand feet or one mile. In this discussion, which is restricted to urban expressways, the subject or problem is one of proper location rather than of spacing of interchanges. The question, rather than being primarily of how far apart should they be, is one of where they should be. The criterion for location of an interchange is usually one of economic justification balanced against its effect on the efficiency and function of the expressway.

1. Volume of Traffic Justifying a Traffic Interchange.

First in the consideration of the location or spacing of interchanges is the question of traffic volumes. No expressway can be planned or designed wisely without adequate counts of traffic volumes within the area affected by the expressway. These counts must be carefully compiled, analyzed, and plotted to present a clear picture of the existing traffic pattern.

But a count of the over-all traffic volumes alone is not sufficient. Careful planning of the location of interchanges requires more detailed traffic data, data which will segregate and show the pattern of that part of the total traffic with which the design of the expressway should be concerned. Such traffic is that which the expressway would handle when properly designed to serve its principal function. In order to obtain this segregation of traffic volumes an origin and destination study must be made. This study should be as complete as possible and should be planned with the purpose of obtaining the picture of the pattern of traffic concerned with the expressway. Intracity traffic, sometimes neglected in cordon-type origin and destination surveys of cities, merits careful consideration.

The data from traffic studies should, of course, be adjusted, expanded or projected to fit the time of completed construction and for a reasonable period in the future as well.

On the basis of a general examination of the traffic data with an on-the-spot knowledge of local traffic behavior, tentative locations for interchanges can be determined. A flow diagram of anticipated traffic then may be made. This diagram should include an interchange turning movement, that is, an estimate of the traffic volume on each access drive or ramp as well as on the main roadways. Consideration should be given to long-time average counts and to peak conditions. The resultant pattern of traffic on existing streets is given principal consideration.

This analysis may readily give an indication of whether or not the access is needed and, if so, what its design capacity should be. However, the scope of the problem extends beyond that of need for access. There is the added consideration: "Is the access economically justified?" It has been mentioned that a numerical criterion for justification is not possible. The nearest approach to a numerical criterion is a benefit-cost ratio derived from a study of economic justification. The tools for this type of investigation in highway planning have not been fully developed but they are sufficiently accurate, when judiciously employed, to demonstrate whether or not a proposal is justified. Methods of economic analysis for the justification of entire highway projects have been used in a few cases, and the system is becoming more widespread. These same methods may be used to justify the construction of an interchange.

On the basis of the estimated traffic volumes, the benefits from the proposed interchange may be evaluated. These benefits may be direct benefits to the users as calculated from the difference in cost between using the proposed facility and an alternate or existing route, or they may be indirect or community benefits to the area served. The cost includes the original and maintenance costs for the period specified. The ratio of this benefit to the cost will serve as a guide to justification.

2. Factors of Convenience and Service Regardless of Traffic Volumes.

In the above method of analysis, the factors of convenience and service may be evaluated along with other factors or benefits. They may not necessarily be a direct function of traffic volumes, but nevertheless they should be evaluated as benefits. It is impossible to evaluate convenience and service precisely, but as factors in the economic justification of an interchange a reasonable monetary value can be assigned to them with sufficient accuracy to become a part of a sound analysis.

3. Factor of Desire to Develop a Backward Area.

It is sometimes said that an interchange may be built in order to develop a backward area even though it is not "economically justified". However, in the light of the interpretation of economic justification as herein discussed, the interchange so planned would be economically justified since the decision involved some monetary evaluation of future benefits in relation to its estimated cost. An exact dollar value of future benefits may not have been stated in the analysis, but some rough conception of its magnitude must necessarily be involved in any reasonable consideration of the problem.

The decision may later be proved to be unsound, or for some causes not anticipated, the location of the interchange may not have proved justified, but at the time of the analysis it may have been justified.

In order to arrive at the justification of an interchange for the purpose of developing of an area, the period of years used as a basis of analysis is very important. It is obvious that in twenty years an interchange may have been proved justified when in one year it could not be considered justifiable. Practical limitations are put on the length of time involved by physical life of construction components, capital costs, etc.

4. Effect on Efficiency of Expressway.

It was stated previously that a highway with too frequent access could not be an expressway. The frequency of access to an expressway does affect its efficiency. At any point of interchange of traffic the smooth flow and safety of traffic is somewhat hampered even though the connection is well designed. Safe speed of travel is thus affected, but the efficiency of the expressway is not rendered completely ineffective unless too frequent access reduces this speed to a point at which the new facility offers no advantage over the existing streets. An expressway without intermediate access to the areas intended to be served would be efficient for through traffic, but it could not be considered efficient in an over-all sense.

Certain physical considerations such as required length of acceleration and deceleration lanes, the number of lanes, weaving distance and design speed would determine a minimum distance between interchanges provided normal design standards are maintained. This problem is particularly evident at a point of intersection of expressways when local access at that point must be provided.

Again no numerical criteria exist for the determination that access is too frequent. It may be stated as a general principle that, when frequent access is required, it is desirable to construct a reasonable number of high-capacity interchanges with adequate feeder connections rather than many minor access facilities.

Ordinarily the justification of an access or interchange may be made on an economic basis. There are, however, other factors which figure in the decision; factors which are characterized by force or pressure and not of free choice on the part of the planner. These factors include the legal, political, or military necessity of providing access where the economic necessity is not sufficient. Sometimes, too, physical barriers or adverse topographical conditions dictate the location of an access at a given location instead, for instance, of continuing parallel service roads.

It sometimes happens that an access may be demonstrated to be entirely justified economically but that available funds are not sufficient to include it. Thus the "ability to pay" is an important factor in the location of interchanges.

DESIGN OF TRAFFIC INTERCHANGES

1. General Considerations.

It is considered that the scope of this report concerns only traffic interchanges between expressways and surface street systems in urban areas. "Traffic interchange" as used herein refers to the interchange between expressways and the surface street system unless otherwise stated This report is not primarily concerned with the detailed geometric design of traffic interchanges. Rather its purpose is to discuss those elements of design of traffic interchanges which concern their relationship to the existing street system and the effect of the interchanges upon, and the service which they render to the urban area in general and the district traversed in particular.

While some general rules and governing considerations may be laid down to guide the designer, it will normally be found that each traffic interchange is a special problem which can best be solved only after analysis of all related factors. When the location, general type and required capacity of the interchange has been determined, actual detailed design and planning may be carried on in accordance with recognized design standards.

The judicious spacing and design of traffic interchanges is of vital importance to the greatest efficiency and use of the expressway and surface street system. Spacing was discussed more fully in the previous section. As noted too many interchanges will hamper the smooth flow of traffic along the expressway. Conversely, too few interchanges will reduce the value of the expressway in providing, the communities or districts through which it passes, the maximum traffic relief or transportation service. It is necessary therefore to balance these two factors to assure a facility which will provide the greatest efficiency and safety of movement and the maximum of traffic service to the urban area. The adopted spacing and design of interchanges should be determined only after an exhaustive study has been made of all factors relating to the expressway design.

Normally, connection will be made to the surface street system either directly to or in close proximity to a major surface artery which is to be kept open across the expressway. Such an artery is usually already carrying a heavy traffic flow. It is therefore undesirable, if it can be avoided, to introduce additional intersections into these busy arteries, or to create intersections which are difficult to control by traffic regulatory devices. These intersections will create additional turning movements, interferences to traffic flow and traffic hazards which may tend to reduce the efficiency of the surface artery, thus reducing the overall benefit which the urban area will derive from construction of the expressway.

Where it is necessary to create new intersections in or directly connected to a major surface artery, the design should preferably be one which does not involve left-turning across traffic at grade. However, it is found in developed urban areas that the expense of grade separating all left turns on surface arteries is so great, and the taking of land so serious in its effect on the district, that it is not feasible to design this type of traffic interchange except in unusually favorable cases. Left-turning in the direction of the heaviest traffic flow or flows may at times be grade separated by special construction, but where this is done, considerable thought must be given to the possibility that future development in the vicinity may alter the pattern of traffic movements, and thus reduce the value of the partial treatment. Locations in a park, public land or in marginal undeveloped areas may permit a design which grade separates all left turns.

The pattern of the surface street system and the angle of the crossing of the expressway, together with a determination of the necessary directions of movement and the volumes of such movements to and from the expressway, are controlling elements which affect the design of the traffic interchange.

Ramps should be designed to provide sufficient moving and storage capacity so that the continuous flow of traffic along the expressway is not hindered. They should be of sufficient length to permit transition between expressway speeds and surface traffic speeds and to provide sufficient storage space so that cars will not overflow onto the expressway or beyond the entrance at the surface artery while making the transition to surface artery or expressway. Properly designed acceleration and deceleration areas should be provided along the expressway in connection with ramps. Except for short ramps having minor use, two lane width or a traversable shoulder should be provided so that disabled cars will not block the ramp. Where off-ramps enter the surface artery and where on-ramps enter the expressway it is desirable to reduce the width to one ample lane (usually 14 feet wide) to (1) discourage illegal entrance of traffic from the surface artery and (2) encourage the use of the accelerating area in entering the expressway.

2. Types of Expressway Interchanges:

a. Interchanges Eliminating Left Turns (Types a)

a-1. Cloverleaf Interchanges - (Types a_1). The type of interchange which eliminates all left turns across

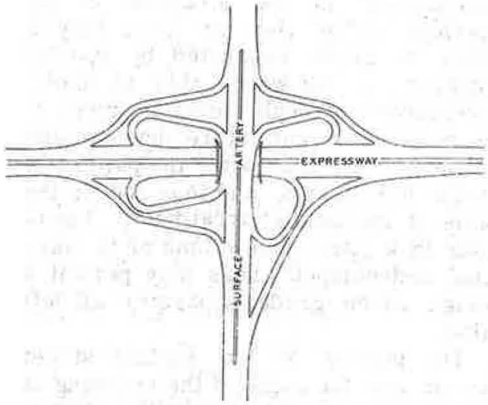

Figure 1. Typical Cloverleaf at Intersection - Surface Artery with Expressway - Type a_1.

traffic with the least additional construction cost is the cloverleaf. A typical cloverleaf is shown in the illustrations as "Type a_1". A cloverleaf interchange, while not usually suitable at the intersection of two expressways because of the low volume traffic which may be handled through it, may be satisfactory in some cases as an interchange between expressway and surface artery. The cloverleaf type involves additional travel distances for the left-turning movements. Its capacity for left-turning traffic is limited by the relatively small radii of the cloverleaf turns, which govern the possible speed of interchange and the length of storage space available before cars back into the expressway. A serious disadvantage of the cloverleaf, especially from the standpoint of traffic along the expressway, is the short weaving distance available for traffic entering and leaving the expressway. This acute angular crossing of traffic is hazardous to traffic along the expressway and to a lesser degree is also hazardous to traffic along the surface artery. Furthermore, it is difficult to regulate traffic along the surface artery at a cloverleaf because of the large radius turns by which traffic enters and leaves the surface artery. Protection of pedestrians walking through the intersection along the surface artery is also difficult. A cloverleaf interchange requires the acquisition of a large amount of right-of-way. For the

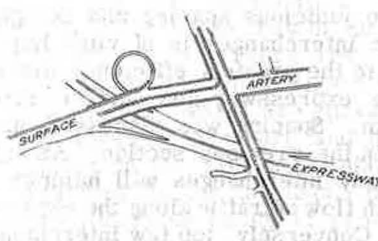

Figure 2. Typical On and Off Ramps - Type a_2.

above reasons its use as an interchange in developed urban areas is limited.

While it is rarely practical from an economic standpoint to eliminate or separate the grades of all left turns at an intersection of expressway and surface artery, it may be practical and desirable to grade separate the heaviest left-turning movement or movements. Where the intersection varies considerably from a right angle it is not always necessary to provide for turning movements in all directions and a partial treatment may therefore be more readily accomplished. Sketch "Type a_1" (partial) shows a partial cloverleaf which eliminates only one left-turning movement at grade into the surface artery.

Many geometric variations of these designs are possible.

a-2. Direct-Connection Interchanges (Types a_2)- This type of interchange includes all those in which left turns are eliminated or grade separated by special construction and wherein turning movements are accomplished with little if any additional travel distance. The interchange of traffic from expressway to surface artery is accomplished with no grade crossings of traffic and with a minimum of merging friction or weaving of traffic.

While theoretically very desirable, direct-connection interchanges become very costly for these usually require several levels of construction with considerable structural expense or large areas of land with consequently high right-of-way costs. A complete interchange of this type could seldom be

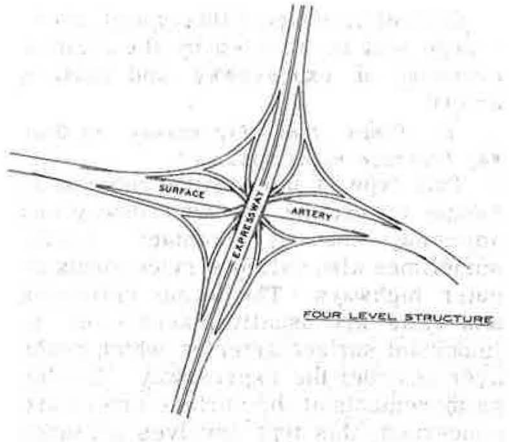

Figure 3. Direct Connection Interchange - Type a_2.

economically justified between an expressway and surface artery in a developed urban area. Again, however, as in the case of the cloverleaf intersection, it may be possible to use the direct interchange principle to provide grade separation for the heaviest or heavier turning movements.

The direct types of interchange may require less right-of-way than the cloverleaf type but are usually more costly in construction expense. A "4-level" intersection providing grade separation for all left turns is shown in the illustrations as "Type a_2" and a "3-level" and a "2-level" intersection at an acute angle which provide for grade separation of certain left turns are shown as "Type a_2" (partial). The above types are very attractive for expressway interchanges and their additional costs can usually be justified for such intersections. Many other geometric variations of this type are possible.

b. Direct Ramps from Expressway to Surface Artery (Type b).

This type of interchange consists of ramps leading directly from the expressway to a surface artery passing over or under the expressway. It is commonly used where no service or frontage roads are provided adjoining the expressway and requires little additional right-of-way at the intersection of the two thoroughfares. If the expressway occupies the location of a

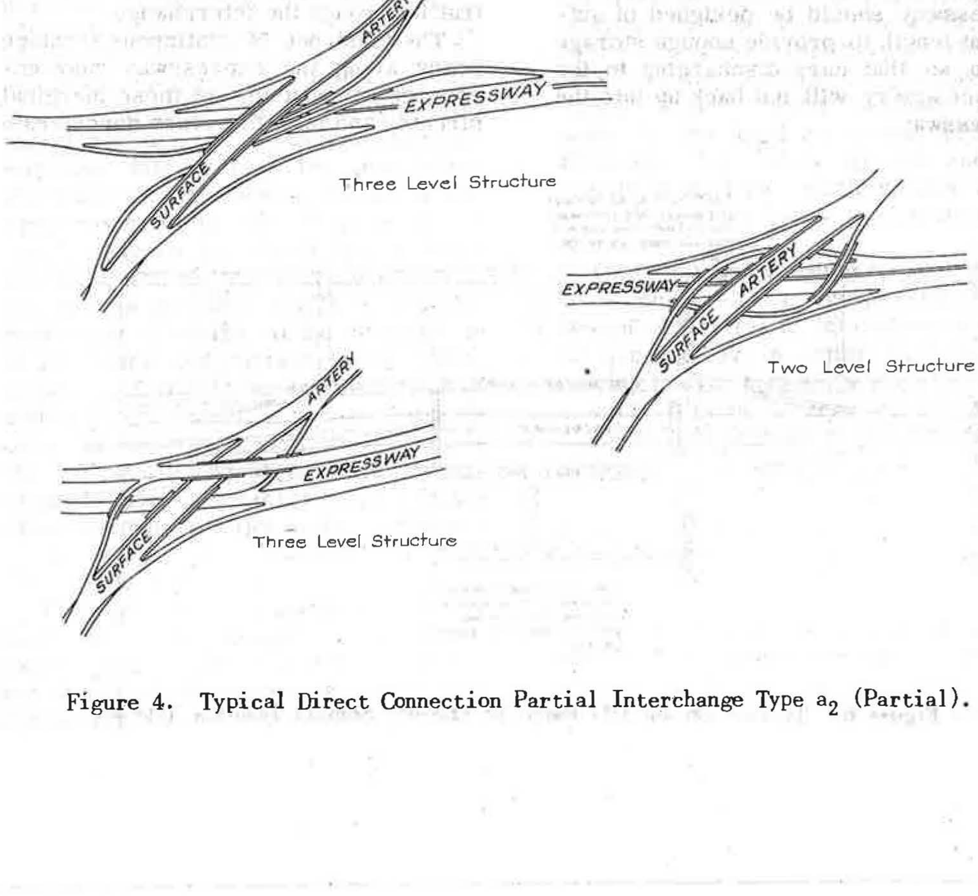

Figure 4. Typical Direct Connection Partial Interchange Type a_2 (Partial).

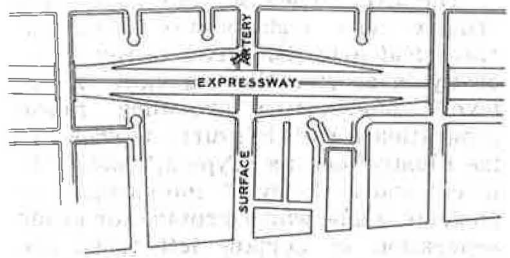

Figure 5. Typical On and Off Ramps - Type b.

former existing street crossing the surface artery, no new intersection is created or turning movements added along the surface artery. If the expressway is along a new right-of-way, an additional intersection is created at the surface artery, involving 4-way left turns across the traffic along this street. If the turning movements are large, or the flow of traffic along the artery is heavy, regulation of the intersection by traffic signal may be required. Such signals should be timed with other signals along the surface artery in order not to delay the flow of traffic along the artery. The ramps from the expressway should be designed of sufficient length to provide enough storage space so that cars discharging to the surface artery will not back up into the expressway.

Geometric design of this type of interchange will be affected by the angle of crossing of expressway and surface artery.

c. Ramps from Expressway to One-Way Frontage Roads (Type c).

This type of interchange consists of ramps connecting the expressway and adjoining one-way frontage roads, sometimes also called service roads or outer highways. The ramp entrances and exits are usually placed close to important surface arteries which cross over or under the expressway. Insofar as movements at the surface artery are concerned, this type involves all turns which occur at a surface artery with a "Type b" interchange. However, it is possible by traffic control to prohibit left turns across the surface artery traffic either entirely or during peak hours and require the accomplishment of this movement by circling the block to the right via existing surface streets if the street pattern permits. The suggested movement is shown on the illustration of "Type c". While this may introduce considerable additional travel for left-turning traffic it may be warranted to provide for smooth flow of traffic through the interchange.

The existence of continuous frontage roads along the expressway may encourage an undue use of these marginal streets, and may therefore concentrate

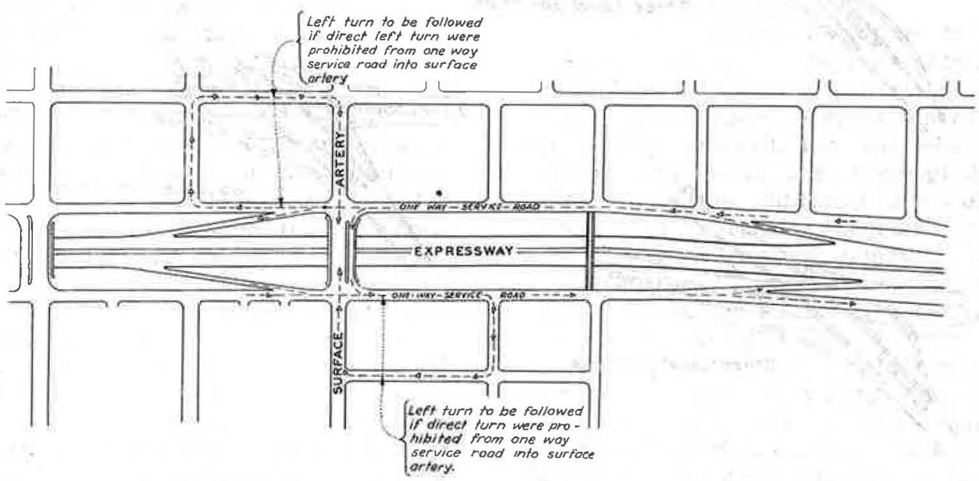

Figure 6. Typical On and Off Ramps at One-Way Service Roads - Type c.

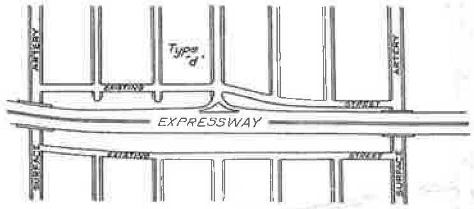

Figure 7. Typical On and Off Ramps - Type d.

large volumes of cross traffic alongside the expressway at the major arteries. This condition tends to partially offset the value of the grade separation of traffic effected by construction of the expressway. Where existing surface streets parallel the expressway, not too far removed therefrom, it is therefore not desirable to create new frontage roads which are continuous over long distances.

d. Ramps to Existing Streets Paralleling the Expressway (Type d).

This type of interchange may be used between an expressway and an existing 2-way street paralleling or adjoining the expressway. On and off ramps should be provided with as generous radii as possible, a desirable minimum being 130 feet. The outlets and inlets of the ramps at the surface street should preferably be aligned (in the proper direction of travel) with an existing local street not carried across the expressway but intersecting the paralleling marginal street. Where design of expressway permits, the off ramp and on ramps may be separated one or more blocks apart at the surface street to obtain less potential conflicts or concentration of traffic at the intersection of the ramps and surface street. Distribution of traffic to and collection of traffic from major surface streets crossing the expressway may be made via the paralleling street, with no additional street intersections being created along the major surface arteries.

e. Ramps to Stub-end Existing Streets (Type e).

This type of interchange consists of inlet and outlet ramps connecting the expressway to the stub-end of a street not of sufficient importance to be continued across the expressway. No additional intersections in the surface street system are created by such interchange. Distribution of traffic to and from the major surface arteries is not as direct as in the case of some of the other interchanges.

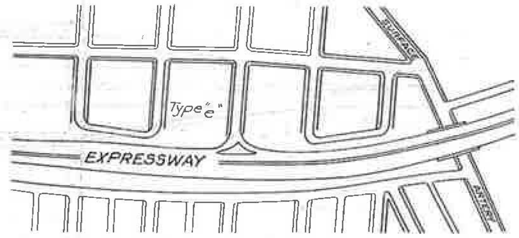

Figure 8. Typical On and Off Ramps - Type e.

f. Ramps to Pairs of One-Way Streets (Type f).

This type consists of direct ramps from an expressway to a pair of one-way surface arteries crossing the expressway with connecting frontage roads. Its use involves the crossing of one-way traffic for left turns into or out of the one-way street, but only merging movements for other turns.

In the planning of an expressway within a developed area, it will probably be found that any or all of the above described types may be applicable at different points along the expressway. The selection of the type to be used at any particular location must be made on the basis of the local conditions with due allowance for future growth and for change in the local traffic pattern which will necessarily follow the construction of the expressway.

Other things permitting, there should be as much uniformity as possible in the design of the traffic interchanges along an expressway in order that the fast moving traffic may know what to expect at each point of interchange and that no element of surprise or uncertainty is present.

3. Volume of Traffic Justifying Elimination of Left Turn on the Existing Street.

Principal objectives in the design of traffic interchanges are the following:

a. At the expressway.

To permit traffic entering the ex-

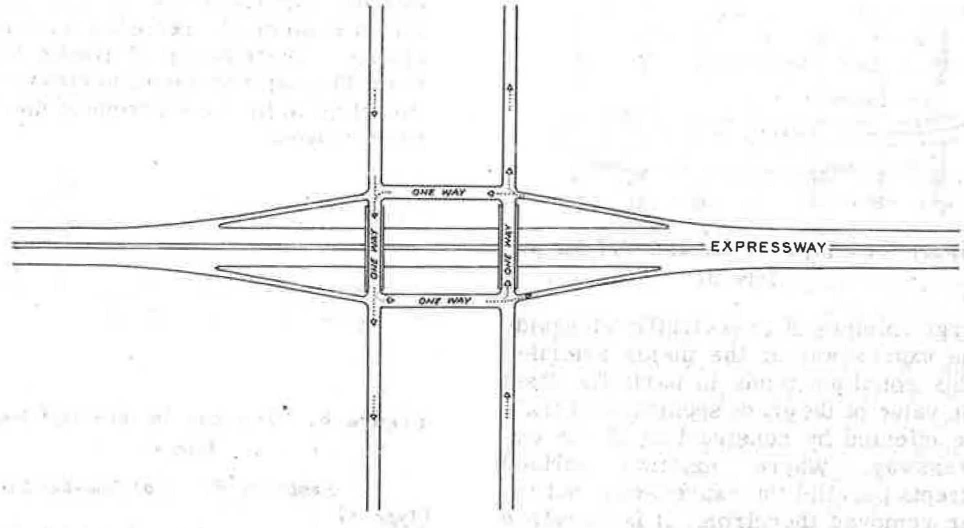

Figure 9. Typical Ramp System at Intersection with Pair of One-Way Streets - Type f.

pressway or leaving the expressway to do so without interfering with the smooth flow of traffic along the expressway.

b. At the surface artery.

To permit traffic moving from the expressway to blend smoothly with the surface street traffic without delay or hazard to either stream of traffic. To permit traffic moving from the surface artery to enter the ramp without delay or hazard to the surface artery traffic.

In connection with objective (b) above, left turns at grade across the surface artery to and from the interchange ramps will naturally affect to varying extents the smooth flow of traffic. Basically, as previously stated, it is therefore desirable to eliminate left turns at grade by design wherever possible or particularly where the number of left turns is sufficient to materially reduce the capacity of the surface artery and the expressway ramps.

Extensive studies of intersection capacities have been reported on by the Committee on Highway Capacity of the Highway Research Board. These include the effect of turning movements on the traffic capacity of an intersection. These data will permit close estimating of the traffic volumes which can be handled through any specific intersection and, therefore, an analysis of the effect of permitted turning movements on the capacity of that intersection. It then becomes the problem of the designer to determine whether this effect will be detrimental to the general traffic flow and whether it is desirable to eliminate left turns at the intersection in question.

The amount of left-turning traffic which can be or should be accommodated at an intersection will be governed by such special considerations as the location of the expressway and the characteristics of traffic flow and traffic control along the surface artery.

For example, if on either side of the expressway intersection, there are traffic signals and permitted left turns between the artery and cross streets, there would appear to be no great need for going to considerable additional expense to eliminate left turns at the intersection of the expressway ramps. Where it is possible to control the traffic along the surface artery at the interchange in such a way that there is no overall delay to traffic along the artery, and the expressway ramps effectively handle the traffic wishing to use them, certainly the elimination of left turns is not justified.

It is probable that there cannot be set up a fixed rule or numerical basis on which to conclude whether left turns should be eliminated. A few left turns might possible disrupt traffic along an

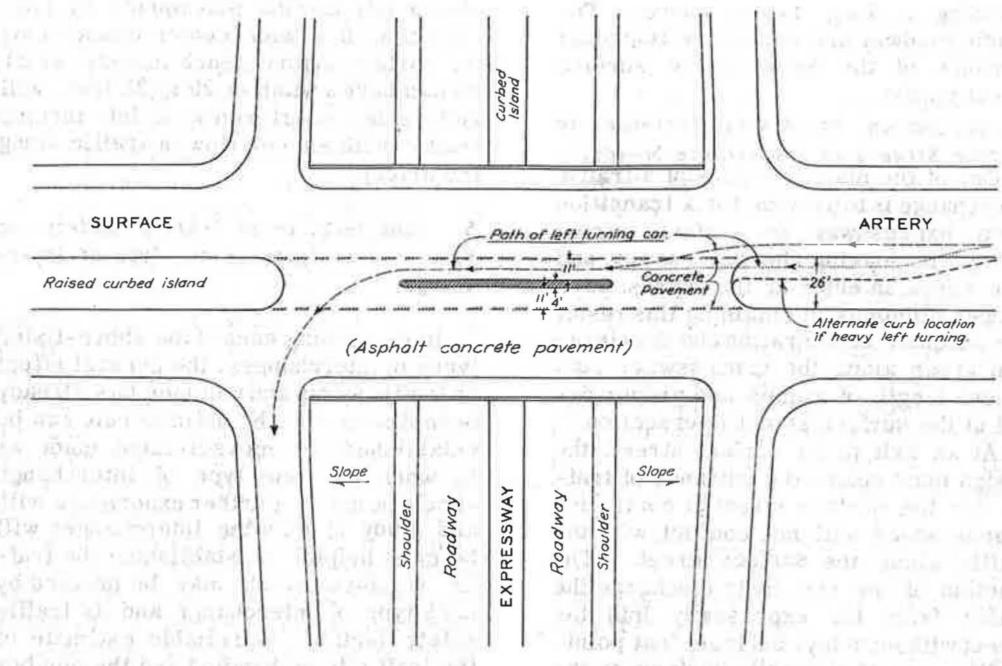

Figure 10. Protected Left Turns at Expressway Ramps.

artery carrying its maximum traffic, whereas a large percentage of traffic entering a less heavily traveled artery might make left turns without causing serious delay to other traffic.

In addition to traffic considerations, a major factor in considering the elimination of left turns at grade will be the economic consideration of the additional cost of facilities to eliminate the left turns.

4. Design at the Existing Street Connections, Left Turn: No Left Turn.

Design of ramp inlets and outlets at the surface artery, together with design of the roadway of the surface artery, should be pointed to the accomplishment of the objective in 3 (b). Following are some of the major considerations which must be carefully studied.

a. Protection Against Entry of Traffic at Off Ramps.

The danger of traffic entering the expressway at off ramps must be considered in its design. Reduction in the width of exit to one generous lane width, usually 14 feet, with appropriate signing, will usually be effective in reducing illegal entrance. If the off-traffic exceeds one lane capacity, a redesign of the surface street roadway may be required to provide against the contingency of improper entrance.

b. Islands at Exits of Off Ramps.

Islands are sometimes placed in the exit of an off-ramp in order to divide the right-turning traffic from the left-turning traffic. This may permit the right-turning traffic to move continuously while the left-turning traffic is waiting opportunity to move and thus expedite the movement of traffic through the intersection. However, some disadvantages should be mentioned.

Any island in a traffic stream is a potential hazard. To relieve public responsibility, it must be well lighted, and a flasher or reflectors should be installed to give warning of its presence. The presence of an island increases the difficulty of controlling the intersection by traffic signals where this is necessary and may encourage right-turning traffic to enter the intersection at excessive speeds unless such entrance is controlled by boulevard stops. The hazard to pedestrians is also materially increased by the width of the crossing and the unusual direction of traffic rounding a long radius curve. The double roadway may encourage improper entrance of the off-ramp by surface street traffic.

c. Design to Assure Entrance to Surface Streets at Appropriate Speeds.

One of the main functions of a traffic interchange is to provide for a transition from expressway to surface street speeds in leaving the expressway and vice versa in entering the expressway. Proper elements in obtaining this result are adequate acceleration and deceleration areas along the expressway, sufficient length of ramps and proper detail at the surface street intersection.

At an exit to the surface street, the design must insure the entrance of traffic into the surface street at controlled speeds which will not conflict with the traffic along the surface street. The function of the exit is to discharge the traffic from the expressway into the street without delay, but from that point, traffic must of necessity conform to the limitations of traffic along the surface street. There is, therefore, usually no advantage in large radii turns or other features which would encourage rapid and uncontrolled entrance of traffic into the surface artery.

It may be necessary to control traffic entering the surface street by boulevard stop or traffic signal.

d. Positive Elimination of Left Turns.

If it is possible to provide convenient access to and from the expressway by prohibiting left turns on the surface artery, this may be accomplished by an actual barrier consisting of a raised curbed island along the center of the artery. Such barriers may also be used to discourage illegal turns into exit ramps. Auxiliary roadways on grade separation bridges may be provided across the expressway to permit "U" turns between one-way frontage roads without the necessity of traffic entering the main roadway of the surface artery. An auxiliary roadway of this type is illustrated on the drawing of Type "c" interchange.

e. Protection of Left-Turning Movements Along the Surface Artery by Center Island Construction.

In some cases it may be possible to shield left-turning movements by construction of a wide center island along the surface artery. Such islands, which should have a width of 20 to 25 feet, will reduce the interference of left-turning traffic with smooth flow of traffic along the artery.

5. Consideration of Traffic Safety and Volumes Justifying Each Type of Interchange.

In describing each of the above-listed types of interchanges, the general effect on traffic safety and volumes has already been discussed. No definite rule can be established nor measurement made as to when any one type of interchange should be used. Further experience with and study of existing interchanges will be most helpful in establishing the traffic volumes which may be handled by each type of interchange and its traffic safety factor. A reliable estimate of the traffic to be handled and the number of turning movements is essential in the selection and design of the traffic interchange. Having this information the data gathered by the Committee on Highway Capacity, Highway Research Board, will be a helpful guide in the selection and design of interchanges. Each design must be based on a careful analysis of the situation and requires close cooperation between the designer and the traffic engineer.

BRIDGING EXISTING STREETS

In the location and design of a controlled access, urban expressway, bridging existing streets poses two problems: (1), Carrying some existing streets over or under the expressway; and, (2) grade separation of feeder streets in areas tributary to the expressway, to accommodate present or anticipated local overloads.

1. Expressway Grade Separations.

A controlled access expressway presents a barrier to movements of traffic from one side to the other unless cross roadways are under- or over-passed. However, all local streets and roadways in an urban area cannot be so bridged. The cost would be prohibitive. Crossings can be constructed only at reasonable spaced intervals unless traffic demands or other controlling factors require more frequent facilities for cross movement.

Crossings are ordinarily provided at or near expressway interchanges and ramp connections. Thus, necessary interchange facilities spaced at intervals along the route of an expressway, the locations of which are primarily determined by heavy traffic demands that must be accommodated and which are adjusted to physical conditions, automatically include reasonably adequate provision, in most instances, for cross movement of both local and expressway traffic. Since such interchanges or ramps are usually at or near points of intersection of the expressway with main cross and feeder roadways which carry heaviest traffic and which provide best distribution, the problem remains of determining what other cross roadways should be bridged for local reasons.

Studies of present and future traffic loadings will indicate the effect of the expressway on the local street system and if the development of the areas it serves will increase, reduce, or shift the traffic load at various points along its course. Such studies will also indicate the measure of intermediate traffic demands for cross movement. Traffic needs thus determined must then be balanced with physical conditions and cost to establish the best locations for necessary intermediate or local crossings. Since the location of grade separations must be adjusted to elevations, adequate bridge clearances, railroad structures, public utilities, streams, local drainage and other physical factors, they cannot always be placed to greatest traffic advantage.

In sections where additional grade separations are determined to be necessary, locations should be selected that will serve the greatest total cross flow of traffic and as many other streets in the area as possible should be connected to the crossing by service roads parallel to the expressway, if the local street system does not serve this purpose.

Criteria for additional crossings include consideration of the following factors:

a. Important through streets or highways, now connecting significant traffic generating areas which will be divided by the expressway, cannot normally be dead-ended and must be over - or under-passed or detoured and combined with other crossings.

b. Cross movement of fire apparatus and other emergency services must be facilitated by reasonably direct routings.

c. Schools, other important public functions and services, business centers and churches require direct or at least reasonably satisfactory cross traffic connections or pedestrian overpasses.

d. Important transit facilities, that cannot be re-routed, will require accommodation for cross movement without excessive detour.

e. Conveniently direct access for vehicles and pedestrians to transportation terminals or stations must be arranged if other cross connections and parallel streets or service roads do not already provide this accommodation.

f. Pedestrian movements.

2. Bridging Streets in Tributary Area.

The construction of an urban expressway frequently increases the traffic load and intensifies congestion on local feeder streets in tributary areas. The utility of a costly expressway will be seriously reduced if these conditions result in retarding or blocking the local collection, discharge and dispersal of expressway traffic. Circulation of local traffic will also be seriously interfered with.

Thus, the construction of an expressway requires coordinated action on the part of state and local officials to take all necessary steps to reduce present and anticipated traffic congestion to an acceptable level. In some instances, grade separation of important local street intersections may be required. Such grade separations are costly and should be undertaken only after all other alternatives have been thoroughly explored and found to be inadequate to meet requirements.

Alternatives include steps listed below under "Opening New Streets and Improvement of Existing Streets". An analysis should also be made of local ramp and interchange facilities to the expressway which, together with service roads, may be capable of arrangement to distribute the traffic load and to ease the burden on local streets that will be seriously affected. Thus, it is often possible, by means of expressway service roads, to collect and disperse local traffic over a number of local streets rather than to concentrate the load on one or more main arteries. This may also avoid grade separations of important feeder streets.

Assuming that all possible lesser steps to relieve present and anticipated congestion are taken and that traffic demands will still exceed the capacity of local intersections, one or more grade separations may be indicated. However, unless the benefit cost ratio, calculated for each such separation, is two to one or greater or other major local controlling factors prevail construction of such grade separations may well be postponed or avoided because of excessive cost and marginal benefits.

OPENING NEW STREETS AND IMPROVEMENT OF EXISTING STREETS

Plans for the development of a controlled access urban expressway should include consideration of street improvements that may be required in tributary areas to provide suitable expressway access and egress and ample street capacity to meet local traffic demands.

1. *Opening New Streets.*

Steps listed in the next section, "Improving Existing Streets" should be thoroughly explored to determine if limited improvements and better management of traffic and of traffic facilities will provide the relief required.

Service roadways parallel to an urban expressway, and usually but not always within its right-of-way, should be constructed where necessary to afford street frontage and access to adjacent property and to facilitate local collection, distribution and interchange of expressway traffic.

Right-of-way and design requirements of an expressway may necessitate the closing of some local streets and the substitution of new ones.

Adaption of local streets to expressway service roads and to interchanges and access ramps may require new street connections for more direct access and traffic reservoir capacity or to segregate, detour or by-pass traffic.

Future development and expansion of local industrial, commercial or residential traffic generating areas may require construction of or provision for new streets to serve as feeders to the expressway.

Additional streets may be needed to add traffic capacity to the existing street system or to permit the establishment of balanced pairs of one-way streets so that heavy increases of local traffic, generated by the expressway, may be accommodated.

2. *Improving Existing Streets.*

Streets reasonably adjacent and parallel to the expressway can often be improved and adapted to function as service roads to the expressway. Rights-of-way, preferably 100 feet wide or more, and greater widths on streets of unusual importance, should be provided on all major streets carrying local expressway traffic. Provision should also be made that major streets through all new subdivisions conform to these width standards. Such streets should carry at least two lanes of moving traffic and one lane for loading and parking at the curb in each direction and be provided with sidewalks of reasonable width. Where funds or other circumstances do not permit initial widening, set back ordinances may be passed to develop necessary widths of rights-of-way in the future as new buildings are constructed or old ones remodeled.

Other steps that may be taken to the extent necessary to insure that the local street system has adequate capacity to accommodate increased local traffic loadings developed by the expressway include:

a. Arrange service roads to permit collection and distribution of expressway traffic via as many local streets as necessary or possible.

b. Widen, resurface, repair or replace old pavements on major feeder streets.

c. Straighten and eliminate jogs and offset streets and extend and connect interrupted streets.

d. Adjust street grades to modern standards.

e. Channelize street intersections and abnormal pavement areas.

f. Increase radius of curb returns to facilitate right turns at intersections.

g. Establish one-way streets to increase their traffic carrying capacities.

h. Correct improper parking and loading and develop off-street parking and truck loading facilities.

i. Arrange sidewalk improvements to accommodate pedestrians and bus loading at points of concentration.

j. Anticipate and provide for convenient interchange of transit passengers between busses operating on the expressway and on local streets by arranging suitable bus loading zones or turn outs on both.

k. Encourage greater use of mass transit vehicles.

l. Coordinate the timing of traffic signals at street intersections.

m. Arrange for strict local enforcement of appropriate traffic, parking and loading regulations and other traffic controls required.

PUBLIC UTILITIES

1. General Considerations.

Public utilities provide services which are essential to the every day activities and welfare of all residents of an urban area. Whether utilities are privately or publicly owned and operated, interruption or costly changes in such facilities are of concern to the public who must pay the ultimate cost either directly or indirectly.

The location of existing and future public utilities is therefore an important factor in expressway design, from the preliminary location studies onward to the preparation of final plans. In relation to design, each location will present its own set of conditions and will constitute a problem demanding original investigation. It is important that the replacement in at least equal condition of all utilities affected by the expressway and their proper maintenance during construction, be treated as an essential element of the expressway design.

The future expansion of utility lines as well as future changes in population, traffic patterns and land use and development must be foreseen so far as such foresight is possible. It is a proper function of expressway design to work closely with planning bodies and all other agencies whose activities bear on future urban development, so that provision for possible future expansion may be included in present construction. There is probably a point of diminishing returns in speculations as to growth that appears distant in time, but it must be remembered that an expressway is an enduring improvement, which should be designed for a long period of usefulness.

2. Responsibility for Utility Changes made Necessary by Expressway Construction.

The principle usually incorporated in franchises and in street and highway codes authorizing utilities to occupy space in city streets or highways is that the utilities are granted permission to occupy their positions subject to the provision that, in the event the future improvement of the street or highway necessitates the removal or relocation of the utility, the resultant expense must be borne by the utility company. This principle was also applied to expressway construction at first.

In connection with expressway construction, the amount of utility disturbance is apt to be considerably greater than in the case of ordinary street or highway improvement. Expressways are most often above or below existing street grades thus materially affecting existing utilities or setting up barriers to the systematic expansion or enlargement of existing utility systems. Extensive relocations are often necessary in order to eliminate utility lines running longitudinally within the expressway limits, the tenancy of such position being usually prohibited. The principle of placing all responsibility for removals or relocation of existing facilities on the utility company or agency is therefore not an equitable one.

Definite provisions setting up the specific responsibilities of the utility and the state have now been written into several state laws. These laws require that the state shall pay for all or specific parts of the cost of relocating or maintaining public utility facilities disturbed by expressway construction.

It is therefore incumbent upon the expressway designer to so locate the expressway, subject to other controlling factors, that the disturbance of existing public utilities and the special provisions which must be made for them in connection with the expressway, will be kept to a minimum consistent with other controlling factors of expressway location and design.

However, the location of utilities in relation to the expressways must be such that there shall be a minimum of interference with the functioning of the expressway once it is completed, and that the desirable esthetics of the expressway are preserved. For this reason it is desirable to set up some standards or rules to govern the location of utilities along or across expressways. Suggested rules for such location are set forth in the following sub-section.

3. *General Rules for Location of Utilities Along or Across Expressways.*

The following general rules are becoming recognized as being good practice for the location or relocation of utilities in relation to expressways:

a. All new public utility facilities, both aerial and underground, located longitudinally with the expressway, shall be excluded from the expressway right of way. They may be located in the outer highways if such are provided paralleling the express roadways.

b. All existing public utility facilities, the maintenance of which would disturb traffic or damage planted or landscaped areas, shall be relocated when the expressway is constructed.

c. Utility crossings of the expressway shall, wherever possible, be made at grade separation structures.

d. Where crossing between grade separation or stream structures is necessary, such crossing shall be underground except in special cases cited below. Any necessary manholes or points of access shall be located outside the permanent right-of-way of the expressway or at points where servicing of the utility will not require access from the express roadways. Cases requiring large or heavy structures to accommodate the utility facility under the expressway shall be subject to special study and individual decision. New underground crossings for additional services or for replacements shall be installed under the expressway roadways, shoulders and division strip either by boring, jacking or other approved methods. In general a conductor casing of sufficient length to clear the width of expressway should be required.

e. Where the expressway passes over a street or highway on a grade separation structure where no traffic interchange is involved, it is permissible to carry aerial utilities through on the underside of the structure provided the utility facilities are of minor character. This is generally construed to mean not more than a total of five wires or cables. In the case of trolleys, both trolley wires and aerial power feeder wires must pass under the structure. No poles shall be located in the street within the projected width of the ordinary right-of-way width of the expressway.

f. Where the expressway passes over a street or highway on a grade separation structure, when no traffic interchange is involved and when no grade change on the existing street is involved, aerial facilities may be permitted to remain in place and pass under the expressway structure, provided the tops of poles do not extent above the elevation of the expressway. This case applies when the existing street is in deep cut or valley below the expressway.

g. Where the expressway passes under a street or highway with little or no grade change on street, no poles or other aerial facilities shall be permitted within the limits of the ordinary right-of-way width of the expressway.

h. Where the expressway passes under or over a street or highway at a grade which requires material grade change of the existing street, utility facilities shall be located underground for the entire length of the grade change.

i. No poles or other aerial facilities shall be located within the permanent right-of-way of the expressway or within traffic interchange areas. (See exceptions listed below).

j. Long distance high voltage transmission and heavy primary electric aerial facilities, also underground telephone and telegraph crossings, where expressway is in deep cut, shall be the subject of special study and individual decision shall be made as to their disposition.

k. In the design of bridges crossing the expressway, reasonable provision shall be made for the future expansion of utility facilities in order to safeguard the policy that utility facilities should be underground now and in the future. No rental charges should be made for such normal number of facilities.

l. Gas and water facilities passing under expressways or over expressways within grade separation structures should be constructed of extra long life materials not subject to leakage. Valves should be installed each side outside the permanent right-of-way limits. Traps, drips, blowoffs, etc. should be located outside the expressway right-of-way when feasible. When not feasible it should be subject to special study and individual decision.

m. Stream crossing structures should be utilized freely to carry water and gas mains under expressways, due regard being given to required waterway capacity. In this case no special provision for long-life proof materials need be made.

n. Where large water and oil pipe facilities are involved, special galleries of suitable design and size should be considered, having due regard for maintenance and replacement problems.

o. Where the expressway crosses pipe facilities (water, gas, oil, gasoline, sewer), where no structure is involved and where the grade elevation of the utility is such that it need not be relocated, the utility shall be rehabilitated, if required, with long life materials of adequate strength.

p. Storm sewers and sanitary sewers which pass under the expressway should be constructed or reconstructed of materials of long-life and adequate strength.

q. Where it has been determined as necessary for utility facilities to cross under an expressway the crossing should be made as nearly normal to the expressway center line as possible. Long, diagonal crossings are not desired.

r. Existing utilities which cross the expressway right-of-way at a number of points within the same general area should be combined, so far as practicable, to reduce to a minimum the total number of crossings.

4. Effect of Types of Expressways on Public Utilities.

Expressways crossing an urban area may accomplish grade separation with the existing street system in three different ways: (1), by being constructed at a grade above the normal ground level, (2), by construction at normal ground level, the grade of existing streets being depressed or elevated across the expressway, or, (3), by construction below normal ground level. It is probable that each of these types will be used at times within an urban area and possibly each will find use on one expressway project. The economies of the various types will be further discussed in the Section, "Economies of Design". The effect of the various types of expressway construction on public utilities or how they are affected by public utilities will now be discussed.

a. Elevated Expressways.

a-1. On Elevated Structure - In general, elevated structure expressways offer the least interference with existing and proposed utility facilities.

It is possible to continue both longitudinal and transverse utility lines in place without change except where there might be interference with footings. Future changes and additional crossings of utilities are readily possible. However, the high cost of this type of structure would seldom warrant its use purely from the standpoint of accommodation of utilities. Nevertheless, in a heavily built-up area, the caring for utilities must be an important consideration in the determination of the type of expressway to be used.

a-2. On Fill - The use of expressway sections constructed on fill is usually dictated by such considerations as balancing cut and fill, surface drainage conditions, or other economic factors. However, the use of fills may be advisable in some cases to avoid extensive revisions of public utilities. This applies particularly where large sewers, storm drains or water mains cross the expressway alinement. Reinforcement of such utilities may be required in these cases to sustain the additional loads due to expressway fill. The existence of such utilities obviously becomes an important factor in locating the expressway.

Fill or embankment design, while less damaging to utility services, is usually less desirable from the viewpoint of the neighborhoods traversed.

b. Expressways at Grade.

Construction of expressways at grade will permit the continuance of existing utilities across the expressway without interruption except as follows:

1. Where utilities are in a street which is depressed to pass under the expressway.
2. Where a street passes over the expressway and it is deemed desirable to relocate the utility facility over the expressway in the grade separation structure and approaches.
3. Where utilities are overhead and come within the provisions of general rules (d), (h), (i), of subsection (3) hereof.

c. Depressed Expressways.

c-1. In Open Cut - Open cut design, since it seems to offer the most advantages in a built-up metropolitan area, will probably be the cross section often used It will be the most damaging to existing utilities, most of which are subsurface, and the ability to extend future utilities across the expressway. Where streets cross over the expressway, provision can usually be made to carry gas, water or sewer pipes and electrical conduits in the grade separation structure, sometimes with minor necessary adjustment of grades. Such utility lines must be adequately protected by proper structural measures. Storm drain pipes when flow grade lines permit can sometimes be carried across the structures in a similar manner by a change of cross section from circular pipe to elliptic, to occupy the reduced headroom available in the bridge structure. Where sewers and storm drains or other utilities are too deep or large to be relocated in the bridge structure, it may be necessary to redesign and rebuild extensive portions of the existing systems. Such cost would usually be a proper charge against the expressway project.

c-2. In Tunnel - In tunnel sections, it is especially desirable that ventilating and lighting or other necessary utility facilities be so located that they may be maintained and repaired without delays or interference with traffic. Tunnel sections will usually occur only where deep cover is available, and conditions as to utilities will not ordinarily be less favorable than in open cut sections.

ECONOMICS OF EXPRESSWAY

1. Economic Need of Expressway.

Most cities when laid out, were not planned for motor vehicle traffic and the result is that many suffer with traffic congestion on main thoroughfares. This congestion is magnified by the use of the streets for parking of vehicles.

One consequence of the congestion is uneconomical operation of motor vehicles for the inhabitants of the city as well as for those who live outside of it but for whom the city is the economic and social focal point.

Another consequence is blighted

areas within the city, arrested development and even retrogression of the prosperity of the city, placing in jeopardy the heavy private and public investments in buildings, streets, sewers, water mains and other facilities inherent to the function of a city.

One or more controlled access expressways within the city and connecting with the main thoroughfares leading into it, properly located and designed, will usually be found to be the basic means needed for alleviating these ills. Owing to the free flow of traffic that may be obtained on such an expressway it will carry speedily and economically a greater volume of traffic than can be carried on city streets with the same roadway width. This in itself will stimulate the prosperity of the city, but it may be of more permanent importance that it will be a starting point for city planners to modernize the city by the construction of off-street parking areas, bus and truck terminals and the many other things needed for the continued prosperity of the city. However, when contemplating the construction of a controlled access expressway in an urban area, it should first be determined whether or not it is economically warranted and next if the funds for its construction and upkeep are or can be made available.

2. Benefit-Cost-Ratio.

As for any other highway improvement the economic soundness of a project for the construction of a controlled access expressway may be determined by computing the benefit-cost-ratio of the project, or in other words, the relation of the money value of the benefits obtained by constructing the expressway to the cost of its construction and subsequent upkeep. In considering the money value of the benefits it must be kept in mind that the problems involved are not solely fiscal but also social and that their solution, therefore, must take into account the prevailing present and future standard of living, or the ability and willingness of the people to pay.

It should be noted that the benefit-cost ratio deals with what may be considered as the amount of interest which may be expected to be returned on the money invested in the project considered. It does not consider whether or not the funds for the project are available.

3. Benefits.

Some of the benefits gained by those that travel on the highways may include some or all of the following:

a. Saving in cost of vehicle operation due to decrease in travel distance, improved alignment and profile, better roadway surface and uninterrupted progress.

b. Saving in time of travel due to the same causes as above and due to increased speed of travel.

c. Increased safety of travel.

d. Improved physical and mental comforts of travel.

e. Improvement of traffic conditions on present streets.

Additional benefits are obtained by those that live or do business in the city. These may include:

f. Better access to places of business.

g. Increase in real estate values.

h. Improvement of blighted areas within the city.

i. Development of new areas.

j. Increased ratable values.

Some benefits may be negative, such as the loss of ratables to the municipality on account of converting taxable property into a non-taxable public thoroughfare. However, the loss of ratables in a municipality is likely to be compensated for, at least partly, by resettlement in other locations within the municipality if it is not already too densely built up throughout, and it may normally be presumed that the presence of the freeway will enhance property values in its vicinity. There must be considered also the frequently expressed fear of a community of a detrimental effect of an actual or fancied division of the community by the expressway.

The money value of some of the benefits are readily determined, particularly that of saving in vehicle operation on account of reduced travel distance, although it may vary from place to place and from time to time with the cost of motor fuel, amount of fuel taxes, improvements of motors and fuels that will produce more mileage per gallon of fuel, as well as of changes in cost and efficiency of other items that affect the cost of vehicle operation.

The money value of saving of time is real and increases with the standard of living. This may be exemplified by the hourly wages paid to drivers of trucks and other vehicles, but it applies equally well to the drivers and passengers of other vehicles.

Records indicate that the accident and fatality rates, due to motor vehicle traffic on limited access roads, are materially below those on other highways. The rates in a city, therefore, should lessen when much of its heavy traffic is carried on a freeway.

The improved physical and mental comfort or peace of mind which may be attained by driving on a controlled access freeway rather than on a busy street, will all of its erratic movements of vehicles and crossing of pedestrians, has a money value. As an example may be cited many toll roads. While they largely are being used because they save travel time they are preferred by many because they permit smooth and uninterrupted progress without constant nervous strain.

The immediate purpose of constructing a controlled access expressway in a city is usually to relieve in an effective and economic manner the congestion of traffic on overburdened city streets. Much of the traffic now using the streets will transfer for at least part of its travel from these streets to the expressway and thereby relieve them of a material part of the traffic. This means that many of the benefits enumerated above will be gained not only by the vehicles using the expressway but also by the traffic in the city streets.

The benefits a to e discussed above, apply to those that use the highways, whether they originate inside or outside the city. They represent the "road users" benefits. The remaining benefits, enumerated as f to j, are of particular advantage to the inhabitants of the city. These may be called the "city's" benefits.

The city benefits are enumerated above as better access to places of business; increase in real estate values; improvement of blighted areas within the city; development of new areas; and increased ratable values. For any specific expressway project some or all of these benefits may apply and others may be added It may be the function of city planners to study and evaluate the money value of these benefits, but it is evident that they have a bearing on the future prosperity of the city, and the subject is of direct concern to highway engineers and planners.

4. *Cost.*

The cost of a controlled access expressway covers the cost items of right-of-way, construction and maintenance of the expressway and its appurtenances, including traffic interchanges between the expressway and the street system. It includes also the cost of operation of movable bridges, lighting system and other items that may be incorporated in the expressway.

The street system connecting to the interchanges must be studied to insure that it will be able to absorb any added traffic, involving perhaps local reconstruction of the street system. At the street end of interchanges additional lane space may be needed as a reservoir to avoid congestion. The cost of these items should be included in the estimate of cost of the expressway when determining the benefit-cost ratio.

In the study of the location of an expressway in an urban area it is generally necessary to investigate several possible locations, including interchanges. The benefit-cost ratio probably will vary for each location, and that which shows the highest ratio is economically preferable. In making these studies, future rather than present traffic volumes should be considered and sufficient right-of-way should be included in the cost estimate for serving the future traffic, although possibly the construction of some lanes and interchanges might be postponed until traffic volume will warrant it.

5. *Sources of Funds.*

If the providing of a controlled access

expressway is to be undertaken by the municipality itself the primary sources of revenue will usually be the portion of the State's "road users'" revenues allocated by the State to the municipality and to the county in which it is located. Road user revenues are derived essentially from State taxes on motor fuel; from motor vehicle registration and other fees; and from Federal Aid for highway purposes. As these funds are likely to be insufficient they generally must be supplemented by local taxes or assessments or by a bond issue.

If the expressway is within the scope of the State highway system the sources of funds will be the portion of the road users' revenues allocated to the State highway department for State highway purposes. As the presence of the expressway may be of benefit not only to road users but perhaps to even a greater extent to the city and the county in which it is located the funds may properly be augmented by contributions from these local sources.

6. *Studies and Research.*

The modern means of studying the economics of highways is comparatively new and the concept of controlled access expressways through a city is even more recent. Therefore, while we can with a fair degree of confidence outline the method of preparing an economic study of a projected limited access expressway and arrive at reasonably accurate conclusions, there are several matters for which intensified additional studies and research are indicated. Some of these matters are the development of a rational method of determining the money value of the benefits of an expressway to the inhabitants of a city together with actual data of the money value of benefits obtained; and up-to-date costs or values of vehicle operation, travel, time, accidents and mental comfort of travel.

EFFECT ON TAX RATABLES

Of vital interest to municipalities participating in the planning of expressways is the effect of an expressway on tax revenues. Of immediate concern is the amount of property taken off the tax rolls. This removal is a loss to the municipality, at least in the immediate sense. With this loss in mind, there is a tendency to restrict widths of right-of-way and seek locations in parks or other public lands. Such a view, however, is sometimes shortsighted when consideration is given to the future effect of such restriction on tax revenues. A restriction of right-of-way may result in the construction of a type of expressway which will act as a barrier, or "Chinese Wall" dividing the community and in some cases causing a deterioration of adjacent property values. An ample right-of-way permitting extensive open areas and landscaping providing a park like atmosphere usually enhances adjoining property values more than enough to offset any apparent saving through restriction of right-of-way.

The above-mentioned benefit, the esthetic value, applies both to areas directly served and to intermediate areas through which the expressway passes. In these intermediate areas the benefits are community benefits; in the areas directly served they are both user and community benefits. Therefore, property values are enhanced in the areas served both by the improved transportation service provided and by the more attractive, open atmosphere created.

The effect of the expressway on the tax revenues is dependent upon the physical character of the facility and to the amount of transportation or traffic service provided.

A few attempts have been made to measure the effect of expressways on tax revenues, but these studies have been too few to be convincing or conclusive. They do demonstrate, in a general way, the validity of the above assertions. Increases in property values above the normal trend have been shown. Or in periods of a general decrease, the areas served by expressway facilities.

The gain in Tax Receipts during a 22 year period of affected areas along Bronx River Parkway in Westchester County, New York State, was more than $22,000,000 over the Tax Receipts if based on normal trend. This gain was about equal to the total net cost of the improvement.

In New York City, a study of changes in the values of improved properties adjacent to the Henry Hudson Parkway showed a rise of 2.51 percent between 1935 and 1938 while the values of improved properties in the areas near but not adjacent to the Parkway decreased 2.91 percent, indicating that the areas adjacent to the Parkway fared 5.42 percent better than the section as a whole.

The property along the Grand Central Parkway in New York City gave a net increase of $4,117,990 in tax revenue above that which might ordinarily have been expected for the ten-year period ending in 1945.

Other examples of the effect of freeway development on adjacent land values are found in California. Much of the Arroya Seco through Los Angeles, South Pasadena and Pasadena is located on park lands. However, a limited section is abutted by private lands and the market value as of September, 1947, was three to twelve times the value in January 1941, and in Los Angeles the increase has been about one and one-half to three times as a direct result of the construction of this facility. Similar increases in property values may be cited for the development in San Francisco of the Junipero Serra Boulevard, the Ventura Boulevard in the San Fernando Valley section of Los Angeles, and the Long Beach and Crenshaw Boulevards. The property values adjacent to these developments are now double the value of property on the next parallel streets.

These examples all very definitely show the effect on the tax ratables due to the construction of expressways.

TRAFFIC ECONOMICS

In the early stage of modern highway development the economic and social problems of highway planning and construction were less complex than they are today. The problems were mainly to make all-weather roads out of the then existing highways and to pay particular attention to those carrying the heaviest traffic. Furthermore, at that time and with the volume and weight of traffic they then carried, the cost of the improvements was comparatively low. It was only in a few cases that the existing or foreseeable traffic volumes were so large that economic studies evidently were warranted, and it was there that the rational study of the economics of highways had its birth. With the present and evidently continuously increasing traffic volumes as well as unit costs of construction, the economic studies have become a necessity, and this applies particularly to expressways in urban areas.

The fundamental data for justification of an expressway must necessarily be the volume of traffic which is expected to use the expressway, not only at the time it is built but for many years thereafter. If immediate traffic should not warrant the complete construction of facilities which will be needed in the future, stage construction may be planned and provided for in the initial construction. For example, provisions should be made for the full number of lanes that may be needed in the future, but only those required for the immediate traffic need to be constructed in the initial stage. Similarly, provisions should be made the interchanges at places where future traffic may warrant them, but their construction may be delayed until the need develops.

An approximate estimate of immediate traffic can be had by a study of traffic counts on present roads within the scope of the expressway, but these counts only tell the volumes of traffic moving on the present routes. Usually they do not provide adequate information as to whether these routes economically serve the purpose or whether they are used because they are the only ones available.

A more complete answer to this question is obtained from properly conducted origin and destination surveys which give information about the points between which and in what volumes people desire to travel. The technique of carrying out these surveys has been developed during the past few years, particularly by the Bureau of Public Roads, and has reached a usable and satisfactory stage.

The information obtained from the traffic studies will provide the answers to the questions of number of lanes and to the location of interchanges needed now and in the future. These answers should be based not only on an average daily but on recurring peak-hour traffic. The 30th peak hour is widely accepted as a satisfactory basis for determining the required number of lanes.

The study of the traffic data should not be limited to the expressway and its interchanges but should be extended to the street system. It is evident that some streets will be relieved by the expressway of some of its traffic volume, at least for awhile, but on others the traffic will increase. This applies particularly to those adjacent to the entrances to and exits from the expressway. In addition, unless proper facilities are provided, the left turn movements on these streets may increase so as to interfere unduly with the traffic on the streets and possibly even with that on the expressway.

ECONOMIC EFFECT ON FRONTING STREET PROPERTIES

Some of the economic effects of expressways on properties fronting existing streets have been discussed in "Effect on Tax Ratables".

1. Business Areas.

A business area, being one of the principal areas served by an expressway, is benefited both through improved transportation service and through esthetic improvement when the facility is so designed. Both the user and the community are benefited.

Properties fronting on existing streets in the immediate vicinity of the expressway are more directly affected, and the effect is for the most part beneficial. Negative benefits may derive, as from the dead-ending of a street or from increased traffic and consequent congestion on some feeder streets, conditions which for physical reasons are sometimes unavoidable.

In a business district, the traffic and transportation problem involves the handling of huge quantities of materials and merchandise in addition to the many people involved. A properly planned expressway will effect savings in the cost of this handling in facilitating rapid receiving and delivery. All are familiar with the seemingly hopeless congestion of commercial traffic on the streets in business districts. The expressway takes some of this load off these existing streets, relieving the congestion, and thus facilitating the flow of passengers and goods.

The easier flow of passengers and the added convenience will induce more customers to come to the district. The increased sales volume is a positive benefit to be carefully considered in an economic analysis.

Not only will customers and business callers be better served but also employees. In modern urban life transportation is one of the principal concerns of the employee. There has been a trend toward suburban development of residential areas, which in many cases are too sparsely settled to support adequate public transportation. The employee is forced to depend upon his automobile for transportation. An expressway providing him express service to the business district will benefit that business district in making it a more desirable place to work.

2. Residential Area.

Just as an expressway makes a business area a more desirable place to work, it makes an outlying residential area a more desirable place to live. The very existence of some outlying residential areas is possible only because the expressway provides convenient, rapid transportation service not otherwise available.

An expressway tends to remove from existing streets of the residential areas served all traffic which does not rightly belong on those streets, and in so doing the value of the area for residential purposes is increased. The growth of heavy street traffic in a residential area has almost always resulted in a deterioration of the area. When this heavy traffic is properly channelized by an expressway, this deterioration can be checked.

Intermediate residential areas not directly served by the expressway can be benefited by the expressway as discussed in "Effect of Tax Ratables". When through traffic is removed from the existing streets in these areas and routed over an expressway with a wide, attractive right-of-way, these intermediate areas benefit although they are not directly served.

Additional facilities such as playgrounds and park areas sometimes included in an expressway project also contribute to the value of a residential district by providing recreational facilities in addition to the transportation service and esthetic value.

Added safety through the protection of life and property offered by an expressway has a material economic value. This same factor applies likewise to business districts.

3. Blighted Area.

The economic effect of an expressway on the properties fronting on existing streets in a blighted area has been partially discussed under the subject of the location of an access with the desire to develop a backward area.

The expressway may physically eliminate a blighted area by including most of it in its right-of-way. Locations making such elimination possible are attractive both from the standpoint of low property damage and from the standpoint of the benefits derived by the elimination of the blight.

An expressway may make a blighted area even more blighted if its right-of-way is unduly restricted or if the expressway is of such a type that it acts as a barrier dividing the community.

That some areas are blighted may be attributed to the fact that its streets have dead ends or adverse grades. Often an expressway project involved the opening of these streets and improvement of street grades. Consequently, the principal reason for the blighted condition is corrected, and a general rehabilitation follows.

EFFECT ON STREET SYSTEMS

The development of a system of expressways will make important changes in the traffic pattern on the existing street system. Some existing major arterials will become minor feeder routes. Traffic will move with much more freedom on those existing streets from which there will be large diversions to the expressways. The accident hazard will be decreased. But, on some of the streets, those into which large volumes of traffic will be discharged, there will be critical problems of traffic accommodation. Thus, on the one hand, there are resultant benefits in the efficiency and safety of motor travel on many of the main streets, and on the other, a problem of fitting interchange connections to the street system, particularly in the city centers, in a manner that will permit existing streets to accommodate increased traffic load.

In so far as the planning of expressway systems is concerned, there is no essential need to evaluate the benefits in efficiency and safety that will be provided through the diversion of traffic from the street system to the expressway system. However, it will no doubt be helpful in presenting the case for expressways to show these advantages as well as others which will result from the development of expressway systems. In the Connecticut Highway Department reports, "Hartford Metropolitan Area Expressways" and "Connecticut's Road Program", this was attempted. The Lindman report of November 1946 on a "Proposed System of Highway Financing for the State of California" emphasizes the reduced hazard and congestion on the existing street system.

While it is not essential to evaluate the benefits in traffic operation on the existing streets, as indicated in the previous paragraph, it is necessary to consider the damage that may be done through the traffic concentrations on the existing street system at interchanges, and to the maximum extent possible, lay out the interchange connections and recommend street control measures that will permit free traffic flow. It may be necessary to widen some of the existing streets, to ban parking and to institute one-way operation. Each interchange ramp connection, the street to which it discharges or from which it draws traffic, and the connecting streets serving the major generators of traffic, present separate problems. Satisfactory street traffic operation can be attained only through careful consideration of traffic volumes in relation to street and intersection capacities all the way between traffic generators and expressway ramps.

STAGE CONSTRUCTION

"Stage construction" is construed as meaning the construction of an expressway to something less than the ultimate planned improvement but to a stage where the facility or a portion of it may be opened to and used by traffic. Excluded are stage construction practices such as the acquisition of rights-of-way, grading of the roadbed, or the construction of structures separately from and in advance of paving operations, since these operations do not produce a usuable improvement.

Examples of stage construction include:

1. Placing a temporary rather than a permanent pavement.
2. Paving less than the ultimate width of roadway, or one roadway of an ultimate divided highway.
3. Deferral of construction of grade separations.
4. Deferral of construction of interchanges, or construction of less than the ultimate interchange, for example, building two ramps of a four-ramp plan.
5. Deferral of construction of service roads.
6. Deferral of landscaping, installation of lighting and other items not essential to a reasonably safe utilization of the improvement.
7. The progressive construction of an expressway by sections or units over a period of years. In this case a constructed section might be complete within its limits but it would constitute only one state of the construction required to make available the benefits of the ultimate improvement.

Proposals for stage construction almost always stem from a need to stretch currently available funds so that traffic conditions may be improved as quickly as possible and prior to the time when the entire expressway can be financed. While this reason for constructing something less than a complete improvement may be a very good one and sometimes the only way to get a project started, a word of caution seems in order. Too ready acceptance of the need for improvising, by stage construction or otherwise, to overcome an apparent inability to finance an improvement, could well prolong beyond reason the time required to remedy the intolerable traffic conditions in urban areas. Without a doubt, it will be necessary (in general) to find additional amounts (and probably, new sources) of funds to meet and keep pace with highway requirements. There should be reluctance to employ stage construction for the purpose of side-stepping the critical issue of inadequate finances for overwhelming highway needs.

In case immediate construction of a complete improvement is determined to be impossible, consideration might well be given to the feasibility of initiating activity over the entire project as quickly as possible. This might be done by utilizing one or more of the first six stage construction techniques previously mentioned instead of the more generally-used method of progressive construction of an improvement by sections which are complete in themselves. Getting work underway throughout the length of the proposed expressway would establish and guarantee the route to be followed by the facility. It might avoid delays over rights-of-way. It also might do much to encourage and influence zoning or re-zoning and other city planning activities, and the efficient and non-conflicting location of industries, housing, and like developments in the urban area.

However, regardless of all other considerations, it must be kept in mind that the primary purpose of the improvement is to correct, or at least, relieve unsatisfactory traffic conditions on city streets. Therefore, it seems obligatory that the effects on those streets should be considered carefully and should carry much weight when decisions regarding the nature and extent of stage construction proposals are to be made. A good stage-construction plan might produce relief quickly where needed most and result in a substantial measure of the desired improvement in traffic conditions being realized and enjoyed several years in advance of what would otherwise be possible. Also, a good plan for stage construction could provide a preview of things to come which might help materially with financing, rights-of-way acquisition or other problems. On the other hand, however, a bad plan could add to the distress on city streets and even endanger the entire proposal by presenting an unfavorable picture of the effects of expressway construction in an urban area.

The effect on city streets of stage construction of expressways will depend on the particular physical, economic and social conditions and traffic problems existing in the urban areas to be entered or traversed as well as on the nature and extent of each stage construction proposal. For this reason, no set rules for evaluating the effects of stage construction can be determined with the idea that they may be applied to all proposals which may be advanced. Each case will require intensive study, particularly of the capacities of existing streets (and their intersections), the loads on them, the probable effect of the proposal on those capacities and loads, and the potential advantages (or disadvantages) in service to traffic which will remain on or be diverted to each street (temporarily or permanently) as well as to that accommodated on the expressway.

One of the major problems encountered in planning urban expressway construction is that of providing for the collection and distribution of traffic by means of the connecting street network. This problem may be intensified when an expressway is constructed by stages. To assure that a stage construction plan is both worthwhile and workable, a complete analysis of traffic flows and travel habits seems essential. As a minimum, it is believed that answers to the following questions should be determined:

1. Which streets will be benefited by the stage construction proposal and to what extent?

2. Which streets will be required to carry heavier loads than at present and are they capable of doing so?

3. Will interchanges to be built as part of the stage construction plan have adequate capacities?

4 If it is planned to defer grade separations, what will be the effect on the expressway and city streets? Will they function with reasonable efficiency or will barriers be created at heavy cross-traffic streets which might nullify all other advantages?

5. If a project is to be constructed by sections, will a particular section, when completed, be effective in providing traffic relief in the area in which it is built? What will be the operational behavior at its end points and can controls be established which will permit traffic to traverse the remainder of the route with reasonable ease until the entire improvement is completed?

Once these questions and others suggested by them are answered, it will be possible to formulate a sound and efficient stage construction plan rather than be compelled to go ahead on a hit-or-miss basis set up mostly with an eye on available funds.

To summarize, it is recognized that stage construction may be necessary. If so, however, the plan to be followed should be based on comprehensive and comparative studies which will insure it is the best that can be devised, that it will better, not worsen, traffic conditions, and that no unworkable situations or traffic bottle-necks will be created by the temporarily curtailed construction program. Also, stage construction should be a last resort rather than the first "out" when funds are scarce.

PARKING AND TERMINAL FACILITIES

Parking and terminal facilities in urban areas include (a) curb spaces along the existing street system; (b) offstreet facilities such as public and private parking lots and garages; (c) parking facilities within commercial buildings for autos and trucks, ranging from recessed street level truck tailboard spaces within building lines, to large areas below or above street floors, connected by ramps or elevators; and (d) such specialized terminals as union bus and truck terminals.

Vehicles that now utilize offstreet parking and terminal facilities arrive there for the most part via existing street systems. Even where urban controlled access expressways are available only portions of vehicle volumes that use offstreet parking and terminal facilities arrive via expressways.

As more urban expressways are constructed and expressway tributary areas grow, increasing proportions of vehicles parking at individual parking and terminal facilities will arrive or depart via expressways. New parking and terminal facilities will then tend to be located as close to expressways as possible in order to reduce vehicle travel on existing street systems to a minimum. This growing intimacy between expressways and large individual parking and terminal facilities is bound to create serious traffic problems. Engineers must consequently provide flexible expressway designs that will relieve inevitable traffic pressures as they arise, since some types of expansions cannot be completely envisaged when expressways are being planned.

It is a commonly accepted fact that a controlled access expressway lane can handle from 5 to 10 times the traffic of a city street lane. Or, in other words one expressway lane can deliver enough traffic to keep 5 to 10 street lanes busy absorbing the traffic, if the traffic can be absorbed. Query: What happens if the rate of difussion on the street system in the vicinity of the expressway is slowed down by the rate at which cars can be parked at large concentrated off-street parking and terminal facilities? Answer: Chronic traffic backups on the expressway, when rush hour traffic is arriving in town.

Conversely, several large individual off-street parking and terminal facilities located in a local area in the vicinity of an expressway entrance ramp may in a peak period deliver to the expressway entrance ramp a flood of traffic far in excess of its ability to absorb it. In this case, there would be chronic traffic congestion on the city street systems, in peak periods when traffic was leaving town.

Approximate locations and spacing of entrance and exit ramps are usually determined by origins and destinations of vehicles in zones tributary to proposed expressways. More precise locations of interchanges can be determined by giving special consideration to individual existing and potential off-street parking and terminal facilities that would contribute substantial portions of traffic to interchanges. Such off-street parking facilities would also indicate the design types of entrance and exit ramps required. Some of these types are described under Design of Interchanges. For example, concentrations of parking facilities in a local area would require that some interchanges be provided with more than merely an accelerating or decelerating lane. Some interchanges might require adjoining service streets that could function as reservoirs, like plazas of vehicular bridges and tunnels. It must be borne in mind that while interchanges proper may have the capacities to deliver to the expressway all the peak period traffic of the surrounding off-street parking facilities at any given point, the expressway itself would have only the margin of its available unabsorbed capacity at that point to absorb the traffic delivered to it by a particular individual entrance ramp.

Consequently, in the design of expressways in the vicinity of interchanges, particularly where there are or are likely to be concentrations of off-street parking and terminal facilities, stretches of expressways may have to be widened to provide extra lanes in the vicinity of the interchanges. These stretches of widened expressways would permit of properly absorbing peak traffic. They would also permit the storage of moving vehicles as the street systems in the vicinities diffuse and the offstreet parking and terminal facilities absorb peak expressway traffic delivered by the local interchanges.

In the selection of locations, determinations of the number of interchanges, and the provision of extra widths of expresswaysproper, in given local areas, the essential desideratum is to maintain a proper balance in the capacities of (a) the expressway proper; (b) its local interchanges; (c) the local traffic light controlled street system in the vicinity of interchanges; and (d) the capacities of local offstreet parking and terminal facilities.

1. Auto Parking Terminals.

It may generally be said that, today existing lots and garages in urban areas ave very largely located without much relationship to where they are actually needed. Many garages are former stables. A few have been built at locations where land is cheap but at much greater than convenient walking distances from major urban destinations. Existing lots have been located whereever land is available, usually in blighted areas at the fringes of business districts, pending redevelopment of the areas. Consequently most existing garages and lots are no criteria for the locations of off-street parking and terminal facilities.

There are, however, certain existing parking facilities which would require particular attention in connection with the design of proposed urban expressways. They are the concentrations of parking in connection with places of public assembly, such as, large ballparks and stadia. Designs of expressway interchanges in their vicinities require special treatment, if chronic traffic congestion is to be avoided.

With regard to future offstreet parking facilities, current thinking appears to favor municipally financed lots and garages. Where large public parks or wide boulevards are available, these are being suggested for underground municipal parking facilities. In some cities like Pittsburgh, for example, comprehensive plans have been prepared for a system of municipally financed and operated garages; those near the shopping areas for short time parkers and toward the fringes of the business district for long time parkers. It is felt that these plans for large municipal parking and terminal facilities will eventually materialize then designs for interchanges in their vicinities should be flexible enough to be constructed or enlarged if and when, traffic to and from them develops.

It is believed that, gradually, municipalities will adopt zoning ordinances requiring new commercial building to provide offstreet parking and truck berths. As a result of this trend, offstreet parking facilities will once more become less concentrated, more diffused. This gradual diffusion of offstreet parking facilities should improve traffic conditions around expressway interchanges by spreading peak traffic loads by the travel time required between nearest and farthest parking areas tributary to individual expressway interchanges.

2. Bus Terminals.

Interurban and intercity buses usually enter cities from several directions via city streets. Large buses travelling along narrow city streets congest these streets out of all proportion to the number of buses entering the city. Where the number of such buses are substantial municipalities out of self protection will eventually require that these buses use a union bus terminal. A union bus terminal would be so located as to be convenient to downtown offices, shopping areas, theaters and hotels, and as close to urban expressways as possible, in order to utilize city streets to a minimum. Where municipalities are contemplating requiring union bus terminals expressway interchanges should be designed to give easy access to and from bus terminals.

For example, the Port Authority's Union Bus Terminal in mid-Manhattan will be provided with special ramps connecting the terminal with the north and south tubes of the Lincoln Tunnel. These ramps will keep 80 percent of the 2,500 bus trips into the Bus Terminal entirely off city streets in the vicinity of the terminal. The sketch of the Port Authority Union Bus Terminal shows the ramp connections with the Lincoln Tunnel.

3. Union Truck Terminals.

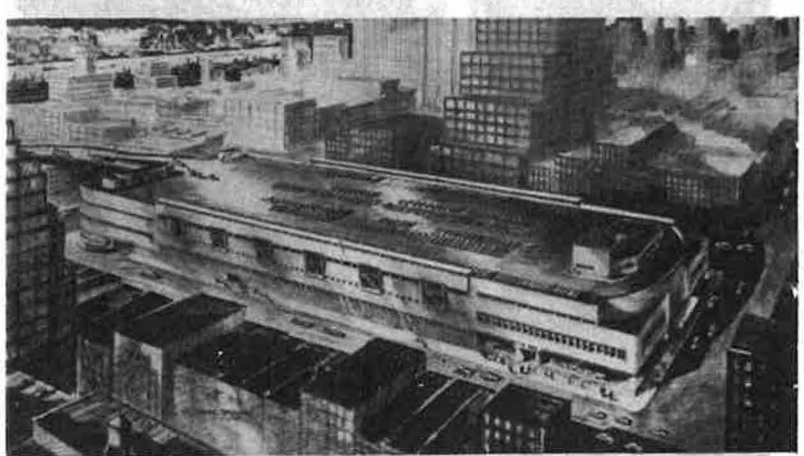

Figure 11. Sketch of Proposed Union Bus Terminal.

Figure 12. Sketch of Approaches to Terminal.

Into and out of most cities long haul, over-the-road tractor-trailer combinations haul freight daily. Individual company truck terminals are usually scattered throughout the city. Many of these trucks and trailers meander about on the narrow streets of cities picking up and delivering small lots of freight. Whether moving or parking on narrow streets, these oversized vehicles congest streets out of all proportion to the numbers of tractor-trailer combinations in relation to other traffic. Consequently where this type of traffic is growing, municipalities will eventually demand that over-the-road truck operators operate out of union truck terminals served by smaller trucks that would perform pickups and deliveries of feright within the cities. In such instances, large tractor-trailer combinations would arrive via expressways and proceed to the Union Truck terminal which would be located close to expressways and thus use city streets to a minimum.

Where it is anticipated that a union truck terminal will be constructed close to an expressway that will be open to commercial vehicles, interchanges in the vicinity of the terminal should receive particular attention. The terminal should be made convenient to both incoming and outgoing vehicles. There

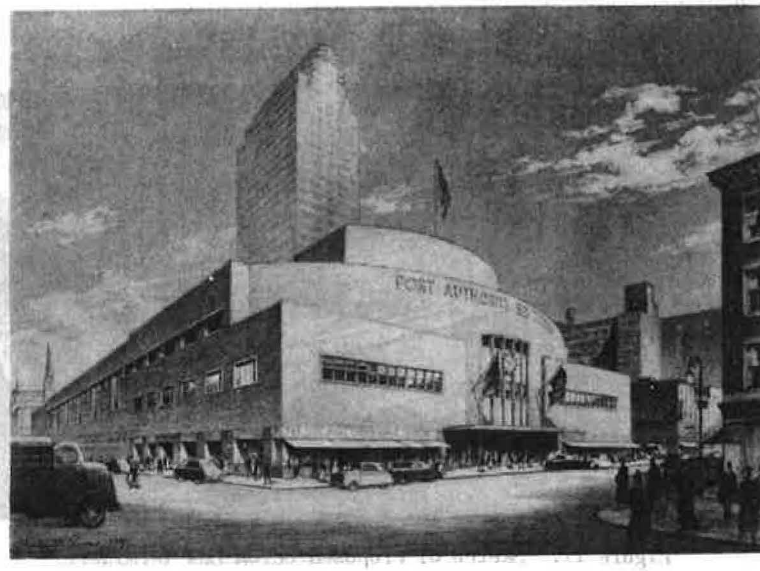

Figure 13.

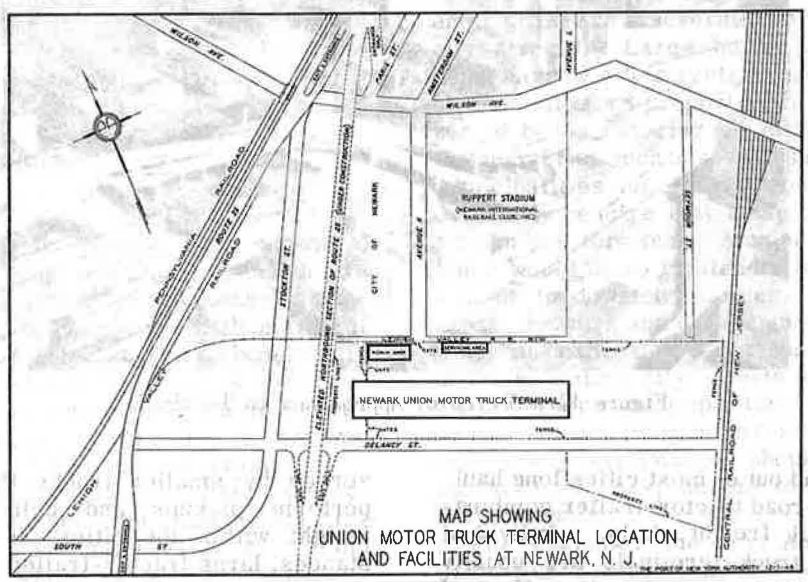

Figure 14.

should be a minimum use of city streets by such trucks. The streets which they use, however, should have the capacity to absorb all trucks delivered by the expressway in peak periods; interchanges should be designed to pass peak traffic; and the expressway should be able to absorb all trucks delivered thereto by the interchanges.

The Port Authority is constructing two Union Truck Terminals, one in New York City in Lower Manhattan, the other in Newark, New Jersey. The truck terminal in Manhattan is within three blocks of the Holland Tunnel via which crossing most of the over-the-road trucks will arrive at the terminal. The Newark Terminal is located near New

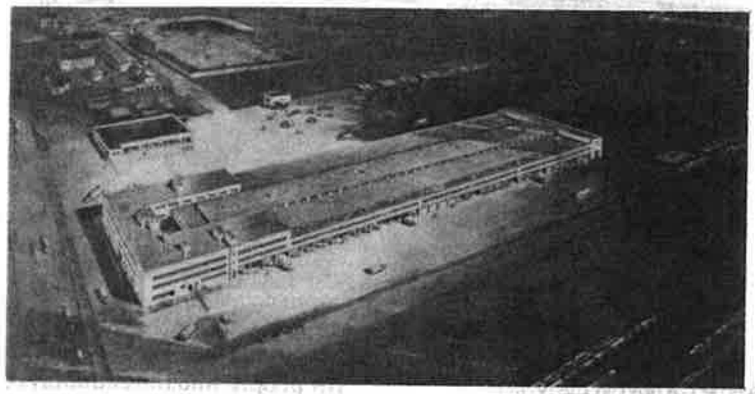

Figure 15.

Figure 16. Union Motor Truck Terminal.

Jersey Route 25, the major express route via which most of the over-the-road trucks will arrive at this terminal. Both truck terminals are located within close proximity of express routes like the Holland Tunnel and N. J. Routes 25 and 100.

The Manhattan entrance and exit of the Holland Tunnel are convenient to the lower Manhattan Union Truck Terminal. Trucks will use city streets to a minimum to reach this terminal. The interchanges of the New Jersey routes will be designed to give easy access to the Newark Truck Terminal. There also trucks will use the streets in the vicinity to a minimum.

Figure 17. Drawing of Truck Terminal Number 2.

URBAN PLANNING AND DEVELOPMENT

Too often urban planning is merely an artifically prepared drawing put on public display for a short time and then relegated to the files. To be effective it must be a living force conceived and dedicated to the purpose of improving the community, the lot of the individual and the promotion of industrial and commercial health. It is not only a mental process, but to be constructive, consummation must be achieved through an action program.

Successful urban planning depends on intelligent conception and the aggressive resolve of civic leaders, public officials, businessmen and the people to put the plan to work and accomplish the goal of a better and more prosperous society. Planning is worthless without action. The plan itself will accomplish nothing.

The conception envisages a definite objective. In urban planning the objective is to arrange and fit the physical plant of modern civilization into the spiritual and constructive desires of men so as to achieve security, enjoyment and satisfaction of life for all. This is not simple in the highly complex civilization of today.

Before planning can start there must be an understanding of the problem. There must be a recognition of the forces at work and what makes city and metropolitan life function. In order to live a city must perform a service to its people and the economy of the region, state and nation. It is a Service Force. In order to plan the city, the planner must know its mission; what services it must render to the people and the economy to justify its existence.

The urban area is a living organism and in every living organism the cells must be renewed when they die. The physical and administrative plant of urban areas must be constantly adjusted and renewed in order to meet the impact of changing conditions; otherwise the area as a whole will deteriorate.

To plan renewal so as to ever and continuously strengthen and expand urban prosperity requires the establishment of the fundamental mission of each city and its component parts. The mission of each city and area will depend on physical resources, present development, markets, land forms, subsurface conditions, present and potential transportation facilities. The mission may be simple or it may be complex. It may be a residential area with simple maintenance-of-life shopping facilities. It may be a transportation center with minimum residential, shopping and commercial plant to serve the basic mission. (The transportation center may involve only one of the great mechanical transportation forms; rail, water, air and highway, or two, or all in combination.) The city may be an industrial area. It may be a residential, shopping, commercial and industrial city. Or it may be a combination of all of these and such a combination is needed to produce a great city. The mission must be in accord with the suitability of the area to successfully meet the requirements of people, commerce and industry.

Today, many cities are sick with the paralysis of high taxes, street traffic congestion, inadequate slow and congested mass transit, obsolescence, inefficient merchandising and an antiquated municipal government administration mechanism. People, commerce and industry are moving out of such cities because of high taxes, desire for open spaces, more light and air, crime incidence, obsolescence, accident hazard and traffic congestion. This flight causes loss in tax ratables. In the past 20 years tax ratables lost by several eastern cities total $248,000,000, $54,000,000 (26 percent), $96,000,000 (12 percent) and $233,000,000 (38 percent) respectively. As long as there is cheap undeveloped land on the outskirts of such cities at low tax rates, obsolescence, high taxes, and traffic congestion will drive dwellers, commerce and industry outward away from the center. As ratables are lost, the tax rate rises, more ratables are lost, again the tax rate rises. This vicious cycle will continue to bankruptcy unless something constructuve is done to revitalize the area. It is unthinkable that the tremendous public investment in schools, streets, sewers, treatment plants, water works, distribution systems, buildings, parks, playgrounds and the private investment in buildings, churches, utilities, railways, plants and fixtures should be wasted.

An entirely new approach is needed to meet the challenge of the automotive age. There must be a new conception of land use so it will be more efficient and can support present high governmental costs; improved administration, more equitable tax structure so property owners and industry do not carry the entire load; and a solution of the traffic congestion problem. The advantages of living and doing business in the city must be restored. The City must be "resold" to the "customer"; i.e., the dweller, the worker, the businessman and the industrialist.

To be successfully "sold", the city must provide:

a. free flowing, adequate and rapid transportation

b. open spaces, light and air

c. segregation of business, industry and housing

d. attractiveness

e. elimination of slums and substandard housing

f. economical cost to the dweller, businessman and industrialist; in a word, the "customer"

g. greenbelts, parks, recreation areas, vehicular parking areas

h. freedom from street traffic congestion

i. safety

j. freedom from crime

k. adequate terminals

It has been said that transportation of persons can never catch up with requirements as long as buildings continue to be built up in the air. This is true if every square foot of the city as laid out for the horse and buggy era is now utilized in the automotive age for the purpose of buildings alone. There must be a balance between land use and land service.

It is recognized that transportation, both individual and mass, would be improved if the dweller could live within walking distance of his work and minimum maintenance-of-life shopping facilities. The multiple dwelling unit located close to but shielded from industry and business offers many advantages. Maintenance-of-life shops could be located in the basement thus providing all weather and close access. Playground, recreation, laundry, garaging and parking facilities should be on the premises. In this way greenbelts, light and air can be had in the most thickly populated and industrialized areas. And only in this way can more service at less tax rate per capita, but with increased tax return to the municipality, be achieved.

Intolerable traffic and parking congestion is the immediate and critical emergency facing urban areas today. The paralysis caused by a deficiency in vital vehicular traffic facilities is strangling highly complex and thickly developed areas. Free flowing traffic arteries and parking facilities are the life lines desperately needed to sustain urban life until complete rescue can be effected by long range planning geared to the automotive age. But these life lines must be carefully and scientifically planned utilizing recently developed modern highway planning techniques and the plan must be coordinated to fit into the over-all regional and city plan. Controlled access highway planning and construction must proceed hand in hand with realistic urban planning and execution.

The most careful and scientific highway planning will not be fully effective unless vigorous and constructive steps are taken to rehabilitate and adjust urban areas to conform to the requirements of the automotive age. This places great responsibility on urban planners. Too often urban planning has been a "prettying up" process with little attempt to analyze overall needs to make the city a better place in which to live, work and conduct successful, economical business and industry. The urban area must be geared into modern mechanized society. Commercial and industrial needs are just as vital as aesthetic and recreational considerations.

Powerful forces not at work tend to destroy many .cities and urban areas. Dry rot has set in. The basic causes of these forces must be ferreted out and vigorous correctives applied if they are to be restored to health. The citv cannot sit idly by. It must do something. Instead of passing the buck to a higher level of government, it must take constructive and immediate action. Only the city can save itself.

The aesthetic aura in city planning must give way to a practical conception based on incisive and scientific analysis of over-all community requirements. Many diverse and conflicting interests must be drawn together to produce a coordinated and balanced plan which will successfully rejuvenate the economy and justify the expenditure of the considerable sums necessary. The capital investment must pay dividends on a cold cash basis, otherwise deterioration and bankruptcy will be accelerated.

As a part of urban planning, modern highway planning utilizes the scientific techniques developed over the past dozen years by the highway planning surveys initiated by the Bureau of Public Roads. These techniques include analyzing existing traffic patterns, existing and future volumes, existing road capacity, origin, destination and desire lines of traffic, benefit-cost ratio, population growth and trends, vehicle registration and trends, land use, mass transit, terminals, concentration of population, shopping and employment, recreation areas, growth and trends of commerce and industry. In integrating with the development plans of national, state and local planning agencies, the influence of present and future water power, water supply reservoirs, airfields, canals, railways, terminals, recreation areas, State and National forests and military installations should be appraised as to their effect on the urban highway system. Urban highways should be planned to serve these facilities, not conflict with them.

The application of these techniques will indicate the traffic lanes required in each traffic shed to serve present and future needs, the type of facility needed, the general course of its location, location and capacity of terminal and parking areas, location and general design of traffic interchange facilities to effectively serve the area and at the same time avoid flooding the existing street system with more traffic load than it can carry. These things can be planned so highway transportation may be integrated into and coordinated with overall urban long range planning to accomplish the mission of the area and revitalize it for better living, greater security and economic stability.

The function of the controlled access highway is to safely and freely carry large volumes of traffic with dispatch. The highway must be located close to the desire lines in each traffic shed. The large capital expenditure and loss in tax ratables involved in urban construction can only be justified by utilizing the most efficient traffic carrying artery known. This indicates the desirability of eliminating cross traffic by grade separating all intersecting highway and rail facilities, eliminating all left turns, dividing opposite direction express highway traffic by a median, utilizing specially designed traffic interchanges of sufficient capacity, adequate sight distance, sufficient traffic lanes of ample width, easy grades and alignment and adopting the controlled access principle. Such a facility will carry from five to ten times more volume than the ordinary city streets of comparable width.

Because of the large tax ratable loss and the grade separated feature which often requires "above grade" construction, such controlled access projects are frequently opposed by citizens and local public officials because of lack of appreciation of the long range view. This presents a challenge. Here is an opportunity for public service by city planning authorities.

Unfortunately, urban planning is served by lip service only in many places. As long as a plan is confined to paper all is accord, but as soon as it is put to work and someone is hurt by the operation, opposition develops. Opposition is quickly and skillfully organized by affected minorities determined to block the improvement, save homes and businesses and prevent the immediate loss in tax ratables destroyed to make way for the improvement. There is imperfect realization of the deteriorating forces already at work which are causing flight of dwellers, commerce and industry due to lack of planning, obsolencence, improper land use, traffic congestion and because the town offers less than the competitor's. Among the general public, proponents of an active improvement project which involves a sacrifice and a physical loss to the city are seldom on hand to champion the undertaking and combat opponents. The leadership of enlightened planning authorities can be of great assistance in this situation.

The man in the street can easily visualize and will admit readily that cross traffic on "at grade" intersections is the principal bar to free and expeditious traffic flow. The red light is the symbol of lack of progress. It is the dream of every motorist to drive on a highway without red lights and cross traffic from beginning to end. But when the motorist and man in the street is transformed into an individual home or business owner and applies his thinking to a specific plan or project which has reached the construction stage, perspective is lost and he does not see why he should make a personal sacrifice to promote the public welfare.

Long range urban planning and adequate public relations must provide the answer to this problem. The public has not been informed properly of the ultimate overall objectives and how a particular project fits into the comprehensive plan to make the city a better place in which to live and work, increase its prosperity and stabilize values. Public relations may be an over-worked phrase but it is sorely needed in urban planning.

Progress and genuine improvement are never achieved without sacrifice. Overworked and belabored city officials face a difficult problem deviled as they are by declining ratables, advancing tax rates, obsolescence, high cost of services and flight of population and industry. Urban planning must face up to the problem. A large part of this job is in informing the public of the over-all plan, its objectives and how and why it will help them and the city. Unless the public can be sold on a long term basis, the city in the long run will wither and die.

Finally the city itself must be resold to dwellers, commerce and industry if unjustified decentralization is to be checked and the capital investment is to be preserved and strengthened. An adequate Plan will accentuate and strengthen the inherent advantages of city life and at the same time lessen or eliminate disadvantages. Without a good plan the city cannot be resold.

Free flowing highways alone will not solve all the problems of the city and urban area, but without such highways the problem cannot be solved at all. Just as the arteries of the body are necessary to carry the blood stream, so there must be traffic arteries to carry the life blood of highway transportation. Without adequate free-flowing highways the urban area will break down completely and no amount of other redevelopment can save the declining city.

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