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T H MacDonald, Presiding

U S Bureau of Public Roads, Washington, D C

Chairman MacDonald The first paper on this morning's program is the report of the Committee on Highway Traffic Analysis

REPORT OF COMMITTEE ON HIGHWAY TRAFFIC ANALYSIS

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The Committee on Highway Traffic Analysis submits the following report.

PLANNING FOR ARTERIAL HIGHWAYS OUTSIDE OF CONGESTED AREAS, INCLUDING BELT LINES FOR DETOURING LARGE CENTERS

State highway departments are frequently confronted with problems incident to arterial highways serving large cities or centers of population A traffic census will indicate that the number of vehicles increases as the distance from the city decreases. This is due to distribution of local traffic near the congested area. A uniform width highway, therefore, is neither necessary nor desirable unless the distance between points of congestion is comparatively small.

A practical solution of this problem is illustrated by the work of the Pennsylvania Department of Highways on Route No 142, the Lincoln Highway in Chester County, Pennsylvania Near Philadelphia this route has been widened to forty feet, further out it is thirty feet wide and in normal rural regions it is eighteen feet wide, thus providing for four, three, and two lanes of travel

This provision for widening the principal arterial highways is not alone sufficient as too great a concentration of traffic will be caused within the critical traffic areas Further relief must be afforded by belt lines, consisting of outer belt routes by-passing traffic congestion areas, and inner belt routes usually through the residential districts of the congested areas There are many minor difficulties involved in the main problem such as unseparated grade crossings, narrow

streets within city limits, sharp turns, steep grades, bridges, and schools and churches along the route. The problems caused by these conditions, however, while often perplexing and objectionable, can usually be solved and should not be allowed to obscure or dominate the solution of the major situation

USE OF HIGHWAYS FOR INTERSTATE TRAVEL

The future development of highway traffic may magnify interstate travel Even now the factor of interstate travel is an important one requiring careful study The main consideration, however, must be of authentic traffic data rather than impressionistic conceptions of transcontinental routes, and conclusions must be based on fact

There is to be considered that some sections of the country, as the Atlantic seaboard, will show a greater percentage of interstate travel than others

In 1923 the traffic count made by the Pennsylvania Department of Highways showed that cars licensed in foreign States contributed 25 per cent of the total traffic observed in border counties within a distance of twenty-five miles from the State line, and 4 per cent in the central counties.

A special analysis in the 1924 traffic census made by the U S Bureau of Public Roads and the Pennsylvania Department of Highways showed that 5 6 per cent of the passenger cars and 4 4 per cent of the trucks observed on the primary system of four thousand miles were of foreign State license.

Analysis of foreign car traffic would show that a large part of the interstate travel is in the border counties and is, strictly speaking, local traffic, the foreign cars coming from points near by in the adjacent State.

As a measure of long distance interstate travel, the important figures are the percentages determined for interior counties

CARRYING CAPACITY OF HIGHWAYS AS AFFECTED BY WIDTH OF SURFACE AND RESTRICTIONS OF USE

An unrestricted speed limit may be considered in the near future an argument to decrease traffic congestion, reduce automobile accidents, and promote a better respect for law enforcement

In this connection, it will be well to take into consideration the traffic and various uses of the highway, the effect of street intersections on traffic flow, and the physical and weather conditions Motor vehicles must not be operated, regardless of speed, in a manner which endangers the life or property of others It is possible that in the

event of accident, any speed exceeding 35 miles per hour might be held prima facie evidence of reckless driving, requiring proof to be otherwise ruled.

In the open country, 20-foot highways seem to be of ample width, but in approaching congested centers the highway should, considering its present and expected future traffic, be able to carry three or more lanes of traffic

Limitation of vehicle size, weight and speed have been found necessary first, for safety and convenience, and, second, to prevent uneconomic injury to and unjustifiable use of the highway

The laws of the various States with respect to such limitations should be made as uniform as is consistent with the present condition of the construction program, especially in view of the increasing amount of interstate traffic

The State highway department responsible for the construction, maintenance, signing, and safety of the State highway system should be responsible for the control over State highway traffic and enforcement of State highway traffic regulations

There are various sections of certain highways which will carry larger and heavier vehicles than others We are confronted with two problems Shall highway regulations be based on the load-carrying capacity of the weaker highways, or shall the highways be made adequate to carry the largest and heaviest loads desired to be placed on them by users of motor vehicles?

The Committee recommends that highways be classified in terms of weight-carrying capacities, recognizing the necessary variation in weight limitations for main traffic and secondary traffic routes, and that consideration be given to the increased traffic value which may accrue in the adoption of a minimum speed law as particularly applied to Class A highways.

THE RELATION BETWEEN VOLUME OF TRAFFIC AND POPULATION AND THE RELATION BETWEEN VOLUME OF TRAFFIC AND INDUSTRIES SERVED

From the fact that highway traffic is largely local, it follows that the volume of traffic will vary in some degree with the density of population adjacent to the road

This is a general condition and traffic relations developed in Pennsylvania will probably be approximated in other States.

The average motor-vehicle trip is about thirty miles, and the counties are practicable traffic study units.

With traffic census stations at regular intervals and approximately thirty miles apart, the total traffic count fairly represents the total travel The ratio of the total travel, in a county, to the number of cars registered in that county, furnishes the traffic factor This can be used for estimating traffic, where census figures are not available, in the following manner:

Outline tributary traffic area, including section of road under consideration, with cross road or town terminals, about thirty miles apart The width of the area will depend on the proximity of parallel roads It averages in general about ten miles in Pennsylvania Total the population of townships, boroughs, and cities, within the area. Estimate the number of motor cars in the section of the county from the number registered in the county, by assuming the same proportion as the population of the section of the country under consideration bears to the total population of the county The county traffic factor, multiplied by the estimated number of motor cars in the area, will approximate the traffic on the road Since the county factor is an average determination, the traffic estimate should be increased for trunk roads to allow for greater percentage on these roads of more than thirty-mile trip travel

When the counties are classified and grouped as agricultural, mining, or manufacturing, according to their predominating industry, it is found that the mining counties produce the least amount of traffic in proportion to the number of cars registered in the area, and that the manufacturing counties produce the most traffic The average of the county factors in Pennsylvania are 0 293 for agriculture, 0 281 for mining and 0 369 for manufacturing

For forecasting, the important factor is found in placing the time and figure for the so-called saturation point in motor-vehicle registration In Pennsylvania, it is assumed that this saturation point will be reached within the life of the durable type pavements that are now being built, and that the motor-vehicle registration curves, after that time will hold their relative position with the population curve.

It is believed that the influence of industrial development will continue to affect the ratio of traffic to registration and that the ratio of population to registration, at the so-called saturation point, will reflect the density of population Accordingly, conservative estimates of 1940 ratios of population to registration range from 2 31 for agricultural counties to 5 33 for the counties containing urban population The two influences, industries and density of population can be combined into one factor, but will yield more reliable results if considered separately

THE LARGE VEHICLE AND THE HEAVY WHEEL LOAD, INCLUDING THE SEMI-TRAILER AND THE SIX-WHEEL BUS

First it is desirable to direct attention to the basic traffic principles, particularly those affecting truck movement. Truck movement is largely short haul Transport surveys conducted in Connecticut, Pennsylvania, and Ohio show the average trip for all trucks to be approximately 25 miles Long hauls by trucks are very rare and represent a very small part of total truck movement The average length of trip by passenger cars is approximately double that of trucks The surveys, above referred to, show that truck traffic is almost negligible on sections of many routes, and particularly is this true of the large vehicle and the heavy wheel load. Since truck traffic is still more restricted in its area of movement than passenger cars which form the great bulk of total traffic, the question arises whether or not it might not be practical to permit larger loads in those areas and on those routes where conditions are favorable for the use of the larger trucks Here enters the problem of the economical justification of strengthening the pavement design to care for the heavy wheel load If the records show in any particular case that heavy wheel loads form a very small per cent of the traffic using the route in question, it is obvious that the extra expense entailed in building the pavement adequate for the larger trucks can not be justified It is, therefore, plain that there should be some restriction on the weight of vehicles

One question which arises in this connection is whether or not large vehicles carrying heavy loads impede traffic and decrease the capacity of the highway to a greater extent than combinations of lighter vehicles and trailers or multiple wheel vehicles, such as six-wheel buses and trucks. Again there is the problem of whether large four-wheel vehicles cause greater damage to our highways than larger numbers of small vehicles or vehicle combinations having three or more axles

In Ohio where the gross load limitation on motor vehicles is comparatively low (20,000 pounds), the use of six-wheel trucks and trailers is small Six-wheel trucks observed during the 1925 highway transport survey in Ohio were only one-tenth of one per cent of total trucks observed Only four-tenths of one per cent of all trucks had semi-trailers attached One per cent of all trucks had four-wheel trailers attached Three-tenths of one per cent were tractor and trailer combinations In other words, the combined total of six-wheel trucks and trucks or tractors with trailers attached was only 1 8 per cent of all trucks

The evidence obtained in Ohio indicates that even when the gross load limitation is comparatively low the number of trailers and six-wheel trucks in operation is relatively small. This seems to indicate that tonnage which might be carried on larger trucks is now carried on a greater number of small trucks.

In the Cook County transport survey it was found that approximately two and one-half per cent of all trucks observed on Cook County highways had trailers attached. The percentage of trucks with trailers attached varied from zero at some places on the highway system to 10 and 14 per cent at others. The gross load limitation in Cook County at that time was 24,000 pounds.

Apparently the use of trailers depends very largely upon special movements and local conditions.

It has been brought out, principally in previous studies by the U. S. Bureau of Public Roads, that the tensile stress set up in a concrete pavement is twice as great with a four-wheel truck as with a six-wheel truck of the same gross load.

In both six and four-wheel trucks the maximum tensile stress occurs in the bottom of the slab, this being the critical stress for both types of trucks.

A load passing over a pavement 21 inches from the edge produced an average stress less than 50 per cent as great as the same load 9 inches from the edge. The pavement in this case was of uniform thickness.

Present maximum permitted loads vary widely in different States, as for example:

Ohio	20,000 lbs.
Pennsylvania	26,000 "
Illinois	25,000 "
City of Chicago	30,000 "
Indiana	28,000 "

Elsewhere in this report is recommended a highway classification in terms of weight-carrying capacities to partially solve this particular problem of highway transport.

CLASSIFICATION OF HIGHWAYS IN REFERENCE TO RIGHT OF WAY AS FUNCTIONS OF TRAFFIC VOLUME AND KIND

Considerable discussion has arisen relative to the proper width of highway right-of-way to properly care for present and future traffic demands. While differences of opinion are found, there is a general agreement that the present narrow widths are in a majority of cases inadequate and undesirable. Modern motor traffic moving at high speed with many large vehicles calls for a different highway

treatment and development than in the days of horse-drawn vehicles Formerly slow-moving vehicles with short wheel bases could be stopped and turned safely in a short radius circle Clear sight distances could be short. Now, greater widths, flat curves, moderate grades and long clear sight lines are essential for the safety and convenience of traffic

One of the most striking points brought out by transport surveys covering rural highways, is that traffic volume varies considerably on any given route Traffic volume is largely a function of population density Traffic is largely a local movement, therefore, as the distance from the large centers of population increases on any given route the traffic decreases accordingly. It is, therefore, obvious from the classification of highways in reference to traffic volume that there will be different traffic divisions on the same route

The problem, therefore, resolves itself into a plan for the future for the estimated life of the pavement type and the further demand of traffic service Therefore, the estimated future traffic is the important consideration

Even with a reasonably accurate knowledge of future traffic volume the roadway cross section design will affect the needed width of right of way to a very considerable extent For example, many city streets are constructed with curb and gutter design, open ditches being eliminated entirely, with an elaborate system of underground drainage, which carry large volumes of traffic on fairly narrow rights of way and, in many cases, a larger volume of traffic than is demanded of any rural highway Insofar as the design of the road for the rural highway approaches the type used in city pavements, eliminating the necessity for open ditches by the use of underground drainage, so much the less width of right of way will be needed when compared with the conventional design of rural highways providing for shoulders and open ditches, occupying a width of right of way, double or more, than that actually used by the traffic

Special conditions exist which require a greater width of highway than demanded under ordinary conditions, such as the width necessary for high fills or deep cuts, at curves, and at intersections or other obstructions where traffic is retarded and the wider pavement necessary to handle large volumes of traffic Having determined the design which will be used for a roadway cross section, the width of pavement deemed necessary to carry the traffic volume must be determined Many investigations have been made along this line and fairly accurate information is available.

In the July, 1921, issue of *Public Roads,* there appeared an article by A N Johnson on the subject of "The Traffic Census and Its Use

in Deciding Road Width" In this article Dean Johnson shows that traffic discharge depends on speed and spacing of vehicles, and asserted that 1,000 vehicles per hour is not too large for a two-lane road

There have arisen two schools of thought as to required right of way particularly in reference to extremely heavy traffic routes On one side it is argued that this problem should be solved by the so-called superhighway, providing two lines of pavement each having several traffic lanes On the other side it is argued that it is better to provide parallel routes rather than extreme widths on a few main routes In this latter case it is pointed out that abutting real estate values are increased enormously by road improvement, especially along heavy traffic routes, and that these benefits in the improvement of parallel routes are in excess of those adjacent to one main artery. Traffic is endeavoring to reach some particular objective—in general, a large center of population—rather than to occupy any particular route This may signify that near large centers of population there is need of a greater number of converging routes to handle the traffic. These routes as they go farther and farther away from the center of population become more widely separated, and the traffic on them decreases correspondingly. The width of right of way and the design of the pavement will naturally change to correspond with this change in traffic.

If the facts in any case indicate the need for wider widths in the near future, provision should be made for acquiring these widths before the property increases so largely in value as to add unduly to the cost of future improvement

The effect of the kind of traffic on width of right of way is more or less a local problem The chief factor in this respect enters when truck traffic is large This condition exists in general only near large centers of population Where the amount of truck traffic justifies, it may be advisable to provide an extra lane or a separate trucking route for this slow-moving traffic.

In practice the width of right of way which is being acquired in various States has depended largely upon land values If land is cheap, comparatively large widths can be obtained, and are obtained, even on routes which are comparatively unimportant However, if land values are high, the cost of the right of way is an important sizeable proportion of the total cost of the improvement It is, therefore, economical in these cases to keep the width of right of way to a minimum which will still give roadway sufficient to handle the traffic Here again is cited an example of what is done in States where land values are high, that is, the road design is materially

changed so as to cut down much of the width now used on rural highways.

The Committee elsewhere recommends the classification of high ways for primary, secondary, and local service The size and number of vehicles will vary in the order named with the greater number of large and swiftly moving vehicles on primary routes The widths of right of way should vary accordingly. The Pennsylvania Department of Highways had fixed, tentatively, upon the following widths. Primary routes 120 feet; secondary routes 100 feet; and local service 80 feet.

These widths provide for ultimate pavement widths, respectively, of 80 feet, 60 feet, and 40 feet. The remainder of the right of way is required for slopes, service poles, parking, and clear sight distance Issue might be taken with these widths, but it is believed that the general plan is fundamentally sound.

SELECTION OF TYPE BY TRAFFIC

The unit weight of truck traffic on certain highways may be such as to definitely require a high type surface These cases, however, are exceptional and selection is generally influenced by economy rather than carrying capacity.

It is frequently stated that the type of improvement should be selected so as to give the lowest annual average cost per mile when the fixed charges (interest on investment and depreciation), and maintenance costs are added to operating costs (average costs of motor-vehicle operation per car mile on the particular type of surface multiplied by the annual traffic, total number of vehicles).

A difficulty appears here Traffic conditions are so changing from year to year and our acquaintance with present day high-type pavements is so short that it is difficult to forecast economic life and annual maintenance costs

Passing this difficulty there are four objections to using a hard and fast rule for any theory of selection of type by traffic·

1 From the standpoint of first cost, funds are not always available in amount sufficient to make all improvements that actually appear economic. Until our State highway systems are 100 per cent improved, there will have to be considered in some localities the expediency of stage construction and laying more miles of "semi-durable" type than would be possible with a higher type

2. From the standpoint of annual cost there are many cases where the carrying charges and maintenance costs (not considering operation costs) for the "semi-durable" type would be less than for the higher type.

3 From the standpoint of traffic service, the traveling public, which actually assumes the cost, in many cases shows a preference for the "semi-durable" types

4 From the standpoint of practicability, availability of materials and construction features would provide many exceptions

The traffic volume, along with economic factors, has a determining influence in the selection of the general class of pavement, and the economic factors determine largely the choice of type within the groups Where the traffic is composed of a considerable number of heavy trucks the type selection must be confined to those pavements which can economically carry the loads applied

It is suggested that each selection of type be principally influenced by economy in annual charges (average annual maintenance plus equal annual charges for depreciation and interest) and that value or economical first costs be the basis of final determination

The danger in a low traffic community lies largely in over-improvement by selecting the high-class pavements to the sacrifice of needed serviceable highways

The relative value of two or more types can be determined, assuming that information as to economic life and maintenance costs is sufficient, by use of a table of annuities

In many cases where the economy of a particular type and practicability of financing is evident, the economical type should be selected In cases where there is reasonable doubt as to the economy of one type as compared with another, especially if funds are limited, and there is a greater demand for improvements than can be immediately satisfied, it may be desirable to give preference to the lower first cost type, provided it furnishes satisfactory traffic service

It is true that construction costs have increased greatly in twenty years, and that within the next twenty years there will probably be further increase, so that from this standpoint long life improvements are advantageous, but on the other hand, we have been continually improving our design for high-type pavement and the lower first cost improvements may be safer investments

PLANNING THE IMPROVEMENT OF STATE HIGHWAY SYSTEMS

There is no fundamental difference in principle between the public business of developing systems of highways, and private enterprises engaged in producing commodities or in the performance of services For example, light and power, gas and telephone utilities and other industries are all engaged in the production of their commodities for public use The history of their modern development and expansion is largely a development based upon a careful analysis

of the demand for their product by present and potential consumers in a given area The soundness of their analysis of this need for new service and the expansion of their plant anticipating this demand for their product has been an influential factor in the progress or lack of progress of many communities.

The same basic economic and engineering principles of management as control in the field of private business, should govern the public business of production in the highway field

Applied to the public business of a State responsible for developing a connected system of highway improvements to facilitate the transportation of people and commodities, *the first principle of production management is that the various sections of a highway system selected for improvement and the types of improvement selected for construction on each section of a highway system should be based upon present and expected future traffic demands,* modified by the various physical and economic characteristics which affect the choice of specific construction types to be built on the various parts of a State system

The second basic principle is the familiar one of the budget upon which all financially sound industries operate Applied to the highway business it involves· First, the determination of the amount of money required to complete the improvement, second, the apportionment of the cost among those who benefit from the improvement of highways, and provision of the legislation necessary to raise the required highway funds, third, the expenditure of the money in accordance with a predetermined plan of highway improvement in which each highway route or section of a route is to be improved to the degree required by the traffic and to no greater or less degree The first and third are functions of the State highway department, the second is the responsibility of the State legislature, and is always the final limiting factor. Provision by a legislature of more than the necessary revenues is apt to encourage waste, provision of sufficient funds, well managed by the highway department, results in a well-balanced system of highway improvements and the economic development of a State as a whole, provision of insufficient improvement funds by a legislature defers the true improvement of a highway system, forces the highway department to spread uneconomically its expenditures of State funds over the entire State system and usually results in the development of a highway system below the requirements of traffic and if continued over a period of years increases the total ultimate cost of highway transportation.

The tremendous recent growth of highway traffic has revolutionized highway transportation. The past 15 years have seen the re-

emergence of highway transportation, one of the oldest methods for the movement of people and goods Mass movement of people and commodities on the principal routes of the various State highway systems is a fact and not a theory

The establishment of scientific plans for highway development, which will result in the maximum of highway improvement and highway transportation service, with available revenue, labor, equipment, and building materials, requires a careful analysis of highway traffic, the trend of its development and its distribution over highway systems. The necessity of such an analysis is now recognized by highway executives, but their efforts have been handicapped by lack of precise knowledge of the present and expected future character of traffic using the various sections of a State system

A plan of State highway improvement materially alters the economic and social development of a people as a whole or any section thereof. The location and improvement or lack of improvement of a given route is of vital importance, not only to the immediate local traffic needs, but also to the traffic demands of larger areas

Therefore, the development of a system of highways should not be judged as "miles and types of highways constructed each year," but considered in terms of the movement of people and goods The planning and construction of a connected system of highways deal, in fact, with the destiny of localities and States, their agriculture, their industries, the growth of suburban areas adjacent to centers of population and the social activities of people This is a tremendous social problem and not merely a problem of physics concerning the mixtures of cement, water, brick, steel, bitumens, stone aggregate, gravel, equipment and labor into what we now term the modern road.

The major problem is not one of the particular types of materials to use, but rather whether to build or not, and how much highway service is necessary in a given area Upon the proper solution of these problems depend the well-being and progress of a people. Considering the improvement of highways from this point of view, there can be no question concerning the necessity of developing sound plans for highway improvement over a period of years in the several States and to provide the necessary money to carry out economically the plan of improvement

The principal classes of highway improvements are (1) new construction, (2) reconstruction, (3) stage construction, (4) building of bridges and culverts, (5) highway and railroad grade separations, (6) widening of present highways, (7) methods of guiding

and safeguarding traffic, and (8) establishment of old or the acquisition of new highway right of way.

Each of these classes of improvements, while more or less distinct as a class, is part of a general scheme of betterment *The development of the plan as a whole, including each of the several classes, should be based largely upon present and expected future traffic and the present "lay-out" and condition of the existing highway system in any given area.*

THE PRINCIPAL FUNCTION OF A HIGHWAY TRANSPORTATION SURVEY IN PLANNING A PROGRAM OF HIGHWAY IMPROVEMENT

1 To measure present and predict the future volume and character of traffic on State primary, secondary, and tertiary systems The principal traffic factors involved in judging the relative traffic importance of the three systems, or sections of each system, are Average daily and maximum total traffic and average daily and maximum truck traffic using each section The average daily number of loaded *light* (½ to 2½ ton trucks, *medium* (3 to 4 ton trucks), and *heavy* (5 to 7½ ton trucks) vehicles is an important factor in the determination of the plan of improvement as well as in the selection of the types to be constructed

2 To determine the relationship between population and demands for highway service and considering present density of population and population trends to aid in developing the plan of highway improvement which will most efficiently serve the present and future traffic needs of this population

3 To classify highway routes or sections of routes as major traffic routes (Class A), secondary traffic routes (Class B), and minor traffic routes (Class C) A Class A highway is defined as one that requires the so-called rigid type of improvement, concrete, brick, bituminous concrete, or their equivalent A Class B highway is defined as one that requires a so-called flexible type of improvement, standard bituminous penetration macadam or its equivalent A Class C highway is defined as one that requires other lesser types of improvement

The principal traffic factors involved in the classification of highway routes or sections of routes are

a Average daily and maximum total traffic and truck traffic

b Forecast of average daily total traffic and truck traffic for periods of five and ten years

c Average daily and expected future number of loaded light,

medium and heavy capacity trucks for each route or section of a route

d. The ratio of total loaded trucks to total traffic in order to separate for special consideration routes or sections of routes on which motor trucks are an abnormally large or small proportion of total traffic

e. The number and frequency of critical heavy loads

f Average maximum traffic as one measure of the width of the improvement, the necessity for improvement, of additional parallel routes and the "by-pass" of congested centers of local traffic.

g Analysis of highway maintenance and capital costs and vehicle operating costs as an important factor in determining the traffic limits for the various types of improvement

4 To measure motor-vehicle miles on the primary, secondary, and tertiary highway systems, and estimate earning capacity of these three highway systems to determine the relative vehicle use value of each as a guide in developing the plan of improvement and the budgeting of construction and maintenance funds

5 Analysis of the present system and the physical condition of the existing improvements on the State system, since the plan of betterment must in general incorporate the existing State highway system as the basis of the improvement plan

A State plan of highway improvement can be separated into two distinct planning phases

1. The general State plan, consisting of a connected system of primary, secondary, and tertiary routes serving each section of the State It should be recognized that there is a considerable variation in the present and expected future volume of traffic on the highway systems of the several States and that within each State there is also considerable variation in its present and expected future traffic on the various sections of the State primary and secondary system

2 The State system and the highway plan in areas adjacent to centers of population The improvement plan of the State and the plan of improvement of the larger cities within a State should be worked out cooperatively

This cooperative planning is essential to the proper location and entry of State routes into congested traffic areas, to avoid dumping traffic from one or more than one State route into an already congested area, to provide for adequate connections and improvement

of the city streets that join State routes at city limits, to make provision for "by-passing" congested traffic areas, to eliminate obstructions to the easier movement of traffic, and finally to provide a plan of belt, arterial and secondary local traffic routes to facilitate the rapid, safe, and unobstructed flow of traffic in congested traffic areas

In the final analysis the worth of a transportation survey and the resulting plan of highway improvement is measured by the actual highway construction, reconstruction, and widening program which is carried into effect over a period of years.

The State highway engineer, as the executive director of the public business of providing highways, is responsible first, for the analysis of the traffic demand for his product on the various sections of the State system, second, for a financial analysis of the yearly cost, the revenues required, the funds available, and the establishment of a budget for the period of the improvement program; third, for the business and engineering management of the improvement program

The major limiting factor is the financial program provided by the legislative organization responsible for raising the revenue to enact into reality any plan of highway improvement, and therefore a large part of the responsibility for the character and extent of a State system of highway improvements rests not upon the State department charged with the duty of constructing highways, but upon the department of State government responsible for the raising of highway funds