speeds are safe on this type of road, with the resulting increase of other types of accidents.

Somehow the message must be conveyed to drivers of cars and trucks that all safety engineered into our highways can be completely nullified by increased speeds.

REMEDIES FOR TRAFFIC CONGESTION IN METROPOLITAN DISTRICTS

Robert B. Brooks,
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A metropolitan district is commonly known as a district which includes a large center of population. Congestion, when applied to traffic, means overcrowding or mutual interference. Remedy, of course, means a cure or correction. To state the subject in a different way, one might say we are discussing what can be done to facilitate driving conditions in cities and their immediate vicinities.

Streets and highways have been called traffic arteries, and rightly so. The traffic which moves over these arteries is the very life blood of our economic existence. A city exists because of transportation facilities. It must be connected with its neighbors. Each citizen must be able to receive from distant sources all the commodities which he eats and which he uses in his business. Our traffic arteries must be used to transport and distribute those articles which the city dweller produces. No chain is stronger than its weakest link. Our major traffic arteries in cities furnish one of the strongest links in our national transportation system.

A city has been defined as a “large aggregation of people having a high degree of density and a facility for intercommunication.” Without this intercommunication, a city would die. As we meet or fail to meet the increased demand on our traffic arteries in cities, so does the growth of our cities increase or decrease in direct proportion.

In Missouri, one of the early problems confronting the highway department in its road-building program was that of providing ingress and egress to cities for local traffic without at the same time penalizing through traffic by routing it through the congested sections. At the start the department encountered old, long-established conditions set up by the slow-moving, horse-drawn vehicles and a system of county roads converging toward the business sections. This was not a serious condition at the time that the road program was planned, for traffic was then relatively light and originated within a few miles of the city. With the increase in the use of automobiles, however, the converging of routes toward the business sections resulted in much congestion of downtown
traffic and also increased the wear on the city pavement, making it costly and difficult for many cities to maintain their main streets. Furthermore, there was no provision in the law whereby the highway department could reimburse the cities for their extra maintenance expense.

BY-PASS ROADS

In 1922, when the first sale of bonds gave an impetus to the construction program, it was realized that relief must be provided for through traffic by means of by-passes and that local traffic must still have ready access to the business districts. The department then adopted the policy of skirting the towns and cities with the main trunk roads, where it could be done without materially adding to the traveled distance and without inconveniencing the local traffic. In those cases where a by-pass could not readily be secured around the city, a location through the city but remote from the business section was adopted.

Large cities like St. Louis, Kansas City, and St. Joseph presented a somewhat different problem, as they are situated on large rivers where river bridges determine the location of the roads for interstate traffic. On the other hand, there are within the state a number of cases like that of Springfield, where it is easy to deflect the traffic around the city and at the same time provide a ready access to the business section.

The constitutional amendment adopted in 1928 provided for supplementary routes and traffic relief routes as an expansion of the Centennial Road Law program. Much more than at first contemplated was accomplished by using such routes to make connections with the business centers and to by-pass the through traffic around the cities. Many of the routes shown as existing in 1925 have been abandoned as state routes or have been taken into the supplementary system and maintained as spur connections.

Typical examples of what has been done to relieve traffic by using by-passes may be cited as follows:

1. Primary spur connections, as at Macon and Cape Girardeau.
2. Secondary road connections, as at Harrisonville and Sikeston.
3. Supplementary road connections, as at Joplin and Marshfield.
4. Traffic relief connections, as at St. Louis and Kansas City.
5. Roads through residential districts but avoiding business or congested sections, as at Columbia.
6. Accommodating the traveling public wishing to go to the business section or the through traffic wishing to skirt the city, without loss of distance for either, as in Springfield.
The by-pass principle has been carried out in villages as small as 100 population, with good results. More has been accomplished than was dreamed of in 1925, and there is still much being done in the way of new construction to facilitate the flow of traffic around cities.

When the by-pass system was first proposed for traffic relief in the population centers, much criticism and discontent was expressed, especially by the local business interests. With the improvement of the main roads and the steady increase in traffic, however, the soundness of the policy adopted by the commission in 1925 is being realized more and more by the local residents of the cities through which the roads pass.

THOROUGH DIAGNOSIS NEEDED

Before a physician can prescribe a remedy for any diseased condition of the human body, it is necessary to make a searching diagnosis. Traffic congestion in metropolitan districts demands not only a careful diagnosis but also studies involving changes in traffic. Statistics play a tremendous part in guiding the judgment of the street and highway traffic engineer.

Fifteen years ago it was the practice for city officials to leave the handling of horse-drawn, as well as motor vehicles, in the hands of local police officers. In the early part of 1925, after I took office as the Director of Streets and Sewers of the City of St. Louis, an idea was discussed with many engineers and officials of other cities that traffic was rapidly getting to be a problem which should be given special study by engineers, and remedies were suggested. Furthermore, it was realized that, though the enforcement of necessary regulations should then be placed in the hands of the police officers, police departments did not have, nor were they supposed to have, a background of engineering education which would fit them to analyze traffic from an engineering standpoint.

Reacting quickly to this suggestion, the St. Louis Board of Aldermen created the position of City Traffic Engineer in the Department of Streets and Sewers, with one draftsman and three traffic inspectors. Mr. Reyburn P. Hoffman, now the Executive Secretary of the St. Louis Safety Council, was appointed to this position which, I believe, was the first position of this kind created in any municipality in the United States, or possibly in the world.

After various traffic intersections had been roughly studied, it was early seen that one's personal judgment could not be relied on to warrant a large expenditure of funds to correct traffic congestion conditions without a more thorough diagnosis. This diagnosis could only be made through the use of statistics.

It was decided that traffic flow was very much like the flow of water, which, unless obstructed, takes the best, easiest and quickest ways in which to flow. We felt that traffic should
inform us what it wanted to do, so that, having made a correct
diagnosis, we could expedite traffic and relieve congestion by
facilitating these traffic channels.

Again, we may liken our needed streets and highways to
the arterial system in our human bodies. The heart of our
human body necessarily has attached to it the largest artery
which divides and subdivides as the needs of our system eco­
nomically justify, until its branches are so small as hardly to
be seen by the human eye. The flow of traffic on a street or
highway can well be likened to the flow of water in a pipe, the
traffic area between curbs having a certain width just as the
iron pipe carrying water has a certain fixed diameter. In order
to get an increased amount of water, one must necessarily
force the water through faster, or else supply a pipe of larger
diameter, or additional pipes. So it is with streets and high­
ways of our metropolitan districts.

INCREASE IN MOTOR VEHICLE REGISTRATION

It is hardly necessary to speak of the increase in the
number of motor vehicles in the United States, but on the
other hand it may be worth while to refresh our memories
by reminding ourselves that in the year 1899 there were 3,000
motor vehicles officially registered in the United States. Four­
ten years later, in 1913, there were 1,000,000 registered
vehicles. In 1916, when the Federal Road Act was passed,
there were 3,500,000 vehicles. In 1921, when the Federal
Highway Act was passed, which provided for a system of
federal aid highways, there were 10,000,000 registered cars.
This number had doubled in 1925 to 20,000,000. This growth
continued to increase, with a slight dropping off in the years
1931-32 and 33, until there was a total of more than 28,000,000
motor vehicles in 1936.

The latest figures obtainable, furnished by the Bureau of
Public Roads, show that this number had increased up to 1938
to a total of 29,705,220 registered motor vehicles, which pro­
duced in license fees alone $399,613,000, or an average of
$13.45 per vehicle for license fee only. For this practically
30,000,000 automobiles, there was collected in the year 1937
a revenue for gas tax, $761,998,000, or an average of $25.65
per motor vehicle. This makes a total motor vehicle license
fee and gasoline tax revenue for the year 1937 of $39.10 per
car. The highest combination of license fee and state gasoline
tax in the United States is paid in Florida, an average of
$68.55. Missouri has the lowest cost to the vehicle owner, with
an average for these two items of $24.95 per car. You may
be interested to know that Indiana ranks thirty-sixth from the
highest, with an average of $34.86 per car.

During the period from 1925 to 1936, when the number of
registered motor vehicles increased from 20,000,000 to 28,-
000,000, an increase of 40%, the gasoline used increased by
110%, and the average annual use of gasoline per registered motor vehicle increased from 430 gallons to 638 gallons, or approximately 48% over the 1925 average.

Excepting the depression period from 1931 to 1934, the average annual use of our highways by motor cars increased through 1937 until it is estimated that 658 gallons of gasoline were consumed per registered vehicle, or a total annual gasoline consumption on our highways of approximately 20 billions of gallons.

In the forty-year period from 1899 to 1939, the number of registered automobiles has increased from 3,000 to 30,000,000, an increase of 1,000,000%. This stupendous increase is mentioned simply to remind us of the difficult traffic problems which have been created by inadequate widths of streets and highways laid out over forty years ago. This is the reason why we have traffic congestion in our metropolitan districts.

**TRAFFIC CAPACITY**

With the traffic engineer and his few assistants legislated into existence first by St. Louis and followed quickly by other large cities, it was necessary to find out what this mobile traffic force wanted to do, where it wanted to go, and whence it came.

Mr. Hoffman and I consulted with various engineers who were even then engaged in counting traffic, and later decided that the voluminous statistical reports of traffic engineers making these counts might best be shown graphically by drawing these volumes to scale, so many thousands of cars per inch of width, and showing this drawn to scale on a map of our city streets. This graphical showing of traffic by volume and statistics is standard practice by traffic engineers in the United States today.

The traffic capacity of a road, briefly, is its capability of accommodating free vehicular movement. Dean A. N. Johnson, of the University of Maryland, in his discussion of traffic capacity states:

> It was first necessary to develop a definition of traffic capacity. We can visualize a road carrying but a few vehicles and agree there is no congestion. But as the number of the vehicles increases, there will be reached a point at which some vehicles will be delayed because they are immediately unable to pass other slower moving vehicles. Such a point indicates the beginning of congestion, or what may be called "working capacity" or "free-moving capacity" of the highway.

> As the volume of traffic increases beyond the free-moving or working capacity, the number of vehicles passing in a given time will still increase, but they will move with more and more restrictions, and the individual driver will have less and less freedom of action. The number of vehicles may increase until a point is reached...
where the total volume is at the maximum, which may be called the "ultimate capacity" of the highway. This stage would immediately precede that of the incipient stagnation, when the number of vehicles on the highway becomes so great as seriously to interfere with their movement, and the number passing a given point during a given time begins to decrease.

Congestion is considered to occur on a road when the number of vehicles reaches a total great enough to fill the road and make turning out impracticable; this condition to last a sufficient length of time to be noticeable, the minimum amount of time being one minute. When congestion occurs, reduction of speed will be noticed, along with the tendency for drivers to crowd one another.

As a result of his investigations in congestion studies, Dean Johnson arrived at the conclusion shown in the following table:

<table>
<thead>
<tr>
<th>Number of Lanes</th>
<th>Vehicles per 5-minute Interval</th>
<th>Practical Hourly Capacity (Vehicles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage of Traffic in One Direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>97</td>
</tr>
<tr>
<td>3</td>
<td>185</td>
<td>165</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

The general conclusion for a two-lane pavement, with which Missouri is more immediately concerned, is that there is no congestion up to 1,000 vehicles per hour. In other words, this is practically the limit of "free moving capacity." It indicates that a density of 16.7 vehicles per minute, or one vehicle every 3.6 seconds, is the beginning of congestion.

Therefore, if 1,000 vehicles per hour is a measure of the hourly capacity of a two-lane pavement, and the maximum flow per hour is approximately 10 per cent (9.76% to be exact) of the total daily volume, then a density of 10,000 vehicles per day may induce some congestion.

Dr. L. I. Hughes, Deputy Chief Engineer of the United States Bureau of Public Roads says that the automobile has helped to "aerate" the cities and develop satellite towns and that traffic congestion in metropolitan districts has apparently had a tendency to further the back-to-the-farm movement so far as the city worker is concerned, thus allowing him to work in the city and live in the country. He further states that we must not cover the area surrounding our cities with too close a network of streets and thus destroy the desirable features of the suburban district.
The guiding of metropolitan traffic is an expensive matter. The most expensive highway construction is in our large cities. Arterial highways serve both the incoming traffic which may be city bound, or the traffic originating within the district. Before remedies can be applied, it is necessary to know the separate volumes which must be handled.

One of the early troubles of the traffic engineer was, and still is, that of eliminating street traffic within the city which in reality does not belong on city streets.

Wayne County, Michigan, with its metropolitan district centering in the City of Detroit, is an outstanding example of advanced planning which helped provide remedies for traffic congestion.

A TRAFFIC RELIEF PLAN

Leroy C. Smith, Chief Engineer of the Wayne County Road Commission says:

A condition of uncertainty would exist in the attempt to provide trunkline highways for metropolitan areas were it not for the salient fact that rights of way may be acquired immediately and actual pavement construction left to follow as the need develops.

The first step in a metropolitan trunk-line plan is therefore the selection of rights of way wide enough for ultimate development. The proposed highways will include (1) arterial highways radiating from the city; (2) traffic headers, or trunk-line loops, which will serve one or more of the following purposes: Provide by-passes for through traffic around congested areas, distribute traffic to and from arterial highways, relieve arterial highways at times of peak loading, or act as cross-town arteries for local traffic; (3) boulevards and parkways for recreational purposes; (4) secondary highways which act as major local streets; (5) highways designed for ultimate mass transportation; (6) express roadways with separate opposite-direction free-traffic lanes; (7) highways which provide space for public utilities (subways, etc.); (8) super highways with facilities both for mass transportation and for local service, having grade separations and provision for interchange at every major intersection; and (9) double-decked streets in which the entire right of way on two levels is used. It is a moot point whether or not parking facilities should also be provided on highways.

Width of right of way is an important matter. For trunk-line highways in the Detroit area, a minimum width of 120 feet is provided. Secondary highways have a minimum width of right of way of 86 feet, and super-highways, 204 feet. For boulevards, a right of way of 150 feet is a practical minimum. Parkway rights of way should not be less than 200 feet in width.

The master plan for the metropolitan area of Detroit, adopted by the authorities controlling metropolitan streets and roads in 1925, dealt primarily with conditions within a 15-mile circle from
the city hall. The six super-highways called for in that plan have been made 204 feet wide within the 15-mile circle and 120 feet wide for many miles beyond that limit, surpassing their planned dimensions. These six highways are Fort Street, Michigan Avenue, Grand River Avenue, Northwestern Highway, Woodward Avenue, and Gratiot Avenue. Over 80 per cent of the 204-ft. rights of way for these highways have been secured. In addition, double pavement sufficient for present needs has been built on these radial arteries and on seven other super-highways. The latter are the Base Line, Mound, Kelly, Stephenson, Southfield, Schoolcraft, and Telegraph roads. Furthermore, 38 of the 42 miles of the Outer Drive have been developed as a boulevard on a 150-ft. right of way, and many of the 120-ft. trunk-line highways and several parks and parkways have been developed.

The entire original master plan is thus almost a reality today in so far as ultimate right-of-way widths are concerned. This progress has been attained on a pay-as-you-go basis without issuance of bonds, as a result of unanimous adoption of the plan, legislation enforcing the plan on property subdividers, adequate condemnation legislation, and conservation of automobile taxes for highway uses.

A supplementary plan adopted in principle by the County Board of Supervisors calls for the widening of 61 miles of unimportant streets through the less prosperous part of the city, to provide 204-ft. thoroughfares which will later be connected to form a loop approximately one mile square. It is believed advisable in this connection to take property on one rather than on both sides of the street. With an existing street width of 66 feet, the depth of the average lot and width of the average alley produce additional widths of 100 feet and 20 feet, respectively. Condemnation of an additional strip of 18 feet from the next (and cheaper) series of lots will thus produce the desired 204-ft. right of way.

Rapid transit by express highway or by rail, to be effective, must be above or below grade, and local needs must be met at grade. It is believed that 204-ft. rights of way are wide enough to provide adequate facilities for both express-highway and rail transit, and in cases where these facilities are on an elevated structure, the area below will be available for parking space as well as for streetcar operation. In this plan, as in others, complete grade separation, and facilities for local interchange of traffic would be provided at intersections. Another plan for free-ways in congested districts contemplates using, for single-direction elevated expressways, 20-ft. alleys at the rears of properties, together with 8 or 13 feet of air rights on each side, giving space for 30-ft. or 40-ft. cartways, respectively. Still another scheme would utilize the air rights over railroad rights of way to provide space for industrial expressways, but inelasticity in expanding railway facilities and the necessity for partial or complete electrification of railroad terminals constitute very serious objections. In general it is better to build
TWENTY-FIFTH ANNUAL ROAD SCHOOL

elevated rather than subsurface structures on account of the saving both in first cost and in cost of alterations (if necessary).

It is difficult to foresee what the future will demand in the way of parking facilities as highway adjuncts. It should be borne in mind that the automobile owner now pays the cost of parking on highways as well as in covered parking areas and in open lots. Perhaps the cost of parking would be less if it were planned to be included in the highway system, and if areas at grade below elevated structures in congested districts were so utilized their value therefor might be a partial justification for adopting an elevated plan. When an entire parcel of property may be condemned at a cost little or no greater than the part needed for the highway, the value of the additional space for parking might also be considered. Again the provision of free parking facilities by businesses in outlying districts is a factor in the success of such outlying centers, and as such decentralization takes place largely at the expense of existing businesses in central districts, consideration should be given to providing parking facilities therein.

SOME EXPERT OPINIONS

Mr. Charles F. Kettering, Vice-President of the General Motors Corporation and one of the leading American research engineers, stated:

Curves of the growth of population and number of motor vehicles in use indicates that our roads must accommodate 50 per cent more motor vehicles within the next 23 years . . .

Although speeds of passenger cars may increase progressively with the years, it appears that the average driver today does not want to go much over 60 miles per hour, but wants to go that fast without effort. It also appears that any passenger car will be able to negotiate a 10-per cent grade without losing speed . . .

Mr. Earl J. Reeder, Chief Traffic Engineer, National Safety Council, recently said:

Many merchants and business people believe that traffic density is a sign of prosperity; whereas it may, rather, be a sign of impending business decay and decentralization. In some cities as much as 30 per cent of the traffic passes through central business districts without making any business stops. Means should be provided for such traffic to by-pass congested districts so that these areas can be reserved for business traffic.

Parking in congested business districts is a controversial problem. The primary purpose of access to the curb is to receive or discharge passengers or merchandise, and only after this function has been adequately provided for should the remaining free curb space be used for parking. It is inconceivable that we shall long continue to park cars almost bumper to bumper in busy city streets, and the time should soon come when building restrictions will require all business buildings to have off-street provisions both for
parking and for loading and unloading of merchandise. A new development which helps the police materially in enforcing parking regulations is the parking meter. This device shows mechanically the amount of time that has elapsed since a coin was inserted by the driver who parked there and reveals at once any violation by over-staying.

**URBAN MASS TRANSPORTATION**

Urban mass transportation is necessarily a vital factor in our urban life. Street cars carry the greatest number of passengers still. In New York City in 1937, the street cars carried five hundred sixty-four million passengers. However, the street-car transportation is retarded by and is mutually interfered with by automotive traffic. Bus transportation averages only about two-thirds the passenger load per vehicle per year. During peak periods an analysis shows that the passenger-carrying capacity of street cars is immensely valuable and will continue so in our large cities for some time to come.

In many cities, traffic from main arterial highways aggravates the transit and traffic problem. Non-stop through traffic should be provided with facilities that would induce it to keep off the city streets. By-pass freeways are a partial remedy, as they will keep some of the through vehicular traffic out of congested sections; elevated or depressed highways within the city, where conditions are favorable for their construction, will accomplish the same result. That part of the highway traffic, and of the local vehicular traffic, which has the community center for its destination, cannot be diverted and must have mobility if the city is to function efficiently.

Traffic lights, parking ordinances, roadway widenings, one-way streets, isolated grade separations, and other palliatives reduce the traffic congestion in city streets, but they do not remedy it. These improvements in facilities for surface traffic to ease congestion invariably attract proportionately more traffic, resulting in still greater congestion in the city streets. The widening of roadways by reducing sidewalk widths is not sound long-range practice, as it merely shifts the congestion from the vehicular area to the pedestrian area of the street.

Additional roadway space can be obtained by cutting new streets through the built-up sections of the city or by widening existing streets. Both methods are expensive and result in the destruction of property from which the city obtains part of its tax revenue. In some cases these methods may even adversely affect the character of a neighborhood.

The alternative to widening streets horizontally is to separate the different kinds of surface traffic permanently by introducing a new traffic level within the existing street width. Elevated structures or subways for rail operations would remove urban mass transportation from the street sur-
face. Doing so in effect widens the street by at least two traffic lanes or 22 feet. The destruction of property is avoided, mass transportation can function, and the remaining surface traffic will move at a faster pace, saving time and energy for all.

Elevated railways are comparatively low in first cost and many riders may prefer them to subways as a transportation medium. From a civic standpoint, however, they have many disadvantages, chief of which are obstruction of the streets by columns and stairs, and interference with light, air, and access to abutting property, making such property less desirable and less valuable for business or residential purposes.

Subways are much more expensive than elevated railway structures, but they do not have the undesirable features of the latter. On the contrary, subways enhance the value of abutting and surrounding property by increasing the total traffic capacity of the street and by eliminating the noise inherent in any form of surface transportation. Moreover, they can provide more convenient close-to-destination service for passengers, as they can be built under high-class business and residential streets which would be barred to elevated railways or elevated highways.

Very few cities have enough local traffic for a transportation system composed entirely, or even in part, of subways that would be self-supporting at a reasonable rate of fare. Only a few cities have built subways, because in the popular mind they are associated with long-distance rapid transit. Nevertheless, many cities need simple transit subways.

EIGHTH INTERNATIONAL ROAD CONGRESS

At the Eighth International Road Congress, held at the Hague, Holland, last summer, the segregation of various classes of traffic on the highway was discussed at length, this being considered one of the principal remedies for traffic congestion. The general report stated: "Segregating different classes of road users, diverting different lines of traffic and the lay-out of crossings are not the only factors that form a consideration, although proper research into these matters will no doubt make for much greater safety on the road."

The conclusions adopted by the Congress on this question were as follows:

1. Road-safety should be the primary consideration in determining the extent to which the different classes of road-users and traffic-streams should be segregated.

2. Apart from the requirements of safety, the carrying capacity of the road, the speed of traffic and also financial considerations are important factors to be considered in dealing with this question.

3. Before the construction or reconstruction of a road system is undertaken, surveys of present and future traffic requirements
and general economic considerations should be made and plan-
ning should take into account the necessity of correlating national
road systems at international frontiers.

4. It is necessary that the technical measures adopted with a
view to separating the various classes of traffic and the opposing
streams of traffic in so far as they are not enforced by the lay-out
of the road should be supplemented by uniform regulations in each
country, and so far as possible internationally.

HIGHWAYS OF TOMORROW

It has been estimated by competent engineers that by 1960
there will be 37,000,000 motor vehicles in operation on our
streets and highways. In our traffic survey work in Missouri
we find that there is a ratio between urban and suburban
mileage covered of 4 to 1. In other words, 80% of the traffic
of Missouri is in cities. It is estimated that another 10% is
in the metropolitan districts contiguous to our cities, which
means that approximately 90% of our present 30,000,000 motor
vehicles, or 90% of 37,000,000 cars in 1960, must be handled
on our streets and highways in metropolitan districts.

In my opinion these highways of tomorrow must be eco-
nomically justified, especially in view of the fact of a state-
ment by Mr. R. E. Toms, Chief Division of Design, United
States Bureau of Public Roads, who said that from 95 to
97% of state highway mileage in the United States may never
progress in improvement beyond a two-lane highway. Since
the building of these arterial highways in metropolitan dis-
tricts must necessarily be a continuing process, it seems to me
that the principal thing to be considered is, after planning
your future needs as remedies, to secure adequate rights-of-
way as far in advance of the rise in prices as possible.

Mr. Thomas H. MacDonald, Chief of the United States
Bureau of Public Roads, says of the highway engineer that
he has put into effect planning surveys from which future
programs can be developed. He has made an extensive study
of design practice out of which will come the necessary
standards. There is a fundamental which he does not think
unattainable, but which cannot be secured without a change in
public policies: that is the right-of-way necessary, not only for
the highway improvements themselves but the additional land
necessary to protect these improvements.

Some of the arterial highways which we are building today
because of the lack of control or divided control, or uncon-
trollable local control of the right sites, will become congested
city or village streets tomorrow. The highway authorities
are unable to carry out expensive construction improvements
and to pay for the acquisition of high-cost land out of current
revenues.

Mr. MacDonald's idea is that these costs should be divided
and the land costs paid out of long-term bonds issued to cover
such projects. There is no form of investment that would be more safe or prove more sound. This would lead us to suggest that during this period when most of the state legislatures are meeting, legislative authority be given to our metropolitan districts to acquire necessary widened rights-of-way for future use as a remedy for traffic congestion in metropolitan districts. If this is not feasible or practical, and if the principle of states' rights does not conflict, the federal legislature might step into the breach and sponsor such right-of-way acquisition.

EUROPEAN PRACTICES

Chief MacDonald commented in Chicago some time ago on remedies for traffic congestion in metropolitan districts of Paris and Berlin, stating:

During a study of conditions abroad, there was opportunity to observe various aspects of this problem of governmental control and the inevitable effects growing out of them. Paris presents the opportunity to observe major projects under way for the relief of street and highway congestion in a metropolitan area. One gets a conception of the instability of great population centers when new transportation facilities are available. If we have accepted the changing aspects of our own cities because they are in a relative sense youthful, the example of Paris is illuminating since it is an old world city, ancient in comparison to any of our own. Paris did not grow without direction, although it cannot be said to have adhered to a single plan through the years. What we now see is the result of progressive conceptions, each developed in harmony with those preceding. The earlier undertakings of major importance, beginning with those fostered by Louis XIV, were the result of power exerted through a single individual. Highways, but particularly bridges, developed by Louis XIV and Napoleon are yet in service, a tribute to the ability of the technicians of a century and a half ago. Because of governmental control exerted through rulers who had the foresight and determination to accomplish improvements of magnificent proportions adequate far into the future, Paris has remained undated, a city without time.

With the advent of motor transportation and the inevitable changes which it has brought in the amount of traffic and the extension of the city's influence into the surrounding country, new major projects are now formulating; and although, in the course of years, France has supplanted its once absolute rulers by a form of democratic government not unlike our own, it is important to note that the modern projects are being conceived and directed by engineers of the National Department of Highways, all of whom have been trained in the École des Ponts et Chaussées, the French School of Roads and Bridges. For it has been this same great technical institution that has supplied the genius to carry out all the great national engineering undertakings at least as far back
as Louis XV, and it is this institution whose sons are now the agents
of a sovereign people in carrying out the modern street and high-
way developments in and surrounding the city of Paris. With this
long unbroken succession of single-minded, long-visioned control I
ask you to compare the situation as to engineering control existing
in the area comprising the Chicago Region.

Or take another example—that of the Germany of today. Here
a program of construction of superhighways is under way which
will give roughly three lines of highways north and south and three
east and west, with a total of about 4,500 miles. The area of Ger-
many is about 3.2 times that of Illinois, its population eight times.
On the basis of area, therefore, the German undertaking is about
equivalent to the construction in Illinois of 1,400 miles of super-
highways; on the population basis, to a construction of about 560
miles in the State. If, however, we base the comparison on the ratio
of motor vehicle registrations, Illinois would be required to build
around 6,650 miles to equal the undertaking of Germany. Without
here considering either cost or details of design, the governmental
situation in Germany that produced the previous conditions and
those that are responsible for the present undertakings are as
strongly contrasted as it is possible for opposites to be. Germany
is composed of 18 states. These states, under the Emperor, were
responsible for the laying out and building each of its own high-
ways. I quote Dr. Allmers, President of the National Association
of the Motor Industry of Germany: "State and provincial govern-
ments, districts and communal authorities, made every effort to
obstruct a sound development based on uniform principles. The
Ministry of Transport was powerless, and years elapsed before
applications were sanctioned by the competent governments of the
federal States. Every district road engineer built his roads in a
different way, but nearly all of them built them in the wrong way,
and only a few appreciated the requirements of automobile traffic
and these few mostly lacked the necessary funds."

Prior to the war there was no concerted national plan directed
toward the building of a system of roads. It is true that the Minis-
try of Transport had a broad study under way, and while I cannot
be certain, I am satisfied that the system which I saw in its devel-
oping paper stages nearly ten years ago, is the system which was
the forerunner, at least, of the system which is now rapidly taking
form. Undoubtedly it is changed in some respects as a national
concept, and certainly the magnificent concept of the engineering
and architectural designs is many times greater than was ever put
forth by the old Germany. But the important point is this,—that
it was not until the National Socialist Party, with its Chief, Herr
Hitler, established its authoritative control over the national life,
that this great scheme,—amazing both in the magnificence of its
engineering and architectural design and in the speed of its realiza-
tion,—began to take form. One feature of it is of outstanding sig-
nificance from the governmental angle.
Practically all of this system occupies wholly new right of ways. That it has been possible to obtain so quickly the locations necessary is a demonstration that all of us who have been concerned with the securing of land necessary for public improvements must agree is a most convincing example of the power and determination of the national government of Germany.

France, through a history of at least a century and a half, has carried out major improvements through a central engineering control with all the personnel developed, or at least given final training in a single institution. In contrast, Germany almost over night upset the status of State control of planning and executing highway improvements and turned to a national plan rigidly controlled in conception and execution through the power of authoritarian government.

ROAD STABILIZATION WITH BITUMINOUS MATERIALS

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The increase in degree of completion of the various highway systems in this country has naturally tended to focus the attention of builders and designers on the need for development of intermediate and low-cost types of base construction.

Early in the history of road construction, intermediate types were dependent to a large degree upon the use of aggregates with or without the use of supplementary binders. There are, however, large areas where aggregates such as gravel and crushed stone are obtainable only at a high or prohibitive cost, and until recently no logical approach to the problem was available in such areas.

A new technique or approach has recently been placed in the hands of designing engineers by the splendid work of technologists of the Bureau of Public Roads and others, through the development of soil science as applied to road design.

Engineers are coming to the realization that the economic construction of road bases requires as extensive use as is possible of the soil material on location, and many recent researches have been directed toward this end.

CLASSIFICATION OF SOIL STABILIZATION

A technical definition of soil stabilization could be "the treatment of soils with admixtures which either, by themselves, introduce or increase a certain stability element (i.e. gravel and sand for friction and interlocking action) or change the soil as a result of physico-chemical or chemical