Progress Report on State Highway Needs in Indiana

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INTRODUCTION

In the 1920's Indiana had one of the best highway systems in the United States. Both in the largest total mileage of improved roads and in the highest percentage of all roads improved, Indiana led all other states. Through appropriate legislation and planning, Indiana maintained this supremacy until the depression of the early 1930's. During the latter period about $15 million of highway funds were diverted to the State General Fund. During this same period and the years to date, the fiscal policy has not kept pace with the growing needs of highways.

In 1948, a study conducted by the State Highway Commission of Indiana indicated that a sum in excess of $1 billion was necessary for the construction and maintenance of an adequate highway system during the period 1950-1960. Recent estimates made by several agencies have varied considerably, but in 1954 the State Highway Department of Indiana estimated the total highway needs of the state to be in excess of $4 billion for a 15-year program (1955-1970). Whatever the total, it is obvious that a large sum of money will be required to improve the highway system to the condition that is adequate for current and near-future requirements.

There is ample proof that the inadequacy of the highway system is contributing to the death and injury of many people, and to the wasting of large sums of money through lost time and increased vehicular operational costs. A study of the mounting accident statistics, a personal involvement in the existing congestion in most urban areas, a ride over narrow roads with narrow bridges, and a check on the volume of traffic estimated for the immediate future will assure one that the

highway system needs major improvement. The questions to be evaluated are: How great are the needs? How much will the needed facilities cost? How are adequate funds to be obtained?

To answer the first two of these questions, a "needs study" of Indiana highways was initiated by the Joint Highway Research Project, School of Civil Engineering, in late 1954. Since that date, the necessary data for such a study have been collected with the co-operation of the State Highway Department of Indiana, the Bureau of Public Roads, and several counties and cities, and with the advice of the Automotive Safety Foundation. The purposes of this study are to determine what and where the highway needs are and to estimate what it will cost to satisfy these needs. The basic objective is to develop information that will assist highway and legislative personnel in the provision of an adequate, efficient, and economical highway system in Indiana.

This report of progress is the first presentation of the data obtained from the study. The report, however, is not complete, for much work remains to be done before the final report is submitted in the fall of 1956. That report will contain a summary of all the data collected, together with an analysis of the highway needs of Indiana.

INDIANA'S TRAFFIC AND HIGHWAYS

In 1925, highway officials were concentrating on developing a highway system of all-weather roads. At that time total vehicle registration in Indiana was about 800,000 (see Figure 1). Registration has con-

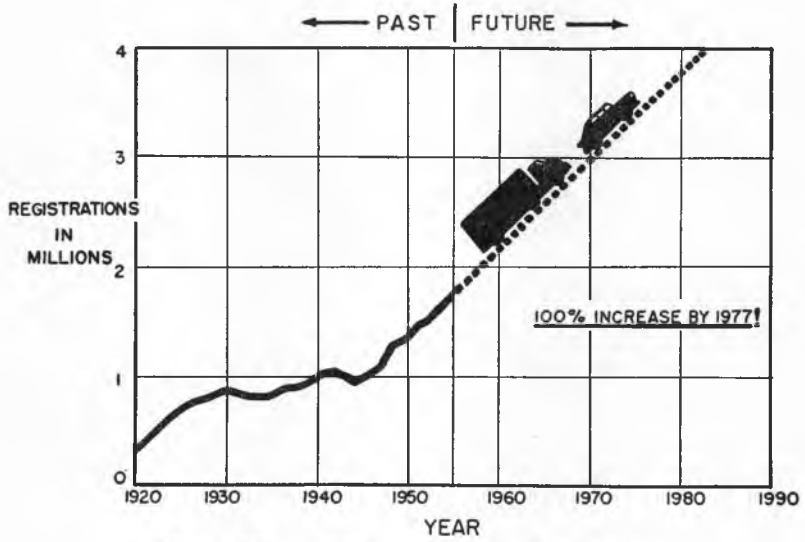

Fig. 1. Motor vehicle registration in Indiana.

tinually increased since 1925, except during the early 1930's and World War II, and at a very rapid rate since the war. By 1956 Indiana had about 2 million vehicles—more than twice the number 30 years ago. If the present trend continues, Indiana will have 2¼ million vehicles in 1960, almost 3 million vehicles in 1970, and almost 4 million vehicles in 1980. The latter figure represents an increase of more than 100 percent over the number of registered vehicles in 1955.

As registration increases, so does the traffic volume. In 1940 motorists traveled about 9 billion miles on Indiana highways and by 1955 the mileage had doubled. By 1960, traffic volumes are expected to increase by one-fourth and by 1980 they may be 2¼ times as high as they were in 1955. An estimation of future traffic volumes is presented in Figure 2. The upper line indicates a possible upper limit for traffic volumes, the lower one is the average expectation. Wars, depressions, and other world and national events may affect this estimate, of course, but experience indicates that traffic volumes retarded by such factors usually return to the original trends soon after the event.

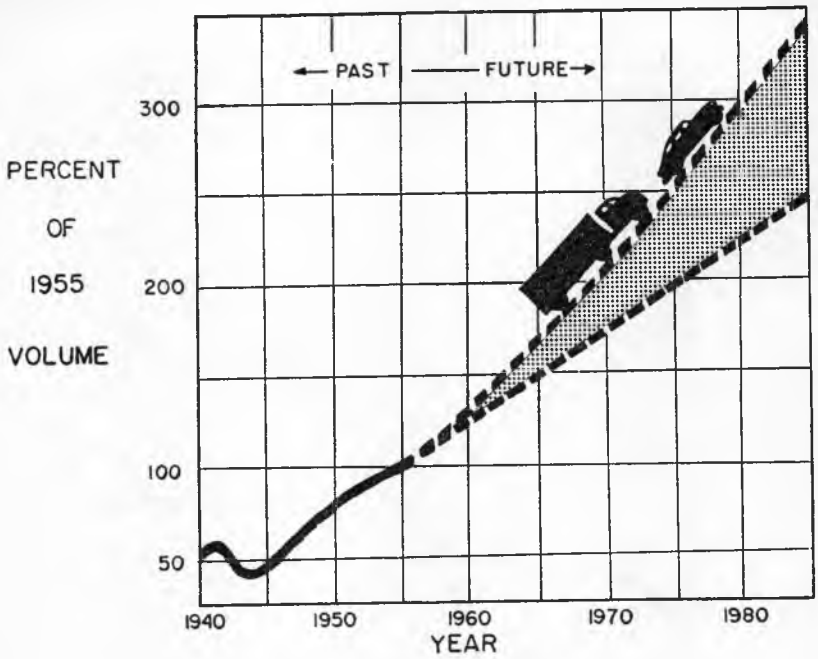

Fig. 2. Growth of traffic.

To carry this greatly increased volume of traffic, Indiana has over 98,000 miles of roads and streets classified as state highways, county roads, and city streets. The major volume of travel occurs on the state highways and on the more important urban thoroughfares. A system of highways connecting the larger cities of the United States has been designated by Federal and State authorities as the Interstate System (see Figure 3). In Indiana this network comprises 1,068 miles and carries a large portion of the total traffic in Indiana. Because of its strategic location, Indiana has a greater mileage in this system of highways than any state of comparable size. The highways in this system must be capable of carrying a large number of high-speed vehicles and a large number of heavily loaded trucks. High standards of construction are required, including multi-lane divided roads, controlled access, grade separations, and other features essential to modern facilities of this kind.

The State Primary System supplements the Interstate System by providing major routes to other cities and areas of the state (see Figure 4). This system totals over 3,200 miles and carries volumes of traffic comparable to those of the Interstate System. These roads must also be built to high standards—many multi-laned and divided.

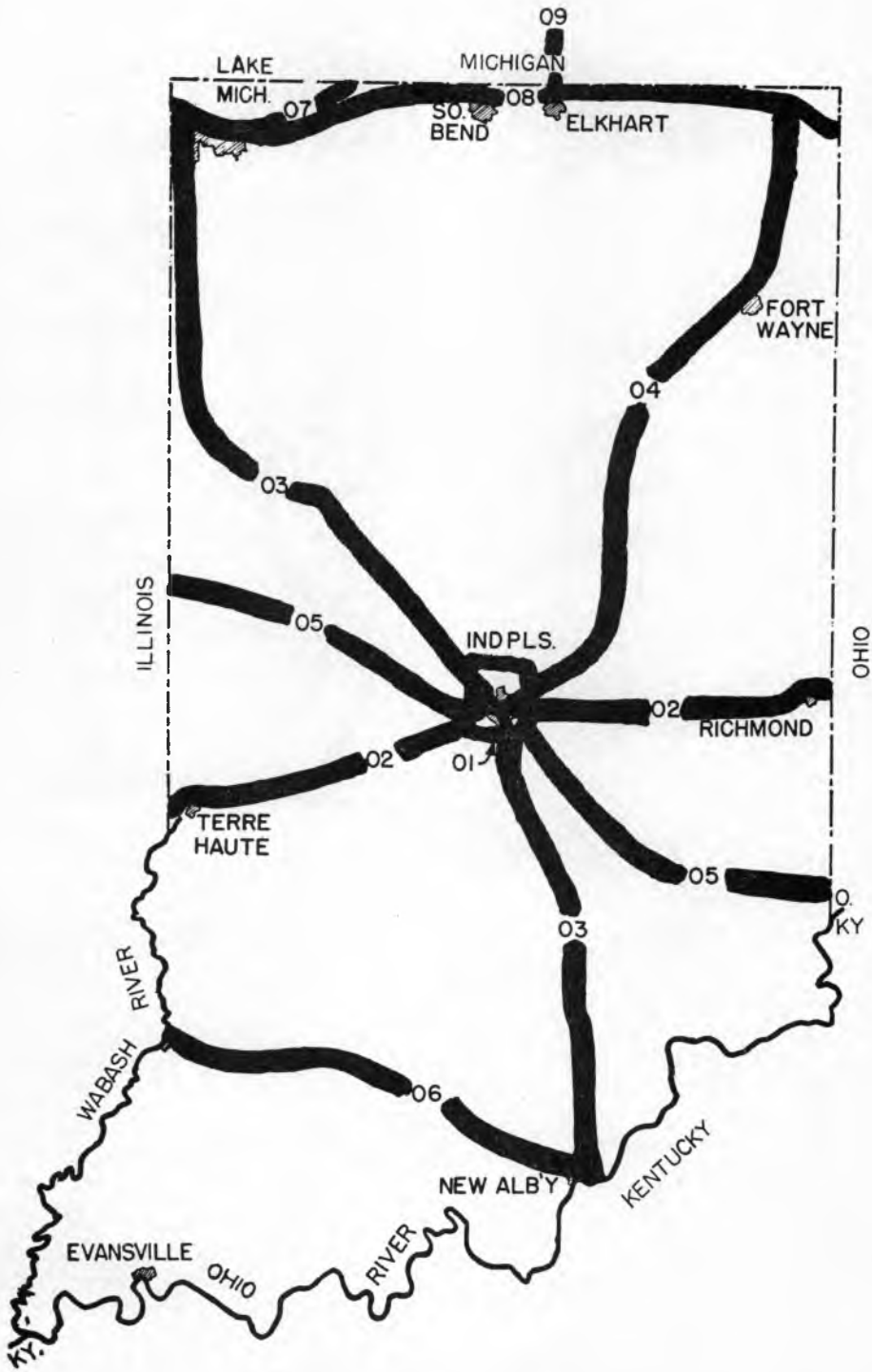

Fig. 3. Interstate system.

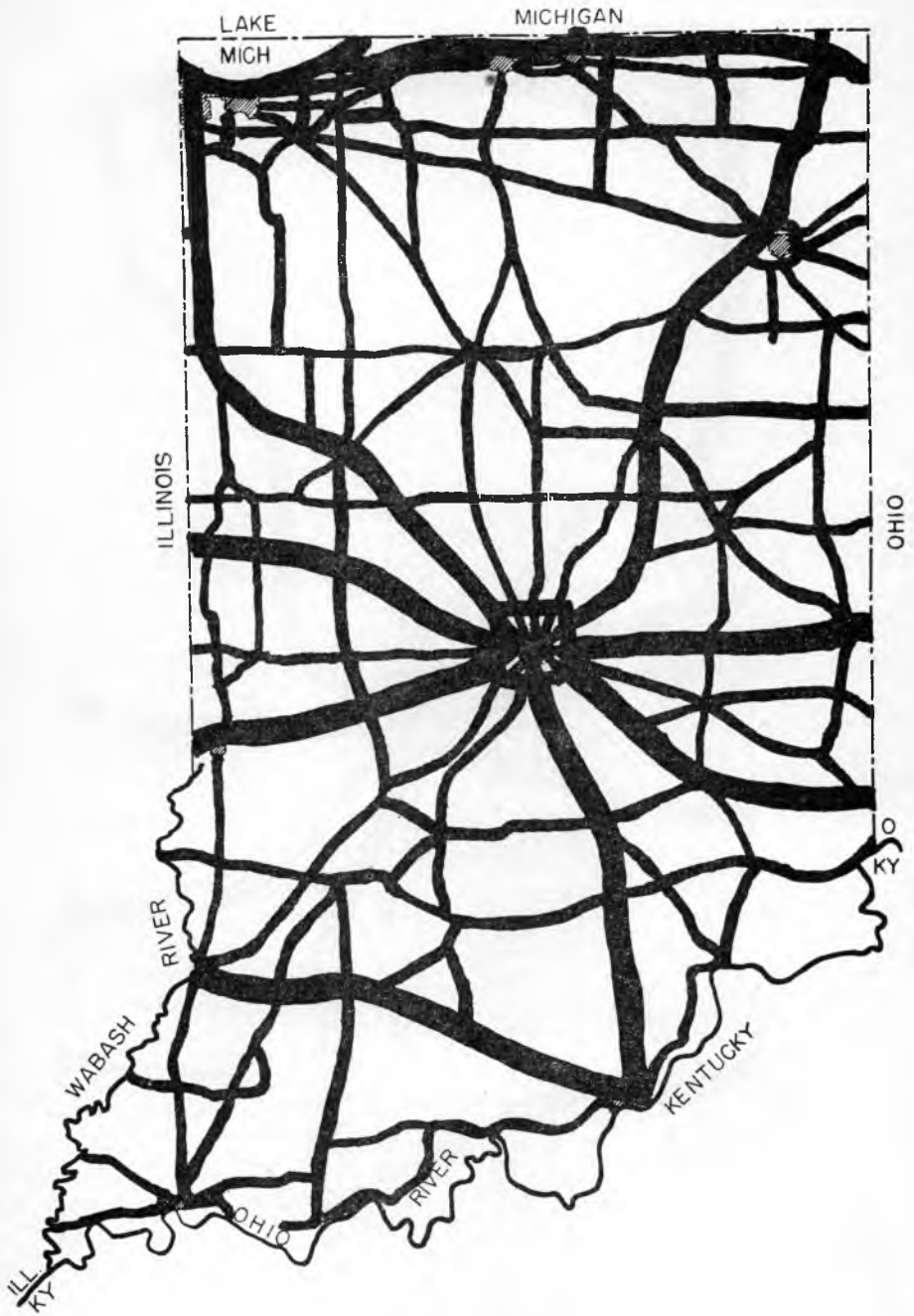

Fig. 4. Interstate and primary system.

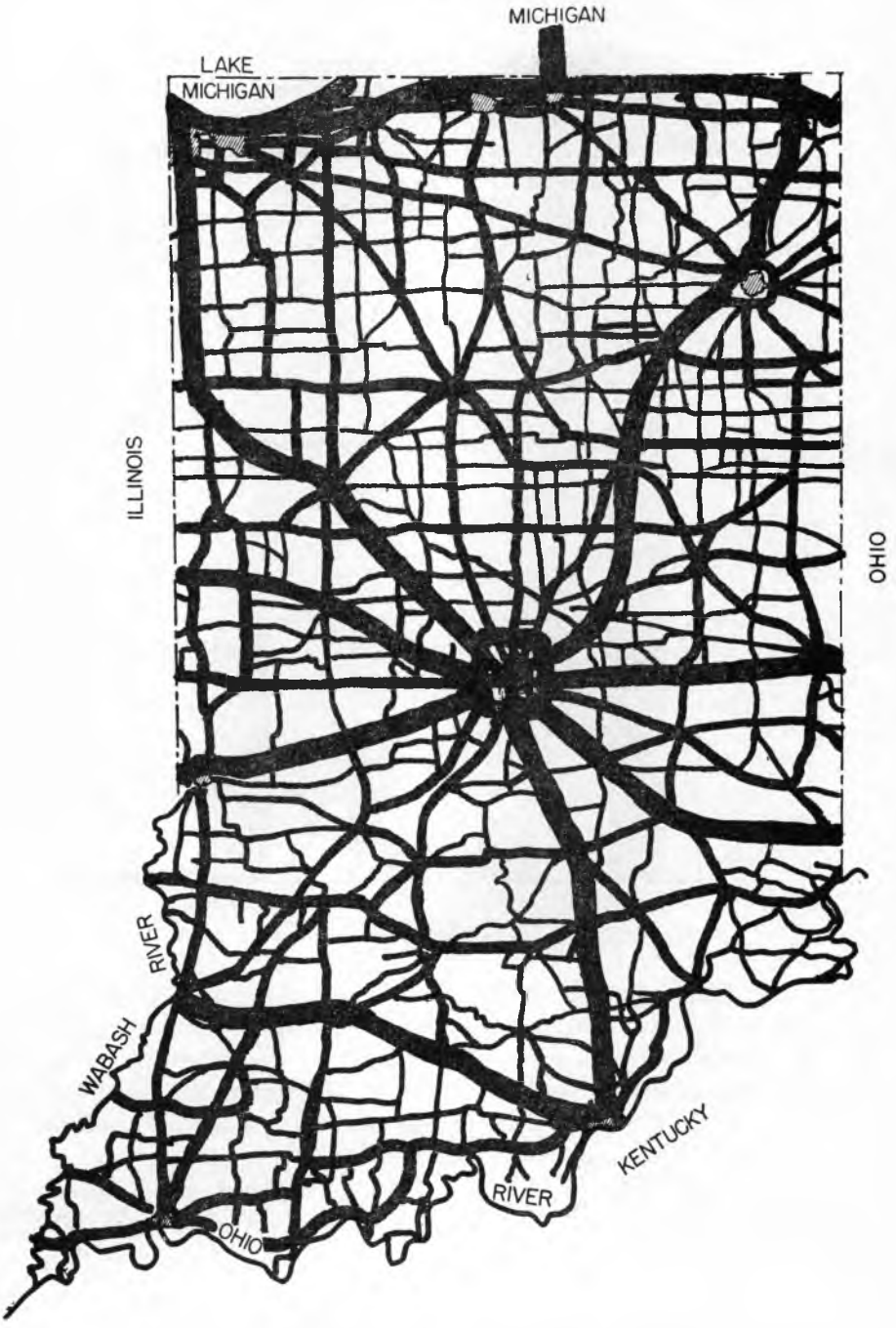

Fig. 5. Interstate, primary and secondary system.

Supplementing both the Interstate and Primary System is the Secondary System (Figure 5). Roads in this grouping feed traffic to the Primary and Interstate Systems and also connect many additional communities and cities of the State. In general, the 5,700 miles of roads in the Secondary System carry less traffic and need not be built to the high standards of either of the other systems. These roads were constructed largely during the period 1920-1940 and many miles are deficient in right-of-way, drainage, base, and pavement and shoulder width. Sharp curves and steep grades are also common deficiencies.

A classification summary of these state highway systems of Indiana is shown in Figure 6. It is to be noted that 10 percent of the entire

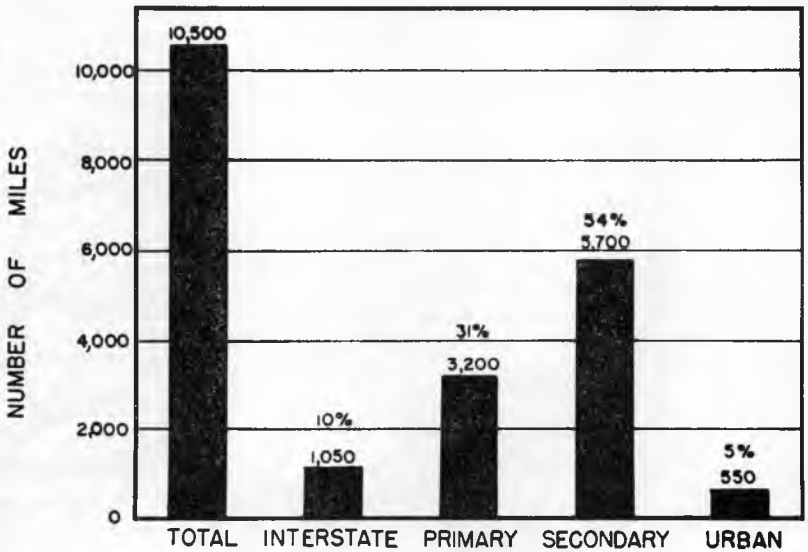

Fig. 6. Classification of the state highway system.

state highway mileage is on the rural Interstate System, 31 percent on the rural Primary Systems, 54 percent on the rural Secondary System, and 5 percent in urban areas. This latter mileage, though small, carries high volumes of traffic and many miles are deficient in the capacity to carry traffic. The need here is critical and, unfortunately, the cost of building urban thoroughfares is high.

The average daily traffic volumes on the Primary* and Secondary Systems are shown in Figure 7. It is to be noted that the average mile of the Primary System carries a much greater number of vehicles than

* In the remaining portion of this paper the Interstate and Primary Systems are combined and are referred to as the Primary System.

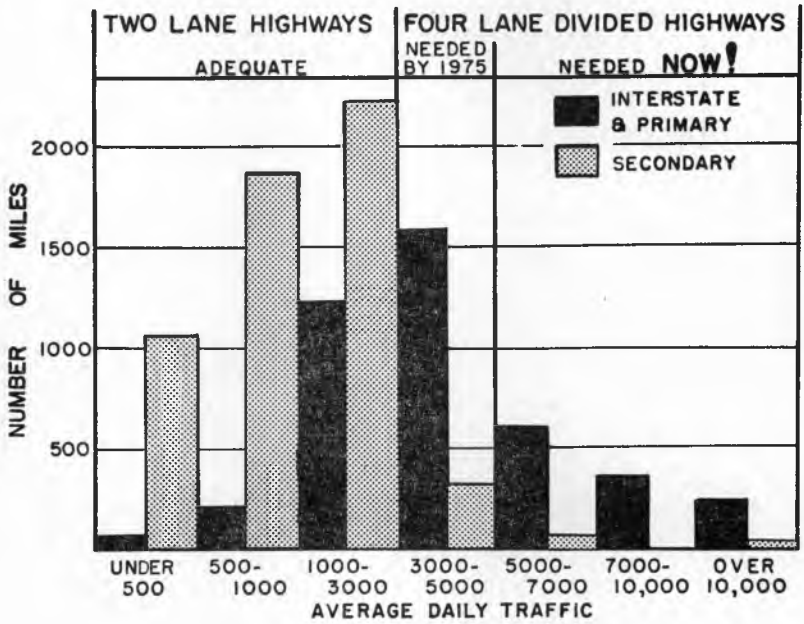

Fig. 7. Traffic volumes on the rural state system.

the average mile of the Secondary System. The capacity factor requires that almost every road that is carrying 5,000 vehicles a day or more should be a multi-lane divided road. Thus, on the basis of traffic requirements, the present Primary System requires about 1,100 miles of multi-lane divided roads and the Secondary System requires about 150 miles. Furthermore, within 20 years the roads carrying 3,000 vehicles today may be carrying over 5,000 and thus another 2,000 miles of multi-lane divided highways may be required on the state system.

About 300 miles of multi-lane divided pavements have already been constructed in Indiana, most of it on the Primary System (see Figure 8). An additional 950 miles of such construction are needed now and within the next 20 years another 2,000 miles may be needed.

HIGHWAY CONDITION

The condition of the present system of roads must be considered in evaluating the highway needs of the state. The type and condition of road surface; the type, quality, and thickness of the pavement, base, and sub-base; and the age must be known. Figure 9 indicates that 40 percent of the Primary System and 43 percent of the Secondary System have surfaces less than 6 years old. Some secondary-type surfaces, how-

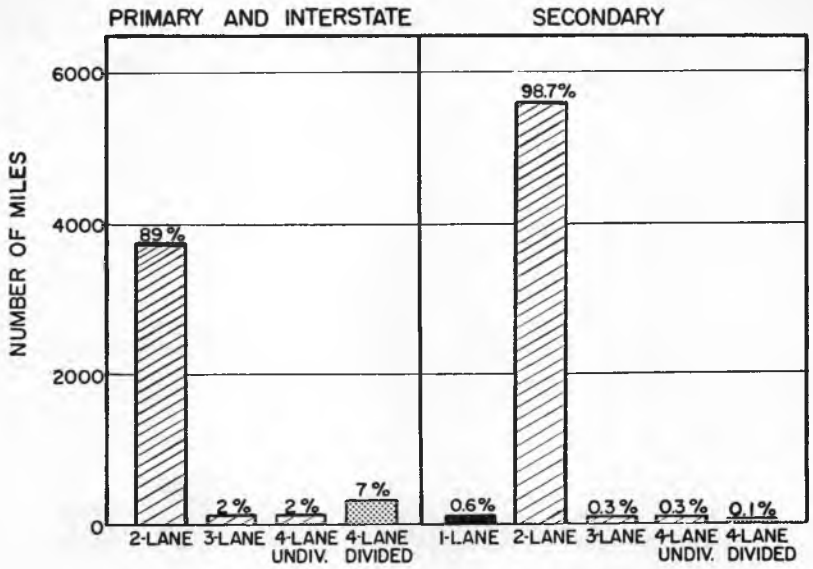

Fig. 8. Mileage by lanes on rural state system.

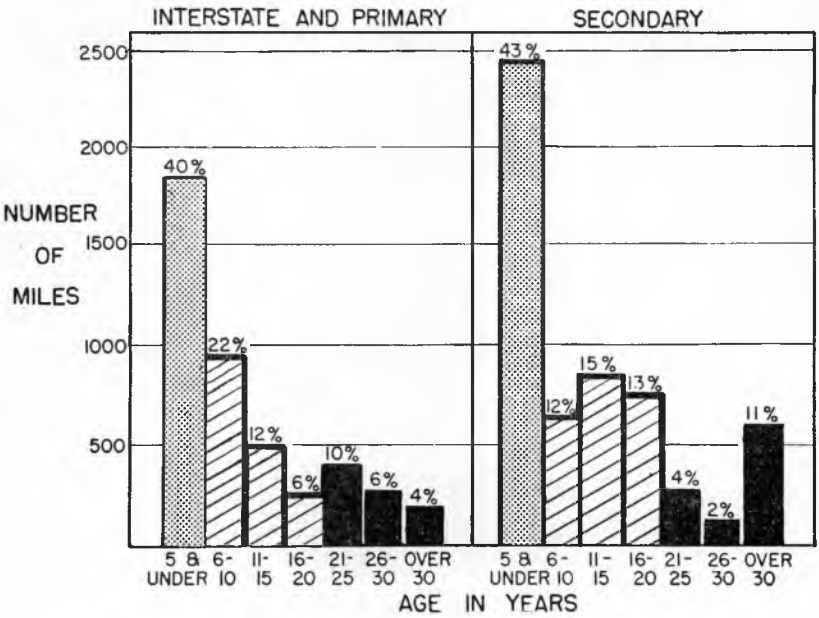

Fig. 9. Age of surface on rural state system.

ever, have a life of not more than 5 years and some of the roads in this group are already in need of resurfacing.

The date of construction of a major component of a road also is an indication of the date of design of the road. The age of a major component of the state highways is presented in Figure 10. Twenty-five

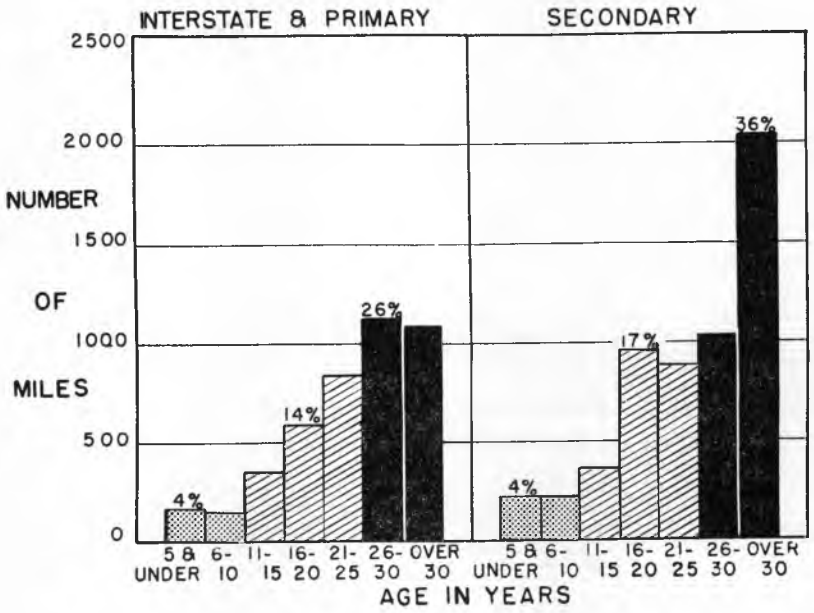

Fig. 10. Age of major construction on rural state system.

percent of the Primary mileage and 36 percent of the Secondary mileage are over 30 years old. Only 4 percent of each system is less than 6 years old. It is pertinent to point out that this indicates that many miles of highways in the state were not designed for present-day traffic and now require redesign and reconstruction.

The desirable characteristics of a road designed to carry present and anticipated traffic must also be known. The standards for a road depend upon the type and amount of traffic the road is required to carry. A county road carrying less than ten vehicles a day obviously should not be built to the same standards as one carrying 1,000 vehicles a day. Neither should this latter road be constructed to the standards necessary for a road that has a traffic volume of 10,000 vehicles, including 1,000 heavy trucks per day. For this reason, standards for construction vary with the classification of the road and all new construction on a particular road should be to standards that will permit that road to carry current and anticipated traffic safely, economically and

freely. These are design standards. Such a standard for a road in level country and on the Primary System is shown in the lower pavement cross-section of Figure 11. The elements required, such as 12-foot-lanes,

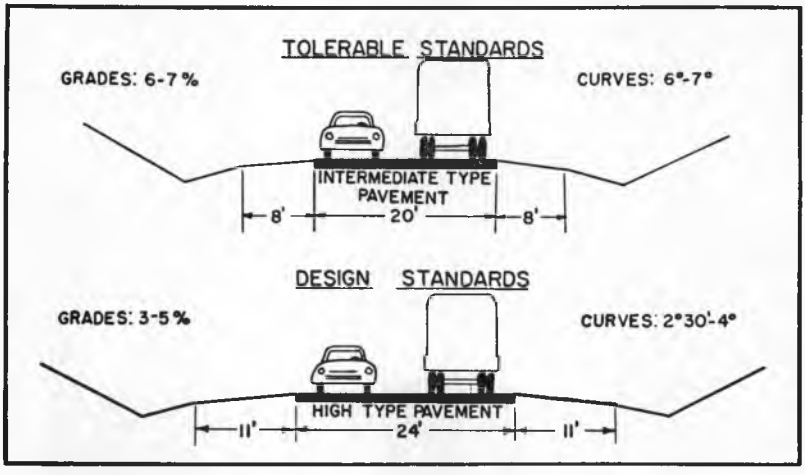

Fig. 11. Comparison of standards for primary highways.

11-foot shoulders, 3-degree curves, 3-percent grades, controlled access and many other features are necessary if the road is to be safe and economical during a life of 20 years or more.

This does not mean, however, that all roads not meeting these design standards must be abandoned or torn up and reconstructed. It does indicate that most of the roads on the Primary System not meeting these standards today must be reconstructed sometime within the next 10-20 years.

Another set of standards is used to select those highways that need reconstruction immediately. These are designated "tolerable standards" and are much less demanding than design standards. They are the lowest conditions that should be tolerated on the highway system. Conditions lower than these standards result in an excessive number of accidents, heavy losses in operating expenses, and/or in an unnecessary amount of congestion. The top half of Figure 11 shows a tolerable standard for a road in the Primary System. Note the narrower pavement and shoulders, as well as greater curvature and steeper grades. These standards also vary with the volume of traffic on the road and with topographic conditions.

Some of the inadequacies on the Primary and Secondary Systems are graphically shown in Figure 12 to Figure 15. In all of these charts, a shaded bar is used to indicate conditions meeting the design standards, an indication of no need. The cross-hatched bars indicate road conditions that meet the tolerable standards but are below design standards—those conditions that probably will require correction within the next 10-20 years. A solid black bar shows those roads having conditions that cannot be tolerated and that require immediate reconstruction.

There are many elements in a highway that determine its adequacy. Among them are surface width, shoulder width, right-of-way width, bridge width and condition, number of entrances to the highway, and physical condition.

Roads that are too narrow cause accidents and have a small traffic capacity. Modern highways on the major systems are constructed 24 feet wide for two lanes of traffic. However, on the Primary System 480 miles are 18 feet wide or less and another 950 miles are only 20 feet wide (see Figure 12). Only 700 miles on this System, or 19 percent,

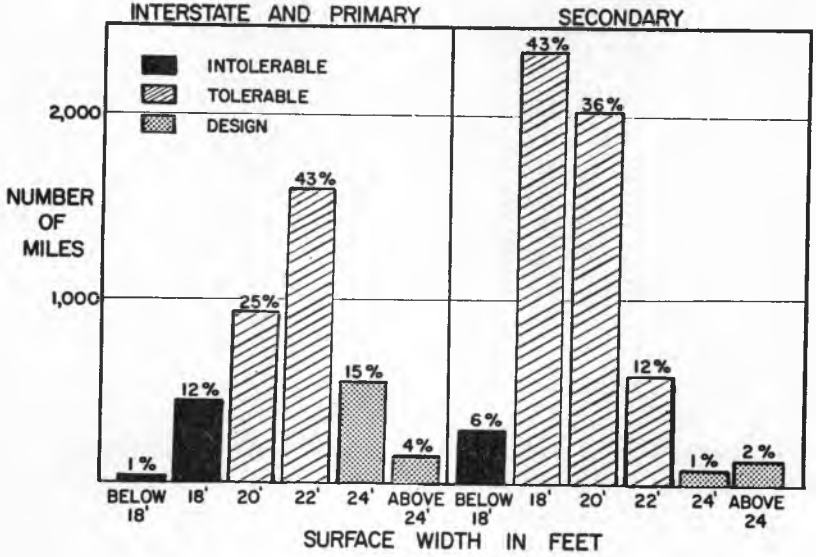

Fig. 12. Surface widths on 2-lane rural highways.

are of design width. Likewise, on the Secondary System, 2,750 miles are not over 18 feet wide, and another 2,050 miles are 20 feet wide. Only 200 miles, or 3 percent, meet the present design specification of 24 feet.

The width of shoulders is also important. Shoulders provide space for emergency stops and also provide for moving traffic a space that is free from roadside interference. Any obstruction within 6 feet of the edge of the pavement results in a decrease in the ability of that road to carry vehicles safely and freely. Drivers shy away from such obstacles and thus the effective width of roadway is decreased. Figure 13 shows

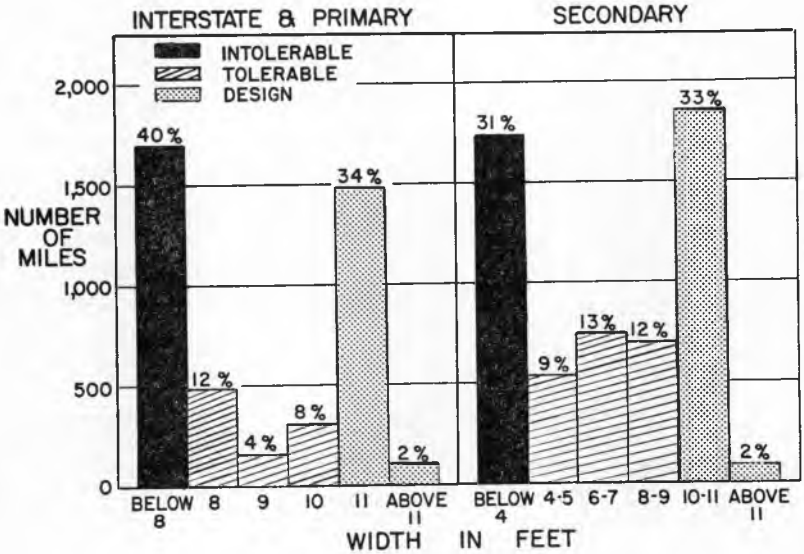

Fig. 13. Shoulder widths on rural state system.

that, on the basis of shoulder width, 40 percent of the mileage of the Primary System is inadequate, 24 percent meets tolerable standards, and only 36 percent meets design standards. On the Secondary System, 31 percent is below tolerable conditions, 34 percent meets tolerable standards, and 35 percent meets design standards.

Much of the highway mileage in the state has been constructed with an insufficient right-of-way width. For the Primary System, a two-lane highway requires a minimum of 46 feet for surface and shoulders and an additional amount for ditches and backslopes. A 100-foot right-of-way is considered desirable for a two-lane highway and in this study a width greater than 50 feet has been considered tolerable (see Figure 14). On the Primary System, however, 15 percent of the mileage has a right-of-way that is 50 feet or less and 76.5 percent has a right-of-way width 51 to 100 feet. Only 8.5 percent has over 100 feet. On the Secondary System, 32 percent of all the mileage has right-of-way 50 feet or less and 66.5 percent has right-of-way width of 51 to 100 feet. Only a little over 1.5 percent has a right-of-way over 100 feet wide.

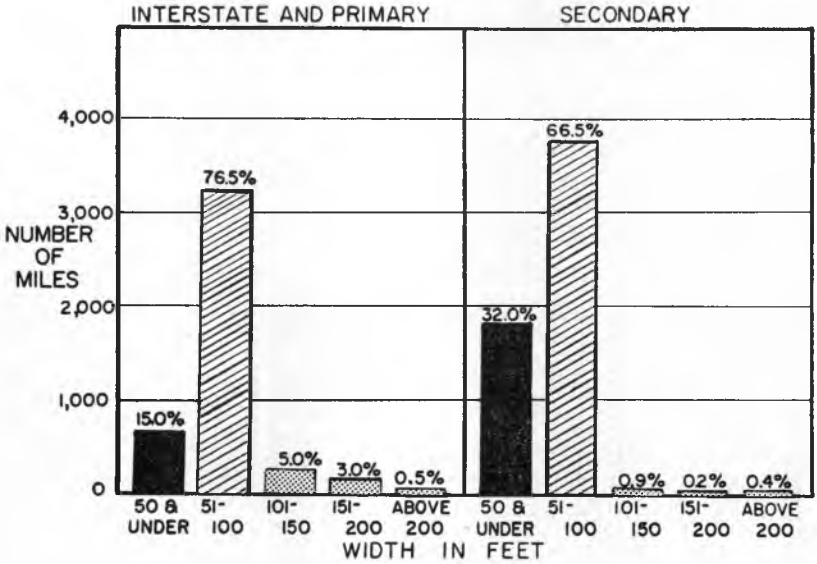

Fig. 14. Right of way widths on rural state system.

Many highways have additional undesirable features, such as narrow bridges and culverts. A bridge, as defined by the State Highway Department of Indiana, is any structure with a span of 20 feet or more. The State Highway Department has been conducting an effective program of replacing or widening narrow bridges and culverts. This is commendable but much remains to be done. For instance, early in 1955, over 1,500 bridges under 25 feet in width were in use (see Figure 15). On

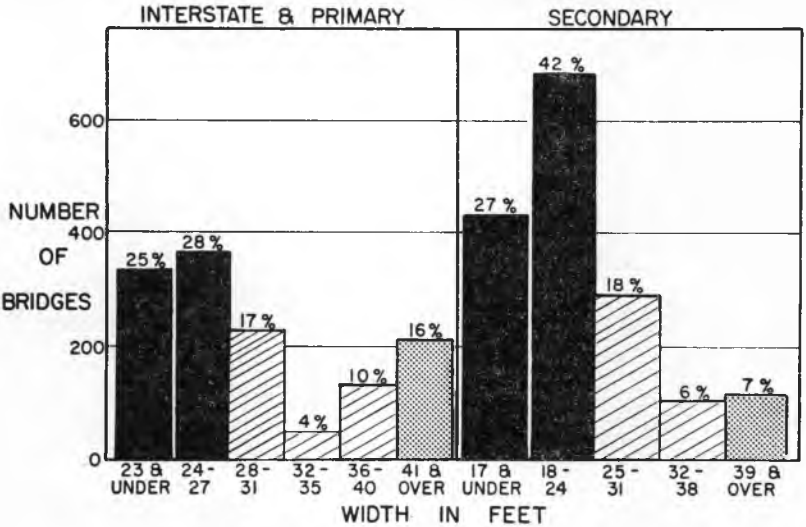

Fig. 15. Bridge widths on 2-lane rural highways.

the Primary System 53 percent were less than 28 feet wide and on the Secondary System 69 percent were less than 25 feet wide. Most of these bridges, about 1,800, are below tolerable standards and should be replaced.

The age (the period of design) of the bridges is also important and is graphically shown in Figure 16. On the Primary System, 11 percent

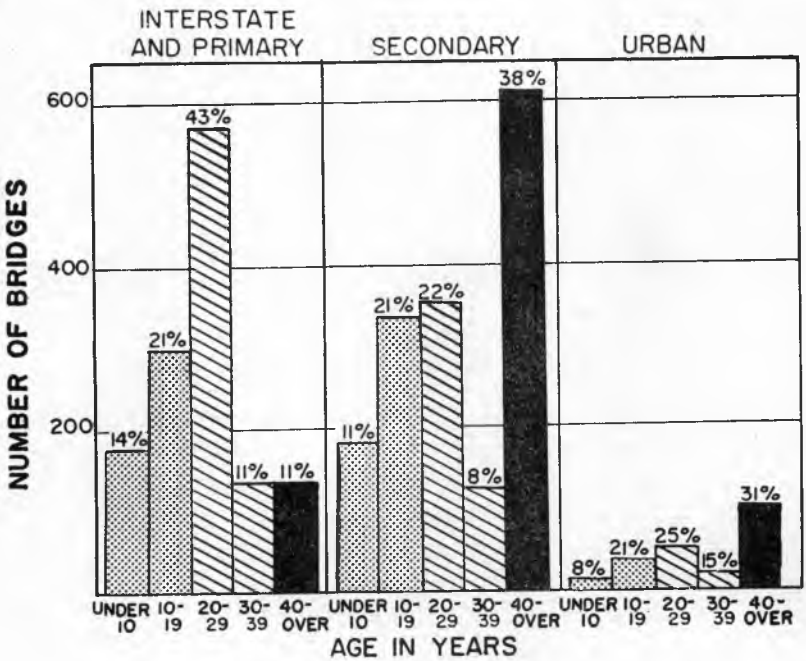

Fig. 16. Age of bridges on the state system.

are at least 40 years old and only 14 percent are under 10 years. By far the greatest number of bridges are between 20-39 years old. On the Secondary System, 38 percent are at least 40 years old and another 8 percent are 30-39 years old. Only 11 percent are less than 10 years old. In urban areas the situation is similar.

Many of the reasons for requiring controlled access for highways that carry large volumes of traffic are unknown or are misunderstood by the general public. A road not only must be planned, designed, and constructed for heavy-traffic volumes but the capacity to carry traffic for years ahead must be protected by limiting the access to it. Every access location is a point of interference to traffic—interference from slow-moving vehicles turning off the road, interference from slow vehicles coming onto the road, and interference from vehicles crossing

the road. The more important the road, the heavier the traffic and the more essential it is to keep traffic moving safely and freely. These important roads, however, are also attractive to businesses, roadside markets, residential developments, and industries. Without controlled access, more entrances are built and the road soon loses the qualities of rapid, efficient and safe movement. Fortunately, experience also indicates that development along a controlled-access highway by industry, business, and housing is rapid and that this development benefits because of the controlled access.

Unfortunately, Indiana initiated controlled-access provisions for its present major highways too late (see Figure 17). As a result, many

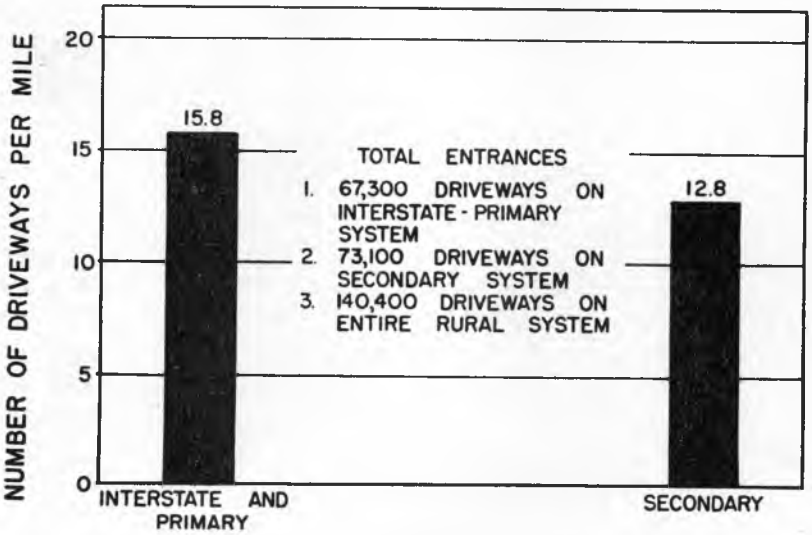

Fig. 17. Frequency of driveways on rural state system.

of the otherwise high-type roads are cluttered by entrances and exits. On the Primary System of the state, the average mile has, exclusive of road intersections, almost 16 entrances per mile and some individual miles have over 100 entrances. Obviously many of these miles of highway should be relocated and the access controlled in order to carry heavy traffic volumes. On the Secondary System there are almost 13 entrances per mile on the average. On most miles of this System, however, entrances can be permitted as these roads in general carry low volumes of traffic.

The situation in urban areas is even more serious than on rural highways. The urban portions of the state highway system are heavily congested and are the critical locations of traffic trouble. Traffic

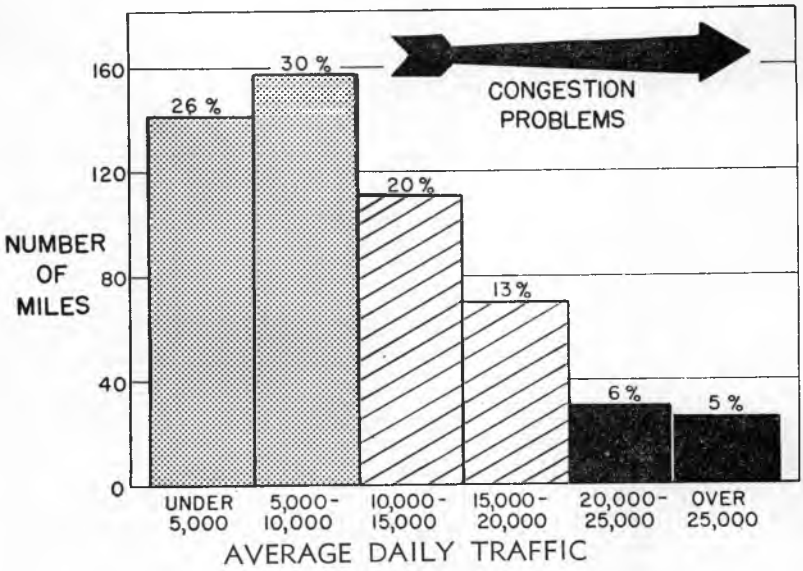

Fig. 18. Traffic volumes on the urban state system.

volumes on these urban highways are shown in Figure 18. Many miles of streets carry over 25,000 vehicles a day and many more carry 10,000-25,000. Indiana only recently initiated expressway-system construction to accommodate such volumes. Many expressways are needed now in the major cities of the state, including Indianapolis, Evansville, Fort Wayne, Calumet area, and South Bend.

In these cities, as well as in almost every city in Indiana, action is also needed to free the arterial street system of unnecessary delay and confusion. For example, on the state highways in urban areas, parking is often permitted at the expense of free-traffic movement. Figure 19 shows the mileage of streets in the state systems by various widths, with and without parking. Parking is prohibited on only a few miles of these urban sections, while in general it should be prohibited on all of them. A street width of less than 25 feet can accommodate two lanes of travel, but cannot also accommodate parking. For safe, efficient, and economical operation, the elimination of parking on most of these streets is a need that should be accomplished immediately.

During the course of this study, engineers rated each mile of highway on the state system on the basis of the physical condition of the highway and the highway's ability to serve the travel using it. The ratings are shown in Figure 20. Less than one-half of the Primary System, Secondary System, and urban streets in the state system were

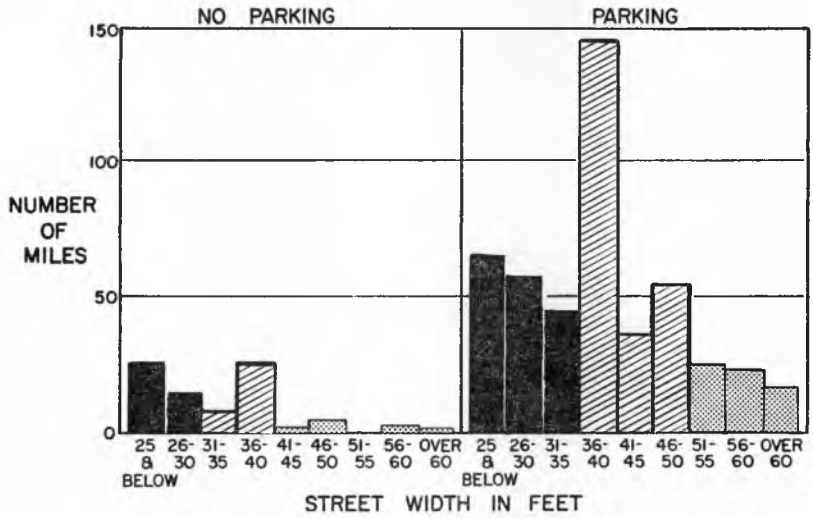

Fig. 19. Parking facilities on urban state system by street width.

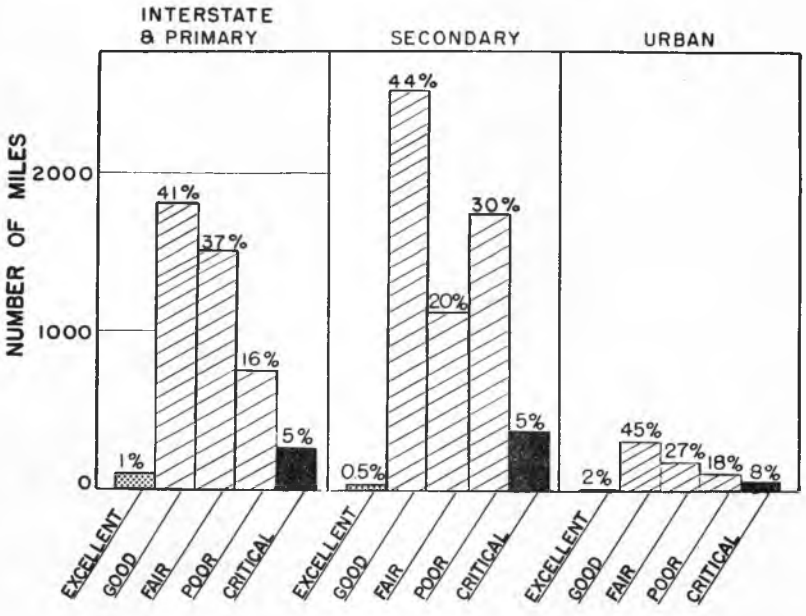

Fig. 20. Overall field ratings.

rated good or better. Only a very small mileage was excellent, while between 21-35 percent of the mileage was considered poor to critical.

In this discussion very little has been said about the road needs of the counties. The counties are maintaining more miles of highway

(over 76,000 miles) than any other unit of government in the state. The traffic volumes are much lower, however, and the required standards are not as high. Many miles of these roads are adequate with a gravel or stone surface, while others need only a low-type stabilized surface. Nevertheless, county roads are in need of better maintenance, additional right-of-way, more mileage of dust-free surface, and adequate provisions for construction of new streets in unincorporated developments. Some county roads are completely inadequate and are in need of major and costly reconstruction as a result of the travel on them induced by location of industries and recent and anticipated residential developments.

FISCAL REQUIREMENTS

On the basis of the data presented, it is clear that the need is great for large-scale improvement of the state system, of city streets, and of county roads. The ability of Indiana to bring this highway system to adequacy is directly related to the money available to eliminate the inadequacies that exist today and that will accumulate in the immediate future. The amount of money that has been available and is available now for use in improving all roads and streets in Indiana is shown on Figure 21. The total has increased from a low of about $30 million

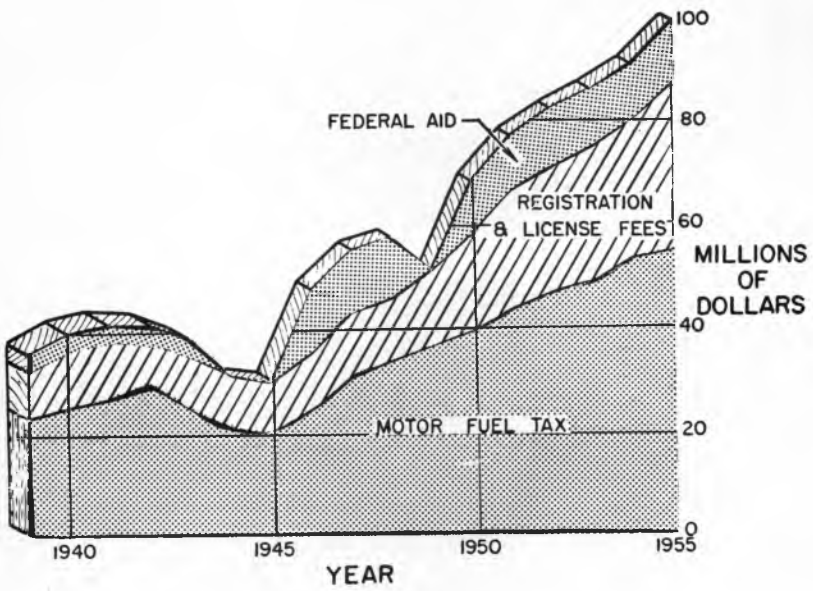

Fig. 21. Major sources of highway revenue.

in 1945 to $100 million in 1955. Of this total for 1955, about 55 percent came from the motor-fuel tax, 32 percent from registration and license fees, and 13 percent from Federal Aid.

The increase in revenues shown here has followed the increase in motor-vehicle travel. More money was obtained in 1955 than in 1954 because there were more vehicles traveling more miles in Indiana. Unfortunately the need for improvements has increased more rapidly than travel has increased. The inadequacy of the highway system today is a result of four factors: (1) increased use of the motor vehicle; (2) higher standards of highway construction required for the present motor vehicle traveling in large volumes; (3) failure in the past to provide the necessary funds for adequate maintenance and reconstruction; and (4) the decreased purchasing power of the dollar. Figure 22

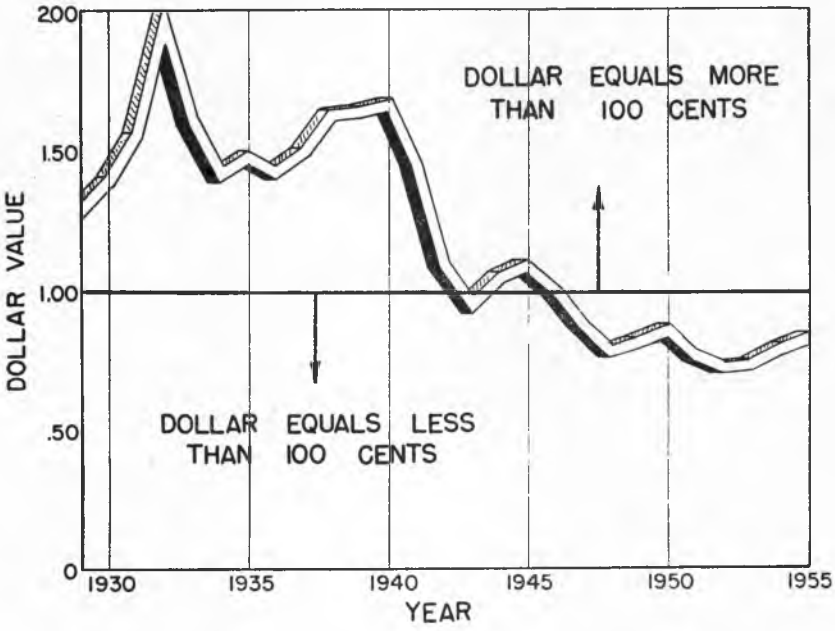

Fig. 22. Purchasing power of the highway construction dollar.

shows the loss in the value of the dollar based on 1946 prices. In 1955 the highway dollar purchased only 79 percent as much as it did in 1946 and about one-half as much as it did in 1932. Furthermore, the major source of highway revenue, the motor-fuel tax, was established in 1929 when the highway-dollar would purchase about 50 percent more than today.

The inescapable fact is that more money for roads was needed the past few years than was available and additional money is needed now to meet the inadequacies that have accumulated.

Under current revenue policies, anticipated income for highways based on anticipated travel and registration increases is indicated in Figure 23. Anticipated annual income for highways, exclusive of Fed-

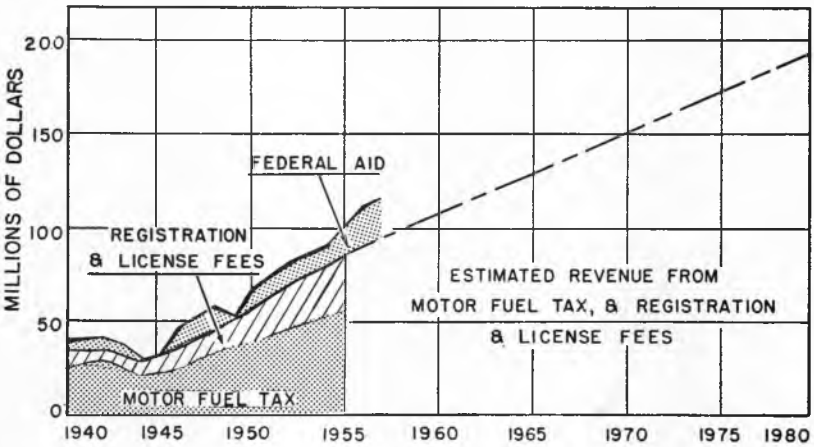

Fig. 23. Estimated revenue from motor fuel tax, and registration and license fees.

eral Aid, will be about $110 million in 1960, $150 million by 1970, $190 million by 1980. These estimations assume that all money collected from highway users in the form of registration fees and motor-fuel taxes will be used only for highways. This principle is presently adhered to in Indiana. It should also be noted that funds for highways at the present time come only from the highway user.

This study has not progressed to the point where this report can show an accurate estimate of funds needed to modernize the highway systems of the state on the basis of a 10-year program, a 15-year program, or a 20-year program. The financial portion of the study has not been completed, but preliminary estimates indicate that approximately $250 million in highway funds are needed for each of the next 15 years to bring all roads and streets to a condition considered adequate for present and anticipated traffic of the near future. During 1956 about one-half of that amount will actually be available (see Figure 24).

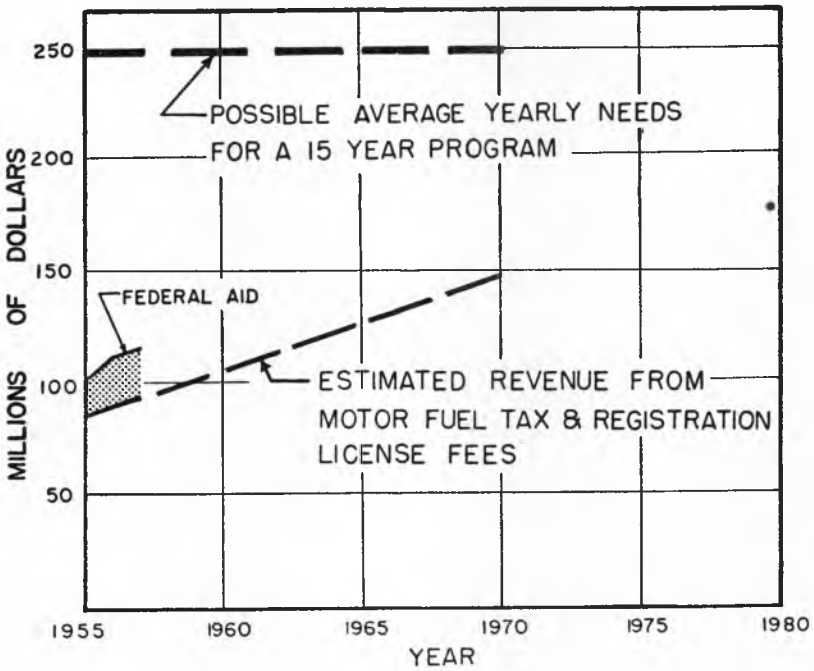

Fig. 24. Estimated needs and revenues for all roads and streets in Indiana.

SUMMARY

This study has produced the following facts relative to the highway needs of Indiana:

1. On the basis of the present trend in vehicle registration, Indiana will have 2¼ million vehicles in 1960, almost 3 million in 1970, and almost 4 million in 1980. The latter figure is an increase to more than double the number of registered vehicles in 1955.

2. Traffic volumes are estimated to be 25 percent higher than those of 1955 by 1960 and 125 percent higher by 1980.

3. Current traffic volumes require an additional 950 miles of multi-lane divided highway in the state and anticipated volumes indicate that an additional 2,000 miles of such highway will be required within the next 20 years.

4. On the Interstate and Primary Systems, 40 percent of the mileage has a surface less than 6 years old, while on the Secondary System 43 percent of the mileage has a surface less than 6 years old.

5. Twenty-five percent of the Interstate and Primary mileage and 36 percent of the Secondary mileage were designed over 30 years ago. Only 4 percent of each system is less than 6 years old.

6. On the Interstate and Primary Systems of the state, 480 miles of highway are 18 feet or less in pavement width and another 950 miles are 20 feet wide. Only 700 miles, or 19 percent, are of adequate design width. On the Secondary System, 2,750 miles are not over 18 feet wide and another 2,050 miles are 20 feet wide. Only 200 miles, or 3 percent, meet the design specifications of 24 feet.

7. On the Interstate and Primary Systems, on the basis of shoulder width, 40 percent of the mileage is inadequate, 24 percent meets tolerable standards, and 36 percent meets design standards. On the Secondary System, 31 percent is below tolerable conditions, 34 percent meets tolerable standards, and 35 percent of the mileage meets design standards.

8. On the Interstate and Primary Systems, 15 percent of the mileage has a right-of-way not exceeding 50 feet and 76.5 percent has a right-of-way 51 to 100 feet wide. On the Secondary System, 32 percent of all the mileage has right-of-way not exceeding 50 feet and 66.5 percent has right-of-way 51 to 100 feet wide.

9. Over one-half (53 percent) of the bridges on the Interstate and Primary Systems are less than 28 feet wide and 69 percent of the

bridges on the Secondary System are less than 25 feet wide. Most of these bridges, about 1,800, should be replaced.

10. The average mile of highway on the Interstate and Primary Systems has almost 16 entrances, exclusive of road intersections; the average mile on the Secondary System has almost 13 entrances.

11. Thoroughfare construction is needed in the major cities of the state to carry the heavy volumes of traffic on the urban portions of the state highways.

12. Less than one-half of the mileage on the state highway system was rated good or excellent by state highway engineers who rated each mile.

13. Of the approximately $100 million available for all highway purposes in 1955, about 55 percent came from the motor-fuel tax, 32 percent from registration and license fees, and 13 percent from Federal Aid.

14. In 1955 the highway construction dollar purchased only 79 percent as much as it did in 1946 and about one-half as much as it did in 1932.

15. On the basis of current revenue policies, the anticipated income for all highways in Indiana, exclusive of Federal Aid, will be about $110 million by 1960, $150 million by 1970, and $190 million by 1980.

16. Preliminary estimates, subject to more complete study, indicate that approximately $250 million in highway funds are needed for each of the next 15 years to bring all roads and streets of Indiana to a condition considered adequate for present and anticipated traffic of the near future.