COMPARATIVE TRAFFIC USAGE OF OLENTANGY RIVER ROAD AND ALTERNATE CITY ARTERIALS IN COLUMBUS, OHIO

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THE SUBJECT study and several similar studies being conducted in various parts of the country are the result of some very notable pioneer work done by M. Earl Campbell, engineer of traffic and operations of the Highway Research Board.

In 1949, Campbell canvassed state highway departments by questionnaire to gather data on methods of making traffic-usage predictions for proposed expressway installations. His work resulted in publication of a Compendium of Correspondence in 1950.

This publication showed conclusively that a wide variety of methods and thinking were being employed throughout the country in making such traffic assignments and that most of these methods were based upon personal judgment and opinion only.

Campbell had previously developed theoretical curves depicting the probable attraction values of the two principal factors, namely, time saving, and distance saving, and the compendium clearly indicated the need for technical research in this field.

Following the lead thus established, the Bureau of Public Roads encouraged the states, through their Planning Survey organizations, to organize projects to test Campbell's conclusions. The tentative procedure as proposed by the bureau was to determine traffic usage on existing high-type facilities and their competitive routes and to develop traffic usage curves in relation to time and distance factors.

In Ohio the Olentangy River Road in the urban area of Columbus was selected as the best of several subjects available for study. Accordingly, agreement was entered into with the Bureau of Public Roads in the spring of 1950 to conduct an analysis of comparative traffic usage of the Olentangy River Road and alternate city arterials.

DESCRIPTION OF FACILITY

The Olentangy River Road is a north-south artery feeding into the Columbus downtown area from the urban area north and northwest of the city.

Its geometric design varies from a six-lane, undivided highway at its southern end to a two-lane, rural road at its northern terminus, where it junctions with US 23 some 20 mi. north of the Columbus downtown area. The portion selected for study consisted of the southerly 9 mi., stretching from downtown Columbus to SR 161, west of the village of Worthington, and contained 0.27 mi. of six-lane, undivided highway, 0.38 mi. of six-lane,

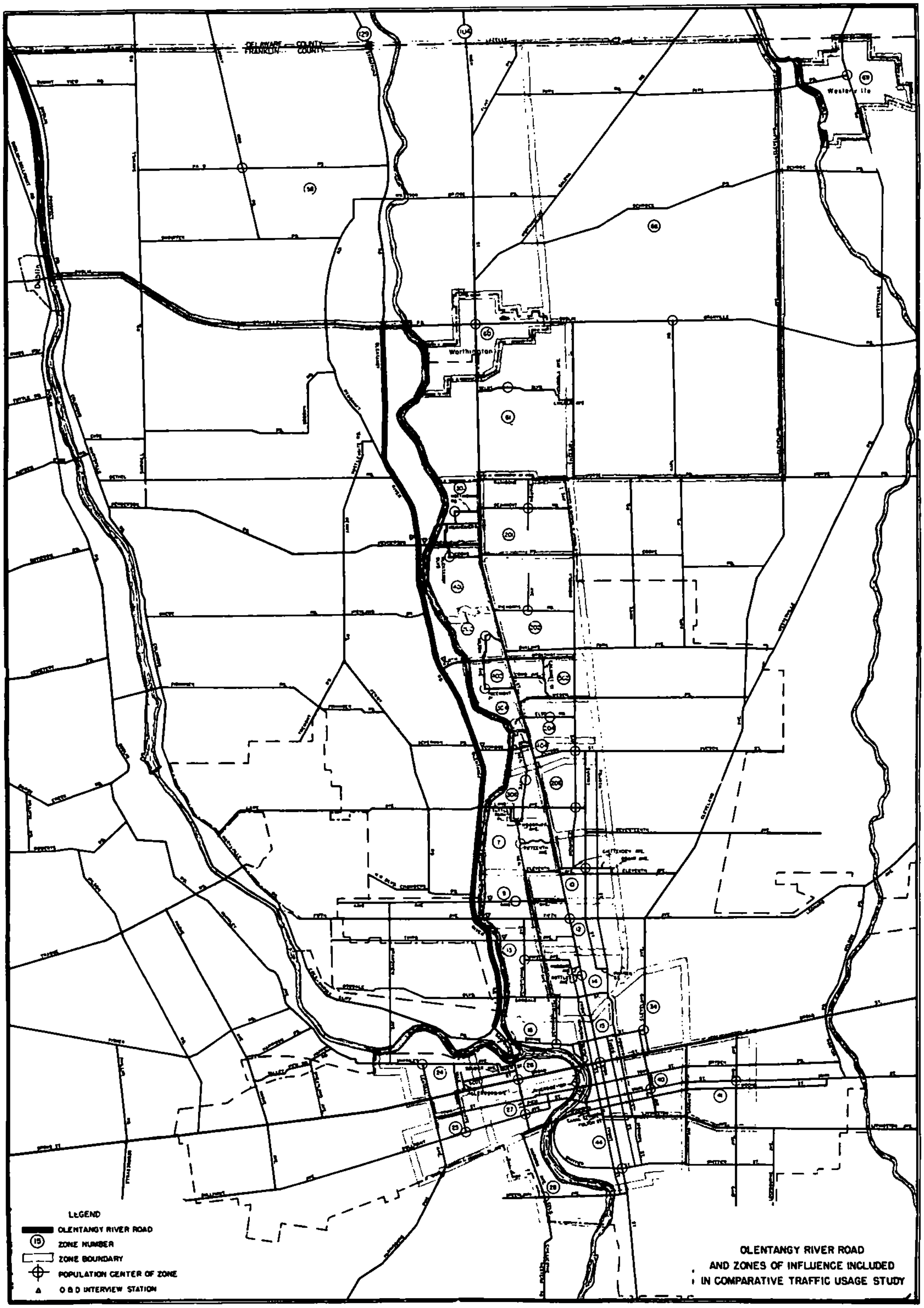

Figure 1. Map of Olentangy River Road and zones of influence included in this study.

divided highway, 4.14 mi. of four-lane, divided highway and 4.27 mi. of rural, two-lane road at the time the study was made.

Built and improved to its present geometric standards by the City of Columbus and Franklin County between 1936 and 1940, the highway is not an expressway, or limited-access facility, in the strictest sense. As originally built and designed, the section under study contained 14 intersections, all at grade. Eight of these intersections are controlled by traffic signals and the remainder by "Stop" signs and channelization which give the right-of-way to the River Road traffic. A minor amount of private access existed at the time of construction, and this was allowed to remain as a not-too-serious threat to the efficiency of the highway. However, in recent years, due to the pressure of big business and influential citizens, the political subdivisions in control have not been able to hold the line against encroachments in the form of private access. However, the Olentangy River, which lies to the east of this road and roughly parallels it for a considerable portion of its course, has been such an effective natural barrier against establishment of access that the highway is and will continue to be superior to its competing routes.

THE PROJECT

We were fortunate in having a complete and recent origin-and-destination study of the entire area of Franklin County. This study had been made in May of 1949. By making relatively minor subdivisions of several zones in the northern part of the City of Columbus and taking a few manual traffic counts, we were able to reconstruct a very reliable picture of zone-to-zone traffic movements in the study area as of June 1950. The only additional traffic information necessary to the Olentangy River Road Study consisted of establishing and operating origin-and-destination stations to trap all traffic as it left the river road bound to the north and east. All of the competing alternate facilities under study were east of the river road.

The remainder of the field work consisted of a zone-to-zone time-delay study during the peak and off-peak hours by way of the Olentangy Road and by way of the competing facilities. Time and distance were measured from centers of population of the zones.

Using the above data, we were able to compute the percentages of traffic making zone-to-zone movements via the river road, the relative time consumed in making the trips via the river road versus the best competing facility and the relative distances.

By expressing the percentage of use of the Olentangy River Road in terms of time saved or time lost in comparison with the competing facility having the minimum time or distance and plotting these data on rectangular coordinates, the spot diagram (Fig. 2) resulted. By refining, weighting and combining these points, a curve very similar to Campbell's theoretical curve was obtained. However, the extreme ends were sketchy and indefinite. At this point, in making a review of our work to date, it became apparent that our originally selected area of influence was too small. Accordingly, we expanded that area by including additional outlying zones in our analysis.

This did not require any additional field work except obtaining time-distance data in those added zones. Traffic information was available from the original field work. This expansion provided 2,458 additional trips, making a total of 7,287 usable trip samples on the river road.

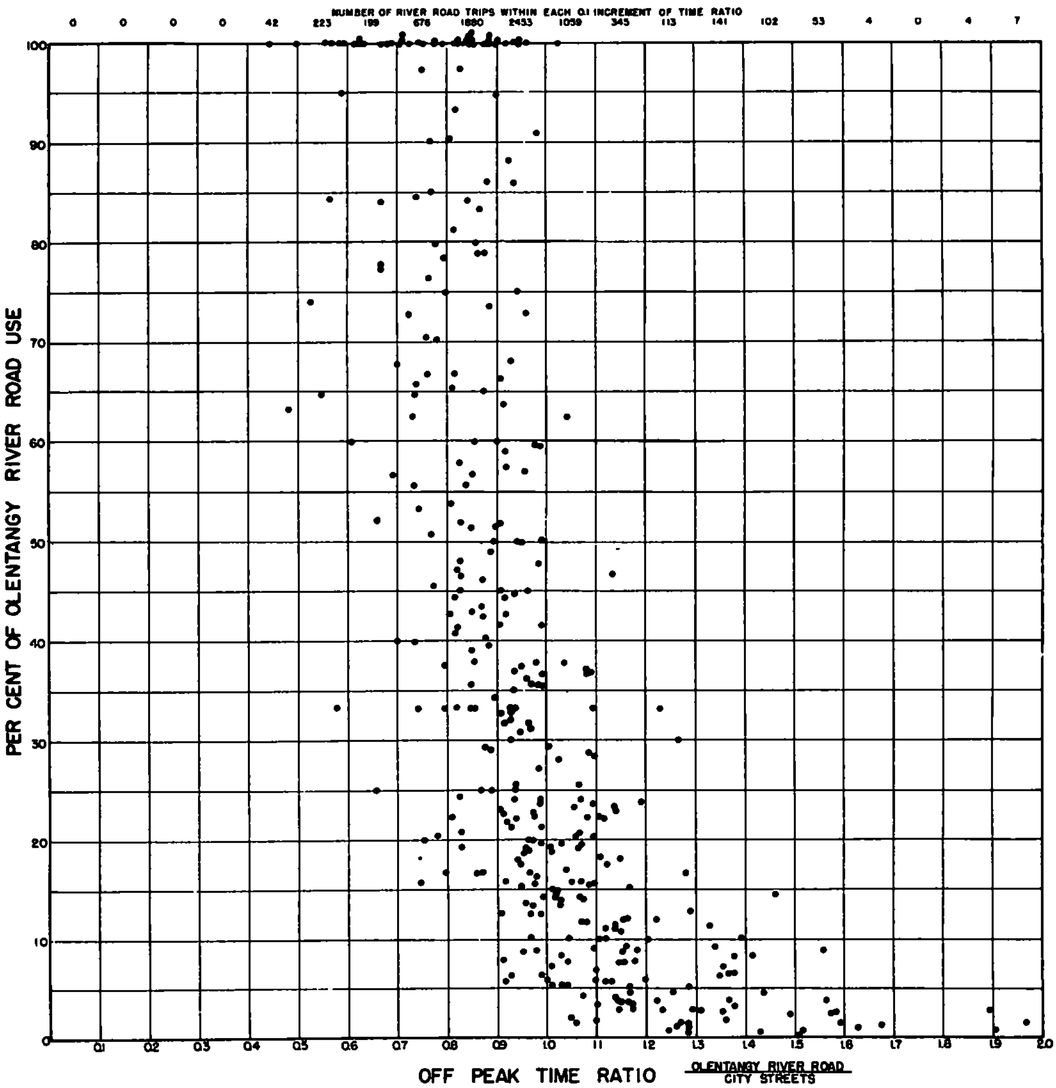

Figure 2. Scatter diagram of relation between percent of traffic usage and off-peak time ratio.

By expansion of the study at this point the time curve (Fig. 3) was developed.

A similar application of data in terms of distance saved or lost resulted in the spot diagram (Fig. 4) and distance curve (Fig. 5).

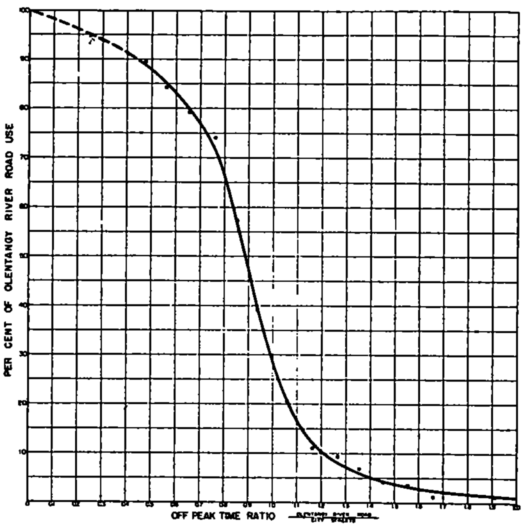

Figure 3. Percent of traffic usage in relation to the off-peak time ratio.

Time and distance curves platted on the same base (Fig. 6) show that 28.5 percent of the traffic will use the Olentangy River Road in spite of adverse time and distance ratios. Up to 71.5 percent will use that facility if time saving is favorable, even though the distance is greater.

This diagram also clearly shows that adverse time will discourage traffic more quickly than adverse distance.

DERIVATION OF FORMULAS FOR PRACTICAL APPLICATION

On the basis of the data collected in this study, it is apparent that the curves depicting the percentage of use in relation to both the time ratio and the distance ratio are of the cumulative frequency or ogive type. Theoretically, these curves will intersect the Y axis at 100 percent of use when the time or distance ratio is 0, corresponding to a condition in which there is no alternate facility and all traffic is required to use the expressway. At the other extremes, the curves will approach but never intersect the X axis (or point of 0 percent of use of the expressway) as some few motorists will be attracted to an expressway regardless of time or distance factors. Between these limits of 100 percent and 0 percent, the intermediate percentages of use for the corresponding ratios of time and distance will vary with each type of facility and upon the many factors that involve traffic behavior.

In order that the data collected in studies of this type may become of practical value in assigning trips to a proposed facility, it would be convenient to devise formulas which will provide data closely conforming to the trend of the observed and analyzed data. The development of such mathematical expressions will, of course, provide only empirical approximations to the trend of the observed data. Some departure or deviation in these mathematical laws above or below the line of observed trend is to be expected. However, if such deviations are minor in character, usable traffic assignments can be made quickly by mechanical procedures.

Accordingly, an effort was made to derive a mathematical expression applicable to the trend of the curve depicting the percentage of use in relation to the time ratios in this study of the Olentangy River Road. The heavy, solid line denotes the curve obtained from the observed data, while the dashed line indicates the trend of a curve derived from the equation

$$P = \frac{100}{1 + (1.162\ T_R)^{5.85}}$$

in which P is percent of use and T_R is the time ratio. This figure shows fairly close conformance between the two curves for time-ratio values greater than 0.7 and a gradual divergence below that point.

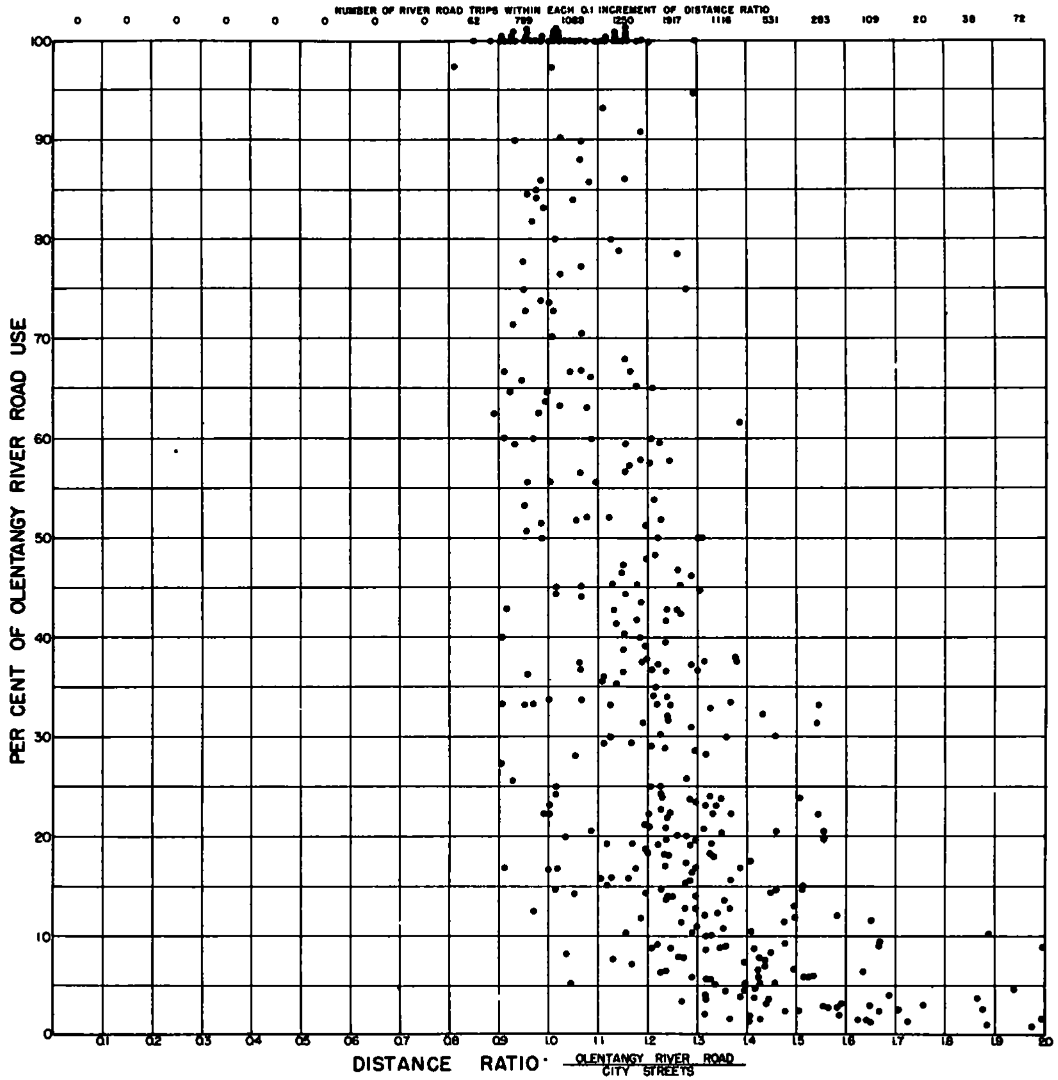

Figure 4. Percent of traffic usage and ratio of distance traveled.

Examination at this point showed a fairly accurate equation for values over 1.0 time ratio. Accordingly, attempts to apply one equation for the entire curve were abandoned, and our efforts were concentrated on developing an equation applicable only for values of 1.0 and over. This resulted in the equation

$$P = \frac{100}{1 + (1.16\ T_R)^{6.2}}$$

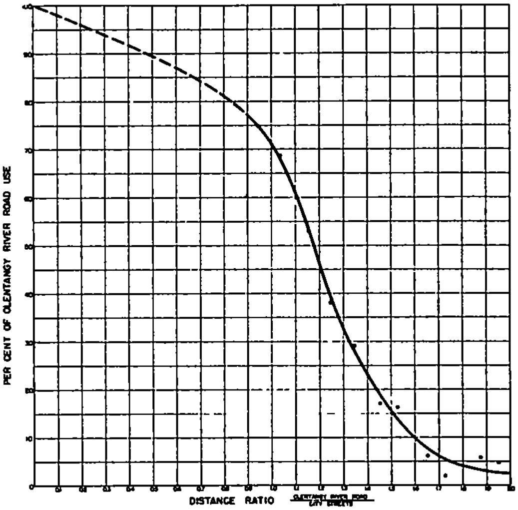

Figure 5. Percent of traffic usage in relation to the distance ratio.

From that point on it was a relatively simple procedure to develop an equation to closely fit the curve for values less than 1.0 time ratio.

This equation is

$$P = 100 - (4\ T_R)^{3.08}$$

At this point it might be well to point out that in spite of our expansion of the study to include the outer zones, relatively few trips were available in establishing the extreme limits of the curves.

It is readily admitted that the upper end of the observed-data curve (from 0 to 0.5 time ratio) is sketchy. Fortunately this part of the curve represents a negligible portion of all traffic.

Incidentally, a correction factor which lengthens the equation can easily be applied to make the equation conform to the curve in this area, but it is considered to be impractical.

This correction factor is $\sqrt[1.2]{6.1 - (8\ T_R - 2.72)^{1.81}}$

Similarly, an equation ($P = \dfrac{100}{1 + (0.86\ D_R)^{6.7}}$) was developed to fit the distance-ratio curve. It will be seen that this equation fits the observed-data curve between the distance-ratio values of 1.0 and 2.0. As the distance-ratio curve below 0.95 is extended beyond established values and represents a negligible volume of traffic, it is considered to be impractical to develop an equation to fit this portion of the curve.

Figure 10 shows the use curves as developed from the mathematical equations.

CONCLUSIONS

It is conceivable that if a sufficient number and variety of existing facilities were thus studied, mathematical equations could be developed to aid in predicting traffic usage on any planned facility by careful selection and adjustment of these known equations much in the same fashion as now employed in selection of a Weir formula or earth-compaction curve.

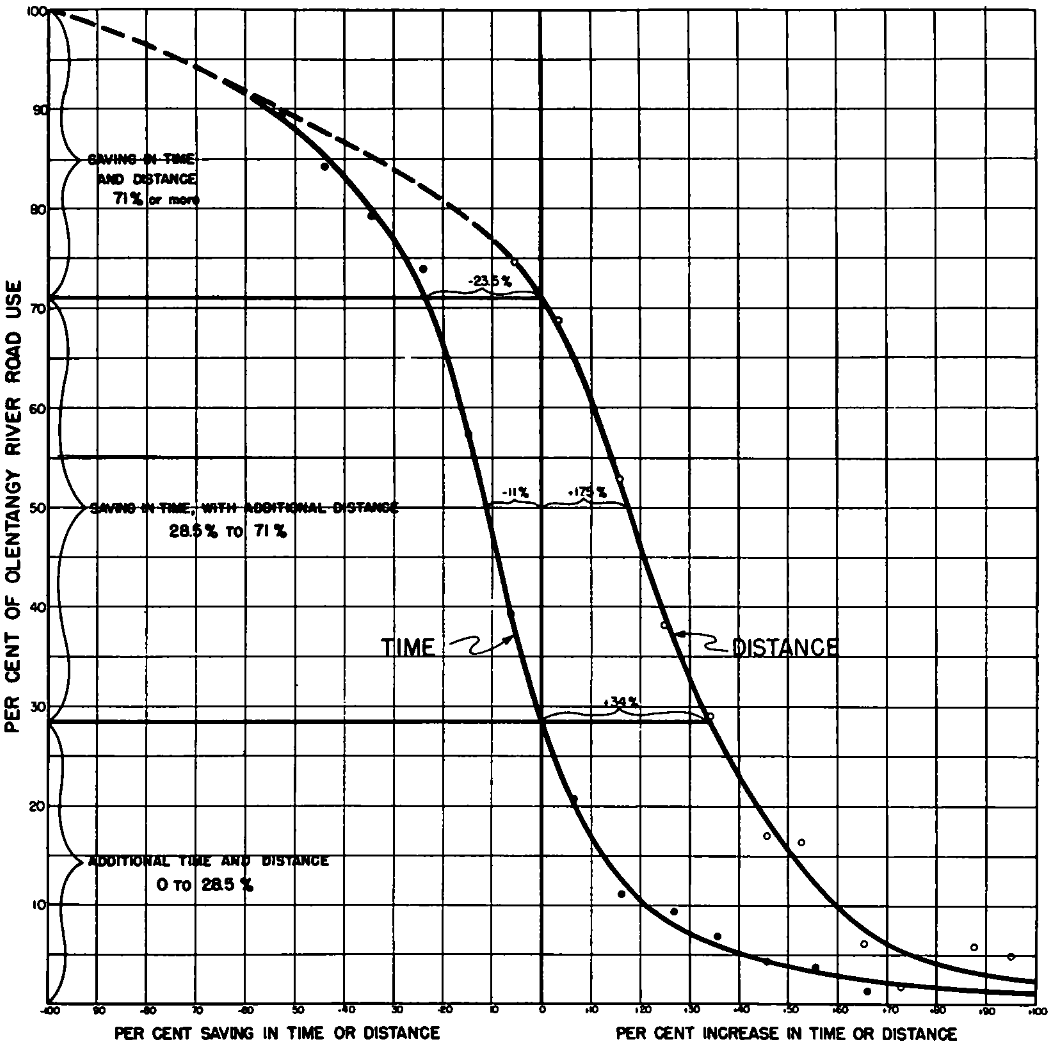

Figure 6. Percent of traffic usage in relation to the percent difference in time or distance.

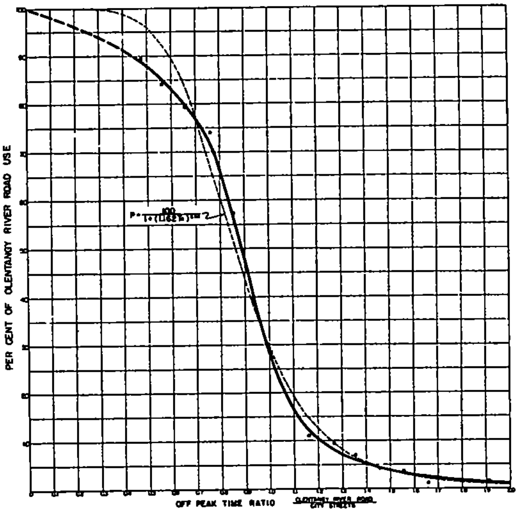

Figure 7. Percent of traffic usage in relation to off-peak time ratio and showing curve of trend based upon equation.

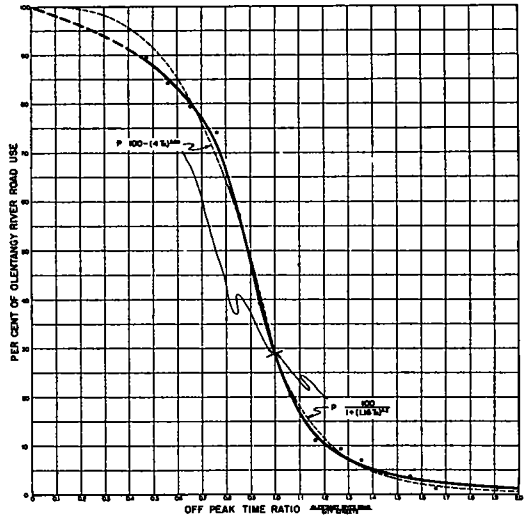

Figure 8. Percent of traffic usage in relation to off-peak time ratio and showing equations for curves of trend for ratios less than 1.0 and more than 1.0.

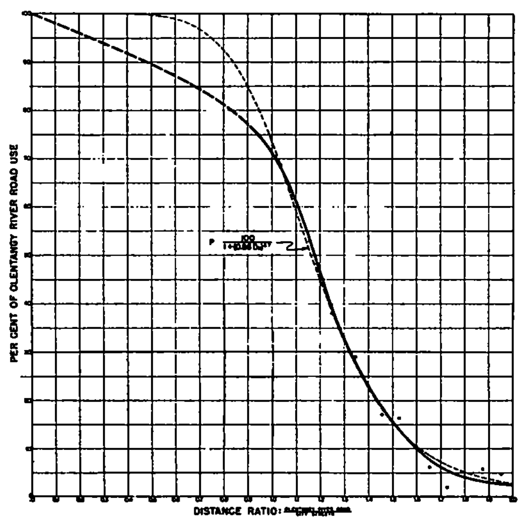

Figure 9. Percent of traffic usage in relation to ratio of distance traveled and showing curve of trend based upon equation.

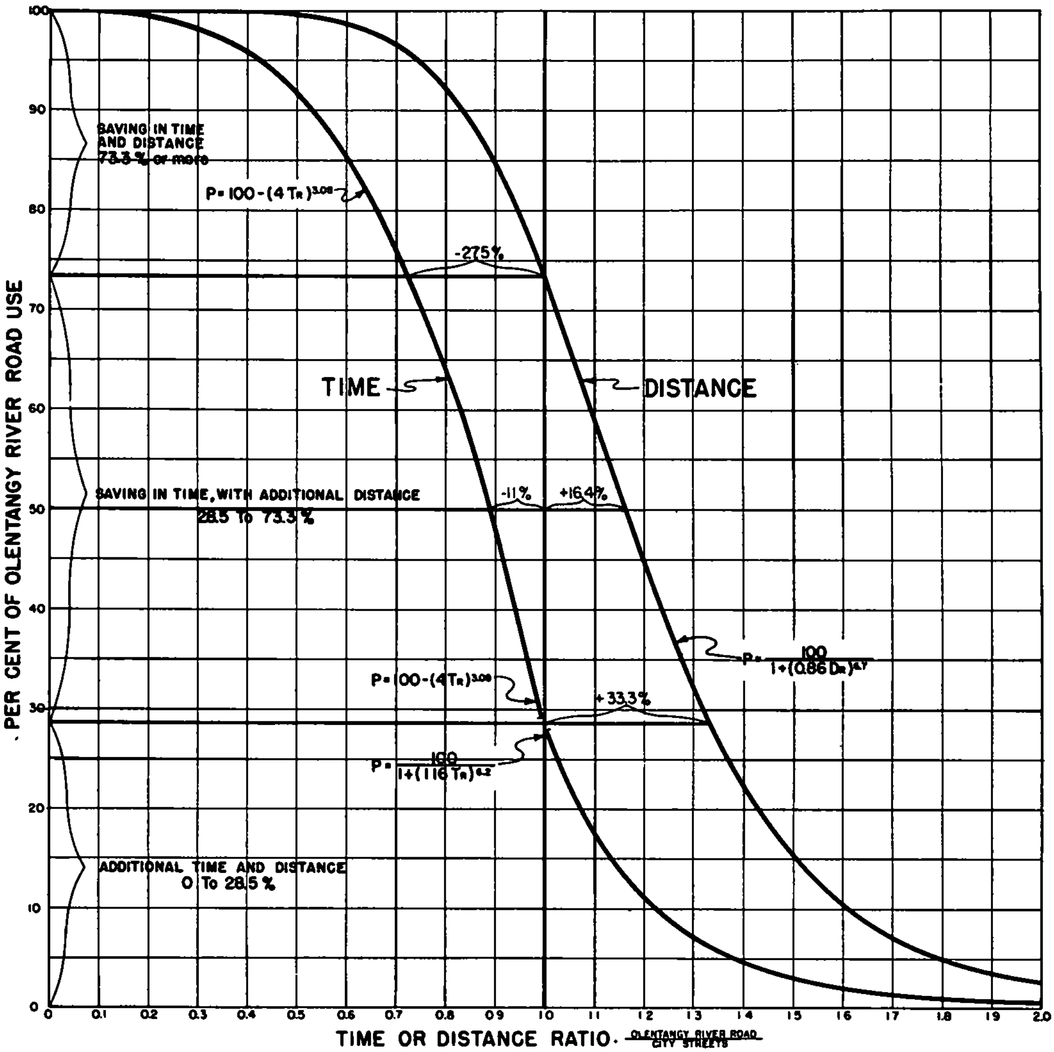

Figure 10. Percent of traffic usage derived from empirical formulas based on time and distance ratios.