TENNESSEE TRAFFIC PATTERNS

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SYNOPSIS

Last year we pointed out the remarkable similarity of successive annual or seasonal patterns at the same station taking the monthly flow as the unit There is a great similarity in general pattern if we use the weekly flow as a unit However, there is a range of variation from 0 to 30 percent in density, or volume, for successive weeks

Wider variation in volumes for daily flow may be expected Comparing each day of the week with the average day for the week, we find a range of values from 0 6 to 1 5 times the average The usual range of values is from 0 8 to 1 20 times the average

The ratios of total weekly traffic to traffic on Wednesday, Friday and Sunday are grouped closely about their average which indicates that the averages for these three days may be used for getting the average weekly flow

The studies indicate conformity of general pattern By taking samples at different hours of different days an average may be obtained which will closely approximate the average for any period The data studied thus far show that the more samples taken, the better will be the conformity If for example, seven hours count were to be made, these seven hours scattered over the different days of the week, the average would be better than to count the seven hours in any one day Further if the hours were selected at a different time for each day, the result would be better than to use the same hour for the several days

SUMMARY OF PATTERNS PRESENTED LAST YEAR

Last year patterns were presented showing seasonal variations in traffic using the flow per month and the flow per week as the unit We found general conformity of pattern from year to year and for different traffic stations Individual patterns, however, varied enough to warn us that no short period count could be made on any one day, or for any one week and expect to get any but the most approximate results for general averages

The mean daily flow for one month may vary as much as 30 percent from the mean daily flow of the next month The mean daily flow for one week may vary as much as 40 percent from the mean for adjacent weeks The daily flow may vary more than 100 percent from adjacent days Averages for corresponding seasonal periods have close enough conformity to project values from season to season, or from year to year

SHORT TIME PATTERNS

The study has been extended during the present year to shorter periods of time in the hope that we may approximate the errors inherent in short period counts For the last several years the Tennessee State Highway Department has been conducting a three day count on the State highway System during the last week of August Toll bridge collections indicate that this is the maximum week of the year Since the traffic, ex-

cept for a very small mileage, may be carried on two lanes of highway, we are as much interested in maximum flow as average flow From the annual patterns we can get a fair estimate of average daily flow for the year

This year (1935) the count was made on Wednesday, Friday and Sunday These days were chosen because the average for Wednesday and Friday has a very constant ratio to the average for the week, while Sunday gives the peak density An extended study was made of the toll bridge patterns to determine the relation between the flow for Wednesday, Friday and Sunday and the average for the week The ratio of total weekly traffic to traffic on Wednesday, Friday and Sunday varied from about ten percent below to ten percent above the average Figure 1 is platted to show the range in values for different stations Obion and Loudon are about 350 miles apart Trotters Landing is about 150 miles from Obion and 250 miles from Loudon This diagram shows the average of ratios for several years

The general conformity is that of figure 2 platted for different years at Loudon Here we may note that nearly all values of the ratio fall within a 20 percent band, 10 percent below and 10 percent above the average Note further that the ratio is very close to unity

The following data for Obion are typical of all the stations studied

Year	Ratio Average for Week to Average for Wed Fri , Sun		
	Minimum	Maximum	Average
1930	0 906	1 200	1 018
1931	0 922	1 082	1 008
1932	0 934	1 147	1 015
1933	0 920	1 089	1 006
Average	0 9205	1 129	1 012

The average for each year is the mean of 52 ratios A table for the several other stations would be a practical repetition of the above

As an innovation a diagram was platted showing the range of difference between

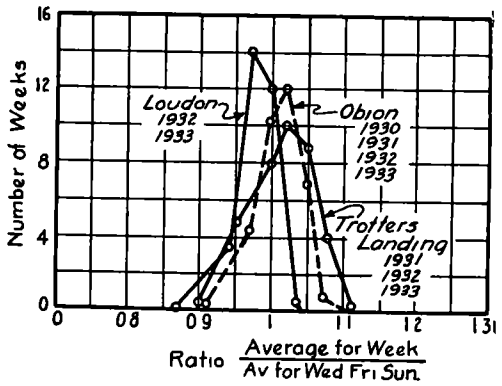

Figure 1. Relation of the Average of Wednesday, Friday, and Sunday Traffic to Average Weekly Traffic

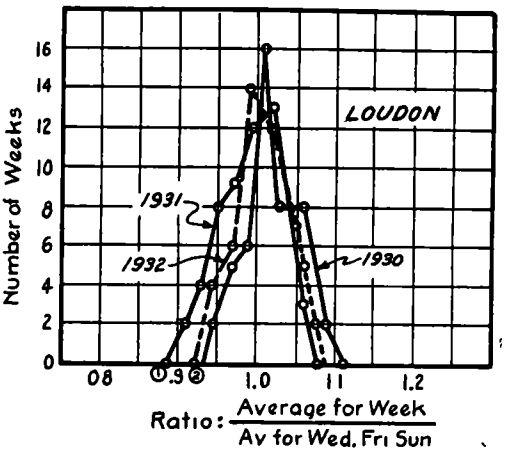

Figure 2. Relation of the Average of Wednesday, Friday, and Sunday Traffic to Average Weekly Traffic for Several Years at One Station

ratios, Values up to the mean and back down again were arbitrarily platted Figure 3 shows a picture of this kind Values of the ratio were arranged in the order of magnitude and platted unit distances between as ordinates and actual

ratio values as abscissae Figure 3 shows relative values for the three days of the week and for Sunday The other days will be similar to Sunday with somewhat less range in abscissae

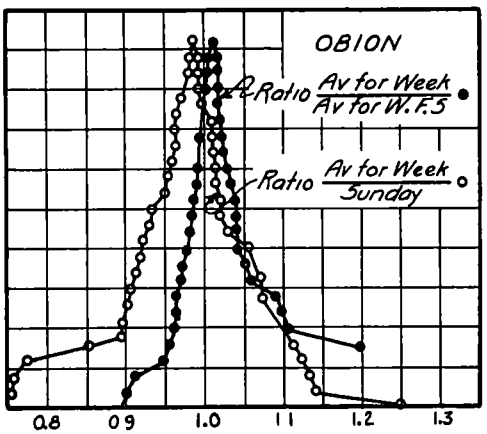

Figure 3 Variation in ratio plotted in order of magnitude to mean, then descending to maximum

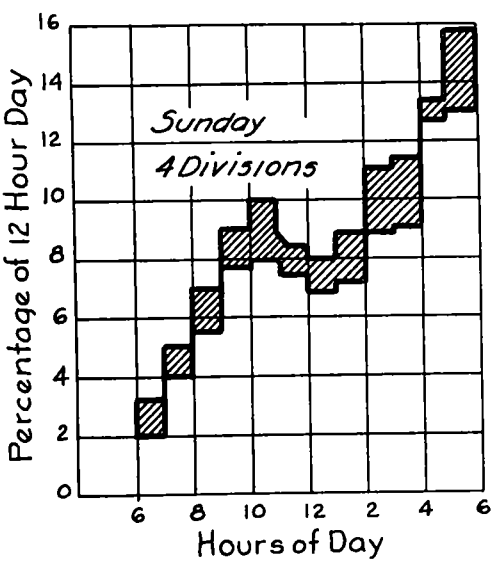

Figure 4

HOURLY PATTERNS

The hourly pattern varies greatly For the purposes of the study we computed hourly percentages of the 12 hour day flow—6 A M to 6 P M The mean of a large number of observations tends to become constant for different stations and for long periods The variations, however, are sufficient to warn us not to take very much stock in the accuracy of a very few observations

Figure 4 shows the range in values for different hours of the day for Sunday The values platted are for the four administrative divisions of the State, taking the mean of many observations in each divisions

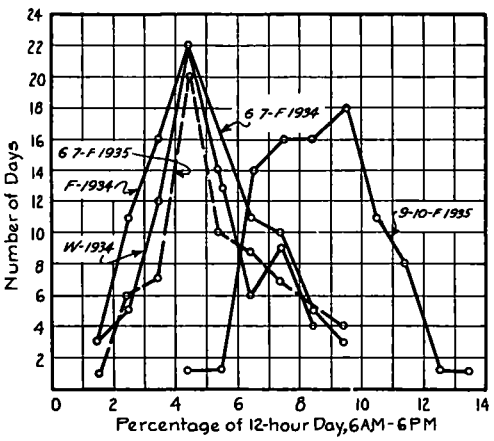

Figure 5. Relation of hourly traffic to that of the 12 hours from 6 A M. to 6 P M

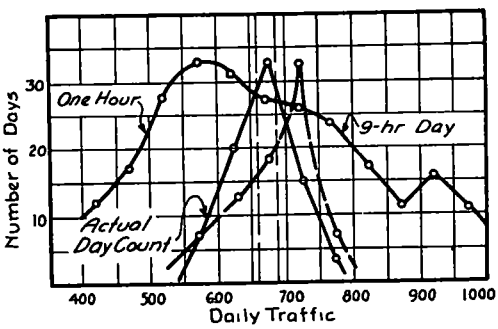

Figure 6. Range in Daily traffic derived from one hour and 9 hour counts compared with actual daily traffic. The pattern was obtained from a composite of a large number of stations

To get a picture of the pattern by hours Figure 5 was drawn Each curve represents about 100 observations Note that the range is from 1 5 percent to 9 5 percent for the hour 6 A M to 7 A M and from 4 5 to 13 5 for 9 A M to 10 A M Note further that the curve for Friday 1934 is about the same as for Friday 1935 Wednesday is about the same as Friday

PREDICTED FLOW BY HOURLY COUNTS

During 1936 we hope to make an extended study of short period counts The toll bridge records are being marked to give hourly flow for the whole year With this yearly cycle we should be able to develop a counting schedule that will give any desired accuracy. In 1935 the hourly flow for a period of one month was studied

Figure 6 shows daily volume of traffic for the month as determined by one hour counts Note that the curve ranged from 400 vehicles per day to more than 1000 vehicles per day although the actual range is from 551 vehicles per day to 769 vehicles per day The pattern used was that obtained from a composite of a large number of stations ranging in flow from 500 to 1000 vehicles per day The pattern gives averages too large as is shown by the actual count compared with average days obtained from the composite pattern

As the number of hours in the sample is increased the variation from the average is decreased We have not gone far enough to measure the probable error as compared with the number of observations but we feel that such measurement will be possible when we get yearly cycles and make a large number of comparisons.

TEMPERATURE AND TRAFFIC

Figure 7 shows the monthly average temperature and average traffic We would expect traffic to vary with the weather and it does There is probably

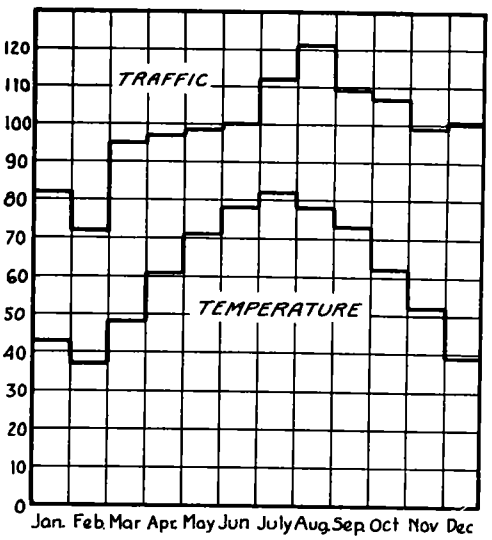

Figure 7 Relation of Traffic to Temperature

no law that will take the place of necessity for certain travel, but there is certainly a relation between temperature and a large volume of travel

CONCLUSIONS

1 A three day count will give the weekly average within a working range of accuracy

2 Hourly patterns are similar but the range of values is so great that a large number of samples are needed to get accurate results

3. For the same number of samples a large number of separate observations gives a better result than the same number of observations over a continuous period

DISCUSSION ON TRAFFIC PATTERNS

MR NATHAN CHERNIACK, *Port of New York Authority* Annual vehicular traffic data were seldom necessary when proposed highway facilities were free and tax supported, since it made little difference how much traffic they carried annually, so long as they could accommodate the peak summer traffic and still leave a margin for future expansion When toll facilities began to be considered and potential revenues constituted the first test of self liquidity, annual traffic data became prime necessities

Wherever continuous vehicular traffic records have been kept, a precise compilation of annual traffic is possible, and there is no need for estimates of annual traffic Where no continuous records are available, however, one never knows what the annual traffic for a given highway facility is, or might have been in the past, much less what it is likely to be in the future

Sample traffic counts have frequently been used as a basis by engineers to estimate annual traffic, but in the preparation of these estimates, three implicit assumptions have invariably been present, namely

(a) That vehicular traffic follows regular periodic cycles
(b) That the degree of regularity has been determined
(c) That the traffic patterns of the facilities for which annual traffic estimates are required are probably similar to those for which traffic patterns have been determined

To what extent these three assumptions have been justified in any given case have usually been left unanswered Consequently, as one of the phases of its more comprehensive studies of the problems which arise in connection with self liquidating facilities, the Port Authority Traffic Survey (W P A Project No 65–97–139) has approached its investigations of vehicular traffic patterns with a view of answering these questions It has therefore pursued its investigations with a three fold objective, namely

(a) To express quantitatively by means of traffic patterns, hourly, daily and monthly traffic cycles for some 34 vehicular toll crossings in the Port of New York and 12 others throughout the nation for which continuous traffic data are available
(b) To determine how consistently the traffic of any given facility follows the periodic cycles peculiar thereto, and
(c) To determine the extent to which corresponding traffic patterns of different facilities conform to, or differ from one another

Each of these objectives looks to the applications of these traffic patterns to the preparation of estimates of annual vehicular traffic on the basis of the smallest necessary traffic sample corresponding to a required probable error in the estimate

HOURLY PATTERNS

The study of hourly traffic patterns of the Holland Tunnel indicates that·

(1) Its hourly patterns are distinctly different for Weekday (Monday to Friday), Saturday and Sunday traffic Each pattern is indicative of motorist travel habits for that day
(2) The hourly patterns for each of

these three days are slightly different in the Summer, in Winter and the Spring and Fall

(3) In the Summer, Monday and Friday patterns differ somewhat from the standard weekday patterns

Based on the above observations, it follows that it requires a minimum of nine different standard hourly patterns to portray the hourly variation in traffic for the 365 different traffic days of the year

(4) Holland Tunnel hourly patterns over a period of eight years (1928–1935) have remained fairly consistent, although some significant changes are noticeable For example, the secondary peak hour on Saturdays between 4 and 5 P M , is gradually disappearing in favor of the major peak hour between 1 and 2 P M indicating the gradual elimination of the full workday on Saturdays

Based on an examination of hour patterns for a number of different facilities it appears that

(5) Hourly patterns of different facilities differ considerably

Hence, a definite test should be made in every instance, to determine whether the characteristics of the undetermined patterns for any facility (whose annual traffic is to be estimated from traffic samples) would be sufficiently similar to those of another facility to approximate the undetermined patterns

DAILY PATTERNS

Analyses of daily patterns of a number of vehicular crossings indicate that.

(1) For any one facility, daily patterns differ from season to season, and

(2) Daily patterns differ radically among different facilities

Hence, in order to obtain a representative cross section of the traffic for any given week, it is necessary to sample traffic at least on a Sunday, Saturday, and on either a Wednesday or a Thursday, or preferably on both days To omit any one of these three samples and rely on relations among the traffic volumes of the different days of the week, established from past experience, will subject the traffic estimate for that week to serious errors

SEASONAL PATTERNS

Analyses of seasonal patterns indicate that.

(1) Seasonal patterns for a given facility or a group of facilities in a given area are consistent from year to year, unless disturbed by such major factors as the opening of a new facility, a change in tolls on one or more of the crossings, or an economic depression

(2) The month of May shows the minimum variation from year to year, the month of October next, and the months of January and February show maximum variations

Consequently, traffic should be sampled preferably in May or October, or as close thereto as possible

(3) Seasonal patterns for different facilities vary radically from one another

Consequently, at no time should the seasonal pattern of one facility be applied to another for the purpose of estimating annual traffic, without tests to determine definitely

(a) Whether the patterns of the

two facilities are likely to be similar, and

(b) The degree of similarity between them

(4) Seasonal indexes have been developed, which reflect true seasonality in traffic, by reason of the fact that proper allowance has been made for annual trend in the process of their determination

With the aid of such specially constructed seasonal indexes, current monthly traffic data have been adjusted to represent current traffic levels which indicate the current month to month trend of vehicular traffic Such current trends are important to operators of toll crossings in following current traffic trends and in bringing out the effects of specific events, such as particularly adverse or favorable weather conditions or important sporting events in generating vehicular traffic using toll crossings

MR MARK MORRIS, *Iowa State Highway Commission* I should like to give briefly some information secured in our master station survey We, of course, tried out several short cuts upon the universe of data we have in the complete annual record of traffic past a single station We took a number of different samples from this universe in a number of different ways In the first method we took samples of 12 days of 24 hours in length, the 12 days evenly distributed throughout the year, using up the 264 weekdays of the year with 22 samples The maximum departure from the true yearly mean was for a single sample, 13 percent In other words, if we had taken but one of the samples uniformly distributed throughout the year we would have been but 13 percent in error for the worst case If we had taken but the 22 samples of 12 24-hour days we would not have been more than 13 percent in error in the worst instance and would not have had to count traffic 365 days to get an answer practically in agreement with that obtained for the true annual average We took another series of 22 samples of 12 days each 8 hours a day from 8 in the morning until 12 and 1 to 5 in the afternoon These were taken for 12 days evenly distributed throughout the year The 22 samples used up the 8 hours available for the series between the hours chosen The maximum departure from the true mean was here, for the worst case, 11 percent We took the forenoon samples in the same way and the maximum departure from the true annual mean was 15 percent The afternoon samples taken in the same way gave a maximum departure of 13 percent In order to make a survey that would be actually cheap we got down to a 1-hour basis We took one hour each day for 12 days distributed throughout the year, three in each quarter The first hour samples were taken from 7 to 8 in the morning, second 8 to 9, and so on until we had the entire 12 hours of the 12-hour day, 7 A M to 7 P M The maximum departure from the true mean was then 21 percent We tried this in different ways starting with a different hour The maximum departure for any of these ways was 15 percent from the true annual mean We still have another method which we wish to try The voluminous data take a long time to work up and there was insufficient time for it prior to this meeting We tried, however, a somewhat similar series in which we counted one hour per day each succeeding day, moving up to a later hour in a little different

manner The maximum departure for that series was 19 percent

The accuracy of the several methods referred to here is dependent on knowledge of the traffic pattern of the station So, it would seem that if the traffic pattern for a series of stations can be determined, with accuracy, it would be possible to reduce greatly the cost of securing satisfactory accurate traffic flow data by using some one of these short counts or sampling methods

MR BURTON W MARSH. For a 1-hour check, sometime between 8 and 9 in the morning and 4 and 5 in the afternoon seems to be the most consistent

DEAN MARSTON You said the maximum departure would be 11, 13, 19 and 21 percent What do you mean by the maximum departure? Is that determined by a single sample?

MR MORRIS If we had depended on a single sample for that answer we would have been in error 21 percent in the worst case