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THE EFFECT OF COMMERCIAL
VEHICLES ON DELAY
AT INTERSECTIONS

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Technical Paper

TO: J. F. McLaughlin, Director
Joint Highway Research Project

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Attached is a Technical Paper titled "The Effect of Commercial Vehicles on Delay at Intersections" which has been authored by Messrs. T. H. Yurysta and H. L. Michael. The paper is a summary of a part of the JHRP research study reported in the Final Report titled "The Effect of Commercial Vehicles on Intersection Capacity and Delay", Report No. JHRP-74-8, June 1974.

The paper will be presented at the January 1976 meeting of the Transportation Research Board and may be published by them. As a consequence the paper is submitted for approval of such publication.

Respectfully submitted,

Harold L. Michael
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Technical Paper
THE EFFECT OF COMMERCIAL VEHICLES ON DELAY
AT INTERSECTIONS

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THE EFFECT OF COMMERCIAL VEHICLES ON DELAY AT INTERSECTIONS

ABSTRACT

This research paper reports the results of a study of the effects of commercial vehicles on intersection delay. The objective was to determine the delay effect of commercial vehicles on through traffic at signalized intersections and to determine the effect of intersection corner radii on right-turning speeds of commercial vehicles. Commercial vehicles were defined as any vehicle having at least 6 tires and two or more axles. Data was collected at intersections from five cities in Indiana. Twenty-three intersection approaches were studied for commercial vehicle delay and nineteen intersection corner radii were studied for right turn speeds of commercial vehicles. The results of this research are both quantitative and qualitative. It was found that a passenger car's average running travel time through a signalized intersection was increased from 39.9 seconds to 49.4 seconds, when one or more commercial vehicles were traveling ahead of it in the same platoon of vehicles. Significant factors or variables were found to either increase or decrease commercial vehicle delay. Right turn speeds of passenger cars, truck combinations, and commercial vehicles were found for varying intersection corner radii. From a delay viewpoint, a 30 foot radius was found to be optimum for a single-unit truck and a 60 foot radius was found optimum for a truck combination.

THE EFFECT OF COMMERCIAL VEHICLES ON DELAY AT INTERSECTIONS

INTRODUCTION

The control of vehicular traffic at an intersection is of critical importance to the Traffic Engineer as this is the point in the traffic stream where travel time delays and accidents are at a maximum. One factor contributing to the maximum travel time delay occurring at intersections is the presence of commercial vehicles or trucks. This factor is becoming increasingly important because registered trucks are increasing as a percentage of all vehicles, and the number of larger trucks being sold in the United States is increasing twice as fast as total motor trucks and buses sold. From 1960 to 1970, sales of trucks with six wheels and three axles increased 310%, while sales of motor trucks and buses increased 160% (2).

OBJECTIVE

The objective of this research report was to isolate and quantify the delay effect of commercial vehicles on through traffic at signalized intersections and to determine the effect of intersection corner radii on right-turning speeds of commercial vehicles.

COMMERCIAL VEHICLE DELAY

Intersection delay is the difference between the actual travel time through an intersection and the travel time through the same intersection at normal roadway speed without deceleration, stopping, and acceleration. In a recent article entitled "Evaluation of Intersection Delay Measurement Techniques", the authors conducted a literature review on the subject of intersection capacity and performance, and concluded that the majority of authors preferred delay as the most desirable and tangible measure of intersection performance (5).

In a literature review conducted by the authors, no studies were found that specifically evaluate the delays caused by commercial vehicles at intersections. It is believed that the difficulty in measuring delay has caused the lack of research in this area.

Measuring Commercial Vehicle Delay

The first step in determining commercial vehicle delay was to define the roadway distance that is affected by the presence of a signalized intersection. This roadway distance originates at a point before an intersection where the average running speed on the roadway is reduced because of the presence of the intersection. The distance terminates after the intersection at a point where the average running speed on the roadway is continued. For this research, an average running speed of 25 miles-per-hour and an average

maximum queue length of 250 feet at an intersection approach during a peak period were assumed. The Traffic Engineering Handbook indicates a deceleration length of 500 feet is required for a vehicle to stop from a speed of 25 miles-per-hour (3), and it has been determined that a mean semi-trailer requires 500 feet to accelerate to a speed of 25 miles-per-hour (4). Thus, to determine commercial vehicle delay, vehicular movements were studied from 750 feet ($500 + 250$) before an intersection to 500 feet after the intersection.

For this study, the Floating Car Method was chosen as the most practical method for measuring travel times through an intersection. This method requires a test car to repeatedly and at random enter a platoon of vehicles approaching an intersection and to remain within the platoon until a point beyond the intersection. The travel time of the test car was measured from a point 750 feet before the intersection to a point 500 feet after the intersection. Besides timing each run, the following factors affecting commercial vehicle delay were determined by the observer in the test car

1. Number of commercial vehicles ahead of the test car in the platoon of vehicles.
2. Position of test car in the platoon of vehicles.
3. Approach lane occupied by the test car.
4. Stop time caused by the red signal (if applicable).
5. Delay caused by pedestrians (if applicable).
6. Delay caused by a slow right-turning vehicle (if applicable).

The following additional factors were counted by a stationary observer:

1. Approach volume per lane
2. Number of loaded phases
3. Right turn volume
4. Left turn volume
5. Commercial vehicle volume

The following items were inventoried at each intersection approach studied:

1. Approach width
2. Parking conditions
3. Number of approach lanes
4. One-way or two-way street
5. Metropolitan area population
6. Curb parking on approach
7. Type of traffic signal
8. Curb radius
9. Speed limit on approach
10. Degree of right turn at cross street
11. Length of green phase
12. Curbing on approach
13. Exclusive turning lanes

The above factors were those that might affect commercial vehicle delay.

The commercial vehicle delay or truck delay was determined by subtracting the average travel time through the intersection when commercial vehicles were present from the

average travel time through the intersection when commercial vehicles were not present. The average travel time was composed of the average running travel time and the average stop time. The stop time in this research is the time from when a vehicle stops because of a red traffic signal to the time the traffic signal turns green. The running travel time in this research is the running time of a vehicle through an intersection and the time that is incurred from the delay of a vehicle to start up once the traffic signal turns green. The running travel time and the stop time were measured separately for each test car run.

Pilot Study for Commercial Vehicle Delay

The number of vehicle runs or sample size needed to determine an average travel time was determined statistically from a pilot study. A statistical equation was used that required an estimate of the standard deviation, population or vehicles per peak period, error tolerance, and a probability level of not exceeding the error tolerance (8). The standard deviation and population were obtained from averaging data from the three intersections used in the pilot study. An error tolerance of 4 seconds with an accompanying 90 percent probability level of not exceeding the error tolerance was allowed to exist within each average travel time. The resulting sample size calculated from the statistical equation was 11.4. Thus, a minimum of 11 travel time runs was required to be 90% assured of an estimate

within 4 seconds of the true mean travel time. This required 22 travel time runs at each intersection approach or 11 runs for a mean travel time with trucks and 11 runs for a mean travel time without trucks.

Results of Data Collection

Twenty-three signalized intersection approaches from five cities in Indiana were analyzed for commercial vehicle delay. These intersections were located in the fringe areas and outlying business districts of the five cities. Data collection was limited to the morning and evening peak traffic periods of clear days. Table 1 presents the results. The average truck delay for all the intersection approaches was 9.2 seconds.

Testing the Results

The Wilcoxon Signed Rank Test was performed on the 23 average truck delay times to determine if a significant truck delay existed (9). A 95% confidence that a truck delay exists was determined.

The next step was to determine if the average stop time when trucks were present was significantly different from the average stop time when trucks were not present at a signalized intersection approach. The Wilcoxon Signed Rank Test was again employed. It was found that the hypothesis of no difference between the two average stop times could not be rejected. It is therefore concluded that the presence of trucks at an intersection does not significantly

increase or decrease the average stop time for a vehicle. As a result, stop time was not used in determining truck delay in this research. Only the running time was used in determining truck delay.

Regression analysis was chosen as the method to develop a model that would predict commercial vehicle delay at any given intersection and to determine which traffic, intersection, and metropolitan area characteristics affect truck delay at intersections. Nineteen factors, that were thought to cause most of the commercial vehicle delay were measured at each of the 23 intersection approaches studied. These factors or variables are presented in Table 2 with their respective measurement range.

The particular regression analysis procedure selected was stepwise linear regression. This regression procedure will enter predictor variables one at a time to the regression equation, in order of highest partial correlation with the dependent variable. Predictor variables will continue to be added until there remains no significant variables or until the list is exhausted. The significance of a particular variable is determined by evaluation of its F-ratio and tolerance level. The computer program entitled "SPSS 15: Regression" was acquired through the Purdue University Statistical Library Program and was employed to perform the stepwise linear regression (11). All the variables presented in Table 2 and various interactions between these variables were entered into the regression analysis.

A method used to increase the significance of the regression equation or model was to eliminate those predictor variables from the model that displayed small multiple correlation coefficients or R^2 values. A partial F test was conducted after each predictor variable was added to determine if the addition of that predictor variable to the model resulted in a significant increase in the R^2 value.

The model in its final form is presented below. This model produced a R^2 value of .971 and an F value of 4.67, significant at the .025 alpha level. The R^2 value of .971 indicates that the predictor variables explain 97.1 percent of the variation about the mean of the given values for the dependent variable, truck delay. The individual R^2 values for the significant predictor variables are presented in Table 3. The estimate of the standard error of the model was 2.23 seconds.

$$\begin{aligned}
 Y = & -2.436 + .00969X_{13} + .0000427X_{26} \\
 & + .236X_{19} - 3.867X_8 + .0000222X_{22} \\
 & + 5.238X_{12} + .000000886X_{24} \\
 & - .236X_3 - .222X_5 + 5.920X_9 \\
 & + .336X_{17} - .0000203X_{18} - 9.572X_{10}
 \end{aligned}$$

Where

Y = truck delay in seconds

X_{13} = peak hour volume in vehicles

X_{26} = degree of right turn x percent trucks

X_{19} = percent trucks

X_8 = exclusive left turn lane (yes=1 and no=0)

X_{22} = percent left turns x peak hour volume x left turn
lane x left turn green phase

X_{12} = left turn green phase (yes=1 and no=0)

X_{24} = metropolitan area population x speed limit in
miles per hour

X_3 = percent right turns

X_5 = curb radius in feet

X_9 = right turn lane (yes=1 and no=0)

X_{17} = approach width in feet

X_{18} = metropolitan area population

X_{10} = curbing on approach (yes=1 and no=0)

An investigation of the residuals from the final model was used to check the practicability of the model in predicting truck delay. The residuals are the differences between the actual truck delay and the truck delay predicted by the model. The frequency chart of the residuals is presented in Figure 1. A 'W' test (10) was performed on the residuals to determine if they followed a normal distribution. (Regression analysis was employed under the assumption that these residuals are normally distributed (9).) The results of the W test did not reject the hypothesis of normality.

An examination of the arithmetic sign preceding each regression coefficient in the model also revealed the practicality of the model. The arithmetic sign that preceded many of the coefficients was obviously to be expected.

However, some of the arithmetic signs were not obvious until a review of the study intersections was performed. The imperceptible signs were interpreted to read as follows:

1. The negative sign preceding left turn lane indicates a left turn lane reduces truck delay. The intersection approaches that were studied that had left turn lanes, also had at least two other lanes. Most of the through passenger cars traveled in the center lane or lanes, and most of the through trucks traveled in the right lane. Since most of the through passenger cars are not in the same lane as the trucks, a minimum truck delay is incurred.
2. The positive sign preceding approach width indicates that an increase in pavement width causes an increase in truck delay. Most of the three and four lane approaches studied displayed speed limits equal to or greater than those on the two lane approaches. The higher speed limits will increase truck delay because trucks take a proportionally longer time to accelerate to a higher speed than passenger cars.
3. The positive sign preceding left turn green phase indicates a left turn green phase increases truck delay. Many drivers assume that a separate left turn green phase results in a reduced through green phase time. This assumption causes drivers to accelerate faster than normal from a stop at an intersection. Since trucks are unable to equal the faster acceleration of passenger cars, a greater delay results.
4. The positive sign preceding right turn lane indicates that a right turn lane will increase truck delay. The presence of a right turn lane usually indicates that there is at least one other lane for through movements only. Consequently, the through-only lane or lanes are forced to carry all the through trucks. This condition increases truck delay for the following reasons:
 1. Right turning vehicles will cause no delay to through vehicles and thus, will not offset truck delay.
 2. Through vehicles cannot change lanes to avoid a slower moving truck.

5. The negative sign preceding metropolitan area population indicates that a larger metropolitan area reduces truck delay. In this research, it was found that fringe areas and outlying business districts in larger metropolitan areas had speed limits that were usually lower than those in similar locations in smaller metropolitan areas. As previously stated, lower speed limits reduce truck delay. Another reason for a larger metropolitan area reducing truck delay is that drivers in larger cities tend to be more aggressive in their driving habits and will take more chances to avoid a slow moving truck.

The arithmetic signs preceding the interaction variables are dependent upon the magnitude and effect of each variable in the interaction. It is very difficult to determine how the magnitude and effect of each variable in the interaction affects the preceding arithmetic sign; and thus, the arithmetic signs preceding interaction variables were not examined.

A final check of the practicability of the model was accomplished by testing it against an independent intersection. Data at this test intersection was obtained from observers stationed in a 40 foot high fire tower overlooking the intersection. A sample of 38% of the total through vehicles was collected. This sample size was statistically proven to yield acceptable average travel times. The sample produced a truck delay of 2.78 seconds per vehicle. The variables that occur in the model were measured at the test intersection and inserted into the model to produce a predicted truck delay of 2.82 seconds. This small error substantiates the models practicality.

Although several checks of the model's practicality proved to be positive, it is not concluded that the model is acceptable at every intersection. Certainly it may not be applicable for intersections with variables that fall outside the ranges presented in Table 2.

RIGHT TURN STUDY

One of the largest single vehicular delays at an intersection may be caused by a long truck negotiating a right turn. Many intersections within urban areas are not able to accommodate turning movements of truck combinations without encroachment on adjacent lanes. Often, one large truck combination will delay a lane of traffic for an entire cycle because of its inability to negotiate a right turn without encroachment on the opposing or adjacent lane on the cross street.

Data Collection for Right Turn Study

Nineteen curb radii were studied to determine their effect on right-turning speeds of commercial vehicles. Each curb radius was measured as a simple curve radius, and curb radii from only right angle intersections were studied. Speeds of right-turning vehicles were obtained by timing a vehicle along a predetermined distance with a beginning and end reference point. The beginning reference point was located on the front tangent of the curve at a distance of 60 feet ahead of the point of intersection of the curve tangents. The end reference point was located on the back tangent at a

distance of 60 feet back from the point of intersection of the curve tangents. The vehicle was required to be traveling in free flow the entire timing distance. Vehicles were subdivided into passenger cars, single unit trucks and buses, and truck combinations. Times were taken for each vehicle sub-class at each curb radius studied, until a good statistical average was obtained. Also measured at each curb radius studied were approach turning width, curbing on approach, and cross street turning width.

Analysis of Data

The first step was to define the relationship between curb radii and vehicular speeds. Transformations were performed on the predictor variable curb radius, and the stepwise linear regression program (11) was employed to determine the best correlation between curb radius and vehicular speeds. The regression line plots resulting from each of the regression equations are presented in Figure 2. The shaded area in Figure 2 represents the 30 to 50 foot curb radius that is recommended by the American Association of State Highway and Transportation Officials (1) and by a recent Institute of Traffic Engineers subcommittee report (7) for trucks at intersecting streets on major streets carrying heavy traffic volumes. This 30 to 50 foot range was subdivided into 5 foot intervals, and the regression equations were employed to calculate the resulting vehicular speeds. The results are presented in Table 3. The difference

between passenger car and single unit truck average right turn speed was smallest at a 30 foot curb radius and largest at a 50 foot curb radius. The difference between passenger car and truck combination average right turn speed was smallest at a 50 foot curb radius and largest at a 30 foot curb radius. From a passenger car delay viewpoint and within A.A.S.H.T.O. recommended limits, minimum delay caused by a right-turning single unit truck is incurred at a curb radius of 30 feet, and minimum delay caused by a right-turning truck combination is incurred at a curb radius of 50 feet. A further inspection of Figure 2 revealed that single unit truck and truck combination speeds increased very little beyond a 60 foot radius. From a 60 foot to 90 foot curb radius, the increase in speed for a single unit truck was less than .1 mile per hour and for a truck combination was .4 miles per hour. These small increases in speed do not justify a 30 foot increase in curb radius, and result in a 60 foot curb radius as the maximum desirable. Therefore, it is recommended that a 30 foot curb radius be employed at intersections on major streets that use a single unit truck as the design vehicle. At intersections on major streets that use a truck combination as the design vehicle, a 60 foot curb radius is recommended. These recommendations apply to intersections located in fringe areas and outlying business districts of metropolitan areas.

Three additional variables were added to the regression equations previously determined, in an effort to increase the predicting power of the equations. The three variables were approach turning width, curbing on approach, and cross street turning width. Also, a new regression equation for commercial vehicles was determined. The data for right turn speeds of single unit trucks and truck combinations was averaged to obtain speed data for commercial vehicles. The regression equations for passenger car, truck combination, and commercial vehicle right turn speeds yielded high R^2 and F values. Figures 3, 4, and 5 are plots of these regression equations.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The following general conclusions concerning the effects of commercial vehicles on intersection delay were determined from this research report.

1. The presence of commercial vehicles in a platoon of vehicles approaching a signalized intersection does not significantly increase or decrease the average vehicle stop time, as defined in this research, at the signalized intersection.
2. The factors or variables that have a significant effect on increasing commercial vehicle delay are peak hour volume, percent of commercial vehicles, the presence of a left turn green phase, the presence of a right turn only lane, and the approach width. The factors that have a significant effect on reducing commercial vehicle delay are the presence of a left turn only lane, the percent of right turns, the right turn curb radius, the metropolitan area population, and the presence of curbing on the approach.

3. An analysis of the Right Turn Study reveals the maximum right turn speed for a truck combination at a signalized intersection is approximately 14 miles per hour and approximately 15 miles per hour for a single unit truck.
4. The presence of curbing at a signalized intersection approach was found to decrease the right turn speed of passenger cars by .7 miles per hour and to decrease the right turn speed of truck combinations by .9 miles per hour.

The following recommendations resulting from this research report are presented.

1. The right turn speeds of passenger cars, truck combinations, and commercial vehicles as presented in Figures 3, 4, and 5 are recommended for application in corner radius design, delay and capacity analysis.
2. This research report found that within AASHTO recommendations a 30 foot radius caused the least delay for a passenger car following a single unit truck and a 50 foot radius caused the least delay for a passenger car following a truck combination. It was also determined that corner radii greater than 60 feet did not appreciably increase right turn speeds of single unit trucks and truck combinations. Therefore, it is recommended that a 30 feet corner radius be employed at intersections on major streets that use a single unit truck as the design vehicle. On major streets at intersections that use a truck combination as the design vehicle, a 60 feet corner radius is recommended where economically feasible.

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TABLE 1

SUMMARY OF DATA FOR COMMERCIAL VEHICLE DELAY STUDY

Intersection	City	Trucks Present		Trucks Not Present		Truck Delay
		Travel Time	Stop Time	Travel Time	Stop Time	
Kentucky at Morris	Indianapolis	49.5 sec	10.0 sec	43.7 sec	10.3 sec	5.8 sec
Kentucky at West	Indianapolis	57.3	23.5	41.7	15.6	15.6
Kentucky at Harding	Indianapolis	49.4	19.4	38.4	9.7	11.0
Morris at Tibbs	Indianapolis	44.4	11.7	32.6	10.7	11.8
Morris at Harding	Indianapolis	72.9	5.1	64.7	5.2	8.2
Morris at Tibbs	Indianapolis	40.7	12.3	33.2	6.6	7.5
Morris at Harding	Indianapolis	58.7	14.5	46.4	13.8	12.3
Virginia at Stevens	Indianapolis	35.8	1.4	28.9	0.5	6.9
Kentucky at White R.	Indianapolis	39.2	12.4	26.5	8.0	12.7
Morris at Harding	Indianapolis	54.3	4.2	38.6	6.0	15.7
Meridian at South	Indianapolis	43.1	7.8	32.8	10.9	10.3
South at West	Indianapolis	52.2	40.1	44.2	40.8	8.0
Morris at Belmont	Indianapolis	40.9	0	36.3	0	4.6
Morris at Holt	Indianapolis	38.5	2.9	28.7	2.1	9.8
Northwestern at 16th	Indianapolis	38.2	6.6	39.4	0.2	-1.2
U.S. 52 at South	Lafayette	50.7	20.6	39.2	27.9	11.5
U.S. 52 at South	Lafayette	44.8	13.9	31.1	15.4	13.7
U.S. 52 at Main	Lafayette	41.7	9.8	34.0	16.8	7.7
U.S. 52 at Main	Lafayette	41.2	14.0	30.8	17.8	10.4
Union at 18th	Lafayette	60.4	11.3	53.7	26.1	6.7
U.S. 31 at Markland	Kokomo	51.4	27.9	44.6	40.3	6.8
Kennedy at 169th	Hammond	76.7	33.7	69.2	41.3	7.5
Indianapolis at 141st	East Chicago	54.0	6.2	38.8	5.3	15.2
Mean		49.4	13.4	39.9	14.4	9.5

TABLE 2
RANGE OF VARIABLES AFFECTING COMMERCIAL VEHICLE DELAY

<u>Variable Number</u>	<u>Variable</u>	<u>Unit of Measurement</u>	<u>Range</u>
X1	Degree of Right Turn	Degrees	42 to 135
X2	Green Phase Length	Seconds	21. to 54.
X3	Percent Right Turns	Percent of Peak Hour Volume	0 to 37.9
X4	Peak Hour Load Factor	Number of Loaded Phases/ Total Phases	0 to .95
X5	Right Turn Curb Radius	Feet	10 to 100
X6	Parking on Approach	Yes or No	Yes & No
X7	Peak Hour Factor	Vehicles per Peak Hr. <u>4xVeh. per Peak 15 min.</u>	.66 to .95
X8	Exclusive Left Turn Lane	Yes or No	Yes & No
X9	Right Turn Lane	Yes or No	Yes & No
X10	Curbing on Approach	Yes or No	Yes & No
X11	Percent Left Turns	Percent of Peak Hour Volume	0.6 to 47.8
X12	Left Turn Green Phase	Yes or No	Yes & No
X13	Peak Hour Approach Volume	Vehicles per Hour	544 to 1505
X14	Percent Single Units	Percent of Peak Hour Volume	1.1 to 11.9
X15	Percent Truck Combinations	Percent of Peak Hour Volume	0 to 12.3
X16	Speed Limit on Approach	Miles per Hour	25 to 55
X17	Approach Width	Feet	21. to 50.
X18	Metropolitan Area - Population	People	83,000 to 1,110,000
X19	Percent of Trucks	Percent of Peak Hour Volume	1.5 to 20.4

TABLE 3

SIGNIFICANT PREDICTOR VARIABLES FOR TRUCK DELAY

Variable No..	Variable Description	R-square Change
13	Peak hour volume in vehicles	.132
26	Degree of right turn x percent trucks	.107
19	Percent trucks	.099
08	Left turn lane (yes = 1 and no = 0)	.092
22	Percent left turns x peak hour volume x left turn lane x left turn green phase	.091
12	Left turn green phase in sec.	.075
24	Metropolitan area population x speed limit in miles per hour	.056
03	Percent right turns	.052
05	Curb radius in feet	.049
09	Right turn lane (yes = 1 and no = 0)	.046
17	Approach width in feet	.038
18	Metropolitan area population	.021
10	Curbing on approach (yes = 1 and no = 0)	.014

TABLE 4
RIGHT TURN VEHICULAR SPEEDS FOR 30 TO 50 FEET CURB RADII

Curb Radius (feet)	Passenger Car Speed (mph)	Single Unit Tk. Speed (mph)	Truck Comb. Speed (mph)	Pas. Car Speed - Single Speed (mph)	Pas. Car Speed - Truck Comb. Speed (mph)
30	14.85	12.60	10.54	2.25	4.34
35	15.21	12.89	11.11	2.32	4.10
40	15.55	13.12	11.58	2.43	3.97
45	15.87	13.32	11.99	2.55	3.88
50	16.17	13.47	12.32	2.70	3.85

FIGURE 1. FREQUENCY OF RESIDUALS FOR TRUCK DELAY MODEL

FIGURE 2. RIGHT TURN SPEEDS AS A FUNCTION OF CURB RADIUS

FIGURE 3. RIGHT TURN SPEED, IN MILES PER HOUR, FOR PASSENGER CARS

FIGURE 4. RIGHT TURN SPEED, IN MILES PER HOUR, FOR TRUCK COMBINATIONS

FIGURE 5. RIGHT TURN SPEED, IN MILES PER HOUR, FOR COMMERCIAL VEHICLES

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