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TRAFFIC SPEED REPORT NO. 80
TRUCK WEIGHT-SPEED STUDY

FEBRUARY 1965
NO. 2

Joint
Highway
Research
Project

by
E.G. EVANS

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

"Traffic Speed Report No. 80

TO: K. B. Woods, Director
Joint Highway Research Project

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

February 4, 1965

File: 8-3-4
Project: C-36-10D

Attached is a Progress Report entitled "Traffic Speed Report No. 80". The results of the 1964 study of the relationship between truck weights and truck speeds are contained herein. The report has been prepared by Mr. E. G. Evans, graduate assistant on our staff, and was prepared from data obtained during the annual truck weight study performed by the Highway Planning Survey Section of the Indiana State Highway Commission. The Project has cooperated in this study in a similar manner for many years.

This report will be distributed in the usual manner to the Highway Commission, the Bureau of Public Roads, the State Police, the Office of Traffic Safety and the Traffic Safety Foundation. It is presented to the Board for information and for the record and for approval of such distribution.

Respectfully submitted,

Harold L. Michael
Harold L. Michael, Secretary

HLM:bc

Attachment

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F. L. Ashbaucher
J. R. Cooper
W. L. Dolch
W. H. Goetz
W. L. Grecco
F. F. Hovey
F. S. Hill
G. A. Leonards
J. F. McLaughlin

F. B. Mendenhall
R. D. Miles
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J. C. Oppenlander
W. P. Privette
M. B. Scott
J. V. Smythe
E. J. Yoder

TO: E. J. Gools, Director,
 Joint Highway Research Program
 FROM: E. J. Gools, Assistant Director,
 Joint Highway Research Program
 Date: 1-15-64
 Project: C-30-100

Attached is a Progress Report entitled "Traffic Speed Report No. 80". The results of the study of the relationship between truck weights and truck speeds are contained therein. The report has been prepared by Mr. E. J. Gools, Graduate Assistant on our staff, and was prepared from data obtained during the annual truck speed survey performed by the Highway Planning Survey Division of the Indiana State Highway Commission. The report has been prepared in this study as a similar manner for your review.

This report will be distributed in the same manner to the Highway Commission, the Bureau of Public Roads, the State Police, the Office of Traffic Safety and the Traffic Safety Council. It is provided to the Bureau for information and for use of staff.

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Respectfully,
 E. J. Gools, Secretary

Kindly
 Attachment
 Copy:

E. J. Gools	E. J. Gools
H. E. Miller	H. E. Miller
H. E. Miller	H. E. Miller
J. C. O'Connell	J. C. O'Connell
M. P. Fritzsche	M. P. Fritzsche
M. P. Fritzsche	M. P. Fritzsche
J. V. Gools	J. V. Gools
H. J. Jones	H. J. Jones
J. L. Ashbaugh	J. L. Ashbaugh
J. E. Cooper	J. E. Cooper
W. L. Dole	W. L. Dole
V. H. Gools	V. H. Gools
W. L. Grisco	W. L. Grisco
T. W. Harvey	T. W. Harvey
T. S. Hill	T. S. Hill
G. A. Jacobs	G. A. Jacobs
J. F. McLaughlin	J. F. McLaughlin

TRAFFIC SPEED REPORT NO. 80
TRUCK WEIGHT - SPEED STUDY

by
Eugene G. Evans
Graduate Assistant

Joint Highway Research Project

File: 8-3-4

Project: C-36-10D

Purdue University

Lafayette, Indiana

February 4, 1965

TRAFFIC SPEED REPORT NO. 80

Introduction

This report is an analysis of the 1964 annual truck weight-speed data which were collected during the months of August and September in conjunction with the Highway Planning Survey Unit of the Indiana State Highway Commission. The Highway Planning Survey Unit makes an annual study of truck weights, size, material hauled, etc. at twenty-three truck weight stations throughout the state. The truck weight-speed study compares the weight of a truck, obtained by the Planning Survey Unit through the use of loadometer scales, and the speed of the same truck, obtained by personnel of the Joint Highway Research Project. These personnel were located at an appropriate site along the highway approximately two miles from the weighing site. A radar meter was used to obtain the truck speeds, and a positive identification method was implemented to match the truck weight with its correct speed. Although the Highway Planning Survey Unit made observations at twenty-three locations throughout Indiana, only ten stations were used for the collection of the weight-speed study data.

Because of a late data collection schedule which conflicted with University schedules of Project personnel, three observation stations usually included were eliminated and four other stations were added. This report, therefore, contains ten truck weight-speed stations; whereas, past reports contained only nine. These ten stations are shown on Figure 1 and are further described as follows:

<u>Station</u>	<u>Highway</u>	<u>Location</u>	<u>Date of Observation</u>	<u>No. of Lanes</u>
58B	U.S. 31	0.2 Mi S of Southport Road	Aug 25	4
75	U.S. 41	0.2 Mi S of U.S. 41 Bus.	Aug 26	4
83	U.S. 41	0.5 Mi N of S.R. 57	Aug 27	4
81	U.S. 150	0.3 Mi E of S.R. 56	Aug 28	2
45B	S.R. 67	1.0 Mi S.W. of Muncie	Sept 3	2
16	U.S. 6	3.0 Mi W. of S.R. 49	Sept 14	2
15	U.S. 30	Between S.R. 55 and S.R. 53	Sept 15	4
14	U.S. 41	0.5 Mi S of N. Jct. S.R. 2	Sept 16	4
12	U.S. 52	2.25 Mi W. of U.S. 41	Sept 17	2
42	U.S. 52	0.1 Mi. S.E. of N. Jct. of S.R. 28	Sept 21	4

Equipment and Field Procedure

The Speed data were obtained by the use of an Electromatic Radar Speed Meter - Model S-5. Prior to conducting the study, the meter was checked for accuracy by the use of a calibrated fifth wheel. Since the radar meter was found to have an error of less than one mile per hour, which is less than the manufacturer's claim for instrument accuracy of a plus or minus two miles per hour, a calibration curve for the meter was deemed unnecessary. Periodically throughout the study the meter was checked with 30 MPH and 45 MPH tuning forks to assure continued accuracy.

In order to minimize the observer effect on the traffic stream, the radar meter head assembly was concealed in a green cardboard barrel near (3 to 5 feet) the pavement edge. The green barrel closely approximated the standard trash barrels which are used by the Indiana Highway Commission, and the barrel blended well with the green grass background. At some locations complete concealment of the observer and observer's car was not possible; however, at all stations the observer and the recording unit were at least twenty feet from the roadway. Since the radar meter head was placed so as to make an angle of less than 10 degrees with the centerline of the observed traffic stream, speed inaccuracies due to this factor were negligible and corrections were unnecessary.

The speed observations were made on level tangent sections of the highway between two and three miles from the weigh stations. In all cases sufficient distance was allowed for trucks to regain normal cruising speeds since data were desired for "free flowing trucks". For this report "free flowing trucks" refers to trucks whose speed was not affected by other vehicles traveling in the same direction.

The truck weight speed data were collected from 8 A.M. to 4 P.M. During the four A.M. hours the observations were made on vehicles traveling in one direction, and during the four P.M. hours the apparatus was moved to the other side of the roadway to observe vehicles moving in the opposite direction.

Procedure and Analysis

For this analysis the data were classified by truck type - single unit or multi-unit - and by road type - two lane or four lane. The single unit trucks were divided into those less than 5000 lbs. and those of 5000 lbs or more. This weight classification corresponds to existing Indiana speed limits for trucks which are as follows:

65 MPH for light (less than 5000 lbs) trucks

55 MPH for heavy (5000 lbs or more) trucks on 4-lane highways with a median of 20 feet or more

50 MPH for heavy trucks on other roadways

With this classification a comparison of the observed speeds with the legal and "enforced" speed limits was possible. These results are presented in Table 3.

A further breakdown in the data is presented in Tables 1 and 2. The observed values are separated into weight classes, and the number observed and the average speed within each weight class are shown. The tables show the average weight, average speed, and the 95% confidence limits for each truck classification at each station. Summaries by truck classification on both types of highway facilities are also tabulated. Table 4 lists the number of observations, average speeds, and average weights by truck classification for the past sixteen years.

Figures 2,3, and 4 are cumulative frequency speed curves by truck classification and by facility type. Figures 5 and 6 indicate the trends in 85th percentile speeds. Figures 7 through 9 show simple regression curves which relates truck speed to truck weight.

Summary and Results

Analysis of Tables 1 and 2 show the following average characteristics for the various road and truck classifications:

Single Unit (Less than 5000 lbs.)

	2-Lane	4-Lane	All
No. of Vehicles	73	92	165
Average Speed - MPH	51.9	53.3	52.7
Average Weight - lbs	4133	4112	4121

Single Unit (5000 lbs or more)

	2-Lane	4-Lane	All
No. of Vehicles	198	314	512
Average Speed - MPH	49.0	50.5	49.9
Average Weight - lbs	12,989	13,777	13,472

Multi-Unit

	2-Lane	4-Lane	All
No. of Vehicles	412	764	1176
Average Speed-MPH	49.7	51.8	51.1
Average Weight - lbs	45,293	43,397	44,061

Table 3 shows that the following percentages of trucks exceeded the existing and enforced speed limits (where the enforced speed limit is assumed to be 5 MPH above the legal speed limit).

		Single Unit		Multi-Unit
		Light	Heavy	
2-lane	Speed Limit	2.7	36.9	46.1
	Enforced Limit	0	15.2	9.7
4-lane	Speed Limit	4.3	20.4	20.4
	Enforced Limit	0	4.1	1.0

From the above table one can conclude that many heavy single unit and multi-unit trucks are speed offenders. Approximately 12% of these trucks were exceeding the "enforced" speed limit on two-lane facilities; whereas only 3% of heavy single unit and multi-unit trucks were exceeding the "enforced" speed limit on four-lane highways.

Observation of the steepness of the central portion of the cumulative frequency curves (Fig. 2,3 and 4) for the heavier trucks indicate that a smaller variation in speeds exist between heavy trucks than between light trucks. These figures also show that the greatest variation in the confidence band for the calculated means occurs for light, single-unit trucks.

Figures 5 and 6 show the plots of the 85th percentile speeds on 2-lane and 4-lane highways. An increase in speeds has occurred since 1963, but a more or less leveling trend is noted when 1964 data is compared with data from the past eleven years.

The computed regression lines and equations for the simple linear regression analysis of weight-speed data is shown on Figures 7-9. A weighted regression analysis program (WRAP) was used for the regression analysis, and the computations were done on the 7090 computer. These figures indicate that there is a slight decrease in speed with an increase in weight. The correlation coefficients (r) indicate, however, that this correlation between weight and speed is small. A perfect correlation coefficient (r) would be a value of one (1.0). In this study the computed r and r^2 values between weight and speed were as follows:

<u>Equation</u>	<u>r</u>	<u>r^2</u>
2-Lane Single Unit	.2899	.0841
4-Lane Single Unit	.2120	.0449
2-Lane Multi Unit	.1599	.0256
4-Lane Multi Unit	.1933	.0374
Single Unit (Total)	.2347	.0551
Multi-Unit (Total)	.1870	.0350

Since the r^2 (coefficient of determination) values are quite small, it can be concluded that increasing truck weight apparently accounts for only a minor part of the observed speed differences. From the values above it is seen that larger r^2 values are realized when only single unit trucks are considered.

Table 4 shows that the average speeds of single unit and multi-unit trucks are 5.7 and 5.2 mph greater, respectively, than at the last observation. When compared with data from previous years, however, the increase is not as large and compares favorably with the general trend. Part of the increase in speed this year may be because of the omission of three previously observed stations and the addition of four new stations. Future truck weight-speed studies may provide further information on the effect of the change of observation stations on the truck weight-speed study results.

Recommendations for Future Studies

1. The observer who is collecting the speed data in the field should be 2 miles or more from the weight station. This allows the truck enough distance to regain normal cruising speed.
2. The observer should be 50 feet or more from the roadway and be hidden from the truck driver's view. Truck drivers appear to be quite proficient at detecting the presence of radar units; therefore, the observer should do everything within his power to make sure that truck drivers are not aware of his presence.

FIG.1 - LOCATIONS OF TRUCK WEIGHT-SPEED STATIONS

FIGURE 2. ACCUMULATIVE SPEED CURVES

FIGURE 3. ACCUMULATIVE SPEED CURVES

FIGURE 4. ACCUMULATIVE SPEED CURVES

FIG. 5 - TRENDS IN THE 85TH PERCENTILE TRUCK SPEED ON TWO-LANE HIGHWAYS (1953-1964)

FIG. 6 - TRENDS IN 85TH PERCENTILE TRUCK SPEEDS ON FOUR-LANE HIGHWAYS (1953-1964)

FIG. 7 - REGRESSION ANALYSIS: SINGLE UNIT TRUCKS BY ROADWAY TYPE

FIG.8 - REGRESSION ANALYSIS: MULTI UNIT TRUCKS BY ROADWAY TYPE

FIG. 9 - REGRESSION ANALYSIS: ALL TRUCKS BY TRUCK TYPE

Stations	FWD-LANE HIGHWAY						RWD-LANE HIGHWAY								Total 2-Lane and 2-Lane									
	12	16	65R	21	Total 2-Lane		14	15	62	59R	75	83	Total 2-Lane											
Weight (lbs)	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks	Ave. No. of Speed Trucks									
1-1	30.5	4	30.5	4	30.5	10	30.5	8	30.5	1	30.5	1	30.5	2	30.5	3	30.5	7	30.5	4	30.5	27	30.5	61
1-2	30.5	10	30.5	4	30.5	10	30.5	8	30.5	1	30.5	5	30.5	5	30.5	10	30.5	10	30.5	7	30.5	40	30.5	114
Total Trucks	22	4	28	4	28	20	73	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Ave. 1st. (lbs)	4,100	2,925	4,063	4,092	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132	4,132
Ave. Speed	52.5	51.7	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5
Conf. Level	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Conf. Level	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Lower	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
1-3	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10
1-4	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10
1-5	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10
1-6	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10
1-7	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10	30.5	10
 					

TABLE 2. THIRY-SECT TRACK RECORD (JPN)

[illegible]

SINGLE UNIT TRUCKS				MULTIPLE UNIT TRUCKS							
Trucks Weighing Under 5000 lbs.				Trucks weighing over 5000 lbs.							
Sta.	No. Trucks observed	% exceeding 65 MPH	% exceeding 70 MPH	No Trucks observed	% exceeding 50 MPH	% exceeding 55 MPH	No Trucks observed	% exceeding 50 MPH	% exceeding 55 MPH		
Two-Lane Highways	16	0.0	0.0	39	41.0	23.1	177	57.1	12.4		
	12	4.5	0.0	49	28.6	10.2	91	41.8	9.9		
	45B	3.6	0.0	51	51.0	21.6	86	39.5	8.1		
	81	0.0	0.0	59	28.8	8.5	58	29.3	3.4		
All 2-Lane	73	2.7	0.0	198	36.9	15.2	412	46.1	9.7		

Year	Single-Unit			Multi-Unit		
	Number	Average Speed	Average Weight	Number	Average Speed	Average Weight
1949	578	42.2	9,400	581	43.2	32,500
1950	791	42.4	8,700	879	42.7	36,700
1951	1242	43.0	8,600	1,402	43.5	36,700
1952	1482	43.4	8,700	1,354	44.1	35,900
1953	1239	43.9	8,400	1,507	43.1	35,800
1954	905	45.8	8,000	1,064	43.6	37,400
1955	762	45.9	8,900	1,120	43.5	38,400
1956	952	47.0	8,300	1,033	44.4	37,900
1957	1028	46.3	9,400	1,161	42.5	37,100
1958	837	46.5	9,900	1,130	46.1	39,500
1959	481	45.5	9,200	604	48.6	40,300
1960	424	49.1	12,000	644	50.3	39,300
1961	938	48.0	10,600	1,149	48.6	42,600
1962	610	48.7	11,800	1,079	49.2	42,700
1963	488	44.9	11,500	736	45.9	43,600
1964	677	50.6	11,200	1,176	51.1	44,100

TABLE 4

TRUCK-WEIGHT SPEED DATA
COMPARISON OF DATA FROM STUDIES IN VARIOUS YEARS