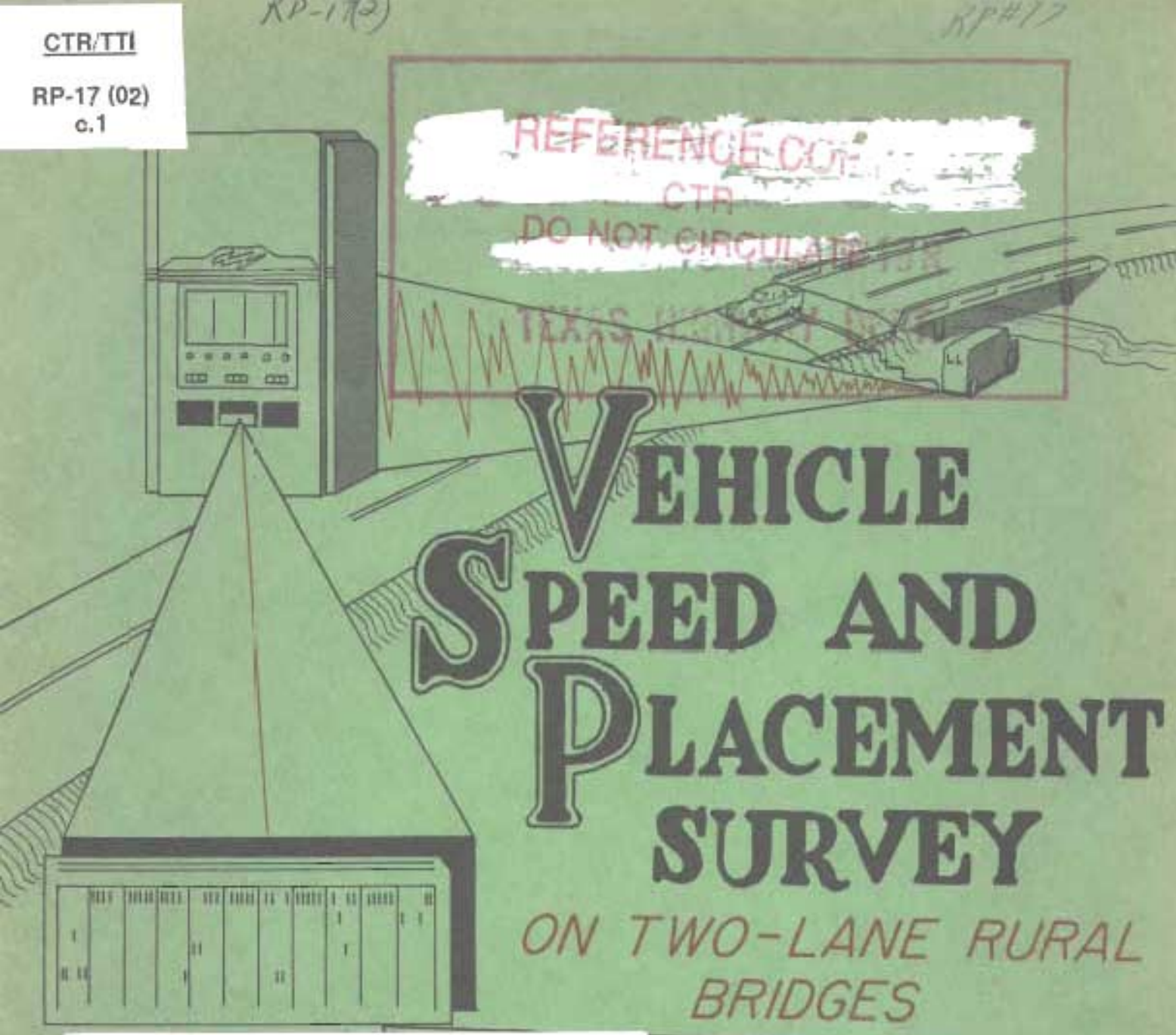
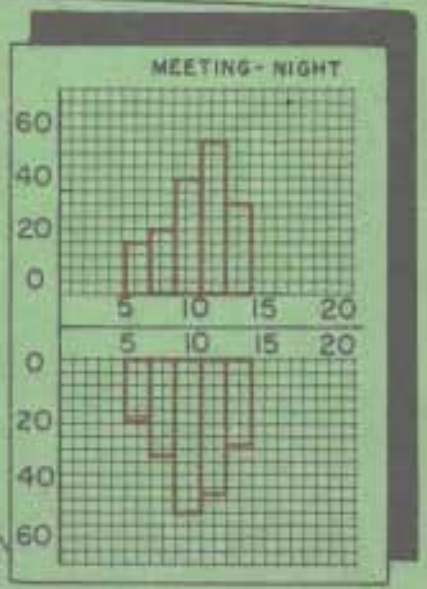


VEHICLE SPEED AND PLACEMENT SURVEY

ON TWO-LANE RURAL BRIDGES



PREPARED BY
TEXAS HIGHWAY DEPARTMENT
ROAD DESIGN DIVISION

JUNE — 1957

VEHICLE SPEED AND PLACEMENT SURVEY

ON TWO-LANE RURAL BRIDGES

Prepared By

TEXAS HIGHWAY DEPARTMENT

ROAD DESIGN DIVISION

JUNE 1957

This research was performed under the general direction of the Road Design Division and was made possible by the co-operation of the U. S. Bureau of Public Roads who furnished the measuring equipment used and also much expert advice and assistance through their representatives from the Headquarters, Regional and District Offices. The project was a co-ordinated effort of the Road Design Division, the Planning Survey Division and Field District No. 15.

The report has been reviewed by the Research and Development Committee of the Texas Highway Department and has been approved for release as an official publication.

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I. GENERAL OBJECTIVES

The general objective of this study was to determine the effect of the width of two lane roadway bridges on the lateral placement of vehicles as compared with the lateral placement on a two lane road. The lateral placement near the end and near the middle of a long bridge was also measured to determine whether or not the vehicles moved laterally while driving across a long bridge.

It was hoped through this study of traffic behavior to find some indication of what the proper width for two lane roadway bridges should be.

II. SUMMARY OF CONCLUSIONS

The conclusions reached as a result of this study are somewhat general and lend themselves to discussion rather than numerical listing. The purpose of the study as mentioned was to determine the effect of bridge width on traffic behavior. It was established that the bridge width has a definite influence on lateral placement of vehicles. It was not possible to arrive at a definite recommendation for widths of two lane highway bridges but the data does indicate that a bridge lane width two feet wider than the road lane adjacent to the bridge causes the average driver to deviate considerably from the lateral position he assumes on the roadway.

It appears that the average driver needs a bridge lane width of about 20 feet in order to cross the bridge with little or no deviation in lateral position from that assumed on the approach roadway.

Negligible difference was found in the lateral placement measured near the middle of a 960 foot bridge and near the end of the same bridge.

III. PREVIOUS RESEARCH

Only one previous study on this subject was located. It was "Influence of Bridge Width on Transverse Position of Vehicles" by W. P. Walker published in Highway Research Board, Volume 21, 1941, Page 361.

The following conclusions were drawn by Mr. Walker:

1. "For complete freedom of movement on a bridge, vehicles should be able to meet one another with the same clearance that they allow while meeting on the highway, and at the same time there should be as much clearance from the curb as is allowed by vehicles moving freely..."

2. "Using the average transverse placement of freely moving and meeting passenger cars as an index, it is found that an 18 ft. pavement with 3 ft. shoulders required a concrete bridge of from 26 to 28 ft. in width. This required width increases to 28 or 30 ft. when the total roadway width is increased to 34 ft. and the pavement is either 20 or 22 ft. wide. The greatest width of bridge required for a 22 ft. pavement was found to be 30.6 ft."

3. "In reaching the conclusion that the bridge widths shown...are proper, no consideration has been given to the requirements of truck traffic. The number of trucks recorded at the locations studied was not sufficiently large to permit of any conclusive analysis..."

IV. METHOD OF STUDY

The equipment used in obtaining the field data consisted of combination speed meters and transverse placement detectors, described in detail in the April 1940 issue of Public Roads.[1] This equipment was furnished and operated by the U. S. Bureau of Public Roads. (Figure 1)

Fig. 1

View of Bridge Showing Tape
for Measuring Lateral Placement

The speed meters operated by use of pneumatic detectors that actuated a timing device which in turn recorded the speed of the vehicle on a moving paper tape. The speed was recorded by groups and for this survey there were twenty-five groups with the upper and lower limits being open classifications.

[1]E. H. Holmes & S. E. Reymer "New Techniques in Traffic Behavior Studies" April 1940 Public Roads.

An electro-mechanical tape which actuated a recording device was used to record the transverse placement. This tape was separated so that most vehicles actuated only two pens on the recorder thus giving an accurate location of the vehicle within three inches.

The moving paper tapes used for recording were timed so that they moved past the pens at a constant rate. This made possible the classification of maneuvers by time spacing and also the matching of speed and placement for each vehicle. Manual notes were made on the paper tape for vehicles other than passenger cars and for the passing maneuver.

The truck containing the recording equipment was located well away from the site and was hidden from view to as great an extent as was possible to avoid influencing driver behavior. The data was hand coded and transferred to punched cards for machine tabulation.

Vehicles were originally classified into 10 types but samples in some types were small and operating characteristics were similar. For analysis only two classifications were used. One included passenger cars and pick-ups while the other included buses and all trucks.

In addition to the meeting and free moving maneuvers, the data was recorded for passing and trailing and all combinations thereof, but samples in these categories were small for analysis.

The following classifications of vehicle maneuvers were made:

Free-moving - Over 7.2 sec. to nearest vehicle both directions.

Trailing - Less than 3.6 sec. to next vehicle ahead traveling same direction, and over 7.2 sec. to next vehicle ahead traveling opposite direction.

Meeting - Less than 3.6 sec. to next vehicle ahead traveling opposite direction.

Passing - 1.8 sec. or less behind or ahead of car being passed.

Being Passed - 1.8 sec. or less behind or ahead of car passing.

All others.

V. LOCATION AND DESCRIPTION OF SITES

The study was conducted on bridges in Highway Department District 15 with headquarters at San Antonio. The locations of the study sites are shown in Figure 2 and a tabulation of data for each of the sites is shown in Figure 3. In each case, the location on the bridge is designated with a B while the road site near the bridge is designated with an A.

Photographs of each site are shown in Appendix 3. As far as possible, all of the bridges studied were similar in appearance as far as the driver was concerned. Rail and curb designs were substantially the same. The bridges varied in length from 156 feet to 360 feet plus the 960 foot bridge.

To make the bridge placement measurements valid, it was felt that the design of the roadway on either side of the bridges should be held constant. This is illustrated in Figure 4. The roadway in each case consisted of two twelve foot lanes with surfaced shoulders. At three of the six sites studied, the road shoulders were eight feet wide while at sites 51 and 52 the shoulders were three feet wide and at site 55 they were ten feet wide. Since in the Vehicle Speed and Placement Survey for Two Lane Rural Highways,[2] it was determined that shoulders three feet wide and wider did not affect the lateral placement of vehicles, it was felt that the inclusion of these sites was valid. Sites 51 and 55 were, however, eliminated from the final analysis for other reasons. The roadway locations at sites 51 and 52, since they were actually at the same place, could not be considered as two locations in a statistical analysis. These were made in conjunction with the bridge sites near the middle and near the end of this 960 foot bridge. Site 51 was, therefore, omitted.

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[2] Vehicle Speed and Placement Survey for Two Lane Rural Highways in Texas, Texas Highway Department, March, 1957.

ROAD AND BRIDGE SITE LOCATIONS

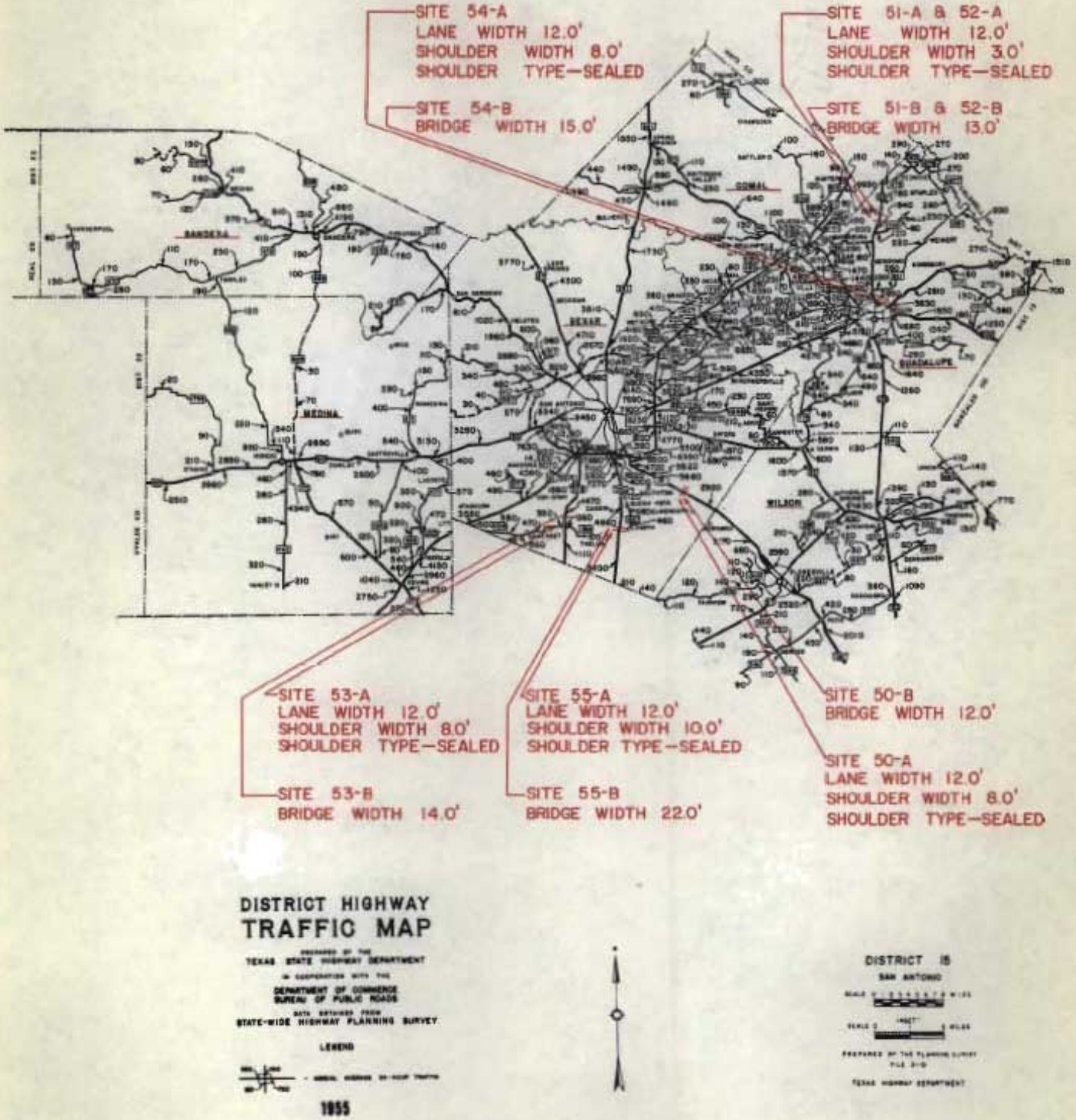


Figure 2

FIGURE 3

CHARACTERISTICS OF ROADWAY AND BRIDGES AT SITES 50-A THROUGH 55-B

Site No.	50-A	50-B Bridge	51-A	51-B Bridge	52-A	52-B Bridge	53-A	53-B Bridge	54-A	54-B Bridge	55-A	55-B Bridge
Bridge Width (Feet)		12.0		13.0		13.0		14.0		15.0		22.0
Bridge Length (Feet)		360.0		960.0		960.0		201.5		200.0		156.0
Lane Width (Feet)	12.0		12.0		12.0		12.0		12.0		12.0	
Shoulder Width (Feet)	8.0		3.0		3.0		8.0		8.0		10.0	
Shoulder Contrast (All Sealed)	Good		Fair		Fair		Good		Fair		Good	
Total Vehicles Counted	2031	1774	1071	1103	1148	1144	1067	1318	3556	2873	2630	2161
% Passenger Cars	82.2	83.7	79.3	79.2	78.3	79.1	80.6	83.4	84.1	85.7	77.1	80.3
% Trucks	15.7	14.7	16.1	16.5	17.4	16.7	18.6	15.7	14.2	12.5	20.8	18.2
% Buses	0.7	0.6	1.3	1.4	2.2	2.2	0.5	0.4	0.4	0.4	0.8	0.6
% Others	1.4	1.0	3.3	2.9	2.1	2.0	0.3	0.5	1.3	1.4	1.3	0.9
Night Vehicles Counted	224	222	153	170	195	201	140	194	776	601	414	430
% Passenger Cars	78.6	78.8	69.9	71.8	76.9	77.1	90.7	93.8	88.7	85.7	67.6	70.2
% Trucks	19.6	19.8	24.8	23.5	20.0	19.9	8.6	6.2	10.6	13.5	30.7	28.6
% Buses	0.9	0.5	2.0	2.4	1.0	1.0	0.0	0.0	0.2	0.3	0.7	0.5
% Others	0.9	0.9	3.3	2.3	2.1	2.0	0.7	0.0	0.5	0.5	1.0	0.7
1955 Average Daily Traffic	3290	3290	1840	1840	1840	1840	1350	1350	3630	3630	4500	4500
County	Bexar	Bexar	Guadalupe	Guadalupe	Guadalupe	Guadalupe	Bexar	Bexar	Guadalupe	Guadalupe	Bexar	Bexar
Highway No.	US 181	US 181	SH 123	SH 123	SH 123	SH 123	SH 346	SH 346	US 90	US 90	US 281	US 281
Control and Section	100-2	100-2	366-2	366-2	366-2	366-2	613-1	613-1	29-2	29-2	73-2	73-2
Location	Approx 850' NW of Bridge 50-B	4 Mi. NW of Wilson C.L.	1.4 Mi. S. of Bridge 51-B	4.0 Mi. S. of Hays C.L.	1.4 Mi. S. of Bridge 52-B	4.0 Mi.S. of Hays C.L.	Approx 1 Mi. S. of Bridge 53-B	4.8 Mi. N. of Atascosa C.L.	.8 Mi. W. of Bridge 54-B	2.0 Mi. E. of S.H. 123	.3 Mi. S. of Bridge 55-B	7.8 Mi. S. of Loop 13

Site 55 was located on a highway carrying 4500 vehicles per day, which would require a four lane facility by Highway Department standards and it was felt

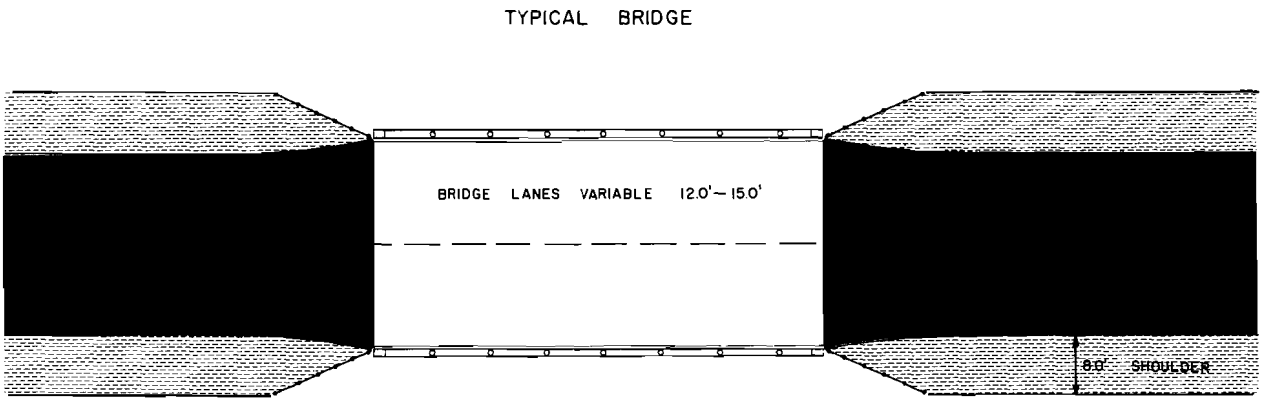


Fig. 4

Typical Bridge Showing Fixed and Variable Conditions

that vehicle placement measurements under these conditions would not be comparable to those at the other sites, particularly since it was found in the Vehicle Speed and Placement Survey for Two Lane Rural Highways[3] that there is a fairly definite relationship between volume and lateral placement. Rain during a part of the study at this site probably also had some influence on the data. Another factor at site 55 which made the data here somewhat doubtful was the fact that the pavement was flared to the width of the bridge for about two hundred feet on either side of the bridge.

Four sites were included in the actual analysis, each having comparable characteristics. Bridge lane widths which were measured from the centerline of the

[3] Ibid.

bridge to the edge of the traveled surface were 12 ft., 13 ft., 14 ft. and 15 ft. The analysis is then actually based on the following sites:

Site 50 bridge lane width 12 feet

Site 52 bridge lane width 13 feet

Site 53 bridge lane width 14 feet

Site 54 bridge lane width 15 feet

Sites 51 and 52 which were on the same bridge were to determine whether or not a consistent placement existed over the length of a long bridge. This bridge was 960 feet long. Site 51 was near the middle of the bridge and Site 52 was near the end. No significant difference in the placement was found.

VI. DISCUSSION OF STUDIES AND ANALYSIS

Speed

Speed studies were made at each of the road sites. Speeds were not measured on the bridges. Cumulative speed curves showing the 85 percentile speed at each of the road sites were plotted and are shown in Appendix 2. There does not appear to be a significant correlation between speed and the factors studied.

Lateral Placement

Lateral placement of vehilces was measured at each of the sites, both on the road and on the bridges. The studies on the road were made far enough from the bridge that the bridge did not influence placement. The minimum distance from the road site to the bridge was 850 feet.

Appendix 1 of this report is a series of bar charts representing the vehicle placements at the sites and is the basic data from which the conclusions were extracted.

In attempting to relate placement data to a basis for the determination of a bridge width several approaches were tried. Walker in his report in Highway Research Board[4] entitled "Influence of Bridge Widths on Transverse Positions of Vehicles" developed a formula by which he computed a bridge width. It consisted of the sum of the following three items:

1. "The distance of the left wheel to the right of the center line for vehicles meeting on the tangent section, which is equivalent to one-half the clearance between the left wheels of vehicles when meeting."
2. "The distance freely moving vehicles preferred to allow between their right wheels and the curb or parapet of the bridge".

[4] Highway Research Board, Vol. 21, 1941, Page 361.

3. "The tread width of the average car, or approximately 5 feet".

In attempting to apply this formula, it was found that item 2/3 was not a consistent figure but varied with the width of bridge. For this reason, this approach did not seem applicable.

It was thought, however, that a bridge width which would encourage a vehicle to maintain the same lateral position on the bridge that it occupied on the road would result in the safest operation, that least likely to result in accidents. This would mean that the driver would be only slightly aware of the presence of a bridge and would not feel that it was necessary to take any action because of the bridge.

In order to establish what this bridge width would be, it was first necessary to establish the average position of vehicles on the road for the various light conditions and maneuvers which could not be kept constant. These averages are represented by the horizontal lines in Figure 5 and 5-A. They were arrived at by averaging the placement figures for the road sites near the bridges. They do not agree exactly with the results of the Vehicle Speed and Placement Survey For Two Lane Rural Highways[5] but are within reasonable range. These placement figures were measured to the centerline of the road or bridge.

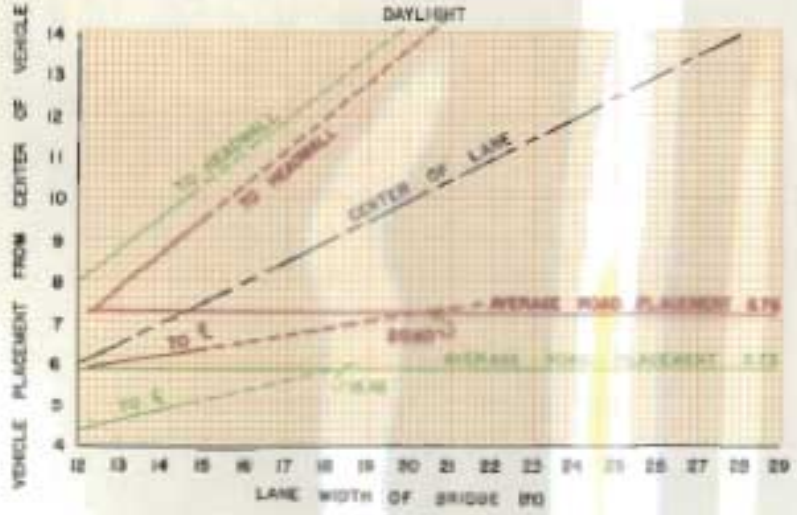
Vehicle placement figures for the various bridges were also plotted on Figures 5 and 5-A. The plotting of these data with reference to the centerline of the bridge produces a line which when extended intersects the horizontal or average road placement line. This point of intersection then

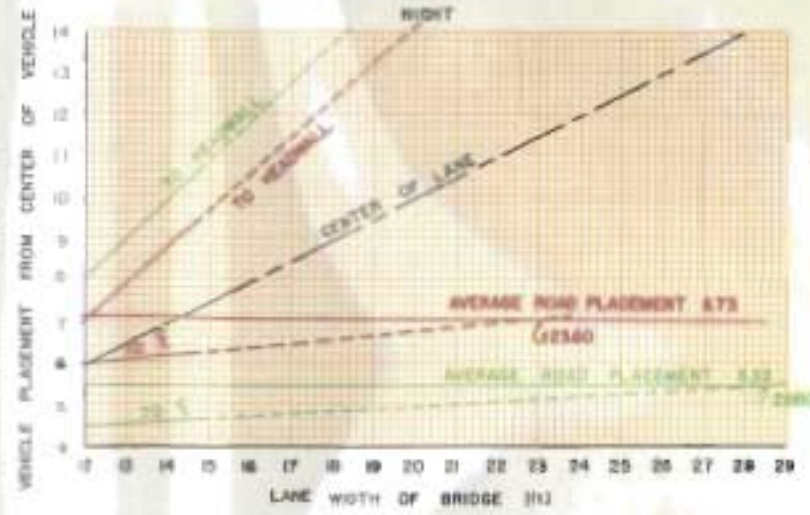
[5]Vehicle Speed And Placement Survey For Two Lane Rural Highways In Texas, Texas Highway Department, March, 1957.

PLACEMENT OF VEHICLES ON BRIDGES VS. BRIDGE LANE WIDTH

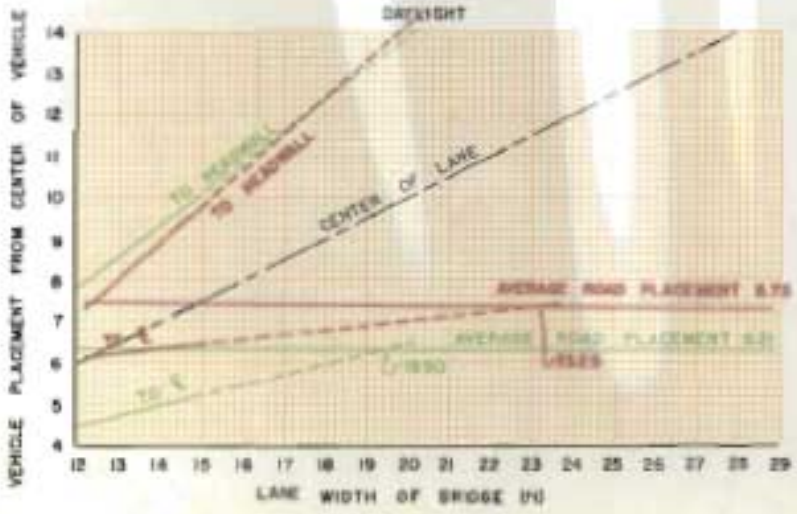
FREE-MOVING
MEETING

PASSENGER CARS





TRUCKS



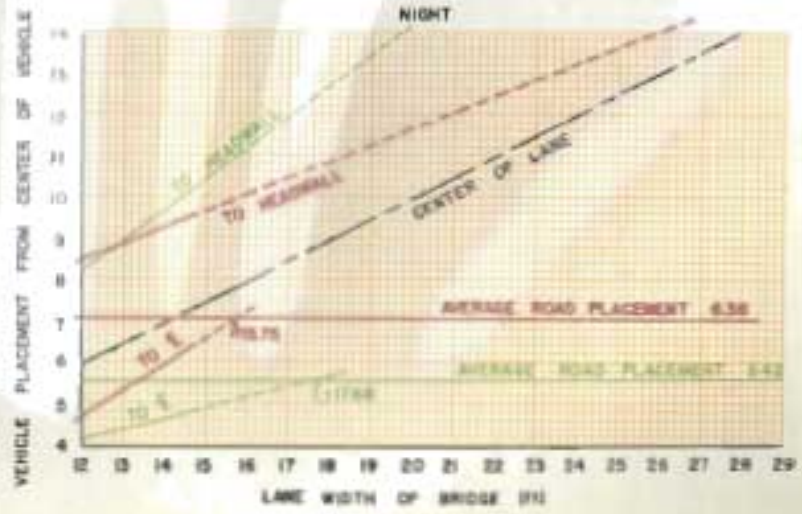


Figure 5

PLACEMENT OF VEHICLES ON BRIDGES VS. BRIDGE LANE WIDTH

FREE-MOVING

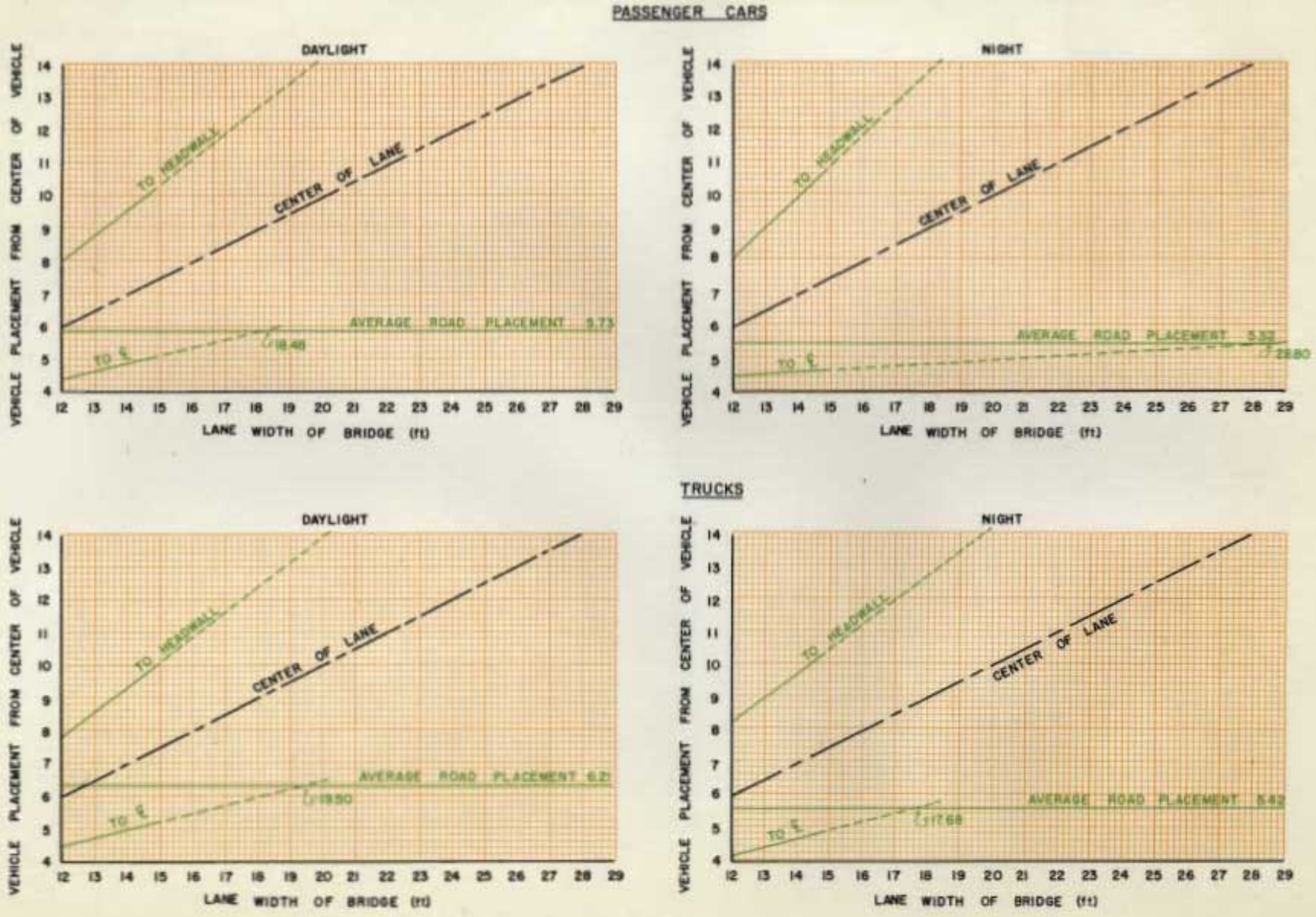


Figure 5

represents the width of bridge lane necessary for the average vehicle to pass over it without altering its lateral placement with respect to the centerline. These intersection points vary for the different conditions as is shown in Figures 5 and 5-A.

Based on this approach to bridge width determination, the data shown in Figure 6 are the widths required for the various conditions. It must be remembered, however, that these widths were arrived at from data on 12'

TABLE OF BRIDGE LANE WIDTHS FOR VARIOUS CONDITIONS

	PASSENGER CARS	TRUCKS
FREE-MOVING — DAYLIGHT	18.48	19.50
FREE-MOVING — NIGHT	28.80	17.68
MEETING — DAYLIGHT	20.60	23.25
MEETING — NIGHT	23.60	15.75

AVERAGE DAYLIGHT	20.45
AVERAGE NIGHT	21.46
AVERAGE MEETING	20.40
AVERAGE TOTAL	20.95

Fig. 6

to 15' bridge lanes. It is possible that rather than a straight line as assumed in Figure 5 the bridge placement data would curve up and intersect the road placement line at some lesser bridge width. Absence of data on

bridge lane widths wider than 15 feet places some doubt on how the bridge placement data would behave in this area. Studies on wider bridges would tie the placement down more accurately but in the absence of this information, it is thought that the straight line expansion of the known data as shown in Figures 5 and 5-A is reasonable.

The required widths vary from a low of 15.75 feet for trucks meeting at night to a high of 28.80 feet for free-moving cars at night. The average bridge lane width for all of the conditions was 20.95 feet.

It would normally be considered proper in a situation of this kind to design for the extreme condition which would mean a bridge lane width of 28.80 feet or a total bridge width of 57.60 feet. However, this seems unreasonable and looking more closely at the data, it can be seen that the 28.80 lane is for free-moving cars at night. Free-moving trucks at night require a width of only 17.68 which indicates that the passenger car drivers are probably allowing an unnecessarily large clearance to the bridge headwall.

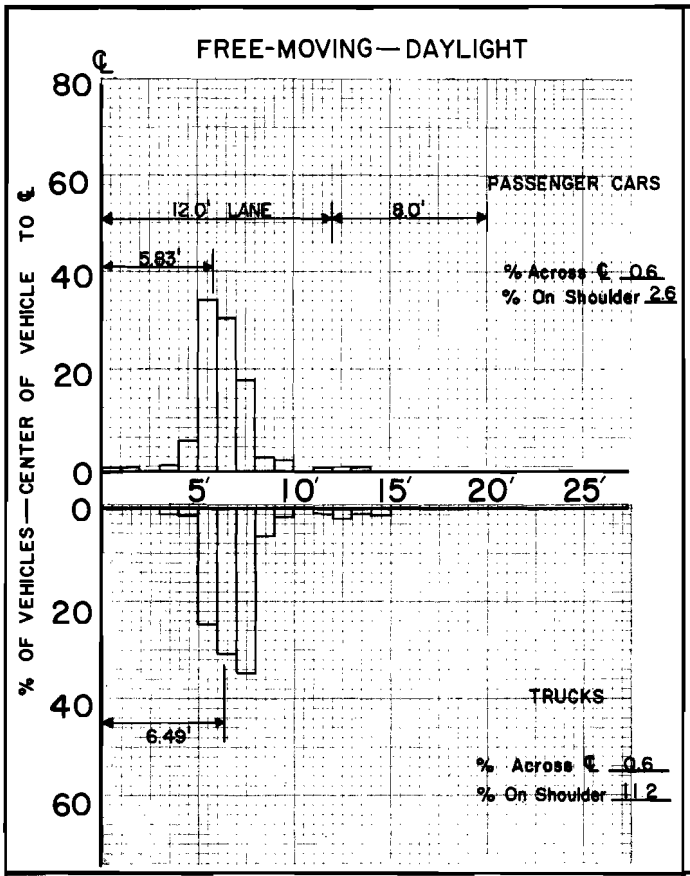
Meeting vehicles probably represent the most realistic condition on which to base a conclusion. It is somewhat surprising that this does not call for the widest bridge. It does seem significant, however, that all of the various averages shown in Figure 6 are in the vicinity of 20 feet.

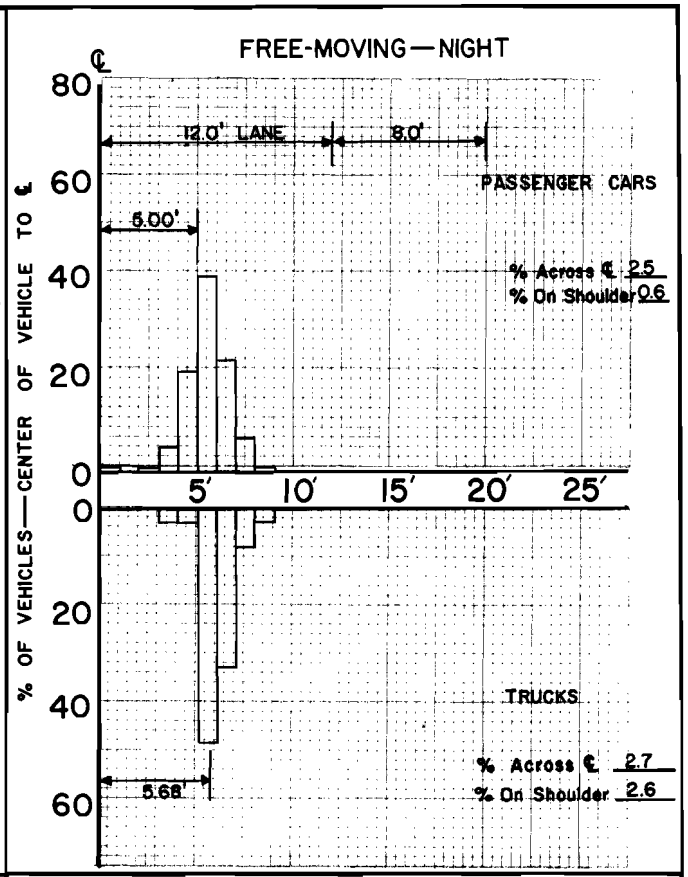
Figures 5 and 5-A also show the placement of vehicles to the bridge headwall and how it varies with the width of bridge. The lines representing the placement distance to the bridge headwall are much steeper than those representing the placement to the centerline. With the ratio between the two being as great as 19 to 1 for free-moving passenger cars at night.

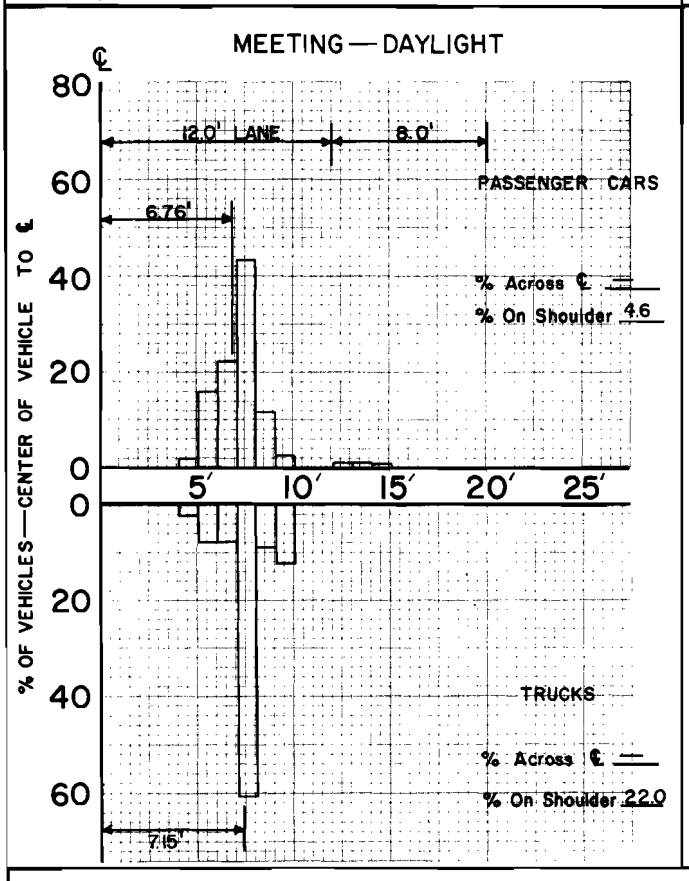
The least ratio is one to one for meeting trucks at night while the average is approximately six to one.

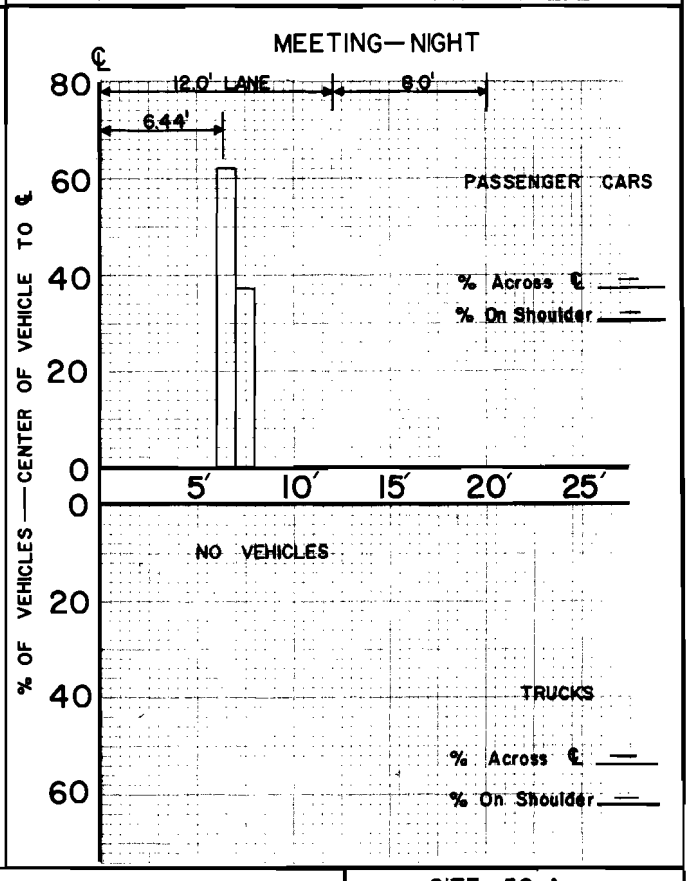
The use of placement data as a basis for determining bridge widths is at best a substitute for adequate accident data. It can be considered indicative of desirable conditions, however, and in the absence of a sufficiently long and detailed accident survey, it appears to be the most reasonable basis available for studying bridge widths.

VII APPENDIXES









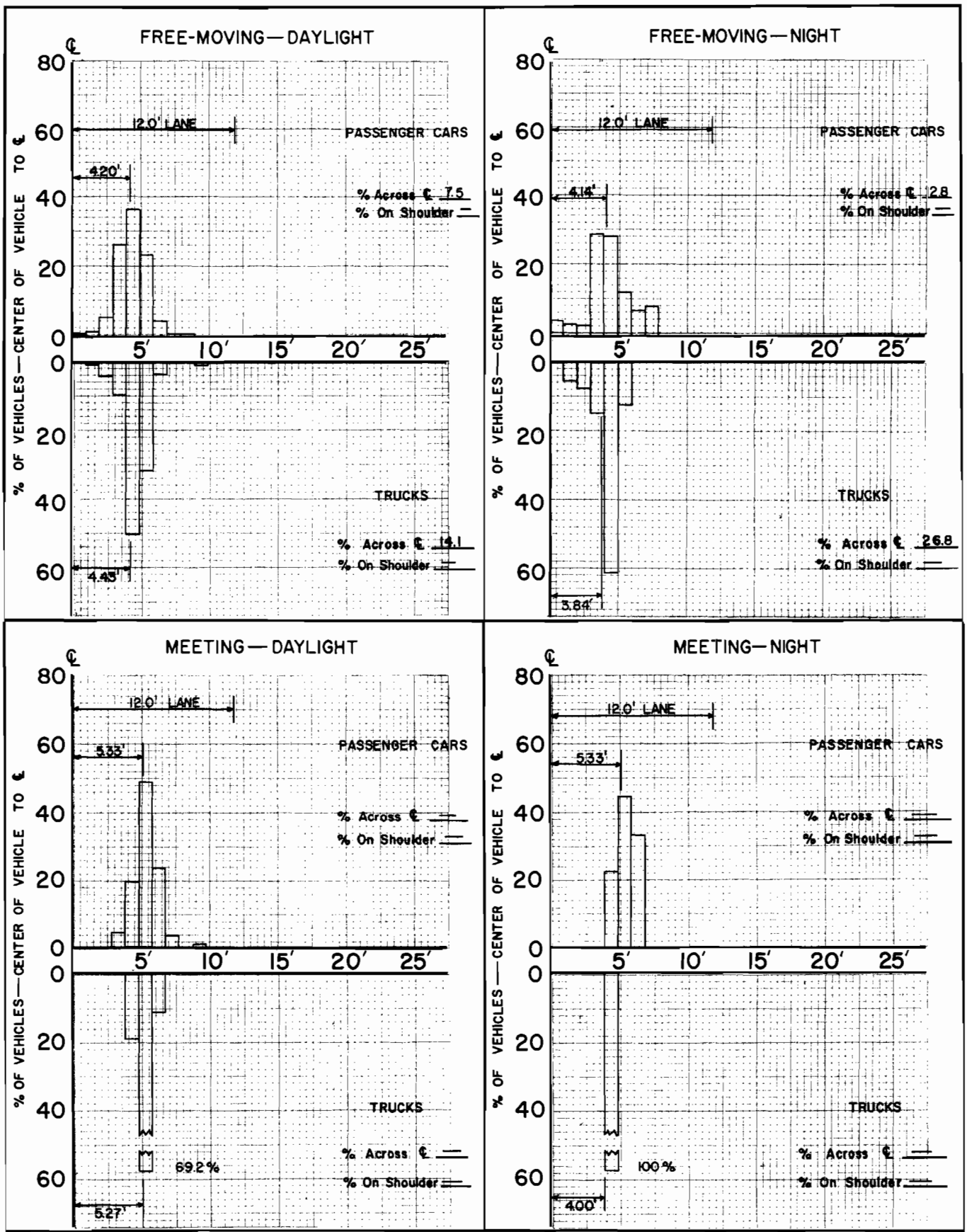
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 50-A

APPENDIX I PAGE I

PLACEMENT BAR CHARTS

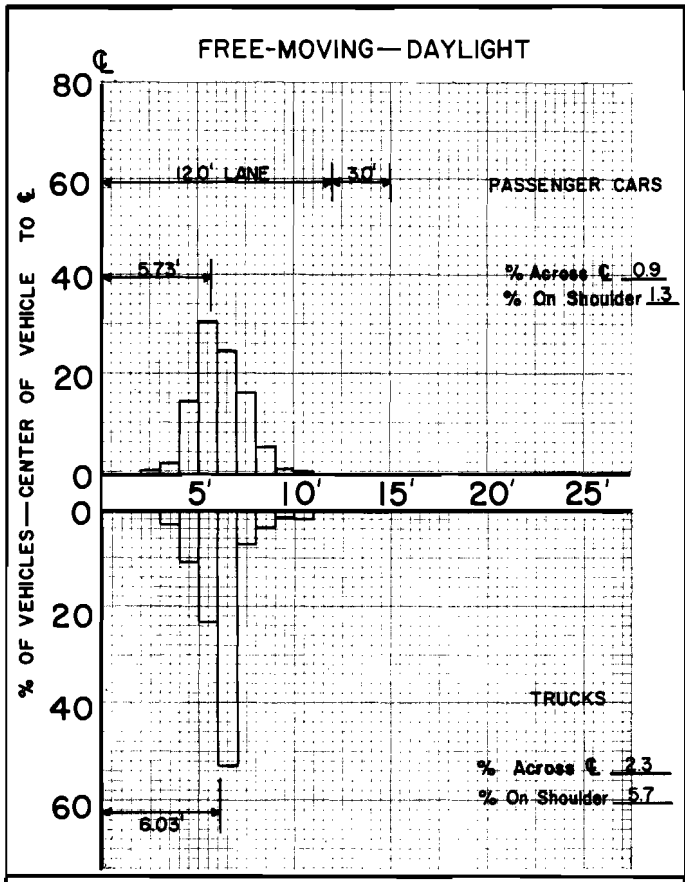
Road Design Division Texas Highway Department June 1957

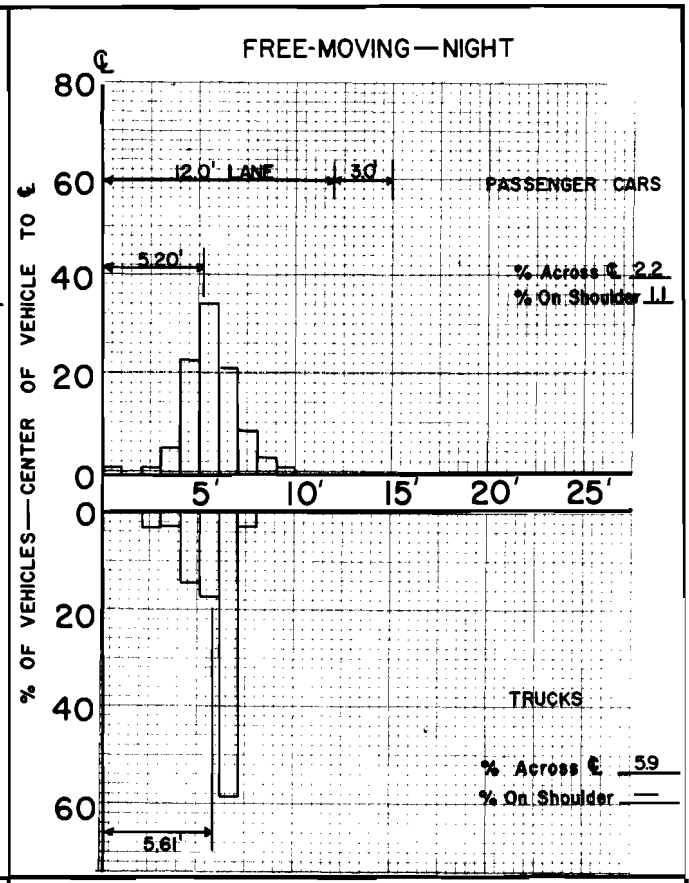


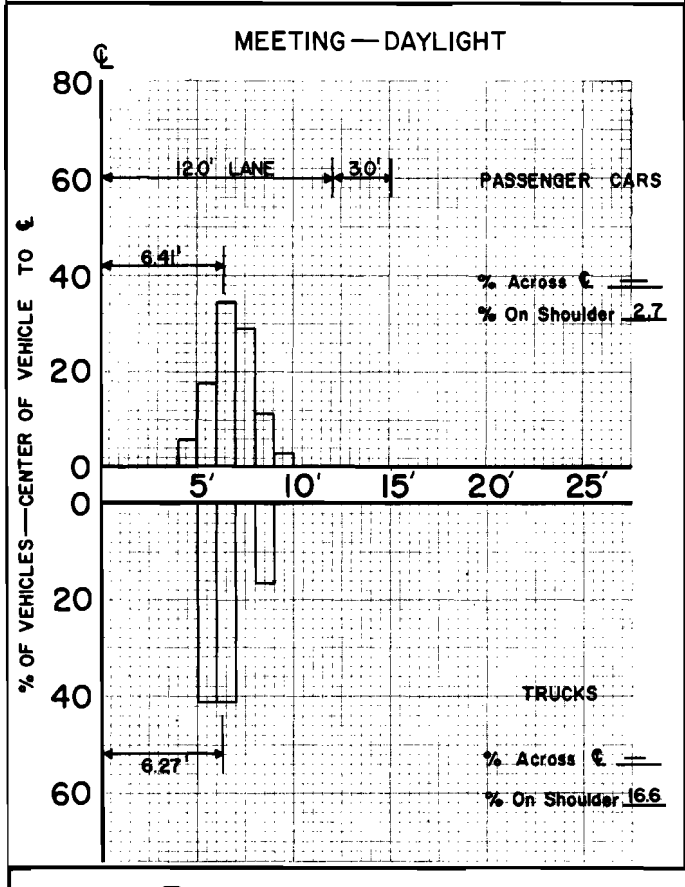
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

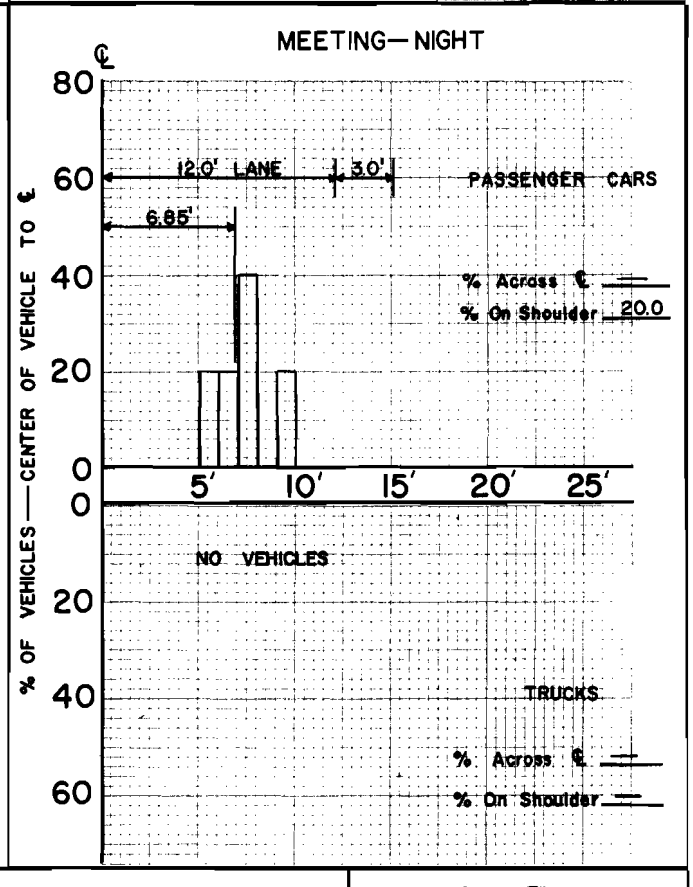
SITE 50-B
APPENDIX 1 PAGE 2
PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department June 1957





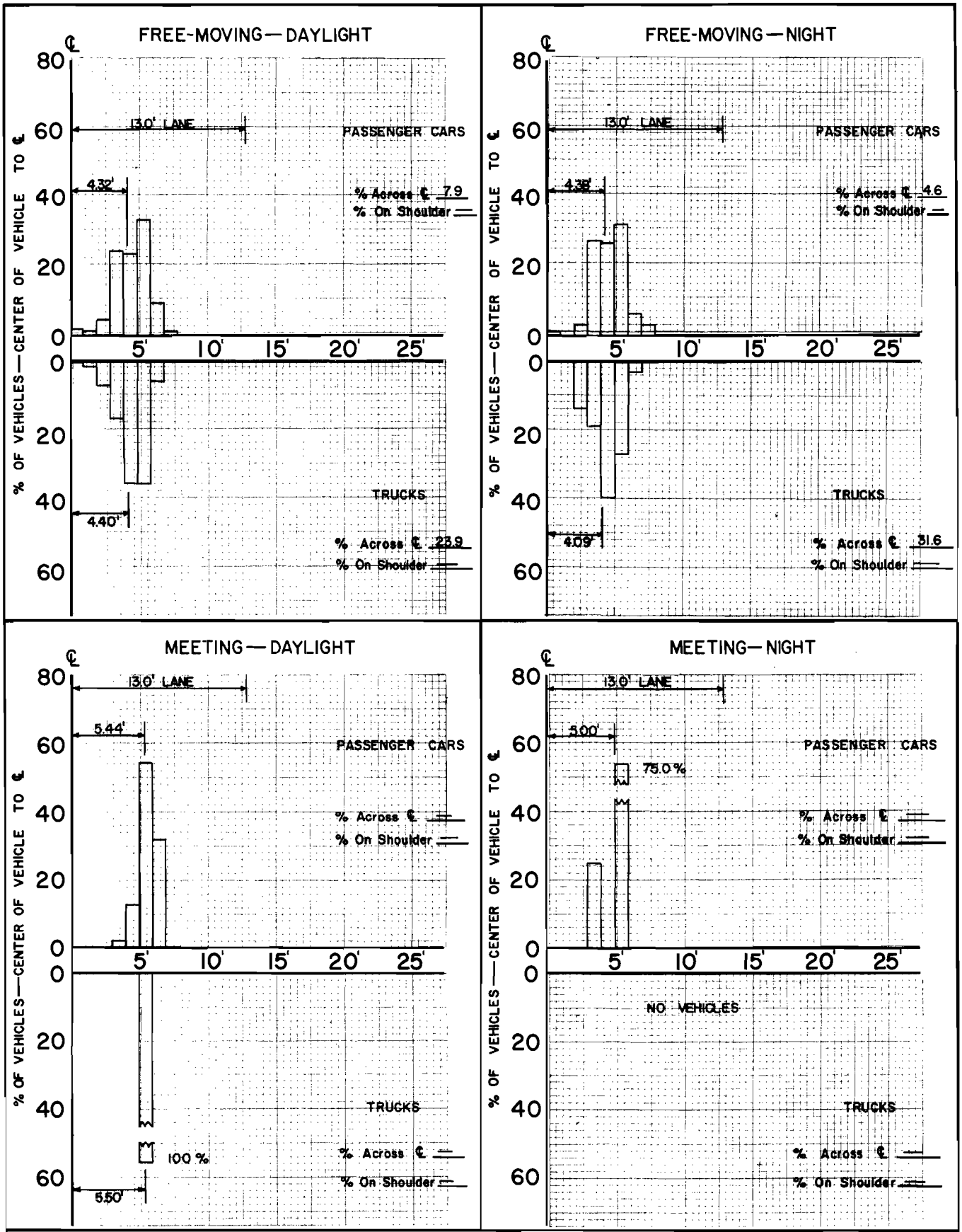




TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 51-A
APPENDIX I PAGE 3
PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department June 1957



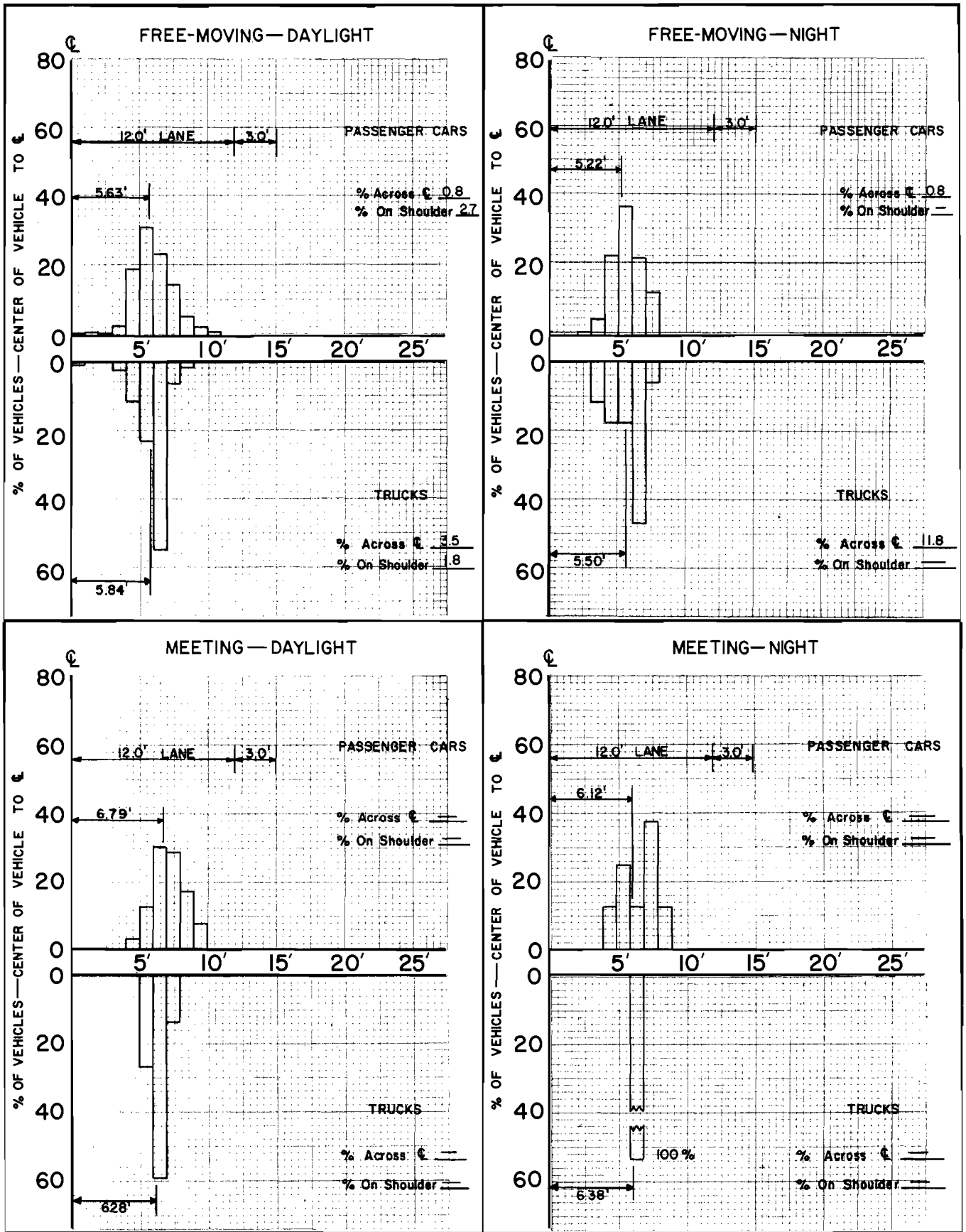
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 51-B

APPENDIX I PAGE 4

PLACEMENT BAR CHARTS

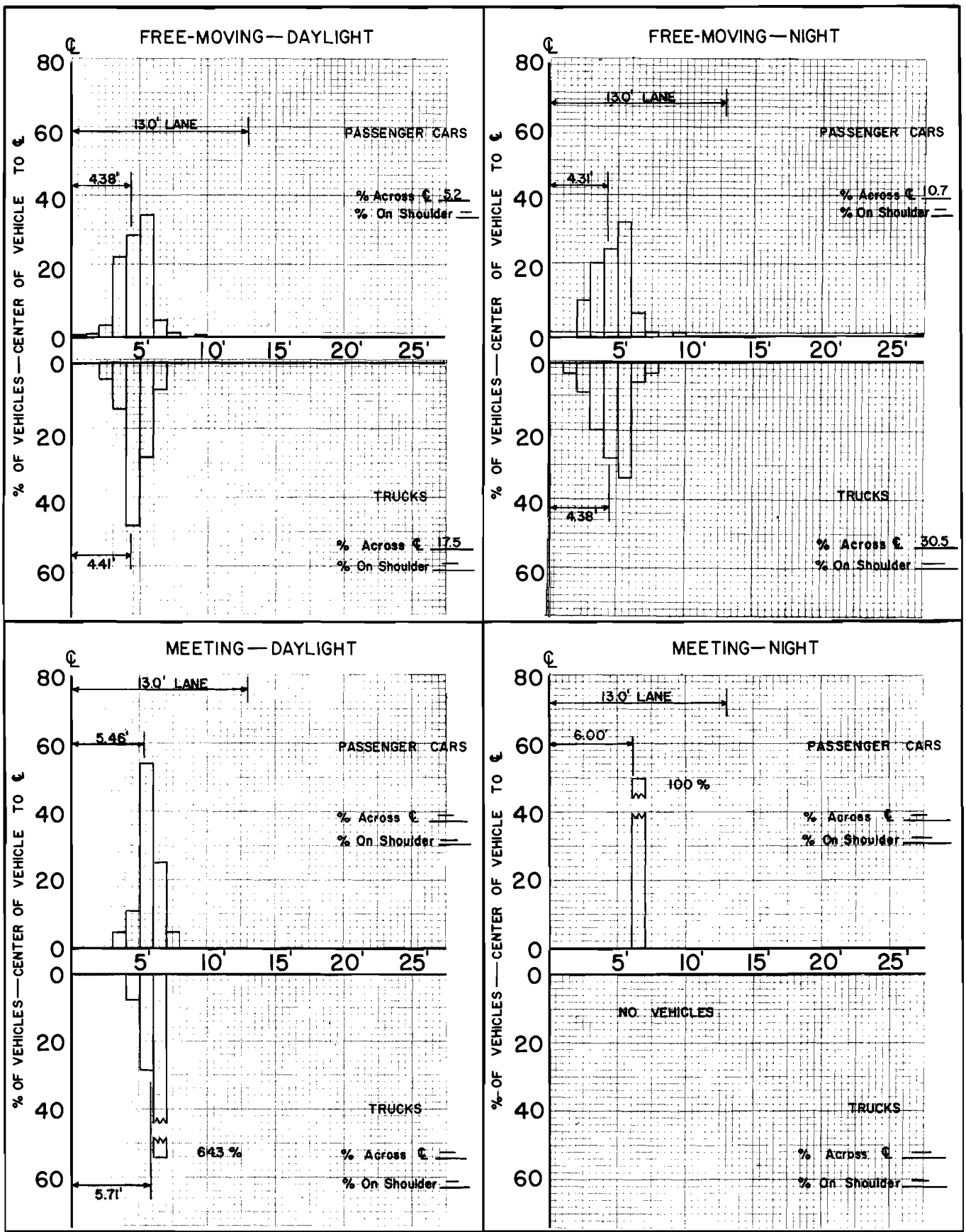
Road Design Division Texas Highway Department June 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 52-A
APPENDIX I PAGE 5
PLACEMENT BAR CHARTS

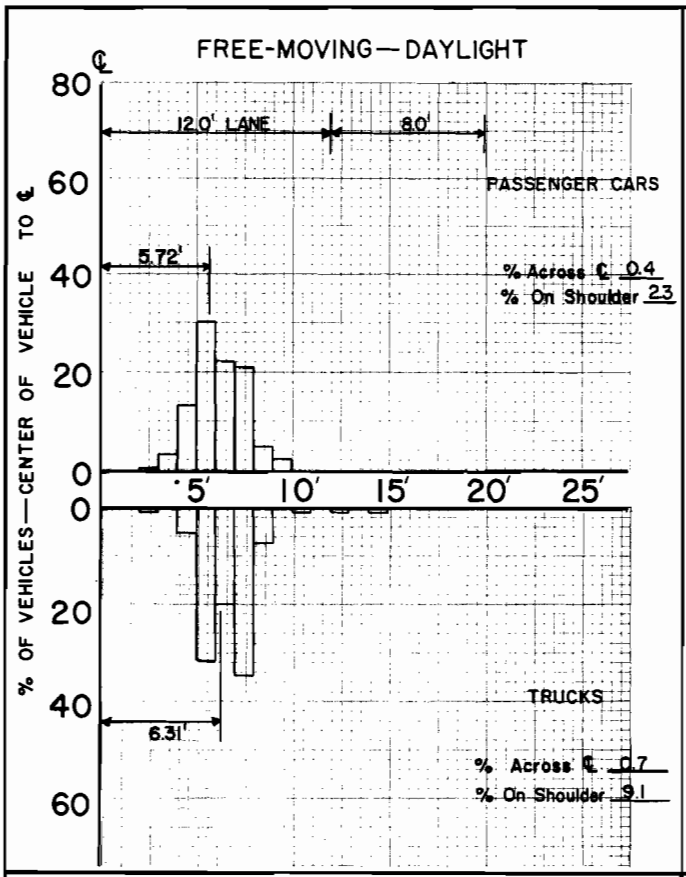
Road Design Division Texas Highway Department June 1957

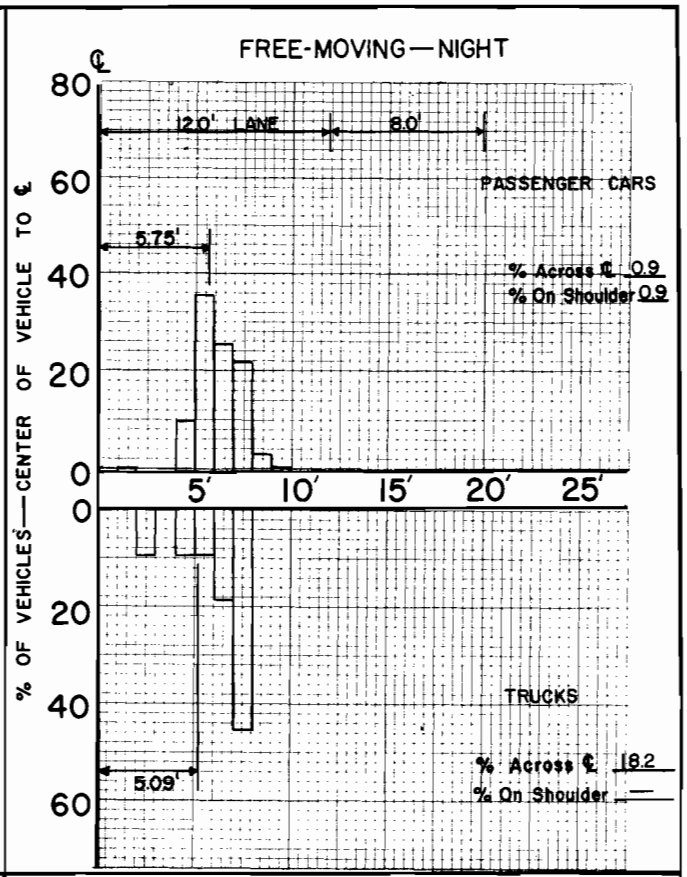


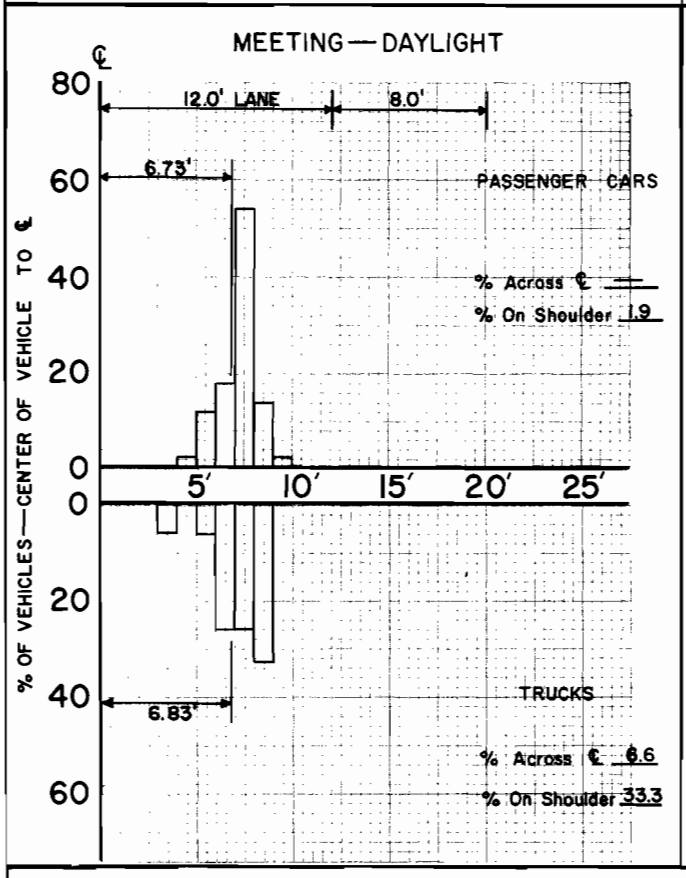
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

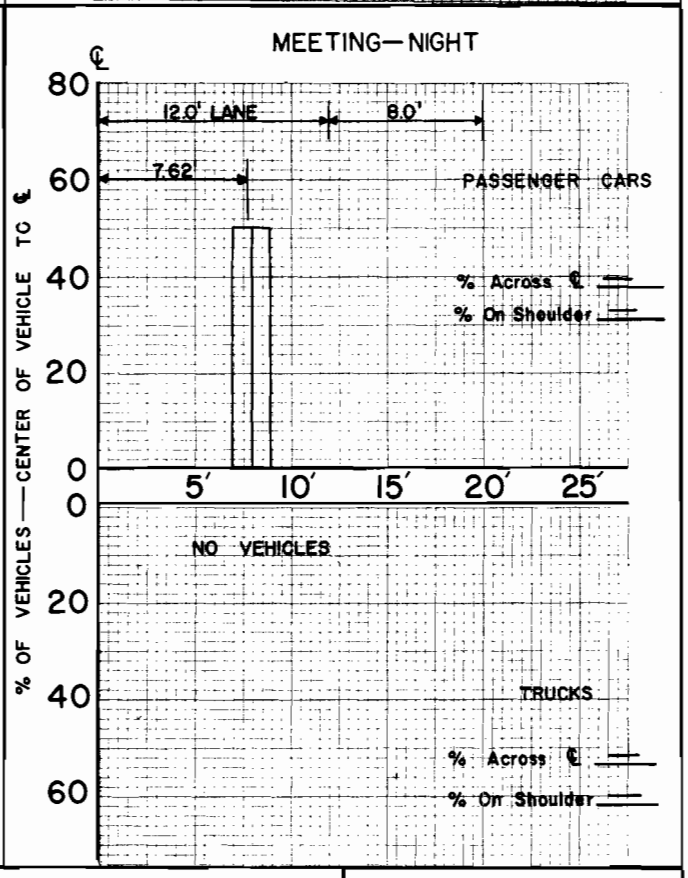
Road Design Division Texas Highway Department June 1957

SITE 52-B
APPENDIX I PAGE 6
PLACEMENT BAR CHARTS









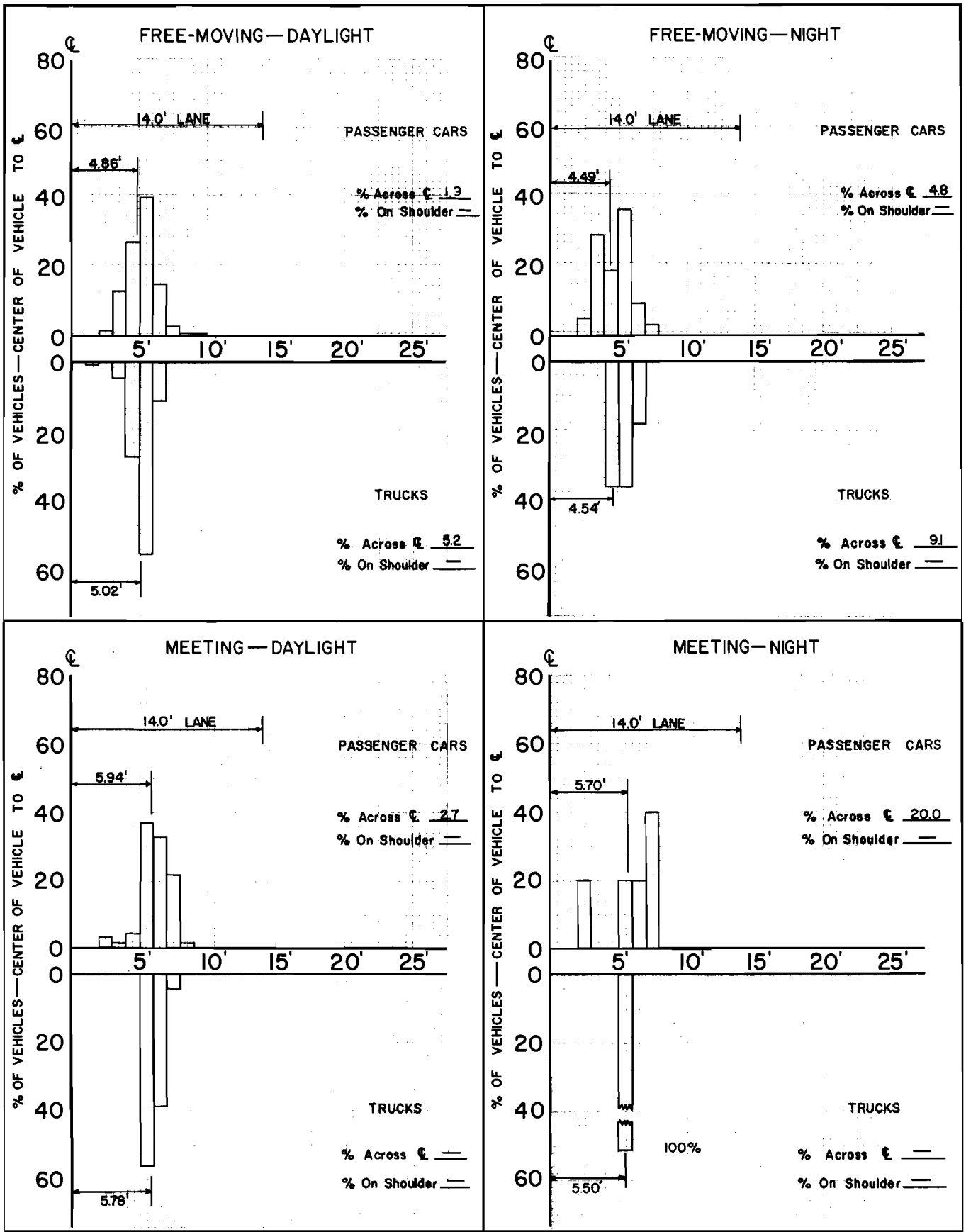
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 53-A

APPENDIX I PAGE 7

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department June 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

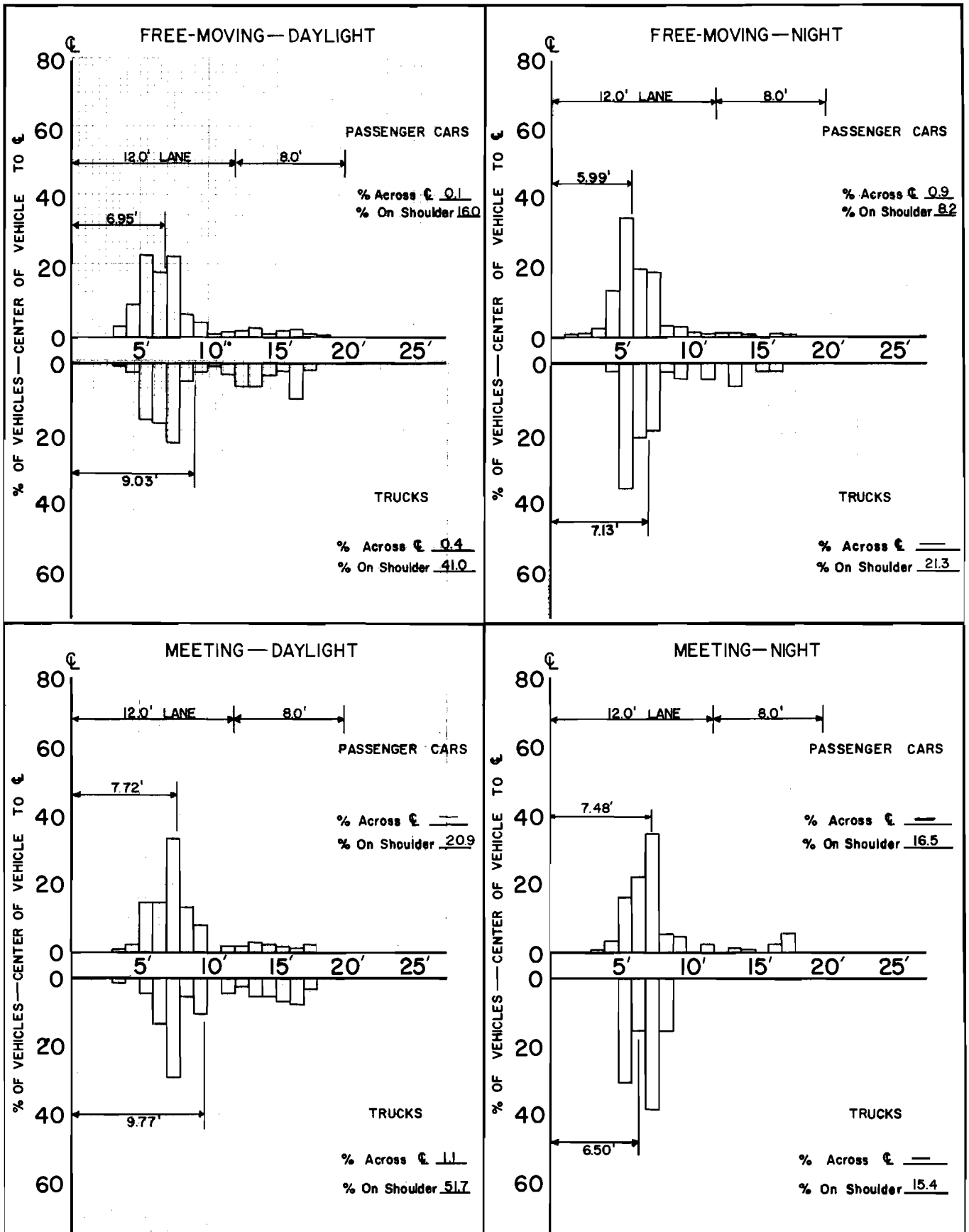
SITE 53-B

APPENDIX I PAGE 8

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department

June 1957

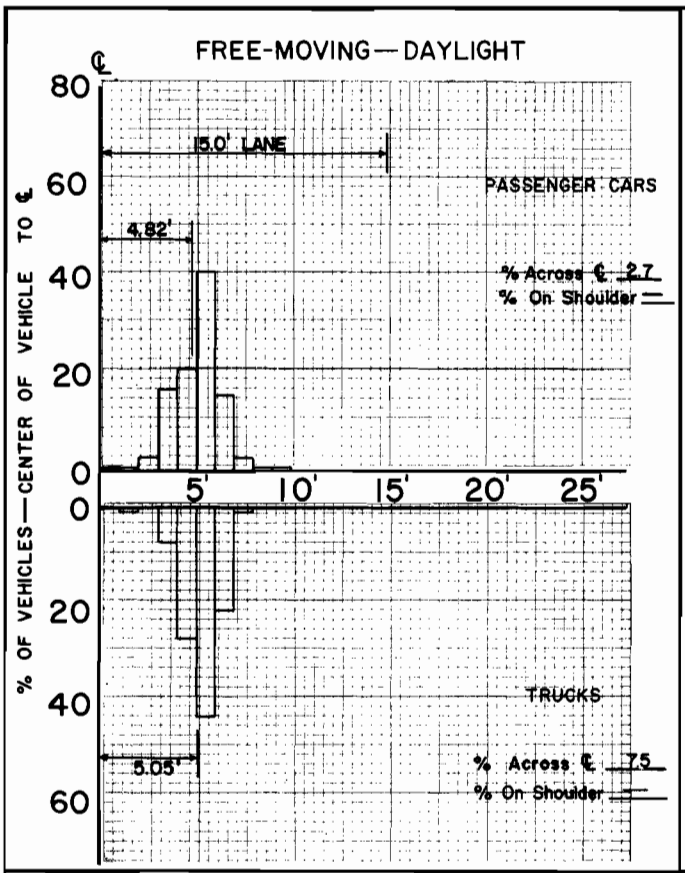


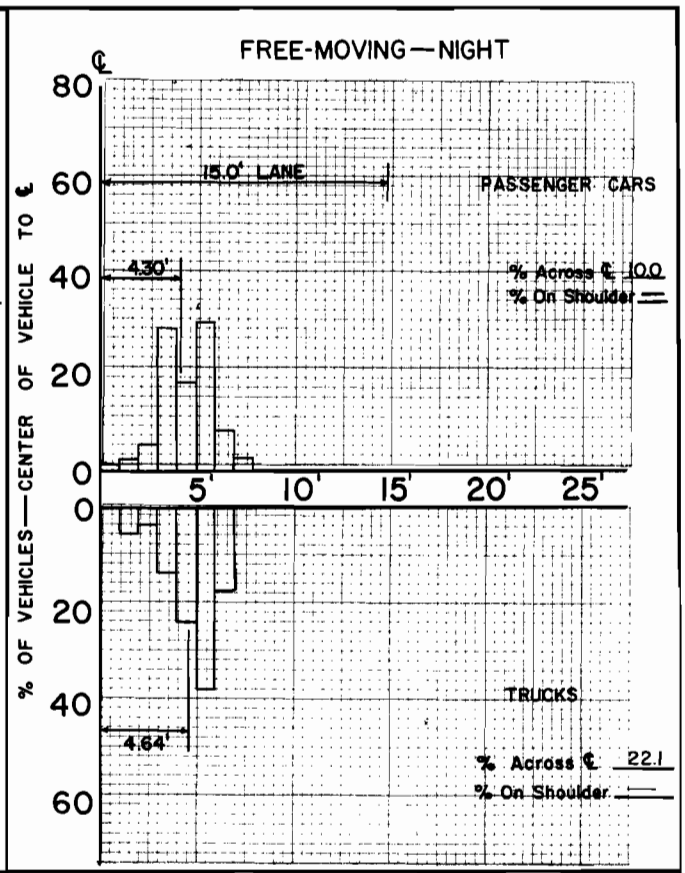
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

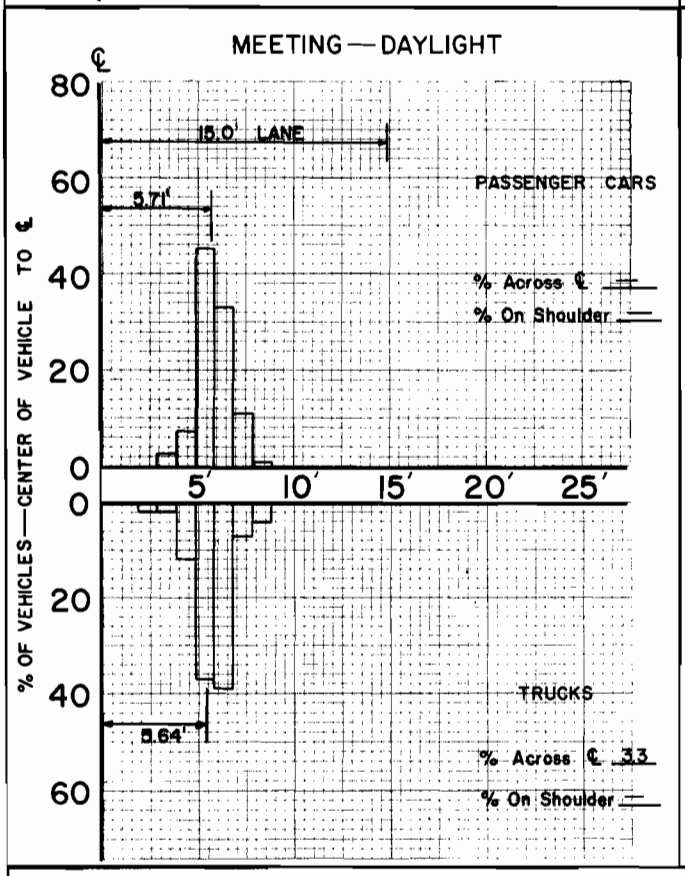
SITE 54-A
APPENDIX I PAGE 9
PLACEMENT BAR CHARTS

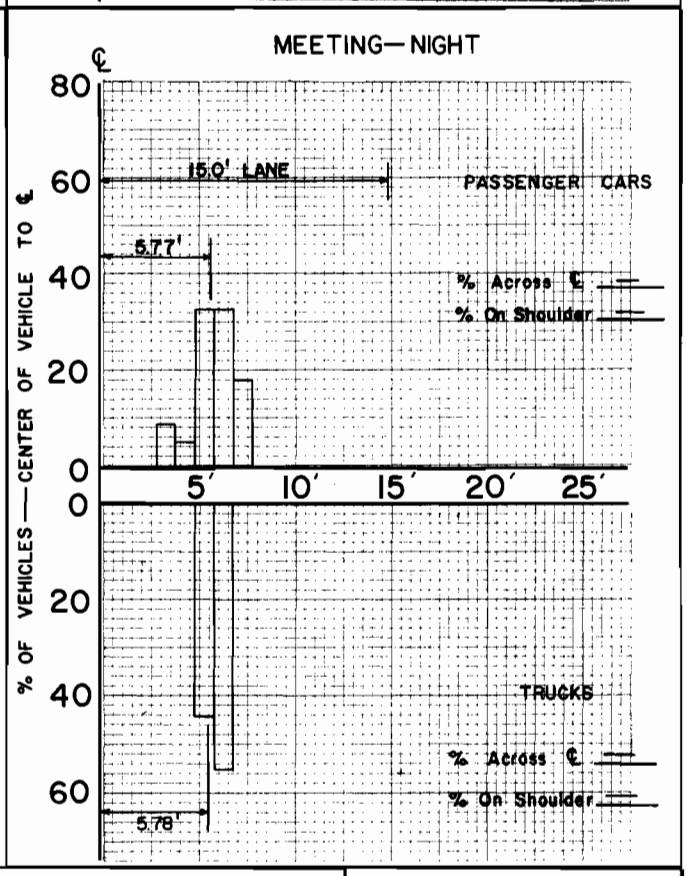
Road Design Division Texas Highway Department

June 1957









TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

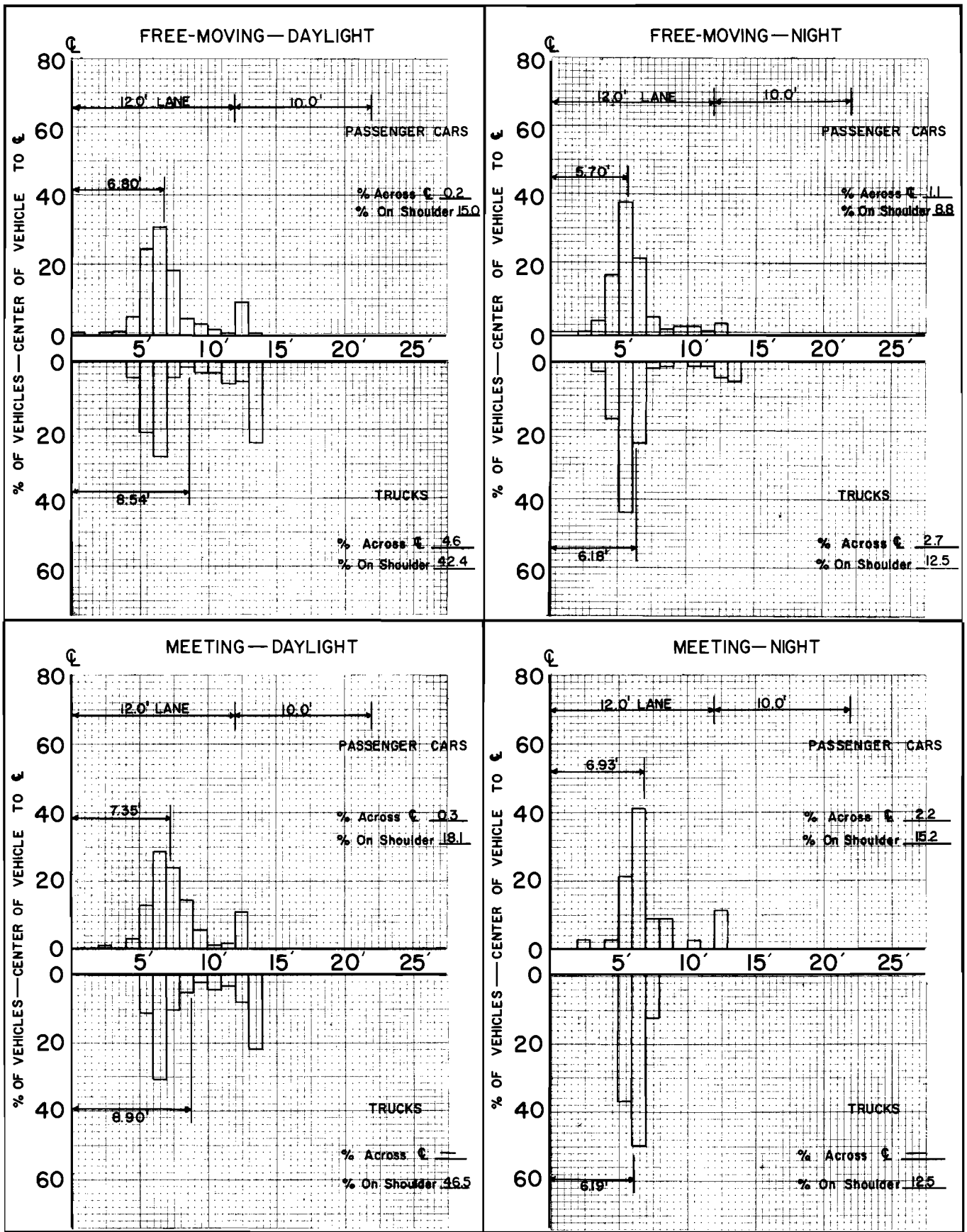
SITE 54-B

APPENDIX I PAGE 10

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department

June 1957



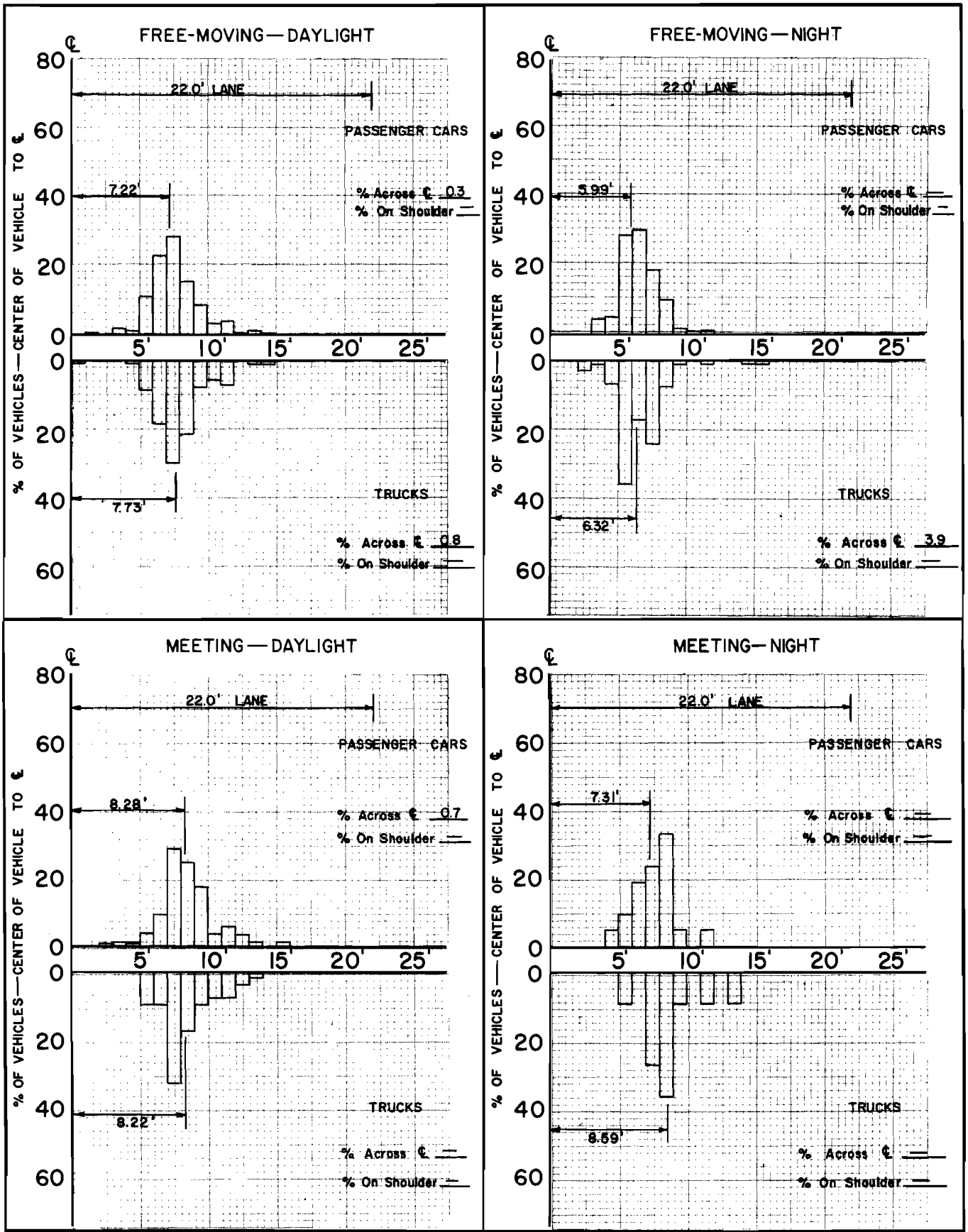
TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 55-A

APPENDIX I PAGE 11

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department June 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

SITE 55-B

APPENDIX I PAGE 12

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department

June 1957

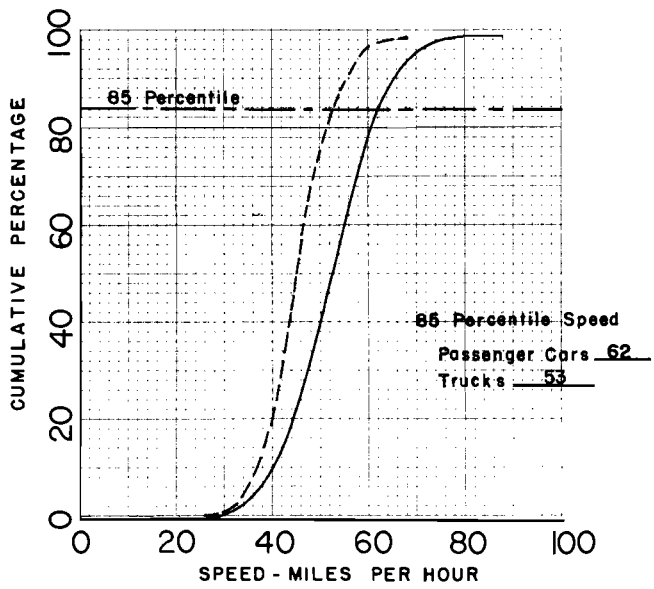
SITE 50-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

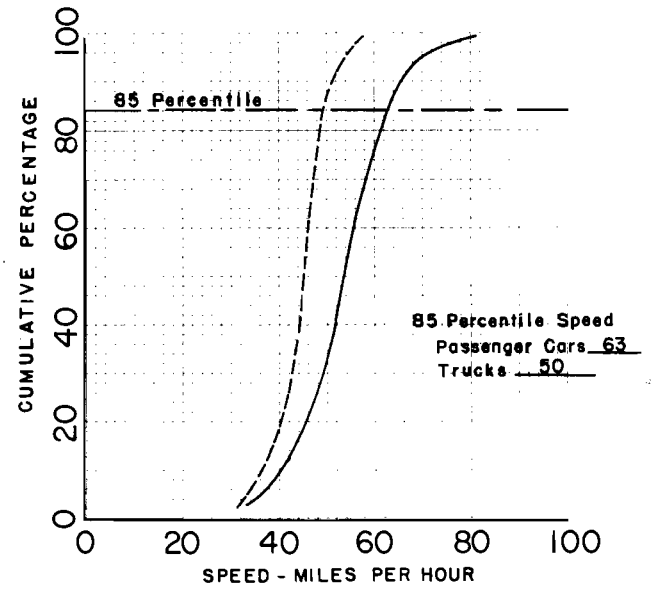


NIGHT

LEGEND

Passenger Cars

Trucks



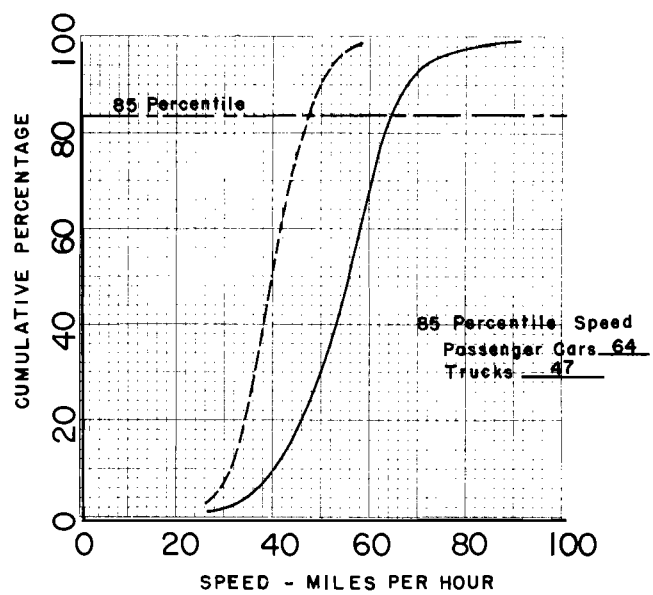
SITE 51-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

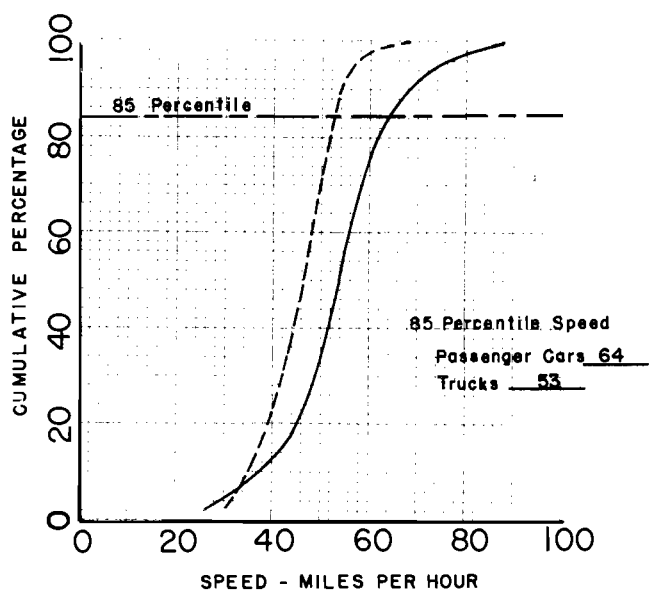


NIGHT

LEGEND

Passenger Cars

Trucks



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

CUMULATIVE SPEED CURVES

Road Design Division Texas Highway Department June 1957

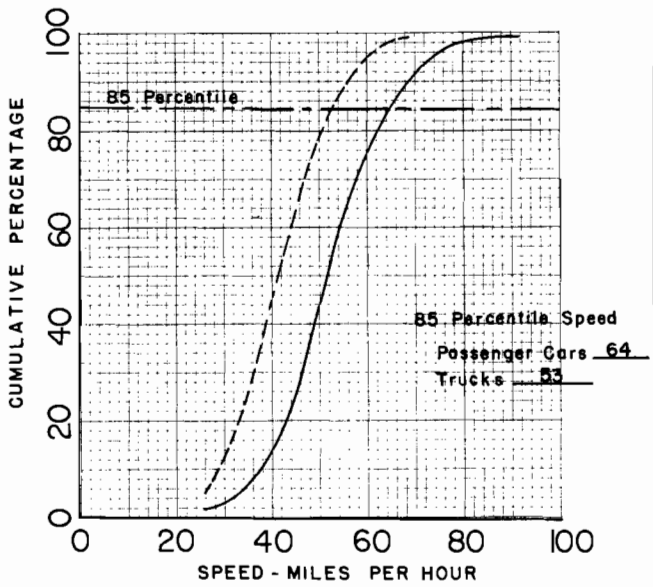
SITE 52-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

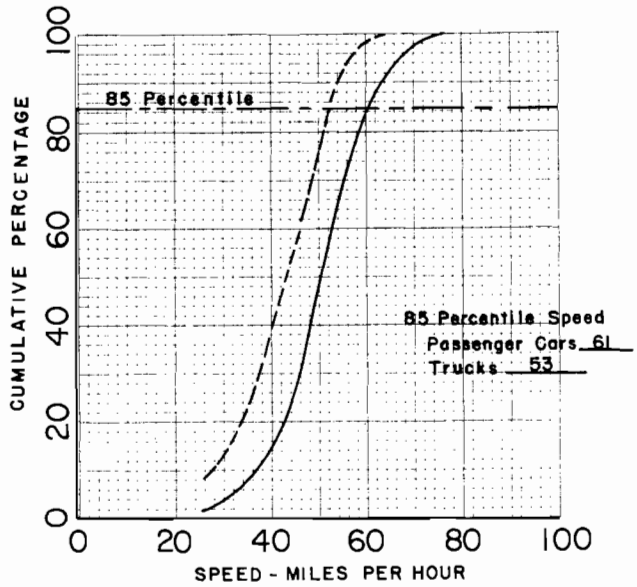


NIGHT

LEGEND

Passenger Cars

Trucks



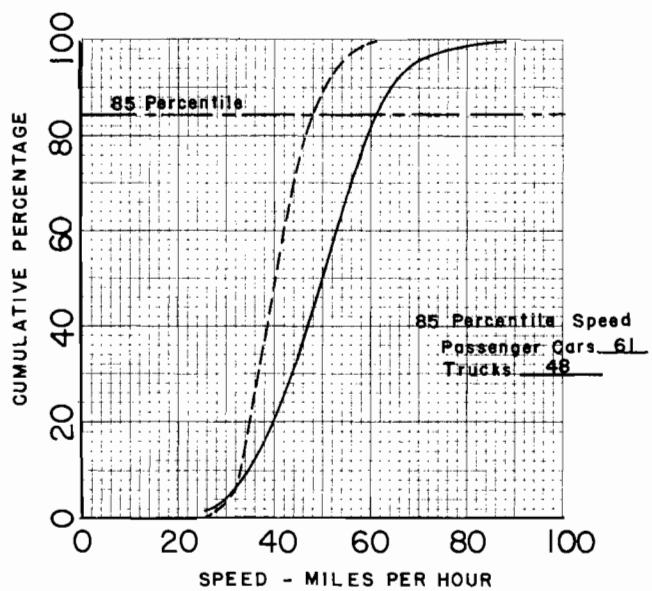
SITE 53-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

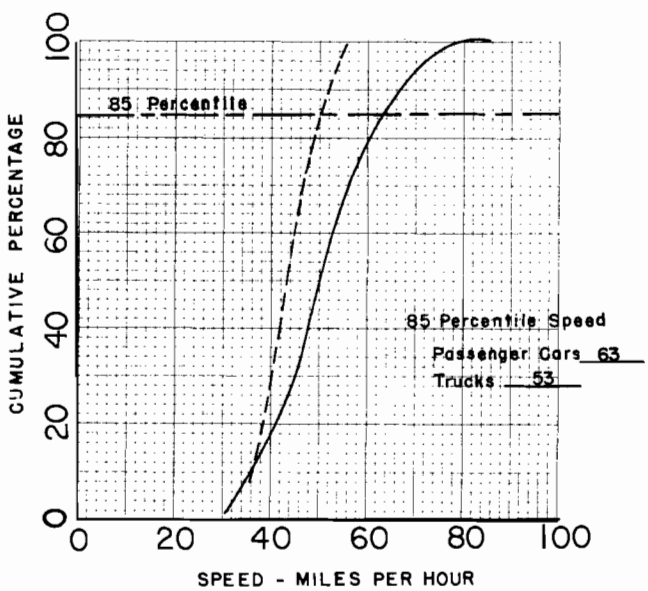


NIGHT

LEGEND

Passenger Cars

Trucks



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

CUMULATIVE SPEED CURVES

Road Design Division Texas Highway Department June 1957

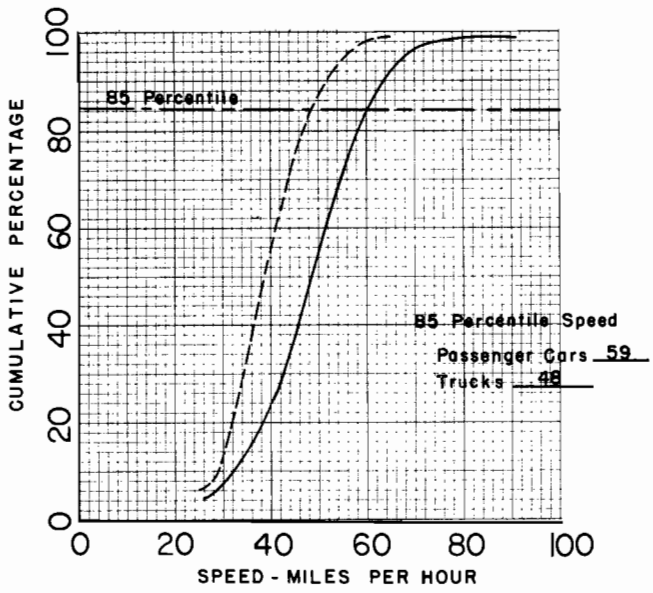
SITE 54-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

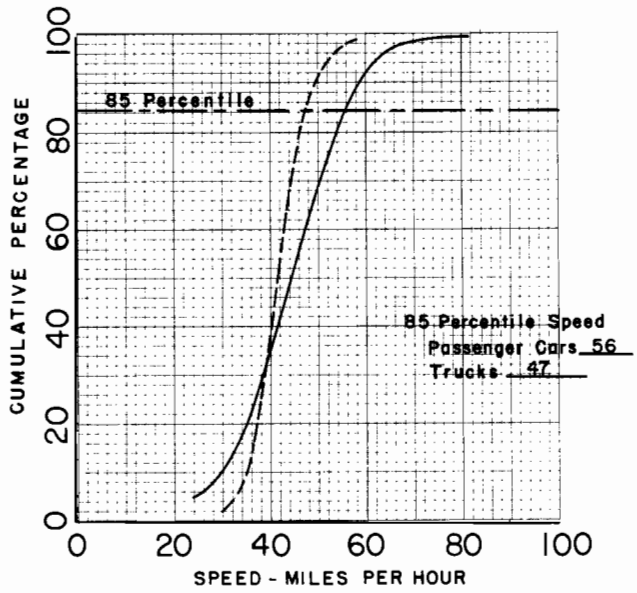


NIGHT

LEGEND

Passenger Cars

Trucks



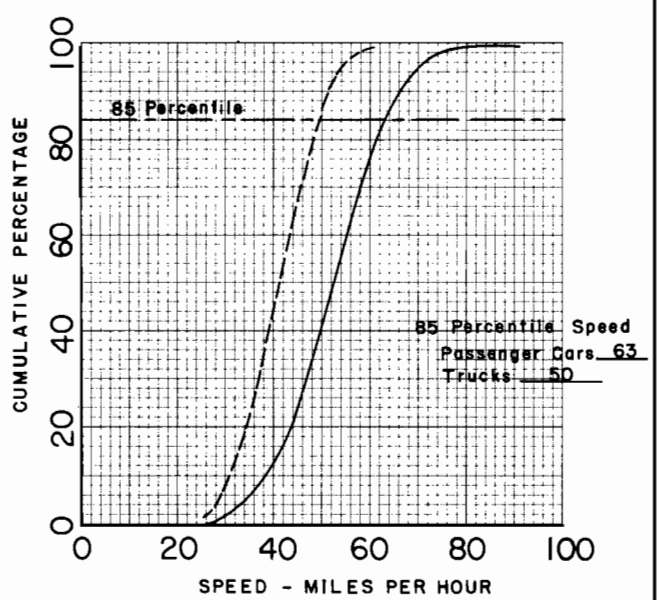
SITE 55-A

DAYLIGHT

LEGEND

Passenger Cars

Trucks

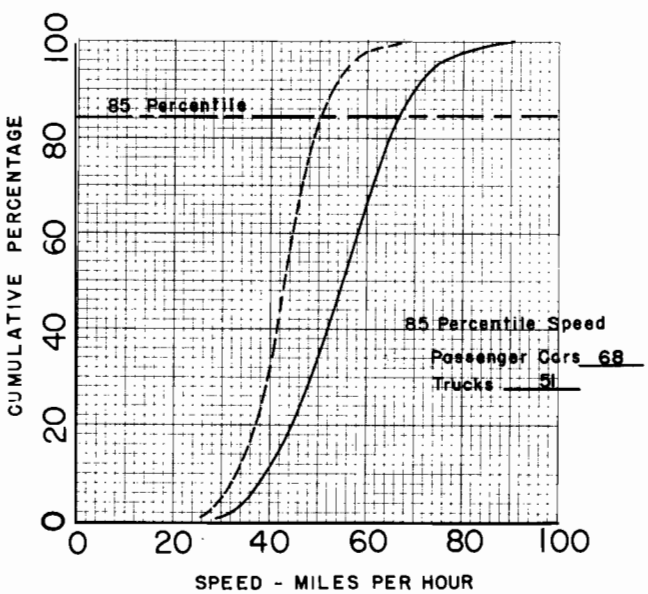


NIGHT

LEGEND

Passenger Cars

Trucks



TRAFFIC BEHAVIOR ON TWO-LANE RURAL BRIDGES IN TEXAS

CUMULATIVE SPEED CURVES

Road Design Division Texas Highway Department June 1957

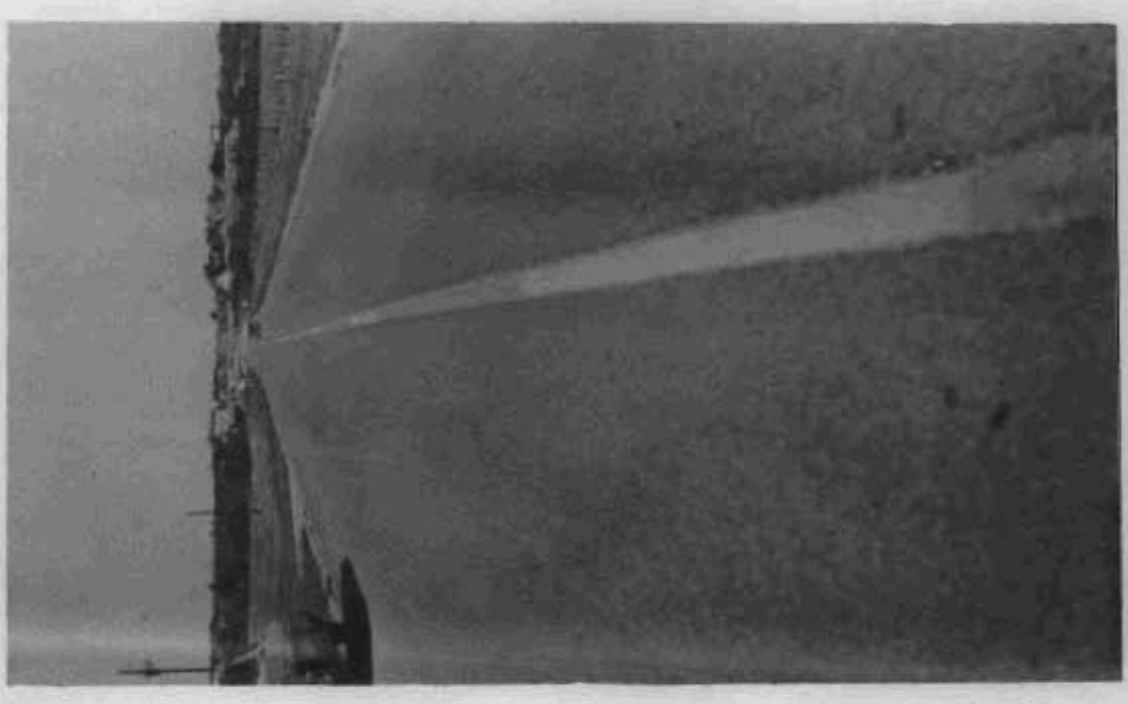
SITE 50-A
LANE WIDTH 12.0'
SHOULDER WIDTH 8.0'
SHOULDER TYPE SEALED

SITE 50-B
BRIDGE LANE WIDTH 12.0'

TRAFFIC BEHAVIOR ON BRIDGES AND TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF BRIDGE SITES
APPENDIX 3 PAGE 1

Road Design Division Texas Highway Department June 1957



SITE 51-A
LANE WIDTH 12.0'
SHOULDER WIDTH 3.0'
SHOULDER TYPE SEALED

SITE 51-B
BRIDGE LANE WIDTH 13.0'

TRAFFIC BEHAVIOR ON BRIDGES AND TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF BRIDGE SITES
APPENDIX 3 PAGE 2

Road Design Division Texas Highway Department June 1957

SITE 53-A
LANE WIDTH 12.0'
SHOULDER WIDTH 8.0'
SHOULDER TYPE SEALED

SITE 53-B
BRIDGE LANE WIDTH 14.0'

TRAFFIC BEHAVIOR ON BRIDGES AND TWO-LANE RURAL HIGHWAYS IN TEXAS

Road Design Division Texas Highway Department June 1957

SITE 54-A
LANE WIDTH 12.0'
SHOULDER WIDTH 8.0'
SHOULDER TYPE SEALED

SITE 54-B
BRIDGE LANE WIDTH 15.0'

TRAFFIC BEHAVIOR ON BRIDGES AND TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF BRIDGE SITES

Road Design Division Texas Highway Department June 1957

SITE 55-A
LANE WIDTH 12.0'

SHOULDER WIDTH 10.0'
SHOULDER TYPE SEALED

SITE 55-B

BRIDGE LANE WIDTH 22.0'

TRAFFIC BEHAVIOR ON BRIDGES AND TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF BRIDGE SITES

Road Design Division Texas Highway Department June 1957