THE EFFECT OF VARIOUS TYPES OF MEDIAN DIVIDERS ON THE LATERAL POSITIONING OF CARS

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One of the generally accepted good design practices in highway engineering is the provision of a median or center divider between opposing lanes of traffic in a multi-lane highway. The most heavily traveled modern highways are being built with these center dividers.

Highways constructed with median dividers reduce the danger of head-on collisions and side-swipes between opposing lanes of traffic. They provide protection for left hand turning movements and a safety zone for pedestrians who must cross the highway.

Among highway engineers there is quite a variance of opinion regarding the effectiveness of the different types and widths of dividers and of the advantages of the curbed vs. non-curbed sections. Technical questions have risen as to the use of the wall type separators and of the proper widths of the two lanes.

In the spring of 1950, the New York State Department of Public Works, in cooperation with the United States Bureau of Public Roads, initiated a research program in an attempt to add to the fund of knowledge on vehicle operation as it relates to highway design. It was agreed that one of the first subjects for investigation would be the study of median dividers in relation to their effect on positioning of free moving passenger cars.

The Long Island Parkway System offered an unusually fertile field for conducting such tests, presenting a variety of highway characteristics and types of medians.

LOCATION PLAN

Representatives of the New York State Department of Public Works and the United States Bureau of Public Roads selected 18 locations for the tests. Each location had a site condition different from the others, some were on tangents and others on curves of varying radii. Six different types of median dividers were represented. Figure 1 shows the general locations of the tests.

Photographs of Test Areas - Photographs of the parkway system in the vicinity of the test locations, (Figs. 2-7), show the character of the roadways and countryside through which the roadways pass. All of the parkways are limited access-ways with no entrance permitted from the adjacent property. Commercial vehicles are prohibited from using the parkway system.

Tests 1, 2, 13, 13A, 14, 15, 16 and 17 were located just inside the New York City corporation line. The remaining tests were located outside the city area in Nassau County. The legal speed limit within the city is 35 m.p.h. and outside 40 m.p.h.

The Parkway System carries heavy traffic to and from New York City with peak hours occurring not only during the normal rush hour periods in the morning and evening, but all during the day, especially in the summer, servicing the millions of people traveling to the Long Island beaches.

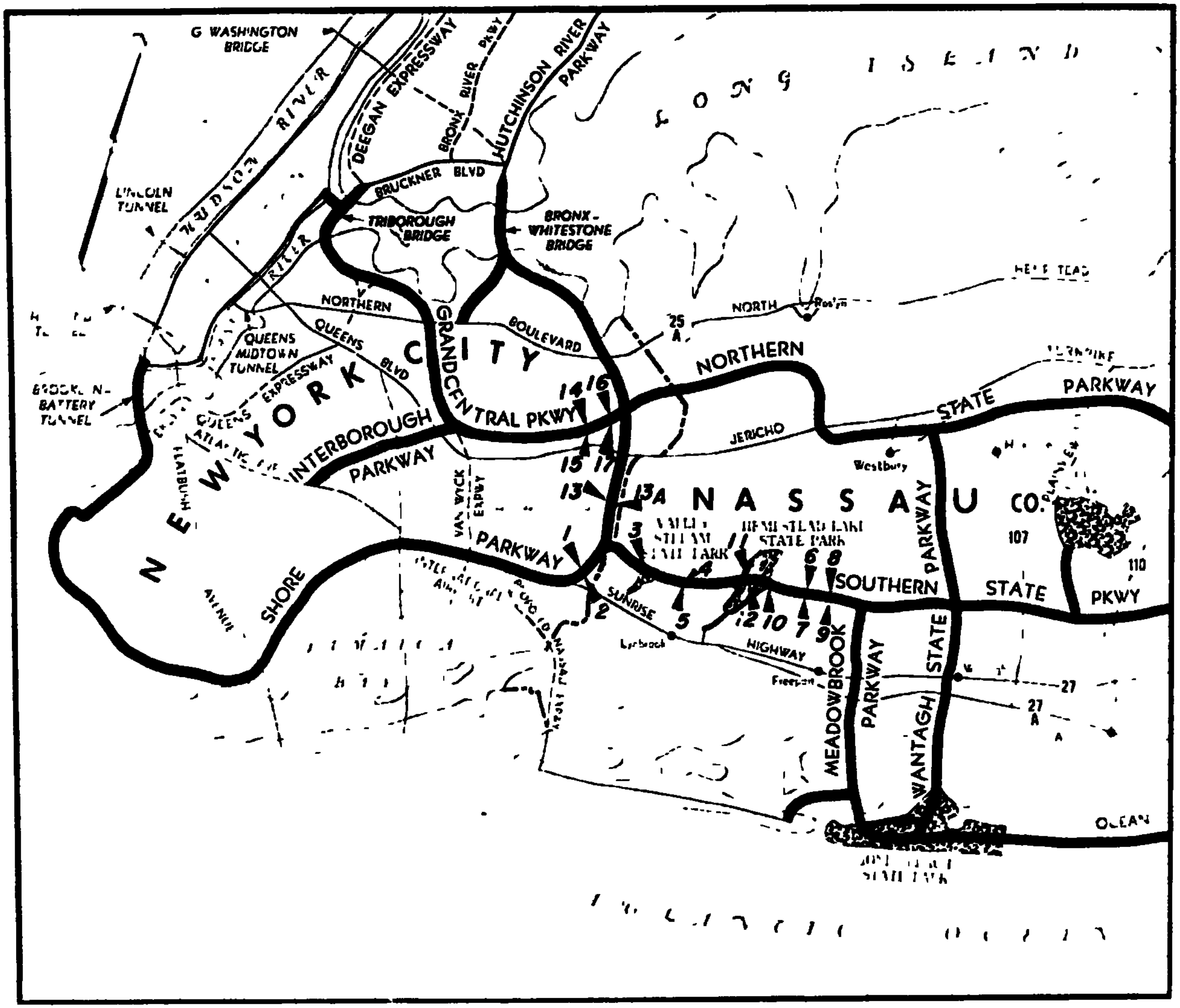


Figure 1. Location of Tests on Median Traffic Dividers

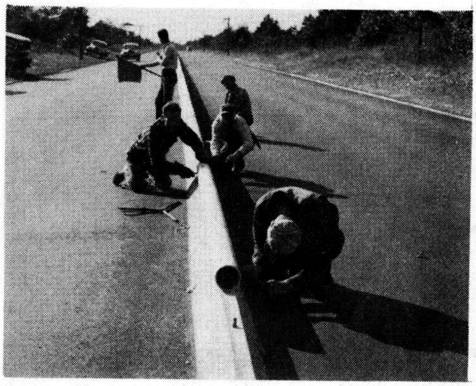


Figure 2. Concrete Wall with Pipe

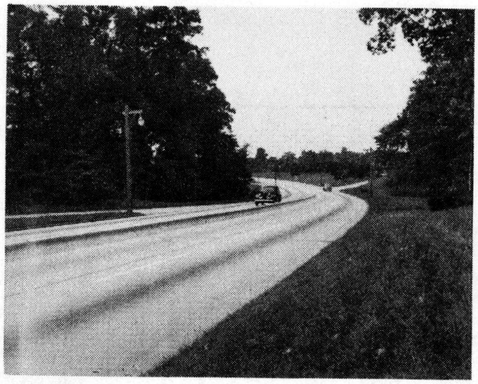


Figure 5. Grand Central Parkway
Concrete Parabolic Divider

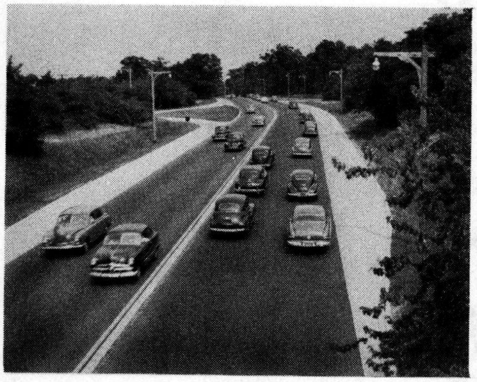


Figure 3. Southern State Parkway
Concrete Wall with Pipe

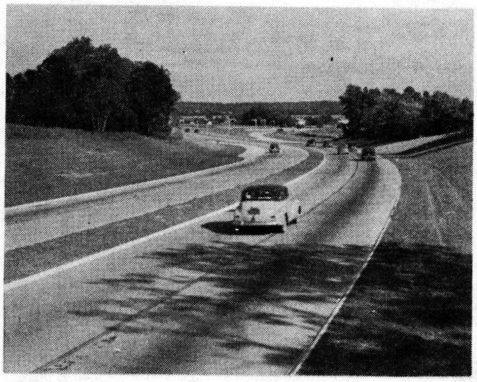


Figure 6. Northern State Parkway
Divided Pavement 9 ft. Center
Mall, 13 ft. Passing Lanes
and 12 ft. Outside Lanes

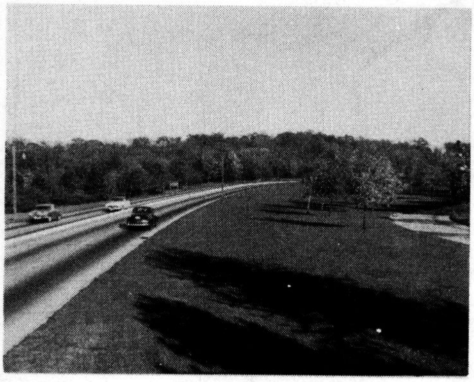


Figure 4. Grand Central Parkway
Concrete Center Divider

TYPES OF MEDIAN TRAFFIC DIVIDERS

Figure 8 shows the six types of median traffic dividers in use on the Long Island Parkway System. Some of the highways under test were originally constructed without wall dividers of any type. Subsequently, the narrow-wall type divider was superimposed upon many miles of pavement to afford a physical separator (See 1, 2 & 3, Figure 8). In 1949, the last of the contracts were let for the construction of the narrow concrete wall (See 1, Fig. 8) with pipe mounting, on the remaining portions of the Parkway System where no physical separator of any type existed.

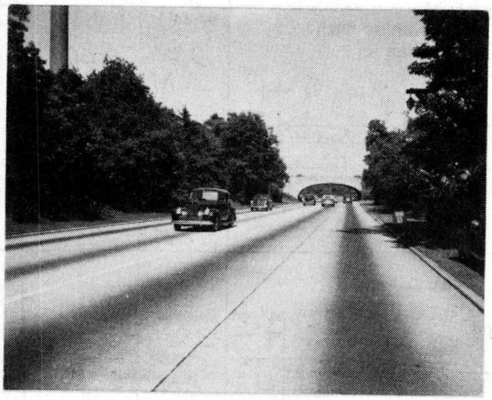


Figure 7. Southern State Parkway 6-in. Paint Line Divider

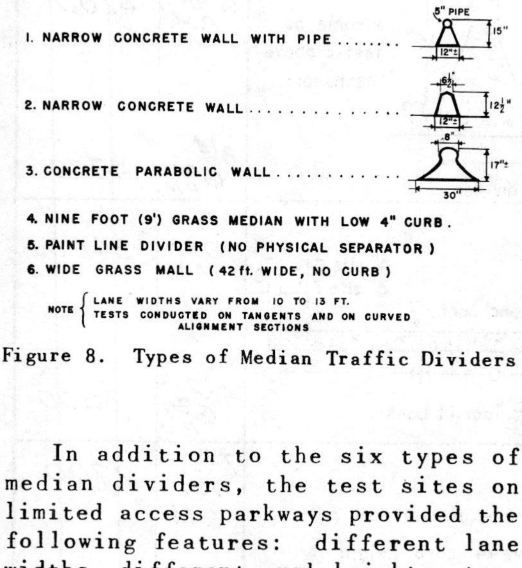


Figure 8. Types of Median Traffic Dividers

In addition to the six types of median dividers, the test sites on limited access parkways provided the following features: different lane widths, different curb heights, tangent and curved roadway alignment, wide variation in traffic volumes, flat grades, elimination of the effects of all type commercial vehicles and marginal interference. These features are shown in detail in Table 1.

CONDUCTING THE TESTS

Tests were conducted during the daylight hours in the month of July 1950, and a record made of approximately 85,000 cars. Each test ran for a period of about 3 hours.

Tests which are grouped together such as 1 and 2, 4 and 5, etc., were taken at the same point on the highway but on the opposing roadway lanes (Table 1). Eight of the tests were taken on curves the sharpest of which was 7.8 deg. (R=735 ft.).

Test equipment was set up in the morning just before the home-to-work movement and data recorded for the 3-hr. period. The equipment was then picked up and set in a new test location later in the day so as to record the work-to-home peak hour movement.

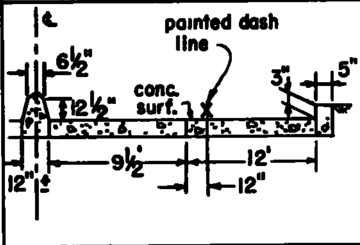
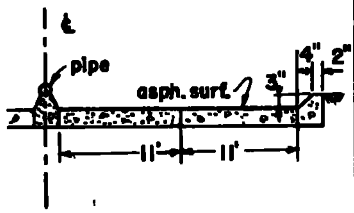
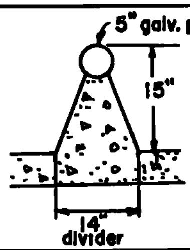
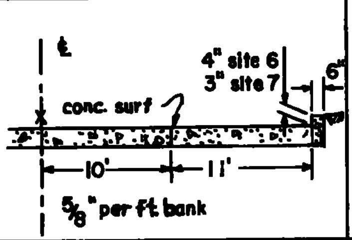
Test Equipment - The portable truck mounted test equipment furnished and operated by the United States Bureau of Public Roads recorded the volume, speed and placement of cars in the two lanes.

A brief description of the equipment and method of recording the data is outlined as follows:

Speed - Rubber air tubes were fastened to the pavement, 20 ft. apart, to record the speeds of vehicles. As the tire passed over the first tube it activated a recording mechanism which was stopped when the tire passed over the second tube. The difference in timing was recorded on an adding machine tape placed in a vehicle which was parked off to one side of the road. In all cases, the location of the equipment and operators in no way influenced the drivers under observation.

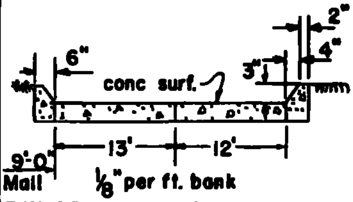
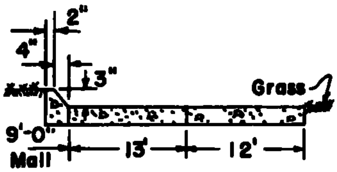
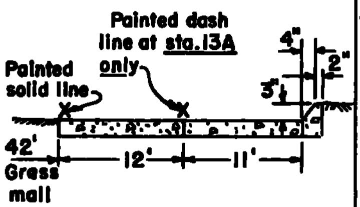
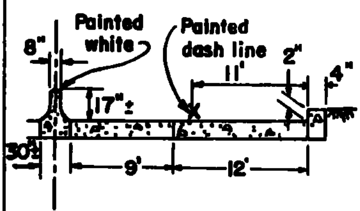
Vehicle Placement - A segmented metal strip in conjunction with a continuous strip was used to determine the lateral position of the vehicle in its lane. Each foot of

TABLE 1
SUMMARY OF FIELD DATA BY TEST SHOWING PAVEMENT CHARACTERISTICS

TEST NO.	ROUTE	NEAR	ALIGN-MENT	DIRECT'N TRAFFIC	HALF CROSS-SECTION LANE 2 LANE 1	TIME	TOTAL VOLUME
1 AND 2	Cross Island Pkwy. N.Y C	Merrick Road N Y C	Tangent 1000'± North 1000'± South	South North		7 15 9 45 A M 2 30 6 00 P.M	4200 5450
3	Southern State Pkwy.	Valley Stream State Park	Curve R=1400'± D=4.1° L=845'	West (Rt.		3 00 5 00 P.M.	3800
4 AND 5	Southern State Pkwy.	Hempstead Avenue	Tangent 500' East 300' West	West East	 same as test 3 above asph. surf.	2 15 6 00 P.M 3 15 6 00 P.M.	4200 4700
6 AND 7	Southern State Pkwy.	Baldwin Road	Curve R=735' D=7.8° L=760'	(Rt. West East) Lt.		7 15 10 00 A M 4 15 6 30 P.M	3400 3600
8 AND 9	Southern State Pkwy.	Baldwin Road	Tangent 375'± WEST 325'± EAST	West East	same as test 6 & 7 above 4" curb height	7 30, 9 30 A M. 2 15 5 30 P.M.	2700 3900

ALL TESTS (1-17) WERE TAKEN WEEKDAYS MONDAY THRU FRIDAY DURING JULY 1950.

TABLE 1 (Continued)
SUMMARY OF FIELD DATA BY TEST SHOWING PAVEMENT CHARACTERISTICS

TEST NO.	ROUTE	NEAR	ALIGN-MENT	DIRECT'N TRAFFIC	HALF CROSS-SECTION LANE 2 LANE 1	TIME	TOTAL VOLUME
10	Southern State Pkwy.	Hempstead Park	Curve R=3100' D=1.85° L=1000'	Rt. East		2^{15} 5^{30} P.M.	3500
11 AND 12	Southern State Pkwy.	Hempstead Park	Tangent 600'± EAST 1000'± WEST	West East		7^{00} 10^{00} A.M. 2^{30} 5^{45} P.M.	6800 4000
13 AND 13A	Cross Island Pkwy.	South of Belmont Park	Tangent 3200'± NORTH 3200'± SOUTH	South North		3^{00} 6^{00} P.M. 7^{00} 10^{00} A.M.	4600 4200
14 AND 15	Grand Central Pkwy	Hillside Park N.Y.C.	Curve R=2500 D=2°± L=850'	Rt. West East Lt.		7^{00} 10^{00} A.M. 3^{40} 6^{00} P.M.	6900 5100
16 AND 17	Grand Central Pkwy	Union Turnpke	Curve R=4200' D=1.25°± L=1200'	Rt. West East Lt.	Same as test 14 & 15 above	7^{00} 10^{00} A M. 3^{00} 6^{00} P.M.	5800 5300

ALL TESTS (1-17) WERE TAKEN WEEKDAYS MONDAY THRU FRIDAY DURING JULY 1950.

the segmented strip contained a 7½ in. "live" or recording section and a 4½ in. "dead" or non-recording section. As the tire passed over the "live" section it made contact with the continuous strip and its position was registered on the adding machine tape located in the nearby recording vehicle. The accuracy of the recordings has been found to be correct within 0.25 ft.

The details of the equipment are described in the Bureau of Public Roads magazine for April, 1940.

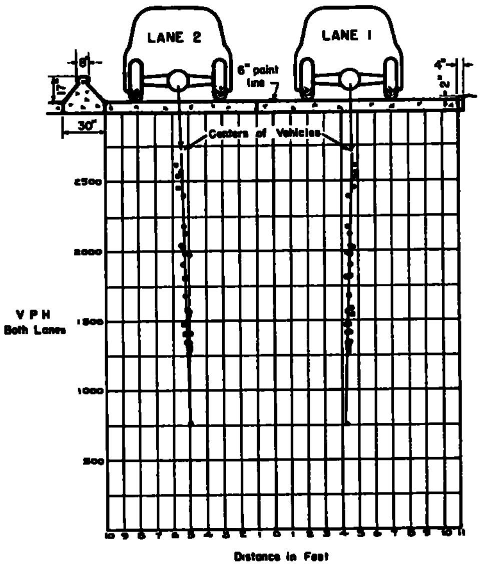


Figure 9. Typical Plotting of Field Data

DEVELOPMENT OF THE BASIC DATA

The field data was sorted out by one tenth of an hour or 6-minute time intervals and the average placement vs. volume for each of these 6-minute periods was plotted on a graph for each lane.

Figure 9 shows a typical pattern of the plottings for a test. Similar plates were prepared for each individual test and in all cases the plotted points were found to follow a straight line variation. The points in the graph were studied and the mean straight line variation between placement and volume drawn.

Referring to Figure 9 it will be noticed that the two lines are not parallel indicating that cars travel further apart or closer to the pavement edges as the volumes increase.

During the tests the volumes in the two lanes ranged from about 500 to 2700 V.P.H. In order to make a comparison of the effect of the different types of medians, it was necessary to make an analysis of the various tests at the same traffic volume. Table 2 shows the tabulation of this analysis. The average position of all cars at 1500 V.P.H. is indicated.

Examination of Table 2 shows the various tests grouped according to type median. Tests 3, 6, and 7 are isolated to show the effect of relatively sharp horizontal curvature. The average positioning of cars by type median are related by the symbol "X", the distance from the edge of the center median to the near side of the cars in lane 2; by the symbol "Y", the lateral distance between cars, and by the symbol "Z", the distance from the outside edge of the cars in lane 1 to the right hand curb or edge of pavement. The width of a car has been taken as 6 ft. 3 in.

It should be noted that for all tests except 3, 4 and 5 some type of lane-line, either a painted line or a longitudinal joint or both existed between lanes 1 and 2. For Tests 3, 4 and 5 the roadway surface consisted of an asphalt surfacing over an existing concrete base and no pavement striping had as yet been provided.

DISTANCE FROM MEDIAN DIVIDER "X"

Referring to Table 2 and considering the distance marked "X" we note that Tests 14 to 17 inclusive, show that cars travel closest (1.5 ft.)

TABLE 2
COLLATION OF TESTS WITH TYPE MEDIAN SHOWING AVERAGE PLACEMENT OF CARS AT 1500 V P H

TEST	CURVE	TOTAL WIDTH (LANE NO 2 / 1)	MALL TYPE	X (LANE 2)		Y		Z (LANE 1)	
14	2°	21' (10' / 11')	30"	1.45		3.35		3.60	
15	2°	21' (10' / 11')	30"	1.65	1.5'	3.35	3.3'	3.40	3.6'
16	1.25°	21' (10' / 11')	30"	1.85		3.05		3.50	
17	1.25°	21' (10' / 11')	30"	1.15		3.45		3.80	
8		21' (10' / 11')	6" line	1.85		3.3		3.25	
9		21' (10' / 11')	6" line	2.05	1.95'	3.6	3.45'	2.75	3.2'
1		21½' (10½' / 11')		1.55		3.7		3.65	
2		21½' (10½' / 11')		2.35		3.2		3.35	
13		23' (12' / 11')	42'	2.85	2.65'	4.1	4.4'	3.45	3.35'
13A		23' (12' / 11')	42'	2.45		4.7		3.25	
4		22' no lanes		3.05	2.95'	3.2	3.3'	3.15	3.2' no lane line
5		22' no lanes		2.85		3.35		3.20	no lane line
11		25' (13' / 12')	9'	3.35	3.4'	5.2	4.9'	3.80	4.1' no curb
12		25' (13' / 12')	9'	3.40		4.65		4.35	no curb
6	78°	21' (10' / 11')	6" line	2.70		2.95		2.70	
7	78°	21' (10' / 11')	6" line	1.65		2.65		4.10	
3	41°	22' no lanes		2.80		2.75		3.85	no lane line
10	1.85°	25' (13' / 12')	9'	4.10		4.45		3.80	

to the concrete parabolic wall-type of median. Lane 2 width is 10 ft. These tests were all taken on a curved alignment but it appeared that because of the flatness of the curves no appreciable difference in placement would occur as a result of this curvature. The second grouping combined the 6-in. paint line separator with the narrow concrete wall-type. Lane 2 width is 10 and 10½ ft. This grouping shows an average placement of 1.95 ft. It is to be noted, that for a 10 or 10½-ft. inner lane, cars traveled closer to the concrete parabolic wall-type median than to either the 6-in. paint line or narrow concrete wall-type median. The effect of the gradual curved slope of the concrete parabolic wall-type median apparently influenced the drivers' choice of lateral position.

It should be remembered that in this discussion that distances are related to the edge of and not to the center of the median.

From the other tests it appears that drivers operate somewhat closer (2.65 vs. 2.95 ft.) to a 42-ft. median strip without curbs (Tests 13 and 13A) than to a wall-type (Tests 4 and 5) in spite of the fact that there is a one foot greater width of pavement available on the 42-ft. median section. Going a step further however, it is noted that a decided likeness exists between Tests 1 and 2 and Tests 4 and 5. At these sites there are similar types of dividers with approximately the same roadway widths (21½ vs. 22 ft.). Tests 4 and 5, however, have no lane lines while Tests 1 and 2 do. It is indicated, therefore, that if Tests 4 and 5 had been provided with lane lines, distance "X" would be reduced from 2.95 to 1.95 ft. Based on this indication it can be stated that lane lines apparently cause drivers in Lane 2 to operate their cars closer to a median divider than where no lane lines are provided. (Note different types of curb in test lanes 2, 4 and 5 and variation in 'Z" distances. Effect of type curb not considered here).

Tests 11 and 12 were taken on tangent sections with wide lanes. It is to be expected that this extra space provided by the greater width of lanes and roadway is responsible for the greater distance (3.4 ft.) at which cars travel from the 9-ft. grass mall center divider.

Tests 6 and 7 were taken on a relatively sharp curve (7.8 deg.). If the distance "X" for these two tests is compared with that for Tests 8 and 9, where the conditions are identical except for the alignment, it will be noted that "X" on the section where the alignment curves to the right (Test 6) is 2.7 ft. as compared with 1.95 ft. for the tangent alignment and 1.65 ft. for Test 7 where the alignment curves to the left. Likewise, the distance "Z" is 4.10 ft. where the alignment curves to the left, compared with 2.70 ft. where it curves to the right and 3.0 ft. on tangent sections. It is believed this merely indicates the common tendency of drivers to cut across horizontal curves, and the above recorded distances are a measure of this movement.

LATERAL DISTANCE BETWEEN CARS "Y"

In considering the clearance distance between cars, column Y, Table 2, it is noted that where the roadway widens to 23 and 25 ft., the clearance between bodies of cars is greater than for the relatively narrower pavements. In comparing the tests where pavement widths range from 21 to 22 ft., it will be noted that distance "Y" is slightly less than 3½ ft. For the 23 and 25-ft. pavement sections this distance is 4.4 and 4.9 ft. respectively.

On the relatively sharp curves, represented by Tests 3, 6, and 7, the "Y" distance is less than on similar pavement tangent sections.

A lateral distance of 3 ft. has been determined from previous studies to be the minimum desirable clearance between car bodies of meeting cars.[1] A 3-ft. lateral distance between bodies of cars traveling in the same direction is desirable. This minimum distance was recorded in all tests except Tests 7 and 3. It is thought probable that if the inside lane on Test 7 was increased 1 ft., it would result in a greater lateral distance between the car bodies. No doubt the provision of a lane line in Test 3 would increase the lateral distance between the car bodies to the minimum desirable.

DISTANCE FROM RIGHT EDGE OF ROADWAY "Z"

The distance "Z" remains constant for equal or nearly equal pavement widths regardless of the center median type. In addition, there seems to be no appreciable difference between the "Z" distance on tangent pavement sections with or without lane lines. (Compare "Z" distances for the first four groupings)

The greatest "Z" distance (4.1 ft.) occurs at Test locations 11, 12, and 7. For Tests 11 and 12 this greater distance is undoubtedly caused by the wider lane (12 ft.) and wider pavement width. The 4.1-ft. in Test 7 has been explained above as probably attributable to driver habits

[1]Proceedings of the Highway Research Board, Vol. 27, (1947), pp. 273-280.

on the relatively sharp curves.

INDICATIONS

In running traffic tests, it is usually necessary to accept physical conditions which will not permit an exact evaluation of the unknown factor.

In these tests there were too many variables to permit such a determination of the effect of the six different medians on the placement of vehicles. The variables consist of different widths of roadway and variations in widths and markings between the two lanes of traffic operating in the same direction. An extension of the Long Island tests to other selected locations which would have suitable site conditions would supply necessary data to permit the drawing of more definite conclusions.

From the information available in these tests, however, the following tendencies are indicated:

1. Drivers ride closer to the edge of the concrete parabolic wall-type divider than to any of the other types of medians tested.

2. The 6-in. paint line divider and the narrow wall-type divider have about the same effect on the positioning of cars in the center lane.

3. Lane lines between two parallel streams of traffic cause motorists in lane 2 (inside lane) to drive closer to the center median than where no lane lines are provided. (Note in the discussion that the effect of type curb is not considered)

4. Medians do not eliminate the common tendency of drivers to cut across horizontal curves.

5. Clearance distance between cars in parallel streams of traffic grow wider as the roadway width increases and as the volume increases.

6. On relatively sharp curves the clearance distance between cars in parallel streams of traffic becomes less than on tangent sections.

7. The distance from the edge of the pavement to cars in Lane 1 (outside lane) is the same or about the same for equal pavement widths, regardless of the type of center median. On tangent sections there is no measurable difference between the positions of cars in Lane 1 (outside lane) for roadways with or without lane lines.

The research section of the Bureau of Highway Planning of the New York State Department of Public Works has inaugurated some studies on the effect of median dividers on the lateral positioning of cars. They are being carried on in co-operation with the United States Bureau of Public Roads.

The procedures for these studies were developed by O. K. Norman and E. B. Shrope and progressed under the direction of Mr. Shrope.