

Accident Experience with Traversable Medians Of Different Widths

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● THIS study is concerned with the accident experience of traversable medians of various widths on limited access, high speed highways. It was sponsored by the New Jersey Turnpike Authority and was conducted by the Yale Bureau of Highway Traffic during the summer of 1954.

Since the study pertains only to limited access facilities, the factors which often determine median design on highways with intersections at grade, such as, the "shadowing" of crossing and turning vehicles, as well as pedestrian protection were not considered in the accident analysis.

Source and Nature of Data

Data for this report were obtained through the cooperation of state highway departments and turnpike authorities. Accident and physical data for limited access facilities such as, Merritt and Wilbur Cross Parkways, DuPont and Shirley Highways, Queen Elizabeth Way, the New Jersey Turnpike, etc., were submitted by the departments in charge of their operations.

To increase the number of samples, state highway departments were requested to select and submit data for sections of rural, divided, high speed highways having limited access characteristics with few intersections and little, or no, roadside development. It was assumed that the operations of these roads were comparable with those of the parkways and turnpikes.

All pedestrian and intersection accidents were excluded from the accident data used in the analysis.

The total mileage of highways analyzed for this study consists of 245 miles of limited access facilities and 181 miles of divided highways with limited access operational characteristics. This mileage fell into 22 sections of high speed highways with traversable median widths varying from 2 ft to 94 ft. Some of the medians are mounded, with or without lip curb, and some are depressed.

The amount of slope in the median cross section is three (horizontal) to one (vertical), or less, in every case. Most of the narrow medians have lip curb up to $7\frac{1}{2}$ in. in height. Neither the lip curb nor median slopes could be classed as barriers according to their accident experience. In fact, it was concluded during the study that the amount of kinetic energy to be controlled at high speeds is so great that nothing short of a substantial physical barrier could prevent the crossing of narrow medians by out-of-control vehicles.

All of the sample facilities operate at high speed except one which has a 45 mph speed limit. While this particular section of road has a good median accident experience, the evidence is not sufficient to attribute this favorable record directly to the speed limit.

None of the sample facilities are lighted except a few which have occasional lighting at special locations. All of the facilities accommodate trucks except Merritt and Wilbur Cross Parkways. One sample facility has a single cable guard rail in the center of its 48 ft median to prevent "U" turns. This semi-barrier makes no significant difference in the median accident experience of this facility.

The medians of all samples, except one, are relatively clear of barriers. In this exception the median is heavily planted with trees. Its extension to the north has a median width of three ft less but it is sparsely planted and provides an ideal basis for a comparison of median operations. The fatal and injury median accident rate for the section planted with trees was higher than that for the unplanted section based on accident records covering a recent three year period. This difference was mostly caused by an average of 50 accidents per year when vehicles struck trees in the median. While it may be believed that the trees prevented "crossed median" accidents, the percents of "crossed median" and "hit tree" accidents which produce fatal and injury accidents

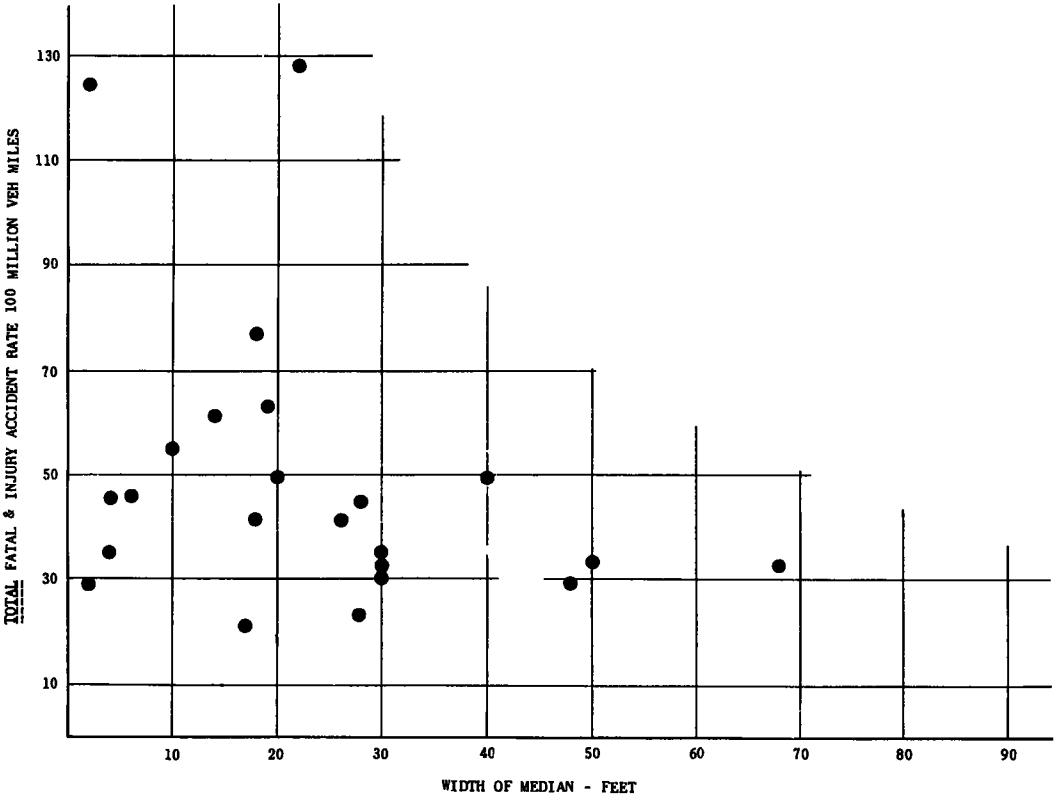


Figure 1. Fatal and injury accident rates by width of median.

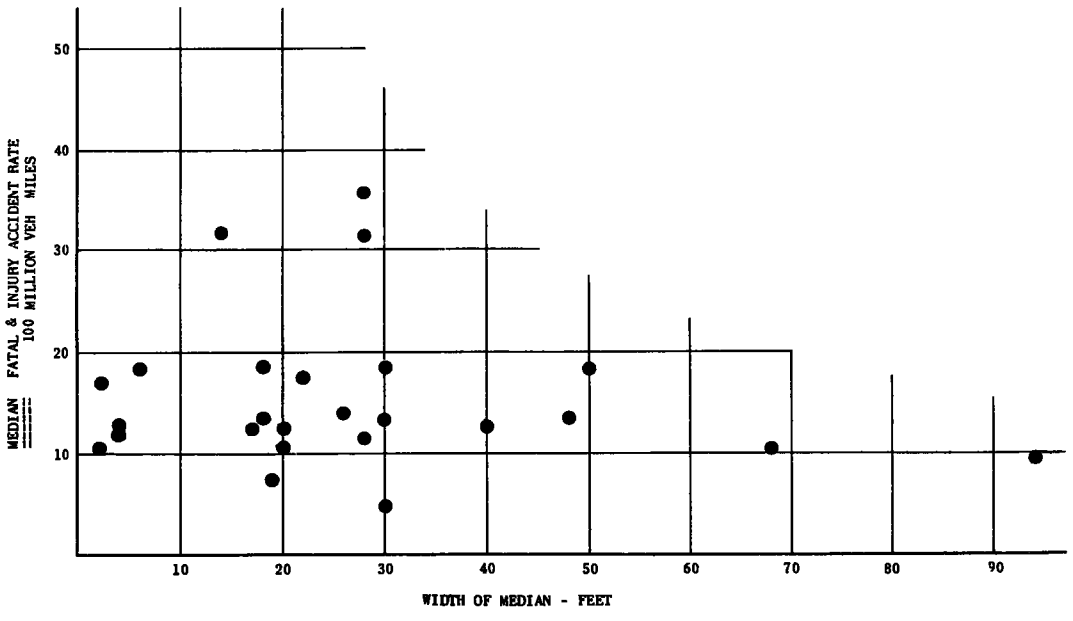


Figure 2. Median fatal and injury accident rate by width of median.

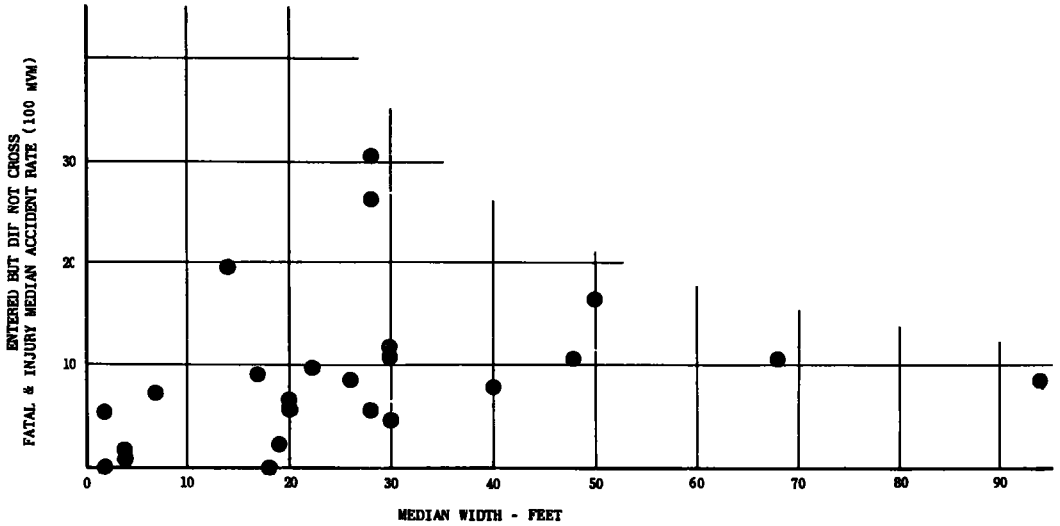


Figure 3. Fatal and injury accident rate for entered but did not cross by width of traversable median.

were about 50 percent in both cases and, obviously, the trees caused many accidents which would not otherwise have occurred.

Total Accident Rates

Figure 1 shows the total, fatal and injury (combined) accident rates by width of median for the 22 facilities studied in this report.

The coverage of accident reporting varies with different highways and highway systems. Injury and fatal accidents are nearly always called to the attention of the police whereas property damage accidents may not be reported. To minimize the differences in accident coverage, only fatal and injury accidents are shown in this figure.

It is clear from Figure 1 that there is no correlation between the overall accident rates of the 22 sample facilities and the width of their traversable median.

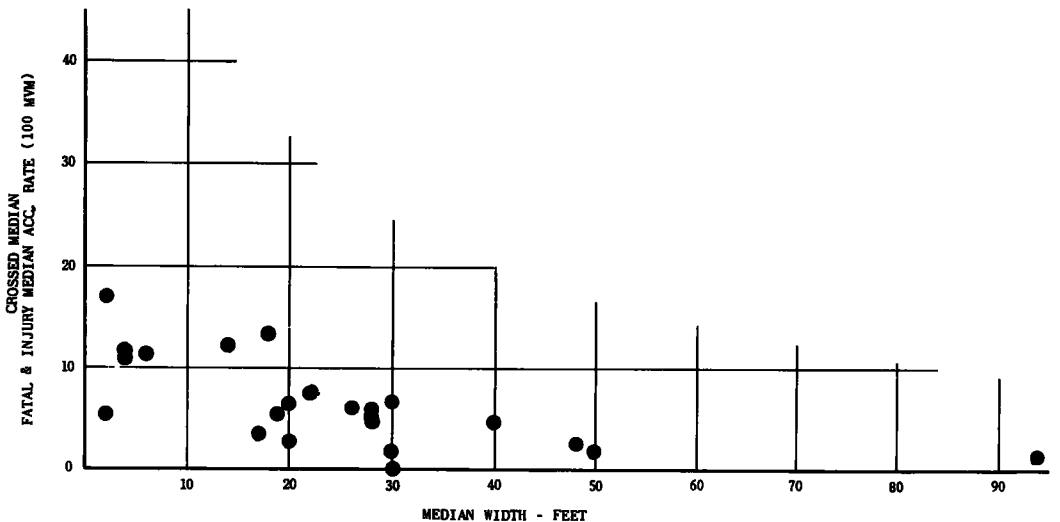


Figure 4. Fatal and injury accident rate for vehicles that crossed median by width of traversable median.

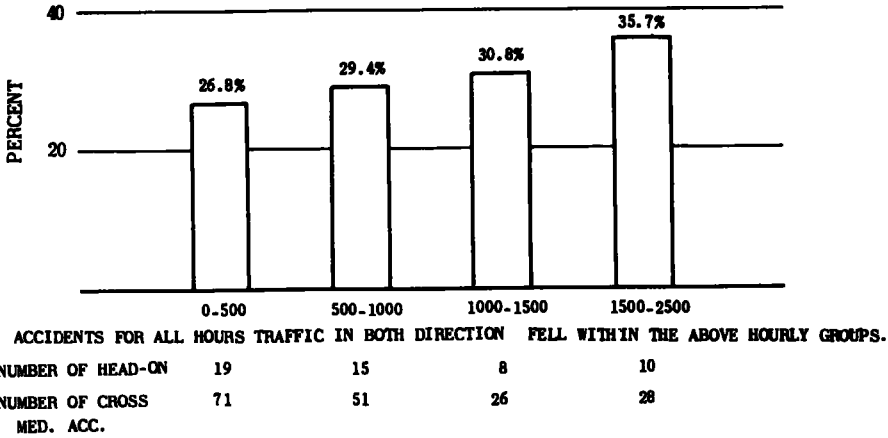


Figure 5. Percent of cross median accidents which were head-on. Accidents during hours of certain traffic volumes (Jan. 1, 1952 to June 30, 1954). New Jersey Turnpike.

Study of individual accident occurrences on the sample facilities implied that there are many different factors, other than median design, which affect accident rates. Some of these factors are: (1) the overall standards of design. (2) road user velocitation. (3) climatic environment, fog, ice, etc. (4) differentials in vehicle speeds.

The combination of these factors produced rates ranging mostly between 30 to 60 fatal and injury accidents per 100 million vehicle miles. Of the two facilities with highest rates, one does not provide right hand shoulders and the other had a high number

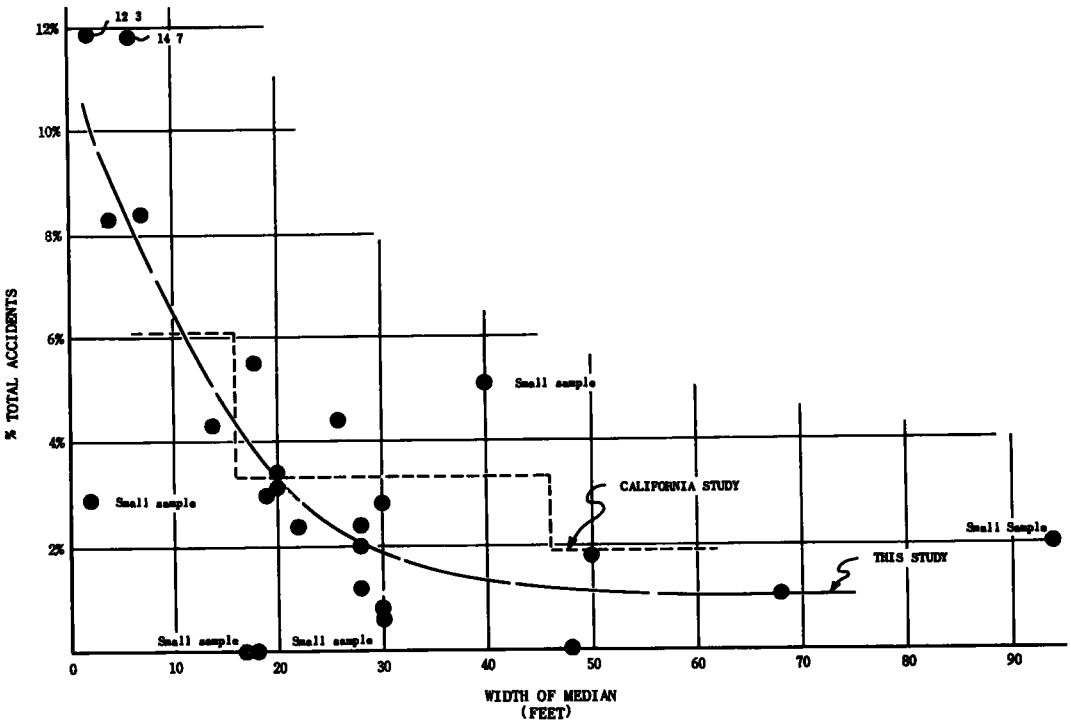


Figure 6. Head-on accidents as percent of total accidents by median width.

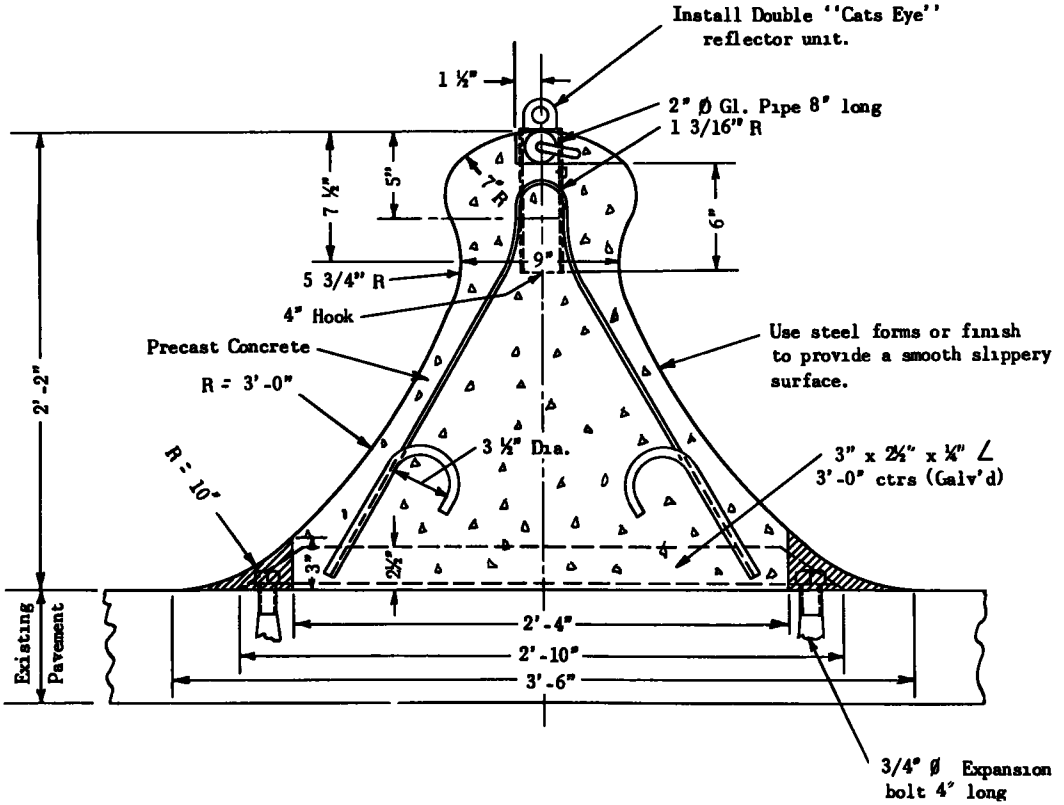


Figure 7. Detail of California parabolic divider.

of intersection accidents which, although excluded from this study, suggests large differentials in speeds.

Median Accident Rates

Figure 2 is concerned with median accident rates only. It shows the injury and fatal

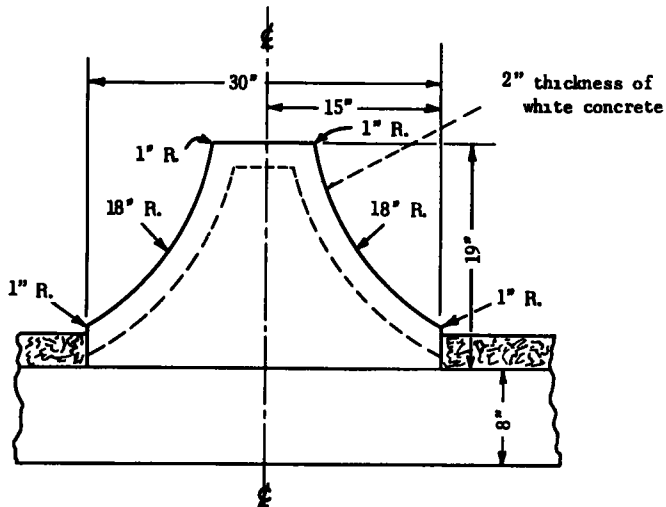


Figure 8. Detail of parabolic divider. US 22, New Jersey.

accident rate, combined, for only those accidents which involved the median by width of median.

Again, there appears to be no correlation between the accident rates and width of median. This phenomenon is difficult to rationalize because greater safety with wider medians would be expected. Perhaps, drivers are more alert when the median is narrow and top speeds are higher on roads with medians of more generous design.

The range of accident rates including the majority of samples shown by Figure 2 is from 10 to 20 injury and fatal accidents per 100 million vehicle miles. Median accidents therefore account for about $\frac{1}{3}$ of the total accidents on these facilities, since their total accident rate ranged between 30 and 60. (see Figure 1)

Figure 3 shows the fatal and injury accident rate for only those vehicles that entered the median but did not cross it.

In the analysis of accident records for this study median accidents were classified as those which occurred either: (a) When the vehicle struck, entered or encroached upon the median but did not cross it, or (b) when the vehicle crossed the median and entered lanes for the opposed flow.

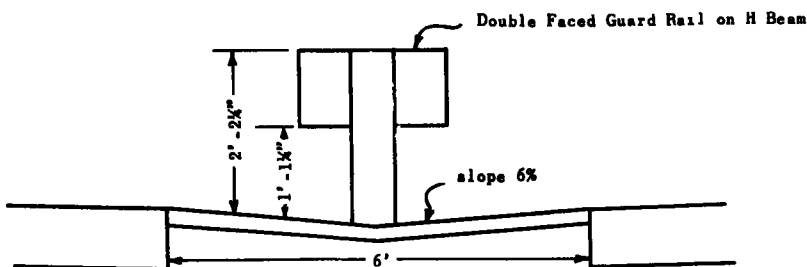


Figure 9. Cross section between Hackensack and Passaic R.R. bridges
New Jersey Turnpike.

Figure 3 shows the fatal and injury accident rate for the first classification of median accidents. The three facilities with highest rates on this figure are ones with highest rates on the previous figure. This indicates that the median itself is the cause of an unusual number of accidents. Detailed data are not yet available to determine the exact cause of these median accidents. The medians of all three of these facilities are relatively free of obstructions and are of depressed design but so are some of the other samples with favorable accident records.

Figure 4 shows the fatal and injury accident rate for vehicles that crossed the median by width of median. This figure shows a good correlation between "crossed median" accident rates and width of traversable median. As might be expected, the rate for this type of accident is reduced with increased median width.

Head-on Accidents

There is no reason why the width of traversable median should influence the accident rate except in the case of head-on collisions with vehicles in the opposed flow. In other words, except for head-on collisions, a traversable median without trees, bridge piers, or other obstructions, offers no greater hazard than the right side road margin so long as physical obstructions are equal distances from the right and left edges of the pavement. Therefore, the objective of median design on limited access facilities is to prevent head-on collisions.

Head-on collisions are a small percent of total accidents but they are extremely severe accidents. Totals of the accident data for this study show that 6 out of 10 head-on accidents are personal injury or fatal accidents. While they accounted for $\frac{1}{25}$ of all injury accidents they were responsible for $\frac{1}{3}$ of all fatal accidents.

In addition, because of the lethal nature of head-on accidents, they are considered very unfavorably by the public. Only one of the drivers is usually in error when a head-on collision occurs and public criticism is "leveled" at lack of protection for the innocent driver.



Figure 10. Steel guard rail on US 101 in California.

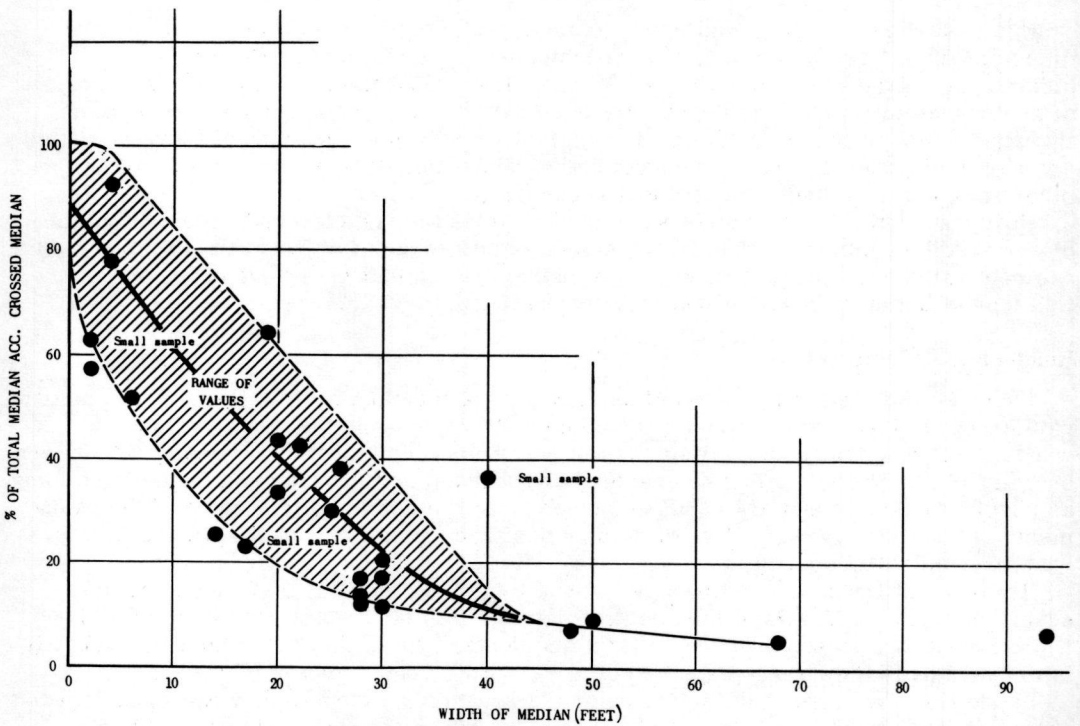


Figure 11. Percent total median accident crossed median by median width (traversable medians).

Logic dictates that the probability of a "crossed median" accident becoming a head-on collision will depend upon the density of traffic. To study the effect of traffic volume on head-on accidents a detailed analysis of traffic accident experience and volume was made for the New Jersey Turnpike. Results of this study are shown on Figure 5. This particular accident analysis covered the 30 month period from January 1, 1952 to July 1, 1954 and hourly volume data were obtained from the Turnpike's toll records.

The percent of "crossed median" accidents on the Turnpike which produced head-on accidents increased from 26.8 percent for the 0-500 vehicles per hour group to 37.7 percent for the 1,500-2,500 vehicles per hour group. While the sample is small, a definite relationship between increased traffic density and head-on collisions was found but the increase of 8.9 percent is less than would be expected. Apparently, drivers are more cautious and alert when operating under high volume conditions but more data are required to prove this reasoning.

Figure 6 shows head-on accident experience as a percentage of total accidents by median width for the 22 samples. It was assumed that head-on accidents expressed as a percent of total accidents would be reliable in spite of differences in accident reporting for the various facilities. The curve superimposed on this figure is an "average" of the data with consideration made of sample size. The curve shows that the percents of total accidents which are head-on accidents range from 1 percent for the wider medians to 14.7 percent for the narrow medians. The percent reduces rapidly with increased width of median up to 40 feet. For median widths greater than 50 feet the reduction is small.

In cooperation with this study, the California Division of Highways made a special analysis of median accidents on all rural high speed highways having limited access characteristics within that state. These facilities were not included in the 22 samples shown on Figure 6. All head-on accidents were expressed as a percent of total accidents by widths of median grouped for medians 6 to 16 feet wide, 16 to 46 feet wide and wider than 46 feet.

The California study results are shown by the dotted lines on Figure 6. The difference for the wider medians of about 2 percent between the two studies cannot be precisely explained but in both cases substantial reductions in head-on accident experience with increased width of median up to 50 feet are shown. Apparently, a 50 foot traversable median width offers sufficient "skid or roll over room" and recovery time to contain most out-of-control vehicles. A median width of several hundred feet would probably be required to contain all median accidents.

Barrier Medians

As a part of this study of traversable medians, exploratory accident investigations were made of the operational characteristics of barrier medians now employed on rural high speed highways. Physical barrier medians are most warranted when highways pass through areas of restricted rights-of-way where traversable medians of adequate width would be very costly.

Figure 7 shows the design detail of the parabolic divider located on the famous Grapevine Grade of US 91 in California. It is 26 in. high, 42 in. wide at its base and is of concrete construction. During three recent years of operations, 50 percent of the accidents caused by hitting the divider involved severe property damage, 32 percent were injury and 11 percent were fatal accidents. In 39 percent of these accidents, the vehicle rolled over after striking the median. However, none of the vehicles crossed or straddled the divider.

Figure 8 shows the design detail of another parabolic divider for which accident experience was studied located in New Jersey on US 22 at Jugtown Mountain. It is 19 in. high, 30 in. wide at its base and is of concrete construction. During the years 1950 through 1953, 77 accidents occurred within the two mile section having this divider and 22 of these could be directly attributed to the median. 44 percent of the accidents caused by hitting the median were property damage accidents and 56 percent involved personal injury. In 5 of these accidents, the vehicle jumped the median and in 5 of them the median was straddled. In six cases, the vehicle swerved across the right lane after contact with the median.

These two accident investigations indicate that a low parabolic divider is too easily mounted and a high one tends to "roll" the vehicle. Apparently, a divider of this type, when designed to prevent crossing, transmits a vertical acceleration to the vehicle, which, under high speed conditions, tends to "roll" it or catapult it into the air.

Figure 9 shows the details of an installation of beam type guard rail placed back-to-back in the median of a one mile section of the New Jersey Turnpike. The barrier is in the center of a six foot slightly depressed section.

Accident records for this section of median were available for the years 1952, 1953 and eight months of 1954. The reportable accidents produced by contact with the guard rail consisted of 10 property-damage-only accidents, 1 injury and 1 fatal accident. The fatal and injury accidents could not properly be charged to the guard rail because the injury accident occurred when a vehicle struck the end of the rail at an opening and the fatal accident occurred when a vehicle skidded along the guard rail into a vehicle parked alongside the rail. In the 12 accidents, one vehicle straddled the rail and another rolled over it. The accident reports indicated in at least two cases that the guard rail caused the vehicle to bounce off and cross to the outside of the road. In most of the accidents, restricted clearance distance between the edge of pavement and guard rail was a causative factor.

Figure 10 shows the installation of Tuthill guard rail on 1.5 miles of highway US101 in California. As shown by the photograph, the installation was made to protect traffic from the row of large trees in the median. During a period of two years prior to the installation 20 median accidents occurred when vehicles hit trees. These accidents consisted of 3 property-damage-only accidents, 14 injury accidents and 3 fatal accidents. During a period of one year after installation of the guard rail there were 4 accidents consisting of 3 property damage and 1 injury accident. In the case of at least two of these accidents, the vehicle was bounced off the guard rail and crossed over the right hand lane.

These studies of the accident experience of different types of physical barriers now employed in the medians of high speed, rural roads are limited in scope and size of sample. In addition to limitations in accident data, higher than normal accident experience may be expected for the barriers studied because they are employed mostly at "accident prone" locations where physical limitations such as, long grades, horizontal curves and limited right-of-way occur. However, it is apparent that none of the barriers have ideal performance characteristics, especially for high speed roads, and all of those studied introduce added hazard when compared with accident experience where traversable medians of adequate width are employed.

Figure 11 shows the percent of total median accidents that crossed the median for the 22 sample facilities with traversable medians of various widths. The "cross hatched" area indicates the range of values found in the data. The curve shown by the heavy line is drawn in the center of the range for median widths.

This curve provides a means of estimating the increased number of accidents which may be produced if a given traversable median is divided with a physical barrier. For example, with a 26 ft traversable median, about 30 percent of the median accidents may be expected to cross the median. But, when the median "recovery" width is reduced $\frac{1}{2}$ by a physical barrier, this figure becomes 55 percent; or 25 percent higher. This increase does not include those vehicles which enter or cross a traversable median and recover control without accident but would be "tripped up" by a physical divider.

The severity of accidents caused by a physical divider depends upon its design. More research in the design of physical dividers, under high speed conditions employing both trucks and passenger cars, is required to solve this problem.

The superiority of a traversable median 40, or more, feet wide over any type of existing physical barrier employed to prevent head-on accidents on high speed, limited access facilities is demonstrated in this study.