MEDIAN VISIBILITY IMPROVEMENTS: NEEDS, METHODS, AND TRENDS

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In order to provide optimum traffic guidance, the median on the divided highway must remain in definite contrast with through traffic lanes to warn drivers of its presence and to delineate its perspective of geometric change at all times. Traffic accident studies, however, indicate that there is inadequate visibility of general median locations, especially during the hours of darkness. Although a variety of techniques has been developed to increase median visibility, no uniform specification has been adopted throughout the nation. It was the intent of this study to assemble and discuss various possible means of increasing median visibility through application of traffic control devices. A two-part study was undertaken: first, an intensive review of published sources was made to gain a thorough knowledge of the historical development of median visibility considerations, and, second, a national questionnaire survey was conducted to gain an awareness of current practices and any innovations for effective median delineation. As a result of intensive investigations concerning various aspects of this subject, suggestions for median visibility improvements are presented based on the current available data.

•TRAFFIC safety and accident prevention continue to assume a more prominent role in the various aspects of highway design. With the development of faster automobiles, the emphasis on safer roads is becoming paramount. The whole concept of traffic safety is based on the fact that accidents are reduced substantially if both hazardous conditions and careless actions are properly diagnosed and corrected. Because hazardous conditions are essentially constant in character, they are obviously easier to correct. Therefore, highway improvement tends to reduce highway fatalities, resulting in a safer transportation system.

Intensive investigations reveal that the foremost factor in the circumstances surrounding traffic accidents is roadway visibility. More significant is the fact that, of all the different types of accidents, vehicle head-on collisions form a prominent part (3, 5). A widely used method for reducing head-on collisions on highways is the provision of medians. Median barriers dividing highways into 2 one-way roadways eliminate head-on collisions almost entirely and often reduce other types of accidents. In general, motorists fear head-on collisions; therefore, the median, whether it is concrete or a strip of vegetation, provides a means of physical and psychological protection for the motorist against such an accident. In addition, with the use of wide medians traffic noise and headlight glare are reduced, thus resulting in less driving tension for the motorist.

Although the median provides mental and physical comfort and a feeling of security for the motorist, one of the most important functions of the median is to delineate the left side of the roadway. Therefore, to keep traffic operations safe and efficient, the physical alignment of the median must be recognized by vehicle operators at the earliest possible moment. A highway median can become more of a hazard than an aid unless it is plainly visible at all times. The satisfactory level of median visibility should, therefore, be considered as an essential safety feature of the highway facility. Just as

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the median itself is considered a safety factor in its function as a barrier between opposing traffic, increased visibility improves the function of the median as a regulator of traffic flow on the divided highway.

The nature and frequency of traffic accidents involving median encroachments indicate that better median visibility is needed, particularly during the nighttime hours. As part of this study, the result of a national survey indicates that the frequency of median accidents varies from state to state, ranging from 1 to 9 percent of the total accidents on divided highways. The accident rate is evidently deemed serious enough to warrant improved techniques in trying to curb this problem. Accordingly, effective methods of increasing median visibility must be determined and should be implemented on a national basis.

Over the past 15 to 20 years there has been extensive research in the field of highway visibility relative to greater vehicular and pedestrian safety. However, the effective measures of improving median visibility have not been rigidly established on a national basis; they have been left to individual discretion. Therefore, if there is a need to improve the visibility of some median locations, no standard method is readily available for adoption under various conditions. This indicates that specifications for median visibility under every possible situation are urgently needed and should be adopted uniformly throughout the nation.

STUDY OBJECTIVE AND SCOPE

The objective of this study was twofold. First, pertinent published sources concerning the median visibility problem were reviewed with the objective of summarizing various possible means of improving median visibility. Second, the methods currently used for median delineation and any new innovations suggested by various localities were analyzed. It is hoped that the methods collected in this report will serve as an aid in determining standard techniques that will effectively remove median visibility problems at many divided highway locations.

In order to obtain knowledge of current practices of median delineation techniques, a questionnaire was prepared and distributed to all state highway departments. The questionnaire was designed to inventory the existing and proposed utilization and application of traffic control devices for median visibility improvements. The number of questionnaires returned was 38, which represents 75 percent of a total of 51 questionnaires distributed. It should be pointed out that the results presented in terms of percentages will not consistently be a percentage of the same total number. Although 38 questionnaires were used, all were not necessarily complete; therefore, the percentage of the total used to reflect trends will be based on the number of states that responded to the particular survey question being analyzed.

MEDIAN VISIBILITY FACTORS

Before a review of various methods of increasing median visibility can proceed, it is important to identify the principal factors that exert a significant influence on the median visibility. Because of the complexities involved and the lack of sufficient data in some cases, it is not possible to include explicitly all possible factors. However, some obvious factors can be easily identified and thus will be briefly discussed.

Difficulties with median visibility may be considered to be due to four primary factors: atmospheric conditions, headlight glare, topography, and median design. Inclement weather conditions, such as rain and fog, reduce the driver's sight distance and thus significantly limit the visibility of medians. While driving at night, the glare caused by oncoming vehicle headlights, in addition to causing ocular discomfort, reduces median visibility and enhances the possibility of colliding with it. On highways with sharp curves or steep hills, the driver's attention may be distracted by the terrain; this increases the danger of hitting the median. Furthermore, various types of medians possess different degrees of visibility properties. Paved, narrow, nontraversable medians usually do not provide an effective contrast in color and texture with the traffic lane surface.

In addition, median visibility in daylight is better than that during the dark hours. This difference in visibility becomes more accentuated when special adverse factors, such as headlight glare, are involved in the night visibility of medians. Therefore, it is more important to develop and utilize delineation systems that will increase night visibility and thereby provide drivers with optimal information about the median alignment during the dark hours. In some cases, particularly at night, drivers have more difficulty in realizing that a highway is divided and not bidirectional than they have in actually seeing the median. This lack of awareness causes wrong-way driving and creates potential accidents.

MEDIAN VISIBILITY IMPROVEMENT TECHNIQUES

Many types of traffic control devices can possibly be employed to combat the multifaceted problem of median visibility. Usually several methods are used together to resolve the total problem of median visibility. The methods may be divided into groups, according to the types and functions of traffic devices used. An attempt has been made to specify the idea involved in each method as briefly as possible. Detailed specifications can be found in the source documents listed in the references, particularly in the 1971 revision of the Manual on Uniform Traffic Control Devices (6). There is no separate section written exclusively on the method of median visibility improvements in the Manual; however, it is felt that many specifications for use of traffic control devices can be assimilated to form various sections for such a purpose.

MEDIAN ILLUMINATION—METHODS AND TRENDS

A comparison of the median accident rates for the illuminated and nonilluminated sections indicates they are in the ratio of 1:2 (2). Thus, the use of highway lighting results in appreciable economic benefits due to reduced accident frequency. However, even with the substantial reduction of accidents, the erection of a continuous line of lights is still too costly. Therefore, only limited median sections of highways should be given priority for lighting.

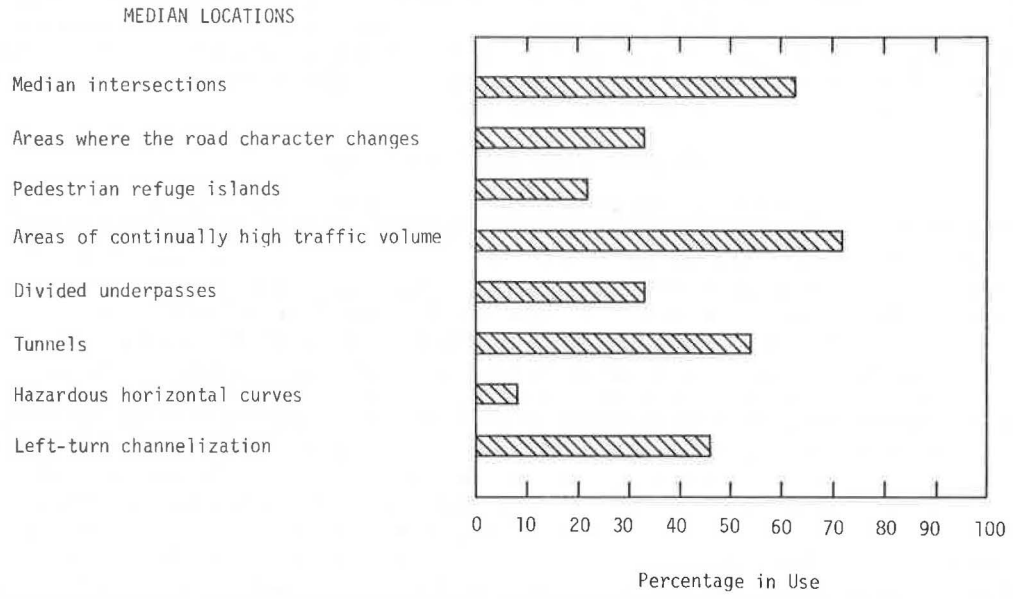

Figure 1. Hazardous median locations where lighting is used.

In the questionnaire survey a list of eight of the hazardous median locations was included, and the states were to check each location where lighting was used within their particular jurisdictions. The results are shown in Figure 1. It should be noted that the figures were compiled from the results of the 25 state highway departments that responded to this question.

Many states felt that lighting was one of the most effective methods of improving median visibility at night but that its cost prevented its widespread use, as indicated previously. The design of the lighting may fluctuate with roadway conditions; however, most states indicate that its purpose is to illuminate adequately the entire roadway in addition to the median. The method used by many states was illumination at intersections, with the light conforming to the standards of intensity and uniformity as established in the American Standard Practice for Roadway Lighting (3).

About two-thirds of the questionnaire returns suggested that under normal conditions lighting poles should not be located in the median of a divided highway with overall pavement and median widths up to 100 ft unless it is economically impractical to light the median from the outside shoulders. Where lighting poles are located within a barrier median, the total median width should be at least 8 ft and the width between barrier curbs at least 4 ft. The majority of states that responded to this question try to keep light poles off of medians in an effort to reduce accidents.

The mounting height of lighting for median visibility is recommended to be between 30 and 50 ft with 40 ft being used by a large percentage of the states. Most states also use lighting ranging between 400 and 1,000 watts, with the 700-watt luminary being predominant. The spacing between the poles is determined by the wattage of the luminary, its height on the pole, and the amount of lighting desired in that area.

APPLICATION OF DELINEATION DEVICES

Reflector Markers

Reflector markers, made of single or clustered buttons or small panels covered with reflective coatings, can be utilized to delineate the general alignment of medians. Because of the difference in the physical and optical properties of various types of reflectors, suggestions for using the different types of reflector markers for the median delineation are given in the following.

Delineators—Delineators can be used effectively to signify the median during the nighttime hours by functioning as edge markers rather than warning devices per se. They may be used on continuous sections of highway or through short stretches where there are changes in alignment. They also may be used at the approach-end of a median. The spacing is from 200 to 528 ft along relatively straight portions of the median, with closer spacing on curves (6). On the approaches to and throughout horizontal curves, the spacing should be such as to make several delineators always visible along the curve ahead of the driver. In any case, delineation should be carried through the transition on a highway with continuous delineation on either or both sides. To be effective in delineating medians, delineators should be mounted at a proper height depending on the type of delineators used. Those that separate traffic in opposite directions shall be yellow, and their spacing shall be the same on both sides of the median. Delineators should always be placed at a constant distance from the edge of the roadway.

Hazard Markers—Hazard markers may consist of single reflectors, clusters of reflectors, or small panels of uniform shape covered with a reflective coating and mounted on separate posts. Reflective elements for delineators should have a minimum dimension of approximately 3 in. In order to mark the median barriers, the delineators should be in line with or inside the innermost edge of the median and placed at a constant distance from the roadway (6). They should also be placed so as to be clearly visible to the approaching driver under normal weather conditions.

Traffic Button—A series of small reflectorized buttons may be used on the surface and near the edge of the median for effective delineation. In general use are glass and plastic buttons, molded plastic with a beaded surface, and prismatic buttons with a transparent acrylic plastic face. To define medians large buttons or bars of cast iron or concrete several inches high, with or without reflectors, lights, symbols, or messages, may also be used.

Curb Marker Light—Another method of median delineation makes use of pavement inserts and curb marker lights. A system of small, surface-mounted lights can be used to develop lineal patterns to increase the intensity of brightness and contrast at night and in conditions of inclement weather, such as rain or fog. They can be affixed directly to the median curb with an epoxy resin. The spacing must be uniform between units, except at intersections where gaps are left in the lineal patterns. Curbed sections should have closer spaced units to maintain the lineal continuity (8).

Markings

The approach end of a median in the line of traffic flow should be designed and marked to indicate its presence and also to outline the proper vehicle paths. The median end first approached by traffic should be preceded by gradually widening marks or roughened strips on the pavement designed to channel the traffic flow into natural paths of travel along the median edge. In other words, this approach-end treatment should guide the driver, without physical restraints, into the proper maneuver well in advance of the median.

Median approach pavement markings consist of a diagonal line, or lines, extending from the center or lane line to a point 1 or 2 ft to the right side of the approach-end of the median. The length of the diagonal marking should be determined by the 85th percentile traffic speed in miles per hour multiplied by the width of the offset in feet. The approach nose should be offset by a greater amount than the offset of the side of the median itself. As faced by the approaching traffic, the approach nose should be offset to the left, the right curb of the median forming a diverging taper to guide the traffic toward the right.

The 1971 MUTCD recommends that double yellow edge-marking lines be used to form median islands. This will aid visibility and also make the driver aware that the median strip is separating travel from the opposite direction. This double yellow median strip was found effective in reducing the number of head-on collisions and other types of accidents (1, 11). For the existence of a median island, a single yellow strip is used and generally placed near the edge of the median traffic lane to take advantage of the cleaning action provided by moving vehicles. If the median barrier is located in the line of traffic flow, reflectorized solid yellow paint should be placed on the curbs to channelize traffic to the right of the median.

Signs

The traffic sign is the most common device for controlling, safeguarding, or expediting traffic. For delineation purposes, signs must be used only where necessary and justified by highway conditions, such as hazards that are not self-evident or clearly visible to vehicle operators. In case of a hidden median, such signs as "Keep Right" or "Divided Highway" should have excellent visibility characteristics to provide adequate advance warning to the driver.

The message delivered by these signs, important enough during the daytime, becomes even more important at night when median visibility is limited. Therefore, the sign must be properly illuminated and reflectorized. When multiple tasks are involved, as in ordinary driving, both objects and signs can be expected to be seen at less than their legibility or visibility threshold distance. Under these circumstances, factors increasing the relative attention value of these signs are of great importance.

Most frequently the "Keep Right" sign is used to direct traffic around a median and, in particular, at the beginning of the median. Because it is of a generally standard form and widely used, the sign can probably be considered more as a symbol than a printed message. The "Keep Right" sign should be mounted a proper distance beyond the approach end of the median. The "Divided Highway" sign can also be used to give drivers advance warning of a section of the highway where the opposing flows of traffic are separated by a median. This diamond-shaped warning sign would normally be placed well in advance of the median.

Glare Screens

When the lights of an approaching automobile remain on high beam during the passing maneuver, most drivers are blinded by the dazzling light and are unable to observe clearly the median within the limits of their own headlight illumination. In various tests the effects of glare on night visibility were measured. It was shown that a large decrement in tracking accuracy occurs due to the overall effect of glare from the lights of the simulated approaching vehicles. Thus, in connection with median visibility at night, glare should be considered a potential hazard.

Because it is undesirable to reduce headlight intensity because of the accompanying loss of road illumination, it is necessary to either increase road illumination by some means without increasing glare or reduce glare without reducing road illumination. A common method used to compensate for the glare reduction that undersized medians do not provide is the use of glare screens. Several forms of glare screens are currently used.

Planting—Median plantings provide drivers with some relief from the headlight glare of opposing vehicles and provide the appearance of a third dimension of depth for roadways that seem to have only two dimensions—length and width—particularly during low-visibility conditions. Proper planting of dense shrubbery on medians can form an effective glare screen and has two additional beneficial effects: the shrubs provide some degree of cushioning for vehicles tending to cross into the opposing traffic lane, and the shrubbery adds to the natural appearance of the scenery (10).

Guardrails—Although the main purpose of guardrails is to prevent intrusion into the opposing lane, they do afford some screening of glare that results in increased median visibility (4, 9). The guardrails seem most effective on separated highways where the opposing lanes are at different elevations. Because the general character of the headlight is to direct light downwards, the glare from the higher road surface is produced with both the high and low beams of a vehicle's headlights. In this situation, a guardrail serves a double purpose when placed on the upper roadway. Besides preventing the intrusion, it shields the eyes of the driver from harmful glare when placed at an appropriate height, depending on the difference in elevation of the two roadways. To be fully effective, guardrails must be highly visible, well-maintained, painted assemblies with reflector buttons or reflectorized materials. A study (2) was conducted to determine the effect of median guardrail on accident rates and severities. The result indicated that median rails can increase the accident rate but the overall severity rates were lowered.

Wire Mesh—The most satisfactory glare screen has been found to be a line of expanded metal mesh placed on the median, parallel to the centerline. Its effectiveness as a screen results from its manufacturing process. The strands of the screen have twists that block any light traveling tangent to the face of screen. The formation of the strands allows the fence to become transparent at angles greater than 20 deg (when glare is relatively unobjectionable). During the day the fence does not block the general view of travelers and allows police surveillance of the opposing traffic lane.

The height of the screen is determined by the use of several relevant factors. The width of the median, the height of the headlight, and the height of the driver's eyes all determine the location of the upper and lower edges of the screen. The obstruction of the glare of high-beam headlights is mandatory. The screen must be low enough to prevent the lights of the smallest sports car from blinding the drivers in the opposing traffic. Conversely, the screen must be high enough so as not to allow the lights of large trucks and buses to shine into the eyes of truck and bus drivers in the opposing lane. The metal screen is not practical along sharp curves or narrow medians because of damage from the overhanging parts of trucks (7).

TRENDS OF DELINEATION TECHNIQUES

All of the state highway departments were asked to list the types of traffic control devices being used for improving median visibility. The method used, of course, is dependent on the conditions under which the median visibility problem exists. However, some of the common techniques used today are shown in Figure 2.

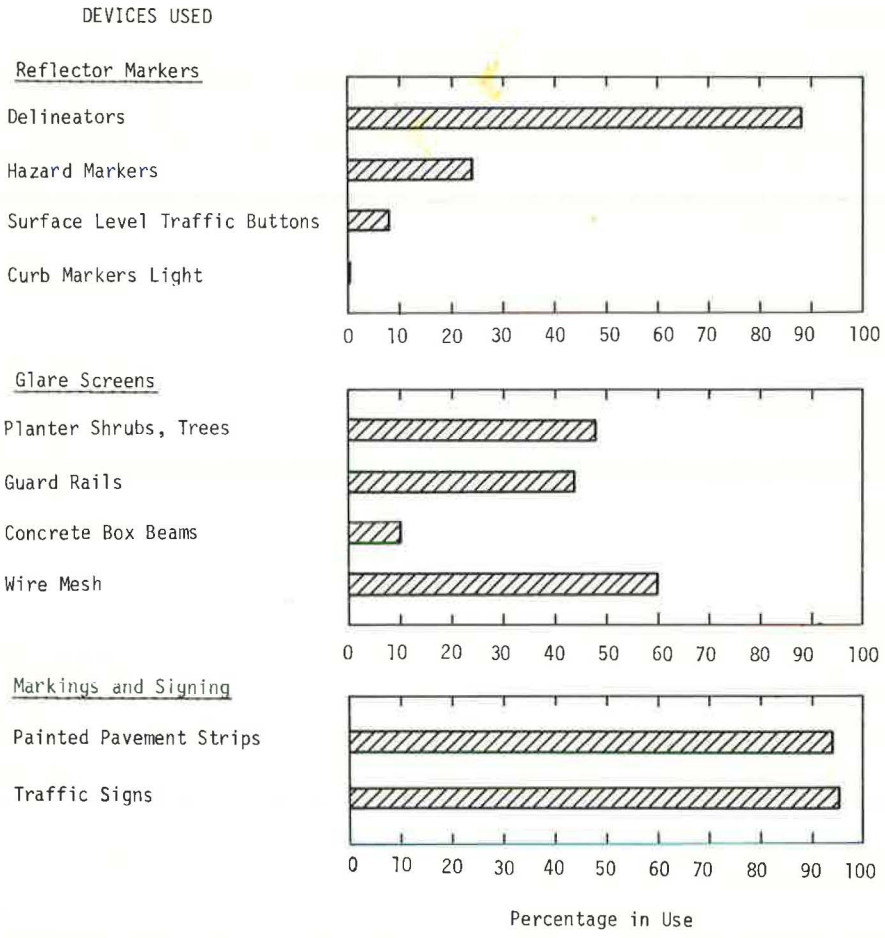

Figure 2. Median delineation methods used in states.

A total of 24 states answered this question. The census showed that pavement markings have generally been used on narrow medians in most of the states. Delineators and hazard markers are used on narrow medians only in an attempt to achieve recognition of the presence of a raised median, particularly at night. Glare screens or guardrails are most common and are used only on narrow medians where traffic volume is high. Planted shrubs and trees are used on curbs but are generally used to block headlights rather than to serve as delineation. Signs in medians are restricted to protected locations, and most states use breakaway sign posts for safety reasons. The percentage of accidents involving collision with median signs was found to be relatively small, varying from 1 to 6 percent from state to state. It is also indicated that most states are presently interested in using the wire mesh glare screen. Fourteen states are currently conducting experiments to test the cost-effectiveness of this technique for the reduction of glare.

Another question was asked concerning the dominant factors in choosing which type of median delineation method to use. The results indicate the following priorities of importance:

1. Economical in installation and maintenance;
2. Compliance with past practice;
3. Aesthetically pleasing;

4. Eliminate, if possible, fixed objects or sight distance obstructions in the median; and
5. Form a continuous marking of the median edge as well as lane control.

VERTICAL DIMENSION TECHNIQUES

With the high volume of traffic that the driver faces on divided highways and the lack of objects in the median to create the third dimension of height, the driver in the median lane tends to watch traffic to locate his position. Thus, with no easy means of determining his lateral position or speed by reference to an object at eye level, the driver has to divert his attention from traffic to view the curb, guardrail, grass, or edge line that delineates the median. This constant visual activity required by the driver to orient his lateral position increases the potential for median encroachments and possible encroachment into the opposing traffic flow.

Many devices, such as curbs, guardrails, fences, reflectorized delineators, raised markers, and painted lines, as well as the general appearance of the median, provide the delineation of the left extremity of the roadway during both daytime and nighttime hours. However, if these devices do not provide the dimension of height as well as of length and depth, they cannot be used efficiently or effectively by the driver to make quick judgments concerning his lateral position. During periods of limited visibility created by rain, snow, fog, or curves in roadway alignment, these delineators become even less effective.

The survey asked a question in relation to the use of vertical dimension techniques. In response, the highway departments (26 returns) listed the techniques now in use to separate the two opposing flows of traffic. Six techniques were listed, and a space for other methods was included. The results of this aspect of the survey are shown in Figure 3.

The three techniques that are most commonly used in rural areas are the split-level roadway design, evergreens or trees, and woodland areas. In essence, the highway departments are constructing two separate pavements with the area between them left in its natural state.

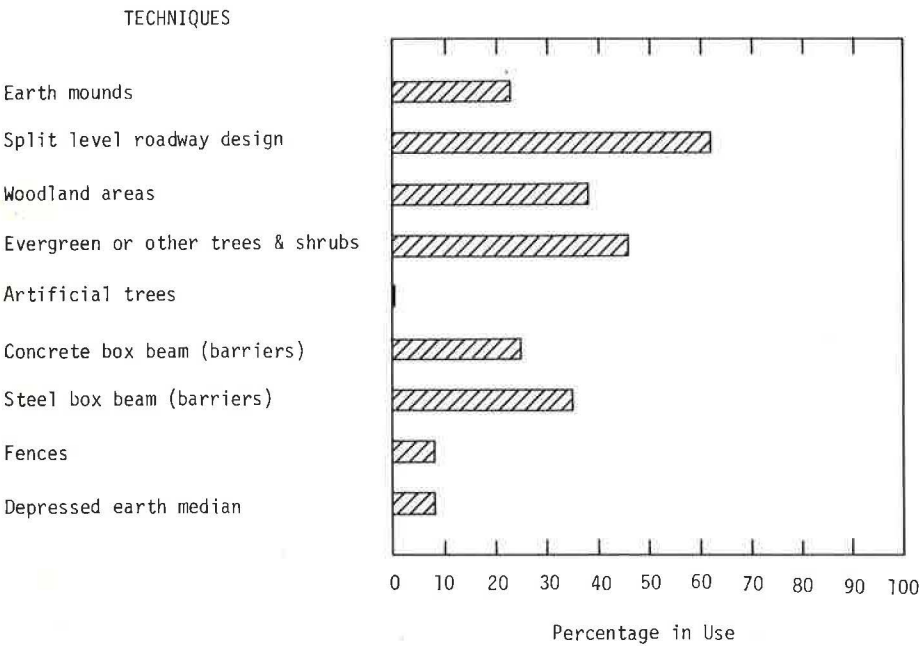

Figure 3. Vertical dimension techniques.

The highway departments were also asked for the dominant factors considered in choosing the vertical dimension techniques used in their states. The following list is a summary of these factors and the order of their relative importance:

1. Avoidance of headlight glare from one roadway to the other;
2. Economy in construction and maintenance;
3. Roadway geometrics and median width;
4. Urban or rural areas;
5. Traffic volume;
6. Preservation of natural topography and growth; and
7. Aesthetic appeal.

The dominant factors in rural areas include cost and the topography of the land. Urban areas also consider these factors and in addition also note the design of the highway and the physical limits of the area in which the highway is located.

If the median is going to fulfill its prime objective of delineating the left extremity of the roadway, the third dimension of height must be incorporated into the design of today's highways. The use of physical features to create this dimension has proved effective in helping the driver remain alert to driving conditions. There is still a great need for research into this field to create effective third-dimensional objects that will not become potential hazards to the motorist.

CONCLUSIONS

The highway median, separating opposing traffic lanes of a roadway, has been found to be an effective measure when used with other control means in assisting traffic to move in a safe and efficient manner. The unexpected appearance of a median can startle a driver and possibly cause an accident. Therefore, the presence of the median should be signaled far enough in advance so as not to require immediate action.

Several possible methods for increasing the visibility of highway medians have been reviewed and summarized. It is quite evident that no single method will always give the best results under all circumstances. Although the important test of any of these methods is the effectiveness of increasing median visibility, the problem of selecting an appropriate method under a given condition is partly an economic one. The resulting median visibility achieved by a method must be weighed against the cost of the method.

To be incorporated into both existing facilities and the plans of the future facilities, effective methods that will enhance the median visibility must be found and utilized correctly in order to avoid all possible traffic accidents due to inadequate median visibility on divided highways. This report has attempted to bring up to date the developments in the area of median visibility. Suggestions based on the current data have been made concerning several aspects of this topic. It is imperative that, as further research is compiled, continuing evaluations be made on this important highway element.

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