SUMMARY REPORT 19-4(S)

CHANNELIZATION

SUMMARY REPORT
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by

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In 1960, Research Project RP-24, "Channelization" was initiated by the Texas Transportation Institute sponsored by the Texas Highway Department. In 1962, the project was included in the cooperative research program with the Texas Highway Department in cooperation with U. S. Department of Commerce, Bureau of Public Roads, and received a new designation as Research Project 2-8-60-19. The general objective of this research was to investigate the effect of design, signing, and delineation of channelization on the factors of safety and efficiency of operation. Three interim reports were prepared to present results of certain phases of the research. These reports were as follows:

1. Research Report 19-1, "Approach-End Treatment of Channelization—Signing and Delineation" (presented at the 42nd Annual Meeting of the Highway Research Board and published in the HRB Bulletin 341).

2. Research Report 19-2, "Marking the Approach-Ends of Channelization" (published in 1963 as TTI Bulletin 25).

3. Research Report 19-3, "A Computer Technique for Perspective Plotting of Roadways" (approval pending).

In this research, primary consideration has been given to the approach-end treatment of channelization. Particular emphasis has been placed on methods of marking or delineating channelization so that it is visible to the driver under conditions of night driving in adverse weather. Studies were conducted to evaluate the relative visibility of signs used to direct traffic around the approach-end of channelizing islands. Other studies were conducted to evaluate the relative visibility and serviceability of marking materials and devices for delineating islands.

Experimentation and developmental work was performed on the materials and geometric configuration aspects of what might be termed "pre-treatment" of channelization—raised markings in advance of channelization to forewarn the driver. In addition to the improved visibility, these raised markings provide a rumble effect to the encroaching driver.

In another phase of the research, an investigation of the safety aspects of channelization was made by a "before" and "after" comparison of traffic accidents occurring on a section of roadway that was channelized as a remedial measure.

In still another phase of the project, a computer program was developed to translate design data (station, elevation, and perpendicular offset data) into a perspective view of the roadway. The procedure utilizes a digital plotter in conjunction with a digital computer. With this program the designer can select several viewing positions and distances to study his proposed design as the driver sees it, whereas he normally relies on plan and profile drawings.

Delineation of Channelization

Research studies on delineation of channelization were conducted in two separate phases: (1) relative visibility and (2) serviceability under actual traffic conditions. The devices and the materials tested included the following:

1. Curb coating materials on barrier curbs and mountable corrugated curbs.

2. Prismatic (reflex) reflectors.

3. Rectangular plate-type delineators (beaded reflector incapsulated in amber plastic).

4. Reflective sheeting.

5. Low-intensity curb lights.

Relative visibility studies were conducted under controlled conditions at the Texas A&M Research Annex. A channelizing island was simulated using each of the delineation materials and devices. The curb coating materials were applied to curb sections constructed of wood to represent barrier curbs, and to special corrugated curb sections cast with concrete. In actual practice, the corrugated curbs produce an audible rumble or hum plus a vibratory sensation when a vehicle encroaches but little was previously known of their visibility characteristics when painted and reflectorized.

Visibility distances were determined by four (4) selected observers driving a vehicle at uniform speed through the test section. An opposing vehicle was located adjacent to the nose of the simulated island as if it were in the inside opposing lane. Both the opposing vehicle and the observer's vehicle displayed low-beam headlights.

The results of the visibility tests are summarized in Figure 1. In general, the curb coating materials were not effective in delineating the channelizing island. The four other materials or devices showed that the visibility distances were 3 to 5 times greater than those of the curb coating materials.

Since these visibility tests showed definitely that the four delineation materials or devices offered the greatest and essentially equal effectiveness under controlled conditions, they were all subjected to tests of serviceability under actual traffic conditions. They were installed on divisional islands in the Bryan-College Station area and kept under close surveillance for an extended period. In these installations, the units were spaced

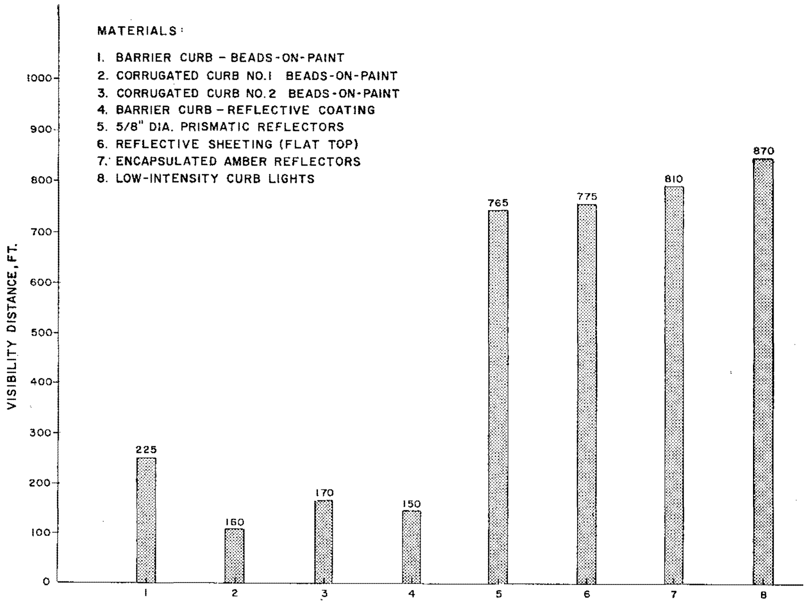

Figure 1. Comparison of relative visibility distance of delineation devices and materials.

12 to 20 feet apart along the island curb and from 2 to 16 inches above the top of the curb.

Of the three reflective devices, the incapsulated amber reflectors appeared to have a slight advantage in serviceability. At the most critical location they needed cleaning about every thirty days during the winter months when inclement weather was prevalent. At other times, however, practically no maintenance was required. Prismatic delineators subjected to the same conditions lost their reflective efficiency due to the road film more rapidly than did the incapsulated delineators. The reason for this was not readily apparent, since both units have smooth plastic faces. It is believed that there were two principal contributing factors: (1) the prismatic reflector has only 5 square inches of surface area whereas, the incapsulated delineator has 15 square inches, but the prismatic reflector has a much greater initial reflective efficiency, and (2) in the prismatic reflector, the reflecting prisms were molded monolithically with the outside surface whereas, the plastic surface on the incapsulated delineator was separate from the reflective element. However, both systems were considerably more effective than delineators built using amber reflective sheeting.

The low-intensity curb lights were fairly effective in actual practice and there was very little tendency for dirt to accumulate on the face of the lens. However, the cost of installation and operation was considerably higher than for the reflector units.

Observation of both amber and white delineators showed that the amber units were much more effective for use on channelizing islands. The amber delineators did not blend with the opposing headlights as did the white reflectors and curb lights. Also, amber appropriately implies a danger area when the island is not traversible. It is also significant to point out the advantage of low-mounting heights used in all of the test installations. The delineators are more closely and more readily associated with the island area and do not get lost in a maze of opposing headlights. There is the disadvantage that they are more susceptible to splash and road film in the low-mounting positions.

From observation of these various materials and devices subjected to normal traffic and weather conditions, it appears that any one of the devices will do a satisfactory job when it is used in conjunction with an organized maintenance program. In view of the fact that a satisfactory job of delineation can be obtained through either of the reflective devices, the curb lights are not considered justifiable because of their high initial cost and the problems of continuous power consumption and maintenance.

Signing the Approach-Ends of Channelization

In this phase of the research, studies were conducted to make a comparative evaluation of the performance characteristics of several types of "KEEP RIGHT" signs used to mark the approach-ends of channelizing islands. The signs which are listed below were similar in geometric configuration, all 24" x 30" with 5" letters but differed in the types of materials used and the method of illumination or reflectorization. The visibility and the legibility tests on the signs were conducted in the same manner as the visibility studies on delineation devices.

Sign No. 1—Beads-on-paint, black letter on white background (Texas Highway Department Standard).

Sign No. 2—Reflective sheeting, black letters on white background.

Sign No. 3—White reflector letters on black background.

Sign No. 4—Internally illuminated, black letter on white background.

Sign No. 5—Same as number 1, except black and white hashmark panel mounted below sign.

Sign No. 6—Same as number 1, except externally illuminated.

Sign No. 7—Same as number 2, except externally illuminated.

Sign No. 8—White reflective sheeting letters on black background.

A comparison of the visibility and legibility distances of the various signs is shown in Figure 2. This comparison shows the average visibility and legibility distances for each of the signs and the results of a multiple range test used to arrange the various signs in groups of significant differences.

The results of this study showed that the signs with reflective letters on black background were generally superior to those with reverse contrasts. Illumination, either internal or external did not improve the performance of these signs appreciably.

Materials and Methods of Marking the Approach Ends of Channelization

This phase of the research was concerned with performance and developmental aspects of a new technique involving raised stripes for marking the approach-ends of channelizing islands and freeway ramps. Instead of merely painting the configuration on the pavement surface, a system of raised stripes was applied by the "surface treatment," or inverted asphalt penetra-

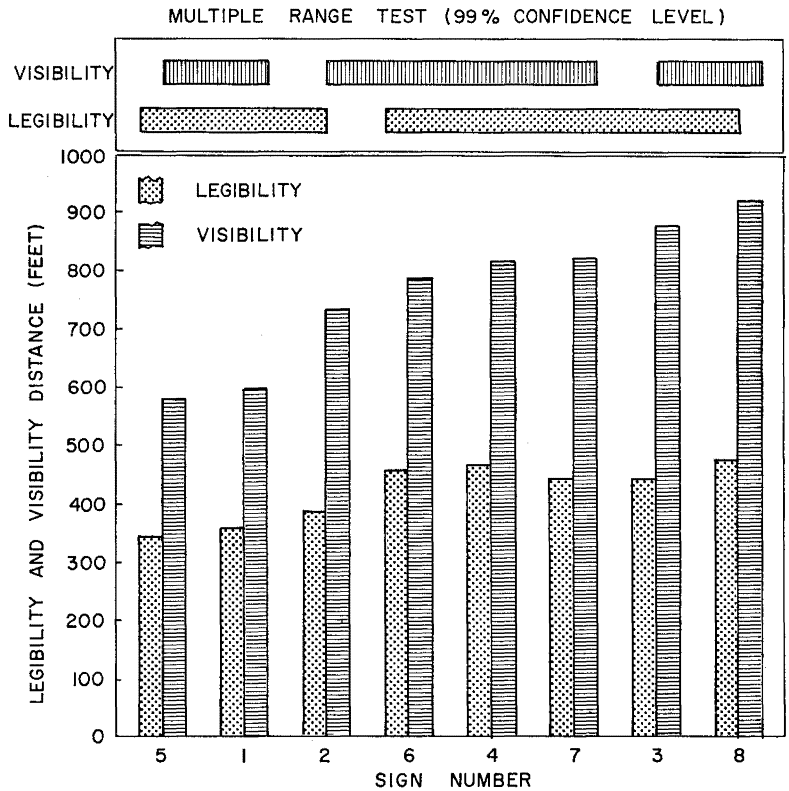

Figure 2. Legibility and visibility distance of signs tested.

tion construction method. This configuration was then painted and reflectorized in the normal procedure. It was anticipated that this technique for striping the approach-ends would improve the visibility of the markings, especially during inclement weather because the reflective surfaces would project above water that normally inundates paint lines. Secondly, the raised stripe would produce a rumble effect to warn the driver of encroachment on the approach-end treatment.

Studies were conducted to determine the visibility characteristics of the raised stripe channelization markings in comparison with the conventional reflectorized paint markings. These studies showed that the visibility distance of a painted and reflectorized raised stripe was not reduced by surface water, whereas, the visibility of conventional reflectorized paint lines was reduced approximately 60 percent.

Although the "surface treatment" raised stripes provided excellent surface texture for visibility, it was felt that they did not provide an adequate rumble effect, due mainly to the small cover stone used in the surface treatment. To increase the height of stripe would require larger cover stone, and past experience has shown that retention of large stone in surface treatments is a real problem. Therefore, other construction methods were investigated to determine a means of increasing the rumble effect.

Two alternate approaches were taken in an effort to increase the rumble effect: (1) increasing the effective height of the stripe, and (2) varying the spacing and configuration of stripes to control the vertical movement of the encroaching automobile. From the standpoint of controlling the height of the stripe, an asphaltic slurry mixture was most satisfactory in constructing the raised markings. The slurry mixture consisted of an asphalt emulsion, water, field sand, slag aggregate and a crushed limestone aggregate. The slurry served to provide adequate embedment for the crushed stone to give good durability and retention of aggregate. The size of the crushed stone used in the mix determined the height of stripe while the angularity of the stone provided the needed surface texture for visibility purposes. Using this technique, it was possible to construct raised stripes up to 1 inch in height, which is more than actually needed on high-speed highways.

Further study of the surface treatment methods showed that it was possible to produce an effective rumble with a low profile stripe by varying the spacing of the stripes. Several experimental installations were made using THD Grade 3 surface treatment aggregate. The most effective design configuration was composed of crossbars, perpendicular to the line of traffic, three feet wide, and spaced at 3-foot intervals.

The research showed that other materials, such as pigmented paving materials, Portland cement concrete, and certain polyester resins, were unsatisfactory materials for constructing raised markings. At the present stage, the pigmented paving materials discolor rapidly due to an inherent tackiness of the material. Portland cement concrete markings could be utilized but they are considered prohibitive from an economic standpoint except when installed in new construction. The polyester resins have been used satisfactorily in previous research on rumble strips; but the outlay of equipment and the precise nature of the application of these materials are considered prohibitive from the standpoint of general maintenance operations.

A preliminary study of the feasibility of prefabricating raised stripes indicated that the idea was feasible when considered from the standpoint of ease of installation. However, the materials developed for the first test installation proved to be unsatisfactory. For the installation, strips of material were formed by molding asphalt and filler materials. These strips were then painted and beaded for reflectorization. Wear and discoloration soon rendered the strips ineffective. If a satisfactory material can be developed, then this method of marking approach-ends appears feasible.

A Study of Traffic Accidents in Channelized Areas

One phase of this research was devoted to determining the effect of channelization on safety of traffic operation. A study was conducted to analyze comparatively the statistics of traffic accidents occurring before and after channelization was installed on an arterial type street. To facilitate this research a section of heavily traveled arterial street was selected in which channelization had been installed at several of the intersections. One-year study periods, immediately before and after the construction, were selected to facilitate the "before" and "after" comparison.

A comparative analysis of the accident data was made on the basis of (1) total number of accidents, (2) accidents per 100 million vehicle miles, (3) accidents by type, (4) accident severity, and (5) accidents by light conditions.

The results of this research showed that there was a reduction in the total number of accidents and in the accident rate (accidents per 100 million vehicle miles) due to the introduction of channelization. When these reductions were compared to increases observed in sections, which remained two-lane, unchannelized for both periods of study, the results were very significant in favor of channelization. Similarly favorable results were found when the accident statistics were further classified by day and night conditions and by "rear-end" and "nonintersection" collisions.

In the comparison of accidents by specific type, there was a significant reduction in rear-end accidents but a substantial increase was observed in fixed object collisions. It is significant to note, however, that all of this increase was attributed to striking "KEEP RIGHT" signs on the channelizing islands.

A significant reduction in personal injuries was observed in the channelized sections. However, there was virtually no difference in the personal injury rate, that is, personal injury per accident.

As a result of this research, it was concluded that the introduction of channelization at major intersections reduces accidents and improves the safety of traffic operation in those areas.

A Study of the Visual Perspective of Channelization and Other Roadway Features

In another phase of the research an attempt was made to study the relationships between the visual perspective aspects of channelization and the profile of the approach roadway. In this regard, a computer program was prepared to accept station, elevation, and perpendicular offset data from design plans and transform them into a perspective view of the roadway ahead of the driver.

The basic concepts of the study were fundamental in nature employing elementary geometry and highway engineering principles. The visual description of the roadway in perspective as the driver sees it is produced by projecting selected points from a three dimensional roadway onto a common two dimensional reference plane. The selected points, represented by X and Y coordinates on the two dimensional reference plane are then joined to represent the drivers visual input.

The computer program operates on an IBM 7094 digital computer to prepare output data on magnetic tape which serves as input to an IBM 1401 digital computer linked to a digital plotter. The digital plotter prepares the perspective views with an incremental accuracy of 100th of an inch in both X and Y directions. This system can produce approximately 20 perspective drawings in 3 minutes of computer time and 4 minutes of digital plotter time.

The computer program was tested by obtaining typical plans of channelized intersections in the local area. Input data for the computer program were prepared from the plans and the results were compared to photographs of the actual intersection.

It is believed that application of the program in conjunction with the design of intersections and approaching roadways would help the designer in controlling the approach profiles to improve the visual perspective of intersections.