

3. Accidents--work zones that have higher than normal accident or fatality rates.

These HAR conditions should be established for each specific work zone and should be contained in the traffic control plan. Field studies should also be developed and scheduled routinely throughout the life of the project. These field studies would determine the need for additional information for the motorist and when an HAR system may be applicable in terms of the defined conditions.

In addition to the guidelines, HAR licensing procedures need to be improved. A license for an HAR system currently takes up to six months to obtain. This time should be reduced if HAR and HAR guidelines are to be used effectively and regularly at work zones.

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Abridgment

Use of Chevron Patterns on Traffic Control Devices in Work Zones

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The objectives of the research were to select the most effective design for the chevron pattern and to evaluate the effectiveness of selected chevron designs under road conditions as compared with currently used designs. In a supplemental test, the effectiveness of the New Jersey concrete barrier was compared with that of the channelizing devices studied. In general, the selected chevron designs were preferred over the currently used patterns. Driver response was found to be not strongly dependent on the channelizing device employed in the taper. A supplemental taper of channelizing devices was found effective for use with the New Jersey concrete barrier.

The objectives of this research were to select the most effective design of the chevron pattern and to evaluate the effectiveness of selected chevron designs under road conditions. The evaluation compared the effectiveness of traffic control devices bearing the chevron design with that of barricades and channelizing devices that bear the currently used stripings.

The scope of the research was limited to the use of barricades and channelizing devices to provide directional guidance.

SELECTION OF A CHEVRON DESIGN

The groups of chevron designs shown in Figure 1 were rated subjectively by observers in vehicles at two points--the point of detection (500 ft) and the point of legibility (300 ft). The demonstrations were conducted under both day and night conditions; 32 observers participated. At night, the groups of designs were observed under both high- and low-beam headlights.

The observers rated the pattern groups at the point of detection in terms of (a) the ability to

command attention, (b) the ability to warn and alert, and (c) overall appearance. At the point of legibility the pattern groups were rated for (a) the ability to convey a clear, distinct message; (b) the ability to guide and direct; and (c) overall appearance. The sets of parameters were summed for each pattern to obtain two cumulative measures that were compared with those for the other patterns in the group. The mean and standard deviation were calculated and the Wilcoxon ranked sign test was used to statistically rank the patterns with a 0.05 level of significance for a two-sided test. The patterns identified by an asterisk in Figure 1 were selected for field testing.

FIELD TESTS

The measure of effectiveness deemed most appropriate for the evaluation of channelizing devices under road conditions was the position of the motorists' lane changes. A right-lane closure on a four-lane divided highway was desired because most motorists drive in the right lane and for them a lane change in the work zone would, therefore, be necessitated.

Procedure

The zonal system shown in Figure 2 was devised to facilitate the collection of data on a driver's lane change as a response to a specific channelizing device. The 350-ft length of the zones is based on the estimated time required to change lanes, which is 4-5 s (1). Zone 1 included the point of detection (500 ft), and zone 2 included the point of leg-

ibility (300 ft.). Note that the legibility distance does not provide the estimated distance for negotiating a lane change (350 ft.).

Traffic counters were placed at the boundaries of

the zones with the rubber tubes extending across the right lane of traffic. By determining the difference in the volume count on the traffic recorders that bound a zone, the number of vehicles that

Figure 1. Chevron pattern groups. Type II Barricade

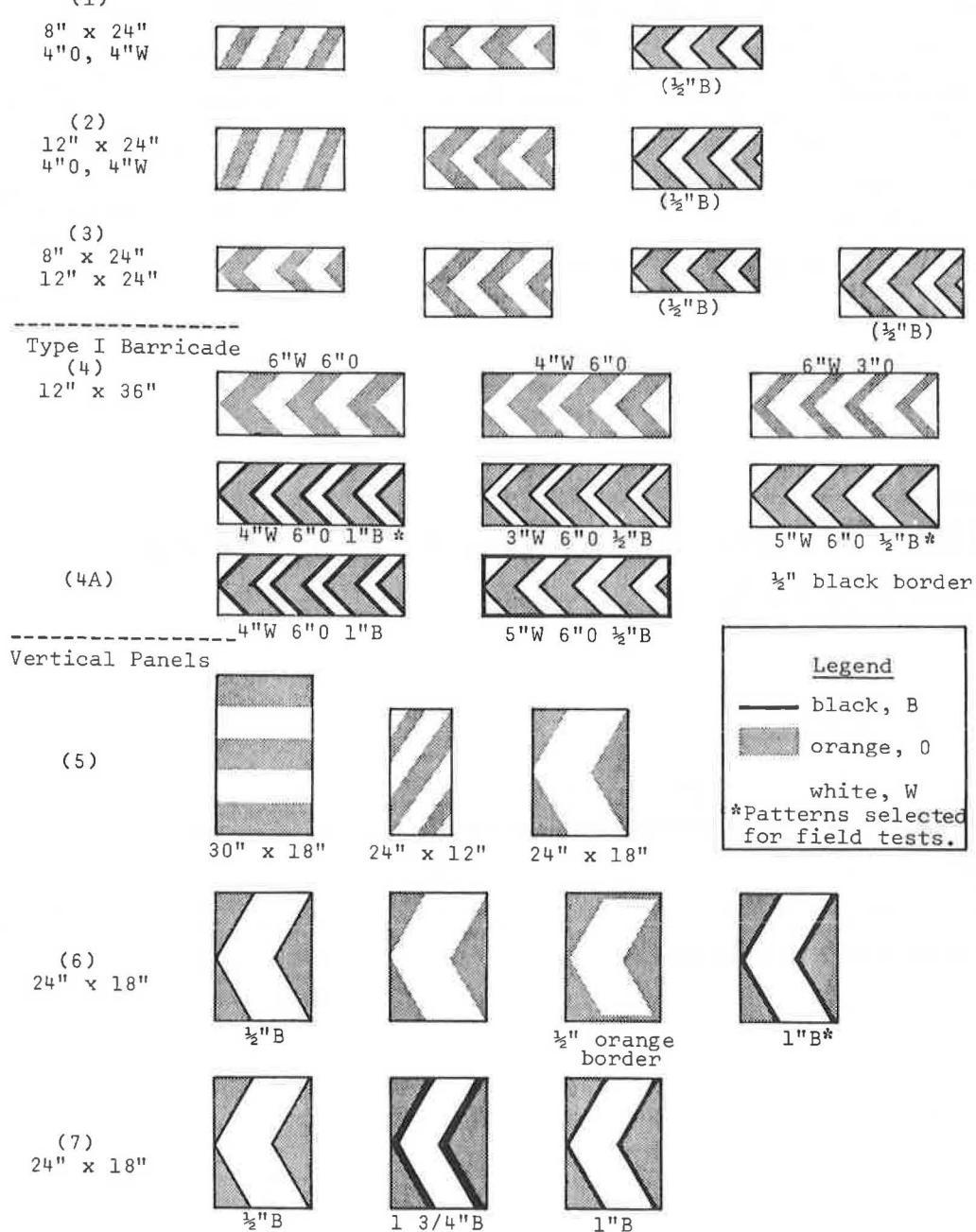


Figure 2. Zone system at test site.

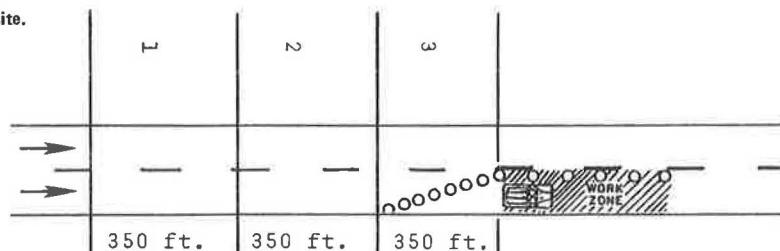
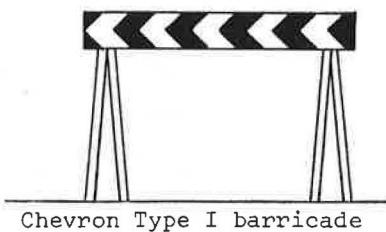
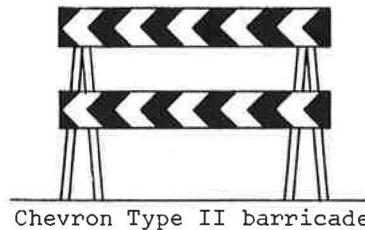


Figure 3. Currently used and proposed devices compared in field tests.

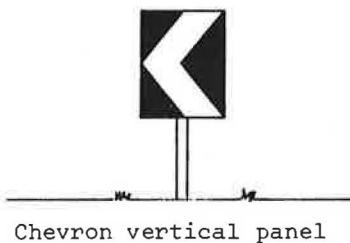
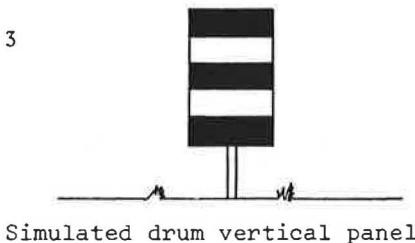
Test No. 1



Test No. 2



Test No. 3



Test No. 4



change lanes in that zone was obtained. Note that zone 3 was the critical zone because forced mergers occurred there.

The devices compared in the field tests are displayed in Figure 3. Data were collected at two sites, both on an Interstate road, for an average of 21 h for each device except the cone, for which data were collected for 8 h in the daytime only. One of the two sites used a 40-ft taper spacing and the other site used an 80-ft taper spacing. A taper length of 560 ft and a flashing arrow panel were used at both sites.

Method of Analysis

The distribution of lane changes by zone was determined for each channelizing device, and the percentage of lane changes by zones was obtained based on the total of all lane changes that occur in the zone system. Then, the percentages for the currently used and proposed barricades and channelizing devices in each test were compared.

In an effort to establish a single parameter for the comparison in a test and to relate the zone of lane change to its position relative to the work area, zonal lane changes were weighted. The percentage of lane changes within zone i , where i rep-

resents the zone number, and the weighted factors were multiplied and summed. Thus,

$$\text{Weighted lane changes} = 3 \times \text{Zone 1} + 2 \times \text{Zone 2} + 1 \times \text{Zone 3} \quad (1)$$

where zone i is the percentage of lane changes in i . Therefore, the more effective channelizing device is indicated by the higher weighted lane changes. These measures were calculated for day, night, and total (day and night) time periods.

Results

The channelizing devices favored for each of the four tests are shown in Table 1. The differences in weighted lane changes are included. The results are similar for the two sites except for test 3.

The total weighted lane changes for each channelizing device except the chevron panel and type I barricade were greater at 40-ft spacing than at 80-ft spacing. The total weighted lane changes for the type I chevron barricade and chevron panel did not vary much with respect to the change in spacing.

An additional test was incorporated in the study to compare the New Jersey concrete barrier with the channelizing devices. Based on reports that address

Table 1. Channelizing device designs selected from field test results.

Test No.	I-81, Cedar Creek, 40-ft spacing	I-81, Narrow Passage, W.L.C.D. ^a	I-81, Narrow Passage, 80-ft spacing	W.L.C.D. ^a
1	Type I chevron	8.8	Type I chevron	20.0
2	Type II chevron	0.3	Type II chevron	2.5
3	Type III diagonal		Type III diagonal	
4	Drum panel	8.7	Chevron panel	11.3
	Diagonal panel	2.4	Chevron panel	3.3
	Chevron panel		Diagonal panel	

Note: The listing of two channelizing devices indicates equal ratings.

^aW.L.C.D. = Difference in weighted lane changes between the preferred pattern and less preferred patterns.

work zone safety (2,3), bridge work and pavement reconstruction are associated with a greater increase in accident rates than are other construction activities. The typical work zone setup for these activities in Virginia employs a New Jersey concrete barrier and flashing arrow panel. Since the channelizing devices were being tested while serving as a supplement to the New Jersey barrier, a supplemental taper seemed to be an obvious alternative. The New Jersey barrier was rated equal to the cone for day only and lower than all other devices based on the weighted lane changes. Steady-burn beacons and reflectors about 6 in long were mounted on the New Jersey barrier, which had a slope of 16:1 for the 192-ft taper. The recommendation to use a supplemental taper with the New Jersey barrier will be included in the Virginia supplement of the Manual on Uniform Traffic Control Devices (4).

CONCLUSION

The results of this study do not support a recommendation that the chevron patterns be used on all channelizing devices. Except for those relating to the type I chevron barricade, the conclusions do not clearly and consistently favor the chevron pat-

terns. Since, in general, distinct differences in effectiveness are not attributable to the differences in patterns used on a specific type of device, panel, or barricade, we may conclude that the effectiveness of a channelizing device is not based primarily on the pattern used. The chevron patterns generally were rated slightly better or equal to the currently used patterns with which they were compared. The responses of drivers as measured by the position of lane changing were similar for the two types of patterns.

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Effectiveness of City Traffic-Control Programs for Construction and Maintenance Work Zones

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The purpose of this study was to evaluate the present state of the art of city traffic-control programs for construction and maintenance work zones. Information was gathered through two separate investigations to determine the status of present city traffic-control programs for construction and maintenance work zones and the effectiveness of these programs. A survey was conducted by sending questionnaires to cities in the United States that asked for information related to various aspects of the cities' traffic-control programs in work zones. Responses were rated according to each city's degree of involvement in regulating traffic controls in work zones. The results indicated that the amount of importance cities place on traffic-control programs for work zones varies widely and the majority of the cities surveyed do a less-than-adequate job in controlling construction and maintenance activity. Work zones in eight of the surveyed cities were studied to evaluate the effectiveness of the cities' traffic-control programs for work zones. This information was used to rate each of the cities' effectiveness and compare it with the survey ratings by using a statistical ranking procedure. A correlation was found between the survey scores and the field investigation scores. This correlation suggests that the quality of traffic control in the work zones is dependent on the degree of involvement the cities have in regulating construction and maintenance work zones.

With the recent shift of emphasis from the construction of new highways to the rehabilitation and upgrading of existing facilities, a significant effort has been made to improve the quality of traffic control through road construction and maintenance work zones. Much research has been performed to develop more-effective devices for traffic control and standards to use them. As a result of this research, several changes have been made in the Manual on Uniform Traffic Control Devices (MUTCD) (1) and in Federal Highway Administration (FHWA) guidelines for federally funded construction projects.

Since the adoption of this MUTCD, studies are beginning to show that, to a large degree, the standards for traffic-control devices for construction and maintenance work zones and the requirements for their proper use are adequate. A major FHWA