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16. Abstract

The objective of this study was to investigate alternatives to paved mountable medians that have been used in the past on sections of four-lane, partially controlled access roads where right-of-way is restricted. These mountable medians present obvious operational problems due to the 3-inch difference in height as compared to the through lanes. In addition, construction and maintenance problems are associated with mountable medians because of the height differential.

A telephone survey of 16 states was conducted to determine their policy for separation of rural four-lane roads with partial control of access and narrow medians. Accident analyses comparing roads in Kentucky with and without mountable medians were also performed.

Considering results from the survey and the accident analysis, it was determined that the flush median (rather than a mountable median) was an appropriate application for separation of rural four-lane roads with partial control of access and medians less than 20 feet wide.

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Research Report
UKTRP-86-11

TREATMENT OF NARROW MEDIANS ON FOUR-LANE RURAL ROADWAYS

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INTRODUCTION

Narrow medians often are required on four-lane roadways in Kentucky due to mountainous terrain (or right-of-way restrictions). In recent years on four-lane roadways, either partially controlled access or access by permit, paved mountable medians have been constructed. These median widths have primarily been 20 feet (pavement edge to pavement edge). However, in recent years, some 14-foot widths have been utilized. The installation of concrete median barriers has not been practical because of the large number of access points.

These mountable medians present a problem for construction, particularily on four-lane improvements constructed over an existing road. In addition to the construction problems, mountable medians have led to maintenance problems such as difficulties in snow removal, differential settlement, water entering the subgrade through cracks adjacent to median curbs, and problems in resurfacing. Operational problems are also encountered because of the bump (overcoming the 3-inch difference in height) the driver experiences in crossing the median when turning left to enter or to exit a private driveway.

As a result of the problems associated with mountable medians, flush medians on four-lane rural sections of highway with partially controlled access are being considered. Questions concerning the conditions under which flush medians should be used are related to geometric conditions, right-of-way restrictions, traffic volumes, and safety. Following are excerpts from the "AASHTO Green Book" (1) concerning some issues related to median applications:

> Neither barrier nor mountable curb should be used on freeways or other high-speed arterials. Depressed medians are generally preferred on freeways. Raised medians have application on arterial streets where it is desirable to regulate left-turn movements. Flush medians are used to some extent on all types of urban arterials. When used on freeways, it is recommended that the median be slightly crowned or depressed for drainage. Many of the disadvantages of raised medians as related to safety can be eliminated when flush or low-profile mountable medians are used.

The "AASHTO Barrier Guide" (2) provides information about the use of median barriers as related to median width and AADT. It is shown that a barrier is not warranted for 20-foot medians unless the AADT exceeds 20,000 and for 10-foot medians unless the AADT exceeds 12,000.

The types of longitudinal lines that could be used to mark medians are listed in the Manual on Uniform Traffic Control Devices (MUTCD) (3). Yellow lines would be used to delineate the left edge of the pavement of divided highways. A single yellow line is used to mark the median edge line at the mountable median locations. The standard width is 4 inches. The width of line indicates the degree of emphasis so increasing the width to 8 inches (a single wide line) would provide an alternate method to mark flush medians. Double lines indicate maximum restrictions, so another alternate would be to place double yellow lines as the median edge line. Snowplowable markers have been used in recent years in Kentucky as lane delineation. Use of these markers to supplement the median edge line would provide added nighttime delineation, especially during wet-weather conditions.

Color-contrast surface treatments and synthetic binder concrete have been used to delineate flush medians but were not observed to provide consistently good delineation and durability (4). The color-contrast surface treatments were generally observed to provide poor delineation, especially at night and in wet weather. Synthetic binder concretes were generally observed to be in good physical condition after up to six years, but the yellow quickly faded to a dirty gray. Although good dry-day delineation was provided, night and wet-weather delineations were very poor.

SURVEY OF OTHER STATES

A telephone survey of 16 state highway agencies was conducted for the purpose of determining their policy for separation of rural four-lane roadways with partial control of access when medians are narrow (less than 20 feet). Included in the survey were the following states: 1) seven states in FHWA Region 4, other than Kentucky, 2) six states having borders in common with Kentucky (in addition to Tennessee, which is also in FHWA Region 4), and 3) the states of Arkansas, California, and New York because they had been mentioned as states using flush medians on some rural roads.

Results of the telephone survey are presented in Tables 1 through 3. Table 1 is a summary of each state's policy for separation of rural four-lane roadways with partial control of access when medians are narrow. It should be noted that this is not their formalized written policy, but a summary of comments from discussions with design personnel who were familiar with median applications in their state. Responses from the 16 states ranged from use of only 88-foot medians with no consideration of narrow medians (Mississippi) to 2- to 4-foot flush medians (New York). A concrete median barrier wall was the most frequently mentioned application and it is standard for five states (Illinois, Missouri, Ohio, South Carolina, and Virginia). California also uses the concrete barrier when AADT's range from 10,000 to 20,000 and medians are 14 to 20 feet. Non-mountable medians are the most frequently used applications in Arkansas and Georgia. Mountable or semi-mountable medians are used in Florida, North Carolina, and West Virginia. Flush medians are used for AADT's less than 10,000 in California and on rural roads with access by permit in New York. Three states indicated they did not have narrow medians on rural roads of this type and their standard application was depressed grass medians ranging from 42- to 88-feet wide (Mississippi, Alabama, and Tennessee). Several states made reference to the "Green Book" (1) and the "AASHTO Barrier Guide" (2) as their formal standard for median applications.

Each state also was questioned concerning their general policy related to the use of flush medians in rural areas (Table 2). Most did not have a formal policy, but some rural roads with narrow medians were treated separately because of right-of-way limitations. In all states there was extensive usage of two-way left-turn lanes in urban areas. However, most states did not continue these two-way left-turn lanes into rural areas (exceptions were Indiana and Tennessee where some usage in rural areas occurred). Of the 16 states surveyed, seven had used flush medians in high-speed rural areas with partial control of access. The most extensive usage of flush medians in rural areas was in Arkansas, California, and New York. In these three states, usage of flush medians appears to be a standard application for some types of roads. In Arkansas, the standard is a 6-inch curbed median that is not mountable;

however, there are several 52-foot roadways with a 4-foot flush median. They had not used flush medians wider than 4 feet and no problems had been associated with the 4-foot medians. In California, there is a standard for two 24-foot roadways with flush median width of 5 feet. In New York where access is by permit for driveways, a 2- to 4-foot flush median is used. Flush medians also are used on roadways with partial control of access and 12- to 14-foot medians.

As noted previously, Indiana and Tennessee were two states where two-way left-turn lanes were used in urban areas and were continued into rural areas in some cases. In Ohio, it was indicated that there was limited usage of flush medians in rural areas and there is a preference of flush medians compared to mountable medians. Georgia reported that flush medians have been used when median widths are 14 to 20 feet; however, safety problems exist that suggest they should be eliminated and further use discontinued.

For the seven states reporting usage of flush medians on high-speed rural highways, a summary of types of traffic control used with flush medians was prepared (Table 3). Three states (Arkansas, Georgia, and Ohio) used only paint-stripe delineation. In California, paint stripes were supplemented with raised pavement markers to delineate the flush median. Indiana used paint stripes and overhead signs for traffic control in a similar manner as two-way left-turn lanes in urban areas would be marked. New York and Tennessee used paint stripes and some form of textured pavement. The use of textured or colored pavement in the median was mentioned as a means of alerting drivers that the median was not a through lane or a turning lane. In New York, the flush median was paved with a synthetic white binder and 1/4-inch aggregate. They did indicate that problems existed with the colored pavement and it was no longer being used. In Tennessee, a different gradation aggregate has been used to show the change from through lanes to a turning lane or median. Georgia mentioned they were considering rolled-in rumble strips on asphalt medians as additional traffic control.

In addition to the 16 states surveyed, it also should be noted that the subject of flush medians was discussed with Federal Highway Administration representatives in Frankfort, Atlanta, and Washington. There was a concensus that no formal policy existed for the type of median that should be used for rural high-speed roadways with narrow medians and partial control of access. When questioned concerning use of mountable versus flush medians, there was some concern whether flush medians may compromise safety under some conditions. There was also a mention of the necessity to delineate the flush median in such a way as to prevent its usage as a through or turning lane. A traffic control application suggested by one FHWA representative was paint stripe and raised pavement marker delineation with rolled-in rumble strips in the median area. Slotted drains for drainage of the flush medians also were suggested.

ACCIDENT ANALYSIS

Accident data were summarized for several sections of rural four-lane roads where mountable medians have been provided. The routes are listed in Table 4. There was a total of 168 miles included in the analysis. Accident data were obtained for a three-year period (1983-1985) and accident rates were

calculated. The rates varied from 93 accidents per 100 million vehicle-miles (ACC/100 MVM) on KY 80 between Hazard and Watergap to 393 ACC/100 MVM on US 23. The overall rate for all locations was 166 ACC/100 MVM, compared to the statewide rate for rural four-lane divided (no access control) highways of 169 ACC/100 MVM using 1980 through 1983 accident data for an average of 211 miles of this type of highway (5). In 1984, on 258 miles of this type of highway, an average rate of 175 ACC/100 MVM was calculated. The overall accident rate for the roadways listed in Table 4 was very similar to the statewide rate for rural four-lane divided (no access control) highways. This category would include roadways with mountable, flush, depressed, and raised medians. The median width for all sections analyzed was 20 feet, with the exception of KY 80 between Hazard and Watergap, which had a 14-foot median.

Accident data at mountable-median locations were analyzed, using the directional analysis code, to determine the number of opposite direction types of accidents that had occurred. These were the types of accidents that could be related to having no median barrier. The types of accidents, as shown in Table 5, were the following:

1. intersection, opposite direction,
2. non-intersection, head-on,
3. non-intersection, opposite direction sideswipe,
4. non-intersection, median crossover, and
5. bridge, opposite direction sideswipe.

Most of these accidents were either non-intersection, opposite direction sideswipe or head-on accidents. The percent of these accidents of the total varied from 1.9 percent on US 60 between Lexington and Versailles to 17.6 percent on US 23 between Dorton and Robinson Creek, with an overall percentage of 6.2 percent.

A comparison between the percentage of these accidents at the mountable-median locations with all statewide accidents is given in Table 6. The overall percentages were similar. This comparison does not indicate that the mountable-median locations have had an unusual problem with opposite-direction types of accidents. A comparison of single vehicle accidents showed that approximately 18 percent of the accidents at the mountable-median locations were single vehicle compared to about 19 percent of statewide accidents that shows there was not a problem with this type of accident.

Severity of the various types of accidents is given in Table 7. The most severe accident types were the head-on and median-crossover accidents that occurred on roadway sections.

Various characteristics of these opposite-direction accidents at the study locations were compared with statewide accidents (Table 8). A summary by light condition revealed that a slightly lower percentage of these accidents ocurred during non-daylight hours compared to statewide accidents. There was a substantially higher percentage of the opposite-direction accidents that occurred during wet or snow conditions compared to statewide accidents. This also would be related to the finding that slippery surface and water pooling was listed as a contributing factor more often in these accidents. The severity of these opposite-direction type accidents was high, with about 48 percent of the accidents involving an injury or fatality. This

compares to 37 percent of all accidents on rural four-lane (no access control) highways and 22 percent for total statewide accidents. The summary by type of vehicle indicates that a slightly higher percentage of trucks were involved in the opposite-direction accidents. As would be expected by virtue of the type of accident, failure to yield right of way was listed in a high percentage of the opposite-direction accidents. Other driver-related factors listed in a substantially higher percentage of accidents than statewide accidents were unsafe speed and improper passing. In addition to the slippery surface and water pooling factors, road construction was listed in a higher percentage of the opposite direction than statewide accidents.

SUMMARY OF RESULTS

A telephone survey of 16 states was conducted for the purpose of determining their policy for separation of rural four-lane roadways with partial control of access when medians are narrow. A concrete median barrier was the most frequently mentioned and it is standard for five states. Non-mountable medians were standard applications in two states. Mountable or semi-mountable medians were used frequently in three sates. Three states indicated they did not have narrow medians on rural four-lane roads. Flush medians were standard applications on rural four-lane roads with less than 10,000 AADT in California and on rural four-lane roads with access by permit in New York.

In all states, there was extensive usage of two-way left-turn lanes in urban areas; however, most states did not continue them into rural areas. Of the 16 states surveyed, seven had used flush medians in high-speed rural areas with partial control of access. The most extensive usage of flush medians was in California, New York, and Arkansas.

The most common type of traffic control to delineate flush medians was paint stripes. California supplemented paint with raised pavement markers. Indiana used overhead signs in a manner similar to two-way left-turn lanes in urban areas. Textured pavements in the median were used in New York and Tennessee. Rolled-in rumble strips were mentioned as additional traffic control.

The accident analysis indicated that the overall accident rate on the routes with mountable medians was very similar to that for all rural four-lane divided (no access control) highways. Also, the percentage of the opposite-direction type of accidents was not higher on these roadways than noted statewide. As expected, the severity of the opposite-direction accidents was high as compared to all accidents on this type of highway. Wet or snowy road surface conditions were a contributing factor that was over represented in the opposite-direction accidents while accidents during darkness were not observed to be over represented compared to statewide accidents.

Considering the response from other states concerning flush medians and the accident analysis of mountable medians in Kentucky, it appears that use of flush medians on some highway sections may be justified. Specifically, the flush median appears to be an appropriate application for separation of rural four-lane roadways with partial control of access and where medians are less than 20 feet wide. The "AASHTO Green Book" (1) indicates that neither barrier

nor mountable curb should be used on freeways or high-speed arterials. The "AASHTO Barrier Guide" (2) indicates that a median barrier is warranted only when the volume exceeds approximately 12,000 AADT for medians 10 feet wide and volumes exceeding 20,000 AADT for medians 20 feet wide.

When flush medians are used, the type of traffic control to be used should include paint stripes, raised pavement markers, and rolled-in rumble strips. Paint stripes should be 8-inch wide yellow stripes on each side of the flush medians and these stripes should be supplemented with snowplowable pavement markers at 40-foot spacings. The rolled-in rumble strip should be continuous and a 3-foot wide strip at 6-inch spacings could be used on each side of the flush median.

For the purposes of drainage when flush medians are used, the roadway should be crowned as normal. If drainage is determined to be a problem in the superelevated sections with flush medians, then consideration may be given to sloping the medians to prevent runoff into the through lanes. Longitudinal slotted drains could be used for drainage.

REFERENCES

1. A Guide on Geometric Design of Highways and Streets, American Association of State Highway and Transportaton Officials, 1984.

2. Guide for Selecting, Locating, and Designing Traffic Barriers, American Association of State Highway and Transportation Officials, 1977.

3. Manual on Uniform Traffic Control Devices, U.S. Department of Transportation, Federal Highway Administration, 1978.

4. Bryden, J. E., "Performance of Shoulder and Median Contrast Treatments," New York State Department of Transportation, 1979.

5. Salsman, J. M. and Agent, K. R.; "Traffic Accident Rates in Kentucky (1983)," University of Kentucky Transportation Research Program, Report UKTRP-85-2, January 1985.

TABLE 1. POLICY FOR SEPARATION OF RURAL FOUR-LANE ROADWAYS WITH PARTIAL CONTROL OF ACCESS WHEN MEDIANS ARE NARROW

STATE	POLICY
Alabama	Normally use 54-foot median; not aware of situations where medians less than 54 feet are used in rural areas.
Arkansas	Standard application is a 6-inch curbed median that is not mountable.
California	For ADT's greater than 20,000, typical median is 30 feet in urban areas and 46 feet in rural areas. For ADT's 10,000 to 20,000, minimum median width is 14 feet and concrete barrier would normally be used. For ADT's less than 10,000, medians as narrow as 4 feet can be used with only paint stripe and RPM separation.
Florida	Most four-lane roads have 22-foot medians. For speeds less than 50 mph, a 4-inch mountable median curb is used. (AASHTO Type E Curb).
Georgia	For medians less than 20 feet, a non-mountable 6- to 8-inch barrier curb is used (AASHTO Type A Curb).
Illinois	Normally use depressed median. Use concrete barrier for 14- to 20-foot median.
Indiana	Use barrier wall or guardrail based on volume warrants in AASHTO Barrier Guide.
Mississippi	An effort has been made to eliminate narrow medians and use only 88-foot medians for new construction.
Missouri	Use New Jersey concrete barrier for narrow medians.
New York	Where access by permit with driveways, typically use 2- to 4-foot flush medians.
North Carolina	For widths less than 30 feet, mountable or grass medians used.
Ohio	For median width less than 30 feet and AADT greater than 1,000 and design speed greater than 50 mph, a barrier is warranted.
South Carolina	Use New Jersey concrete barrier for medians less than 20 feet on rural high-speed roads.
Tennessee	Recommended minimum width is 42 feet and an effort has been made to eliminate medians less than 20 feet when possible.
Virginia	Box beam rail or concrete barrier used when required to medians 14 to 20 feet wide.
West Virginia	Semi-mountable median used for widths 14 to 20 feet.

TABLE 2. POLICY FOR USE OF FLUSH MEDIANS

STATE	POLICY
Alabama	Used only in urban areas and are transitioned to 54-foot medians when going from urban to rural location.
Arkansas	For some 52-foot roadways, a 4-foot flush median is used with only paint stripe separation. Not aware of any problems associated with 4-foot medians. Have not used flush medians wider than 4 feet.
California	Have standard with two 24-foot roadways with 4- to 8-foot shoulders and variable median width. Median width is 5 feet for four lanes and 8 feet for six or more lanes.
Florida	Do not use flush medians for rural high-speed roads.
Georgia	Flush medians have been used when median widths are 14 to 20 feet; however, safety problems exist that suggest they should be discontinued.
Illinois	Use in urban areas with two-way left-turn lanes when speed limit is 45 mph or below.
Indiana	Used in both rural and urban areas with two-way left-turn lanes. When number of access points increase, two-way left-turn lanes are used.
Mississippi	Used on five-lane sections with two-way left-turn lanes, primarily in urban areas.
Missouri	Used with 14-foot two-way left-turn lanes in urban areas. Discontinued use of flush medians because of severe accidents.
New York	Used on roadways with partial control of access having 12- to 14-foot medians.
North Carolina	Flush medians used only in urban areas where turning lanes are required.
Ohio	Typically used in urban areas with two-way left-turn lanes. Have some applications of flush medians in rural areas and prefer them to mountable medians.
South Carolina	Use only for medians less than 20 feet in urban areas.
Tennessee	Has been used on rural high-speed locations with continuous two-way left-turn lanes.
Virginia	Flush medians not used, always provide some type of mountable curb even in urban areas.
West Virginia	Only used in urban areas as two-way left-turn lanes.

TABLE 3. TYPES OF TRAFFIC CONTROL USED WITH FLUSH MEDIANS IN RURAL AREAS

STATE	POLICY
Alabama	N/A
Arkansas	Paint-stripe separation only for medians 4 feet wide.
California	Paint stripes used and supplemented by RPM's in some cases.
Florida	N/A
Georgia	Only use paint-stripe delineation; however, they are considering rolled-in rumble strips as asphalt medians.
Illinois	N/A
Indiana	Paint stripes and overhead signs are used for traffic control.
Mississippi	N/A
Missouri	N/A
New York	Paint stripes and median is paved with synthetic white binder. (Color contrast is no longer used.)
North Carolina	N/A
Ohio	Typically use only paint stripes.
South Carolina	For flush medians in urban areas, previously used chip seal or raised aggregate and there were problems with debris accumulation in medians.
Tennessee	Different gradation aggregate has been used to show change from through lanes to turning lane.
Virginia	N/A
West Virginia	N/A

TABLE 4. SUMMARY OF ACCIDENT DATA FOR SECTIONS WITH MOUNTABLE MEDIANS*

ROUTE	ROUTE DESCRIPTION	LENGTH	ADT**	NUMBER OF ACCIDENTS (1983-85)	ACCIDENT RATE (ACC/100 MVM)
KY 80	Hazard - Watergap	38.43	5,500	179	93
US 60	Lexington - Versailles	8.31	27,800	428	169
US 23	Prestonsburg - Pikeville	25.42	13,480	704	188
US 23	Paintsville - Louisa	23.68	6,900	234	131
US 23	Louisa - Southshore	55.70	10,940	1,299	225
US 23	Dorton - Robinson Ck	8.88	2,380	91	393
US 119	Huddy - S Williamson	7.63	7,890	69	105

* Median width was 20 feet for all sections except KY 80 between Hazard and Watergap, which had a 14-foot median.

** Weighted average daily traffic volume using volumes for various sections of route.

TABLE 5. SUMMARY OF TYPE OF ACCIDENT FOR SECTIONS WITH MOUNTABLE MEDIANS

ROUTE	TYPE OF ACCIDENT: INTERSECTIONS — OPPOSITE DIRECTION	NON-INTERSECTIONS — HEAD-ON	NON-INTERSECTIONS — SIDESWIPE*	NON-INTERSECTIONS — MEDIAN CROSSOVER	BRIDGES — SIDESWIPE*	TOTAL	PERCENT OF TOTAL
KY 80 Hazard-Watergap	1	4	8	2	0	15	8.4
US 60 Lexington-Versailles	1	3	3	1	0	8	1.9
US 23 Prestonsburg-Pikeville	8	7	25	9	0	49	7.0
US 23 Paintsville-Louisa	1	13	19	0	0	33	14.1
US 23 Louisa-Southshore	15	14	22	3	1	55	4.2
US 23 Dorton-Robinson Ck	0	1	15	0	0	16	17.6
US 119 Huddy-S. Williamson	0	3	7	0	0	10	14.5
TOTAL	26	45	99	15	1	186	6.2

* Opposite direction sideswipe.

TABLE 6. COMPARISON OF TYPE OF ACCIDENT FOR SECTIONS WITH MOUNTABLE MEDIANS VERSUS STATEWIDE AVERAGES OF ALL ACCIDENTS

	TYPE OF ACCIDENT					
	INTERSECIONS	NON-INTERSECTIONS			BRIDGES	
	OPPOSITE DIRECTON	HEAD-ON	SIDESWIPE*	MEDIAN CROSSOVER	SIDESWIPE*	TOTAL
Percent of All Accidents on Sectons with Mountable Medians	0.9	1.5	3.3	0.5	0.03	6.2
Statewide Average Percent for All Accidents in 1984	1.0	1.5	4.8	0.1	0.00	7.4

TABLE 7. SEVERITY BY TYPE OF ACCIDENT

DIRECTIONAL ANALYSIS DESCRIPTION	NUMBER OF ACCIDENTS			PERCENT INJURY OR FATAL
	PROPERTY DAMAGE	INJURY	FATAL	
Intersection				
Opposite Direction - Both Vehicles Straight	5	2	0	29
Opposite Direction - Other	17	2	0	11
Roadway Section				
Head-on	13	30	2	71
Opposite Direction Sideswipe	55	43	1	44
Median Crossover	6	7	2	60
Bridge				
Opposite Direction Sideswipe	1	0	0	0

TABLE 8. COMPARISON OF CHARACTERISTICS OF OPPOSITE DIRECTION ACCIDENTS AT STUDY LOCATIONS WITH STATEWIDE ACCIDENTS

VARIABLE	CATEGORY	PERCENT WITH GIVEN CHARACTERISTIC: OPPOSITE DIRECTION ACCIDENTS AT STUDY LOCATIONS	PERCENT WITH GIVEN CHARACTERISTIC: STATEWIDE ACCIDENTS (1984)
Light Condition	Daylight	74.2	70.3
	Dawn-Dusk	4.3	3.7
	Darkness	21.5	25.9
Road Surface Condition	Dry	59.1	70.7
	Wet	25.3	20.9
	Snow	15.1	8.3
	Muddy	0.5	0.2
Severity of Accident	Injury	45.2	21.6
	Fatal	2.7	0.5
Type of Vehicle	Automobile	88.2	91.7
	Single Unit Truck	5.6	4.2
	Combination Truck	2.4	2.2
Contributing Factor	Any Human Factor	74.7	78.4
	Unsafe Speed	12.4	8.6
	Alcohol	7.0	6.5
	Failed to Yield Right-of-Way	38.2	16.9
	Following Too Close	2.2	4.4
	Improper Passing	3.2	1.3
	Disregard Traffic Controls	3.8	2.7
	Turning Improperly	2.7	2.8
	Driver Inattention	21.5	29.0
	Any Environmental Factor	36.0	22.0
	View Obstruction	3.2	3.8
	Road Construction	6.5	0.4
	Slippery Surface	21.0	11.5
	Water Pooling	5.9	0.7
	Any Vehicular Factor	4.8	7.2