USE OF HIGHWAY GEOMETRICS TO IDENTIFY ROADSIDE HAZARD LOCATIONS

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(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

Charlottesville, Virginia

October 1977
VHTRC 78-R21

GENERAL GUIDANCE AND ADVICE ON THE RESEARCH REPORTED HEREIN HAS BEEN PROVIDED BY THE TRANSPORTATION PLANNING RESEARCH ADVISORY COMMITTEE

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SUMMARY

In recent years more than one-third of the nation's annual traffic fatalities have resulted from vehicle crashes with roadside obstacles. The purpose of this study was to determine if criteria developed for identifying roadside hazard locations in a Georgia study could be applied in Virginia to reduce the number of these crashes. Basically, the study was focused upon roadway locations conforming with three criteria; namely, (1) nonlocal highways, (2) curvature of 6 degrees or greater, and (3) 2% or steeper downgrades. It consisted of (1) identifying all criteria sites on primary highways in Augusta County, (2) randomly selecting and then pairing ten sites meeting the criteria and ten sites not meeting the criteria, (3) collecting traffic accident data for the sites, and (4) comparing the crash experience for the ten pairs. It was found that 2.6 times more single-vehicle fixed object crashes occurred at the sites meeting the Georgia criteria.

It was recommended that officials managing the Virginia highway safety improvement program should place increased emphasis on low cost improvements by initiating action to remove or modify roadside hazards at locations meeting the three criteria. Such improvements could include special traffic signing, pavement grooving or resurfacing to increase skid resistance, repainting of pavement markings, recontouring of ditches, relocation of utility poles, removal of trees on a selected basis, or the installation of guardrails.

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INTRODUCTION

In recent years more than one-third of the nation's annual traffic fatalities have resulted from vehicle crashes with roadside obstacles.(1) Such crashes, according to a report on a 1976 study conducted in Georgia, could be reduced in number by identifying and improving locations at which they are especially likely to occur.(2) Essentially, the Georgia study concluded that roadway sections meeting the following criteria should be considered potentially hazardous.

1. Nonlocal highways
2. Curvature greater than 6 degrees, and
3. 2% or steeper downgrade.

One analysis of information from the study concluded that the 2.6% of the 67,000 miles of highway studied that conformed with these criteria experienced 21.4% of the 300 fatal single vehicle-fixed object crashes occurring in the study area. Consequently, it was recommended that "top priority should be given to roadside hazard modification on or near curves greater than 6 degrees, particularly those accompanied by downhill grades of 2% or steeper on nonlocal roads".(2) A coauthor of the report interpreted the data to suggest that if no improvements are made at the sites, "one death will occur per 31 miles of such roads per year".*

Other studies have tended to support the validity of these roadside hazard criteria. Accident rates on highways curved at least 4 degrees were found to be between two and four times higher than rates on other highway sections.(3,4,5,6,7)

* Personal correspondence from L. S. Robertson of the Insurance Institute for Highway Safety.

The Georgia findings should be useful to officials managing the highway safety improvement program. In 1973, the program received federal funds specifically for projects to eliminate roadside hazards.(8) Since 1976, federal funds for state programs have been allocated in a category combining projects for improving roadside hazard locations with projects for improving high hazard locations (e.g., busy intersections)(9) and state program management officials have some leeway in setting the proportion that will be spent for roadside hazard projects. Thus, information concerning the usefulness of roadside hazard criteria should aid them in arriving at decisions concerning what will or will not be done to reduce vehicle crashes with roadside obstacles.

PURPOSE

To find out whether the Georgia criteria could be usefully applied in Virginia, a pilot study was conducted to compare traffic crashes at criteria sites with traffic crashes on other highway sections.

METHOD

The pilot study consisted of (1) identifying all sites meeting the Georgia criteria on rural primary highways in Augusta County, (2) randomly selecting and then pairing ten sites meeting the criteria and ten sites not meeting the criteria, (3) collecting traffic accident data for the sites, and (4) comparing the crash experiences for the ten pairs.

Techniques from the Georgia study were used to develop an analysis of fixed object crashes in which single vehicles approached a roadway curve of at least 6 degrees having a 2% or steeper downgrade. Designated criteria and noncriteria locations were established to encompass 0.32 km (0.2 mile) of highway per study site. Each of the sites not meeting the criteria was located a mile in advance of the criteria site with which it was paired, except in special cases where the closest alternate location had to be substituted.

The locations of 31 suitable criteria sites, listed in Appendix I, were identified by reviewing the design plan geometrics for 223 km (138.6 miles) of rural primary (nonlocal) highways in Augusta County. The HP-RNDORD (random number generator)

computer program was used to randomly select 10 criteria sites which were matched with 10 noncriteria sites. The characteristics of the study sites are summarized in Appendix II. Data were then collected from records of all traffic accidents reported at the 10 pairs of sites during 1971 through 1975. Within 1.6 km (1 mile) of each site, the milepost locations of all reported crashes were checked.

There were no construction operations which could have affected the accident rates during the study period. Roadway speed limits were 88.5 km per hour (55 mph), the maximum allowable, at 7 of the criteria sites, and 72.5 km per hour (45 mph) at the other three. All sites were on undivided highways, and the average daily traffic volume for the combined sites was 2,075 during the study period.

ANALYSIS

Information from a Minnesota roadside study,[5] a New York study of accidents related to highway shoulders,[3] an interstate highway accident study,[7] and the National Cooperative Highway Research Program project 2-3[4] clearly suggests that 100% to 300% more traffic crashes can be expected at the criteria sites than on other highway segments. The data from the Virginia pilot study, summarized in Table 1, showed that the 10 criteria sites experienced 78.6% more total crashes than the 10 noncriteria sites.

Table 1

Summary of Crash Data for Study Sites, 1971-75

Crash Severity	Noncriteria Sites	Criteria Sites
Fatal crashes	1	0
(Fatalities)	(1)	(0)
Injury crashes	3	8
(Persons injured)	(7)	(10)
Property damage only crashes	10	17
Total crashes	14	25

The crashes are categorized by type in Table 2.

Table 2

Distribution of Study Site Crashes by Type, 1971-75

Collision Type	Noncriteria Sites		Criteria Sites	
	No. Crashes	Percent of Total	No. Crashes	Percent of Total
Single vehicle-fixed object	5	35.7	13	52.0
Rear end	3	21.4	1	4.0
Sideswipe	1	7.2	4	16.0
Angle	0	0.0	2	8.0
All others	5	35.7	5	20.0
Total	14	100.0	25	100.0

Single vehicle-fixed object crashes accounted for 35.7% and 52.0% of the total crashes at the noncriteria and criteria sites, respectively. The difference in total crashes (11) at the sites was largely due to the greater number of fixed object crashes (13 vs. 5) at the criteria sites. Thus, the criteria site curve and grade conditions were associated with 2.6 times more single vehicle-fixed object crashes.

The statewide statistics shown in Table 3 are indicative of the degree of severity of single vehicle-fixed object crashes.

The single vehicle-fixed object crashes are listed by study site number in Table 4. Apparently, none of the individual sites had a conspicuously high frequency of fixed object crashes.

The data from the pilot study tend to support the Georgia study's conclusion that sites having curvatures of at least 6 degrees and 2% downgrades are associated with higher frequencies of fixed object accidents than are other roadway locations.

Table 3

Statewide Fixed Object Crashes by Degree of Severity

Type	Virginia Accidents, 1975*	
	Number	Percent of Total
Fatal crashes	305	1.2
Personal injury crashes	9,024	35.0
Property damage only crashes	16,454	63.8
Total	25,783	100.0

(Source: Virginia Crash Facts, Virginia Department of State Police.)

Table 4

Fixed Object Crashes by Study Site, 1971-75

Site Number	Noncriteria Site	Criteria Site
9	1 (1)**	3
26	2 (1)***	2 (2)**
11	0	1 (1)**
7	0	4 (1)**
16	0	0
12	0	0
20	1 (1)**	1 (1)**
19	1	0
29	0	2
24	0	0
Total	5 (2)**(1)***	13 (5)**

* Fixed object crashes not involving another vehicle or pedestrian.
** Injury crashes.
*** Fatal crashes.

IMPLEMENTATION OF FINDINGS

A program for implementing the findings of the pilot study should include four activities; namely, (1) a review of highway design plans to identify criteria sites, (2) the collection of crash and traffic data for an accident analysis, (3) an inspection of field conditions at the sites which have experienced fixed object crashes, and (4) a determination of what low cost highway safety improvements are needed to remove or modify hazardous roadside obstacles.

RECOMMENDATIONS

The Virginia highway safety improvement program should place increased emphasis on low cost improvements by initiating action to eliminate roadside hazards at heavily traveled roadway sections having 6 degree or greater curves and 2% or steeper gradients. Such improvements could include special traffic signing, pavement grooving or resurfacing to increase skid resistance, repainting of pavement markings, recontouring of ditches, relocation of utility poles, removal of trees on a selected basis, or the installation of guardrails.

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9. Highway Safety Act of 1976, Public Law 94-280, U. S. Congress, May 5, 1976.

APPENDIX I

VIRGINIA PILOT STUDY SITES, AUGUSTA COUNTY

Site Number	Route Number	Milepost Number			
		Criteria Site		Noncriteria Site	
		Beginning	End	Beginning	End
1	11	16.43	16.63	N/A*	N/A*
2	254	19.06	19.26	18.06	18.26
3	254	21.37	21.57	20.37	20.57
4	254	22.32	22.12	23.32	23.12
5	254	22.54	22.34	23.54	23.34
6	254	22.76	22.56	23.76	23.56
7	340	26.35	26.55	25.35	25.55
8	250	1.02	1.22	0.36	0.56
9	250	1.23	1.43	0.57	0.77
10	250	24.29	24.09	N/A	N/A
11	250	31.17	30.97	32.17	31.97
12	250	32.95	32.75	33.95	33.75
13	42	10.83	10.63	11.95	11.75
14	42	11.53	11.73	10.23	10.43
15	42	12.93	13.13	11.96	12.16
16	42	15.30	15.10	16.60	16.40
17	42	16.04	16.24	17.04	17.24
18	42	17.76	17.96	18.80	19.00
19	42	17.72	17.52	18.72	18.52
20	42	20.15	19.95	21.15	20.95
21	42	21.67	21.47	22.67	22.47
22	42	22.16	21.96	23.16	22.96
23	252	10.08	10.28	11.08	11.28
24	252	9.58	9.38	10.58	10.38
25	252	9.11	8.91	10.81	10.61
26	252	8.85	8.65	9.85	9.65
27	42	7.82	8.02	6.82	7.02
28	42	8.71	8.51	10.20	10.00
29	42	9.20	9.40	8.20	8.40
30	42	9.61	9.41	11.11	10.91
31	42	9.83	9.63	11.33	11.13

*N/A - Not applicable because a matching noncriteria site could not be established where a highway (site 1) entered city limits and (site 10) the number of traffic lanes varied.

APPENDIX II

STUDY SITE CHARACTERISTICS

Criteria Site			Noncriteria Site				
Number	Maximum Curvature (degrees)	Maximum Gradient (percent)	Number	Maximum Curvature (degrees)	Maximum Gradient (percent)	Speed Limit Km/hr	Average Daily Traffic 1971-75
9	9	4.9	9	3	4.9	72.5	6,254
26	6	5.6	26	0	5.0	88.5	1,254
11	6	5.0	11	2	2.0	88.5	1,615
7	6	7.0	7	2	3.0	72.5	3,298
16	6	2.1	16	5	1.7	88.5	989
12	7	4.0	12	0	2.0	88.5	1,615
20	6	2.6	20	4	5.0	88.5	1,912
19	6	2.8	19	3	2.4	88.5	989
29	10	4.8	29	3	1.0	72.5	1,551
24	6	4.4	24	0	4.0	88.5	1,254