FHWA-78-4

MAINE FACILITY RESEARCH SUMMARY

DYNAMIC SIGN SYSTEMS FOR NARROW BRIDGES

RURAL ROAD EXPERIMENTATION FOR TRAFFIC SAFETY AND CAPACITY

U.S. DEPARTMENT OF TRANSPORTATION
Report No. FHWA-RD-78-33
MAY 1978

FOREWORD

This summary report will be of particular interest to traffic engineers and others who are concerned with traffic operations in the vicinity of narrow bridges. The report briefly describes an experiment that examined several dynamic sign systems for alerting motorists to the presence of narrow bridges.

The results of the study showed that use of strobe lights, flashing beacons, neon signs and lights illuminating the bridge had very little effect in causing drivers to alter their travel speed (2 mph) or their lateral position in approaching and traversing the bridge.

Sufficient copies of this report are being distributed by FHWA to provide two copies to each regional office, two copies to each division office, and two copies to each State highway agency. The State and division office copies are being sent directly to each division office.

Charles F. Scheffey
Director of Research

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-RD-78-33		

4. Title and Subtitle	5. Report Date
MAINE FACILITY RESEARCH SUMMARY: DYNAMIC SIGN SYSTEMS FOR NARROW BRIDGES	May 1978
	6. Performing Organization Code
7. Author(s) Joseph S. Koziol, Jr.	8. Performing Organization Report No. DOT-TSC-FHWA-78-4
9. Performing Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration Transportation Systems Center Cambridge MA 02142	10. Work Unit No. (TRAIS) HW801/R8202 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Office of Research Washington DC 20590	13. Type of Report and Period Covered Final Report June 1976-December 1977 14. Sponsoring Agency Code

15. Supplementary Notes

The FHWA Monitor was Maurice Lanman

16. Abstract

An overview of the Maine Facility - a two lane rural highway test site - is presented and an experiment conducted at the facility between August and December 1976 is summarized. The experiment was designed to test and evaluate the application of dynamic (activated) sign systems in alerting motorists to the presence of narrow bridges on two-lane rural highways.

This is the second in a series of reports planned to summarize completed experiments run at the Maine Facility. The first report entitled "MAINE FACILITY RESEARCH SUMMARY, Results 1973-1976" was completed in May 1977 and described five experiments including Speed Control in Rural School Zones, Evaluation of Speed Control Signs for Small Rural Towns, Narrow Bridge Warning Devices, Flashing Traffic Control Devices at Intersections, and Passive Signing at Railroad Crossings.

The experiment summarized in this report is discussed in more detail in a Transportation Systems Center Final Report (see reference 3).

17. Key Words	18. Distribution Statement
Traffic Safety, Rural Highways, Activated Sign Systems, Narrow Bridge, Experimentation, Evaluation, Driver Behavior	DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	18	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

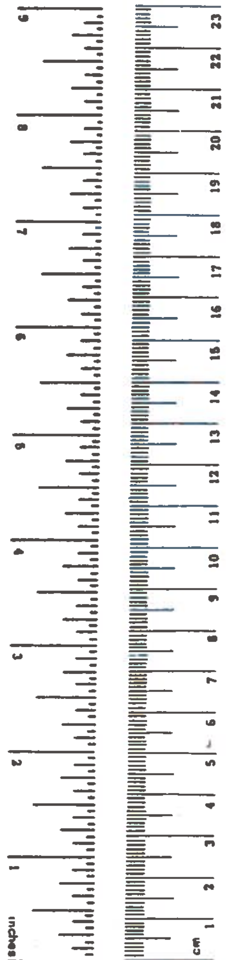
PREFACE

This report is intended to disseminate the results of research activities at a two-lane rural test site for improving traffic safety and capacity on two-lane rural roads through speed and hazard-warning displays, and to introduce potential users to the experimental capabilities of the site. More detailed information on the subject matter of this report is available from the Transportation Systems Center, Code 721, Cambridge MA 02142; from the Federal Highway Administration, Traffic Systems Division, HRS 33, Washington DC 20590; or from the Maine Facility (see the mail-in form on page 13).

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

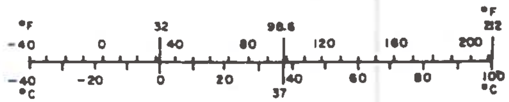


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1. INTRODUCTION

This report presents an overview of the Maine Facility – a two-lane rural highway test site – and summarizes a past experiment conducted there. The Maine Facility[1] is a 15-mile (24 km) section of electronically instrumented two-lane highway capable of detecting vehicles and their approximate size and tracking their positions in real time. The data are collected via a computer-controlled data acquisition system and stored on magnetic tape for subsequent data reduction and evaluation of traffic behavior. Manual data such as vehicle type, male/female driver, and in-state/out-of-state vehicle may also be collected and collated with the electronic data for evaluation. Data reduction to the form of statistical tables is also performed at the facility.

Thus, the facility serves as a test site (data collection and reduction) for obtaining basic traffic characteristics data and for developing and evaluating static and dynamic traffic control remedial aids in the interest of improving safety and the level of service on rural two-lane highways. The 15-mile section of highway has many of the potentially dangerous characteristics found on rural two-lane highways – sight-restricted intersection, narrow bridge, steep grades, populated areas, at-grade railroad crossings, narrow shoulders, and a relatively high percentage of seasonal nonlocal traffic. Several experiments have already been conducted at the facility. Five of these studies and results were summarized in the first of a series of reports[2] on experiments conducted at the Maine Facility. This report describes and summarizes the results of a sixth experiment – to test and evaluate the application of dynamic (activated) sign systems in alerting motorists to the presence of narrow bridges on two-lane rural highways. This experiment was conducted at the facility between August and December 1976. A complete report[3] on this experiment is also available. All additional completed experiments run at the Maine Facility will be similarly summarized, and information on these can be obtained by filling out the mail-back form on the last page of this report.

2. EVALUATION OF DYNAMIC SIGN SYSTEMS FOR NARROW BRIDGES

The objective of this experiment was to evaluate the effectiveness of dynamic (activated) sign systems in alerting motorists to the presence of narrow bridges on two-lane rural highways. A previous experiment concerned with passive remedial systems to reduce the hazards and vehicle conflicts on narrow bridges was also conducted at the Maine Facility, summarized in the first Maine Facility Research Summary Report[2] and detailed in a more comprehensive report.[4]

Vehicle speed and lateral placement (perpendicular distance to roadway centerline) data were gathered for each of the dynamic sign systems tested as well as for the base (before) passive system as drivers approached and crossed the narrow bridge. These data were used as the primary measures of effectiveness for determining the ability of each of the sign systems to increase safety and improve driver awareness of potential hazards. Also, a roadside survey was independently conducted by the State of Maine and evaluated to determine public reaction to the dynamic sign systems.

The bridge is an overhead steel truss bridge 200 feet long with a guardrail and with a 22-foot curb width. The approach pavement was 24 feet in width. A schematic of the test site including plan and profile views is shown in Figure 1. Vehicle speed data were collected using permanently installed loop sensors that detected vehicles and tracked their positions. The locations of the sensors are indicated in the figure. A total of nine loop sensors were used with tracking capability in both directions. Four loop sensors were located west of the bridge covering a distance of approximately 600 feet while five loop sensors were located east of the bridge covering a distance of approximately 800 feet. All sensors were separated by about 200 feet.

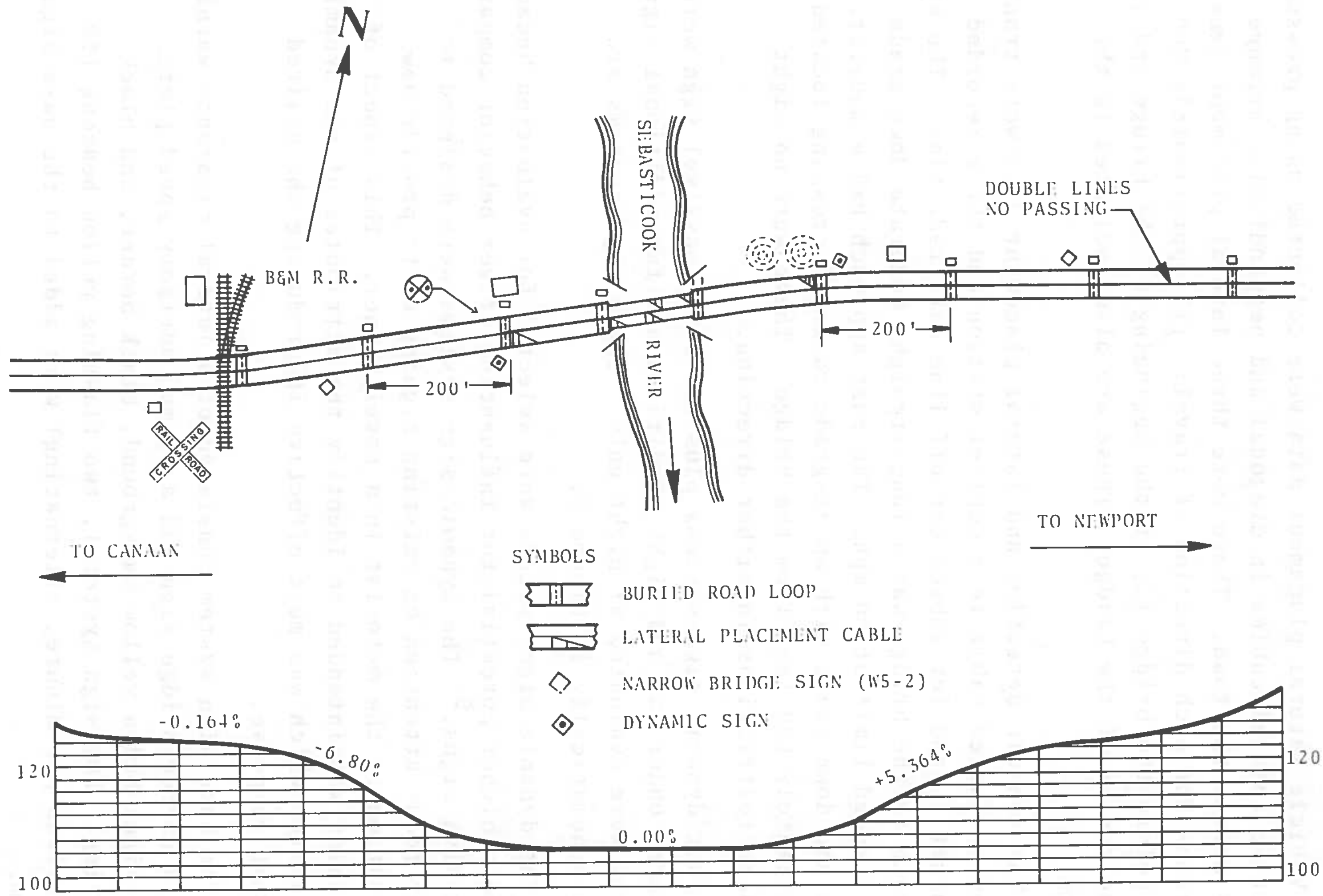


FIGURE 1 MAINE FACILITY NARROW BRIDGE SITE

Vehicle lateral placement data were collected using pressure-sensitive coaxial cables in diagonal and perpendicular arrangements across the road. There were three lateral placement sensor locations for each direction of travel: (1) approximately 200 feet before the bridge (2) at the beginning of the bridge and (3) in the center of the bridge. These are also indicated in the figure.

The vehicle detection and lateral placement data were transmitted by buried cable to a control station and there recorded on magnetic tape for subsequent off-line data reduction. The west approach to the bridge was a long straight moderate down grade with a speed limit of 50 mph. The east approach had a moderate curve and down grade with an at-grade railroad crossing located approximately 600 feet from the bridge. There were no sight-distance restrictions in either direction.

Four dynamic sign systems plus the base (passive) sign were evaluated under day and night conditions and two additional sign systems were evaluated at night only. These sign systems are shown schematically in Figure 2.

The dynamic sign systems were selected for evaluation because of their higher potential for influencing driver behavior compared to passive signs.[5] The dynamic sign systems were designed to either focus attention on existing signing or to provide new information to the motorist in a novel manner. This aspect of the design was intended to identify the attributes of the dynamic sign system which was most effective in producing the desired motorist response.

The base sign system consisted of a lateral clearance warning sign, a narrow bridge sign and a 35 mph advisory speed plate. These signs had a yellow background, black border, and black lettering. For sign system 1, two flashing yellow beacons (60 repetitions per minute, alternating) were added to the base sign system.

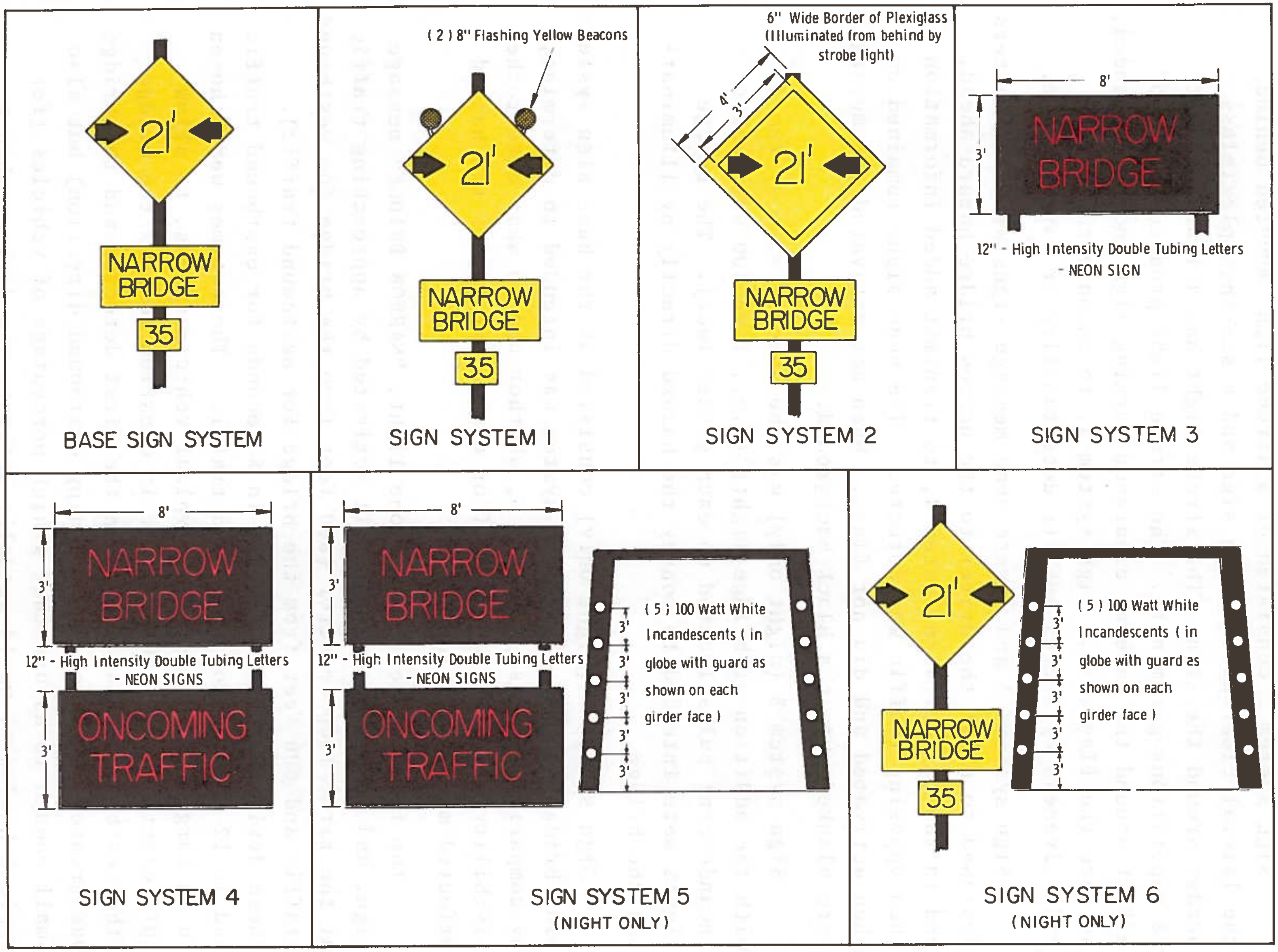


FIGURE 2. SIGN SYSTEMS

Sign system 2 consisted of a strobe light mounted behind the lateral clearance warning sign and a six-inch plexiglass border around the sign. The strobe light had a flash rate of 78 repetitions per minute. The strobe light produced a "halo" effect around the lateral clearance warning sign and was intended, as were the flashers in sign system 1, to enhance the sign effectiveness by increasing its detectability or target value.

Sign systems 3 and 4 were neon message signs with red letters designed to alert the driver to the narrow bridge hazard ahead, and in the case of sign system 4, to transmit added information when opposing traffic was detected. The neon signs remained on when activated and did not flash. When not activated the messages were blanked-out in a black background.

Sign system 5 (night only) was the same as sign system 4 with the addition of bridge lights (i.e., five 100-watt white incandescent bulbs located on each girder face). The bridge lights were intended to convey the hazard directly by illuminating the bridge.

Sign system 6 (night only) consisted of the base sign system plus bridge lights. This sign system was intended to determine, by comparison with sign system 5, whether and to what extent the visibility of the hazard itself or a sign warning of the hazard affected motorists' reactions.

The flashing beacons, strobe light, "NARROW BRIDGE" message sign, and bridge lights were all activated by approaching traffic at the first loop detector (800 feet from the bridge for westbound traffic and 600 feet from the bridge for eastbound traffic). These devices were deactivated in 8 seconds for eastbound traffic and in 12 seconds for westbound traffic. These times were chosen to be large enough, assuming typical vehicle speeds, to allow sufficient time for the vehicle in question to pass the bridge (the westbound distance between the first detector and the bridge was greater than the corresponding eastbound direction) but also small enough to assure that a high percentage of vehicles (for typical headways) would actually activate the devices when a cluster of vehicles approached the bridge. Those following-vehicles with short headways that did not activate a sign system (i.e., entered the measurement region with the sign system already activated by a prior vehicle) were excluded from the analysis.

The "ONCOMING TRAFFIC" message signs were activated by traffic approaching the opposite side of the bridge at the first loop detector. These signs were deactivated at the detector loops 200 feet past the bridge by the "oncoming traffic" vehicle. This method was used to assure that the "ONCOMING TRAFFIC" message was in effect when the "oncoming traffic" vehicle was in the vicinity of the bridge. The "NARROW BRIDGE" message signs and the "ONCOMING TRAFFIC" message signs operated independently. Additional software was employed to prevent false activations/deactivations (e.g., by vehicles crossing over the centerline).

The major findings of this study were:

o Opposing vehicles (conflict situation) had the dominant effect on driver behavior, causing 2-4 mph lower speeds across the bridge, 1-2 mph speed reductions during the approach to the bridge, and more lane centering (i.e., vehicles moved one foot away from the roadway centerline) compared to the absence of opposing vehicles (no-conflict situation).

o Road geometry (direction of travel) seemed to have the next greatest effect on driver behavior. In the westbound direction, drivers slowed down about 4 mph as they approached the bridge from 49 mph 600 feet before the bridge to 45 mph across the bridge. In the eastbound direction, drivers increased their speed about 4 mph from 41 mph at a railroad crossing located 600 feet before the bridge to 45 mph across the bridge. In terms of lateral placement, eastbound traffic drove closer to the roadway centerline by .75 foot when approaching the bridge, whereas westbound traffic drove closer to the roadway centerline by .45 foot when crossing the bridge.

o The most effective sign system during the day, in terms of speed characteristics, appeared to be the strobe lights. This sign system showed a bridge speed reduction of 2 mph compared to the base sign system under most test conditions. The flashing beacons also showed some indications of effectiveness during the day, but not as strong and consistent as that for the strobe light. The remaining signs were not consistently effective for the various test conditions.

o At night the most effective sign system appeared to be the flashing beacons, again showing a reduction of 2 mph compared to the base sign system under most test conditions. The remaining signs were not consistently effective for the various test conditions.

o The above sign system findings were masked somewhat by indications of novelty and seasonal effects.

o There was no strong consistent sign system effect in terms of the lateral placement measures.

o The roadside survey data indicated that the neon message signs were the "best" signs in terms of attention-getting and information-conveying capability. This was determined by the fact that the respondents to the survey were able to identify the neon message signs (on cards handed to them) more often and the neon message signs made more respondents aware of the narrow bridge compared to the other sign systems.

o Both the survey data and the electronic data showed that the "ONCOMING TRAFFIC" message sign and the strobe lights caused some confusion to the drivers.

o The added information "oncoming traffic", appeared to serve no practical purpose. Most drivers were probably made aware of the oncoming vehicle by its presence rather than by the message.

In summary the results of this experiment showed no substantial and consistent differences between the existing and dynamic sign systems in terms of the speed and lateral placement measures. It may have been that these measures were not sensitive to or good indicators of the possible change in driver behavior due to the new signs. The roadside survey provided additional driver awareness measures for determining the safety benefits of the new sign systems but did not reveal any important improvements.

REFERENCES

1. Stanley R. Byington and Merton J. Rosenbaum, "The Maine Facility," Public Roads, 37 (December 1973), 246-255.

2. Joseph S. Koziol, "MAINE FACILITY RESEARCH SUMMARY RESULTS 1973-1976," U. S. Department of Transportation, Report No. FHWA-RD-77-54, May 1977.

3. Joseph S. Koziol, Peter H. Mengert, "Evaluation of Dynamic Sign Systems for Narrow Briges," U.S. Department of Transportation, Report No. DOT-TSC-FHWA-78-3 (in preparation).

4. "Safety at Narrow Bridge Sites," Texas Transportation Institute, Prepared for National Cooperative Highway Research Program, Transportation Research Board, National Research Council under NCHRP Project 20-7, September 1976 (on file at the Transportation Systems Center).

5. King, G. F., Abramson, P., Cohen, J. W., and Wilkinson, M. R., "Seven Experiment Designs Addressing Problems of Safety and Capacity on Two-Lane Rural Highways," KLD Associates, Inc., Contractor Final Report, November 1977 (on file at the Transportation Systems Center).

The Maine Facility
Attn: Maurice Lanman
RFD Box 421
Pittsfield ME 04967

Please send me:

☐ Additional information on the experiments described below:

____

____

____

☐ Future summaries of completed experiments.

☐ Additional information on the operation of the Maine Facility.

Name____

Address______________________________________

City____________________State__________Zip___

2,000 Copies