Object Markers at Narrow Bridges on Low Volume Rural Roadways

by

Margaret J. Rys

Associate Professor of

Industrial and Manufacturing Systems Engineering

Rajasekhar R. Pudi

Graduate Assistant

and

Robert W. Stokes

Associate Professor of Civil Engineering

Kansas State University

Manhattan, KS 66506

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Vernon Everhart, P.E.

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16 Abstract

Bridges are a necessary part of any roadway system. Their construction requires a more sophisticated engineering design analysis and a higher construction cost than that for the roadways connecting them. Until relatively recently, bridge width on low volume roads was not a major concern and would often be reduced for economic reasons. Bridges and culverts that are narrower than the approach roadway cause considerable problems for a driver because they violate his/her expectations. In such cases, the Manual on Uniform Traffic Control Devices (MUTCD) states that Type 3 object markers shall be used on each approach. However, if narrow bridges are used by low, wide farm equipment (a harvester with 24 ft to 30 ft cutter bar), the object markers are frequently knocked-down. There is a need for signing and marking practices that allow rural, low volume bridges and culverts to be marked in accordance with the MUTCD and still allow farm equipment to pass over the bridge without destroying or damaging the object markers. Kansas State University conducted a study to identify and evaluate potential alternatives for marking narrow bridges. Based on the results of the literature review, the surveys of current practices and the field observations, several alternative signing strategies for low volume bridges were formulated. These alternatives include: 1) do not use object markers on low volume roadways, 2) reduce the height of object markers on low volume roadways, 3) stagger the object markers on low volume roadways, 4) use flexible sign supports, 5) use removable object markers, and 6) redesign the object marker and/or support. Implementation of such practices statewide could result in substantial cost savings to the highway agencies. However, signing and marking practices must also consider the safety of road users.

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PREFACE

This research project was funded by the Kansas Department of Transportation K-TRAN research program. The Kansas Transportation Research and New-Developments (K-TRAN) Research Program is an ongoing, cooperative and comprehensive research program addressing transportation needs of the State of Kansas utilizing academic and research resources from the Kansas Department of Transportation, Kansas State University and the University of Kansas. The projects included in the research program are jointly developed by professionals in KDOT and the universities.

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ABSTRACT

Bridges are a necessary part of any roadway system. Their construction requires a more sophisticated engineering design analysis and a higher construction cost than that for the roadways connecting them. Until relatively recently, bridge width on low volume roads was not a major concern and would often be reduced for economic reasons. Bridges and culverts that are narrower than the approach roadway cause considerable problems for a driver because they violate his/her expectations. In such cases, the Manual on Uniform Traffic Control Devices (MUTCD) states that Type 3 object markers shall be used on each approach. However, if narrow bridges are used by low, wide farm equipment (a harvester with 24 ft to 30 ft cutter bar), the object markers are frequently knocked-down. There is a need for signing and marking practices that allow rural, low volume bridges and culverts to be marked in accordance with the MUTCD and still allow farm equipment to pass over the bridge without destroying or damaging the object markers. Kansas State University conducted a study to identify and evaluate potential alternatives for marking narrow bridges. Based on the results of the literature review, the surveys of current practices and the field observations, several alternative signing strategies for low volume bridges were formulated. These alternatives include: 1) do not use object markers on low volume roadways, 2) reduce the height of object markers on low volume roadways, 3) stagger the object markers on low volume roadways, 4) use flexible sign supports, 5) use removable object markers, and 6) redesign the object marker and/or support. Implementation of such practices statewide could result in substantial cost savings to the highway agencies. However, signing and marking practices must also consider the safety of road users.

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1. BACKGROUND AND PROBLEM STATEMENT

Bridges are a necessary part of any roadway system. Their construction requires a more sophisticated engineering design analysis and a higher construction cost than that for the roadways connecting them. Until relatively recently, bridge width on low volume roads was not a major concern and would often be reduced for economic reasons (Bowman and Brinkman, 1988). This practice has resulted in narrow bridges on many low volume rural highways. Bridges and culverts that are narrower than the approach roadway may cause problems for a driver because they violate his/her expectations. Therefore, it is necessary to provide positive guidance so that the driver has sufficient information to safely negotiate the narrow bridge or culvert. In such cases, the Manual on Uniform Traffic Control Devices (MUTCD) states that Type 3 object markers shall be used on each approach. However, if narrow bridges are used by low, wide farm equipment (e.g., a harvester with 7.3 m (24 ft) to 9.1 m (30 ft) cutter bar), the object markers are frequently damaged or knocked-down. Some alternate arrangement is needed so that bridge ends can be marked in accordance with the MUTCD and still allow farm equipment to pass over the bridge without destroying or damaging the object markers.

2. RESEARCH OBJECTIVES

The goal of this research effort is to identify alternative means for marking bridges on low volume rural roads to allow large farm vehicles to safely traverse these bridges without damaging or knocking down the object markers. The main objectives of this research project are: 1) to identify the types and physical dimensions of farm equipment using narrow bridges in Kansas, 2) to identify and evaluate alternative methods for marking narrow bridges and culverts, and 3) to develop guidelines for marking bridges based on roadway width and width of typical farm equipment in the area.

3. WORK PLAN

The study consisted of the following basic tasks.

Task 1: Establish Advisory Committee.
Task 2: Literature Review.
Task 3: Conduct Field Observations and Surveys of County Personnel, District Maintenance Personnel and Farmers in a Sample of Kansas Counties.
Task 4: Identify Potential Alternatives.
Task 5: Evaluation of Alternatives.
Task 6: Develop Guidelines for Marking Narrow Bridges.
Task 7: Documentation.

The results of the basic study tasks are described in the following sections of this report.

4. LITERATURE REVIEW

A literature search was conducted to identify previous relevant research efforts. Several general references concerning safety and marking practices on narrow bridges were identified. These are listed in the Bibliography section of this report. However, no information relating directly to the problems associated with large farm equipment and narrow bridges was found.

In order to obtain additional information, a description of the project was posted on the electronic mailing list of the Institute of Transportation Engineers. A message obtained from a city transportation engineer in Louisiana indicates that other states also face similar problems due to agricultural equipment. The respondent offered the following suggestion.

> *The proposed new Part 5, Low Volume Roads, of the MUTCD recommended to the FHWA includes the installation of warning signs as optional, based on engineering judgment. This may offer some relief on the installation of Type 3 Object Markers, as is*

now our practice at bridges and culverts. On very low volume roadways (50 VPH or less) it may be appropriate to install the "No Traffic Signs" warning sign even on Category 2 and 3 roadways. We have many gravel and paved roadways where the volumes are extremely low, use is usually local and the condition of the roadway and hazards are readily apparent to the road user.

5. SURVEYS AND FIELD OBSERVATIONS

Surveys of county highway officials, farmers and farm equipment dealers were conducted to gain additional insight into the problem. Field observations also were conducted to quantify the problems associated with large farm equipment on narrow bridges. The results of these surveys and field observations are summarized in the following subsections of this report.

5.1 Survey of County Highway Officials

The survey of county highway officials was designed to gather information concerning 1) the types of object markers (OMs) currently in use on narrow bridges, 2) the extent of the damage to OMs caused by large farm vehicles, and 3) any measures used by the counties to reduce or eliminate problems associated with large farm vehicles on narrow bridges. An example of the survey questionnaire is presented in Appendix A. The survey results are summarized below.

The survey questionnaire was mailed to all county highway officials in Kansas in the July/August 1997 edition of the KDOT Bureau of Local Projects County Newsletter. The questionnaire was also distributed at various county highway meetings and conferences.

Seventy-four county highway officials from 64 counties responded to the survey (see Figure 1). Tables 1 and 2 provide summaries of the survey results. Table 1 summarizes the responses to questions concerning the definition of a "narrow" bridge, the type(s) of object markers used on narrow bridges, the type(s) of posts used to mount object markers at narrow bridges and the season of the year when problems with large farm vehicles on narrow bridges are most prevalent.

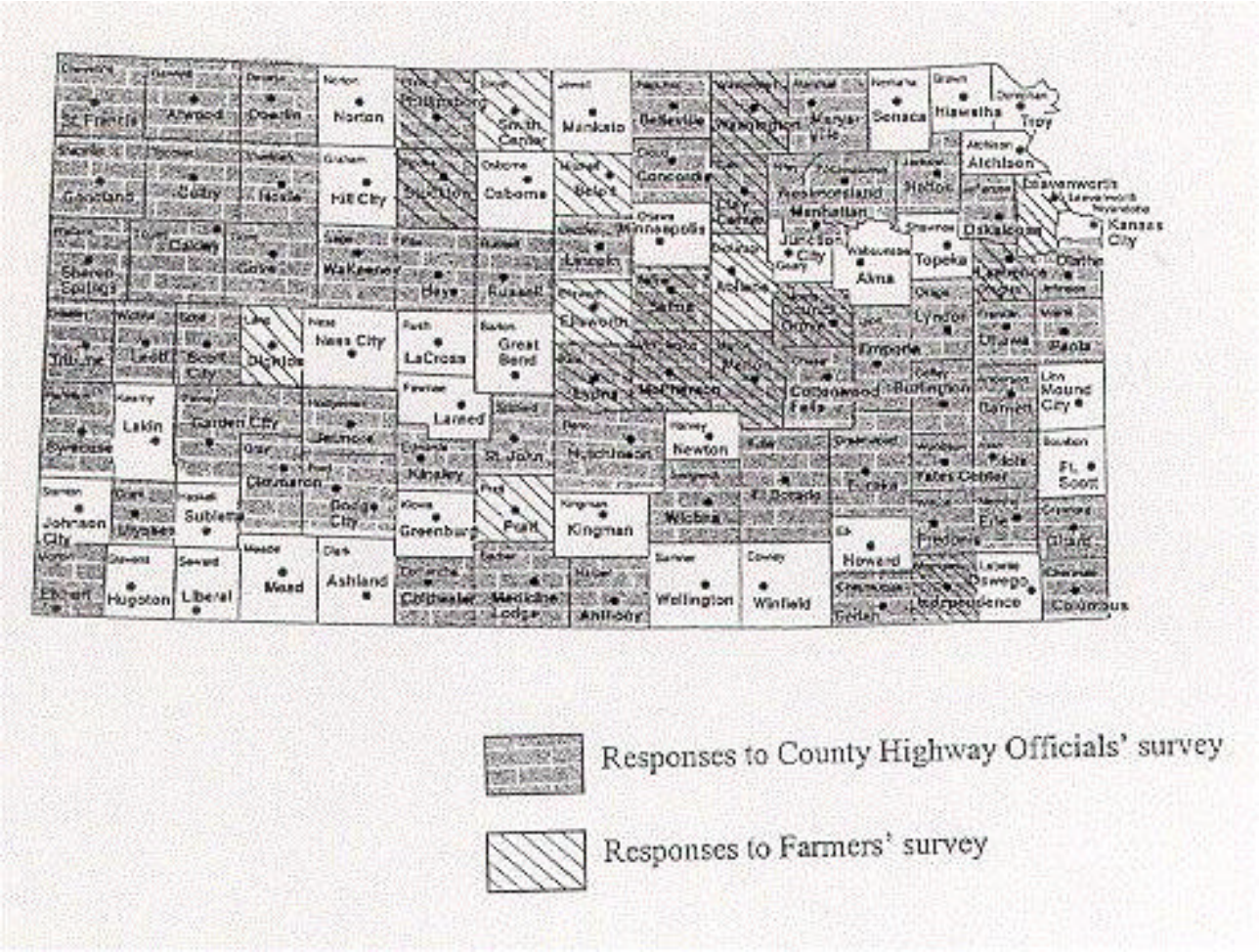

Figure 1. Distribution of Survey Responses in Kansas.

Table 1. Summary of Responses from County Highway Officials Concerning Current Practices for Signing and Marking Narrow Bridges.

Question	Number Of Responses	Percentage of Responses
Width of bridge considered narrow		
Less than 20 ft.	40	54.0
Less than 24 ft.	30	40.5
Other	04	05.5
Type of OM used at narrow bridges		
Type 2	07	09.9
Type 3	40	56.3
Type 2 & Type 3	11	15.5
Type 2, Type 3 and Carsonite	07	09.9
Other	06	08.4
Methods used for marking narrow bridges		
Standard at bridge ends	43	*
Staggering OM	37	*
Tapering	17	*
Installation at lower than normal height	25	*
Other	09	*
Types of Post		
Steel 'U' channel	38	52.7
Steel 'U' channel and other steel	01	01.4
Steel 'U' channel and flexible	17	23.6
Other steel and flexible	01	01.4
Flexible	07	09.7
Wood, steel 'U' channel and flexible	02	02.8
Wood	02	02.8
Wood and flexible	02	02.8
Steel 'U' channel, other steel and flexible	01	01.4
Wood, other steel and flexible	01	01.4
Period of problems		
Summer	26	37.8
Summer, Spring and Fall	13	18.8
Fall and Spring	08	11.6
Summer and Spring	06	08.7
Fall	06	08.7
Other	10	14.4

* More than one method used by some counties for marking narrow bridges/culverts.

The survey results provided the following information concerning the definition of a "narrow" bridge, the type(s) of object markers used on narrow bridges, the type(s) of posts used to mount object markers at narrow bridges and the season of the year when problems with large farm vehicles on narrow bridges are most prevalent.

- Over 95% of the respondents define a narrow bridge as a bridge of less than 7.3 m (24 ft) in width.
- 82% of the counties use steel 'U' channel posts for mounting OMs.
- At the present time, less than 10% of the counties use flexible posts for mounting OMs. 57% of the respondents use only Type 3 object markers on narrow bridges and culverts.
- Approximately 82% of counties use a combination of object markers (Type 3 and other object markers).
- The summer months are when counties have the most problems with object markers at narrow bridges.

Table 2 summarizes responses from county highway officials concerning the number of narrow bridges in the counties represented in the survey, the costs associated with repairing and replacing damaged object markers and how frequently such repairs/replacements are needed.

Table 2. Summary of Responses from County Highway Officials Concerning Number of Narrow Bridges and Costs of Marking Narrow Bridges.

Question	Min.	Max.	Avg.
Number of narrow bridges/culverts in county	0	4000	375
Cost to repair damaged OM ($/OM)	7.85	300	42.75
Cost to replace damaged OM ($/OM)	15	300	61.18
Number of OMs repaired per year	0	400	130
Number of OMs replaced per year	0	450	110

The survey results suggest that, on the average, Kansas counties replace or repair over 100 damaged object markers per year per county at an average annual cost of $6,000 to $7,000 per county.

5.2 Survey of Kansas Farmers

In an attempt to assess the magnitude of the problem from the user's perspective, a survey of Kansas farmers was conducted. The intent of the survey was to gather information concerning 1) the types of farm equipment currently in use on low volume roads and narrow bridges, 2) the types of problems encountered by operators of this equipment on narrow bridges, and 3) suggestions for eliminating or reducing these problems. An example of the survey questionnaire used to solicit input from Kansas farmers is presented in Appendix B.

The questionnaire was distributed at the Kansas Commodity Classic held in Salina, KS on

December 2, 1997. Eighteen completed surveys were obtained from the farmers who attended the meeting. As shown in Figure 1, most of the respondents were from North, East and Central Kansas. Table 3 summarizes the results of the survey of Kansas farmers.

Table 3. Summary of Results from Survey of Kansas Farmers.

Question	Response
Agricultural Equipment (wider than 20 ft):	
Combine (20-30 ft)	15
Planter (24-30 ft)	03
Cultivator (32 ft)	01
Problems encountered:	
Difficulty in getting around or past highway signs	16
Difficulty crossing narrow bridges	12
Other	05
None	02
Suggested solutions:	
Making the signs low	08
Staggering the signs	08
Mount signs on flexible supports	16
Detachable posts	06

While the small sample size precludes drawing any definitive conclusions, the survey responses indicate that operators of large farm equipment experience problems in maneuvering around highway signs on narrow bridges and that some alternative means of marking these bridges is

needed. The following general observations can be drawn from the results of the survey of Kansas farmers.

- Most of the agricultural equipment currently in use is wider than the bridges typically found on low volume rural Kansas roadways.

- Operators of large farm equipment experience problems in maneuvering around the signs and supports currently used to mark bridges on low volume roads.

- Most farmers favor the use of signs on flexible supports, placing the signs farther from the roadway and lowering the height of signs.

- Many of the respondents indicated they do not like the use of staggered signs, as it is still difficult to steer around the signs.

5.3 Survey of Farm Equipment Dealers

Several local farm equipment dealers were contacted to gather information on the physical dimensions of farm equipment currently in use in Kansas. The information obtained from the farm equipment dealers was used to compile an inventory of the physical dimensions and characteristics (transport width, etc.) of typical farm equipment currently in use in Kansas. This information may be useful to highway designers concerned with "design vehicle" considerations for low volume rural roadways and bridges. This information is summarized in Appendix C.

5.4 Field Observations

The initial field observations were conducted in Riley County, KS in October 1997. The purpose of the field observations was to gain first hand information concerning the problems experienced by operators of large farm vehicles in traversing narrow bridges. The experience gained from the field observations in Riley County was used to plan and conduct similar studies in other Kansas counties. More than 20 pictures and 50 slides of signing and marking practices and examples of damaged object markers were obtained during the field observations in Riley County. Figures 2 through 6 illustrate typical conditions observed by the study team in the field.

Figure 2 shows object markers consisting of both flexible posts as well as staggered steel "U" channel posts. When rigid posts are used to support object markers on narrow bridges, it is essential that the posts be staggered to allow wide farm equipment to maneuver between the markers.

Figures 3 through 5 illustrate various types of damage to object markers observed during the field visits. As shown in Figure 3, the most prevalent types of damage observed in the field were scratched faces and broken corners on the object markers. The scratched faces on the object markers are a concern because of the reduced reflectivity that results from such damage. The broken/damaged lower corners are probably due to agricultural equipment cutter bars, etc., "snagging" the sign edge. In some cases, snagged cutter bars, etc. may actually pull the sign post/support out of the ground (see Figure 4).

The broken corners on the upper edges of the object markers may be due to the sign being crushed against the bridge railing as the equipment passes over the deflected flexible post and/or

by striking the equipment when the deflected sign springs back to a vertical position after the farm equipment passes over the object marker/post. Damage caused by the sign being crushed against the bridge railing as the equipment passes over the deflected flexible post is apparent in Figure 5. In this case the object marker has been installed too close to the bridge railing. As the sign post deflects, the upper portion of the sign/post comes in contact with the bridge railing and may suffer damage in the form of broken corners (see sign on near left side of Figure 5) or a sheared sign support (see broken post on far right side of Figure 5).

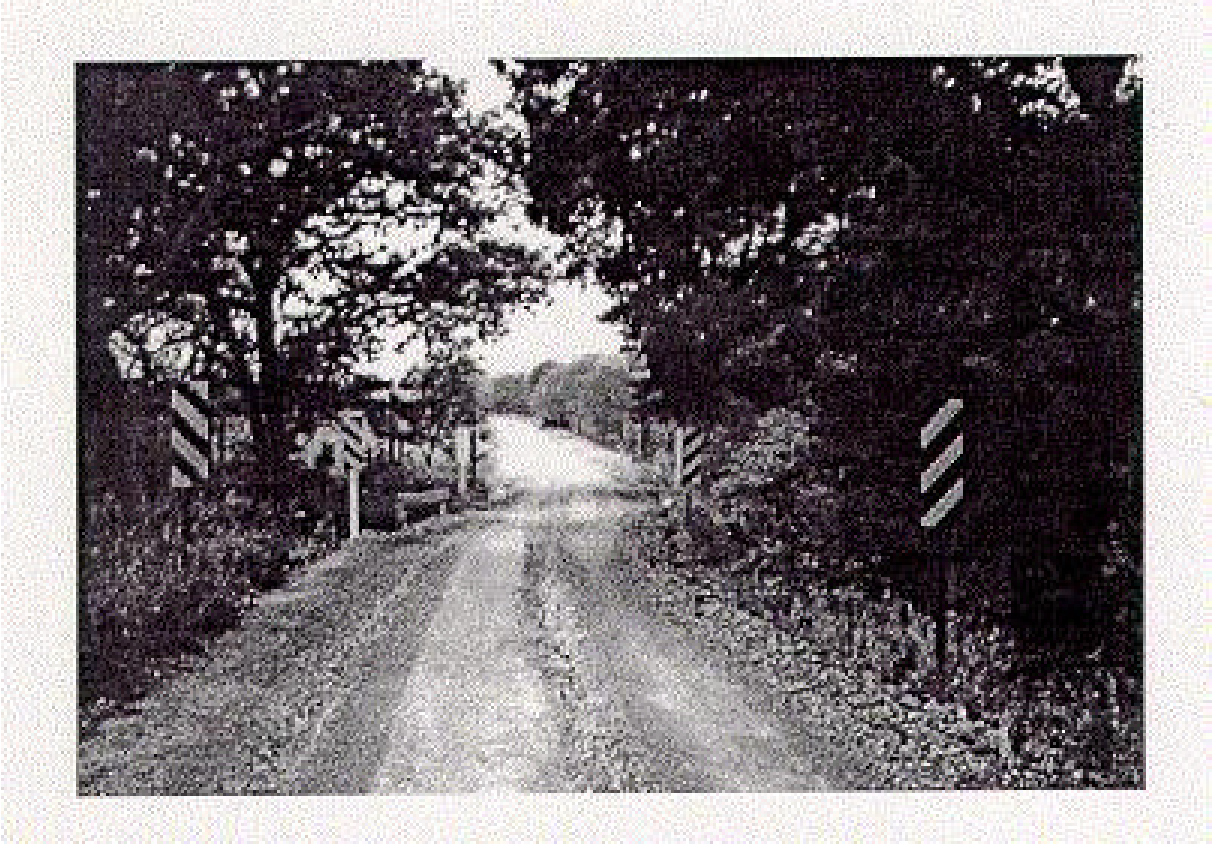

Figure 2. Staggered object markers mounted on steel "U" channel posts as well as flexible carsonite posts.

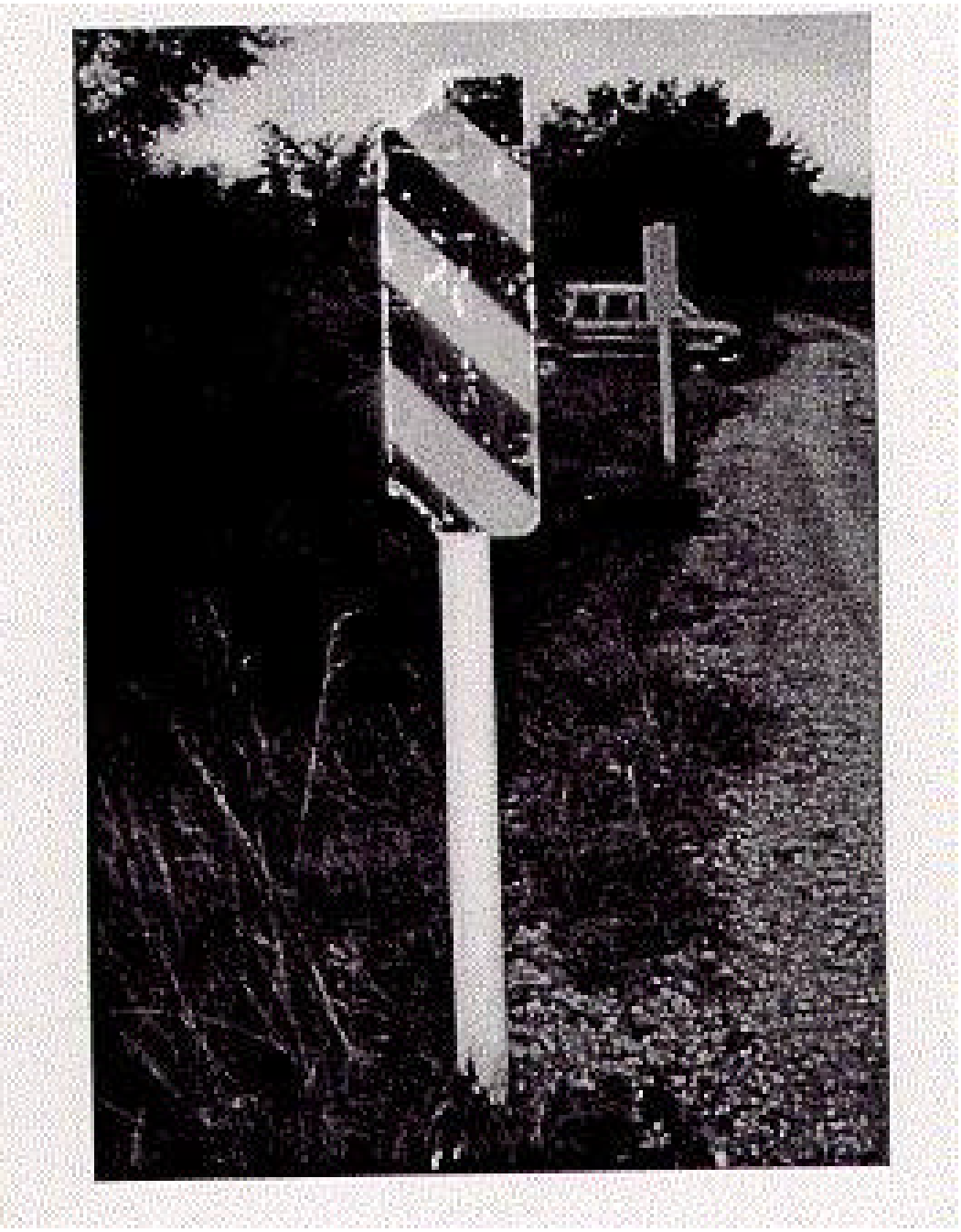

Figure 3. Object marker with scratches on the face and broken corners.

Figure 4. Object marker lying on the ground with broken post.

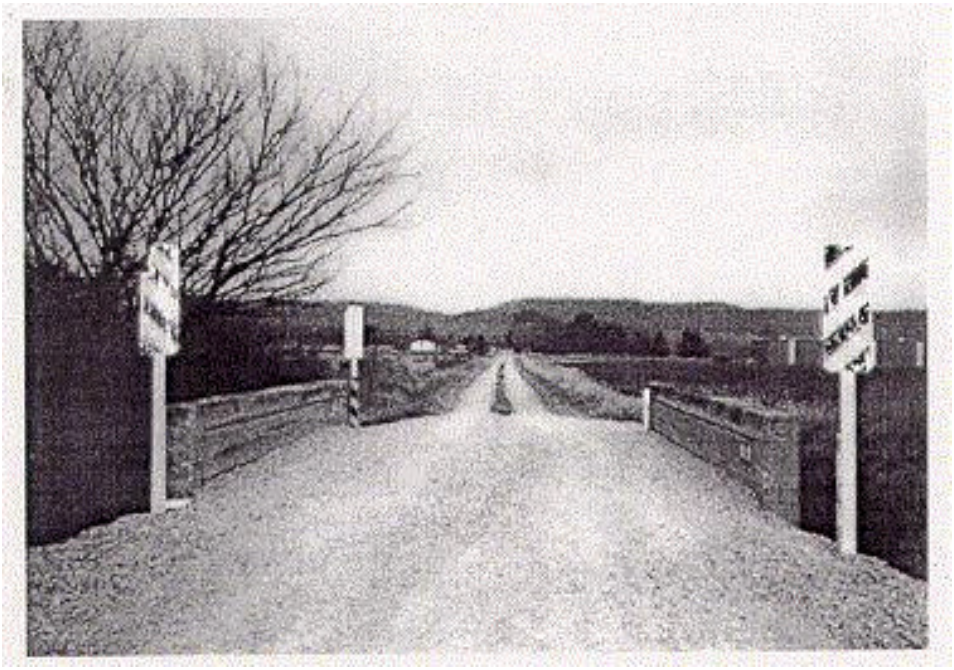

Figure 5. Object markers with damaged corners, scratched faces and broken post.

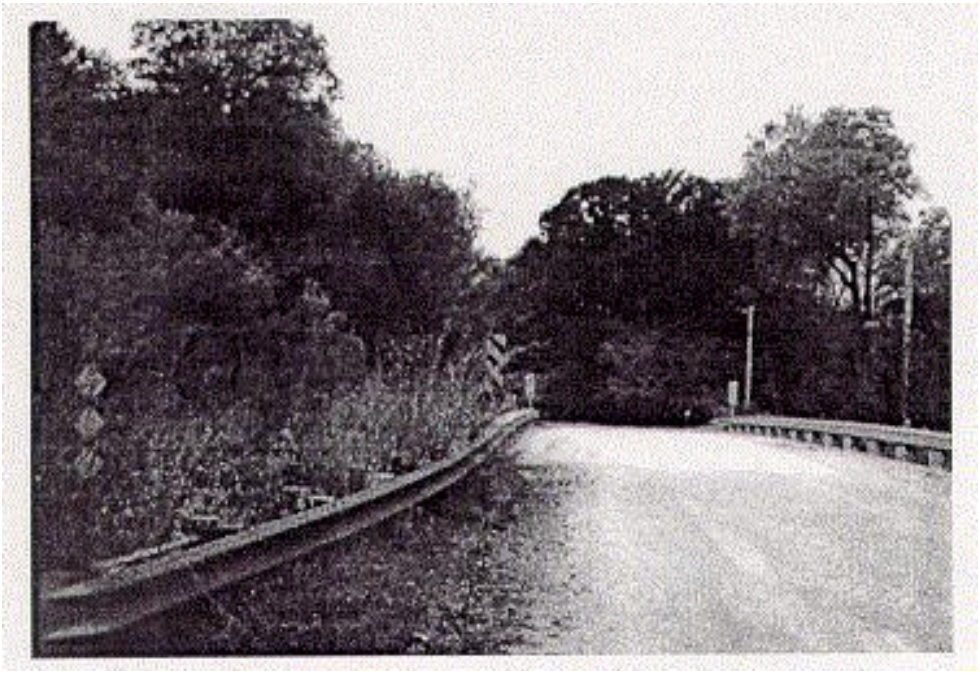

Figure 6: Object marker partially obscured by vegetation.

Some operators of large farm equipment have suggested that simply lowering the height of object markers would eliminate much of the problem. However, lowering the height of object markers by mounting the markers on the face of bridge railings or by reducing the height of sign supports greatly reduces their visibility. Object markers mounted on the face of bridge railings can become obscured by mud splatters and object markers on shortened sign supports can become obscured by vegetation (see Figure 6).

6. IDENTIFICATION AND EVALUATION OF ALTERNATIVES

Based on the results of the literature review, the surveys of current practices and the field observations, several alternative signing strategies for low volume bridges were formulated. These alternatives include: 1) do not use object markers on low volume roadways, 2) reduce the height of object markers on low volume roadways, 3) stagger the object markers on low volume roadways, 4) use flexible sign supports, 5) use removable object markers, and 6) redesign the object marker and/or support. A brief description of each alternative is presented below.

Do Not Use Object Markers

Part 5 of the proposed new MUTCD addresses "Traffic Control Devices for Low Volume Rural Roads." Section 5C.10 of the proposed Part 5 states that "*A warning sign with the legend, "NO TRAFFIC SIGNS," may be used on Category 1 roadways [an unimproved roadway with less than 200 AADT (Annual Average Daily Traffic)] to advise a road user that no traffic control devices are installed on the roadway. This sign may be installed at the point where road users would enter the Category 1 roadway*." If adopted, this provision of the MUTCD could provide the mechanism for local highway officials to deal with the problem of accommodating large farm equipment on narrow bridges on low volume rural roads. Because traffic on low volume roads is primarily local traffic and the conditions of the roadway are generally known to the road users, the absence of object markers should not pose a safety problem. If the "No Traffic Signs" approach is used, it may be useful to employ the "tapering" techniques described in the

Handbook of Traffic Control Practices for Low Volume Roads (LVR) to effectively inform motorists of any narrow roadways/bridges ahead.

Reduce the Height of Object Markers

Simply lowering the height of object markers would appear to be a viable solution to the problem of accommodating wide farm equipment and other large vehicles on narrow bridges. In fact, the current edition of the Handbook of Traffic Control Practices for Low Volume Roads (LVR) allows some latitude in sign mounting height. Page 57 of the LVR notes that "*When used for marking objects in the roadway or eight feet or less from the shoulder or curb, the mounting height to the bottom of the object marker should normally be four feet above the surface of the nearest traffic lane."* On page 58, the LVR notes that "*when object markers or markings are applied to a hazardous object which by its nature requires a lower or higher mounting,* ***the vertical mounting height may vary according to need***." The problem with lowering the height of object markers is that they may become obscured by vegetation or splattered mud, snow, or ice.

"Staggered" Object Markers

Another means of accommodating wide vehicles on narrow bridges is to stagger the object markers. This practice consists of mounting object markers on both sides of single posts positioned on the right side of each approach (see Figure 7). This arrangement allows wide vehicles to clear the object markers by steering to the left on the approach to the bridge and then steering to the right as they exit the bridge. However, some farmers indicate that many bridges are too narrow and/or too short to allow them to maneuver around the object markers without striking the bridge railing.

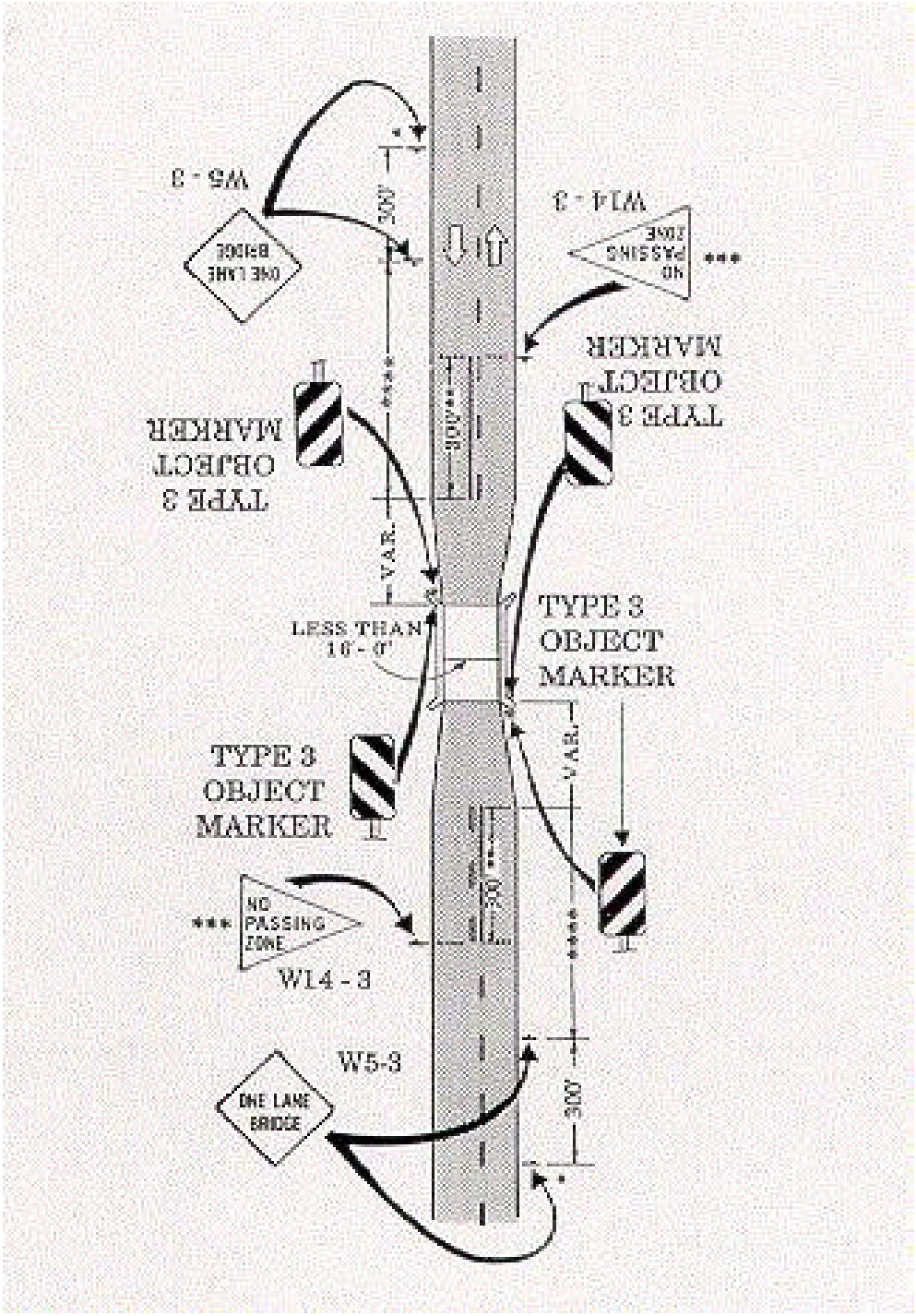

Figure 7. Type 3 object markers on both sides of the single post positioned on right side of each approach.

Flexible Sign Supports

Several counties in Kansas currently use flexible sign supports for object markers on bridges and culverts on low volume rural roadways (see Figures 2 and 3). These flexible supports have the advantage of allowing markers to be placed in accordance with MUTCD specifications while still allowing wide vehicles to pass over them. The problem with flexible supports is that cutter bars and other protrusions on wide vehicles may "snag" the lower edges of the object marker and damage and/or "uproot" the object marker and its support (see Figures 3 and 4). Some county highway officials also indicate that high wind loads can cause considerable deflection and "flapping" of the object markers. This problem is especially pronounced when object markers are mounted on both sides of the flexible support, as in the case of staggered installations. A variation on the idea of flexible supports is the spring-loaded impact recovery system (Figure 8).

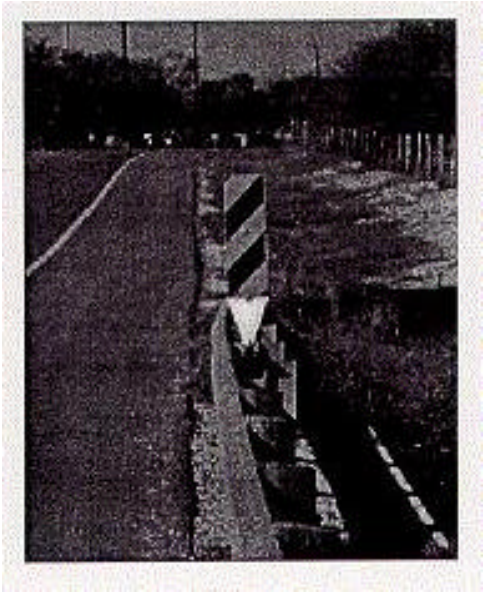

Figure 8. Type 3 object marker mounted on a guardrail post using spring loaded impact recovery system.

Removable Object Markers

Some county highway officials have suggested the use of removable sign posts mounted in a fixed socket-like base. A variation on this idea is the use of hinged/folding supports that can be manually lowered by equipment operators at narrow bridges and culverts. Such systems require the operators of wide equipment to manually remove and reinstall the signs/supports at bridges/culverts. A potential problem with removable sign systems is that the base receptacle can become clogged with debris making removal and reinstallation difficult. In addition, the equipment operator may not want to get off the equipment to remove/replace the signpost.

Redesign the Object Marker and/or Support

The field observations indicate that the lateral spacing of object markers installed in accordance with the MUTCD does not allow sufficient clearance for many types of wide farm equipment. As a result, object markers need to be either staggered, mounted at a reduced height or mounted on flexible supports. In the case of object markers mounted on flexible supports, the most common types of sign damage observed in the field were broken or bent sign corners and scratched sign faces. This damage to the lower sign corners and the scratched sign faces appears to be the result of the equipment "snagging" on the lower edges of the sign face and dragging over the sign face. In the case of damaged upper sign corners, the damage appears to result from installing the sign supports too near the bridge railing. In such situations, the upper edges of the sign can be crushed against the railing as large vehicles pass over the deflected sign/support. A simple and inexpensive means of preventing vehicles from snagging the lower sign edges might be angle the edges as illustrated in Figure 9(a). The I-beam shape of the typical flexible support could serve as a channel to guide the farm implement protrusions (cutter bar teeth, etc.) over the surface of the sign face. In the case of staggered installations; the sign face could be “sandwiched” between two flexible supports (Figures 9(b), 9(c) and

9(d)). Another potential solution to the "snagging problem" might be to install a curved faceplate over the base of the sign, as illustrated in Figure 10.

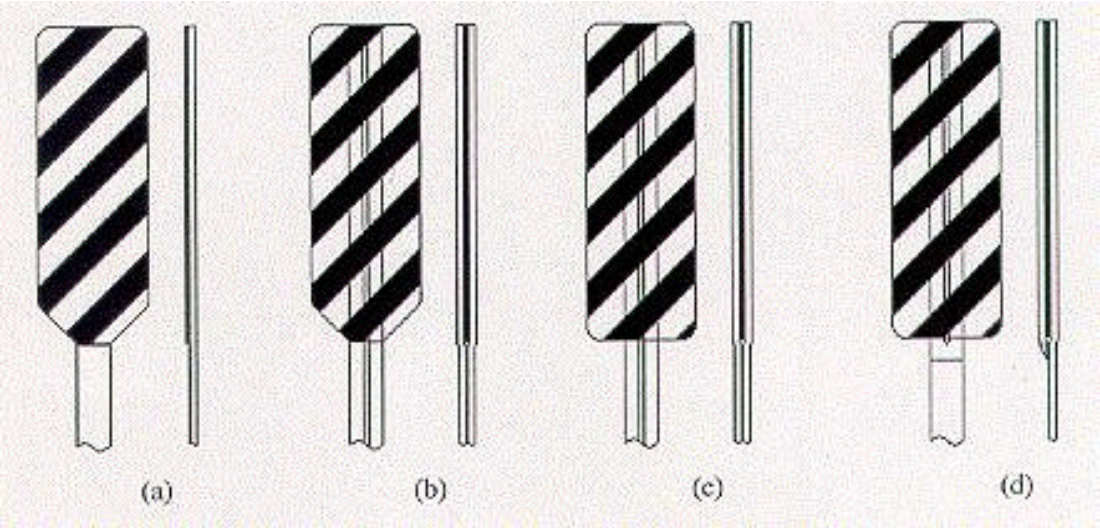

Figure 9. Alternative sign/support designs.

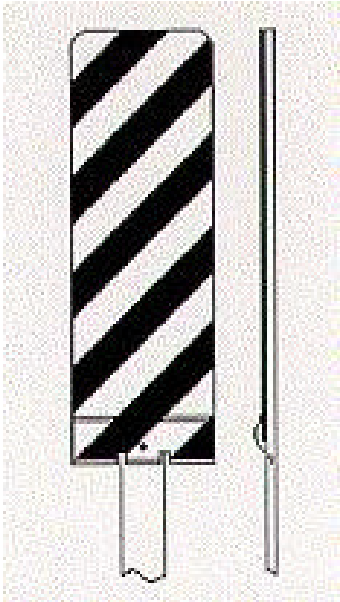

Figure 10. Object marker with curved "snag" plate.

Another possibility is a one-piece flexible sign/support system. For example, a flexible, one-piece, 305 mm (12-inch) wide sign and support assembly could be manufactured. The sign portion of the assembly (i.e., the upper 914 m (36 inches) of the assembly) could be painted prior to installation by the local highway agency. A variation on this idea would be to manufacture the one-piece sign/support with a narrower, conventional width for the support portion of the assembly.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The results of this study indicate that the lateral spacing of object markers installed in accordance with the MUTCD does not allow sufficient clearance for many types of wide farm equipment. There is a need for signing and marking practices that allow rural, low volume bridges and culverts to be marked in accordance with the MUTCD and still allow farm equipment to pass over the bridge without destroying or damaging the object markers. As a result, object markers need to be either staggered, mounted at a reduced height or mounted on flexible supports. Implementation of such practices statewide could result in substantial cost savings to county highway agencies. However, signing and marking practices must also consider the safety of other road users.

7.2 Recommendations

Based on the results of this study, the following general guidelines concerning the installation of object markers at narrow bridges on rural, low volume roads should be considered for further study.

1. It is the recommendation of this study that highway agencies continue to mark bridges and culverts in accordance with the basic intent of the current MUTCD and

the LVR Handbook. The guidelines presented in the MUTCD and the LVR Handbook are intended to ensure the safety of all road users and should not be modified unless it can be shown that such modifications will not adversely affect roadway safety.

2. In those locations where substantial numbers of large, wide farm vehicles must be accommodated on low volume rural roadways with narrow bridges, it is recommended that county highway officials use flexible supports for the required object markers. These supports should be in the form of flexible posts or spring-loaded impact recovery systems. It is also recommended that the object markers used on such supports be modified to reduce the possibility of cutter bars and other protrusions on wide vehicles from "snagging" the lower edges of the object marker and/or "uprooting" the object marker and its support.

3. To ensure uniformity, the results of this study should be considered for inclusion in the next edition of the LVR Handbook.

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APPENDIX A

Sample Questionnaire for Survey of County Highway Official

OBJECT MARKERS AT NARROW BRIDGES AND CULVERTS

Questionnaire

1. Name of the county/jurisdiction: _____
2. Name: _____
3. What do you consider a "narrow" bridge or culvert for a two lane roadway?
   _____ less than 20 ft _____less than 24 ft _____ other (please specify)
4. Number of narrow bridges and culverts in your county/jurisdiction: _____
5. Type of object markers (OM) used at narrow bridges and culverts in your county/jurisdiction:
   _____ Type 2 _____ Type 3 (12"x36") _____ other (please specify)
6. What method(s) do you use for marking narrow bridges?
   _____ standard at bridge ends_____ tapering
   _____ staggering OM _____ installation of OM at lower than normal height
   _____ other (please specify) _____
   _____
7. Type of post normally used for mounting OM at narrow bridges:
   _____ Wood _____ Steel "U" channel _____ "other" Steel _____Flexible
   _____other please specify
   Height of the post: _____
8. Briefly describe the problems you have with OM (at narrow bridges) in your area.
   _____
   _____
   _____
9. Average cost to *repair* damaged OM: $_____/year or $_____/OM
   Average cost to replace an OM: $_____/OM
   How many OM do you replace/repair every year? _____/_____
10. In which of the following seasons do you experience more problems with OM (at narrow bridges)?
    _____Summer_____ Winter _____Fall _____Spring
11. Describe any innovative methods or non-standard materials you use to prevent damage to OM:

_____
_____

Thank you for your response! Please feel free to add any other comments.

Please fold, tape, stamp and mail!

APPENDIX B

Sample Questionnaire for Survey of Kansas Farmers

Object Markers at Narrow Bridges

Questionnaire for farmers

Kansas State University with the cooperation of KDOT is conducting a study to identify and evalulate alternative methods for marking bridges and culverts. The purpose of this research is to develop guidelines for marking bridges and culverts based on roadway width and width of typical farm equipment in the area. It would be greatly appreciated if you would fill out the attached questionnaire and mail it to the Kansas State University research team. The questionnaire is self addressed. Simply complete, fold, tape (do not staple), stamp and send.
Thank you for your assistance.

1. County in which the farm is located: _____

2. What type(s) of large agricultural/harvesting equipment do you use?

Type	**Width*(in ft)**	**Manufacturer/Model**
_____	_____	_____
_____	_____	_____
_____	_____	_____

**Please indicate the width as transported on road.*

3. Do you have to drive your harvesting equipment on county and other public roads in getting to and from your fields? Yes/No
   If yes, do you encounter any of the following problems?
   (a) Difficulty in getting around or past highway signs and/or roadside obstructions.
   (b) Difficulty crossing narrow bridges.
   (c) Other (please specify).
   _____
4. Which of the following solutions do you think would remove or reduce these problems?
   (a) Making the signs low.
   (b) Staggering the signs.
   (c) Mount signs on flexible supports.
   (d) Detachable posts.
5. Do you have any other suggestions for improving the situation? Please explain.
   _____
   _____

May we contact you if we have additional questions? If yes, please fill out your name and phone number below:
Name: _____ Ph: _____

Thank you for your participation!

APPENDIX C

Characteristics of Farm Equipment Used in Kansas

Characteristics of farm equipment used in Kansas

Manufacturer	Type	Model	Transport	Working Width
New Holland	Tractors	82 series	Width 10'9"	
Gleaner	Combines	R42/R52	11'1"	12', 14', 17'3", 20'7" (with corn heads)
			12'9"/12'11"	20'7", 17'3", 21'5" 26'1", 31'5" (with corn heads)
	Soybean Head	400 rigid		18', 20', 25', 27', 30'
		400 flex		15', 16', 18', 20', 22', 25', 30'
Wil-Rich	Field cultivator	3411	14'4"	19'3" - 34'5"
		3420	16'8"	14'7" - 46'1"
		3450	18'5"	28'7" - 48'5"
Case	Combo-mulch	6800	19'4"	
	Ripper	6810/6814	12'	
	Conser-till plow	6500		11'
		6650	9'6" - 16'6"	8'9" 16'3"
	Combo-mulch Finisher	4200	15'11"	11'8" - 15'1" (nonfolding)
				20'8" - 34'2" (folding)
	Vibratine field cultivator	365	16'	13'8" -25'8"
	Seedbed conditioner	568		12'6" - 25'8"
John Deere	Till Drills	1520	15', 20'	
		455 folding	15'2"	25', 30', 35'
		450 end drill	10'	8'1"
			12'6.5"	10'7" - 10'8"
			14'2.5"	12'2" - 12'3"

Characteristics of farm equipment used in Kansas (continued)

Manufacturer	Type	Model	Transport	Working Width
John Deere, cont.	Planters (Max	1750	15'0.5"	13' -13'4"
	Emerge Plus Drawn)	1760	13'3" -21'	
		1770	15'8"	
		1780	15'3"	
	Planters (Max	1700	16'3" -23'9"	
	Emerge Plus Integral)	1710	13'3" -28'10"	
		1720	18'10" - 20'6"	
		1730	16'5" -23'8"	
	Combine (Maximizer)	9400/9500	15'9" - 25'10"	
		9600	12'3"	
	Cultivator	400 series	12'10"	
		400 folding series	21'	15' -30'
			16'	28', 31'
	Sprayers	6500	21'2"	41'
			9'6"	47'
			13'	