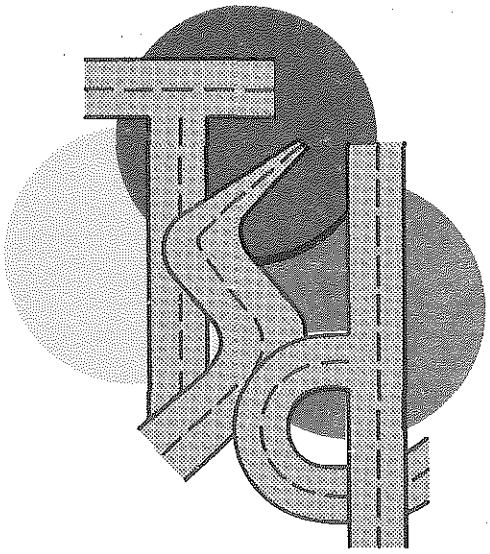
Final Report

Maintenance Problems With Small Breakaway and Yielding Sign Supports

TSD-490-81



TRAFFIC and SAFETY DIVISION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
AND TRANSPORTATION

MICHIGAN DEPARTMENT
OF
TRANSPORTATION

Final Report

Maintenance Problems With Small Breakaway and Yielding Sign Supports

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By
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BACKGROUND

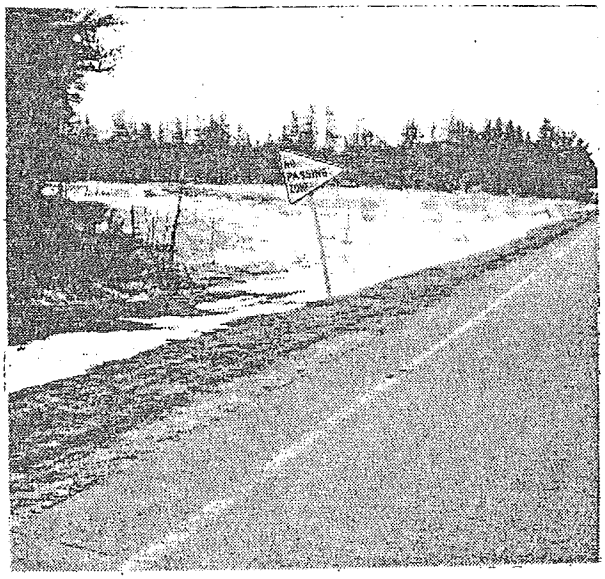
The trend toward down-sizing of passenger cars during the past few years has led to numerous modifications of roadside appurtenances as transportation engineers nationwide strive to create the safest highway environment possible. Research performed by the Texas Transportation Institute for the Federal Highway Administration bears out the fact that even smaller roadside signs, while not presenting a serious hazard to large automobiles, do produce extensive property damage to smaller cars and often cause fatalities and injuries to their occupants.

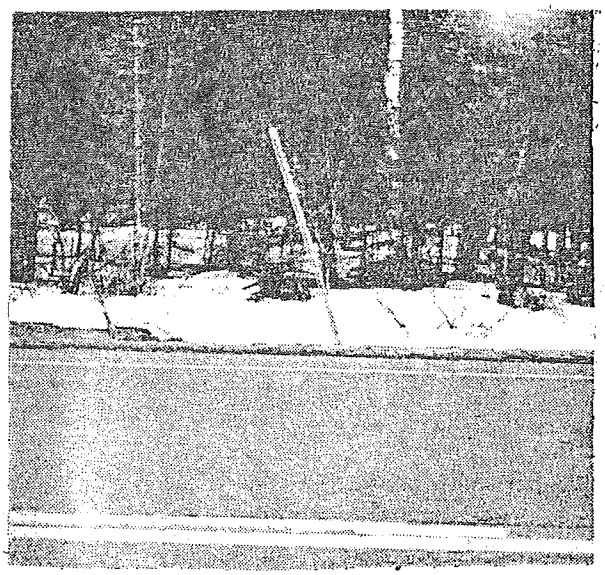
Because of the smaller and lighter-weight vehicles now being designed and the desire to produce a safer roadside, AASHTO specifications now contain criteria for breakaway and yielding-type sign supports. As a result, various support systems are being developed which offer considerably less resistance to impact when struck by a motor vehicle.

The adoption of new support systems offering lower impact resistance, however, does present a problem in Michigan, particularly in northern counties where unusually heavy snowfalls are encountered. During snow removal operations for example, flying snow from high-speed plows creates a dynamic loading on signs which frequently causes permanent deflection and twisting of small breakaway and yielding-type supports.

PURPOSE OF STUDY

The intent of this study was to evaluate various breakaway and yielding-type sign support systems currently available in order to determine their capabilities for withstanding the rigors of snow removal operations. It was anticipated that the study would also reveal some measure of cost effectiveness for those support systems evaluated.





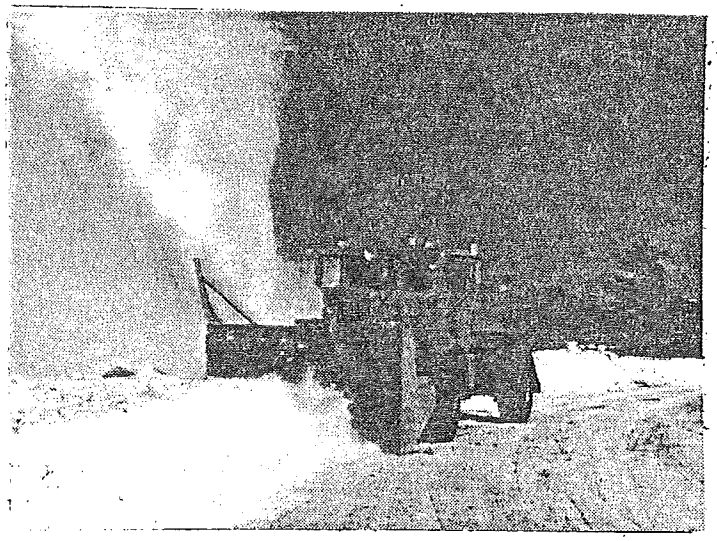


Figure 1: Snow plowing operations often cause damage to sign installations.

STUDY PLAN

Various types of small sign supports were selected for performance evaluation, particularly the effect of dynamic loadings created by snow removal operations. All supports considered were below the maximum allowable change in momentum requirements established by the revised AASHTO specifications.[1]

In order to ensure uniform exposure of supports to snow removal operations, a 12-mile section of M-123 in Luce County (Figure 2) was chosen for the erection of six different types of supports. All supports and signs were erected by June 28, 1979. A breakdown of the number of each type support and station locations are outlined in Tables A-F (pages 11-17). Of the six supports tested, it should be noted that U-Channel and wood supports are operational and have been used extensively by the MDOT for some time. Following is a listing of the six types tested together with manufacturers' names for those not operational:

1. Wood support (4"x6") with steel sleeve and concrete embedment (Figure 3).

2. Three-pound U-Channel steel support (Figure 4).

3. Telespar steel support (24H12), Unistrut Telespar Systems, 35005 Michigan Avenue West, Wayne, Michigan, 48184 (Figure 5).

4. Frangible K-Coupling breakaway joint (2PB-2200), General Coupling, Inc., 2707 Durand Avenue, Racine, Wisconsin, 53403 (Figure 6).

5. Break-Safe joint (S4x7.7), Transpo-Safety, Incorporated, 111 Cedar Street, New Rochelle, New York, 10801 (Figure 7).

6. Eze-Erect support (2½-pound - 4-pound), Franklin Steel Company, P.O. Box 671, Franklin, Pennsylvania, 16323 (Figure 8).

A brief description of how each support is designed to function is included in the Appendix.

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[1] Federal Highway Administration Notice N5040.20, dated July 14, 1976, institutes application of AASHTO specifications and transmits suggested guidelines for application of breakaway requirements of AASHTO specifications.

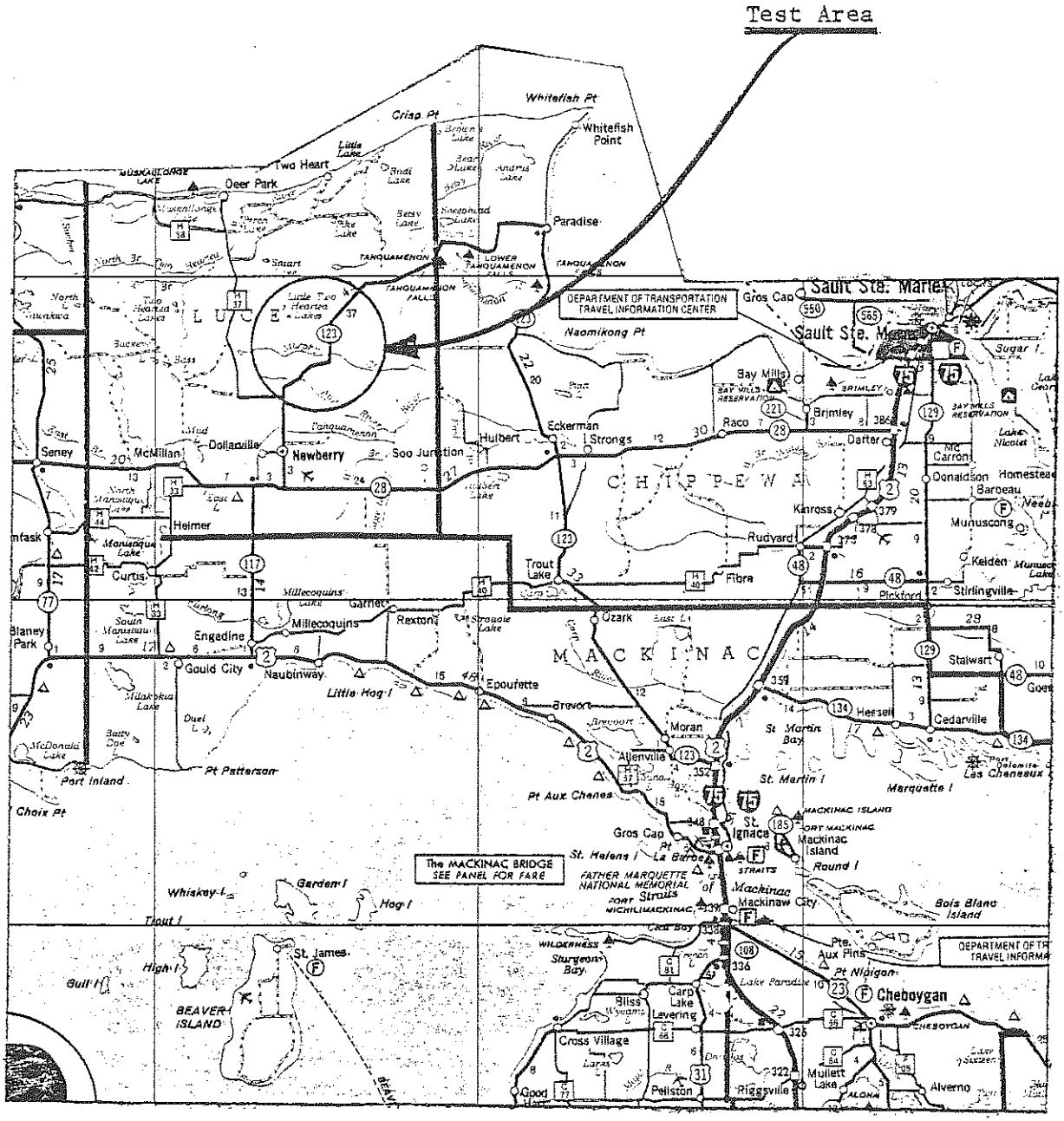

Figure 2: Test site for small sign supports

Figure 3: Wood Support (4" x 6")

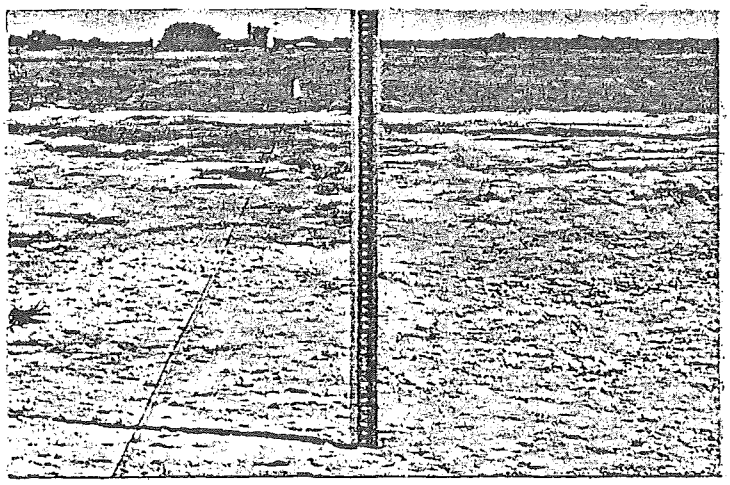

Figure 4: Three-Pound U-Channel Support

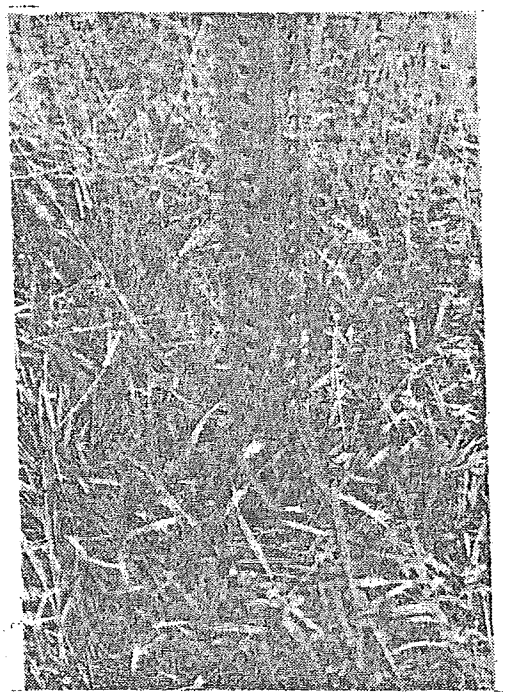

Figure 5: Telespar Steel Support (24H12)

Figure 6: Frangible K-Coupling Breakaway Joint

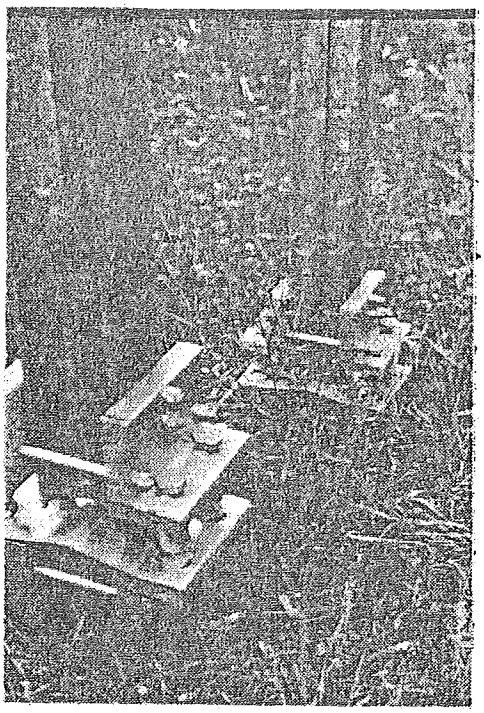

Figure 7: Break-Safe Joint (S4 x 7.7)

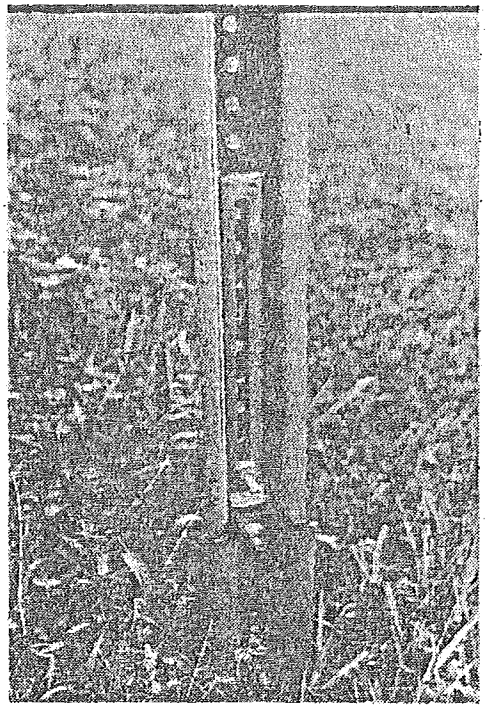

Figure 8: Eze-Erect Support (2 1/2 - 4 pound)

CONCLUSIONS

Although the study extended over a two-year period, the data collected was insufficient to support a sound recommendation for yielding or breakaway small sign support requirements in heavy snow removal areas. For example: some supports had to be re-erected (Eze-Erect) because the manufacturer reported improper initial installation; maintenance repair on other supports (K-Coupling) was not "in-kind"; and, perhaps most important, sign locations throughout the test area were far from typical, since they were located five feet from edge of pavement. Most highway cross sections permit signs to be placed at least ten feet from edge of pavement.

After allowing for these limiting conditions, however, some insight on support performance is revealed. In Tables B, G, and H, it will be noted that U-Channel supports consistently performed better than other yielding or breakaway supports (Table H, page 18). Therefore, based on the analysis of this limited data, it is concluded that in areas where snow removal operations create a problem in maintaining sign supports, Three-pound U-Channel should presently be considered the most cost-efficient small roadside sign support.

Because of the limiting conditions (page 8) under which this study was performed, it is also concluded that additional evaluations of yielding or breakaway supports on more typical highway cross sections should be conducted. Additional evaluations are necessary if final recommendations are to be formulated that will fulfill the intent of the study.

DISCUSSION

Limiting Conditions

Before maintenance experience and costs are discussed, it is important to note a number of circumstances affecting the study.

First, the 86-inch snowfall for the winter of 1979-80 was less than normal (120 inches) for this area, thereby reducing snow removal operations. Because of the unusually mild winter, it was decided to extend the study through the 1980-81 season in order to observe the effect on small sign supports under possibly more realistic snow conditions.

A second situation affecting study results concerned Eze-Erect supports. After numerous failures were experienced early in the test period, the installations were inspected by the supplier's representatives. Following their inspection, we were informed that the supports, in many cases, were not properly installed. As a result, arrangements were made to reinstall them under the guidance of the manufacturer. This work was completed January 8, 1981; therefore, performance data included in this report for Eze-Erect supports is limited to the period between January 8 and April 22, 1981.

Third, maintenance records revealed that some of the K-Coupling joints were not replaced as originally installed -- some locations were repaired by splicing the above- and below-ground sections with 3-pound post material. Also, the records indicate other means of repair may have been implemented in maintaining installations with the K-Coupling.

Finally, it should be noted that this section of M-123 is not typical of many two-lane, two-way highway cross sections. In this area, M-123 has 3-foot shoulders (two feet paved) which resulted in the nearest edge of sign being only five feet from edge of roadway. However, since all signs in the study area were similarly erected, the results of the test should have been comparable.

Maintenance Experience

During the test period (June 28, 1979 through April 22, 1981), Luce County Maintenance forces made periodic inspections of the supports and performed required maintenance. The following tables (A through F) are broken down by support type and size and summarize observed deficiencies. The tables also show the type of maintenance performed (if any) at each location. Other data listed in each table include station location, number of supports, and sign code and size.

Based on the type of damage observed, it is assumed that reported deficiencies were related to snow plowing operations; however, if evidence exists that damage was due to other causes, appropriate footnotes have been added.

Table A

Wood Support (4" x 6")

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
66+00	1	R4-1-24	none			
84+00	1	R4-1-24	post needs wedge	4-2-81		
92+50	1	R4-1-24	none			
102+50	1	R4-2-24	none			
120+50	1	R4-2-24	none			
176+00	1	R4-2-24	none			
200+75	1	R4-2-24	broken post	2-13-81	replaced	2-13-81
266+00	1	R4-2-24	none			
269+70	1	R4-2-24	none			
408+70	1	R4-2-24	none			
420+00	1	R4-2-24	none			
456+30	1	R4-2-24	none			
460+50	1	R4-2-24	none			
478+00	1	R4-2-24	none			
480+50	1	R4-2-24	none			
488+00	1	R4-1-24	broken post	3-11-81		
495+20	1	R4-2-24	none			
501+00	1	R4-2-24	none			

Summary

Supports installed	18
Deficiencies observed.	3
Supports performing satisfactorily	15

Table B

U-Channel Steel Support (3#)

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
7+50	1	R4-1-24	none			
33+50	1	R4-1-24	none			
130+70	1	R4-1-24	post bent	4-2-81		
154+75	1	R4-1-24	none			
185+50	1	R4-1-24	none			
190+60	1	R4-1-24	none			
199+50	1	R4-2-24	none			
209+70	1	R4-1-24	post bent	4-2-81		
209+70	1	W14-3-48	none			
255+50	1	R4-1-24	none			
255+50	1	W14-3-48	none			
279+75	1	R4-1-24	none			
399+70	1	R4-1-24	none			
432+50	1	R4-1-24	post bent	3-11-81		
450+50	1	R4-1-24	post bent	3-11-81		
465+80	1	R4-1-24	none			
469+50	1	R4-1-24	post bent	4-2-81		
491+00	1	R4-1-24	none			
508+20	1	R4-1-24	none			

Summary

Supports installed 19
Deficiencies observed. 5
Supports performing satisfactorily 14

Table C

Telespar Steel Support (24H12)

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
7+50	1	W14-3-48	post bent	2-9-81		
130+70	1	W14-3-48	post bent	2-9-81		
185+50	1	W14-3-48	post bent	4-3-80		
190+60	1	W14-3-48	post bent	4-3-80	repaired	4-14-80
-	-	-	sign damaged post bent	1-20-81	sign replaced post still bent	1-20-81
279+75	1	W14-3-48	post bent	4-3-80	post straightened	4-3-80
399+70	1	W14-3-48	post bent	4-3-80		
432+50	1	W14-3-48	post bent	4-3-80		
450+50	1	W14-3-48	post bent	4-3-80		
465+80	1	W14-3-48	post bent	4-3-80		
469+50	1	W14-3-48	post bent	4-3-80		
488+00	1	W14-3-48	post bent	3-11-81		
491+00	1	W14-3-48	post bent	3-11-81		
508+20	1	W14-3-48	post bent	4-3-80		

Summary

Supports installed	13
Deficiencies observed.	14
Supports performing satisfactorily	0

Table D

Frangible K-Coupling Breakaway Joint (2PB-2200)

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
12+50	2	W1-6-48	both broken	4-3-80	both replaced	4-3-80
-	-	-	both broken	1-8-81		
103+00	2	W11-10-36	both broken	2-22-80	temp. repair	4-3-80
106+00	2	D3-2 7' x 1.5'	both broken	4-3-80	replaced	4-3-80
-	-	-	both broken	1-8-81	replaced w/o K-Coup.	4-6-81
114+00	2	D3-2 7' x 1.5'	both broken	4-3-80	Rt. post replaced	4-14-80
-	-	-	both broken	1-8-81	replaced w/o K-Coup.	4-6-81
253+50	2	W1-2-36	both broken	1-20-80	both spliced with 3# post	4-3-80

Summary

Supports installed	10
Deficiencies observed.	16
Supports performing satisfactorily	0

Table E

Breaksafe Joint (S4x7.7)

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
9+00	2	W1-2-36	none			
21+50	2	W1-2-36	none			
64+00	2	W1-2-36	loose connections[1]	4-2-81		
86+50	2	W1-2-36	none			
117+00	2	W11-10-36	none			
162+50	2	W1-6-48	sign not level[1]	4-2-81		
168+00	2	W1-6-48	none			
265+50	2	W1-6-48	sign not level[1]	4-2-81		
269+00	2	W1-6-48	none			
282+00	2	W1-2-36	none			

Summary

Supports installed	20
Deficiencies observed.	6
Supports performing satisfactorily	14

[1] Frost heave reported.

Table F[1]

Eze-Erect Support

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
			2½-Pound			
42+20	1	M1-6-24	loose bolt	4-2-81		
3+00	1	R4-2-24	broken bolts	2-9-81	bolts replaced	2-9-81
-	-	-	broken bolts	2-25-81	bolts replaced	2-25-81
-	-	-	loose bolts	4-2-81		
23+00	1	R4-2-24	loose bolts, post bent	2-9-81	retightened	2-25-81
74+00	1	R4-2-24	broken bolts	2-9-81	bolts replaced	2-9-81
108+50	1	M1-6-24	broken bolts	2-9-81	bolts replaced	2-9-81
-	-	-	broken bolts	2-12-81	bolts replaced	2-12-81
111+50	1	M1-6-24	broken bolts	2-9-81	bolts replaced	2-9-81
-	-	-	broken bolts	2-25-81	bolts replaced	2-25-81
151+50	2	W1-4-36	none			
175+50	2	W1-6-48	loose bolts	4-2-81		
177+00	2	W1-6-48	none			
396+50	1	M1-6-24	post and footing bent	4-2-81		

Summary

Supports installed	13
Deficiencies observed	12
Supports performing satisfactorily	2

[1] Experience limited to January 8, 1981, through April 22, 1981.

Table F[1]

Eze-Erect Support

Location	No. of Supports	Sign Code & Size	Maintenance Required			
			Deficiency	Date	Treatment	Date
			4-Pound			
2+00	2	W1-6-48	broken bolt (one post)	2-25-81	bolt replaced	2-25-81
33+50	1	W14-3-48	none			
66+00	1	W14-3-48	none			
76+00	1	R4-2-24	broken bolts[2]	2-9-81	bolts replaced	2-9-81
-	-	-	broken bolts[2]	3-18-81	bolts replaced	3-18-81
84+00	1	W14-3-48	none			
92+50	1	W14-3-48	none			
154+75	1	W14-3-48	none			
187+50	2	W1-4-36	broken bolts (outside post)	4-2-81		
401+50	1	M1-6-24	none			

Summary

Supports installed	11
Deficiencies observed	3
Supports performing satisfactorily	8

[1] Experience limited to January 8, 1981, through April 22, 1981.

[2] Deficiency apparently caused by motor vehicle accident.

Comparative Costs

From the data presented in Table G, it will be noted that the U-Channel Support, at $65, is the most economical insofar as initial installation cost is concerned. It is followed, in order, by K-Coupling ($90), Eze-Erect ($96-104), Telespar ($150), Breaksafe ($230), and wood ($265).

With regard to replacement costs[1], however, K-Coupling at $30 is the lowest followed by Eze-Erect ($37), U-Channel ($65), Breaksafe ($70), wood ($75), and Telespar ($80).

Costs were also related to performance. Table H combines both initial installation and replacement costs (estimated) throughout the test period, producing a service/cost ratio for each type support. In this view it will be noted that wood, Telespar, and Breaksafe supports are each approximately three times as costly as U-Channel. Although K-Coupling and Eze-Erect supports are shown to be about one and one-half to twice the cost of U-Channel, test results relating to these supports are somewhat inconclusive (see footnotes, Table H).

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[1] Replacement costs (excluding U-Channel) assume that replacement involves only the breakaway feature of the support -- often, support sections above (and sometimes below) ground may also require replacement which adds proportionately to the cost.

Table G
Comparative Costs[1]

Support Type	Number Supports Installed	Initial Cost (per supp't)			Replacement Cost (per supp't)			Number Times Deficiency Observed
		Material	Labor & Equipm't	Total	Material[2]	Labor & Equipm't	Total	
U-Channel	19 (9 locations)	$ 15	$ 50	$ 65	$15	$50	$65	5
Eze-Erect (4#)	11 (10 locations)	24	80	104	2	35	37	3
Eze-Erect (2½#)	13 (5 locations)	16	80	96	2	35	37	12
K-Coupling	10	20	70	90	10	20	30	16
Telespar	13	90	60	150	60[3]	20	80	14
Breaksafe	20 (10 locations)	130	100	230	20	50	70	6
Wood	18	65	200	265	25	50	75	3

[1] All costs are estimated costs supplied by Maintenance Division, MDOT.

[2] For breakaway-type supports, includes breakaway feature only.

[3] Estimated replacement cost for this support assumes new upper section and no salvage value for damaged section.

Table H
SERVICE COST ANALYSIS[1]

Support Type	Initial Cost	Maint. Cost	Total Cost	No. Supports	Service Cost Per Supp't	Service Cost Ratio
U-Channel	$1,235	$ 325	$1,560	19	$ 80	1.0
Eze-Er (4#)[2]	1,150	110	1,260	11	115	1.4
Eze-Er (2½#)[2]	1,250	445	1,700	13	130	1.6
K-Coupling[3]	900	480	1,380	10	140	1.8
Telespar	1,950	1,120	3,070	13	230	2.9
Breaksafe	4,600	420	5,020	20	250	3.1
Wood	4,770	225	4,995	18	275	3.4

[1] Service costs are derived from estimated costs for initial installations and estimated replacement costs to April 22, 1981.

[2] Eze-Erect test period was from January 8 to April 22, 1981. Test period for all other supports was from June 28, 1979, to April 22, 1981.

[3] Field repair was not "in-kind" -- some broken K-Coupling joints were replaced with U-Channel post splices.

APPENDIX

Description of Supports Evaluated

1. Wood Support (4-inch by 6-inch) With Steel Sleeve and Concrete Embedment (Figure 3): The wood support is considered a yielding, non-reusable sign post designed to splinter and break away upon motor vehicle impact.

2. Three-Pound U-Channel Steel Support (Figure 4): The U-Channel steel support is also considered to be a yielding-type support. Upon impact, it will either shear near ground level or twist away from the impacting vehicle's path.

3. Telespar Steel Support (24H12), Unistrut Telespar Systems, 35005 Michigan Avenue West, Wayne, Michigan, 48184 (Figure 5): A Telespar steel support consists of a square base section driven to near ground level and a square sign support section telescoped into the base and bolted. Theoretically, an impacting vehicle will shear off the sign support near the top of the base section, leaving the latter undamaged, thereby permitting easy replacement of the sign support section.

4. Frangible K-Coupling Breakaway Joint (2PB-2200), General Coupling, Inc., 2707 Durand Avenue, Racine, Wisconsin, 53403 (Figure 6): The K-Coupling, made of cast iron, is used to connect upper and lower parts of a U-Channel post. It is designed to readily break upon impact by a motor vehicle.

5. Break-Safe Joint (S4x7.7), Transpo-Safety, Inc., 111 Cedar Street, New Rockelle, New York, 10801 (Figure 7): The Break-Safe assembly is used to hold upper and lower sections of back-to-back U-Channels together. The key element in this system is a set of four couplings designed to break away upon impact and theoretically permit reerection of the upper post section merely by installing new couplings.

6. Eze-Erect Support (2½-Pound - 4-Pound), Franklin Steel Company, P.O. Box 671, Franklin, Pennsylvania, 16323 (Figure 8): This support is composed of upper and lower U-Channel sections which are overlapped and bolted together using a retainer strap designed to prevent the upper U-Channel section from flying up and penetrating the windshield area.