

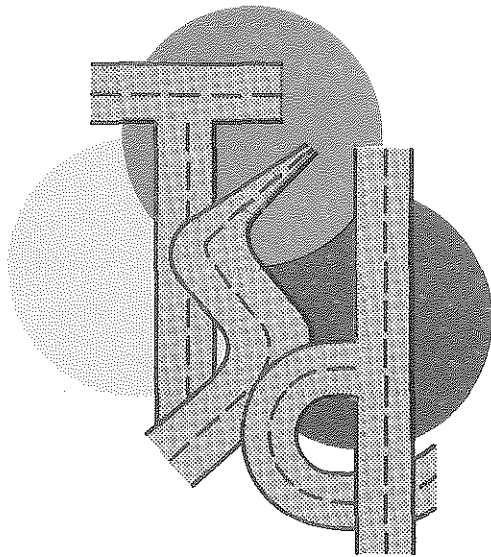
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EVALUATION OF TWO SAFETY PROJECTS FOR
CURVE SUPERELEVATION AND DRAINAGE CORRECTION

TSD-224-73

US-27 Southeast of Ithaca - Gratiot County

US-127 about three miles north of Jackson, Jacks



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SYNOPSIS

This report is an evaluation of two projects where selective surfacing was placed on two rural freeway curves exhibiting an unusual frequency of loss-of-control vehicle accidents.

At the first location (US-27 east of Ithaca), 600 feet of surfacing was applied to a portion of the southbound roadway to improve drainage characteristics after it was determined that rain water was accumulating to a sufficient depth to create the possibility of vehicle hydroplaning.

This first project, costing \$9,000, reduced accidents from 16 the year "before" to two the year "after" for an 87% reduction. This amounted to a yearly savings of \$34,000 in accident reductions.

At the second location (US-127 north of Jackson), bituminous resurfacing of the superelevation transition on both roadways and shoulders at the north end of the curve was done to lessen the incidents of out-of-control vehicles entering or crossing the median.

The second project, costing \$70,000, showed a reduction in reported accidents from five the year "before" to three the year "after". While the change in the number of accidents is not significant, there was no evidence of out-of-control vehicle action in the median after the project was completed.

SITE LOCATIONS

US-27 and US-127 are two of the major north-south routes in Michigan carrying considerable tourist traffic from neighboring states and from the south central part of Michigan to the northern areas of the State. US-127 extends from the Ohio State Line northerly to its junction with US-27 in the city of Lansing. US-27 begins at the Indiana State Line, intersects US-127 in Lansing and continues northerly to its junction with I-75 south of Grayling, which in turn ends at the International Bridge at The Canadian Border (Figure #1) in Sault Ste. Marie.

The study locations involve two curves; 1) a three degree curve on the southbound roadway of US-27, one mile north of the freeway ending, southeast of Ithaca and; 2) a two degree, forty minute curve on the northbound and southbound roadways of US-127, about three miles north of Jackson.

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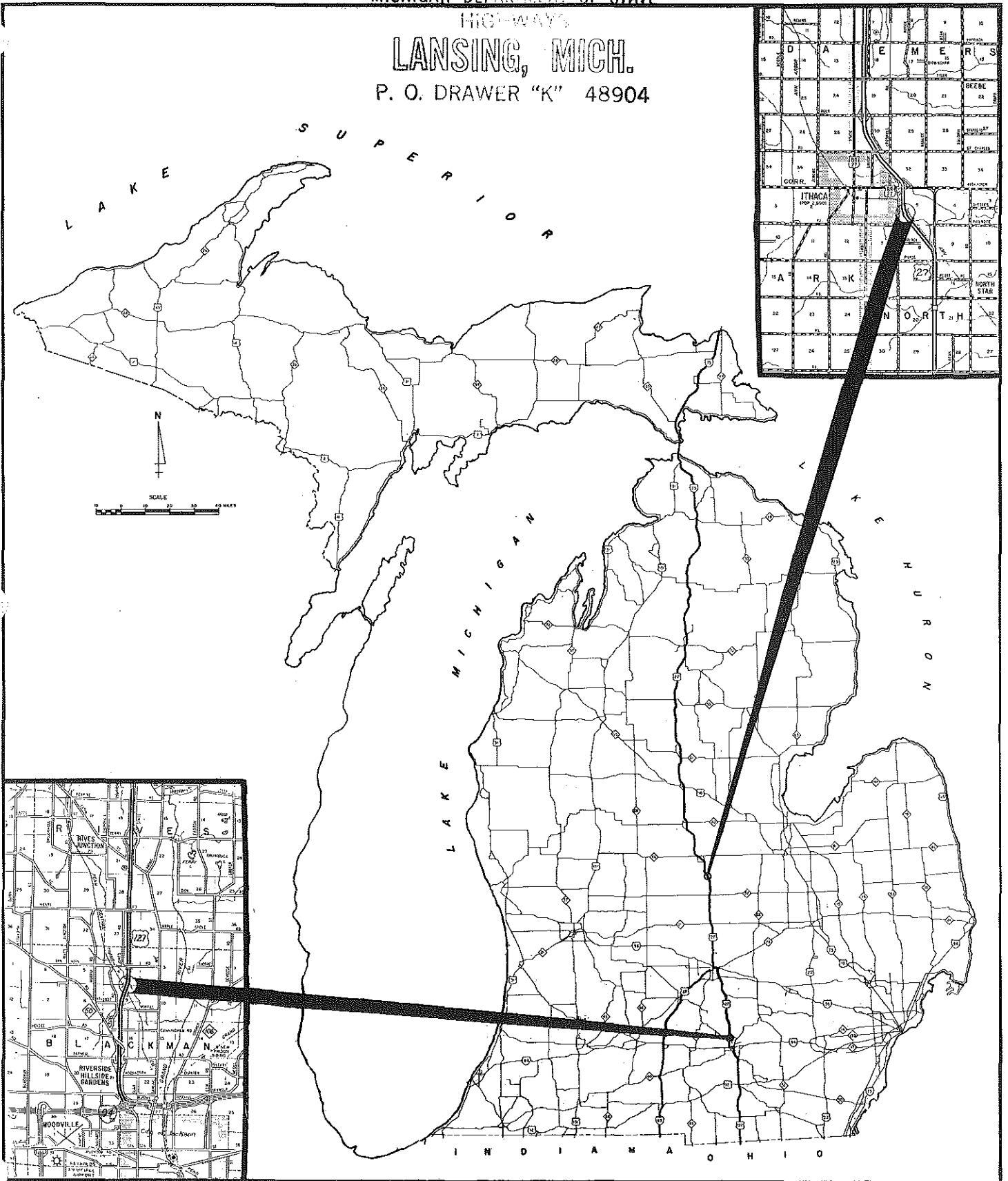


FIGURE 1-

LOCATION #1

(Southbound US-27 near Ithaca)

BACKGROUND:

Prior to the safety improvement project, there had been numerous ran-off-roadway accidents, notably during wet weather. Observations revealed that at the beginning of the curve, rain water was not draining directly to the pavement edge but was washing diagonally across the pavement. This was caused by pavement settlement, creating a conflict between the grade and the superelevation. During the year "before" the project, there were sixteen reported accidents, ten of which were injury accidents with fifteen persons injured.

Prior to the initiation of the project, attempts were made in 1969 to alleviate the problem by raising the pavement slabs, that had settled, by means of mud-jacking and by installing four 4-foot by 8-foot target arrows on the curve and other warning signs.

In addition to the analysis of reported accidents, observation revealed the characteristics of the water drainage and associated hydroplaning of vehicles. The project to correct the condition, was then authorized.

Prior to construction activity in September, 1970 inquiries were made at local area service stations to determine more accurately the true extent of the problem by ascertaining the number of vehicles requiring wrecker assistance at this curve. Information gathered during June, July, and August, 1970 indicated that there were 42 calls for wrecker service as a result of drivers losing control on the curve. Police agencies reported nine accidents during the same three month period.

This information revealed that incidents involving out-of-control vehicles were far greater than were being reported.

IMPROVEMENTS AND RESULTS

Observations of the drainage characteristics of the pavement at the beginning of the southbound US-27 curve indicated that settlement was causing water to accumulate to a depth sufficient to enable high speed vehicles to hydroplane and lose almost complete directional control. Bituminous surfacing was applied to the roadway to return elevations to the original grade (see Figures #2 and #3) by adjusting the depth of the overlay which improved water run-off characteristics.

A study conducted after completion of the project, indicated that the number of accidents and calls for assistance by wreckers was dramatically reduced. There was an 87% (16 to 2) reduction in total accidents in the "after" period and injury accidents were reduced by 80% (10 to 2) with the number of injuries reduced by 73% (15 to 4).

The follow-up inquiries made during June, July, and August, 1971 further indicated that requests for wrecker assistance were reduced by 93% (42 to 3) from the same period of 1970.

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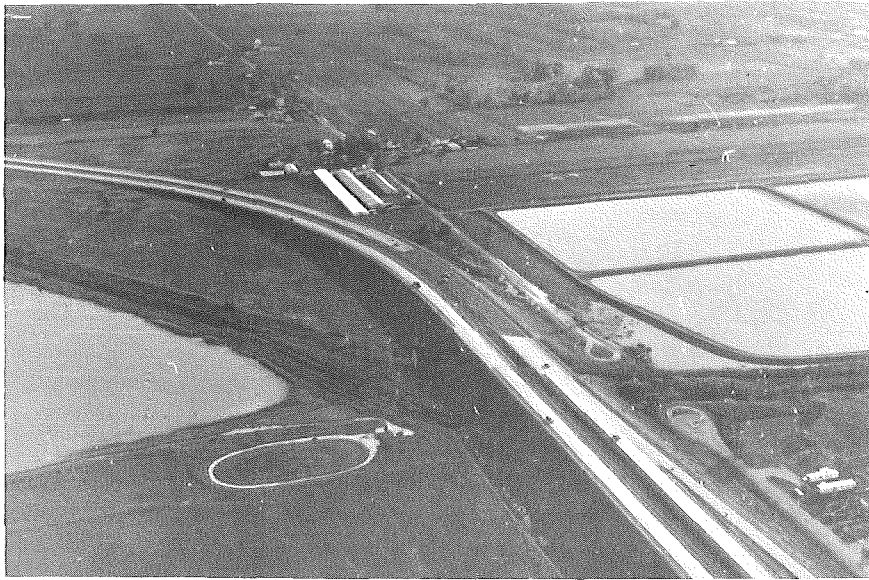


FIGURE #2

Aerial view of US-27 near Ithaca, looking south. The dark portion of the southbound roadway is where the bituminous overlay was applied.

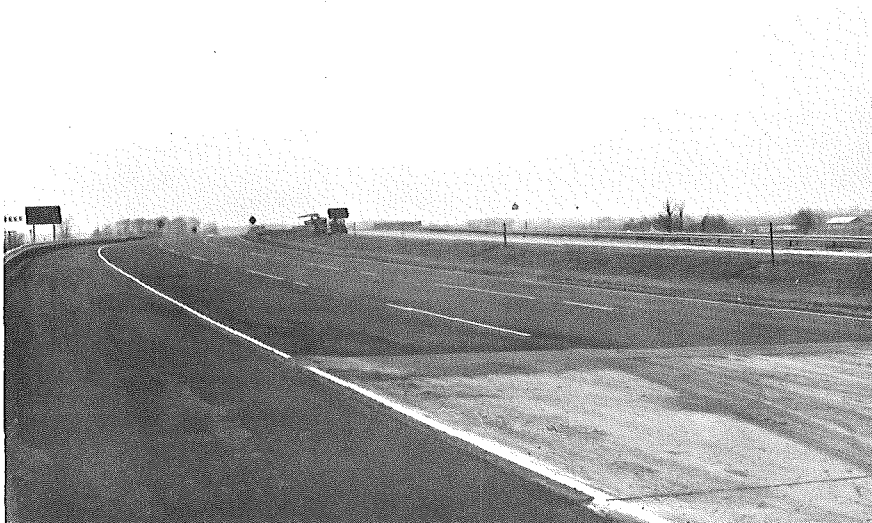


FIGURE #3

Looking north at the bituminous overlay on southbound US-27.

ACCIDENT RECORD TABLE
(Location #1, US-27 near Ithaca)

	"Before" 9-15-69 to 9-14-70	"After" 10-8-70 to 10-7-71
Total Accidents	16	2
Property Damage	6	0
Injury Accidents	10(15)*	2(4)*
TYPE OF ACCIDENTS		
Wet Surface	100%	100%
Ran-off-Roadway	15	1
Others	1	1

*() number of persons injured.

NUMBER OF MOTORISTS ASSISTED

During the Months of June, July, and August	Year	
	1970	1971
Number assisted by Road Service Vehicles	42	3
Number of those assisted and reporting an accident	9	1

The accident reduction experienced by this safety improvement project occurred in the face of a moderate increase of 6% (9,400 in 1969 to 10,000 in 1970) in the average daily traffic on US-27.

Appendix A shows that the reduction in accidents is statistically significant, using conservative Chi Square Tests.

The computed benefit to the public derived through the reduction of the number of accidents for one year "after" the project is \$34,000 (Appendix B). Comparing this benefit with the improvement cost of \$9,000 reveals that the benefits exceeded the cost nearly four-fold in a one year period.

LOCATION #2

(Northbound and Southbound
US-127 North of Jackson)

BACKGROUND:

The analysis of accidents and evidence of vehicle tracks and guardrail damage in the field indicated that some vehicles were entering the median or crossing into the opposing lanes of traffic, creating a potential for serious accidents. During the year prior to the safety improvement project five accidents occurred at this location.

Measurements indicated that the northerly transition of the superelevation on both roadways occurred north of the points of curvature (on tangent), which created a driver control problem. Vehicles tended to drift into the curve too early or stay in the curve too long. Bituminous resurfacing was applied to the superelevation transitions of both roadways north of the railroad overpass (see figure #4). The gravel shoulders were also surfaced.

Investigation subsequent to the resurfacing indicated that the corrective treatment made it easier for drivers to negotiate the beginning of the southbound curve and the ending of the northbound curve.

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FIGURE #4



Aerial view of US-127,
North of Jackson.
Looking south before
the improvement. The
curve at the bottom of
the picture is the
study location.

FIGURE #5



Ground view of US-127,
North of Jackson.
Looking north after
the improvement.

ACCIDENT RECORD TABLE

(Location #2, US-127 north of Jackson)

	"Before" 7-6-70 to 7-5-71	"After" 8-3-71 to 8-2-72
TOTAL ACCIDENTS	5	3
Property Damage	3	2
Injury Accidents	2(4)*	1(4)*
TYPE OF ACCIDENTS		
Ran-off-Roadway	5	2
Others	0	1

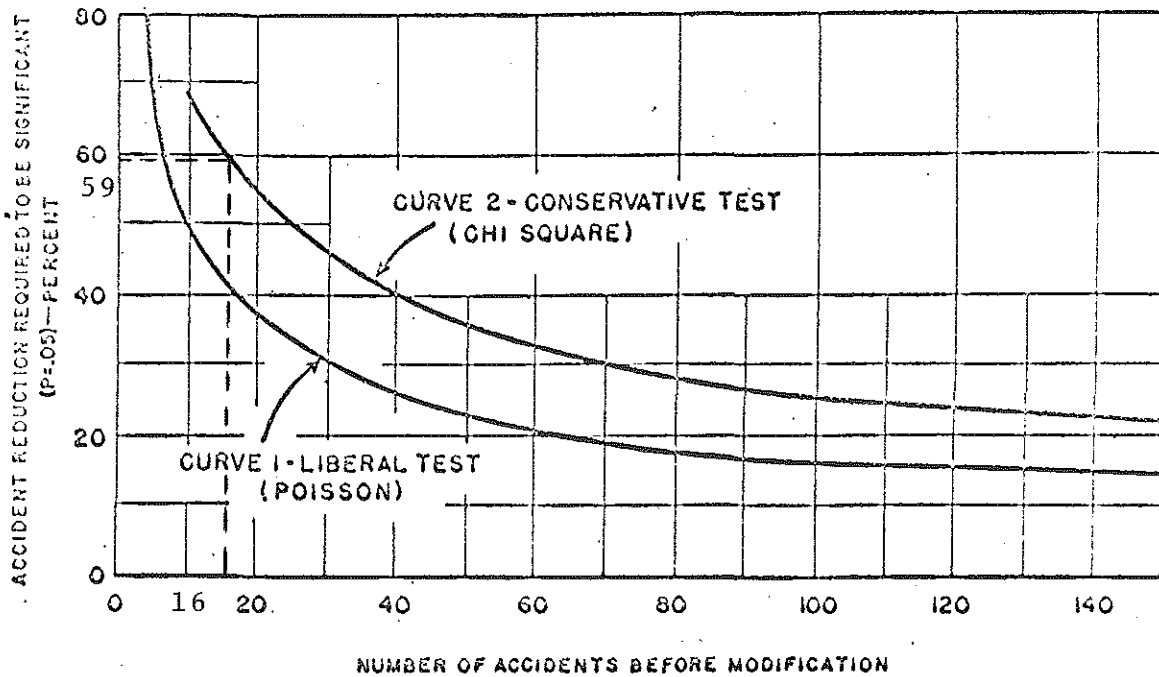
*() Number of persons injured.

In the year after the project the number of accidents was reduced from five to three. Although Appendix A and Appendix B show that there was not a statistically significant reduction in accidents and monetary savings, the potential for loss of control on the curve was minimized. Field investigations showed that there was no evidence of tracks in the median from out-of-control vehicles, and there was a lessening of damage to the guardrail on the northerly approach to the railroad structure.

APPENDIX A

The Significance of the Accident Reduction

The graph below appeared in an article entitled, "Two Simple Techniques for Determining the Significance of Accident Reduction Measures" by Richard H. Michaels in the September, 1966, issue of Traffic Engineering magazine.



Curves for determining the statistical significance of accident-reducing techniques.

Curve 1 is the liberal curve and may be used where more than minimum accident records are available such as two years before and two years after. Curve 2 should be used where data may only be available one year before and one year after, as in this case.

During the year period (September 15, 1969 to September 14, 1970) before the improvement on US-27 near Ithaca, there were 16 accidents at the subject area. Using Curve 2, the percentage reduction required to be significant is 59%. There was an 87% reduction in accidents at the subject location.

Therefore, the accident reduction at this location is statistically significant.

At the other location on US-127 north of Jackson, the accident reduction (5 to 3) is not statistically significant.

APPENDIX "B"

Computed Benefits Derived Through Accident Reduction
Cost Analysis

The method of evaluating accident costs, used below, is given on Page 67 of Roy Jorgensen's report of Highway Safety Improvement Criteria, 1966 edition. This same method is given in the Federal Highway Administration PP21-16 (March 7, 1969).

In the following analysis the costs provided by the National Safety Council for 1970 are:

Non-fatal Injury - 2,700

Property Damage Accident - 400

$$B = \frac{ADTa}{ADTb} \times (2,700 \times R_1^* + 400 R_2^*)$$

where

B = benefit in dollars

ADTa = average daily traffic volume after the improvement
(10,000 and 10,000)

ADTb = average daily traffic volume before the improvement
(9,400 and 10,000)

R₁ = reduction in injuries (15-4 = 11 and 4-4 = 0)

R₂ = reduction in property damage accidents (6-0 = 6 and 3-2 = 1)

The computed benefits to the motoring public accrued during the "after" period is then:

$$B = \frac{10,000}{9,400} \times (2,700 \times 11 + 400 \times 6) = \$34,000 \text{ for location \#1}$$

$$B = \frac{10,000}{10,000} \times (2,700 \times 0 + 400 \times 1) = \$400 \text{ for location \#2}$$

*In the above noted reference, R₁ is listed as A_{fi} x P_{fi}. It is evident upon inspection that P_{fi} = $\frac{R_1}{A_{fi}}$ (see definition above)

so that A_{fi} x P_{fi} = A_{fi} x $\frac{R_1}{A_{fi}}$ = R₁. Similarly R₂ replaced A_{pd} x P_{pd}.