

Experimental Installation of Rumble Strips in Indiana

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INTRODUCTION

The Superintendent of the Indiana State Police in a memorandum dated May 16, 1966, to the Chairman of the Indiana State Highway Commission requested that we investigate the merits of the installation of rumble strip areas where we have high frequency accident locations—see Fig. 1.



Fig. 1. Experimental Rumble Strips in Indiana.

The request was investigated by the Division of Traffic and the Traffic Accident Review Committee selected five locations for the trial installations. On July 11, 1966, the Division of Maintenance was asked for assistance in the placement of these installations.

The standards were made available by the Design Department and are very similar to the ones being experimented with in the State of Kentucky. We contacted the State of Illinois and found out that they too are experimenting and were getting varied results. Some had shown a decrease in accidents while others had shown no change. Their design is similar, however, they use an epoxy bonding material to embed hard, sharp aggregate which has a top size of $\frac{1}{2}$ in.

DESIGN OF RUMBLE STRIPS

The rumble strips which we installed consist of a series of nine rumble strip areas located at different spacings according to the design standards which are included in the appendix. Each area consists of 11 strips spaced 8 in. apart and are 8 in. wide.

Since this project was experimental we varied the thickness from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick. We constructed each rumble strip area with 11 strips instead of 12 which was called for in the standard specifications. The fabrication of the forms used in the field to construct each rumble strip area did not lend itself to 12 strips since it was built with 4 ft x 8 ft or 4 ft x 12 ft sheets of $\frac{3}{8}$ in. plywood and 2 in. x 4 in. lumber.

The construction of these projects were done by the Division of Maintenance with its own forces. The Division of Traffic helped layout the rumble strip locations and the Greenfield District Traffic Department gave us added assistance by providing traffic control at both of their locations, one of which required a detour (Kokomo).

LOCATION OF FIVE INSTALLATIONS

Listed below are the location sites of each of the first rumble strip areas:

1. On S.R. 252, just west of the U.S. 31 intersection (1,025 vpd)
2. On U.S. 31, north of the transition from two lane to four lane (north end of Kokomo By-pass—9,700 vpd)
3. On S.R. 3, at the approach to U.S. 35 south of Muncie (5,325 vpd)
4. On U.S. 30, near Penguin Point just east of Warsaw (15,600 vpd)
5. On S.R. 63, north and south of U.S. 136 (1,825 to 2,200 vpd)

All of the projects were installed in the same general manner with the same type of material and equipment. A representative from the central office was present during three of the five projects constructed—S.R. 3, U.S. 31 and U.S. 30.

CONSTRUCTION PROCEDURES

A form was made and used to uniformly construct each rumble strip area and the layout of the form is included in the appendix. Below is the outline of the construction procedures used in building the rumble strip areas.

1. Place form at first rumble strip location with the 2x4's parallel to centerline.
2. With form in place, use keel and mark the pavement where the tack coat is to be applied.
3. Remove form and brush on the tack coat.
4. After the tack coat has broken, replace the form and place bituminous material quickly—it will cool rapidly because of its small quantity.
5. After luting the bituminous material evenly between the plywood forms, rolling will begin with the form still in place. Two complete passes with the roller shall be made as a minimum.
6. Remove the form and make one more final pass with the roller.
7. Clean the excess bituminous material that isn't in the actual strips.

HISTORY AND STATUS OF INSTALLATIONS

A general description of each project and its present condition as of February 1969, is listed below.

On S.R. 252, Just West of the U.S. 31 Intersection

This project was installed August 16, 1966. A tack coat of AE-90T was applied to the bituminous pavement and an AP sand mix was placed at a thickness of $\frac{1}{4}$ in.

As of February 19, 1969, all rumble strips were still there, however, the thickness was $\frac{1}{8}$ in. or less. The noise and vibration made by the rumble strip areas is beginning to become rather soft and replacement probably should be undertaken this year to assure effectiveness.

On U.S. 31, North of the Transition from Two Lane to Four Lane (North End of Kokomo By-pass)

This project was placed on September 15-16, 1966 and required a detour of the southbound traffic. A tack coat of MWS-150 was brushed on the concrete pavement before placing the hot AE Surface, Type IV at a thickness of $\frac{3}{8}$ in.

As of February 21, 1969, all rumble strips were still there, however, two strips at two areas and one strip at three areas had less than 50% loss. The present thickness was between $\frac{3}{16}$ to $\frac{1}{4}$ in. The rumble strip areas were still effective.

On S.R. 3, at the Approach to U.S. 35 South of Muncie

This project was installed on September 29-30, 1966. A tack coat of MWS-150 was brushed on the concrete pavement and with the

exception of the first rumble strip area (farthest south of the intersection) a hot AE surface, Type IV mix, was placed at a depth of $\frac{3}{8}$ in. plus. At the first rumble strip area we used #11 aggregate. During the second day, rain occurred while placing the second, third and fourth rumble strip areas located at the south end of the installation.

As of February 25, 1969, all rumble strips were still there with the exception of the second area which was 50% gone. Three feet were gone on the first strip of the third area and 50% of the first strip and 10% of the second strip were gone in the fourth area. With the exception of the ninth rumble strip area (the one farthest north) the average thickness was $\frac{1}{4}$ in. plus which is considered enough to make an effective installation.

On U.S. 30, near Penguin Point Just East of Warsaw

This project was placed on October 6-7, 1966. A tack coat of RC-3000 was painted on the concrete pavement prior to the placement of $\frac{3}{8}$ in. of AP sand mix. Shoving of the strips was noted in the wheel tracks of the driving lane in November 1966.

As of February 25, 1969, the following observations were made: (a) the condition of the rumble strip areas in the passing lane were in good shape, (b) 7 of the 9 rumble strip areas were shoved badly in the driving lane and (c) the thickness was about $\frac{3}{8}$ in. plus in the passing lane and $\frac{1}{8}$ to $\frac{1}{4}$ in. in the driving lane outside of the wheel tracks.

The effectiveness has been lost in the driving lane and recommendations were made to the Subdistrict to trim up the strips in the driving lane to restore the rumble strip areas to the proper cross section.

S.R. 63, North and South of U.S. 136

The original installation was made on November 15-16, 1966, but 85% of it was gone by December 5th and it was rebuilt the following year in July. When it was rebuilt only seven of the rumble strip areas were installed. A diluted tack coat of MWS-150 was used on the concrete pavement and $\frac{1}{2}$ in. of hot AE surface, Type IV, was placed.

As of February 21, 1969, all seven of the rumble strip areas north of U.S. 136 were there and the thickness varied from $\frac{3}{8}$ to $\frac{1}{2}$ in. Only two strips had any damage and they were at one area. The rumble strip areas south of U.S. 136 had some damage. The third area from the north was completely gone and the seventh area had some damage in two strips. The thickness varied from $\frac{1}{4}$ to $\frac{3}{8}$ in. This installation was still effective.

EFFECTIVENESS OF RUMBLE STRIPS

The Division of Traffic has kept accident records on these locations since their construction in 1966. I don't profess to be a traffic engineer but, since I was asked to give a paper on rumble strips, I feel that it is my duty as a maintenance engineer to try to evaluate each of these locations based on the accidents records given me by the Division of Traffic. The format of these accident records have been slightly modified and appear in figures 2 to 6. Here is the evaluation as a maintenance engineer views it:

On S.R. 252, Just West of the U.S. 31 Intersection

One-year accident records indicate eight accidents before and only one accident after the installation of the rumble strips. However, in reviewing the type of accidents it appears that five accidents occurred before and none after in one year.

Eleven accidents occurred before the rumble strips were placed and only two after according to the two-year accident records. However, the types of accidents were not indicated so a more knowledgeable evaluation could not be made—see Fig. 2.

This rumble strip installation has certainly lowered the accidents at this location.

On U.S. 31, North of the Transition from Two Lane to Four Lane (North End of Kokomo By-Pass)

This location involves a single-lane pavement that becomes a dual-lane pavement. Two-year accident records show a total of 13 accidents with eight persons injured and property damage of \$7,881. After the rumble strips, there were ten accidents, two people injured and property damage of \$4,622—see Fig. 3.

From this information, it appears that this installation did not reduce the accident rate.

On S.R. 3, at the Approach to U.S. 35 South of Muncie

On September 30, 1966, the rumble strip installation was completed. On July 28, 1966, this intersection was changed from a "T" intersection to a complete intersection by extending Macedonia Street. Two-year accident records indicated 18 accidents occurred before with 17 persons injured, and 14 have occurred after the installation, with 10 persons injured. Property damage varied from \$33,900 before to \$6,888 after in a two-year period—see Fig. 4.

Except for the property damage reduction, in my judgment, this installation has shown no great improvement after two years of observation.

On U.S. 30, near Penguin Point Just East of Warsaw

This particular location is where a dual-lane pavement narrows to a single lane. The accident records provided by the Division of Traffic were for a 24-month period before installation and a 12-month period after—see Fig. 5.

Thirteen accidents occurred in a two-year period before the rumble strips and seven in a one-year period after. However, in reviewing the type of accidents, we find that ten of the 13 accidents in the two-year period involved the area where the rumble strips were to be placed and after the rumble strip were installed only three accidents occurred in a one-year period.

It appears that this installation is proving successful.

On S.R. 63, North and South of U.S. 136

Only one year of accident records were available at this location because the initial installation didn't bond to the concrete pavement and was replaced in July 1967. Five accidents occurred before and three occurred after in a one-year period—see Fig. 6.

In reviewing the type of accidents, the five before all failed to negotiate the curve. Since the rumble strips were installed, one failed to make the turn and the remaining two appeared to have been confused by the rumble strips.

It is my conclusion at this time that not enough information is available to make a proper conclusion.

So from a maintenance engineer's standpoint it appears that two of the locations have been improved by the rumble strip installations and two have indicated no improvement. One, I feel, didn't have enough information for final appraisal.

CONCLUSIONS

In conclusion, as a maintenance engineer, I feel that the placement of selected rumble strip areas is a worthy investment in protecting human life and for a cost of between \$350 to \$500 per installation it is money well spent. We cannot afford not to invest in safety for the public. If we help save a life or eliminate a personal-injury accident the investment is justified. However, a word of caution—too many rumble-strip installations could possibly cause a loss of meaning.

APPENDIX

The data below provides information on the materials required, construction procedures and installation procedures for the placement of rumble strips—see Fig. 7.

Material Requirements

4—2 in. x 4 in. x 8 ft (for ease of handling make form in two sections)

2—12 ft x 4 ft plywood $\frac{3}{8}$ in. thick (cut plywood 8-in. widths and 12 ft long)

Tacking material: AE-T or RC-70

4 tons Hot A.E. Surface, Type IV (sand mix) or Hot A.E. Surface, Type III or H.A.C. Surface, Type "B" (about half of this material is wasted due to the need for extra material, because of heat loss)

Procedure

Place form at proper location on pavement and mark area to be tacked with a lumber crayon. Remove form and tack the marked area with AE-T or RC-70. Brush on plenty of tack and completely cover the desired area where the bituminous material is to be placed. Replace the form so the tacked area shows and place the bituminous material. Make at least two passes with a roller with the form still in place. Then remove the form and roll again. Open to traffic in one-half hour.

Fig. 2. Intersecting arrows show the location and types of accidents. Rumble strips were placed on S.R. 252 W. and U.S. 31 on 8-16-66 at an estimated cost of \$325. Before and after accident data are shown on the left and right respectively for a two-year period. (Before 8-16-64 to 8-16-66; after 8-16-66 to 8-16-68)

	Before	After
Total accidents	11*	2†
Property damage accidents	6	1
Personal injury accidents	3	1
Fatal accidents	2	0
Persons injured	10	2
Persons killed	4	0
Total property damage	\$8295	\$1950

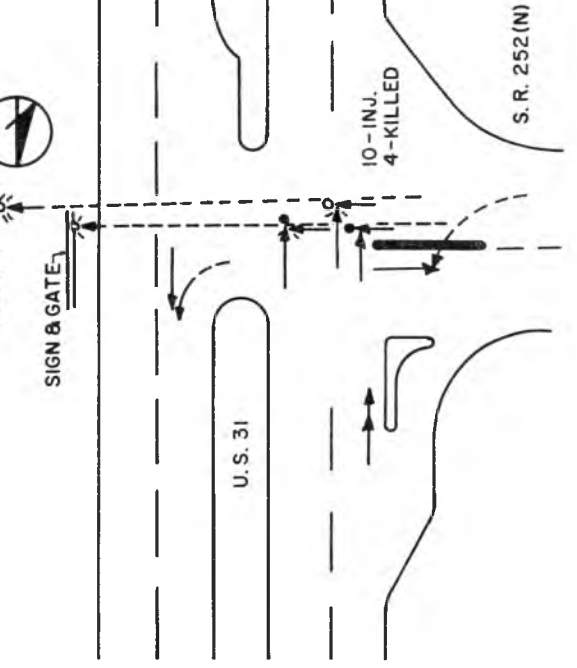
* Day—7, night—4, dry—10, wet—1

† Day—1, night—1, dry—2, wet—0

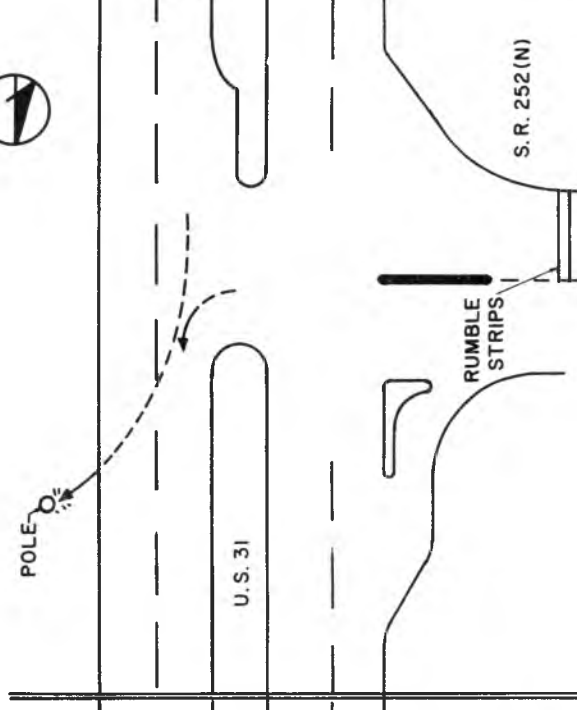
BEFORE

OIL
BARRELS

SIGN & GATE



AFTER



S. R. 252 (N)

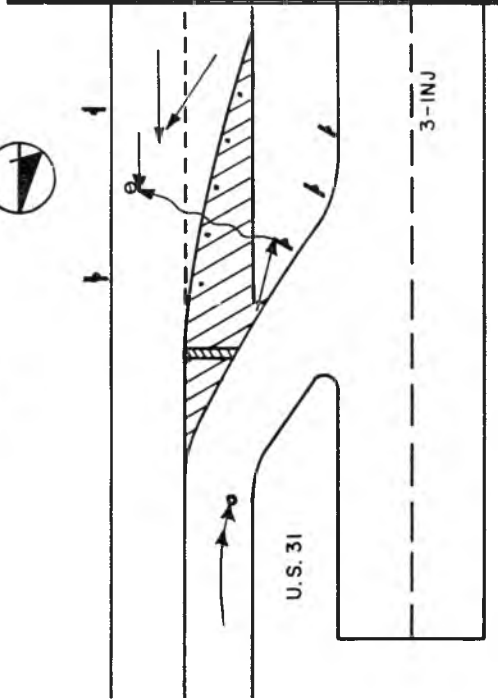
U.S. 31

10-INJ.
4-KILLED

RUMBLE
STRIPS

S. R. 252 (N)

BEFORE



AFTER

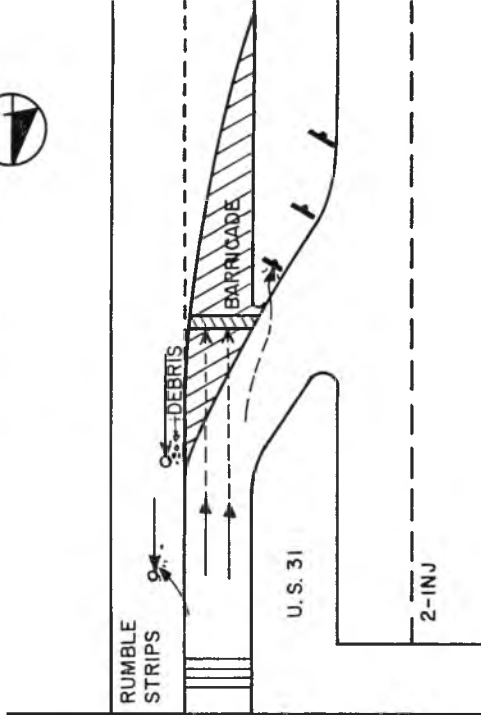


Fig. 3. Arrows indicate the location and types of accidents. Rumble strips were placed on U.S. 31 north of the transition on the south bound lane at an estimated cost of \$325 on September 9, 1969. Before and after accident data for a two-year period are shown on the left and right respectively. (Before 9-9-64 to 9-9-66; after 9-9-66 to 9-9-68)

	Before	After
Total accidents	13*	10†
Property damage accidents	7	8
Personal injury accidents	6	2
Fatal accidents	0	0
Persons injured	8	2
Persons killed	0	0
Total property damage	\$7881	\$4622

* Day—2, night—11, dry—10, wet—3

† Day—5, night—5, dry—5, wet—5

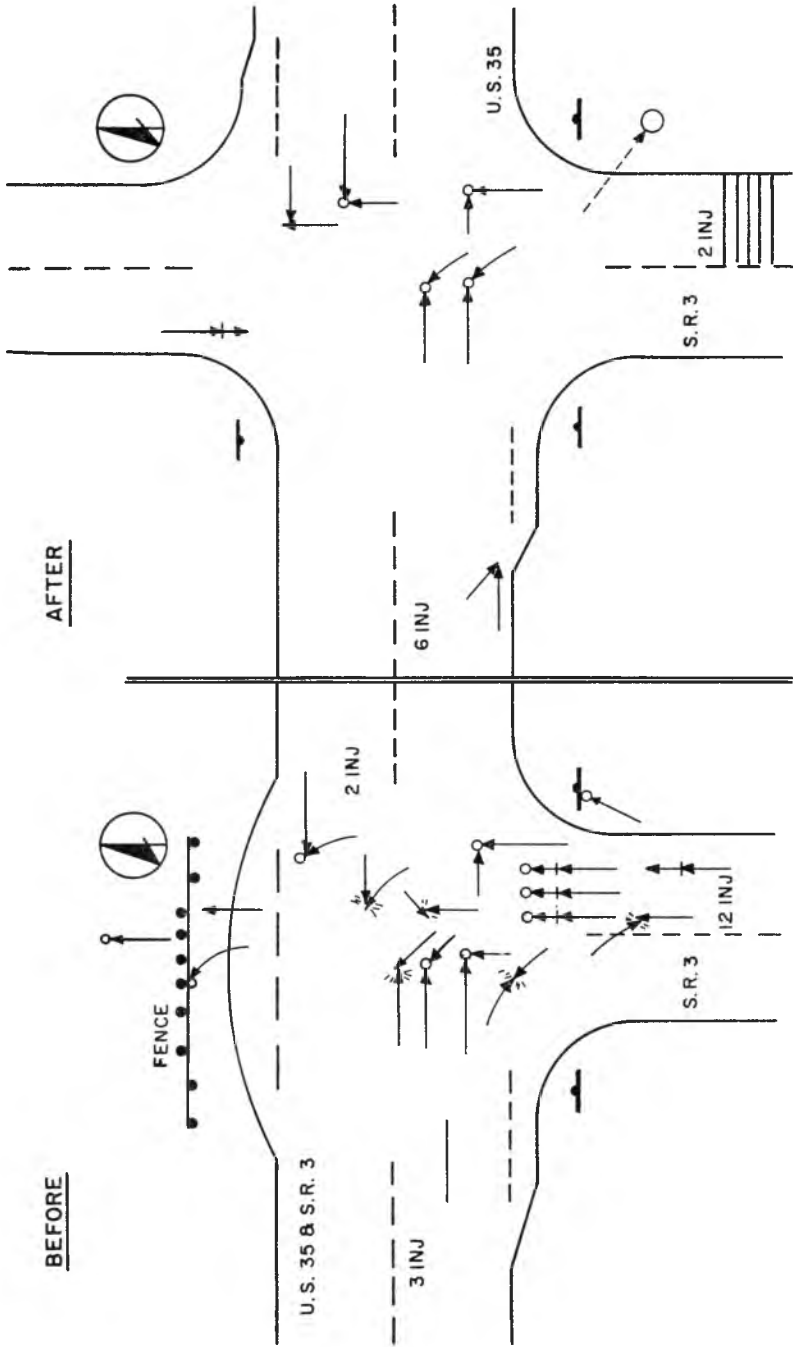


Fig. 4. Arrows indicate the location and types of accidents. Rumble strips were placed on new S.R. 3 south of U.S. 35 on September 30, 1966 at an approximate cost of \$325. Before and after accident data are shown on the left and right respectively. The before data covers a two-year period, 9-30-64 to 9-30-66 and the after data covers two years, 9-30-66 to 9-30-68. (On July 28, 1966 Macedonia Street was opened from S.R. 3 and U.S. 35 North by the City of Muncie)

	Before	After
Total accidents	18*	14†
Property damage accidents	8	9
Personal injury accidents	10	5
Fatal accidents	0	0
Persons injured	17	10
Persons killed	0	0
Total property damage	\$33900	\$6888

* Day—11, night—7, dry—12, wet—6

† Day—9, night—5, dry—11, wet—3

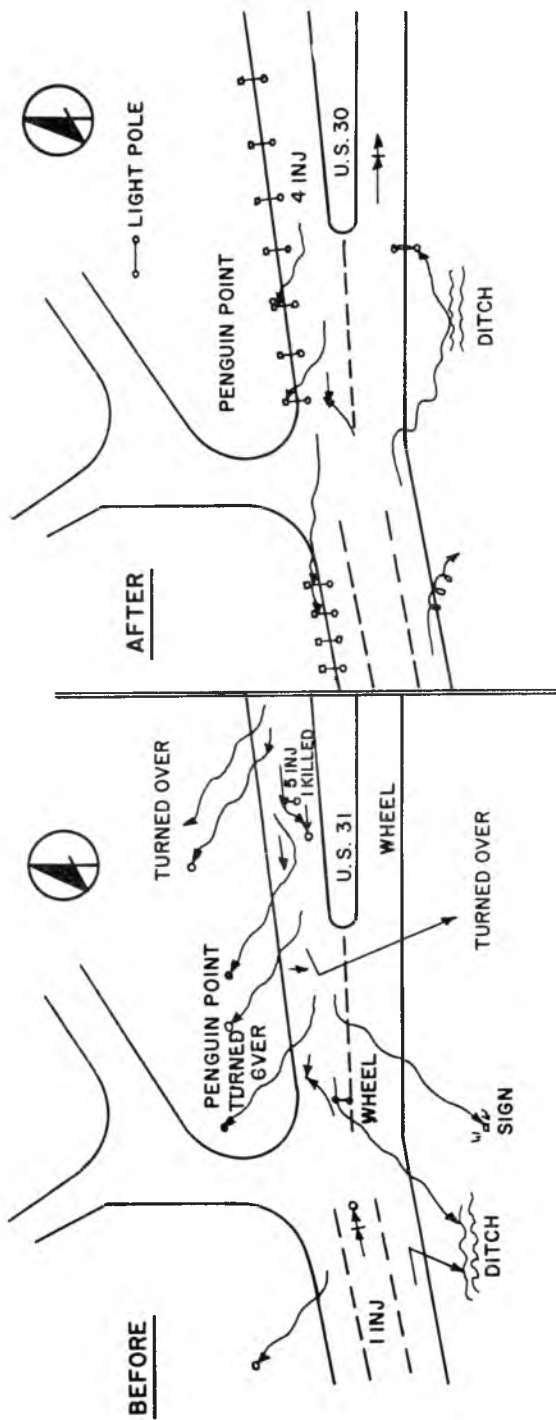


Fig. 5. Arrows indicate the location and types of accidents. The highway location is U.S. 30 east of Warsaw. Lights were installed April 21, 1967 at a cost of \$3586. Before and after accident data are shown on the left and right respectively. The before data covers a two-year period, 4-21-65 to 4-21-67 and the after data covers one year, 4-21-67 to 4-21-68.

	Before	After
Total accidents	13*	7†
Property damage accidents	7	6
Personal injury accidents	5	1
Fatal accidents	1	0
Persons injured	6	4
Persons killed	1	0
Total property damage	\$14465	\$4500

* Day—4, night—9, dry—11, wet—2

† Day—3, night—4, dry—5, wet—2

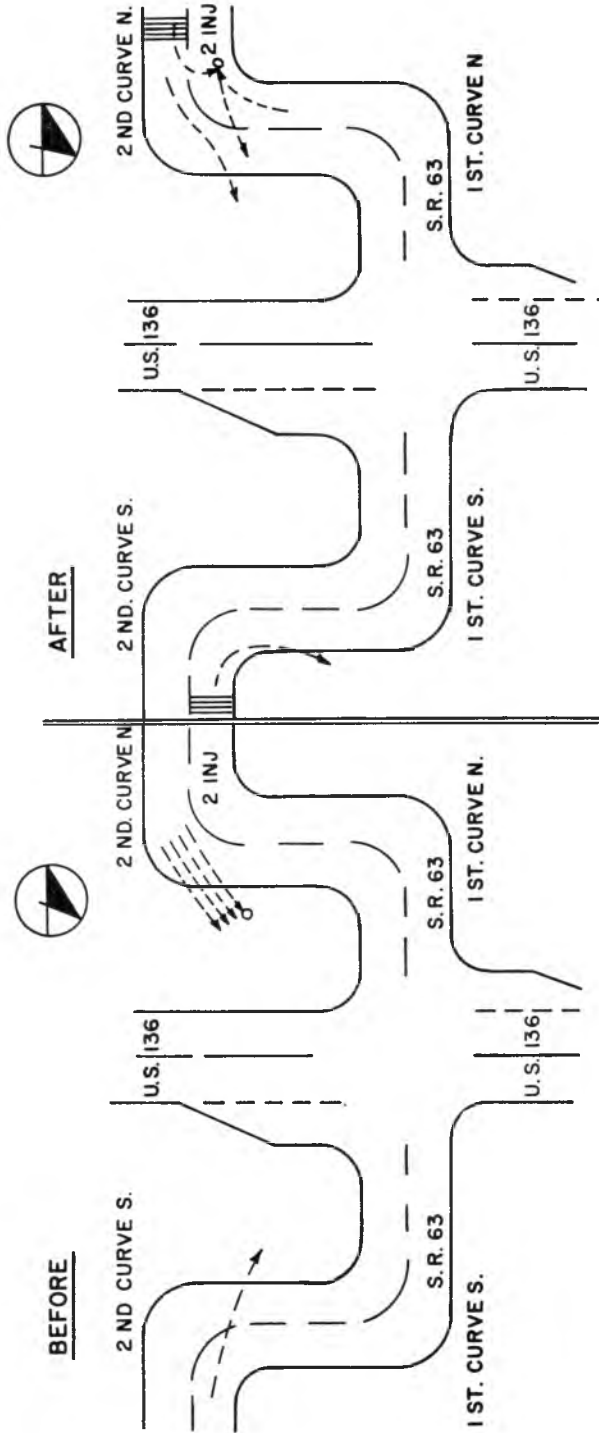


Fig. 6. The arrows indicate the locations and types of accidents. Rumble strips were placed on S.R. 63 north of the second curve north of U.S. 136 and south of the second curve south of U.S. 136 on July 16, 1967 at an estimated cost of \$325 for each location. The before accident data for a one year period is on the left and right respectively. The data covers one year; the before year was 7-19-66 to 7-19-67 and the after year was 7-19-67 to 7-19-68.

	Before	After
Total accidents	5*	3†
Property damage accidents	4	2
Personal injury accidents	1	1
Fatal accidents	0	0
Persons injured	2	2
Persons killed	0	0
Total property damage	\$5400	\$2150

* Day—4, night—1, dry—5, wet—0

† Day—0, night—3, dry—0, wet—3

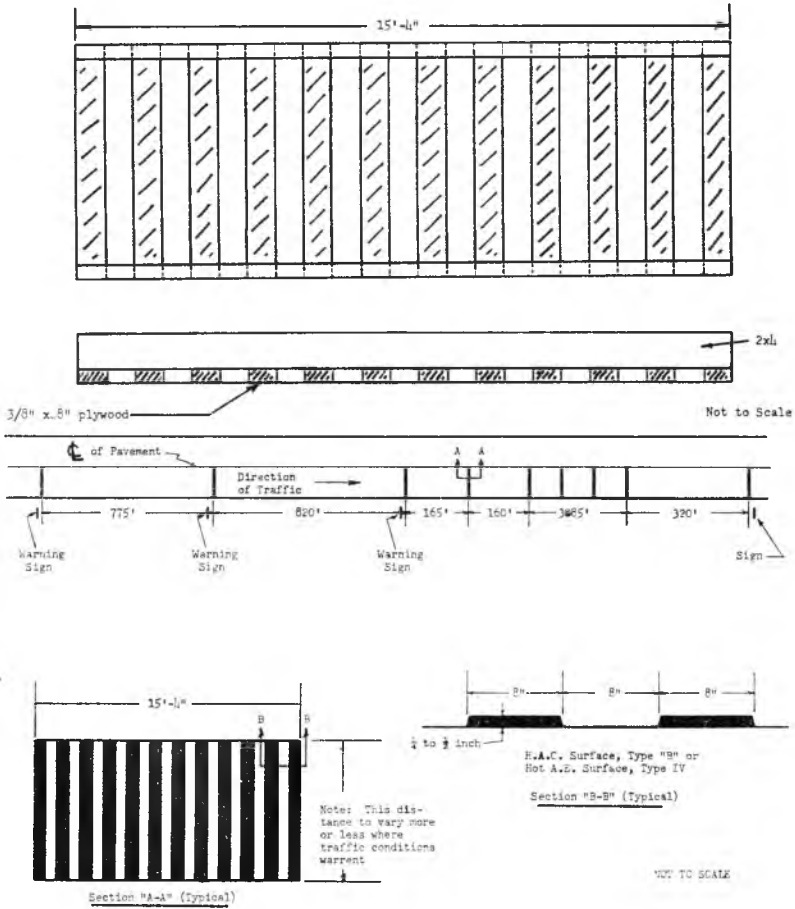


Fig. 7. Rumble Strip Installation.