

A Study of School Crossing Protection

F. D. MILLER, Traffic Engineer
St. Louis County, Missouri
H. L. MICHAEL, Associate Director
Joint Highway Research Project

INTRODUCTION

The problem of providing school crossing protection is a highly sensitive one. Many additional traffic control devices—signals, signs, marking, etc.—would have to be provided if all the demands of parents and others were satisfied. Such demands, however, are often of an emotional nature and often unjustified, and if satisfied may even increase the hazards.

It is true that everyone wants to protect children, but it is also true that this strong desire may result in overprotection of them while going to and from school. Excessive protection at school crossings will not equip children with the degree of self-reliance and personal responsibility they need at unprotected crossings and at other times of the day.

The basic rule of school crossing protection was well stated by Sielski (1)* when he said, "It is the responsibility of the child, aided by the school safety patrol member, to select proper gaps in traffic. If there is less than one safe gap per minute, it is the responsibility of the community to establish restrictive controls to create adequate gaps." The type of such required control to be used depends largely on the volume of traffic, the nature of the crossing, and other existing conditions.

Although national standards on school crossing controls exist, one finds that many state and local jurisdictions express their own individuality as to the type as well as the operation of traffic control devices at school crossings. Uniformity in the use of these devices, an important requirement for safety, certainly does not exist.

SCHOOL CROSSING SAFETY

Although much stress and effort are placed on school crossing protection, school children are involved in very few accidents while going to and from school when compared to other locations. According to the

* Numbers in parentheses refer to listings in the bibliography.

National Safety Council only 5 per cent of injuries to school children occurred when going to and from school (3). Fig. 1 graphically shows this 5 per cent. Included are all injuries which required a doctor's

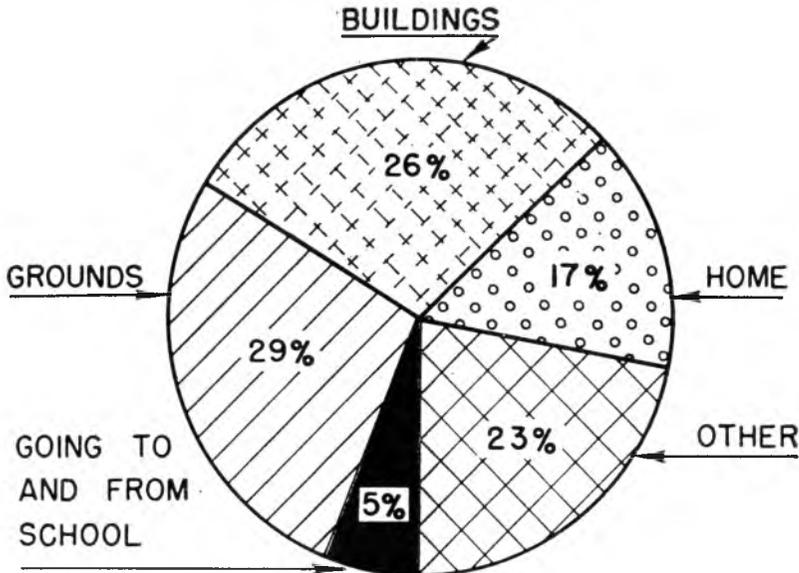


Fig. 1. School child injuries.

care or caused an absence of one-half day or more. Of this 5 per cent, the principal injury source was motor-vehicle accidents, yet they caused only one third of the 5 per cent. Accidents on school grounds, in school buildings, at home and at other locations accounted for 95 per cent of school child injuries.

As part of this study the motor-vehicle accident record in Indiana for 1960 was analyzed. In 1960, 1,124 deaths and 38,316 injuries occurred in such accidents according to the records of the Indiana State Police (see Fig. 2). Of these totals, 155 of the deaths and 2,666 of the injuries were pedestrians, of which 37 of the deaths and 1,255 of the injured were of elementary school age (5-14 years).

The data just given were for the full 12 months of 1960, day and night, and on school days and weekends. Further analysis revealed that only nine deaths and 300 injuries occurred in Indiana to school child pedestrians for the entire year 1960 during the four hours of the days when school children were walking to and from school. Undoubtedly some of these deaths and injuries occurred while the child was not walking to and from school and some occurred because of gross carelessness on the part of the school child, such as darting into the street between intersections.

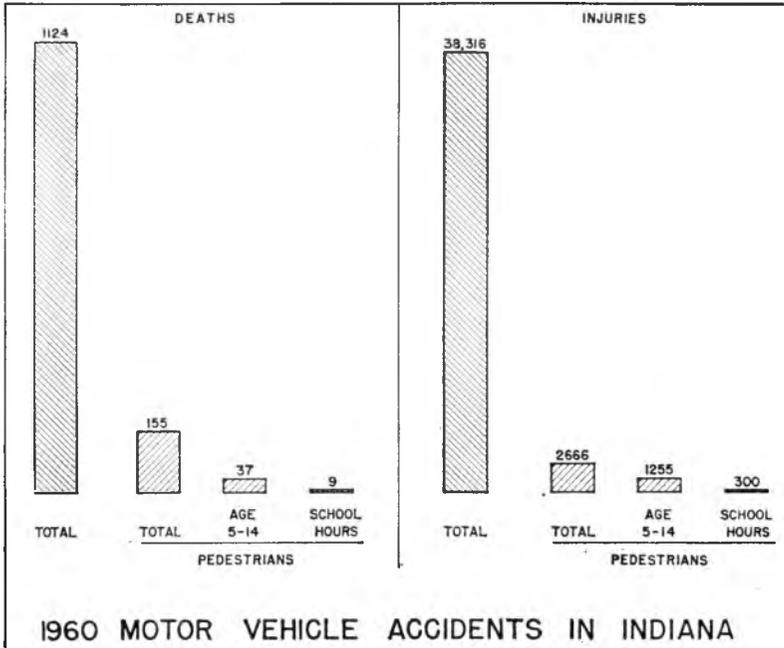


Fig. 2. Comparison of deaths and injuries of pedestrians to total deaths and injuries in Indiana.

If perfect school crossing protection could have been provided during the approximately four hours when children were walking to and from school in 1960 and the nine deaths and 300 injuries could have been prevented, the total deaths due to motor vehicles in 1960 would have been reduced by only 0.8 per cent and the total injuries due to motor vehicles would have been reduced only a similar 0.8 per cent. All of the nine deaths and 300 injuries, of course, could not have been prevented and reduction of motor vehicle deaths and injuries would not have been reduced even the small amount indicated.

It is true, of course, that saving of even a few lives and preventing a few injuries are desirable, but it is also possible that protection of the school child pedestrian while going to and from school can be overdone and result in children being improperly educated in the crossing of streets, which they must do by themselves at other times of the day. It certainly is true that substantial improvement in the motor vehicle death and injury rate must occur in areas other than at school crossings.

The safety record at protected school crossings is good, and the desire of all persons is to maintain that record and at the same time to obtain a similar record of safety for children at all locations and at all times. Evidence indicates that this can best be done by providing a

complete safety program and a thorough safety education to the child. An important aspect of such a program is that it must include necessary school crossing protection, but that it must not minimize the individual responsibility for safety that each child must obtain at an early age.

Some research has been conducted on school crossing protection and on the various control or warning devices which have been used, but complete knowledge of the effects of various devices on the factors important in school crossing protection was not available. It was for this reason that the research reported in this study was initiated.

PURPOSE AND SCOPE

The purpose of this research was to evaluate some effects of various devices used for school crossing protection at school crossings. For several traffic control signs the effect on speed was evaluated; for separated crossing structures, the use of the facility was investigated; and for pedestrian-actuated signals, the use by school children and the effect on vehicular traffic were studied.

In the study of separated crossing structures, overpasses and underpasses, data were collected during two crossing periods of one day and then repeated at a later date. In the study of pedestrian-actuated signals, data were collected on two days during the afternoon crossing period when children were leaving school. For the study of traffic control signs, data were collected during each of the four time periods of days when children used the crossing. In order to eliminate the variable of the day of the week, data were collected for each sign condition on two week days which were picked at random for each series of speed studies.

STUDY LOCATIONS

The study concerning the effect of various traffic control signs at school crossings in rural-suburban areas was conducted at Northwestern Avenue (U. S. 52—Business Route) at Garden Street in West Lafayette, Indiana. Southbound traffic approaches the school crossing from a fourlane, divided rural arterial. Northwestern Avenue at the studied location, however, is a four-lane undivided facility with a speed limit of 40 miles per hour and an annual average daily traffic of approximately 6,600 vehicles. Prior to the study no school crossing signs had been placed on this reconstructed highway. Thus, this location was ideal for studying the effect of various control devices on major thoroughfare traffic at a school crossing in a developed residential area.

The several traffic control signs and flashing signals which were used in this study are shown in Table 1 and in Figs. 3-7, although not always individually in the latter. These signs and signals were used in

TABLE 1
SIGNS USED IN STUDY

Sign Identification	Description
A	30" warning sign, "SCHOOL CROSSING"
B	36" warning sign, "SCHOOL CROSSING"
C	"SPEED LIMIT 25 WHEN CHILDREN PRESENT" sign
D	portable "SCHOOL CHILDREN CROSSING" sign
E	single flashing beacon placed directly above a sign
F	horizontal alternate flashing beacons directly above a sign
G	vertical alternate flashing beacons, one directly above and one directly below a sign



Fig. 3. Traffic control device used—school crossing sign.



Fig. 4. Traffic control device used—special speed limit sign with single flashing signal.



Fig. 5. Traffic control device used—special speed limit sign with vertical alternate flashing signals.



Fig. 6. Traffic control device used—special speed limit sign with horizontal alternate flashing signals.

14 combinations which are listed in Table 2, together with spacing distances and location relative to the school crossing.

The study of pedestrian-actuated signals at school crossings was made at two locations. One school crossing was located on Union Street, a two-lane major arterial, at 26th Street in Lafayette (Fig. 8). Here a two-lens signal which, when actuated, indicated yellow for a few seconds and then a steady red for about 25 seconds in all directions was used. At all other times the signal did not present an indication of any type.



Fig. 7. Traffic control device used—portable school crossing sign.

TABLE 2
SIGN CONDITIONS AND LOCATIONS OF SIGNS

Sign Condition crossing	Location and Signs†		
	Post No. 1	Post No. 2	Post No. 3
	←300'→	←450'→	←200'→
1	A	—	—
2	B	—	—
3	B	B	—
4	B	C	—
5	B	C	B
6	—	B and E	—
7	B	C and E	—
8	B	C and E	B
9	A	C and E	A
10	B	C and F	—
11	B	C and G	—
12	B	D*	—
13	B	D* and C	—
14	B	D*, C, and E	—

* D located in center of roadway across from Post No. 2.

† See Table 1 for sign type code.

The other school crossing was located midblock on 38th Street in Indianapolis (Fig. 9). Standard three-lens type traffic signals with push-buttons for pedestrian actuation were in use at this location. The signal here indicated green to vehicular traffic, unless actuated; actuation



Fig. 8. Pedestrian-actuated signal installation at Lafayette.



Fig. 9. Pedestrian-actuated signal installation at Indianapolis.

was supervised during major crossing periods by an adult guard on this four-lane divided arterial.

The study of overpass and underpass school crossings was made at six locations. One underpass, located in East Chicago, had doors on each end of the tunnel which were locked at night (Fig. 11). The other underpass, located in Richmond, had been abandoned because of nuisance use (Fig. 12). The overpasses were located in Evansville, Clarksville, Oolitic, and Indianapolis, Indiana (see Fig. 13-16). The approaches to three of these overpasses were fenced to channel children

onto the structure. Two overpasses had low-gradient ramps, one had metal steps (Evansville), and the fourth was at ground level over a depressed expressway (Indianapolis).

PROCEDURE

Traffic control devices at school crossings have an effect on a number of things including speed, safety, appearance of the roadway, cost, practicality, and acceptance by local residents. The effect on speed and safety were the primary concerns of the sign study conducted on Northwestern Avenue in West Lafayette.

A radar speed meter was used to record the speeds of free-moving vehicles, and speeds were checked under each of the 14 different sign conditions during the times children were going to and from school. A one-week waiting period during which no data were taken followed each new sign condition in order to give motorists time to adjust to the new condition. Under each sign condition data were collected two days for each direction during the hours of 7:30-8:30 a.m., 11 a.m.-12n., 12:15-1:15 p.m., and 3-4 p.m. Speeds recorded were also classified as to whether children were present at the roadside during each time period.

The 85th percentile speeds obtained for each of the 14 sign conditions were statistically analyzed to determine the effect on the traffic speeds of 1) the sign condition, 2) the direction of travel, 3) the time of the day, and 4) the presence of children at the crossing.

The effect of pedestrian-actuated signals at a school crossing was studied at the two locations by observing how the children used them and by a study of the effect on traffic as a result of the signal.

The effect of overpass and underpass school crossings was studied at the six locations by observing how children used these facilities.

RESULTS

Study of Traffic Control Signs

The results of the study of the 14 sign combinations revealed significant differences among the four factors, including significant interaction. This indicates that different combinations of sign condition, direction of travel, time of day, and the presence of children significantly affected speed at the school crossing. Another affecting factor, which was not included in the analysis, was discovered as the study proceeded. This was revealed by the indication that speeds were affected by the side of the road on which children were present. Speeds were slower (1-5 miles per hour) when children were on the near side of the road from traffic, than they were when children were on the far side. This was true for the location of this study, a four-lane highway; it may not be true for a two-lane highway.

Fig. 10 shows the 85th percentile speeds for each of the 14 sign conditions, each condition being indicated by a code number. On the

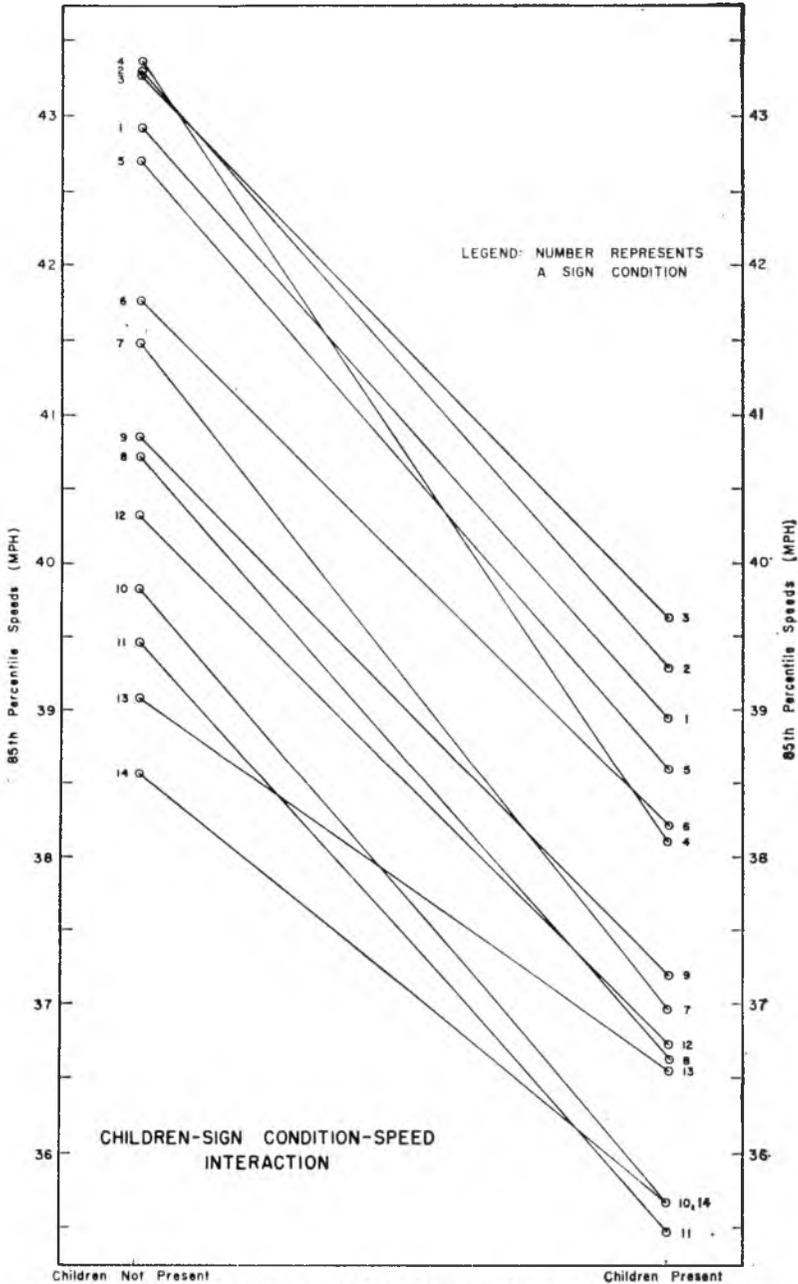


Fig. 10. Effect of traffic control devices at school crossings on speed.

left is the speed when children were not present; on the right the speed when children were present. Notice that for each sign condition the 85th percentile speed decreased significantly (3-4 miles per hour) when children were present at the edge of the roadway as compared to when they were not present. The crossing of some lines is the result of interaction between the presence of children and the traffic sign conditions. Considering only the condition when children were present, the sign conditions fall into three separate speed groups as can be seen on the right side of the figure.

The upper group is composed of those sign combinations which, except for one condition, did not use a flashing signal. The one, No. 6, which did use a single flashing signal did not use the special speed limit sign. The best of this group utilized only one "School Crossing" sign and the special speed limit sign.

The middle group consisted of sign conditions which used one or more "School Crossing" signs, the special speed limit sign and a single flashing signal; or a "School Crossing" sign, the special speed limit sign and the portable "School Children Crossing" sign located in the center of the roadway. The 85th percentile speed for this group was approximately two miles per hour lower than for the previous group.

The lower group consists of sign combinations employing a "School Crossing" sign, the special speed limit sign and flashing twin signals mounted horizontally or vertically; or a "School Crossing" Sign, the special speed limit sign, the portable sign, and a single flashing signal on the speed limit sign. This group gave 85th percentile speeds which were approximately one (1) mile per hour lower than the previous group. The sign combination giving the lowest speed was a "School Crossing" sign followed by the special speed limit sign equipped with vertical flashing signals.

The 85th percentile speed was the lowest in the morning when children were going to school for all sign conditions but one. Generally, speeds were slightly lower when children were going to school and people were going to work in the morning and after lunch. Speeds were slightly higher when children were going home from school before lunch and in the evening.

The sign, "Speed Limit 25 When Children Present," was used in nine of the 14 sign conditions. The area in which the school crossing is located was zoned at other times for 40 miles per hour. The lowest 85th percentile speed obtained during the study when children were present and with this sign in use was 32.5 miles per hour, while the highest 85th percentile speed was 43.1 miles per hour, the latter when children were not present.

Pedestrian-Actuated Signal Study

The results of this study at the location (Fig. 8) where no school guard was present and where the two-lens signal was used showed that during the period of 3-4 p.m. when children were going home from school, 42.8 per cent of the children used the pedestrian-actuated signal at the crossing. The other 57.2 per cent selected their gaps in traffic without the use of the signal. Many times these gaps were not of sufficient length to allow safe crossing, leading to undesirable practices. Some of the children dashed across the street while others, especially the larger groups, walked across at a normal pace and caused traffic to stop. In the process some stood in front of some vehicles and teased the drivers. Over 1 per cent of the students pushed the button after they had crossed, causing traffic to stop unnecessarily. Approximately 13 per cent of the vehicles failed to stop or remain stopped when the signal indication was red. This may, to a large extent, have resulted from the misuse of the signal by the children, and to a lesser degree from impatience on the part of drivers when only a few children crossed during a 25-second red indication.

The delay to traffic caused by the operation of the signal was greatest during the first 15-minute interval of the 3-4 p.m. period when an approximate average of 45 children used the signal.

Accident records show that since the installation of this signal in September, 1960, to June, 1961, two of the three accidents at the intersection were rear-end collisions during the time children were going to school, and resulted in \$1,160 property damage. In one case a vehicle ran into the rear of three vehicles stopped to let children cross. As a comparison there were no accidents at this school crossing during school crossing periods among the seven accidents occurring during the three previous years before the signal installation.

The results of the study at the second pedestrian-actuated signal location (Fig. 9) where the standard traffic signal was used with an adult guard showed that during the period of 3-4 p.m., when children were going home from school, 98.3 per cent of the children used the pedestrian-actuated signal at this school crossing. An adult guard actuated the signal and allowed the children to cross only in large groups. Only 1.7 per cent of the children did not use the facility provided for their protection.

The delay to traffic caused by the operation of the signal was greatest from 3:15-3:30 p.m. when an approximate average of 280 children crossed. The average stop delay to motorists was about 20 seconds.

No comparison can be made of the accidents occurring before the installation of the pedestrian-actuated signal in September, 1956, and those occurring since, because the conditions of the roadway were also changed in 1956. A concrete median strip and separate lanes for left turns were added. Of all the accidents within one-half block of the crossing on 38th Street, two rear-end collisions occurred near the crosswalk during the morning hours when children were probably going to school. The amount of damage was not reported.

Underpass and Overpass School Crossing Study

The underpass school crossing at the one location still open (Fig. 11) was used by 100 per cent of the children needing to cross the highway to attend the elementary school nearby. The only enforcement was the threat of punishment to those who did not use the facility.



Fig. 11. Underpass school crossing at East Chicago.

An adult school guard at a nearby intersection reported those that crossed the street instead of using the facility to school officials who then punished the disobedient children. The doors were locked during the night to keep the tunnel from becoming a place of nuisance and crime.

The second underpass, a school crossing at Richmond High School (see Fig. 12) was abandoned because of improper events which occurred in the tunnel. It was closed with heavy fence at each end of the tunnel.

The overpass school crossing at the location shown in (Fig. 13) was used by 100 per cent of the children who needed to cross the highway in order to attend the elementary school near the crossing.



Fig. 12. Underpass school crossing at Richmond.



Fig. 13. Overpass school crossing at Evansville.

Two types of enforcement existed. School patrols were stationed at either end of the structure at the top of the stairs. The structure is connected to a guard fence which channels the children toward the structure.

The overpass school crossing at the location shown in Fig. 14 was used by 60.5 per cent of the children needing to cross the highway. The majority of these children were elementary school age. The remaining 39.5 per cent, most of whom were high school age, crossed elsewhere. Of these, 34.5 per cent crossed at the signalized intersection one block east of the overpass, 3 per cent crossed at the nonsignalized in-



Fig. 14. Overpass school crossing at Clarksville.

tersection one block west of the overpass, and 2 per cent crossed between intersections by jumping over the limited access fence. Those crossing at the signalized intersection conflicted with turning movements. The only enforcement consisted of a fence along both sides of the expressway, but with openings at the two intersections, one on each side of the overpass and each approximately one block distant.

The overpass school crossing at a location shown in Fig. 15 was



Fig. 15. Overpass school crossing at Oolitic.

used by 100 per cent of the children needing to cross the highway to the elementary school located on the west side of the highway. A teacher escorted the children to the crossing in the evening as they left school. This was the only enforcement at this crossing.



Fig. 16. Overpass school crossing at Indianapolis.

At another location (Fig. 16), 74.0 per cent of the children needing to cross the highway used the ground-level school crossing over the depressed expressway while 25.1 per cent crossed at a ground-level signalized intersection one-half block north of the overpass where the expressway is no longer depressed. The remaining 0.9 per cent crossed the depressed expressway by climbing down the expressway, crossing it, and then climbing back to ground level. A small number of adults also used the overpass. Of those children using the overpass, 2.5 per cent played around the structure, especially on their way home from school in the evening. They did such things as crawl under the fence and slide down the slopes to the depressed expressway and climb over the guard fence on the overpass and walk on the concrete ledge of the overpass above the traffic below. Both sides of the expressway are fenced and connected to the overpass.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the results of the studies of school crossing protection made for the research reported herein:

- A. In the study of 14 sign conditions at the one crossing:
 1. The four factors studied—sign condition, time of day, direction of travel, and presence of children—proved to have sufficient interaction in all combinations, except time of day with presence of children, to significantly affect the 85th percentile speed.
 2. The 85th percentile speeds were lowest when children were going to school in the morning than for any other time period.

3. The presence of children at the edge of the roadway significantly lowered (3-4 miles per hour) the 85th percentile speed under each sign condition. It was also apparent that the presence of children on the side nearer the vehicle had the greater effect.
4. The 85th percentile speed was not changed significantly when the size of the warning sign, "School Crossing," was increased from 30 to 36 inches; nor did it change significantly when an additional "School Crossing" sign was added.
5. The 85th percentile speed was decreased by the following indicated approximate values when the noted control device or devices were added to the standard "School Crossing" sign from that obtained when only the "School Crossing" sign was used:
 - a. "Speed Limit 25 When Children Present"—decrease of one (1) mile per hour
 - b. Portable "School Children Crossing" sign—decrease of two (2) miles per hour
 - c. Single flashing signal—decrease of one (1) mile per hour
 - d. Speed limit sign and single flashing signal—decrease of two (2) miles per hour
 - e. Speed limit sign and twin flashing signals—decrease of four (4) miles per hour
 - f. Speed limit, sign, single flashing signal, and portable sign—decrease of four (4) miles per hour
6. The two most effective sign combinations of the 14 studied at this location were:
 - a. A "School Crossing" sign followed by a "Speed Limit 25 When Children Present" sign with a twin flashing signal mounted vertically.
 - b. A "School Crossing" sign followed by a "Speed Limit 25 When Children Present" sign with a single flashing signal mounted on it and a portable "School Children Crossing" sign placed in the center of the roadway.
7. The use of any of the 14 sign conditions had a rather small effect on speed. The 85th percentile speed without any school crossing signs of any kind decreased 2-3 miles per hour when children were present from that when children were not present. The maximum additional reduction ob-

tained with signs and flashing signals was an additional 3-5 miles per hour.

8. In view of the difficulties experienced in keeping the portable sign in place because of wind and vehicles, the fact that someone must place the sign in the roadway at the proper times and remove it when each crossing period ends, the standards of the uniform manual (2) that portable signs in the roadway are prohibited, and the findings of this study that other sign conditions give equally effective results, it is recommended that the portable "School Children Crossing" sign not be used.
- B. In the study of the two pedestrian-actuated signals it was found that operation supervised by an adult guard during peak crossing periods was far superior to operation by the school children. Operation by the adult guard resulted in far better use by children of the protection, less delay to motorists, fewer accidents, and the minimization of misuse of the signal by playing children. It is recommended where pedestrian-actuated signals are used at school crossings that an adult guard, or at least a school patrol, supervise the actuation during major crossing periods.
 - C. In the study of underpasses and overpasses which have been constructed for school children crossings in Indiana it was found that:
 1. Underpass school crossings are less desirable than overpass school crossings because they have greater potential for nuisance use. This problem was solved by providing doors to the tunnel which were kept locked during the night in one case, and by abandonment in another.
 2. Overpass and underpass school crossings were more effectively used by elementary school children than high school students. In most cases some form of enforcement was necessary to secure maximum use, with this enforcement more of a necessity but less effective for high school children than for elementary-age children. The enforcement was by adult guards, teachers, school patrols, or fence.
 - D. It was found from a study of the accident statistics of Indiana for 1960 that the total motor vehicle death or injury rate in the state could be reduced only a maximum of approximately 1 per cent if all deaths and injuries occurring to elementary school age pedestrians during the hours when they normally walk to

and from school could be prevented. It is obvious that a major attack on the motor-vehicle fatality and injury problem in Indiana must include much more than school child protection.

REFERENCES

1. Hoffman, Lawrence, "School Crossing Protection," *Traffic Engineering*, Vol. XXV, September, 1955, pp. 494-497.
2. National Joint Committee on Uniform Traffic Control Devices, U. S. Department of Commerce, Bureau of Public Roads, *Manual on Uniform Traffic Control Devices for Streets and Highways*, Washington, D. C., June 1961.
3. National Safety Council, *Accident Facts*, 1953 and 1955 editions.