NOT FOR PUBLICATION

# RED COLORED PAVEMENT

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## ABSTRACT

A "before" and "after" study was performed on a ramp ending with a stop sign and at the ramp's intersection with a one-way roadway. Speeds and lags for both day and night conditions were measured "before" and "after" the ramp was paved red.

Four pneumatic tubes, at various distances from the stop line, were placed on the ramp. Ramp traffic was registered on a twenty-pen recorder. Speeds were computed using the difference in time and the distances between tubes. (Average speeds were determined for points 100 ft., 200 ft., and 318 ft. from the stop line.)

Ramp traffic stopping, and ramp and highway traffic crossing the intersection were manually recorded using a twenty-pen recorder. Average accepted and rejected lags were computed.

"Before" and "after" measurements were compared: the daytime speeds were significantly lower after the ramp was paved red, but for nighttime speeds, and for daytime and nighttime lags, there were no significant differences.

D.W. Gwynn
J. Seifert

# RED COLORED PAVEMENT

The motorists on today's highways are called upon to assimilate vast amounts of information about the ever-changing traffic stream around them. They must digest and react to a multitude of traffic-control devices within a relatively short period of time.

Over the past twenty-five to thirty years, various experimental sections of colored pavement have been examined in an effort to determine their potential as an aid to better driver performance and highway safety. However, very little controlled research has been reported, and that which has, did not lead to conclusive results.

Initial attempts at producing colored pavement resulted in some unsatisfactory results. A principal source of complaint was color fading, and early applications suffered from an insufficient amount of pigments.

Although colored pavement studies to date have not proven or disproven, for that matter, its effectiveness as an aid to better driving performance and safety, other studies dealing with the use of color as a means of conveying information indicate that color coding is a significant means of conveying information to the motorist.[1,2]

[1]Birren, Faber "Safety on Highways" Amer. J. Opthal., Series 3, 43, 1957
[2]Robinson, C.C. "Color in Traffic Control," Traffic Engineering Mag., May 1967

"do not enter" and cause him to react accordingly? This was an important question at this location since it was at a ramp-type location where the color red could have conveyed either meaning. However, since to our knowledge it has not stopped anyone from entering the ramp, it did not convey the meaning of "do not enter."

## PURPOSE

The purpose of this portion of the study is to evaluate the effects of red colored pavement on various aspects of driver behavior at a ramp location ending in a stop condition.

## DESCRIPTION OF SITE

The location of the section of highway selected for the study was the intersection of U.S. 206 and N.J. 68 in Mansfield Township, Burlington County, New Jersey (see Figure 1 and Photo 1). A 280-foot section of the Route 206 southbound ramp (between U.S. 206 southbound lanes and U.S. 206 northbound lanes) was paved with a 3/4" red asphalt pavement on June 22, 1967. Prior to this, the ramp was concrete. This ramp leads to a stop condition at the northbound lanes of U.S. 206 and connects into N.J. 68 eastbound (on the east side of the northbound lanes of U.S. 206). The terrain is flat and open, with no sight-distance restrictions. The speed limit on U.S. 206 is 55 mph in both directions. There are two oversize (44" x 44") internally illuminated (neon tubing) flashing stop signs at the end of the ramp (see Photo 2). The ramp is illuminated by two 4,000 lumen incandescent overhead lights spaced 170 ft. apart, on the right-hand

In this case, the red color was to alert the motorist to an impending stop condition. In an attempt to evaluate this, two characteristics were measured -- the speeds of vehicles* approaching the stop signs were measured "before" and "after" the installation of the red pavement at various points to be discussed later. Also, the number of vehicles disregarding the stop signs were measured "before" and "after" the installation of the red pavement. A third characteristic was also measured that was felt could be affected by the red pavement. This was the acceptance of lags by vehicles crossing U.S. 206 north from the ramp. It was felt that the red pavement might alert the motorist to a hazardous condition and cause him to be more cautious to conditions at the intersection, thereby perhaps choosing to accept longer lags. A lag, for the purpose of this study, is the time interval between the arrival of a vehicle at the stop sign on the ramp and the arrival of the first vehicle on U.S. 206 at the center of the intersection of the ramp and U.S. 206 north. A lag will also be referred to as a time interval between the arrival of a vehicle at the center of the intersection of U.S. 206 north and the arrival of the next vehicle on U.S. 206 north at the same location when a vehicle is waiting on the ramp to cross U.S. 206 north. To insure an adequate, consistent sample, only lags for cars which are first in line on the ramp will be tabulated. (Lags for queued vehicles will not be tabulated.)

## SPEED MEASUREMENTS

Speeds were measured by use of pneumatic tubes stretched across the ramp at distances of 50 ft., 150 ft., 250 ft., and 386 ft., from the

*Vehicles refer to passenger cars or vehicles with four tires.

## VEHICLES DISREGARDING STOP SIGN

The number of vehicles which passed through the stop sign, making no attempt to slow or stop, was recorded during the same time periods as the collection of lag data.

## ANALYSIS AND RESULTS

Speeds "Before" and "After"

The speed data was analyzed statistically by utilizing the standard test for testing significant differences in means:

The formula utilized for this test is as follows:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

Where:

$\overline{X}_1$ and $\overline{X}_2$ are the mean speeds for "before" and "after";

$N_1$ and $N_2$ are the sample sizes for "before" and "after";

$S_1$ and $S_2$ are the standard deviations of the speeds "before" and "after."

The level of significance used in the test was the 90% level of significance. If the t value obtained in the test is greater than the t value for the 90% level (1.65) of significance, then there is assumed to be a significant difference in the results at this level of significance.

As stated previously, the speeds were obtained at distances of 100, 200, and 318 feet from the stop line. Table 3 shows the speeds "before" and "after" at each point and for "day" and "night" conditions. This is also shown in Figures 3 and 4.

speeds grouped closer around the mean, as at point A, than to have a larger variation, as at point C.

For "night" conditions, there was a significant difference at the 90% level at point A, as was for "day" conditions. However, there was no significant difference at points B and C. The "after" variance was again less than the "before" variance.

The fact that the mean speeds are not significantly different for "before" and "after" conditions during hours of darkness, appears to support the opinions of our engineers who have driven the section during both "day" and "night" conditions. The red pavement is certainly visible during "day" conditions, but appears to "blackout" at night. The red color does not appear to be discernible, thereby logically indicating that the red pavement should have no effect on changing speeds in the area.

Although the average speeds were only slightly less during the "after" period for "day" conditions, it is possible that the red pavement alerted the motorist to the impending stop-hazardous condition which thereby contributed to the reduction in the average approach speeds. For "night" conditions, since it appears at least visually that the red pavement was not distinguishable, the average speeds should not have been affected by the red pavement and, statistically, they were not.

## LAG ACCEPTANCE AND REJECTION

Vehicles accepting or rejecting lags of from 0.5 seconds to 15.0 seconds were analyzed to determine the mean lag accepted and the mean lag

## DISREGARD OF STOP SIGN

Under "day" conditions before the pavement was installed, 8 out of 282 vehicles observed passed through the stop sign without making any attempt to slow or stop. After the installation, 3 vehicles out of 351 observed passed without stopping. For "night" conditions, 2 out of 252 observed passed "before" as compared with one (1) out of the 311 observed "after." A test for significant difference in proportions, also at the 90% level, indicates that there is no significant difference in the passing "before" and "after" for day or night conditions.

## CONCLUSIONS

No definite conclusions can be drawn from this study concerning the overall effectiveness of the use of red colored pavement, particularly since it deals with only one location. However, it is felt that this study gives some insight into the effect of the red colored pavement on approach speeds and lag acceptance and rejection. At this site, it appears that the red pavement may have a significant effect on causing the average approach speed at two of the three study points to be significantly less for "day" conditions. It also may have an effect on the variation of speeds at two of the study points, although the variation was less at one point "after" and greater at the other. It could be argued that the difference in average speeds was too small to be appreciable logically; however, it was appreciable statistically at the 90% level of significance. For "night" conditions, there was no change in the average "before" and "after" speeds statistically; since the red color was not discernible at night, this appears logical.

# APPENDIX

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TABLE 1

SPEED DATA COLLECTION TIMES

| DATE | DAY OR NIGHT | HOURS | SAMPLE SIZE |
|---|---|---|---|
| | | Before | |
| 5/4/67 | Day | 4:00 p.m. - 6:30 p.m. | 286 |
| 5/4/67 | Night | 8:30 p.m. - 10:30 p.m. | 297 |
| | | After | |
| 7/27/67 | Day | 3:45 p.m. - 7:00 p.m. | 603 |
| 7/27/67 | Night | 8:45 p.m. - 10:15 p.m. | 402 |

TABLE 3

BEFORE & AFTER SPEED DATA

| SITE | DISTANCE FROM STOP SIGN | MEAN SPEED (MPH) BEFORE | MEAN SPEED (MPH) AFTER | SIGNIFICANT DIFFERENCE |
|---|---|---|---|---|
| | | Day | | |
| A | 318' | 38.7 | 37.6 | Yes |
| B | 200' | 32.1 | 31.5 | Yes |
| C | 100' | 24.1 | 23.9 | No |
| | | Night | | |
| A | 318' | 37.4 | 37.1 | No |
| B | 200' | 31.5 | 31.2 | No |
| C | 100' | 23.9 | 23.6 | No |

TABLE 5

LAG DISTRIBUTIONS

NIGHT

| MIDPOINT VALUE (SEC.) | ACCEPTED | | REJECTED | |
|---|---|---|---|---|
| | Before | After | Before | After |
| 0.25 | 0 | 0 | 4 | 10 |
| 0.75 | 0 | 0 | 8 | 12 |
| 1.25 | 0 | 0 | 9 | 8 |
| 1.75 | 0 | 0 | 6 | 20 |
| 2.25 | 0 | 0 | 6 | 8 |
| 2.75 | 0 | 0 | 4 | 9 |
| 3.25 | 0 | 0 | 4 | 7 |
| 3.75 | 0 | 1 | 7 | 14 |
| 4.25 | 0 | 0 | 8 | 12 |
| 4.75 | 0 | 1 | 5 | 6 |
| 5.25 | 0 | 0 | 5 | 5 |
| 5.75 | 0 | 0 | 3 | 13 |
| 6.25 | 0 | 0 | 3 | 7 |
| 6.75 | 0 | 1 | 3 | 7 |
| 7.25 | 0 | 2 | 5 | 7 |
| 7.75 | 1 | 0 | 4 | 4 |
| 8.25 | 0 | 3 | 2 | 2 |
| 8.75 | 3 | 3 | 4 | 7 |
| 9.25 | 3 | 1 | 4 | 2 |
| 9.75 | 5 | 4 | 0 | 1 |
| 10.25 | 6 | 3 | 1 | 1 |
| 10.75 | 3 | 3 | 2 | 4 |
| 11.25 | 2 | 3 | 0 | 2 |
| 11.75 | 4 | 0 | 0 | 2 |
| 12.25 | 6 | 6 | 2 | 0 |
| 12.75 | 3 | 3 | 0 | 1 |
| 13.25 | 4 | 3 | 0 | 3 |
| 13.75 | 1 | 4 | 0 | 0 |
| 14.25 | 0 | 3 | 0 | 0 |
| 14.75 | 3 | 3 | 0 | 0 |
| TOTAL | 44 | 47 | 99 | 174 |
| Over 15.00 | 164 | 216 | 1 | 0 |
| Mean | 11.28 | 11.05 | 4.49 | 4.51 |
| Std. Dev. | 1.77 | 2.65 | 3.05 | 3.19 |

NOTE: Means are computed using values of 15.00 seconds or less.

# FIGURES

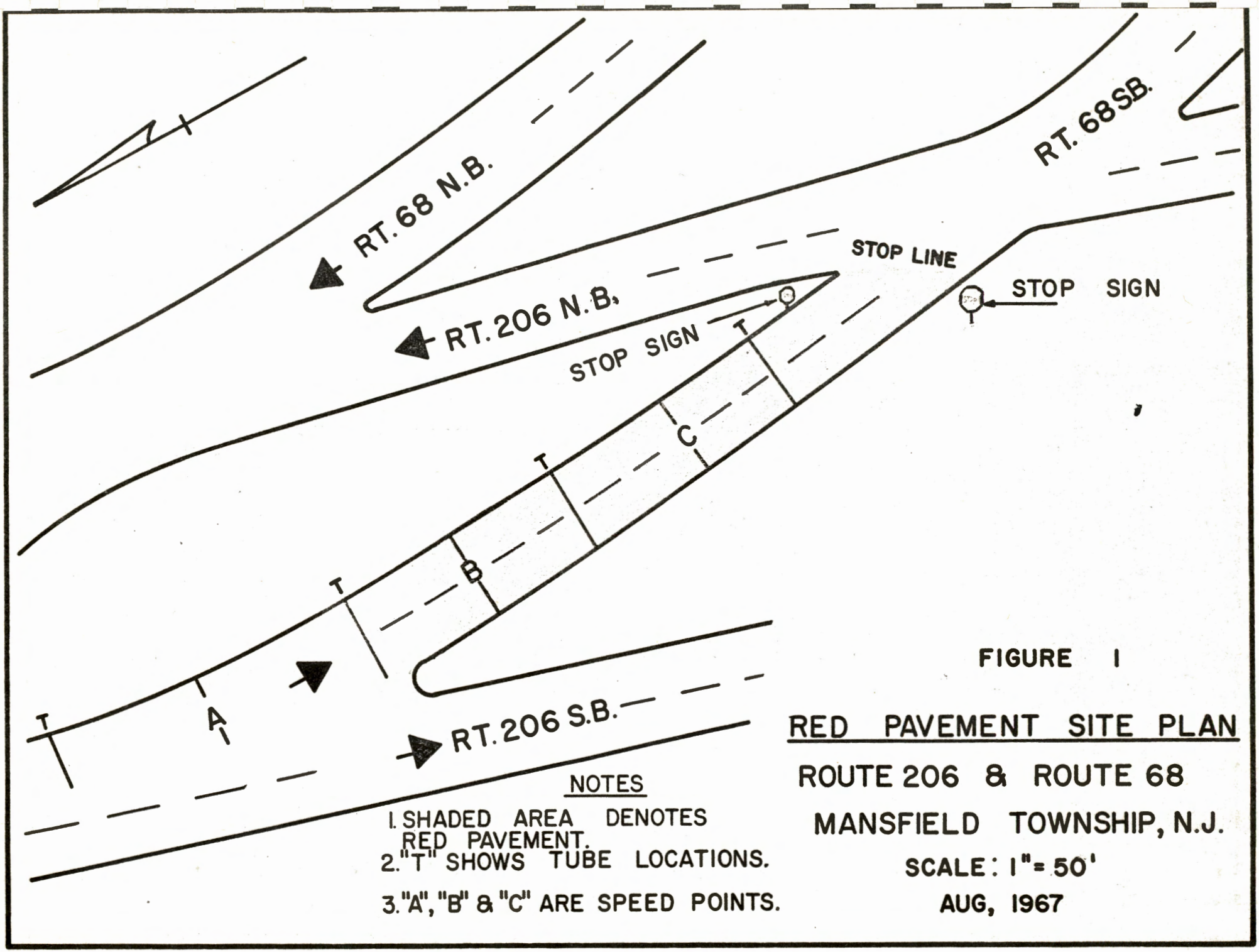


FIGURE 1

## RED PAVEMENT SITE PLAN

ROUTE 206 & ROUTE 68

MANSFIELD TOWNSHIP, N.J.

SCALE: 1" = 50'

AUG, 1967

NOTES

1. SHADED AREA DENOTES RED PAVEMENT.
2. "T" SHOWS TUBE LOCATIONS.
3. "A", "B" & "C" ARE SPEED POINTS.

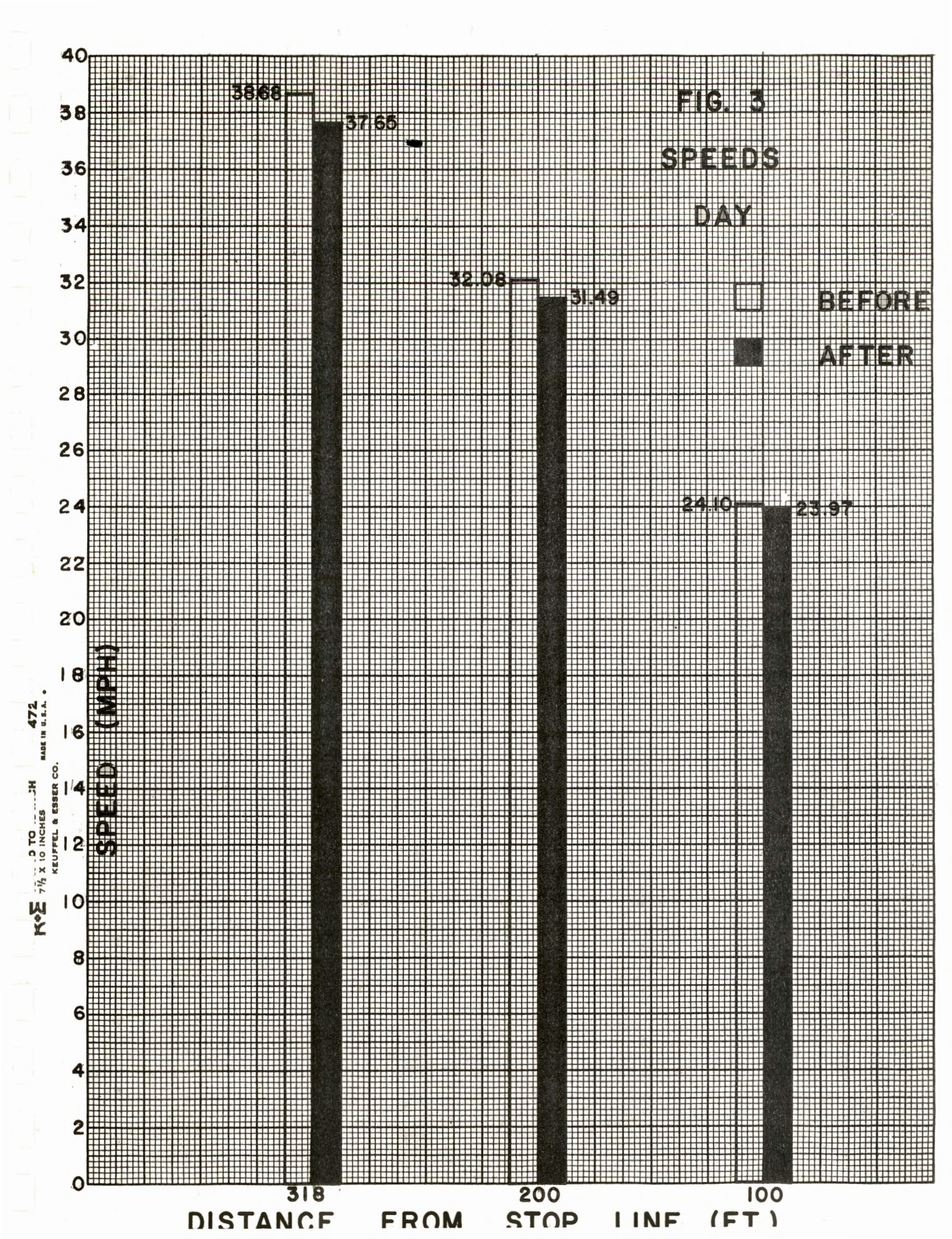
FIG. 3
SPEEDS
DAY
BEFORE
AFTER
38.68
37.65
32.08
31.49
24.10
23.97
SPEED (MPH)
DISTANCE FROM STOP LINE (FT.)
318
200
100
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
KEUFFEL & ESSER CO.
MADE IN U.S.A.

PHOTOS

PHOTO 1

U.S. 206 ~~—~~ N.J. 68

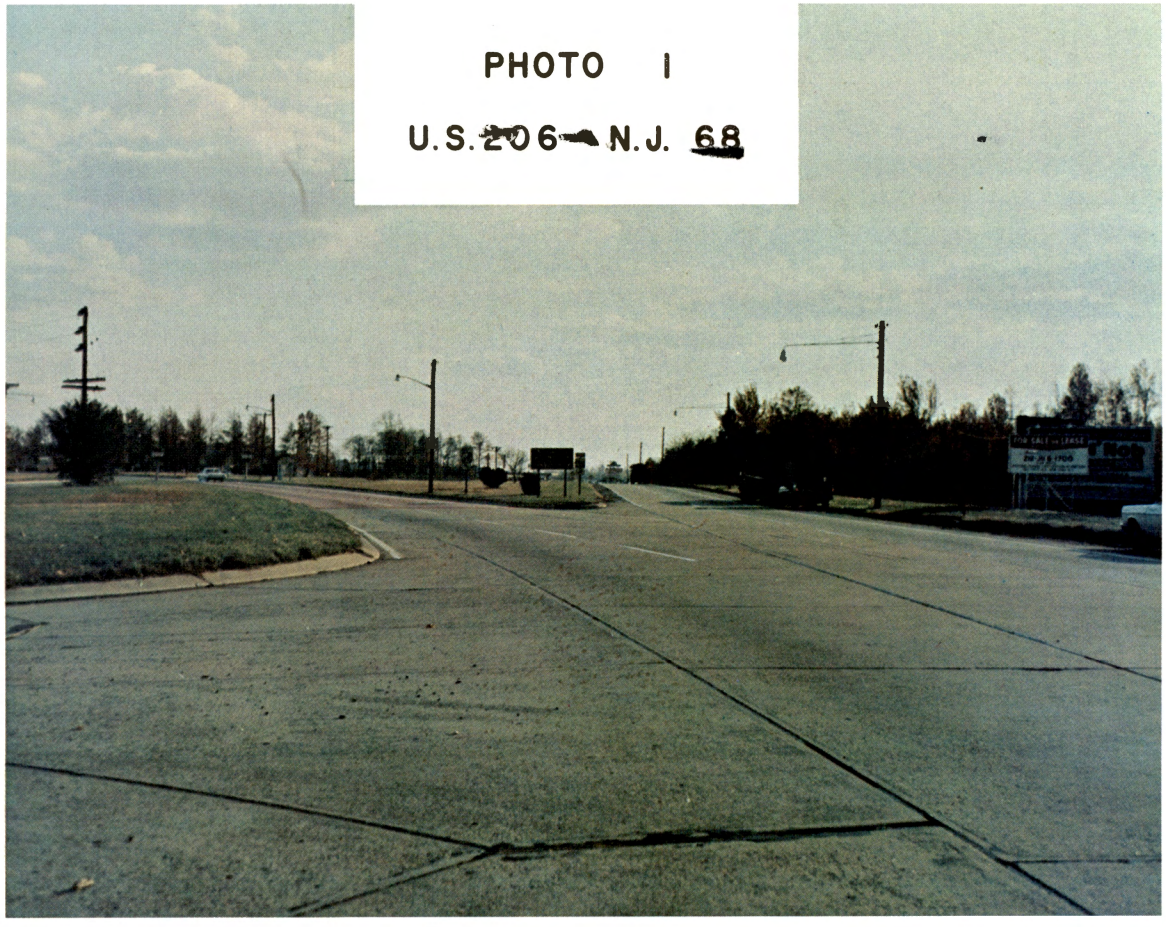

PHOTO 2

U.S. 206 – N.J. 68