State of Illinois
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
Division of Highways
Bureau of Research and Development

Research and Development
Administrative Report No. 35A

# PERFORMANCE EVALUATION

# OF

# BITUMINOUS SHOULDERS FOR RESURFACED PAVEMENTS

A Highway Problem Investigation

July 1971

## SUMMARY

For many years prior to 1968, the Illinois standard for pavement resurfacing with bituminous concrete included a gravel or crushed stone wedge at the pavement edge. To reduce the traffic hazard and the attendant continual maintenance caused by the displacement of this material, the standard was changed to include an 18-inch width of bituminous material 3 inches thick in the shoulder area at the pavement edge. Experience soon showed this section to be too thin to maintain structural integrity. In 1969, the standard was changed to provide for a 6-inch section where widening of the pavement was not required and for full thickness where widening was required.

To assess the adequacy of the revised bituminous shoulder standard, shoulders on 158 miles of resurfaced pavements were observed. No major distress was found on any of the shoulders built in accordance with this standard. Where significant quantities of minor distress in the form of longitudinal cracking at the pavement-shoulder joint were found, an association with improper edge striping and non-standard shoulder slopes, alone or in combination, was observed. It was evident that, when the design and striping details are adhered to, shoulders built in accordance with the standard should provide satisfactory performance.

## INTRODUCTION

Prior to 1968, the Illinois standard design for bituminous concrete resurfacing included a three-foot wide wedge of gravel or crushed stone at the pavement edge. Being unbound, this material was susceptible to dislodgment and displacement by minor intrusions of traffic often resulting in the development of a serious, potential traffic hazard in the form of a vertical dropoff at the pavement edge. In 1968, to better accommodate these minor traffic invasions and to reduce the necessity for continual shoulder maintenance, the aggregate wedge was replaced by a standard calling for a 3-inch thick layer of bituminous material 18 inches wide (Figure 1, Detail (a)). In 1969, after early failures were seen to be associated with the inadequacy of the three-inch thickness, a new design standard was adopted which revised the bituminous shoulder thickness to a minimum of six inches in conjunction with pavements not requiring widening (Figure 1, Detail (b)), and to the full thickness of the widening on jobs being widened (Figure 1, Detail (c)). Edge striping and a distinct slope break are included in the design to identify the intended pavement edge.

To provide a check on the adequacy of the six-inch design, H. W. Monroney, District Engineer of District 6, requested that the Bureau of Research and Development investigate the performance of shoulders constructed in accordance with this latest standard. This report presents the findings of the investigation.

## THE INVESTIGATION

Fifteen resurfacing sections totaling 158 miles and scattered throughout the central part of the State were selected for observation. Eleven of the sections involved pavements without widening and constructed in accordance with the details shown in Detail (b). Two sections involved pavement widening and the full-depth shoulder design (Detail (c)). While the concern of the

investigation was the performance of the new shoulder design, particularly the six-inch design, two older sections built under the previous standard (Detail (a)) were included for comparison. General information concerning the study sections is presented in Table 1.

Since the present standard was not adopted until 1969, the oldest shoulder constructed in accordance with the new standard was only two years old when surveyed. While this does not provide sufficient time to obtain a complete picture of the performance of the design, any gross inadequacy should already be apparent.

Observation of the two widened pavement sections (Detail (c)) provided no indication of any distress. This was not surprising since the structural capacity of these shoulders is the same as the widened portion of the pavement.

Similarly, no major distress was found on any of the 11 sections which employed the 6-inch shoulder thickness (Detail (b)). Longitudinal cracking, however, was found at the pavement-shoulder joint on several of the sections with the 6-inch shoulder thickness. Typical examples of this defect are shown in Photos 1 and 2. These photographs also reveal deviations from the designed cross section. The distinct change in slope between the pavement and shoulder shown in Detail (b) is not present. In addition, the pavement in Photo 2 has been incorrectly edge striped with the stripe being placed on the bituminous shoulder. One or both of these conditions was found at all locations where a significant amount of longitudinal cracking was noted.

Only a minor amount of pavement-shoulder joint cracking was noted on those sections where edge striping and shoulder slope details were followed. A typical example of this is shown in Photo 3.

For some reason not entirely clear, most of the cracking at the pavement-shoulder joint was observed on pavements that had not been resurfaced previously.

TABLE 1

GENERAL INFORMATION

| District | Marked Route | Length (miles) | Location From | Location To | Shoulder Cross Section [1/] | Year of Construction |
|---|---|---|---|---|---|---|
| 4 | US 34 | 8.07 | Galesburg | Monmouth | (b) | 1970 |
| 4 | IL 29 | 12.89 | N. of Chillicothe | Putnam | (b) | 1970 |
| 5 | IL 10 | 9.62 | Champaign | E. of White Heath | (b) | 1969 |
| 5 | US 150 | 16.66 | N.W. of Farmer City | Mohomet | (c) | 1970 |
| 5 | IL 1 | 5.90 | Paris | Horace | (b) | 1969 |
| 5 | US 51 | 9.79 | Decatur | Maroa | (b) | 1970 |
| 5 | IL 48 | 12.65 | Decatur | Cisco | (c) | 1970 |
| 5 | IL 1 | 12.48 | E. of Henning | Hoopeston | (b) | 1970 |
| 5 | IL 16 | 12.23 | Pana | Shelbyville | (a) | 1968 |
| 6 | US 51 | 15.33 | Pana | Moweaqua | (b) | 1970 |
| 6 | US 36 - 54 | 7.03 | Jacksonville | E. of Riggston | (b) | 1970 |
| 6 | US 36 | 7.80 | Springfield | Dawson | (b) | 1970 |
| 6 | US 36 | 10.90 | Dawson | Illiopolis | (a) | 1968 |
| 6 | US 36 - 54 | 12.88 | Springfield | Alexander | (b) | 1970 |
| 6 | US 67 | 3.76 | Jacksonville | N. of Woodson | (b) | 1969 |

[1/] For specific shoulder details refer to the indicated typical cross section shown on Figure 1.

Little or none of this cracking was observed on pavements with multiple resurfacings. Photo 4 shows a typical example of the six-inch shoulder on a pavement resurfaced a second time. The location shown is also in an area where obvious traffic movements across the shoulder have not caused any visible distress.

The presence of more distress at locations lacking adherence to the shoulder slope and striping details points out the importance of these features. They serve to inform the driver of the location of the pavement edge and discourage all but emergency use of the additional pavement width, thereby limiting the potential for traffic-induced shoulder distress.

The two sections with the three-inch bituminous concrete shoulder design of Detail (a) showed many areas of severe distress, pointing out the inadequacy of the original three-inch design. A typical example of this distress is shown in Photo 5. It should be pointed out, however, that areas of little distress, such as in Photo 6, were also present.

## CONCLUSIONS AND RECOMMENDATIONS

Observation of a total absence of major distress in a representative mileage of the six-inch thick bituminous shoulder pavement included in the current resurfacing standard suggests that this design should serve well. The observed presence of significant amounts of longitudinal cracking at the pavement-shoulder joint, almost entirely associated with nonstandard sloping of the shoulder pavement and improper location of the edge stripe, indicates the desirability of close adherence to these design details that were included to discourage all but emergency driving in the shoulder area.

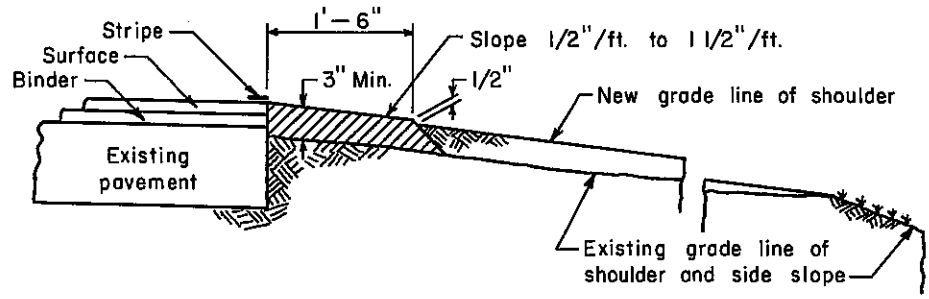
Based on the observations that were made, the following recommendations are offered:

(1) Care should be taken to assure that the distinctive change in slope at the pavement-shoulder joint as called for in the resurfacing standard is achieved.

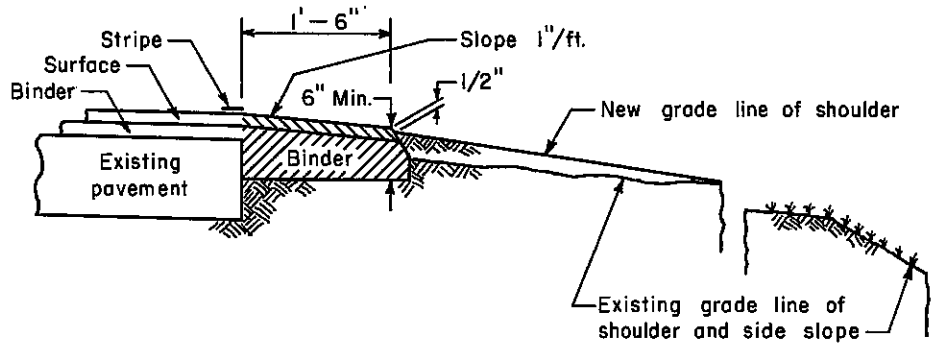
(2) Care should be exercised to assure that the edge stripe is properly located inside the pavement edge.

(3) The edge stripe should be placed on resurfaced pavements as soon as possible after construction. Temporary edge striping had been used on several of the good-performing sections observed. Consideration should be given to extending this practice to all resurfacing projects incorporating the bituminous shoulder standard. The temporary striping, in addition to serving traffic, provides a guide to the striping crew in painting the initial edge stripe.

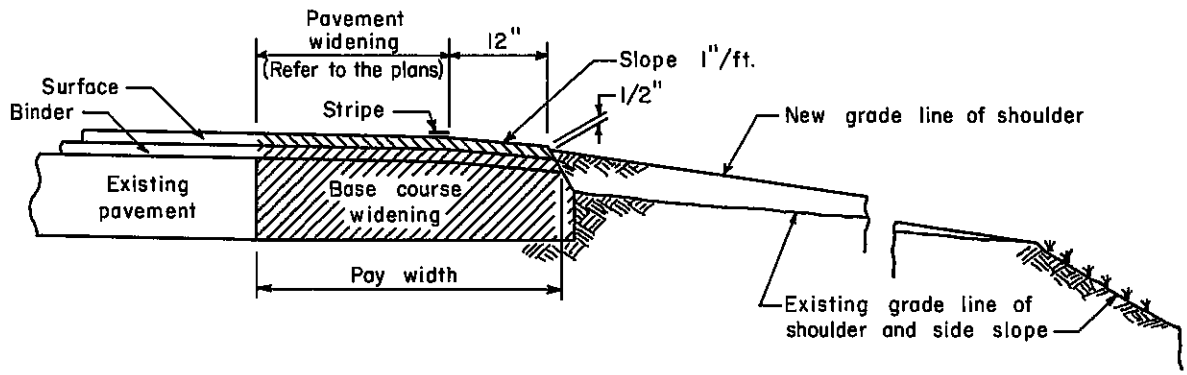
(4) Although none of the six-inch bituminous shoulders included in the investigation are expected to require major maintenance in the near future, the close association between pavement-shoulder joint cracking and improperly located edge striping suggests that, where the original stripe was placed out of position, care should be exercised during restriping operations to see that the new stripe is placed correctly.




(a) DETAIL FOR BITUMINOUS SHOULDER (PRE-1969)




(b) DETAIL FOR BITUMINOUS SHOULDER WITHOUT WIDENING




(c) DETAIL FOR BITUMINOUS SHOULDER WITH WIDENING

FIGURE I. TYPICAL SHOULDER CROSS SECTIONS FOR PAVEMENT RESURFACING

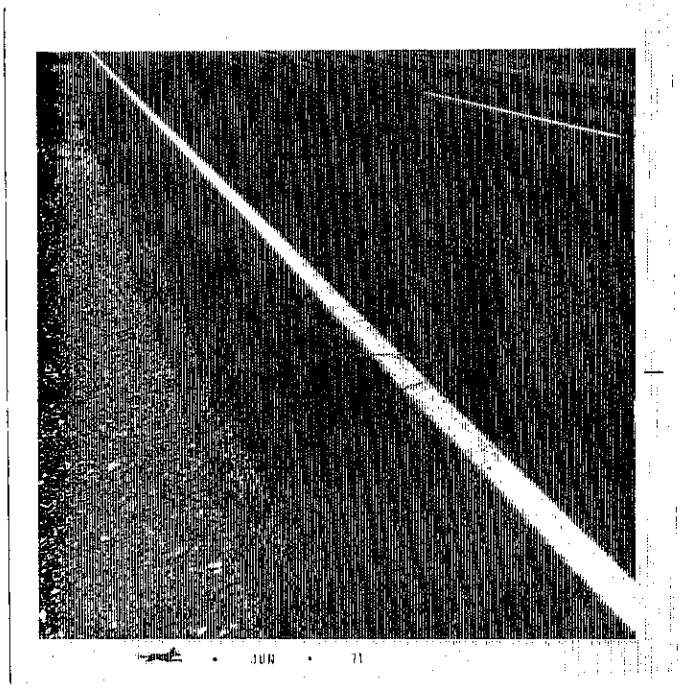



Photo 1. A typical longitudinal crack along the pavement-shoulder joint. The present resurfacing is the first resurfacing over the old PCC pavement.


Photo 2. Longitudinal cracking along the pavement-shoulder joint. Note the lack of distinct change in slope between the pavement and shoulder and the positioning of the edge stripe on the shoulder.

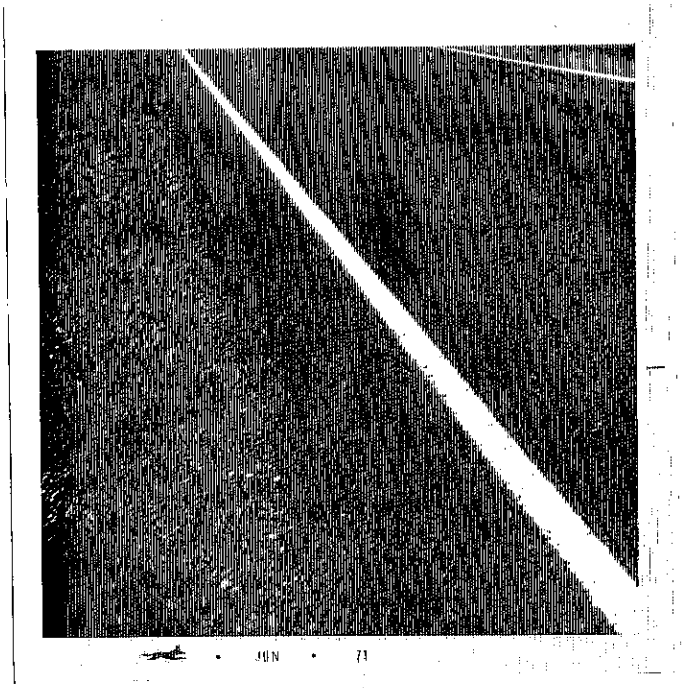


Photo 3. A short length of longitudinal cracking occasionally found on pavements with multiple resurfacings.

Photo 4. A more typical view of the shoulder adjacent to a pavement with multiple resurfacings. This area is at a crossroad and has been subjected to numerous turning movements.

Photo 5. A typical view of the distress on the three-inch bituminous concrete shoulder design.

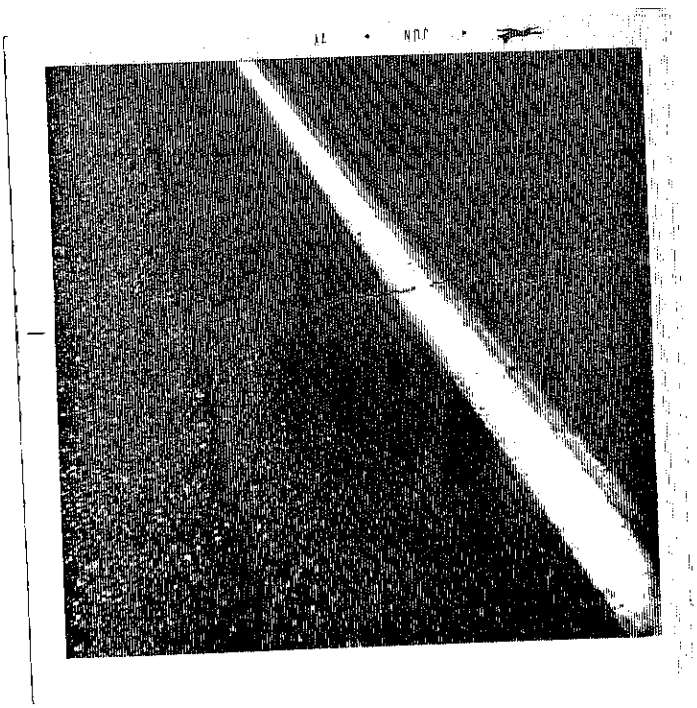


Photo 6. A three-inch bituminous concrete shoulder showing little distress at the present time.