

Research Report  
No. 403

EXPERIMENTAL PORTLAND CEMENT CONCRETE SHOULDERS  
DESIGN AND CONSTRUCTION

by

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[US 31W Hardin-Meade Counties; F-FG 79(23)]

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## INTRODUCTION

Kentucky's first portland cement concrete shoulder project was conceived in 1970 and was inspired by the Portland Cement Association's issue *Concrete Shoulders for Safe Modern Highways*, **Concrete Report**, 1970, and FHWA's Informational Memorandum CMPB-17-70, *Experimental Project for the Evaluation of Portland Cement Concrete Shoulders Adjacent to Concrete Mainline Pavement*; Project Prospectus, National Experimental and Evaluation Program; May 12, 1970. It was expected that at least two states in each region would participate in the national program. A 3.442-mile section of US 31W, between Radcliff and Tiptop, beginning at the intersection of US 60 and extending southward, scheduled for reconstruction, was chosen for implementation. The site is shown in Figure 1. Bids were taken February 15, 1973, and project is now nearing completion. Construction cost will be nearly 6 million dollars.

## PROJECT DESCRIPTION

Normal design of shoulders for this type of project would have been full-depth dense-graded aggregate daylighted through the shoulder slope and covered with a double, inverted seal extending 10 feet from the pavement edge. The original, proposed cross section is shown in Figure 2. This section was revised to accommodate the experimental concrete shoulders. For comparison, a section of bituminous concrete shoulders was provided at the northern end of the project. The bituminous concrete is 2 inches in depth. Figure 3 shows a layout of the shoulder sections. The mainline, concrete pavement is 9 inches thick and is founded on 4 inches of dense-graded aggregate. The subgrade slopes 3/16 inch per foot from the centerline; this cross slope is maintained to the daylighting point on the shoulder slope.

### Concrete Shoulder Details

Five-, 6-, and 7-inch shoulders, with and without wire mesh (44-pound 6 x 12 mesh, as required in the mainline pavement) were thought to encompass shoulder structural requirements. A tied, longitudinal joint was provided between the mainline pavement and the shoulder slabs to prevent faulting there and to permit separate construction of the shoulders. This detail is shown in Figure 4. Shoulder sections containing wire mesh were jointed at 50-foot intervals to match the mainline joints; the mesh does not span the joints; and no load transfer dowels were required in the shoulder joints. An intermediate, 25-foot joint was required in

the sections without wire mesh. Normally, a high percentage of 50-foot slabs develop a crack at the midpoint or two cracks at the third points. Sympathetic cracking through the shoulder is expected and will be subject for study.

### Experimental Seals

A companion feature on this project is the use of neoprene joint seals. Standard joint details (1/8 to 1/4 inch in width, sawed 1/4th the slab thickness plus 1/4 inch in depth; hot-poured, rubberized asphalt seal) used in the control section extended into the first section of concrete shoulders. In other words, liquid injection seals are being provided in the mainline and shoulders from the beginning to Station 220 + 00. All longitudinal joints were required to be sawed 1/8 to 1/4 inch in width; construction joints are sawed to a depth of 1 1/2 inches; otherwise joints are sawed to 1/4 the slab thickness plus 1/4 inch; transverse joints from the beginning to Station 273 + 00 are also 1/8 to 1/4 inch in width and required a 7/16-inch compression seal. Transverse joints from Station 273 + 01 southward to the end were sawed 3/16 to 5/16 inch in width and required compression seals 9/16 inch in width. Transverse compression seals are required to be continuous from the centerline through the shoulder. Longitudinal seals were required to be 50 feet in length unless intersected by a transverse joint. The ends of the longitudinal sections were required to be cemented to the transverse seals.

### Rumble Strips

In order to prevent or deter use of the shoulders as traveling lanes, heavily corrugated rumble strips were formed into the shoulder concrete. These details are shown in Figure 5. Although a standard edgeline will be provided, obedience to both features will be a subject for study and evaluation.

### Construction

A picture history of construction is included herewith as an appendix.

## DISCUSSION

### Structural Design

It was thought that the structural design of shoulders should be at least equal to that of concrete streets in residential areas and withstand legal axleloads and occasional overloads. Criteria for estimating loadings for shoulder design remain rather vague. There is always the possibility that mainstream traffic may be diverted onto shoulders for indefinite periods of time. To underdesign concrete shoulders would be a rather unforgivable folly.

Although an FHWA notice, dated June 5, 1974, eliminated the experimental status of concrete shoulders and indicated project-by-project approval when economically justified, the evaluation of this project will continue as originally planned inasmuch as economic justification will be required for future projects. The notice mentioned recommends not less than 6-inch thick shoulder slabs, without steel, on a stabilized base course.

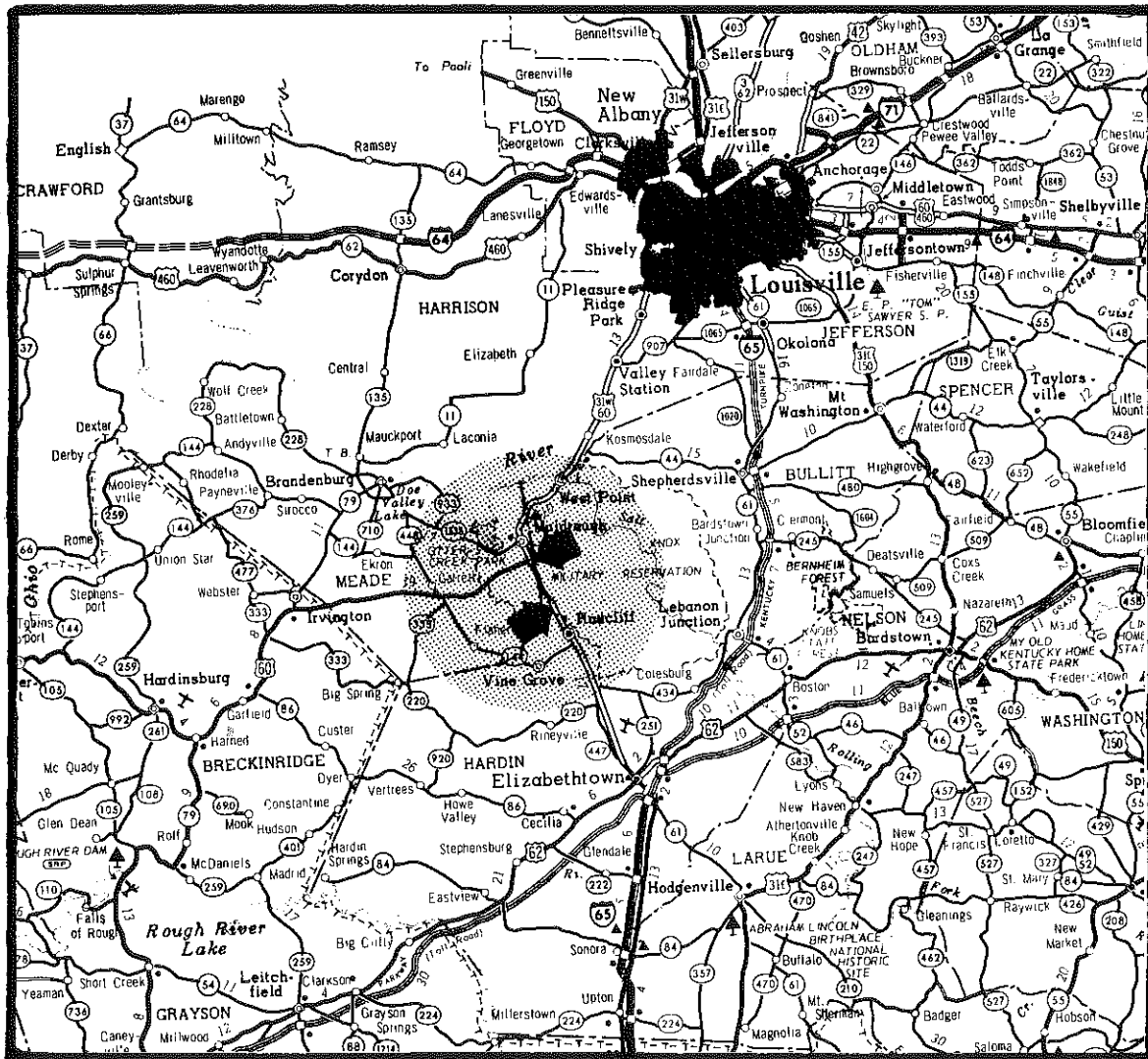
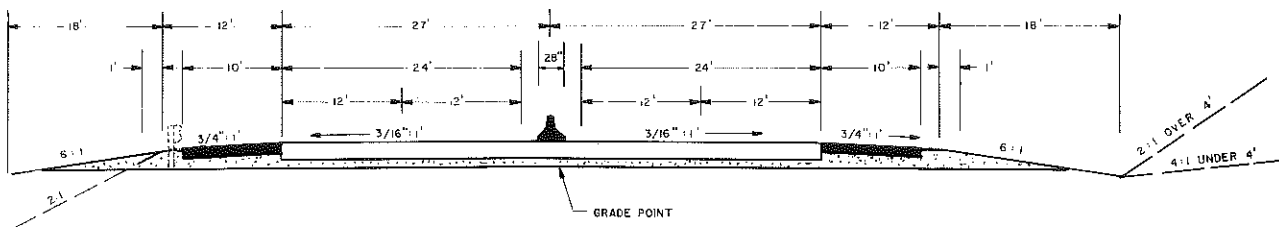
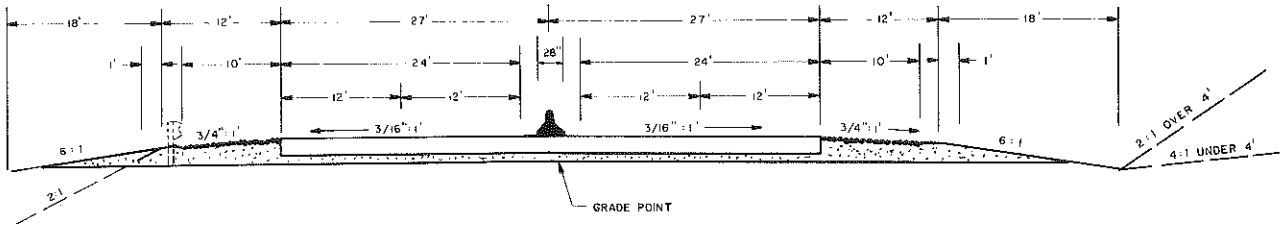
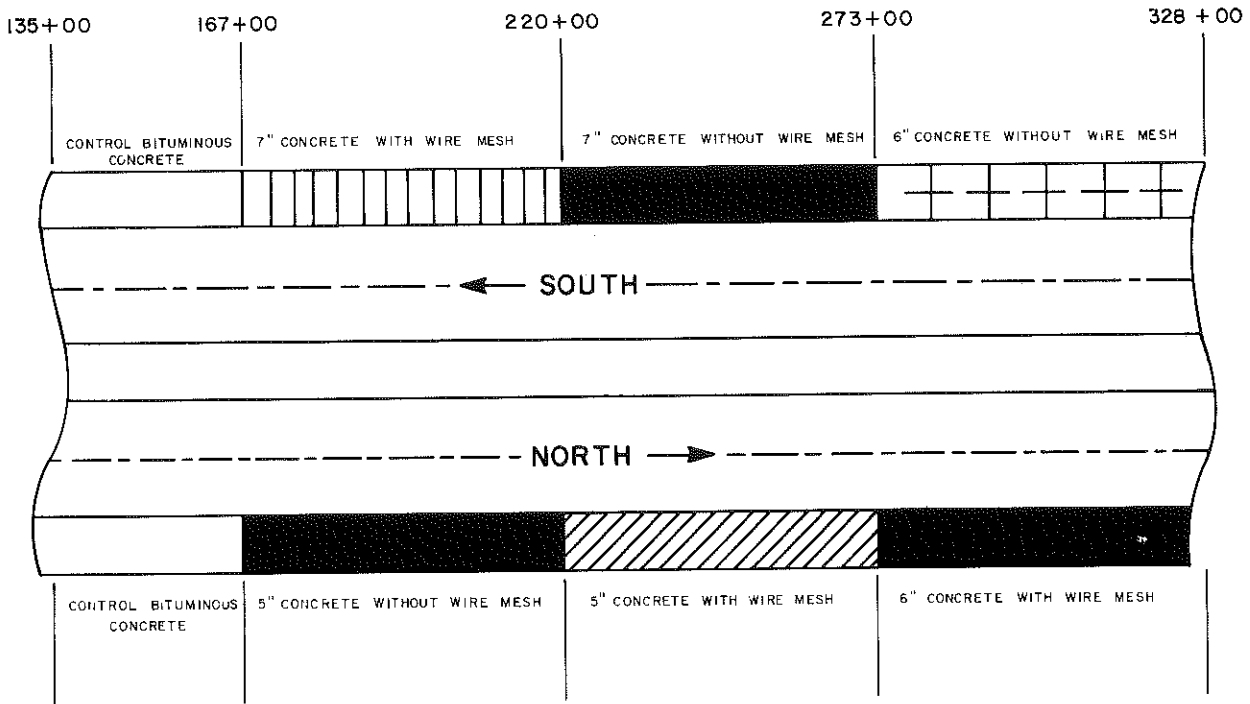


Figure 1. Project Location.



ELIZABETHTOWN-LOUISVILLE RD. (U.S. 31 W)

Figure 2. Original Cross Section; Modified for Concrete Shoulders.



**Figure 3.    Layout of Shoulder Sections.**

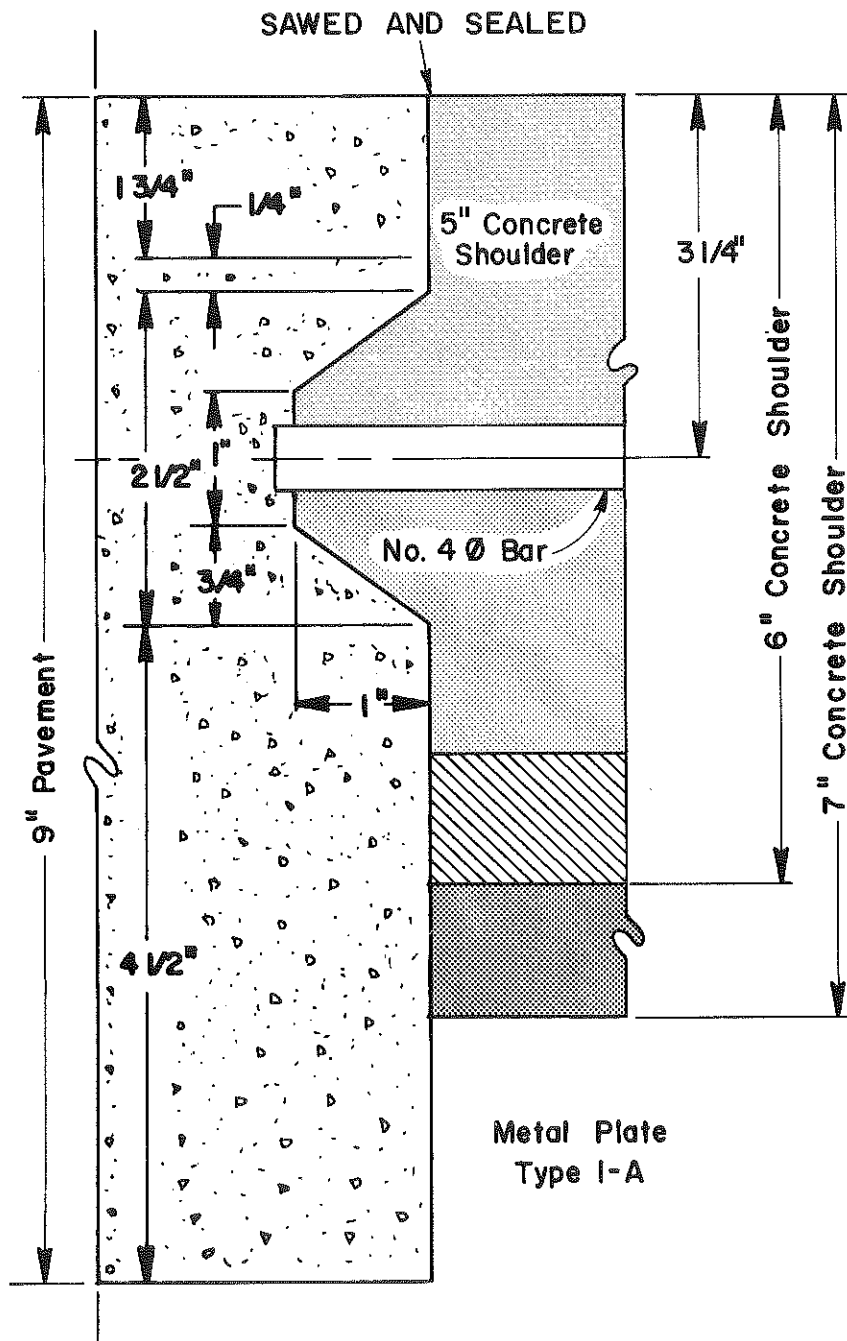


Figure 4. Joint Detail; Edge of Mainline Pavement and Shoulder.

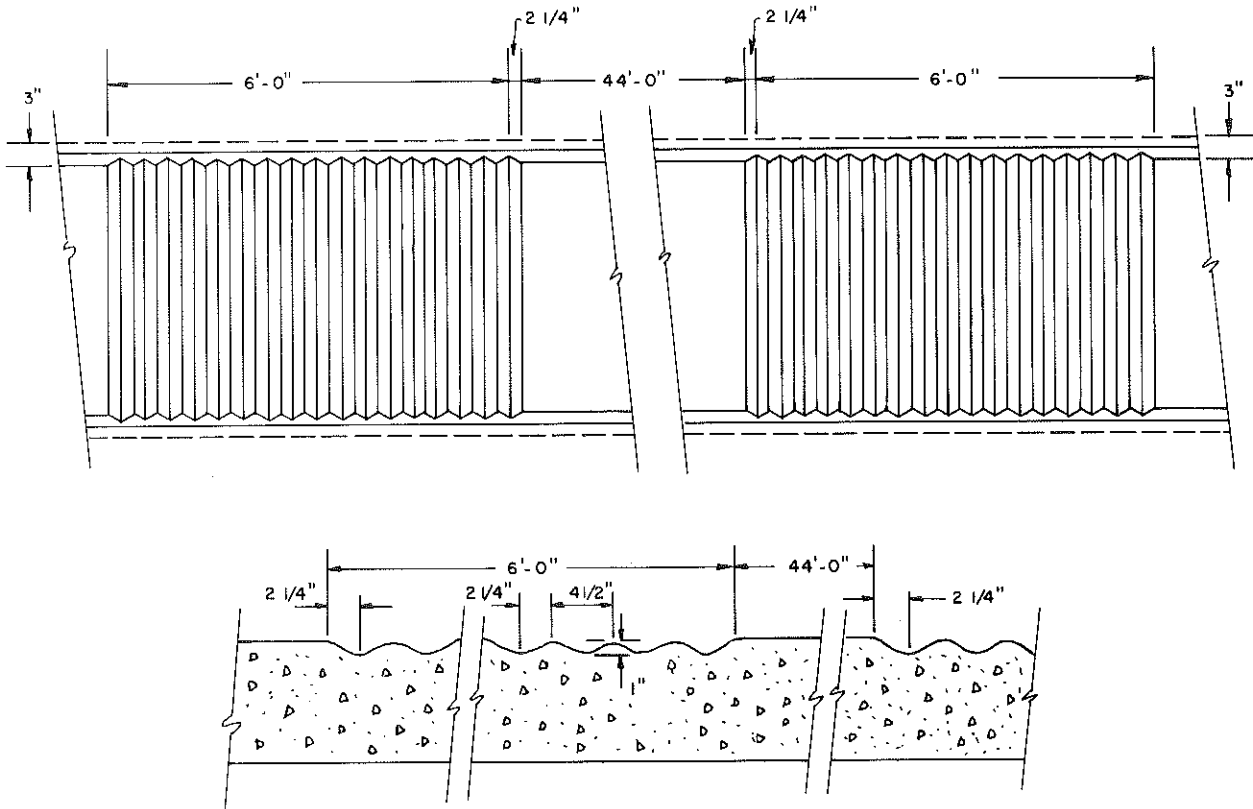


Figure 5. Rumble Strip Details.



**APPENDIX**  
**HISTORY OF CONSTRUCTION**

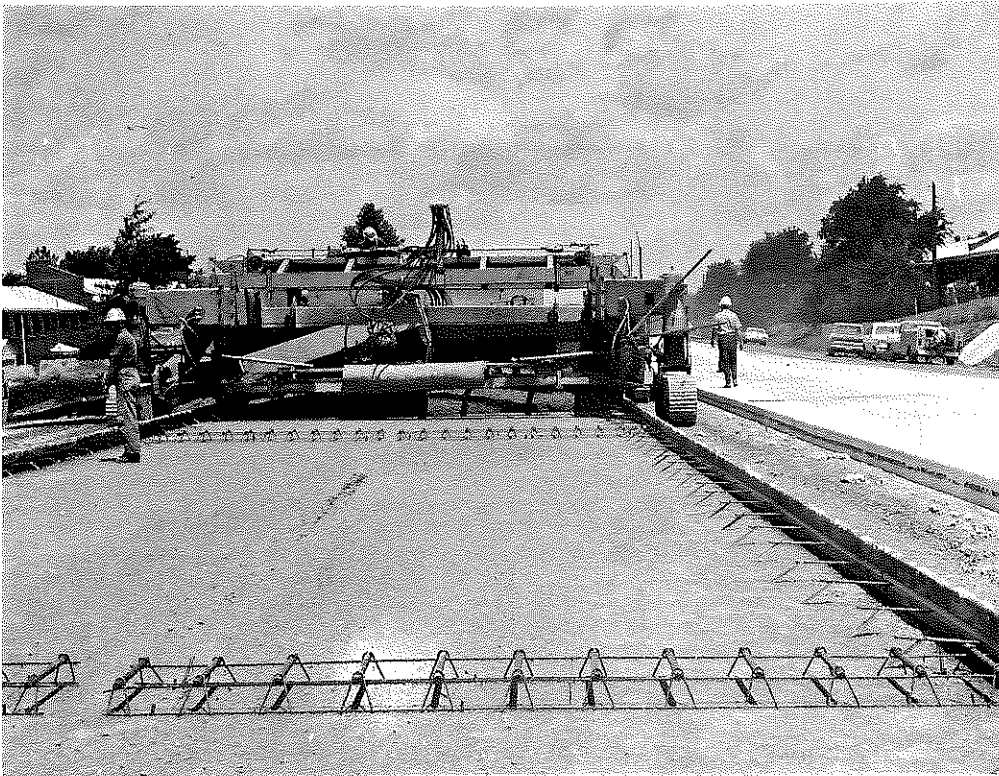


Figure A-1. Mainline Paving.

Figure A-2. Mainline Paving.



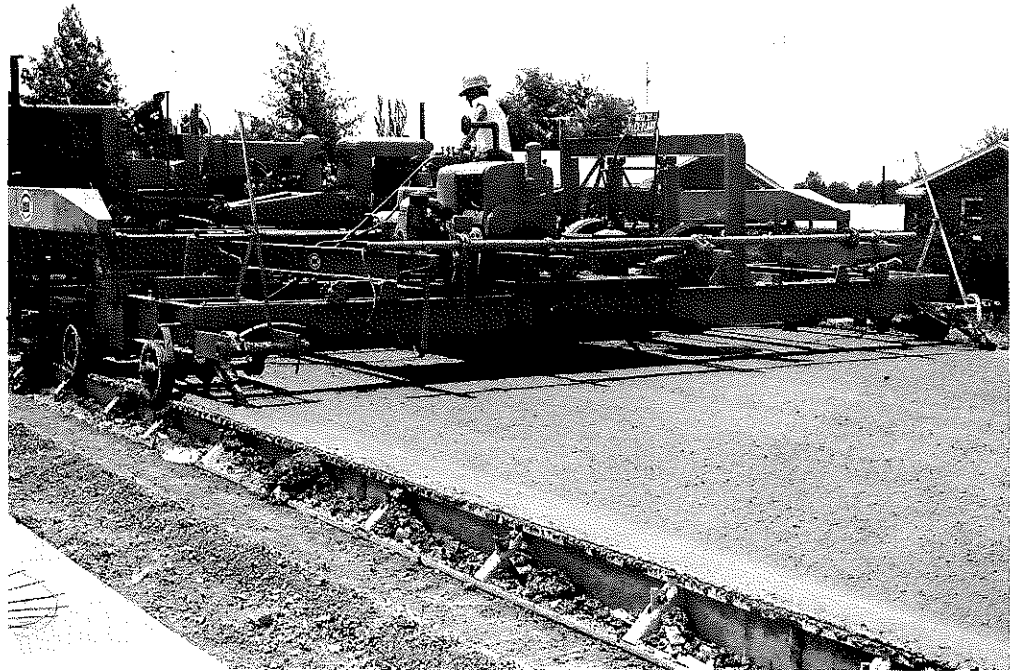
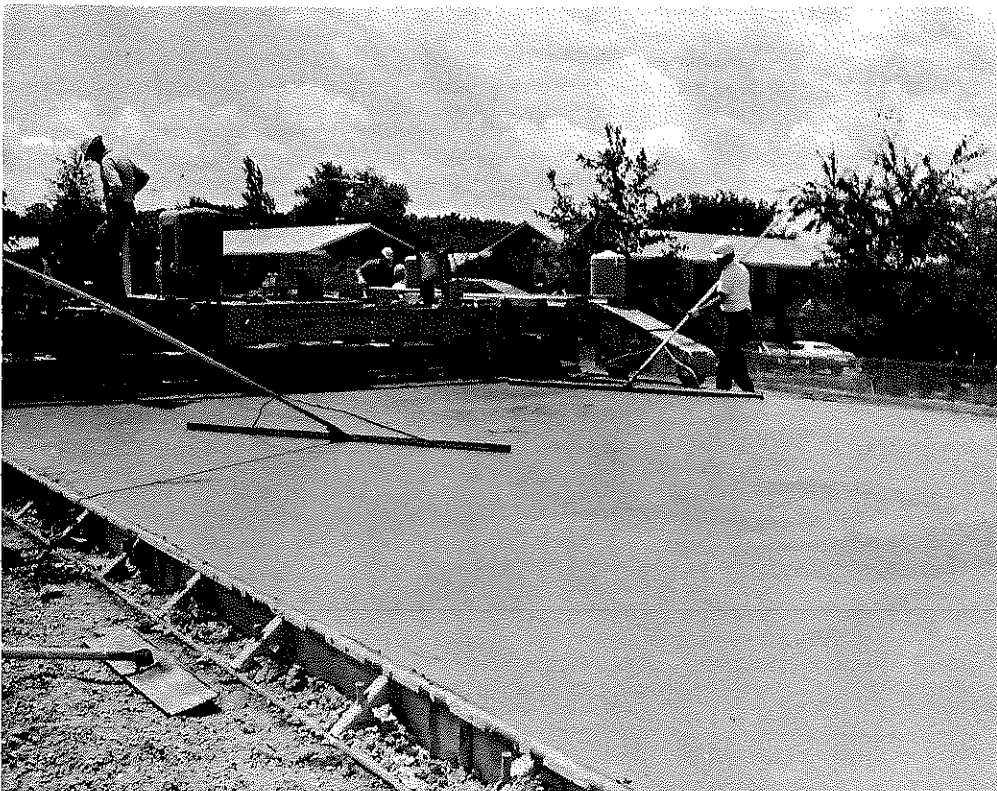


Figure A-3. Mainline Paving.

Figure A-4. Mainline Finishing.



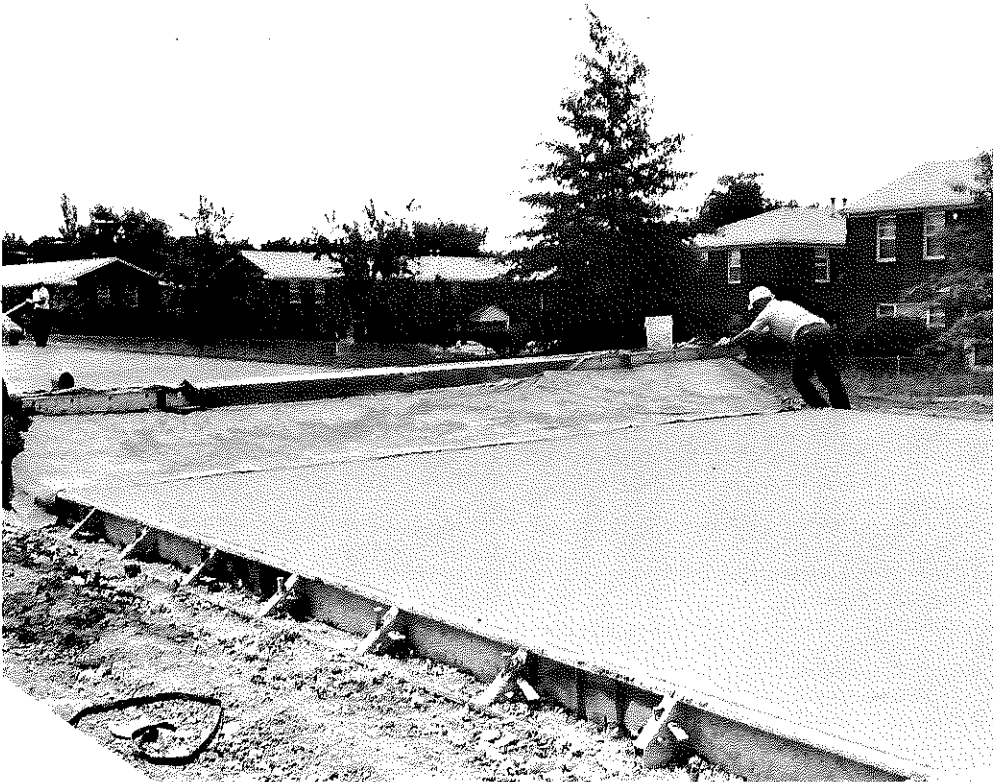
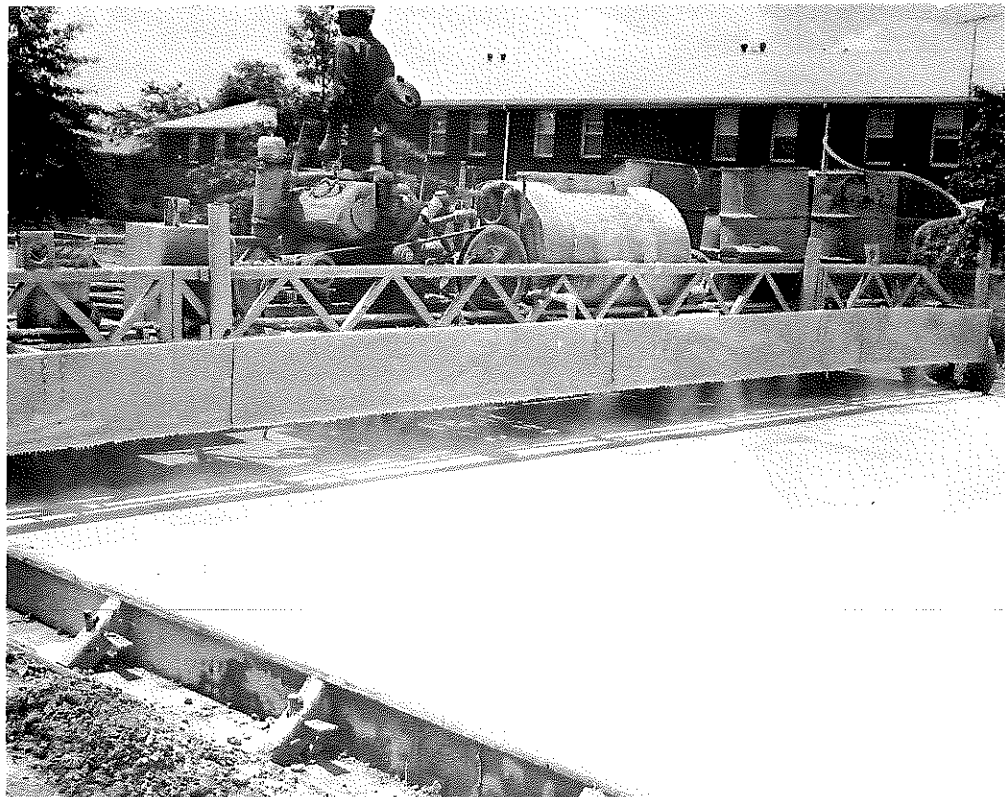
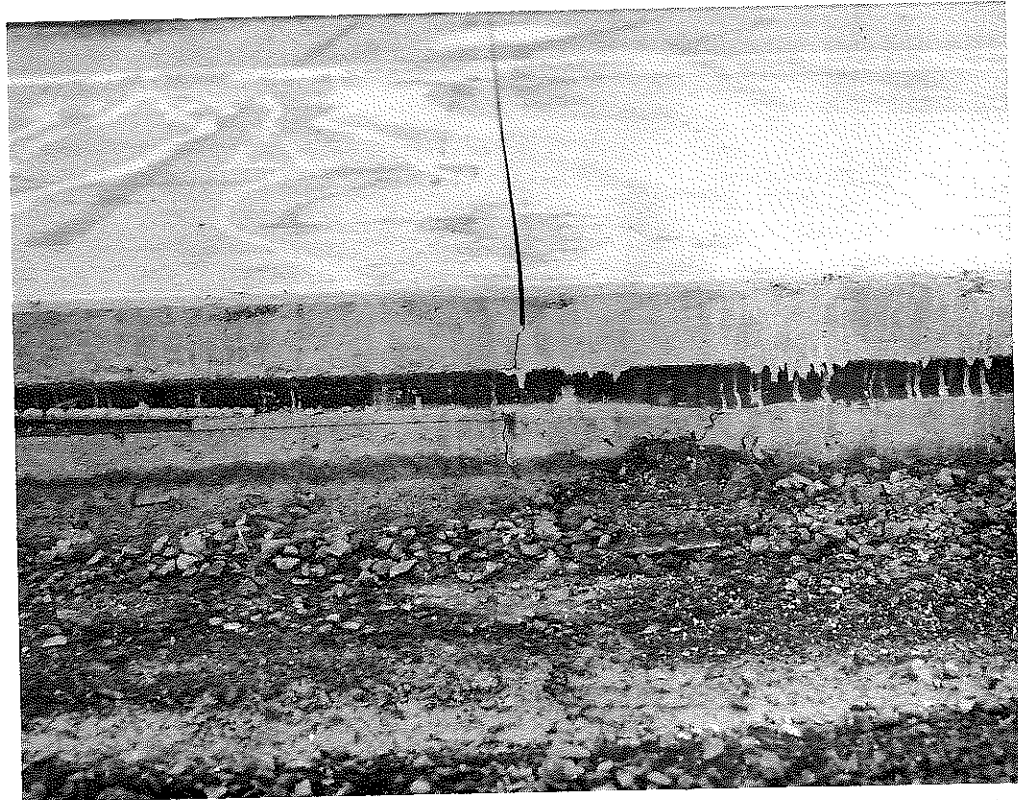


Figure A-5. Burlap Drag; Mainline.

Figure A-6. Applying Curing Membrane; Mainline.





**Figure A-7. Key and Bar Connectors between Mainline and Concrete Shoulder.**

**Figure A-8. Shoulder Paving.**



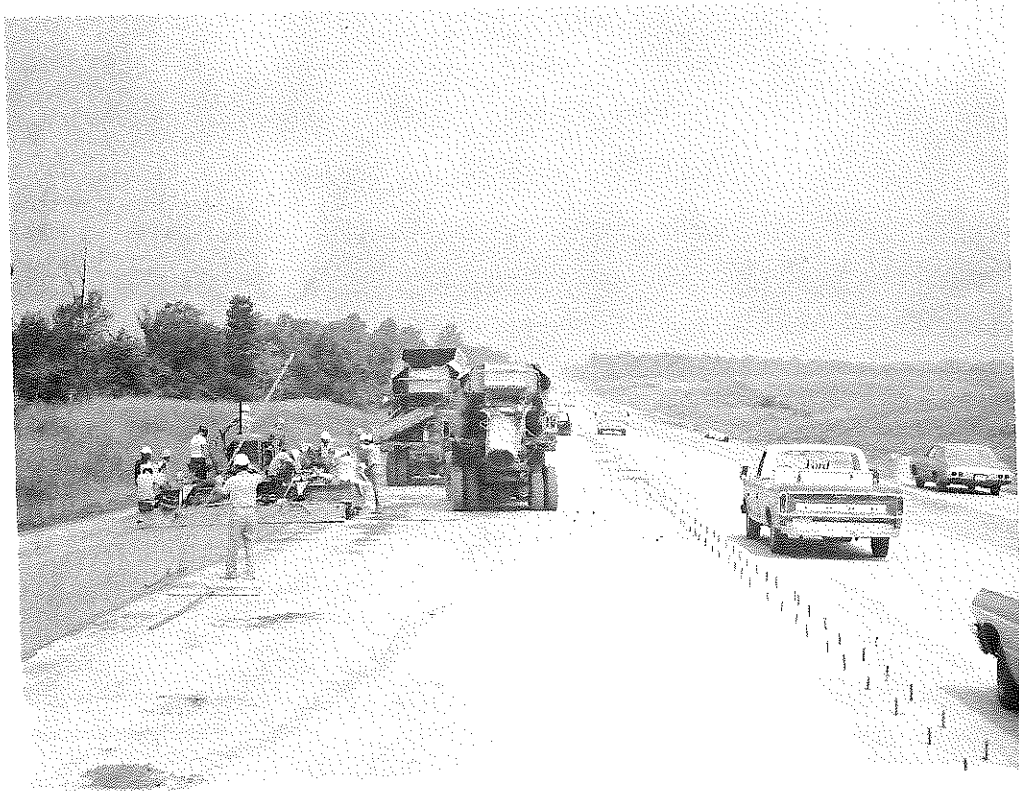


Figure A-9. Shoulder Paving.

Figure A-10. Widening Joints; Note Crack in Shoulder.



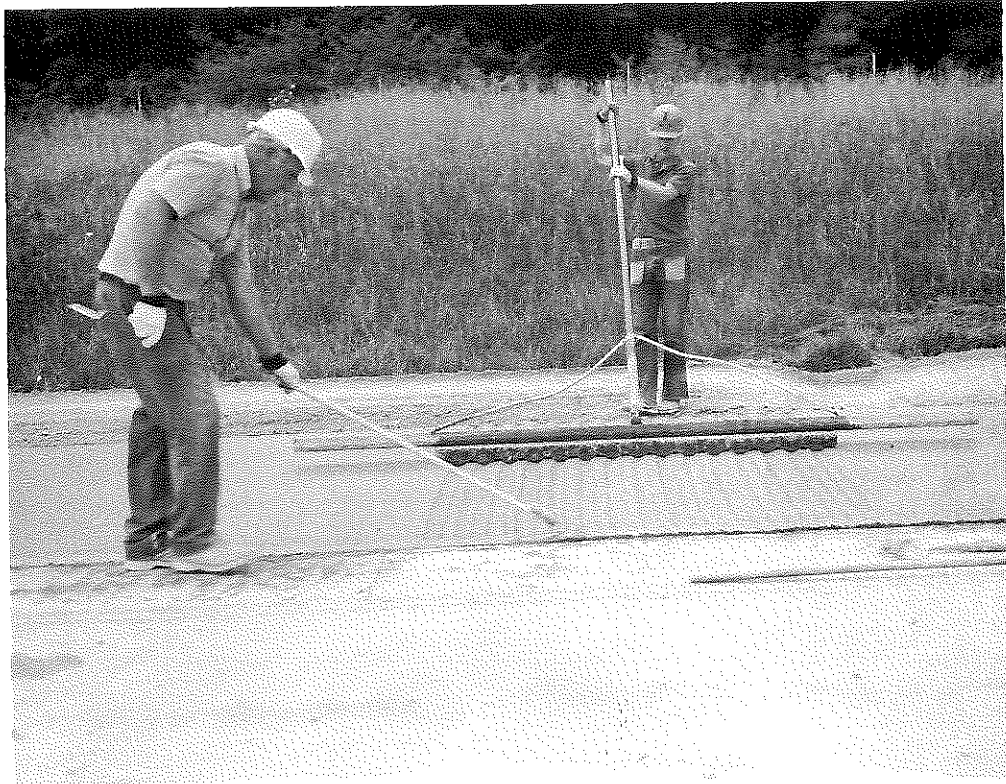
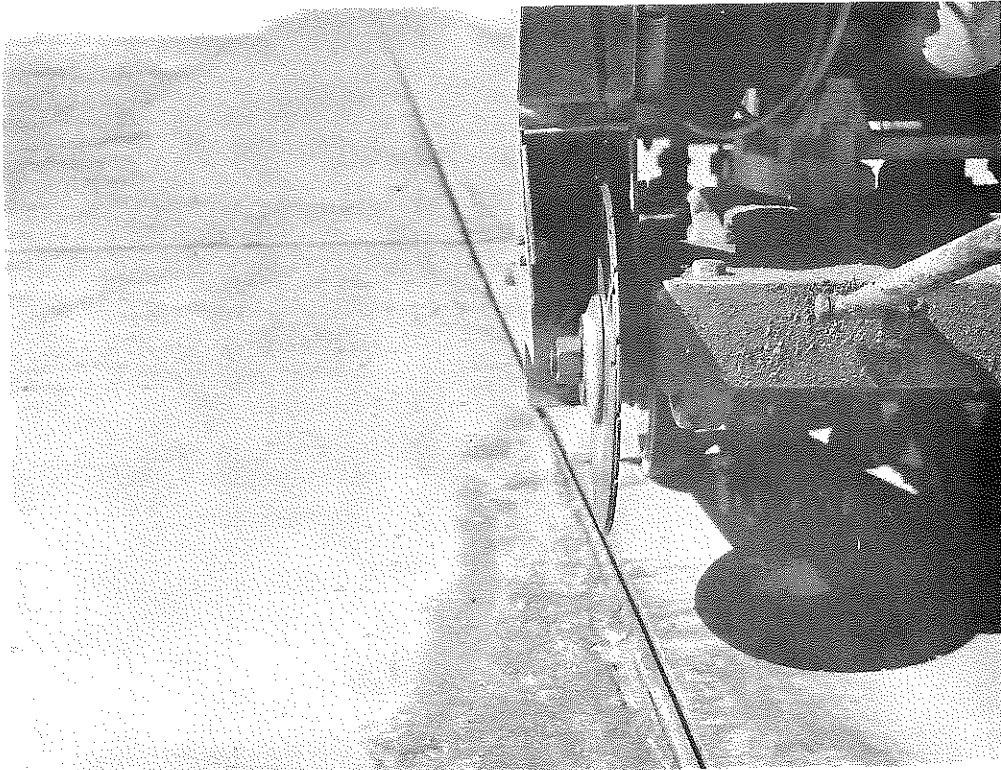


Figure A-11. Forming Rumble Strips in Shoulder.

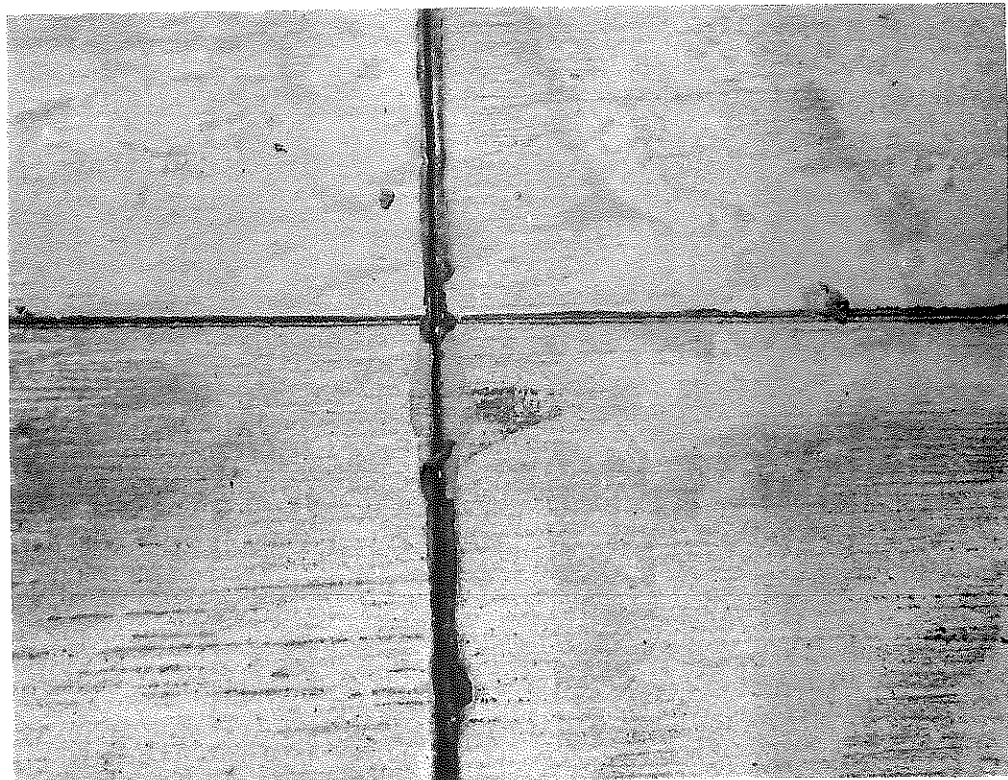
Figure A-12. Drainage Problem at Rumble Strip.





**Figure A-13. Widening Joints for Neoprene Seals.**

**Figure A-14. Hot-Poured Joint Sealer.**





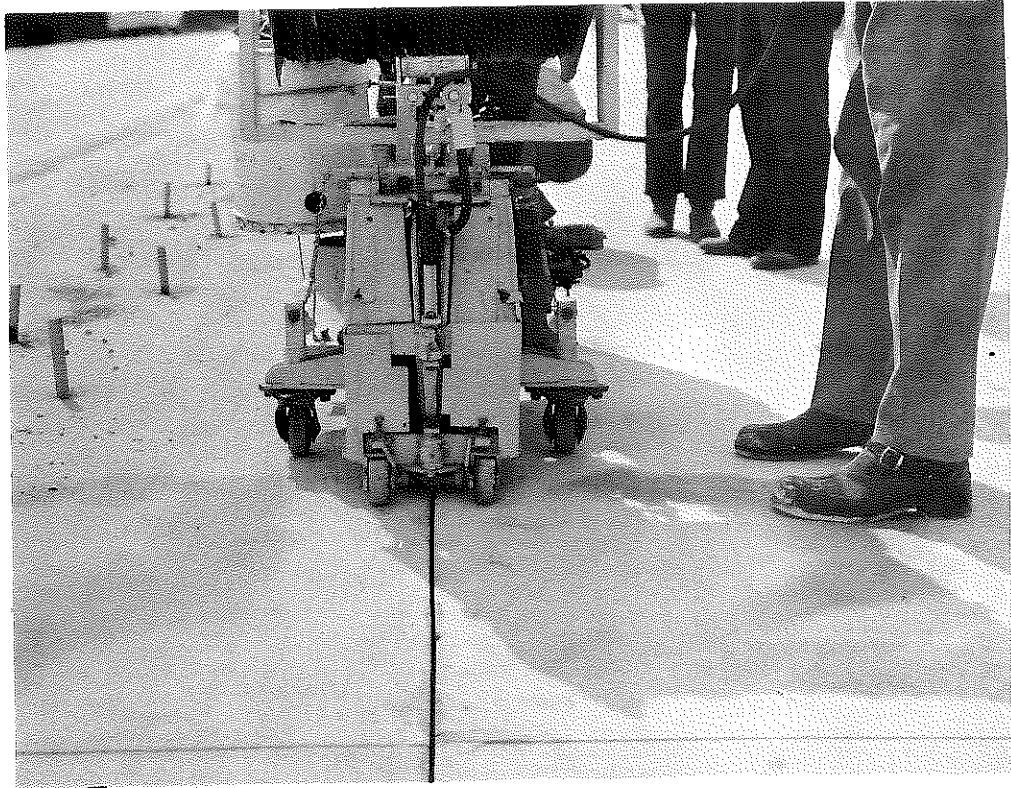
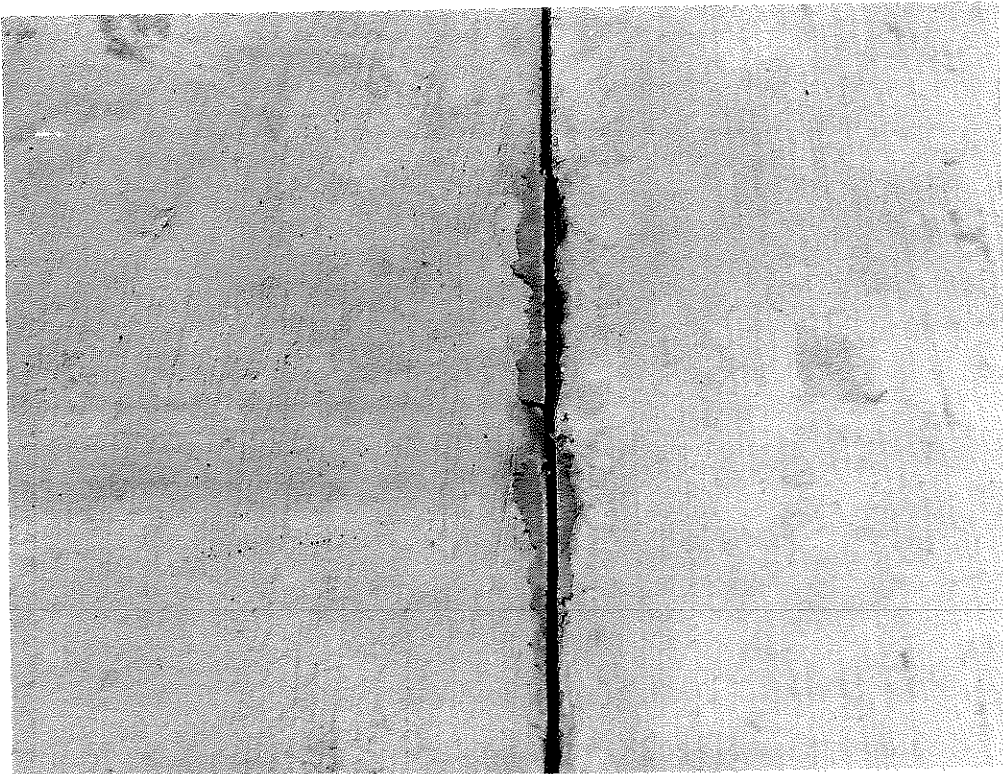


Figure A-15. Installing Neoprene Compression Seals.

Figure A-16. Problem Area with Neoprene Seals.

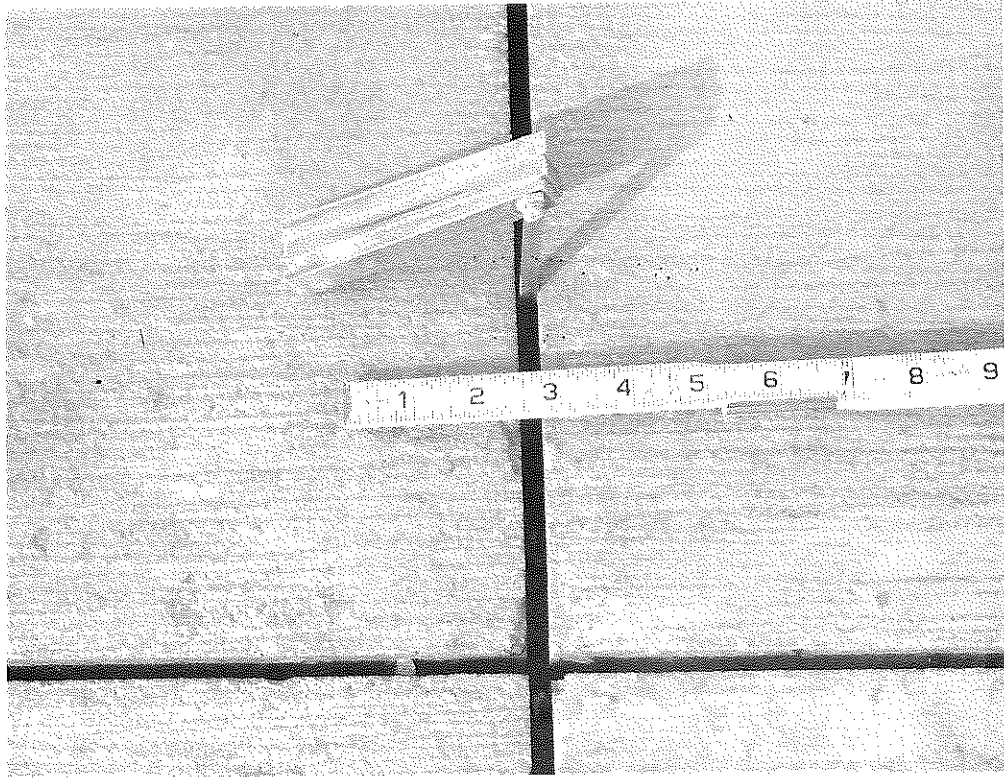




**Figure A-17. Problem Area with Neoprene Seals.**

**Figure A-18. Installing Neoprene Seal at Inner Edge Joint.**





**Figure A-19. Contractor's Gage for Joint Width.**

**Figure A-20. Installing Median Barrier.**

