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EVALUATION OF EXPANSION-CONTRACTION JOINT CONSTRUCTION METHODS
M 153 North of Ypsilanti (Construction Project F 81121A, C2)

J. E. Simonsen

Research Laboratory Division
Office of Testing and Research
Research Projects 60 F-58(1) and 59 NM-8
Research Report No. R-543

Michigan State Highway Department
Lansing, September 1965

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At the July 29, 1964 meeting of the Committee for Investigation of New Materials, a proposal prepared by the Research Laboratory Division for a construction feasibility study of expansion-contraction joints was considered and approved for inclusion in the plans and specifications of a regular construction project. The Committee requested the Road Construction Division to select a project scheduled for paving in the Fall, and the Laboratory was assigned the responsibility of readying the experimental materials as well as evaluating the construction methods.

Background of the Field Study

The purposes of the expansion-contraction joint are fourfold: first, to establish deliberate control of the formation of planes of weakness rather than relying on randomly cracked planes of weakness in contraction joints; second, to equalize width changes among joints and thereby defer joint sealant failures; third, to provide for some expansion of slabs resulting from temperature and moisture changes or from incompressible materials entering the joints through failed sealants; and fourth, to equalize compressive forces across joint faces.

The idea of providing a narrow expansion-contraction joint between slabs is not new. In Research Report No. 68 (March 1945) titled "The Design of Concrete Pavements for Postwar Construction," which was used as a basis for current concrete pavement design, the subject was discussed with the recommendation that 1/2-in. expansion joint material be used in place of 1-in. material in joints between 100-ft slabs. The final decision, however, resulted in elimination of expansion joints except at bridges, structures, and at stated intervals during Fall construction. At that time, observations on older pavements indicated that excessive localized stresses must occur at adjoining faces of joints, because of the following acknowledged facts: 1) adjacent joint faces never being in an ideal vertical condition to receive compressive forces, due to curling and warping effects caused by temperature and moisture; 2) unequal distribution and character of infiltrated material; and 3) certain construction abnormalities.

A proposal by the Concrete Joint Institute for construction of an experimental pavement containing expansion-contraction joints was reviewed by the Committee for Investigation of New Materials at a meeting on June 30, 1959. On July 6, 1960, the Committee agreed that the Department should proceed with the plans for construction of an experimental project containing a section of expansion-contraction joints as proposed by the Institute. However, at its December 28, 1960 meeting, when the specifications for this project were reviewed, it was decided to eliminate the expansion-contraction joint section from the field project, because the method of filler installation and joint groove forming could not be detailed with sufficient assurance that delays might not develop during construction operations.

Shortly after rejection of the proposed field project, the Research Laboratory, in cooperation with the Concrete Joint Institute and manufacturers of load transfer assemblies, initiated a study to solve the problem of installing the narrow-width filler in the field. The manufacturers submitted various designs and samples of expansion joint load transfer assemblies including provision for holding the filler in position during paving operations. The method finally selected consisted of placing the filler in a standard expansion joint assembly in which the rigidity of the filler support wires would be increased, and additional support provided along the bottom of the filler by use of a standard contraction joint base plate and specially made base plate aligners. Fig. 1 illustrates the joint filler supporting arrangement and assembly change.

Laboratory experiments were performed to determine a feasible procedure for forming the joint grooves. Because sawing joint grooves or forming them by use of wood strips placed on top of the filler after machine finishing of the pavement surface were considered impractical at the time, the groove forming experiments were limited to various types of caps designed to be lifted to the pavement surface and left in place while reconsolidating the concrete against the cap sides and during curing for protection against dirt infiltration. Based on the experimental results and economic considerations, an expendable, high-impact, polystyrene plastic channel cap, 1/2 by 1 in. inside with 1/16-in. walls, was recommended for use in forming the joint grooves.

A more rigid 1/2-in. wide filler was developed by the Concrete Joint Institute. In order to form a 1/2 by 1/2 in. joint groove over the filler, an 8-1/2 in. filler depth was prescribed. To facilitate filler installation to the required length of 24 ft, each joint location was to be supplied with one 12-ft piece and two 6-ft pieces. The 12-ft length was

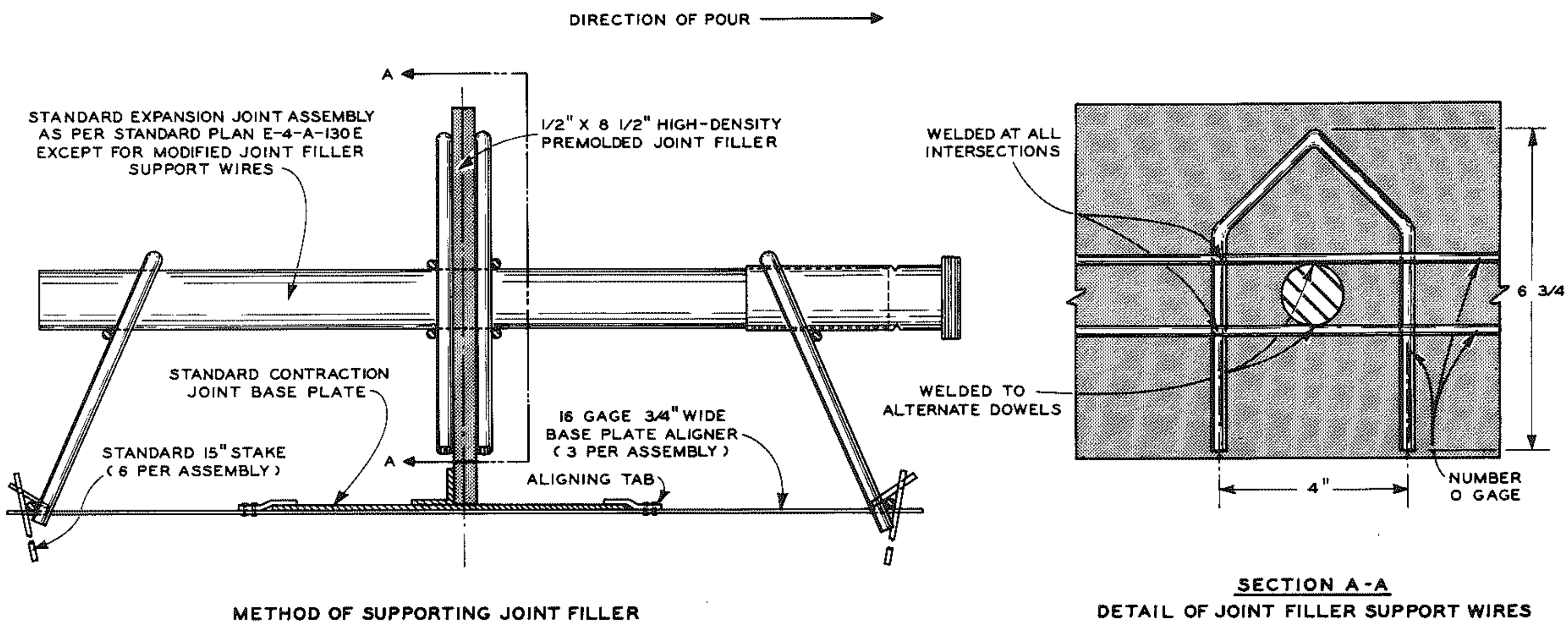

Figure 1. Method of supporting joint filler and detail of joint filler support wires.

to be installed in the traffic lane and the two 6-ft pieces in the passing lane. In this manner the shape of the offset crown could be matched somewhat more closely than by using two 12-ft pieces of filler.

Field Study Objectives and Construction

The objectives of the construction feasibility study were to test the proposed method of installing the filler and forming the joint grooves under actual construction conditions. In addition, delays in paving operations caused by use of the expansion-contraction joints were to be measured. Based on the results of this study, consideration would be given to construction of an entire project containing this type of joint for the purpose of comparing its performance to that of standard contraction joints.

Provisions for constructing an experimental pavement section containing six consecutive expansion-contraction joints were included in the contract for Construction Project F 81121A, C2, located on M 153 in Washtenaw County approximately 4 miles north of Ypsilanti, and extending east from the junction with M 14. The contract was awarded on August 12, 1964, to the joint low bidders--Eisenhour Construction Co., East Lansing, and O. E. Gooding Co., Ypsilanti. The experimental assemblies were fabricated by the Universal Form Clamp Co., Chicago, and the premolded joint filler material supplied by the Concrete Joint Institute, Chicago. The Research Laboratory furnished the base plate aligners and the plastic caps.

Paving operations began October 6, 1964, and were completed October 15, 1964. The project consisted of a 3/4-mile section of divided highway, each roadway being 24-ft wide and of 9-in. uniform thickness. A joint spacing of 71 ft 2 in. was maintained throughout the project, with every fifth joint being a 1-in. expansion joint, except in the areas of the control and experimental sections; there, the expansion joint spacing was changed to provide for installation of six consecutive joints of one type. The six experimental joints were installed on the eastbound roadway from Sta. 581+26 to 584+82 and a control section containing six consecutive contraction joints was included in the westbound roadway from Sta. 581+39 to 584+95.

The concrete was produced in the contractor's mixing plant, set up at the western end of the project, and delivered to the grade in agitator trucks. The pavement was constructed by the two-course method. Concrete for the first 6-in. course was deposited directly from the trucks on the grade and spread with a Jaeger spreader. The reinforcement was placed atop the first course from a steel buggy. After approximately 150 ft of concrete and steel had been placed in this manner, the equipment was backed up and the second course poured. Concrete placed atop the first course from the trucks was spread and initially finished with the Jaeger spreader. Final machine finish of the surface was accomplished by use of a Jaeger combination finisher-float machine. Contraction joint grooves were formed by use of styrofoam and the grooves in expansion joints by use of wood strips. Hand floating, burlap dragging, and application of membrane curing compound completed the paving operations.

Evaluation of Construction Techniques

The installation procedure for the expansion-contraction joint was the same as for a standard 1-in. expansion joint, but more time-consuming. Installation of six assemblies of each type by a two-man crew required an average of 28 min. per expansion-contraction assembly and 22 min. for installing a standard 1-in. expansion assembly. This time differential is attributed to the crew's inexperience in fitting the various components of the expansion-contraction assembly together and the necessity of adjusting the subgrade elevation at the joint location to ensure that the filler was 1/2 in. below final pavement surface. By comparison, average time for a two-man crew to install a contraction joint assembly was 12 min. Overall and closeup views of a typical assembly installation of each type are shown in Fig. 2.

In paving over the expansion-contraction assemblies the concrete was deposited as equally as possible on both sides of the assembly at the same time (Fig. 3), and during leveling of the first course the spreader auger was lifted just enough to clear the filler about 2 to 3 ft before reaching the assembly. A typical assembly is shown after the first course was poured in Fig. 4. During spreading and finishing of the second course the paving equipment passed over the assemblies with the auger or screeds set at the required elevation. Fig. 5 illustrates the spreader passing over an assembly during spreading of the second course.

Observation of the paving operations at the assembly locations and checking of the vertical alignment of the filler after machine finishing of the surface indicated that the method used to hold the filler in position during paving provided adequate support to resist tilting of the filler.

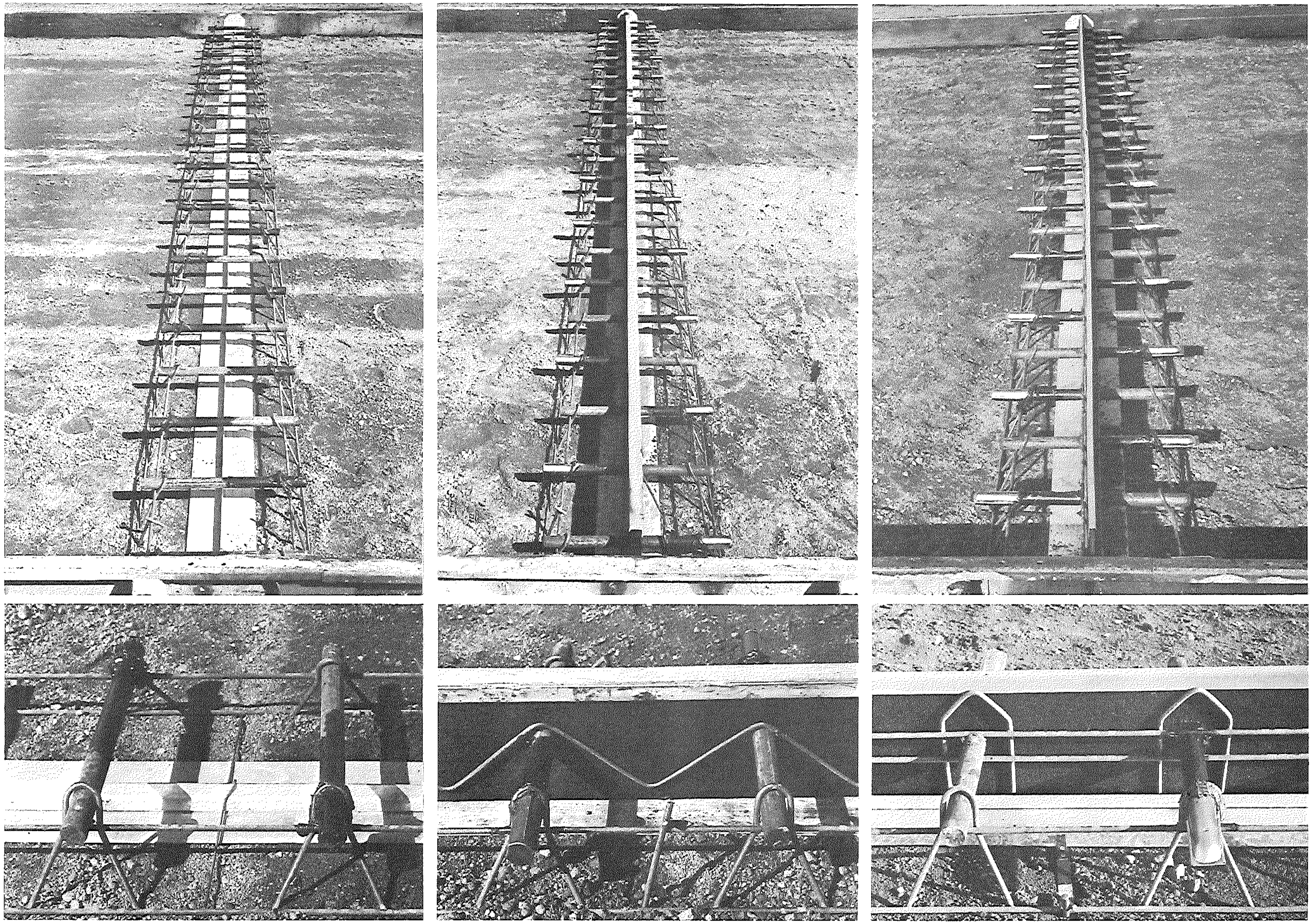

Figure 2. Overall and closeup views of typical assembly installations: standard contraction assembly (left), standard 1-in. expansion assembly (center) and expansion-contraction assembly (right).

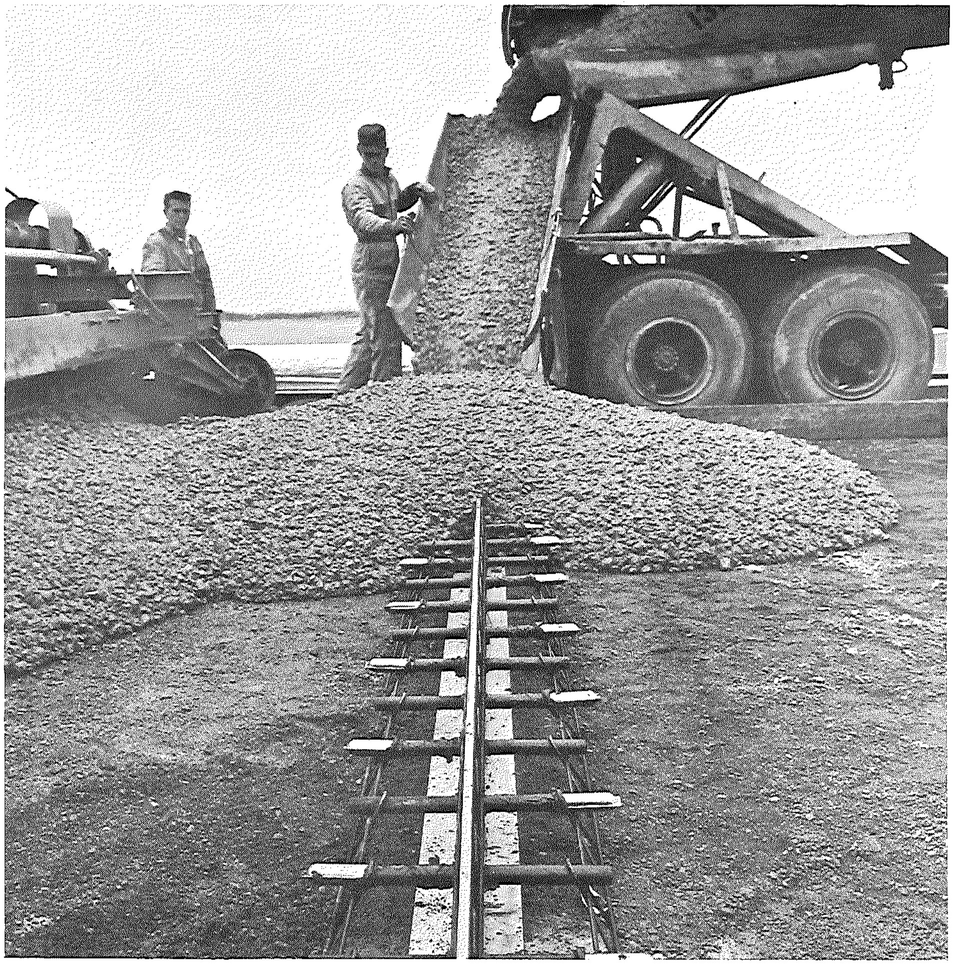

Figure 3. Depositing concrete over expansion-contraction joint assembly.

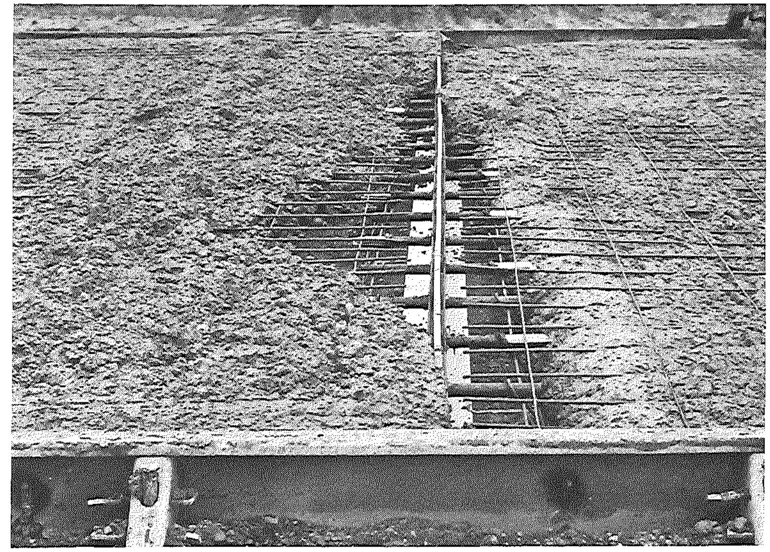

Figure 4. Condition of expansion-contraction joint assembly during the spreading of first course.

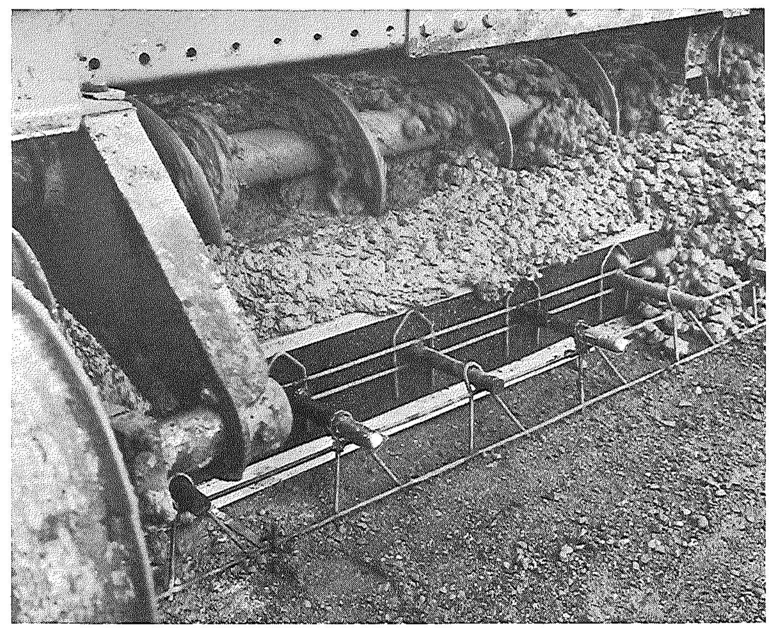

Figure 5 (right). Spreader passing over expansion-contraction joint assembly during placement of second course.

Forming of the joint grooves by lifting the plastic cap to the pavement surface through the overlying concrete, and then reconsolidating the displaced concrete against the cap sides, was not successful. In passing over the assemblies, aggregate lodged between the auger blades and the filler and inflicted considerable damage to the caps (Fig. 6). Thus it was necessary to remove the damaged caps completely and form the joint grooves using wood strips as shown in Fig. 7.

Because the contractor's mixing plant output was insufficient to keep the paving equipment operating at full capacity, the progress of paving was not delayed by the necessity of stopping the spreader and lifting the auger at the expansion-contraction assembly locations during placement of the first course.

Concluding Remarks

The field installation study showed that the method developed to hold the 1/2-in. filler in position during concrete placement was satisfactory. However, installation of an expansion-contraction joint assembly required about 50 percent more time than for a regular contraction joint assembly. Thus, doubling the size of the installation crew apparently would be necessary, to keep ahead of paving equipment on a project where all joints were of this particular type. If the expansion-contraction joint assembly were to be used in large quantities, a new technique would be required in packaging the assemblies for shipment, because the shape of the filler support wires prevents utilization of the current method of "nesting" assemblies for shipping.

Failure of the plastic cap method for constructing the joint grooves indicates that additional study would be necessary to develop a different joint groove construction procedure. A possible method would be to reduce the filler height to 8 in. and protect the filler by use of steel caps during paving operations. The caps would be removed after machine finishing of the surface and the displaced concrete floated into place over the filler. Completion of the plane of weakness would require a 1/8- by 1-in. transverse sawcut across the filler within approximately 24 hr after pouring. The joint grooves could then be sawed to the predetermined dimensions at the contractor's convenience after curing of the concrete. This suggested method would be more expensive than the present wood strip forming procedure, but should improve the quality of the joint grooves.

Figure 6. Removing plastic caps damaged by paving equipment.

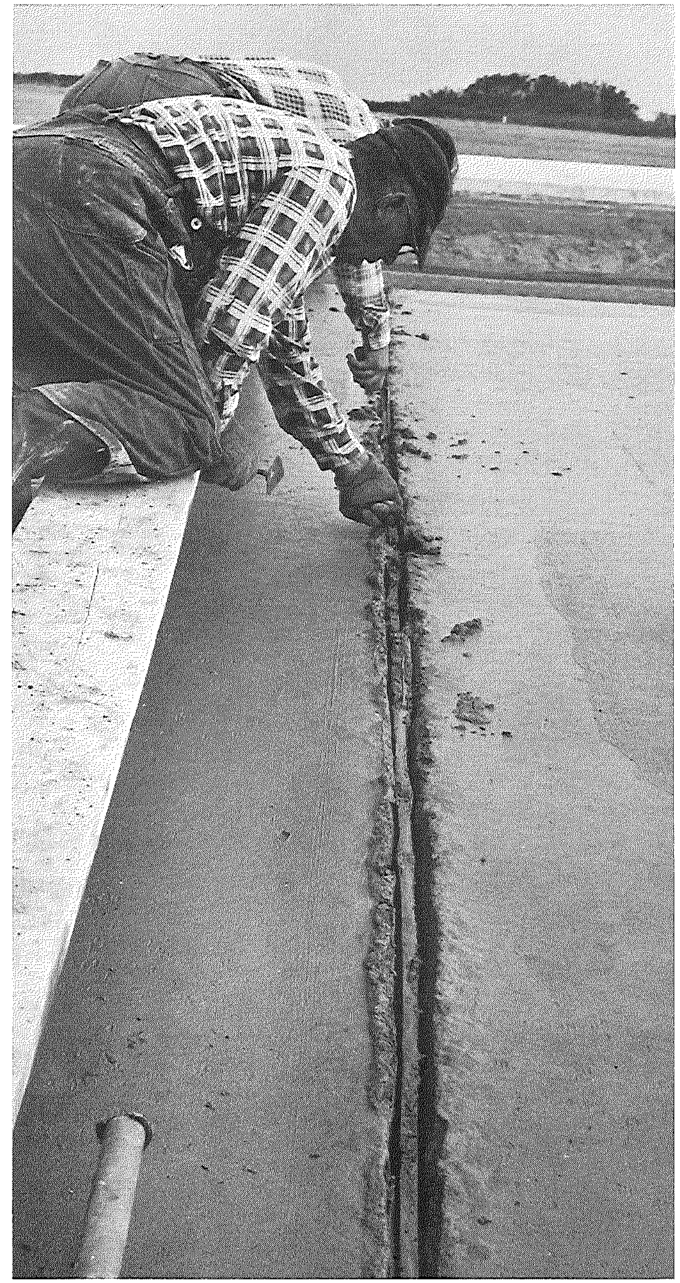

Figure 7 (right). Forming joint grooves by use of wood strips.

Although progress was not delayed during paving of the expansion-contraction joint section included in this project, it is possible that exclusive use of this type of joint would decrease the paving rate slightly on projects where the contractor's equipment is utilized to full capacity.

In summary, the study contained two basic elements: 1) stability of basket and filler as a unit, and 2) method of forming the joint sealant groove above the filler. The work appeared successful in the first aspect, but indicated the need for a better solution for the second.

It is recommended that further research work on developing an improved method for obtaining the joint sealant groove above the expansion filler be held in abeyance on this research project for two reasons. First, current specifications on Joints in Concrete Pavement specify sawing of the joint groove above the expansion joint filler. The techniques used by the contractor to do this and the results obtained will be considered as possibilities for use with these expansion-contraction joints. Second, with the completion of the current HPR study on "Concrete Pavement Design," it will be possible to determine the severity of present joint problems with greater certainty, as well as the need for expansion-contraction joints to alleviate these problems.