Slip-Form Paving—Construction Practices on Colorado Interstate System

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Construction methods for concrete pavement are subject to a wide variety of procedures. Many new types of equipment are being developed to produce better concrete pavement faster and more economically. A recent concrete pavement project in Colorado is described briefly. The entire operation from subbase to completed roadway was accomplished in record time and involved careful job planning by the contractor.

•COLORADO has been among the pioneer states in permitting slip-form paving for concrete highways. The latest project on I-25, immediately south of the Wyoming border, was constructed with some of the newest and most modern equipment. The 16.7 mi of four-lane divided highway was completed in 40 paving days. On one 14-hr day the contractor placed 9,354 ft of 8-in. thick nonreinforced concrete pavement.

SUBGRADE

The project specified a 4-in. thickness of Class 1 granular subbase, full subgrade width. Specifications required 100 percent passing 1½ in. screen, 40 to 70 percent passing No. 4, and 5 to 15 percent passing No. 200. This material was placed with a Jersey spreader, then shaped with blades and compacted. Two inches of base course surfacing with specified grading of 100 percent passing ¾-in. screen, 40 to 70 percent passing No. 4, 30 to 55 percent passing No. 10 and 5 to 12 percent passing No. 200 was then placed by means of belly-dump trucks. This material was bladed and rolled and was purposely overbuilt about 1 in. above the grade. The contractor then used an unusual Ko-Cal base courser manufactured by Koehring (Figs. 1 and 2). It was controlled to grade by preset wires. This subgrader does not carry material ahead. The base course surfacing is the same material as used for shoulder stabilization and the overbuilt portion is pushed to the shoulder area by the machine. The subgrader does not work satisfactorily if low areas requiring an addition of material are encountered. The machine originally had only one grade guide which operated in conjunction with a pendulum and proved unsatisfactory. Another grade control unit was added to the opposite side of the machine during this construction, and excellent results were obtained even when going around curves. The problem of superelevation was easily taken care of by the extra wire. The machine was also modified by replacing the original tamping bar with a vibratory pan compactor. The speed of this subgrader (approximately 700 ft/hr) required fast action by the materials testing crews. Over 5,000 tons of subbase was placed on an average day, requiring 6 gradation, 6 P.I., 6 L.L., and 2 density tests. The placement of approximately 1,900 tons of base course surfacing per day also required 4 gradation, 4 P.I., 4 L.L., and 2 density tests. This speed necessitated fast action by the staking crews. To keep ahead of the paver operation, the subgrader was generally operated approximately 1 mi ahead. The subgrade machine followed very closely behind the wetting and rolling operation which consisted mainly of flat-wheeled vibratory compactors.

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Figure 1. Front view, Ko-Cal subgrade finisher.

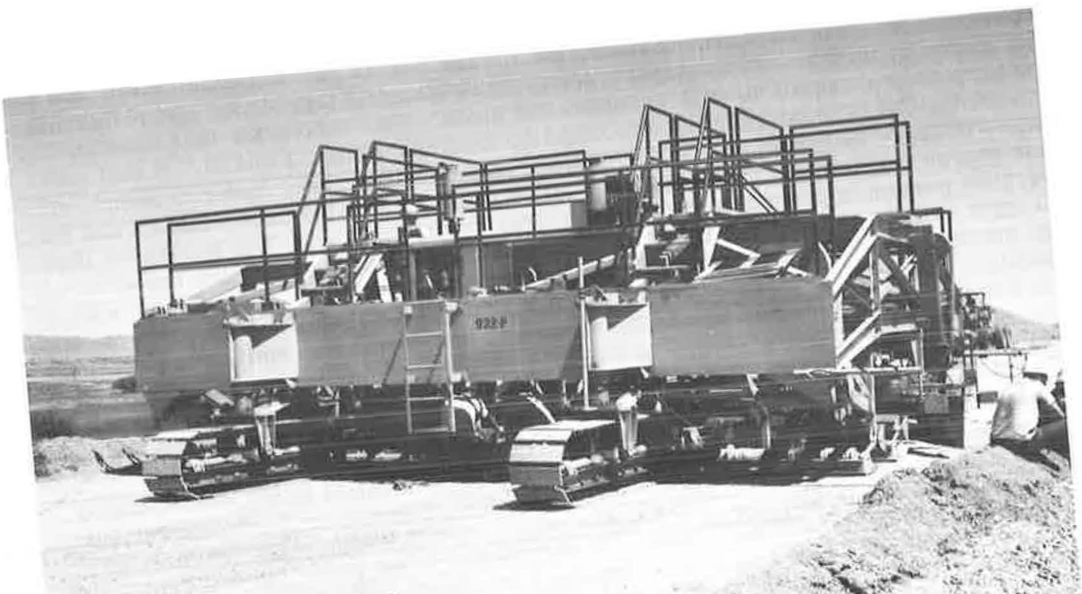

Figure 2. Rear view, Ko-Cal subgrade finisher.

PAVEMENT

A large modular type of crushing plant was used for preparation of the aggregate. This plant included a jaw crusher of the double jaw type and two cone crushers, one each set for $^3/_4$- and $1^1/_2$-in. material. Production averaged 500 tons/hr and the plant could produce sand, $^3/_4$- and $1^1/_2$-in. material for concrete, as well as $^3/_4$-in. base course and $1^1/_2$-in. subbase material simultaneously.

Concrete was completely mixed with water in a C.S. Johnson central mix plant (Fig. 3). This plant had a capacity of 500 cu yd/hr. The two Koehring mixers had a capacity of $8^1/_2$ cu yd each with a 1-min mixing time. A three-compartment, 67-cu yd storage bin provided aggregate for the mixers. Major items included three fully automatic aggregate weigh batchers, a 6,000-lb automatic cement weight batcher, 1,200-gal water tank and a 48-in. wide transfer belt. Cement was stored in a separately mounted 2,680-cu ft silo equipped with pneumatic fill pipe assemblies. The central mixing plant appeared to provide ample concrete with fewer problems than other projects where traveling mixers have been used. Also the concrete trucks did not cause as much damage to the subgrade as we have frequently encountered with traveling mixer setups.

Approximately 24 dump trucks were required to haul concrete from the plant (Fig. 4). Specifications permitted use of nonagitating trucks having smooth, water-tight bodies. Delivery was required in a thoroughly mixed and uniform mass. Discharge of concrete was required within 45 min after the introduction of the mixing water. Maximum length of haul was approximately 4 mi.

Concrete pavement was placed with a Guntert-Zimmerman slip-form paver (Figs. 5 and 6). The paver runs on crawlers and is controlled by the same preset wires used for controlling the subgrader. Average pavement placed was approximately 4,400 lin ft/day. Because of the speed of the paver, it was necessary to increase the number of stinger-type vibrators from 11 to 22. These vibrators were located ahead of the main screed. This is the first wire-controlled slip-form paving project in Colorado.

Figure 3. Concrete batching and mixing plant.

Figure 4. Dump trucks for hauling mixed concrete.

Figure 5. Guntert-Zimmerman slip-form paver.

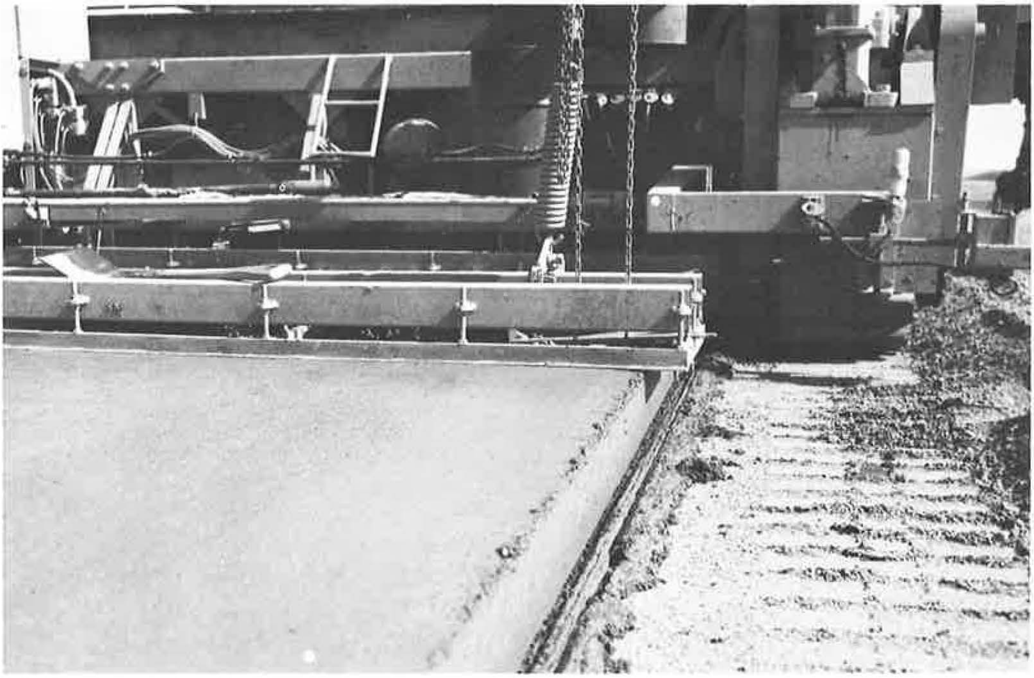

Figure 6. Rear view of slip-form paver.

Figure 7. Equipment for sawing longitudinal joint.

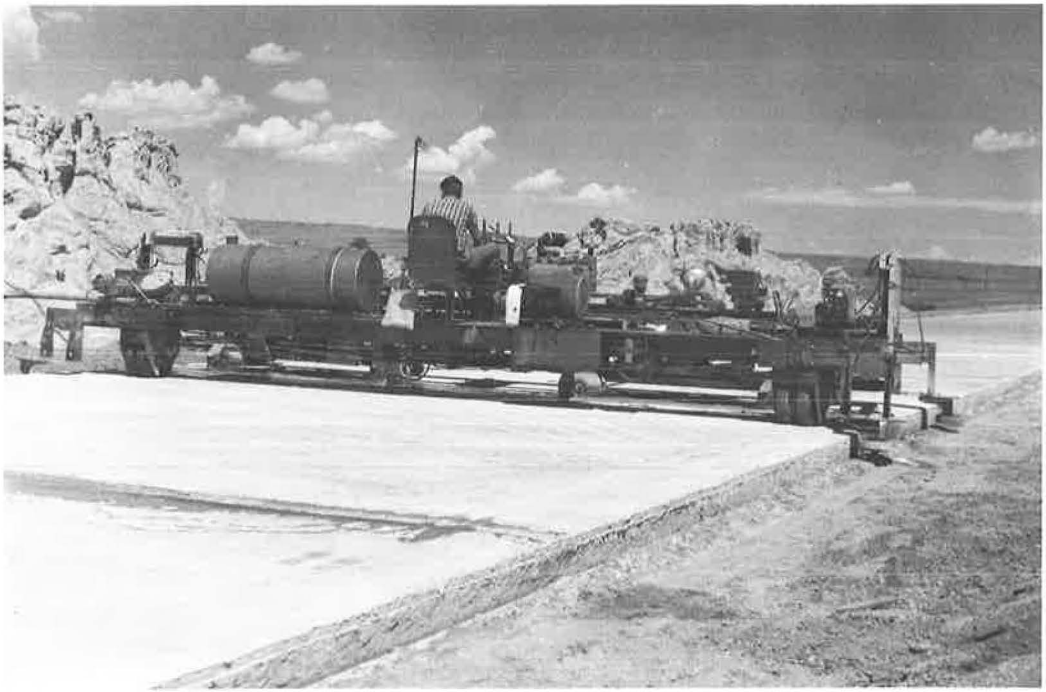

Figure 8. Equipment for sawing transverse joints.

A Clary rotating tube screed was also added to the paver together with a five-unit spray bar which was continuously in operation when the paver was moving. Vegetable-type spray nozzles were used for the spraying operation. The screed helped considerably in sealing surface voids and producing good finish. Final hand finishing consisted of straightedging and the use of paddle floats. An aluminum tube was then dragged along to provide a final finish and to seal surface voids. Texture was obtained by use of a burlap drag. Membrane curing compound was used to seal the pavement surface during the curing period.

It appears that a good specification for concrete density would be very desirable. We understand Oregon is using such a specification. The vibrators on the paver were reduced from 22 to 16 on a subsequent paving project in an adjoining state. We have found evidence of low concrete density in several test cores on different paving projects.

We are also wondering if we are working too much of the entrained air out of the concrete surface. Tests are presently under way to determine the entrained-air distribution in some concrete cores.

JOINTS

Specifications required sawed transverse and longitudinal joints, $\frac{1}{8}$ in. to $\frac{1}{4}$ in. wide and 2 in. deep (Figs. 7 and 8). The tranverse joints at 20 ft intervals are on a diagonal offset of 5 ft in the 24 ft width to reduce joint noise by permitting only one wheel to cross the joint at a time. All joints were to be filled with hot poured-type sealer meeting Federal Specification SS-S-164. During construction it was decided to omit sawing approximately 2 mi of the longitudinal joint and to place a 2-in. wide plastic strip. Accurate placement at first was difficult but was gradually accomplished. Where this strip was placed with its top edge near the pavement surface, a very neat joint resulted. If the plastic strip was placed above or below the concrete surface, a slight amount of spalling became evident. Test cores show that where the strip is properly placed, the joint was cracked cleanly through the 8-in. slab. This is not always true in the case of the sawed joints. We are permitting use of the plastic strip at the contractor's option on some additional projects to better determine its value. Its use can effect a substantial saving over the cost of sawing and sealing.

We are using ½-in. diameter, 24-in. long tie bars spaced 36 in. apart in our longitudinal joint. With a straight-line crown on the pavement we thought these bars might be eliminated. We believe they are sometimes responsible for longitudinal cracking in the lanes due to contraction in the 24-ft width. We are observing a section on which the tie bars were eliminated. There is some evidence of one slab being higher than the other through this section. A recent inspection indicates that the joint is opening more than desirable and probably will continue to do so. This leaves an opening for water to enter and can cause damage to the pavement if not kept sealed. Dowel bars have been eliminated from expansion joints but are still provided at construction joints. Approach slabs to bridges are reinforced and are tied to the concrete pavement. Normally, in continuous bridge deck construction, to avoid cracking of the bridge abutment, the approach slab is not tied to it.