construction of the transportation research center test track

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At the Transportation Research Center, located on 8,100 acres approximately 50 miles northwest of Columbus, Ohio, a test track was designed and constructed. The purpose of this paper is to describe the relevant and unique design and construction details of the base materials and portland cement concrete placed on the 7.5-mile-long loop of the test track. The paper also relates construction details and problems that eventually led to changes in the contract design.

•The Transportation Research Center was created by the Ohio General Assembly to permit extensive full-scale testing of both transportation hardware and novel ideas in the field of transportation. Details of the design and construction of the TRC test track follow.

DESIGN

Geometrics

The main loop of the TRC test track is 7.5 miles long, and the width ranges from 36 feet along the tangents to more than 47 feet in the curved areas. The tangents and curves are 1.89 and 1.86 miles long respectively (Fig. 1). The tangents are sloped to the inside at $^3/_{16}$ in./ft for the full width. The transition between the tangents and curves is accomplished with 2,300 feet of spiral. To accommodate design speeds approaching 140 mph required that extreme superelevation and a safety lane be provided in the curves. The degree of curvature for the end loops is 2 deg 23 min with superelevation in the middle of the curve varying from 0.127 at the low side of the pavement to 0.800 at the outside of the safety lane (Fig. 2). Because of the design, pavement surface in the curves appears to be concave or parabolic.

The track was designed with a longitudinal gradient of 2.28 feet per 1,000 feet, a differential in elevation of only 23 feet between the north and south extremes of the straightaways. The embankment in the loops provides nearly 18 feet of elevation variance between the outside edge and the corresponding inside edge.

Pavement

Pavement design criteria for the large loop and adjacent skid pad area far exceeded requirements of conventional PCC pavement design for public highways. The design single-axle load was 32 kips and 48 kips for tandem. The original design provided for a 10-in. plain PCC pavement with a 4-in. cement-treated base (CTB) in addition to a 4-in. aggregate subbase (Fig. 3). Pipe underdrains were provided at the inside edge

Figure 1. Schematic of large loop of test track.

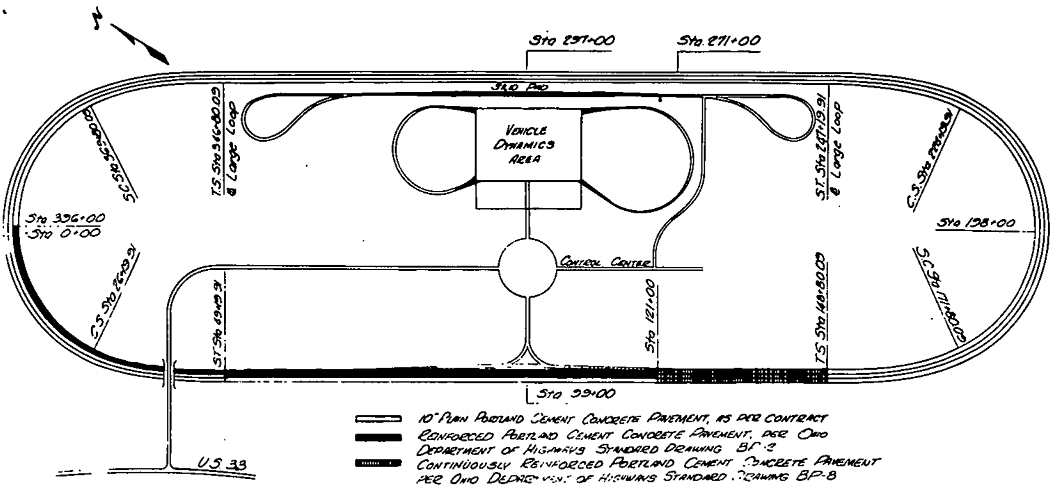
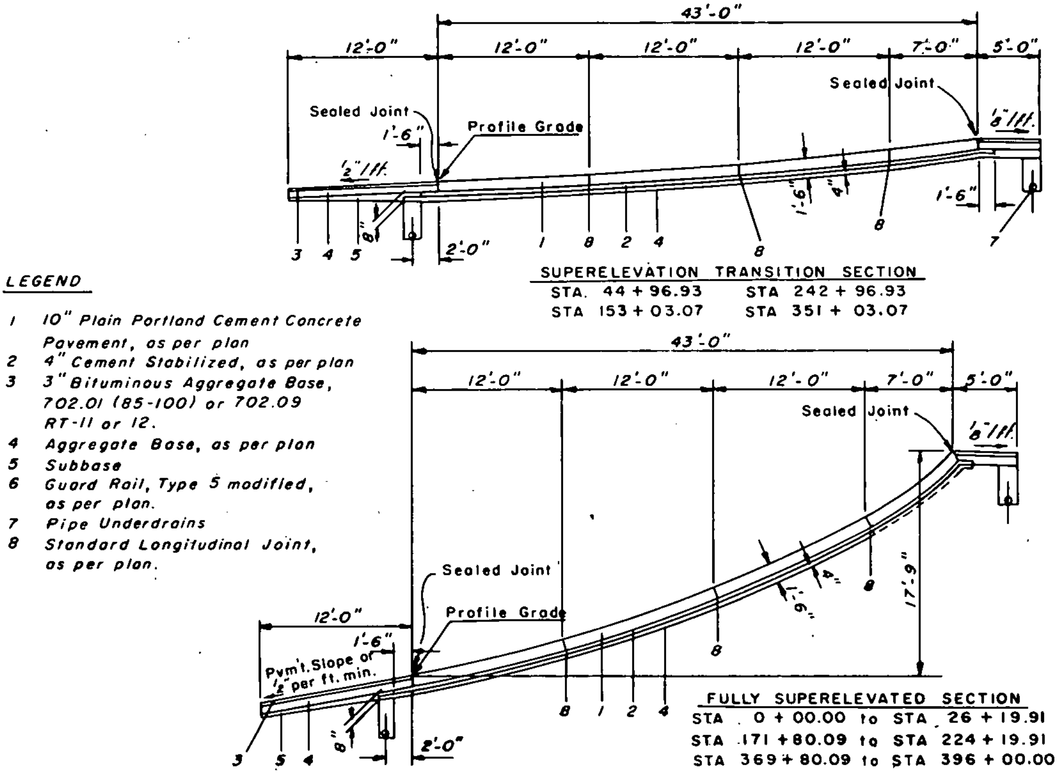


Figure 2. Superelevation of large loop.



of the pavement and on the outside edge in areas where excavation dictated and at the direction of the engineer.

The concrete pavement was designed with an 18-ft joint spacing. The design called for jointing of the slabs with 1¼-in. plastic-coated dowels. The ¼-in. contraction joint was sawed 2 in. in depth and sealed with a neoprene compression seal. Although subsequently changed, the original design of the longitudinal joint called for a premolded nonmetallic keyway to be placed for multilane construction or a formed keyway between separately placed lanes. This design required 27- by ⅝-in. deformed tie bars to be placed at middepth along 48-in. centers. The ¼-in. longitudinal joint also used a similar but smaller compression seal. As an aid in keeping water from entering between the pavement edge and the 3-in. bituminous aggregate shoulder, a liquid joint sealer was specified. For this purpose, the design specified a joint not less than 2 in. deep with a minimum width of ¼ in. in which a conventional hot- or cold-applied joint seal would be placed following pavement and shoulder construction.

As stated previously, the original design specified that the large loop be constructed with unreinforced, doweled PCC pavement. Subsequently, however, TRC officials recommended that a segment of the large loop be constructed with varying degrees of reinforcement. For several years Ohio State University has been researching and developing a prototype automobile with an electronic guidance system. In the operational phase of development of this automated vehicle, it became apparent that the degree and location of reinforcement could affect its performance. With this in mind, we decided to use the test track facilities to conduct further research and tests of the vehicle under varying pavement design techniques.

Ultimately it was agreed to incorporate three variations using reinforcement (Fig. 1). On one test section in the north curve for 4,920 feet, conventional 54-lb mesh would be placed on the CTB on the 12-ft inside lane. The second test area included the adjacent west tangent in which the same reinforcement would be placed within the PCC pavement on the inside 24 feet of roadway for a length of 7,180 feet.

With this arrangement the 24-ft pavement was constructed with transverse contraction joints placed at 36-ft intervals. The adjoining and tied 12-ft lane was built according to the original design. The third test section included the remaining segment of the west tangent. The design for this 2,780-ft segment called for the placement of 10-in. continuously reinforced concrete (CRC) pavement for the full width of 36 feet. The CRC pavement incorporated deformed wire fabric amounting to 0.612 percent of the pavement cross section.

CONSTRUCTION

Subgrade and Subbase

The subgrade was constructed in accordance with currently available construction techniques. The soil subgrade was prepared in accordance with the Ohio Department of Transportation's (ODOT) Construction and Material Specifications. Soils with a minimum laboratory dry weight of 100 lb/ft^3 were required. The subgrade was compacted to a depth of 12 in. with a density stipulation that compaction be not less than 100 percent of maximum dry density as determined by AASHO T-99.

The subgrade on the tangents was trimmed by using combinations of a CMI Autograde and a motor grader. To obtain the desired cross section required in the grading contract, we used a D8 dozer and grader. The grader, supported by the dozer, made successive passes down the slope and trimmed the surface to grade (Fig. 4). The contractor tentatively plans to use a Gradall to cut the final subgrade. On the curves the surface of the final subgrade and base will be finished to a series of chords rather than the more typical curved template. The contract states that all specified minimum thicknesses must be met, and any additional base or concrete required for this procedure will be furnished at no additional cost.

A 4-in. aggregate base was placed and compacted on the soil subgrade. This material met the following grading requirements:

Sieve Size	Percentage Passing
2 inch	100
1 inch	70-90
$^3/_4$ inch	50-85
No. 4	25-60
No. 40	7-30
No. 200	0-10

Crushed gravel containing a minimum of 90 percent fractured pieces was the aggregate.

At the beginning of the compaction operation a test section was placed to establish the maximum density of the material to be used. With the granular material at or near the predetermined optimum moisture, the degree of compactive effort was established. Thereafter, the remaining material to be placed was compacted to not less than 98 percent of the test density. The maximum dry weight for the material used was 129 lb/ft^3.

On the west tangent the contractor placed the subbase for a width of 28 feet and then followed this with a 12-ft add-on section by using a conventional dozer-attached spreading box. The box spreader was used solely on the east tangent. The subbase was compacted with a vibrating roller and then trimmed with a CMI and grader. The finished surface of the completed subbase was required to fall within a $^3/_8$-in. tolerance after the grade was checked with a 10-ft straightedge applied parallel to the centerline.

Cement-Treated Base

The immediate underlying support for the PCC pavement was a 4-in. blanket of cement-treated base. The CTB specification required that the aggregate consist of durable particles of limestone, slag, gravel, or sand and be free from injurious amounts of shale, clay lumps, and organic impurities. Pit-run or crushed-run material, commercially sized materials, or a combination was permitted. The material was required to contain a minimum of 25 percent between the No. 10 and No. 200 sieves, and the plasticity index could not exceed 12. The aggregate proposed for use was well graded and had a high percentage (90 percent and above) of fractured pieces and a low percentage passing the No. 200 sieve.

Table 1 gives the grading requirements along with a typical grading reported by the ODOT testing laboratory.

Based on the materials to be used, our laboratory determined the quantity of cement that would be required to obtain a minimum strength of 400 psi in 7 days. The laboratory specimens conformed to the size designated in AASHO T-134. Although it was possible to obtain the desired strength with less than 5 percent cement by weight, it is an established procedure not to reduce the cement content below this figure because of the large number of freeze-thaw and wet-dry cycles encountered in Ohio.

The laboratory determined the density of the combined cement aggregate mixture to be 136.6 lb/ft^3 with an optimum moisture of 8.6 percent. The specification for the CTB required that, after the mixture had been placed, it be compacted to 95 percent or more of the maximum laboratory density as determined in accordance with AASHO T-134, Method B. The combination of cement, aggregate, and water could not be left undisturbed for more than 30 minutes. In addition, at the start of compaction, the percentage of moisture in the aggregates based on oven-dry weights was not to be below optimum nor more than the amount that would cause the CTB to become unstable during compaction and finishing. Compaction was to be completed within 2 hours after water was added to the mixture.

In addition to using the specially designed and fabricated Gunnert-Zimmerman slip-form equipment to place the concrete pavement, the contractor wanted to use this same equipment for placing and compacting the CTB in one operation. This procedure would ultimately lead from a minimum placement width of 39 feet to a maximum of 50 feet in the curves.

The CTB was mixed in a 9-yd^3 Rex central mix concrete plant located within ½ mile of the west tangent. One batch of plant mix yielded approximately 14.5 tons of total mixed materials. The aggregate dry weight was approximately 24,700 lb to which 1,240 lb of cement and 3,500 lb of 420 gallons of mix water were added. The actual amount of water required depended on the moisture content of the aggregate being used. As one can see the percentage of moisture in the mixture based on the dry weight was quite high. This will be explained.

As noted previously the contractor had wanted to use the Gunnert-Zimmerman Slip-form equipment to place the CTB. On the first day of placement, many possibilities and few reservations about the capabilities of the slip-form procedure in general were revealed. It was the intent to place the CTB at the lowest possible moisture content and yet obtain the desired density. Although the plant was capable of producing a continuously uniform mixture at or slightly above optimum, the paver could not compact a properly finished surface. The density could be obtained, but the surface was beset with irregular deep striations and an unacceptable surface. A Gunnert-Zimmerman representative who had operated this equipment for similar base placement elsewhere noted that successful performance could be obtained with higher moisture levels.

After several hundred feet and an unsatisfactory end result the moisture content of the mixture was increased. The desired workability was obtained by increasing the percentage of moisture to approximately 14 percent. The adjusted mix was closely observed to determine the effect of higher water content on density. As expected, the field tests showed a notable reduction in density as moisture increased. Although density was reduced, the minimum requirements of 140.9 and 129.8 lb/ft^3 for wet weight and dry weight were obtained. Because of the increased water-cement ratio, there was concern about obtaining the ultimate design strength. The resulting CTB appeared plastic and in effect had the consistency of low-slump concrete. Because of the nature of the mixed materials, cylinders were cast to gather information on compressive strength. Conventional 6-in. concrete cylinder molds were used in lieu of the standard 4- by 4.5-in. specimen. Cylinders were cast and then broken at 1-, 4-, 5-, and 8-day intervals (Table 2). The initial breaks after 1 day of cure appeared low; but, given the low cement factor (approximately 2 sacks/yd^3), early handling of specimens, and large L/D ratio, high early strengths were not expected. The cylinder strengths following moist curing over a weekend nearly doubled, which was encouraging. The averages for four cylinders at the 4- and 5-day intervals were 172 psi and 191 psi. Two cylinders broken after 8 days of cure averaged 218 psi.

The plastic CTB was transported to the test track site in triaxle dump trucks in batches of about 7.5 yd^3. The CTB was discharged onto a belt spreader attached to the slip-form equipment (Fig. 5). Five sensors, operated by two taut wire lines, provided the horizontal and vertical controls for the paver. The spreader was designed to place the base for the full width. The base in the tangent is 39 feet wide and widens to approximately 50 feet in the loops. The mixture was deposited uniformly in front of the paver, consolidated with spud vibrators spaced at 18-in. centers, confined, and then extruded. No oscillating screeds were used in the finishing process. The extruded CTB was dense and homogeneous and had the appearance of a neatly placed and well-formed PCC pavement slab

Figure 3. Pavement design.

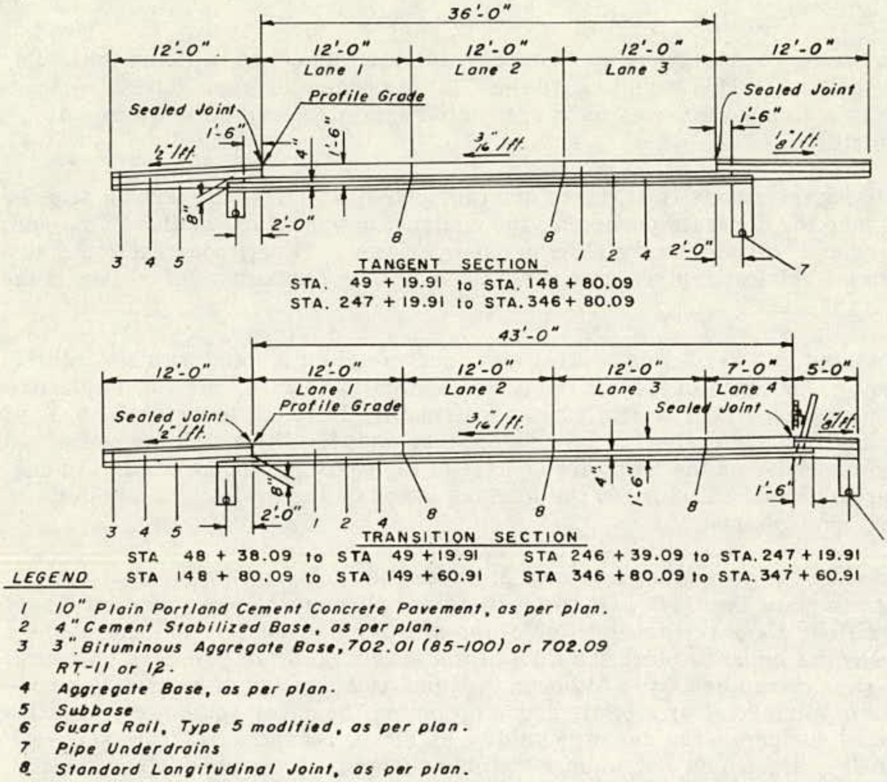


Figure 4. Preparing rough subgrade on curve.

Table 2. Compressive strength, in psi, of cylinder specimens.

	5 Percent Cement		7 Percent Cement	
Age	Individual	Average	Individual	Average
1	85 99	92	—	—
4	170 173 170 173	172	375 378	377
5	195 202 184 184	191	—	—
8	216 219	218	576 580	578

Table 1. Grading requirements of the CTB material.

Sieve Size	Specified Gradation, Percentage Passing	Typical Gradation, Percentage Passing
1-inch	100	100
$\frac{3}{4}$-inch	—	100
$\frac{1}{2}$-inch	—	97
$\frac{3}{8}$-inch	—	88
No. 4	55-100	67
No. 10	37-100	49
No. 40	—	20
No. 200	5-35	10

Figure 5. Placement of CTB.

(Fig. 6). The brown color and the 4-in. thickness were the only notable differences. Placement of the CTB reached a maximum production of 3,400 feet per day with an average daily rate of 2,300 feet. The contractor's personnel consisted of a superintendent, foreman, operator, oiler, and five laborers.

The mix design, density requirements, strength considerations, and problems in placing were resolved. However, one additional problem arose. Following placement of the first day's run, an unusual amount of transverse cracking was detected at the surface of the CTB. The CTB had to be maintained in a moist condition before the RT9 or RT10 curing material was placed. The specifications require that the tar be applied at a rate of 0.3 gal/yd^2 with a cover sand to be placed at a rate of 0.005 yd^3/yd^2. The cracking became apparent before the tar was applied. The cracks were irregularly spaced hairlines, 10 to 15 feet apart. Some areas depicted clumps of closely spaced cracks, 2 to 5 feet apart. The cracks did not open up and could not be detected through the curing material once it had been placed. It should be pointed out that because of the dense, satin type of finish of the plastic CTB any cracking was readily apparent. It was our position that, although the cracking might not affect the performance of the base, every effort should be made to reduce it to a minimum.

To maintain a better moist cure before the tar was applied, we decided to increase the cement content; this procedure is supported by data from the Portland Cement Association's Soil Cement Laboratory Handbook. A change from 5 to 7 percent was made. The additional cement reduced cracking immensely, and in most areas cracking could be detected only at intervals of several hundred feet. To determine the strength gain contributed by the additional cement, we cast 6- by 12-in. cylinders from the plastic CTB on the day the design was changed. Two cylinders were broken at 4 days and two cylinders at 8 days (Table 2). Despite the limited number of samples, there was good indication that the strength gain was considerably greater than the 5 percent design. After the field evaluation and examination of the test results, we decided to proceed with the higher cement factor.

To test the strengths of the CTB, we extracted two cores from the base on each of the first 3 days after the mix design was modified. The cores were approximately 3.5 in. in diameter, were cut to the full depth of the base, and were broken at 28 days. The 28-day strengths ranged from 620 to 910 psi with an average of 730 psi.

As noted previously, the specifications required that the CTB be cured and protected with the application of RT9 or RT10. Because difficulties in placing this material and the cover sand on the steep slopes of the curves were anticipated, as was the task of setting dowel baskets on the steep inclines, the contractor suggested applying a concrete curing membrane in these areas. Several years ago, on an Ohio highway project a test area of CTB was cured with white-pigmented concrete curing membrane applied at 200 ft^2/gal, and the results showed a 15 percent increase in strength at an age of 11 days; at 100 ft^2/gal, there was an increase of 49 percent. The comparison was made with adjacent areas cured with bituminous material.

Before any judgment was made on his suggestion, the contractor was asked to conduct a test installation on the skid pad area. A 365- by 39-ft test section of CTB was constructed on which the white-pigmented curing membrane was sprayed at a rate of 150 ft^2/gal. Subsequently, six cores were cut from the membrane-treated section and a like number from the adjacent area treated with tar. The two sections were placed on the same day, and cores were cut 7 days after placement. Three cores from each group were then broken in compression on the 7th day, and the remaining cores were placed in moist cure before breaking on the 28th day. The resulting data are given in Table 3. The compressive strengths at 7 days indicated that the membrane-cured base had a 39 percent greater strength; however, the remaining two sets of cores after an additional 21 days of moist curing revealed a noticeable change in the strength gain as compared to an 18 percent gain with the membrane-treated cores. After longer moist curing the tar-treated cores showed a comparable but greater strength average.

Portland Cement Concrete Pavement

The concrete mix design for the PCC pavement included many items of interest. The cement factor was reduced from Ohio's standard for PCC pavement of 611 to 564 lb/yd^3. It was determined that the cement content could be lowered and the desired strengths would be obtained if an aggregate with a very good performance record were used. With this in mind a crushed dolomite stone from the Ohio Guelph or Greenfield ledges was specified. This coarse aggregate had a nominal top size of 1 in. and met the grading requirements of AASHO M-43, size No. 57 (Table 4). The fine aggregate met the grading given in Table 4 and, in addition, was a natural sand containing not less than 50 percent silica dioxide as determined by ASTM Designation C 146. Materials were proportioned in accordance with the American Concrete Institute's standard designation ACI 613. The concrete mixture design was based on a slump of 2 in. ± 1 in. with a water-cement ratio not exceeding 0.49. The air-entraining agent was sufficient to maintain an air content of 7 ± 1 percent.

The contractor chose a private test laboratory to design the mixes based on approved materials from the sources he had selected. During the laboratory testing and evaluation program, supplemental trial mixes were prepared that incorporated a water-reducing agent. The purpose of this testing was to determine whether the use of this chemical admixture would enhance the workability of the concrete. Of particular concern to the contractor was the ultimate task of having to place and finish low-slump concrete on the very steep circular curves. The laboratory evaluation indicated that 1.25-in. slump concrete with a water-reducing agent gave the same degree of workability as the standard concrete mixture with a 1.75-in. slump. Based on these findings the contractor elected to use a water-reducing chemical admixture meeting the requirements of ASTM C 494 for all concrete placed in the curves of the large loop.

The trial mix with a uniform slump of 1.75 in. and an air content of 7.75 percent produced 7- and 28-day compressive strengths for the conventional concrete mix of 3,870 and 5,670 psi respectively. Correspondingly, with a 1.25-in. slump, 7.75 percent air content, and a 3.7 percent reduction in mix water the admixtured concrete gave compressive strengths of 3,710 and 5,650 psi at the same respective curing periods. The trial mix design was the basis not only for establishing a proper yielding mixture but also for obtaining a good workable mix. Slight variations were made in the field to correct for minor changes in specific gravity. The typical mix design for the concrete placed in the tangents and skid pad areas is as follows:

Material	Quantity/Cubic Yard
Type I cement	546 lb
Coarse aggregate	1,660 lb
Fine aggregate	1,280 lb
Water	31 gal
Air-entraining agent	15 oz
Water-reducing admixture	36 oz

Immediately following placement of the CTB, the contractor made the necessary modifications in the Gunnert-Zimmerman slip-form equipment and proceeded to place the 10-in. PCC pavement. The contractor decided to first complete the base on the west tangent and then to pave that 10,000-ft section.

The west tangent included two of the variations in reinforcement. After the CTB was completed on the west tangent, reinforcement at the north end was begun. The revised plans called for placing conventional 6- by 12-ft (54 lb/100 ft^2) wire fabric. The reinforcement for this section of pavement was positioned on supporting continuous chairs so that it would be approximately 4 in. below the surface (Fig. 7).

Figure 6. CTB after extrusion behind slip-form paver.

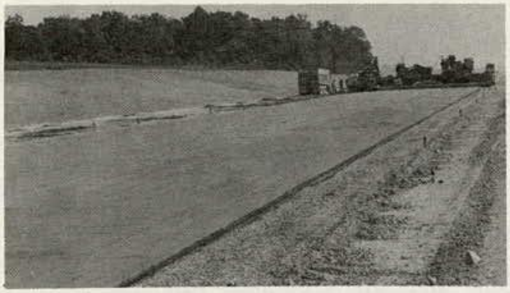


Table 4. Concrete aggregate gradations.

Sieve Size	Percentage Passing Fine Aggregate	Coarse Aggregate
1½-inch		100
1-inch		95-100
¾-inch		—
½-inch		25-60
⅜-inch	100	—
No. 4	95-100	0-10
No. 8	70-95	0-5
No. 16	45-80	
No. 30	25-60	
No. 50	10-30	
No. 100	1-10	
No. 200	0-4	

Figure 8. Placement of concrete on west tangent.

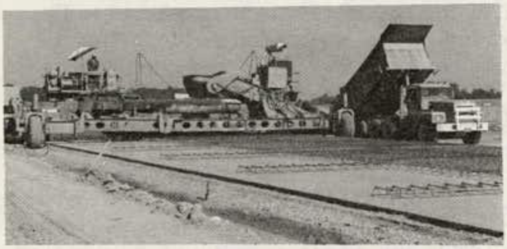


Figure 10. Placement of PCC pavement on CTB.

Table 5. Concrete test data.

Tests	Range	Average
Slump, in.	1.25-2.50	1.72
Air, percent	6.3-7.8	7.1
Compressive strength, psi		
Cylinders, 7 days	3,200-5,000	4,100
Cylinders, 28 days	5,300-7,700	6,700
Beams, 5 days	660-930	780

Table 3. Compressive strength of CTB cured with RT9 and concrete curing membrane.

Cure	Core No.	Age (days)	Compressive Strength (psi)	Average
RT9	1	7	460	
	2	7	470	
	3	7	540	490
	4	28	860	
	5	28	780	
	6	28	1,040	890
Membrane	7	7	620	
	8	7	770	
	9	7	660	680
	10	28	800	
	11	28	850	
	12	28	740	800

Figure 7. Supports for reinforcement, dowels, and tie bars.

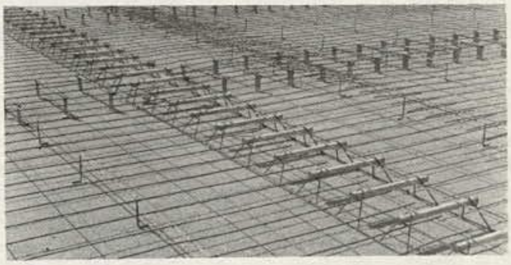
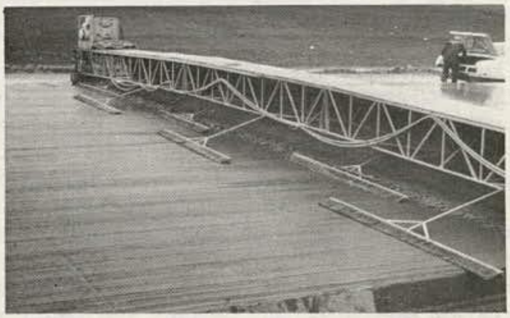


Figure 9. Nailing of supports for tie bars at 1-ft intervals.

Figure 11. Final finish: longitudinal texturing.



From the north for 7,180 feet, the inside two lanes (24 feet) required this type of reinforcement. The outside lane (12 feet) was placed according to the original plan (Fig. 8). In this length of pavement all lanes of pavement were tied together. The original plan specified not only that the lanes would be tied, but also that all adjoining lanes would require a keyway between them. It was the intent that preformed material be used to accomplish this for multilane construction. The consultant was asked to reevaluate this design because of anticipated construction difficulties in multilane placement. An alternate proposal was made. Instead of the original design, keyways could be eliminated if the tie bars were placed at 12-in. centers. A keyway with hook bolts at 30-in. spacing was used in longitudinal joints where adjacent lanes might be placed in separate operations. The contractor positioned the tie bars on chairs so that they would be at middepth in the slab. Initially each tie bar was supported by two chairs fastened to the CTB with 2-in. nails. The supports were nailed to the CTB with a compressed-air-actuated gun (Fig. 9). Problems of movement during placement of concrete caused the contractor to position the tie bars by using preassembled wire baskets.

The contraction joints in this reinforced section were spaced at 36 feet. With this arrangement the adjoining plain pavement with 18-ft joint spacing would have corresponding joints every 36 feet. The contraction joints were connected by plastic-coated dowels supported by wire baskets. The dowels were 1¼ in. in diameter and 18 in. long and were coated with a 4-mil adhesive undercoating and 17-mil surface coating of high-density extruded polyethylene plastic. This coating is expected to provide sufficient protection to prevent corrosion of the dowel bars. The dowel baskets were positioned to hold the dowels parallel to the surface and then fastened by driving ½- by 18-in. pins through the CTB. Again it was necessary to use a compressed-air-driven tool to accomplish this task.

After sufficient lead time was obtained with the mesh, tie bar, and dowel basket installation, the contractor started placing concrete at the north end of the west tangent. The concrete was mixed in the same central plant that mixed the CTB. The 9-yd^3 batches were mixed for 60 seconds and then deposited into triaxle trucks with open top carriers and rear-mounted discharge chutes. After the concrete was transported to the paving site, it was discharged onto a belt spreader, which was an integral part of the slip-form equipment. One segment of the belt spreader was mobile and could move laterally across the pavement and distribute the concrete uniformly in front of the slip-form paver. The diesel-powered paver distributed the concrete with rotating augers and then consolidated the mass with vibrators spaced at 18-in. intervals for the full 36 feet of pavement width (Fig. 10). Following the high degree of consolidation the concrete was formed to the desired dimensions and extruded without the aid of any additional oscillating screeds. The resulting product required little additional hand finishing. The only powered equipment trailing the paver was a self-propelled rubber-tired bridge that was necessary for imparting the required longitudinal texture (Fig. 11). The desired texture depth of $^1/_{16}$ in. was obtained by dragging burlap and plastic-bristled brooms attached in combination behind the bridge. After the texturing operation, the concrete was cured with a white-pigmented membrane applied at a rate of 175 ft^2/gal. The personnel at the paving site on a typical day consisted of a superintendent, foreman, operator, oiler, three concrete finishers, and five laborers.

Construction of the combined plain and conventionally reinforced pavement on the west tangent required 7 days. The first 3 production days were marred with operational problems. The most recurring situation seemed to be the movement of wire fabric and longitudinal tie bars immediately ahead of the paver. As the paver moved forward with a head of concrete, the fabric tended to creep and buckle. This forced the reinforcing out of proper vertical position and across the contraction joints. This situation required that paving be stopped and corrective action be taken. This problem was overcome by driving iron pins to restrain this movement. Two rows of three pins each were driven for each mat of fabric. These pins were positioned at the end of the fabric nearest the paver; and, at laps, only the forward mat was restrained. By doing it in this fashion any slight movement of the reinforcement would not result in buckling. Once these problems were overcome, production averaged more than 1,900 feet per day excluding 1 day of shutdown due to rain.

Often at the completion of a day's run, the contractor employed a unique procedure for obtaining a construction joint. Instead of placing the conventional type of wood or metal bulkhead over the dowel basket assembly and fastening it to grade, he elected to pass slightly over the proposed construction joint with the paver and then return later in the day, saw over the midpoint of dowels, and carefully remove the concrete over that portion of the dowel assembly that would become part of the forward slab to be placed when paving resumed. As an aid in the removal, heavy polyethylene sheeting was placed over the dowels and base where concrete would subsequently be removed. It was the contractor's desire to develop this technique on the tangents to gain experience and then to employ the same procedure on the concave surface in the curves.

Following completion of the first 7,180 feet of the plain and reinforced pavement, the contractor proceeded to place the last 2,780 feet of 10-in. CRC pavement for the full 36-ft width (Fig. 1). A 14- by 10-in. wide flange beam was embedded into a 10-in. sleeper slab, and this acted as the joint between the previously placed pavement and the CRC pavement. One-in. styrofoam material was placed against the web of the beam and polyethylene at the surface of the sleeper slab to permit movement of the CRC pavement. As in the area of jointed reinforced pavement, the contractor again positioned the deformed wire fabric on supporting chairs. The requirements for the longitudinal joints remained the same, and there were no variations in construction. Placement of concrete required 2 days and proceeded very smoothly.

Immediately following completion of paving on the west tangent, the paver was moved to the east tangent and the CTB was placed. Paving commenced again in 3 weeks. The east tangent contained no pavement design variables and was constructed as plain 10-in. PCC pavement with contraction joints at 18 feet. All the original design concepts were included. With the exception of several scattered days of rainy weather, construction of the east tangent proceeded in straightforward fashion. The best day produced 2,050 feet, and the average full day amounted to approximately 1,500 feet.

Field Test Data

Table 5 gives a summary of the concrete test data taken from field and laboratory records for the pavement placed during 1972. Forty cores were taken after completion of the two tangents to determine compliance for design thickness. The cores ranged from 9.5 to 10.7 in. with an average thickness of 10.0 in. After the thickness measurements were made, the cores were capped and broken. The average age at testing was 4.1 months, and the average compressive strength was 6,600 psi. As can be seen from Table 5 the compressive strength of the cylinders at 28 days is slightly greater than that of the pavement cores broken 3 months later.

A similar relationship was determined after the concrete was sampled and cylinders and cores that were specimens from the last 2 days of paving were tested. Four pairs of cylinders and eight cores were obtained to determine the variation in strength, if any, between cylinders and cores of the same age and sampled at the same location. All the cores were extracted on the 5th day of cure and shipped to the laboratory. Four were broken on the 7th day, and the rest were moist cured for the remaining 21 days. The cylinders were brought to the laboratory 2 days prior to testing. Again one-half were broken at 7 days and the remaining at 28 days. The results revealed average cylinder strengths of 4,490 and 7,030 psi at 7 and 28 days. Correspondingly, the cores were 3,000 and 5,020 psi. These data show that the cylinders exhibited 50 percent greater strengths at 7 days and 40 percent greater at 28 days. Although past research has indicated such strength variations between cores and cylinders, there was feeling that, with the high degree of consolidation or densification induced by this slip-form equipment, this strength gap would be significantly reduced.

Because of weather and field conditions there were no roughness index data to include at the time of this report. The overall riding quality is good and roughometer data should eventually bear this out.

Because of very poor weather during the fall paving season, hope of paving the end spirals and curves was dropped. The contractor, however, was able to place the CTB for the skid pad and initiate a few days of paving in that area.

The most challenging task lies ahead when the contractor must face an assignment that seems insurmountable. Nearly 1,000 man-hours will be required to widen the form line of the slip-form paver to approximately 50 feet in order to place the 4-in. CTB and 10-in. PCC pavement on the curves with a vertical grade differential of nearly 18 feet.