2. L. W. Teller and H. L. Bosley, "The Arlington Curing Experiments," *Public Roads*, Feb. 1930
3. E. C. Sutherland and S. W. Benham, "Experiments with Continuous Reinforcement in Concrete Pavements," *Public Roads*, Jan. 1940, see p. 206
4. H. W. Giffin, "Transverse Joints in the Design of Heavy Duty Concrete Pavements," *Proceedings* Highway Research Board, Vol. 23 (1943)
5. C. A. Hogentogler, "Economic Value of Reinforcement in Concrete Roads," *Proceedings*, Highway Research Board, Vol. 5 (1925)
6. Hogentogler and Willis, "Functions of Steel Reinforcement in Concrete Pavements and Pavement Bases," *Proceedings* Highway Research Board, Vol. 11 (1931)
7. Cashell and Benham, "Experiments with Continuous Reinforcement in Concrete Pavement. A Five-Year History," *Proceedings* Highway Research Board, Vol. 23 (1943)

PRELIMINARY REPORT ON CURRENT EXPERIMENT WITH CONTINUOUS REINFORCEMENT IN NEW JERSEY

William Van Breemen

Engineer of Special Assignments, New Jersey State Highway Department

SYNOPSIS

In the fall of 1947 two sections of continuously-reinforced concrete pavement were constructed on New Jersey Route 25 between Hightstown and Cranbury. This section of highway carries a considerable volume of heavy truck traffic. The northerly section is 5430 ft. long, of 8-in. uniform thickness, and contains 0.90 percent of longitudinal reinforcing steel. The southerly section is 5130 ft. long, of 10-in. uniform thickness, and contains 0.72 percent of longitudinal reinforcing steel. The project also included the construction of a series of experimental slabs 187 ft. in length having an additional amount of longitudinal reinforcing steel within their central portions.

Reference lines were established to determine the magnitude of subsequent longitudinal movements of the ends and interior portions of the continuously-reinforced sections. Numerous gauge points were installed to subsequently determine: (1) the widths of cracks; (2) changes in the lengths of various parts of the sections; (3) changes in the widths of all transverse joints, and (4) the amount of opening of the longitudinal joints. Series of gauge points were installed in the 187-ft. slabs to determine the changes in length of various parts of the slabs during expansion and contraction. Levels were taken in several locations to determine the amount of subsequent changes in pavement elevation.

This paper pertains primarily to the details of the design, materials employed, construction procedures, and incidental research. Data pertaining to behavior during construction and early life are included.

It appears needless to elaborate on the fact that the joints in the conventional design of concrete pavement constructed in the past have been a major contributing cause of various kinds of serious difficulties. Although very definite improvements in the design of joints and other incidental pavement features appear to have been made in recent years, the joints nevertheless remain as points of weakness. This situation has provoked thought as to whether, by means of installing a sufficient quantity of longitudinal reinforcing steel, a successful concrete pavement could be constructed that, in effect, would be continuous throughout. The design of pavement that has evolved from this line of thinking is commonly called "continuously-reinforced". The outstanding features of this design are:

1. The installation of a substantially greater amount of longitudinal reinforcing steel than is installed in pavements of conventional design.

2. The continuation of the longitudinal reinforcing steel through the construction joints that occur between the successive sections of pavement constructed from day to day. These successive sections are, therefore, securely fastened together by the reinforcing steel passing through the construction joints and collectively tend to function in the same way that the pavement would have functioned had it been constructed in one continuous operation.

3. The complete omission of intermediate transverse joints of any kind other than construction joints.

It appears that for a design of this kind to be successful a sufficient amount of longitudinal reinforcing steel must be installed to enable the steel to accomplish two things.

1. Compel the occurrence of transverse cracks at very close intervals.

2. Prevent the opening of all cracks and construction joints to the extent that they have no detrimental effect.

Unfortunately, because of the unknown effects of the many factors involved, it appears impossible at present to calculate with any degree of certainty the minimum quantity of reinforcing steel required to cause these results. Expressed in terms of the cross-sectional area of the longitudinal steel as compared with the cross-sectional area of the pavement, estimates of the required amount of steel vary from 0.5 percent to one percent, depending upon the assumed tensile strength of the concrete and the steel. In actual practice, however, a substantially lower percentage of steel may prove adequate. For this reason, and for the reason that a successful pavement of this design would have several meritorious features not inherent in concrete pavements of conventional design, two experimental sections of continuously-reinforced concrete pavement, each section being approximately one mile long, were recently constructed in New Jersey.

TABLE 1
SUMMARY
TRUCK WEIGHTS AND LOADOMETER SURVEY
CRANBURY TO HIGHTSTOWN
1947

	Trucks	%
Total Trucks	2844	100
5 Tons and over	2622	92
10 Tons and over	2101	74
15 Tons and over	1510	53
20 Tons and over	1061	37
25 Tons and over	463	16
30 Tons and over	155	5½
35 Tons and over	51	1¾

	Axles	%
Total Axles	8000	100
2 Tons and over	7480	93½
4 Tons and over	4325	54
6 Tons and over	3215	40
8 Tons and over	2440	30½
10 Tons and over	1442	18
12 Tons and over	391	5
14 Tons and over	97	1¼
16 Tons and over	20	¼

Notes:
Average daily volume of traffic, both directions, is 7303
Average daily truck traffic, both directions, is 2844.
These tables are tentative and are subject to revision.
They are the direct relationship between trucks weighed and trucks counted and do not include any adjustment for the type of vehicle.

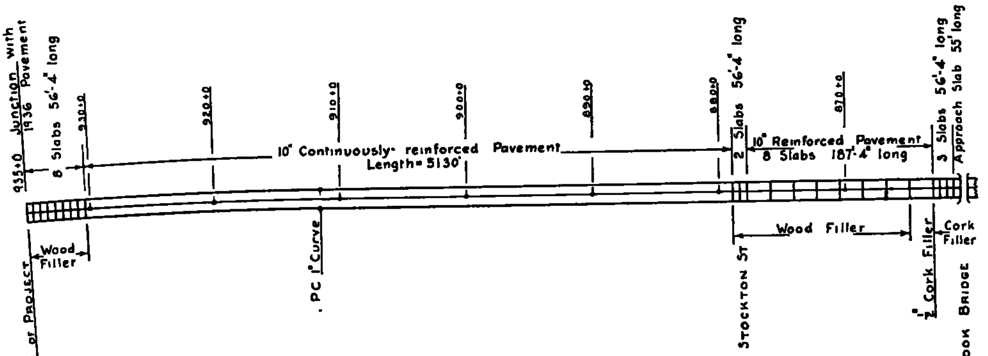
GENERAL DESCRIPTION OF PROJECT

In August 1947 a contract was awarded for the dualization of a section of New Jersey Route 25 between Hightstown and Cranbury. This section is 2.63 mi. long. Route 25 is one of the major highways running north and south through New Jersey and carries much of the heavy trucking that is done between the metropolitan areas of New York and Philadelphia and points north and south. Data relative to the present truck traffic at the location of this project are given in Table 1.

This section was laid out as a divided highway in 1936, but only the paving of the southbound roadway was completed at that time. In 1938 the north-bound roadway was graded, but remained unpaved until this project was undertaken.

Figure 1 shows a general layout of the southerly section. This section is 5130 ft. long, of 10-in. uniform thickness, and has 0.72 percent of longitudinal reinforcing steel.

Figure 2 shows a general layout of the northerly section. This section is 5430 ft.



NOTES

All pavement shown above is 10" reinforced concrete, 24' wide, constructed in two 12' lanes. The longitudinal joint between the lanes has a keyway, but no filler or tie bars.

All pavement is of uniform thickness

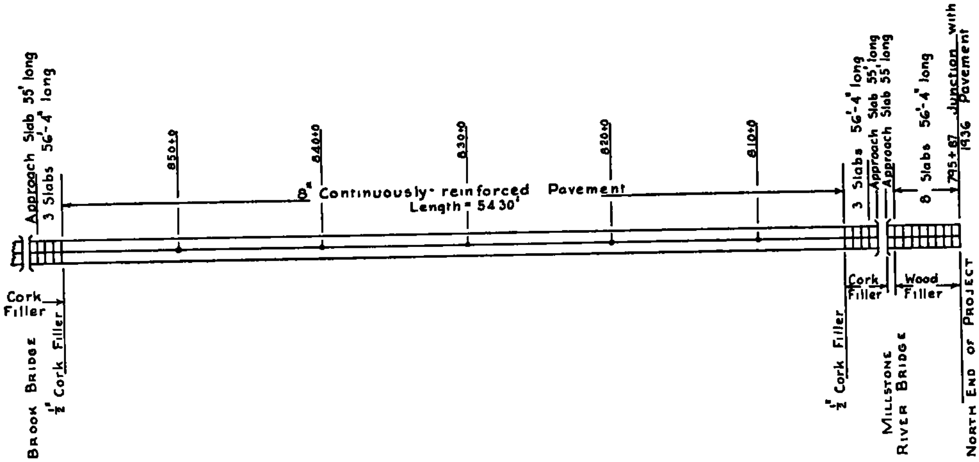
The joints between all slabs and sections of pavement are expansion joints having wood or cork filler, as indicated No other kind of joint was installed, except that the 55' bridge approach slabs have intermediate warping joints spaced 10' apart

Except in the joints indicated above, and except for the 2" cork that was installed between the bridge deck and the approach slab, wherever cork filler is shown, the thickness of the filler is 1"

The wood fillers indicated above are cypress, ¾" thick

Except immediately adjacent to bridges, all expansion joints have 1¼" round dowels, 17 11/16" long, partly encased in monel tubing, 12" center to center

Figure 1. General Layout of Pavement—Southerly Section



NOTES

All pavement shown above is reinforced concrete, 24' wide, constructed in two 12' lanes The longitudinal joint between the lanes has a keyway but no tie bars or filler

All pavement, except the 8" continuously-reinforced section, is of 10" uniform thickness The 8" continuously-reinforced section is of uniform thickness, except that, at each end there is a uniform transition in thickness from 10" to 8" within a distance of 30'.

The joints between all slabs and sections of pavement are expansion joints, having wood or cork filler, as indicated No other kind of joint was installed except that the 55' bridge approach slabs have intermediate warping joints spaced 10' apart

Except immediately adjacent to bridges, all expansion joints have 1¼" round dowels, 17 11/16" long, partly encased in monel tubing, 12" center to center

Except for the 2" cork that was installed between the bridge deck and the approach slab, or otherwise noted, wherever cork filler is shown the thickness is 1"

All wood fillers are cypress, ¾" thick

Figure 2. General Layout of Pavement—Northerly Section

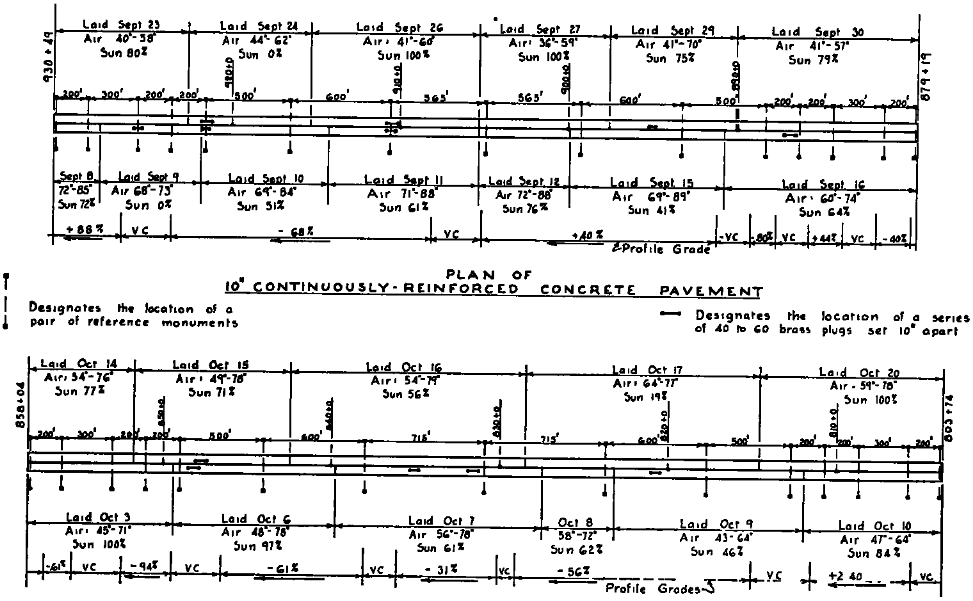
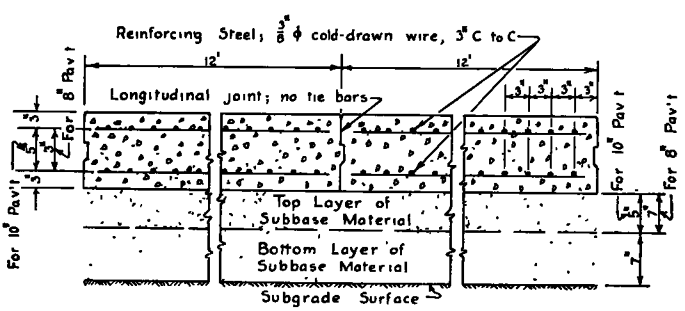
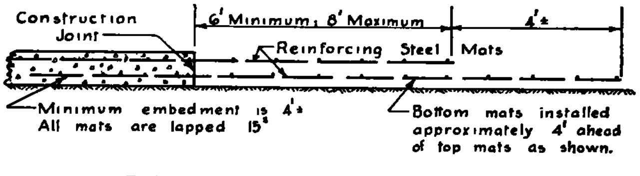


Figure 3. Top: Plan of 10-in. Continuously-Reinforced Concrete Pavement
Bottom: Plan of 8-in. Continuously-Reinforced Concrete Pavement
Shown are construction dates, prevailing air temperatures, percent of possible sunshine, location of reference monuments, and 10-in. gauge plugs.



TYPICAL TRANSVERSE SECTION THROUGH
CONTINUOUSLY-REINFORCED CONCRETE PAVEMENT



TYPICAL LONGITUDINAL VIEW
AT END OF DAY'S CONSTRUCTION

Figure 4

long, of 8-in. uniform thickness, and has 0.90 percent of longitudinal reinforcing steel.

Figure 3 shows both sections, and includes information pertaining to the dates the various portions of the sections were constructed, the weather prevailing during construction, profile grades, and locations of reference monuments and gauge plugs.

Figure 4 shows a typical cross section through the 8-in. and 10-in. continuously-reinforced sections, and the details of a typical construction joint.

TABLE 2
SUBGRADE SOIL DATA

Location of Soil	801 + 0 to 814 + 0	814 + 0 to 851 + 0	851 + 0 to 861 + 0	861 + 0 to 902 + 50	902 + 50 to 911 + 0	911 + 0 to 918 + 0	918 + 0 to 928 + 0	928 + 0 to 935 + 0
% Passing 1½-in Screen	100	99	100	100	100	100	100	100
Passing 1-in Screen	100	98	100	100	98	100	99	100
Passing ¾-in Screen	100	96	100	100	95	99	97	99
Passing ⅜-in Screen.	99	91	100	97	89	97	92	97
Passing No. 4 Sieve	98	88	100	95	87	96	88	95
Passing No 10 Sieve	97	88	100	93	86	95	85	92
Passing No 40 Sieve	48	65	89	79	79	85	74	62
Passing No 60 Sieve	30	37	53	55	65	70	60	53
Passing No 200 Sieve	18	20	20	49	51	49	46	46
Hydrometer Analysis								
% Finer than 05 mm.	16	18	18	44	44	44	42	43
Finer than .005 mm.	4	6	4	21	9	6	11	17
Finer than 001 mm	1	3	1	4	3	1	3	8
Specific Gravity	2.69	2.63	2.60	2.63	2.72	2 59	2.71	2.66
Liquid Limit	N. P	N. P.	N. P.	26	28	21	35	31
Plastic Index	N. P	N. P.	N. P.	8	5	6	12	11
Field Moisture Equivalent	30	23	23	26	29	22	32	34
California Bearing Ratio	43	11	57.3	16.7	1.7	14	7	35
Per Cent Swell, 4 Days	0.41	2.06	0.18	1.55	8.19	1.58	4.45	0.84
Per Cent Moisture, top 1 in	11.5	12.8	13.0	13.5	19.5	13.5	18.0	12.2
Proctor Maximum Density	122	124	121	122	118	119	115	118
Proctor Optimum Moisture	10	10	11	12	13	12	15	13
Optimum Moisture, Gal per Cu. Ft.	1.49	1.49	1.60	1.75	1.84	1.79	2.15	1.84

The data were obtained from samples taken 1 ft below subgrade surface.

SUBGRADE DATA

Data pertaining to the location and characteristics of the subgrade materials are shown in Table 2. Because the subgrade constructed in 1938 was above grade, an average cut of 2 ft. was required throughout. A pneumatic-tired roller and a 3-wheel 10-ton roller were employed for final compaction.

Both sections were constructed on granular sub-base material. This material was, however, composed of two layers differing somewhat in composition. The bottom layer was 7 in. thick throughout, and was composed of material having an average elutriable content of about 3 percent. The top layer was 7 in. thick under the 8-in. pavement, and 5 in. thick under the 10-in. pavement, and had an average elutriable content of from 6 to 7 percent. This design was adopted because of difficulties encountered in the past in obtaining the adequate compaction of sub-base materials having a very low elutriable content. The objective of the method employed was to render the entire sub-base susceptible to firm compaction by covering the relatively clean bottom layer with a top layer of material containing just enough elutriable material to enable it to support heavy compaction equipment. After compaction, the sub-base materials were very stable and, in most places, were capable of supporting heavily-loaded batch trucks without displacement.

The gradings and elutriable contents of both layers of sub-base material "as placed" throughout the project are shown in Figure 5.

CONCRETE DATA

Cement: Lehigh air-entraining.

Fine Aggregate: River glacial sand, and quartz sand.

Coarse Aggregate: Diabase trap rock, graded 2¼ in. down.

Proportions (by wt.) 1:1.75:3.50.

Average Slump: 4 in. (High slump specified to facilitate embedment of reinforcing steel.)

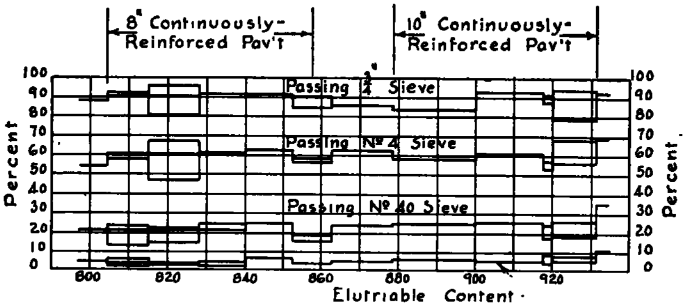
Curing: Colorless membrane.

Tests made at 28 days on cylinders and beams made of representative samples of the concrete placed on different days during the early stages of construction gave the following average results:

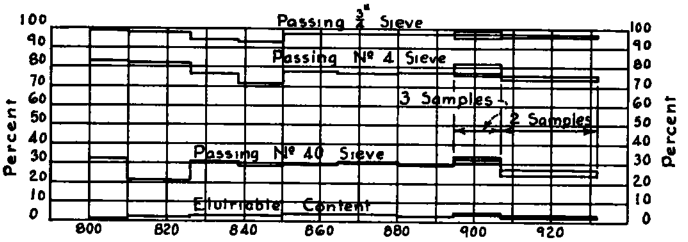
Compressive Strength: Min. 4513, Max. 6544, Av. 5042 psi.

Modulus of Rupture: Min. 608, Max. 968, Av. 749.

Tests made thus far on two tension specimens indicate that the strength of the concrete in direct tension, at an age of about five weeks, is approximately 300 psi. and that the modulus of elasticity in tension is approximately 5,000,000. Pending the results of tests on additional specimens, these tension data are not necessarily conclusive.



SUBBASE DATA—TOP COURSE—AS BUILT



SUBBASE DATA—BOTTOM COURSE—AS BUILT

Figure 5

REINFORCING STEEL

It was the original intention to install deformed bars, and to vary the sizes of the bars. However, because of an unforeseen shortage of deformed bars, and to expedite the completion of the project because of a hazardous traffic condition, the contractor was permitted to substitute welded wire mats. The mats were 16.25 ft. long and approximately 6 ft. wide. During installation, the mats were placed adjacent to one another to cover the full width of a 12-ft. lane, but were not lapped along the center lines of the lanes. The mats were composed of the following materials:

Longitudinal members: ⅜-in. round, cold-drawn wire, 16.25 ft. long, 3 in. center to center.

Transverse members: No. 5 cold-drawn wire, 12.2 in. center to center. (16 transverse wires per mat, the first wires being approximatey 1 in. and 11 in. from the ends of the mats.)

Tension tests made on representative samples taken from these mats indicate the following average value for the ⅜-in. longitudinal members:

Ultimate tensile Strength: 84,600 psi.

In order to favor the attainment of adequate bond, particular care was taken during construction to avoid the installation of reinforcing steel that had not acquired a thin coating of rust.

PAVEMENT CONSTRUCTION

The concrete in both of the continuously-reinforced sections was placed in three courses, the courses being struck off to the proper level by means of a mechanical spreader. The reinforcing mats were placed on and tamped into the upper surfaces of the first and second courses immediately after these courses were struck off.

During the first four days of construction the top mats were placed directly above the bottom mats, the results being that the laps in all of the mats were localized at specific points. Because of uncertainty in regard to the adequacy of the 15-in. lap employed the decision was made to install all bottom mats approximately 4 ft. ahead of the top mats in order to guarantee that at all cracks either the top mat or bottom mat would have ample embedment. For the purpose of permanently establishing the locations of the laps, during construction the letters "T" and "B", respectively, were inscribed in the pavement surface immediately above the northerly ends of the top and bottom mats. Practically all portions of the continuously-reinforced sections are marked in this manner.

Construction joints at the ends of each day's construction were made by placing on the subgrade three boards of the proper thickness, one above the other, and continuing the reinforcing steel forward through the spaces between the boards. These construction joints were so located that all mats were embedded a minimum of 4 ft. in the section just completed, and a minimum of 6 ft. in the succeeding section. In order to effect an appearance of continuity throughout, the construction joints were not edged.

Almost all construction joints are plain, butt joints having no load-transfer except that provided by the reinforcing steel. A few of the construction joints in the 8-in. pavement were so made as to have a ¾-in. offset in the abutting end surfaces, the direction of the offset being such as to tend to prevent faulting.

The placement of the concrete in three courses caused no difficulties or delays, nor did the installation of the double lines of reinforcing steel. There were no indications that the design is either impractical or unduly time-consuming to construct. The rate of construction was essentially the same as on a normal paving project.

RESEARCH

Some of the most important questions remaining to be answered concerning the behavior of these continuously-reinforced sections are:

1. Will the reinforcing steel be capable of preventing the opening of the cracks to the extent that they have no detrimental effect? This is undoubtedly the most important question of all because the success or failure of the pavement as a continuous structure naturally depends upon how much the cracks eventually open. If the cracks open very little the pavement appears to have good prospects of remaining structurally intact. On the other hand, trouble of one kind or another is almost certain to develop at any cracks that open excessively. This also applies to the construction joints.
2. What is the tensile stress in the reinforcing steel during periods of minimum pavement temperature? Unfortunately, circumstances prevented the installation of suitable means for determining the stresses developed in the reinforcing steel. However, in view of the large quantity of steel installed, and its high tensile strength (approx. 84,000 psi.), it appears doubtful that the steel will ever be over-stressed in direct tension. If the cracks open excessively it will probably be due primarily to failure in bond.
3. What will be the magnitude of the daily and seasonal changes in over-all length, and will there be an increase or decrease from year to year?
4. Will there be a central zone in each section that remains at constant length?

In order to obtain data relative to these questions, numerous measuring points were installed during construction.

Gauge Plugs for Crack-Width Determination—At many locations within the central zones of the continuously-reinforced sections brass gauge plugs were installed to provide means of taking precise measurements from time to time of the amounts that the cracks are open. These plugs, averaging 10 in. apart, were installed while the concrete was still plastic, along lines parallel with the longitudinal axis of the pavement. As many as 60 consecutive plugs were installed in certain locations. The intermediate distances between plugs were measured to the nearest .001 in. These measurements were taken as soon as the concrete had definitely hardened. Having been installed in numerous locations, these series of plugs will make possible the precise determination of the subsequent widths of a considerable number of the cracks that occur in sections constructed under different weather conditions.

The locations of these gauge plugs are shown in Figure 3.

Reference Monuments—To determine from time to time the magnitude of the longitudinal movements at the ends and various interior points of the continuously-reinforced sections, permanent transverse reference lines were established. The locations of these lines are shown in Figure 3.

Because it had been estimated that there will be a central zone in each section that remains at constant length, and that the ends of these zones will be located somewhere within the 1000 ft. of pavement at the ends of the sections, the transverse reference lines were established at relatively close intervals near the ends of the sections.

Reinforced concrete monuments were installed to permanently establish the locations of these lines. These monuments were cast-in-place in 6-in. diameter holes bored to a depth of 4 ft. The tops of the monuments are approximately 4 in. below the ground surface. Brass plugs were installed in the monuments and the pavement to establish points precisely on the reference lines.

Incidental Gauge Plug Installations—During construction, gauge plugs set 20 in. apart were installed longitudinally, transversely, and in series, in many locations to determine the changes in length that occur in specific areas. The "as constructed" distances between these plugs were measured to the nearest 0.0001 in. by means of an invar gauge.

Gauge plugs were also installed at all transverse joints throughout the entire project. Permanent temperature wells were installed.

Pavement Levels—In certain areas, levels were taken at 5-ft. intervals along both edges of the lanes to determine the magnitude of subsequent changes in elevation. These levels were taken prior to traffic of any kind on the pavement, and were taken with considerable care. Readings were taken to the nearest, estimated, .001 ft. Permanent bench marks were established in the immediate vicinity of each series of levels. Bench marks consist of a $\frac{9}{16}$-in. diameter brass rod, 5 ft. long, installed in a 6-in. diameter hole. The lower end of the rod is anchored in 1 ft. of concrete placed around the rod during installation, the remainder of the hole being filled with earth. The tops of the rods are 4 in. below the ground surface. During construction, small rectangular areas were trowled smooth in the pavement surface to permanently establish the points where the level shots were taken, and to provide an even surface upon which to place the rod.

Supplementary Experimental Pavement—As a supplementary experiment, a series of slabs 187 ft. long were included in this project. These slabs have no intermediate joints of any kind. They have, however, an additional quantity of longitudinal reinforcing steel within their central portions, in an amount that is expected to prevent the detrimental opening of any transverse cracks that might occur. Gauge plugs were installed in various portions of these slabs. Gauge plugs were also installed at all transverse expansion joints between slabs.

Invar Strain Gauge and Reference Bar—A special invar gauge and reference bar were devised for the taking of precise measurements between the 20-in. gauge points installed in this project. These devices are so constructed as to be self-compensating for all normal changes in temperature.

The general features of the gauge and reference bar are shown in Figure 6. It will be noted that compensation of the reference bar is effected by utilizing a relatively short piece of stainless steel to compensate for the changes in length of the invar bar. For any given change in temperature, the change in length of the 1.85 in. of stainless steel is essentially equivalent to the change in length of the 21.85 in. of invar. Consequently, despite changes in temperature, the distance between the reference holes remains constant. Compensation of the gauge is effected by a portion of the indicator dial acting in conjunction with a portion of the stainless steel runner.

BEHAVIOR DURING CONSTRUCTION AND EARLY LIFE

It was observed that the concrete placed during the earlier part of the morning usually acquired a temperature 10 to 20 deg. higher than the concrete placed during the afternoon, the greatest differentials occurring on warm, sunny days. Apparently because of this differential, cracking occurred first in those portions of the pavement that were constructed during the morning, and the closest spacing of the cracks occurred in those portions of the pavement that were constructed earliest in the morning.

Because the temperature of the concrete placed during the late afternoon remained very nearly constant during the following night, the pavement constructed during the late afternoon underwent very little, if any, expansion or contraction during the first night. Consequently the end of the pavement was found to be essentially in its "as constructed" position the following morning.

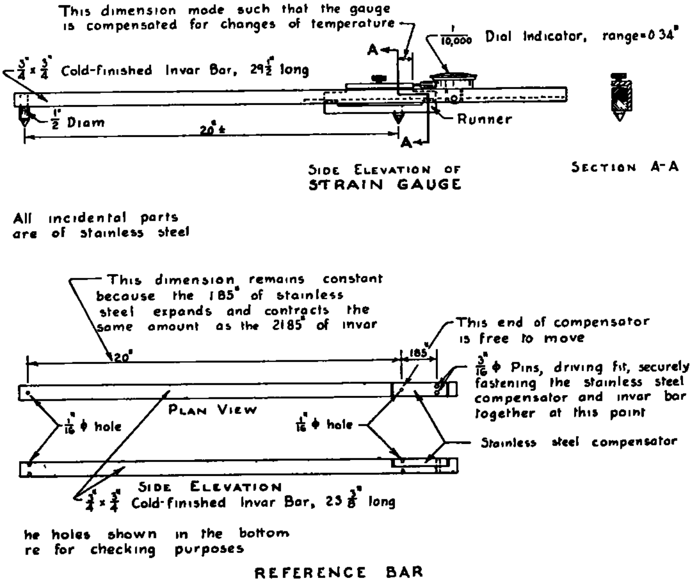


Figure 6. Details of Invar Strain Gauge and Invar Reference Bar (Gauge and reference bar are compensated for temperature.)

The results of measurements and observations made during early November, at which time the average pavement temperature was approximately 48 deg., are as follows:

The ends of the 10-in. section had moved inwardly a minimum of 0.29 in. and a maximum of 0.40 in. The greatest movements had occurred at the ends of the lane constructed during the warmest weather. At points 200 ft. from the ends, the pavement had moved inwardly an average of 0.10 in. No movement had occurred 500 ft. from the ends.

The ends of the 8-in. section had moved inwardly a minimum of 0.22 in. and a maximum of 0.28 in. Practically no movement had occurred 200 ft. from the ends.

The cracks in the 10-in. section were open an average of 0.01 in. One crack was open 0.02 in. This crack was in a location where the pavement had attained a temperature of 105 deg. within 12 hours after construction.

The cracks in the 8-in. section were open an average of 0.008 in., the maximum opening being 0.013 in.

These crack data are based on the measured opening of 49 cracks that had occurred between the guage plugs installed in various locations, and are believed to be representative.

The construction joints in the 10-in. section were open an average of 0.01 in., the maximum opening being 0.03 in. The construction joints in the 8-in. section were open an average of 0.005 in., the maximum opening being 0.009 in.

The crack interval was very erratic and ranged from approximately 1 ft. to 58 ft. The greatest concentration of cracks was in the portions of the pavement constructed earliest in the morning. In these locations there were areas from 200 to 300 ft. in length where the cracks averaged from 3 to 4 ft. apart.

Careful examination disclosed no cracks in the 187-ft. slabs. The opening that had occurred at the expansion joints between these slabs ranged from a minimum of 0.30 in. to a maximum of 0.60 in.

ACKNOWLEDGMENTS

The author wishes to acknowledge the very helpful assistance of Messrs. H. W. Giffin, H. E. Phillips, and R. H. Stelljes of the New Jersey State Highway Department in the preparation of this report.

AN EXPERIMENTAL CONTINUOUSLY REINFORCED CONCRETE PAVEMENT IN ILLINOIS

H. W. Russell, *Engineer of Materials* and J. D. Lindsay, *Assistant Engineer of Materials, Illinois Division of Highways*

SYNOPSIS

In the fall of 1947, the Illinois Division of Highways started construction of an experimental pavement consisting of eight continuously reinforced test sections, ranging in length from 3500 to 4230 ft., each section separated from adjacent ones by an expansion joint. Four of the sections are uniformly 7 in. thick and four are uniformly 8 in. thick.

One section of each thickness is reinforced longitudinally with 0.3, 0.5, 0.7, and 1.0 percent of steel, respectively. Round deformed rail-steel bars were used for longitudinal reinforcement. The transverse reinforcement consists of ⅜-in. round deformed, intermediate grade, billet-steel bars at 12-in. centers in one half of each section and at 18-in. centers in the other. The pavement contains no center joint, the transverse reinforcing bars being continuous across the pavement.

The pavement was built directly on the natural subgrade, as graded, about 90 percent of which is composed of potentially "pumping" soils. A normal strength concrete with a cement factor of 1.4 bbl. per cu. yd. and a slump of 1¼ to 1½ in. was used. The reinforcing bars were assembled on the subgrade into a continuous mat supported 3 in below the pavement surface. Concrete was placed in one lift and distributed and consolidated by a spreader and a vibratory finishing machine.

Provisions were made for measuring horizontal and vertical movements at various locations along the pavement; also for measuring the width of transverse cracks that develop. Unit strains in the longitudinal reinforcing bars are measured by SR-4 strain gages. Temperatures of the concrete and subgrade are measured with thermocouples.

Already numerous fine transverse cracks have developed, as expected, in the completed test sections. Unit tensile stresses of almost 40,000 lb. per sq. in. have been measured in the longitudinal reinforcement in the 7 in. section with 0.7 percent steel. The yield point of the steel is approximately 70,000 lb. per sq. in.

One of the major problems in highway engineering is that of improving pavements structurally so that they will meet more adequately the demand of present day and anticipated future traffic and provide longer serviceable life. The problem is made more difficult because heavy truck and bus traffic is constantly increasing in volume and weight.