BRICK TEST ROADS UNDER TRAFFIC MAY POINT THE WAY TO IMPROVED CONSTRUCTION METHODS

By Fred E Swineford, *Chief Engineer*
Bureau of Tests, Ohio State Highway Department

SYNOPSIS

New and improved products, materials and equipment have been recently employed in constructing three brick test roads in Ohio The performance of these test sections under traffic will show to what extent the present standard designs should be revised

The longitudinal brick project is the second of its type to be constructed in Ohio With the brick laid in courses parallel to the center line of the road, the finished pavement presents a pleasing appearance and a good riding surface If the service record shows that longitudinal brick surface courses are equal to transverse courses, additional projects will be constructed in this manner because the cost of laying is slightly lower

The reinforced grout filled block pavement constructed of 8 by 8 by 3¾-in vitrified paving block with ⅜-in round bars grouted into each joint may prove to be a satisfactory method of resurfacing existing stable bases

The results of the monolithic vitrified brick project constructed with modern finishing machinery may bring back this type which was quite generally used about twenty years ago

During 1938 three brick pavement projects embodying new features, not now used in the standard brick type for Ohio, were constructed by the Ohio Department of Highways The first was a longitudinally laid brick job being the second of its type to be built in Ohio The second, tried for the first time, was a short section of reinforced grout filled vitrified block pavement The third was monolithic vitrified brick While many miles of monolithic brick pavement were built in Ohio between 1915 and 1923, this type has not been constructed except experimentally since that time The majority of these monolithic pavements have given good service but they were dropped because it was found difficult to give them a good riding surface However, due to the recent development of improved finishing machinery, the section built this year meets the standard requirements for surface smoothness

LONGITUDINAL BRICK PAVEMENT

In 1938 on one and one-half miles of pavement on U. S. Route 33 at Rockbridge in Hocking County, Ohio, the brick were laid with their longest dimension parallel to the center line of the road The essential difference between this job and a similar project built in 1936 was that batting along one curb was permitted It had been found on the earlier longitudinally laid job, that making closures by shifting brick between header curbs was apt to disturb the bedding course and result in unevenness in the surface

The concrete base and integral concrete headers on each side were placed without joints except those which occurred at the end of each day's work A ¾-in natural asphaltic limestone bedding course was spread over the concrete base In order to aid the brick droppers in maintaining straight courses, the bedding course was lightly scored with parallel lines 2 ft apart, by dragging over it a templet with spikes 2 ft apart

The cost of handling and laying brick was three per cent less on this project than on a similar one where the brick were laid crosswise This lower cost is apparently due to the ability of each

brick dropper to work continuously down the road with his several courses without being compelled to walk across the road to start new courses frequently. On this project four brick droppers placed the brick. All the batting necessary due to irregularity in the size of the brick and the slight variation in width between the curbs was done along one curb.

The bituminous filler used on this project met the Ohio Highway Department Supplemental Specification No. 78 for Blended Asphalt. This type of filler was one of the four most satisfactory fillers used in the Ohio experimental filler test road built in 1935.

A recent survey of five projects with one year or more service using this filler has shown that it is decidedly less exuding than the old Standard F-1, and it is now required on all bituminous filled brick pavement construction. The completed brick pavement with the brick laid longitudinally presents a pleasing appearance and a good riding surface.

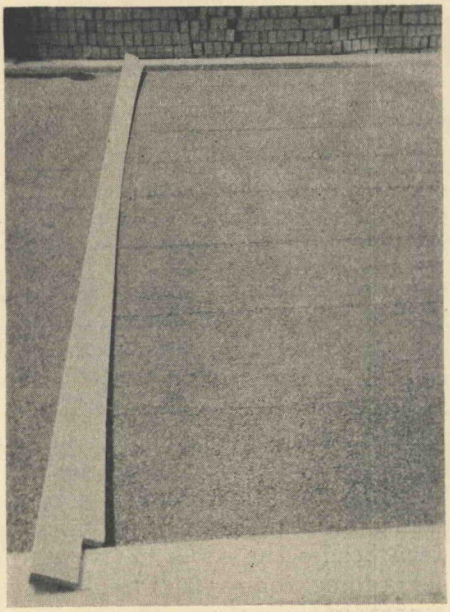

Figure 1. Templet Used to Score Bedding Course, Enabling the Droppers to Maintain Straight Rows of Bricks.

Figure 2. Such Batting to Closure as Was Necessary Was Done Along One Curb. Two thirds of a brick broken lengthwise was permitted for a bat.

REINFORCED GROUT FILLED BLOCK PAVEMENT

In cooperation with the National Paving Brick Association the Maintenance Department of Division No. 6 of the Ohio Department of Highways constructed a 200-ft. experimental section of reinforced grout filled brick pavement in August of 1938. Vitrified paving blocks 8 by 8 by $3\frac{3}{4}$-in. were laid on a sand bedding course 1 in. deep spread over an old 16-ft. water bound macadam base which had been widened 2 ft. 6 in. on each side with new water bound macadam and leveled with limestone screenings treated with calcium chloride.

Bar mats consisting of $\frac{3}{8}''$ round bars spaced 9 inches center to center each way and supported three-fourths of an

inch above the bedding course were placed upon the bedding course to act as reinforcement. Adjacent mats were joined by $\frac{3}{8}$ in. by 30 in. deformed bars wired to the adjoining mats.

Two other types of reinforcing were tried in equal length sections, they were, individual $\frac{3}{8}$-in. round deformed bars and $\frac{1}{4}$-in. welded wire mats similar to the bar mats. 24 by $\frac{3}{8}$-in. round deformed bars were pressed into the grout $\frac{3}{4}$-in. below the surface and at right angles to the edge of the pavement in 80 of the joints along one edge, the purpose being to determine on future inspections if this additional steel is required. A portion of the individual bars used were bent into a 13-in. "U" on one end to furnish reinforcement in the top of the slab near the edge.

The 8 by 8-in. vitrified blocks were placed in the squares formed by the bar and spaced to form a neat checkerboard pattern. The blocks were then rolled with a hand roller weighing 12.5 lb. per in. of width. Portland cement grout was then squeegeed over the surface to complete filling of the joints. Cotton mats kept wet were used to cure the grout.

This project is located on U. S. Route 23 in Delaware County, Ohio, 4.5 miles

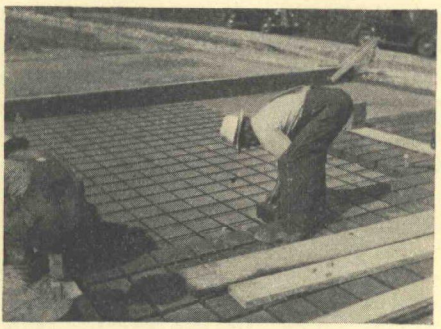

Figure 3. As Laying of the Blocks Progressed the Mats Were Raised to Their Proper Elevation Above the Cushion.

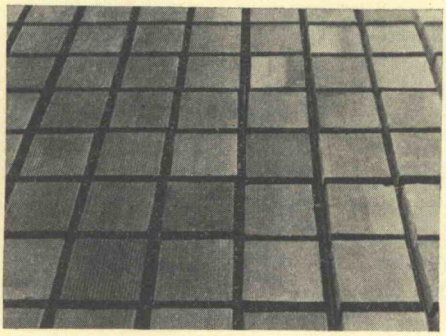

Figure 4. Looking Across the Block Pavement Prior to Grouting

Figure 5. Distribution of Grout Was Handled by Means of Hand Squeegees. Cotton mats for curing are visible back of the workmen.

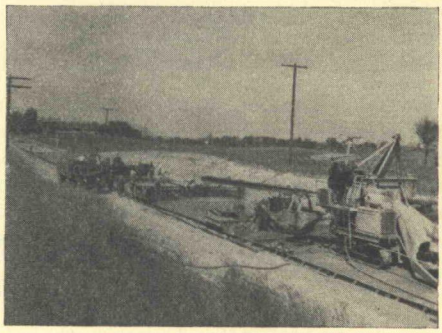

Figure 6. Train of Equipment Used in Constructing Monolithic Vibrated Brick Pavement. This view shows the approximate normal spacing.

north of the City of Delaware, and joins the north end of the brick Acceptance Test Road Project, which is now under construction. This type of reinforced vitrified block pavement exclusive of a base course costs approximately $1.00 per square yard less than the standard type of vitrified brick and concrete base. Its use may therefore be extended for surfacing compacted foundations similar to the base upon which this test section was placed.

MONOLITHIC VITRIFIED BRICK PROJECT

An Ohio project which has attracted more widespread attention than any other is the monlithic vibrated brick job recently completed in Stark County on U. S. Route 21. The specifications called for a wearing course of grout filled vitrified paving brick laid on a plastic concrete base sufficiently firm for laying brick but of a consistency that would permit the brick to bond with the concrete.

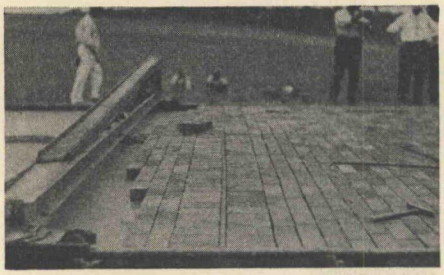

Figure 7. The First Course of Brick on Each Side of Transverse Expansion Joints Are Laid Longitudinally. The joint material visible here is premolded cork which extends downward 3½ in. where it rests on bituminous premolded joint material extending to the bottom of the base slab.

Following immediately behind the concrete paver which was used for the base was a vibratory concrete finisher. The contractor elected to exercise his option and use vibratory finishing on the base course in order to have firmer concrete on which to lay brick and thereby shorten the interval between placing the concrete and dropping brick. This machine is also equipped to strike off the concrete 3-in. below the finish grade on the first pass in order to place the required steel mesh reinforcing. Behind the finisher came the machine by means of which the longitudinal ribbon center joint material was installed. The ribbon joint material consisted of a ⅛-in. thickness of premolded bituminous material 5.5 in. wide and was furnished in 50 ft. rolls. It was placed 2.5 in. into the base and the 3 in. remaining above the surface was held vertically by means of oiled steel plates until just before the bricks were vibrated.

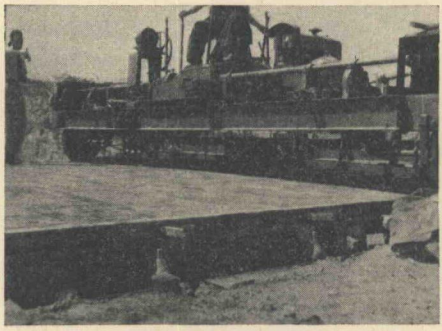

Figure 8. Brick Vibrator for Removing Surface Irregularities and Imbedding Brick in Plastic Concrete Base.

One-inch transverse expansion joints extending the full depth of the surface course and base course were installed at 60 ft. intervals. The joint filler for the bottom 6 in. was bituminous premolded material between metal plates shaped to form extrusion chambers on each side. Resting directly on the bituminous joint material was 3.5 in. of premolded cork which filled the joint to within one-half inch of the pavement's surface. A poured bituminous seal completed the filling. The joint assembly exclusive of the cork was contained in a welded wire

cage which served to hold the joint material and dowel bars in place during the concreting operation The dowels were 24-in by ¾-in smooth round bars capped and greased, spaced 12 in center to center and served to transfer load across the joint

The brick were unloaded from the trucks directly on to a roller carrier brick conveyer The brick droppers took the brick directly from the conveyer and dropped them on the plastic concrete base The brick were 3 by 4 by 8½-in vertical fiber lug brick laid to form a 3-in surface course.

The Flexible Road Joint Machine Company's new brick vibrator was then used in place of the conventional rollers This new machine which is similar to a concrete paving screed was carried on steel side forms and performed two operations First, that of firmly bedding the brick in the plastic concrete and, secondly, that of forming a good riding surface Eighteen metal straight edge tampers which rested on the brick surface were 12 in wide and 6 ft long and were actuated by four high frequency electric vibrators mounted on a beam spanning the straight edges As the machine passed over the brick the mortar from the base was brought up into the joints about one-half inch There was very little breakage or chipping of the brick due to the action of the vibrator

The grout mixer which followed consisted of a one-bag mixer on an old fashioned machine carriage The fine aggregate was weighed and sacked at a central location and the mixer charged from a runway behind the mixer

The grout was conveyed to the brick surface through a gravity chute and was worked into the joints with hand squeegees

Preliminary curing was with wet burlap for 24 hours after which a covering of 3 in of wet straw was maintained until the concrete beams indicated that the required modulus of rupture had been obtained

Time, traffic, and the elements will show in what respects these test sections are durable or subject to failure. Annual inspections will be made to observe from these sections which features should be embodied in future designs

DISCUSSION ON BRICK TEST ROADS

Mr H Z Schofield, *National Paving Brick Association* Mr Swineford has pointed out the saving in labor effected by longitudinal laying as compared with the usual transverse laying of brick. A comparison of the data also shows that the number of brick per square yard required in the longitudinal project was over one per cent less than in the transversely laid project Engineers observing the completed longitudinal pavement are of the opinion that it possesses a somewhat smoother riding quality than the transverse type Two opinions have been expressed by engineers regarding the effect on the driver of the continuous lines of the longitudinal pavement, some claim that these lines are an aid to driving while others feel that the lines are somewhat disconcerting.

Our previous experience with reinforced brick pavement construction was in Springfield, Illinois, on a reinforced brick pavement slab constructed, in 1931, in the yard drive of a paving brick plant In constructing this slab there was no preparation of the subgrade except the placing of a thin sand cushion Bricks were placed on edge and in "basket-weave" fashion with three bricks constituting a square unit. The reinforcement consisted of ⅜-in round deformed bars placed at approximately nine inch centers, both transversely and longitudinally, and at

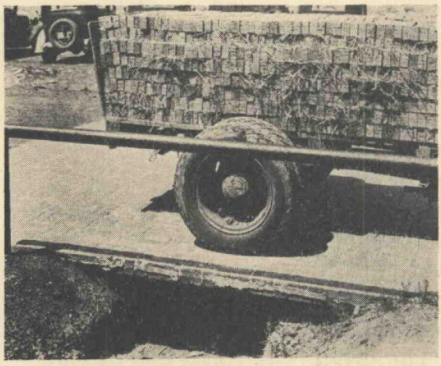

Figure 1.

1 in. above the slab bottom. A mortar (one part cement to two parts sand) was then grouted in. Two weeks after the slab was completed, an excavation 5 ft. square was made under one side of the slab. It has been estimated that during the past seven years 30,000,000 bricks have been trucked over that portion of the slab which spans the excavation (Fig. 1). In addition, the Illinois State Highway Department ran a ten week concentrated test on the bridged slab. The slab today remains in perfect condition. The Ohio test section described by Mr. Swineford was a cooperation of the Ohio State Highway Department, the National Paving Brick Association, the Wire Reinforcement Institute and the Concrete Reinforcing Steel Institute.