EXPERIMENTAL COMPOSITE PAVEMENT IN NEW JERSEY

John L. Haller
Assistant Supervising Engineer
Bureau of Structures & Materials
Division of Research & Evaluation
New Jersey Department of Transportation

EXPERIMENTAL COMPOSITE PAVEMENT IN NEW JERSEY

This paper concerns a composite pavement design constructed on Route 3 in New Jersey. The subject pavement was designed in the latter part of 1961 and construction completed in the middle of 1963. Because of the unique pavement design proposed for this project, the Bureau of Public Roads requested the New Jersey Department of Transportation to consider it as an experimental project. It was agreed that the State would study the behaviour of the composite pavement design and report annually on the observations and collected data. The completed project has been reported on at periodic intervals: 1-1/2, 2-1/2, and 3-1/2 years.

The basic reporting methodology agreed upon consists of the following:

1. Traffic data including loadings.
2. Determination of the serviceability index.
3. Deflection measurements.
4. Settlement determinations.
5. Concrete base performance.
6. Bituminous concrete surface performance.

The composite pavement design was used on a portion of the projects in New Jersey involving the Route 3 and New Jersey Turnpike approach complex to the Lincoln Tunnel, connecting New Jersey with New York. Several factors influenced the use of a composite design rather than a conventional design in the approach section of the Route 3 crossing of the Hackensack River. The terrain over which this portion of the highway was constructed is meadowland; the subsoils consisting of thin varved layers of silt, clay, and sand. Approximately twelve feet of organic peat and muck overlaid the underlying soils.

Due to the urgency of the need for improvements to the overall approach complex, the following factors were involved in the design of the pavement section:

1. Route 3, over the Hackensack River was carrying, in 1961, approximately 80,000 vehicles daily, and about 17 percent of these vehicles were in the heavy truck category. It was, therefore, imperative that the pavement section should be of an unusually sturdy construction, in order that it remain virtually trouble-free and require an absolute minimum of maintenance over a relatively long period of time.

2. A decrease in construction time was desirable and could be accomplished by removal and replacement of the organic peat and muck with Zone 2 material (open graded quarried or bank run material, 0-8 percent passing #200 mesh), placing a normal earth embankment and constructing a pavement thereon. However, this type of construction would not permit preconsolidation of the underlying compressible materials.

3. Serious doubts existed as to the advisability of employing New Jersey's standard design of reinforced concrete pavement (78'-2" slab length) because of the compressible

nature of the underlying soil and the possibility of appreciable differential settlements causing serious cracking.

4. Investigations and studies, available at that time, of the performance of flexible pavements on major trucking routes in New Jersey, on the AASHO road test, and on sections of the New Jersey Turnpike in the area of this project, led to uncertainty as to the adequacy of any conventional flexible pavement under the extreme traffic conditions of this project.

5. Bituminous surfacing materials are apparently capable of satisfactorily carrying heavy truck traffic, and remaining crack free, provided they are on a very stable foundation. This was borne out by the outstanding performance of the pavements on two rehabilitation projects which involved thick overlays placed on existing concrete pavement. In both instances, the existing pavement was badly cracked, depressed, and undergoing pumping. An overlay consisting of a 3 inch FA-BC-2 surfacing on 8 inches of macadam base, on 3 inches of essentially stone screenings, was constructed on Route U. S. 22 between Somerville and Chimney Rock in 1952, and is still in satisfactory condition. In the northbound roadway of Route U. S. 130, in the vicinity of Deans, an overlay was constructed in 1949 consisting of a 2 inch FA-BC-1 surfacing on 3 inches of penetration macadam, on 6 inches of macadam base, on 5 inches of bank-run gravel. This overlay, under considerable heavy truck traffic, is almost completely

crack-free, to grade, and unrutted. It is considered to be in practically perfect condition. Whereas, a then considered relatively high-type flexible section constructed in the north-bound roadway is now very badly cracked, appreciably rutted, and exhibits numerous areas of localized settlement.

The particular design objectives for use of a composite pavement on this project were:

1. To maintain the structural integrity of surface despite an anticipated differential settlement resulting from the deep fill and the compressible nature of the underlying soil.

2. To achieve the high load carrying capacity of a rigid pavement necessitated by the large volume of heavy truck traffic.

3. To achieve the continuity of surface of a flexible pavement.

The section of the main-line composite pavement and shoulder, designed on these principles, is shown in Figure 1 and summarized as follows:

(Insert Figure 1)

<u>Main-Line Composite Pavement, Route 3, Section 1-D</u>:

3-1/2" FA-BC-2 (1-1/2" top course, 2" bottom course)

5" Macadam base (Bituminous-stabilized base not to be permitted as an alternate.)

3" Densely-graded stone base

8" Plain concrete base

6" Subbase

Adjacent Shoulders:

2" bituminous concrete shoulder

23-1/2" of subbase, the top 6-1/2" of subbase to be of quarry processed stone.

Contraction joints were constructed in the concrete base at intervals of 15 feet. A three inch base of densely graded stone was applied between the concrete base and the five inch macadam base. This was to act as a buffer to prevent the reflecting of cracks from the concrete base up, into the 3-1/2 inches of FA-BC-2 surface pavement.

Several construction contracts were associated with the approach complex to the Lincoln Tunnel. Reporting is limited to the Route 3 westbound roadway on the east side of the Hackensack River. The available initial data on the west side of the river and the eastbound roadway are not sufficient for analysis.

Construction cost of the pavement for the initial contract amounted to $12.39 per square yard. This cost, much higher than originally anticipated, was attributed to the inexperience of the contractor with this type of pavement. In subsequent contracts, the cost was reduced to $9.85 per square yard. A high-type bituminous concrete pavement or a reinforced portland cement concrete in New Jersey averages approximately $6.00 to

$9.00 per square yard. Following are the two way AADT experienced on this portion of Route 3 for the indicated periods:

1963 - 80,400 vehicles

1964 - 83,890 vehicles

1965 - 84,730 vehicles

1966 - 83,460 vehicles

The truck percentage for westbound Route 3 was 19.0 percent (approximately constant for the 1964-1966 period) with an approximate lane distribution as follows:

Lane 4 (inside-left)	- 6.0%
Lane 3	- 32.0%
Lane 2	- 43.0%
Lane 1 (outside right)	- 19.0%

Route 3 Westbound was constructed on new alignment and completed in mid-1963. While existing Route 3 was being rehabilitated to accomodate eastbound traffic, from July 2, 1963 to May 27, 1964, the completed Route 3 westbound was divided into five lanes, each ten feet wide, and was utilized for both eastbound and westbound traffic. During this period it was subjected to approximately 3,505,056 18-kip equivalent axle repetitions. Since May 28, 1964, the roadway has been used exclusively as four lanes for westbound traffic. The accumulated by-lane 18-kip equivalent axle repetitions since May 28, 1964 up to November 29, 1966, the date of the latest surveys, is as follows:

Lane 4 (inside-left)	-	276,059
Lane 3	-	1,472,311
Lane 2	-	1,979,230
Lane 1 (outside-right)	-	874,188
Total		4,601,788 18-kip equivalent axle repetitions

The relatively high traffic-load condition for the initial period up to May 1964 is due to the fact that the route carried traffic in both directions.

Roughometer surveys were conducted periodically on all lanes of the approach section of the Route 3 crossing of the Hackensack River from July 1963 (prior to opening to traffic) to November 1966 (latest survey). The first three surveys were conducted by personnel of the Structural Research Division of the Bureau of Public Roads. The latest survey was conducted with the assistance of the New York Port Authority and without the use of personnel from the Bureau of Public Roads. Although no acceptable roughness levels have been established for New Jersey using a BPR type roughometer, limited roughness data is available for both the reinforced portland cement concrete and bituminous concrete pavement types. The measured values obtained for the subject composite pavement are within the limits of the available data. Virtually no change was found in the pavement roughness and the serviceability index since constructed.

Periodic Benkelman Beam surveys have been made on the outside (right) and inside (left) lanes of the Route 3 westbound roadway east of the Hackensack River since the inception of the study. Initially, a 7,500 pound wheel load was employed. The more recent surveys were made with a 9,000 pound wheel load. Deflections were obtained in the right wheel path of the outside (right) lanes at contraction joints (aggregate interlock load transfer), construction joints (no load transfer), and midpoints of the concrete base slabs.

Table 1 shows the average periodic deflection measurements.

(Insert Table 1)

Limited deflection data is available for New Jersey pavements. Available limited data for other New Jersey pavements indicate deflection ranges of 0.01 to 0.03 inches and 0.006 to 0.010 inches for bituminous concrete and portland cement concrete pavements respectively. The deflections observed thus far on Route 3, indicate they are well within acceptable limits.

Periodic close interval profile and cross-section readings have been taken on Route 3, Section 1D, the section to which this report pertains. Figure 2 shows a portion of a typical profile as of June 1963 (as constructed), November

1964, June 1965, and December 1966. Figure 3 indicates a

(Insert Figures 2 and 3)

portion of a typical cross-section taken on the above dates.

The settlement observed thus far has been approximately 0.06 feet. Most of this settlement took place during the first 18 months.

Visual inspections of Route 3, Section 1D were made in November 1963, January 1966, and March 1967. These inspections revealed no significant defects in the composite pavement. Several longitudinal cracks have been observed. They are not considered as being detrimental to the overall performance of the composite pavement. Virtually no transverse cracking of the pavement has been observed, except immediately adjacent to the structure. This absence of transverse cracking in the surface indicates the buffer layers of densely graded stone and macadam are preventing the contraction joints of the concrete base from being reflected into the surface. Maintenance thus far has been negligible. Some minor patchwork was accomplished at the structure because of pavement settlement.

Profile surveys and visual inspections have shown no unusual conditions in the performance of the composite pavement. Therefore, no intimate study of the concrete base has been undertaken. All joint locations have been marked, however, and if necessary, excavations can be made when deemed necessary to determine the condition of the joints and the performance of the base.

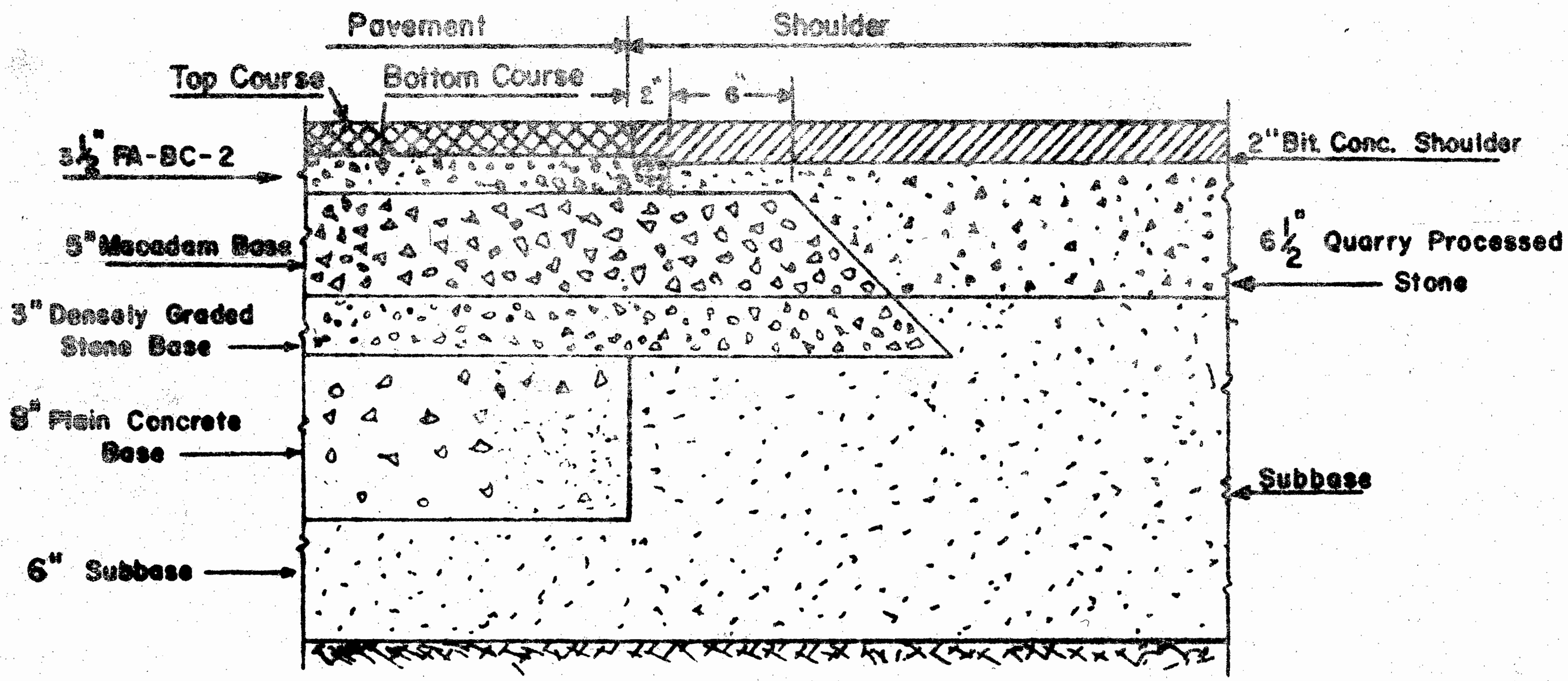
Over the 42-month period of operation thus far observed, the composite pavement has performed in accordance with the original design objectives stated on page 3.

John L. Haller

Date	Deflections (Thousandths of an Inch)	
	Joints	Midpoints
Dec. 1963 *	5	5
May 1965 *	8	7
Oct. 1965	7	7
June 1966	7	7
Nov. 1966	7	6

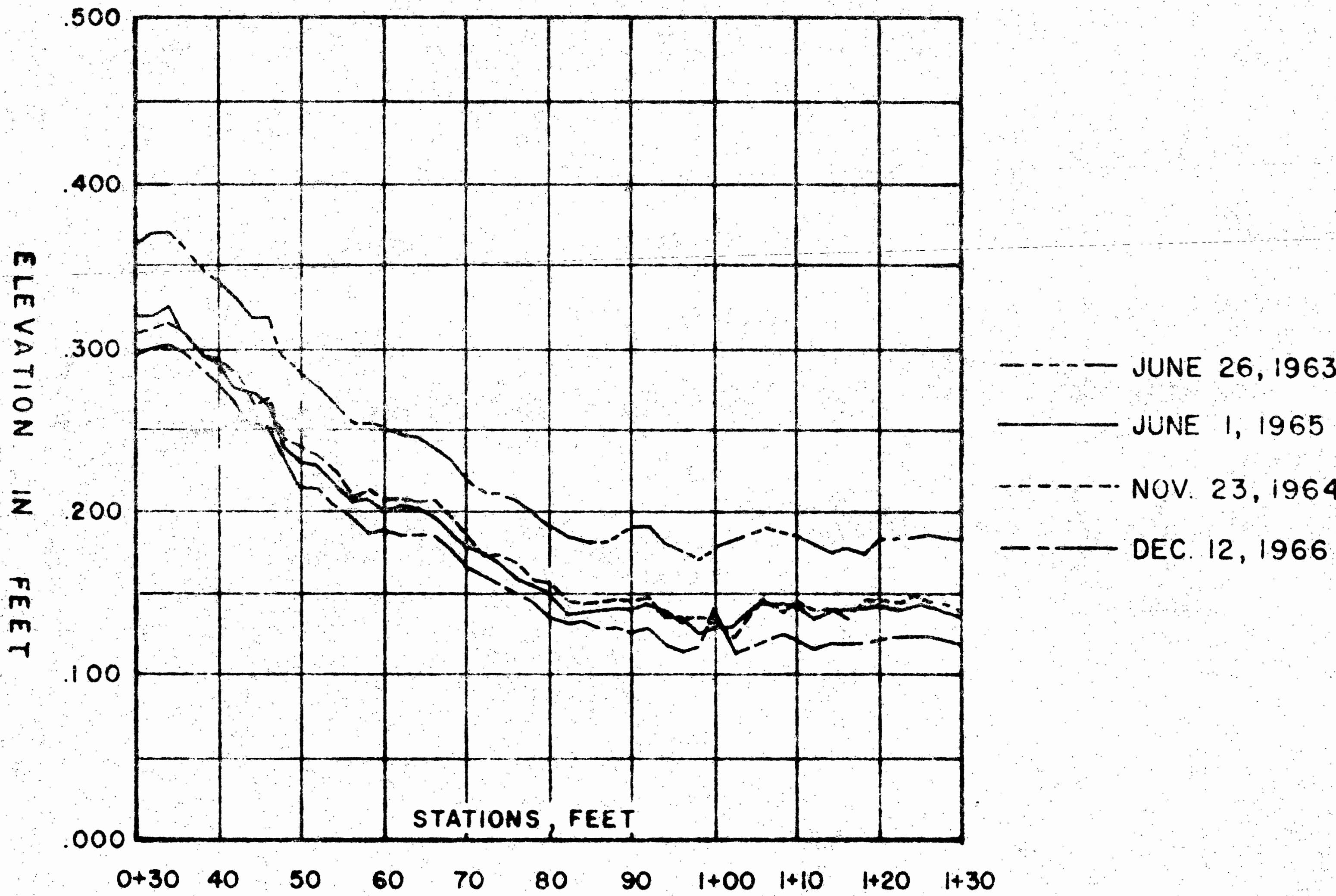
* 7,500 pound Wheel load.

T A B L E 1



EXPERIMENTAL COMPOSITE PAVEMENT SECTION

FIGURE-1



PROFILE OF PAVEMENT SURFACE – OUTER (right hand) WESTBOUND LANE

STATIONS 0+30 TO 1+30

ROUTE 3, SECTION 1-D

FIGURE – 2

John L. Haller

John L. Haller

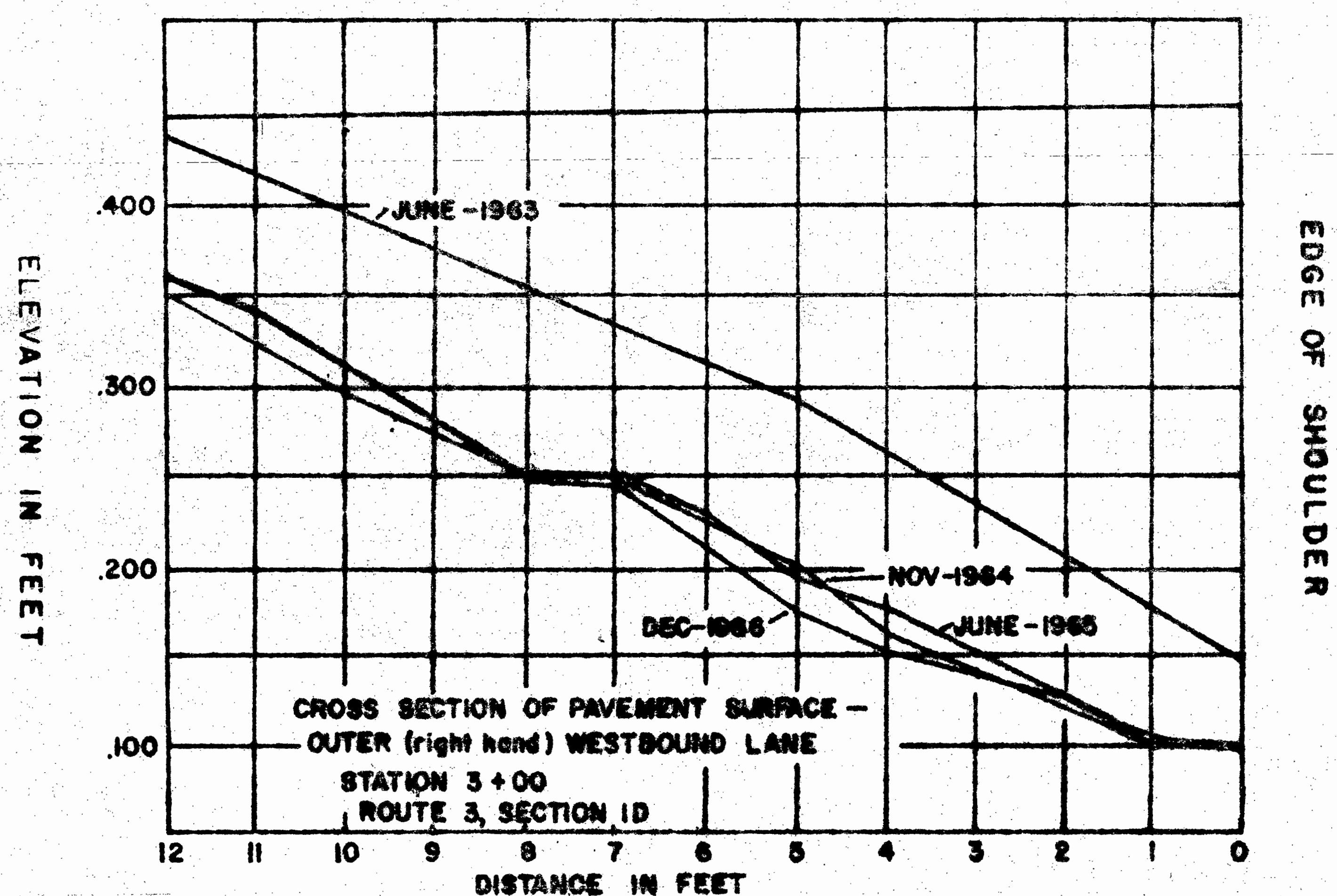


FIGURE-3