# EVALUATION OF FULL DEPTH ASPHALTIC CONCRETE PAVEMENTS

INTERIM REPORT

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## ABSTRACT

This report provides a review of the performance and structural characteristics exhibited on two full depth asphaltic concrete pavement projects constructed on the Louisiana interstate system.

The roughness characteristics of both full depth projects were evaluated by means of the Mays Ride Meter. Roughness values ranged from 40 to 80 inches per mile indicating a "very good" to "good" riding surface. The structural characteristics of these projects were determined by means of the Dynamic Deflection Determination System (Dynaflect) in conjunction with visual inspection. Deflection values have increased gradually during the two years following construction but remain within the acceptable range for 13 inches of asphaltic concrete. The surface curvature index values indicate good load transfer capability. Other than slight pitting of the wearing course in the wheelpaths, no rutting or other visual signs of deterioration were observed.

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## INTRODUCTION

The relatively new section design concept of full depth asphaltic concrete pavement has now been implemented in Louisiana on Interstate Highway 12 near Slidell (project control number 454-04-09) and on Interstate Highway 20 near Holly Ridge (project control number 451-07-08). Since this design is new to Louisiana and anticipated increased traffic will necessitate thicker asphaltic concrete section design, it is desirable at this time to periodically investigate sections of these projects from a performance viewpoint. The specific aim of this project will be to evaluate the full depth asphaltic concrete pavement design concept by observing the performance and structural characteristics of such a section over an extended period of time. This report presents the results of two years of evaluation of the two full depth asphaltic pavement projects in Louisiana.

## SCOPE

Evaluation of the two full depth projects are being conducted twice a year over a five-year period. The pavement evaluation data presented in this report represents the outside lane of each project. Deflection measurements were taken along the center of the outside lane every 100 feet. Mays roughness values represent an average of inside and outside wheelpaths of the outside lane. Rutting measurements are also an average of both wheelpaths.

## METHODOLOGY

A 1000-foot test section (outside lane only) was designated in both roadways of projects 454-04-09 and 451-07-08. Those tests most relevant to roadway performance were conducted within the test sections. These include physical surveys to measure the amount of rutting, cracking, patching, and other distress indicators, as well as mechanical tests with the Mays Ride Meter and Dynamic Deflection Determination System (Dynaflect). Evaluations are being conducted twice each year, once during the summer and once during the winter, over a period of five years.

### Rutting, Cracking, and Patching

A rutting depth measurement device (see Figure 1) provided an average rut depth for each test section. Readings were taken every 50 feet in each wheelpath.

As pavement cracking and patching occur they are to be measured in square feet per 1000 square feet of pavement area.

The Dynaflect (see Figure 2) is a trailer-mounted device which induces a dynamic load on the pavement and measures the resulting deflections by use of geophones (usually five) spaced under the trailer at approximately one-foot intervals from the application of the load. The pavement is subjected to a 1000-pound dynamic load at a frequency of eight cycles per second, which is produced by the counter-rotation of two unbalanced flywheels. The generated cyclic force is transmitted vertically to the pavement through two steel wheels spaced 20 inches center to center. Any horizontal reactions will cancel each other due to the opposing rotations. The dynamic force varies in sine wave fashion from 500 pounds upward to 500 pounds downward during each rotation. The entire force transmitted to the pavement, however, consists of the weight of the trailer (about 1600 pounds) and the dynamic force which alternately adds to and subracts from the static weight. Thus, the dynamic force during each rotation of the flywheels at the proper speed varies from 1100 to 2100 pounds.

The Deflection measurements induced by the system are expressed in terms of milli-inches (thousandths of an inch). In order to covert these Dynaflect readings to the more widely used Benkelman Beam values, it is necessary to multiply the Dynaflect readings by a factor of approximately 21.

First sensor Dynaflect values for satisfactorily performing full depth asphaltic concrete (13 inches of hot mix asphaltic concrete) should be comparable to deflection readings for 10 inch portland cement concrete pavement, 0.80 milli-inches or less. The numerical difference between sensor I and sensor II, the Surface Curvature Index (SCI), is indicative of the load transfer capability of the surface pavement layer in question. For satisfactory load transfer, it is felt that the SCI value should be less than or equal to 0.15 milli-inches.

All deflection readings are taken in the center of the outside lane, every 100 feet along the 1000-foot sections.

Roughness

The Mays Ride Meter is used to evaluate the pavement roughness by recording the mechanical vertical displacement created by the relative motion between the rear axle and the body of the vehicle. This mechanical movement is converted into an electrical impulse through a photo electric cell. The electrical signal is transmitted back into a mechanical movement which is recorded on graph paper. The Mays Ride Meter when installed in a passenger vehicle and operated at traffic velocities supplies a permanent graphical log of roughness summation. All roughness measurements are expressed in units of inches per mile. For Tentative Mays Ride Meter Rating, see Table 1.

## INVESTIGATION OF PERFORMANCE

### I-12 Slidell

In general, the performance of the two 1000-foot sections on I-12 continues to be very good. The six evaluations to date represent only three years of life (current Σ 18 kip load = 186,220). (See Table 2.)

Deflection values still remain below the tolerable limit for 13 inches of HMAC, 0.80 milli-inches. (See Figure 3.) Maximum deflections ranged from 0.33 to 0.56 milli-inches, the current average maximum deflection being 0.52 milli-inches. The SCI values indicate good load transfer capability with an increase from 0.03 to 0.06 milli-inches over the past three years.

Average roughness values ranged from 40 to 68 inches per mile indicating a "very good" to "good" riding surface.

On the westbound roadway inside lane a localized longitudinal crack (approximately 500 feet long) was found 700 feet from the west end of the project. A core taken in this area indicated that the crack extends through the wearing and binder courses. (See figures 4 through 6.) If the pavement in this area continues to deteriorate, a more extensive investigation will follow. Other than slight surface pitting (minor loss of surface aggregate) in the wheelpaths, no rutting or other visual signs of deterioration have been observed. The shoulder, however, does contain transverse cracks approximately 10 feet apart with longitudinal cracking about one foot out from the pavement edge. (See Figure 7.) It should be noted that the shoulder is not a full depth section, but consists of 3-inch asphaltic concrete binder course over a 6-inch aggregate base sourse. (See Figure 8.)

### I-20 Holly Ridge-Dunn

From a performance standpoint, the two 1000-foot test sections on this project also continue to be satisfactory. During the six evaluations the Σ 18 kip load has increased from 95,502 to 406,380. (See Table 3.)

Maximum deflections ranged from 0.43 to 0.73 milli-inches, still within the acceptable range for this type pavement. (See Figure 9.) There has been a slight, gradual increase in deflection with some fluctuation in this trend caused by changing, seasonal, subgrade moisture contents. The SCI values indicate good load transfer between the pavement and base, and have increased from 0.03 to 0.09 milli-inches.

Average roughness values ranged from 64 to 80 inches per mile indicating a "very good" to "good" riding surface.

Skid numbers at 40 m.p.h. ranged from 55 to 61 with an average of 58, indicating a good skid resistant riding surface.

Recent observations of the surface texture on I-20 have revealed evidence of raveling (pitting) and minor longitudinal cracking. Much of the fine aggregate material has begun to diminish, leaving some of the large aggregate particles near the pavement surface without sufficient bond. (See Figure 10.) The problem is not confined to any one particular area, but does appear to be worse in the wheelpaths, particularly the inside wheelpath of the outside lanes. In order to investigate the possible cause of the surface deterioration, representative cores were taken for laboratory analysis. It was determined from the extracted asphalt that excessive hardening of the binder material had occurred in the wearing course, suggesting that the surface raveling may get worse with time. A periodic monitoring system has been initiated to keep abreast of any further deterioration in the wearing course.

Other than slight pitting in the wheelpaths, no rutting or other visual signs of deterioration were observed.

## SUMMARY OF RESULTS

The findings of this report indicate the following:

1. The Surface Curvature Index values indicate good load transfer capability, increasing from a 0.03 milli-inches to 0.09 milli-inches. Average maximum deflection values have increased slightly during the three years following construction but remain below 0.08 milli-inches (maximum acceptable deflection for 13 inches of hot mix asphaltic concrete).

2. Mays Ride Meter roughness values ranged from 40 to 80 inches per mile. These values would generally be classified as "very good" to "good".

3. From a structural standpoint, the performance of test sections on both full depth projects continues to be satisfactory. Signs of deterioration such as rutting and alligator cracking have not occurred on either of the full depth projects. The 1000-foot test sections on I-20 and I-12 are representative of the projects in which they are located.

4. On the westbound I-12 section a localized longitudinal crack, approximately 500 feet long and extending through the wearing and binder courses, was observed and documented for investigation in the future. On the I-20 section a periodic monitoring system has been initiated to keep abreast of the surface raveling and minor longitudinal cracking.

TABLE 1

MAYS RIDE METER RATINGS
(TENTATIVE)

| Rating | Flexible Pavements |
|---|---|
| Very Good | 0 - 64 |
| Good | 65 - 96 |
| Fair | 97 - 160 |
| Poor | 161 - 230 |
| Very Poor | 231 and above |

TABLE 2
SLIDELL-(I-12)
STATE PROJECT 454-04-09

* SECTION 1 WESTBOUND LANES

| Date Evaluated | ADT | Σ Load (18 KIP) | Mays In./Mile | Dynaflect Deflection | |
|---|---|---|---|---|---|
| | | | | Sensor No. 1 | Surface Curvature Index (Sensor I - Sensor II) |
| 5-23-72 | 1540 | 27,412 | 41 | 0.43 | 0.05 |
| 8-21-72 | | 36,595 | -- | 0.43 | 0.04 |
| 3-12-73 | 2400 | 61,350 | -- | 0.38 | 0.05 |
| 10-9-73 | | 94,901 | 50 | 0.40 | 0.05 |
| 3-29-74 | 3230 | 126,932 | -- | 0.42 | 0.04 |
| 9-23-74 | | 165,024 | 54 | 0.48 | 0.05 |
| 12-31-74 | | 186,220 | | | |

* SECTION 2 EASTBOUND LANES

| | | | | | |
|---|---|---|---|---|---|
| **8-24-71 | --- | --- | --- | 0.41 | 0.06 |
| 5-23-72 | 1540 | 27,412 | 40 | 0.46 | 0.04 |
| 8-21-72 | | 36,595 | --- | 0.46 | 0.03 |
| 3-12-73 | 2400 | 61,350 | --- | 0.33 | 0.04 |
| 10-9-73 | | 94,901 | 57 | 0.45 | 0.04 |
| 3-29-74 | 3230 | 126,932 | --- | 0.48 | 0.04 |
| 9-23-74 | | 165,024 | 68 | 0.56 | 0.06 |
| 12-31-74 | | 186,220 | | | |

* Open to traffic 8/71

** Readings taken before open to traffic

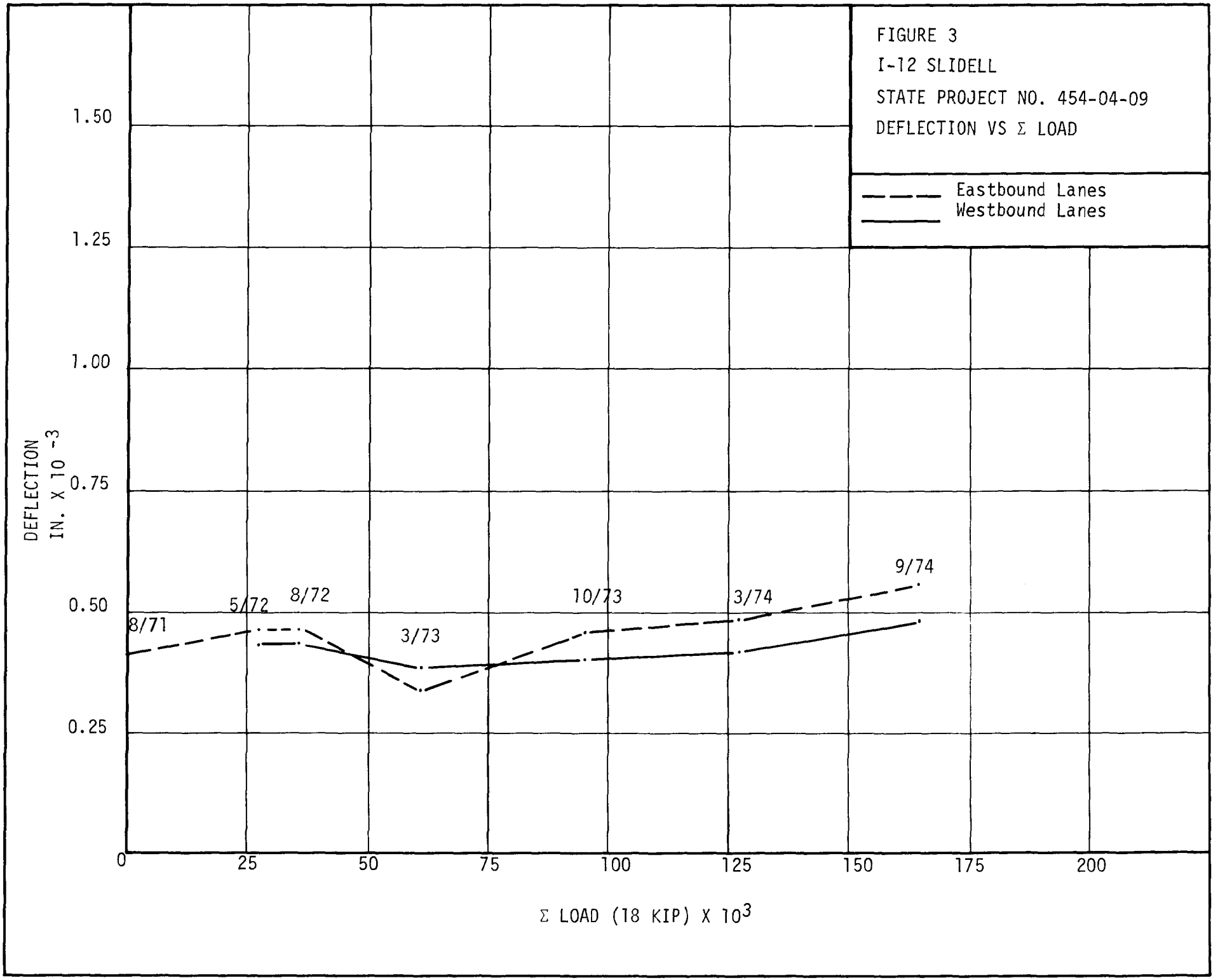
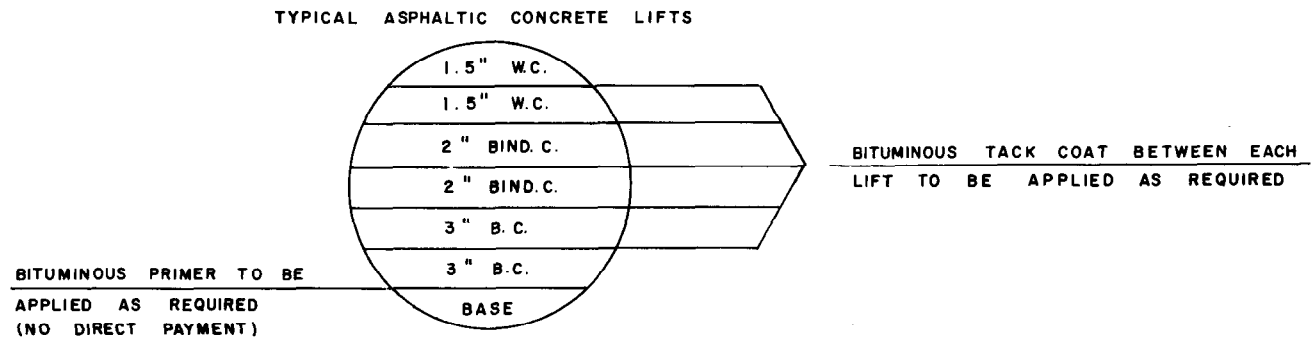
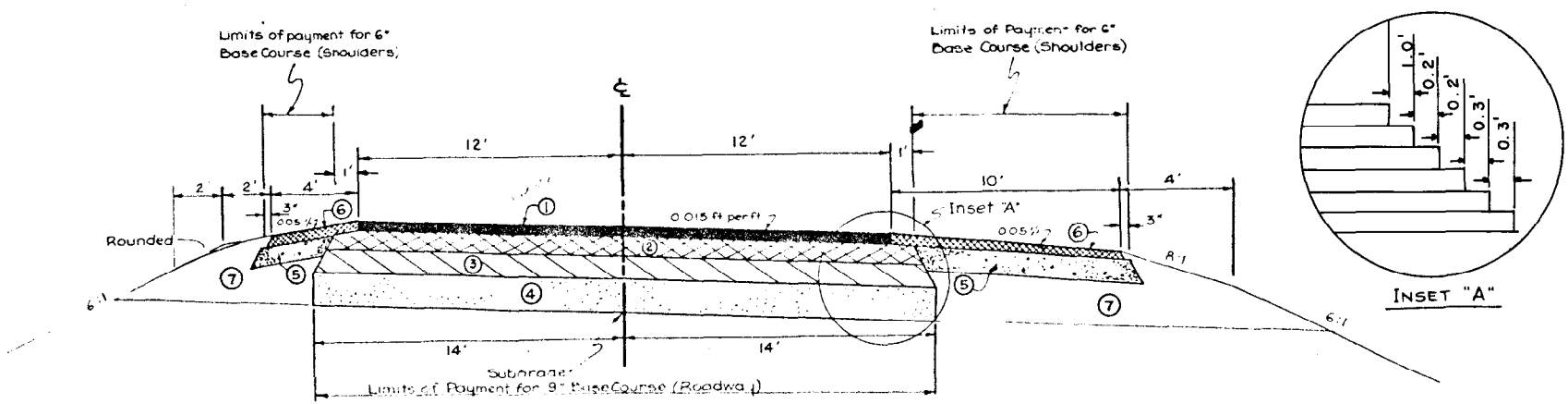


FIGURE 3
I-12 SLIDELL
STATE PROJECT NO. 454-04-09
DEFLECTION VS Σ LOAD
Eastbound Lanes
Westbound Lanes
DEFLECTION IN. X 10 -3
1.50
1.25
1.00
0.75
0.50
0.25
0
25
50
75
100
125
150
175
200
Σ LOAD (18 KIP) X 10^3
8/71
5/72
8/72
3/73
10/73
3/74
9/74




## TYPICAL FLEXIBLE SECTION

(RIGHT ROADWAY)

① 3" ASPHALTIC CONCRETE (WEARING COURSE) (TYPE 3 WITH AC-3)
② 4" ASPHALTIC CONCRETE (BINDER COURSE) (TYPE 3 WITH AC-3)
③ 6" ASPHALTIC CONCRETE (BASE COURSE) (TYPE 3 WITH AC-3)
④ 9" BASE COURSE (ROADWAY) (AGGREGATE)
⑤ 6" BASE COURSE (SHOULDER) (AGGREGATE)
⑥ 3" ASPHALTIC CONCRETE (BINDER COURSE) (TYPE 1 OR 2 WITH AC-5) TO BE CONSTRUCTED IN 2 LIFTS OF 1 1/2" EACH
⑦ SPECIAL BORROW EXCAVATION (SELECTED MATERIAL)

FIGURE 8

TABLE 3
HOLLY RIDGE-DUNN (I-20)
STATE PROJECT 451-07-08

*SECTION 1 EAST BOUND LANES

| Date Evaluated | ADT | ℄ Load (18 KIP) | Mays In./Mile | Dynaflect Deflection | |
|---|---|---|---|---|---|
| | | | | Sensor No. 1 | Surface Curvature Index (Sensor I - Sensor II) |
| 8-24-72 | 5150 | 95,502 | 74 | 0.70 | 0.08 |
| 3-8-73 | 6660 | 159,541 | -- | 0.45 | 0.05 |
| 10-18-73 | | 245,569 | 64 | 0.49 | 0.04 |
| 4-2-74 | 6290 | 307,359 | -- | 0.65 | 0.08 |
| 9-24-74 | | 370,834 | 80 | 0.76 | 0.09 |
| 12-31-74 | | 406,380 | | | |

*SECTION 2 WEST BOUND LANES

| | | | | | |
|---|---|---|---|---|---|
| 8-24-72 | 5150 | 95,502 | 72 | 0.66 | 0.08 |
| 3-8-73 | 6660 | 159,541 | -- | 0.43 | 0.05 |
| 10-18-73 | | 245,569 | 77 | 0.48 | 0.05 |
| 4-2-74 | 6290 | 307,359 | -- | 0.67 | 0.08 |
| 9-24-74 | | 370,834 | 80 | 0.73 | 0.09 |
| 12-31-74 | | 406,380 | | | |

* Open to traffic 10/71

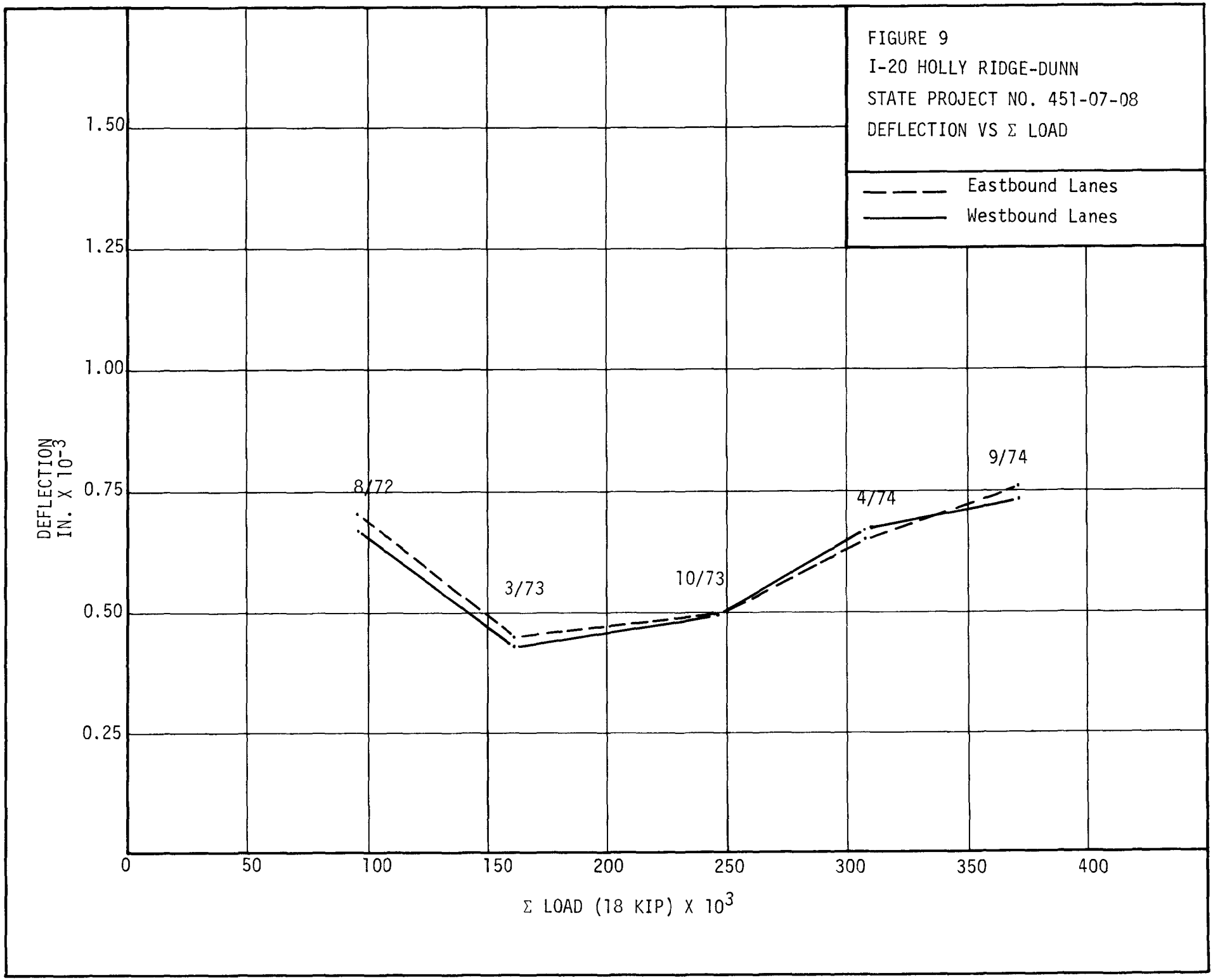


FIGURE 9
I-20 HOLLY RIDGE-DUNN
STATE PROJECT NO. 451-07-08
DEFLECTION VS Σ LOAD
Eastbound Lanes
Westbound Lanes
DEFLECTION IN. X 10-3
1.50
1.25
1.00
0.75
0.50
0.25
0
50
100
150
200
250
300
350
400
Σ LOAD (18 KIP) X 10^3
8/72
3/73
10/73
4/74
9/74