EVALUATION OF A DRAINAGE BLANKET
IN AN ASPHALT SHOULDER SECTION

INTERIM REPORT

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TABLE OF CONTENTS

TABLES AND FIGURES

SCOPE

The aim of this research project was to develop a permeable, yet stable, hot mix asphaltic drainage system for a typical pavement section. Development of such systems should provide the Department with effective means of draining water from highway bases and subbases and thus prolong the lives of those highways.

Previous research indicates that a multi-layered system of asphalt-treated drainage courses is many times more effective than single-layered aggregate drains. In this study, the investigators evaluated the permeability and stability of a two-layered asphalt-treated drainage system incorporated into the shoulder of a major roadway.

Laboratory Development of Trial Mix

The following hot mix design procedure was used and conclusions drawn by the District 62 Laboratory in Hammond, Louisiana, prior to construction of the drainage blanket:

Aggregates having grading characteristics, including both coarse and fine, were used with variable amounts of 60-70 penetration grade asphalt cement to make experimental mixtures in the laboratory. The most generally used were coarse aggregates suitable for Portland cement concrete and bituminous surface treatment, and fine aggregate suitable for Portland cement concrete. In addition, trial mixtures using uniformly graded and well graded coarse aggregates were used. After elimination of obviously impractical and unsuitable combinations, the laboratory design program centered around mixtures with the following gradation:

Percent Passing	1	2	3	4
3/4" (19.0mm)	100		100	
1/2" (12.5mm)	99		92	
3/8" (9.5mm)	68	100	79	100
No. 4 (4.75mm)	23	49	44	41
No. 10 (2.00mm)	1	25	26	12
No. 40 (425µm)		15	15	6
No. 80 (180µm)		3	3	1
% A.C.	2.0	2.0	2.5	2.5

Laboratory specimens were prepared using a concrete compaction block, 6 inch (152mm) diameter compaction mold, 6 inch (152mm) diameter steel finishing tool, and standard 10 pound (4.5Kg) Marshall hammer. Materials were heated to 325°F (163°C), mixed by hand, and compacted into 6 inch (152mm) diameter specimens approximately 2-1/2 to 3 inches (64 to 76mm) thick. The compactive effort consisted of 30 blows of the standard Marshall hammer applied to only one side of the specimen through the 6 inch (152mm) diameter steel finishing tool. Specimens remained in the mold for 24 hours, then were removed and prepared for testing.

Testing consisted of determining specific gravity and permeability of the specimens which was done according to the following procedures:

Specific Gravity - bulk specific gravity was determined in accordance with LDH TR-304, except the specimens were wrapped in Saran Wrap rather than being paraffin coated.

Permeability - the specimen was placed on a porous stone. A specially prepared concrete cylinder mold (one that has a 4 inch (102mm) diameter hole cut in the metal bottom and a bead of grease around the remaining metal portion of the bottom), is placed firmly on top of specimen. A rubber membrane testing cell was placed around the cylinder mold, specimen and porous stone. Approximately 5 psi (0.35Kg/sq.cm.) lateral pressure was applied to testing cell. Five hundred ml (0.13 gal.) of water was poured into the cylinder mold and on the top surface of the specimen. The time for all the water to disappear from the top surface of the specimen was recorded. Permeability was expressed as ml/min/sq.in.

Due to the high void content of these mixtures reliable stability values could not be obtained and this physical property was not included in the design consideration.

Average test results of the laboratory prepared specimens were as follows:

Mixture Number	Density (lbs/cu.ft.)	Permeability (ml/min/sq.in.)
1	116	Water penetrated too fast to record
2		2.3
3	123	5.6
4		9.9

Laboratory Field Trial

Three trial batches of mix were produced in a fully automatic Cedarapids batch plant and placed approximately 4 inches (102mm) thick with a conventional

Cedarapids spreader. This mixture was similar in gradation to laboratory mixture number 3. No compaction was applied (except as noted below) and the mix was allowed to cool 24 hours. During production, specimens were prepared for laboratory testing using the same procedures as in preparing the laboratory mixtures. Tests of the mixture and specimens showed the following results:

Sieve Designation	% Passing
Gradation	
3/4" (19.0mm)	100
1/2" (12.5mm)	94
3/8" (9.5mm)	79
No. 4 (4.75mm)	49
No. 10 (2.00mm)	28
No. 40 (425μm)	14
No. 80 (180μm)	4
No. 200 (75μm)	2
Percent Asphalt Cement	2.6
Density (lbs/cu.ft.)	121
Permeability (ml/min/sq.in.)	3.3

The mixture placed by the spreader was also field tested for permeability and resistance to deformation by the application of a static load. The field permeability test was performed using the following procedure:

A metal gallon can with bottom removed was placed on the mix, and weighted with a steel plate.

Grease was applied around the base of the can to seal around it.

A measured volume of water was poured into the can.

The time for all water to disappear from the top surface of the mix was recorded.

Permeability was expressed as ml/min/sq.in.

A static load of approximately 4 psi (0.28 Kg/sq.cm) was applied to the surface of the mixture by using a 50 lb. (22.7 Kg) scale weight supported by a standard 4 inch (102mm) Marshall briquette made from a Type 1 wearing course mixture. Results of these two tests were:

Permeability	4.5 ml/min/sq.in.
Deformation under 4 psi static load after 92 hrs.	1/8 inch (3.2mm)

A section of this mixture was rolled with an empty haul truck. However, this produced an extremely impermeable condition, resulting in the decision to eliminate all pneumatic rolling from the construction requirements for this material.

Laboratory Design Conclusions

The design of a drainage blanket should be based on factors that will produce a mixture that will be durable, utilize local sources of aggregates, and exhibit desirable permeability characteristics. During the laboratory studies, permeability seemed to be adversely affected by an increase in stability (as determined by the Marshall Method), and it was felt that stability should not be considered in the mix design. Likewise, the preliminary field trial indicated that rolling could be critical and should be limited in nature. Factors which were considered to be of primary importance are gradation and asphalt content, the former for permeability and the latter for durability.

Field Installation of Drainage Blanket

On May 30, 1973, an experimental section of a hot mixed drainage system was constructed in North Louisiana. The location chosen was a 920 foot (281 meter) section of the shoulder of I-20, approximately 1-1/2 mile (2.4 Kilometers) east of the junction of I-20 with La. 33 at Ruston. The construction was performed on the outside shoulder of the westbound roadway in an area showing much evidence of pumping and water incursion into the load carrying section of the roadway.

Material placed in the test section had the following gradation:

% Passing	Type "A" Drainage Mix	Type "B" Drainage Mix	Type "C" Surface Mix
3/4" (19.0mm)	97	100	100
1/2" (12.5mm)	90	93	94
3/8" (9.5mm)	68	65	82
No. 4 (4.75mm)	20	8	56
No. 10 (2.00mm)	8	2	45
No. 40 (425μm)	4	1	22
No. 80 (180μm)	3	1	12
No. 200 (75μm)	2		6
% Asphalt Cement	3.2	2.6	5.1

The shoulder was excavated and all existing material removed to a depth of 14 inches (356mm) below the edge of the riding surface and to a typical 1:20 slope (See Figure 1). A 200 by 8 foot (61.0 by 2.4 meter) section of the subgrade was found to be unsuitable and was replaced with 45 tons (40.8 metric tons) of Type "C" hot mix which was spread and rolled. The shoulder was reconstructed in the following sequence (see Figure 2 and 3):

1st lift - 2 inches (51mm) Type "C" surfacing placed on the raw soil subgrade.

2nd lift - 5 inches (127mm) Type "B" drainage mixture, placed partly in one pass, and partly in two 2-1/2 inch (63mm) passes.

3rd lift - 5 inches (127mm) Type "A" drainage mixture, placed in one pass.

4th lift - 2 inches (51mm) Type "C" surfacing

A detailed account of the actual construction is as follows (See Figure 2).

On May 30, 1973, the subgrade was neither rolled nor primed but was sealed with 165 tons (150 metric tons) of Type "C" hot mix resulting in a 2 inch (51mm) lift. That evening, 45 tons (41 metric tons) of Type "B" hot mix was placed on the Type "C" for a length of 170 feet (52 meters) from the east end of the project resulting in a 5 inch (127mm) lift. Attempts at rolling this section was ineffective due to instability related to properties of the mix. An attempt was made to roll it the following day, but it was too cool to densify.

On May 31, 1973, a 2-1/2 inch (64mm) lift of Type "B" hot mix was placed from the west end of the project in an easterly direction for 300 feet (91 meters). This lift was delivered at 225°F (107°C) and contained 2.5 percent asphalt cement but could not be rolled until cooled with water. Next, a 5 inch (127mm) lift of 257.5 tons (233.6 metric tons) of Type "B" hot mix was laid beginning 170 feet (52 meters) from the east end of the project in a westerly direction to the beginning of the 300 foot (91 meter), 2-1/2 inch (64mm) lift. This 5 inch (127mm) lift could not be rolled until the surface was reduced to a temperature between 100 and 75°F (38 and 24°C). The initial 300 foot (91 meter), 2-1/2 inch (64mm) lift was then covered with another lift of Type "B" hot mix, 2-1/2 inch (64mm) thick. Again, the lift could not be rolled until the surface temperature was reduced to 100°F (38°C).

On June 1, 1973, a 5 inch (127mm) lift of Type "A" hot mix was placed throughout the project. This lift could be rolled at a temperature of approximately 145°F (63°C) after cooling with water.

Upon completion of the drainage blanket a 2 inch (51mm) lift of Type "C" hot mix was used to surface and complete the shoulder on June 2, 1973.

Observations

The drainage blanket mix exhibited greater porosity than considered necessary. The passage of water through Types "A" and "B" hot mix was so rapid that no measurements could be made with the testing equipment that was available. When the surface was loaded at the top outside edge (truck parking load), the drainage blanket was displaced laterally by the load. The dynaflect readings revealed high deflections indicating insufficient stability (See Table 1).

Implementation

Another mix will be considered in an attempt to increase stability with a subsequent decrease in permeability, this decrease not being critical. The mix design is as follows:

The aggregate shall be graded with sufficient bituminous material that the resulting mixture meets these requirements:

Sieve Designation	Percent Passing by Weight
1" (25.0mm)	100
3/4" (19.0mm)	90 - 100
1/2" (12.5mm)	70 - 100
3/8" (9.5mm)	50 - 80
No. 4 (4.75mm)	10 - 35
No. 10 (2.00mm)	0 - 20
No. 80 (180μm)	0 - 5
% Crushed - Retained on No. 4 (4.75mm)	60% minimum
Asphalt Content	1 - 4% by weight

TABLE 1

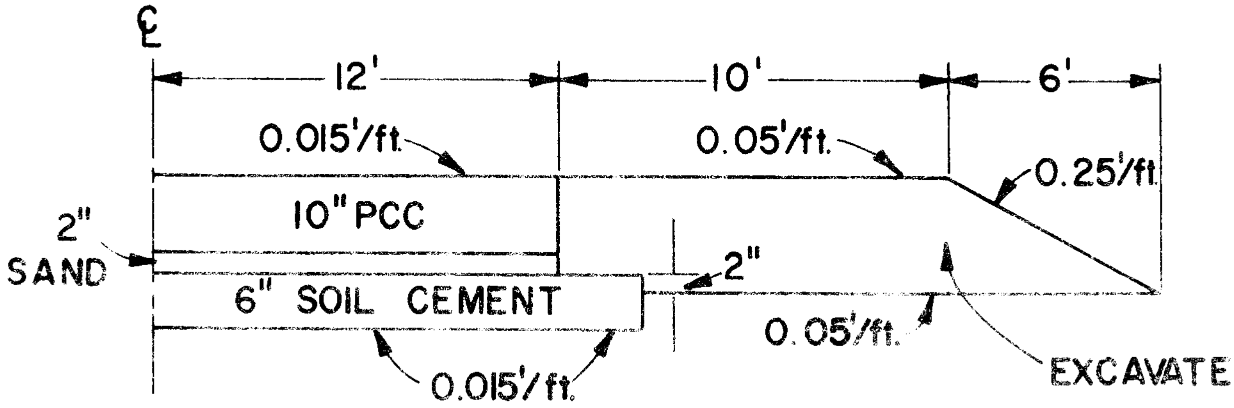
Dynaflect Deflection Data

Section Location	Sensor #1	#2	#3	#4	#5
Drainage Blanket	1.15	0.86	0.54	0.36	0.26
0 to 1000 ft.West	0.80	0.58	0.39	0.24	0.18
0 to 1000 ft.East	0.96	0.70	0.44	0.26	0.18

Note:

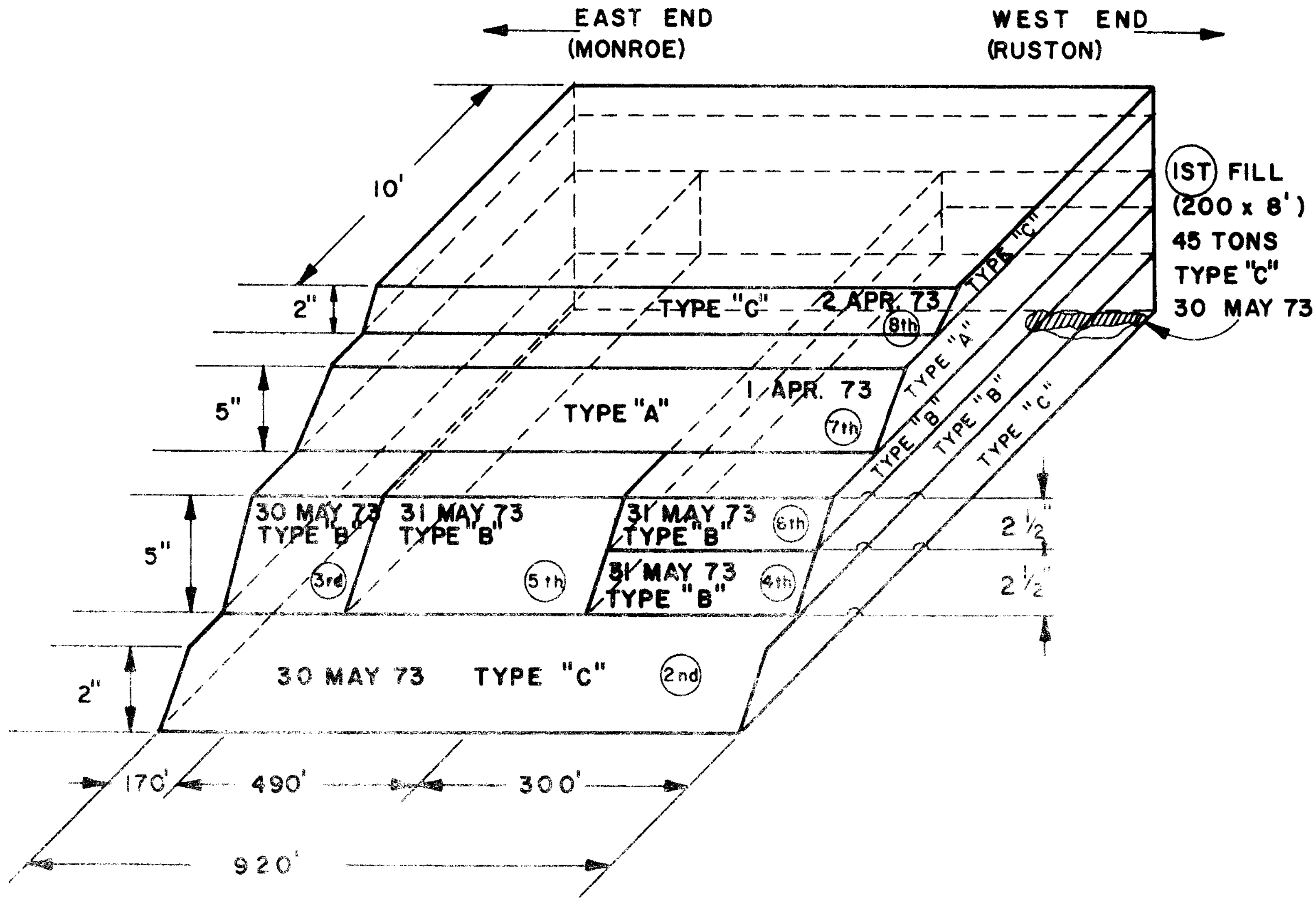
Dynaflect deflection readings were taken every 0.02 miles (0.03 Kilometers) on the drainage blanket section, as well as on 1000 foot (305 meter) adjacent shoulder sections, east and west of the drainage section.

All values represent milli-inches of deflection and are averages of deflection along each respective section. Larger deflection values on the drainage blanket section indicate less stability than the existing shoulders on either side.



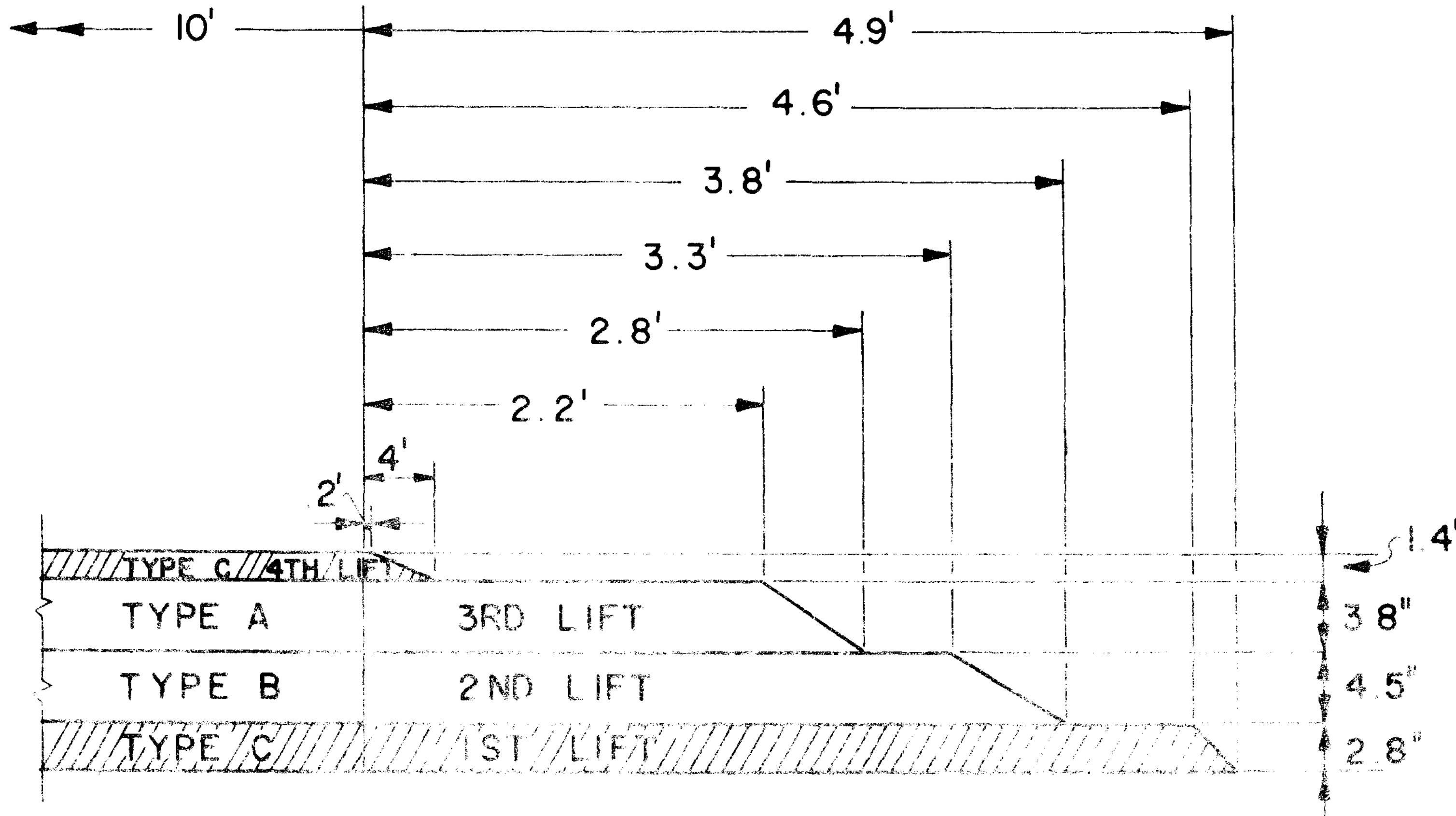
SHOULDER SECTION EXCAVATION
(TYPICAL SECTION)

FIGURE 1



CONSTRUCTION OF DRAINAGE BLANKET

FIGURE 2



DRAINAGE BLANKET (I-20)
AVERAGE SECTION (ACTUAL AVERAGE DIMENSIONS)

FIGURE 3