TEXTURING OF CONCRETE PAVEMENTS

(Interim Report No. 3)

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SYNOPSIS

During the month of June, 1973, the concrete surface of a section of Interstate 10 in the Baton Rouge area was textured using several different texturing techniques, such as burlap drag, brooms and metal tines. The purpose of this experimental research project is to learn which will perform the best in regard to skid resistance, nonhydroplaning properties, durability and uniformity. In June, 1979, five years after the roadway will have been opened to traffic, the final evaluation of the textured sections will be performed.

This interim report covers the three-year evaluation period; generally, remarks stress the changes from the two-year data to the three-year data.

Preliminary investigations indicated the following observations and recommendations:

1. Generally, skid numbers for the broom and metal tine experimental textures were higher than those for the burlap drag texture, which was specified in the Louisiana Department of Transportation and Development Standard Specifications and extensively used throughout the State.

2. Metal tines, preceded by heavy burlap drag and applied transversely to the centerline of the concrete pavement, produced grooves 1/8 to 3/16 inch deep with the highest skid number, a low speed gradient, and a noise level comparable to that of the normal burlap drag. As a result of the favorable data gathered on this study, this texturing technique has been adopted by the Louisiana Department of Transportation and Development as standard on all concrete pavements and bridge decks.

3. The extra heavy nylon broom was capable of producing a texture with high initial skid number, but the time of finishing was so critical that a uniform texture could not consistently be obtained. The researchers anticipated that the broom finish would have a wear rate greater than that of the tined finish; however, as of this date no significant difference has been noted.

4. None of the experimental textures produced objectionable road noise or increased the noise level significantly over normal burlap drag.

5. Accident data at this time is still very meager and is inconclusive. It appears accident data is not going to show anything conclusive, even with time, because of the short test sections.

6. Texture depth values, skid resistance values and noise level values remained fairly constant from the one-year evaluation period to the two-year evaluation period, but skid resistance values dropped at the end of the three-year evaluation period and the texture depth values dropped slightly. Noise level values were much higher overall; however, these values are suspect because of a change in test vehicles and tires.

SCOPE

The scope of this report is to describe the results obtained at the end of thirty-six months for the third twelve-month period of this field research project. It includes the construction of test sections and the evaluation period after the project was opened to traffic. Each test section was evaluated using the following techniques:

A. Visual Observation
B. Skid Resistance Measurements
C. Sand Patch Method for Determining the Texture Depths
D. Noise Level Measurements
E. Accident Data

METHOD OF PROCEDURE

A portion of State Project No. 450-10-19, Federal Aid Project No. I-10-3(51)160, was selected as the site of the test installations. That project was located immediately south of Baton Rouge, Louisiana, on Interstate 10 between the College Drive and Siegen Lane intersections. The project was contracted to the T. L. James Construction Company to construct the selected surface finishes onto a 10-inch, jointed, unreinforced concrete pavement. Eight different surface textures were constructed using a CMI Autograde Texturing Finisher machine. Figures 1a, 1b, and 1c map the location of each test section listed in Table 1.

It was originally proposed that surface finishes using a burlap drag with tag ends and burlap with 60p trailing nails also be included in the study. However, attempts to use these methods did not prove successful; therefore, they were dropped from the study as being inconsistent in their ability to provide a sufficient texture depth with the stiff concrete mix which was used.

The experimental textured sections were completed in June, 1973, and construction traffic used the roadway until May, 1974, when the highway was officially opened to the public.

The roadway finish was subjected to testing immediately after construction was completed and then at 3, 6, 9, 12, 24, and 36-month intervals after the highway was opened to the public. The following procedures were used as a basis for testing the performance of each experimental section.

GENERAL DISCUSSION

Types of Surface Texture

Eight different types of surface texture were constructed and are under evaluation. They are: normal burlap drag (control section), transverse texturing with soft bristle broom, transverse texturing with heavy polyplastic broom, transverse texturing with extra heavy nylon broom, transverse texturing with metal tines, longitudinal grooving with extra metal tines preceded by heavy burlap drag, longitudinal texturing with extra heavy nylon broom, and transverse grooving with metal tines preceded by heavy burlap drag. In addition, two areas within the experimental broom sections which were rained on had to be resurfaced with a neat cement grout and retextured. One area was retextured with a heavy polyplastic broom and the other with an extra heavy nylon broom. These two areas are being evaluated with the remainder of the test sections.

OBSERVATIONS

This interim report covers the three-year evaluation period and stresses the changes from the two-year data to the three-year data. Tables 2 and 3 in the Appendix contain the initial, one-year, two-year and three-year skid results along with initial, six-months, two-year and three-year noise values.

The following observations were noted:

1. Generally skid numbers for all experimental textures were higher than the burlap drag texture which had been required in the Louisiana Department of Transportation and Development Specifications and extensively used throughout the State.

2. Metal tines, preceded by heavy burlap drag and applied transversely to the centerline of the concrete pavement, produced grooves 1/8 to 3/16 inch deep with the highest skid number, a low speed gradient and with noise levels comparable to those of the normal burlap drag. This texturing technique has been adopted by the Louisiana Department of Transportation and Development as standard and is presently being applied to all new concrete pavements and bridge decks.

3. The extra heavy nylon broom was capable of producing a texture with high initial skid number, but the time of finishing was so critical that a uniform texture could not consistently be obtained. (It was anticipated that the broom finish would wear more rapidly than the tine finish; however, as of this date, no significant difference has been noted.)

4. The experimental textures did not produce objectionable road noise or increase the noise level significantly over the normal burlap drag finish.

5. Accident data at this time is still very meager and is inconclusive. It appears that accident data is not going to show anything conclusive, even with time, because of the short test sections.

6. Texture depth values, skid resistance values and noise level values remained fairly constant from the one-year evaluation period to the two-year evaluation period, but skid resistance values dropped at the end of the three-year evaluation period and the texture depth values dropped slightly. Noise level values were much higher overall; however, these values are suspect because of a change in test vehicles and tines.

APPENDIX

TABLE 1

STATIONING AND TYPES OF FINISHES

Texture No.	Station to Station		Type of Finish
1	658+00	640+00	Burlap Drag, Longitudinal (Control Section)
2	632+40	620+40	Mechanical Broom, Soft Bristle Brush, Transverse
3	620+40	600+75	Mechanical Broom, Heavy Poly-plastic Transverse
3a	600+75	588+40	Mechanical Broom, Heavy Poly-plastic Transverse - Retextured
4	588+40	561+20	Mechanical Broom, Extra Heavy Nylon, Transverse
4a	577+20	572+80	Mechanical Broom, Extra Heavy Transverse - Retextured
5	557+11	530+60	Metal Tines (1/2" center, 4" long), Transverse
6	525+74	507+70	Metal Tines (1/2" center, 4" long), Longitudinal, Preceded by Burlap Drag
7	507+70	480+20	Mechanical Broom, Extra Heavy Nylon, Longitudinal
8	477+75	435+00	Metal Tines (1/2" center, 4" long), Transverse, Preceded by Burlap Drag

TABLE 2

FIELD SKID DATA

Finish No. 1	SN_{20}	SN_{30}	SN_{40}	SN_{50}	SN_{60}	Speed Gradient	Texture Depth
Initial	60		45	-	38	0.55	0.024
1 yr.	62		55	54	52	0.26	0.019
2 yr.	-		56	52	52	0.28	0.019
3 yr.	-	49	44	41	-	0.40	0.017
Finish No. 2							
Initial	65		50	-	45	0.50	0.029
1 yr.	69		58	57	56	0.35	0.019
2 yr.	-		57	53	54	0.23	0.018
3 yr.	-	46	46	36	-	0.70	0.017
Finish No. 3							
Initial	70		66	-	52	0.50	0.039
1 yr.	68		56	54	52	0.38	0.020
2 yr.	-		60	55	53	0.40	0.019
3 yr.	-	50	44	42	-	0.40	0.018
Finish No. 3a							
Initial	56		44	-	42	-	0.028
1 yr.	65		39	41	42	0.55	0.023
2 yr.	-		34	31	33	0.13	0.022
3 yr.	-	34	34	27	-	0.45	0.020
Finish No. 4							
Initial	73		66	-	50	0.59	0.056
1 yr.	69		57	57	53	0.35	0.032
2 yr.	-		57	54	52	0.30	0.028
3 yr.	-	47	41	42	-	0.25	0.025
Finish No. 4a							
Initial	73		71	-	47	0.63	0.078
1 yr.	70		57	60	55	0.35	0.046
2 yr.	-		59	55	55	0.25	0.038
3 yr.	-	54	49	50	-	0.30	0.035

TABLE 2
(CONTINUED)

FIELD SKID DATA

Finish No. 5	SN_{20}	SN_{30}	SN_{40}	SN_{50}	SN_{60}	Speed Gradient	Texture Depth
Initial	70		61	-	53	0.43	0.033
1 yr.	72		57	53	53	0.50	0.029
2 yr.	-		55	54	53	0.10	0.025
3 yr.	-	49	45	44	-	0.40	0.025
Finish No. 6							
Initial	74		58	-	47	0.70	0.034
1 yr.	71		56	52	52	0.47	0.024
2 yr.	-		57	53	51	0.35	0.022
3 yr.	-	49	45	44	-	0.25	0.021
Finish No. 7							
Initial	67		58	-	49	0.45	0.052
1 yr.	70		60	57	54	0.41	0.034
2 yr.	-		60	54	49	0.58	0.027
3 yr.	-	48	46	43	-	0.25	0.024
Finish No. 8							
Initial	69		67	-	54	0.40	0.039
1 yr.	71		59	58	54	0.43	0.032
2 yr.	-		57	56	52	0.23	0.028
3 yr.	-	53	48	48	-	0.35	0.027

TABLE 3

EXTERIOR NOISE DATA (dBA)

	40 mph	60 mph
Finish No. 1		
Initial	74	79
6 mos.	72	79
2 yr.	74	80
3 yr.	80	84
Finish No. 2		
Initial	76	82
6 mos.	76	83
2 yr.	77	82
3 yr.	81	87
Finish No. 3		
Initial	76	83
6 mos.	77	83
2 yr.	78	83
3 yr.	86	89
Finish No. 3a		
Initial	-	-
6 mos.	79	85
2 yr.	-	-
3 yr.	-	-
Finish No. 4		
Initial	75	83
6 mos.	78	83
2 yr.	76	82
3 yr.	83	88
Finish No. 4a		
Initial	79	86
6 mos.	78	85
2 yr.	81	88
3 yr.	84	90

TABLE 3
(CONTINUED)

EXTERIOR NOISE DATA (dBA)

	40 mph	60 mph
Finish No. 5		
Initial	73	80
6 mos.	75	81
2 yr.	76	80
3 yr.	78	84
Finish No. 6		
Initial	72	79
6 mos.	75	82
2 yr.	74	80
3 yr.	79	81
Finish No. 7		
Initial	75	81
6 mos.	74	80
2 yr.	75	81
3 yr.	81	83
Finish No. 8		
Initial	74	80
6 mos.	75	81
2 yr.	75	80
3 yr.	82	84

Method of Test for

MEASURING TEXTURE DEPTH OF PORTLAND CEMENT CONCRETE WITH METAL TINE FINISH

LDH Designation: TR 229-73

Scope

1. This method describes the procedure for measuring texture depth of fresh or hardened concrete finished with a metal tine.

Apparatus

2. (a) A tire tread depth measuring gauge with 1/32 of an inch (1 mm) graduations similar to the one shown in Figure 1.

(b) Wire brush

(c) Steel straightedge approximately 1/4 x 1 x 12 inches (6 x 25 x 305 mm).

Procedure

3. The depth of texture shall be measured from the original concrete surface. Any projections above the original surface shall be removed by wire brushing or with the steel straightedge prior to taking a measurement on hardened concrete. If measurements are being made on fresh concrete, the depth gauge shall be pressed down until substantially at the level of the original concrete surface.

With the depth gauge guides in contact with the original concrete surface, the plunger is depressed until contact is made with the bottom of the groove in the concrete. The gauge is then removed

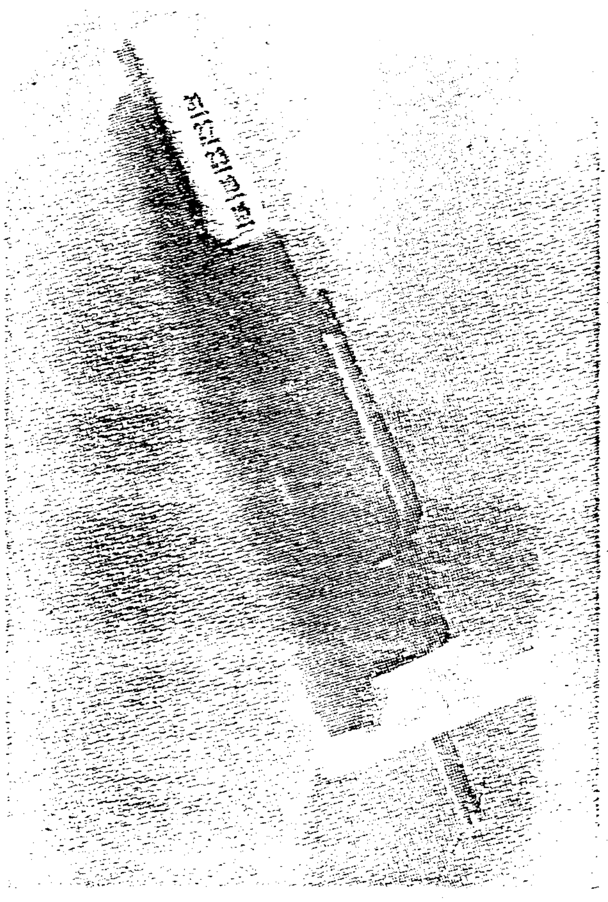

Figure 1

Depth Measuring Gauge

from the surface with care being taken to prevent the plunger from being disturbed. The texture depth is then read to the nearest 1/32 of an inch (1 mm) on the calibrated plunger. The plunger is then rezeroed and another depth measurement taken. This procedure is repeated until the necessary measurements are completed.

A sufficient number of random measurements shall be made throughout each day's operation to insure that the required texture depth is obtained.

Report

4. The depth of texture measured at a minimum of two locations per lot (or day's production if less than a lot) shall be recorded for each day's operation. At each of the locations, five measurements shall be taken transversely across the roadway. The individual readings and the average shall be recorded for each location.

Method of Test for

MEASUREMENT OF TEXTURE DEPTH BY SAND-PATCH

LDH Designation: TR 617-74

Scope

1. This method describes a procedure for determining the average texture depth of a selected portion of a pavement surface.

Apparatus

2. The apparatus shall consist of the following:

(a) Sand spreading tool consisting of a 2 ½ in. (63.5 mm) diameter flat wooden disc with a 1/16 in. (1.59 mm) thick hard rubber disc of the same diameter attached to one face and a short dowel serving as a handle attached to the other face.

(b) Metal cylinder with a volume of approximately 1.5 in.^{3} (24.6 cm^3).

(c) Natural silica sand from Ottawa, Illinois, graded to pass a No. 50 (.300 mm) sieve and retained on a No. 100 (.150 mm) sieve.

(d) Balance sensitive to .01 g.

(e) Ruler, 12 in. (305 mm) long, with markings in divisions of every 0.1 in. (2 mm).

(f) Wire brush and soft hand brush.

Procedure

3. (a) Normally a volume of 1.50 in.^{3} (24.6 cm^3) of sand is used in performing this test. This volume can be obtained by a cylinder 0.75 in. (19 mm) in inside diameter and 3.40 in. (86.4 mm) in height.

(b) If a volume other than 1.50 in.^{3}(24.6 cm^3) is desired, prepare a conversion table in which texture depths, T, can be determined for sand-patch diameters, D, ranging from 4 to 12 inches (100 to 306 mm) in increments of 0.1 in. (2 mm).

(1) Calculate the exact volume, V, of the metal cylinder prepared for this purpose.

(2) To prepare the conversion table, use the equation $T = \frac{4V}{\pi D^2}$

(c) Determine the weight of sand needed to fill the metal cylinder.

(1) Fill the cylinder to the top with dry sand and gently tap the base of the cylinder three times on a rigid surface. Add more sand to fill the cylinder again to the top and level the top with a straightedge.

(2) Determine the weight of sand in the cylinder. This weight of sand should be placed in suitable containers (35 mm film cans) and used for every sand-patch test. (The weight has been determined to be 38.83 grams for every 1.50in.^{3}[24.6cm^3].) If a balance is not available, the required amount of sand can be measured for each test by filling the metal cylinder according to the method described in Section 3c (1).

(d) The pavement surface selected for test *must be dry. If the pavement has not been subjected* to traffic, scrub the test surface with a wire brush to remove any loosely bonded particles or curing compounds that will be worn away by a small amount of traffic. Otherwise, the pavement surface should be swept with a soft hand brush.

(e) Pour the measured sand on the test surface and spread it with the rubber disc spreading tool into a circular patch with the surface depressions filled to the level of the peaks. The sand spreading tool should be kept flat on the surface and moved in a circular motion. Avoid losing any sand, especially during windy conditions. Sand used for one test should not be reused for another test.

(f) Measure the diameter of the sand-patch at five or more equally spaced locations and record to the nearest 0.1 in. (2 mm).

(g) For very smooth pavement surfaces where patch diameters are greater than 12 in. (305 mm), the diameter shall be listed as 12 in. (305 mm) plus and texture depth less than 0.013 in. (0.33 mm).

Calculation of Texture Depth

4. Compute the average diameter of the sand-patch and determine the texture depth by using the formula $T = \frac{4V}{\pi D^2}$, where:

V = Volume (in.^{3} or mm^3)
D = Sand patch diameter (in. or mm)
T = Texture depth (in. or mm)

Texture depths for a volume of 1.50 in.^{3}(24.6 cm^3) and diameters ranging from 4 to 12 inches (100 to 306 mm) in increments of 0.1 in. (2 mm) are given, in inches in Table I and in millimeters in Table II.

Reference

This test method is a modification of Test Method Tex-436-A, "Measurement of Texture Depth by the Sand-Patch Method," Texas Highway Department.

TABLE I

Texture Depth, in. (1.50 in.^{3} volume)

D = Sand-patch diameter, in.
T = Texture depth, in.

D	T	D	T	D	T
4.0	0.119	6.7	0.043	9.4	0.022
4.1	0.113	6.8	0.041	9.5	0.021
4.2	0.108	6.9	0.040	9.6	0.021
4.3	0.103	7.0	0.039	9.7	0.020
4.4	0.098	7.1	0.038	9.8	0.020
4.5	0.094	7.2	0.037	9.9	0.019
4.6	0.090	7.3	0.036	10.0	0.019
4.7	0.086	7.4	0.035	10.1	0.019
4.8	0.083	7.5	0.034	10.2	0.018
4.9	0.080	7.6	0.033	10.3	0.018
5.0	0.077	7.7	0.032	10.4	0.018
5.1	0.074	7.8	0.031	10.5	0.017
5.2	0.071	7.9	0.031	10.6	0.017
5.3	0.068	8.0	0.030	10.7	0.017
5.4	0.065	8.1	0.029	10.8	0.016
5.5	0.063	8.2	0.028	10.9	0.016
5.6	0.061	8.3	0.028	11.0	0.016
5.7	0.059	8.4	0.027	11.1	0.016
5.8	0.057	8.5	0.026	11.2	0.015
5.9	0.055	8.6	0.026	11.3	0.015
6.0	0.053	8.7	0.025	11.4	0.015
6.1	0.051	8.8	0.025	11.5	0.014
6.2	0.050	8.9	0.024	11.6	0.014
6.3	0.048	9.0	0.024	11.7	0.014
6.4	0.047	9.1	0.023	11.8	0.014
6.5	0.045	9.2	0.023	11.9	0.013
6.6	0.044	9.3	0.022	12.0	0.013

TABLE II

Texture Depth, mm (24.6 cm^3 volume)

D = Sand-patch diameter, mm
T = Texture depth, mm

D	T	D	T	D	T	D	T
100	3.13	152	1.35	204	0.75	256	0.48
102	3.01	154	1.32	206	0.74	258	0.47
104	2.89	156	1.29	208	0.72	260	0.46
106	2.79	158	1.25	210	0.71	262	0.46
108	2.68	160	1.22	212	0.70	264	0.45
110	2.59	162	1.19	214	0.68	266	0.44
112	2.49	164	1.16	216	0.67	268	0.44
114	2.41	166	1.14	218	0.66	270	0.43
116	2.33	168	1.11	220	0.65	272	0.42
118	2.25	170	1.08	222	0.64	274	0.42
120	2.17	172	1.06	224	0.62	276	0.41
122	2.10	174	1.03	226	0.61	278	0.40
124	2.04	176	1.01	228	0.60	280	0.40
126	1.97	178	0.99	230	0.59	282	0.39
128	1.91	180	0.97	232	0.58	284	0.39
130	1.85	182	0.94	234	0.57	286	0.38
132	1.80	184	0.92	236	0.56	288	0.38
134	1.74	186	0.90	238	0.55	290	0.37
136	1.69	188	0.89	240	0.54	292	0.37
138	1.64	190	0.87	242	0.53	294	0.36
140	1.60	192	0.85	244	0.53	296	0.36
142	1.55	194	0.83	246	0.52	298	0.35
144	1.51	196	0.81	248	0.51	300	0.35
146	1.47	198	0.80	250	0.50	302	0.34
148	1.43	200	0.78	252	0.49	304	0.34
150	1.39	202	0.77	254	0.49	306	0.33