VARIATIONS OF TINE TEXTURING OF PCC PAVEMENT

Final Report
for
MLR-93-4

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Project Development Division

Iowa Department of Transportation

Final Report
for
Research Project MLR-93-4

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8. ABSTRACT

Seven experimental texture sections were constructed on the Polk-Jasper RP-163-1(50)--16-77 project just east of Des Moines. The experimental sections included two groove depths for longitudinal tine texture and 13 mm (½ in.), 19 mm (≤ in.) and variable spaced transverse tine textures. An artificial turf textured section was also included. Friction values and a rating of objectionable noise were determined for all sections. All transverse tine textures generated a high level of objectionable noise. The longitudinal tine texture was rated very good in regard to objectionable noise. At this time, all tined textures are providing satisfactory friction values.

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DISCLAIMER

INTRODUCTION

Iowa has relied very heavily on portland cement concrete (PCC) pavement since the first Iowa placement in 1904. In general, Iowa PCC pavements have performed very well with many giving over 50 years of use. Beginning in 1952, a burlap or carpet drag texture was required on Iowa PCC pavement. Iowa began testing the friction properties of paved primary roadways in 1968. This testing showed that burlap drag texture was soon worn away. The tire wear polished the surface and resulted in friction properties less than desired levels. Soft limestone coarse aggregates used in Iowa are very susceptible to the wearing and polishing.

Research on deeper textures was initiated in 1969 on US 63 west of Traer (1). Transverse tining and longitudinal and transverse brooming were compared to burlap drag texturing. Friction testing showed that all of the textures except the transverse tining had been worn away and polished in five years. Based on this research, transverse tine texturing has been required on PCC primary pavement since 1977. It was recognized that the transverse tine texturing resulted in increased noise, but this additional noise was an acceptable tradeoff for improved safety.

In the late 1980s and the 1990s, the complaints about noise from the transverse tine texturing increased. Motorists today object to the higher noise levels. The predominance of complaints are by drivers and passengers about noise inside the vehicle.

A recent Portland Cement Association report presents the state of practice for surface texture of PCC pavement (2).

OBJECTIVE

The objective of this research is to evaluate variations of tine texturing to determine if one with friction property longevity and reduced noise could be identified.

PROJECT AND CONTRACTOR

The various experimental tine textures were placed in the western two miles of the Polk-Jasper RP-163-1(50)--16-77 project just east of Des Moines. It is on IA 163 and begins at milepost 12.36 (approximately six miles west of Prairie City) and ends at milepost 17.01 (Figure 1). The contractor on this project was Cedar Valley Corporation of Waterloo, Iowa.

MATERIALS AND MIX PROPORTIONS

The contractor, Cedar Valley Corporation, used the following materials in the experimental section:

Cement - Type I Holnam from Mason City, Iowa

Coarse Aggregate - Kaser Corporation, Sully Mine - Specific Gravity = 2.59

Fine Aggregate - Van Dusseldorp Sand and Gravel, Colfax-Specification Gravity = 2.67

Fly Ash - Midwest Fly Ash - Ottumwa Class C

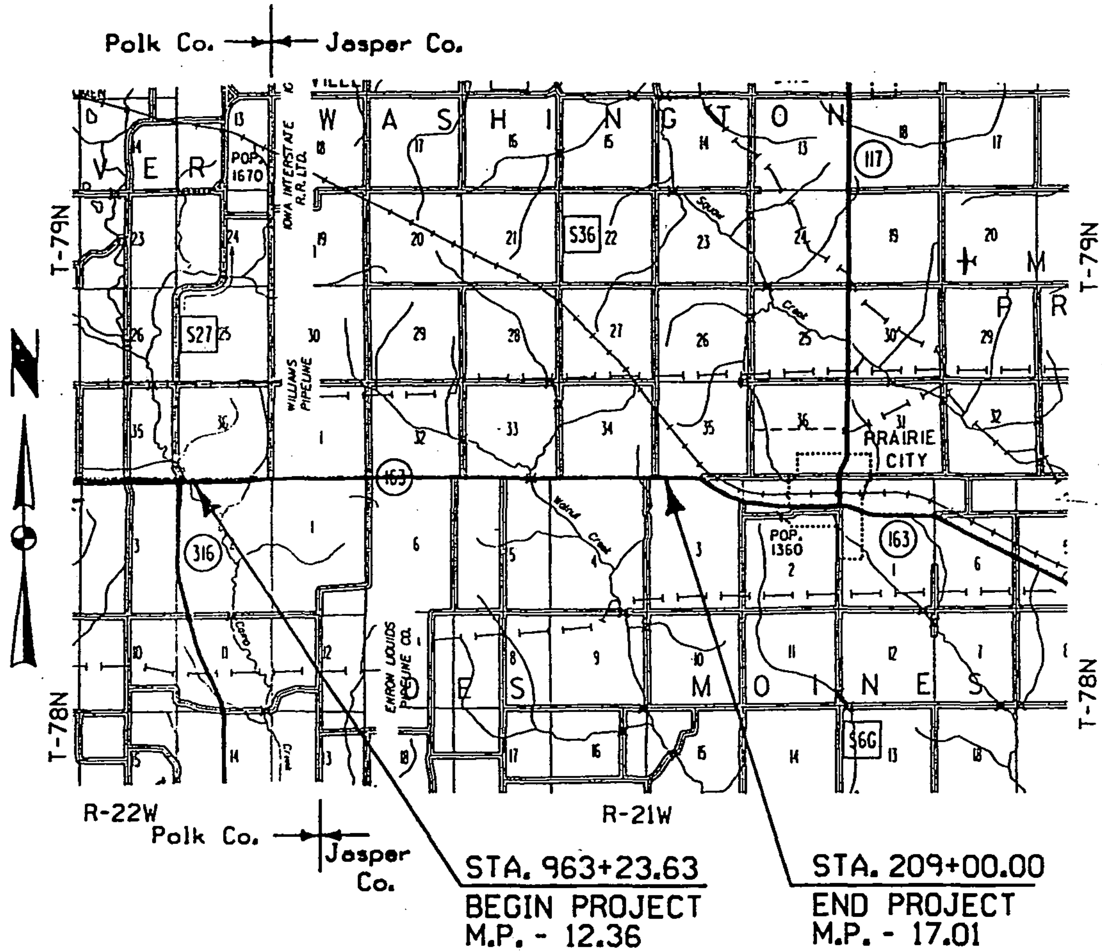


Figure 1 - Project Location

The contractor used two mix proportions in the experimental section. The only difference was that fly ash was not used in one portion. This should not have a significant effect on the tine textures. The batch weights for the two mixes are:

	MIX NO.			
	C4WR		C4WRC	
	Kg	lbs	Kg	lbs
Cement	269	593	228	503
Fly Ash, Class	None	None	41	91
Coarse Aggregate	669	1475	665	1466
Fine Aggregate	692	1525	668	1516
Water	115	254	116	256

TEXTURING EQUIPMENT AND OPERATION

The currently specified surface texture for Iowa DOT portland cement concrete (PCC) pavement is 3 mm (1/8 in.) to 5 mm (3/16 in.) deep transverse grooves spaced on 19 mm (¾ in.) center to center. This grooving is imparted by a tining buggy with a 3 m (10 ft) wide rake with flexible metal reeds. It makes a pass from left to right, then moves forward and imparts the next texture pass on the return trip from right to left. The depth of groove is regulated by the amount of downward pressure that is applied and the time since mixing and placement.

The texture for one section was imparted by dragging artificial turf longitudinally behind a trailing bridge with no tine texturing following the artificial turf drag. The artificial turf drag preceded the tine texturing on all other sections.

The longitudinal tining was imparted using four 1.8 m (6 ft) wide tining rakes with tines spaced 19 mm (¾ in.) center to center. The handles of these rakes were pivoted over the trailing bridge. A flexible luggage strap was fastened in tension to the end of the handle opposite the tines. Weight was applied to the rake end to regulate the depth of the longitudinal grooves. The longitudinal grooves on these two experimental sections are not as straight as desired. They wander back and forth laterally until the contractor developed an understanding of how to correct the problem.

TEST SECTIONS

The test sections were placed in the westbound roadway as shown in Figure 2. Construction of the experimental sections began on October 17, 1993 and was completed October 23, 1993.

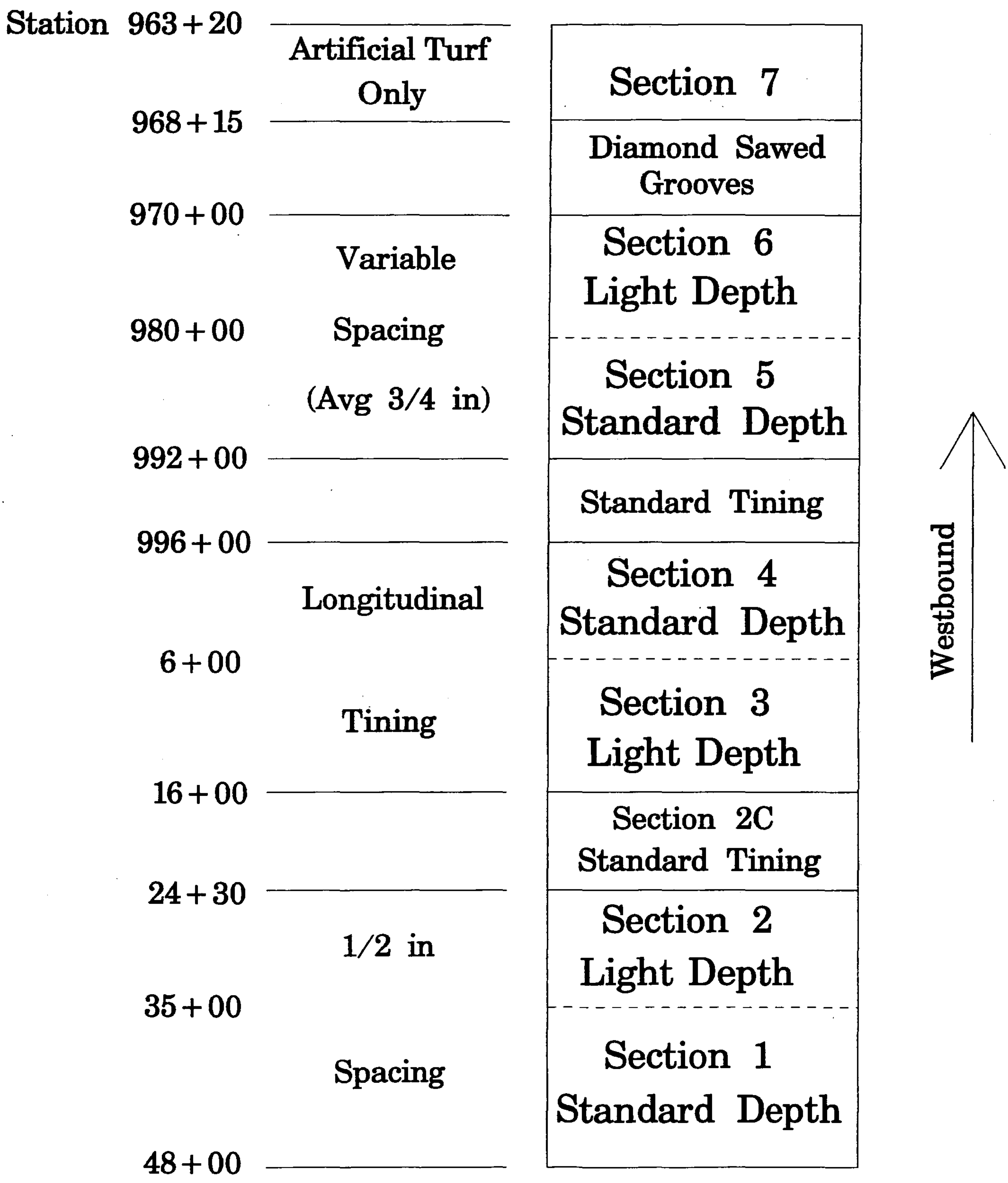
TEXTURE DEPTHS

The groove depths are somewhat variable. This is probably due to the variability of the time between batching and placement and the time when the texture was imparted. The average groove depths conform very well to what was intended. Groove depths were measured twice using a tire tread depth gauge graduated in 0.8 mm (1/32 in.) increments. The average for each experimental section being:

SECTION	AVERAGE GROOVE DEPTH, 0.8 mm (1/32")	
	1994	8-6-96
1	3.25	3.33
2	2.25	2.00
2C	3.13	3.33
3	2.50	2.67
4	4.00	3.33
5	2.75	3.67
6	2.50	1.33
7	No Grooves	

The groove depths were measured to the nearest 0.8 mm (1/32 in.) graduation. Values to 0.01 are given only to indicate the average not to indicate accuracy.

Figure 2 Test Section Layout
IA 163 Polk County



EVALUATION OF NOISE

Sound measuring equipment was not readily available. There was also a feeling that it would be difficult to accurately measure the level, frequency and tone as heard by a human ear. A particular combination of these may be the most objectionable. The noise evaluation was conducted by four individual raters making two runs traveling 89 kmph (55 mph) in a minivan with the windows all closed and the air conditioner off. Each individual rated sections from "1" being "not objectionable" to "10" being "very objectionable." The average panel ratings on August 6, 1996 were:

SECTION	AVERAGE PANEL NOISE RATING
1	6.4
2	5.7
2c	5.8
3	2.4
4	3.0
5	7.4
6	6.1
7	1.6

FRICTION TESTING

The friction values of all experimental sections were determined using an ASTM E274 two-wheeled trailer. The average friction values for a ribbed tire on a wetted surface at 64 kmph (40 mph) are:

SECTION	AVERAGE FRICTION VALUES 1994	1995	1996
1	46	55	54
2	52	58	53
2c	53	57	56
3	48	54	50
4	49	50	45
5	49	49	49
6	54	52	50
7	41	47	47

DISCUSSION

From experience and research, broom or artificial turf textures are worn away by traffic in a relatively short period of time (1). A tined texture is needed to ensure longevity of the macrotexture. A deeper texture is necessary to allow the water to escape from beneath the tire and provide adequate safety to the motorist.

There have been a number of complaints due to the tire noise generated by the current Iowa DOT transverse tine texturing. The ratings by the panel of the noise from the transverse tine textured supports the opinion that transverse tine textures are more objectionable. On these experimental sections, even reducing the depth of the transverse tine textures did not significantly reduce the objectionable noise.

On this project, changing the tine spacing from the current uniform 19 mm (¾ in.) spacing to either a 13 mm (½ in.) spacing or a variable spacing did not significantly reduce the objectionable noise. In fact, the variable spaced tining at a standard depth yielded the most objectionable noise.

The least objectionable noise was generated from the artificial turf, but this section will probably not provide satisfactory long term friction values. The noise rating of sections 3 and 4 using longitudinal tine texture was relatively low and very definitely less than transverse tine textures. There has been some concern about motorcycle safety with longitudinal grooves. California has researched this issue (3) and currently uses longitudinal grooving.

CONCLUSIONS

The following conclusions can be made from this research on tined texturing:

1. Transverse tine textures generate objectionable tire noise.
2. The depth of transverse tine texture does not change the level of objectionable noise to any significant degree on this research.
3. The 13 mm (½ in.), 19 mm (¾ in.) and variable tine spacing transverse textures used in this research all yielded approximately the same level of objectionable noise.
4. The longitudinal tine texture generated substantially less objectionable noise than the transverse tine texture.

RECOMMENDATION

Based on the results of this research, the Iowa DOT should change the specification for texturing of PCC pavement to require 3mm (1/8 in.) to 5 mm (3/16 in.) deep longitudinal tine texturing. The specification should further require controls to ensure the straightness of the longitudinal tining.

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