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Mechanical Texturing Of Three Bridge Decks

J. G. FRED HISS, JR.

SPECIAL REPORT 101

ENGINEERING RESEARCH AND DEVELOPMENT BUREAU
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MECHANICAL TEXTURING OF THREE BRIDGE DECKS

J.G. Fred Hiss, Jr., Assistant Director
of Engineering Research and Development

Final Report on Research Project 12-6
Conducted in Cooperation with
The U.S. Department of Transportation
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16. Abstract

This report's primary purpose is to present findings from visual surveys of long-term performance of various surface texturings of bridge decks at three locations. In addition, results of 1988 friction measurements on one of these decks are compared with measurements in 1981 and 1982. An interim report (Research Report 108) on this study discussed experimental application of sawed-groove texturing on three bridges and operational use of diamond grinding to rectify an aggregate friction problem on another. Tine-texturing, the then-current standard texturing method, served as a control on each of the bridges. Based on the visual surveys, the following conclusions appear warranted: 1) sawed-groove texturing appears to be the most durable over a 10-year period, 2) tined-groove texturing was somewhat less durable than sawed-groove texturing, and 3) diamond-ground grooving was the least durable.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

LENGTH

Symbol	When You Know	Multiply By	To Find	Symbol
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
in²	square inches	645.2	millimetres squared	mm²
ft²	square feet	0.0929	metres squared	m²
yd²	square yards	0.836	metres squared	m²
mi²	square miles	2.59	kilometres squared	km²
ac	acres	0.395	hectares	ha

MASS (weight)

Symbol	When You Know	Multiply By	To Find	Symbol
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

VOLUME

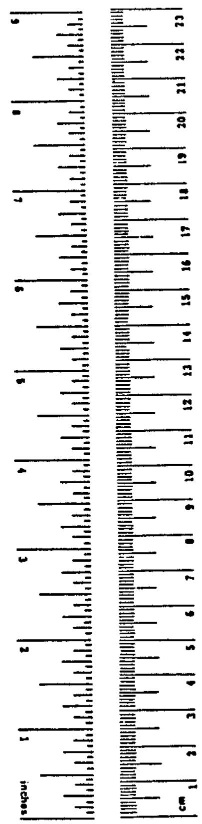
Symbol	When You Know	Multiply By	To Find	Symbol
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft³	cubic feet	0.0328	metres cubed	m³
yd³	cubic yards	0.0765	metres cubed	m³

NOTE: Volumes greater than 1000 L shall be shown in m³.

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* SI is the symbol for the International System of Measurements



APPROXIMATE CONVERSIONS TO SI UNITS

LENGTH

Symbol	When You Know	Multiply By	To Find	Symbol
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
mm²	millimetres squared	0.0016	square inches	in²
m²	metres squared	10.764	square feet	ft²
km²	kilometres squared	0.39	square miles	mi²
ha	hectores (10 000 m²)	2.53	acres	ac

MASS (weight)

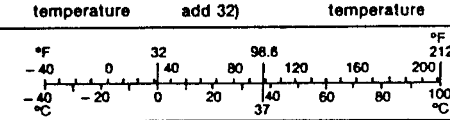
Symbol	When You Know	Multiply By	To Find	Symbol
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

VOLUME

Symbol	When You Know	Multiply By	To Find	Symbol
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m³	metres cubed	35.315	cubic feet	ft³
m³	metres cubed	1.308	cubic yards	yd³

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

CONTENTS

I. INTRODUCTION

When the study reported here was initiated in 1979, the standard procedure for transverse texturing on new portland-cement-concrete bridge decks was to use a tined metal rake. This method had the potential to produce grooves deep enough to provide long-lasting, high-friction surfaces, but it was hard to attain grooves deep enough to meet the specified minimum of 2/16 in. This was particularly true where hand-tools were used (1). The problem was aggravated when using stiffer high-density low-slump (HDLS) concrete that resisted penetration, or latex-modified concrete (LMC) that was too fluid when placed to hold the grooves. A possible alternative method considered to obtain the desired texture was to saw grooves after the concrete had cured. Sawing grooves into concrete pavements was then widely used to restore texture on worn surfaces, but had not been generally accepted or promoted for new concrete bridge decks.

In 1980, surface texture on portions of bridge decks at two locations in New York was obtained by sawcutting grooves. Portions of these decks not sawed were tine-textured and served as control sections. In 1981, surface texture of a third bridge deck was restored by diamond grinding. FHWA permitted this texture-restoration method at this site, but with the condition that its evaluation be included in this research project.

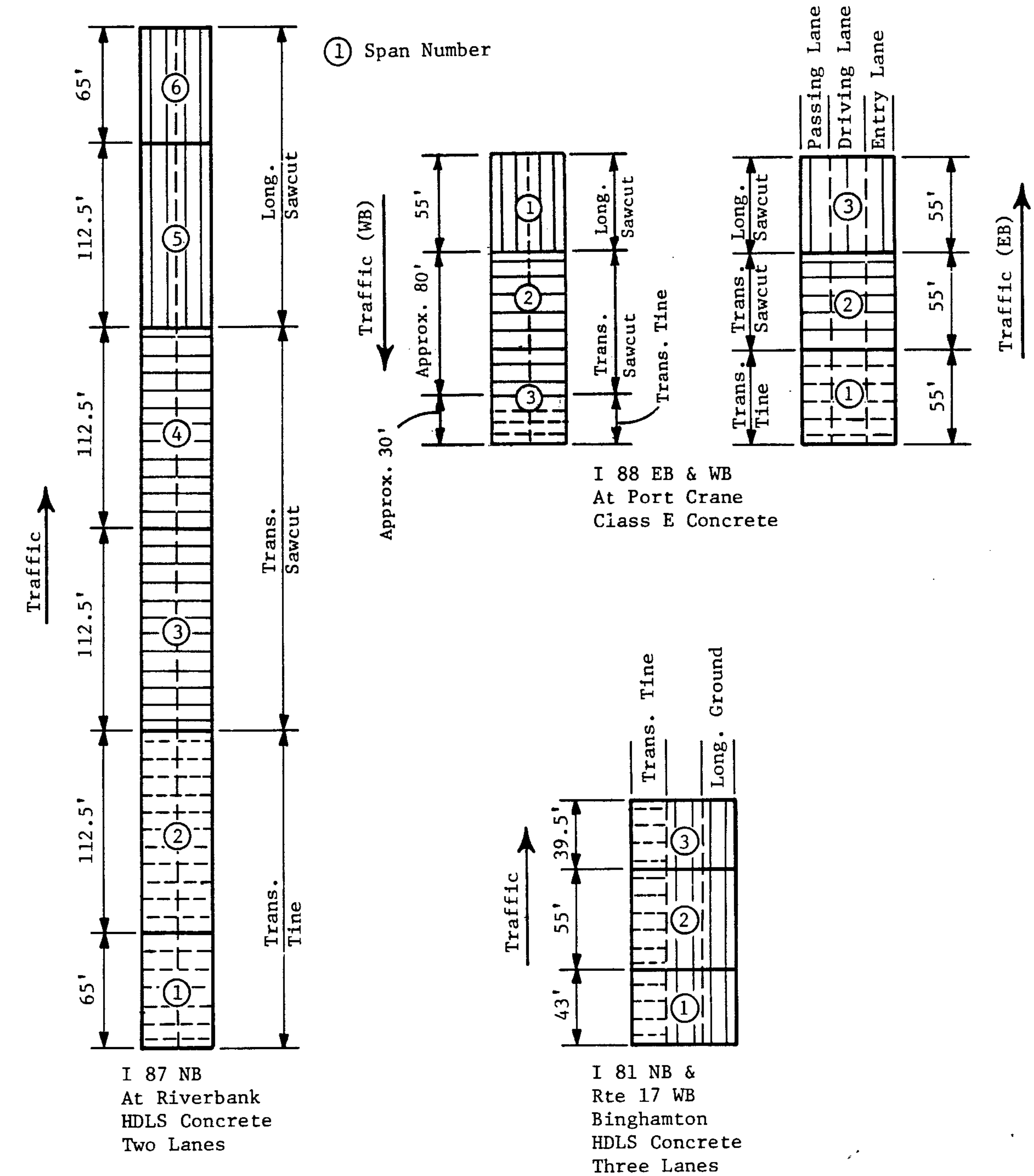
In September 1983, an interim report (2) was published. It discussed experimental application of sawed-groove texturing on the bridges at the two sites and operational use of diamond grinding to rectify an aggravated friction problem at the third. This report presents findings of field surveys 10 years after construction of the sawed-grooved test sections. It also presents findings of a field survey of the diamond-ground test section 9 years after construction, and friction measurements taken 7 years after construction.

A. Background

Research in New York (1) had shown that initial grooves 3/16-in. deep should provide adequate friction (FN_{40} >32) for the design life (15 years) of most pavements. The Department was encouraged by FHWA to try sawcutting on an experimental basis, with the provision that this be compared with tine-texturing, for both frictional properties and concrete durability (3,4). As a result, two bridge deck overlay projects were selected during the 1980 construction season, into which sawed textures were incorporated experimentally -- one on a HDLS overlay and the other on a conventional-concrete full-depth monolithic-slab reconstruction (5).

The first project involved a HDLS overlay of an existing three-lane, six-span structure on northbound I 87 at Riverbank in Warren County. The first two spans

Figure 1. Texturing plans.



were textured transversely by tining, the third and fourth transversely by sawing, and the fifth and sixth longitudinally by sawing (Fig. 1).

The second project was a full-depth monolithic reconstruction and widening on two parallel, bridges carrying I 88 over Rte 369 between Port Crane and Sanitaria Springs in Broome County (referred to here for brevity as "Port Crane"). This involved reconstruction of both bridge decks, each approximately 165 ft in length, using conventional Class E concrete. One section on each of the two decks was textured by transverse tining, one by transverse sawing, and one by longitudinal sawing (Fig. 1). (The schematic diagram of the westbound (WB) bridge in Research Report 108 was in error. The longitudinal sawcut section is at the east end of the bridge and the transverse sawcut section is composed of the center span and about half the western-most span.) All sawed grooves on both projects were nominally 3/16-in. ± 1/16 in. deep, and 1/10-in. wide on 3/4-in. centers.

The third project was added to the study the following year (1981) when longitudinal diamond grinding was chosen as the method to restore friction to a series of recently constructed decks that had polished and become slippery shortly after being opened to traffic. The specific structure selected for the investigation was a 137.5-ft, three-span bridge (Fig. 1) carrying I 81 northbound and Rte 17 westbound over Chenango Street in Binghamton. It had been resurfaced in 1980 with HDLS concrete, but had polished rapidly under exceptionally high channelized traffic.

B. Purpose

The primary purpose of this report is to present findings from visual surveys of long-term performance of the various surface textures.

II. RESULTS

During September 1990 the test sites at Port Crane and Binghamton were surveyed to determine how they were performing after about 10 years in service (9 years for I 81 at Binghamton). A similar survey was performed at the Riverbank in December 1990. Photographs during these surveys are shown here, with comments recorded during the surveys. In addition, June 1988 friction measurements at Binghamton are discussed.

A. I 87 NB at Riverbank

This was built with HDLS concrete in October 1980, and surveyed after 10 years in service as shown in Figures 2 through 4. Sawcut texturing appears more durable than tine texturing, and spalling and popouts seem not to have posed a problem.

B. I 88 EB and WB at Port Crane

This was built with Class E concrete in October 1980, and surveyed after 10 years in service as shown in Figures 5 through 8. Overall, centerline sawcut grooves are in better condition than those formed by tine texturing. Spalling and popouts were not a major problem, but the tine-textured surface showed greater wear.

C. I 81 NB and Rte 17 WB at Binghamton

This was built with HDLS concrete in August 1981, and surveyed after 9 years in service, as shown in Figures 9 and 10. Diamond-ground texturing had worn away in the wheelpaths, and tine texturing although still visible was also worn.

In addition to the visual survey, the Materials Bureau friction-measuring trailer made measurements in June 1988. Results, along with friction numbers on the same bridge measured in 1981 and 1982 (and published in Research Report 108), were as follows (note that the 1988 FN_{40} numbers are above the minimum 32 generally accepted lower limit):

		Ribbed Tire FN_{40}		
Texture	Location	1981	1982	1988
Tined	Far lefthand passing lane	29.7	30.6	39.6
Ground	Righthand driving lane	45.5	51.2	35.5

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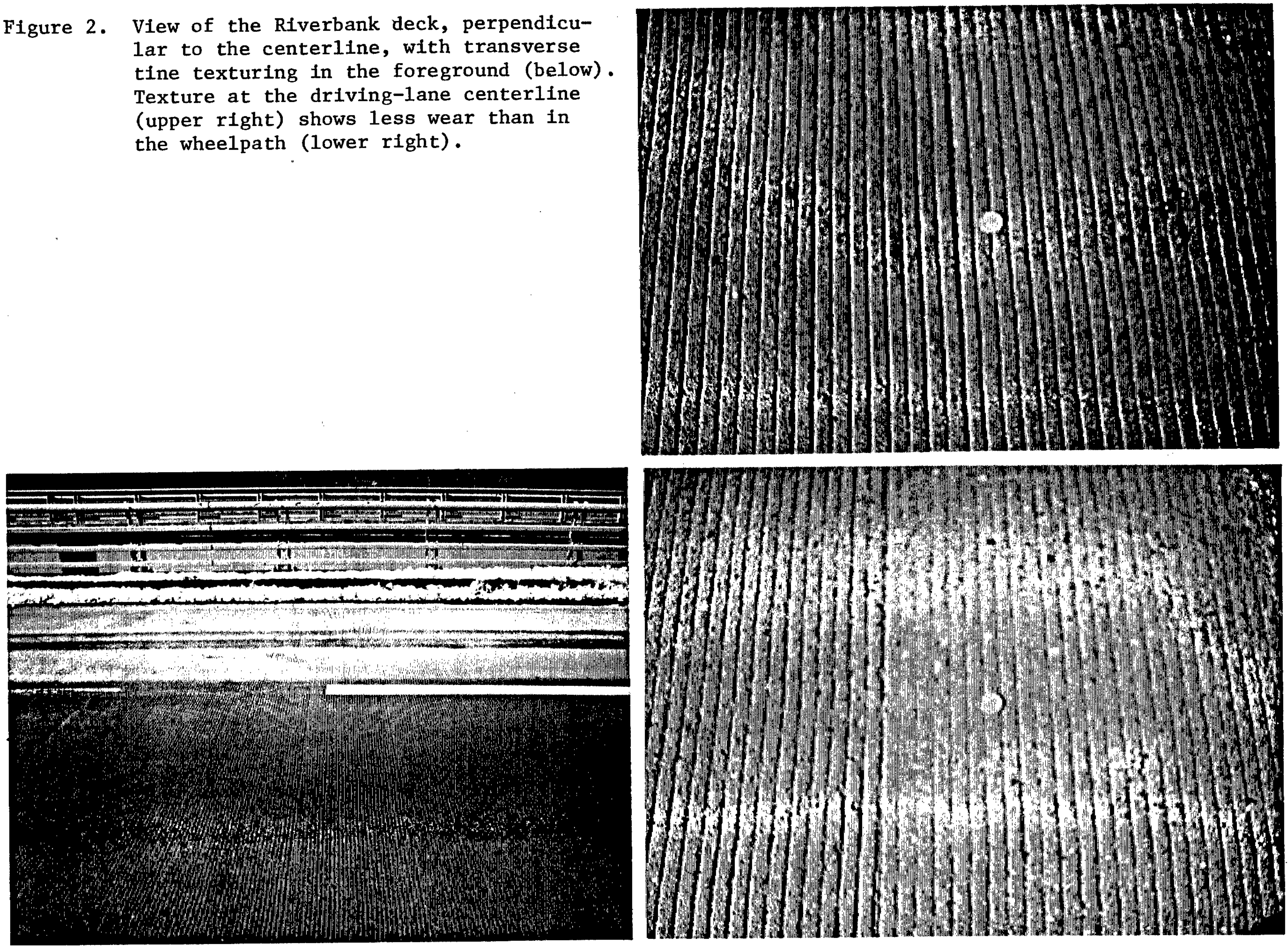


Figure 2. View of the Riverbank deck, perpendicular to the centerline, with transverse tine texturing in the foreground (below). Texture at the driving-lane centerline (upper right) shows less wear than in the wheelpath (lower right).

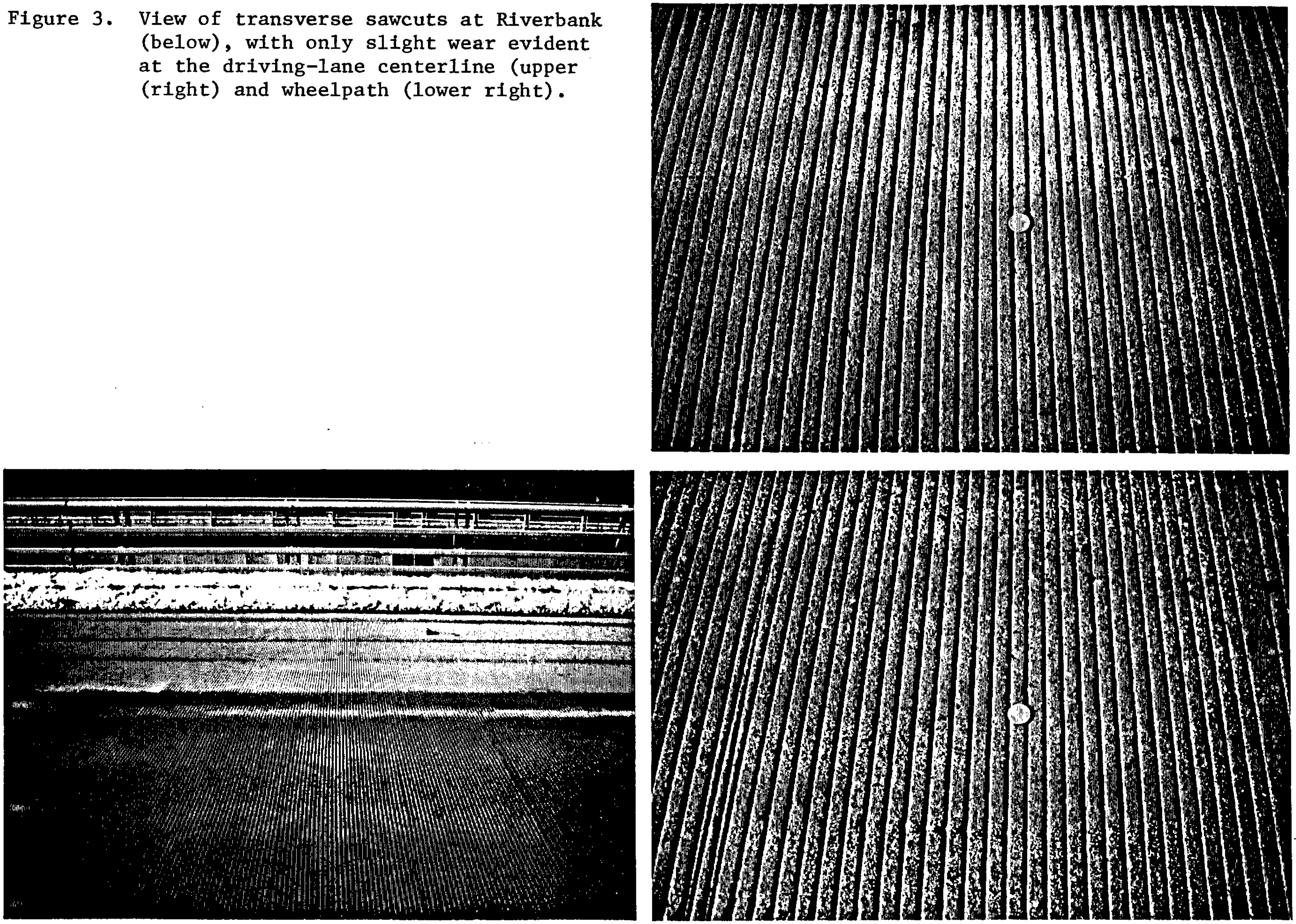
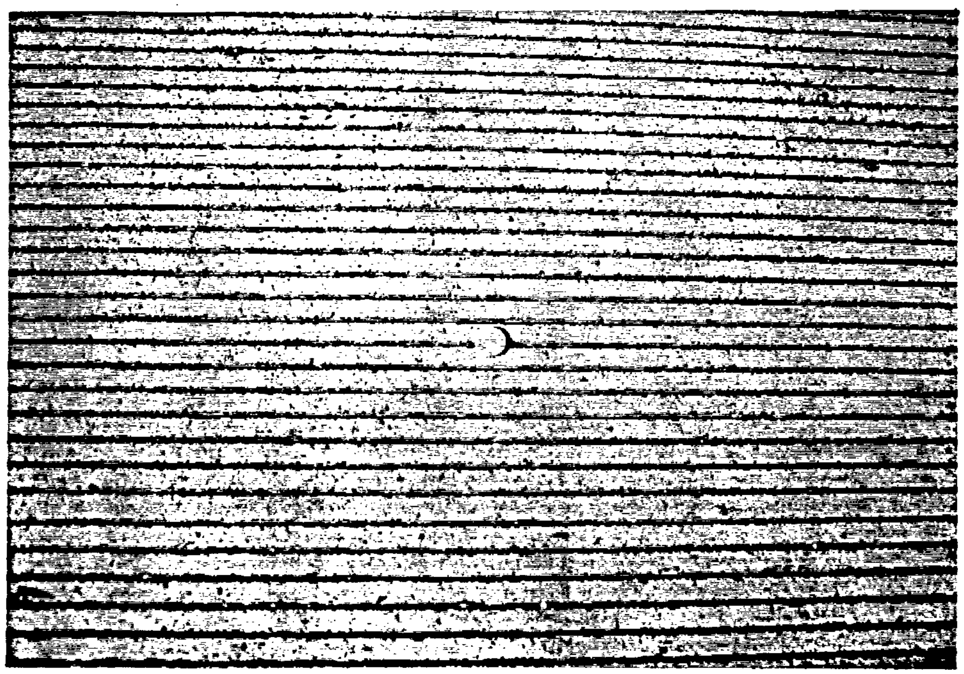


Figure 3. View of transverse sawcuts at Riverbank (below), with only slight wear evident at the driving-lane centerline (upper (right) and wheelpath (lower right).

Figure 4. Wear of longitudinal sawcuts at Riverbank, at the driving lane centerline (above) and in a wheelpath (below).



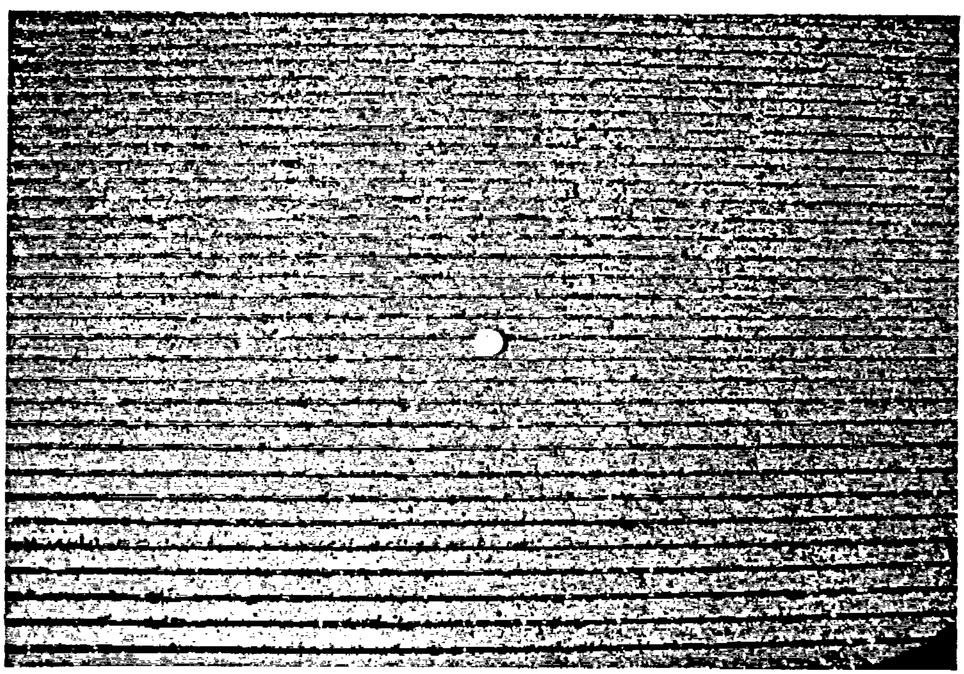
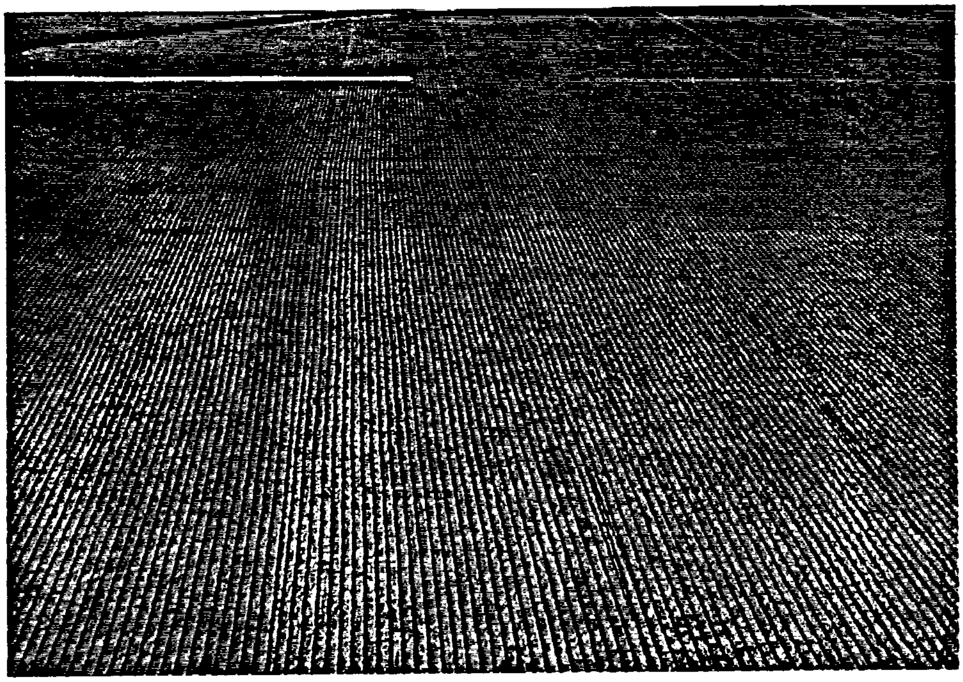


Figure 5. General view (above) and detail (below) of transverse tine texturing on the eastbound Port Crane bridge.



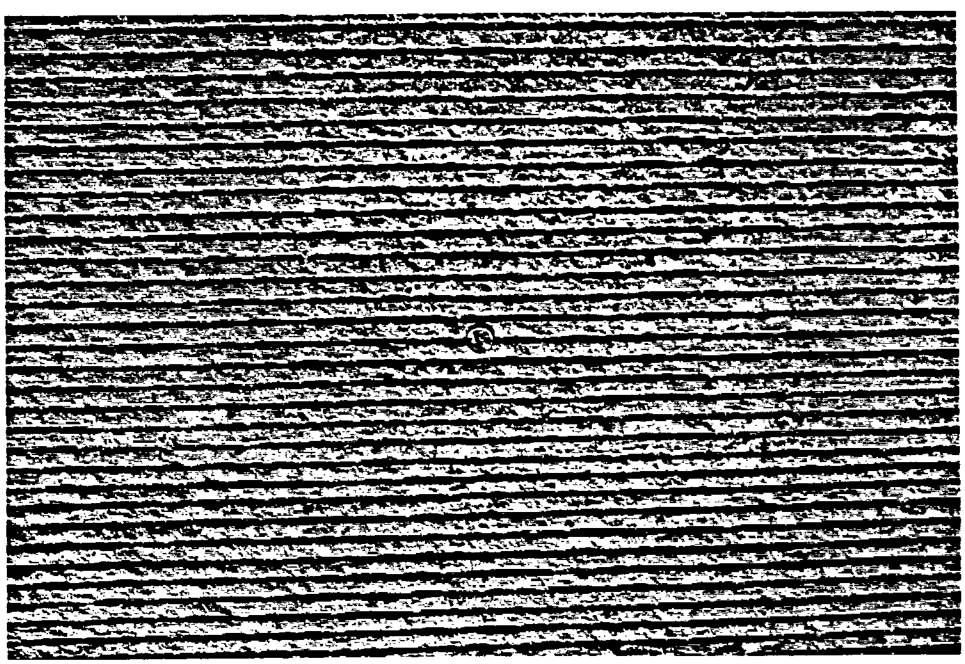


Figure 6. General view (above) and detail (below) of transverse sawcutting on the eastbound Port Crane bridge.

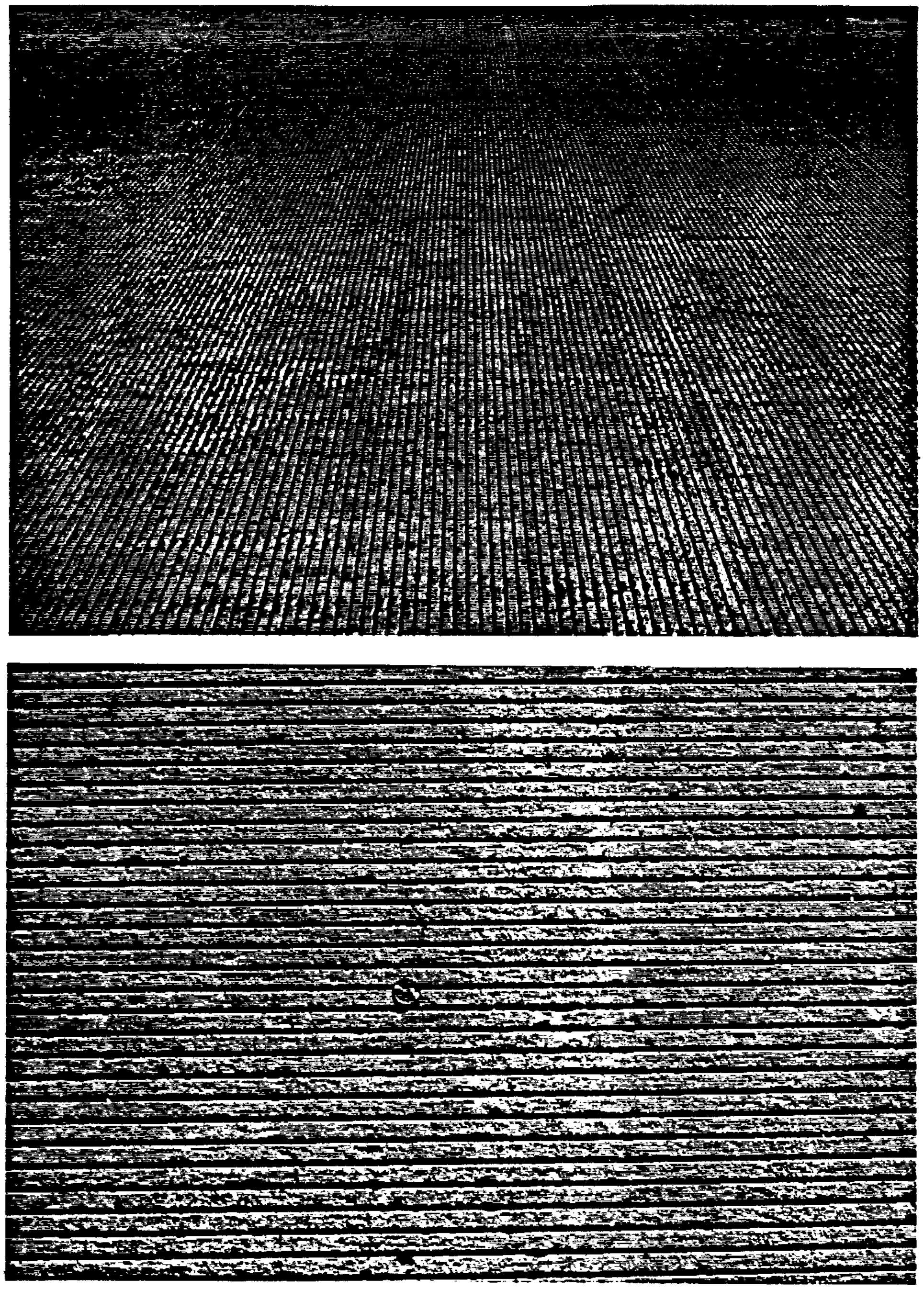


Figure 7. General view (above) and detail (below) of longitudinal sawcutting on the eastbound Port Crane bridge.

Figure 8. Longitudinal sawcutting on the westbound Port Crane bridge (above), with detail of juncture of sawcut grooves (below left) and tined grooves (below right).

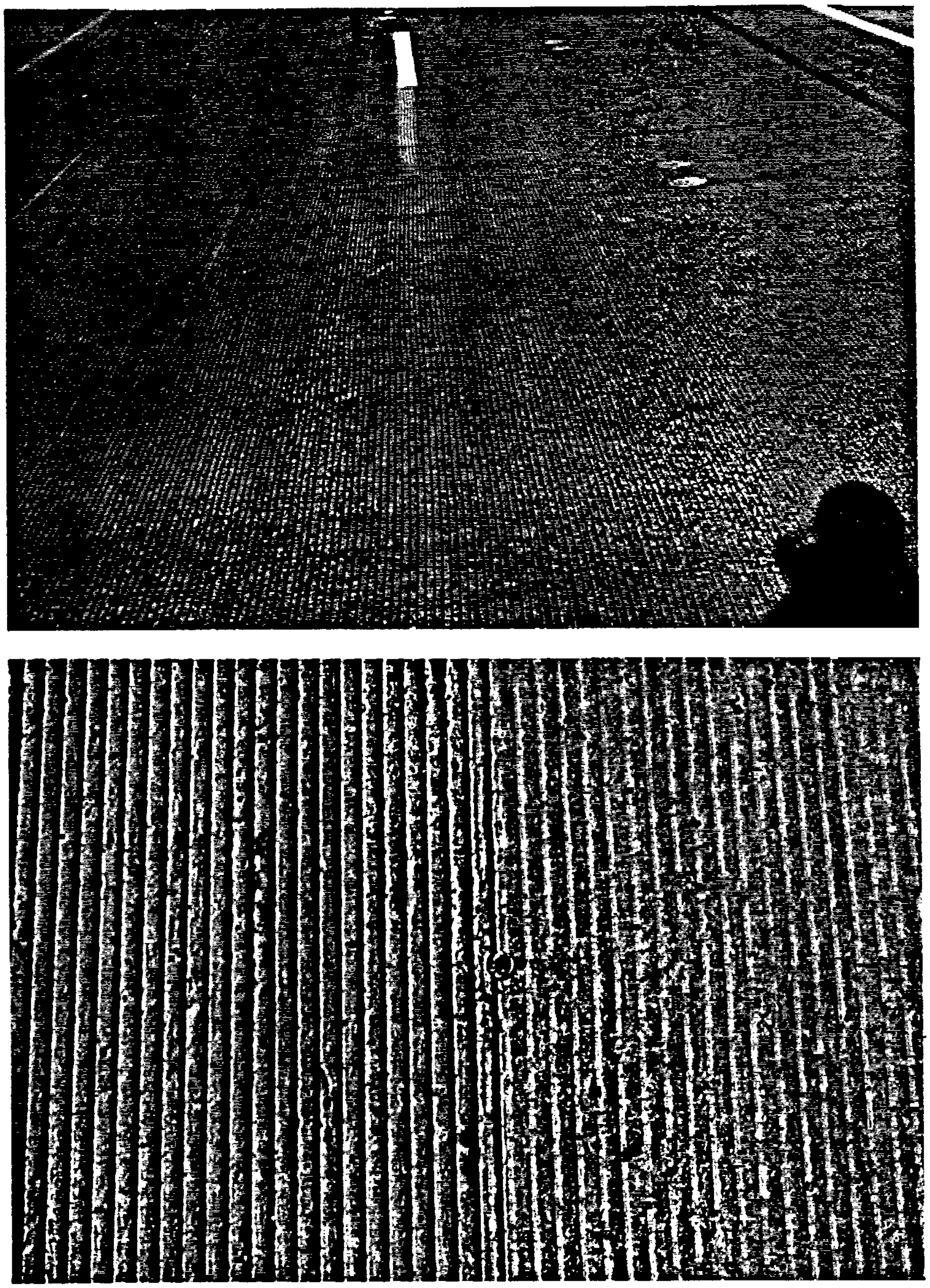


Figure 9. Diamond-ground texture on the Binghamton deck driving lane is shown near the shoulder (above) and worn away in a wheelpath (bottom).

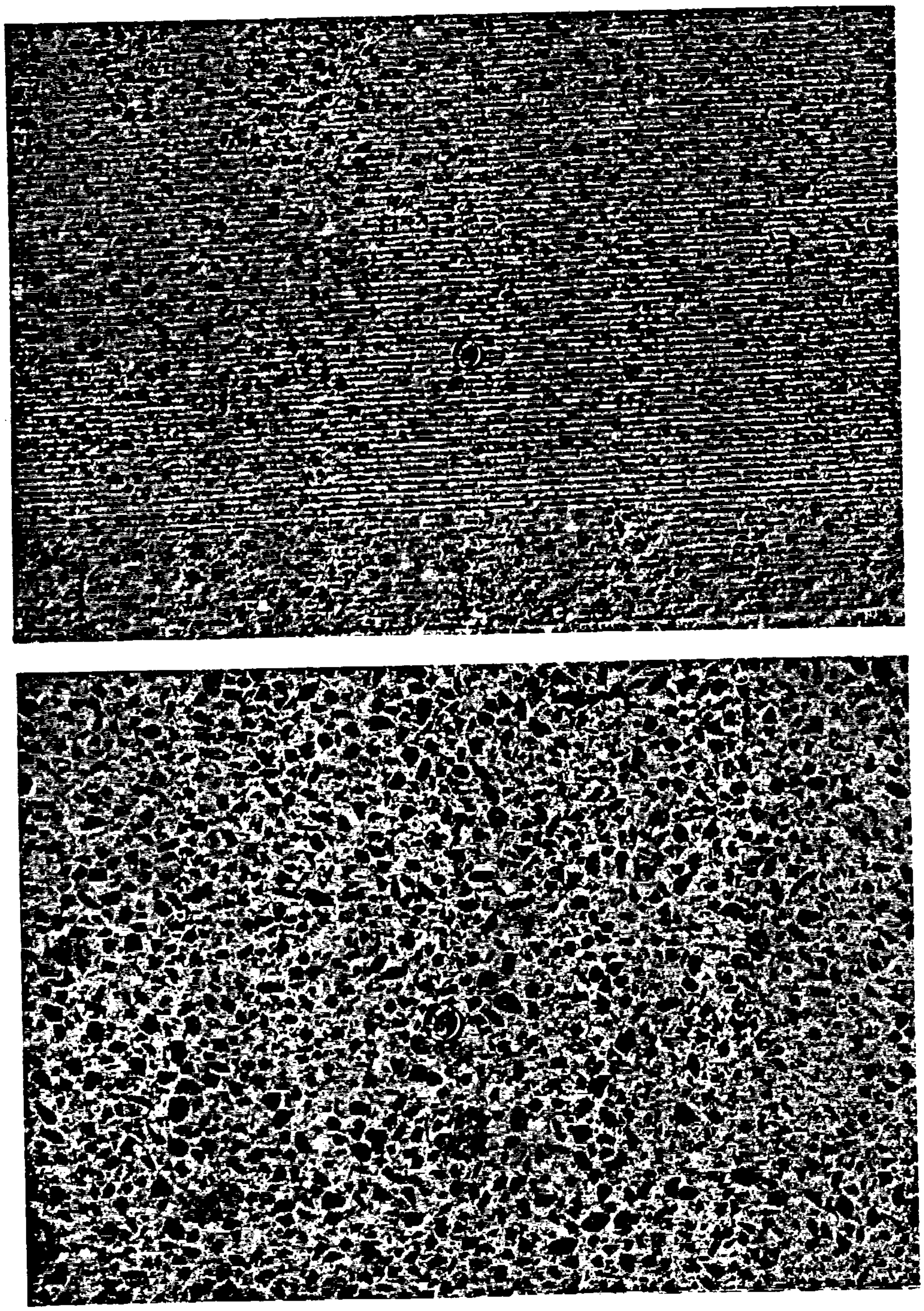
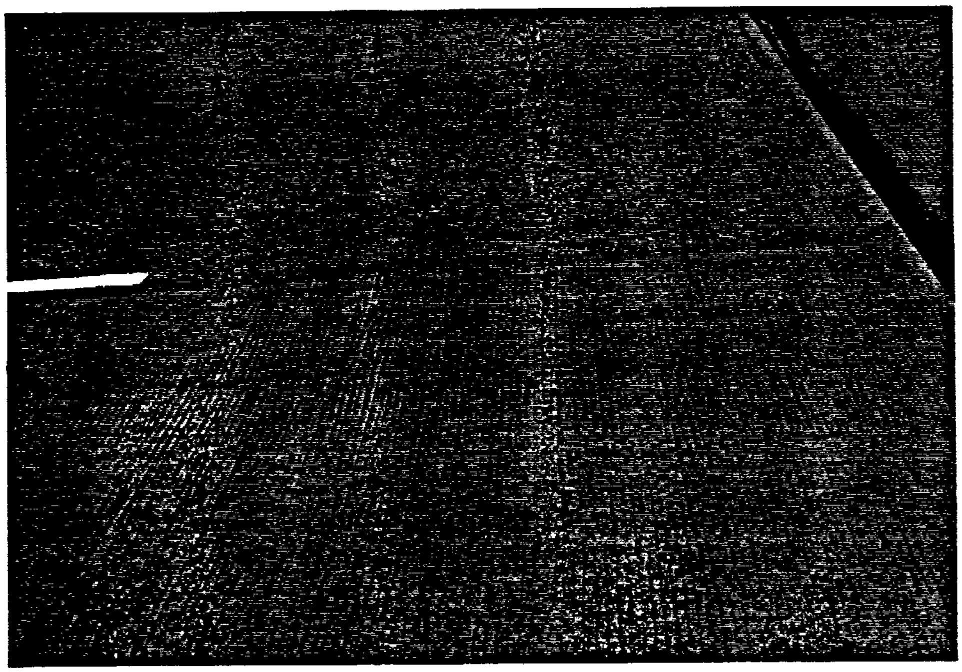
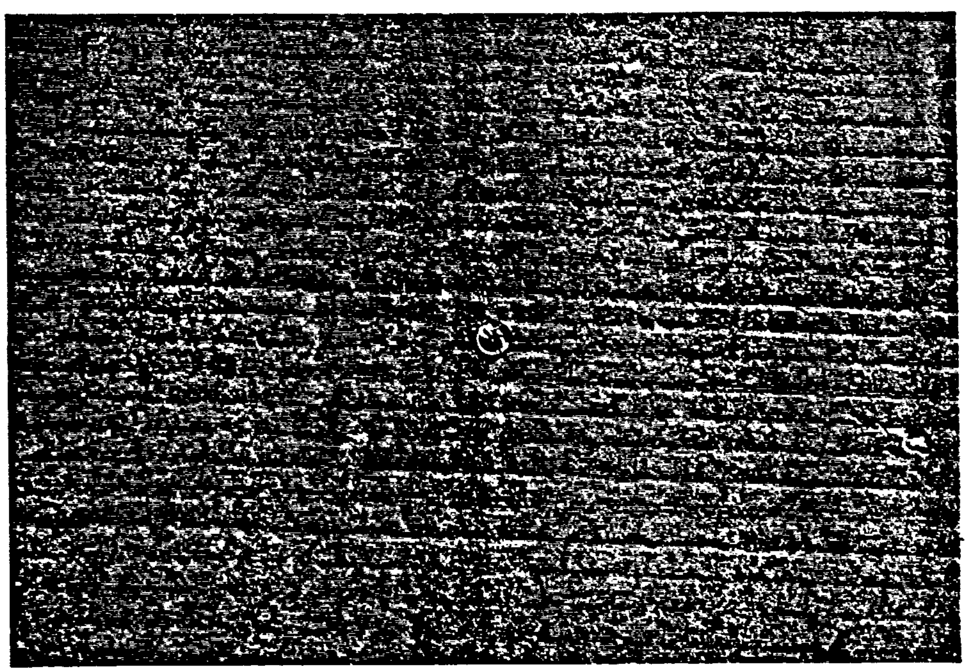


Figure 10. Diamond-ground texturing in the center lane at Binghamton (background above) contrasts with tine-texturing in the outer passing lane (foreground above). Detail of the worn tine-texturing is shown below.





It appears, however, that readings on the tined-textured surface have increased almost 10 points since 1981, while those on the diamond-ground surface decreased by 10 points or more. Although different measuring devices were used to obtain the earlier readings than those in 1988, it is not known why one (tined-textured) increased while the other (diamond-ground) decreased, since both textures appear to have worn. The large drop in the diamond-ground texture could be expected because much had worn away. Increased friction of the tined surface, coupled with evidence of wear, seems to imply that a higher-friction aggregate may have been exposed.

III. CONCLUSIONS

Based on visual surveys conducted at all three test locations in 1990, the following conclusions appear warranted:

1. Sawed-groove texturing appears to be the most durable over a 10-year period;
2. Tined-groove texturing was somewhat less durable than sawed-groove texturing, and
3. Diamond-ground grooving was the least durable.

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