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16. Abstract

This report describes the condition of an internally sealed concrete bridge deck on IH-20 near Monahans, Texas. The deck was heat treated in October of 1980 and opened to traffic in May of 1982. The deck contains wax beads throughout its full depth; however, only the top two inches were heated to internally seal the concrete. The overall objective of this study was to obtain additional information on the performance of internally sealed concrete under service conditions.

The results of half-cell potential tests and a crack survey are discussed. The deck has experienced severe cracking and a bridge deck protection system will probably be needed to prevent further deterioration and possible corrosion of the reinforcing steel. The deck cracking appears to be related to the heat treatment.

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EVALUATION OF
INTERNALLY SEALED CONCRETE DECK
MONAHANS, TEXAS

By

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Texas State Department of Highways & Public Transportation

Demonstration Study No 1-5-79-538

"Internally Sealed Concrete Bridge Decks"

Work Done in Cooperation with
U.S. Department of Transportation
Federal Highway Administration

FHWA Demonstration Project No. 49

"Internally Sealed Concrete"

January 1984

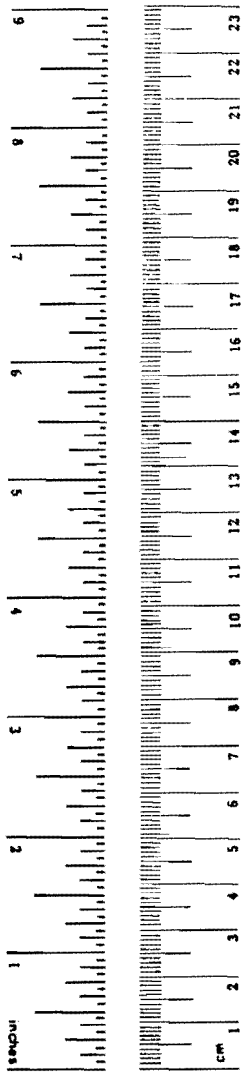
The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

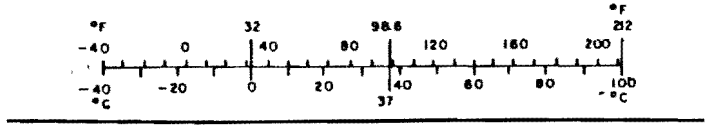


TABLE OF CONTENTS

	Page No.
INTRODUCTION	1
Background	1
Objectives	1
TESTS PERFORMED	2
Half-Cell	2
Crack Survey	2
SUMMARY AND CONCLUSIONS	4

LIST OF FIGURES

		Page No.
Figure 1.	Results of Corrosion Potential Survey Made July 7, 1981	5
Figure 2.	Results of Corrosion Potential Survey Made November 15, 1983	6
Figure 3.	Plan View of Deck Showing Results of Crack Survey Made July 30, 1981	7
Figure 4.	Plan View of Deck Showing Results of Crack Survey Made November 15, 1983	8
Figures 5.-10.	Photographs of Cracking on Top of Deck	9-11
Figures 11.-16.	Photographs of Cracking on Bottom of Deck	12-14
Figure 17.	Plan of Eastbound Lanes Showing Results of Crack Survey Made December 1, 1981	15

INTRODUCTION

Chloride induced corrosion of the top mat of reinforcing steel, with the resultant cracking and spalling of surface concrete, is generally considered to be one of the major causes of the premature deterioration of bridge decks. Through the efforts of the Federal HIghway Administration, a method using wax beads was developed to internally seal concrete against the intrusion of deicing salts and other corrosive compounds.

Background

In 1980, the Texas State Department of Highways and Public Transportation constructed an internally sealed bridge deck as part of the Federal Highway Administration's Demonstration Project 49 "Internally Sealed Concrete". The experimental bridge is located approximately five miles east of Monahans, Texas and carries the westbound lanes of Interstate Highway 20 over Texas Park Road 41. Heat treatment of the deck slab was completed October 30, 1980 and the bridge was opened to traffic in May, 1982.

Objectives

The objectives of this project were to construct a bridge deck impregnated with wax beads, heat treat the deck to internally seal the concrete, and evaluate the performance of the internally sealed deck under service conditions. An interim report, "Internally Sealed Concrete-Monahans, Texas", describing the first two of these objectives was published in January, 1982.

TESTS PERFORMED

Half-Cell

Two half-cell surveys, using a copper-copper sulphate reference cell, have been conducted. The first one was conducted approximately nine months after heat treating the deck. The bridge was not open to traffic and no deicing salts had been applied. All measured half-cell potentials were less negative than -0.20v which indicates non-corroding steel. The results of this survey are shown in Figure 1.

The second half-cell survey was conducted approximately 18 months after the bridge had been opened to traffic. The bridge had been under traffic during one winter season and deicing materials, in the form of a salt-sand mixture, had been applied to the deck only three or four times. All measured half-cell potentials were again less negative than -0.20v indicating that the reinforcing steel is not actively corroding at this time. The results of this survey are shown in Figure 2.

Crack Survey

The deck was examined before and immediately after heating and no cracks were found that could be related to the heat treatment. Another survey was made on July 30, 1981, approximately nine months after heating, and the results of this survey are shown in Figure 3. The deck was surveyed again on November 15, 1983, approximately three years after heating and 18 months after the bridge was opened to traffic. The results of this survey are shown in Figure 4. When Figure 4 is compared with Figure 3, it is obvious that a dramatic increase in deck cracking

occurred during the time between surveys. Figures 5 through 10 are photographs of cracks on top of the deck and Figures 11 through 16 are photographs of cracks on the bottom of the deck.

The parallel structure carrying the eastbound lanes of Interstate Highway 20 did not have an internally sealed concrete deck slab. The concrete used in its deck contained a super water reducing agent which resulted in a low water/cement ratio concrete with qualities similar to the Iowa System concrete. Figure 17 is a plot of the cracks in this deck slab. This crack survey was made on December 1, 1981, and the only cracks found were those over the interior bents. These cracks are typical for slabs placed continuously over simple span beams. This deck was visually inspected on November 15, 1983, and no significant changes in the cracking pattern were observed.

SUMMARY AND CONCLUSIONS

The objectives of this study were to construct an internally sealed bridge deck using wax beads and evaluate its performance under service conditions. Heat treatment of the deck was completed in October 1980, and the bridge was opened to traffic in May 1982.

Based upon the tests conducted and observations made, the following statements and conclusions are made:

1. Extensive cracking has occurred in the internally sealed deck. Although it was not evident immediately after heating of the deck, it now appears that heating of the deck may be the cause of this cracking.

2. The corrosion potential survey showed no evidence of reinforcing steel corrosion. This was not unexpected since the bridge has been in service only one winter season and had only three or four applications of a sand-salt mixture.

3. The internally sealed deck will require some type of protection system to prevent further concrete damage and possible corrosion of the reinforcing steel.

4. Further use of internally sealed concrete in bridge decks is not recommended until there can be positive assurance that the heat treatment will not adversely affect the concrete.

BRIDGE DECK EVALUATION FORM

BRIDGE NAME P.R. 41 O'Pass

LOCATION: IH 30

East of

Monahans, Tx Dir. WB

DATE TESTED: July 7, 1981

CORROSION SURVEY
(READING x 0.01 Volts) – ☒

RESISTIVITY SURVEY ☐

DELAMINATION SURVEY – ☐

DISTRICT

Work By:

Deck Temp. °F

No. of Spans

Year Constr.

Bridge Type

BRIDGE NOTES:

P = Patch

G = Ground Point

C = Continuity Check Point

= Spalled Areas

= Hollow Areas

= Significant Crack

℄ = Center Line

→ = Traffic Flow

○ = Sampled for Chloride Analysis

X ____ " = Cover Over Top Rebar

= Outside of Deck Area
[Always to be drawn showing boundaries of deck]

REMARKS: Deck internally sealed with wax base

Sheet ____ of ____

DRAW NORTH ARROW

(Draw Contours)

FEET DOWN DECK	FEET ACROSS DECK				
	0	13	19		13
10	2	3	4	3	9
20	2	1	3	6	8
30	3	9	6	6	8
40	3	3	7	4	8
50	4	2	7	2	7
60	5	3	6	4	7
70	4	2	6	3	9
80	4	2	8	8	9
90	3	2	4	1	7
00	4	2	4	1	7
10	3	2	5	2	7
20	4	3	6	4	11
30	4	2	4	2	7
40	4	5	4	3	7
50	5	4	4	3	7
60	12	14	12	9	13
70					

Figure 1. Results of Corrosion Potential Survey Made July 7, 1981

DRAW NORTH ARROW

BRIDGE DECK EVALUATION FORM

BRIDGE NAME P.R. 41 O'Pass

LOCATION: IH 30 E. of Monahans, Tx

Dir. WB

DATE TESTED: Nov. 15, 1983

CORROSION SURVEY (READING x 0.01 Volts) – ☒

RESISTIVITY SURVEY ☐

DELAMINATION SURVEY – ☐

DISTRICT ____

Work By: ____

Deck Temp. ____ °F

No. of Spans ____

Year Constr. ____

Bridge Type ____

BRIDGE NOTES:

P = Patch

G = Ground Point

C = Continuity Check Point

[hatched] = Spalled Areas

[cross-hatched] = Hollow Areas

ΛΛΛΛΛ = Significant Crack

℄ = Center Line

⟶ = Traffic Flow

○ = Sampled for Chloride Analysis

X ____ " = Cover Over Top Rebar

[hatched] = Outside of Deck Area [Always to be drawn showing boundaries of deck]

REMARKS: Deck internally sealed with wax beads

Sheet ____ of ____

(Draw Contours)

TO ⟵ FEET DOWN DECK

FEET DOWN DECK			
70			
60	3	2	4
50	0	0	0
40	0	0	0
30	1	0	0
20	0	1	1
10	0	0	0
00	0	0	0
90	0	0	0
80	0	0	0
70	0	0	0
60	0	0	0
50	3	0	0
40	0	0	0
30	0	0	0
20	1	0	0
10	2	0	0
0	1	2	17

⟵ FEET ACROSS DECK

Figure 2. Results of Corrosion Potential Survey Made November 15, 1983

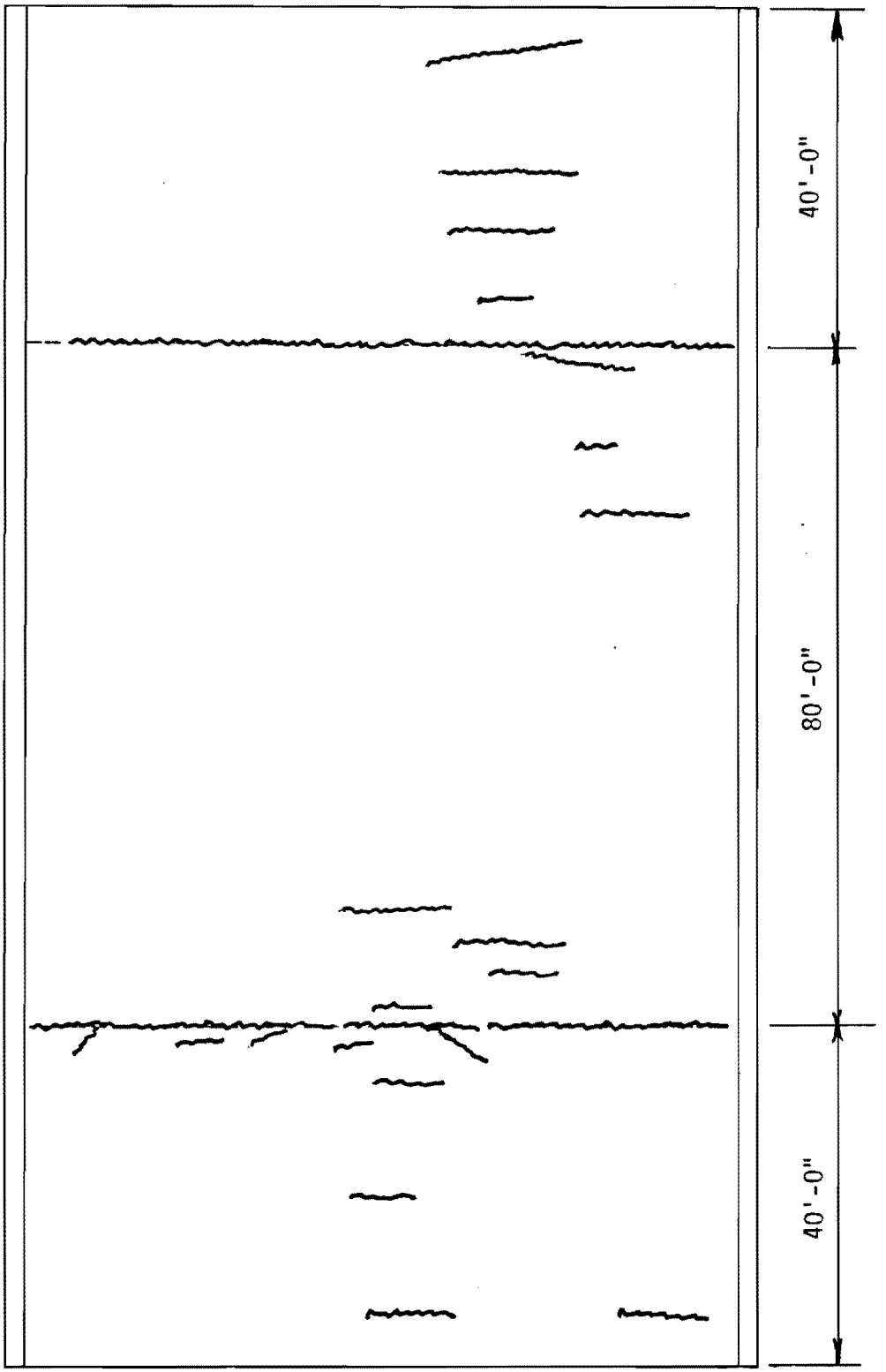


Figure 3. Plan View of Deck Showing Results of Crack Survey Made July 30, 1981

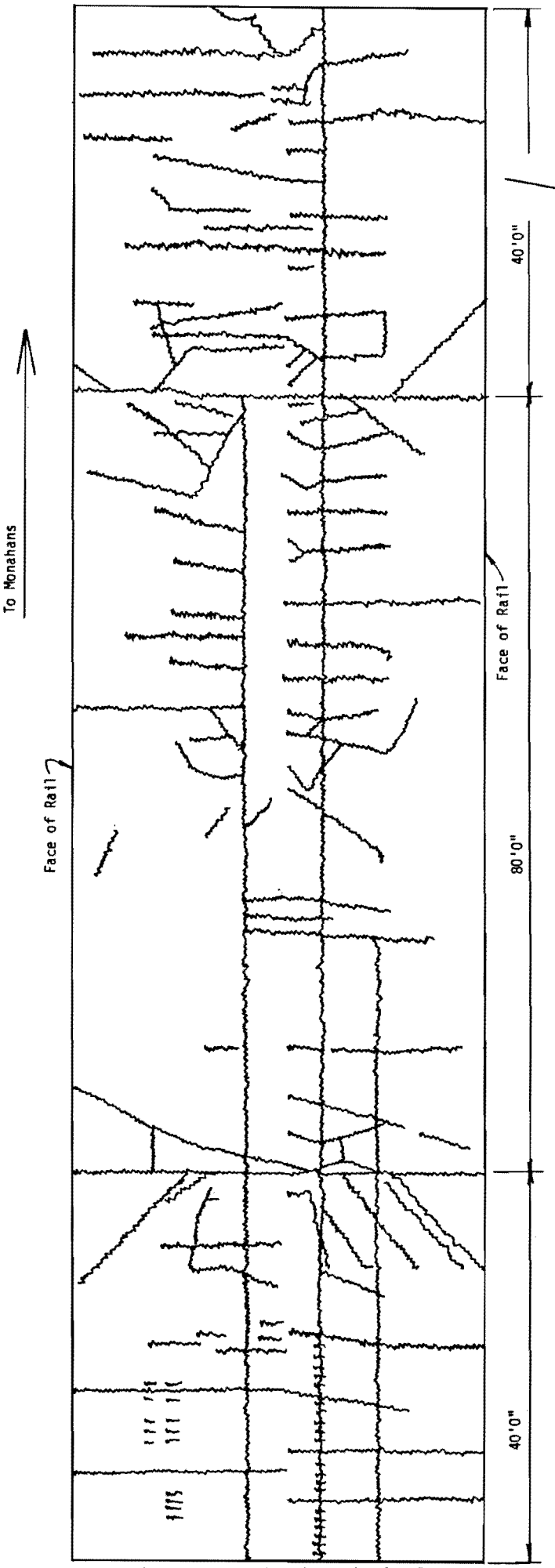


Figure 4. Plan View of Deck Showing Results of Crack Survey Made Nov. 15, 1983

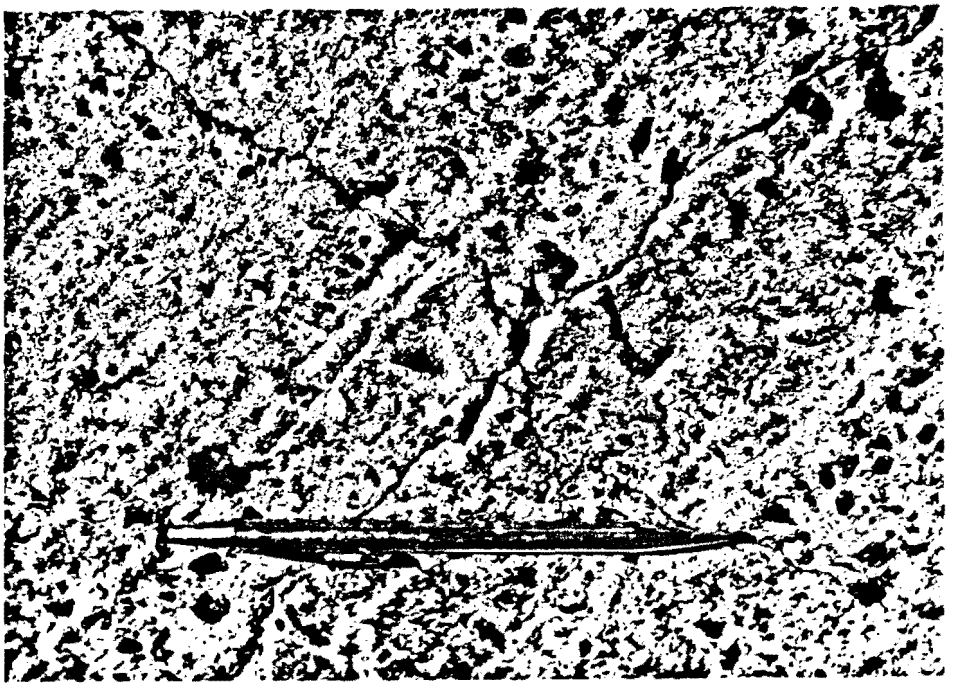


Figure 5. Cracking on Top of Deck

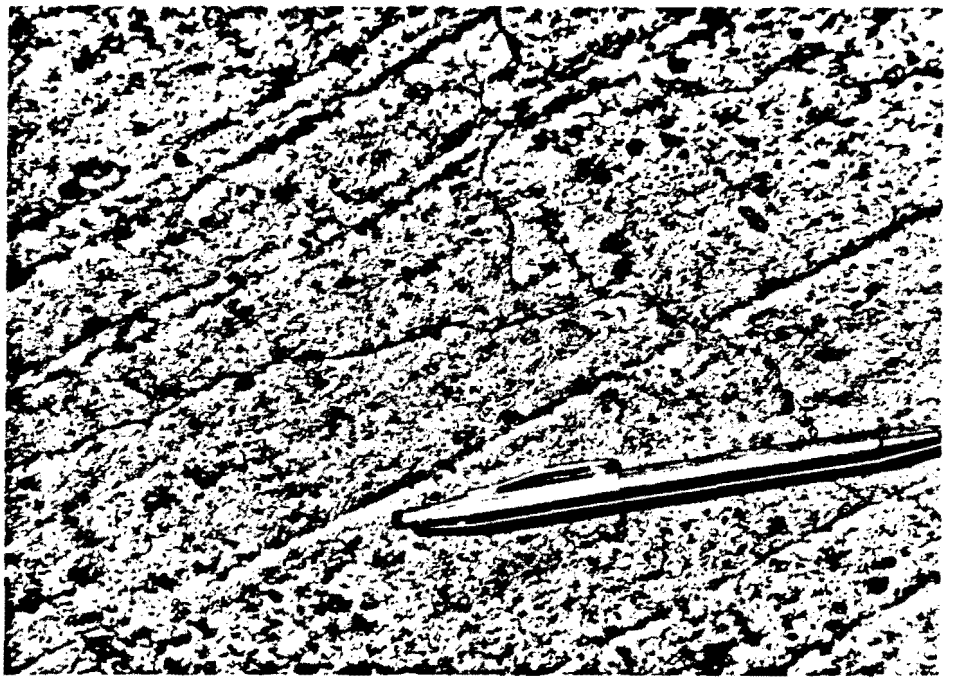


Figure 6. Cracking on Top of Deck

Figure 7. Cracking on Top of Deck

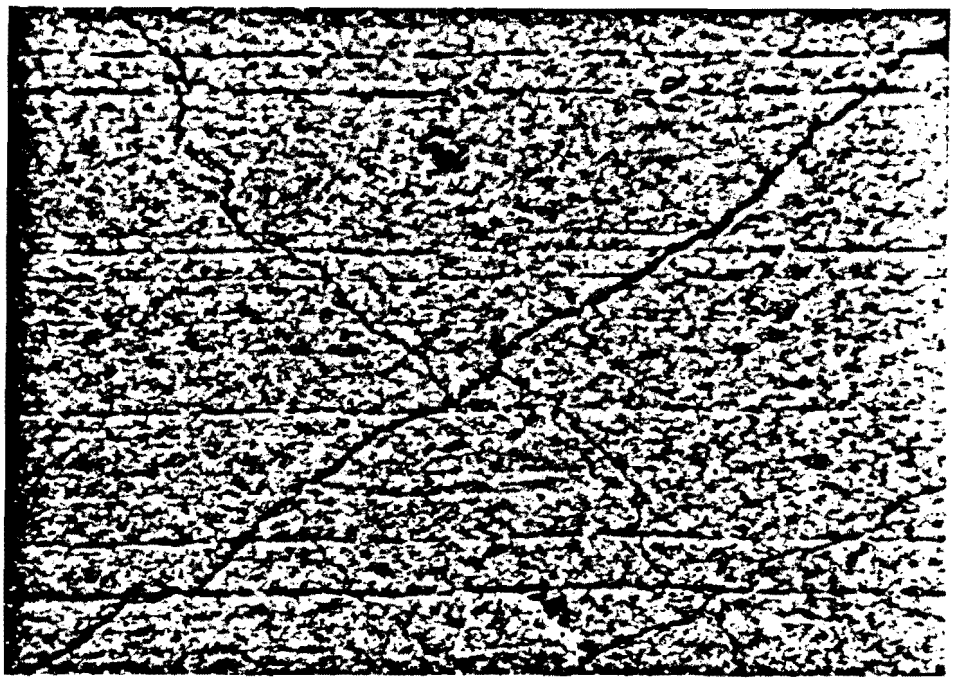


Figure 8. Cracking on Top of Deck

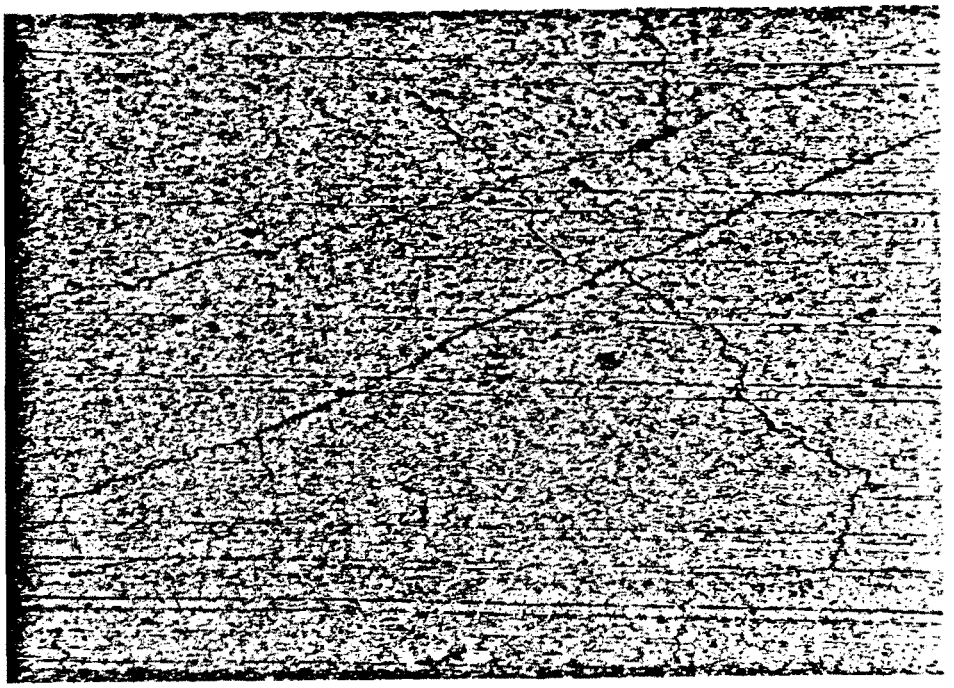


Figure 9. Cracking on Top of Deck

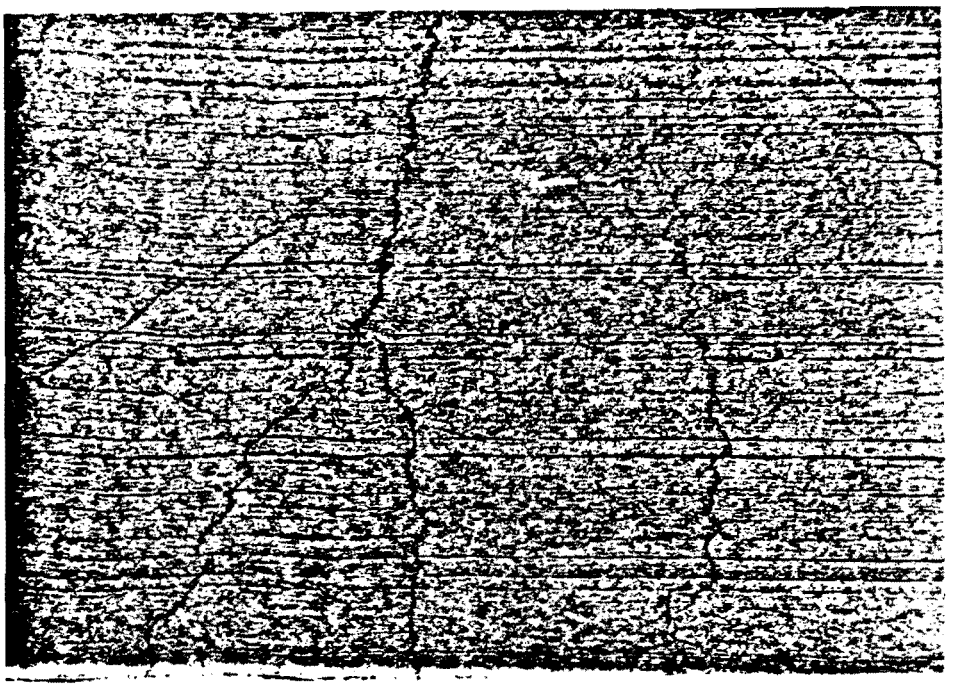


Figure 10. Cracking on Top of Deck

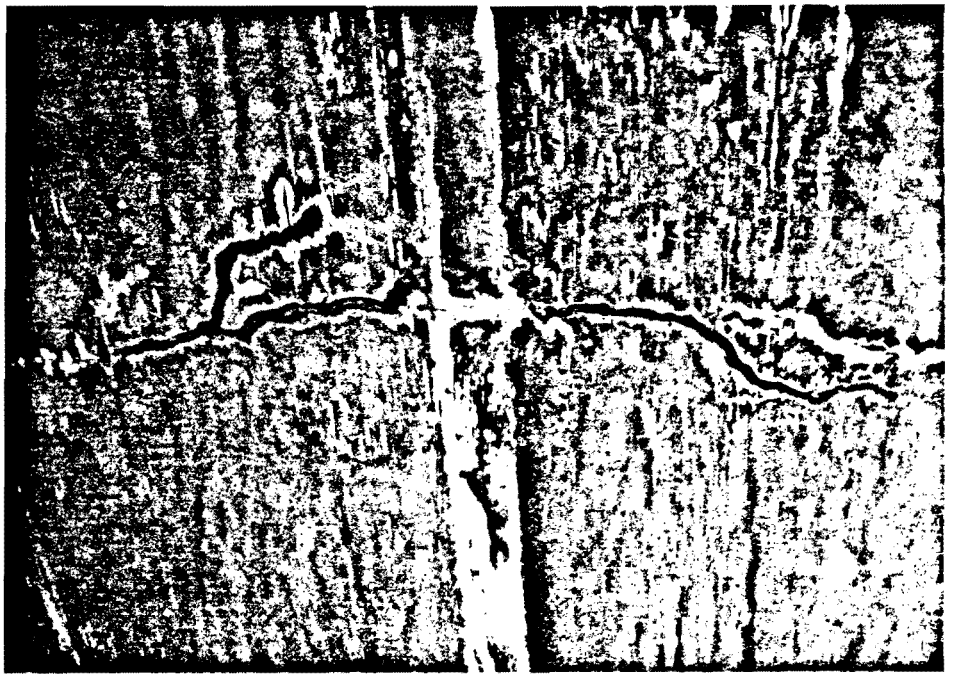


Figure 11. Cracking on Bottom of Deck

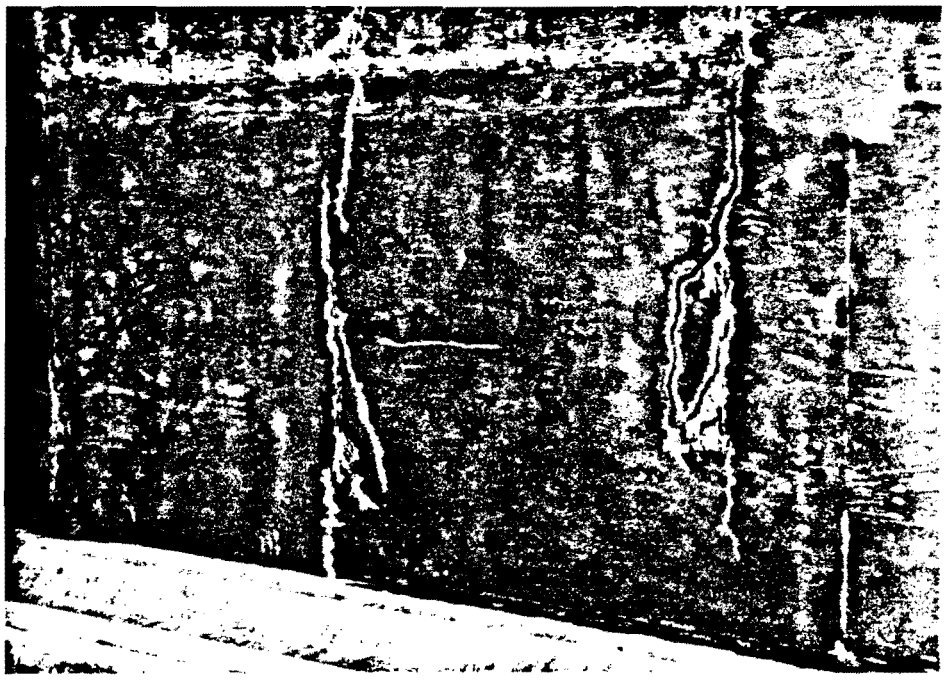


Figure 12. Cracking on Bottom of Deck

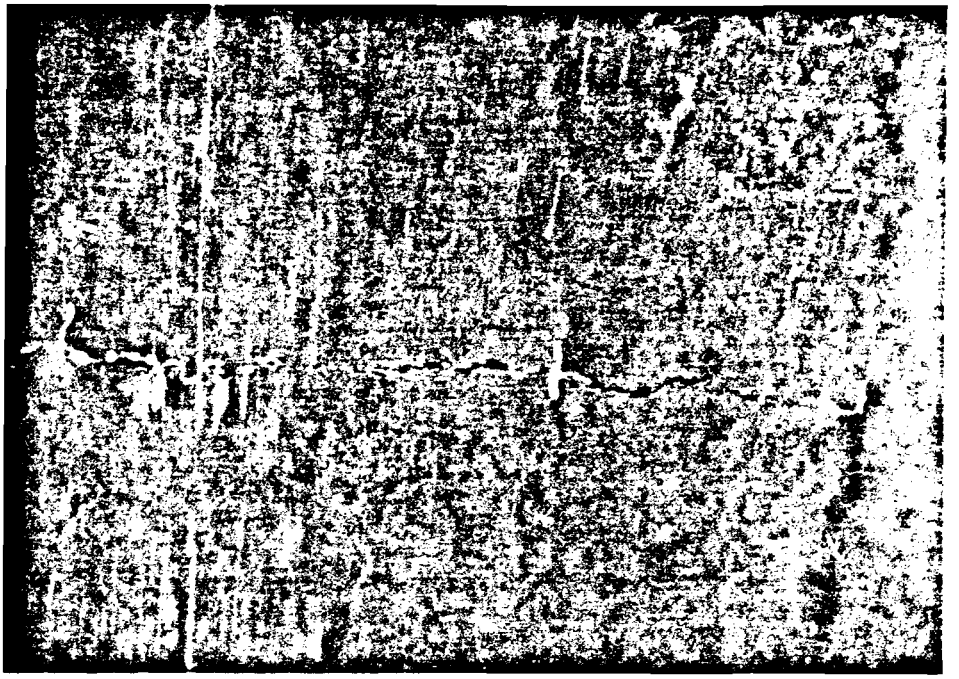


Figure 13. Cracking on Bottom of Deck

Figure 14. Cracking on Bottom of Deck

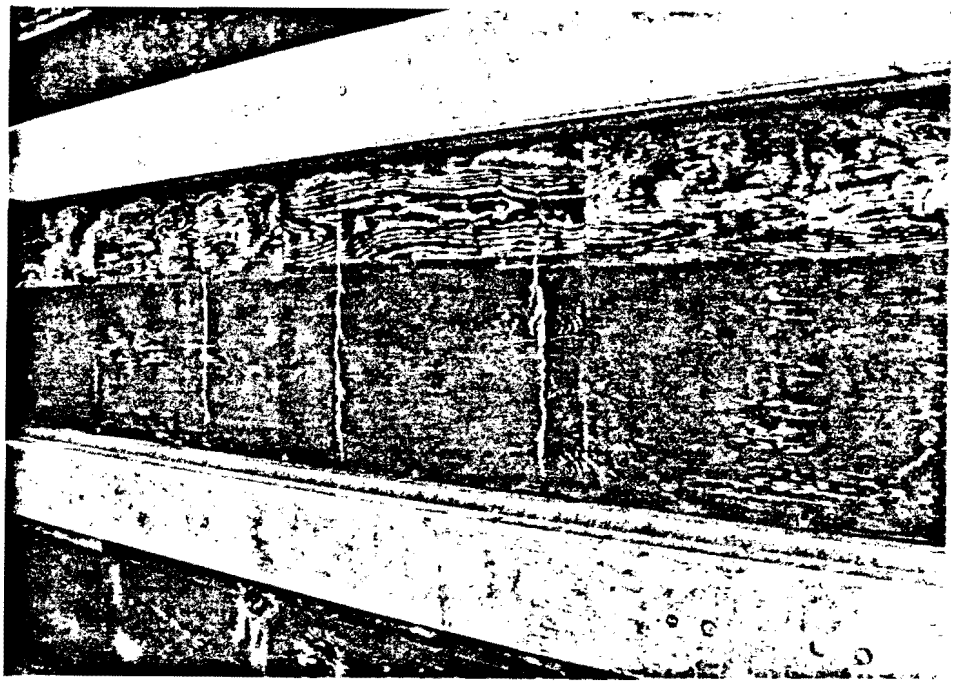


Figure 15. Cracking on Bottom of Deck

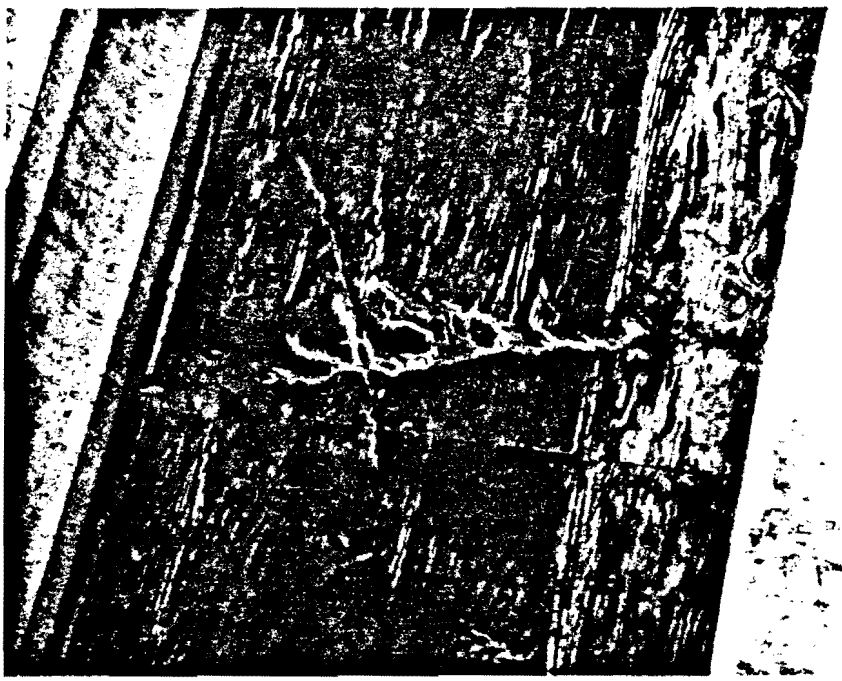


Figure 16. Cracking on Bottom of Deck

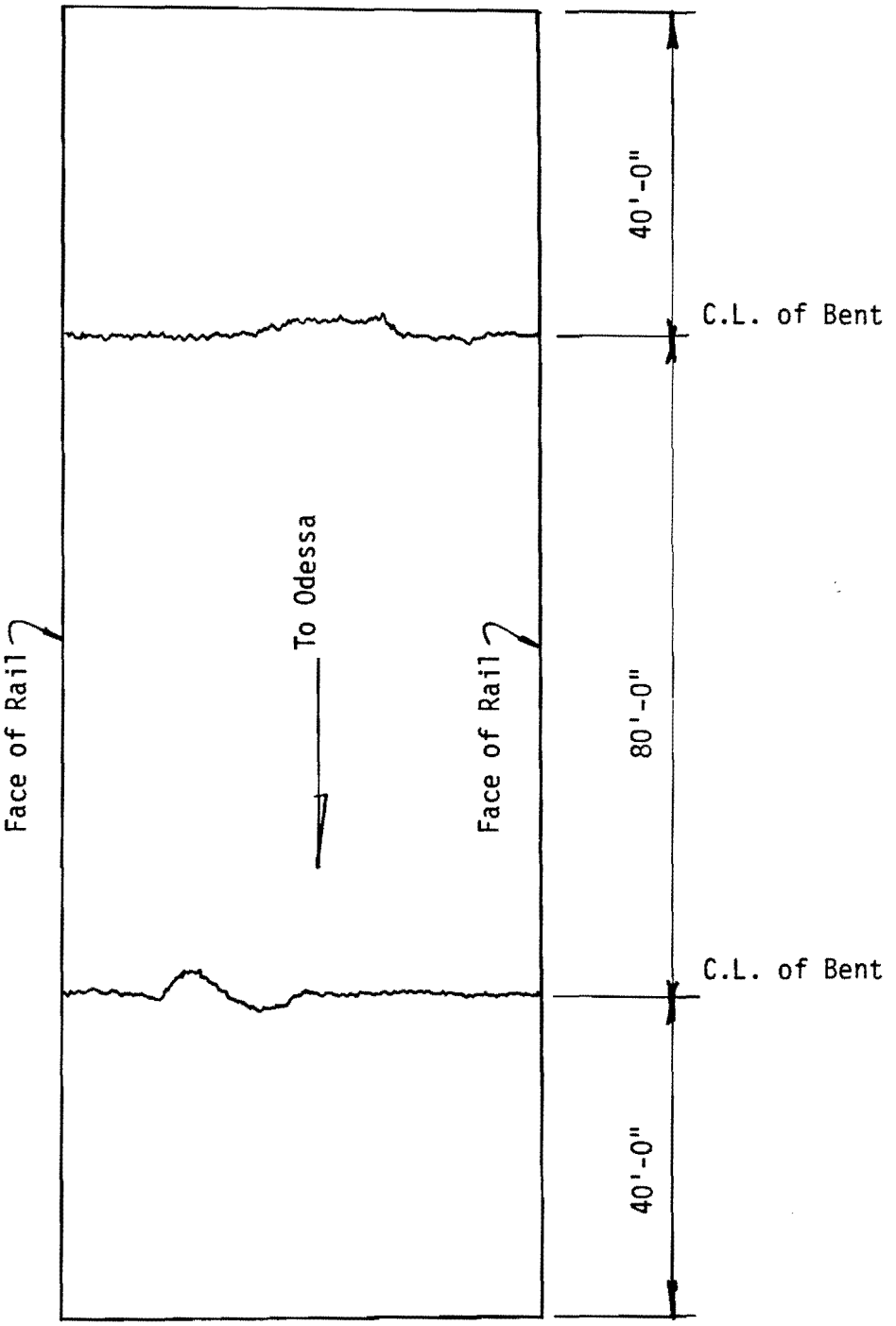


Figure 17. Plan View of Eastbound Lanes Showing Results of Crack Survey Made December 1, 1981