MICHIGAN
STATE HIGHWAY DEPARTMENT
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State Highway Commissioner

INVESTIGATION OF BLOW-UP ON M-47

CONSTRUCTION PROJECT 73-46, C4

SOUTH OF ST. CHARLES

Research Project 39 F-7 (14)

Evaluation of Post War Pavements

Research Laboratory
Testing and Research Division
Report No. 239a
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INVESTIGATION OF BLOW-UP ON M-47 CONSTRUCTION PROJECT 73-46, C4 SOUTH OF ST. CHARLES

At the request of W. W. McLaughlin, Testing and Research Engineer, a special study has been made of a blow-up in a concrete pavement which occurred on July 21, 1955 at a contraction joint on Construction Project 73-46, C4, Station 464 + 42.

The project under study was constructed in 1949 by Bridgeport Core and S nd of Saginaw. Subsequent condition surveys indicate the pavement to be in excellent physical condition. It has an unusually low percentage of transverse cracks and spalling for a project of its age. This blow-up is the first major physical defect to appear in the entire project.

This is a report of conditions found at the blow-up area when the damaged pavement was removed by Maintenance Division personnel under the supervision of Mr. Muehlenbach of Saginaw. E. A. Finney and L. T. Oehler of the Research Laboratory were present when the repairs were made on July 27th and August 3rd, 1955.

Factors contributing to the cause of the blow-up are not definitely known. It is strongly suspected that low quality concrete in that particular area might have been the primary factor in the incident, supported by certain physical conditions at the joint which might have existed but were not detected in the survey. The blow-up did not occur at a construction or night joint.

The study resulted in additional factual evidence on dowel bar corrosion. After 6 years, net reduction in bar diameter varied from approximately 3 to 10%.

Project Facts

Project No.	- 73-46, C4
Completed	- 1949
Length	- 4.426 miles
Thickness	- 8-inch uniform
Width	- 22 feet
Joint Spacing	- 50 feet contraction joints; no expansion joints
Mesh	- light weight, 50.3 lbs/100 sq. ft.
Load Transfer	- 1-inch dowels at 12" spacing
Curing	- clear membrane
Cement	- Aetna, Bay City
Fine Agg.	- J. Post & Sons, Durand
Coarse Agg.	- J. Post & Sons, Durand
Contractor	- Bridgeport Core & Sand

Description of Blow-Up

The picture in Figure 1 on the adjacent page shows the blow-up area prior to starting permanent repairs. The broken concrete had been removed previously and the hole temporarily filled with a bituminous material.

The concrete slab on the north side of the joint (in background) was raised approximately 2 inches above the surface of the pavement on the south side of the joint. The concrete on the north side of the joint was not broken. The top portion of the south slab was shattered and pulverized for a distance of 4 feet from the joint.


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Typical Condition of Dowel System

Figure 2 on the adjacent page shows the condition in which the dowels were found upon removal of the concrete. Note sound condition of slab on left side of joint (north) and shattered condition of concrete on south side.

It may be seen in the picture that the south end of the dowels had been forced out of the dowel basket assembly clips. Note dowel in foreground. The dowels were found to be displaced upward as much as 1-3/4 inches to 2-5/8 inches.

Typical Position of Dowels

Figure 3 on the adjacent page is a close view of a dowel which clearly illustrates how the dowels were moved upward out of the dowel clips by the blow-up action.

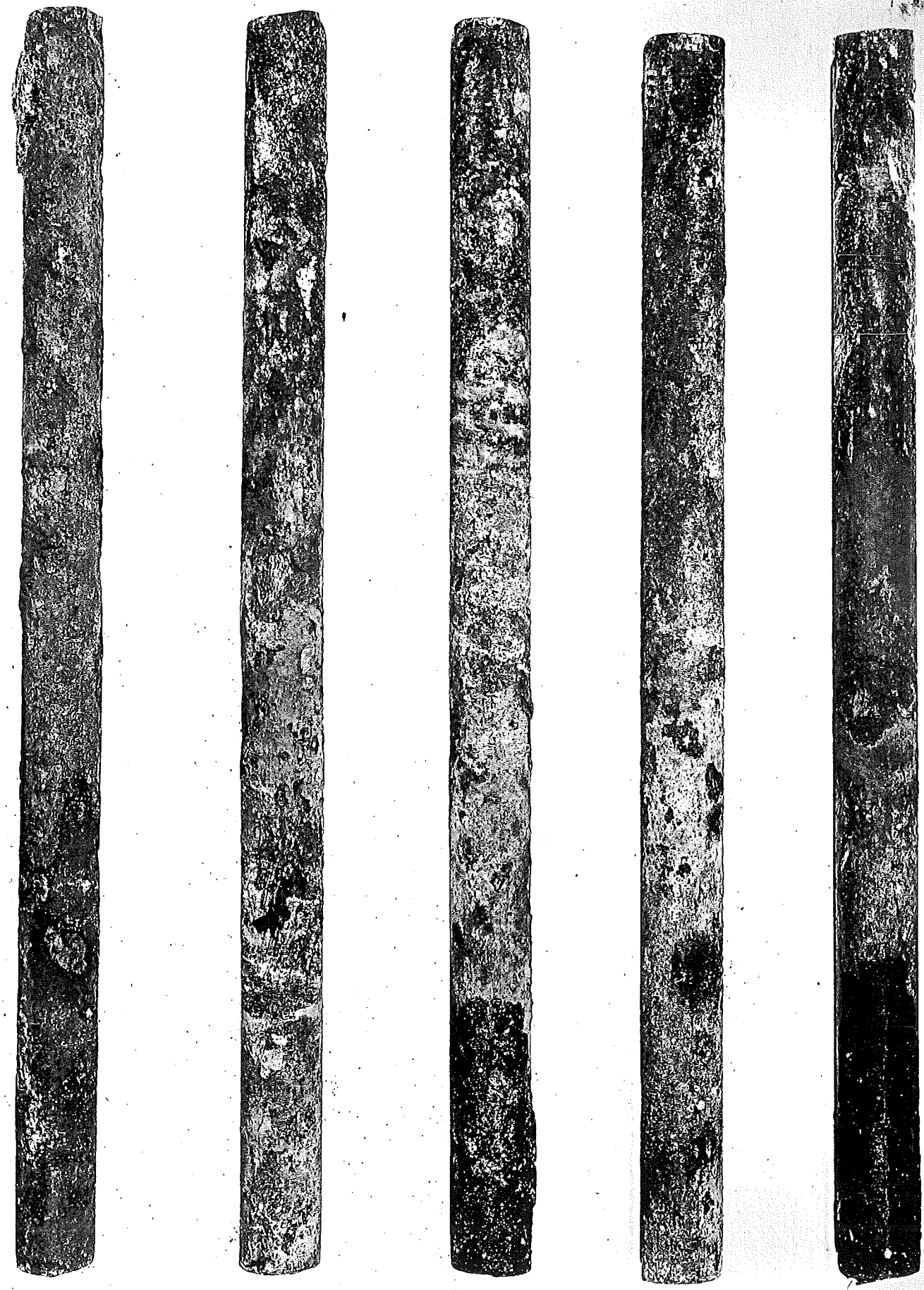
Condition of Concrete at Edge of Pavement

Figure 4 illustrates the spalled condition of concrete at edge of pavement.

Condition of Dowel Bars

All dowel bars were successfully removed from the damaged joint and taken to the laboratory for further examination as to their physical condition.

Without exception, all dowels were found to be badly rusted and pitted as illustrated in Figures 5 and 6.



Rusting of Dowel Bars

The dowels were cleaned by sandblasting and their condition with respect to rusting carefully noted. With reference to Figure 6, adjacent page, it was observed that rusting has occurred on all dowels but varied between the extreme conditions as shown in Figure 6. Further, with few exceptions, rusting occurred more at one end of the dowel than the other. It is logical to assume that the sliding end of the dowel would rust faster than the fixed end.

Table I presented below contains a summary of measurements concerning depth and extent of rust. Average reduction in diameter due to rusting ranged from about 1.5 to 6 percent. For maximum conditions reduction in diameter varied from about 3 to 13 percent.

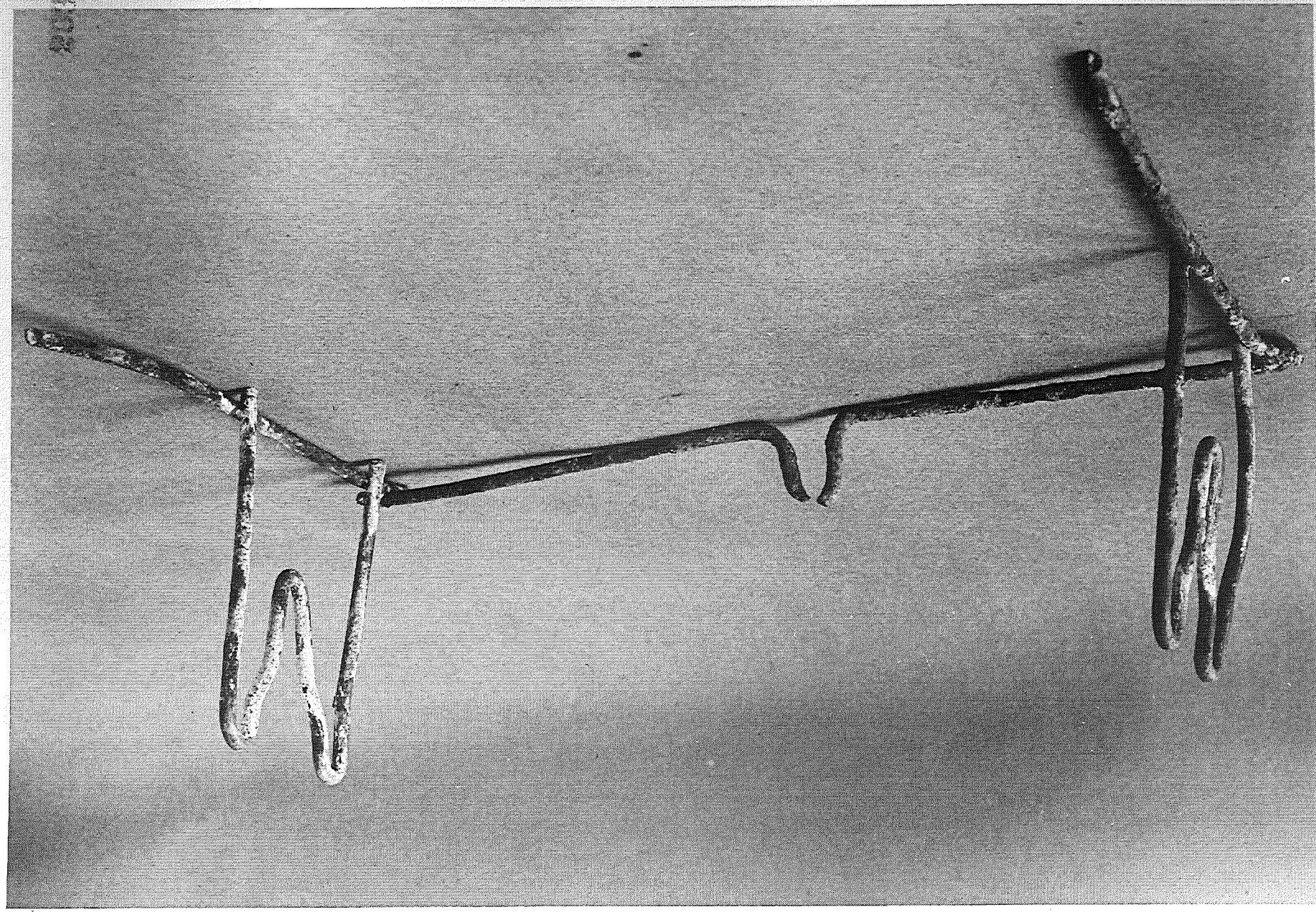
TABLE I

Rusting of One-Inch Dowel Bars

Bar No.	Deepest Pits Inches	% Reduction in Dia.	Av. Depth of Pits Inches	% Reduction in Dia.	% of Bar Pitted
1	0.130	13.0	0.060	6.0	60
2	0.040	4.0	0.025	2.5	30
3	0.068	6.8	0.035	3.5	20
4	0.030	3.0	0.020	2.0	30
5	0.045	4.5	0.025	2.5	15
6	0.035	3.5	0.025	2.5	10
7	0.047	4.7	0.030	3.0	40
8	0.058	5.8	0.030	3.0	40
9	0.030	3.0	0.020	2.0	20
10	0.054	5.4	0.025	2.5	20
11	0.038	3.8	0.025	2.5	70
12	0.040	4.0	0.025	2.5	25
13	0.098	9.8	0.040	4.0	55
14	0.028	2.8	0.018	1.8	15
15	0.040	4.0	0.020	2.0	60
16	0.040	4.0	0.015	1.5	60
17	0.040	4.0	0.020	2.0	50
18	0.038	3.8	0.020	2.0	15
19	0.030	3.0	0.020	2.0	25
20	0.040	4.0	0.025	2.5	20

Condition of Dowel Bar Basket

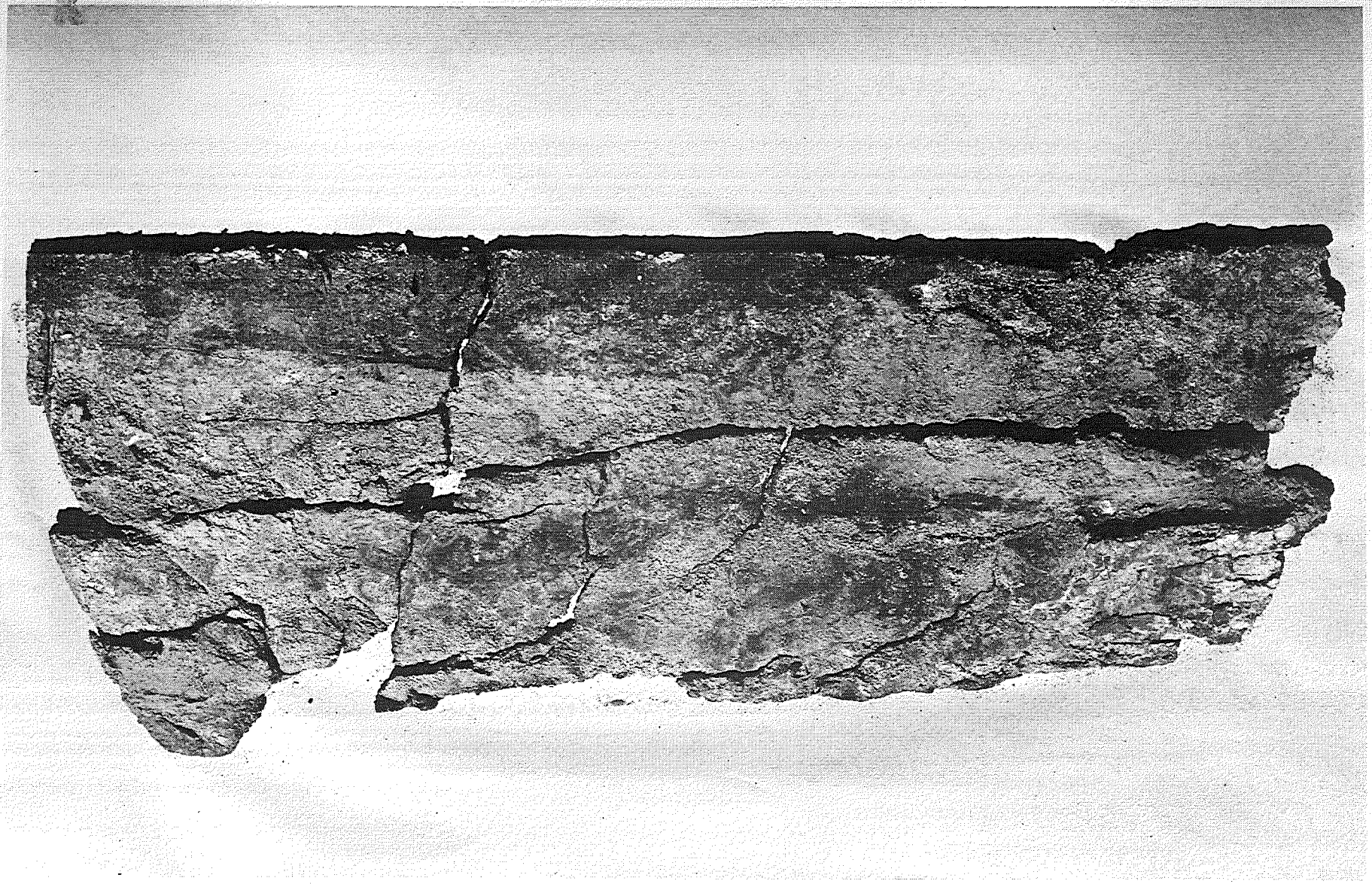
Figure 7, page 15, illustrates the condition of a section of dowel bar basket as removed from pavement.



Bituminous Base Plate

A section of the bituminous base plate was carefully removed for examination. Figure 8, next page, shows the cracked condition of the plate as it was found under the pavement. The longitudinal crack was under this joint.

The material was found to be soft and brittle with but little structural strength.



Condition of Tie Bars

One tie bar was received and examined for rusting. Rusting occurred for a distance of about 2 inches on each side of center. See Figure 9, next page. Note deep pitting at center of bar.

Condition of Concrete

In the blow-up area there was considerable concrete in the condition as shown in Figure 10. Note poor binding properties between course aggregates and cement mortar.

Condition of Concrete

Compressive strength tests were made with a Swiss Hammer on the pavement and on specimens taken from blow-up area.

Tests on specimens prepared from chunks of concrete taken from blow-up are as follows:

Sample 1.	3300 psi.	Sample A.	4200 psi.
Sample 2.	3450 psi.	Sample B.	4450 psi.

These results may be lower than actual compressive strength due to the small type of specimen.

Results with Swiss Hammer on undisturbed pavement -

1	4500 psi.	4' south of joint.
2	5500 psi.	16' south of joint.
3	5800 psi.	40' south of joint.
4	5000 psi.	3' south of joint.
5	5750 psi.	2' north of joint.
6	6500 psi.	3' north of joint.
7	5700 psi.	2' north of joint.

Figure 11 shows specimen of spalled concrete taken from blow-up area. Note poor bonding conditions between coarse aggregate and mortar.