Kentucky Power Company
KPSC Case No. 2026-00001
Commission Staff's First Set of Data Requests
Dated March 19, 2026

DATA REQUEST

KPSC 1_1 Refer to the Direct Testimony of Tanner S. Wolffram (Wolffram Direct Testimony), page 5, lines 11–14. Explain whether thorough inspections have been conducted on cooling towers for Mitchell Unit 1 and Big Sandy gas fired Unit. Provide the inspection reports associated with those inspections.

RESPONSE

Engineering and third-party inspections have been conducted on cooling towers for Mitchell Unit 1 and Big Sandy. The surface irregularities and deformations found in Mitchell Unit 2's cooling tower are unique to Mitchell Unit 2 and were not identified in the Mitchell Unit 1 and Big Sandy cooling towers. The following is a list of those inspections:

Mitchell Unit 1:

- 1990 Shell and Base Inspection
- 2011 Shell Inspection
- 2016 Lidar Scan Inspection
- 2017 Lidar Scan Inspection
- 2020 Drone Inspection report

Please see KPCO_R_KPSC_1_1_Attachment1 for the Mitchell Unit 1 inspection reports. No report exists for the Mitchell Unit 1 2011 Shell inspection.

Big Sandy:

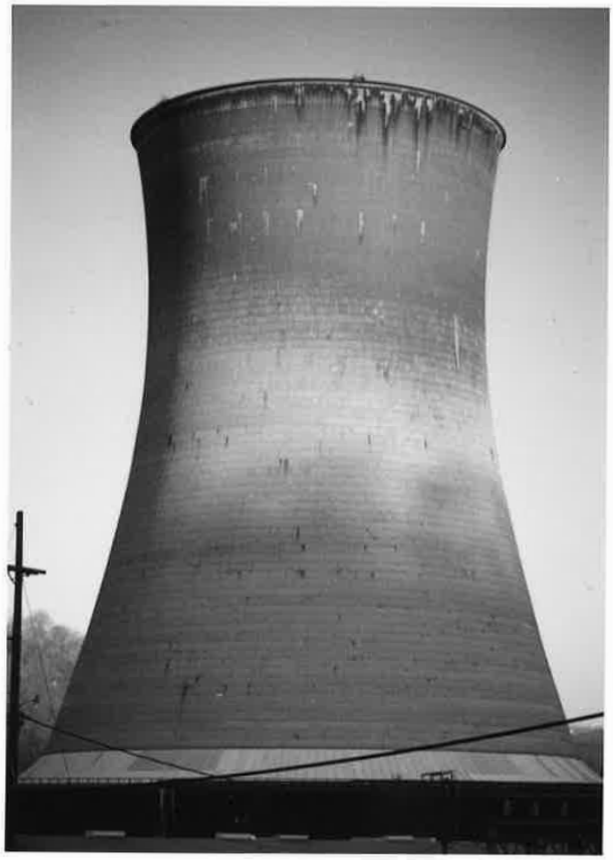
- 2002 Shell Inspection
- 2020 Drone Inspection report

Refer to KPCO_R_KPSC_1_1_Attachment2 for the Big Sandy inspection reports.

Witness: Daniel W. Pizzino

Pullman Power Products Corporation

AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA



Report
for
Inspection of 370'–0" High
Reinforced Concrete Cooling Tower

American Electric Power Service Corporation
Ohio Power Company
Service Order B–6858
March 12, 1990

Pullman Power Products Corporation
Job No. 5476
June 4, 1990

Pullman Power Products Corporation

AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

INDEX

AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION I — DESCRIPTION & PROCEDURE

The natural draft cooling tower serving the Mitchell Plant Unit No. 1 located in Moundsville, West Virginia was originally designed and constructed by The Marley Cooling Tower Company in 1968.

The reinforced concrete hyperbolic shell is 370.00′ above the top of basin with center line shell diameters of 178.02′ at the top, 160.50′ at the throat and 248.00′ at the base of the shell. The shell thickness is 5-1/2" throughout its full height with exception of the cornice and lintel beam.

The hyperbolic shell is supported by a lintel beam atop 32 pre-cast X-brace column supports which are supported by an additional 32 plinths.

Mitchell Plant Unit No. 1 tower is a cross-flow design utilizing a wooden hot water distribution basin with treated douglas fir fill and corrugated asbestos cement drift eliminators.

The tower is equipped with redwood distribution piping, two (2) wood stair towers and crossover walkways, circumferential wood walkway, fiberglass canopy supported from laminated wood beams and a lightning protection system. No shell access is available.

Between April 2 and April 13, 1990, an inspection of the structural components was performed. These components include the hyperbolic shell, cornice beam, lintel beam, X-brace shell supports, cold water basin floor and the concrete

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divider wall. Present at the inspection for Pullman Power Products Corporation were:

J. R. Biggs.....Manager, Repair Department
Dennis Kendall.....Inspector
Steve Meyer.....Assistant
Danny Keith.....Assistant

The interior of the shell was inspected from vantage points at the cornice beam and from the cold water basin. The concrete was subjected to hammer testing from the access brackets. Photographs were secured and have been numbered 1 - 43 comprising Section III of the report.

The exterior of the shell was inspected for its full height from four (4) drop zone locations predetermined by an American Electric Power Service Corporation representative. Access for the inspection was provided for by placing rigging brackets upon the cornice with the aid of a helicopter. Once the brackets were in place, men were lifted to the bracket locations to further secure them in order to rig electrically operated Skyclimbers equipped with two-man cages. Photographs were secured at every 20′ increment in elevation and other noted areas of concern. Hammer testing (sounding) was performed in random and suspicious areas where the shell's surface was accessible. Also, selected construction joints were mechanically cleaned to provide further inspection data. The areas which lay outside the drop zones were visually examined with binoculars with defects documented by means of a telephotographic survey. In all, 280 photographs were secured of the shell's exterior. They are numbered 44 - 323 and comprise Section V of the report.

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SECTION I DESCRIPTION & PROCEDURE

The lintel beam, X-brace shell support columns, plinths, cold water basin floor and expansion joints plus the concrete divider wall were visually inspected from the basin. Hammer testing was performed at accessible locations. Access to the basin is limited to only small equipment such as a bobcat, subsequently the inspection team was unable to place any special access equipment within this area. Typical photographs of the observed conditions were secured, are numbered 324 - 425 and comprise Section VII of the report.

The inspection findings from visual examination at grade were cataloged in order to provide a Defect Location Map, including leaking/stained joints and cracks, which is found in Section VIII of the report. All photographs and defect descriptions as supplied, are located by means of construction lifts and radial reference points. Construction lifts are numbered from no. 1 to no. 78 with no. 1 being the top. Radial reference points are numbered from no. 1 to no. 224 corresponding to laminated wood beam canopy supports with no. 1 radial located relative to the tower's inlet pipes as shown. The lintel beam segments, X-brace shell support columns and plinths are numbered from no. 1 to no. 32 and are also located relative to the tower's inlet pipes. Also provided is a key plan reference for plant North as given by Marley general arrangement drawings.

Pullman Power Products Corporation

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SECTION II

SHELL INTERIOR

Inspection Findings

Photographs no. 1 - 22 were taken at the top of the shell and give views of the uppermost five (5) lifts of the tower plus the cornice beam and lightning protection system. As seen in the photographs, the lightning protection air terminals and encircling cable appear to be continuous. However, more information relative to the initial installation/design is required to provide statement as to grounding capabilities. Note the extent of algae growth for this portion of the shell. One (1) spall in the top of the cornice was noted as shown in Photographs no. 13 and 14.

Photographs no. 23 - 27, also taken from the top of the shell, provide documentation from lifts no. 5 - 16. Again note the extent of algae growth, photographs no. 36 and 37 at radials 209 and 210 give close up views of this growth. Photographs no. 29 and 30 show existing construction embedments and were secured to provide information as to relative rust staining from continuously exposed carbon steel. Although difficult to see in Photograph no. 32, a total of eight (8) rock pockets were noted at the bottom of lifts no. 7 9, 10 and 12 in the relative west quadrant.

Photographs no. 38 - 43 show the X-brace supports and bottom of the shell. These photographs were taken from the cornice and no defects were noted from that vantage point.

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SECTION III

SHELL INTERIOR

Photograph Index

Photograph No.	Location
1	Top, North
2	Top, North
3	Top, North
4	Top, Northeast
5	Top, East
6	Top, East
7	Top, East
8	Top, Southeast
9	Top, Southeast
10	Top, Southeast
11	Top, South
12	Top, South
13	Top, South
14	Top, South
15	Top, South
16	Top, Southwest
17	Top, Southwest
18	Top, Southwest
19	Top, Northwest
20	Lifts 1 - 5, North
21	Lifts 1 - 5, Northeast
22	Lifts 1 - 5, Northwest
23	Lifts 5 - 10, North
24	Lifts 5 - 10, Northeast
25	Lifts 5 - 10, Southeast
26	Lifts 5 - 10, Southwest
27	Lifts 5 - 10, West
28	Lifts 5 - 10, Northwest
29	Lift 12, Northeast
30	Lifts 8 - 16, Northeast

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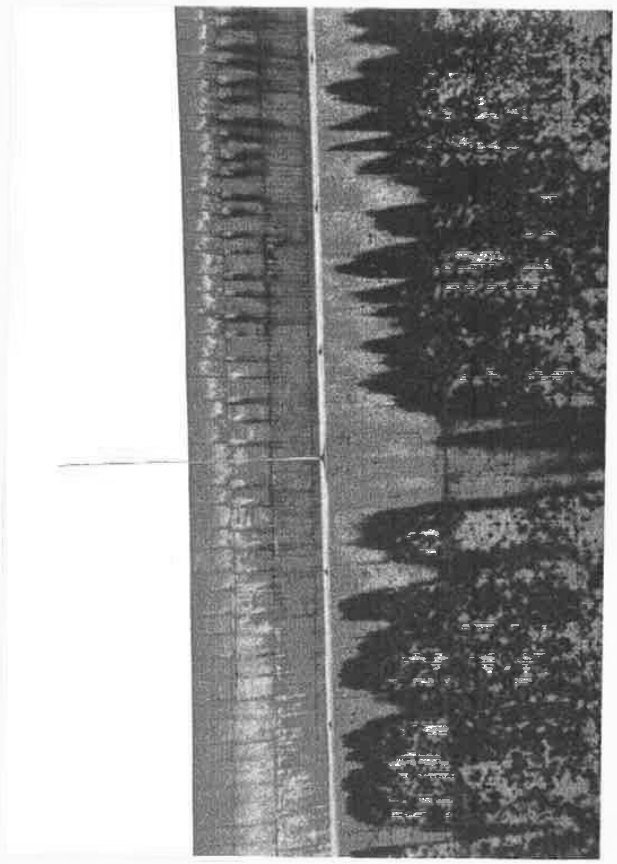
SECTION III

SHELL INTERIOR

Photograph Index

Photograph No.	Location
31	Lifts 5 - 12, Southeast
32	Lifts 6 - 14, West
33	Lifts 10 - 16, Northwest
34	Below Lift 12, Southeast
35	Below Lift 12, West
36	Algae Close Up, Radial 209
37	Algae Close Up, Radial 210
38	Bottom, North
39	Bottom, Northeast
40	Bottom, South
41	Bottom, Southwest
42	Bottom, Southwest
43	Bottom, West



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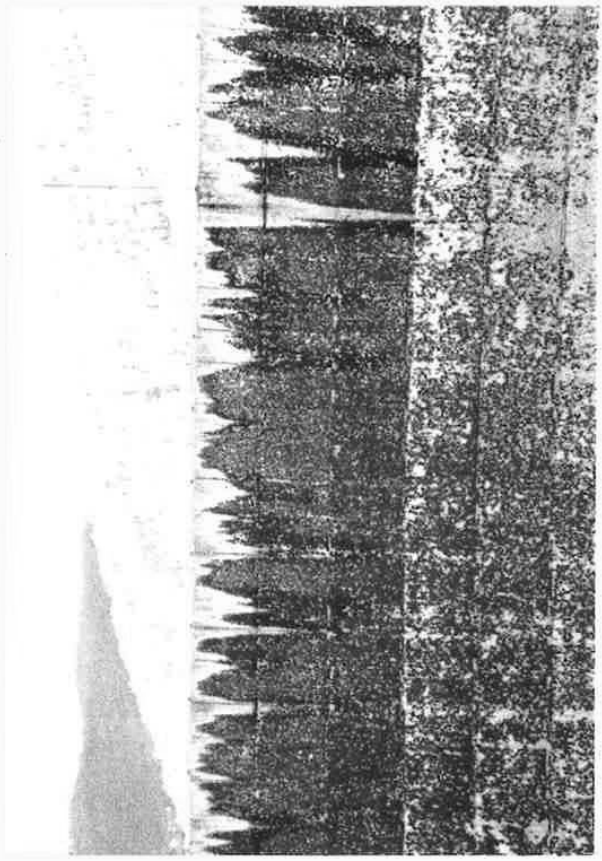

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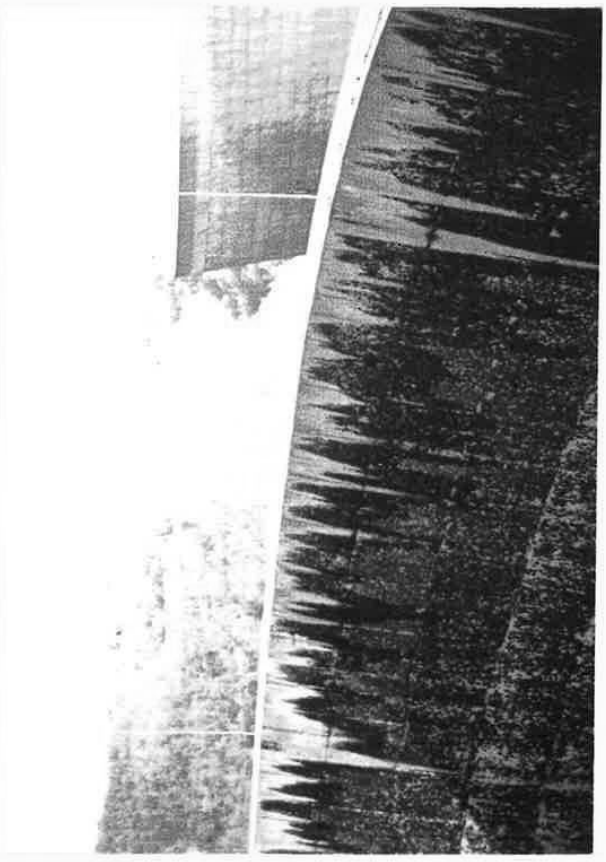

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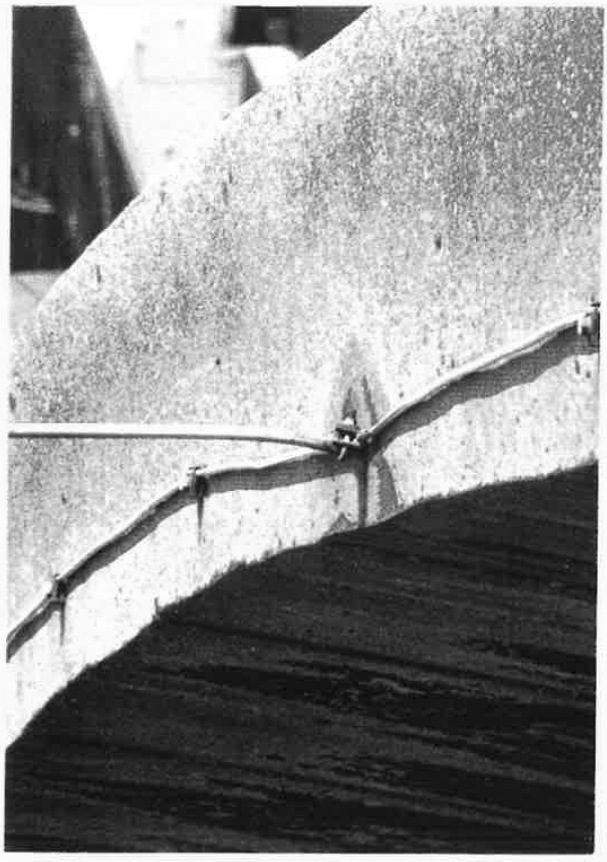

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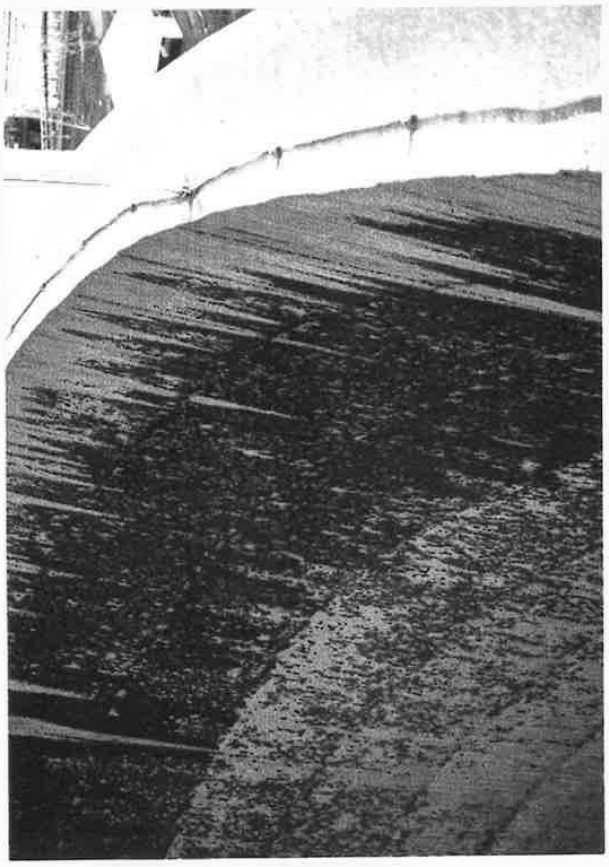

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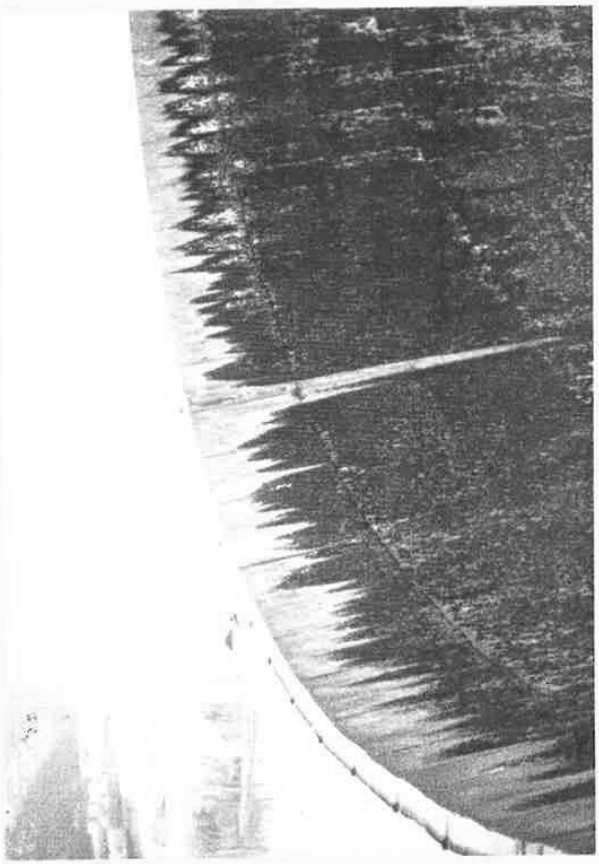

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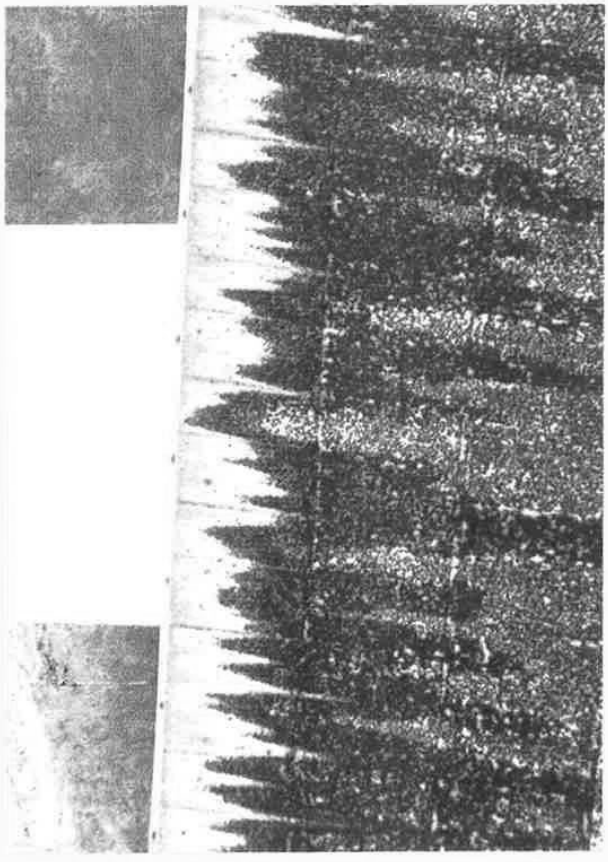

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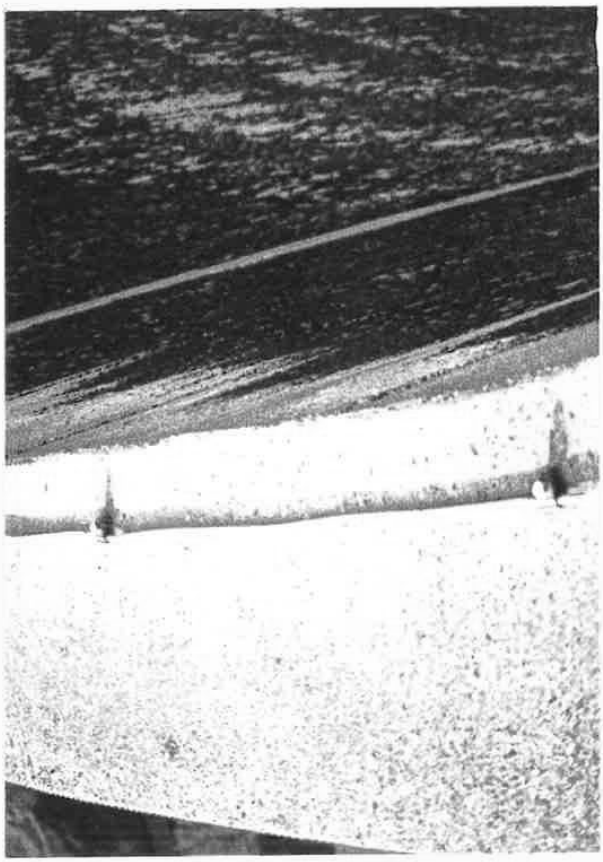

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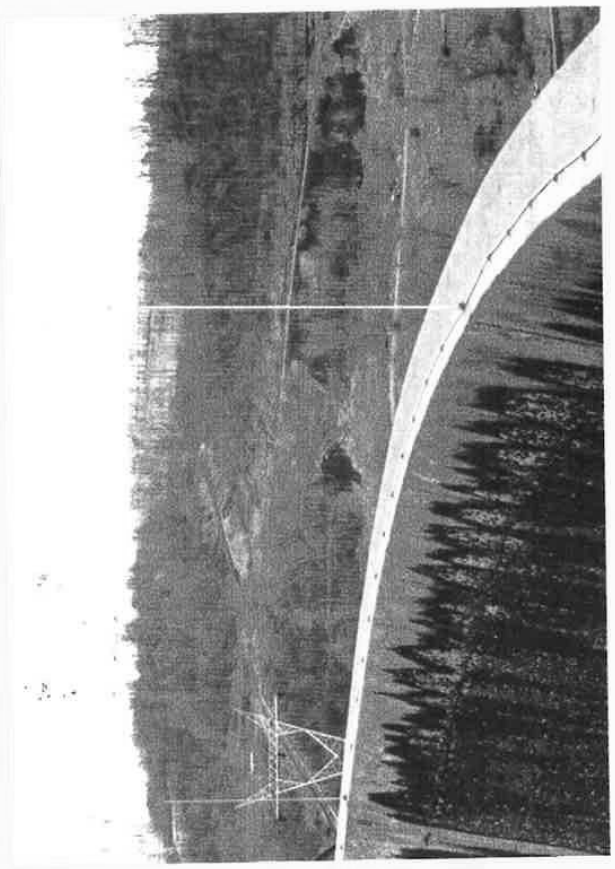

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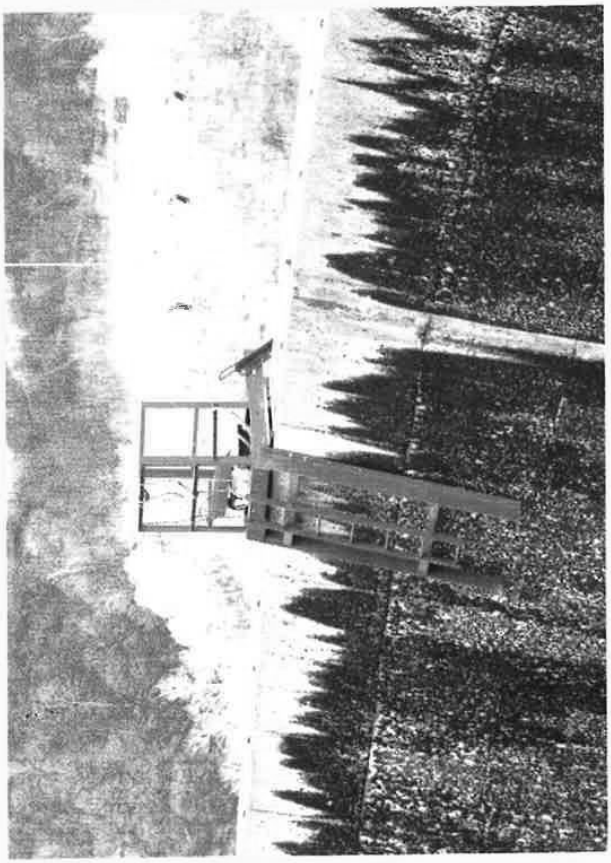

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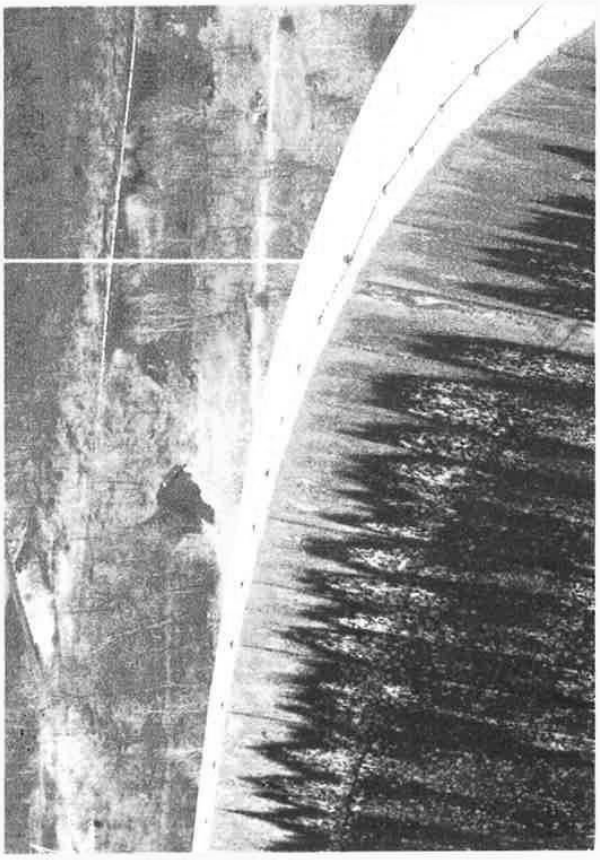

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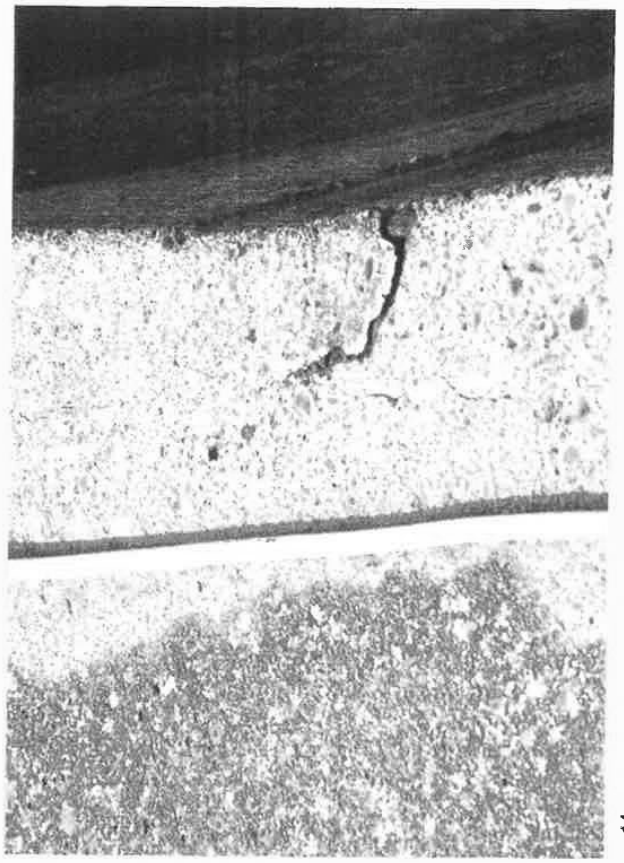
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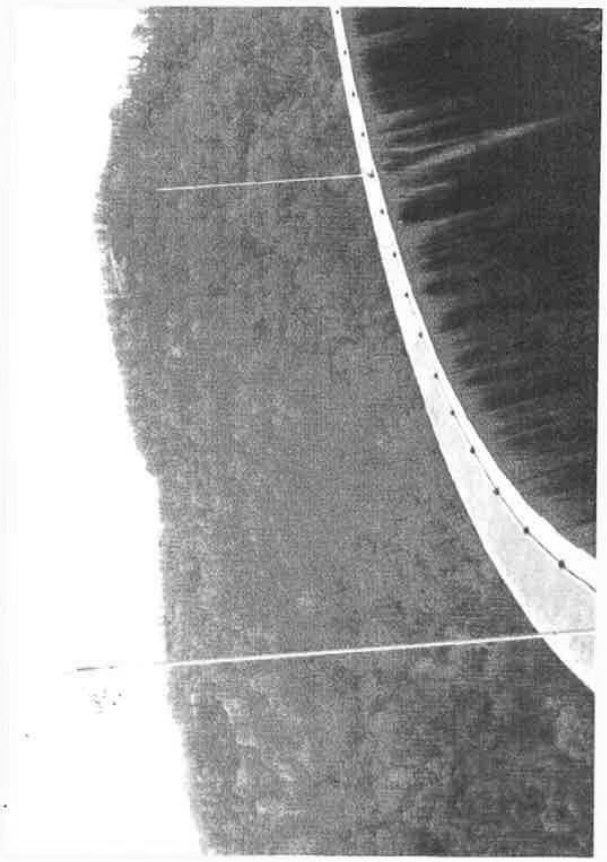
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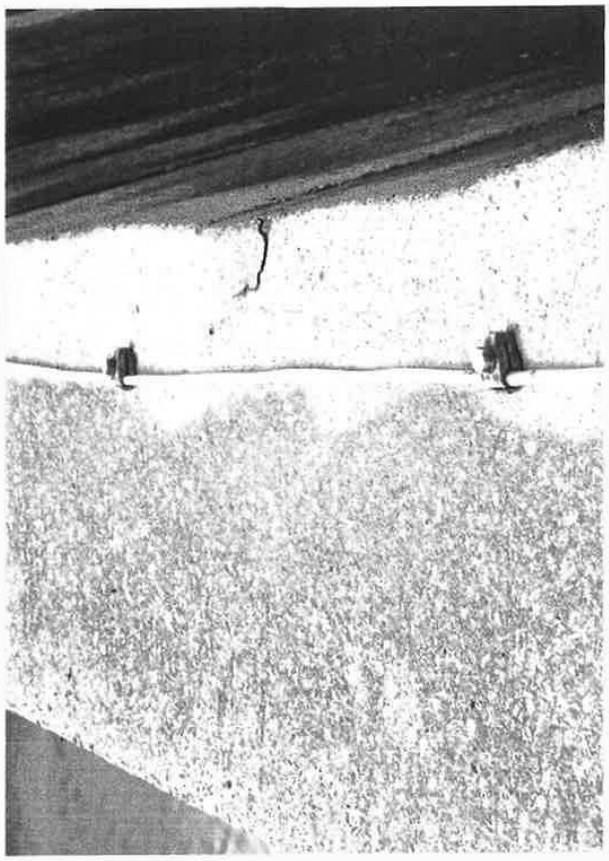
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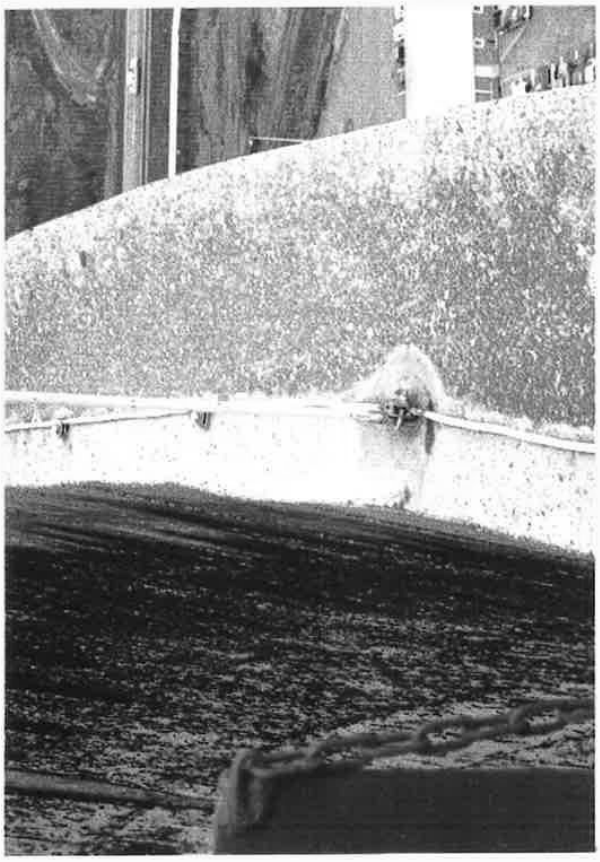
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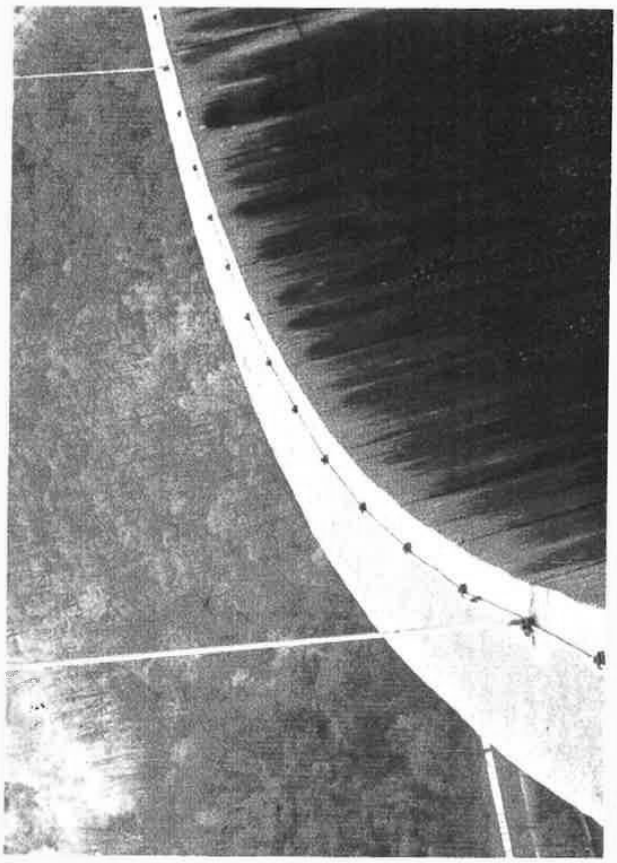

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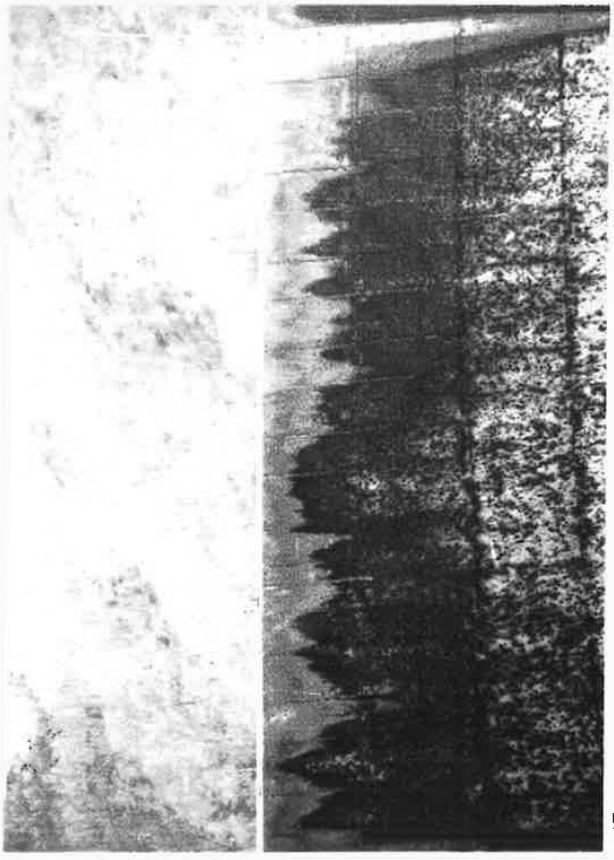

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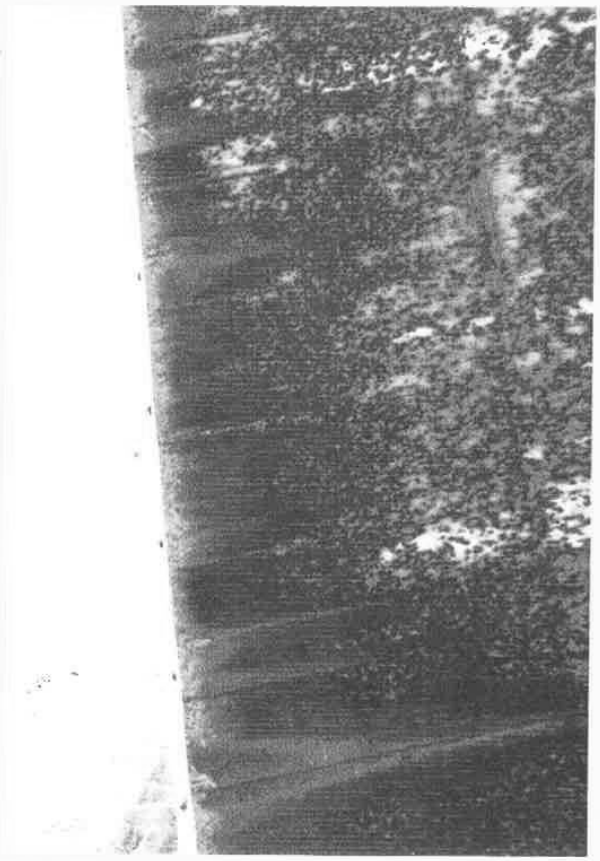

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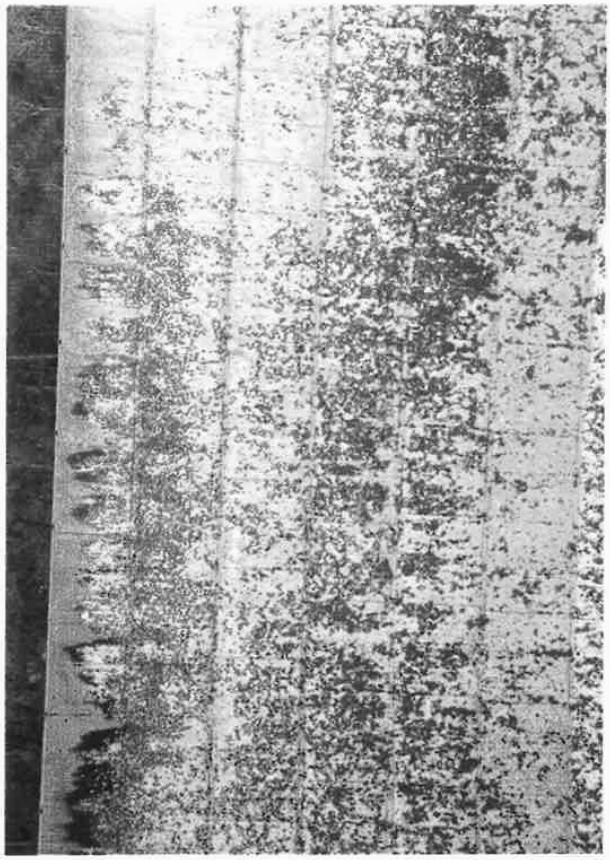

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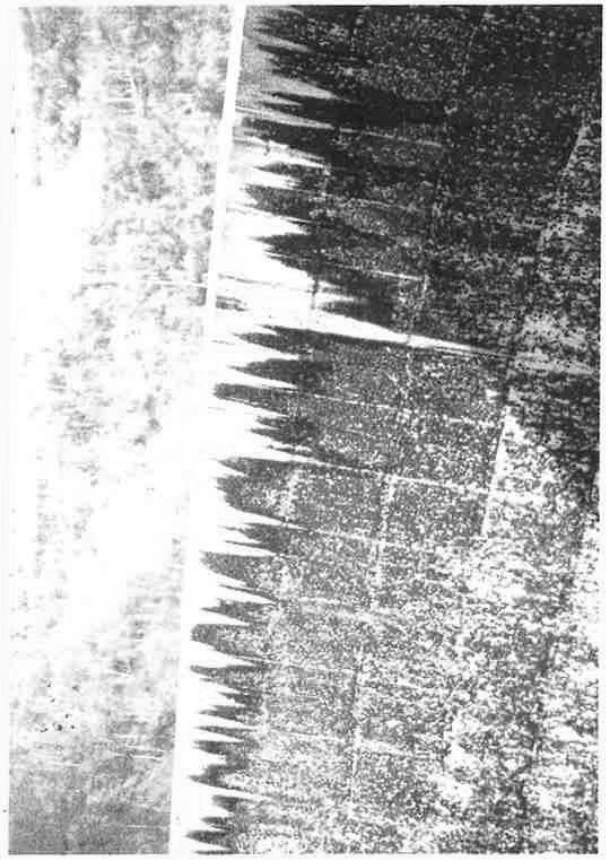

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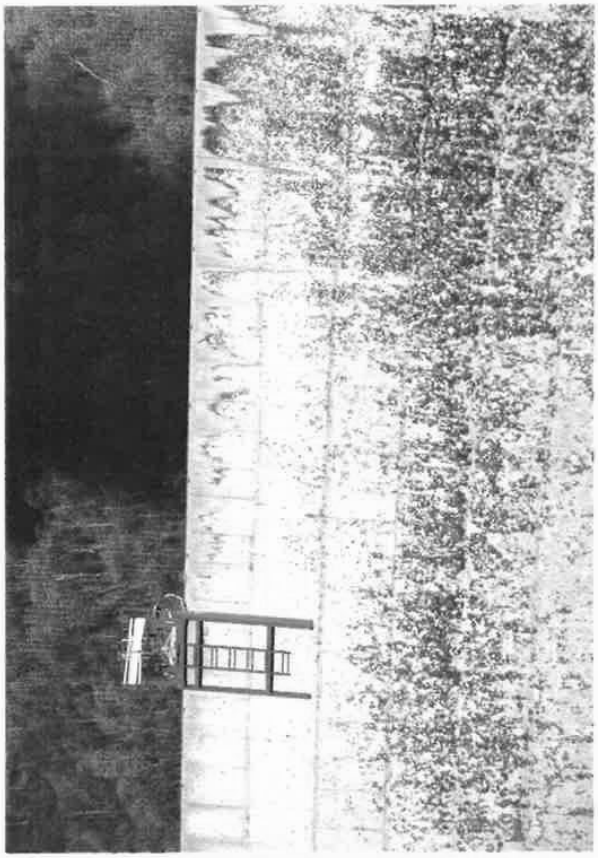

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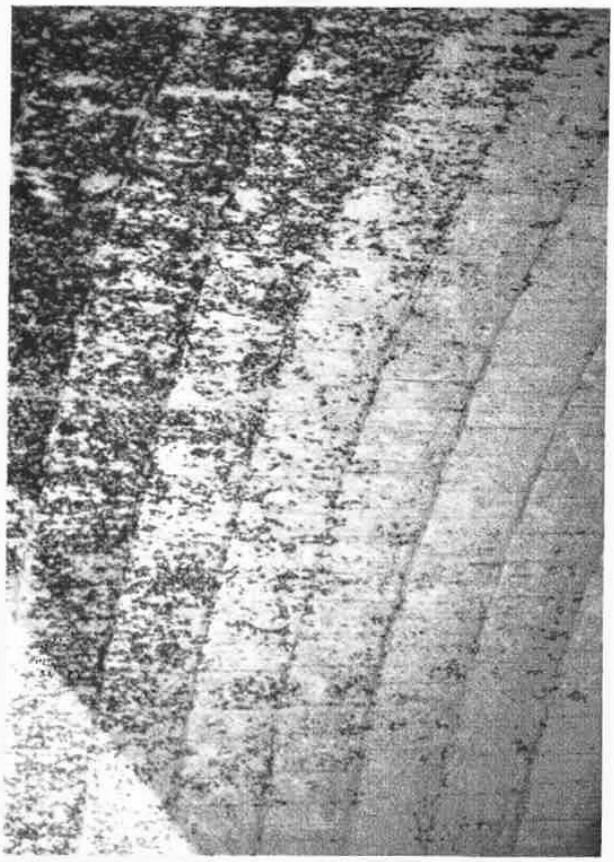

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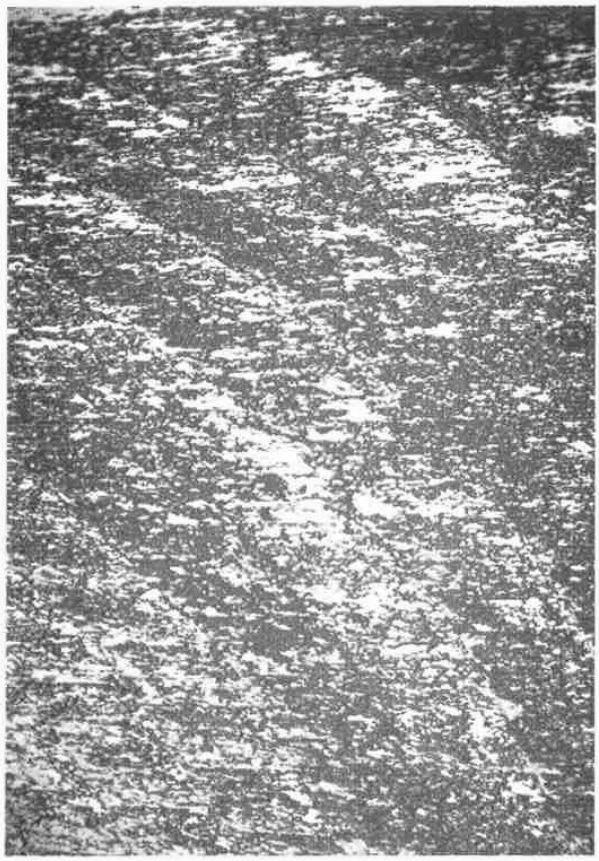

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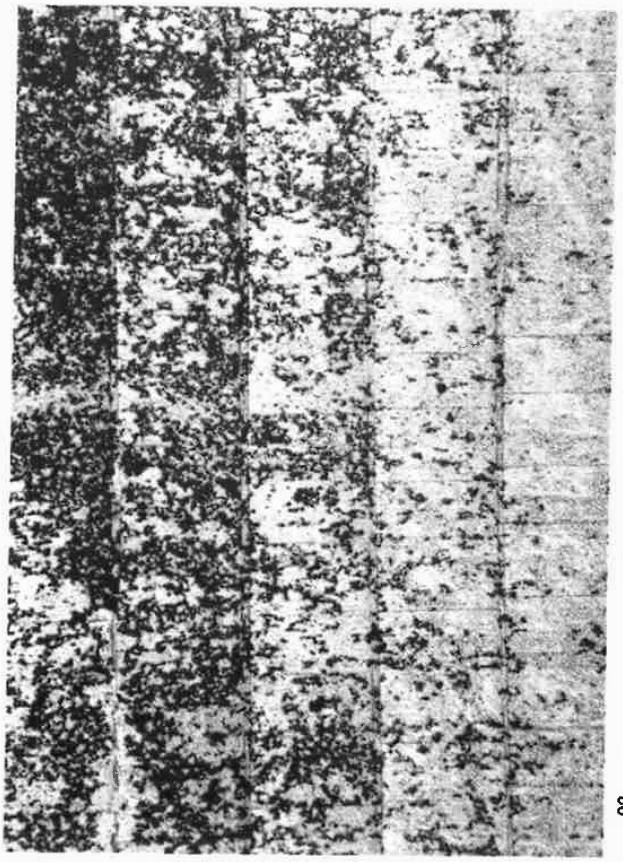

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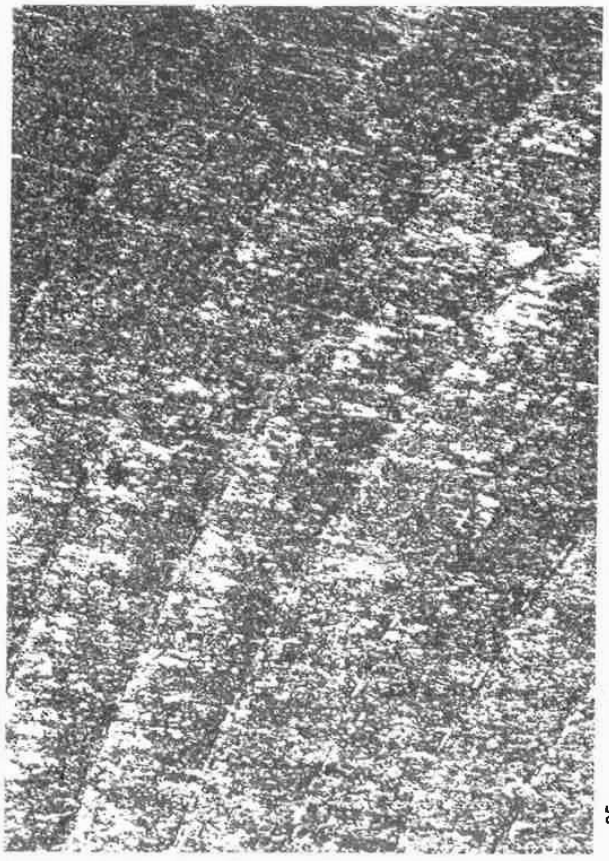

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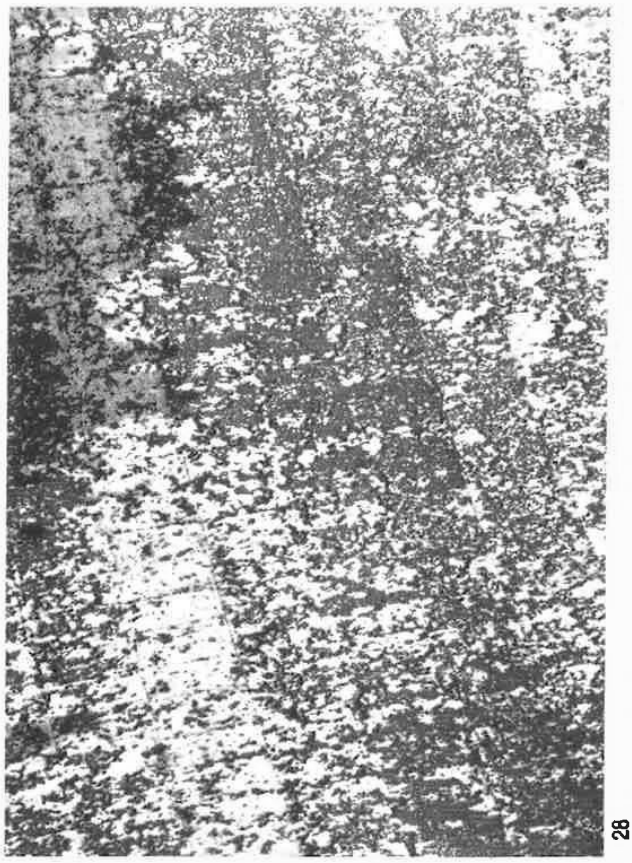
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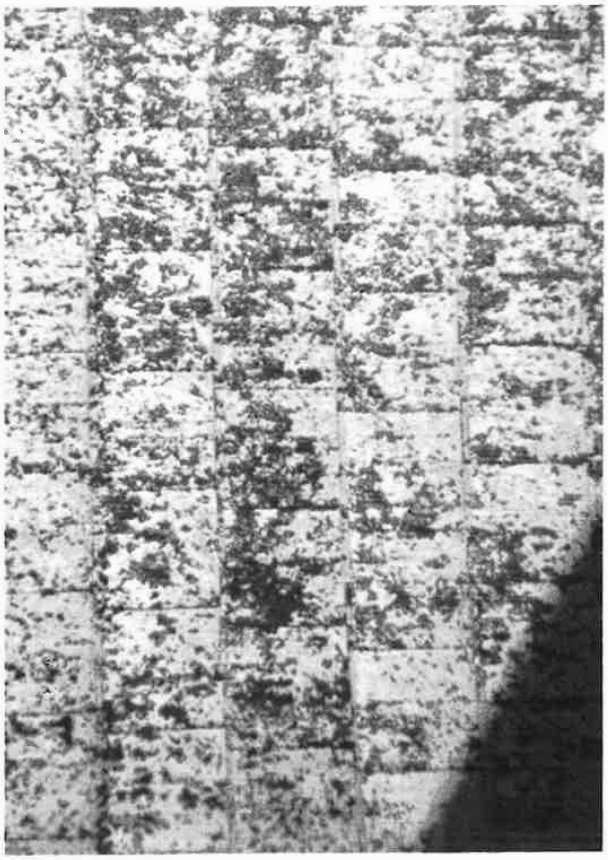
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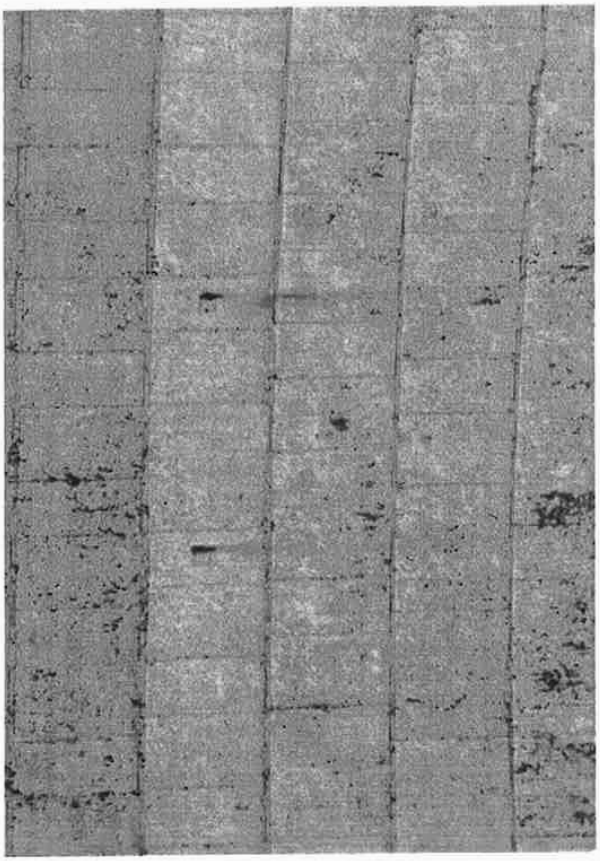
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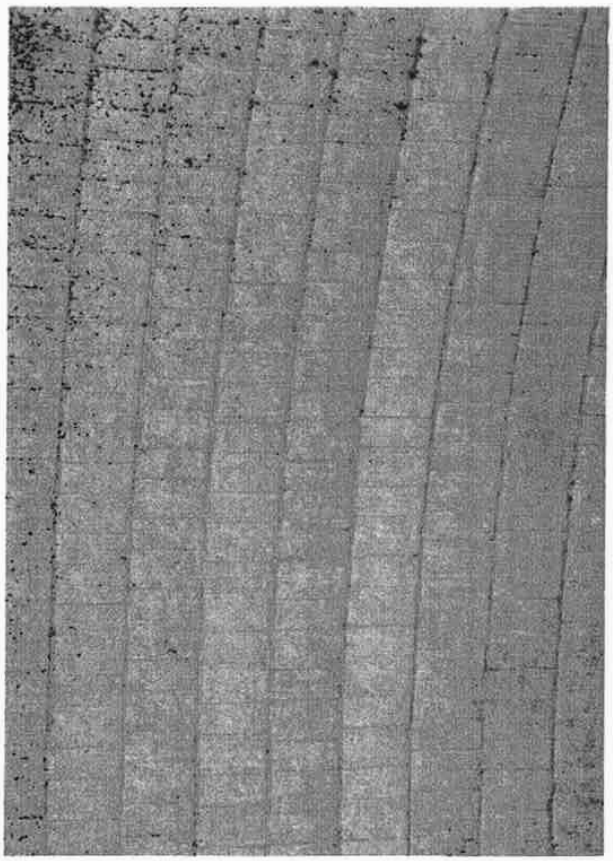

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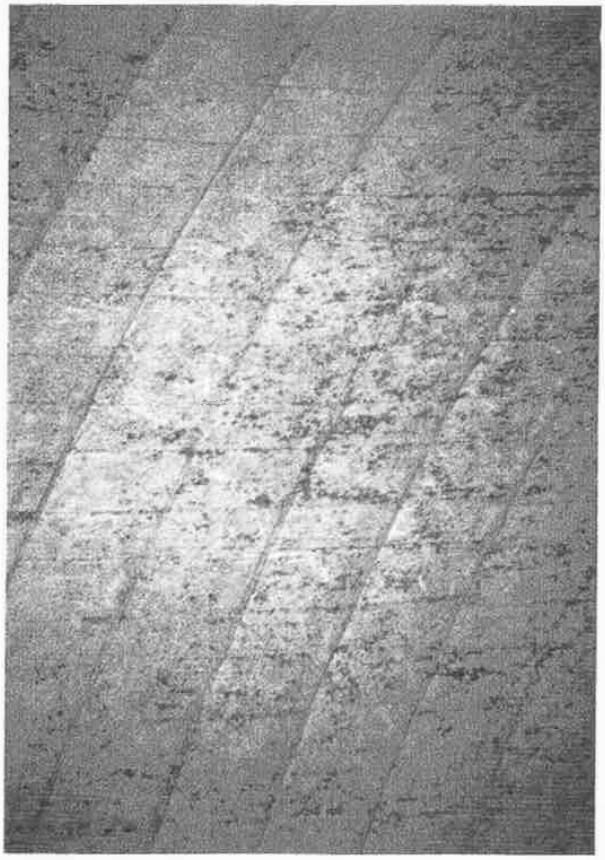

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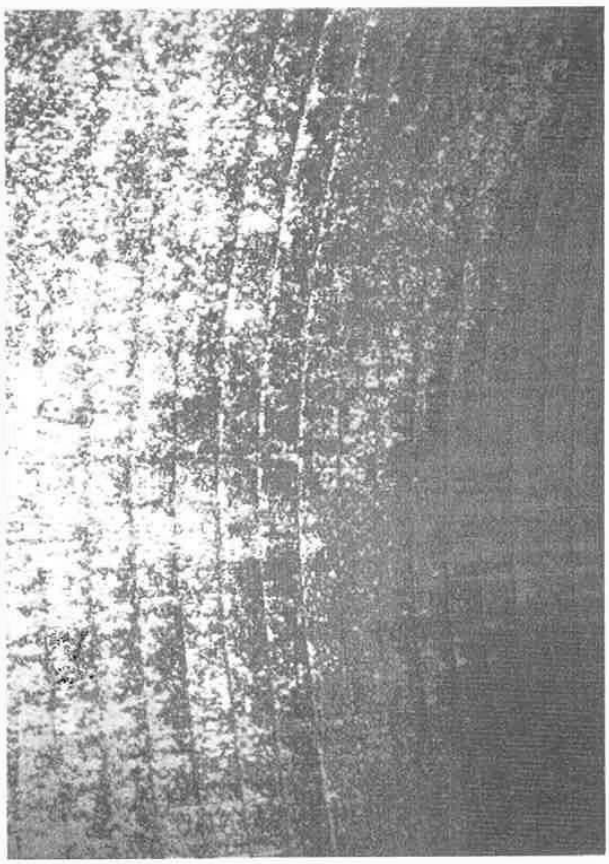

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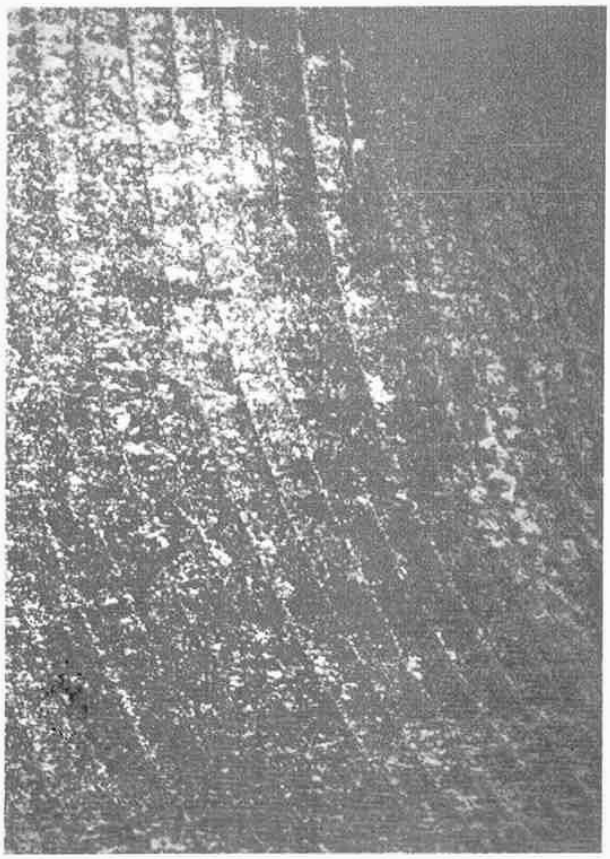

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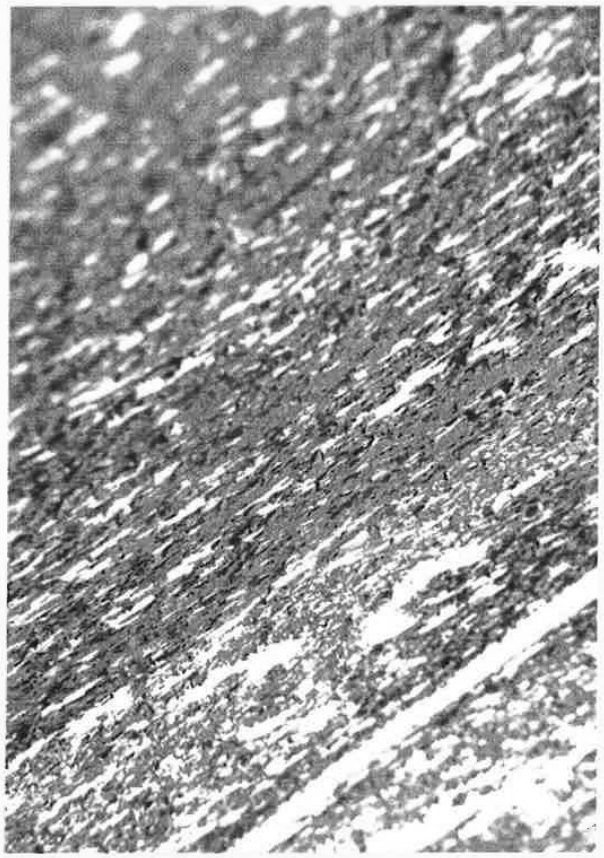

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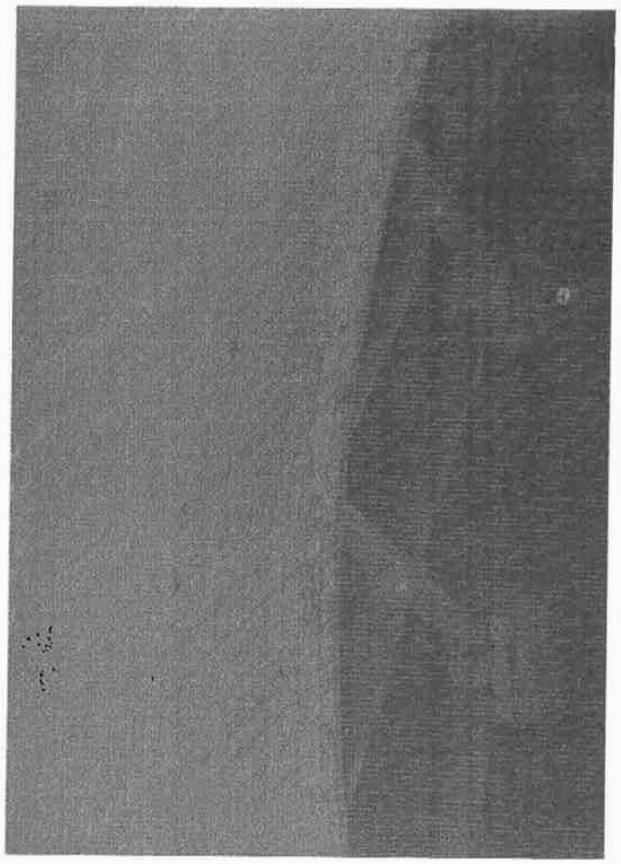

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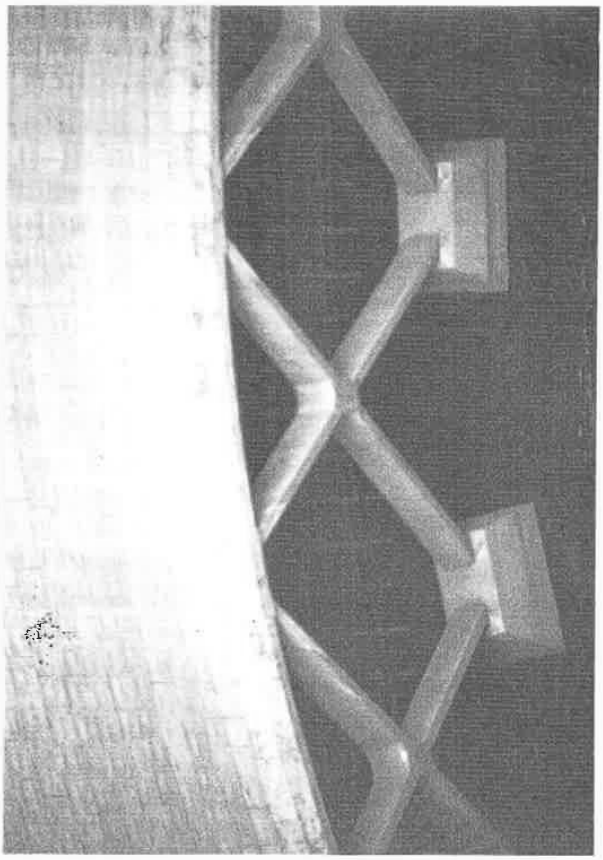

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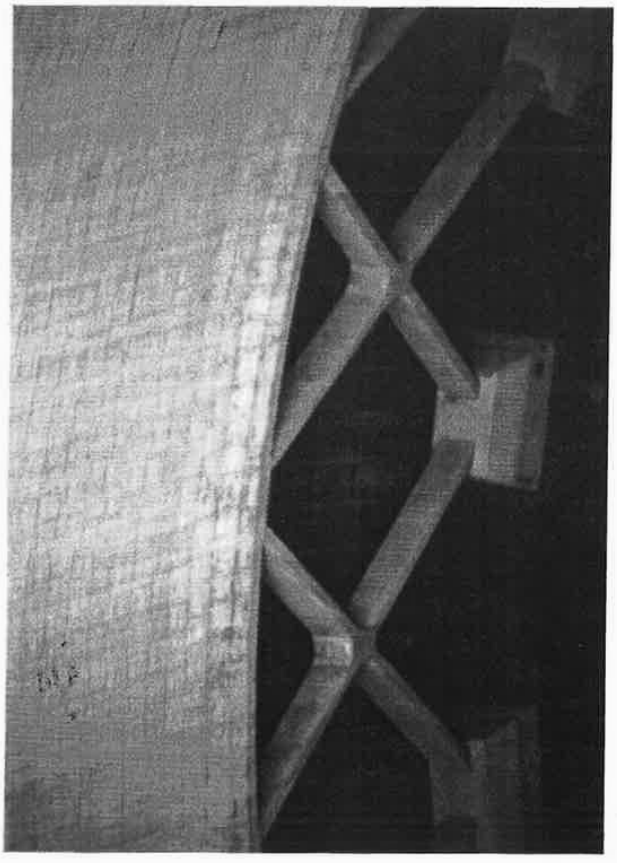

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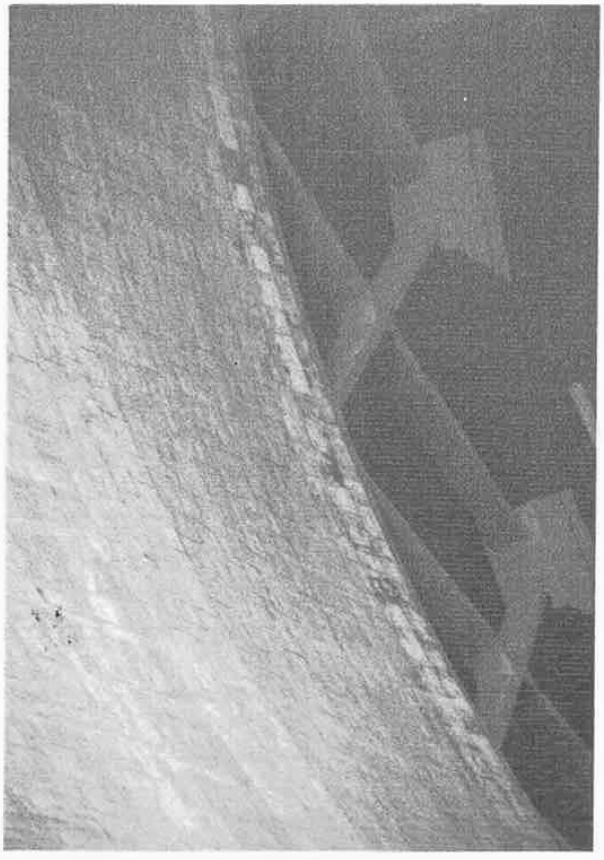

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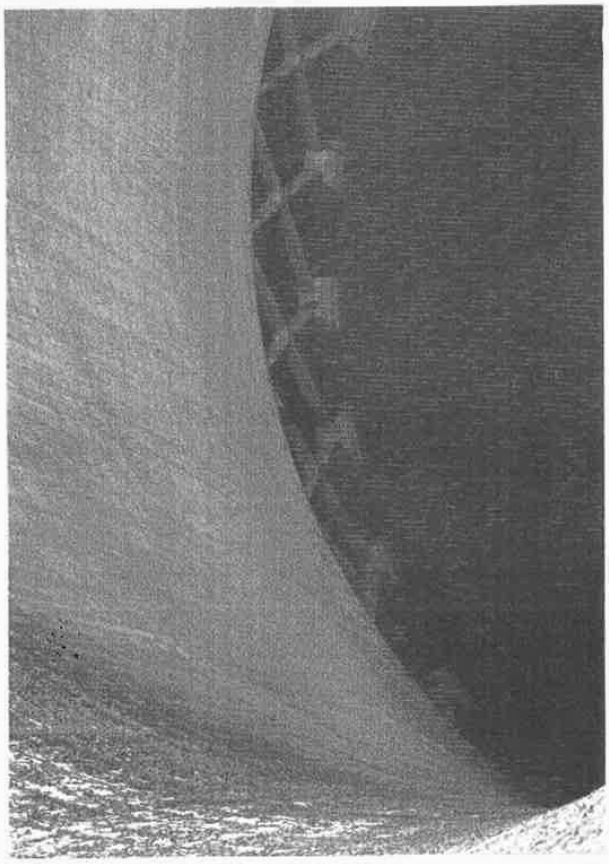

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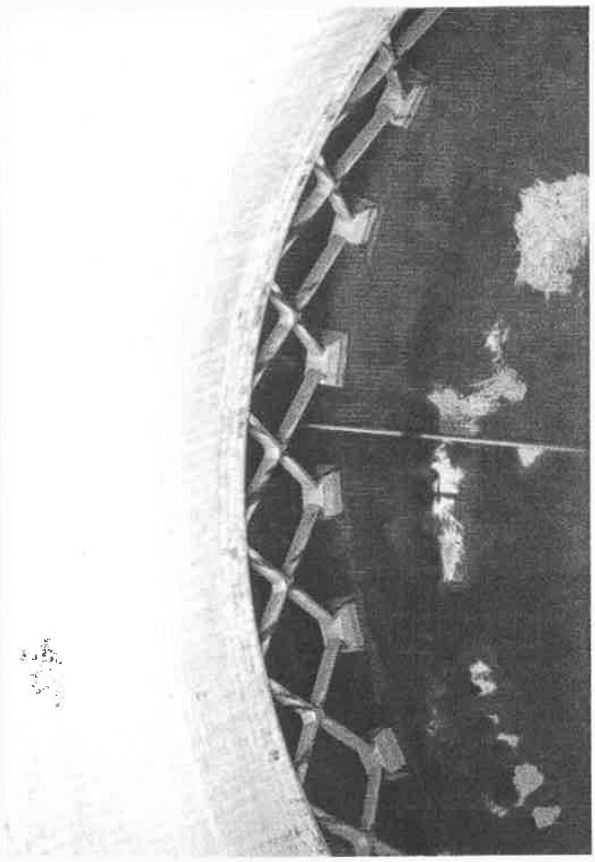

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OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION IV

SHELL EXTERIOR

INSPECTION FINDINGS

The first three (3) photographs no. 44 - 46 show a general view of the east face of the shell secured from grade, Unit No. 2 cooling tower in operation and a view of the helicopter-aided initial access task.

Photographs no. 47 - 50 show the condition at the top four (4) construction lifts. The staining for most of this area appears to stem from condensation of the exiting plume while the unit is in operation, however, the east face (photograph no. 50) exhibits weeping at the bottom of lift no. 1 and resultant efflorescence deposits.

Photographs no. 51 - 69 document the present condition of lifts 1 - 5. Defects noted range from loosened wall tie plugs as seen in photograph no. 52, several cracks of which either stem from wall tie plugs or correlate to construction joints as seen in photographs no. 56, 57, 58, 64, 65, 68 and 69. Several open lift joints and resultant efflorescence are visible in the remainder of this set of photographs.

Lifts no. 6 - 11 exhibit additional joint weepage and some cracking such as vertical or along construction joints and pop-outs from wall tie areas as seen in photographs no. 70 - 84. It appears that during construction of the shell after the forms were raised, the entire exterior surface was finished in a manner such as sacking. Note debonding of the sacking as shown in photograph no. 83.

Photographs no. 85 - 105 document conditions noted at lifts no. 14 - 16. As can be seen in the photographs, defects noted include weeping/open construction joints with typical deposits plus several cracks along joints and wall tie locations.

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SECTION IV SHELL EXTERIOR

INSPECTION FINDINGS

Photographs no. 106 - 120 provide further examples of weeping joints, vertical and horizontal cracks from lifts no. 17 - 20. Shown in photographs no. 109 and 110, note rust spots which appear to stem from wall ties and aggregate.

Photographs no. 121 - 149 include lifts no. 25 - 33 and noted conditions are as follows: cracking was observed in these areas from all four (4) drop zones; photograph no. 122 shows the beginning of spalled area; photograph no. 150 shows a spalled area with rust stain stemming from the exposed aggregate; a notable leaking joint with efflorescence stain and exposed aggregate can be seen in photographs no. 129 and 130; a diagonal leaking cold joint with rock pocket is seen in photograph no. 137; photograph no. 138 is a leaking joint with rock pockets and moss growth apparently stemming from silt accumulation within the joint.

Lifts no. 34 - 43 exhibit the same typical defects with severity similar to the proceeding lifts as stated above. Photographs no. 150 - 185 document these typical defects such as: weeping joints and resultant efflorescence deposits, moss formation, open joints/rock pockets, rust stemming from aggregate or construction wall ties and spalls. Photograph no. 160 is an example of rusting aggregate as opposed to a wall tie, note the spalling area in the top center of the photograph. The rust bleeding from this area appears to be from aggregate, not a wall tie, because of the close proximity of the wall tie plug to its immediate left. Suspected patched rock pocket areas can be seen in photographs no. 154, 170, 179 and 185 in which it appears that portions of a patch has spalled off exposing an open joint/rock pocket.

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INSPECTION FINDINGS

Moving down the tower to areas between lifts no. 44 - 51 documented by photographs no. 186 - 202, we continue to find the same typical defects as described in the before-mentioned text, however, the weeping joints appear not to be as severe.

Lifts no. 53 - 60, shown in photographs no. 203 - 226, exhibit an increase in moss formation at the open joints/rock pockets. Also observed was additional signs of apparent silt accumulation within the open construction joints.

Photographs no. 227 - 256 include lifts no. 62 - 66 which show continued signs of moss growth and silt accumulation at open construction joints. Photographs no. 228, 229, 247 and 248 document joint condition before and after cleaning to determine depth of the defect and general investigation. Hammer testing results revealed that the surrounding areas appeared to be sound. Cracks noted within this set of lifts are shown on photographs no. 233 - 238, 245, 246, 249 and 250.

The remainder of lifts no. 68 - 78, which complete the external inspection drop zones, are documented by photographs no. 257 - 296. The first photograph in this set (photograph no. 257) is an example of rock pocket/weeping joint that appears to have been patched and sacked during initial construction. The spalled area is a result of hammer testing which reveals the silt accumulation at the construction joint and exposed aggregate directly above. Photographs no. 258 and 259 show the extent of joint deterioration before and after cleaning the area (bottom of lift no. 69, radial 144). Note the moss growth and extent of silt accumulation. Photographs no. 275 - 277 provide views of an

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additional area mechanically investigated which reveals the same moss growth and silt as previously noted. It was also reported that at this joint when the screwdriver was removed, a strong, sulphur-like smell was present.

Photographs no. 283 and 284 provide additional patching/sacking evidence that mask potential problem areas over deterioration that eventually causes the surface to spall and expose the open joint (also see photographs no. 292 and 294). Photograph no. 295 depicts a section of horizontal rebar that appears to have "floated" to the outside of the lift section during initial construction. Photograph no. 288 shows another example of a "floated" piece of reinforcing steel which has subsequently corroded by being exposed to the environment. Seen in photograph no. 296 is a horizontal construction joint that appears to be patched and is open to the surface for 25 to 30% of the tower circumference. For the most part where accessible for hammer testing, it was reported that the surrounding areas of the weeping joints, outside the apparent deterioration, appear to be sound. The remainder of this set of photographs provide for additional crack, open joint with resultant rust staining, wall tie plug pop-out and void location documentation.

Photographs no. 297 - 323 include views of the shell, secured from grade utilizing telephotographic equipment, of notable areas between the four (4) inspection drop zones. Continued trends of weeping joints/rock pockets, cracks and similar defects were visible. Photograph no. 300 shows an example of open/weeping joints plus exhibits a rust stain possibly stemming from a wall tie. Examples of areas that appear to have been patched and sacked which have spalled/eroded away revealing weeping joints/rock pockets are shown in photographs no. 303, 304, 305, 311 and 315. Notable cracks are visible in photographs no. 306, 316, 317, 318, 320, 321, 322 and 323.

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SECTION V

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Photograph Index

Photograph No.	Location
44	Exterior, East Face
45	Unit No. 2, Looking North
46	Unit No. 1, Gain Access
47	Top, Radial 28
48	Top, Radial 108
49	Top, Radial 167
50	Top, Radial 197
51	Underside of Cornice, Radial 145
52	Underside of Cornice, Radial 145 - 147
53	Underside of Cornice, Radial 143 - 145
54	Underside of Cornice, Radial 211
55	Underside of Cornice, Radial 209
56	Underside of Cornice, Radial 210
57	Lift No. 1, Radial 69
58	Lift No. 1, Radial 144
59	Lift No. 1, Radial 187
60	Lift No. 1, Radial 186
61	Lift No. 2, Radial 208
62	Lift No. 2, Radial 211
63	Top of Lift No. 2, Radial 210
64	Lift No. 2, Radial 69
65	Lift No. 4, Radial 145
66	Lift No. 3, Radial 188
67	Lift No. 4, Radial 187
68	Lift No. 4, Radial 189
69	Lift No. 5, Radial 211
70	Lift No. 6, Radial 209
71	Lift No. 6, Radial 210 - 214
72	Lift No. 10, Radial 69

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Photograph No.	Location
73	Lifts 6 - 7, Radial 145 - 149
74	Lift No. 10, Radial 182
75	Lift No. 10, Radial 194
76	Lift No. 10, Radial 189
77	Lift No. 8, Radial 208
78	Lift No. 10, Radial 210
79	Top of Lift No. 11, Radial 211 - 213
80	Lift No. 11, Radial 208
81	Bottom of Lift 11, Radial 208
82	Lift No. 11, Radial 69 - 72
83	Lift No. 10, Radial 145
84	Lift No. 11, Radial 147 - 150
85	Lift No. 14, Right of Radial 187
86	Lift No. 14, 20' Left of Radial 187
87	Lift No. 15, Radial 187
88	Lift No. 15, Left of Radial 187
89	Bottom of Lift No. 13, Radial 214
90	Lift No. 15, Radial 210
91	Lift No. 14, Radial 69
92	Lift No. 15, Radial 69
93	Lift No. 15, Radial 70
94	Down from Lift No. 15, Radial 70
95	Lift No. 15, Radial 145
96	Lift No 16, Radial 145 - 146
97	Right of Lift No. 15, Radial 180
98	Right of Lift No. 15, Continued, Radial 180
99	Lift No. 15, Radial 185
100	Lift No. 15, Showing Branch, Radial 185
101	Down from Lift No. 15, Radial 185
102	Down from Lift No. 15, Radial 185
103	Down from Lift No. 15, Continued, Radial 185

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Photograph No.	Location
104	Top of Lift No. 16, Radial 207
105	Top of Lift No. 16, Radial 210
106	Lift No. 17, Radial 210
107	Top of Lift No. 17, Radial 215 - 216
108	Lift No. 20, Radial 71
109	Lift No. 20, Radial 71.5
110	Lift No. 20, Radial 71
111	Lift No. 17, Radial 149
112	Top of Lift No. 16, Radial 140
113	Lift No. 20, Radial 145
114	Lift No. 20, Radial 190
115	Lift No. 20, Radial 188
116	Lift No. 20, Radial 185
117	Lift No. 20, Radial 180
118	Top of Lift No. 18, Radial 212
119	Top of Lift No. 19, Radial 212
120	Lift No. 20, Radial 210
121	Down from Lift No. 20, Radial 210
122	Lift 25, Radial 70
123	Lift 25, Radial 71
124	Down from Lift 25, Radial 71
125	Lift 25, Radial 145
126	Lift 25, Radial 150
127	Lift 27, Radial 185
128	Top of Lift No. 25, Radial 210
129	Top of Lift No. 26, Radial 211
130	Top of Lift No. 26, Close Up, Radial 211
131	Lifts No. 26 - 33, Radials 209 - 211
132	Lift No. 27, Radial 69
133	Lift No. 31, Continuation of Photo No. 132, Radial 69
134	Lift No. 30, Radial 70

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Photograph Index

Photograph No.	Location
135	Lift No. 30, Continuation of Photo No. 134, Radial 70
136	Lift No. 33, End of Crack from Photo No. 134, Radial 71
137	Top of Lift No. 28, Radial 147
138	Top of Lift No. 31, Radial 142
139	Lifts No. 27 - 30, Radial 145
140	Lift No. 30, Radial 145
141	Lift No. 30, Radial 189
142	Lift No. 30, Radial 187
143	Lift No. 30, Radial 180
144	Lift No. 31, Radial 189
145	Lift No. 31, Radial 186
146	Lift No. 30, Radial 210
147	Top of Lift No. 31, Radial 216
148	Top of Lift No. 32, Radial 214
149	Top of Lift No. 32, Radial 210
150	Lifts No. 35 - 38, Radials 208 - 211
151	Top of Lift No. 34, Radial 208
152	Lift No. 35, Radial 69
153	Lift No. 34, Radial 144
154	Bottom of Lift No. 34, Radials 145 - 149
155	Lift No. 35, Radial 145
156	Lift No. 35, Radial 185
157	Lift No. 35, Radial 188
158	Lifts No. 36, Radial 188
159	Lifts No. 38, Radial 188
160	Top of Lift No. 35, Radial 207
161	Lift No. 35, Radial 210
162	Bottom of Lift No. 37, Radial 207
163	Top of Lift No. 37, Radial 216

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Photograph Index

Photograph No.	Location
164	Lift No. 38, Radial 209 - 211
165	Top of Lift No. 38, Radial 213
166	Lift No. 39, Radial 67
167	Lift No. 39, Radial 65
168	Lift No. 40, Radial 67
169	Top of Lift No. 38, Radial 140 - 144
170	Top of Lift No. 41, Radial 146
171	Top of Lift No. 41, Radial 147 - 153
172	Lift No. 40, Radial 145
173	Lift No. 40, Radial 192
174	Lift No. 40, Radial 188
175	Lift No. 40, Radial 185
176	Lift No. 40, Close Up, Radial 185
177	Lift No. 40, Radial 210
178	Top of Lift No. 41, Radial 215
179	Top of Lift No. 42, Radial 206
180	Top of Lift No. 41, Radial 210
181	Lift at Interface of 40 - 41, Radials 210 - 216
182	Top of Lift No. 42, Radial 204 - 206
183	Bottom of Lift No. 42, Radial 209
184	Under Lift No. 43, Radial 69
185	Top of Lift No. 42, Radial 146
186	Lift No. 44, Radial 190
187	Lift No. 45, Radial 210
188	Lift No. 45, Radials 208 - 209
189	Lift No. 45, Radial 69
190	Lift No. 45, Radial 145
191	Lift No. 45, Radial 187
192	Lift No. 45, Radial 182
193	Top of Lift No. 47, Radial 207
194	Top of Lift No. 47, Radial 212

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Photograph Index

Photograph No.	Location
195	Lift No. 50, Radial 69
196	Lift No. 50, Radial 70.5
197	Lift No. 50, Left of Radial 70
198	Top of Lift No. 50, Radial 148
199	Lift No. 50, Radial 145
200	Lift No. 51, Radial 187
201	Lift No. 50, Radial 210
202	Top of Lift No. 51, Radial 209
203	Lift No. 55, Radial 66.5
204	Top of Lift No. 55, Radial 149
205	Lift No. 55, Radial 145
206	Lift No. 53, Radial 190
207	Lift No. 53, Radial 192
208	Lift No. 55, Radial 188
209	Lift No. 55, Radial 190
210	Lift No. 55, Radial 186
211	Lift No. 55, Radial 185
212	Lift No. 53, Radial 209
213	Lift No. 55, Radial 210
214	Lift No. 57, Radial 211
215	Top of Lift No. 57, Radial 209
216	Top of Lift No. 57, Radial 207
217	Top of Lift No. 58, Radial 207
218	Top of Lift No. 58, Radial 217
219	Lift No. 60, Radial 69
220	Top of Lift No. 58, Radial 143
221	Lift No. 60, Radial 145
222	Lift No. 60, Radial 186
223	Lift No. 59, Radial 190
224	Lift No. 59, Radial 188
225	Lift No. 59, Radial 186
226	Top of Lift No. 60, Radial 210

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Photograph No.	Location
227	Lift No. 62, Radial 65
228	Bottom of Lift No. 62, Radial 147, Before Cleaning
229	Bottom of Lift No. 62, Radial 147, After Cleaning
230	Lift No. 63, Radial 187
231	Lift No. 63, Radial 185
232	Lift No. 63, Radial 183
233	Top of Lift No. 63, Radial 189
234	Top of Lift No. 63, Radial 189
235	Below Lift No. 63, Radial 189
236	Below Lift No. 63, Radial 189, Continuation of Photo No. 235
237	Below Lift No. 63, Radial 189, Continuation of Photo No. 236
238	Below Lift No. 63, Radial 189, Continuation of Photo No. 237
239	Lift No. 63, Radial 190
240	Lift No. 63, Radial 192
241	Lift No. 63, Radial 195
242	Top of Lift No. 62, Radial 208
243	Top of Lift No. 63, Radial 207
244	Top of Lift No. 63, Radial 209
245	Lift No. 65, Radial 69
246	Below Lift No. 65, Radial 69, Continuation of Photo No. 245
247	Bottom of Lift No. 65, Radial 144, Before Cleaning
248	Bottom of Lift No. 64, Radial 144, After Cleaning
249	Center of Lift No. 65, Radial 145
250	Center of Lift No. 65, Radial 145, Close Up
251	Lift No. 65, Right of Radial 187
252	Lift No. 65, Radial 187

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Photograph No.	Location
253	Lift No. 65, Left of Radial 187
254	Top of Lift No. 65, Radial 213
255	Lift No. 65,, Radial 210
256	Top of Lift No. 66, Radial 206
257	Lift No. 68, Radial 68
258	Bottom of Lift No. 69, Radial 144, Before Cleaning
259	Bottom of Lift No. 69, Radial 144, After Cleaning
260	Lift No. 68, Radial 187
261	Lift No. 68, Radial 186
262	Bottom of Lift No. 67, Radial 210
263	Top of Lift No. 68, Radial 208
264	Top of Lift No. 68, Radial 212
265	Lift No. 70, Right of Radial 69
266	Lift No. 70, Radial 69
267	Lift No. 70, Radial 145
268	Lift No. 70, Radial 188
269	Lift No. 70, Radial 187
270	Lift No. 70, Radial 186
271	Lift No. 70, Radial 210
272	Top of Lift No. 71, Radial 218
273	Lift No. 71, Radial 211, Before
274	Lift No. 71, Radial 211, After
275	Lift No. 72, Radial 69
276	Lift No. 72, Radial 69
277	Lift No. 72, Radial 69, Continuation of Photo No. 276
278	Lift No. 75, Radials 142 - 145
279	Lift No. 75, Radial 145
280	Lift No. 73, Radial 210
281	Bottom of Lift No. 73, Radial 210, Before
282	Bottom of Lift No. 73, Radial 210, After

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Photograph No.	Location
283	Lift No. 73, Radial 69
284	Lift No. 73, Radial 69
285	Lift No. 75, Radial 69
286	Lift No. 78, Radial 145
287	Lift No. 75, Radial 210
288	Lift No. 75, Radial 211
289	Lift No. 76, Radial 69
290	Lift No. 76, Radial 70
291	Lift No. 76, Radial 73
292	Lift No. 76, Radial 64
293	Top of Lift No. 78, Radial 208
294	Top of Lift No. 78, Radial 210
295	Lift No. 76, Radial 180
296	Lift No. 78, Radial 180

SHELL EXTERIOR BETWEEN DROPS/TELEPHOTO

297	Lift No. 12, Radial 28
298	Lift No. 25, Radial 28
299	Lift No. 40, Radial 28
300	Lift No. 38, Radial 35
301	Lift No. 61, Radial 76 (800 mm lens)
302	Lift No. 61, Radial 76 (400 mm lens)
303	Lift No. 68, Radial 86
304	Lift No. 75, Radial 87
305	Lift No. 74, Radial 95
306	Lift No. 35, Radial 105
307	Lift No. 55, Radial 106
308	Lift No 57, Radial 107
309	Lift No. 21, Radial 108
310	Lift No. 32, Radial 108
311	Lift No. 55, Radial 109
312	Lift No. 75, Radial 109

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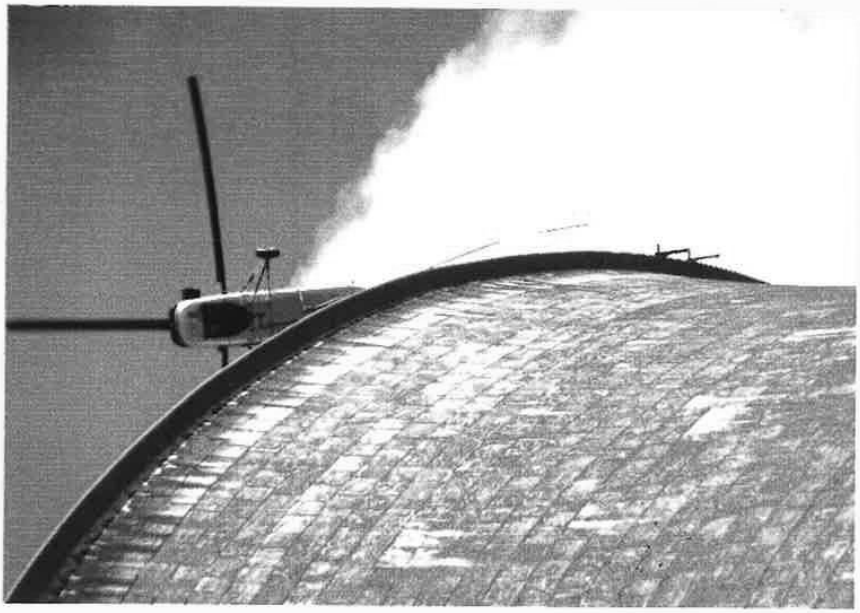
SECTION V — SHELL EXTERIOR BETWEEN DROPS/TELEPHOTO

Photograph Index

Photograph No.	Location
313	Lift No. 53, Radial 114
314	Lift No. 60, Radial 122
315	Lift No. 71, Radial 161
316	Lift No. 11, Radial 167
317	Lift No. 13, Radial 167
318	Lift No. 21, Radial 167
319	Lift No. 76, Radial 180
320	Lift No. 18, Radial 197
321	Lift No. 29, Radial 197
322	Lift No. 40, Radial 197
323	Lift No. 38, Radial 216



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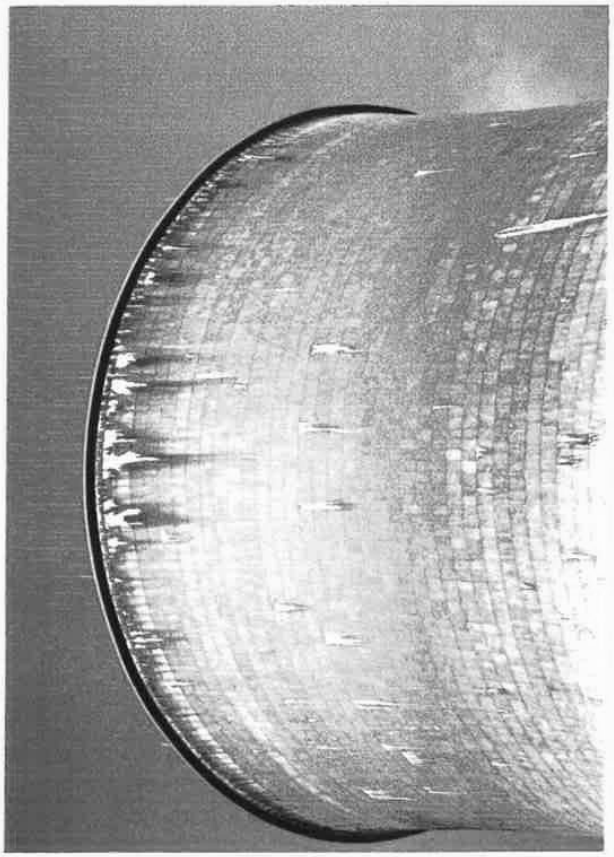

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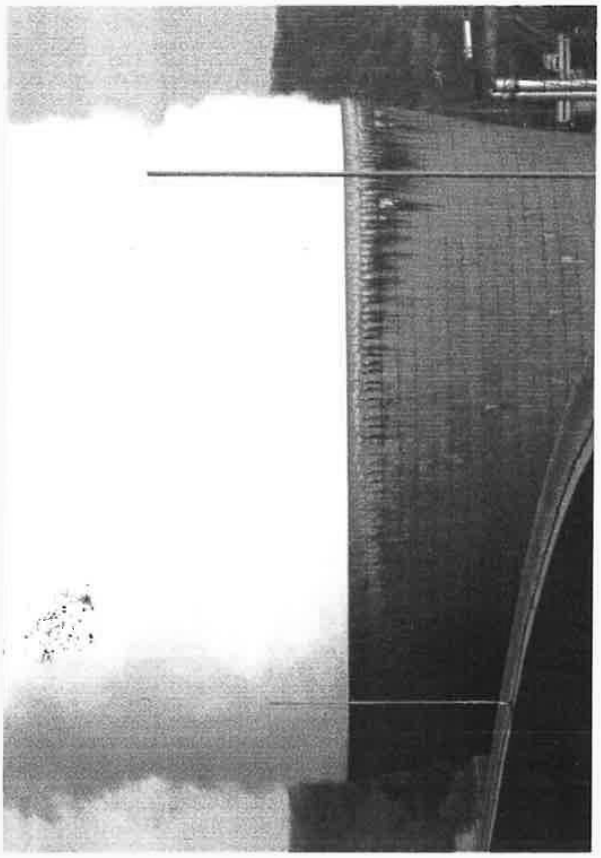

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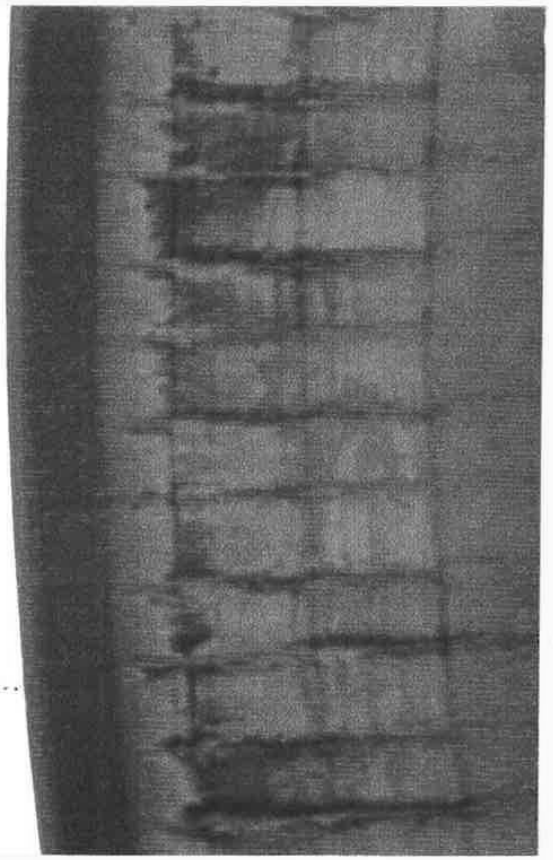
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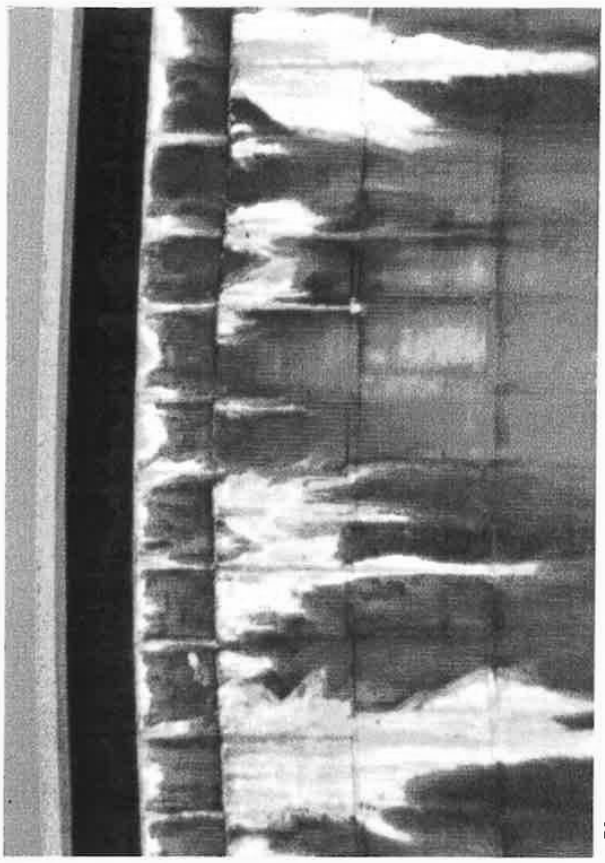
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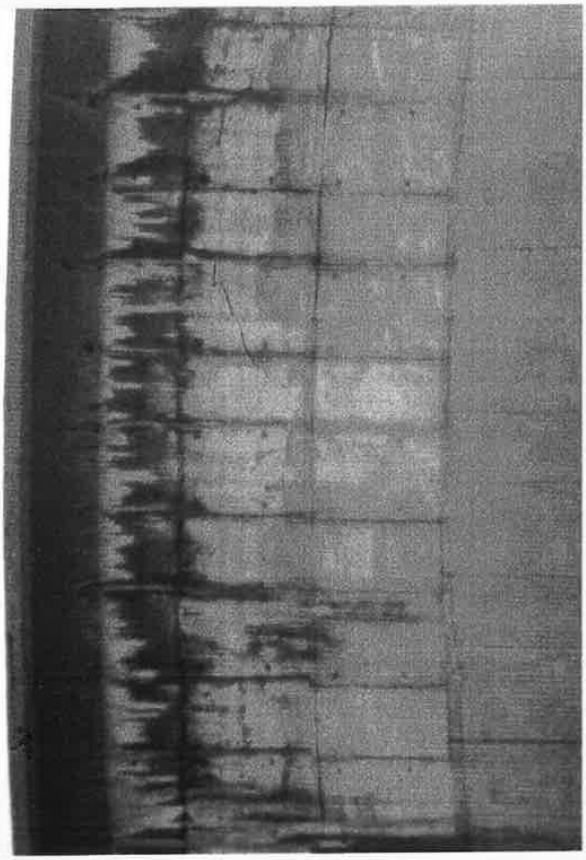
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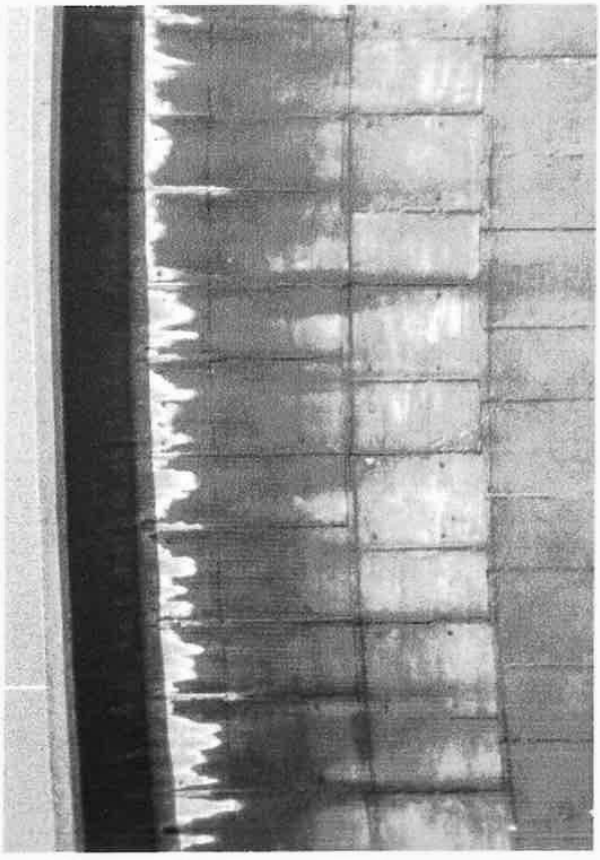
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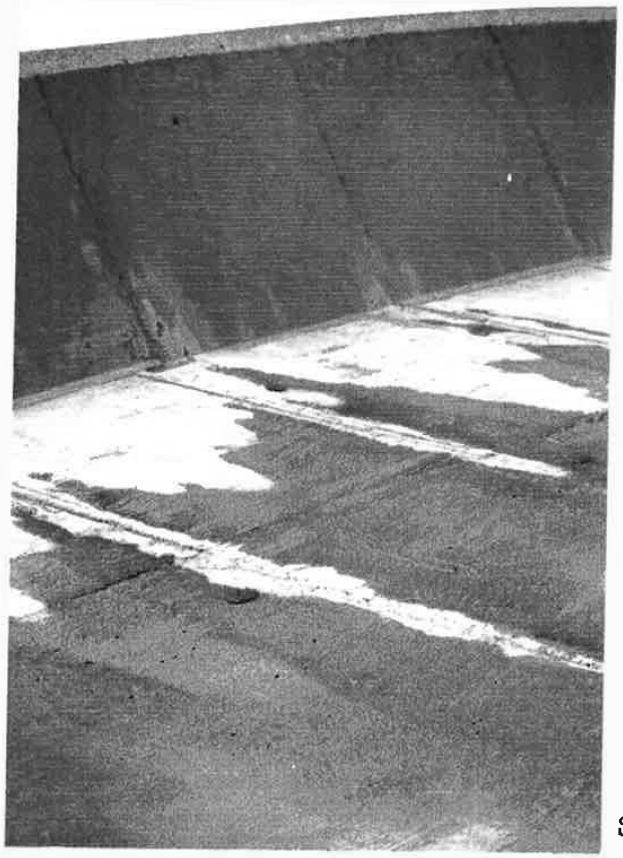
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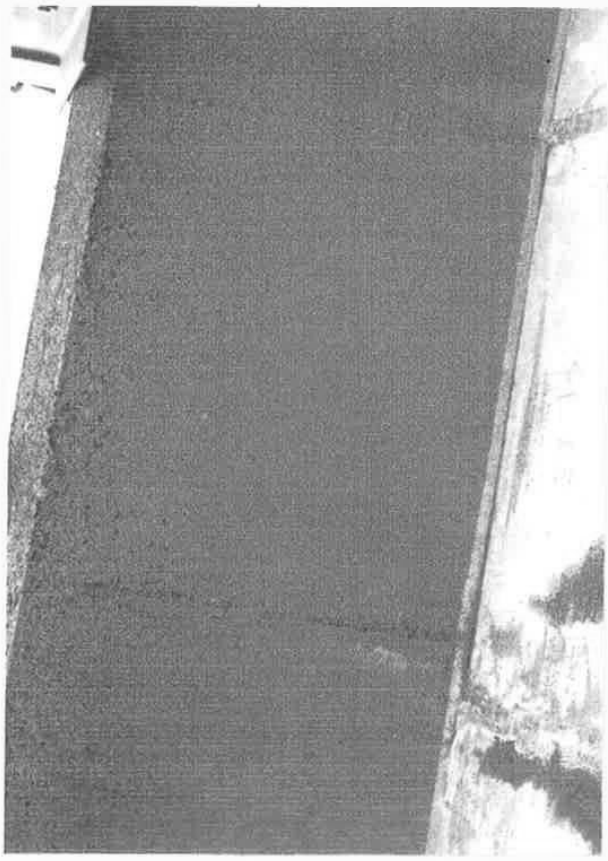
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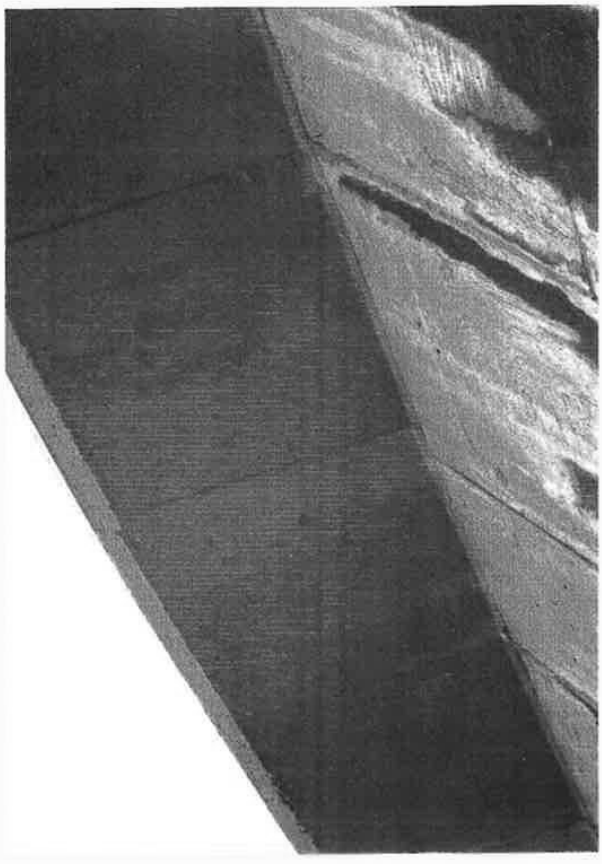
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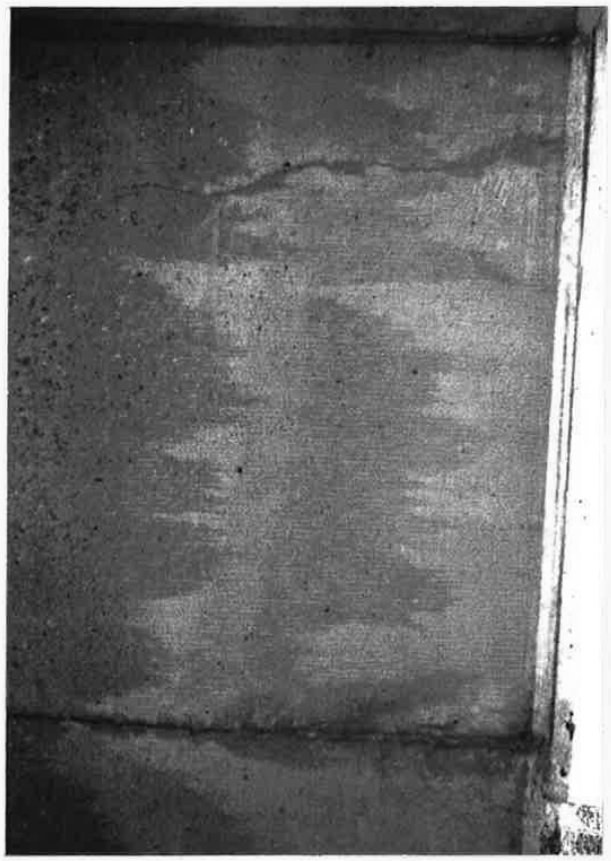

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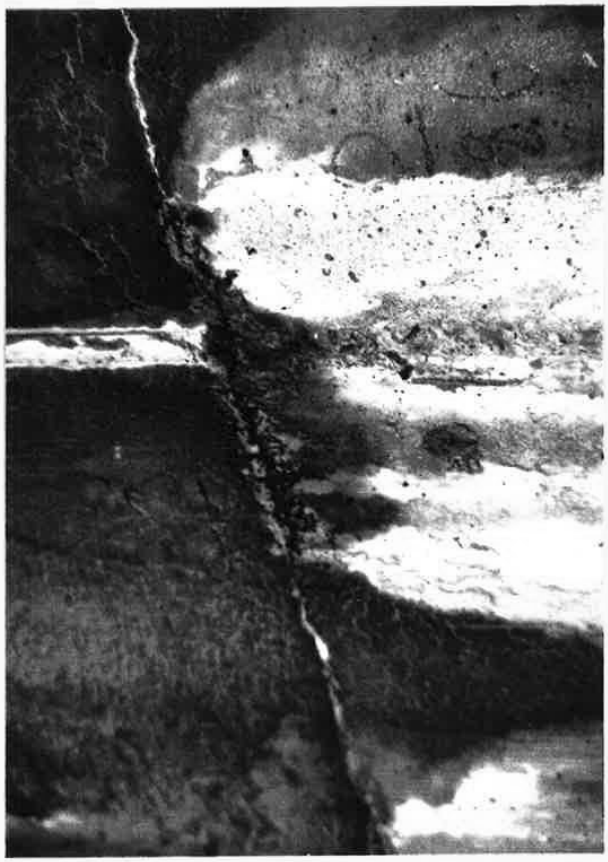

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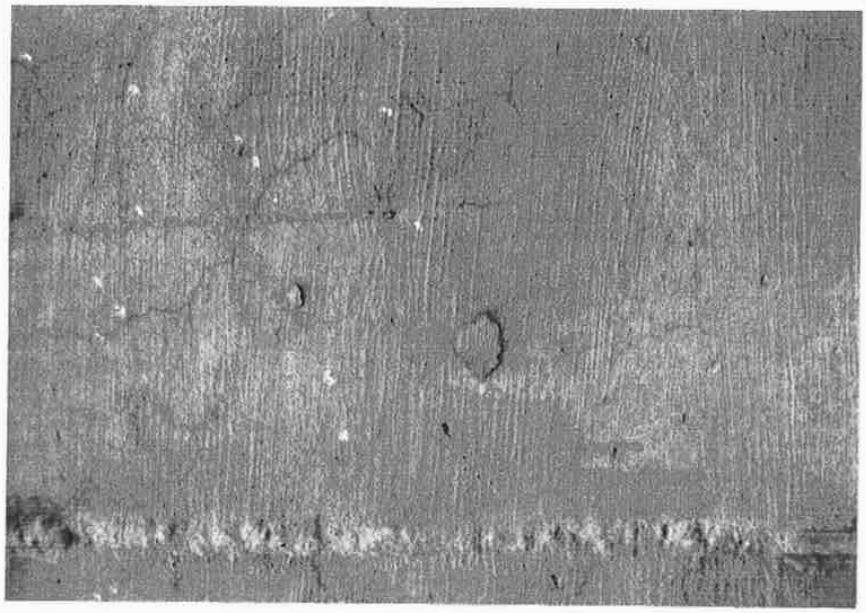

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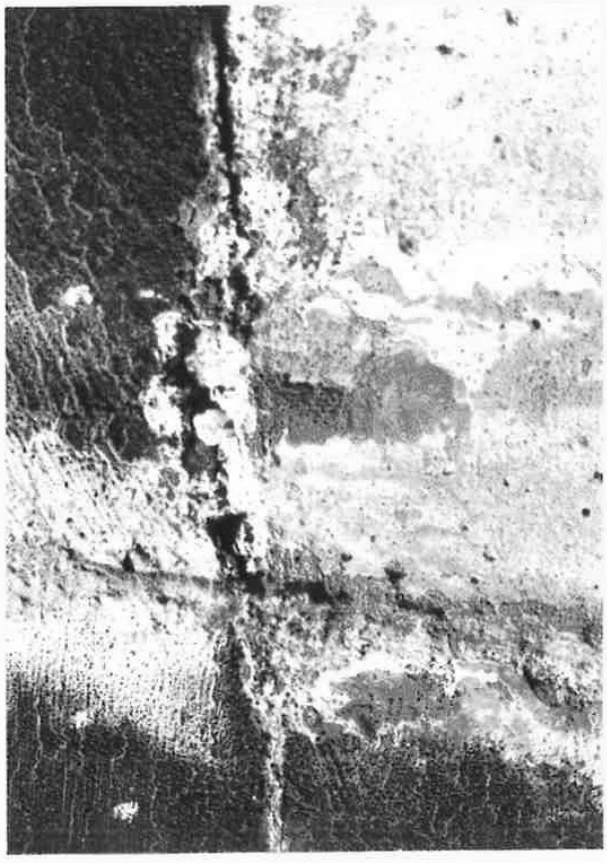

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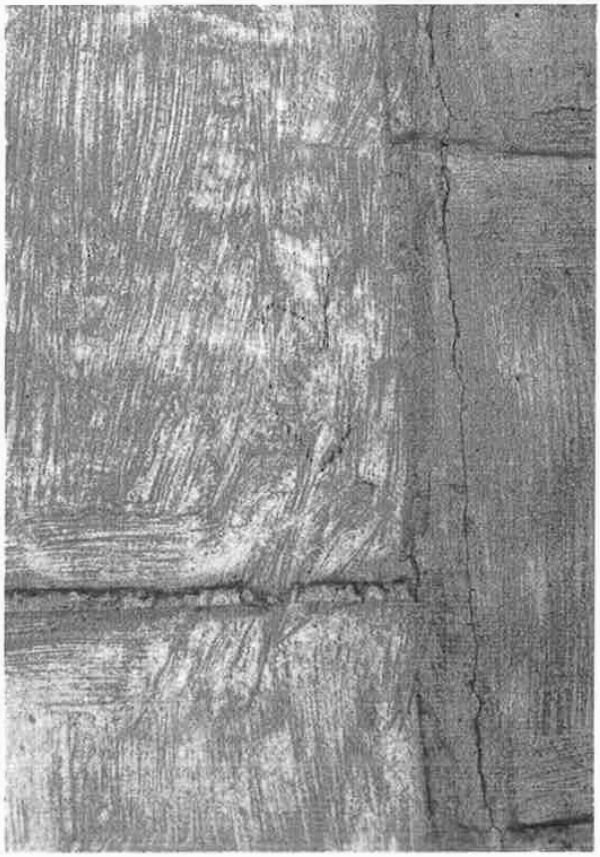

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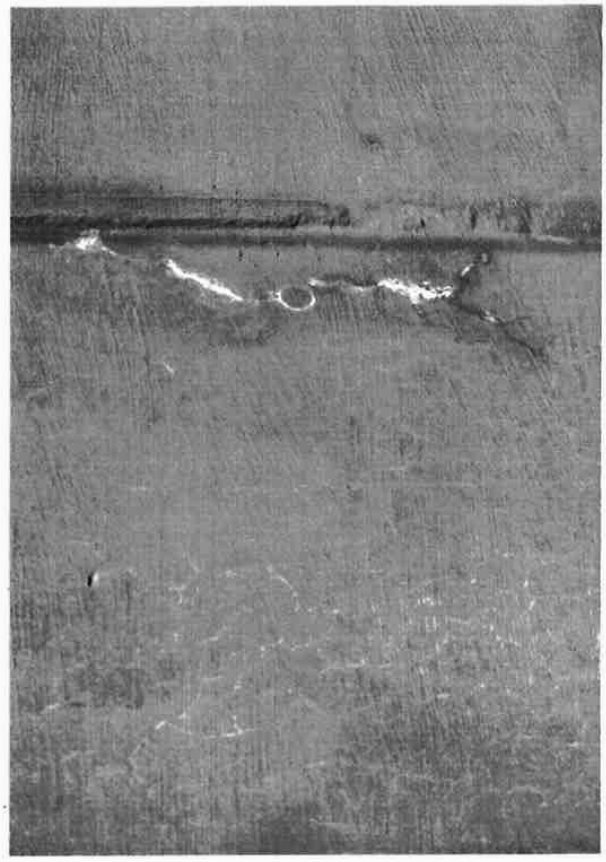
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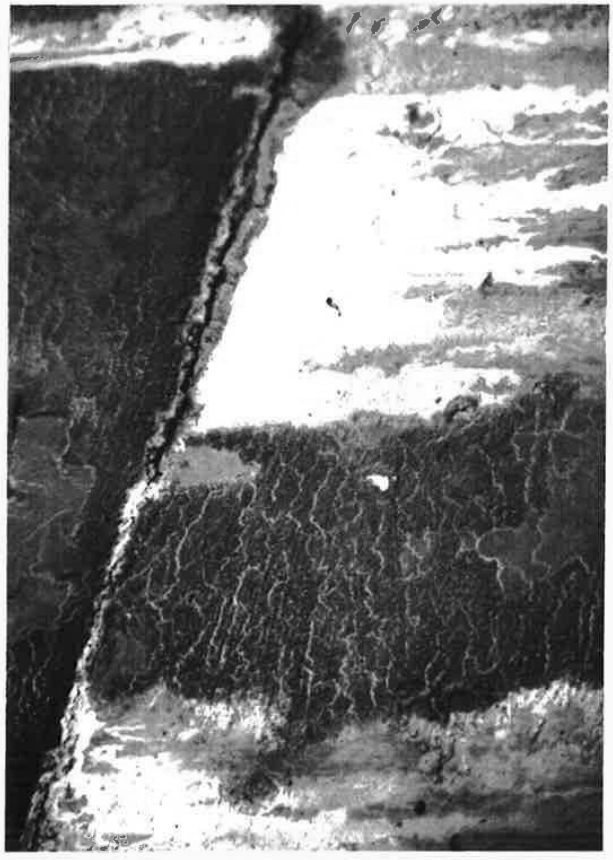
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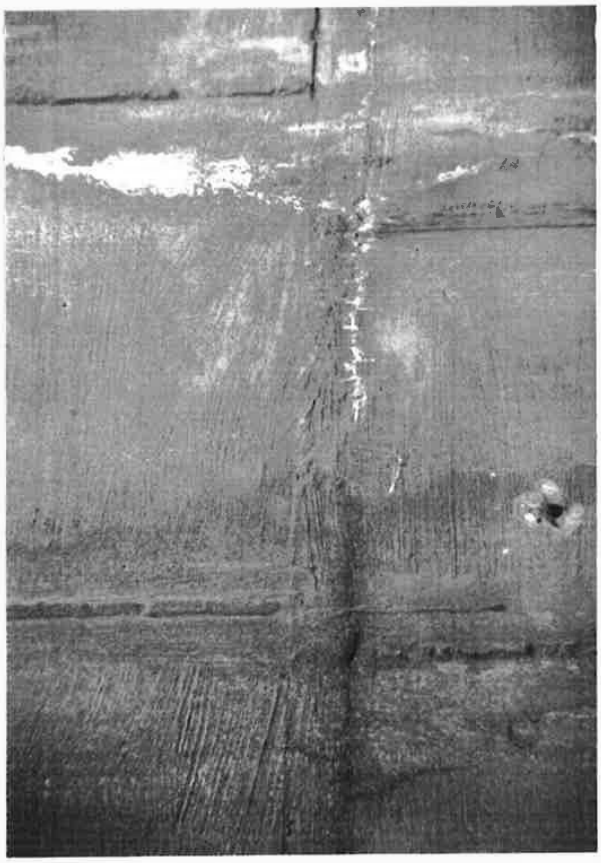
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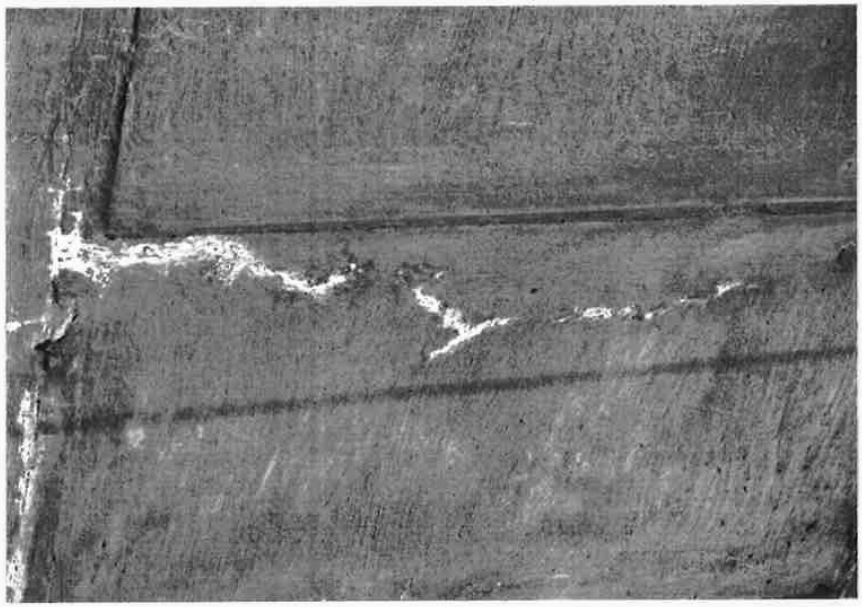

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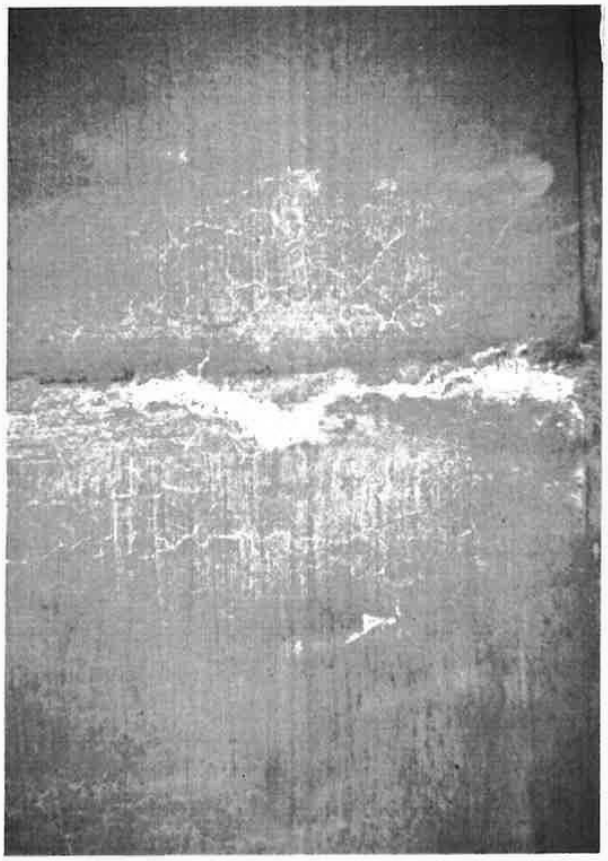

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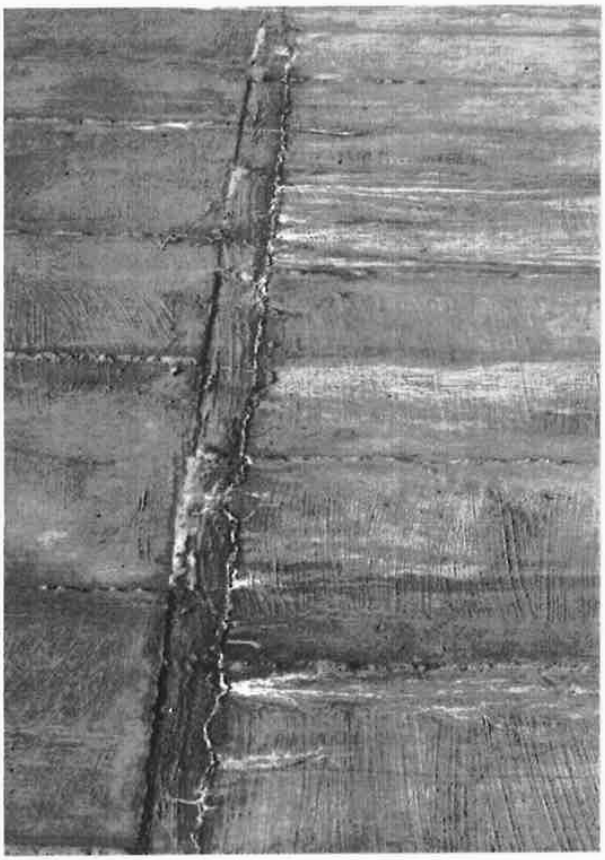

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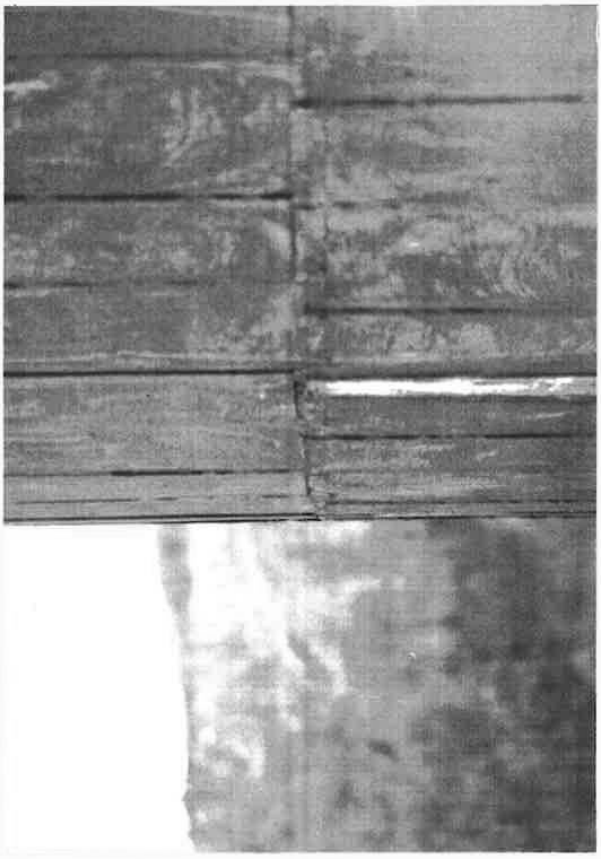

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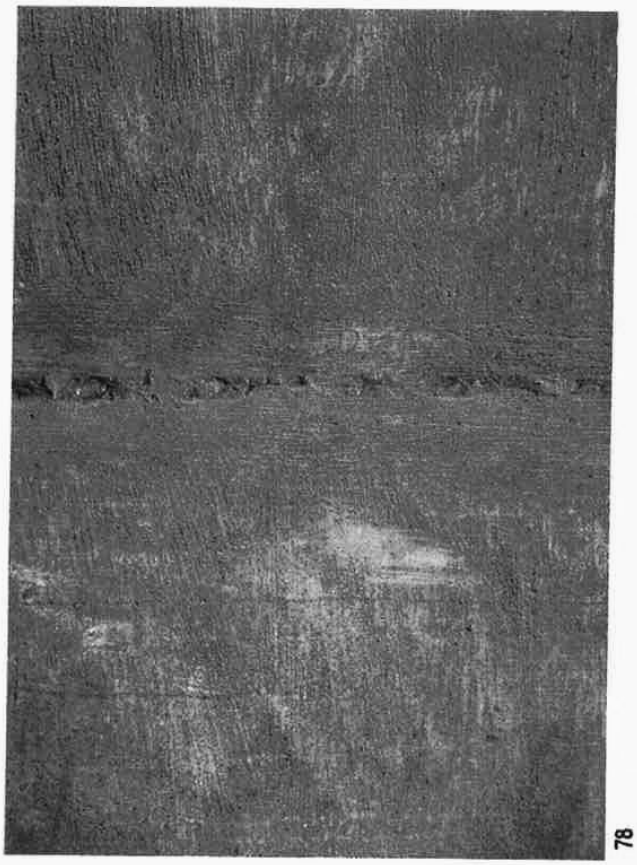
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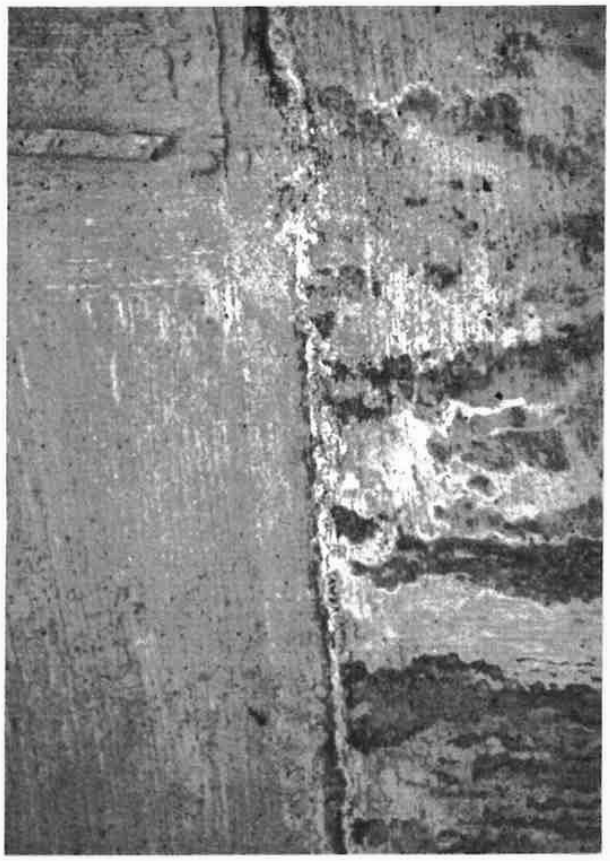
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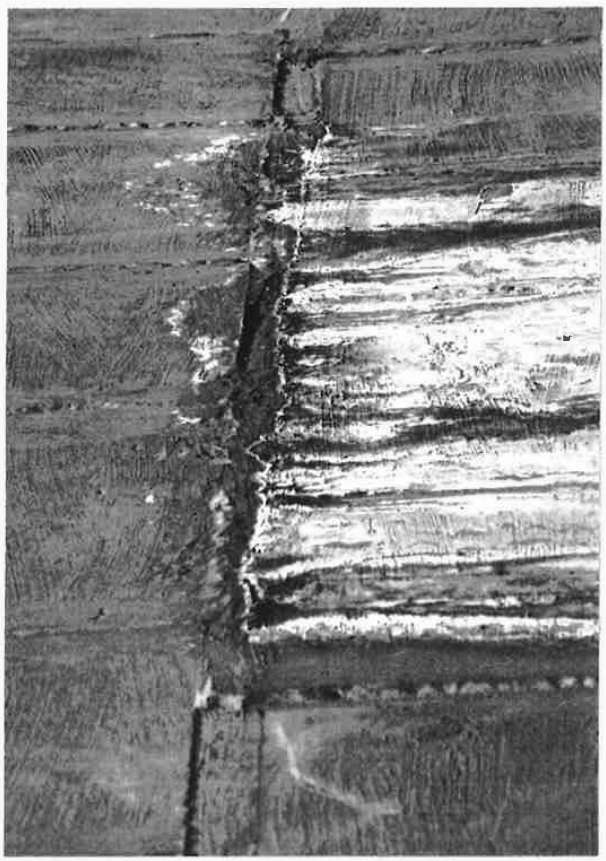
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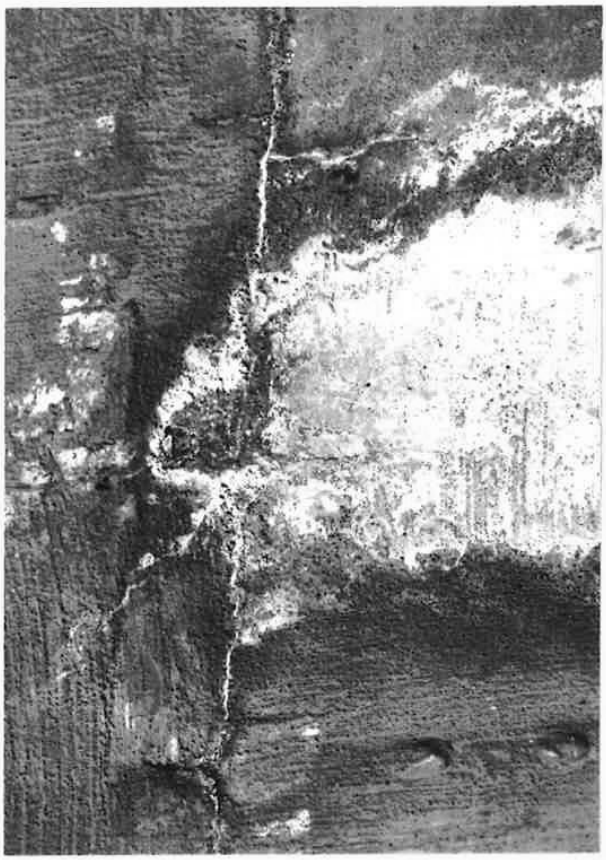
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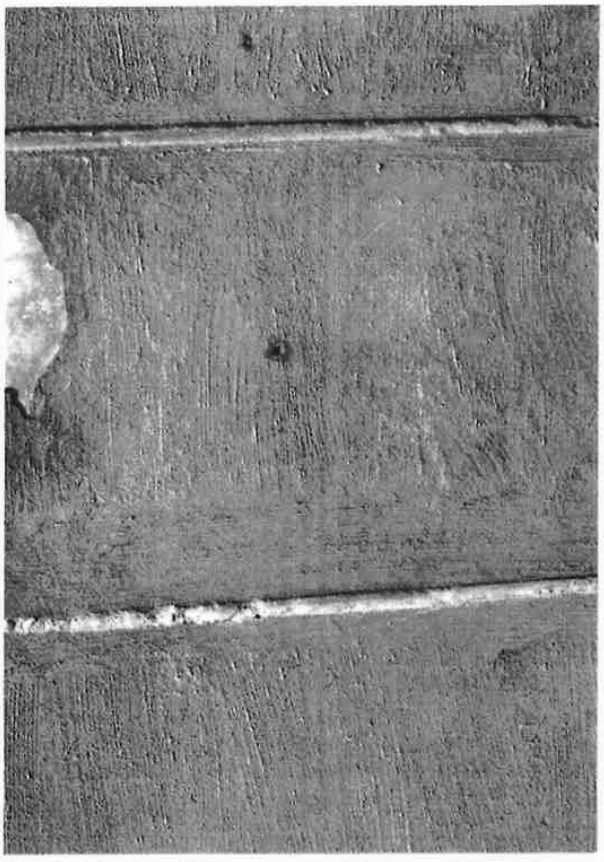
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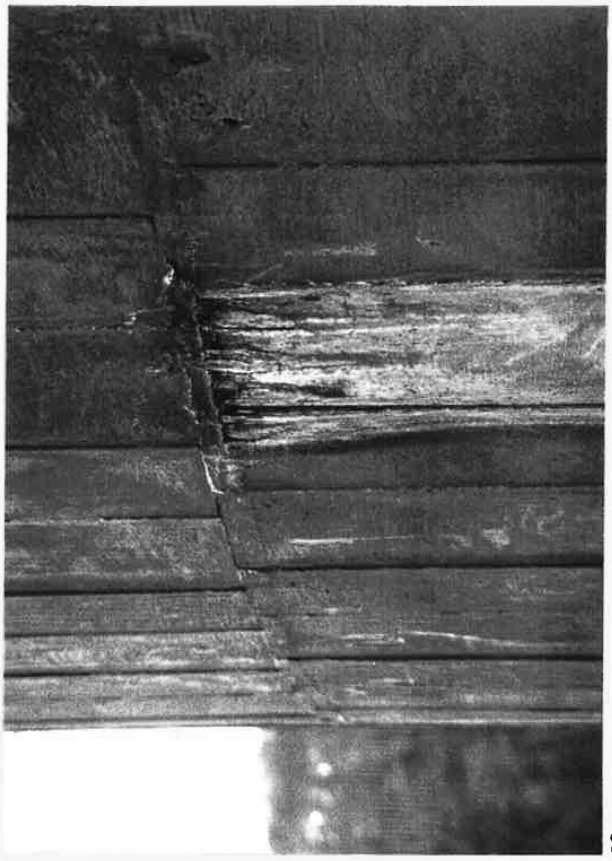
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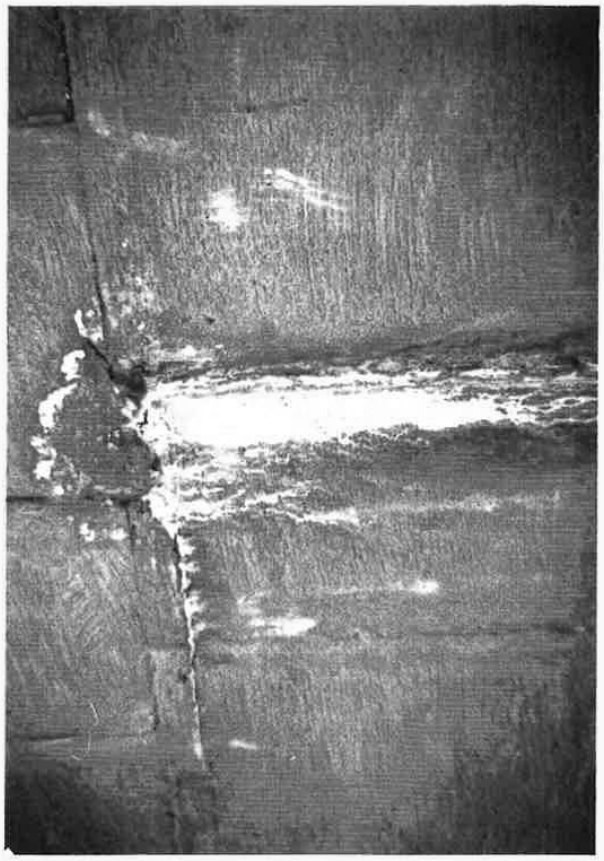
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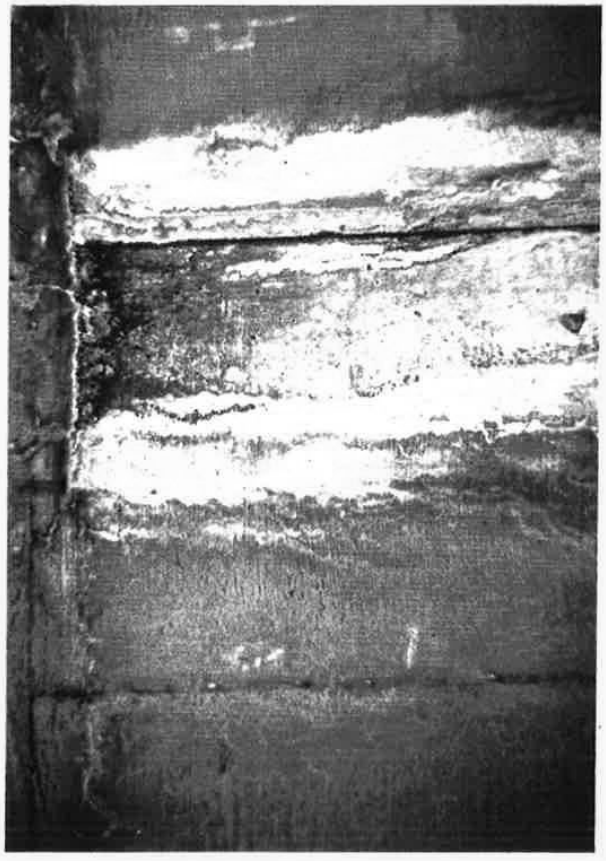
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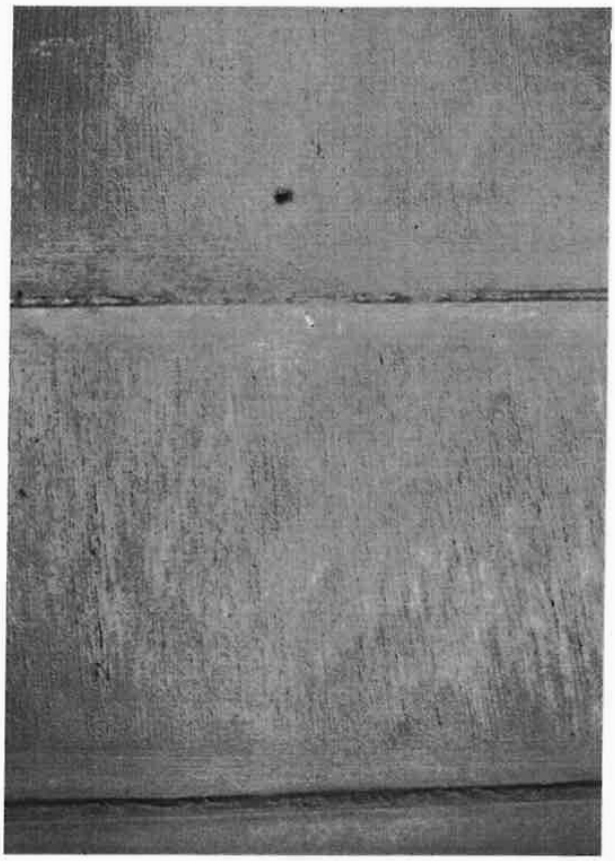
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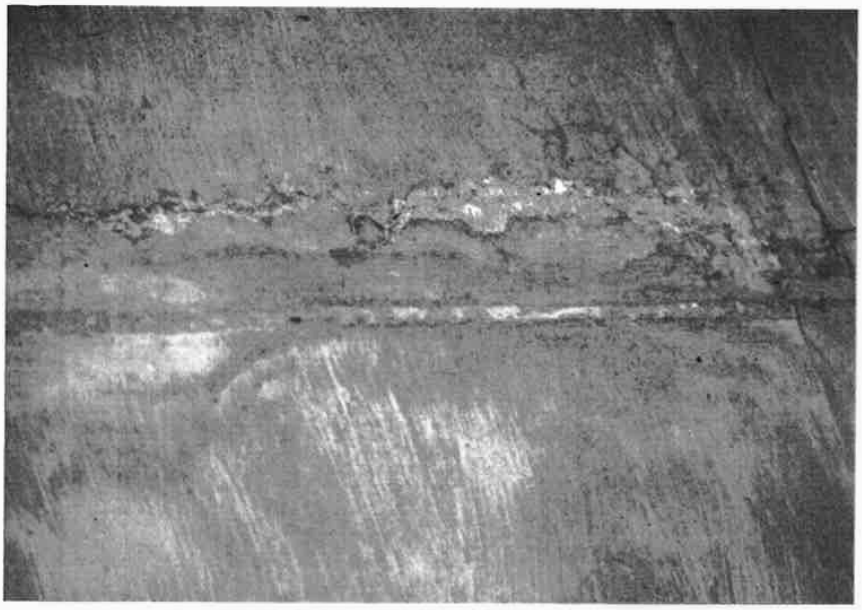

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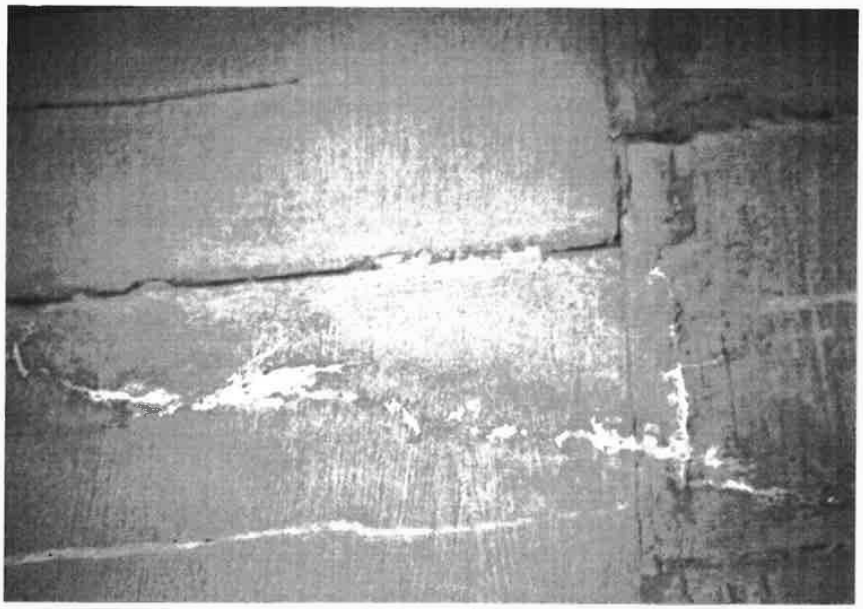

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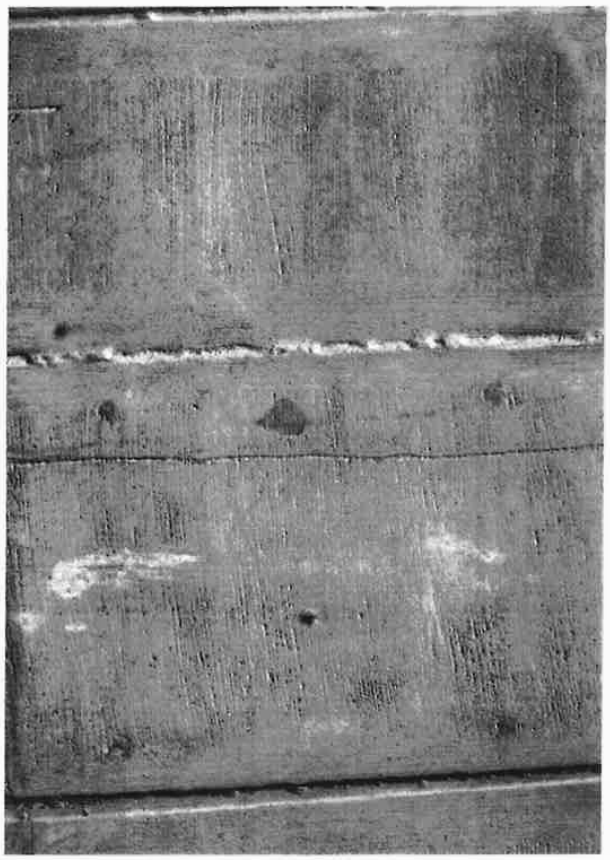

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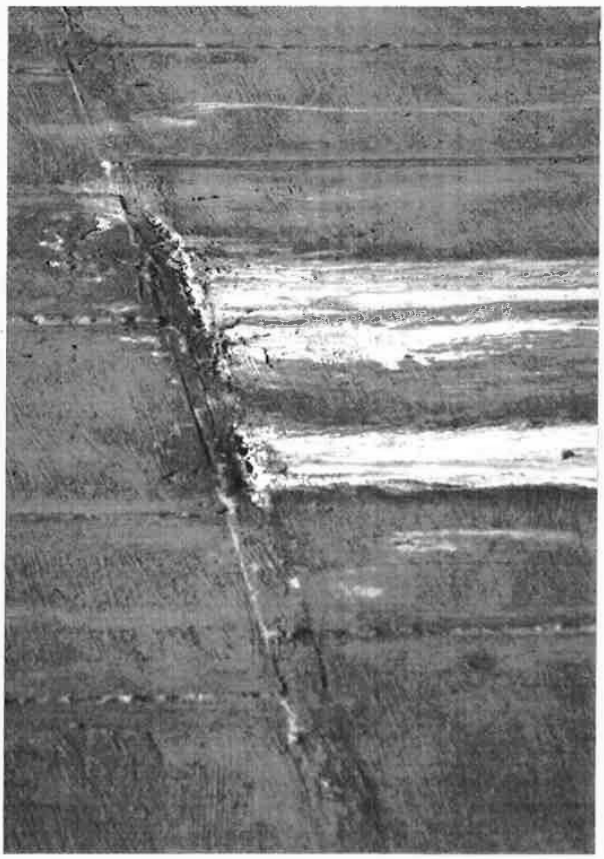

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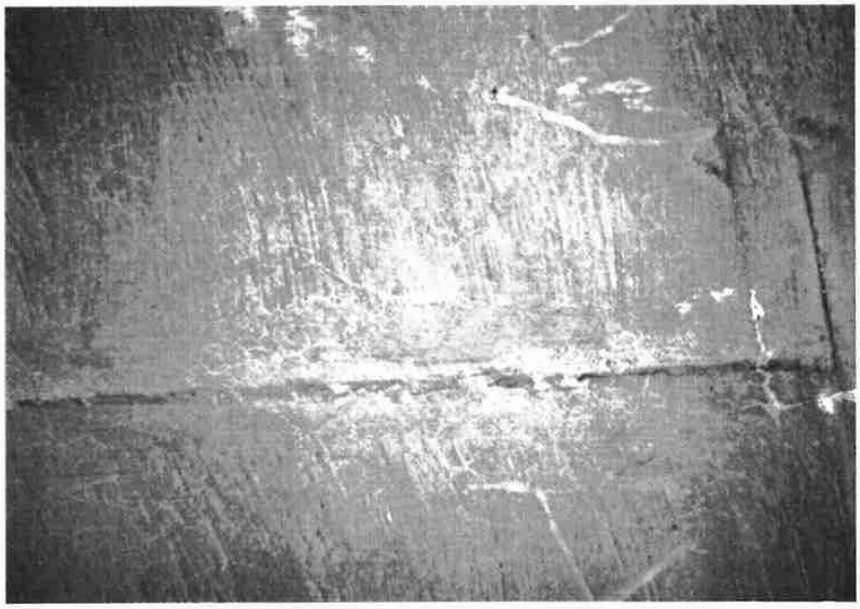

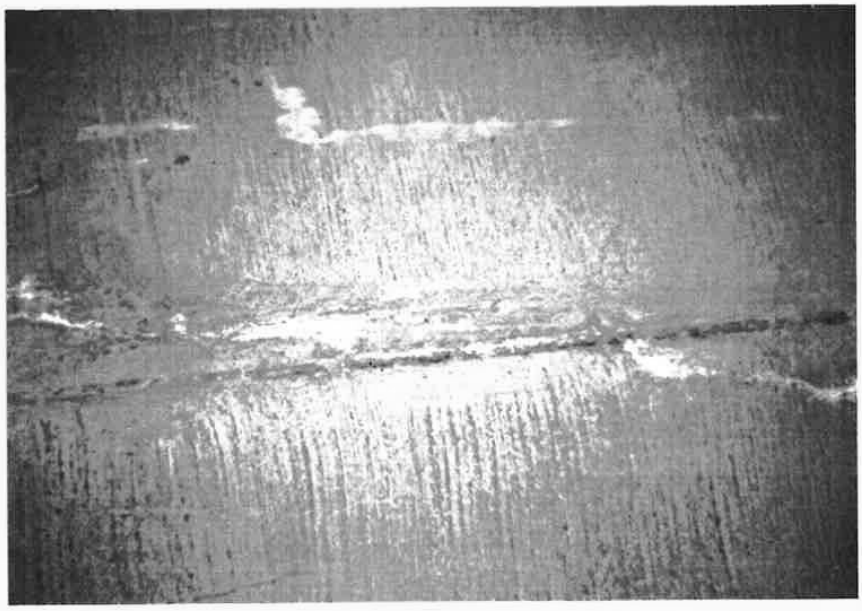

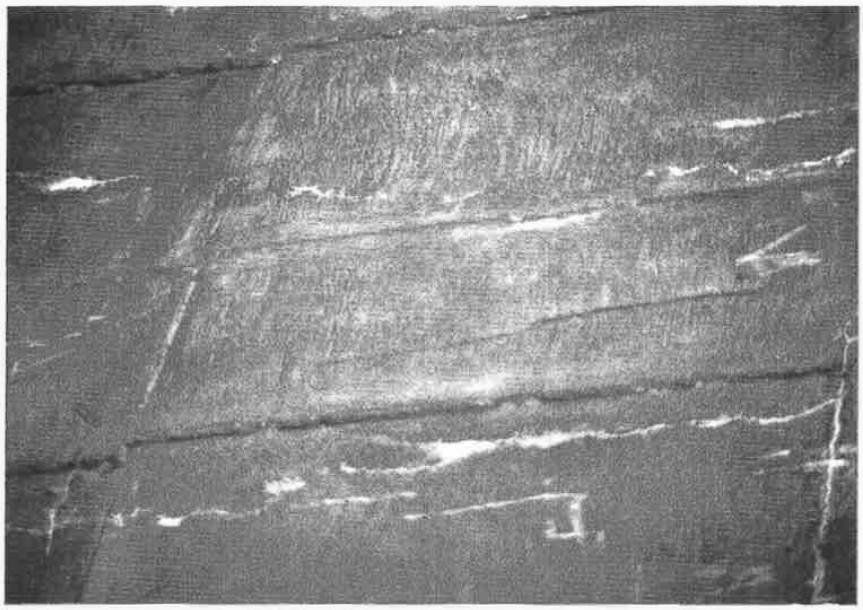

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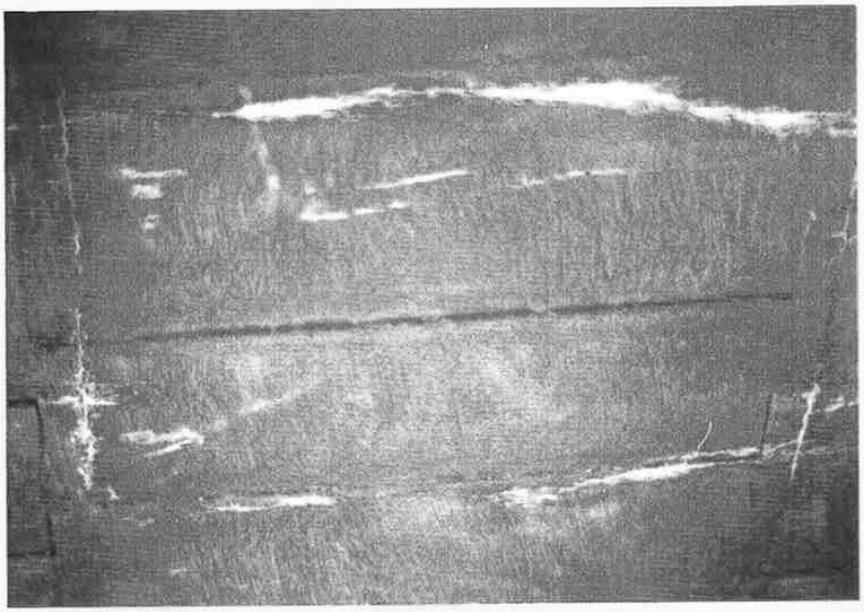

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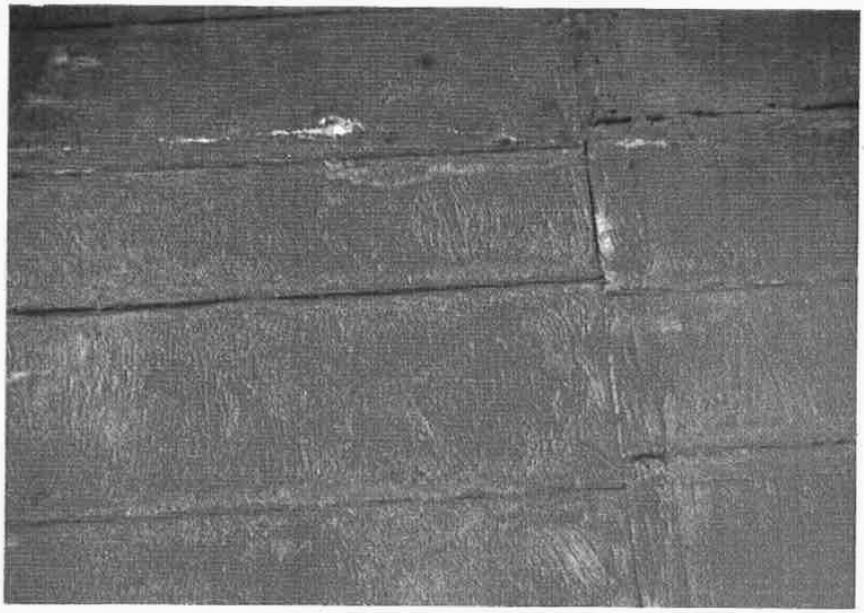
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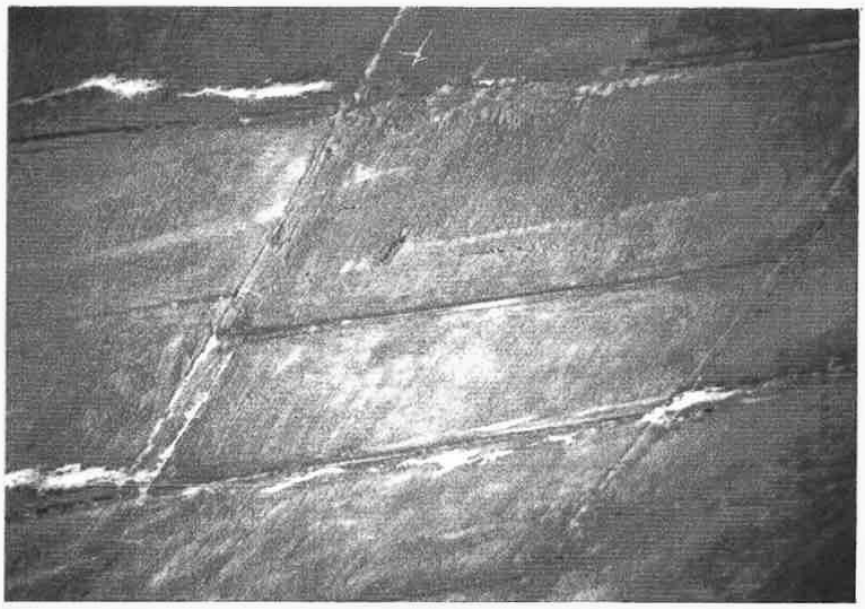
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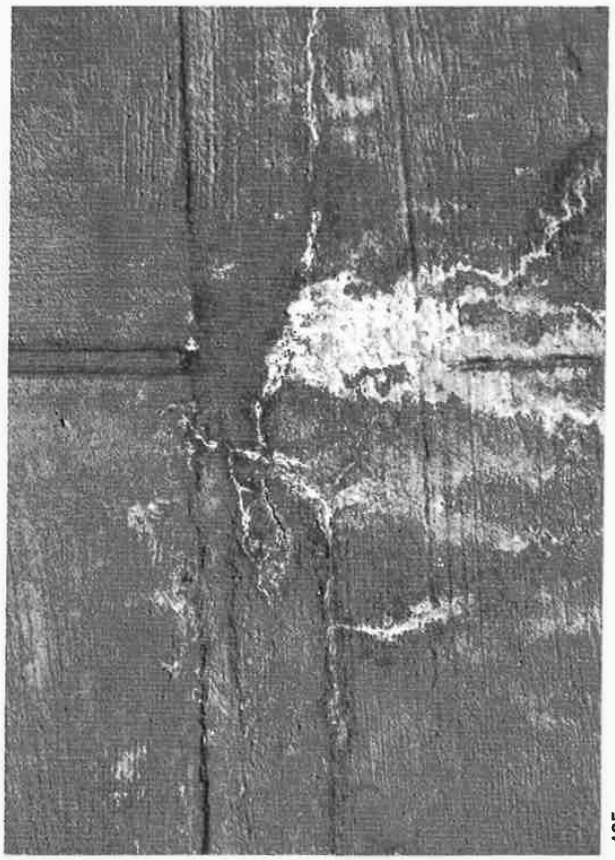
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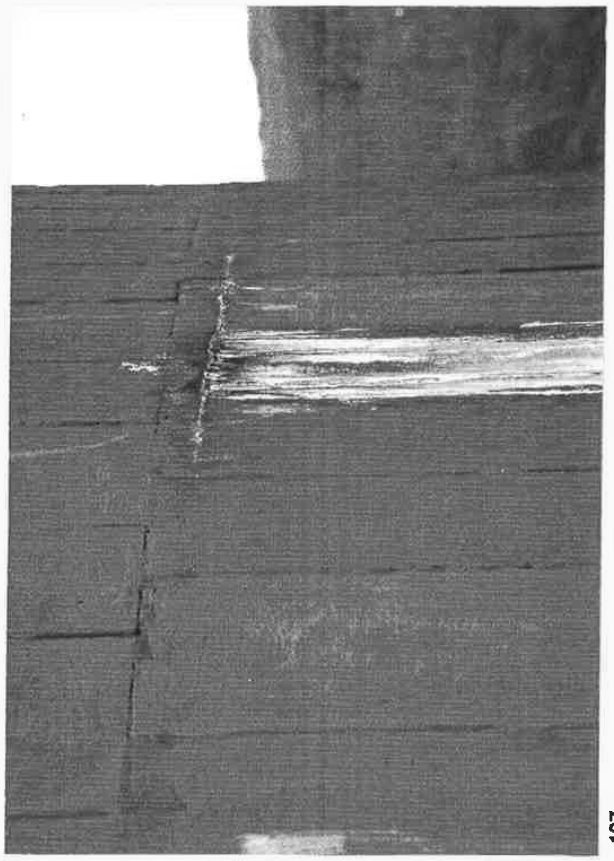
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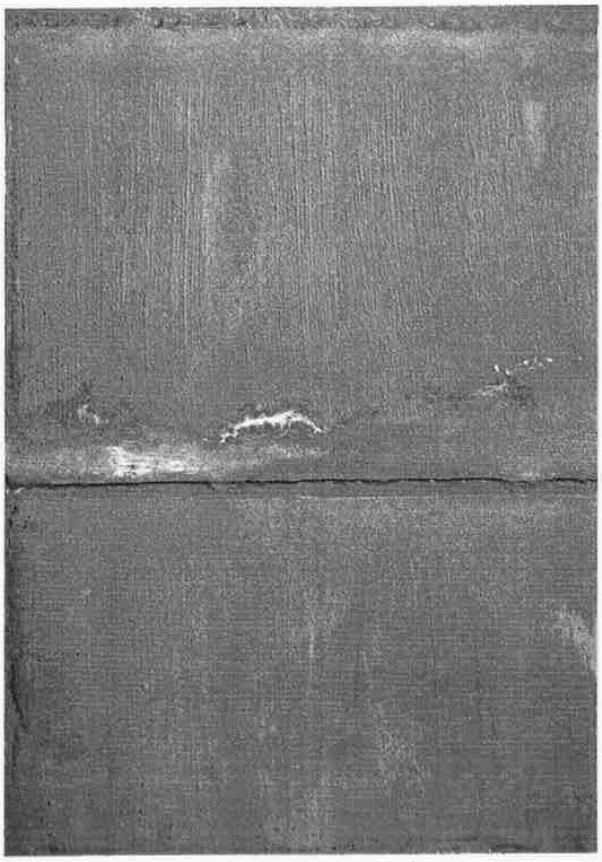
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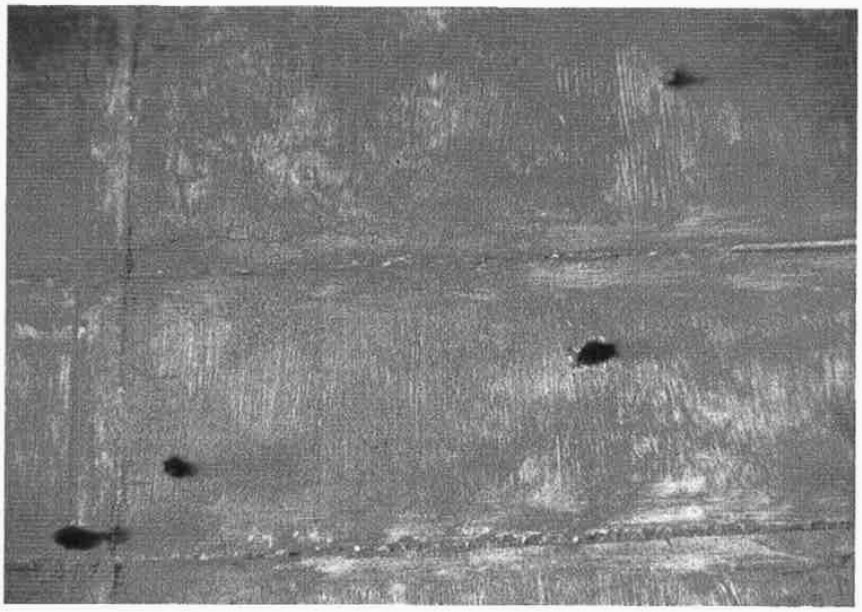

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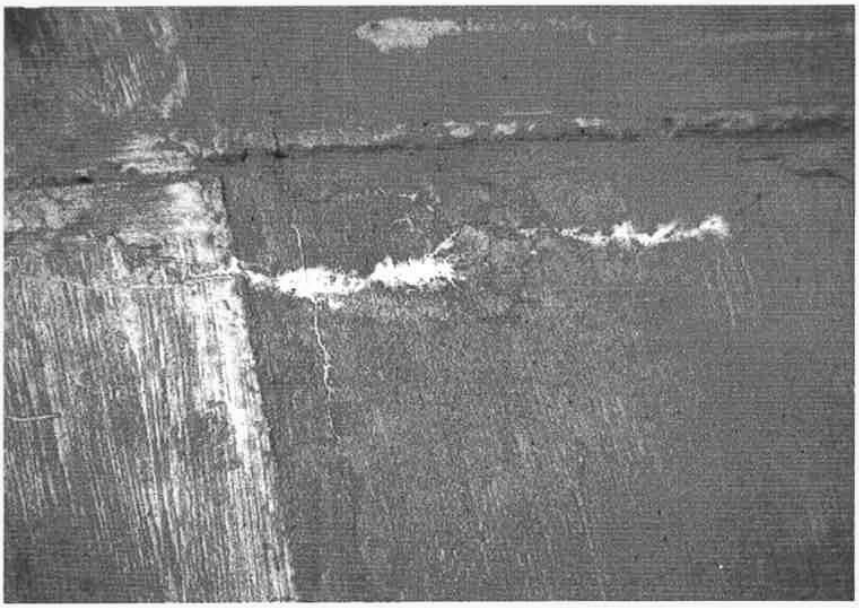

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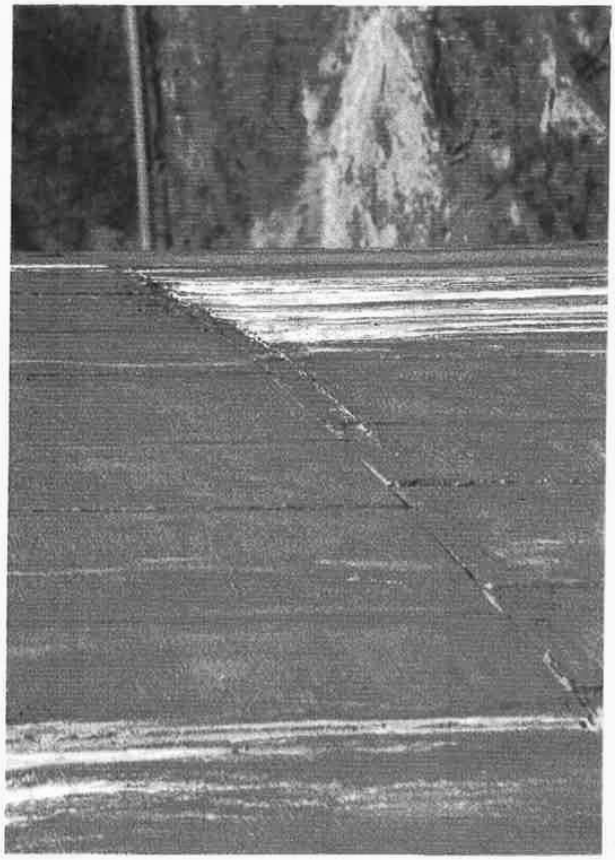
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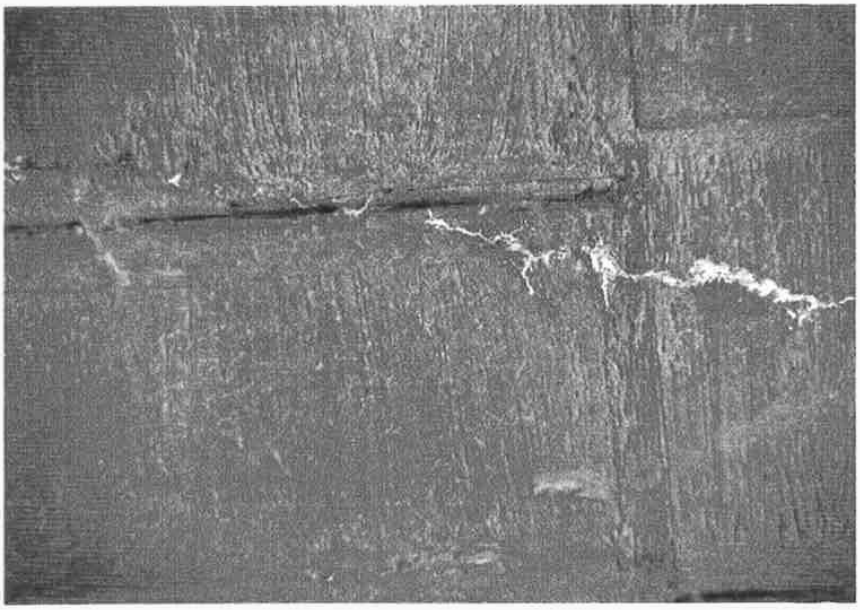

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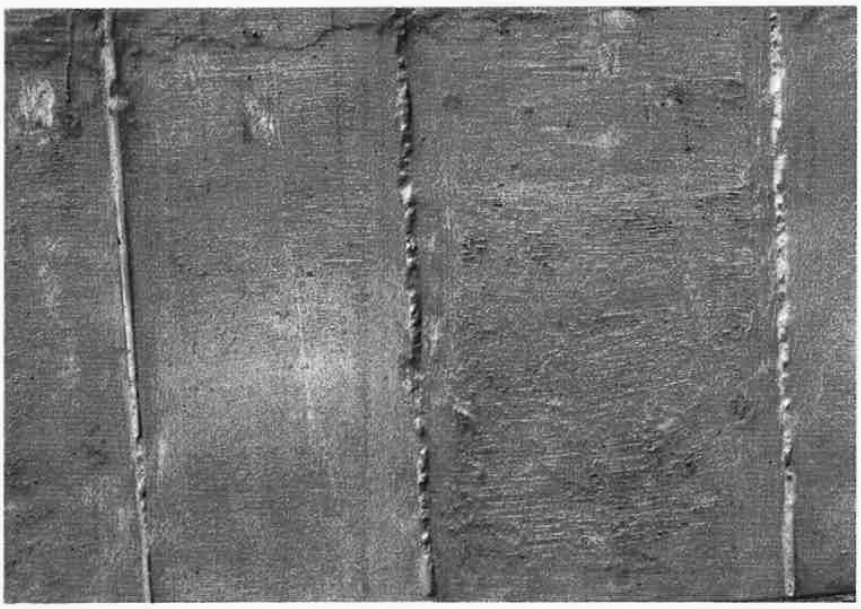

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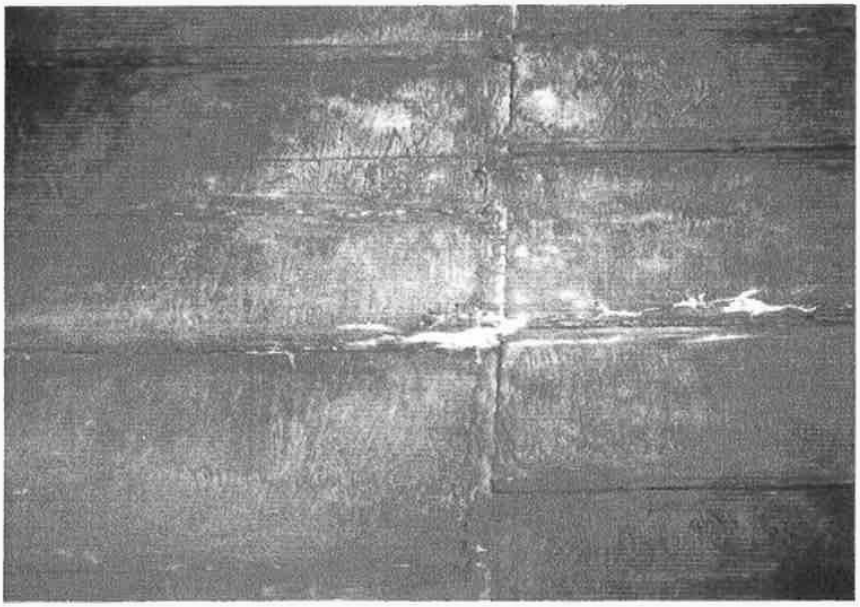

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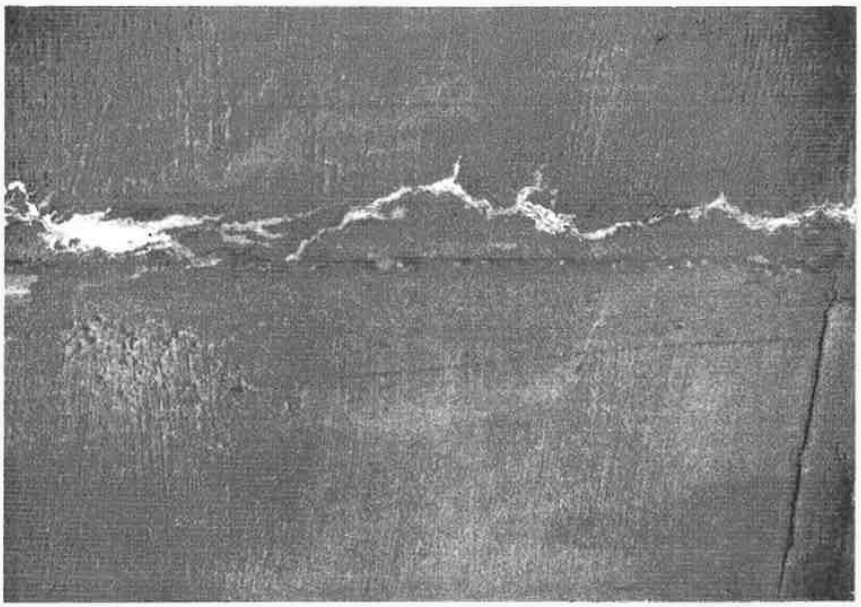

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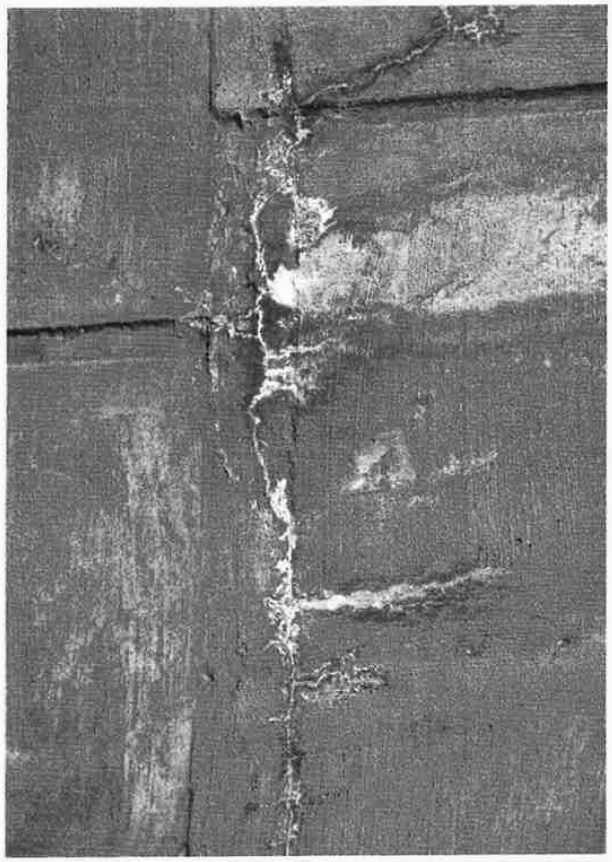

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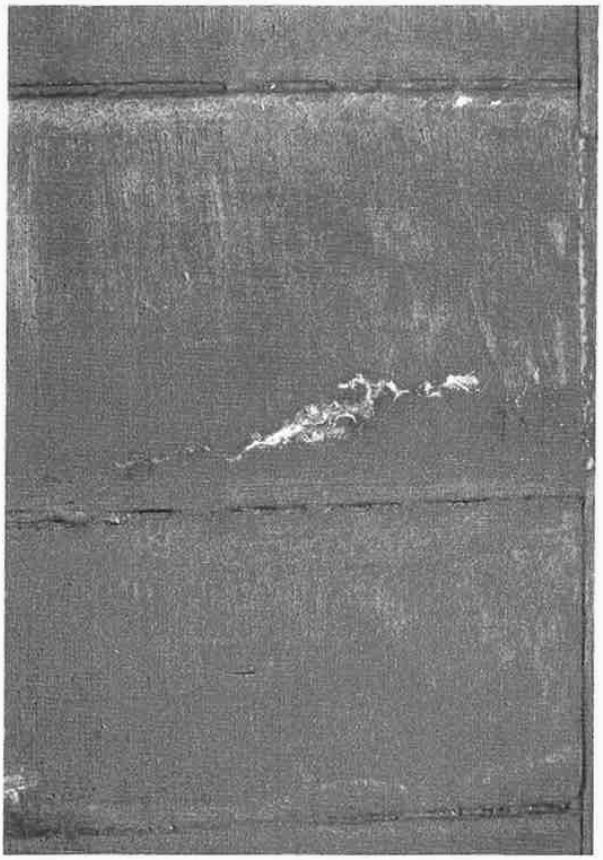

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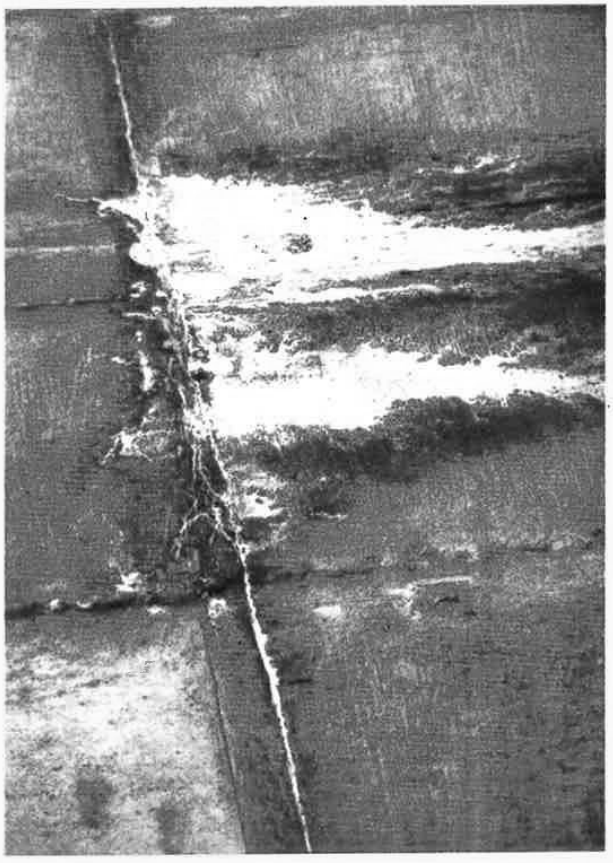

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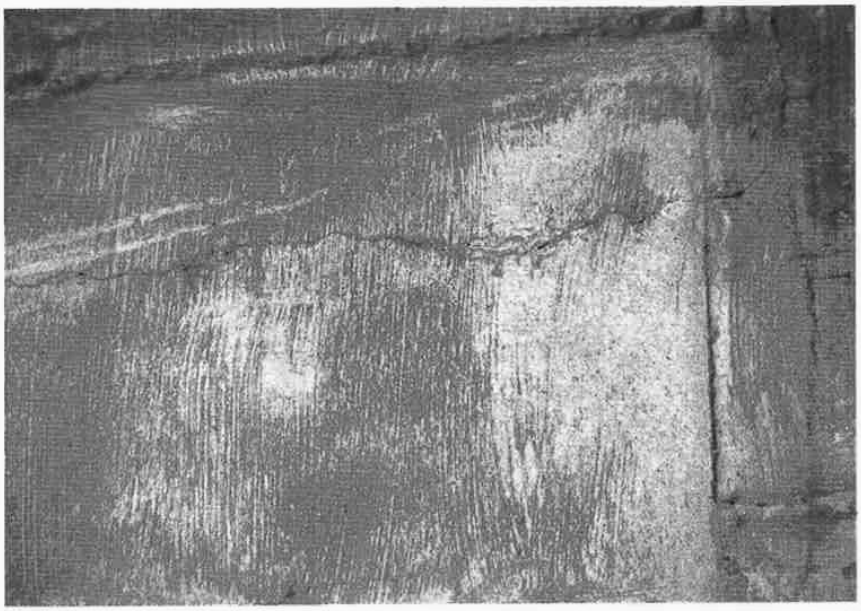

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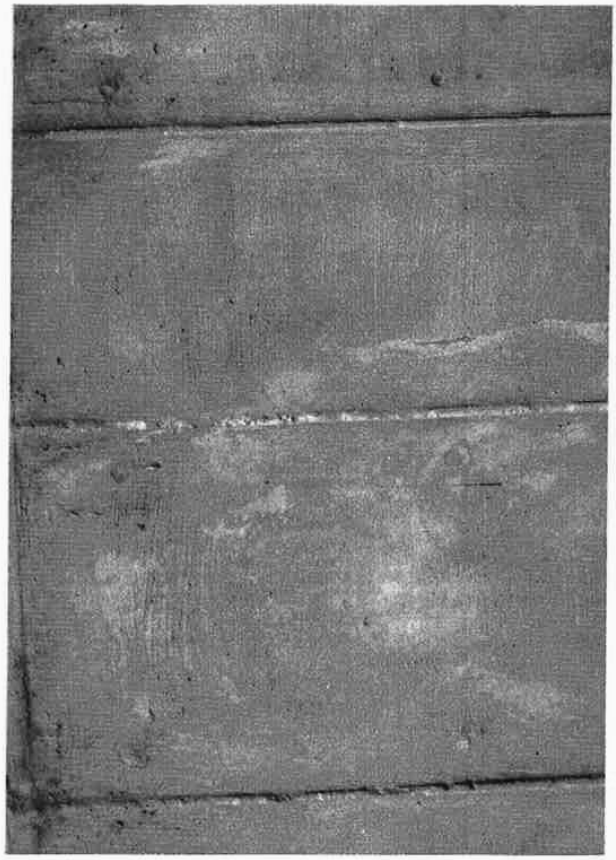
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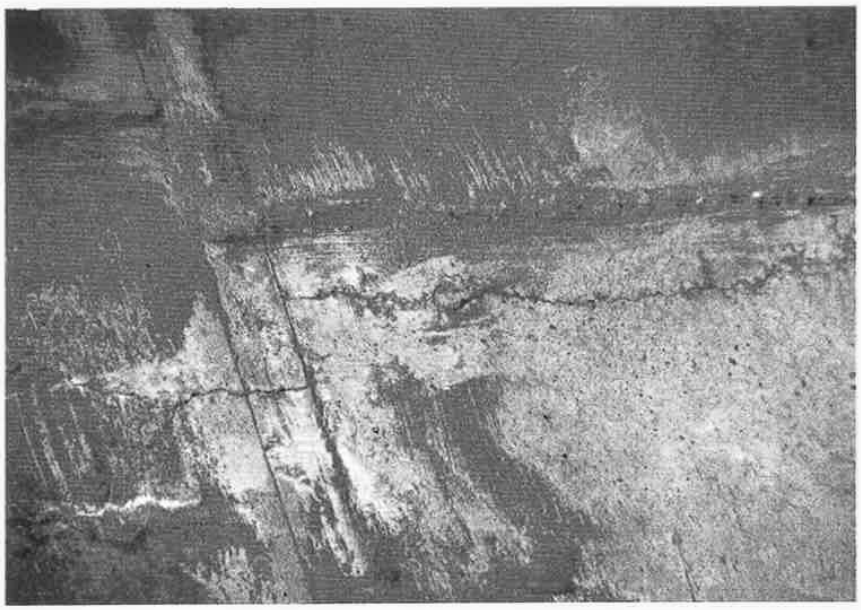
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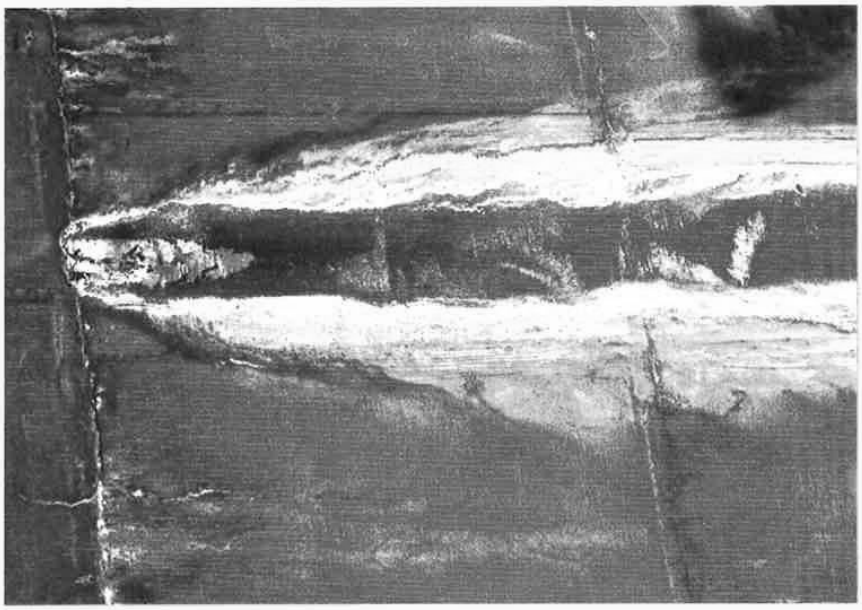

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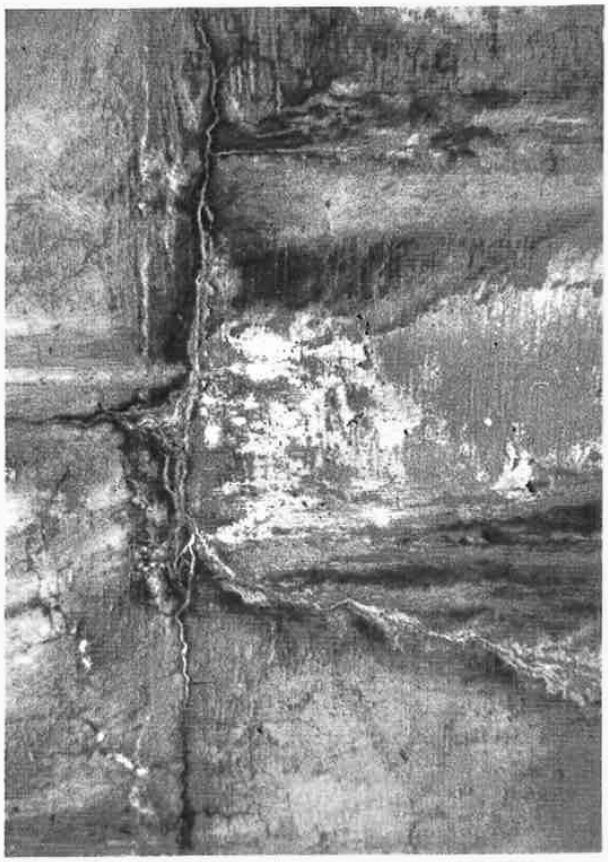

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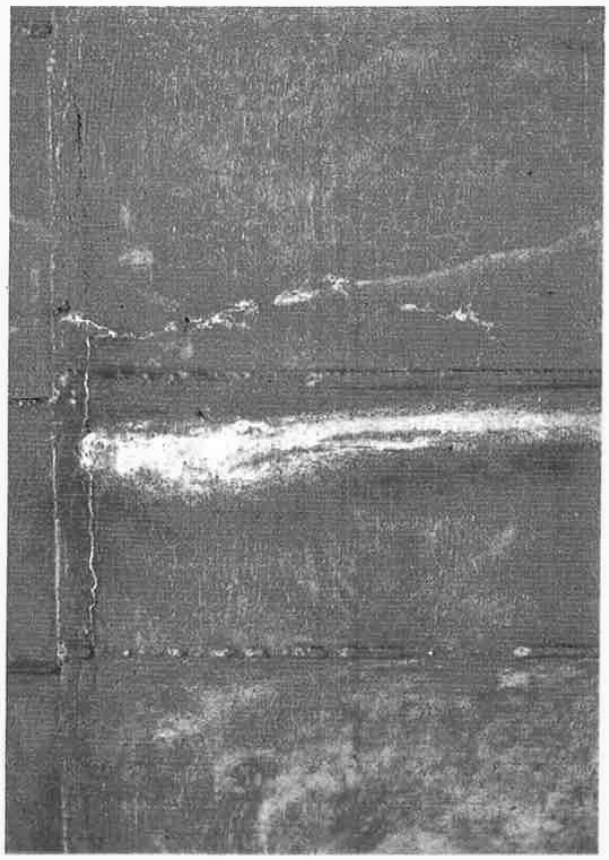

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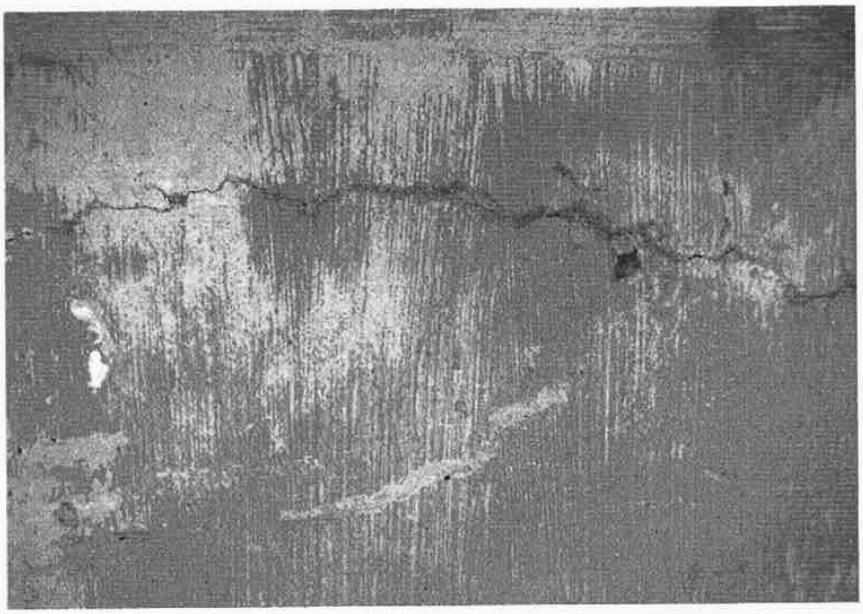
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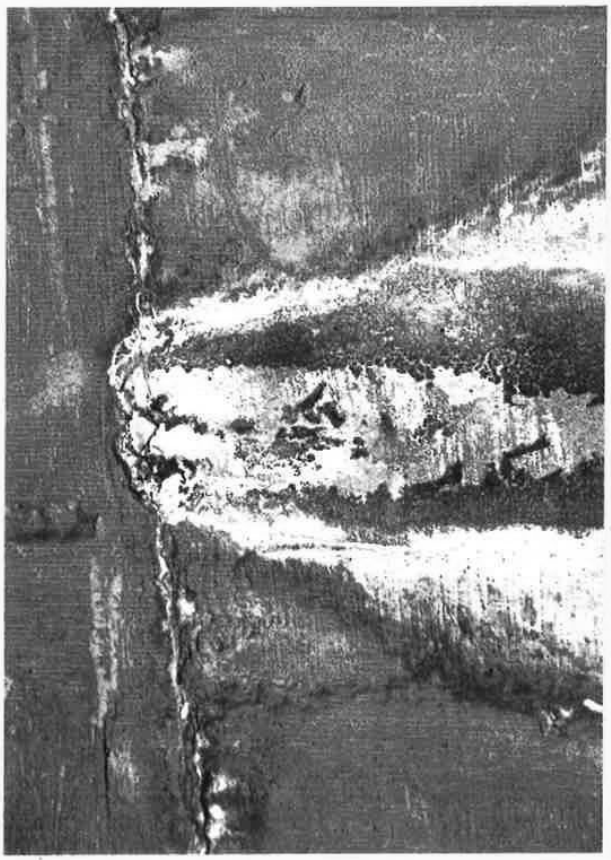
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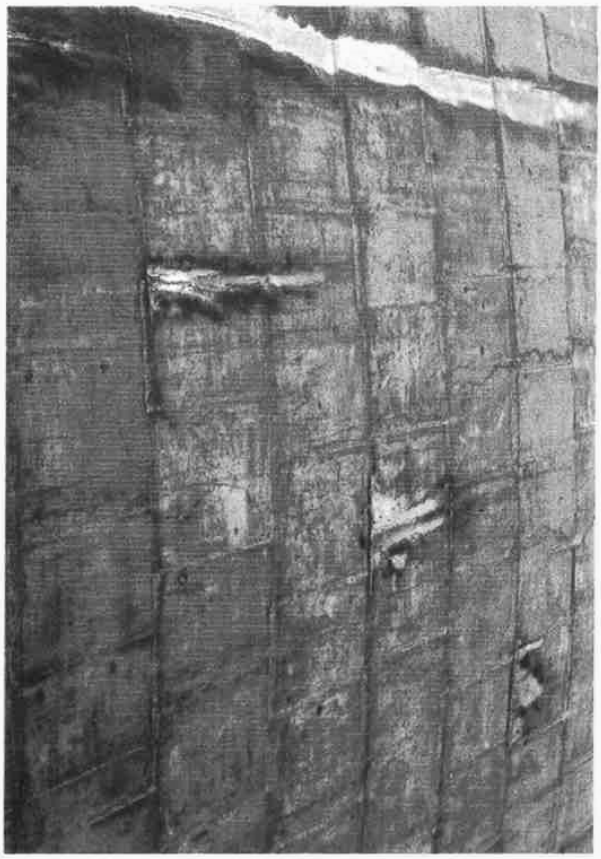
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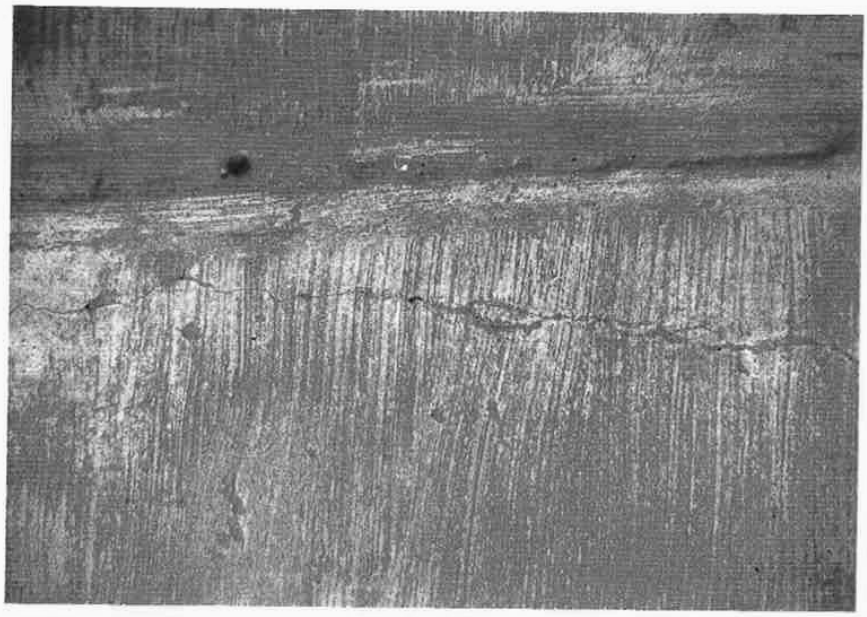

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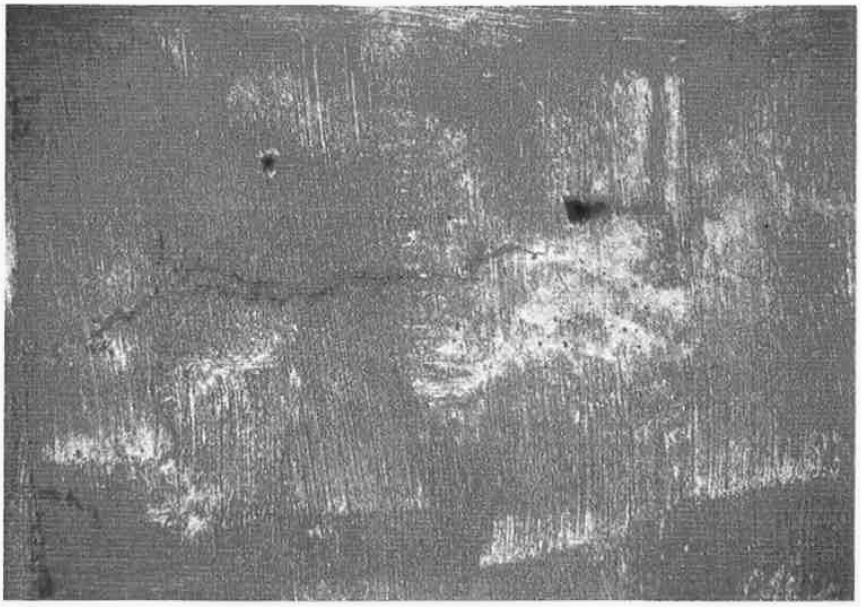

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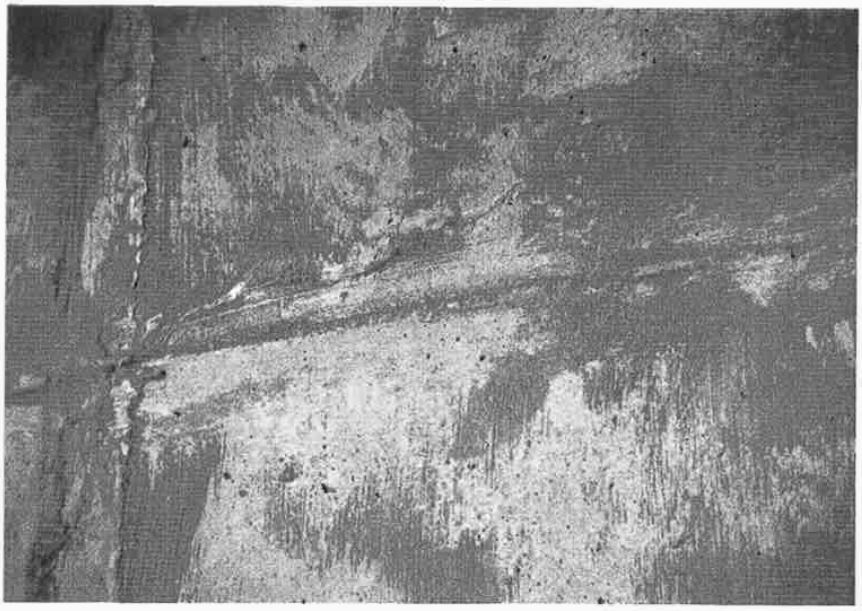

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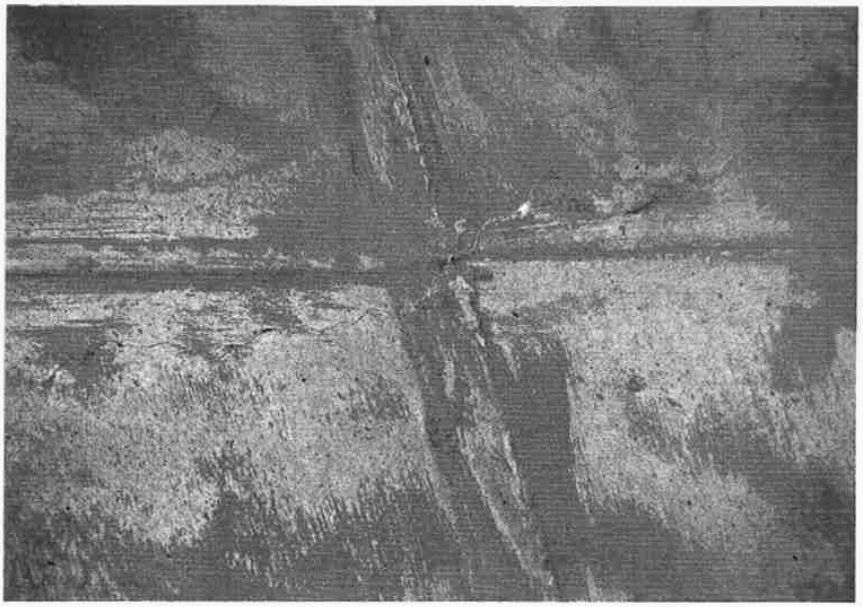

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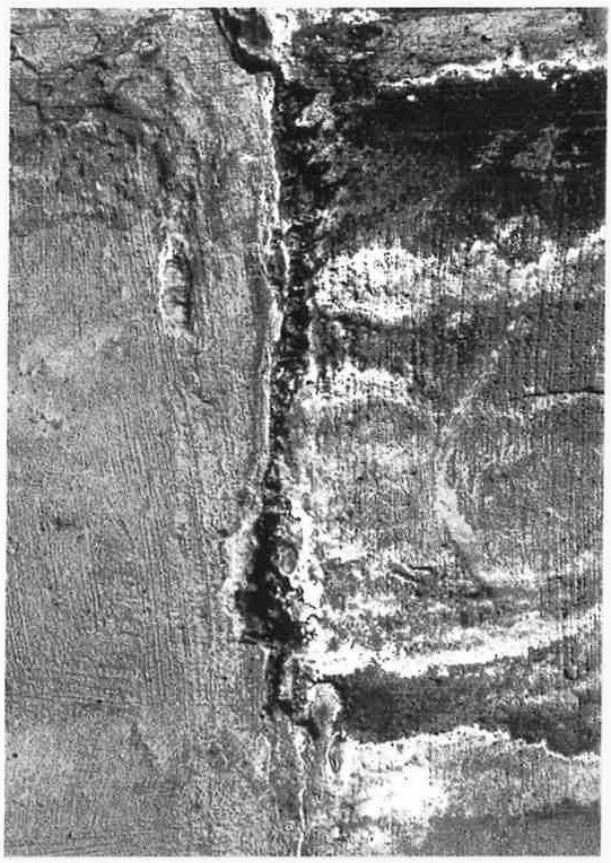
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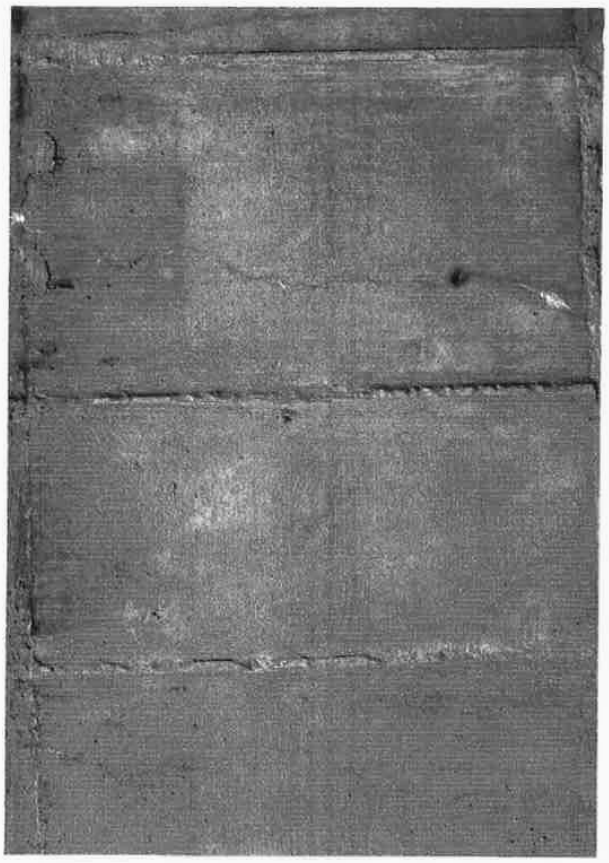
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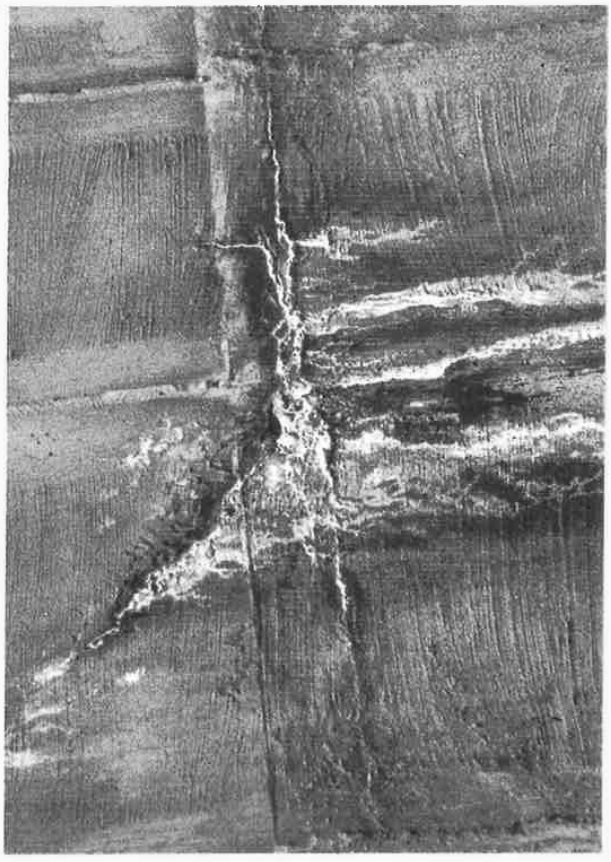
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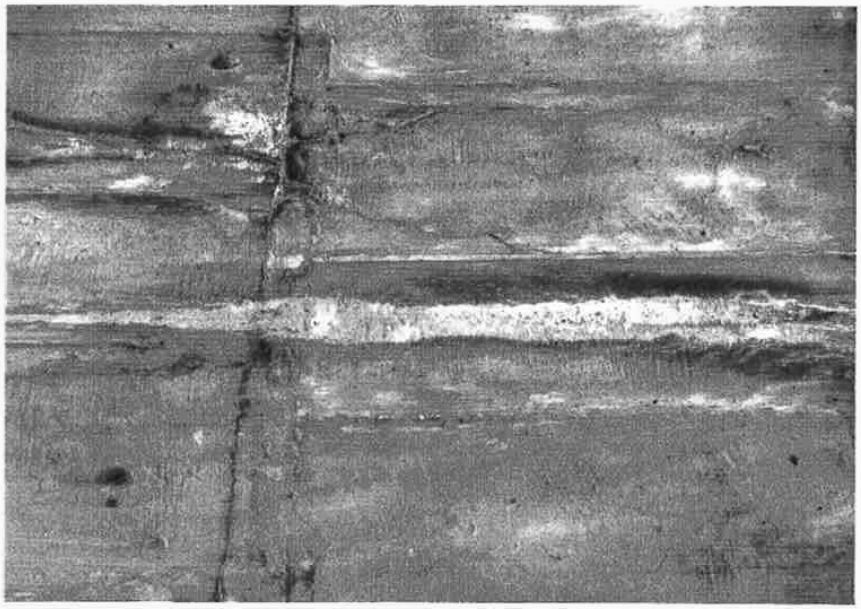

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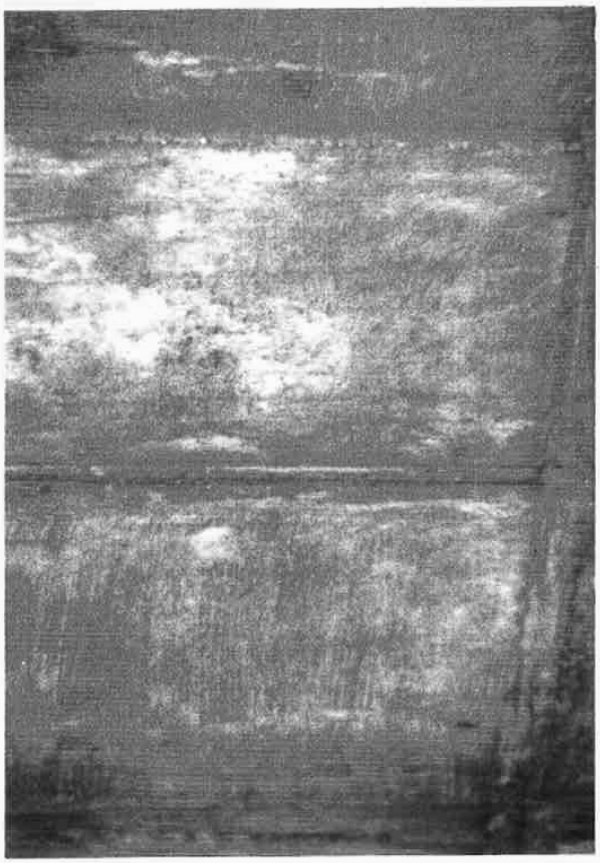

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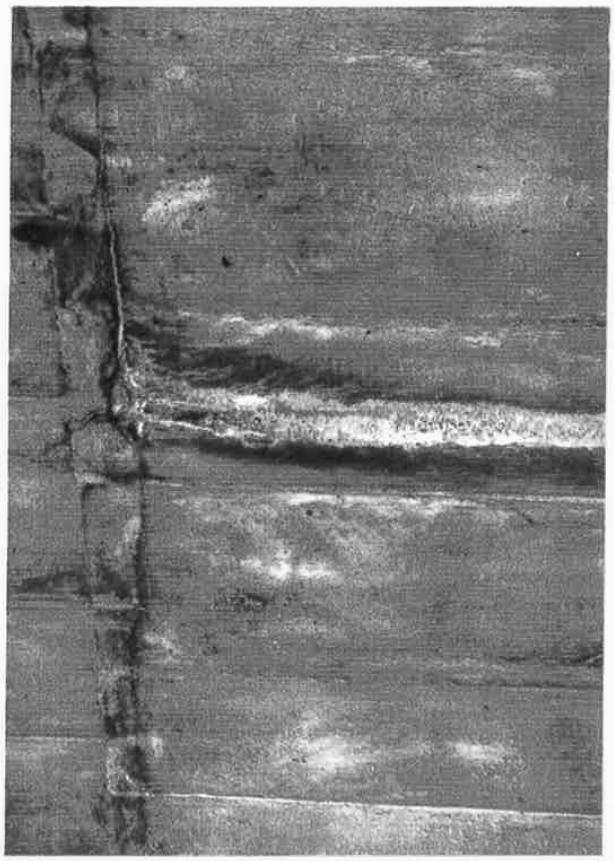
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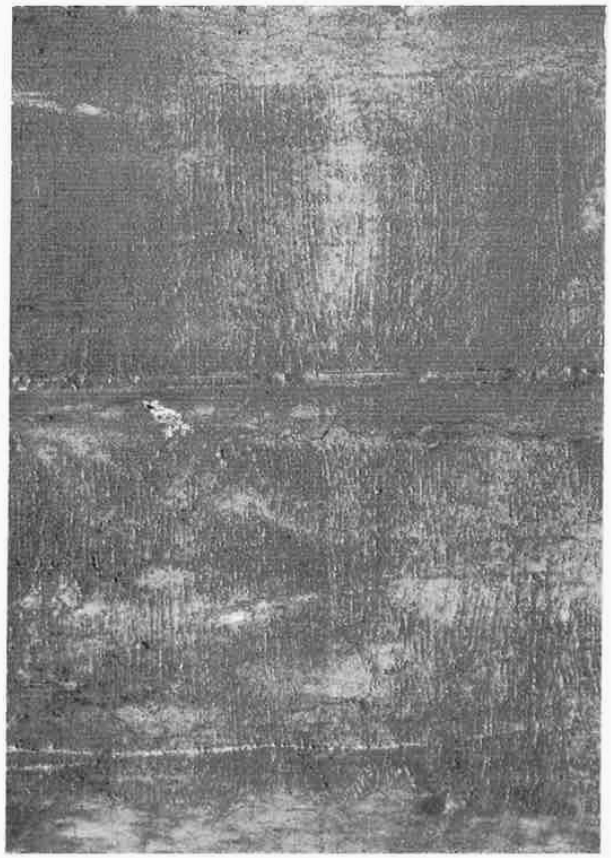
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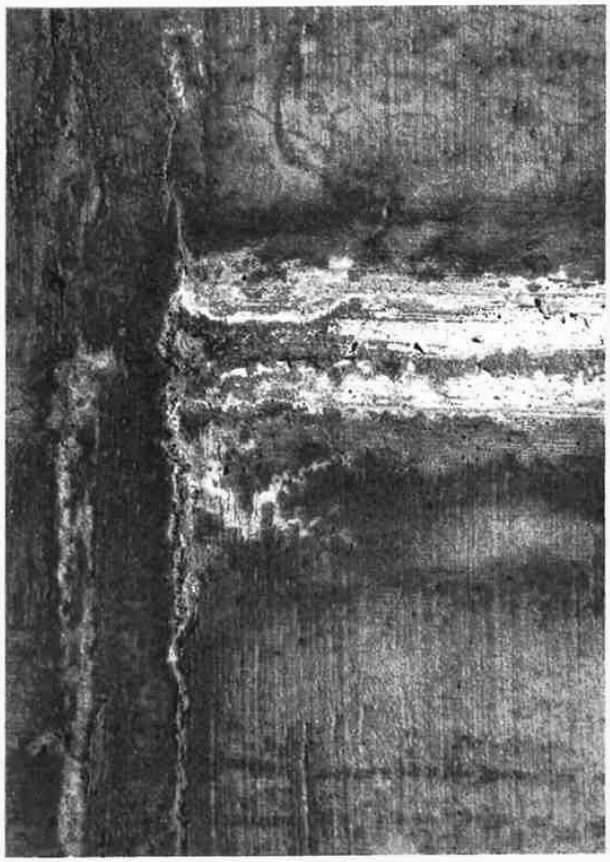
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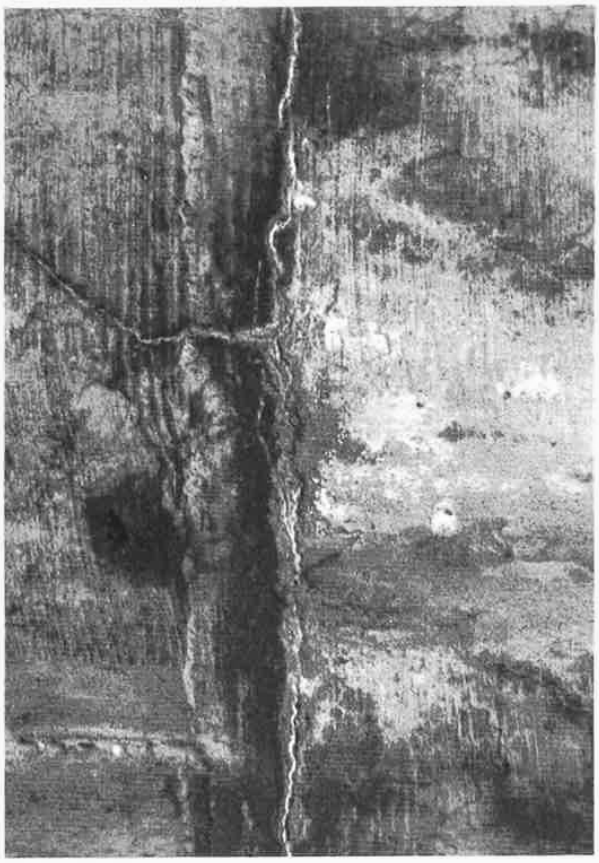
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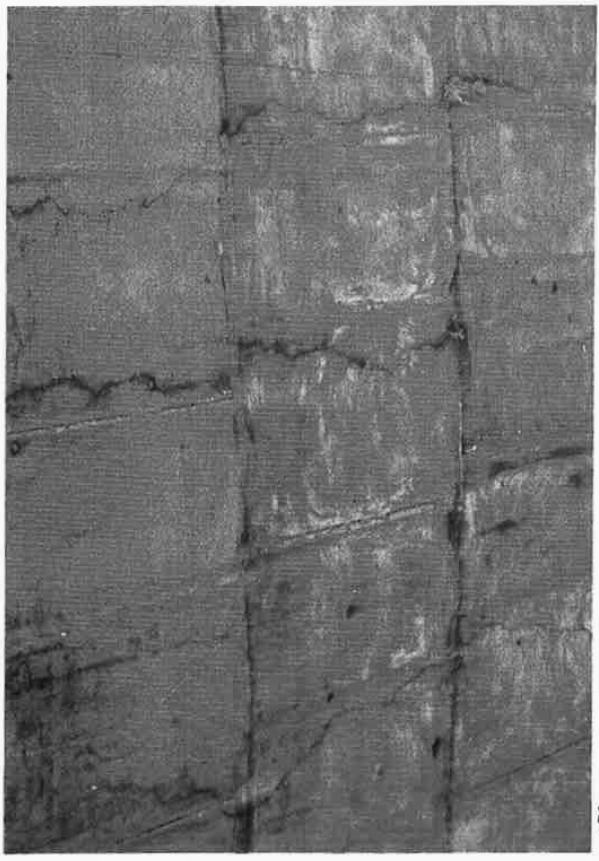
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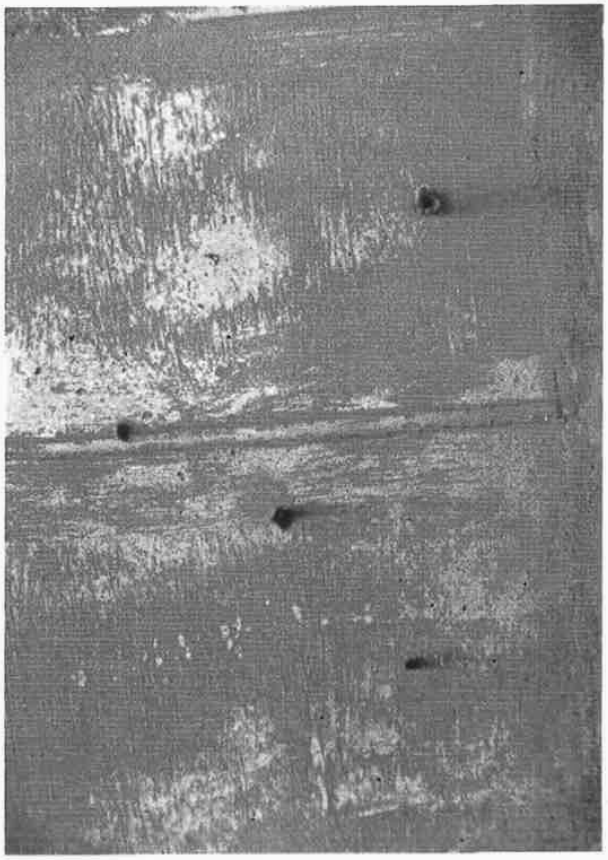
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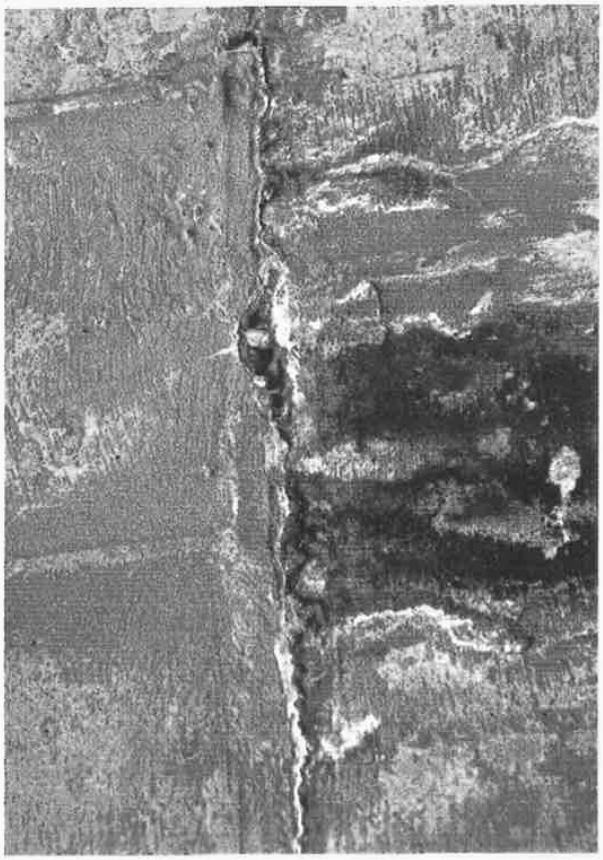
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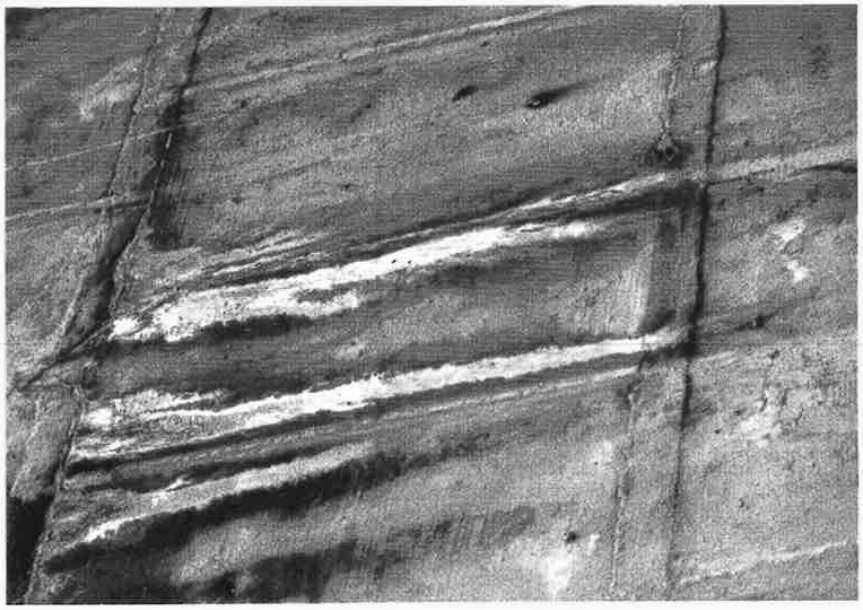

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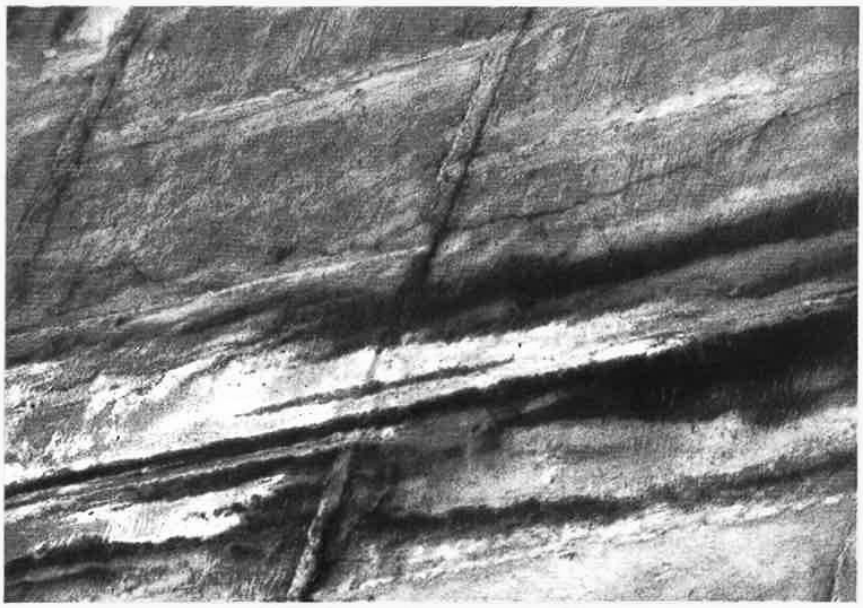

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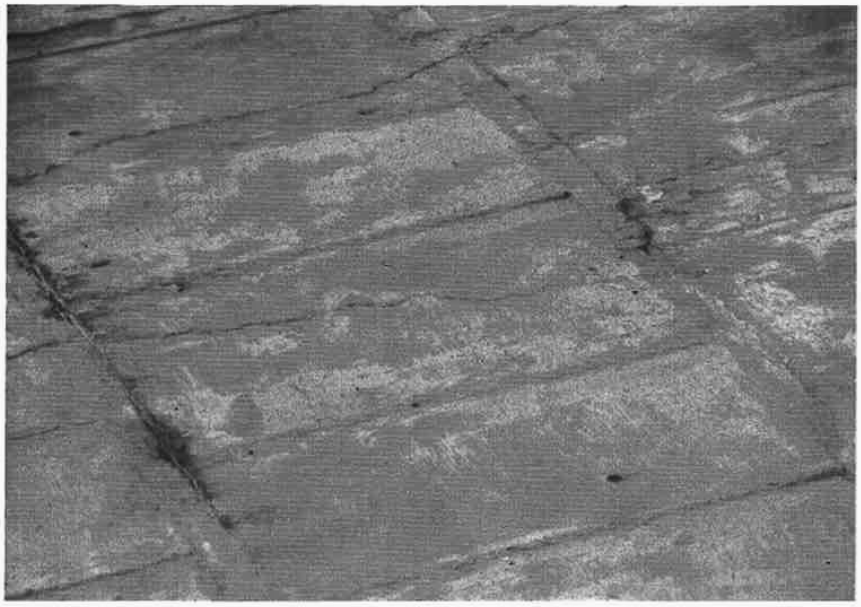
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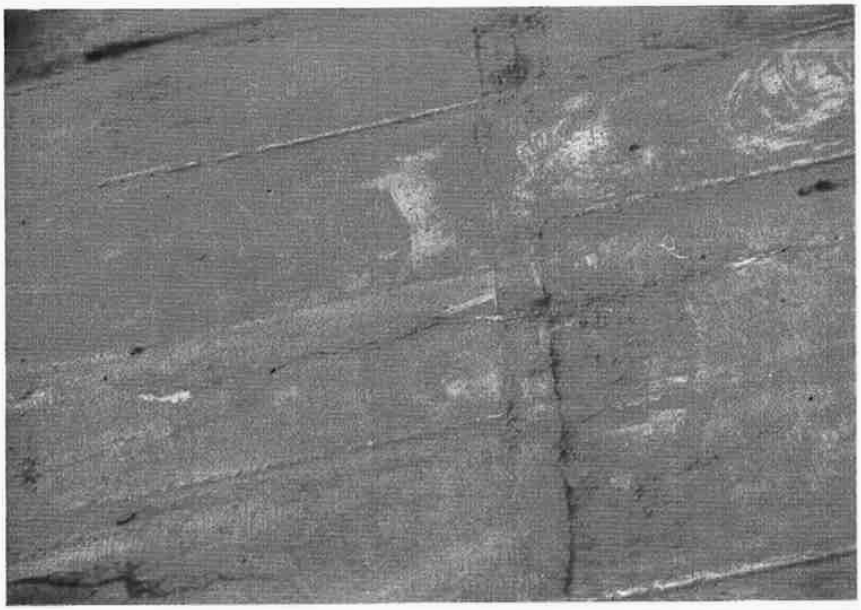
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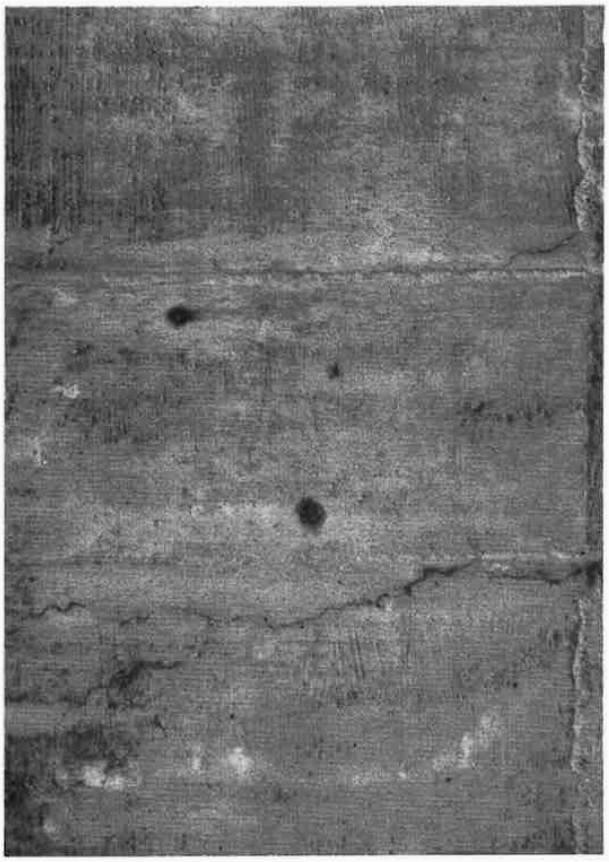
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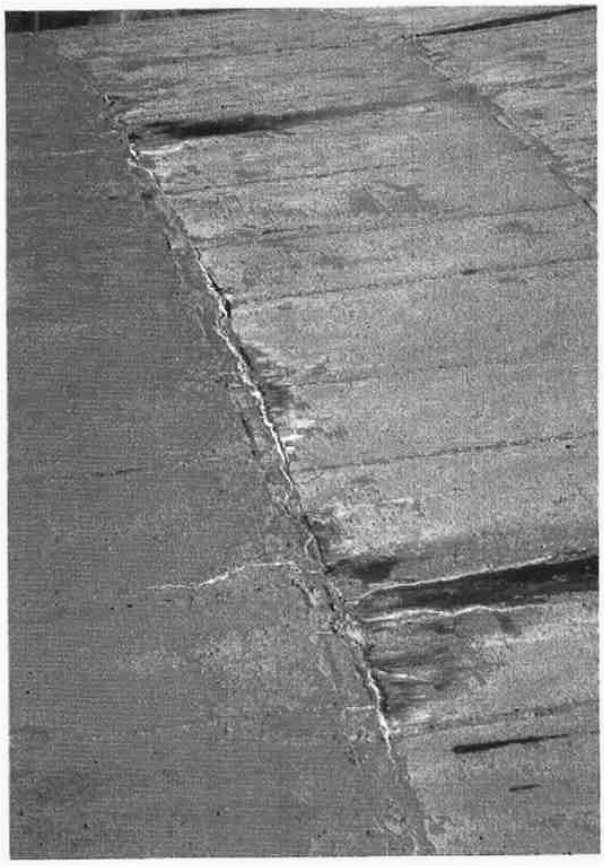
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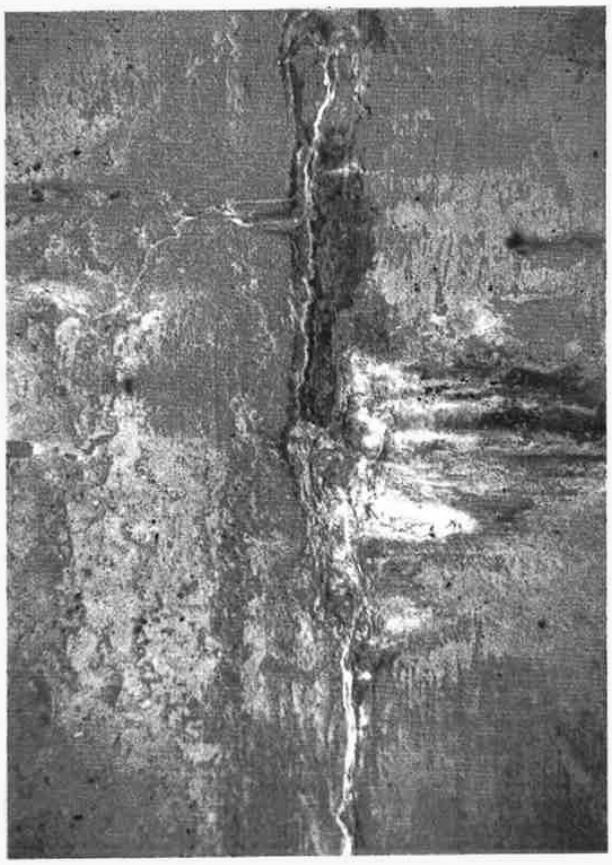
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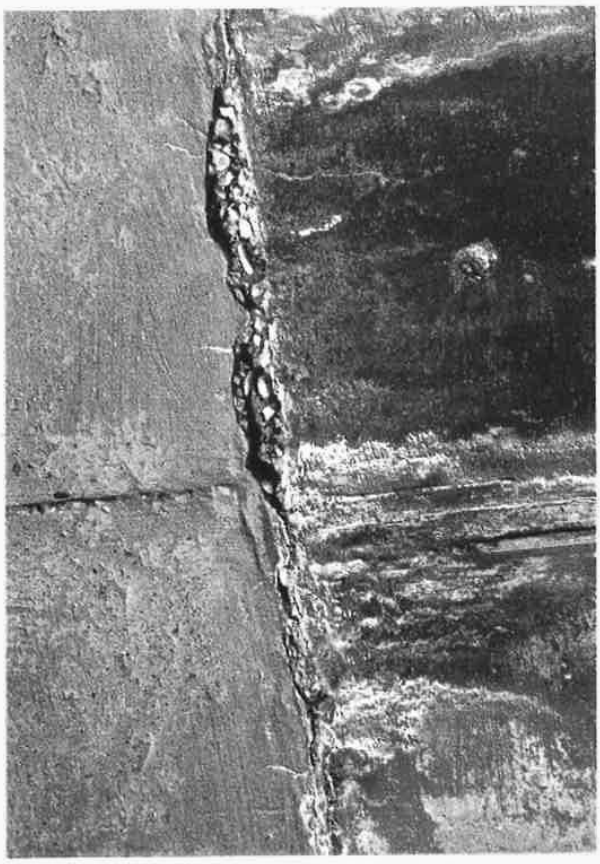
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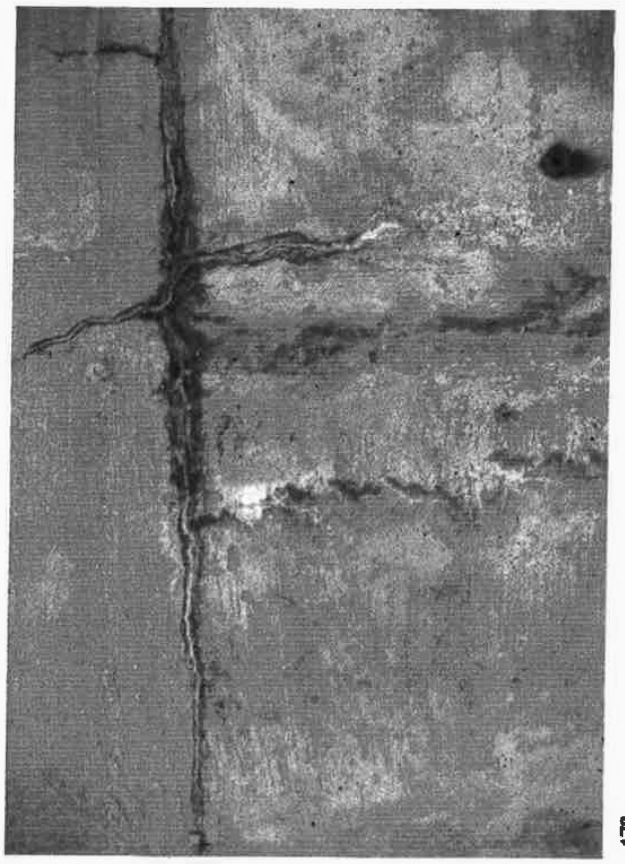
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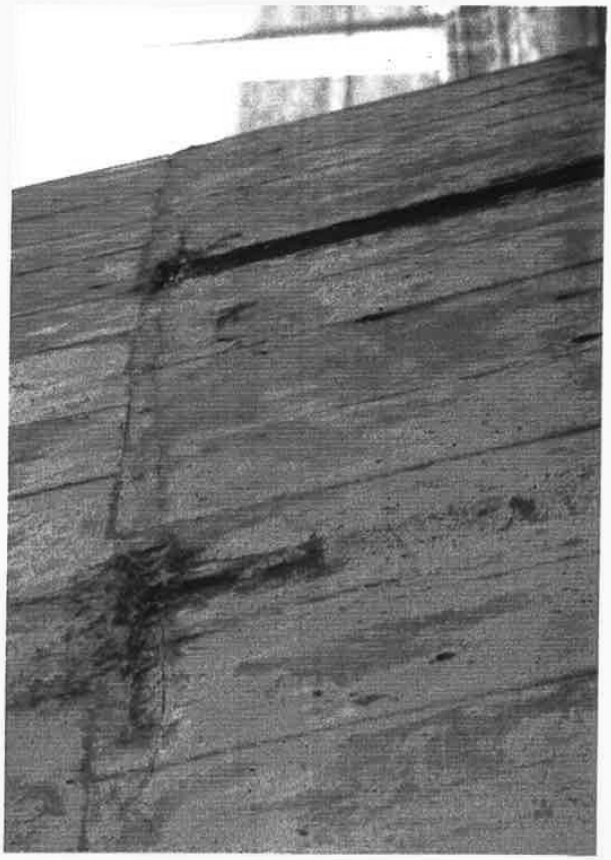
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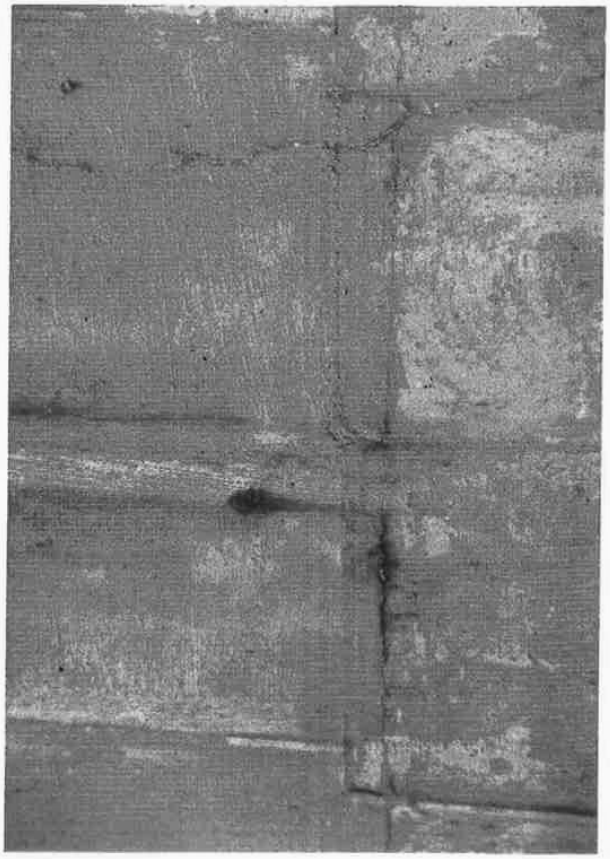
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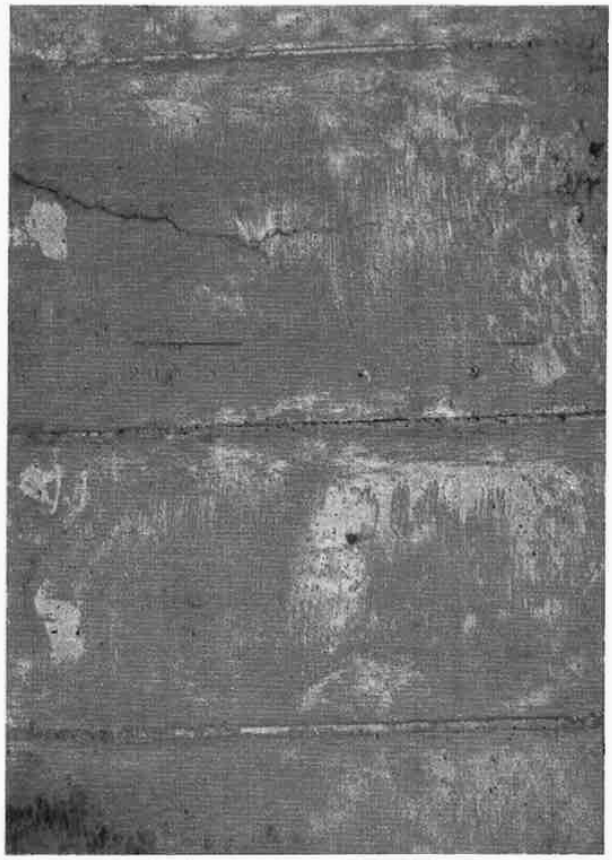
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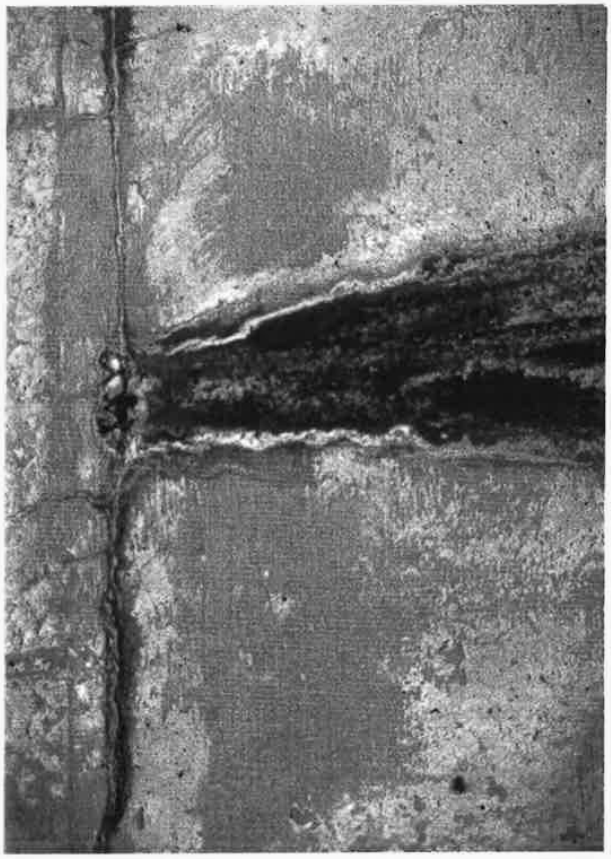
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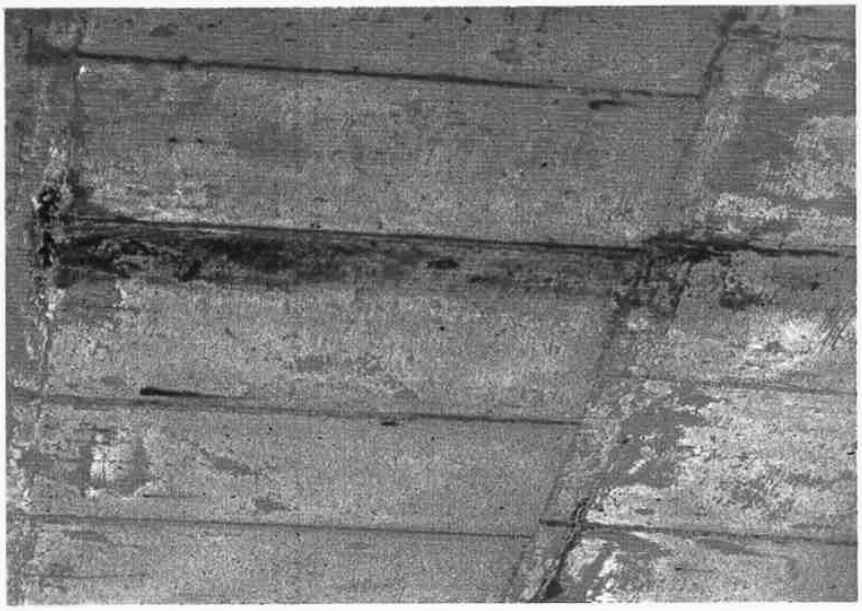

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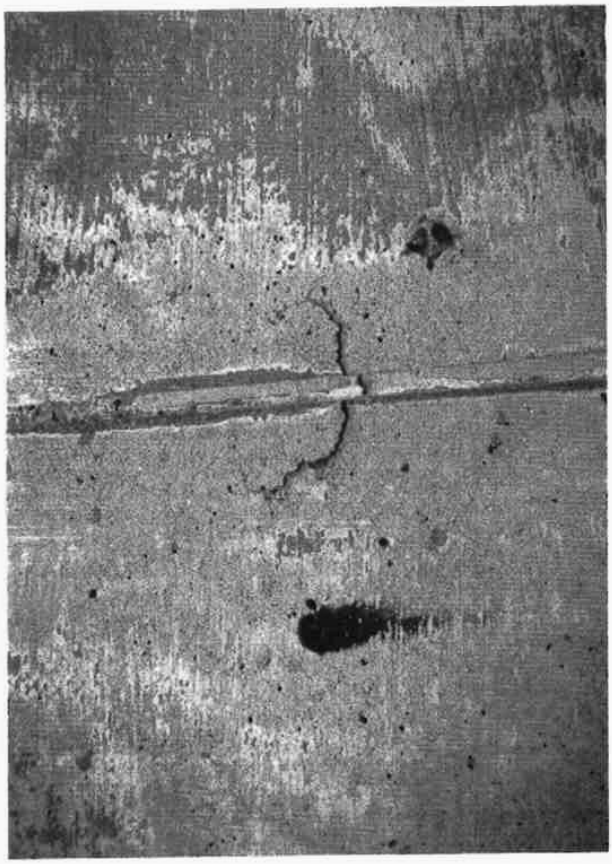

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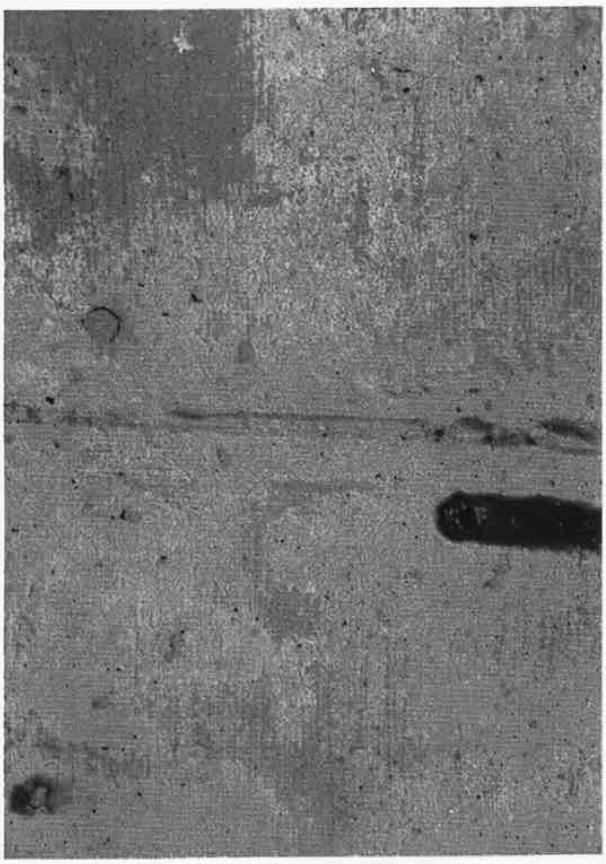

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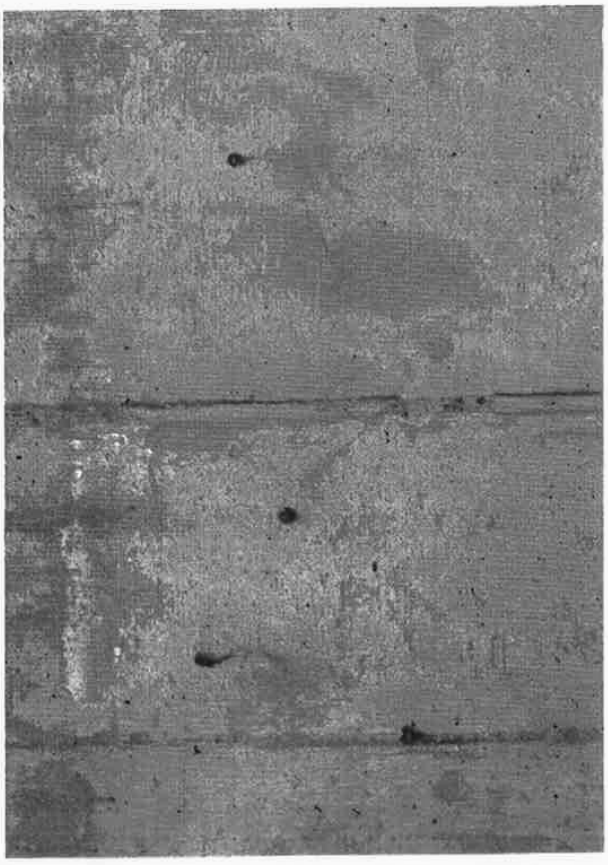

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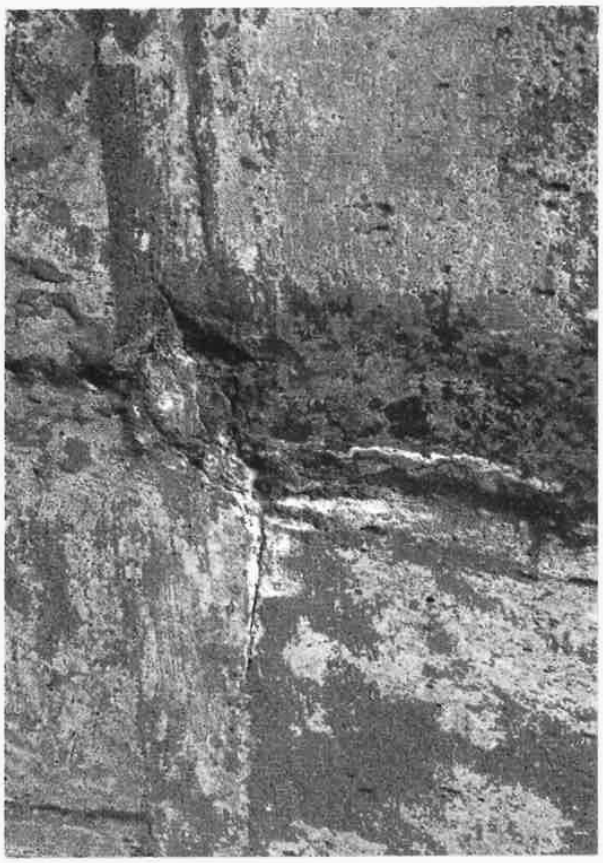
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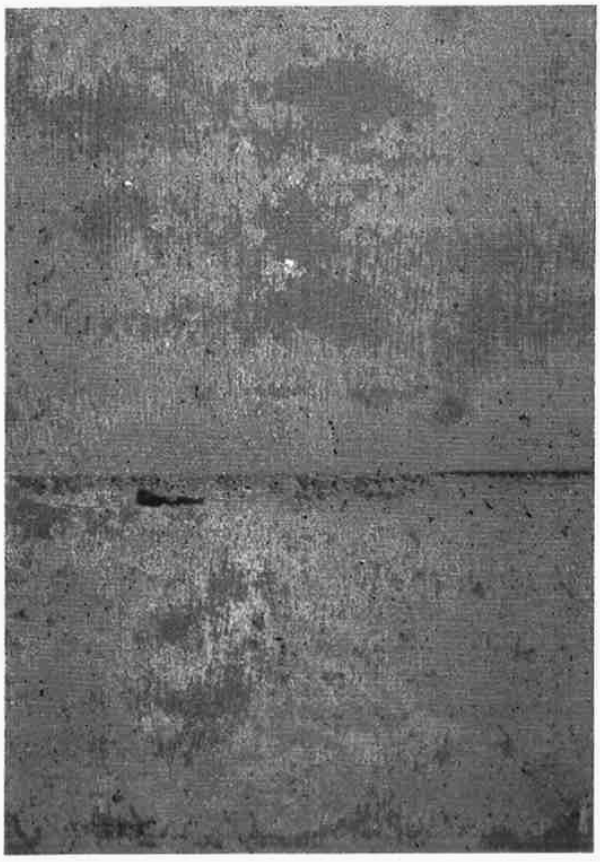
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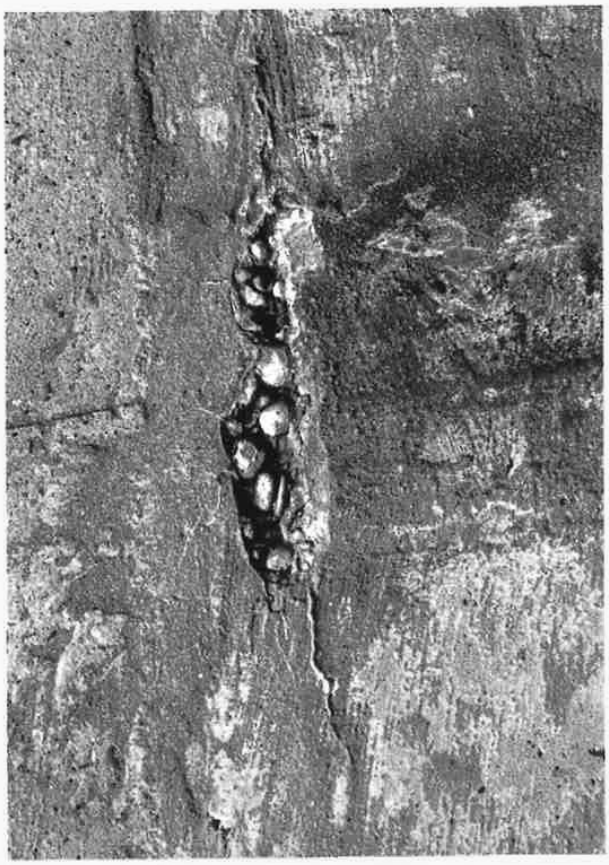

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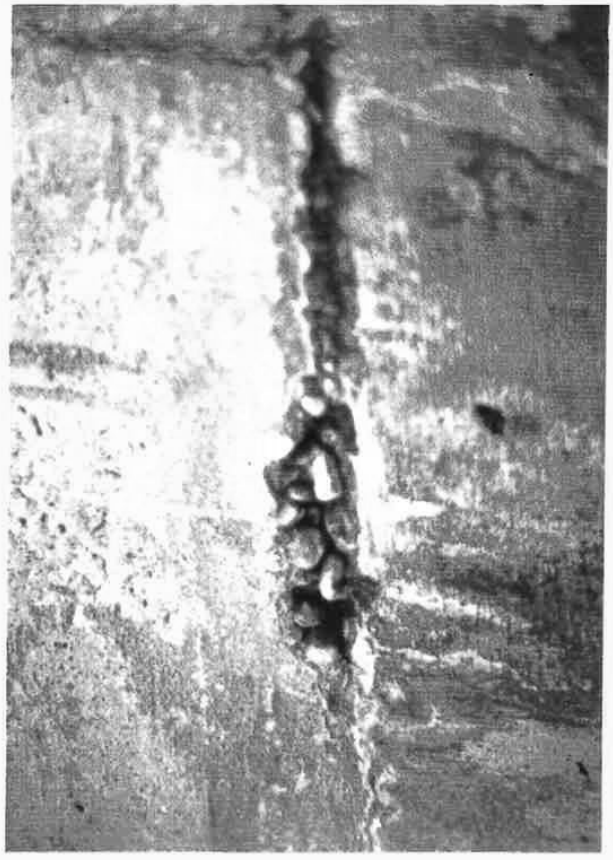

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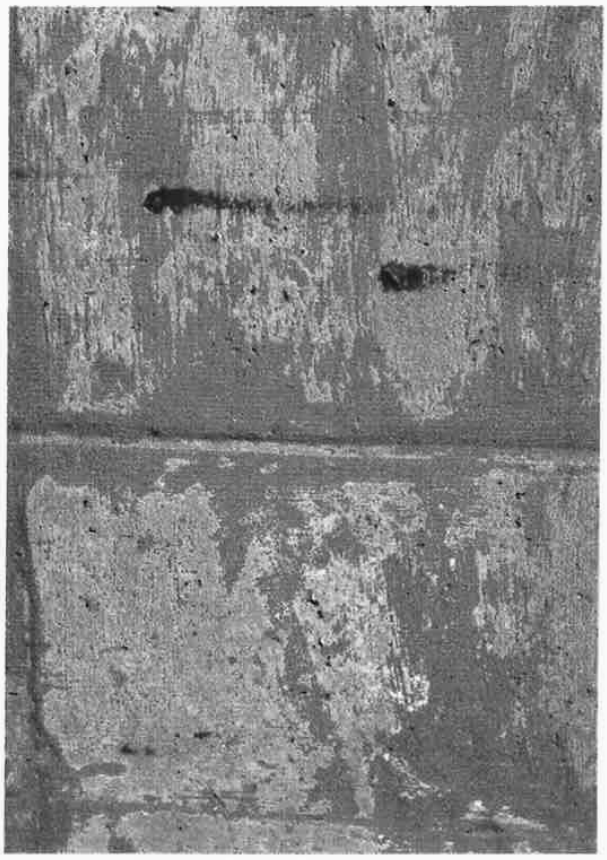

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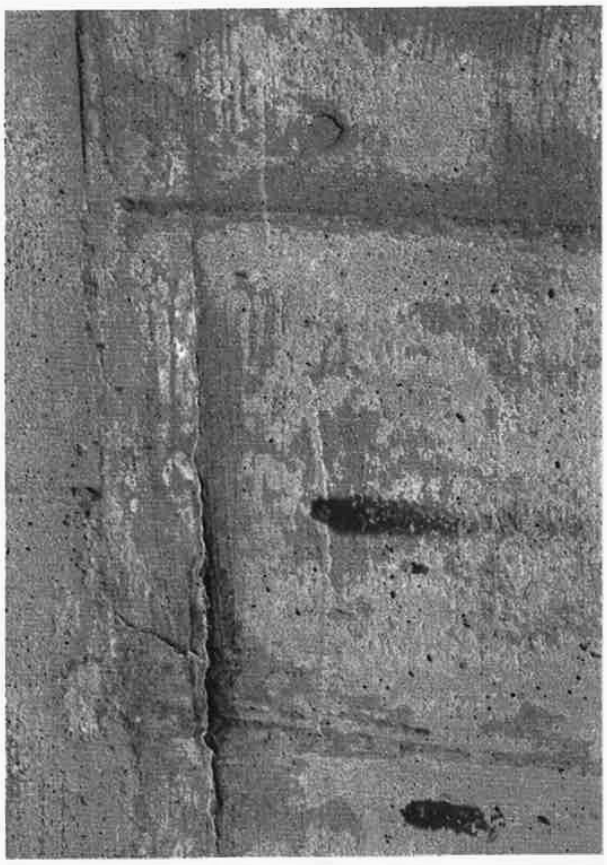

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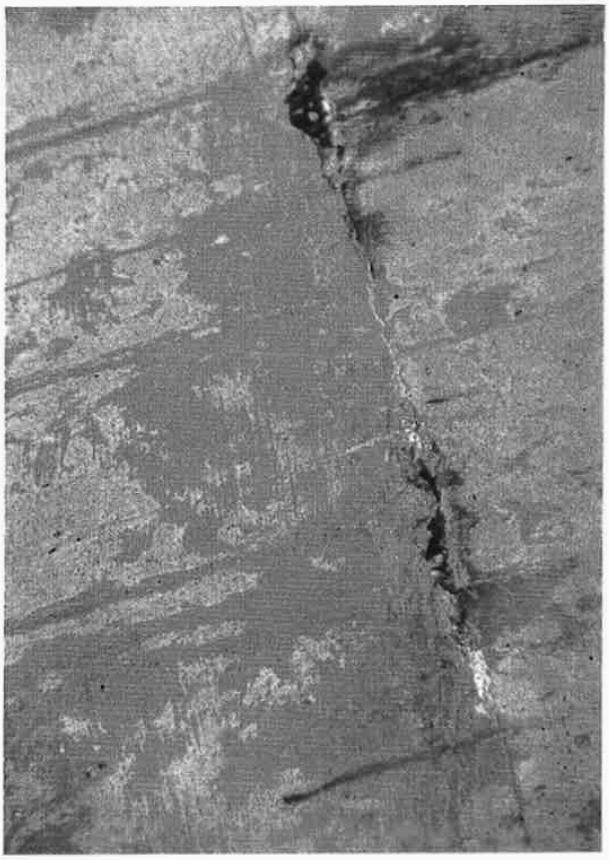

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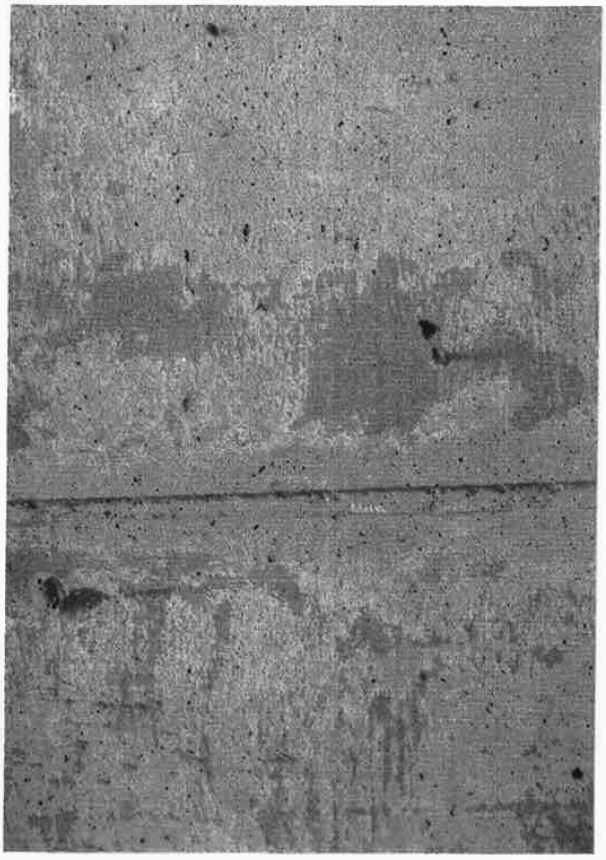

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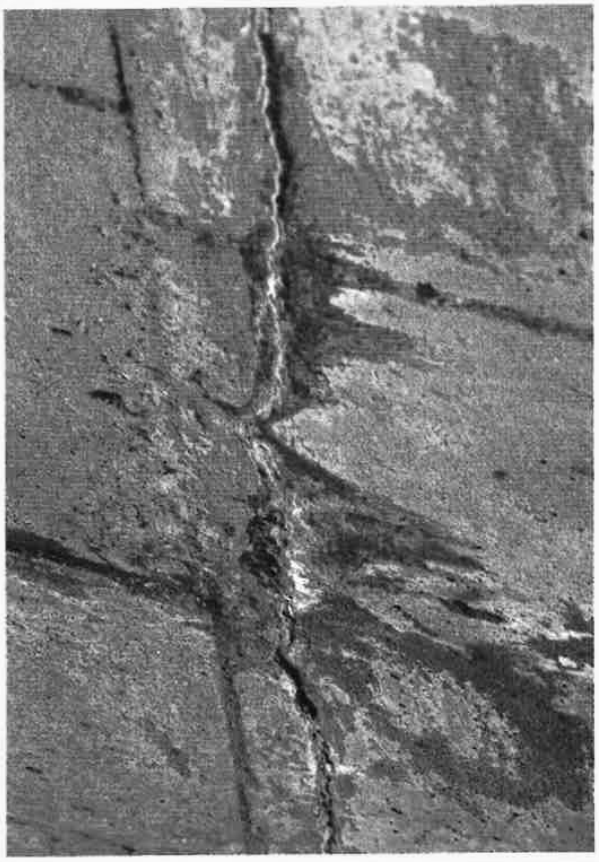
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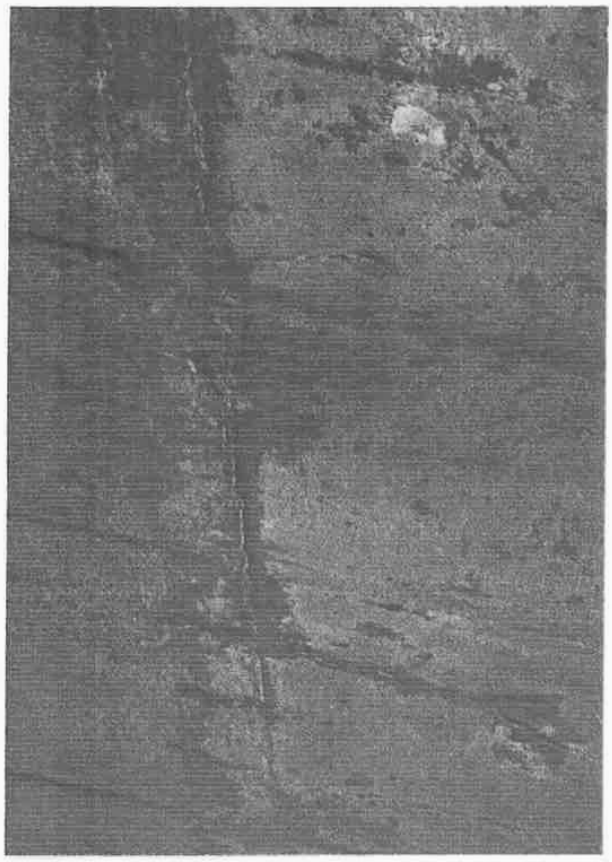
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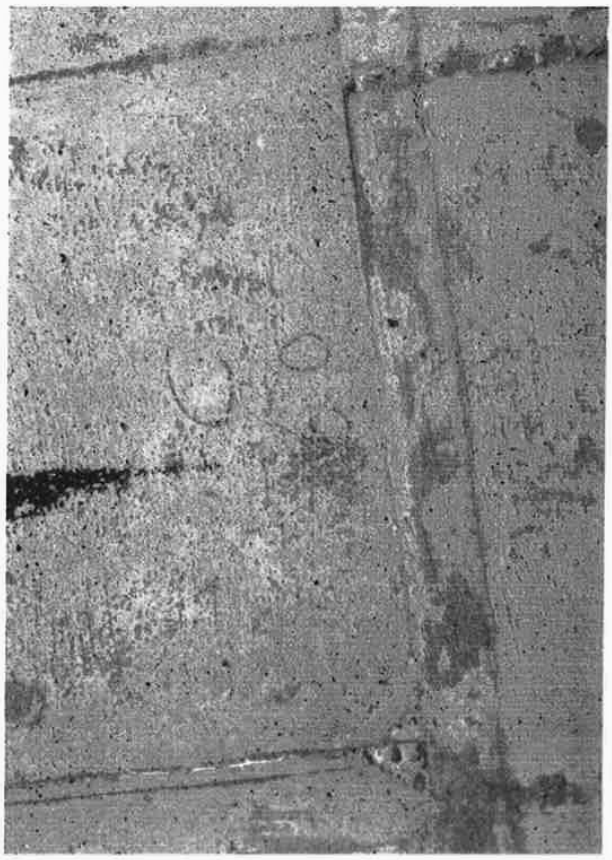
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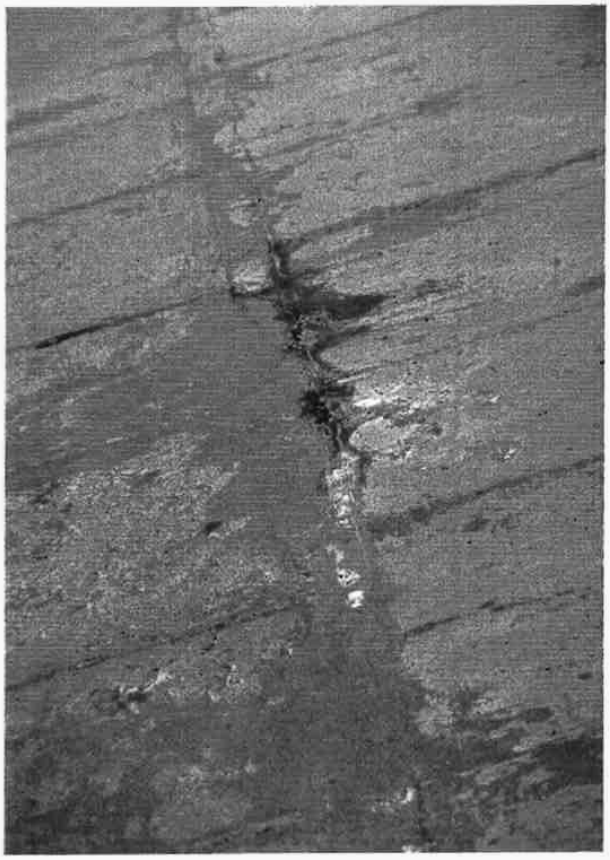
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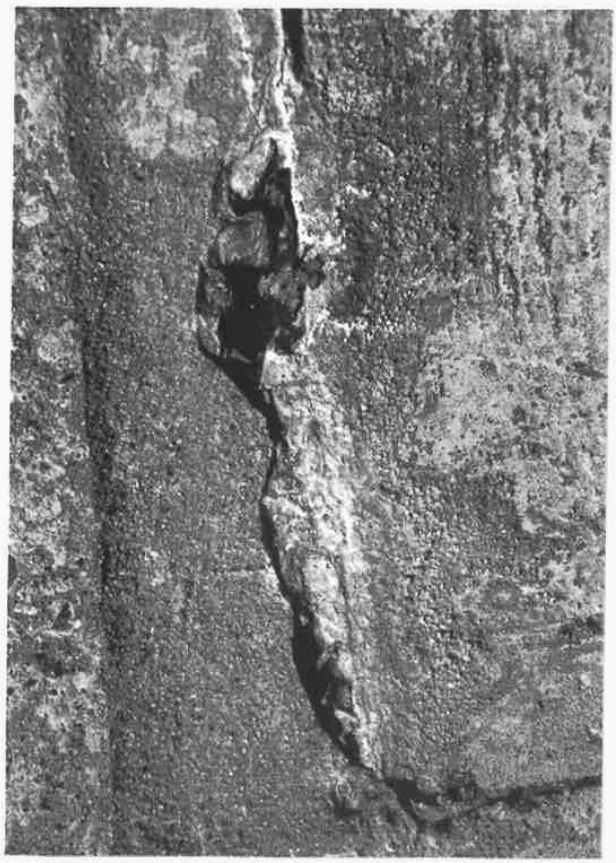

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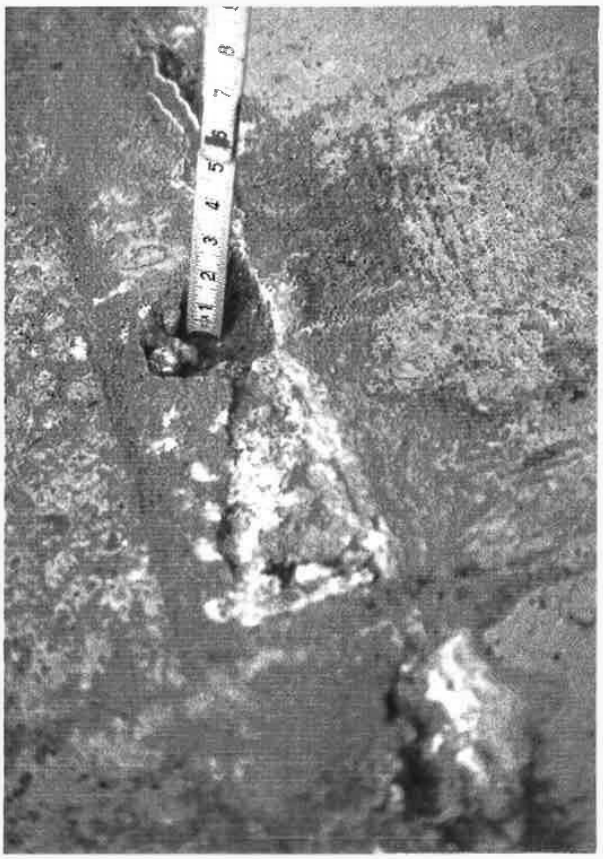

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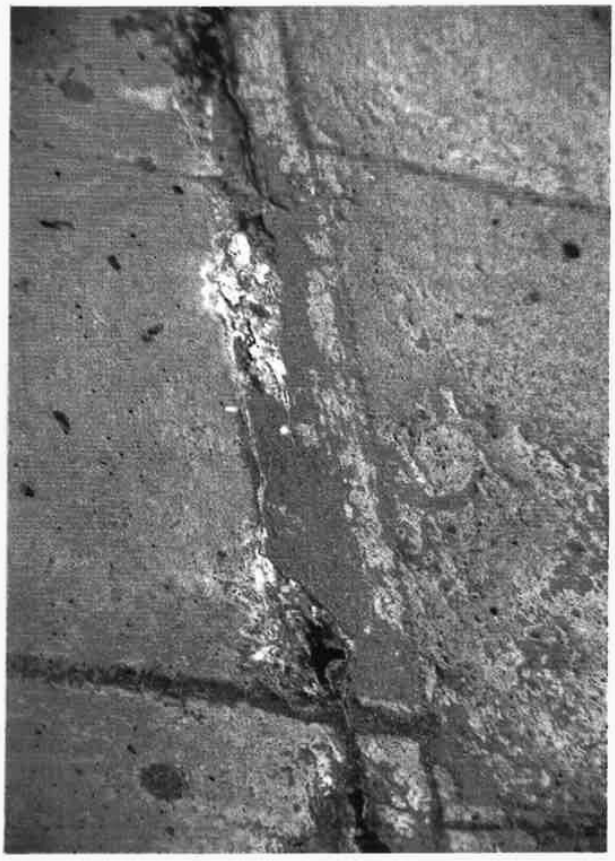
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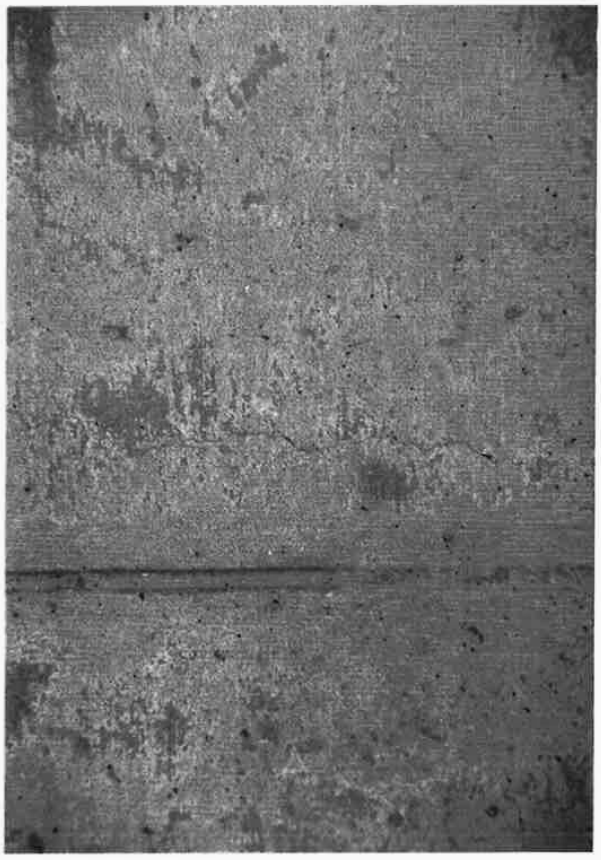
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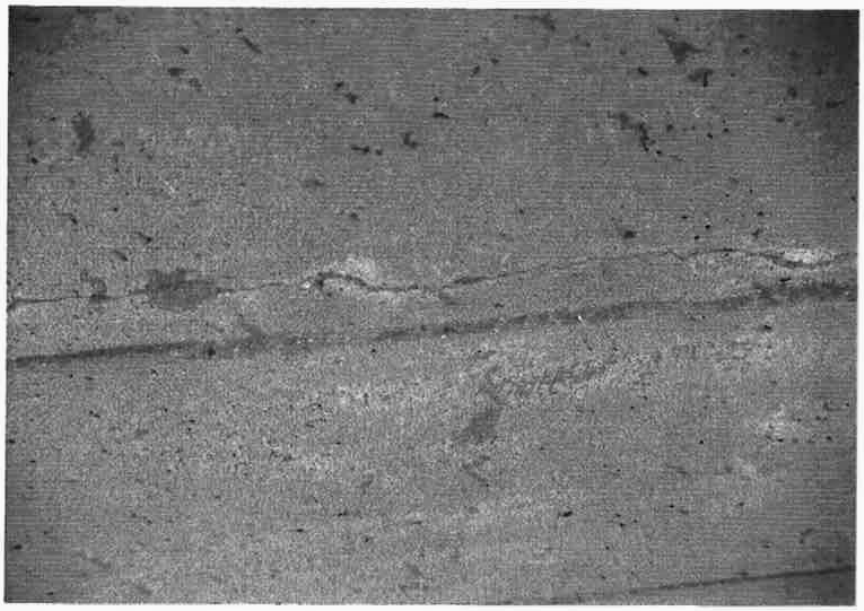

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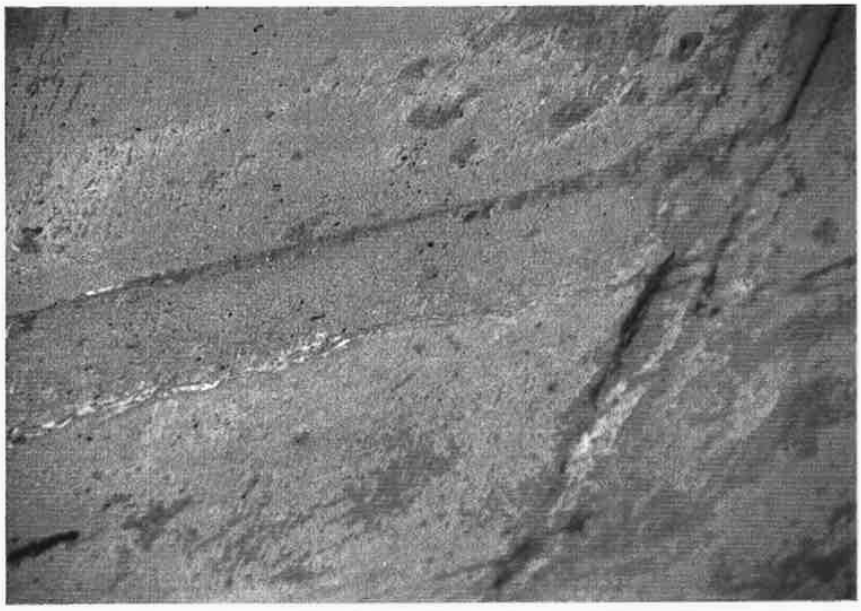

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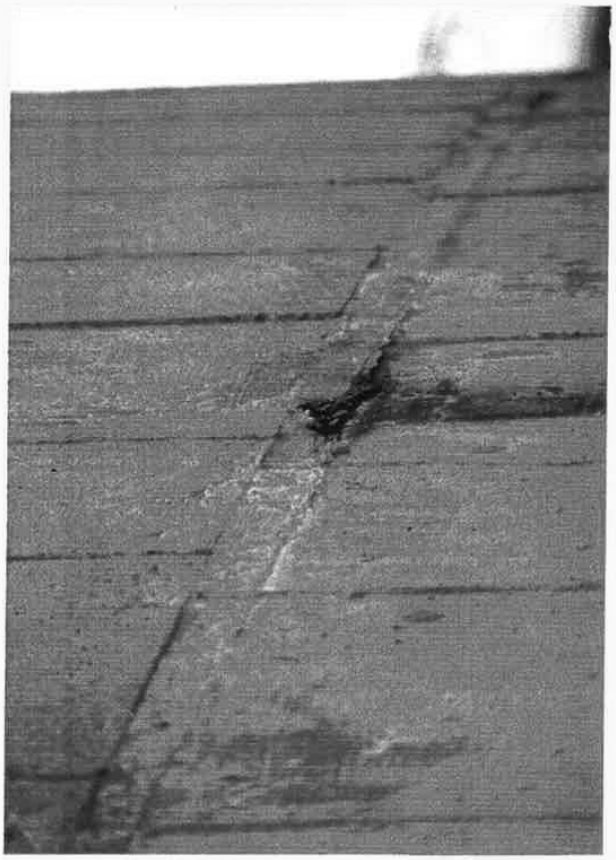
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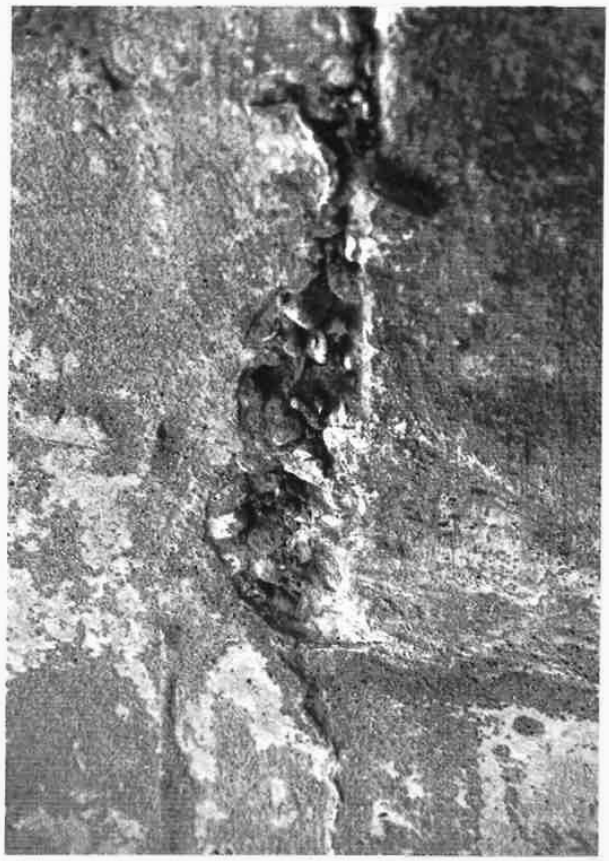
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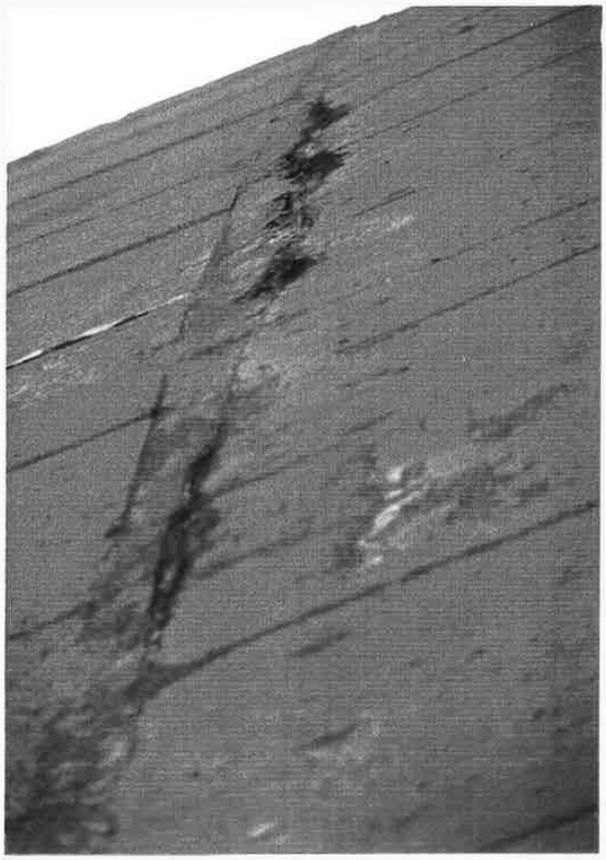
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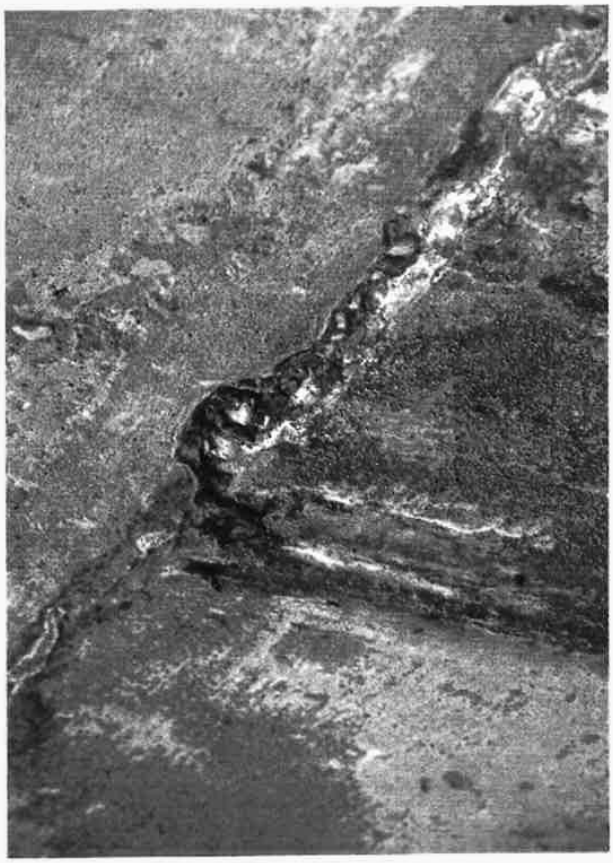

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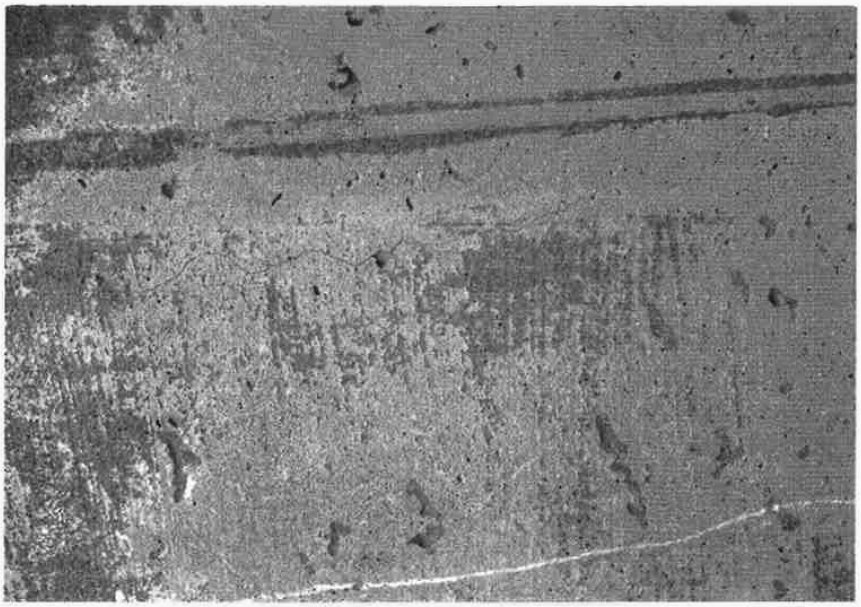

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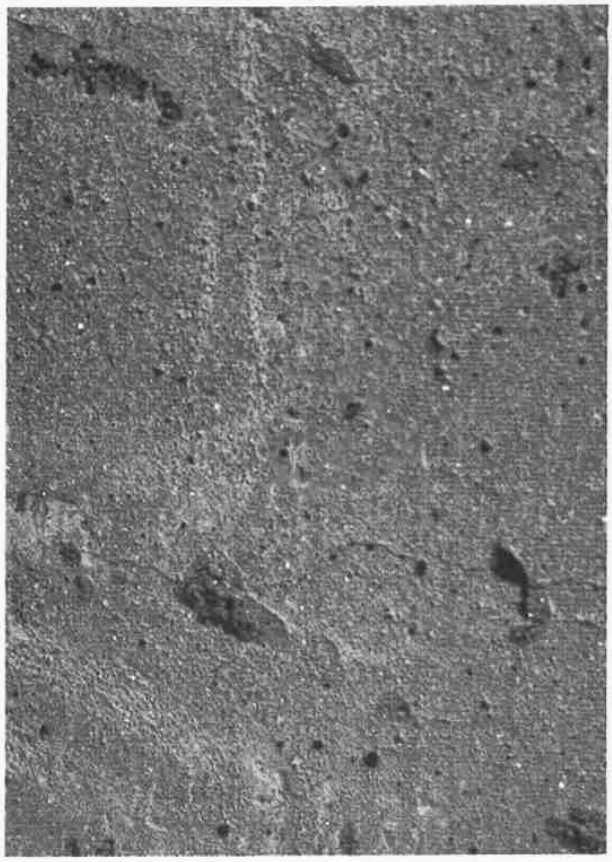
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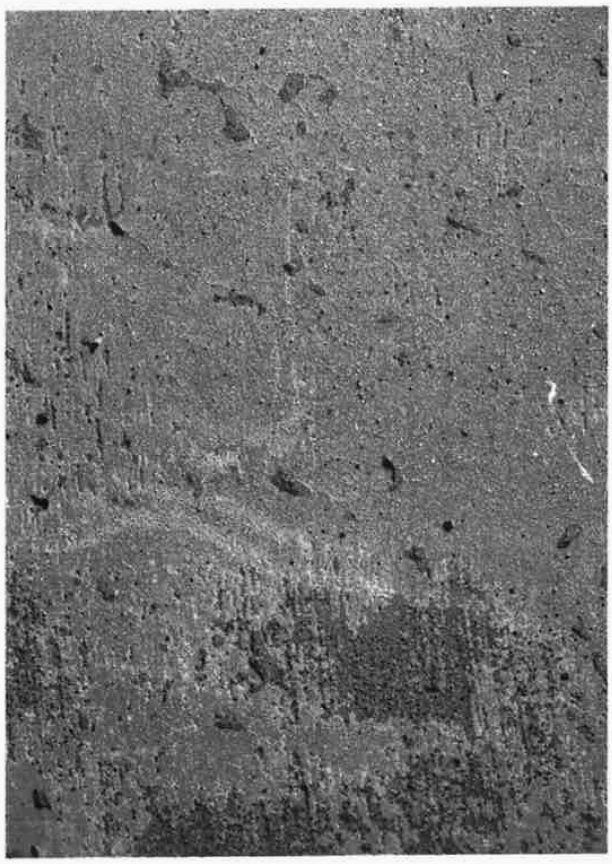
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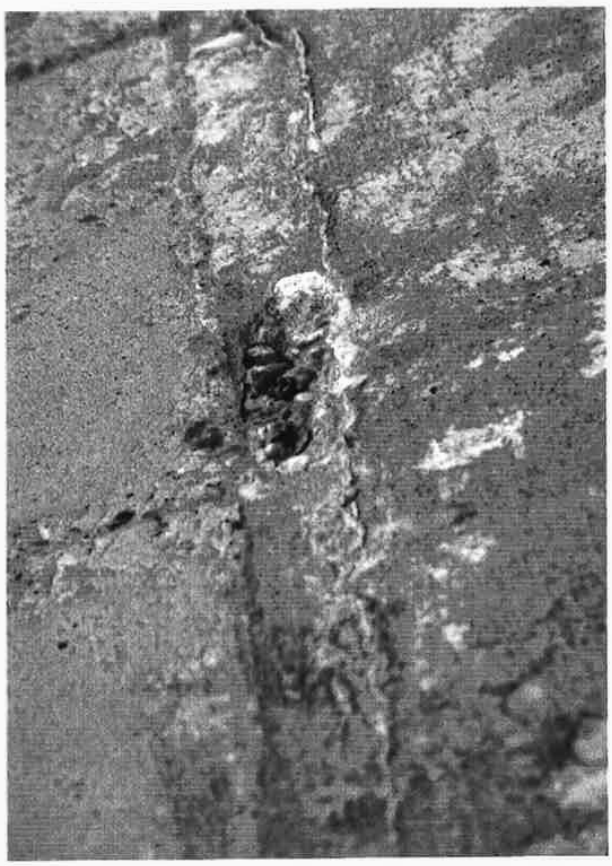
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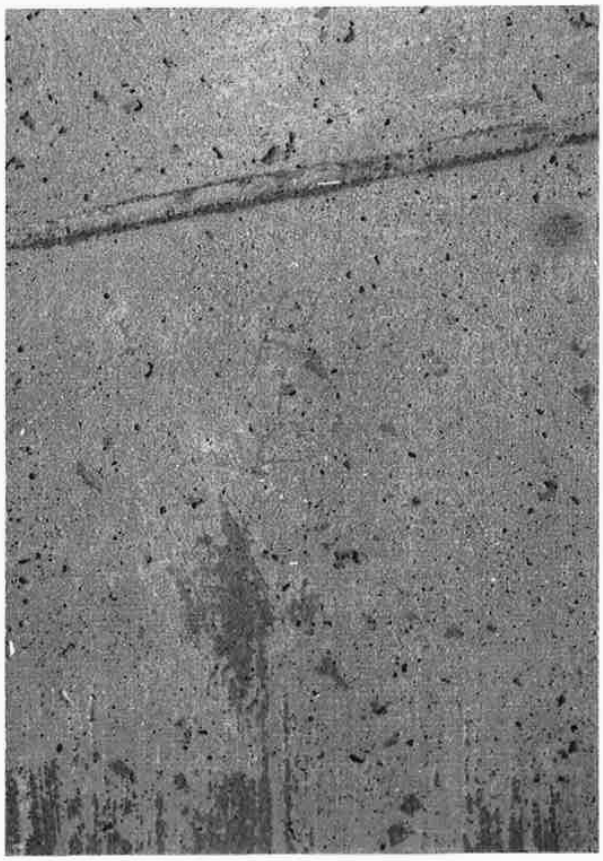
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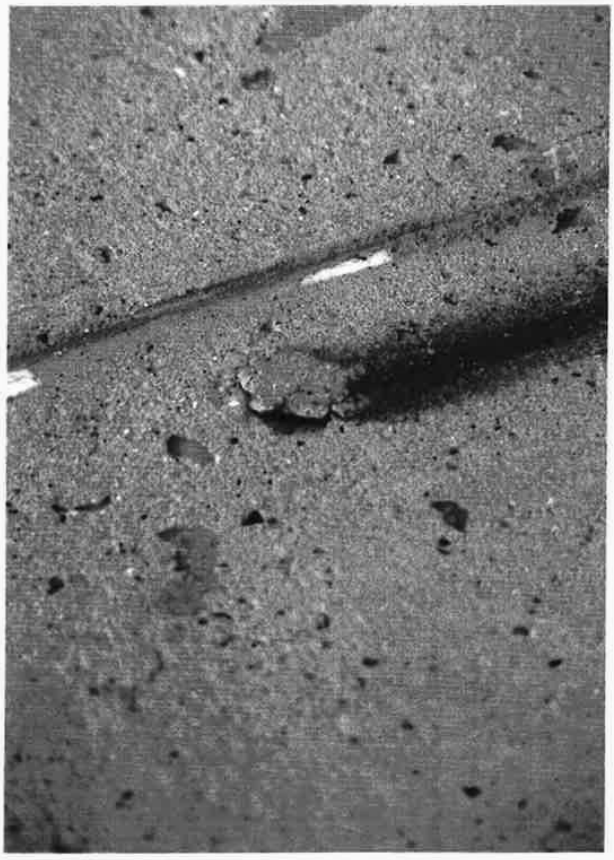

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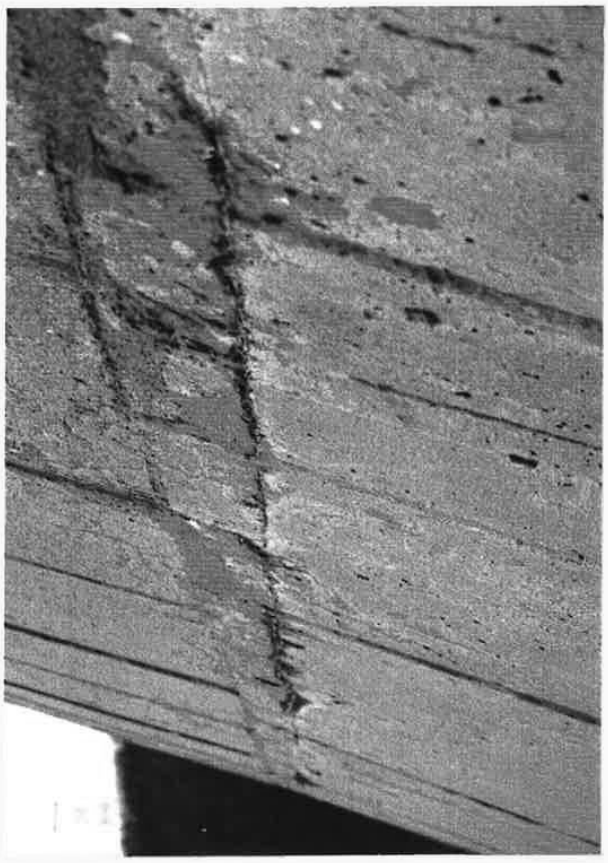

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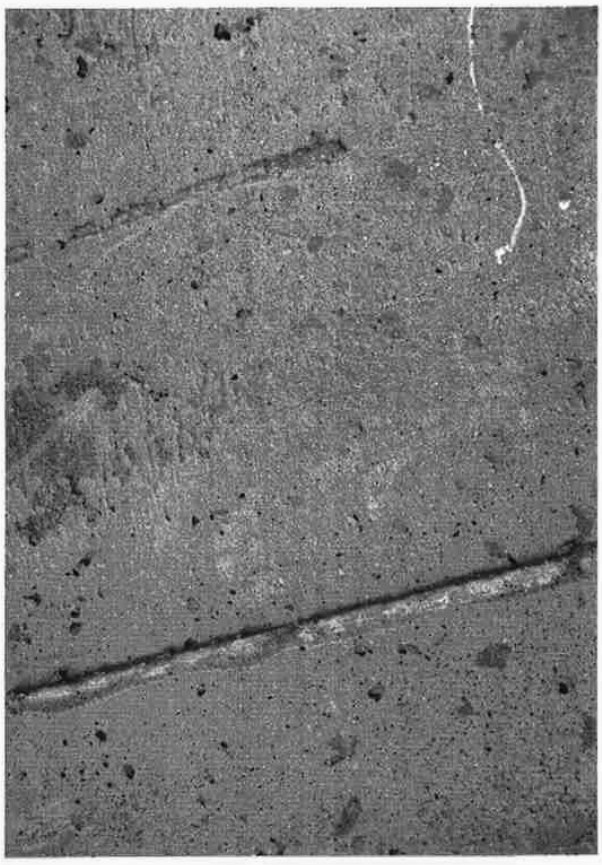

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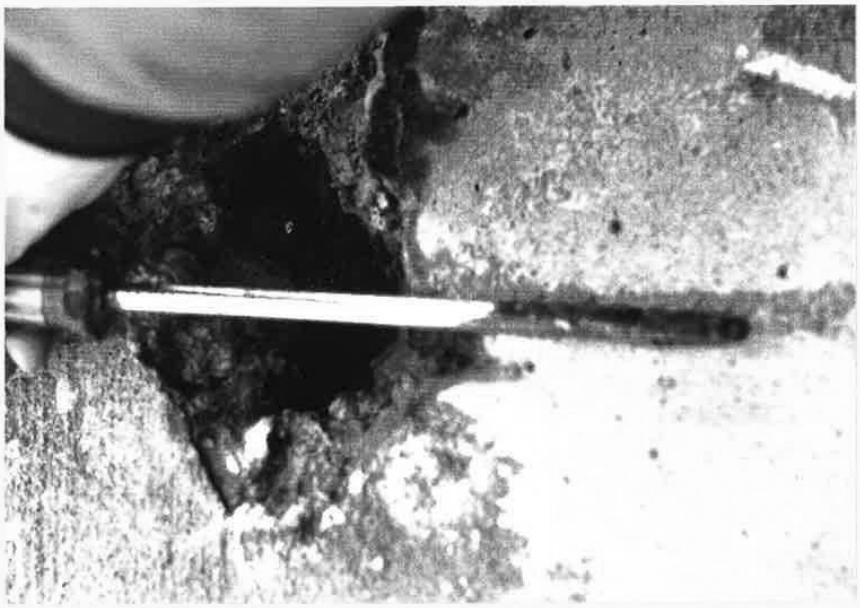

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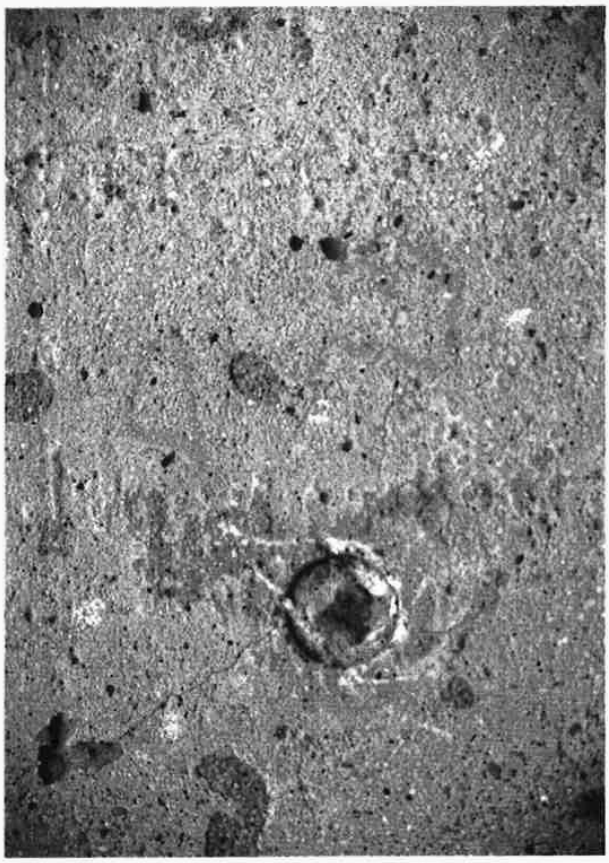

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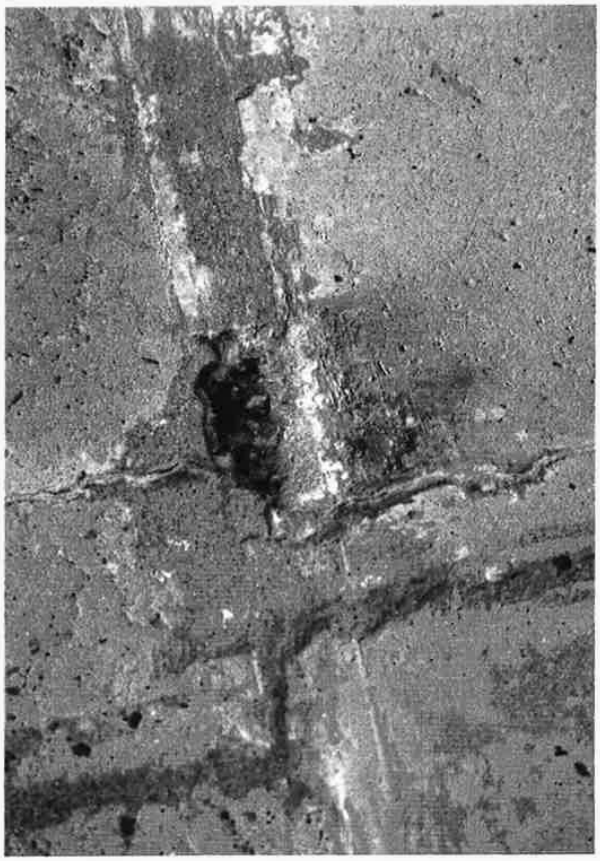

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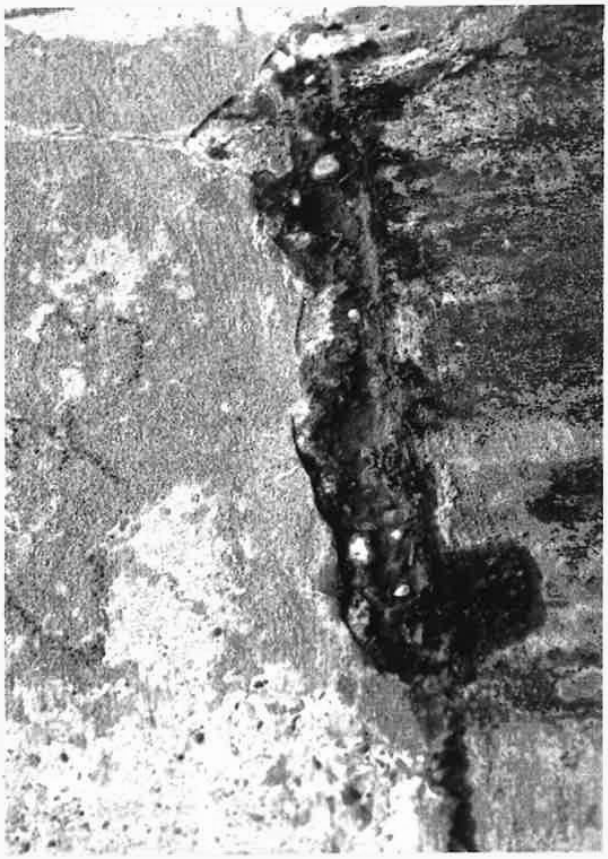
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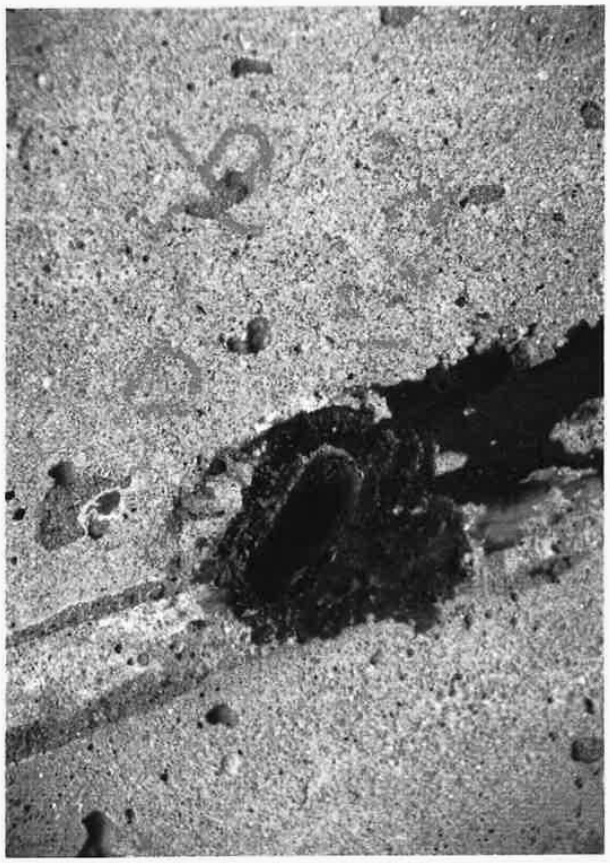
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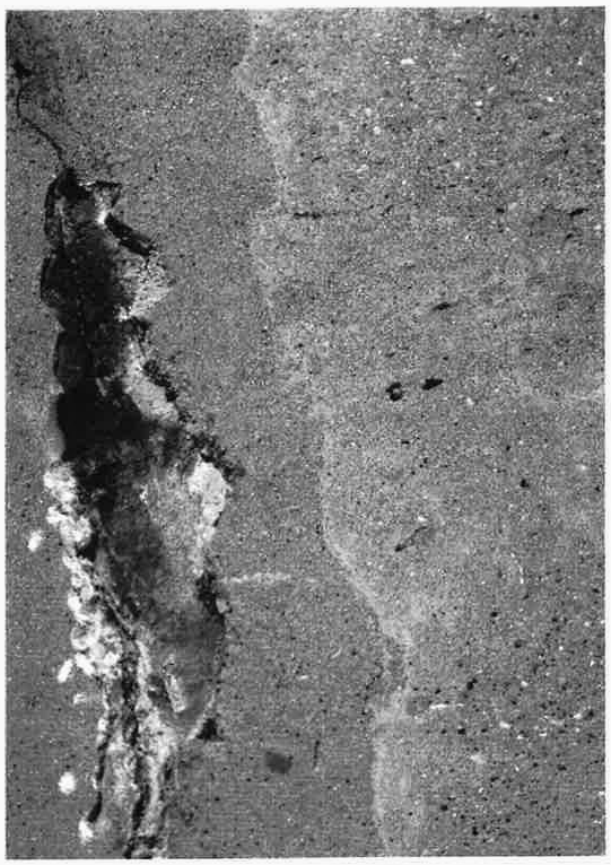
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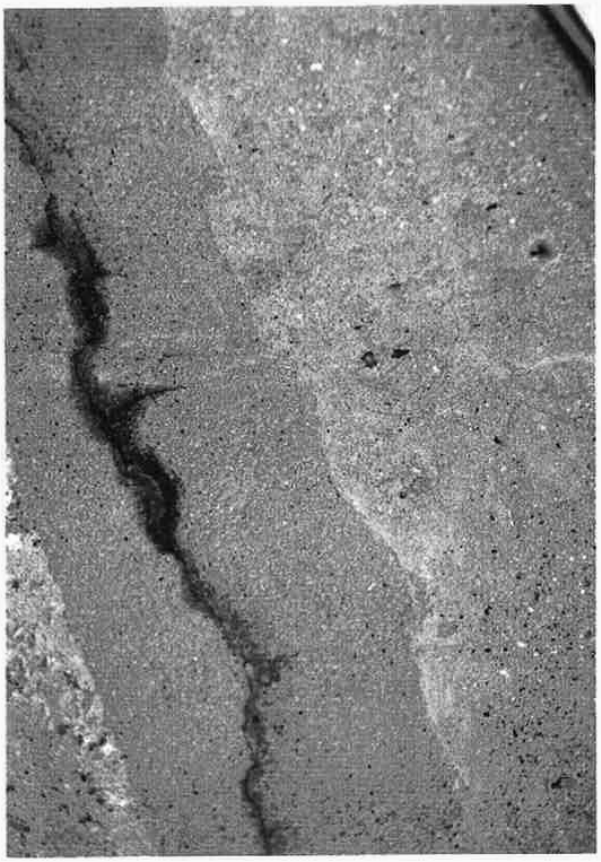
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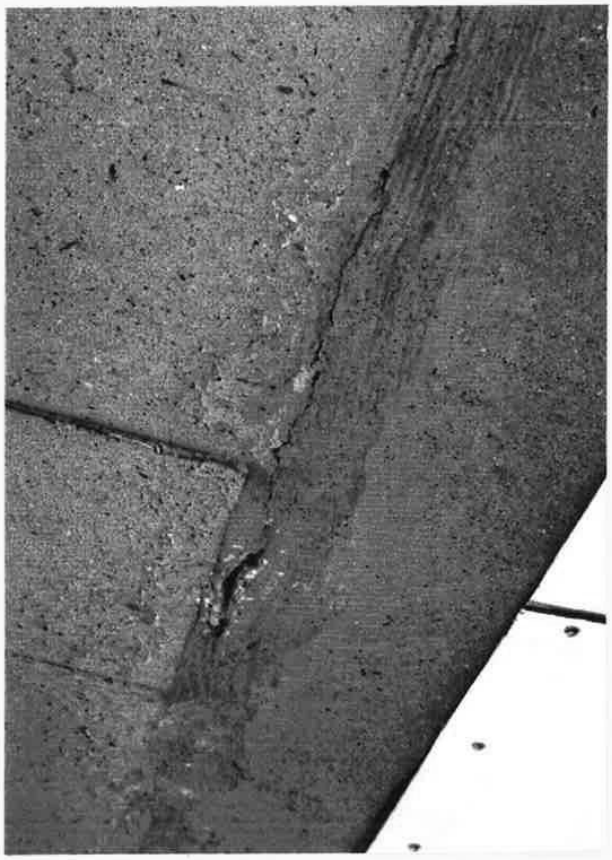
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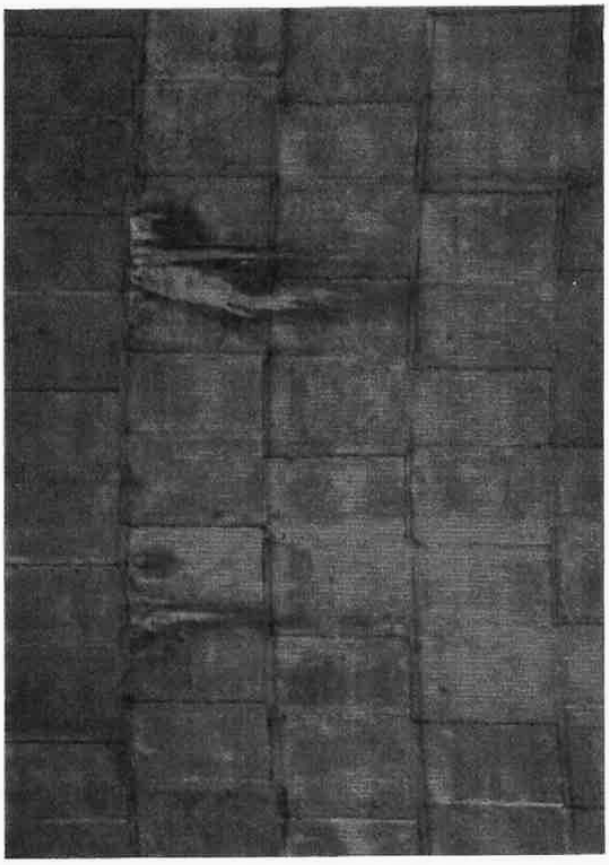
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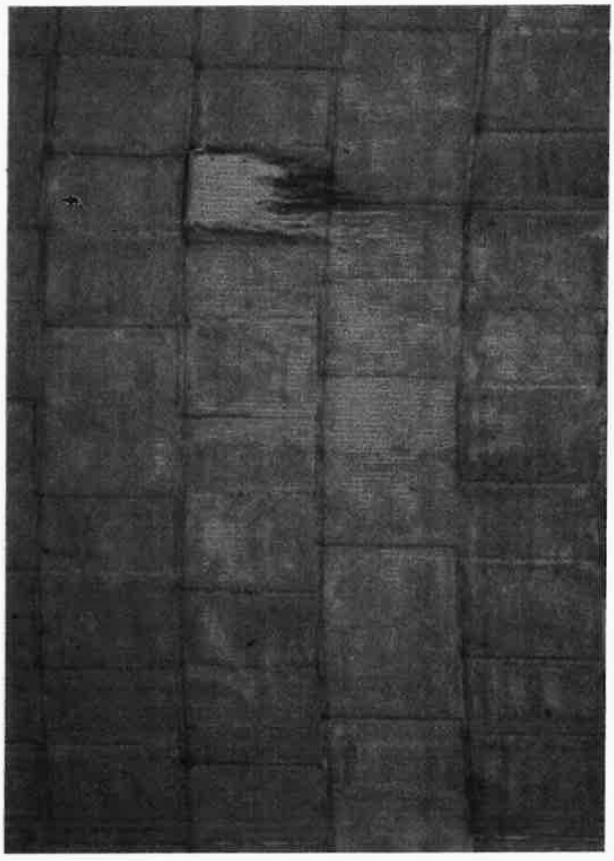
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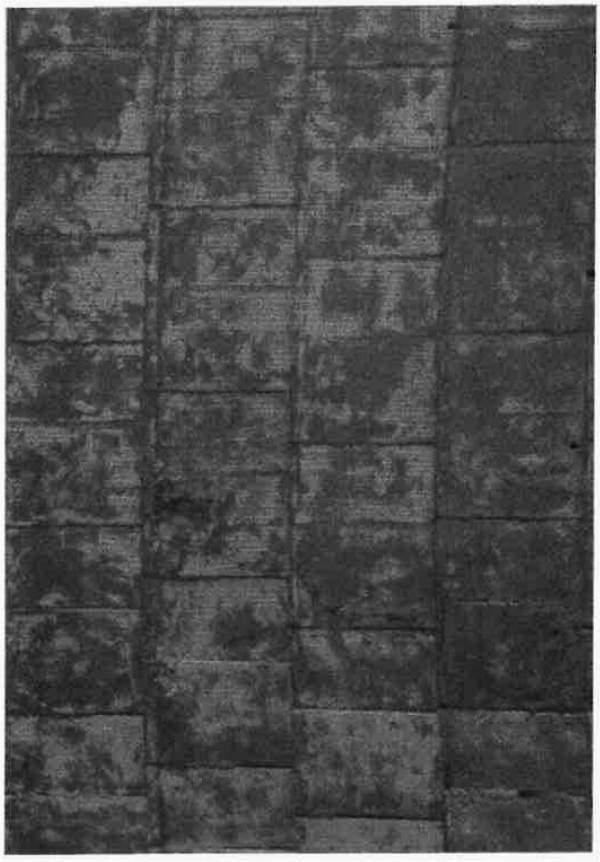
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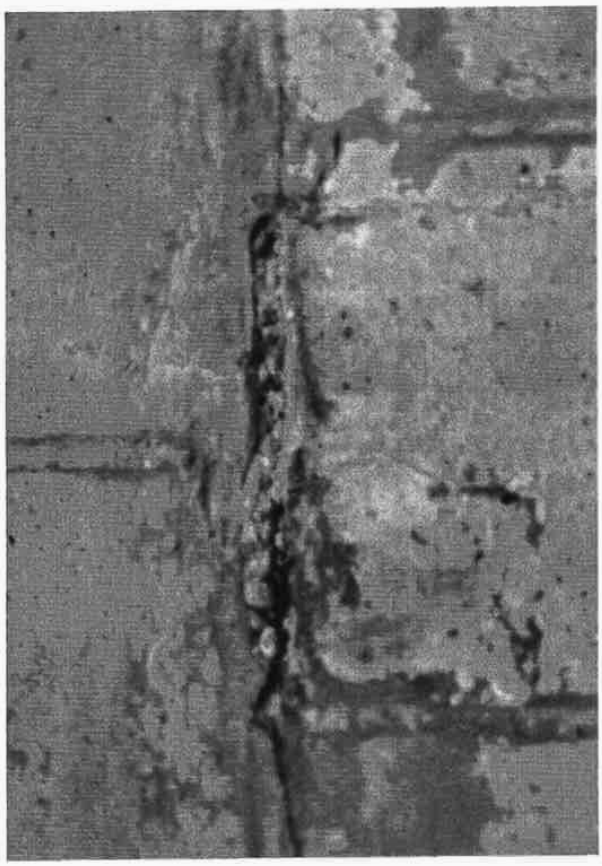
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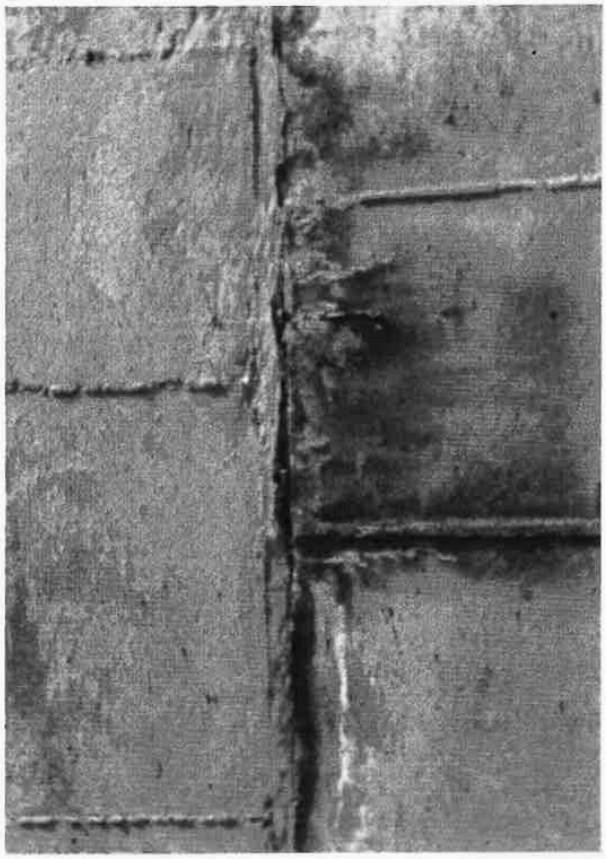
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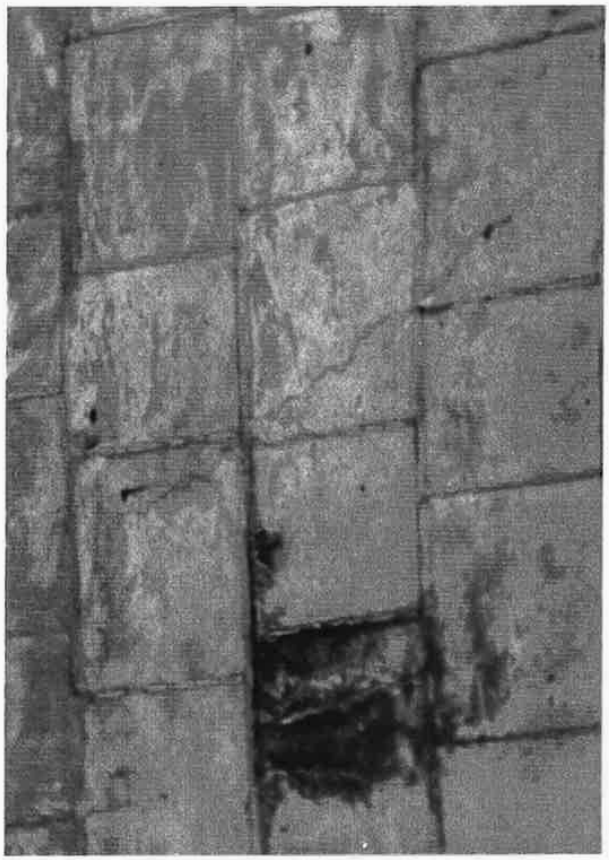
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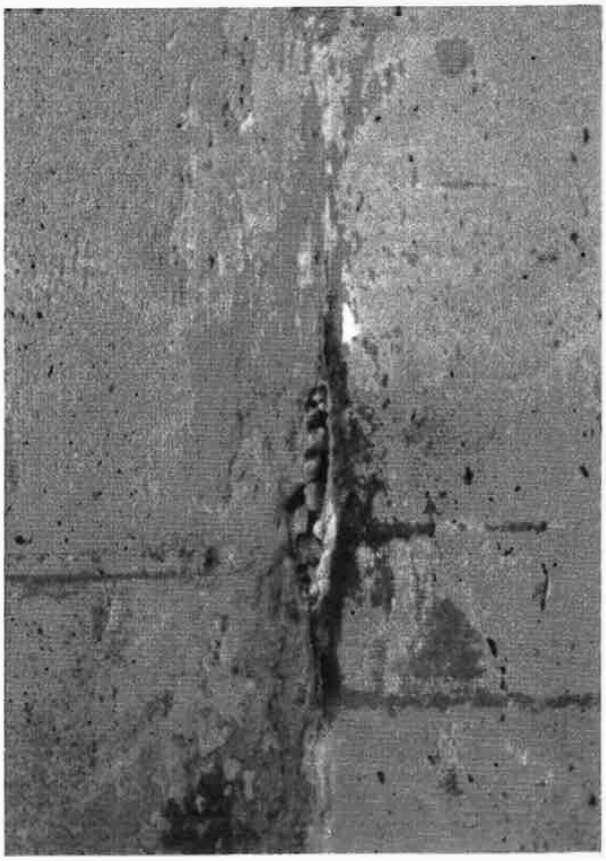
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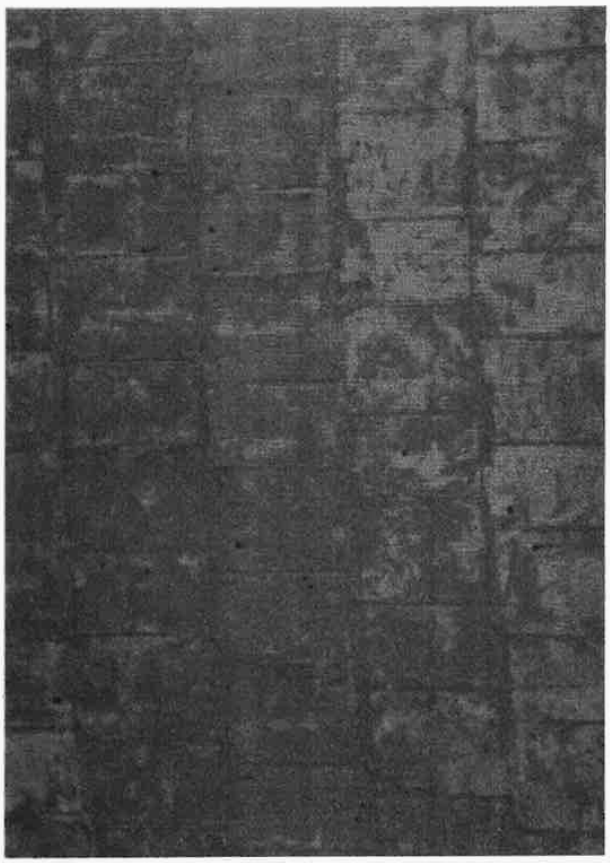
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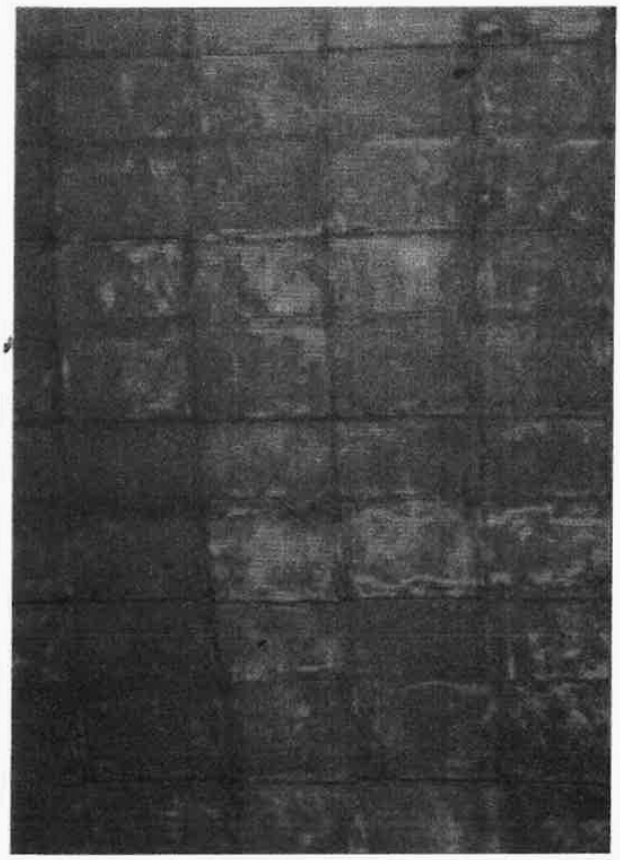
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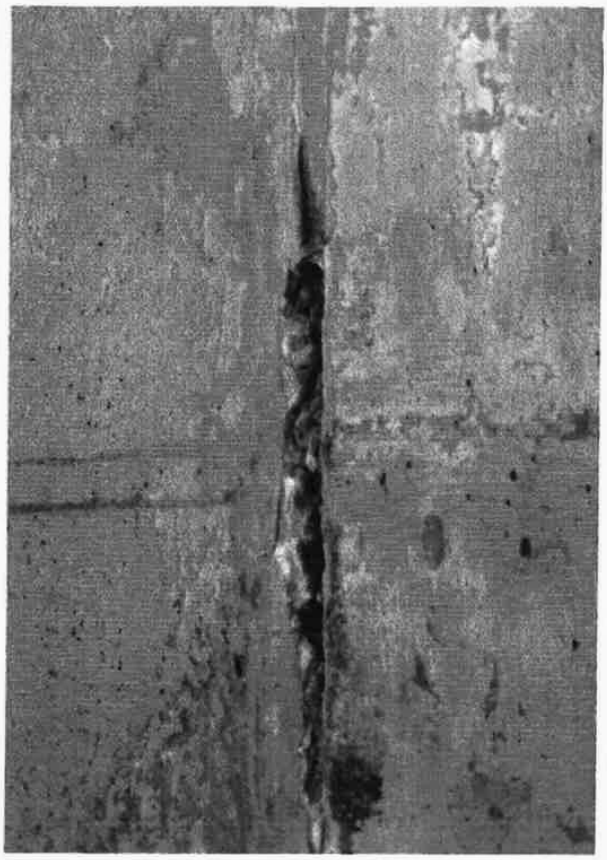
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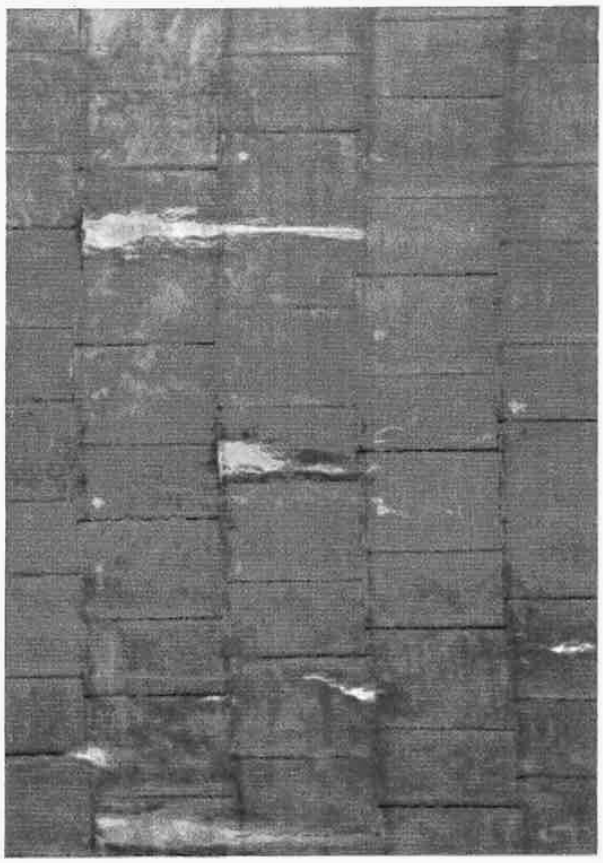
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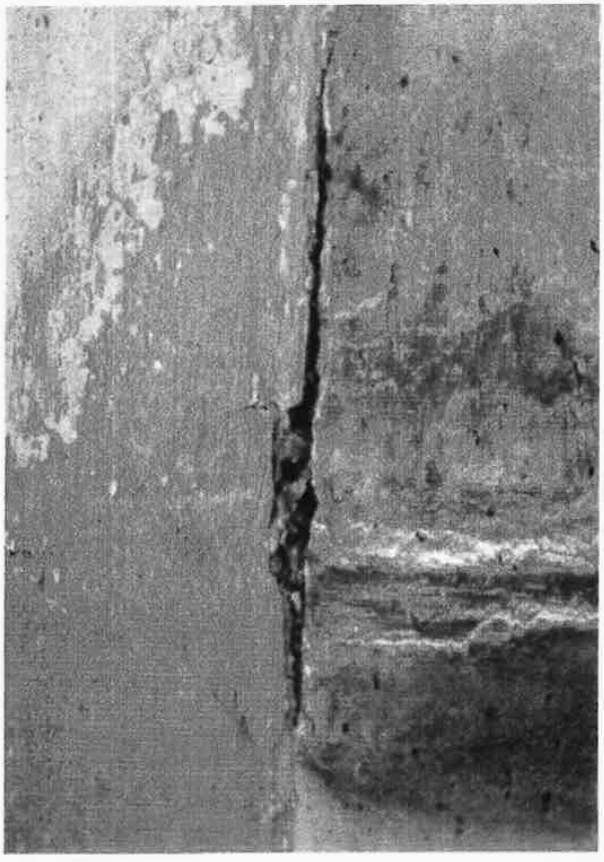
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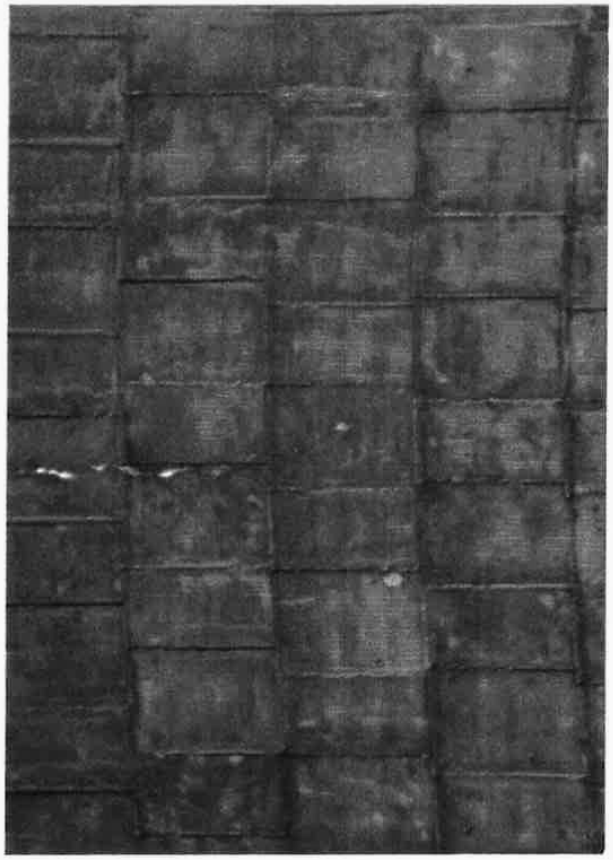
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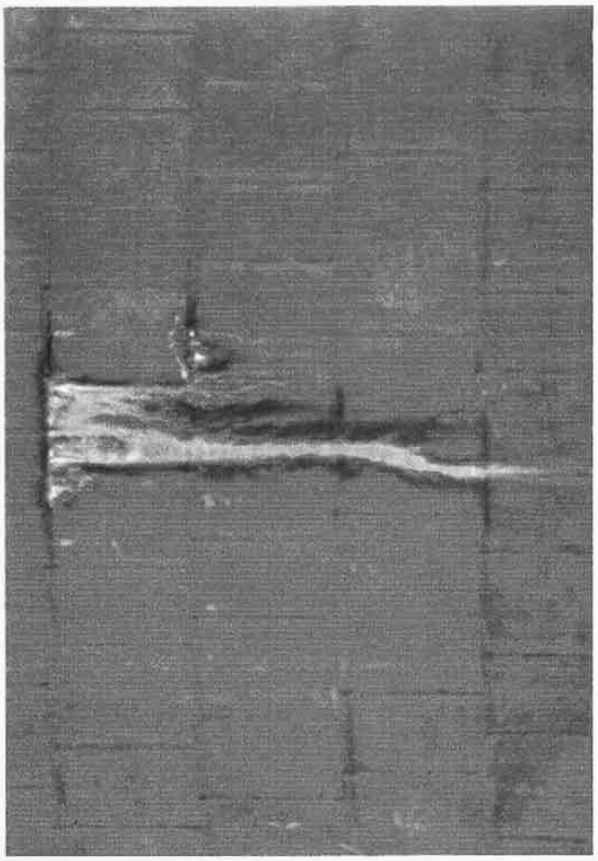
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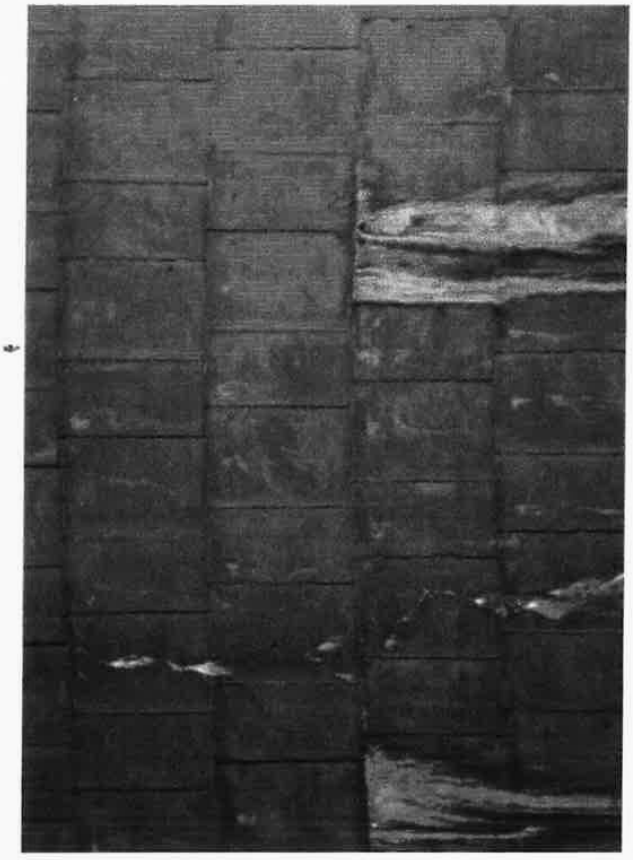
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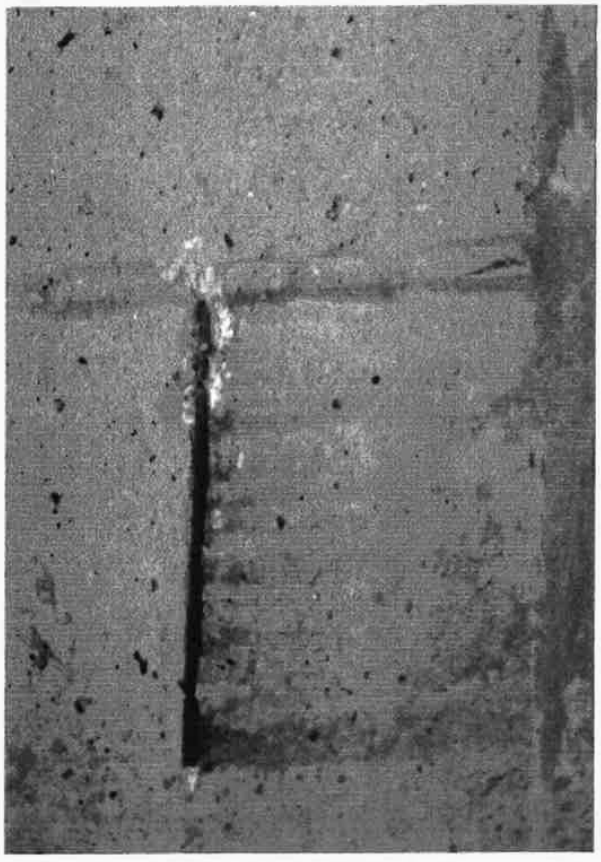
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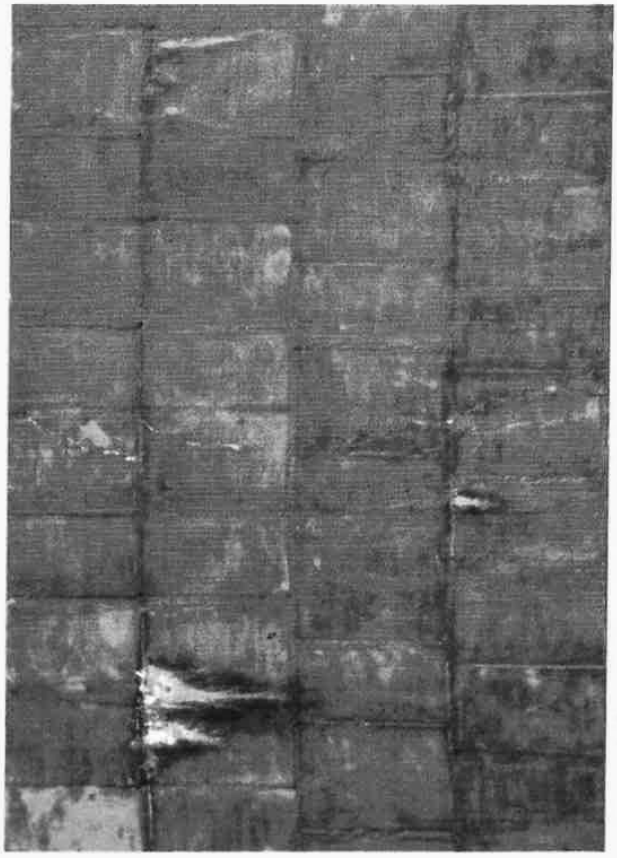

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AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
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SECTION VI — LINTELS, COLUMNS, PLINTHS AND BASIN

INSPECTION FINDINGS

Photographs no. 324 - 353 document typical conditions of the 32 lintel beam segment areas secured from the cold water basin within the tower. The bottom portion of the lintel beam shows signs of erosion and exposed aggregate exampled by photographs no. 324, 332, 336 and 338. Noted cracks in lintel are as follows: segment no. 1, photograph no. 325, exhibits a crack in the thickened portion of the lintel beam between the X-braces at the far right of the photograph; segment no. 14 has a reported crack stemming from a wall tie located just left of center in photograph no. 333; segment no. 15 exhibits a crack the full height of the lintel area shown just right of center in photograph no. 334; segment no. 22 has a reported crack that begins at the top of the lintel and extends vertically for one-half its height (photograph no. 341); segment no. 24 exhibits a crack in the thickened portion at the far right in photograph no. 344 and segment no. 26 exhibits a notable crack with efflorescence deposits as shown in photograph no. 346. Lintel beam segment areas no. 6 - 10 are not represented in this report by photographs due to film damage, however, the areas were reported to be relatively free from notable defects with exception to segment no. 9 which has a reported small, hairline crack. Also noted was the efflorescence deposits stemming from the wall tie areas as seen in most of this set of photographs.

Photographs no. 354 - 385 represent the 32 X-brace columns that were visually inspected from the cold water basin. Reports indicate the columns are in relatively good condition with exception to the following noted defects: X-brace no. 8 was found to have a hairline crack, difficult to see in photograph no. 361, however, this crack is reported to be on the top right leg of the brace just adjacent to the top crotch; X-brace no. 9 exhibits two (2)

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SECTION VI — LINTELS, COLUMNS, PLINTHS AND BASIN

INSPECTION FINDINGS

cracks stemming from the upper crotch of the support with deposits forming on these areas as seen in photograph no. 362; X-brace no. 10 is reported to have three (3) cracks also starting from the top crotch area with similar deposit formation and one (1) small spalled area to the below-left as seen in photograph no. 363; X-brace no. 12 is noted to have one (1) crack from top crotch with deposits, see photograph no. 365; X-brace no. 14 exhibits crack/deposits at upper crotch, crack running right side of top column and small rock pocket below as seen in photograph no. 367; X-brace no. 27 reported to have similar pattern crack and deposits at left side of upper crotch, photograph no. 380; and X-brace no. 28 is noted to have a crack stemming from a void as seen in photograph no. 381.

Photographs no. 386 - 391 document typical expansion joint condition findings for the cold water basin floor and at the divider wall. In general, all expansion joints inspected were found to be hard, brittle and non-functional per their intended purpose. Photograph no. 388 is included to show the extensive silt removal operation in process during the time of the inspection.

The remainder of the photographs are numbers 392 - 425 and depict the condition of the plinth/column support pedestals. Through visual inspection, hammer testing and as can be seen in the photographs, these areas appeared to be sound and no detrimental defects were reported.

Pullman Power Products Corporation

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OHIO POWER COMPANY
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SECTION VII — LINTEL, COLUMNS, PLINTHS AND BASIN

Photograph Index

Photograph No.	Location
324	Lintel Section No. 1
325	Lintel Section No. 1
326	Lintel Section No. 2
327	Lintel Section No. 3
328	Lintel Section No. 4
329	Lintel Section No. 5
330	Lintel Section No. 11
331	Lintel Section No. 12
332	Lintel Section No. 13
333	Lintel Section No. 14
334	Lintel Section No. 15
335	Lintel Section No. 16
336	Lintel Section No. 17
337	Lintel Section No. 18
338	Lintel Section No. 19
339	Lintel Section No. 20
340	Lintel Section No. 21
341	Lintel Section No. 22
342	Lintel Section No. 23
343	Lintel Section No. 23
344	Lintel Section No. 24
345	Lintel Section No. 25
346	Lintel Section No. 26
347	Lintel Section No. 27
348	Lintel Section No. 28
349	Lintel Section No. 29
350	Lintel Section No. 30
351	Lintel Section No. 31
352	Lintel Section No. 32
353	Lintel Section No. 32

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SECTION VII — LINTEL, COLUMNS, PLINTHS AND BASIN

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380	X-Brace Column No. 27
381	X-Brace Column No. 28
382	X-Brace Column No. 29
383	X-Brace Column No. 30
384	X-Brace Column No. 31
385	X-Brace Column No. 32
386	Divider Wall Expansion Joint, Looking South
387	Divider Wall Expansion Joint, Looking North
388	Between Plinths No. 25 and 26
389	Typical Basin Floor Expansion Joint South of Divider Wall
390	Typical Basin Floor Expansion Joint South of Divider Wall
391	Typical Basin Floor Expansion Joint South of Divider Wall
392	Plinth No. 1
393	Plinth No. 2
394	Plinth No. 3
395	Plinth No. 3
396	Plinth No. 4
397	Plinth No. 5
398	Plinth No. 6
399	Plinth No. 7
400	Plinth No. 8
401	Plinth No. 9
402	Plinth No. 10
403	Plinth No. 11
404	Plinth No. 12
405	Plinth No. 12

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Photograph Index

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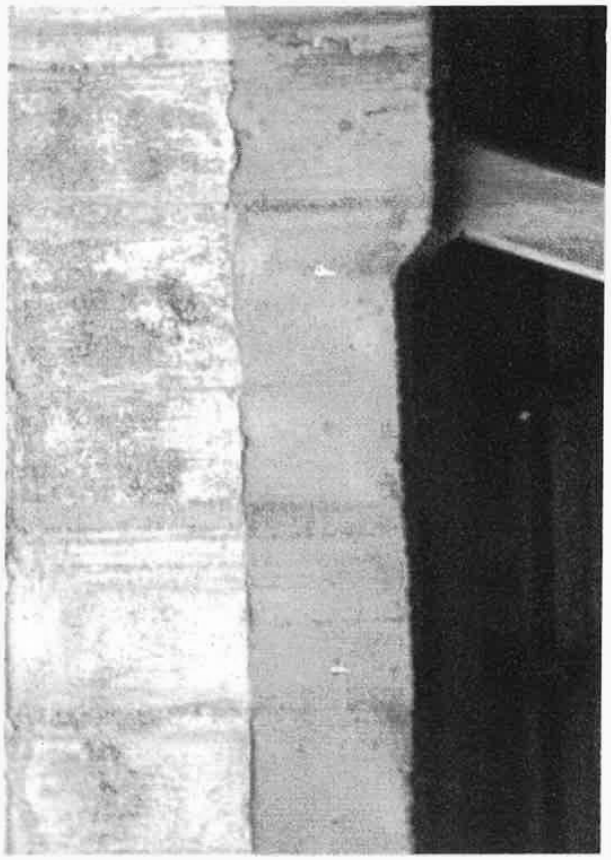
407	Plinth No. 14
408	Plinth No. 15
409	Plinth No. 16
410	Plinth No. 17
411	Plinth No. 18
412	Plinth No. 19
413	Plinth No. 20
414	Plinth No. 21
415	Plinth No. 22
416	Plinth No. 23
417	Plinth No. 24
418	Plinth No. 25
419	Plinth No. 26
420	Plinth No. 27
421	Plinth No. 28
422	Plinth No. 29
423	Plinth No. 30
424	Plinth No. 31
425	Plinth No. 32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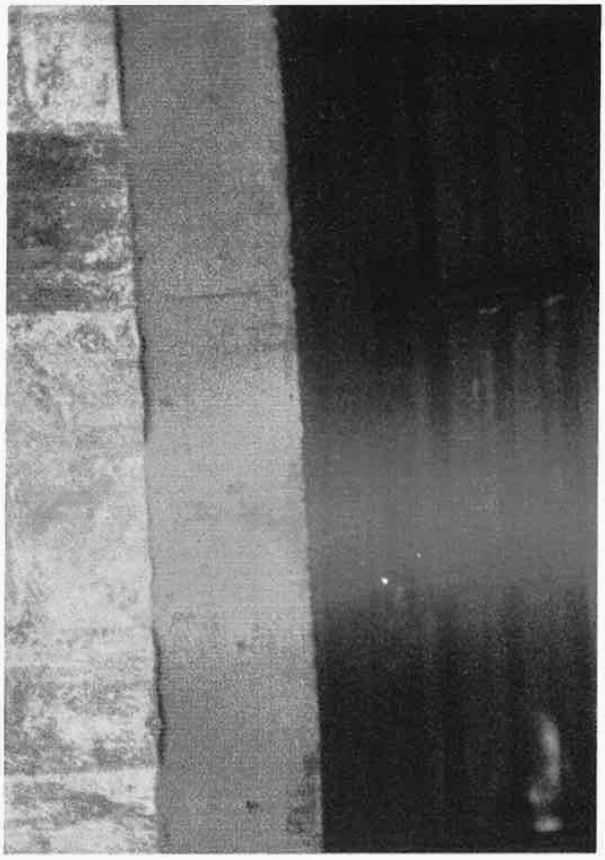
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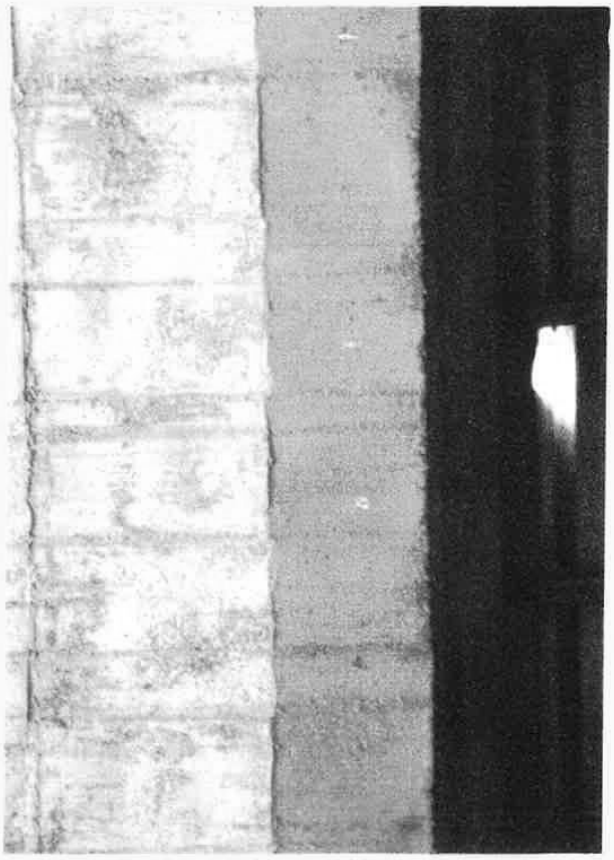
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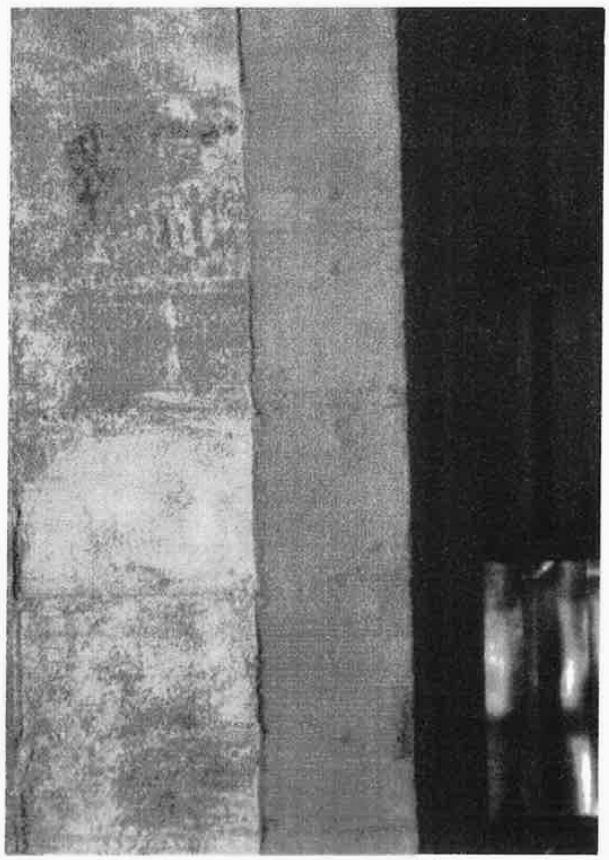
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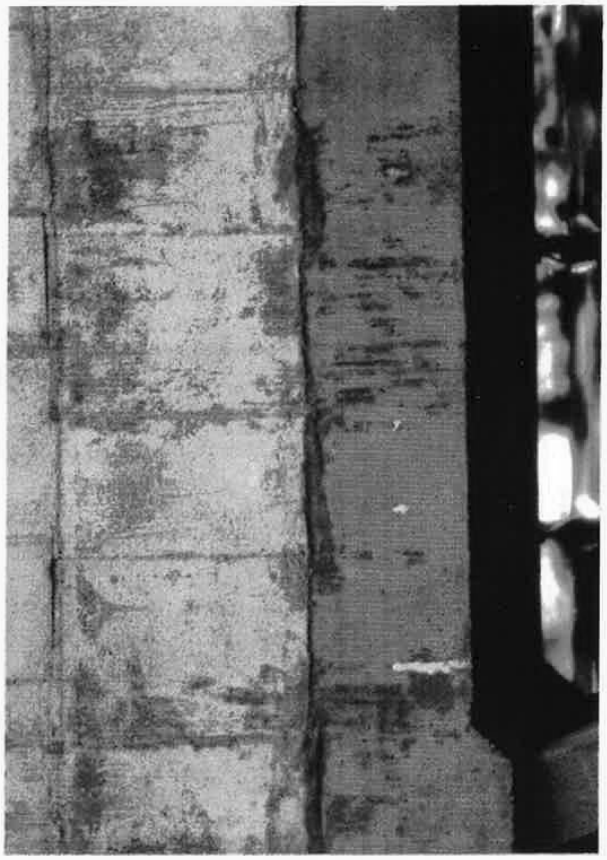
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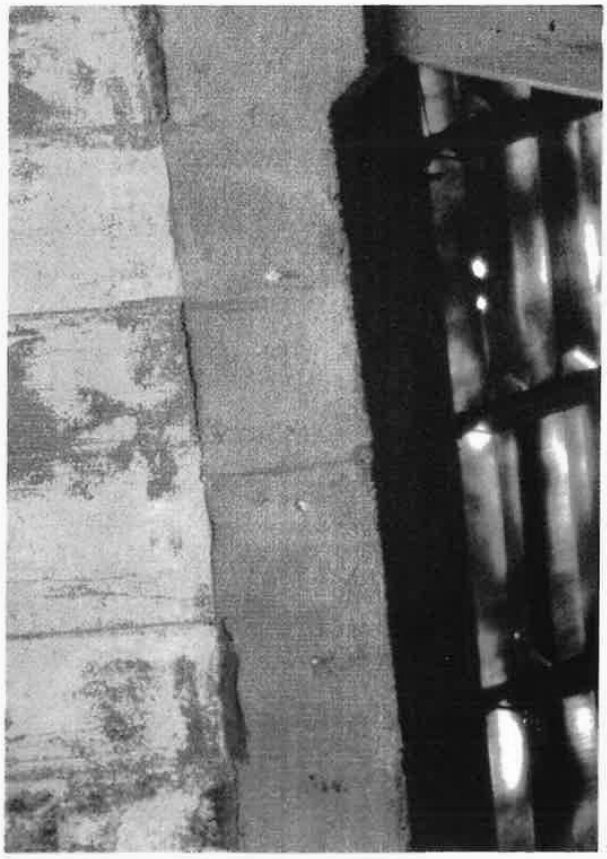
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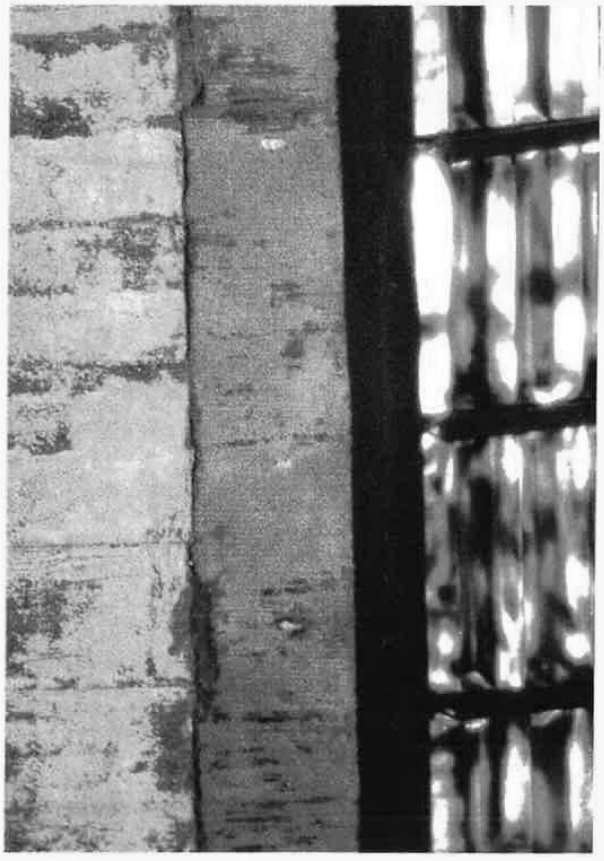
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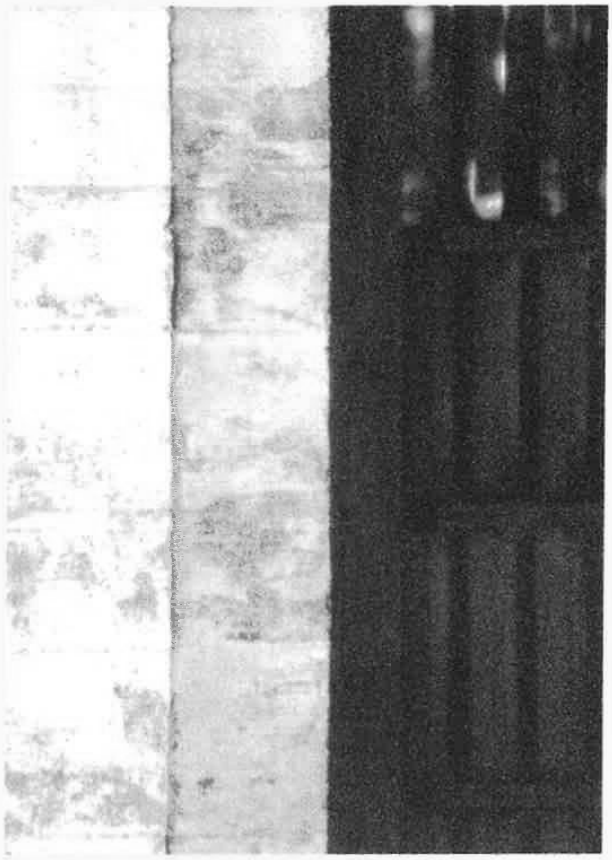
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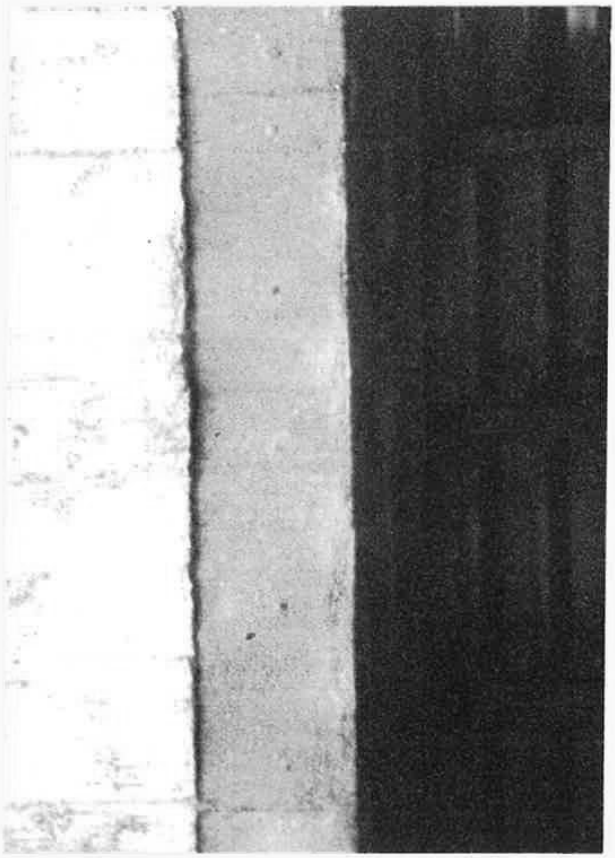
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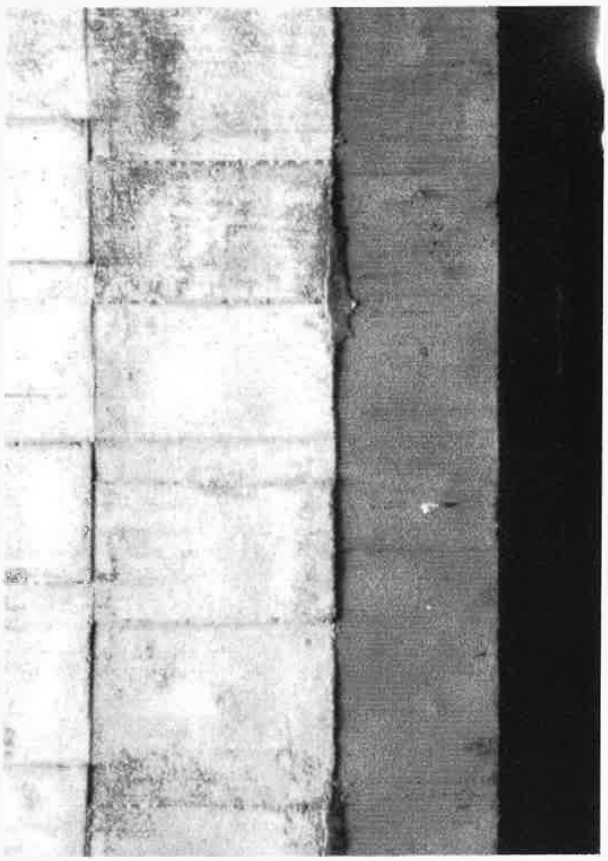
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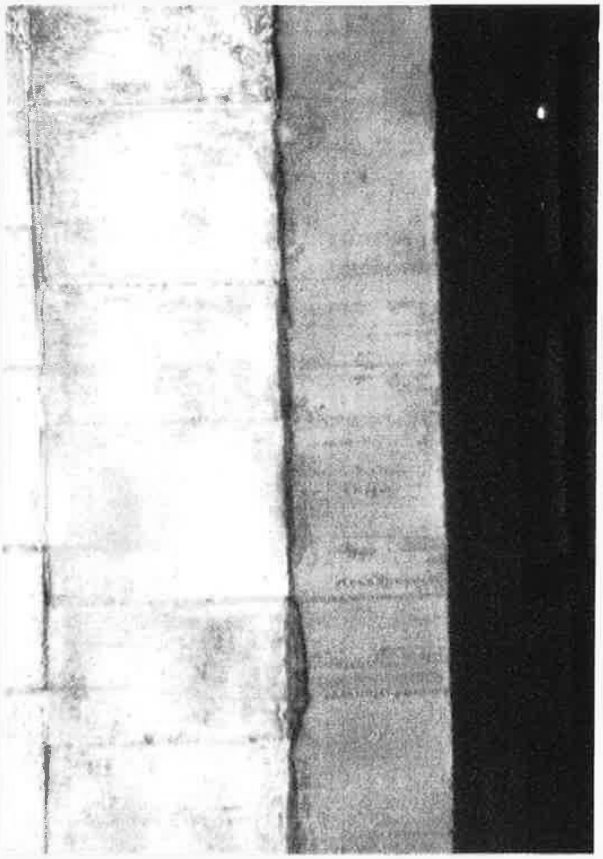
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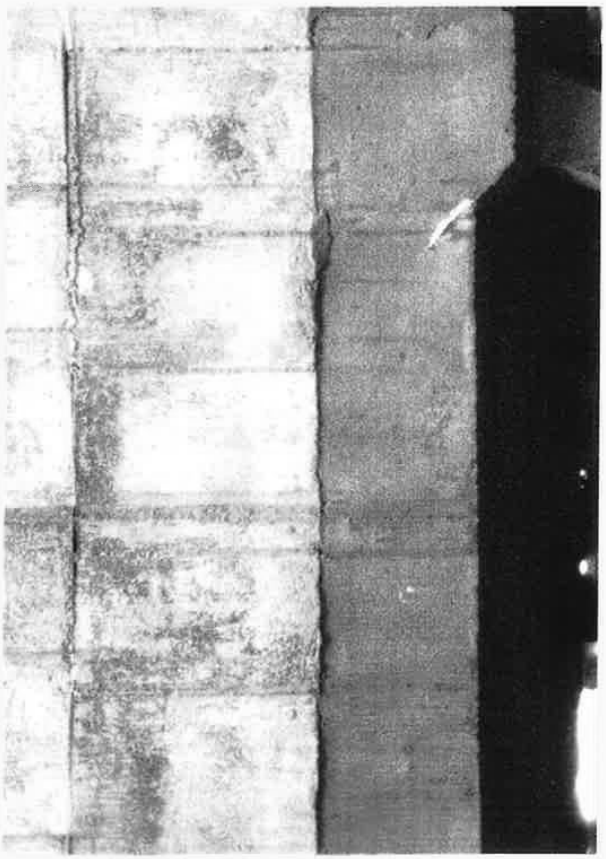
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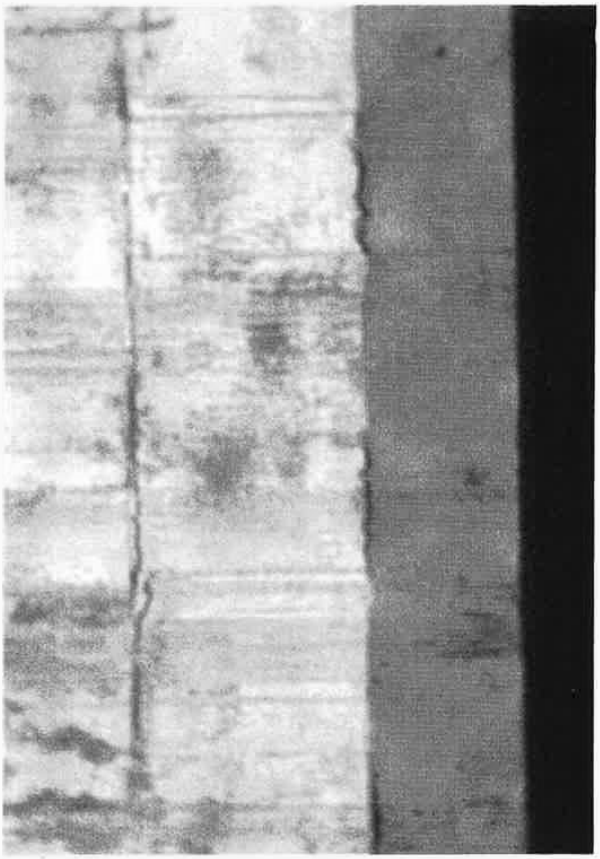
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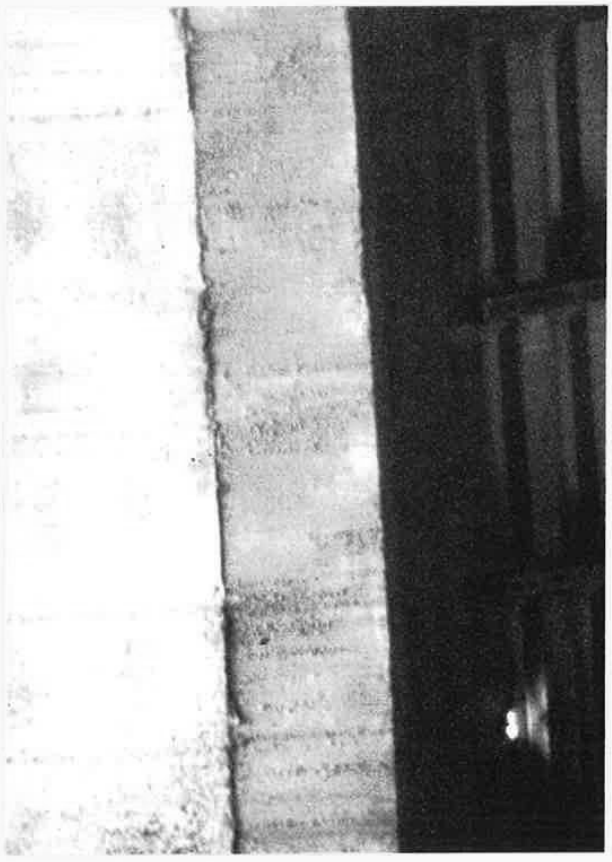
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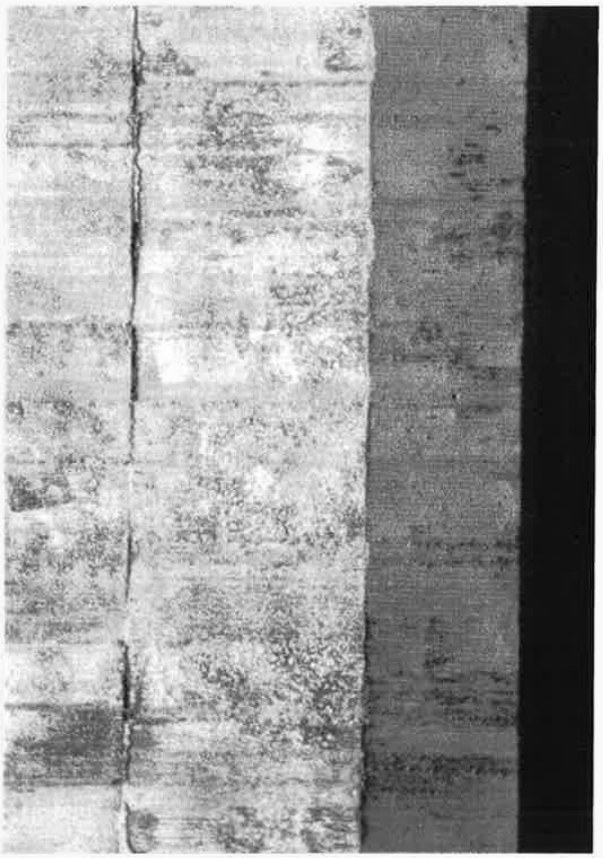
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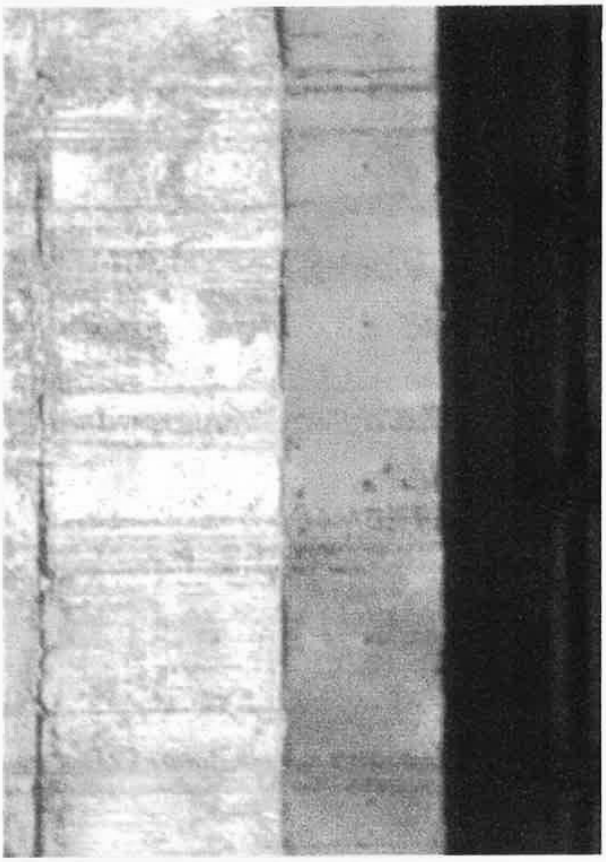

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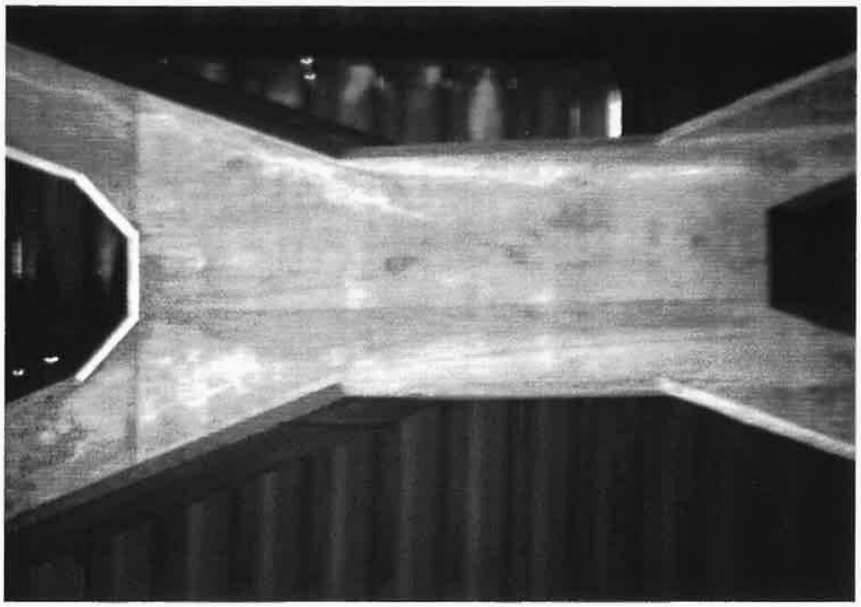

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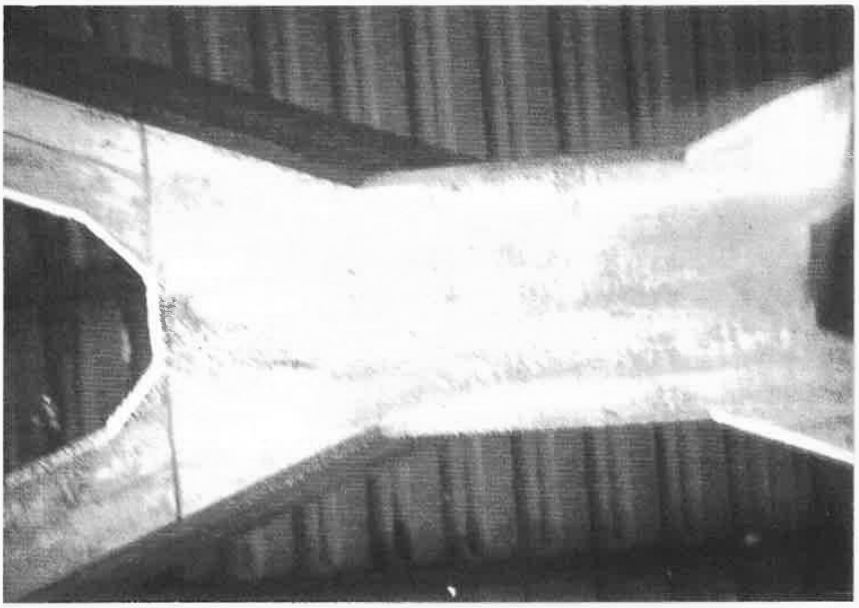

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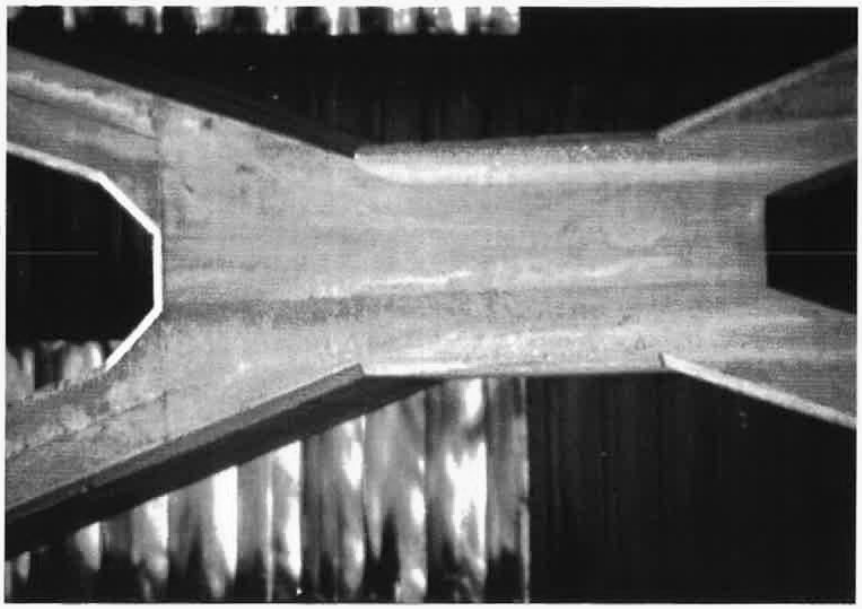

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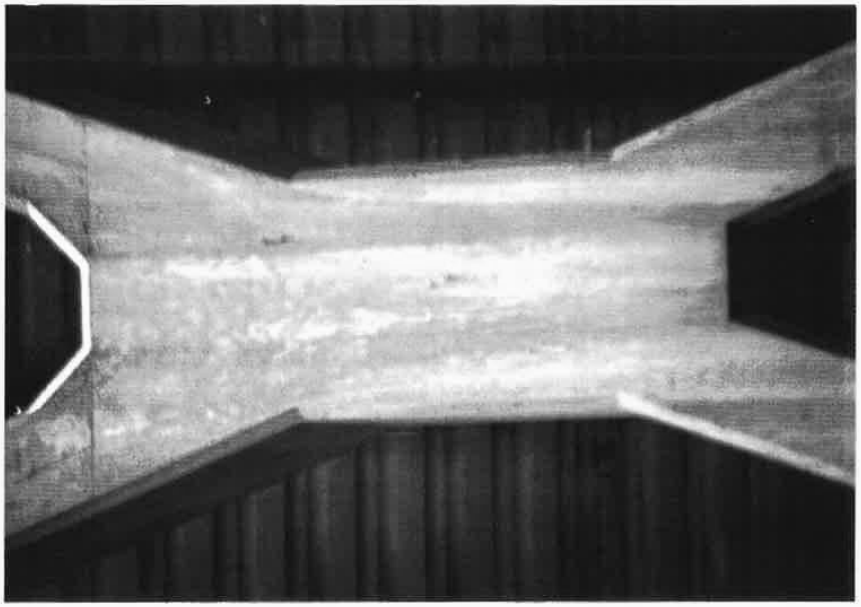

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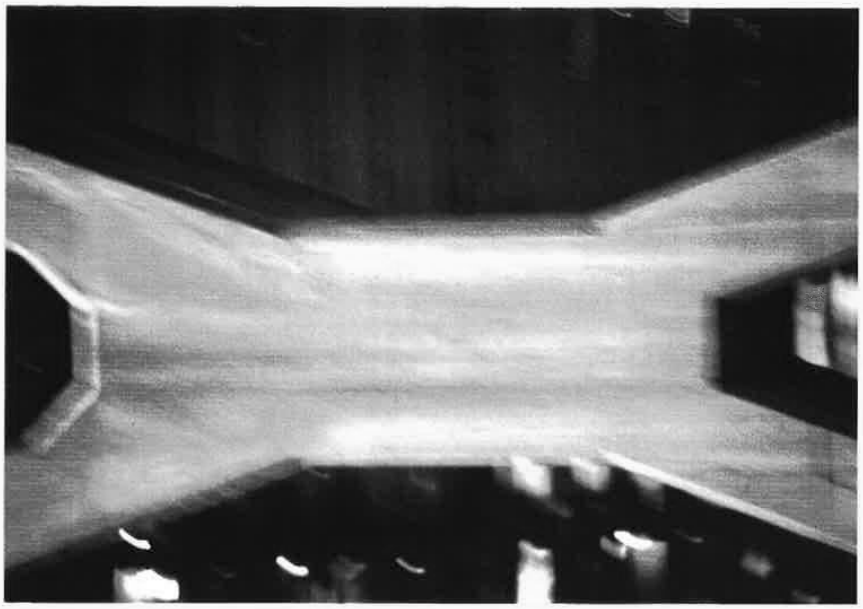

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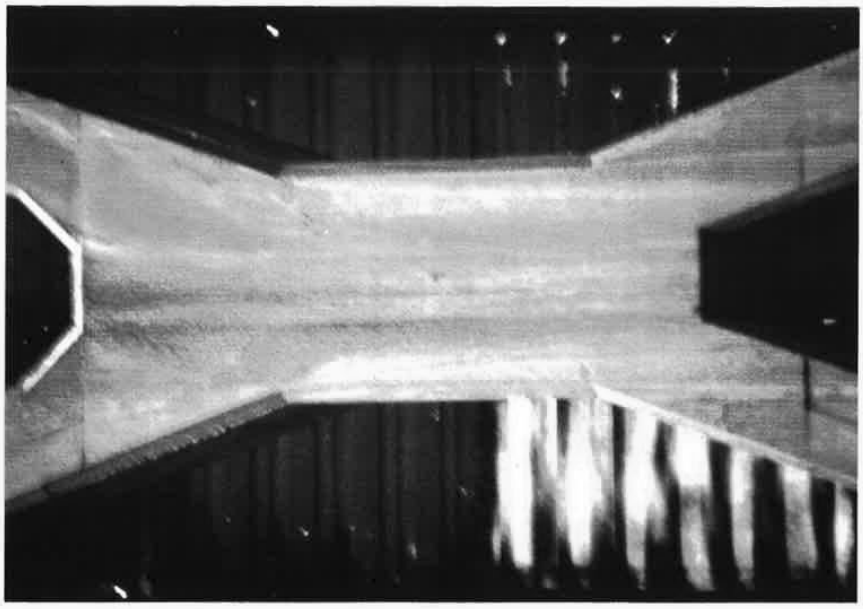

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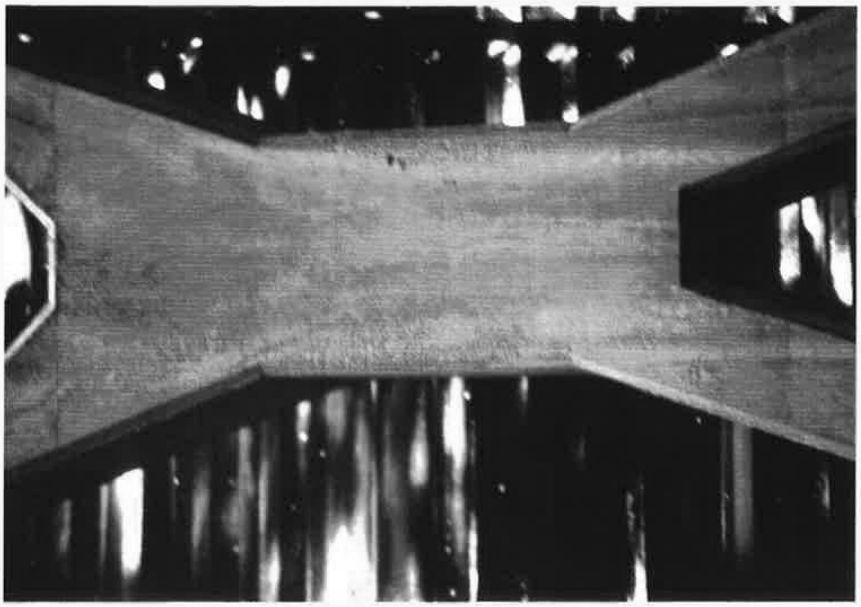

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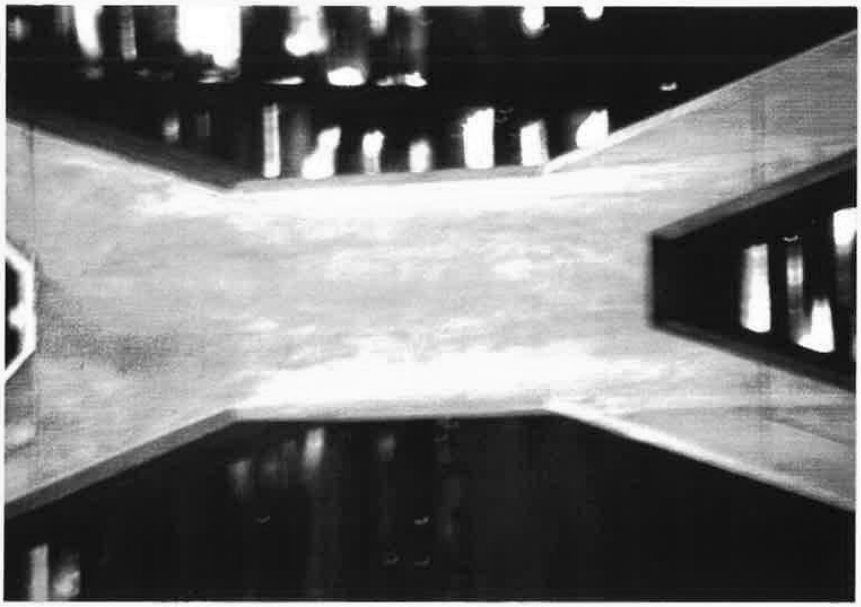

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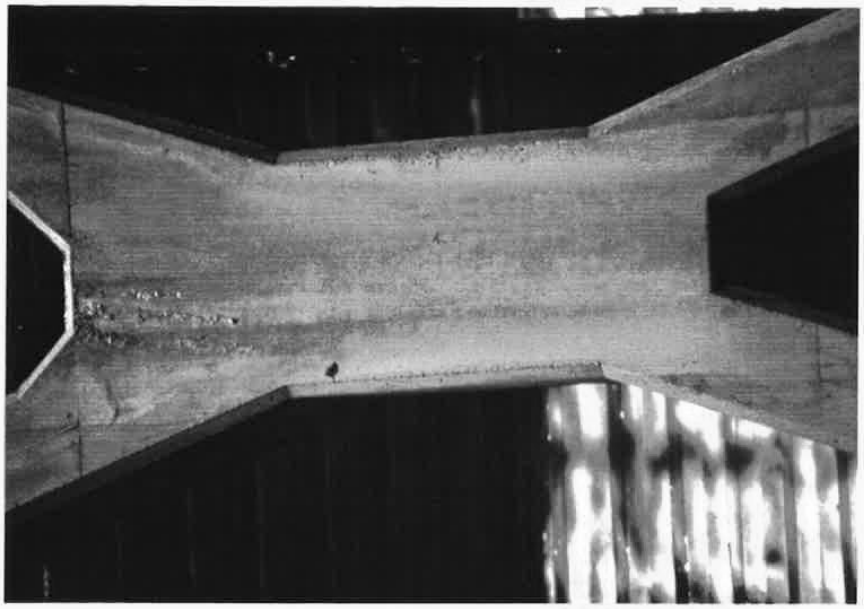
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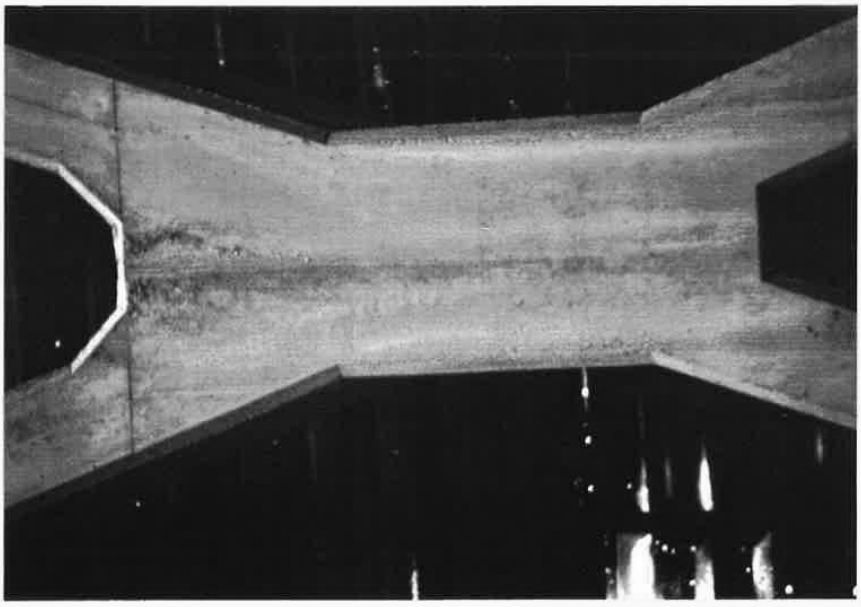
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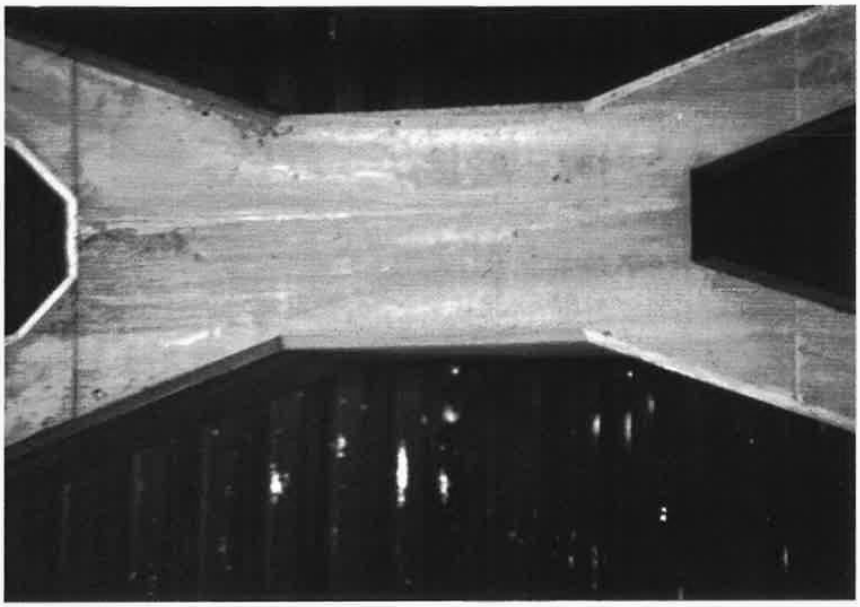

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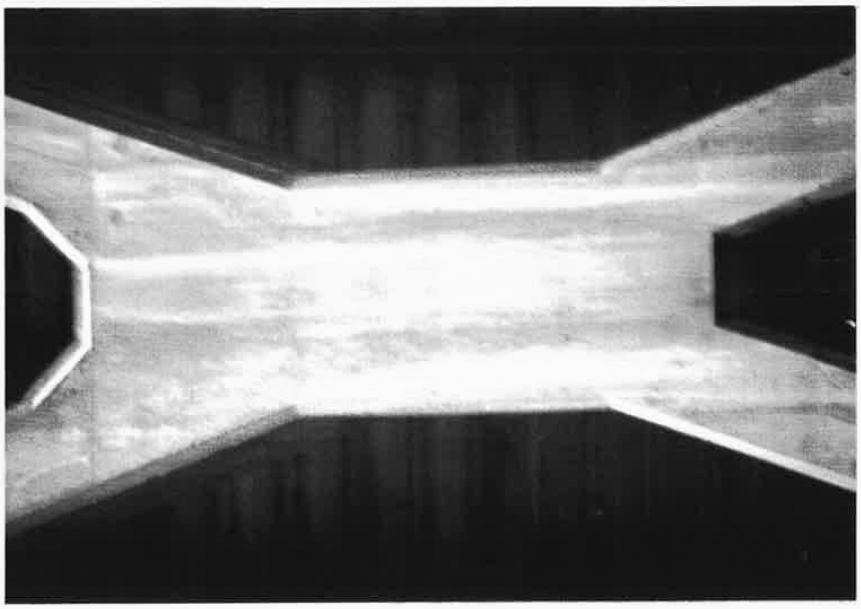

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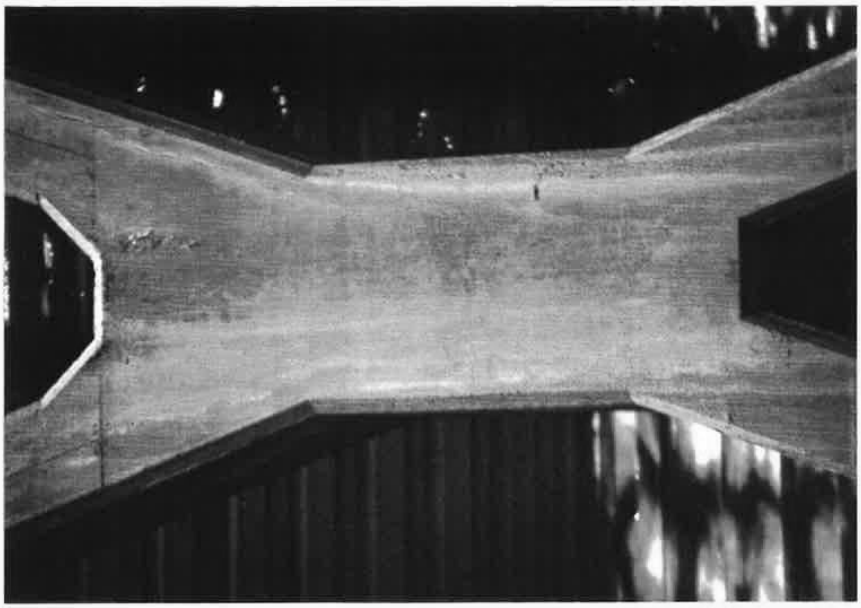

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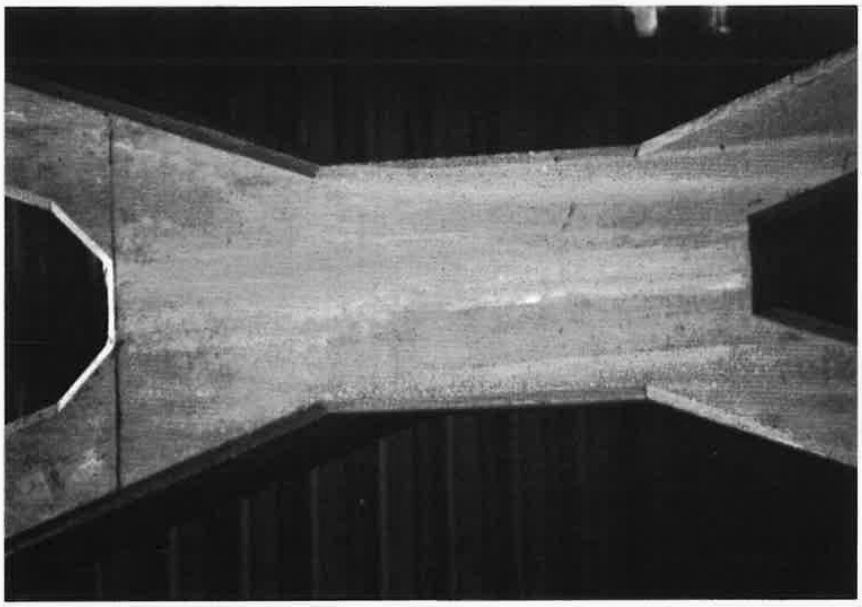

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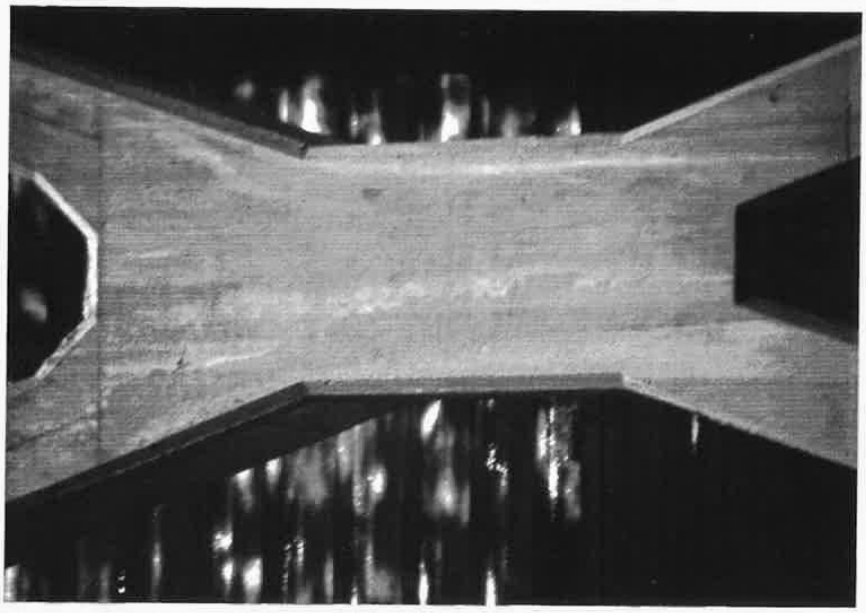

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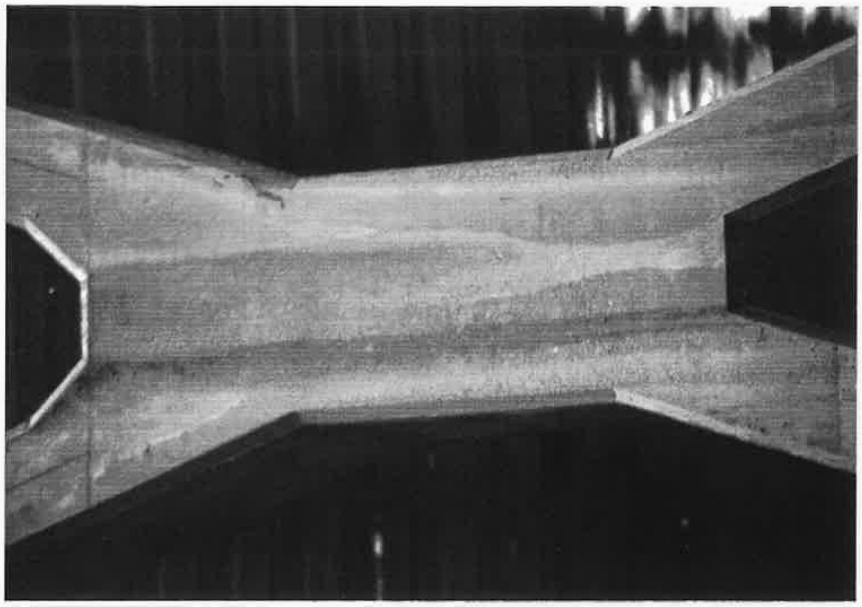

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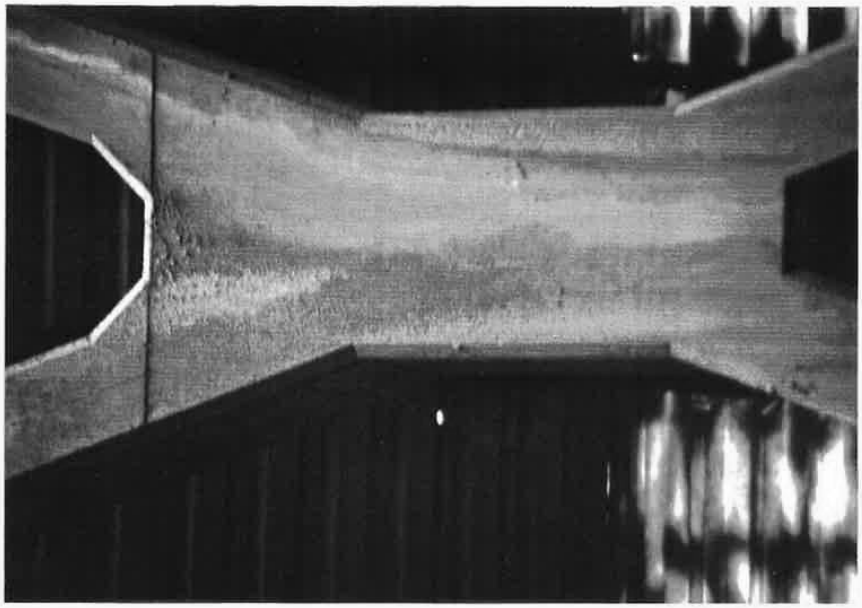

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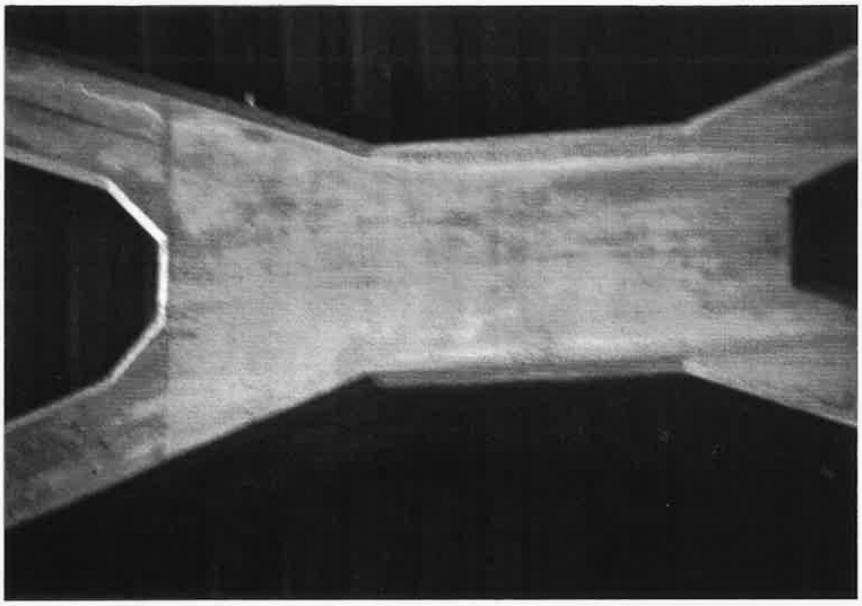

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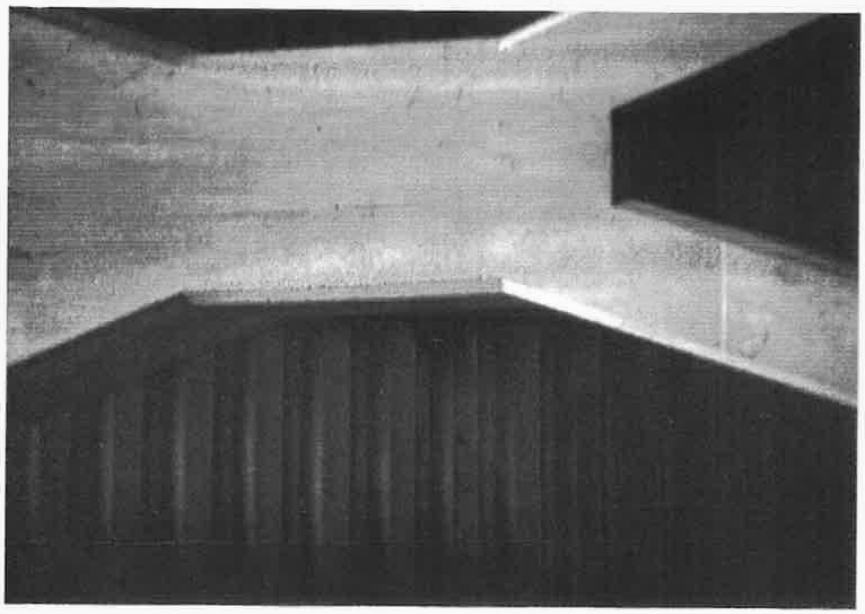

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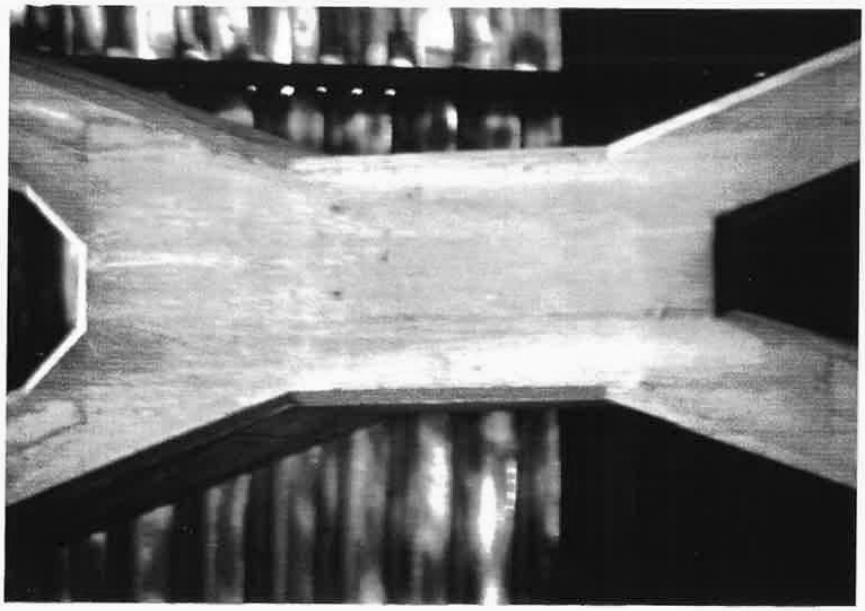

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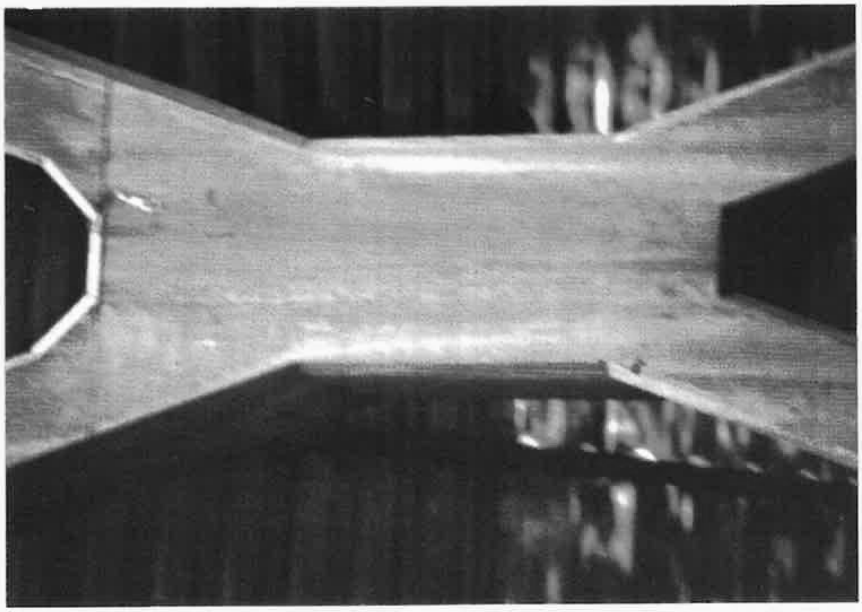

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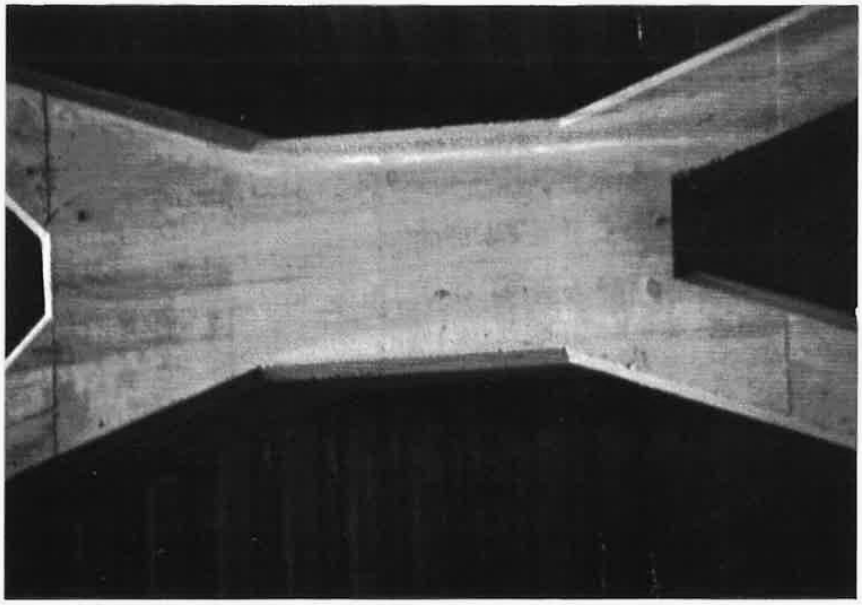

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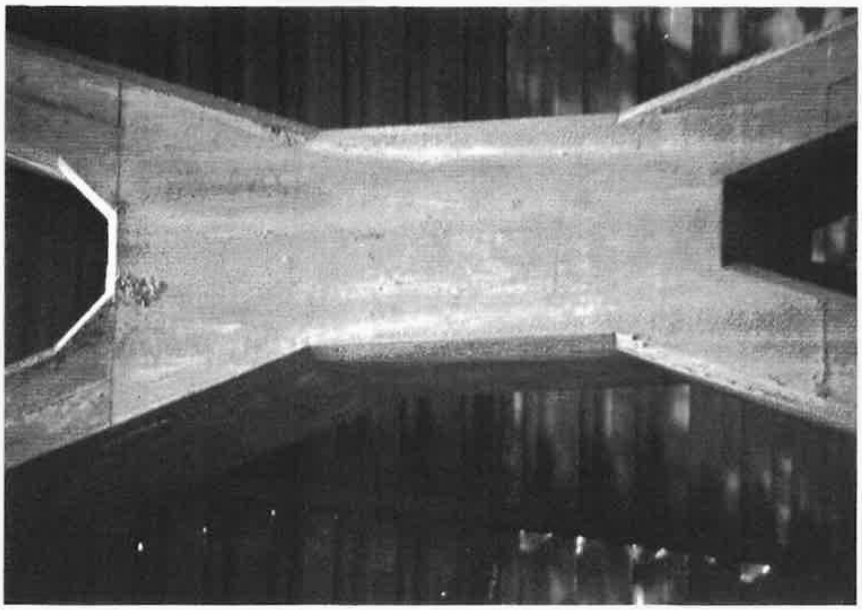

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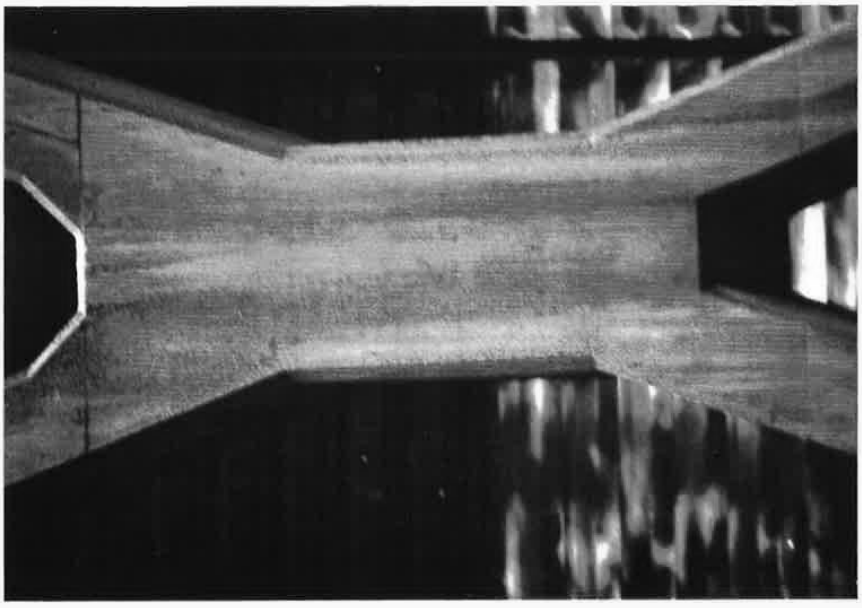

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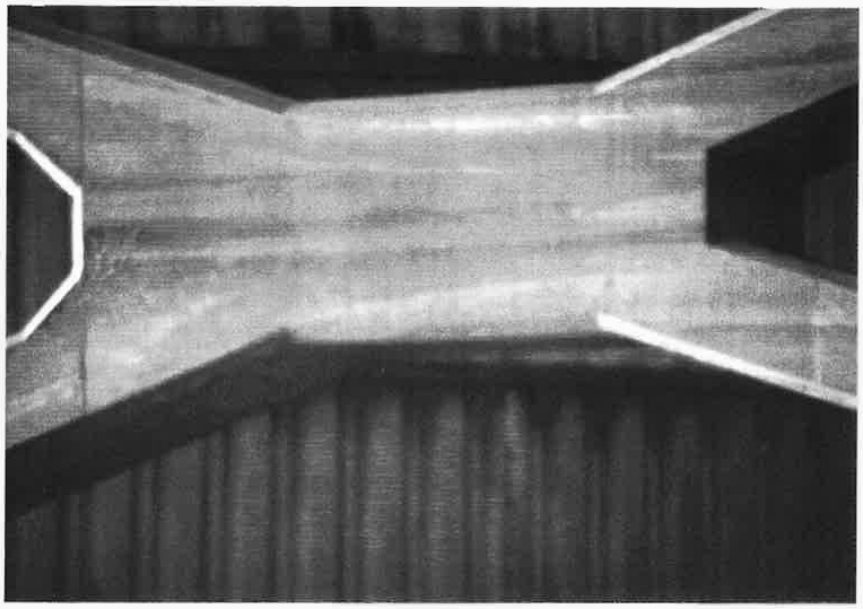

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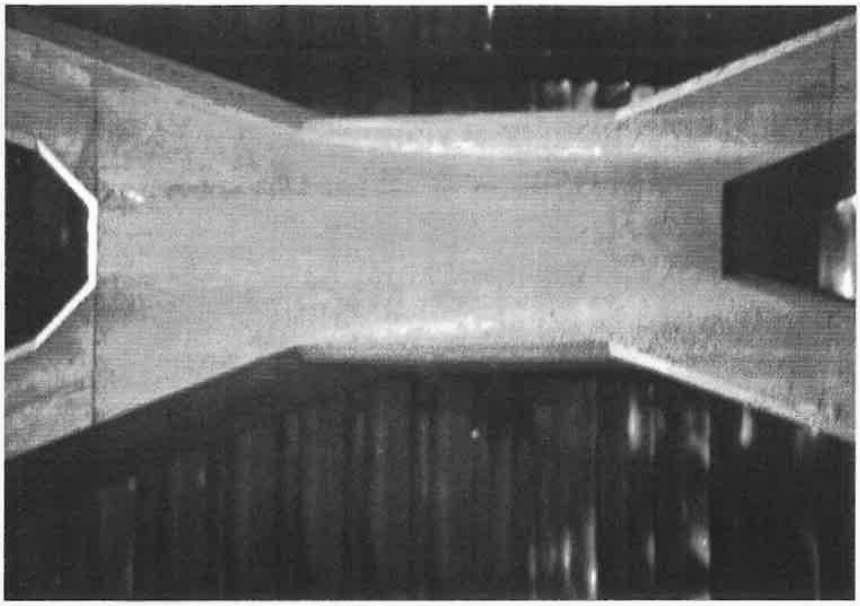

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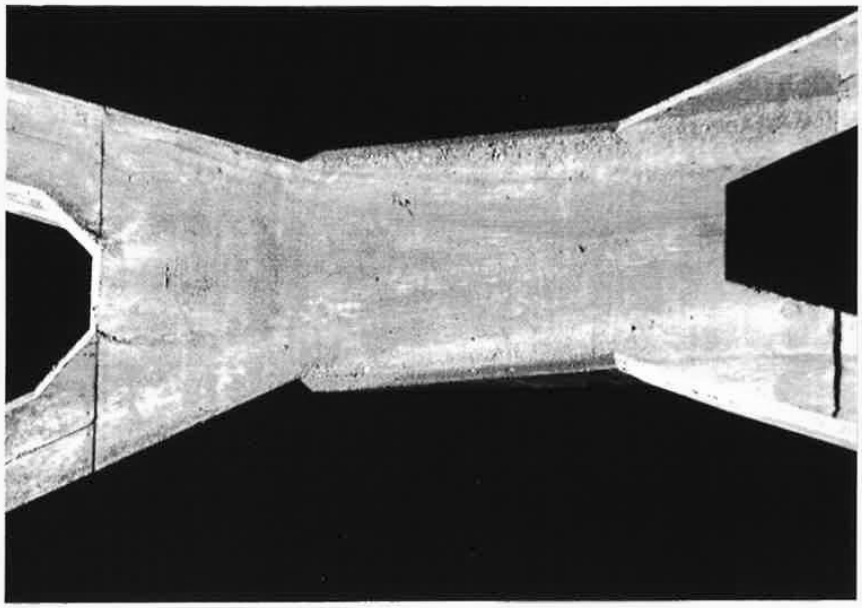

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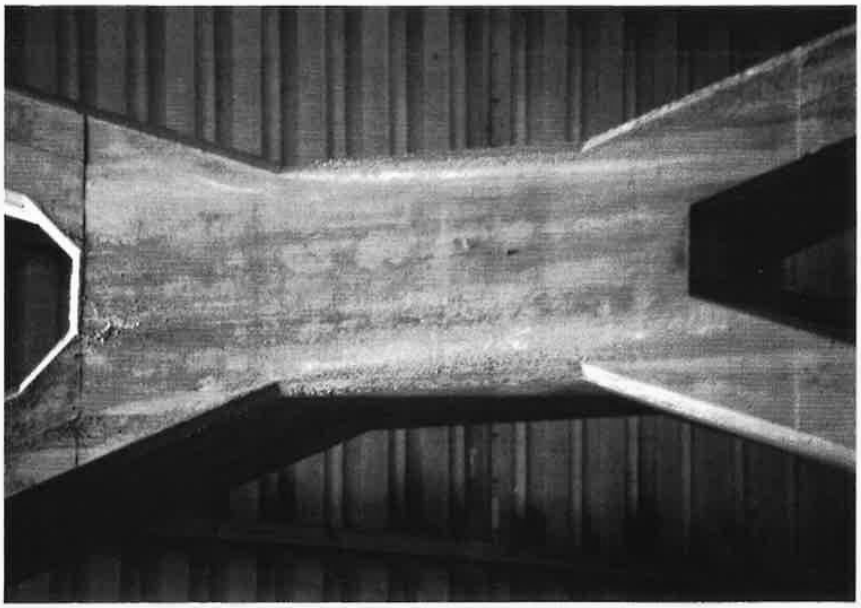

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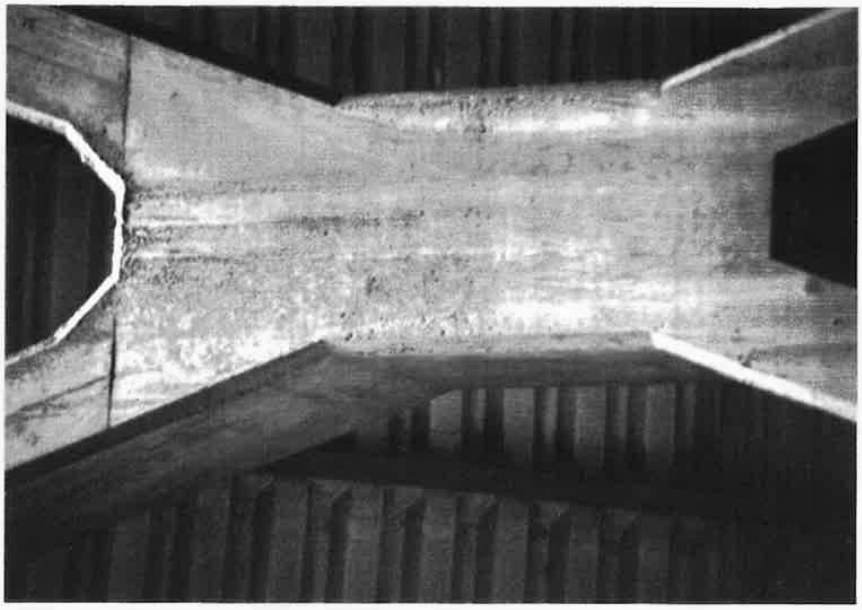

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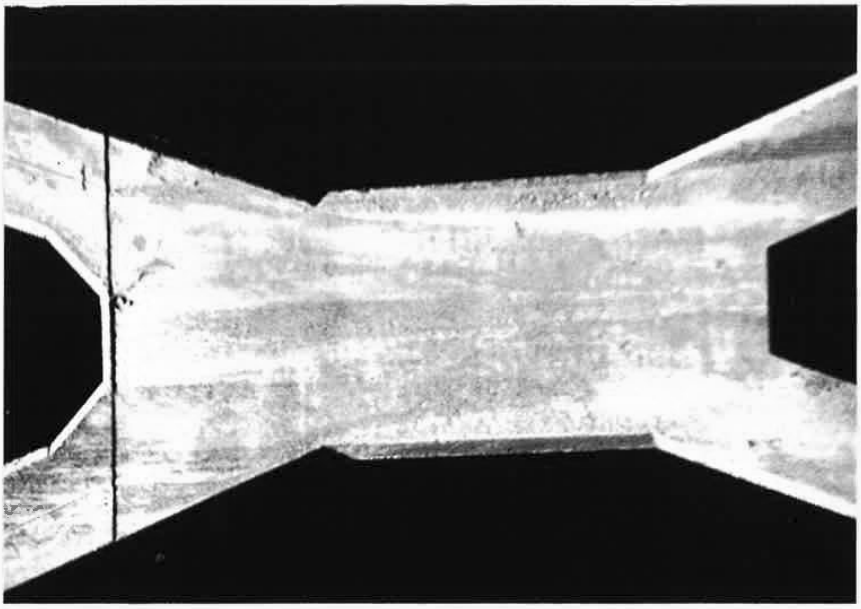

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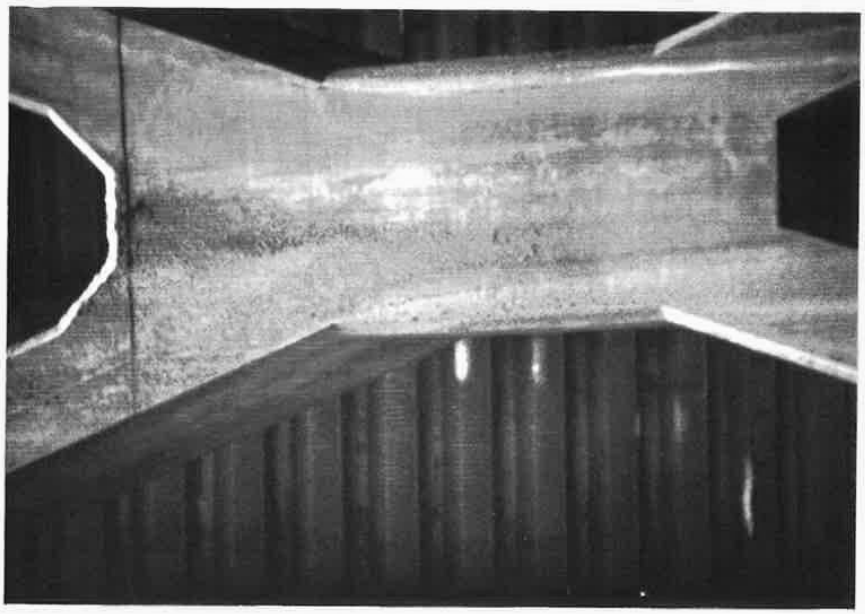

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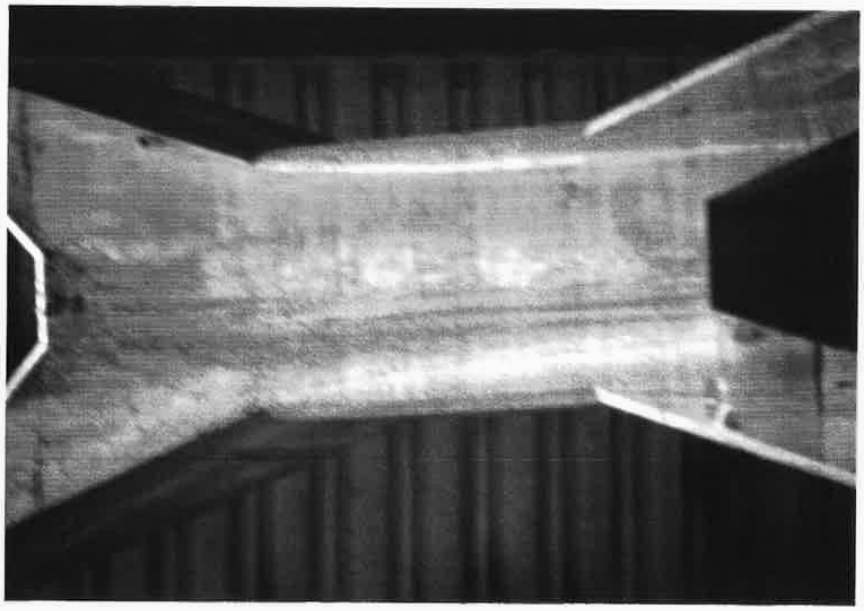

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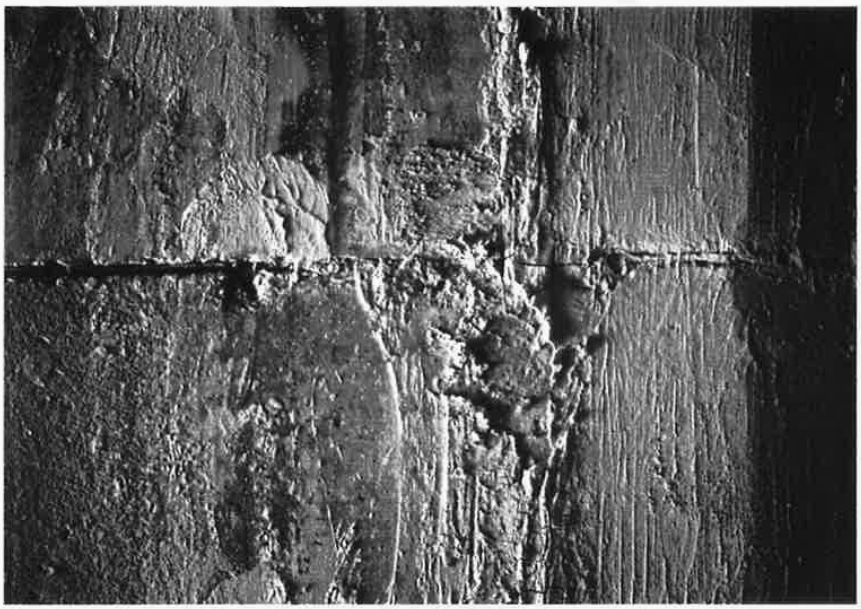

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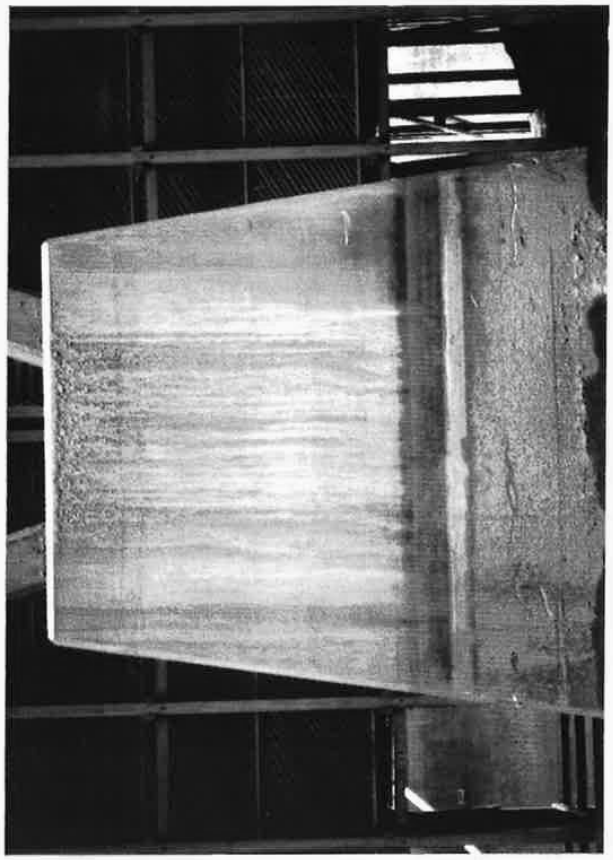

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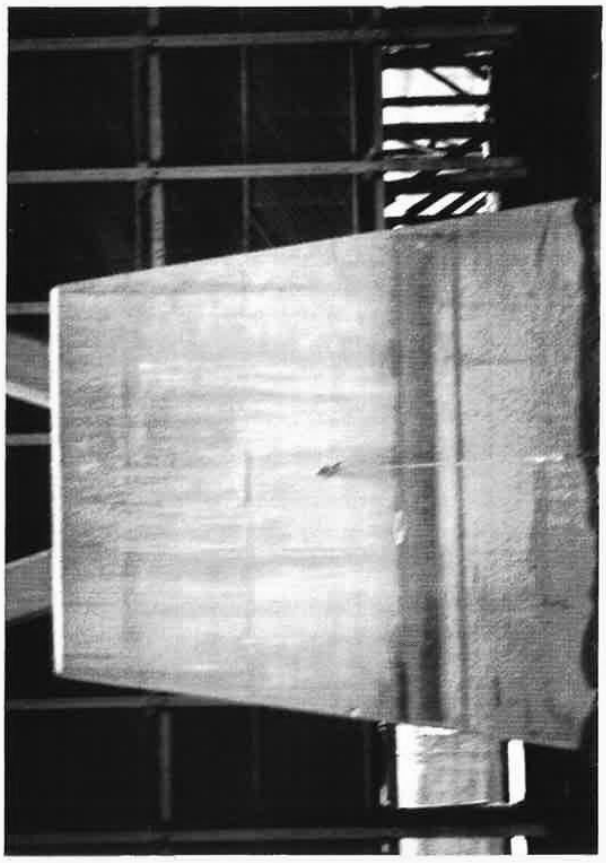

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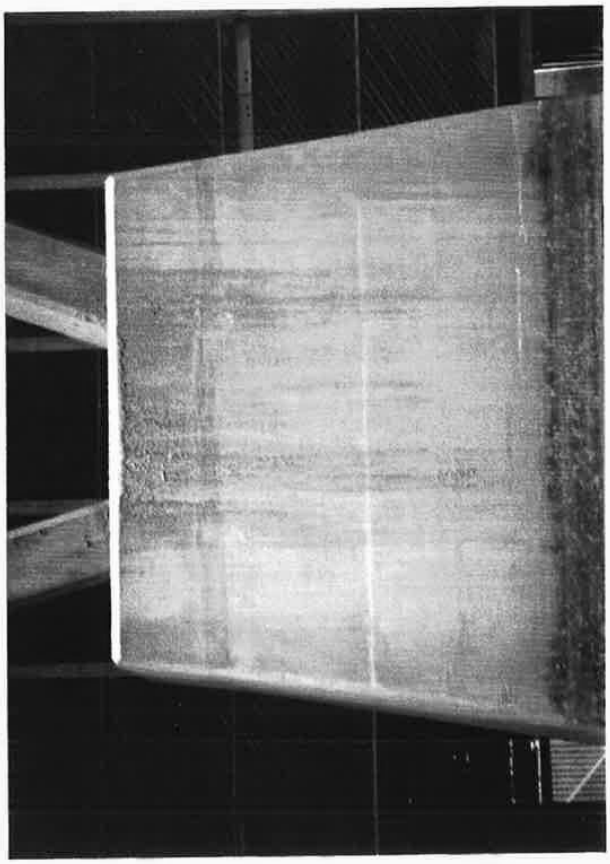

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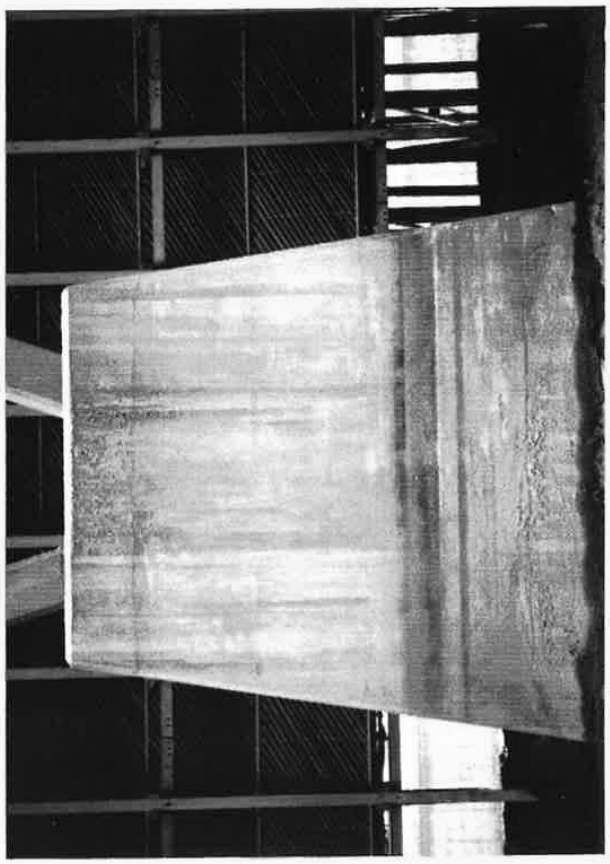

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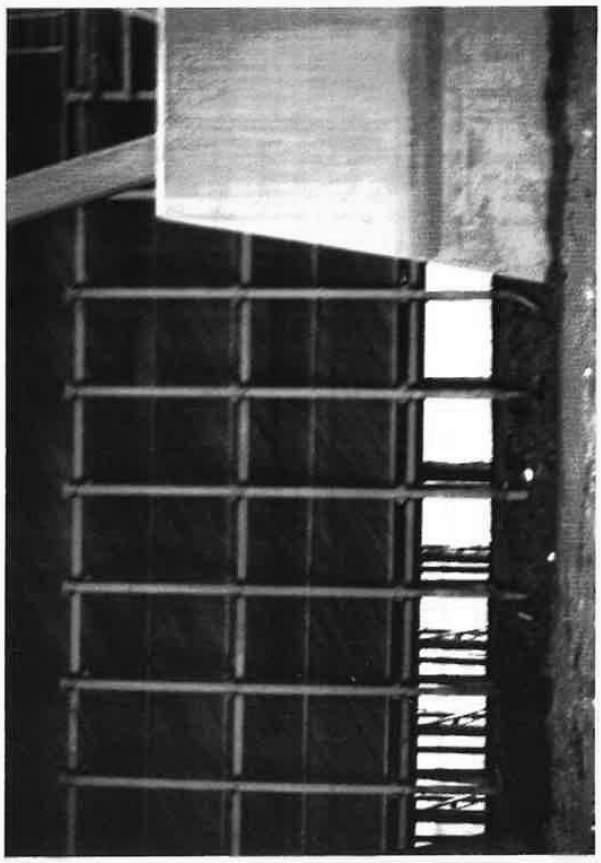

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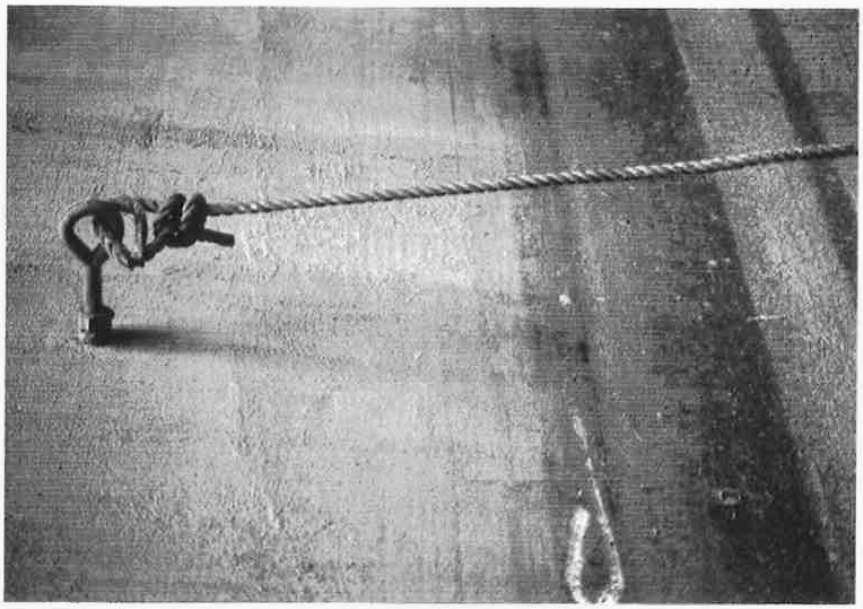

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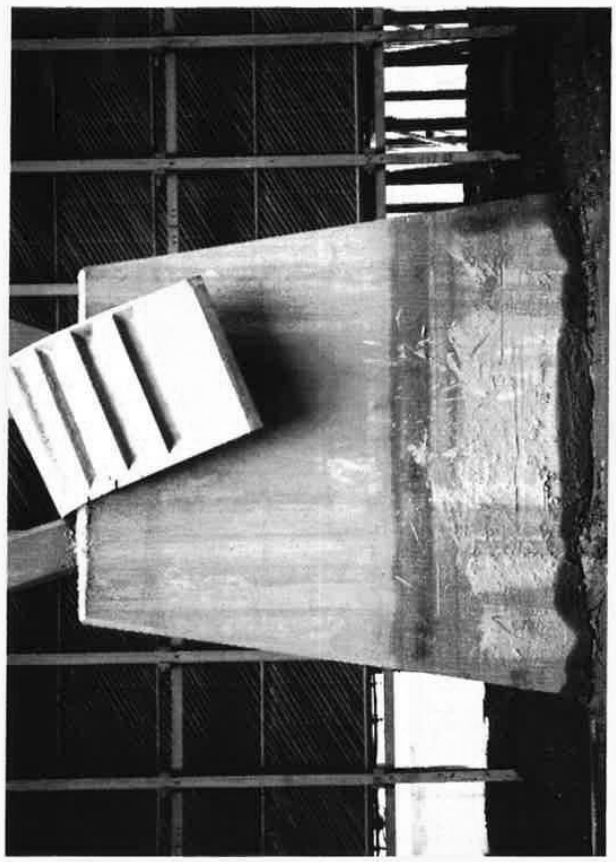

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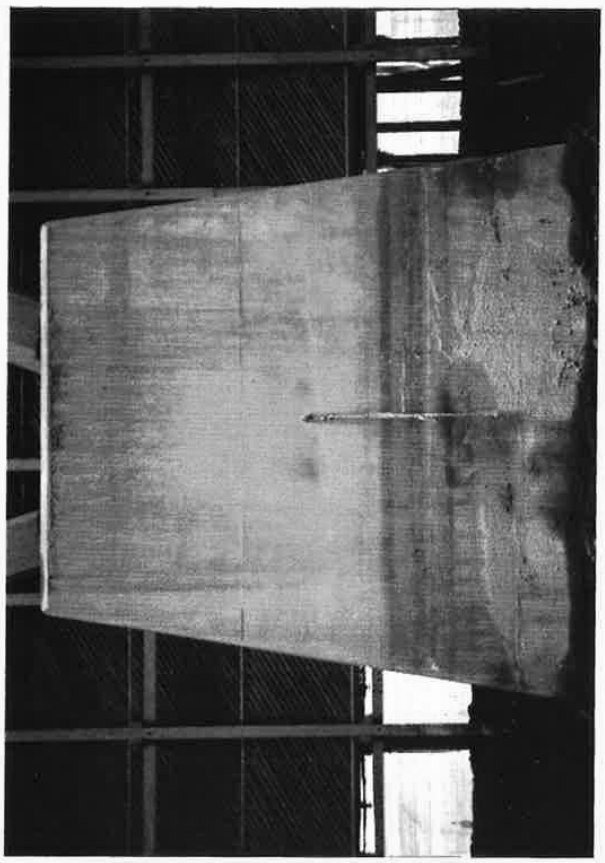

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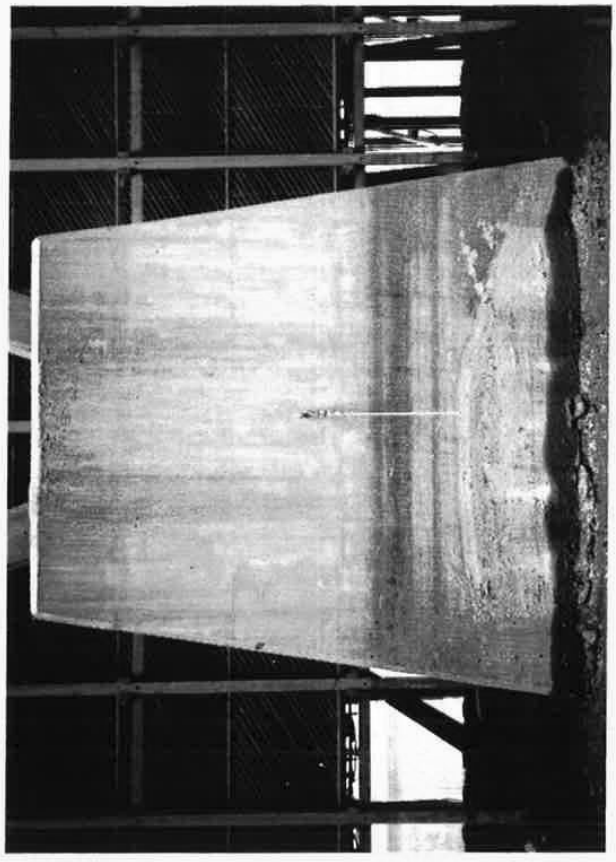

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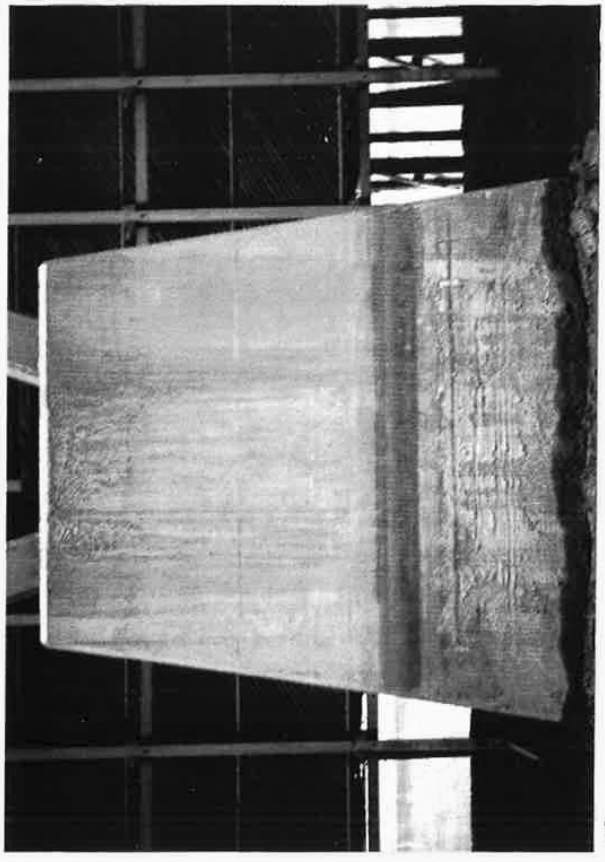

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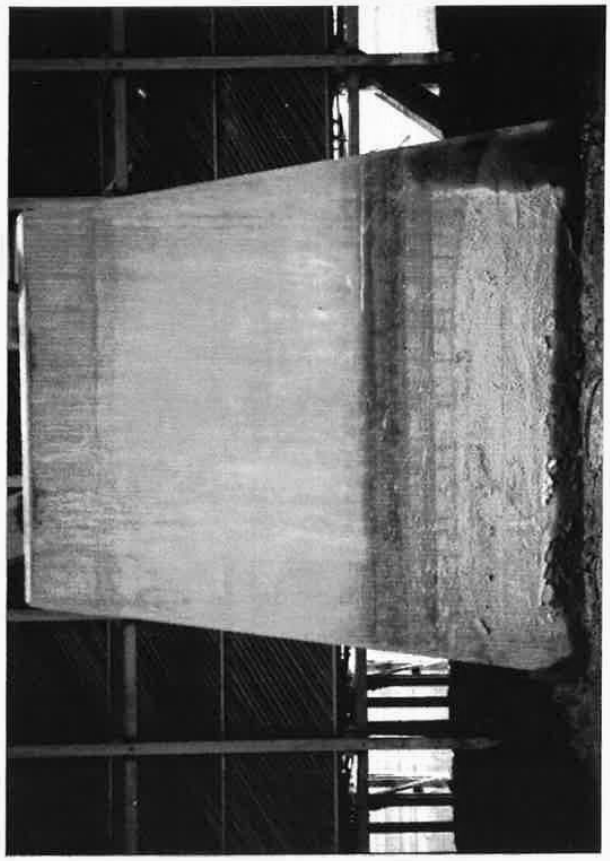
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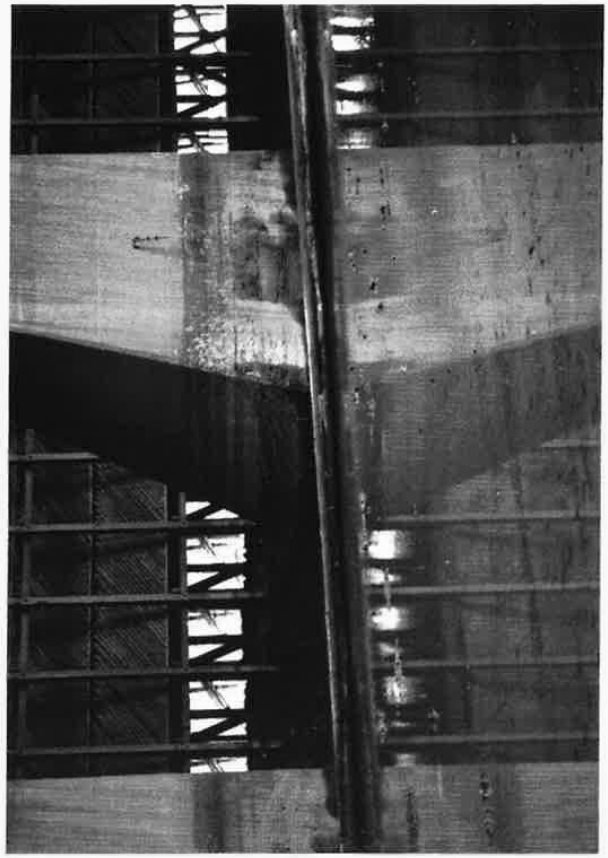
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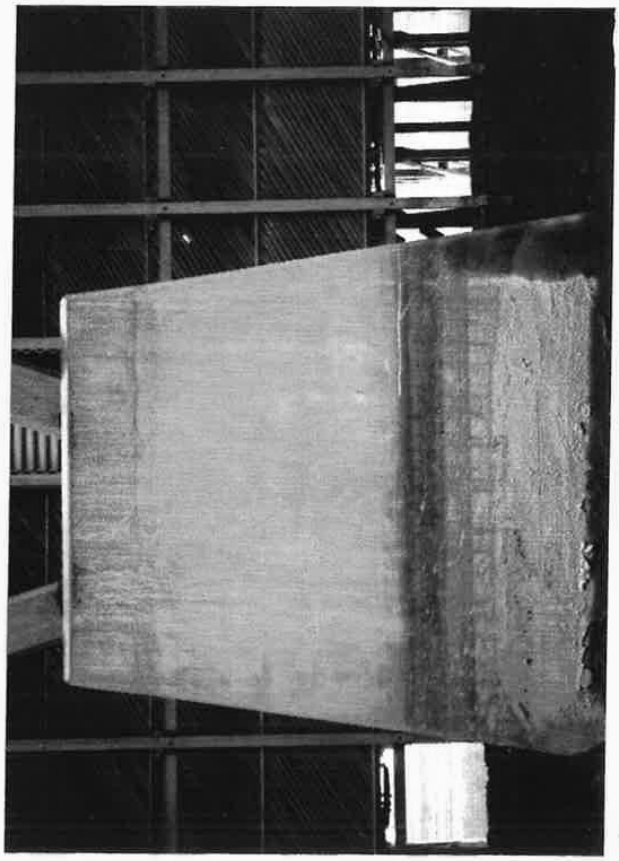
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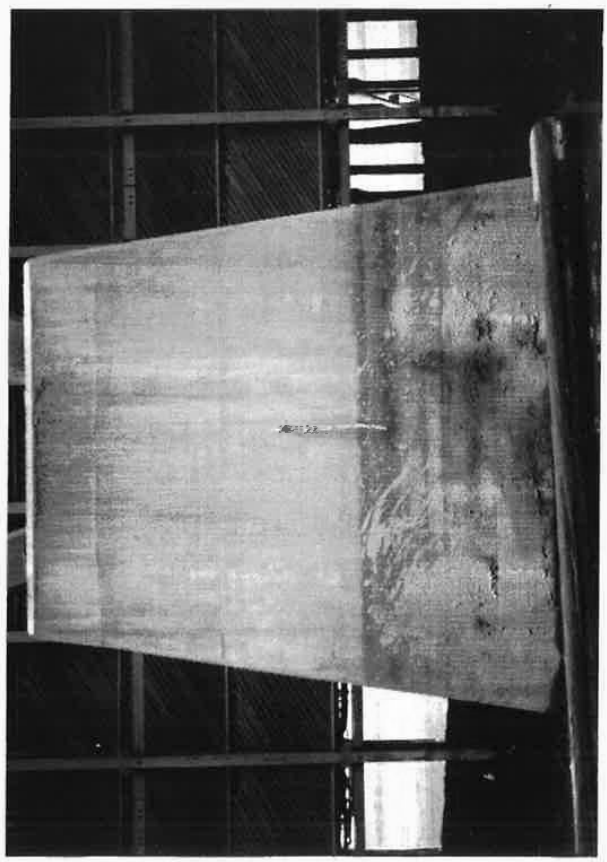
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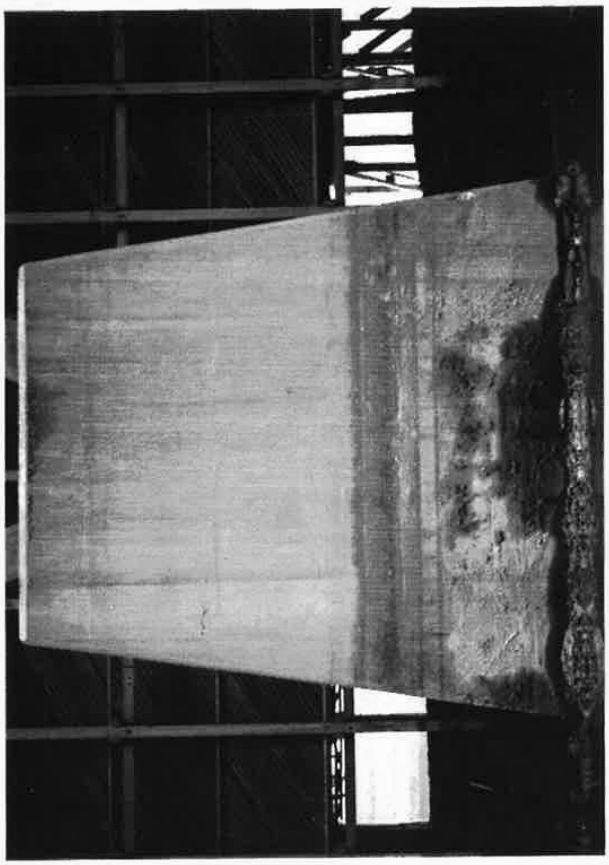
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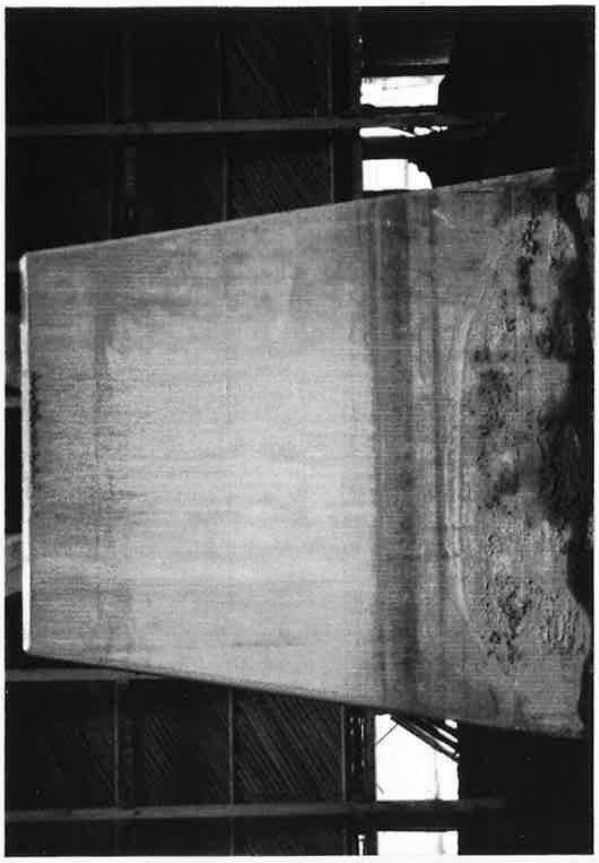
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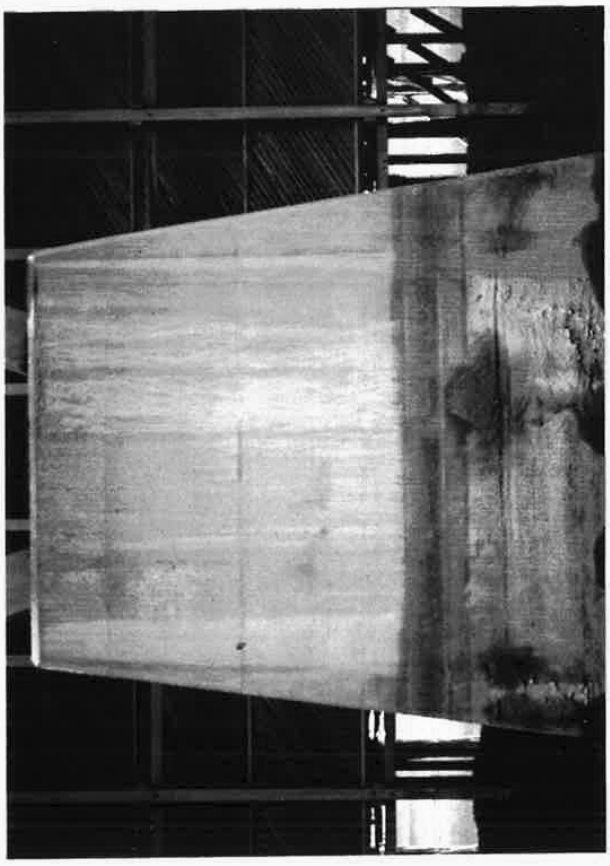
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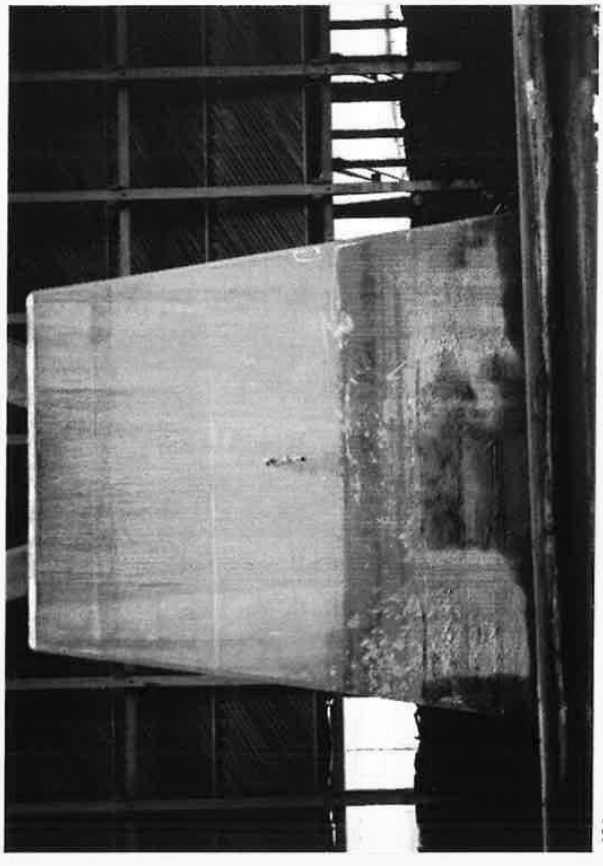
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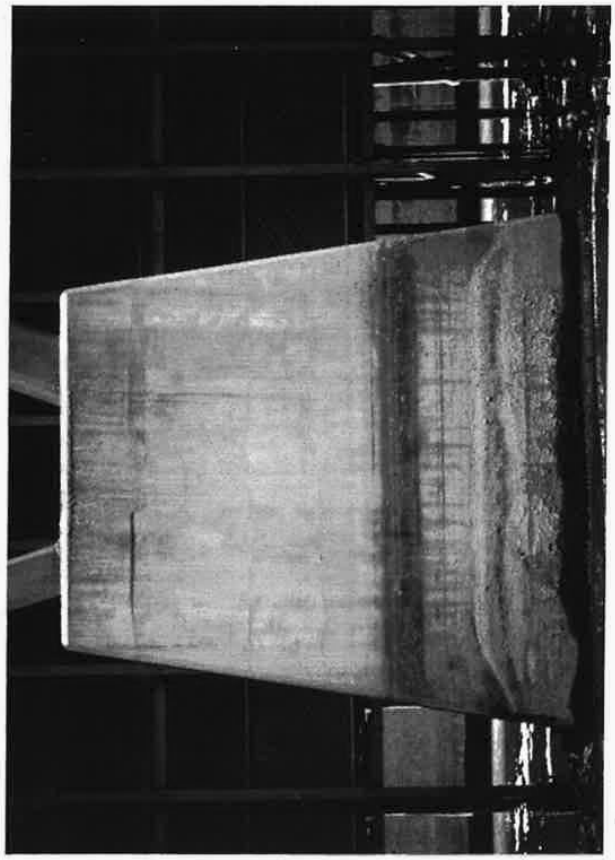
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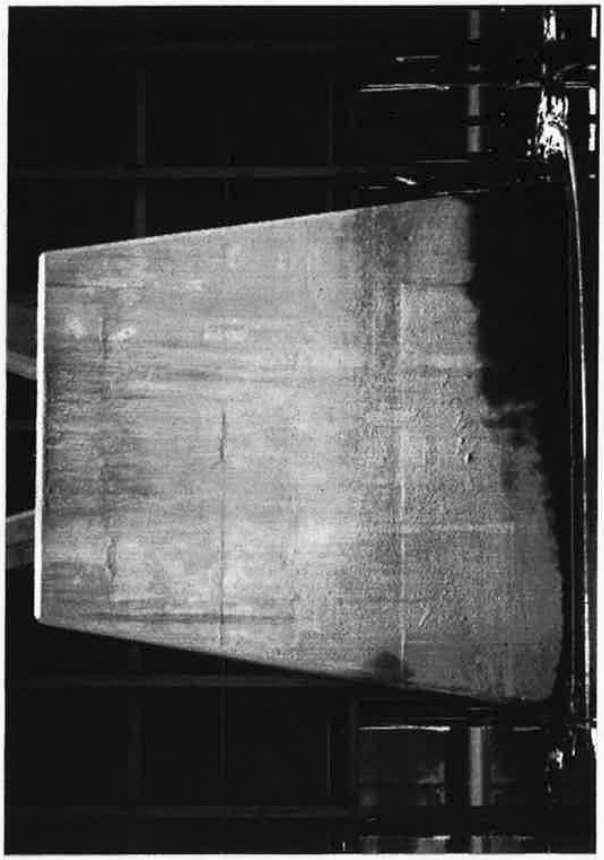
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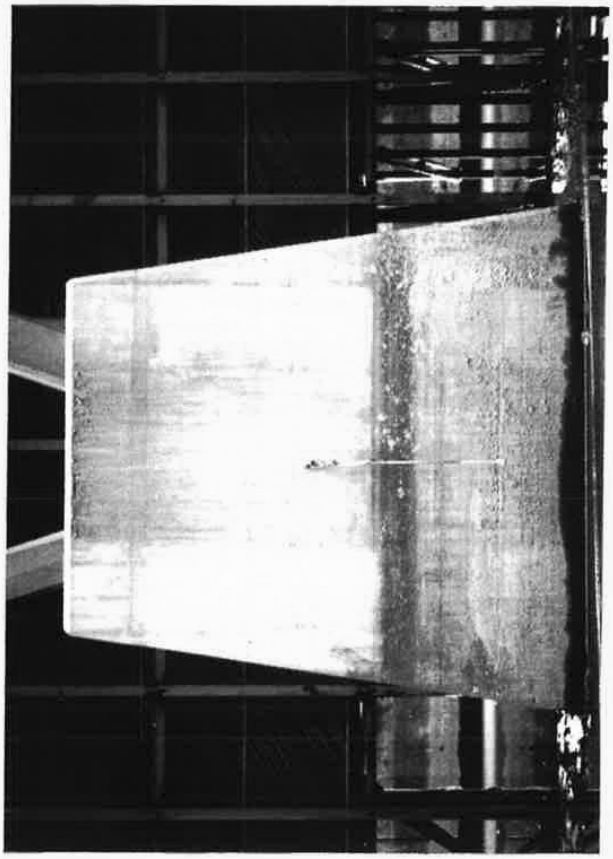
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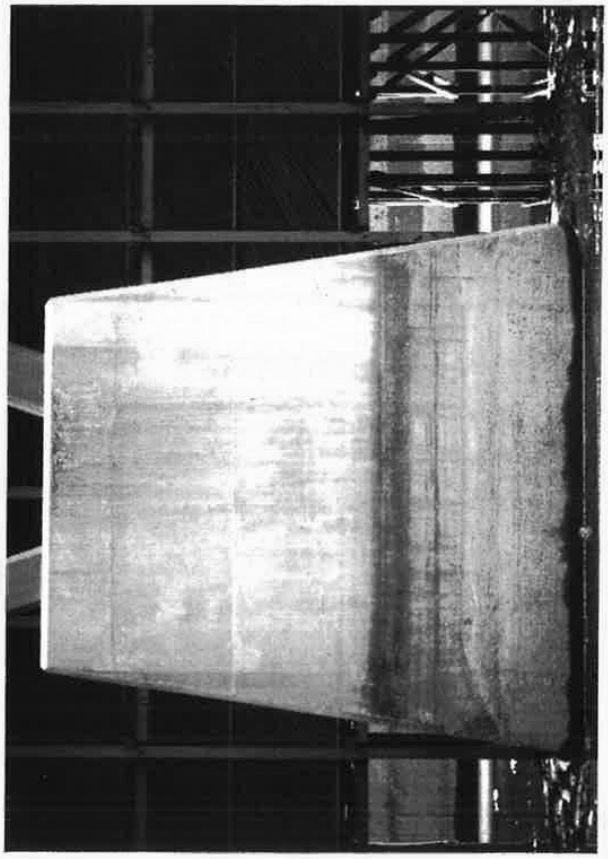
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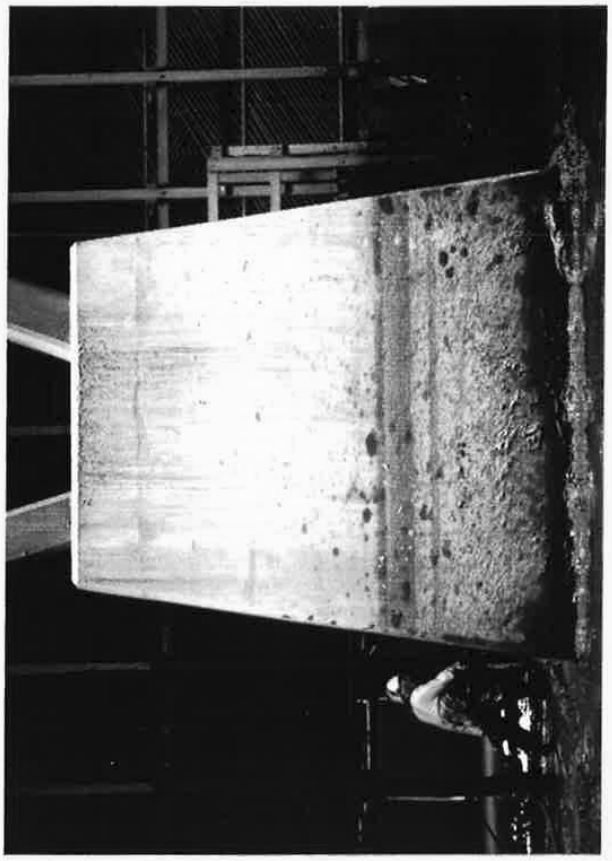
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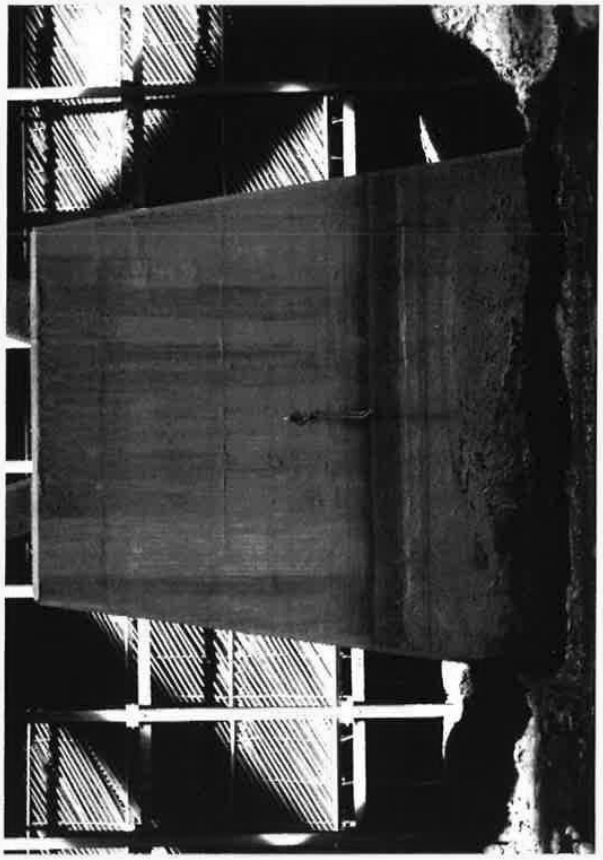
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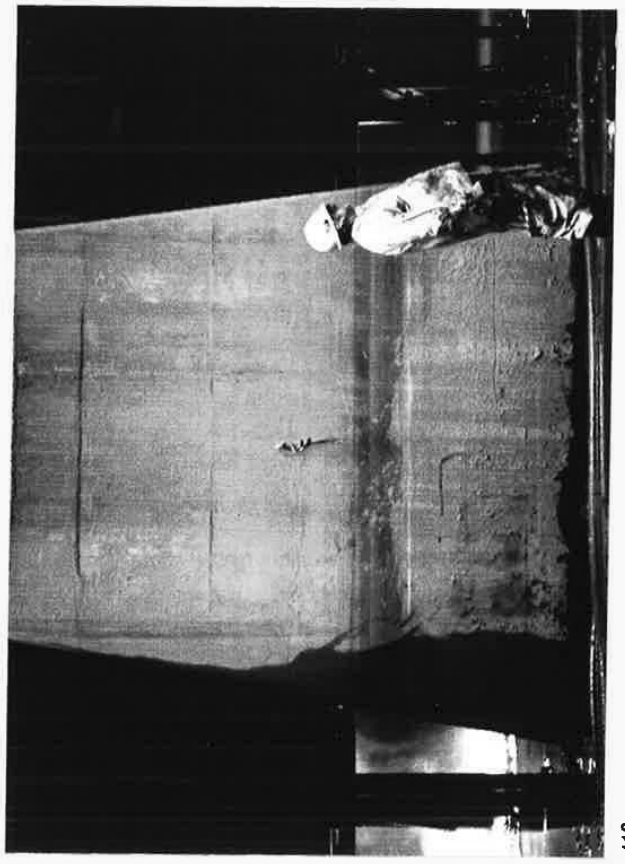
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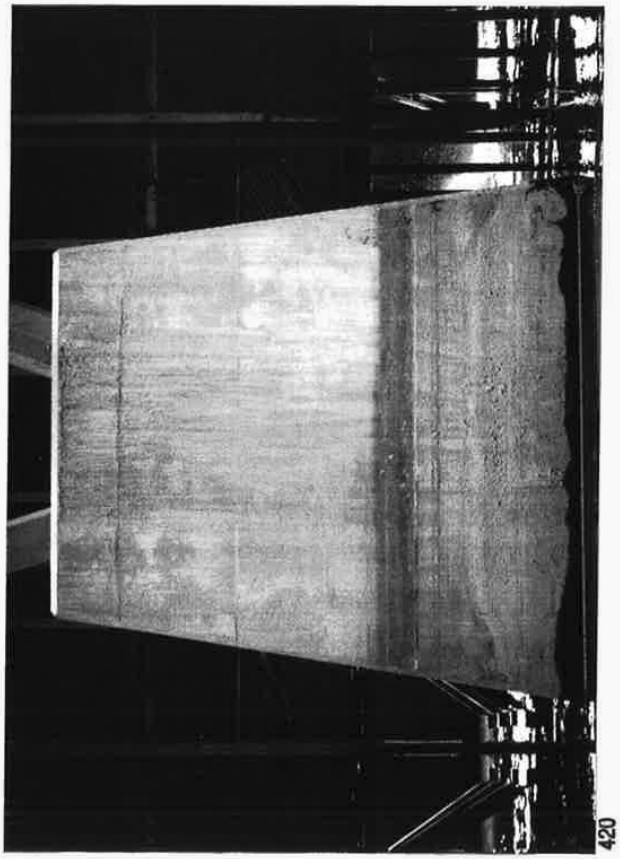
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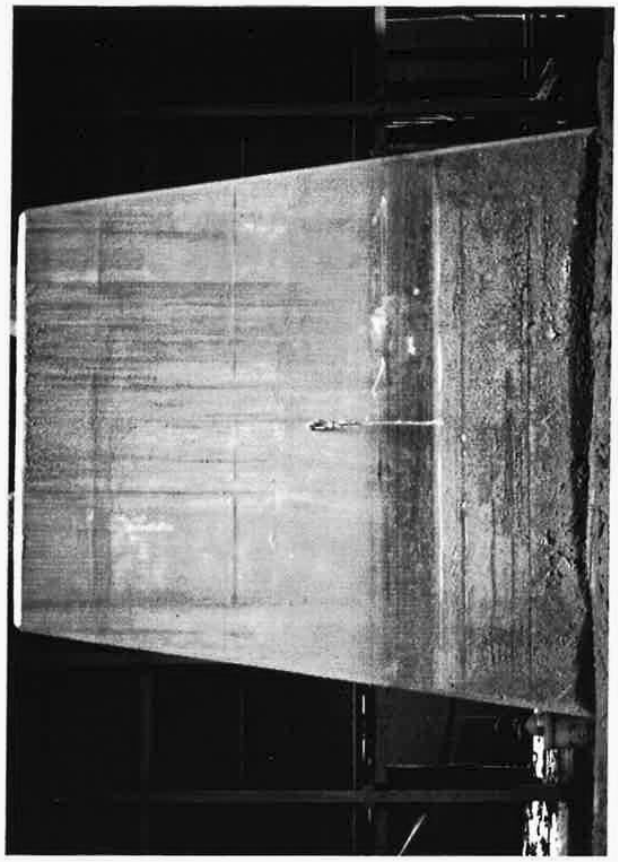
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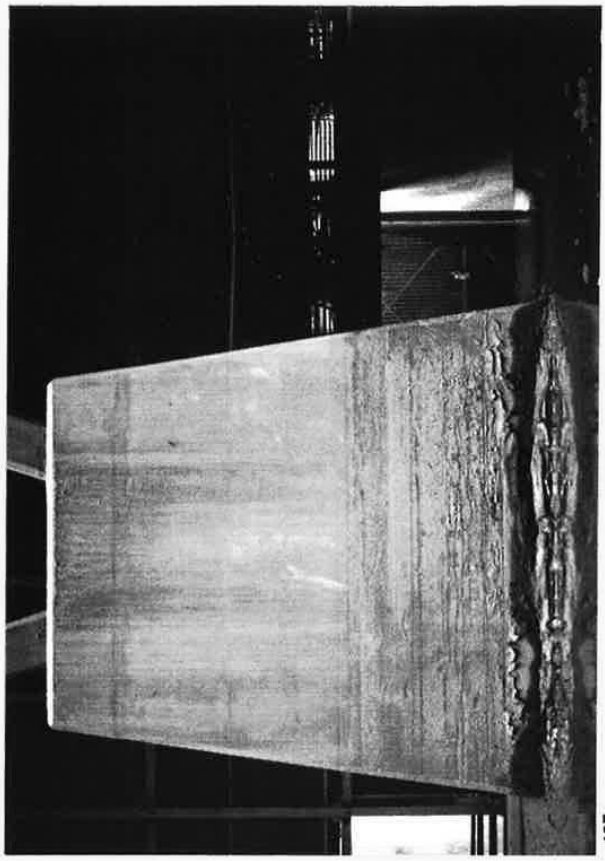
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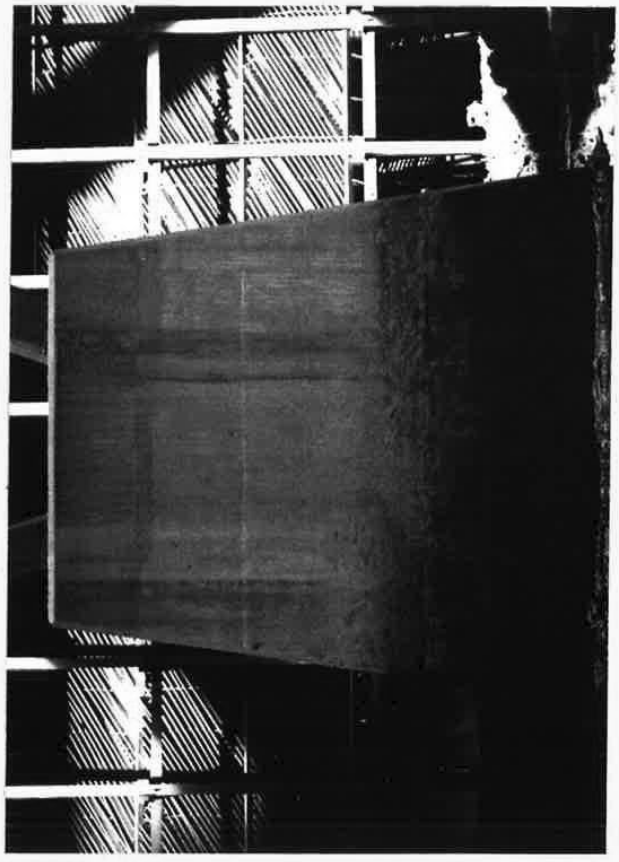
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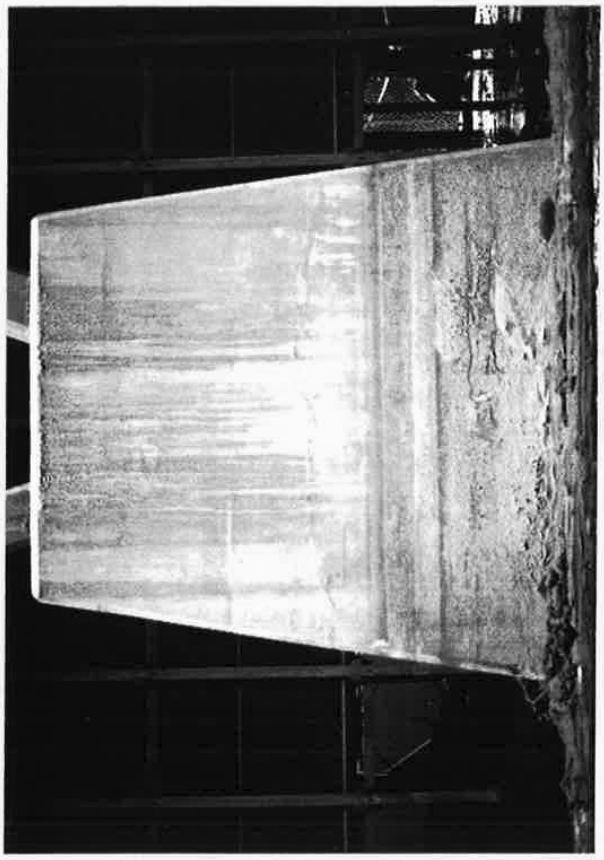
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AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION VIII SUMMARY

DISCUSSION

The Mitchell Plant Unit No. 1 natural draft cooling tower's structural components as inspected were found to be in relatively good condition. A number of defects/flaws are present, however, which if not addressed and are allowed to continue from their present state, may eventually become of major importance when the long-term continued operation that is desired for this structure is considered.

Due to the present condition, age and operational function of this particular structure, specifically, the constant exposure to moisture at the internal surfaces, the thin walled configuration of the shell design, the resultant reinforcement steel arrangement, construction techniques utilized during erection and environmental influences imposed upon the structure, we feel it is necessary to employ a structural maintenance program.

Maintenance to a cooling tower's shell in most cases was of no consideration during the initial design of these structures as demonstrated by the lack of any access provided to perform such work. As with any piece of equipment, on-going maintenance should be performed to insure lasting performance and provide for cost-effective insurance against major structural repairs.

Based upon the inspection findings and our conclusions, the areas of concern which we shall address are as follows:

1.) Weeping/open joints and rock pockets (honeycomb) at construction lifts.

AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION VIII

SUMMARY

DISCUSSION

Numerous areas as documented by this report are present and visible on the shell exterior. These areas are a continuous avenue to transport moisture from the tower's operation through the shell wall. The water as it travels through the wall, delivers and deposits silt plus other chemical compositions which present dangers in creating an environment that can break down the protective alkaline coating of the reinforcing steel and cause corrosive attack to the reinforcement steel.

The open joints also provide an entrance for the introduction of additional elements forced into these areas by weather. Moss is found to grow from numerous impacted locations and efflorescence deposits are forming at other locations raising further concerns relating the the reinforcing steel's exposure. These areas in their present condition being impacted with materials and constantly saturated by moisture, which during freeze/thaw cycles and joint deterioration, will continue to open further and present the threat of corrosion to the reinforcing steel.

The discovery that several imperfections encountered during the initial construction were patched and sacked to present an acceptable final appearance may be cause for further concern. This concern is related to the probable unveiling of additional rock pocket areas as this patching spalls off the surface exposing deterioration that may be present and further subjecting the joint to continued, accelerated disintegration. As can be seen in the photographs, the sacked finish from approximately the throat area down to the bottom of the shell has eroded away and provided additional evidence that patched areas at cold joint locations are present.

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SECTION VIII SUMMARY

DISCUSSION

2.) Wall tie patch pop-outs.

During initial construction of the shell, patching of the wall tie areas after raising the forms was performed and is common practice for this type of construction. However, over the years numerous areas have been exposed to moisture and corrosive agents causing the exterior patch to spall off the surface of the shell. These areas then become another path for potential corrosive attack to the reinforcing steel. As can be seen throughout the photographs, rust stains bleeding from these spalled wall tie locations is evident and it is reasonable to assume that in some locations, wall ties are in contact with the reinforcing steel and warrant concern.

3.) Cracks.

Cracks are common to all concrete structures. Some examples are surface shrinkage cracks incurred during the concrete curing process and others aid in relieving the structure from stresses imposed upon the shell such as wind, settlement and thermal effects. Concern should be directed to cracks that pose threats to structural integrity or provide pathways for external/internal elements to reach the reinforcement steel and cause corrosion. Based upon the inspection findings, the cracks as reported do not appear to pose any immediate structural concerns. However, these cracks should be monitored for growth and if signs of continued cracking persist, structural analysis would be called for. No rust stains were reported to be bleeding from cracks noted, however, this evidence alone is not conclusive proof that corrosion of the reinforcing steel is not present.

AMERICAN ELECTRIC POWER SERVICE CORPORATION
OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION VIII SUMMARY

DISCUSSION

Areas of possible corrosion are cracks that propagate from open joint and wall tie locations with efflorescence deposits as exampled by photographs no. 68 - 71, 89, 94, 97 - 106, 108, 110, 114 - 116, 134 - 136, 140, 141, 150, 151, 158, 159 and 346.

4.) Algae growth/interior shell surface.

The algae growth as reported upon the shell's interior surface is typically found in all towers. Problems that may arise from its presence are foremost the ability to conceal defects such as rock pockets, rust stains, etc., additional potential problems being the nature of this algae growth is to adhere to the surface, grow into fissures and open joints and accelerate the already present erosion process experienced under normal operation. Lastly, this growth acts like a sponge and the algae as it is permitted to grow and is constantly fed by moisture, will further complicate the deliverance of water to known pathways through the shell.

5.) Expansion joints/basin floor and divider wall.

Based upon inspection findings as stated in Section VI, the expansion joints examined were found to be hard, brittle and nonfunctional. Per our inspection reports, it is reasonable to assume this condition persists throughout the basin floor area and, due to the age of the equipment, the findings were not unexpected.

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OHIO POWER COMPANY
MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

SECTION VIII SUMMARY

DISCUSSION

Based upon the inspection data obtained from close visual examination of the shell exterior, we have extrapolated this information to provide the following:

a.) Approximately 50% of the leaking construction joints as shown on the Defect/Orientation Location Maps were found to stem from a rock pocket areas in varying degrees.

b.) The highest concentration of rock pocket areas occurred from lifts no. 31 and down.

c.) Approximately 60% of the cracks along their lengths as depicted on the maps were found to exhibit efflorescence deposits.

d.) Weather effects we found to be most severe in the two (2) relative north quadrants.

RECOMMENDATIONS

It is our opinion that, in order to preserve the cooling tower shell's structural integrity and provide for extended operational service, a maintenance program should be implemented as follows:

1.) Of utmost concern are the open pathways that allow moisture to travel and the introduction of chemical deposits to form through the shell wall. Isolation from the main contributor of this water can be achieved from the shell's interior surface. A coating system applied to the shell's interior should provide the most economic solution. Considering the expensive

AMERICAN ELECTRIC POWER SERVICE CORPORATION
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MITCHELL PLANT, UNIT NO. 1
MOUNDSVILLE, WEST VIRGINIA

RECOMMENDATIONS

alternative of repairing the leaking areas of the shell from the exterior surface, which would entail labor-intensive accessing of each and every location, application of a coating system and identifying any remaining areas of leakage for future spot repairs seems to be the most viable maintenance direction.

Enclosed for your review, is a letter plus product information of a manufacturer-recommended coating system for this application. We have gained experience in the installation of a very similar system for Pennsylvania Power and Light Company at their Montour Station located in Washingtonville, Pennsylvania. Reports as to suitability and performance have been very favorable.

Further, we feel this approach will provide the most benefit for the money when understanding the multitude of potential problems faced with when considering all avenues that can expose the reinforcement steel to corrosion.

2.) Secondly, in order to restore the expansion joint system within the tower's cold water basin, the basin area should be suitably cleaned and a new expansion joint system installed.

We have included copies of product information for your review, applicable to this recommendation.

Following under separate cover you will receive budget information which addresses pricing to perform the above stated recommended maintenance program.

Concrete Construction
Suite 230, Lakeside Plaza
1575 North Universal Avenue
Kansas City, Missouri 64120-1377
Telephone (816) 231-7400
Fax (816) 241-5582
Telex 424237

Pullman Power Products Corporation

June 12, 1990

RA 6/15 PHA/CST CT 6/15

JUN 13 1990

→RASnyder

Mr. B. A. Bennett
Assistant Vice President, Civil Engineering
Ohio Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Subject: Ohio Power Company Service Order B-6858
Mitchell Plant Unit No. 1, Moundsville, West Virginia
Pricing Information for Recommended Maintenance Program
Pullman Power Products Corporation Job. No. 5476

Dear Mr. Bennett,

In follow up of the recently submitted inspection report covering the structural components of the Unit No. 1 cooling tower serving the Mitchell Plant located in Moundsville, West Virginia, we are pleased to provide the following budgetary pricing information to perform recommended maintenance as stated. Discussed within the inspection report was the application of a coating system to the interior surface of the shell in order to seal this surface from the constant exposure of moisture under normal operating conditions.

Pullman Power Products Corporation proposes to supply all labor, supervision, materials, equipment and insurance necessary to perform the maintenance as specified under Scope of Work following:

Scope of Work

1.) Rig the tower with the aid of a helicopter to utilize cornice brackets and eight (8) pick boards to access the shell's entire internal surface. The brackets will be movable in order to achieve full coverage.

2.) High-pressure water blast the interior surface to provide a suitable surface preparation.

3.) Apply the three (3) coat system as listed under Option No. 2 within the Sika Corporation letter of May 9, 1990 enclosed.

4.) Remove all rigging from the tower. If requested, a cable can be left in place attached to a permanent bracket atop the cornice for future access.

Our budgetary price to perform the work as stated above is:

Six Hundred Forty-Five Thousand Dollars ($645,000.00)

Pullman Power Products Corporation

June 12, 1990
Mr. B. A. Bennett
Ohio Power Company
Page Two

Budget information is based on the following:

1.) All pricing is to be considered current.

2.) No special surface preparation beyond water blasting has been included.

3.) Application of the coating system is within the surface coverage limits as supplied by Sika (enclosed).

4.) The cooling tower being out of operation.

5.) Working eight (8) hour days, five (5) days a week for approximately eight (8) weeks.

6.) AEP supplying a suitable source of water and adequate source of 220 V, single-phase electric power at outlets near the base of the tower.

7.) Utilizing union labor under the Maintenance Addendum for Stacks and Chimneys.

8.) A mutually agreeable set of Commercial Terms and Conditions.

Due to the unknown quantities of the expansion joint materials within the cold water basin area, if agreeable to AEP, this work can be performed on a cost-reimbursement basis in which rates of reimbursement would be per our standard charges for extra work only.

Please find all applicable product information enclosed for your review. We trust this information will be of interest to you for this application. We will be touch with you to set up a meeting, at your office and your convenience, to further discuss our report and maintenance recommendations. We look forward to hearing from you.

Very truly yours,

Richard A. Babineau
Contracts Engineer

RAB/clg

Enclosures

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May 9, 1990

Mr. Richard Babineau
Pullman Power Products Corporation
Lakeside Plaza, Suite 230
1575 N. Universal Ave.
Kansas City, Missouri 64120-1377

Dear Richard:

This letter is in regards to Sika's suggested methods for coating and protecting concrete cooling tower interior walls for various American Electric Power projects. Sika has an excellent project history with various cooling tower projects utilizing Colma Sol epoxy coating.

To reduce the time consuming/labor intensive task of filling "honeycombs" and "bugholes" we offer two alternate methods detailed below. Bill Frichette, American Electric Power's Concrete Repair and Inspection Manager (614-836-4165), is very knowledgable in concrete repair and coatings, as well as Sika products. Therefore, we suggest that you contact him for product review, mil thickness requirements, field trials, etc. I would be glad to meet with AEP, at your request, to discuss these methods.

Option #1:

2 coats Colma Sol
1 sand cement parge (if necessary)
1 coat Colma Sol

Two coats of Colma Sol should fill most "bugholes", "honeycombs", etc. If some imperfections still exist after the second coat cures, a sand cement parge can be sponge floated into these areas. Upon initial drying, the excess sand/cement can be light water blasted off, and a third coat of Colma Sol can be applied. Coverage will depend on the properties of the concrete as well as the total Colma Sol mil thickness recommended by A.E.P. Typical coverage on concrete is 300-400 SF/gal. Based on this coverage, Colma Sol material cost would be approximately $.30-.40/S.F.

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While providing a great material and labor cost saving as compared to the conventional method (Hi Mod Gel Epoxy in Bugholes/3 coats Colma Sol) this method may still be labor intensive depending on the size and amount of concrete imperfections. An excellent labor savings options utilizing Sika's innovative and easy to spray water based epoxy, Armatec 110 is detailed below:

Option #2:

1 coat Armatec 110
2 coats Colma Sol

Sika has field tested this technique recently with great success. The Armatec 110, being a water based epoxy cement is very easy to spray (Goldblat Pattern Pistol Hopper Sprayer) and since it has a slurry consistency, it has excellent "bughole"/"honeycomb" filling properties.

Since this is a new technique which has not been lab tested, we recommend field testing to determine bonding properties, coverage, and finish requirements. We would be more than happy to work with Pullman Power for field demonstrations, bond strength testing, etc. This coat should take care of filling concrete architectural imperfections, and once followed up with 2 coats of Colma Sol should result in an excellent, well bonded, waterproof, labor efficient system.

Coverages again will vary, but as a guide estimating 100-150 SF/gal. Armatec 110 coverage, and 300 SF/gal/coat Colma Sol coverage results in an approximately material cost of $.40 - .55/S.F. Obviously, the major costs are built into labor, and this method should eliminate the labor intensive "bughole spot filling."

Please call me to arrange field and/or lab demonstrations as well as follow up to American Electric Power, if necessary. Sika realizes the importance of this project and are committed to providing the products and service necessary to meet AEP's and Pullman Power's needs.

Looking forward to hearing from you soon!

Sincerely,

Jim Chilinski

Colma® Sol

Protective, solvent-based, vapor-barrier, epoxy resin coating

Technical Data

Description:	Colma Sol is a 2-component, solvent-based, epoxy protective coating for dry substrates.
Where to Use:	Use as a thin-mil, vapor-barrier, corrosion- and chemical-resistant protective coating for structural substrates.
Advantages:	• Convenient B:A=1:1 ratio by volume. • Simple-to-apply consistency (sprayable) provides a high-abrasion, chemical-resistant, durable coating. • Longer pot life assures easy handling. • Superior bond prevents peeling and flaking. • Colma Sol has USDA approval for use in food plants. • Colma Sol, gray, after cure, is in conformity with Federal Regulations and may be used in contact with potable water.
Coverage:	320-530 sq ft/gal (3-5 mils).
Packaging:	4-gal unit.

Typical Data for Colma Sol:
(Material and curing conditions @ 73F and 50% R.H.)

Shelf Life:	2 years in original, unopened containers.	
Storage Conditions:	Store dry at 40-80F. Condition material to 65-80F before using.	
Color:	Clear, white, and gray.	
Mixing Ratio:	Component 'A' : Component 'B' = 1:1 by volume.	
Viscosity:	Approximately 500 cps.	
Pot Life:	Approximately 8 hours.	
Tack-Free Time:	Approximately 35 minutes.	
Recoat Time:	24 hours minimum.	
Open Time:	Light foot traffic Rubber-wheeled traffic	1 day 2-3 days
Immersion and chemical exposure:	10 days	
Abrasion Resistance (ASTM D-968):		
14 day	Abrasion coefficient	62 liters/mil
Adhesion (ASTM D-3359):		
7 day	Adhesion classification	5A
Elongation (ASTM D-522):		
14 day	Elongation	>28%

How To Use

Surface Preparation: Surface must be clean, sound, and dry. Remove dust, laitance, grease, curing compounds, other coatings, impregnations, waxes, foreign particles, disintegrated materials.
Preparation Work: Concrete - sandblast or use other approved mechanical methods.
Steel - sandblast to white-metal finish.

Mixing: Pre-mix each component. Proportion equal parts by volume of Components 'A' and 'B' into clean mixing container. Mix with low-speed (400- 600-rpm) drill and Sika paddle for 3 min, until uniform in color. Mix only that quantity you can use within its pot life.

Induction Period: After mixing, cover mixing container and let stand for 1 hr allowing initial chemical reaction to start. This assures you of a uniform application quality and hiding power.

Application: Apply Colma Sol to properly prepared **dry** substrates using high-quality brushes, rollers, or spray equipment. Two coats are recommended at 3-5 mils/coat. Apply coating at ambient temperatures between 50 and 95F. Recoat time must be a minimum of 24 hr.
For slip resistance - Add approximately ½ lb/gal of Colma Sol Granules into mixed material and apply as first coat. Saturate roller or brush with material and apply first on a disposable cardboard or other surface to evenly distribute granules on the equipment. Do not spray with Colma Sol Granules in the material.

Limitations:

- Do not apply to surfaces where vapor can condense and freeze.
- Do not encapsulate saturated concrete in areas of freezing and thawing.
- Do not apply to porous surfaces where moisture-vapor transmission will occur during the application. Consult Technical Service.
- Epoxy resin coating will weather and chalk upon exposure to sunlight.
- Minimum application temperature 50F.
- Recoat time, 24 hr minimum.
- Coating is a vapor-barrier after cure.
- Substrate must be absolutely dry at time of application.
- Minimum age of new concrete before applying coating is 21 to 28 days depending on curing and drying condition.
- Maximum wet-mil thickness/coat 6 mils.
- For spray applications only, coating may be thinned with a maximum of 5% Sika Epoxy Thinner by volume.
- Do not use on exterior, on-grade substrates.

Caution: **Warning - Component 'A'** - Combustible. Keep away from sparks and open flame.
Component 'B' (Gray and White) - Flammable. Contains xylene. Keep away from sparks and open flames.
Component 'B' (Clear) - Combustible. Keep away from sparks and open flame.

Irritant: **Component 'A'** - Prolonged contact with skin may cause irritation. Avoid eye contact.
Component 'B' - Contact with skin may cause severe burns. Avoid eye contact.
Product is a strong sensitizer. Use of safety goggles and chemical-resistant gloves recommended. Avoid breathing vapors. Use of explosion-proof exhaust ventilation recommended. Use of NIOSH/MSA organic vapor respirator is recommended. Remove contaminated clothing.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician immediately. For respiratory problems, remove person to fresh air. Wash clothing before re-use.

Clean Up: Remove sources of ignition; ventilate area. Collect with absorbent material. Dispose of in accordance with local disposal regulations. Uncured material can be removed with approved solvent. Cured material can only be removed mechanically.

KEEP CONTAINER TIGHTLY CLOSED **KEEP OUT OF REACH OF CHILDREN**
NOT FOR INTERNAL CONSUMPTION **FOR INDUSTRIAL USE ONLY**
CONSULT MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION

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Drawer 250, Sika and Colma are registered trademarks. Made in USA. Sept, 1988.

Sika® Armatec 110

EpoCem® Like Epoxy. Like Cement

Water-based epoxy resin/ portland cement bonding agent

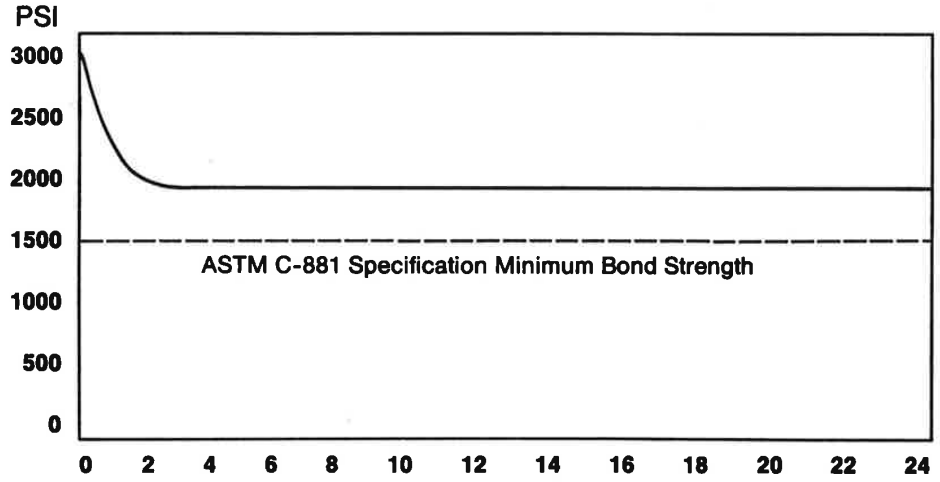
Technical Data

Description:	Sika Armatec 110 is a 3-component, water-based epoxy resin/portland cement bonding agent.
Where To Use:	Bonding agent for fresh, plastic mortar and concrete to hardened concrete and steel.
Advantages:	• Excellent adhesion to concrete and steel. • Non-vapor barrier. • Can be used exterior on-grade. • Factory proportioned units. • Easily spray applied. • Non-flamable. • Free of organic solvents. • VOC compliant. • Corrosion protection for reinforcing steel.
Coverage:	80 sq. ft/gal. on smooth concrete.
Packaging:	3.5-gal unit. 169.7-fl.-oz. epoxy resin binder (Component A and Component B) in a carton and a 46.82 lb. Component C in a multi-wall bag.

Typical Data for Sika Armatec 110:
(Material and curing conditions @ 73F and 50% R.H.)

Shelf Life:	1 year in original, unopened packaging.
Storage Conditions:	Store dry at 40-95F. Condition material to 65-80F before using. If Components A and B are frozen, discard.
Color:	Concrete gray.
Mixing Ratio:	Mix entire unit.
Consistency:	Slurry mortar.
Pot Life:	Approximately 90 minutes.
Contact Time:	24 hours maximum from 40-85F.

14 Day Bond Strength
(over extended open times)
New concrete to old per ASTM C-882



How To Use

Surface Preparation: Surface must be clean, sound, and saturated surface dry but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, disintegrated materials.
Preparation Work: Concrete - Sandblast or use other approved mechanical methods. **Steel** -Sandblast to white-metal finish.

Mixing: Shake contents of both Component A and Component B. Empty entire contents of both Component A and Component B into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a Sika paddle on a low-speed (400- 600-rpm) drill. Slowly add the entire contents of Component C while continuing to mix. Mix for 3 minutes until blend is uniform and free of lumps.
Mix only that quantity that can be applied within its pot life.

Application: **As a bonding agent** - Apply by stiff-bristle brush or broom. Spray apply with Goldblast Pattern Pistol or equal equipment. Place fresh, plastic concrete or mortar while the Sika Armatec 110 is wet or dry, up to 24 hours.
For corrosion protection - Apply by stiff-bristle brush or spray at 160 sq ft/gal (10 mils). Take special care to properly coat the underside of the totally exposed steel. Allow coating to dry 2-3 hours @ 73F, then apply a second coat at the same coverage. Allow to dry again before the repair mortar or concrete is applied.

Limitations:

- Minimum substrate temperature 40F.
- Maximum substrate temperature 85F.
- Minimum thickness 20 mils as a bonding agent.
- Maximum contact time 24 hours.
- Mix entire unit. Do not proportion.
- Substrate must be thoroughly saturated prior to application.
- Do not add water to the mix.

Caution:

Component A - Irritant -Contains epoxy resin
Component B - Irritant -Contains amines.
Component C - Irritant -Contains portland cement and silica.
Product is a strong sensitizer. Avoid eye, skin, and respiratory contact. Use of safety goggles, chemically-resistant gloves, and appropriate NIOSH/MSA approved respirator recommended. Avoid breathing vapors and dust. Use only with adequate ventilation. Remove contaminated clothing.

First Aid: In case of eye contact, flush with water for 15 minutes; immediately consult a physician. In case of skin contact, wash with soap and water; consult a physician for irritation. For respiratory problems, remove person to fresh air and institute artificial respiration if necessary; consult a physician. In case of ingestion, immediately consult a physician. Wash clothing before reuse.

Clean-Up: **Component A and Component B:** Ventilate area of spill. Contain and collect with absorbent material. Flush area with water.
Component C: Ventilate area of spill. Sweep or vacuum into suitable containers. Flush area with water.
Dispose of in accordance with current applicable local, state, and federal regulations. Uncured material can be removed with water. Cured material can only be removed mechanically.

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February, 1990

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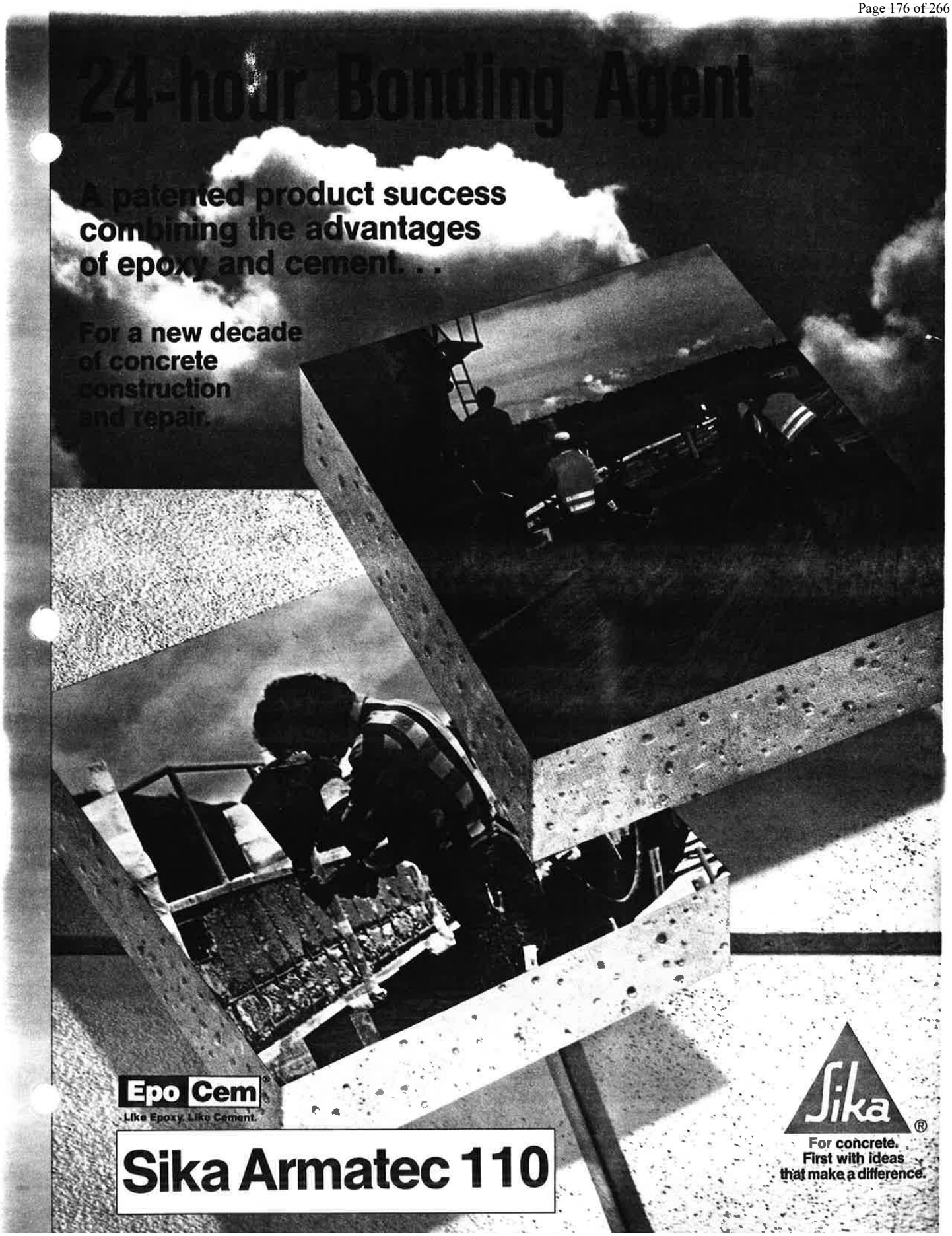

24-hour Bonding Agent
A patented product success combining the advantages of epoxy and cement. . .
For a new decade of concrete construction and repair.
Epo Cem®
Like Epoxy. Like Cement.
Sika Armatec 110
Sika®
For concrete.
First with ideas that make a difference.

24-hour open time

Sika® Armatec 110

Sika succeeds with a technological breakthrough in a unique combination of epoxy and cement. Sika Armatec 110 provides you with the longest open time available in a structural bonding agent for forming, overlays, concrete rehabilitation, and shotcreting. Combining the advantages of epoxy and cement, Sika Armatec 110 also provides protection against corrosion of reinforcement steel.

You can now prepare cementitious surfaces and steel and apply Sika Armatec 110 today... place concrete tomorrow.

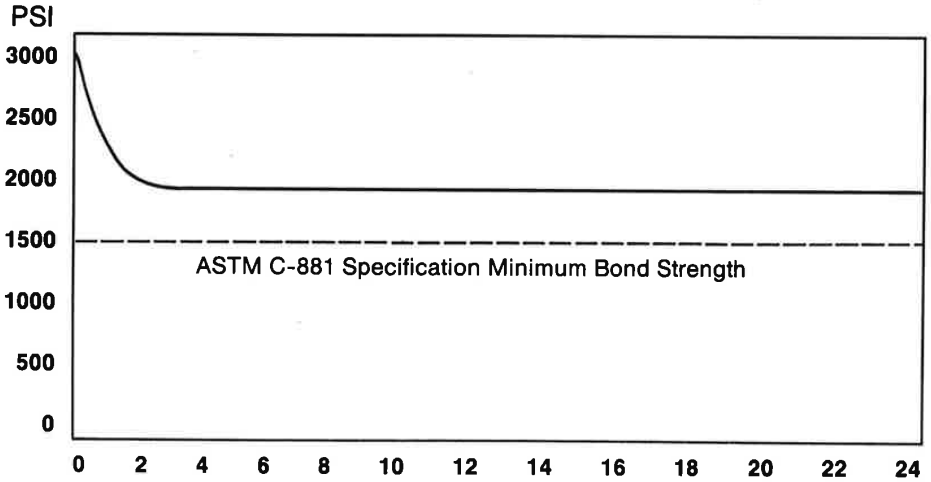
The mechanical, chemical, and physical properties of epoxy and cement working together in Sika Armatec 110 give you these unequalled advantages:

- 24 hour open time (see graph below)
- economical, lower cost than conventional bonding agents
- contains corrosion inhibitors
- does not create a vapor barrier
- easy-to-use, water cleanup
- solvent-free, virtually odorless
- brush-on, broom-on, or easy-spray thru hopper gun.

For you - Armatec 110 from Sika - the people with ideas that make a 'erence.

14 Day Bond Strength

(over extended open times)
New concrete to old per ASTM C-882



Epo Cem®

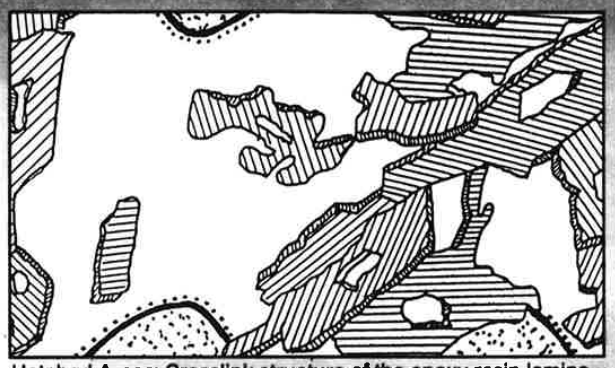
Like Epoxy. Like Cement.

A product that combines
the mechanical and chemical properties of
Epoxy
with the physical properties of
Cement
to achieve optimum strength and performance.

Sika Armatec 110 is based on the unique, patented Epocem concept, cement-based mortars that contain epoxy resin as a secondary binder component. The interaction of these two fundamentally different binder systems is based on the formation of an interlocking framework of epoxy resin through which the cement crystals penetrate and cure.

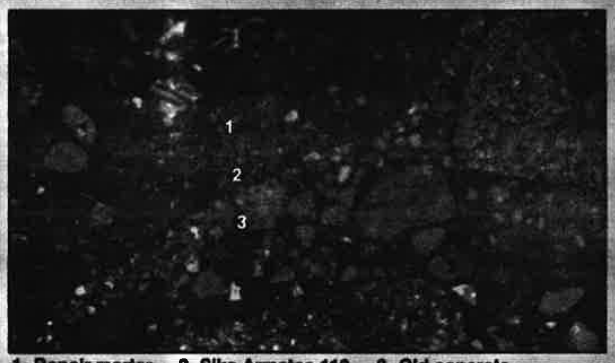
Product Data

Pot Life	90 minutes
Contact Time (open time)	24 hours
Consistency	slurry mortar
Application Thickness	.020 inches (20 mils) minimum
Color	concrete gray



Hatched Areas: Crosslink structure of the epoxy resin lamina
Dotted Areas: Cement grains before hydrating

Hatched Areas: Crosslink structure of the epoxy resin lamina
Ray Areas: Cement crystals formed before hydrating



1. Repair mortar 2. Sika Armatec 110 3. Old concrete

Microscopic view of Sika Armatec 110 as a bonding bridge between existing concrete and polymer-modified, cementitious repair material (Sikacem 133 machine-applied repair mortar).

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Export Division

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Description: Sikagard 62, Seamless Flooring System, is a 2-component, moisture-insensitive, solvent-free epoxy resin binder for a slip-resistant, seamless flooring system for application by the broadcast method.

Where to Use: Use for interior applications requiring an abrasion- ,chemical- , and slip-resistant overlay with easy maintenance characteristics.

Advantages:

- System is insensitive to moisture before, during, and after cure.
- Excellent adhesive properties to most substrates.
- Convenient, easy mix B:A = 1:1 ratio by volume.
- Superior, long-term abrasion resistance and durability.
- Excellent chemical resistance.
- All colors have USDA approval.
- Easy care, slip-resistant overlay.

Coverage:
Prime coat -225 to 400 sq ft/gal (4-7 mils)
Binder coat -32 sq ft/gal (50 mils)
Broadcast aggregate -2 lb/sq ft to excess
Seal coat -Approximately 160 sq ft/gal

Packaging: 4-gal units; 1-qt units, 12/case.

Typical Data for Sikagard 62 Seamless Flooring System:
(Material and curing conditions @ 73F and 50% R.H.)

Shelf Life:	2 years in original, unopened containers.
Storage Conditions:	Store dry at 40-95F. Condition material to 65-85F before using.
Color:	Gray, red, tan.
Mixing Ratio:	Component 'A' : Component 'B' = 1:1 by volume.
Viscosity:	Approximately 2,700 cps.
Pot Life:	Approximately 35 minutes.
Application Life:	20-25 minutes.
Tack Free Time:	Approximately 4 hours.
Open Time:	Light foot traffic - 5-7 hours. Rubber-wheel traffic - 8-10 hours.
Immersion and chemical exposure:	3 days

Compressive Properties (ASTM D-695):
Compressive Strength, psi

	40F*	73F*	90F*
8 hour	-	200	-
16 hour	-	4,500	-
1 day	40	5,900	5,800
3 day	5,900	8,800	7,200
7 day	7,700	8,800	8,300
14 day	7,700	8,800	9,000
28 day	9,300	9,200	9,000

Modulus of Elasticity, psi: 7.0 X 10^5 psi

Tensile Properties (ASTM D-638):

14 day	Tensile Strength	3,400 psi
	Elongation at Break	0.5 %

Flexural Properties (ASTM D-790):

14 day	Flexural Strength (Modulus of Rupture)	5,800 psi
	Tangent Modulus of Elasticity in Bending	1.5 X 10^6 psi

Bond Strength (ASTM C-882): Hardened concrete to hardened concrete

2 day (dry cure)	Bond Strength	2,800 psi
14 day (moist cure)	Bond Strength	2,100 psi

Water Absorption (ASTM D-570):		
7 day	Total Water Absorption (24 hour immersion)	0.6%
Shrinkage (ASTM C-883):		
7 day		passes test
Abrasion Taber Abrader (Abrasion wheel-H-22; 1000-gm load):		
7 day	Weight loss, 1,000 cycles	1.34-gm
	Weight loss, 8,000 cycles	11.05-gm

* Material cured and tested at the temperatures indicated.

How To Use

Surface Preparation: Surface must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated materials.

Preparation Work: Concrete - Sandblast or use other approved mechanical means.
Steel - Sandblast to white-metal finish.

Mixing: Pre-mix each component. Proportion equal parts by volume of Components 'A' and 'B' into a clean mixing container. Mix with a low-speed (400- 600-rpm) drill and Sika paddle for 3 minutes, until uniform in color.
Mix only that quantity that can be used within its application life.

Application: Prime the prepared substrate with neat Sikagard 62, using a roller. Coverage should be 275-400 sq ft/gal.
While the primer is still tacky, apply the binder material with a 3/16-in. x 3/16-in. notched-rubber squeegee. Allow the binder to self-level. Slowly broadcast an oven-dried sand (20-30 gradation is preferable) so that the sand falls vertically into the binder. Continue to broadcast lightly, making several passes, allowing the binder to bleed through the sand before making next pass. Cover completely with sand before binder becomes tack-free.
After broadcast system has reached sufficient cure as not to be damaged, remove excess sand. Seal coat the broadcast with a neat coat of Sikagard 62 using a roller or flat squeegee, depending on the degree of slip-resistance you require.

Limitations:

- Minimum substrate temperature for application 50F.
- Do not apply over wet, glistening surface.
- Material is a vapor barrier after cure.
- Do not apply to porous surfaces exhibiting moisture-vapor transmission during the application. Consult Technical Service.
- Minumim age of concrete prior to application is 21-28 days, depending on curing and drying conditions.
- Do not apply to exterior, on-grade substrates.
- Use oven-dried aggregate only.
- Do not thin with solvents.
- For interior applications only.

Caution: **Component 'A'-Irritant** - Prolonged contact with skin may cause irritation. Avoid eye contact. **Component 'B'-Corrosive** - Contact with skin may cause severe burns. Avoid eye contact. Product is a strong sensitizer. Use of safety goggles and chemical-resistant gloves recommended. Remove contaminated clothing. Avoid breathing vapors. Use adequate ventilation. Use of a NIOSH/MSA organic vapor respirator recommended.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician immediately. For respiratory problems, remove person to fresh air. Wash clothing before re-use.

Clean Up: Collect with absorbent material, flush area with water. Dispose of in accordance with local disposal regulations. Uncured material can be removed with approved solvent. Cured material can only be removed mechanically.

KEEP CONTAINER TIGHTLY CLOSED **KEEP OUT OF REACH OF CHILDREN**
NOT FOR INTERNAL CONSUMPTION **FOR INDUSTRIAL USE ONLY**
CONSULT MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION

Executive Office: P.O. Box 297, Lyndhurst, NJ 07071 - Tel 201-933-8800 - TWX 710-989-0108 - FAX 201-933-9379

Regional* and District Sales Offices

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Export Division

NJ, Lyndhurst ..... 201-933-8800 TWX ..... 710-989-0108 Telefax 201-933-9379

SIKA CORPORATION
products/systems/services...worldwide

Description:	Sikaflex-2c is a 2-component, premium-grade, polyurethane-base, elastomeric sealant. Principally a chemical cure in a non-sag and self-leveling consistency. Available in 43 colors with convenient Color-Pak.
Where to Use:	• Intended for use in all properly designed working joints with a minimum depth of ¼ in. • Ideal for vertical and horizontal applications. • Placeable at temperatures as low as 40F. • Adheres to most substrates commonly found in construction.
Advantages:	• Capable of ±50% joint movement. • Chemical cure allows the sealant to be placed in joints exceeding ½ in. in depth. • High elasticity with a tough, durable, flexible consistency. • Exceptional cut- and tear-resistance. • Exceptional adhesion to most substrates without priming. • Available in 43 architectural colors. • Color uniformity assured via Color-Pak system. • Non-sag even in wide joints. • Self-leveling consistency is easy to apply into horizontal joints. • Jet fuel resistant. • Paintable with water-, oil-, and rubber-base paints. • Both grades meet ASTM C-920. • Both grades meet Federal Specification TT-S-00227E.
Coverage:	1 gal yields 231 cu in. or 154 lin ft of a ½-in. X ¼-in. joint.
Packaging:	1.5-gal. Available on special order, 3-gal units.

Typical Technical Data for Sikaflex-2c:
(Material and curing conditions 73F and 50% R.H.)

Colors:	A wide range of architectural colors are available. Special colors available on request.
Shelf Life:	One year in original, unopened container.
Storage Conditions:	Store dry at 40-95F. Condition material to 65-75F before using.
Application Temperature	40 to 100F, ambient and substrate temperatures. Sealant should be installed when joint is at mid-range of its anticipated movement.
Service Range:	-40 to 167F

Property:	**Non-sag**	**Self-leveling**	**Test Method**
Application life:	3-4 hr	3-4 hr	TT-S-00227E
Tack-free Time:	6-8 hr	6-8 hr	ASTM C-679
Final Cure:	3 day	3 day	
Shore A Hardness:	25±5	40 ± 5	ASTM D-2240
Tensile Strength at Break:	200 psi	200 psi	ASTM D-412
Tensile Elongation:	650%	650%	ASTM D-412
100% Modulus:	75 psi	100 psi	ASTM D-412
Tear Strength:	125 lb/in.	125 lb/in.	ASTM D-624

Adhesion in Peel: TT-S-00227E

Substrate	Peel Strength	% Adhesion Loss	Peel Strength	% Adhesion Loss
Aluminum	30 lb	Zero	30 lb	Zero
Glass	30 lb	Zero	30 lb	Zero
Concrete	25 lb	Zero	30 lb	Zero

Weathering Resistance:	Excellent
Ozone Resistance:	Excellent
Chemical Resistance:	Good resistance to water, diluted acids, diluted alkalines, and residential sewage. Consult Technical Service for specific data.

Caution:

Combustible: Keep away from open flames and high heat. Contains xylene; avoid breathing vapors. Use with adequate ventilation.

Irritant: Avoid skin and eye contact. Use of NIOSH/MSA approved organic vapor respirator, safety goggles, and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean Up: Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with applicable local, state, and federal regulations.

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CT, Hartford 203-560-2124	MO, Kansas City 816-921-1022	TX, Greenville 214-454-6030
FL, N. Miami Beach 305-940-1959	MO, St. Louis 314-231-5499	TX, Houston 713-461-3010
*FL, Tampa 813-933-5259	*NJ, Lyndhurst 201-933-8800	VA, Richmond 804-271-4029
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IL, St. Charles 312-513-0570	OH, Brooklyn Heights 216-749-7225	WA, Seattle 206-762-3829
IN, Indianapolis 317-843-0274	*OH, Columbus 614-476-3335	WI, Milwaukee 414-272-3100

Export Division

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SIKA CORPORATION
products/systems/services...worldwide

1. PRODUCT NAME

SIKAFLEX-2c NS/SL Two-component, Non-Sag, Self-Leveling, Premium-Grade, High-Performance, Elastomeric Joint Sealant

2. MANUFACTURER

SIKA CORPORATION
Construction Products Division
201 Polito Avenue
P.O. Box 297
Lyndhurst, NJ 07071
Phone: (201) 933-8800
TWX 710-989-0288
Telefax (201) 933-9379

3. PRODUCT DESCRIPTION

Sikaflex-2c is a 2-component, principally a chemical cure, non-sag/self-leveling permanently flexible polyurethane sealant that is self-priming with most construction materials. It resists attack from dilute acids and alkalines, jet fuel, water, and residential sewage. Curing to a flexible consistency with exceptional cut- and tear-resistance, Sikaflex-2c offers superior performance when used between substrates with dissimilar coefficients of expansion: i.e., concrete, wood, glass, steel, aluminum, copper, ceramics, brick, asbestos cement, polyester, and epoxy.

Basic Uses: Building Construction: Sikaflex-2c is designed for all expansion and contraction joints, where maximum expansion/contraction should not exceed ±50%. Used where a chemical-cure sealant is required.

Heavy Construction: Sikaflex-2c can be used in a wide range of projects including municipal buildings, condominiums, sport stadia, parking garages, water treatment plants, canals, department stores, bridges, and similar structures.

Limitations: The ultimate performance of Sikaflex-2c depends on good joint design and proper application. Maximum expansion and contraction should not exceed 50% of average joint width. Do not cure in the presence of curing silicones. Avoid contact with alcohol and other solvent cleaners during cure. Allow 3-day cure before subjecting sealant to total water immersion. Avoid exposure to high levels of chlorine. Do not apply when moisture-vapor-transmission condition exists since this can cause bubbling within the sealant. Avoid over-mixing sealant.

Caution: Combustible. Keep away from open flames and high heat. This product contains xylene. Use only with adequate ventilation. Avoid prolonged breathing of vapors.

Irritant: Avoid skin and eye contact. Use of NIOSH/MSA approved organic vapor respirator, safety goggles, and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean-Up: Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with applicable local regulations.

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SPEC DATA®

This Spec-Data sheet conforms to editorial style prescribed by The Construction Specifications Institute. The manufacturer is responsible for technical accuracy.

Sika Corporation
May 1988
(Supersedes May 1986)

4. TECHNICAL DATA

(Material and curing conditions 73F and 50% R.H.)

PROPERTY	NON-SAG	SELF-LEVELING	TEST METHOD
Application	2-3 hr	3-4 hr	TT-S-00227E
Cure Time: Tack-Free Time	6-8 hr	6-8 hr	ASTM C-679
Final Cure	3 days	3 days	
Shore A Hardness cured and tested 14 days	25 ± 5	40 ± 5	ASTM D-2240
Tensile Strength at Break:	200 psi	200 psi	ASTM D-412
Tensile Elongation	650%	650%	
100% Modulus cured and tested 14 days	75 psi	100 psi	
Tear Strength: cured and tested 14 days	125 lb/in.	125 lb/in.	ASTM D-624

ADHESION IN PEEL

SUBSTRATE	PEEL STRENGTH	ADHESION LOSS	PEEL STRENGTH	ADHESION LOSS	
Aluminum	30	0%	30 lb	0%	TT-S-00227E
Glass	30	0%	30 lb	0%	
Concrete	25	0%	30 lb	0%	
Weathering		Excellent		Excellent	
Tear Resistance		Exceptional		Exceptional	
Application Temperature		40F to 100F		40F to 100F	
Service Range		-40F to 167F		-40F to 167F	

07900

Composition and Materials: Sikaflex-2c, is principally a chemical-cure that shows excellent resistance to weathering: service range extends from -40 to 167F.

Grade: Non-sag and self-leveling consistency.

Packaging: 1.5-gal and 3-gal units.

Shelf Life: One year in original, unopened containers.

Storage Conditions: Store dry at 40-95F. Condition material to 65-75F before using.

Colors: Twelve standard colors: white, colonial white, aluminum gray, black, limestone, dark bronze, capitol tan, sandalwood, buff, bronze, precast, and redwood tab. Special colors may be formulated to match particular needs.

Applicable Standards: U.S.A. Federal Specification TT-S-00227E, Types I and II, Class A. ASTM C-920-79, Type M, Class 25, Grade P & NS.

5. INSTALLATION

Joint Design: The ultimate performance of Sikaflex-2c depends on good joint design and proper application. Maximum expansion and contraction should not exceed ±50% of average joint width. A width to depth ratio of 2:1 is preferable. Foam backer rods are recommended to control depth-to-width ratio, and to prevent bonding at bottom of joint.

Surface Preparation: Clean all surfaces. Joint walls must be sound, clean, dry, and free from oil, grease and frost. Curing compound residues and any other foreign matter must be thoroughly removed. Surface preparation is best accomplished by mechanical means such as sandblasting. Consult Technical Service for further recommendations.

Priming: Priming is typically not necessary. Most substrates only require priming if testing indicates a need or where sealant will subjected to immersion after cure. Consult Sikaflex Primer Technical Data Sheet or Technical Service for complete information as to primer requirements.

Mixing: Pour entire contents of Component 'B' into pail of Component 'A'. Now add entire contents of Color-Pak into pail and mix with a low-speed drill (400- 600-rpm) and Sikaflex paddle. Mix for 3-5 minuted to achieve a uniform color and consistency. Scrape down side of pail periodically. Avoid entrapment of air during mixing.
NOTE: When mixing 3-gal unit Two containers of Component 'B' and Two Color Paks must be used.

Application: Recommended application temperatures, 40-100F. Preconditioning units to approximately 70 F is necessary when working at extremes. Move pre-conditioned units to work areas just prior to application. Apply sealant only to clean, sound, dry, and frost-free substrates. Sikaflex-2c should be applied into joints when joint is at mid-point of its designed expansion and contraction. When placing self-leveling grade, pour sealant into joint slot in one direction and allow sealant to flow and level out as necessary. Tool as required. To place non-sag grade, load directly into hand gun or use a follower plate feeding system. Place nozzle of gun into bottom of the joint and fill entire joint. Keeping the nozzle deep in the sealant, continue with a steady flow of sealant preceding the nozzle tip to avoid air entrapment. Avoid overlapping of sealant to eliminate entrapment of air. Tool as required.

6. AVAILABILITY AND COST

Sikaflex-2c is available from Sika manufacturing facilities and distributors in key areas within the continental U.S.A. Consult regional or district office for sources of supply and pricing.

7. WARRANTY

"SIKA WARRANTS ITS PRODUCT TO BE FREE OF MANUFACTURING DEFECTS AND THAT THEY WILL MEET SIKA'S PUBLISHED PHYSICAL PROPERTIES WHEN APPLIED IN ACCORDANCE WITH SIKA'S DIRECTIONS AND TESTED IN ACCORDANCE WITH ASTM AND SIKA STANDARDS. THERE ARE NO OTHER WARRANTIES BY SIKA OF ANY NATURE WHATSOEVER, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH THIS PRODUCT. SIKA CORPORATION SHALL NOT BE LIABLE FOR DAMAGES OF ANY SORT, INCLUDING ANY REMOTE OR CONSEQUENTIAL DAMAGES, RESULTING FROM ANY CLAIMED BREACH OF ANY WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR FROM ANY OTHER CAUSE WHATSOEVER. SIKA SHALL ALSO NOT BE RESPONSIBLE FOR USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT HELD BY OTHERS."

This warranty must be printed in the same manner as heretofore in order to be effective.

8. MAINTENANCE

Maintenance is not typically required. If the sealant is damaged, remove bead. Reprepare surface, prime where required, then install Sikaflex-2c.

9. TECHNICAL SERVICES

Sika maintains district offices in major metropolitan centers and has an extensive distributor network. Technical Service representatives available for on-site consultation. Laboratory facilities and application engineering available upon request.

10. FILING SYSTEMS

SPEC-DATA® II. Additional product information available upon request.

Distribution: Sika products are available from a national network of Sika District Offices and Distributors.

Executive Office: P.O. Box 297, Lyndhurst, NJ 07071 - Tel 201-933-8800 - TWX 710-989-0228 - FAX 201-933-9379

Regional* and District Sales Offices

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CO, Denver 303-458-7452	MN, Bloomington 612-854-6577	TX, Dallas 214-661-3610
CT, Northford 203-484-2551	MO, St. Louis 314-231-5499	TX, Greenville 214-454-6030
FL, N. Miami 305-940-1959	*NJ, Lyndhurst 201-933-8800	TX, Houston 713-461-3010
*FL, Tampa 813-933-5259	NY, Albany 518-452-7453	VA, Richmond 804-271-4029
GA, Atlanta 404-761-7143	OH, Chesterland 216-729-4200	VT, Montpelier 802-229-4905
*IL, Des Plaines 312-298-2810	*OH, Columbus 614-476-3335	WA, Seattle 206-762-3829

Description: Sikaflex primers are special materials formulated to improve the bond of Sikaflex urethane sealants when applied to specific substrates.

Sikaflex Primer 260/205
Sikaflex Primer 260/205 is a dual-purpose, clear, virtually colorless coating. Use it for promoting adhesion of urethane sealants to various metallic, non-metallic, and plastic substrates.

Sikaflex Primer 429/202
Sikaflex Primer 429/202 promotes adhesion to clean, sound, and dry concrete, masonry, and woods -- including teak and mahogany -- prior to placing Sikaflex sealants.

Sikaflex Primer 449/203
Sikaflex Primer 449/203 is used to promote adhesion to pvc, solvent-based enamel, PPG's fluorocarbon Duranar-finish, and certain plastics such as ABS and Plexiglas.

Where to Use: Most substrates require a primer only if testing shows need for it or where the sealant will be underwater after cure. Certain substrates do require a primer under all conditions.

Advantages:
- Single-component, ready to use
- Easily applied by brush, dauber, or spray.

Coverage: Following are average coverages, depending on porosity of substrate:

Sikaflex Primer	260/205	429/202	449/203
Coverage per pint			
Lin ft ½- x ½-in. joint	300-500	300	300-500

Packaging: Sikaflex 260/205 and 449/203 primers are available in pints, 6/carton.
Sikaflex 429/202 primer is available in pints, 6/carton; and gallons, 4/carton.

Technical Data for Sikaflex Primers:
(Material and curing conditions @ 73F and 50% R.H.)

Color:	Clear
Shelf Life:	6 months in original, unopened containers.

How To Use

Surface Preparation: The key to good bondability with Sikaflex sealants/primers is surface preparation. Specifically, all surfaces must be dry and free of dirt, grease, mold release agents, loose mortar, laitance, and any foreign matter. If the joint contains old sealant, it and all extraneous material must be removed and the substrate cleaned by mechanical means. Apply primers at substrate temperatures of 40F and rising. Surface must be frost-free.

Application: Shake or stir primer well before using. Apply to dry, clean, oil-free surface with a brush, dauber, or spray.

Sikaflex Primer	260/205	429/202	449/203
dry time before installing sealant	>1 hr <8 hr *	>1 hr <8 hr *	>30 min <8 hr *

*If sealant cannot be installed within 8 hours of priming, reprime.

Limitations:

- Primer should not be used if it starts to gel in container.
- Protect Sikaflex Primers from moisture. Once container has been opened, use contents immediately.
- Do not attempt to use partial containers.
- Do not reseal or re-use. Resealing may cause moisture contamination and gelling.

CONSTRUCTION SUBSTRATE	SURFACE PREPARATION	SEALANT AND PRIMER RECOMMENDATIONS					
		SIKAFLEX-1a	PRIMER REQUIRED	SIKAFLEX-15LM	PRIMER REQUIRED	SIKAFLEX-2c	PRIMER REQUIRED
Concrete and Masonry	Surfaces must be clean, sound, dry, and free of form oils, grease, or treatments that prevent proper adhesion. Mechanical abrasion may be required. Substrate conditions will change for each job and a test application is recommended to establish the need for or type of preparation required. For best results, primer may be required, on some jobs.						
Concrete Block		Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)
Placed Concrete							
Precast Concrete							
Mortar							
Grout							
Brick							
SikaTops							
Stone	Surfaces must be clean and dry. Test applications are recommended to determine need for & type of surface preparation. Primer may be required, depending on substrate.						
Granite		Acceptable	N.R. Sikaflex 429 (If test shows need) Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need) Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need) Sikaflex 260 (If test shows need)
Marble							
Paints	Surfaces must be clean and dry. Wipe the surface with a clean rag to remove any dust. Since the paint formulation may change, a test application is recommended.						
Acrylic Latex		Do not use	N/A	Do not use	N/A	Do not use	N/A
Emercoat 33							
DeSoto Fluropon							
PPG Duracron S600							
Solvent-based Enamel		Acceptable	Sikaflex 449 Sikaflex 449	Acceptable	Sikaflex 449 Sikaflex 449	Acceptable	Sikaflex 449 Sikaflex 449
PPG Fluorocarbon Duranar			N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)
PPG Polycron			Sikaflex 449 N.R. Sikaflex 260 (If test shows need)		Sikaflex 449 N.R. Sikaflex 260 (If test shows need)		Sikaflex 449 N.R. Sikaflex 260 (If test shows need)
Kynar							
Siliconized Polyester							
Alucobond							
Plastics	Surfaces must be clean and dry. Dry and/or solvent-wipe* with clean rags.						
PVC		Acceptable	Sikaflex 449	Acceptable	Sikaflex 449	Acceptable	Sikaflex 449
ABS							
Plexiglas							
Plexiglas DR							
Lucite							
Rovel Plastic[1]							
Lexan			Sikaflex 260		Sikaflex 260		Sikaflex 260
Teflon		Do not use	N/A	Do not use	N/A	Do not use	N/A
Polyethylene		Do not use	N/A	Do not use	N/A	Do not use	N/A
Polypropylene		Do not use	N/A	Do not use	N/A	Do not use	N/A
Tuffak		Acceptable	Sikaflex 449	Acceptable	Sikaflex 449	Acceptable	Sikaflex 449
Polyester/Fiberglass		Acceptable	Sikaflex 449 (If test shows need)	Acceptable	Sikaflex 449 (If test shows need)	Acceptable	Sikaflex 449 (If test shows need)
Glass	Surfaces must be dry and free of all contaminants. Surfaces should be dry and/or solvent-wiped*. The solvent used should be checked for compatibility with adjacent materials that it will contact.						
Glass — sheet, float, or plate		Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)
Porcelain							
Ceramic Tile							
Metals	Surface must be dust- and oil-free.						
Aluminum — anodized	Dry and/or solvent-wipe* with clean rags.	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)
Aluminum — mill finish	Dry and/or solvent-wipe* with clean rags.						
Lead	Dry and/or solvent-wipe* with clean rags.						
Copper	Remove oxide by sanding. Dry and/or solvent-wipe* with clean rags.						
Brass							
Zinc	Dry and/or solvent-wipe* with clean rags.						
Tinplate	Dry and/or solvent-wipe* with clean rags.						
Steel (bright/clean)	Dry and/or solvent-wipe* with clean rags.						
Steel — stainless	Dry and/or solvent-wipe* with clean rags.		Sikaflex 260		Sikaflex 260		Sikaflex 260
Steel — galvanized	Dry and/or solvent-wipe* with clean rags.		Sikaflex 260		Sikaflex 260		Sikaflex 260
Rubber	Due to varying formulations, test applications are necessary in each case to determine compatibility.						
Urethane		Acceptable	N.R. Sikaflex 449 (If test shows need)	Acceptable	N.R. Sikaflex 449 (If test shows need)	Acceptable	N.R. Sikaflex 449 (If test shows need)
Woods	Surface must be clean and dry. Treated woods must be tested for adhesion.						
Unfinished woods		Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)
Preformed Panels	Surfaces must be clean and dry.						
Dryvit		Do not use	N/A	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	Sikaflex 429
Pleko							
Sto							
Omega-Poly 20		Acceptable	N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)
Other							
Asphaltic Substrates	N/A	Do not use	N/A	Do not use	N/A	Do not use	N/A

N/A — Not Applicable
N.R. — Sealant has been found to bond to the surface without need of primer.
[1] — Slight surface attack may result from primer.
* — *Solvent Handling Requirements* — Do not use alcohol or alcohol-containing solvents.

Solvents are volatile and flammable and should be kept away from heat and open flames. Use only with adequate ventilation and avoid prolonged breathing of vapor. Avoid contact of vapor with open flame or sparks.

When these solvents are used, as described, proper safety precautions must be observed. All solvents must be considered toxic and should be used only in well-ventilated areas. Prolonged exposure to solvent vapors must be avoided. If flammable solvents are used, storage, mixing, and use must be in areas away from open flames or other sources of ignition. The selection of any solvent, particularly chlorinated hydrocarbon solvents, will require consideration of applicable OSHA, EPA, and other federal, state, and local regulations.

Material Safety Data Sheets outlining the known hazards and safety precautions associated with the product or solvent used are published for most materials and may be obtained from the appropriate suppliers and used accordingly.

Caution:
Sikaflex Primers

Warning: **Flammable.** Keep away from sparks and open flames.
Use of an explosion-proof exhaust is recommended.
Sikaflex 260/205 Primer contains methanol.
Sikaflex 429/202 Primer contains methyl-ethyl-ketone and toluene.
Sikaflex 449/203 Primer contains methyl-ethyl-ketone and toluene.
Avoid breathing of vapors. Use of a NIOSH/MSA approved organic vapor respirator is recommended.

Irritant: Product may cause severe burns. Avoid skin and eye contact. Safety goggles and rubber gloves are recommended for prolonged use.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact a physician. For respiratory problems, remove person to fresh air. If ingested, contact physcian immediately.

Clean Up: In case of spillage, ventilate area, collect with absorbent material and dispose of in accordance with applicable local, state, and federal regulations.

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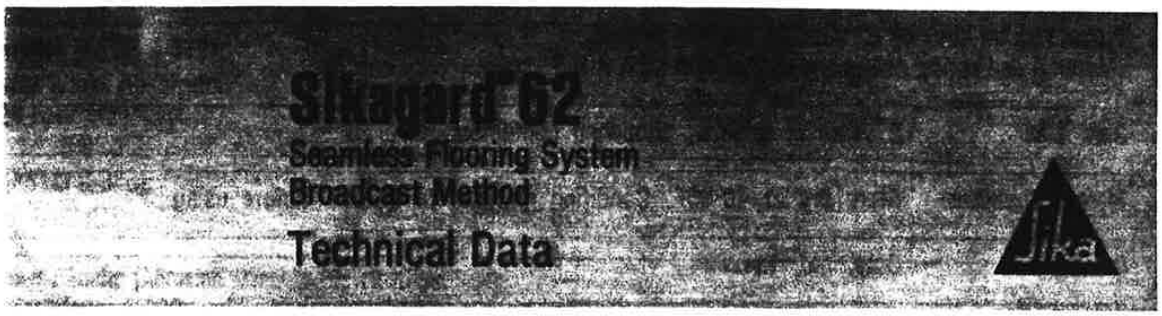

Description: Sikagard 62, Seamless Flooring System, is a 2-component, moisture-insensitive, solvent-free epoxy resin binder for a slip-resistant, seamless flooring system for application by the broadcast method.

Where to Use: Use for interior applications requiring an abrasion- ,chemical- , and slip-resistant overlay with easy maintenance characteristics.

Advantages:

- System is insensitive to moisture before, during, and after cure.
- Excellent adhesive properties to most substrates.
- Convenient, easy mix B:A = 1:1 ratio by volume.
- Superior, long-term abrasion resistance and durability.
- Excellent chemical resistance.
- All colors have USDA approval.
- Easy care, slip-resistant overlay.

Coverage:
Prime coat -225 to 400 sq ft/gal (4-7 mils)
Binder coat -32 sq ft/gal (50 mils)
Broadcast aggregate -2 lb/sq ft to excess
Seal coat -Approximately 160 sq ft/gal

Packaging: 4-gal units; 1-qt units, 12/case.

Typical Data for Sikagard 62 Seamless Flooring System:
(Material and curing conditions @ 73F and 50% R.H.)

Shelf Life:	2 years in original, unopened containers.
Storage Conditions:	Store dry at 40-95F. Condition material to 65-85F before using.
Color:	Gray, red, tan.
Mixing Ratio:	Component 'A' : Component 'B' = 1:1 by volume.
Viscosity:	Approximately 2,700 cps.
Pot Life:	Approximately 35 minutes.
Application Life:	20-25 minutes.
Tack Free Time:	Approximately 4 hours.
Open Time:	Light foot traffic - 5-7 hours. Rubber-wheel traffic - 8-10 hours.
Immersion and chemical exposure:	3 days

Compressive Properties (ASTM D-695):
Compressive Strength, psi

	40F*	73F*	90F*
8 hour	-	200	-
16 hour	-	4,500	-
1 day	40	5,900	5,800
3 day	5,900	8,800	7,200
7 day	7,700	8,800	8,300
14 day	7,700	8,800	9,000
28 day	9,300	9,200	9,000

Modulus of Elasticity, psi: 7.0×10^5 psi

Tensile Properties (ASTM D-638):

14 day	Tensile Strength	3,400 psi
	Elongation at Break	0.5 %

Flexural Properties (ASTM D-790):

14 day	Flexural Strength (Modulus of Rupture)	5,800 psi
	Tangent Modulus of Elasticity in Bending	1.5×10^6 psi

Bond Strength (ASTM C-882): Hardened concrete to hardened concrete

2 day (dry cure)	Bond Strength	2,800 psi
14 day (moist cure)	Bond Strength	2,100 psi

Water Absorption (ASTM D-570):		
7 day	Total Water Absorption (24 hour immersion)	0.6%
Shrinkage (ASTM C-883):		
7 day		passes test
Abrasion Taber Abrader (Abrasion wheel-H-22; 1000-gm load):		
7 day	Weight loss, 1,000 cycles	1.34-gm
	Weight loss, 8,000 cycles	11.05-gm

* Material cured and tested at the temperatures indicated.

How To Use

Surface Preparation: Surface must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated materials.

Preparation Work: Concrete - Sandblast or use other approved mechanical means.
Steel - Sandblast to white-metal finish.

Mixing: Pre-mix each component. Proportion equal parts by volume of Components 'A' and 'B' into a clean mixing container. Mix with a low-speed (400- 600-rpm) drill and Sika paddle for 3 minutes, until uniform in color.
Mix only that quantity that can be used within its application life.

Application: Prime the prepared substrate with neat Sikagard 62, using a roller. Coverage should be 275-400 sq ft/gal.
While the primer is still tacky, apply the binder material with a 3/16-in. x 3/16-in. notched-rubber squeegee. Allow the binder to self-level. Slowly broadcast an oven-dried sand (20-30 gradation is preferable) so that the sand falls vertically into the binder. Continue to broadcast lightly, making several passes, allowing the binder to bleed through the sand before making next pass. Cover completely with sand before binder becomes tack-free.
After broadcast system has reached sufficient cure as not to be damaged, remove excess sand. Seal coat the broadcast with a neat coat of Sikagard 62 using a roller or flat squeegee, depending on the degree of slip-resistance you require.

Limitations:

- Minimum substrate temperature for application 50F.
- Do not apply over wet, glistening surface.
- Material is a vapor barrier after cure.
- Do not apply to porous surfaces exhibiting moisture-vapor transmission during the application. Consult Technical Service.
- Minumim age of concrete prior to application is 21-28 days, depending on curing and drying conditions.
- Do not apply to exterior, on-grade substrates.
- Use oven-dried aggregate only.
- Do not thin with solvents.
- For interior applications only.

Caution: **Component 'A'-Irritant** - Prolonged contact with skin may cause irritation. Avoid eye contact. **Component 'B'-Corrosive** - Contact with skin may cause severe burns. Avoid eye contact. Product is a strong sensitizer. Use of safety goggles and chemical-resistant gloves recommended. Remove contaminated clothing. Avoid breathing vapors. Use adequate ventilation. Use of a NIOSH/MSA organic vapor respirator recommended.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician immediately. For respiratory problems, remove person to fresh air. Wash clothing before re-use.

Clean Up: Collect with absorbent material, flush area with water. Dispose of in accordance with local disposal regulations. Uncured material can be removed with approved solvent. Cured material can only be removed mechanically.

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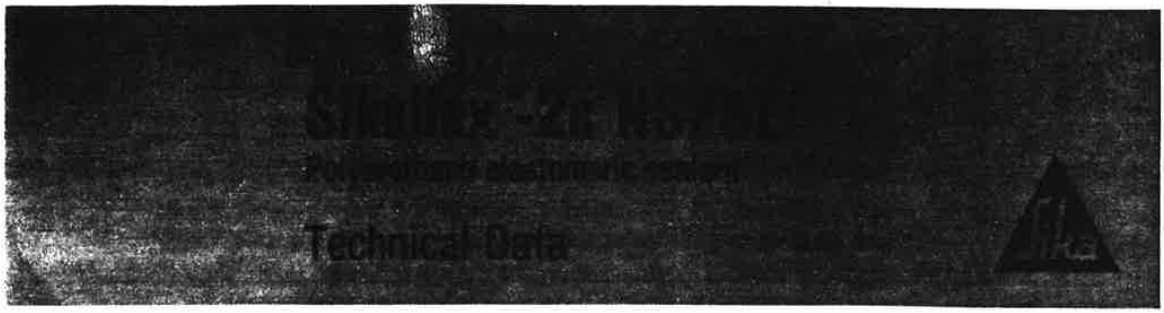

Description:	Sikaflex-2c is a 2-component, premium-grade, polyurethane-base, elastomeric sealant. Principally a chemical cure in a non-sag and self-leveling consistency. Available in 43 colors with convenient Color-Pak.
Where to Use:	• Intended for use in all properly designed working joints with a minimum depth of ¼ in. • Ideal for vertical and horizontal applications. • Placeable at temperatures as low as 40F. • Adheres to most substrates commonly found in construction.
Advantages:	• Capable of ±50% joint movement. • Chemical cure allows the sealant to be placed in joints exceeding ½ in. in depth. • High elasticity with a tough, durable, flexible consistency. • Exceptional cut- and tear-resistance. • Exceptional adhesion to most substrates without priming. • Available in 43 architectural colors. • Color uniformity assured via Color-Pak system. • Non-sag even in wide joints. • Self-leveling consistency is easy to apply into horizontal joints. • Jet fuel resistant. • Paintable with water-, oil-, and rubber-base paints. • Both grades meet ASTM C-920. • Both grades meet Federal Specification TT-S-00227E.
Coverage:	1 gal yields 231 cu in. or 154 lin ft of a ½-in. X ¼-in. joint.
Packaging:	1.5-gal. Available on special order, 3-gal units.

Typical Technical Data for Sikaflex-2c:
(Material and curing conditions 73F and 50% R.H.)

Colors:	A wide range of architectural colors are available. Special colors available on request.
Shelf Life:	One year in original, unopened container.
Storage Conditions:	Store dry at 40-95F. Condition material to 65-75F before using.
Application Temperature	40 to 100F, ambient and substrate temperatures. Sealant should be installed when joint is at mid-range of its anticipated movement.
Service Range:	-40 to 167F

Property:	**Non-sag**	**Self-leveling**	**Test Method**
Application life:	3-4 hr	3-4 hr	TT-S-00227E
Tack-free Time:	6-8 hr	6-8 hr	ASTM C-679
Final Cure:	3 day	3 day	
Shore A Hardness:	25±5	40 ± 5	ASTM D-2240
Tensile Strength at Break:	200 psi	200 psi	ASTM D-412
Tensile Elongation:	650%	650%	ASTM D-412
100% Modulus:	75 psi	100 psi	ASTM D-412
Tear Strength:	125 lb/in.	125 lb/in.	ASTM D-624

Adhesion in Peel:

				TT-S-00227E
Substrate	Peel Strength	% Adhesion Loss	Peel Strength	% Adhesion Loss
Aluminum	30 lb	Zero	30 lb	Zero
Glass	30 lb	Zero	30 lb	Zero
Concrete	25 lb	Zero	30 lb	Zero

Weathering Resistance:	Excellent
Ozone Resistance:	Excellent
Chemical Resistance:	Good resistance to water, diluted acids, diluted alkalines, and residential sewage. Consult Technical Service for specific data.

How To Use

Surface Preparation: All joint-wall surfaces must be clean, sound, and frost-free. Joint walls must be free of oils, grease, curing compound residues, and any other foreign matter that might prevent bond. Ideally this should be accomplished by mechanical means.
Bond breaker tape or backer rod must be used in bottom of joint to prevent bond.

Priming: Priming is typically not necessary. Most substrates only require priming if testing indicates a need or where sealant will be subjected to water submersion after cure.
Consult Technical Service or Sikaflex Primer Technical Data Sheet for additional information on priming.

Mixing: Pour entire contents of Component 'B' into pail of Component 'A'. Now add entire contents of Color-Pak into pail and mix with a low-speed drill (400- 600-rpm) and Sikaflex paddle. Mix for 3-5 minutes to achieve a uniform color and consistency. Scrape down sides of pail periodically. Avoid entrapment of air during mixing.
Color pak must be used.
Note: When mixing 3-gal unit **two** containers of Component'B' and **two** Color Paks must be used.

Application: Recommended application temperatures 40F-100F. Pre-conditioning units to approximately 70F is necessary when working at extremes. Move pre-conditioned units to work areas just prior to application.

Apply sealant only to clean, sound, dry, and frost-free substrates. Sikaflex-2c should be applied into joints when joint slot is at mid-point of its designed expansion and contraction. When placing self-leveling grade, pour sealant into joint slot in one direction and allow sealant to flow and level out as necessary. Tool as required.
To place non-sag grade, load directly into bulk gun or use a follower plate loading system. Place nozzle of gun into bottom of joint and fill entire joint. Keeping the nozzle deep in the sealant, continue with a steady flow of sealant preceding nozzle to avoid air entrapment. Also, avoid overlapping of sealant since this also entraps air. Tool as required.
For use in horizontal joints in traffic areas, the absolute minimum depth of the sealant is ½ in. and closed cell backer rod is recommended over open cell to offer greater support.

Limitations:

- The ultimate performance of Sikaflex-2c depends on good joint design and proper application.
- Minimum depth in working joint is ¼ in.
- Maximum expansion and contraction should not exceed 50% of average joint width.
- Do not cure in the presence of curing silicones.
- Avoid contact with alcohol and other solvent cleaners during cure.
- Allow 3-day cure before subjecting sealant to total water immersion.
- Avoid exposure to high levels of chlorine.
- Do not apply when moisture vapor transmission condition exists since this can cause bubbling within the sealant.
- Avoid over-mixing sealant.
- Minimum depth of sealant in horizontal joints subject to traffic is ½ in.

Caution:

Combustible: Keep away from open flames and high heat. Contains xylene; avoid breathing vapors. Use with adequate ventilation.

Irritant: Avoid skin and eye contact. Use of NIOSH/MSA approved organic vapor respirator, safety goggles, and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean Up: Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with applicable local, state, and federal regulations.

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SPEC DATA®

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1. PRODUCT NAME

SIKAFLEX-2c NS/SL Two-component, Non-Sag, Self-Leveling, Premium-Grade, High-Performance, Elastomeric Joint Sealant

2. MANUFACTURER

SIKA CORPORATION
Construction Products Division
201 Polito Avenue
P.O. Box 297
Lyndhurst, NJ 07071
Phone: (201) 933-8800
TWX 710-989-0288
Telefax (201) 933-9379

3. PRODUCT DESCRIPTION

Sikaflex-2c is a 2-component, principally a chemical cure, non-sag/self-leveling permanently flexible polyurethane sealant that is self-priming with most construction materials. It resists attack from dilute acids and alkalines, jet fuel, water, and residential sewage. Curing to a flexible consistency with exceptional cut- and tear-resistance, Sikaflex-2c offers superior performance when used between substrates with dissimilar coefficients of expansion: i.e., concrete, wood, glass, steel, aluminum, copper, ceramics, brick, asbestos cement, polyester, and epoxy.

Basic Uses: Building Construction: Sikaflex-2c is designed for all expansion and contraction joints where maximum expansion/contraction should not exceed ±50%. Used where a chemical-cure sealant is required.

Heavy Construction: Sikaflex-2c can be used in a wide range of projects including municipal buildings, condominiums, sport stadia, parking garages, water treatment plants, canals, department stores, bridges, and similar structures.

Limitations: The ultimate performance of Sikaflex-2c depends on good joint design and proper application. Maximum expansion and contraction should not exceed 50% of average joint width. Do not cure in the presence of curing silicones. Avoid contact with alcohol and other solvent cleaners during cure. Allow 3-day cure before subjecting sealant to total water immersion. Avoid exposure to high levels of chlorine. Do not apply when moisture-vapor-transmission condition exists since this can cause bubbling within the sealant. Avoid over-mixing sealant.

Caution: Combustible. Keep away from open flames and high heat. This product contains xylene. Use only with adequate ventilation. Avoid prolonged breathing of vapors.

Irritant: Avoid skin and eye contact. Use of NIOSH/MSA approved organic vapor respirator, safety goggles, and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean-Up: Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with applicable local regulations.

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4. TECHNICAL DATA

(Material and curing conditions 73F and 50% R.H.)

PROPERTY	NON-SAG	SELF-LEVELING	TEST METHOD
Application:	3-4 hr	3-4 hr	TT-S-00227E
Cure Time: Tack-Free Time	6-8 hr	6-8 hr	ASTM C-679
Final Cure	3 days	3 days	
Shore A Hardness cured and tested 14 days	25 ± 5	40 ± 5	ASTM D-2240
Tensile Strength at Break:	200 psi	200 psi	ASTM D-412
Tensile Elongation	650%	650%	
100% Modulus cured and tested 14 days	75 psi	100 psi	
Tear Strength: cured and tested 14 days	125 lb/in.	125 lb/in.	ASTM D-624

ADHESION IN PEEL

SUBSTRATE	PEEL STRENGTH	ADHESION LOSS	PEEL STRENGTH	ADHESION LOSS	
Aluminum	30	0%	30 lb	0%	TT-S-00227E
Glass	30	0%	30 lb	0%	
Concrete	25	0%	30 lb	0%	
Weathering		Excellent		Excellent	
Tear Resistance		Exceptional		Exceptional	
Application Temperature		40F to 100F		40F to 100F	
Service Range		-40F to 167F		-40F to 167F	

Composition and Materials: Sikaflex-2c, is principally a chemical-cure that shows excellent resistance to weathering: service range extends from -40 to 167F.

Grade: Non-sag and self-leveling consistency.

Packaging: 1.5-gal and 3-gal units.

Shelf Life: One year in original, unopened containers.

Storage Conditions: Store dry at 40-95F. Condition material to 65-75F before using.

Colors: Twelve standard colors: white, colonial white, aluminum gray, black, limestone, dark bronze, capitol tan, sandalwood, buff, bronze, precast, and redwood tab. Special colors may be formulated to match particular needs.

Applicable Standards: U.S.A. Federal Specification TT-S-00227E, Types I and II, Class A. ASTM C-920-79, Type M, Class 25, Grade P & NS.

5. INSTALLATION

Joint Design: The ultimate performance of Sikaflex-2c depends on good joint design and proper application. Maximum expansion and contraction should not exceed ±50% of average joint width. A width to depth ratio of 2:1 is preferable. Foam backer rods are recommended to control depth-to-width ratio, and to prevent bonding at bottom of joint.

Surface Preparation: Clean all surfaces. Joint walls must be sound, clean, dry, and free from oil, grease and frost. Curing compound residues and any other foreign matter must be thoroughly removed. Surface preparation is best accomplished by mechanical means such as sandblasting. Consult Technical Service for further recommendations.

Priming: Priming is typically not necessary. Most substrates only require priming if testing indicates a need or where sealant will subjected to immersion after cure. Consult Sikaflex Primer Technical Data Sheet or Technical Service for complete information as to primer requirements.

Mixing: Pour entire contents of Component 'B' into pail of Component 'A'. Now add entire contents of Color-Pak into pail and mix with a low-speed drill (400- 600-rpm) and Sikaflex paddle. Mix for 3-5 minuted to achieve a uniform color and consistency. Scrape down side of pail periodically. Avoid entrapment of air during mixing.

NOTE: When mixing 3-gal unit **Two** containers of Component 'B' and **Two** Color Paks must be used.

Application: Recommended application temperatures, 40-100F. Preconditioning units to approximately 70 F is necessary when working at extremes. Move pre-conditioned units to work areas just prior to application. Apply sealant only to clean, sound, dry, and frost-free substrates. Sikaflex-2c should be applied into joints when joint is at mid-point of its designed expansion and contraction. When placing self-leveling grade, pour sealant into joint slot in one direction and allow sealant to flow and level out as necessary. Tool as required. To place non-sag grade, load directly into bulk gun or use a follower plate loading system. Place nozzle of gun into bottom of the joint and fill entire joint. Keeping the nozzle deep in the sealant, continue with a steady flow of sealant preceding the nozzle to avoid air entrapment. Avoid overlapping of sealant to eliminate entrapment of air. Tool as required.

6. AVAILABILITY AND COST

Sikaflex-2c is available from Sika manufacturing facilities and distributors in key areas within the continental U.S.A. Consult regional or district office for sources of supply and pricing.

7. WARRANTY

"SIKA WARRANTS ITS PRODUCT TO BE FREE OF MANUFACTURING DEFECTS AND THAT THEY WILL MEET SIKA'S PUBLISHED PHYSICAL PROPERTIES WHEN APPLIED IN ACCORDANCE WITH SIKA'S DIRECTIONS AND TESTED IN ACCORDANCE WITH ASTM AND SIKA STANDARDS. THERE ARE NO OTHER WARRANTIES BY SIKA OF ANY NATURE WHATSOEVER, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH THIS PRODUCT. SIKA CORPORATION SHALL NOT BE LIABLE FOR DAMAGES OF ANY SORT, INCLUDING ANY REMOTE OR CONSEQUENTIAL DAMAGES, RESULTING FROM ANY CLAIMED BREACH OF ANY WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR FROM ANY OTHER CAUSE WHATSOEVER. SIKA SHALL ALSO NOT BE RESPONSIBLE FOR USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT HELD BY OTHERS."

This warranty must be printed in the same manner as heretofore in order to be effective.

8. MAINTENANCE

Maintenance is not typically required. If the sealant is damaged, remove bead. Reprepare surface, prime where required, then install Sikaflex-2c.

9. TECHNICAL SERVICES

Sika maintains district offices in major metropolitan centers and has an extensive distributor network. Technical Service representatives available for on-site consultation. Laboratory facilities and application engineering available upon request.

10. FILING SYSTEMS

SPEC-DATA® II. Additional product information available upon request.

Distribution: Sika products are available from a national network of Sika District Offices and Distributors.

Executive Office: P.O. Box 297, Lyndhurst, NJ 07071 - Tel 201-933-8800 - TWX 710-989-0228 - FAX 201-933-9379

Regional* and District Sales Offices

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*CA, Santa Fe Springs 213-941-0231	MA, Marblehead 617-631-9247	PA, Philadelphia 215-923-6575
CA, Union City 415-487-2294	MD, Annapolis 301-268-7774	SC, Spartanburg 803-573-8867
CO, Denver 303-458-7452	MN, Bloomington 612-854-6577	TX, Dallas 214-661-3610
CT, Northford 203-484-2551	MO, St Louis 314-231-5499	TX, Greenville 214-454-6030
FL, N. Miami 305-940-1959	*NJ, Lyndhurst 201-933-8800	TX, Houston 713-461-3010
*FL, Tampa 813-933-5259	NY, Albany 518-452-7453	VA, Richmond 804-271-4029
GA, Atlanta 404-761-7143	OH, Chesterland 216-729-4200	VT, Montpelier 802-229-4905
*IL, Des Plaines 312-298-2810	*OH, Columbus 614-476-3335	WA, Seattle 206-762-3829

Description: Sikaflex primers are special materials formulated to improve the bond of Sikaflex urethane sealants when applied to specific substrates.

Sikaflex Primer 260/205
Sikaflex Primer 260/205 is a dual-purpose, clear, virtually colorless coating. Use it for promoting adhesion of urethane sealants to various metallic, non-metallic, and plastic substrates.

Sikaflex Primer 429/202
Sikaflex Primer 429/202 promotes adhesion to clean, sound, and dry concrete, masonry, and woods -- including teak and mahogany -- prior to placing Sikaflex sealants.

Sikaflex Primer 449/203
Sikaflex Primer 449/203 is used to promote adhesion to pvc, solvent-based enamel, PPG's fluorocarbon Duranar-finish, and certain plastics such as ABS and Plexiglas.

Where to Use: Most substrates require a primer only if testing shows need for it or where the sealant will be underwater after cure. Certain substrates do require a primer under all conditions.

Advantages:
- Single-component, ready to use
- Easily applied by brush, dauber, or spray.

Coverage: Following are average coverages, depending on porosity of substrate:

Sikaflex Primer	260/205	429/202	449/203
Coverage per pint Lin ft ½- x ½-in. joint	300-500	300	300-500

Packaging: Sikaflex 260/205 and 449/203 primers are available in pints, 6/carton.
Sikaflex 429/202 primer is available in pints, 6/carton; and gallons, 4/carton.

Technical Data for Sikaflex Primers:
(Material and curing conditions @ 73F and 50% R.H.)

Color:	Clear
Shelf Life:	6 months in original, unopened containers.

How To Use

Surface Preparation: The key to good bondability with Sikaflex sealants/primers is surface preparation. Specifically, all surfaces must be dry and free of dirt, grease, mold release agents, loose mortar, laitance, and any foreign matter. If the joint contains old sealant, it and all extraneous material must be removed and the substrate cleaned by mechanical means. Apply primers at substrate temperatures of 40F and rising. Surface must be frost-free.

Application: Shake or stir primer well before using. Apply to dry, clean, oil-free surface with a brush, dauber, or spray.

Sikaflex Primer	260/205	429/202	449/203
dry time before installing sealant	>1 hr <8 hr *	>1 hr <8 hr *	>30 min <8 hr *

*If sealant cannot be installed within 8 hours of priming, reprime.

Limitations:

- Primer should not be used if it starts to gel in container.
- Protect Sikaflex Primers from moisture. Once container has been opened, use contents immediately.
- Do not attempt to use partial containers.
- Do not reseal or re-use. Resealing may cause moisture contamination and gelling.

CONSTRUCTION SUBSTRATE	SURFACE PREPARATION	SEALANT AND PRIMER RECOMMENDATIONS					
		SIKAFLEX-1a	PRIMER REQUIRED	SIKAFLEX-15LM	PRIMER REQUIRED	SIKAFLEX-2c	PRIMER REQUIRED
Concrete and Masonry	Surfaces must be clean, sound, dry, and free of form oils, grease, or treatments that prevent proper adhesion. Mechanical abrasion may be required. Substrate conditions will change for each job and a test application is recommended to establish the need for or type of preparation required. For best results, primer may be required, on some jobs.						
Concrete Block		Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)
Placed Concrete							
Precast Concrete							
Mortar							
Grout							
Brick							
SikaTops							
Stone	Surfaces must be clean and dry. Test applications are recommended to determine need for & type of surface preparation. Primer may be required, depending on substrate.						
Granite		Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)
Marble			Sikaflex 260 (If test shows need)		Sikaflex 260 (If test shows need)		Sikaflex 260 (If test shows need)
Paints	Surfaces must be clean and dry. Wipe the surface with a clean rag to remove any dust. Since the paint formulation may change, a test application is recommended.						
Acrylic Latex		Do not use	N/A	Do not use	N/A	Do not use	N/A
Emercoat 33							
DeSoto Fluropon							
PPG Duracron S600							
Solvent-based Enamel		Acceptable	Sikaflex 449	Acceptable	Sikaflex 449	Acceptable	Sikaflex 449
PPG Fluorocarbon Duranar			Sikaflex 449		Sikaflex 449		Sikaflex 449
PPG Polycron			N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)
Kynar			Sikaflex 449		Sikaflex 449		Sikaflex 449
Siliconized Polyester			N.R. Sikaflex 260 (If test shows need)		N.R. Sikaflex 260 (If test shows need)		N.R. Sikaflex 260 (If test shows need)
Alucobond							
Plastics							
PVC		Acceptable	Sikaflex 449	Acceptable	Sikaflex 449	Acceptable	Sikaflex 449
ABS							
Plexiglas							
Plexiglas DR							
Lucite							
Rovel Plastic[1]	Surfaces must be clean and dry. Dry and/or solvent-wipe* with clean rags.						
Lexan			Sikaflex 260		Sikaflex 260		Sikaflex 260
Teflon		Do not use	N/A	Do not use	N/A	Do not use	N/A
Polyethylene		Do not use	N/A	Do not use	N/A	Do not use	N/A
Polypropylene		Do not use	N/A	Do not use	N/A	Do not use	N/A
Tuffak		Acceptable	Sikaflex 449	Acceptable	Sikaflex 449	Acceptable	Sikaflex 449
Polyester/Fiberglass		Acceptable	Sikaflex 449 (If test shows need)	Acceptable	Sikaflex 449 (If test shows need)	Acceptable	Sikaflex 449 (If test shows need)
Glass	Surfaces must be dry and free of all contaminants. Surfaces should be dry and/or solvent-wiped*. The solvent used should be checked for compatibility with adjacent materials that it will contact.						
Glass — sheet, float, or plate		Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)
Porcelain							
Ceramic Tile							
Metals	Surface must be dust- and oil-free.						
Aluminum — anodized	Dry and/or solvent-wipe* with clean rags.	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)	Acceptable	N.R. Sikaflex 260 (If test shows need)
Aluminum — mill finish	Dry and/or solvent-wipe* with clean rags.						
Lead	Dry and/or solvent-wipe* with clean rags.						
Copper	Remove oxide by sanding. Dry and/or solvent-wipe* with clean rags.						
Brass							
Zinc	Dry and/or solvent-wipe* with clean rags.						
Tinplate	Dry and/or solvent-wipe* with clean rags.						
Steel (bright/clean)	Dry and/or solvent-wipe* with clean rags.						
Steel — stainless	Dry and/or solvent-wipe* with clean rags.		Sikaflex 260		Sikaflex 260		Sikaflex 260
Steel — galvanized	Dry and/or solvent-wipe* with clean rags.		Sikaflex 260		Sikaflex 260		Sikaflex 260
Rubber							
Urethane	Due to varying formulations, test applications are necessary in each case to determine compatibility.	Acceptable	N.R. Sikaflex 449 (If test shows need)	Acceptable	N.R. Sikaflex 449 (If test shows need)	Acceptable	N.R. Sikaflex 449 (If test shows need)
Woods							
Unfinished woods	Surface must be clean and dry. Treated woods must be tested for adhesion.	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	N.R. Sikaflex 429 (If test shows need)
Preformed Panels							
Dryvit	Surfaces must be clean and dry.	Do not use	N/A	Acceptable	N.R. Sikaflex 429 (If test shows need)	Acceptable	Sikaflex 429
Pleko							
Sto							
Omega-Poly 20		Acceptable	N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)		N.R. Sikaflex 449 (If test shows need)
Other							
Asphaltic Substrates	N/A	Do not use	N/A	Do not use	N/A	Do not use	N/A

N/A — Not Applicable
N.R. — Sealant has been found to bond to the surface without need of primer.
[1] — Slight surface attack may result from primer.
* — *Solvent Handling Requirements* — Do not use alcohol or alcohol-containing solvents.

Solvents are volatile and flammable and should be kept away from heat and open flames. Use only with adequate ventilation and avoid prolonged breathing of vapor. Avoid contact of vapor with open flame or sparks.

When these solvents are used, as described, proper safety precautions must be observed. All solvents must be considered toxic and should be used only in well-ventilated areas. Prolonged exposure to solvent vapors must be avoided. If flammable solvents are used, storage, mixing, and use must be in areas away from open flames or other sources of ignition. The selection of any solvent, particularly chlorinated hydrocarbon solvents, will require consideration of applicable OSHA, EPA, and other federal, state, and local regulations.

Material Safety Data Sheets outlining the known hazards and safety precautions associated with the product or solvent used are published for most materials and may be obtained from the appropriate suppliers and used accordingly.

Caution:
Sikaflex Primers

Warning: **Flammable.** Keep away from sparks and open flames.
Use of an explosion-proof exhaust is recommended.
Sikaflex 260/205 Primer contains methanol.
Sikaflex 429/202 Primer contains methyl-ethyl-ketone and toluene.
Sikaflex 449/203 Primer contains methyl-ethyl-ketone and toluene.
Avoid breathing of vapors. Use of a NIOSH/MSA approved organic vapor respirator is recommended.

Irritant: Product may cause severe burns. Avoid skin and eye contact. Safety goggles and rubber gloves are recommended for prolonged use.

First Aid: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact a physician. For respiratory problems, remove person to fresh air. If ingested, contact physcian immediately.

Clean Up: In case of spillage, ventilate area, collect with absorbent material and dispose of in accordance with applicable local, state, and federal regulations.

KEEP CONTAINER TIGHTLY CLOSED **KEEP OUT OF REACH OF CHILDREN**
NOT FOR INTERNAL CONSUMPTION **FOR INDUSTRIAL USE ONLY**
CONSULT MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION

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Fax: 513.771.2120
nmanning@3d-engineering.net

Long Range Scan of Cooling Tower

Prepared for: AEP AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, OH 43215
614-716-1393

Prepared by: Nick Manning

Approved by: Rob Glassburn, P.E.

10597 Chester Rd
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Phone: 513.771.7710
Fax: 513.771.2120
rglassburn@3d-engineering.net

Date: 5/3/2016

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CERTIFICATE OF INSPECTION

CUSTOMER:	American Electric Power 1 Riverside Plaza Columbus, OH 43215 614-716-1393
PO NUMBER:	Verbal
PART DESCRIPTION:	Cooling Tower
UNIT OF MEASURE:	Feet
INSPECTED BY:	Nick Manning & Andrew Sudkamp
INSPECTION EQUIPMENT:	Faro Laser Scanner Focus^{3D} X330 S/N LLS071405659
INSPECTION DATE:	04/13/16

This is to certify that the item listed above was inspected with instrument(s) calibrated with standards traceable to the International System of Units (SI) through a National Metrological Institute (NMI) or an ISO17025 Accredited Laboratory.

Approved by: _____ Date: 5/3/2016

Rob Glassburn, P.E.
VP of Operations

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Method:

The cooling tower was scanned using a FARO Laser Scanner Focus^{3D} X330. Point cloud data was collected for the tower in a set of individual scans that were brought into FARO Scene. Once imported into FARO Scene the individual scans were aligned to one other with the aid of the on board GPS of the X330. The scan data was then imported into PolyWorks IMInspect.

Two CAD models were created based on the data collected and supplied by the customer. The first CAD model was created using a cross section of the tower located in a "good" section of the tower. A profile of the tower was created in Solidworks by revolving the cross section about a center axis. The second CAD model was created based on the customer supplied drawing that outlined diameters and specific elevations. As with the first model a profile of the tower was created in Solidworks based on the cross section that was made from the supplied dimensions.

Three comparison methods were used in order to show the magnitude of the deviations between the created model and the collected point cloud data. Method one used the first CAD model in the position that it was created in order to compare the data. Method two used the first CAD model as well but this time a best-fit alignment was used to place the data. Finally for method three the second CAD model was used with a best-fit alignment. Color maps for each one of these comparison methods were created and can be found within the report. Points showing the approximate directions of North, South, East, and West were created to use as reference.

Color map screenshots in this report will show a scale on the right side of the image (Please note the scale may change from page to page). Positive deviations mean the scan data is above the CAD model surface; negative deviations mean the scan data are below the CAD model surface. Some areas may appear gray – these areas are either out of the color scale range or do not have data for comparison.

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Comparison Method 1
CAD Model 1 in Original Position

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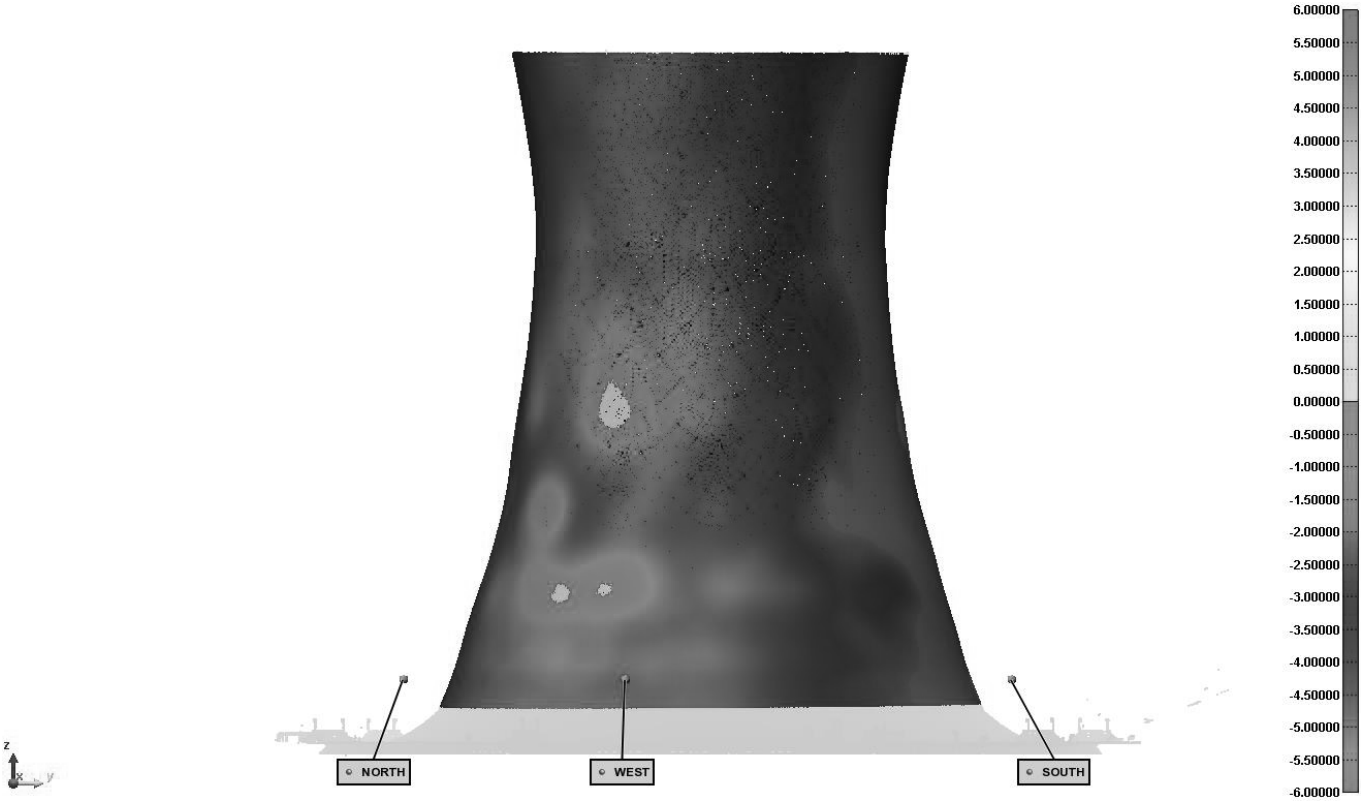

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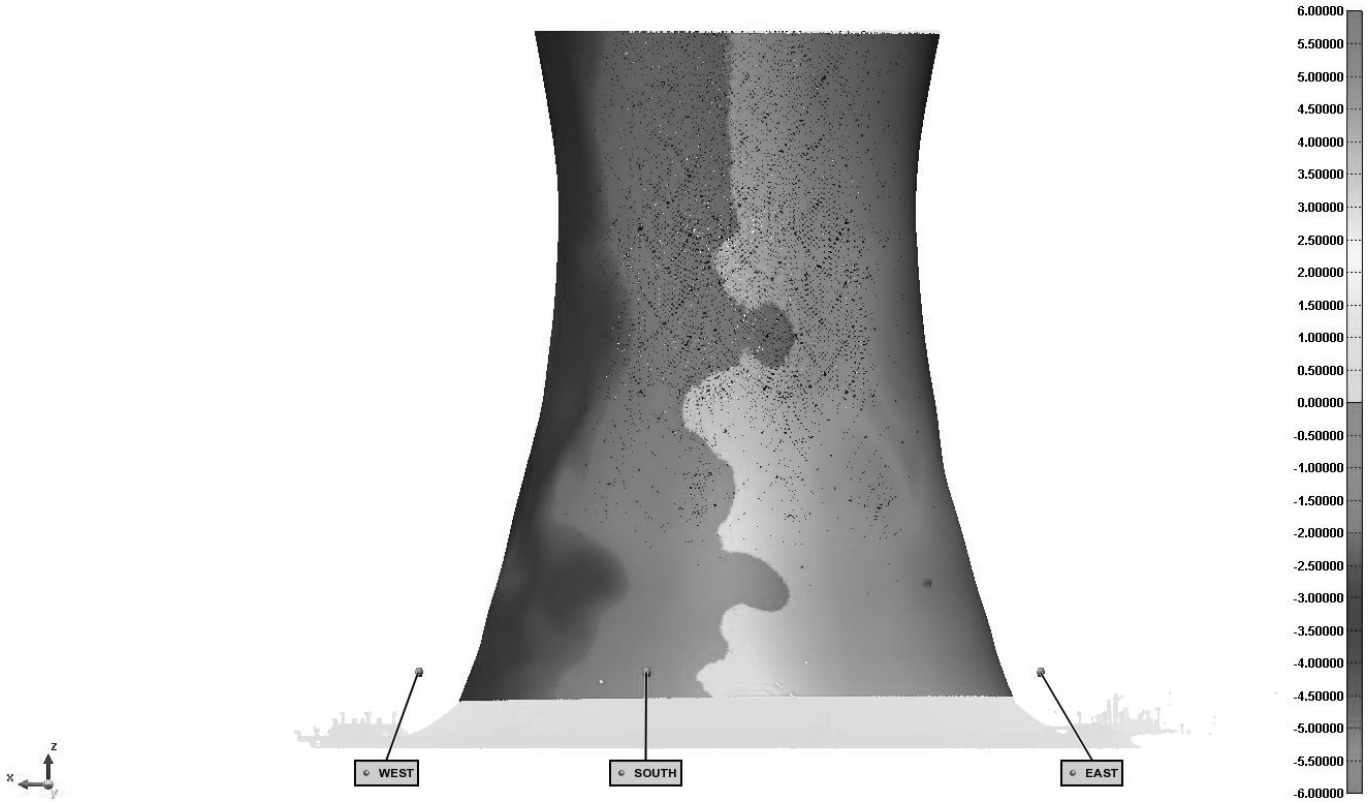

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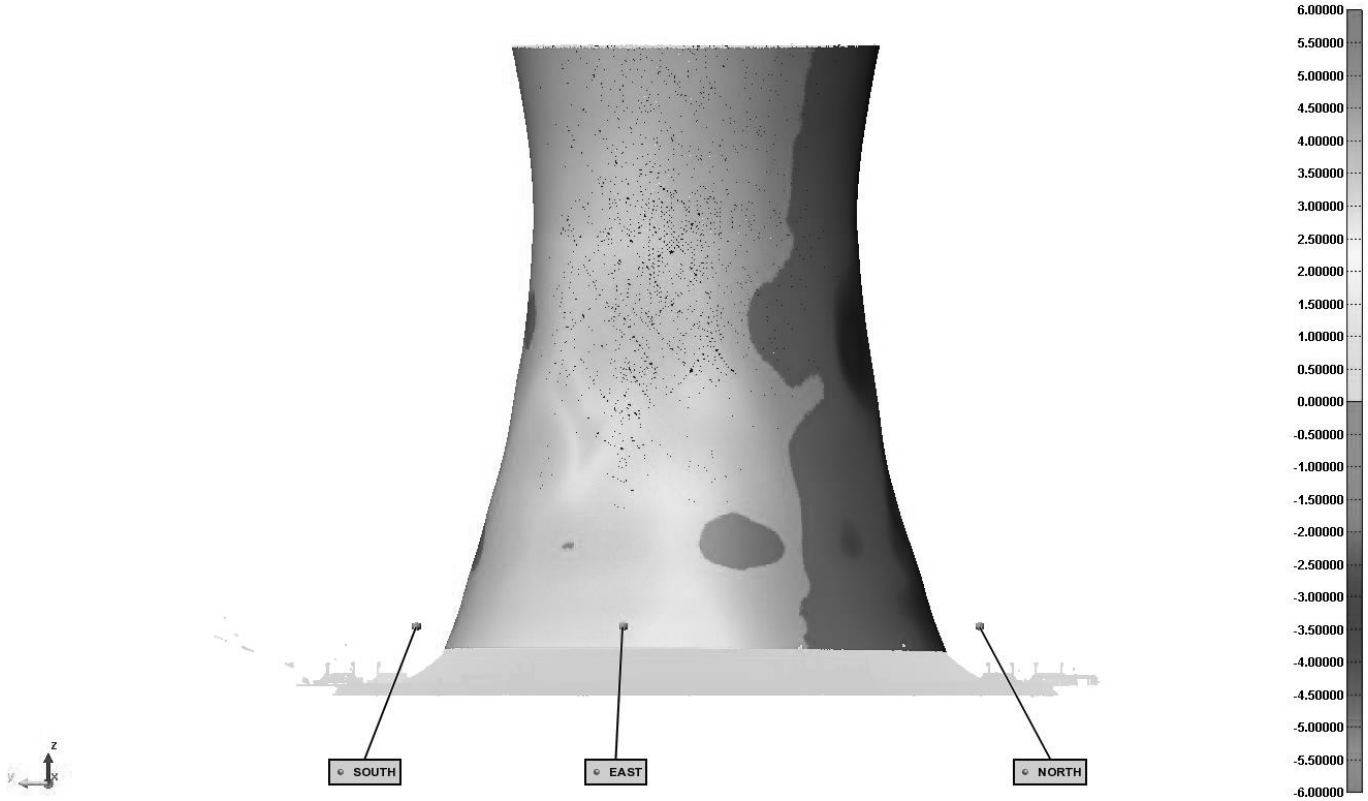

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Comparison Method 2
CAD Model 1 Best Fit Alignment

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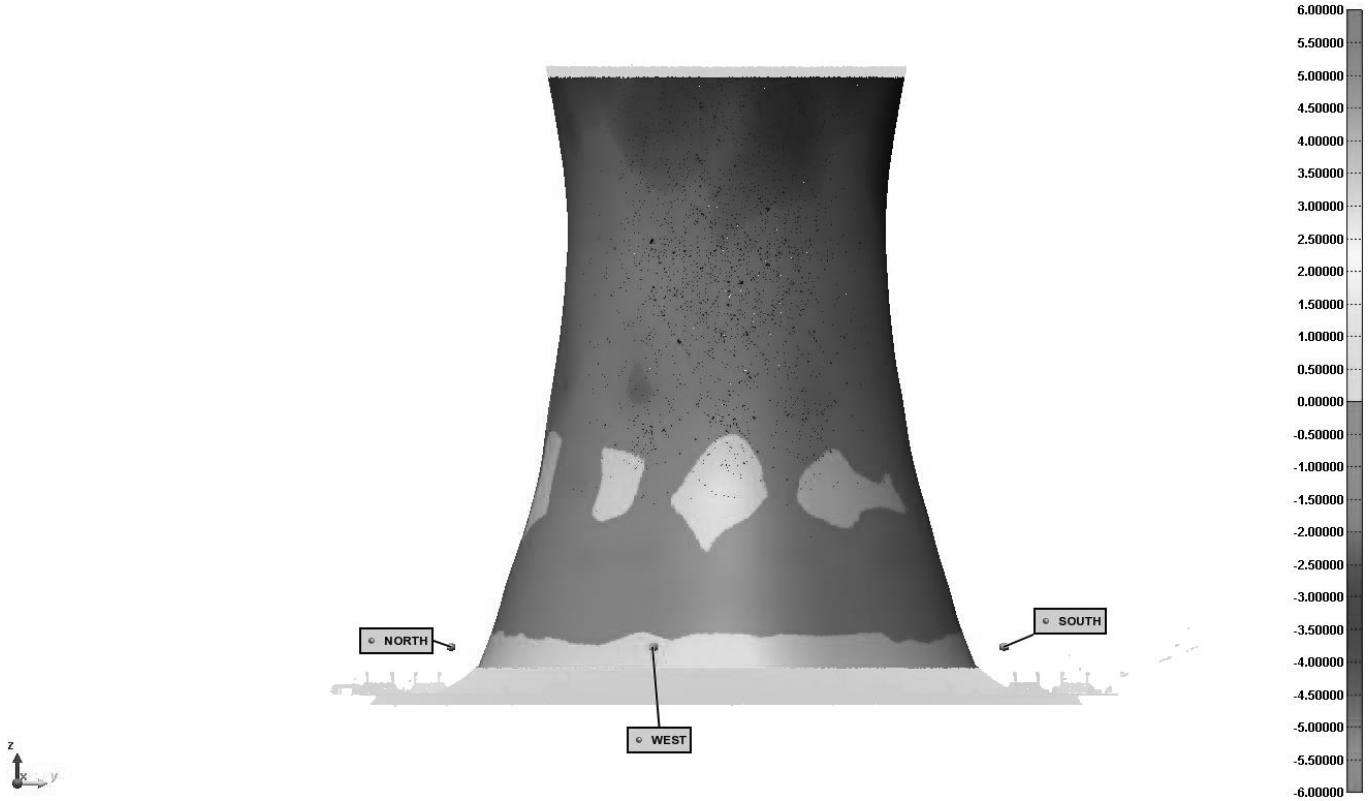

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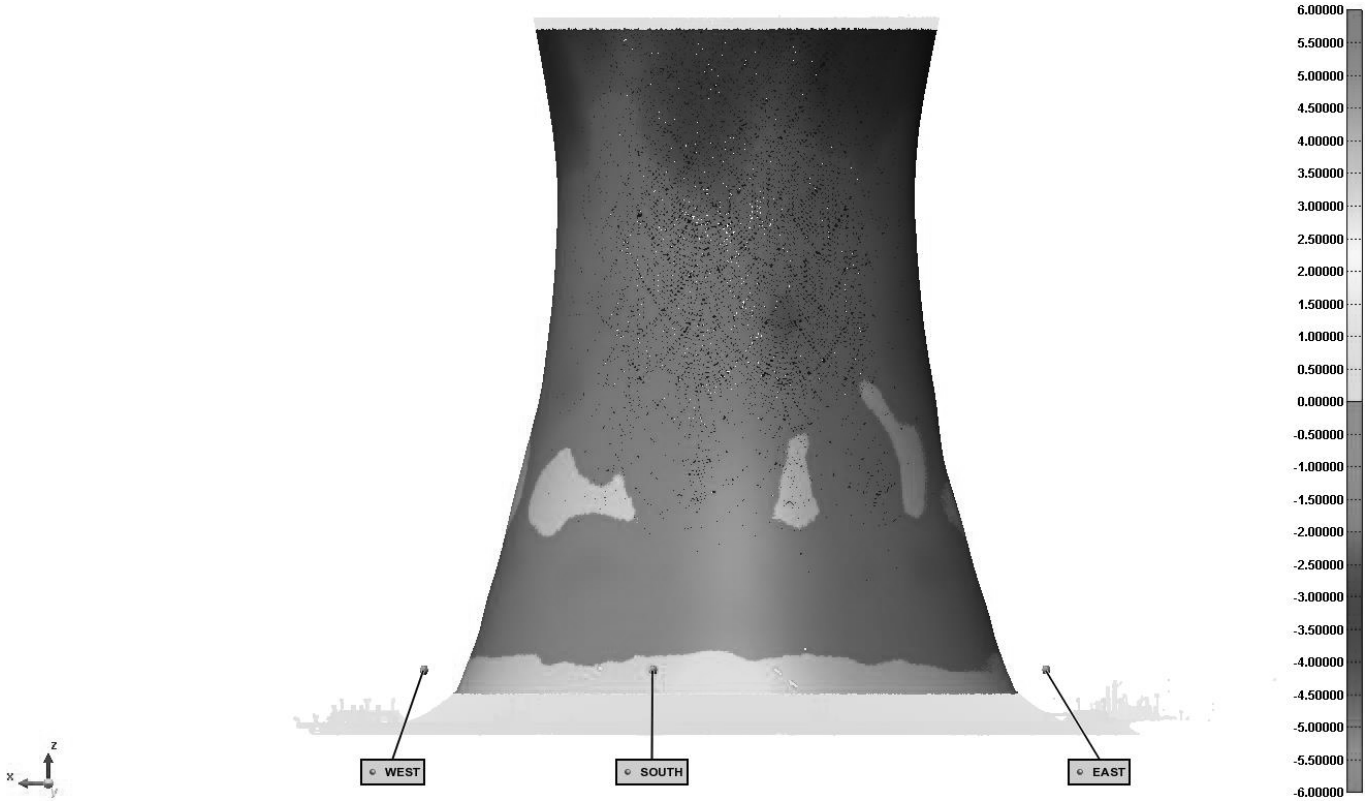

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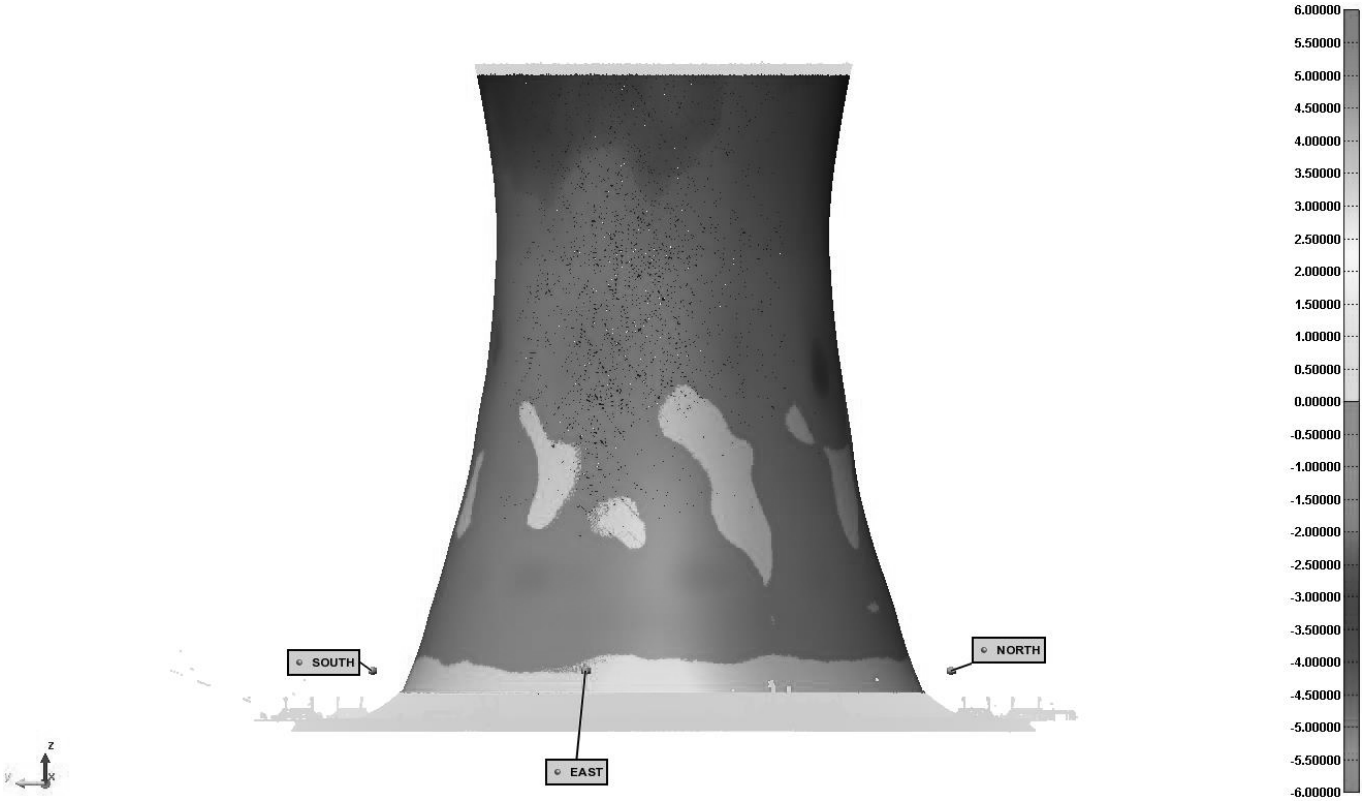

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Comparison Method 3
CAD Model 2 Best Fit Alignment

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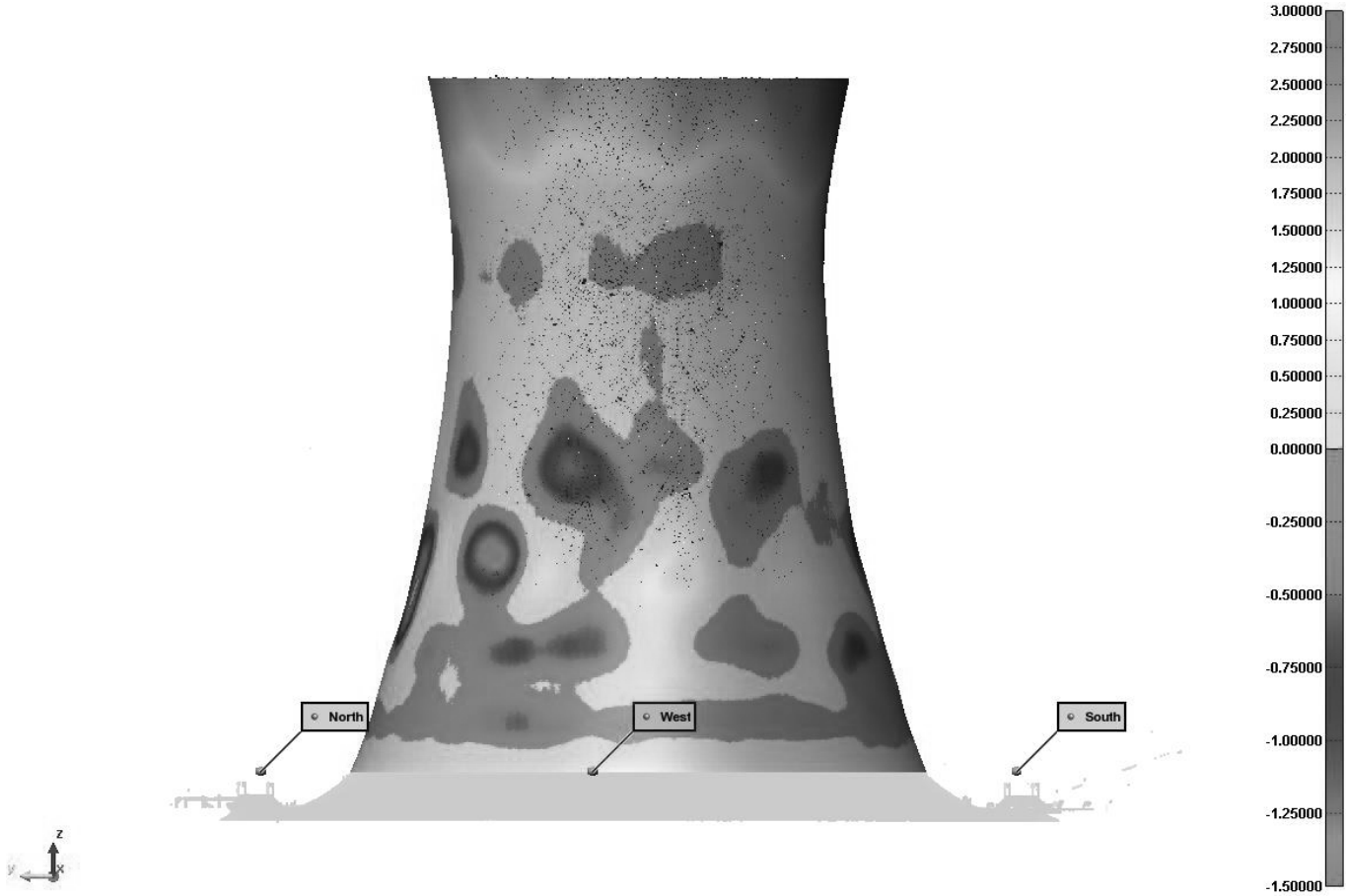

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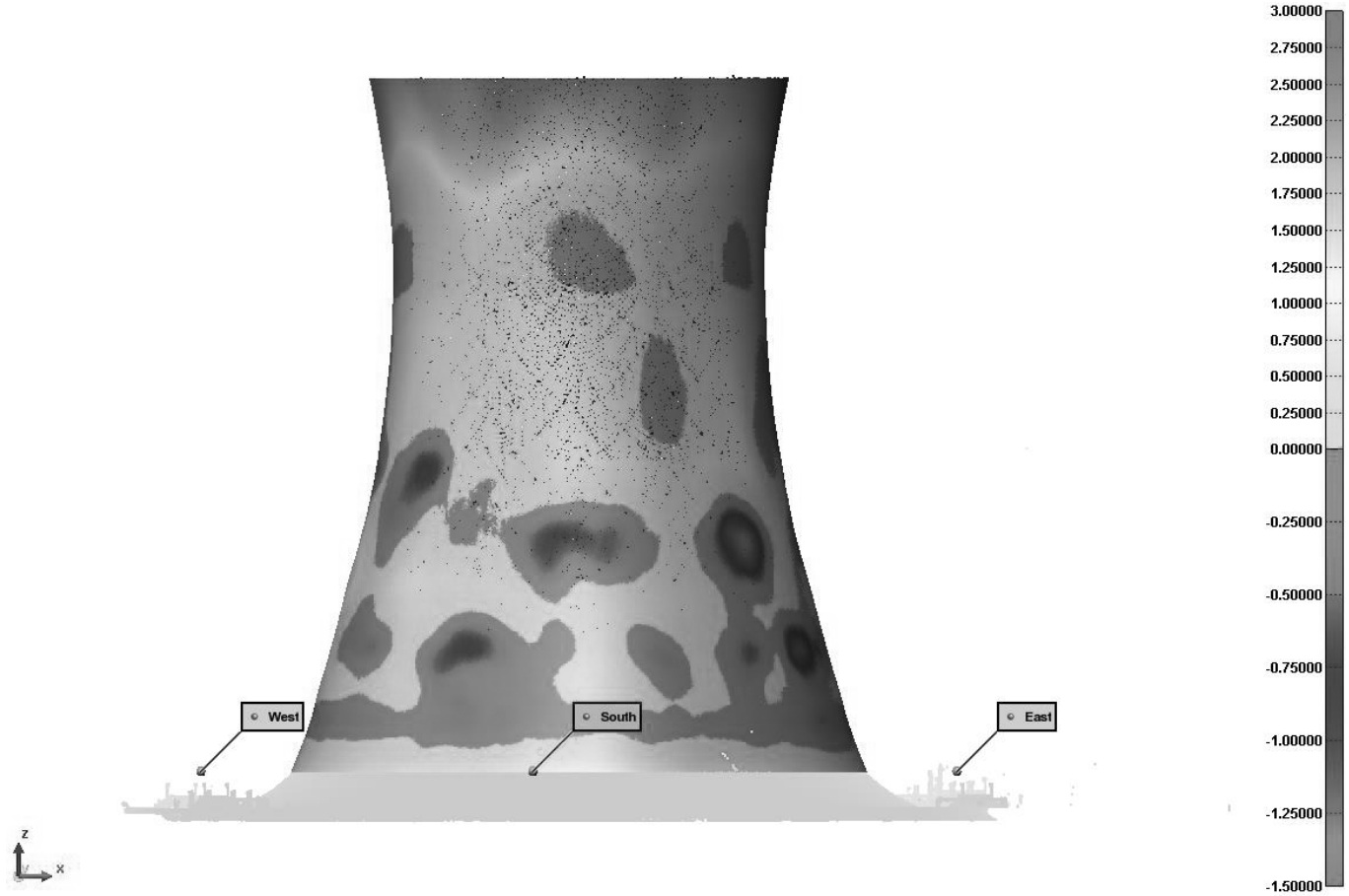

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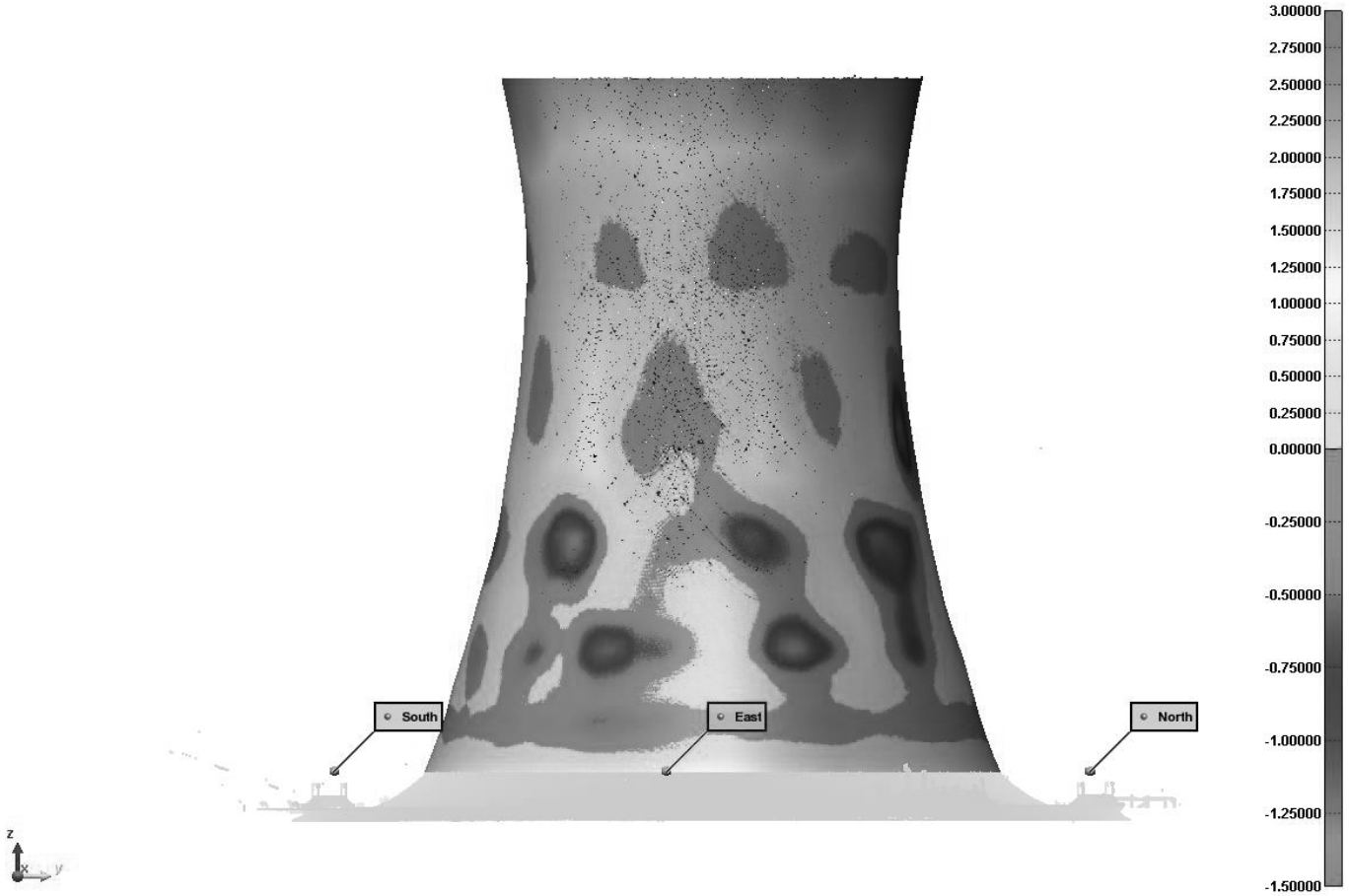

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Long Range Scan of Cooling Towers

Prepared for: AEP AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, OH 43215
614-716-1393

Prepared by: Andrew Sudkamp & Christopher Schreiber

Approved by: Rob Glassburn, P.E.

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Date: 1/23/2017

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CERTIFICATE OF INSPECTION

CUSTOMER:	American Electric Power 1 Riverside Plaza Columbus, OH 43215 614-716-1393
PO NUMBER:	Verbal
PART DESCRIPTION:	Cooling Towers
UNIT OF MEASURE:	Feet
INSPECTED BY:	Andrew Sudkamp & Christopher Schreiber
INSPECTION EQUIPMENT:	Faro Laser Scanner FocusS 350 S/N LS-8-S-350
INSPECTION DATE:	01/13/17

This is to certify that the item listed above was inspected with instrument(s) calibrated with standards traceable to the International System of Units (SI) through a National Metrological Institute (NMI) or an ISO17025 Accredited Laboratory.

Approved by: _____ Date: 1/23/2017

Rob Glassburn, P.E.
VP of Operations

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Method and Observations:

The cooling towers were scanned using a FARO Laser Scanner FocusS 350. Point cloud data was collected for the towers in a set of individual scans that were brought into FARO Scene. Once imported into FARO Scene the individual scans were aligned to one other with the aid of the on board GPS of the scanner. The scan data was then imported into PolyWorks IMInspect.

A CAD model was created based on the customer supplied drawing that outlined diameters and specific elevations. A surface profile of the tower was created in Solidworks based on the cross section that was made from the supplied dimensions.

The scan data for each tower was aligned to the CAD model using a best-fit alignment. Color maps for each tower were created and can be found within the report. Along with the scan to CAD comparisons, the scan data of Tower 2 collected for this project was aligned to the scan data from project AEP160407 of Tower 2 scanned 4/13/16. A scan to scan comparison was conducted for these, also using a best-fit alignment. Points showing the approximate directions of North, South, East, and West were created to use as reference.

Color map screenshots in this report will show a scale on the right side of the image (Please note the scale may change from page to page). Positive deviations mean the scan data is above the CAD model surface; negative deviations mean the scan data are below the CAD model surface. For the scan to scan comparison, the scan data from project AEP160407 was treated as the reference data (CAD model) and the scan data from this project was treated as the scan data. Some areas may appear gray – these areas are either out of the color scale range or do not have data for comparison.

The temperature range during the scan session on 4/13/16 was 32°F to 45°F. The temperature range during the scan session on 1/13/17 was 30°F to 36°F.From the scan to scan comparison, it should be noted that the new scan shows an overall pattern of negative deviation, and specifically, the northeast side of Tower 2 showed a larger deviation than the rest of the structure possibly due to wind effects.

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Tower 1
Scan to CAD Comparison

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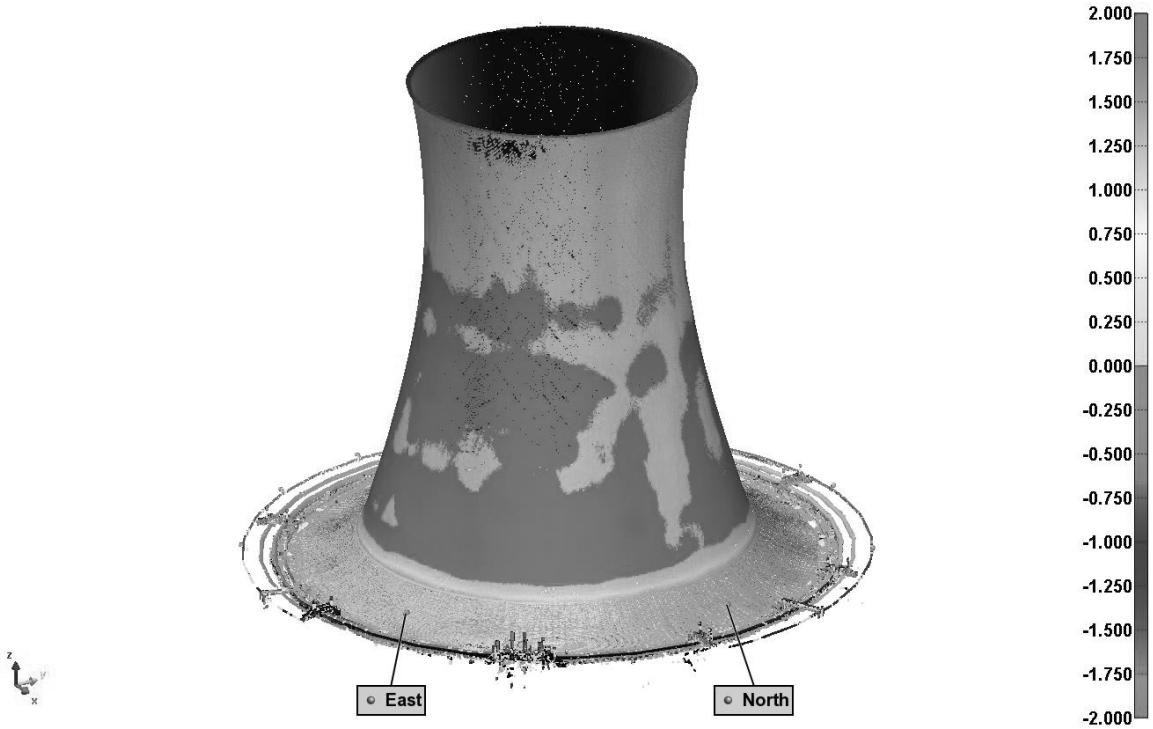
asudkamp@3d-engineering.net



Scan to CAD Comparison (Best Fit Alignment) with +/- 2.000 ft color scale range. Note that positive deviations mean the scan data is above the CAD model surface and negative deviations mean the scan data is below the CAD model surface. Areas shown in grey represent areas of the scan that are either outside of the scale area shown or areas in which no data was collected and are not compared.

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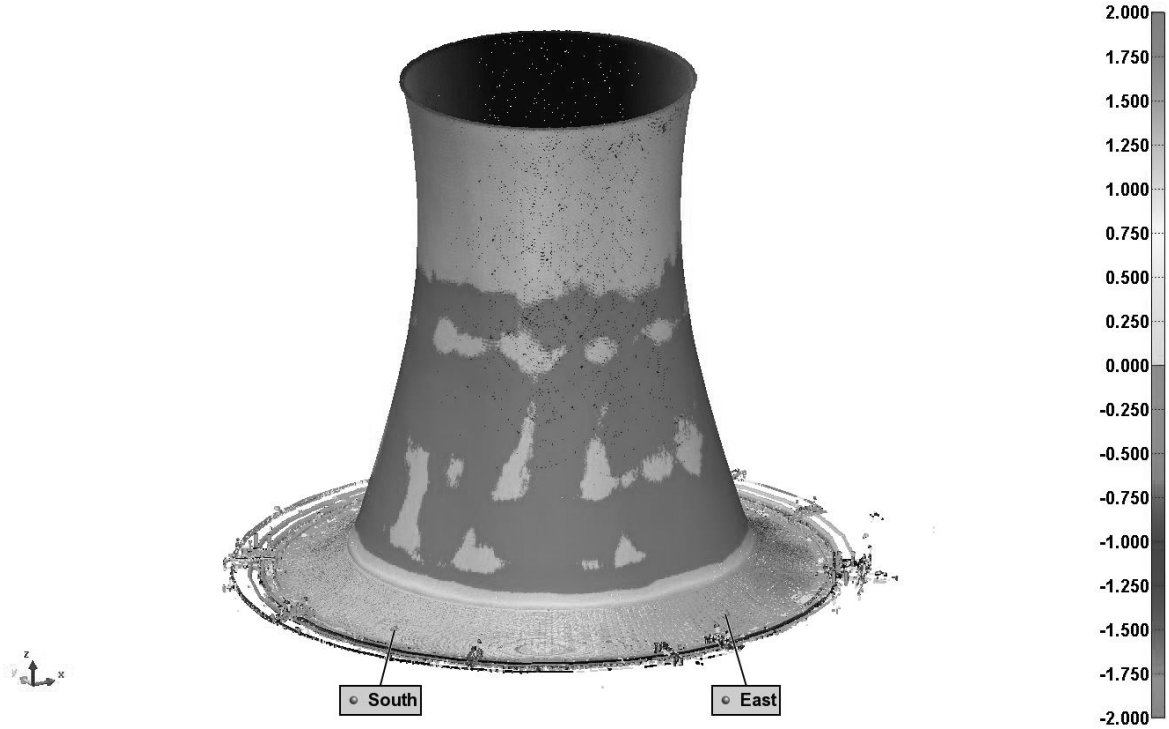

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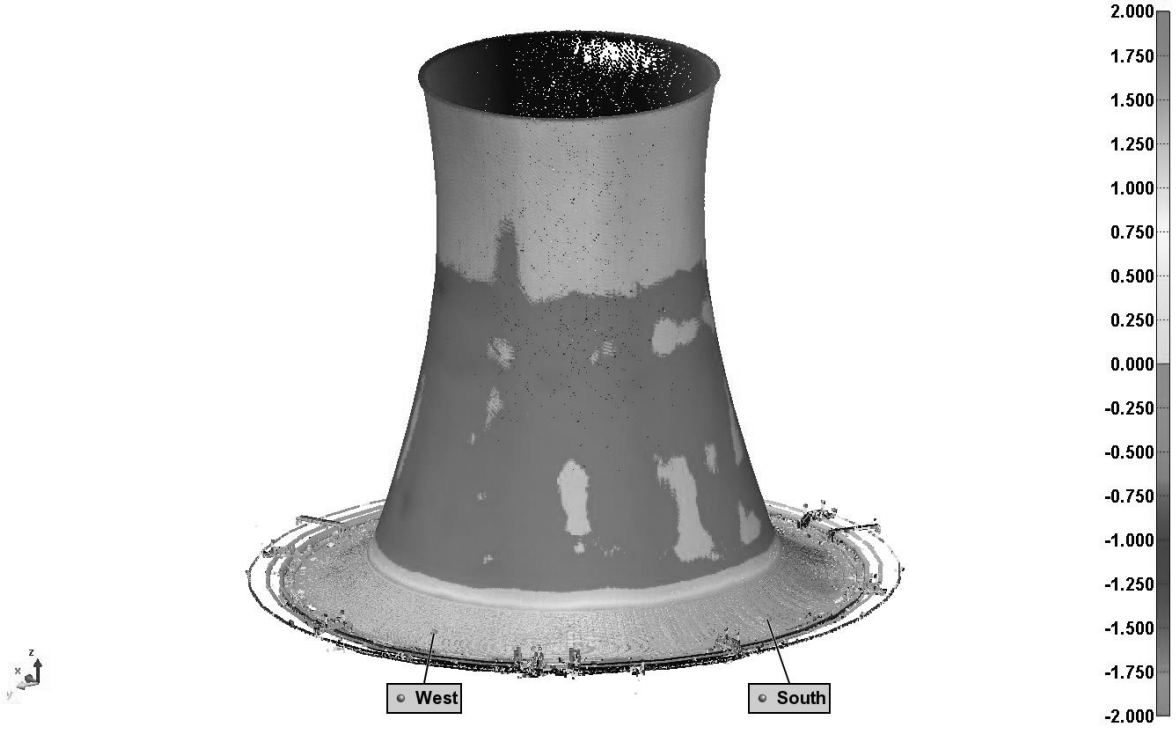

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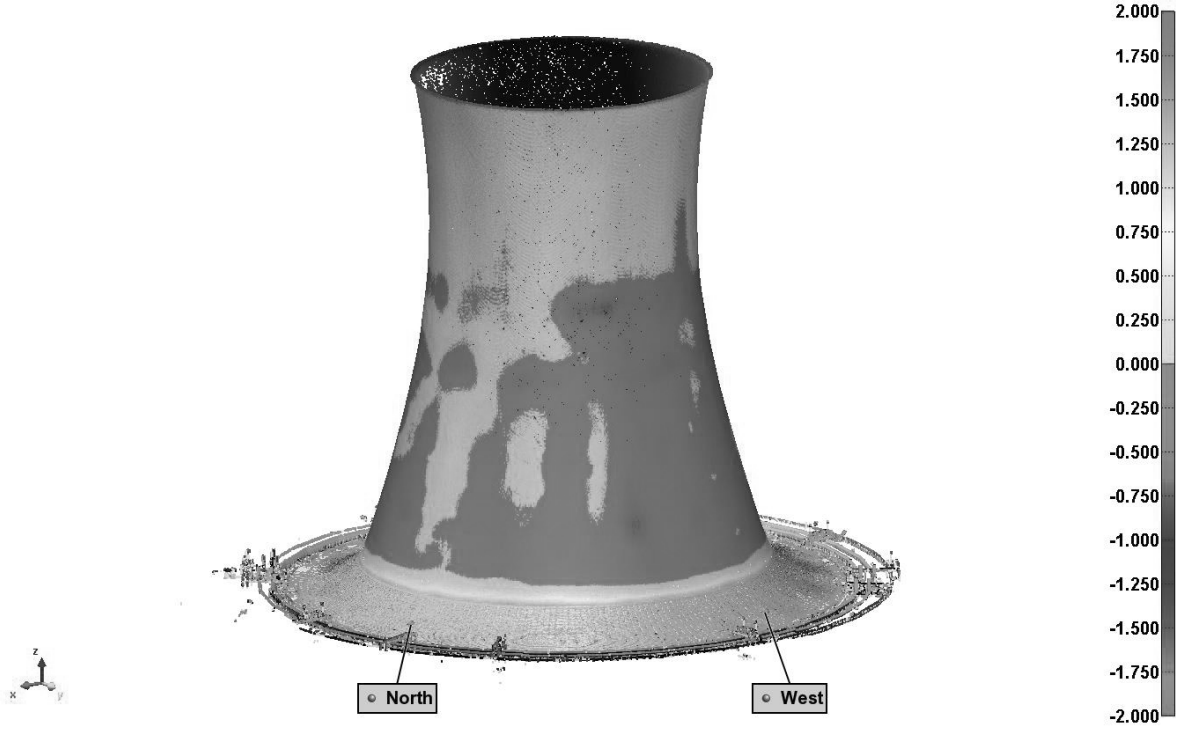

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Tower 2
Scan to CAD Comparison

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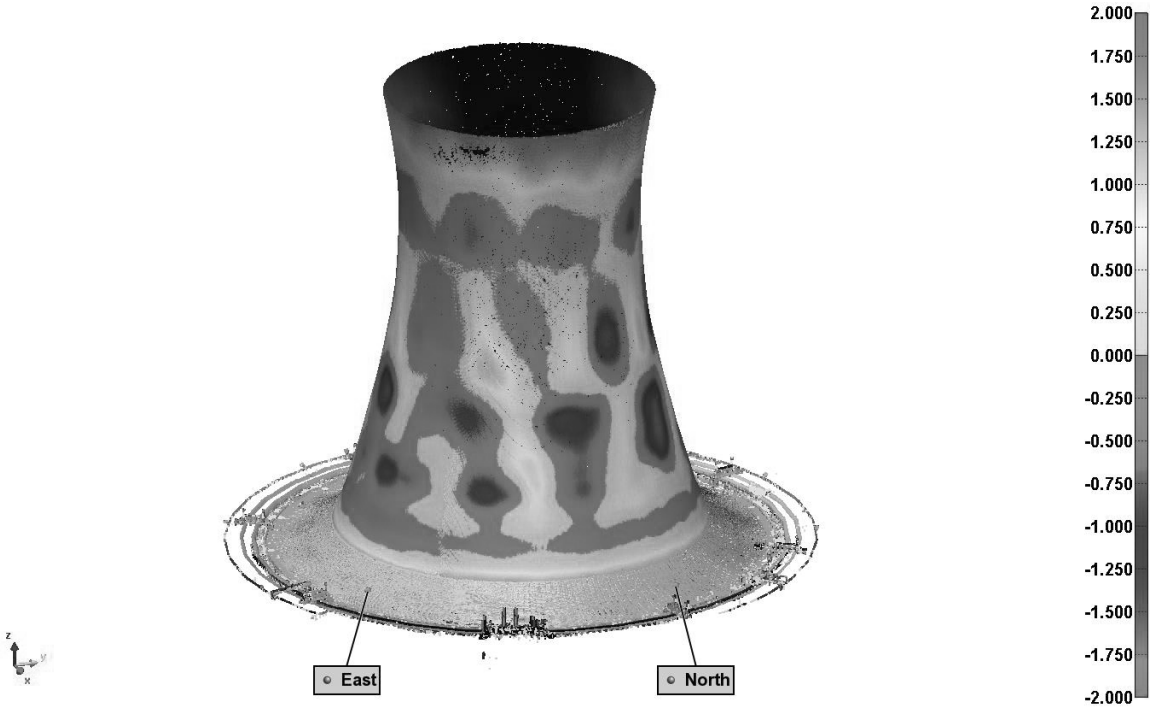

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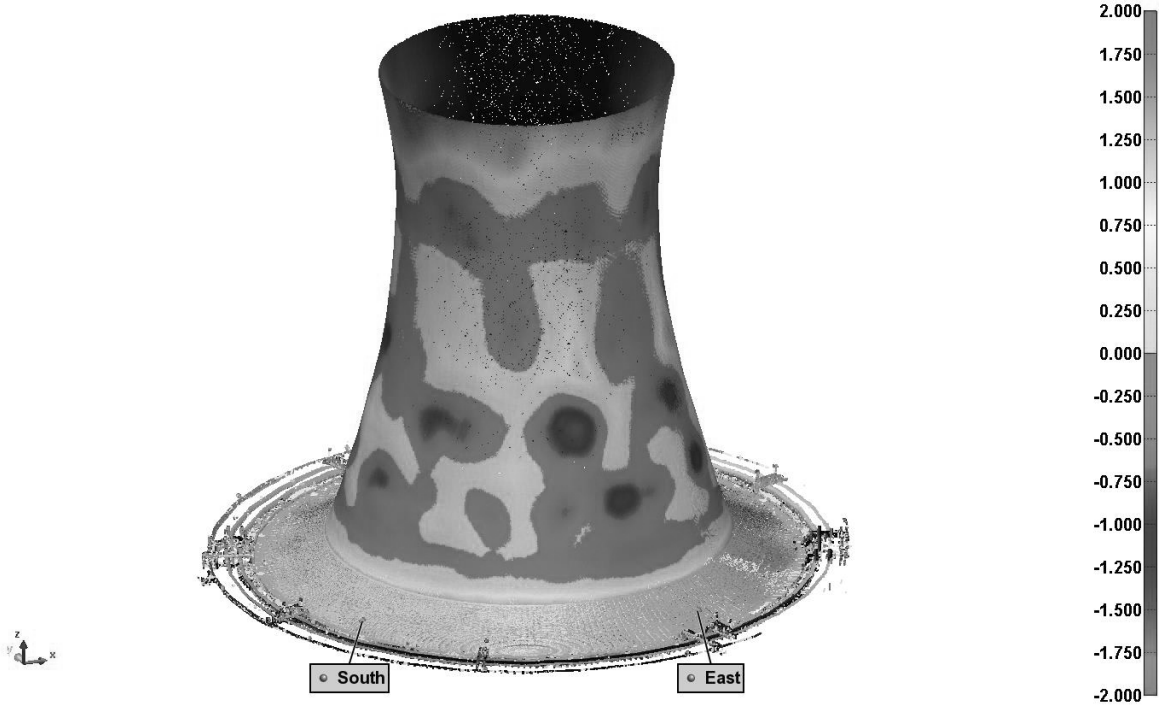

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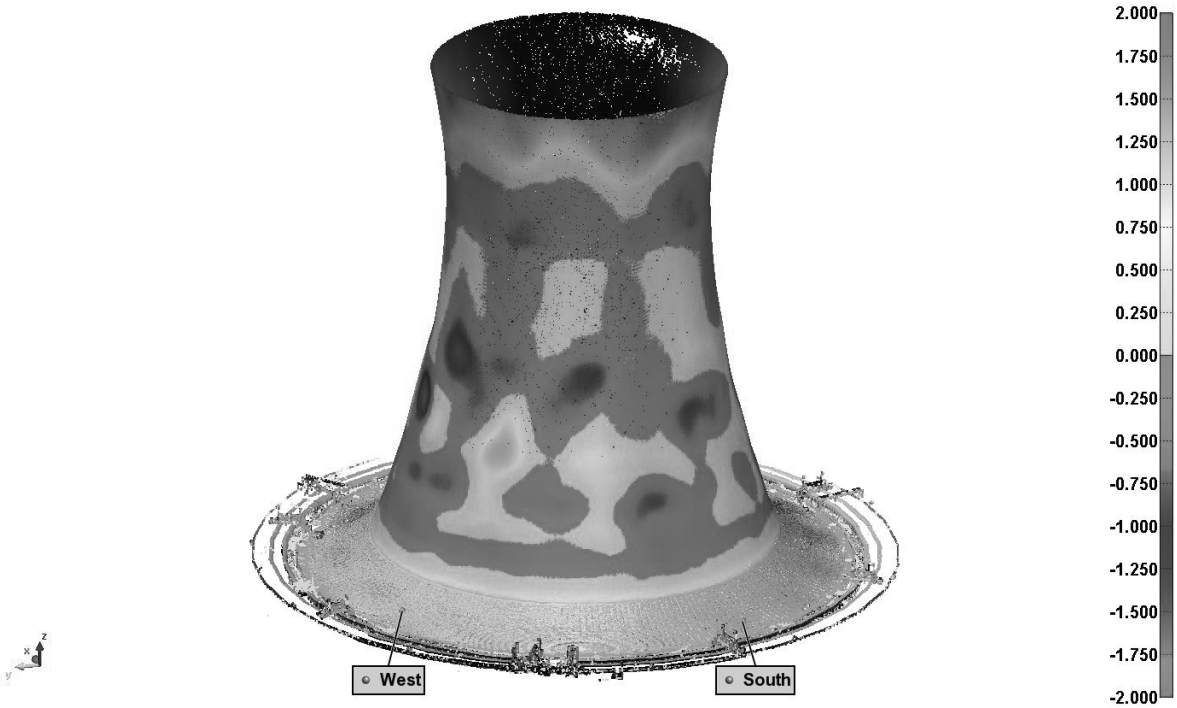

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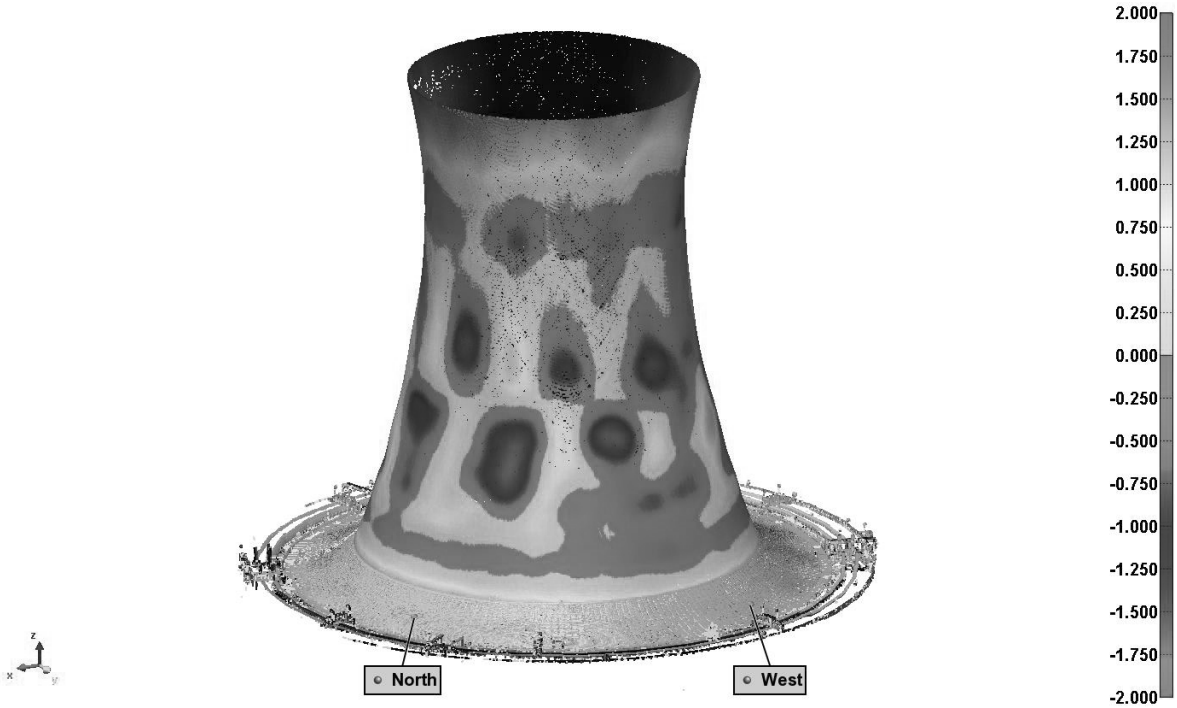

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Tower 2
Scan to Scan Comparison

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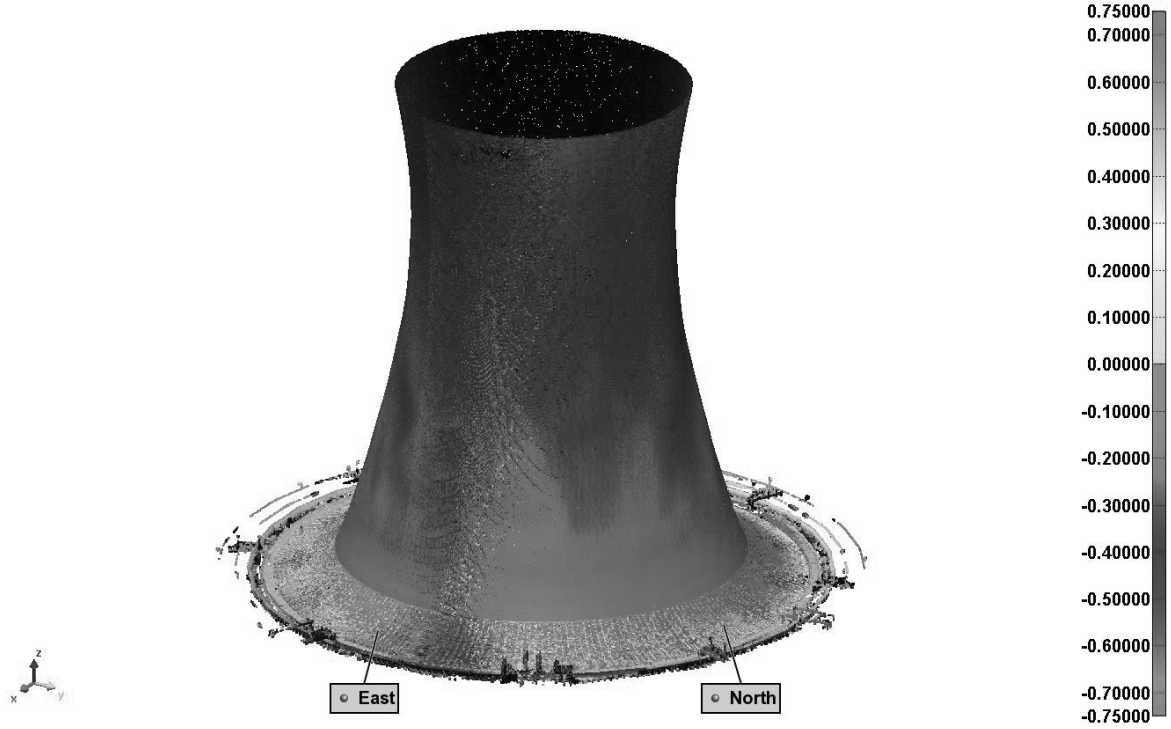

Scan to CAD Comparison (Best Fit Alignment) with +/- 0.750 ft color scale range. Note that positive deviations mean the 1/13/17 scan data is above the 4/13/16 scan surface and negative deviations mean the 1/13/17 scan data is below the 4/13/16 scan surface. Areas shown in grey represent areas of the scan that are either outside of the scale area shown or areas in which no data was collected and are not compared.

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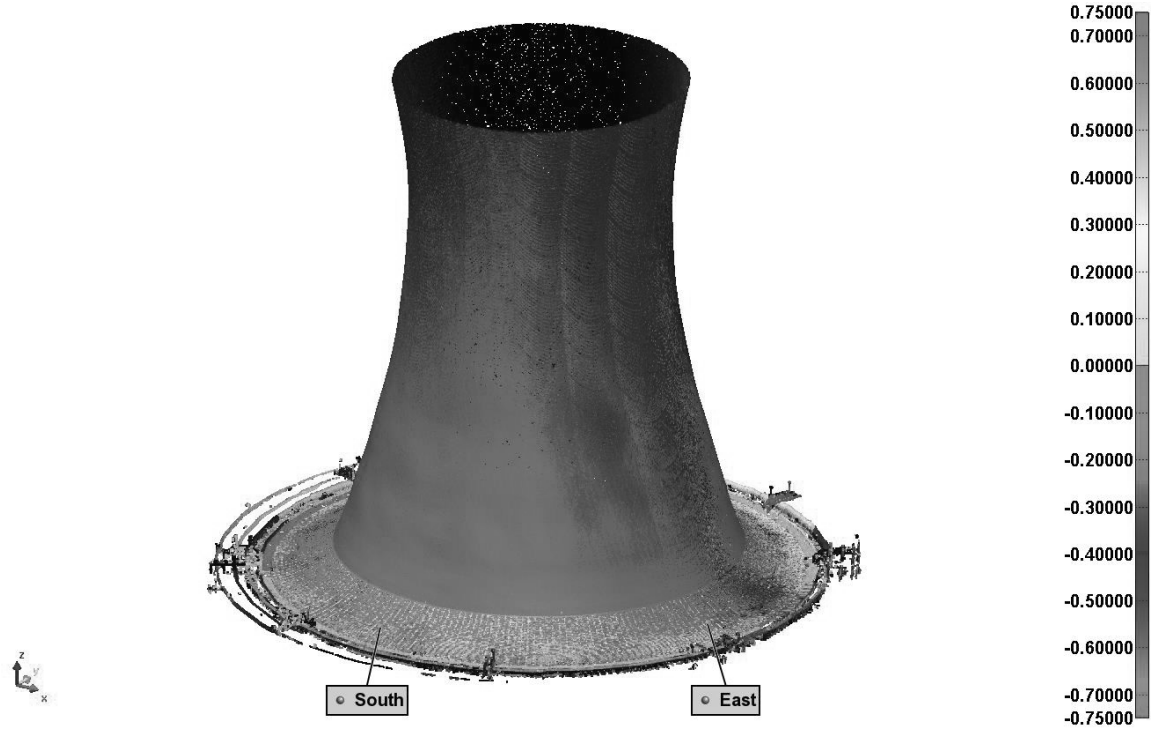

Scan to CAD Comparison (Best Fit Alignment) with +/- 0.750 ft color scale range. Note that positive deviations mean the 1/13/17 scan data is above the 4/13/16 scan surface and negative deviations mean the 1/13/17 scan data is below the 4/13/16 scan surface. Areas shown in grey represent areas of the scan that are either outside of the scale area shown or areas in which no data was collected and are not compared.

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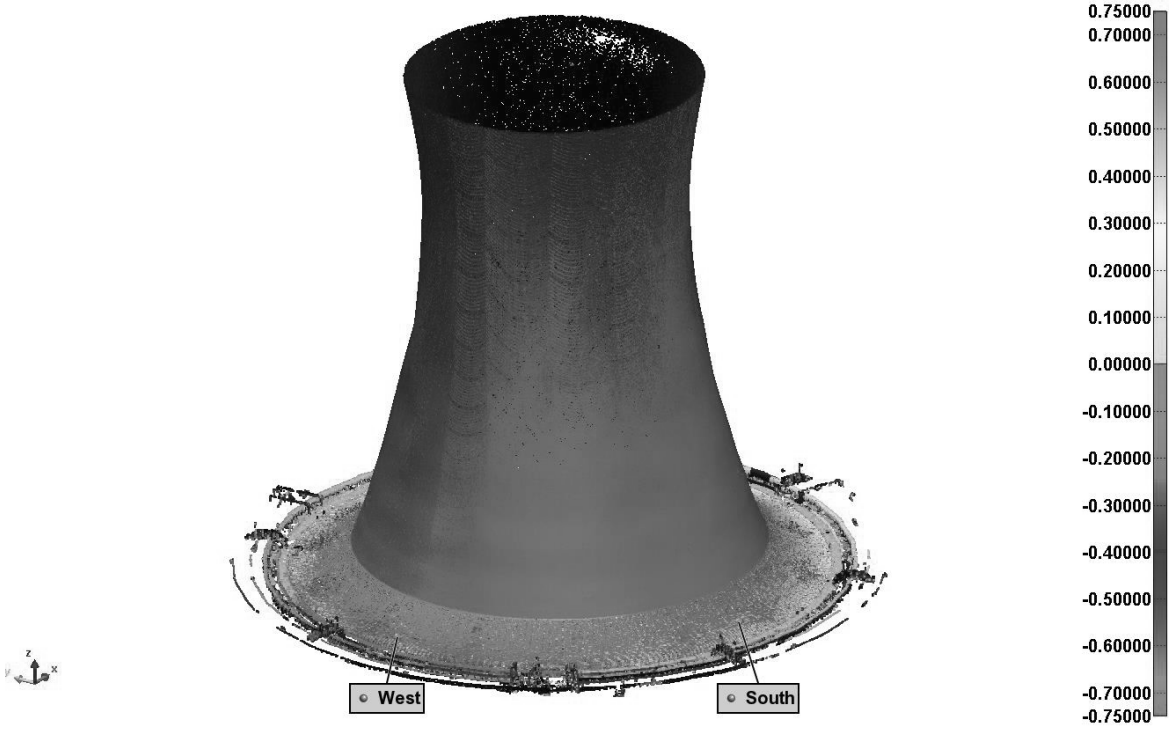

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*Reference : **R 20 LY 1942** Version: **2***

Customer
AEP, Columbus, USA

Data capture, Expertise, Central platform
Sterblue, Los Angeles, USA
Sites, Dardilly, France

External visual inspection of the Mitchell U1 cooling tower

July 10th 2020

1. Revision History

STERBLUE REFERENCES					
Project number	3546 LY	Work number	362055	Inspection date	2020-04-23 - 2020-04-24

CUSTOMER REFERENCES			
N° Order	Ah-cde-selor-D19LY6739_V3	Name	AEP

Version	Date	Writer	Controller	Approving	Modifications
2	2020-12-16	BOUCHE	COLLARD	DAUXIN	*Changes in object ID*
1	2020-07-01	BOUCHE	COLLARD	DAUXIN	*Initial release*

2. Table of contents

3. Scope

This document deals with the visual and photogrammetric inspection of the shell of Mitchell U1 cooling tower.
This document aims at giving the map of defects, their characteristics and some statistics about the shell.

This report is completed by appendixes:

- Appendix 1 presents the table of defects
- Appendix 2 presents the map of defects
- Appendix 3 presents e map of defects with falling risk overlaying the low resolution orthophotography
- Appendix 4 presents the map of defects with low resolution orthophotography
- Appendix 5 present the map of distortions
- Appendix 6 present the map of defects overlaying the distortions map

The orthophotography distortion is joined to this report with the listing of the defects and their XYZ coordinates.

The stakeholders of this project are:

Sterblue builds the central platform for infrastructure inspections. It develops the tools to capture clean data from multiple sources like drones, helicopters, smartphones or satellites. Sterblue builds the interfaces and tools to provide customers with insightful analytics.

- 25 employees
- 3 offices: Los Angeles (USA), Nantes (France), Lisbon (Portugal)
- 4 applications: Cooling towers, Distribution/Transmission grid and Wind Turbines

In the frame of this project Sterblue automated the data capture, generated the low resolution orthopicture and made all the data available on its platform.

Sites is a structural health monitoring pioneer and a specialist engineering company dedicated to infrastructure performance and service life.

- 400 employees
- 35 years of experience
- Over 1,000 structures monitored each year

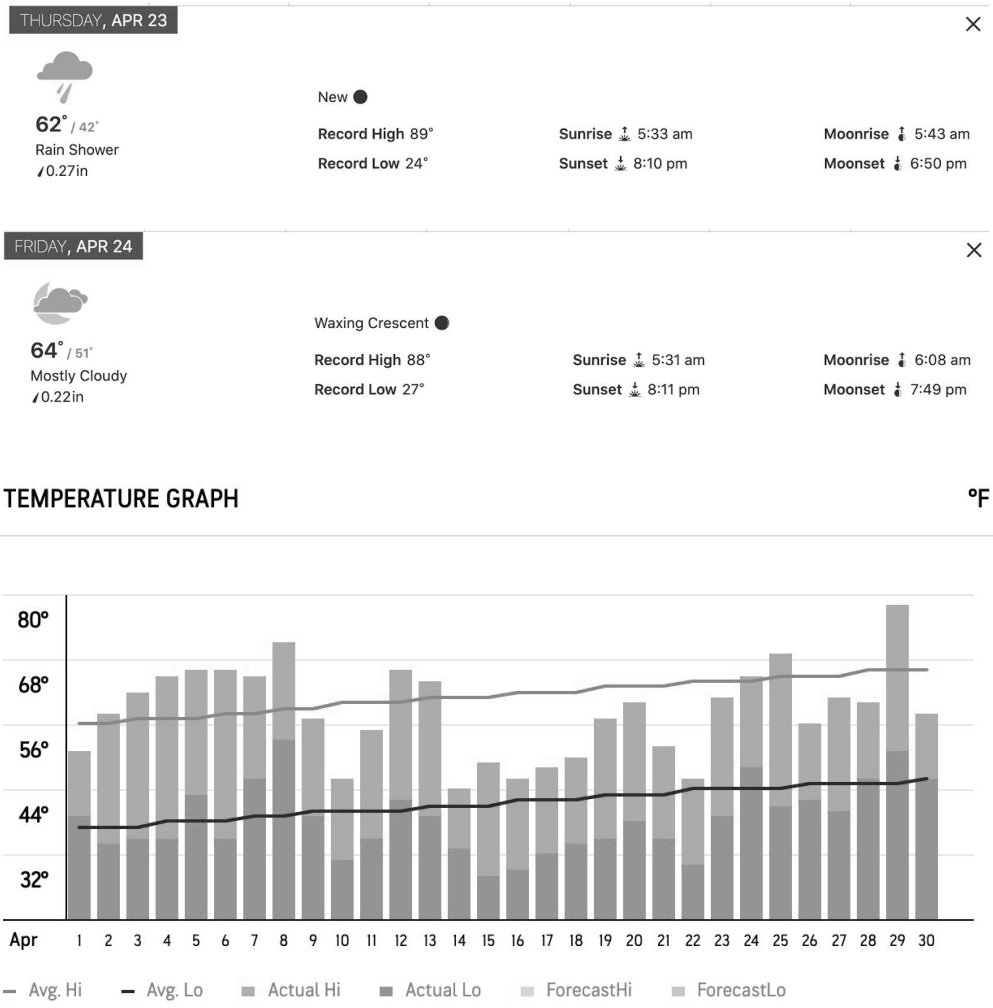
In the frame of this project Sites generated the high resolution orthopicture and analysed the images.

4. Inspection summary

Pictures have been shot from the 23rd to the 24th of April 2020 by a Matrice 210 RTK v2 UAV.

4.1. Weather

Cloudy with some sun.



4.2. Context of analysis

The model was georeferenced thanks to the coordinate of the first RTK base used during the UAV flights and reported in the flight journal and the theoretical shape.
The theoretical model of the shell has been created using the document “Mitchell U2 CT Shell Dwg 13 _ 14.pdf”, assuming that the Mitchell U1 and Mitchell U2 towers are identical.

4.3. Units

Meter and US foot units are used for the lengths, surfaces and 3D coordinates. Inches units are used for the opening of cracks.

US Feet	Meter
1.000	0.305
3.281	1.000

US Inch	Millimeter
1.000	25.400
0.039	1.000

Tables of conversion between US foot/inch and meter/millimeter

4.4. Coordinate system

All the 3D data are known in the NAD83 / West Virginia North (EPSG : 26834) coordinate system, which is defined in meters.
The scaling error of this coordinate system is less than 5 mm (0.2 in) on the 91 m (300 ft) of this structure.

4.5. References

Due to the absence of measured topographical points on the structure or on the site, GPS coordinates were used in order to georeference the tower.
All flights were performed with a DJI Matrice 210 RTK v2 UAV. For each picture taken, the GPS coordinates of the UAV were recorded with an accuracy within 10 cm relative to the RTK base.
To be able to fly all around the tower, the RTK antenna has been positioned on two different points. Each of these points have been determined in real time thanks to GPS data, with an accuracy within 5 m.

The coordinates of the first RTK base used during the UAV flights have been chosen as reference to locate the 3D model in the NAD83 / West Virginia North coordinate system. As coordinates of the RTK base were reported in the WGS84 system, they were post-converted into the NAD83 / West Virginia North system.

RTK base coordinates in WGS84 system		
Longitude (°)	Latitude(°)	Altitude(ft)
-80.818	39.827	569.746

RTK base coordinates in NAD83/West Virginia North system		
East (ft)	North (ft)	Altitude (ft)
1598253.293	486219.281	569.746

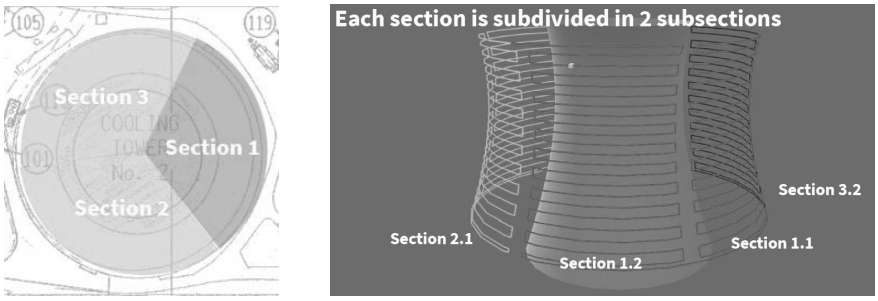
Coordinates of the RTK base used as reference (23 April 2020)

5. Data acquisition and treatments

5.1. UAV flights

2 types of flights have been done at a distance of about 12 m (40 ft) from the structure:
- The first one for overview and photogrammetric structure with the DJI X5s camera with a 15mm lens. Pixel size (GSD) : 3.5 mm (0.14 in),
- The second one for inspection with the DJI X5s camera with a 45 mm lens.
  Pixel size (GSD): 1 mm (0.04 in).

The acquisition of the high resolution pictures was organized by dividing the area to be covered in 3 sections and each section in 2 subsections, according to the following flight plan.

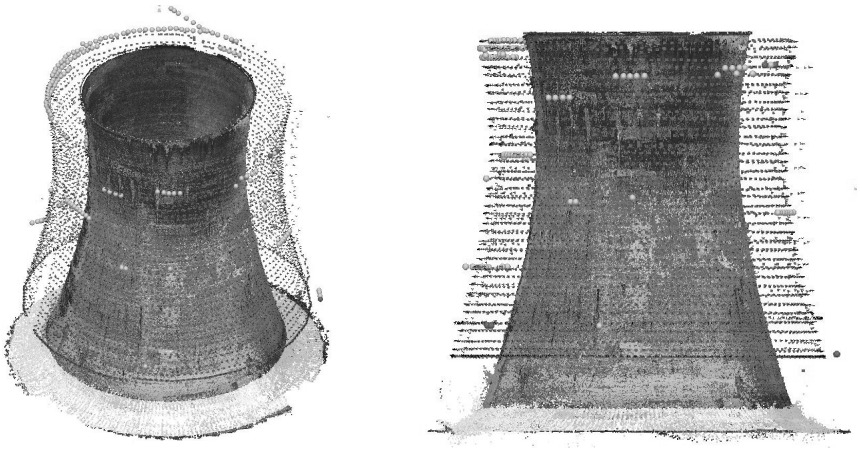


Flight plan (figures provided by Sterblue)

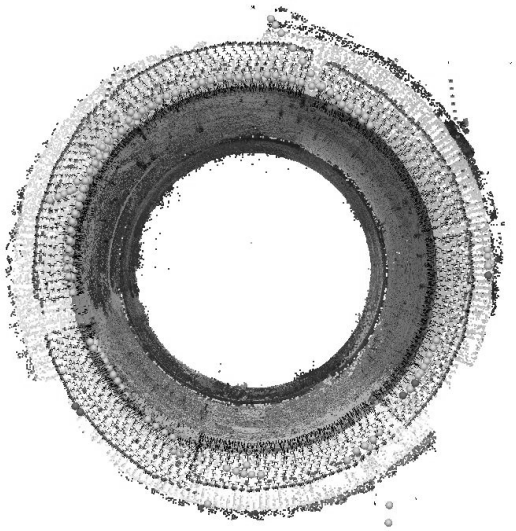
These flights allowed to capture 800 photos for the low resolution flight, and 5700 photos for the high resolution flight.
A photogrammetric reconstruction is used to calculate 3D positioning of these photos and 3D reconstruction of the tower as a point cloud and 3D mesh.

1.1. Camera alignment

Following captures show the position of pictures taken during both flights.



Perspective view of the cameras positions – Elevation view of the cameras positions



View from the top of the cameras positions

5.2. Georeferencing and scaling of 3D model

The shooting coordinates of each photo, known in the WGS84 system, have been converted to NAD83 / West Virginia North system (the system uses meter units) and used to locate and scale the 3D model.

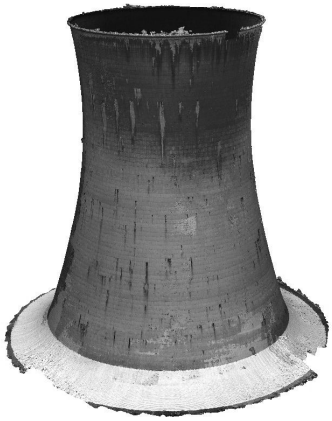
Not all of picture coordinates were used: first, only the coordinates of pictures captured during flights referenced with the first RTK base were taken into account, because of the shift in coordinates that occurs when changing the RTK base. However, some flights referenced on the first RTK base are still presenting inconsistencies in the photos coordinates. They were ignored for the georeferencing step.

The consequences of ignoring some of the flights for the georeferencing is negligible compared to the +/- 16 ft of the ground station GPS accuracy.

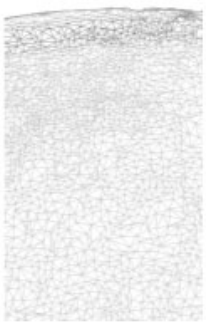
After combining all factors that can affect the accuracy of the georeferencing, we can estimate that the 3D model of the tower has been located within +/- 16 ft. It should be noted that this localization error is composed of translations only. The orientation to the geographic North of the model is correct. The scale of the model is correct thanks to the tower drawings.

5.3. Point cloud and 3D model

After aligning cameras, georeferencing and scaling the tower, we can generate a point cloud made of 160 million 3D points (colored), and we can generate a mesh of triangles. After generating these 3D data, the mesh texture is generated. The mesh is composed of 1 million of triangles.



3D point cloud (colored)



3D mesh of triangles (left : not textured) – right : textured

This data is delivered on the Google Drive link as a .las file for the point cloud and a .obj file for the 3D textured mesh.
Units are meter and coordinate system is NAD83 / West Virginia North (Meters). For a better display of these objects, they were exported with a shift in their coordinates.

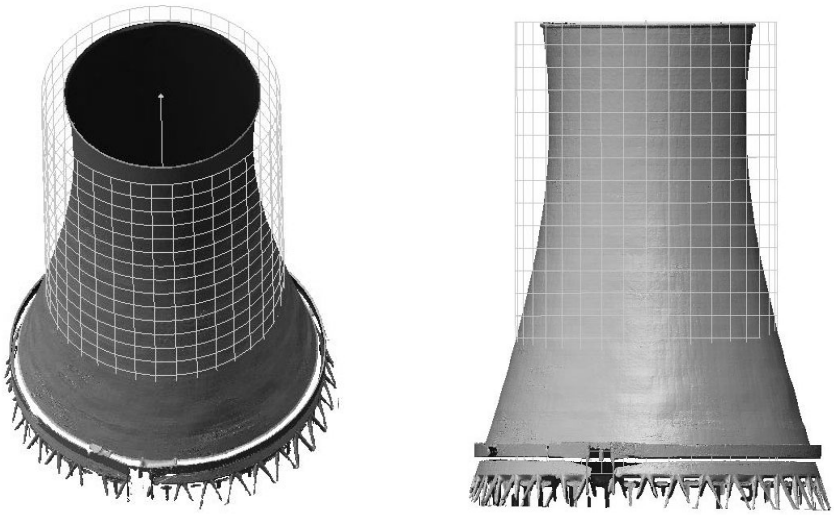
Shift East (ft)	Shift North (ft)	Shift Altitude (ft)
6088284.121	486387.795	0

5.4. Orthophotography

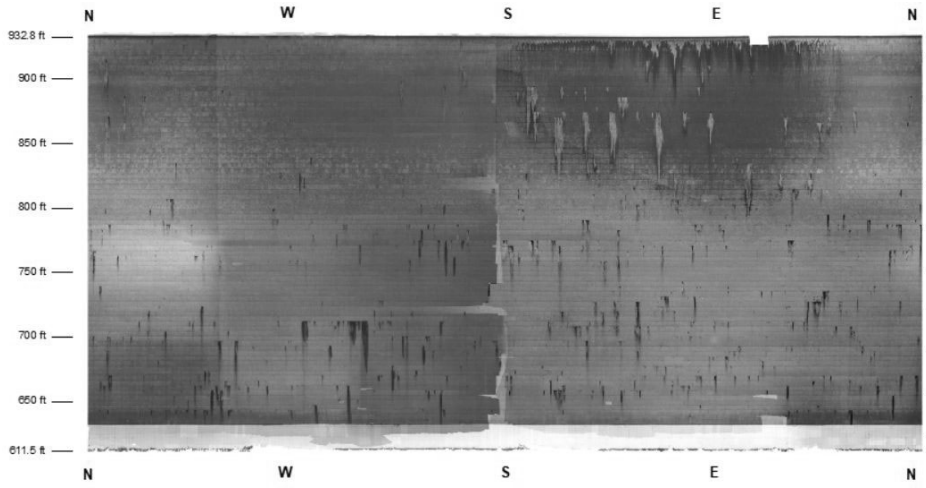
The textured 3D model has been unwrapped following a cylinder. The parameters of the cylinder are:

- Center:
  - East (X) = 6088284.121 ft
  - North (Y) = 486387.795 ft
- Radius: 103.258 us ft (average radius between top and bottom tower radius)
- Cut : North
- Unwrap rotation : natural view from outside

5.4.1. Cylindrical projection



Cylinder used for the data unwrapping



Cylindrical unwrapping

This projection on the cylinder and unwrapping leads to some scaling error on lengths which is corrected in the database by computing the 3D coordinates of the defects on the shell and re-computing the lengths.

5.4.2. Orthophoto resolution

Two orthophotos have been generated:

- 1 pixel = 0.04 in for the orthopicture generated from high resolution pictures (M210 UAV + X5s camera + 45mm lens)
- 1 pixel = 0.14 in for the orthopicture generated from overview pictures (M210 UAV + X5s camera + 15mm lens)

The overview orthopicture was helpful to integrate pixels in areas not covered with highly detailed images.

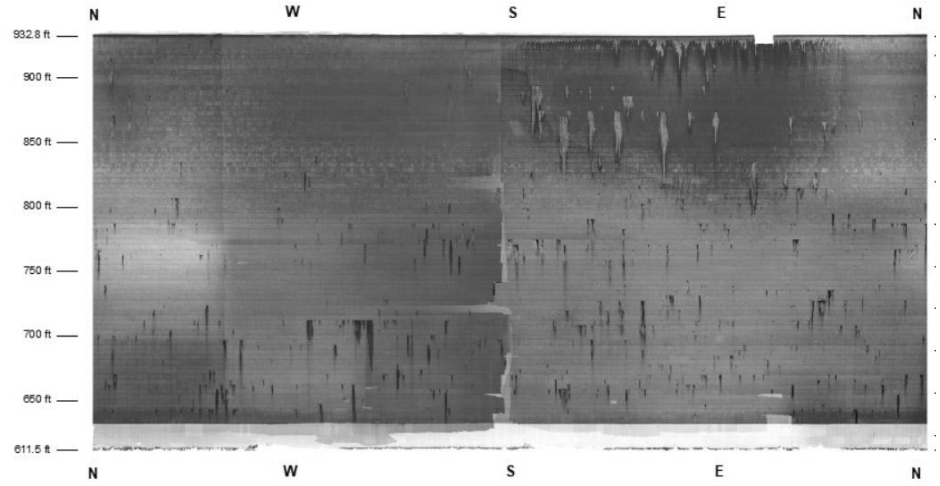
Units of the orthophotos are feet.

The orthophotos are georeferenced on a X,Y flat coordinate system. For this cylindrical projection:

- X= circonference position. X is between 0ft (0°) to 646.325 ft (360°),
- Y= elevation, from 611.5 ft (bottom of the shell) to 932.8 ft (top of the shell).

Elevation references are given in the NAD83/West Virginia North reference system. Closest georeferenced system to Mitchell U1 Cooling Tower.

One single file with these 2 orthophotos overlaying gives the better of each image: the 0.04 in (1 mm) image is on top of the 0.14 in (3.5 mm).



5.4.3. Orthophoto visualisation

The orthophotography is delivered as a .tiff file, linked to its georeferencing file (.tfw). It can be read with any GIS software (ArcGis, Qgis, Mapinfo,…).

An html viewer is uploaded on google drive to easily view the orthophotography.

6. Inspection characteristics

From the orthophotography, we made a visual inspection to identify defects of the shell. Cracks have been drawn with an opening of more than 0.03 in. Corrosion, concrete spit, seepage, spalling or visible steel are drawn if we are able to see them.

According to their geometric characteristics, the defects can be recorded as:

- linear defects (for example cracks),
- surface defects (for example crazing area),
- punctual defects (for example corrosion punctures).

6.1. Defects id

Each defect has a single number (id) which is written on the map and helps to find the type and features.

6.2. Defects types

The following list includes defect types identified, and coded:

- cracks (CR),
- corrosions (CO),
- seepages (SE),
- spallings (SP),
- miscellaneous defects not covered by the types above (DX).

Defects in the miscellaneous (DX) category are identified by a secondary feature

6.3. Defects secondary feature(s)

A defect's secondary feature is a physical feature that completes defect type classification and coded:

- efflorescence (EF),
- concrete splinter (CS),
- seepage (SE),
- crazing (CA - Network of fine random cracks),
- spalling (SP),
- visible steel (VS),
- rust trace (RT),
- honeycombing (HC),
- repair (REP),
- other (OT).

A defect may be given the type of one, two or even no secondary features.

6.4. Defects location

- on reinforced concrete (RCO),
- on sealing (SEA - corresponds to zones which have been already repaired).

6.5. Defects particularities

- concrete rework (CRE),
- formwork hole (FH),
- with falling risk (FR).

6.6. Defects measured features

Measured features describe defect characteristics that may be quantified using a numerical value:

- position (X, Y, Z) (ft),
- length (ft),
- average and maximum opening (in), for cracks,
- surface area (ft^2), if the defect is a surface,
- orientation : 0° is vertical, 90° is horizontal, between 15° and 75°, it is inclined.

6.7. Evolution

For a future inspection of the wall, a second orthophotography overlaying exactly the first one will enable us to give the evolution of the defects. These names would be used as a new property:

- CRE : New defect,
- EVO : Evolutionary defect,
- NEV : No evolution,
- FUS : Defect merged with another one (name of this defect in the remark),
- FUSF : defect that has been merged with a FUS defect and then deleted,
- SUP : defect deleted,
- REP : defect deleted because it has been repaired,
- NOB: no observation (because no image of this area).

6.8. Accuracy for photogrammetric inspection

The expected performance as a result of the measurement distance are as follows:

- detected cracks : opening average above 0.008-0.012 in,
- defect location precision in the XYZ coordinate system : 0.8 in,
- defects length : accuracy 2 in.

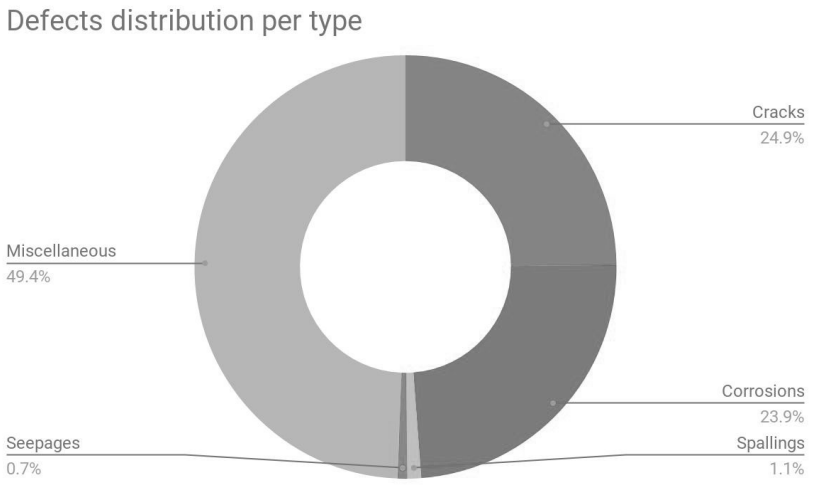
Note that only cracks with openings larger than 0.032 in were labelled.

7. General results

The following tables give some statistical results of the inspection.

7.1. Defects distribution per type

	Family of defects					Total
	Cracks	Corrosions	Spallings	Seepages	Miscellaneous	
	CR	CO	SP	SE	DX	
Number of defects	1458	1404	52	43	2897	**5854**
Cumulative length (ft)	3611.52	5.15	12.42	29.08	4217.5	**7875.67**

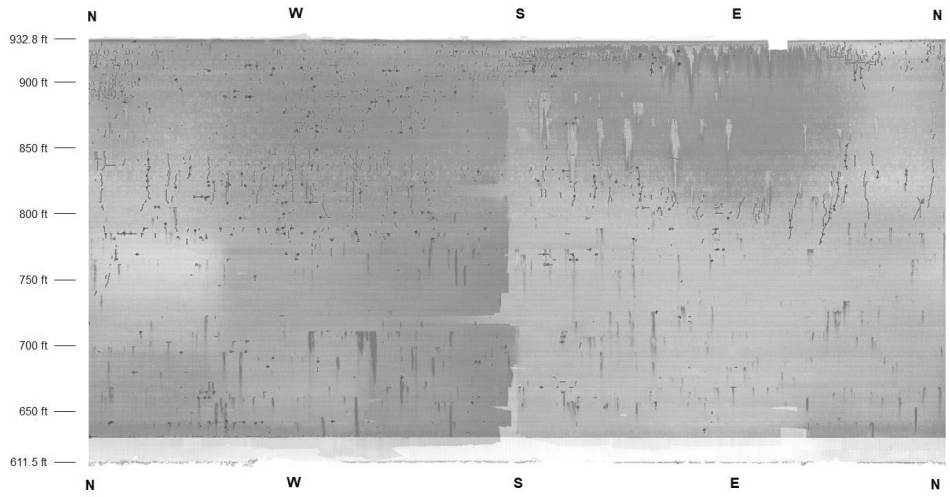


Defects are spread all over the tower.

The large number of defects are miscellaneous defects (2897). Most of the miscellaneous defects are efflorescences (2420) with no seepage. When an efflorescence has water seepage, it is classified as a seepage with efflorescence.

7.2. Cracks

There is a small number of cracks and a third of them are with efflorescence. They are almost all located on the upper part of the structure. The cracks under 0.03in opening were not drawn. The following capture shows the distribution of the cracks on the entire shell:



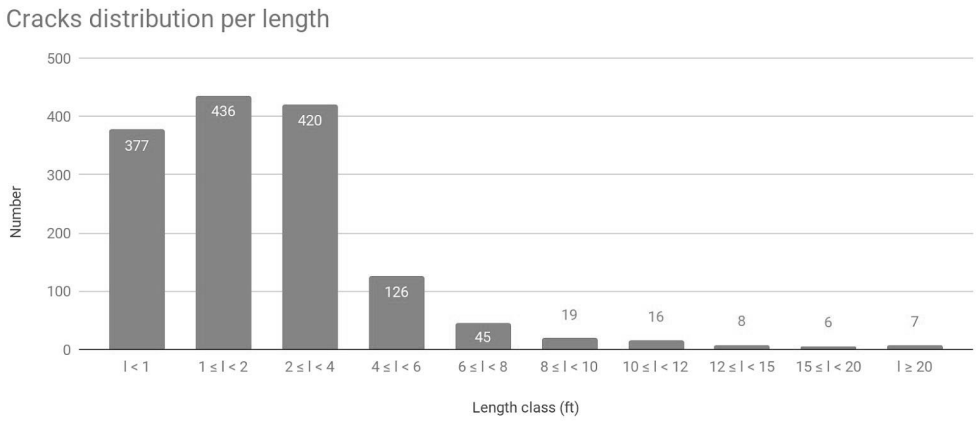
Distribution of cracks

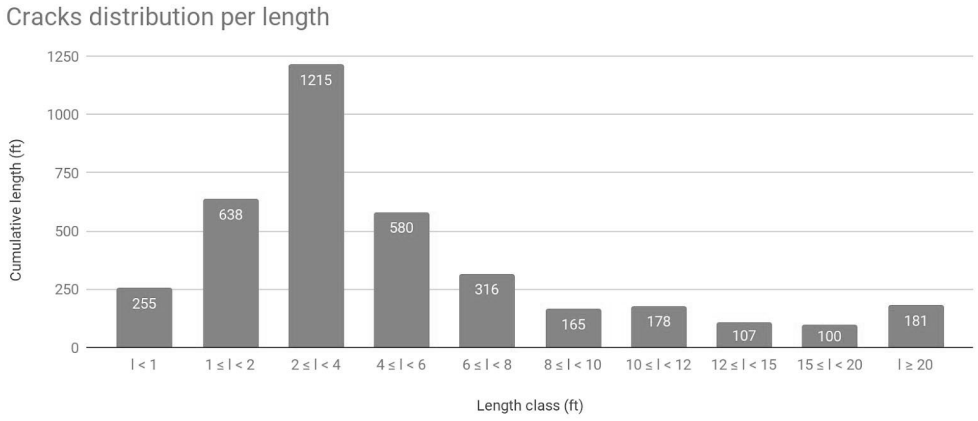
7.2.1. Cracks distribution and histogram per length classification

The following tables and charts illustrate the cracks distribution per length classification expressed in feet.

Length class (ft)	l < 1	1 ≤ l < 2	2 ≤ l < 4	4 ≤ l < 6	6 ≤ l < 8	8 ≤ l < 10	10 ≤ l < 12	12 ≤ l < 15	15 ≤ l < 20	l ≥ 20
Number	377	436	420	126	45	19	16	8	6	7
Cumulative length (ft)	255	638	1215	580	316	165	178	107	100	181

The main part of the cracks are smaller than 8 ft and 86.3% of them are measuring less than 4 ft long.

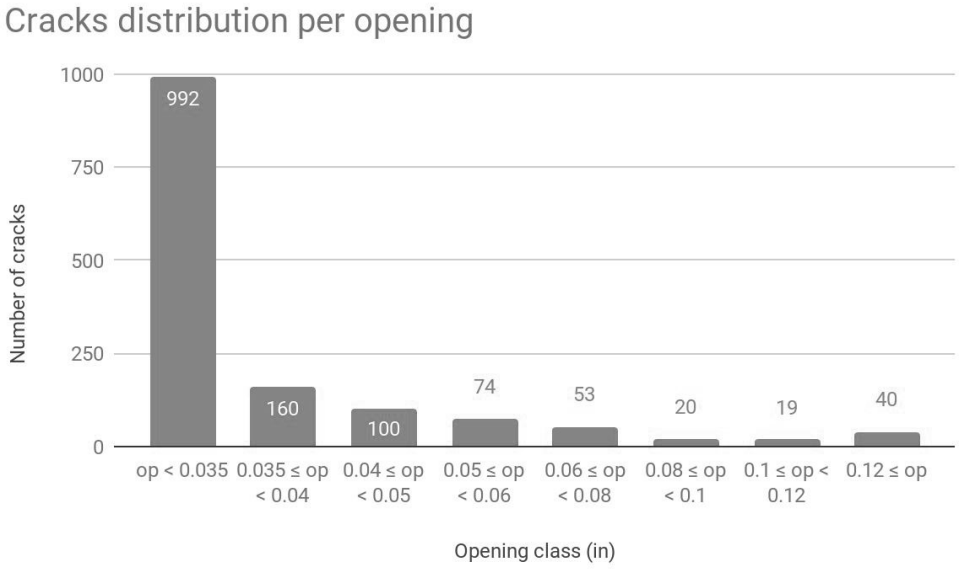


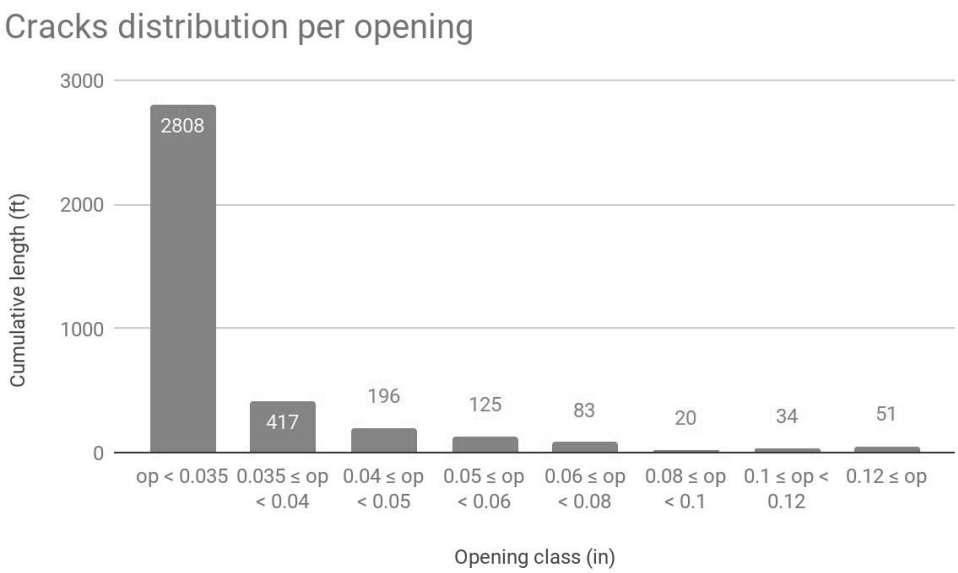


7.2.2. Cracks distribution and histogram per opening classification

The following tables and charts illustrate the cracks distribution per opening classification expressed in inches.

Opening class (in)	op < 0.035	0.035 ≤ op < 0.04	0.04 ≤ op < 0.05	0.05 ≤ op < 0.06	0.06 ≤ op < 0.08	0.08 ≤ op < 0.1	0.1 ≤ op < 0.12	0.12 ≤ op
Number	992	160	100	74	53	20	19	40
Cumulative length (ft)	2808	417	196	125	83	20	34	51



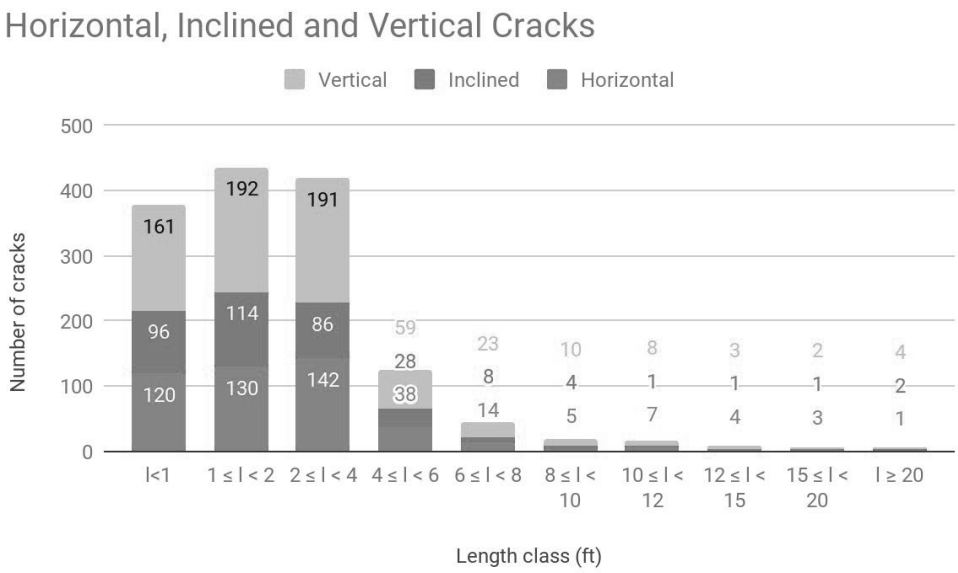


7.2.3. Cracks distribution per orientation

The orientation of cracks is calculated from the coordinates.
If the angle formed between the crack and the vertical axis is more than 15 degrees, the crack is considered as inclined.

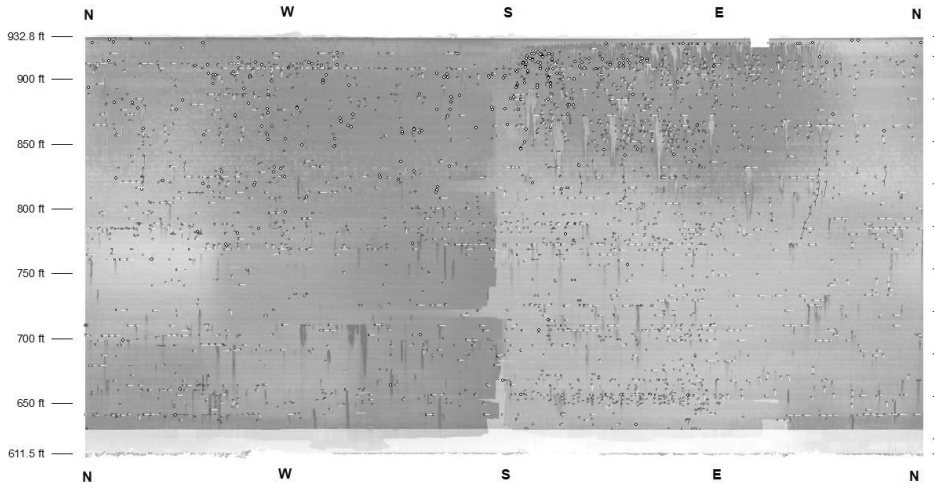
	l<1	**1 ≤ l < 2**	**2 ≤ l < 4**	**4 ≤ l < 6**	**6 ≤ l < 8**	**8 ≤ l < 10**	**10 ≤ l < 12**	**12 ≤ l < 15**	**15 ≤ l < 20**	**l ≥ 20**
Horizontal	120	130	142	38	14	5	7	4	3	1
Inclined	96	114	86	28	8	4	1	1	1	2
Vertical	161	192	191	59	23	10	8	3	2	4

Most of the cracks are inclined.



7.3. Seepage and efflorescence

The following capture shows the distribution of the seepage and efflorescence:



Distribution of seepage and efflorescence

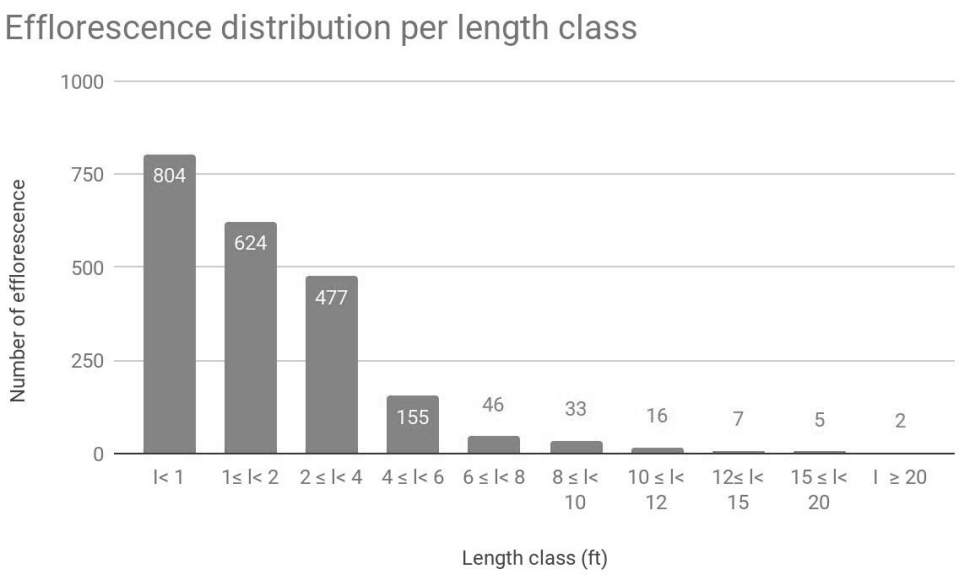
An efflorescence with seepage is classified as seepage because the water leak is more important than an efflorescence. Most of the seepages are on the bottom part of the cooling tower.

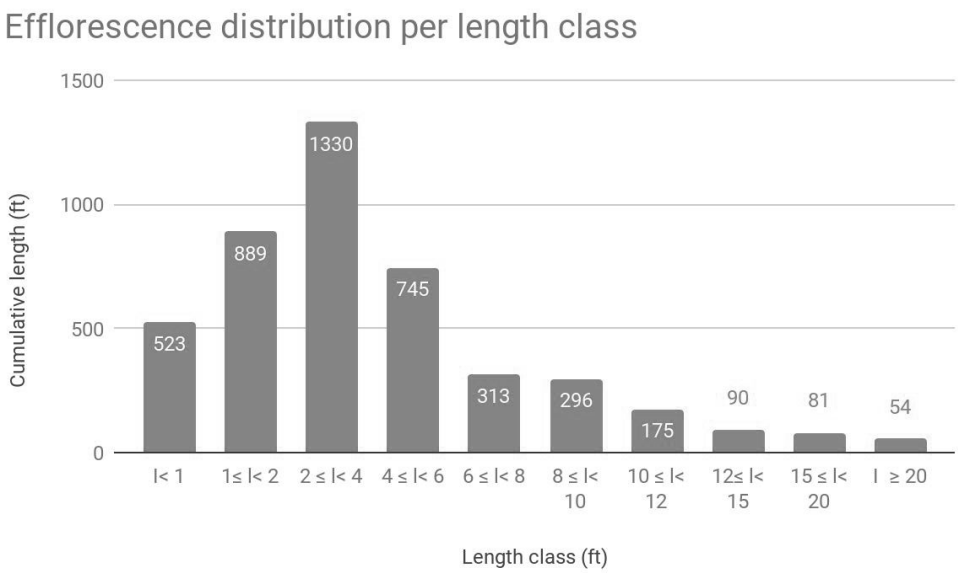
Efflorescences are most of the time small cracks with traces of efflorescence, but the opening of the crack is not visible with the efflorescence. A lot of efflorescences are located between the southern and eastern part of the shell.

7.3.1. Efflorescence distribution and histogram per length classification

Length dass (ft)	I< 1	1≤ I< 2	2 ≤ I< 4	4 ≤ I< 6	6 ≤ I< 8	8 ≤ I< 10	10 ≤ I< 12	12≤ I< 15	15 ≤ I< 20	I ≥ 20
Number	804	624	477	155	46	33	16	7	5	2
Cumulative length (ft)	523	889	1330	745	313	296	175	90	81	54

Approximatively 80% of efflorescences are shorter than 2 ft (0.61 m).





7.4. Holes and falling risk

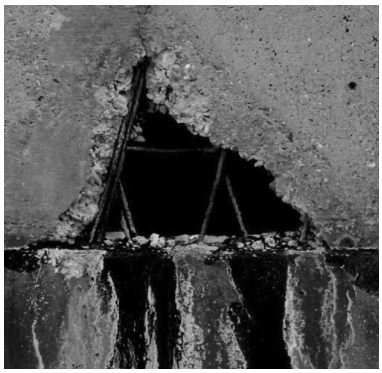
7.4.1. Holes

Two important through shells holes were identified:

- The first one (Defect ID n°3462) is located at 95ft from the bottom of the shell, on the SE side. We can see the vapor inside and the steel bars. The width of the hole is 1.74ft and the height is 0.69ft You can locate it precisely using any GIS software recommended above and opening the 2D data.

Hole (1.74ft width x 0.69ft height)

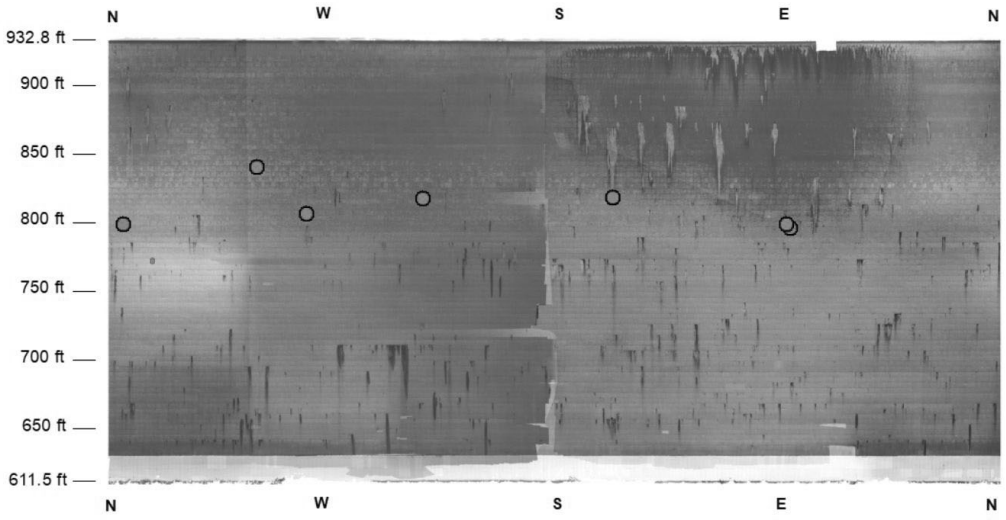
- The second one (Defect ID n°2340) is located 49ft from the bottom of the shell, on the South side. The width is 2.4ft and the height is 1.8ft.



Hole (2.4ft width x 1.8ft height)

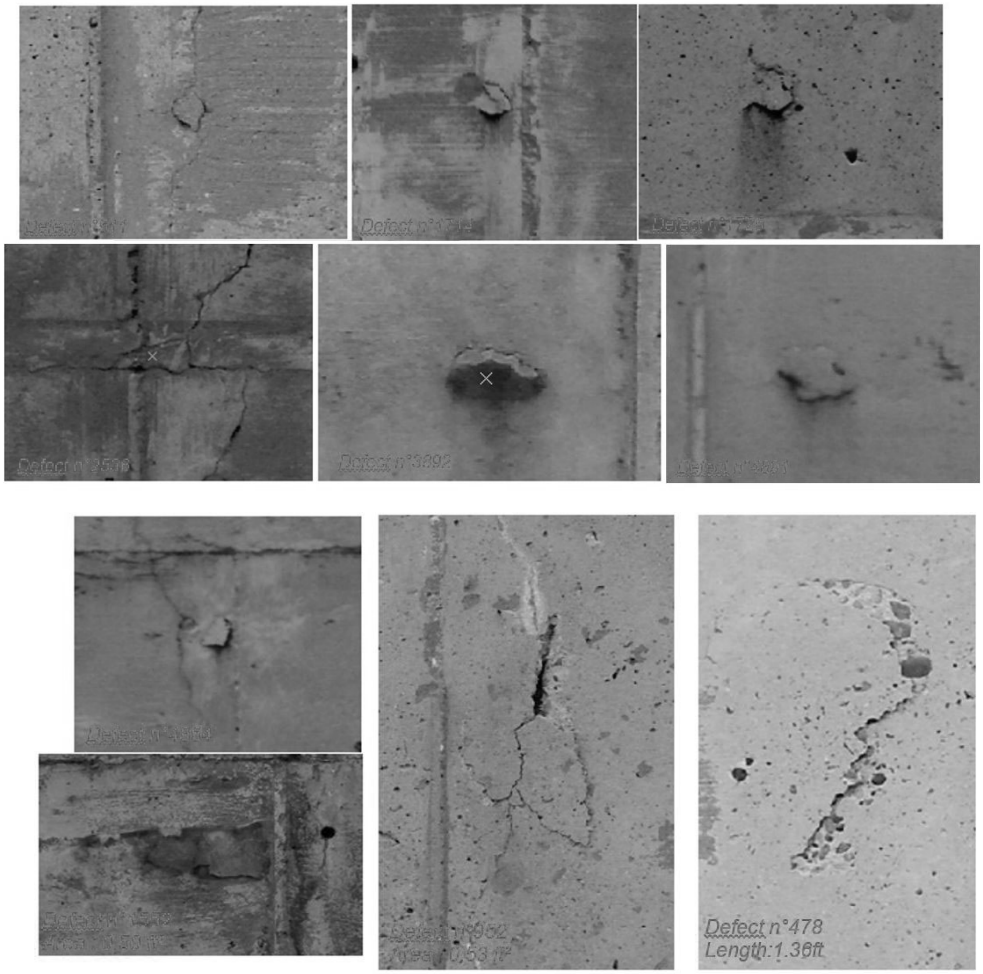
7.4.2. Defects with falling risk

10 defects with falling risks were detected. All of them are spallings: 7 points, 1 line and 2 surfaces. See paragraph “6. Inspection characteristics” for explanation on points, lines and surfaces.
The following map found in Appendix 3 gives the location of all of these falling risks. A major part of these defects are above 200 ft from the bottom of the shell.



Defects with falling risk

The following captures show examples of these defects with falling risks, you can use QGIS with the delivered 2D data to locate each of those defects on the shell and see high resolution pictures.



Defects with falling risk

These disorders are large enough to represent risks for people accessing the bottom of the cooling tower.

8. Inspection synthese

- Total amount of defects: 5854
- Cumulative length of cracks: 7875.67 ft
- Cumulative length of corrosions (visible steel): 5.15 ft
- Surface of shell + white fiberglass canopy deck plastic lining: ≈ 229 002 ft² (184 967 ft² for the shell alone)
- Number of defect per surface unit: 0.026 def/ft²
- Length of cracks per surface unit: 0.013 ft/ft²

The defects identified on the structure illustrate mainly the pathology of materials (concrete spalling, corrosion, reinforcement swelling cracks) and also a mechanical malfunction (cracks at 45 ° and significant distortions in the lower part of the structure). As a reminder, the threshold for detection of cracks was 0.03 in (0.8 mm), which is considered as a high value for a reinforced concrete structure exposed to the elements. Crack openings of more than 0.06 in (1.5 mm) have been found, they could correspond to a plasticization of reinforcement in these areas.

The photographic coverage shows that often the concrete coating is weak, which explains both the cracks that follow the reinforcement, efflorescence and many apparent reinforcement and concrete spalling.

A regular inspection is recommended to evaluate the evolution of the structure.

9. Distortions analysis

9.1. Theoretical model

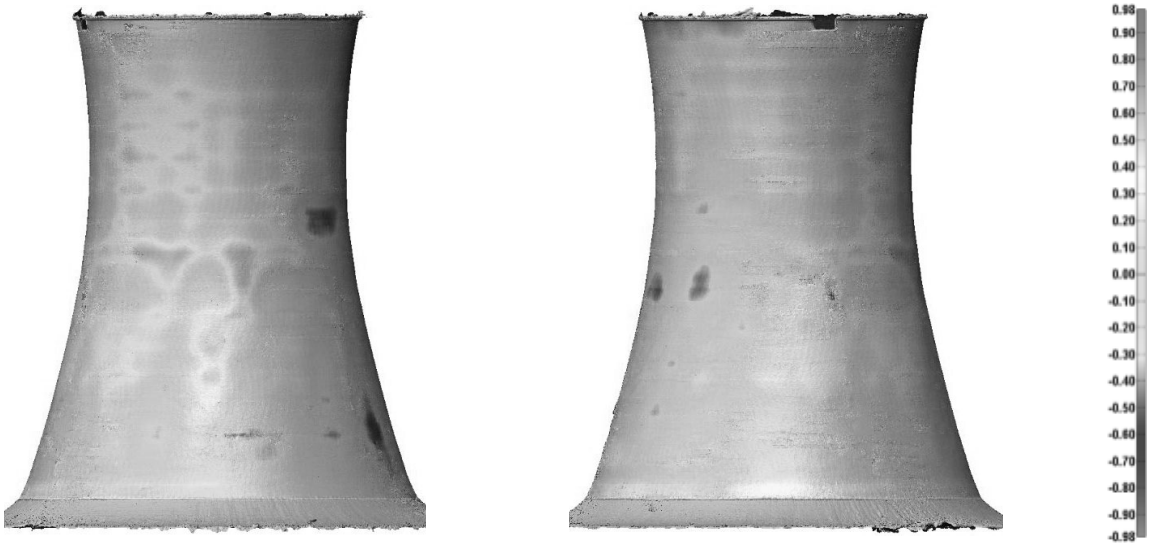
The theoretical model has been built from the document “Mitchell U2 CT Shell Dwg 13 _ 14.pdf” with the help of drawings and the equation of the hyperbolic curve, assuming that Mitchell U1 and Mitchell U2 towers are identical.

9.2. Comparison and unwrapping

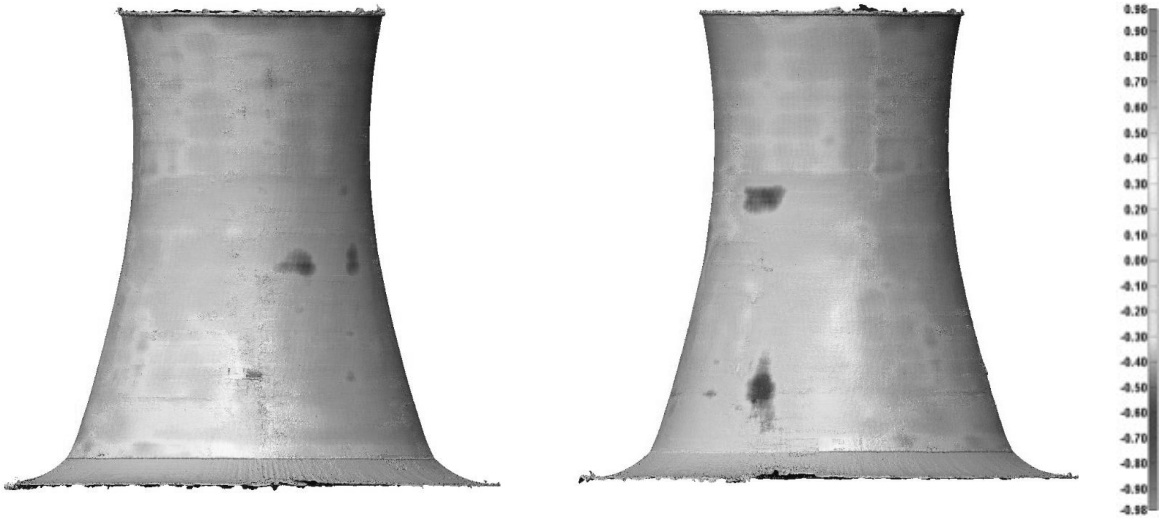
We are able to compare the theoretical model to the real model after aligning them in the same coordinate system. The alignment process has been done by using the altitude of the bottom, the top and the neck of the shell.
The comparison gives distances between the two surfaces. These distances are coded with colors:

- Green for no distortions,
- Hot color (yellow, red) for outside distortions,
- Cold colors (blue, purple) for inside distortions.

The maximum inside measured distortion is -0.59 ft and the maximum outside distortion is +0.65 ft.

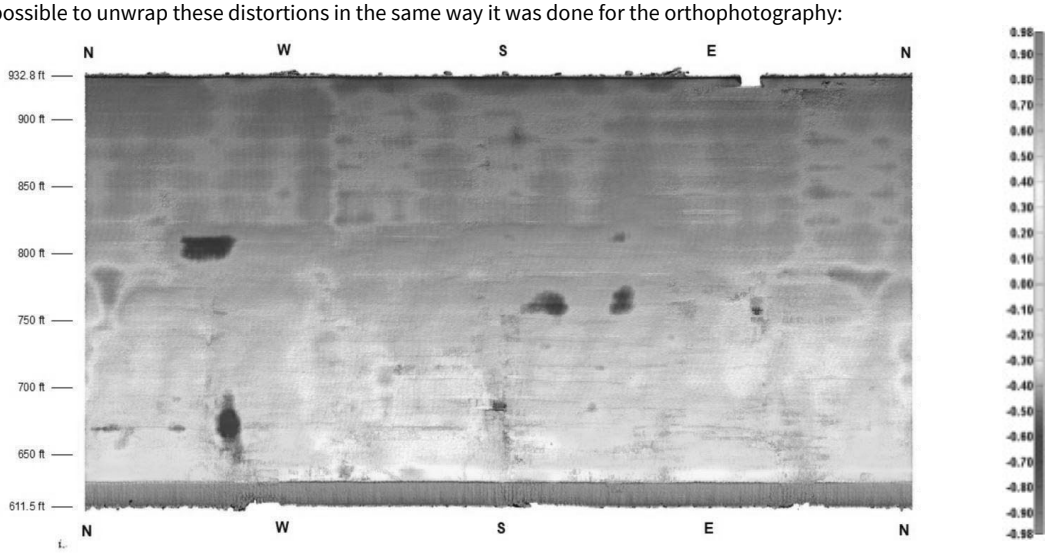


Views from North and East - scale in foot (right)



Views from South and West - scale in foot (right)

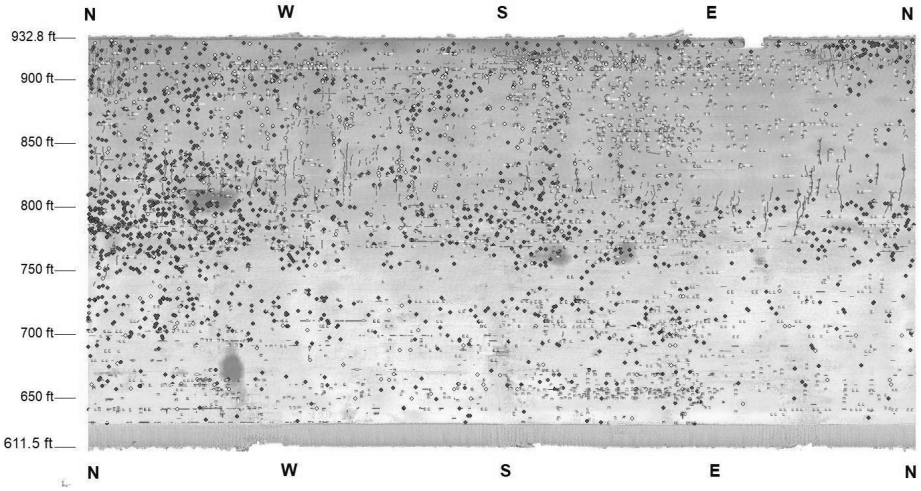
It is possible to unwrap these distortions in the same way it was done for the orthophotography:



Cylindrical unwrapping of the distortions - scale in feet (right)

9.3. Defect overlay

It is now possible to overlay the visual defects of the shell with the geometrical distortions of the shell:



The superposition of the disorder mapping with the deformations measured in relation to the theoretical drawings show that there does not seem to be a correlation between deformations and defects. The deformations remain low.

10. Data

The following data are available on the Amazon S3 shared link (valid for 30days only):

- Table of defects and table of defects with 3D coordinates of all the points,
- PDF of mappings,
- .tiff file of the orthophotography compatible with GIS software,
- Shape files of defects,
- Point cloud as .las file,
- 3D textured model as .OBJ file.

11. Links to the images on the Sterblue Cloud

The ortho picture is visible on the Sterblue Cloud together with all the defects. You will need access to the Sterblue Cloud and to the Mitchell Plant U1 inspection mission. Ask your Sterblue contact for access or write to operations@sterblue.com.

- Link to the mission and all the inspection images: here
- High resolution ortho picture + defects: here

You can download the images using the Sterblue Desktop app.

12. Conclusion

This report has presented the visual inspection of the Mitchell U1 cooling tower with photos taken with an UAV and automatic flights.

The data provided on Google Drive defines a visual archive of the shell on the 24th of April 2020. It does not define an accurate geometry archive because of the lack of 3D references.

This cooling tower has many defects, some with the risk of falling concrete.

It is possible to combine these data with a future photo coverage of the tower to give an accurate evolution of the defects on the tower.

APPENDICES

Appendix 1: table of defects
Appendix 2: map of defects
Appendix 3: map of defects with falling risk overlaying the orthophotography
Appendix 4: map of defects overlaying the orthophotography
Appendix 5: map of distortions
Appendix 6: map of defects overlaying the distortions