TETRA TECH

October 18, 2022

Submitted via email:
kolson@cityofkeywest-FL.gov

Karen Olson
Deputy Director
City of Key West
Port & Marine Services
201 William Street
Key West, FL 33040

Subject: Key West Angelfish Pier Seawall Structural Assessment

Dear Ms. Olson:

Tetra Tech is pleased to submit this seawall structural assessment report for your review. The report discusses the condition of the seawall located along northwest corner of the Garrison Bight west of the bridge and south of Palm Avenue Causeway and provides recommendations for repairs and replacements. If you have any questions or need any additional information, please contact me.

Sincerely,

David W. Frodsham, PE
Project Engineer
FL PE No. 75507

cc: Steve McAlearney, Director, Ports & Marine Services

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CA #: 2429

TETRA TECH

2022

CITY OF KEY WEST
PORT & MARINE SERVICES

KEY WEST GARRISON BIGHT MARINA
ANGELFISH PIER SEAWALL STRUCTURAL ASSESSMENT REPORT

Prepared By:
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1.0 EXECUTIVE SUMMARY

On August 10 and 11, 2022, Tetra Tech conducted a limited above and below-water structural inspection of the seawall at Angelfish Pier, located in the Garrison Bight Marina in the City of Key West. The examination of 660 linear feet of seawall started at the west end and continued along Palm Avenue Causeway in the east direction to the bridge crossing. Inspection findings revealed that the seawall consisted of a combination system of concrete soldier T-pilings and concrete lagging panels with a concrete cap. The project limits (area highlighted in yellow) and general location references are depicted in Figure 1.

Figure 1: Angelfish Pier Seawall Inspection Limits and Surrounding Area

The structural seawall assessment was performed on the identified components (pile, lagging panel, and cap) from the shelf elevation and up. It included observations of the structural elements that were visible during the inspection. Since the concrete railing to the cap is not a structural member of the seawall, it was not in the inspection scope.

Qualified divers inspected the seawall in the presence of a Florida state-licensed professional engineer with experience in seawall/bulkhead structural evaluation and construction. The purpose of the seawall assessment was to perform a visual above and below water inspection of its respective structural

components and develop a report that documents existing conditions and identified deficiencies. This report will catalog the findings and estimate repair/replacement construction costs. This report contains observations that were apparent to the naked eye and based upon engineering judgment and standard industry practices.

The numbering alignment system for the seawall was established at station 0+00 (denoted as a "zero" feet, starting point) with two tape measures placed along the seawall to match linear distance at the shelf and top of concrete cap elevations. Seawall findings were projected perpendicular to the station number on the alignment. The inspection consisted of a limited nondestructive assessment to determine the type and condition of existing deficiencies. Tetra Tech coordinated fieldwork logistics with the City of Key West staff and performed the inspection within its designated limits in the presence of transient marine vessels.

The examination revealed deficiencies in the seawall structural components. The deficiency types and severity vary based on the location within the seawall. In assessing the structure's overall condition, it is not evident that observed deficiencies will lead to spontaneous (immediate) failure. The recommendations presented in this report are to replace the seawall structure within the next five to seven years. However, an immediate effort is required to repair voided space underneath the concrete sidewalk observed at station 6+20. The responsible contractor must verify the extent of the voided area below the concrete sidewalk.

2.0 INTRODUCTION

The project area is located along the central north shore of Key West and lies within the northwest shore of the Garrison Bight Marina. Global Positioning System (GPS) coordinates for the site can be generalized as follows: Latitude 24° 33' 39.3" North, Longitude 81° 47' 18" West. The purpose of the seawall inspection was to determine the existing physical condition of the structural elements (from what is visible to the naked eye). The information for the structural assessment was provided by the City of Key West Port and Marine Services division. The name of the structure, the total inspected seawall length along the field-established alignment, general references, and plan view of the marina layout are depicted in Figure 2.

The inspected seawall is built out of three structural concrete members: cap, pile, and lagging panel, which for simplicity, will be further referred to in this report as a slab. Precast concrete T-piles are driven into a hard mudline/shelf at a typical eight feet on center spacing and with the precast lagging panel (or slab) tightly inserted between each piling. Since no horizontal (fitted or construction) joints are within the slab, it is presumed that the slab was monolithic and precast. The slab extends below the mudline to the mudline/hard shelf. Because the scope of the assessment was limited to the naked eye, the presence of absence of tieback rods and deadman could not be confirmed. However, it would by typical for a seawall of this configuration to be laterally supported by tieback rods and deadman. Cast-in-place cap is placed on top of the slab and pilings and designed to work in conjunction with the former in providing additional horizontal restraint as a continuous beam at the top of the overall earth-retaining system.

An additional consideration of the described structural system is the anticipated failure mode at the flange of the pile, which may be due to the corrosion of the reinforcing steel and spalling of the concrete.
The observed imprinted on the pile date (e.g., 7-10-64) suggests the pile casting date and presumes construction within the following days. The service life of a concrete structure in the marine environment can detrimentally affect the concrete material and dramatically reduce the structure's life span. If properly maintained, a concrete pile & panel seawall is typically designed to remain in service for up to 50 to 60 years. The dated pilings may suggest that seawall is close to 60 years old.

Inspection findings revealed three types of failure mechanisms at the pile's flange, slab, and cap that may indicate progressing failure of structural components and suggest the structure's end of service life.
The report will further discuss deficiency findings and the types of failure mechanisms in the analysis portion of this document.

Figure 2: Angelfish Seawall Inspection Extent and General Area Overview

3.0 SITE DESCRIPTION

The structural inspection performed at the Angelfish Pier Seawall consisted of approximately 660 linear feet of continuous concrete structure along the northwest area within the Garrison Bight Marina, as shown in Figure 2. The entire bulkhead supports recreational boating operations and is open to the public for access. On the land side of the seawall, the concrete pedestrian sidewalk is directly abutting the cap, adjoining the public road and parking spaces in its entire length. The concrete railing is installed along the whole length of the bulkhead and has twelve gates used by the boating businesses. On the waterside, starting at the west end of the seawall and east of Thai Island Restaurant, a linear wooden dock system is anchored to the seawall between stations 0+00 (shown in Figure 3) and 1+20. Refer to Appendix A (Angelfish Pier Seawall Deficiency Location Map) for the dock's location. The existing dock has two decks stacked on top of each other. The lower deck, which seemed to be abandoned, has partially fallen apart in the direction of the ascending stations. Within the 0+00 – 1+20 station range, the team encountered obstructions (e.g., screens) below the deck level and the water surface and construction material near and along the wall below the water level. Tetra Tech dive team identified and documented the locations of three stormwater drainage outfalls (culverts) established along the seawall stations 0+09, 2+47, and 5+67. There is one 24-inch internal diameter reinforced concrete culvert at 0+09 station and two 16-inch internal diameters reinforced concrete culverts at stations 2+47 and 5+67. Water and electric lines were observed installed at the cap level between station 0+00 through approximately station 5+80.

Figure 3: Inspection Starting Point (STA 0+00). West (top right) and east (bottom left) Direction Views.

While the water depth trend along the seawall varied from being shallower on the west and deeper on the east, the mudline at the seawall was generally between four and eight feet to the water surface.

Sediment composition along the seawall's bottom (base of seawall) was hard rock with minor accumulated sediment, sand, and miscellaneous debris. Topographic measurements of the project locations were not in the inspection scope. Refer to Appendix D (Seawall STA 0+00 - 1+20 Above-water level Inspection – Photolog) for above-water observations at the seawall.

4.0 INSPECTION METHODOLOGY

The team completed the inspection using a 19-feet long boat to safely access the inspection area by water and ensure continuous safety oversight during the execution of the field activities. A three-person dive team (including two divers, a boat operator/safety oversight), and an engineer were on-site during the inspection. Divers trained in structure inspections used scuba to inspect the wall and catalog deficiencies visually.

Divers used the measuring tape to establish underwater seawall alignment to mark and record the location of observed deficiencies. The second tape was placed at the cap and used to identify the damages from the shore. Tape measure readings were made sure to match. The team used a station range from 0+00 through 6+60 as a baseline for underwater and above water deficiency identification and cataloging. The geographical location helped identify additional guides to referencing sides on each structural component.

Vertical observation progressed in an up-and-down motion from the seawall's bottom to the water line unless an identified deficiency extended above the water line. The engineer conducted an independent above-water line inspection of the seawall and cross-referenced the details of the underwater findings with the divers. Divers followed a systematic approach to measuring all deficiencies along the seawall using the tape measure and distances from the cap or shelf. The engineer then reviewed the information to confirm observations and accurately represent the observed deficiencies. Additionally, the engineer assessed identified defects on the bulkhead at low tide from the waterside using a boat.

Underwater inspection notes were taken separately during the initial inspection, with videos of the seawall and deficiencies taken following the review. The team collected video recordings and photographs of the findings. Captured still images were gathered from the video and combined with underwater photography to show a representative record of the existing condition.

Observations were limited by what could be readily seen and accessed by the divers and the engineer. The seawall components below the water line were covered by moderate to heavy marine growth. Although it would not affect the detection of any significant deficiencies, it limited the visibility of possible minor deficiencies in these areas.

5.0 OBSERVATIONS AND ANALYSIS

The team mapped the deficiencies' locations, and the engineer transferred notes into a digital format that summarizes all observed defects in the following Appendices. Refer to the individual Appendix for information:

1) Appendix A (Angelfish Pier Seawall Deficiency Location Map). Appendix A is a two-page map illustrating the project location, marked deficiencies locations, relevant existing utilities, and built-up dock at the seawall.
2) Appendix B (Seawall Deficiency – Table). All identified deficiencies were summarized in the electronic table and correspond to their unique identification, referenced station, location on the structural component, damage rating category, and a narrative describing the extent of the damage. Refer to the table's footnote section for the unique deficiency identification and used conventions. Each tabulated deficiency has a corresponding photograph in Appendix C (Seawall Deficiency – Photolog).
3) Appendix C (Seawall Deficiency – Photolog). This Appendix represents all identified in Appendix B deficiencies. Photolog summarizes each deficiency finding captured by the diver from below and above the water line and briefly describes the illustration.
4) Appendix D (Seawall STA 0+00 - 1+20 Above-water level Inspection – Photolog). This Appendix shows the seawall captured on camera from the dock level, where conditions permitted, at ten-foot increments. Note: Due to the existing accumulation of construction debris and present obstructions at the dock, the team decided that dive conditions were unsafe.
5) Appendix E (Failing Concrete Slab at Paved Sidewalk – Photolog). This Appendix illustrates existing sidewalk damage (between 6+00 and 6+60) due to the undermining at the slab starting at 6+00.
6) Appendix F (Preliminary Seawall Construction Estimates). This Appendix presents probable construction itemized cost breakdown estimates associated with the replacement of the seawall segment.

The engineer determined the severity levels of the observed deficiencies and categorized all the deficiencies into the following four main categories: Minor (1), Moderate (2), Major (3), and Critical (4). All categories' criteria are summarized in Table 1 below.

Table 1: Deficiency Category Criteria

Deficiency Severity Level	General Deficiency Description
Minor (1)	Initial stages of damage. Hairline cracks, shallow voids, and chipped concrete. Environmental impact – Concrete surface weathering and marine growth.
Moderate (2)	Sizable cracking, void, undermining below the concrete cap (no evidence of material washout), less than 1-inch breaks in concrete (no steel reinforcement exposed), rust staining through hairline cracks, and honeycombing.
Major (3)	Cracking leads to concrete spalling, planar surface misalignment at construction joints and cracks, greater than 1-inch breaks in concrete (no steel reinforcement exposed), rust staining through sizable cracks, and honeycombing.

Critical (4)	Spalls in concrete surfaces, planar surface misalignment (with material separation) at cracks and spalls, and rust staining through spalls and cracks. Broken off concrete material with exposed reinforcement and/or in rust staining.

Deficiency severity levels presented in Table 1 can further explain the potential failure mechanism of the structures located in the coastal region and continuously or semi-continuously exposed to saltwater.

- Minor (1)– a deficiency undergoing the initial stages of hairline surface cracks development and concrete surface roughening due to the thermal effects, physical abrasive action and concrete surface weathering, blunt force impacts, and environmental exposure (like marine growth) is not likely to contribute to the failure of the structural component.
- Moderate (2) – a deficiency that has progressed from its initial stages, and a noticeable underlying structural defect can be recognized, and the deficiency is sizable. At this stage, the deficiency has not yet progressed to a state that is likely to contribute to the failure of the structural component.
- Major (3) – a deficiency that has progressed to its initial failure. At this stage, noticeable damage to the structural component can be observed and its dimensions verified. This deficiency severity level represents a risk to a structural member and a possible threat to the overall structural integrity of the system or a part of the system.
- Critical (4) – a deficiency with evidence of an ongoing failure mechanism. At this stage, sizable damage to the structural component can be observed and its dimensions verified. This deficiency severity level represents risk to a structural element and risk to the overall structural integrity of the system or a part of the system due to the reduction of the cross-sectional area and decreased ability to carry imposed loads safely.

The seawall's piling is the primary structural element and was observed spaced at eight feet on the pilings' center. Slabs are the secondary structural elements and are typically sufficiently pushed into the mudline between evenly spaced pilings. The seawall system is constructed to a planned alignment and designed to resist lateral (horizontal) earth pressure along its vertical height (possibly via tieback system). Since there was no evidence of an anchor system on the slabs, it is possible that the seawall at Angelfish Pier is a cantilevered system and resists horizontal forces only through the pilings. It is likely that a tieback system to the seawall exists. Due to the limited naked-eye observations, inspection findings did not confirm this seawall feature. The cast-in-place concrete cap provides a continuous adequate joined connection to the primary and secondary structural elements at the top of the seawall and additional support against the lateral forces. Figure 5 includes an elevation view of the seawall and typical pile-slab arrangement within the structural system.

At service, the slab within the seawall is considered an independent beam and predominantly subjected to flexural forces along its transverse direction. The slab develops reaction forces at the adjacent contact area with the piling, which translates forces to the piling and subjects it to the flexural forces in its longitudinal direction. Individually, pilings resists arising forces due to the retained behind the seawall

earth pressure that is a tributary to the piling's width, height, and embedment depth. However, the intended load transfer mechanism in the T-pile connection is designed to occur through the slab onto the pile's flanges because the slab has more area that resists the weight of the soil.

In examining the pilings, failure of the top two to three feet of flange length is common at many piling locations. It manifests in spalled concrete areas at the pile's face, exposed corroding rebars, and localized to the spalls' rust staining. Refer to Figure 4 for the top view sketch of the connection and examined failure pattern at the pile-to-slab connection and Figure 5 for elevation view and cracks/spalls typical location on the pile. As illustrated in Figure 4, the flange is primarily subjected to shear forces. Due to the unique material properties of concrete, the crack occurs at a 45-degree angle when an area is subjected to shear loading.

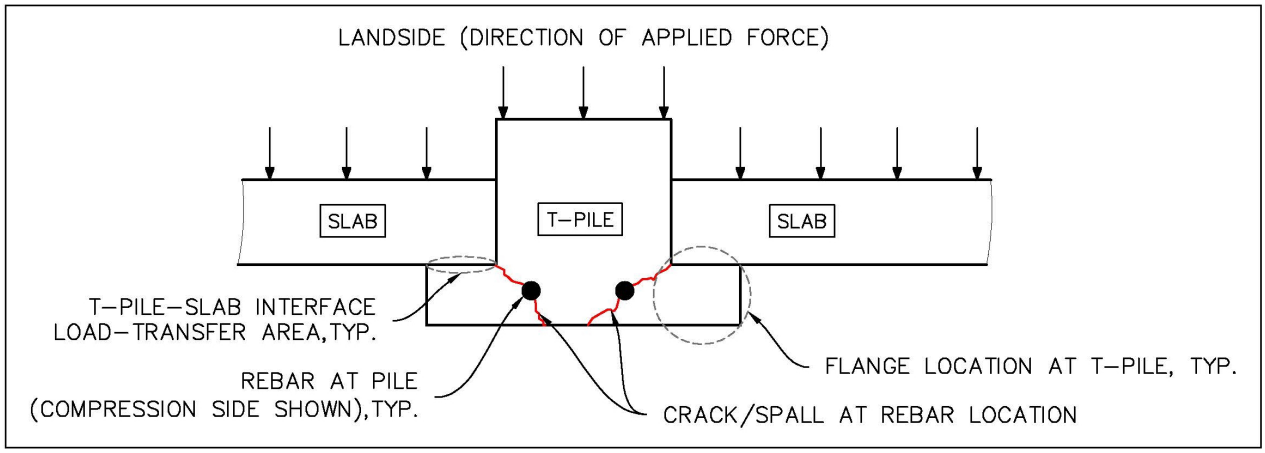


Figure 4: T-Pile and Slab Structural Connection Plan View. Failure at Compression Flanges.

The crack development at the flange and its propagation into a spall can be due to a few factors. Simultaneously occurring, these factors contribute to the overall ongoing failure of the flange at the top of the pile. Cyclic change in loading conditions and isolated additional surges in loading behind the wall may have changed the magnitude of forces on the slab and subsequently on the flange and led to crack formation. The aging of the concrete, erosion of the fines in the concrete surface, chloride intrusion, and thermal shrinkage may have also caused the crack propagation at the top portion of the pile. Once formed, the crack may expose reinforcing steel to the stormwater runoff and corrosive elements of the salt water. Rebar will oxidize once it becomes exposed to moisture, and steel corrosion will generate rust material around the rebar, causing localized internal tensile stresses within the concrete and crack propagation and eventually material spalling. Previously established cracks over time spalled to what they look like in the present. Spalled and separated concrete material at the flange loses the ability to resist intended loads.

As a result of the concrete spalling at the flanges, slab and cap have become subjected to undesired loading conditions. Along the spalled length of the flange, the slab becomes unsupported and left to resist the weight of soil as a cantilevered beam and develops unanticipated flexural and shear stresses along its transverse direction. The typical failure mechanism at secondary structural components is common to flexural stress marks within the top portion of the slab. Concrete spalling at the pile changed internal forces at the cap's bottom, where it seals the top of primary and secondary structural elements. Cracks and spalls at the cap are characteristic of the forces arising within the cap in the locations of spalling pilings. Cracks in the cap at pilings locations suggest expansive forces within the cap at those locations. Figure 5 shows typical locations of cracks and spalls on the slab and the cap.

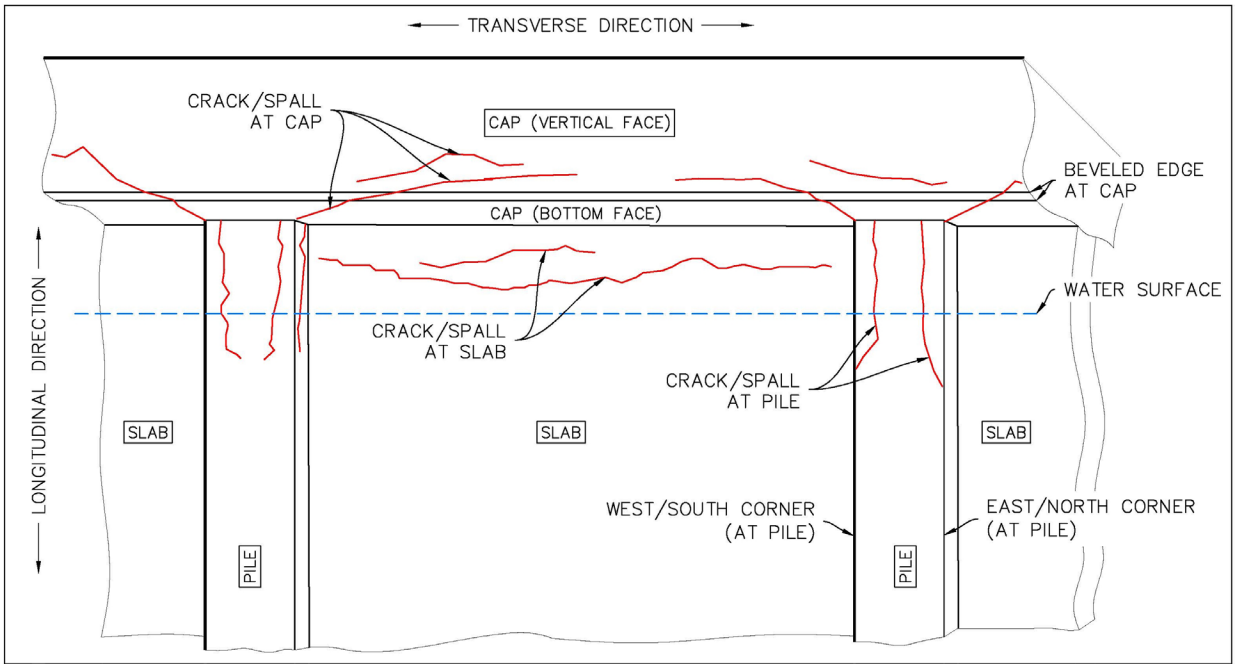


Figure 5: Typical Location of Cracks/Spalls at Pile, Slab, and Cap. Typical Failure Modes at Pile.

Three types of common deficiencies per structural features are summarized in the table format in Table 2. Among the total of 90 examined defects, 49 (or 54% of the total) attributed to a common type of defect discussed in the pilings, 24 (or 27% of the total) attributed to a typical defect type observed in slabs, 15 (or 17% of the total) similar kind of defect in the cap, and 2 (or 2% of the total) defects in the headwall. The defect percent allocation per structural feature has been calculated with respect to the deficiency rating category. For example, out of the total 49 defects in piling there are 5 (or 10% of the total) defects have been rated with a moderate level of severity, 20 (or 41% of the total) defects with a major severity level, and 24 (or 49% of the total) defects are in critical condition. A similar thought process applies to the other structural feature categories. Finally, the last row of the table relates the total number of defects per severity level category and its comparison to the overall number of discovered defects. It is apparent that almost half (46%) of the overall findings have been examined with a major type of defect, while the

rest of the results become almost equally divided between critical and moderate categories, 28% and 27%, respectively.

Additionally, the highest number of defects prescribed a critical condition status is in the piling category, representing 49% of the total in the same category. While using a similar approach, it can be seen in the table that when the defects are compared within the same type of major deficiencies, the vast majority of the 20 defective items are still in the piling category, with 41%. The next one is in the slab category with 12 items at 80%, and the cap category with 8 items at 33%.

Table 2: Total Deficiency Count and Deficiency Percent Allocation per Category

Item	Total # & % of Defects	Moderate (2)	Major (3)	Critical (4)
Pile (P)	49 (54%)	5 (10%)	20 (41%)	24 (49%)
Slab (S)	24 (27%)	15 (63%)	8 (33%)	1 (4%)
Cap (C)	15 (17%)	3 (20%)	12 (80%)	-
Headwall (HW)	2 (2%)	1 (50%)	1 (50%)	-
Total Count (per category)	**90**	**24 (27%)**	**41 (46%)**	**25 (28%)**

As an additional consideration, a construction defect known as honeycomb appears in the vast majority of the examined number of pilings and slabs. Honeycomb generally indicates a poor liquid concrete consolidation during construction, represents poor material properties, reduces the protective concrete cover to the reinforcing steel, and overall impacts the structure's service life.

The frequency of deficiency occurrence seems to increase significantly starting at station 2+30, as can be seen in the map presented in Appendix A. The severity deficiency level appears to have increased from the same station, with a dramatic shift occurring at station 4+10 as a critical level type of defects becomes apparent.

The progressing stages of ongoing seawall system failure were noted at approximately station 6+00 and extended through station 6+60. Due to the undermining at the slab bottom within the approximate station range, 6+05 – 6+13 (described in Appendix B, Item # 80, ID: S24, Appendix C, Figures 130 and 131, and Appendix E), the concrete pavement at the sidewalk has shown multiple cracks at station range 6+00 – 6+60. It is presumed that the velocity of current and wake forces scoured the finer material at the slab bottom and led to the undermining at that location in the seawall. Also, a gap at station 6+20 between the cap and adjoining sidewalk has a void depth measured behind the seawall to extend four feet below the sidewalk. The depth of undermining under the slab at the shelf was approximately two feet behind the wall. Standing water was seen through the gap with the naked eye. The engineer could not verify the extent of the voided area due to the limited nature of the inspection. The undermining at the slab had negatively impacted its physical conditions. The slab lost eight feet of support at the shelf and started

leaning out of its plane toward the water. The presence of typical cracks and spalls on the slab's and cap's exterior surfaces and varied gap widths at the slab and piling interface may directly correlate to the slab's unsupported length. Described observations are illustrated in Appendix C in Figures 127 - 129, 132, and 134. The extent of eroded backfill is unknown.

6.0 RECOMMENDATIONS

Overall, it is evident that the majority of findings, approximately 74%, are in the categories that will require future repairs or replacements. Suppose a repair option is to be considered to remedy identified defects. In that case, it is anticipated that nearly as much as 28-46% of the defects will require an individual assessment of all deficient structural elements. It is estimated that 430 linear feet, two-thirds of the seawall at station range 2+30 and 6+60, will require examination of the reinforcing steel in its structural members. The seawall repair at station range 6+00 – 6+60 will require removal of the cap, undermined slab replacement, and examination of the affected individual structural components for structural integrity if they are retained in their existing locations. Undermining at the slab must be addressed, and the intimate contact between the exiting slab bottom (or a replacement slab) and the shelf must be restored.

While the concrete sidewalk lies outside the project area and is not in the inspection's scope, convinced by the documented observations engineer extends the learned knowledge to inform the City of Key West about this finding. Separately from the seawall repairs, it is prescribed to take the necessary and urgent steps to closely examine the area underneath the sidewalk at station range 6+05 through 6+20.

As was mentioned earlier in the report, the seawall's age is estimated to be around 60 years, and the structure is reaching the end of its useful service life. The failure mechanisms observed are consistent with the preliminary analysis of the initial stages of seawall structural system failure. The adequate repair costs can be in the range of the new seawall construction.

This report recommends replacing the seawall structure at Angelfish Pier starting at station 2+30 through 6+60 within the next five to seven years, with a possible option to replace the seawall from station 0+00 to 2+30 due to its advanced age. This timeline should be sufficient to acquire the necessary funding to replace the seawall and go through permitting and design phases.

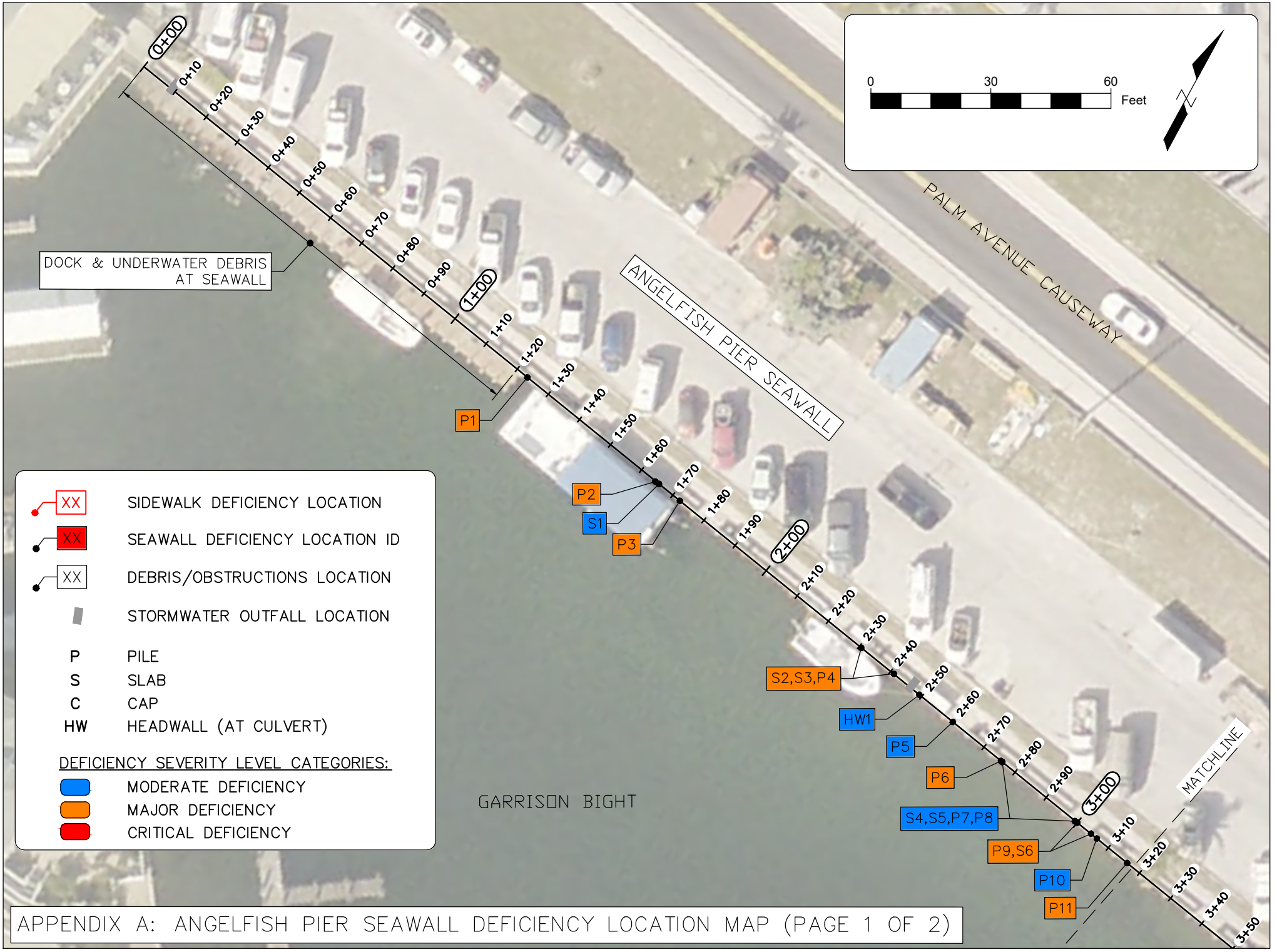
While installing individual pilings and slabs to support currently failing structural components is possible, it is economically feasible to construct a new seawall of a similar or better structural frame and materials. So it is encouraged to direct the efforts toward permitting and design processes where the City of Key West will consider economical cost alternative options. Additionally, the installation of individual pilings and slabs may render the geometry of the seawall limited to use by occupying businesses.

The demolition of the existing structure will not be necessary if a new seawall is to be constructed some small distance away from the existing one. In this case, the new seawall can be a cantilevered wall. A probable cost associated with erecting 430 linear feet of the new structure is projected at $1,958,675, with an itemized cost breakdown shown in Table 3, and attached separately in Appendix F.

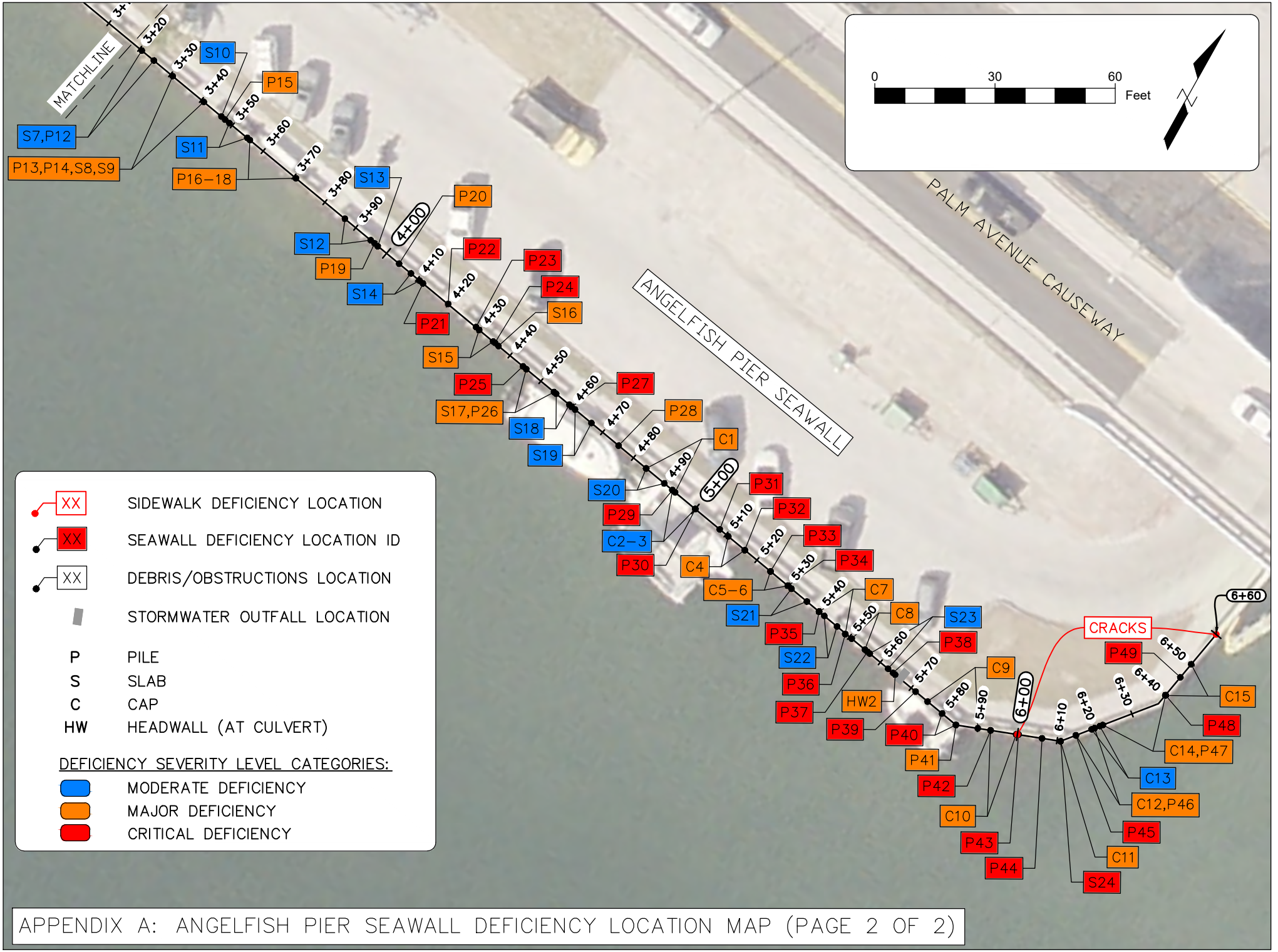
Table 3: Angelfish Pier Seawall Construction Replacement Estimate

	Angelfish Pier Seawall at Garrison Bight - 430 LF Seawall				October, 2022
	Description	**QTY**	**Unit**	**Unit Price**	**Amount**
	Direct Cost				
	General - Seawall				
1	Upland Staging Area (provided by City of Key West)	1	LS	10,000	$ 10,000
2	Utility Coordination	1	LS	3,000	$ 3,000
3	Preconstruction Seismic Survey & Video	1	LS	4,500	$ 4,500
4	Temporary Construction Fencing (6' High, 12' Sections of Chain Link with Wind Screen & Sandbags)	800	LF	11	$ 8,800
5	Erosion & Sediment Control	1	LS	20,000	$ 20,000
6	General Site Preparation & M.O.T.	1	LS	25,000	$ 25,000
7	Demo - cap, sidewalks, slabs	2,500	SF	10	$ 25,060
8	Temporary Utility Relocation, Pumpout, Water & Electric	1	LS	50,000	$ 50,000
9	Steel Sheet Piling (24' long, A-690 including freight)	430	LF	850	$ 365,500
10	Steel Sheet Piling installation (driven from water)	430	LF	380	$ 163,400
11	Concrete - Cap, 6,000 PSI, Ext. Aggressive Env, 7 - #5 bar w/ Stirrups	430	LF	357	$ 153,510
12	Extend Drainage Outfalls	3	EA	5,000	$ 15,000
13	Tremie Grout for fill between sheetpile(= 430'x1.5'x8'/27)	200	CY	350	$ 70,000
14	Sidewalk	2,600	SF	7	$ 17,035
16	Testing - Allowance for Concrete	1	LS	10,000	$ 10,000
17	Vibration Monitoring - during pile driving operations	1	LS	11,000	$ 11,000
18	Site Restoration (including sidewalk and other impacts)	1	LS	70,000	$ 70,000
19	Chemical Grouting of Cracks/Seams	40	LF	35	$ 1,400
20	Tremie Grout Gaps in Seawall Cap	16	CY	500	$ 8,000
				Subtotal	**$ 1,031,205**
				Direct Cost	**$ 1,031,205**
	Contractor Cost				
24	FOOH & HOOH (Overhead) Combined (6% Typical of Direct Cost (DC))	6.0%		61,872	$ 61,872
25	Mobilization/Demobilization (10% Typical of DC + above costs)	10.0%		109,308	$ 109,308
26	Profit (17% Typical of DC + above costs)	17.0%		204,405	$ 204,405
27	Bonds, Permits & Insurance (2% Typical of DC + above costs)	2.0%		28,136	$ 28,136
	Direct + Contractor Cost			**403,721**	**$ 1,434,927**
	Project Cost				
28	City of Key West Allowance Account for Administration and On-site Supervision (SIOH)	5.0%		71,746	$ 71,746
29	Contingency	30.0%		452,002	$ 452,002
	Direct + Contractor + Project Cost			**523,748**	**$ 1,958,675**
	Total Construction Cost				**$ 1,958,675**

APPENDIX A



APPENDIX A: ANGELFISH PIER SEAWALL DEFICIENCY LOCATION MAP (PAGE 1 OF 2)



APPENDIX A: ANGELFISH PIER SEAWALL DEFICIENCY LOCATION MAP (PAGE 2 OF 2)

APPENDIX B

APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
1	**P1**	Pile top	1+23	Crack/Spall Rust Staining	3	• (2)-24 x ¼ x ¼ Longitudinal cracks/spalls at two flanges, one at each flange. Rust staining. • Heavily corroded anchor bolt with square washer.
2	**P2**	Pile top	1+64	Break/Spall Rust Staining	3	• (2)-16 x ¼ x ¼ Longitudinal cracks/spalls at two flanges, one at each flange. Rust staining. • 10 x 2 x 2 Break in top of west corner of pile at flange-slab interface. Rust staining.
3	**S1**	Slab top	1+65	Crack	2	18 Long by 1/8 wide longitudinal crack at 2 inches east of pile's east flange.
4	**P3**	Pile top	1+72	Crack/Spall	3	24 x (¼-½) x ½ Longitudinal crack/spall at top of east flange.
5	**S2**	Slab top	2+31 – 2+34	Honeycomb/ Erosion	3	36 x 12 x 3 Concrete erosion in the honeycomb region at cap-slab interface. Construction defect (concrete overpour).
6	**P4**	Pile top	2+35	Crack/Spall	3	Multiple longitudinal and transverse cracks and spalls at pile top: cap-pile interface west and east flanges.
7	**S3**	Slab top	2+38 – 2+41	Honeycomb/ Erosion	3	36 x 6 x ½ Concrete erosion in the honeycomb region at cap-slab interface. Construction defect (concrete overpour).
8	**HW1**	East side	2+49 – 2+50	Honeycomb	2	24 x 13 x 2 Honeycomb on east side at mid-height of culvert headwall. Construction defect (concrete overpour).
9	**P5**	Pile top	2+60	Honeycomb	2	24 x 7 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
10	**P6**	Pile top	2+76	Crack/Spall Honeycomb	3	• (2)-24 x 2 x ¼ Cracks along at two flanges with intermittent spalling. No rust staining. • Honeycomb across the top of pile. Construction defect (concrete overpour).
11	**S4**	Slab top	2+76 – 2+80	Crack	2	6 Feet long by 1/8 wide diagonal crack in the top third, west side, of the slab.
12	**P7**	Pile top	2+83	Honeycomb	2	24 x 9 x 2 Honeycomb region at cap-pile interface. Possible concrete break on east side. Construction defect (concrete overpour).
13	**P8**	Pile top	2+94	Honeycomb Spall	2	24 x 7 x 1 Honeycomb at top of pile. Construction defect (concrete overpour).
14	**S5**	Slab top	2+93 – 2+99	Honeycomb	2	72 x 13 x ½ Honeycomb at top of slab. Construction defect (concrete overpour).
15	**P9**	Pile top	3+00	Crack/Spall Honeycomb	3	• 14 x 2 x ½ Crack/spall at top of pile on west flange. • 7 x 3 x 1/8 Crack in the top east corner at flange. • 24 x 3 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
16	**S6**	West side Mid area	3+01 – 3+04	Crack	3	Two adjoint longitudinal and transverse cracks on slab. • 18 Long by 1/8 wide longitudinal crack is 2 inches apart from and parallel to east flange. • 24 Long by 1/8 wide transverse crack starts at the longitudinal crack at slab's mid-height (from shelf).

[D] **D**eficiency **S**everity **L**evel (**DSL**): 1 – **Minor**, 2 – **Moderate**, 3 – **Major**, 4 – **Critical**.

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[B] STA (station) 1+15 represents 115 feet.

[C] Deficiency measurement convention (in inches) for Length x Width x Depth is L x W x D. All dimensions are in inches unless stated otherwise.

APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
17	**P10**	Pile top	3+07	Break Honeycomb	2	8 x 9 x 1-½ Break in concrete repair at flange east top corner. Construction defect (concrete overpour).
18	**P11**	Pile top	3+16	Crack/Spall Honeycomb	3	• 30 x 1 x ½ Crack/spall at east flange, starts adjacent to repair area at top of pile. • 24 x 14 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
19	**S7**	Slab top	3+21 – 3+23	Honeycomb	2	24 x 11 x ½ Honeycomb at top of slab. Construction defect (concrete overpour).
20	**P12**	Pile top	3+24	Honeycomb	2	5 x 9 x 1 Honeycomb at top of pile. Construction defect (concrete overpour).
21	**P13**	Pile top	3+31	Crack Honeycomb	3	• 24 x ¼ x ¼ Crack at west flange at top of pile. • 3 x 5 x 1 Honeycomb at top of pile. Construction defect (concrete overpour).
22	**S8**	Slab top	3+33 – 3+41	Crack/Spall	3	• Multiple transverse cracks with 1/8 width across entire slab's top (86-96 inches). • 13 x 3 x ½ Transverse crack at STA 3+35 (slab's midspan).
23	**P14**	Pile top	3+39	Exposed Rebar Honeycomb	3	• 4-Inch protrusion of #11 size rebar at top of pile's east flange-slab interface, 4 inches from the pile-top-cap interface. • 5 x 3 x 1 Honeycomb at top of pile. Construction defect (concrete overpour).
24	**S9**	Slab top	3+41	Spall	3	12 x 10 x ¼ Spall at top west slab corner. Rust staining with delamination. No identified metal surfaces.
25	**S10**	Slap top	3+47	Honeycomb	2	6 x 4 x 1 Honeycomb at east top corner of slab. Construction defect (concrete overpour).
26	**P15**	Pile top	3+48	Crack/Spall	3	(2)-20 x (¼-3) x 1/8 Longitudinal cracks/spalls at west and east flanges at top of pile. Intermittent regions with spalls and rust staining at each crack.
27	**S11**	Slab top	3+49 – 3+55	Crack	2	72 x ¼ x 1/8 Transverse crack at top of slab, one foot below the cap.
28	**P16**	Pile top	3+56	Spall/Crack Honeycomb	3	• 24 x 20 x 2 Longitudinal spall at pile top on south side. Concrete surface planar separation is up to ½ inch. • 24 x 20 x ¼ Honeycomb at top of pile. Construction defect (concrete overpour). Spall at the interface of the original concrete and repair surfaces. Rust staining.
29	**P17**	Pile top	3+63	Crack	3	15 x 2 x ¼ Longitudinal crack at top of pile's west flange.
30	**P18**	Pile top	3+71	Crack Honeycomb	3	• 24 x ½ x 1 Longitudinal crack at top of pile's west flange • 24 Long by ¼ wide vertical crack at top of pile's east flange. • 7 x 5 x 1 Honeycomb at top of pile's east flange. Construction defect (concrete overpour).
31	**S12**	Slab top	3+87 – 3+95	Crack	2	72 x (¼-½) x 1/8 Transverse crack to slab top, 1 foot below the cap with intermittent rust stain areas.

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APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
32	**P19**	Pile top	3+96	Crack Honeycomb	3	• (2)-24 x (¼-½) x (1-2) Longitudinal cracks at west and east top of pile. • 36 x 3 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
33	**S13**	Slab top	3+97	Rust Staining	2	5 x 3 Rust staining area at top west slab's corner.
34	**P20**	Pile top	4+04	Spall/Crack	3	22 x ¼ x ¼ Longitudinal crack at pile's top west flange.
35	**S14**	Slab top	4+08 – 4+11	Honeycomb	2	36 x 8 x ½ Honeycomb at top slab.
36	**P21**	Pile top	4+12	Break/Spall Exposed Rebar Rust Staining	4	30 x 24 x 5 Break/spall in concrete cover at top of pile. Loss of concrete material (reduction in cross-section) and rust staining in the region of break. 3-5 Inches of reinforcing steel is exposed. 5-20% of Rebars' individual cross-sectional areas are lost due to corrosion.
37	**P22**	Pile top	4+20	Break/Spall	4	28 x 24 x 3 Breaks/spalls in concrete at west and east flanges of top of pile. Up to ½ inch of planar concrete surface separation at bottom of spalled area. Reduction in cross-section.
38	**P23**	Pile top	4+28	Break/Spall Honeycomb	4	• 24 x 24 x 4 Breaks/spalls in concrete at west and east flanges of top of pile. 7 x 3 x 5 Break (material loss) at bottom of break/spall on east flange. Reduction in cross-section. • 24 x 1 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
39	**S15**	Slab top	4+30 – 4+35	Crack Honeycomb	3	• 60 Long by 1/8 wide transverse crack at top of slab, (8-12) inches from cap's bottom. • 60 x 3 x 1 Honeycomb at top of slab. Construction defect (concrete overpour).
40	**P24**	Pile top	4+36	Break/Spall	4	• 24 x 24 x 4 Breaks/spalls in concrete at west and east flanges of top of pile. 12 x 3 x 5 Spall (material loss) at bottom of break/spall on east flange. Reduction in cross-section. • 24 x 4 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
41	**S16**	Slab top	4+37 – 4+38	Honeycomb	3	24 x 7 x 1 Honeycomb at west corner of top of slab. Construction defect (concrete overpour).
42	**P25**	Pile top	4+44	Break/Spall Honeycomb	4	• (22-28) x 24 x (4-7) Breaks/spalls in concrete at west and east flanges of top of pile. Multiple regions with material loss at west and east flanges at top and bottom of spalls. Reduction in cross-section. • 24 x 4 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
43	**S17**	Slab top	4+45 – 4+52	Honeycomb	3	84 x 10 x 3 Honeycomb at top of slab. Construction defect (concrete overpour). Appears to be exposed metal.
44	**P26**	Pile top	4+53	Break/Spall Honeycomb	3	• 16 x 24 x ¼ Breaks/spalls in concrete at west and east flanges at top of pile.

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APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
						• 24 x 4 x ½ Honeycomb at top of pile. Construction defect (concrete overpour).
45	**S18**	Slab top	4+54 – 4+59	Crack	2	60 Long by 1/8 wide transverse crack at top of slab, (10-12) inches from cap's bottom.
46	**P27**	Pile top	4+60	Crack/Spall	4	26 x 12 x ½ Crack at top of east flange. Crack spalled and material separation is present in the affected area.
47	**S19**	Slab top	4+61 – 4+67	Crack	2	72 Long by 1/8 wide transverse crack at top of slab, (0-10) inches from cap's bottom.
48	**P28**	Pile top	4+76	Crack Rust Staining	3	22 Long x ¼ wide crack at top of west flange with rust staining.
49	**S20**	Slab top	4+84 – 4+90	Crack	2	72 Long by 1/8 wide transverse crack at top of slab, (7-12) inches from cap's bottom.
50	**C1**	Cap	4+84 – 4+93	Crack	3	Approximately 12-feet long by up to 1-inch-wide crack starts at cap's bottom at west flange of soldier pile (identified in Item #51 as P29) and propagates onto cap's south side westward direction. And, approximately 3-feet long by up to 1-inch-wide crack (with spalled area) starts at cap's bottom at east flange of soldier pile (identified in Item #51 as P29) and propagates onto cap's south side eastward direction.
51	**P29**	Pile top	4+92	Crack/Spall Exposed Rebar Rust Staining	4	Multiple cracks/spalls at top of pile's south face, west, and east flanges. Cracks spalled and material separation is present in the affected area. Multiple regions with material loss at east flange, along the spall. Reduction in cross-section. West flange has up to 10 inches of exposed (rusted) rebar.
52	**C2**	Cap	4+92 – 4+95	Crack	2	Approximately 3-feet long by 1/8-inch-wide crack starts at cap's bottom at east flange of soldier pile (identified in Item #51 as P29) and propagates onto cap's south side eastward direction.
53	**C3**	Cap	4+95 – 5+00	Crack	2	Approximately 5-feet long by ¼-inch-wide crack starts at cap's bottom at west flange of soldier pile (identified in Item #54 as P30) and propagates onto cap's south side westward direction.
54	**P30**	Pile top	5+00	Crack/Spall Rust Staining	4	Multiple cracks/spalls at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges at 12 inches down from top of pile. Reduction in cross-section.
55	**P31**	Pile top	5+08	Crack/Spall	4	Multiple cracks/spalls (reach up to 28 inches long) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges at 12 inches down from top of pile. Rust staining. Reduction in cross-section.
56	**C4**	Cap	5+11 – 5+16	Crack	3	Approximately 5-feet long by up to ½-inch-wide crack starts at cap's bottom at west flange of soldier pile (identified in Item #57 as P32) and propagates onto cap's south side westward direction.

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APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
57	**P32**	Pile top	5+16	Crack/Spall	**4**	Multiple cracks/spalls (reach up to 26 inches long) at top of pile's west, south, and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Rust staining. Reduction in cross-section.
58	**P33**	Pile top	5+24	Crack/Spall	**4**	25 Long by ½ wide longitudinal crack/spall at top east flange with rust staining.
59	**C5**	Cap	5+24 – 5+26	Crack	**3**	Approximately 2-feet long by up to ½-inch-wide crack starts at cap's bottom at east flange of soldier pile (identified in Item #58 as P33) and propagates onto cap's south side eastward direction.
60	**C6**	Cap	5+25 – 5+30	Crack	**3**	Approximately 5-feet long by up to ¼-inch-wide crack starts at cap's bottom at west flange of soldier pile (identified in Item #61 as P34) and propagates onto cap's south side westward direction.
61	**P34**	Pile top	5+30	Crack/Spall	**4**	Multiple cracks/spalls (reach up to 18 inches long) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Rust staining. Reduction in cross-section.
62	**S21**	Slab top	5+31 – 5+37	Crack	**2**	72 Long by 1/8 wide transverse crack at top of slab, (6-17) inches from cap's bottom.
63	**P35**	Pile top	5+40	Crack/Spall	**4**	Multiple cracks/spalls (reach up to 22 inches long) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Reduction in cross-section.
64	**S22**	Slab top	5+42 – 5+47	Crack	**2**	60 Long by 1/8 wide transverse crack at top of slab, (0-9) inches from cap's bottom.
65	**C7**	Cap	5+40 – 5+48	Crack	**3**	Approximately 8-feet long by 1/8 wide crack at cap's bottom at specified station range.
66	**P36**	Pile top	5+48	Crack/Spall	**4**	Multiple cracks/spalls (reach up to 28 inches long) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Reduction in cross-section.
67	**C8**	Cap	5+51 – 5+55	Crack	**3**	Approximately 4-feet long by up to ½-inch-wide crack starts at cap's bottom at west flange of soldier pile (identified in Item #68 as P37) and propagates onto cap's south side westward direction.
68	**P37**	Pile top	5+56	Crack/Spall Rust Staining	**4**	Multiple cracks/spalls (reach up to 24 inches long x 4 wide x 3 deep) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Reduction in cross-section.
69	**S23**	Slab top	5+57 – 5+63	Crack	**2**	72 Long by 1/8 wide transverse crack at top of slab, (5-12) inches from cap's bottom.
70	**P38**	Pile top	5+64	Crack/Spall Rust Staining	**4**	Multiple cracks/spalls (reach up to 28 inches long x 7 wide x 3 deep) at top of pile's west and east flanges. Cracks spalled and material separation and loss are

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APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
						present at both flanges, down from top of pile. Reduction in cross-section.
71	**HW2**	West side	5+66	Honeycomb	3	20 x 15 x ½ Honeycomb area at headwall mid height on west side.
72	**P39**	Pile top	5+72	Crack/Spall Exposed Rebar Rust Staining	4	Multiple cracks/spalls (reach up to 32 inches long x 24 wide x 4 deep) at top of pile's west and east flanges, with rust staining at east flange. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Reduction in cross-section.
73	**C9**	Cap	5+75 – 5+90	Crack	3	• Two (2-10) feet long by 1/8-inch-wide crack start at cap's bottom at west and east flanges of soldier pile (identified in Item #74 as P40) and propagate onto cap's south side westward and eastward directions. Crack at east flange spalls to 3 x 2 x 1 void at cap's bottom edge. • 5-Feet-long by 1/8-inch-wide crack starts at STA 5+85 and continues along south and southeast faces of cap to STA 5+90. Crack spalls at STA 5+86, at bottom edge, to a fracture size of 4 x 3 x 2.
74	**P40**	Pile top	5+80 – 5+85	Crack/Spall Gap	4	• Multiple cracks/spalls (reach up to (24-28) inches long x 24 wide x 2 deep) at top of pile's west and east flanges. Cracks spalled and material separation and loss are present at both flanges, down from top of pile. Reduction in cross-section. • Filler material fell off (or never installed) from the inside of the construction/expansion joint of (2-3)-inch gap along its entire length at STA 5+80 and 5+85.
75	**P41**	Pile top	5+85	Crack/Spall	3	Multiple cracks/spalls (reach up to 18 inches long x (12-24) wide x 1/8 deep) at top of pile's south and north flanges.
76	**P42**	Pile top	5+93	Crack/Spall	4	Multiple cracks/spalls (reach up to 22 inches long x (12-24) wide x up to ¼ deep) at top of pile's west and east flanges. Crack at north flange spalled to 4 x 3 x 3.
77	**C10**	Cap	5+93 – 6+00	Crack	3	• Approximately 4-feet long by up to 1/8-inch-wide crack starts at cap's bottom at north flange of soldier pile (identified in Item #76 as P42) and propagates onto cap's east side northward direction. • 5-Feet-long by 1/8-wide traverse crack is east face of cap at STA 5+95 through 6+00. • 11 x 4 x ½ Honeycomb at bottom edge of cap at STA 5+99.
78	**P43**	Pile top	6+00	Crack/Spall	4	Multiple cracks/spalls (reach up to 32 inches long x 24 wide x up to 1 deep) at top of pile's south and north flanges.
79	**P44**	Pile top	6+07	Crack/Spall Gap	4	• Multiple cracks/spalls (reach up to (20-22) inches long x 24 wide x up to ¼ deep) at top of pile's south and north flanges.

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APPENDIX B: SEAWALL DEFICIENCY - TABLE

#	ID[A]	LOCATION	STA[B]	TYPE	DSL[D]	DESCRIPTION[C]
						• Filler material fell off (or never installed) from the inside of the construction/expansion joint 1-inch gap along its entire length at STA 6+08.
80	**S24**	Slab Top & Bottom	6+11	Crack/Spall Undermining	**4**	• Vertical edge at slab's corner cracked and spalled in 16 x 12 area. Rust staining and material loss. Reduction in cross-section. • Undermining at slab-shelf interface at STA 6+05 through 6+13. Undermining 8 feet long by 16 inches high and by 22 inches deep.
81	**C11**	Cap	6+11	Crack Rust Staining	**3**	3-Feet-long by 1/8-wide diagonal crack is on cap's vertical and bottom faces.
82	**P45**	Pile top	6+14	Crack/Spall	**4**	• Multiple cracks/spalls (reach up to (20-22) inches long x 24 wide x up to ¼ deep) at top of pile's south and north flanges. Rust staining. • Filler material fell off (or never installed) from the inside of the construction/expansion joint 1-inch gap along its entire length at STA 6+13.
83	**C12**	Cap	6+14 – 6+21	Crack	**3**	7-Feet-long by up to ¼-wide transverse crack is on cap's vertical face with rust staining.
84	**P46**	Pile top	6+21	Crack Rust Staining	**3**	(2)-12 Long by 1/8 wide vertical cracks on south and north flanges with rust staining.
85	**C13**	Cap	6+19 – 6+21	Honeycomb	**2**	Scattered two honeycomb areas of 9 x 5 x ½ size at cap's bottom edge.
86	**P47**	Pile top	6+27	Crack Rust Staining	**3**	21 Long by ¼ wide longitudinal crack at north flange at pile's top.
87	**C14**	Cap	6+22 – 6+40	Crack Rust Staining	**3**	Multiple up to 9-feet-long by up to ¼-wide transverse crack is on cap's vertical face with rust staining. Last two feet of crack, on north end, translates into 24 x 6 x 2 spall at STA 6+29 – 6+31.
88	**P48**	Pile top	6+40	Crack/Spall	**4**	Multiple cracks/spalls (reach up to (24-26) inches long x 24 wide x up to ½ deep) at top of pile's south and north flanges.
89	**P49**	Pile top	6+46	Crack/Spall	**4**	Multiple cracks/spalls (reach up to (24-28) inches long x 24 wide x up to ½ deep) at top of pile's south and north flanges. 19 x 11 x 2 Break of concrete at north flange.
90	**C15**	Cap	6+40 – 6+50	Crack Rust Staining	**3**	10-Feet-long by ¼-wide transverse crack is on cap's vertical face with rust staining.

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APPENDIX C

APPENDIX C: SEAWALL DEFICIENCY - PHOTOLOG

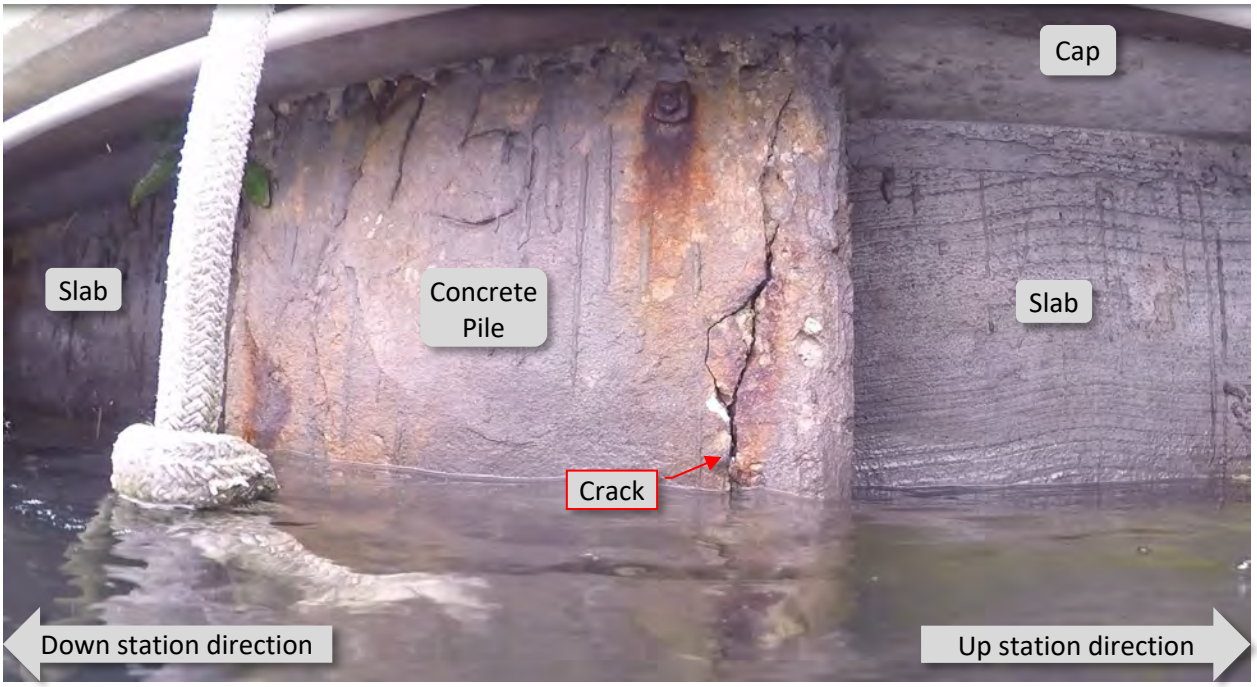

Figure 1: P1. STA 1+23. Crack/spall on pile and corroded anchor bolt. TYPICAL seawall components and direction is shown.

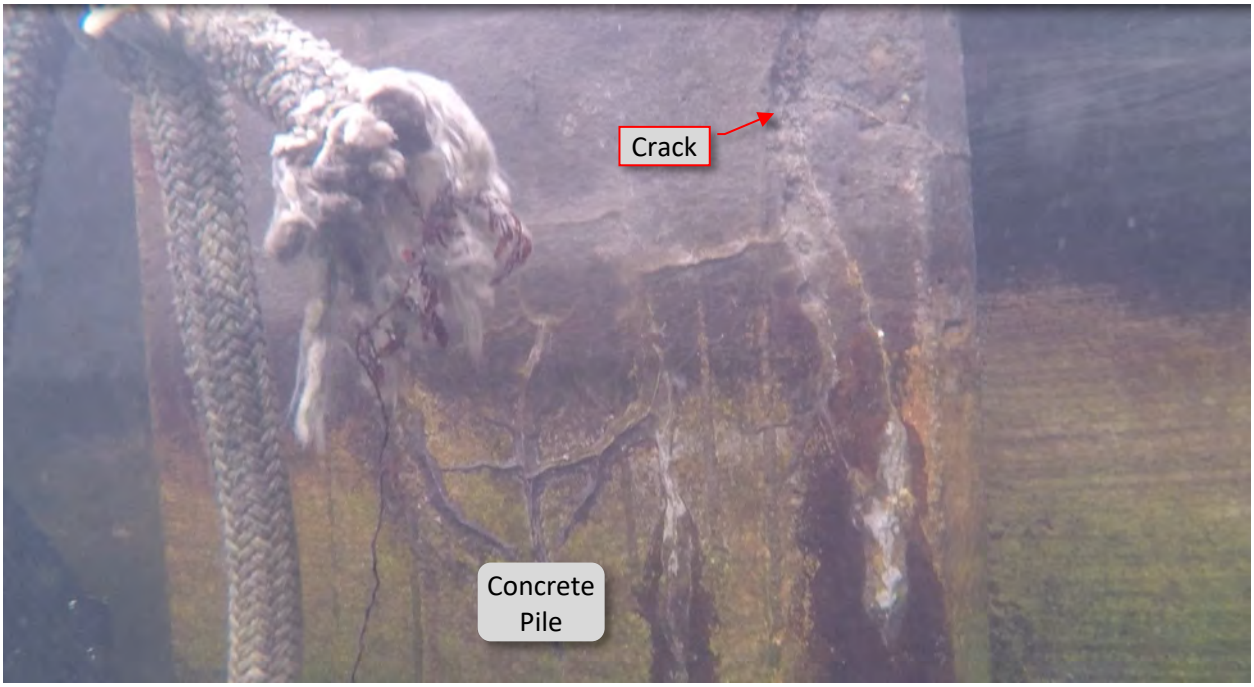

Figure 2: P1. STA 1+23. Crack/spall on pile. Underwater view.

Figure 3: P2. STA 1+64. Crack/spall on pile.

Figure 4: P2. STA 1+64. Break at top west flange and crack on south face on pile.

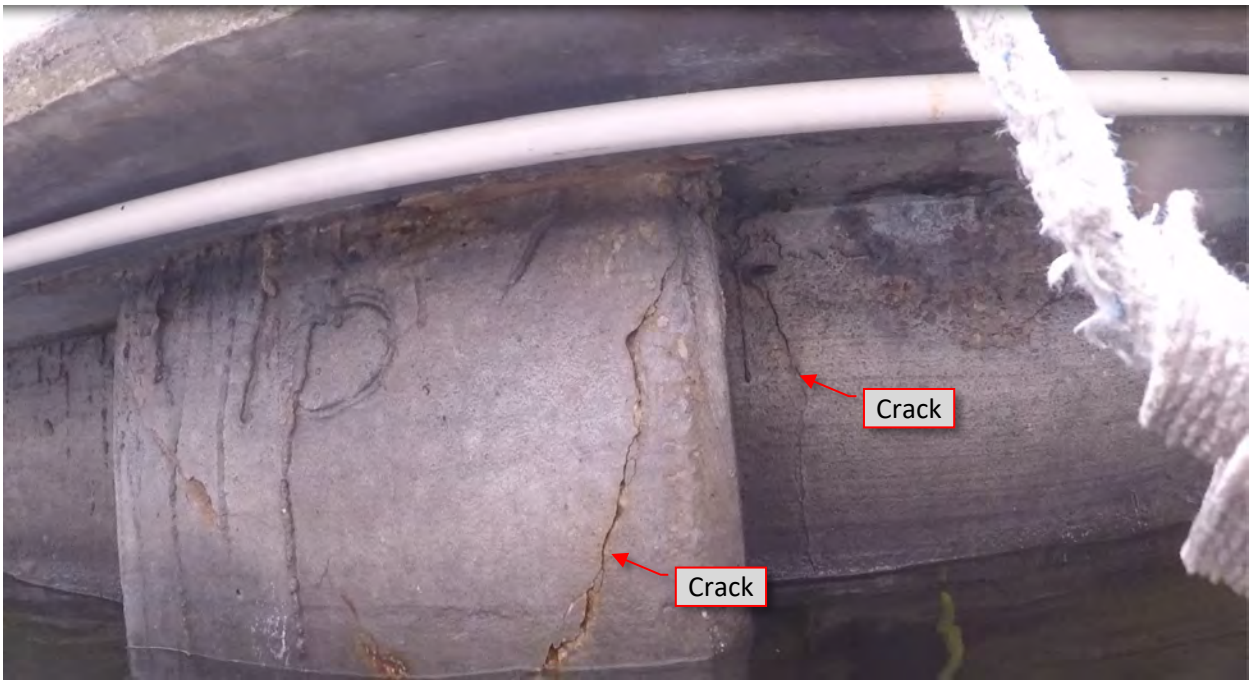

Figure 5: S1. STA 1+65. Crack at slab. P2. STA 1+64. Crack on south face on pile.

Figure 6: P3. STA 1+72. Crack/spall at pile.

APPENDIX C: SEAWALL DEFICIENCY - PHOTOLOG

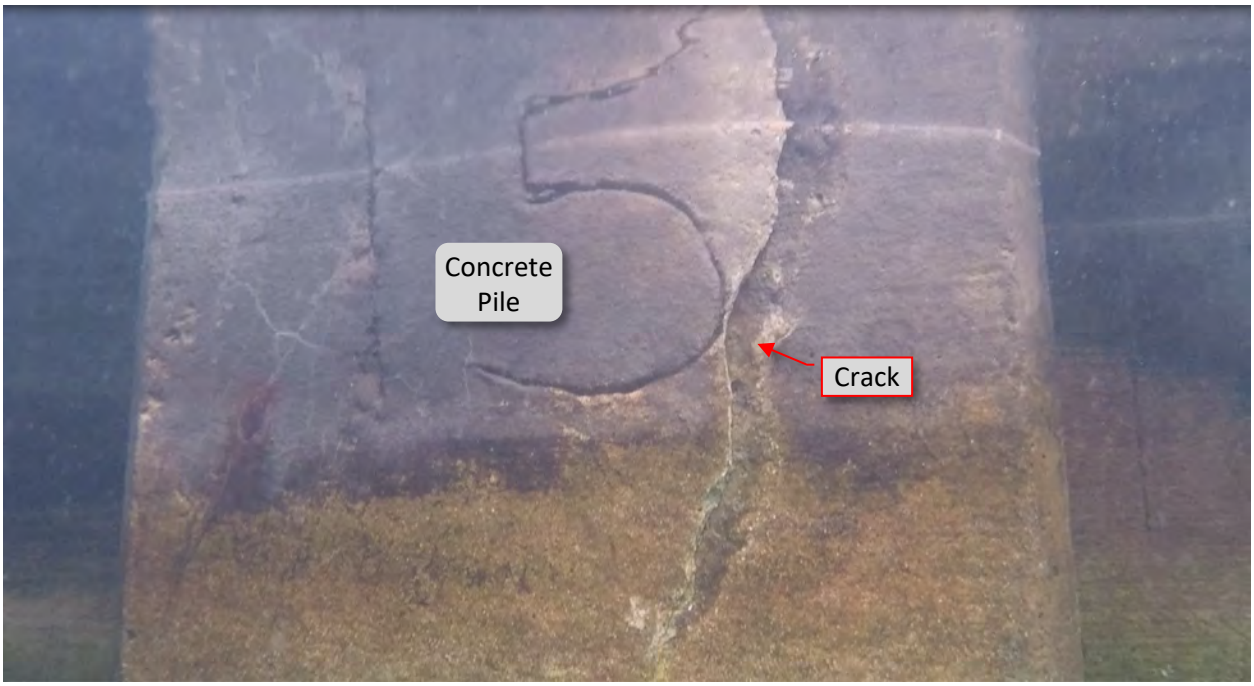

Figure 7: P3. STA 1+72. Crack/spall at pile. Underwater view.

Figure 8: S2. STA 2+31 - 2+34. Concrete erosion at honeycomb area on slab.

Figure 9: P4. STA 2+35. Multiple cracks and spalls at pile.

Figure 10: P4. STA 2+35. Multiple cracks and spalls at pile. Underwater view.

APPENDIX C: SEAWALL DEFICIENCY - PHOTOLOG

Figure 11: S3. STA 2+38 - 2+41. Concrete erosion at honeycomb area on slab.

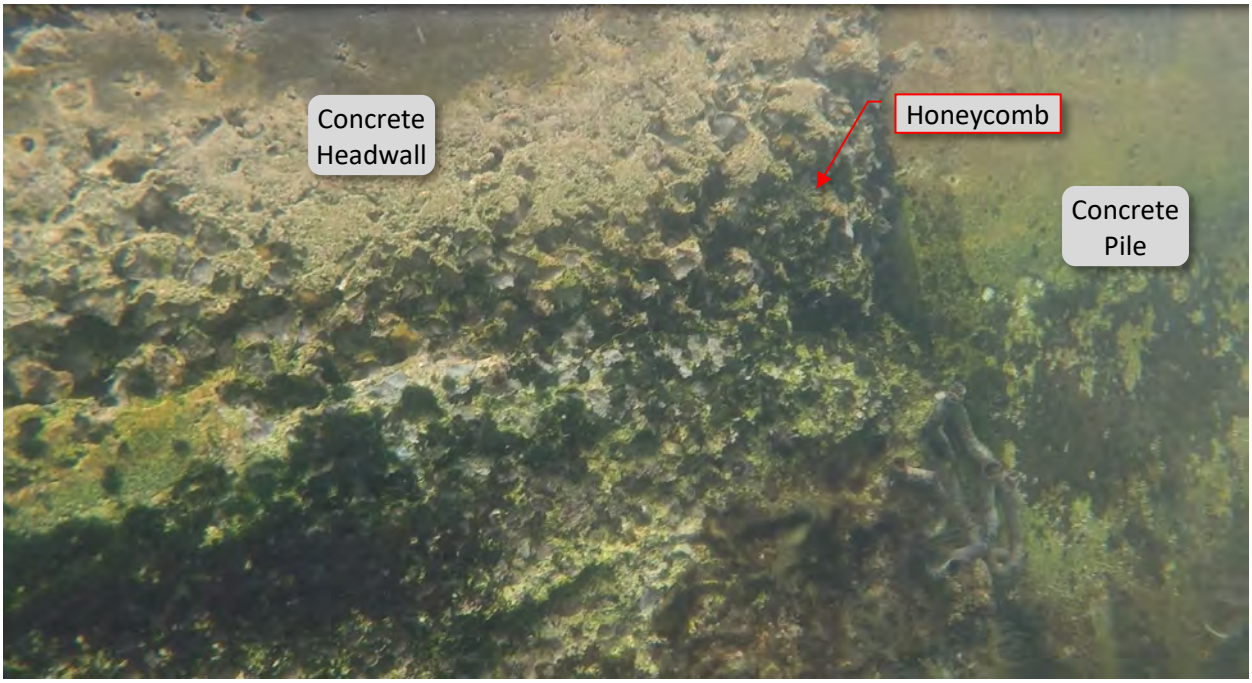

Figure 12: HW1. STA 2+49 - 2+50. Honeycomb area at culvert headwall.

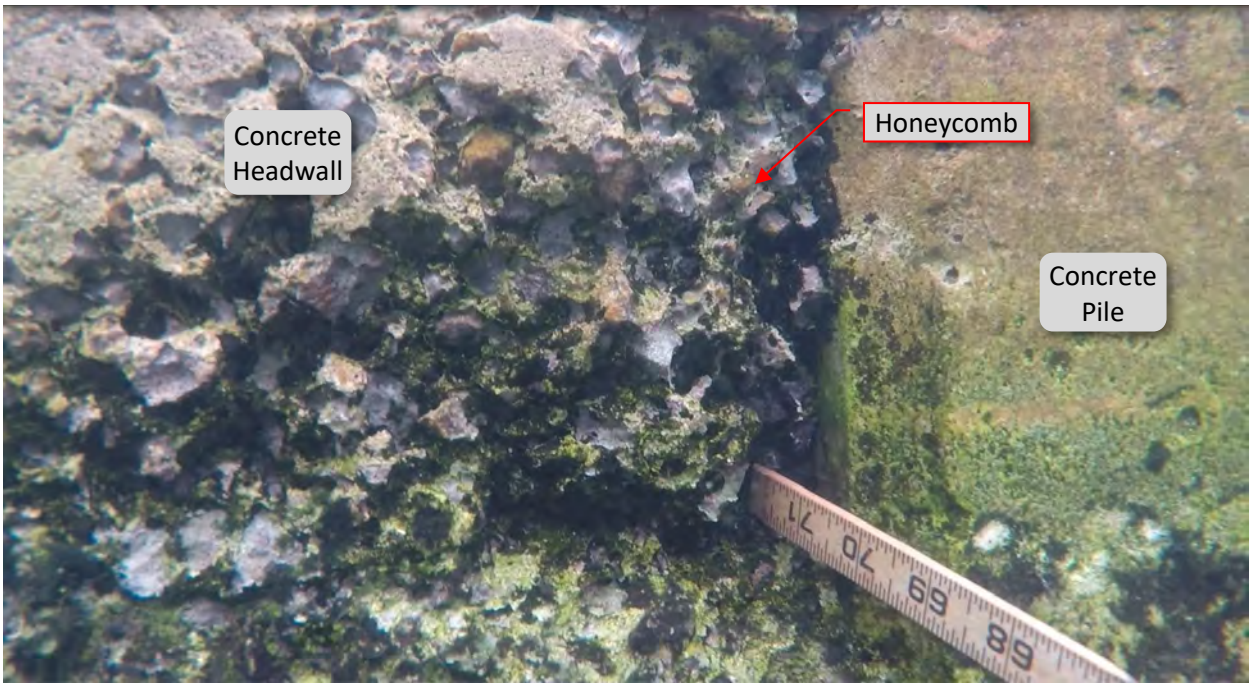

Figure 13: HW1. STA 2+49 - 2+50. Honeycomb depth at culvert headwall.

Figure 14: P5. STA 2+60. Honeycomb at pile top.

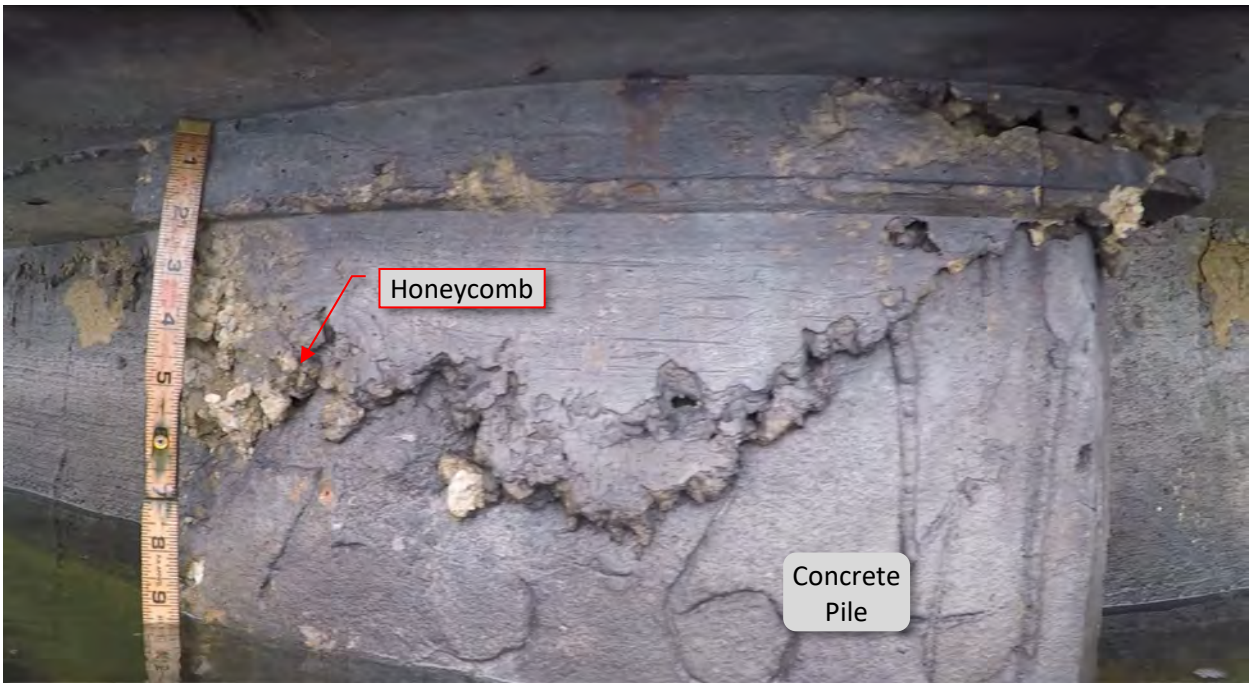

Figure 15: P6. STA 2+76. Honeycomb across the pile top.

Figure 16: P6. STA 2+76. Crack/spall at west flange on pile. Underwater view.

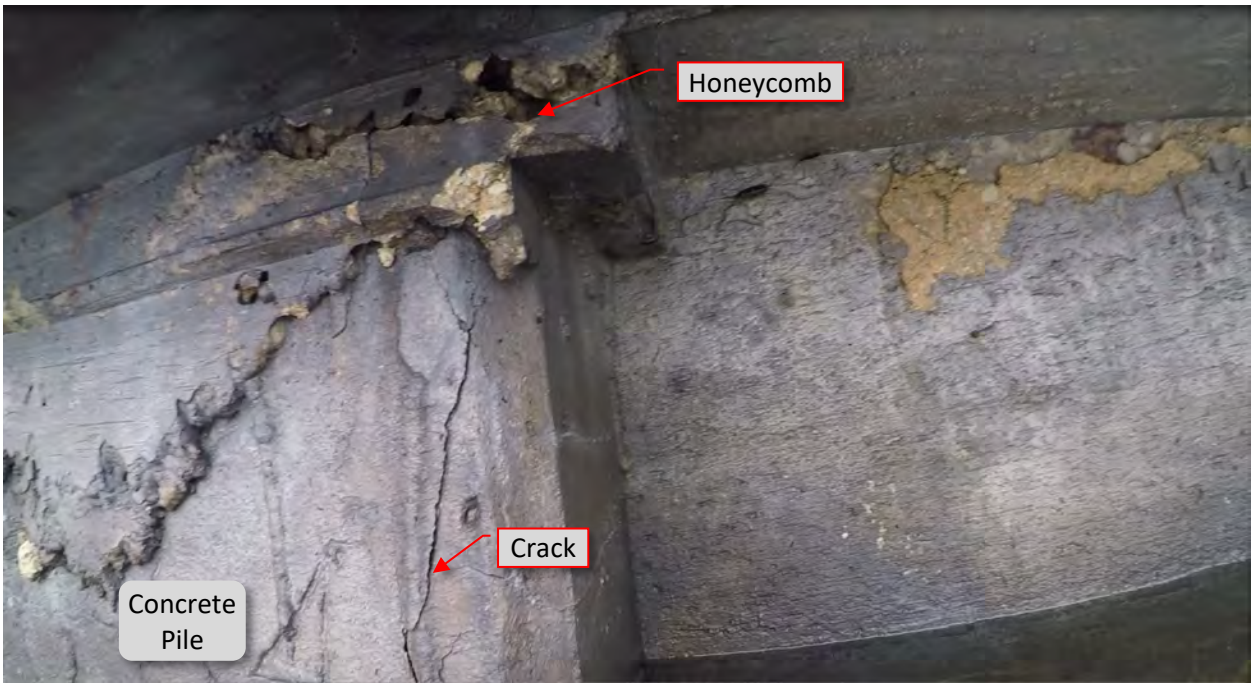

Figure 17: P6. STA 2+76. Honeycomb across the pile top. Crack/spall at east flange on pile.

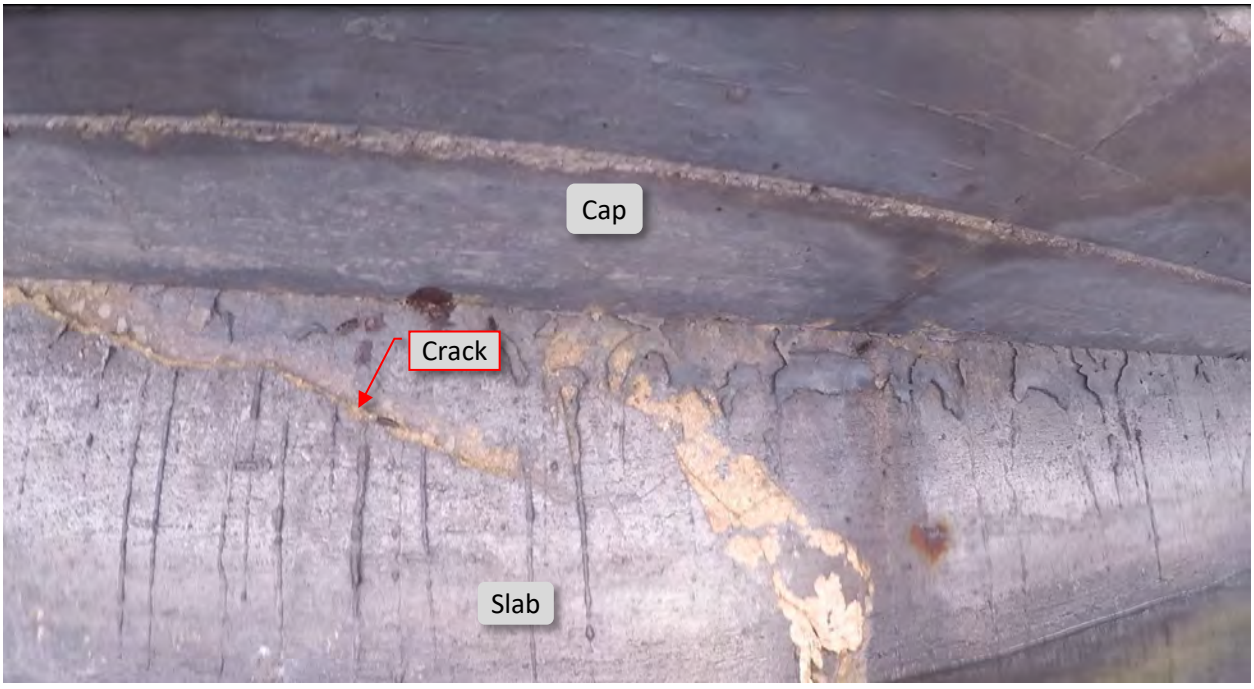

Figure 18: S4. STA 2+76 - 2+80. Crack on slab.

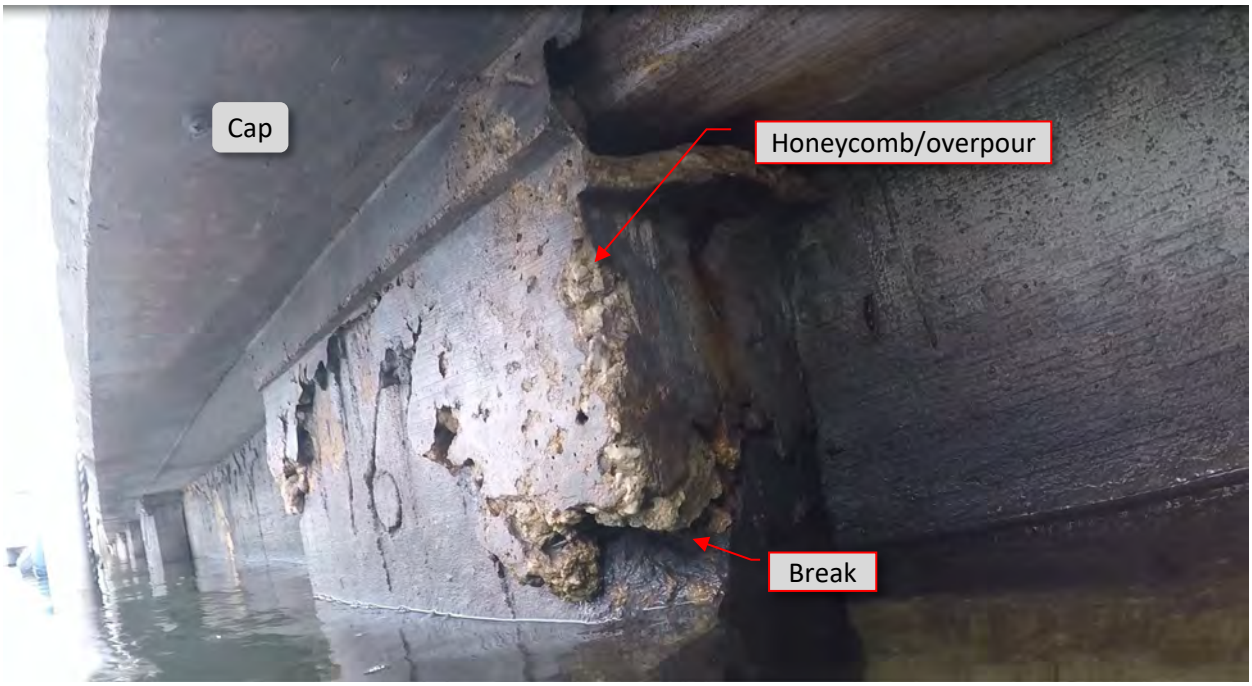

Figure 19: P7. STA 2+83. Honeycomb area, concrete overpour, and break at east flange at pile.

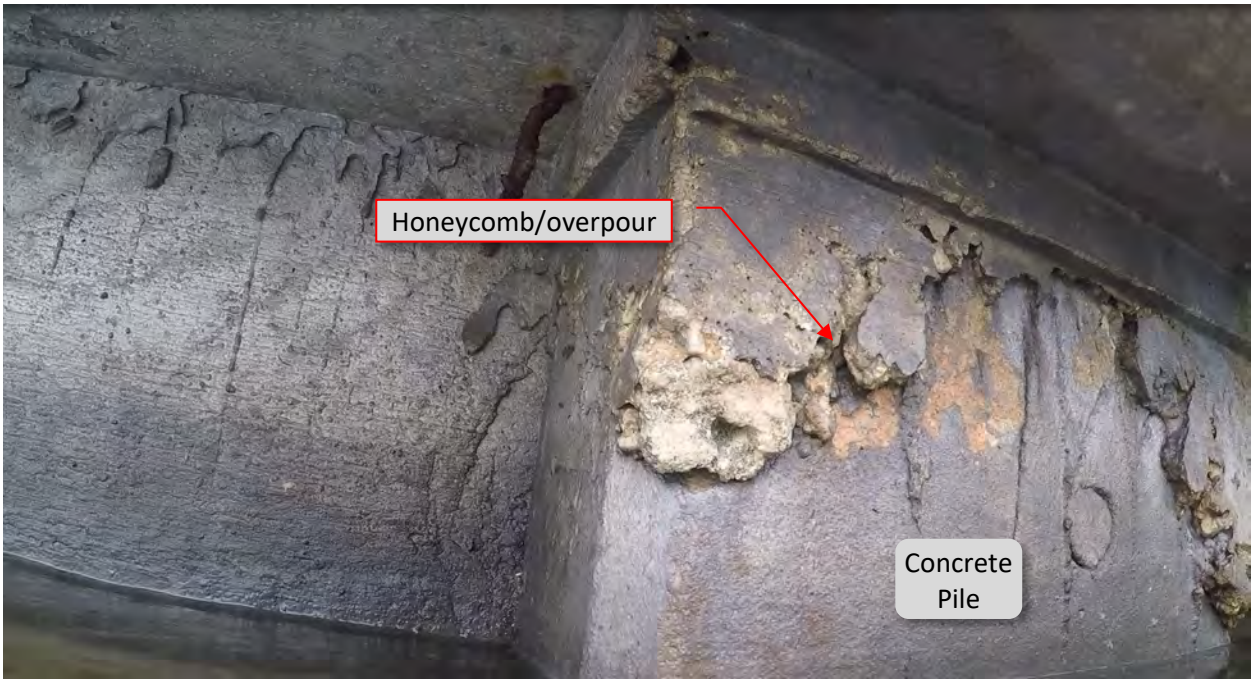

Figure 20: P7. STA 2+83. Honeycomb area and concrete overpour at west flange at pile.

Figure 21: P8. STA 2+94. Honeycomb area and concrete overpour at east flange at pile.

Figure 22: S5. STA 2+93 - 2+99. Honeycomb at top of slab. West direction view.

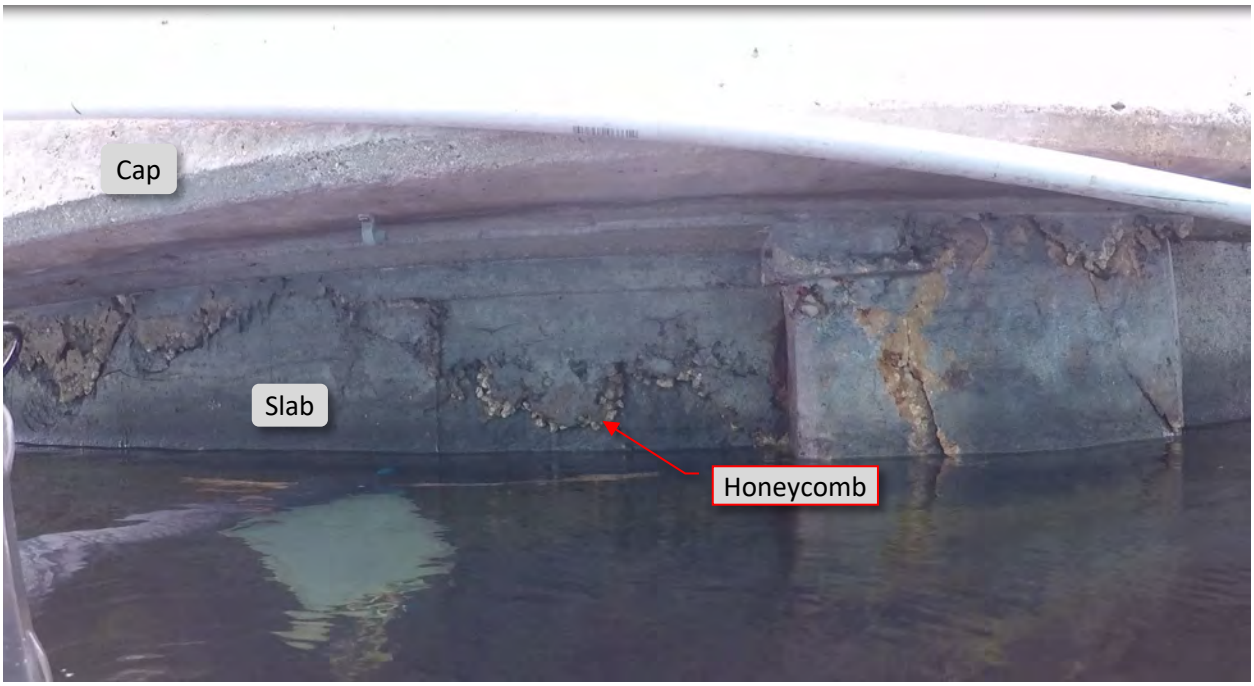

Figure 23: S5. STA 2+93 - 2+99. Honeycomb at top of slab. North direction view.

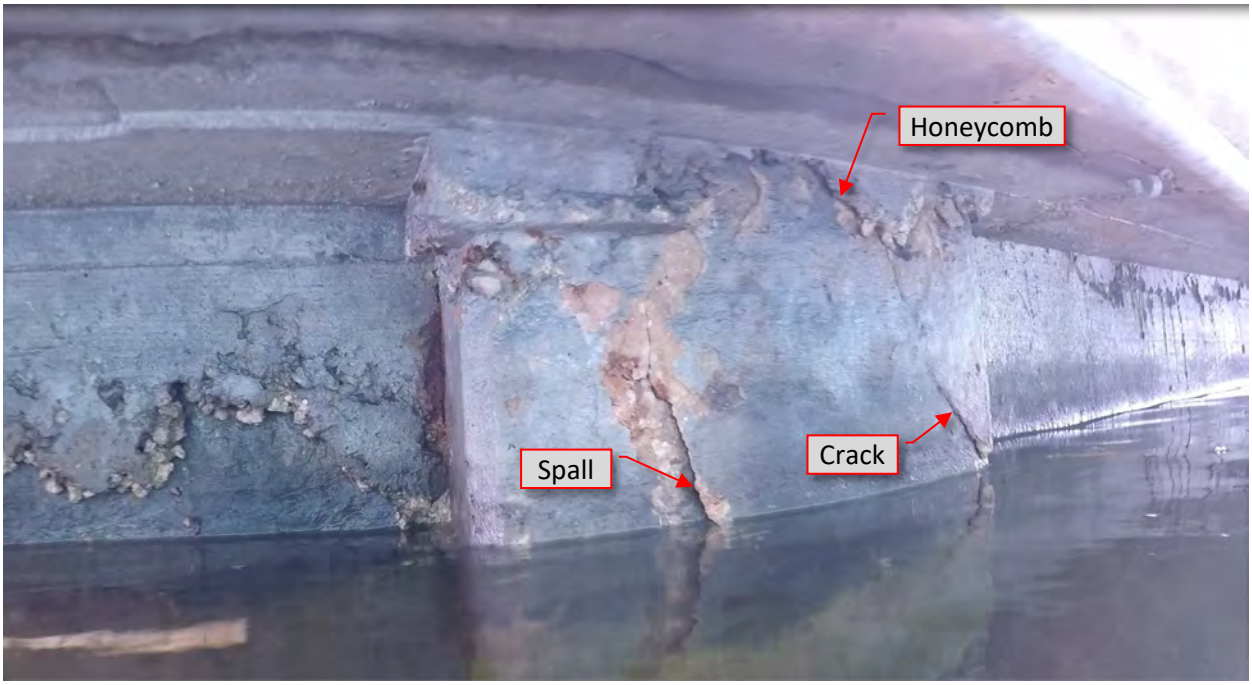

Figure 24: P9. STA 3+00. Spall on west flange, crack on east flange at pile, and honeycomb at top of pile.

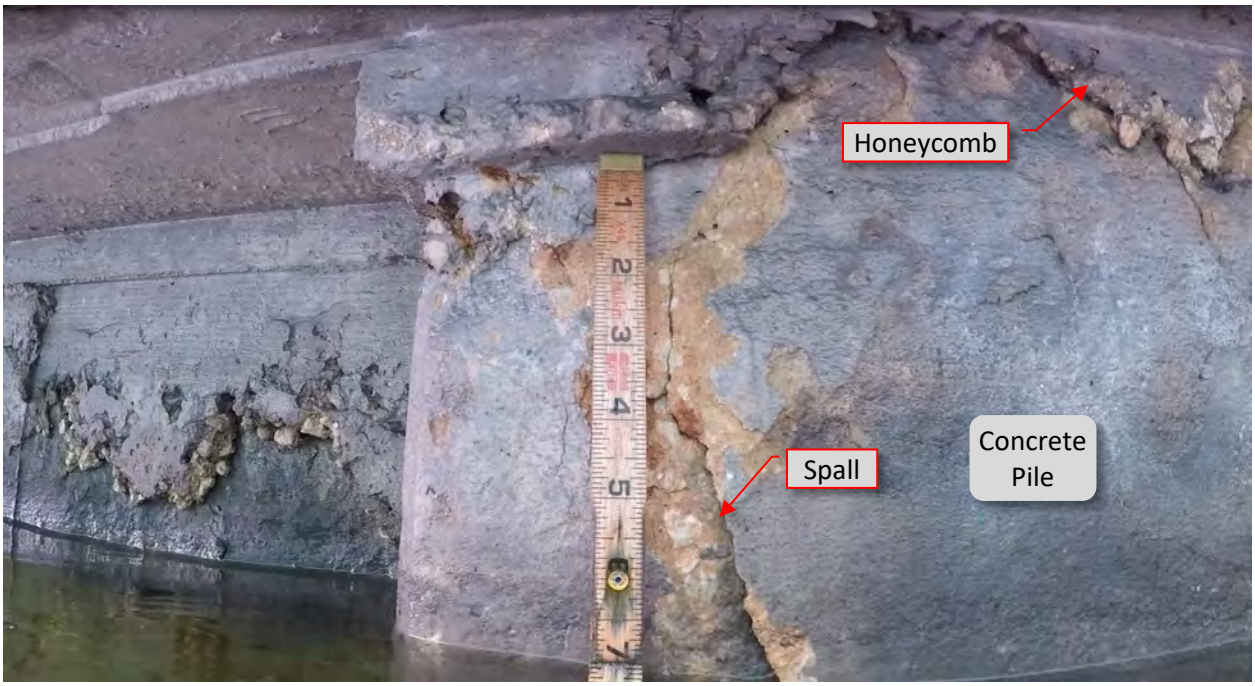

Figure 25: P9. STA 3+00. Spall on west flange at pile and honeycomb at top of pile.

Figure 26: S6. STA 3+01 - 3+04. Two perpendicular cracks on slab at mid height from shelf to cap. Underwater view.

Figure 27: P10. STA 3+07. Break at top east flange corner at pile. Honeycomb area.

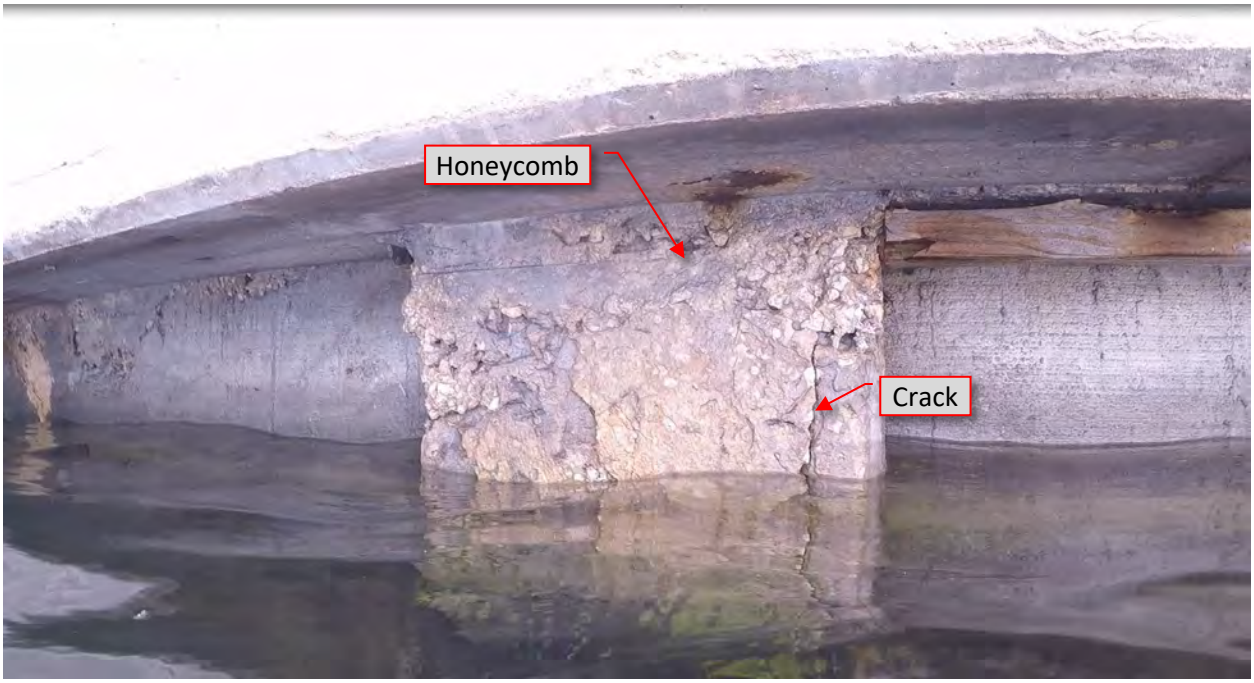

Figure 28: P11. STA 3+16. Crack/spall at east flange at pile. Honeycomb area.

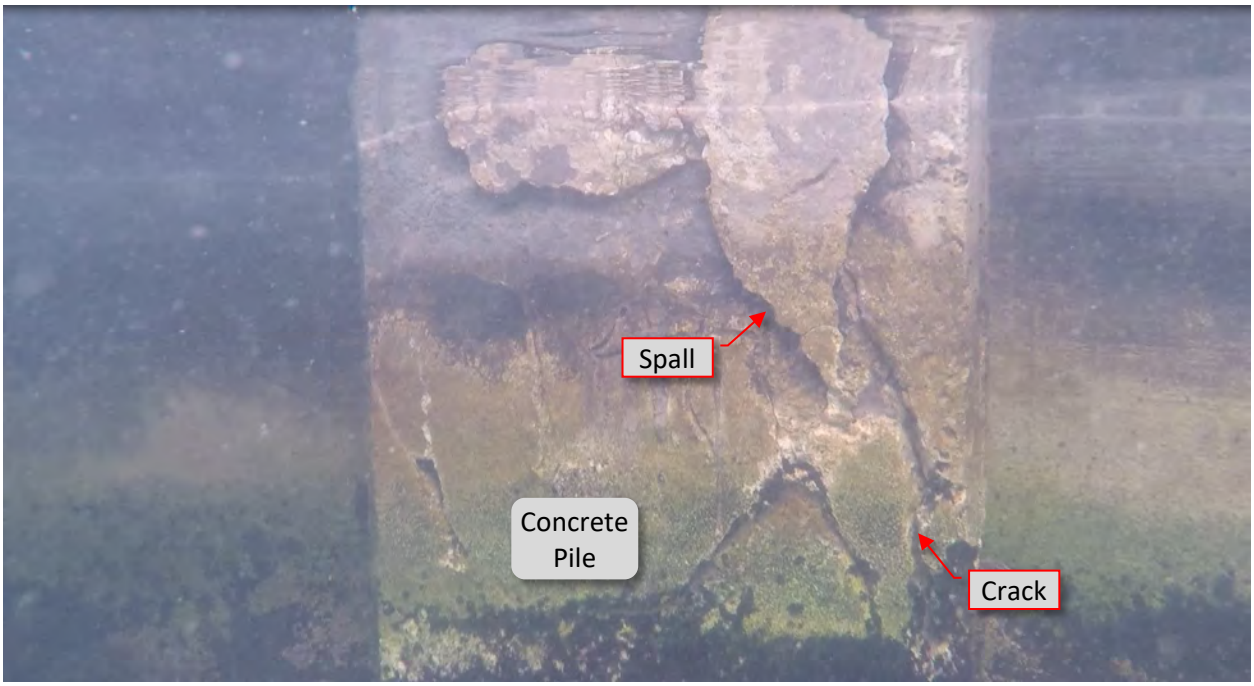

Figure 29: P11. STA 3+16. Crack/spall at east flange at pile. Underwater view.

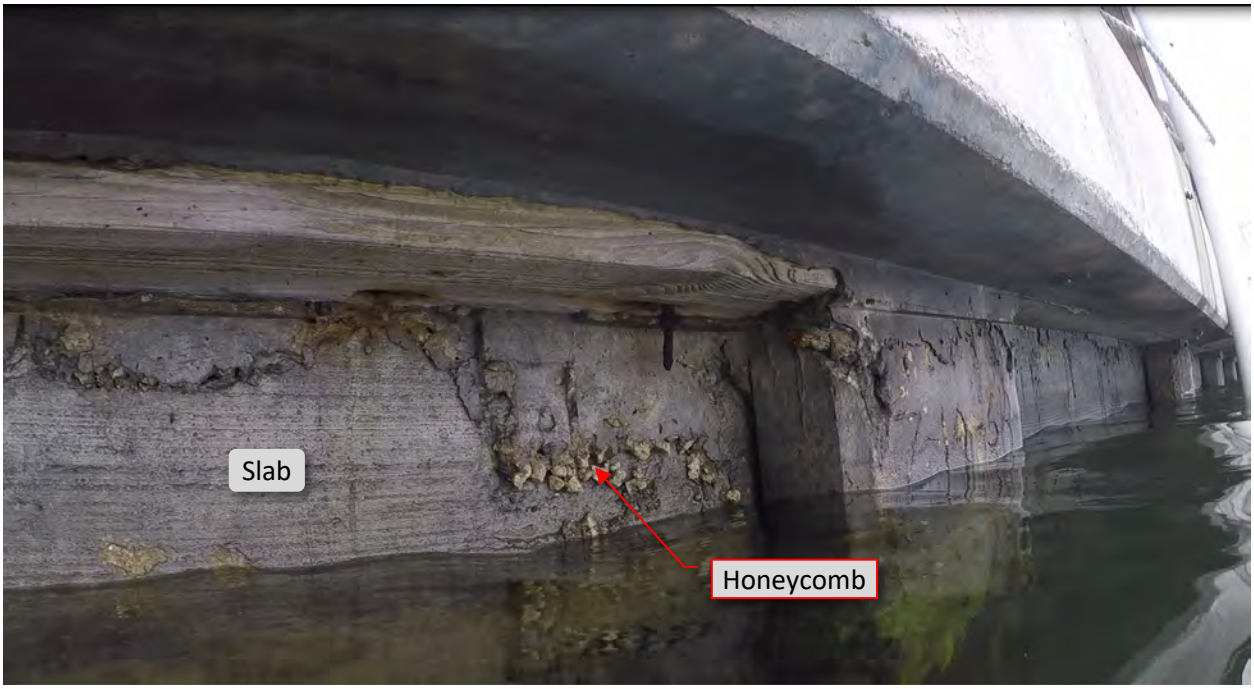

Figure 30: S7. STA 3+21 - 3+23. Honeycomb at slab.

Figure 31: P12. STA 3+24. Honeycomb at pile top.

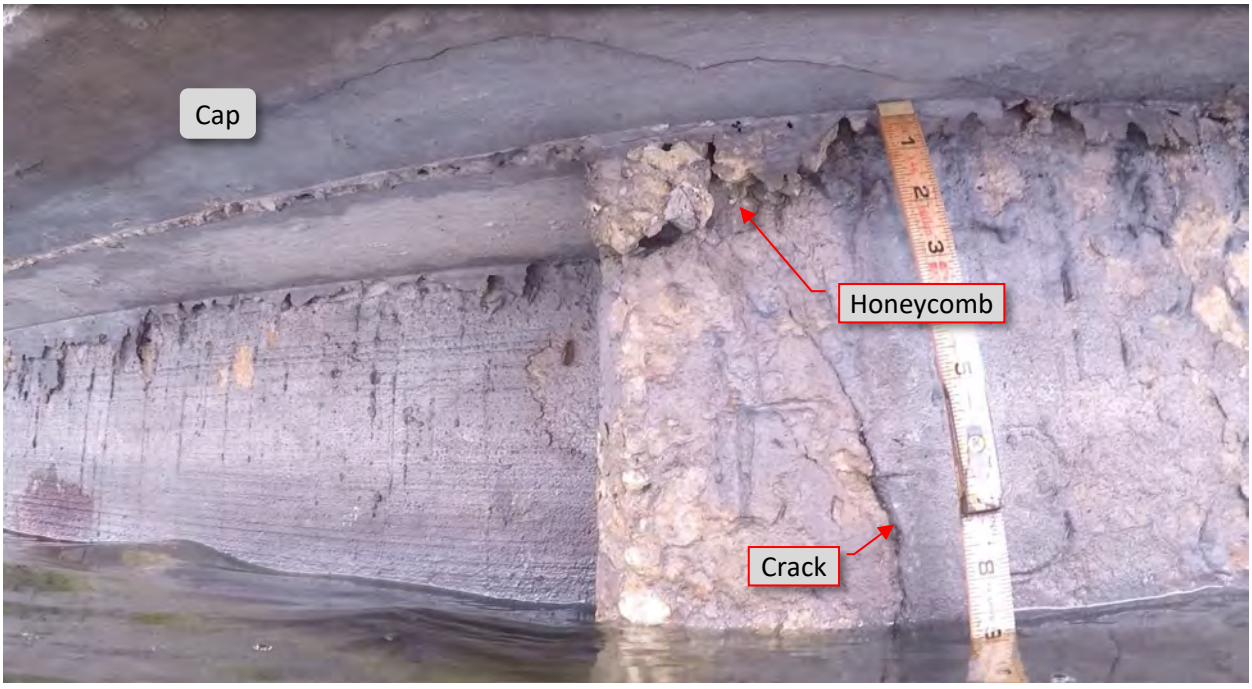

Figure 32: P13. STA 3+31. Crack at west flange at pile. Honeycomb area.

Figure 33: P13. STA 3+31. Crack at west flange at pile. Underwater view.

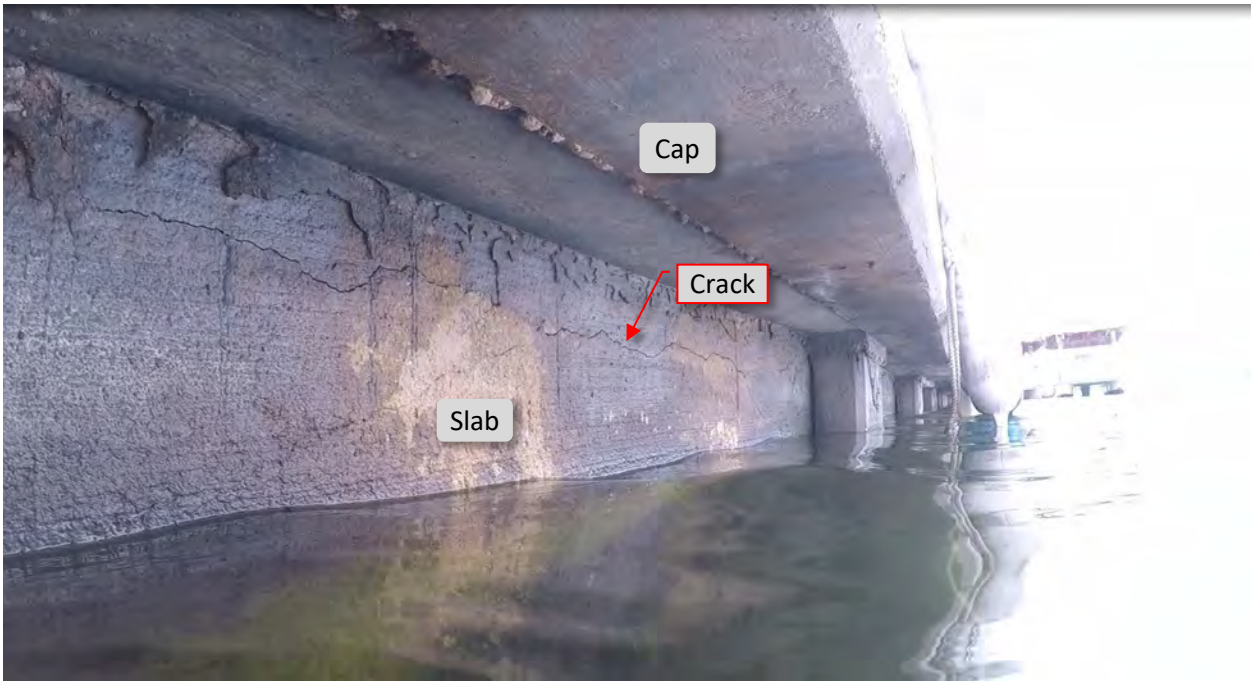

Figure 34: S8. 3+33 - 3+41. Crack/spall at top of slab.

Figure 35: S8. 3+33 - 3+41. Crack at slab midspan. Underwater view.

Figure 36: P14. STA 3+39. Honeycomb area at pile.

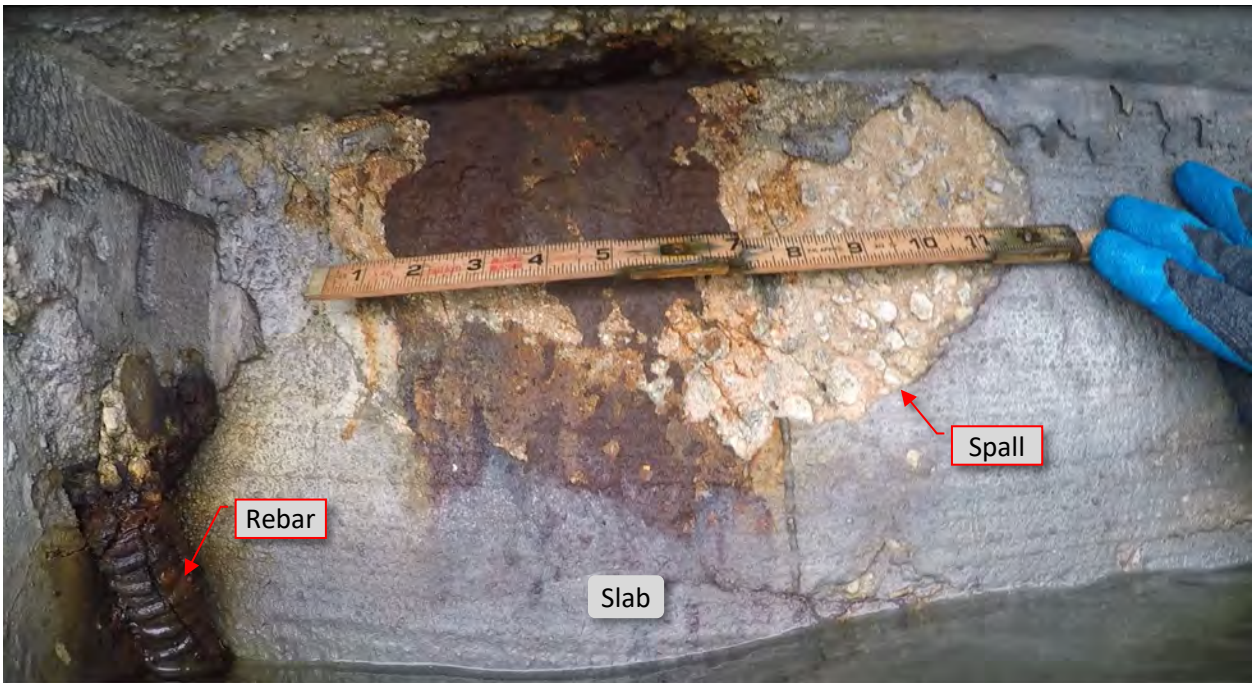

Figure 37: P14. STA 3+39. #11 Size rebar protrusion at east flange. S9. STA 3+41. Spall with rust staining at slab west corner.

Figure 38: S10. 3+47. Honeycomb area at top east corner of slab. P15. STA 3+48. Crack/spall at west flange at pile.

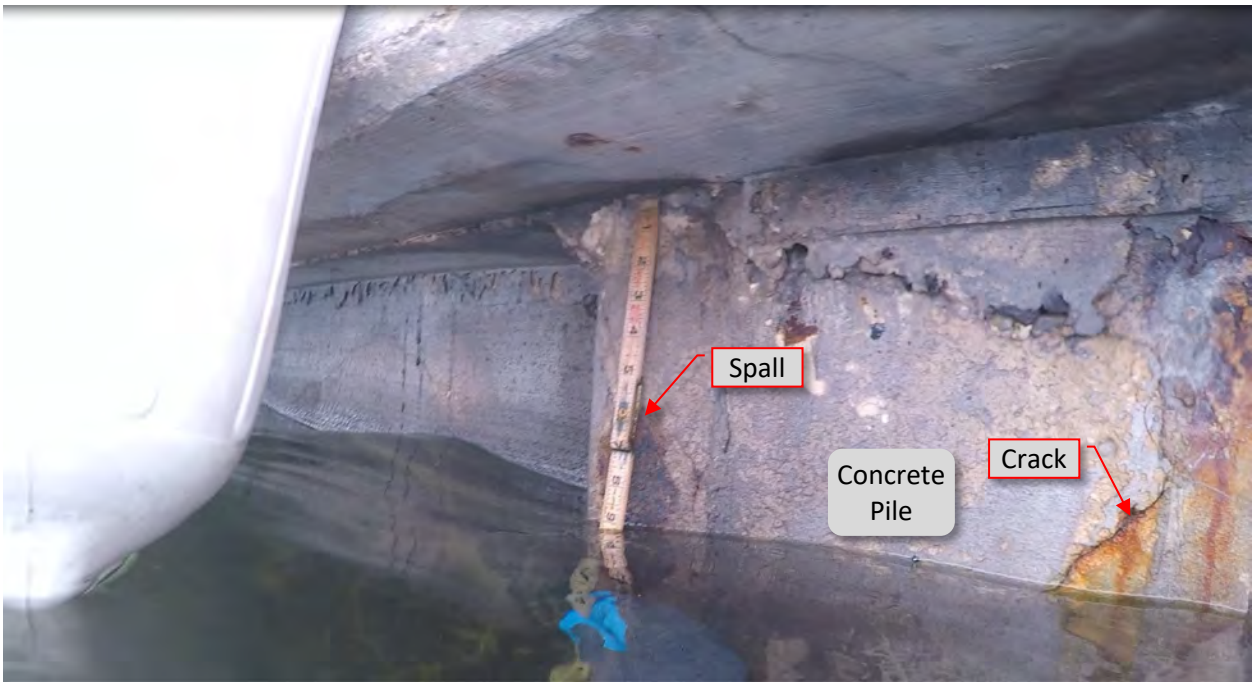

Figure 39: P15. STA 3+48. Cracks/spalls at each flange at pile.

Figure 40: P15. STA 3+48. Cracks at south face and spall at west flange at pile.

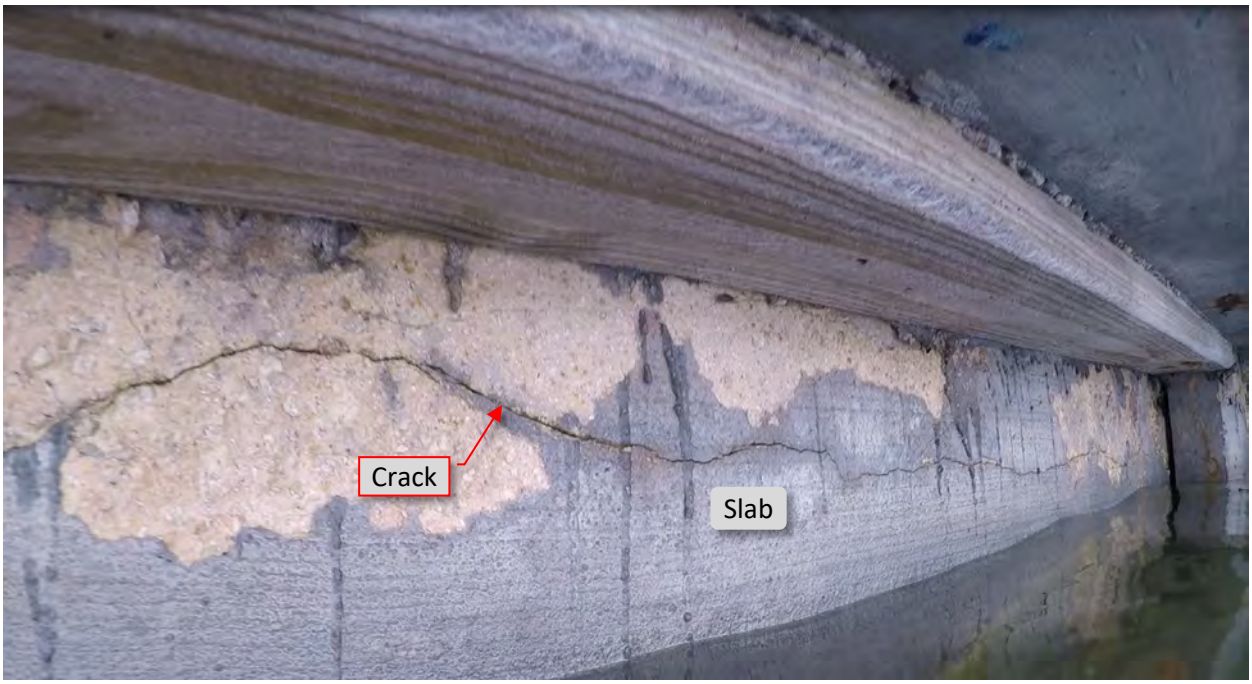

Figure 41: S11. STA 3+49 - 3+55. Crack at top of slab.

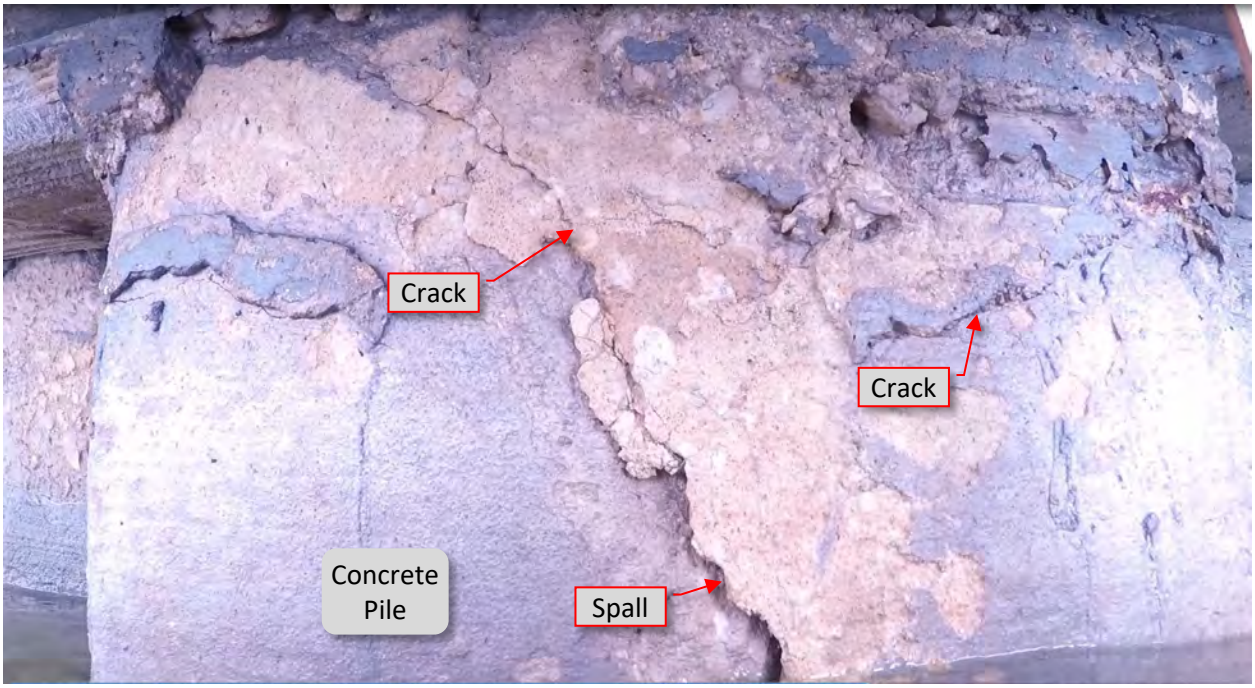

Figure 42: P16. STA 3+56. Spall/crack on south side at pile.

Figure 43: P16. STA 3+56. Spall/crack on south side and near east flange at pile.

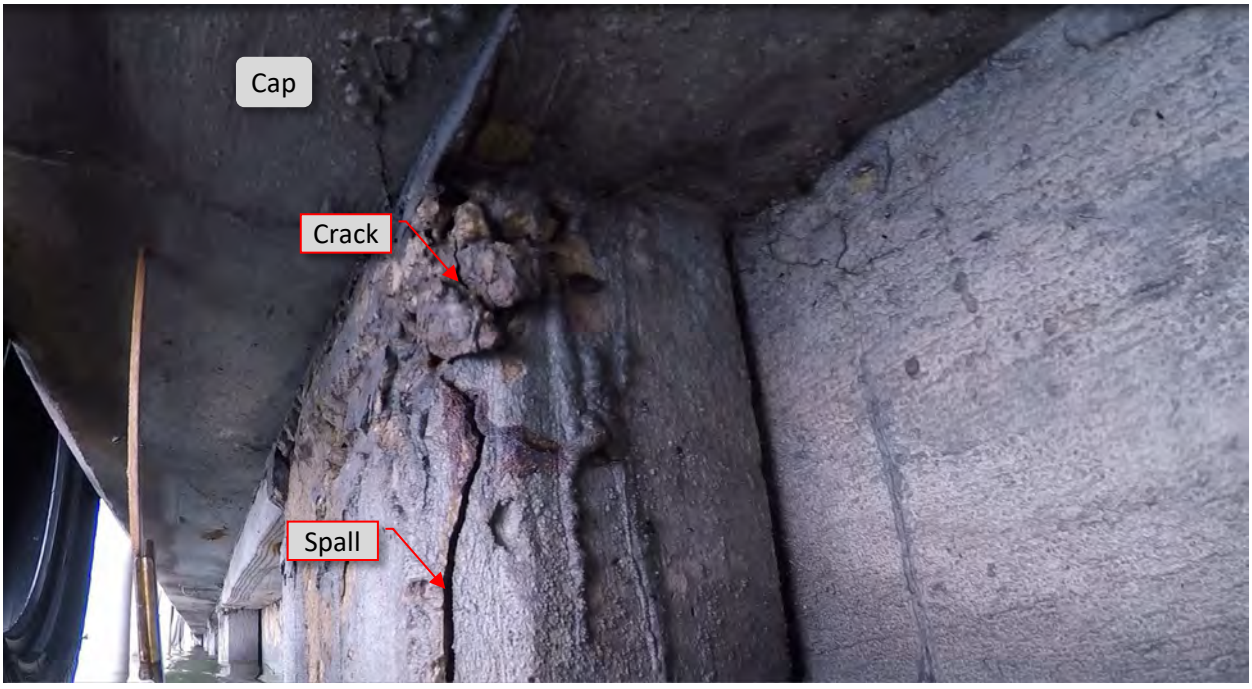

Figure 44: P16. STA 3+56. Spall/crack on south side and near east flange at pile. Honeycomb area at op of pile.

Figure 45: P17. STA 3+63. Crack at west top of flange at pile.

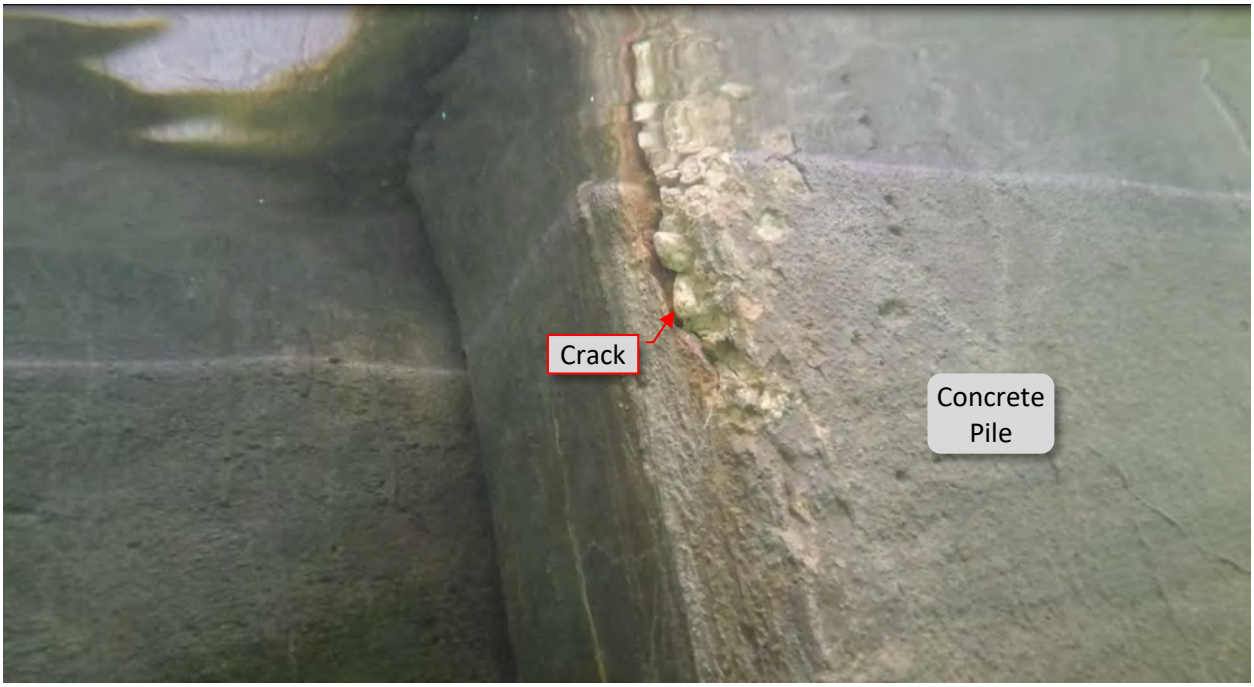

Figure 46: P17. STA 3+63. Crack at west top of flange at pile. Underwater view.

Figure 47. P18. STA 3+71. Spall/crack at west top of flange at pile. Honeycomb area.

Figure 48: P18. STA 3+71. Spall/crack at west flange at pile. Underwater view.

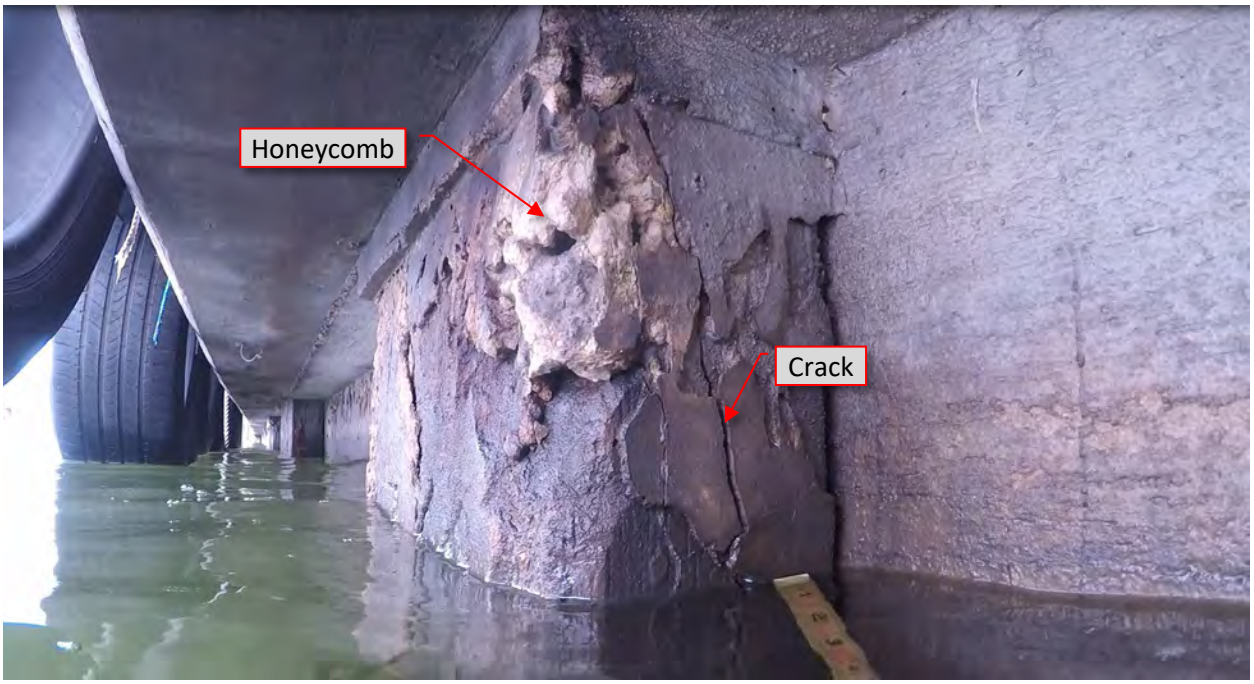

Figure 49: P18. STA 3+71. Crack at east flange at pile. Honeycomb area.

Figure 50: P18. STA 3+71. Crack at east flange at pile. Underwater view.

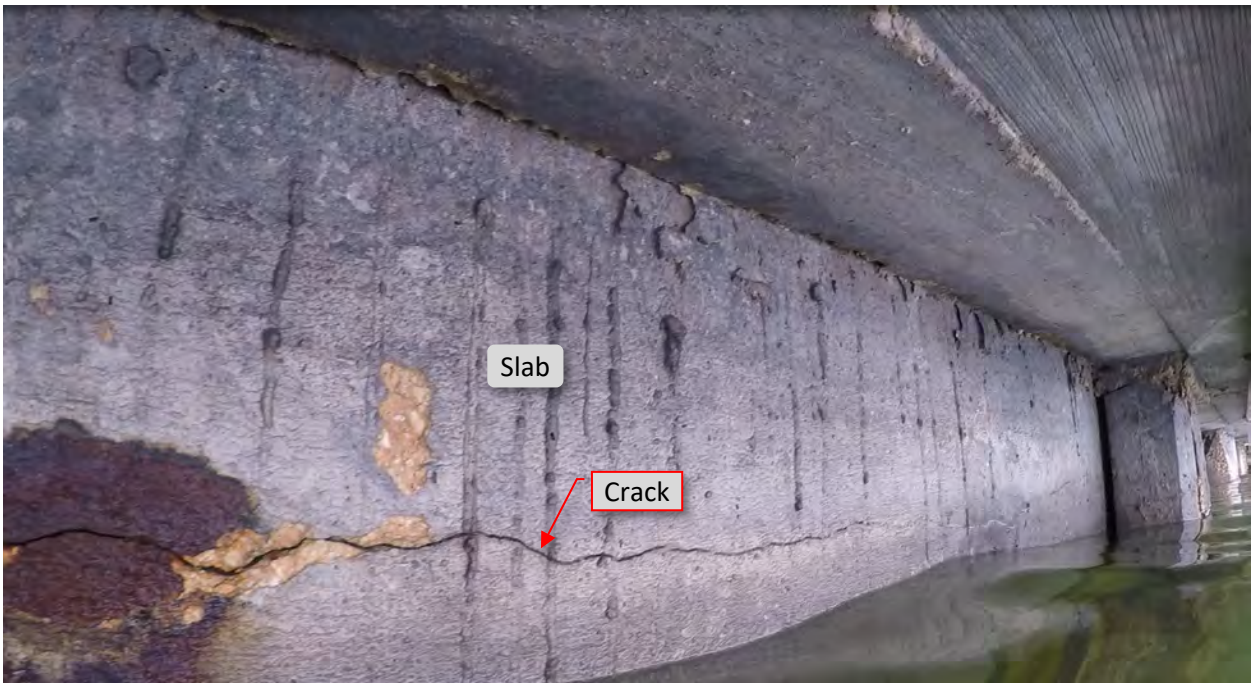

Figure 51: S12. STA 3+87 - 3+95. Crack at top of slab.

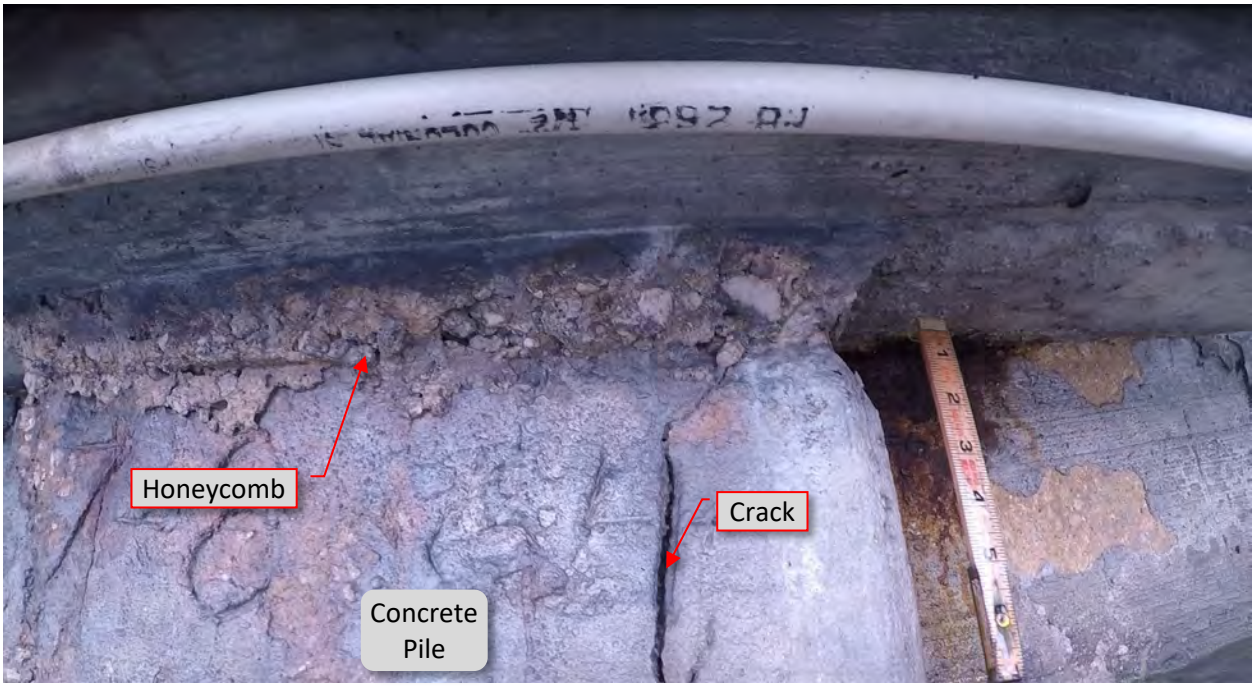

Figure 52: P19. STA 3+96. Crack at east flange at pile. Honeycomb area.

Figure 53: P19. STA 3+96. Crack at west flange at pile. Honeycomb area.

Figure 54: S13. STA 3+97. Rust staining area at top of slab west corner.

Figure 55: P20. STA 4+04. Spall/crack at west flange at pile.

Figure 56: P20. STA 4+04. Spall/crack at west flange at pile. Underwater view.

Figure 57: S14. STA 4+08 - 4+11. Honeycomb at top of slab.

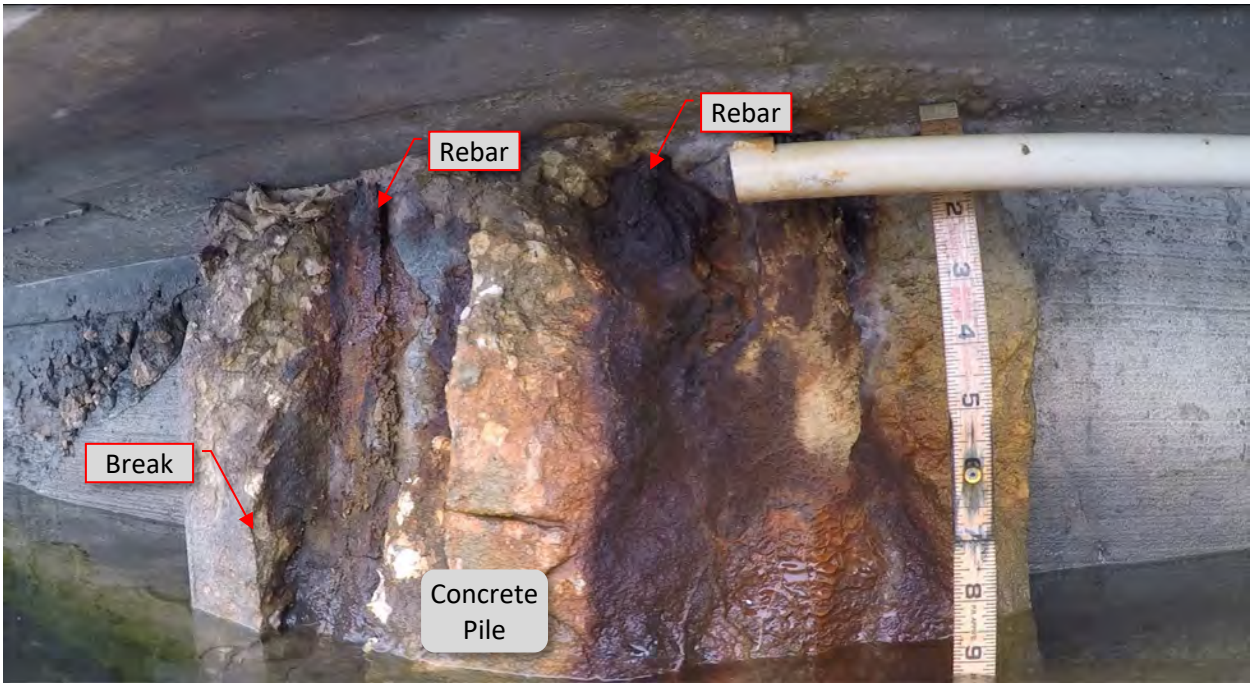

Figure 58: P21. STA 4+12. Break/spall at pile. Loss of concrete and rebar due to corrosion, and rust staining.

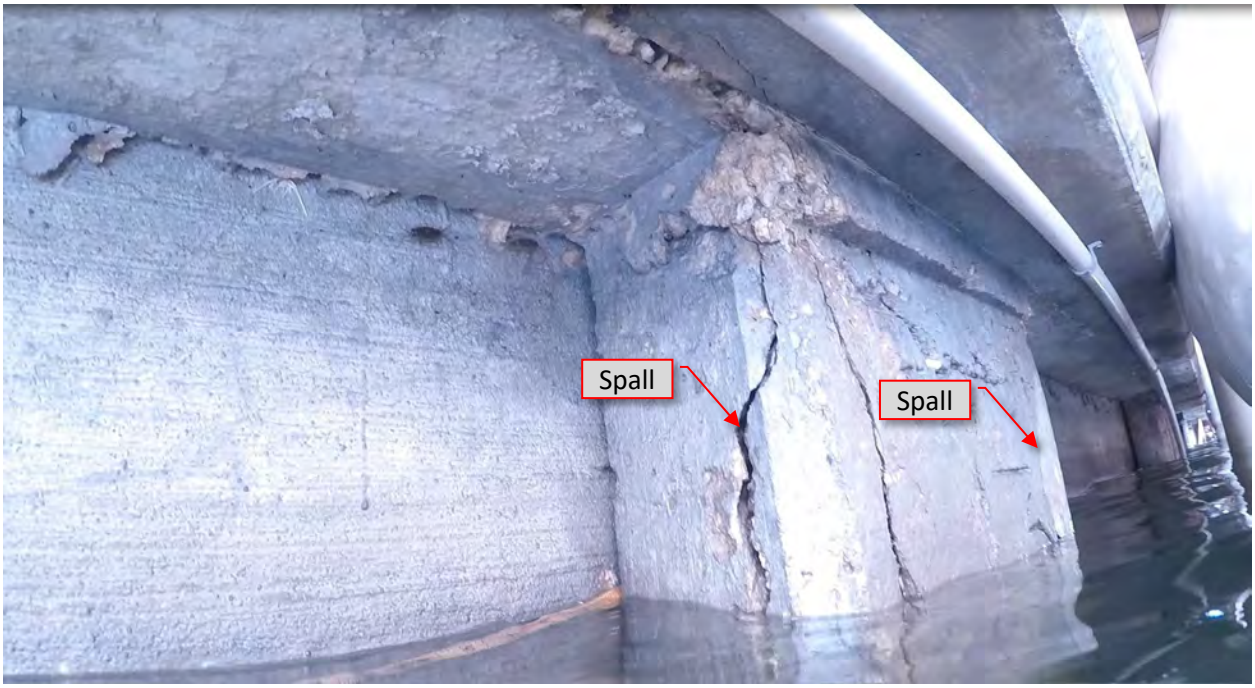

Figure 59: P22. STA 4+20. Break/spall at west and east flanges at pile.

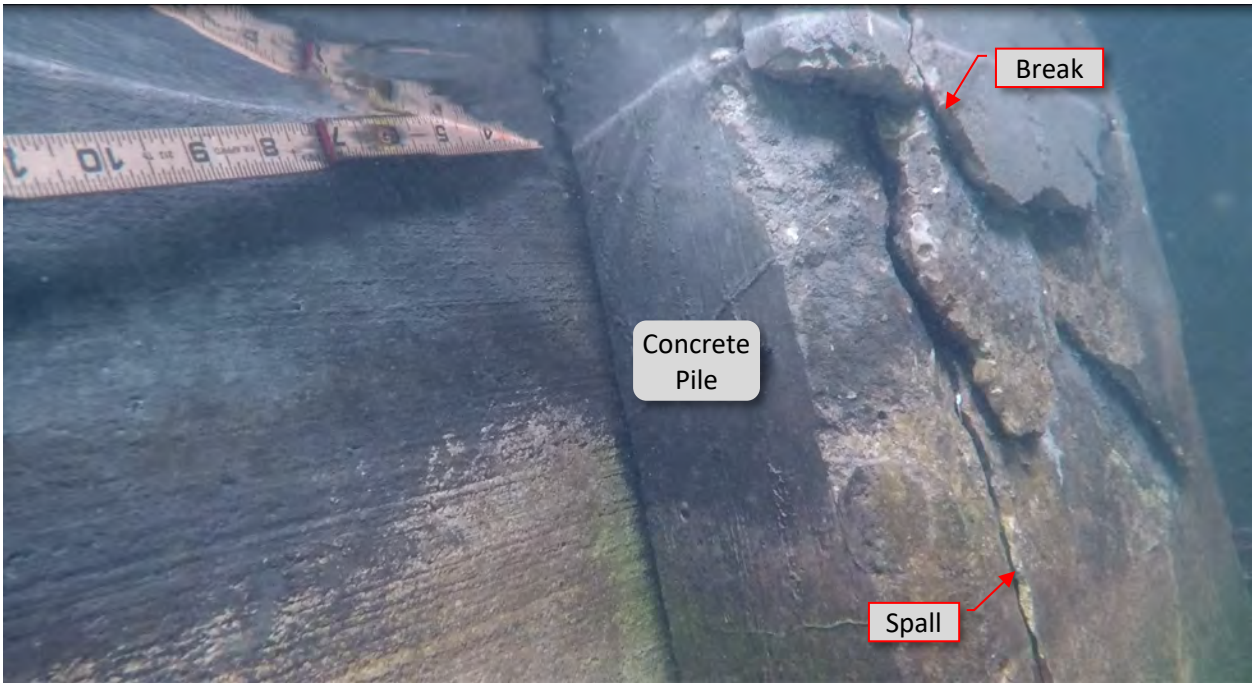

Figure 60: P22. STA 4+20. Break/spall at west and east flanges at pile. Loss of concrete. Underwater view.

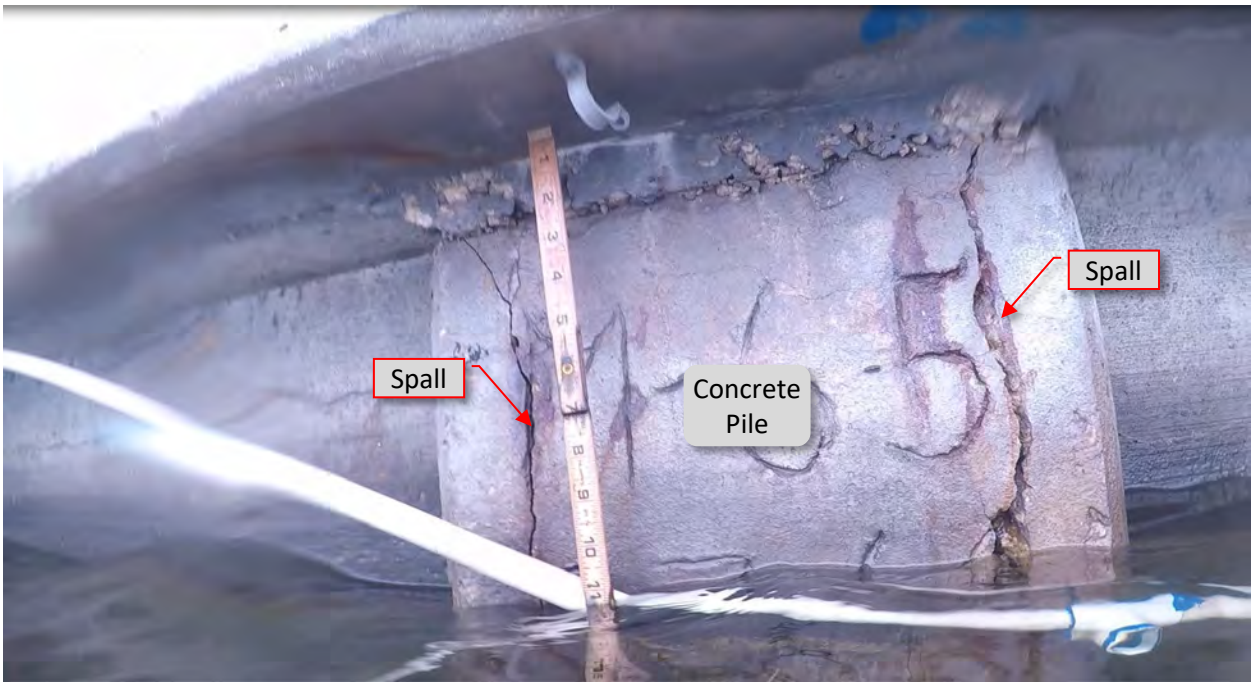

Figure 61: P23. STA 4+28. Break/spall at both flanges at pile. Honeycomb area.

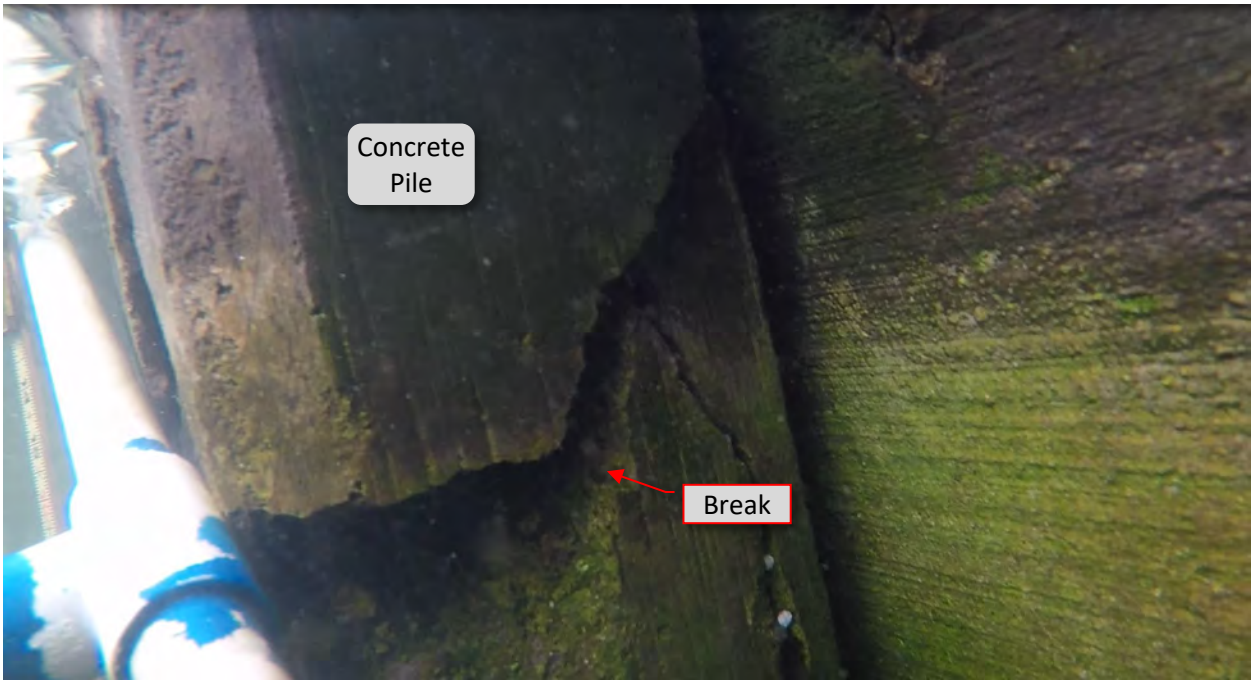

Figure 62: P23. STA 4+28. Break/spall at east flange at pile. Loss of concrete.

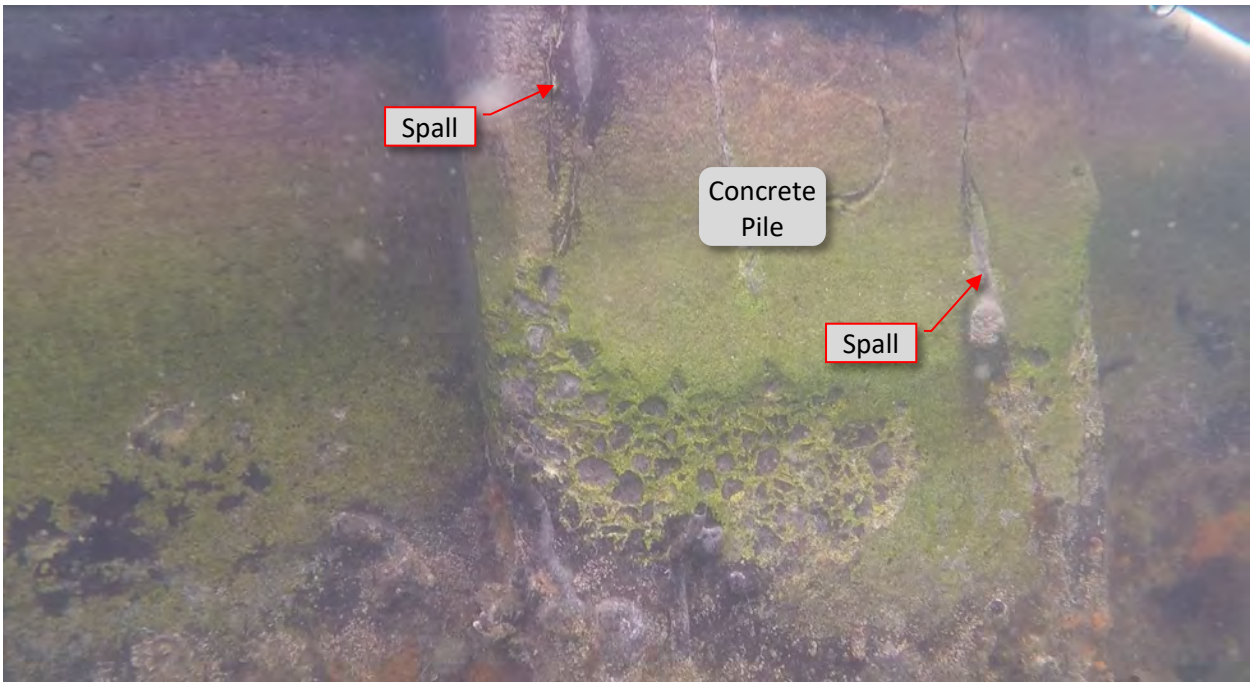

Figure 63: P23. STA 4+28. Spalls at both flanges at pile.

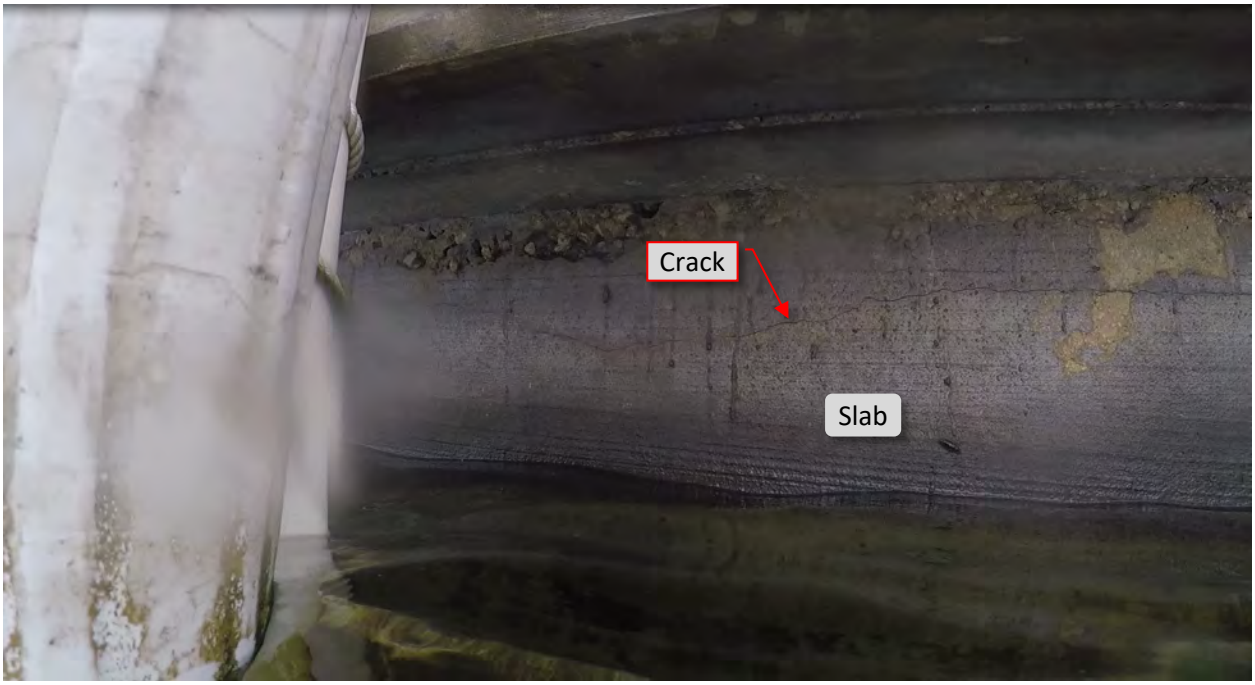

Figure 64: S15. STA 4+30 - 4+35. Crack at top of slab. Honeycomb area.

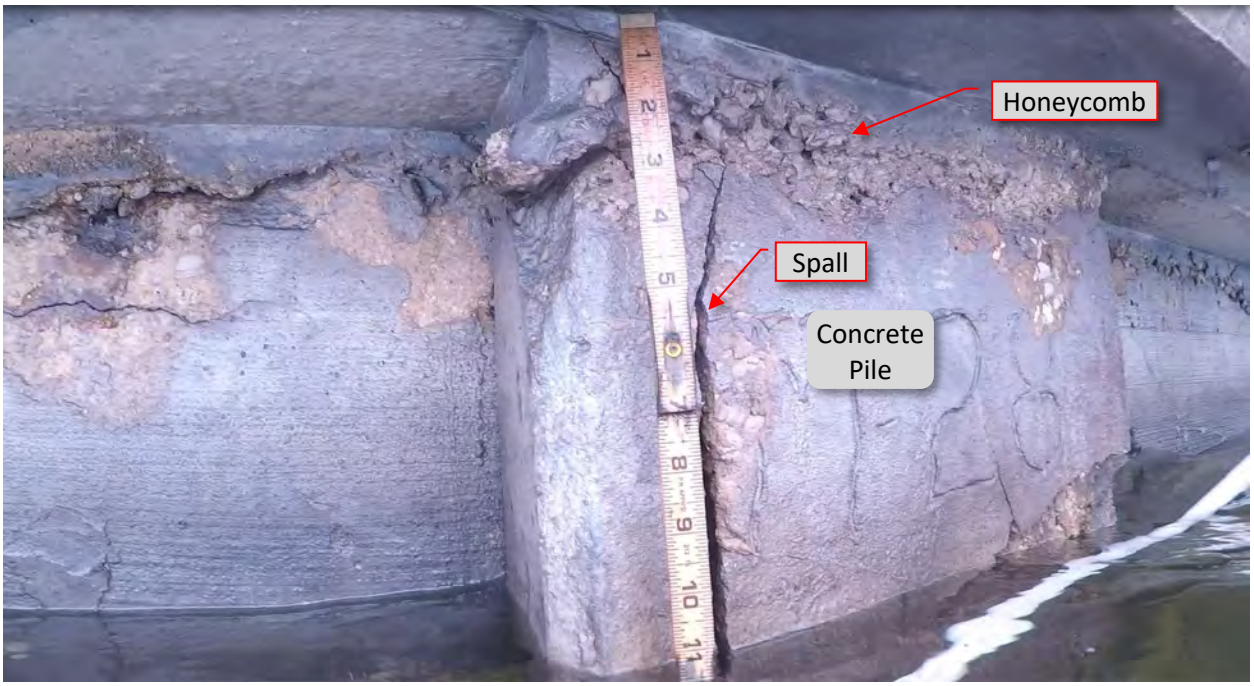

Figure 65: P24. STA 4+36. Break/spall at both flanges at pile. Honeycomb area.

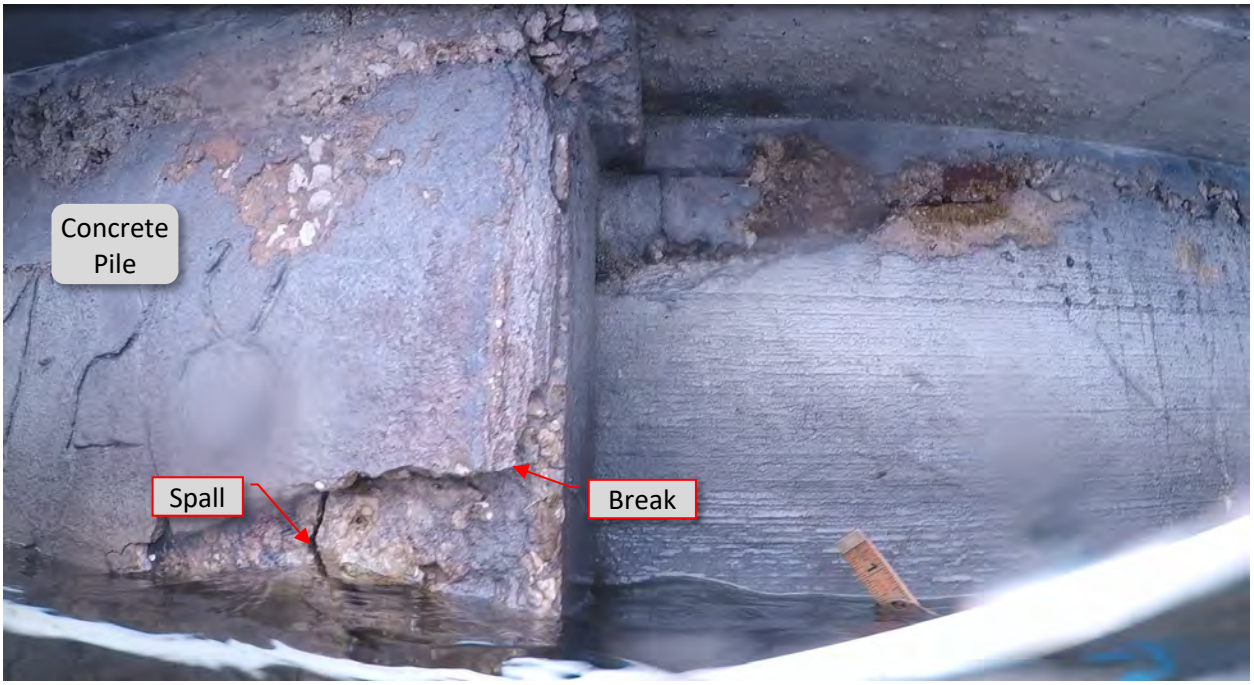

Figure 66: P24. STA 4+36. Break/spall at east flange at pile. Loss of concrete. Honeycomb area.

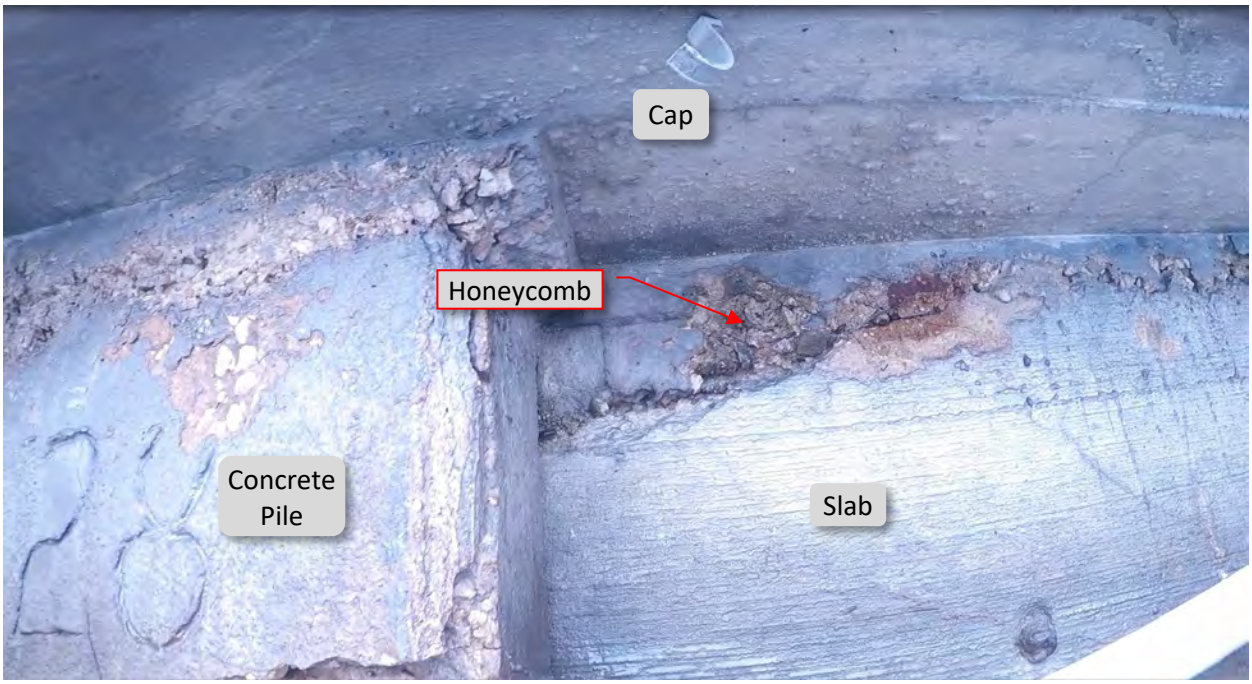

Figure 67: S16. STA 4+37 - 4+38. Honeycomb area at west top corner of slab.

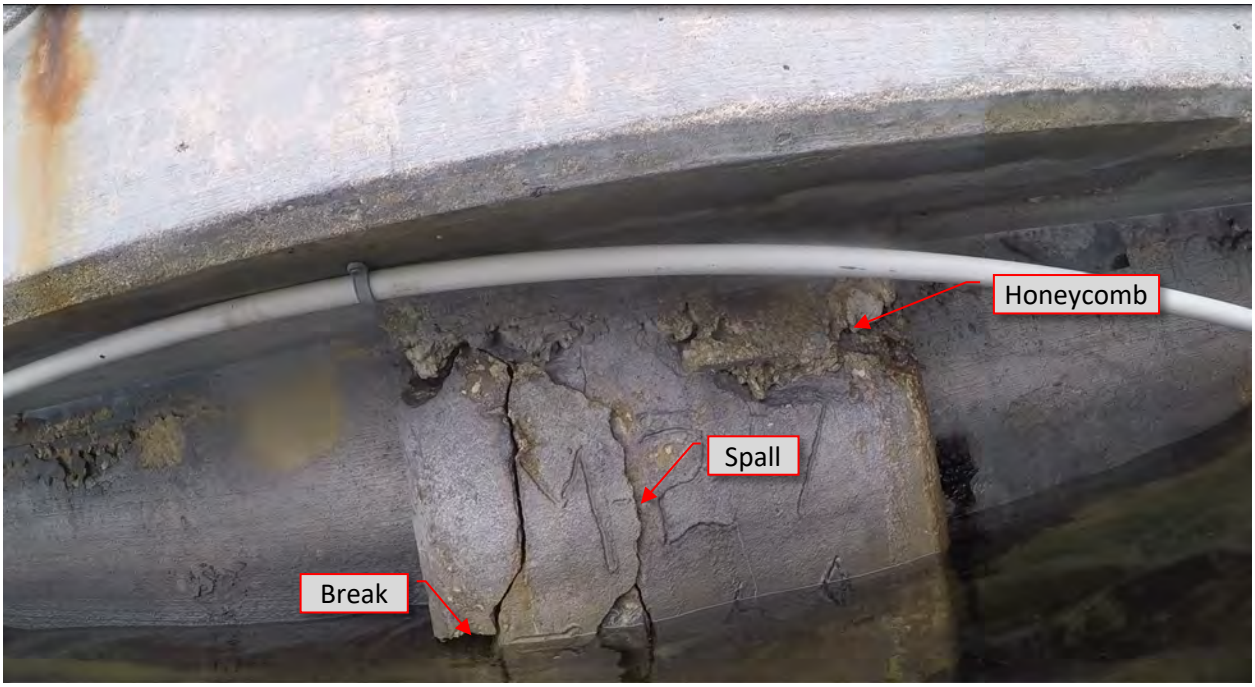

Figure 68: P25. STA 4+44. Breaks/spalls at both flanges at pile. Loss of concrete. Honeycomb area.

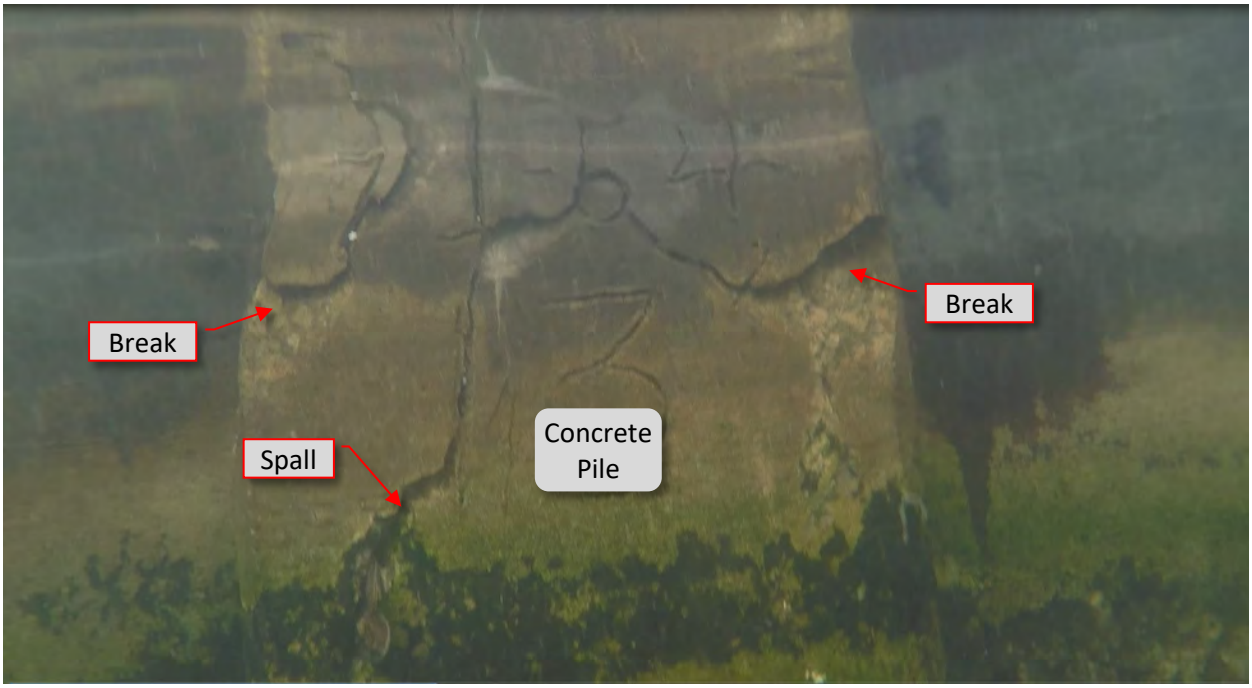

Figure 69: P25. STA 4+44. Breaks/spalls at both flanges at pile. Loss of concrete. Honeycomb area. Underwater view.

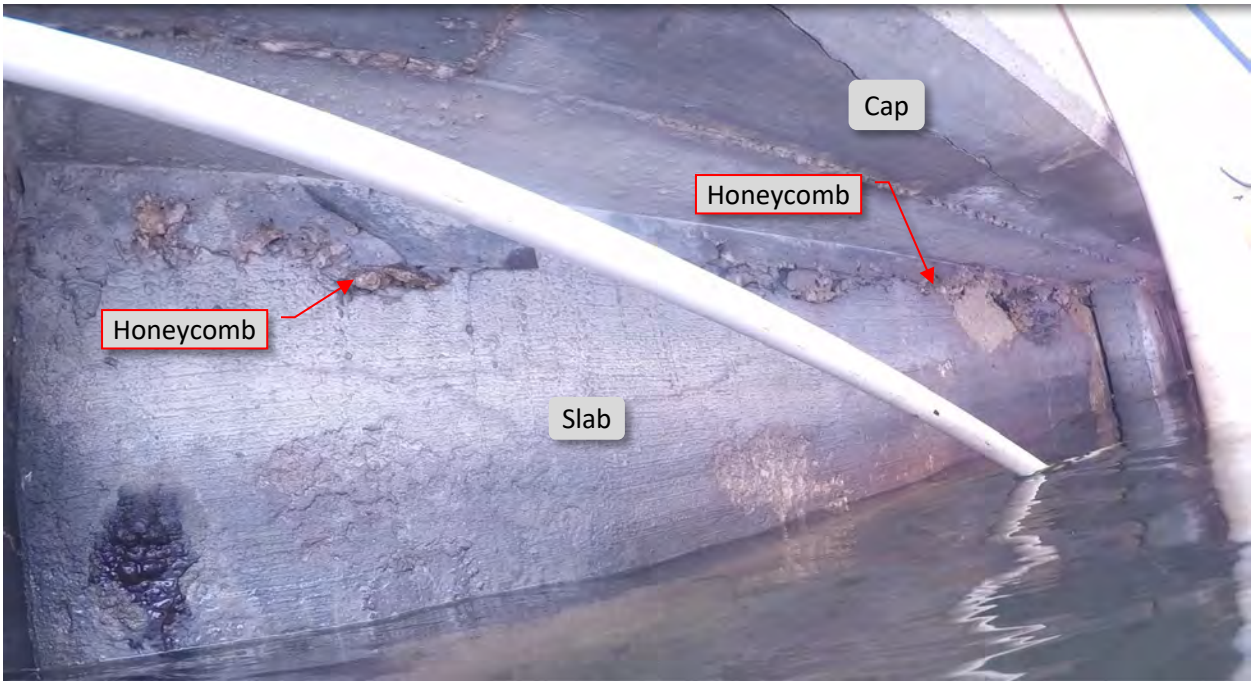

Figure 70: S17. STA 4+45 – 4+52. Honeycomb area along the top of slab.

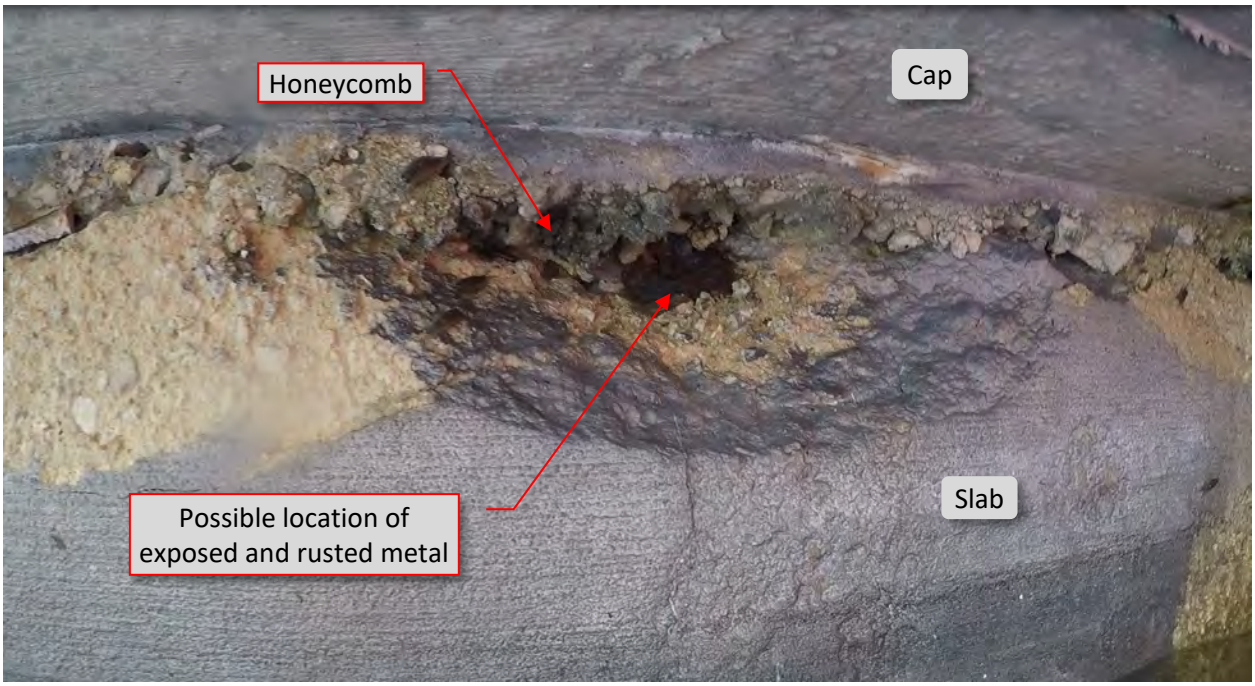

Figure 71: S17. STA 4+45 - 4+52. Honeycomb area at top of slab and presumed location of exposed metal.

Figure 72: P26. STA 4+53. Breaks/spalls at both flanges at pile. Honeycomb area.

Figure 73: S18. STA 4+54 - 4+59. Crack at top of slab.

Figure 74: P27. STA 4+60. Crack/spall at top of east flange.

Figure 75: P27. STA 4+60. Crack/spall at top of east flange. View of east face at pile.

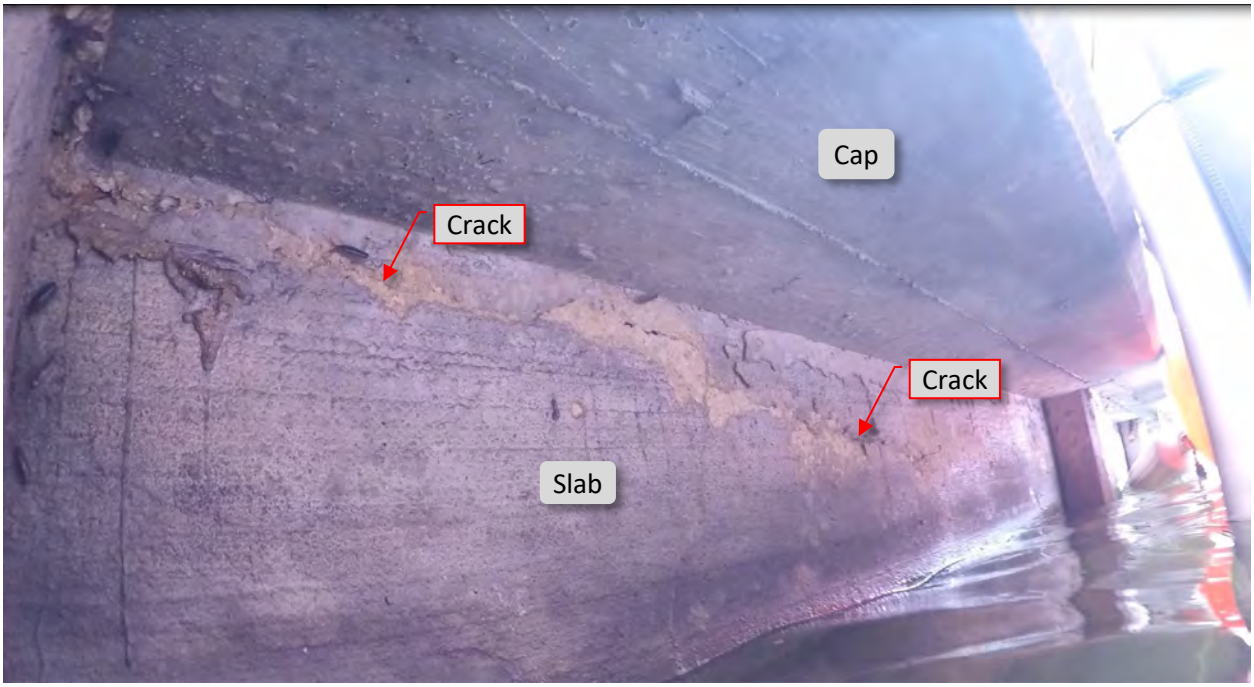

Figure 76: S19. STA 4+61 - 4+67. Crack at top of slab.

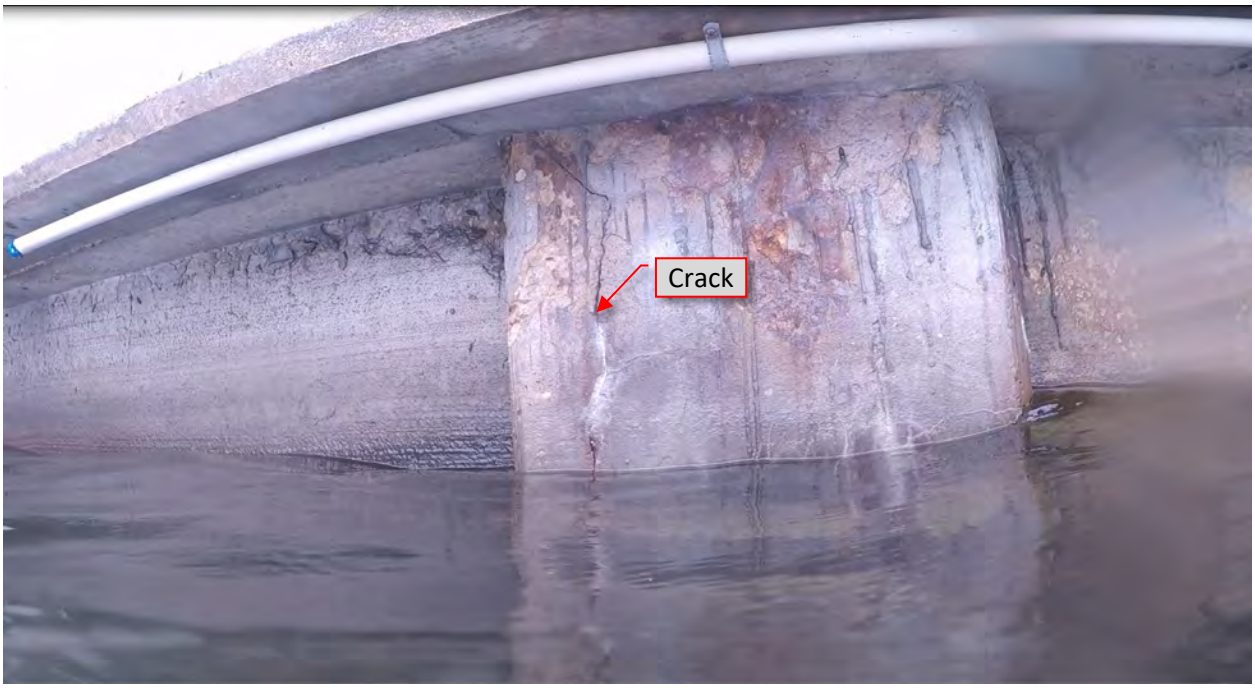

Figure 77: P28. STA 4+67. Crack at top of west flange with rust staining.

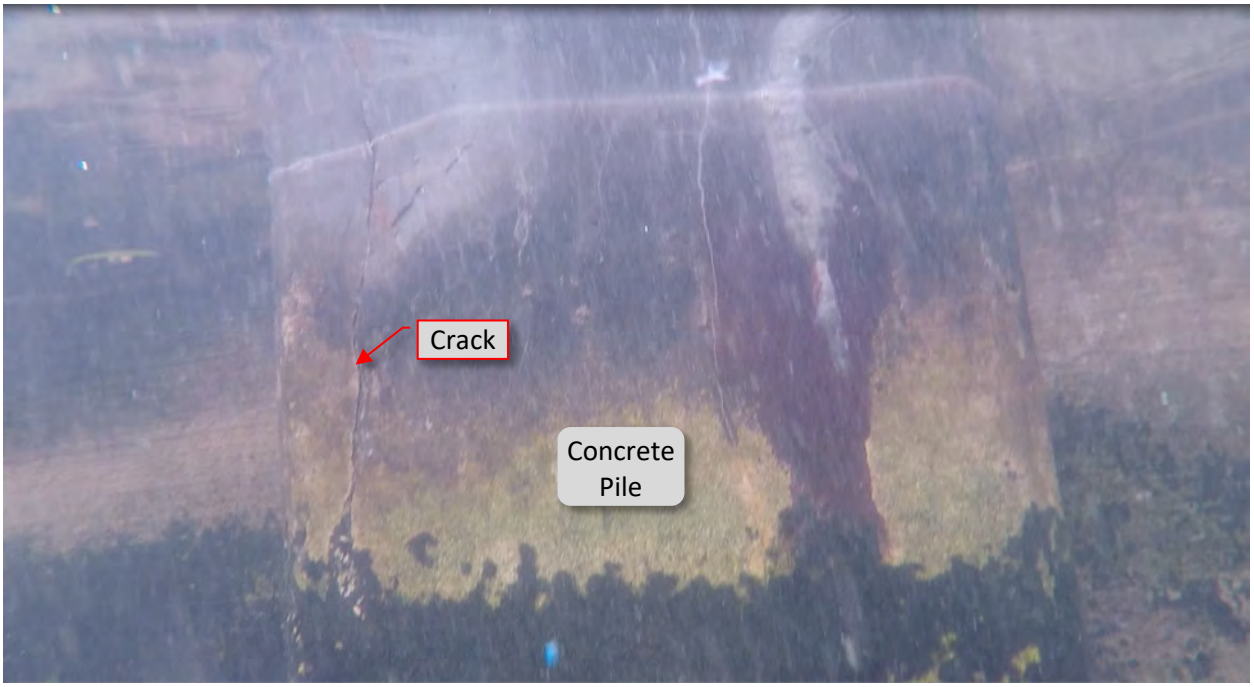

Figure 78: P28. STA 4+67. Crack at top of west flange with rust staining. Underwater view.

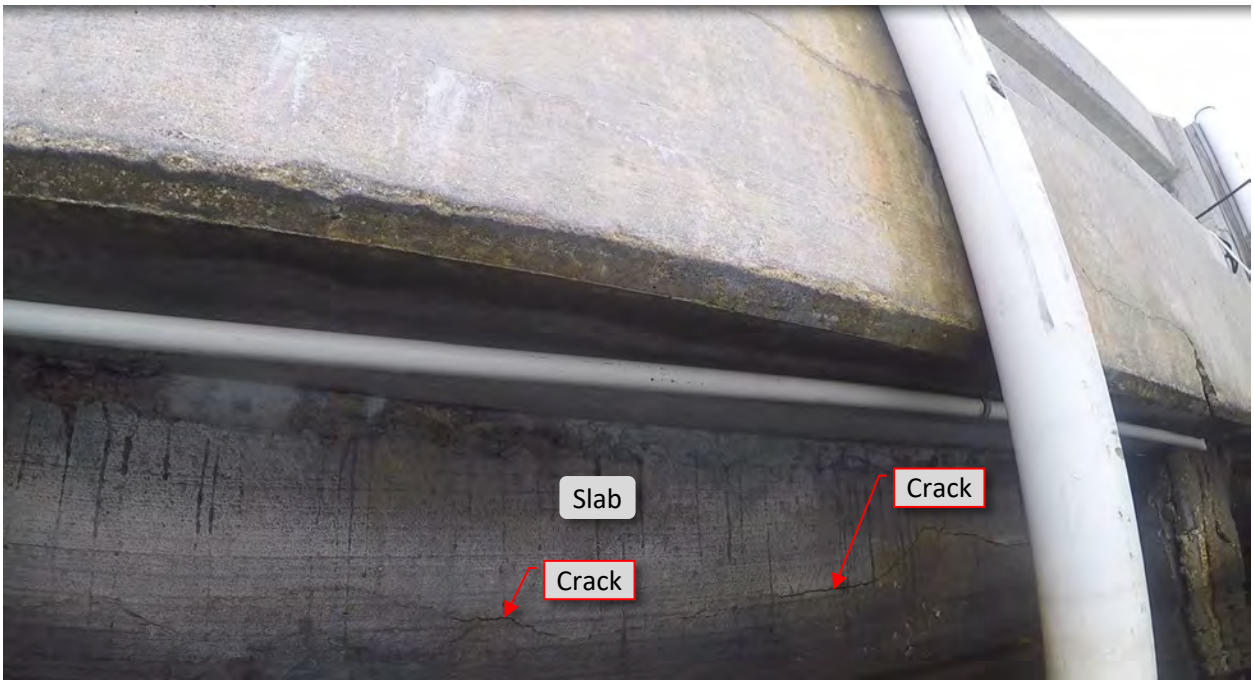

Figure 79: S20. STA 4+84 - 4+90. Crack at top of slab. View of west to mid span of slab.

Figure 80: S20. STA 4+84 - 4+90. Crack at top of slab. View of mid to east span of slab.

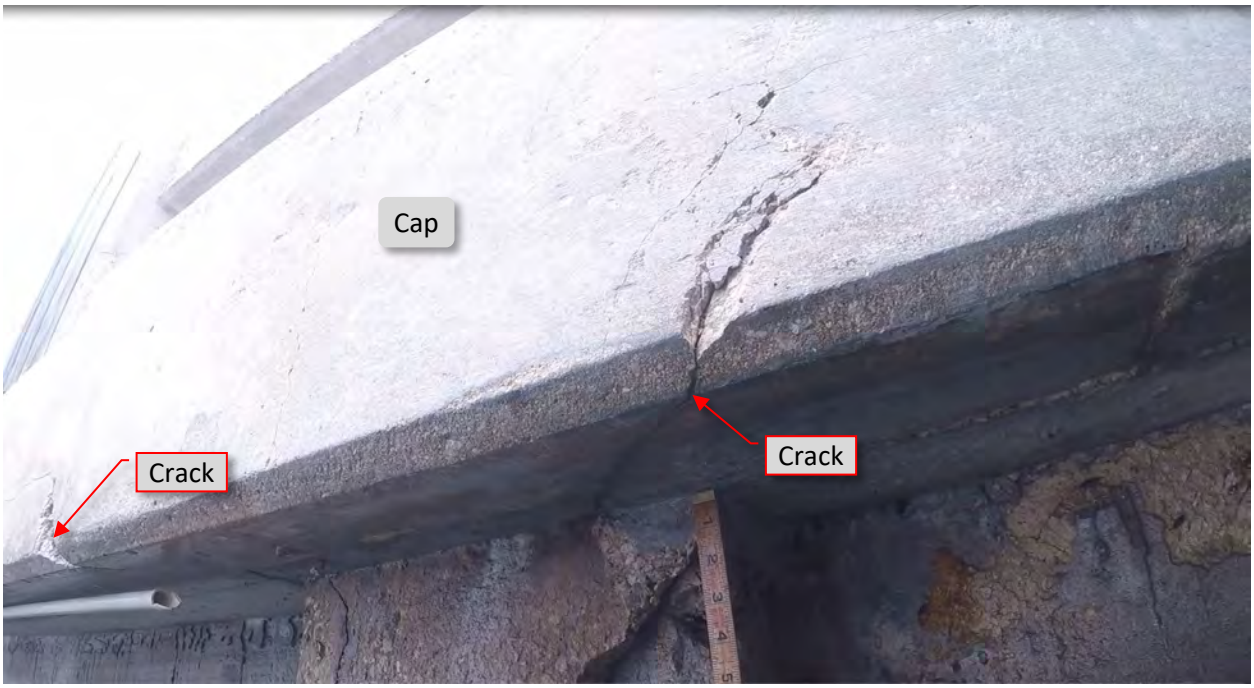

Figure 81: C1. STA 4+84 - 4+93. Two cracks spalled west and east direction on cap from pile's top.

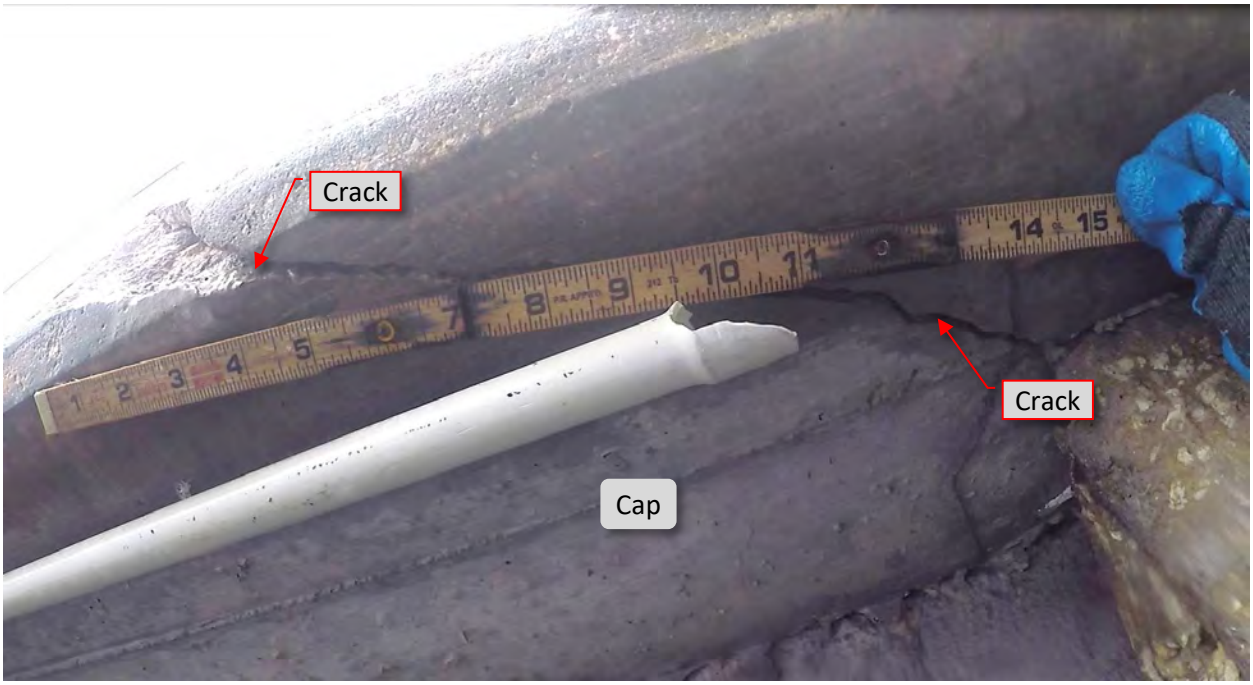

Figure 82: C1. STA 4+84 - 4+93. One crack spalled west direction on cap from pile's top.

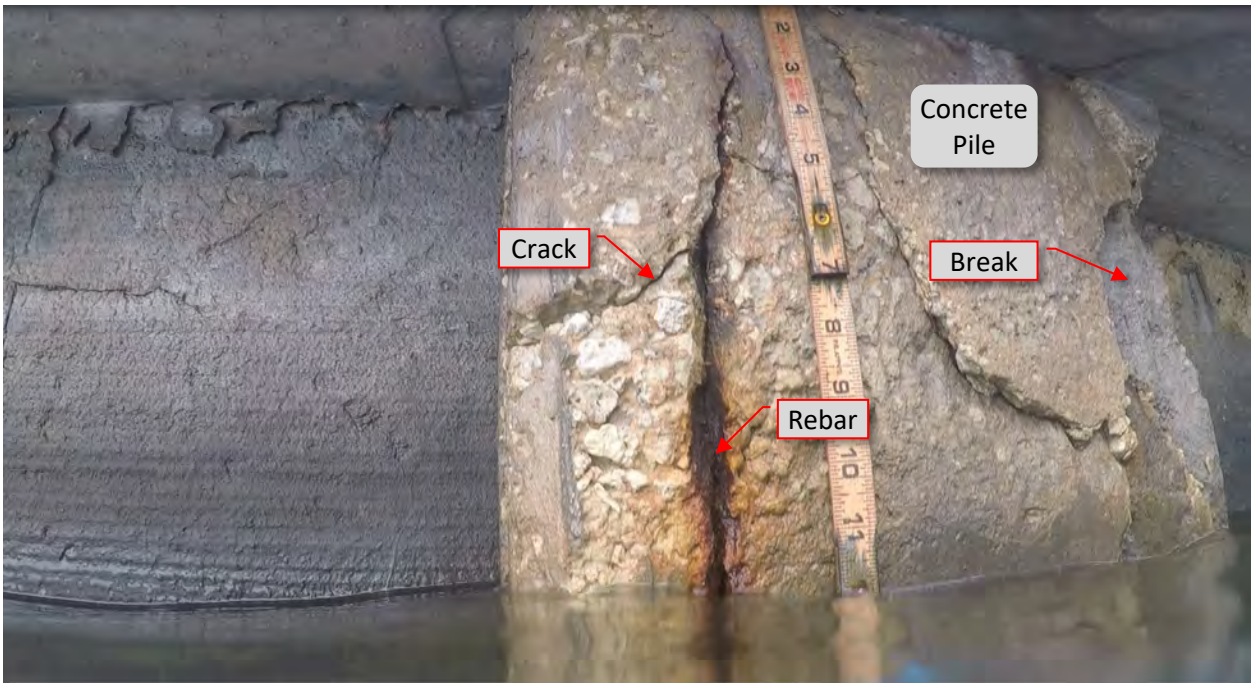

Figure 83: P29. STA 4+92. Cracked and spalled west flange, south face and east flange, rusted rebar, and loss of concrete at pile.

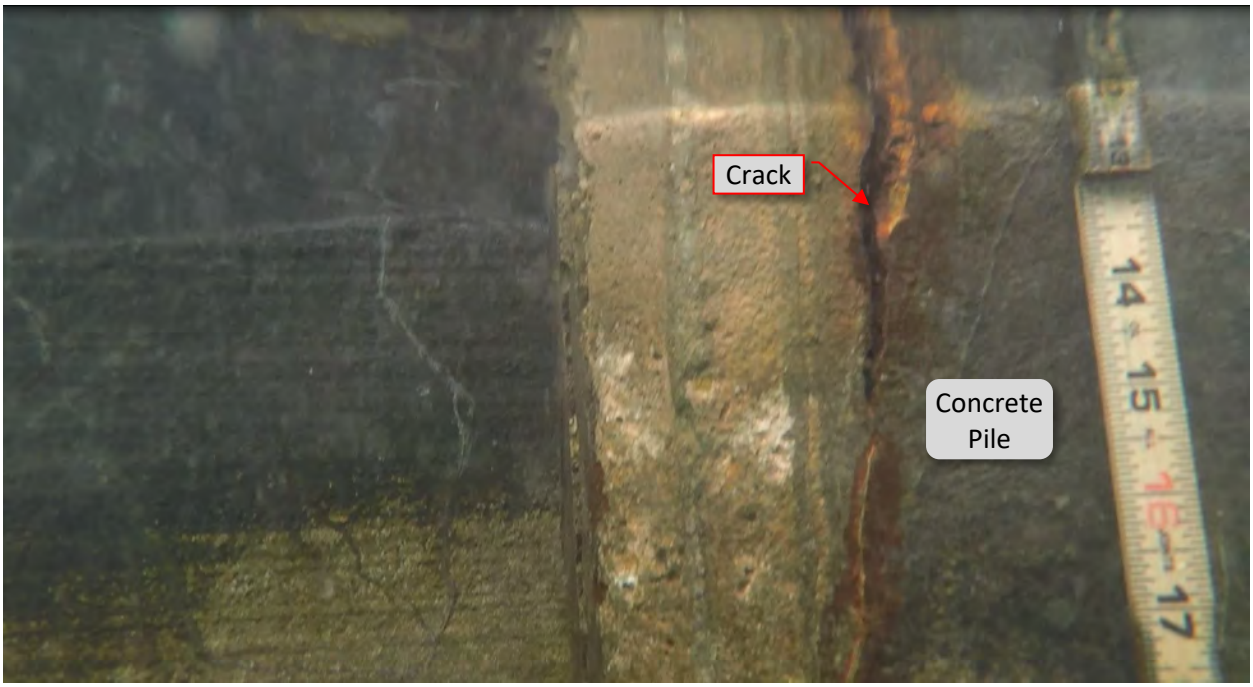

Figure 84: P29. STA 4+92. Cracked and spalled west flange and rust staining at pile

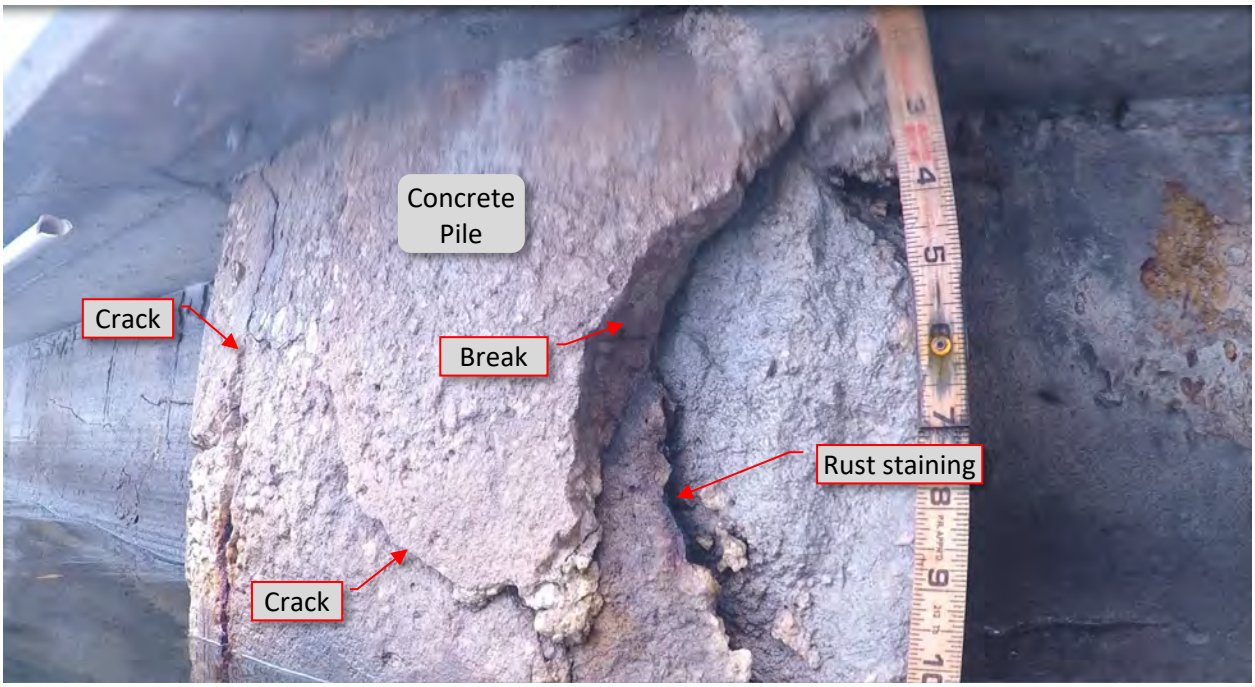

Figure 85: P29. STA 4+92. Cracked and spalled east flange, south face and west flange, rust staining, and loss of concrete at pile.

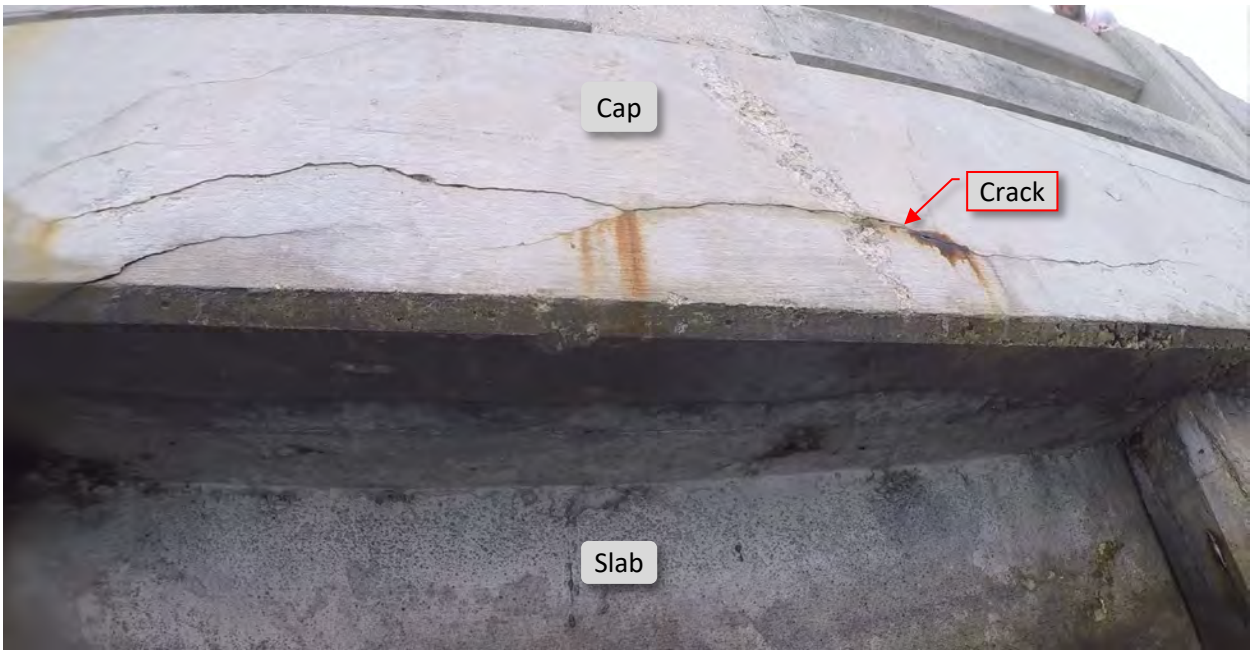

Figure 86: C2. STA 4+92 - 4+95. Crack at cap vertical face.

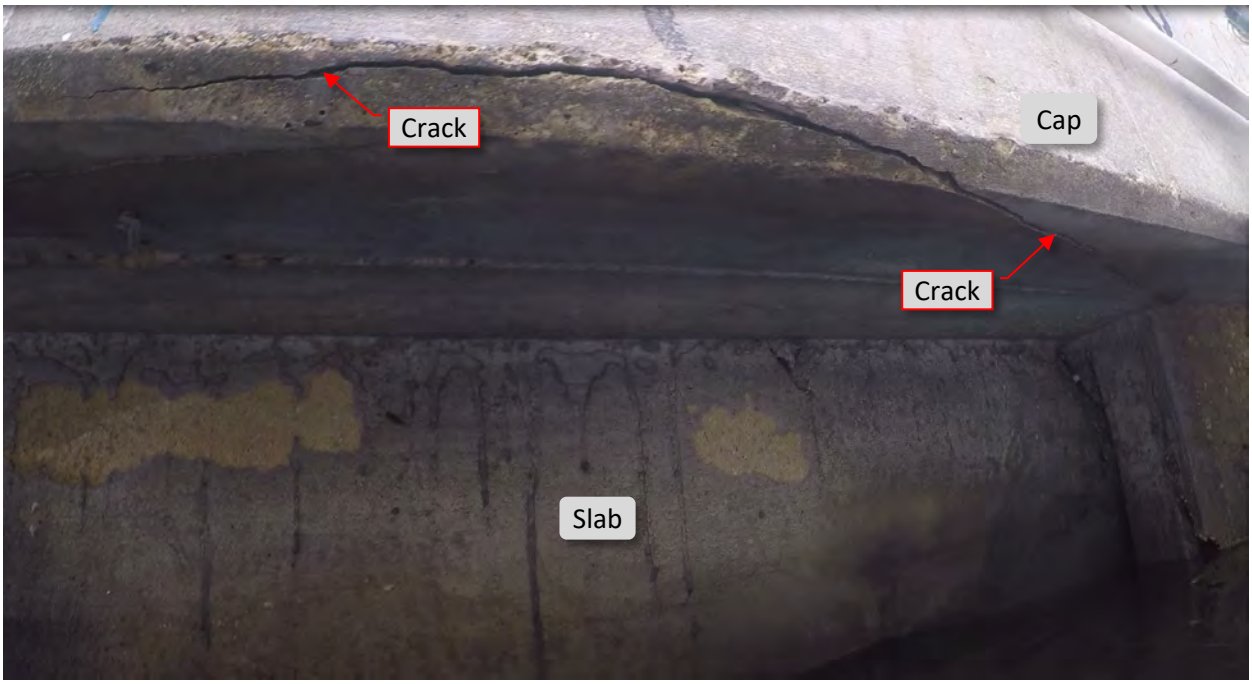

Figure 87: C3. STA 4+95 - 5+00. Crack at cap's bottom face and edge.

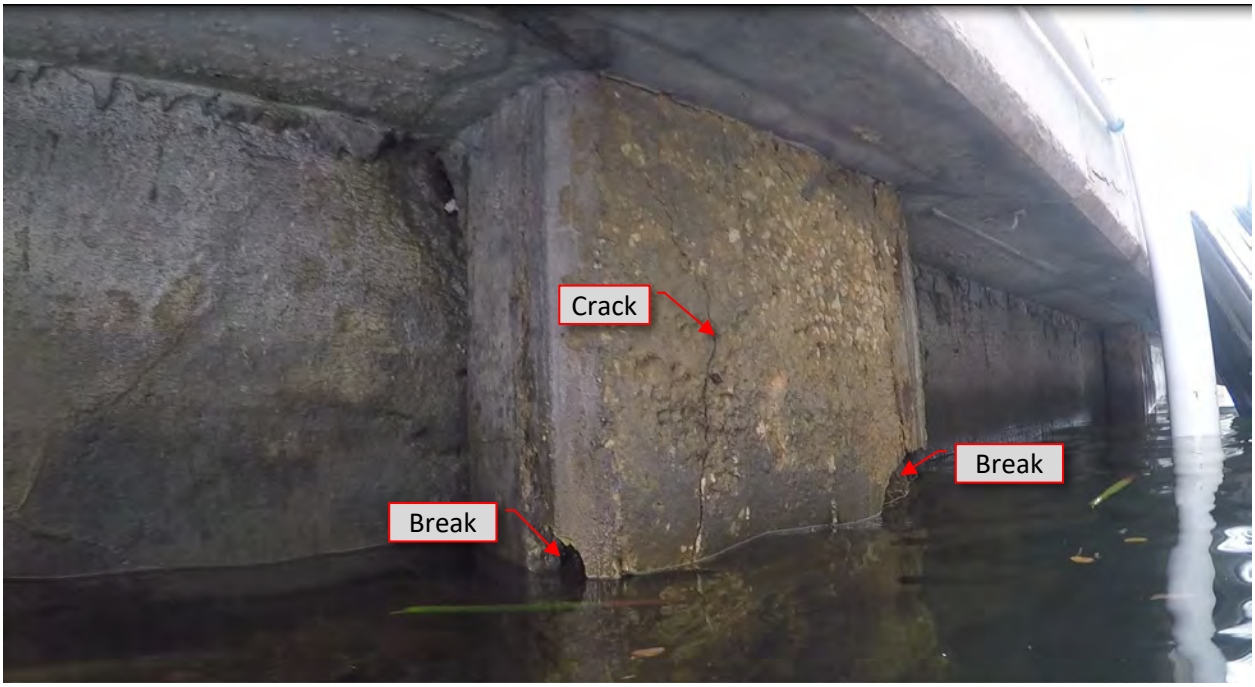

Figure 88: P30. STA 5+00. Cracks/spalls at both flanges at pile and loss of concrete.

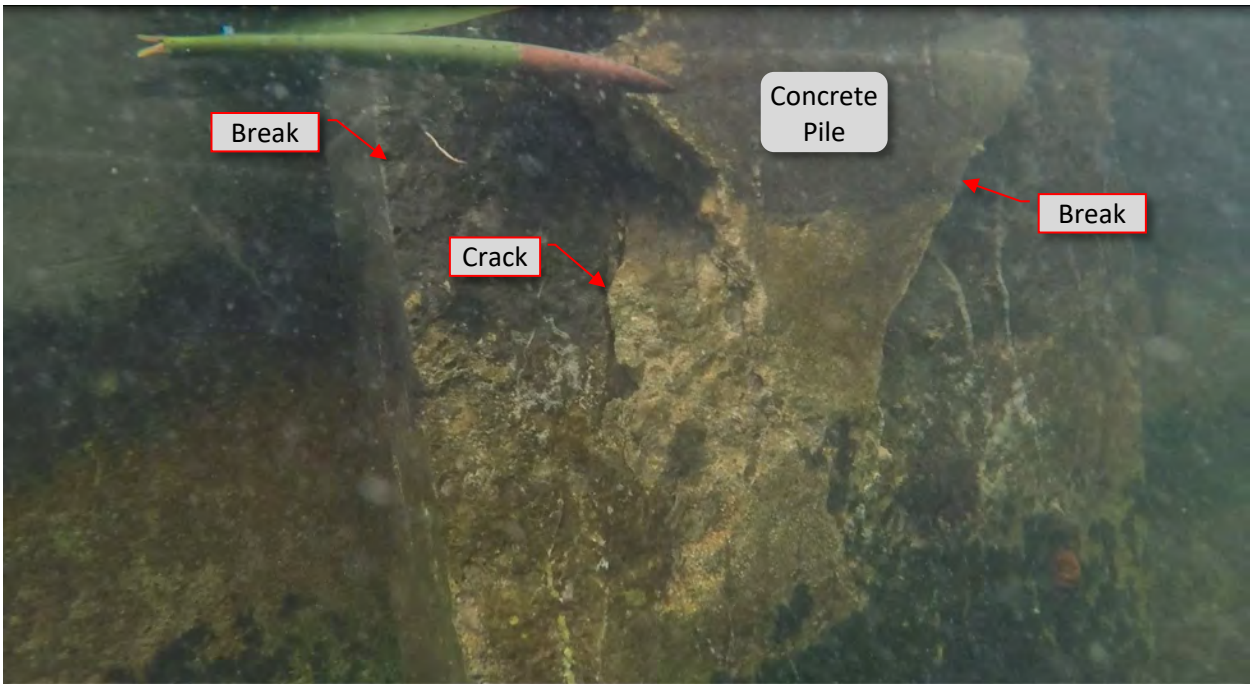

Figure 89: P30. STA 5+00. Cracks/spalls at both flanges and loss of concrete. Underwater view.

Figure 90: P31. STA 5+08. Cracks/spalls at both flanges at pile and loss of concrete.

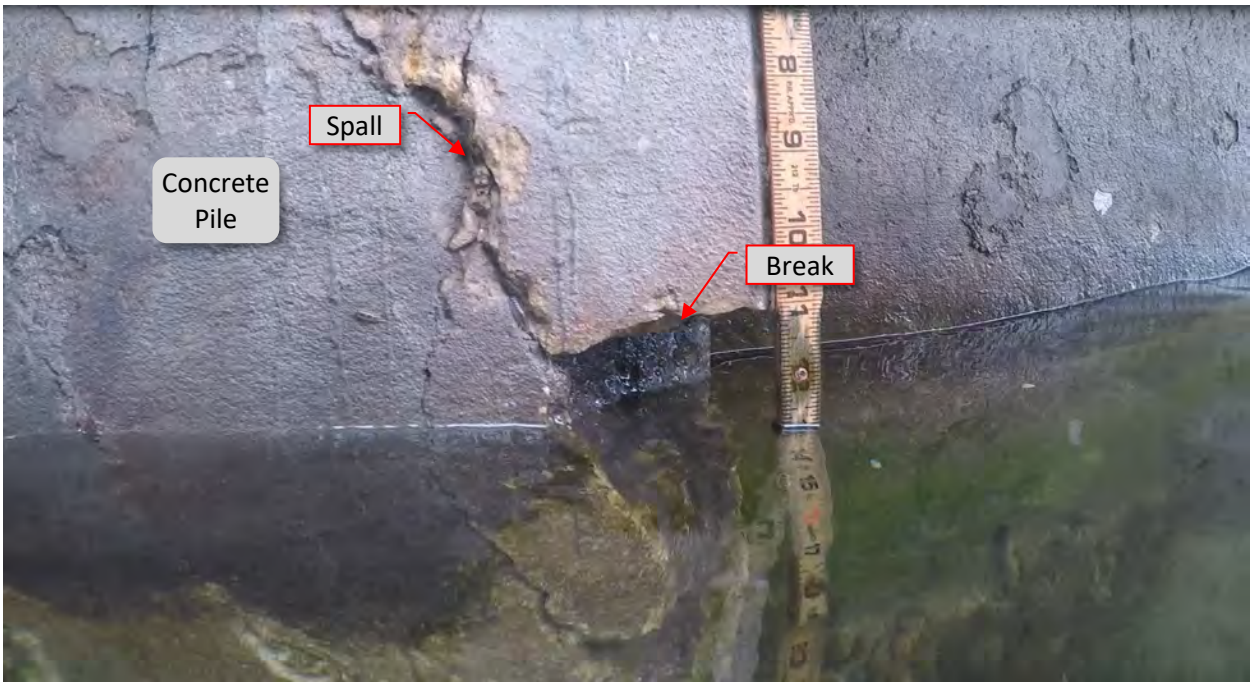

Figure 91: P31. STA 5+08. Cracks/spalls at east flange and loss of concrete.

Figure 92: C4. STA 5+11 - 5+16. Crack on cap's south face.

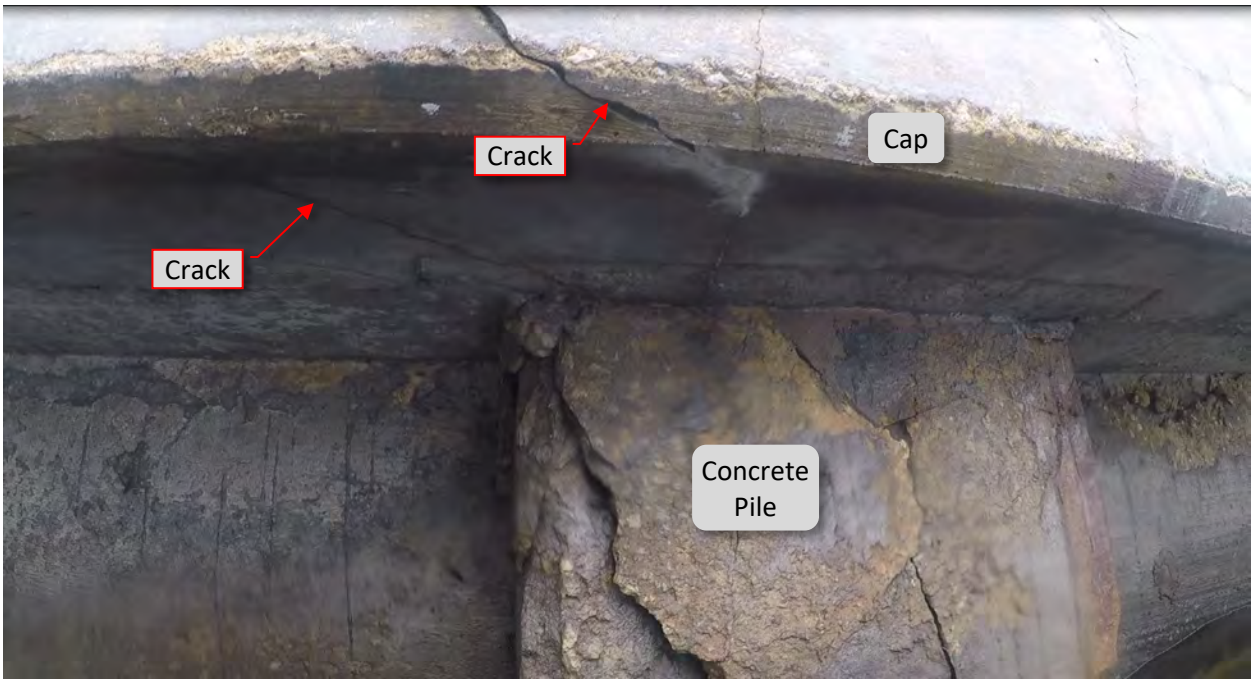

Figure 93: C4. STA 5+11 - 5+16. Cracks on cap's bottom face starts from west flange at pile.

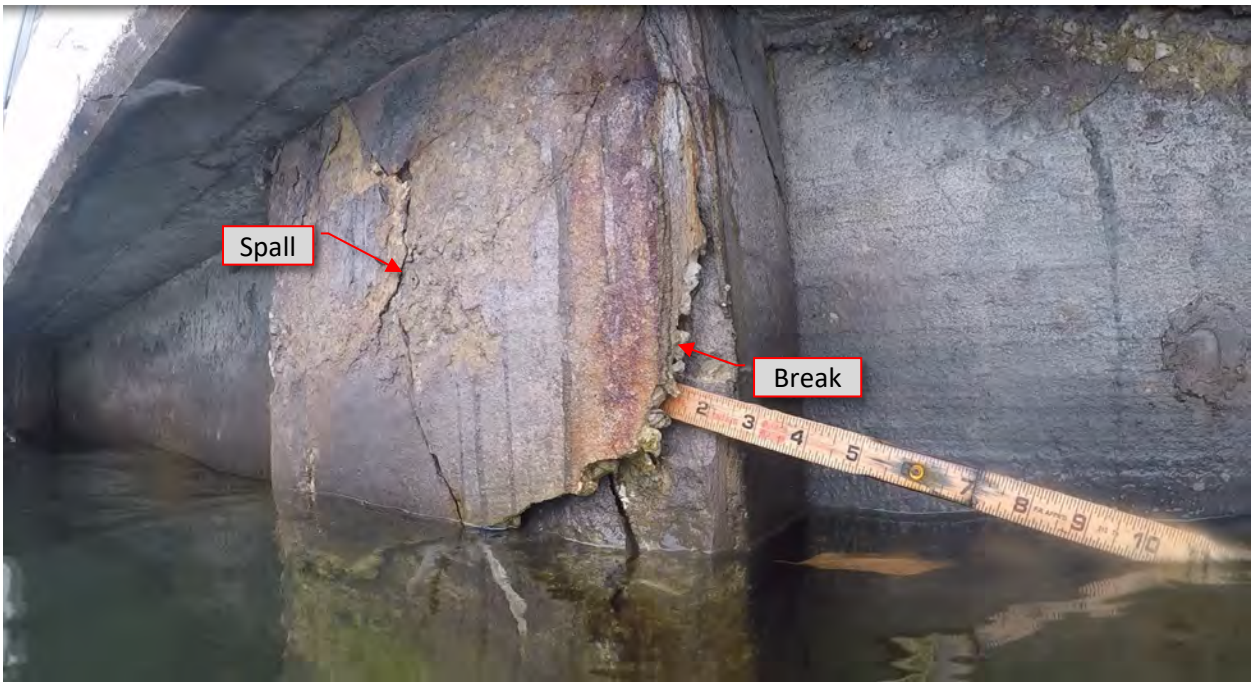

Figure 94: P32. STA 5+16. Cracks/spalls at both flanges and south face, loss of concrete, and rust staining.

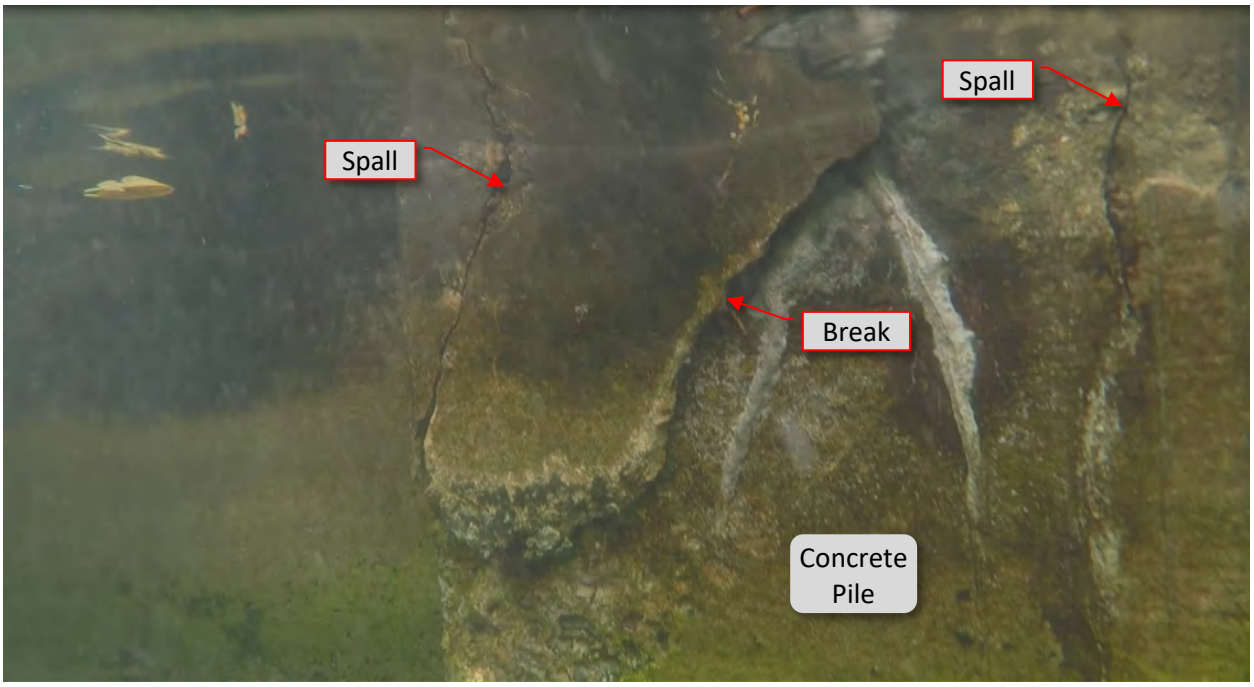

Figure 95: P32. STA 5+16. Cracks/spalls at west flange and south face, loss of concrete, and rust staining. Underwater view.

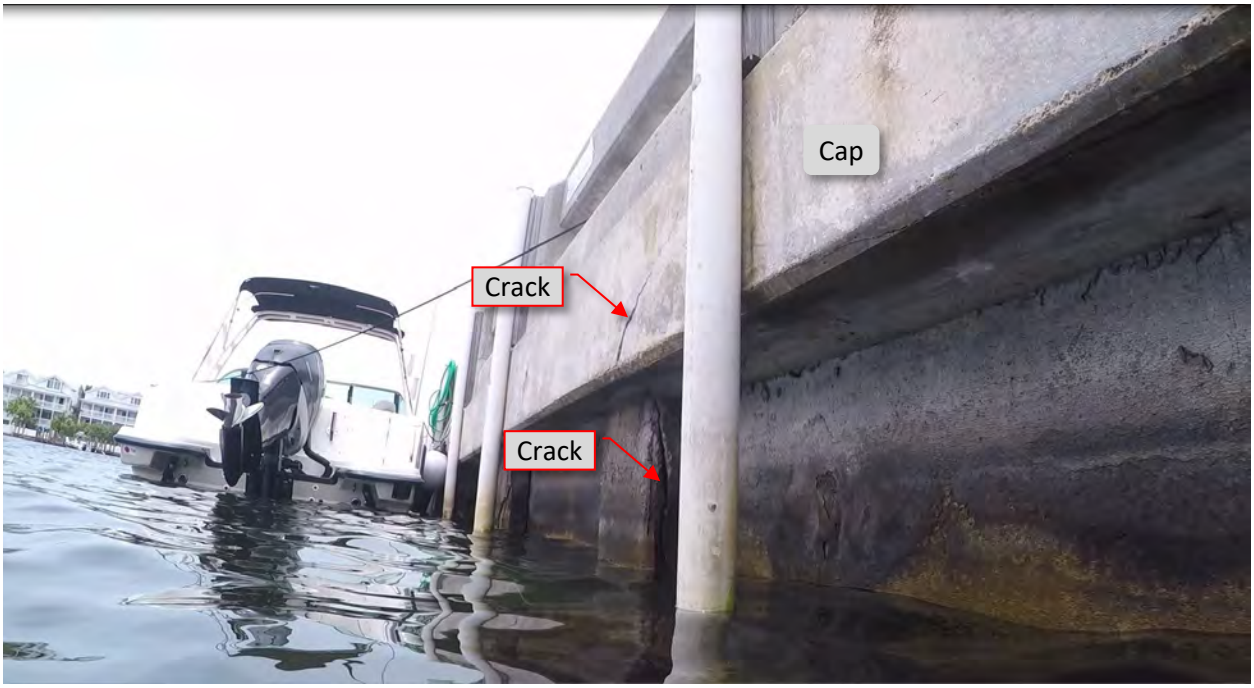

Figure 96: P33. STA 5+24. Crack/spall at top east flange with rust staining. C5. STA 5+24 – 5+26. Crack at cap south face.

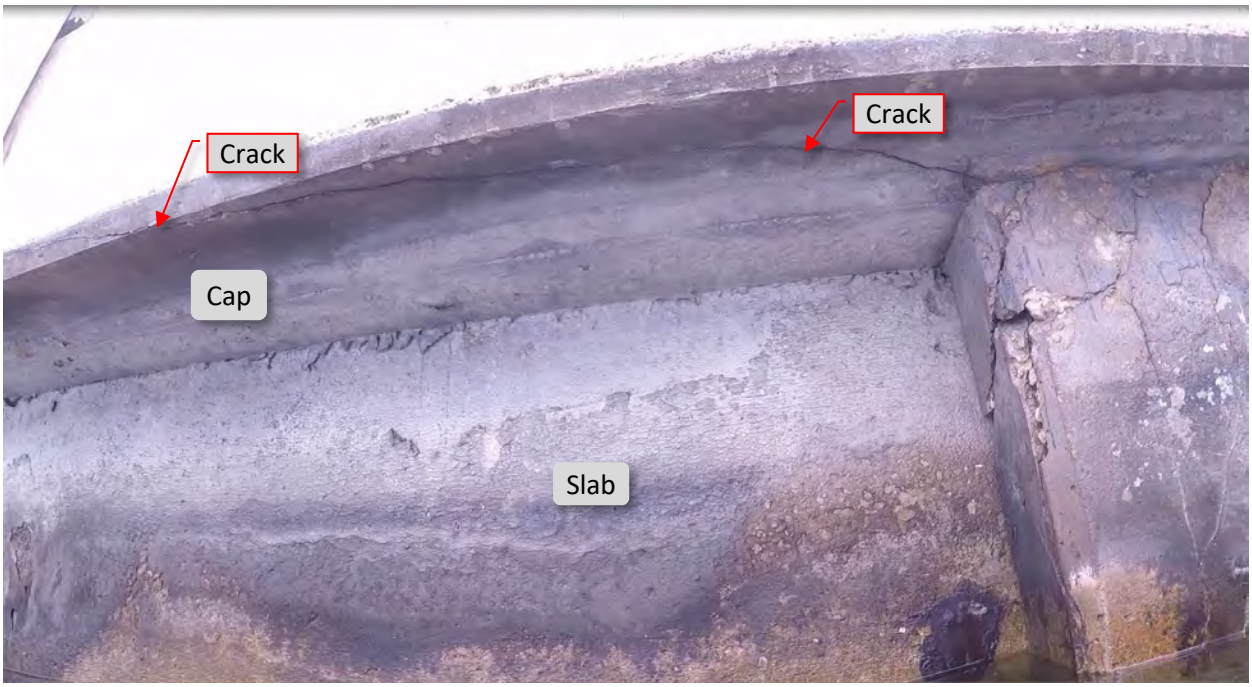

Figure 97: C6. STA 5+25 - 5+30. Crack at cap bottom face.

Figure 98: P34. STA 5+30. Cracks/spalls at top of pile west and east flanges, loss of concrete, and rust staining.

Figure 99: P34. STA 5+30. Cracks/spalls at top of pile west flange and loss of concrete.

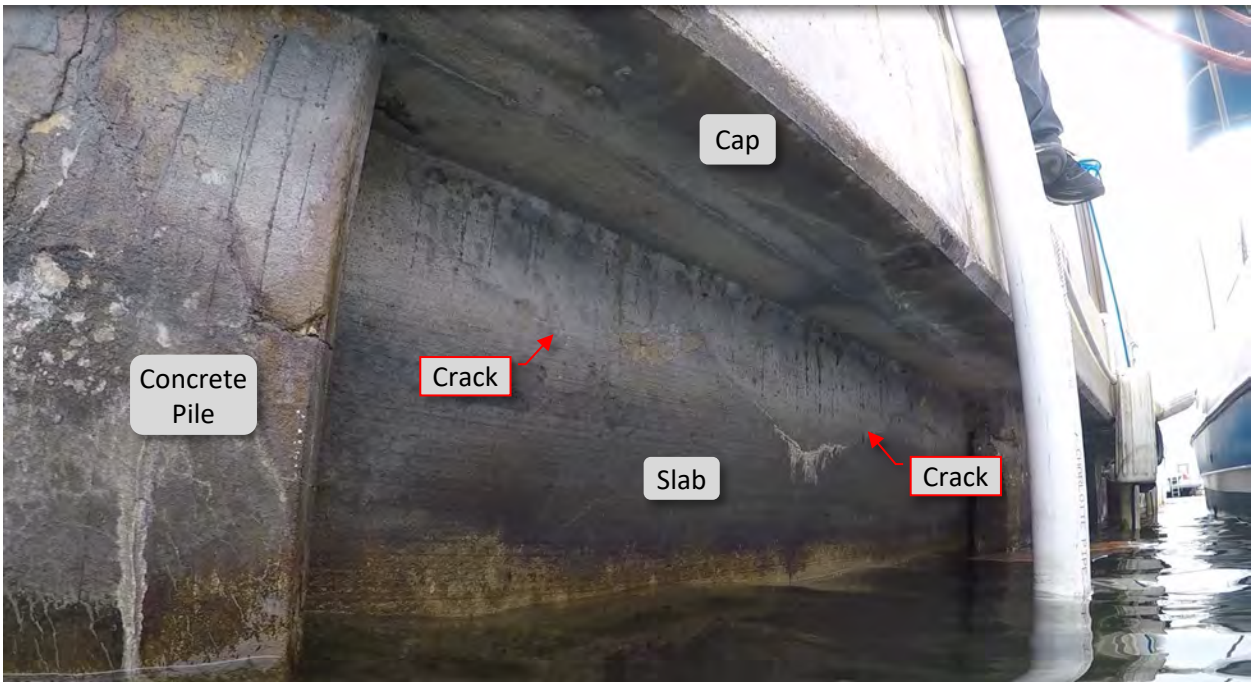

Figure 100: S21. STA 5+31 - 5+37. Crack at top of slab.

Figure 101: P35. STA 5+40. Cracks/spalls at both flanges and loss of concrete. View of east flange.

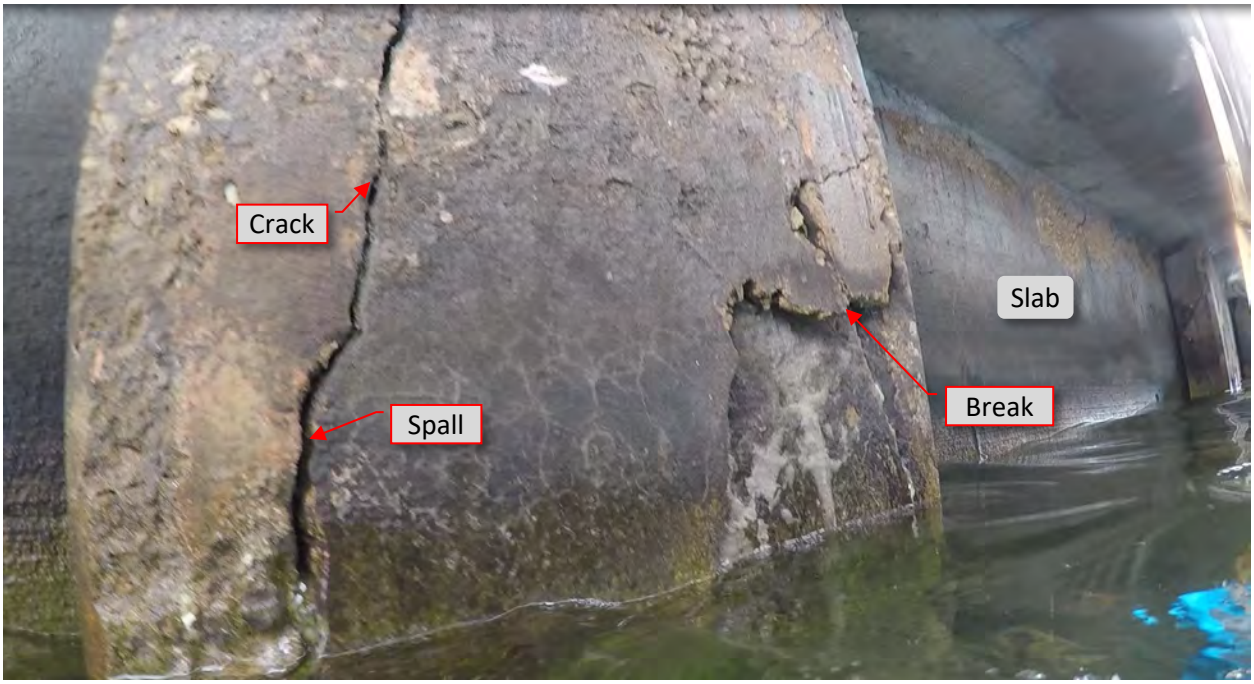

Figure 102: P35. STA 5+40. Cracks/spalls at both flanges at pile and loss of concrete. View of west flange.

Figure 103: S22. STA 5+42 - 5+47. Crack at top of slab.

Figure 104: C7. STA 5+40 - 5+48. Crack at cap's bottom face.

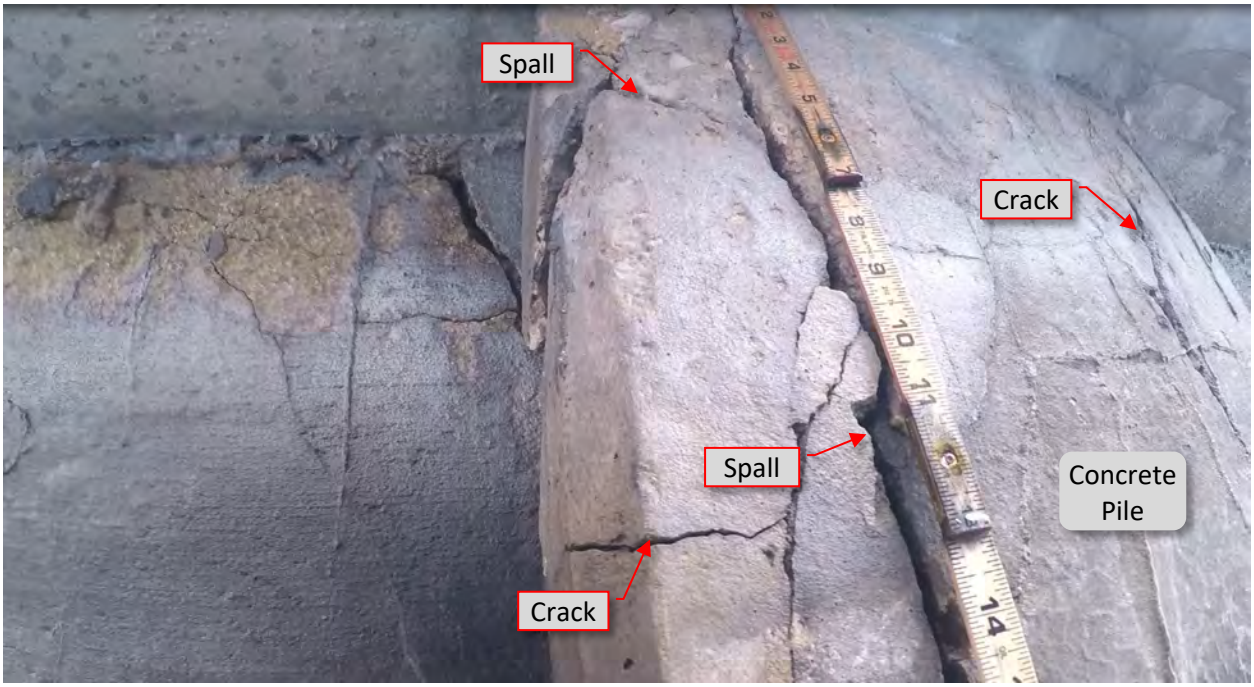

Figure 105: P36. STA 5+48. Cracks/spalls at both flanges at pile and loss of concrete. View of west flange.

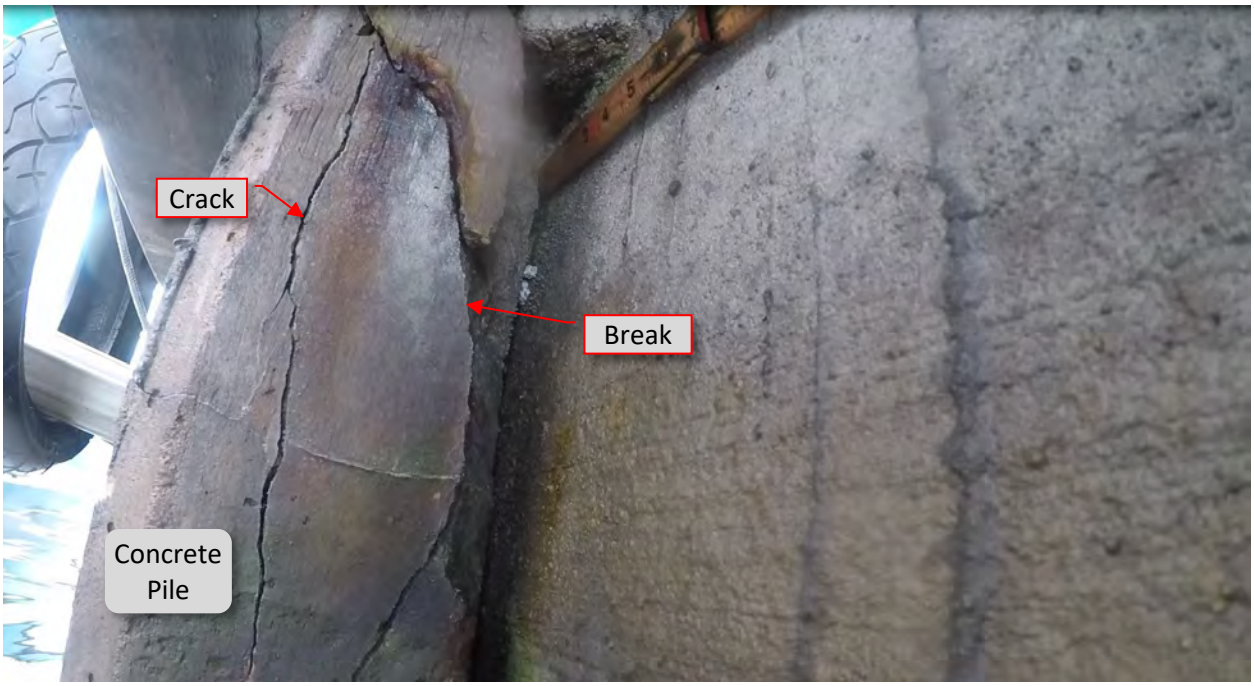

Figure 106: P36. STA 5+48. Cracks/spalls at both flanges at pile and loss of concrete. View of east flange.

Figure 107: C8. STA 5+51 - 5+55. Crack at cap's bottom and south faces west of pile.

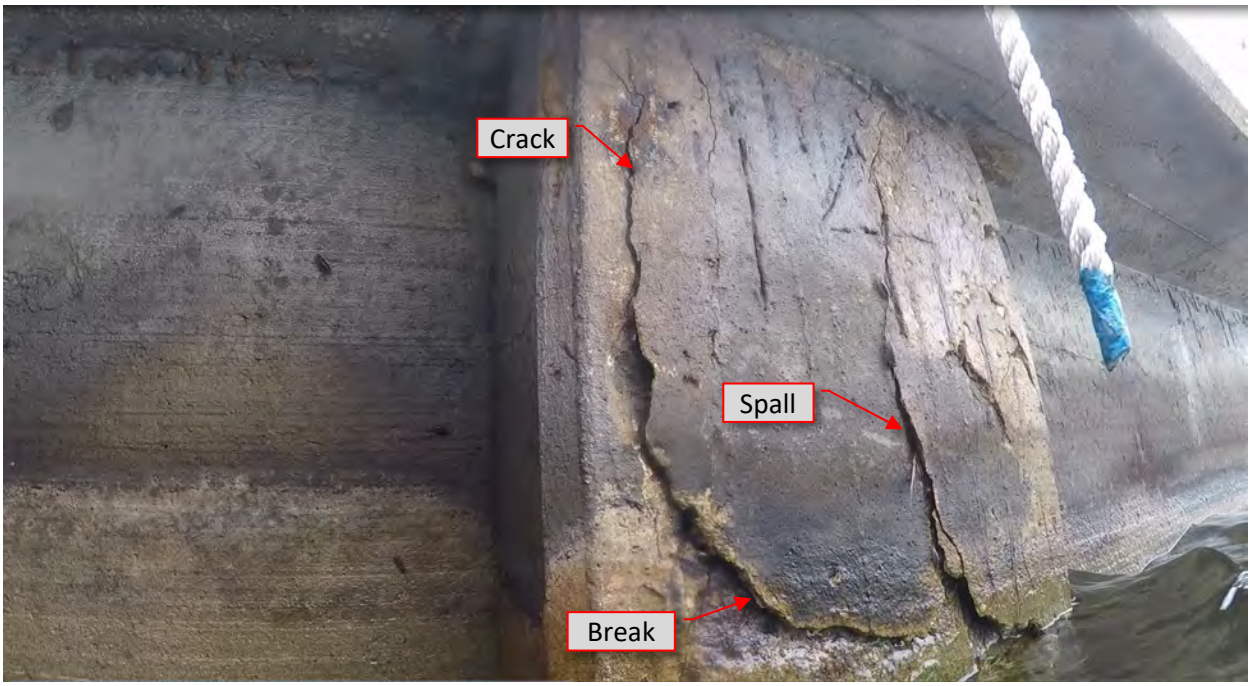

Figure 108: P37. STA 5+56. Cracks/spalls at both flanges at pile and loss of concrete.

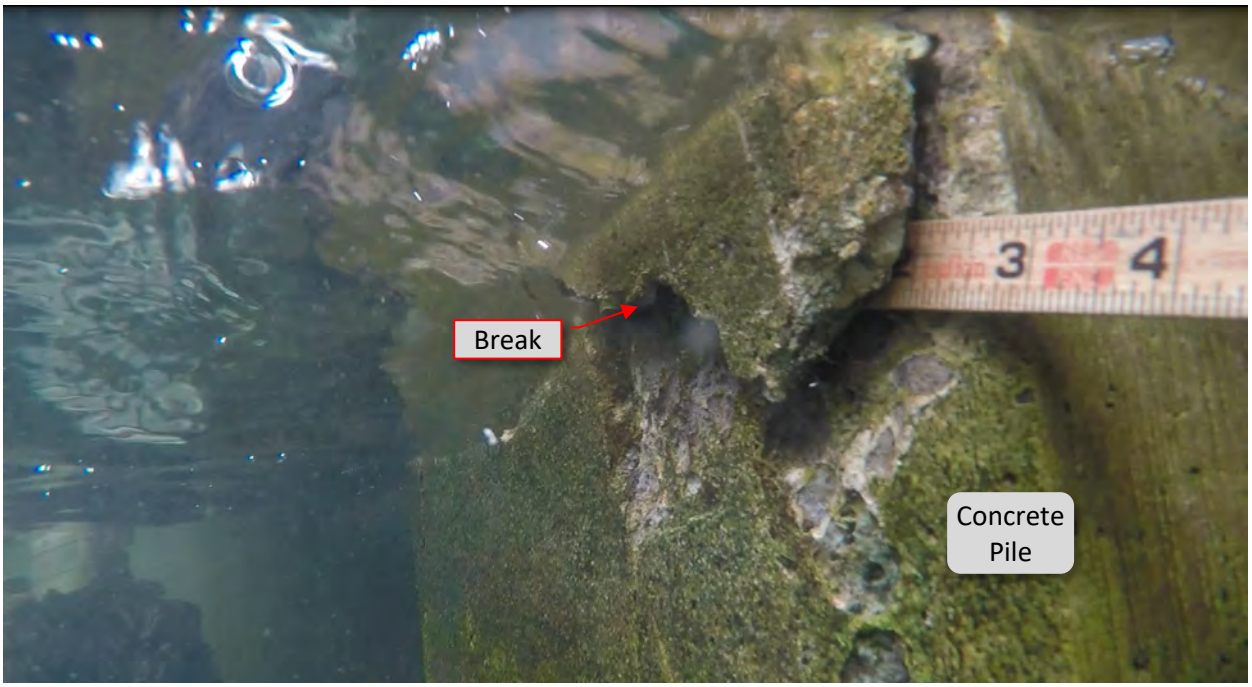

Figure 109: P37. STA 5+56. Cracks/spalls at east flange at pile and loss of concrete. Underwater view.

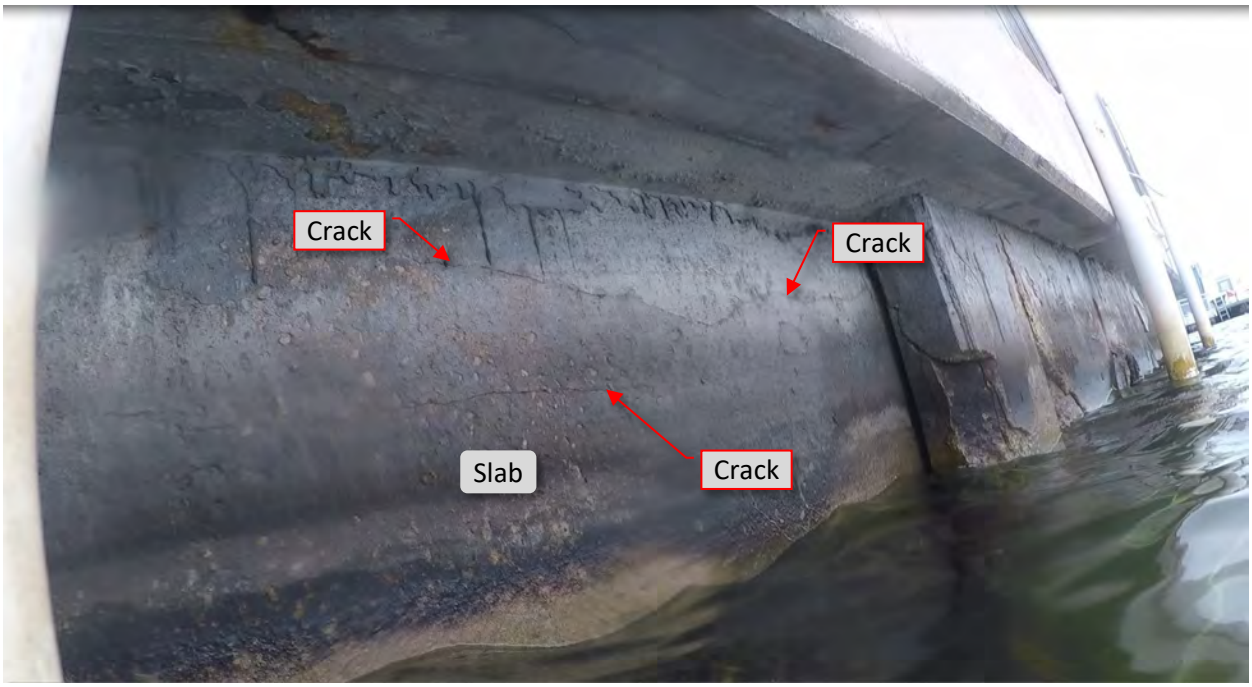

Figure 110: S23. STA 5+57 - 5+63. Crack at top of slab.

Figure 111: P38. STA 5+64. Cracks/spalls at both flanges at pile and loss of concrete. View of west flange.

Figure 112: P38. STA 5+64. Cracks/spalls at both flanges at pile and loss of concrete. View of west flange at water level.

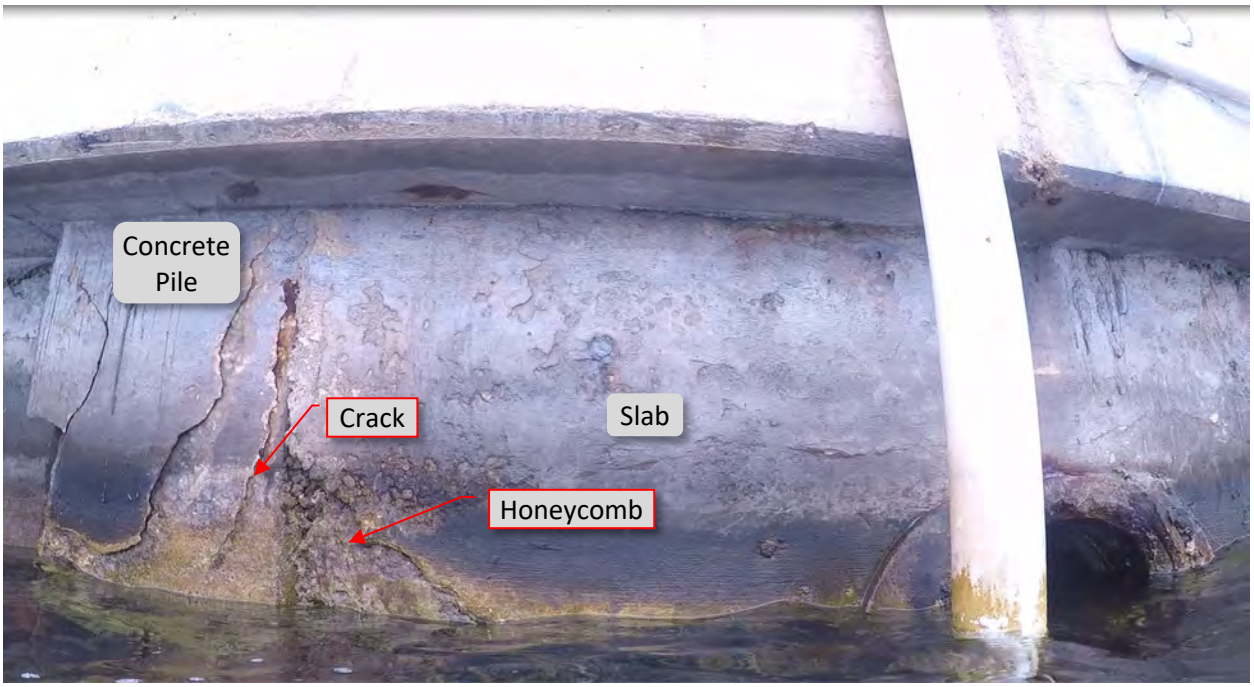

Figure 113: HW2. STA 5+66. Honeycomb area at headwall west side. P38. STA 5+64. Spall/crack at east flange at pile.

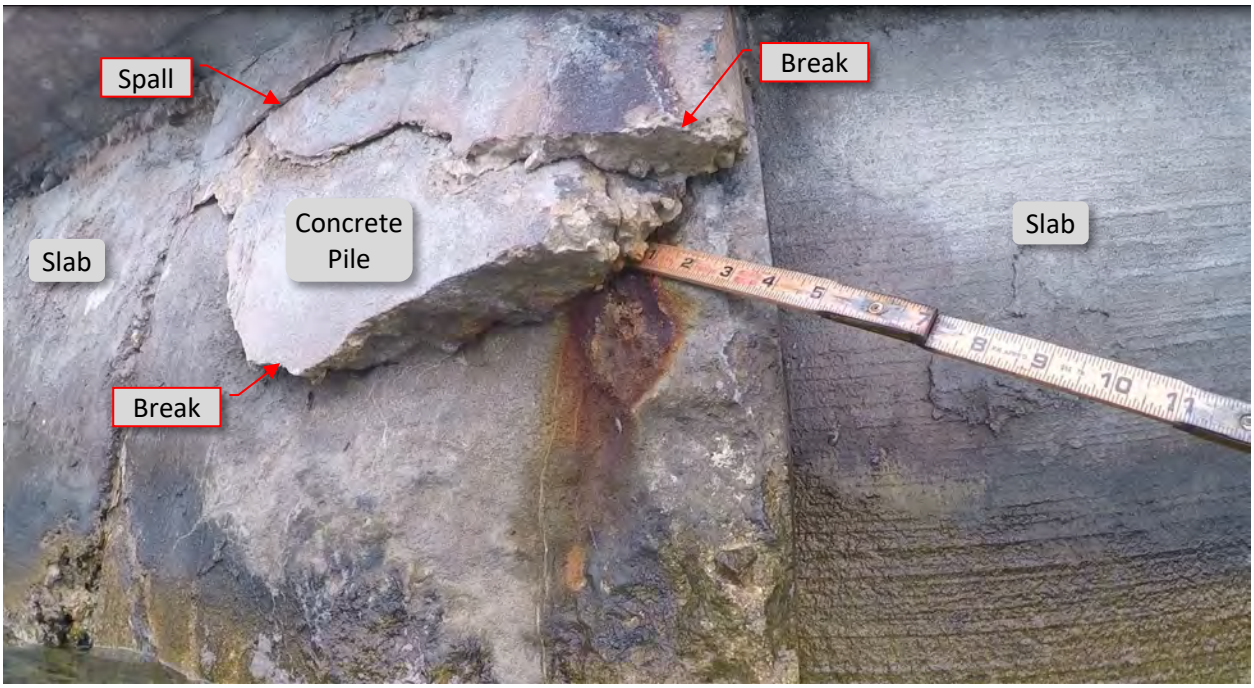

Figure 114: P39. STA 5+72. Cracks/spalls at both flanges at pile with rust staining at east flange, and loss of concrete.

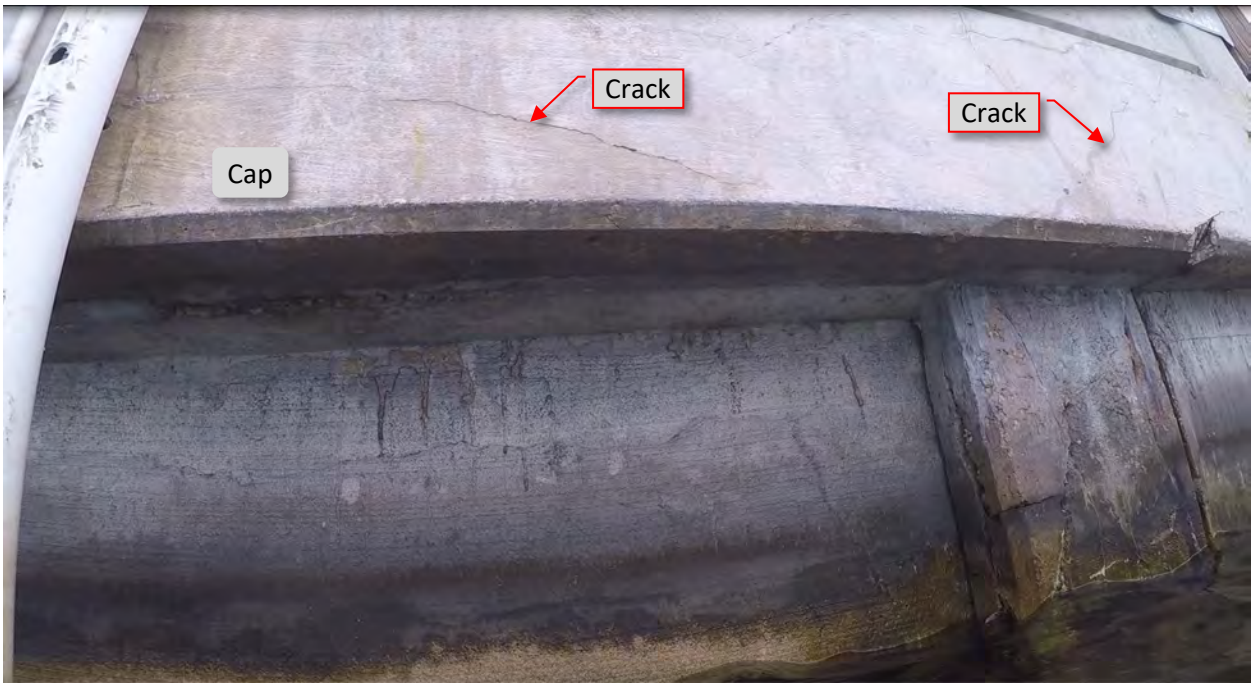

Figure 115: C9. STA 5+75 - 5+90. Crack at cap's bottom and vertical faces in the westward direction, starts from pile.

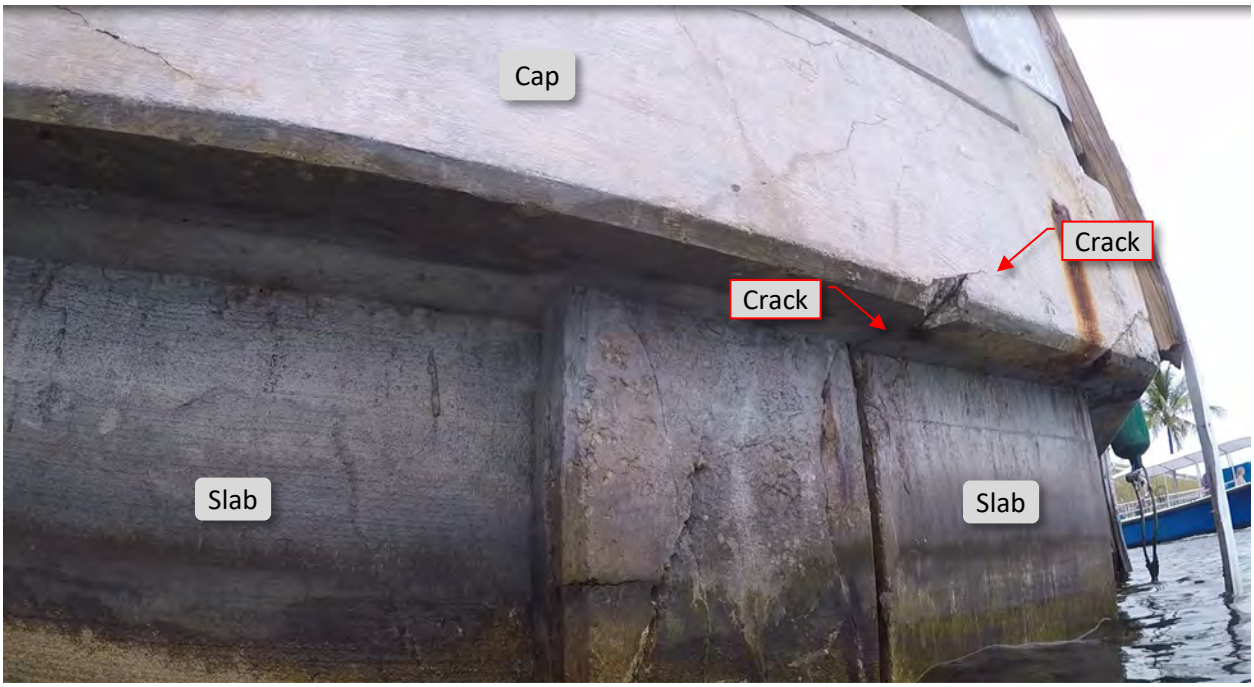

Figure 116. C9. STA 5+75 - 5+90. Crack at cap's bottom and vertical faces in the eastward direction, starts from pile.

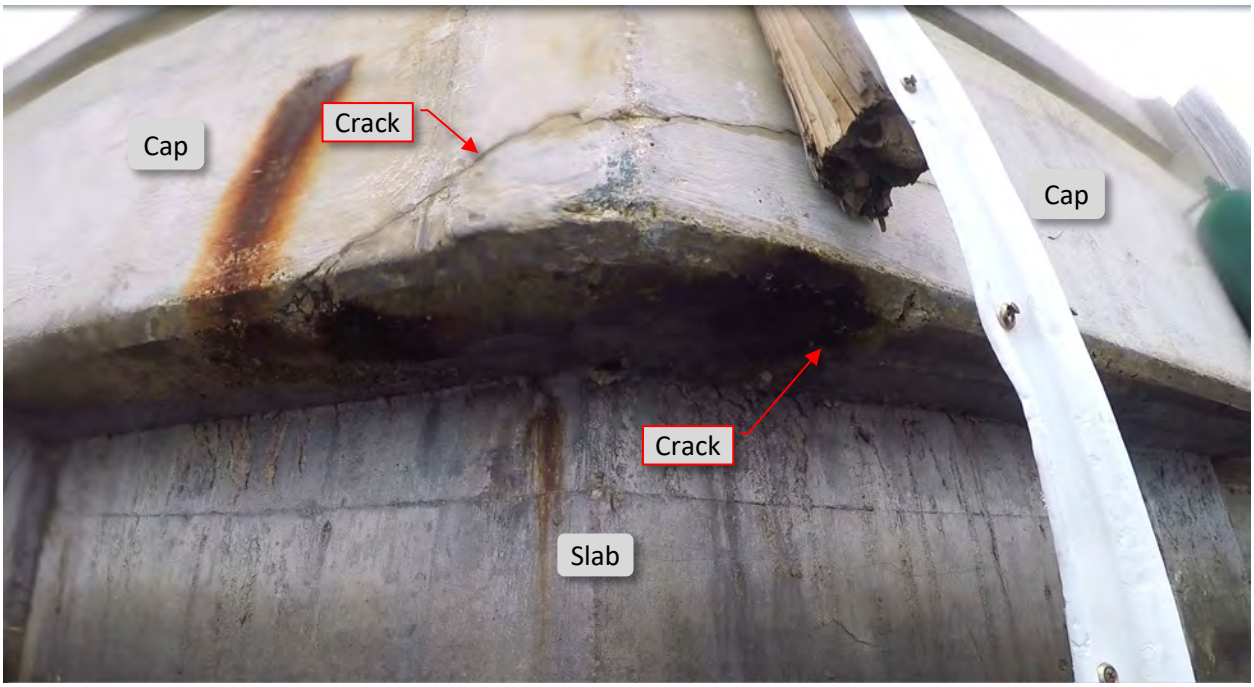

Figure 117. C9. STA 5+75 - 5+90. Crack at cap's bottom edge and vertical face.

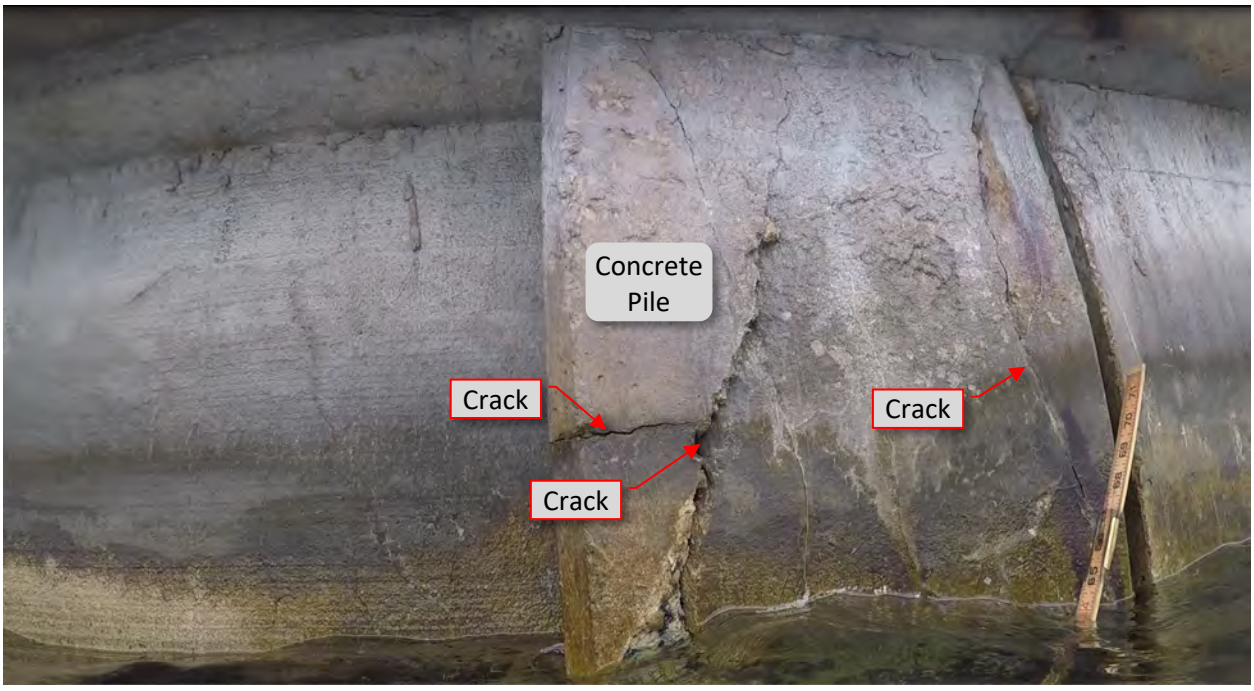

Figure 118: P40. STA 5+80. Cracks/spalls at both flanges at pile and loss of concrete. Gap at construction/expansion joint.

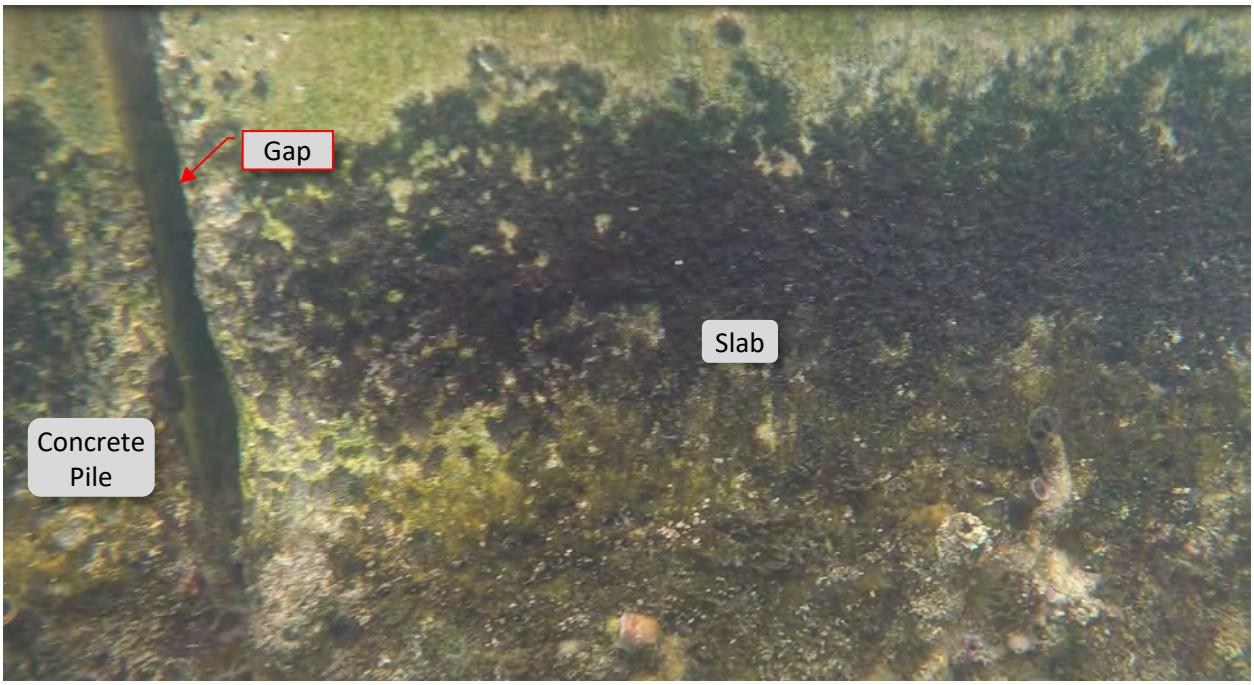

Figure 119: P40. STA 5+80. Gap at construction/expansion joint. Underwater view.

Figure 120: P40. STA 5+85. Gap at construction/expansion joint.

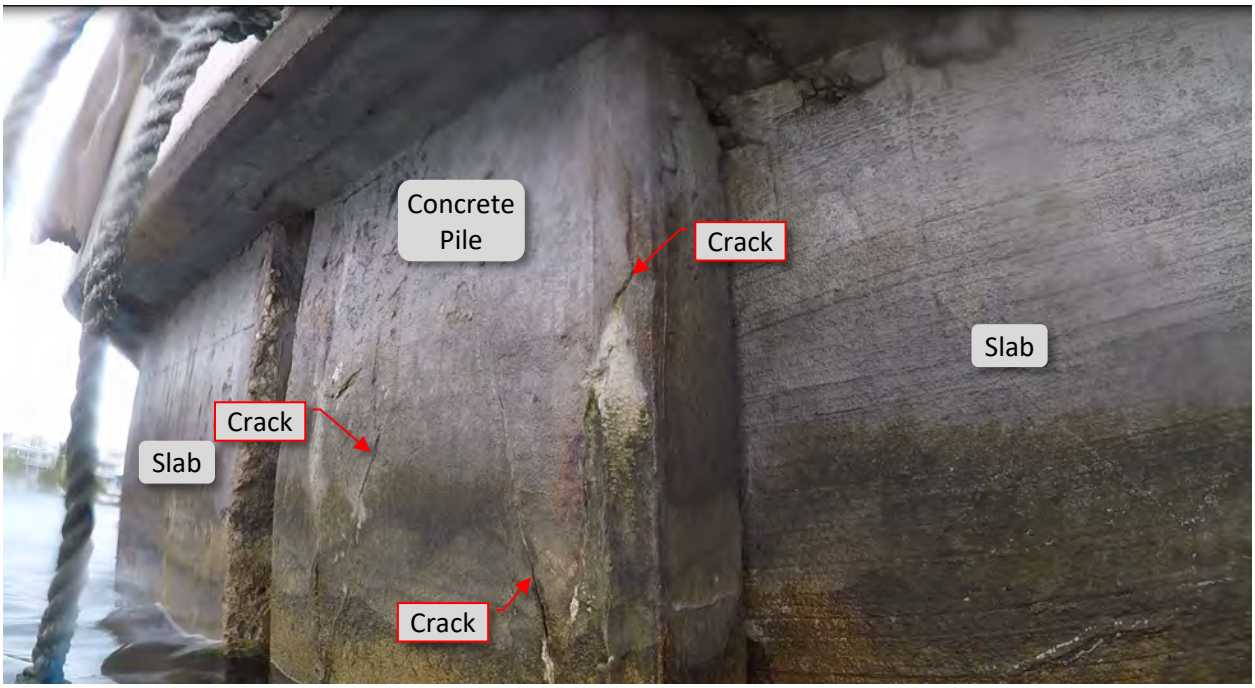

Figure 121: P41. STA 5+85. Crack/spalls at both flanges at pile.

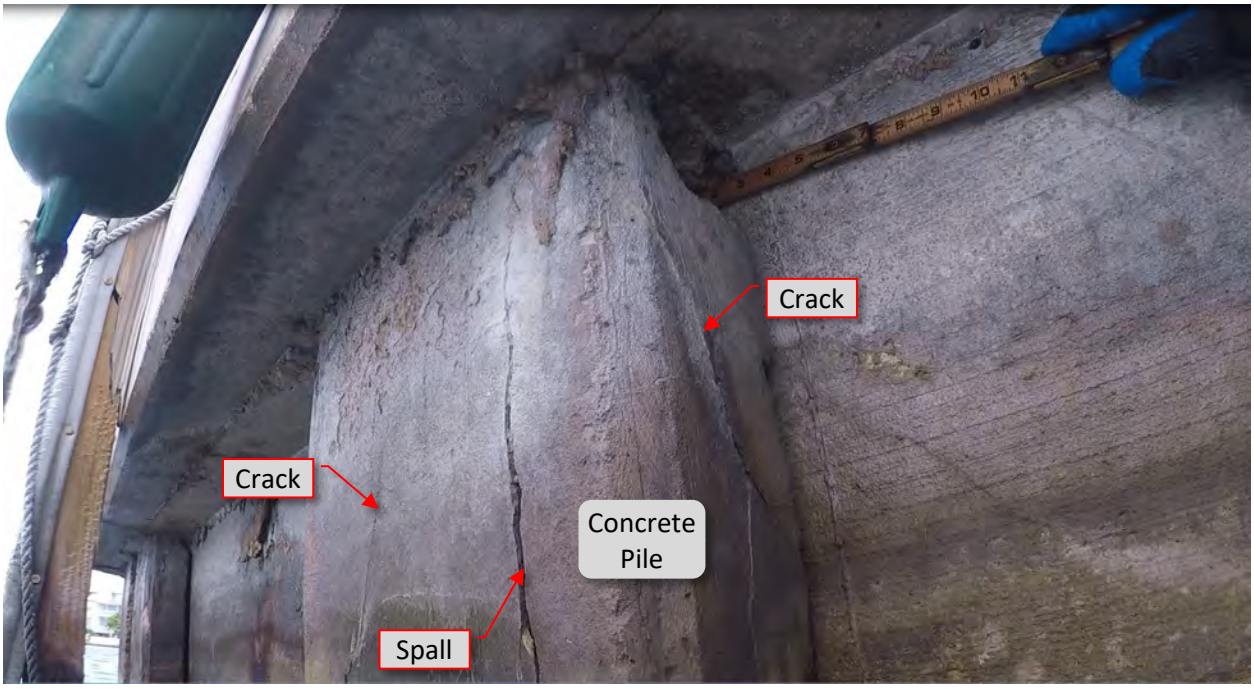

Figure 122: P42. STA 5+93. Crack/spalls at both flanges at pile and loss of concrete.

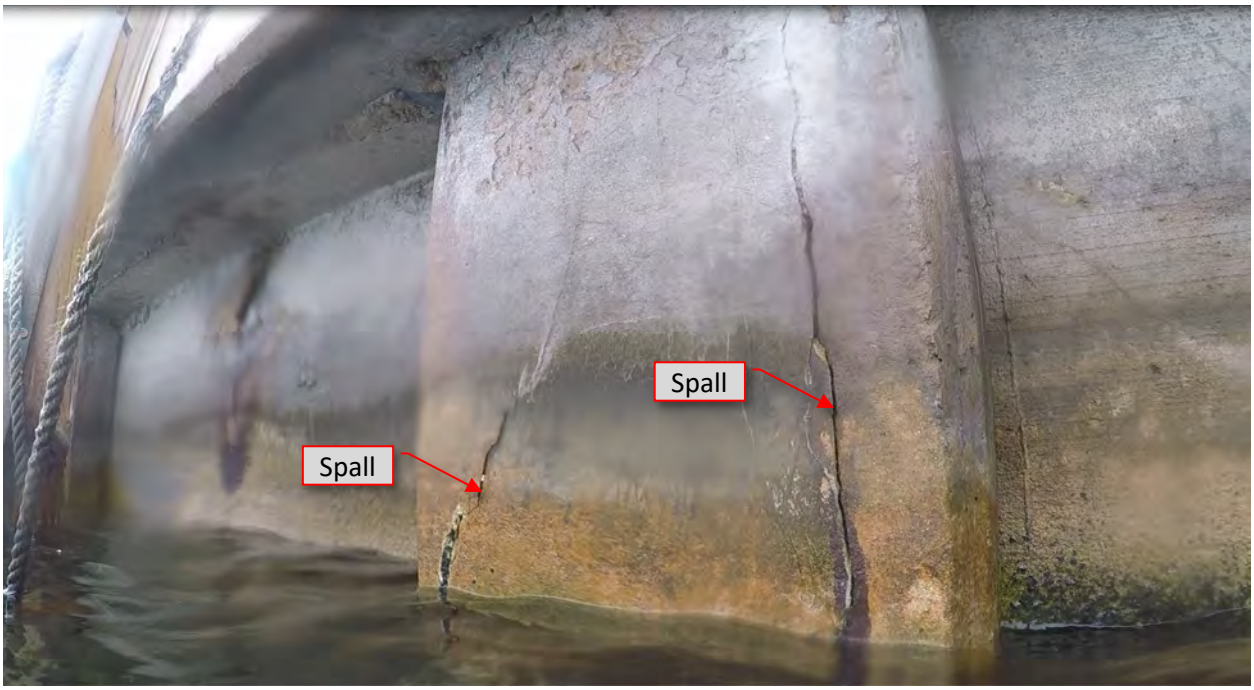

Figure 123: P42. STA 5+93. Crack/spalls at both flanges at pile.

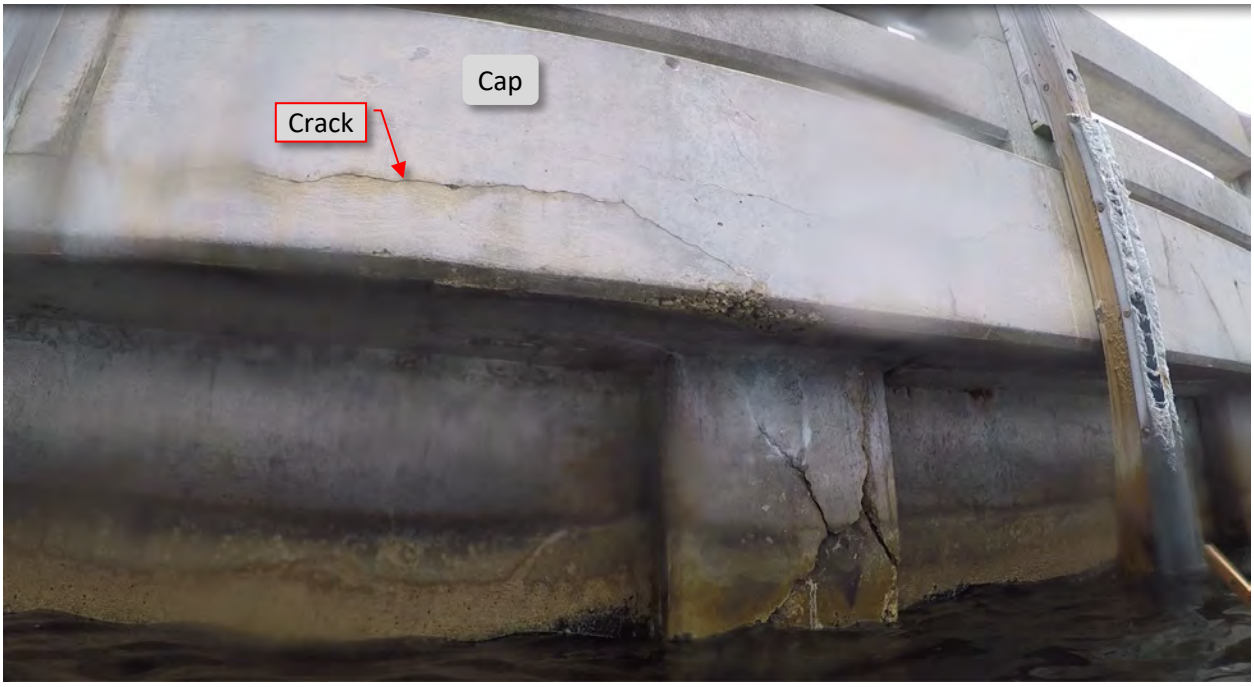

Figure 124. C10. STA 5+93 - 6+00. Crack at vertical face of cap.

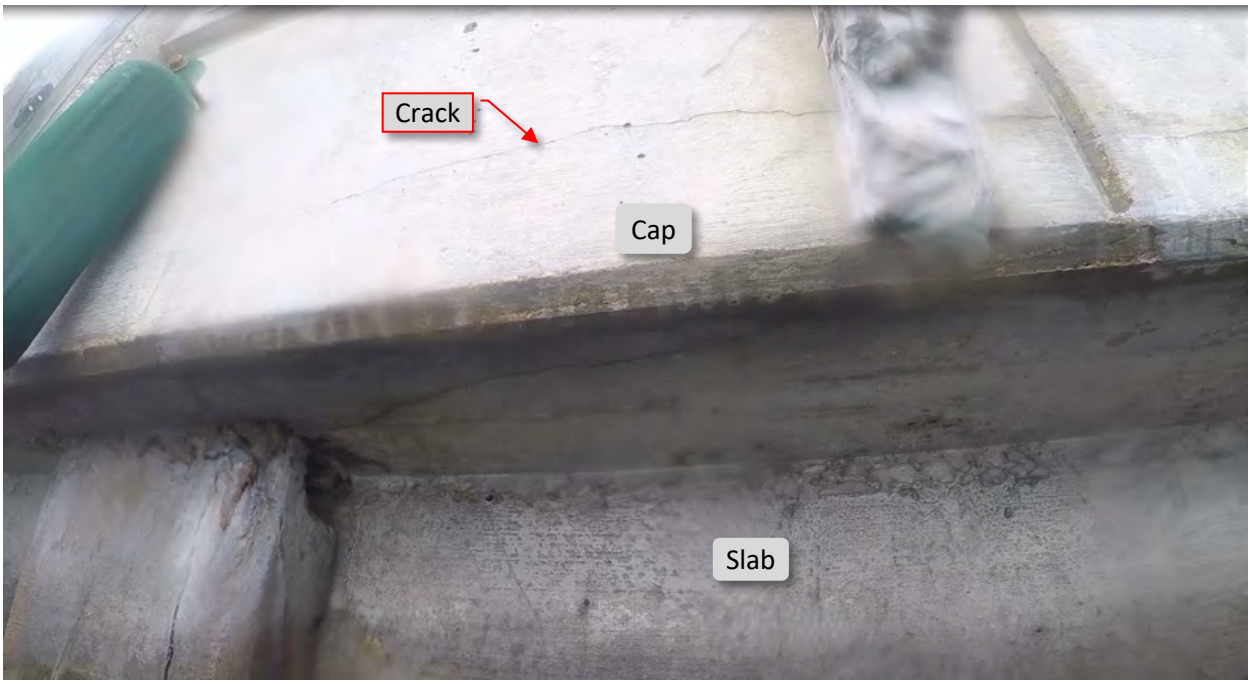

Figure 125: P43. STA 5+93 - 6+00. Crack at vertical face of cap.

Figure 126: P43. STA 5+93 - 6+00. Honeycomb area at cap's bottom edge.

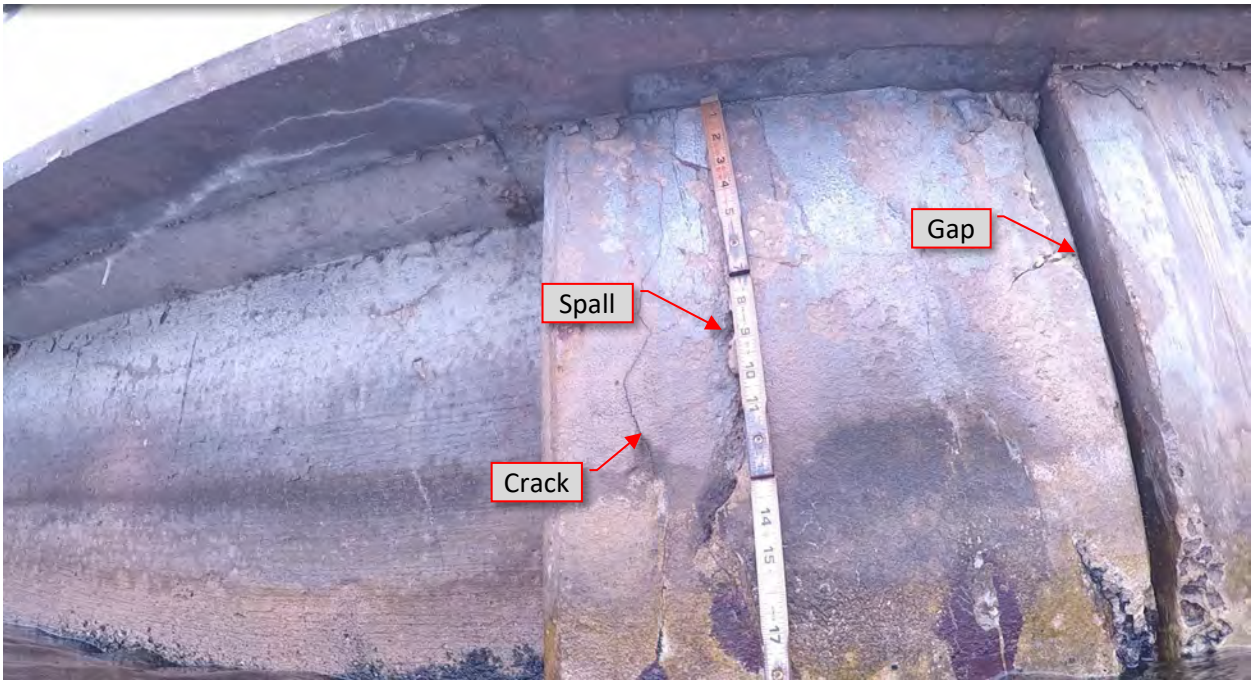

Figure 127: P44. STA 6+07. Cracks/spalls at both flanges at pile. Gap at construction/expansion joint.

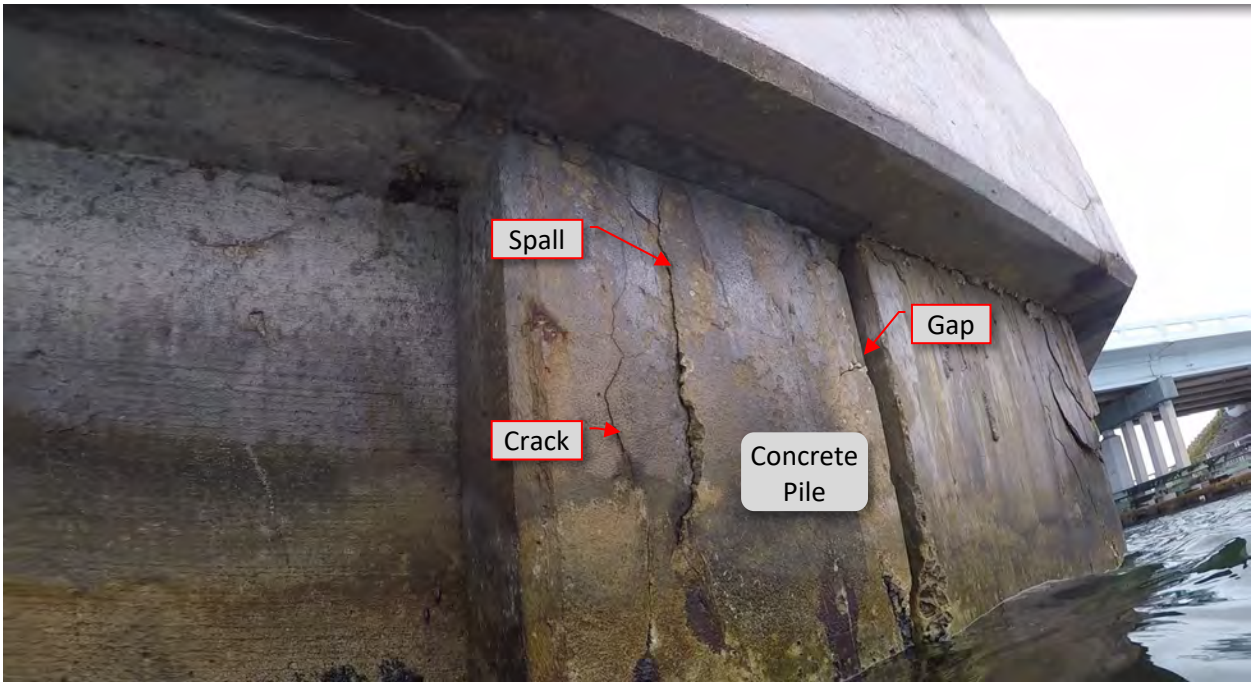

Figure 128. P44. STA 6+07. Cracks/spalls at both flanges at pile. Gap at construction/expansion joint.

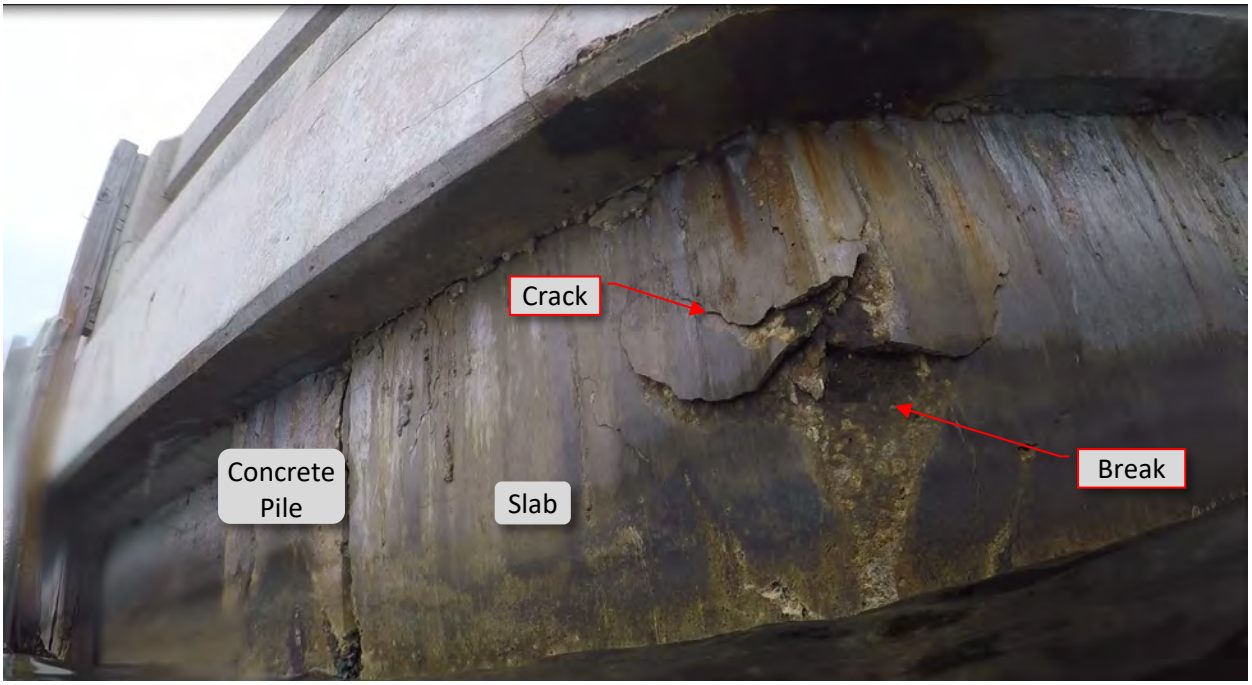

Figure 129: S24. STA 6+11. Crack at slab corner and loss of material.

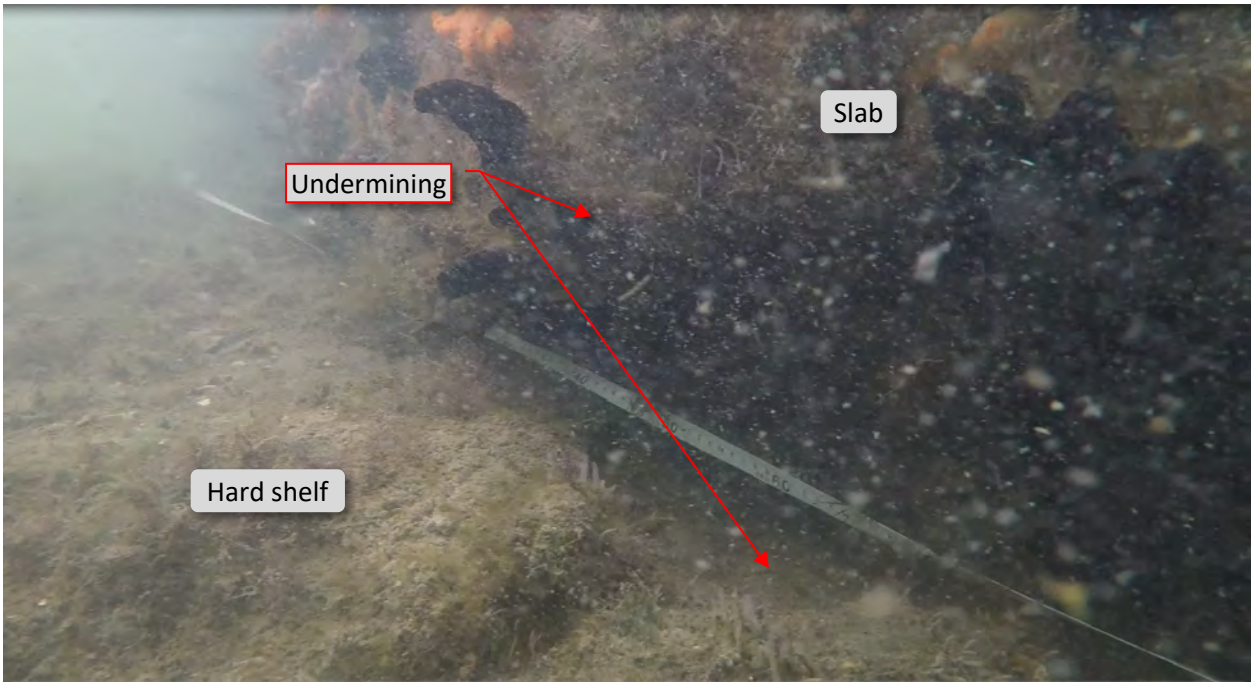

Figure 130: S24. STA 6+11. Undermining at the slab at shelf-slab interface.

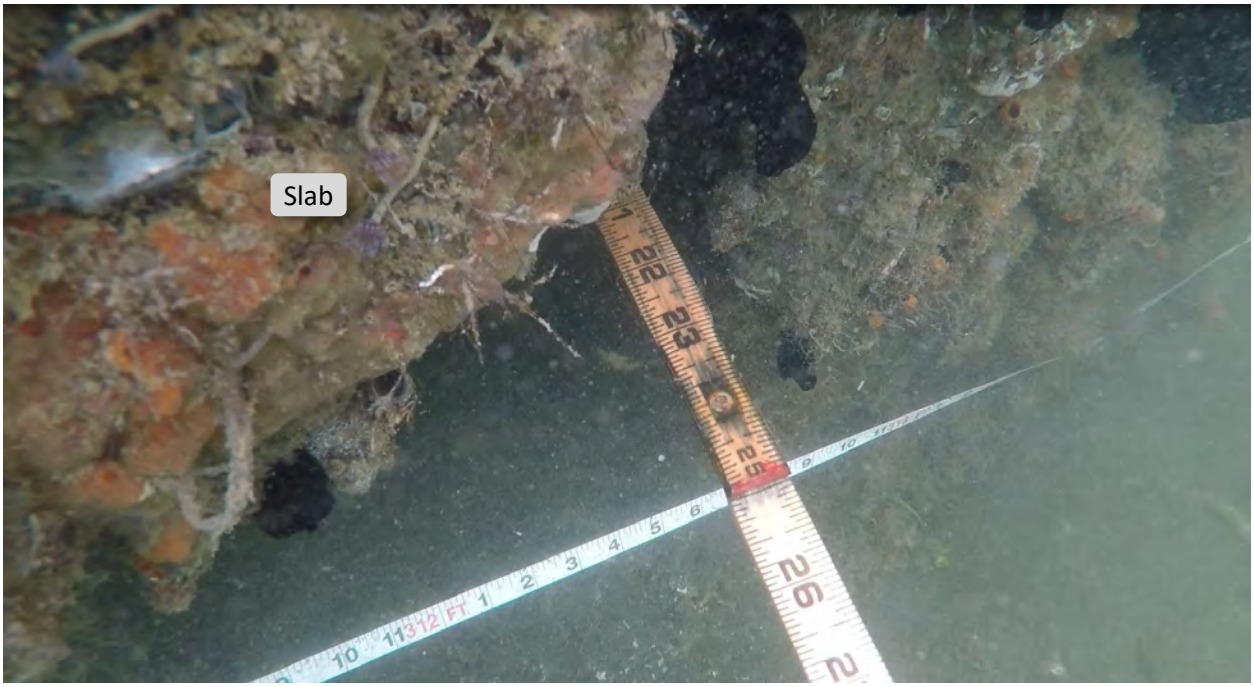

Figure 131: S24. STA 6+11. Depth of the undermining at the bottom of the slab.

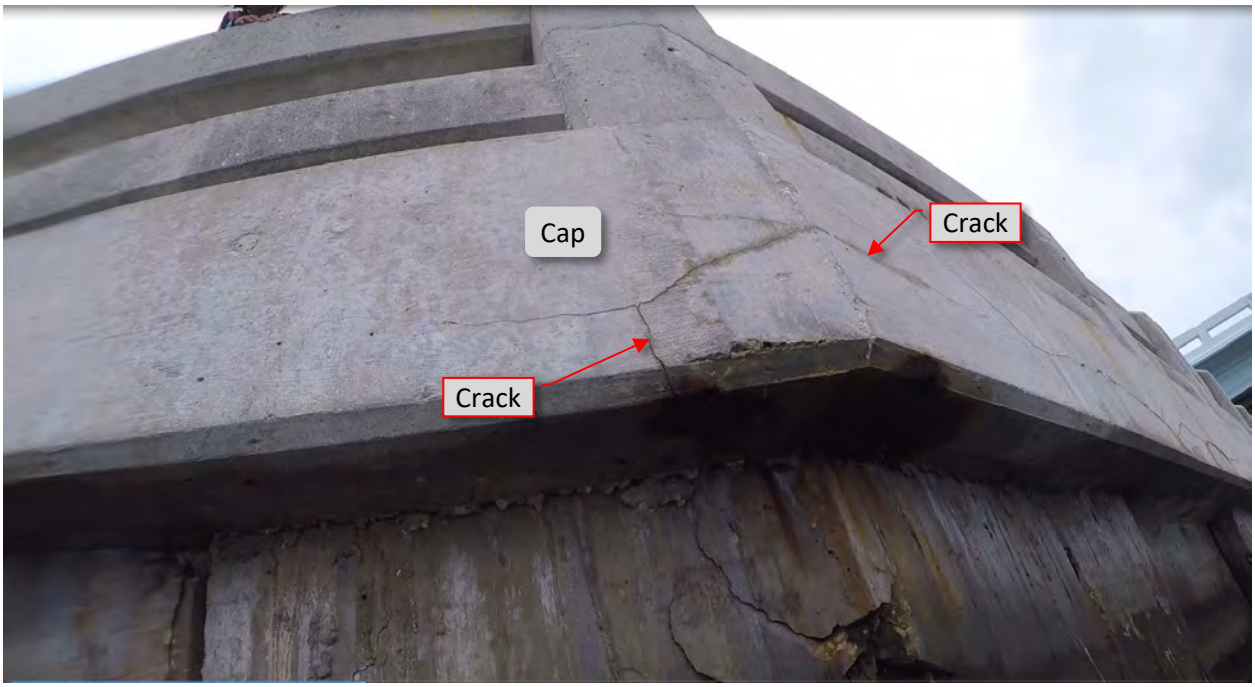

Figure 132: C11. STA 6+11. Crack at cap's vertical and bottom faces.

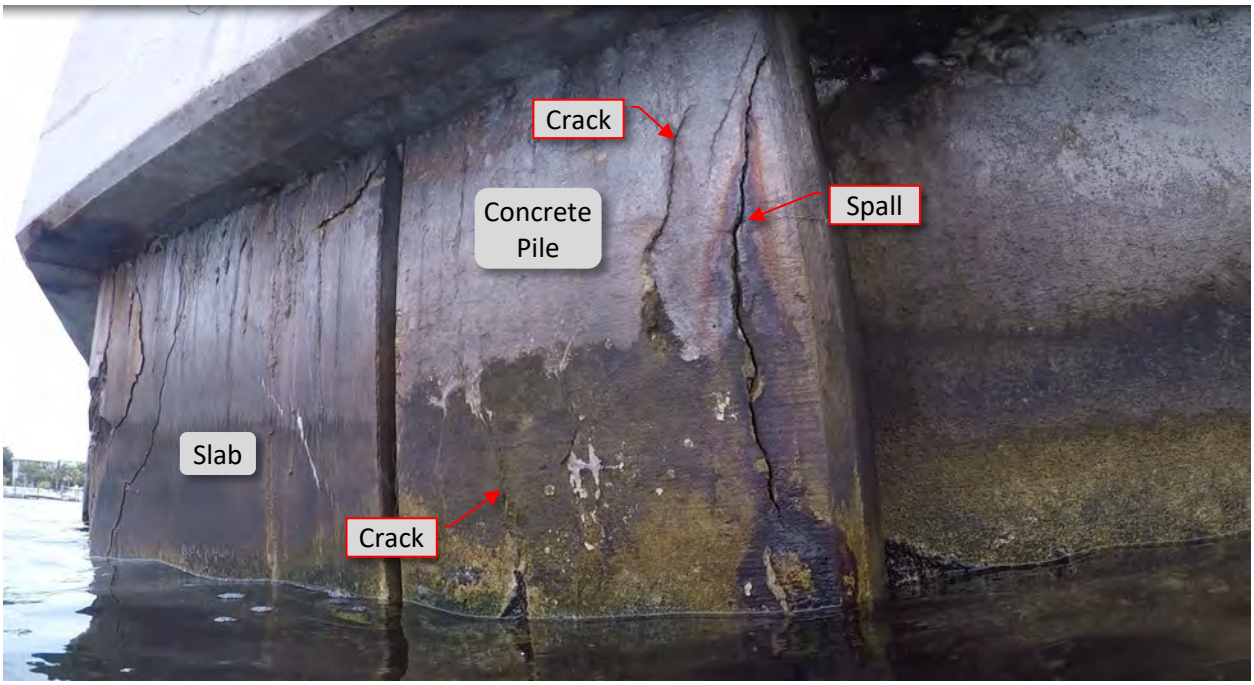

Figure 133: P45. STA 6+14. Cracks/spalls at both flanges at pile. Gap at construction/expansion joint.

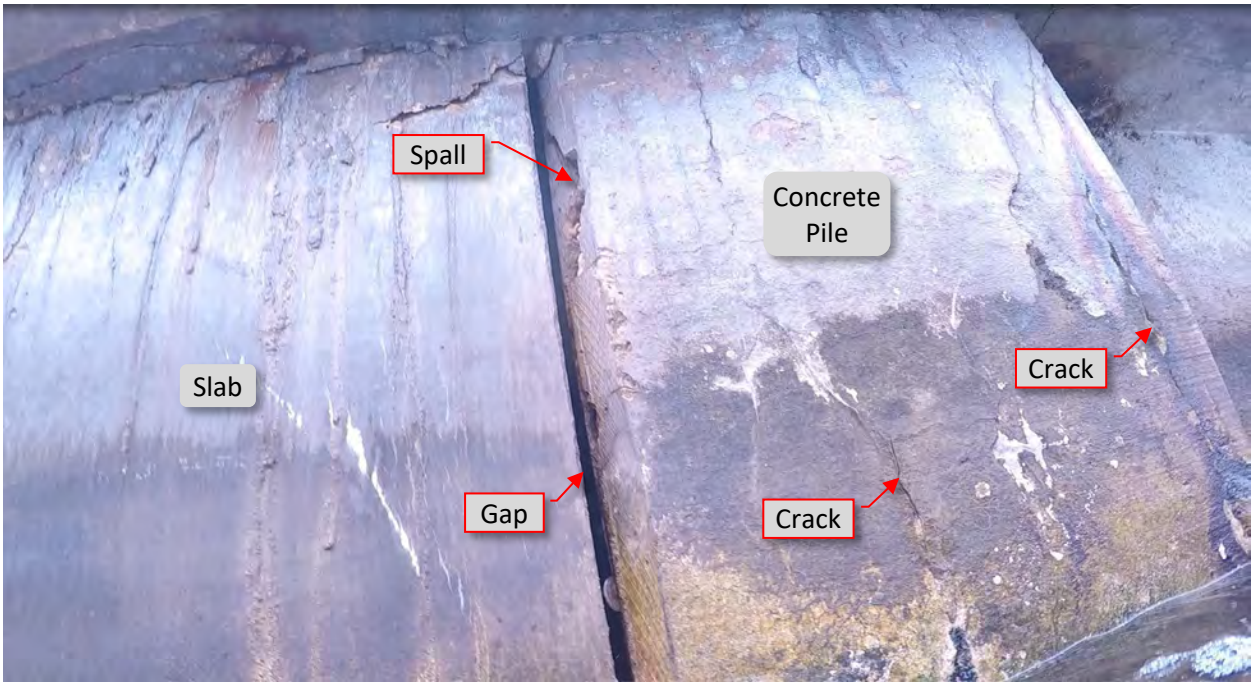

Figure 134: P45. STA 6+14. Cracks/spalls at both flanges at pile. Gap at construction/expansion joint.

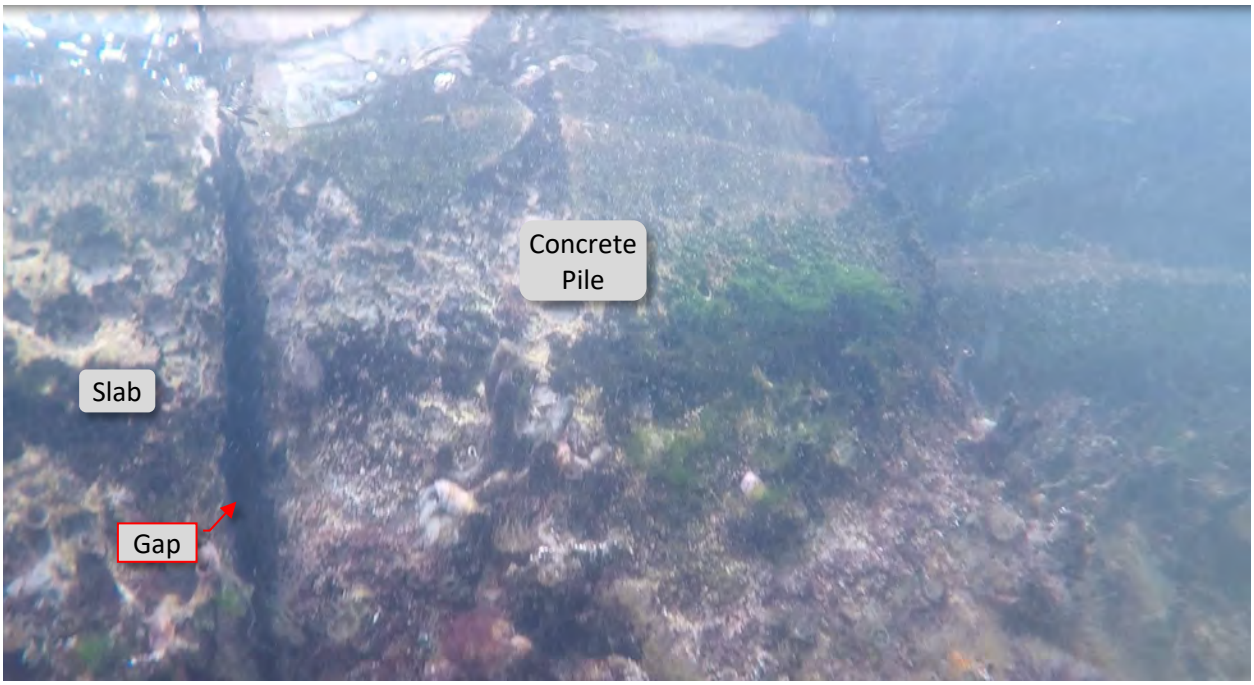

Figure 135: P45. STA 6+14. Gap at construction/expansion joint. Underwater view.

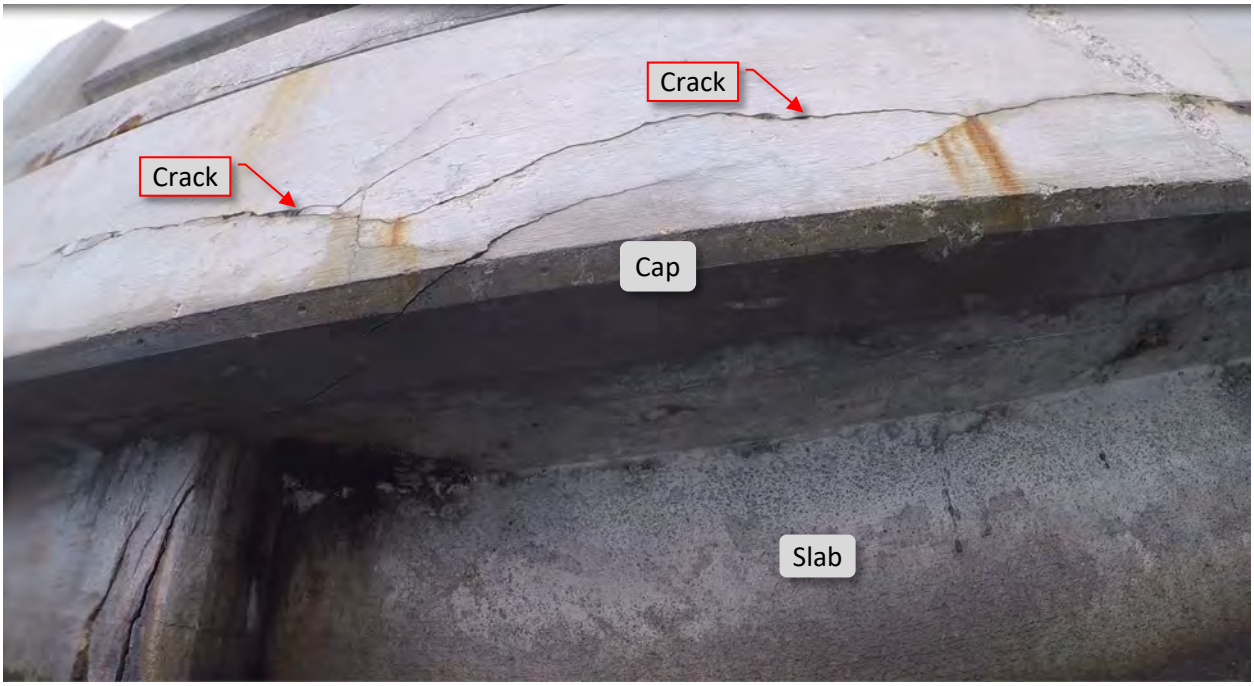

Figure 136: C12. STA 6+14 - 6+21. Crack at cap's bottom and vertical faces.

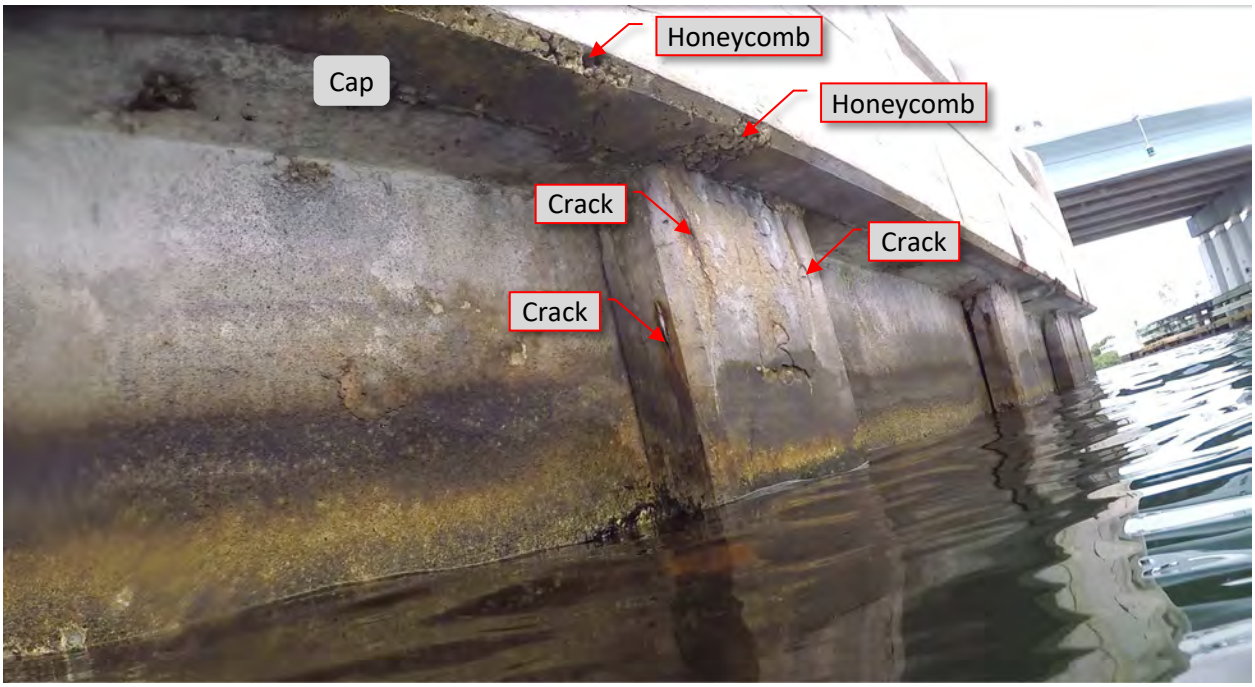

Figure 137: P46. STA 6+21. Cracks at both flanges at pile. C13. STA 6+19 - 6+21. Honeycomb areas at cap's bottom edge.

Figure 138: P47. STA 6+27. Crack at north flange at pile.

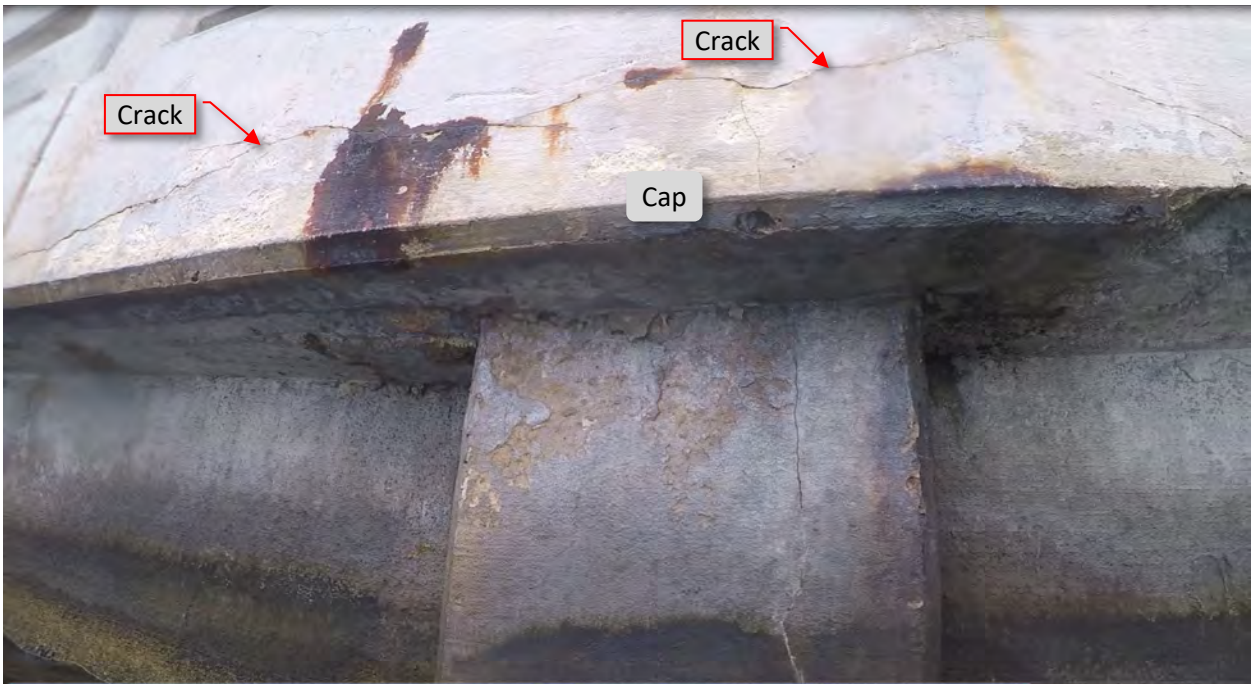

Figure 139: C14. STA 6+22 - 6+40. Crack at cap's vertical face.

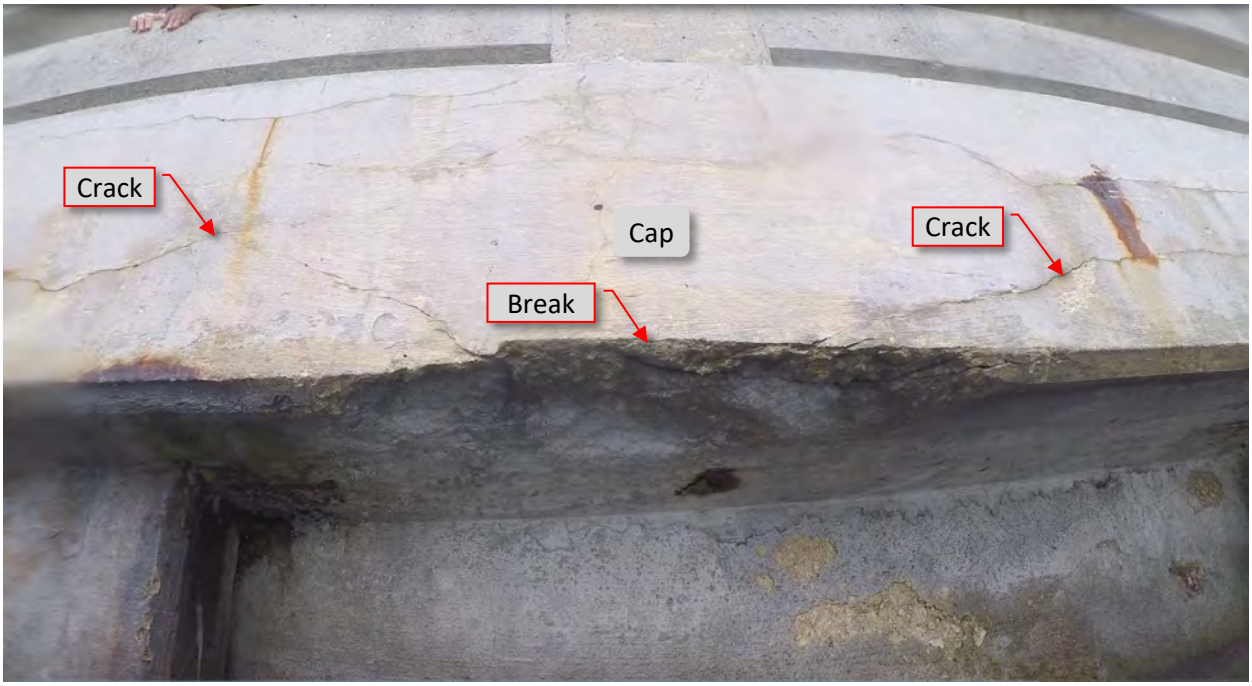

Figure 140: C14. STA 6+22 - 6+40. Crack at cap's vertical face and break of concrete at cap's bottom edge.

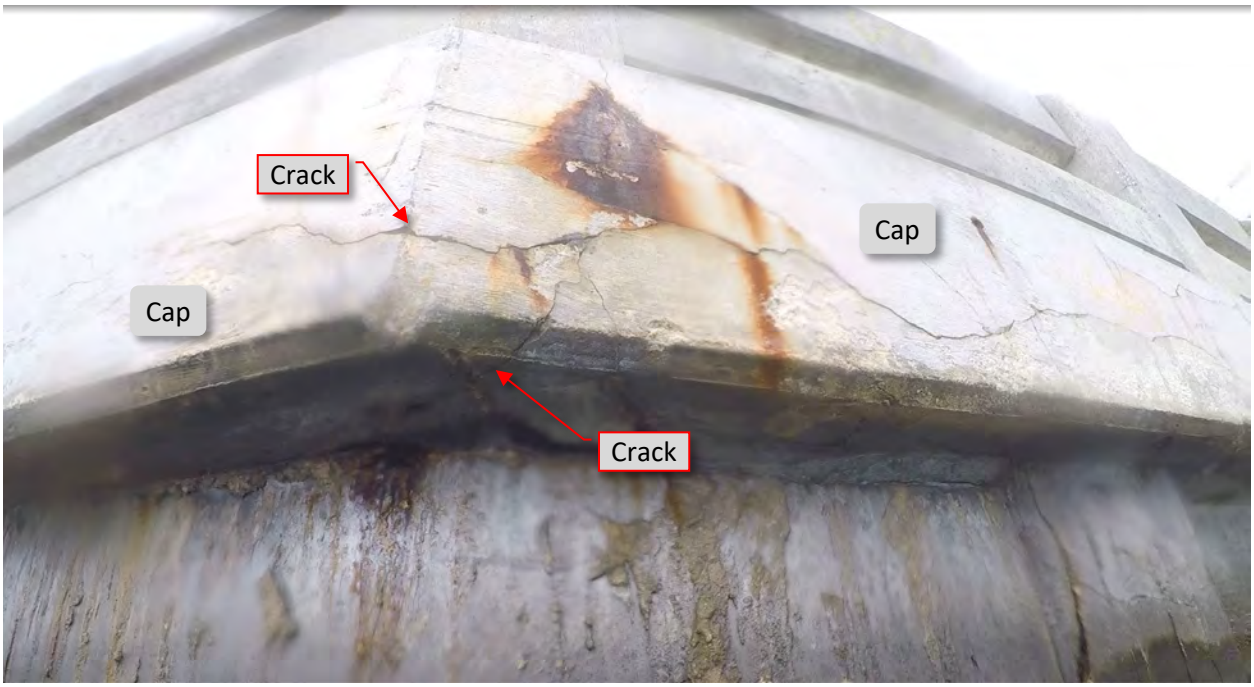

Figure 141: C14. STA 6+22 - 6+40. Crack at cap's vertical and bottom faces.

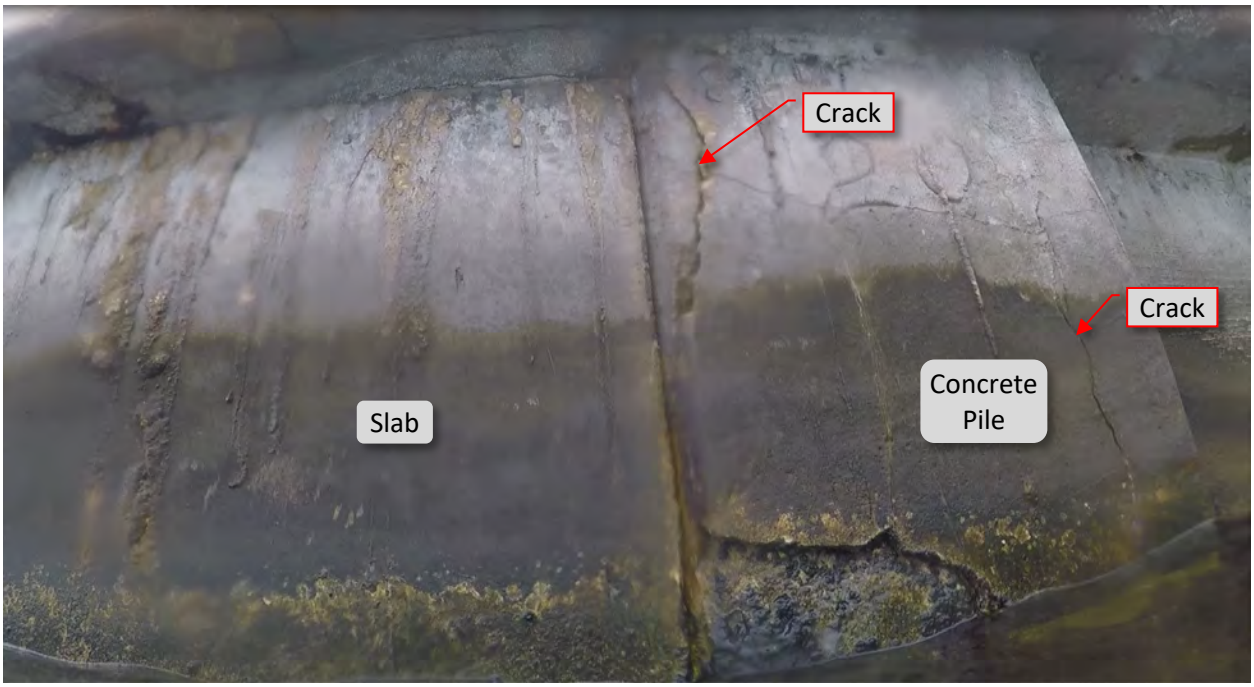

Figure 142: P48. STA 6+40. Cracks at both flanges at pile.

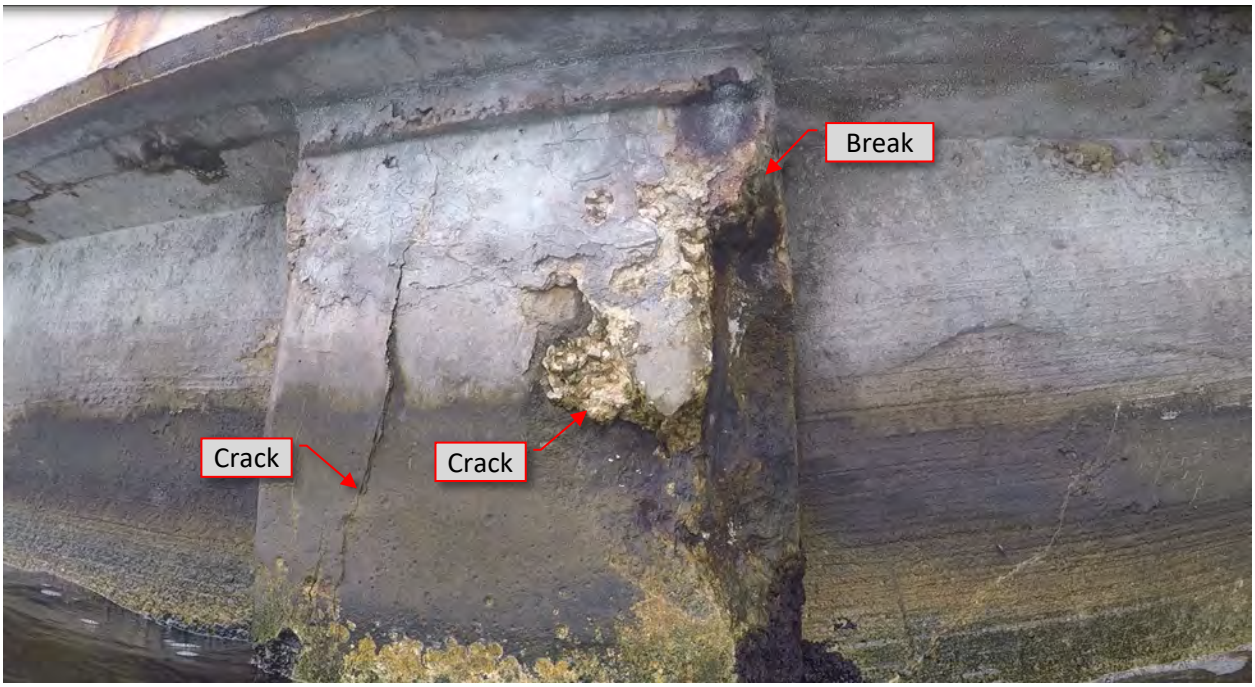

Figure 143: P49. STA 6+46. Cracks at both flanges at pile and loss of concrete.

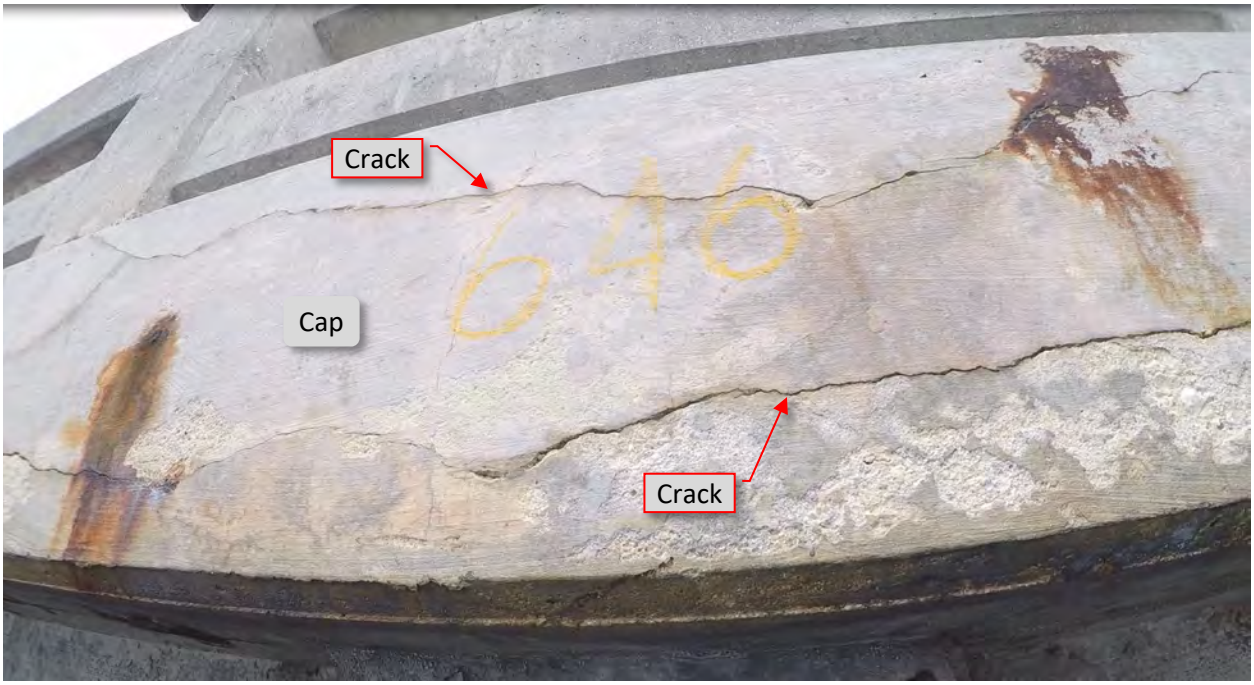

Figure 144. C15. STA 6+40 - 6+50. Crack at cap's vertical face.

APPENDIX D

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 1: STA 0+00. Northwest direction view. Obstructions and debris in front of seawall.

Figure 2: STA 0+00. North direction view. Obstructions and debris in front of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 3: STA 0+10. Northwest direction view. Obstructions and debris in front of seawall and at culvert at STA 0+09.

Figure 4:STA 0+10. Northeast direction view. Partial view of seawall, debris, and obstructions.

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Figure 5: STA 0+20. Northwest direction view. Obstructions and debris in front of seawall, and partial view of seawall.

Figure 6: STA 0+20. Northeast direction view. Obstructions and debris in front of seawall, and partial view of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 7: STA 0+30. Northeast direction view. Obstructions and debris in front of seawall, and partial view of seawall.

Figure 8: STA 0+40. Northeast direction view. Obstructions in front of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 9: STA 0+40. Northwest direction view. Obstructions and debris in front of seawall, and partial view of seawall.

Figure 10: STA 0+50. Northeast direction view. Obstructions and debris in front of seawall, and partial view of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 11: STA 0+60. Northeast direction view. Obstructions and debris in front of seawall, and partial view of seawall.

Figure 12: STA 0+70. Northeast direction view. Obstructions and debris in front of seawall, and partial view of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

Figure 13: STA 0+80. Northeast direction view. Obstructions and debris in front of seawall.

Figure 14: STA 0+90. North direction view. Seawall partial view with present debris, and partial view of seawall.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

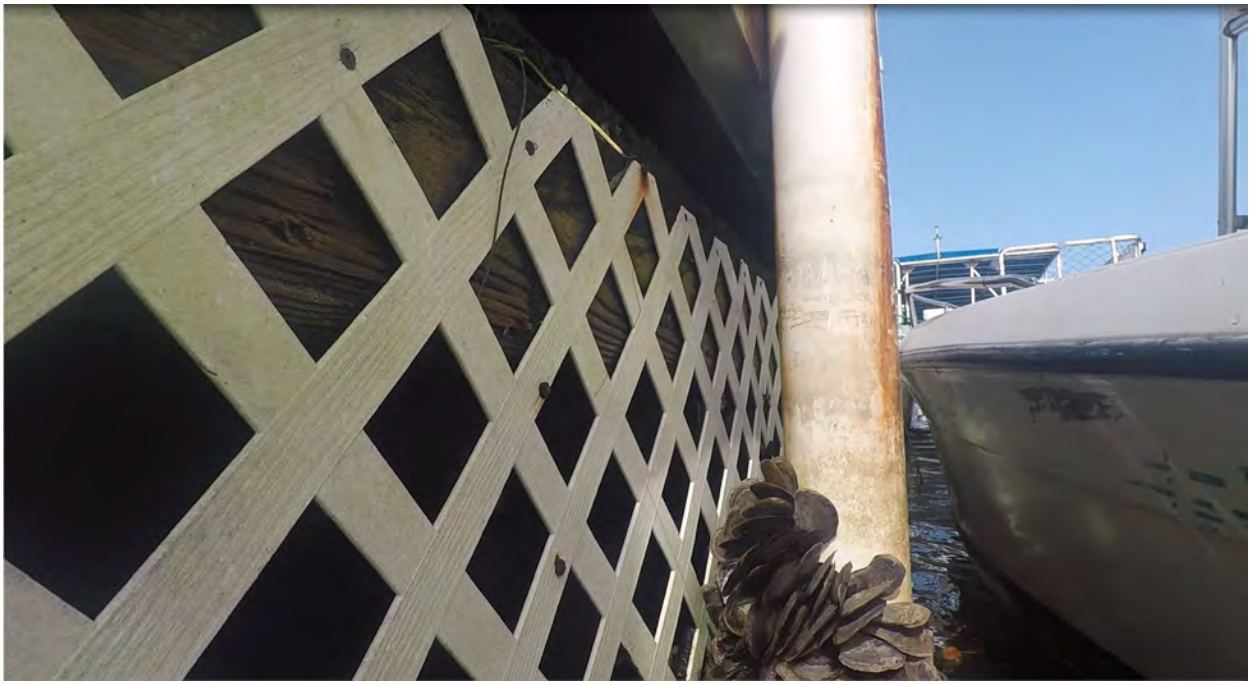

Figure 15: STA 1+00. Northeast direction view. Obstructions and debris in front of seawall.

Figure 16: STA 1+20. Northwest direction view. Seawall partial view with present overhead and in the water hazard.

APPENDIX D: SEAWALL STA 0+00 – 1+20 ABOVE-WATER LEVEL INSPECTION - PHOTOLOG

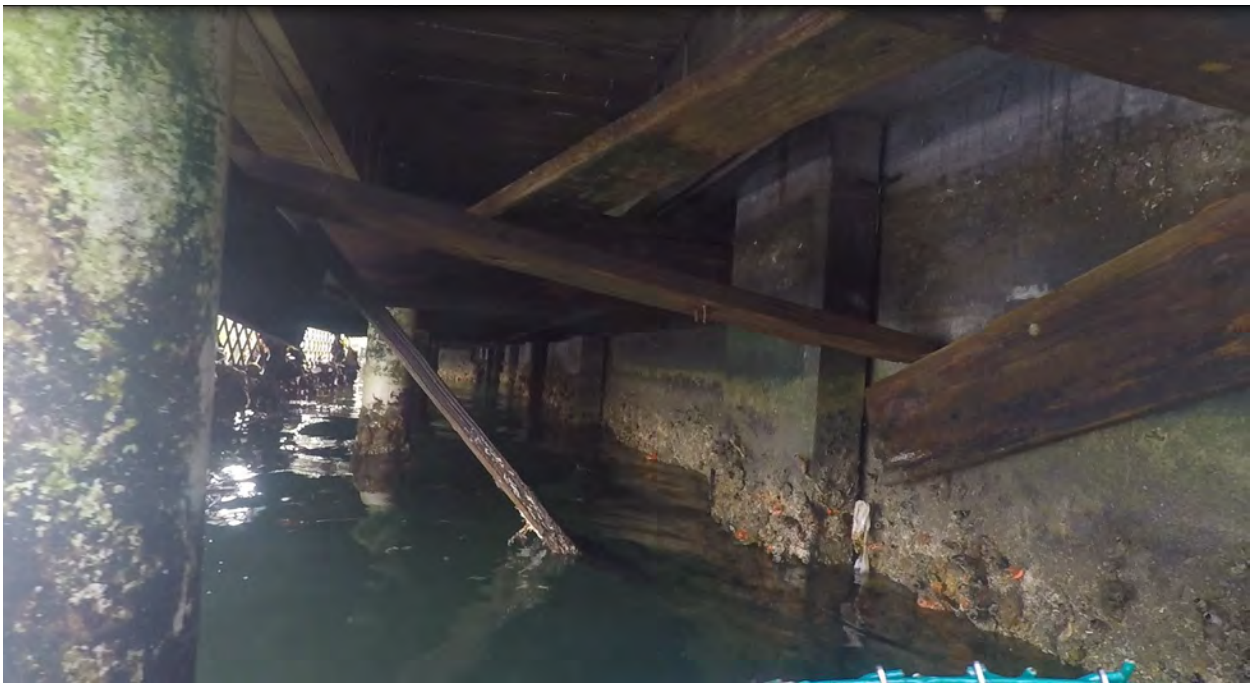

Figure 17: STA 1+20. West direction view. Seawall partial view with present overhead and in the water hazard.

APPENDIX E

APPENDIX E: FALLING CONCRETE SLAB AT PAVED SIDEWALK – PHOTOLOG

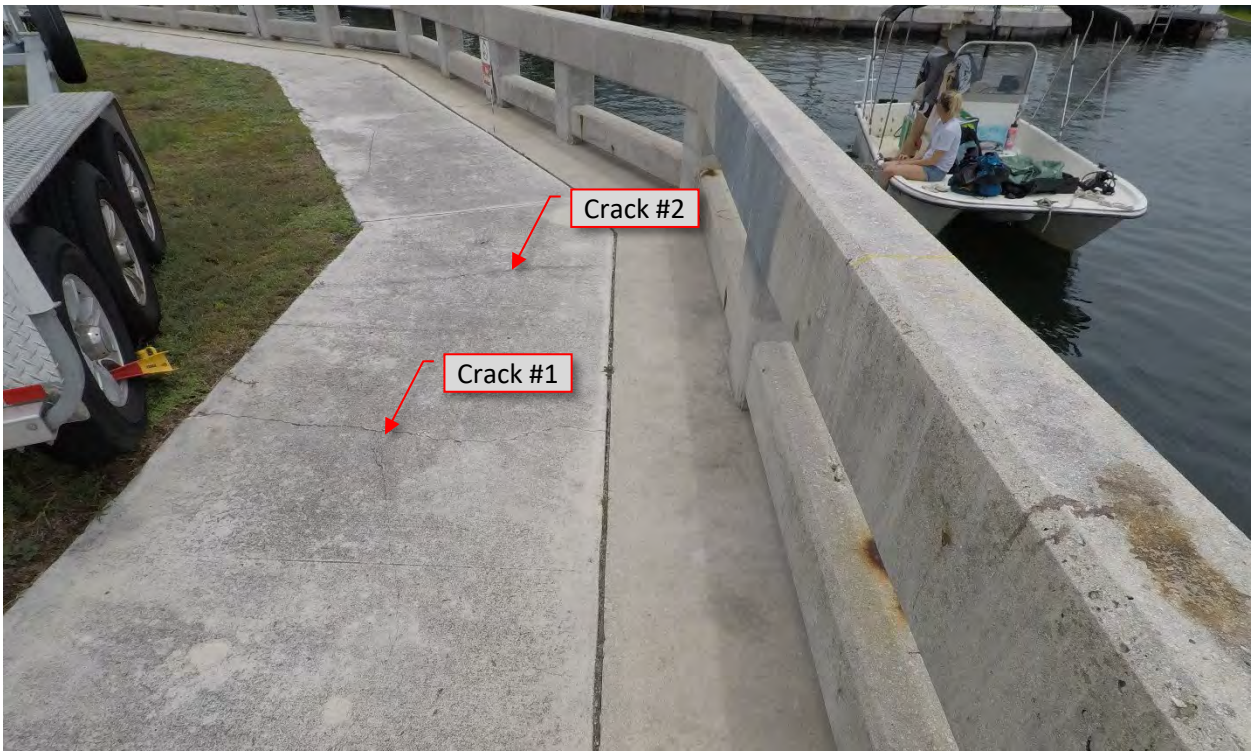

Figure 1: STA 6+00 - 6+10. Cracks in concrete slab to sidewalk.

Figure 2: STA 6+00 - 6+10. Cracks in concrete slab to sidewalk. Closer view of the cracks.

APPENDIX E: FALLING CONCRETE SLAB AT PAVED SIDEWALK – PHOTOLOG

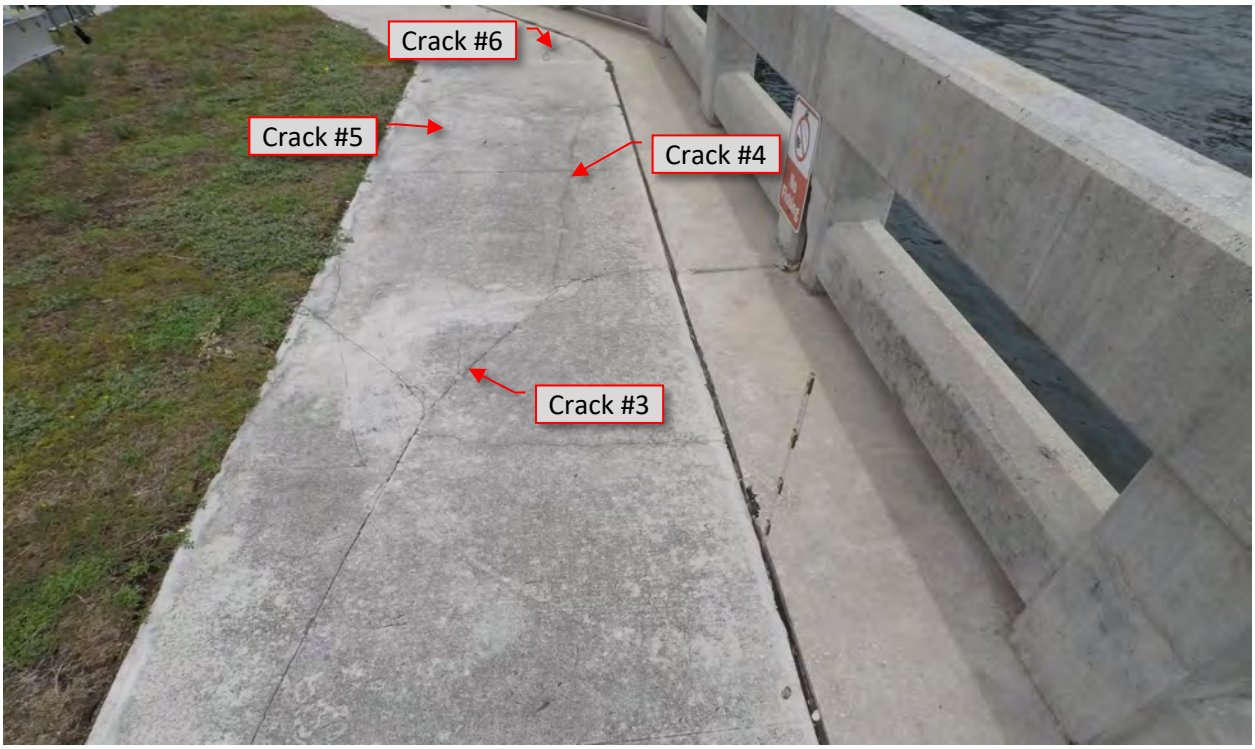

Figure 3: STA 6+15 - 6+25. Cracks in concrete slab to sidewalk.

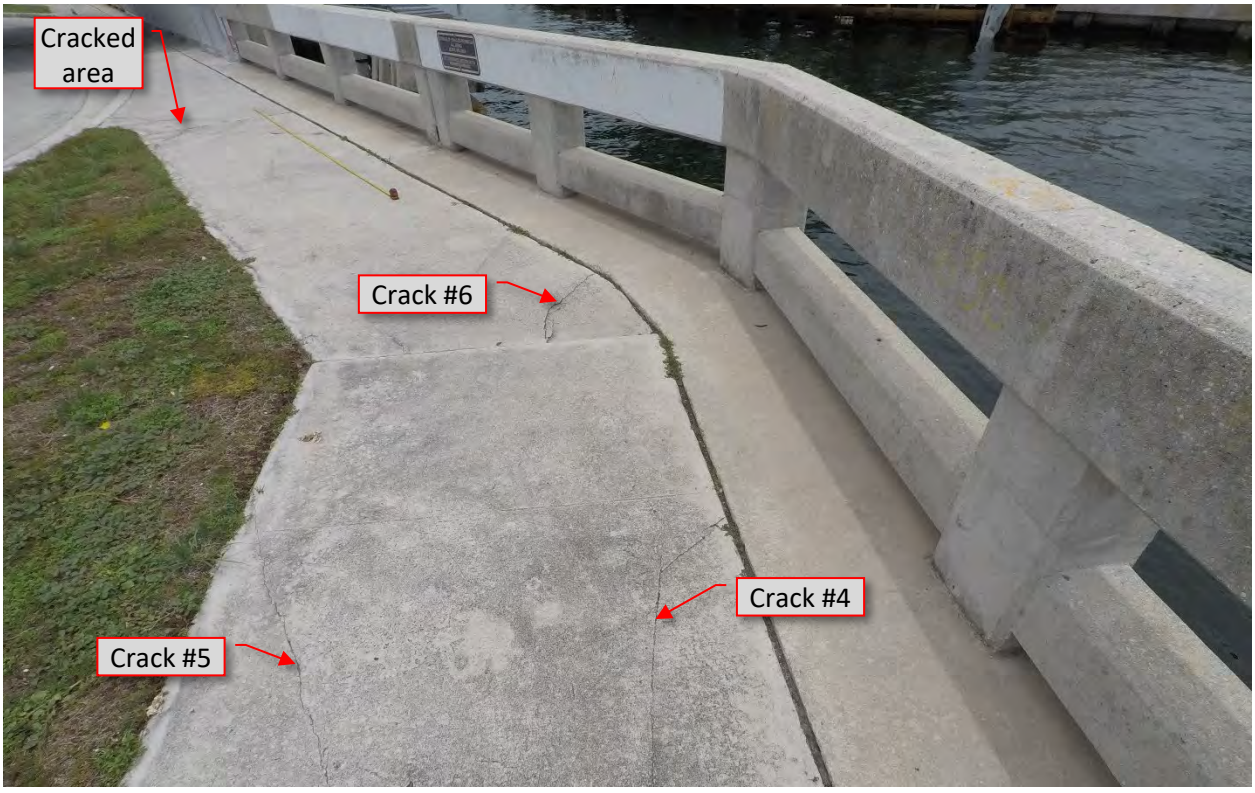

Figure 4: STA 6+25 - 6+50. Cracks in concrete slab to sidewalk.

APPENDIX E: FALLING CONCRETE SLAB AT PAVED SIDEWALK – PHOTOLOG

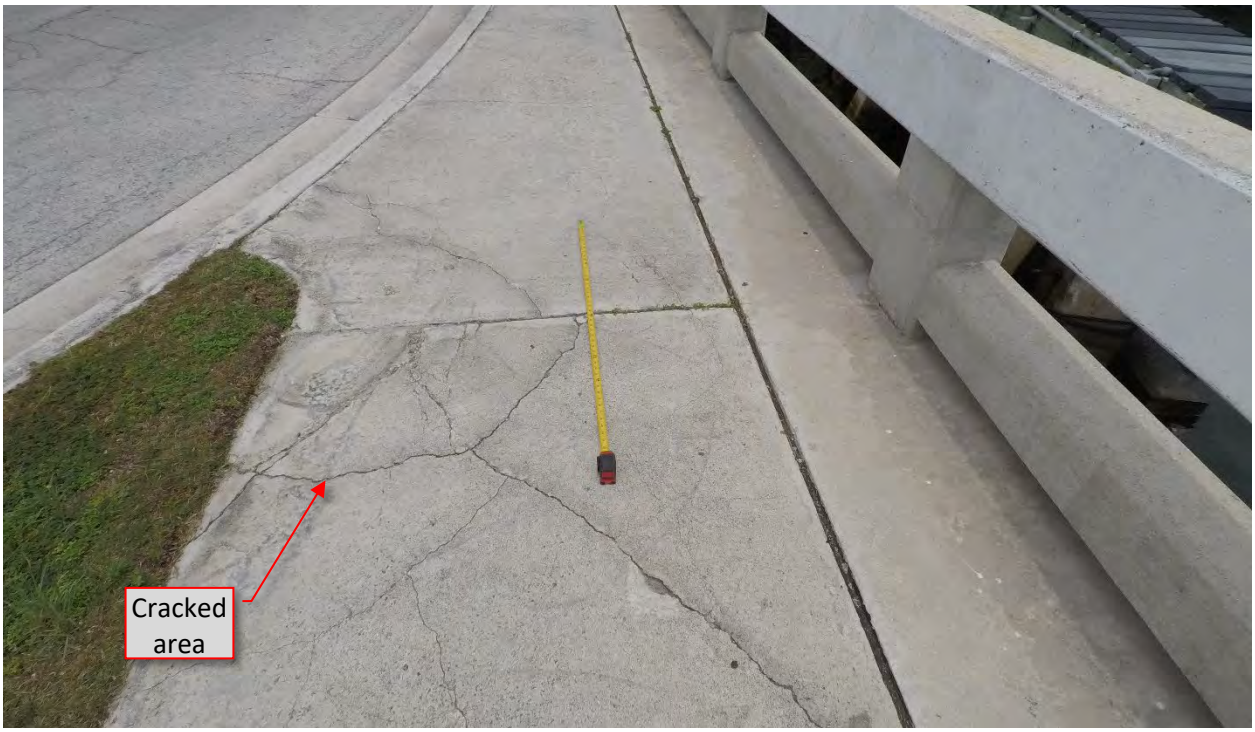

Figure 5: STA 6+50 - 6+60. Cracks in concrete slab to sidewalk.

Figure 6: STA 6+20. 48-Inch void at gap between seawall cap and concrete slab at sidewalk.

APPENDIX E: FALLING CONCRETE SLAB AT PAVED SIDEWALK – PHOTOLOG

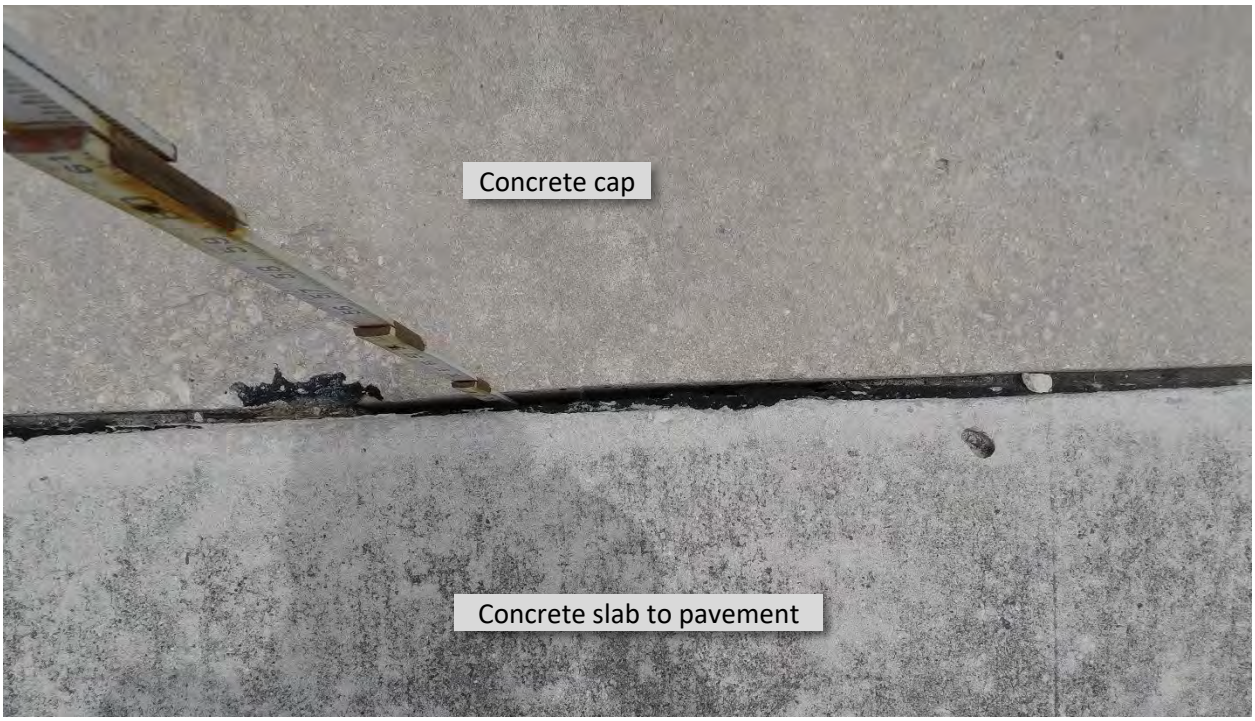

Figure 7: STA 6+20. Depth of void measurement. Top view of the gap between seawall cap and concrete slab to sidewalk.

APPENDIX F

APPENDIX F: PRELIMINARY SEAWALL CONSTRUCTION ESTIMATES

	Angelfish Pier Seawall at Garrison Bight - 430 LF Seawall				**October, 2022**
	Description	**QTY**	**Unit**	**Unit Price**	**Amount**
	Direct Cost				
	General - Seawall				
1	Upland Staging Area (provided by City of Key West)	1	LS	10,000	$ 10,000
2	Utility Coordination	1	LS	3,000	$ 3,000
3	Preconstruction Seismic Survey & Video	1	LS	4,500	$ 4,500
4	Temporary Construction Fencing (6' High, 12' Sections of Chain Link with Wind Screen & Sandbags)	800	LF	11	$ 8,800
5	Erosion & Sediment Control	1	LS	20,000	$ 20,000
6	General Site Preparation & M.O.T.	1	LS	25,000	$ 25,000
7	Demo - cap, sidewalks, slabs	2,500	SF	10	$ 25,060
8	Temporary Utility Relocation, Pumpout, Water & Electric	1	LS	50,000	$ 50,000
9	Steel Sheet Piling (24' long, A-690 including freight)	430	LF	850	$ 365,500
10	Steel Sheet Piling installation (driven from water)	430	LF	380	$ 163,400
11	Concrete - Cap, 6,000 PSI, Ext. Aggressive Env, 7 - #5 bar w/ Stirrups	430	LF	357	$ 153,510
12	Extend Drainage Outfalls	3	EA	5,000	$ 15,000
13	Tremie Grout for fill between sheetpile(= 430'x1.5'x8'/27)	200	CY	350	$ 70,000
14	Sidewalk	2,600	SF	7	$ 17,035
16	Testing - Allowance for Concrete	1	LS	10,000	$ 10,000
17	Vibration Monitoring - during pile driving operations	1	LS	11,000	$ 11,000
18	Site Restoration (including sidewalk and other impacts)	1	LS	70,000	$ 70,000
19	Chemical Grouting of Cracks/Seams	40	LF	35	$ 1,400
20	Tremie Grout Gaps in Seawall Cap	16	CY	500	$ 8,000
				Subtotal	**$ 1,031,205**
				Direct Cost	**$ 1,031,205**
	Contractor Cost				
24	FOOH & HOOH (Overhead) Combined (6% Typical of Direct Cost (DC))	6.0%		61,872	$ 61,872
25	Mobilization/Demobilization (10% Typical of DC + above costs)	10.0%		109,308	$ 109,308
26	Profit (17% Typical of DC + above costs)	17.0%		204,405	$ 204,405
27	Bonds, Permits & Insurance (2% Typical of DC + above costs)	2.0%		28,136	$ 28,136
	Direct + Contractor Cost			**403,721**	**$ 1,434,927**
	Project Cost				
28	City of Key West Allowance Account for Administration and On-site Supervision (SIOH)	5.0%		71,746	$ 71,746
29	Contingency	30.0%		452,002	$ 452,002
	Direct + Contractor + Project Cost			**523,748**	**$ 1,958,675**
	Total Construction Cost				**$ 1,958,675**