Holden Beach Oceanfront Pier
Due Diligence Inspection
Holden Beach, North Carolina

October 15, 2021

ATM of NC

Applied Technology & Management of NC

www.appliedtm.com

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Attachments

1. Introduction and Background

1.1. Scope of Work

The Town of Holden Beach (the Client) engaged Applied Technology & Management (ATM of NC) to perform a Due Diligence assessment of the Holden Beach fishing pier. The town is considering acquiring the pier and has requested that an assessment of the pier be completed prior to purchase.

The purpose of the assessment is to evaluate the general condition of the pier, determine the structural stability of the pier, identify the remaining service life of critical components, and what level of effort may be required to ensure the pier remains functional.

The works by ATM included a review of available technical information which could be provided or obtained by ATM and a site visit to visually inspect the pier. The works also included identification of any specific damages or areas of concern and an estimate of remaining service life of key components of the pier. The works by MidAtlantic Engineering Partners (MidAtlantic) included visual and tactile inspection of the piles. The MidAtlantic divers were limited in performing the underwater inspection due to severe weather conditions however some tactile pile inspections were conducted. In addition to the underwater and intertidal pile inspection, the divers also utilized aerial drone photography for the pier/pile inspection. The report by MidAtlantic is attached at the end of this report.

This report provides preliminary recommendations only as ATM's and MidAtlantic's review was limited to visual and tactile inspection only. No destructive or laboratory testing was conducted, and areas that were not readily visible were not inspected.

1.2. General Facility Description

The pier is located in Holden Beach, North Carolina. The pier may be accessed through the landside building on site and the current cost to go onto the pier is $1 per person for the day. The fishing pier location is shown in Figure 1 on NOAA chart 11536 and Figure 2 presents recent beach survey data on either side of the pier. The pier terminates in about 10 feet of water.

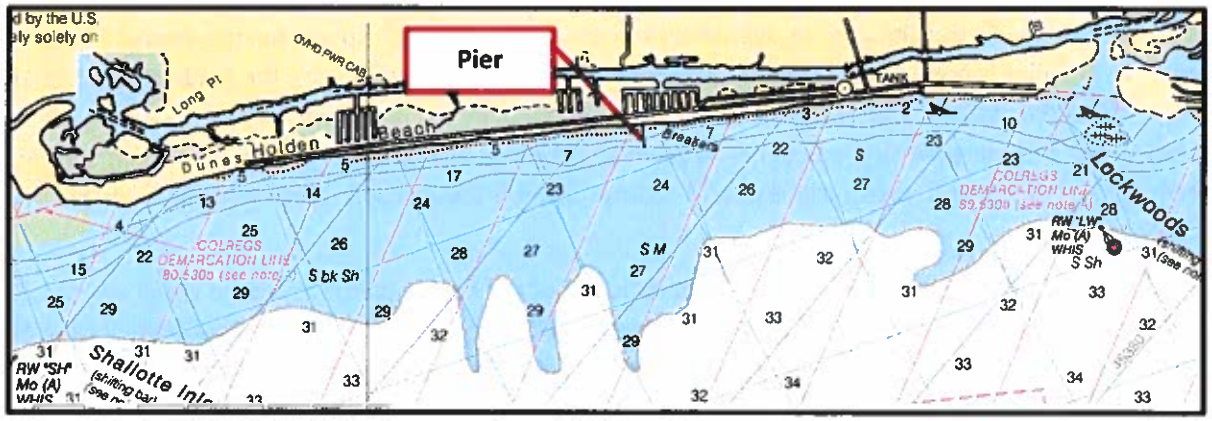


Figure 1: Holden Beach Oceanfront Fishing Pier on NOAA chart 11536.

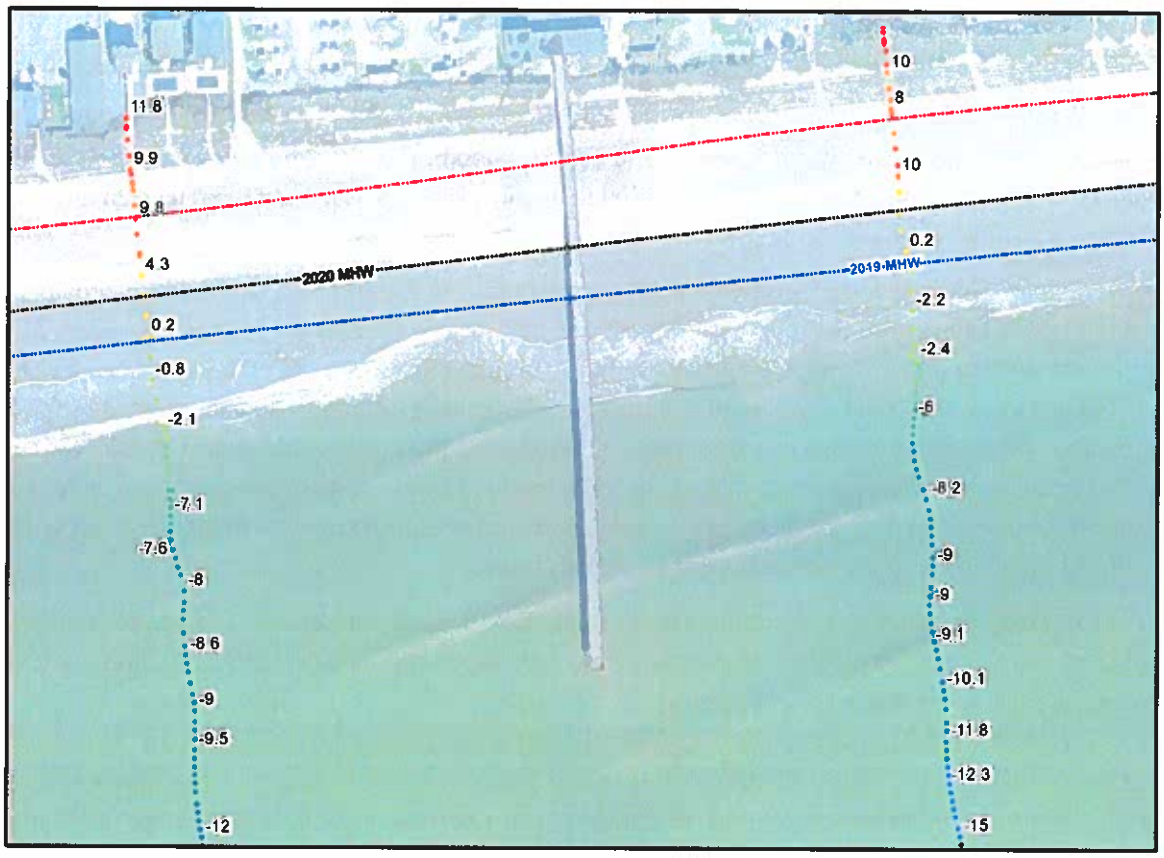


Figure 2: Recent beach survey data near the pier. Depths are in feet NAVD88 and can be thought of as mean sea level.

The original fishing pier was constructed in 1957. Hurricane Floyd damaged the pier and destroyed the seaward end of the fishing pier in 1999. Floyd-related repairs to the pier occurred however the seaward end was not rebuilt (resulting in an overall shorter pier). No records or plans for the repairs could be located. The pier is now around 750 feet long and varies from 12 feet wide on the landward end to 16 feet wide on the seaward end. It appears that various improvements have been made to the pier since its construction including pile and pile bent replacement. The pier also has several benches, a fish cleaning station, light poles, and trash facilities. ATM did not inspect the landside building as part of this due diligence work.

In the absence of as-built information, the construction of the fishing pier is based on visual and tactile observations during the site visit. The pier consists of a two-pile system spaced at approximately 12' with vertical and horizontal cross-members. The timber piles are assumed to be attached by a dowel through the top of the 8" x 8" pile bent and/or metal straps, although this could not be confirmed. There are timber stringers with an unknown connection and timber decking attached to the stringers by nails. There is a timber railing along the entire pier. The width of the pier is 12' near shore for 250' and increases to 16'

for approximately 500'. The elevation of the pier is unknown although the seaward end is higher than the landward end.

Figure 3 presents a cross-section schematic of pier elements. More detail and photos of pier elements are presented later in this report.

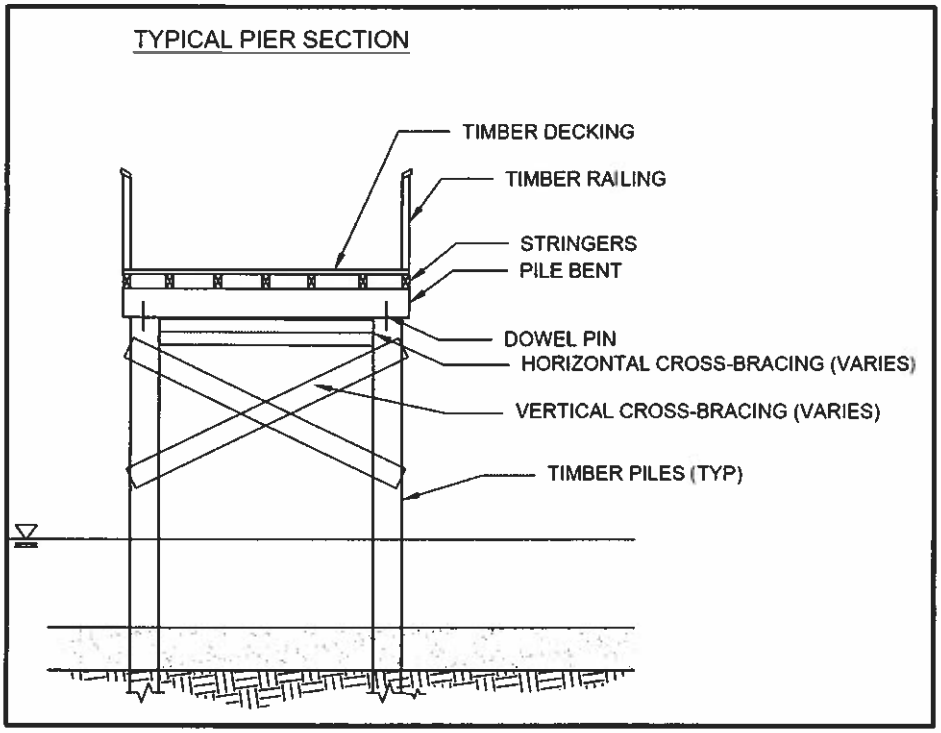


Figure 3: General schematic of Holden Beach oceanfront pier and its elements.

1.3. Pier Design Documentation Review

The Client provided ATM with all available technical records and documents on file. This information was limited to various building permits and a parcel survey. There were no plans or structural details, design criteria, technical and performance specifications, shop drawings, as-builts, geotechnical information, or wind/wave studies that could be located. ATM contacted the Building Inspector from the Town of Holden Beach and Backwater Marine Construction (reported contractor that has performed some repairs) to request this or any other available information, however ATM did not receive a response from the marine contractor while permit request information was only available from Town records. After several contact attempts by ATM and town staff, it appears that Backwater Marine Construction is no longer in business.

Although physical maintenance records were unavailable, it did appear that some maintenance and component replacement had occurred including installation of new piles and some pile caps and cross-bracing. The age of the new components or maintenance is unknown.

In lieu of historical documentation on the marine elements that may represent the baseline condition for the pier, ATM referred to our experience with the pier materials and systems, historical data, and measurements recorded during the site visit.

2. Site Observations

2.1. Methodology

A topside visual inspection of the pier was undertaken by ATM staff on September 20-21, 2021. The assessment generally followed the guidelines in ASCE Manual of Practice (MOP) No. 130 Waterfront Facilities Inspection and Assessment (ASCE, 2015), including Tables 2-4 and 2-14 from the Manual.

Table 2-4. Damage Ratings for Timber Elements

Damage Rating		Existing Damage[a]	Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)]
NI	Not Inspected	• Not inspected, inaccessible, or passed by[b]	
ND	No Defects	• Sound surface material	
MN	Minor	• Checks, splits, and gouges less than 0.5 in. wide • Evidence of marine borers or fungal decay	Minor damage not appropriate if • Loss of cross section • Marine borer infestation • Displacements, loss of bearing, or connections
MD	Moderate	• Remaining diameter loss up to 15% • Checks and splits wider than 0.5 in. • Cross-section area loss up to 25% • Corroded hardware • Evidence of marine borers or fungal decay, with loss of section	Moderate damage not appropriate if • Displacements, loss of bearing or connections
MJ	Major	• Remaining diameter loss 15 to 30% • Checks and splits through full depth of cross section • Cross-section area loss 25 to 50%; heavily corroded hardware • Displacement and misalignments at connections	Major damage not appropriate if • Partial or complete breakage
SV	Severe	• Remaining diameter loss more than 30% • Cross-section area loss more than 50% • Loss of connections and/or fully nonbearing condition • Partial or complete breakage	

[a]Any defect listed is sufficient to identify relevant damage grade.
[b]If not inspected due to inaccessibility or passed by, note as such.

Figure 4: Table 2-4 from ASCE MOP 130

Table 2-14. Condition Assessment Ratings

Rating		Description
6	Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.
5	Satisfactory	Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.
4	Fair	All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
3	Poor	Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.
2	Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1	Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high-priority basis with strong urgency.

Figure 5: Table 2-14 from ASCE MOP 130

ATM's observations on the specific elements of the pier are included herein.

2.1. Timber Piles

The MidAtlantic divers conducted an inspection of the piles and gave each pile a rating as shown in Table 1, ranging from "Minor" to "Severe" damage. Most of the piles were recently replaced with newer vintage greenheart timber piles, and the old piles were either cut down or completely removed. The inshore section of the pier appears to be older vintage timber piles. The overall rating of the timber piles by the divers is determined to be fair condition. There were 5 identified piles in critical condition that should require maintenance immediately and are listed in Table 2. A more detailed discussion on the inspection of the timber piles is included in the attached Diver Inspection Report.

Table 1: Pile Damage Rating Summary

RATING	QTY OF PILES	PERCENT OF PILES
Minor	101	84.9
Moderate	11	9.2
Major	2	1.7
Severe	5	4.2
TOTAL:	119	100

Table 2: Major to Severe Damage Timber Pile Summary

PILE LOCATION	ELEMENT RATING	REASON FOR RATING
17A	Severe	100% Non-Bearing pile. timber cap is supported by steel fish plates (Photograph 2).
24A	Major	Pile is 50% bearing. due to displacement of pile shims (Photograph 3).
25B	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 4).
40A	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 5).
52A	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 6).

Surface Condition

There are no observed defects due to fungal, borer, or biological attack above the mean low water level. Due to weather conditions at the time of inspection, underwater visual and tactile inspections were limited, however it was found that subsurface pile conditions were similar to intertidal and above water pile conditions. Five piles were cracked, broken, and/or overstressed and are in critical condition as shown in Figure 6. The rest of the piles appear to be in satisfactory condition. The underwater inspection also generally found the piles to be in satisfactory condition.

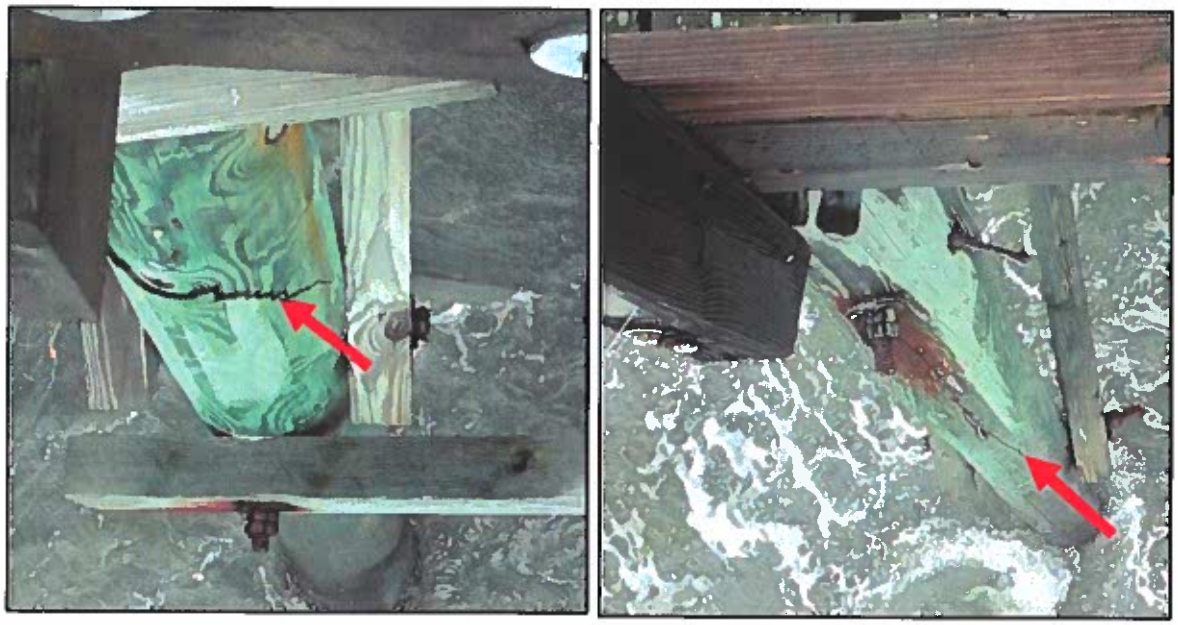


Figure 6. Cracked piles in critical condition

Alignment & Loading

There are several locations where piles were non-plumb and are leaning or tilted. Misalignment may be the result of storm damage, subsidence, or lack of structural support from crossbeams. There are also two critical areas where the piles have a reduced load bearing capacity. See Figures 7-9.

Figure 7. Photo of significant leaning of piles in two locations

Figure 8. Photo of leaning piles nearshore

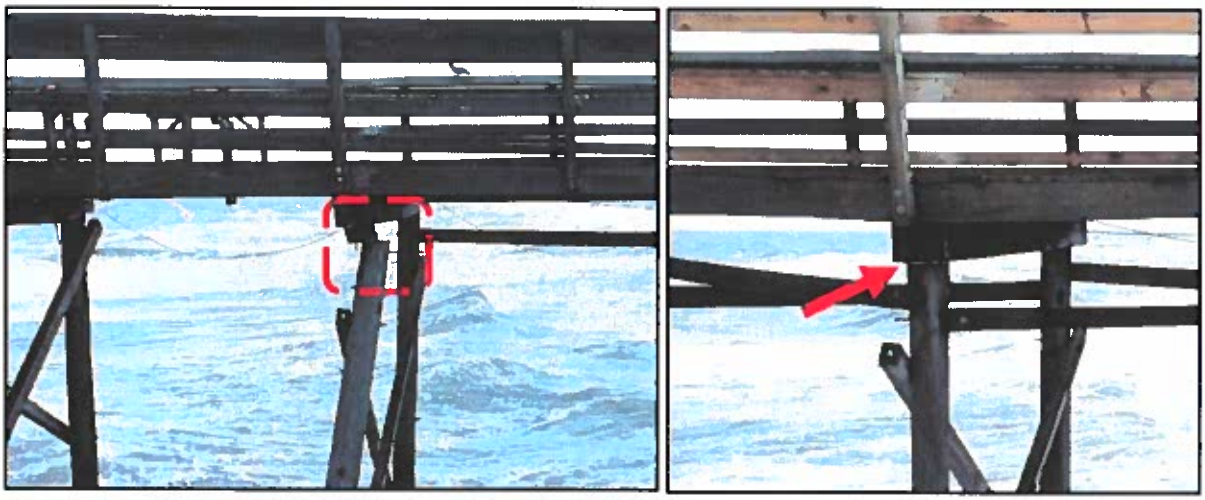


Figure 9. Photo of 50% bearing capacity pile (left), Photo of 100% non-bearing capacity pile (right) (air gap exists between pile and pile bent with only metal straps providing support)

Pile Embedment

In absence of the piling as-built elevations and installation records, ATM could not ascertain the top elevation, overall length, or pile embedment. Pile embedment information is critical in determining the structural capacity of the piles. In reviewing recent beach profile survey data at Station 170+00 approximately 350 feet to the east of the pier, it is known that several more feet of sand exists when compared with 2016 (pre- Central Reach Project beach fill) survey data (see Figure 10). Pulling existing piles or even excavating around existing piles is not recommended. One possibility would be to pull a previously cut or non-load bearing piling to assess embedment depth. Timely replacement of the 3 cracked/broken piles identified in Table 2 could also provide valuable information on embedment depth.

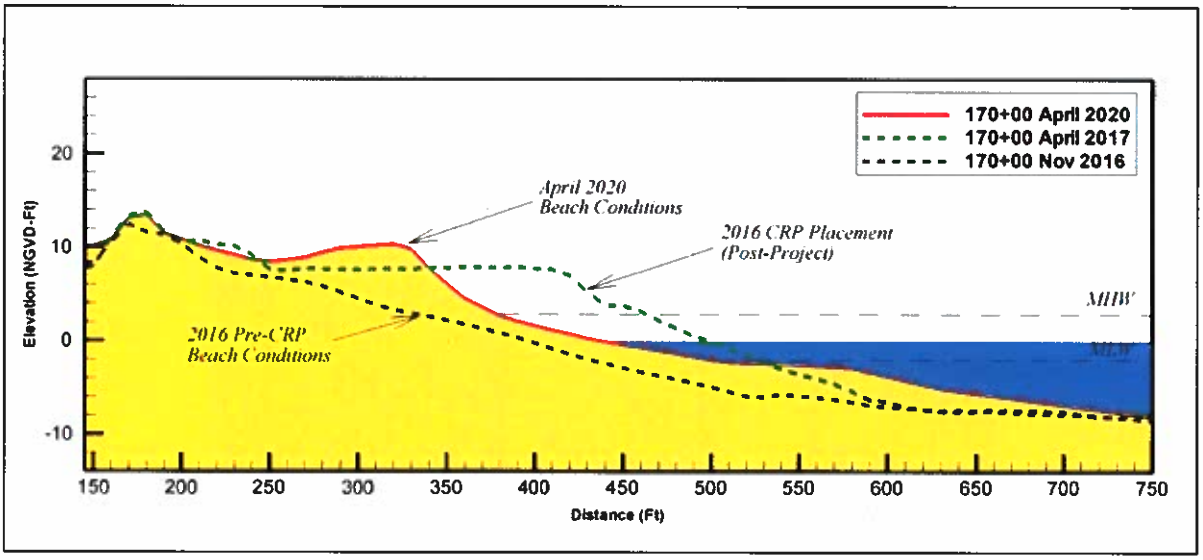


Figure 10: Beach survey station closest to the pier compared with pre- and immediate post- Central Reach Project (CRP) conditions. Note that several more feet of sand currently exists.

2.2. Cross-Bracing, Pile Bents, Stringers, and Connections

Cross Bracing

A majority of the horizontal and vertical cross-braces are either missing, detached, or broken which is a *critical condition for the structure* (see Figure 11). The hardware throughout the entire structure is heavily corroded and has greater than 50% section loss. There is an inconsistent use of cross-bracing along the pier. Below are examples of broken or missing cross-bracing. Figure 12 is an example of the significantly corroded hardware connecting the cross-bracing to the piles.

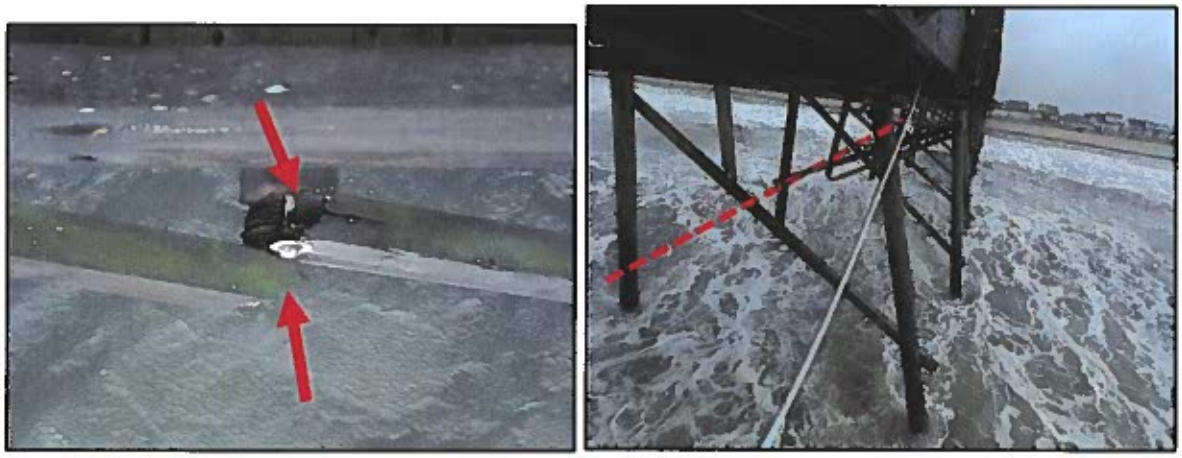


Figure 11. Example of broken cross-brace (left) and missing vertical cross-brace (right)

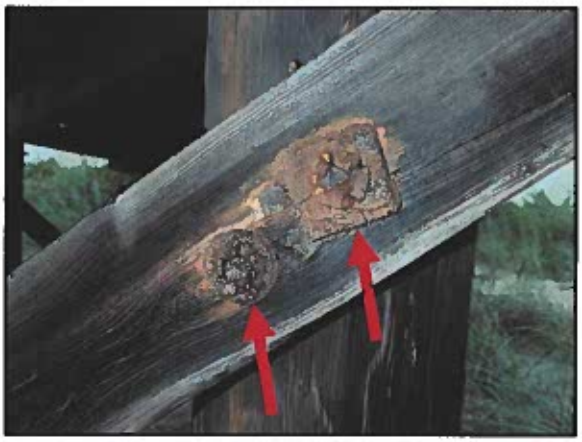


Figure 12. Example of hardware in critical condition (over 50% section loss)

Pile Bents

The pile bents vary in size, and several have been recently replaced. Overall, most of the pile bents are in good condition. Some of the pile bents are exhibiting wood rot at the ends and are in poor condition. The piles appear to be attached to the pile bents by a dowel of unknown dimension and condition and/or straps. An example of a pile bent in poor condition is shown in Figure 13.

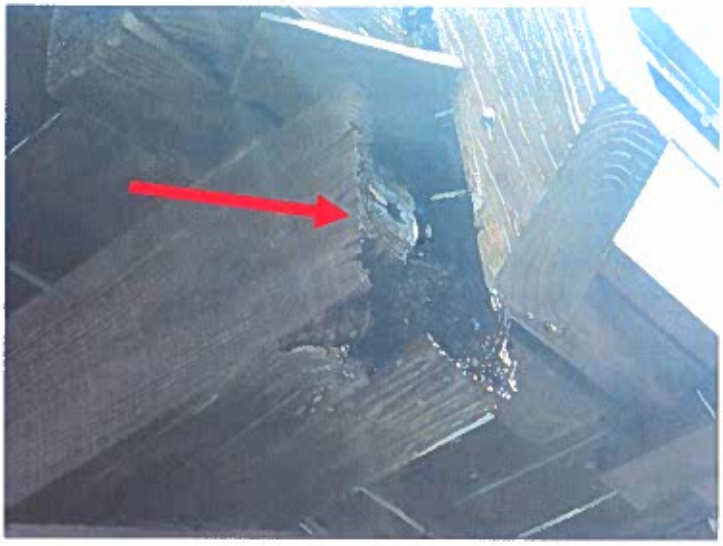


Figure 13. Example of a pile bent in poor condition, exhibiting deterioration at the end.

Stringers

The stringers appear to be in fair condition. Upon inspection, there were various methods of connection including nails, steel L-brackets and steel straps as shown in the Figure 14 - 16. In several locations there was no apparent connection between the stringers and the pile bents. Therefore, their condition is unknown. The connection hardware was inconsistent overall, and in many cases, they exhibited moderate to extreme corrosion.

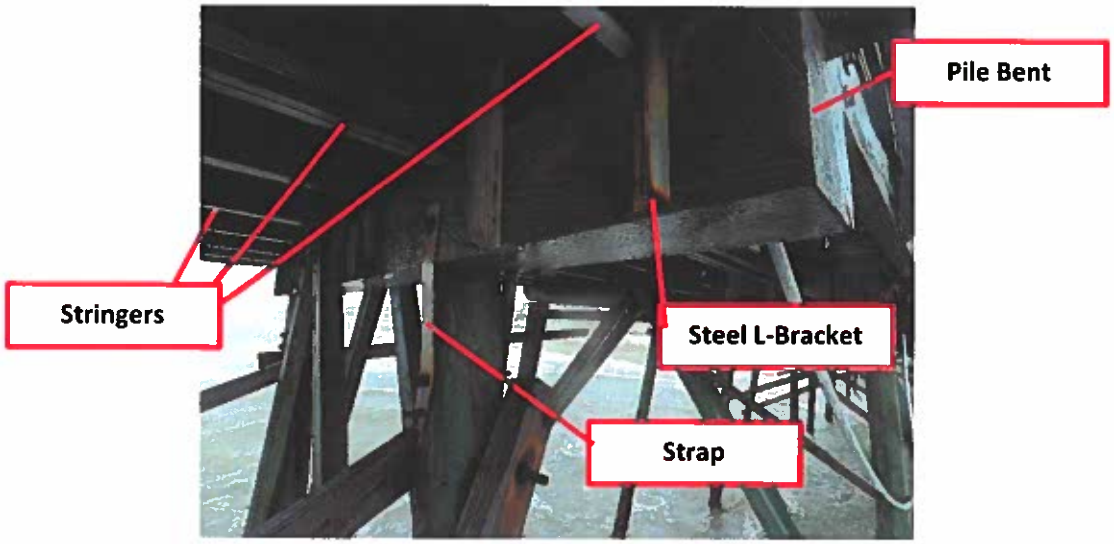


Figure 14. Example of stringers attached to pile bents by steel L-brackets with moderate corrosion (fair condition). Pile is attached to pile bents by straps.

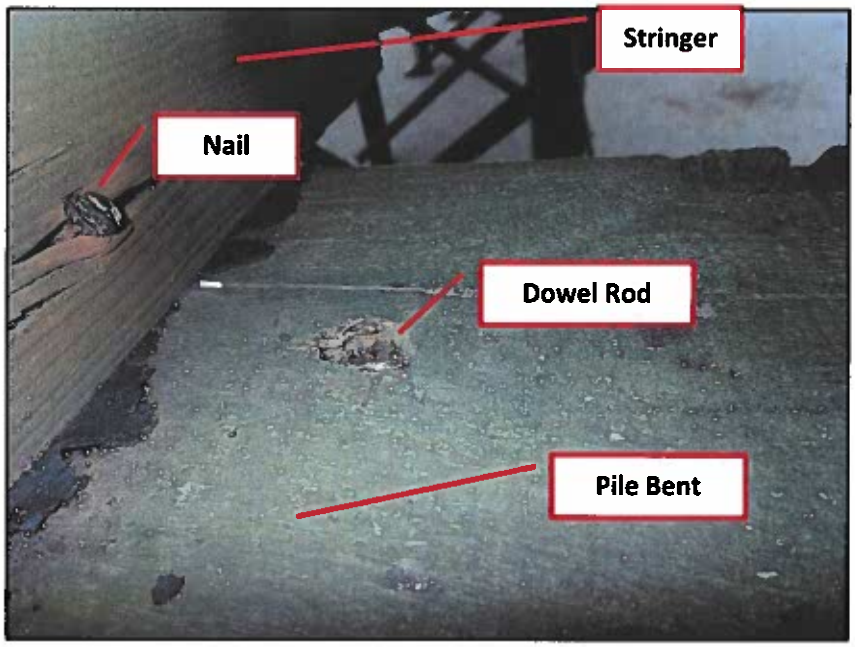


Figure 15. Example of what appears to be a dowel rod through the top of the pile bent to connect to the timber pile below. Also shown is a nail attaching the stringer to the pile bent.

Figure 16. Example of timber bracing (red arrows) used to connect stringers to pile bents. Pile attached to pile bent by metal strap. Note that one of the stringers is not sitting on the pile bent in this photo.

2.3. Timber Decking

The timber decking appears to be in fair condition. There are several locations where boards have been recently replaced. The age of the decking is unknown but shows signs of degradation consistent with age and exposure including rusting hardware and wood splitting. The decking appears to be maintained and no tripping hazards were observed.

The structure has a few notable areas where deflection and rotation are apparent on the walkway surface. The variation in pier surface is consistent with locations where piles were leaning significantly or broken.

Figure 17. Example of timber decking

Deck elevation above wave attack is an important consideration and based on the deck survival from hurricanes over the last few decades (since Floyd), it appears the deck elevation is of adequate height. However this is no guarantee that the deck will survive under extreme storm conditions, especially with sea level rise and potentially more powerful storms. Figure 18 presents a screenshot of wave attack during Hurricane Irene (2011) where wave height is just below the pier deck. Not rebuilding the seaward portion of the original pier following Floyd was also a good decision as wave heights during storms are larger in deeper water.

Figure 18: Wave heights just below pier deck during Hurricane Irene (2011).

2.4. Handrails

Overall, the timber handrails appear to be in poor condition. There is one critical section of handrail on the east side nearshore that exhibited excessive movement when pushed upon. There were several areas where new handrails were installed. There were a few locations where the handrail had degraded timber and exhibited >25% cross sectional loss. *Handrails in poor condition are a severe safety risk.*

Figure 19. Example of railing in poor condition

The conduit for the electrical wiring for light posts is enclosed in timber along the railing. There are several locations where the connections were compromised and are a recognized safety hazard.

Figure 20. Photo of detached conduit enclosure attached to handrail

2.5. Other Items

Utilities

Utilities on the pier include electrical to power the 10 light poles and water lines that extends to the fish cleaning station. The plumbing and electrical may be out of compliance and would likely require replacement in order to comply with current codes. Some electrical connections are exposed and are considered a recognized safety hazard.

Fish Cleaning Station

The fish cleaning station appears to be significantly degraded and will require replacement.

3. Remaining Useful Life of Critical Elements

3.1. Overall

Based on the available information provided to ATM and the preliminary results of our inspection, the Holden Beach fishing pier has likely surpassed its remaining service life considering it was constructed in 1957, which is ~64 years old. Most fixed timber pier structures are constructed for a 50-year life span with regular maintenance. Without maintenance records it is difficult to ascertain when key components such as the pilings were replaced.

One of the key concerns observed during the inspection was the heavily corroded and missing/damaged connection hardware throughout the pier structure. Most connections appear to have more than 50% sectional loss (thereby reducing their strength by 50%).

In order to extend the service life to a reasonably acceptable time, many of the connections and bracing will need total replacement. While the piling may have a longer remaining service life than the other components, significant maintenance and repair of the other key structural components will need to be completed.

3.2. Timber Piles

Based on a visual and tactile inspection only, and without physical testing or design information, it is difficult to estimate the capacity of the piles to withstand future storm conditions. Routine inspection of the piles should be undertaken for signs of ongoing deterioration and signs of section loss and/or capacity loss. The identified cracked/broken piles require replacement and the reduced load bearing piles require repairs.

3.3. Cross-Bracing, Pile Bents, Stringers, and Connections

Missing, detached, or broken cross-braces are critical elements and require replacement. Most of the pile bents and stringers are in fair condition and do not require immediate replacement. Nearly all visible connections are in critical condition and will require replacement. ATM recommends the use of marine-grade stainless steel to deter corrosion of metal fasteners where exposed to sea water.

3.4. Handrails

The stability of handrails is a life-safety element and should be corrected immediately.

4. Findings and Recommendations

Key findings of the assessment are listed below

- The Holden Beach fishing pier is significantly exposed during storm events including winds, waves, swell, current, and extreme water levels from storm surge. Although we do not have elevation information on the pier, the deck is likely above wave impact height, however wind forces during an extreme event could cause as much or more damage as hydrodynamic loading.
- Without critical design information related to the timber piles and site conditions, it is difficult to perform a critical assessment of existing and remaining capacity. The three piles that are cracked or broken should be replaced immediately. The two piles that have reduced load bearing should be repaired immediately.
- Pile length and embedment information is not available. This information is critical to determine the structural capacity of the piles.
- Cross-bracing (vertical and horizontal) of the piles has been compromised in several locations, thereby reducing the ability for the structure to resist horizontal loading from wave attack. The cross-bracing is a critical component to ensure the piles do not lean or fail.
- Ongoing wear to the decking from weathering will require ongoing maintenance and replacement of deck boards as necessary.
- Corrosion of fasteners and bolt connections of the structural elements of the pier will reduce strength and performance. ATM recommends replacing the connections with marine-grade stainless steel to deter corrosion in metal fasteners where exposed to sea water.
- In many areas, the handrails are loose and/or structurally deficient. This is considered a life-safety issue and should be corrected immediately.

Immediate repairs to the pier to extend the service life to a reasonable period of time (10-15 years) is estimated to be on the order of $500,000 to $750,00. This would include replacement or significant repair of the three damaged piles, replacement of the damaged pile caps, installation of new cross bracing and total replacement of corroded fasteners and connections. This estimate assumes that significant material such as decking and stringers can be salvaged, and the construction can be completed by land-based equipment (i.e., no mobilization of barges or water-based equipment).

APPENDIX A – MidAtlantic Engineering Partners Pier Inspection Report

Note that MidAtlantic Engineering provided estimated costs for repair that ATM staff believe is too low, especially when considering the recent increase in construction prices.

INTRODUCTION

MidAtlantic Engineering Partners was retained by Geosyntec, to perform an underwater inspection of the timber piles at the Fishing Pier located at 441 Ocean Blvd W, Holden Beach, NC (Photograph 1). The inspection was performed on September 21st, 2021 and included an above inspection of 58 timber pile bents typically consisting of two piles per bent. Due to the sea state at the time of inspection (~3 to 5ft breaking waves) it was not feasible or safe to perform diving operations. While on-site we inspected all the upland piles and waded into the wave break at low tide to perform a tactile inspection on the accessible piles until water depths exceed 5ft. The primary objectives of the inspection were to assess the general condition of the timber piles, assign an overall Condition Assessment Rating (CAR), and provide high-level recommended repairs.

Methodology

The inspection of the timber piles was conducted by a three-person engineer dive team. MidAtlantic attempted to perform diving operation on the piles, but due to the sea state it was unsafe to continue. Alternatively, MidAtlantic inspected all the upland piles and performed a hands-on tactile inspection on the accessible piles by wading into the wave break until water depths exceed 5ft. Piles which could not be safely inspected by a person in the water the piles were visually inspected using a drone. All work was performed in accordance with the ASCE Underwater Investigations Standard Practice Manual, No. 130.

The inspection included a Level I general inspection effort of 100 percent of all accessible elements. The Level I inspection effort included a visual and tactile evaluation to confirm the facility layout and identify structural elements with obvious major damage or deterioration. Measurements of the main structural components were taken so that quantified repair recommendations could be developed.

Condition Assessment Criteria

The Condition Assessment Rating can be interpreted as the "health" of the systems comprising the structure. The Condition Assessment Rating (CAR) is driven by the information gathered during the investigation process. Defect severity, quantity, frequency, and impact to the facility operations are processed to derive the defined Condition Assessment Ratings. Standardized Condition Assessment Ratings are required to categorize the results of the inspection and provide a basis for comparison of the defect effects against the deficiencies and known results in other facilities. The ability to generate an accurate comparison across large amounts of data, historic or current, is required for a successful waterfront management plan. The Condition Assessment criteria, as per the ASCE inspection manual, can be found in Appendix C.

A damage rating is assigned to each element inspected during the investigation. The rating reflects the condition of the individual element only and is independent of the element's structural importance or type of inspection being conducted. The elemental damage ratings are standardized to provide a qualitative description of an element's condition based on a quantified level of damage. The damage rating characteristics as per the ASCE inspection manual can be found Appendix C.

DESCRIPTION

The Holden Beach Fishing Pier is a timber constructed ocean pier that extends approximately 725-feet into the Atlantic Ocean. The pier is exposed to direct ocean waves without any wave break screen. The pier consists of 58 timber pile supported bents. Each bent is approximately 10ft on center and consist of two opposing battered timber piles. The bents are framed together via timber bracing providing lateral support. Bents -1 and 1 are constructed of three timber plumb piles.

Bents -6 to Bent 11 are original vintage piles and from Bents 11 to Bent 52 (end of pier) are like new greenheart timber piles with varying diameter from 8-inches to 10-inches.

To aid in the description and location of each waterfront system, MidAtlantic labeled each timber bent from -6 to 52. The northern piles are the Alpha "A" row, and the southern piles are the Bravo "B" rows.

OBSERVED CONDITIONS

The timber piles associated with the Fishing Pier structure are in overall **Fair** condition. The ASCE Waterfront Facilities Inspection Manual describes a CAR of Fair as, "All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized area of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low." Table 1 summarizes the pile conditions observed during the inspection.

Table 1: Timber Pile Rating Summary

RATING	QTY OF PILES	PERCENT OF PILES
Minor	101	84.9
Moderate	11	9.2
Major	2	1.7
Severe	5	4.2
TOTAL:	119	100

The inshore section of the pier from Bent -6 to Bent 10 are predominantly original vintage 10 - 12-inch diameter timber piles. The piles typically exhibited localized light checking/weathering. The piles located between Bents 11 thru 52 are newer vintage greenheart timber piles 8 to 10-inch diameter. The piles located in between Bents 11 thru 30 have up to 1" thick marine growth (barnacles) below mean low water (MLW) and typical have no defects above MLW. The remaining piles from Bents 31 thru 52 were only inspected above MLW via drone and typically no defects observed. Isolate major to severe defects were identified at the top of some of the piles which are summarized in Table 2.

Table 2: Major to Severe Timber Pile Summary

PILE LOCATION	ELEMENT RATING	REASON FOR RATING
17A	Severe	100% Non-Bearing pile, timber cap is supported by steel fish plates (Photograph 2).
24A	Major	Pile is 50% bearing, due to displacement of pile shims (Photograph 3).
25B	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 4).
40A	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 5).
52A	Severe	Top 18-inch of the pile is broke/overstressed (Photograph 6).

Additionally, between Bents 26 to 28 deflection and rotation was noted in the walking surface. The cause of this deflection appears to be overstressing in the pile cap of Bent 27 and the timber stringer from Bent 27 to 26 (Photograph 7). However, during the time of the inspection, the pier appears stable at the time of inspection.

RECOMMENDATIONS

MidAtlantic has developed recommendations for the timber piles for the Fishing Pier based on observed conditions. The following recommendations should be compared with current and future use parameters to determine the most practical and economical allocation of funds. Recommendations have been identified as Priority and Routine level repair items.

Priority repair items should be executed within the next one to three years to minimize facility limitations or load restrictions. Priority level actions are recommendations for which no immediate measures are required. Priority actions should take precedence over any other scheduled maintenance or repair work on the structure. This level of recommended action reflects conditions that if left unaddressed, could result in further significant deterioration of a structural elements, associated loss of load carrying capacity, and more robust, expensive repairs.

Routine repair items are maintenance items, which should be executed within the next three to five years. Routine maintenance items help extend the service life of the facilities and minimize the need for structural repairs and rehabilitation, which are often costly and can involve temporary facility shutdowns. Routine level actions should be undertaken as part of a scheduled maintenance program. Postponing these actions will not affect the structural integrity of the facility or significantly increase the cost to repair the structure.

The nature of the due diligence inspection is it serves to provide a high-level condition assessment of the facility, with a limited number of elements inspected only visually and tactilely. Prior to making repairs, future functionality of the facility needs to be determined and a feasibility study performed. Once facility functionality is determined, a design level inspection of the facility should be performed to confirm suitability for future operations.

Priority Recommendations (1-3 years)

Priority level actions are recommendations for which no immediate measures are required. However, priority actions should take precedence over any other scheduled maintenance or repair work on the structure. This level of recommended action reflects conditions that if left unaddressed, could result in further significant deterioration of a structural elements, associated loss of load carrying capacity, and more robust, expensive repairs. Table 3 summarizes the priority recommendations.

Table 3: Priority Repair Recommendations Summary

ELEMENT	RECOMMENDATION	ESTIMATED COST
Timber Piles	Install timber pile shim (17A).	$ 3,000
	Replace inkind timber pile shims (24A).	$ 3,000
	Post pile repair to the top 2 feet of the three overstressed piles (25B, 40A & 52A).	$ 15,000
Timber Pile Cap	Replace inkind timber pile cap (Bent 27).	$ 9,000
Timber Stringer	Replace inkind timber stringer (Bent 27 to 26).	$ 7,000
	Priority Recommendation Subtotal:	$ 37,000

Routine Recommendations (3-5 years)

Routine level actions should be undertaken as part of a scheduled maintenance program. Postponing these actions will not affect the structural integrity of the facility or significantly increase the cost to repair the structure. These actions should be undertaken within a three to five-year time frame or longer depending on the future use of the site. Table 4 provides a summary of Routine and Maintenance Recommendations for the site.

Table 4: Routine Recommendations Summary

ELEMENT	RECOMMENDATION	ESTIMATED COST
Entire Facility	Perform a routine inspection of the pier, piles, hardware, decking, stringers and bracing every 5-years.	$ 20,000
	Routine Recommendation Subtotal:	$ 20,000

FUTURE INSPECTION

Based on the current conditions of the Holden Beach Fishing Pier structural element, MidAtlantic recommends a Routine Inspection be performed at minimum every five years. The American Society of Civil Engineers (ASCE) Underwater Investigations Standard Practice Manual suggests that structures rated Satisfactory, which are exposed to an aggressive environment (brackish waters and or with current), shall receive Routine Inspection every five years or following a major storm event.

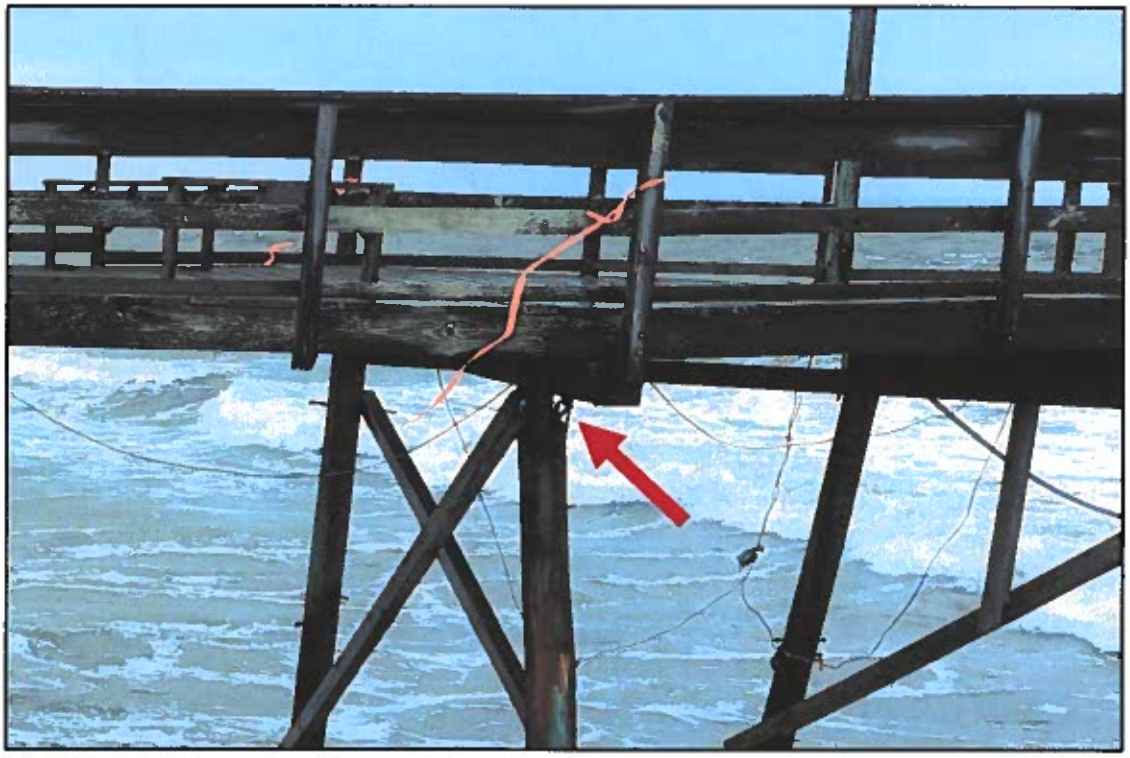
APPENDIX A

PHOTOGRAPHS

Photograph 1: Overall of Holden Beach Pier

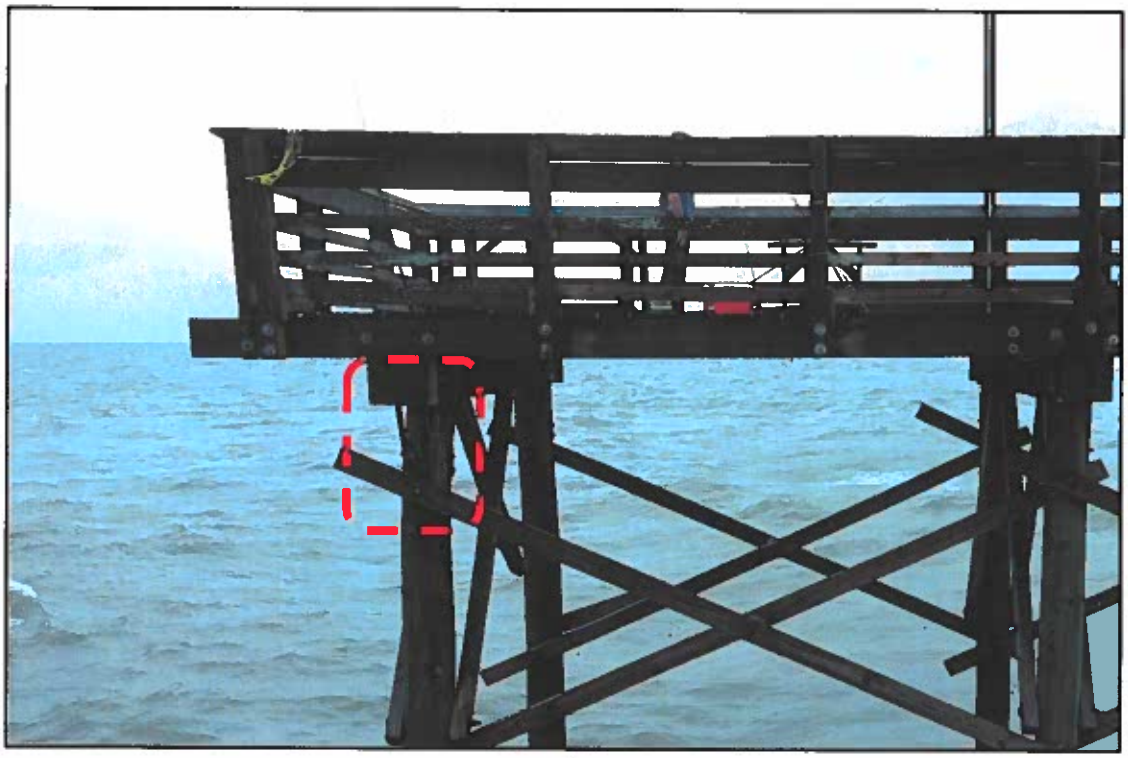
Photograph 2: Pile 17A - 100% Non-Bearing pile, timber cap supported by steel fish plates

Photograph 3: Pile 24A - 50% Bearing due to displaced pile shims

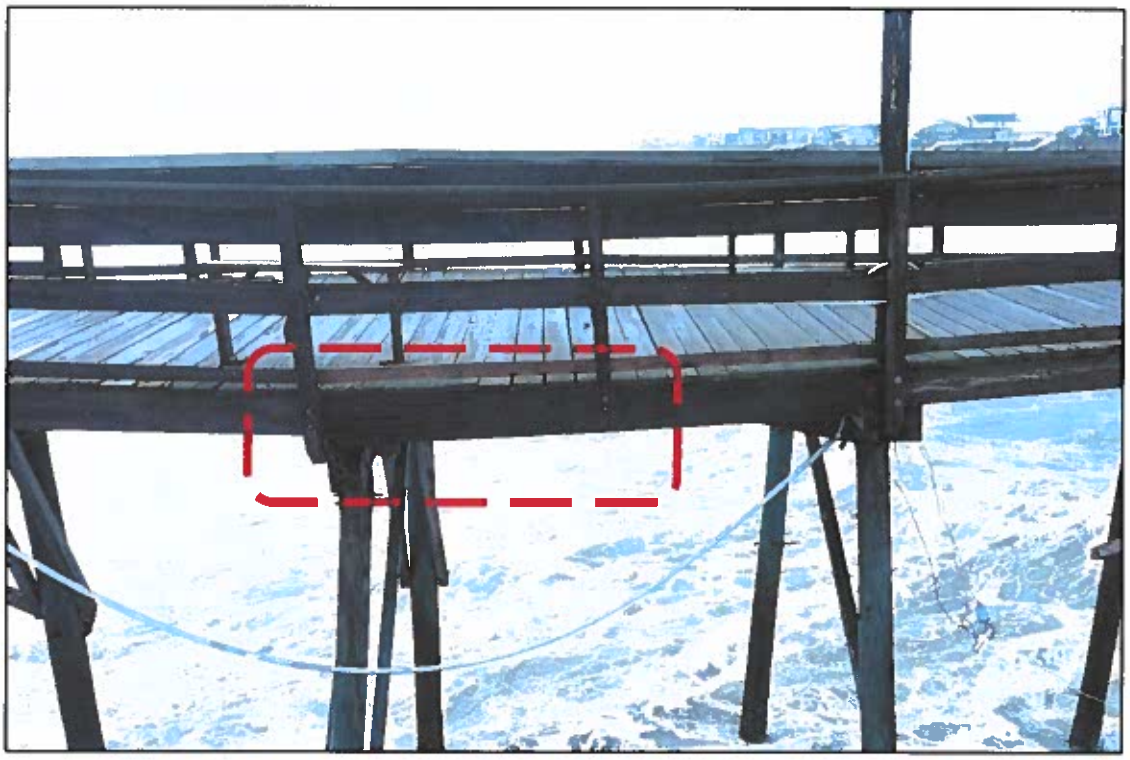


Photograph 4: Pile 25B - Top 18-inch pile is broke/overstressed

Photograph 5: Pile 40A - Top 18-inch pile is broke/overstressed



Photograph 6: Pile 52A - Top 18-inch pile is broke/overstressed



Photograph 7: Bent 27 - Overstressed pile cap & stringer

APPENDIX B

INSPECTION NOTES

Structure	Bent	Row	Element	Shape	Material	Rating	Deterioration	Severity	Section Loss %	Dimensions (L x W x D)	Comments	Level II/III	Photo?	Photo #	Photo Comments	Date (MM/DD/YYYY)
FISHING PIER	-6	A	Pile	Round	Timber	MD	Checking	LT	< 10	-	18" exposed pile	No	No	-	-	9/21/2021
FISHING PIER	-6	B	Pile	Round	Timber	MD	Checking	LT	< 10	-	18" exposed pile	No	No	-	-	9/21/2021
FISHING PIER	-5	A	Pile	Round	Timber	MJ	Rot	HVY	50-75	-	Base of pile with 50% section loss; Original pile diameter 11", pile diameter at base 6".	No	No	-	-	9/21/2021
FISHING PIER	-5	B	Pile	Round	Timber	MD	Checking	LT	< 10	-	Shim located on top; 24" exposed pile length	No	No	-	-	9/21/2021
FISHING PIER	-4	A	Pile	Round	Timber	MD	Checking	LT	< 10	-	36" exposed pile length, 8-inch diameter pile	No	No	-	-	9/21/2021
FISHING PIER	-4	B	Pile	Round	Timber	MD	Checking	LT	< 10	-	36" exposed pile length, 8-inch diameter pile	No	No	-	-	9/21/2021
FISHING PIER	-3	A	Pile	Round	Timber	MN	None	-	-	-	New Pile 13" diameter; 48" exposed pile length	No	No	-	-	9/21/2021
FISHING PIER	-3	B	Pile	Round	Timber	MN	None	LT	-	-	New Pile 13" diameter; 48" exposed pile length	No	No	-	-	9/21/2021
FISHING PIER	-2	A	Pile	Round	Timber	MD	Checking	MD	15-25	-	Section loss at base of pile 20%, due to checking	No	No	-	-	9/21/2021
FISHING PIER	-2	B	Pile	Round	Timber	MN	None	-	-	-	-	No	No	-	-	9/21/2021
FISHING PIER	-1	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	-1	A.5	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	-1	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	1	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	1	A.5	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	1	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	2	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	2	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	3	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	3	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	4	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	4	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	5	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	5	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	6	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	6	B	Pile	Round	Timber	MD	Checking	MD	15-25	-	-	No	No	-	-	9/21/2021
FISHING PIER	7	A	Pile	Round	Timber	MD	Checking	MD	15-25	-	-	No	No	-	-	9/21/2021
FISHING PIER	7	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	8	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	8	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	Localized abrassion damage southeast face (4-inch long x 1-inch deep)	No	No	-	-	9/21/2021
FISHING PIER	9	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	9	B	Pile	Round	Timber	MD	Checking	MD	15-25	-	Southface with moderate checking	No	No	-	-	9/21/2021
FISHING PIER	10	A	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	10	B	Pile	Round	Timber	MN	Checking	LT	< 10	-	-	No	No	-	-	9/21/2021
FISHING PIER	11	A.1	Pile	Round	Timber	MN	None	-	-	-	-	No	No	-	-	9/21/2021
FISHING PIER	11	A	Pile	Round	Timber	SV	Rot	-	-	-	Rot @ mudline. Pile has been abandoned with new pile 11 A.1 installed adjacent	No	No	-	-	9/21/2021
FISHING PIER	11	B	Pile	Round	Timber	MD	Checking	MD	10-15	-	-	No	No	-	-	9/21/2021
FISHING PIER	12	A	Pile	Round	Timber	MD	Checking	MD	10-15	-	-	No	No	-	-	9/21/2021
FISHING PIER	12	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	13	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 8" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	13	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	14	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 8" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	14	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	15	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021

Structure	Bent	Row	Element	Shape	Material	Rating	Deterioration	Severity	Section Loss %	Dimensions (L x W x D)	Comments	Level II/III	Photo?	Photo #	Photo Comments	Date (MM/DD/YYYY)
FISHING PIER	15	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	16	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	16	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	17	A	Pile	Round	Timber	SV	None	-	-	-	100% Non-Bearing, cap supported by fish plates.	No	Yes	0077	100% Non-Bearing, cap supported by fish plates.	9/21/2021
FISHING PIER	17	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	18	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	18	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	19	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	19	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	20	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	20	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	21	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	21	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	22	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	22	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	23	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	23	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	24	A	Pile	Round	Timber	MJ	None	-	-	-	50% Bearing, Shims failing due to displacment	No	Yes	0072	Failing shims and 50% bearing.	9/21/2021
FISHING PIER	24	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	25	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	25	B	Pile	Round	Timber	SV	Broke	HVY	-	-	Top 18" of pile broke/overstressed	No	Yes	0021	Top 18" of pile broke/overstressed	9/21/2021
FISHING PIER	26	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	26	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	27	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	27	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	28	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	28	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	29	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	29	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	30	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021

Structure	Bent	Row	Element	Shape	Material	Rating	Deterioration	Severity	Section Loss %	Dimensions (L x W x D)	Comments	Level II/III	Photo?	Photo #	Photo Comments	Date (MM/DD/YYYY)
FISHING PIER	30	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	31	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	31	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	32	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	32	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	33	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	33	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	34	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	34	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	35	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	35	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	36	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	36	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	37	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	37	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	38	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	38	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	39	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	39	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	40	A	Pile	Round	Timber	SV	Broke	HVY	-	-	Top 18" of pile broke/overstressed	No	Yes	0057		9/21/2021
FISHING PIER	40	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	41	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	41	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	42	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	42	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	43	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	43	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	44	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	44	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	45	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021

Structure	Bent	Row	Element	Shape	Material	Rating	Deterioration	Severity	Section Loss %	Dimensions (L x W x D)	Comments	Level II/III	Photo?	Photo #	Photo Comments	Date (MM/DD/YYYY)
FISHING PIER	45	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	46	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	46	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	47	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	47	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	48	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	48	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	49	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	49	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	50	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	50	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	51	A	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	51	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021
FISHING PIER	52	A	Pile	Round	Timber	SV	Broke	HVY	-	-	Top 18" of pile broke/overstressed	No	Yes	0044	Top 18" of pile broke/overstressed	9/21/2021
FISHING PIER	52	B	Pile	Round	Timber	MN	None	-	-	-	New greenheart pile - 9-10" Diameter pile	No	No	-	-	9/21/2021

APPENDIX C

ASCE CONDITION ASSESSMENT RATING (CAR)

Table 2-14. Condition Assessment Ratings

Rating		Description
6	Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.
5	Satisfactory	Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.
4	Fair	All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
3	Poor	Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.
2	Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1	Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high-priority basis with strong urgency.

2.6.2 Condition Assessment Ratings

The Condition Assessment Rating should be assigned upon completion of the Routine Inspection and remain associated with the structural unit (as defined in Section 3.1.1) until the structure is rerated following a quantitative engineering evaluation and repairs, or upon completion of the next

Table 2-4. Damage Ratings for Timber Elements

Damage Rating		Existing Damage[a]	Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)]
NI	Not Inspected	• Not inspected, inaccessible, or passed by[b]	
ND	No Defects	• Sound surface material	
MN	Minor	• Checks, splits, and gouges less than 0.5 in. wide • Evidence of marine borers or fungal decay	Minor damage not appropriate if • Loss of cross section • Marine borer infestation • Displacements, loss of bearing, or connections
MD	Moderate	• Remaining diameter loss up to 15% • Checks and splits wider than 0.5 in. • Cross-section area loss up to 25% • Corroded hardware • Evidence of marine borers or fungal decay, with loss of section	Moderate damage not appropriate if • Displacements, loss of bearing or connections

(Continued)

Table 2-4. Damage Ratings for Timber Elements *(Continued)*

Damage Rating		Existing Damage[a]	Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)]
MJ	Major	• Remaining diameter loss 15 to 30% • Checks and splits through full depth of cross section • Cross-section area loss 25 to 50%; heavily corroded hardware • Displacement and misalignments at connections	Major damage not appropriate if • Partial or complete breakage
SV	Severe	• Remaining diameter loss more than 30% • Cross-section area loss more than 50% • Loss of connections and/or fully nonbearing condition • Partial or complete breakage	

[a] Any defect listed is sufficient to identify relevant damage grade.
[b] If not inspected due to inaccessibility or passed by, note as such.

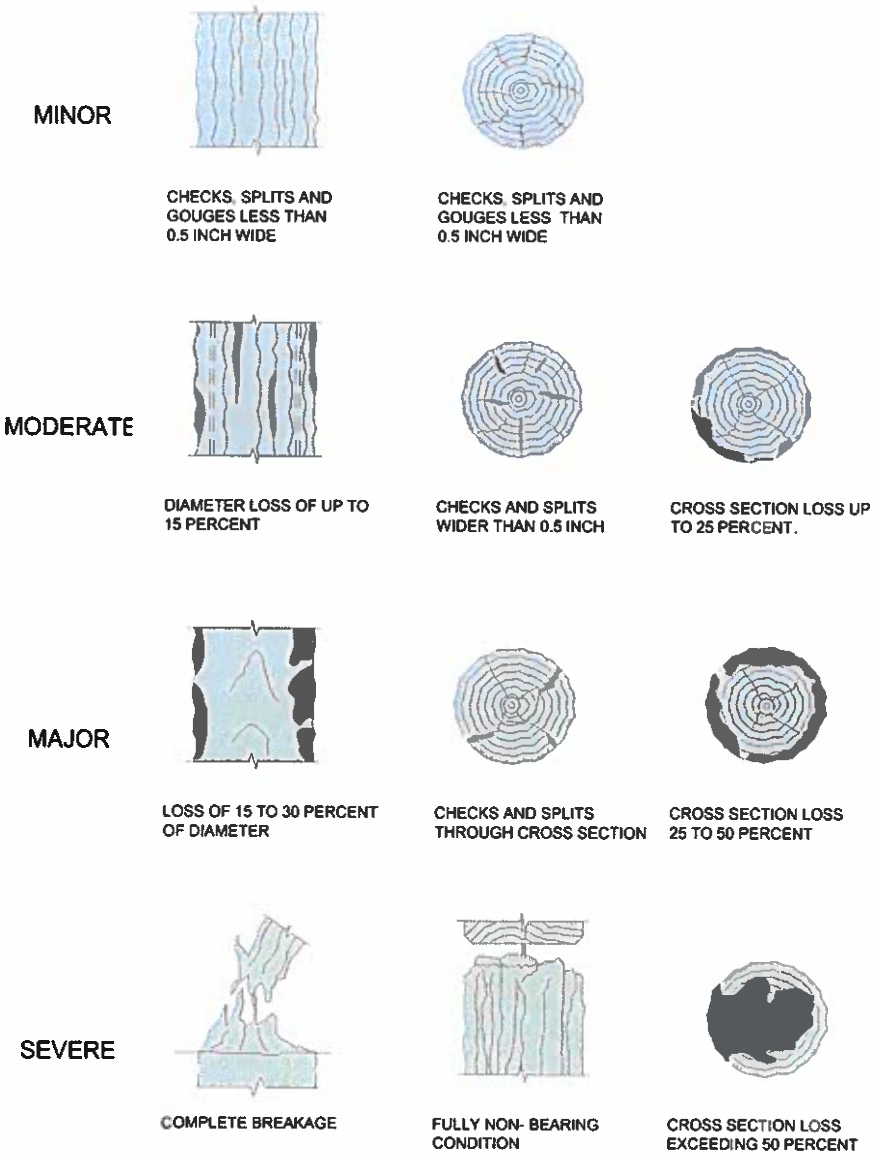


Fig. 2-2. Condition ratings for timber elements
Source: Courtesy of CH2M HILL, Inc. and Ben C. Gerwick, Inc., reproduced with permission.