AAPA
Facilities and Engineering Seminar

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San Diego, CA

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ATKINS

AAPA American Association of Port Authorities

Alliance of the Ports of Canada, the Caribbean, Latin America and the United States

Realizing the Value of Port Infrastructure Reinvestment Through Life Cycle Cost Analysis

-OR-

Everything is fine until it's not!

ATKINS

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Agenda

- Introduction of Atkins
- Project Identification
- The Process
- Inspection, Assessment, and Surveys
- Structural Testing
- Pre-Engineering
- Asset Management Integration

Atkins at a glance

- Atkins is one of the world's foremost engineering design consultancies. Established in 1938.
- A long-standing reputation for technical excellence in providing clients cost-effective and carbon-conscious solutions.
- 18,000 employees worldwide
- World's 15th largest global design firm (ENR 2014)
- 2,700 US Employees in 80 offices

Who we are: vision and mission

ATKINS

Vision

To be the world's best infrastructure consultancy

Mission

Plan Design Enable

Plan

From cost and risk planning, feasibility studies and logistics, to impact assessments and stakeholder engagement activity, we plan every aspect of our clients' projects.

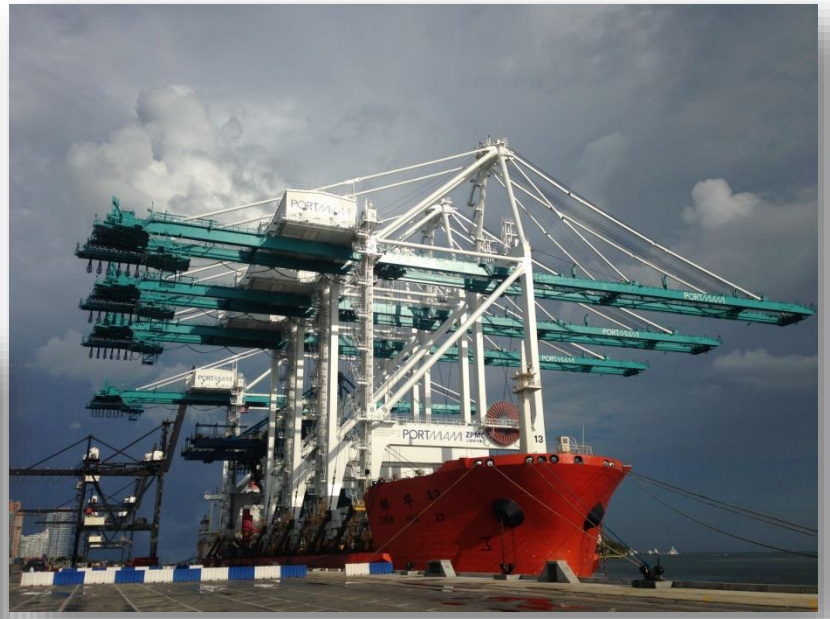
Design

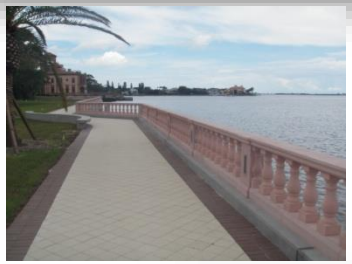
Atkins designs intellectual capital such as management systems and business processes. We also design physical structures such as office towers, schools, bridges and highways.

Enable

Our clients entrust us with the management of projects, people and issues – ensuring that deadlines are met, costs are controlled, and success is delivered.

Ports & Terminal Group





Ports and Terminals
Atkins Cross Practice Integration

ATKINS

PORTS and COASTAL

- Program management
- Emergency response

Landside

- Planning
- Cruise facilities
- Cargo facilities
- Structures
- Rail yards
- Infrastructure
- Warehousing
- Security and Administrative Facilities

Waterside

- Physical modeling
- Dredging
- Aids to navigation
- Structures
- Off-shore
- Marina facilities
- Beach management
- Beach nourishment

TRANSPORTATION

- Planning
- Roadways
- Multimodal
- Structures
- Tolls

PROCESS ENGINEERING

- Upstream , midstream, downstream refining and terminals
- Greenfield and brownfield development projects
- Onshore facilities (production, processing, terminal, tank farm)
- Offshore facilities (subsea)
- Front end process design and technology selection
- Multidisciplinary feasibility, concept and FEED studies
- Production operations support

CONSTRUCTION SVCS

- Contracting
- Construction inspection
- Long-range scheduling

ENVIRONMENTAL

- Ecological studies
- NEPA process
- Permitting
- Hazardous waste
- FATE modeling
- Resource mapping
- Archeology
- Environmental damage assessments

The Process

- Collect Existing Information
- Initial Visual Inspection
- Assessment, Testing and Evaluation
- Preliminary Basis of Design
- Options Analysis and Cost Estimates
- Re-evaluate the Basis of Design and Options vs Operational Requirements and Budget

Decision Drivers

- Safety
- Operational Requirements
- Cost, Budget and ROI
- Strategic Plan
- Tenant Requirements

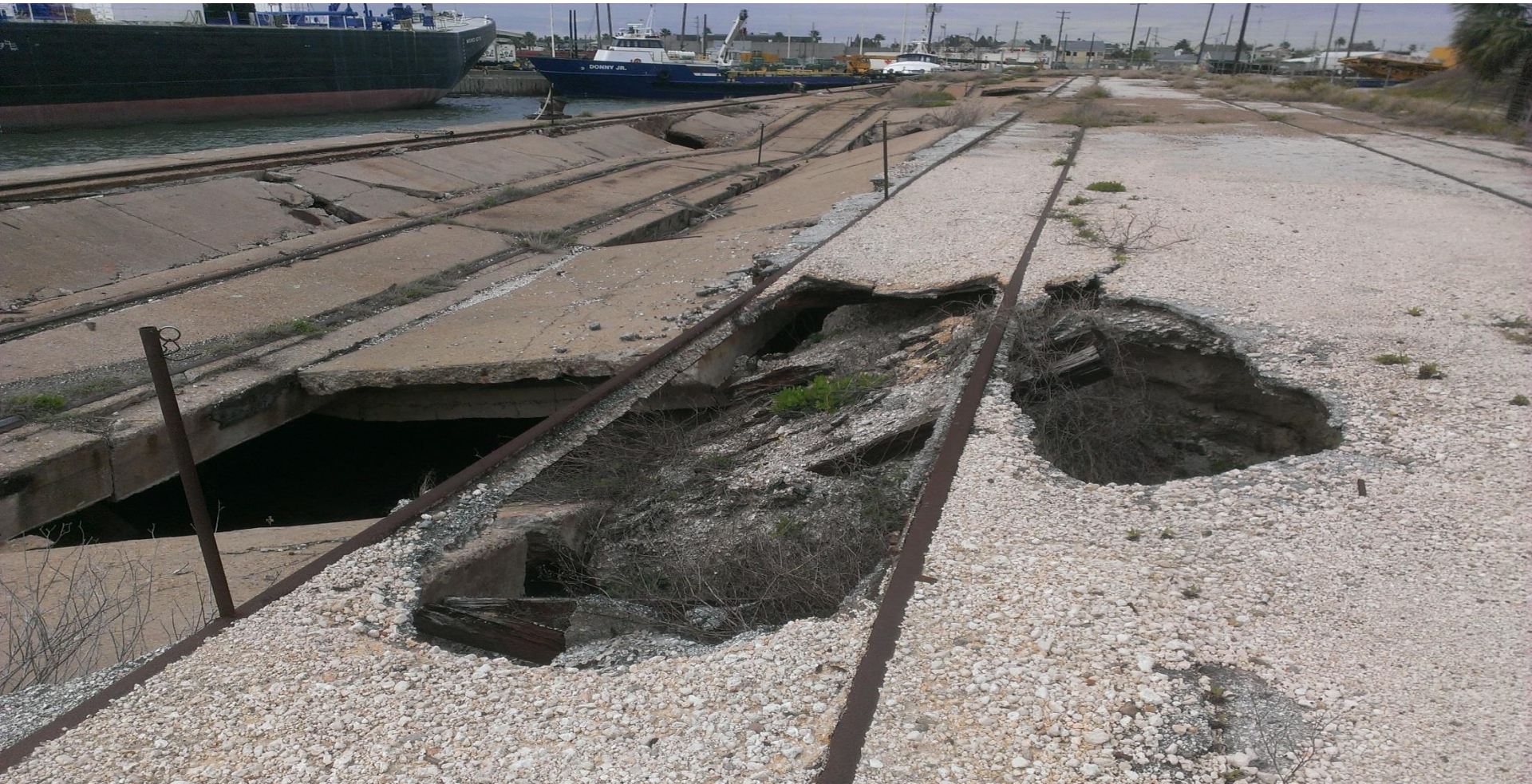
Project Identification:
What type of project do you have?

- **Repair and Rehabilitate – Hold the line**
- **Upgrade - Improve**
- **Demolish and Replace – Start over**

Repair and Rehabilitate?

Upgrade?

Demolish and Replace?



Assessment Phase: Surveys

1. Above and below deck Land Surveying
2. Bathymetric and Multi-Beam Survey
3. Subsurface Utility Investigation: Stormwater, Product Lines, Electric, Communications, Etc.

Geotechnical Data Goals

- Axial capacity of existing as well as proposed piles
- Lateral capacity of piles
- Physical properties of soils: Strength, Reactivity, Etc

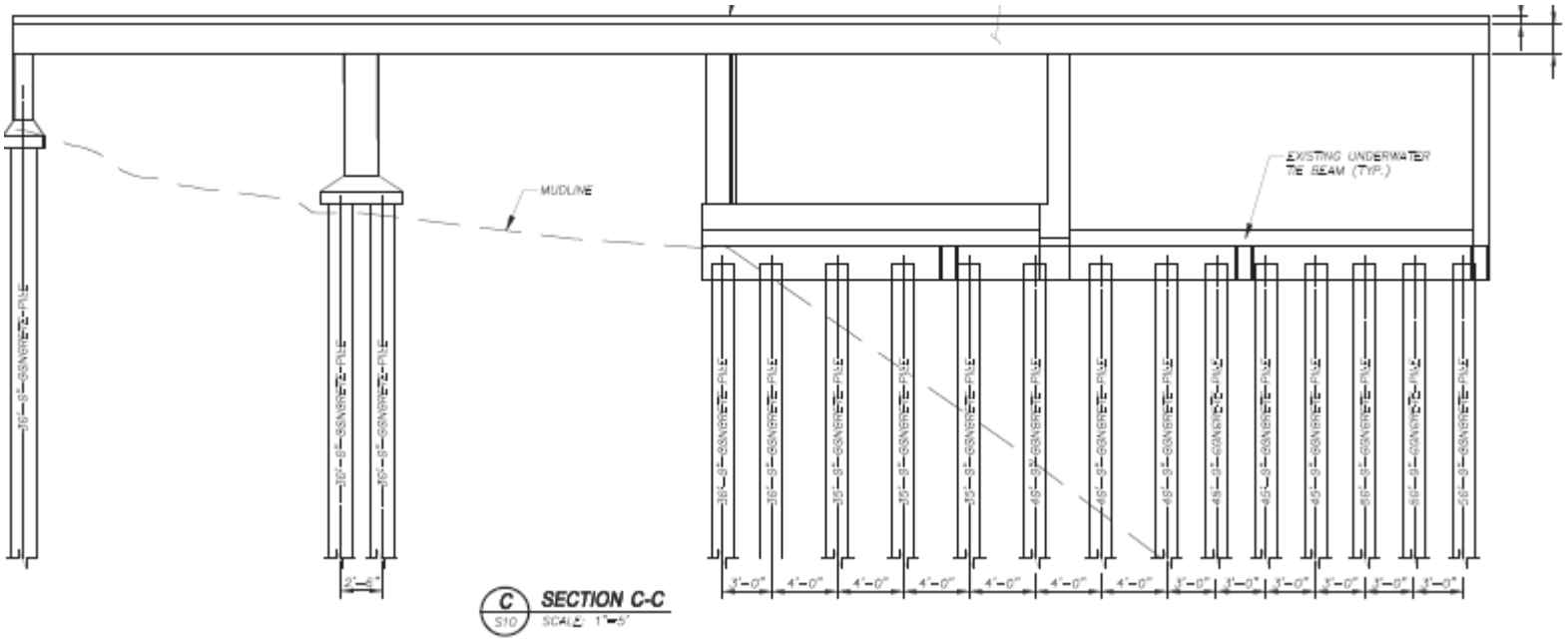
Geotechnical Findings

Description	Plasticity Index (%)	Moisture Content (%)	Moisture Content vs. Plastic Limit[1]	Undrained Shear Strength[2] (psf)	SPTN-Value[3] (bpf)	Percentage of Fines[4] (%)
Silty Sand	NP[5]	12 to 13	---	---	2 to 4	25 to 26
Fat Clay	29 to 62	23 to 75	-1 to +53	700 to 3100	WOH[6] to 16	90 to 99
Lean Clay and Sandy Lean Clay	8 to 29	20 to 35	+2 to +16	1100 to 2500	WOH[6] to 16	69 to 100
Silt and Sandy Silt	3	26	+9	---	WOH[6] to 2	---
Clayey Sand, Silty Sand, and Sand	3	20 to 24	+4	---	2 to 9	6 to 36

Elevation[2] (feet)	Estimated Unit Wt. (pcf)	Effective Unit Weight[3] (pcf)	Soil Type	LPILE Soil Type Number[4]	Lateral Subgrade Modulus (pci)	Strain (in/in)	Undrained Shear Strength (psf)	Angle of Internal Friction (degrees)
+12 to +5	120	--	Sand	5	25	--	0	26
+5 to -2	115	53	Sand	5	20	--	0	25
-2 to -26	120	58	Clay	1	--	0.020	200	0
-26 to -36	125	63	Clay	3	--	0.007	1000	0
-36 to -46	125	63	Clay	3	--	0.007	1500	0
-46 to -58	125	63	Clay	3	--	0.007	1700	0
-58 to -78	120	53	Clay	3	--	0.007	2000	0

Typical Structural Assessment

- Tactile and Visual Structural Inspection
  - Above Water Structural Inspection
    - Top of Slab
    - Bottom of slab to water surface
  - Underwater Structural Inspection

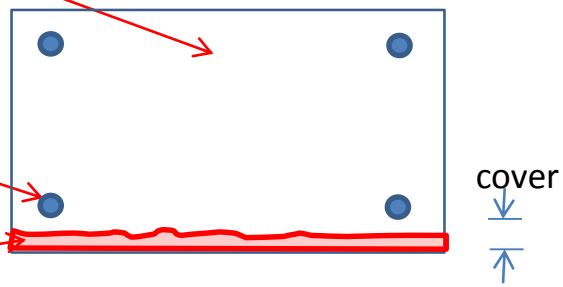


Materials Assessment / Testing

Concrete compressive strength evaluation destructive and non-destructive coring and Schmidt hammer tests

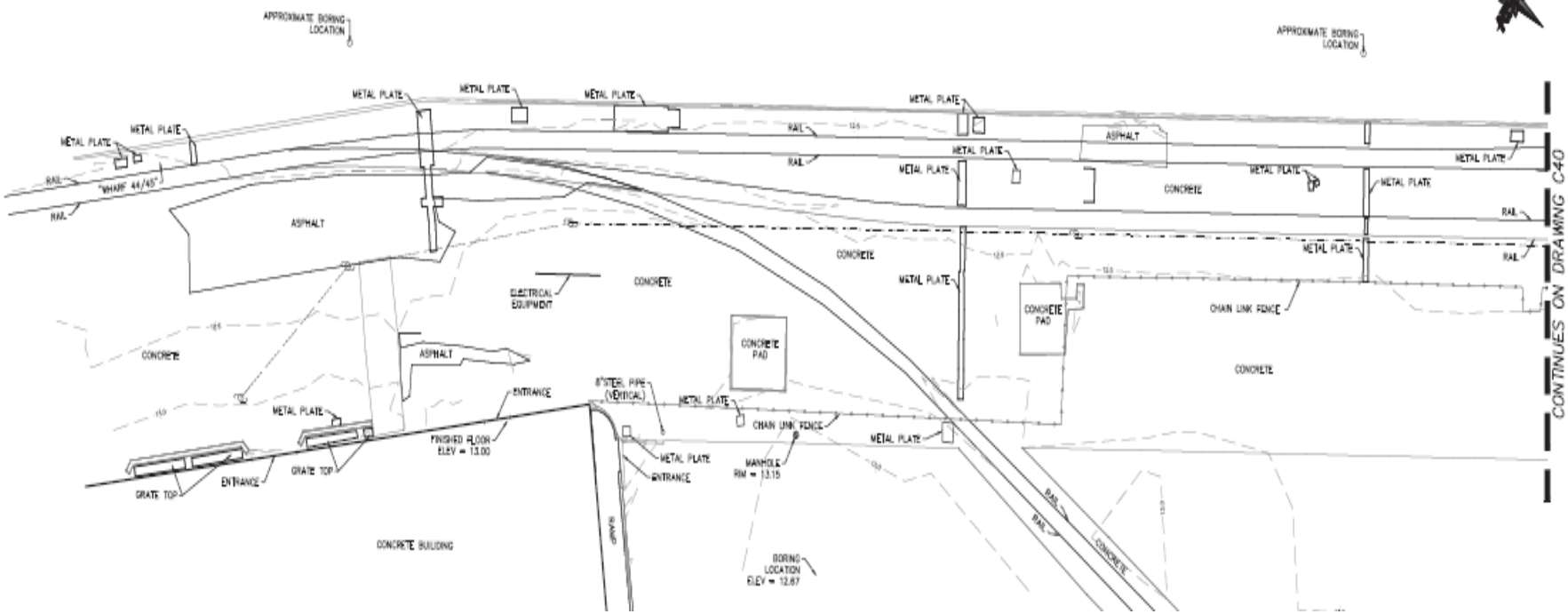
Rebar investigation (using Ground Penetrating Radar)

Carbonation depth testing

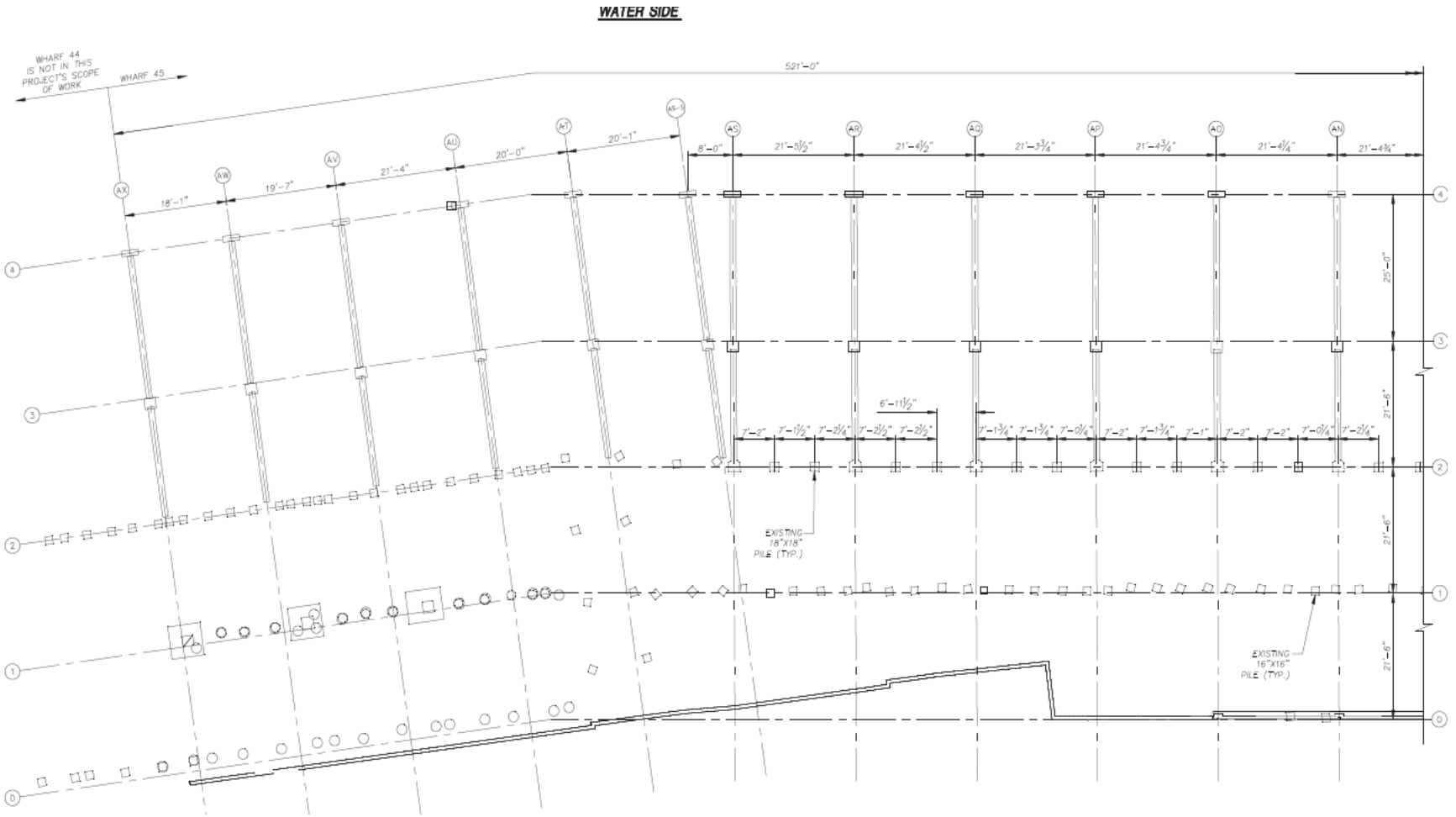


Typical structural cross sections

Topside Survey: Features Structures



Below-Deck Survey: Location and geometry of existing elements

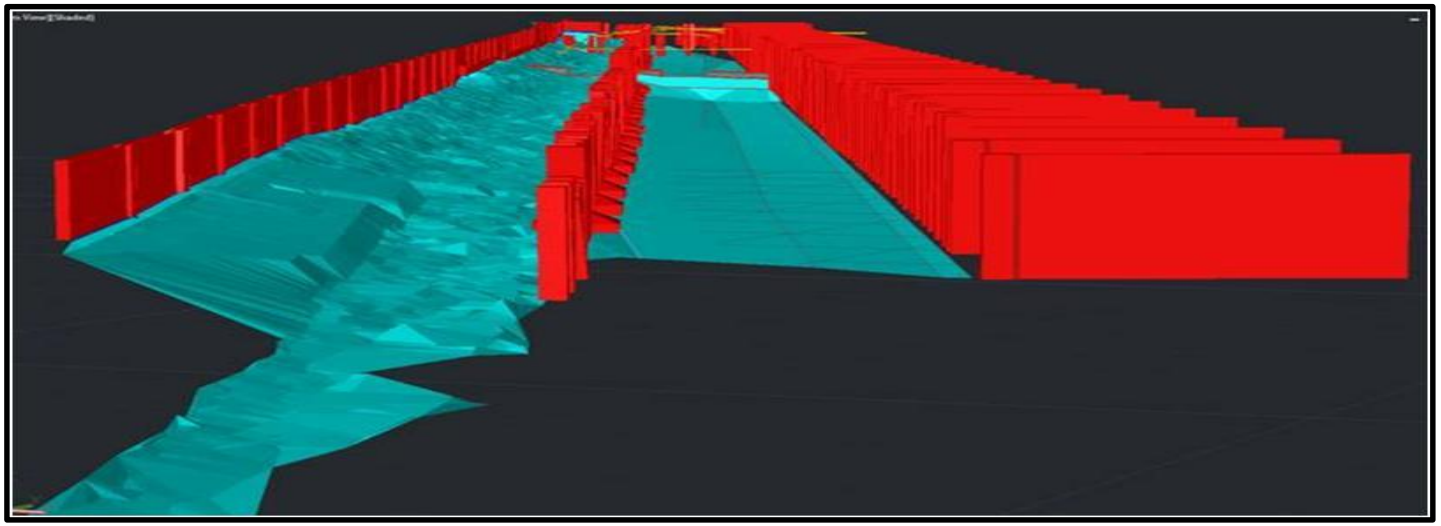


Underwater Multi-beam Bathymetric Survey

- Similar to the above water 3D imaging, provides mudline as well as structural/foundation elements information
- Provides information concerning piles and their location
- Combines with the above-water imaging in the 3D model
- No Surprises, nothing unexpected detected
- Useful for design including slope-stability analysis

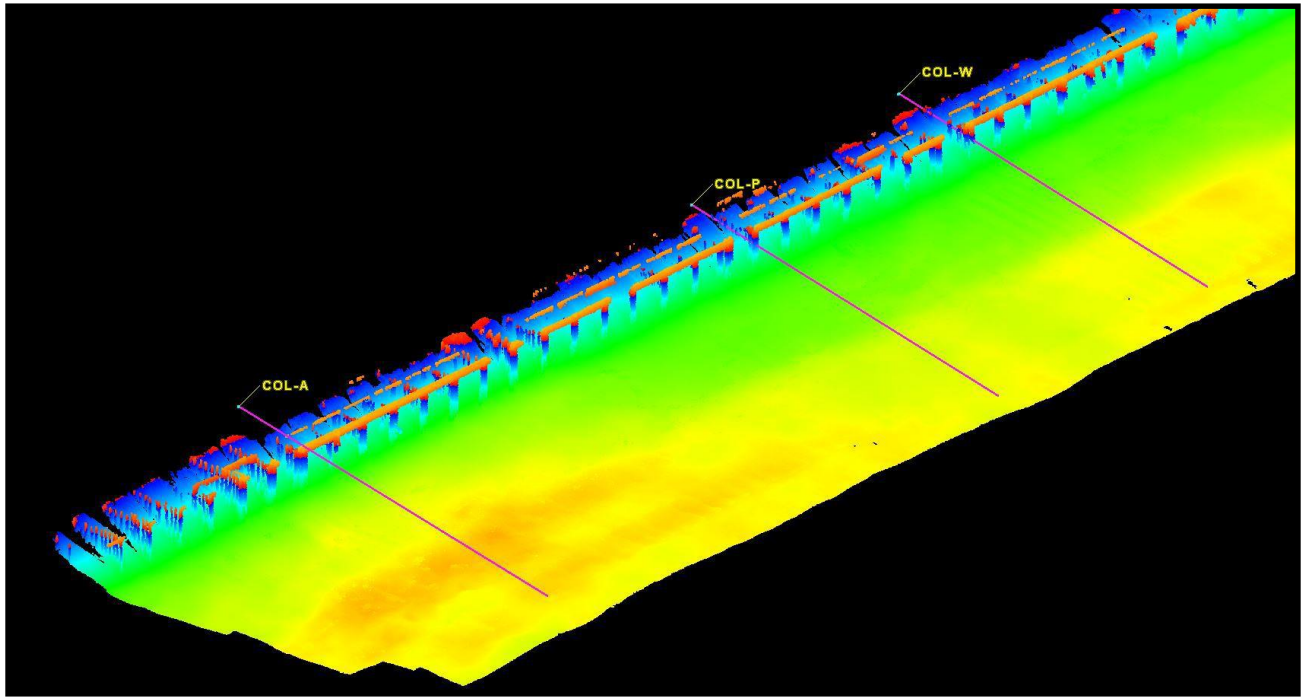
Utility Survey

3D Model



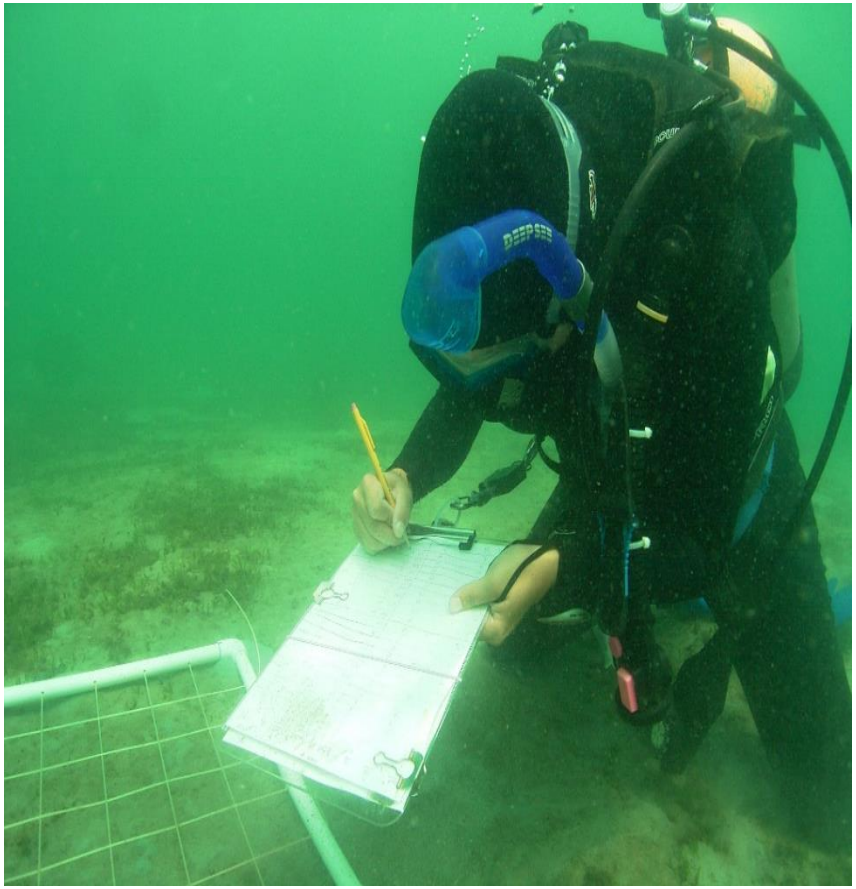
The 3D model is similar to as-built drawings. It can be a very effective tool in planning work due to it's accuracy.

Bathymetry and multi-beam survey

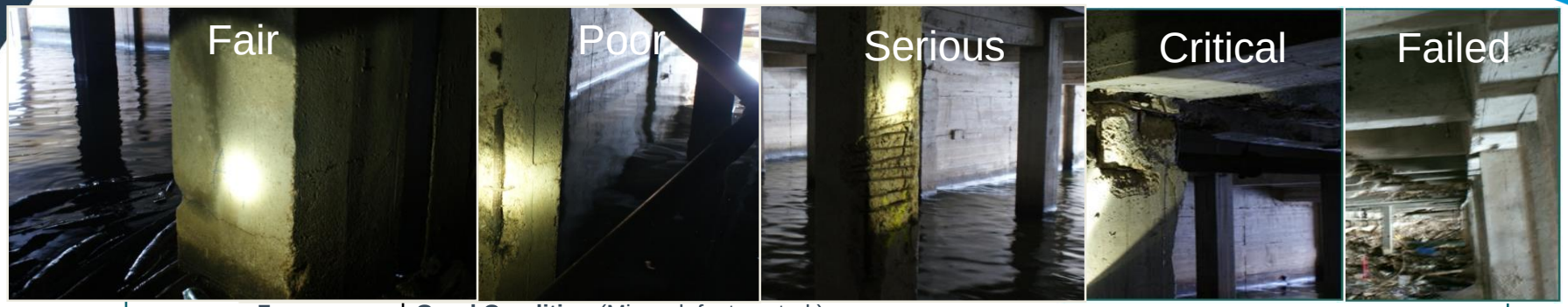


3D Rendering of the Site

What should you look for?



ASCE Structural Inspection Rating System



7	**Good Condition** (Minor defects noted.)
6	**Satisfactory Condition** (Structural elements show some minor deterioration.)
5	**Fair Condition** (All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.)
4	**Poor Condition** (Advanced section loss, deterioration, spalling, or scour.)
3	**Serious Condition** (Loss of section, deterioration, spalling, or scour have seriously affected the primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.)
2	**Critical Condition** (Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed structural support. Unless closely monitored, it may be necessary to close the structure until corrective action is taken.)
1	**Failed Condition**

Sample Sub-water Results

- Only water side piles are inspected
- 95% of the piles are in excellent condition
- All piles are found to be 18”x18” square concrete piles versus 16”x16” shown on plans. Depth to mudline confirmed.
- Inspection discovered beams connecting the bents

Total number of piles	1294
Number of piles inspected	645
Number of piles in rating 1-4	30 (5%)
Number of piles in rating 5 or better	615 (95%)

Underwater Inspection

Underwater Beams

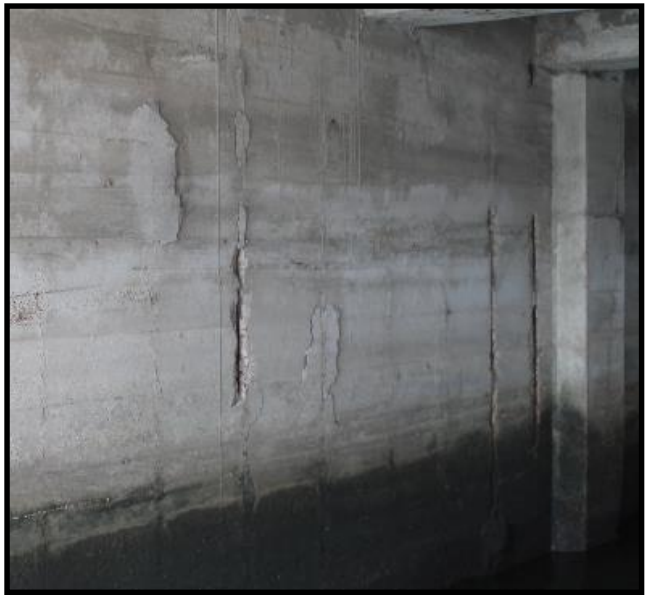
Above Water Structural Inspection: Beams

Number of beams/Pile caps	686
Number of beams in rating 1-4	518 (~75%)
Number of Beams in rating 5-6	168 (~25%)

Above Water Structural Inspection: Columns

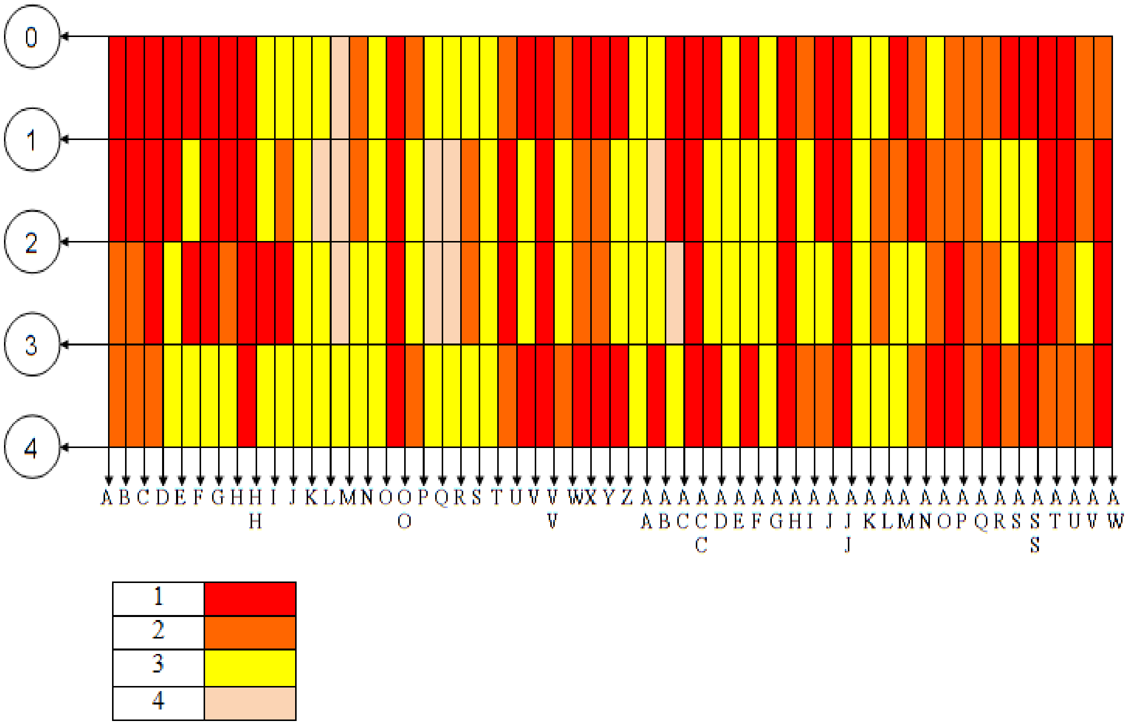
Number of columns	529
Number of columns with rating 1-4	271 (51%)
Number of columns with Rating 5-6	258 (49%)

Above Water Structural Inspection: Shear Walls



Number of shear wall segments	106
Number of shear wall segments in rating 1-4	27 (~25%)
Number of shear wall segments in rating 5-6	79 (75%)

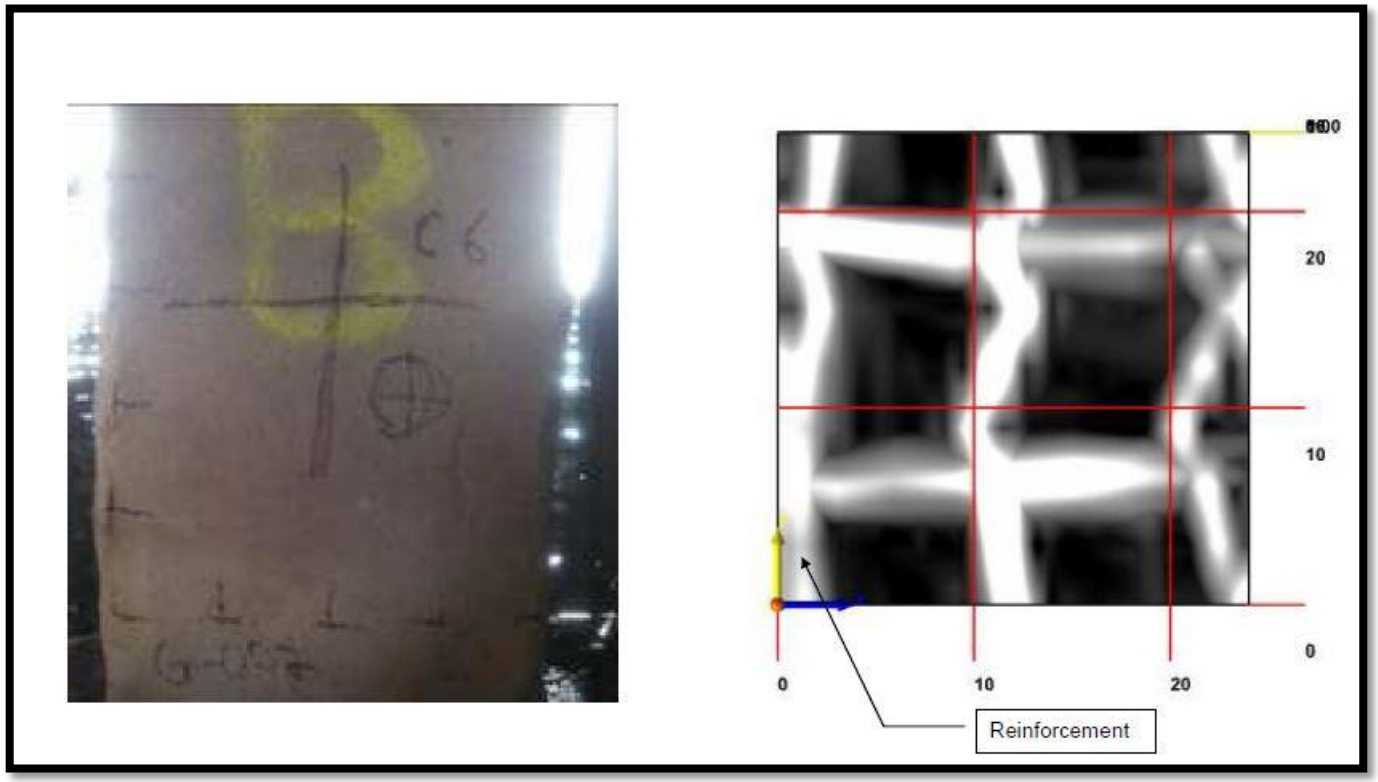
Structural Slab Inspection



Number of slab segments	232
Number of segments in rating 1-4	232
Rating 5-6	0

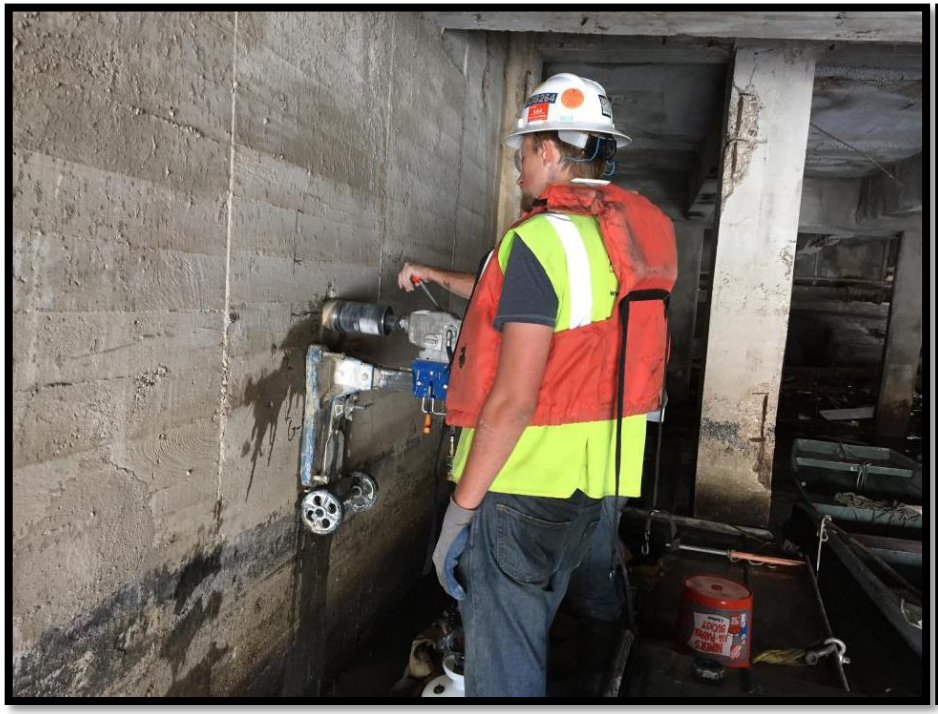
GPR Scan to Locate Rebar

GPR Scan to Locate Rebar

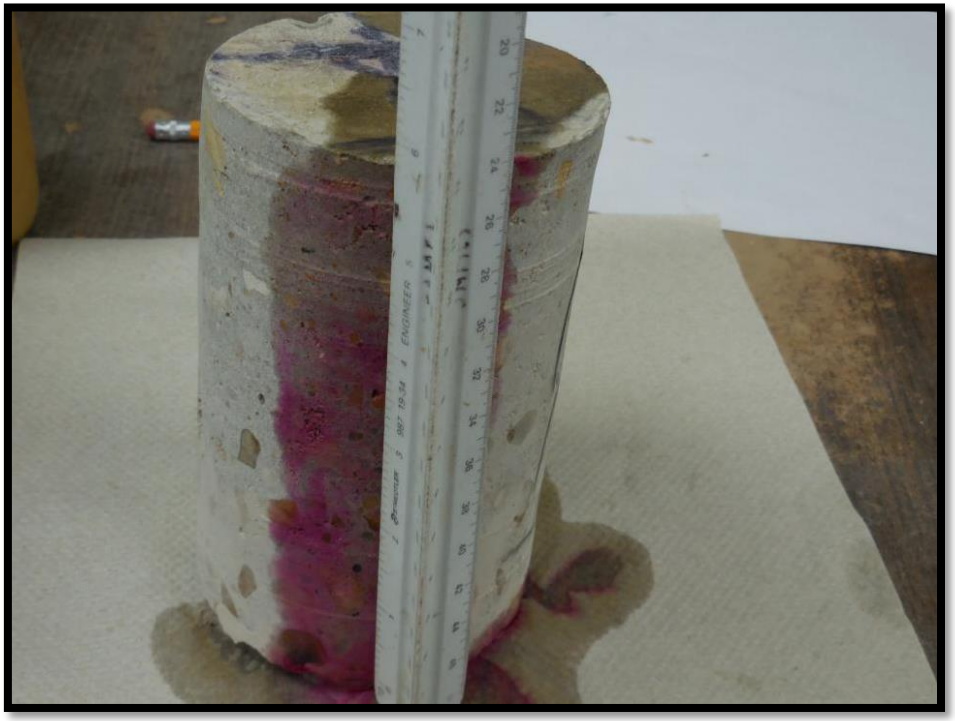


Schmidt Hammer Test – non-destructive test for surface concrete

Concrete Coring: to confirm concrete properties, perform Carbonation Depth Test

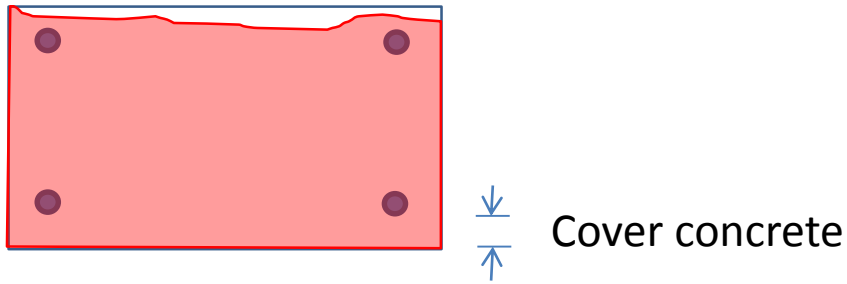


Carbonation Depth Test



Structural Material Testing: Durability

- If Chemical ingress depth has exceeded the cover concrete, then there will be continued, unabated, rebar corrosion



Typical structural cross sections

Structural Material Testing: Concrete

No.	Structural Entity	Average Compressive Strength (psi)	Standard Deviation (psi)
1	Row - 0 piles/walls	2984	246
2	Row -1 24" columns	3386	155
3	Row -1 16" columns	2902	237
4	Shear walls	3246	214
5	Row 2 shear wall columns	3598	471
6	Row 2, 18" columns	3233	326
7	Row 3 shear wall columns	3458	556

- Concrete compressive strength reliably above 3000psi and low variability
- More than 100 rebound hammer tests show reliable concrete compressive strength throughout the structural members

Topsides Assessment: Hardware/Fenders

Establishing the Basis of Design

- Operational Requirements – Now and the foreseeable future
  - Cargoes to be handled and methods
  - Vessel characteristics
  - Barges vs ships
- Structure strength and capacity
- Single tenant or general purpose
- Design life
- Access issues
- Rail and intermodal requirements

Pre-Engineering Methodology

- Evaluate methodologies based on planned uses
- Foundations analysis in APile and LPile
- Structural sections based on current ACI design process
- Fenders designed based on berthing energy analysis
- Finite Element Analysis dolphin foundations
- Costs estimates based on actual quotes from manufacturers, suppliers and local contractors

Project Example

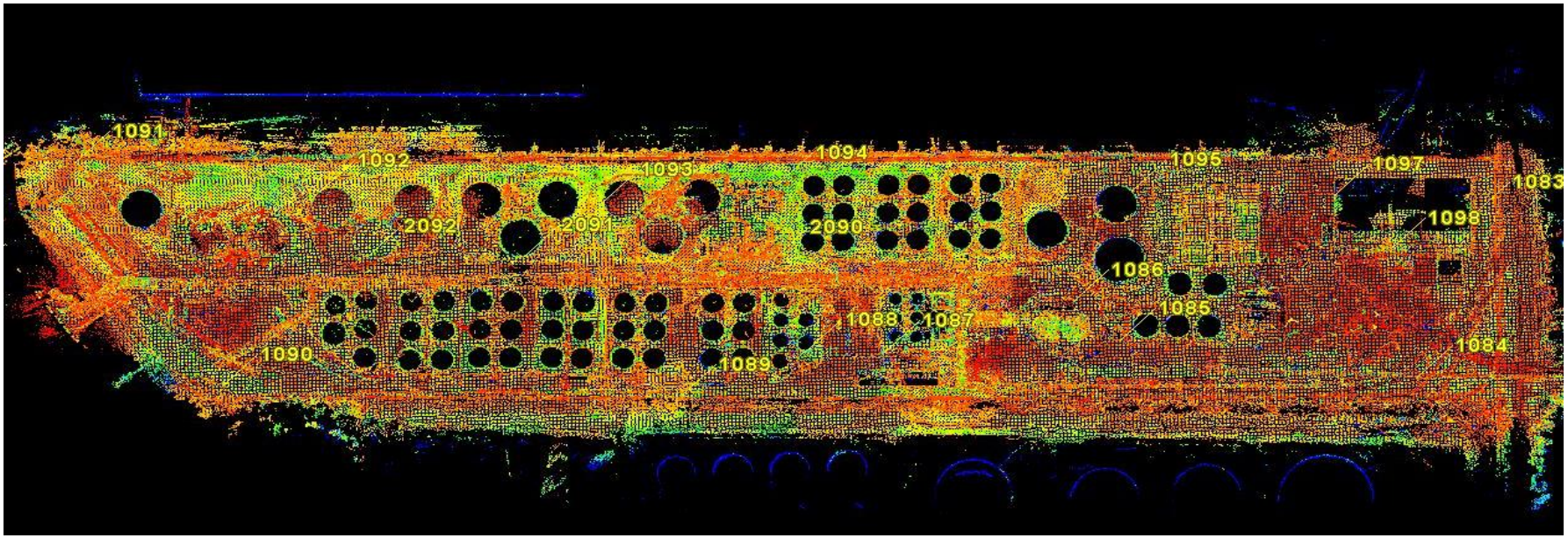
Before

After

Integrating Asset Management into the Process

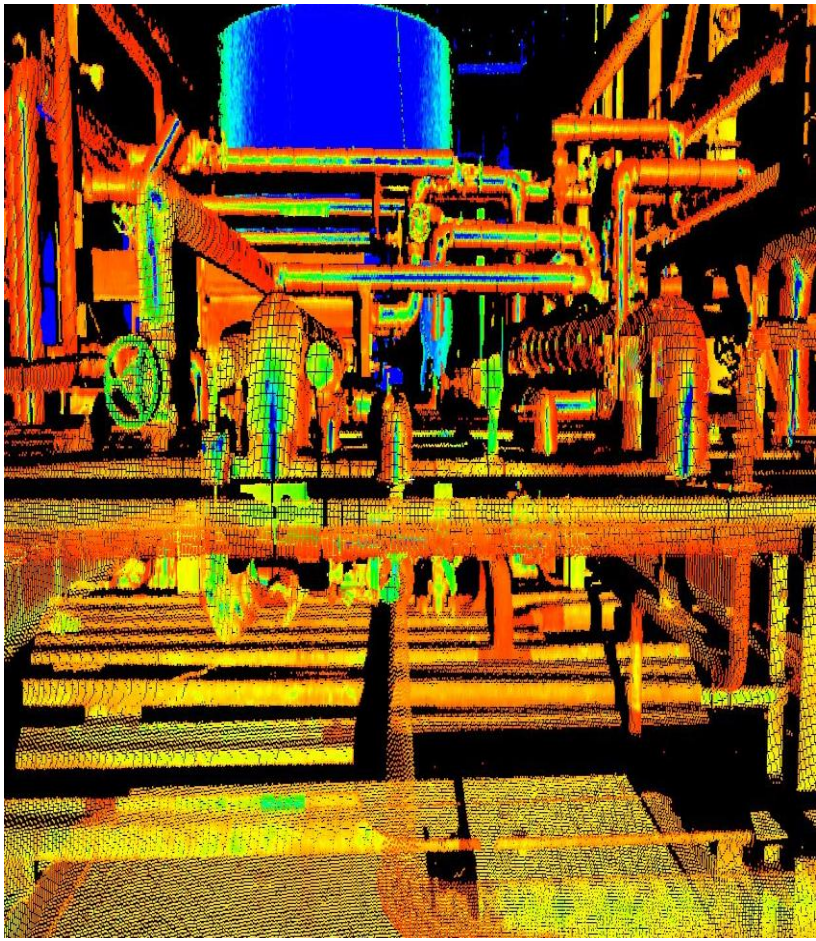
Asset Management

Optimize life-cycle costs and facilitate asset preservation
GIS technology with ESRI's latest ArcGIS server platform

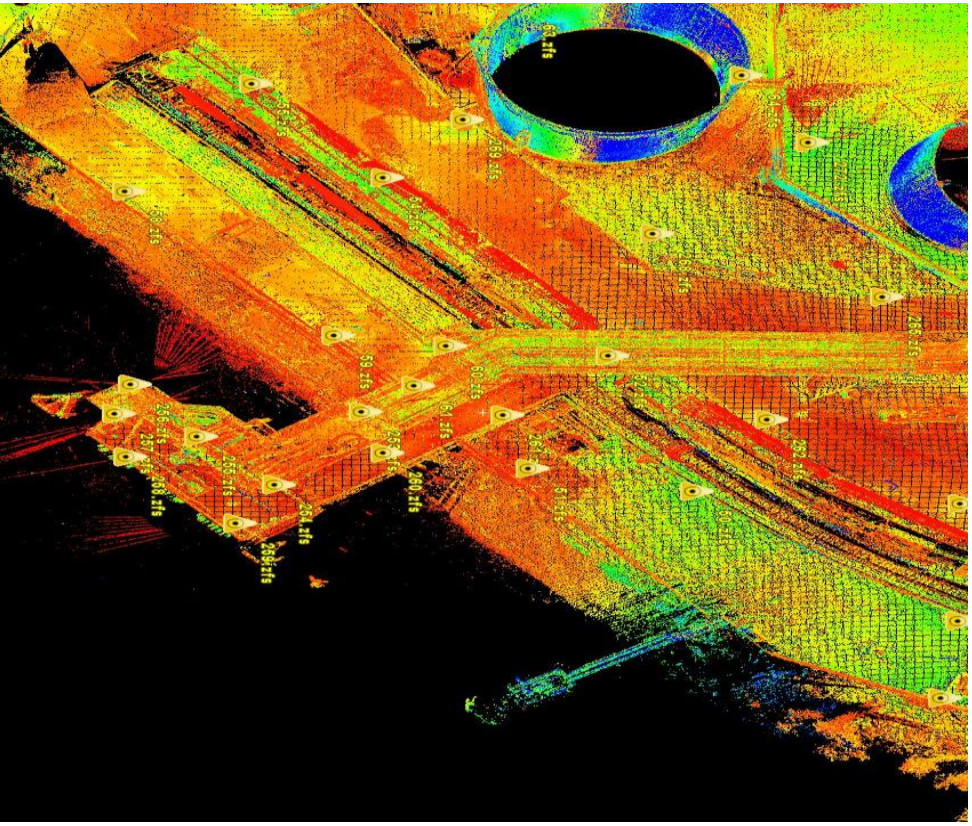


High-definition Surveying

- Terrestrial laser scanning
- 3D Models & 4D Visualization
- Digital terrain models
- Ortho-rectified imagery
- Sections, elevations & profiles
- Structural & site plans
- Surface deviation analysis
- 2 & 3 dimensional planimetrics
- Vertical & horizontal clearances



Marine Structural Applications



- Provides terminal operators with a tool to better manage assets; readily access record drawings and facility infrastructure information.
- Enhanced decision support
- Increased accessibility
- Improved collaboration and consensus development
- Platform standardization

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Thank you!

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