USACE LA District and Fugro Utilize Vessel-based Mobile Laser Scanning and Bathymetry Survey Techniques to conduct Comprehensive Condition Surveys of Four District Breakwaters

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Why?

- The U. S. Army Corps of Engineers’ portfolio of Civil Works infrastructure is valued more than $232 Billion.
- As stewards of these assets, we are responsible to sustain them at their optimal level of performance.
- There will likely be continued competition for scarce public resources.
- Asset Management Goals: Transparent, risk-based investment decision business process.
Los Angeles District Nav Portfolio

- 14 Harbors.
- 38 Coastal Structures.
- 1st Authorized Project in 1852
- Initial Construction in 1890s thru 1990’s.
- Repairs and rehab between 1900’s and 2010.
STEPS

1. Maintain Accurate Inventory of all assets.
2. Keep current Condition Assessments.
3. Determine Impacts, Consequences and Risk.
5. Balance benefits, risks, and consequences over the life-cycle.
6. Identify USACE assets to be considered for divestiture.
# Coastal Navigation Structures Condition Rating

<table>
<thead>
<tr>
<th>Damage Condition levels</th>
<th>CNS Structural Condition Rating (SCR) Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insignificant damage or defects - A</td>
<td>Only small areas of the structure show signs of deterioration, which is considered to be insignificant.</td>
</tr>
<tr>
<td>Minor damage or defects - B</td>
<td>Minor deterioration is noted over small areas of the structure.</td>
</tr>
<tr>
<td>Moderated damage or defects - C</td>
<td>Moderate deterioration of materials is noted over many areas of the structure.</td>
</tr>
<tr>
<td>Seriously Degraded - D</td>
<td>Deterioration of materials is noted over a significant area of the structure.</td>
</tr>
<tr>
<td>Completely Degraded - F</td>
<td>More than 50% of materials composing the structure show signs of extreme deterioration.</td>
</tr>
</tbody>
</table>

2. There is no evidence that the structure has a critical design flaw or has been significantly compromised by environmental factors. In this case, the structure is considered to be in good condition. | There is no evidence that the structure has a critical design flaw or has been significantly compromised by environmental factors. In this case, the structure is considered to be in good condition. |

3. The structure is showing deterioration that may require repair in the near future. | The structure is showing deterioration that may require repair in the near future. |

4. The structure is in poor condition and may require significant repairs. | The structure is in poor condition and may require significant repairs. |

5. The structure is in very poor condition and may require extensive repairs or replacement. | The structure is in very poor condition and may require extensive repairs or replacement. |
How?

Integrate bathymetry with a topographic data to close the gap between surface and underwater topography.

Complete survey crossing the water/land interface.
Bathymetric (seafloor) terrain surveys

Multibeam bathymetric echosounder (MBES):

- Creates *swathes* of survey data (not just a single beam)
- Creates continuous seafloor map
- Variable swath width (width vs. detail) and can be rotated
Bathymetric (seafloor) terrain surveys
With Rotated Sensor

Rotated Multibeam Sensor for surveying laterally to the waterline
Integrated Data Collection from Vessel

A survey that integrates bathymetry with a topographic data can close the gap between surface and underwater topography.
Integrating Bathymetry and Laser Scanning

**Multibeam Bathymetry Echosounder (MBES) Data**
- Sonar (sound) based ranging technology
- Wide coverage on both sides of vessel
- Millions of individual point observations
Integrating Bathymetry and Laser Scanning

Mobile Laser Scanning Data (LiDAR)
- Laser (light) based ranging technology
- Scan land and features beside vessel
- Millions of individual point observations
Four Breakwaters, Two Sites

San Pedro Breakwater

Dana Point West

LA/LB Middle Breakwater

Dana Point East
Four Breakwaters, Two Sites

Port of Los Angeles

San Pedro Breakwater

Port of Long Beach

LA/LB Middle Breakwater
Breakwater Survey: San Pedro, California
Harbor & Breakwater Survey: Dana Point

Data density:
- **Scanner:**
  - Horizontal = 0.10 m
  - Vertical = 0.05 m
  - Survey speed = 2.5 – 3.5 knt
- **Multibeam:**
  - Horizontal Resolution = 1 m
  - Survey speed = 4.5 knt
Breakwater Survey: Middle Breakwater
Editing Point Cloud to Create Surface
Dana Point w/ Multibeam and Scanner Data
Breakwater and Harbor Chart
Dana Point - Cross Section Through Main Channel

Notes:
1. Elevations in meters
2. Vertical datum: MLLW
3. Distances in meters
Cross-Section Comparisons: Condition vs. Design

Breakwater Cross Section
Current Condition and Construction Design

Cross-section comparisons highlight the condition vs. design for both harbor and ocean sides, marked with station 15+00.
Cross-Section Comparisons: Present vs. Historical

USACE SAN PEDRO BREAKWATER COMPREHENSIVE CONDITION SURVEY
STATION NUMBER 48+50

BREAKWATER CROSS SECTION
CURRENT CONDITION AND CONSTRUCTION DESIGN
**SCR by FCR = DCR**

### CNS Functional Condition Rating (FCR) Table

<table>
<thead>
<tr>
<th>Level of Functionality</th>
<th>F</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>SCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full -- A</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>Sufficient -- B</td>
<td>D</td>
<td>F</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>II</td>
</tr>
<tr>
<td>Reduced -- C</td>
<td>C</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>III</td>
</tr>
<tr>
<td>Severely Degraded -- D</td>
<td>B</td>
<td>D</td>
<td>C</td>
<td>B</td>
<td>B</td>
<td>IV</td>
</tr>
<tr>
<td>Completely Degraded -- F</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>V</td>
</tr>
</tbody>
</table>

#### 5x5 Matrix for combining Structural Condition Rating (SCR) and Functional Condition Ratings (FCR) to select a resulting District Condition Rating (DCR) for application in the Tier 1 Approach for Asset Management Portfolio Condition Assessments

### Coastal Navigation Structures

#### Consequence/Economic Impact Category

<table>
<thead>
<tr>
<th>Consequence Category</th>
<th>Consequence Rating Criteria</th>
</tr>
</thead>
</table>
| I                    | 1. Demonstrated highest economic impact⁴  
2. Imminent life safety impact  
3. Critical to safe navigation by commercial vessels at High Use Navigation Project (>10 million tons)  
4. Critical to safe navigation at DoD Strategic Ports |
| II                   | 1. Demonstrated High economic impact⁴  
2. Probable life safety impact  
3. Probable impacts to subsistence harbors/critical harbors of refuge.  
4. High economic loss (5 - 10 million Tons)  
5. Alternate modes of transportation exist for Energy Distribution Facilities, but at a higher cost than waterborne transportation |
| III                  | 1. Demonstrated Moderate economic impact⁴  
2. Possible life safety impact  
3. Possible impacts to subsistence harbors/critical harbors of refuge.  
4. Moderate economic loss (1 – 5 Million Tons) |
| IV                   | 1. Low economic impact⁴  
2. Little impacts to subsistence harbors/critical harbors of refuge.  
3. Low economic impact (<1 million Tons)  
4. No life safety impact |
| V                    | 1. Negligible economic impact. No impacts to subsistence harbors/critical harbors of refuge.  
2. Negligible economies (Recreation Harbors, No commercial Activity)  
3. No life safety impact |

1. Thresholds and basis for economic impact are under development. One measure of economic impact can be demonstrated using rate savings, benefit, transportation cost savings, or damages avoided.  
2. SCR at this rating are generally not considered for short-term investments, such as engineering, construction, and minor maintenance, to save costs and extend the life of the facility, but are monitored for long-term investments, such as replacement.  
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**Notes:**
1. Design and safety, etc.  
2. SCR at this rating are generally not considered for short-term investments, such as engineering, construction, and minor maintenance, to save costs and extend the life of the facility, but are monitored for long-term investments, such as replacement.  
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Thank-you for Your Time

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