SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

DESIGN
INVESTIGATE
REHABILITATE

Condition Inspection of Marine Structures

ICRI Fall Convention
November 2017

Presented by:
Julie A. Galbraith, P.E.
Simpson Gumpertz & Heger, Inc.

Presentation Outline

- Importance of Inspections
- Types of Inspections
- Inspection Team
- Methodology & Criteria
- Condition Ratings

Why do Inspections?

- Necessary Maintenance!
- Deterioration rate varies
- Damage not always visible
- Lower repair cost if addressed sooner

Types of Inspection

- Routine inspections
- Repair inspections
- Post-event inspections
- Due diligence
- New construction
- Baseline Inspection – new or first routine

Routine Inspection

- Many public/private agencies; bridges
- CBC Chapter 31F (MOTEMS) – California
- 3 Levels
- Overall condition of structure (CAR)
- Recommendations for future maintenance
- Inspection on 2-6 year schedule

Routine Inspection

TABLE 31F-2-1
MAXIMUM INTERVAL BETWEEN UNDERWATER INSPECTIONS (YEARS)[1]

INSPECTION CONDITION ASSESSMENT RATING (CAR)[2]	CONSTRUCTION MATERIAL					
	Unwrapped Timber or Unprotected Steel (no coating or cathodic protection)[3]		Concrete, Wrapped Timber, Protected Steel or Composite Materials (FRP, plastic, etc.)[3]		CHANNEL BOTTOM OR MUDLINE—SCOUR[4]	
	Benign[3] Environment	Aggressive[3] Environment	Benign[3] Environment	Aggressive[3] Environment	Benign[3] Environment	Aggressive[3] Environment
6 (Good)	6	4	6	5	6	5
5 (Satisfactory)	6	4	6	5	6	5
4 (Fair)	5	3	5	4	6	5
3 (Poor)	4	3	5	4	6	5
2 (Serious)	2	1	2	2	2	2
1 (Critical)	N/A[5]	N/A[5]	N/A[5]	N/A[5]	N/A[5]	N/A[5]

1. The maximum interval between Underwater Inspections shall be changed as appropriate, with the approval of the Division, based on the extent of deterioration observed on a structure, the rate of further anticipated deterioration or other factors.
2. Benign environments include fresh water and maximum current velocities less than 1.5 knots for the majority of the days in a calendar year.
3. Aggressive environments include brackish or salt water, polluted water, or waters with current velocities greater than 1.5 knots for the majority of the days in the calendar year.
4. For most structures, two maximum intervals will be shown in this table, one for the assessment of construction material (timber, concrete, steel, etc.) and one for scour (last 2 columns). The shorter interval of the two should dictate the maximum interval used.
5. MOTs rated "Critical" will not be operational, and Emergency Action shall be required in accordance with Table 31F-2-6.
6. ICARs shall be assigned in accordance with Table 31F-2-4.

Repair Inspections

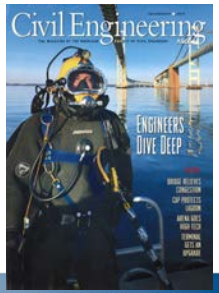
- Inspection of specific parts of the structure
- Detailed documentation of defects
- Becomes the basis for:
  - Selection of repair methodology
  - Development of repair bid documents

Post Event Inspections

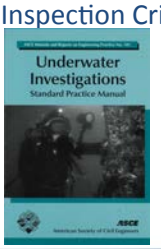
- Rapid Evaluation
- Focus on specific parts of the structure
  - Based on event type, load path
- Is the structure safe for use?
- Restrictions on operations?

Inspection Team

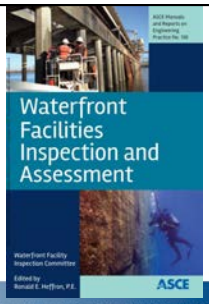
- Team Leader
  - PE, 5+ years experience
- Engineer-Divers
  - Commercially trained
  - Active in > 25% underwater
- EITs & Certified Technicians



Inspection Criteria



- ASCE Manuals and Reports on Engineering Practice
- No. 101 (2001)
- No. 130 (2015)



Inspection Methodology

- Routine Inspection 3 general areas:
  - Topside
  - Above water (under deck)
  - Underwater (divers)

Topside Inspection

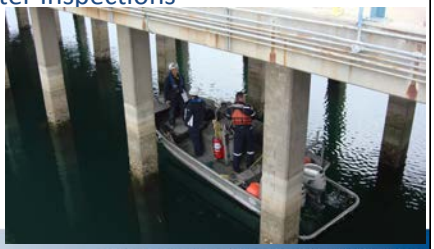
Topside Inspection

Topside Inspection

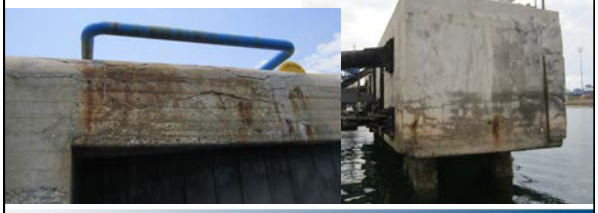
- View of the sides from adjacent structures

Above Water Inspections

- Deck soffit
- Beams
- Top of piles
- Bulkheads
- Proper timing with tides



Above Water Inspections

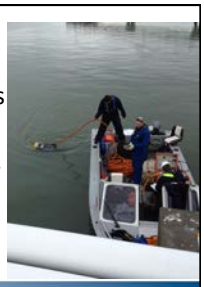


Above Water Inspections

Above Water Inspections

Underwater Inspections

- Piles, bulkheads, retaining walls
- Requires 3 - 5-person crew
- Diving with surface supplied air
- Hard hats, safety equipment



Underwater Inspection Levels

Level I

- Visual & tactile
- All piles
- Signifcant damage
- Broken piles, major cracks, spalls

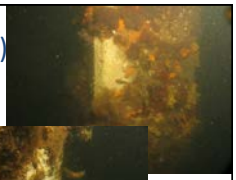
Level II

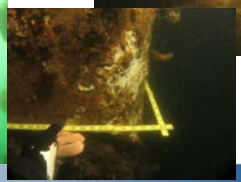
- Clean piles at 3 elevations
- ≥10% of piles; 100LF of bulkhead
- Surface defects hidden by marine growth

Level III

- NDT, or partially destructive testing
- Not routine for concrete
- Suspect areas
- Cores, scanning

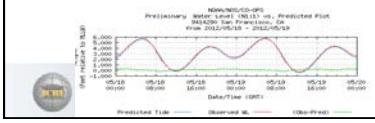
Level I & Level II (Examples)



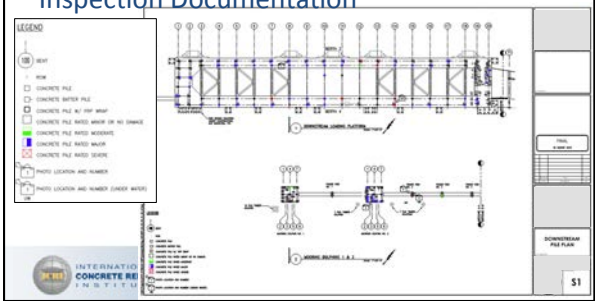


Planning for an Inspection

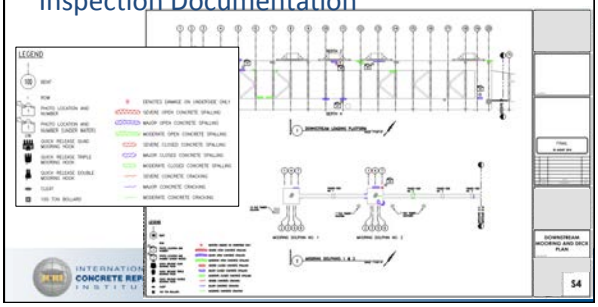
- Consider schedule influences
  - Vessel traffic, tides, weather
- Know your site
  - Safety zones, current
- Select experienced team



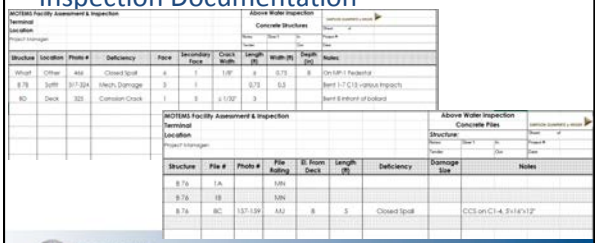
Inspection Documentation



Inspection Documentation



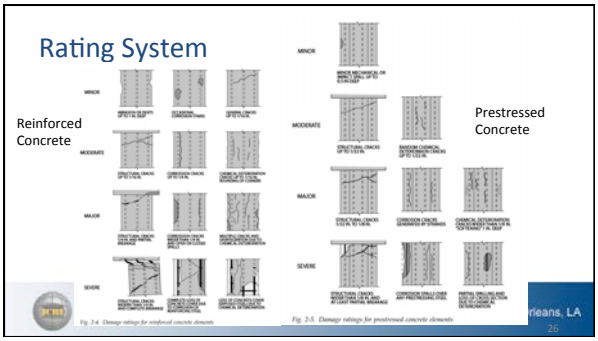
Inspection Documentation



Rating System

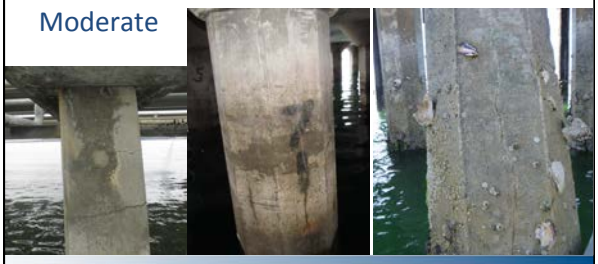
Reinforced Concrete

Prestressed Concrete



Minor

Moderate



Major

Severe

Severe (cont)



Engineer's Role in Inspection

- Understand load paths
- Decipher the cause of damage
- Engineering judgement
  - Significance of damage, especially given the redundancy and use of the structure
- Communicate with the client the implications of the results

Cause of Damage - Structural


Cause of Damage – Corrosion accelerated

Example

Example (continued)

- Based on inspection: Cause = Delamination from corrosion or steel
- Removal at detailed inspection: confirmed lack of adequate cover

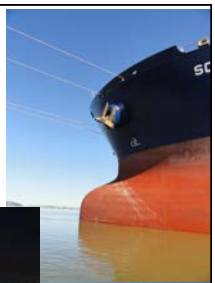
Cause of Damage → Effective Repair (cont)

How do clients use Inspection results?

- Overall condition ratings
  - Prove fitness for purpose
  - Dictate date of next inspection
  - Reduce operations, lower load rating, partial closure (if Severe)
- Prioritize repairs – develop mitigation strategy
- Insurance claims, valuation for sale (specific purposes)

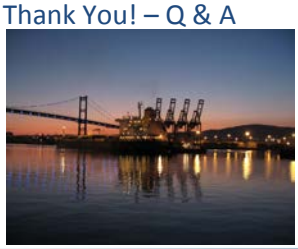
Summary

- Inspection is necessary maintenance
- Multiple types of marine inspection
- Industry standards for methodology, ratings
- Engineers play a critical role in the process of inspection and mitigation



Thank You! – Q & A

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures



Julie A. Galbraith, P.E. (CA)
Senior Staff II – Structures

510.457.4600

jagalbraith@sgh.com

www.sgh.com