Prediction and Mitigation of Passing Ship Interaction Effects
Presentation Outline

• Coast & Harbor Engineering
• Overview of passing ship interaction effects
• Analysis methodology
• Model overview and validations
• Modeling advances
• Mitigation measures
• Conclusions
Coastal, marine and dredging engineers
Expertise in coastal processes, coastal and dredging design, and maritime
Coast & Harbor offices in Corpus Christi, Austin, New Orleans, San Francisco, Seattle, Delray Beach
2014 – A Division of Hatch Mott MacDonald
Passing Ship Interaction Effects

- Still Water
- Higher Water
- Water Level Depression
Passing Ship Interaction Effects

April 10, 1912 at Southampton
http://www.lostliners.com/content/flagships/Titanic/maiden.html
Passing Ship Interaction Effects
Passing Ship Interaction Effects
Passing Ship Analysis Methodology

1. Ship hydrodynamic modeling
2. Hydrodynamic fields, load calculations
3. Impact analysis
   a. Dynamic mooring analysis
      • Mooring lines, bollards, fenders
      • Motions, downtime
   b. Squat, maneuvering
   c. Effects of channel deepening, channel bank erosion, habitat impacts
Hydrodynamic Model Overview

- Hydrodynamic model generated from CHE’s coastal processes modeling system
- Incorporates ambient currents, waves, winds, tides
- Expanded to include multiple moving/berthed vessel hull models, complex maneuvering.
Validation - Field Hydrodynamic Data
MRGO
Validation - Passing Vessel Forces
MARIN (1974)

- **SURGE**
- **SWAY**
- **YAW**
Validation - Passing Vessel Forces
MARIN (2010)
Model Validation Summary

• Field hydrodynamics
  • Port of Oakland 1999: containerships in canal-type channel
  • MRGO 2005: bulk carrier in trench-type channel
  • Corpus Christi Ship Channel 2004: tankers in trench-type channel
  • Port Canaveral 2013: cruise ships in canal-type channel

• Laboratory hydrodynamics
  • Flanders 2009: containerships with submerged bank
  • MARIN 2010: containerships with quay

• Laboratory loads
  • MARIN 1974: tankers in open water
  • MARIN 2010: containerships with vertical bulkhead
Modeling Advances

• Maneuvering in Complex Channels
  – Changing speed
  – Changing drift angle
  – Most channels aren’t straight

• Ambient Hydrodynamics
  – Steady currents
  – Variable current fields near terminals

• Hydrodynamic Phenomena - Surprises
  – Bow waves
  – Broken bore effects
  – Bathtub effects
Route Specification for Complex Channels

- Channels are very complex, and need to avoid using any false bathymetry for accurate hydrodynamics
- Typically defined with assistance from channel design drawings or other similar information
- Some channels have “kinks”, can be difficult to prescribe route with changes in speed and drift angle
- Simulator developed for quick and efficient route development for passing ship studies
Ship Simulator (Desktop) - Example
Route Generated from Simulator
Vessel Hydrodynamics Using Simulator Route
Vessel Hydrodynamics Using Simulator Route
Ambient Currents
Bow Waves (Solitons)
Bow Waves (Solitons)

“Fanal Trader” at 13.7 knots

“El Dorado” at 8.6 knots
Bore Effects
Bathtub Effects
Bathtub Effects

[Diagram showing WSE [ft, MLLW] with graphs for Surge and Sway forces over time.]
Bathtub Effects

Velocity [knots]
8.00
0.00

Disney Dream
5/1/2015
05:30 Arrival

West Gage

East Gage
Bathtub Effects

Date & Time [UTC]

WSE [ft]

Disney Magic

Bathtub Effects

Norweigan Gem
Overview of Modeling System Applications

• System has been successfully applied at over 90 different berths world-wide
• System applied to wide range of vessels including tankers, barges/barge packs, LNG carriers, cruise ships, destroyers, submarines, tugs, pontoons
• Many successful recent applications in Texas
  • Houston (Port, private)
  • Galveston (private)
  • Corpus Christi (Port, private)
  • Port Arthur (Port, private)
  • Beaumont (Private)
Mitigation Measures

- Majority of on-channel projects begin design with preferred concept, mooring system evolves following initial results
- In confined channel, typically lack of surge restraint is biggest problem
- Mitigation measures evaluated include:
  - More lines in spring service, if possible/safe
  - Berth modifications to reduce forces on berthed ships (setback, over-dredging, end shapes)
  - Waterway modifications to facilitate lower-speed transit
  - Mooring system enhancements
  - Draft limitations at berth
  - Mitigation measure effectiveness is very site specific
Conclusions

• Numerical modeling provides accurate passing ship forces
• Efficient and realistic evaluation of vessel hydrodynamic problems
• In confined channels, passing ship forces are a major factor affecting design of mooring system and berth
• Vessel hydrodynamic evaluations are now becoming a routine and typical part of terminal development and mooring system design/upgrade
Prediction and Mitigation of Passing Ship Interaction Effects

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