Operationally Forecasting Required Tug Resources for Vessel Turning

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Presentation

1. Context – Swinging Vessels in Ports
2. Tug Vector Force Balance Solver
3. Port Adelaide Validation Case Study

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Swing Vessels In Ports

A complicated port operation:

- Multiple port stakeholders
  (vessel traffic service (VTS), pilots, tug master, towage operators)
- Variations in individual vessel particulars
  (windage areas, drafts, hull form, displacement, auxiliary thrusters)
- Towage resources
  (number and capacity/bollard pull rating)
- Environmental forcing variables
  (winds, currents, water levels/ depths, waves)

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Conventional Safe Swing Scheduling

Conventional management of safe swing vessel scheduling windows in Ports achieved as follows:

1. A set of simple 'Port Rules' dictating minimum tug resources as a function of:
   - Relative environmental thresholds (Wind, current/tide etc)
   - Vessel class/size (DWT or LOA)
2. These rules typically devised from:
   - Pilots experience
   - Full bridge simulations results from a very small subset of potential swing scenarios

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Example of conventional 'port rules' safe swing scheduling

Port Adelaide, #5 Swing Basin

Size		Swing – Flood	Swing – Ebb	Tug Requirements (minimum 70 tonnes bollard pull)	Wind Limitations
LOA < = 275m & Beam < = 40.3m		no limit	no limit	Displacement < = 127,000 tonnes: 2 tugs (min 70 tonnes bollard pull)	All container vessels exceeding 306m LOA: max allowable winds 25 knots (arrival ordeparture)
LOA 276-306m & Beam < = 40.3m	UKC > 20%	no limit	no limit	Displacement > 127,000 tonnes: 3 tugs	All container vessels up to 306m LOA & all other vessels: max allowable winds to 35 knots but may be reduced to 25 knots at pilots discretion taking into account wind direction, broadside windage area of the vessel and available useable tug power
	UKC < 20%	0.3kt or 30cm/hr	0.3kt or 30cm/hr		
LOA <= 306 Beam 40.3 - 49m	UKC > 20%	0.3kt or 30cm/hr	0.3kt or 30cm/hr		
	UKC < 20%	slack water	slack water		
LOA 307-350m & Beam < = 49m	UKC > 20%	0.3kt or 30cm/hr	0.3kt or 30cm/hr		
	UKC < 20%	slack water	slack water		
LOA > 350m or Beam > 49m		slack water	slack water		

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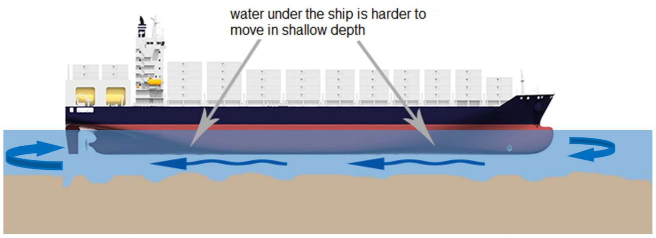
NCOS Safe Swing Module

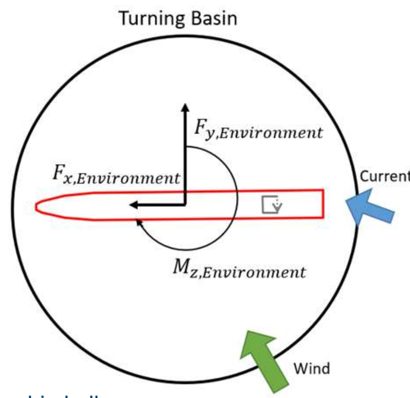
Tug vector forces to overcome:

- The environmental forces from wind and currents;
- Turning moment from the vessel itself;
- Turning moment from the added (virtual) mass of the vessel.

Shallow Water Effect (Depth < 2 x Draft)



Added Mass: the mass due to additional force needed to push the water around the ship hull



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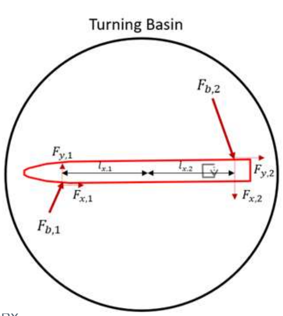
Tug Vector Force Balance Solver Example

The solver utilises a quasi-steady calculation of the tug vector forces and moments
The effect of bow/stern thrusters have been implemented into Solver

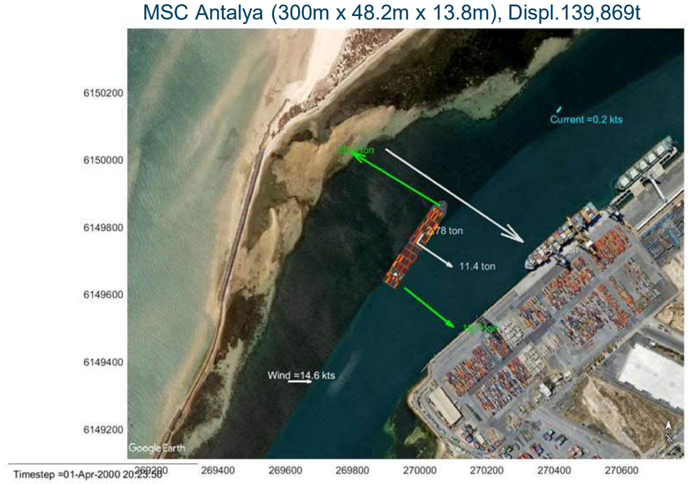
$$\sum F_x = F_{x,env} + F_{x,tugs} = 0$$

$$\sum F_y = F_{y,env} + F_{y,tugs} = 0$$

$$\sum M_z = M_{z,env} + M_{z,mass} + M_{z,tugs} = 0$$



MSC Antalya (300m x 48.2m x 13.8m), Displ.139,869t



Green - Tug Vectors
White – Vessel Forcing

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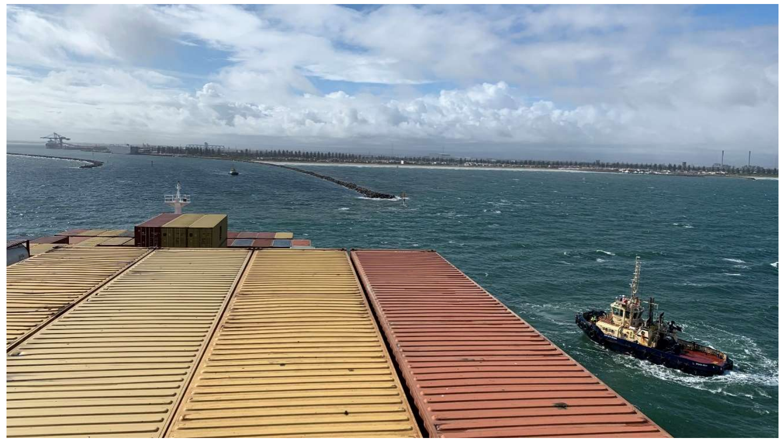
Port Adelaide Validation Case Study

1. APL Miami - 9,200TEU
   (328m x 45m x 12.9m)

2. Cosco Rotterdam - 5,600TEU
   (280m x 40m x 12.4m)

3. Gulf Bridge - 8,600TEU
   (335m x 42.8m x 12.1m)



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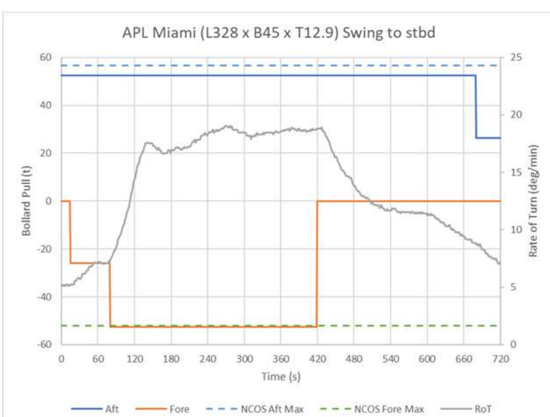
APL Miami 9,200TEU

(328m x 45m x 12.9m)

- Tide 0.8m CD
- Current Speeds ~ 0.1kt
- Winds ~ SE 17kt



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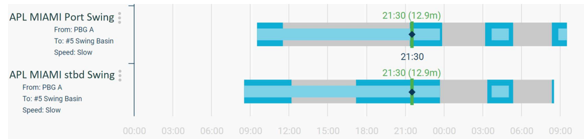
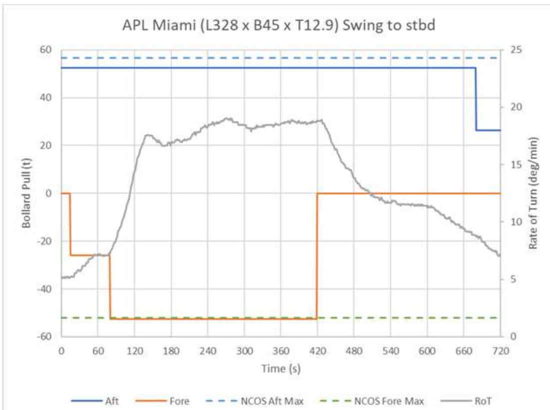
APL Miami 9,200TEU
(328m x 45m x 12.9m)



- Tide 0.8m CD
- Current Speeds ~ 0.1kt
- Winds ~ SE 17kt



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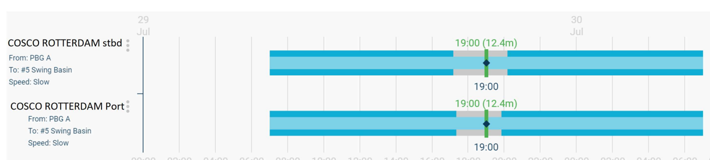
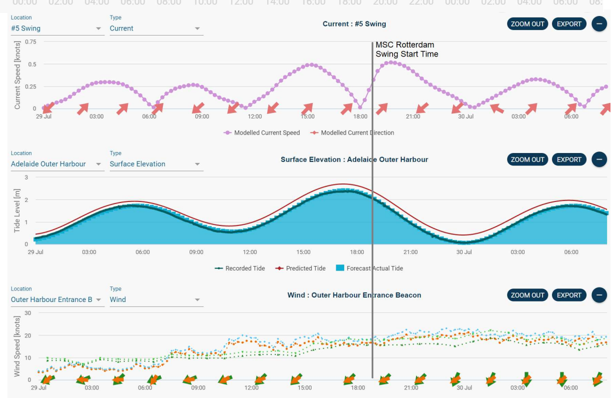
Cosco Rotterdam 5,600TEU (280m x 40m x 12.4m)

- Tide 2m CD
- Current Speeds ~ 0.45 kt ebb
- Winds ~ NE 16.5 kt





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Gulf Bridge 8,600TEU (335m x 42.8m x 12.1m)

- Tide 2m CD
- Current Speeds ~ 0.51 kt ebb
- Winds ~ S 10kt

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Summary

1. Conventional approaches to scheduling safe swing windows in ports has a number of potential limitations
2. The tug vector force balance solver is proposed as an alternative approach to calculation of safe swing windows in a dynamic, operational port environment
3. It has been successfully deployed to provide improved safe swing window scheduling at Port Adelaide and
4. The ability to incorporate bow/stern thruster capacity into force balance as well as the effect of shallow water were added.
5. A series of validation cases were employed to verify the NCOS safe swing module
6. NCOS safe swing module has successfully identified challenging swing scenarios that would be unsafe to operate

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