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Simulator study to determine the wind speed limitation for a Passenger Cruise Vessel entering and berthing in the Port of Hambantota, Sri Lanka

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Abstract

Sri Lanka is being promoted as a tourist destination and the port of Hambanthota is having visits from Passengers. The port of Hambanthota in Sri Lanka is on the busy main east-west sea route. It has become necessary to determine if a Passenger Cruise Ship can be berthed safely in differing monsoonal wind conditions. Before a ship is manoeuvred into a port in the real sense, simulator trials are necessary to be carried out to see if the ship can be manoeuvred safely in varying conditions with all available resources. Simulator trials have been recognized as a cost-effective way to determine the safe limitations and prevent mishaps. The CINEC simulator research team successfully created the simulator environment of the port of Hambanthota as a part of the research under AHEAD operations of the ministry of high education funded by the world bank. As per the analysis of the results of simulator trials, it has been concluded that the wind speed should be limited to 20 knots for safe berthing mainly due to the berthing tug power used.

Keywords: Passenger Cruise Vessel, Royal Princess, Hambanthota Port, Wind limits.

Problem Statement

To improve tourism The Port of Hambanthota needs to bring Passenger Cruise ships alongside berths using the available resources including the available tug power. Before a ship is manoeuvred into a port in the real sense, simulator trials are necessary to be carried out to see if the ship can be manoeuvred safely in varying conditions with all available resources. Even though the ship's characteristics can be judged according to the information available onboard the ship, its behaviour and limitations inside a port are difficult to predict because the different external resources such as capacity and performance of the available tug boats are not going to be the same for all the ports in the world. Since the ship handler's main task is to use all available forces under his/her control to handle the vessels motion while compensating for the uncontrollable natural forces like wind and current, studying the limits of wind and or current forces which can be tolerated by a ship under tugs in a particular harbour with environmental conditions normally expected has great importance. Since the current inside the Hambanthota harbour is not significant compared to the wind effect this study focuses on the wind limits for safely handling the vessel to the berth.

However, in absence of this kind of study done for Hambanthota harbour shipping companies have difficulty in the risk assessment which makes them hesitant when deciding to call Hambanthota harbour. This study

aims to fill this vacuum by producing simulator-based test results to propose the wind speed limitation for a Passenger Cruise Vessel entering and berthing in the Port of Hambantota.

Problem areas:

1. What would be the permissible maximum westerly wind speed limitation for this vessel to be berthed safely, whilst being assisted by the two 67-tonne BP tugs.)
2. To determine whether the vessel can safely enter the harbour in the navigable channel.
3. To determine whether the vessel can be stopped safely in the basin upon entering the breakwaters.
4. With the offshore westerly winds whether the vessel can be brought alongside safely, using the 2 x 67 tonne BP azimuth stern drive tugs and the ship's bow thrusters.
   (This 67-tonne BP tug usage was determined to match the tug power in the port of Hambanthota)

Methodology

The method used was to monitor and set safe wind speed limits on the vessel's passage inbound from the entrance channel to the berth starboard side alongside the cross berth in the port of Hambanthota using two tugs. The passenger ship model 1 was manoeuvred, in the CINEC Wartsila-Transas NTPro 5000 Bridge Simulator and advise on limitations. This ship model is one of the medium-sized passenger ships presently in service.

The total tug power requirement should be calculated before a ship enters a port dependent on the prevailing weather conditions.

Tests were carried out in Three offshore wind directions namely Northwesterly (315 degrees), Westerly (270 degrees), and Southwesterly (225 degrees) in wind speeds of 20, 25 and 30 knots. In all 9 exercises, the vessel was to approach the cross berth and stop one ship length off heading the wind. Then the 2 tugs would push the ship onto the berth keeping the ship on a southerly heading parallel to the berth as shown in below figure 1.

The ship was prepositioned near the approach channel with a heading of 331°(T) with a speed of 14.7 knots which is the half-ahead speed of the ship.

Then the ship handler manoeuvred the ship to the berthing position by following the courses and distances given in the planned passage shown in figure 1 and tugboats were engaged once the ship is inside the cross berth turning basin, heading the wind, one ship length off the berth. The ship was swung to the port side to align with the berth and then pushed to the berth with the help of the tugboats.

These test manoeuvres were carried out as three simulator exercises in three different wind directions and wind speeds as shown in table 1 below.

Table 1: Exercises and wind conditions

Exercise No.	Exercise 1			Exercise 2			Exercise 3		
Manoeuvre No.	1	2	3	1	2	3	1	2	3
True Wind	W 270° (T)	SW 225° (T)	NW 315° (T)	W 270° (T)	SW 225° (T)	NW 315° (T)	W 270° (T)	SW 225° (T)	NW 315° (T)
Wind Speed	20 kt	20 kt	20 kt	25 kt	25 kt	25 kt	30 kt	30 kt	30 kt

A total of nine manoeuvres were carried out in this study.

However, manoeuvring results pertaining to north-westerly and south-westerly wind conditions have been omitted to shorten the paper since westerly winds are the most effective prevailing winds for this berthing at Hambanthota harbour.

Following motion parameters were recorded and graphed for analysis.

- Relative wind speed
- Relative wind direction
- Ships heading
- Ships longitudinal Speed.

Then the conclusions were drawn by comparing the data against the ship handlers' feedback on the difficulty of handling the vessel in each manoeuvre.

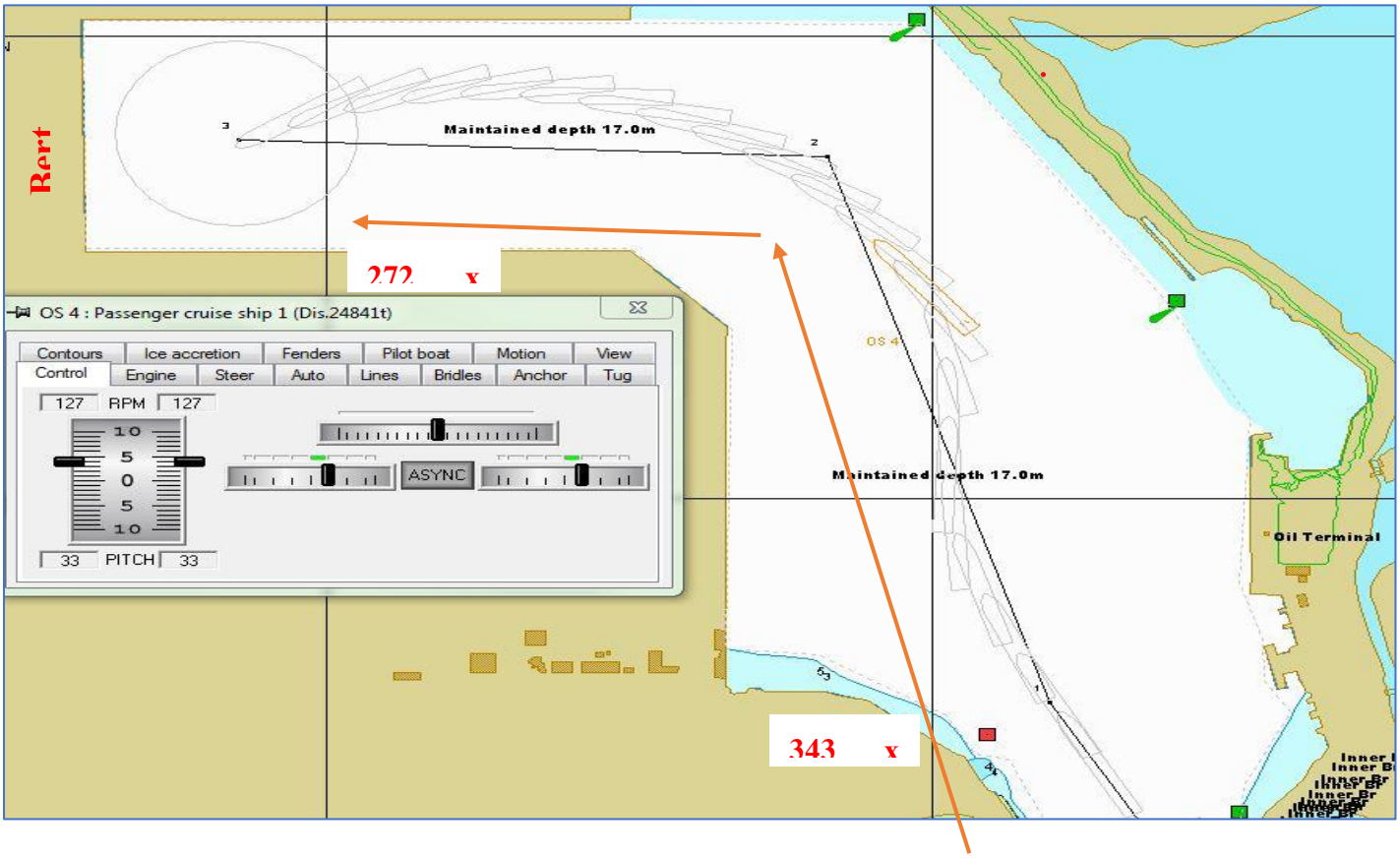


Figure 1: Intended passage plan.

Figure 1: intended passage plan, indicates the planned passage to approach the berthing position. The red arrow marks the direction to follow, and the true heading and leg distance is marked as red text.

Figure 2: Ship model used Passenger Cruise Ship 1

Figure 2 depicts the ship model used for the study and the detail of the model is given below.

Length overall	230.9 m
Breadth extreme	29.20 m
Draft	08.02 m
Displacement	24,841.0 tonnes
Engine output watts	2 x 14580 Kilo
Propulsion	twin screw, inward rotating Controllable pitch propellor
Astern power	63% of ahead
Bow thruster	1500kw
Rudders	2 x Normal balanced rudder

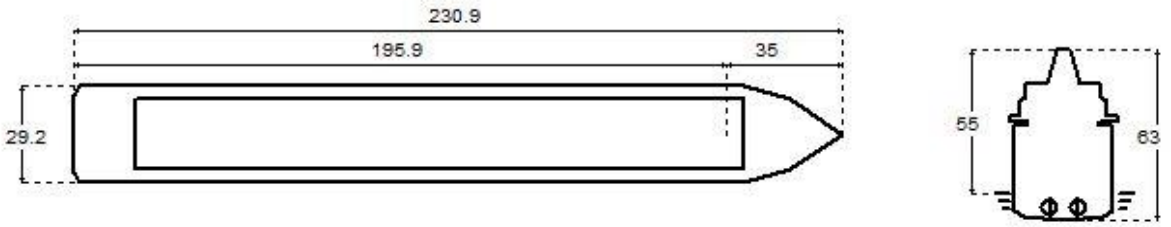
More details of the ship model are available in the pilot card of the ship model which is shown in Figure 3

PILOT CARD

Ship name	Passenger cruise ship 1 (Dis.24841t) TRANSAS 2.31.29.0 *			Date	06.02.2016
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	24841 tons		Draft forward	8.02 m / 26 ft 4 in	
Deadweight	4661 tons		Draft forward extreme	8.02 m / 26 ft 4 in	
Capacity			Draft after	8.02 m / 26 ft 4 in	
Air draft	55 m / 180 ft 11 in		Draft after extreme	8.02 m / 26 ft 4 in	

Ship's Particulars

Length overall	230.9 m	Type of bow	Bulbous
Breadth	29.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	13 / 13		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	30 / 30		



Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 2	Number of bow thrusters	1
Maximum angle	35	Power	1500 kW
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	12 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	161 s	4.28 cbls	Advance	2.81 cbls
HAH to HAS	142.3 s	2.91 cbls	Transfer	1.04 cbls
SAH to SAS	119.2 s	1.5 cbls	Tactical diameter	2.71 cbls

Main Engine(s)

Type of Main Engine	Medium speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Inward
Maximum power per shaft	2 x 14580 kW	Propeller type	CPP
Astern power	63 % ahead	Min. RPM	30
Time limit astern	N/A	Emergency FAH to FAS	46.2 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	24	23200	126.1	1.2
"FAH"	20	15500	126.1	1.02
"HAH"	14.7	9500	126.1	0.75
"SAH"	8.8	5000	125.9	0.4
"DSAH"	3.7	3500	90.1	0.2
"DSAS"	4.4	4500	90	0.2

Figure 3: Pilot card of the ship model

Figure 4: Tug Model used.

Figure 4: depicts the tugboat model used to assist the ship during the exercise. For this study, two of these tugboats were used. Each boat was capable of 67 tonnes of bollard pull. Other information about the tugboat model is as follows.

LOA	42 m
Breadth	15.3m
Draft	6.3 m
Displacement	1060 t
Bollard Pull	67t
Propulsion	AZD 2 x 2938KW High-speed diesel.

Results

Below figure 5 and figure 6 shows the graphical representation of the ship model motion resulted during the study with 30kt of westerly winds and the graph of ship speed & heading, wind direction & speed during the study with 30kt of westerly winds respectively.

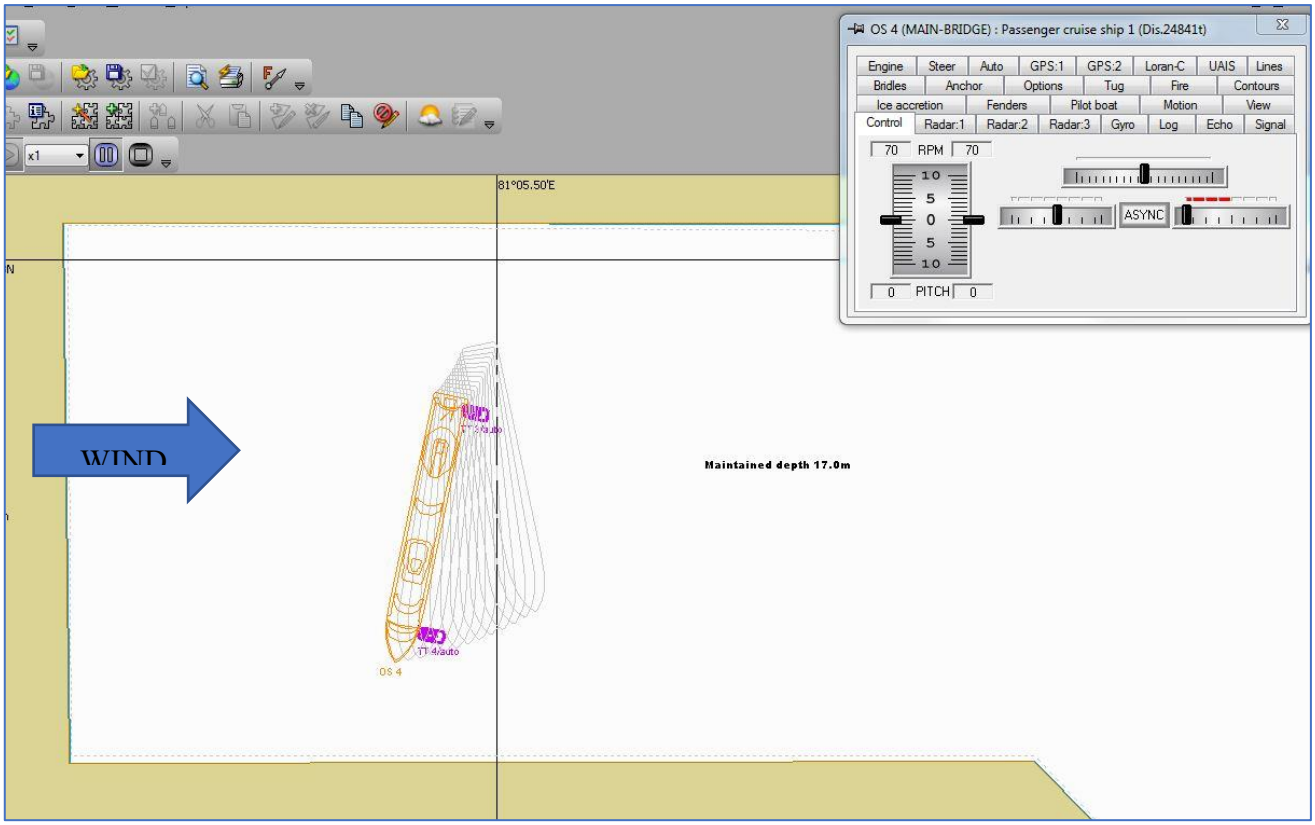


Figure 5: Motion of the ship with 30 kt wind under tugs.

Figure 5 shows the motion trend of the ship setting to port against even with 2 tugs pushing full.

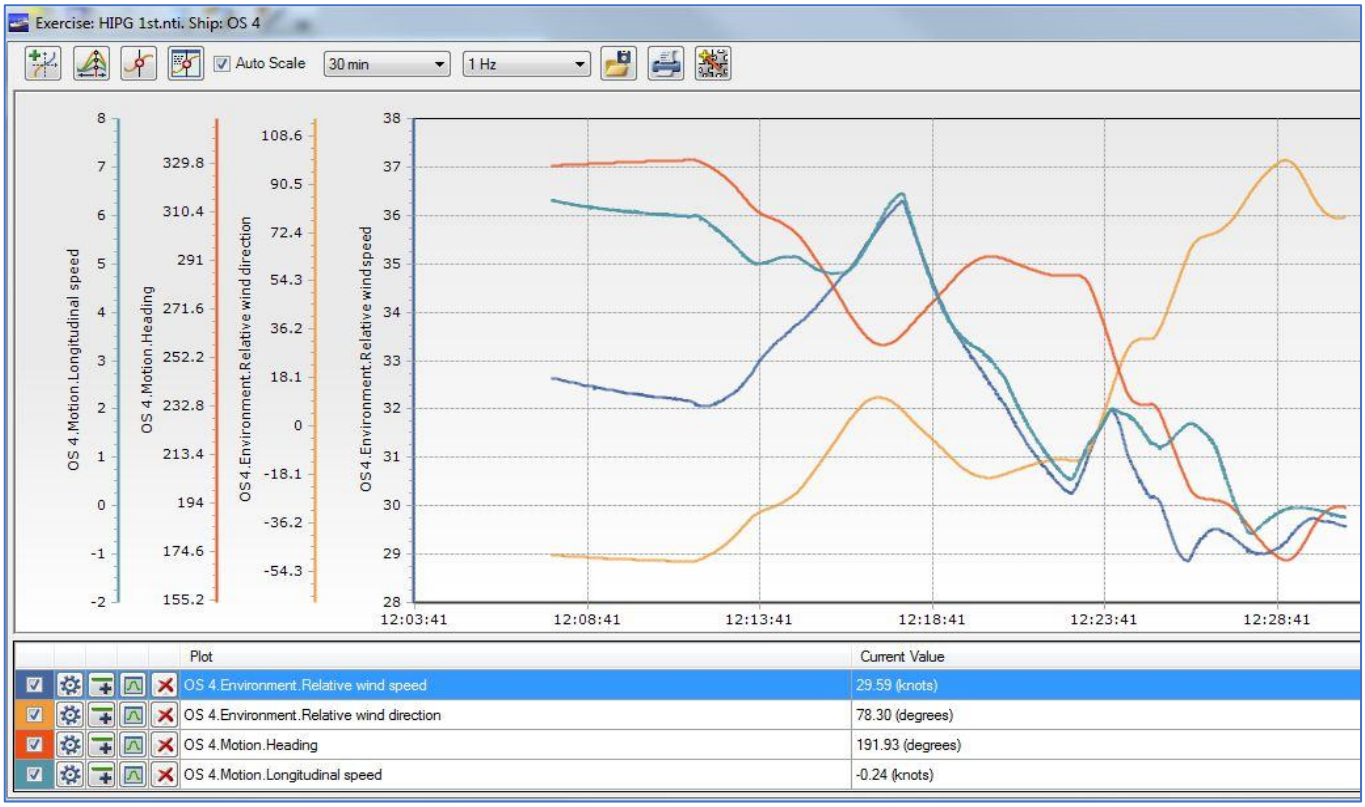


Figure 6: Motion graphs of ship speed & heading, wind direction & speed.

Summary Analysis

Table 2 summarizes the results of all the test manoeuvres with the ship handler's comments on the level of difficulty of each situation.

Table 2: Summary of results.

True wind speed in knots	20	20	20	25	25	25	30	30	30
True wind direction in knots	225	270	315	225	270	315	225	270	315
Current in knots	0	0	0	0	0	0	0	0	0
Channel transit	good	good	good	good	good	good	difficult	difficult	Difficult
Stopping in basin using engine Half astern	Good. ahead of berth	Good. ahead of berth	Good. ahead of berth	Good. ahead of berth	Good. ahead of berth	Good. ahead of berth	managed off berth	managed off berth	Managed off berth
Escort tug used	no	no	no	no	no	no	no	no	No
Coming alongside berth with 2 tugs	good	good	good	difficult	Very difficult	Very difficult	Not possible	Not possible	Not possible

Approach channel:

The starting speed was 14.7 Knots at manoeuvring Half Ahead.

In all three wind speeds the vessel managed to enter the harbour basin.

Stopping and berthing starboard side cross berth:

The two tugs and the vessel's bow thrusters were used to the maximum in each manoeuvre. It was clear that the total BP available 67x 2 + 20 = 154 tonnes (i.e., the power of the 2 tugs and the bow thruster was the deciding factor for safe berthing against the strong westerly wind. (The vessel had a 1500 kW bow thruster equivalent to 20 tonnes BP)

The total Bollard pull requirement as calculated in a 25 kt beam wind:
$0.08 \times A \times V^2 /1000 = 0.08 \times 12000 \times 12.5 \times 12.5 /1000 \quad = 150$ tonnes
The tug allocation: the escort tug was let go and then used to push on the port quarter. The second tug pushing on the port bow and the bow thruster forward was the three athwartship power sources.
At 25 Knots there was difficulty with extended pushing time and at 30 knots the wind power was not possible to overcome.

Conclusion

From the above test result analysis, it can be concluded that at 30 knots with Southwesterly, Westerly and Northwesterly winds the vessel was unable to come alongside with the tug power used. At 25 knots there was difficulty in coming alongside. Therefore, the **safe maximum at south westerly, Westerly and Northwesterly wind directions will need to be restricted to 20 knots. (23 knots as per calculation).**
The standby tug should push attached to the port bow.
The escort tug should disengage and push on the port quarter.
Vessel to be brought alongside athwartship keeping parallel to the berth on a southerly heading using the BT, Tug 1 & Tug 2.
It is recommended that the vessel's berthing to the cross berth during westerlies, the wind speed should be limited to 20 knots for safe berthing mainly due to the berthing tug power used.
Come off the cross berth 230m (the length of one ship) off heading the wind. Get the 2 x 67t tugs to push full and the BT at 1500KW. Parallel to the berth 180 heading. Safe at 20 knots. Difficult at 25 knots.

Acknowledgements

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Abbreviations:

ULCC: Ultra Large Container Carrier
TEU: twenty-foot equivalent units
BP: Bollard Pull
AZD: Azimuth Stern Drive
KW: Kilowatt
BT: Bow thruster.

References

1 www.HIPG.lk- Port information
2 Calculate tug power required – before you need it (MAIB safety digest 01/2013)
https://www.gov.uk/government/organisations/marine-accident-investigation-branch
3 Simulators – the answer to everything? – Mert Daggecen (www.nautinst.org/seaways/november 2022)
4.https://www.doverport.co.uk/operations/operating-limitations/

5. H. Perera - Simulator study to determine the wind speed limitation for an Ultra Large Container Vessel entering and berthing in the Port of Hambanthota, Sri Lanka.