ASEAN Ports and Shipping 2023 Exhibition and conference

Supported by Port Authority of Thailand (PAT)

Presenter: Capt. Zakhir Khan from Bintulu Port Authority, Malaysia

Theme: Port Cooperation in Forming Sustainable Por operation to create regional economic value

การท่าเรือแห่งประเทศไทย

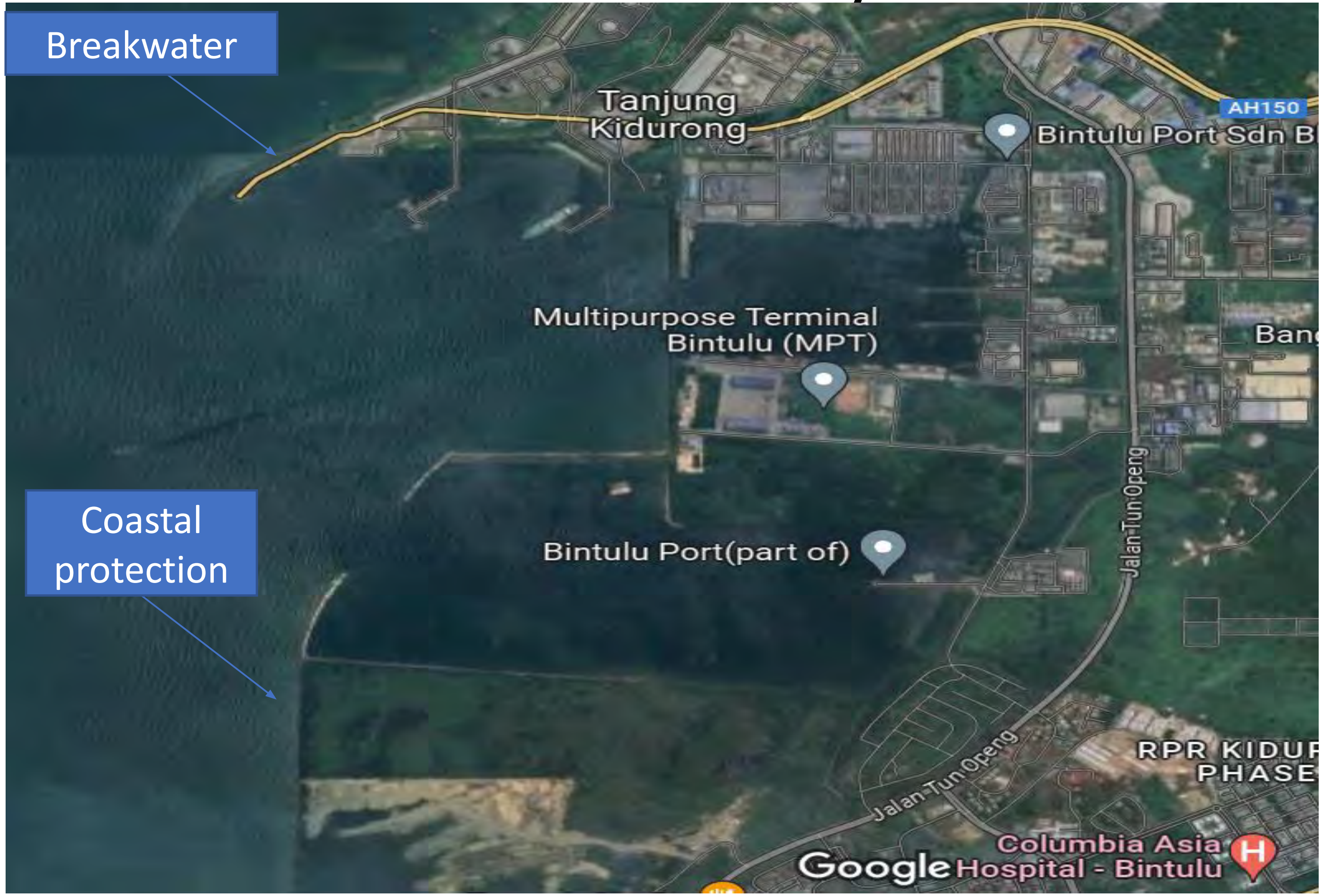
PORT AUTHORITY OF THAILAND

Title: Designing new terminal facilities for sustainable operation by reducing environment impact and increase investment efficiency

How do we reimagine new design jetty construction ?

- Reduce siltation ?
- Reduce cost of construction and or on time base ?
- ESG(environmental sustainable governance) on CO2 emission?
- Required coastal shore protecting to avoid coastline erosion ?
- Capex dredging cost?
- Yearly maintenance dredging cost?

Understanding the challenges of using the conventional design terminal facilities and environmental impact over the last 40 years or more



- To operate a 400 meter jetty, we require additional attached following facilities:
- breakwaters facility of 1,000 meter length
- coastal water protection(high and low bund) of 3,500 meter length to avoid coast erosion impact
- create basin of 1500m diameter for vessel to approach the jetty access
- channel length of 5,000 meter for vessel to have water access
- yearly dredging cost to maintain the depth of the basin and the channel
- Yearly environmental monitoring cost to maintain the coastline

The old conventional design over the last 40 years has the follow continuous impact

- Inefficient terminal design
- Higher operating cost
- Reduce competitiveness
- High impact to the local communities staying nearby the coastline of the permanent terminal or port development activities

OPTIMIZING RESOURCES TO ENHANCE LONG TERM ROI BY

- CONDUCT INCLUSIVE RESEARCH METHODOLOGY APPROACH DURING DESIGNING PHASE
- PROPOER SITE LOCATION
- PLANNING SUSTAINABILE GOALS
- CONDUCT SIMULATION AND MODELING TO OPTIMIZE THE NEW DESIGN

Sharing the successful collaborations leading to innovative and efficient designing of new terminal facilities

Building a new methanol product offtake/export jetty facilities which is located approximately 6 km to the north of Bintulu Port in East Malaysia by adopting new design for sustainable operation by reducing environment impact and increase investment efficiency

COMMENCE IN 2018 AND WILL OPERATE TO EXPORT 2 MILLION TONNE OF METHONAL YEARLY BY 2024

CONDUCTED INCLUSIVE RESEARCH METHODOLOGY APPROACH NEW DESIGNINGTO **BUILD 500 M WAVE SCREEN**, 3KM LONG TRESTLE, BERTH FACILITIES & ACCESS CHANNEL BOTTOM ELEVATION OF -11.5 m CD

- Met-ocean Observations
- Numerical Wave Model Study
- Numerical Current and Sediment Model Study
- Ship Manoeuvring and Under Keel Clearance (UKC) Study;
- Marine Traffic Risk Assessment (MTRA) Study;
- 2D & 3D Physical Modelling Study.

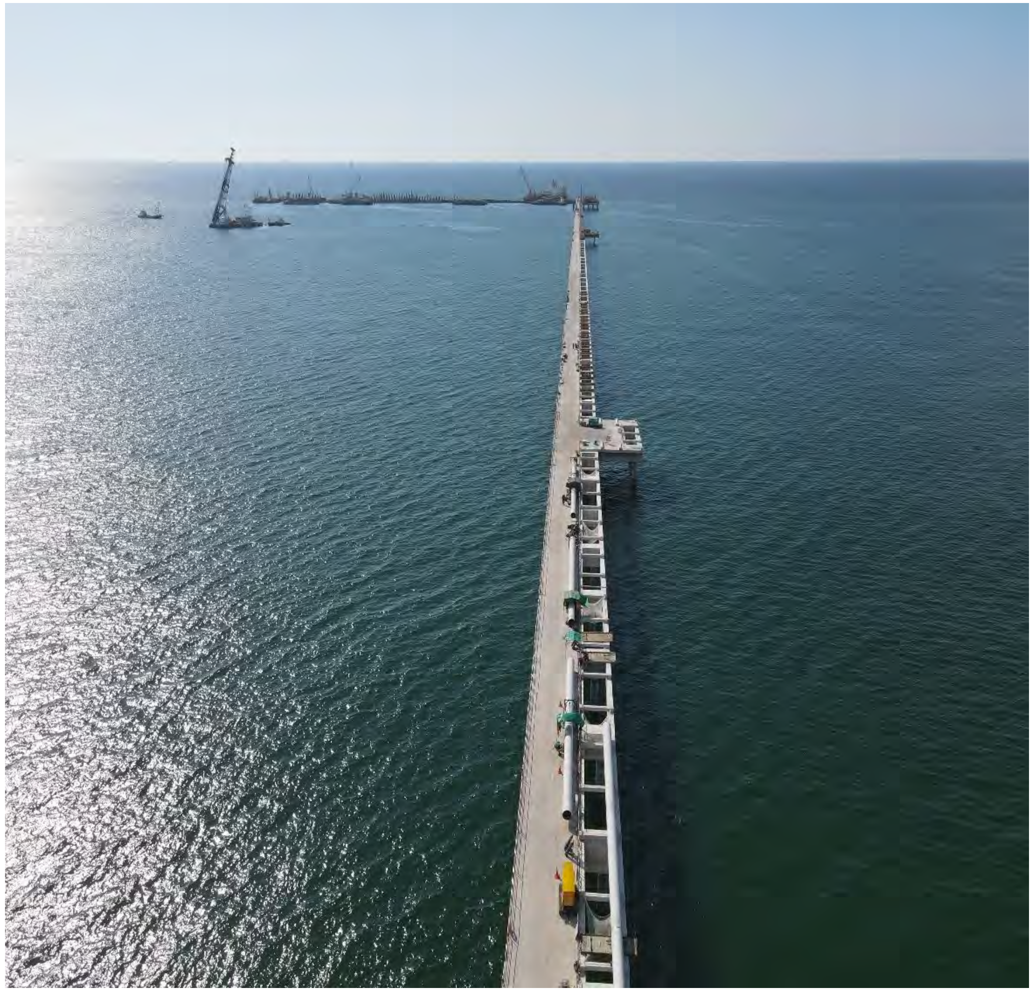
Test results new design shows that under operating condition downtime was average 3% which less then the limit of 4.4% and wave height limit was 0.5 meters.

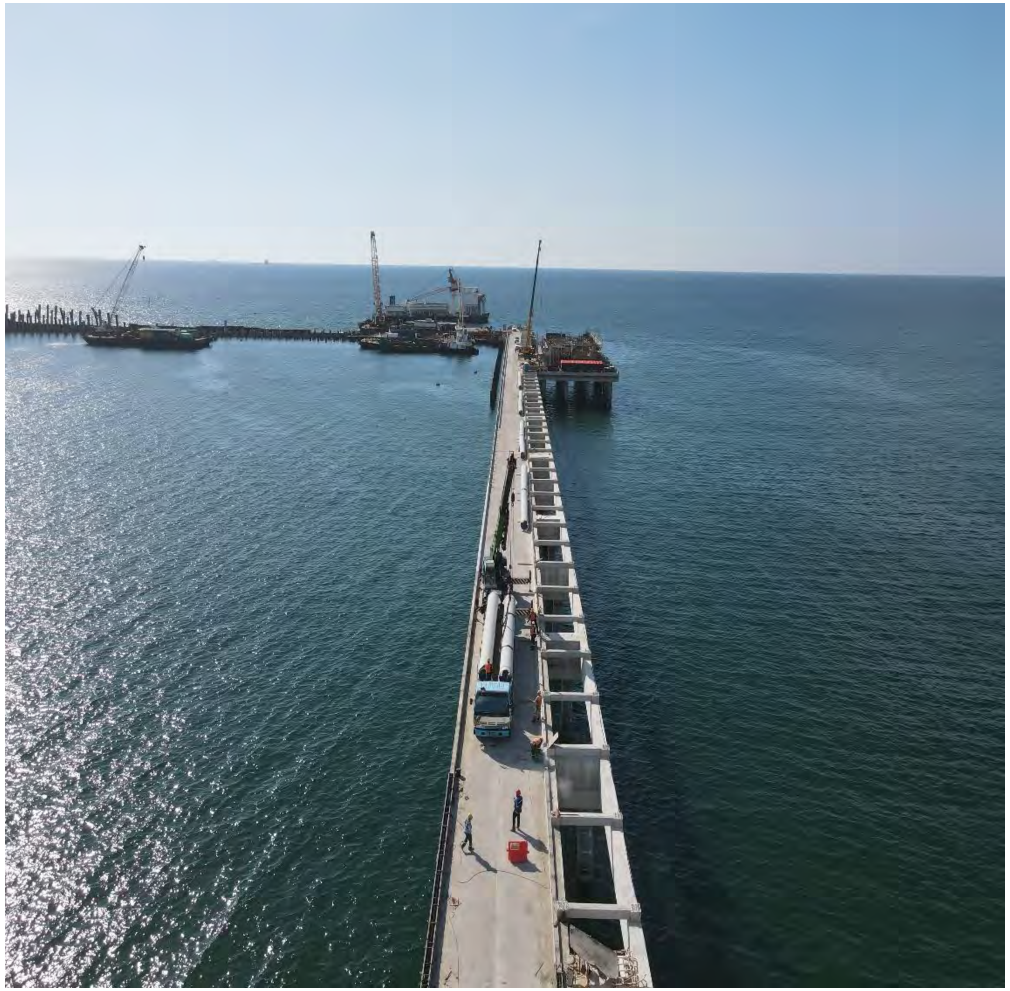
Under extreme condition, the waves behind the wave screen optimization, overtopping rate at pipeline deck, the wave force on the wave screen and stability of scour protection rocks are tested less then over topping limit

The performance of the wave screen physical modelling studies is to:

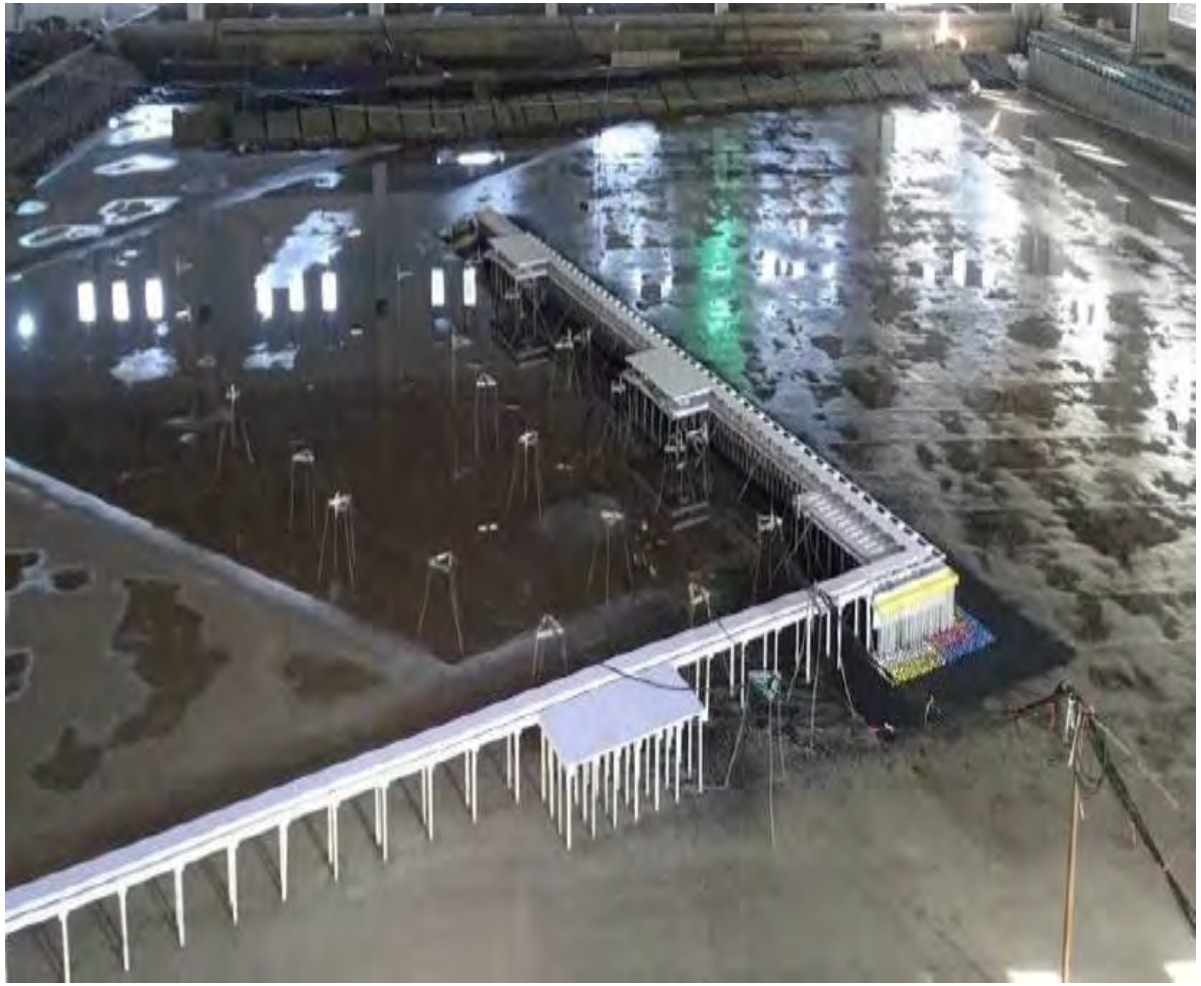
- Investigate waves behind the wave screen
- Perform the ship mooring study for dynamic vessel responses
- Downtime estimation;
- Investigate the wave overtopping on the pipeline deck, wave force, stability of scour protection rocks, and scour around the wave screen.

Updated construction Methanol Jetty up to September 2023





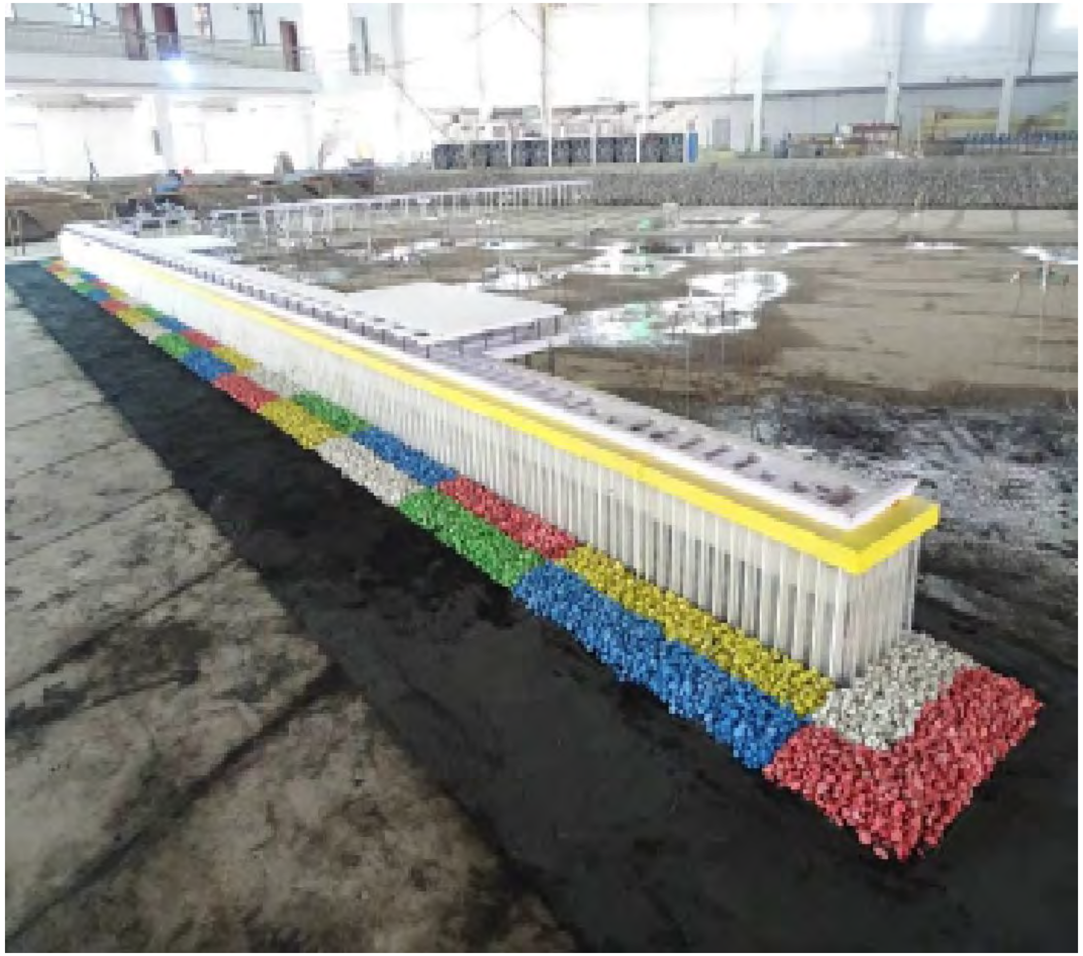
Physical modeling layout



- In the 3D physical model, the seabed, the berthing area, the turning circle, the access channel, and the structures of wave screens and jetty were all modelled exactly based on the geometric similarity, making them similar to the prototype

Model of the wave screen from the head

OUTSIDE TOE FROM HEAD VIEW



OUTSIDE TOE FROM END VIEW

Photos of the cross section modelling wave screen(scale 1:20 & 1:30.7)

Construction of wave screen specification

- The wave screen is 500m long, with two berths with each jetty platform width of 54m, one tug berth, and access channel with the bottom elevation of -11.5mCD, etc.
- The wave screen is constructed by a series of closely-spaced piles, with pile diameters of 2000mm and pile gaps of 100mm, with the 4.7m high pre-cast panel installed behind the piles.
- The crest elevations of the piles, beams, the wave wall and the pipeline deck of the wave screen are +2.7m, +4.5m, +6.0mCD and +8.5mCD respectively. At the outside toe of the wave screen, 300~500kg rocks are adopted for the scour protection.

Test results and analysis for 2D physical model

Investigate the waves behind the wave screen and the dynamic vessel response

During Operational condition

- The waves behind the wave screen are the combined waves of diffracted waves and transmitted waves;
- The dynamic vessel response includes the six degrees of freedom motion components of vessels, tension for mooring lines and force/deflection of fenders, under the combined action of diffracted waves and transmitted waves;
- Analyze downtime based on the wave height, motion and force criteria, and provide the corresponding operational wave limits

During extreme condition

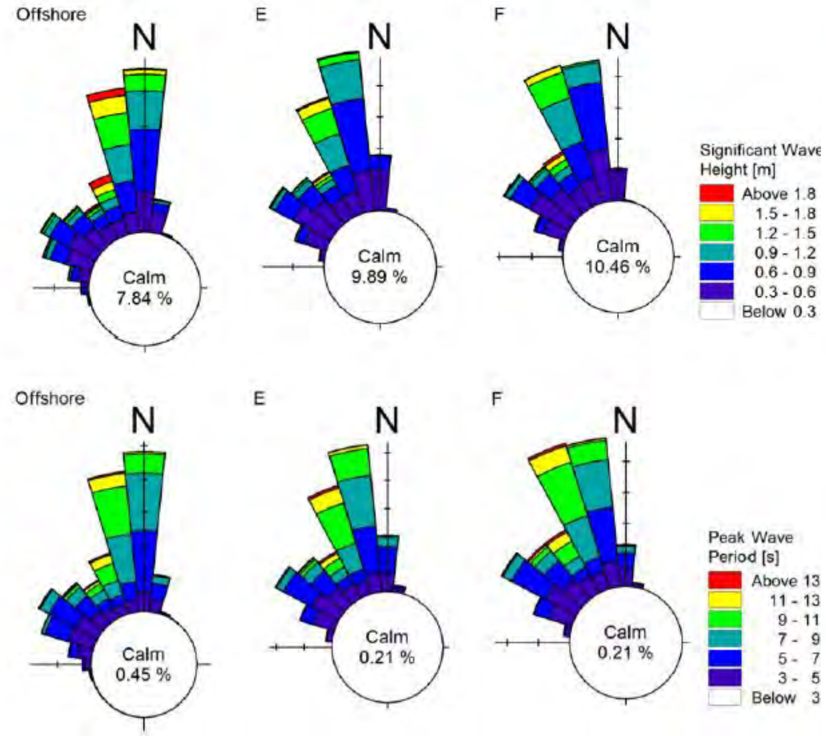
- Investigate the waves behind the wave screen to determine the design wave conditions for the berth structures, under the wave action of 50-year return period

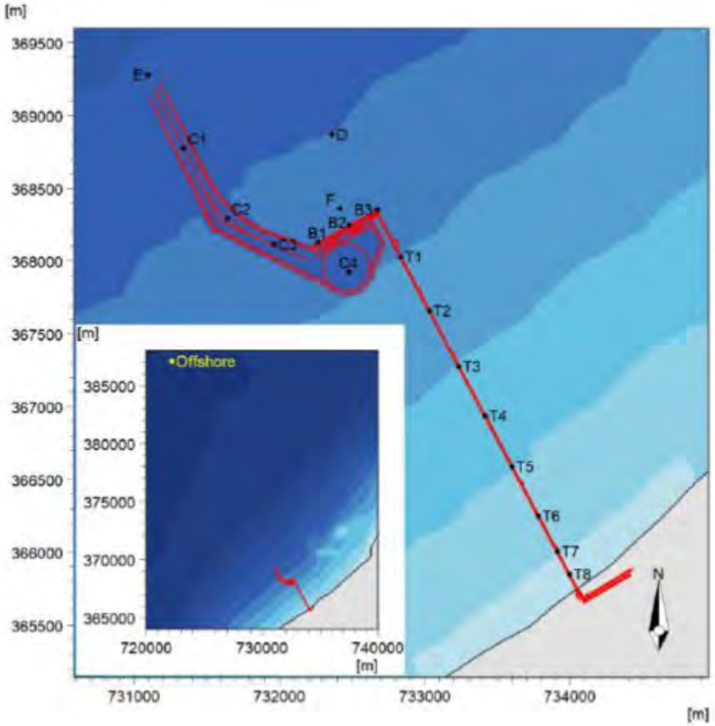
- Investigate the wave overtopping, wave force, stability of scour protection rocks and scour in front of the wave screen, under the wave action of 50-year return period

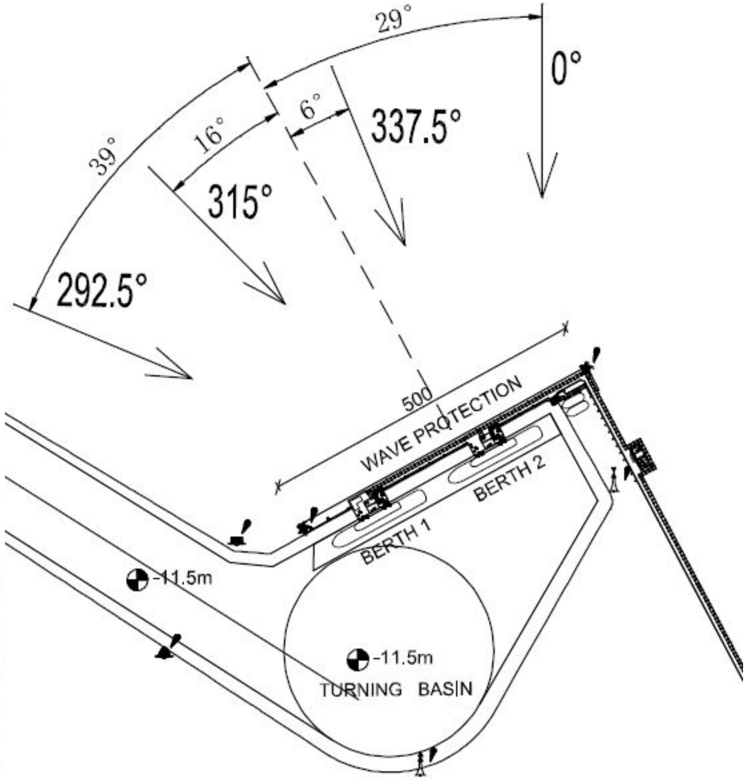
- Investigate the wave overtopping under the wave action of 1-year return period

Selection of jetty angel based on wave direction

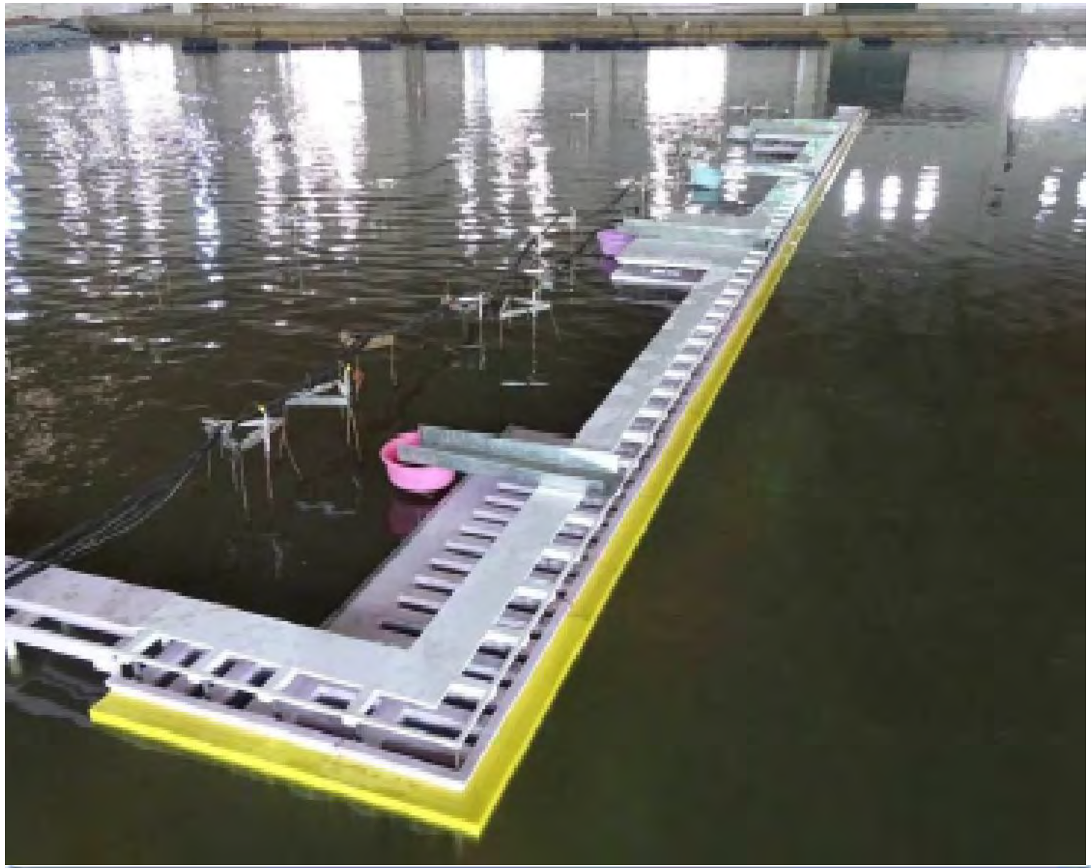
- It can be seen from the numerical wave model study results that, due to the wave refraction on the bathymetry in the process of wave transformation from offshore to the jetty location, **the most severe wave directions for the jetty transfer from 315°~360°to 315°~337.5**°.







Overtopping collector boxes behind the wave screen & stability test for the scour protection rocks



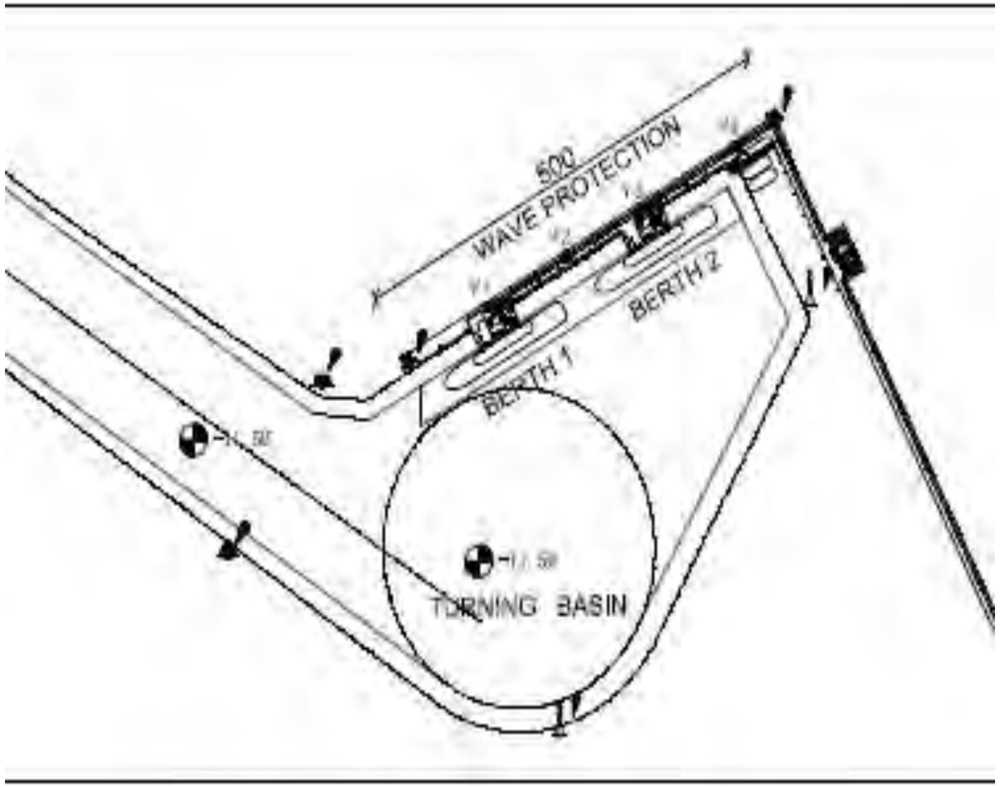
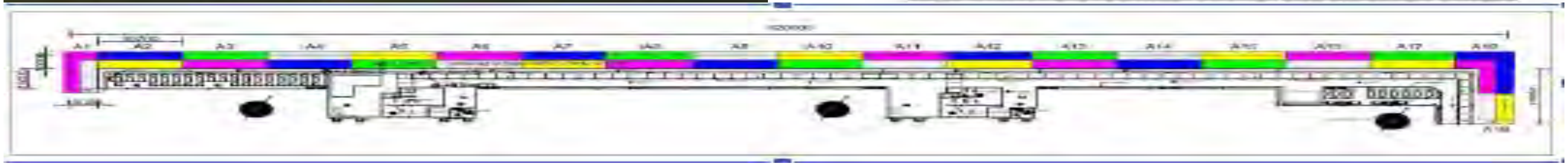


Figure 4.3-19 Arrangement of overtopping measuring points



The wave screen attached to the jetty has a good shielding results to the berth area as whole with the wave heights at the berths in comparison to convention design building a jetty, breakwater and basin separately over the last 40 years practices

Incident wave		Wave heights at berth 1, significant wave height H_{m0} (m)			
Wave period T_p (s)	Wave height H_{m0} (m)	292.5° wave	315° wave	337.5° wave	0° wave
5	1.0	0.42	0.31	0.30	0.26
	1.5	0.56	0.42	0.39	0.35
8	1.0	0.54	0.39	0.35	0.30
	1.5	0.74	0.52	0.48	0.42
11	1.0	0.61	0.40	0.38	0.33
	1.5	0.86	0.55	0.50	0.44
	2.0	1.07	0.72	0.62	0.54
14	1.0	0.69	0.41	0.39	0.35
	1.5	0.97	0.59	0.52	0.47
	2.0	1.19	0.75	0.65	0.58

Berths	Downtime for different wave directions (%)						Total downtime (%)	Downtime limit (%)
	270° wave	292.5° wave	315° wave	337.5° wave	0° wave	22.5° wave		
Berth 1	0.054	0.657	0.724	2.287	0.000	0.001	3.70	5.3
Berth 2	0.054	0.169	0.488	1.655	0.001	0.001	2.37	3.5

TOTAL DOWN TIME AVERAGE IS 3%

Photo of tests of 2,000 DWT vessel at berth 1 and 15,000 DWT vessel at berth 2

ESTIMATED DOWNTIME CORRESPONDING TO THE VESSEL RESPOND CRITERIA IS AVERAGE 1.4%

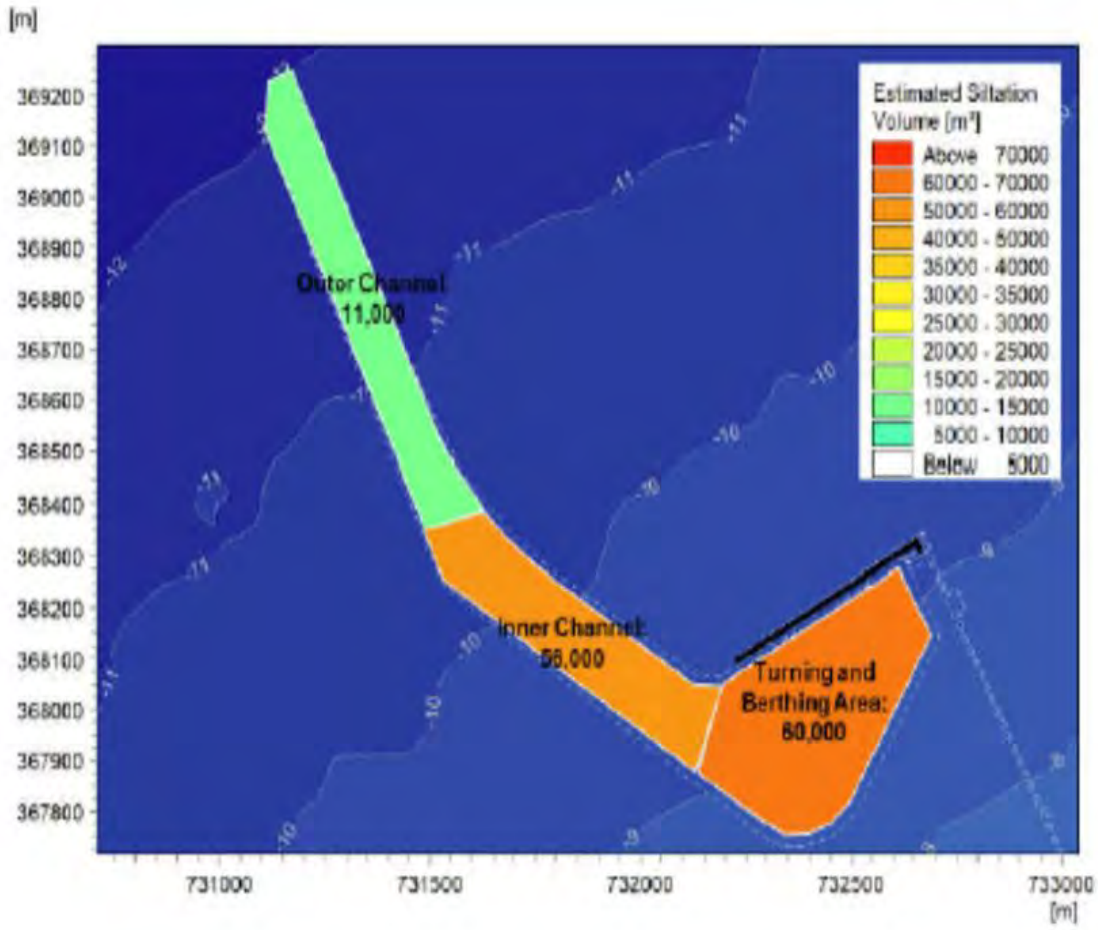
Vessels	Berths	Downtime for different wave directions (%)				Total downtime (%)	Downtime limit (%)
		292.5° wave	315° wave	337.5° wave	0° wave		
2,000 DWT vessel	Berth 1	0.061	0.425	0.302	0.000	**0.79**	**5.3**
	Berth 2	0.008	0.318	0.207	0.000	**0.53**	**3.5**
15,000 DWT vessel	Berth 1	0.000	0.384	1.077	0.000	**1.46**	**5.3**
	Berth 2	0.000	0.330	1.004	0.000	**1.33**	**3.5**

WAVE OVERTOPPING

- Overtopping rate was measured at the pipeline deck of the wave screen (top elevation of +8.5m) under the both 50-year return period and 1-year return period wave action.
- It is observed during the wave overtopping tests that there is no wave overtopping at the pipeline deck under 1-year return period wave condition, and there is slight wave overtopping at the pipeline deck under 50-year return period wave condition.
- It can be seen from the overtopping test results that, under 50-year return period high water level of +3.51m and 50-year return period wave condition, the maximum overtopping rate at the pipeline deck is 1.5 L/m/s, and under 1-year return period high water level of +3.21m IS 0.0 L/m/s

Wave direction	Water level	Wave return period (years)	Wave height H_{m0} (m)	Wave period T_p(s)	Overtopping measuring points	Measured overtopping rate q (L/m/s)	Overtopping limit (L/m/s)
315°	50-year return period high water level +3.51m	50	3.3	14.0	Y1	0.6	50
					Y2	1.1	
					Y3	1.5	
					Y4	1.0	
	1-year return period high water level +3.21m	1	1.8	9.2	Y1	0.0	1
					Y2	0.0	
					Y3	0.0	
					Y4	0.0	
337.5°	50-year return period high water level +3.51m	50	3.0	13.3	Y1	0.5	50
					Y2	0.4	
					Y3	0.4	
					Y4	0.6	
	1-year return period high water level +3.21m	1	2.1	10.5	Y1	0.0	1
					Y2	0.0	
					Y3	0.0	
					Y4	0.0	

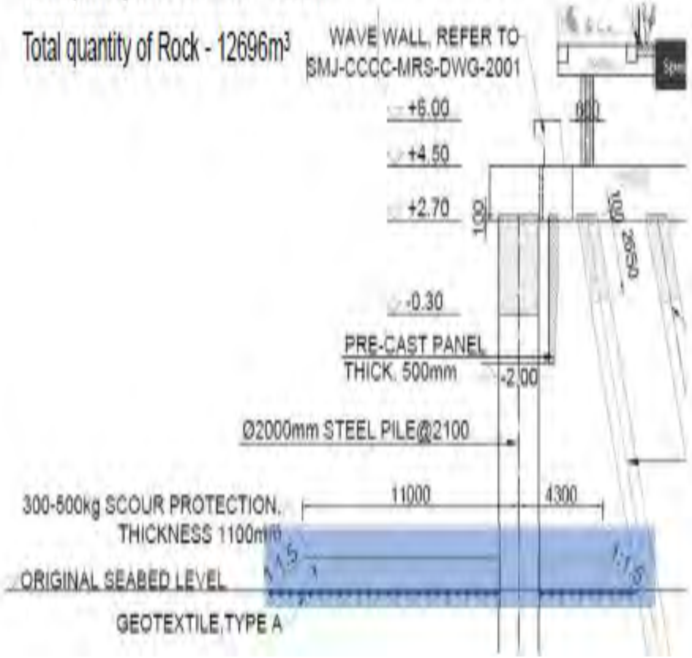
SEDIMENTATION RESULTS OVER 1 YEAR USING WAVE SCREEN DESIGN



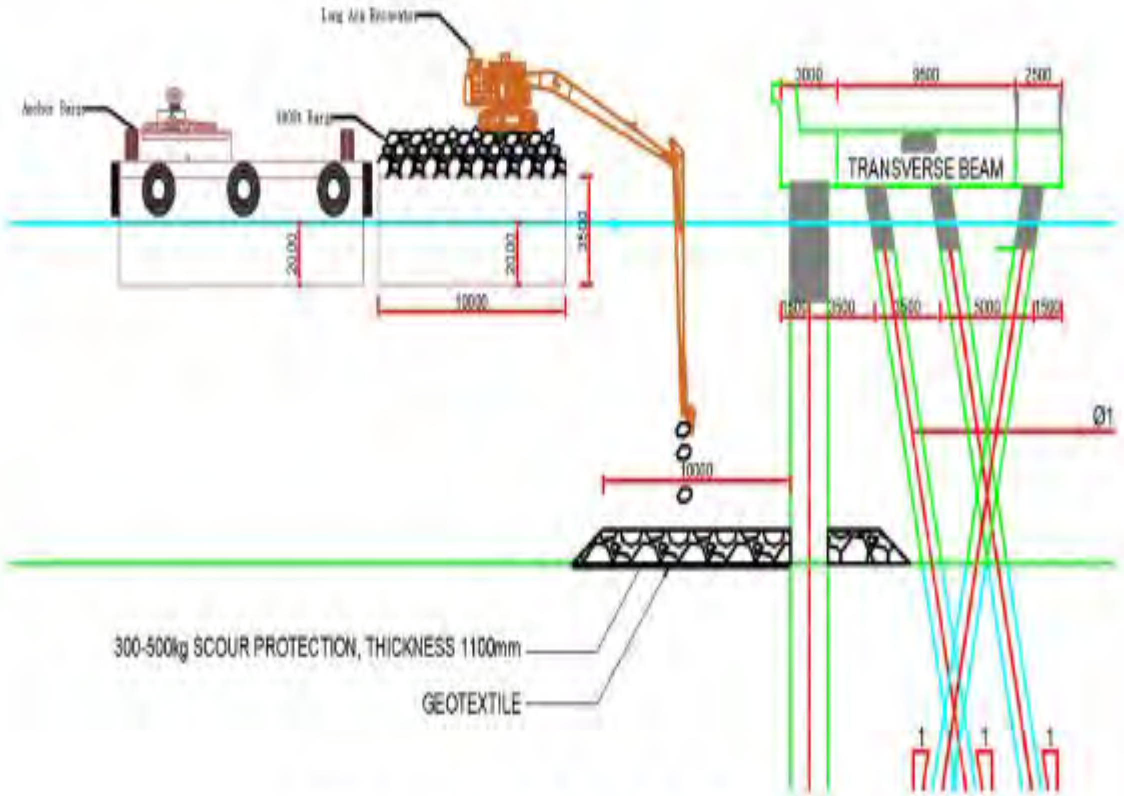
Section	Volumes [1000 m³/year]	Sedimentation Rates [cm/year]
Outer channel	11	11
Inner channel	56	48
Turning and berthing area	60	38
Total	127	-

RIPRAR CONSTRUCTION AT WAVESCREEN

- Geotextile laying will be carried out by using the paving barge, and the riprap in seawater will be carried out by the long arm excavator with multipurpose barge or materials barge with filling and leveling materials.
- Total quantity of Geotextiles – 8280m²
- Total quantity of Rock - 12696m³



1. Work Preparation
2. Geotextile Preparation
3. Positioning Paving Barge
4. Geotextile Installation
5. Rock Installation and Flatten



Filling and Install the rock for Riprap

This new design using wave screen will optimize the jetty and embrace a holistic approach by integrating:

- RESEARCH USING PHYSICAL MODELING, NUMERICAL MODELING
- DESIGNING THROUGH V BIM(VIRTUAL BUILDING INFORMATION MODELING)
- BUILDING THE WAVE SCREEN ATTACHED TO THE JETTY
- WILL REDUCE ENVIRONMENT IMPACT NEXT 40 YEARS
- TO INCREASE INVESTMENT EFFICIENCY

IN CONCULSION BY INTRUCING WAVE SCREENS INSTEAD OF BREAKWATERS IN THE DESIGN OF AN OPEN SEA TERMINAL DEVELOPMENT, SEVERAL SIGNIFICANT BENEFITS CAN BE REALIZED

- Substantial reduction in siltation impact and decrease in the frequency of maintenance dredging, extending the interval from every year to once every 5 years or longer
- Coastal erosion protection is minimized, the length reduced form 3,500 meters to just 400 meters, resulting to a minimum impact on coastal erosion
- A considerable decrease in construction and maintenance cost for the faculties associated with operating the terminal
- Shortened construction period by 20 months, leading to a reduction in CO2 emissions
- **The ability to construct the terminal in open sea deeper waters by cutting capital dredging cost, making it feasible to accommodate larger classes of vessels**

THANK YOU