Philippine Ports and Logistic 2024 Exhibition and Conference

Endorsed by the department of Transportation, Philippine

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

Theme: Ports & Terminal Optimization: Discussion about enhancing new design efficiency while lowering operational cost.

Presentation Title: Improving **upfront** design efficiency and reducing long term operation expenses in port or terminal infrastructure through simulation validation prior construction

How can we make port construction more efficient and cost-effective by incorporating simulation into the design phase?

- Minimize the initial capital outlay for construction.
- Decrease the environmental impact in terms of CO_2 emissions through adherence to ESG principles.
- Reduce implement coastal shore protection measures to mitigate coastline erosion risks.
- Lower the expenses associated with capital dredging activities.
- Mitigate the adverse effects of siltation.
- Diminish the costs related to maintenance dredging procedures.
- Reduce overall operational and maintenance expenditures.

Understanding the challenges of using the conventional design port infrastructure and environmental impact

- 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 poor design has the follow continuous impact

Inefficient terminal design which reduce efficiency

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

"Inclusive Research Methodology for Designing 500 MW Wave Screen, 3 km Trestle, Berth Facilities & Access Channel (-11.5m CD)"

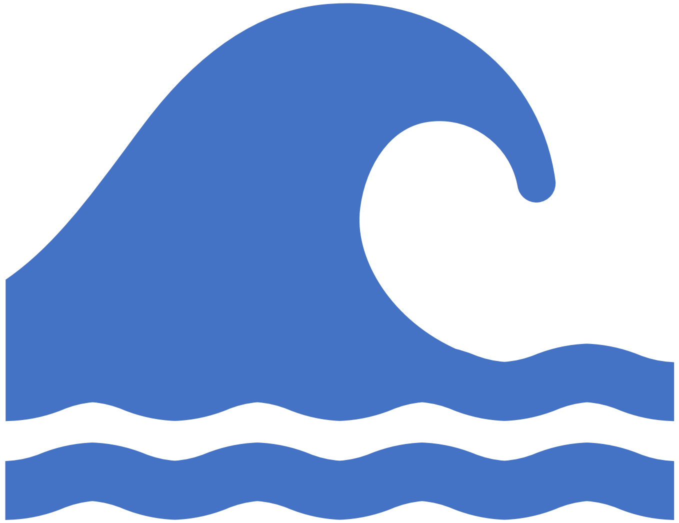
- Met-ocean Observations
- Numerical Wave Model Study
- Numerical Current and Sediment Model Study
- Ship Manoeuvring and Under Keel Clearance (UKC) Study;
- Marine Traffic Risk Assessment (MTRA) Study;
- 2D & 3D Physical Modelling Study.

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

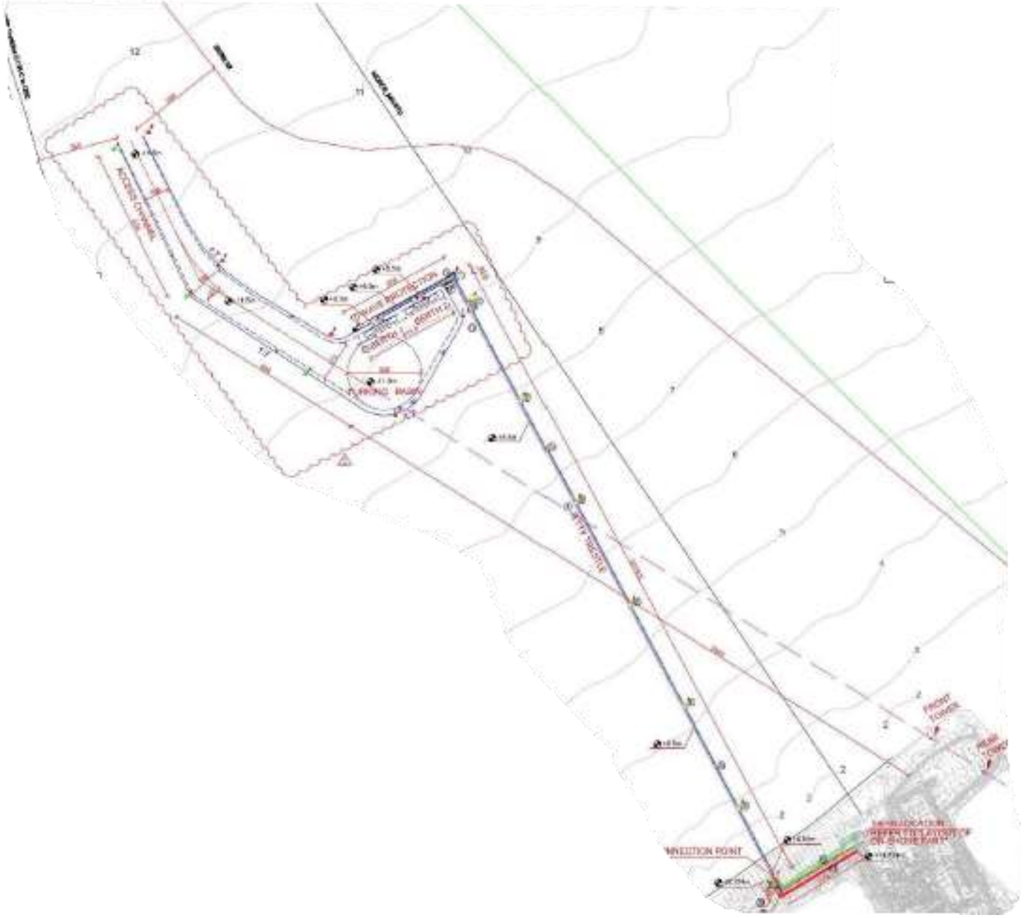
Under extreme condition, the waves behind the wave screen optimization, overtopping rate at pipeline deck, the wave force on the wave screen and stability of scour protection rocks are tested less then over topping limit

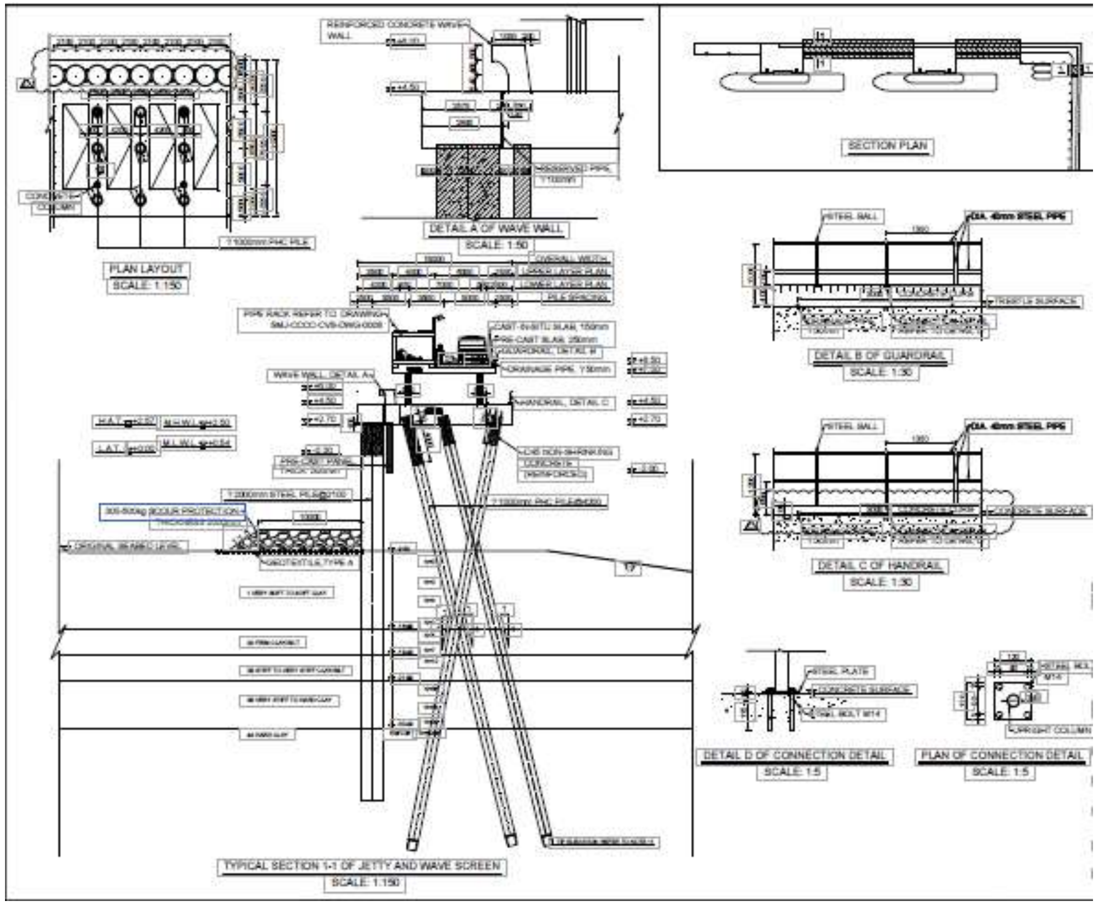
The performance of the wave screen physical modelling studies is to:

- 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.

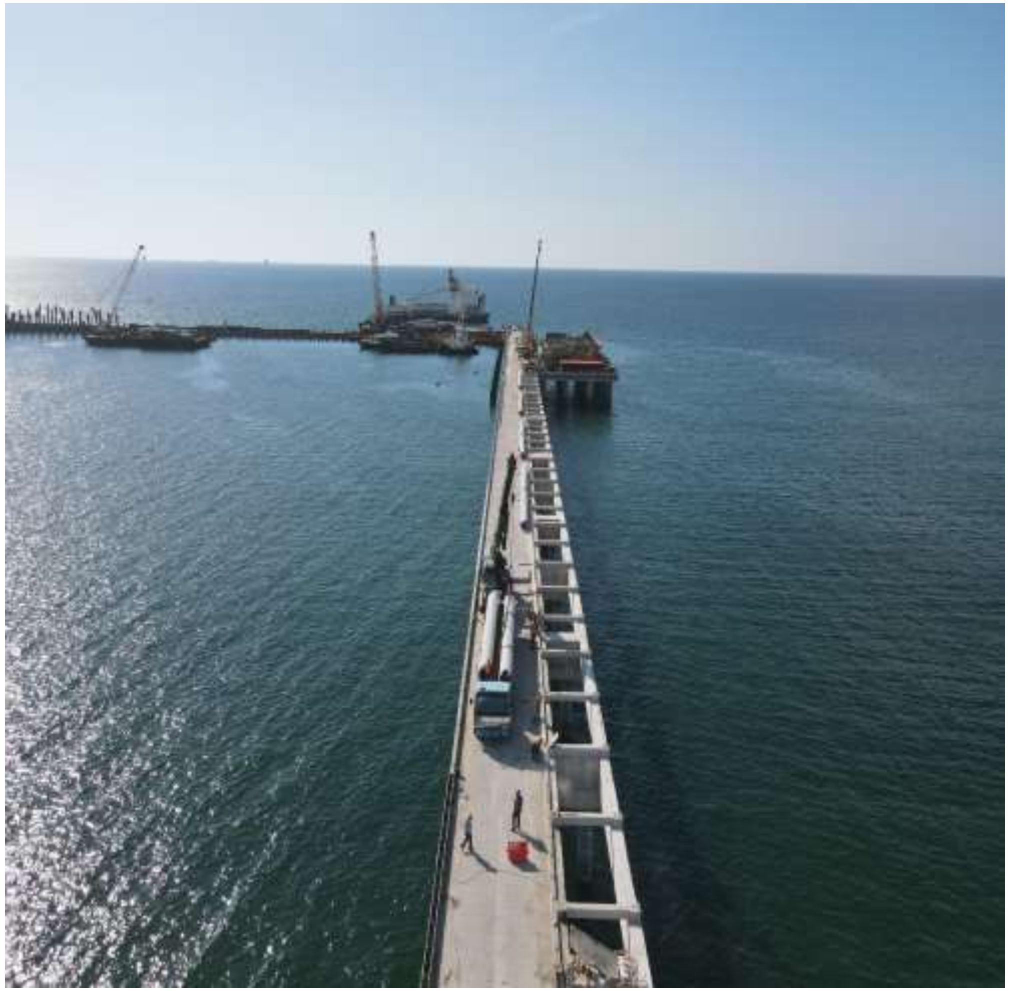


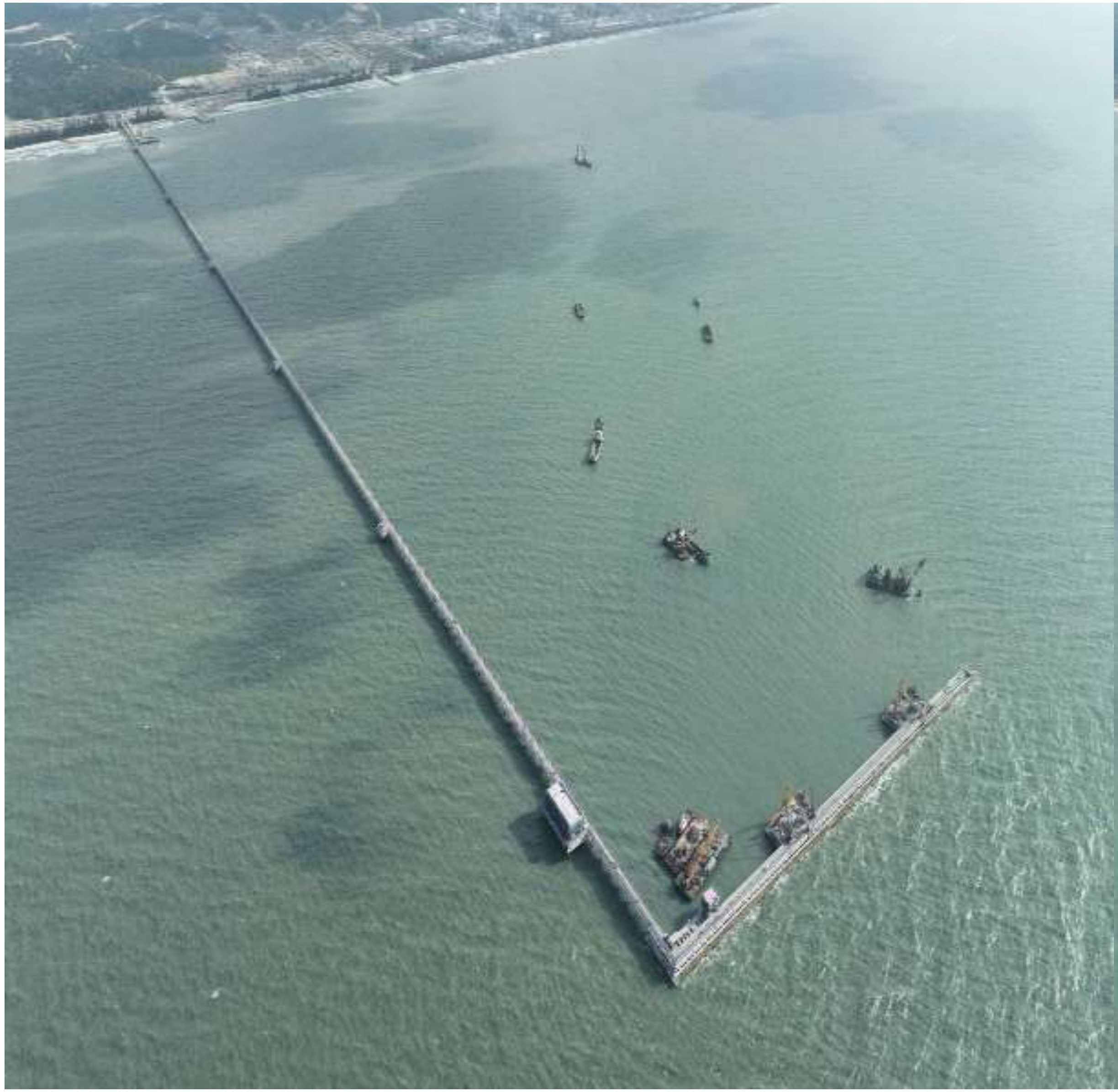
General layout & typical section of the wave screen





Updated construction Methanol Jetty up to September 2024



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 like the prototype

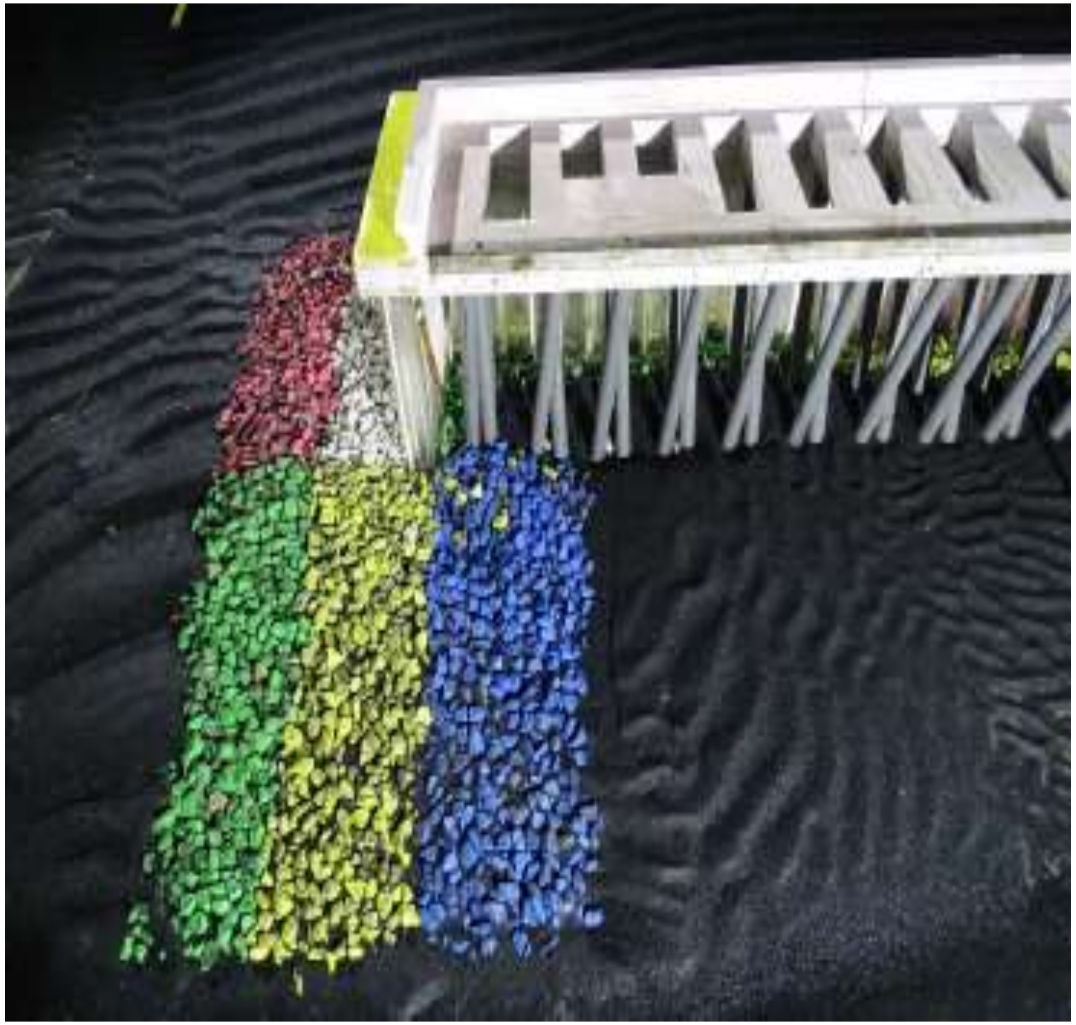
Model of the wave screen from the head

OUTSIDE TOE FROM HEAD VIEW

OUTSIDE TOE FROM END VIEW

OPTIMIZING PLAN OF THE SCOUR PROTECTION ROCKS

INNER SIDE CONER OF THE SCREEN WAVE HEAD



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.

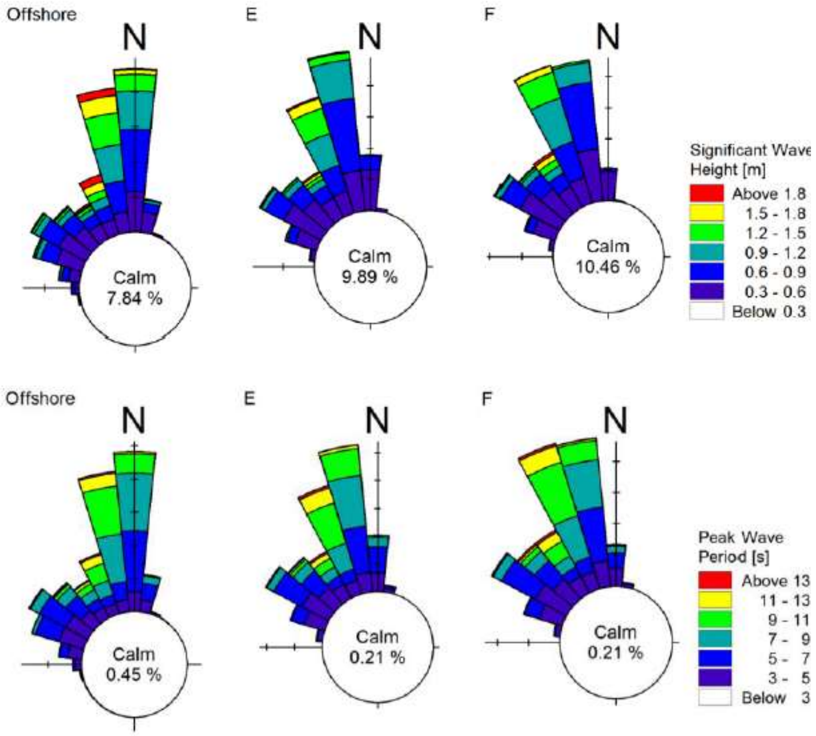
The crest elevations of the piles, beams, the wave wall and the pipeline deck of the wave screen are +2.7m, +4.5m, +6.0mCD and +8.5mCD respectively. At the outside toe of the wave screen, 300~500kg rocks are adopted for the scour protection.

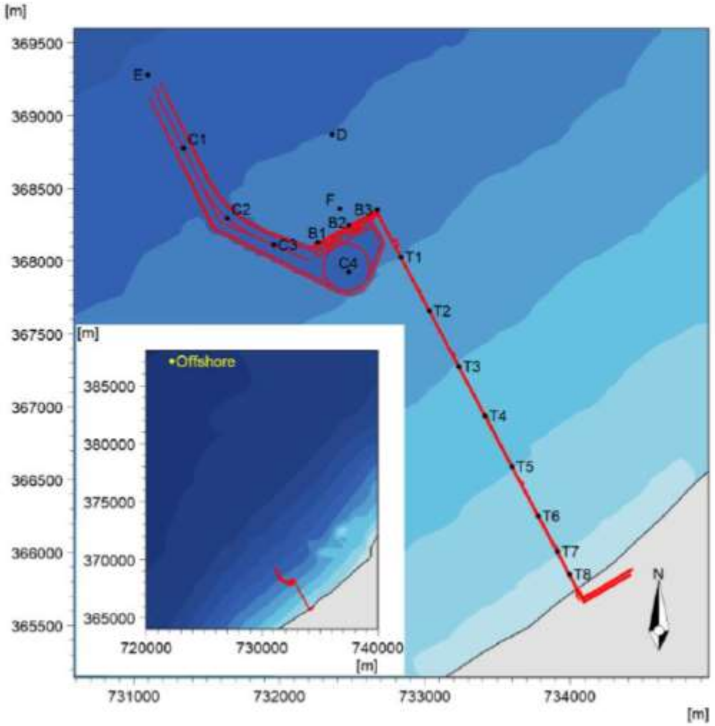
Test results and analysis for 2D physical model

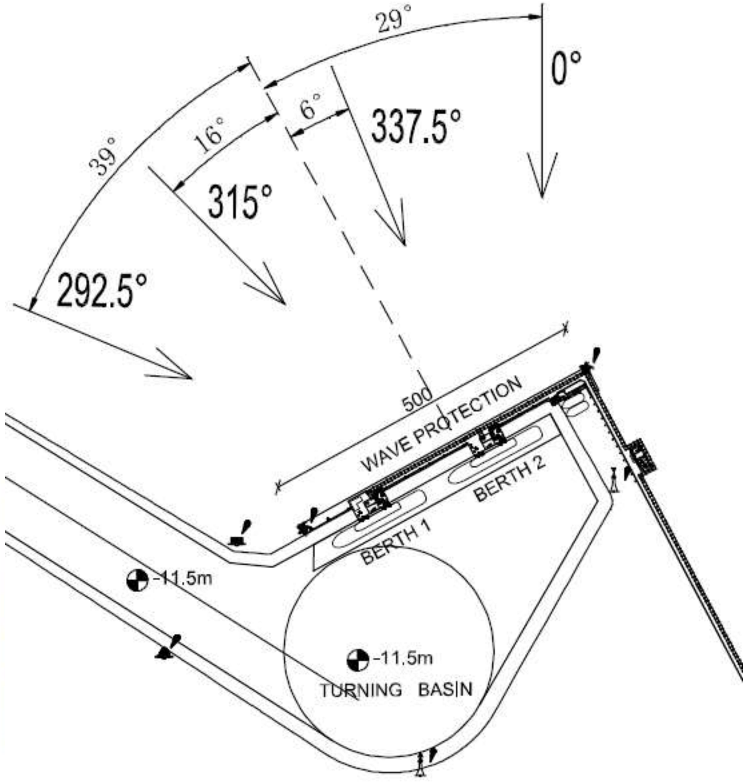
Investigate the waves behind the wave screen and the dynamic vessel response

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

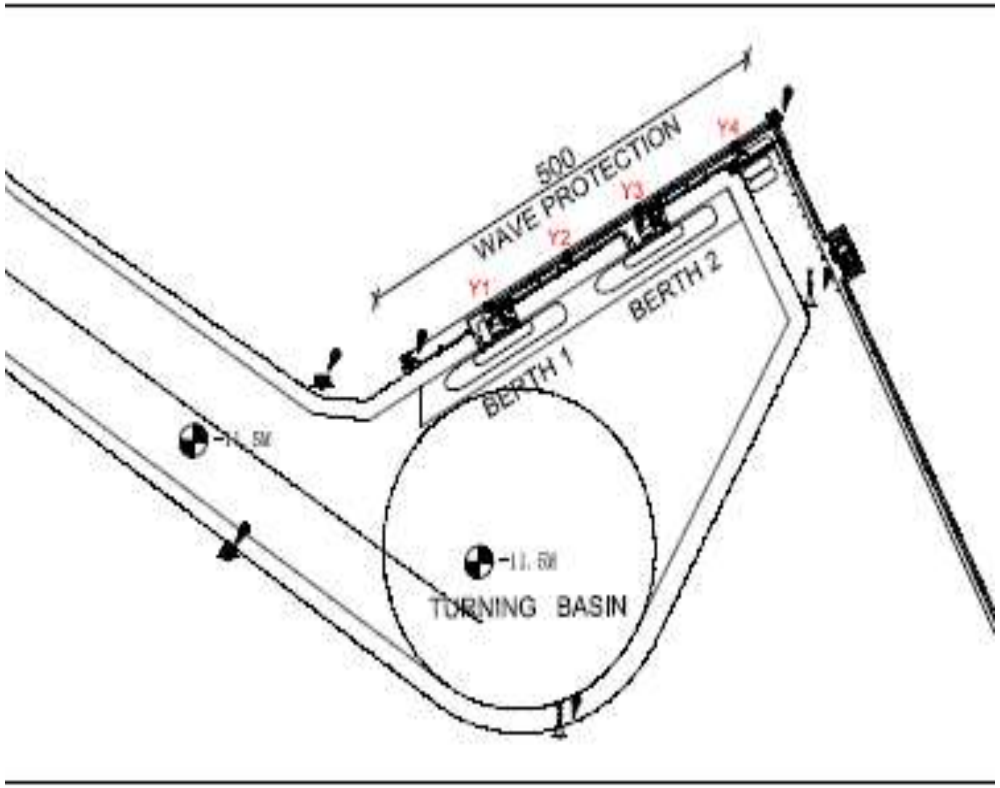
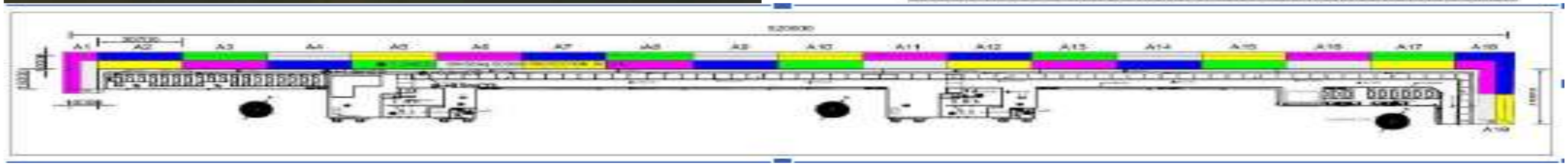


Figure 4.3-19 Arrangement of overtopping measuring points

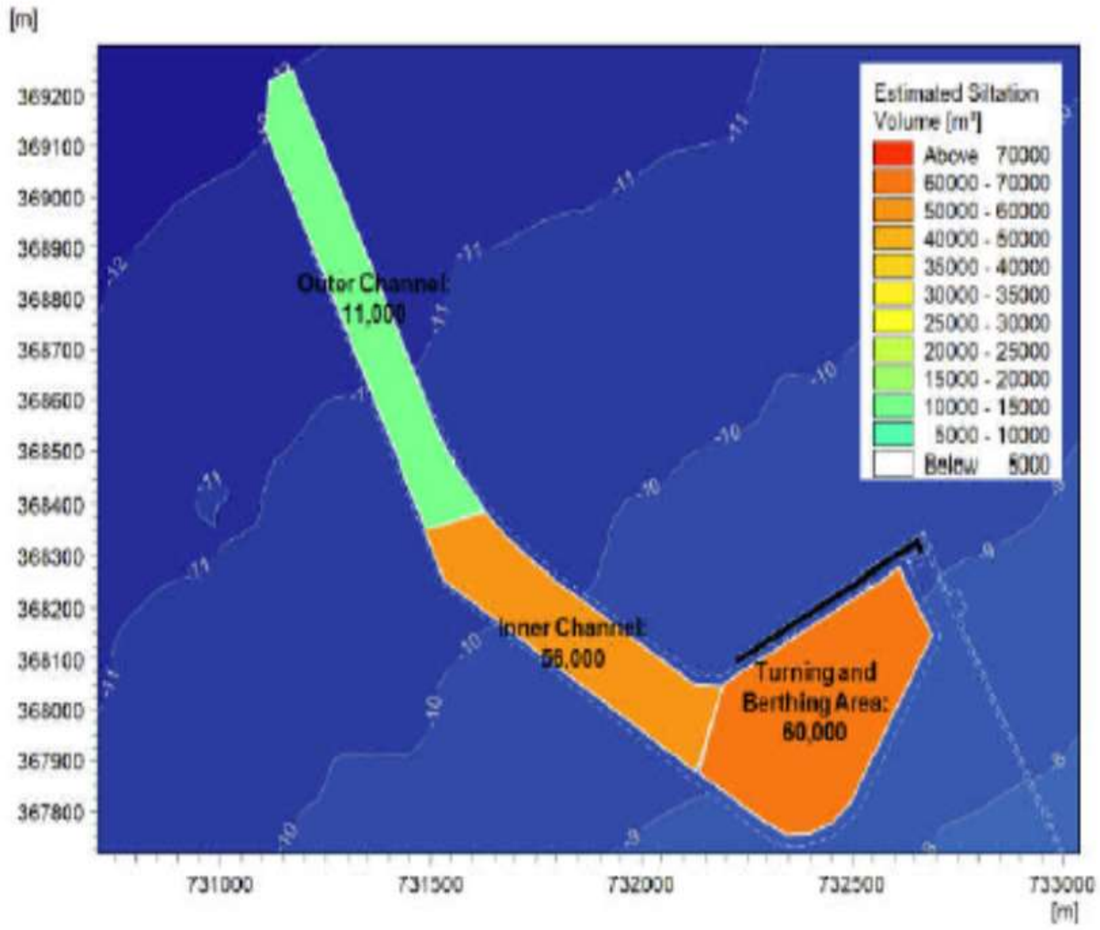


WAVE OVERTOPPING

- 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	

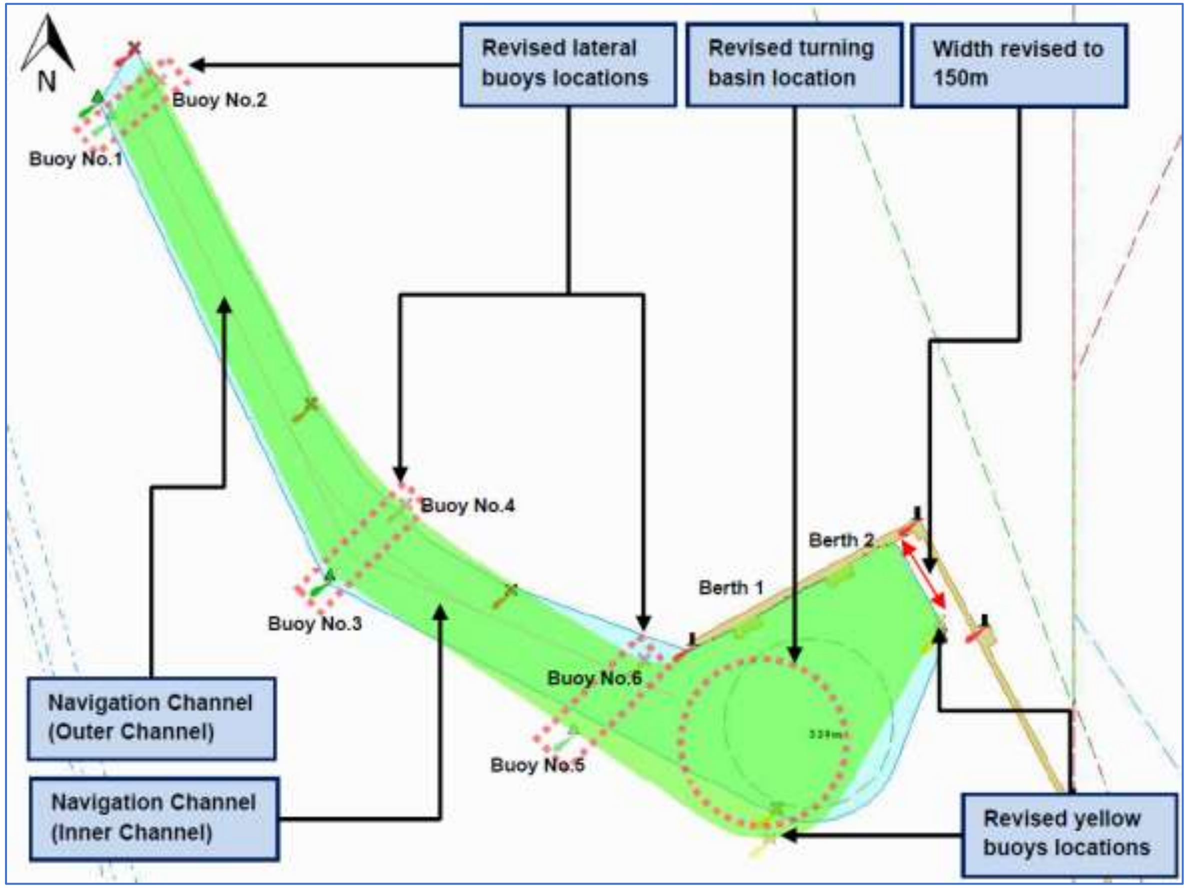
SEDIMENTATION RESULTS OVER 1 YEAR USING WAVE SCREEN DESIGN



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	-

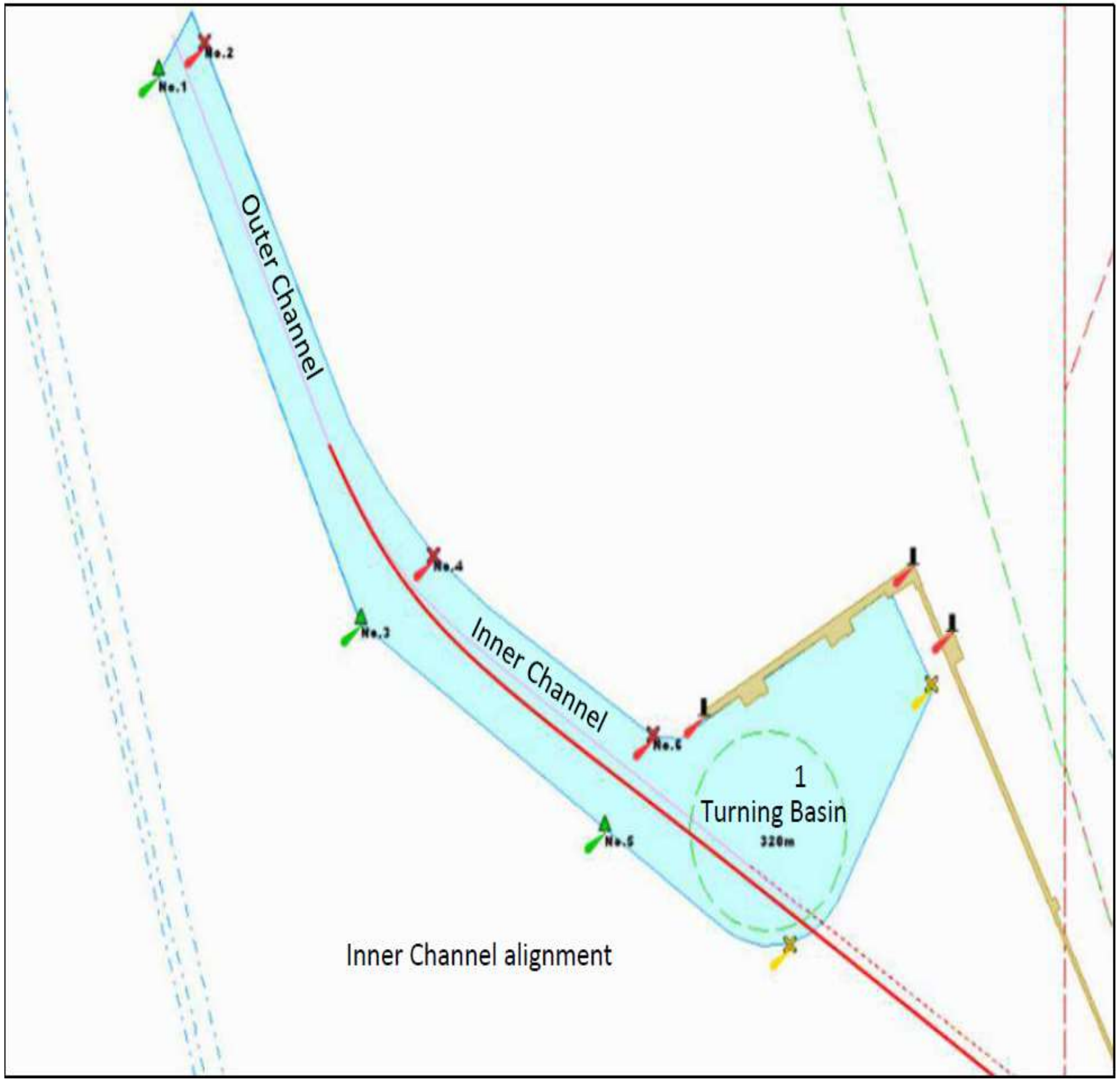
AFTER PHYSICAL MODELLING STUDIES, WE CONDUCT FULL MISSION SHIP SIMULATION TO VALIDATE THE DESIGN BEFORE CONSTRUCTION

- Evaluating the design's ability to handle maneuvers within the channel, behind the wave screen and at the jetty layout to ascertain the safety and effectiveness of the proposed infrastructure and waterway design



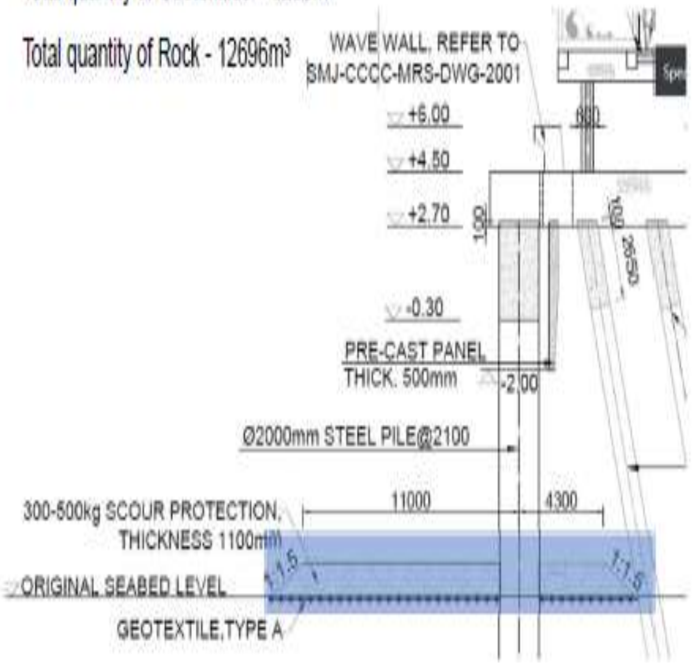
- Assess the wave screen jetty layout in terms of approach, berthing, unbreathing and departure of the design vessels

- Assess and determine the optimum layout for the dredged area and turning basin.

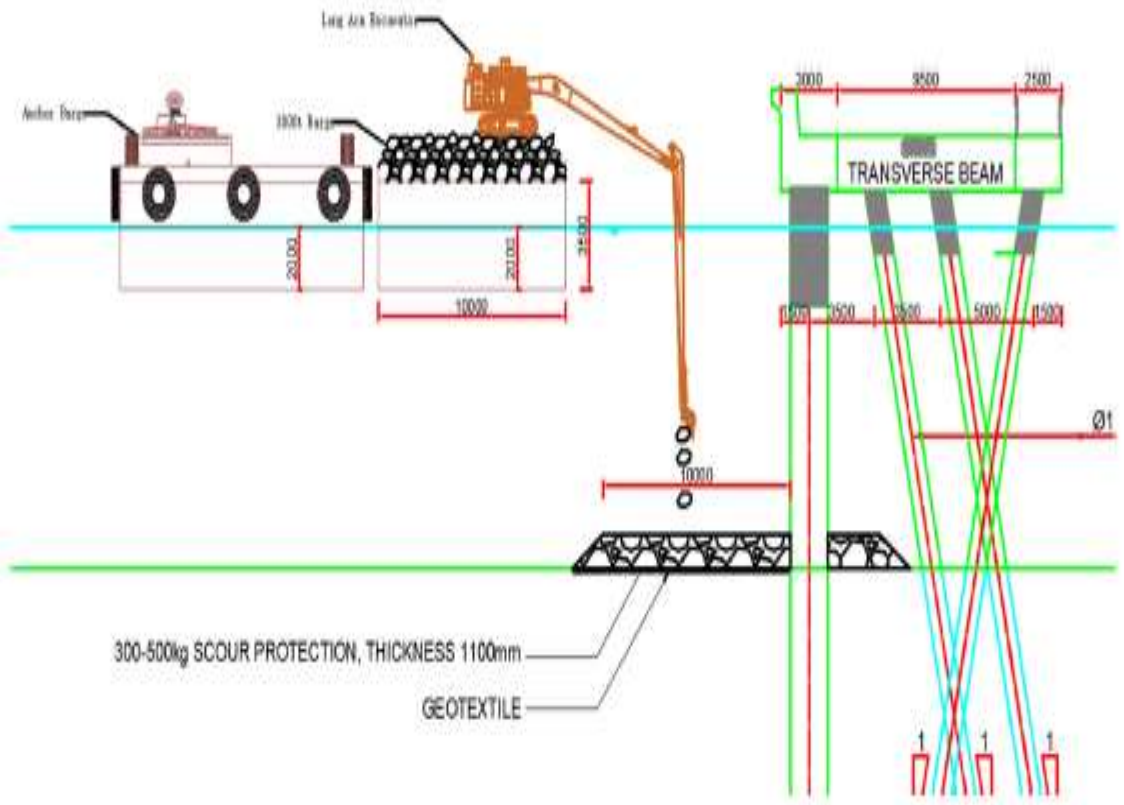


RIPRAR CONSTRUCTION AT WAVESCREEN

- 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 – 8280m^2
- Total quantity of Rock - 12696m^3

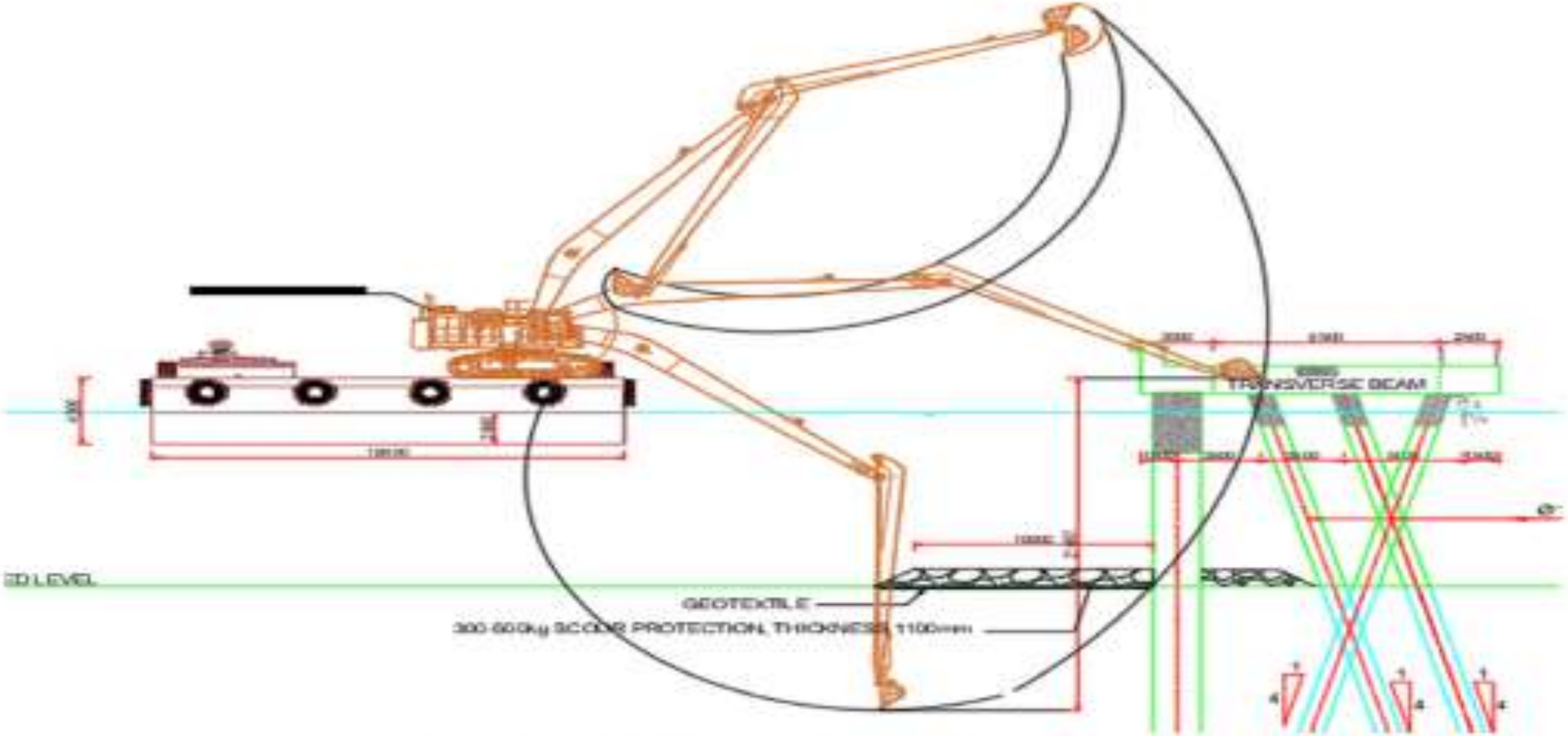


1. Work Preparation
2. Geotextile Preparation
3. Positioning Paving Barge
4. Geotextile Installation
5. Rock Installation and Flatten



Filling and Install the rock for Riprap

RIPRAR CONSTRUCTION AT WAVESCREEN



Leveling the Under Water 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

BY IMPLEMENTING ADVANCED EFFICIENT WAVE SCREENS DESIGN IN PLACE OF TRADITIONAL BREAKWATERS FOR AN OPEN SEA TERMINAL PROJECT, **LONG TERM UPFRONT CAPEX & OPERATIONAL COSTS WILL BE REDUCED** AS OUTLINED BELOW:

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

DURING CONSTRUCTION PHASE

AFTER CONSTRUCTION COMPLETION PHASE