Stantec

Upgrade for the Maritime Police Wharf (MPW) on Betio Island

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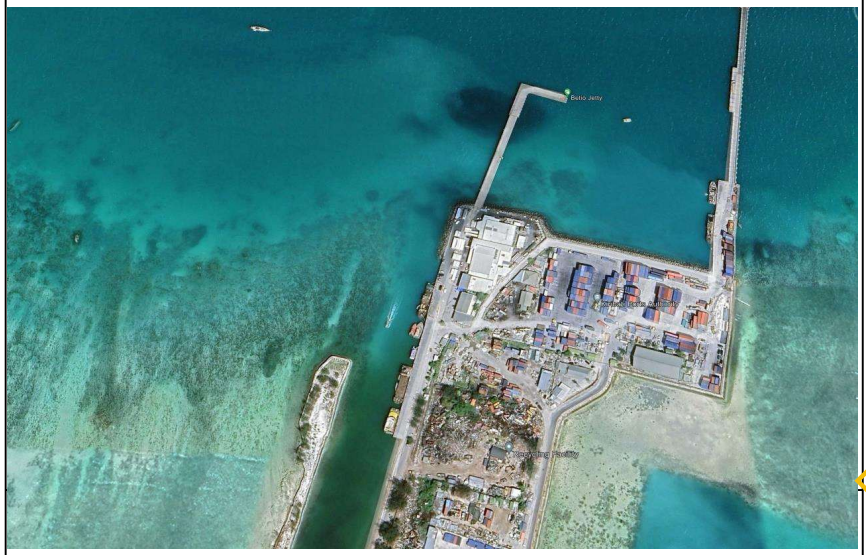
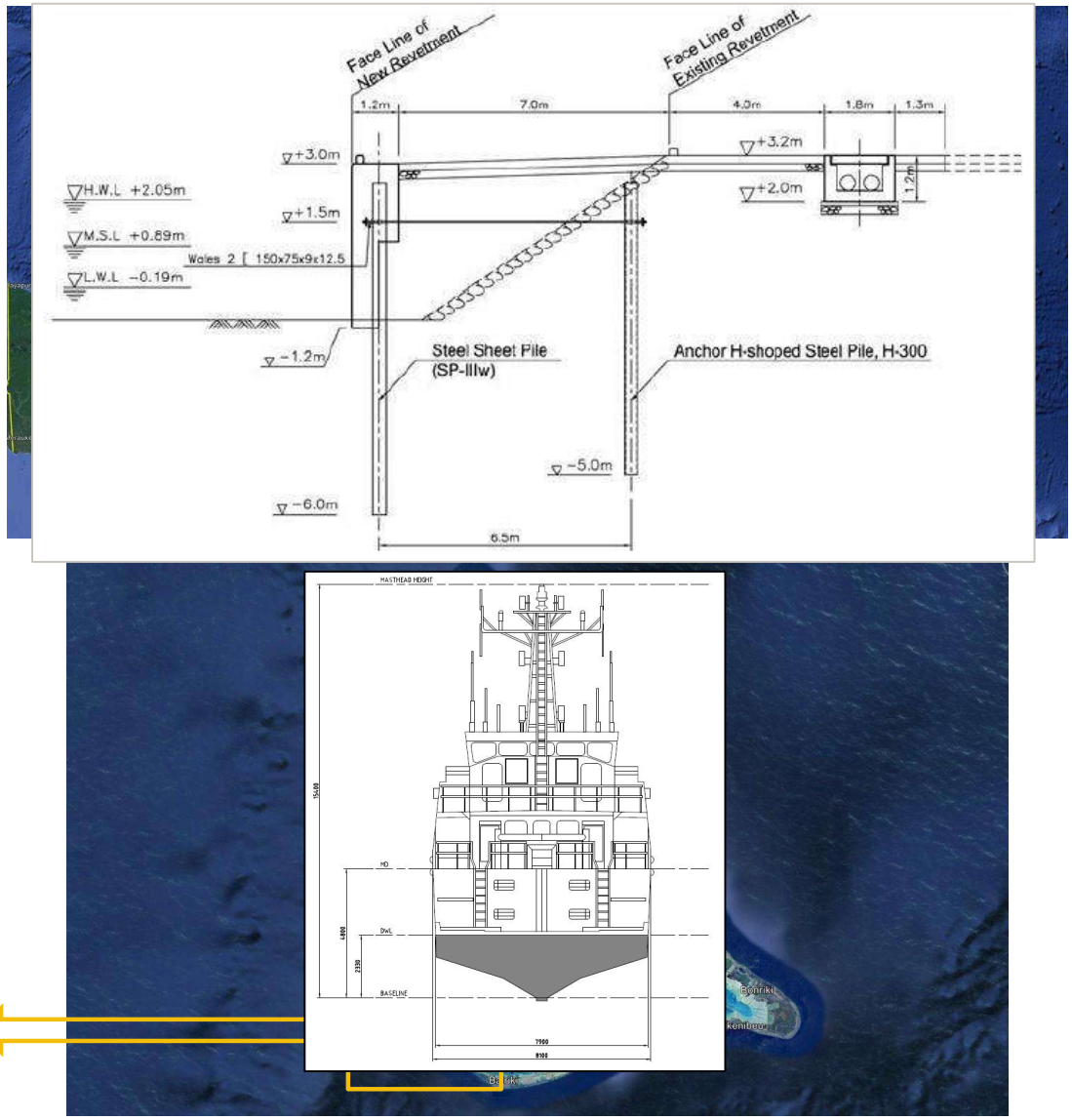
PIANC APAC 2024
Sydney

Introduction

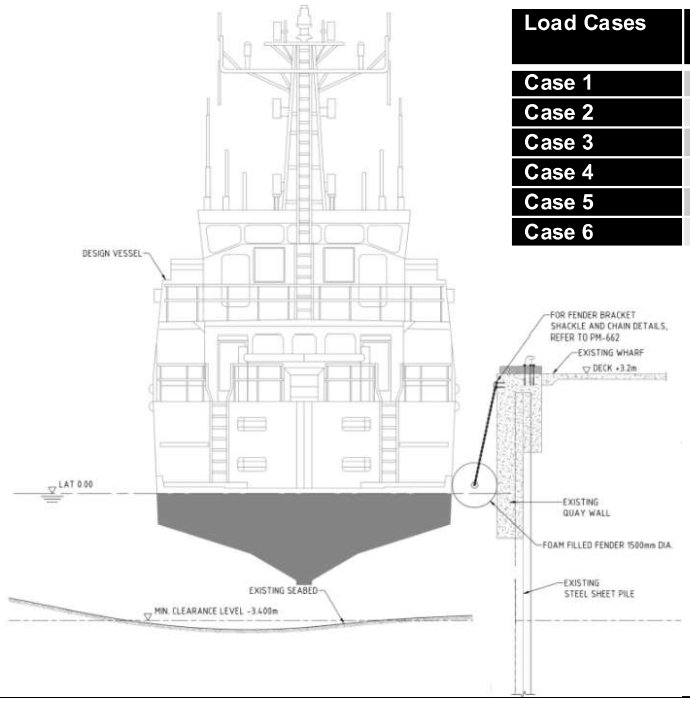
Location: Betio Island, Tarawa Atoll





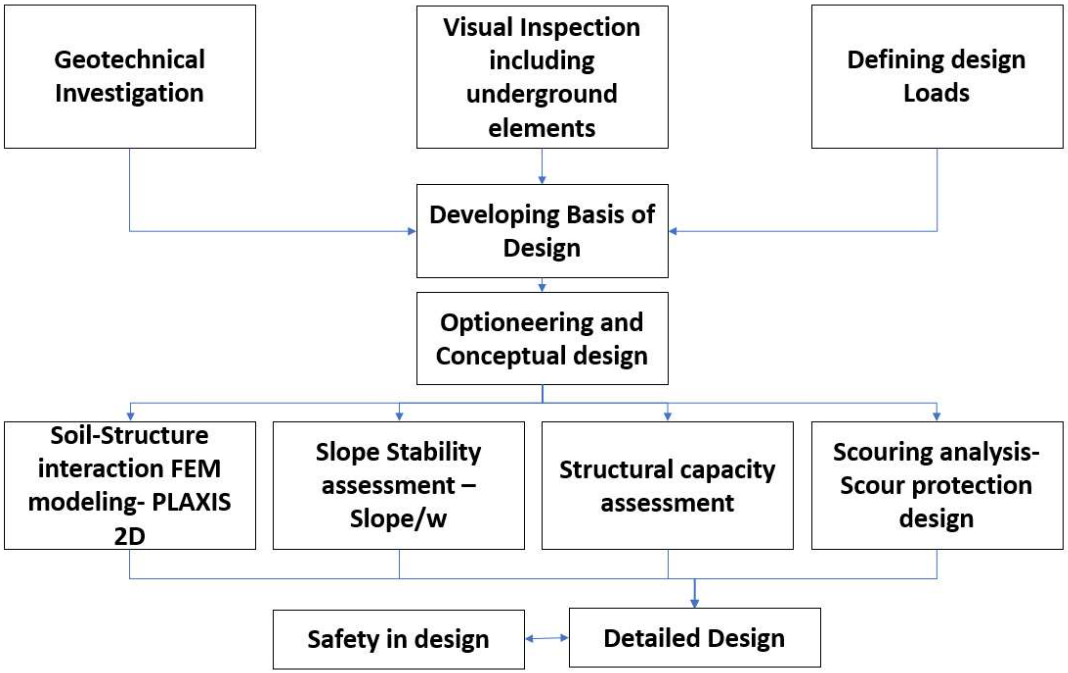
Problem

- Berthing pocket dredge depth
- Future scour risks
- Unknown as-built details and condition of buried elements



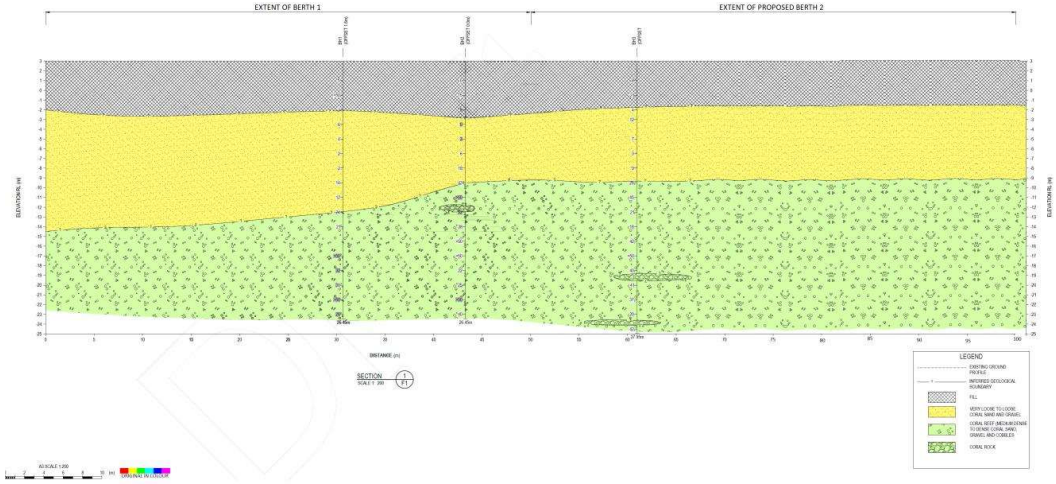
Load Cases	FoS on Wall Embedment
Case 1	1.066
Case 2	1.048
Case 3	1.088
Case 4	1.075
Case 5	0.836
Case 6	1.184

Design Approach



Data Gathering

- Inspection findings
- Geotechnical investigation results
- Loading



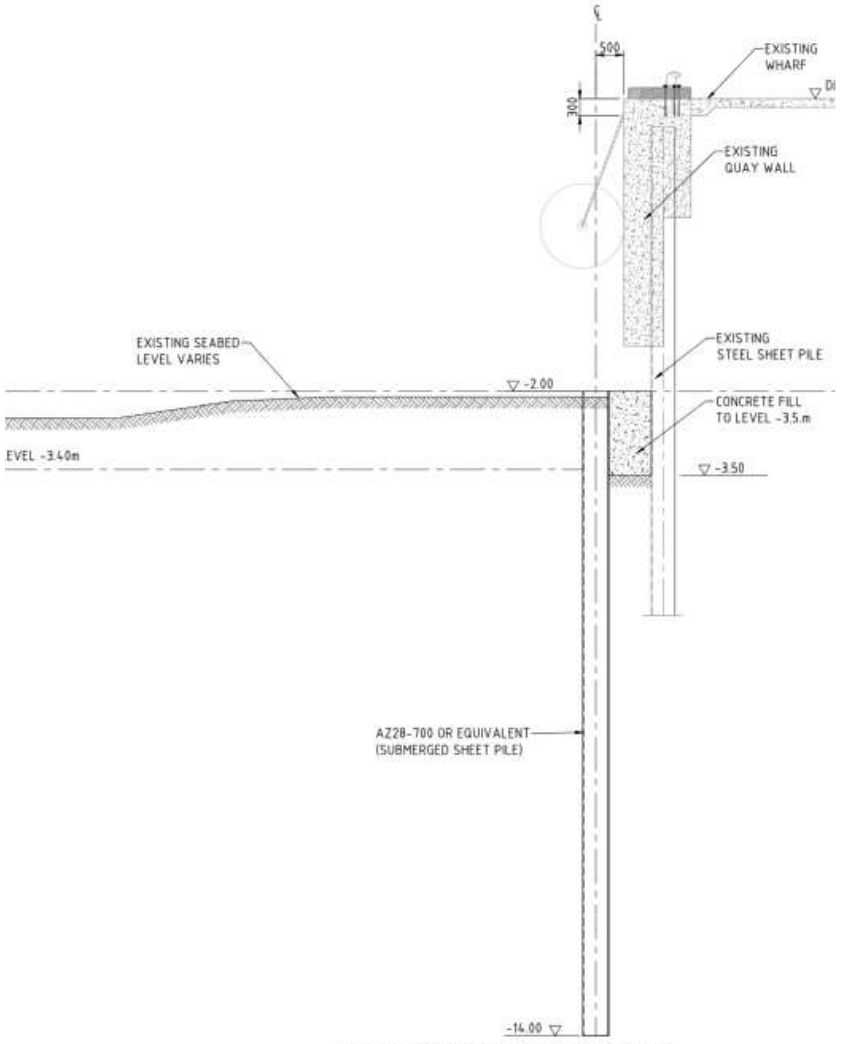
Conceptual Design

Options:

- Install a row of sheet piles with the top level at the seabed to enhance the toe capacity of the existing wall.
- Install a new sheet piled wall designed to work in conjunction with the existing structure.
- Install a completely new sheet piled wall, rendering the existing structure redundant.

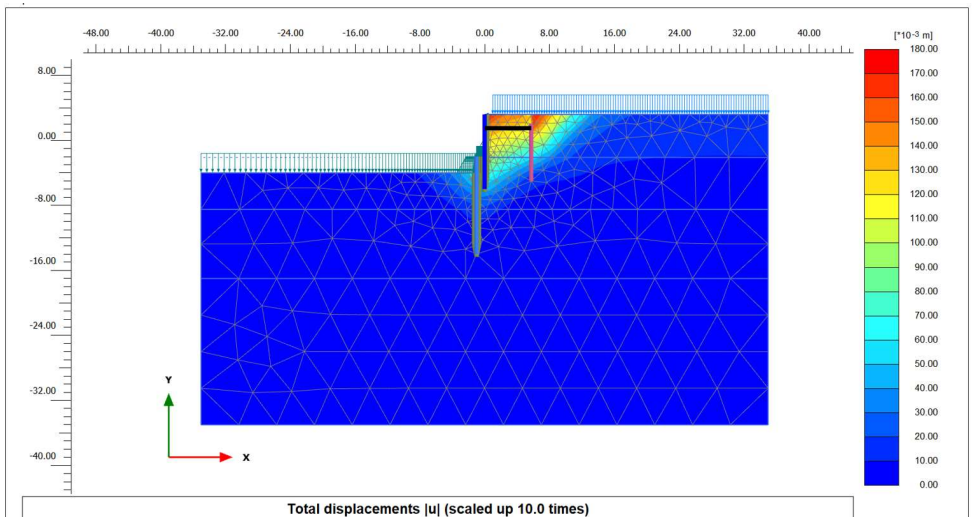
Selected Option

- Top of the submerged sheet-piled wall to be at -2.0 m (LAT) and the toe at -14 m (LAT).
- The gap between the existing wall and the submerged sheet-piled wall from -2.0 m (LAT) to -3.4 m (LAT) is filled with concrete to provide a rigid bearing connection between the walls.



Soil-Structure Interaction Analysis

- The FEM based program PLAXIS
- The global stability factor improved to between 1.27 and 1.67 for ULS load combinations
- The maximum displacements for SLS load combinations checked.
- Indicating the internal forces of structural elements for ULS load combinations.



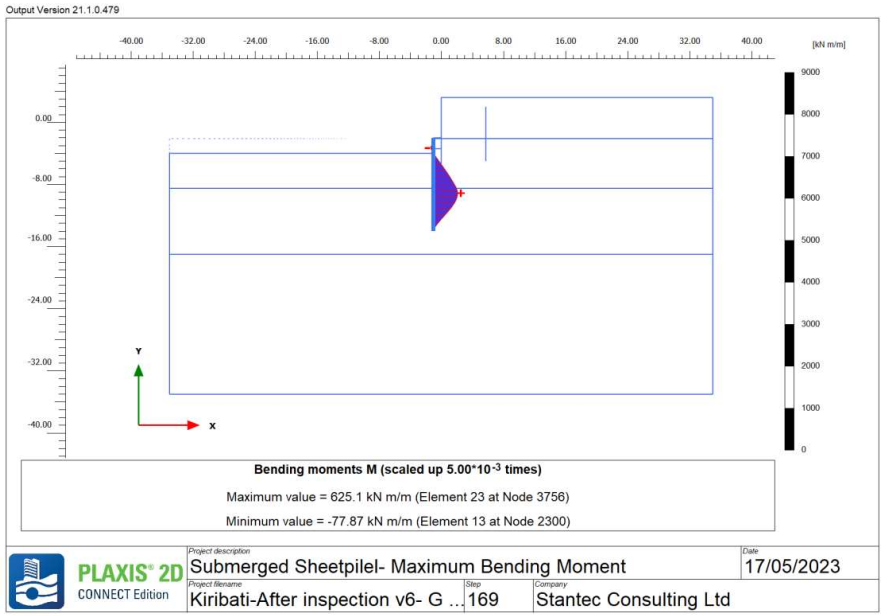
Load Combination	Global Stability Factor
Case 4	1.67
Case 5	1.29
Case 6	1.33
Case 7	1.31
Case 8	1.27

ULS-Results for Strength Design- Section

Load Combination	Maximum Bending moment			Maximum Shear Force			Axial Force (kN)
	Existing Wall (kNm/m)	Submerged Sheet-Pile (kNm/m)	Anchor Piles (kNm)	Existing Wall (kN/m)	Submerged Sheet-Pile (kN/m)	Anchor Piles (kN)	Tie Rod
Case 9	139.1	477.4	97.9	154.9	271.6	118.602	193.38
Case 10	82.66	625.1	107.052	213.3	240.1	131.868	215.91
Case 11	131	447.9	94.644	135.5	231.4	114.708	185.82
Case 12	86.08	359.9	97.812	126.5	97.04	114.092	179.36
Case 13	112.5	247.6	88.396	63.68	68.15	98.384	155.09
Case 14	128.1	250.1	87.912	67.04	101.4	100.606	161.41

Structural Assessment

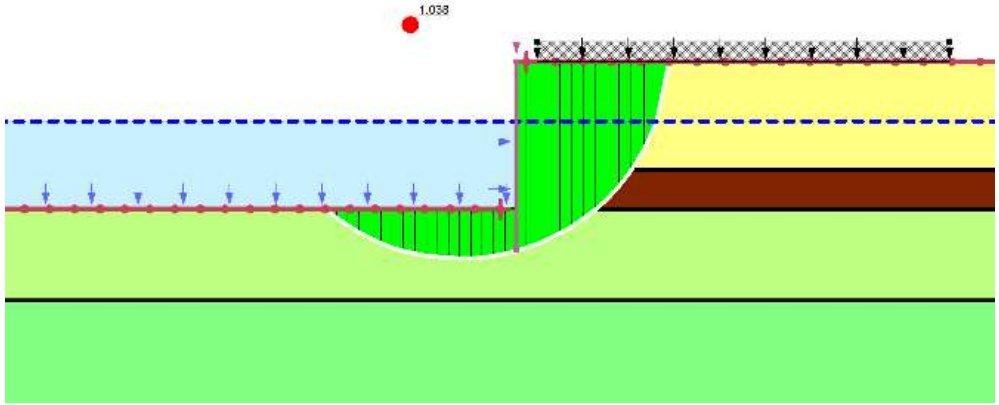
- Using PLAXIS model results
- Iteration between PLAXIS model and structural capacity of the elements
- Corrosion allowance
- In accordance with AS 4100

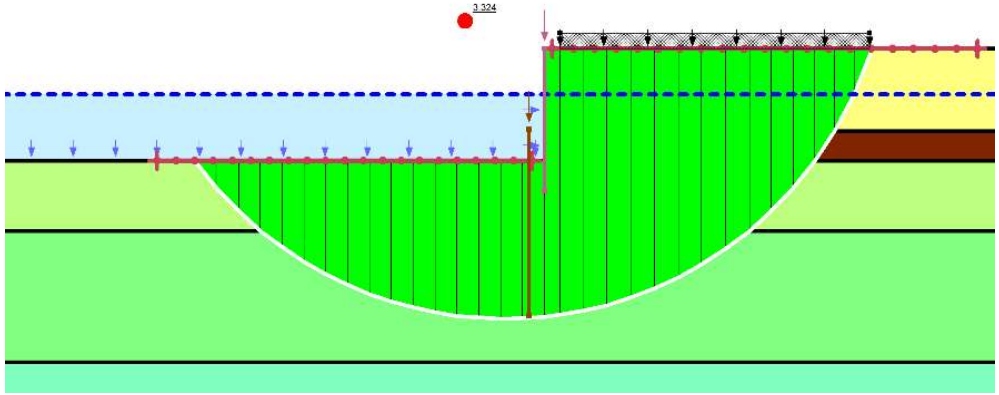


Member	Section	F_y	F_u	Capacity Factor (Φ)	Corrosion	Φ M_s (After corrosion)	Φ V_{vm} (After corrosion)
		MPa	MPa		mm	kN.m	kN
Submerged sheet-pile	AZ-28-700	350	430	0.9	2	674.43	1076.85
Existing wall sheet-pile	SP III W	350	430	0.9	2	495.51	705.60
Anchor Piles	H 300	350	430	0.9	2	232.55	506.52

Slope Stability Assessment

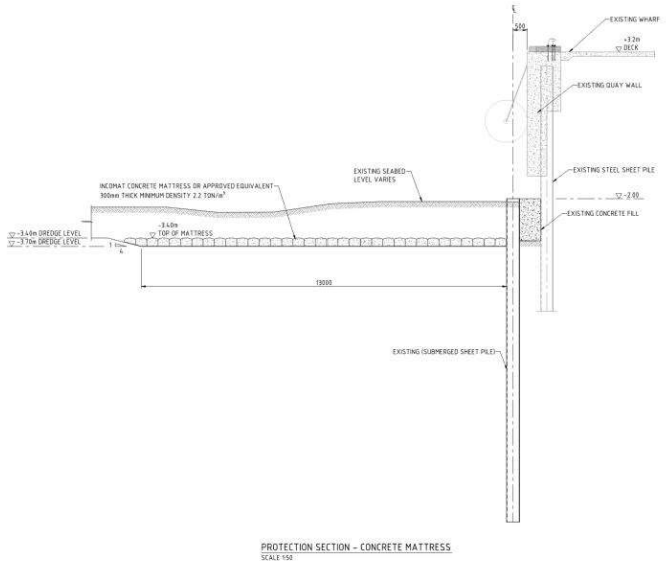
- Slope/W module of GeoStudio program
- Morgenstern-Price method
- FOS improved from 1.04 without submerged sheet-pile to 3.324 with the installation of submerged sheet-pile.





Scour protection design

- potential scouring caused by vessel propellers
- PIANC Report n° 180
- Concrete mattress



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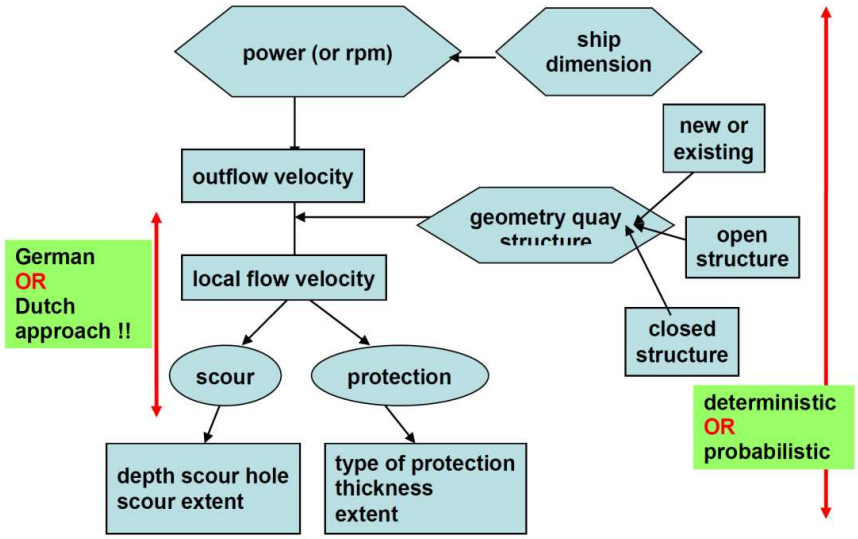


Minimum thickness of the mattress

$$\Delta D = \emptyset \frac{0.035}{\psi_{cr}} k_h k_{sl}^{-1} \frac{k_t^2 V^2}{2g}$$

Minimum Weight of the mattress

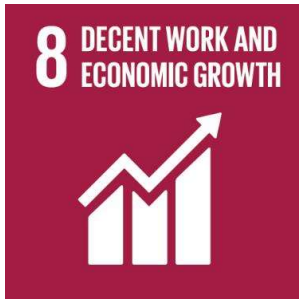
$$D \geq \frac{C_L}{2.\Delta.g} . V_{bottom}^2$$

Extend of the mattress

- The influence area of the jets
- The width of the passive soil volume in front of the quay wall that is required to ensure the geotechnical stability of the quay wall.

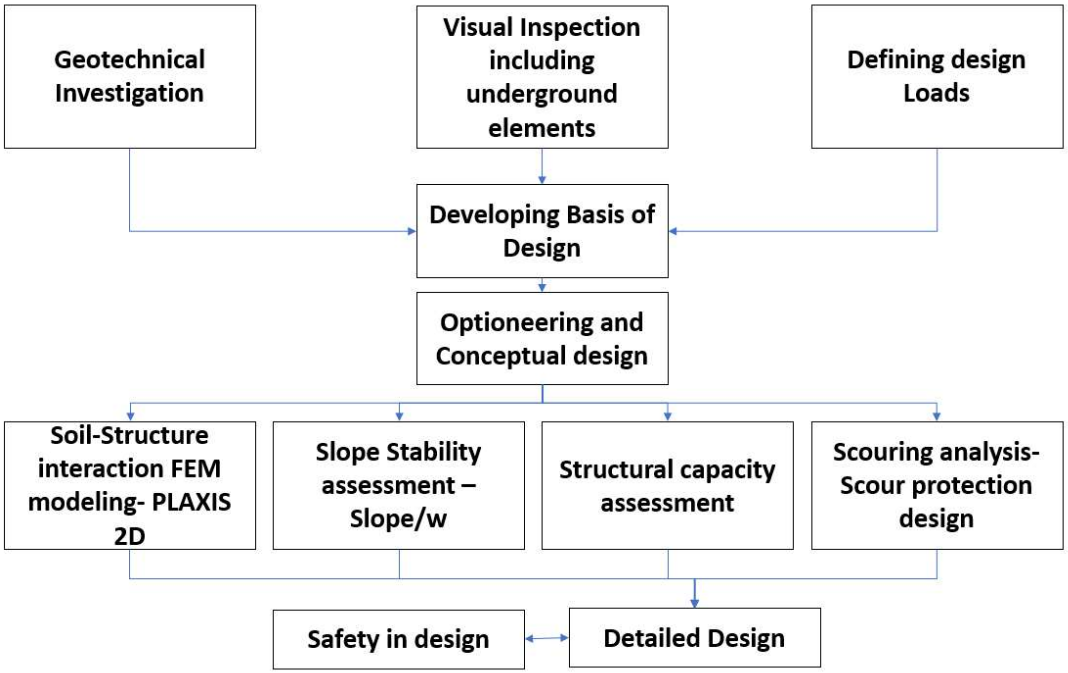
United Nations Sustainable Development Goals

- Goal 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all



- Goal 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Conclusion


Geotechnical Investigation
Visual Inspection including underground elements
Defining design Loads
Developing Basis of Design
Optioneering and Conceptual design
Soil-Structure interaction FEM modeling- PLAXIS 2D
Slope Stability assessment – Slope/w
Structural capacity assessment
Scouring analysis- Scour protection design
Safety in design
Detailed Design

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Thank you