

Title document:

## **Shadow Calculations NSF01**

Company:

**Van Oord Offshore Wind Projects BV**

Client:

**NSF**

Project Name:

**Pile design NSF01**

Project Number:

**144978**

## Substantiation of results

Comparison of Van Oord O-PILE method with Aqitec's methodology used in report 20230710\_Pile\_Report\_v0.4.

### Assumptions

Based on the soil input provided by Van Oord and the report of the concept design executed by Aqitec, shadow calculations were performed with the following assumptions:

- API method was used for determination of axial and lateral capacity of the anchor piles. Cyclic degradation is taken into account in the output of lateral capacity.
- Scour was considered as seabed-lowering, as also assumed by Aqitec.
- For lateral capacity, different load cases with increasing force were picked. The resulting displacement at the mudline was compared with the load-displacement curve provided by Aqitec.
- For axial capacity, cumulative skin friction resulted in O-PILE was compared with the outside skin friction calculated by Aqitec.

### Conclusion

With the above assumptions we have come to the conclusion that, in terms of axial capacity, which is also the driving requirement for the design, the findings are in good accordance between Aqitec's and Van Oord results.

However discrepancy was found in the lateral capacity calculations. If a load of 1250 kN is applied at the Pad-eye level ~0.02m of deflection is expected by Van Oord compared to the ~0.03m found by Aqitec. It is to bear in mind that this difference in results will also cause a difference in the distribution of stresses within the anchor pile, therefore may also affect the design under a structural point of view.

Project Information	
Project Client	NSFGI
Location	Borsstee III
Project No	144978
Date of Report	05-07-2023
Engineer	VANNOORDWIJQ
Notes	

General Analysis Information	
Pile Penetration	m 11.8
Pile Length	m 16.3
General Scour	m 0
Local Scour	m 0
Overburden Reduction Zone	m 0

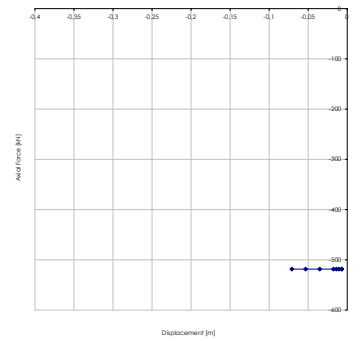
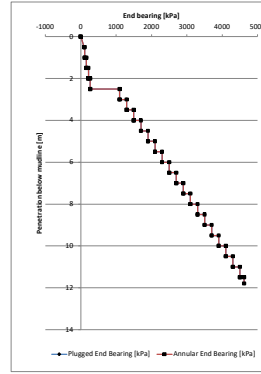
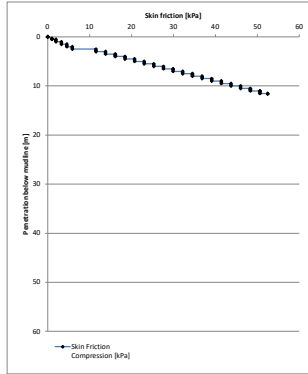
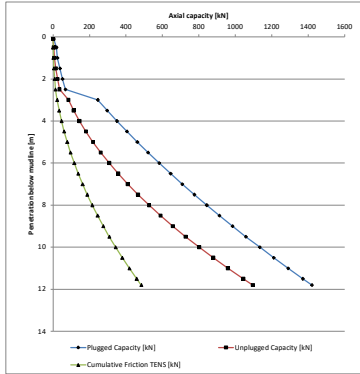
Other Axial Analysis Parameters	
TZ Method	API RP2GEO
Zmax Check	0.01
Optional End Bearing Limit	Unchecked
Optional Skin Friction Limit	Unchecked
Allow layer specific Tension T Modifier	Unchecked
Tmod	1
Zmod (TZ Curve)	1
Ermod	1
Zmod (QZ Curve)	1
Clay Friction Multiplier	1
Clay Alpha	0.7
Clay Exp 1	-0.5
Clay Exp 2	-0.25
ICP Base Condition	UNDRAINED
Sand Friction Multiplier	1
CPT Diameter	m 0.036
Pile Roughness	0.000025
API K Sand Compression	0.8
API K Sand Tension	0.8
Axial Chart Warning	FALSE

End Bearing Correction	
Smooth Plugged End Bearing	Unchecked
Plugged End Bearing Correction - Distance Above	m 0
Plugged End Bearing Correction - Increment	m 1
Smooth Unplugged End Bearing	Unchecked
Unplugged End Bearing Correction - Distance Above	m 0
Unplugged End Bearing Correction - Increment	m 1

Lateral Analysis Parameters	
Cyclic Dr Ratio	CYCLIC
SIFF Clay API Factor (Cyclic Only)	0.7
SIFF Clay API Limit Strength (Cyclic Only)	kPa 96
sd for Wessells/Dunavant	m 1
Y Modifier	1
Y Modifier	1
Fragile Transition Depth	m 10
Rock mass shear strength at 1% LCE	ks 0.1
Duramant Cycles	100
ROCKRES97 kcm	0.0005
ROCKRES97 Top Depth of Rock Layer	m 0
NOVULLO cycles	100
Allow V shifts	Unchecked
Manually define Xv	Unchecked
Xv	m
Modify Y for large diameter piles	
Allow layer specific Cyclic P Modifier	Unchecked
Clay Jazjean Hpd	
Clay Jazjean Hpd	
Clay Jazjean Factor on Su	
Clay Jazjean Allow manual sd	
Clay Jazjean sd	
Modified SANDAPI_A_min	
Modified SANDAPI_A_max	
Modified SANDAPI_n_exponent	

SRD Parameters	
SRD Main Method	
K Sand Compression	0.7
Nc_Rock	3
Stevens Unplugged UB Factor - Sand	2
Stevens Unplugged UB Factor - Sand	1.5
Stevens Plugged Skin Factor	1.3
Stevens Nc - Clay UB	15
Stevens Upper Bound End Factor	1.5
ALM Upper Bound Factor	1.25
ALM Factor on Sand Friction	1
ALM Factor on Clay Friction	1.8
Include Effect of Installation Weight	Unchecked
Installation WEIGHT 1 [kN]	600
Installation WEIGHT 2 [kN]	800
Installation WEIGHT 3 [kN]	1000
Upper Bound Lambda Maximum - Clay - Collat	0.5
Lower Bound Lambda Maximum - Clay - Collat	0.2
Upper Bound Lambda Residual - Clay - Collat	0.25
Lower Bound Lambda Residual - Clay - Collat	0.05
Upper Bound Lambda Maximum - Sand, Rock - Collat	1
Lower Bound Lambda Maximum - Sand, Rock - Collat	1
Upper Bound Lambda Residual - Sand, Rock - Collat	0.5
Lower Bound Lambda Residual - Sand, Rock - Collat	0.3
Collat Degradation Length [m]	10
Optional End Bearing Limit	Unchecked
Optional Skin Friction Limit	Unchecked

Checked  
use a different length to the penetration

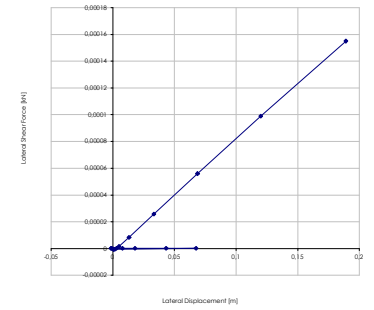


Analyses	
Checked	TZ, QZ Curves and Axial Capacity
Unchecked	Auto Generate Axial Load Cases
Checked	Axial Load Displacement Response
Unchecked	Axial Mobilized Capacity
Checked	PY Curves
Unchecked	Auto Generate Lateral Load Cases
Checked	Lateral Load Displacement Response
Unchecked	Soil Resistance to Driving

Analysis Options	
Unchecked	Conductor Mode
Checked	Retain Old Results
100	Iteration Limit
Unchecked	Uncouple TZ/QZ and PY Generation from Load
Checked	Displacement Response
0	Start MPC pile embedment depth [m]
-0.1	Negative displacement range limit [0°/1°]
0.003	Displacement Interval * D [m] for Mobilized Capacity

Chart Options	
Checked	Include Border on Charts
Checked	Include Location Box on Charts
Checked	Include Project Number Box on Charts
Checked	Include Project Name Box on Charts
Checked	Include Client Name Box on Charts
Checked	Reshape Chart [to A4 or A5] for Copying

Output Unit Options	
[kN]	Axial Capacity Output Unit
[kPa]	End Bearing Output Unit



#### Analysis Notes

05/07/2023 10:59:00 - Errors occurred during license check: Dinkley dongle error.  
 Dinkley Pro Net dongle cannot connect to server. Error code: 436. OPLTE will start in DEMO mode.  
 05/07/2023 10:59:01 - This file was created using the full version of OPLTE and you are attempting to open it using the demo version. Check the Analysis Notes for further info.  
 05/07/2023 10:59:01 - As this file was created using the full version of the Analyse Command has been disabled. If you really want to analyse this file in demo mode then rename it in demo mode and then reopen OPLTE.  
 27/06/2023 16:44:20 - File saved  
 27/06/2023 16:53:22 - File saved  
 27/06/2023 18:54:20 - File saved  
 27/06/2023 18:55:05 - Error: The pile full length exceeds the defined length in the Pile Properties table  
 27/06/2023 18:55:15 - Error: The pile full length exceeds the defined length in the Pile Properties table  
 27/06/2023 18:58:13 - File saved  
 27/06/2023 18:58:16 - Locate Axial Response Peaks Started 27/06/2023 18:58:16  
 27/06/2023 18:58:16 - Locate Axial Response Peaks Ended 27/06/2023 18:58:16  
 27/06/2023 18:58:22 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 18:58:37 - Locate Axial Response Peaks Started 27/06/2023 18:58:37  
 27/06/2023 18:58:37 - Locate Axial Response Peaks Ended 27/06/2023 18:58:37  
 27/06/2023 18:58:38 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 19:00:25 - No Lateral Grid Data Found. input Grid Point not defined  
 27/06/2023 19:01:44 - Locate Axial Response Peaks Started 27/06/2023 19:01:44  
 27/06/2023 19:01:44 - Locate Axial Response Peaks Ended 27/06/2023 19:01:44  
 27/06/2023 19:01:45 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 19:02:18 - No Lateral Grid Data Found. input Grid Point not defined  
 27/06/2023 19:04:41 - Locate Axial Response Peaks Started 27/06/2023 19:04:41  
 27/06/2023 19:04:41 - Locate Axial Response Peaks Ended 27/06/2023 19:04:41  
 27/06/2023 19:04:42 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 19:04:48 - Locate Axial Response Peaks Started 27/06/2023 19:04:48  
 27/06/2023 19:04:48 - Locate Axial Response Peaks Ended 27/06/2023 19:04:48  
 27/06/2023 19:04:49 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 19:07:56 - Locate Axial Response Peaks Started 27/06/2023 19:07:56  
 27/06/2023 19:07:56 - Locate Axial Response Peaks Ended 27/06/2023 19:07:56  
 27/06/2023 19:07:57 - Error encountered from procedure 'Extract Grid Option 1' Error Number 9  
 27/06/2023 19:08:49 - File saved  
 27/06/2023 19:09:36 - File saved  
 27/06/2023 19:09:57 - Analysis Started 27/06/2023 19:09:57  
 27/06/2023 19:10:04 - Error: Overburden reduction depth must be greater than the local scour depth  
 27/06/2023 19:10:04 - Analysis Finished 27/06/2023 19:10:04  
 27/06/2023 19:10:18 - File saved  
 27/06/2023 19:10:23 - Analysis Started 27/06/2023 19:10:23  
 27/06/2023 19:10:26 - Error: General Scour must be a number >= 0  
 27/06/2023 19:10:27 - Error: Local Scour must be a number >= 0  
 27/06/2023 19:10:27 - Analysis Finished 27/06/2023 19:10:27  
 27/06/2023 19:10:37 - File saved  
 27/06/2023 19:10:52 - File saved  
 27/06/2023 19:10:53 - Analysis Started 27/06/2023 19:10:53  
 27/06/2023 19:10:53 - Error: Axial soil input for layer 1 not a number or missing: Beta Comp [ ]  
 27/06/2023 19:11:00 - Data is missing or not numeric, check Analysis Notes box for details  
 27/06/2023 19:11:00 - Analysis Finished 27/06/2023 19:11:00  
 27/06/2023 19:12:46 - File saved  
 27/06/2023 19:13:39 - File saved  
 27/06/2023 19:13:49 - Analysis Started 27/06/2023 19:13:49  
 27/06/2023 19:13:49 - Error: Axial soil input for layer 1 not a number or missing: Beta Comp [ ]  
 27/06/2023 19:13:51 - Data is missing or not numeric, check Analysis Notes box for details  
 27/06/2023 19:13:51 - Analysis Finished 27/06/2023 19:13:51  
 27/06/2023 19:15:15 - File saved  
 27/06/2023 19:16:34 - File saved  
 27/06/2023 19:16:36 - Analysis Started 27/06/2023 19:16:36

SRD Custom Input	Custom 1	Custom 2	Custom 3	Custom 4	Custom 5
SAND Skin Friction Factor	0.6	1.2	1.8		
CLAY Skin Friction Factor	0.6	1.2	1.8		
SAND End Bearing Factor	0.3	0.6	0.9		
CLAY End Bearing Factor	0.3	0.6	0.9		
Plugged / Unplugged	UNPLUGGED	UNPLUGGED	UNPLUGGED		