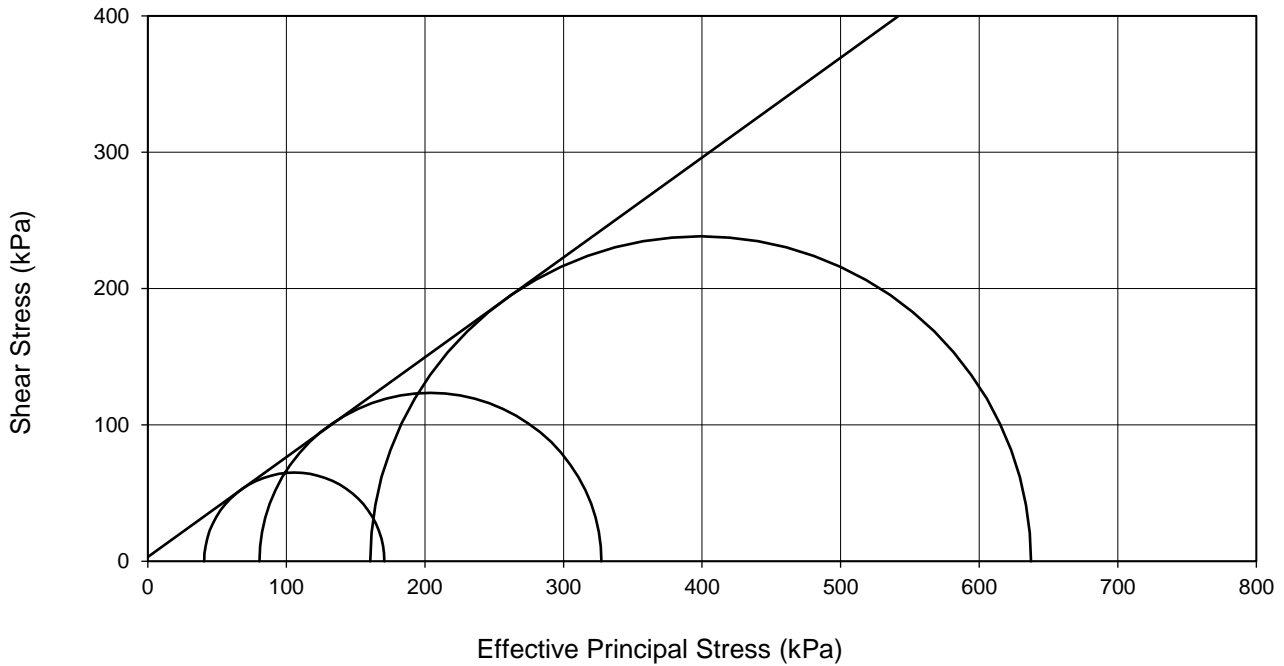


Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 10.00-10.45

Description:
Greyish brown fine to medium SAND with occasional fine to medium gravel. .



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

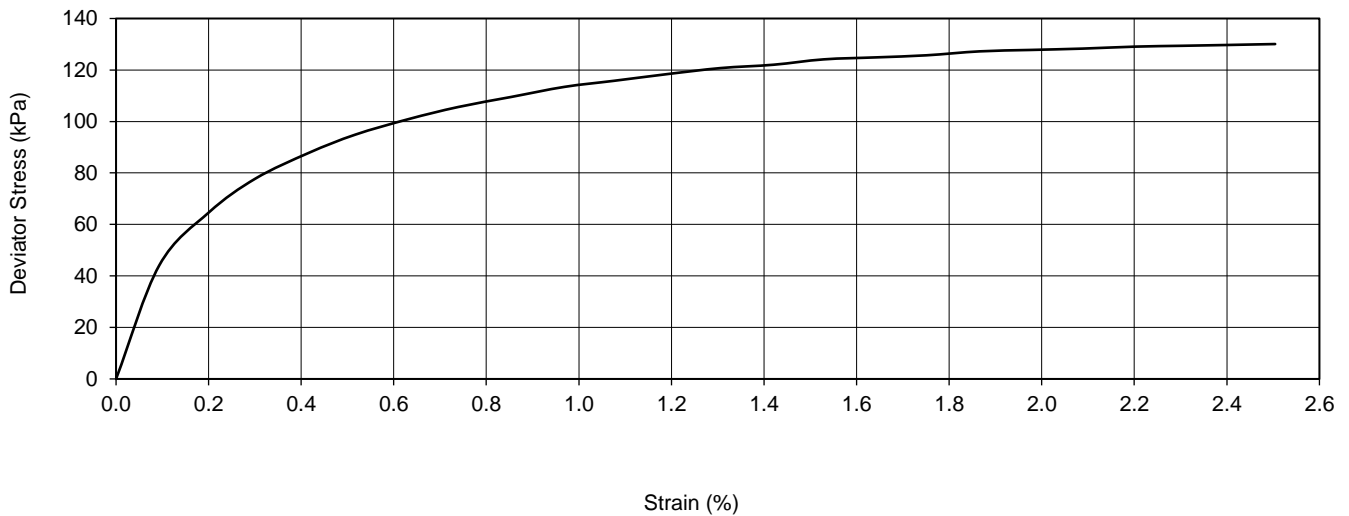
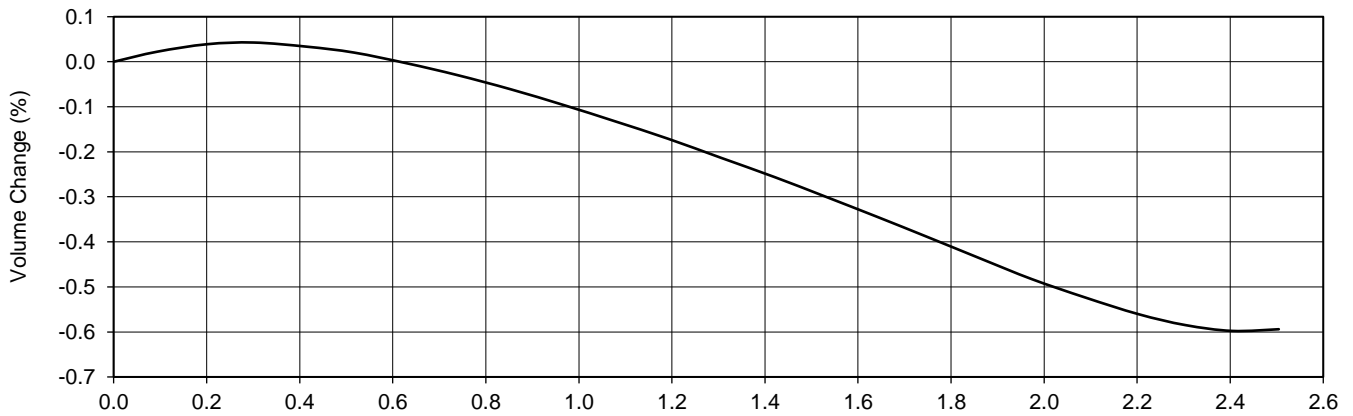
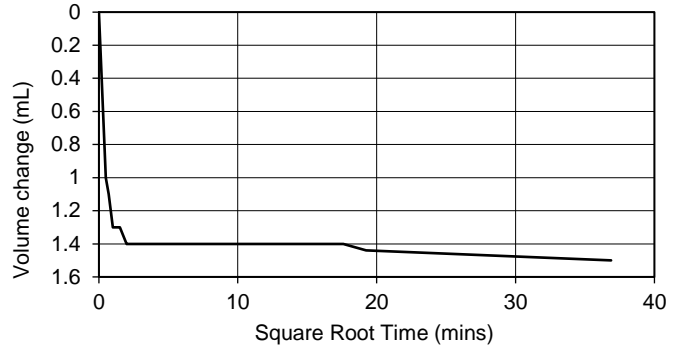
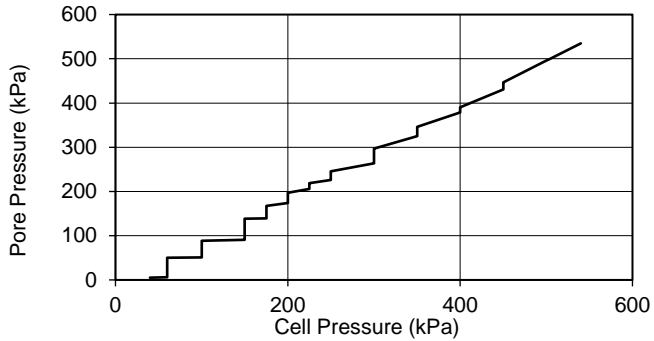
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 10.00-10.45

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

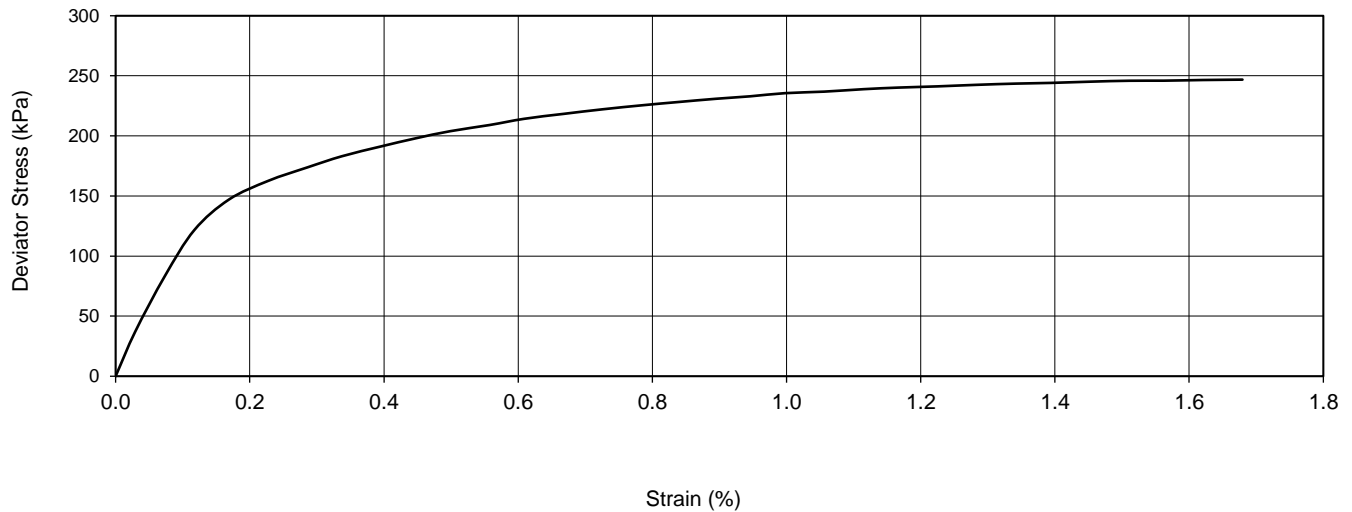
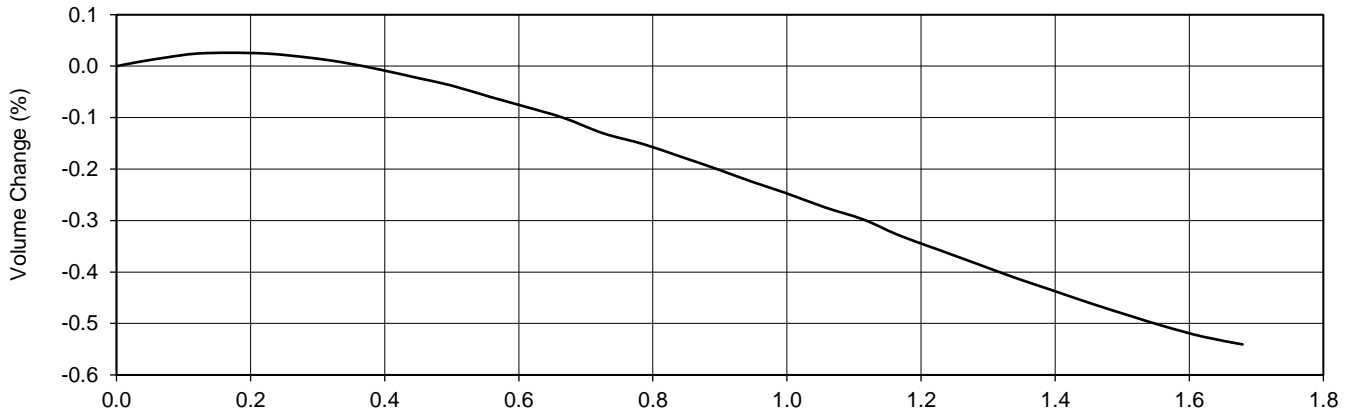
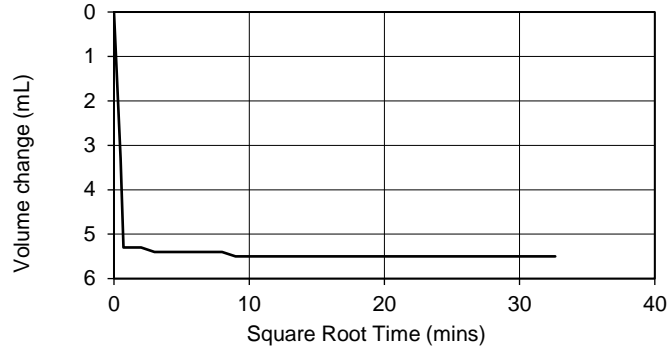
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 10.00-10.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

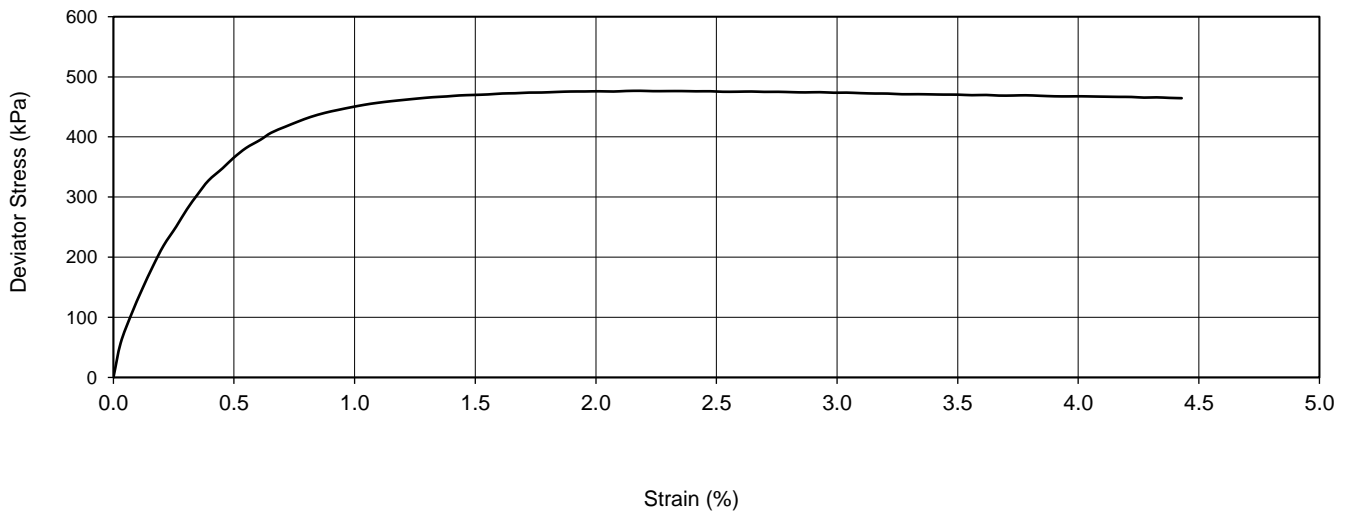
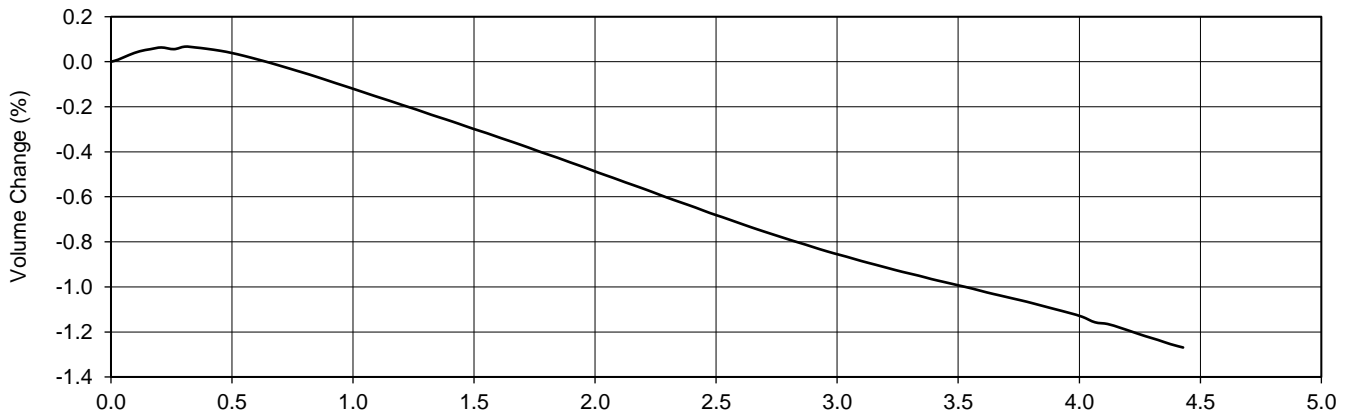
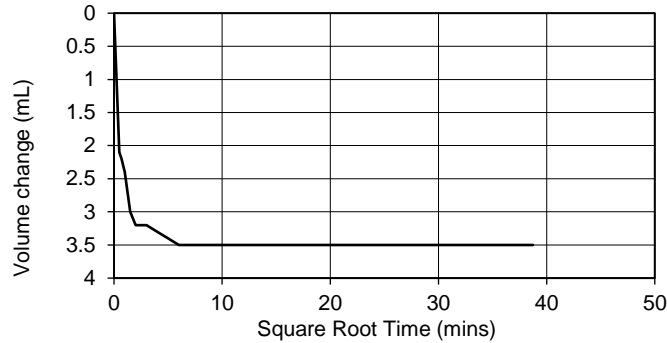
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 10.00-10.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

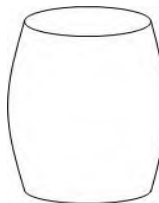
**ARDERSIER PORT
S23053**

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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05	Description: Brownish grey slightly silty fine to medium SAND with rare shell fragments and fine gravel.
Depth (m): 16.50-16.95	

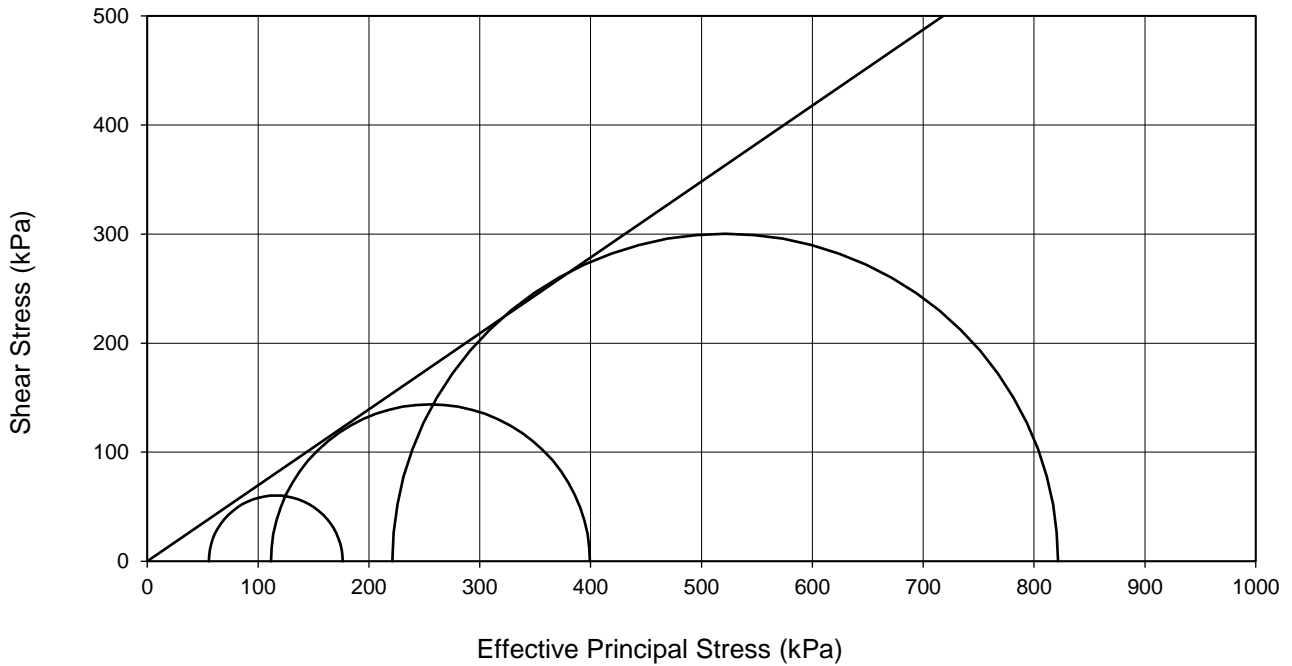
SPECIMEN DETAILS Depth within original sample Remarks	NA Orientation within original sample: NA Remoulded to a target 10% water content and a target dry density of 1.304Mg/m ³		
TEST DETAILS Specimen Type and Preparation Cell Preparation Specimen Number Initial Diameter <i>mm</i> Initial Length <i>mm</i> Initial Water Content % Initial Wet Density <i>Mg/m³</i> Drainage Conditions	B (Remoulded) Checks performed in accordance with Clause 3.5		
	Multistage		
	70.22 139.49 10.4 1.43 One end and radial boundary		
SATURATION STAGE Final Cell Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Parameter B Duration <i>day(s)</i>	Method: Clause 5.2 655 642 1.00 7		
CONSOLIDATION STAGE Cell Pressure <i>kPa</i> Back Pressure <i>kPa</i> Effective Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Dissipation % Duration <i>day(s)</i>	Stage No 1	Stage No 2	Stage No 3
	655 600 55 600 100 1	710 600 110 600 100 1	820 600 220 600 100 1
SHEARING STAGE Cell Pressure <i>kPa</i> Rate of Axial Displacement <i>mm/min</i> Initial Pore Pressure <i>kPa</i> Initial Effective Stress <i>kPa</i>	655 0.015 600 55	710 0.020 600 110	820 0.020 600 220
CONDITIONS AT FAILURE <i>criteria</i> Pore Pressure <i>kPa</i> Minor Effective Principal Stress <i>kPa</i> Deviator Stress <i>kPa</i> Major Effective Principal Stress <i>kPa</i> Volume Change <i>mL</i> Volumetric Strain % Axial Strain % Membrane & filter correction applied to Deviator Stress <i>kPa</i> Duration <i>day(s)</i>	Maximum deviator stress		
	599 56 121 177 3.60 0.7 5.0 6 1	598 112 288 400 -0.20 0.0 7.1 6 1	599 221 601 822 -3.31 -0.7 7.3 6 1
Final Water Content % Final Wet Density <i>Mg/m³</i>	29.5 1.79		
EFFECTIVE STRESS PARAMETERS Cohesion <i>kPa</i> Angle of Shear Resistance <i>degrees</i>	0 35		
FAILURE SKETCH			

Checked and Approved by <i>P. Heritage</i> P Heritage - Project Manager 16/10/2023	Project Number: GEO / 38553 Project Name: ARDERSIER PORT S23053	 
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 16.50-16.95

Description:
Brownish grey slightly silty fine to medium SAND with rare shell fragments and fine gravel.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

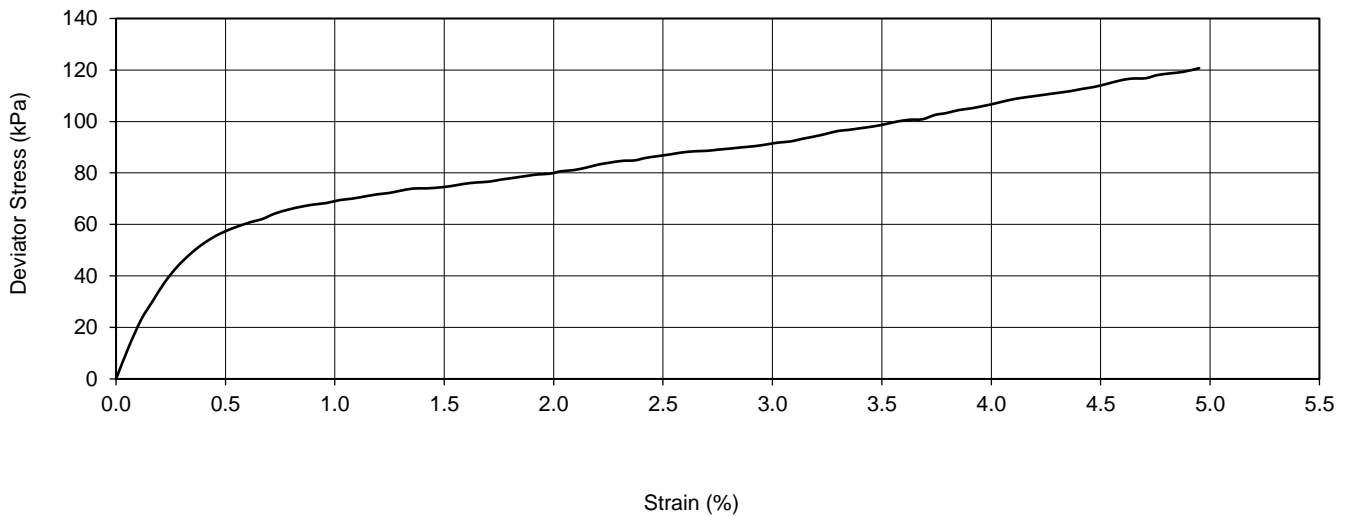
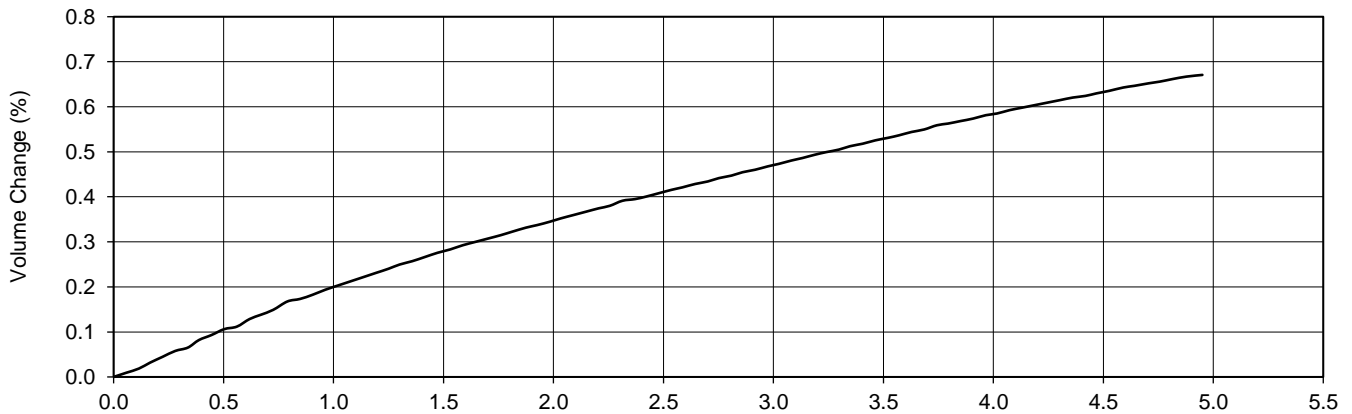
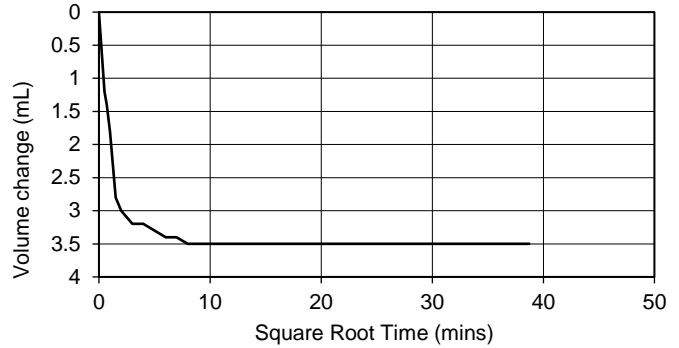
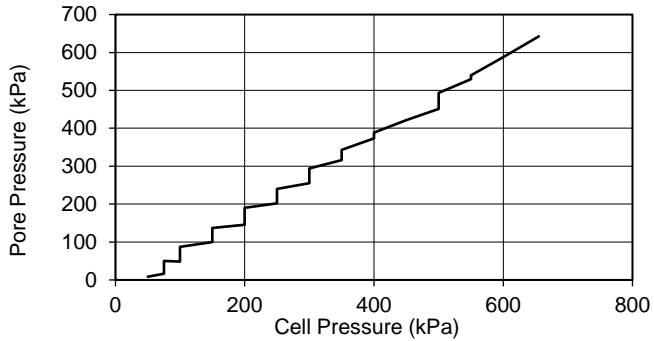
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 16.50-16.95

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

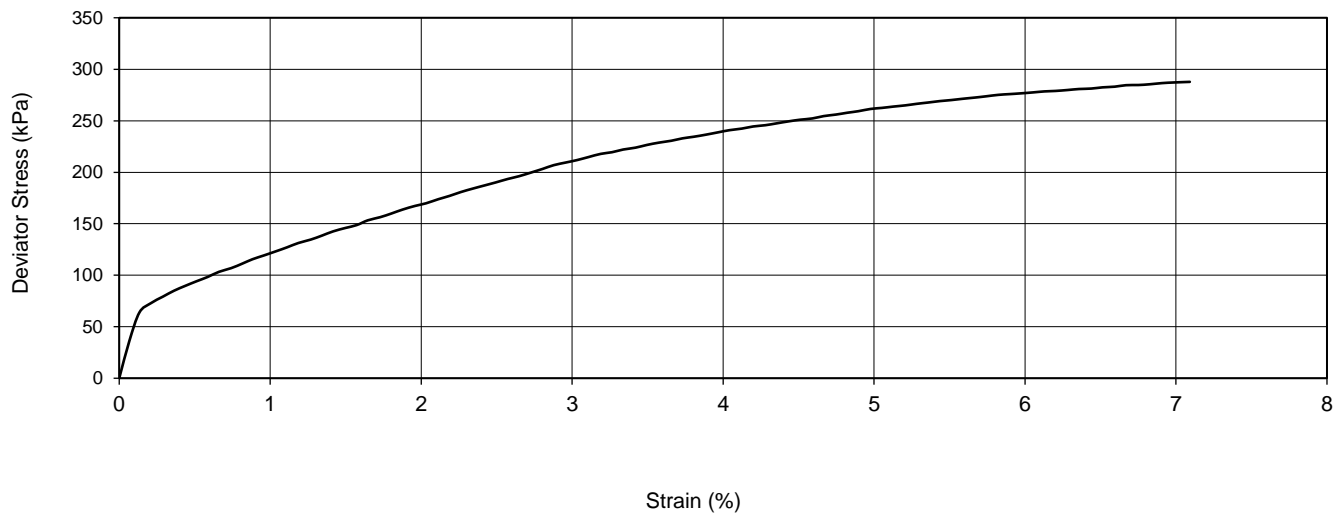
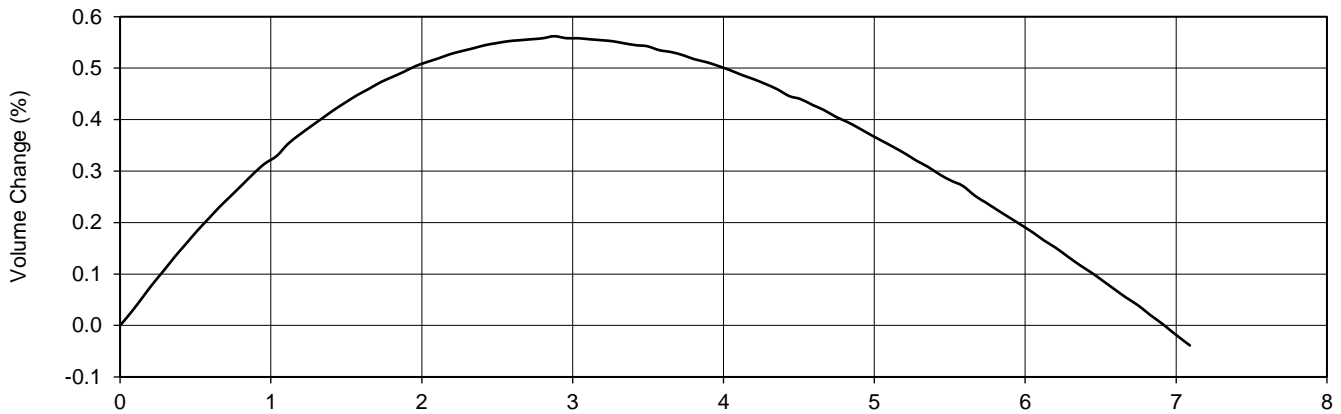
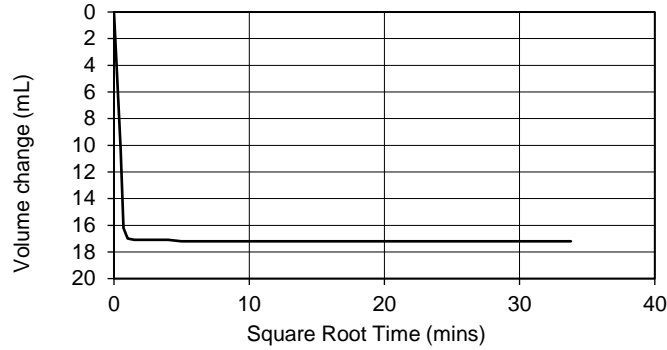
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 16.50-16.95

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

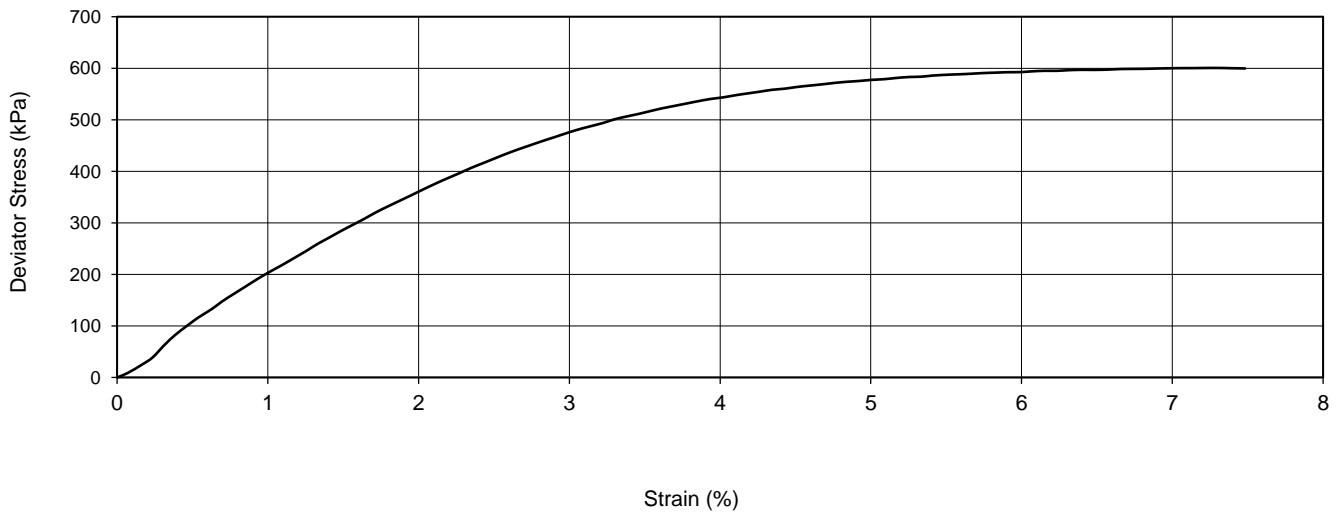
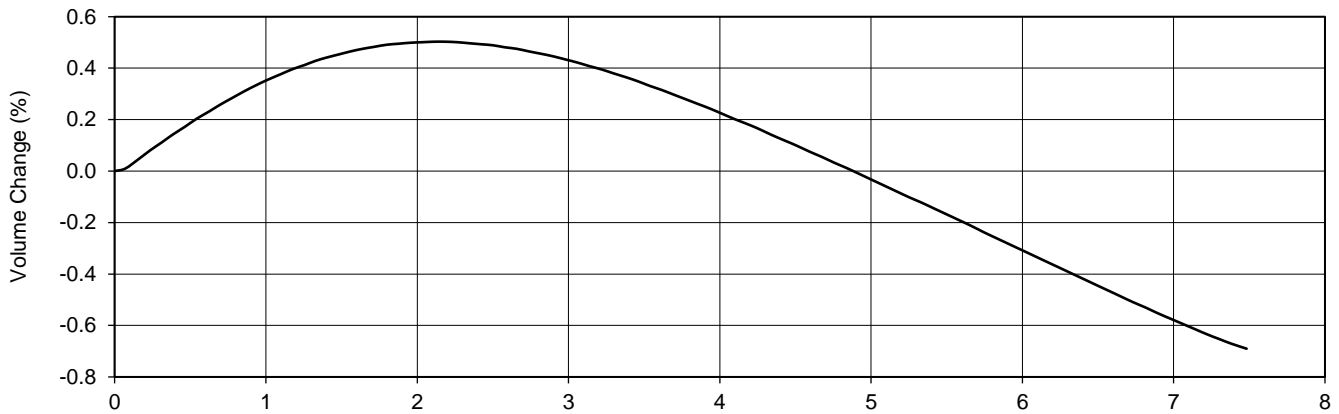
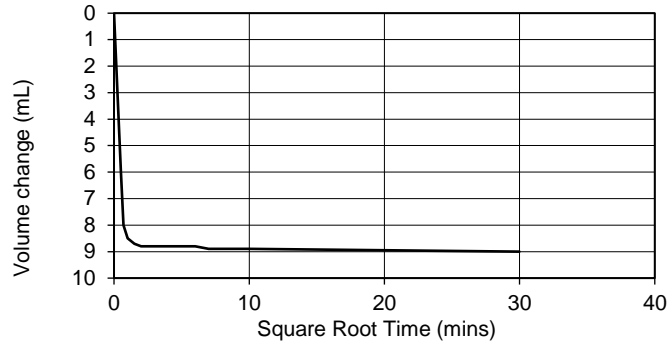
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP05
Depth (m): 16.50-16.95

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
16/10/2023

Project Number:

GEO / 38553

Project Name:

**ARDERSIER PORT
S23053**

GEOLABS®



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Solmek
12 Yarm Road
Stockton-on-Tees
TS18 3NA

03 October 2023

Report No : GEO/38551/01

Page 1 of 1

For the attention of Mr A Cutts

	Date samples received	08/08/2023
	Date written instructions received	28/07/2023
Our ref	Date testing commenced	09/08/2023
Your Ref	Date of sample disposal	31/10/2023
Project	ARDERSIER PORT	

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

Item No	Test Quantity	Description
1	2	Maximum & Minimum Density
2	1	Shear Strength by Direct Shear
3	1	Isotropic Consolidated Drained Multistage Triaxial Compression (CIDM) - Remoulded

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
on behalf of **GEOLABS Limited**



J Sturges
Operations Manager



1402 - JIP Max-Min BHSP06 19.50 B - 38551-494542.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Location</td> <td>BHSP06</td> </tr> <tr> <td>Depth (m)</td> <td>19.50-19.95</td> </tr> <tr> <td>Sample Type</td> <td>B</td> </tr> </table>	Location	BHSP06	Depth (m)	19.50-19.95	Sample Type	B	Description: Brownish grey slightly silty fine to medium SAND with rare fine to medium gravel.
Location	BHSP06						
Depth (m)	19.50-19.95						
Sample Type	B						

Percentage of material retained on the 2 mm test sieve 0.1 %
 The fines content was measured to be 4.5 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.59 g/cm³**
 (after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.587	g/cm ³
Maximum dry density after surcharge application	1.594	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	



Determination No 2

Maximum dry density before surcharge application	1.584	g/cm ³
Maximum dry density after surcharge application	1.591	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.17 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	517.85 g
	2	520.89 g
	3	520.80 g
	4	520.52 g
	5	519.87 g
	Minimum	519.99 g

Checked and Approved by  J Powell - Technical Consultant 17/08/2023	Project Number: 38551 Project Name: ARDERSIER PORT S23053	
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1402 - JIP Max-Min BHSP06 22.50 B - 38551-494546.XL.SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP06
Depth (m)	22.50-22.95
Sample Type	B

Description:
Brownish grey slightly silty fine to medium SAND with frequent fine to medium gravel and shell fragments.

Percentage of material retained on the 2 mm test sieve 10.2 %
The fines content was measured to be 5.3 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.62 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.594	g/cm ³
Maximum dry density after surcharge application	1.614	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.605	g/cm ³
Maximum dry density after surcharge application	1.617	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.20 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	531.95 g
	2	533.99 g
	3	533.02 g
	4	535.19 g
	5	534.78 g
	Minimum	533.79 g

Checked and Approved by

J Powell - Technical Consultant
17/08/2023

Project Number: **38551**
Project Name: **ARDERSIER PORT
S23053**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP06
 Depth (m) 22.50-22.95
 Sample Type B

Description:

Brownish grey slightly silty gravelly fine to medium SAND
 with occasional shell fragments. Gravel is fine to medium.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 45% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.78	59.78	59.78
Width	<i>mm</i>	59.77	59.77	59.77
Height	<i>mm</i>	25.23	25.43	25.43
Initial water content	%	22.0	22.0	22.0
Initial bulk density	<i>Mg/m³</i>	1.66	1.65	1.65
Initial dry density	<i>Mg/m³</i>	1.36	1.35	1.35
Initial voids ratio		0.943	0.958	0.958
Degree of Saturation	%	61.8	60.8	60.8

Shearing Stage

Normal stress	<i>kPa</i>	75	150	300
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.4	0.4	0.4
Maximum shear stress	<i>kPa</i>	58.7	117.7	232.9
Horizontal displacement at MSS	<i>mm</i>	2.6	2.8	3.4
Vertical Displacement at Peak	<i>mm</i>	-0.19	-0.23	-0.18

Final water content	%	24.4	22.9	23.1
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

		Peak Condition
Apparent Cohesion	<i>kPa</i>	1
Angle of Shearing Resistance	<i>degrees</i>	37.5

Notes: ¹ Maximum dry density = 1.62 mg/m³ and minimum dry density = 1.20 Mg/m³

Tested by JJR
 Checked and Approved by



C F Wallace - Technical Director
 19/09/2023

Project Number:

GEO / 38551

Project Name:

**ARDERSIER PORT
S23053****GEOLABS**®

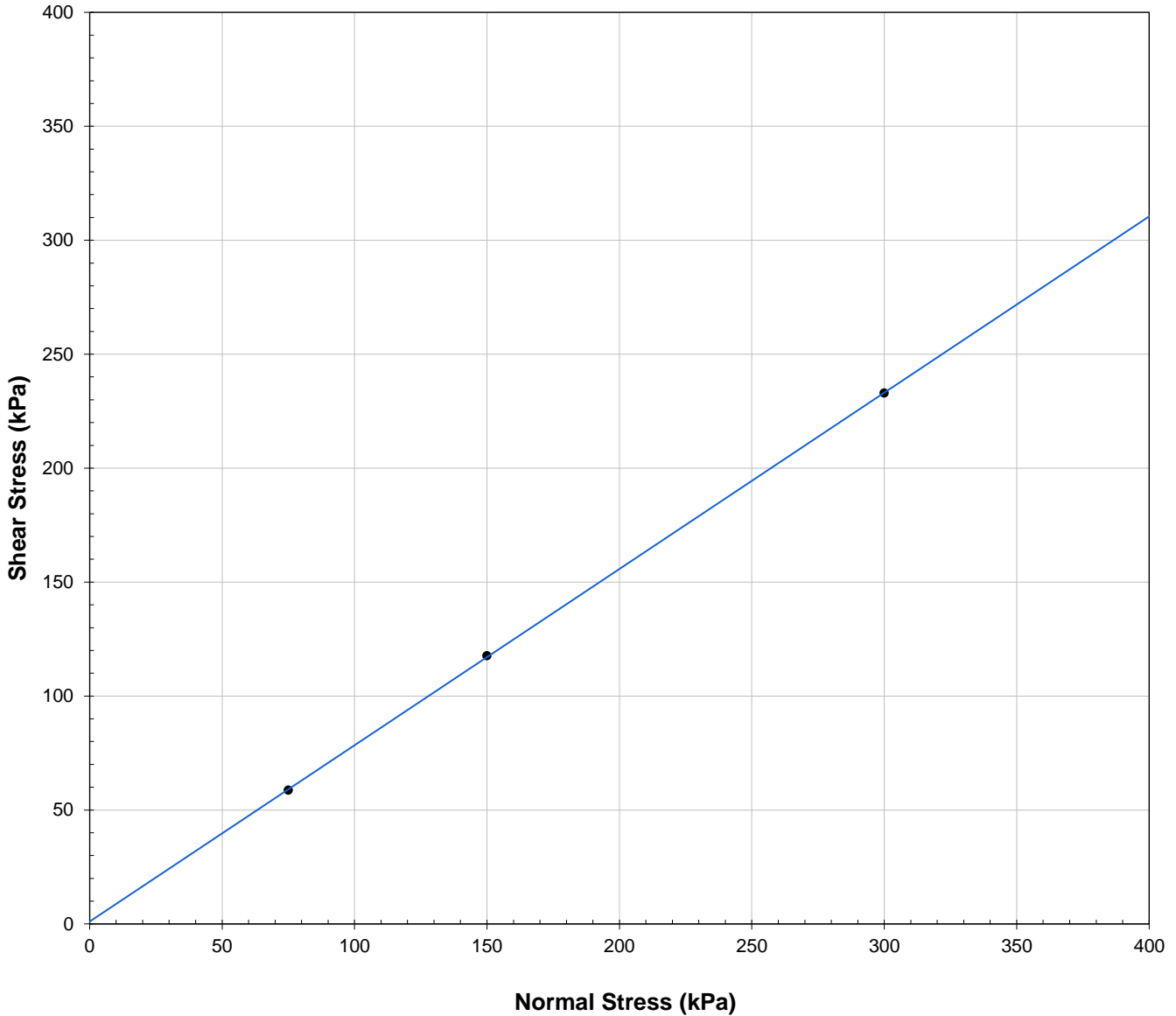
DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)


Borehole No	BHSP06
Depth (m)	22.50-22.95
Sample Type	B

Description:
Brownish grey slightly silty gravelly fine to medium SAND with occasional shell fragments. Gravel is fine to medium.

Shear Stress v Normal Stress



Peak: $c' = 1$
 $\Phi' = 37.5$

Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
19/09/2023

Project Number:
GEO / 38551
Project Name:
**ARDERSIER PORT
S23053**



DIRECT SHEAR TEST – SHEARBOX

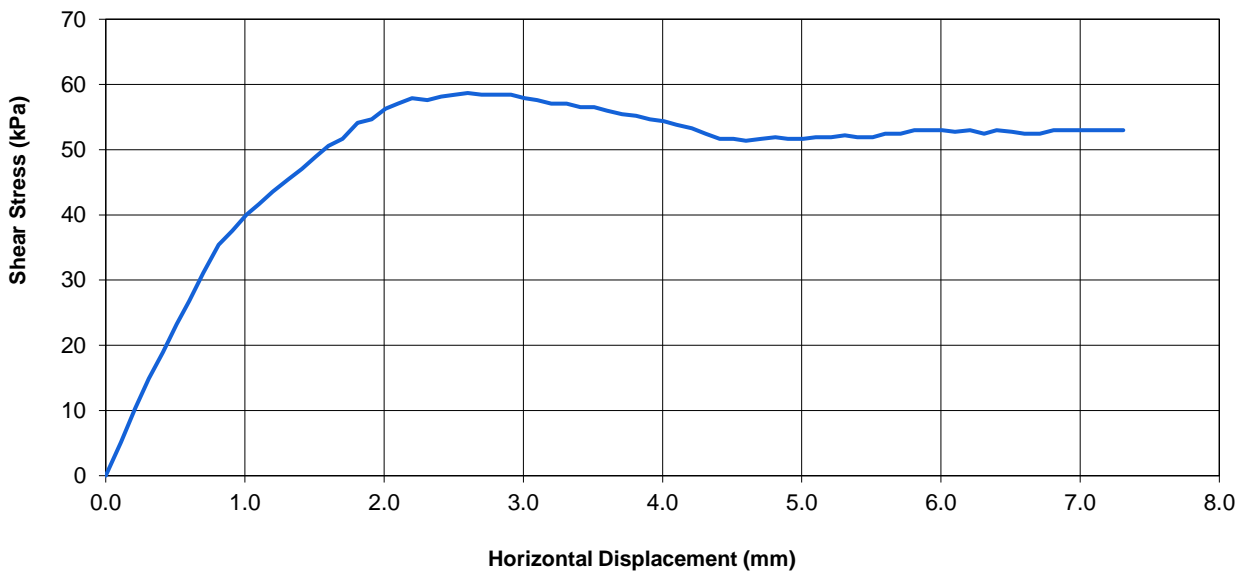
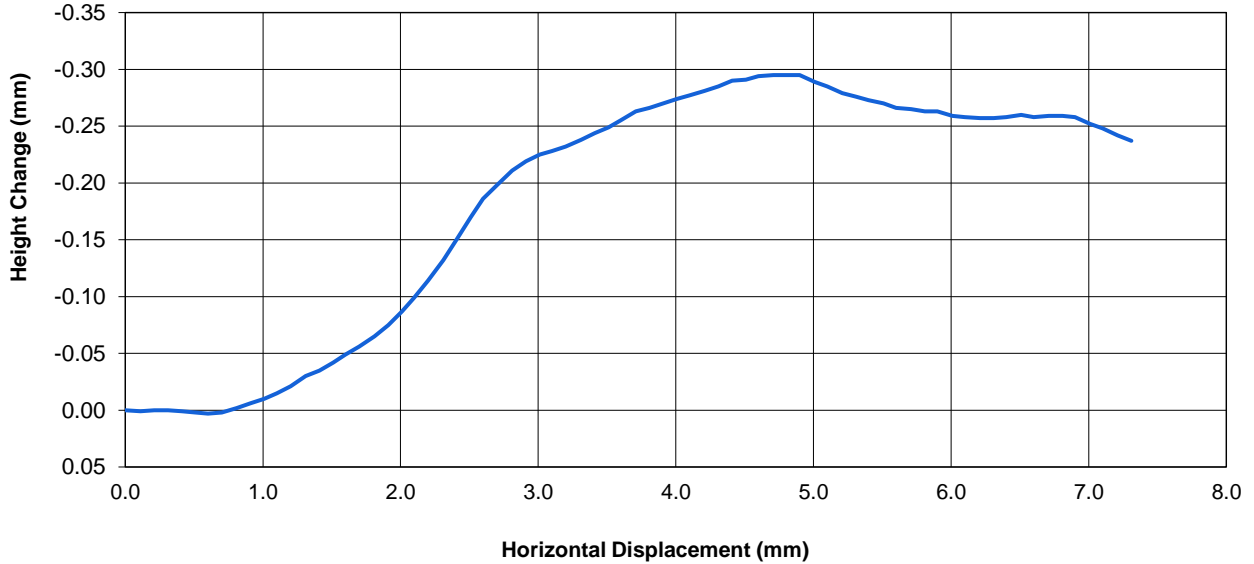
(small shearbox apparatus)


Borehole No BHSP06
 Depth (m) 22.50-22.95
 Sample Type B

Description:
 Brownish grey slightly silty gravelly fine to medium SAND with occasional shell fragments. Gravel is fine to medium.

Specimen: 1

Shear Stage



Tested by JJR
 Checked and Approved by

 C F Wallace - Technical Director
 19/09/2023

Project Number:
GEO / 38551

Project Name:
**ARDERSIER PORT
 S23053**



DIRECT SHEAR TEST – SHEARBOX

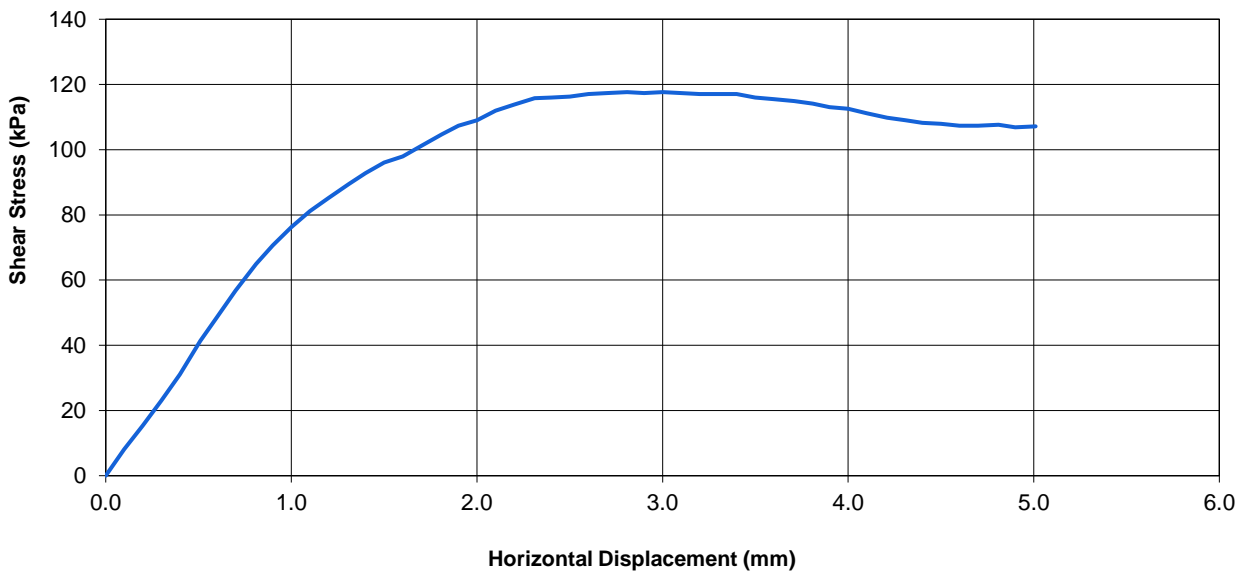
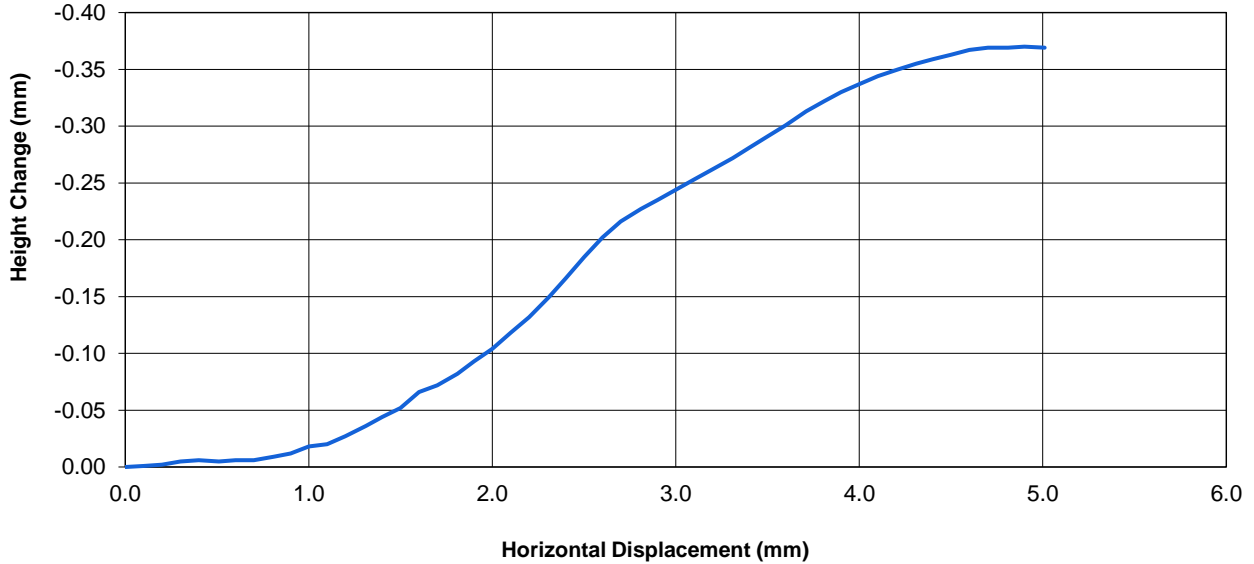
(small shearbox apparatus)


Borehole No BHSP06
 Depth (m) 22.50-22.95
 Sample Type B

Description:
 Brownish grey slightly silty gravelly fine to medium SAND with occasional shell fragments. Gravel is fine to medium.

Specimen: 2

Shear Stage



Tested by JJR
 Checked and Approved by

 C F Wallace - Technical Director
 19/09/2023

Project Number:
GEO / 38551

Project Name:
**ARDERSIER PORT
 S23053**



DIRECT SHEAR TEST – SHEARBOX

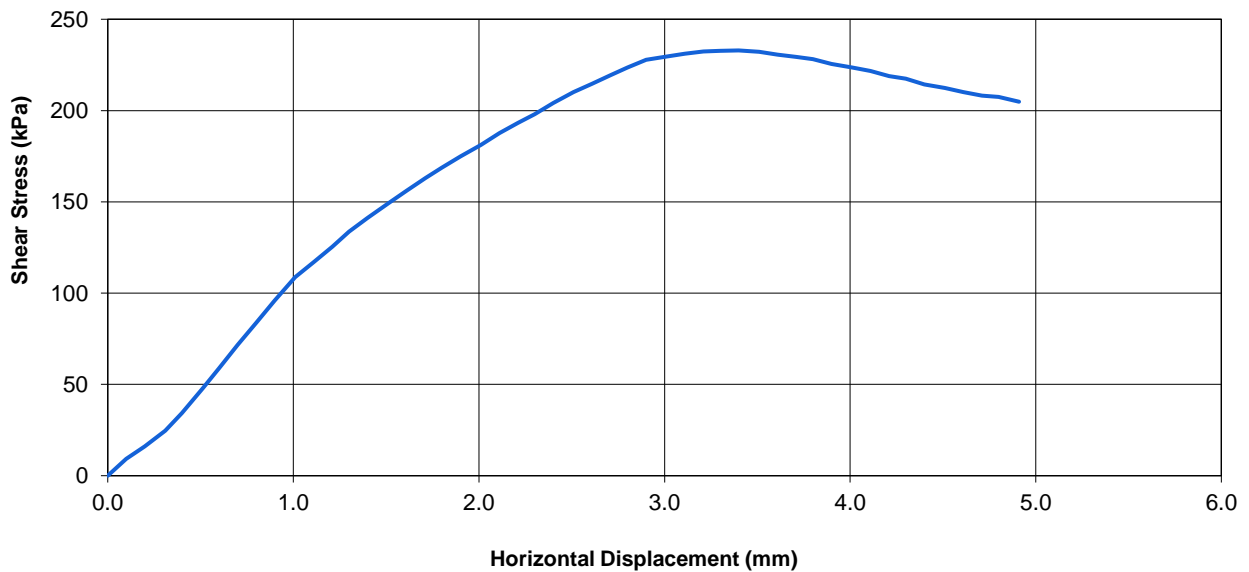
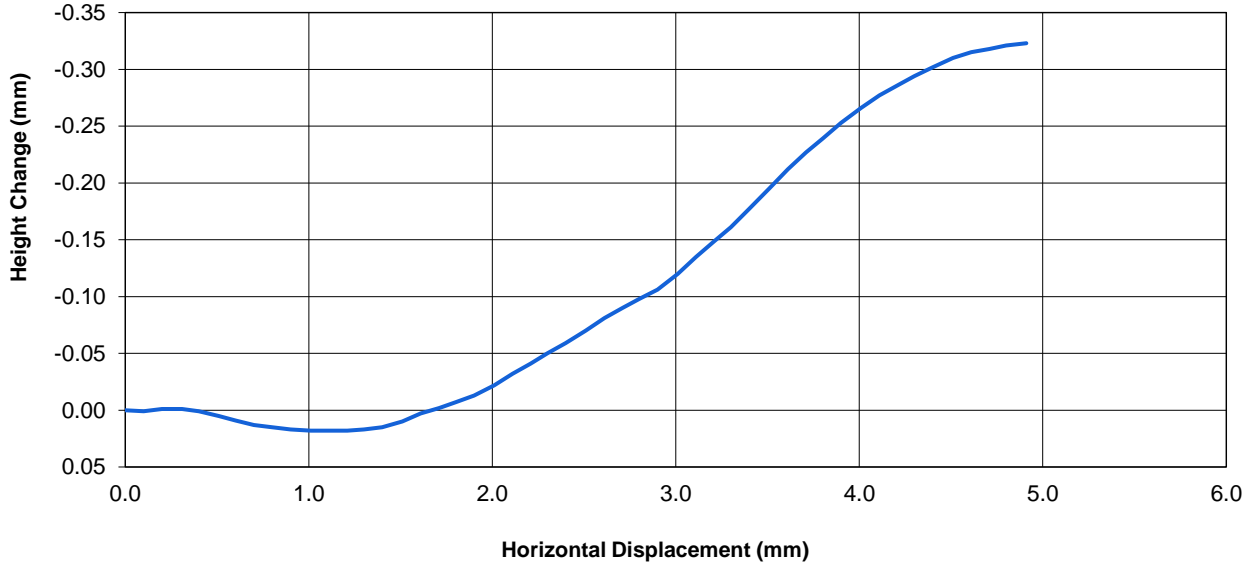
(small shearbox apparatus)


Borehole No BHSP06
 Depth (m) 22.50-22.95
 Sample Type B

Description:
 Brownish grey slightly silty gravelly fine to medium SAND with occasional shell fragments. Gravel is fine to medium.

Specimen: 3

Shear Stage



Tested by JJR
 Checked and Approved by

 C F Wallace - Technical Director
 19/09/2023


Project Number:
GEO / 38551




Project Name:
**ARDERSIER PORT
 S23053**



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP06	Description: Brownish grey slightly silty fine to medium SAND with rare fine to medium gravel. .
Depth (m): 19.50-19.95	

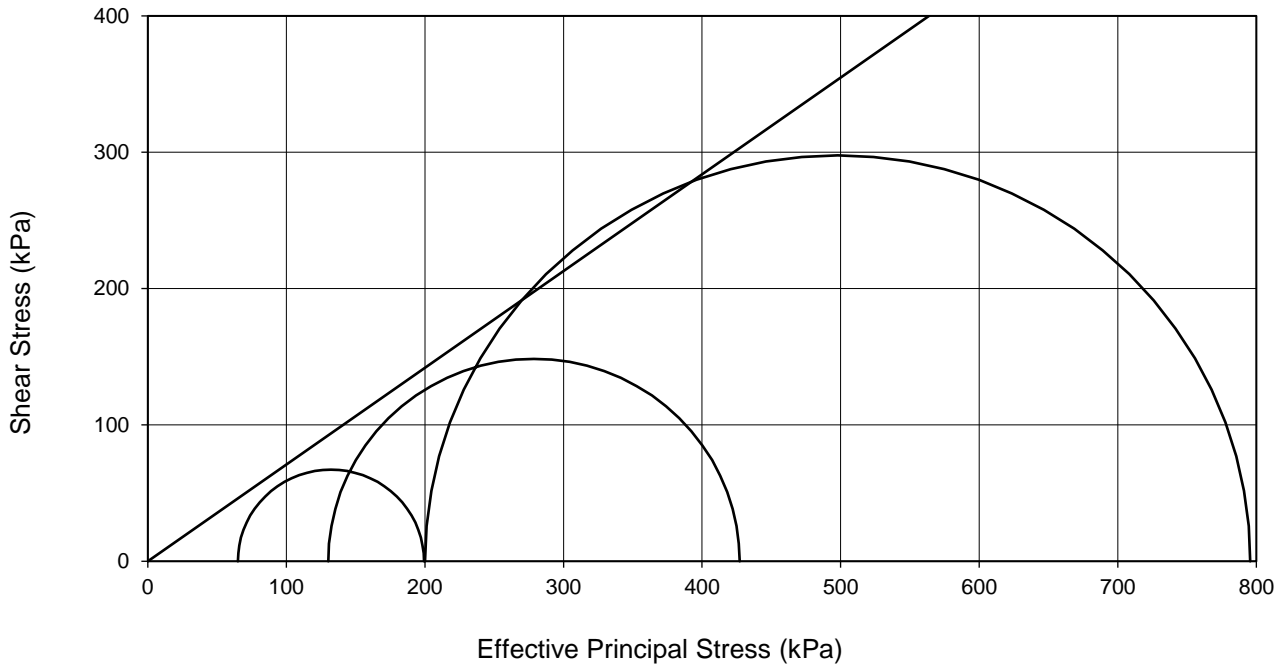
SPECIMEN DETAILS Depth within original sample Orientation within original sample	20 mm from top Vertical		
TEST DETAILS Specimen Type and Preparation Cell Preparation	B (Remoulded) Checks performed in accordance with Clause 3.5		
Specimen Number	Multistage		
Initial Diameter <i>mm</i>	70.22		
Initial Length <i>mm</i>	139.49		
Initial Water Content <i>%</i>	10.4		
Initial Wet Density <i>Mg/m³</i>	1.48		
Drainage Conditions	One end and radial boundary		
SATURATION STAGE	Method: Clause 5.2		
Final Cell Pressure <i>kPa</i>	665		
Final Pore Pressure <i>kPa</i>	656		
Final Pore Pressure Parameter B	0.99		
Duration <i>day(s)</i>	6		
CONSOLIDATION STAGE	Stage No 1	Stage No 2	Stage No 3
Cell Pressure <i>kPa</i>	665	730	800
Back Pressure <i>kPa</i>	600	600	600
Effective Pressure <i>kPa</i>	65	130	200
Final Pore Pressure <i>kPa</i>	600	600	600
Final Pore Pressure Dissipation <i>%</i>	100	100	100
Duration <i>day(s)</i>	1	1	1
SHEARING STAGE			
Cell Pressure <i>kPa</i>	665	730	800
Rate of Axial Displacement <i>mm/min</i>	0.015	0.021	0.016
Initial Pore Pressure <i>kPa</i>	600	600	600
Initial Effective Stress <i>kPa</i>	65	130	200
CONDITIONS AT FAILURE <i>criteria</i>	Maximum deviator stress		
Pore Pressure <i>kPa</i>	600	600	600
Minor Effective Principal Stress <i>kPa</i>	65	130	200
Deviator Stress <i>kPa</i>	134	297	595
Major Effective Principal Stress <i>kPa</i>	199	427	795
Volume Change <i>mL</i>	1.40	1.15	1.29
Volumetric Strain <i>%</i>	0.3	0.2	0.2
Axial Strain <i>%</i>	2.6	3.2	4.8
Membrane & filter correction applied to Deviator Stress <i>kPa</i>	6	5	5
Duration <i>day(s)</i>	1	1	1
Final Water Content <i>%</i>	31.6		
Final Wet Density <i>Mg/m³</i>	1.80		
EFFECTIVE STRESS PARAMETERS			
Cohesion <i>kPa</i>	0		
Angle of Shear Resistance <i>degrees</i>	35.5		
FAILURE SKETCH			

Checked and Approved by  P Heritage - Project Manager 02/10/2023	Project Number: GEO / 38551 Project Name: ARDERSIER PORT S23053	 
--	--	--

Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP06
Depth (m): 19.50-19.95

Description:
Brownish grey slightly silty fine to medium SAND with rare fine to medium gravel. .



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38551

Project Name:

**ARDERSIER PORT
S23053**

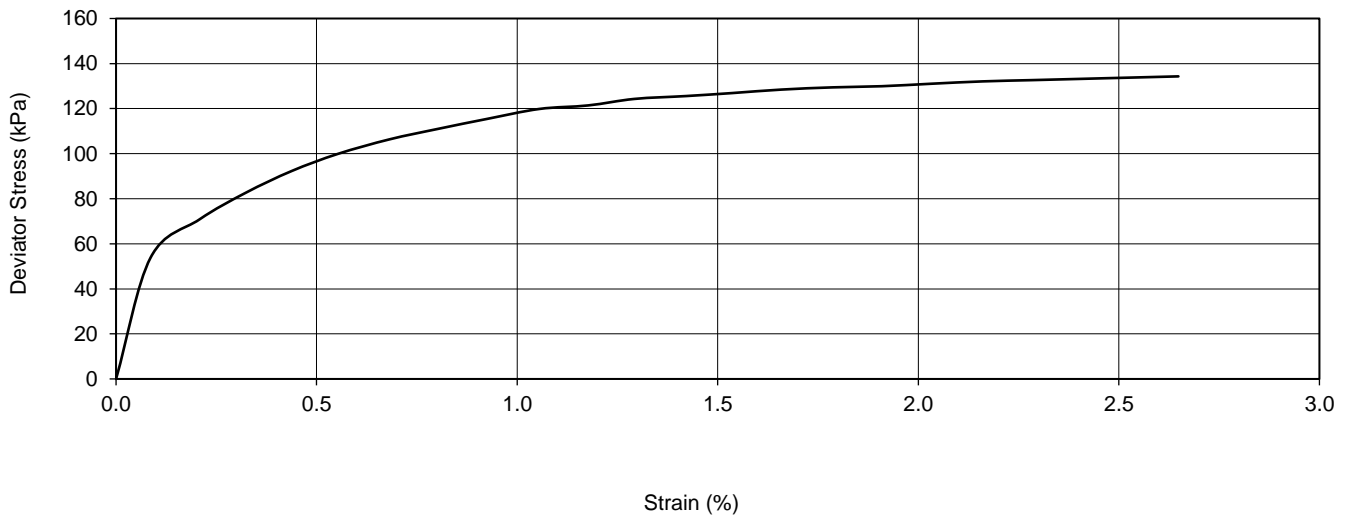
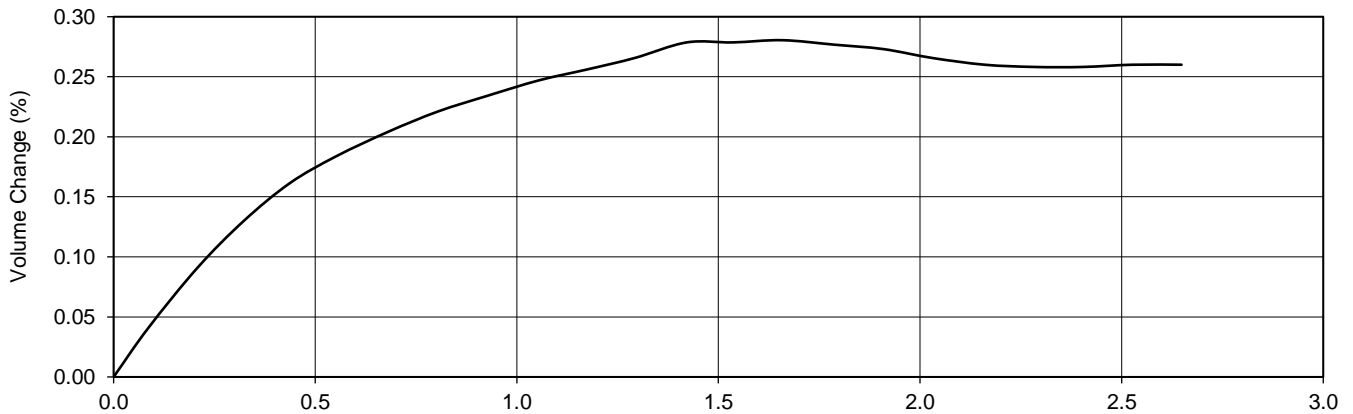
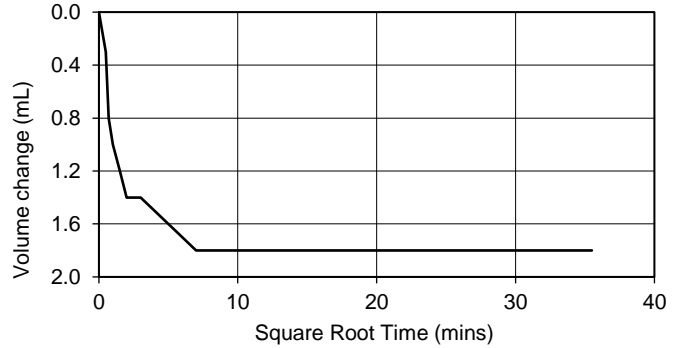
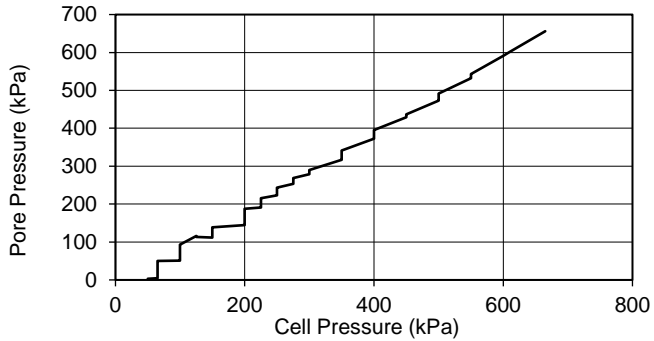
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP06
Depth (m): 19.50-19.95

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38551

Project Name:

**ARDERSIER PORT
S23053**

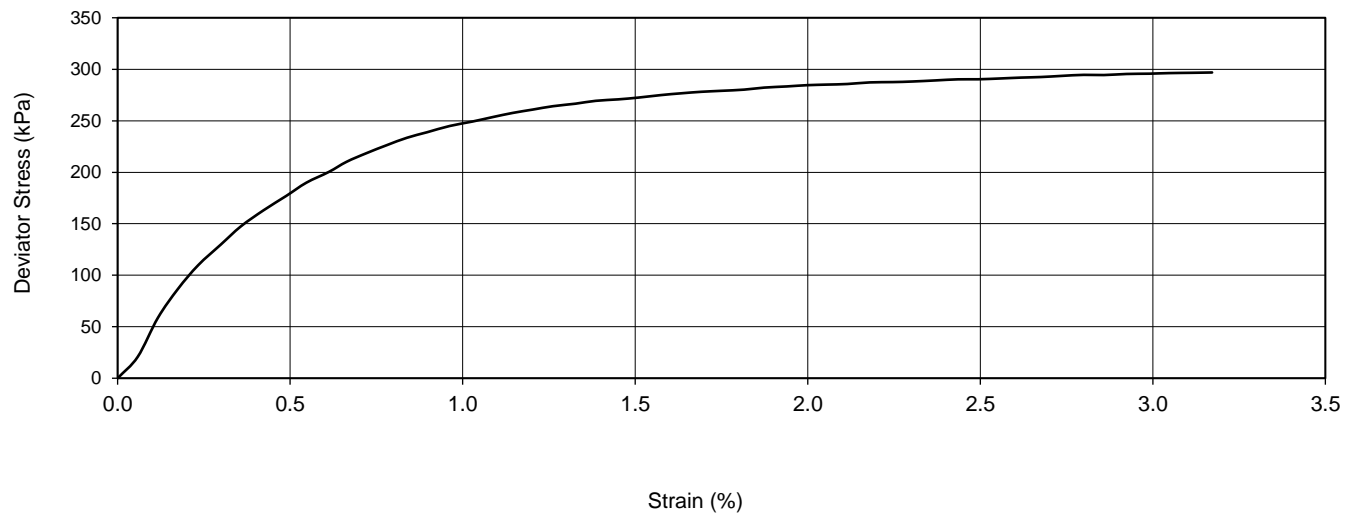
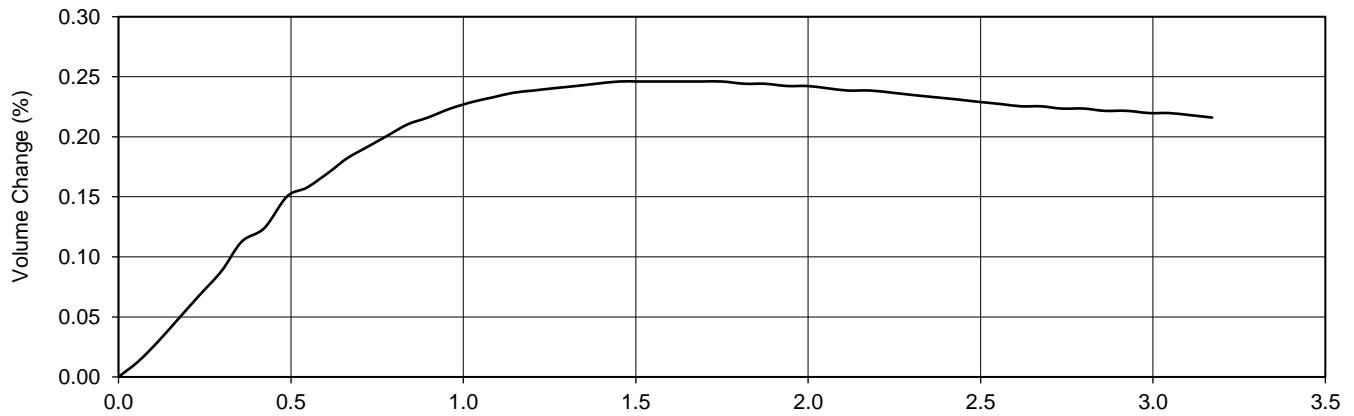
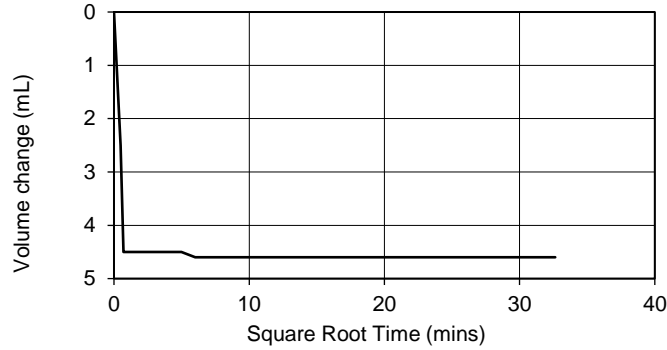
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP06
Depth (m): 19.50-19.95

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38551

Project Name:

**ARDERSIER PORT
S23053**

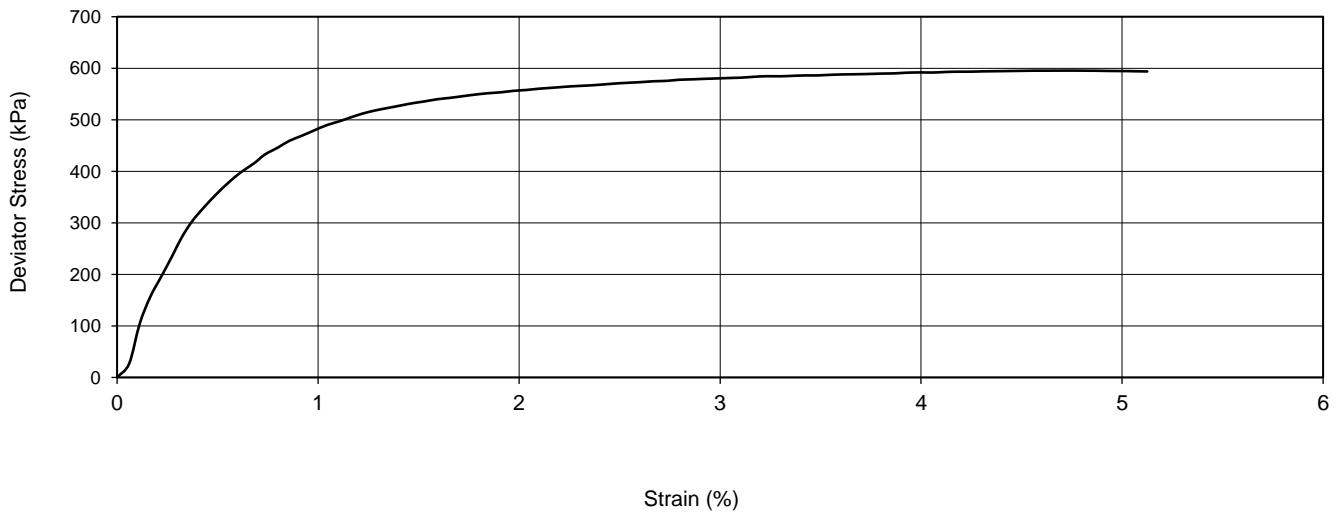
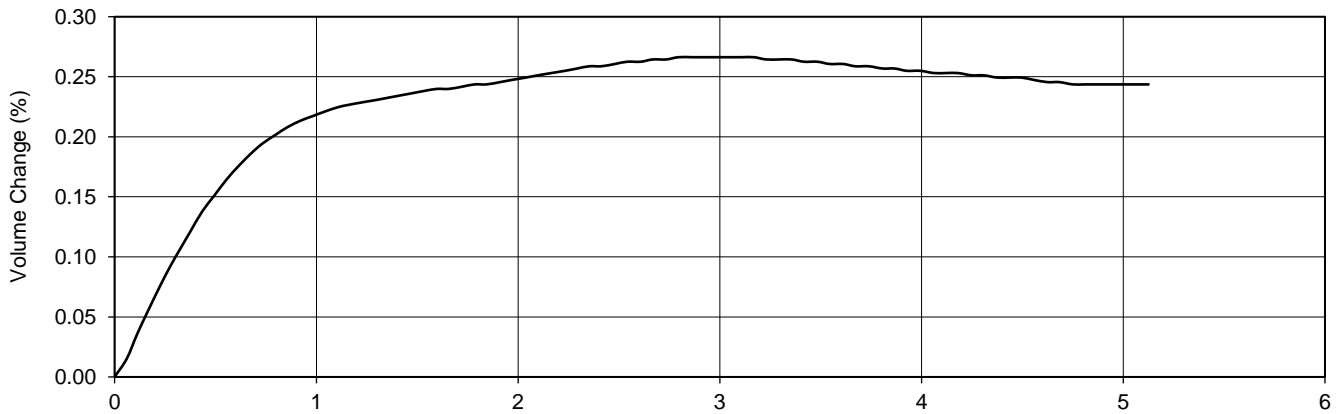
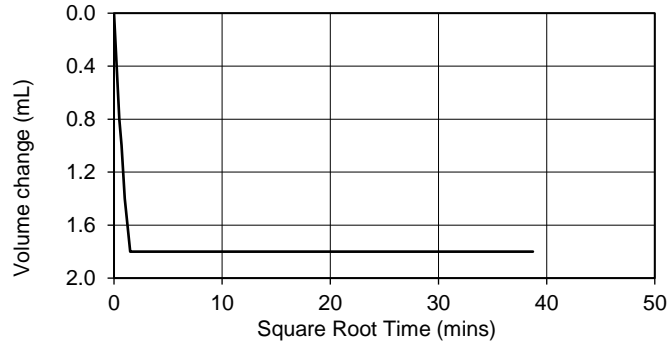
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP06
Depth (m): 19.50-19.95

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38551

Project Name:

**ARDERSIER PORT
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 web: www.geolabs.co.uk

Solmek
 12 Yarm Road
 Stockton-on-Tees
 TS18 3NA

03 October 2023

Report No : GEO/38552/01

Page 1 of 1

For the attention of Mr A Cutts

	Date samples received	27/07/2023
	Date written instructions received	28/07/2023
Our ref	Date testing commenced	29/07/2023
Your Ref	Date of sample disposal	31/10/2023

Our ref **GEO / 38552**
 Your Ref **S23053**

Project **ARDERSIER PORT**

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

Item No	Test Quantity	Description
1	4	Maximum & Minimum Density
2	2	Shear Strength by Direct Shear
3	2	Isotropic Consolidated Drained Multistage Triaxial Compression (CIDM) - Remoulded

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
 on behalf of **GEOLABS Limited**



J Sturges
 Operations Manager



Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP07
Depth (m)	5.00-5.45
Sample Type	B

Description:

Light brown fine to medium SAND with rare fine gravel.

Percentage of material retained on the 2 mm test sieve 0.2 %
 The fines content was measured to be 1.1 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.60 g/cm³**
 (after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.591	g/cm ³
Maximum dry density after surcharge application	1.602	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.592	g/cm ³
Maximum dry density after surcharge application	1.605	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.27 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	561.11 g
	2	562.00 g
	3	562.89 g
	4	562.93 g
	5	561.87 g
	Minimum	562.16 g

Checked and Approved by



J Powell - Technical Consultant
22/08/2023

Project Number: **38552**

Project Name: **ARDERSIER PORT
S23053**



Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP07
Depth (m)	7.00-7.45
Sample Type	B

Description:	
	Light brown gravelly fine to medium SAND.

Percentage of material retained on the 2 mm test sieve 7.7 %
 The fines content was measured to be 2.7 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.58 g/cm³**
 (after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.573	g/cm ³
Maximum dry density after surcharge application	1.580	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.576	g/cm ³
Maximum dry density after surcharge application	1.585	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.22 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
Mass of sand	Run	
	1	543.05 g
	2	544.60 g
	3	542.86 g
	4	542.54 g
	5	542.99 g
	Minimum	543.21 g

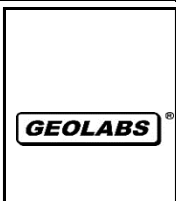
Checked and Approved by



J Powell - Technical Consultant
22/08/2023

Project Number: **38552**

Project Name: **ARDERSIER PORT**
S23053



1402 - JIP Max-Min BHSP07 10.50 B - 38552-494545.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP07
Depth (m)	10.50-10.95
Sample Type	B

Description:
Greyish brown fine to medium SAND with rare fine to medium gravel and shell fragments.

Percentage of material retained on the 2 mm test sieve 0.3 %
The fines content was measured to be 3.1 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.56 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.546	g/cm ³
Maximum dry density after surcharge application	1.557	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.552	g/cm ³
Maximum dry density after surcharge application	1.564	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

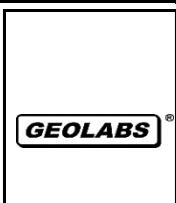
Minimum Dry Density **1.19 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	529.66 g
	2	530.03 g
	3	529.95 g
	4	530.99 g
	5	529.86 g
	Minimum	530.10 g

Checked and Approved by

J Powell - Technical Consultant
22/08/2023

Project Number: **38552**
Project Name: **ARDERSIER PORT
S23053**



1402 - JIP Max-Min BHSP07 15.00 B - 38552-494544.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP07
Depth (m)	15.00-15.45
Sample Type	B

Description:
Brownish grey fine to medium SAND with frequent gravel and shell fragments.

Percentage of material retained on the 2 mm test sieve 10.6 %
The fines content was measured to be 2.5 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.55 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.548	g/cm ³
Maximum dry density after surcharge application	1.560	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.542	g/cm ³
Maximum dry density after surcharge application	1.548	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.21 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	533.47 g
	2	536.90 g
	3	536.35 g
	4	536.28 g
	5	535.06 g
	Minimum	535.61 g

Checked and Approved by

J Powell - Technical Consultant
22/08/2023

Project Number: **38552**
Project Name: **ARDERSIER PORT
S23053**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP07
 Depth (m) 7.00-7.45
 Sample Type B

Description:

Light brown gravelly fine to medium SAND.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 75% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.78	59.78	59.78
Width	<i>mm</i>	59.77	59.77	59.77
Height	<i>mm</i>	23.70	23.70	23.62
Initial water content	%	20.4	20.4	20.4
Initial bulk density	<i>Mg/m³</i>	1.77	1.77	1.78
Initial dry density	<i>Mg/m³</i>	1.47	1.47	1.48
Initial voids ratio		0.802	0.802	0.796
Degree of Saturation	%	67.5	67.5	68.1

Shearing Stage

Normal stress	<i>kPa</i>	40	80	160
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.18	0.18	0.18
Maximum shear stress	<i>kPa</i>	36.9	56.8	118.7
Horizontal displacement at MSS	<i>mm</i>	1.3	5.4	2.8
Vertical Displacement at Peak	<i>mm</i>	-0.22	0.32	-0.07

Final water content	%	22.1	24.9	23.8
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		6
Angle of Shearing Resistance	<i>degrees</i>	35.0

Notes: ¹ Maximum dry density = 1.58 Mg/m³ and minimum dry density = 1.22 Mg/m³

Tested by JJR
 Checked and Approved by



C F Wallace - Technical Director
 20/09/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
 S23053**

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DIRECT SHEAR TEST – SHEARBOX

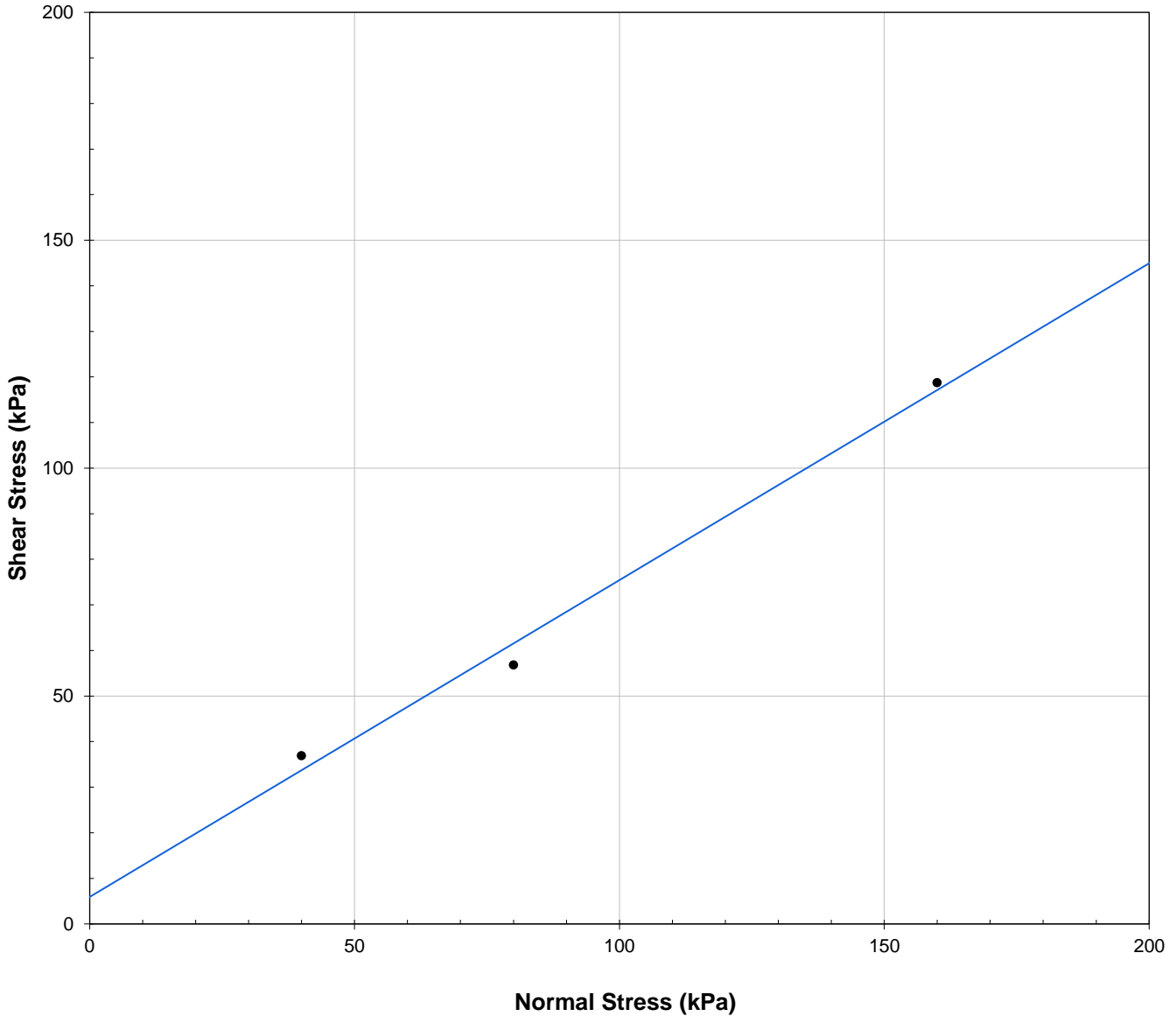
(small shearbox apparatus)

Borehole No BHSP07
Depth (m) 7.00-7.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.

Shear Stress v Normal Stress



Peak: $c' = 6$
 $\Phi' = 35.0$

Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
20/09/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

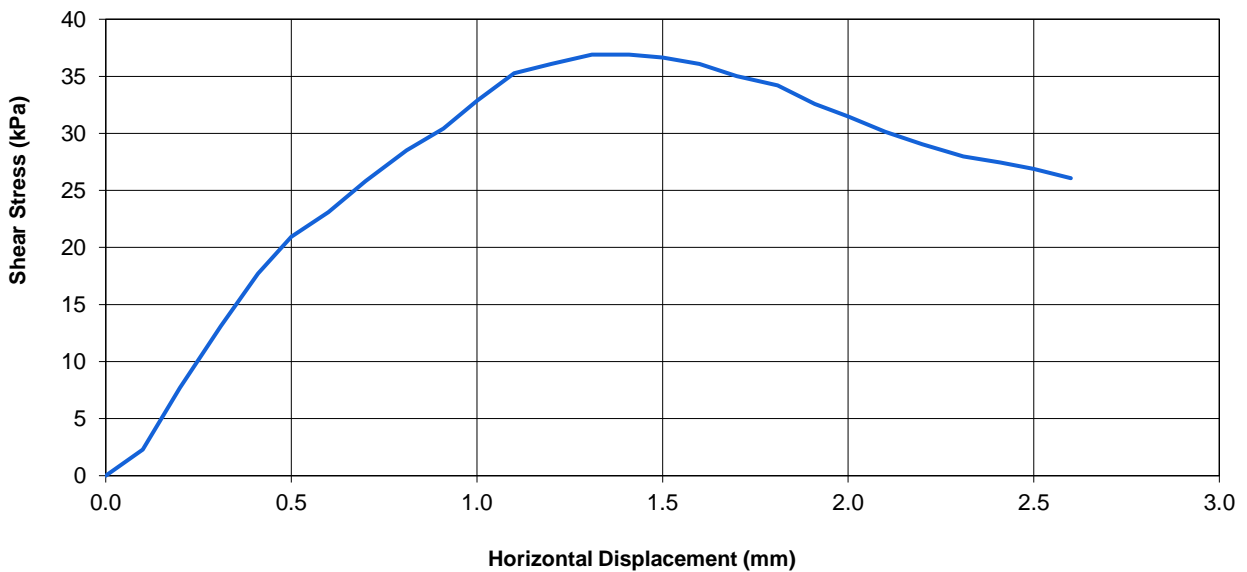
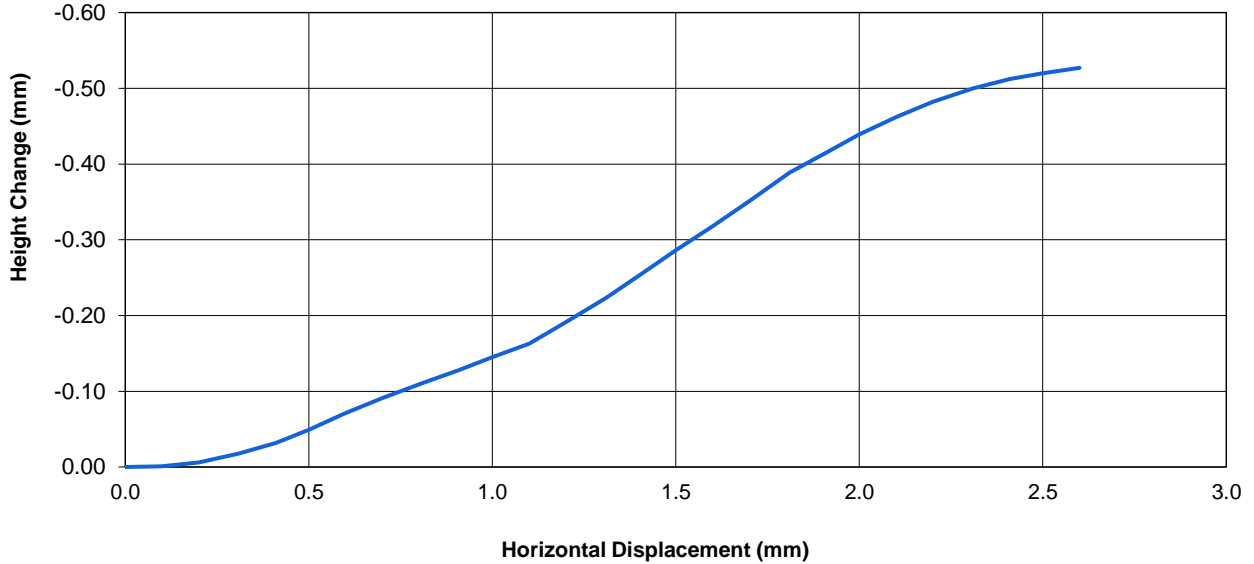
Borehole No BHP07
Depth (m) 7.00-7.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.

Specimen: 1

Shear Stage



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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

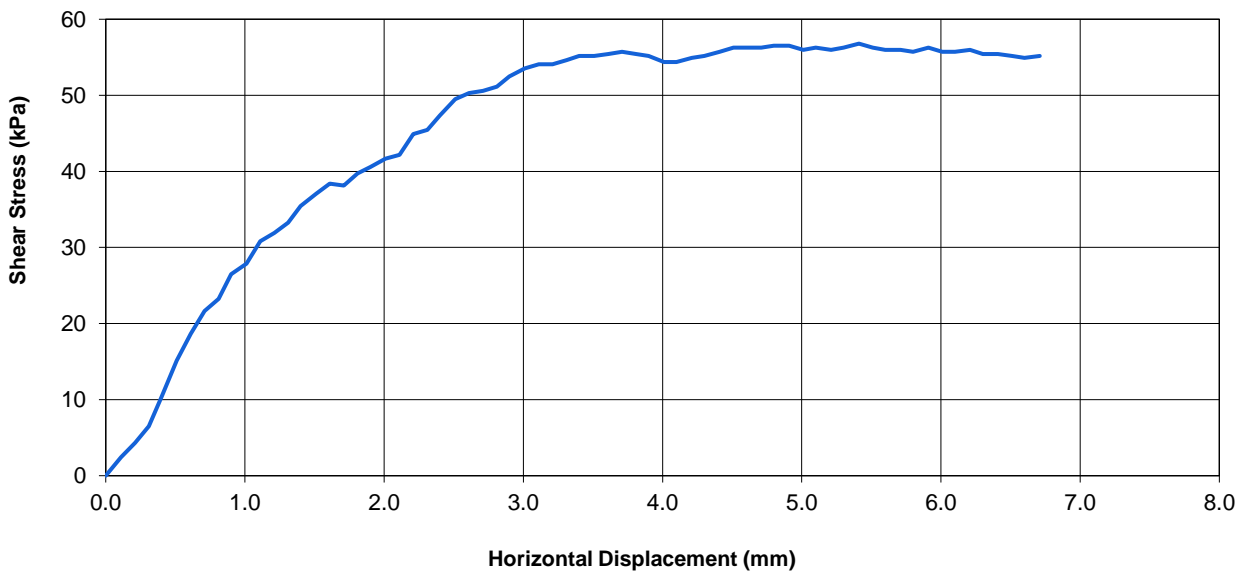
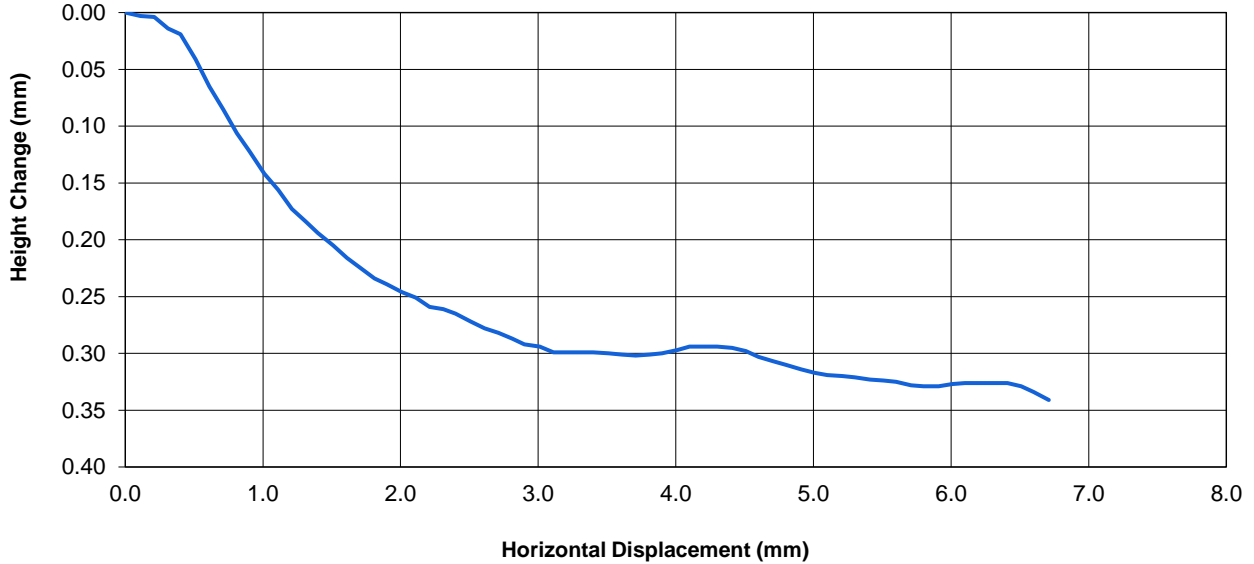
Borehole No BHSP07
Depth (m) 7.00-7.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.

Specimen: 2

Shear Stage



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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

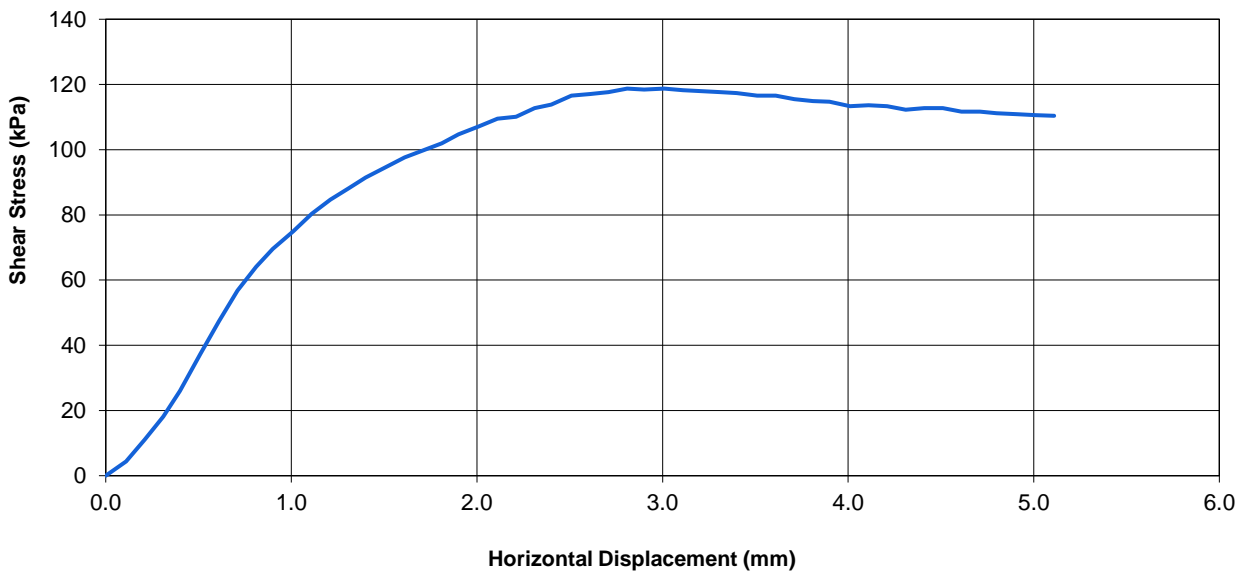
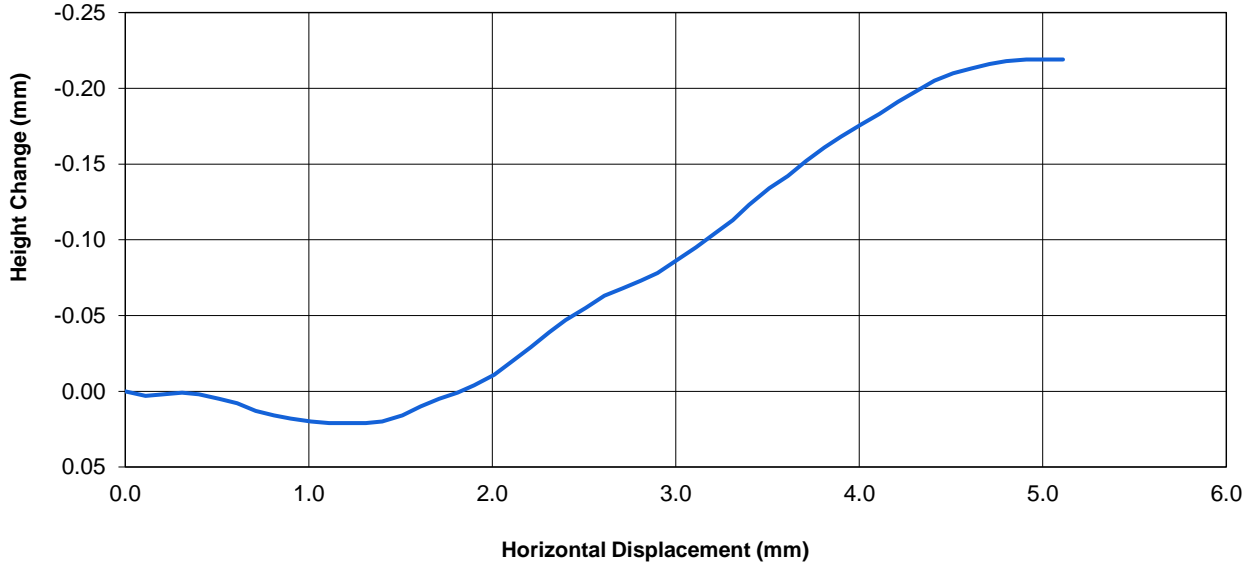
Borehole No BHSP07
Depth (m) 7.00-7.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.

Specimen: 3

Shear Stage



Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
20/09/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP07
 Depth (m) 15.00-15.45
 Sample Type B

Description:

Brownish grey gravelly fine to medium SAND with occasional shell fragments.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 55% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.78	60.00	60.06
Width	<i>mm</i>	59.77	59.98	59.99
Height	<i>mm</i>	25.30	25.18	25.08
Initial water content	%	20.2	20.2	20.2
Initial bulk density	<i>Mg/m³</i>	1.66	1.66	1.66
Initial dry density	<i>Mg/m³</i>	1.38	1.38	1.38
Initial voids ratio		0.920	0.925	0.920
Degree of Saturation	%	58.3	58.0	58.3

Shearing Stage

Normal stress	<i>kPa</i>	60	120	240
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.18	0.18	0.18
Maximum shear stress	<i>kPa</i>	38.7	78.3	152.8
Horizontal displacement at MSS	<i>mm</i>	6.7	4.1	7.3
Vertical Displacement at Peak	<i>mm</i>	0.24	0.21	0.33

Final water content	%	29.3	28.9	30.5
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		1
Angle of Shearing Resistance	<i>degrees</i>	32.5

Notes: ¹ Maximum dry density = 1.55 Mg/m³ and minimum dry density = 1.21 g/m³

Tested by JJR
 Checked and Approved by



C F Wallace - Technical Director
 20/09/2023

Project Number:

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Project Name:

**ARDERSIER PORT
S23053****GEOLABS**®

DIRECT SHEAR TEST – SHEARBOX

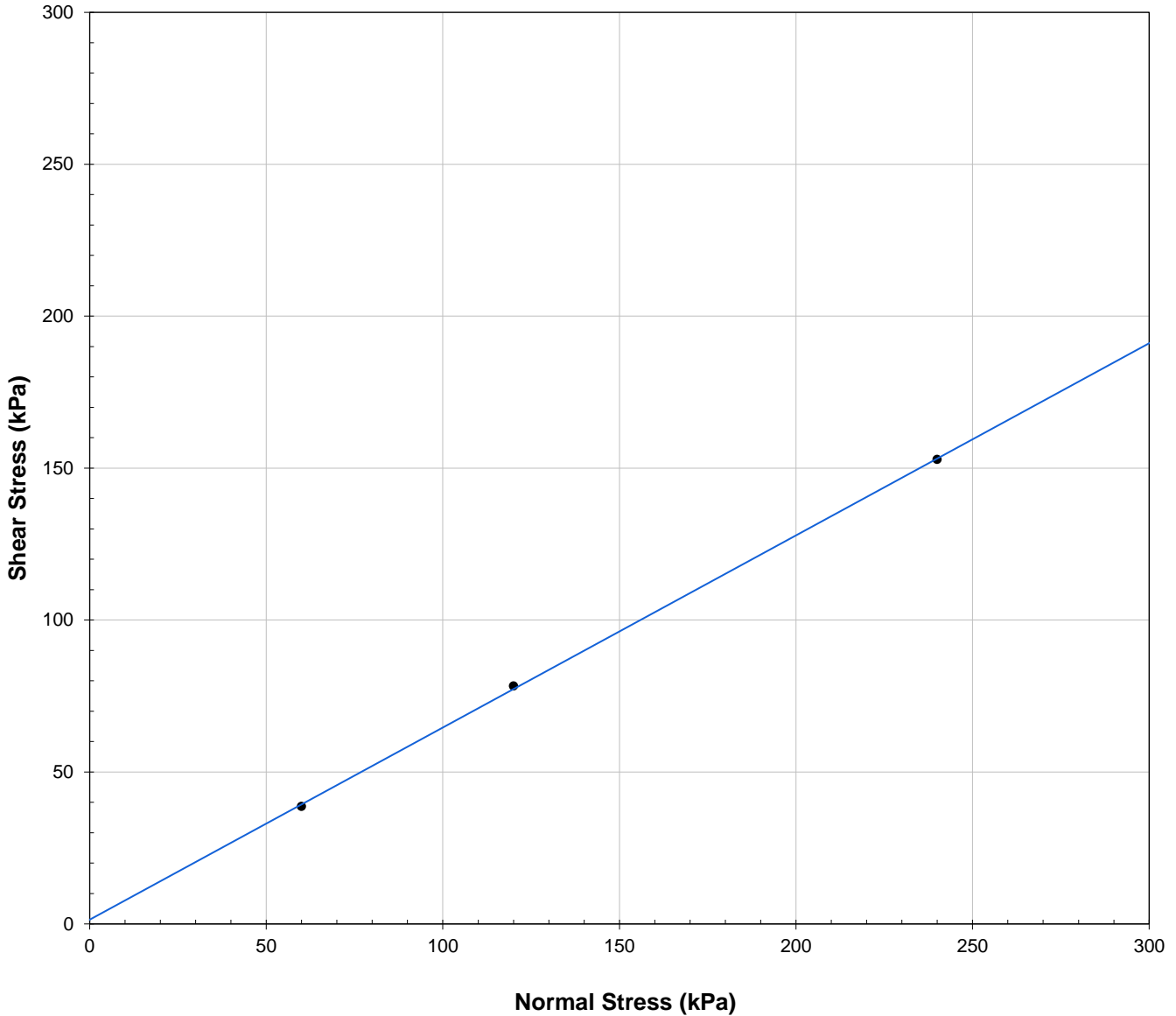
(small shearbox apparatus)

Borehole No BHSP07
Depth (m) 15.00-15.45
Sample Type B

Description:

Brownish grey gravelly fine to medium SAND with occasional shell fragments.

Shear Stress v Normal Stress



Peak: $c' = 1$
 $\Phi' = 32.5$

Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
20/09/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

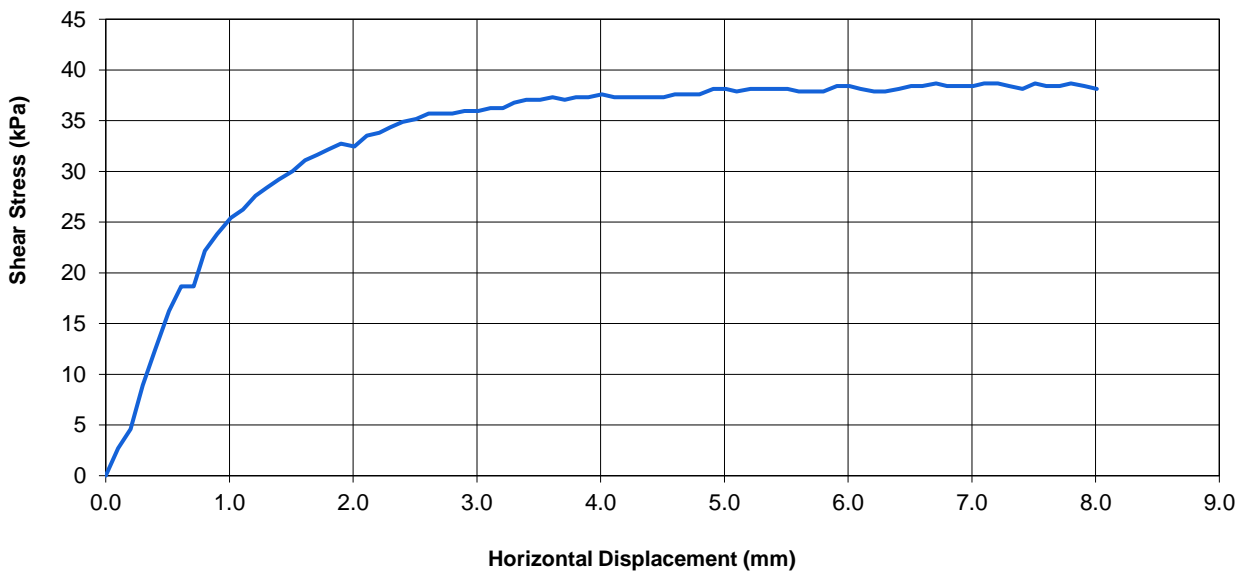
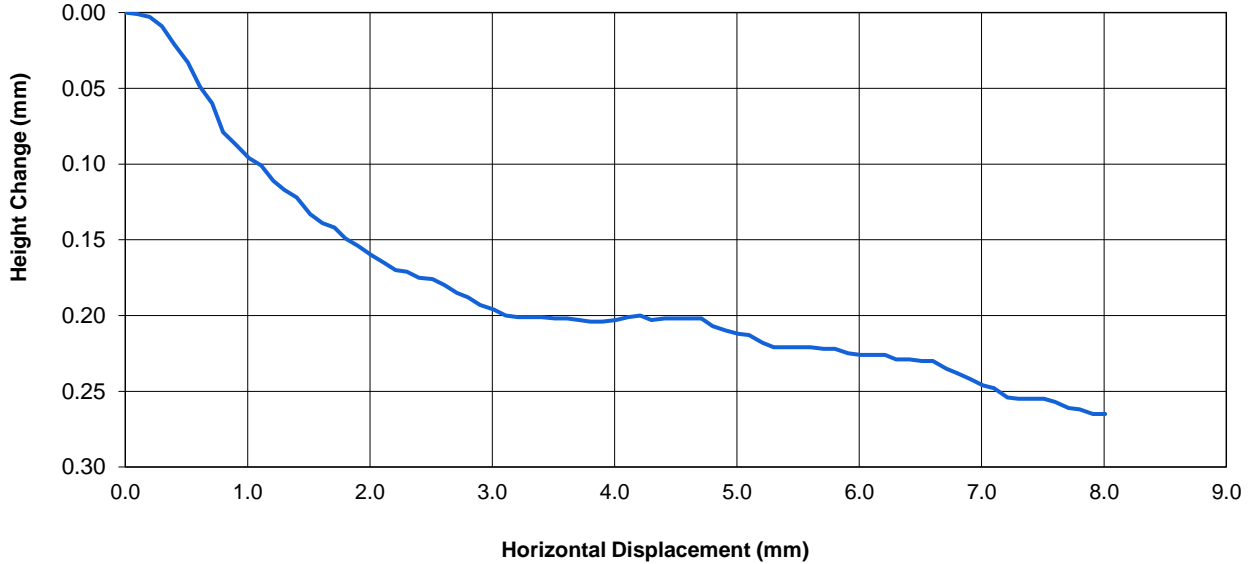
Borehole No BHSP07
Depth (m) 15.00-15.45
Sample Type B

Description:

Brownish grey gravelly fine to medium SAND with occasional shell fragments.

Specimen: 1

Shear Stage



Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
20/09/2023

Project Number:

GEO / 38552

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**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

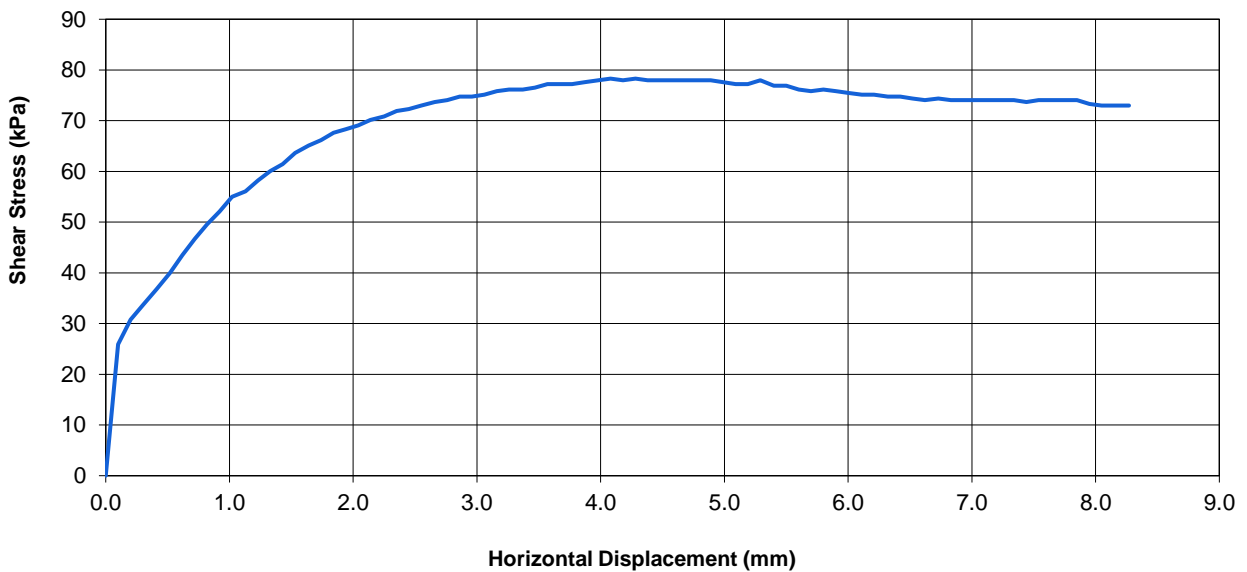
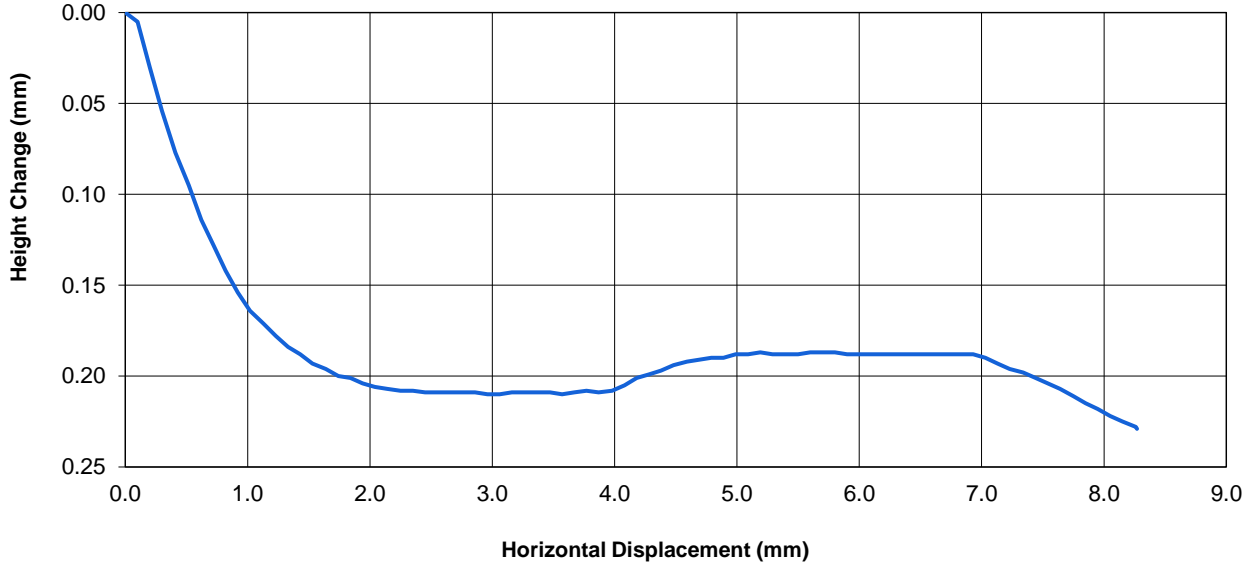
(small shearbox apparatus)


Borehole No BHSP07
 Depth (m) 15.00-15.45
 Sample Type B

Description:
 Brownish grey gravelly fine to medium SAND with occasional shell fragments.

Specimen: 2

Shear Stage



Tested by JJR
 Checked and Approved by

 C F Wallace - Technical Director
 20/09/2023

Project Number:
GEO / 38552
 Project Name:
ARDERSIER PORT
S23053



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

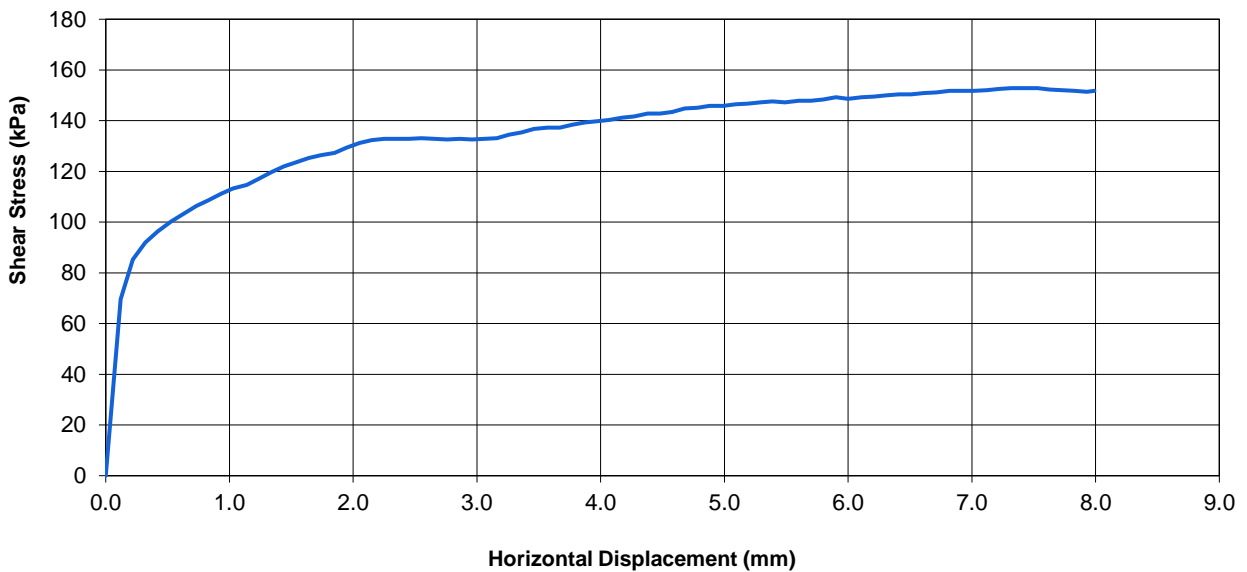
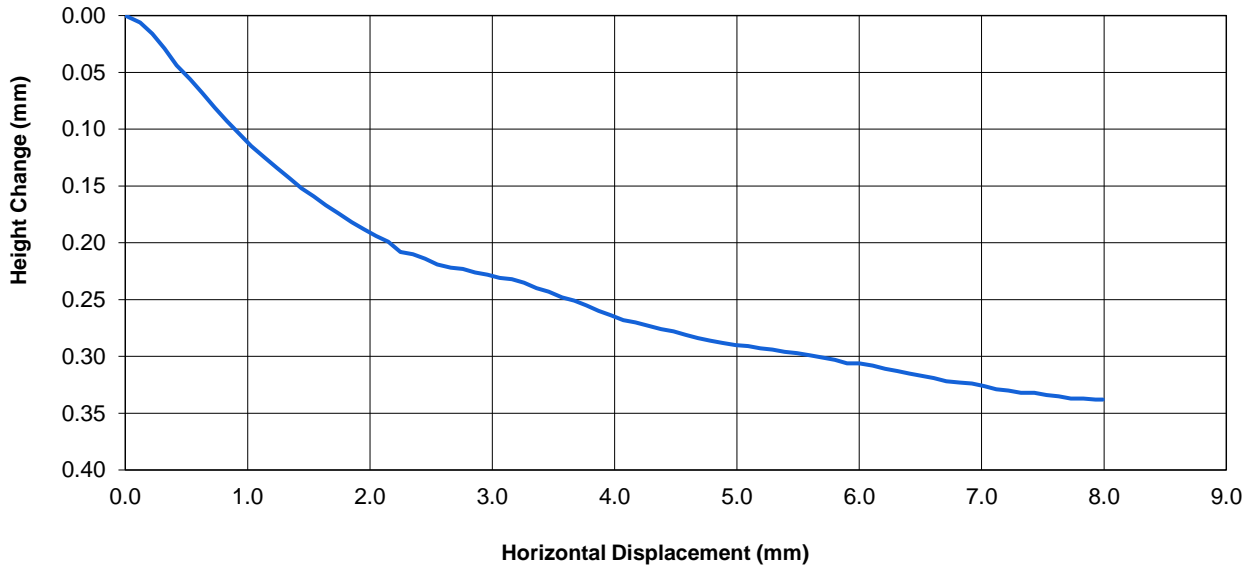
Borehole No BHSP07
Depth (m) 15.00-15.45
Sample Type B

Description:

Brownish grey gravelly fine to medium SAND with occasional shell fragments.

Specimen: 3

Shear Stage



Tested by JJR
Checked and Approved by

C F Wallace - Technical Director
20/09/2023

Project Number:

GEO / 38552

Project Name:


**ARDERSIER PORT
S23053**




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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07	Description: Light brown fine to medium SAND with rare fine gravel.
Depth (m): 5.00-5.45	

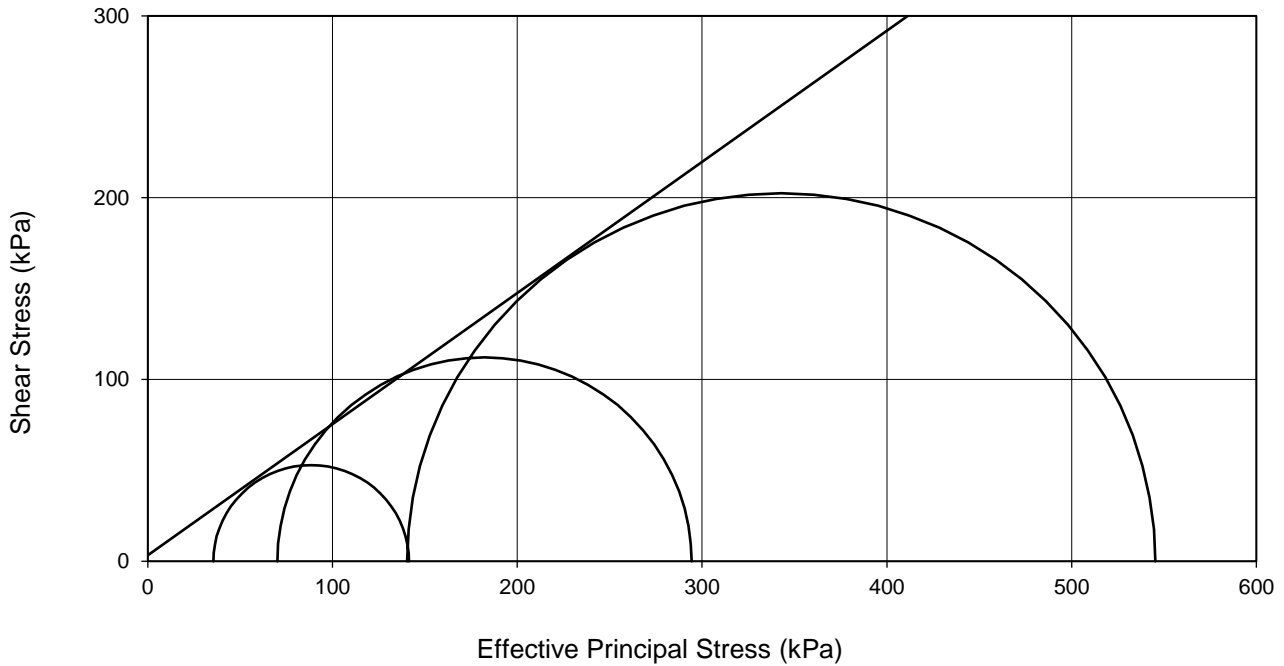
SPECIMEN DETAILS Depth within original sample Remarks	NA Orientation within original sample: NA Remoulded to a target 10 % MC and a target dry density of 1.521 Mg/m ³		
TEST DETAILS Specimen Type and Preparation Cell Preparation Specimen Number Initial Diameter <i>mm</i> Initial Length <i>mm</i> Initial Water Content <i>%</i> Initial Wet Density <i>Mg/m³</i> Drainage Conditions	B (Remoulded) Checks performed in accordance with Clause 3.5		
	Multistage		
	70.22	139.49	9.9
	1.67	One end only	
SATURATION STAGE Final Cell Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Parameter B Duration <i>day(s)</i>	Method: Clause 5.2 635 619 1.00 6		
CONSOLIDATION STAGE Cell Pressure <i>kPa</i> Back Pressure <i>kPa</i> Effective Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Dissipation <i>%</i> Duration <i>day(s)</i>	Stage No 1 635 600 35 600 100 1	Stage No 2 670 600 70 600 100 1	Stage No 3 740 600 140 600 100 1
SHEARING STAGE Cell Pressure <i>kPa</i> Rate of Axial Displacement <i>mm/min</i> Initial Pore Pressure <i>kPa</i> Initial Effective Stress <i>kPa</i>	635 0.015 600 35	670 0.020 600 70	740 0.016 600 140
CONDITIONS AT FAILURE <i>criteria</i> Pore Pressure <i>kPa</i> Minor Effective Principal Stress <i>kPa</i> Deviator Stress <i>kPa</i> Major Effective Principal Stress <i>kPa</i> Volume Change <i>mL</i> Volumetric Strain <i>%</i> Axial Strain <i>%</i> Membrane correction applied to Deviator Stress <i>kPa</i> Duration <i>day(s)</i>	Maximum deviator stress		
600 35 106 141 -3.60 -0.7 2.6 1 1	600 70 224 294 -4.20 -0.8 3.0 0 1	600 140 405 545 -4.54 -0.9 4.0 0 1	600 140 405 545 -4.54 -0.9 4.0 0 1
Final Water Content <i>%</i> Final Wet Density <i>Mg/m³</i>	23.4 1.90		
EFFECTIVE STRESS PARAMETERS Cohesion <i>kPa</i> Angle of Shear Resistance <i>degrees</i>	3.3 36		
FAILURE SKETCH			

Checked and Approved by  P Heritage - Project Manager 02/10/2023	Project Number: GEO / 38552 Project Name: ARDERSIER PORT S23053	 
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 5.00-5.45

Description:
Light brown fine to medium SAND with rare fine gravel.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

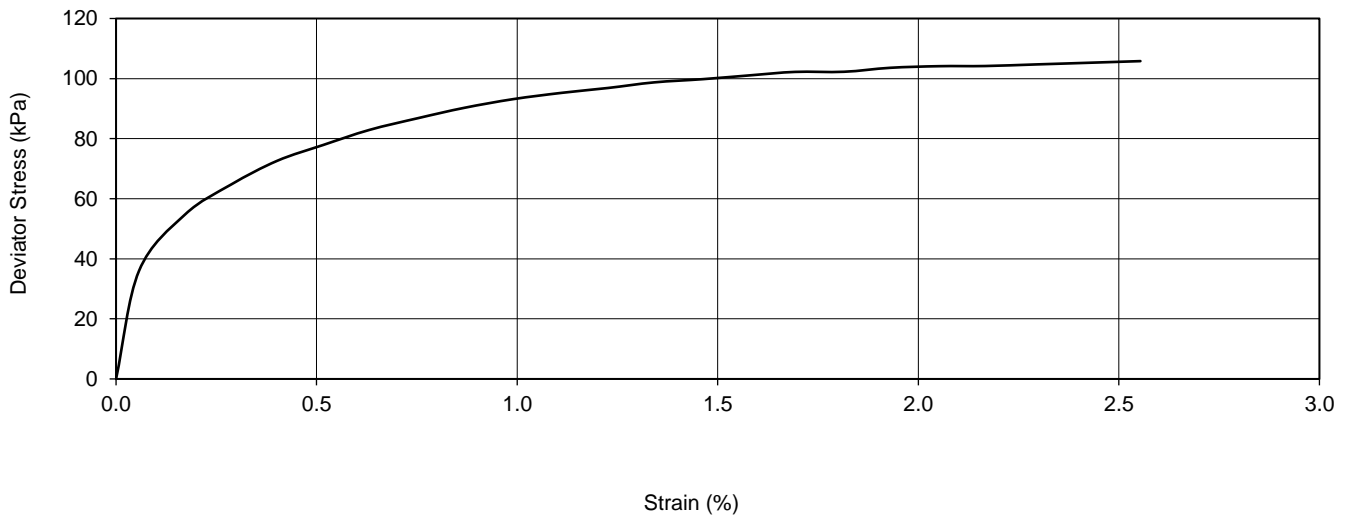
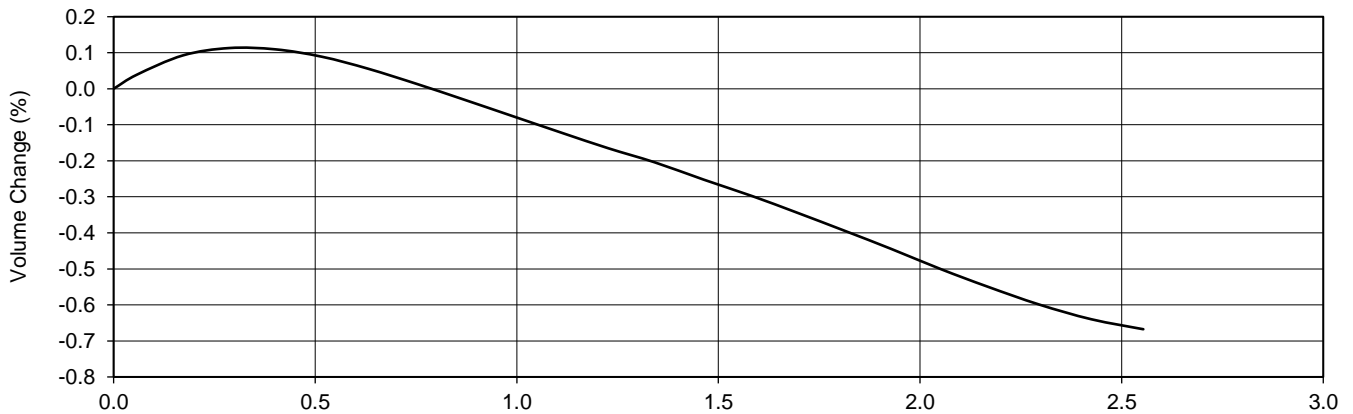
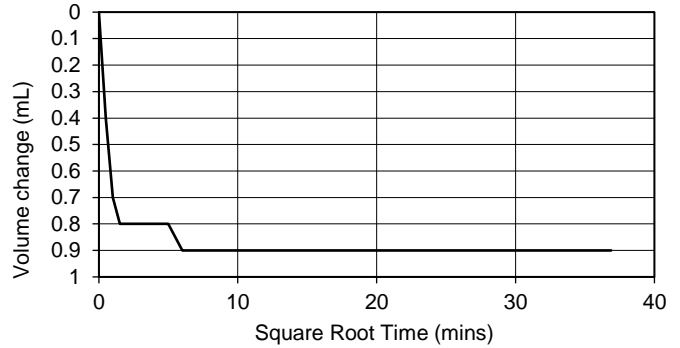
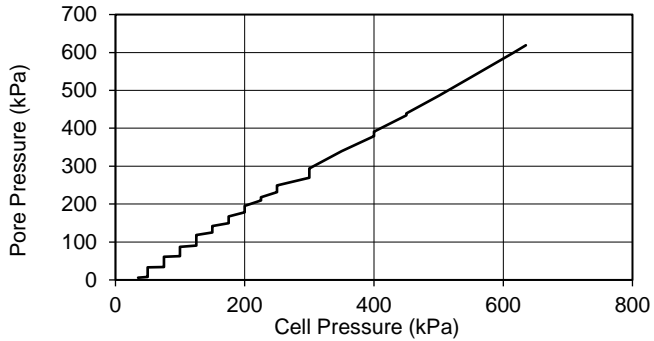
GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 5.00-5.45

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

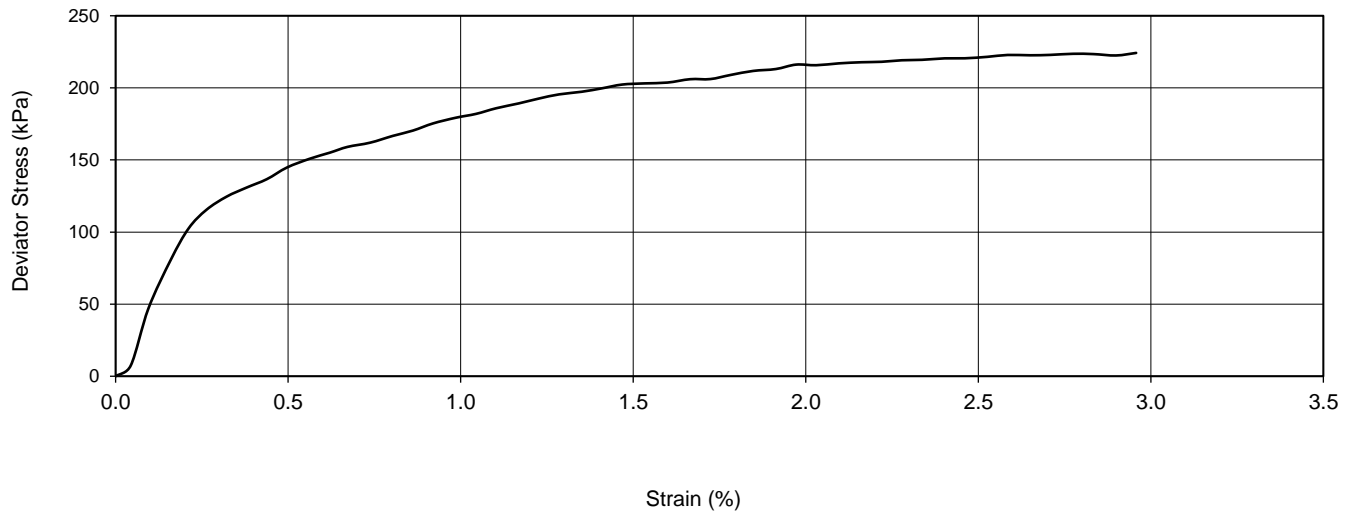
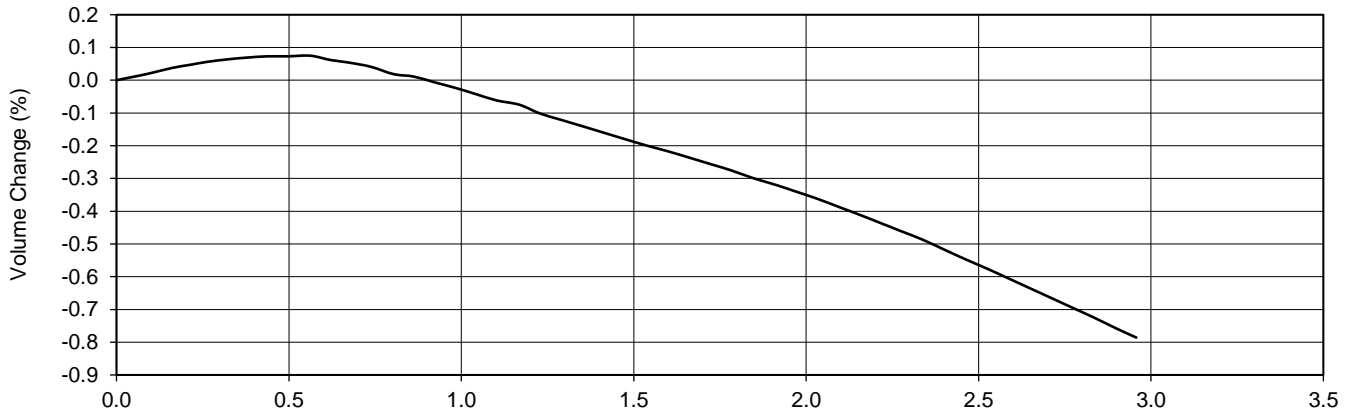
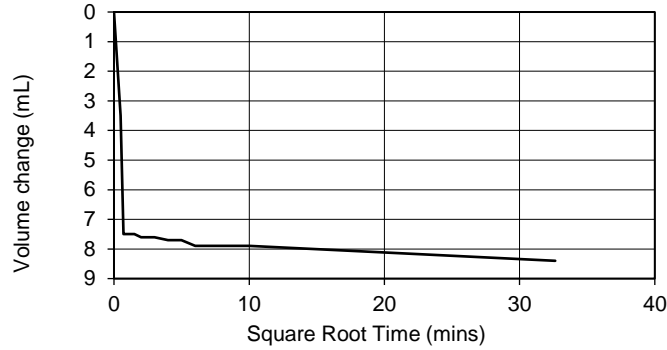
GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 5.00-5.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

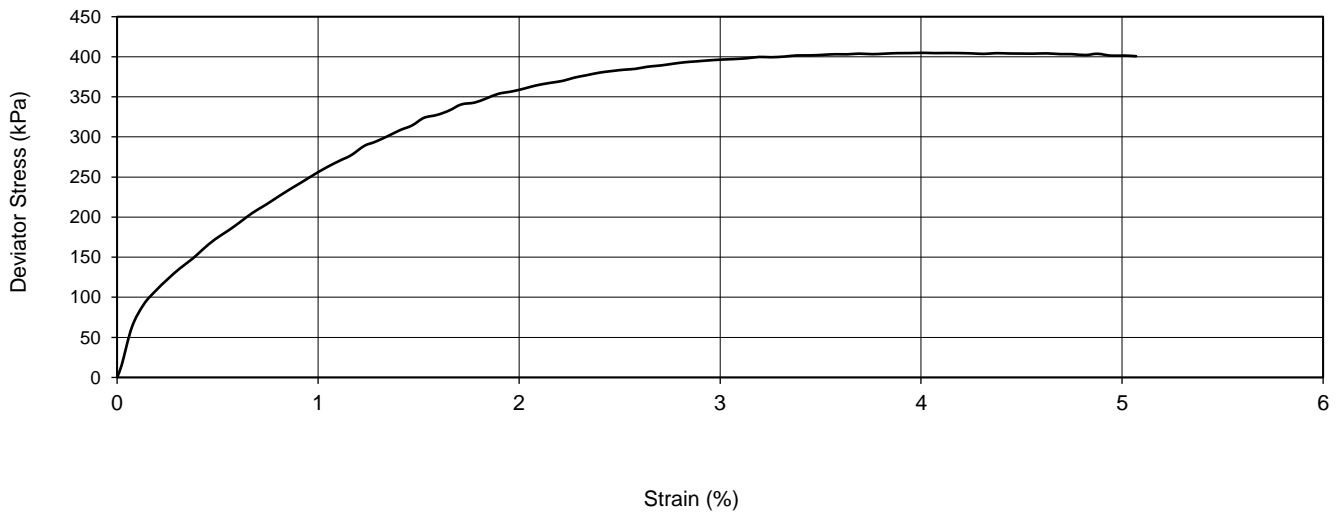
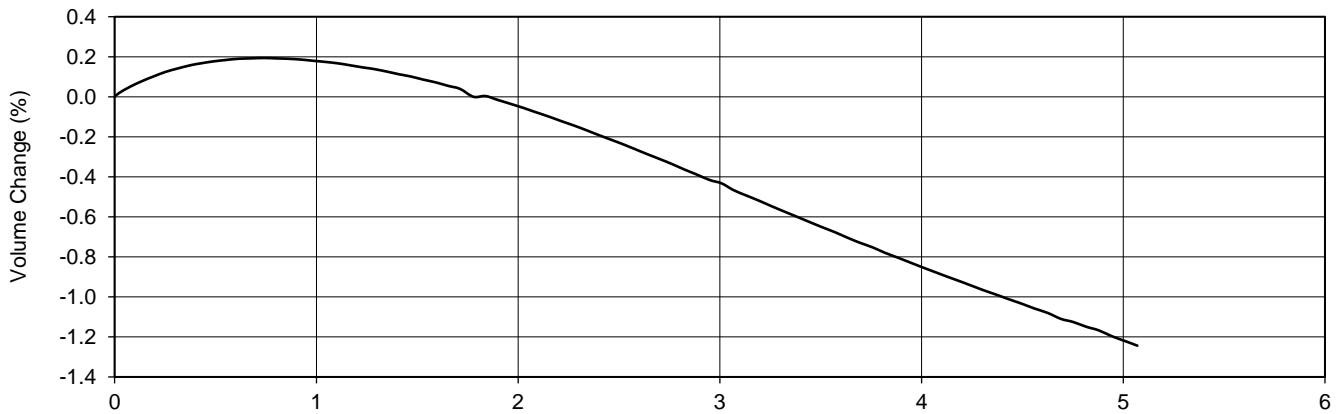
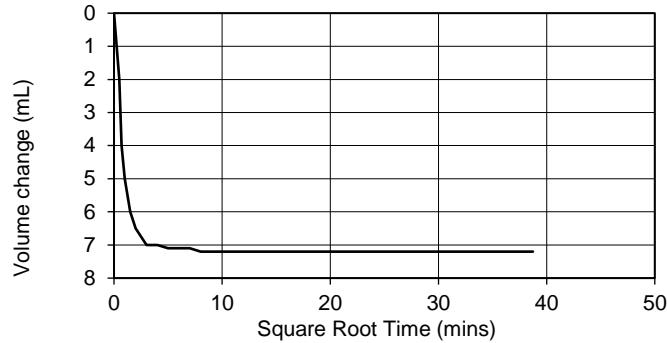
GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 5.00-5.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:


**ARDERSIER PORT
S23053**


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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07	Description: Greyish brown fine to medium SAND with rare fine to medium gravel and shell fragments.
Depth (m): 10.50-10.95	

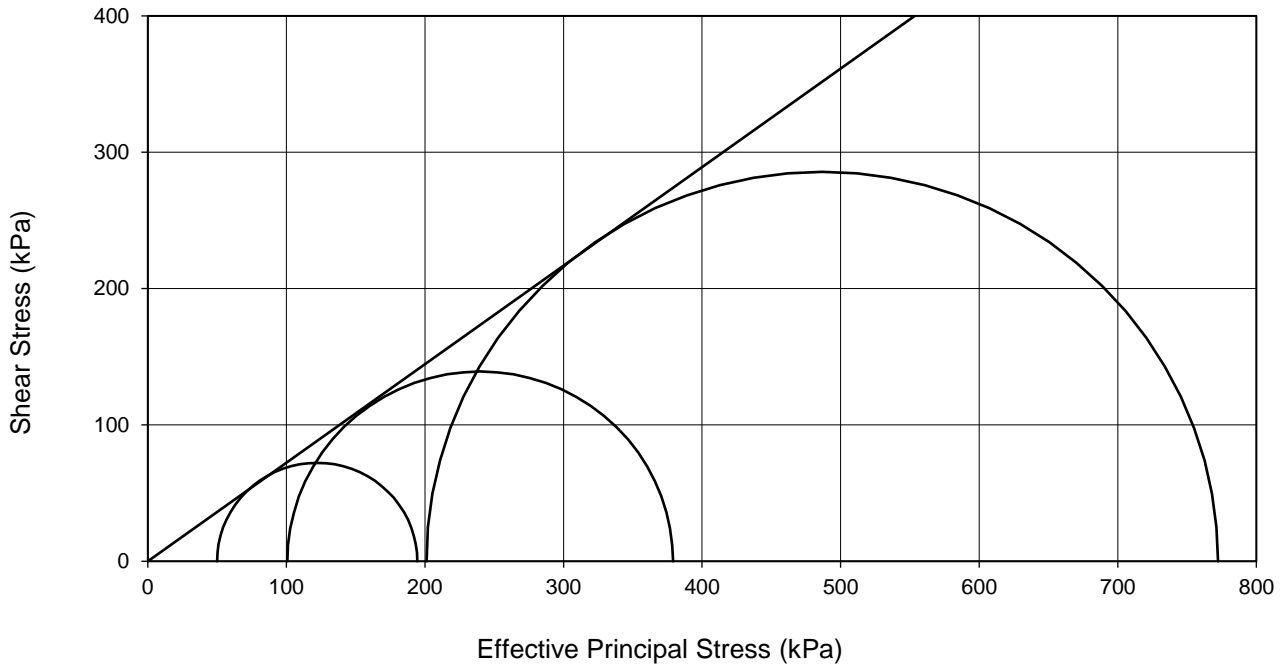
SPECIMEN DETAILS Depth within original sample Remarks	NA Orientation within original sample: NA Remoulded to a target 10 % MC and a target dry density of 1.427 Mg/m ³		
TEST DETAILS Specimen Type and Preparation Cell Preparation Specimen Number Initial Diameter <i>mm</i> Initial Length <i>mm</i> Initial Water Content % Initial Wet Density <i>Mg/m³</i> Drainage Conditions	B (Undisturbed) Checks performed in accordance with Clause 3.5		
	Multistage		
	70.22	139.49	10.4
	1.57	One end only	
SATURATION STAGE Final Cell Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Parameter B Duration <i>day(s)</i>	Method: Clause 5.2 650 645 1.00 6		
CONSOLIDATION STAGE Cell Pressure <i>kPa</i> Back Pressure <i>kPa</i> Effective Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Dissipation % Duration <i>day(s)</i>	Stage No 1 650 600 50 600 100 1	Stage No 2 700 600 100 600 100 1	Stage No 3 800 600 200 600 100 1
SHEARING STAGE Cell Pressure <i>kPa</i> Rate of Axial Displacement <i>mm/min</i> Initial Pore Pressure <i>kPa</i> Initial Effective Stress <i>kPa</i>	650 0.015 600 50	700 0.020 600 100	800 0.016 600 200
CONDITIONS AT FAILURE <i>criteria</i> Pore Pressure <i>kPa</i> Minor Effective Principal Stress <i>kPa</i> Deviator Stress <i>kPa</i> Major Effective Principal Stress <i>kPa</i> Volume Change <i>mL</i> Volumetric Strain % Axial Strain % Membrane correction applied to Deviator Stress <i>kPa</i> Duration <i>day(s)</i>	Maximum deviator stress		
600 50 144 194 -2.90 -0.5 2.1 1 1	600 599 101 278 379 -1.81 -0.3 3.1 0 1	600 599 201 571 772 -4.09 -0.8 4.5 1 1	600 599 201 571 772 -4.09 -0.8 4.5 1 1
Final Water Content % Final Wet Density <i>Mg/m³</i>	28.6 1.86		
EFFECTIVE STRESS PARAMETERS Cohesion <i>kPa</i> Angle of Shear Resistance <i>degrees</i>	0 36		
FAILURE SKETCH			

Checked and Approved by <i>P. Heritage</i> P Heritage - Project Manager 02/10/2023	Project Number: GEO / 38552 Project Name: ARDERSIER PORT S23053	
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 10.50-10.95

Description:
Greyish brown fine to medium SAND with rare fine to medium gravel and shell fragments.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

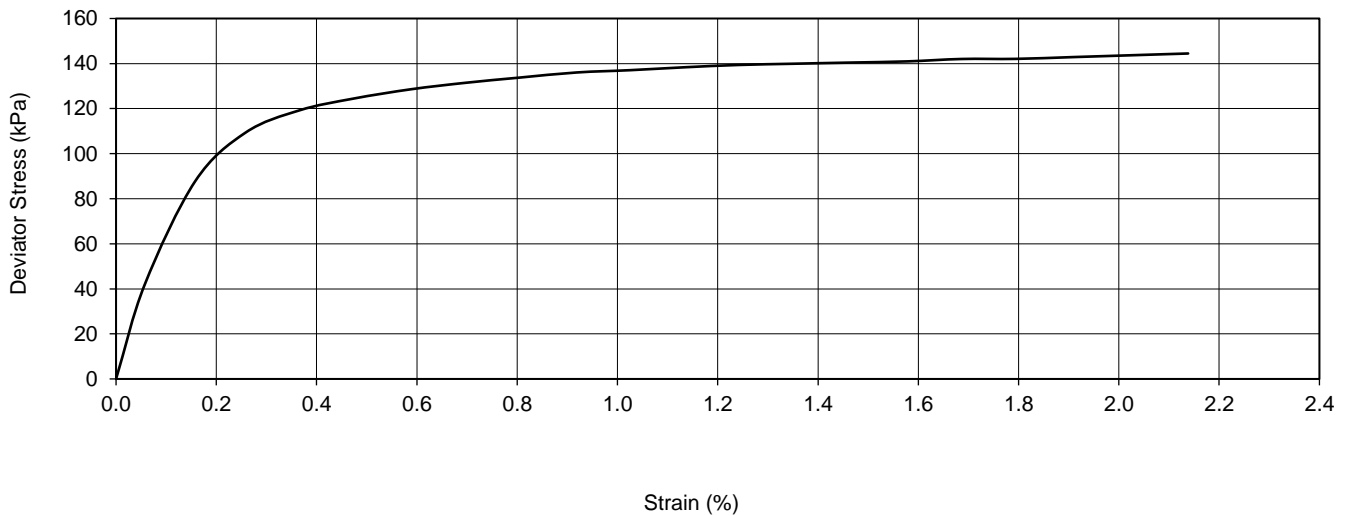
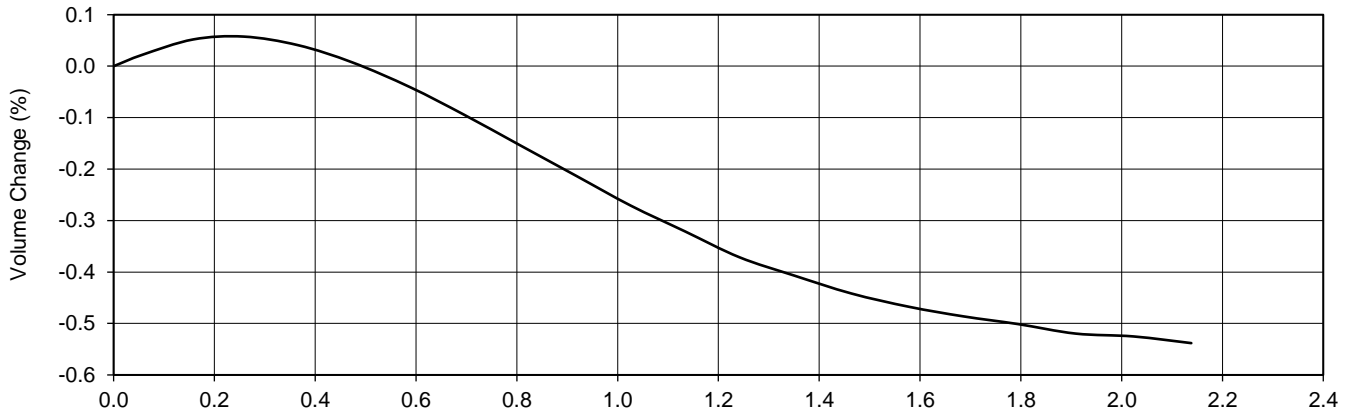
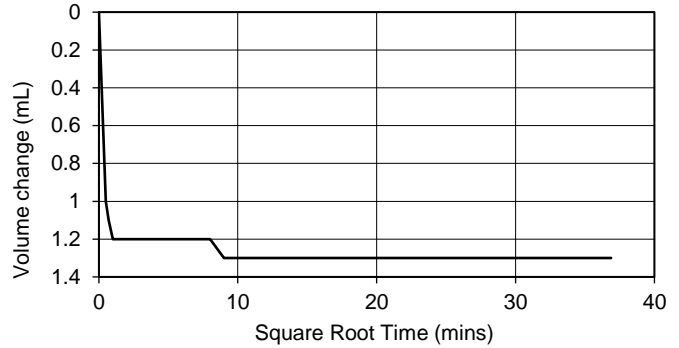
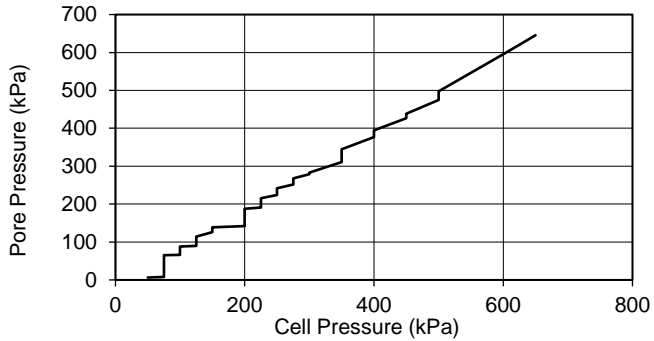
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 10.50-10.95

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

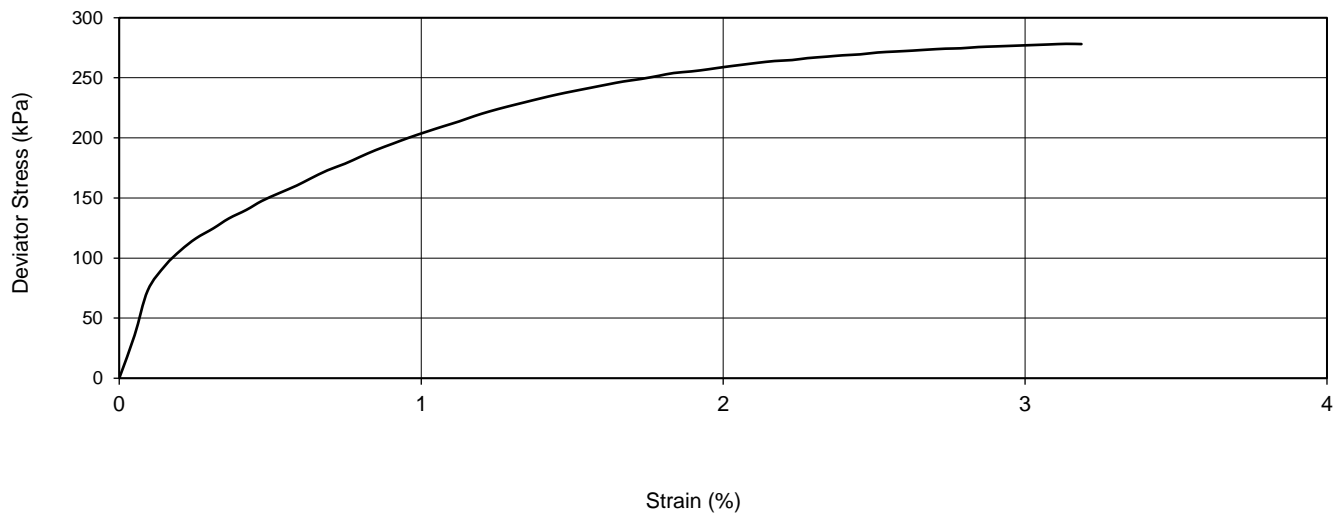
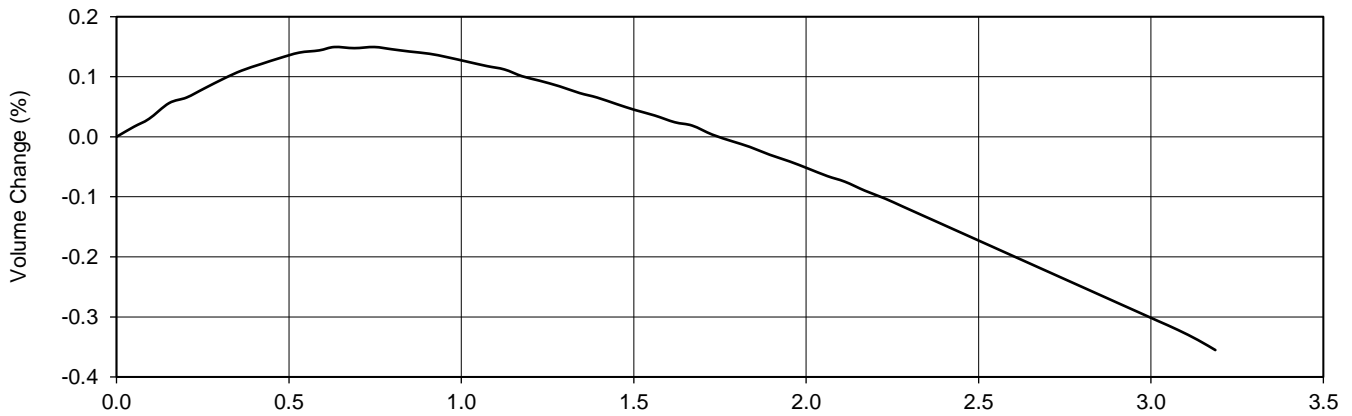
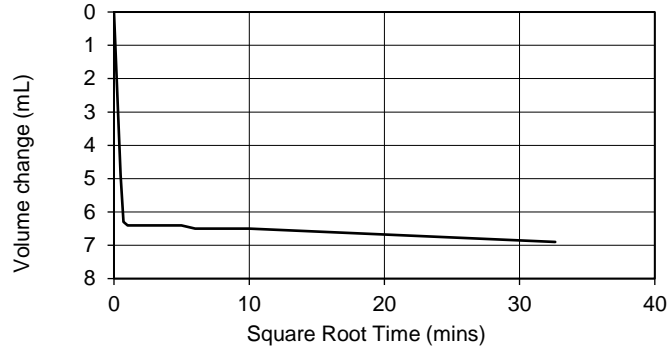
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 10.50-10.95

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

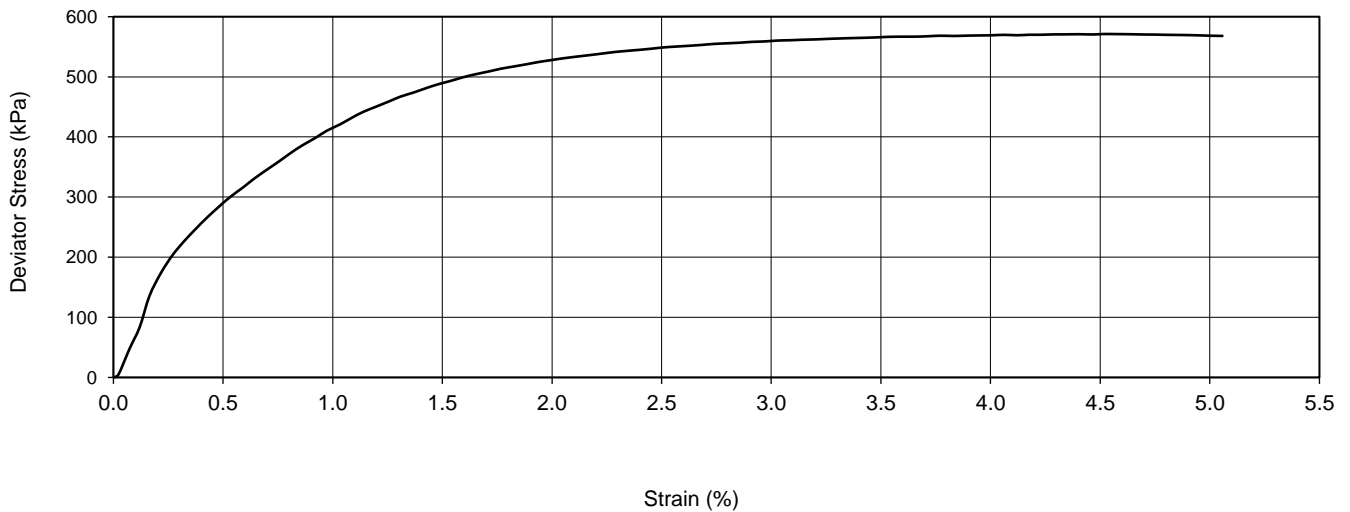
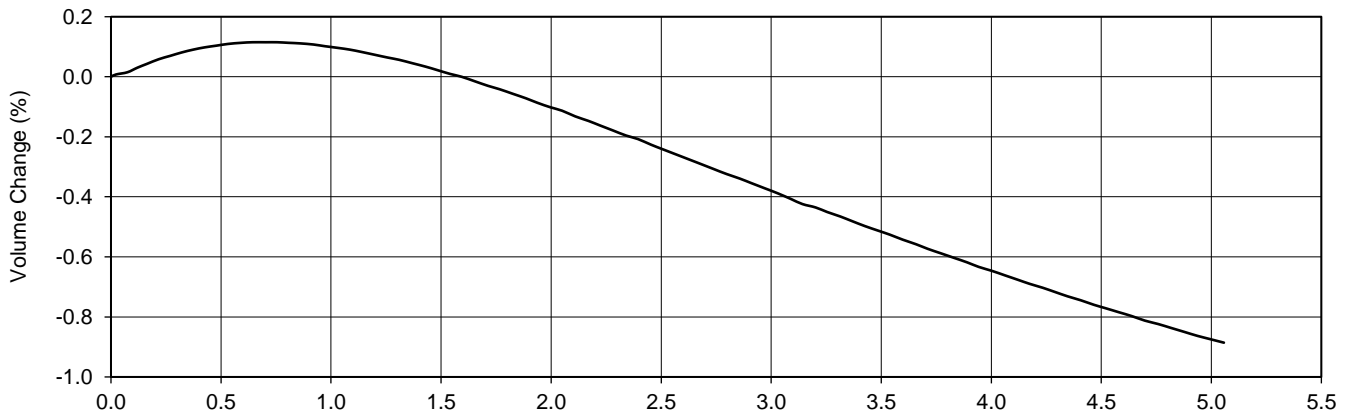
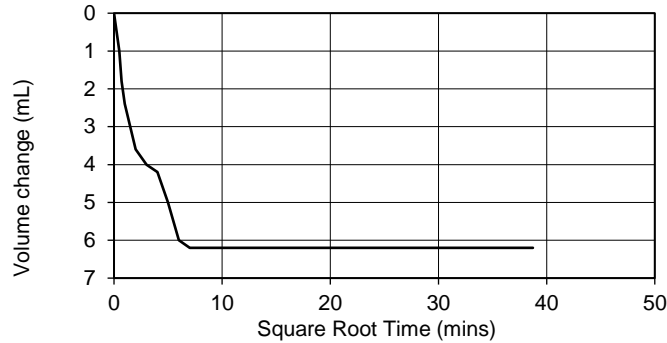
GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP07
Depth (m): 10.50-10.95

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
02/10/2023

Project Number:

GEO / 38552

Project Name:

**ARDERSIER PORT
S23053**

GEOLABS®



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Solmek
12 Yarm Road
Stockton-on-Tees
TS18 3NA

06 September 2023

Report No : GEO/38343/01

Page 1 of 1

For the attention of Mr A Cutts

Our ref **GEO / 38343**
Your Ref **S23053**

Date samples received 22/06/2023
Date written instructions received 26/06/2023
Date testing commenced 27/06/2023
Date of sample disposal 04/10/2023

Project **ARDERSIER PORT**

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

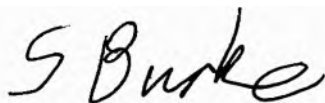
Item No	Test Quantity	Description
1	5	Maximum & Minimum Density
2	3	Shear Strength by Direct Shear
3	2	Isotropic Consolidated Drained Multistage Triaxial Compression (CIDM)

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
on behalf of **GEOLABS Limited**



S Burke
Senior Technician

1402 - JIP Max-Min BHSP08 06.00 B - 38343-490777.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP08
Depth (m)	6.00-6.45
Sample Type	B

Description:
Light brown fine to medium SAND with numerous mica crystals and occasional fine to medium gravel.

Percentage of material retained on the 2 mm test sieve 1.5 %
The fines content was measured to be 0.6 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.64 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.616	g/cm ³
Maximum dry density after surcharge application	1.644	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.628	g/cm ³
Maximum dry density after surcharge application	1.646	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.30 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	578.23 g
	2	580.33 g
	3	577.80 g
	4	577.48 g
	5	576.78 g
	Minimum	578.12 g

Checked and Approved by

J Powell - Technical Consultant
14/07/2023

Project Number: **38343**
Project Name: **ARDERSIER PORT
S23053**



1402 - JIP Max-Min BHSP08 07.00 B - 38343-490772.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP08
Depth (m)	7.00-7.45
Sample Type	B

Description:
Light brown fine to medium SAND with occasional fine to medium gravel.

Percentage of material retained on the 2 mm test sieve 1.0 %
The fines content was measured to be 0.9 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.61 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.591	g/cm ³
Maximum dry density after surcharge application	1.606	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.595	g/cm ³
Maximum dry density after surcharge application	1.620	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

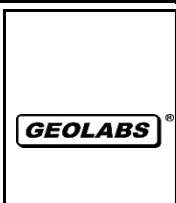
Minimum Dry Density **1.26 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	560.51 g
	2	560.90 g
	3	562.88 g
	4	561.48 g
	5	560.02 g
	Minimum	561.16 g

Checked and Approved by

J Powell - Technical Consultant
14/07/2023

Project Number: **38343**
Project Name: **ARDERSIER PORT
S23053**



1402 - JIP Max-Min BHSP08 18.00 B - 38343-490781.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP08
Depth (m)	18.00-18.45
Sample Type	B

Description:
Brownish grey fine to medium SAND with rare shell fragments, numerous mica and rare fine gravel.

Percentage of material retained on the 2 mm test sieve 0.4 %
The fines content was measured to be 3.5 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.59 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.567	g/cm ³
Maximum dry density after surcharge application	1.582	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.572	g/cm ³
Maximum dry density after surcharge application	1.593	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.14 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	508.19 g
	2	507.36 g
	3	509.00 g
	4	508.49 g
	5	507.81 g
	Minimum	508.17 g

Checked and Approved by

J Powell - Technical Consultant
14/07/2023

Project Number: **38343**
Project Name: **ARDERSIER PORT
S23053**



1402 - JIP Max-Min BHSP08 19.50 B - 38343-490778.XL.SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP08
Depth (m)	19.50-19.95
Sample Type	B

Description:
Brownish grey fine to medium SAND with occasional fine to medium gravel and numerous of mica crystals.

Percentage of material retained on the 2 mm test sieve 1.4 %
The fines content was measured to be 2.4 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.58 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.567	g/cm ³
Maximum dry density after surcharge application	1.582	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.571	g/cm ³
Maximum dry density after surcharge application	1.582	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

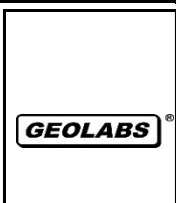
Minimum Dry Density **1.15 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	508.28 g
	2	510.43 g
	3	510.90 g
	4	511.30 g
	5	508.88 g
	Minimum	509.96 g

Checked and Approved by

J Powell - Technical Consultant
14/07/2023

Project Number: **38343**
Project Name: **ARDERSIER PORT
S23053**



1402 - JIP Max-Min BHSP08 25.50 B - 38343-490779.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP08
Depth (m)	25.50-25.95
Sample Type	B

Description:
Grey fine to medium SAND with occasional medium to coarse gravel and shell fragments.

Percentage of material retained on the 2 mm test sieve 3.0 %
The fines content was measured to be 5.0 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.61 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.595	g/cm ³
Maximum dry density after surcharge application	1.606	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.594	g/cm ³
Maximum dry density after surcharge application	1.604	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.13 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	500.06 g
	2	502.90 g
	3	503.03 g
	4	501.53 g
	5	502.94 g
	Minimum	502.09 g

Checked and Approved by

J Powell - Technical Consultant
14/07/2023

Project Number: **38343**
Project Name: **ARDERSIER PORT
S23053**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP08
 Depth (m) 6.00-6.45
 Sample Type B

Description:

Light brown gravelly fine to medium SAND.
 Gravel is fine to medium.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a a relative density of 80% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.78	59.78	59.78
Width	<i>mm</i>	59.77	59.77	59.77
Height	<i>mm</i>	23.99	24.13	24.17
Initial water content	%	19.1	19.1	19.1
Initial bulk density	<i>Mg/m³</i>	1.87	1.86	1.85
Initial dry density	<i>Mg/m³</i>	1.57	1.56	1.56
Initial voids ratio		0.691	0.701	0.704
Degree of Saturation	%	73.3	72.2	71.9

Shearing Stage

Normal stress *kPa* 30 60 120

Peak Conditions:

Rate of horizontal displacement	<i>mm/min</i>	0.4	0.4	0.4
Maximum shear stress	<i>kPa</i>	28.1	46.5	99.5
Horizontal displacement at MSS	<i>mm</i>	1.8	2.9	2.2
Vertical Displacement at Peak	<i>mm</i>	-0.23	-0.21	-0.19

Final water content % 24.7 24.2 24.6
 Duration *day(s)* 1 1 1

Shear Strength Parameters

		Peak Condition
Apparent Cohesion	<i>kPa</i>	2
Angle of Shearing Resistance	<i>degrees</i>	39.0

Notes: ¹ Maximum dry density = 1.64 Mg/m³ and minimum dry density = 1.30 Mg/m³

Tested by SRA
 Checked and Approved by



C F Wallace - Technical Director
 20/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
 S23053**

GEOLABS®



DIRECT SHEAR TEST – SHEARBOX

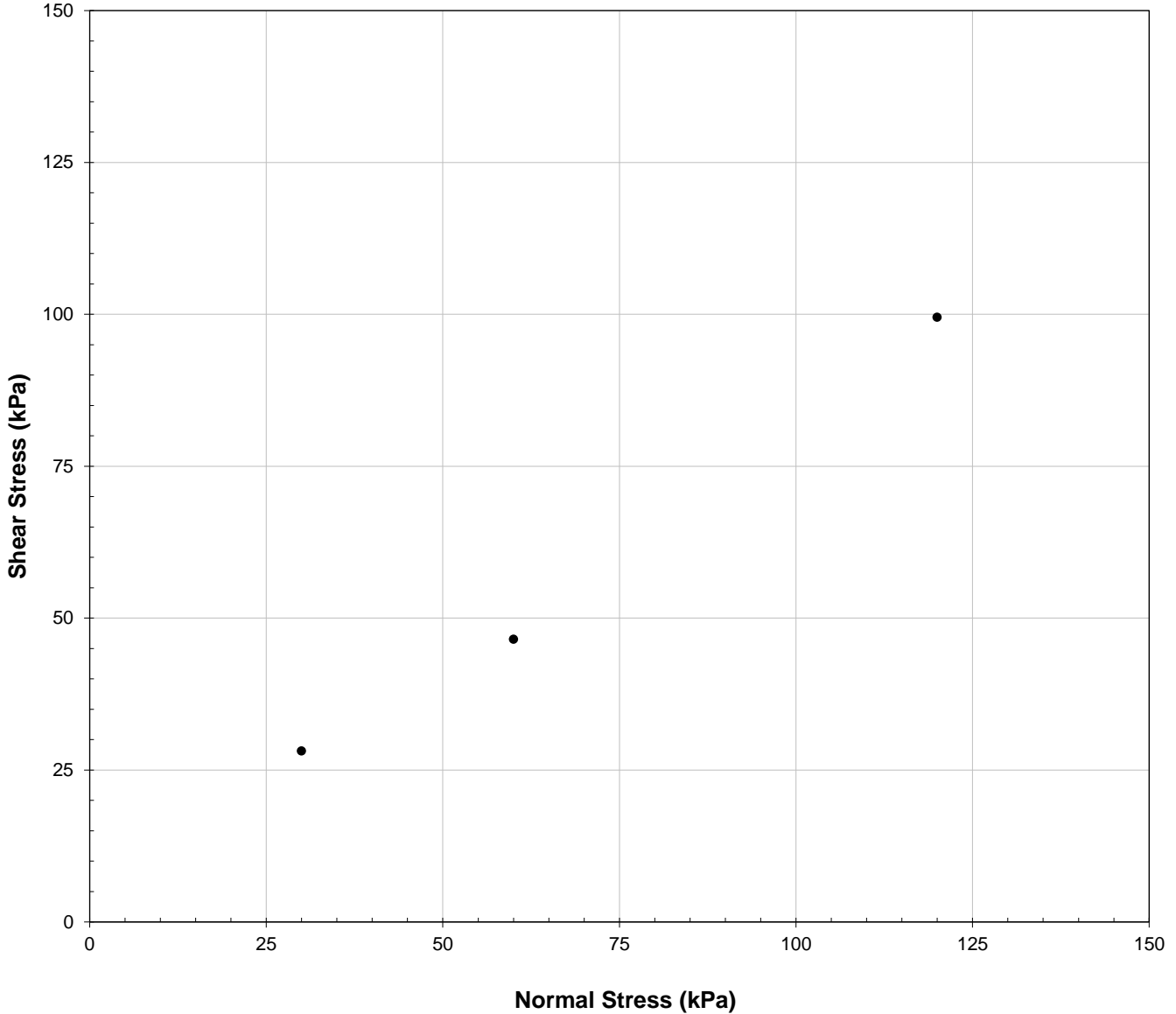
(small shearbox apparatus)

Borehole No BHSP08
Depth (m) 6.00-6.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.
Gravel is fine to medium.

Shear Stress v Normal Stress



Peak: $c' = 2$
 $\Phi' = 39.0$

Tested by SRA
Checked and Approved by

C F Wallace - Technical Director
20/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

GEOLABS®



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

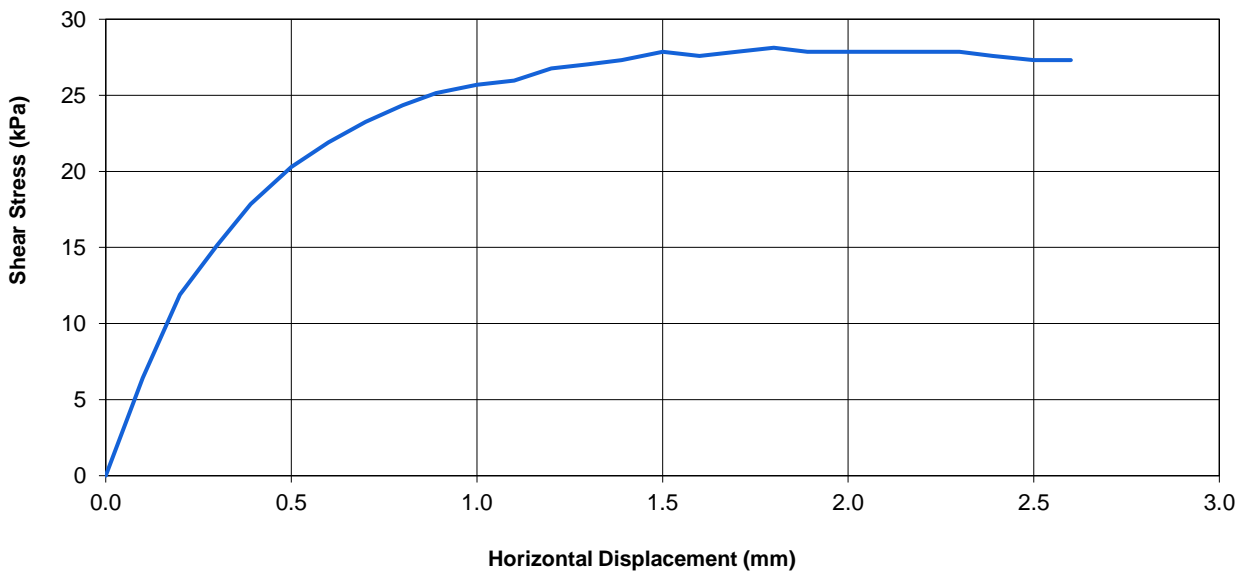
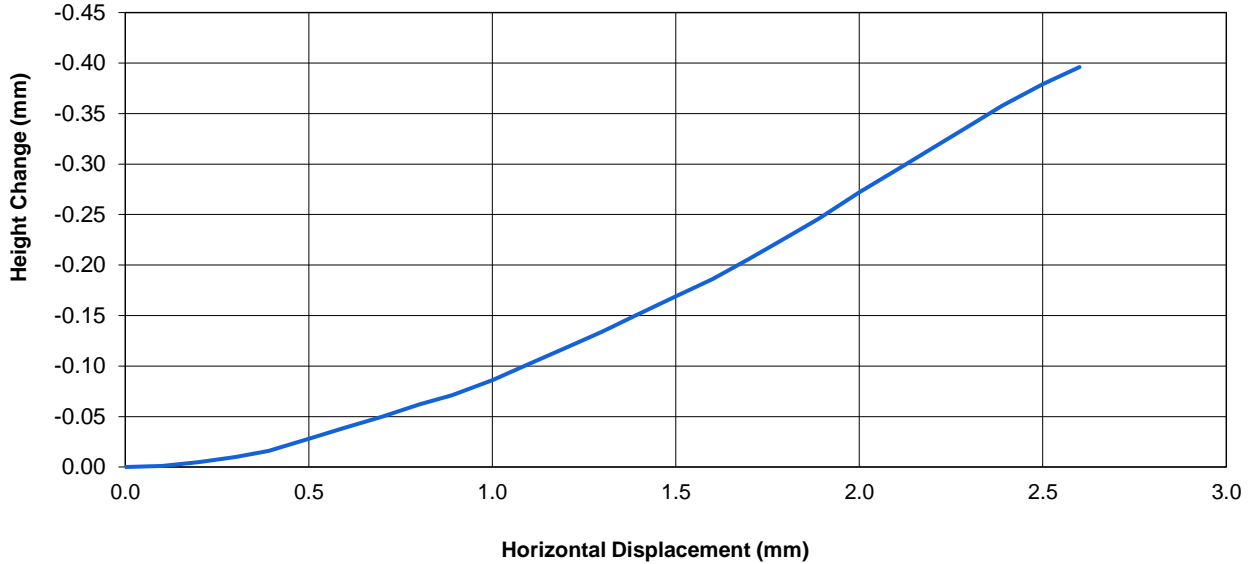
Borehole No BHSP08
Depth (m) 6.00-6.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.
Gravel is fine to medium.

Specimen: 1

Shear Stage



Tested by SRA
Checked and Approved by

C F Wallace - Technical Director
20/07/2023

Project Number:

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Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

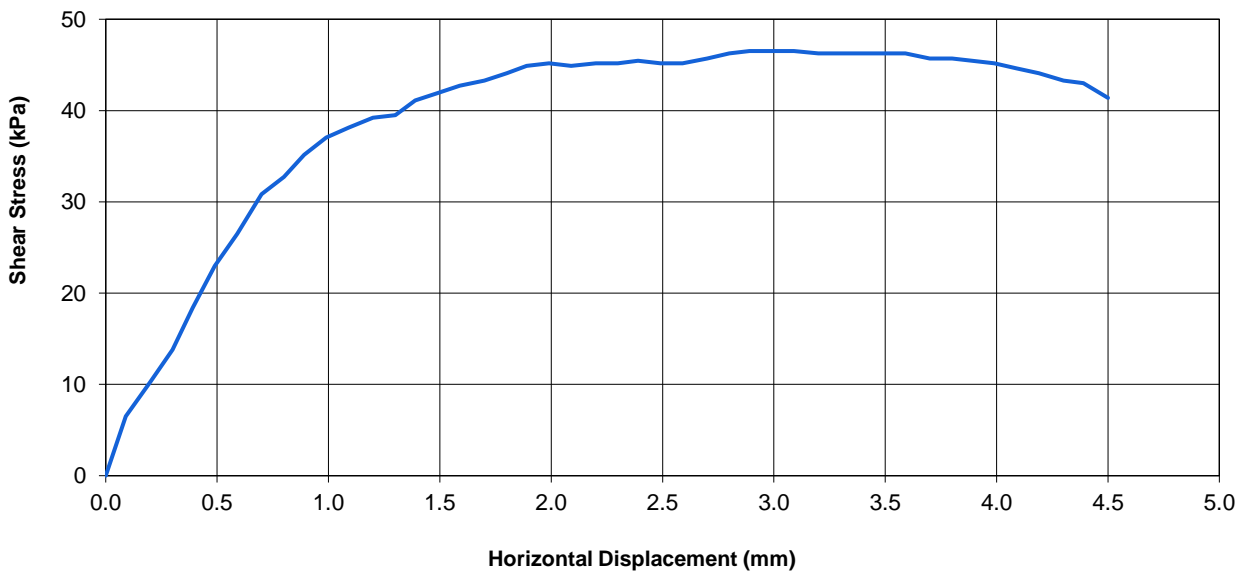
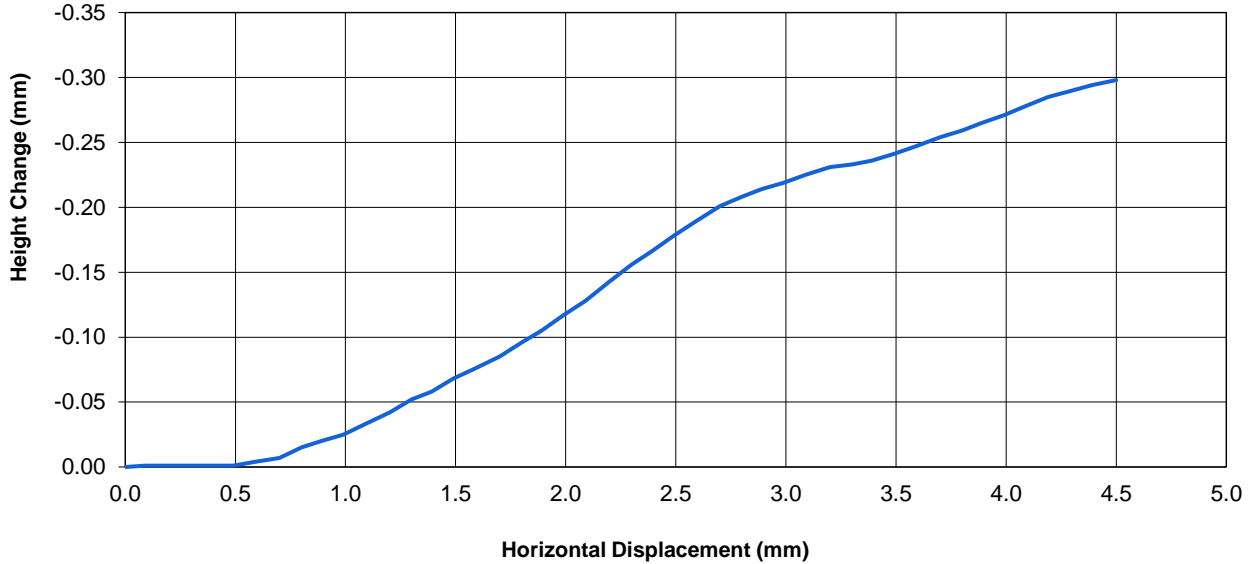
Borehole No BHSP08
 Depth (m) 6.00-6.45
 Sample Type B

Description:

Light brown gravelly fine to medium SAND.
 Gravel is fine to medium.

Specimen: 2

Shear Stage



Tested by SRA
 Checked and Approved by

C F Wallace - Technical Director
 20/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
 S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

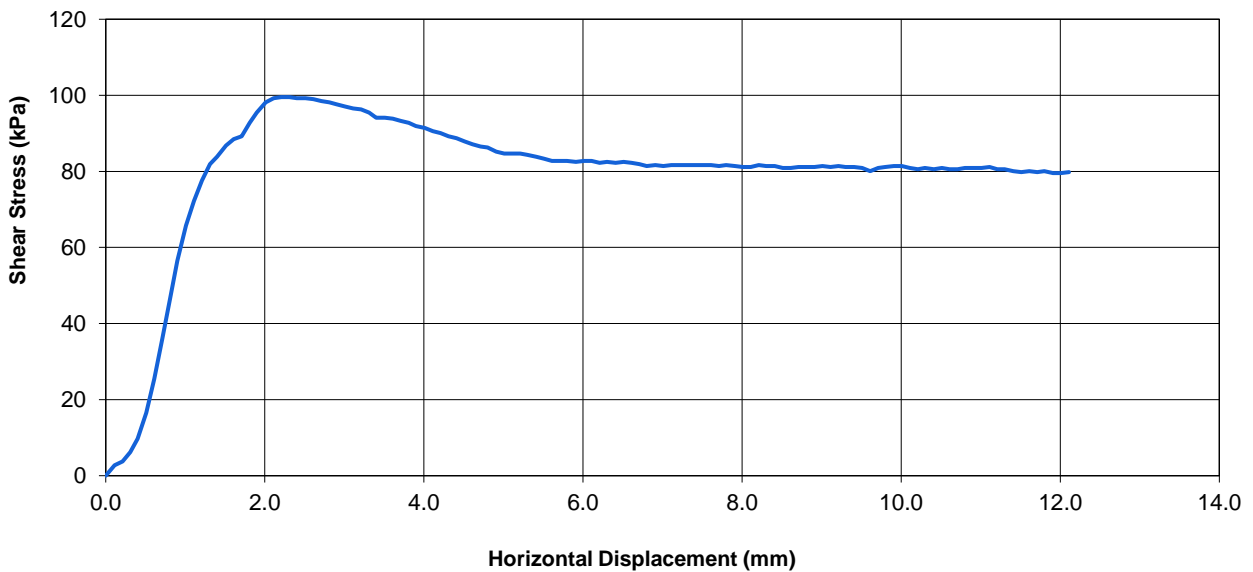
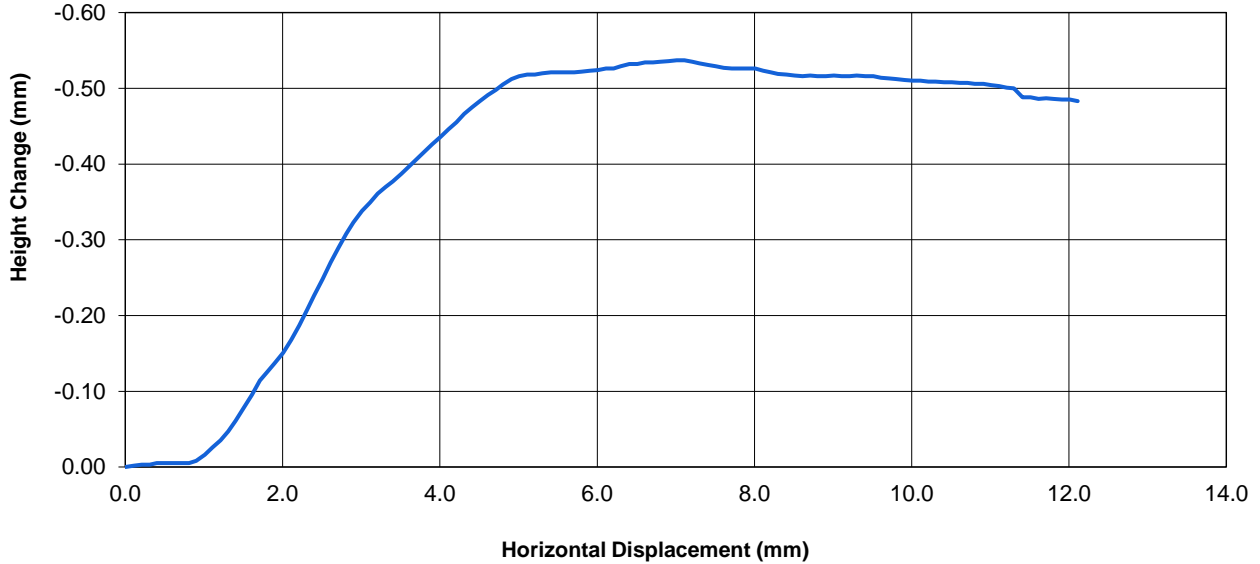
Borehole No BHSP08
Depth (m) 6.00-6.45
Sample Type B

Description:

Light brown gravelly fine to medium SAND.
Gravel is fine to medium.

Specimen: 3

Shear Stage



Tested by SRA
Checked and Approved by

C F Wallace - Technical Director
20/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP08
 Depth (m) 19.50-19.95
 Sample Type B

Description:

Grey gravelly SAND with rare mica crystals.
 Gravel is fine to medium.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 60% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	60.04	60.05	60.05
Width	<i>mm</i>	60.00	60.00	60.01
Height	<i>mm</i>	25.54	25.42	25.39
Initial water content	%	21.5	21.5	21.5
Initial bulk density	<i>Mg/m³</i>	1.63	1.64	1.64
Initial dry density	<i>Mg/m³</i>	1.34	1.35	1.35
Initial voids ratio		0.975	0.966	0.964
Degree of Saturation	%	58.5	59.0	59.1

Shearing Stage

Normal stress	<i>kPa</i>	60	120	240
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.4	0.4	0.4
Maximum shear stress	<i>kPa</i>	41.6	86.1	168.0
Horizontal displacement at MSS	<i>mm</i>	5.0	4.9	6.6
Vertical Displacement at Peak	<i>mm</i>	-0.02	0.43	0.65

Final water content	%	26.6	25.9	26.5
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		1
Angle of Shearing Resistance	<i>degrees</i>	35.0

Notes: ¹ Maximum dry density = 1.58 Mg/m³ and minimum dry density 1.15 Mg/m³

Tested by JJR
 Checked and Approved by

P. Heritage

P Heritage - Project Manager
 26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
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DIRECT SHEAR TEST – SHEARBOX

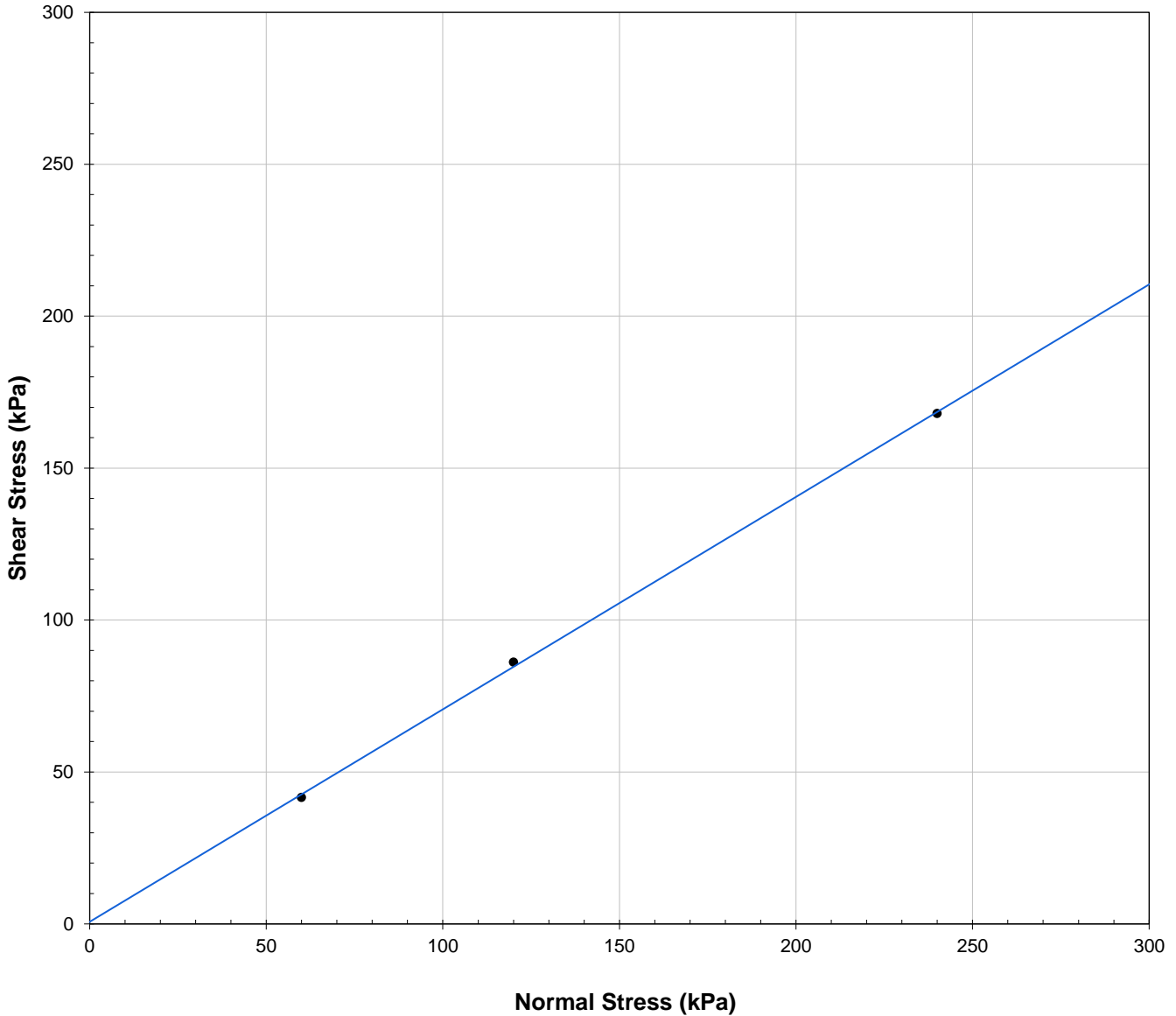
(small shearbox apparatus)

Borehole No BHSP08
Depth (m) 19.50-19.95
Sample Type B

Description:

Grey gravelly SAND with rare mica crystals.
Gravel is fine to medium.

Shear Stress v Normal Stress



Peak: $c' = 1$
 $\Phi' = 35.0$

Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
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DIRECT SHEAR TEST – SHEARBOX

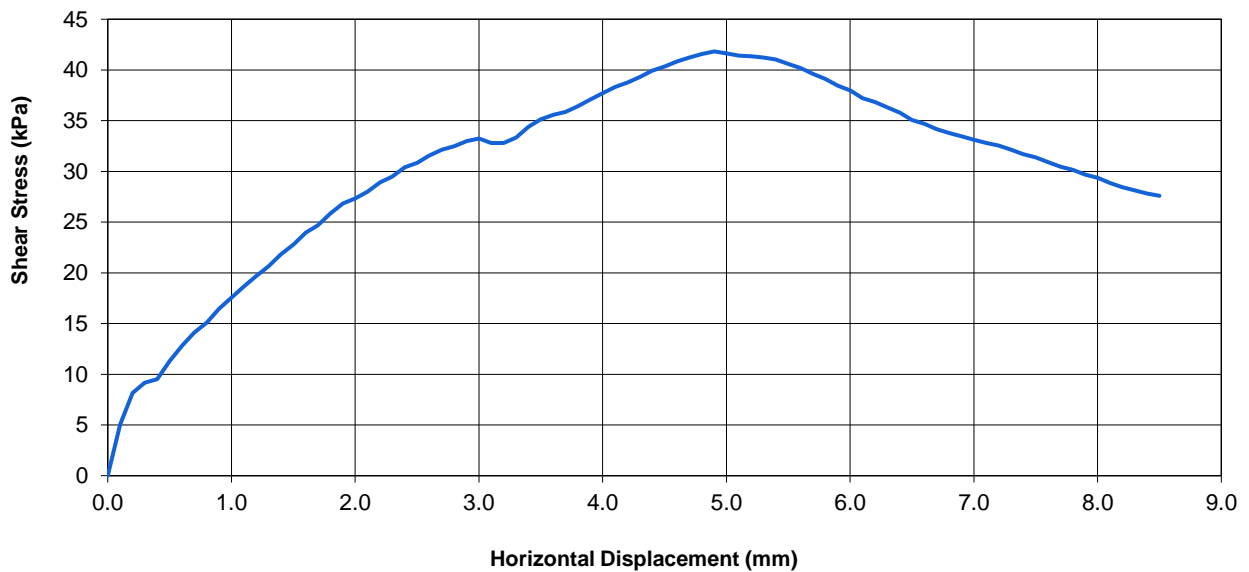
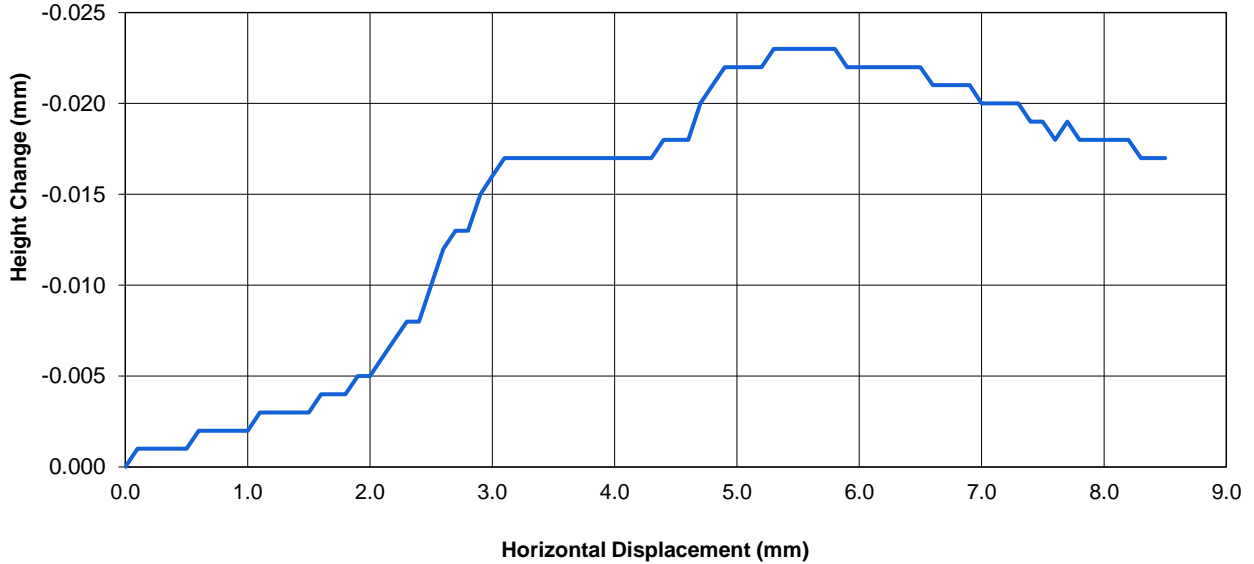
(small shearbox apparatus)


Borehole No	BHSP08
Depth (m)	19.50-19.95
Sample Type	B

Description:
 Grey gravelly SAND with rare mica crystals.
 Gravel is fine to medium.

Specimen: 1

Shear Stage



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 P Heritage - Project Manager
 26/07/2023

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GEO / 38343

Project Name:
**ARDERSIER PORT
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DIRECT SHEAR TEST – SHEARBOX

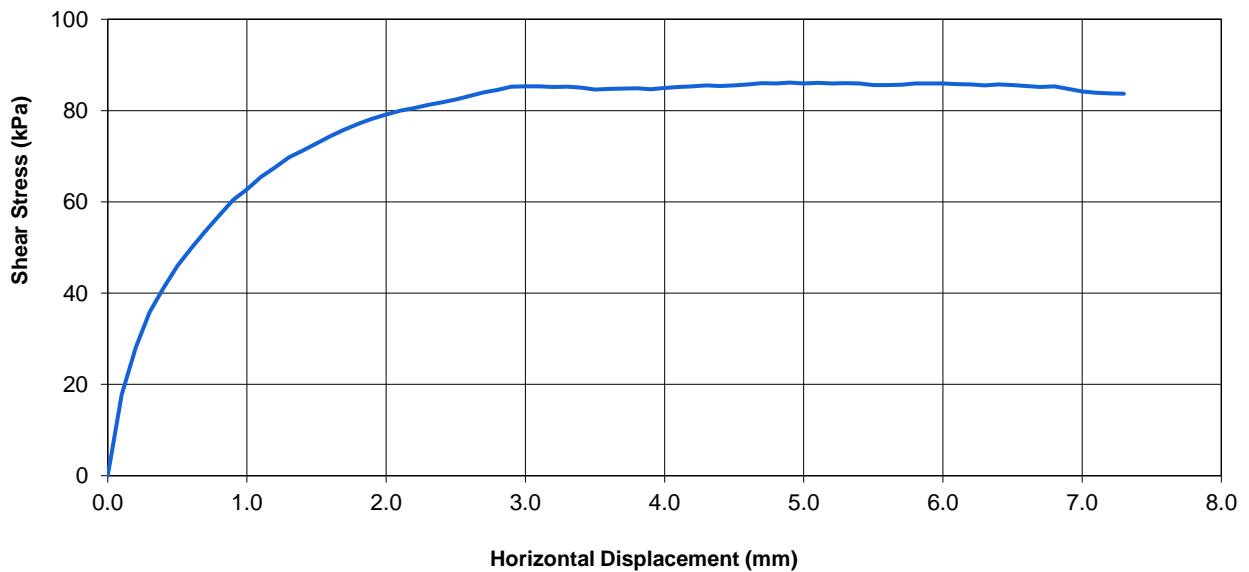
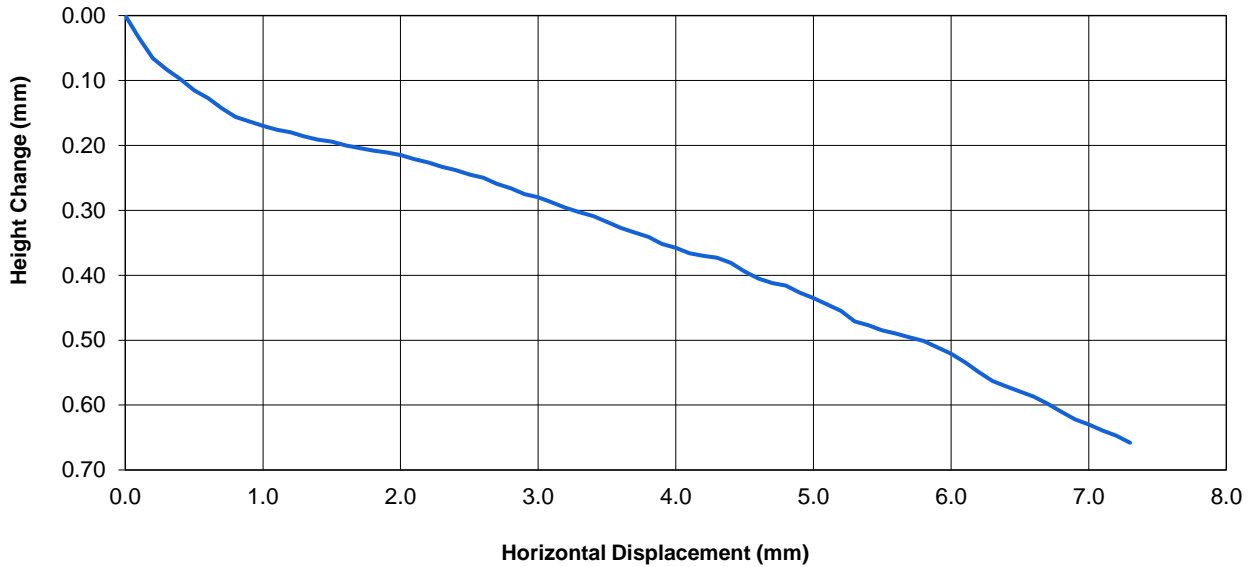
(small shearbox apparatus)


Borehole No BHSP08
 Depth (m) 19.50-19.95
 Sample Type B

Description:
 Grey gravelly SAND with rare mica crystals.
 Gravel is fine to medium.

Specimen: 2

Shear Stage



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 Checked and Approved by

 P Heritage - Project Manager
 26/07/2023

Project Number:
GEO / 38343
 Project Name:
**ARDERSIER PORT
 S23053**



DIRECT SHEAR TEST – SHEARBOX

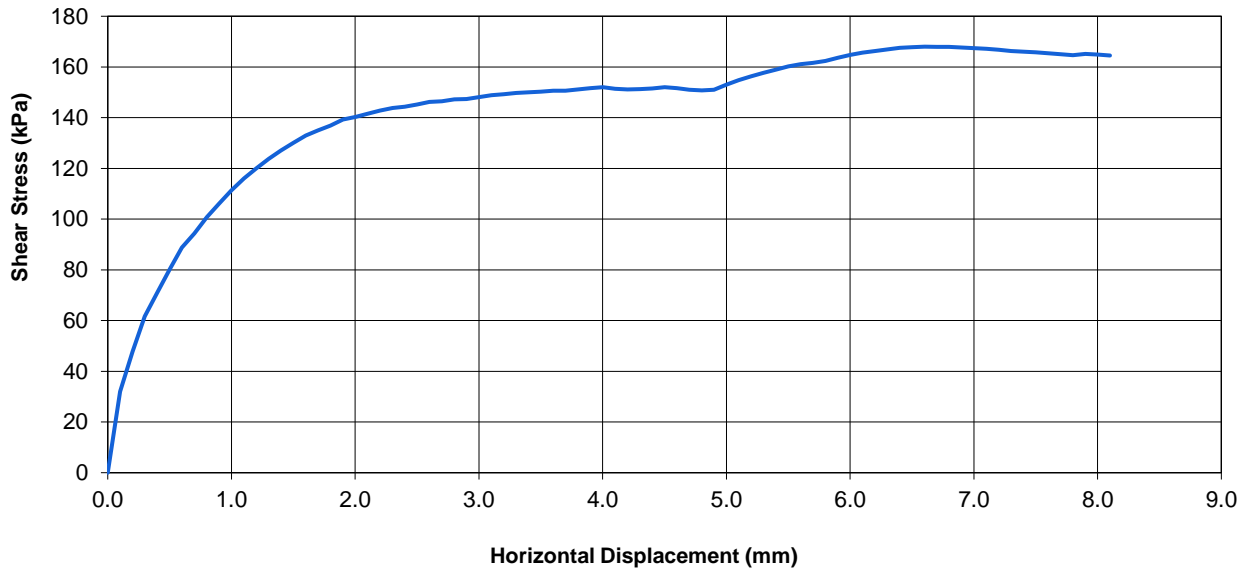
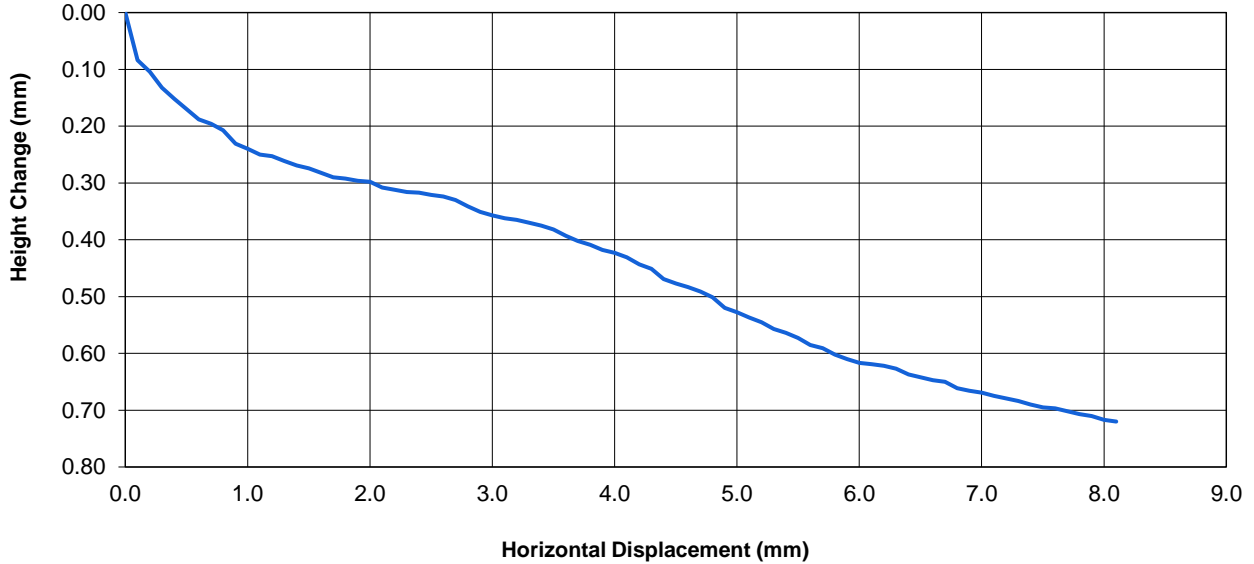
(small shearbox apparatus)


Borehole No BHSP08
 Depth (m) 19.50-19.95
 Sample Type B

Description:
 Grey gravelly SAND with rare mica crystals.
 Gravel is fine to medium.

Specimen: 3

Shear Stage



Tested by JJR
 Checked and Approved by

 P Heritage - Project Manager
 26/07/2023

Project Number:
GEO / 38343

Project Name:
**ARDERSIER PORT
 S23053**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP08
 Depth (m) 25.50-25.95
 Sample Type B

Description:

Grey gravelly fine to medium SAND with rare shell fragments.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 50% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.78	60.05	60.03
Width	<i>mm</i>	59.77	60.03	60.03
Height	<i>mm</i>	25.08	25.06	25.13
Initial water content	%	24.5	24.5	24.5
Initial bulk density	<i>Mg/m³</i>	1.67	1.66	1.66
Initial dry density	<i>Mg/m³</i>	1.34	1.33	1.33
Initial voids ratio		0.971	0.987	0.992
Degree of Saturation	%	66.9	65.8	65.5

Shearing Stage

Normal stress	<i>kPa</i>	75	150	300
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.4	0.4	0.4
Maximum shear stress	<i>kPa</i>	51.9	103.9	199.4
Horizontal displacement at MSS	<i>mm</i>	6.9	8.8	9.1
Vertical Displacement at Peak	<i>mm</i>	0.38	0.34	0.84

Final water content	%	24.8	25.7	25.9
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		4
Angle of Shearing Resistance	<i>degrees</i>	33.0

Notes: ¹ Maximum dry density = 1.61 Mg/m³ and minimum dry density = 1.13 Mg/m³

Tested by JJR
 Checked and Approved by

P. Heritage

P Heritage - Project Manager
 26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053****GEOLABS**®

DIRECT SHEAR TEST – SHEARBOX

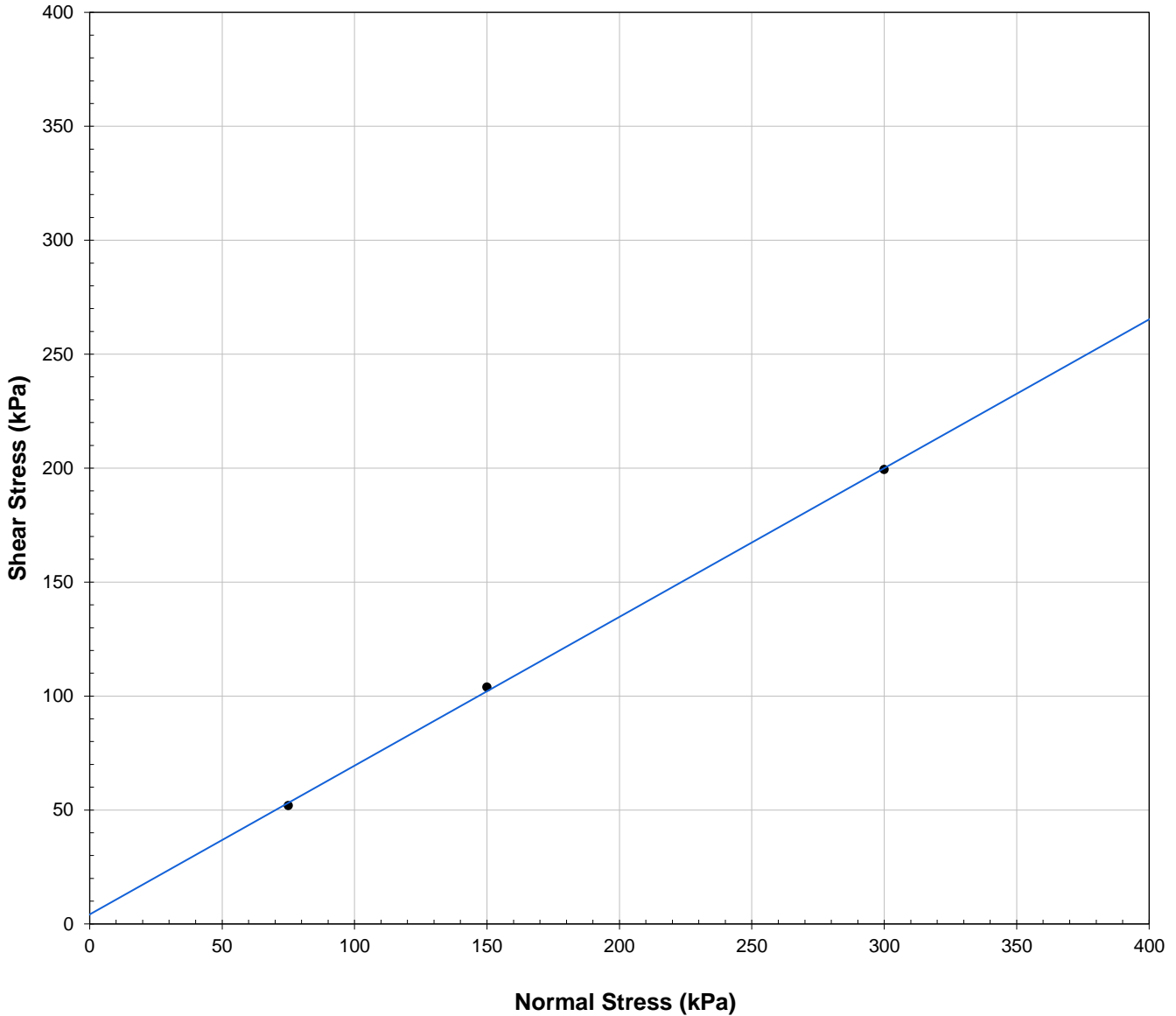
(small shearbox apparatus)

Borehole No BHSP08
Depth (m) 25.50-25.95
Sample Type B

Description:

Grey gravelly fine to medium SAND with rare shell fragments.

Shear Stress v Normal Stress



Peak: $c' = 4$
 $\Phi' = 33.0$

Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

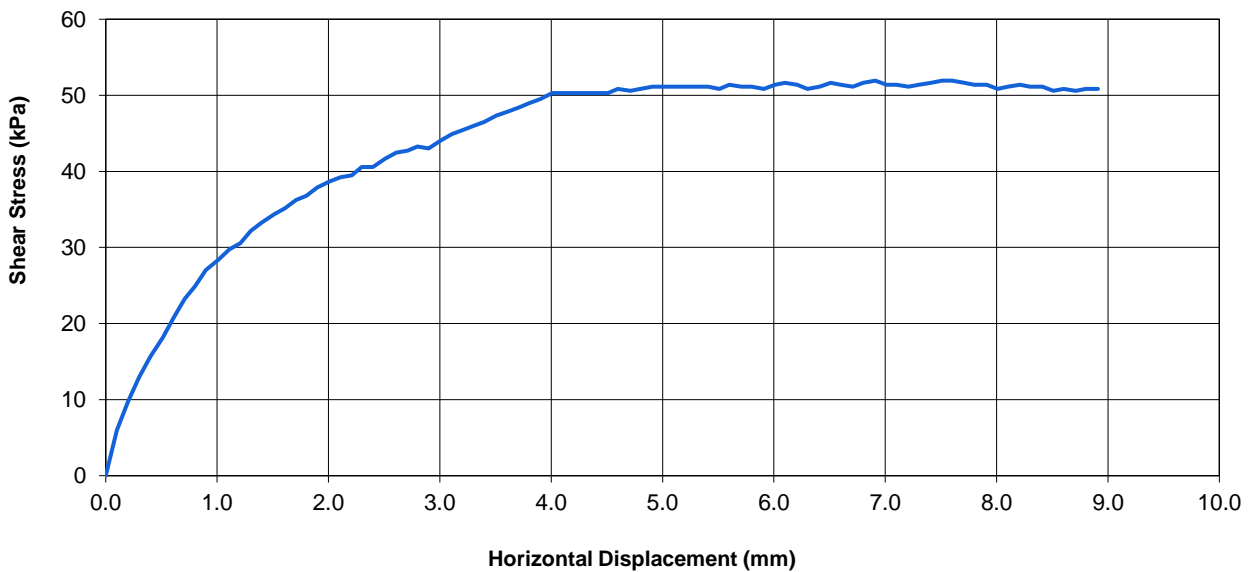
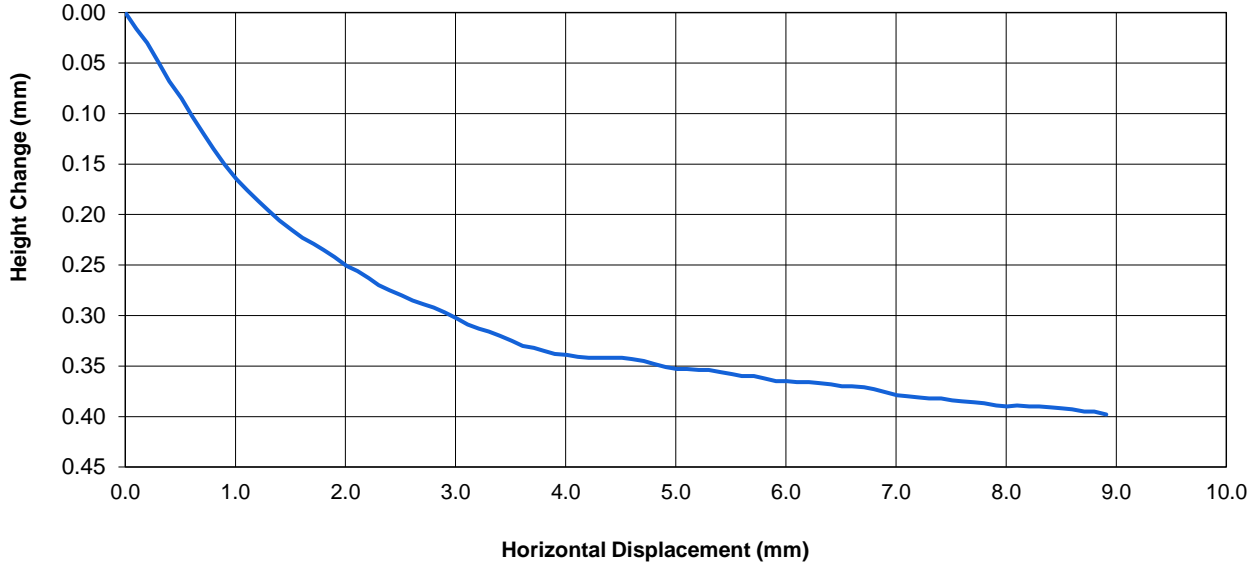
Borehole No BHSP08
Depth (m) 25.50-25.95
Sample Type B

Description:

Grey gravelly fine to medium SAND with rare shell fragments.

Specimen: 1

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

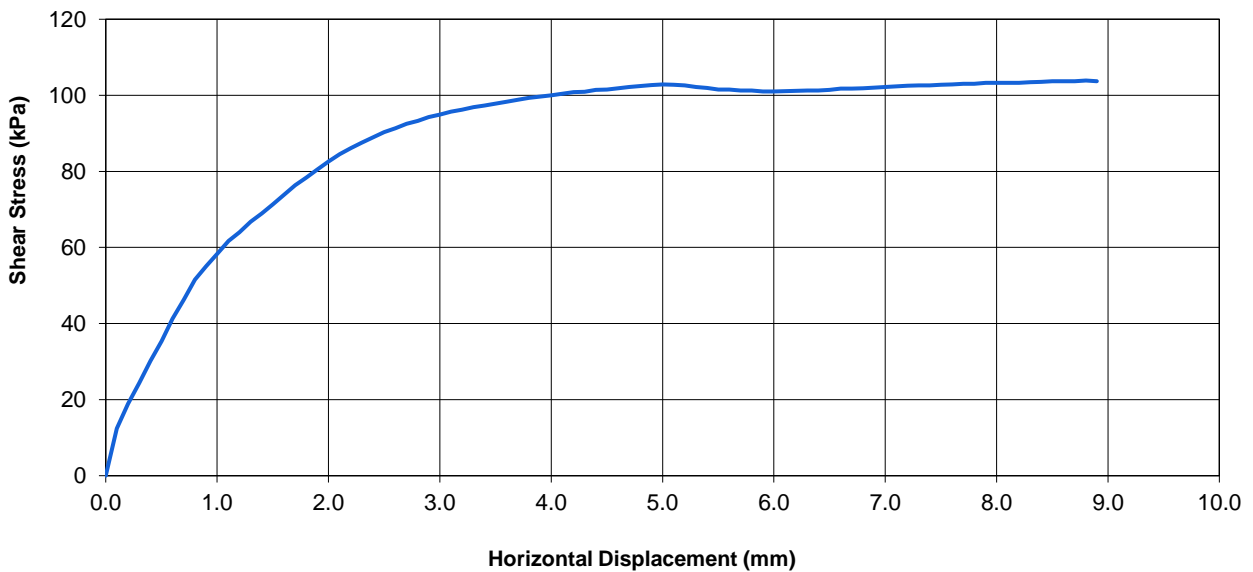
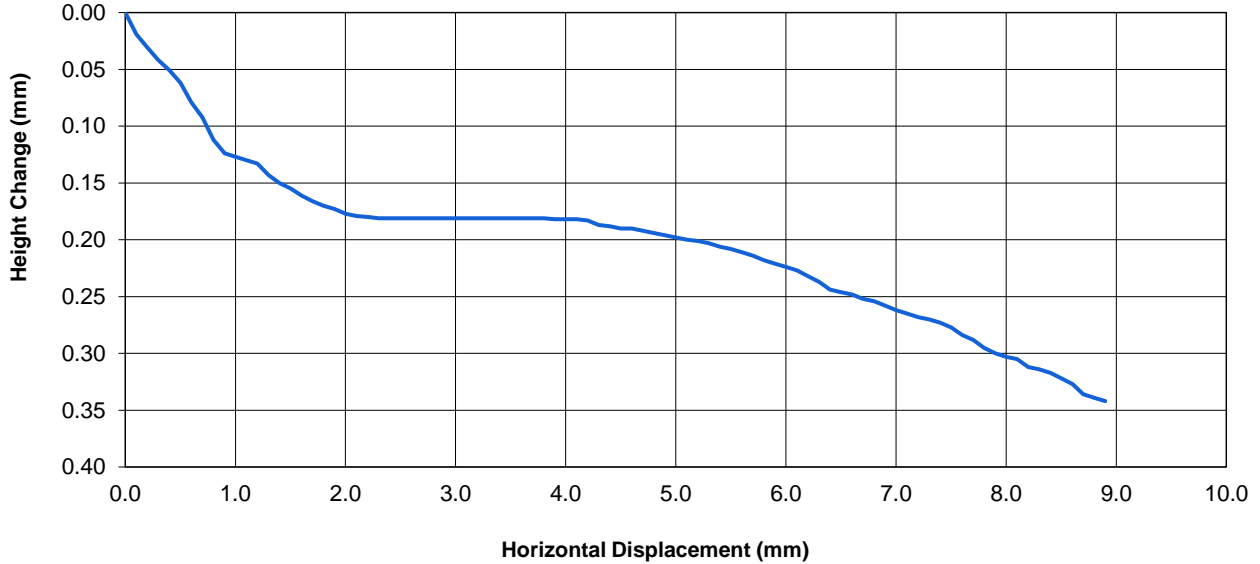
Borehole No BHSP08
Depth (m) 25.50-25.95
Sample Type B

Description:

Grey gravelly fine to medium SAND with rare shell fragments.

Specimen: 2

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
26/07/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

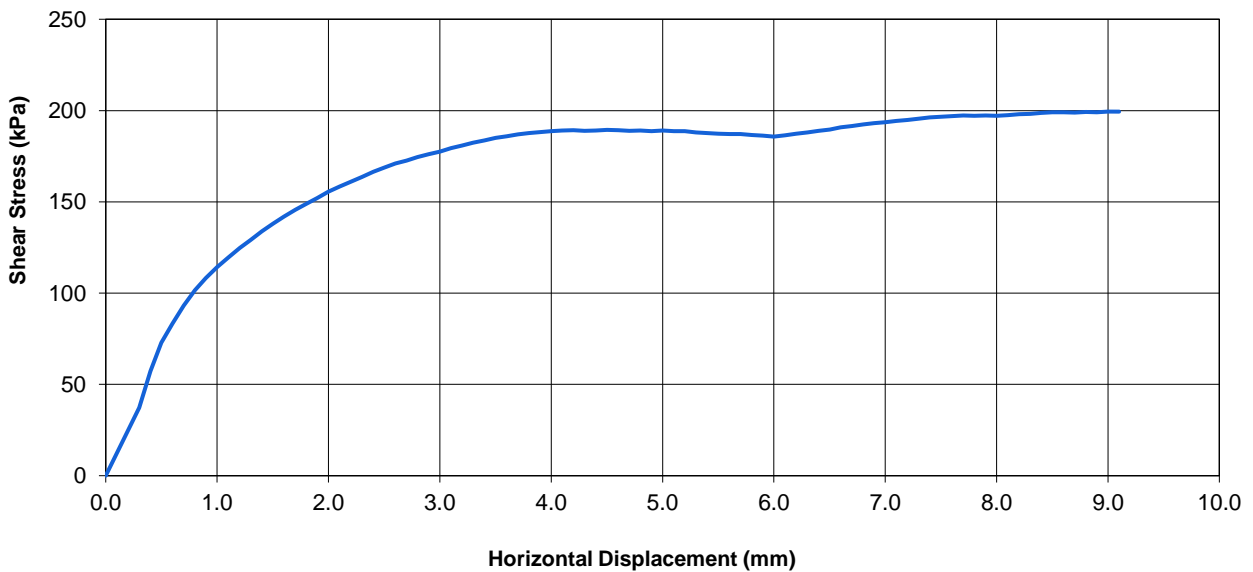
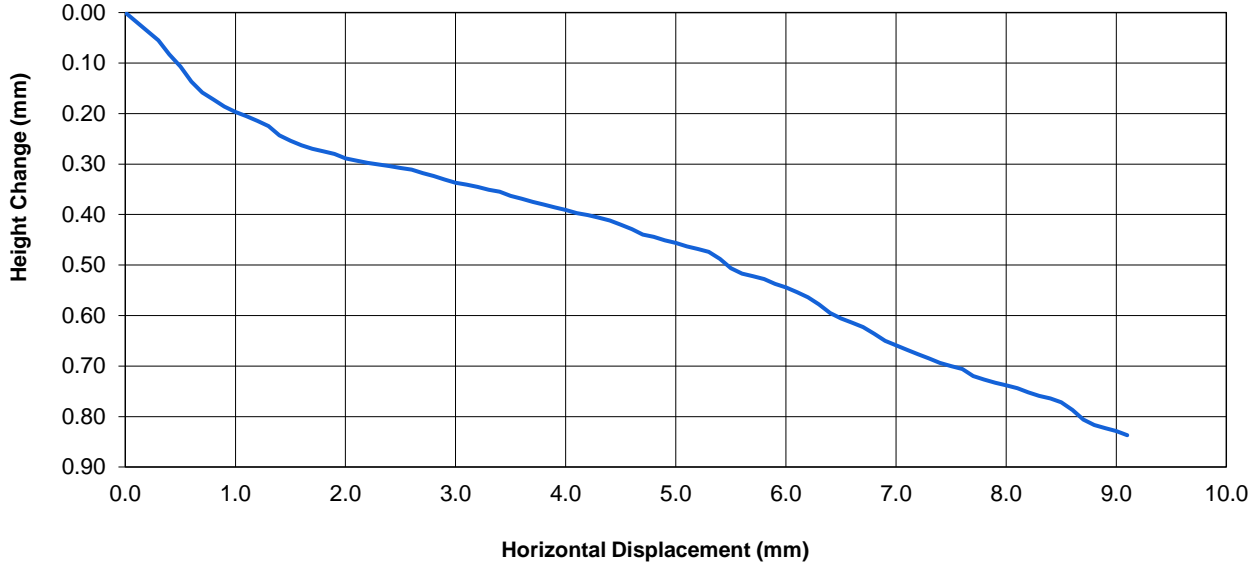
Borehole No BHSP08
Depth (m) 25.50-25.95
Sample Type B

Description:

Grey gravelly fine to medium SAND with rare shell fragments.

Specimen: 3

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
26/07/2023

Project Number:

GEO / 38343

Project Name:

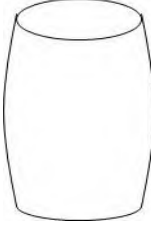
**ARDERSIER PORT
S23053**



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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08	Description: Yellowish brown slightly gravelly SAND. Gravel is fine.
Depth (m): 7.00-7.45	

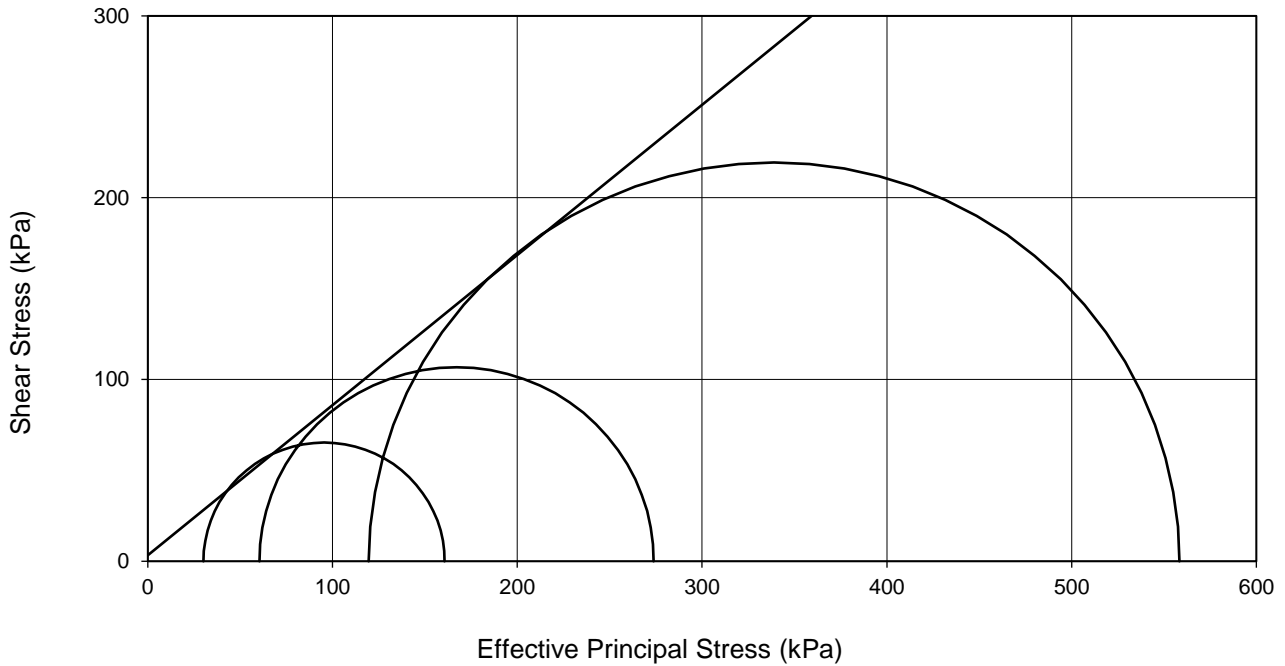
SPECIMEN DETAILS Depth within original sample Remarks	NA Orientation within original sample: NA Remoulded to a target 10.0 % MC and a target dry density of 1.525 Mg/m ³		
TEST DETAILS Specimen Type and Preparation Cell Preparation Specimen Number Initial Diameter <i>mm</i> Initial Length <i>mm</i> Initial Water Content <i>%</i> Initial Wet Density <i>Mg/m³</i> Drainage Conditions	B (Remoulded) Checks performed in accordance with Clause 3.5		
	Multistage		
	One end only		
SATURATION STAGE Final Cell Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Parameter B Duration <i>day(s)</i>	Method: Clause 5.2 630 615 1.00 6		
CONSOLIDATION STAGE Cell Pressure <i>kPa</i> Back Pressure <i>kPa</i> Effective Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Dissipation <i>%</i> Duration <i>day(s)</i>	Stage No 1 630 600 30 600 100 1	Stage No 2 660 600 60 600 100 2	Stage No 3 720 600 120 601 100 0
SHEARING STAGE Cell Pressure <i>kPa</i> Rate of Axial Displacement <i>mm/min</i> Initial Pore Pressure <i>kPa</i> Initial Effective Stress <i>kPa</i>	630 0.015 600 30	660 0.012 600 60	720 0.015 601 119
CONDITIONS AT FAILURE <i>criteria</i> Pore Pressure <i>kPa</i> Minor Effective Principal Stress <i>kPa</i> Deviator Stress <i>kPa</i> Major Effective Principal Stress <i>kPa</i> Volume Change <i>mL</i> Volumetric Strain <i>%</i> Axial Strain <i>%</i> Membrane correction applied to Deviator Stress <i>kPa</i> Duration <i>day(s)</i>	Maximum deviator stress		
	600 30 131 161 -2.78 -0.5 1.1 0 1	600 60 213 273 -2.80 -0.5 3.4 0 1	600 120 439 559 -6.95 -1.3 4.1 0 1
Final Water Content <i>%</i> Final Wet Density <i>Mg/m³</i>	26.0 1.95		
EFFECTIVE STRESS PARAMETERS Cohesion <i>kPa</i> Angle of Shear Resistance <i>degrees</i>	3.3 39.5		
FAILURE SKETCH			

Checked and Approved by  P Heritage - Project Manager 05/09/2023	Project Number: GEO / 38343 Project Name: ARDERSIER PORT S23053	
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 7.00-7.45

Description:
Yellowish brown slightly gravelly SAND. Gravel is fine.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

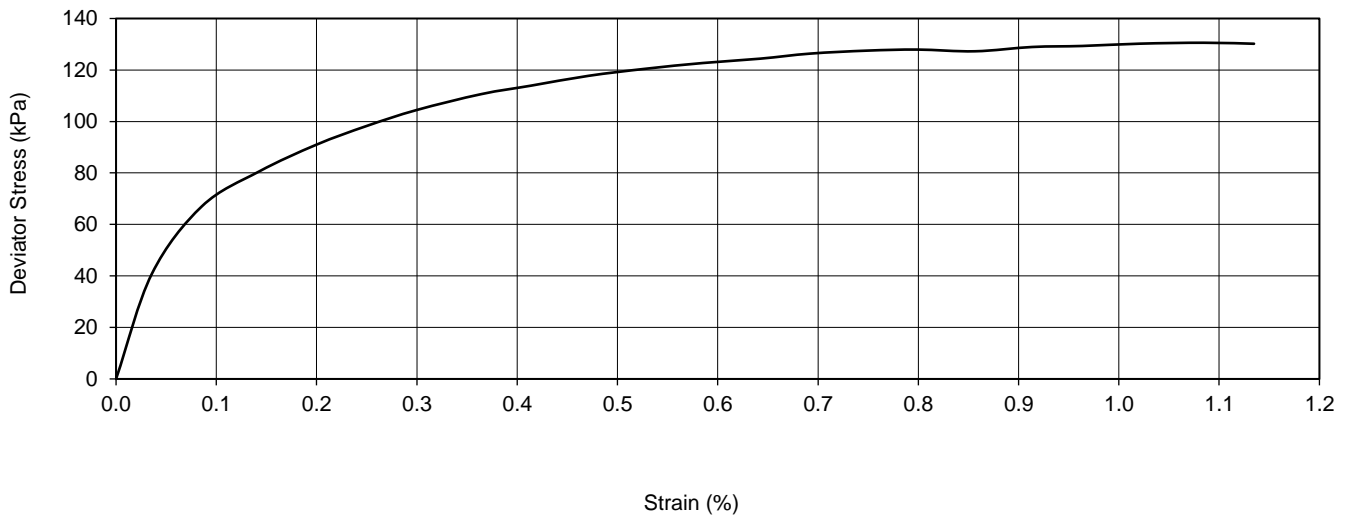
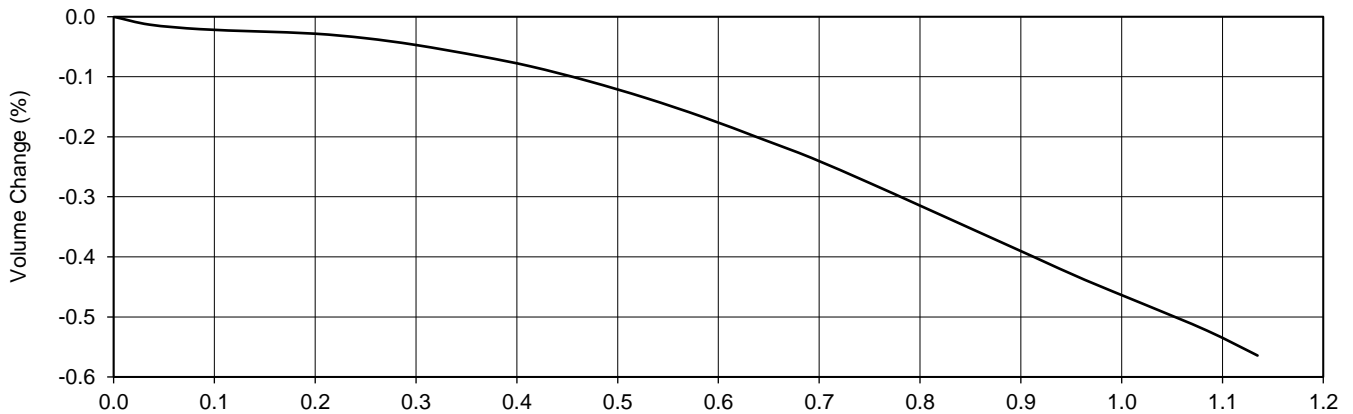
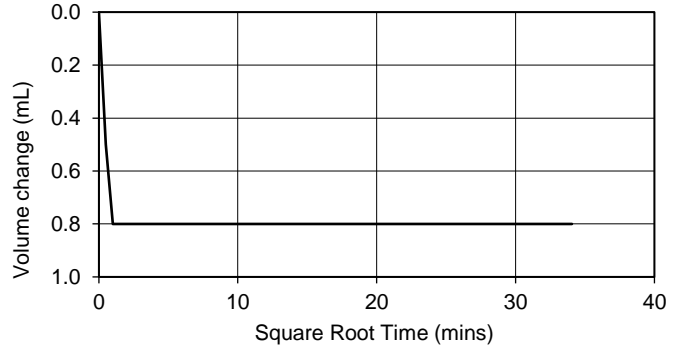
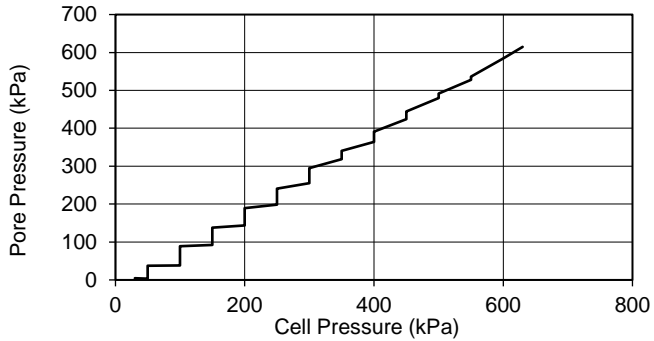
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 7.00-7.45

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

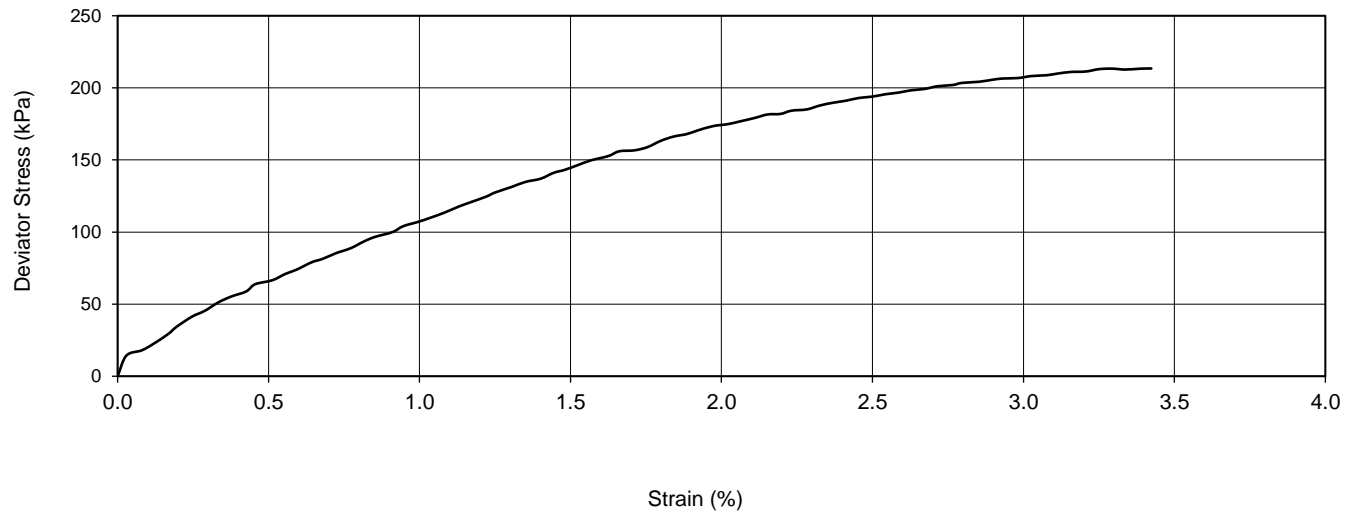
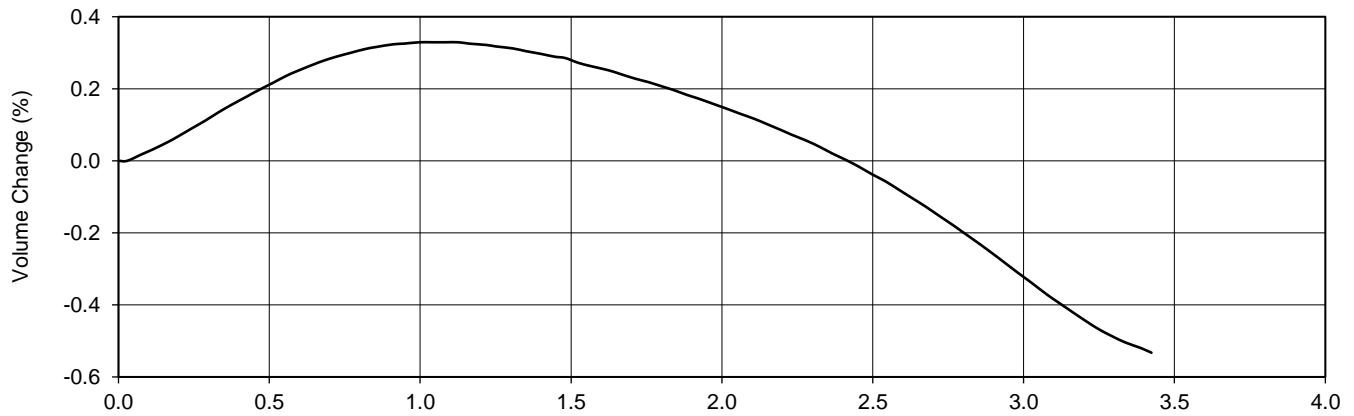
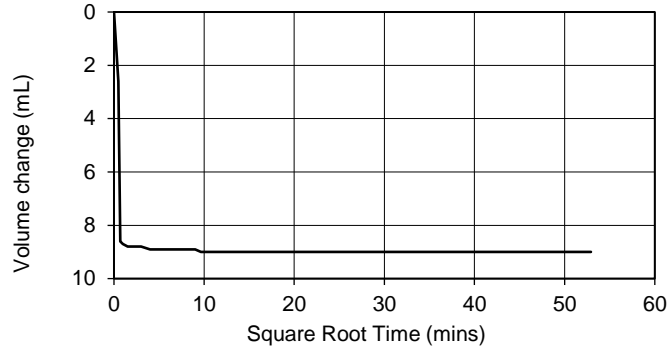
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 7.00-7.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

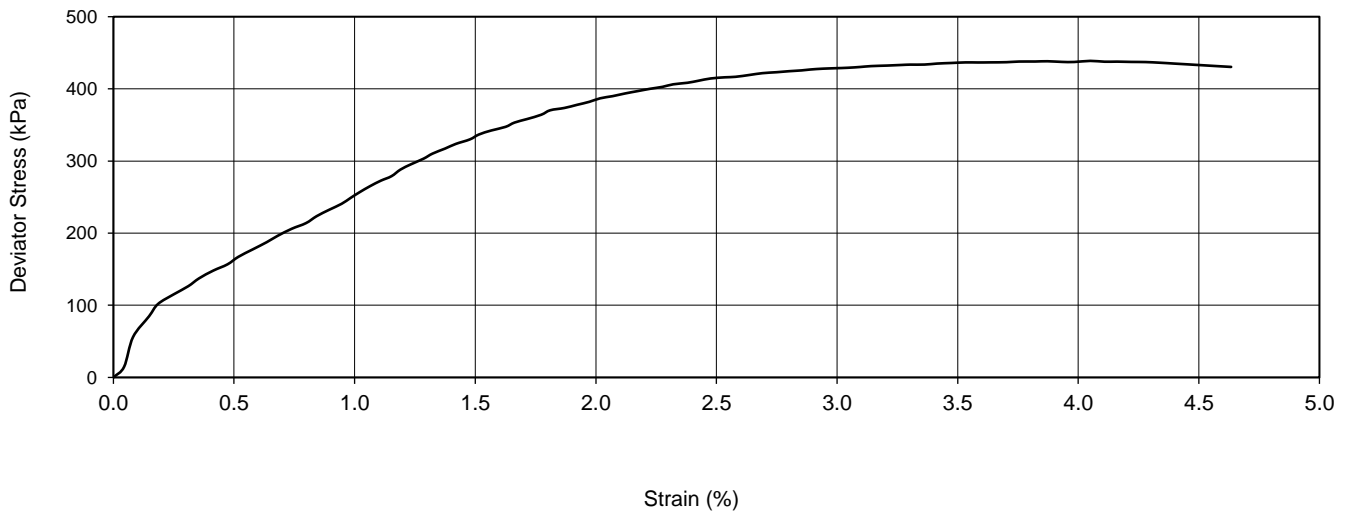
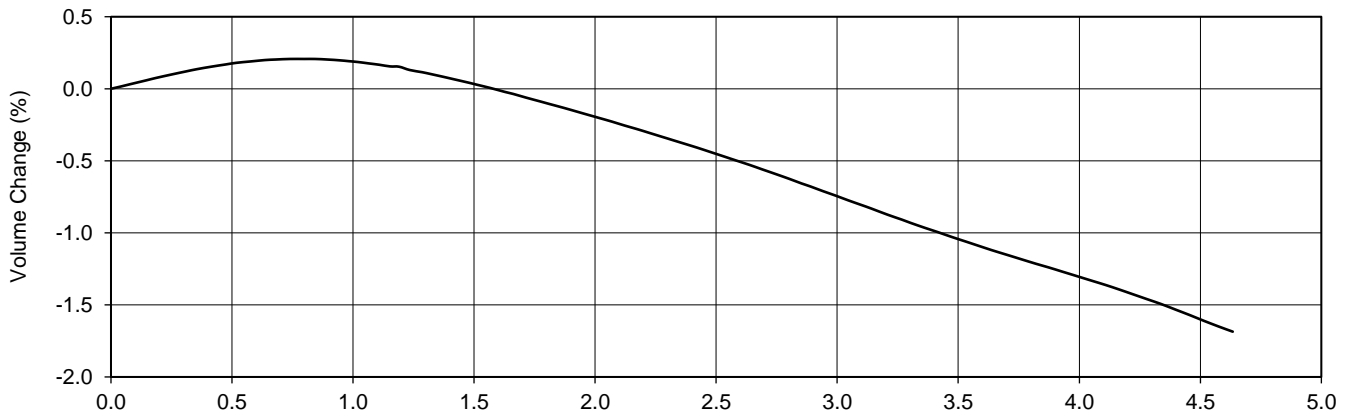
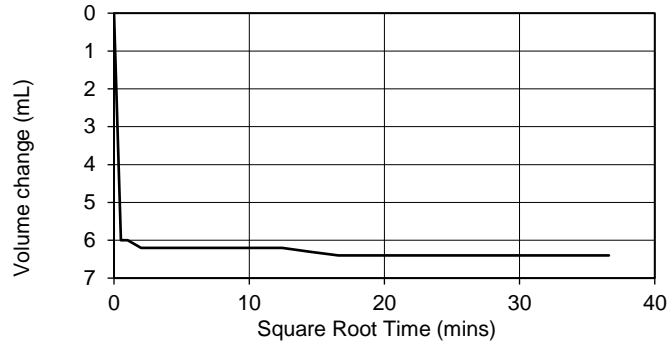
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 7.00-7.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

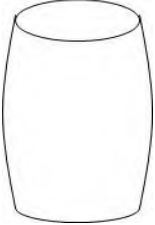
**ARDERSIER PORT
S23053**



GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08	Description: Dark grey slightly gravelly SAND. Gravel is fine.
Depth (m): 18.00-18.45	

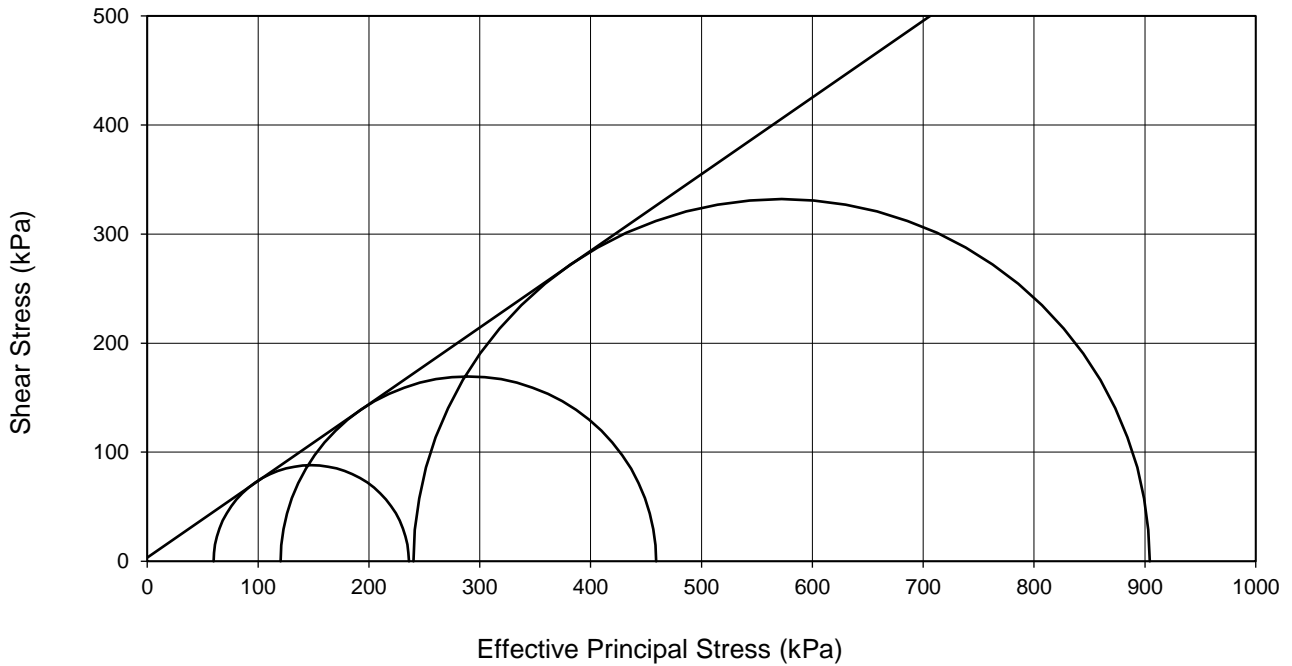
SPECIMEN DETAILS Depth within original sample Remarks	NA Orientation within original sample: NA Remoulded to a target 10.0 % MC and a target dry density of 1.373 Mg/m ³		
TEST DETAILS Specimen Type and Preparation Cell Preparation Specimen Number Initial Diameter <i>mm</i> Initial Length <i>mm</i> Initial Water Content <i>%</i> Initial Wet Density <i>Mg/m³</i> Drainage Conditions	B (Remoulded) Checks performed in accordance with Clause 3.5		
	Multistage		
	69.54	140.19	10.5
	1.52	One end only	
SATURATION STAGE Final Cell Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Parameter B Duration <i>day(s)</i>	Method: Clause 5.2 660 644 1.00 6		
CONSOLIDATION STAGE Cell Pressure <i>kPa</i> Back Pressure <i>kPa</i> Effective Pressure <i>kPa</i> Final Pore Pressure <i>kPa</i> Final Pore Pressure Dissipation <i>%</i> Duration <i>day(s)</i>	Stage No 1 660 600 60 600 100 1	Stage No 2 720 600 120 600 100 1	Stage No 3 840 600 240 600 100 1
SHEARING STAGE Cell Pressure <i>kPa</i> Rate of Axial Displacement <i>mm/min</i> Initial Pore Pressure <i>kPa</i> Initial Effective Stress <i>kPa</i>	660 0.015 600 60	720 0.015 600 120	840 0.020 600 240
CONDITIONS AT FAILURE <i>criteria</i> Pore Pressure <i>kPa</i> Minor Effective Principal Stress <i>kPa</i> Deviator Stress <i>kPa</i> Major Effective Principal Stress <i>kPa</i> Volume Change <i>mL</i> Volumetric Strain <i>%</i> Axial Strain <i>%</i> Membrane correction applied to Deviator Stress <i>kPa</i> Duration <i>day(s)</i>	Maximum deviator stress		
	600 60 176 236 -0.20 0.0 1.7 0 1	600 120 339 459 -1.61 -0.3 2.5 0 1	600 240 664 904 -1.18 -0.2 3.5 0 1
Final Water Content <i>%</i> Final Wet Density <i>Mg/m³</i>	31.2 1.84		
EFFECTIVE STRESS PARAMETERS Cohesion <i>kPa</i> Angle of Shear Resistance <i>degrees</i>	3.3 35		
FAILURE SKETCH			

Checked and Approved by  P Heritage - Project Manager 05/09/2023	Project Number: GEO / 38343 Project Name: ARDERSIER PORT S23053	 
--	--	--

Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 18.00-18.45

Description:
Dark grey slightly gravelly SAND. Gravel is fine.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

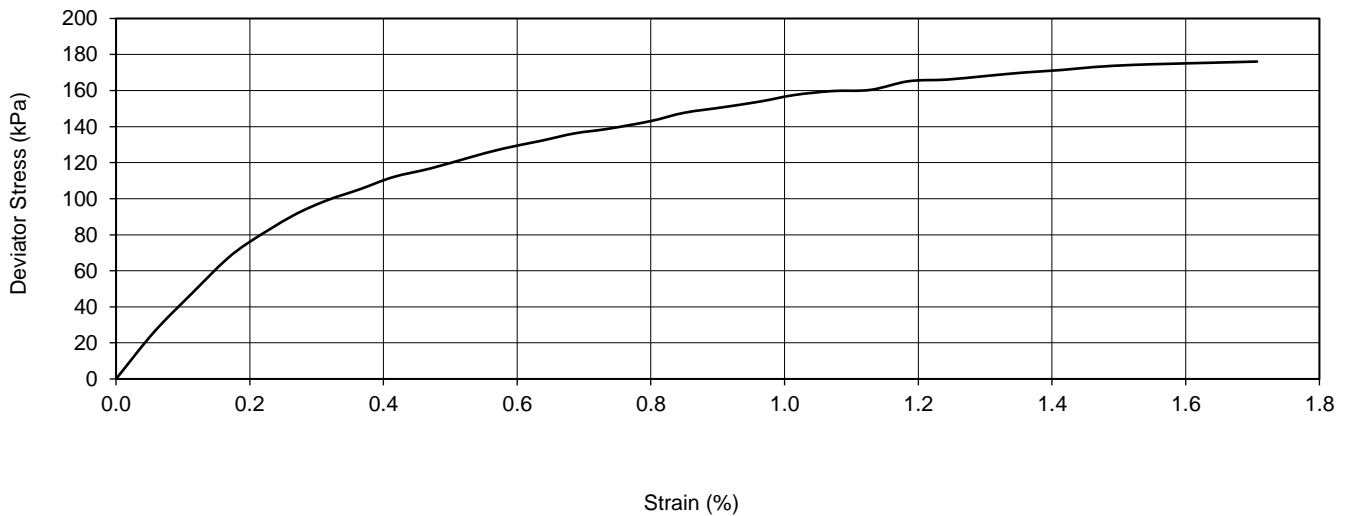
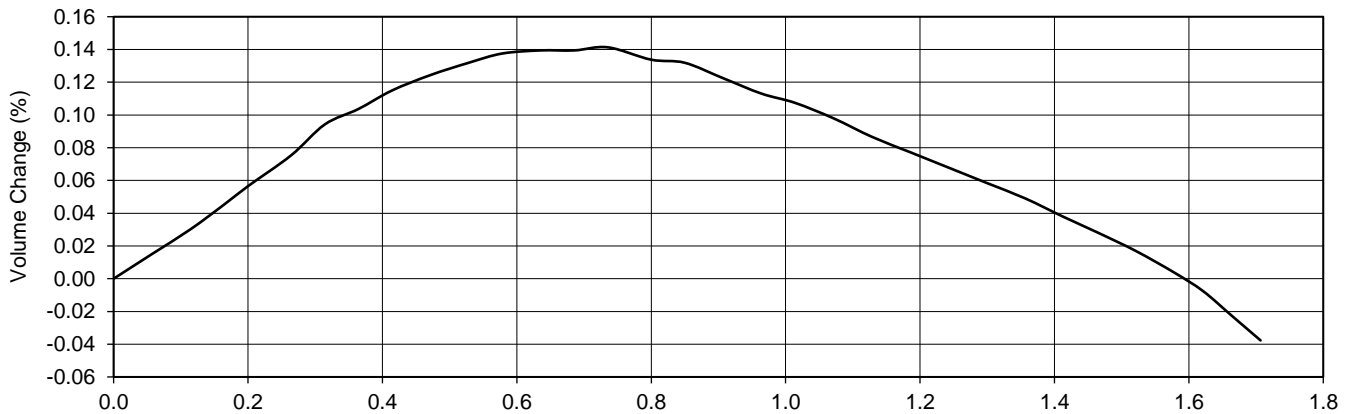
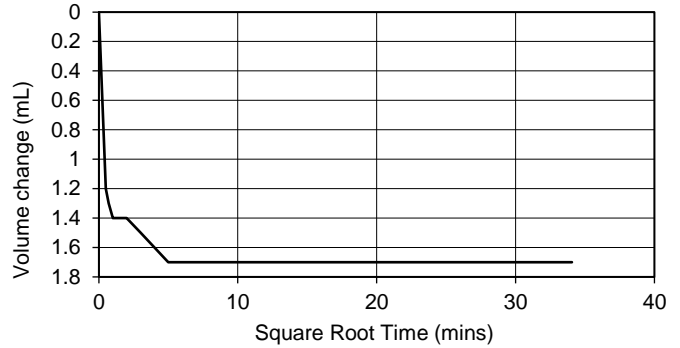
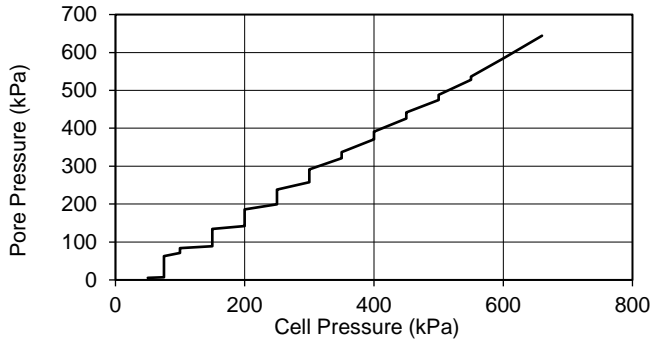
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 18.00-18.45

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

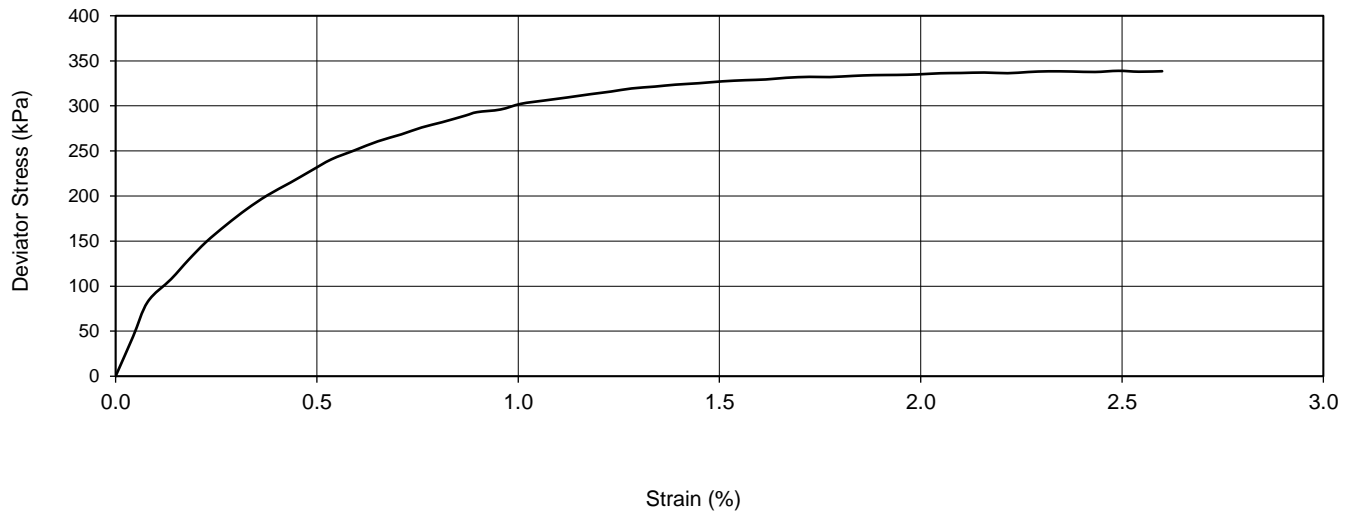
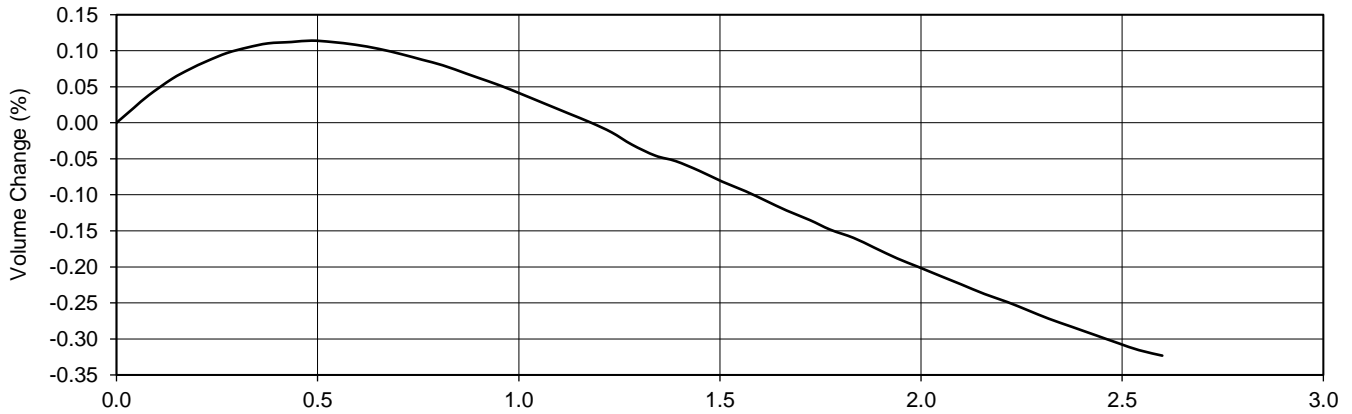
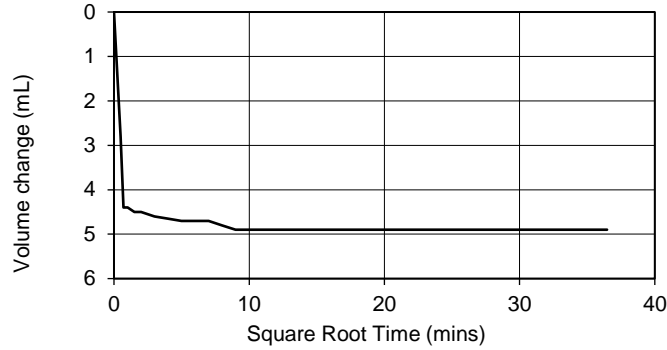
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 18.00-18.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

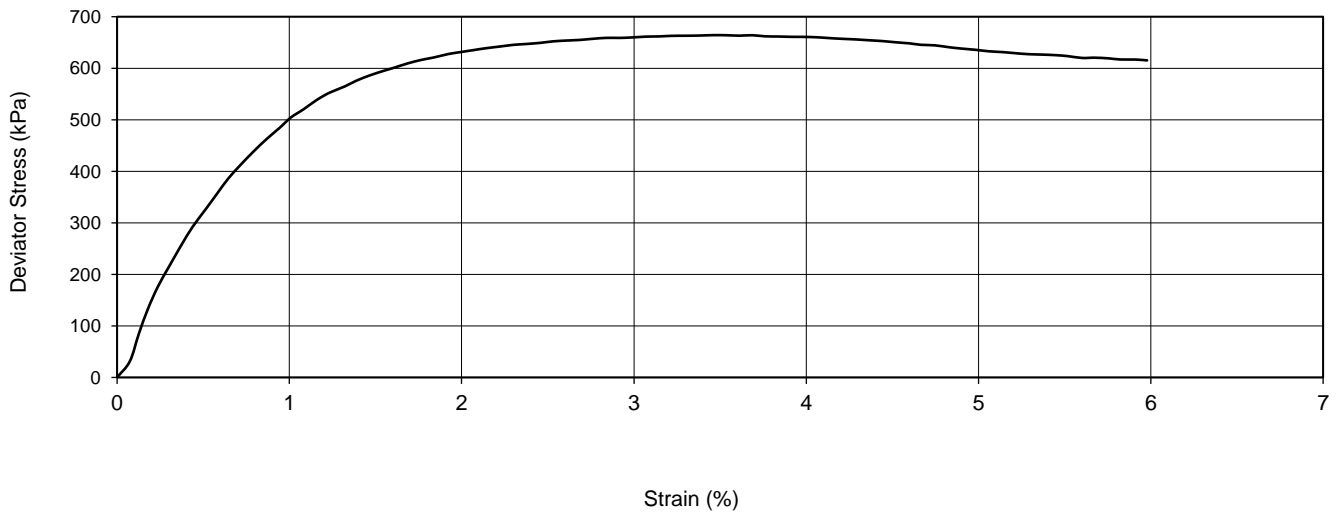
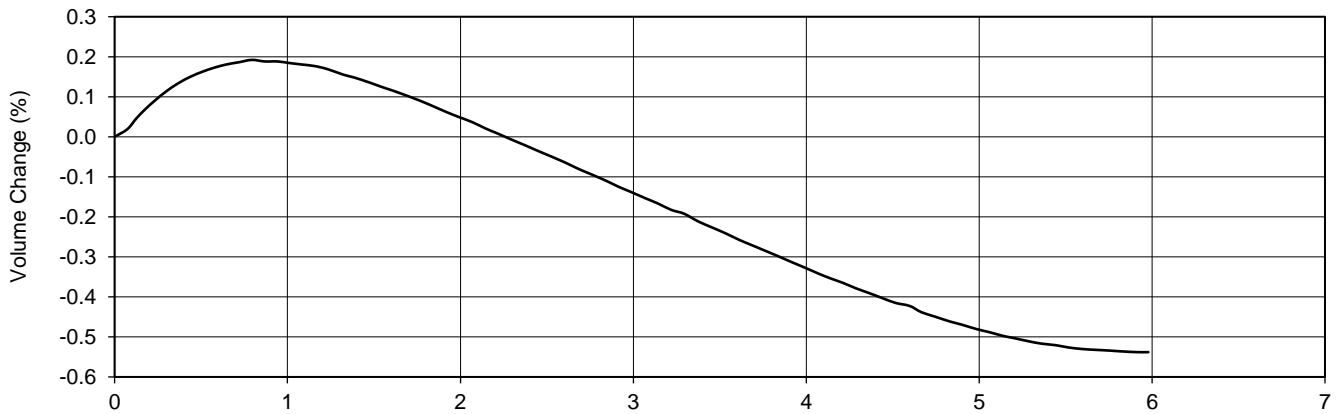
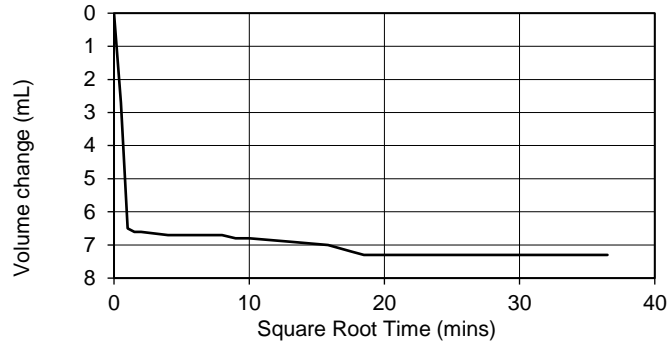
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP08
Depth (m): 18.00-18.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
05/09/2023

Project Number:

GEO / 38343

Project Name:

**ARDERSIER PORT
S23053**

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 web: www.geolabs.co.uk

Solmek
 12 Yarm Road
 Stockton-on-Tees
 TS18 3NA

06 September 2023

Report No : GEO/38342/01

Page 1 of 1

For the attention of Mr A Cutts

		Date samples received	22/06/2023
		Date written instructions received	27/06/2023
Our ref	GEO / 38342	Date testing commenced	28/06/2023
Your Ref	S230503	Date of sample disposal	04/10/2023
Project	ARDERSIER PORT		

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

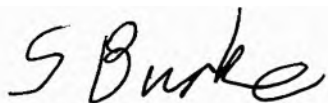
Item No	Test Quantity	Description
1	5	Maximum & Minimum Density
2	3	Shear Strength by Direct Shear
3	2	Isotropic Consolidated Drained Multistage Triaxial Compression (CIDM)

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
 on behalf of **GEOLABS Limited**



S Burke
 Senior Technician



1402 - JIP Max-Min BHSP09 06.00 B - 38342-490775.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP09
Depth (m)	6.00-6.45
Sample Type	B

Description:
Brown and greyish brown gravelly fine to medium SAND. Gravel is medium to coarse.

Percentage of material retained on the 2 mm test sieve 11.3 %
The fines content was measured to be 3.2 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.65 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.646	g/cm ³
Maximum dry density after surcharge application	1.658	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	


Determination No 2

Maximum dry density before surcharge application	1.636	g/cm ³
Maximum dry density after surcharge application	1.649	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

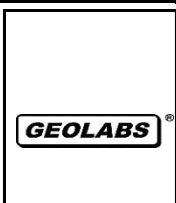
Minimum Dry Density

Minimum Dry Density **1.20 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	532.97 g
	2	534.62 g
	3	534.78 g
	4	533.87 g
	5	534.88 g
	Minimum	534.22 g

Checked and Approved by

C F Wallace - Technical Director
19/07/2023

Project Number: **38342**
Project Name: **ARDERSIER PORT
S230503**



Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Location</td> <td>BHSP09</td> </tr> <tr> <td>Depth (m)</td> <td>12.00-12.45</td> </tr> <tr> <td>Sample Type</td> <td>B</td> </tr> </table>	Location	BHSP09	Depth (m)	12.00-12.45	Sample Type	B	Description: Brown and brownish grey slightly silty gravelly fine to medium SAND.
Location	BHSP09						
Depth (m)	12.00-12.45						
Sample Type	B						

Percentage of material retained on the 2 mm test sieve 12.3 %
 The fines content was measured to be 1.7 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.64 g/cm³**
 (after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.607	g/cm ³
Maximum dry density after surcharge application	1.630	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Determination No 2

Maximum dry density before surcharge application	1.627	g/cm ³
Maximum dry density after surcharge application	1.643	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.22 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	541.32 g
	2	542.99 g
	3	543.35 g
	4	542.18 g
	5	543.86 g
	Minimum	542.74 g

Checked and Approved by C F Wallace - Technical Director <small>19/07/2023</small>	Project Number: 38342 Project Name: ARDERSIER PORT S230503	
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Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Location</td> <td>BHSP09</td> </tr> <tr> <td>Depth (m)</td> <td>15.00-15.45</td> </tr> <tr> <td>Sample Type</td> <td>B</td> </tr> </table>	Location	BHSP09	Depth (m)	15.00-15.45	Sample Type	B	Description: Brown and greyish brown gravelly fine to medium SAND.
Location	BHSP09						
Depth (m)	15.00-15.45						
Sample Type	B						

Percentage of material retained on the 2 mm test sieve 11.3 %
 The fines content was measured to be 3.2 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.65 g/cm³**
 (after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.646	g/cm ³
Maximum dry density after surcharge application	1.658	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	



Determination No 2

Maximum dry density before surcharge application	1.636	g/cm ³
Maximum dry density after surcharge application	1.649	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.20 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	532.97 g
	2	534.62 g
	3	534.78 g
	4	533.87 g
	5	534.88 g
	Minimum	534.22 g

Checked and Approved by  C F Wallace - Technical Director 19/07/2023	Project Number: 38342 Project Name: ARDERSIER PORT S230503	
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1402 - JIP Max-Min BHSP09 21.00 B - 38342-490774.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP09
Depth (m)	21.00-21.45
Sample Type	B

Description:
Grey and greyish brown slightly silty gravelly fine to medium SAND.

Percentage of material retained on the 2 mm test sieve 26.1 % **(please note)**
The fines content was measured to be 2.6 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.71 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.694	g/cm ³
Maximum dry density after surcharge application	1.710	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	


Determination No 2

Maximum dry density before surcharge application	1.690	g/cm ³
Maximum dry density after surcharge application	1.705	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.24 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.11	g
	Run	
Mass of sand	1	551.11 g
	2	550.69 g
	3	553.71 g
	4	552.05 g
	5	553.00 g
	Minimum	552.11 g

Checked and Approved by

C F Wallace - Technical Director
19/07/2023

Project Number: **38342**
Project Name: **ARDERSIER PORT
S230503**



1402 - JIP Max-Min BHSP09 23.00 B - 38342-490776.XL-SM

Determination of Maximum and Minimum Dry Density of Sands

NGI-Geolabs Recommended Method Statement (As published in 'Development of new robust procedures for the determination of maximum and minimum dry densities of sand' by Knudsen.S et al at ISFOG 2020 {delayed publication})

Location	BHSP09
Depth (m)	23.00
Sample Type	B

Description:
Brownish grey gravelly fine to medium SAND. Gravel is medium to coarse.

Percentage of material retained on the 2 mm test sieve 5.4 %
The fines content was measured to be 2.3 %, so within the 12 % permitted fines

Maximum Dry Density

Mean Maximum Dry Density **1.60 g/cm³**
(after surcharge application)

Determination No 1

Maximum dry density before surcharge application	1.590	g/cm ³
Maximum dry density after surcharge application	1.602	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	


Determination No 2

Maximum dry density before surcharge application	1.590	g/cm ³
Maximum dry density after surcharge application	1.602	g/cm ³
Shaker amplitude setting before surcharge application	2	
Shaker amplitude setting after surcharge application	2	

Minimum Dry Density

Minimum Dry Density **1.21 g/cm³**

Water calibrated volume of the mould	443.90	cm ³
Mass of the mould	897.12	g
	Run	
Mass of sand	1	537.27 g
	2	538.16 g
	3	538.88 g
	4	539.02 g
	5	538.80 g
	Minimum	538.43 g

Checked and Approved by

C F Wallace - Technical Director
19/07/2023

Project Number: **38342**
Project Name: **ARDERSIER PORT
S230503**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP09
 Depth (m) 6.00-6.45
 Sample Type B

Description:

Brown gravelly fine to medium SAND. Gravel is fine.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 80% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	59.94	59.94	59.94
Width	<i>mm</i>	60.04	60.04	60.04
Height	<i>mm</i>	21.80	21.84	21.92
Initial water content	%	7.8	7.8	7.8
Initial bulk density	<i>Mg/m³</i>	1.66	1.65	1.65
Initial dry density	<i>Mg/m³</i>	1.54	1.53	1.53
Initial voids ratio		0.724	0.727	0.734
Degree of Saturation	%	28.6	28.4	28.2

Shearing Stage

Normal stress *kPa* 25 50 100

Peak Conditions:

Rate of horizontal displacement	<i>mm/min</i>	0.18	0.18	0.18
Maximum shear stress	<i>kPa</i>	21.0	41.1	80.7
Horizontal displacement at MSS	<i>mm</i>	0.3	0.6	0.7
Vertical Displacement at Peak	<i>mm</i>	-0.10	-0.13	-0.13

Final water content	%	20.2	19.7	19.5
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

		Peak Condition
Apparent Cohesion	<i>kPa</i>	1
Angle of Shearing Resistance	<i>degrees</i>	38.5

Notes: ¹ Maximum dry density = 1.65 Mg/m³ and minimum dry density = 1.20 Mg/m³

Tested by JJR
 Checked and Approved by

P. Heritage

P Heritage - Project Manager
 03/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
 S230503**

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DIRECT SHEAR TEST – SHEARBOX

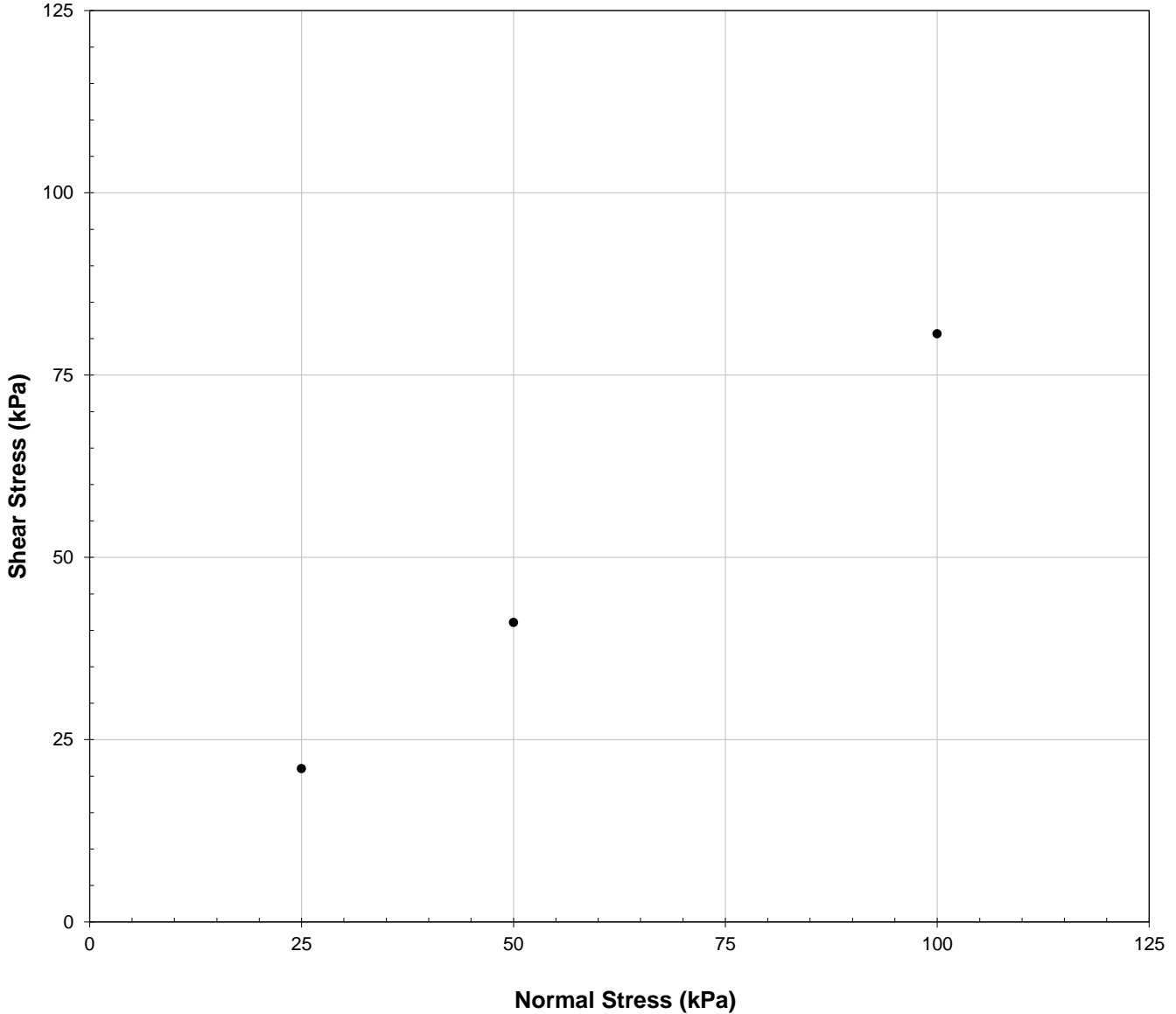
(small shearbox apparatus)

Borehole No BHSP09
Depth (m) 6.00-6.45
Sample Type B

Description:

Brown gravelly fine to medium SAND. Gravel is fine.

Shear Stress v Normal Stress



Peak: $c' = 1$
 $\Phi' = 38.5$

Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
03/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

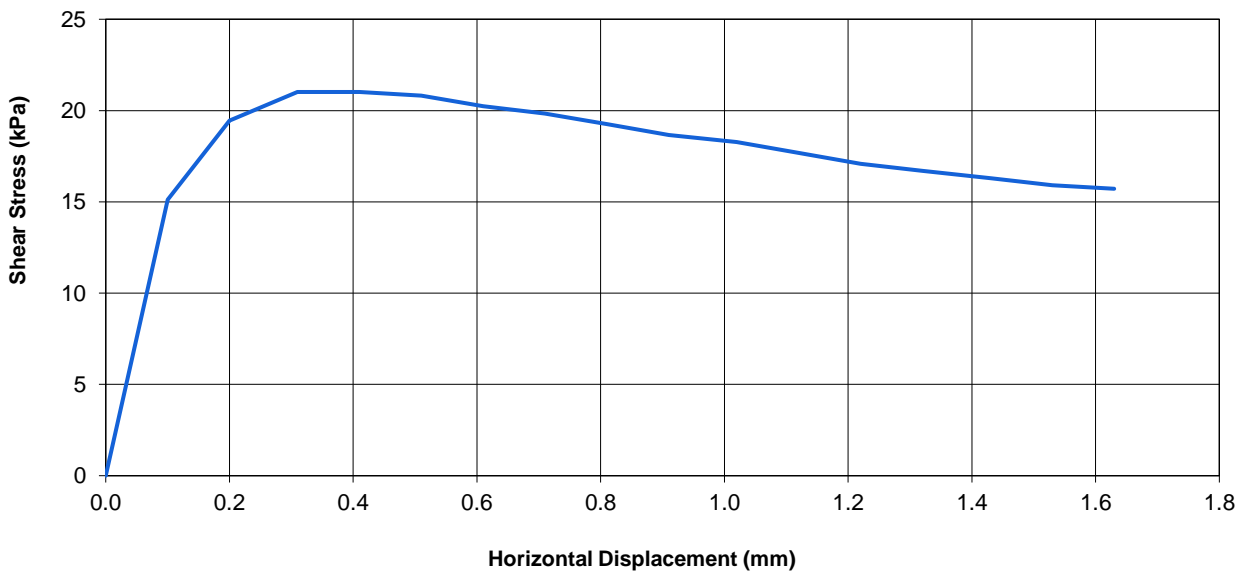
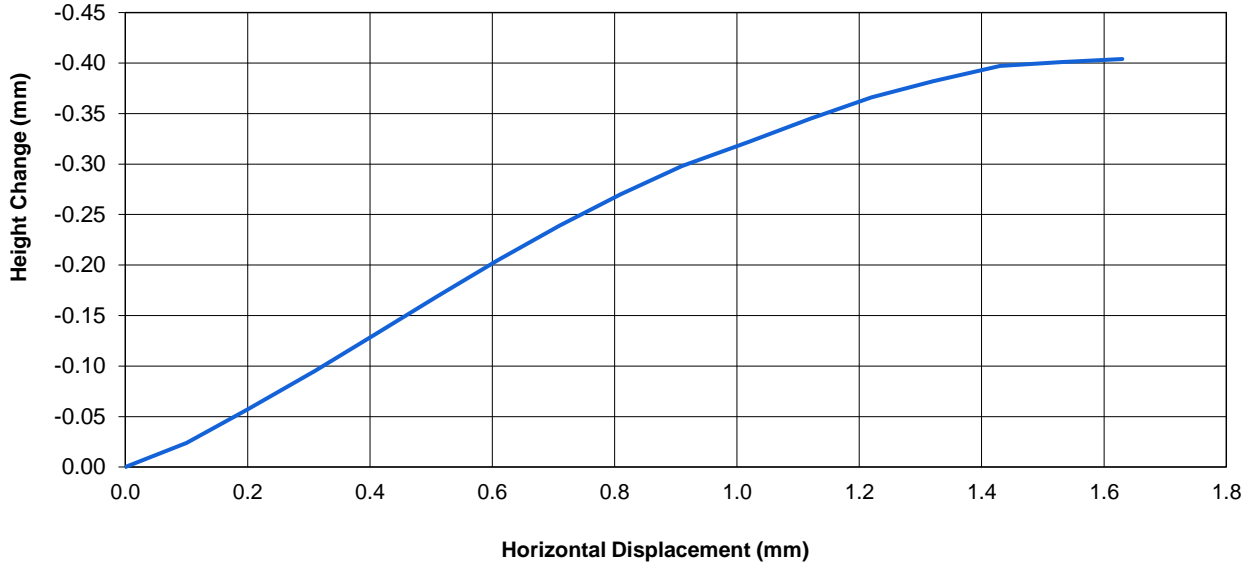
Borehole No BHSP09
Depth (m) 6.00-6.45
Sample Type B

Description:

Brown gravelly fine to medium SAND. Gravel is fine.

Specimen: 1

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
03/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

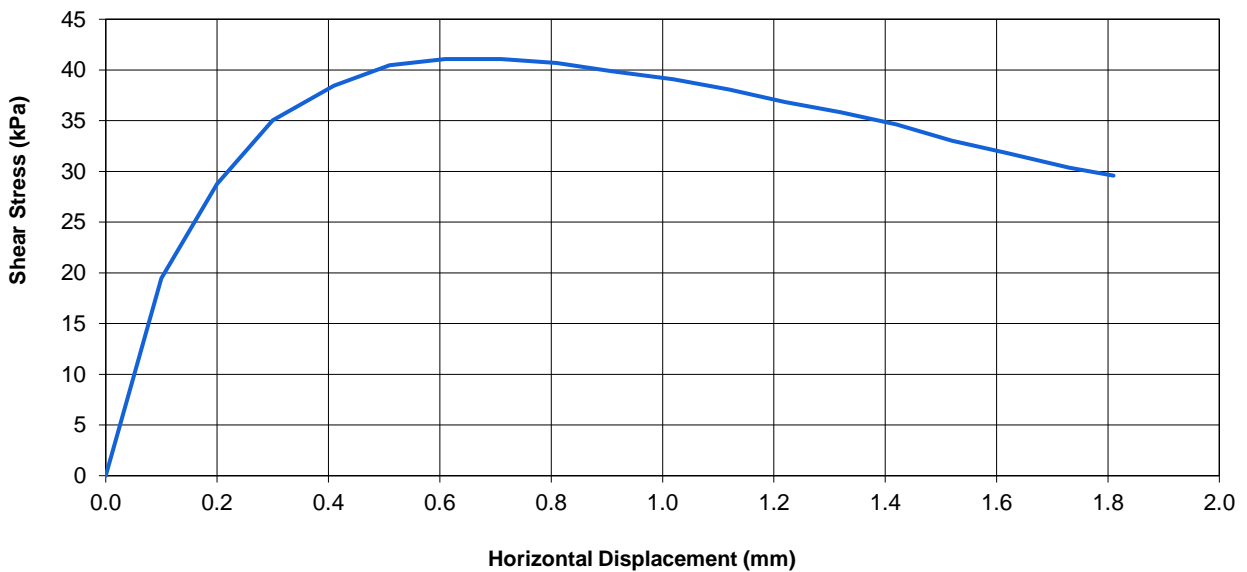
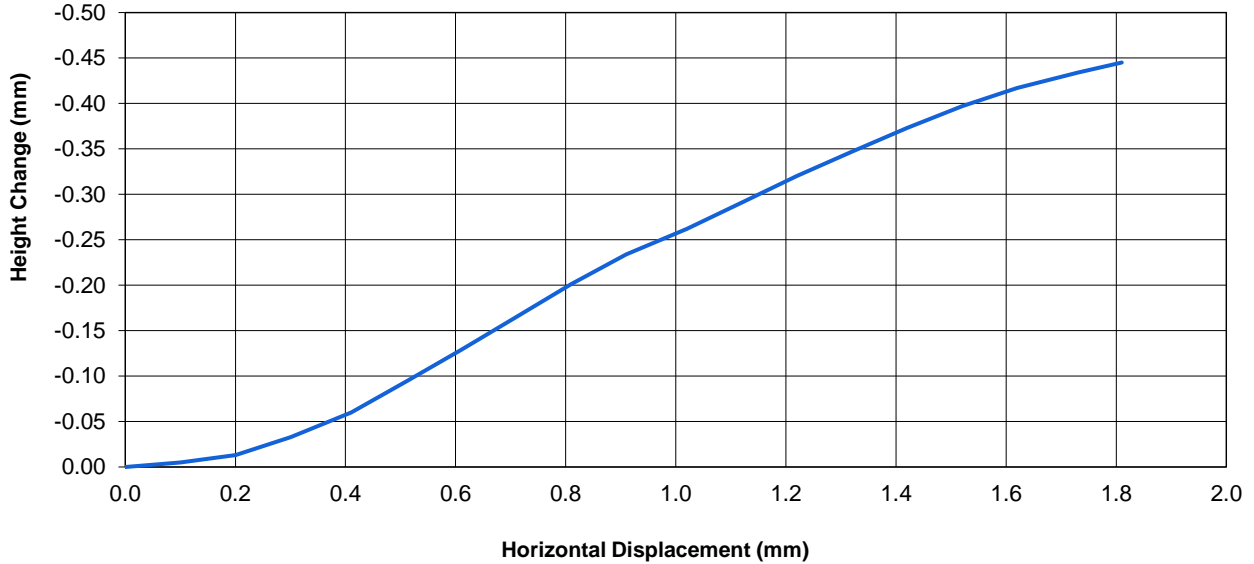
(small shearbox apparatus)


Borehole No BHP09
 Depth (m) 6.00-6.45
 Sample Type B

Description:
 Brown gravelly fine to medium SAND. Gravel is fine.

Specimen: 2

Shear Stage



Tested by JJR
 Checked and Approved by

 P Heritage - Project Manager
 03/08/2023

Project Number:
GEO / 38342
 Project Name:
ARDERSIER PORT
S230503



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

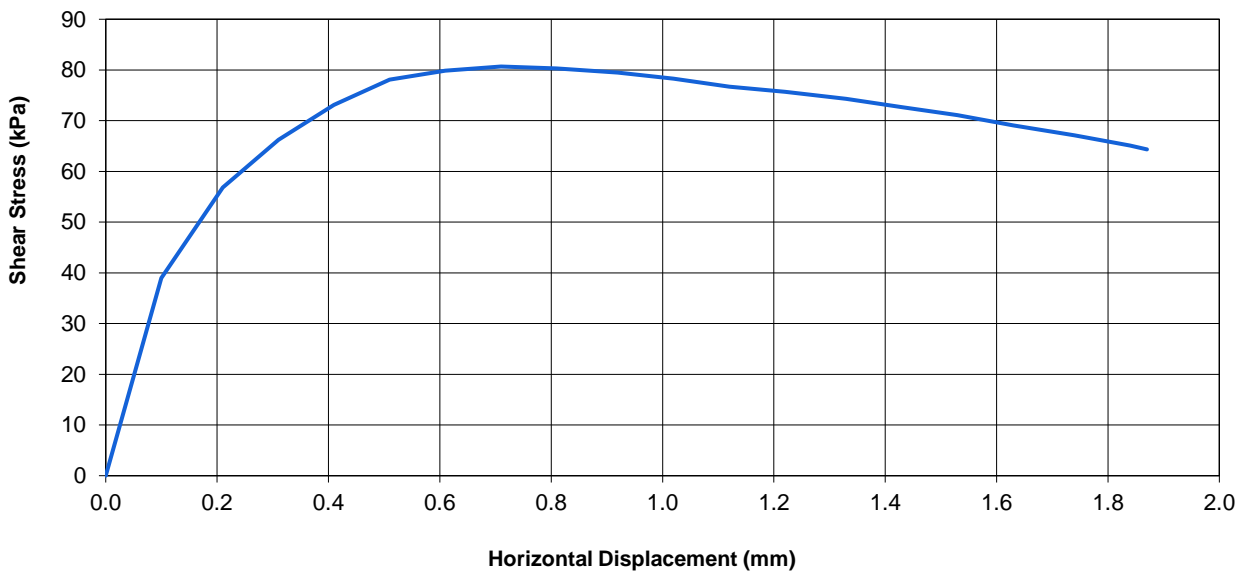
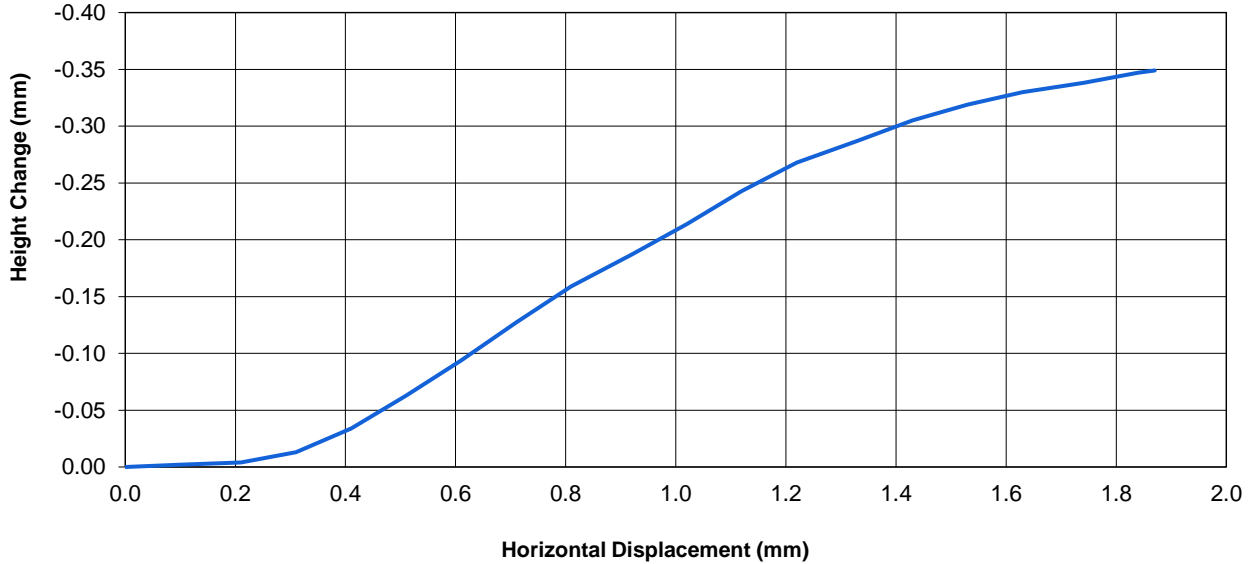
Borehole No BHSP09
Depth (m) 6.00-6.45
Sample Type B

Description:

Brown gravelly fine to medium SAND. Gravel is fine.

Specimen: 3

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
03/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP09
 Depth (m) 15.00-15.45
 Sample Type B

Description:

Greyish brown gravelly fine to medium SAND.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 75% ¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	60.04	60.05	60.05
Width	<i>mm</i>	60.00	60.00	60.01
Height	<i>mm</i>	23.10	22.93	23.16
Initial water content	%	20.1	20.1	20.1
Initial bulk density	<i>Mg/m³</i>	1.80	1.82	1.80
Initial dry density	<i>Mg/m³</i>	1.50	1.51	1.50
Initial voids ratio		0.766	0.753	0.771
Degree of Saturation	%	69.6	70.8	69.2

Shearing Stage

Normal stress	<i>kPa</i>	45	90	180
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.18	0.18	0.18
Maximum shear stress	<i>kPa</i>	38.7	69.6	130.0
Horizontal displacement at MSS	<i>mm</i>	4.2	6.8	3.5
Vertical Displacement at Peak	<i>mm</i>	0.02	0.59	0.20

Final water content	%	26.1	24.8	25.6
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		9
Angle of Shearing Resistance	<i>degrees</i>	34.0

Notes: ¹ Maximum dry density = 1.65 Mg/m³ and minimum dry density = 1.20 Mg/m³

Tested by JJR
 Checked and Approved by

P. Heritage

P Heritage - Project Manager
 04/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
 S230503**

GEOLABS®



DIRECT SHEAR TEST – SHEARBOX

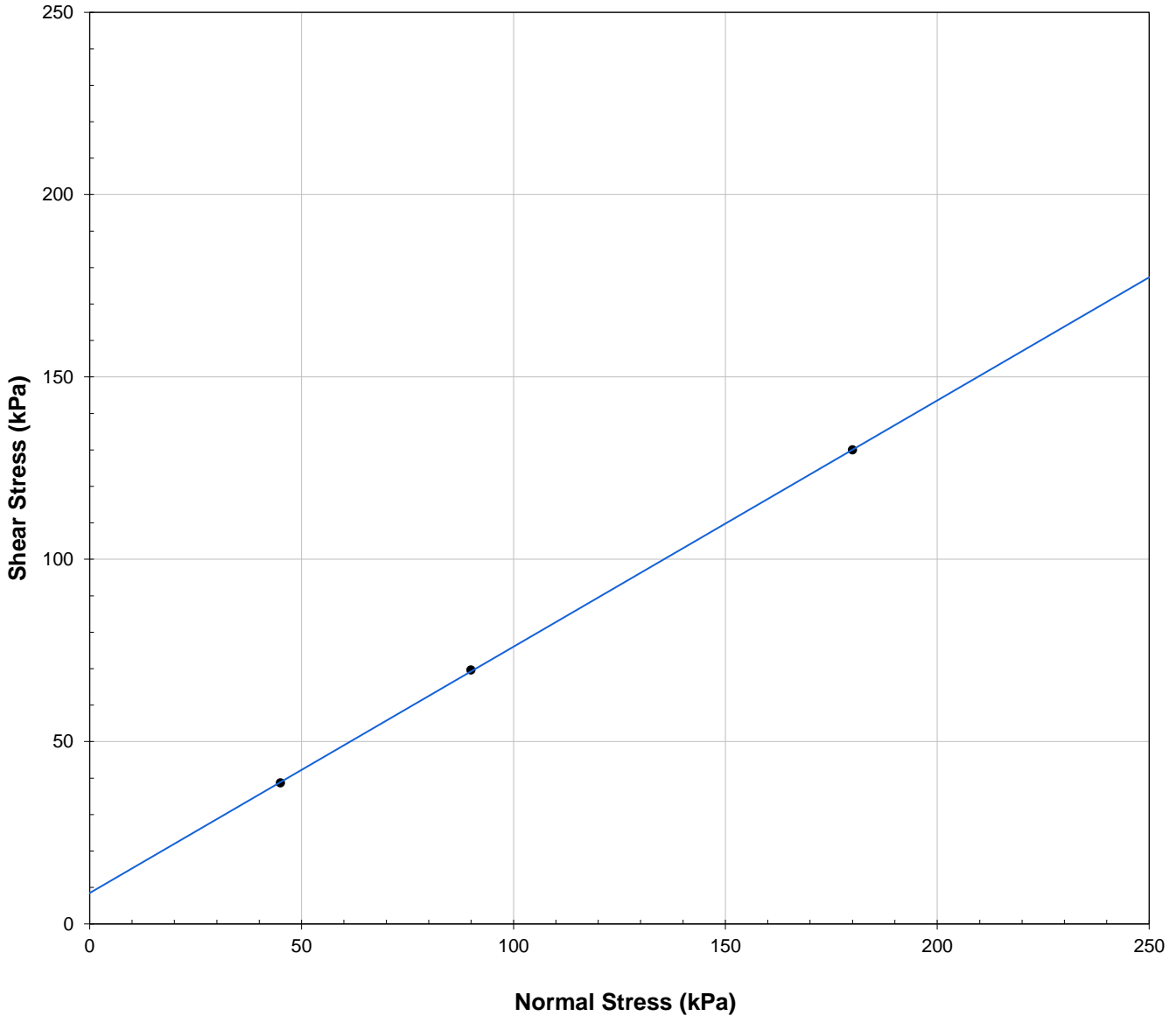
(small shearbox apparatus)

Borehole No BHSP09
Depth (m) 15.00-15.45
Sample Type B

Description:

Greyish brown gravelly fine to medium SAND.

Shear Stress v Normal Stress



Peak: $c' = 9$
 $\Phi' = 34.0$

Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

GEOLABS®



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

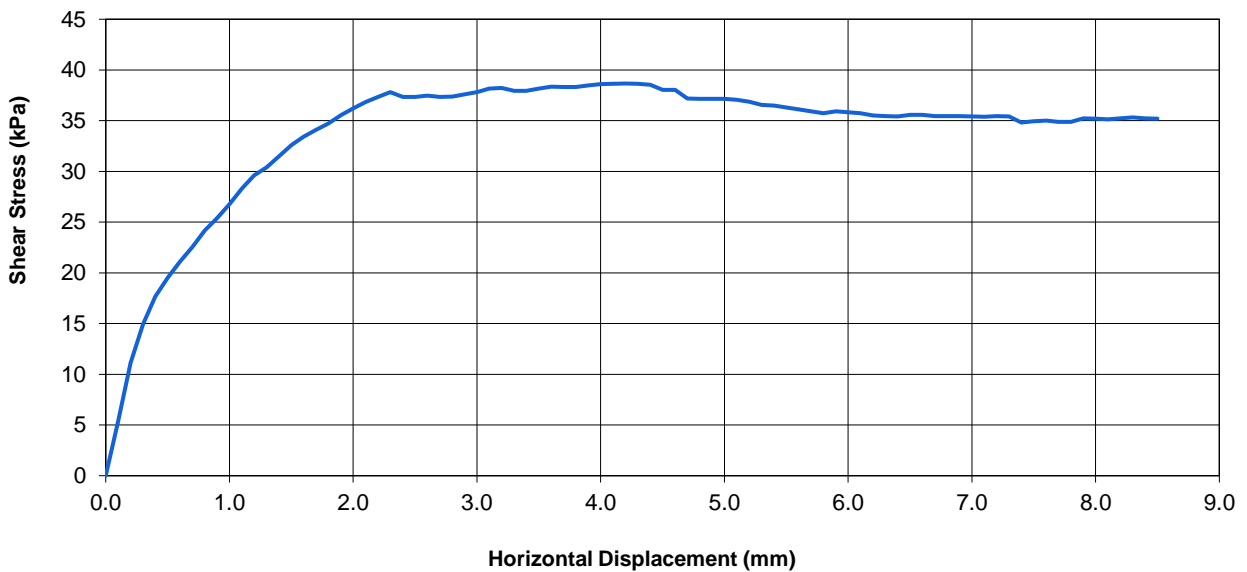
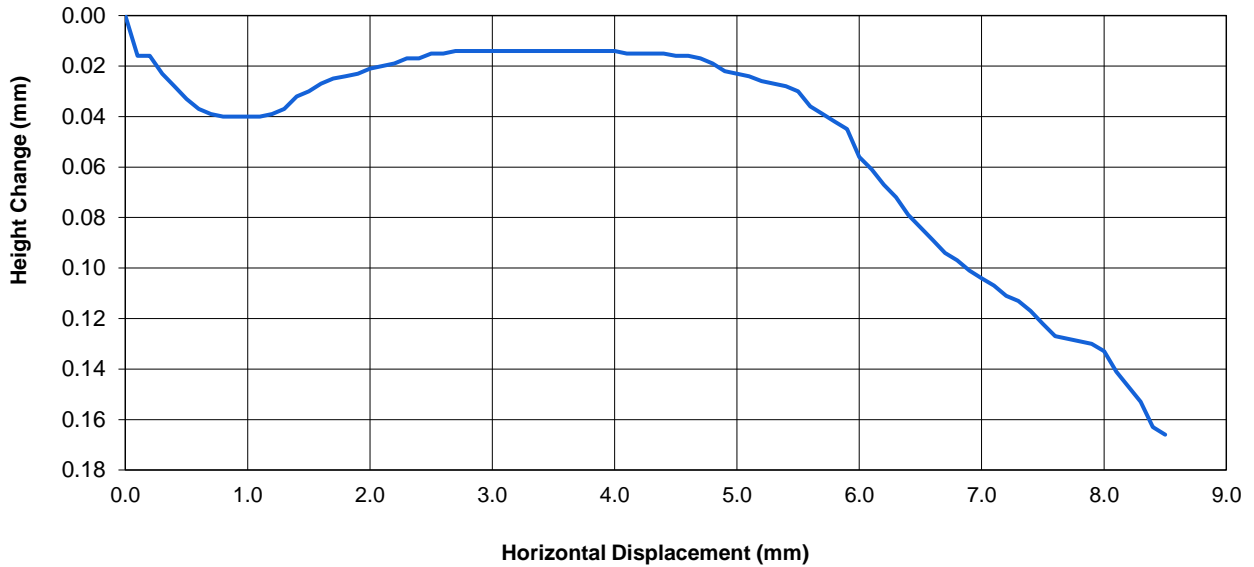
Borehole No BHSP09
Depth (m) 15.00-15.45
Sample Type B

Description:

Greyish brown gravelly fine to medium SAND.

Specimen: 1

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

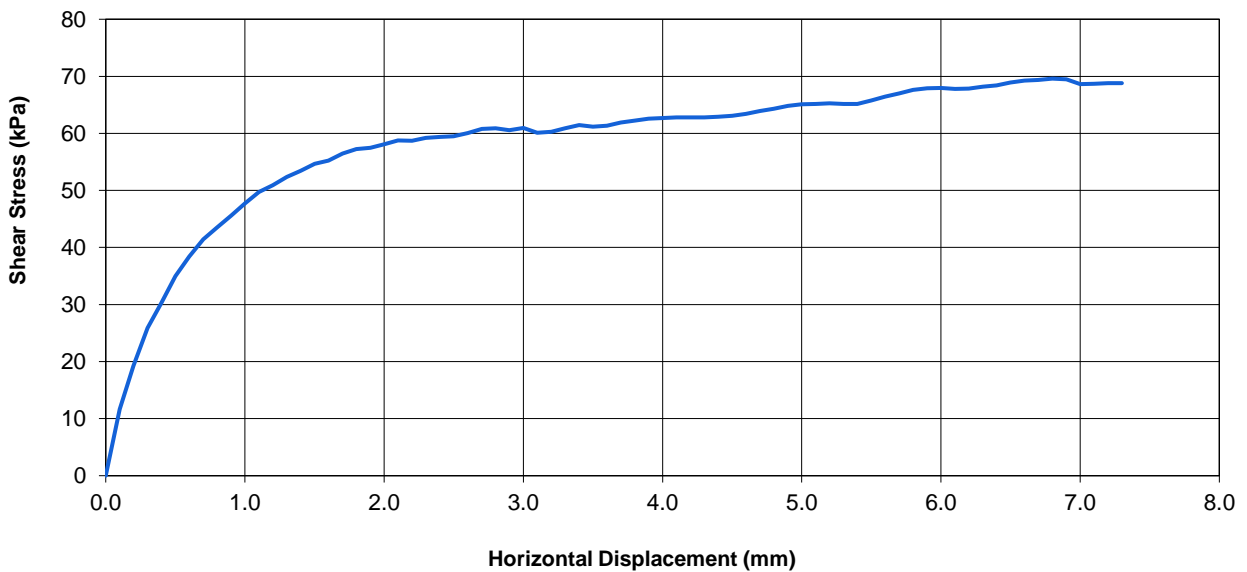
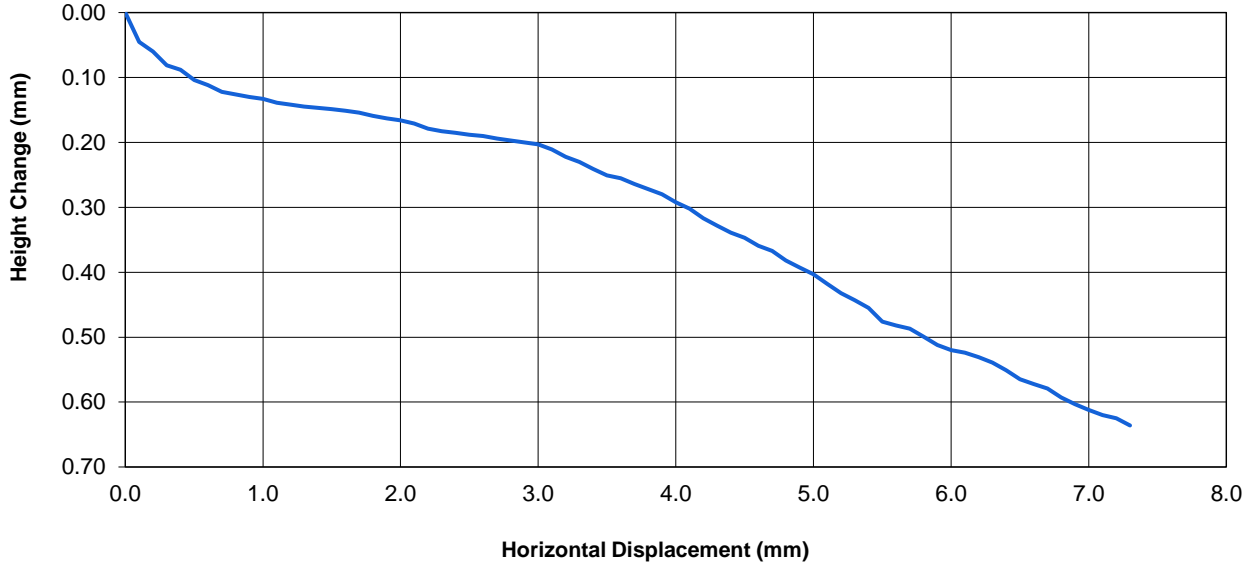
Borehole No BHSP09
Depth (m) 15.00-15.45
Sample Type B

Description:

Greyish brown gravelly fine to medium SAND.

Specimen: 2

Shear Stage



Tested by JJR
Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/08/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

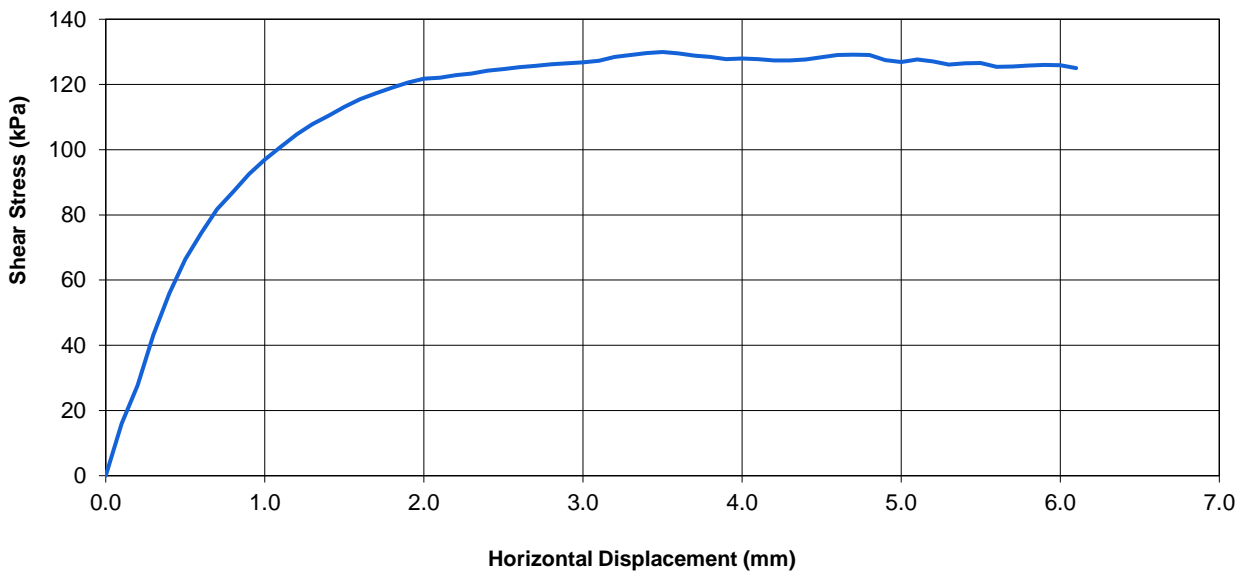
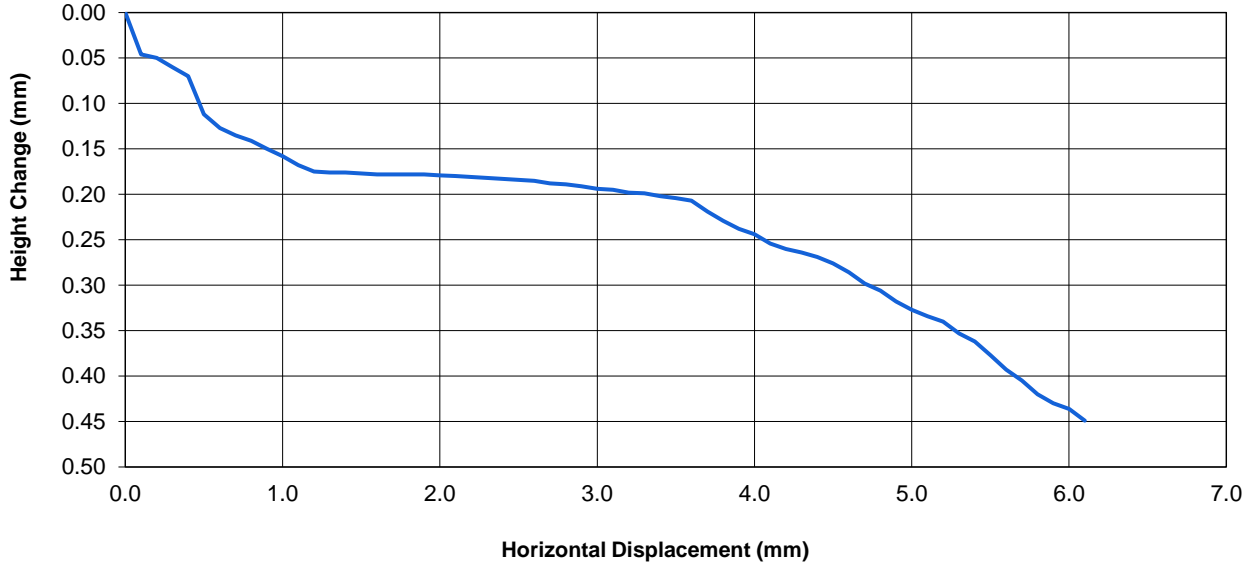
Borehole No BHSP09
Depth (m) 15.00-15.45
Sample Type B

Description:

Greyish brown gravelly fine to medium SAND.

Specimen: 3

Shear Stage



Tested by JJR
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P. Heritage

P Heritage - Project Manager
04/08/2023

Project Number:

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Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

Borehole No BHSP09
 Depth (m) 23.00
 Sample Type B

Description:

Brownish grey gravelly fine SAND. Gravel is medium to coarse.

Specimen Details

Depth within original sample *m* n/a
 Orientation within original sample n/a
 Test condition Submerged
 Preparation < 2 mm material remoulded at existing water content to a relative density of 50%¹

Particle density *Mg/m³* 2.65 (assumed)

Specimen Number		1	2	3
Length	<i>mm</i>	60.05	60.05	60.03
Width	<i>mm</i>	60.05	60.03	60.03
Height	<i>mm</i>	25.36	25.17	25.32
Initial water content	%	19.8	19.8	19.8
Initial bulk density	<i>Mg/m³</i>	1.64	1.65	1.64
Initial dry density	<i>Mg/m³</i>	1.37	1.38	1.37
Initial voids ratio		0.935	0.921	0.931
Degree of Saturation	%	56.1	57.1	56.4

Shearing Stage

Normal stress	<i>kPa</i>	60	120	240
Peak Conditions:				
Rate of horizontal displacement	<i>mm/min</i>	0.18	0.18	0.18
Maximum shear stress	<i>kPa</i>	46.2	94.2	168.5
Horizontal displacement at MSS	<i>mm</i>	3.3	5.2	6.2
Vertical Displacement at Peak	<i>mm</i>	-0.04	0.23	0.24

Final water content	%	24.6	25.2	26.1
Duration	<i>day(s)</i>	1	1	1

Shear Strength Parameters

	<i>kPa</i>	Peak Condition
Apparent Cohesion		9
Angle of Shearing Resistance	<i>degrees</i>	34.0

Notes: ¹ Maximum dry density = 1.60 Mg/m³ and minimum dry density = 1.21 Mg/m³

Tested by JJR
 Checked and Approved by

P. Heritage

P Heritage - Project Manager
 04/08/2023

Project Number:

GEO / 38342

Project Name:

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DIRECT SHEAR TEST – SHEARBOX

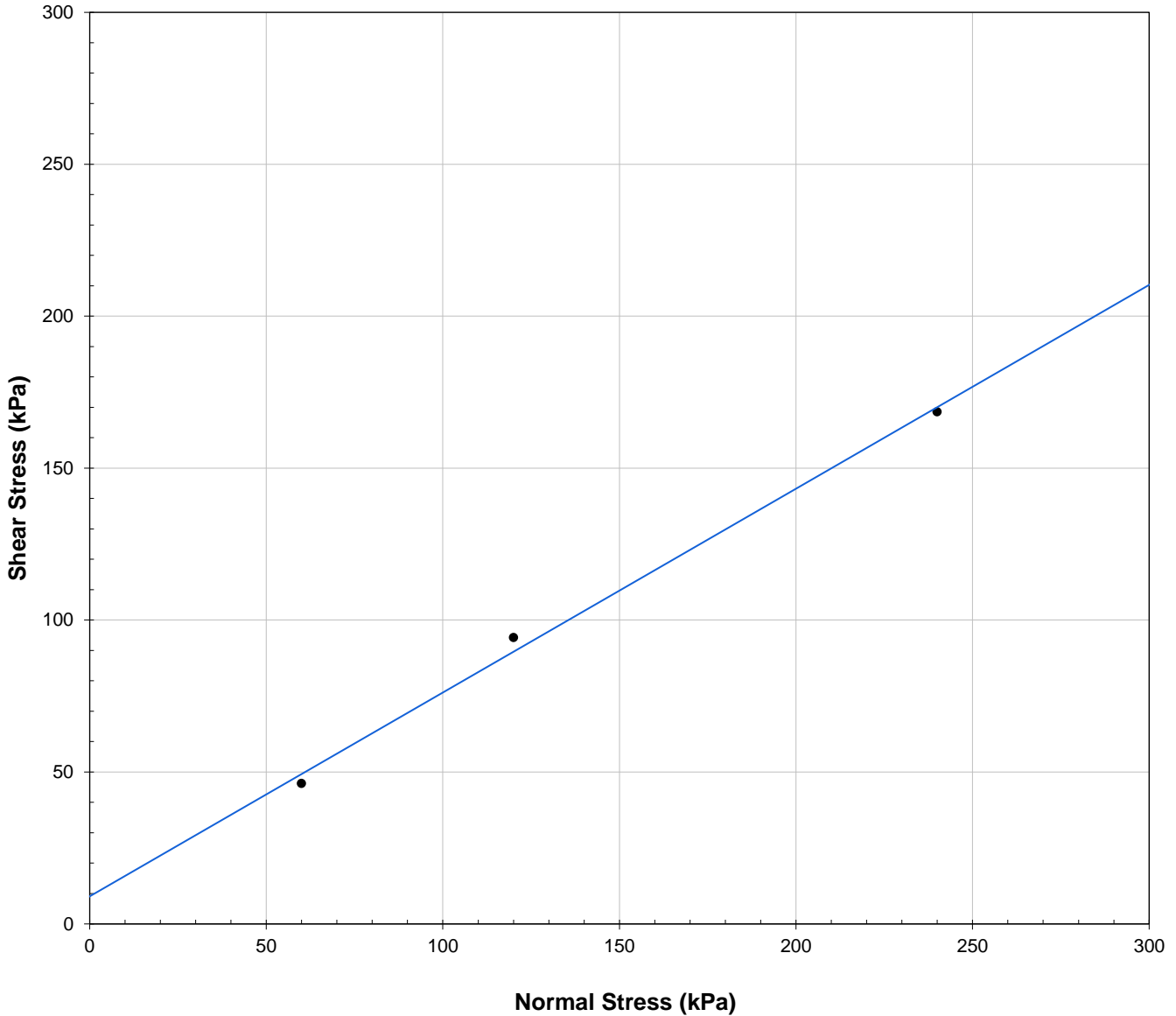
(small shearbox apparatus)

Borehole No BHSP09
Depth (m) 23.00
Sample Type B

Description:

Brownish grey gravelly fine SAND. Gravel is medium to coarse.

Shear Stress v Normal Stress



Peak: $c' = 9$
 $\Phi' = 34.0$

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04/08/2023

Project Number:

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Project Name:

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S230503**

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DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

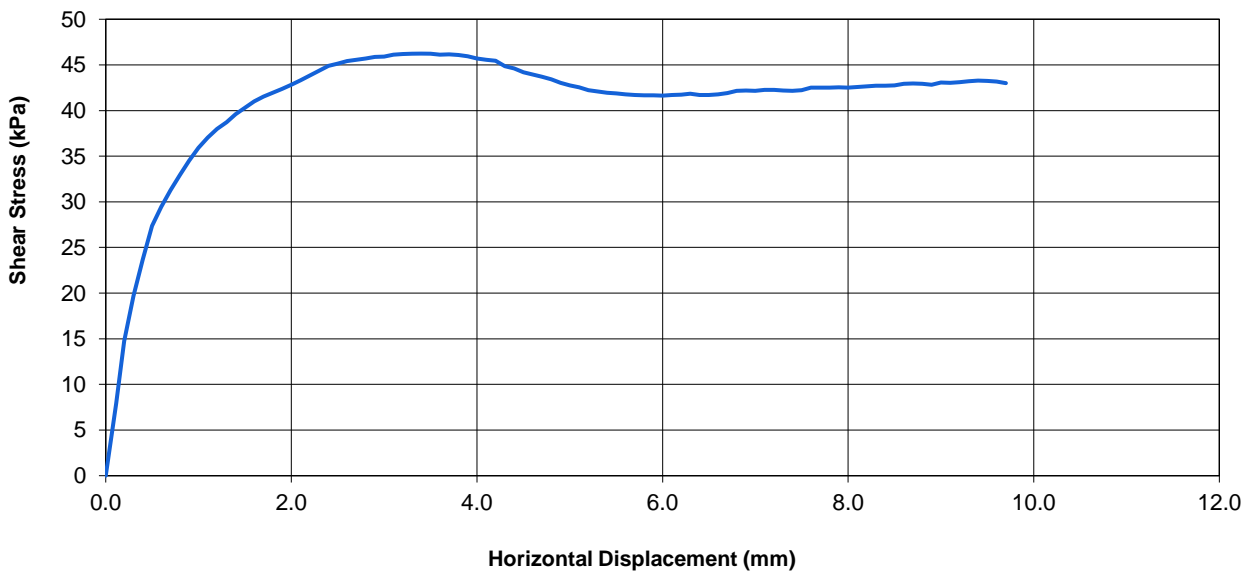
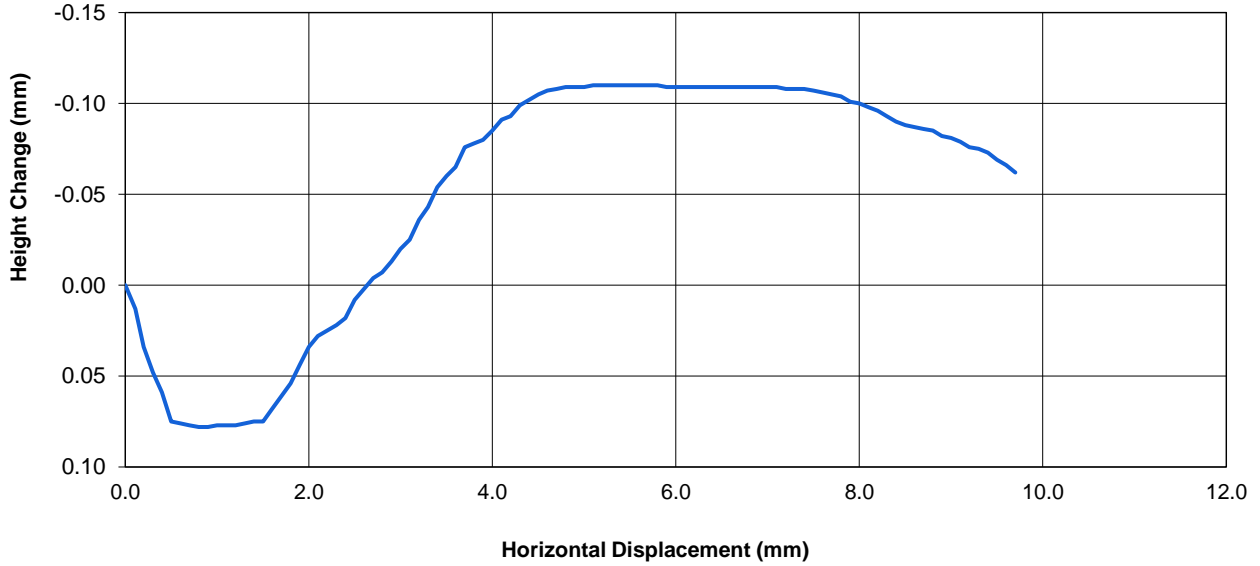
Borehole No	BHSP09
Depth (m)	23.00
Sample Type	B

Description:

Brownish grey gravelly fine SAND. Gravel is medium to coarse.

Specimen: 1

Shear Stage



Tested by JJR
Checked and Approved by
P. Heritage
P Heritage - Project Manager
04/08/2023

Project Number:
GEO / 38342

Project Name:
**ARDERSIER PORT
S230503**



DIRECT SHEAR TEST – SHEARBOX

(small shearbox apparatus)

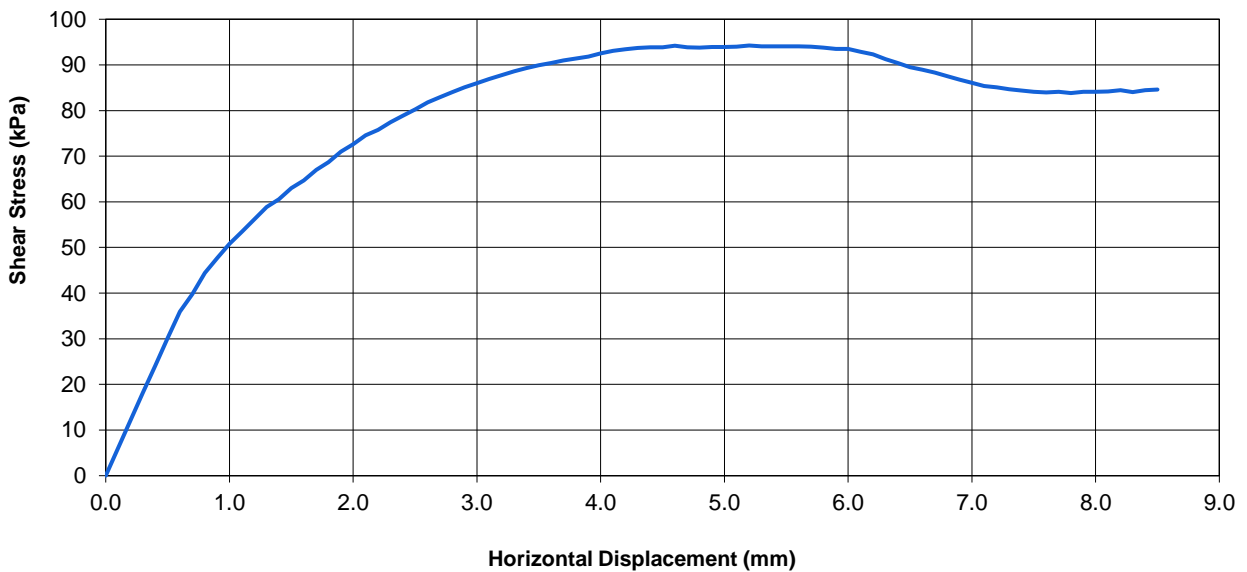
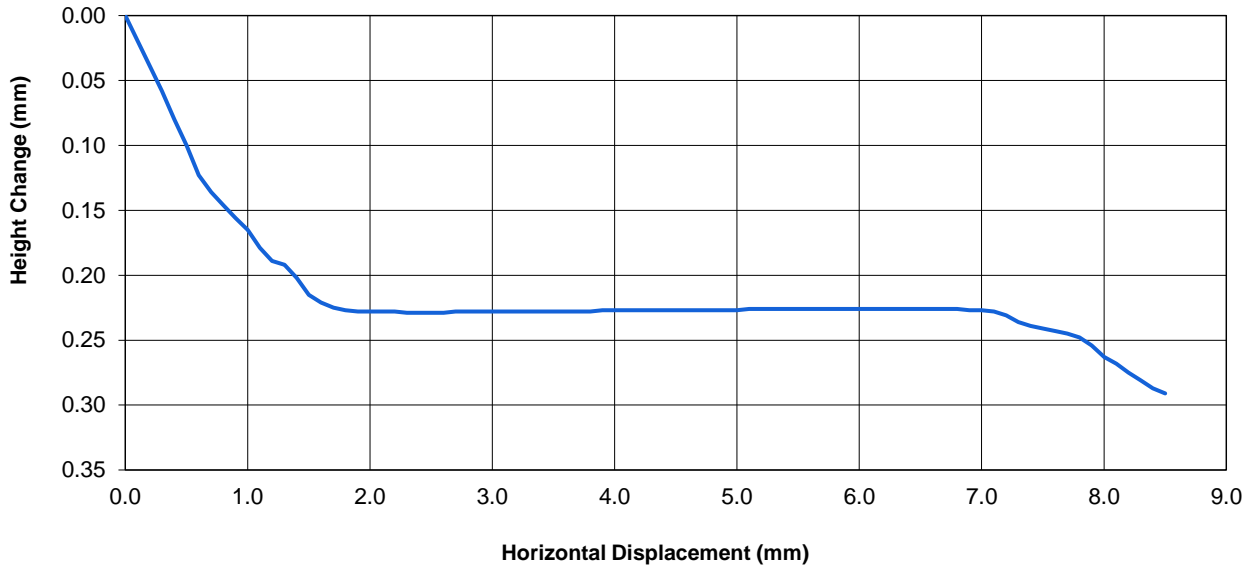
Borehole No BHSP09
Depth (m) 23.00
Sample Type B

Description:

Brownish grey gravelly fine SAND. Gravel is medium to coarse.

Specimen: 2

Shear Stage



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04/08/2023

Project Number:

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Project Name:

**ARDERSIER PORT
S230503**

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DIRECT SHEAR TEST – SHEARBOX

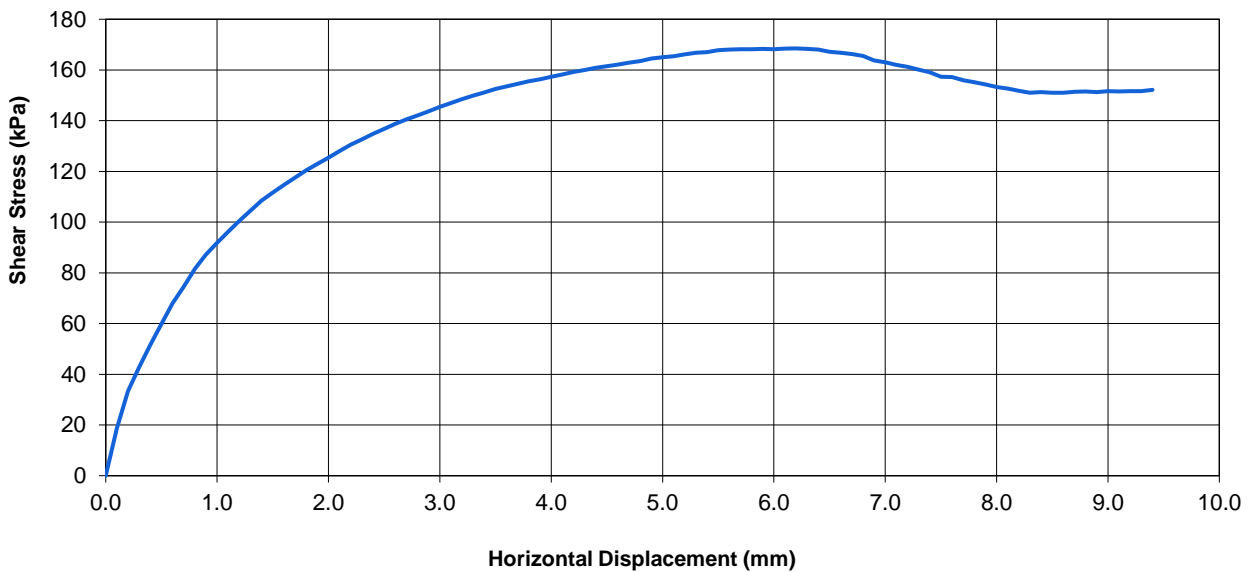
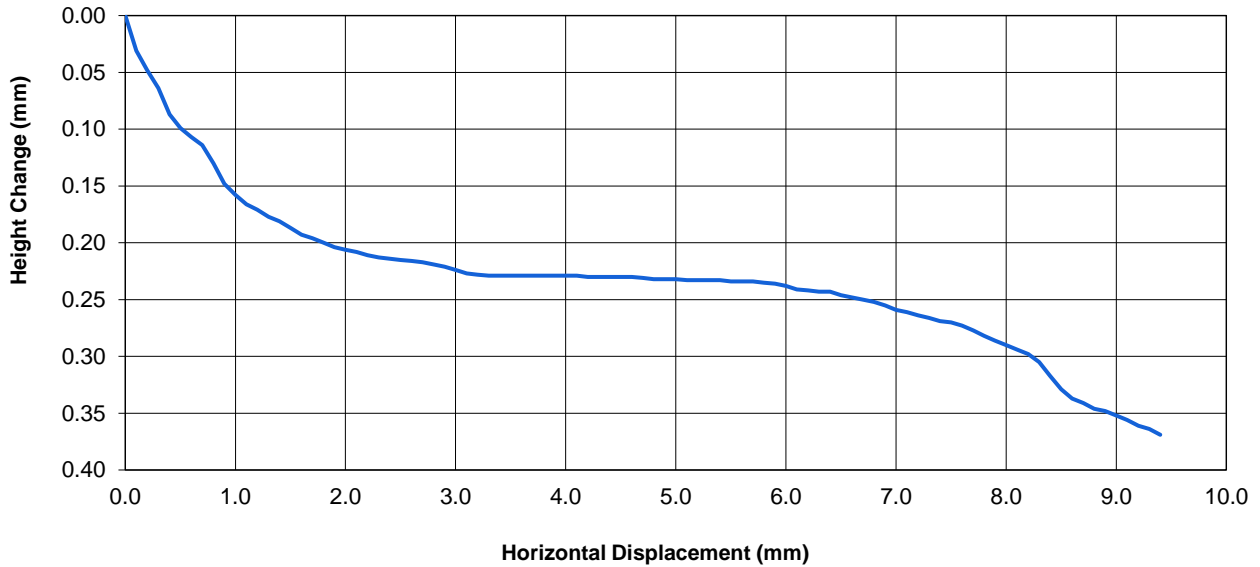
(small shearbox apparatus)


Borehole No BHSP09
 Depth (m) 23.00
 Sample Type B

Description:
 Brownish grey gravelly fine SAND. Gravel is medium to coarse.

Specimen: 3

Shear Stage



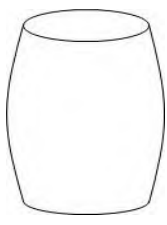
Tested by JJR
 Checked and Approved by

 P Heritage - Project Manager
 04/08/2023




Project Number:
GEO / 38342
 Project Name:
ARDERSIER PORT
S230503



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09	Description:
Depth (m): 12.00-12.45	Greyish brown slightly gravelly SAND.

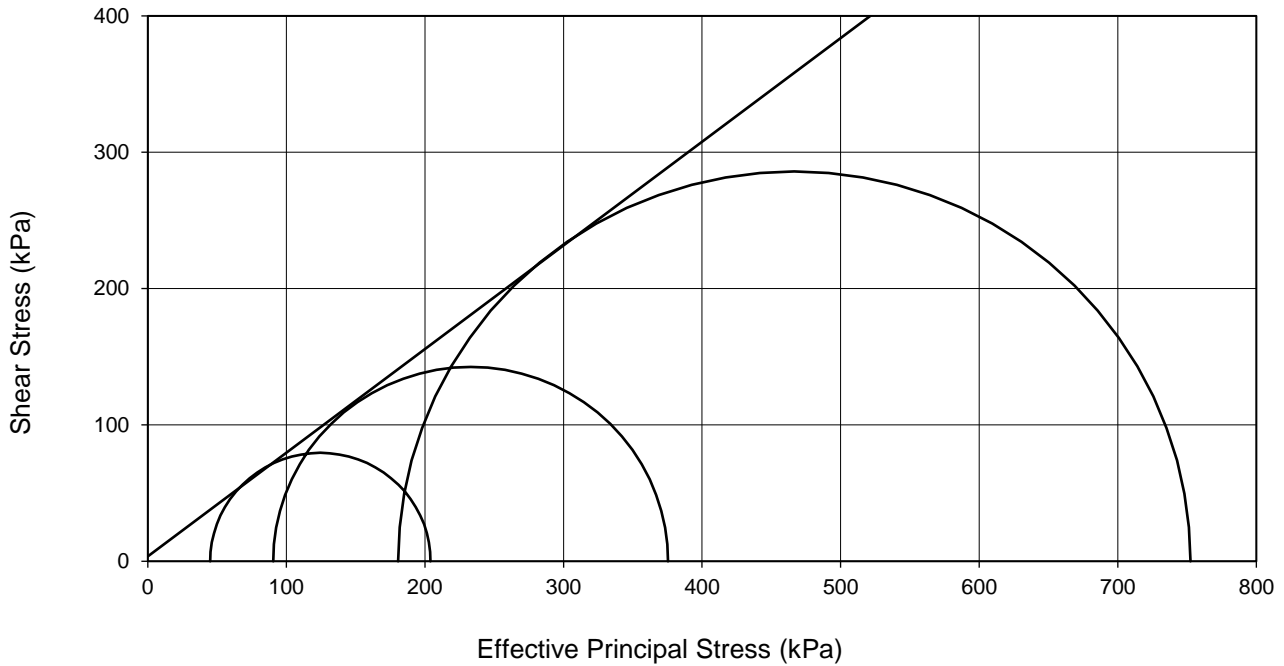
SPECIMEN DETAILS	NA		
Depth within original sample	Orientation within original sample: NA		
Remarks	Remoulded to a target 10.0 % MC and a target dry density of 1.51 Mg/m ³		
TEST DETAILS	B (Remoulded)		
Specimen Type and Preparation	Checks performed in accordance with Clause 3.5		
Cell Preparation	Multistage		
Specimen Number			
Initial Diameter <i>mm</i>	69.59		
Initial Length <i>mm</i>	140.22		
Initial Water Content <i>%</i>	10.2		
Initial Wet Density <i>Mg/m³</i>	1.65		
Drainage Conditions	One end only		
SATURATION STAGE	Method: Clause 5.2		
Final Cell Pressure <i>kPa</i>	545		
Final Pore Pressure <i>kPa</i>	536		
Final Pore Pressure Parameter B	0.95		
Duration <i>day(s)</i>	6		
CONSOLIDATION STAGE	Stage No 1	Stage No 2	Stage No 3
Cell Pressure <i>kPa</i>	545	590	680
Back Pressure <i>kPa</i>	500	500	500
Effective Pressure <i>kPa</i>	45	90	180
Final Pore Pressure <i>kPa</i>	500	500	500
Final Pore Pressure Dissipation <i>%</i>	100	100	100
Duration <i>day(s)</i>	1	1	1
SHEARING STAGE			
Cell Pressure <i>kPa</i>	545	590	680
Rate of Axial Displacement <i>mm/min</i>	0.020	0.020	0.020
Initial Pore Pressure <i>kPa</i>	500	500	500
Initial Effective Stress <i>kPa</i>	45	90	180
CONDITIONS AT FAILURE	Maximum deviator stress		
Pore Pressure <i>kPa</i>	500	500	499
Minor Effective Principal Stress <i>kPa</i>	45	90	181
Deviator Stress <i>kPa</i>	159	285	572
Major Effective Principal Stress <i>kPa</i>	204	375	753
Volume Change <i>mL</i>	-1.09	0.00	1.32
Volumetric Strain <i>%</i>	-0.2	0.0	0.3
Axial Strain <i>%</i>	2.0	2.6	6.0
Membrane correction applied to Deviator Stress <i>kPa</i>	0	0	1
Duration <i>day(s)</i>	1	1	1
Final Water Content <i>%</i>	24.6		
Final Wet Density <i>Mg/m³</i>	1.90		
EFFECTIVE STRESS PARAMETERS			
Cohesion <i>kPa</i>	3.6		
Angle of Shear Resistance <i>degrees</i>	37		
FAILURE SKETCH			

Checked and Approved by	Project Number:	GEO / 38342
 P Heritage - Project Manager 04/09/2023	Project Name:	ARDERSIER PORT S230503
		 

Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 12.00-12.45

Description:
Greyish brown slightly gravelly SAND.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

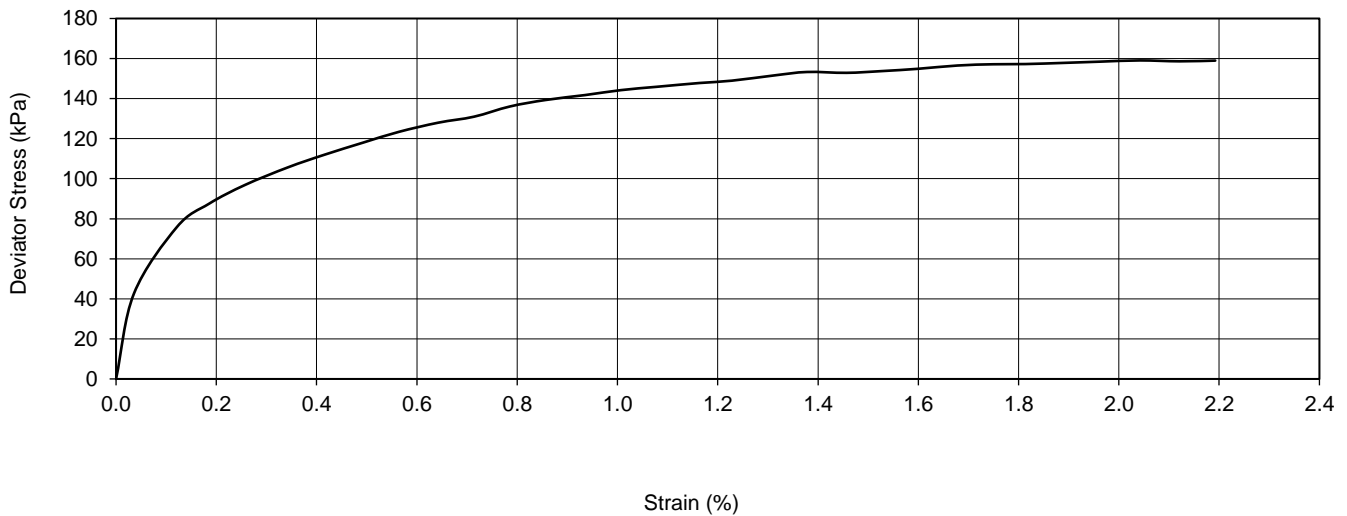
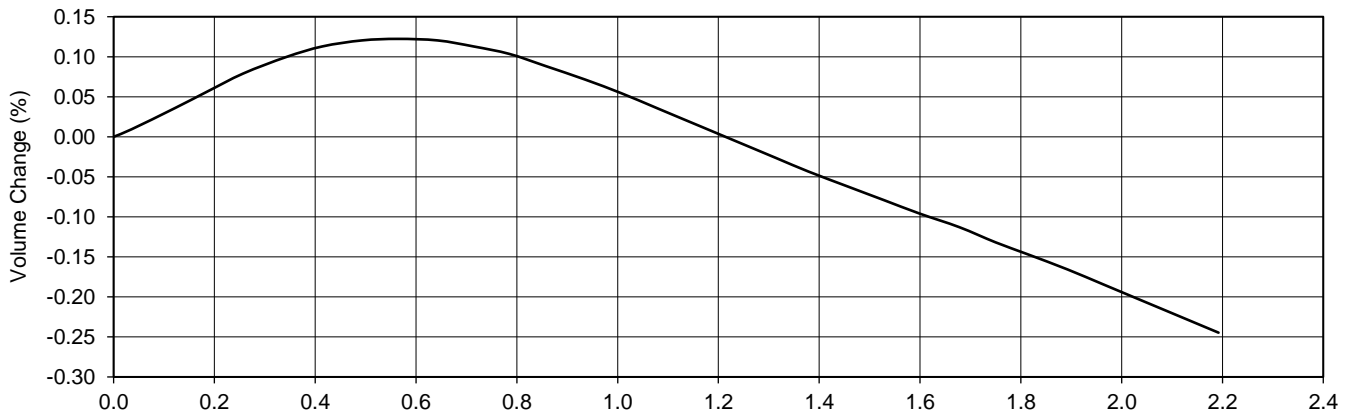
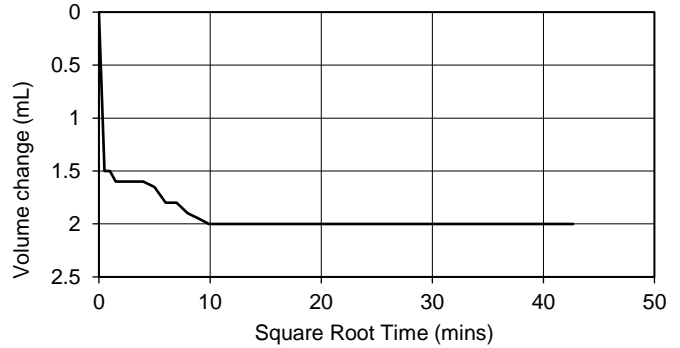
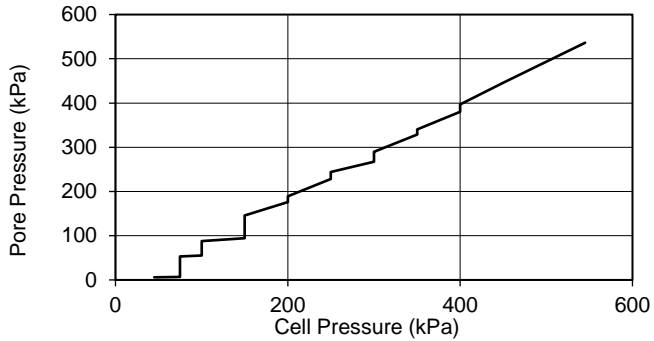
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 12.00-12.45

Stage No 1



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P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

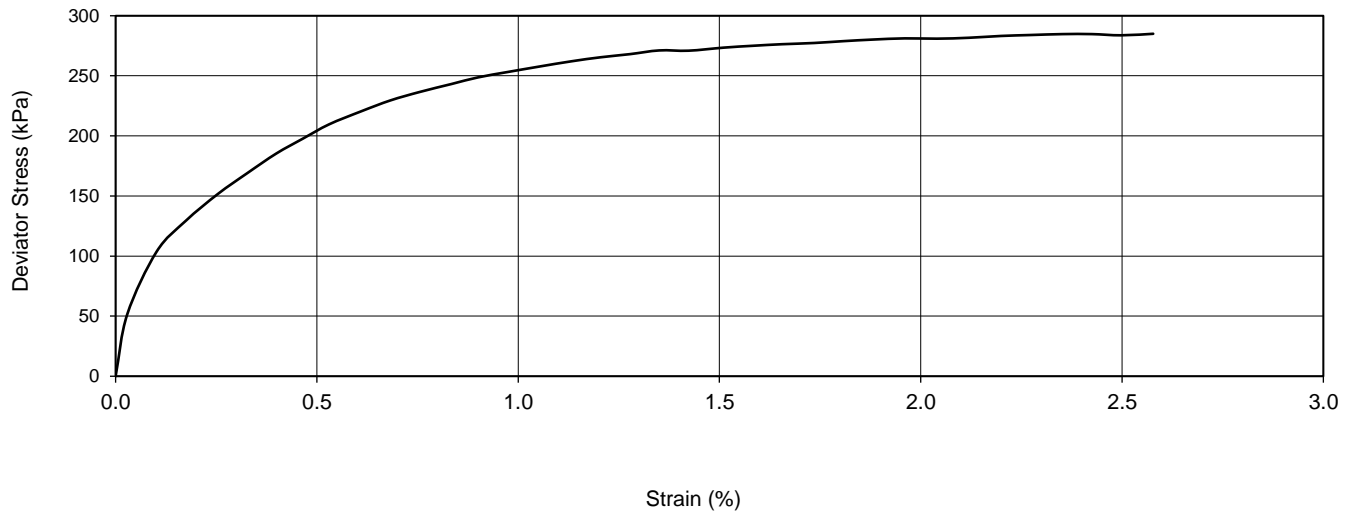
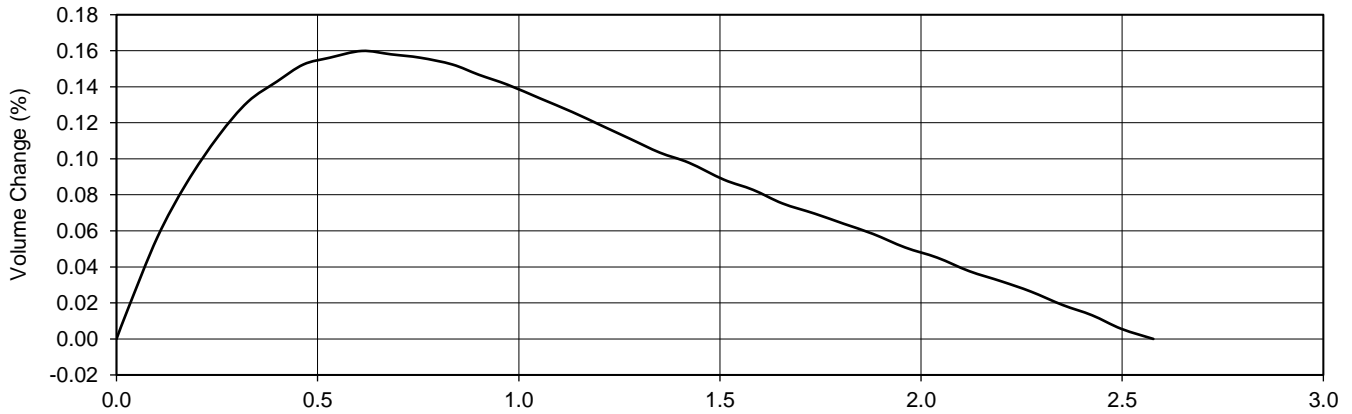
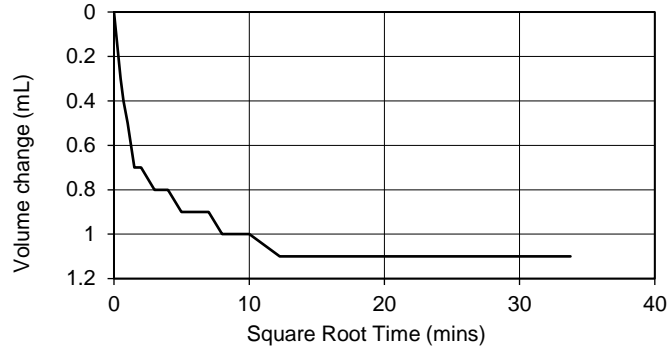
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 12.00-12.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

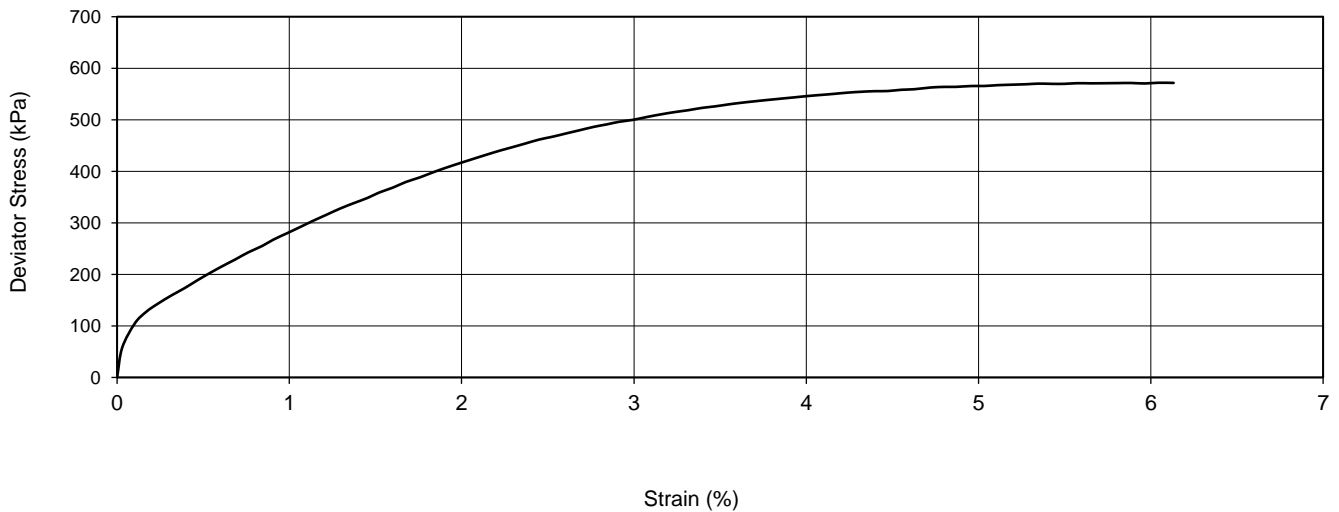
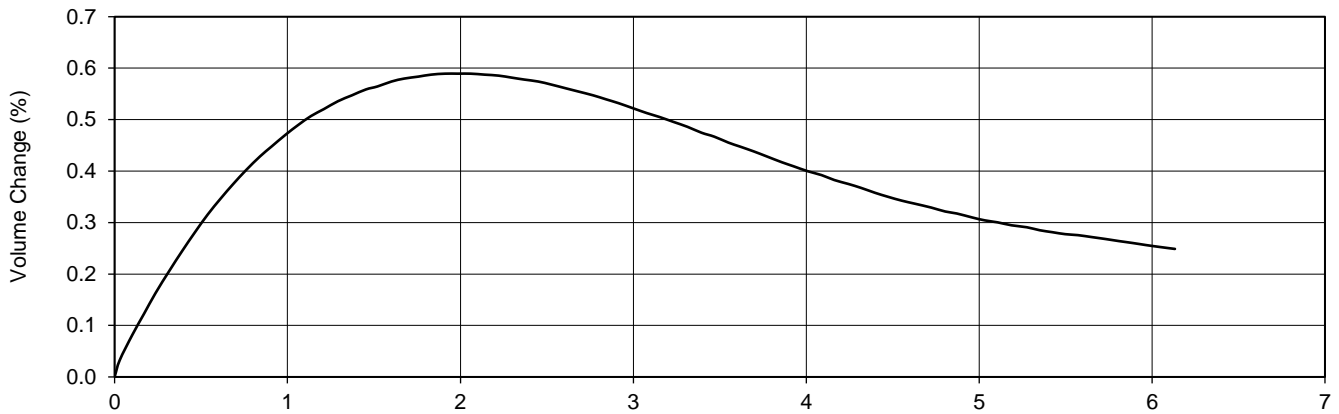
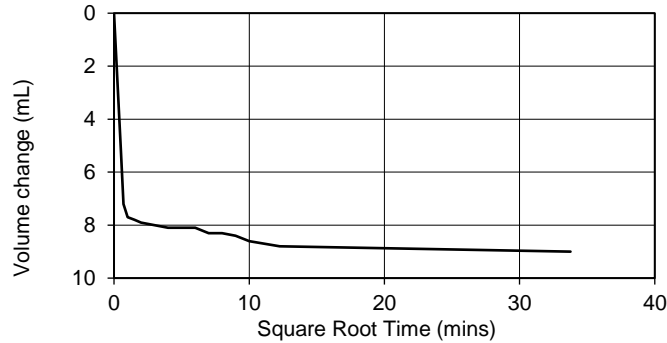
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 12.00-12.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:


**ARDERSIER PORT
S230503**

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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09	Description:
Depth (m): 21.00-21.45	Grey and greyish brown slightly silty gravelly fine to medium SAND.

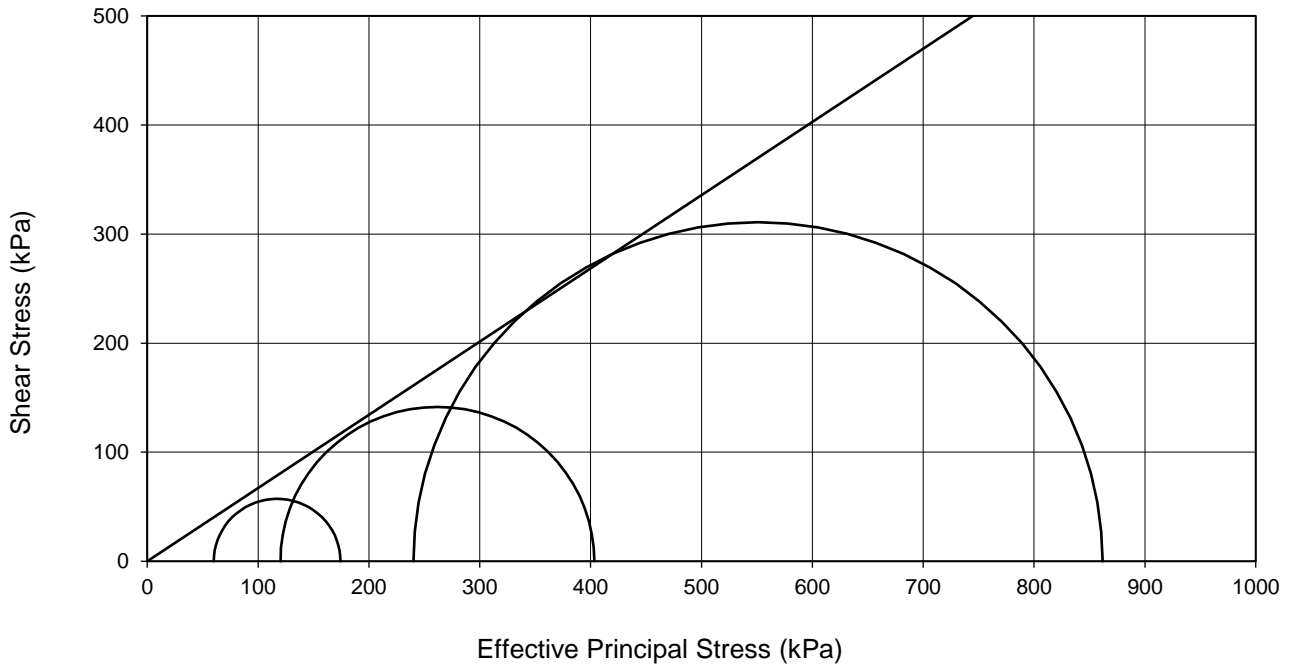
SPECIMEN DETAILS	NA		
Depth within original sample	Orientation within original sample: NA		
Remarks	Remoulded to a target 10.0% MC and a target dry density of 1.44 Mg/m ³		
TEST DETAILS	B (Remoulded)		
Specimen Type and Preparation	Checks performed in accordance with Clause 3.5		
Cell Preparation	Multistage		
Specimen Number	69.26		
Initial Diameter <i>mm</i>	140.22		
Initial Length <i>mm</i>	9.7		
Initial Water Content <i>%</i>	1.59		
Initial Wet Density <i>Mg/m³</i>	One end and radial boundary		
Drainage Conditions	Method: Clause 5.2		
SATURATION STAGE	460		
Final Cell Pressure <i>kPa</i>	448		
Final Pore Pressure <i>kPa</i>	0.97		
Final Pore Pressure Parameter B	6		
Duration <i>day(s)</i>	Stage No 1		
CONSOLIDATION STAGE	Stage No 2		
Cell Pressure <i>kPa</i>	460	520	640
Back Pressure <i>kPa</i>	400	400	400
Effective Pressure <i>kPa</i>	60	120	240
Final Pore Pressure <i>kPa</i>	400	400	400
Final Pore Pressure Dissipation <i>%</i>	100	100	100
Duration <i>day(s)</i>	1	1	1
SHEARING STAGE	Stage No 3		
Cell Pressure <i>kPa</i>	460	520	640
Rate of Axial Displacement <i>mm/min</i>	0.015	0.020	0.020
Initial Pore Pressure <i>kPa</i>	400	400	400
Initial Effective Stress <i>kPa</i>	60	120	240
CONDITIONS AT FAILURE	Maximum deviator stress		
Pore Pressure <i>kPa</i>	400	400	400
Minor Effective Principal Stress <i>kPa</i>	60	120	240
Deviator Stress <i>kPa</i>	114	283	622
Major Effective Principal Stress <i>kPa</i>	174	403	862
Volume Change <i>mL</i>	4.06	1.69	0.55
Volumetric Strain <i>%</i>	0.8	0.3	0.1
Axial Strain <i>%</i>	2.7	3.4	4.1
Membrane & filter correction applied to Deviator Stress <i>kPa</i>	6	5	5
Duration <i>day(s)</i>	1	1	1
Final Water Content <i>%</i>	19.6		
Final Wet Density <i>Mg/m³</i>	1.78		
EFFECTIVE STRESS PARAMETERS	0		
Cohesion <i>kPa</i>	34		
Angle of Shear Resistance <i>degrees</i>	<div style="text-align: center;">  </div>		
FAILURE SKETCH			

Checked and Approved by	Project Number:	GEO / 38342
 P Heritage - Project Manager 04/09/2023	Project Name:	ARDERSIER PORT S230503
		 

Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 21.00-21.45

Description:
Grey and greyish brown slightly silty gravelly fine to medium SAND.



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

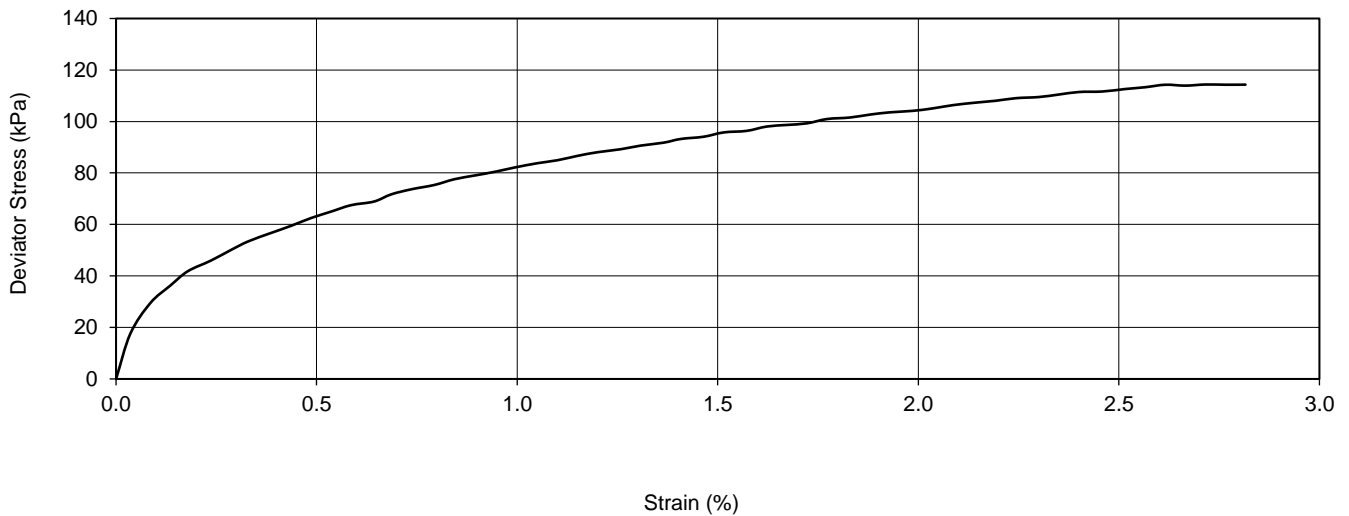
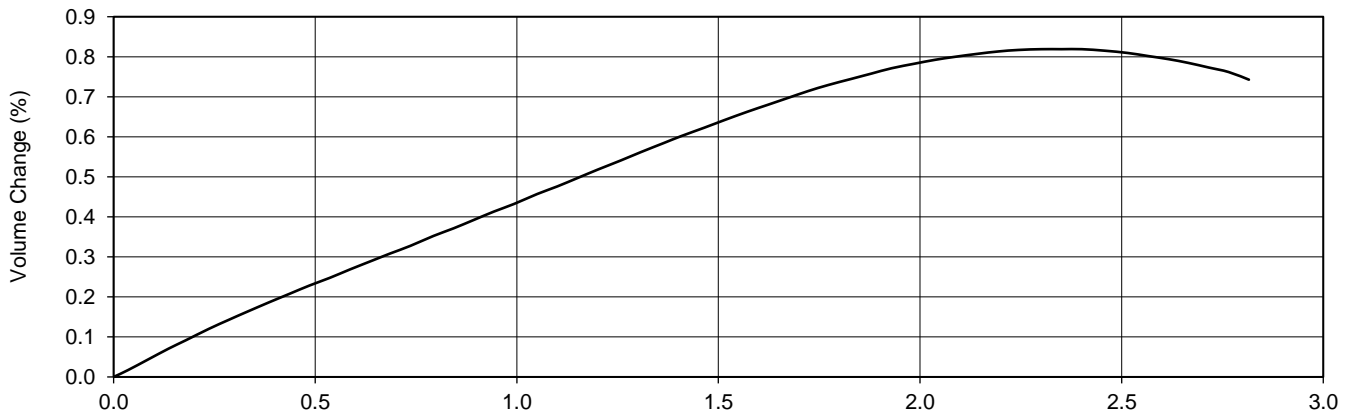
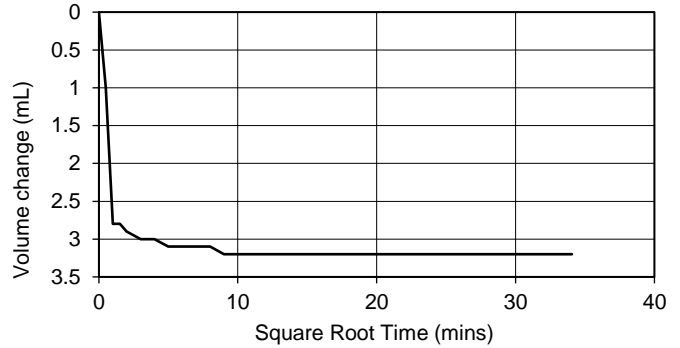
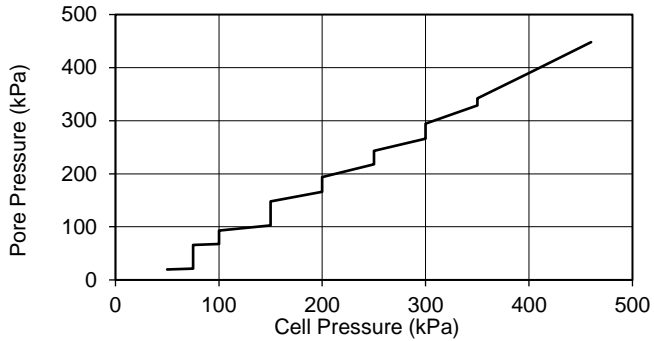
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 21.00-21.45

Stage No 1



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

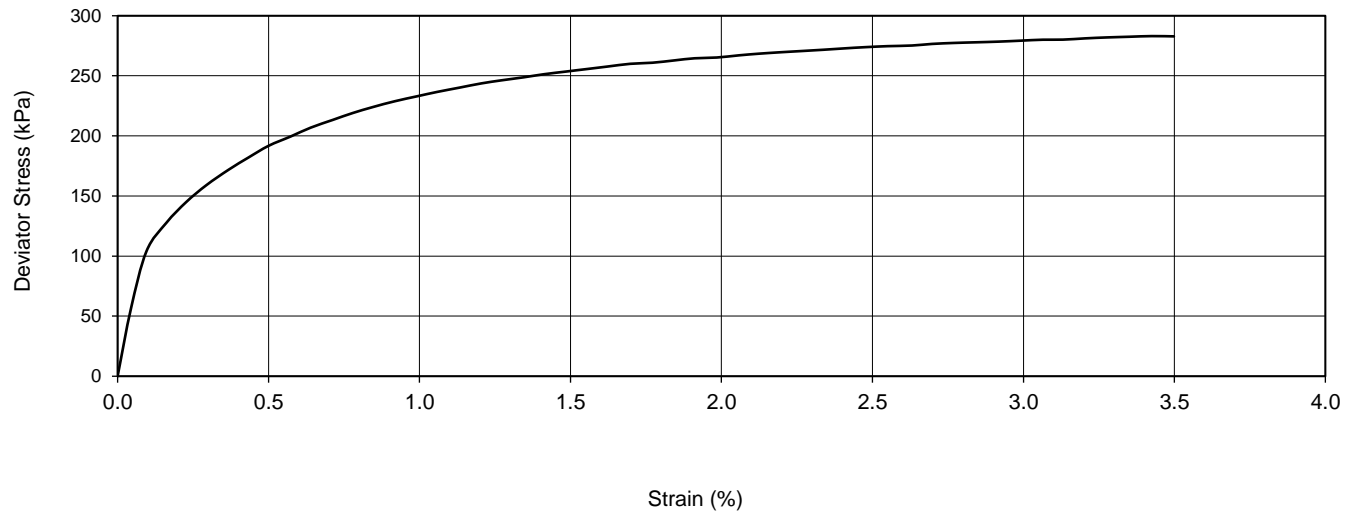
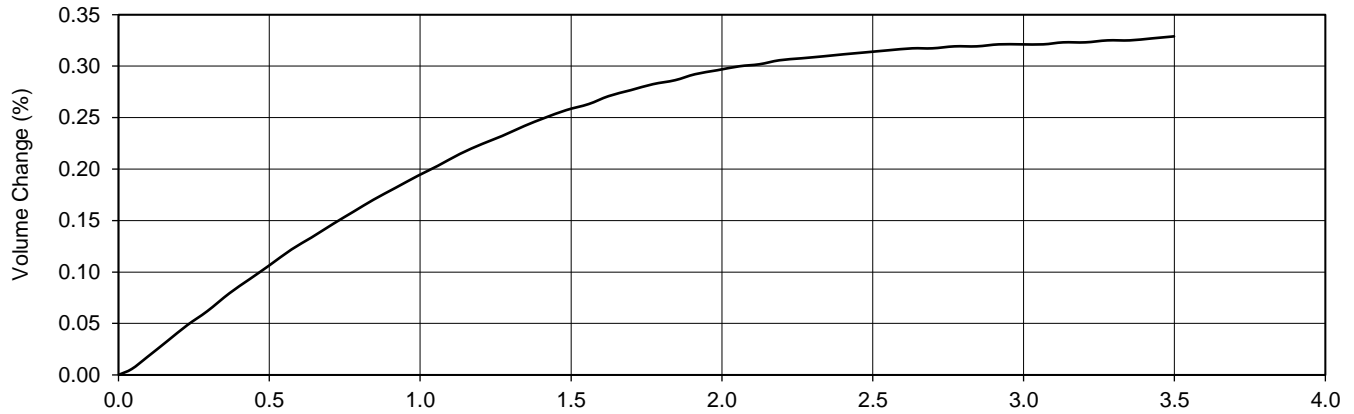
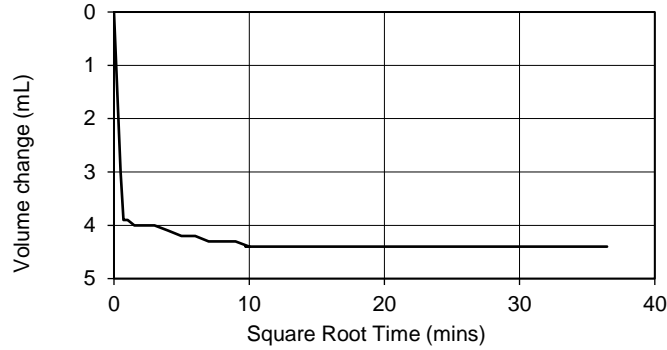
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Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 21.00-21.45

Stage No 2



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

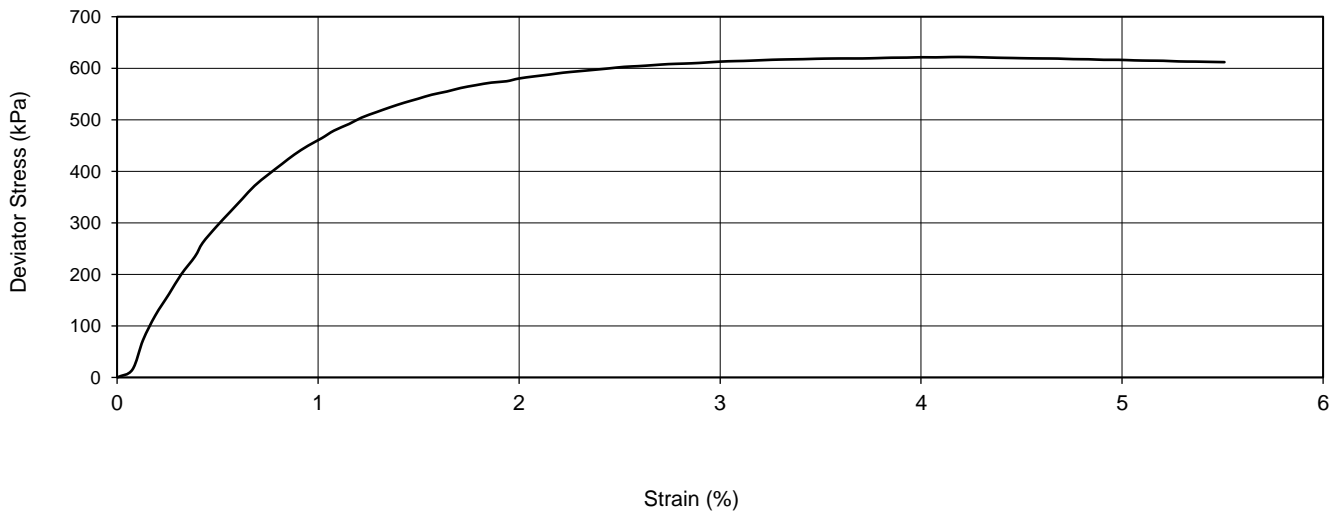
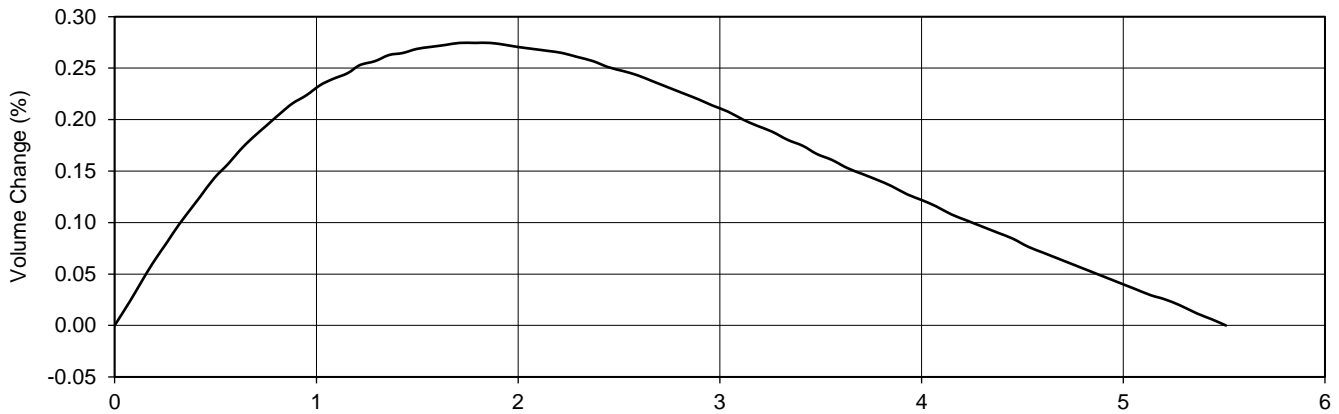
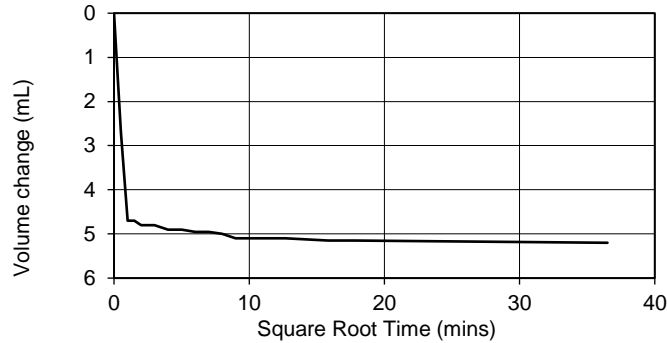
GEOLABS®



Consolidated Drained Multistage Triaxial Compression Test with Measurement of Volume Change

Borehole No.: BHSP09
Depth (m): 21.00-21.45

Stage No 3



Checked and Approved by

P. Heritage

P Heritage - Project Manager
04/09/2023

Project Number:

GEO / 38342

Project Name:

**ARDERSIER PORT
S230503**

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APPENDIX D



12 Yarm Road • Stockton-on-Tees • TS18 3NA

Tel: 01642 607083 • Email: info@solmek.com

SOIL INFILTRATION RATE

Project: S230503

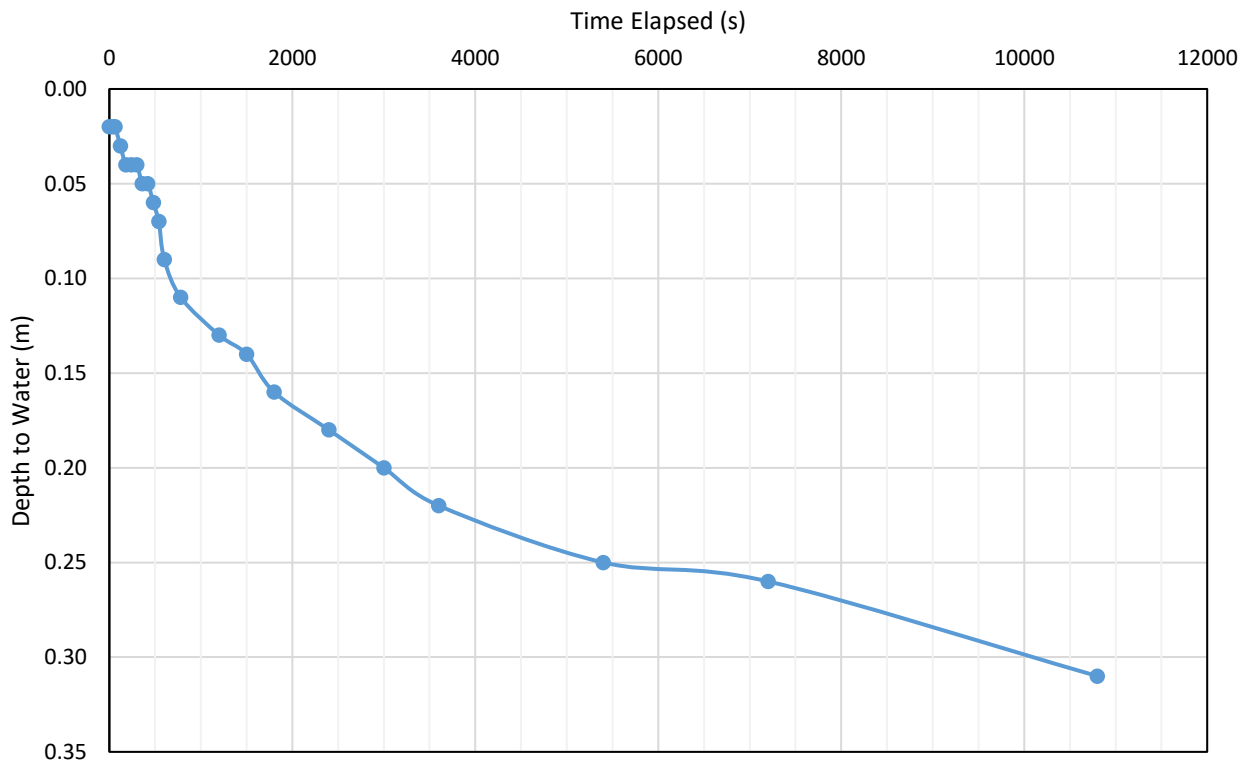
Project name: Ardersier Port Falling Head RT

Report date: 05/07/2023

Test date: 27/06/2023

Test location: BHSP07

Falling Head Test BS22282-1(2012) Geohydraulic Testing



Internal borehole diameter 0.2500 m

Base depth of borehole 10.00 m

Cross-sectional area of borehole 0.0491 m²

Linear regression slope 3.02E-06

Shape Factor 14.3385

Permeability Coefficient (k) 1.03E-08 m/s

Produced by	Dated	Checked by	Dated
S.MCNIFF	05/07/23	A.CUTTS	12/07/23



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Tel: 01642 607083 • Email: info@solmek.com

SOIL INFILTRATION RATE

Project: S230503

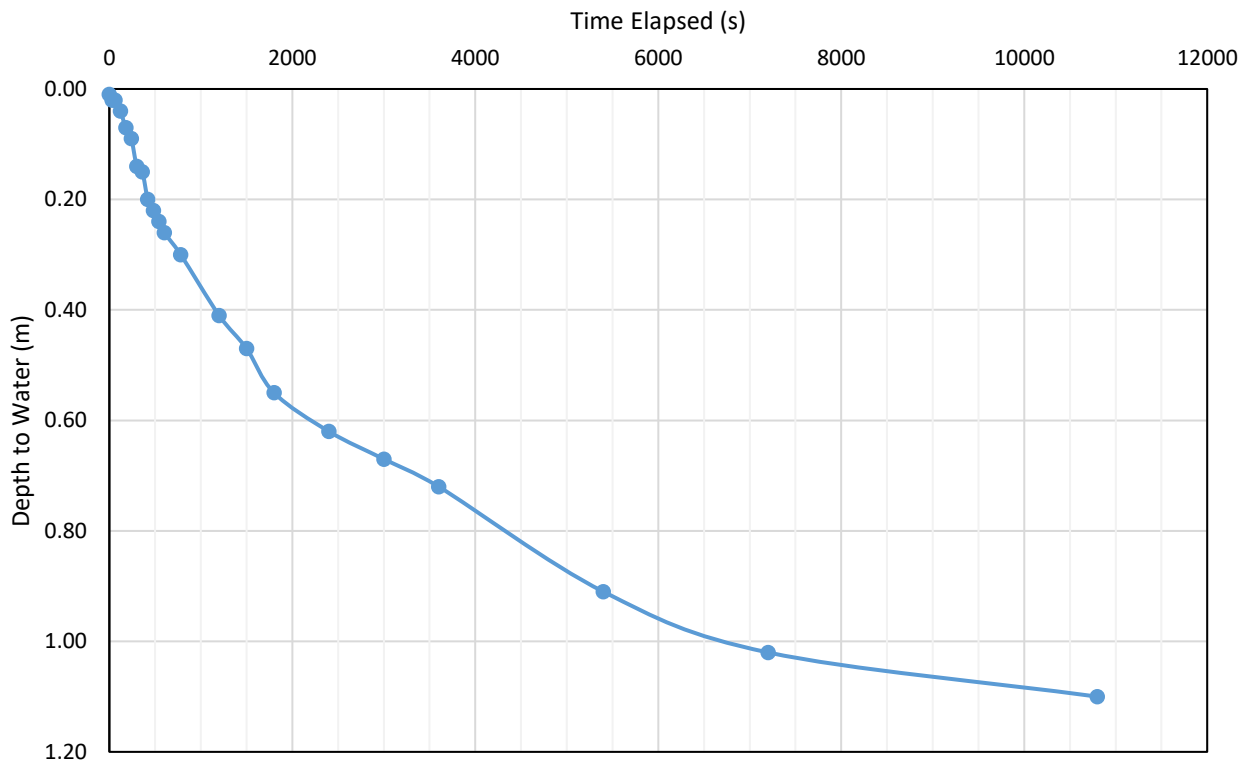
Project name: Ardersier Port Falling Head Test LT

Report date: 05/07/2023

Test date: 27/06/2023

Test location: BHSP07

Falling Head Test BS22282-1(2012) Geohydraulic Testing



Internal borehole diameter 0.2030 m

Base depth of borehole 20.00 m

Cross-sectional area of borehole 0.0324 m²

Linear regression slope 5.84E-06

Shape Factor 23.7845

Permeability Coefficient (k) 7.95E-09 m/s

Produced by	Dated	Checked by	Dated
S.MCNIFF	05/07/23	A.CUTTS	12/07/23



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SOIL INFILTRATION RATE

Project: S230503

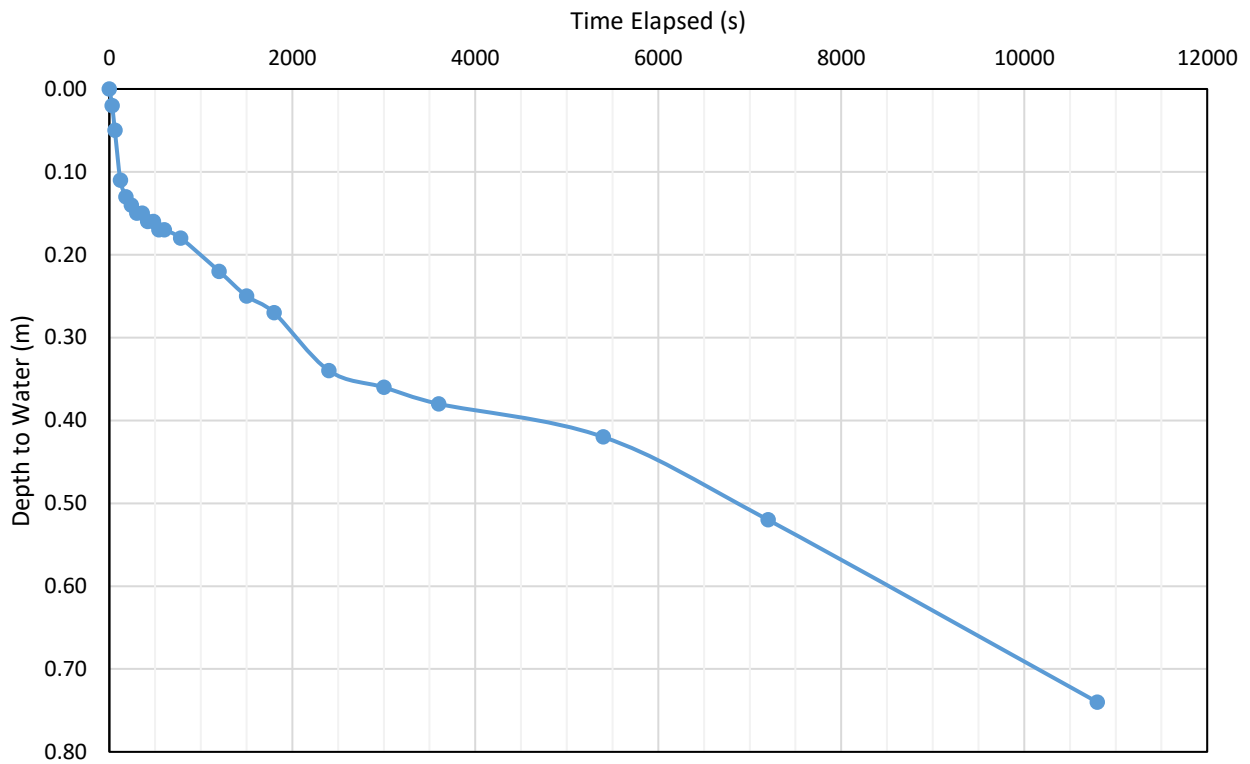
Project name: Ardersier Port Falling Head Test LT

Report date: 05/07/2023

Test date: 29/06/2023

Test location: BHSP07

Falling Head Test BS22282-1(2012) Geohydraulic Testing



Internal borehole diameter 0.1530 m

Base depth of borehole 35.00 m

Cross-sectional area of borehole 0.0184 m²

Linear regression slope 1.75E-06

Shape Factor 35.8992

Permeability Coefficient (k) 8.95E-10 m/s

Produced by	Dated	Checked by	Dated
S.MCNIFF	05/07/23	A.CUTTS	12/07/23



12 Yarm Road • Stockton-on-Tees • TS18 3NA

Tel: 01642 607083 • Email: info@solmek.com

SOIL INFILTRATION RATE

Project: S230503

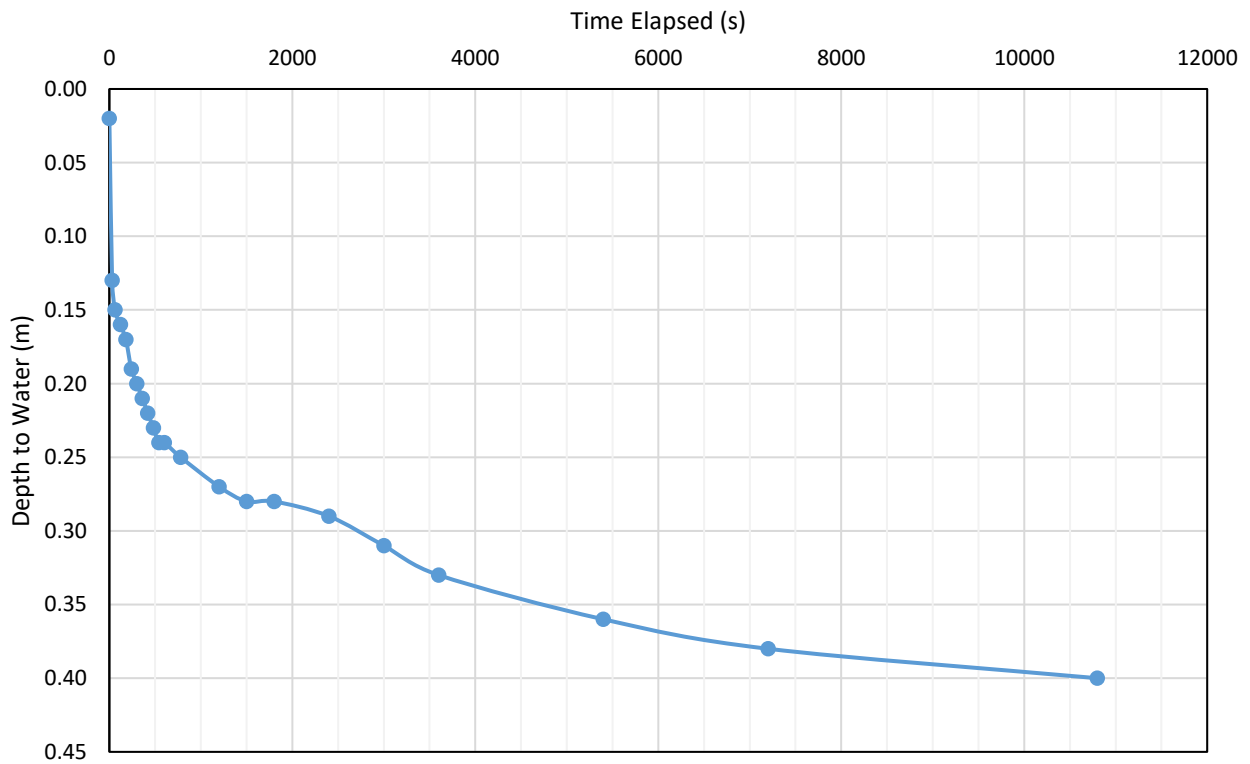
Project name: Ardersier Port Falling Head Test RTRisi

Report date: 05/07/2023

Test date: 08/06/2023

Test location: BHSP08

Falling Head Test BS22282-1(2012) Geohydraulic Testing



Internal borehole diameter 0.2540 m

Base depth of borehole 10.00 m

Cross-sectional area of borehole 0.0507 m²

Linear regression slope 2.66E-06

Shape Factor 14.3907

Permeability Coefficient (k) 9.35E-09 m/s

Produced by	Dated	Checked by	Dated
S.MCNIFF	05/07/23	A.CUTTTS	12/07/23



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SOIL INFILTRATION RATE

Project: S230503

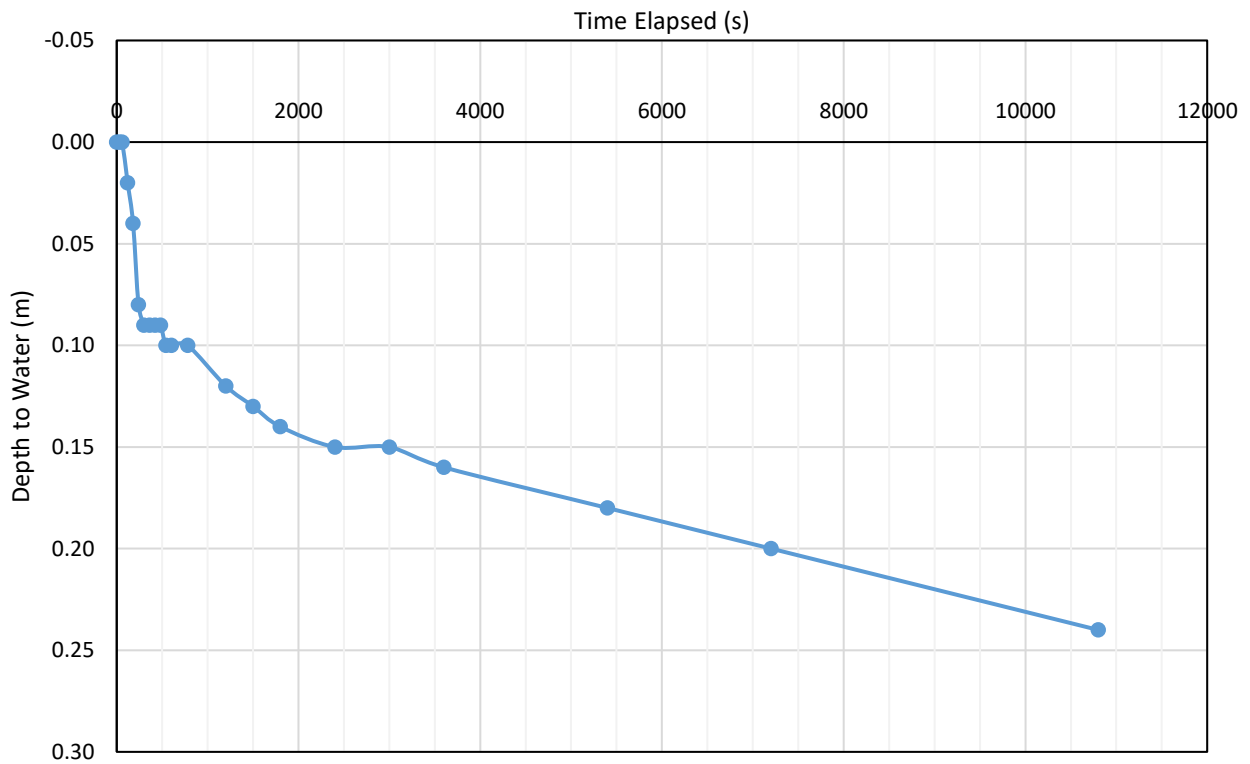
Project name: Ardersier Port Falling Head Test RT

Report date: 05/07/2023

Test date: 08/06/2023

Test location: BHSP08

Falling Head Test BS22282-1(2012) Geohydraulic Testing



Internal borehole diameter 0.2000 m

Base depth of borehole 21.00 m

Cross-sectional area of borehole 0.0314 m²

Linear regression slope 9.44E-07

Shape Factor 24.6763

Permeability Coefficient (k) 1.20E-09 m/s

Produced by	Dated	Checked by	Dated
S.MCNIFF	05/07/23	A.CUTTS	12/07/23

APPENDIX E



GROUNDWATER DATA LOGGER SUMMARY 25 October 2023 – 01 February 2024

From 11.00am 25/10/2023 to 11.00am 01/02/2024

BHSP07 GW Data

	Temperature (C)	Pressure (mBar)	Water Level (mbgl)
Min	4.144	955.395	-0.358
Mean	7.466	1005.316	0.95
Max	11.837	1070.959	1.727

BHSP08 GW Data

	Temperature (C)	Pressure (mBar)	Water Level (mbgl)
Min	4.577	955.395	0.24
Mean	8.42	1005.316	1.417
Max	12.524	1070.959	2.275

APPENDIX :

♣Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2024)

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party invoiced) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek.

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Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2011 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional indemnity Insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.

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ARDERSIER PORT ENERGY TRANSITION FACILITY PORT EXTENSION



November 2025

Appendix 3.2 Outline Construction Environmental
Management Document

Ardersier Port Extension

Issue No.	Date	Author (Name / Role)	Approved by (Name / Role)	Issue status	Distribution	Remarks
001	11.11.25	Becky McLean	Campbell Fleming	Draft	Submitted with application	Outline

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1 INTRODUCTION

This outline Construction Environmental Management Document (CEMD) has been produced by Ardersier Port in conjunction with Civic.

The CEMD has been produced using the principles within The Highland Council Guidance Note on Construction Environmental Management Process for Large Scale Projects (August 2010).

The primary purpose of this document is to ensure that the mitigation described and defined in the 2025 Environmental Impact Assessment Report (EIAR) is implemented during the main construction activities.

The Schedule of Mitigation taken from the finalised EIAR (post-consultation) is provided within **Appendix A**.

This CEMD replaces the 2018 CEMD that was prepared for the previous planning consent.

1.1 APPROACH TO ENVIRONMENTAL MANAGEMENT

The adopted CEMD will contain the following specific mitigation plans. Those in **bold** have been drafted as part of this application and are provided in draft in EIAR Chapter 5 of the EIAR. Other appendices are currently in development:

- Appendix A – EIA Schedule of Mitigation¹ – included in this version
- Appendix B – Site Noise Management Plan
- **Appendix C – Construction Dust Management Plan**
- **Appendix D – Travel Plan Framework**
- **Appendix E – Interim Biosecurity Plan**
- Appendix F – Habitat Management Plan
- Appendix G – Marine Mammal Mitigation Plan
- **Appendix H – Site Waste Management Plan**

The main delivery component for the mitigation identified within these plans will be the production of detailed Construction and Environmental Management Plans (CEMPs) prior to specific elements of construction work commencing. These will relate to individual specific site/aspects of the construction work and will apply the principles of the agreed mitigation to show how the mitigation is implemented effectively down to the specific site level.

¹ Port of Ardersier Limited (November 2025), Ardersier Port Expansion – Environmental Impact Assessment Report – Chapter 15 – Mitigation

1.2 CHANGE CONTROL AND DOCUMENT CONTROL

The CEMD and associated plans, will be subject to approval from Statutory Authorities and will be updated as the various plans that form part of the CEMD evolve. All documents will be reviewed periodically to ensure they are kept up to date and relevant throughout the construction phase.

Where a change is proposed we will implement our Management of Change Procedure (part of our International Organisation for Standardisation (ISO) systems) which includes:

- Define the proposed change.
- Establish a review group internally.
- Assess the change according to potential impact on people, environment, assets and reputation (PEAR framework).
- Consult with relevant Regulators.
- Document the process and consultation.

The CEMD will be updated as appropriate during the progress of the works.

Document control procedures will be implemented to ensure all correspondence, drawings and technical data received are recorded, distributed, filed and archived in an efficient and controlled manner. Document control activities shall include:

- Review of documents and drawings prior to release to ensure that requirements are clearly stated and that they are authorised for issue.
- Identification of documents to be controlled.
- Review and approval of changes to documents and drawings; and
- Control of documents, including approved changes to preclude inadvertent use of obsolete or superseded documents.

2 PROJECT OVERVIEW

For a full description of the proposed development refer to the 2025 EIAR and appendices. A synopsis is given below for context.

2.1 SITE DESCRIPTION

Ardersier Port is located on the Moray Firth. The site is bordered by the Moray Firth to the north, Carse of Delnies to the east, Carse Wood to the south, and the sand dunes and tidal sandflats of Whiteness Sands to the west. Fort George's live firing range is to the southwest, and Whiteness Head Spit, which shelters a harbour.

The site has a long industrial history, having been a hub of activity for the energy sector in Scotland. In the 1970s a substantial area of land was reclaimed from the foreshore and utilised for industrial purposes for the fabrication and construction of offshore platforms for the oil and gas industry, employing in the region of 4,500 people.

Activity ceased in early 2000 and it was vacant for approximately 18 years. Once closed, it became one of the largest brownfield sites in the UK and the site has undergone significant decontamination works since operations ceased.

The proposed extension site is located adjacent to the consented port as shown in **Figure 1** (the area outlined in orange).

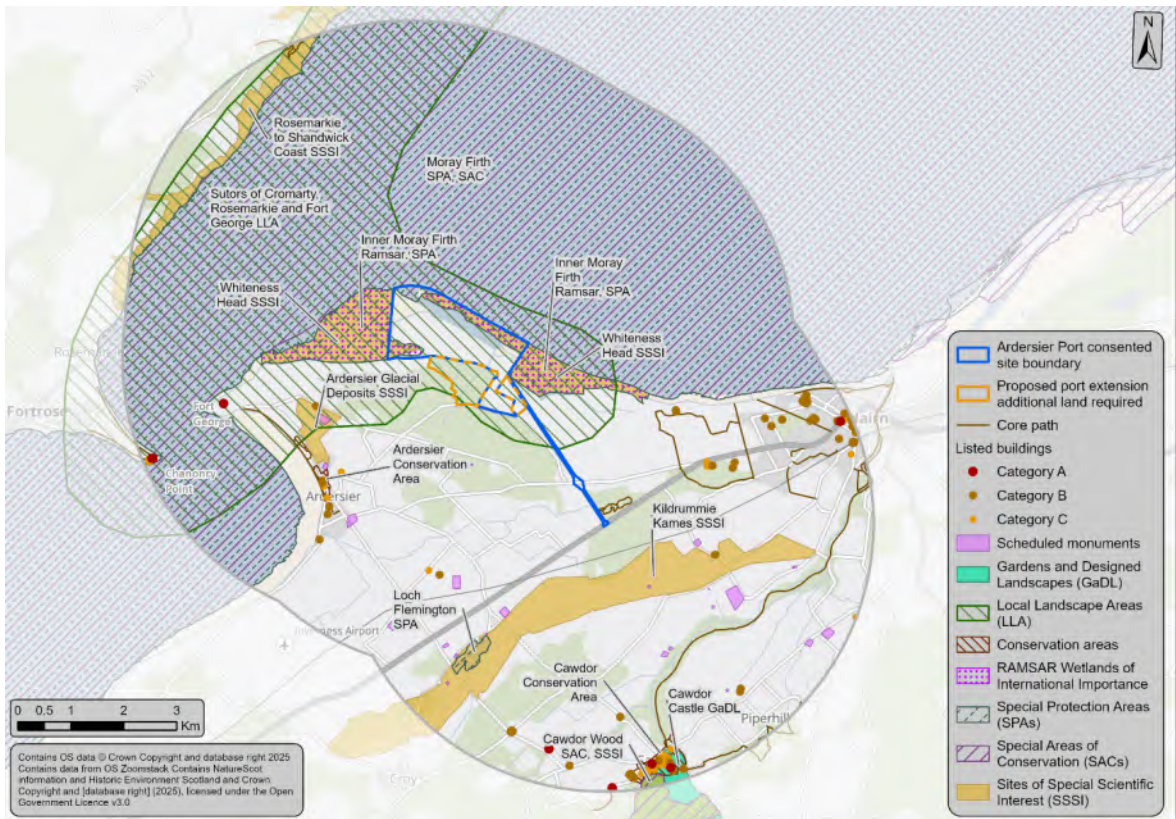
2.2 ENVIRONMENTAL SENSITIVITIES

Key environmental considerations include the sensitive marine and terrestrial habitats, potential impacts on landscape and cultural heritage, and the need to minimise water environment, air quality, noise, carbon, and transport impacts during construction and operation, all key designations and areas of sensitivity are shown in **Figure 2**.

Figure 1: Proposed Extension Site



Figure 2: Environmental Designations & Constraints



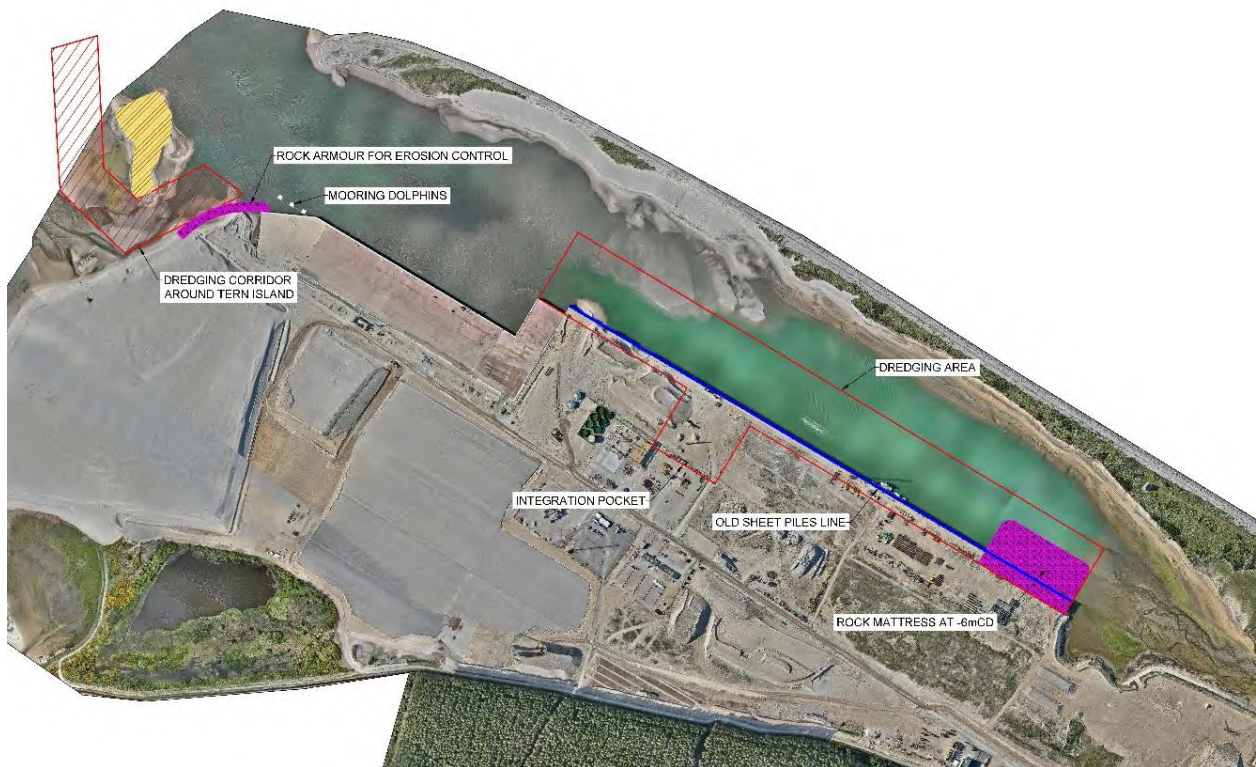
2.3 WORKS OVERVIEW

The construction works relevant to this CEMD include the following terrestrial and marine works.

Marine (Figure 3)

- Construction of an integration pocket for wind turbine assembly
- Removal of old sheet piles with possible use of temporary sand berm.
- Dredging to deepen the harbour to generally -12.4m Chart Datum (CD) in the western harbour extension area and to up to -6mCD in the easternmost part of the harbour (up to 2,000,000m³).
- Disposal of dredgings at licenced disposal ground if no beneficial re-use identified.
- Dredging to west of Tern Island.
- Rock armour for erosion control and rock mattress on seabed in -6mCD area.
- Installation of three mooring dolphins (piled berthing structures).

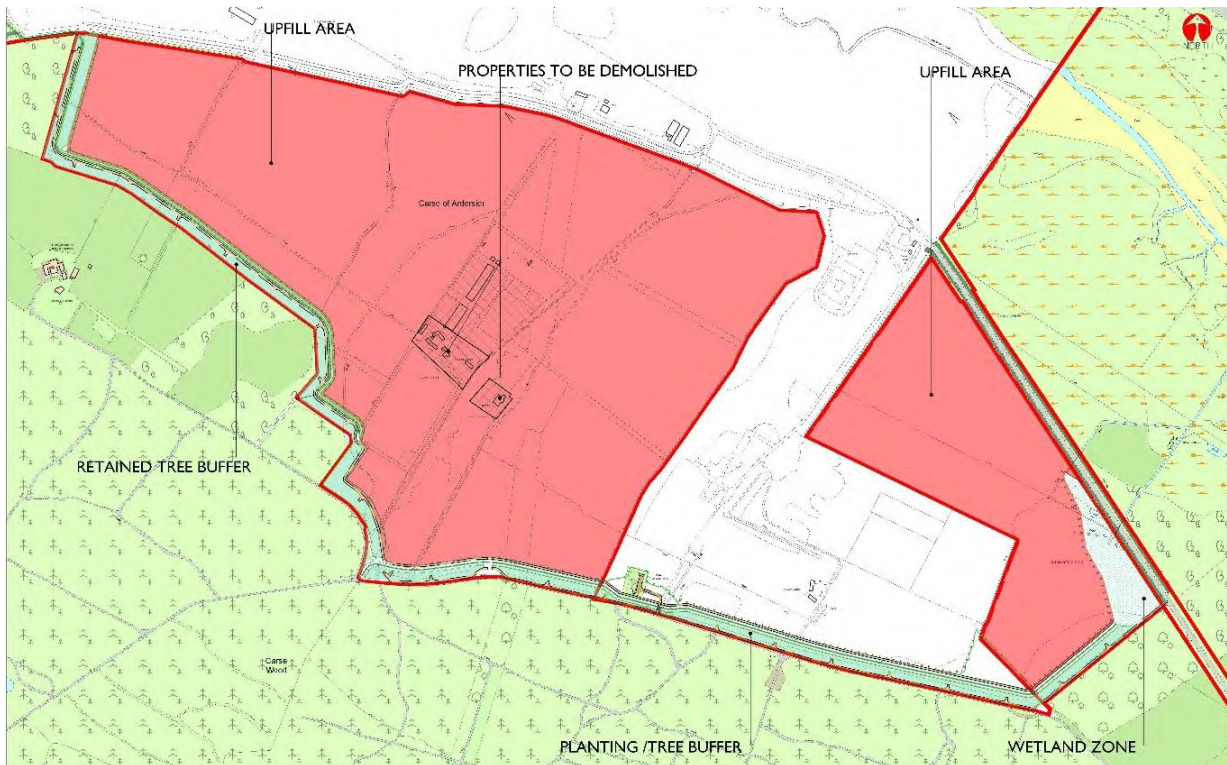
Figure 3: Marine Works Layout



Terrestrial (Figure 4)

- Site clearance of extension area comprising tree felling and clearing.
- Demolition of existing buildings.
- Land raising (upfill) and levelling of extension area to suitable height with previously dredged sand.
- Creation of working platform through stone placement.
- Surface water management during construction; and
- Installation of new permanent watercourses to extension land southern perimeters.

Figure 4: Site Clearance Areas (West - Scots Pine plantation, East - Scrub and Birch) - Terrestrial Works



2.4 WORKS PROGRAMME

With regards to high level timelines, the construction phase is expected to take place between mid-2026 and end 2029. This could take place in discrete phases within that overall time period.

3 ROLES & RESPONSIBILITIES

During construction, Ardersier Port Limited has overall responsibility for delivering the commitments in the CEMD and associated plans.

Ardersier Port Limited will halt any activity where environmental commitments are not being successfully delivered, where legal requirements are being breached or where there is a significant risk to the environment.

Any significant deviations from agreed methods of work will be formally agreed with the relevant parties in advance of the changes and CEMP revised if applicable/necessary.

3.1 ENVIRONMENTAL ROLES AND RESPONSIBILITIES

Roles and responsibilities are outlined below and will be refined during the appointment of Contractor(s).

3.1.1 Head of Consenting / Env. Project Director

The Head of Consenting (HoC) /Project Director has specific environmental responsibilities including:

Demonstrate positive environmental commitment through actively supporting the initial set-up of systems and sustaining effective environmental management and monitoring measures.

- Ensure adequate provision of competent resources.
- Review and sign off of any CEMP's or changes to the CEMD.
- Ensure all consents and licenses are in place prior to work commencing and monitor progress against the Schedule of Mitigation commitments.
- High level engagement with external Stakeholders and Regulators.

3.1.2 Environmental Site Manager / Environmental Advisor

An Environmental Site Manager for the construction phase will be nominated from within Ardersier Port personnel. This person's responsibilities will include:

- Day to day liaison with Contractors on environmental matters and implementation of their CEMP's.
- Arranging audits of the Contractor on an appropriate frequency.
- Conduct or arrange ecological and environmental surveys as required by planning or marine licencing;
- Engage suitable external support when required such as licenced bat workers, and any Environmental Clerk of Work (EnvCoW)/ Ecology Clerk of Work (ECoW) support deemed necessary for specific tasks.
- Arranging toolbox talks for site personnel and Contractors as necessary.
- Stakeholder/Regulator engagement.
- Record keeping of audits and inspections.

3.1.3 Site EnvCow/ECoW

Ardersier Port have a suitably qualified and experienced EnvCoW/ECow on site full time. This allows day-to-day observations on site and therefore greater continuity and consistency of inspection and auditing. The site EnvCoW will audit and record findings for general construction works at a suitable frequency.

3.1.4 Environmental Clerk of Works (EnvCoW) Role/External Consultants

Where workload dictates or specialist works are required (such as bat work or other works requiring to be carried out under licence) such external support will be engaged.

3.1.5 Marine Mammal Observer (MMO)

The Marine Mammal Mitigation Plan (MMMP) defines monitoring and mitigation to protect marine mammals through the marine works. This requires MMOs to be deployed for certain activities.

The MMO roles will include personnel as follows:

- Suitably trained or experienced MMO on dredging vessels (barges/dredger), likely dredging company crew.
- Suitably trained or experienced MMO to observe piling works or other noisy construction works as defined in the MMMP.
- Ardersier MMO/Environmental Manager to provide oversight of Contractor MMOs and carry out spot audits and record checks.

3.1.6 All Site Personnel

All personnel will be made aware of the key commitments in the CEMD and briefed on the requirements of any relevant CEMPs to their Work.

3.1.7 Contractors

The Contractor(s) will be provided copy of the CEMD. They will then be required to prepare detailed CEMPs for their scope of Works. The Contractors CEMP's will be reviewed and agreed with Ardersier Port prior to major construction works commencing. The finalised CEMPs will provide the basis for auditing of the Contractors Works through their contract.

Contractors will be contractually obliged to have a nominated point of contact for all environmental matters (Contractor Environmental Manager) to provide regular feedback and information to Ardersier Port Limited on the progress and success in delivering all conditions, mitigation and commitments on site.

3.2 KEY CONTACT

Dr. C Fleming
Head of Consenting
Ardersier Port
Port Approach
Ardersier
Inverness
IV2 7QX

4 COMMUNICATION, MONITORING AND TRAINING

4.1.1 Communication

There are two key aspects to communications, internal (site team and contractors) and external (stakeholders and regulators).

With regard to internal communications, the site Environmental Manager and Contractors environmental manager(s) will convene a monthly meeting to discuss forthcoming works (month ahead), review any incidents, non-compliance, good practice or improvements that have occurred or are possible looking forward.

This meeting will be formally recorded and distributed to the Head of Consenting/Project Director.

For external communication, in any circumstances that require a change to the CEMD the following process will be followed:

- Informally advise The Highland Council (THC) and other relevant Stakeholders (NatureScot/SEPA) of the intended change.
- Draft and review proposed changes.
- Formally submit to THC for consultation.

4.1.2 Monitoring and Auditing

As part of defining and agreeing a CEMP for a discrete package of Work or Contractor, a schedule of audits will be agreed between Ardersier Port and the Contractor(s). This will include the Contractors own audit schedule, and audits carried out on the Contractor, against their CEMP content, by Ardersier Port.

Copies of all audits will be retained for inspection by The Highland Council or other Regulators if required.

4.1.3 Environmental Training and Awareness

The Ardersier Port environmental teams' competence and experience to deliver the various roles described above shall be appraised continually by the Head of Consenting.

The Ardersier Port general site induction package includes environmental awareness aspects. Awareness training for all site personnel will be provided where they are involved in waste management, working in or near watercourses, surface water pollution and control, dust management measures and noise management measures.

Records of all training required and provided to all employees will be maintained and made available for inspection if required.

5 APPENDICES

APPENDIX A - EIA SCHEDULE OF MITIGATION

Final Schedule of Mitigation to be added following determination

APPENDIX B - SITE NOISE MANAGEMENT PLAN

APPENDIX C - CONSTRUCTION DUST MANAGEMENT PLAN

APPENDIX D – TRAVEL PLAN

APPENDIX E – INTERIM BIOSECURITY PLAN

APPENDIX F - HABITAT MANAGEMENT PLAN

APPENDIX G - MARINE MAMMAL MITIGATION PLAN

APPENDIX H - SITE WASTE MANAGEMENT PLAN

ARDERSIER PORT ENERGY TRANSITION FACILITY PORT EXTENSION



November 2025

Appendix 3.3: Socio-economic Assessment

Economic Impact Assessment of Ardersier Port Extension

A report to

 **Haventus**

October 2025



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1.

Executive Summary

This report assesses the current and future socio-economic impacts of the development and operation of Ardersier Port Extension.

Situated in the Moray Firth with direct access to the North Sea and part of the Green Freeport allocation, the existing Ardersier Port is a deep-water, sheltered port with 153 hectares of brownfield land available for development. Once completed it will provide facilities to support floating and fixed offshore wind developers to carry out staging and integration, foundation fabrication, component manufacturing and maintenance requirements. It will be the largest dedicated offshore wind deployment port facility in Scotland, capable of hosting and supporting gigawatt scale projects. Ardersier Port Extension development will significantly expand the site's capacity to support offshore wind projects. It adds nearly 200 acres of operational land, new quay infrastructure and facilities for assembly and storage.

Strategic national economic and offshore wind industry policy advocates and supports investment to enable port infrastructure supporting offshore wind industry growth. Ardersier Port will be a major contributor to the infrastructural development required to deliver offshore wind projects, actualising economic benefits, jobs and skills growth, and development opportunities promised in the net zero transition.

It is located within the Highland region, a rural economy with limited job opportunities of scale and an aging population. The port development, and particularly the extension project, holds transformative potential for the region and will be important for generating employment opportunities. In conjunction with wider development of the Green Freeport throughout the Highland and Moray regions it will contribute to the retention of the working-age population. It also serves as an excellent project to attract new workers to the region, across all stages of the offshore wind project lifecycle.

The economic impact of the extension project has been split into 3 distinct areas:

- Port Extension development and construction;
- Port Extension operations; and
- Offshore wind impact.

1.1 Port Development and Construction

It is estimated that the total economic impact (including indirect and induced) generated from the development and construction phase of Ardersier Port Extension would be up to:

- £53.8 million GVA and 464 years of employment in Moray & Highland;
- £119.0 million GVA and 1,019 years of employment across Scotland; and



- £284.9 million GVA and 2,662 years of employment in the UK.

As the development and construction of Ardersier Port Extension will take place over a period of time, the economic impacts generated will occur over time, with the largest share of impact is expected to occur during 2027/2028, subject to potential development timelines.

1.2 Port Operations

Economic activity will also be generated on an annual basis from the on-site operations of the Ardersier Port Extension. It is estimated that the total annual economic impact generated from the operation stage of the Ardersier Port Extension (after displacement) would be up to:

- £45.2 million GVA and 445 jobs in Moray & Highland;
- £58.3 million GVA and 569 jobs in Scotland; and
- £95.1 million GVA and 888 jobs across the UK.

These figures exclude impact associated with the offshore wind sector.

1.3 Offshore Wind Impacts

The occupation of the facilities after the completion of the extension at the port would support further the delivery of fixed offshore wind and ScotWind floating offshore wind projects (from 2028/29). The activities at the port are part of the wider offshore wind development impacts considered. Figures are indicative and are based on assumptions for the wider offshore wind sector by ORE Catapult¹ and the previous economic impact assessment BiGGAR Economics has undertaken for the port for consistency.

The Ardersier Port including the extension would contribute to the development of the offshore wind sector. Scottish organisations are expected to secure contracts worth £16 billion to support this deployment by 2040. Of this, about £4 billion is expected to be attributed to the extension project.

This expenditure will drive economic activity that will support employment and generate Gross Value Added (GVA). Employment and GVA are expected to grow throughout the 2030s. In 2040, the additional deployment of offshore wind that is supported by Ardersier Port Extension alone is expected to generate approximately:

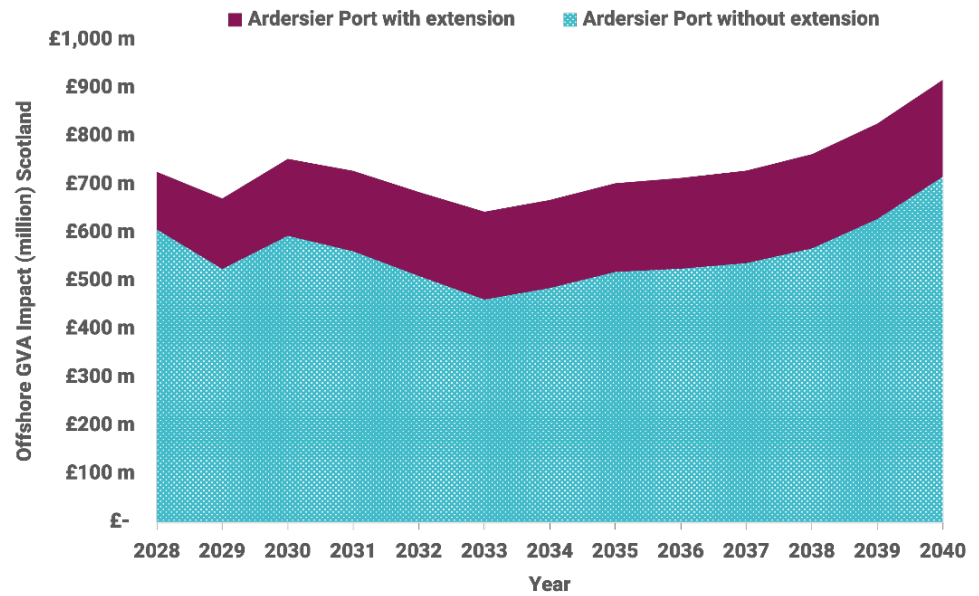
- £720 million GVA and support c.800 jobs in Moray & Highland;
- £1.8 billion GVA and support c.2,000 jobs in Scotland; and
- £6.1 billion GVA and support c.7,100 jobs across the UK;

¹ Floating Offshore Wind Industrialisation Roadmap – Deployment Scenarios produced by ORE Catapult in 2022.



The following figure illustrates the difference in the Scottish GVA outcomes across time with and without the Ardersier Port Extension, highlighting the significance of this project in enhancing economic impact associated with the offshore wind sector.

Figure 1-1: Scottish GVA Impacts Over Time due to Ardersier Port Extension



Source: BiGGAR Economics Analysis

By 2040, approximately half of the employment and GVA impacts will be within companies that are directly contracted onto these projects and half will be in the wider supply chain and induced.

1.4 Wider Socio-Economic Implications

The Ardersier Port Extension will increase further port's capacity to influence the social vitality of the immediate area and the Inner Moray Firth, contributing to a more sustainable and prosperous future for the region. A key driver of depopulation in rural areas is the lack of high-quality employment opportunities which would attract working age people and work to retain current residents as they enter the workforce. With the capability to enable approximately 3,000 long-term on-site jobs, Ardersier Port including the extension is positioned to make a significant contribution toward reversing depopulation trends and supporting the sustainability of the regional economy.

Ardersier Port has the potential to be the largest single site of private sector employment in Highland



Overall, the development, construction, and ongoing operation of Ardersier Port Extension has the potential to provide additional socio-economic benefit to the local community, Highland and Scottish economies, as well as enabling growth of the offshore wind industry in the UK.



2.

Introduction

BiGGAR Economics has been commissioned to undertake an economic impact assessment of Ardersier Port Extension.

2.1 Project Background

2.1.1 Existing Ardersier Port Development

Ardersier Port has a rich history in serving the energy sector and was home to McDermott's Fabrication Yard from the 1970s through to 2001. Many North Sea oil and gas platforms were manufactured here but the site has been vacant since the early 2000s. It is now identified as prime for development to deliver critical infrastructure required by the offshore wind industry.

Situated in the Moray Firth with direct access to the North Sea, Ardersier Port is located approximately 15 miles east of Inverness, 3 miles east of the village of Ardersier, and 6 miles to the west of the town of Nairn. It is approximately 9 miles from Inverness airport, with good road transportation links being close to the A96, which connects Inverness to Aberdeen.

Ardersier Port is a deep-water, sheltered port with 153 hectares of brownfield land available for development. Once the development is completed, it will provide facilities to support fixed and floating offshore wind developers to carry out staging and integration, foundation fabrication, component manufacturing and maintenance requirements. It will be the largest dedicated offshore wind deployment port facility in Scotland, capable of hosting and supporting gigawatt scale projects.

The site is owned by Haventus (Ardersier) Limited and the development is supported by investors Quantum Capital Group, Scottish National Investment Bank and UK Infrastructure Bank.

The proposition for the site is closely aligned with the Inverness and Cromarty Firth Green Freeport's strategic focus on the facilitation of new high-value jobs, contributing to the local skills ecosystem and helping to deliver a fair transition to net zero. Ardersier works collaboratively with other ports in the Green Freeport area to strengthen the area's potential as an offshore wind cluster. Dependent on the site's customer mix, there is high potential for activities delivered at Ardersier to contribute to innovation, both in existing and new energy technologies.

2.1.2 Ardersier Port Extension

The proposed extension of the Ardersier Port Energy Transition Facility builds on the existing consented development by adding nearly 200 acres of new operational land, expanded quay infrastructure and enhanced capacity of offshore wind-related

activities. It includes deeper dredging of the harbour, land-raising and platform creation and facilities for storage, assembly and partial manufacturing of turbine components. The extension will support increased vessel traffic and provides the additional space and flexibility needed to facilitate large-scale offshore wind deployment, strengthening Scotland's role in energy transition.

The figure below shows the consented site and the proposed extension, highlighting the size of this development overall.

Figure 2-1: Ardersier Port Site



Source: Haventus (Ardersier) Limited (2025).

Despite the potential scale of the offshore wind sector, and the investment that has already been made at Ardersier Port, the realisation of the economic opportunity added due to the extension is vital. This study has been commissioned to:

- estimate the economic impacts of the proposed development; and
- explain the impact and the implications within the current socio-economic context.

The impacts and implications are assessed at a local, regional and national level.

2.2 Report Structure

The remainder of this report is structured as follows:

- Chapter 3 presents the strategic economic case for the development;
- Chapter 4 sets the proposed development within the local, regional and national socio-economic context;



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- Chapter 5 explains the approach and methodology used to assess the economic impact of Ardersier Port Extension;
 - Chapter 6 estimates the economic impact of the development; and
 - Chapter 7 discusses some of the wider socio-economic implications.



3.

Strategic Context

Offshore wind has been established as a central resource in achieving both energy security and net zero targets, with Scotland at the forefront in championing both offshore wind policy and investment. The extension at Ardersier will allow the port to benefit further from the opportunities created by offshore wind, delivering high-quality jobs to the Local Area.

Offshore wind technology provides a renewable, low-carbon, energy source that converts the power of wind into electricity without the greenhouse gas emissions associated with traditional energy sources. Offshore wind has grown rapidly in Scotland in recent years, contributing 15.3GW of electricity generation to Scotland in 2023, an 8.6GW increase since 2013².

Due to its larger scale, offshore wind holds a higher generation capacity and is cost efficient. Offshore wind's Contracts for Difference (CfD) strike price cost per unit was £37.35/MW (in 2012 prices) for Allocation Round 4 (AR4), almost 70% lower than its cost in the first CfD AR1 in 2015 at £119.89/MWh. Improvements in efficiency, innovation and supply chains has reduced the CfD price and has led to a considerable saving for consumers³.

The UK and Scotland have consistently grown and expanded their offshore wind capabilities with 2023 setting new records of 49TWh offshore wind green electricity generation. This saved 18.5m tonnes of CO2 emissions annually⁴. Through this expansion in offshore wind the UK now boasts 17% of its electricity generation from this technology, houses 43% of European offshore wind capacity, and is home to the world's largest offshore windfarm, Dogger Bank, which powers the equivalent of 6 million homes annually⁵.

² Scottish Government (2024) *All-Energy conference: speech by Energy Secretary*. Accessed: <https://www.gov.scot/publications/energy-conference-speech-energy-secretary/>

³ UK Government (2023) *Offshore Wind Net Zero Investment Roadmap*. Accessed: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1167856/offshore-wind-investment-roadmap.pdf

⁴ The Crown Estate (2024) *UK offshore industry gearing up for a new era of sustainable growth*. Accessed: <https://www.thecrownestate.co.uk/news/uk-offshore-wind-industry-gearing-up-for-a-new-era-of-sustainable-growth>

⁵ Dogger Bank Wind Farm (2024) *Building the world's largest offshore wind farm*. Accessed: <https://doggerbank.com/>



This expansion has been facilitated by national and local policies that have encouraged, advanced and nurtured offshore wind growth.

3.1 National Strategies

The Climate Change Act 2008 served as an important catalyst to the expansion of the UK renewable base as it provided a legally binding target of net zero greenhouse gas emissions for the UK by 2050⁶, and Scotland by 2045⁷. Offshore wind has been selected as a favourable technology to achieve net zero given its lower cost, lower impact on communities, considerable potential for economic growth, and suitability to Scotland's geographical resource advantages of high wind levels and vast sea area⁸.

Under the UK government's Ten Point Plan for a Green Industrial Revolution 2020, advancing offshore wind is central in accelerating net zero and boosting sustainable economic growth setting an ambitious target of 40GW of offshore wind by 2030⁹. This plan further targets £160m of investment into UK ports and manufacturing infrastructure recognising the role ports will play in delivering this expansion. The UK and Scottish Governments encourage local supply chain content through Supply Chain Plans (SCP), Supply Chain Development Statements (SCDS), and the planned Sustainable Industry Reward (SIR) framework, which are designed to stimulate a much-needed UK based supply chain¹⁰.

This ambition was later updated in 2023 in the UK Net Zero Offshore Wind Roadmap increasing the ambition to 50GW of offshore wind by 2030¹¹. This roadmap details a range of policies and investments across innovation, jobs and skills, strengthening supply chains, streamlining planning processes, collaboration, and infrastructure. Of this 50GW target, 5GW is committed to floating offshore wind. The Department of Energy Security and Net Zero (DESNZ) is supporting this ambition through the Floating Offshore Wind Manufacturing Investment Scheme (FLOWMIS) that provides £160m of competitive funding to assist floating offshore wind through UK port and

⁶ Climate Change Committee (2008) *A legal duty to act*. Accessed: <https://www.theccc.org.uk/what-is-climate-change/a-legal-duty-to-act/#:~:text=The%20Climate%20Change%20Act%202008,to%20deliver%20on%20these%20requirements>

⁷ Scottish Government (2020) *Securing a green recovery on a path to net zero: climate change plan 2018 – 2032 – update*. Accessed: <https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/>

⁸ Scottish Government (2022) *Scotland's National Strategy for Economic Transformation*. Accessed: <https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/pages/5/>

⁹ UK Government (2020) *The ten point plan for a green industrial revolution*. Accessed: <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>

¹⁰ Crown Estate Scotland (2023) *Supply Chain Development Strategy*. Accessed: <https://www.crownestatescotland.com/sites/default/files/2023-07/foi-259-supply-chain-development-statement-summary.pdf>

¹¹ UK Government (2023) *Offshore Wind Net Zero Investment Roadmap*. Accessed: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1167856/offshore-wind-investment-roadmap.pdf

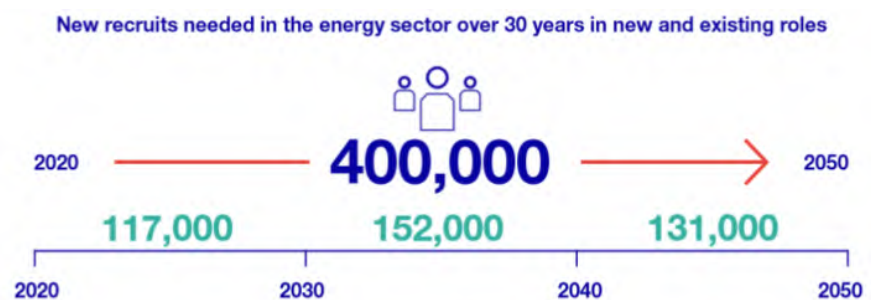


manufacturing investments¹². Expected port developments under the Offshore Wind Roadmap seek to support the supply chain in full, from manufacturing, to installation, and operation and maintenance of fixed foundation offshore wind turbines. It also seeks to develop large-scale deepwater ports designed to fabricate, assemble, store and deploy floating offshore wind turbines.

Through these investments it is predicted that offshore wind sector growth will generate 90,000 direct and indirect jobs by 2030. This will offer a more sustainable industry both environmentally and socio-economically to regions dependent on otherwise seasonal and in some cases declining sectors.

Job creation across the supply chain will be a large output of the offshore wind expansion. The National Grid's *Building the Net Zero Energy Workforce Report* predicts a requirement for a total of 400,000 energy sector jobs across the next three decades to deliver net zero by 2050 – see Figure 1¹³.

Figure 3-1: National Grid Recruitment Projection (2020)



In a world-leading partnership between industry and government, the North Sea Transition Deal (2023) was devised to support oil and gas workers, businesses, and supply chains to decarbonise¹⁴. Through utilising existing competencies, infrastructure, and investment to transition to new industries offshore wind will be utilised in a way that both decarbonises and supports oil and gas production. Under the INTOG¹⁵ leasing round released by Crown Estate Scotland (CES), 13 projects were issued totalling 5.5GW of capacity. These projects are the first of their kind as they are designed to develop floating offshore wind through a series of commercial

¹² Department of Energy Security and Net Zero (2022) *Floating Offshore Wind Manufacturing Investment Scheme: request for information*. Accessed: <https://www.gov.uk/government/calls-for-evidence/floating-offshore-wind-manufacturing-investment-scheme-request-for-information>

¹³ National Grid (2020) *Building the Net Zero Energy Workforce Report*. Accessed: <https://www.nationalgrid.com/stories/journey-to-net-zero/net-zero-energy-workforce>

¹⁴ UK Government (2021) *North Sea Transition Deal*. Accessed: <https://www.gov.uk/government/publications/north-sea-transition-deal>

¹⁵ Crown Estate Scotland (2023) *INTOG: 13 projects selected to support green innovation and help decarbonise North Sea*. Accessed: <https://www.crownestatescotland.com/news/intog-13-projects-selected-to-support-green-innovation-and-help-decarbonise-north-sea>



pilot innovation projects (less than 100MW) and directly reduce emissions of oil and gas production in the North Sea¹⁶.

Under the North Sea Transition Deal an integrated People and Skills Plan was designed to equip the oil and gas workforce with the relevant skills required to move into adjacent offshore energy industries. By combining floating offshore wind and oil and gas production through INTOG projects this vision is supported and mitigates the exit of skilled workers in the labour force. Through learning and understanding renewable technologies alongside oil and gas, re-skilling of the energy labour force can be better managed as we phase out fossil fuels enabling a smoother transition between industries for existing workers.

These projects came just one year after the 2022 ScotWind licencing round that awarded 20 projects with seabed option agreements and a predicted generation capacity of 30GW¹⁷. 13 out of the 20 projects are to be floating rather than fixed turbines seeking to capitalise on Scotland's strength in floating offshore wind testing through commercial scale projects.

Based on areas of the seabed identified by the Scottish Government's Sectoral Marine Plan for Offshore Wind, ScotWind is 'plan-led' with seabed options placed in pre-determined areas found suitable for future commercial scale offshore wind. These sites were selected to accommodate deep water technologies and turbines for inshore and offshore waters¹⁸.

Given its long-established legacy in offshore engineering ScotWind provides a platform to reshape Scotland's oil and gas legacy towards a green and sustainable economic future with supply chain commitments required from the start from developers. The first of its kind, applicants were required to include a SCDS and Outlook which detailed the planned location and type of supply chain requirements for all stages of their project. Intended to provide indications of full life cycle needs – development, manufacturing and construction, operations and maintenance – early analysis indicates an average investment outcome of £1.5bn per project in Scotland¹⁹. Further, having secured £755m for public spending through ScotWind CES anticipates £4m per GW pa output for public spending over the coming 10 years which will be passed directly to the Scottish Government.

¹⁶ Offshore Renewable Energy Catapult (2024) *Leading technology centres create network to drive innovation in floating offshore wind*. Accessed: [https://ore.catapult.org.uk/press-releases/leading-technology-centres-create-network-to-drive-innovation-in-floating-offshore-wind/#:~:text=The%20INTOG%20leasing%20round%2C%20managed.\)%20innovation%20projects%20\(IN\)](https://ore.catapult.org.uk/press-releases/leading-technology-centres-create-network-to-drive-innovation-in-floating-offshore-wind/#:~:text=The%20INTOG%20leasing%20round%2C%20managed.)%20innovation%20projects%20(IN)

¹⁷ Offshore Wind Scotland (2022) ScotWind Licensing Round. Accessed: <https://www.offshorewindscotland.org.uk/the-offshore-wind-market-in-scotland/scotwind-leasing-round/>

¹⁸ Scottish Government (2020) *Sectoral marine plan for offshore wind*. Accessed: <https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/>

¹⁹ Crown Estate Scotland (2022) *ScotWind leasing round*. Accessed: <https://www.crownestatescotland.com/scotlands-property/offshore-wind/scotwind-leasing-round>



3.2 Inverness and Cromarty Green Freeport

Inverness and Moray Firth are favourably located to service and supply many of the ScotWind and INTOG projects. These projects bring much needed economic diversification and stability to the region and reduce reliance on seasonal industries and generate sustainable growth paths that could span decades.

A major win for the region was the accreditation of Green Freeport status by the UK and Scottish Government²⁰. Freeports seek to serve as national hubs for global trade and investment, provide hotbeds for innovation, and create regeneration for communities most in need through high-skilled job creation²¹. This is done by identifying specific areas – *zones* – to receive ‘economic levers’ designed to boost investments and generate meaningful economic growth in regions that otherwise remain overlooked by industrial strategies²². These levers include trade and investment support; customs and trade tariff benefits; tax reliefs; planning regulations; regeneration and infrastructure funding; and funding to support innovation.

After the appointment of 7 UK Freeports, a separate bidding process was undertaken in Scotland run jointly by both the UK and Scottish Governments to identify two Freeport zones. The Scottish Green Freeport model adapts the UK Government’s model seeking to achieve five objectives: (1) Promote regeneration and job creation through inclusive sustainable growth; (2) Establish hubs for global trade and investment; (3) Contribute to a just transition and net zero economy; (4) Drive fair work practice; and (5) Foster an innovation environment²³.

To ensure an equitable distribution of benefits from this model, Greenport operators and businesses are required to adopt the Fair Wage First approach that includes paying the real Living Wage (£12/hour 2024²⁴); implement the Scottish Business Pledge; commit and supporting sustainable and inclusive growth in local communities; and contribute to Scotland’s just transition and net zero.

The Inverness and Cromarty Green Freeport gained status in 2023 and constitutes a cross-sector partnership between the five ports in the region - Port of Cromarty Firth, Port of Nigg, Port of Inverness, Ardersier and Highland Deephaven. This union could be transformative to the economic development of the Scottish Highlands and to the Scottish economy as a whole. Through planned construction projects, science,

²⁰ The Highland Council (2021) *Inner Moray Firth Local Development Plan (IMFLDP)*. Accessed: https://www.highland.gov.uk/info/178/development_plans/202/inner_moray_firth_local_development_plan

²¹ UK Government (2022) *UK Freeports Programme Annual Report 2022*. Accessed: <https://www.gov.uk/government/publications/uk-freeports-programme-annual-report-2022/uk-freeports-programme-annual-report-2022>

²² UK Government (2021) *Freeports*. Accessed: <https://www.gov.uk/guidance/freeports>

²³ Scottish Government (2023) *Green Freeports*. Accessed: <https://www.gov.scot/policies/cities-regions/green-ports/>

²⁴ Scottish Government (2024) *Fair work milestone*. Accessed: <https://www.gov.scot/news/fair-work-milestone/>



technology, engineering, arts and mathematics (STEAM) skills engagement and advancement, renewable activities and cluster network development Inverness and Cromarty Firth Green Freeport currently predict up to 10,250 jobs to the region and a further 16,500 jobs across the UK²⁵ that could generate £690million GVA per year for the Scottish Economy²⁶ as direct outcomes of the alliance.

Ardersier Port is well located to support the 35GW of ScotWind and INTOG projects given its proximity to many of these projects and its participation in the Inverness and Cromarty Firth Green Freeport. As a tax site within a Green Freeport, Ardersier is ideally situated to support offshore wind developers and manufacturers of offshore wind equipment and components. Ardersier Port expansion and re-development constitutes the largest dedicated offshore wind deployment facility in Scotland that will be capable of supporting gigawatt scale projects through quayside access suitable for infrastructure manufacturing, assembly, marshalling, and integration of offshore wind components²⁷

In addition to the awarding of Green Freeport status, further support was won for the region by the Scottish Government through the support of their £500m Just Transition Fund²⁸. This fund seeks to scale up renewable energy production, increase investment in net zero energies, and deliver a stable energy environment with fairer consumer costs. This investment will work in tandem with the Green Freeport to develop the region into a centre for excellence for energy transition.

Initial investments at Ardersier contribute strongly to this regional strategy; with the £300m investment from Quantum Capital Group, and a further £100m loan from the Scottish National Investment Bank and UK Investment Bank.

3.3 Summary

The north of Scotland is in an exciting position in the offshore wind market and is uniquely placed to take advantage of its geographical assets to generate meaningful and sustained economic development.

Ardersier Port will be a major contributor to the infrastructural development required to deliver offshore wind projects and actualise the economic benefits, jobs and skills growth, and development opportunities promised in the transition to net zero. The extension will allow Ardersier to increase its ability to support the sector, increasing the number and longevity of high quality jobs in the Local Area.

²⁵ Inverness and Cromarty Green Freeport (2023) *Inverness and Cromarty Green Freeport*. Accessed: <https://greenfreeport.scot/>

²⁶ BiGGAR Economics (2022) *Opportunity Cromarty Forth: Economic Impact and Baseline Report*.

²⁷ The Scottish National Investment Bank (2023) *Ardersier Port*. Accessed: <https://www.thebank.scot/ardersier-port>

²⁸ Scottish Government (2023) *Scotland's Energy Strategy Transition Plan: Ministerial Statement*. Accessed: <https://www.gov.scot/publications/scotlands-energy-strategy-transition-plan-ministerial-statement/>



4.

Socio-Economic Context

This section discusses the socio-economic context of Ardersier Port Extension.

This section sets the development within its socio-economic context, including data on population trends, industrial structure, labour market activity, tourism overview, and the Scottish Index for Mass Deprivation (SIMD). The baseline focuses on the following study areas:

- Local area: The electoral wards of Culloden & Ardersier, Tain & Easter Ross, Cromarty Firth, Dingwall & Seaforth, Aird & Loch Ness, Inverness South, Inverness West, Inverness Milburn, Inverness Central, Inverness Ness-Side, Black Isle, Nairn & Cawdor;
- Highland and Moray;
- Scotland; and
- The UK.

4.1 Population

4.1.1 Population Estimates

In 2022, the population of Highland and Moray was 334,500 or 6.1% of the total population of Scotland. The population of the Local Area was 141,937, equivalent to 42.4% of the population of Highland and Moray.

The proportion of residents aged 16-64 years old (61.3%) in the Local Area is in line with the average for Highland and Moray (60.9%) but is below average compared to Scotland as a whole (63.8%) and the UK (62.8%). This lower share average of working age population in the Local Area and Highland and Moray indicates a lack of employment opportunities, generating outward migration of this demographic.

The share of people aged 65 and over is higher in both the Local Area (21.7%) and Highland and Moray (22.9%) compared to Scotland and the UK, where this demographic accounts for 19.6% and 18.8% of the population, respectively.

Table 4-1: Population Estimates, 2022

	Local Area	Highland and Moray	Scotland	UK
Aged 0-15	17.0%	16.1%	16.6%	18%
Aged 16-64	61.3%	60.9%	63.8%	63%
Aged 65+	21.7%	22.9%	19.6%	19%
Total	141,937	334,500	5,479,900	67,652,999

Source: ONS (2023), Population estimates and National Records of Scotland (2023), Mid-2022 Population Estimates

4.1.2 Population Projections

It is expected that, between 2022 and 2043, the total population of Highland and Moray will fall from 334,500 to 326,216, a reduction of 2%, while it is expected that the populations of Scotland and the UK will increase over the same period, by 2% and 7%, respectively.

It is expected that the share of people aged 65 and over will increase in Highland and Moray from 22.9% in 2022 to 30.2% in 2043. It is expected that the share of the population accounted for by this demographic in 2043 will be significantly above average compared to Scotland (24.9%) and the UK as a whole (24.0%).

Over the same period, projections predict a 10.6% reduction of in the working age population (aged 16-64) in Highland and Moray, representing a total reduction of 21,670 people of working age in the region. This suggests a lack of employment opportunities leading to outmigration, with potential consequences for the sustainability of the region's economy as well as local services as a declining working age population will have to support a growing ageing population.

Table 4-2: Population Projections

Year	Highland & Moray		Scotland		UK	
	2022	2043	2022	2043	2022	2043
Total	334,500	326,216	5,479,900	5,574,819	67,652,999	72,563,415
Aged 0-15	16.1%	14.1%	16.6%	14.8%	18.4%	17.0%
Aged 16-64	60.9%	55.8%	63.8%	60.3%	62.8%	58.9%
Aged 65+	22.9%	30.2%	19.6%	24.9%	18.8%	24.0%

Source: ONS (2018), Population Projections – Local Authority Based by Single Year of Age, National Records of Scotland (2020), Population Projections for Scottish Areas (2018-based), Welsh Government (2021), National Population projections 2021-based and NISRA (2025), Projected Future population of Northern Ireland by Age and Sex.



4.2 Industrial Structure

In 2023, 73,325 people were employed in the Local Area. Human health and social work activities constitute the largest employer in the Local Area (19.6%), accounting for an above average share of employment compared to Highland and Moray (15.4%), Scotland (15.6%), and the UK (13.6%).

The construction sector employs 6.9% of workers in the Local Area and 6.1% of workers in Highland and Moray. Employment in this sector in the Local Area and Highland and Moray is above the average in Scotland (5.1%) and the UK (4.9%), suggesting opportunities in the region from the Ardersier Port extension and the resulting activities.

Manufacturing accounts for 7.1% of employment in Highland and Moray, average compared to Scotland (6.7%) and the UK (7.4%). The Ardersier Port extension is also expected to result in benefits for this sector in the region, targeting the expansion of offshore wind manufacturing and thus providing long-term work in this sector.

The extension of Ardersier Port has the potential to help address the ageing population profile of the Local Area and Highland and Moray by generating opportunities for the local workforce in construction and manufacturing, attracting inward migration of workers.

Table 4-3 Industrial Structure, 2023

	Local Area	Highland & Moray	Scotland	UK
Health health & social work activities	19.6%	15.4%	15.6%	13.6%
Retail	10.0%	8.9%	8.7%	8.3%
Accommodation & food services	9.1%	11.3%	8.6%	7.9%
Education	7.4%	7.4%	8.2%	8.3%
Construction	6.9%	6.1%	5.1%	4.9%
Public administration & defence	6.2%	5.0%	6.2%	4.6%
Business administration & support services	6.1%	4.2%	6.8%	8.5%
Transport & storage	6.0%	4.6%	4.5%	4.9%
Professional, scientific & technical	5.3%	4.5%	7.2%	9.3%
Manufacturing	5.0%	7.1%	6.7%	7.4%



Arts, entertainment, recreation & other services	4.2%	4.6%	4.4%	4.6%
Wholesale	3.2%	2.6%	2.8%	3.6%
Motor trades	2.5%	2.0%	1.7%	1.7%
Information & communication	2.4%	1.5%	3.1%	4.4%
Mining, quarrying & utilities	2.3%	2.7%	2.5%	1.2%
Agriculture, forestry & fishing	2.0%	10.1%	3.4%	1.4%
Property	1.2%	1.3%	1.5%	2.0%
Financial & insurance	0.6%	0.7%	3.2%	3.3%
Total	73,325	168,450	2,657,000	32,259,000

Source: ONS (2025), Business Register and Employment Survey 2023

4.3 Labour Market Indicators

As shown in Table 4-4, in 2024, the share of working age people in Highland and Moray who are economically active (80.2%) is above average compared to both Scotland (77.0%) and the UK as a whole (78.5%). The unemployment rate in the 12 months to September 2023 was 3.4% in Highland and Moray, average compared to Scotland (3.4%) and slightly below the UK average of 3.8%.

In 2024, the median annual gross wage of Highland and Moray residents was £37,888, below median wages across Scotland (£38,286). This was largely driven by Moray, where the median annual gross wage was £34,849, compared to £38,823 in Highland.

Table 4-4 Labour Market Indicators

	Highland & Moray	Scotland	UK
Economic Activity Rate	80.2%	77.0%	78.5%
Unemployment Rate*	3.4%	3.4%	3.8%
Medium Annual Gross Income (all residents)	£37,888	£38,286	£37,430

Source: ONS (2025), Annual Population Survey - Data for January 2024-December 2024 and ONS (2025), Annual Survey of Hours and Earnings – Resident Analysis. *Data for October 2022-September 2023



4.4 Tourism

Table 4-5 details the number of visits and expenditure of domestic and international overnight visitors to Highland, Grampian (comprised of Aberdeen, Aberdeenshire, and Moray Speyside) and Scotland in 2023.

There were 1.8 million domestic overnight visitors to Highland in 2023, with a total expenditure of £437 million. This is equivalent to a spend per trip of £243. The same year, Grampian received 1.1 million domestic overnight visitors, with a total expenditure of £252 million, equivalent to an average spend per trip of £229. The average spend per trip to both areas was below average compared to Scotland as a whole, where the 12.4 million domestic overnight visitors spent a total £3,189 million, equivalent to £257 per trip.

There were 0.5 million international overnight visitors to Highland in 2023, accounting for 13% of the total 4.0 million international overnight trips in Scotland. This group spent a total £325 million, an average spend per trip of £650. Grampian received 0.3 million visitors, 9% of total international overnight trips in Scotland. International visitors to Grampian spent an average £527 each trip, totalling £158 million. Spend per trip by international overnight visitors was also lower than average in these regions compared to Scotland as a whole (£898).

Table 4-5 Visitor Numbers and Expenditure, 2023

Number of Visitors	Highland	Grampian	Scotland
Visitor Numbers (Million)			
Domestic Overnight Visitors	1.8	1.1	12.4
International Overnight Visitors	0.5	0.3	4.0
Expenditure (£ million)			
Domestic Overnight Visitors	£437	£252	£3,189
International Overnight Visitors	£325	£158	£3,593

Source: Kantar TNS (2024), Great Britain Tourism Survey 2023 and ONS (2024), International Passenger Survey.

4.5 Scottish Index of Multiple Deprivation (SIMD)

The SIMD is a measure of relative deprivation that ranks small areas of Scotland across seven dimensions: income, employment, education, health, access to services, crime, housing. These areas are ranked based on which quintile (fifth of the



distribution) they belong to, ranging from the first 20% (quintile) being the most deprived to the fifth the least.

There are 438 small areas in Highland and Moray, 8% of which are in Quintile 1, meaning 8% of the small areas in Highland and Moray are in the 20% most deprived small areas in Scotland, suggesting lower than average levels of severe deprivation in Highland and Moray.

Levels of severe deprivation are also below average in the Culloden & Ardersier and the as a whole Local Area, where 0% and 13% of small areas are located in Quintile 1, respectively.

In Culloden and Ardersier 29% of small areas are in Quintile 5, the 20% least deprived areas of Scotland, while 12% and 9% of small areas were in this quintile in the Local Area and Highland and Moray, respectively. This demonstrates that levels of deprivation Culloden and Ardersier overall are lower than in the Local Area and Highland and Moray.

Table 4-6 Scottish Index of Multiple Deprivation

	Culloden & Ardersier	Local Area	Highland & Moray
1 (20% most deprived)	0%	13%	8%
2	29%	17%	17%
3	21%	26%	34%
4	21%	31%	32%
5 (20% least deprived)	29%	12%	9%
Total Small Areas	14	180	438

Source: Scottish Government (2020), Scottish Index of Multiple Deprivation 2020

4.6 Socio-Economic Context Summary

With a smaller share of the working-age population supporting a higher proportion of those aged over 65 years, the port development will be important for generating employment opportunities in the immediate area. The extension will primarily contribute to the retention of the working-age population by attracting new workers to the region, helping to address the projected decline in this demographic in Highland and Moray.



5. Methodology

This section describes the approach and methodology used to assess the economic impacts associated with Ardersier Port Extension.

5.1 Approach to Port Impacts

Ardersier Port Extension will generate economic activity in both the short and long-term. This would arise from the port **development and construction** phase (short-term) and from the long-term **operation** of the port. The primary metrics of assessment used to estimate this activity are:

- **Gross Value Added (GVA)** – a measure of economic value added by an organisation or industry;
- **Years of employment** – a measure of employment which is equivalent to one person being employed for a full year. It is typically used when considering short-term employment impacts, such as those associated with construction; and
- **Jobs (FTEs)** – a measure of headcount employment supported by an organisation or industry.

Data on development and capital expenditure was used as the basis of the input-output modelling exercise to estimate the economic impact associated with the Ardersier Port Extension. These costs represent an increase in turnover, supporting economic activity.

Construction costs were then categorised to one of the industrial sectors used by the Scottish and UK Governments in official statistics, e.g. construction. This sector was used as the basis for estimating GVA and employment impacts. Information on turnover, GVA and employment is sourced from the UK Annual Business Survey (ABS)²⁹, which is published by the ONS.

For the sector, GVA can be presented as a percentage of turnover and therefore, to estimate the direct GVA impact, turnover is multiplied by the GVA/turnover ratio. Similarly, to estimate the direct employment impacts, turnover in each contract is divided by turnover/employee in the relevant sector.

As well as **direct** GVA and employment impacts, there will also be **indirect** and **induced** impacts associated with spending in the wider supply chain and employees' spending. These impacts were estimated by applying sector-specific Type I (indirect) and Type II (indirect and induced) multipliers to the direct impact. These multipliers

²⁹ Office for National Statistics (ONS) (2024), Annual Business Survey.



were sourced from the Scottish Government Input-Output Tables³⁰. The total impact associated with a project encompasses the direct, indirect and induced impacts.

Operations costs were categorised to a sector which was created using averages from all the relevant port-related sub-sectors used by the Scottish and UK Government in official statistics e.g., warehousing and support activities for transportation. To calculate operations impacts, a similar approach was followed to the construction phase, but employment multipliers were applied to job figures to calculate turnover and GVA.

For the purpose of this report, impacts have been assessed for the study areas of:

- Moray & Highland;
- Scotland; and
- The UK.

All figures are presented in 2024 prices, accounting for inflation.

5.2 Approach to Offshore Wind Impacts

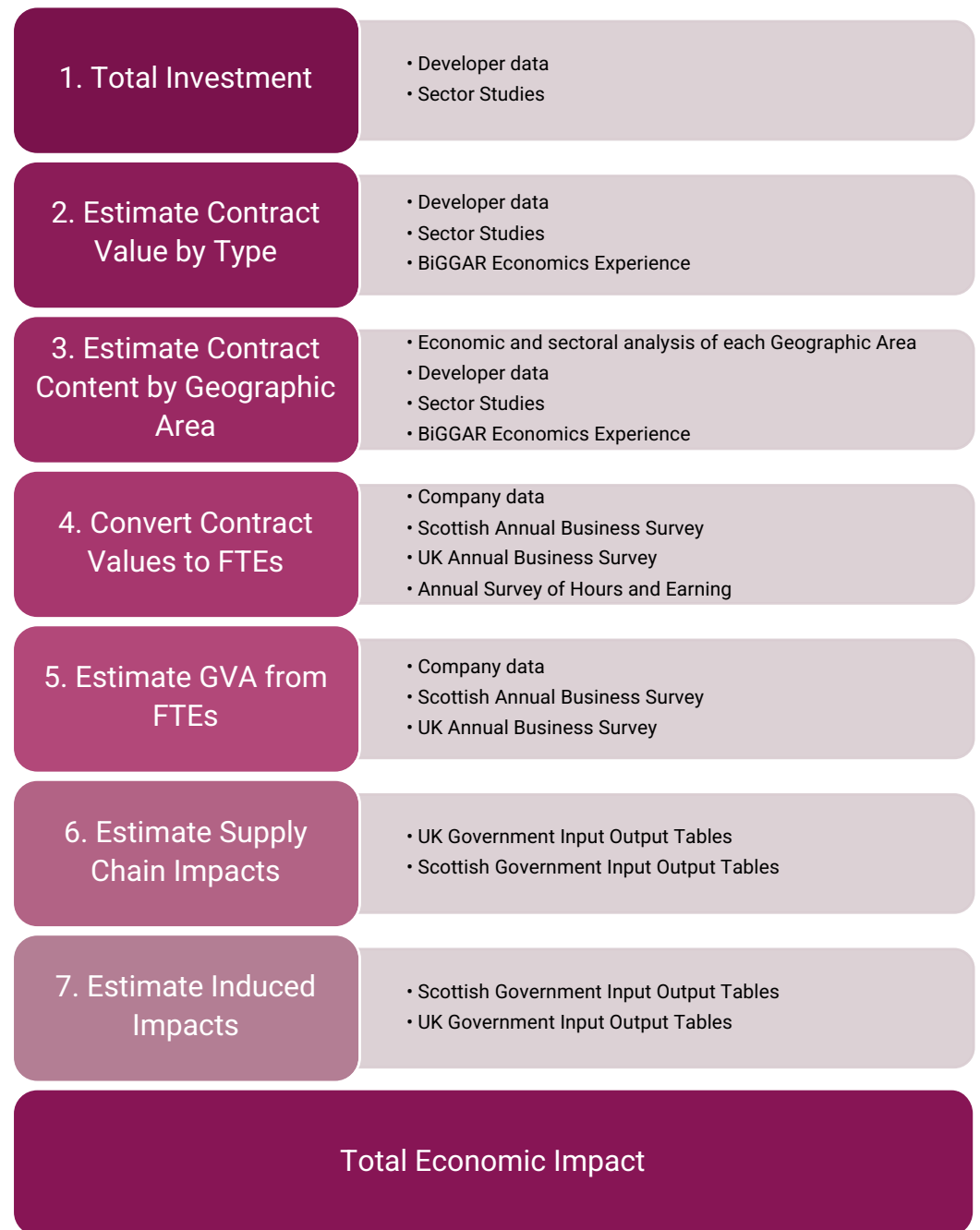
Having selected the study areas for which GVA and employment impacts are considered, it is then possible to gather relevant information and estimate economic impacts on the offshore wind sector. The estimation of the economic benefits from an offshore wind project is based on a purposely-built tool developed by BiGGAR Economics. As set out in the figure below, the analysis is also based on an Input-Output methodology built upon the following steps in line with the approach taken to the Contracts for Difference Supply Chain Plan assessments:

- estimation of the total investment associated with the project (construction and development and operations and maintenance);
- estimation of contract value by type;
- estimation of contract content by geographical area;
- conversion of contracts into the direct employment supported by the project;
- estimation of direct GVA based on direct employment supported;
- estimation of supply chain (indirect) impacts on GVA and employment; and
- estimation of the staff spending (induced) impacts on GVA and employment.

³⁰Scottish Government (2020), Supply, Use and Input-Output Tables.



Figure 5-1: Economic Impact Methodology and Data Sources



This assessment is based on BiGGAR Economics' economic impact assessments of several Scotwind and INTOG offshore wind projects, including several that are considering using Ardersier Port. Our work has included the assessment of the economic impacts of local effects in and around ports to be used as bases for construction and for operations. The economic impact that is enabled by the Ardersier Port Extension investment is driven by the additional capacity of offshore wind that could be deployed in the Scotland and the UK.



5.2.1 Discounting

The analysis, where appropriate, also provides estimates based on the Net Present Value (NPV) of activity. This is based on His Majesty Treasury's guidance on economic appraisal as included in the Green Book³¹, where it is recommended that impacts occurring over long periods of time are discounted to account for the different value people give to present compared to future consumption. The HMT's suggested discount factor of **3.5%** is applied.

5.2.2 Learning Rate

It is assumed that the offshore wind sector will experience a reduction in costs as the sector learns and develops through deployment. The cost reductions are based on analysis by the Offshore Renewable Energy Catapult³² and the level of deployment of floating offshore wind in UK waters. This analysis estimates that with innovation, the costs of floating offshore wind would reduce by 9.5% for every doubling of installed capacity above 1 GW. Similarly, the National Renewable Energy Laboratory (NREL)³³ has estimated that the learning rate for offshore wind would be 11.5% for floating and 8.8% for fixed bottom. For the purposes of this assessment, it is assumed that the learning rate is approximately 10%.

The additional port capacity through the extension will enable the offshore wind sector to achieve cost reductions quicker. The reduced costs have been taken into consideration when calculating the projected economic impact of the capital expenditure.

5.2.3 Additionality

The HM Treasury Green Book recommends taking account of the following factors to assess what would have happened if an investment or development did not take place (the net impact). These include:

- **Deadweight** – the outcomes that would have taken place without the intervention under consideration. Specifically, in this example the outcomes that would occur without the construction of the extension project. In this case, the business-as-usual would be represented by the existing Ardersier Port development calculated finding the difference between the 150GW and 100 GW scenarios (see below);
- **Displacement** – the extent to which activity generated might replace activity elsewhere in the study areas;
- **Substitution** – where one type of labour or factor of production, such as capital equipment, is substituted for another but there is no increase in employment or output. This is not considered to be relevant to this assessment; and
- **Leakage** – the proportion of activity that might take place outside of the main study areas. The economic impact considers the impact in Moray & Highland, Scotland and the UK as a whole to capture leakage effects.

³¹ HM Treasury (2022), The Green Book 2022.

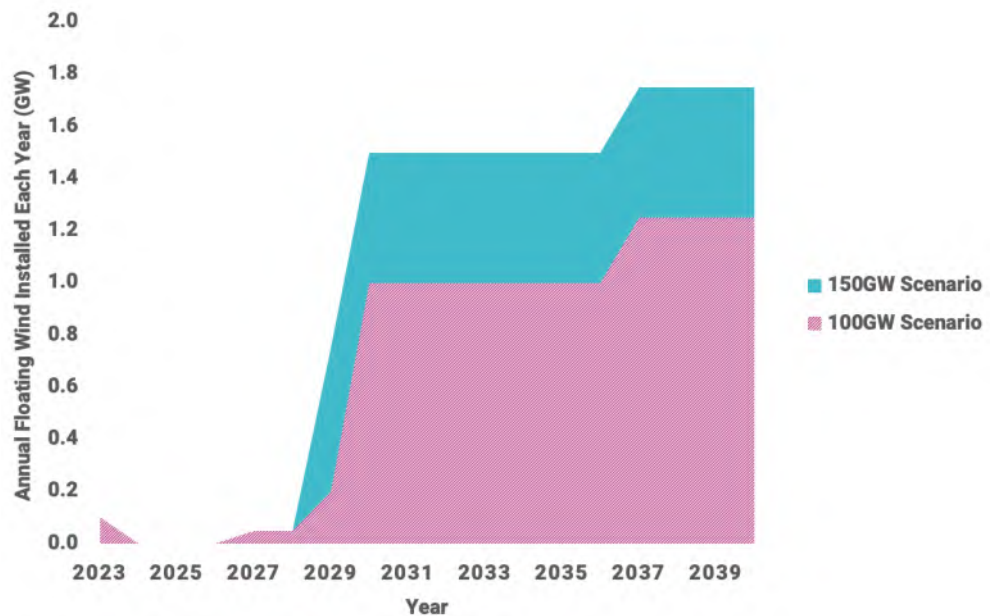
³² ORE Catapult (2021) Floating Offshore Wind Cost Reduction Pathway to Subsidy Free

³³ National Renewable Energy Laboratory (2022) A systematic framework for projecting the future cost of offshore wind energy

Deadweight

The figure below shows that the installed capacity deployed to floating offshore wind locations due to the Ardersier Port development, would be approximately equal to the difference between the 150GW and the 100GW Scenarios for Scotland from 2028 onwards. This shows that the 150GW scenario would see about 1.8 GW of floating offshore wind installed in 2040 in Scotland as a result of the Ardersier Port investment. This 50 MW difference in the scenarios is attributed to the port’s facilitation of turbine handling and logistics, serving as a proxy for the port’s contribution to sector growth.

Figure 5-2: Additional Floating Offshore Wind Capacity considered - Scotland



Source: BIGGAR Economics Analysis using Floating Offshore Wind Industrialisation Roadmap – Deployment Scenarios produced by ORE Catapult in 2022.

Cumulatively this would result in about 6 GW of additional floating offshore wind in Scotland by 2040 that would otherwise have occurred, without the development of the Ardersier Port.

The analysis considers the economic impacts of the additional capacity. The first step is to calculate the economic impacts of the Ardersier Port as a whole with and without the extension project from the difference between the two scenarios depicting a scenario where the port is developed, compared to the scenario where Scottish ports do not have the necessary facilities and capacity (deadweight). The difference between the economic impacts of Ardersier Port with and without the extension would then represent the impact of the Ardersier Port Extension. These are computed accounting for the offshore wind supply chain content in each study area. Based on information provided by Haventus, the extension provides operational capacity for the offshore wind sector as a whole which could support the floating capability, however the additional floating offshore wind capacity is expected to



remain unchanged with the Ardersier Port Extension project and therefore, no additional capacity is expected to be attributed to the extension.

For fixed offshore wind, a total of up to 100 units were expected to be passing through the facility over a period of 12 months without the extension project. It was anticipated that one third of the installed capacity would be additional due to the potential for this activity taking place in other ports such as Dundee, Leith and Cromarty. This would result in a total installed capacity of c.500 MW per year and a similar approach was considered to the floating offshore wind. With the extension, this figure is expected to double over a period of 12 months.

Considering this increase in the number of fixed turbine units passing through the port due to the extension, a **proportional scaling approach** is adopted based on the previously derived impact figures for the Ardersier Port investment. The impacts are scaled in proportion to the updated turbine volumes, under the assumption that:

- Only the number of turbine units have increased and all other factors including how the port operates and how much each turbine contributes remain unchanged;
- Each additional turbine adds the same level of impact as it did in the original estimate of Ardersier Port; and
- The port can manage the extra turbine units without new limitations e.g. no additional delays or bottlenecks have been introduced since the previous assessment.

This approach ensures continuity of original analysis and provides consistent estimates of the port's extension increased impacts.

5.2.4 Offshore Wind Expenditure

The share of the total expenditure of the offshore wind sector that occurs in Scotland and the UK is based on analysis by BVG Associates³⁴ of the potential for organisations to meet the requirements of the offshore wind sector. As part of this study, the distribution of contracts required to meet the 60% UK content ambition was considered for the offshore wind sector as a whole.

This analysis found that both fixed and floating offshore wind projects were likely to have a higher level of UK content, as there would be a greater demand to install turbines onto the floating foundations within the UK. The split by contract type is shown in the table below and the share of Scottish and UK content for fixed and floating offshore projects is used as the basis for the analysis of the scenarios.

³⁴ BVG Associates (2021) UK and Scottish content baseline and roadmap: A report for the Scottish Offshore Wind Energy Council



Table 5-1: Scottish and UK Content by Contract Area, 60% Local Content Scenario

	Scottish Content		UK Content	
	Fixed	Floating	Fixed	Floating
Development and project management	24%	53%	88%	88%
Turbine	3%	4%	22%	12%
Substations	26%	32%	51%	51%
Foundations	25%	61%	68%	61%
Cables	1%	3%	32%	32%
Turbine and foundation installation	6%	43%	0%	47%
Cable installation	10%	10%	6%	13%
Installation other	25%	57%	76%	78%
Operations and maintenance	29%	65%	86%	86%
Decommissioning	21%	69%	40%	90%
Total	20%	47%	60%	62%

Source: BVG Associates (2021).



6. Economic Impact Assessment

This section outlines the findings of the economic impact assessment.

6.1 Ardersier Port Extension Development and Construction

The development and construction of the Ardersier Port Extension is associated with:

- Deepening of the inner harbour by dredging (approximately 2,000,000 m³);
- Removal of old sheet piles in front of the new quay wall along with possible temporary sand bunds;
- Possible local scour protection (rock armour) in inner harbour;
- Localised rock mattress for east of harbour;
- Site clearance of extension lands (tree felling, stump and topsoil removal);
- Land raising and levelling of extension lands to suitable height with dredged sand;
- Creation of working surface through stone placement; and
- Installation of new drainage to extension land southern perimeter.

The port is set to open in Autumn 2025, with decisions on the extension applications expected in early 2026. Construction is expected to take about two years to complete, with works anticipated to be finished in 2028/29, depending on the timing of an investment decision.

Based on information provided by Haventus, the total cost associated with the development and construction of the full extension project is projected to be around £365.0 million.

Of this total, it is expected that around 71% on construction and civil engineering works and 29% on development. For each category of spend, a breakdown of the types of contracts required is estimated based on a share of the total value. These categories of spend were then assigned to a relevant economic sector, with the majority of contracts relating to construction, manufacturing and civil engineering.

The share of spend of each of these contracts going to businesses in each of the study areas was then assessed. Of the total expenditure, 69% is expected to be located within the UK. The largest areas of spend were estimated to be that relating to the integration of quay wall and dredging. Based on the location of suppliers, it was assumed this spend would take place within the UK.



In this way, it is estimated that 25% of development and construction contracts would go to Moray & Highland, totalling £93.1 million. Across the UK, total spend is estimated to be £253.0 million (69%) whereas £166.5 million would be located in Scotland (46%).

Table 6-1: Development and Construction Expenditure by Study Area

	Moray & Highland		Scotland		UK	
	£m	%	£m	%	£m	%
Turnover	93.1	25%	166.5	46%	253.0	69%

Source: BiGGAR Economics Analysis

Applying sectoral turnover/GVA and turnover/employee ratios to each category of spend, it is estimated that the direct economic impact generated from the development and construction of Ardersier Port Extension would be £37.3 million GVA and 347 years of employment in Moray & Highland, £66.4 million GVA and 616 years of employment across Scotland and £98.1 million GVA and 899 years of employment in the UK as a whole.

Applying the relevant Type 1 and Type 2 multipliers to the direct impact, it is estimated that the total economic impact (including indirect and induced) generated from the development and construction phase of Ardersier Port Extension would be:

- £53.8 million GVA and 464 years of employment in Moray & Highland;
- £119.0 million GVA and 1,019 years of employment across Scotland; and
- £284.9 million GVA and 2,662 years of employment in the UK.

A breakdown of the GVA and Employment impacts is shown in the tables below.

Table 6-2: GVA Impacts (£m) of the Development and Construction

	Moray & Highland	Scotland	UK
Direct GVA (£m)			
Development	17.4	30.5	39.2
Civil Engineering (marine)	15.6	28.4	48.2
Civil Engineering (onshore)	4.3	7.5	10.8
Equipment	-	-	-
Total Direct	37.3	66.4	98.1
Indirect GVA (£m)			
Development	1.9	8.1	35.2
Civil Engineering (marine)	3.4	15.6	59.8
Civil Engineering (onshore)	1.0	4.5	14.0



Equipment	-	-	-
Total Indirect	6.3	28.2	109.0
Induced GVA (£m)			
Development	3.6	8.3	36.4
Civil Engineering (marine)	5.2	12.7	34.2
Civil Engineering (onshore)	1.4	3.3	7.1
Equipment	-	-	-
Total Induced	10.2	24.3	77.8
Total GVA	53.8	119.0	284.9

Source: BIGGAR Economics Analysis. Note: Sums may not add up due to rounding.

Table 6-3: Employment Impacts (Years of Employment) of the Development and Construction

	Moray & Highland	Scotland	UK
Direct Employment			
Development	176	309	397
Civil Engineering (marine)	129	236	399
Civil Engineering (onshore)	41	72	103
Equipment	-	-	-
Total Direct	347	616	899
Indirect Employment			
Development	17	73	285
Civil Engineering (marine)	32	147	590
Civil Engineering (onshore)	10	43	168
Equipment	-	-	-
Total Indirect	59	264	1043
Induced Employment			
Development	25	57	334
Civil Engineering (marine)	26	64	309
Civil Engineering (onshore)	8	18	78
Equipment	-	-	-
Total Induced	58	139	721
Total Employment	464	1,019	2,662

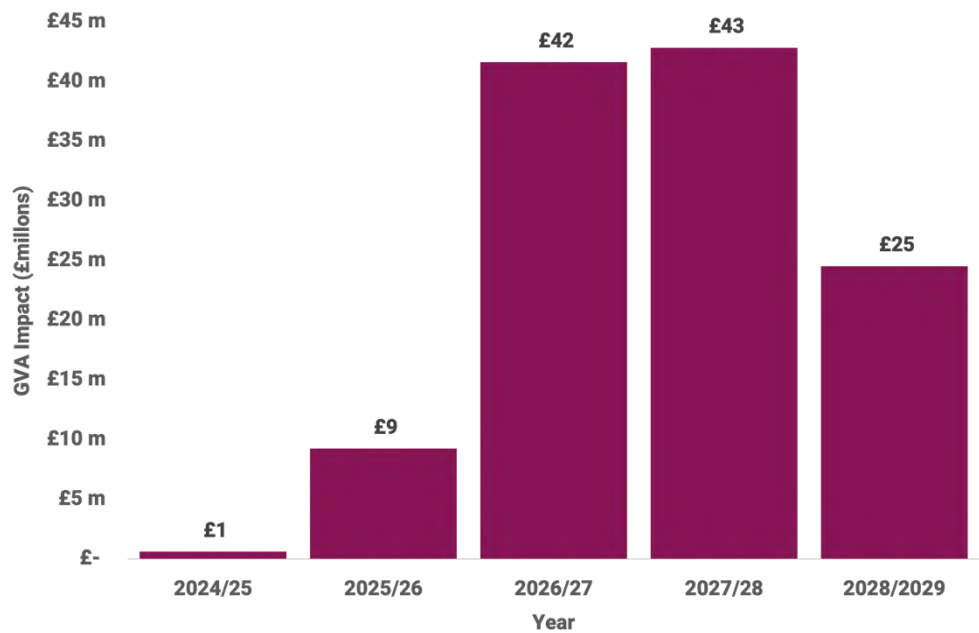
Source: BIGGAR Economics Analysis. Note: Sums may not add up due to rounding.



6.1.1 Impact Over Time

The development and construction of Ardersier Port Extension will take place over a period of time (approximately 5 years). As shown in Figure 6-1, the largest share of impact is expected to occur during 2027/28, depending on the timing of the proposed development.

Figure 6-1: GVA Impact of Ardersier Port Extension, Scotland



Source: BIGGAR Economics Analysis

6.2 Ardersier Port Extension Operations

Economic activity will also be generated on an annual basis from the on-site operations of the Ardersier Port Extension. Based on information provided by Haventus, assumptions on displacement and wider multiplier effects were applied on on-site job figures. It is estimated that the operations of the Ardersier Port Extension would be associated with up to £84.0 million spending per year in the UK as a whole. The largest areas of spend are associated with sectors such as warehousing and support activities for transportation.

Applying relevant Type 1 and Type 2 multipliers to the direct impact, it is estimated that the total annual economic impact generated from the operation stage of the Ardersier Port development (after displacement) would be up to:

- £45.0 million GVA and 442 jobs in Moray & Highland;
- £58.0 million GVA and 566 jobs in Scotland; and
- £95.1 million GVA and 888 jobs across the UK.



A breakdown of these figures is shown in the tables below.

Table 6-4: Annual Economic Impact of Operation – GVA (£m)

	Moray & Highland	Scotland	UK
Direct GVA (£m)	40.4	40.4	40.4
Indirect GVA (£m)	5.4	13.4	32.0
Induced (£m)	4.3	10.6	33.5
Total GVA (after displacement)	45.0	58.0	95.1

Source: BIGGAR Economics Analysis. Note: Sums may not add up due to rounding.

Table 6-5: Annual Economic Impact of Operation – Employment (jobs)

	Moray & Highland	Scotland	UK
Direct Employment	400	400	400
Indirect Employment	52	130	275
Induced Employment	40	100	312
Total Employment (after displacement)	442	566	888

Source: BIGGAR Economics Analysis. Note: Sums may not add up due to rounding.

6.3 Offshore Wind Impacts

The occupation of the new facilities due to the extension project would support the delivery of fixed wind and ScotWind floating wind projects (from 2028/29). The activities at the port are part of the wider offshore wind development impacts considered in this section. Figures are indicative and are based on assumptions for the wider offshore wind sector by ORE Catapult.

6.3.1 Deployment and Ardersier Port Site

This analysis considers two deployment scenarios to initially derive the impacts of the Ardersier Port site as a whole, one which describes the level of activity in the sector and another which describes the activity that would have occurred regardless of the Ardersier Port investment. These deployment scenarios are:

- 150GW Scenario – This is the level of activity in the floating offshore wind sector that is described by the high case. It forms part of a wider deployment scenario in which 150GW of offshore wind is deployed in UK waters by 2050, of which floating wind accounts for 50% of capacity. In this scenario, 5GW of floating offshore wind is deployed by 2030 of which 3GW is in Scotland, and 34GW is deployed by 2040 of which 20GW is in Scotland;
- 100GW Scenario – This is the level of activity in the floating offshore wind sector that is described by the base case. It forms part of a wider deployment scenario in which 100GW of offshore wind is deployed in UK waters by 2050, of which



floating wind accounts for 33% of capacity. In this scenario, 3GW of floating offshore wind is deployed by 2030 of which 1GW is in Scotland, and 20GW is deployed by 2040 of which 12GW is in Scotland.

The level of installed capacity of floating offshore wind in each of the scenarios for Scotland is outlined in the table below. This shows that by 2040, there would be about 8GW of additional floating offshore wind deployed in Scotland of which about 6GW would be associated with the Ardersier Port investment as a whole. This indicates that the port is expected to have a large impact on the sector overall.

Table 6-6: Cumulative Scottish Installed Floating Capacity by Scenario and Additionality

	2028	2030	2035	2040
100GW Scenario	0.2	1.4	6.4	12.4
150GW Scenario	0.2	2.5	10.0	20.0
Additional Capacity	-	1.1	3.6	7.6

Source: BIGGAR Economics Analysis using Floating Offshore Wind Industrialisation Roadmap – Deployment Scenarios produced by ORE Catapult in 2022.

The economic impact that is enabled by the Ardersier Port investment is driven by the additional capacity of floating offshore wind that could be deployed in Scotland (see also Figure 5-2). This shows that the sector would grow quicker to 2040 due to the Ardersier Port investments and is used as the basis to extract the impacts associated with the Ardersier Port Extension project.

More details about the deployment scenarios are provided in Floating Offshore Wind Industrialisation Roadmap – Deployment Scenarios, produced by ORE Catapult in 2022. The results of this report are indicative and come from the difference between the two scenarios and proportional adjustments to accommodate the alterations due to the Ardersier Port Extension project based on assumptions considered for the sector. Similar assumptions are made for the fixed offshore.

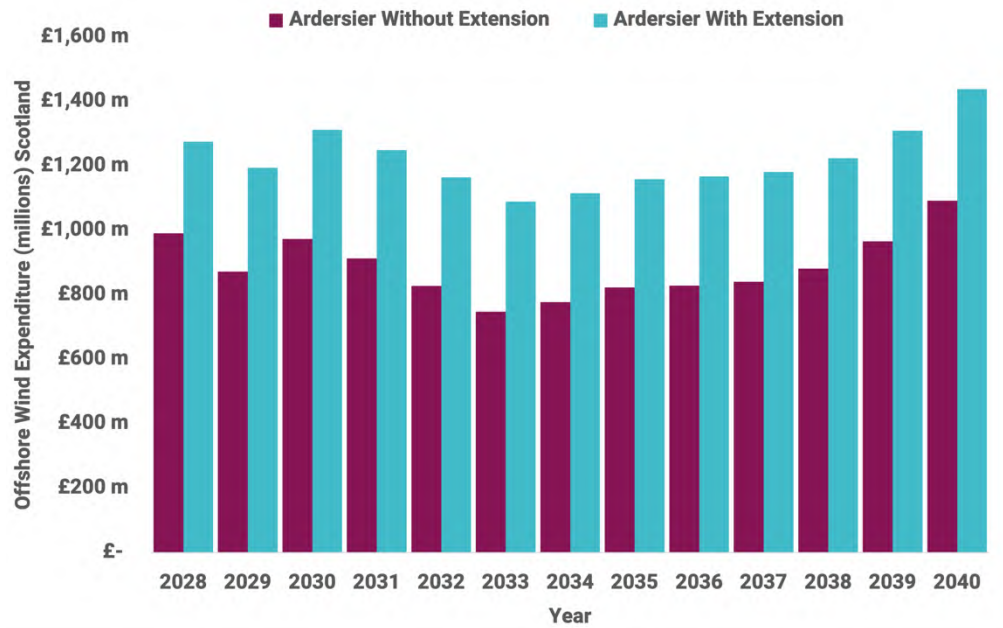
6.3.2 Offshore Wind Expenditure

The development of offshore wind sector associated with the Ardersier Port Extension will stimulate additional investment in the UK energy sector across the CAPEX and OPEX phases. The level of expenditure by contract type was estimated using the deployment scenarios, expected cost levels and the share of expenditure that is likely to occur in each study area.

This expenditure is expected to peak initially in 2030. In 2040, the offshore wind sector is projected to spend about £764.7 million in the UK whereas £178 million would be spend in Moray & Highland and about £346.0 million in Scotland as a result of the Ardersier Port Extension. The net present value of this expenditure in Scotland is £3.4 billion.

Figure 6-2 shows the expenditure in Scotland with and without the Ardersier Port Extension.

Figure 6-2: Additional Scottish Expenditure in Offshore Wind due to Ardersier Port Extension



Source: BiGGAR Economics Analysis

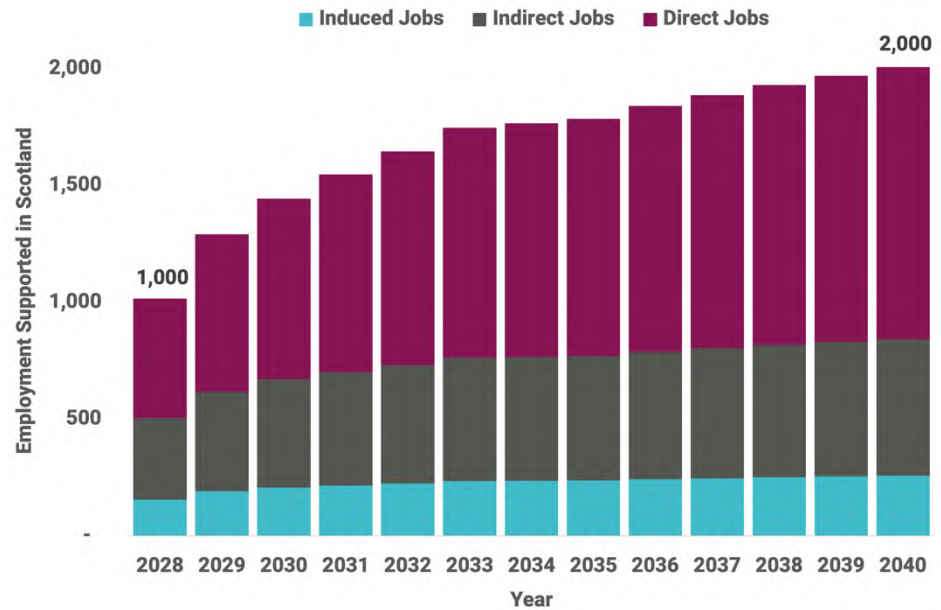
6.3.3 Employment Impacts over Time

This expenditure will drive economic activity that will support employment and generate Gross Value Added (GVA).

Employment is expected to grow steadily from 2028 as the level of annual deployment increases and there is a greater demand for O&M activities to service the growing installed capacity and manufacturing activities due to the occupation of the Ardersier Port Extension facilities. In 2028, the offshore wind sector could support almost 2,900 jobs across the UK, 1,000 in Scotland and 300 in Moray & Highland. This will include the jobs that will be supported in the preparation and construction of the port facilities (see Section 6.1).

Over the medium term, to 2040, the offshore wind sector will support about 7,100 jobs across the UK, 2,000 in Scotland and 800 in Moray & Highland. By 2040, approximately half of those jobs will be associated with those directly commissioned on these projects and half would be elsewhere in the wider supply chain and induced.

Figure 6-3: Additional Scottish Employment Impacts Over Time due to Ardersier Port Extension



Source: BIGGAR Economics Analysis

Of the total employment in 2040, more than half would be attributed to operations and maintenance activities in each study area and about 14% to manufacturing and fabrication activities in Moray & Highland, 16% in Scotland and 14% in the UK as a whole.

This is because the extension facilities primarily provide additional operational areas within the existing energy transition facility. The extension focuses on expanding quay access, improving operational flexibility and supporting turbine logistics which are key factors of offshore wind operations and maintenance. Whilst the existing site is anticipated to host the main manufacturing facilities, additional benefits provided by the extension are mainly related to operational activities but may also include assembly operations and logistics.

Table 6-7: Employment Impacts Over Time, Split by Activity (Jobs), 2040

	Moray & Highland	Scotland	UK
DEVEX Jobs	20	100	500
CAPEX Jobs	200	400	1,000
MANEX Jobs	100	300	1,000
OPEX Jobs	500	1,100	4,700
Total GVA	800	2,000	7,100

Source: BIGGAR Economics Analysis. Note: Sums may not add up due to rounding.

6.3.4 GVA over Time

As with the employment figures, the level of Gross Value Added is expected to increase stably from 2028, as the sector ramps up deployment to reach the targets



for 2030. At this point the offshore wind sector will generate about £40.0 million to Moray & Highland, £120.0 million to Scotland and around £300.0 million to the UK economy.

By 2040, the sector is expected to generate approximately £700.0 million GVA in the UK, £200.0 million in Scotland and £90.0 million in Moray & Highland as a result of the Ardersier Port Extension activities. Over the period, it is estimated that the Net Present Value of the GVA of the sector will be about £700.0 million in Moray & Highland, £1.8 billion in Scotland and £6.0 billion in the UK as a whole.

Table 6-8: GVA Impacts Over Time, Split by Source (£m)

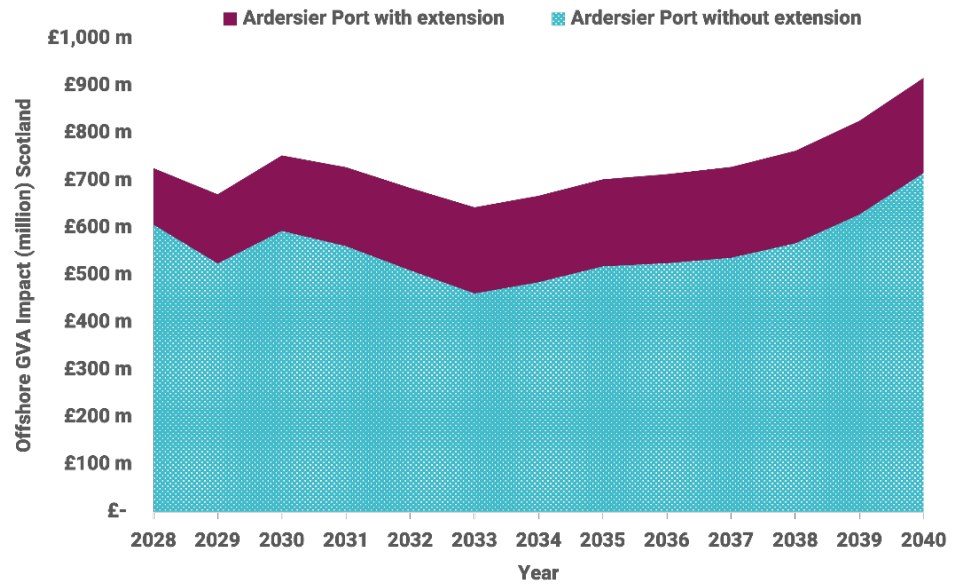
	Moray & Highland (NPV)	Scotland (NPV)	UK (NPV)
Turnover	1,700	3,400	7,100
Direct GVA	500	1,000	2,200
Indirect GVA	100	400	2,100
Induced GVA	100	400	1,700
Total GVA	700	1,800	6,000

Source: BiGGAR Economics Analysis. Note: Sums may not add up due to rounding.

As with the employment impacts, by 2040, more than half of the GVA will be within companies that are directly contracted onto these projects and the remaining will be in the wider supply chain and induced.

Figure 6-4 shows the GVA impact in Scotland with and without the Ardersier Port Extension.

Figure 6-4: Scottish GVA Impacts Over Time due to Ardersier Port Extension



Source: BiGGAR Economics Analysis

Of the total GVA, between 33-45% would be attributed to operations and maintenance activities in each study area and about 14% to manufacturing and fabrication activities in Moray & Highland, 22% in Scotland and 20% in the UK as a whole. The following table includes a breakdown of the GVA impacts by activity and study area.

Table 6-9: GVA Impacts Over Time, Split by Activity (£m)

	Moray & Highland (NPV)	Scotland (NPV)	UK (NPV)
DEVEX GVA	40	200	700
CAPEX GVA	200	600	1,500
MANEX GVA	100	400	1,200
OPEX GVA	300	600	2,700
Total GVA	700	1,800	6,000

Source: BiGGAR Economics Analysis. Note: Sums may not add up due to rounding.



7. Wider Socio-Economic Implications

The expansion of Ardersier Port will deliver long-term, high-quality jobs to the Local Area, helping to address depopulation

Wider socio-economic benefits and implications of Ardersier Port investment as a whole include:

- supply chain development;
- skills by bringing jobs, providing work placements and supporting education;
- improved and expanded housing through support on strategic housing plans;
- tourism and recreation by enabling path networks and connecting communities;
- other infrastructure and services improvements; and
- the local community through meaningful engagement to aid community wealth building, including provision of a community benefit fund.

The extension of Ardersier Port holds a further transformative potential for the region. It seeks to create a larger working platform to improve efficiency and enable the expansion of Ardersier's activities, particularly in relation to providing services for the offshore wind sector. It is expected that the extension will support the number and size of shipping vessels travelling to and docking at the port and generate additional operational activities on site to support the assembly of offshore wind components.

7.1 Employment and Population Retention

It is expected that, by the early 2030s, there is the potential for more than 3,000 long-term operational jobs on site at Ardersier Port, of which 400 could be enabled by the extension (as outlined in Section 6). This represents a significant increase in the number of jobs located in the Local Area, where there were 73,325 jobs in 2023. Employment in the Local Area grew by 2% between 2015 and 2023, and the expected jobs at Ardersier Port represent a 4% increase on total employment in the area in 2023.

The development of Ardersier Port and the extension also represents an important opportunity for Highland and Moray as a whole. In 2023, total employment in Highland and Moray was 168,450, a 6% increase since 2015. The potential operational jobs at Ardersier Port are estimated to account for 2% of the region's 2023 workforce. Current major private sector employers include LifeScan, a medical technology manufacturer which employed around 850 people in Highland as of



2017³⁵, and Mowi Scotland, an aquaculture company with approximately 1,500 employees split between Highland and Fife³⁶. Major employers in Moray include Baxters Food Group, a food manufacturer, which employed approximately 700 staff in Moray as of 2016³⁷. SSE Renewables is also a significant employer in the region, with 1,800 staff and contractors in the Highlands and Islands, highlighting the strategic importance of the renewable energy sector and the potential for Ardersier Port to support its continued growth. With a potential 3,000 operational jobs at Ardersier Port, this would make the port the largest site of private sector employment in the region in the early 2030s.

Delivering significant employment opportunities such as those created by Ardersier Port and the extension is vital for areas like Highland and Moray where declining and ageing populations present major challenges. As outlined in Section 4, it is expected that the working age population of Highland and Moray will fall by 10.6% between 2022 and 2043, a reduction of 21,670 people of working age. The Scottish Government has identified tackling depopulation in rural areas as a national strategic priority, recognising that current demographic trends risk increasing pressure on local infrastructure and services as ageing populations are supported by a shrinking workforce. As identified by a number of local stakeholders^{38 39}, a key driver of depopulation in rural areas is the lack of high-quality employment opportunities which would attract working age people and work to retain current residents as they enter the workforce. By enabling potentially 3,000 long-term on-site jobs, Ardersier Port is positioned to make a significant contribution toward reversing depopulation trends and supporting the sustainability of the regional economy.

³⁵ Highlands and Islands Enterprise (2017), Life Sciences. Available: <https://www.hie.co.uk/our-region/highlandambition/work-here/>

³⁶ Mowi Scotland (2025), About Mowi Scotland. Available: <https://mowi.com/uk/about/>

³⁷ Press & Journal (2016), Up to 80 jobs at risk as Baxters look to cut costs at Fochabers. Available: <https://www.pressandjournal.co.uk/fp/news/moray/918793/80-jobs-risk-baxters-look-cut-costs-fochabers/>

³⁸ Highlands and Islands Enterprise (2025), Regional Economic Strategy 2025-2035

³⁹ Moray Economic Partnership (2018), The Moray Economic Strategy 2018-2028

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