

# One Dimensional Consolidation Properties

BS 1377: Part 5: 1990

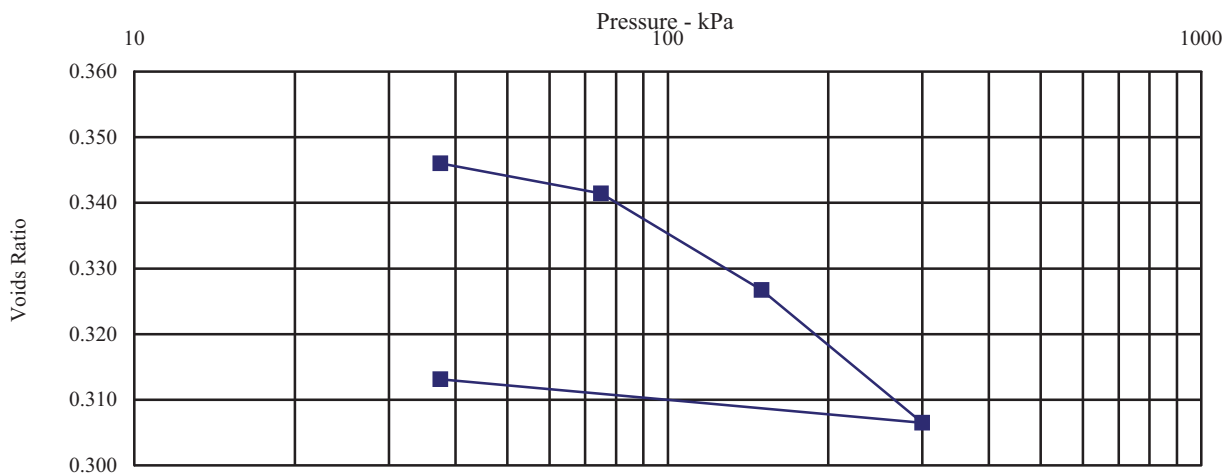
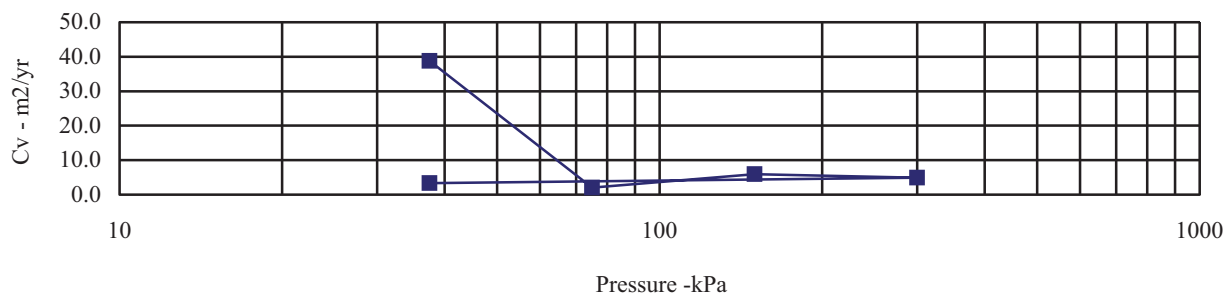
Hole Number: BH9

Depth (m): 7.50-7.95

Sample Number:

Sample Type: U

Initial Conditions		Pressure Range		Mv	Cv	Specimen location	
Moisture Content (%):	13	kPa		m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	2.20	0	-	37.5	0.239	38.776	Method used to
Dry Density (Mg/m3):	1.95	37.5	-	75	0.091	2.021	determine CV:
Voids Ratio:	0.358	75	-	150	0.146	5.977	Nominal temperature
Degree of saturation:	94.8	150	-	300	0.102	4.873	during test ' C:
Height (mm):	20.05	300	-	37.5	0.019	3.345	Remarks:
Diameter (mm)	75.02	See summary of soils description.					
Particle Density (Mg/m3):	2.65						
Assumed							



Checked by	Date	Approved by	Date
<i>[Signature]</i>	11/08/14	<i>[Signature]</i>	11/08/14



**PHASE 2 LIVERPOOL BUSINESS  
PARK, SPEKE.**

**Contract No.**

**PSL14/3631**

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# One Dimensional Consolidation Properties

BS 1377: Part 5: 1990

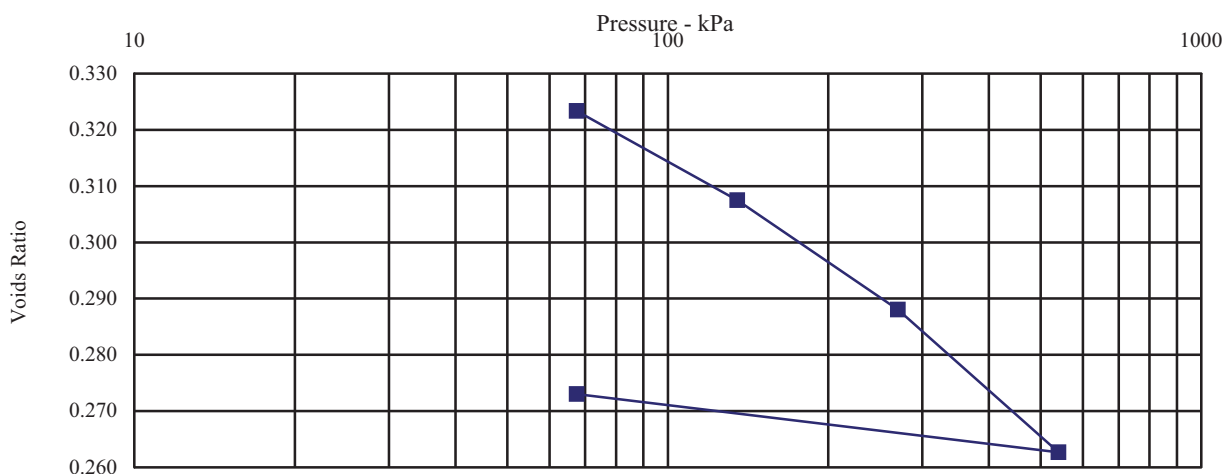
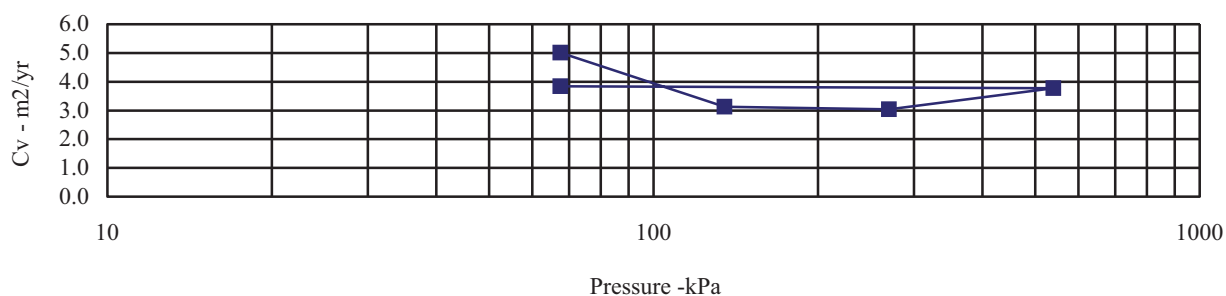
Hole Number: BH9

Depth (m): 13.50-13.95

Sample Number:

Sample Type: U

Initial Conditions		Pressure Range		Mv	Cv	Specimen location	
Moisture Content (%):	13	kPa		m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	2.21	0	-	67.5	0.301	5.007	Method used to determine CV:
Dry Density (Mg/m3):	1.96	67.5	-	135	0.178	3.123	
Voids Ratio:	0.351	135	-	270	0.110	3.040	Nominal temperature
Degree of saturation:	95.9	270	-	540	0.073	3.775	during test ' C:
Height (mm):	20.01	540	-	67.5	0.017	3.840	Remarks: See summary of soils description.
Diameter (mm)	75.02						
Particle Density (Mg/m3):	2.65						
Assumed							



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<i>[Signature]</i>	11/08/14	<i>[Signature]</i>	11/08/14



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# One Dimensional Consolidation Properties

BS 1377: Part 5: 1990

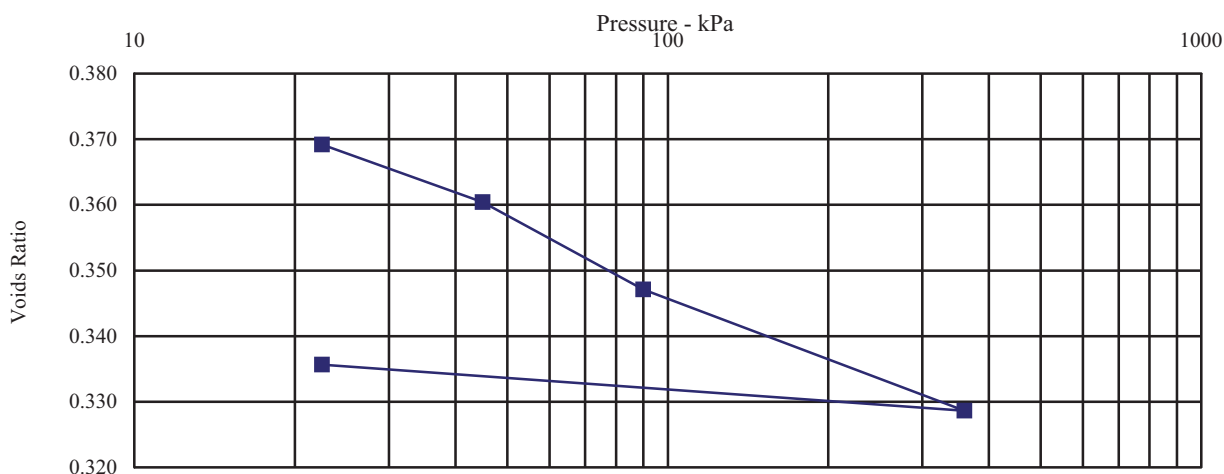
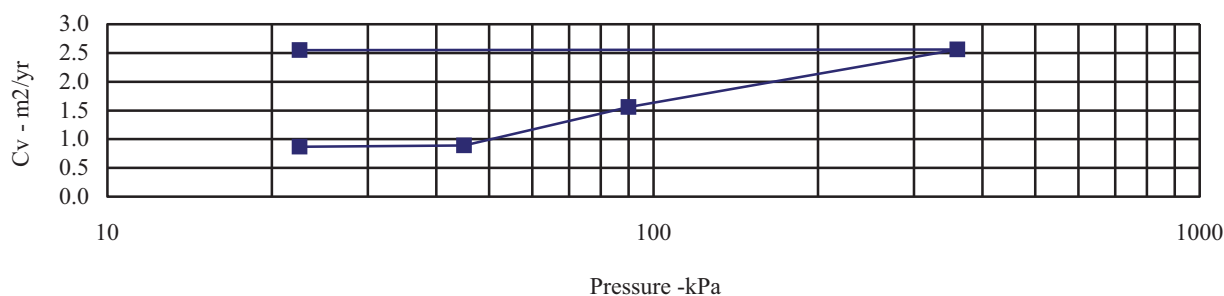
Hole Number: BH10

Depth (m): 4.50-4.95

Sample Number:

Sample Type: U

Initial Conditions		Pressure Range			Mv	Cv	Specimen location	
Moisture Content (%):	14	kPa			m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	2.27	0	-	22.5	0.444	0.869	Method used to	
Dry Density (Mg/m3):	1.99	22.5	-	45	0.284	0.893	determine CV:	t90
Voids Ratio:	0.383	45	-	90	0.218	1.559	Nominal temperature	
Degree of saturation:	103.2	180	-	360	0.076	2.558	during test ' C:	20
Height (mm):	20.22	180	-	22.5	0.034	2.552	Remarks:	
Diameter (mm)	75.02	See summary of soils description.						
Particle Density (Mg/m3):	2.75							
Assumed								



Checked by	Date	Approved by	Date
<i>[Signature]</i>	11/08/14	<i>[Signature]</i>	11/08/14



**PHASE 2 LIVERPOOL BUSINESS  
PARK, SPEKE.**

Contract No.

PSL14/3631

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# LABORATORY REPORT



4043

**Contract Number: PSL14/3632**

Client's Reference:

Report Date: 15 September 2014

Client Name: Arc Environmental  
Solum House  
Unit 1 Elliott Court  
St Johns Road, Meadowfield  
Durham  
DH7 8PN

**For the attention of: Matt Bradford**

Contract Title: Phase 3 Liverpool Business Park, Speke

Date Received: 24/7/2014

Date Commenced: 24/7/2014

Date Completed: 13/8/2014

**Notes: Opinions and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson  
(Director)

A Watkins  
(Director)

M Beastall  
(Laboratory Manager)

D Lambe  
(Senior Technician)


S Royle  
(Senior Technician)

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# SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Depth m	Description of Sample
TPA		B	2.00	Brown slightly gravelly very sandy CLAY.
TPB		B	1.00	Dark brown slightly gravelly silty SAND.
TPC		B	2.00	Brown slightly gravelly sandy CLAY.
TPD		B	2.00	Brown slightly gravelly sandy CLAY.
TPE		B	3.00	Brown slightly gravelly very sandy CLAY.
TPF		B	2.00	Brown slightly gravelly sandy CLAY.
BHA		D	4.00	Brown slightly gravelly sandy CLAY.
BHB		D	5.00	Brown slightly gravelly sandy CLAY.
BHC		B	3.50-4.00	Brown slightly gravelly sandy CLAY.
BHD		D	3.20	Brown slightly gravelly sandy CLAY.
BHE		D	3.00	Brown slightly gravelly sandy CLAY.
BHA		B	1.50-2.00	Greyish brown slightly gravelly clayey SAND.
BHD		B	1.50-3.00	Dark grey mottled reddish brown gravelly clayey silty SAND.
TPB		B	3.00	Brown slightly gravelly very sandy CLAY.
TPF		B	1.00	Greyish brown clayey SAND.
BHB		B	1.50-3.00	Dark brown slightly gravelly very clayey very silty SAND.
BHE		D	1.00	Dark grey mottled reddish brown very gravelly clayey silty SAND.
BHA		U	4.50-4.95	Firm reddish brown slightly gravelly slightly sandy CLAY.
BHA		U	7.50-7.95	Stiff reddish brown slightly gravelly slightly sandy CLAY.

<div></div>	Compiled by	Date	Checked by	Date	Approved by	Date
	<i>Mar</i>	13/08/14	<i>M. S.</i>	13/08/14	<i>M. S.</i>	13/08/14
PHASE 3 LIVERPOOL BUSINESS PARK.				Contract No: PSL14/3632		
				Client Ref: 14-156		

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Depth m	Description of Sample
BHB		U	3.50-3.95	Stiff reddish brown sandy CLAY.
BHB		U	6.00-6.45	Soft reddish brown slightly gravelly sandy CLAY.
BHC		U	4.50-4.95	Stiff reddish brown slightly gravelly sandy CLAY.
BHD		U	3.50-3.95	Firm reddish brown slightly gravelly sandy CLAY.
BHD		U	7.50-7.95	Firm reddish brown sandy CLAY.
BHE		U	3.50-3.95	Hard reddish brown sandy CLAY.
BHE		U	6.00-6.45	Hard reddish brown sandy CLAY.



**Professional Soils Laboratory**

Compiled by	Date	Checked by	Date	Approved by	Date
<i>Mar</i>	13/08/14	<i>N.S.D</i>	13/08/14	<i>N.S.D</i>	13/08/14
PHASE 3 LIVERPOOL BUSINESS PARK.				Contract No:	PSL14/3632
				Client Ref:	14-156

(B.S. 1377 : PART 2 : 1990)

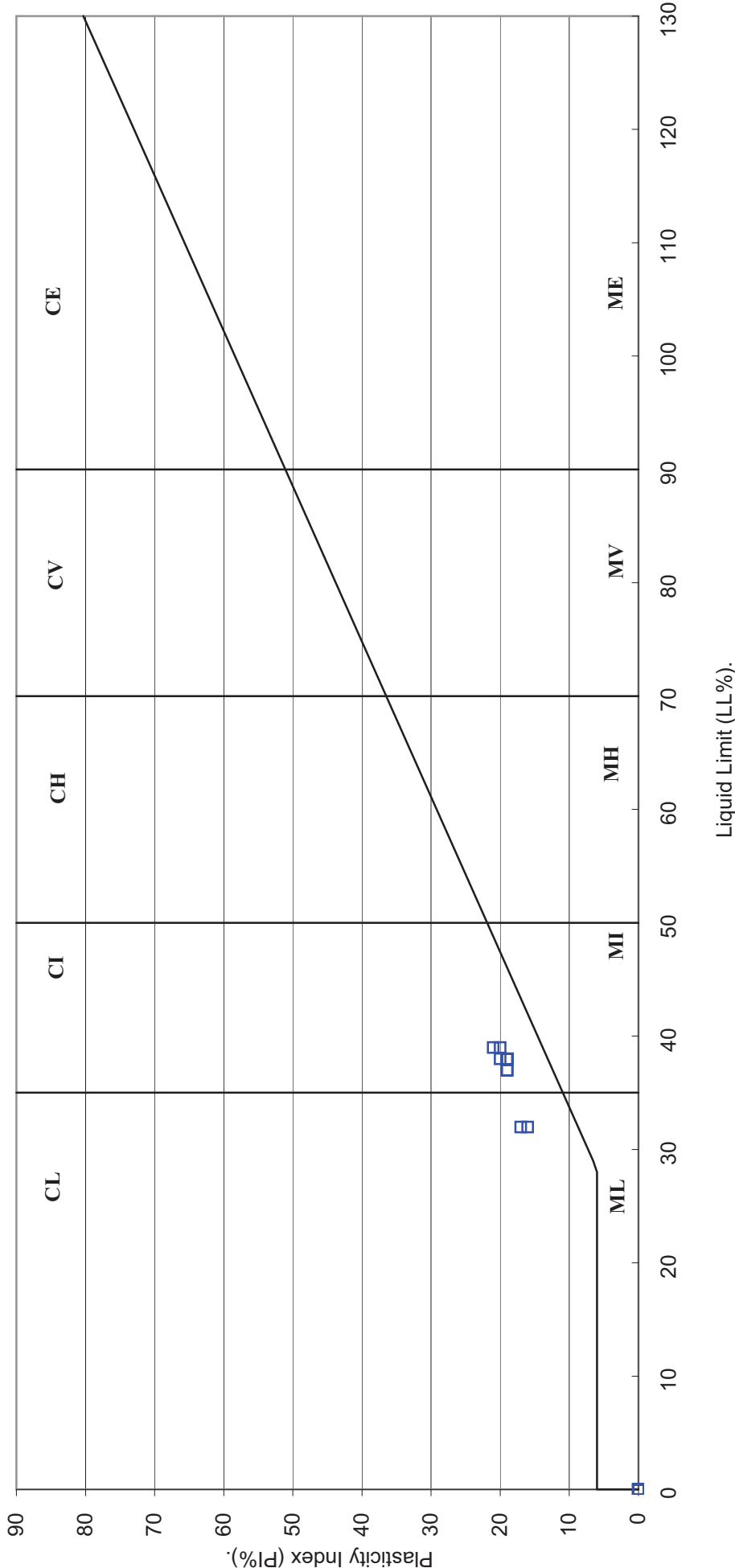
**SYMBOLS: NP : Non Plastic**

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PSLR002 Issue 1

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)





**Professional Soils Laboratory**

Compiled by	Date	Checked by	Date	Approved by	Date
<i>Umar</i>	13/08/14	<i>A.h.S</i>	13/08/14	<i>A.h.S</i>	13/08/14
PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					
Contract No:				PSL14/3632	
Client Ref:				14-156	



# Particle Size Distribution Test

BS1377 : Part 2 : 1990

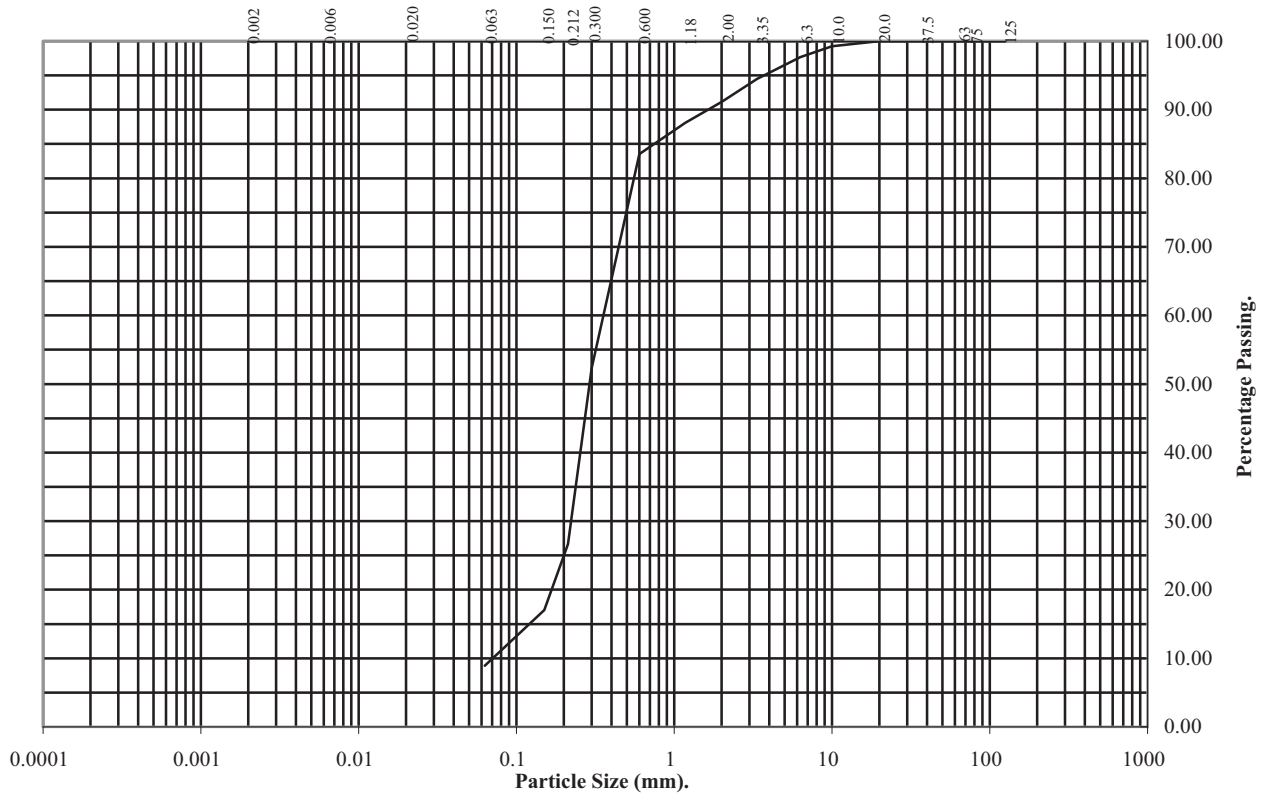
Wet Sieve, Clause 9.2

Hole Number: BHA

Depth (m): 1.50-2.00

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	99
6.3	98
3.35	94
2	91
1.18	88
0.6	84
0.3	52
0.212	27
0.15	17
0.063	9

Soil Fraction	Total Percentage
Cobbles	0
Gravel	9
Sand	82
Silt / Clay	9

**Remarks:**

See summary of soil descriptions.

Checked By	Date	Approved By	Date
<i>H. S.</i>	13/08/14	<i>H. S.</i>	13/08/14

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PHASE 3 LIVERPOOL BUSINESS PARK,  
SPEKE.

Contract No.:  
PSL14/3632

# One Dimensional Consolidation Properties

BS 1377: Part 5: 1990

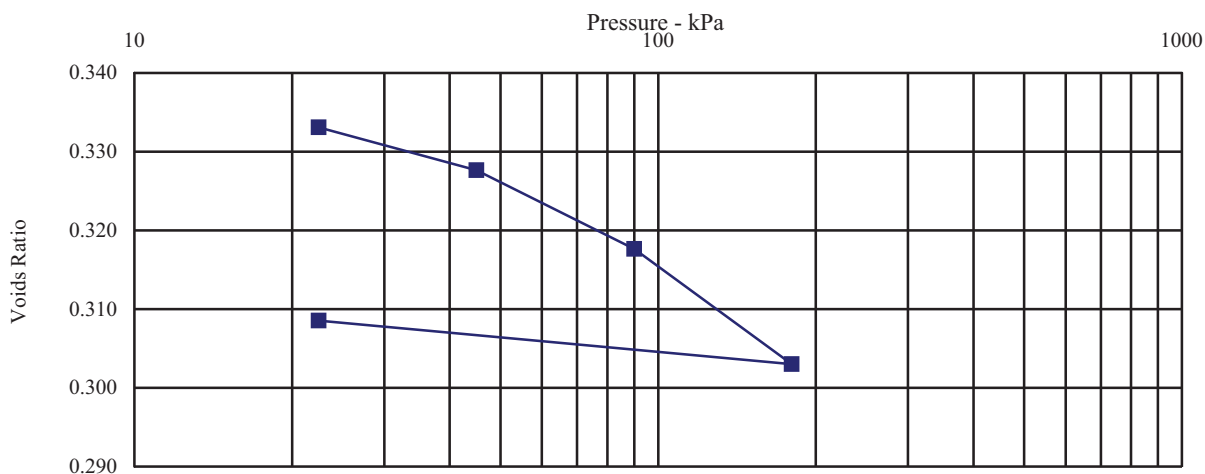
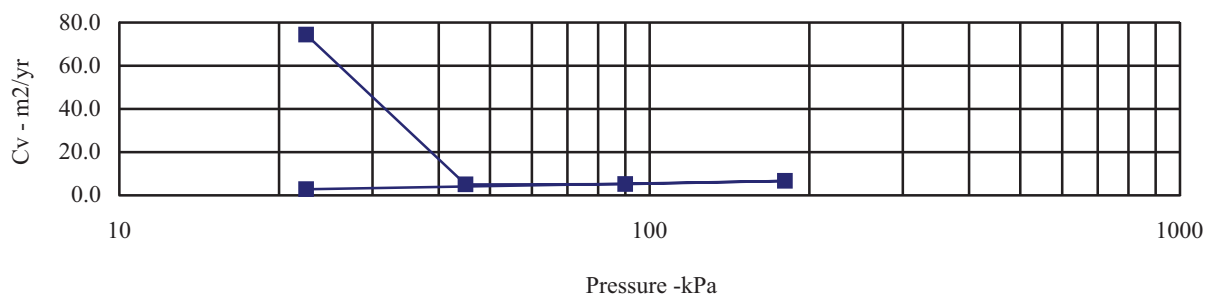
Hole Number: BHA

Depth (m): 4.50-4.95

Sample Number

Sample Type: U

Initial Conditions		Pressure Range			Mv	Cv	Specimen location	
Moisture Content (%):	12	kPa			m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	2.23	0	-	22.5	0.131	74.434	Method used to	
Dry Density (Mg/m3):	1.98	22.5	-	45	0.182	4.983	determine CV:	t90
Voids Ratio:	0.337	45	-	90	0.167	5.218	Nominal temperature	
Degree of saturation:	97.3	90	-	180	0.123	6.722	during test ' C:	20
Height (mm):	20.09	180	-	22.5	0.027	2.829	Remarks:	
Diameter (mm)	75.02	See summary of soils description.						
Particle Density (Mg/m3):	2.65							
Assumed								



Checked by	Date	Approved by	Date
<i>N. S.</i>	13/08/14	<i>N. S.</i>	13/08/14



PHASE 3, LIVERPOOL BUSINESS  
PARK, SPEKE.

Contract No.

PSL14/3632

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# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

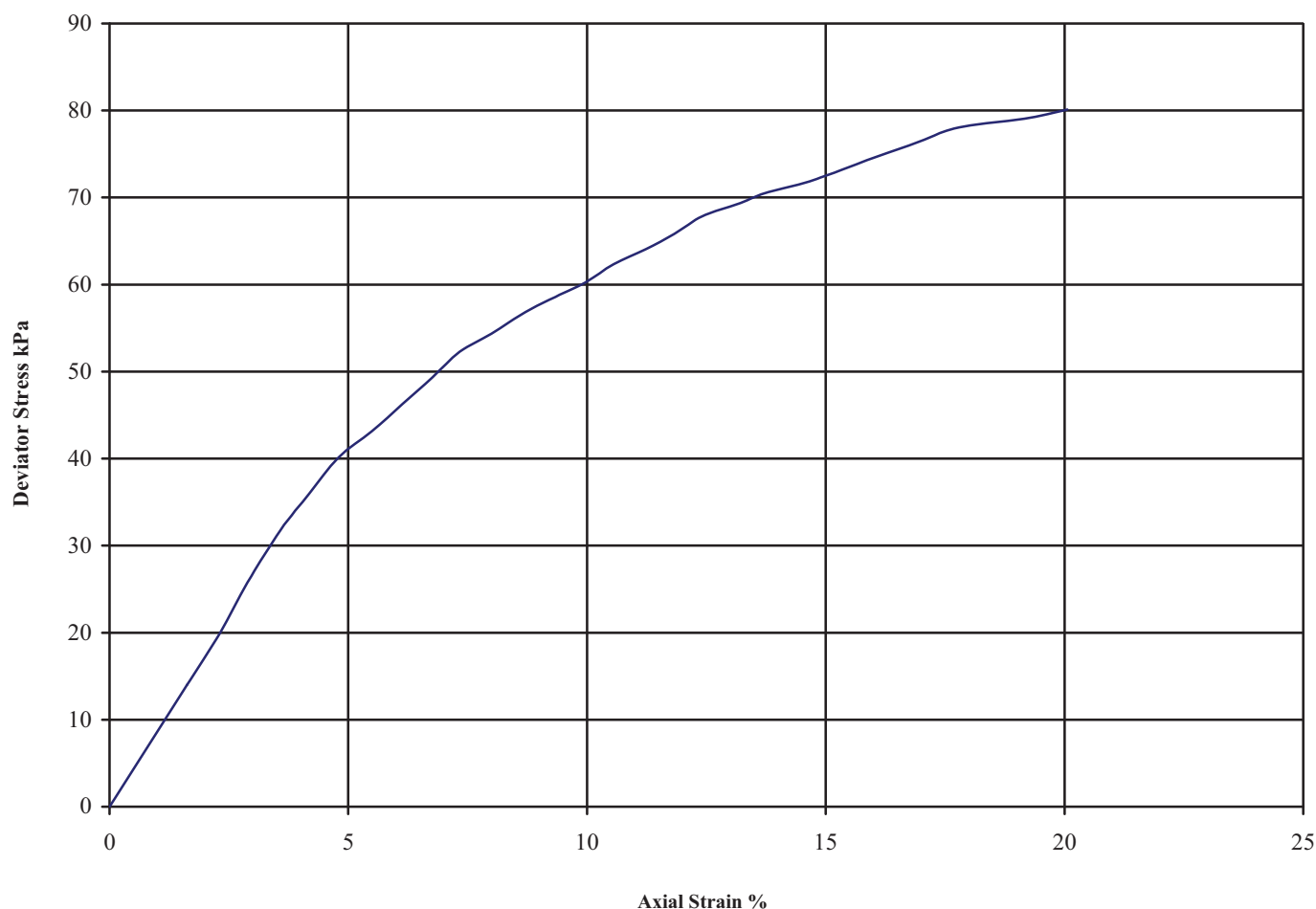
B.S. 1377 : Part 7 : Clause 8 : 1990


Hole Number: BHA

Depth (m): 4.50-4.95

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		150.0	Test:	100 mm Single Stage.		Undisturbed	
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)  $\theta_3$	Corr. Max. Deviator Stress (kPa)  $(\theta_1 - \theta_3)_f$	Shear Strength Cu (kPa)  $\frac{1}{2}(\theta_1 - \theta_3)_f$	Failure Strain (%)	Mode of Failure	Remarks	
									Sample taken from Bottom of tube	
									Rate of strain = 2.6 %/min	
									Latex Membrane used 0.4 mm thickness,	
A	14	2.17	1.90	90	80	40	20.1	Compound	Correction applied 0.33 kPa	
									See summary of soil descriptions.	
									Checked	Date
 Professional Soils Laboratory										
									PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.	
									Contract No: PSL14/3632	

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

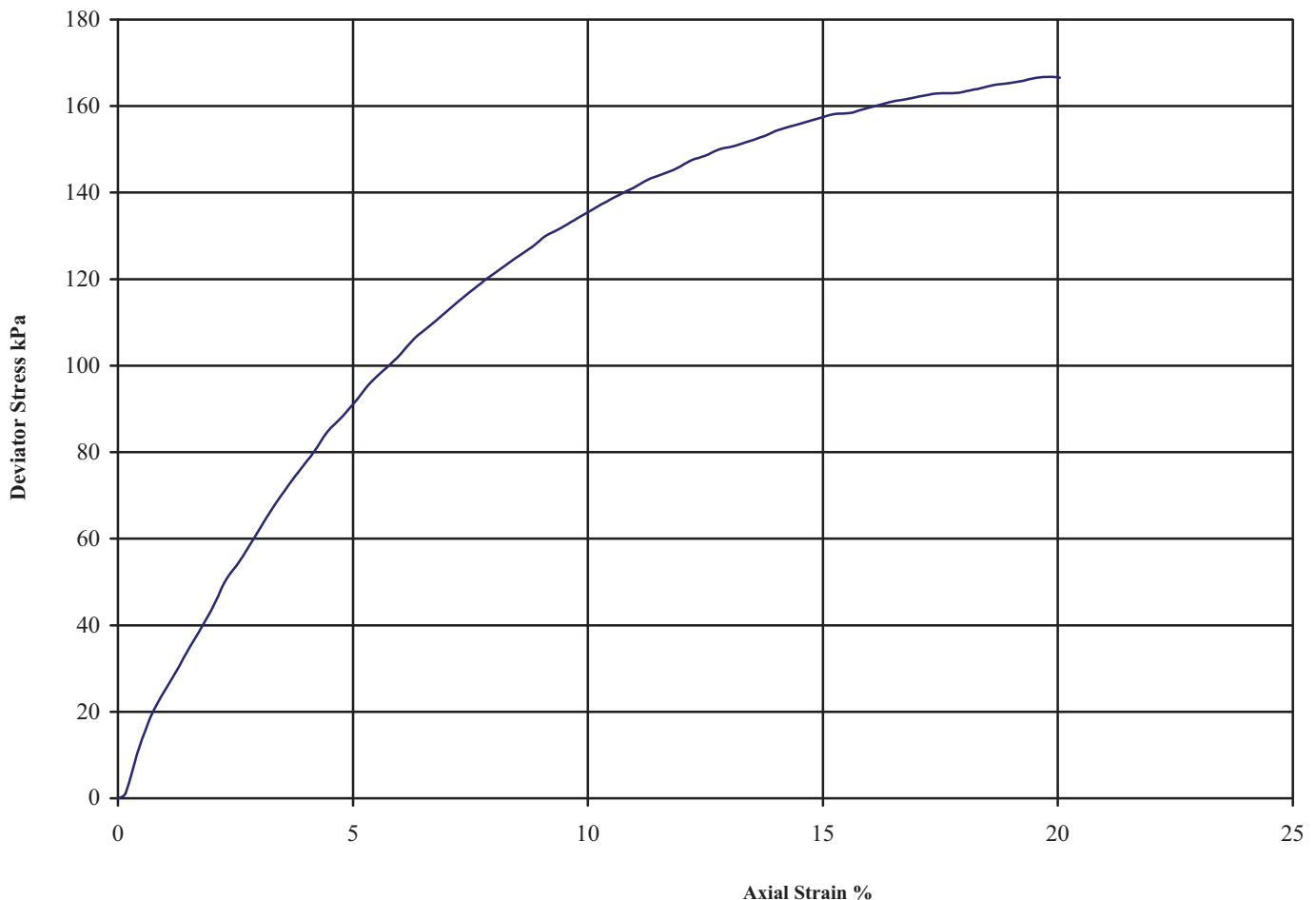
B.S. 1377 : Part 7 : Clause 8 : 1990




Hole Number: BHA

Depth (m): 7.50-7.95

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		210.0	Test:	100 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Remarks			
					Deviator Stress (kPa)	Cu Strength (kPa)			Sample taken from Bottom of tube			
					$\theta_3$	$(\theta_1 - \theta_3)_f$			$\frac{1}{2}(\theta_1 - \theta_3)_f$	Rate of strain = 1.9 %/min		
										Latex Membrane used 0.4 mm thickness, Correction applied 0.33 kPa		
A	15	2.22	1.93	150	167	83	19.9	Compound	See summary of soil descriptions.			
									Checked	Date	Approved	Date
										13/08/14		13/08/14
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			

# Particle Size Distribution Test

BS1377 : Part 2 : 1990

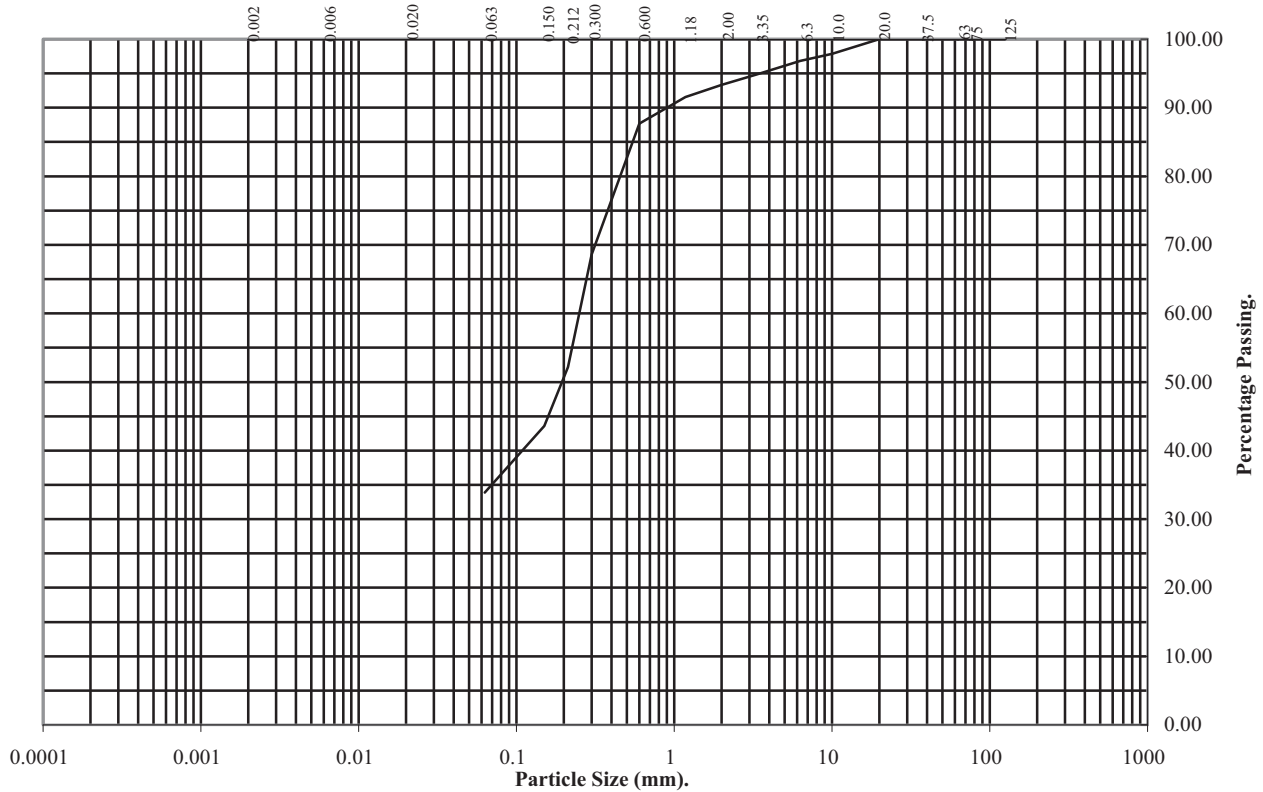
Wet Sieve, Clause 9.2

Hole Number: BHB

Depth (m): 1.50-3.00

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	98
6.3	97
3.35	95
2	93
1.18	92
0.6	88
0.3	69
0.212	52
0.15	44
0.063	34

Soil Fraction	Total Percentage
Cobbles	0
Gravel	7
Sand	59
Silt / Clay	34

## Remarks:

See summary of soil descriptions.

Checked By	Date	Approved By	Date
<i>M. S.</i>	13/08/14	<i>M. S.</i>	13/08/14

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SPEKE.

Contract No.:  
PSL14/3632

# One Dimensional Consolidation Properties

BS 1377: Part 5: 1990

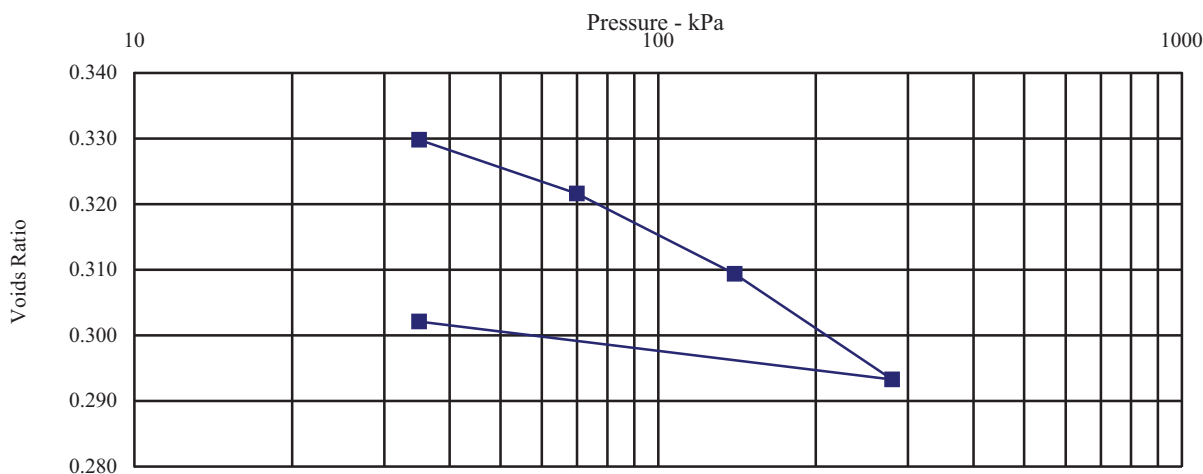
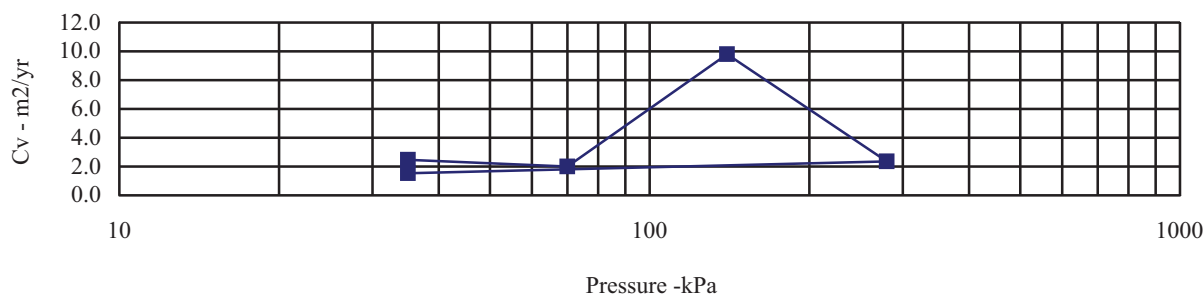
Hole Number: BHB

Depth (m): 3.50-3.95

Sample Number

Sample Type: U

Initial Conditions		Pressure Range		Mv	Cv	Specimen location	
Moisture Content (%):	14	kPa		m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	2.26	0	- 35	0.096	2.460	Method used to	
Dry Density (Mg/m3):	1.99	35	- 70	0.176	2.010	determine CV:	t90
Voids Ratio:	0.334	70	- 140	0.133	9.809	Nominal temperature	
Degree of saturation:	108.5	140	- 280	0.088	2.347	during test ' C:	20
Height (mm):	20.23	280	- 35	0.028	1.523	Remarks:	
Diameter (mm)	75.09	See summary of soils description.					
Particle Density (Mg/m3):	2.65						
Assumed							



Checked by	Date	Approved by	Date
<i>H. S.</i>	13/08/14	<i>H. S.</i>	13/08/14



PHASE 3, LIVERPOOL BUSINESS  
PARK, SPEKE.

Contract No.

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# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

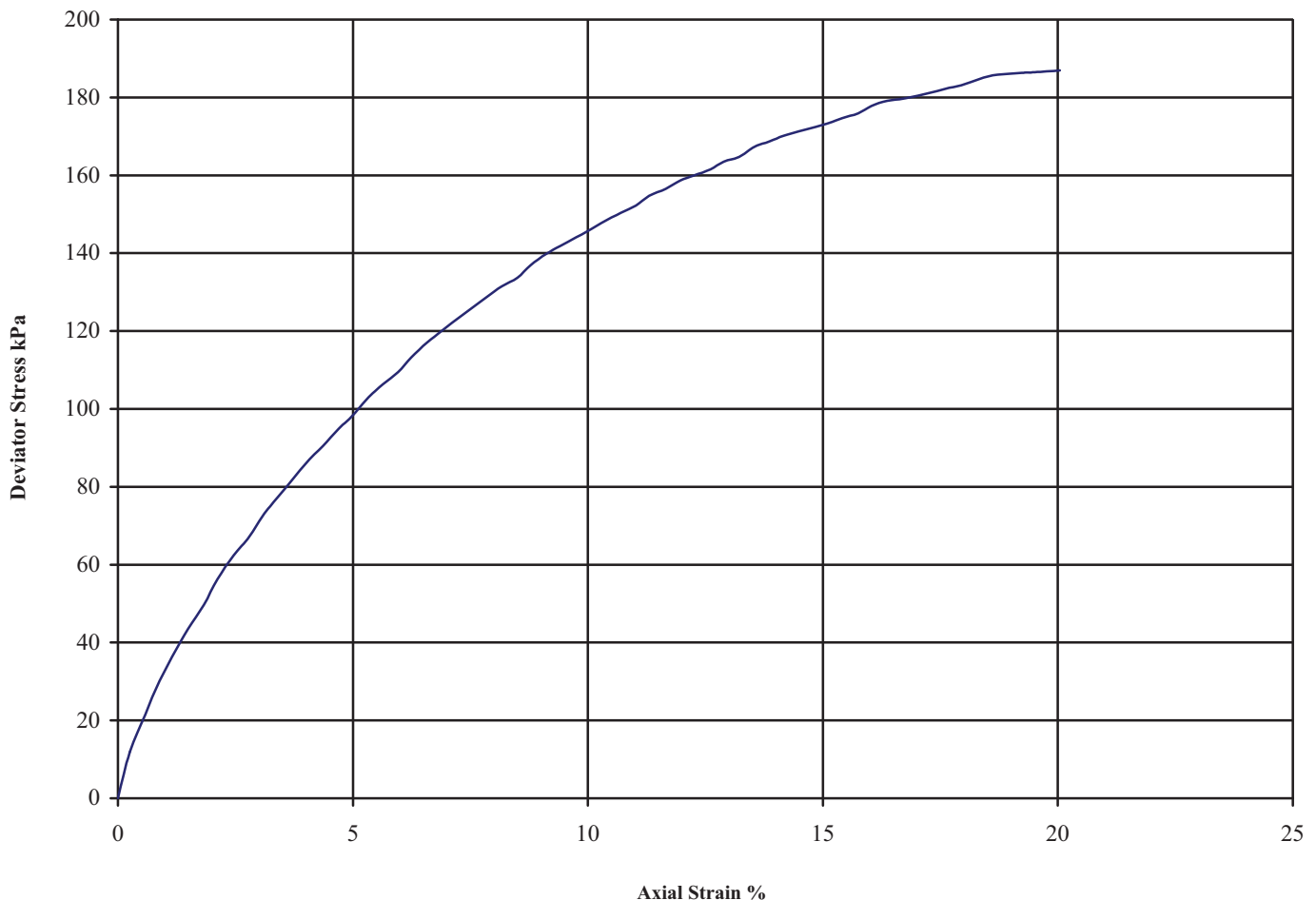
B.S. 1377 : Part 7 : Clause 8 : 1990




Hole Number: BHB

Depth (m): 3.50

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		210.0	Test:	100 mm Single Stage.		Undisturbed				
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Remarks  Sample taken from Bottom of tube Rate of strain = 1.9 %/min Latex Membrane used 0.4 mm thickness, Correction applied      0.33      kPa  See summary of soil descriptions.				
					Deviator Stress (kPa)	Cu (kPa)							
					$\theta_3$	$(\theta_1 - \theta_3)_f$							$\frac{1}{2}(\theta_1 - \theta_3)_f$
A	14	2.20	1.93	70	187	93	20.0	Compound					
									Checked	Date	Approved	Date	
										13/08/14		13/08/14	
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632				

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

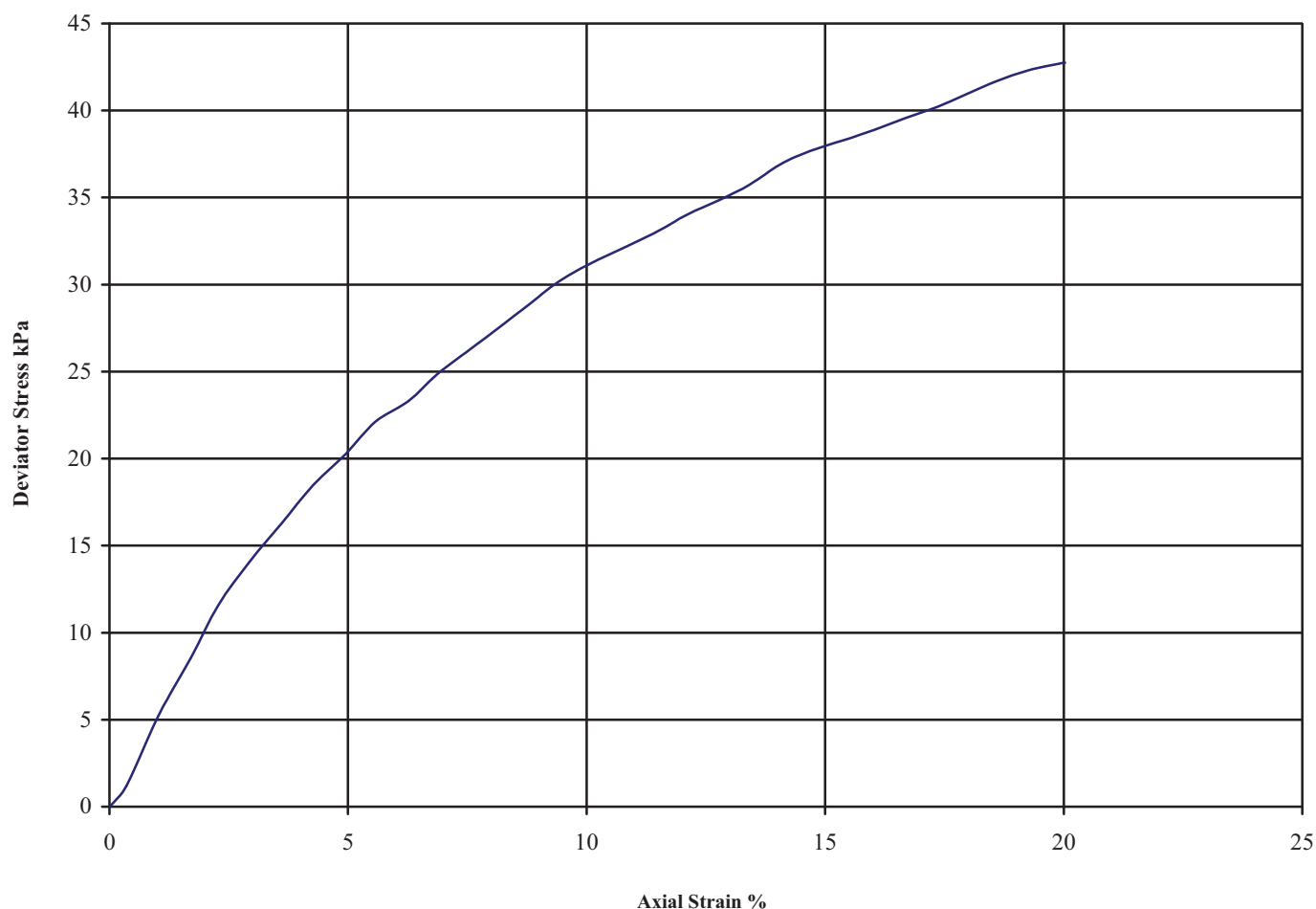
B.S. 1377 : Part 7 : Clause 8 : 1990




Hole Number: BHB

Depth (m): 6.00-6.45

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		185.0	Test:	100 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure	Mode of Failure	Remarks			
					Deviator Stress (kPa)	Strength Cu (kPa)	Strain (%)					
					$\theta_3$	$(\theta_1-\theta_3)_f$	$\frac{1}{2}(\theta_1-\theta_3)_f$					
A	14	1.93	1.69	120	43	21	20.0	Compound	See summary of soil descriptions.			
									Checked	Date	Approved	Date
										13/08/14		13/08/14
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			



# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

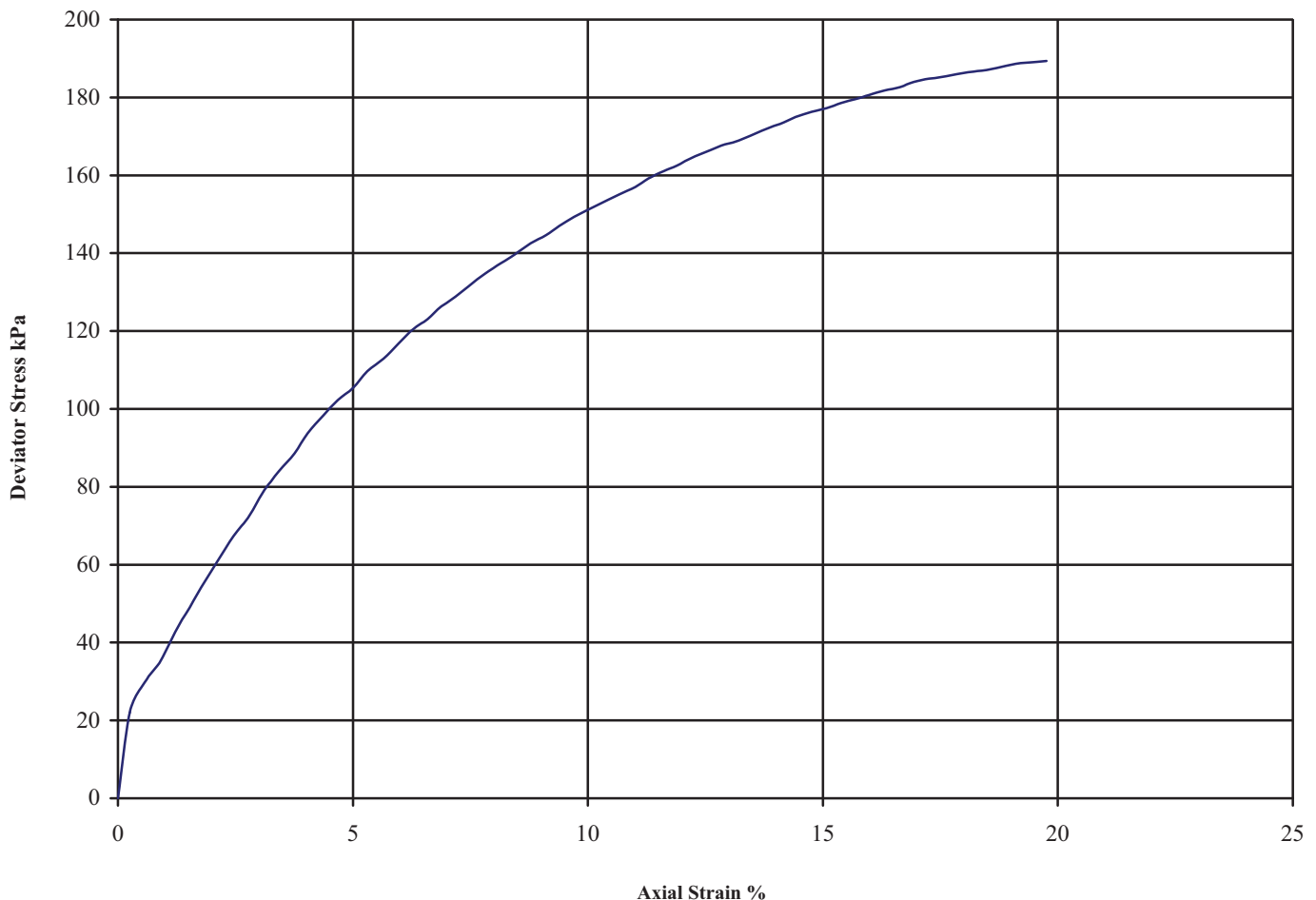
B.S. 1377 : Part 7 : Clause 8 : 1990


Hole Number: BHC

Depth (m): 4.50-4.95

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		210.0	Test:	100 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Remarks			
					Deviator Stress (kPa)	Cu (kPa)			Sample taken from Bottom of tube			
					$\theta_3$	$(\theta_1 - \theta_3)_f$			$\frac{1}{2}(\theta_1 - \theta_3)_f$	Rate of strain = 1.9 %/min		
										Latex Membrane used 0.4 mm thickness, Correction applied 0.33 kPa		
A	13	2.27	2.01	90	189	95	19.8	Compound	See summary of soil descriptions.			
									Checked	Date	Approved	Date
									<i>M. S.</i>	13/08/14	<i>M. S.</i>	13/08/14
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			

# Particle Size Distribution Test

BS1377 : Part 2 : 1990

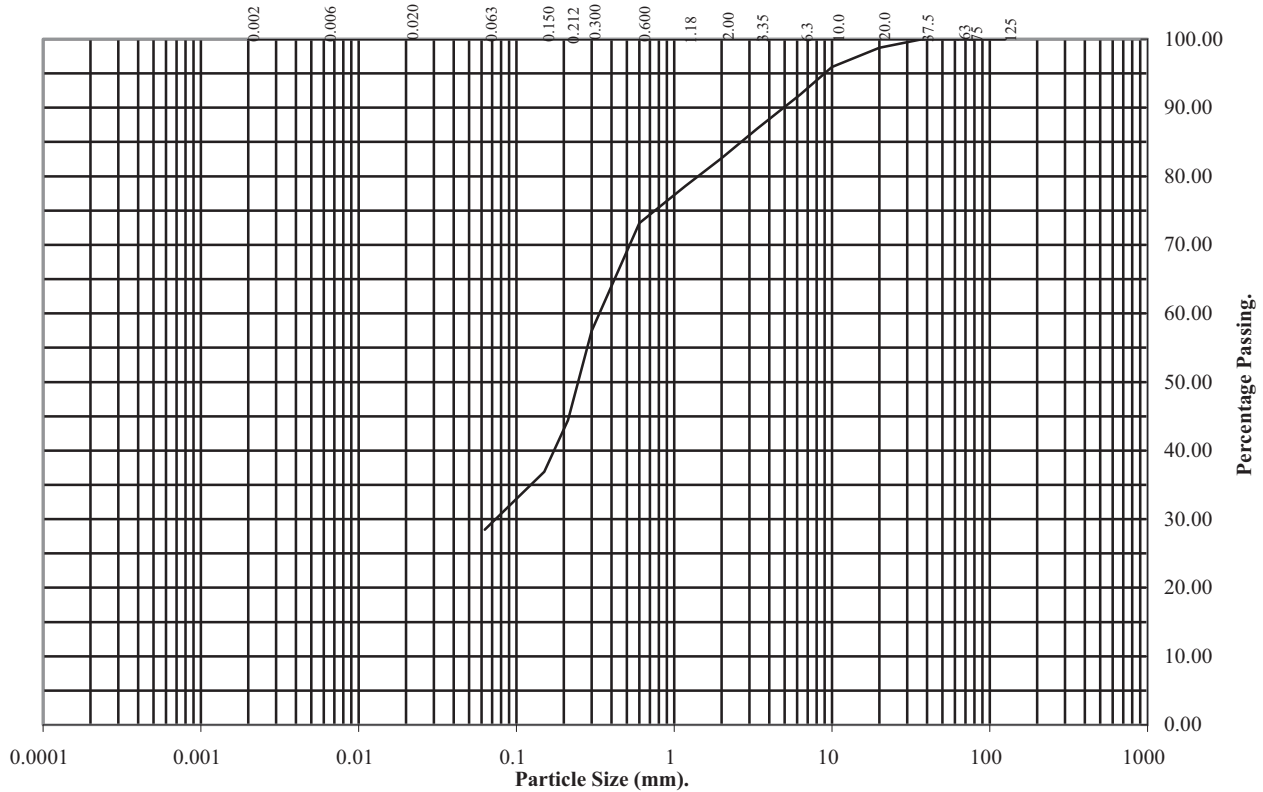
Wet Sieve, Clause 9.2

Hole Number: BHD

Depth (m): 1.50-3.00

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	99
10	96
6.3	92
3.35	87
2	83
1.18	79
0.6	73
0.3	57
0.212	44
0.15	37
0.063	28

Soil Fraction	Total Percentage
Cobbles	0
Gravel	17
Sand	55
Silt / Clay	28

## Remarks:

See summary of soil descriptions.

Checked By	Date	Approved By	Date
<i>N. S.</i>	13/08/14	<i>N. S.</i>	13/08/14

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Professional Soils Laboratory

PHASE 3 LIVERPOOL BUSINESS PARK,  
SPEKE.

Contract No.:  
PSL14/3632

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

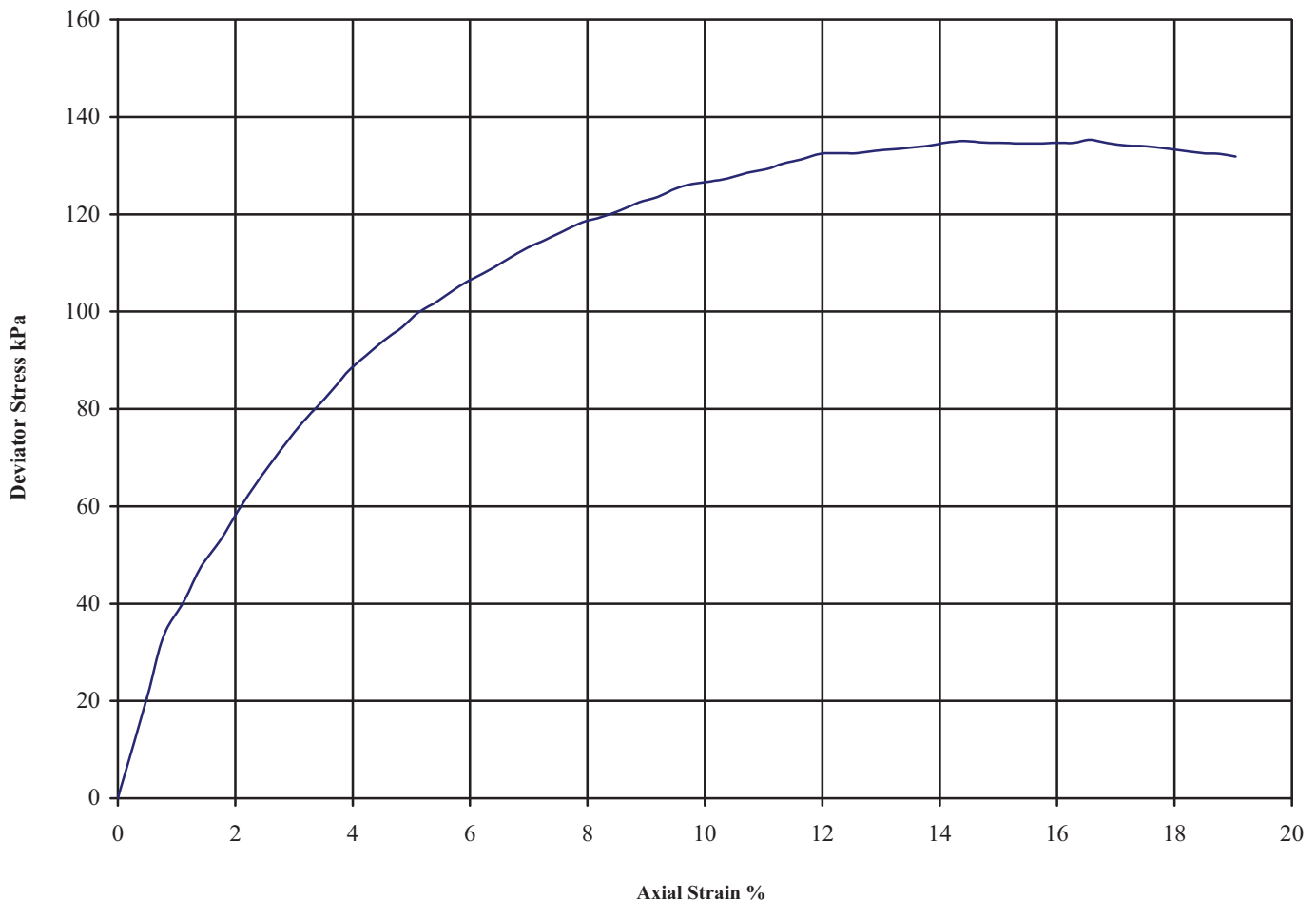
B.S. 1377 : Part 7 : Clause 8 : 1990


Hole Number: BHD

Depth (m): 3.50

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		210.0	Test:	100 mm Single Stage.		Undisturbed				
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Remarks  Sample taken from Bottom of tube Rate of strain = 1.9 %/min Latex Membrane used 0.4 mm thickness, Correction applied      0.34    kPa  See summary of soil descriptions.				
					Deviator Stress (kPa)	Cu (kPa)							
					$\theta_3$	$(\theta_1 - \theta_3)_f$							$\frac{1}{2}(\theta_1 - \theta_3)_f$
A	14	2.10	1.84	70	135	68	16.6	Compound					
									Checked	Date	Approved	Date	
									<i>M. S.</i>	13/08/14	<i>M. S.</i>	13/08/14	
					PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

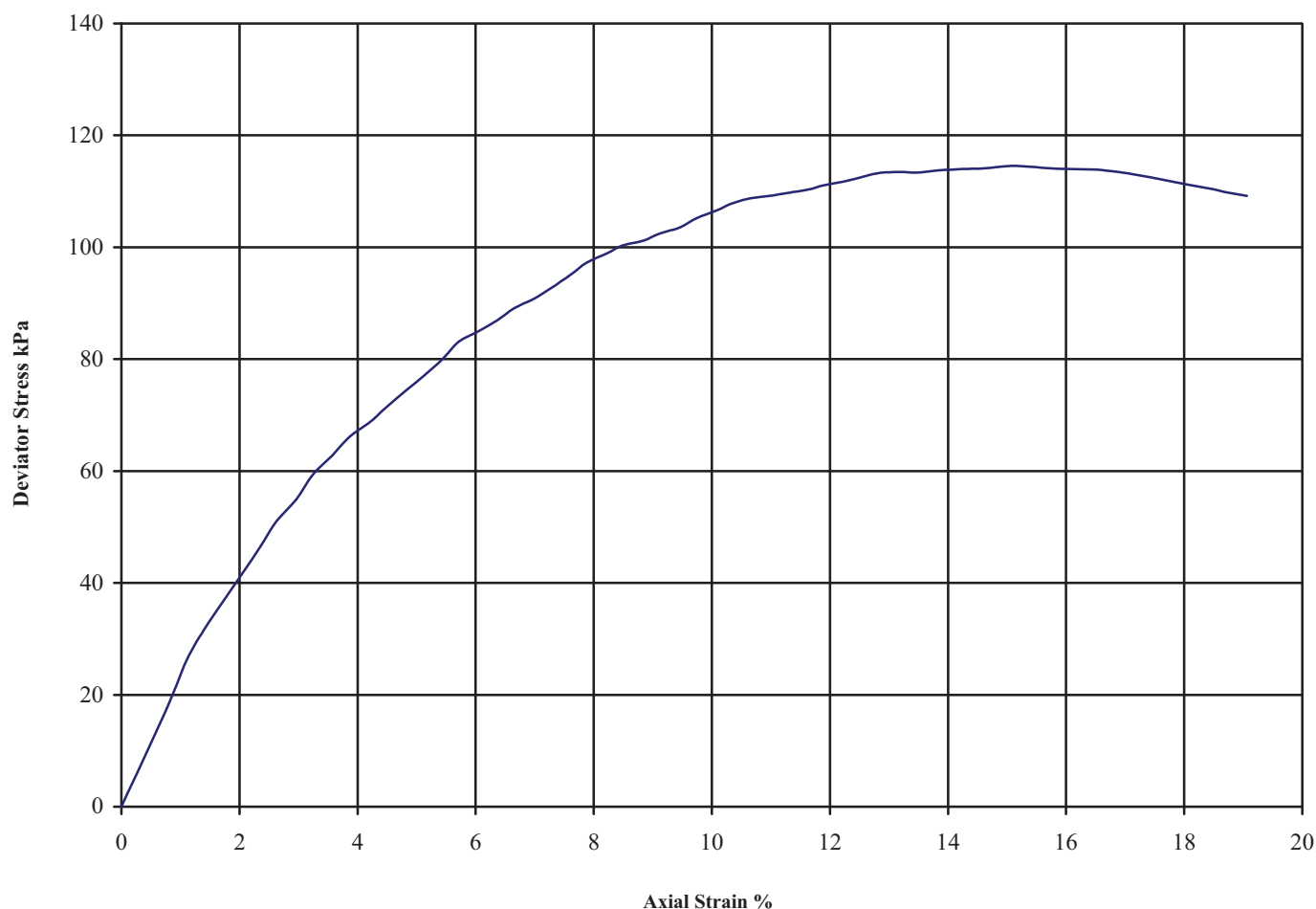
B.S. 1377 : Part7 : Clause 8 : 1990




Hole Number: BHD

Depth (m): 7.50-7.95

Sample Number:

Sample Type: U



Diameter (mm):		102.0	Height (mm):		210.0	Test:	100 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)  $\theta_3$	Corr. Max. Deviator Stress (kPa)  $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa)  $\frac{1}{2}(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Remarks			
									Sample taken from Bottom of tube			
									Rate of strain = 1.9 %/min			
									Latex Membrane used 0.4 mm thickness,			
A	19	2.15	1.81	150	115	57	15.0	Compound	Correction applied 0.34 kPa			
									See summary of soil descriptions.			
									Checked	Date	Approved	Date
										13/08/14		13/08/14
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			

# Particle Size Distribution Test

BS1377 : Part 2 : 1990

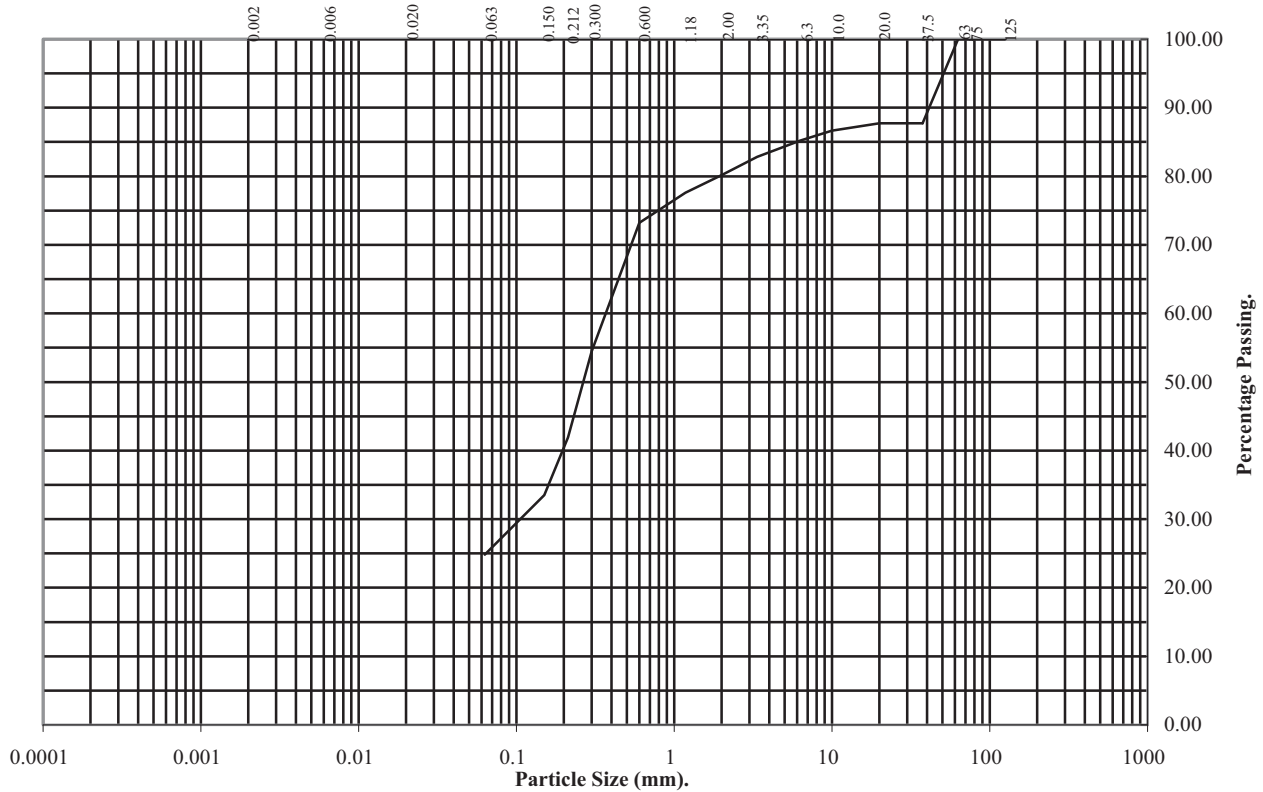
Wet Sieve, Clause 9.2

Hole Number: BHE

Depth (m): 1.00

Sample Number:

Sample Type: D



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	88
20	88
10	87
6.3	85
3.35	83
2	80
1.18	78
0.6	73
0.3	54
0.212	42
0.15	34
0.063	25

Soil Fraction	Total Percentage
Cobbles	0
Gravel	20
Sand	55
Silt / Clay	25

## Remarks:

See summary of soil descriptions.

Checked By	Date	Approved By	Date
<i>N. S.</i>	13/08/14	<i>N. S.</i>	13/08/14

**PSL**

Professional Soils Laboratory

PHASE 3 LIVERPOOL BUSINESS PARK,  
SPEKE.

Contract No.:  
PSL14/3632

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

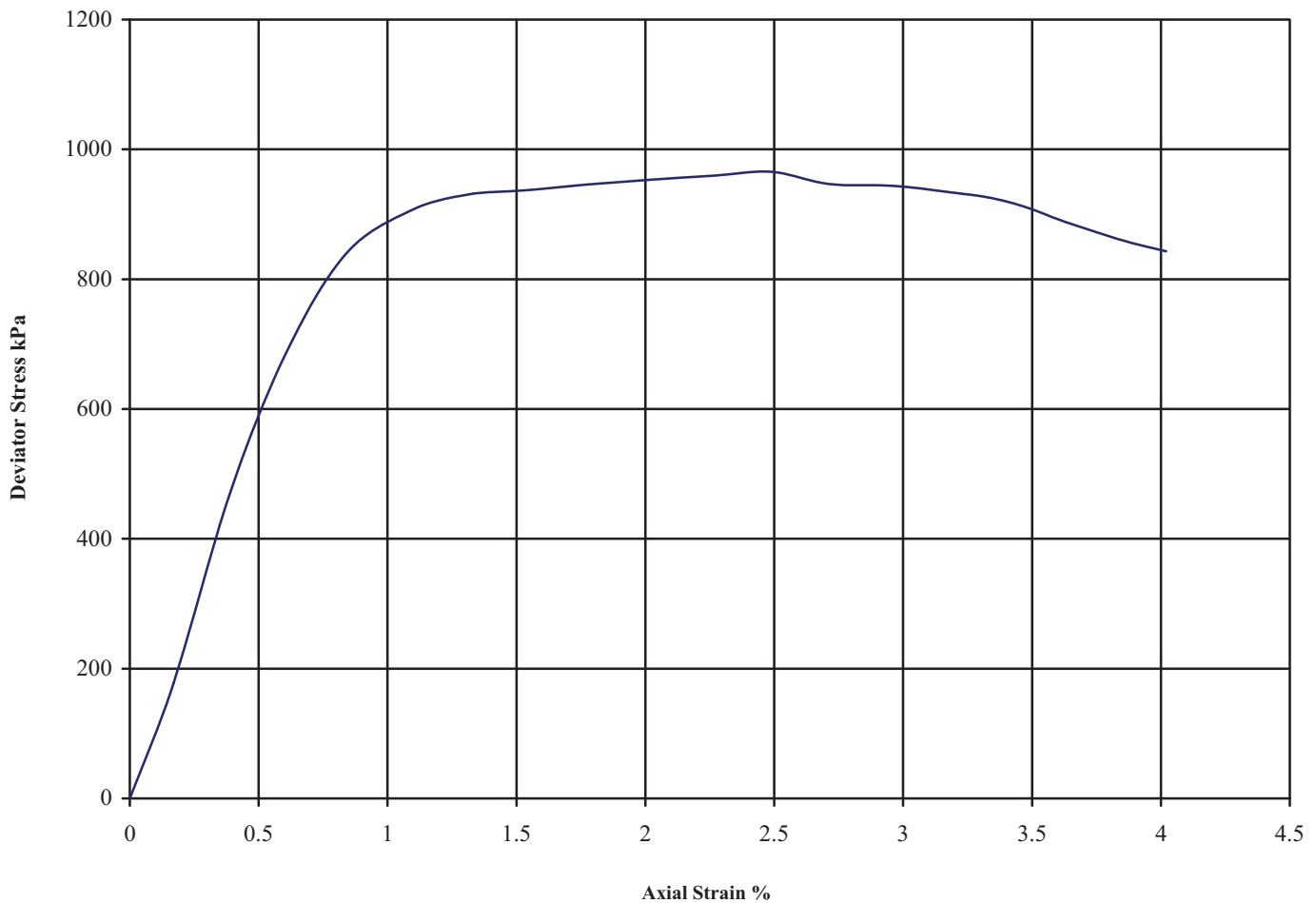
B.S. 1377 : Part 7 : Clause 8 : 1990




Hole Number: BHE

Depth (m): 3.50

Sample Number:

Sample Type: U



Diameter (mm):		38.0	Height (mm):		76.0	Test:	38 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max. Deviator Stress (kPa)	Shear Strength Cu (kPa)	Failure Strain (%)	Mode of Failure	Remarks			
									Sample taken from Bottom of tube			
									Rate of strain = 1.9 %/min			
									Latex Membrane used 0.4 mm thickness,			
A	8.3	2.22	2.05	70	966	483	2.5	Brittle	Correction applied 0.99 kPa			
									See summary of soil descriptions.			
									Checked	Date	Approved	Date
										13/08/14		13/08/14
 Professional Soils Laboratory				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			

# Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

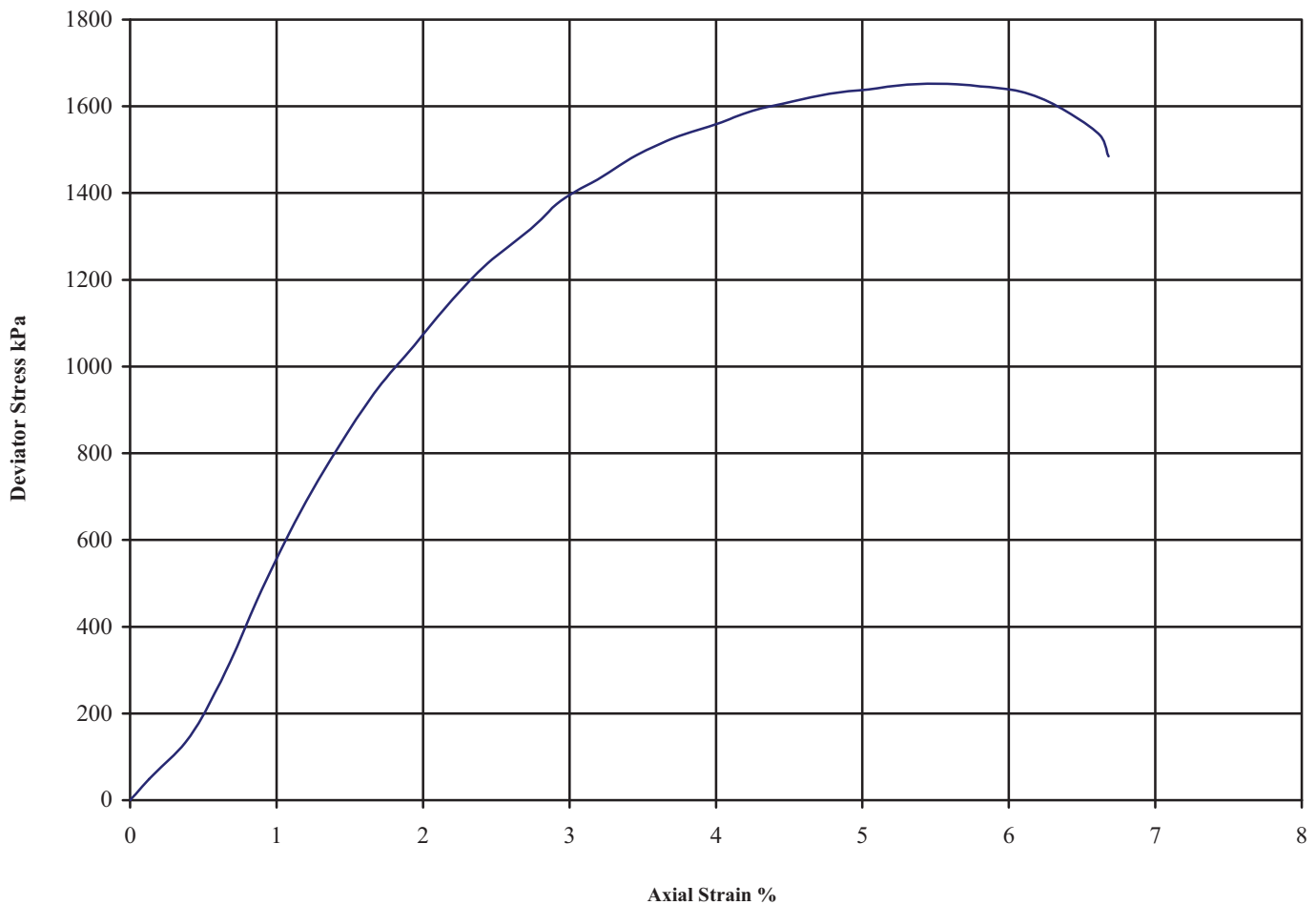
B.S. 1377 : Part7 : Clause 8 : 1990


Hole Number: BHE

Depth (m): 6.00

Sample Number:

Sample Type: U



Diameter (mm):		38.0	Height (mm):		76.0	Test:	38 mm Single Stage.		Undisturbed			
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Remarks			
					Deviator Stress (kPa)	Cu (kPa)			Sample taken from Bottom of tube			
					$\theta_3$	$(\theta_1-\theta_3)_f$			$1/2(\theta_1-\theta_3)_f$	Rate of strain = 1.9 %/min		
										Latex Membrane used 0.4 mm thickness, Correction applied 0.97 kPa		
A	8.5	2.22	2.04	120	1652	826	5.5	Brittle	See summary of soil descriptions.			
									Checked	Date	Approved	Date
									<i>H. S.</i>	13/08/14	<i>H. S.</i>	13/08/14
				PHASE 3 LIVERPOOL BUSINESS PARK, SPEKE.					Contract No: PSL14/3632			





# Particle Size Distribution Test

BS1377 : Part 2 : 1990

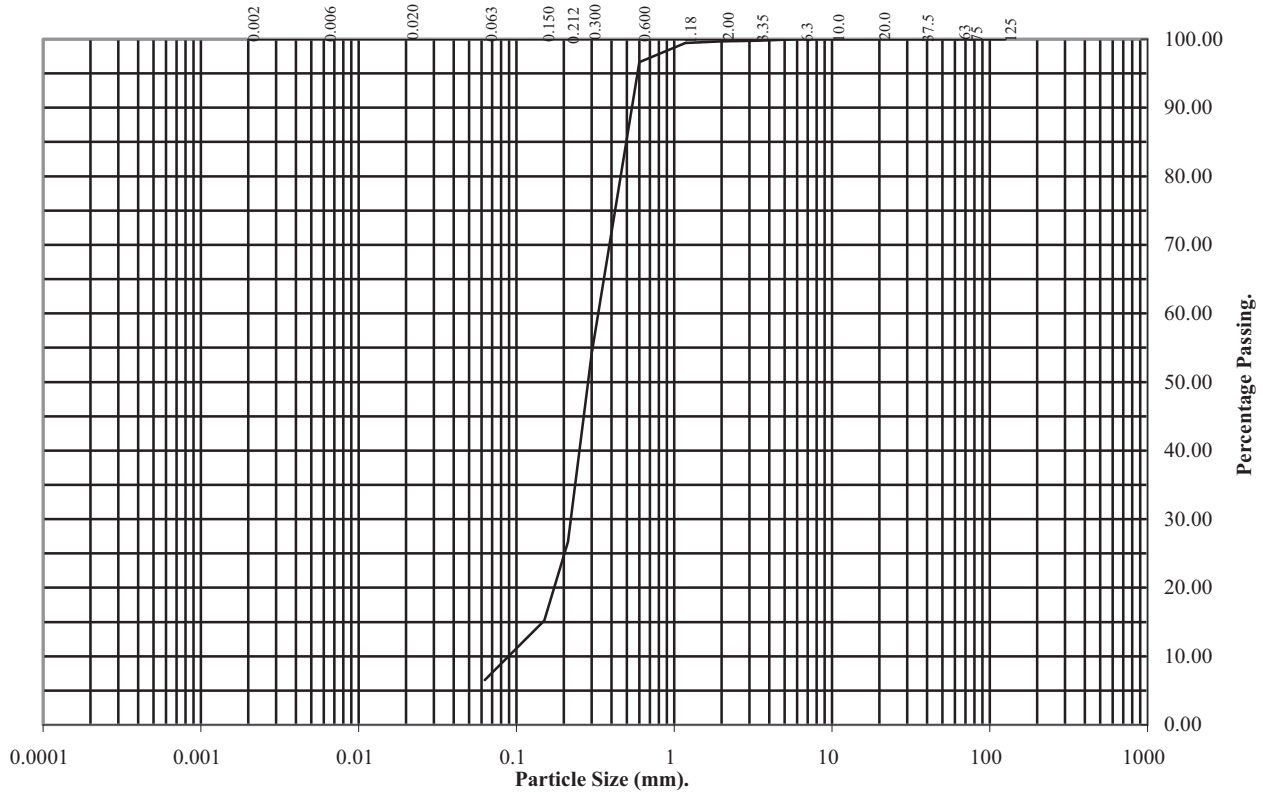
Wet Sieve, Clause 9.2

Hole Number: TPF

Depth (m): 1.00

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	99
0.6	97
0.3	54
0.212	27
0.15	15
0.063	7

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	93
Silt / Clay	7

## Remarks:

See summary of soil descriptions.

Checked By	Date	Approved By	Date
<i>M. S.</i>	13/08/14	<i>M. S.</i>	13/08/14

**PSL**

Professional Soils Laboratory

PHASE 3 LIVERPOOL BUSINESS PARK,  
SPEKE.

Contract No.:  
PSL14/3632

# **APPENDIX V**

**Ground Contamination Risk Assessment Data: Methodology  
Notes for Off-Site Disposal  
CL:AIRE Statistical Analysis Sheets**

## **Ground Contamination Risk Assessment**

### **Assessment Framework:-**

Ground contamination risk assessments are undertaken to identify potential risks from historical and recent land contamination on a given site and enable appropriate risk management actions to be undertaken in accordance with the regulatory context of the site and any future development. There are a range of technical approaches to the assessment of chemical contaminants in the UK, all of which broadly fit within a tiered/phased approach and the current UK approach is set out in the Defra and Environment Agency Publication: CLR 11: Model Procedures for the Management of Land Contamination (*Defra/EA 2004*).

ARC's approach to undertaking ground contamination risk assessments is based on the tiered/phased framework in accordance with CLR11, and for Human Health, the recently updated CLEA (Contaminated Land Exposure Assessment) framework and model for assessing potentially contaminated land in the UK. This framework and model is based primarily on the following publications and software: Science Reports SC050021/SR2 (EA 2008b Human Health toxicological assessment of contaminants in soil) and SC050021/SR3 (Updated technical background to CLEA model – replaces the previous guidance documents CLR9, CLR10 and Briefing notes 1 – 4); Science Report SC050021/SR4 (CLEA Software (version 1.06 beta) handbook) and the new CLEA software (replaces Science Report SC050021/H CLEA UK Handbook (draft) and the CLEA UK Software version 1.0 beta), along with the publication of a review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA), Project no. SC050021/Technical Review 1.

At present, the SGV's (Soil Guidance Values) published as part of the previous CLEA UK Handbook (draft) and software (version 1.0 beta), have been withdrawn along with guidance documents CLR7 and CLR8, and replacement of the SGV values, using the updated model and software (version 1.06), is currently ongoing, and the new guidance documents for CLR7 & CLR8 have yet to be published. Currently, Defra and the EA have published TOX and SGV reports for the following select substances: Benzene, Toluene, Ethylbenzene, Xylenes, Arsenic, Cadmium, Mercury, Nickel, Selenium and Phenol. Although updated SGV values have been calculated for the aforementioned analytes, at present for the majority of the potential contaminants, relevant data is yet to be made available for the new model. According to Defra and the EA, the schedule for publication of the remaining reports will depend on various factors, and they anticipate publishing the remaining TOX and SGV reports for Cyanide, Lead, Dioxins, Dioxin-like Polychlorinated Biphenyls and Polycyclic Aromatic Hydrocarbons during the remainder of 2010.

When considering ground contamination risk assessments for Controlled Waters (groundwater and surface waters), ARC follows the EA guidance on Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006.

### **Methodology:-**

During this transitional period, prior to the publication of all the new SGV values for the above mentioned analytes, ARC consider that the most appropriate methodology for completing a ground contamination risk assessment for soils on this site will be to utilise the recently published SGV values (Benzene, Toluene, Ethylbenzene, Xylenes, Arsenic, Cadmium, Chromium (III & VI), Mercury, Nickel, Selenium and Phenol), combined with the former CLEA model SGV's based on the CLEA UK software and other newly published and recognised GAC's (generic assessment criteria) for the remaining analytes. It is widely recognised by ground contamination risk assessment practitioners that the new CLEA model will generally result in higher SGV and GAC (generic assessment criteria) values for the standard end uses, and consequently continued use of the former CLEA model will result in a slightly more conservative assessment.

For general soil surface contamination, the new SGV value for inorganic Mercury can be compared with chemical analysis for total mercury content, as the concentrations of elemental and methylmercury compounds are likely to be very low, in accordance with Science Report SC050021 / Mercury SGV. In addition, the updated SGV values are based upon a Soil Organic Matter (SOM) content of 6%, in line with the most recent Defra and EA guidance. Once all the relevant data is available, a reassessment of the ground contamination present on this site can be carried out, if felt necessary, as this may result in a reduction in the scope of remediation works (if required). It should be noted that guidance document CLR11: Model Procedures for the Management of Land Contamination has not been withdrawn.

## **Ground Contamination Risk Assessment (Cont'd)**

### **Methodology (Cont'd):-**

ARC ground contamination risk assessments, in accordance with CLR11, are based on the established *source-pathway-receptor* pollutant linkage methodology and 'suitable for use' approach (Part IIA, EPA 1990 - inserted through Section 57 EA 1995), and adopts the tiered/phased approach beginning with a preliminary assessment (also referred to a desk top study). If potential pollutant linkages are identified from the preliminary assessment, for both Human Health and/or Controlled Waters, then Level 1 Quantitative Risk Assessments are appropriate guideline values. For soils these typically comprise soil guideline values (SGV's), generic assessment criteria (GAC) or site specific assessment criteria (SSAC) and for controlled waters, Environmental Quality Standards (EQS) or UK Drinking Water Standards.

Where any Level 1 criteria have been exceeded, various courses of action are available for recommendation, in order to try and 'break' the pollutant linkage by designing into the proposed development works and/or by recommending appropriate remediation works, i.e. removal of source, treatment of contaminants, installation of permanent barriers, etc. and/or by carrying out more detailed site specific quantitative risk assessment (DQRA, i.e. Level 2 or above). Completing further DQRA for any contaminants present, can take into account factors such as the introduction of physical barrier and the actual availability of plausible contaminant migration pathways, as well as site specific data such as the type, properties and characteristics (permeability, porosity, density, etc.) of the soil present on site, groundwater depth and flow, site specific exposure criteria and values, and contaminant retardation, attenuation, dilution and degradation. Similarly, when considering potential risks to off-site receptors, these are considered by assessing the potential risks to on-site receptors, as well as the potential mobility of any contaminants present within either the soils or water/groundwater below this site.

For the purpose of this report, preliminary and level 1 risk assessments consider two main categories of receptor, and these are as follows:

- On site Human Health – (CLEA Model).
- Controlled Waters – (groundwater) – (EA Remedial Targets Methodology).

When considering the risk to construction workforce, the results of the screening can be used by the Main Contractor/Project Coordinator, when devising an adequate Site Health & Safety Plan, in accordance with current CDM Regulations, and when assessing the level of PPE required on site. Similarly, when considering the risks to building materials, again the results of the contamination screening can be used to determine the level of protection that may be required, and reference should be made to the utilities suppliers for their comments.

### **Level 1 - Human Health:-**

Level 1 human health related assessments are based upon the current CLEA Model, with site values assessed against published Soil Guidance Values (SGV's), and where these values are not available against the published CIEM (Chartered Institute of Environmental Health)/LQM Generic Assessment Criteria (GAC), Atkins ATRISKsoil® SSV values and USEPA Region 9 Screening Values (2009). For statistical analysis, the site is assessed to delineate any potentially differing areas of contamination (averaging areas), based on the results of the preliminary investigation as well as the result of any visual, olfactory or analytical evidence following completion of the intrusive investigation works. Following this geographical delineation of the site, where generic or pervasive contaminants are anticipated, for each 'averaging area' under consideration, the results are assessed using the established methods of statistical analysis given in the CL:AIRE Guidance on Comparing Soil Contamination Data with a Critical Concentration ( $C_c$ ), May 2008. In this case, the results of the sample population are assessed to determine whether they represent a normal or non-normal distribution and the statistical upper confidence limit is (95% percentile –  $UCL_{0.95}$ ) is calculated and then compared with the chosen Level 1 Critical Concentration ( $C_c$ ) value for the site (i.e. the appropriate SGV, GAC or SSV).

In addition, further statistical analysis is undertaken to determine whether the maximum concentration(s) recorded represent statistical outliers, i.e. potential 'hot spots', and where necessary these are removed from the sampling populations and a reassessment of the averaging areas/potential hot spot areas identified.

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## **Ground Contamination Risk Assessment (Cont'd)**

### **Methodology (Cont'd):-**

#### **Level 1 - Human Health (Cont'd):-**

Where targeted screening is undertaken, i.e. speciated PAH's for 'ashy' type materials, screening for suspected organic contamination, etc., the maximum site values recorded ( $C_M$ ) at each location have been compared to the chosen Level 1 Critical Concentration ( $C_C$ ), with no requirement for statistical analysis to be undertaken on for these samples.

#### **Level 1 – Controlled Waters:-**

The Level 1 controlled waters risk assessment has been carried out (in accordance with the guidance; Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, Environment Agency, 2006) by comparing samples of leachate, with the chosen Level 1 Critical Concentration ( $C_C$ ) value, based on an appropriate water quality standard (EQS, UK Drinking Water, etc.), and which is also taken as the Level 1 Leachate Remedial Target ( $LTC_1$ ).

The number of samples chosen for screening is determined by assessing the potential risk of contamination reaching a sensitive receptor, i.e. shallow groundwater, nearby surface water feature, etc., based on the results of the preliminary investigation, as well as olfactory, visual, anecdotal and analytical evidence collected during the intrusive investigation works.

Where the potential risk is considered to be low between 0% and c.25% of the samples are targeted for screening, c.25% to c.50% where the risk is considered to be moderate and c.75% to 100% where the risk is considered to be high. This is to ensure that the potential risk is adequately assessed without carrying out unnecessary testing. When considering any 'hot spots' identified, samples are specifically targeted for screening on a sample by sample and analyte by analyte basis.

### **Notes for Off-Site Disposal**

When considering the removal of any materials from this site as a waste, to be disposed of at a landfill, it can be seen that where the uncontaminated natural strata (excluding any 'topsoil' or 'peat' materials) can be kept separate from any made ground or contaminated natural strata, then these materials can be considered as 'inert' and taken to an Inert Landfill Site.

Where made ground or contaminated natural strata is to be removed off site as a 'waste', a preliminary classification assessment, regarding off-site disposal, can be made utilising the contamination soils screening undertaken as part of the Level 1 Risk Assessment for Human Health. If there is sufficient screening to classify these materials as Non-Hazardous, then they can be disposed of at a Non-Hazardous Landfill. If insufficient preliminary screening has been undertaken to carryout the classification assessment, then further preliminary soils screening should be undertaken, where required.

If the results of the preliminary classification assessment indicate that the materials to be removed from site as a 'waste' should be classified as Hazardous Waste, then prior to disposal, full WAC screening should be completed so that these materials can be classified as either Stable Non-Reactive Hazardous Waste or Hazardous Waste, and disposed of at a suitable waste disposal facility.

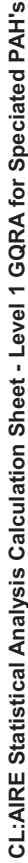
If possible, removal of materials from site as a 'waste' should be kept to a minimum, however, if materials have to be removed to accommodate finished ground levels etc., it is recommended that the volume to be disposed of is calculated, as the amount of additional screening required, including any full WAC screening, will be dependant upon the volume of material to be disposed of.

# CL:AIRE Statistical Analysis Calculation Sheet - Level 1 GQRA for Generic Contaminants



Client/client ref: Commercial Development Projects Ltd Project ref: 16-433 Site ref: Speke Data description: Contamination Screening Results Contaminant(s): Generic Soils - Commercial Test scenario: Planning												
Critical concentration, C <sub>c</sub>		640 SAUL	190 SAUL	8600 SAUL	33 SAUL	68000 SAUL	2330 C4SL	1100 SAUL	980 SAUL	12000 SAUL	730000 SAUL	34 ATRISK(SOIL) SSV - 2011
Notes												
Sample size, n		22										
Sample mean,		10.1201535										
Standard deviation, s		10.5725975										
Number of non-detects		0										
Set non-detect values to:		2										
Outliers?		Yes	Yes	No	No	Yes	Yes	No	Yes	No	Yes	No
Distribution		Non-normal	Non-normal	Normal	Single value	Non-normal	Non-normal	Single value	Normal	Normal	Non-normal	Single value
Statistical approach		3	3	3	3	3	3	3	3	3	3	3
Test scenario:		95%										
t statistic, t <sub>0</sub> (or k <sub>0</sub> )		-279.439217	-1439.611812	-2693.262564	N/A	-7292.89307	-60.27640616	N/A	-450.9778827	-189144.5386	-26691.23353	N/A
Upper confidence limit (on true mean concentration, μ)		19.9454837	0.95167273	78.1404632	0.5	75.7287082	249.868729	0.25	23.003339	0.76143682	205.464446	1
Evidence level		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Base decision on:		2	1	2	2	2	2	2	2	2	2	2
Result		μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>	μ < C <sub>c</sub>
Select dataset												





Report Type: Geo-environmental Investigation Report.  
Project: - 16-433 Speke.  
Prepared For:- Commercial Development Projects Ltd.



CL:AIRE Statistical Analysis Calculation Sheet - Level 1 GQRA for Speciated TPH's

Client/client ref: Commercial Development Projects Ltd Project ref: 16-433 Site ref: Speke, Liverpool Data Ref: Geochemical Contamination Results Contaminant(s): Speciated TPH (All/Aro Split) Test scenario: Planning		TPH Aliphatic EC5-EC6 (mg/kg)	TPH Aliphatic EC6-EC8 (mg/kg)	TPH Aliphatic EC8-EC10 (mg/kg)	TPH Aliphatic EC10-EC12 (mg/kg)	TPH Aliphatic EC12-EC16 (mg/kg)	TPH Aliphatic EC16-EC35 (mg/kg)	TPH Aliphatic EC35-EC44 (mg/kg)	TPH Aromatic EC5-EC7 (mg/kg)	TPH Aromatic EC7-EC8 (mg/kg)	TPH Aromatic EC8-EC10 (mg/kg)	TPH Aromatic EC10-EC12 (mg/kg)	TPH Aromatic EC12-EC16 (mg/kg)	TPH Aromatic EC16-EC21 (mg/kg)	TPH Aromatic EC21-EC35 (mg/kg)	TPH Aromatic EC35-EC44 (mg/kg)
Critical concentration, C <sub>c</sub>		12000	40000	11000	47000	90000	1800000	1800000	86000	180000	17000	34000	38000	28000	28000	28000
Notes		S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)	S4UL (6% SOW)
Sample size, n		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Sample mean, $\bar{x}$		0.05	0.10454545	0.15454545	1.59090909	2.86363636	147.909091	88.1818182	0.005	0.005	0.005	0.5	0.54545455	3.68181818	3.95454545	0.63636364
Standard deviation, s		7.2776E-18	0.08790491	0.22633443	1.99772598	3.93122697	141.635062	76.9049	9.097E-19	9.097E-19	9.097E-19	0	0.15075567	5.81494939	5.10124762	0.45226702
Number of non-detects		11	7	6	7	3	0	0	11	11	11	11	10	5	5	10
Set non-detect values to:		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Outliers?		# DIV/0!	No	Yes	No	No	No	Yes	No	No	No	No	Yes	No	No	Yes
Distribution		Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Single value	Non-normal	Non-normal	Non-normal	Non-normal
Statistical approach		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Test scenario:		Evidence level required: 95%														
t statistic, t <sub>0</sub> (or k <sub>0</sub> )		-5.46876E+21	-1509183.605	-161187.8522	-78026.76156	-75927.11796	-42146.58405	-77623.56053	-3.13544E+23	-6.56254E+23	-6.19796E+22	N/A	-835988	-15968.02943	-18201.89595	-205328.6667
Upper confidence limit (on true mean concentration, $\mu$ )		0.05	0.22007514	0.45200717	4.21643541	8.03028081	334.054031	189.254658	0.005	0.005	0.005	0.5	0.74358632	11.3241589	10.6588983	1.23075895
Evidence level		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Base decision on:		2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
Result		$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$
Select dataset																



