

Project 3 Fernfield, Baglan				Job no. 23-030	
Calcs for Rear Retaining Walls				Start page no./Revision 1	
Calcs by JD	Calcs date 27/04/2023	Checked by	Checked date	Approved by	Approved date

INTRODUCTION

INCLINED WALL BEHIND PROPERTY.

The wall is to be constructed at an incline of 13 degrees into the retained material and comprises a 440mm thick dense blockwork wall.

Soil properties have been determined by testing and a copy of the report from Barratt Associates Ltd. is appended to the calculations.

Due to the soils self supporting nature the proposed wall does not retain the soil against forward motion, but the soil acts to support the sloping masonry as a weather protection to the face of the slope.

Soil properties

Moist density;	$\gamma_{mb} = 21.0 \text{ kN/m}^3$
Wall Angle to vertical;	$\alpha = 77 \text{ deg}$
Characteristic peak shearing resistance angle;	$\phi'_{pk,k} = 20.0 \text{ deg}$
Cohesion Coefficient	$C = 38 \text{ kPa}$
Wall friction angle;	$\delta_{r,k} = 0 \text{ deg}$ (eggshell drainage sheet behind)
Design base friction angle;	$\delta_b = 14.0 \text{ deg}$
Bearing capacity of founding soil;	$q = 150 \text{ kN/m}^2$

Section 1: 5.5m Wall level with road at top

Slope of retained soil;	$\beta = 0.0 \text{ deg}$
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Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2)$$

$$= 0.417$$

$$Z_o = 2C / \gamma_{mb} K_a$$

$$= 2 \times 38 / 21 \times 0.417$$

$$= 8.68\text{m}$$

Surcharge on plan can be represented by 0.5m of soil ($21 \times 0.5 = 10.5\text{kN/m}^2$)

Height of wall $H = 5.5\text{m} + 0.5\text{m}$ Surcharge = 6m

As the freestanding height of the cohesive soil Z_o is greater than the height of the wall with surcharge allowance there is no force to be retained and the wall acts to protect the soil face from erosion and weathering.

Horizontal load on wall	$P_a = 0.5K_a \gamma_{mb} (H - Z_o)$ $= 0 \text{ kN}$ Pressure applied can not be negative
Lever arm	$l_a = 0.333 \times 6.0$ $= 2.0\text{m}$
Overturning Moment	$M = 0 \text{ kNm/m}$
Dead Load from wall	$R_v = 5.5 \times 0.44 \times 18$ $= 43.6 \text{ kN}$
Lever arm	$l_w = 2.75 \sin 13 + 0.22$ $= 0.782\text{m}$
Restoring Moment	$M_r = 43.6 \times 0.782$

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$$= 34.1 \text{ kNm/m}$$

Therefore O.K. for Overturning

CHECK SLIDING

The net horizontal force is toward the soil slope and is resisted by the resistance of the soil.

THEREFORE O.K. FOR SLIDING

CHECK BEARING CAPACITY

Length of effective base $440\text{mm} + 5.5\sin 13 = 1.677\text{m}$

$$\begin{aligned} \text{Lever arm to resultant} &= Mr - Mo / R_v \\ &= -34.1 / 43.6 \\ &= 0.782\text{m} \\ \text{Eccentricity} &e = 0.782 - (1.677/2) \\ &= -0.06\text{m} \end{aligned}$$

$$\begin{aligned} \text{Max base pressure} &= (R_v/B) (1+6e/B) \\ &= (43.6 / 1.677)(1+0.06/1.667) \\ &= 27 \text{ kN/m}^2 < 150 \text{ kN/m}^2 \end{aligned}$$

THEREFORE O.K. FOR BEARING

Section 2: 4.0m Wall level with 19 degree slope to road at top

Slope of retained soil; $\beta = 19.0 \text{ deg}$

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \frac{\sin(\alpha + \phi')^2}{(\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta))}]^2)}$$

$$= 0.646$$

$$\begin{aligned} Z_o &= 2C / \gamma_{mb} K_a \\ &= 2 \times 38 / 21 \times 0.646 \\ &= 5.6\text{m} \end{aligned}$$

Surcharge on plan can be represented by 0.5m of soil ($21 \times 0.5 = 10.5\text{kN/m}^2$)

Height of wall $H = 4\text{m} + 0.5\text{m Surcharge} = 4.5\text{m}$

As the freestanding height of the cohesive soil Z_o is greater than the height of the wall with surcharge allowance there is no force to be retained and the wall acts to protect the soil face from erosion and weathering.

$$\begin{aligned} \text{Horizontal load on wall} &Pa = 0.5K_a \gamma_{mb} (H - Z_o) \\ &= 0 \text{ kN Pressure applied can not be negative} \\ \text{Lever arm} &la = 0.333 \times 4.0 \\ &= 1.33\text{m} \\ \text{Overturning Moment} &M = 0 \text{ kNm/m} \\ \text{Dead Load from wall} &R_v = 4.0 \times 0.44 \times 18 \\ &= 31.7 \text{ kN} \\ \text{Lever arm} &lw = 2 \sin 13 + 0.22 \\ &= 0.67\text{m} \end{aligned}$$

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Restoring Moment

$$\begin{aligned} M_r &= 31.7 \times 0.67 \\ &= 21.2 \text{ kNm/m} \end{aligned}$$

Therefore O.K. for Overturning

CHECK SLIDING

The net horizontal force is toward the soil slope and is resisted by the resistance of the soil.

THEREFORE O.K. FOR SLIDING

CHECK BEARING CAPACITY

Length of effective base $440\text{mm} + 4\sin 13 = 1.34\text{m}$

Lever arm to resultant

$$\begin{aligned} &= M_r - M_o / R_v \\ &= -21.2 / 31.7 \\ &= 0.669\text{m} \end{aligned}$$

Eccentricity

$$\begin{aligned} e &= 0.669 - (1.34/2) \\ &= -0.0012\text{m} \end{aligned}$$

Max base pressure

$$\begin{aligned} &= (R_v/B) (1 + 6e/B) \\ &= (31.7 / 1.34)(1 + 0.001/1.34) \\ &= 24 \text{ kN/m}^2 < 150 \text{ kN/m}^2 \end{aligned}$$

THEREFORE O.K. FOR BEARING

Barratt Associates Ltd.

Civil, Structural & Geotechnical Engineering Consultants

ANTHONY THOMAS

**3 FERNFIELD,
BAGLAN SA12 8AL**

REPORT ON SAMPLING AND LABORATORY TESTING

Contract: 23205

Date: April 2023

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REPORT ON SAMPLING AND LABORATORY TESTING

carried out at

**3 FERNFIELD,
BAGLAN SA12 8AL**

Prepared for

**ANTHONY THOMAS
3 FERNFIELD,
BAGLAN SA12 8AL**

Contract No: 23205

Date: April 2023

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1.0 INTRODUCTION

- 1.1 It is understood that it is proposed to construct a retaining wall to the rear of 3 Fernfield Baglan. A public road is located close to the top of the wall and Neath Port Talbot Highways required further information on the soil being retained.
- 1.2 On the instructions of Anthony Thomas, an investigation was undertaken to determine ground conditions to enable soil parameters for retaining wall design to be obtained.
- 1.3 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.
- 1.4 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.
- 1.5 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.
- 1.6 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

- 2.1.1 The site is situated at east of the A48, south of Smallwood Road, Baglan and may be located by National Grid Reference SS 754 918.

2.2 Site Description

- 2.2.1 The site is occupied by a bungalow which is to be extended. The site is generally level; however, it is located at the bottom of the north western slope of Mynydd Dinas.
- 2.2.2 In order to gain height up the slope Fernfield forms a hairpin bend around western, northern and eastern sides of the site. The difference in height of the road from the western side of the site to the eastern side of the site is approximately 10m although some height is taken by gabions on the western side of the site. It is understood from the structural engineers that the height of the retaining wall will be approximately 5m.

2.3 Geological Setting

- 2.3.1 The geological map indicates the site to be underlain by superficial deposits of Glacial Till which are underlain by sandstone and mudstone of the Rhondda Member of the Pennant Sandstone Formation.
- 2.3.2 The Coal Authority interactive map also indicated that the site is located in the Development High Risk area with regard to mine workings.

3.0 SITE WORK

- 3.1 The site work was carried out on the 6th April 2023. The location of the slope is indicated on the aerial photograph in Appendix 1, Figure A1.1. The slope had partially been excavated by the Client which had exposed the soil to be retained as indicated in the photographs below:



3.2 Representative disturbed bulk samples of the soil in the slope were taken by hand excavation and despatched to the laboratory. The total weight of the samples was approximately 120kg. The slope was dry at the time of the site visit.

3.3 The ground level at the slope location was not determined.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 Geotechnical soil analysis was undertaken of sample obtained during the investigation as follows:

4.1.2 1 No. Determination of Effective angle of internal Friction and Effective cohesion in accordance with BS1377 Part 7 1990, Ref 7.1, using a 300mm by 300mm shear box.

4.1.3 The laboratory test report is given in Appendix 3.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Rhondda Member Mudstone

5.1.1 The material recovered was described as brown silty fine to coarse sand and gravel with some cobbles and occasional boulders and based on the angular nature of the gravel and cobbles, appeared to be the partially weathered top of the mudstone stratum.

5.2 Groundwater

5.2.1 The slope was dry at the time of the site visit.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

6.1 Structural Details

- 6.1.1 It is understood that the bungalow is to be extended and in order to make room for the extension the slope needs to be cut into and a retaining wall built. Precise structural details were not available at the time of preparation of this report.

6.2 Assessment of Soil Condition

- 6.2.1 The results of the laboratory shear box testing are included in the Appendix 3. The results indicated that the Effective cohesion (c') of the soil was 38kPa and the Effective Angle of Friction (ψ') was 20 degrees. It is recommended that these parameters be adopted for the design of the retaining structure.

7.0 REFERENCES

- 7.1 British Standard 1377:1990, Part 9, 'Methods of Test for Soils for Civil Engineering Purposes'.
- 7.2 British Standards Institute: BS EN 1997-2:2007 Incorporating corrigendum June 2010, 'Eurocode 7 - Geotechnical Design – Part 2: Ground investigation and testing.'
- 7.3 British Standards Institute: BS 5930:2015 'Code of practice for ground investigations', BSI 2015.
- 7.4 ISO 22475-1:2006, 'Geotechnical Investigation and Testing – Sampling Methods and Groundwater Measurements' Part 1: Technical Principles for Execution.
- 7.5 ISO 14688 Part 1:2002 and Part 2:2004, 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

For and on behalf of Barratt Associates Limited



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APPENDIX 1
DRAWINGS

23205 3 Fernfield

Write a description for your map.

Legend

Location of Proposed
Retaining wall

Fernfield

Fernfield

A48



30 m

Google Earth

Image Landsat / Copernicus

Down Baglan Rd



APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 7.2 and BS 5930, ref. 7.3.

A2.1.2 Trial Pits

Shallow trial pits are generally dug by mechanical excavator, however, in difficult access locations or adjacent to structures, such pits may be hand dug. Pits are best used where the ground will stand unsupported and generally, the maximum depth of machine dug pits is 4m to 5m. Where personnel are required to enter pits, it is essential that side support is provided. Entry by personnel into unsupported pits deeper than 1.2m is not allowed for health and safety reasons.

Trial pits allow the in-situ condition of the ground to be examined both laterally and vertically and also allow discontinuities to be recorded. The field record should give the orientation of the pit with details of which face was logged, assessment of stability of sides of pit and groundwater as well as the strata encountered. Photographs of the pit should also be taken.

In-situ testing, such as hand penetrometer, hand vane, Macintosh probe, or similar, can be undertaken in the sides or base of pits while both disturbed and undisturbed samples recovered.

It is generally advisable to backfill the pits as soon as possible, open pits should not be left unattended.

A2.2 SAMPLES

A2.2.1 General

Samples have been recovered and stored in accordance with the guidelines given in ISO 22475-1:2006, ref. 7.4 and BS 5930, ref. 7.3.

The undisturbed samples recovered from the percussive sampler were of varying diameters depending upon the depth taken and the ground conditions encountered.

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

A2.3 DESCRIPTION OF SOILS

A2.3.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref. 7.5, supplemented by section 6 of BS 5930, ref. 7.3 have been used in the soil descriptions contained within this report.

APPENDIX 3
LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

- A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are given in the laboratory test reports.
- A3.1.2 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

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Date: 24 April 2023
Test Report Ref: TR 947967

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Contract: Baglan - 23205

LABORATORY TEST REPORT

TEST REQUIREMENTS:

To determine the Effective Angle of Internal Friction and Effective Cohesion in accordance with SHW Volume 1, Series 600, Clause 636 and
BS 1377: Part 7: 1990 (Using a 300mm x 300mm Shear Box)

SAMPLE DETAILS:

Certificate of sampling received:	No
Laboratory Ref. No:	S109836
Client Ref. No:	B1 @ 0.00m
Date and Time of Sampling:	Unknown
Date of Receipt at Lab:	11/04/2023
Date of Start of Test:	17/04/2023
Sampling Location:	Unknown
Name of Source:	Unknown
Method of Sampling:	Unknown
Sampled By:	Client (Test results apply to sample as received)
Tested By:	DJ
Material Description:	Granular - 40mm Down
Target Specification:	N/A

Sample preparation:

Percentage of material > 20mm Removed before test =	32.7%
Percentage of material > 14mm and <20mm in sample prior to preparing =	17.8%
Percentage of material > 14mm and <20mm Removed before test =	4.8%
Maximum Percentage of material >14mm and <20mm Permitted in test sample :	15.0%

RESULTS:

See attached

This test report shall not be reproduced, except in full, without the written approval of Celtest Company Limited.

These results relate only to the items tested.

Comments:

None

Report checked and approved by:

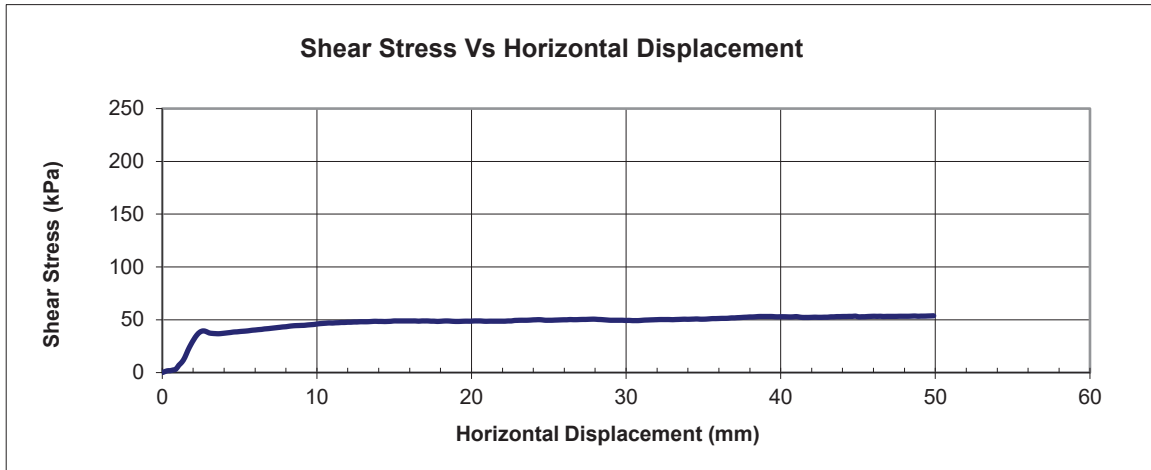


Chantelle Kopec-Williams
Job Coordinator

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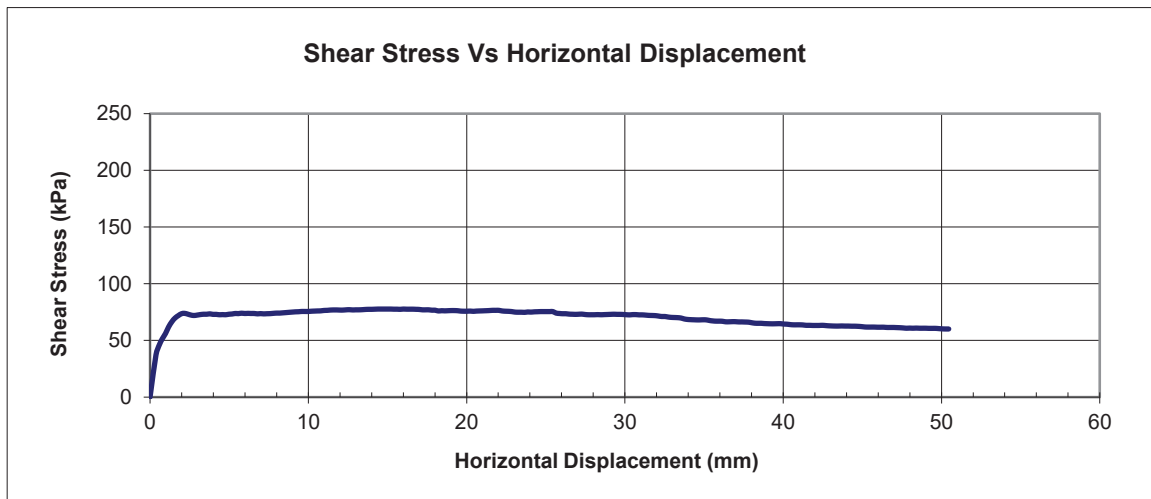
Normal Loading

50 kPa



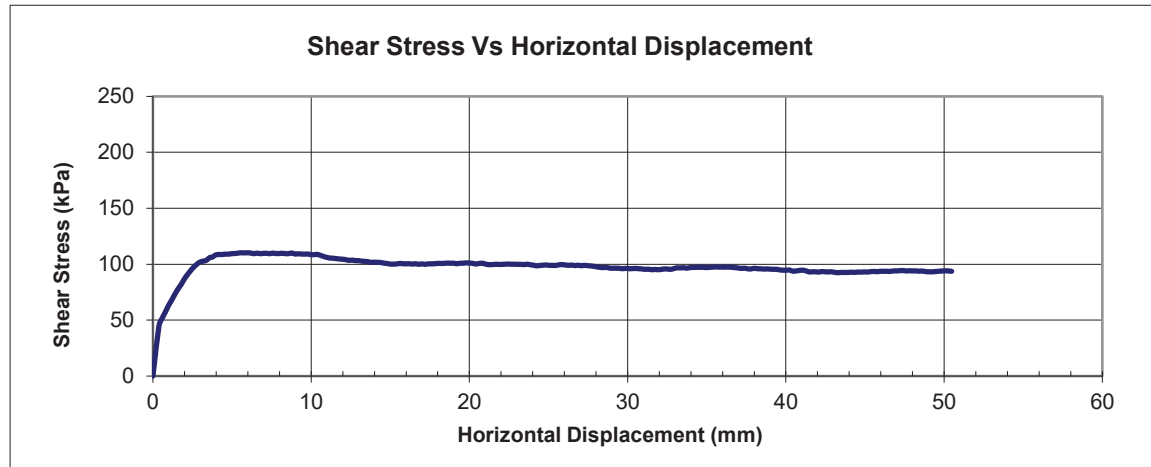
Normal Loading

100 kPa



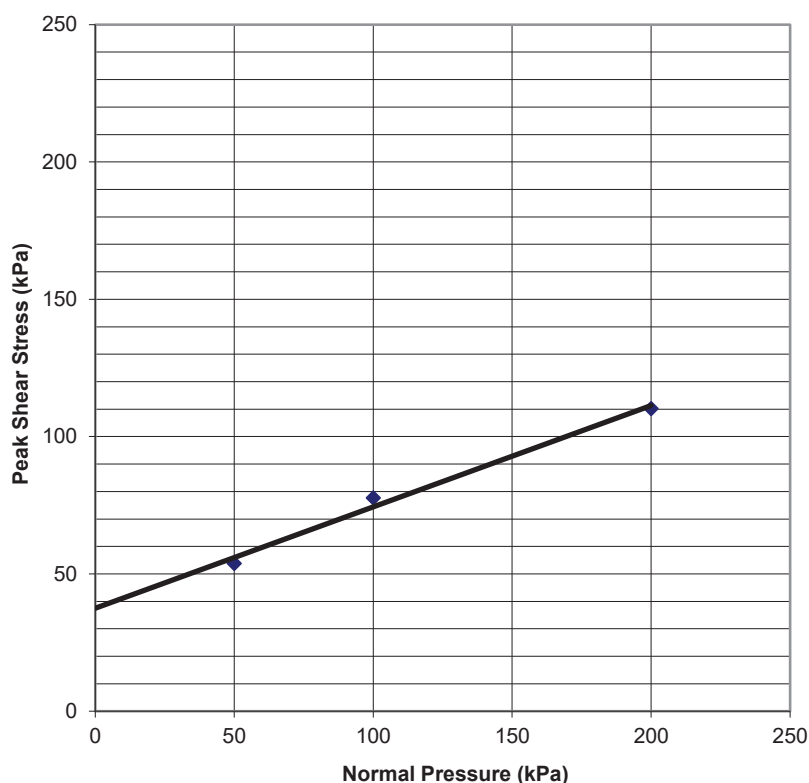
Normal Loading

200 kPa



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Angle of Shearing Resistance & Cohesion



Specimen Dimensions (mm)	300x300x150		
Height of Specimen	150	150	150
Normal Pressure (kPa)	50	100	200
Peak Shear Strength (kPa)	54	78	110
Effective Cohesion : c' =	38 kPa		
Effective Angle of friction : ϕ' =	20 °		
Rate of Displacement (mm/min)	1.0	1.0	1.0

Initial Bulk Density (Mg/m^3)	2.12	2.15	2.13
Moisture Content (%) (1)	8.8	8.8	8.8
Initial Dry Density (Mg/m^3)	1.95	1.98	1.96
% of Max Dry Density (2)	90	92	91
Maximum Dry Density (Mg/m^3)	2.16		
Optimum Moisture Content (%)	8.8		
Particle Density (Mg/m^3)	2.8 Assumed		

(1) Test moisture content requirement: At optimum moisture content.

(2) Test density requirement: 90-94% of maximum dry density.