APPENDIX A

WALL DESIGN AND SOIL PROPERTIES

A.1 Model Wall Design

The model wall was designed at prototype scale, initially setting L/H = 0.75.

Wall geometry at prototype scale		
Wall height	H	4.50m
L/H ratio		0.75
Reinforcement length	L	3.375m
Inclination	θ	90^o
Microgrid properties		
Factored allowable tension	T_{al}	14kN/m
Soil Properties		
Unit weight of fill	γ_f	16.7 kN/m^3
Internal friction angle	Φ	33^o
Active Earth Pressure Coefficient	K_{af}	0.295
Angle of failure plane angle	ψ	61.5^o

Static horizontal wall thrust, F_A

$$F_A = 0.5\, K_{af}\gamma_f H^2$$

$$F_A = (0.5 \text{ x } 0.295 \text{ x } 16.7 \text{ x } 4.5^2) = 74.7 \text{ kN/m}$$

External stability: Check sliding failure

$$F^*_h \leq \Phi\, F^*_v \tan \Phi$$

$$F^*_h \leq (1.0 \text{ x } 253 \text{ x } \tan(33)) = 165 \text{ kN/m}$$ SLIDING OK

External stability: Check overturning failure

$$M^*_d \leq \Phi\, M^*_r$$

$$M^*_d = (74.7 \text{ x } 0.5 \text{ x } 4.5) \leq \Phi\, M^*_r = (0.75 \text{ x } 253 \text{ x } 0.5 \text{ x} 3.375)$$

$$M^*_d = 168 \text{ kN/m} \leq \Phi\, M^*_r = 321 \text{ kN/m}$$ OVERTURNING OK

Check number of reinforcement layers, N, required

$N = F_A / T_{al} = 5.3$

Hence 5 Layers of reinforcement, spaced vertically by 0.75 m has been selected.

Internal stability: Check pullout failure

Maximum tensile force in reinforcement, F^*_j:

$F^*_j = \sigma^*_{hj} S_{vj}$

Factored design soil interaction strength against pullout, $T^*_{di,l}$:

$T^*_{di,l} = \Phi \, \Phi_n \, F^* \, \alpha \, \sigma^*_{vi} \, L_e \, C$

Where, Φ is the uncertainty factor for soil-reinforcement interaction (assumed 0.8), Φ_n reduction factor associated with consequence of failure (1.0), F^* is pullout resistence (manufacturer tested as 0.8), α is the scale correction factor (1.0), L_e is the reinforcement length in the resistant zone, and C is the reinforcement effective unit perimeter (2.0 for geogrid and geotextiles).

Hence, the reinforcement strength must satisfy:

$F^*_j \leq T^*_{di,l}$

Reinforcement Layer	L_e[1] (m)	Vertical stress at layer, σ^*_{vj} (Kn/m^2)	Factored soil interaction strength, $T_{il,1}$(Kn/m)	Max Tensile force in reinforcement, F^*_j (Kn/m)
1	2.97	62.6	268	13.9
2	2.56	50.1	185	11.1
3	2.15	37.6	117	8.31
4	1.75	25.0	63	5.54
5	1.34	12.5	24	2.77

[1] Calculated from assumed failure surface angle, $\psi = 61.5^o$

PULLOUT OK

A.2 Seal Friction Measurements

Reduction of the seals influence on model behaviour involves minimising the friction force between model wall facing and box sidewall. The friction force is calculated as below:

$$F_f = \mu_s F_N$$

Where F_f is the friction force, μ_s is the static coefficient of friction, and F_N is the force normal to the box sidewall. The normal force against the box sidewall comprises the earth pressure force along the vertical length of the seal, in addition to the outwards force provided by the seal against the box sidewall. Thus reduction of the friction force can occur by reducing the coefficient of static friction and / or reduction of the normal force provided by the seal. While we cannot change the earth pressure on the seal, appropriate material selection, and a reduction of the seal's contact area will reduce the friction against the side wall.

Static coefficient of friction

The friction between various materials, Ployester plastic (PE), Teflon tape (TE), grease and steel was trialed via simple tilt table tests, and the static coefficient of friction, μ_s, calculated by:

$$\mu_s = \tan\theta$$

The test results are shown in Table A-1.

Table A-1. Tilt-table tests on different seal materials to determine coefficient's of friction

Material	Trial 1	Trial 2	Trail 3	Trail 4
PE - PE				
θ	22	23	23.5	21
μ_s	0.404	0.42	0.44	0.38
Teflon – PE (semi-rough) contact				
θ	20	18	18	18
μ_s	0.36	0.32	0.32	0.32
Teflon – PE (smooth) contact				
θ	16	16	16	16
μ_s	0.28	0.28	0.28	0.28
Teflon – greased PE (semi-rough) contact				
θ	23	23	22	21
μ_s	0.42	0.42	0.404	0.38
Teflon – steel contact				
θ	18	18	18	18
μ_s	0.32	0.32	0.32	0.32

Hence the Teflon PE (smooth contact was selected) as explained in Section 3.3.3.

A spring force was attached to the top of the facing panel whilst inside the box. Multiple spring force trials were made on the seal comprising a Teflon and PE contact, and only 1 N of force was required to generate wall rotation about the toe.

A.3 Particle Size Distribution

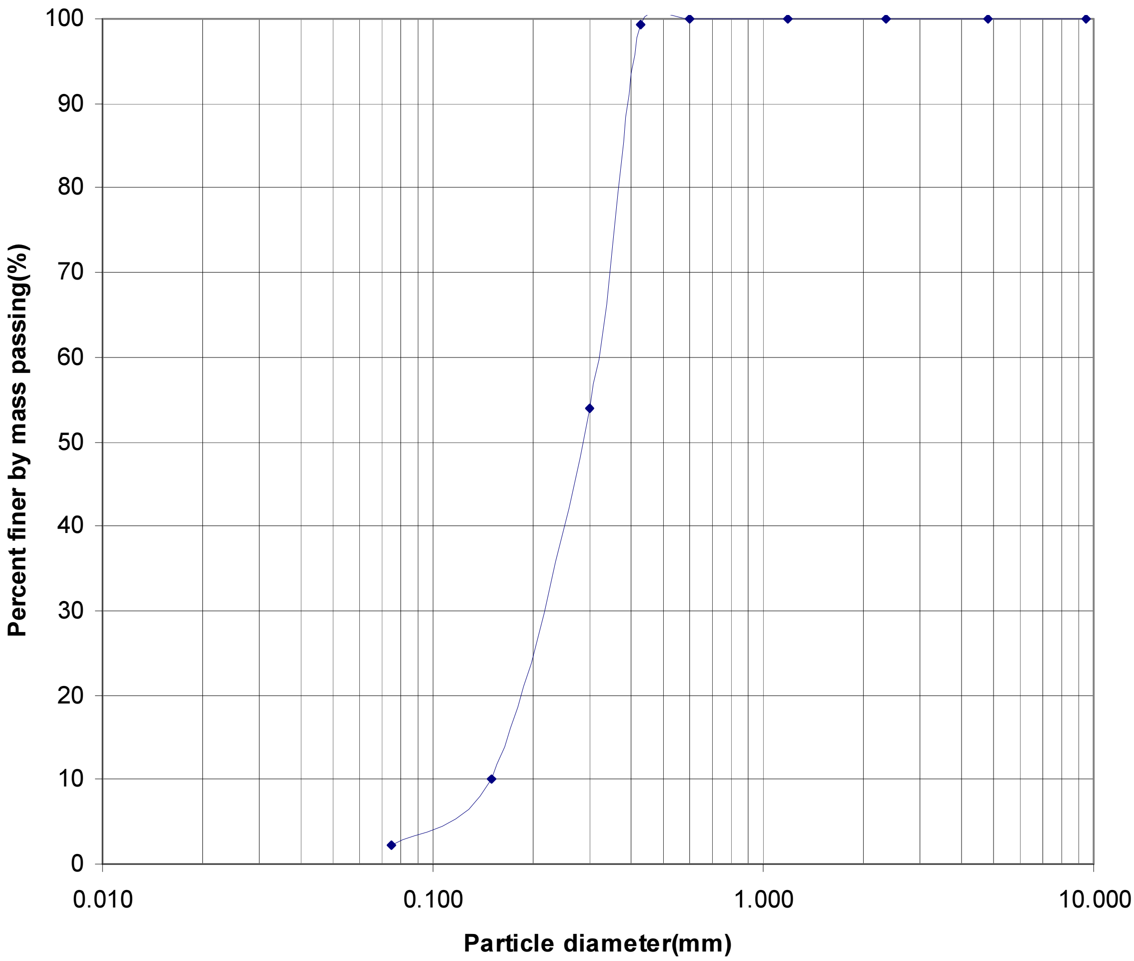

Figure A-1. Particle Size Distribution of Albany Sand

Coefficient of Uniformity C_U is calculated as:

$$C_U = \frac{d_{60}}{d_{10}} = \frac{0.121}{0.103} = 1.17$$