Eskom Enterprises	Enterprises Division **ENGINEERING DEPARTMENT**	DOCUMENT NUMBER **200-6166**	REVISION **11**
DOCUMENT TYPE: **Specification**		DATE: **2013 – 08 – 07**	
DISCIPLINE/AREA: **Civil**			

TITLE: **Specification for the preparation of engineered fills and backfill to all structures except backfill in turbine hall**

COMPILED BY

Alan Parrock
Geotechnical Engineer

Gerrie van Jaarsveld
Engineering Geologist

THIS DOCUMENT HAS BEEN SEEN AND ACCEPTED BY:

Specialist
Discipline Manager
Senior Manager Power Plant
Senior Manager Power Delivery
Senior Manager Electrical C&I
Senior Manager Civil
Senior Manager Engineering Support
Process Moderator

APPROVED BY

Mario Bisschoff
Lead Site Civil Engineer

REVISION	REVISED BY	DESCRIPTION OF REVISION	APPROVAL	DATE
1	F Mercier	Incorporated comments from Alstom	G Dudenska	2009-01-09
2	A Parrock	Adapted to materials available on Site	G Dudenska	2009-02-27
3	A Parrock	Spec. condensed specifying material only and testing regime	G Dudenska	2009-03-03
4	A Parrock	Additional test regime added, andapplicable areas revised	G Dudenska	2009-04-23
5	G van Jaarsveld	Testing frequencies added, and applicable areas revised. Additional test regime added	G Dudenska	2009-07-28
6	H Liebenberg	Includes for fill in TH around TG block	G Dudenska	2009-08-28
7	G van Jaarsveld	Revised layerworks specification and test regime. Excludes for fill in TH around TG block	R Venter	2009-11-18
8	G van Jaarsveld	Spec. includes for backfill and fill to all structures excluding turbine hall	R Venter	2010-03-08
9	I Deale	Revised Clegg Impact Value requirement for G7 material	S Mutale	2010-10-11
10	G van Jaarsveld	Incorporated use of recycled materials in fills	CS Bessit	2012-12-03
11	G van Jaarsveld	Substitute G5 with G6 material	M Bisschoff	2013-08-07

C.A.N.	DATE OF LAST REVIEW: 2012-12-03

1. SPECIFICATION

The following specification will apply to the preparation of engineered fills at the Air Cooled Condensers (ACC), Auxiliary Bay, Boiler House, Precipitator Road, Fabric Filter Plant (FFP), Common Plant, Balance of Plant and buildings but excludes all backfill in the Turbine Hall. Where the approved construction drawings differ from this specification the drawings shall take precedence.

1.1 GRADING, ATTERBERGS, CBR AND STIFFNESS

On site crushed quartzite	
G7	
Layers	To -600mm below top of fill
Nominal maximum size	75mm
Grading Modulus	2.7 ≥ GM ≥ 0.75
PI	< 12 or <3 x GM+ 10 (greater of the two)
LS x (% passing 0.425mm sieve)	≤ 320
CBR at 93% of Mod AASHTO	≥ 15
Swell 100% Mod AASHTO	< 1.5%
CIV (IV)	≥ 26
E value at CE value	Minimum Secant Young's modulus of 60MPa at 200kPa
G6	
Layers	Top 600mm of layerworks
Nominal maximum size	63mm
Grading Modulus	2.6 ≥ GM ≥ 1.2
PI	< 12 or <2 x GM+ 10 (greater of the two)
LS x (% passing 0.425mm sieve)	≤ 320
CBR at 95% of Mod AASHTO	≥ 34
Swell 100% Mod AASHTO	< 1.0%
CIV (IV)	≥ 33
E value at CE value	Minimum Secant Young's modulus of 80MPa at 200kPa

1.2 DELETERIOUS MATERIALS

In order to maximize the use of recycled materials a maximum of 1% by mass of wood, plastic and metals will be allowed in engineered fills. Notwithstanding the above no deleterious materials will exceed 1/6 of any compacted layer thickness. Care shall be taken to thoroughly mix deleterious materials, conforming to the above requirements, with aggregates to ensure the creation of a uniform fill.

1.3 LAYER THICKNESS

All layers shall not exceed 300mm compacted thickness provided vibrating pad foot rollers with a static drum mass of at least 7 400kg, a centrifugal force in vibrating mode of at least 300kN and an amplitude which varies from 1mm to 2mm is utilized.

Where smaller compaction plant to that described above is utilized loose layer lifts of 200mm or 150mm compacted shall be constructed.

1.4 FIELD DENSITY

95% of Mod AASHTO density at a moisture content of 0 to +2% of optimum.

1.5 FIELD DENSITY CONTROL

A nuclear density meter shall be used to determine the field density of fills. The moisture content of 5% of all tests performed using the nuclear density meter should be correlated with the results obtained on oven dried samples with the moisture content determined as per clauses 2.15, 3.5, 4.1 and 4.4 of method A7 of TMH 1(1979). The appropriate correction factor between nuclear density meter moisture content and oven dried moisture content should be used at all times in the calculation and reporting of field density.

1.6 STATISTICAL QUALITY CONTROL

A statistical quality control method (Scheme 1) as contained in Section 8200 of COLTO (1998) shall be used for acceptance or rejection of density results and material quality. No conditional acceptance with payment reduction is permitted.

1.7 FIELD STIFFNESS

The field stiffness of intermediate layers should be determined through Clegg Hammer and/or static plate load tests and combination of these methods for upper 600mm of layerworks.

1.7.1 CLEGG HAMMER

If the Clegg Hammer is used to determine field stiffness a 4.5kg CIST/883/Stor/Blu Clegg Hammer (SDI 2009) should be used to perform the tests. One (1) Clegg Hammer test should be performed per 20m^2 of test area at positions representative of the entire test area using 5 hammer drops at each position. The 4th drop at each of the test positions should be analysed statistically and the mean and standard deviation derived. All 4th drop values should be used in the analysis including those where 'trend aborts'. Where no 4th drop value is recorded a repeat test should be carried out 300mm away from the initial test position. The Cautious Estimate (CE) value of the Clegg Impact Value (CIV (IV)) should be determined as the mean – 0.5 x the standard deviation. If this value exceeds 26 for G7 and 33 for G5 material the layer should be approved provided the other attributes of this specification are attained. If not the layer should be re-rolled until the specification is attained.

If the Clegg Hammer is used a set of forty (40) Clegg Hammer tests and a single static plate load test should be carried out in close proximity to one another every six weeks for correlation purposes. A 450mm diameter circular steel plate should be used according to the method described in Section 1.7.2.

1.7.2 STATIC PLATE LOAD TESTS

The Clegg Hammer test may be substituted or supplemented by the static plate load test (PLT) to 600mm below top of fill but is compulsory on top of fill. PLT tests shall be carried out according to ASTM D1196 (2004) with the proviso that at least one unload/reload cycle is performed. The first load cycle should be performed to 250kPa bearing pressure and the second load cycle to the maximum pressure that can be applied using a kentledge with a minimum weight of 25 tons. PLT's should be performed with a 450mm diameter rigid circular steel plate to 600mm below top of fill and with a >600mm diameter rigid circular steel plate on top of fill. Where the designer's pressure range and load cycle requirements for specific structures differ from these the designer's requirements shall take precedence.

If Clegg Hammer tests are substituted and/or replaced by PLT tests to 600mm below top of fill the following procedure should be followed:

- Excavate one 300mm and one 600mm deep excavation through fill every 800m^2.
- Carry out one PLT at surface of third layer, one PLT at base of 300mm excavation and one PLT at base of 600mm excavation.

- Position excavations at sufficient distances apart to avoid interference between adjacent tests when tests are carried out in parallel.

For all PLT test results the E-value for each load increment or decrement should be established using the formulations of Poulos and Davis (1974). The secant modulus of all layers below 600mm of top of fill should be a minimum of 60MPa at a bearing pressure of 200kPa on the first load phase and that of the top 600mm of the fill a minimum of 80MPa at a bearing pressure of 200kPa on the first load phase.

If these E-values are met or exceeded the layer should be approved provided the other attributes of the specification are attained. If not the layer should be re-rolled until the specification is attained.

1.8 ABBREVIATIONS

The following abbreviations have been used in this specification.

Abbreviations	Description
CBR	California Bearing Ratio
CE	Cautious estimate ie mean – 0.5 x standard deviation
CIV	Clegg Impact Value
GM	Grading modulus
LL	Liquid Limit
LS	Linear shrinkage
Mod	Modified AASHTO compactive effort
NRB	National Roads Board compactive effort
PI	Plasticity Index
PLT	Plate load test
PRA class	Public Roads Association Classification
Proc	Proctor compactive effort
SWELL/MOD	Swell at the Modified AASHTO Density
Unified	Unified classification system

1.9 REFERENCES

ASTM. 2004. Standard test method for non-repetitive plate load tests of soils and flexible pavement components for use in evaluation and design of airport and highway pavements. D 1196 – 93 (Reapproved 2004) pp 1-3.

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