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# Soil Environment Services Ltd

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UKAS Accreditation Laboratory Number: *pending*

## LABORATORY TEST CERTIFICATE

**Client:** Grange Quarry Ltd  
Kirkburn Industrial Estate  
Lockerbie  
Dumfries & Galloway  
DG11 2FF

**Contact:** Douglas Stewart

**Client Job Ref.:** GQAT0141 Broom Sand and Kelhead Sand – Source Kirkburn

**Purchase order:** NA

**Date received:** 22/08/18

**Date completed:** 01/09/18

**Test:** Thermal resistivity, voids ratio

**Material:** Cement Bound Sand (CBS)

**Specifications:** See pages 2 and 3

**Notes and methods:** See final page.

Tested on behalf of *Soil Environment Services* by:



**Dr Robin S Davies** BSc PhD MISoilSci  
Managing Director

*This testing has been undertaken by Soil Environment Services with all reasonable skill, care and diligence, within the terms of The Contract with The Client. The results are the property of The Client who can assign these to any third party who will then be afforded the same assurances as detailed within the terms of the original Contract with The Client.*

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## Soil Environment Services Ltd

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Thermal Properties									
Laboratory sample ref:	Material	Resistivity (Km/W)			Resistivity	Test Moisture	Final sample Moisture	Dry Density	Voids
		1	2	3	Average	% w/w	% w/w	Mg/m <sup>3</sup>	Ratio
Broom Sand	CBS 14:1 @ 10% moisture	1.269	1.233	1.366	1.289	0.00	8.338	1.858	0.36
Kelhead Sand	CBS 14:1 @ 10% moisture	1.092	1.123	1.158	1.124	0.00	8.033	1.936	0.38

### Compliance with specifications

#### Broom Sand

- Thermal resistivity in the fully dry state - FAIL
- Voids Ratio - PASS

#### Kelhead Sand

- Thermal resistivity in the fully dry state - PASS
- Voids Ratio - PASS

Pass specifications (Laboratory)	SELECTED SAND	GRAVEL/SAND	CEMENT BOUND SAND
Resistivity fully dry (km/W)	<2.7	<1.2	<1.2
Density (Mg/m <sup>3</sup> )	>1.6	>1.8	NA
Voids ratio	NA	NA	<0.54

## Test specifications

1. Overall test specification: IEEE Std 442./ ENAT 97-1:1997, Version 2, 2016.
2. Compacted to BS1377 2.5 kg Hammer – 9 blows per layer, 3 layers.
3. Thermal test method: *Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure. ASTM Designation D5334-14, 2015.*
4. National Grid Test Specification 3.05.07.

## Test equipment

- Decagon KD2 – Pro Thermal analyser using a RK-1 rock probe.
- ELE Proctor ~1 litre mould with an ELE 2.5 kg hammer.
- Impact Test Equipment soil drying oven set at 105°C.

## Notes

1. The sample received was mixed at as received moisture then water addition to approximate to 10% +/- 2%.
2. Three tests (replicates) have been undertaken for each sample within the sample mould and the average also reported in the results.
3. The sample reference used is as supplied.
4. The moisture content is calculated as percent w/w which is defined as weight for weight. Moisture status is specified to be approximate to 10% +/- 2% and is adjusted as required. NB The cement chemically binds approximately 1-2% of the added moisture. Zero m.c. = dried at 105°C
5. The voids ratio in the table is calculated using the specified method.
6. For TR vs density, the number of compaction impacts are per layer with three layers as per BS1377.

### **Mixing and testing method**

On each occasion, the material was weighed first and cement added as per the specification (18:1 sand to cement\* weight for weight ratio, 14:1 volume ratio) or as detailed below the results. The water was then added to adjust as per required. The CBS was then compacted as per the specification. The mould was left for a minimum of 4 hours at 60°C for significant curing (>80%) to take place prior to drying at 105°C. The moulds are left to cool to 20°C prior to testing.

\* Cement provided SES Ltd.