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# TEST REPORT

# SC1221/1

## CAPILLIARY TEST ON TAILINGS WITH LIQUEFACTION SAND FILLING THE VOIDS

**CLIENT**
Ministry of Business Innovation and Employment - BHG
National Office
L6, 86 Customhouse Quay
Wellington 6011
New Zealand

## Test sponsor

Ministry of Business Innovation and Employment - BHG
National Office
P O Box 1473
Wellington 6140
New Zealand

# LIMITATION

The results reported here relate only to the item/s tested.

# TERMS AND CONDITIONS

This report is issued in accordance with the Terms and Conditions as detailed and agreed in the BRANZ Services Agreement for this work.

# SIGNATORIES

**Author**

R. W. Causer
Senior Technician

**Reviewer**

Graeme Beattie
Principal Structural Engineer/Team Leader

# DOCUMENT REVISION STATUS

| ISSUE NO. | DATE ISSUED | REVIEW DATE | DESCRIPTION |
|---|---|---|---|
| 1 | 1 December 2014 | NA | Initial Issue |

# 1. BACKGROUND

It is necessary to raise the slab on ground floors of many houses in Christchurch following the earthquakes of 2010 and 2011 to return them to an acceptable level. The re-levelling process generally involves the injection of grout or resin beneath the slab and in doing so the damp proof membrane (DPM) is penetrated. The settlement of the floor is usually associated with liquefaction of the ground beneath the house and the liquefied sand has been observed to percolate into the tailings typically used beneath floor slabs prior to the earthquakes.

The aim of this project was to assess the capillary action of water on a sample column of rounded aggregate tailings with Christchurch liquefaction material filling the voids between the aggregate rounds. The experiment was devised to determine what the typical capillary rise would be through the mix of tailings and sand. This would allow the Ministry of Business, Innovation and Employment (MBIE) to prepare guidance on the treatment of the DPM when re-levelling work was undertaken.

This report only considers the test methodology and test results and does not include analysis of the data. The impact on damaged slab on ground building stock where the slab substrate has had liquefaction material fill the voids is complex and depends on the mitigation techniques proposed for levelling the slab. It is proposed that this sample test will give an indication for the minimum water table depth below the underside of the DPM to ensure liquid water does not ingress through penetrations created in the slab for remediation purposes.

# 2. TEST METHODOLOGY

## 2.1 Material Selection

The material was selected and procured from Christchurch and prepared at BRANZ by drying in an oven to drive off free moisture.

Samples of the two different materials underwent a sieve analysis at Materials Advisory and Testing Service Ltd (MATS) and the grading reports are appended to this report (Appendix A). The reports have the following identifiers:

Lab Ref. No. MA 14/387A

Material: Rounded aggregate (tailings) identified as bedding rounds

Lab Ref. No. MA 14/387B

Material: Fine sand/silt identified as Christchurch Liquefaction material

## 2.2 Test Apparatus

The test apparatus consisted of a square acrylic tube measuring 400 mm x 400 mm x 1,000 mm high and closed at the bottom end. A ½" pipe tank fitting was installed 50 mm up from the bottom of the closed tube. Tubing was secured to the tank fitting and attached to an inlet water supply fitted with a float valve. The float valve was fitted to an adjustable slide and was used to simulate the water table height. The float valve operation ensured water in the float chamber was always at the set water table height. A diagram of the test setup is presented in Figure 1.

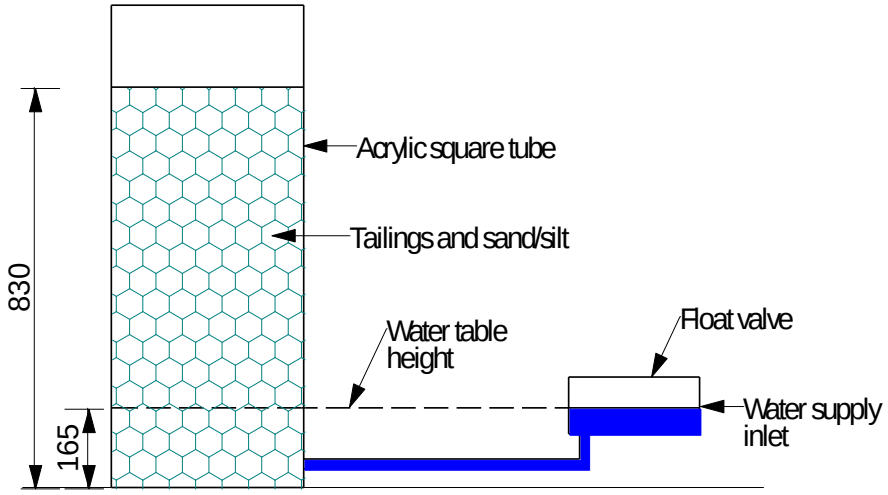



**Figure 1. Test Apparatus General Layout**

## 2.3 Test Method

The test method followed the steps below:

1. The rounded aggregate was supplied in a clean and dry state. The liquefaction material was dried in an oven to drive off free moisture.
2. A layer of rounded aggregate (tailings) approximately 50 mm thick was placed in the bottom of the acrylic square tube followed by the dry liquefaction material (Figure 2). A concrete vibrator was then used to ensure the fine sand/silt settled into the voids between the rounded aggregate. This process was continued alternating aggregate and fine sand/silt in 50 mm thick layers until a height of aggregate and fine sand/silt filling the voids had reached 830 mm.
3. An acrylic square panel was placed on the top of the column of aggregate and sand mix and was sealed to the inside face of the tube with aluminium tape.
4. The water table height was set at 165 mm above the base of the square tube using the float valve apparatus.
5. The water supply was opened to the float valve. A periodic record was made of the height of the water in the column of aggregate and sand mix. The water height was determined by visual inspection with the water height showing by the

darkening of the tailings/sand mix. An indication of the discolouration caused by the rising moisture is given in Figure 3.

6. The test was continued without interruption until the rate at which the water height changed had levelled off.

**Figure 2. Tailings and fine sand (liquefaction material) layering**

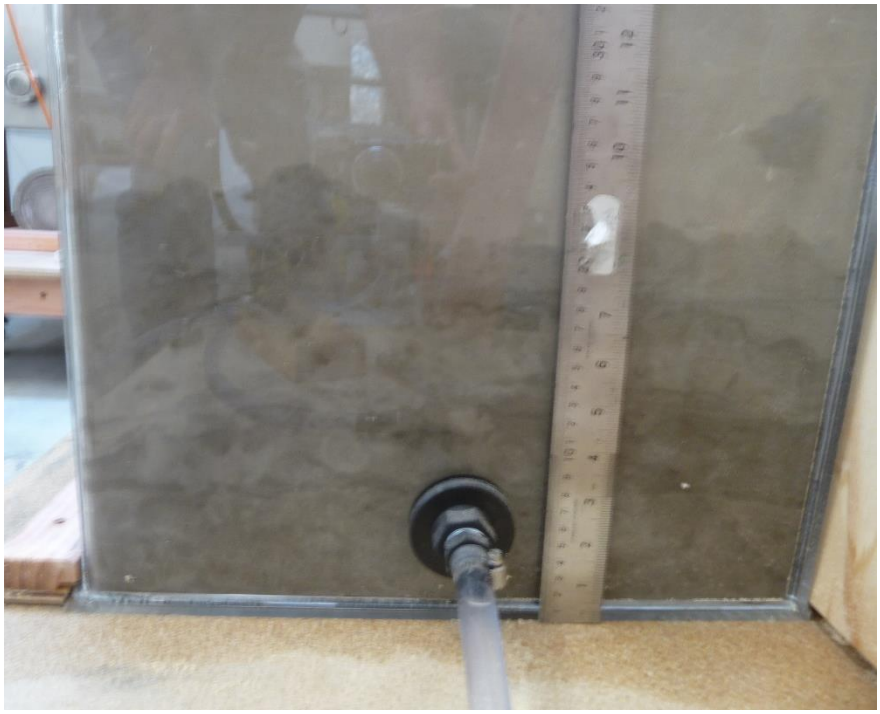


**Figure 3. Water height visible in the column of tailings and sand mix**

# 3. RESULTS

Figure 4 shows the recorded height of damp tailings/sand/silt (mm) above the initial set point of 165 mm, being the simulated water table height, against time (hours) from the start of the experiment. The dots are actual readings of height and the trend line is a natural logarithmic best fit to the data.

The trend curve was allowed to deviate from the test data during the early part of the test due to uneven rise over the area of the specimen in this phase. By allowing the trend deviation at the start the start of the test, a better fit could be made for the middle to the tail end of the test.

It was found that the fitted model has the following form:

$-125.473 + 10.6656 \ln [x^{9.97448}]$

which means that the predicted height of the dampness (mm) above the water table will be equal to:

$(-125.473 + 10.6656 \ln [\text{Time from start (hr)}^{9.97448}]$

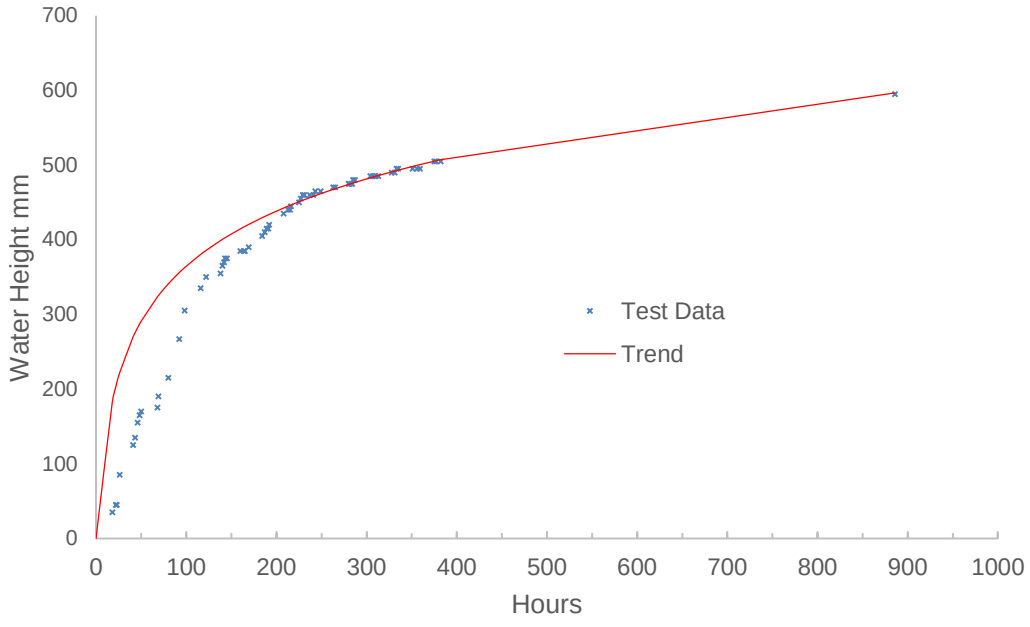



**Figure 4. Graph showing the height of damp tailings/sand/silt above the initial water table height against time**

# APPENDIX A

Materials Advisory & Testing Service Ltd
A Civil Engineering & Materials Consultancy

Postal: PO Box 37-231, Stokes Valley, Lower Hutt 5141, NZ
Delivery: 8 Cates Street, Stokes Valley, Lower Hutt
Work: (04) 566 0266
Fax: (04) 569 9847
Email: mats-ltd@paradise.net.nz

## TEST REPORT FOR SOILS / SANDS

*Material & Specification:* **N/A**

(Results obtained in accordance with NZS 4402: 1988)

**Lab. Ref. No. MA 14/ 387A**

***Job / Project :*** **SC1221 - CAPILLARY TEST**
***Material :*** *Rounded aggregate*
***Sample Source :*** Unknown - refer to Client
***Client Ref.:*** Bedding Rounds

***Date received :*** 6 November 2014
***Supplied by :*** Client
***Sampled by :*** Unknown (*Not Accredited)
***Sampling method :*** Unknown (*Not Accredited)
***State of field sample :*** As received - said to be Oven Dry
***Date of test :*** 6 to 7 November 2014

Client:

**BRANZ**
Private Bag 50 908
**PORIRUA 5240**
Attn: Mr Rob Causer

### Sieve Analysis (Dry)

Test method: NZS 4402:1986 test 2.8.2
*Standard BS sieve*

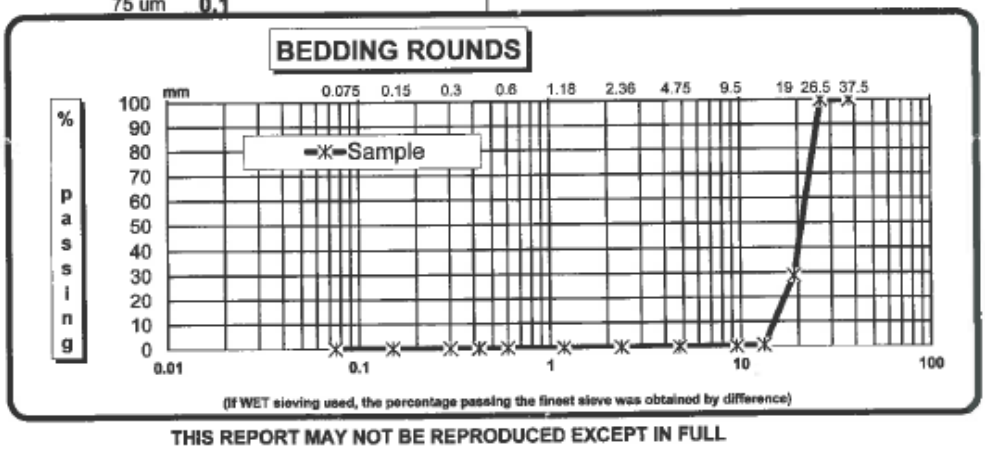
| | Result: % passing |
|---|---|
| 26.5 mm | 100 |
| 19.0 mm | 29 |
| 13.2 mm | 1 |
| 9.5 mm | 0 |
| 4.75 mm | 0 |
| 2.36 mm | 0 |
| 1.18 mm | 0 |
| 600 um | 0 |
| 425 um | 0 |
| 300 um | 0 |
| 150 um | 0 |
| 75 um | 0.1 |

### OTHER TESTS

**DENSITY of SAMPLING TUBE MATERIAL**
(using actual Material Mass, and Calculated Volume from measurement within Tube)

| | |
|---|---|
| BULK DENSITY (kg/m$^3$): | NA |
| DRY DENSITY (kg/m$^3$): | NA |
| WATER CONT. (as rec'd), %: | 0.0 |

**NOTES:**




(If WET sieving used, the percentage passing the finest sieve was obtained by difference)



***Comments:*** *SAMPLING was not performed by this LABORATORY.*

**Approved:**
Duigald Myers *(DIRECTOR)*
Date: **7 November 2014**

Data input by: *Duigald Myers*
Checked by:
*(This Report is computer generated)*



F-SOIL Wet or Dry.XLT

Materials Advisory & Testing Service Ltd
Civil Engineering & Testing Consultants

Postal: PO Box 37-231, Stokes Valley, Lower Hutt 5141, NZ
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Work: (04) 586 0266
Fax: (04) 589 6847
Email: mats-ltd@paradise.net.nz

# TEST REPORT FOR SOILS / SANDS

*Material & Specification:* **N/A**

(Results obtained in accordance with NZS 4402: 1986)

**Lab. Ref. No. MA 14/ 387B**

***Job / Project :*** **SC1221 - CAPILLARY TEST**
***Material :*** *Fine Sand / Silt*
***Sample Source :*** Unknown - refer to Client
***Client Ref.:*** ChCh Liquefaction Material

***Date received :*** 6 November 2014
***Supplied by :*** Client
***Sampled by :*** Unknown (*Not Accredited)
***Sampling method :*** Unknown (*Not Accredited)
***State of field sample :*** As received - said to be Oven Dry
***Date of test :*** 6 to 7 November 2014

Client:

**BRANZ**
Private Bag 50 908
**PORIRUA 5240**
Attn: Mr Rob Causer

## Sieve Analysis (Dry)

Test method: NZS 4402:1986 test 2.8.2

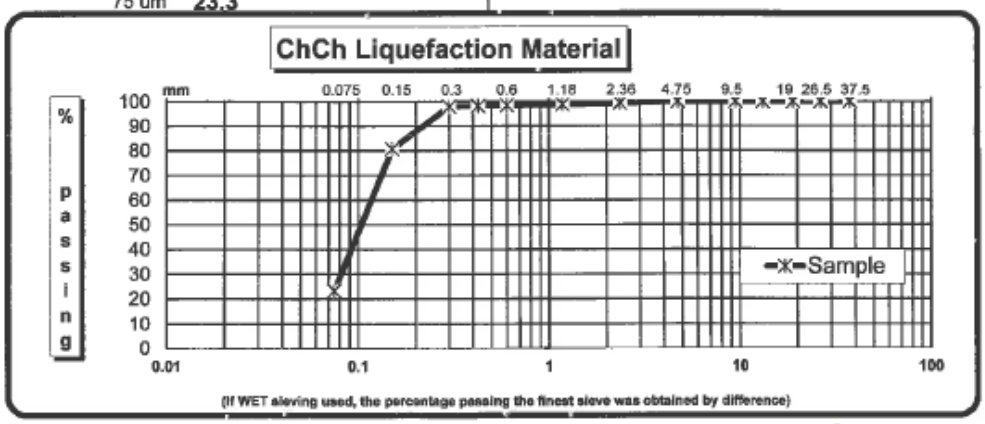
| *Standard BS sieve* | Result: % passing |
|---|---|
| 26.5 mm | 100 |
| 19.0 mm | 100 |
| 13.2 mm | 100 |
| 9.5 mm | 100 |
| 4.75 mm | 100 |
| 2.36 mm | 99 |
| 1.18 mm | 99 |
| 600 um | 98 |
| 425 um | 98 |
| 300 um | 98 |
| 150 um | 81 |
| 75 um | 23.3 |

## OTHER TESTS

**DENSITY of SAMPLING TUBE MATERIAL**
(using actual Material Mass, and Calculated Volume from measurement within Tube)

| | |
|---|---|
| **BULK DENSITY (kg/m$^3$):** | NA |
| **DRY DENSITY (kg/m$^3$):** | NA |
| **WATER CONT. (as rec'd), %:** | 0.0 |

**NOTES:**




(If WET sieving used, the percentage passing the finest sieve was obtained by difference)



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**Approved:**
Duigald Myers *(DIRECTOR)*
Date: **7 November 2014**

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Checked by:
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