

Improvement of B-series compliance testing: a workshop

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Waka Kotahi - NZTA



CETANZ
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Aukaha Resilience

The CETANZ logo consists of a cluster of white, 3D-rendered spheres of varying sizes, arranged in a roughly circular pattern.

We've heard

- Nathan: Integrity and resilience is critical to make it in the long run
- Greg: Change is here in the Subgrade testing space
- Pritpal, Thorsten & Emile: There is some direction needed around the Plateau Density Test

- This is really what this workshop is about.

Background

- Waka Kotahi is preparing to update the B-Series specifications
- Our customers, road users, have told us they expect more.
- We need the lab industry to assist with required change.

Background

- Laboratories are generally third party participants on projects.
- Labs are contracted to carry out compliance testing
- Specs and contract documents often contradict, conflict, or have ambiguous requirements.
- Labs receive a varied level of instruction by the client, which don't clarify these issues.
- Labs need to make decisions that are outside of their responsibilities

B-Series

Similarities, differences and challenges

	TNZ B/02:2005 Unbound Granular Pave Layers	TNZ B/5: 2008 In-situ Modified Pave Layers	NZTA : B/6:2012 In-situ Stabilised Sub-Base
MDD & OWC	NZS 4402, Test 4.1.3 1:5000m ²	7.5 & 7.7) NZS 4402, Test 4.1.3 7.7.1) 1:5000m ²	7.1, 7.4 & 8.1) NZS 4402, test 4.1.3 8.1) 1:5000m ² behind stabiliser
Plateau Density test	7.5) the Contractor <i>shall undertake</i> 100m length Target MDD = greater of Lab MDD and PDT. 7.6) Engineer <i>may accept</i> PDT as MDD 7.6) Frequency: 1:5000m ² (not clearly defined)	7.7) “ <i>when the material changes visibly</i> ” & Refs 7.7.1 for MDD, no PDT frequency. 7.7.1) Frequency 1:1000m ² implied 7.7.1) Contractor <i>shall undertake</i> . Target MDD <i>agreed</i> between Eng & Contractor.	7.6) the Contractor <i>shall undertake</i> 100m, agreed target Maximum Dry Density 8.1) Engineer <i>may accept</i> PDT as MDD Refs 8.1) for MDD, but not PDT.
Degree of compaction	7.6) 5:1000m ² Sub-base Base ≥ 95 % ≥ 98 % ≥ 92 % ≥ 95 %	7.7.1) 5:1000m ² Sub-base Base ≥ 95 % ≥ 98 % ≥ 92 % ≥ 95 %	8.1) 5:1000m ² Sub-base ≥ 95 % ≥ 92 %.
Moisture content NDM Method	No method <i>Nil stated</i>	7.7) IANZ-endorsed NDM, No method <i>Nil stated</i>	No method <i>Nil stated</i>
DoS (Solid Density)	5:1000m ² NZS 4407, Test 3.7.1 (<i>no allowance for assumptions</i>) <80% - Lots of ‘but’s e.g. >5x10 ⁶ ESAs <60%, other 65%	5:1000m ² 7.7) NZS 4407, Test 3.7.1 (<i>no allowance for assumptions</i>) <80% - No ‘but’s	Nil required
Strength	Nil (M4, M3)	7.2.2 UCS from behind Stabiliser, but <i>no frequency or test method</i> . No ITS	7.5.7) ITS to NZTA T/19 7.5.7) 1:5000 m ² or 250 Lm
PSD	Nil (M4, M3)	7.6.4) <i>visually assessed</i>	7.5.8) 3:5000 m ² or 250 Lm Wet sieve analysis – <i>No test method</i>
Sampling	No method stated	No method stated	No method stated

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Sampling	No method stated	No method stated	No method stated

B-Series

Discrepancies and challenges for testing

Sampling

- *No statement in specifications or test methods* as to how to sample, or where to sample from.
- NZTA Z01 & Z08 *require that both sampling and testing* is to be IANZ accredited yet very few test reports state that sampling is endorsed.
- NZS 4407 *specifically* requires random sampling (*as does B-series*) but samples are *rarely random* (Section 2.2), or *client-directed*.

Testing issues

- If lab sampling is not accredited, how can the accredited lab assume that the sample is representative

ISO 17025 issues (as I see it)

- Can they be IANZ endorsed if NZS 4407 Section 2.2 requires random selection of representative samples?

Vibrating Hammer Compaction Test

NZS 4402, Test 4.1.3

MDD/OMC	Test 4.1.3	B02	B05	B06
Curing before compaction	No allowance	Silent	Silent	“Sealed plastic bag and <i>cured for 1 hour</i> before compacting”
On-site compaction	No allowance	Silent	“ <i>preferably on site</i> to avoid changes in moisture content”	Silent
UCS, ITS or CBR	NZS 4402, Test 4.1.3			
Max size	Part 1.6.10 refers to Part 1.6.3 (c) & (d) Note 2: if compacting for CBR: -19mm fraction No fraction for UCS or ITS			
UCS or ITS	Note 2: Whole sample to be compacted, indicated by exception.			

Testing issues

- Density reduces if comp starts late due to breaking of hydration bonds.
- Compaction response due to anvil issues for on-site testing
- Drying out of sample due to improper care

ISO 17025 issues (as I see it)

- Pre-compaction curing – B05 no curing, B06 curing. Diff client requirements for similar processes.
- If no allowance for on-site testing in test method or specification, how can it be accredited?

NDM Method

No statement in B-series specs as to test method

- **Direct Transmission** – NZS 4407:2015 Test 4.2
- **Backscatter** – NZS 4407:2015 Test 4.2
- **CETANZ TG3 (2014)**
 - Not a spec or a test method, also not a client requirement. Where does it fit in?
 - Is it still relevant? Refers to old test methods & pre-dates NZS 4407:2015?

Testing issues

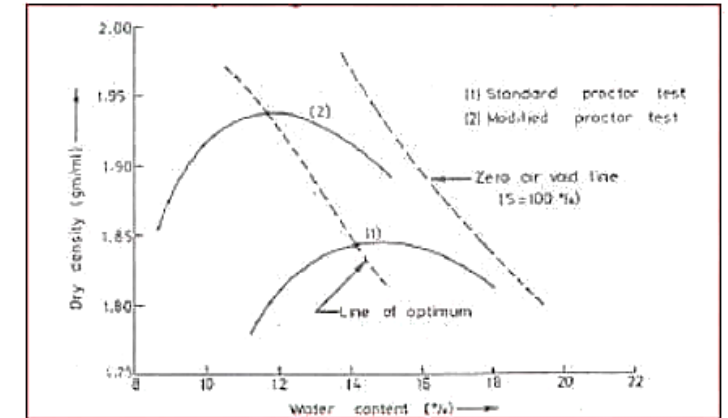
- How do you determine compliance if you don't get direct instruction as to what and how to test?

Common issues

- No statement as to test duration to be used
- Void-free surface? “small quantities of fine sand or fines”
- Moisture correction “*is strongly recommended*” but in Scope, ‘*will require sample of the material under test from one or more of the test sites*’

ISO 17025 issues (as I see it)

- If no instruction as to what method to use, can this be endorsed?
- No allowance for assuming MC correlation, yet reports endorsed with ‘assumed value’



Moisture content

Test method?

- *No statement* in specs.
 - MDD/OWC test refers to test method NZS 4402: 1986 Test 2.1
 - NDM refers to test method NZS 4407:2015 Test 3.1
- Test methods similar but NZS 4402 more complex - ambiguity
- NZS 4402 Note (4) & NZS 4407 3.1.7 (b) Uncertainty is to be established, but made ambiguous in last paragraph.

Testing issues

- Vibe MDD is a NZS4402, and spec'ed for use. Does this imply use of NZS4402 for %MC. If so, then is it appropriate for coarse grained material?
- Are the results identical for both methods for the same material?

ISO 17025 issues (as I see it)

- Can they be IANZ endorsed if test method requires uncertainty.

(4) The uncertainty (Δ_w) in percent water content value (w) arising from the precision of the balance used may be expressed as:

$$\Delta_w = \frac{200 \Delta_m}{M} \left(1 + \frac{w}{100} \right)^2 \dots\dots\dots \%$$

where Δ_m = uncertainty in balance reading (twice the standard deviation of the balance reproducibility) (g)
M = mass of wet soil sample (g).

For all determinations of water content by this Standard the ratio $\Delta_m:M$ has been specified as less than 1:3000 with suitable balances selected accordingly. The corresponding uncertainty is then:

$$\Delta_w \leq \frac{1}{15} \left(1 + \frac{w}{100} \right)^2 \dots\dots\dots \%$$

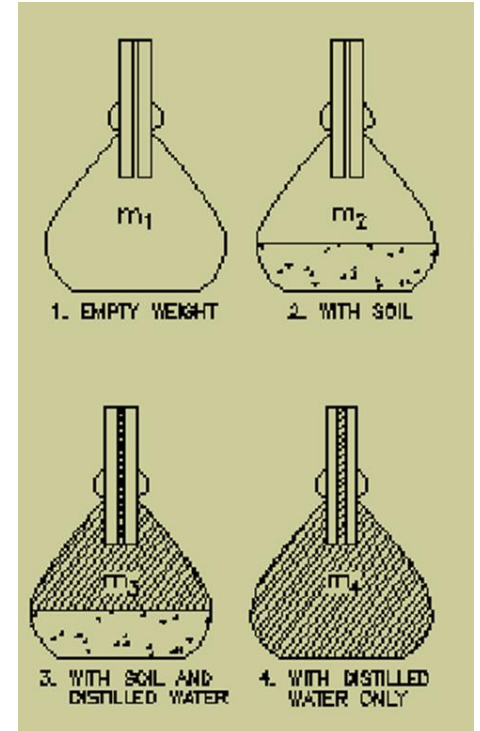
being less than ± 0.1 % at 20 % water content and less than ± 0.3 % at 100 % water content.

Because of natural soil variability many water content determinations in soil engineering do not need to be made to this accuracy. Thus where appropriate a less sensitive balance may be used, provided the ratio element $\Delta_m:M$ is reported with the results. Where the water content determination forms part of another laboratory test in this Standard the 1:3000 ratio shall be maintained, unless otherwise allowed for in the particular test.

Solid Density for DoS

NZS 4407, Test 3.7.1

- “*Essentially the same*” as NZS 4402.Test 2.7.1.
- *No allowance for assumed SD* in the specs or in associated test methods.
- NZS 4402 Test 4.1.3 Note 12: Allowance for assuming SD for Zero Voids line *ONLY*.



Testing issues

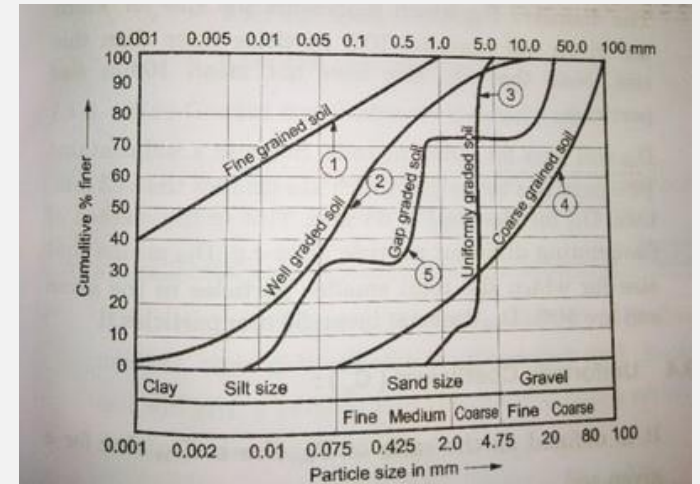
- DoS is sensitive to SD
- No allowance for assuming SD
- Delay in test outcomes

ISO 17025 issues (as I see it)

- No allowance for *assuming SD* so how can DoS be endorsed?

PSD – Wet method

- Only referred to in B6:
 - *No test method*, but assume NZS 4402:1986 Test 2.8.1 Wet Sieving
 - “To be *completed* within 4 hours of mixing” VS test method which has up to 3 drying cycles
 - Does this imply on-site testing? If so, how?



(c) Oven-dry the material retained on the 19.0 mm sieve, weigh to 0.1 % of its mass and record (M_1). (j) Oven-dry the material retained on the 4.75 mm sieve. Sieve this retained material through appropriate sieves as in Test 2.8.2. Weigh to 0.1 % (k) When the whole of the sample has been retained on a sieve, wash, dry all the retained material in the oven at 105 °C to 110 °C (see Note (8)). Floc-
 2-3 Days min
 culate the suspension of silt and clay with just sufficient of the 10 % solution of hydrochloric acid and allow to settle (see Note (9)). Decant or siphon off the supernatant liquid, and dry the fine material in the oven at 105 °C to 110 °C.

Testing issues

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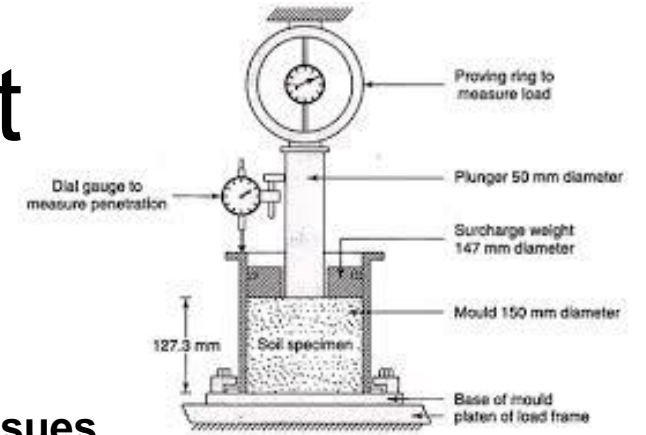
ISO 17025 issues (as I see it)

- Pre-compaction curing – B5 no curing, B6 curing. Diff client requirements for similar processes.
- If no allowance for on-site testing in test method or specification, how can it be accredited?

California bearing ratio (CBR) – Test

CBR

- *No method in specs*
 - NZS 4407: 2015 Method 3.15?
 - NZS 4402:1986: Test 6.1.1?
 - Vibe Hammer Test Method states NZS 4402:1986: Test 6.1.1 is to be used.
 - No allowance for on-site testing in method.
- To be instructed:
 - Compaction method (Std, Heavy or Vibe).
 - Water content for compaction – recent round robin 5 labs – 4 different compaction MC
 - Surcharge loading
 - Soaking period



Testing issues

Ambiguity leads to uncertainty and variability

- How do you determine %MC for compaction? OWC = $\pm 5-7.5\%$ air voids?

ISO 17025 issues (as I see it)

If you don't get specific instruction on all variables, then lab is making assumptions of client requirements and cannot produce compliant ISO 17025 results.

Indirect Tensile Strength (ITS)

NZTA T/19

- Not just the ITS test method but a full design method.
- No allowance for on-site testing in method.
- Carry out the following aggregate characterisation tests, *unless waived by the design engineer*.
 - Water content NZS 4407 Test 3.1.
 - Particle Size Distribution - NZS 4407, Test 3.8.1
 - Plasticity Index (PI): NZS 4407, Test 3.4 or if $CPL > 50$ then NZS 4402, Test 2.4
 - MDD/OMC: NZS 4402, Test 4.1.3 for the fraction passing the 37.5 mm sieve.

Testing issues

- Pre-compaction curing?
- Compaction within specification time limits?
- Compaction moisture content?

ISO 17025 issues (as I see it)

- If PSD, MDD, etc is *not* done, can the test result be endorsed?
- Can ITS test method be endorsed by itself, *without specific instruction by client*?

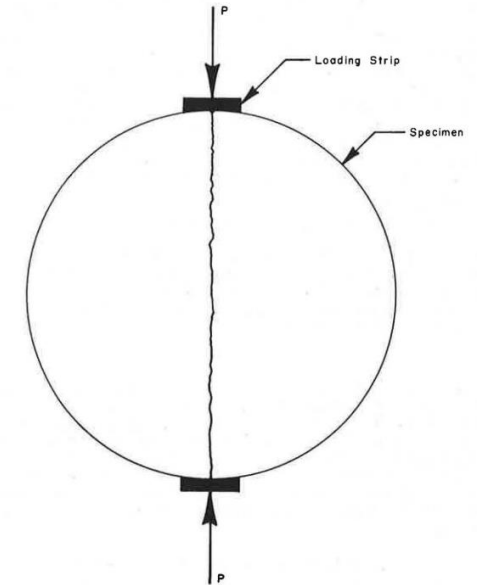
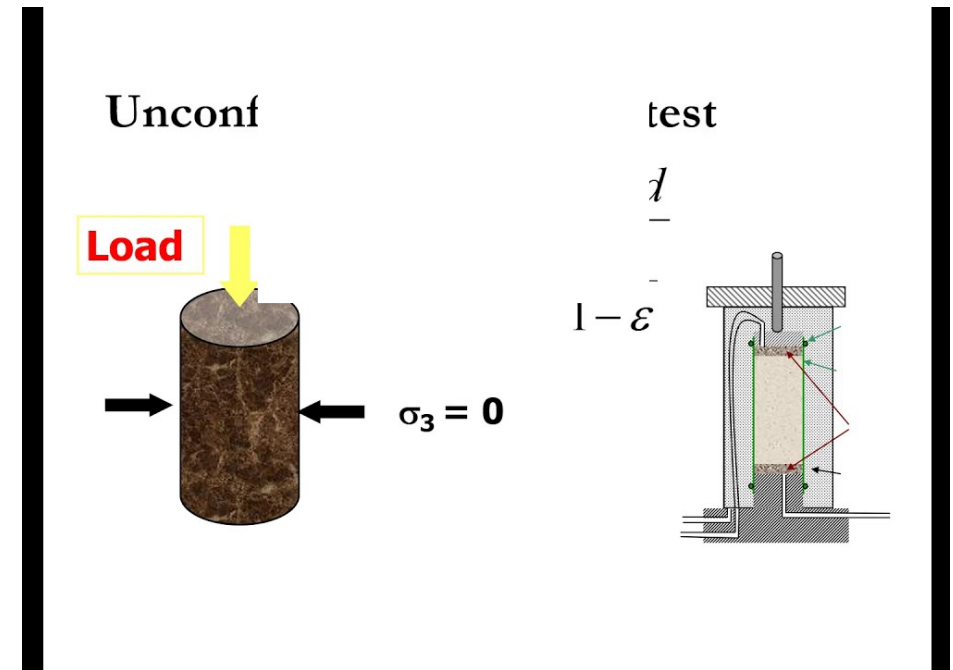


Figure 1. The indirect tensile test.

UCS

- Only required in B05: No test method stated
- What is the basis of testing?

Testing issues



ISO 17025 issues (as I see it)

Aims of workshop

- HEAR FROM YOU!
- Establish best practice for specifying, sampling, and on-site and laboratory testing
- Identify common testing issues and provide solutions (*NOT RE-DESIGNING TEST METHODS*)
- Improve B-series specifications

Group Work

Groups numbered 1-6

- Group 1 & 3: Vibe hammer and associated tests, in-field vs in-lab.
- Group 2 & 4: Sampling, UCS, ITS, CBR, In-field vs In-lab.
- Group 3 & 6: NDM BS & DT, %WC.

35 min session

Feedback

Specs vs Testing

Think about the problems

- What are the root cause of the problems?
- Why is this problems happening?
- How have we managed to work around these issues.
- What do we do / have we done to fix them?
- What changes are needed? Specs, Test instructions, etc (***NOT TEST METHOD***)
 - Priority changes
 - Less important issues

Workgroup:

Compliance testing for the B-Series specifications: Changes identified

Specifications

Test Method