Maximising outcomes with materials testing

Toowoomba IPWEA

Andrew Kennedy
Our values, our diversity

Customers first
Unleash potential
Be courageous
Ideas into action
Empower people
Our strategic plan

**Customer focus**
Objective: A customer-centric organisation that better meets the needs of our customers

**Innovation**
Objective: An organisation that embraces change and adapts to external influences to minimise the impact of disruption

**Contemporary workforce**
Objective: A prepared and capable workforce that meets the future mobility needs of Queenslanders

**Sustainable funding**
Objective: Responsive finance and investment arrangements that deliver value for money

**Our vision**
Creating a single integrated transport network accessible to everyone

**Liveable regions and active cities**
Objective: A network that connects communities and contributes to Queensland’s quality of life

**Building prosperity**
Objective: A network that advances economic prosperity across our cities and regions
About us

Creating a single integrated transport network accessible to everyone

We manage:

- 33,353 km state-controlled roads
- 3078 bridges
- 20 ports

There were:

- 3.6m drivers licensed
- 5.1m vehicles registered
- 3259 taxis licensed
- 232,901 recreational boat registrations
- 866,194 recreational boat licences

Services provided:

- 178m in SEQ
- 11.9m outside SEQ

We serve:

- 3.39m customers served face-to-face at 59 Customer Service Centres
- Our customers conducted 7.2m online services
- 2.6m go cards in use
- Over 485,000 passengers travel on the SEQ network on average each day

Statistics sourced from the Department of Transport and Main Roads Annual Report 2016–17
A customer-centric organisation that better meets the needs of our customers

- 14m transactions per year
- 51.8% of the transactions were completed digitally
- 7 min 28 sec average wait time in Customer Service Centres
- 74% services have digital self-service option
- TMR call centres handle 1.5m+ inbound and outbound interactions per year
- 178,511 enquiries answered through our social media channels
- 24,601 web chat interactions helping customers complete their online transactions
- TMR represents 80% of all state government transactional services
- 3.38m website visits through our QLD Traffic website
- 7.8% increase in digital self-service transactions in 2016–17
- 76% registration renewals completed via digital self-service channels in 2016–17
- 8.2 Customer satisfaction rating (scale of 1–10)

Statistics sourced from CSSR corporate reporting and Department of Transport and Main Roads Annual Report 2016–17
Quality of the product / service delivered

What is the Quality Standard of a product or service delivered in a contract environment awarded in the open market?
Quality of the product / service delivered

- The standard documented in the contract?
Quality of the product / service delivered

The quality standard delivered is the standard that the principal / customer accepts.
Supplier Surveillance

- Reducing the risk

- Monitoring delivery performance at time of delivery
Supplier Surveillance

• Monitoring delivery performance at time of delivery?

• How?

• Product = Compliance / Audit testing
• Process = Surveillance / Audit against a documented standard
50% of our construction costs are for the materials we purchase

95% of TMR compliance testing now conducted by private industry.

The Contractor selects who provides this testing, and also pays for it.

This testing market is worth about $60 million
How reliable is my test result?

1. Test results are not precise values
2. Why is there variation in test results?
Measurement Uncertainty?

1. Performance of the measuring device/s

2. Number of measurements

3. Repeatability / Reproducibility of the activity

4. Varies between Laboratories and dependant on equipment and skills used in that Laboratory for that instance of testing
# Examples of Uncertainty

<table>
<thead>
<tr>
<th>Property to be Tested</th>
<th>Method Number</th>
<th>Sensitivity (e.g. Repeatability/ Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry density/moisture relationship (MDD/OMC)</td>
<td>Q142A (Q110A)</td>
<td>MDD ±2.0% of reported value OMC ±10.0% of reported value</td>
</tr>
<tr>
<td>Compacted density</td>
<td>Q141A (Q112)</td>
<td>MDD ±0.04 t/m³</td>
</tr>
<tr>
<td></td>
<td>Q141B (Q111A)</td>
<td></td>
</tr>
<tr>
<td>Relative compaction</td>
<td>Q140A (Q111C)</td>
<td>±2.5</td>
</tr>
<tr>
<td>Degree of saturation</td>
<td>Q146 (Q111D)</td>
<td>±10</td>
</tr>
<tr>
<td>California bearing ratio</td>
<td>Q113A 4pt</td>
<td>±50% of reported value</td>
</tr>
<tr>
<td></td>
<td>Q113C 1pt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AS1289.6.1.1 1pt</td>
<td>±80% of reported value</td>
</tr>
<tr>
<td>Flakiness index</td>
<td>Q201A</td>
<td>±3</td>
</tr>
<tr>
<td>Ten percent fines value (wet)</td>
<td>Q205B</td>
<td>±30</td>
</tr>
<tr>
<td>Degradation factor</td>
<td>Q208B</td>
<td>±5</td>
</tr>
</tbody>
</table>
What about Characteristic Values?

**Measurement of Uncertainty of a Characteristic Value** = Single Test MU \( \times \frac{1}{\sqrt{n}} \)

where \( n = \) number of tests used to determine the mean

Compacted density individual test MU is approx 1.5%

- If \( n = 3 \) then the CV mu is 0.87%
- If \( n = 9 \) then the CV mu is 0.5%
Compliance Testing

- Test result **credibility**
- All about the **competency** of the **doer**
- Not the company badge
- Competency standards for testing staff exist within the accreditation system
Compliance Testing

Sampling

• The **sample** represents the **lot**

• Waste of time testing if the sample does not represent the lot

• **Sampling** is a **test**, the **most important** test we do

• Sampling methods exist
Auditing & Surveillance

Authority

- MRTS 50 Clause 9
- Construction Materials Testing Supplier Registration Scheme
Background

- Decline in standard of CMT industry
- Pricing structure - last in the contract award - meat raffle
- Materials is a HIGH risk to Department
Integrity of Private Testing Suppliers

% of Samples with Non Conformances

Plant 1
- Auditor Present
- No Auditor Present

Plant 2
- Auditor Present
- No Auditor Present

6 June 2018
Normal Distribution

1. Test results should show a normal distribution* (Bell Curve)
2. Failure to do so is an indicator fraudulent activity might be occurring
Normal Distribution

Typical histogram of compaction on a project
Normal Distribution

1. Histogram of first 100 compaction results on a project
2. Specification limit = 95%
Generation of test results

Why make up test results?

- Save time and money
- Cover up non conforming product
- Reduce / eliminate rework
- Reduce / eliminate applied financial penalties
- Pressure from Contractors
- Pressure from within the organisation (where testing is completed internally)
How wide spread is it?

- We don’t know for sure but our audits indicate it is a problem in some parts of the CMT industry.
- Many more defects are reported when surveillance officers are witnessing testing (1.5 to 2 times as many)
- Statistical analysis showing saw tooth “bell curves”
- Multiple instances of manufactured test results uncovered

In 4 years we have audited 70 testing suppliers – 10% have been deregistered for fraud
How are they doing it?

• Until recently it was thought “cheating” was being done manually by adjustment of numbers during testing. The previous examples are all thought to be simple manual adjustment.

• There have been rumours for many years of software systems that are back calculating raw data to support a desired test result, but we never found evidence of it – until recently.
Cheating Software

3 different software systems discovered in last two years

- Queensland – January 2016
- Northern Territory – March 2016
- Victoria – May 2016
Qld - SuperDuper Dee4 V1.4.4

The software was Excel spreadsheet based, but very sophisticated.

- Version number
- Generates results for most TMR and AS test methods used for road construction compliance
- Tracks resources so lab equipment can’t be in use for two tests at once
- Tracks staff so they are not “overused”
## CBR

<table>
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<th>12.5</th>
<th>37891</th>
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<tbody>
<tr>
<td>CBR - 2.5mm</td>
<td>90</td>
</tr>
<tr>
<td>Load</td>
<td>11880</td>
</tr>
<tr>
<td>CBR - 5.0mm</td>
<td>120</td>
</tr>
<tr>
<td>Load</td>
<td>23760</td>
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Note: Only input data in BLUE cells

<table>
<thead>
<tr>
<th>Mould #</th>
<th>18</th>
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<tbody>
<tr>
<td>MDD</td>
<td>2.04</td>
</tr>
<tr>
<td>OMC</td>
<td>9.2</td>
</tr>
<tr>
<td>Mass Dry Sample</td>
<td>6500</td>
</tr>
<tr>
<td>Sample Moist %</td>
<td>3.9</td>
</tr>
<tr>
<td>Mass Dry Sample</td>
<td>6256</td>
</tr>
<tr>
<td>Mass at OMC</td>
<td>6832</td>
</tr>
<tr>
<td>Water Required</td>
<td>332</td>
</tr>
<tr>
<td>% Dry Density</td>
<td>100</td>
</tr>
<tr>
<td>% Wet Density</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Std / Mod</th>
<th>s</th>
</tr>
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<tbody>
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<td>MDD</td>
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<tr>
<td>Mould #</td>
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<tr>
<td>Cure Moist</td>
<td>3.9</td>
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<tr>
<td>Top 30</td>
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<tr>
<td>% Dry Density</td>
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<tr>
<td>% Wet Density</td>
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Date: 30/06/2008
**Table:**

<table>
<thead>
<tr>
<th>Column 1</th>
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<tr>
<td>Value 1</td>
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<td>Value 4</td>
<td>Value 5</td>
<td>Value 6</td>
</tr>
<tr>
<td>Value 7</td>
<td>Value 8</td>
<td>Value 9</td>
</tr>
</tbody>
</table>

**Graph:**

The graph illustrates the relationship between the independent variable (X) and the dependent variable (Y) as shown in the table above.
Perspective?

Is this in wide spread use?
Is it being used to undercut CMT Suppliers doing the right thing?

We don’t know – but:

• Northern Territory government and NATA were given a copy of a different software system

• NATA came across yet another software system in Victoria.

• 3 different versions of this type of software are now known to exist
Savings?

- Gradings - $80 to 115
- Moisture content - $20
- 5pt liquid limit – $75 to 145
- 4pt soaked CBR - $350
- Field density – nuc $40 to 50 ; Sand $50 to 70
- Moisture Density relationship - $100 to 130

But peanuts compared to construction costs – one failing lot, which is “passed” can be worth $100,000
Our Obligations

We run a CMT Supplier registration system that requires the use of qualified and competent staff undertaking compliance testing in an ethical manner.

Firstly we do this to ensure the people of Queensland are getting what they are paying for. Not just the testing service, but of course the product.

Secondly we have an obligation to those whom follow our requirements, to ensure we do not enable / reward those whom do not (those whom cheat).
How do we meet our obligations?

By conducting surveillance and audit of CMT Suppliers to ensure ethical behaviour and competency.

Monitoring of test data on projects (control charts, statistical analysis).

Not accepting quotes for testing significantly under normal market rates.

Ensuring any compliance testing done is only by approved CMT suppliers.

We must try and protect CMT Suppliers from undue influence.
How do we deal with this?

- Conditions applied to Registration
- Suspension of Registration
- Reporting issues to NATA
- Joint audits with NATA
- Forming relationship with Industry Body - AGTA
- Protecting CMT Suppliers who do the right thing, by acting on those who do the wrong thing.
In Conclusion –

Back to where we started
Quality of the product / service delivered

The quality standard delivered is the standard that the principal / customer accepts.
Description of Non Conformance

Compaction CV failure 91.8%, As Per MRTS04 - Table 15.3-B – Density requirements which is CV = 95%
Field Moisture Content being a factor in some results cause of failure of CV.

Corrective Action: (What immediate action will be taken to correct the work)
Leave as is - Area will be reworked by another others at a later date.

Preventative Action: (What action will be taken to prevent it from reoccurring)
Ensure sufficient compaction of layers to comply with MRTS4 Table 15.3-B – Density requirements, also monitor moisture content of material during compaction works.

Date: 16/8/2017
Thank you and stay connected

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Blog  blog.tmr.qld.gov.au