A review of New Zealand’s specifications and laboratory test methods for fine aggregate and sand

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Content

Aggregate Facts

Locality of Source

Current NZ Tests

Initial Findings

Conclusions

Recommendations for further work
Aggregate facts

NZ consumption of aggregates: 45m tonnes/annum
Time taken to establish a new quarry: >10 years
Auckland’s current consented aggregate supply: 12 years
Economic impact: $2 billion/annum and 9,707 jobs

<table>
<thead>
<tr>
<th>Country</th>
<th>Tonnes per person</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>10.9</td>
</tr>
<tr>
<td>United States</td>
<td>8.4</td>
</tr>
<tr>
<td>Australia</td>
<td>7.0</td>
</tr>
<tr>
<td>Europe</td>
<td>6.9</td>
</tr>
<tr>
<td>Great Britain</td>
<td>4.7</td>
</tr>
<tr>
<td>World (estimate)</td>
<td>3.0</td>
</tr>
</tbody>
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Source: Aggregate and Quarry Association
Locality of source

The cost of a truckload of gravel can double every 30kms travelled

Source: Aggregate and Quarry Association
Importance of Aggregate Fines Quality

Potential to cause premature failure
Influence on compaction
Segregation is another key concern
Breakdown of material in service through repeated loadings
Consistency of material is vital
Repairs are not acceptable
Current New Zealand tests to classify the cleanliness of fine aggregates and sand

Limit the amount of -75um material

Sand Equivalent
Developed 1954 by Hveem

Methylene Blue or Clay Index
Developed 1967 by Jones

Plasticity Index
Developed 1911 by Atterberg
When are the tests applied to classify the cleanliness of fine aggregates and sand

Typically:
• All NZ Specifications limit the 75um Material
• All commonly adopt Sand Equivalent
• Clay Index less popular not used in concrete industry
• Plasticity Index mainly used in roading applications

No tests adapted specifically for uniqueness of NZ Rock sources

Testing to establish the cleanliness >$2m/annum

Local aggregates are often dismissed due to non compliance with National NZ Specifications

Traffic loadings increasing in many areas
Issues with the current NZ tests

All are laboratory based tests

Turnaround of results

Accuracy and consistency of tests

Reliance on the skill and experience of the aggregates technician

Inconsistent interpretation and understanding of results

Increase in the use of rock fines especially in the production of concrete and potential incompatibility with current tests
Sand Equivalent

- Quickest of current tests taking approx 30 mins
- Settling Test
- Not directly measuring clay content
- Simple and relatively cheap
- Accuracy and repeatability concerns
Clay Index

- Direct measure of clay content
- Turnaround time often > 2-3 working days
- Potential to measure non deleterious minerals
- Concrete industry adoption
Plasticity Index

- Reliance on technician
- Turnaround time often > 5 working days
- Potential to measure non-swelling minerals
- Incorrect air drying
Initial Findings: Sand Equivalent Versus Clay Index

- Single quarry source & multiple products
- Sample size = 90
- Lower CI with increasing SE
- 37% of samples ≥40 (Sand Equivalent)
- 87% of samples ≤3 (Clay Index)
Initial Findings: Sand Equivalent versus Clay Index

- Multiple Quarries and Products
- Sample size = 197
- 24% of samples $\geq 40$ (Sand Equivalent)
- 74% of samples $\leq 3$ (Clay Index)
Comparison with % passing 75um

- Single quarry source & multiple products
- Sample size = 90
- 37% of samples ≥40 (Sand Equivalent)
- 87% of samples ≤3 (Clay Index)
- 63% of samples ≤7 (% Passing 75um)
Conclusions

Percentage of fines in NZ aggregate products does not appear excessive

Key is quality of the fines not quantity

Evidence to suggest that using Sand Equivalent as primary test method is not maximising the use of NZ aggregates

Clay Index and Sand Equivalent give differing levels of conformance for same sample

Specifications can create testing and consistency issues for aggregate industry

Specifications are reliant on adopted test methods for aggregates
Recommendations for further work

Review in greater detail existing test methods and levels of precision, including effect of sampling methods.

Develop a test programme to compare existing test methods targeting a wider range of test values.

Relate results to specific swelling clays using XRD data.

Review properties of NZ rock fines and compare to overseas rock sources to identify similarities and differences.

Investigate new technology to detect, distinguish and measure clay minerals in the field.