

Water and Aggregate for Concrete

NZRMCA Technical Note 3



Introduction

The current NZS 3104 for Concrete Production 2003 cites NZS 3121 Specification for Water and Aggregate for Concrete 1986, as part of the supplier requirements for aggregates.

The problem is that since 1986 there have been a number of significant changes in building

controls and New Zealand Standards, which have not been taken up in NZS 3121, i.e. have remained unchanged for 20 years.

The purpose of this paper is to identify changes deemed necessary by the Technical Committee of the NZRMCA to NZS 3121.

Principal Issues/Discussion

1. Chloride Content

There is no specific requirement in NZS 3121 which requires the identification of any chlorides present in the aggregate and/or sand.

The concrete production industry is required to produce concrete used in prestressed and reinforced concrete applications with limitations on the final chloride content.

The chloride can come from a number of sources but usually from admixtures and aggregate. While the aggregate producer does not have the direct responsibility for the blending/mixing process for the concrete the ready mixed concrete producer must be able to calculate chloride content in the concrete. Hence the acid soluble chloride content in aggregates supplied as fit for concrete production need to have a chloride content stated by the aggregate supplier.

Within NZS 3121 there is a requirement to check that water from other sources (Clause 3.4) does not have chloride in excess of 500 ppm.

For aggregate producers using sea dredged or beach materials, the chloride content needs to be measured, certified and given to the ready mixed concrete producer. Inland quarry/pit operations need to have a fix on possible chloride levels but not a continuing quality control of levels.

Typical plaster sand specification chloride limits in NZS 4251 are 0.03% - 0.05% by mass. However, there is a considerable "dilution" of sand influence in concrete compared to plaster.

The determination of chloride content can be done in several ways after sampling in accordance with NZS 3111.

- a. Chemical test for chloride content BS1881: Part124 or ASTM C1152.
- b. XRF (x-ray fluoroscopy method).

There currently is a further investigation into the differences of results that may result from different testing methods but broadly the relative accuracy only becomes a possible problem where chloride contents become close to the various specified limits.

The results need to be quoted in % by mass.

The calculation of chloride in the concrete for the concrete producer is shown in IB 83 (publication can be downloaded from www.cca.org.nz).

2. Alkali Aggregate Reaction

Considering the length of time that New Zealand has acknowledged the risk of AAR it is surprising that an aggregates document of 1986 contains no reference to AAR susceptibility of aggregates.

It is the ready mixed concrete producer's responsibility to check that Normal concrete will have a limited risk of disruptive alkali aggregate reaction. The producer has also to notify a Specifier when the risk occurs in Special concrete. The factors involved in assessing the risk are:

- a. Identification of aggregate/sand that has a risk of reaction in an alkaline environment.
- b. Level of alkalis present in the concrete primarily governed by cement content, alkali content of the cement together with alkalis arising from use of admixtures.
- c. Reactions can become severe at blending combinations of materials both reactive and non-reactive, i.e. pessimum proportions within the concrete mixing.

It is considered that NZS3121 aggregate producers should take up the responsibility of identifying whether materials are potentially reactive.

The aggregate producer needs to identify whether their materials contain potentially reactive components by comparing with the list of reactive materials in Table 7 of the CCANZ publication *TR 03 Alkali Aggregate Reaction* which is downloadable from www.cca.org.nz.

The identification of potentially reactive components/materials is basically a petrographic evaluation. Some testing methods are also listed in TR3 but for normal concrete applications identification by petrography is the usual method.

Conclusions

This paper attaches a *Recommended Changes to NZS 3121* and this should be used in contractual discussions with your Aggregate Supplier. In any supply contract you may be arranging we recommend that in addition to requiring supply to comply with the current edition of NZS 3121, the *Recommended Changes to NZS 3121* should be included as part of the contract.

There was one area that we were unable to get agreement with the Aggregates Industry and

The ready mixed concrete producer using IB 81 Alkali Content of Concrete, Mix Water and Aggregates also downloadable from www.cca.org.nz can then ascertain whether their concrete can meet the 2.5 kg/m³ alkali content limitation set when using AAR susceptible materials.

3. Cleanness of Sand

The current requirement is for sand to have a cleanness value not lower than 60. A higher value is desirable.

The test NZS 3111 Part 18 is basically a sediment settling test and hence measures fine dust and clay-like particles. The presence of clay-like particles is detrimental to strength and to the maintenance of workability properties of the concrete over time. It has been acknowledged in NZS 3104 that the presence of fine hard particles often present in manufactured sands may not be detrimental to the concrete.

Hence an alternative test method that can distinguish between clay-like particles and hard rock particles could lead to the greater use of materials not currently acceptable under the 60 SE rule.

The Aggregates industry has suggested using the Clay Index test with an upper limit of 3. This has been included in proposed changes to NZS 3121 However even without the test, the alternative path of concrete equivalency property testing is included.

At the time of writing the first discussion paper, we were looking at modified testing methods. However this has been resolved by using the Clay Index method suggested ex Aggregates Industry.

that related to the frequency of testing as required by NZS 3104. The weekly testing requirement/1,000 tonne production contained in the Recommendations may not provide sufficient testing to comply with NZS 3104 which requires testing governed by material use, i.e. 150 m³ for sand and 300 m³ for aggregate. Where supplier testing does not meet this frequency then extra testing is needed either by negotiation with the Aggregate Supplier or by supplementary tests undertaken by the concrete producer.

RECOMMENDED CHANGES TO NZS 3121

ADDITIONAL CLAUSES:

- C3.4** Water recovered from the washing out of concrete mixing bowls may be reused in future concrete loads provided it meets the compliance criteria of (i) or (ii) above.

Due consideration will need to be taken of its specific gravity and high fines content which may significantly affect setting times. Guidance can be obtained from the 2004 CCANZ Report titled "The Use of Recycled Washwater in Ready Mixed Concrete Production".

- 4.1.1** General – No Change.

- 4.1.2** Aggregates, both coarse and sand, that are AAR susceptible shall be declared by the aggregate producer to the purchaser.

- C4.1.2** Sand or aggregates may be potentially reactive in a hardened concrete matrix. This adverse reaction can be controlled by identifying the reactive materials and eliminating them from use in concrete or by limiting the total alkalis in the concrete mix

The producer can initially identify potentially reactive materials by reference to Table 7 of the CCANZ Report TR3, "Alkali Silica Reaction" 2nd Edition which lists the geological rocks/minerals likely cause alkali aggregate reaction (AAR) in concrete.

The purchaser (concrete producer) requires this information so that precautions are included in any concrete mix designs to limit alkali content,

- 4.1.3** Aggregates, both coarse and sand, shall have their acid soluble chloride levels tested by the supplier and declared to the purchaser.

Where sea dredged and or beach deposits are the source of aggregate materials, the aggregate supplier shall test for chloride on regular basis to

ensure that the process keeps within chloride limits declared to the concrete producer.

Where inland quarry or pits are the source of aggregate materials, a single confirming test shall be carried out.

- C4.1.3** Chemical test methods for determining acid soluble chloride content are contained in BS 1811 Part 124 or ASTM C1162. An alternative test is X-ray fluorescence (XRF).

Results are to be expressed in % by mass. The purchaser (concrete producer) requires this information so that precautions are included in any mix designs to avoid breaching maximum chloride levels specified in NZS3101/09 for reinforced concrete.

AMENDMENTS TO CLAUSES:

- 5.4.2** After "each week's" add the following words "or each 1000 tonnes of individual production which ever is the greater....."

Add the following words:

"(a) Section 6 of NZS 3111 and 'optionally'.

(b) Loose NZS 3111".

- C5.4.2** This frequency of testing may not equate to the minimum testing requirements of NZS 3104. Hence additional testing may need to be arranged by the Concrete Producer either by increased testing by the supplier or by directly carrying out supplementary testing.

- 6.3** Add to the clause as the last sentence, "Unless petrographic analysis or other test methods demonstrate that the fine material is predominately fine rock particles with a Clay Index less than 3 and the sand or blend of sands can be demonstrated to comply with Clause 6.4."

6.5.2 Replace with:

“Frequency of Sampling and Testing

For each sand produced at least one sample shall be obtained from each week’s or each 1000 tonnes of production and either tested by means of a sieve analysis using the method set out in section 6 of NZS 3111, or the same flow test as set out in section 9 of NZS 3111.”

Note:

- (1) Where a concrete producer is blending sands, the sands which make up the blend shall be sampled individually and then blended in the proportions used in the concrete prior to carrying out the flow cone test.”

C6.5.2 This frequency of testing may not equate to the minimum testing requirements of NZS 3104. Hence additional testing may need to be arranged by the Concrete Producer either by increased testing by supplier or by directly carrying out supplementary testing.

6.5.3 Replace with:

“Acceptance Criteria

Not less than 45 of the last 50 consecutive test results shall comply with (a) or (b) of the following requirements as appropriate:

- (a) (i) *The sand or resultant blend of sands, when subjected to a sieve*

analysis in accordance with section 6 of NZS3111, shall not contain more than 5% by mass retained on the 4.75mm test sieve, and

- (ii) *The individual fineness modulus values obtained, or in the case of blended sands the combined fineness modulus values, shall not vary by more than 0.20 from the average fineness modulus of the 50 samples.*

- (b) *For each sand, or a blend of sands produced, the requirements in respect of the following:*

- (i) *The amount of material retained on a 4.75mm test sieve shall not exceed 5 % by mass.*

- (ii) *The voids content of the sand passing the 4.75mm test sieve shall not exceed 48%.*

- (iii) *The flow time shall lie within the limits set out in table 3.*

- (iv) *The individual flow times obtained do not vary by more than 2s from the average flow time of the 50 samples.”*

6.7 Add *“unless alternative testing in clause 6.3 has been completed”.*



**Prepared by the NZRMCA Technical Committee
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