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Building Engineering Division (#05-00)

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See **Distribution**

Dear Sir/Madam

CONTROLLING TOTAL ALKALI CONTENT IN STRUCTURAL CONCRETE TO MINIMISE RISK OF ALKALI-SILICA REACTION (ASR)

Singapore currently imports aggregates from numerous overseas sources and the quality of these aggregates varies quite significantly. These aggregates being derived from natural rock can contain minerals such as silica, chlorides, sulphates etc that may have adverse effects on the durability of concrete. For instance, aggregates with reactive silica in the presence of alkalis in concrete could lead to the detrimental Alkali-Silica Reaction (ASR) which will cause cracks in the concrete.

2 As a precautionary measure, BCA has introduced a three-stage testing regime^a to screen out aggregates with potential for ASR or with other undesirable attributes. Qualified Persons, ready-mixed concrete (RMC) suppliers and builders are also advised to carry out checks on the quality of aggregates for use in the production of structural concrete. Qualified Persons should check with their RMC suppliers to ensure that there are sufficient tests on aggregates for presence of ASR and other essential chemical tests have been conducted to ensure the suitability of the aggregates for use in structural concrete.

3 Currently, the Sixth Schedule of the Building Control Regulations prohibits the use of aggregates that have potential for ASR in structural concrete works. To prepare for a wider choice of supply of aggregates for our construction sector in the long run, BCA will be introducing control measures in the production of structural concrete which will allow the use of aggregates with marginal reactivity to ASR. These aggregates with marginal reactivity are defined as having expansion not greater than 0.2% when evaluated using ASTM C1260^b (Mortar-Bar Method). The measures listed in paragraph 4 below will take effect from 1 Jan 2009. Consequently, aggregates with marginal reactivity will also be allowed for use in structural concrete. Reactive aggregates with expansion greater than 0.2% in the Mortar-Bar Method, or having potential for Alkali-Carbonate Reaction (ACR), or aggregates deriving from volcanic rocks will still be prohibited.

^a The 3-stage testing regime consists of pre-import test in Stage 1, confirmation test in Stage 2 (inclusive of isolation to the consignment of shipment), and random test in Stage 3.

^b ASTM C1260 "Standard Test Method for Determining the Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)"

4 The following control measures are required for **all** structural concrete including those used in the casting of precast structural elements manufactured both locally and overseas with effect from 1 Jan 2009:

- a) Control on alkali content^c
 - (i) use of low alkali cement with equivalent $\text{Na}_2\text{O} \leq 0.6\%$; or
 - (ii) limit the total alkali content of concrete to 2.5 kg equivalent $\text{Na}_2\text{O} / \text{m}^3$;

- b) Checks by qualified person (QP)
 - (i) QP or his site supervisor are advised to carry out audit checks on the type of cement and quality of sand and coarse aggregates (of granite origin) used at the RMC plants producing structural concrete for their projects;
 - (ii) QPs are required to obtain monthly reports on the latest test records on cement and/or calculations of total alkali content of the concrete mix from their respective RMC suppliers; and
 - (iii) These reports shall be maintained at their respective sites for verification.

5 To minimise the risk of ASR occurring, QPs are advised to incorporate specification clauses for the control of alkalinity in concrete into contracts for all future development projects.

6 We have checked with all the ready-mixed concrete suppliers and all are already currently using low alkali cement. And almost all the precasters who are batching their structural concrete at their precast plants are also using low alkali cement. As such, we expect that this requirement, when it comes into effect in Jan 2009, will unlikely to have any appreciable cost impact, if there is any at all. Our industry partners comprising RMC suppliers and precasters have expressed their support for this national effort towards our move to diversify our sources for aggregates.

7 I would appreciate it if you could bring to the attention of your members the contents of this circular. Please contact Senior Executive Engineer/Mr Lung Hian Hao at Tel: 6325-2090 or email: lung_hian_hao@bca.gov.sg if you need further clarification.

Thank you.

^c Further guidance can be obtained from BRE Digest 330 (2004) "Alkali-silica reaction in concrete"

Yours faithfully

A handwritten signature in black ink, consisting of several fluid, connected strokes. The signature is positioned below the text "Yours faithfully".

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