APPENDIX C

Modified ASTM C 1260 Test Method to Evaluate Aggregate Reactivity in Presence of Deicer Solutions

INTERIM TEST PROTOCOL

Modified ASTM C 1260 Test Method to Evaluate Aggregate Reactivity in Presence of Deicer Solutions

1. SCOPE

The interim test method described in here provides a means to evaluate the alkali-silica reactivity of aggregates in the presence of airfield deicing and anti-icing chemical solutions. The methodology presented in this document is based largely up on some modifications to the procedure that is established in the Standard ASTM C 1260 test method[1].

The modifications to the standard test method were developed and employed as part of the IPRF 03-9 research study[2] sponsored by IPRF/FAA. Due to the limitations in the scope of the research project that led to the development of this interim test procedure, specific influence of several factors (such as the composition of the cement, the temperature of the test, the concentration of the soak solutions and other factors) that may potentially influence the observations in this test method has not been thoroughly investigated. In view of the limitations cited above, this test procedure should be considered interim in nature.

Despite the limitations of this interim test method as outlined above, this method has been successful employed in the IPRF/FAA research study in identifying deleterious interactions between the deicers and aggregates in a consistent manner among the aggregates evaluated in the research study. Also, this method has shown potential to distinguish the efficacy of different mitigation measures.

2. REFERENCED DOCUMENTS

Standard ASTM C 1260 Test Method

3. SIGNIFICANE AND USE

With this test method, it is possible to characterize the reactivity of aggregate in mortar bars, in presence of specific airfield deicing chemical. Limited testing that was conducted in the development of this test method did not discern any specific influence of composition of typical Portland cements on the observed behavior of aggregate reactivity. Therefore, it is suggested that existing requirements for Portland cement as indicated in ASTM C 1260 test procedure be adopted in this interim test procedure. (This requirement entails the autoclave expansion of the portland cement be less than 0.2% for use in this test procedure).

In this test method as the aggregate reactivity is characterized with respect to a specific deicing or anti-icing chemical, there is no one specific soak solution. Another significant deviation from the standard ASTM C 1260 test method is the duration of test. Instead of the typical 14-day soak period that is employed in the ASTM C 1260 test method, a longer soak period of 28 days is recommended in the interim test procedure with deicers to observe any later age expansions. The details of the reagents

to be used, composition of the soak solution and the duration of testing in the interim test method are addressed in sections 5 and 8.

4. APPARATUS

Same as in the Standard ASTM C 1260 Test Method.

5. REAGENTS

As the proposed test method focuses on evaluating the influence of a specific deicer on the potential reactivity of aggregate, it is recommended that the soak solution employed in the test procedure be prepared from the commercial deicing chemical under consideration, rather than a reagent grade chemical. *(Investigation of equivalent reagent grade deicer chemicals in the IPRF/FAA research project, have yielded similar results to those of commercial deicers themselves. Moreover, commercial deicers typically also include other minor ingredients such as corrosion inhibitors, dyeing agents, etc, whose effect will not be obvious if reagent grade materials will be employed in the test procedure).*

Depending on the specific deicing or anti-icing chemical and aggregate combination to be evaluated, the soak solution for use in the proposed interim test procedure is limited to aqueous solution of the following chemicals:

(i) Potassium Acetate
(ii) Potassium Formate
(iii) Sodium Acetate
(iv) Sodium Formate

5.1 Liquid Anti-Icing/Deicing Soak Solutions

The liquid anti-icing chemicals (potassium acetate and potassium formate-based solutions) shall be used in the test method at a concentration recommended for application in field by the manufacturer. Based on the available literature on the liquid deicer/anti-icing chemicals (potassium acetate and potassium formate), the typical concentration at which these chemicals are applied in field is at 50% solution by weight. It is therefore recommended that the deicing solutions, as obtained from the manufacturer, be used as the soak solutions in the interim test procedure.

5.2 Solid Deicing Chemicals

In case of solid deicing chemicals (sodium acetate and sodium formate-based products), the concentration of the soak solution shall be a saturated solution of the deicing chemical at room temperature. The choice of using a saturated solution of the solid deicing chemical at room temperature presents an aggressive, yet realistic exposure condition for the concrete.

Although at the time of application of the solid deicing chemical on an icy pavement, the resulting concentration of the solution generated by the melting ice may be much less than a saturated solution at room temperature, it is likely that the generated brine will be absorbed by the concrete, and due to subsequent cycles of wetting and drying can reach a level of concentration close to saturation. It is therefore recommended in

this test procedure that a saturated solution of the solid deicer at room temperature be used in the test method.

The saturated solution of a solid deicing chemical is prepared by dissolving sufficient quantity of the deicer chemical in deionized or distilled water, such that a small portion of the solid deicer remains at the bottom of the container after a 24-hour period of dissolution. Alternately, the saturated solution can be prepared by heating a mixture of the solid deicer and water and cooling it to room temperature, such that a precipitate of the solid deicer is present in the mixture upon cooling of the solution to room temperature.

5.3 Warning

Before handling any of the deicer and anti-icer solutions, be aware of safety concerns as described by the manufacturer in the Materials Safety Data Sheet (MSDS) supplied with the products.

6. CONDITIONING

Follow the procedure as elaborated in section 6 of the Standard ASTM C 1260 test method.

7. SAMPLING AND PREPARATION OF TEST SPECIMENS

Follow the procedure as described in section 7 of the Standard ASTM C 1260 test method.

8. PROCEDURE

Follow the same procedure as in Section 8 of the Standard ASTM C 1260 test method, with exception of the following steps:

8.1 Initial Storage and Reading (Same as in Standard ASTM C 1260 Test Procedure)

8.2 Zero Readings

After taking the zero reading as per section 8.2 of the Standard ASTM C 1260 test procedure, place the mortar bars in sufficient quantity of the deicer solution (4 ± 0.5 volumes of solution for 1 volume of the mortar bar) that is being considered in the test method, instead of the 1 N NaOH solution. The deicer solution shall be maintained at $80.0 \pm 2.0^{o}C$.

8.3 Subsequent Storage and Measurement

Take comparator readings of specimens periodically up to 28 days, with at least 6 intermediate readings after the zero reading, at approximately same time of the day.

The standard ASTM C 1260 test method specifies a 14-day soak period in a 1N NaOH solution, for evaluating the potential reactivity of the aggregate. Based on the IPRF/FAA 03-9 research study[2] on the evaluation of aggregate reactivity in deicing soak solutions, it is observed that much of the expansion in the mortar bars containing

reactive aggregates occurs within the initial 14-day soak period for most of the reactive aggregates. However there are exceptions to this trend and expansion measurements at 28 days should be taken to observe any delayed response.

Findings from IPRF 03-9 study[2] indicate that mortar bar expansions exceeding 0.1% at 14 days of soak in deicer solution (or 16 days after casting the mortar bars) indicate potential for aggregate reactivity in presence of the deicing chemical.

9. CALCULATION

Follow the same procedure as in Standard ASTM C 1260 Test Procedure.

10. REPORT

Follow the same procedure as in Standard ASTM C 1260 Test Procedure.

11. PRECISION AND BIAS

Not established yet for the modified procedure as presented in the INTERIM TEST PROCEDURE

REFERENCES

1. ASTM C 1260-01 Test Procedure – *Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)*, Vol. C 4.02, ASTM International, 100 Barr Harbor Drive, Conshohocken PA 19428-2959, 2004.
2. Rangaraju, P.R. and Olek, J. "Potential for Acceleration of ASR In Presence of Airfield Deicing Chemicals" Final Report, *IPRF Project 01-G-002-03-9*, p. 287, March 2007.