Approaches to Mitigate Alkali Silica Reaction (ASR) Effects at Airports

ACRP Staff Comments

The proposed research bears some similarity to 17-08-04, where it entails coordinated efforts to collaborate to avoid issues during construction projects.

TRB Aviation Committee Comments

AIRCRAFT/AIRPORT COMPATIBILITY: ASR is a continuing concern that affects airports in cold climates. The proposed research would have a positive impact on design of airport pavements, but the FAA Tech Center might be funding the effort directly.

Review Panel Recommendation and Comments

Recommended as a synthesis. ASR can be a problem at some airports. This research has been done on the highway side--unclear as to what this is--testing for aggregates and additives. There is nothing out there right now. This is a chemical reaction; is there anything unique in the airport environment that would need to be addressed? Pavement testing is fundamental research not applied research. The FAA generally wants to do the pavement testing. Innovative Pavement Research Foundation and FAA did research on airfield pavement. The proposed research is far too broad for the time and budget proposed and would not likely produce meaningful results. But the topic would make a good synthesis of current practice by pulling all the information into one place.

AOC Disposition

This problem statement received an average rating of 2.6 points out of a possible 5 points among voting AOC members. There was no discussion. No funds were allocated.
AIRPORT COOPERATIVE RESEARCH PROGRAM PROBLEM STATEMENT

I. PROBLEM TITLE
Approaches to Mitigate Alkali Silica Reaction (ASR) Effects at Airports

II. BACKGROUND
Alkali silica reaction (ASR) is a pervasive problem in concrete structures in nearly all 50 states in the US. ASR occurs when siliceous aggregate reacts with cement alkali hydroxides within the concrete matrix pores. The reaction creates a gel substance, alkali silica gel, along the aggregate perimeter and within aggregate cracks. The gel absorbs water, expands, and creates tensile stresses within the concrete matrix. The tensile stresses initially are manifested as surface cracking, map cracking, however over time cause large pavement expansion.

As stated in the FHWA Facts Book, (Thomas et al March 2013) there are three requirements for the damaging ASR reaction to occur; these are:
1. A sufficient quantity of reactive silica (within aggregates)
2. A sufficient concentration of alkali (primarily from portland cement)
3. Sufficient moisture

Elimination of any one of these requirements will prevent the occurrence of damaging alkali-silica reaction. Prevention and mitigation of damaging ASR is based upon eliminating or reducing one or more of these three requirements.

Concrete mix requirements for new airfield construction are specified in Item P-501 of AC 150/5370-10F (FAA 2011). ASR is avoided through stringent aggregate testing (mortar bar method), limiting the alkalis in the cement, and using Class F fly ash additive. However, many older airfields constructed prior the AC 150/5370-10F requirements are experiencing large slab expansion resulting in cracking due to ASR. Methods to prevent ASR in new highway pavement construction are reviewed in Thomas et al (December 2013).

ASR expansion in concrete structures has now been identified in all 50 states in the US. ASR has been identified at many US commercial airports: Denver and Colorado Springs in Colorado; Hartsfield-Jackson Atlanta International Airport, Georgia; Memphis International, Tennessee; Greenville-Spartanburg Airport, South Carolina; Idaho Falls, Idaho; regional airports in Wyoming, Albuquerque, and Northwest Arkansas Regional Airport, Arkansas (Rangaraju et al 2006). More recently, ASR was identified at the Detroit Metropolitan Airport (Lawrence 2015). Because of the ASR severity, Runway 4L-22R will need to be replaced.
Northwest Arkansas Regional Airport (XNA) is in the process of replacing their current 16/34 runway due to ASR. It will cost approximately $75 million to construct a temporary runway and reconstruct the 16/34 runway. The runway was constructed in 1998, but has experienced significant distress due to ASR. Distress was manifested through significant slab panel expansion, joint misalignment, heaving, and joint closure.

ASR approaches to retard ASR progression after it has been identified are limited. Approaches typically use sealants to prevent water intrusion, however, pavement joints open and close and therefore allow a path for water intrusion into the pavement areas adjacent to the pavement joints. Identification of ASR in pavements has often been described as a death sentence for those pavements.

Airports are looking for measures to take that can reduce the likelihood of deleterious expansion in airport pavements from ASR. The use of lithium nitrate additive is an expensive option and we know of only one major airport that has used this method. At this time, there is not enough field research to justify this expense or its prove its effectiveness.

III. OBJECTIVE

Review current approaches used for mitigating ASR effects at airfield pavement sections. Propose new approaches for ASR mitigation for new pavement construction. Evaluate the new approaches through laboratory and petrographic testing. Construct new concrete panels at an airport with known ASR problems with the most promising mitigating measures and monitor the slabs for two years.

IV. PROPOSED TASKS

1. Review current ASR mitigation approaches.
   a. Use of fly ash class C and F
   b. Use of Slag
   c. Use of lithium nitrate
   d. Use of Silica fume

2. Propose new approaches for ASR mitigation for new construction.
   a. Use of a specialty cement such as calcium sulfoaluminate cement
   b. Using a new test for screening aggregates
   c. New or improved additives
   d. Use of fiber material in the mix
   e. Reducing the number of joints by having greater slab sizes
   f. Decreasing the porosity of the concrete mix to reduce water and deicer infiltration.
   g. Reducing the pH of the concrete mix

3. Experimental testing of the proposed new approaches
   a. Prepare laboratory concrete specimens
   b. Expose laboratory concrete specimens to various accelerated solutions
   c. Conduct petrographic analysis of test specimens

4. Identify a potential test airport experiencing ASR
5. Implement the ASR mitigation approach at the airport site.
   a. Construct new slabs at the test airport with the most promising new approaches
6. Monitor the slab condition over a two-year period through recording slab expansion behavior.

V. ESTIMATED FUNDING
Estimated problem funding: $400,000

VI. ESTIMATED RESEARCH DURATION
Research period: 36 months

VII. RELATED RESEARCH
Federal Highway Administration (FHWA) conducted a research project on Methods for Preventing ASR in New Construction: Results of Field Exposure Sites, which was published in 2013. This research included the used of lithium nitrate as an additive to the Portland cement concrete. However, additional research is needed to implement better ASR prevention measures for airports.

VIII. PROCESS USED TO DEVELOP THE PROBLEM STATEMENT
Collaborated effort between Michael McNerney (University of Texas at Arlington) and Ernie Heymsfield (University of Arkansas).

IX. PERSON DEVELOPING THE PROBLEM STATEMENT AND DATE
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References:
FAA (Federal Aviation Administration). (2011).“Standards for specifying construction of airports.” Advisory Circular 150/5370-10F, Washington, DC

