ACRP Problem Statement 17-08-03

Recommended Allocation: --

Increasing Joint Spacing for Lower Maintenance Concrete Pavements

ACRP Staff Comments

The proposed research could build on related National Cooperative Highway Research Program research.

TRB Aviation Committee Comments

AIRCRAFT/AIRPORT COMPATIBILITY: Research into appropriate joint spacing or even jointless PCC pavements can result in cost savings on pavement designs. But the durability of a larger than 25 x 25 panel needs to be proven.

Review Panel Recommendation and Comments

Not recommended. The FAA revised their guidance based on research they performed. Trying to incorporate way too many aspects in a short time. Is there now a problem with slab performance since the FAA revised the joint spacing guidance? A good starting point to determine whether the change has an impact. The FAA does allow the 25 ft. for certain conditions, which would eliminate the need for this research. Not sure this research is warranted. Research could only benefit those airports with that widebody aircraft. Basic research vs. applied research? FAA may want to handle this pavement research.

AOC Disposition

There was no discussion. No funds were allocated.
I. PROBLEM TITLE
Increasing Joint Spacing for Lower Maintenance Concrete Pavements

II. BACKGROUND

Portland cement concrete chemistry is unchanged in 200 years and characteristically portland cement concrete will have significant shrinkage. Because of portland cement shrinkage properties and a study of field performance of longevity versus joint spacing that was conducted several years ago, the FAA has established that 20 feet is the maximum recommended joint spacing for portland cement airfield pavements.

Previously, the standard was 25 feet maximum joint spacing and FAA will allow 25 feet joint spacing on airfields that have shown a history of good performance. Most of the 25 foot or longer joints spacing were constructed many years ago when portland cement was different.

Although portland cement chemistry has not changed, modern cement is generally ground finer to promote faster setting times and early strength. Unfortunately, this also promotes more shrinkage and is detrimental to longer joint spacing.

Joints are source of pavement deterioration. Joints are pathway for water to enter the pavement system. The edge load on a rigid pavement is significantly higher than the interior load. That is why pavements are often constructed with load transfer devices or a thickened edge to compensate for the increased stresses on the pavement at the edge or joint. Corner breaks, joint spalling, pumping and faulting are all-joint related rigid pavement distresses that lead to maintenance issues in the pavement. Also the replacement of joint sealant is another maintenance related joint distress.

At 20-foot joint spacing, widebodied aircraft are operating with their main gear on the joint located 20 feet from the centerline. The B747 and the B777 both have a 36-foot dimension from the center of the dual tire bogie to the other main gear bogie. Adding the tire width, the dimension is very close to 40 feet even without accounting for the wander of the aircraft on the taxiway and runway. To eliminate or reduce this edge stress it would be very advantageous to have a 37.5 or 40 foot joint spacing.

Another severe impact on pavement life is Alkali Silica Reaction or ASR. From field experience, we have noticed that water intrusion plays an essential role in ASR propagation. If you have seen a pavement that has ASR, you will notice the evidence of map cracking first on the surface and around the joints. From petrographic analysis, we have seen many slabs exhibiting no ASR in the center of the slab but moderate ASR near the edge of the slab.

Ideally, we would like to construct concrete pavements without joints. Continuously reinforced concrete pavements (CRCP) are constructed without transverse joints by using just the right amount of steel to allow the formation of very tight transverse cracks that does not allow water intrusion and at just the right spacing. CRCP is quite popular in several states for highway pavements. Although there have been several runways constructed with CRCP many years ago, there has not been a CRCP airfield pavement constructed since the problem during construction in Houston that resulted in honeycombing from a vibrator not working.

Prestressed concrete pavement has successfully been tested on Taxiway F in 1993 at Greater Rockford Airport in Rockford Illinois (Herrin). The prestressed pavement was constructed 1,200 long and 75 feet wide with no joints. The cement used was a special shrinkage compensating
cement (Type K cement) that is a blend of portland cement and calcium sulfoaluminate cement (CSA). Steel fibers were also use in the mix design. The pavement has performed very well. At the 10 years of service evaluation the prestressed pavement with no joints had a better pavement condition index (PCI) of 98 with only ten new longitudinal cracks observed between the 5 and 10 year marks. Conversely, the conventional jointed pavement with 18.75-foot longitudinal and 20-foot transverse joint spacing had deteriorated at the joints with almost all of the transverse joints containing joint spalling. The PCI at ten years was only 67, which would indicate little service life remaining.

Joint spacing can be increased to 37.5 or 40 feet in rigid pavement. However, the key is: can it be done such that it is practicable, affordable and produces long life with reduced maintenance. Using post tensioning will work but is it practicable and affordable? Using shrinkage-compensating Type K cement may work but may require reinforcement. Using belitic calcium sulfoaluminate cement that has been used on airfield pavements for over 20 years is more expensive, but is the life cycle cost beneficial? Fiber reinforcement may have some benefits but has not been shown to be effective as standalone approach.

III. OBJECTIVE
The objective of this research is to determine the best methods of increasing the longitudinal and transverse joint spacing of rigid concrete airfield pavement to 37.5 feet or more. After determining the best methods for practicality, affordability and pavement longevity, construct one or more test sections on a cooperating airport and report on the design and construction of the test section.

IV. PROPOSED TASKS
PHASE ONE
1. Conduct literature search
   a. Document airfield pavements constructed with joint spacing greater than 25 feet
   b. Document CRCP and prestressed concrete pavements constructed on airfields.
   c. Review shrinkage compensating (Type K) and calcium sulfoaluminate cement construction on airfields or large slab sizes.
   d. Search for new rigid pavement solutions for large pavement slabs in other industries.
2. Survey of large hub airports
   a. Survey the 30 large hub airports about their interest in increased joint spacing and history of joint related distress and maintenance.
3. Develop proposed solution
   a. Using the all alternatives approach brainstorm all potential solutions to increasing joint spacing to 37.5 or more.
4. Analyze proposed solutions
   a. Using a two-step approach to evaluate all proposed alternatives.
   b. Step one: eliminate the alternatives that are very unlikely to be acceptable for practicability or affordability.
   c. Step two: do an in depth cost comparison, constructability analysis, longevity analysis, and a life cycle analysis for the remaining alternatives.
   d. Based on the analyses, select the most promising alternatives worthy of constructing a full-scale test section.
5. Brief the technical committee on the results of the phase one research.

PHASE TWO
6. Select proposed solution(s) for field test
7. Select proposed airport for test site.
8. Construct full-scale field test on selected airport.
10. Prepare draft final report.

V. ESTIMATED FUNDING
Recommended Funding: $300,000.00

VI. ESTIMATED RESEARCH DURATION
Research Period: 18-24 Months

VII. RELATED RESEARCH
none

VIII. PROCESS USED TO DEVELOP PROBLEM STATEMENT
This problem statement was developed in a collaborative process between Dr. Michael T. McNerney (formerly FAA Airport Engineering Division) of The University of Texas at Arlington and Dr. Eric Bescher of the University of California at Los Angeles. Additional discussion was held with Mr. Scott Murrell, formerly of the Port Authority of New York and New Jersey, concerning PANYNJ desire for increased joint spacing to get widebodied aircraft outside of the longitudinal joint.

IX. PERSON(S) DEVELOPING THE PROBLEM

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X. REFERENCES

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