0-6617-P1

WORKSHOP SUMMARY

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Project 0-6617: Revamping Aggregate Property Requirements for Portland Cement Concrete

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Performing Organization:	**Sponsoring Organization:**
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Performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.	

This document contains a summary of discussion during the Workshop for Project 0-6617 held on June 22, 2011 at the Pickle Research Campus in Austin Texas. This workshop was conducted to fulfill the requirements of Task 4 of the project, and represents project deliverable P1 (Workshop, Handouts, and CD) to be provided under contractual agreement.

A list of persons present at the meeting is included in Appendix A. A list of the tests recommended at the workshop is included in Appendix B.

A CD containing this document, a copy of the presentation given at the Workshop, and an audio recording of the Workshop will be delivered to Michael Dawidczik.

This document will be incorporated into the final comprehensive report that will be delivered at the end of the project.

If you have any questions or comments concerning this document please contact the research team at your convenience.

TxDOT Project 0-6617 scheduled a workshop on June 22, 2011 at the Pickle Research Campus in Austin, Texas to provide the researchers the opportunity to gather from the experience of TxDOT personnel, a retired representative from the Ontario Ministry of Transportation and representatives from major aggregate producers from the state. This meeting provided for a free and open discussion of (1) current problems in portland cement concrete related to aggregates; (2) the most important aggregate properties and tests to measure those properties; (3) number and types of aggregates to be used in the study; (4) the appropriate methods for establishing performance test limits and criteria; and (5) determining the most appropriate test methods to establish the required performance of aggregates in concrete. The primary goal of the research will be to recommend aggregate tests and limits that will (1) ensure the desired concrete performance and (2) identify aggregates not currently allowed in the Aggregate Quality Monitoring Program (AQMP) that will provide good performance. During this meeting, attendees were able to discuss past failures observed in concrete pavements and structure as well as to discuss the properties and tests that would be most useful in screening for quality materials. The research team was present during the discussion, but did not make comments in order to provide an unbiased discussion between the producers and TxDOT.

The following distress mechanisms were discussed during the meeting and summarized below:

- Note: Alkali Silica Reaction (ASR) is being studied by other research projects and is not within the scope of this research project.
- From a TxDOT perspective, a failure should be defined as a distress that causes money to be spent on repair or replacement earlier in the concrete life than anticipated. For example, even though minor pop-outs may be only a cosmetic issue, they must eventually be dealt with and would therefore be considered a failure.
- There have not been very many concrete failures in TxDOT projects that can be directly attributed to aggregates. There are perhaps two main explanations for this. The first being that it is very difficult to pinpoint the cause of a concrete failure due to the composite nature of the material. The second explanation may be that the Aggregate Quality Monitoring Program (AQMP) has been successful in ensuring that good quality aggregates are used in TxDOT projects, and therefore failures are rare. Despite the general success of concrete aggregate

usage by TxDOT, it is possible that current specifications are too conservative and precludes the use of good aggregates around the state.

- The desire for differing specifications based on application was suggested. The main categories would be for structural needs and paving needs. Limits and testing would need to be established that would best predict and screen for materials to be used in these applications.
- One aggregate issue in Texas includes excessive cracking in continuously reinforced concrete pavements (CRCP) using siliceous river gravels, likely due to the high coefficient of thermal expansion (COTE) of this aggregate type. This issue has primarily occurred in the Houston District. Because of this problem, many districts have banned the use of river gravels in CRCP. However, the Fort Worth district has successfully used river gravels blended with 50% limestone in CRCP projects with no issues. Current research is investigating mitigation options for CRCP projects which use river gravels. TxDOT is currently in the process of introducing a statewide COTE requirement for CRCP projects.
- Other concrete issues around the state include freezing and thawing in the Panhandle and D-cracking which has been identified at the Abilene Airport. However, these aggregate sources were later abandoned because of these problems.
- There have also been isolated incidents of polishing when carbonate fine aggregate was used, e.g., on I-35 near San Antonio and in the Dallas and Fort Worth area, which was a 100% carbonate fine aggregate pavement.

- In areas where high volume paving was done and mass concrete was placed, issues with heat generation and management have been seen; this problem typically results in thermal cracking. Issues with aggregate thermal conductivity seem to have been a likely cause.
- The use of optimized gradation was highly supported by both producers and many of the TXDOT district personnel. It was commented that reductions of one sack of portland cement per cubic yard could be achieved by using optimized gradation. One comment made, however, suggested that the extra testing required for optimized gradations are often complicated and either not run or run incorrectly. One major problem concerning optimized gradation is the lack of storage bins at ready mix plants and hesitation of plants to have multiple aggregate piles.
- One specific example of a concrete failure due to an aggregate was in the Dallas District in Collin County where an aggregate from southern Oklahoma (Lattimore Stringtown) was used in a bridge deck. This aggregate had pyrite, shale, and asphaltic material which made it perform very poorly in service. Aggregates with high contents of pyrites and other sulfides should be avoided. Aggregates with high shale content should be avoided as well. Producers can usually deal with shale during processing but this process can sometimes be tricky. If the shale is not handled correctly an aggregate with a 0.4% decant at the quarry can result in a 1.0% or higher decant when the material reaches the ready mix plant.

Once the issues listed above had been discussed, a list of the material properties and corresponding test methods was developed to provide a basis for selecting tests to be performed to screen aggregates:

More Important Properties:

- Combined gradation (more important for producer than buyer)
- Resistance to degradation
    - Aggregate Impact Value
    - LA Abrasion
    - Micro-Deval
- Shape – flat, elongated, angularity, etc.
    - AIMS
- Texture
    - AIMS
- Strength (important for structures)
    - Compression point load index
    - Concrete cylinder compression (high-strength concrete)
- Modulus of Elasticity (of concrete)
- Coefficient of Thermal Expansion (COTE)
    - Is there a way to run on aggregate instead of concrete?
- Modulus of Elasticity (of aggregate)
    - Is there a test that can measure this on aggregates other than a core taken from the quarry? (River gravels prove to be difficult to measure directly).

- Freezing and thawing behavior
    - D cracking - ASTM 666 as modified by Dave Starks, run at 2 cycles/day
    - Pop-outs - Iowa Pore Index / Canadian Freeze Thaw
    - Sodium Sulfate or Magnesium Sulfate Soundness
- Resistance to dimensional change
    - Wetting/drying cycles
        - Canadian Freeze-thaw
    - Temperature
        - COTE
    - Sustained Loading (creep)
        - Is there a test that can measure creep of aggregates?
- Resistance to abrasion
    - Micro-Deval with AIMS
- Lack of objectionable substances
    - Chloride ions
    - Sulfides
    - Clays
- Skid Resistance
    - Acid Insoluble Test
- Thermal Conductivity
- Petrography

Less important properties:

- Discrete measurements of decantation

- Difference between TxDOT gradation and ASTM C33
- Strength (less important for pavements)
- Absorption
- Chemical Resistance

After the discussion of aggregate properties and tests were discussed, a discussion was held to determine the number and types of aggregates to collect for the study:

- Possible to get bad sources from other states
    - Example: D-cracking susceptible aggregates from Michigan/Kansas/etc.
- The aggregate list provided by TxDOT for the project was created to encompass a good representation of the Texas geology (Edwards' formation, etc.)
- It was also stated that more materials from Edwards formation may be required due to the complex geologic formations found within
- There should be special interest taken in materials that are relatively new to use in Texas, i.e., igneous, granite, dolomite, etc.
- The researchers were informed that this study would not be all inclusive; rather, it would be a starting point for TxDOT to continue the testing on the remaining materials before any changes are made to the specification.

After this, a discussion concerning the procedure for establishing the limits for use with the new tests was conducted:

- Do we need different limits for different classes of concrete?
    - Most likely
- How did Ontario establish limits?
    - Known performance of existing concrete

    - Field visits
    - If a source yields poor performing aggregates, it tends not to be reused
- Correlation of AIMS texture and shape to strength may be possible.
    - Must have volumetrically constant mix for strength testing
- Cubical aggregates are needed during testing – flaky aggregates can give erroneous results
- Petrographic examination is critical.

The primary discussion was ended at this point. Chris Rogers, formerly with the Ontario Ministry of Transportation, gave a presentation on "Thoughts Concerning New Aggregate Test Methods." A copy of this presentation will be included on the CD that will be submitted along with this document. This presentation focused on the newer test methods that have recently been adopted for use in many of the Canadian provinces. It focused on the similarities that existed between Texas and Canada to show the validity for the application for these tests.

At the end of the day, the workshop focused on selecting the best tests to be performed during this project. A complete list of the tests recommended by the attendees to be run during this project is presented in Appendix B. This discussion focused on identifying tests that would be valuable to run from an academic standpoint as well as tests that would be important to have for incorporating into a new test standard. During the discussion, an agreement was reached between the researchers and the PMC that Los Angeles abrasion testing, and magnesium sulfate soundness testing would be conducted by TxDOT, since these two tests are not very good predictors of performance and will likely be excluded from future specifications. Additional testing by the research team will be selected to offset the work that would no longer be required (L.A. Abrasion, MGSO4 Soundness, and Petrographic Examination).The information collected by the researchers at the workshop will be combined with data gathered during Task 1, Task 2, and Task 3 to compose Deliverable P2 (Test Plan) and Deliverable TM4 (Development of Testing Program).

Appendix A

6617 Workshop Attendees

UT/CTR

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Appendix B

0-6617 Recommended Tests

UT CMRG

Coarse Aggregate

Important Tests

1. Micro-Deval (TEX 461A)
2. AIMS (Shape, Texture)
3. Canadian Freeze Thaw (CSA A23.2-24A)
4. ASTM C666 (Stark Modification) or Iowa Pore Index

Less Important Tests

5. Decant (TEX 406A)
6. Specific Gravity (TEX 403A)
7. Absorption (TEX 403A)
8. Other Tests (Aggregate Crushing (BS 812.110) / Aggregate Impact (BS 812.112)

Fine Aggregate

Important Tests

1. Micro-Deval (ASTM D7428)
2. AIMS (Shape, Texture)
3. Acid Insoluble (TEX 612J)

Less Important Tests

4. Deleterious Substances
    a. Methylene Blue Test (Colorimetric) for Clays
    b. Organic Impurities (TEX 408A)
    c. Other Materials (TEX 413A)
5. Specific Gravity (TEX 403A)
6. Absorption (TEX 403A)

Concrete Testing

1. Strength (Compressive/Flexural) (TEX 418A/TEX 448A)
2. COTE (TEX 428A)
3. Modulus of Elasticity (ASTM C469)

TxDOT

1. Petrographic Examination
2. LA Abrasion
3. Magnesium Sulfate Soundness