Research Highlights

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RAP In Concrete Pavement

- The focus of this research;
  - evaluate the use of recycled asphalt pavement as coarse aggregate for use in concrete pavement.
  - a former research project determined that the MOE of the concrete could be reduced with the addition of recycled asphalt pavement (RAP)
  - by reducing the MOE we could build a more “flexible” concrete pavement

RAP

- more “flexible” concrete pavement;
  - should provide a longer service life
  - less brittle, able to “move”
  - higher MOE tends to restrict movements
    - Pavement has to move with thermal changes
    - Loading conditions

RAP- What we've found

- The mixes, designed as a Class I Pavement mix.
- They had varying amounts of RAP and w/c ratios (4 different RAP sources)
- RAP portions were 20%, 40%, 70% and 100% replacement of coarse and fine aggregate
    - Some mixes included only coarse aggregate substitution
    - Some had only fine aggregate substitutions
    - Some had both fine and coarse aggregate substitutions

RAP- What we've found

- W/C ratios were 0.45, 0.50 and 0.55
- No fly ash used in the mixes

– As the RAP content increased, compressive strength was reduced
– As the w/c ratio went up the compressive strength was reduced (as expected)

RAP- What we've found

- The control mix (normal Class I Pav't) was compared to the ideal RAP mix with a 20% replacement of coarse aggregate.
  - In general compressive strength was reduced from 5376 to 4250 psi at 28 days.
    - Less loss at early ages,
    - greater loss in the long term ages. (app. 18 to 24% reduction for all mixes with RAP)

RAP- What we've found

- MOE was reduced approximately 19% at 28 days. (from app. 3.93 – 3.33 x 10^6 psi)
- Flexural strength was reduced from 13 to 17% at 28 days (app. 577 – 530 psi)
- Splitting tensile strength was reduced approximately 17% at 28 days (app. 517 – 451 psi)
- CTE testing indicated a slight increase in thermal expansion from 4.40 to 4.60 (x10^-6/F)

In Conclusion

- it does appear that the RAP will provide a concrete with
  - Lower MOE
  - less cracking potential.
  - The project will be completed in August of 2012.
- The final report will indicate how the Department will proceed as far as implementing.
- We'll build a test section on the SR 301 test road.

Mass Concrete

- Use finite element modeling (FEM) to predict differential and maximum concrete temperatures in massive elements.
  - TNO Diana FEM program
- If we can predict the concrete temperatures based on the components in a mix design,
  - Then we limit the number of elements to be modeled by the contractor

We'll do this by;

- Assessing the dimensional size of the element and verifying the least dimension of the structure.
  - Heat escapes through the path of least resistance, or the least dimension of the element.
  - The least dimension is typically the thickness of the element

We'll do this by;

- Determine the heat of hydration of the cementitious materials
  - determined by isothermal calorimetry
    - gives us an indication of the potential heat development from the cemetitious materials.
- Determine the diffusivity of the aggregates proposed for the mix.

We'll do this by

- The model will indicate if the concrete temperature will approach the limits established in Section 346.
- If this happens,
  - insulation or other methods to help minimize heat loss will be required.
  - may include;
    - increasing the fly ash or
    - reducing the cement content of the mix.

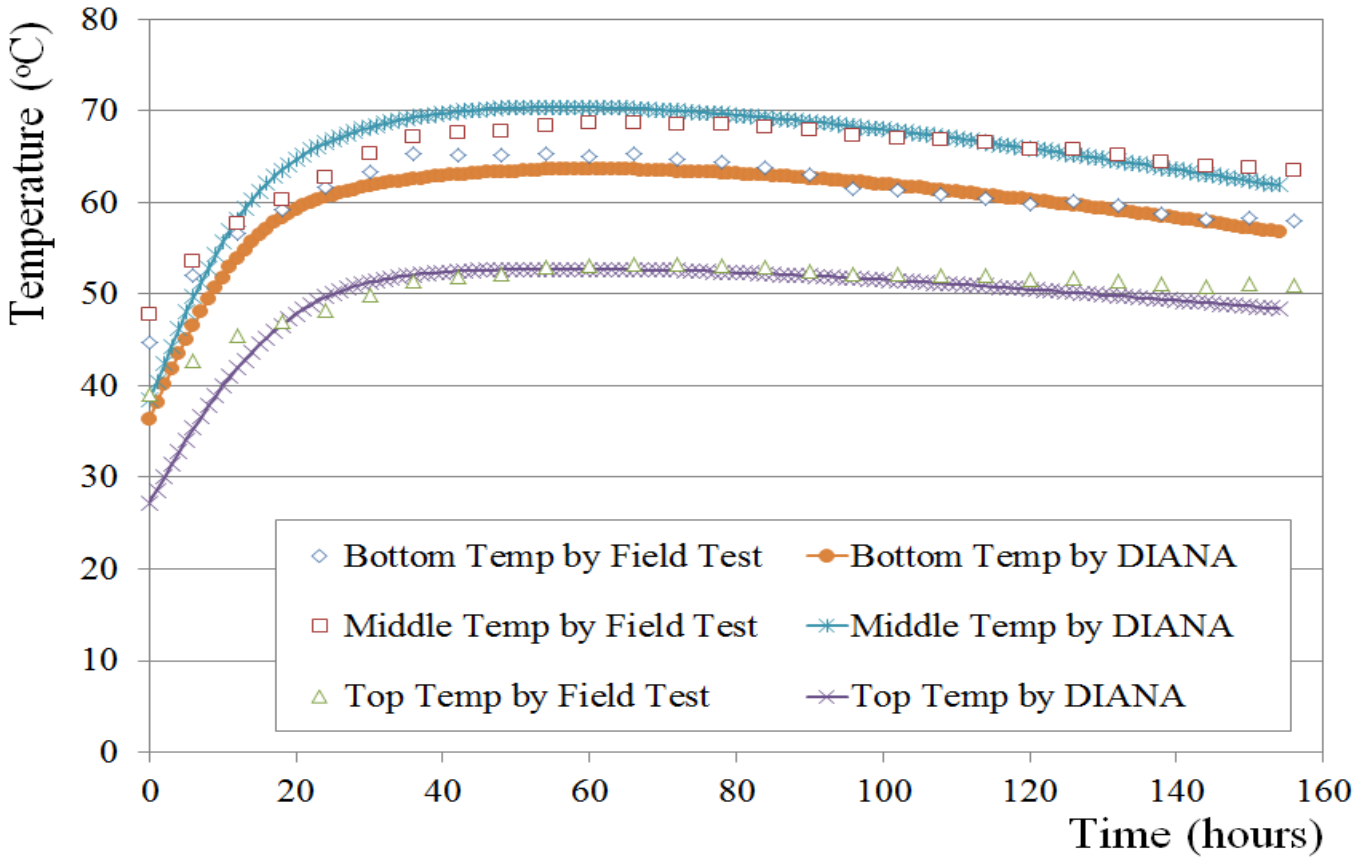
Mass- Field Work

- Adrian Lawrence, is about 6 months into a 2 year study and has already indicated some benchmarks.
  - good correlation between the prediction models and the actual temperatures of the in place mass structure.

Mass- Field Work

- Large footer on a project in South Florida
- Dimensions are, 46’x28’x7’
  - ¾” Insulation was added to the bottom, 1” plywood to the sides, the top has a 1” insulating blanket.
  - Instrumented through the central axis in the least dimension (7’)
- The following diagram indicates the correlation between temperature sensors placed in the element and the FEM prediction

Verification of FE Results with Field Data



In Conclusion

- Appears that the TNO Diana software will be very helpful in predicting concrete temperatures in massive elements.
- We'll continue to monitor additional mass elements to
  - refine the modeling process and
  - to identify any shortcomings of the program

Maturity Meter for Slab Replacement

- Develop the parameters needed to accurately predict the maturity of high early strength (HES) concrete.
- ASTM C1074 was developed for concrete elements where a normal curing time could occur.
- Was not developed for HES concrete

The Intent

- The intent is to develop the parameters that will allow the use of the maturity method to determine strength for opening to traffic.

The Research is to:

- Provide the contractor and the department with an accurate method of
  - determining strength
  - opening pavement to traffic.
  - Should also eliminate potential damage to cylinders when they are moved at early ages.
  - Compressive strength testing will still be required for acceptance.

Some Proposed Changes

- Currently acceptance is at 24 hours,
- the specification is being changed to accept concrete at 28 days

- Will eliminate the need for a laboratory to break the cylinders:
  - Prior to opening to traffic (usually very early in the morning)
  - At 24 hours (which may be a weekend or a holiday)

Some Proposed Changes

- Provide guidelines for the use of the Maturity Method for high early strength concrete.
  - Through a Florida Method
- The project has just started, and will have a contract time of 24 months.

NDT Testing for QC and QA:

- We've developed a piece of equipment that can be transported to the field and used to evaluate concrete using NDT methods.
  - The equipment is fully automated.
    - The operator will locate a starting point,
    - Identifies the dimensions of the grid, and set the increments.
    - The equipment scans the element with three different detectors.

NDT Testing

- It uses the following tests to verify the integrity of the concrete element.
  - ultrasonic array scanning,
  - impact echo
  - ground penetrating radar (GRP)

NDT Testing

- The new research will focus on making the equipment more robust to allow transporting the equipment,
  - to protect it against weather,
  - additional refinements to incorporate other NDT equipment.
- The project has just started, to be completed in 18 months.

Ammonia in Fly Ash:

- The work is being conducted by the Hinkley Center for Solid and Hazardous Waste Management with the Environmental Engineering College at the U of F.
  - was initiated in March, 2011
- the literature search has been completed
- initial work has indicated that the acceptable limits of ammonia in fly ash need to be identified.

- The Coal Fired power plants have to meet new Environmental Protection Agency (EPA) limits
  - one way for them to do that is to inject ammonia into the combustion exhaust gases
  - the ammonia reacts with the NOx to form a relatively harmless form of nitrogen gas.
- where the ammonia is injected into the exhaust determines how much ammonia attaches to the fly ash particles.

Conclusion

- The study is about 10 months into an 18 month study and the hope is that we will establish ammonia limits and safe guidelines for fly ash use.
- More to come.

Other Research

- Virtual Cement and Concrete Testing Lab (VCCTL)
- Fiber reinforced wraps for girder repairs
- Post Tensioning Grouts
  - A replacement test for the high temperature fluidity test
  - Evaluation of bleeding tendencies of grout.

Thanks - Any Questions?