Overview of Concrete Pavement Research at TFHRC

CP Road Map Executive Committee
Chicago, IL - January 11, 2011

Ahmad Ardani, P.E
Research Materials Engineer
FHWA-TFHRC
FHWA’s Pavement Program
Six Focus Areas

- Pavement Design and Analysis
- Materials and Construction Technology
- Pavement Management & Preservation
- Pavement Surface Characteristics
- Construction and Materials Quality Assurance
- Environmental Stewardship
TFHRC Pavement Research Teams

- Pavement Design & Construction
- LTPP
- Pavement Materials
- Exploratory Advance Research (EAR)
Pavement Design & Construction

- Pavement Design, Management
- Performance Modeling
- MEPDG Implementation
- QA/QC, PBS
- NDT, Wireless, Forensic

Program Manager: Katherine Petros
Pavement Design & Construction
PCCP Research Activities

- Remaining Service Life (Mactec- Nadarajah Siva)
  - Structural Condition, US, Safety
  - Project/Network

- Smart Sensors (MSU- Fred Faridazar)
  - Design/Develop wireless sensor to collect
    - Loading, Stress/Strain & Temp Data
    - Facilitate pavement repair/rehab & preservations
Pavement Design & Construction

PCCP Research Activities

- **Upgrade HIPERPAV III** (Transtec- Fred Faridazar)
  - To allow automatic download of National Weather Service data
  - Incorporate slag aggregate as an input

- **PaveSpec Enhancement** (ARA- Rick Bradbury)
  - Incorporate MEPDG’s PCC Models into PaveSpec
  - Work with DOTs to implement PRS statewide
Pavement Design & Construction

PCCP Research Activities

- Quantifying Sustainability *(Not Advertised- Nadarajah Siva)*
  - Select Pavement type incorporating Environmental Factors + LCCA

- Pavement Friction *(VTRC-Jim Sherwood)*
  - Friction Thresholds
    - Most suitable equipment
    - Work with States to collect data
    - Develop FMS – integrate to PMS

- FWDs In MEPDG *(ApTech- Nadarajah Siva)*
  - Developing guidelines
LTPP Program

- Since 1987
- 2500 Test Section Covers:
  - GPS, Monitors performance
    - In-service Pavements
  - SPS, Examines Effectiveness
    - Preventive Maintenance, Rehab, Construction Practices
- LTPP Database: MEPDG Cal/Valid

Program Manager: Aramis Lopez
**Exploratory Advance Research (EAR)**

- Advance High-Risk/Payoff Research
  - Nanoscale Research
  - Emerging Issues, Promotes Innovation

- Ultimate Goal:
  - Fill the Gap, Basic & Applied Research
  - Accelerate Adoption of Innovative Technologies, Methods & Materials

Program Manager: Dave Kuehn
EAR PCCP Research

- Exploring Cement Hydration Kinetics (J. Biernacki, TTU)
  - Roadmap, 10 Yr Effort
  - Contact: Rick Meininger

- Crack-Resistant Concrete (Z. Grasley, A&M U.)
  - SRCC: SF, MK, Carbon Nanotubes, Rice Husk Ash and Limestone Powder
  - Contact: Rick Meininger

- Benefits of High-Volume Flyash (J. Weiss, Purdue)
  - Incompatibilities: Prescreening, FA Treatment, Timing & Rate of Admixture addition
  - PBS, IC, Predicting Performance
  - Contact: Rick Meininger
Pavement Materials Research Team

- Innovative Solutions to Problems
  - In-house & Contract Research
  - State-of-the-art Equipment
  - Forensic Investigations

- Laboratories:
  - Concrete
  - Asphalt
  - Chemistry
  - Aggregate

Program Manager: Dr. Jack Youtcheff
Concrete Lab

Basic Equipments:
- Aggregate (AIMS II)
- Curing T./Walk-in Env. chambers
- Mechanical properties
- Setting time, Flow table, Air void
- Durability (MRD), RCP
- Petrography lab
Concrete Laboratories

- Advanced Equipment:
  - Isothermal Calorimetry
  - DSR
  - CTE
    - AASHTO TP 60
    - AASHTO T-336
    - Ruggedness
    - Key input in MEPDG for PCC
Concrete Pavement Materials
Research Strategic Plan

- Sustainable Concrete Pavement
  - Longer-Lasting
  - Achieving Balance
    - Economic
    - Environment – Reducing CO2 footprint
    - Social Impact
  - In-line with track 13 of CP-Road Map
Concrete Pavement Materials Research

- Fly Ash Workshop
- Fly Ash Characterization
- Coefficient of Thermal Expansion (CTE)
- Modification of ASTM C-78
- Impact of agg. size & quantity on CTE
- CP-Road Map
Steps Needed in the Research & Development of New Specifications for the Proper Inclusion of Fly Ash into Concrete Mixtures for Highway Pavements and Transportation Structures
Fly Ash Workshop objectives

- Forum: collaborate, exchange information
- Improve existing FA specification
- Dramatically increase FA
- Explore, Identify Research needs
Fly Ash Workshop Results

- Response to FA workshop: Enthusiastic
  - Attended by: Researchers, practitioners, DOTs, Power plant & FA suppliers
- Over 30 presentations presented, covering:
  - FA production, characterization, beneficiation
  - Proportioning, optimization, PBS
  - Pros & Cons (incompatibility)
  - HVFA, 100% based FA cementing materials

Summary Report: ftp://hrtsguest:hrtsguest@fhwaftp.fhwa.dot.gov/hrts/from
Development of a Framework for Proper proportioning & Characterization of FA/SCM in Concrete Mixes, Phase I
Flyash Use Dates Back to Early 1930s
- Highways, Airfields, Dams

Usage:
- Specifying 10 to 30 %
- Average Spec: 20% Substitution
Research Needs

- Protocol on the Use of Flyash
  - Where
  - When
  - Type
  - How Much (Optimum Dosage)

- Specification Exist (Percentages)
  - Empirical, Anecdotal
  - Arbitrary
Flyash Characterization

- **Question**: Adequacy of ASTM C 618 to:
  - Predict flyash behavior or performance?
  - Characterize flyash (F & C)?

- **Class F** (bituminous coal)
  - SiO2 + AL2O3 + Fe2O3 ≥ 70%

- **Class C** (sub-bituminous coal)
  - SiO2 + AL2O3 + Fe2O3 ≥ 50%
Objectives

- To use calorimeter DSR, XRF, SEM, XRD
  - Chemical, physical, Granulometric properties
  - Monitor hydration & strength gain
  - Characterize, identify incompatibilities
  - Increase dosage - pros & cons
  - Coordination with other researchers
  - Develop a framework for the use flyash
Progress to Date

- Developed experimental Design
- 18 different mixes
  - High & low alkali cement
  - F ash
  - High carbon/activated carbon FA
  - C ash
  - Dosages: 20%, 40% & 60
Proposed Quick in-house studies

- Miniaturization of Beams for Concrete Flexural Strength Testing
  - Modification of ASTM C78

- Examining the Impact of Aggregate size & quantity (FM) on CTE Measurements
End