

Design and Proportioning of Concrete Paving Mixtures: AN UPDATE



American Concrete
Pavement Association

Technology Transfer Concrete Consortium

April 8th, 2008

Baton Rouge, LA

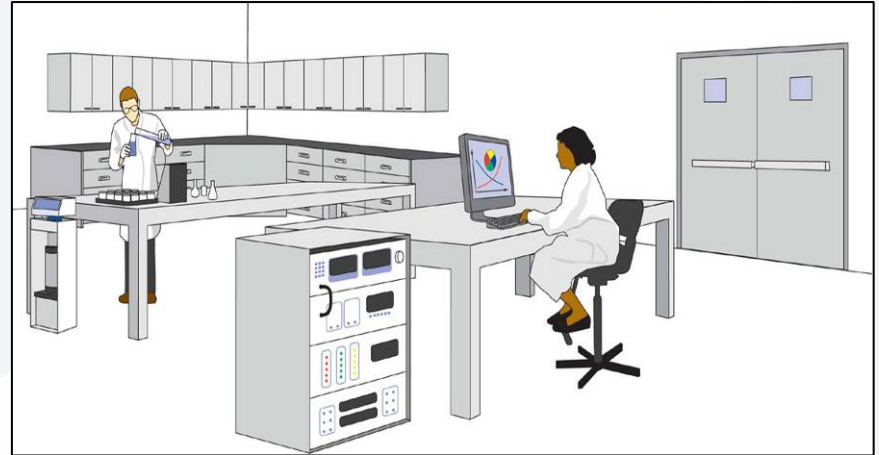
Part of the Mix Track...

- Track 1 – Performance Based Concrete Pavement Mix Design System
- Considered critical track...
- Industry “tapped” to develop GUIDE documents...
- Cooperative effort between PCA and ACPA



Why is this important to us?

- We have no choice!
 - Shift of responsibilities...
 - Loosing expertise...
 - Performance specs...
 - Current tools are not good enough...
- **An easy-to use and reliable method to design and proportion robust concrete paving mixtures is critically needed!**
- Paper at Atlanta Conference (07) discussing this...



(Graphic: CP Tech Center)

Activities so far..

- Mix Track Forum (Oct 06)
- Resolution BOD (Dec 06)
 - ...develop state of the art methodologies in design, proportioning & acceptance of concrete paving mixes...
- MCC Meeting (Feb 07)
 - Approach endorsed...
- Meeting w/ PCA (Sep 07)



RESOLUTION

BOARD OF DIRECTORS
AMERICAN CONCRETE PAVEMENT ASSOCIATION

TITLE: Resolution in support of The Concrete Pavement Roadmap research track on Performance-Based Concrete Pavement Mixture Design.

WHEREAS, The American Concrete Pavement Association (ACPA) is the technical, promotion, and legislative advocacy organization of the concrete pavement industry, and

WHEREAS, Concrete pavements have long been recognized as the long-life, durable pavement structure, and

WHEREAS, ACPA, since its founding in 1963, has fostered continual improvements in materials selection, concrete proportioning and construction methodologies for concrete pavements, and

WHEREAS, ACPA has pursued innovative ideas throughout its history, such as fast-track construction, ultra-thin overlays, and optimized surface characteristics, and


WHEREAS, ACPA continuously seeks to advance the concrete pavement industry with its agency partners through mutually-beneficial programs, and

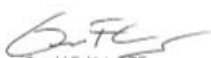
WHEREAS, The Performance-Based Concrete Pavement Mixture Design track of the Concrete Pavement Roadmap is a collaborative research and deployment effort between all stakeholders in the concrete pavement industry to develop state-of-the-art methodologies in design, proportioning and acceptance of concrete paving mixtures for the 21st century,

NOW THEREFORE, be it resolved this 30th day of November, 2006, that the American Concrete Pavement Association supports the Performance-Based Concrete Pavement Mixture Design track of the Concrete Pavement Roadmap, and will join FHWA, State Departments of Transportation and Academia in assertively bringing the goals of the program into practice in the highway community.






Peter Deem
2006 ACPA Chairman


Pat Nolan
2006 ACPA 1st Vice Chairman


Kari Saragusa
2006 ACPA 2nd Vice Chairman

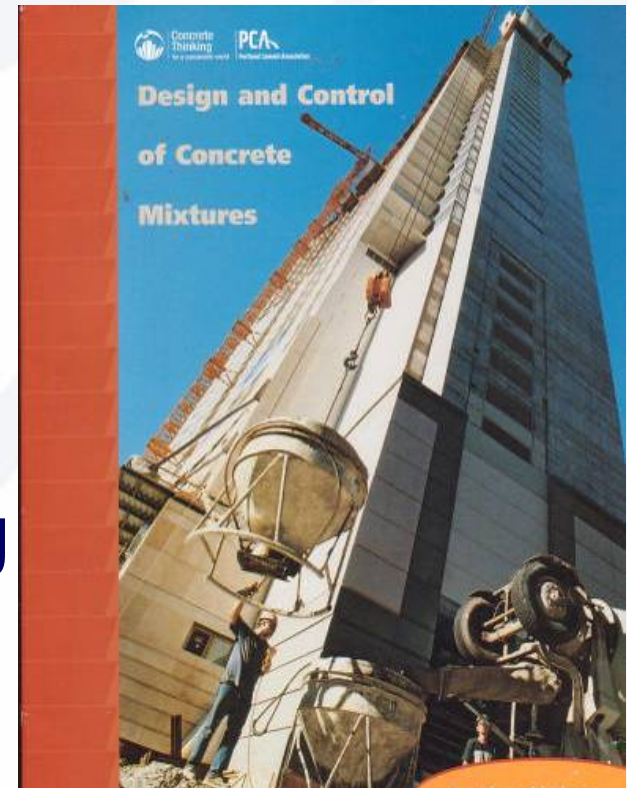

Gerald F. Voigt, PE
ACPA President & CEO

Activities so far..

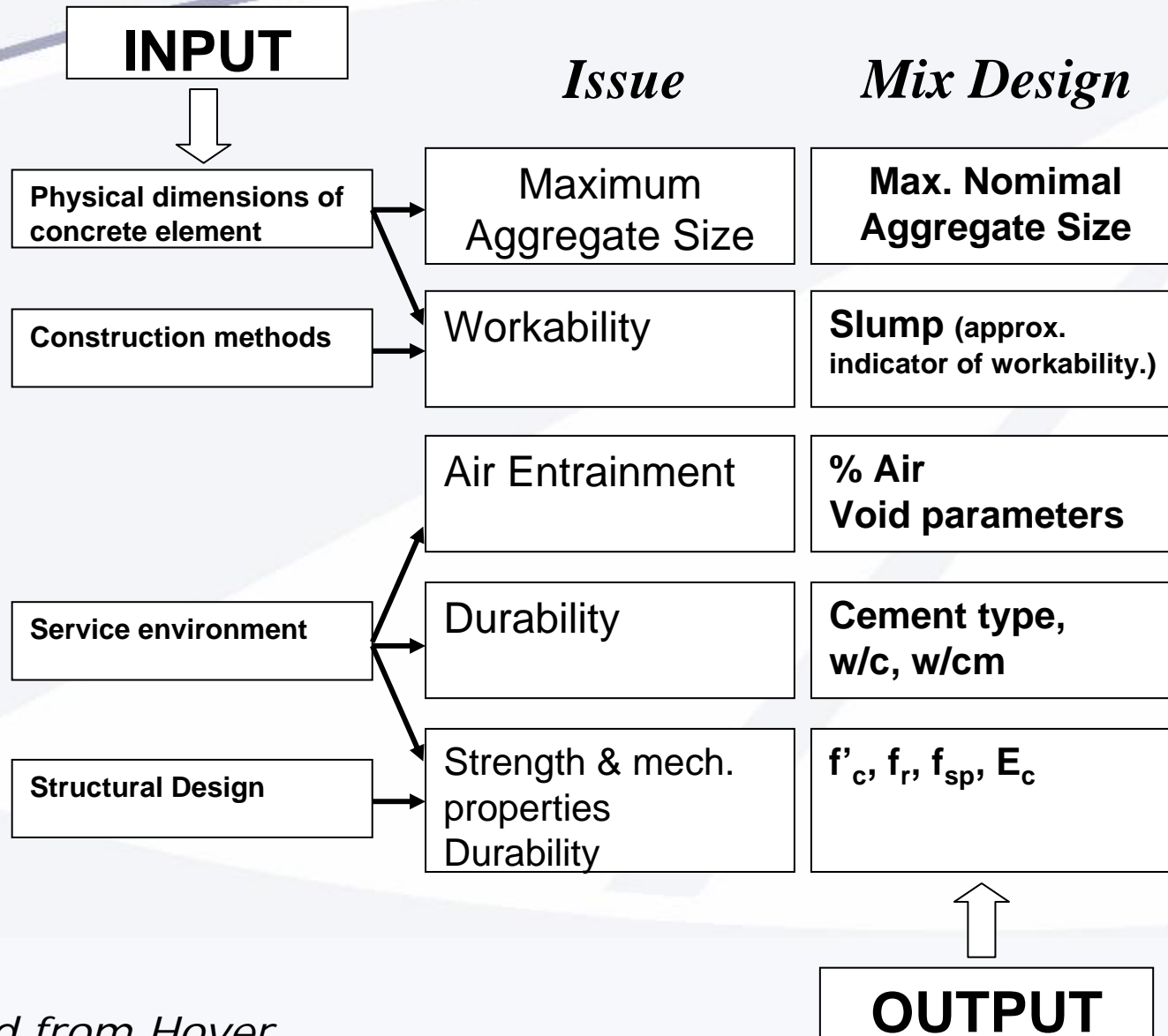
- Follow-up meeting w/ PCA (Jan 08)
- Weekly conference calls
 - ACPA/PCA/(CP Tech Center)...
 - Establish tentative timeline 
 - Further develop outline 
 - Identify authors 
 - Define review panel 

Guide Document: EB-401

- Title: **Design and Proportioning of Concrete Paving Mixtures**
- Modeled after PCA's EB-001
- Editors: Kosmatka/Wilson/Wathne
- Hire Consultants to assist w/
 - New design methods, proportioning strategies, specialty mixtures
- Print run 10,000 – Retail ~ \$50
- Sold on PCA & ACPA web sites



Guide - Mixture design...?



Guide - Mixture proportioning...?

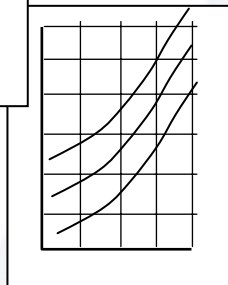
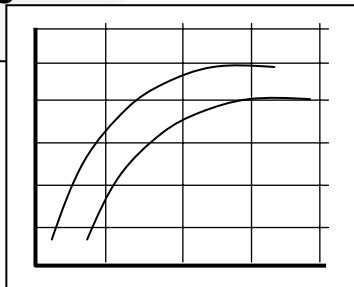
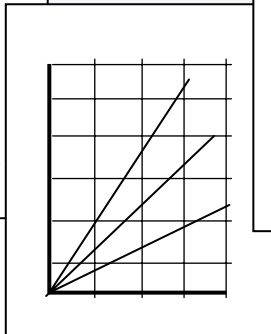
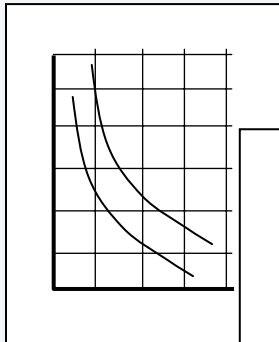
Mix Design Requirements

Materials Characteristics

Production Technology

Controlling Relationships

*General trends suggested by research/
models*



Specifics from user data & experience!



Mixture Proportions

Water	<i>lb/CY</i>
Cement	<i>lb/CY</i>
Fly ash	<i>lb/CY</i>
Coarse Agg.	<i>lb/CY</i>
Int. Agg.	<i>lb/CY</i>
Fine Agg.	<i>lb/CY</i>
Air content	<i>%</i>
AE admix	<i>fl oz.</i>
WR admix	<i>fl oz</i>

Tentative Timetable

- Tentative TIMETABLE...
 - March 08 – Develop framework from EB001, IMCP, etc
 - Spring 08 – Select authors, let contracts, delegate assignments and start writing.
 - Summer 08 – 20% review meeting with external interagency group, continue developing content, internal edits
 - Fall 08 – Assemble components into draft. Authors and editors review complete draft. Submit draft to review panel.
 - Winter 08-09 – 80% review meeting (San Antonio). Incorporate comments.
 - Spring/Summer 09 – Finalize, print and market

Outline

EB401 Outline

Design and Proportioning of Concrete Paving Mixtures

Chapter 1- Introduction to Concrete for Paving

Purpose of This Publication

Fundamentals of Concrete for Pavements

Fresh Concrete Properties

Hardened Concrete Properties

Durability

Chapter 2- Cementitious Materials

Portland, Blended, and Other Hydraulic Cements

Types of Portland Cement

Blended Hydraulic Cements

Hydraulic Cements

Special Cements

Selecting and Specifying Cements

Chemical Compounds and Hydration of Portland Cement

Physical Properties of Cement

Impact of Cement Characteristics on Properties of Concrete

Supplementary Cementitious Materials (SCMs)

Fly Ash

Slag

Silica Fume

Natural Pozzolans

Effects on Freshly Mixed Concrete

Effects on Hardened Concrete

Dosage (Typical)

Multi-Cementitious Systems

Handling and Storage

Availability

Chapter 3- Aggregates

Characteristics of Aggregates

Grading

Particle Shape and Surface Texture

Bulk Density (Unit Weight) and Voids

Relative Density (Specific Gravity)

Density

Absorption and Surface Moisture

Bulking

Resistance to Freezing and Thawing

Wetting and Drying Properties

Abrasion and Skid Resistance

Strength and Shrinkage

Resistance to Acid and Other Corrosive Substances

Thermal Properties

Potentially Deleterious Materials

Alkali-Aggregate Reactivity

Marine-Dredged Aggregate

Recycled Aggregates

Industrial Co-generated Products (Slag)

Recycled-Concrete Aggregate

Recycled-Asphalt Aggregates

Handling and Storing Aggregates

Availability

Use of Marginal Aggregates

Chapter 4- Mixing Water

Sources of Mixing Water

Municipal Water Supply

Site Source Water

Reclaimed Water

Industrial Wastewater

Water from Concrete Production (Wash Water)

Ice

Possible Impurities

Alkali Carbonate and Bicarbonate

Chloride

Sulfate

Other Common Salts

Seawater

Acid Waters

Alkaline Waters

Waters Carrying Sanitary Sewage

Organic Impurities

Interaction with Admixtures

Mix Water Specifications for Concrete (ASTM 1602)

Chapter 5- Chemical Admixtures

Air-Entraining Admixtures

Water-Reducing Admixtures

Mid-Range Water Reducing Admixtures

High-Range Water Reducing Admixtures

Plasticizers for Flowing Concrete

Retarding Admixtures

Accelerating Admixtures

Specialty Admixtures

Hydration-Control Admixtures

Corrosion Inhibitors

Shrinkage-Reducing Admixtures

Alkali-Aggregate Reactivity (ASR) Inhibitors

Coloring Admixtures (Pigments)

Bonding Admixtures and Bonding Agents

Effects on Freshly Mixed Concrete

Effects on Hardened Concrete

Compatibility of Admixtures and Cementitious Materials

Chapter 6- Designing Concrete Paving Mixtures

Factors to Be Considered

Workability

Service Environment

Temperature (Hot and Cold Weather Concreting)

Batching Method

Placement Method

Strength

Durability

Volume Stability

Smoothness

Appearance

Surface Characteristics

Safety

Accoustics

Economy

Sustainability

Selecting Mix Characteristics

Strength Requirements

Determining Water-to-Cementitious Materials Ratio (w/cm)

Outline

Coarse Aggregate Requirements.....	
Air Content.....	
Workability.....	
Water Content.....	
Cementitious Material Content.....	
Cementitious Material Type.....	
Multi-Cementitious Systems.....	
Admixture Effects.....	
Fine Aggregate Requirements.....	
Examples.....	
Chapter 7- Proportioning Concrete Paving Mixtures.....	
Proportioning.....	
Proportioning from Field Data.....	
Proportioning by Trial Mixtures.....	
Measurements and Calculations.....	
Density (Unit Weight) and Yield.....	
Absolute Volume.....	
Procedure.....	
Absolute Volume Method.....	
Using Multiple Cementing Materials and Admixtures.....	
Other Design Methods.....	
Examples (Continued from CH6).....	
Chapter 8- Evaluation of Concrete Paving Mixtures.....	
Design Review.....	
Testing Concrete.....	
Compatibility.....	
Case Studies.....	
Chapter 9- Special Types of Concrete Pavements.....	
Lean Concrete.....	
Soil Cement/Cement Treated Base.....	
Roller-Compacted Concrete.....	
Pervious Concrete.....	
White and Colored Concrete.....	
Rapid-Hardening Concrete.....	
Partial-Depth Repairs.....	

Review Panel

- Contractors:

Farid Hamad (Lane)

Pete Capon (Rieth Riley)

Mark Brown (Zachry)

- Suppliers:

Barry Descheneaux (Holcim)

Don Taubert (Capitol)

Colin Lobo (NRMCA)

- FHWA:

Sam Tyson

Rick Meininger

Angel Correa

- Academia/Consulting:

Tom Vandam

Ken Hover

Jay Shilstone

- DOT's

Lisa Lukefahr (TX)

John Staton (MI)

Todd Hanson (IA)

- CP Tech Center

Peter Taylor

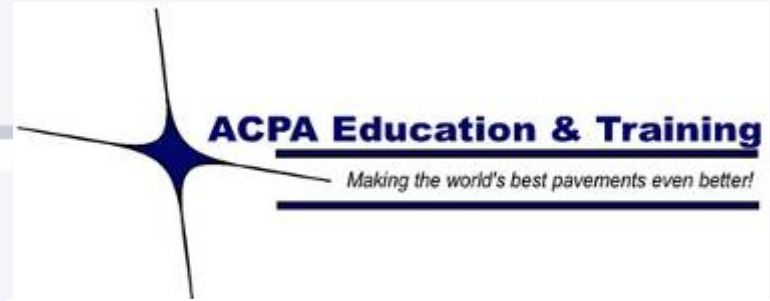
Consensus driven process!

- Industry is taking the lead, but with input and involvement from FHWA, DOTs, CP Tech Center, academia...
- A review panel with subject-matter experts has been assembled to review and comment on EB401
- Most of the pieces are already here... ACI 211.1 and PCA volumetric methods, IMCP guidance, MCO, Shilstone, COMPASS?
- Guidance ultimately incorporated in training efforts!

Don't forget...

- ACPA E&T Program...
- Full schedule available on our website at:

www.pavement.com



Topics for our 2008 program :

- Concrete Mix Design Basics
 - Concrete Pavement Materials
 - PCCP Sustainability
 - Curing
 - Hydration Processes
 - Introduction to the M-E PDG
 - Joint Layout and Design
 - Life Cycle Cost Basics
 - Materials Incompatibility
 - Maturity
 - Slipform Paving Operations
 - Soil Stabilization
 - Texturing Concrete Pavements
 - Thickness Design – Municipal
 - Troubleshooting Slabs on Grade
- PROFESSORS SEMINAR
CONCRETE PAVEMENT 101/201

Questions?

KICK the asphalt habit...

PAVEMENTS  .com