

**AGENDA**  
**ACI Committee 345**  
**Bridge Construction, Maintenance, and Repair**  
**Fall 2013 Convention**  
**Phoenix, AZ**  
**C-106 B**  
**Sunday, October 20, 2013, 1:30 pm to 3:30 pm**

1. Introduction
2. Approval of Spring 2013 (Minneapolis) minutes
3. Membership status  
The committee currently has 2 officers and 13 other voting members, 6 consulting members, and 25 associate members (a total of 46 members as shown in Appendix A)

Membership changes:

- a. New associate member: Yoon-si Lee
  - b. Termination of membership: Reza Akbari, Jeff Bazzo, Gerald Anderson, and Christopher Waldron
4. Technical Sessions/Special Publication:  
  
“Advanced Materials and Sensors towards Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair” edited by Jimmy Kim (15 papers)  
  
“Sustainable Performance of Concrete Bridges and Elements Subject to Aggressive Environments: Monitoring, Evaluation, and Rehabilitation” moderated by Jimmy Kim, Baolin Wan, and Isamu Yoshitake (3 sessions for F2014 in Washington, D.C.): sponsored by ACI-201 (durability), 343 (bridge design), and 345 (abstract due by Nov. 30)
  5. Liaison reports from other committees (TAC, 342, 343, others)
  6. Status of Documents
    - a. 345.2R-13 (Guide for Widening Highway Bridges) published in July 2013 (led by Williams and Kim)
    - b. 345.1R – Maintenance of Concrete Bridge Elements, published July 2006. Present Document Status – Due for revision/re-approval in 2014.
      - a) Ad-hoc committee (Kim, Silfwerbrand, Williams, and St John) reviewed the document and proposed revisions.
      - b) A ballot has been issued and details were discussed in Minneapolis
      - c) Another ballot has been done in June 2014 (details will be discussed to finalize this document)
    - c. 345.XR – Guide for Concrete Bridge Deck Repair and Rehabilitation

## **Chapter 1 – Introduction (Brown)**

### **1.1 Purpose and Scope**

Includes activities normally considered as requiring repair and rehabilitation. Excluded are maintenance activities such as deck cleaning and concrete sealer applications.

Includes:

- a) crack repair
- b) pothole repair
- c) restoration of skid resistance
- d) overlays
- e) demolition and deck removal are beyond scope of document

## **Chapter 2 – Notations and Definitions (Brown)**

## **Chapter 3 – Condition Evaluation (Paul St. John & Jeff Smith)**

### **3.1 Overview**

- 3.1.1 Deterioration Processes and Mechanisms
- 3.1.2 Repair vs Rehabilitation

### **3.2 Documentation Review**

### **3.3 Field Survey Techniques**

- 3.3.1 Visual Examination of Bridge Deck
- 3.3.2 Conventional Delamination Detection
  - 3.3.2.1 Chain Drag
  - 3.3.2.2 Hammer Sounding
- 3.3.3 Electrochemical Testing
  - 3.3.3.1 Electrical Half-Cell Potential Survey (ASTM C 876)
  - 3.3.3.2 Corrosion Rate Evaluation
    - 3.3.3.2.1 Linear Polarization
      - a) Unguarded electrode
      - b) Guarded electrode
    - 3.3.3.2.2 Potentiostatic Electrochemical Impedance Spectroscopy
- 3.3.4 Resistance and Resistivity
  - 3.3.4.1 2-point Direct-Path Resistance
  - 3.3.4.2 2-point Probe Resistivity
  - 3.3.4.3 4-point Wenner Array
- 3.3.5 Physical Sampling
  - 3.3.5.1 Coring
    - 3.3.5.1.1 Compressive and Tensile Strength & Modulus
    - 3.3.5.1.2 Petrographic Evaluation
      - a) Aggregate Type/Condition
      - b) Cement Paste Quality
      - c) Air Entrainment
      - d) Deleterious Reactions (ASR, Carbonation, DEF, Sulfate Attack)
      - e) Construction quality (freezing/thawing damage, over-finishing, honeycombing, cold joints)
      - f) Presence of pozzolans or mineral admixtures
      - g) Presence of surface treatments/penetrating sealers

- 3.3.5.2 Drilling/Concrete Powder Sampling
- 3.3.6 Chloride Concentration Testing
  - 3.3.6.1 Acid-soluble Chloride Titration
  - 3.3.6.2 Water-soluble Chloride Titration
  - 3.3.6.3 Rapid Chloride Test using Calibrated Ion-Selective Electrode
  - 3.3.6.4 X-ray Defraction technique
  - 3.3.6.5 Chloride Profiling and Diffusion Modeling
- 3.3.7 Non-Destructive Evaluation Methods
  - 3.3.7.1 Infrared Thermography
  - 3.3.7.2 Ground Penetrating Radar
  - 3.3.7.3 Sonic Methods - Impact Echo
  - 3.3.7.4 Ultrasonic Methods and Surface Wave Methods

**Chapter 4 – Material and Method Selection (Weyers & St. John) Brown to contact Weyers**

**4.1 Overview**

**4.2 Materials**

- 4.2.1 Crack repair
  - 4.2.1.1 Gravity systems – MMA
  - 4.2.1.2 Pressurized systems – epoxy
- 4.2.2 Pothole Repair
  - 4.2.2.1 Types of Rapid Systems
    - 4.2.2.1.1 Temporary
    - 4.2.2.1.2 Permanent
  - 4.2.2.2 Polymer Systems
    - 4.2.2.2.1 Pre-packaged systems
    - 4.2.2.2.2 Proportioned systems
  - 4.2.2.3 Asphalt Concrete
  - 4.2.2.4 Rapid Strength Gain Systems – concrete
- 4.2.3 Skid Resistance
  - 4.2.3.1 Polymer concrete overlays
  - 4.2.3.2 Grooving
- 4.2.4 Overlays
  - 4.2.4.1 Polymer Concrete Overlays
  - 4.2.4.2 Asphalt Overlays
    - 4.2.4.2.1 Without Membrane
    - 4.2.4.2.2 With Membrane
  - 4.2.4.3 Concrete Overlays
    - 4.2.4.3.1 Rapid Strength Gain Concrete
    - 4.2.4.3.2 Latex Modified Concrete
    - 4.2.4.3.3 Low-slump Dense Concrete
    - 4.2.4.3.4 Microsilica Concrete

**4.3 Methods**

- 4.3.1 Criteria
  - Remaining service life required:
    - a) Time of repair to rehabilitation
    - b) Rehabilitation to replacement
- 4.3.2 Performance Aspects
  - 4.3.2.1 Service Life

- 4.3.2.2 Costs
- 4.3.2.3 Traffic Conditions
- 4.3.2.4 Weather Conditions
- 4.3.3 Specifications and Testing of Systems

## Chapter 5 – Removal Methods and Surface Preparation **(Williams)**

### 5.1 Overview

In addition to project-specific requirements, method selection must also be guided by the following principles of sound practice:

- 1) The structure to be coated should not be damaged.
- 2) Reinforcing steel should not be damaged nor its bond with the concrete loosened.
- 3) Vibration, impact, or thermal loads applied should not weaken the concrete.

### 5.2 Method Overview (Present in order from least to most aggressive)

- 5.2.1 Low-Pressure Water Cleaning (Cleaning Method)
- 5.2.2 Grinding (Erosion Method)
- 5.2.3 Abrasive Blasting (Pulverizing Method)
- 5.2.4 Steel Shotblasting (Pulverizing Method)
- 5.2.5 Scarifying (Impact Method)
- 5.2.6 Needle Scaling (Impact Method)
- 5.2.7 High and Ultra High Pressure Water Jetting (Erosion Method)
- 5.2.8 Scabbling (Impact Method) – too much risk of micro-cracking?
- 5.2.9 Flame Blasting (Expansion Method)
- 5.2.10 Milling (Impact Method) – too much risk of micro-cracking?
- 5.2.11 Full Depth Removal – Saw cut, chipping hammers

### 5.3 Method Selection Process – Reduce risk of micro-cracking

### 5.4 Summary/Conclusions

## Chapter 6 – Repair Methods **(St. John/Kim/Williams)**

### 6.1 Overview **Complete (Williams)**

### 6.2 Standard Repairs

- 6.2.1 Patching
  - 6.2.2.1 Partial Depth
  - 6.2.2.2 Full-Depth
- 6.2.2 Crack Repair
  - 6.2.2.1 Gravity Fill Methods
    - a) Rout and Seal
    - b) Flood coat
  - 6.2.2.2 Pressure Methods
    - a) Epoxy Injection

### 6.3 Repairs with Advanced Composites **Complete (Kim)**

## Chapter 7 – Overlays **(Sprinkel & Silfwerbrand)**

### 7.1 Scope

### 7.2 Need for Overlays

- 7.2.1 Restored or Strengthened Load-Carrying Capacity **Complete (Silfwerbrand)**
- 7.2.2 Waterproof Barrier
- 7.2.3 Skid Resistance

- 7.2.4 Wearing Course
- 7.2.5 Reduction of Wheel Load Effect
- 7.3 Required Properties of Overlays**
  - 7.3.1 Properties required of all overlays
    - 7.3.1.1 Adhesion to concrete
    - 7.3.1.2 Cohesion
    - 7.3.1.3 Skid Resistance
    - 7.3.1.4 Durability
  - 7.3.2 Properties required of waterproof barriers
    - 7.3.2.1 Impermeability
    - 7.3.2.2 Crack Resistance
    - 7.3.2.3 Temperature Compatibility
- 7.4 Types of Overlays**
  - 7.4.1 Plain Concrete Overlays **Complete (Silfwerbrand)**
  - 7.4.2 Reinforced Concrete Overlays **Complete (Silfwerbrand)**
  - 7.4.3 Fiber Concrete Overlays **Complete (Silfwerbrand)**
  - 7.4.4 Latex Modified Concrete Overlays
  - 7.4.5 Hydraulic Cement Concrete Overlays
  - 7.4.6 Polymer Overlays
  - 7.4.7 Membrane and AC Overlays
- 7.5 Design Considerations**
- 7.6 Construction Considerations**
  - 7.6.1 Scarification and Removal of Unsound Concrete
  - 7.6.2 Cleaning
  - 7.6.3 Substrate Preparation
  - 7.6.4 Placement and Consolidation
  - 7.6.5 Curing
  - 7.6.6 Skid Resistance
  - 7.6.7 Traffic Vibrations **Complete (Silfwerbrand)**
- 7.7 Other Considerations**
  - 7.7.1 Material Performance Specifications
    - 7.7.1.1 Cement Type
    - 7.7.1.2 w/cm
    - 7.7.1.3 Aggregate Size
    - 7.7.1.4 Air Content
    - 7.7.1.5 Slump
    - 7.7.1.6 Compressive Strength
    - 7.7.1.7 Shrinkage
    - 7.7.1.8 Ductility **Complete (Silfwerbrand)**
  - 7.7.2 Environmental Considerations
    - 7.7.2.1 Climate **Complete (Silfwerbrand)**
    - 7.7.2.2 Traffic **Complete (Silfwerbrand)**

## **Chapter 8 – Electrochemical Methods (Brown)**

- 8.1 Overview of reinforcement corrosion causes and processes (ACI 222R?)**
  - 8.1.1 Influence of OH<sup>-</sup> and pH
  - 8.1.2 Influence of chloride
  - 8.1.3 Other factors

## **8.2 Electrochemical testing for corrosion**

- 8.2.1 Corrosion potential
  - 8.2.1.1 Methods
  - 8.2.1.2 Limitations and constraints
- 8.2.2 Corrosion rate
  - 8.2.2.1 Methods
    - a) Linear Polarization
    - b) Electrochemical Impedance Spectroscopy
  - 8.2.2.2 Limitations and constraints
- 8.2.3 Resistivity

## **8.3 Electrochemical Treatment Processes**

- 8.3.1 Impressed Current Applications
  - 8.3.1.1 Cathodic Protection and Prevention (NACE RP0290-2000)
    - 8.3.1.1.1 Methods
      - a) Overlays containing Strip or Mesh Anodes
      - b) Conductive Coatings
    - 8.3.1.1.2 Limitations and Constraints
  - 8.3.1.2 Electrochemical Chloride Extraction (NACE 01101)
  - 8.3.1.3 Re-alkalization
- 8.3.2 Galvanic Applications
  - 8.3.2.1 Cathodic Protection and Prevention
    - 8.3.2.1.1 Methods
      - a) Galvanic Coatings
      - b) Bulk Anodes and Distributed Anodes
    - 8.3.2.1.2 Limitations and Constraints

## **Chapter 9 – Appurtenances, Joints, Parapets and Approach Slabs**

### **9.1 Sidewalks (*Foden*)**

- 9.1.1 Introduction to Concrete Sidewalks
- 9.1.2 Types of Loads/Stresses Acting on Sidewalks
- 9.1.3 Possible Damages of Concrete Sidewalks
  - 9.1.3.1 Concrete Problems (Deterioration, Cracking, Abrasion, Corrosion, Water Leakage, Delamination, Surface Smoothing, Freeze-Thaw, Disintegration, etc.)
  - 9.1.3.2 Damage Due to Moving/Static Loads of Heavy Vehicles
  - 9.1.3.3 Fracture or Settlements in Sidewalks with Hollow Like Section
  - 9.1.3.4 Load Effects to Cantilevered Sidewalks
  - 9.1.3.5 Other Damages
- 9.1.4 Repair, Rehabilitation or Strengthening Techniques
- 9.1.5 Stress Reduction Techniques
- 9.1.6 Reinforcement Requirements
- 9.1.7 Surface Preparation
- 9.1.8 Overlays and Coatings
- 9.1.9 Placements Methods

### **9.2 Parapets (*Foden*)**

- 9.2.1 Introduction to Concrete/Steel Parapets
- 9.2.2 Types of Loads/Stresses Acting on Parapets
- 9.2.3 Possible Damages of Parapets

- 9.2.3.1 Concrete Problems (Deterioration, Cracking, Corrosion, Water Leakage, Delamination, Freeze-Thaw, Disintegration, etc.)
- 9.2.3.2 Damage Due to Impact Effects of Moving Vehicles
- 9.2.3.3 Steel-Concrete Connections
- 9.2.3.4 Other Damages
- 9.2.4 Reinforcement Requirements
- 9.2.5 Repair, Rehabilitation or Strengthening Techniques

### 9.3 Joints

- 9.3.1 Bridge Deck Joints Classification **Complete (Carroll)**
- 9.3.2 Expansion/Non-Expansion Joint Functions **Complete (Carroll)**
- 9.3.3 Traffic Bearing Expansion Joints **Complete (Carroll)**
  - 9.3.4 Other Types and Features (Carroll: may be deleted?)
- 9.3.5 Review of Current Practice **Complete (Carroll)**
  - 9.3.5.1 Design Procedures **Complete (Carroll)**
  - 9.3.5.2 Construction Practice **Complete (Carroll)**
  - 9.3.5.3 Selection Guidelines **Complete (Carroll)**
    - 9.3.6 Possible Problems with Bridge Deck Joints
    - 9.3.7 Deck Joints Maintenance, Repair and Rehabilitation Practice (address below)
      - 6.1.2.c
      - 6.2.3 Joint Repairs
        - 6.2.3.1 Joint Types
        - 6.2.3.2 Surface Preparation
        - 6.2.3.3 Joint anchorage repair or replacement
  - 9.3.8 Deck Joints Waterproofing and Sealing
  - 9.3.9 Lessons for Maximizing Joint Service Life

### 9.4 Approach Slabs **(Williams/Harris)**

- 9.4.1 Introduction to Approach Slabs
- 9.4.2 Types and Features
- 9.4.3 Reinforcement Requirements
- 9.4.4 Seismic Effects to Approach Slabs
- 9.4.5 Possible Damages for Approach Slabs
- 9.4.6 Settlement in Approach Slabs and Abutment Backfill
- 9.4.7 Repair and Rehabilitation of Approach Slabs

## 7. Other Business

## Appendix A

Membership as of Oct. 2013: **46 members**

**Officers: 2**

Kim, Yail Jimmy (Chair); Carroll, Chris (Secretary)

**TAC Contact**

Sprinkel, Michael M

**Voting members: 13**

Beaver, Jesse; Brown, Michael C; Foden, Andrew J; Gepraegs, Oliver K; Matejowsky, Alan B; Oglesby, Rita K; Sandberg, Harold R; Silfwerbrand, Johan L; Sprinkel, Michael M; St John, Paul J; Vaughn, Ronald E; Weyers, Richard E; Williams, Mark Erik

**Consulting members: 6**

Anderson, James C; Danley, Byron; Fouad, Fouad H; Harwood, Allan; Virmani, Yash; Wouters, Jeffrey

**Associate members: 25**

Al Wakeel Shahlaa A; Bartlett, F Michael; Branson, Tobias J W; Carrato, John L; Carter, Paul D; Castrodale, Reid W; Cumming, Neil A; Estenssoro, Luis F; Guth, Dena L; Haque, Mohammed E; Harris, Devin K; Hughees, Mark E; Huza, Richard; Klein, Gary J; Lee, Yoon-si; Morcous, George; Nash, William R; Pulido, Claudia P; Simpson, John M; Smith, Jeffrey L; Soubra, Khaled S; Suh, Kwangsuk; Takhtovich, Eugene; Watts, Ralph D; Zhu, Zhenyu