

AGENDA
ACI Committee 345
Bridge Construction, Maintenance, and Repair
Spring 2014 Convention
Reno, NV
N-6
Sunday, March 23, 2014, 1:30 pm to 3:30 pm

Chair: Jimmy Kim at University of Colorado Denver
Secretary: Chris Carroll at University of Louisiana at Lafayette

1. Introduction
2. Approval of Fall2013 (Phoenix) minutes
3. Membership status
The committee currently has 2 officers and 13 other voting members, 6 consulting members, and 26 associate members (47 members as shown in Appendix I)

Membership changes:
 - a. New associate member: Junwon Seo at South Dakota State University
4. Technical Sessions/Special Publication:
 - a. “Advanced Materials and Sensors towards Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair” edited by Jimmy Kim (14 papers: submitted for TAC’s approval)
 - b. “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 (Final request submitted with 15 presenters)
 - c. “Structural Health Monitoring of Concrete Structures” with ACI-444 in Washington, D.C
 - d. “Design and Performance of Concrete Bridges and Buildings When Interacted with Soils and Foundations” in Denver, CO (F2015) moderated by Jimmy Kim and N.Y. Chang (to be requested), co-sponsored by ACI-343
5. Liaison reports from other committees (TAC, 342, 343, others)
6. Status of Documents
 - a. 345.1R-XX – Maintenance of Concrete Bridge Elements, Present Document Status – Staff edit done (Feb. 7, 2014), TAC review in progress (Jimmy Kim to present in TAC meeting in Reno)
 - b. 345.XR – Guide for Concrete Bridge Deck Repair and Rehabilitation (Appendix II)
7. Technical Presentation
 - a. Ron Vaughn (bridge decks with NYSDOT)

- b. Andy Foden (structural response monitoring for Pulaski Skyway Bridge rehabilitation)
- c. George Morcous (TBA)

8. New business

9. Adjournment

Appendix I

Membership as of Feb. 2014: **47 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; Gepreags, 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: 26

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; Seo, Junwon; Simpson, John M; Smith, Jeffrey L; Soubra, Khaled S; Suh, Kwangsuk; Takhtovich, Eugene; Watts, Ralph D; Zhu, Zhenyu

Appendix II

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⁻ 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