

Technology Transfer, Delivery, and Implementation of Best Practices for Jointed Concrete Pavements

**Summary Report
October 2017**



U.S. Department
of Transportation

**Federal Highway
Administration**

Sponsored by
Federal Highway Administration
Office of Pavement Technology
FHWA-HIF-17-045

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document. This report does not constitute a standard, specification, or regulation.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA-HIF-17-045	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Technology Transfer, Delivery, and Implementation of Best Practices for Jointed Concrete Pavements		5. Report Date October 2017	
		6. Performing Organization Code:	
7. Author(s) Peter Taylor		8. Performing Organization Report No.	
9. Performing Organization Name and Address National Concrete Pavement Technology Center Iowa State University 2711 South Loop Drive, Suite 4700 Ames, IA 50010-8664		10. Work Unit No.	
		11. Contract or Grant No. DTFH61-14-D-00005	
12. Sponsoring Agency Name and Address Office of Pavement Technology Federal Highway Administration 1200 New Jersey Avenue, S.E. Washington, DC 20590		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes The FHWA Contracting Officer's Task Manager was Sam Tyson.			
16. Abstract Implementation of current understanding, analytical tools, and new test methods must be accelerated if the construction industry is to continue to meet the infrastructure needs of the community at large in an environment of shrinking budgets. A continuing challenge to the concrete paving industry is the ever present need to implement new technologies as they are proven, coupled with the need to educate new employees throughout the industry about best practices. The object of this task order was to help meet this need by conducting technology transfer, delivery, and implementation of best practices for jointed concrete pavements. This report summarizes the activities, products developed, and accomplishments. Activities such as those conducted under this task order are invaluable in ensuring that long lasting and sustainable pavement systems can be reliably specified, constructed, and maintained.			
17. Key Words blended aggregates, concrete mixture gradation, concrete mixture optimization, dowel basket anchoring, jointed concrete pavements, material-related distress, pavement construction, pavement quality assurance, supplementary cementitious materials, ternary mixtures		18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service, 5301 Shawnee Road, Alexandria, VA 22312 http://www.ntis.gov	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 16	22. Price N/A

TABLE OF CONTENTS

INTRODUCTION	1
OVERVIEW	1
TASKS, PRODUCTS, AND ACCOMPLISHMENTS	1
Task 1: Bibliographies	1
Task 2: Technical Briefs	1
Task 3: Webinars	2
Task 4: Workshops.....	2
Task 5: Summary Report.....	3
CONCLUSIONS	3
APPENDIX A: SAMPLE WORKSHOP AGENDA AND PRESENTATION SLIDES	5
APPENDIX B: BEST PRACTICES WORKSHOP RATINGS AND EVALUATIONS	7
Workshop Evaluations: Kansas City, Missouri - April 20, 2017 - 30 Participants.....	7
Workshop Evaluations: Gainesville, Florida - May 9, 2017 - 38 Participants.....	8
Workshop Evaluations: Salt Lake City, Utah - May 18, 2017 - 21 Participants.....	10
Workshop Evaluations: Vicksburg, Mississippi - July 12, 2017 - 24 Participants.....	11

INTRODUCTION

The National Concrete Pavement Technology (CP Tech) Center at Iowa State University is submitting this report as part of a task order for technology transfer, delivery, and implementation of best practices for jointed concrete pavements.

OVERVIEW

A continuing challenge to the concrete paving industry is the ever present need to implement new technologies as they are proven, coupled with the need to educate new employees throughout the industry about best practices.

The object of this task order was to help meet this need by conducting technology transfer, delivery, and implementation of best practices for jointed concrete pavements. Activities were focused on four specific topics:

- Material-Related Distress
- Blended Aggregates for Concrete Mixture Optimization
- Concrete Paving Mixtures with One or More Supplementary Cementitious Materials
- Innovative Materials and Methods for Accelerated Construction and Maintenance of Concrete Pavements

The tasks conducted included developing six technical briefs, developing and presenting ninety-minute webinar presentations for each topic, and developing and presenting workshops that addressed each topic.

TASKS, PRODUCTS, AND ACCOMPLISHMENTS

Task 1: Bibliographies

Deliverable: Four bibliographies – one covering each of the Topics

This topic was cancelled at the request of the FHWA.

Task 2: Technical Briefs

Deliverable: Six Technical Briefs (tech-briefs)

Six Best Practices tech-briefs were developed and published. They are available on the FHWA website and as linked documents (pdfs) from the CP Tech Center websites.

- [Materials-Related Distress: Aggregates](#), FHWA-HIF-15-013, May 2015, 6 pages
- [Materials-Related Distress: Hardened Cement Paste](#), FHWA-HIF-15-018, June 2015, 6 pages

- [Blended Aggregates for Concrete Mixture Optimization](#), FHWA-HIF-15-019, July 2015, 4 pages
- [Supplementary Cementitious Materials](#), FHWA-HIF-16-001, February 2016, 7 Pages
- [Effective Quality Assurance for Concrete Paving Operations](#), FHWA-HIF-16-002, April 2016, 6 pages
- [Dowel Basket Anchoring Methods](#), FHWA-HIF-16-021, May 2016, 6 pages

All of the tech briefs were distributed to participants of the relevant webinars and at the workshops discussed below.

Task 3: Webinars

Deliverable: Four Webinars each presented at least twice

Nine webinars were presented as summarized in the following table.

Topic	Date	Presenter	Participants
Materials-Related Distress of PCC	3/9/2016	Peter Taylor	70
Materials-Related Distress of PCC	3/23/2016	Peter Taylor	154
Materials-Related Distress of PCC	5/11/2016	Peter Taylor	96
Optimized Gradation for Concrete Paving Mixtures	5/19/2016	Matt Sheehan	70
Optimized Gradation for Concrete Paving Mixtures	5/31/2016	Matt Sheehan	33
Supplementary Cementitious Materials	11/1/2016	Larry Sutter	69
Supplementary Cementitious Materials	11/8/2016	Larry Sutter	32
Dowel Basket Anchoring Methods	3/16/2017	Jerry Voigt	73
Dowel Basket Anchoring Methods	3/30/2017	Jerry Voigt	70

Links to recorded webinars (mp4 files) and to pdfs of the webinar presentation slides are accessible on the National CP Tech Center website at www.cptechcenter.org/webinars/.

Task 4: Workshops

Deliverable: One full day workshop, presented four times

Four workshops were held around the country as listed in the following table.

Location	Date	Presenters	Participants
Kansas City, KS	4/20/2017	Steve Tritsch, Eric Ferrebee	30
Gainesville, FL	5/9/2017	Steve Tritsch, Eric Ferrebee	38
Salt Lake City, UT	5/18/2017	Matt Sheehan, Larry Sutter	21
Vicksburg, MS	7/12/2017	Steve Tritsch, Larry Sutter	24

A typical workshop agenda and links to pdfs of the Powerpoint slides that were used for the presentations are included as Appendix A.

Rating summaries and feedback from workshop participants are included in Appendix B.

Task 5: Summary Report

Deliverable: A report summarizing the activities and deliverables under the Task Order

All of the documents have also been provided to the FHWA in electronic format, along with one recording of each webinar.

CONCLUSIONS

This document serves as a summary report that discusses and includes the following:

- The tasks undertaken (above)
- Electronic and printed copies of the products developed and presented (Appendix A)
- Agendas, slideshows, participant lists, and feedback and ratings from the webinars and workshops (Appendices)
- Review of the benefits of the tasks
 - Education continues to be a significant need in the concrete pavement community. This is due to rapidly changing technologies available and the turnover in the workforce with experienced people retiring or being transferred to new responsibilities. Activities such as those conducted under this task order are invaluable in ensuring that long lasting and sustainable pavement systems can be reliably specified, constructed, and maintained.
 - Implementation of current understanding, analytical tools, and new test methods must be accelerated if the construction industry is to continue to meet the infrastructure needs of the community at large in an environment of shrinking budgets.
 - One means of delivering the understanding and education is in the form of short, readily accessible tech briefs that users can access on small electronic devices. Further in depth training can then be gained by accessing recorded webinars. Products such as those developed in the task order help to meet these needs.
- Recommendations for future activities
 - It is recommended that similar task orders continue to be issued. Suggested topics include the following:
 - Mixture proportioning
 - Testing practices for quality assurance
 - Understanding of the effects of the foundation system on pavement performance

APPENDIX A: SAMPLE WORKHOP AGENDA AND PRESENTATION SLIDES

This appendix shows a sample agenda for the one-day workshops that included the five presentations:

- Optimized Gradation for Concrete Paving Mixtures
- Supplementary Cementitious Materials
- Materials-Related Distress of PCC
- Dowel Basket Anchoring Methods
- Quality Assurance

Click on the links on the agenda to view pdfs of the Powerpoint slides that were used for the presentations.



U.S. Department of Transportation
Federal Highway Administration

National Concrete Pavement
Technology Center



Concrete Pavement Best Practices

April 20, 2017

Presented by the National CP Tech Center & FHWA

Location: Cabela's - 10300 Cabela Drive, Kansas City, KS 66111

Speakers:

Steve Tritsch, PE, Associate Director, National CP Tech Center, Iowa State University
Eric Ferrebee, PE, Technical Services Engineer, American Concrete Pavement Association

Agenda:

- 9:00 Introductions
- 9:15 [Gradations](#)
- 10:30 [Supplementary Cementitious Materials](#)
- 11:45 Lunch (on your own)**
- 12:45 [Materials Related Distress](#)
- 2:00 [Dowel Anchoring](#)
- 3:15 Break**
- 3:30 [Quality Assurance](#)
- 4:10 Review & wrap up
- 4:30 Adjourn



APPENDIX B: BEST PRACTICES WORKSHOP RATINGS AND EVALUATIONS

This appendix shows the participant ratings and evaluations from the four Best Practices workshops that were held, as summarized in the following table.

Location	Date	Presenters	Participants
Kansas City, KS	4/20/2017	Steve Tritsch, Eric Ferrebee	30
Gainesville, FL	5/9/2017	Steve Tritsch, Eric Ferrebee	38
Salt Lake City, UT	5/18/2017	Matt Sheehan, Larry Sutter	21
Vicksburg, MS	7/12/2017	Steve Tritsch, Larry Sutter	24

Workshop Evaluations: Kansas City, Kansas - April 20, 2017 - 30 Participants

Rating Category	Rating Average
1. Organization of the program	1.47
2. Speakers knowledgeable	1.42
3. Speakers effective communicators	1.58
4. Usefulness of material presented	1.53
5. Program met expectations	1.74

Ratings were on a scale of 1–5
1=Very Good and 5=Needs Improvement

6. What were the most worthwhile parts of this program?

Well-presented information - knowledgeable presenters. Presented in easy to understand terms. Presentations were very good and well-supported by the tech briefs. (4)

Thank you for lunch.

Open Q&A discussion. (2)

SCM/material distress. (3)

The dowel and quality presentations were very informative for someone who is typically out in the field witnessing things going on. Most of the information coincides with that. Has already been seen and with past experience.

Optimized gradations. (3)

Dowel baskets.

The sections on MRD and dowel anchoring. This info more directly related to our work.

Great topics. Thought depth of materials was good.

Operations topics such as dowel baskets and QC/QA were particularly relevant for me.

7. What were the least worthwhile parts of this program?

Chemistry. Some of the chemistry in the MRD session could have been explained a little better instead of just showing the reaction and moving on. A brief description would have been nice. Chemistry topics not relevant to what I do. (3)

Dowels.

Parts on gradation and SCMs.

Don't hurry through the first two presentations. We ended up having plenty of time to cover everything.

8. Do you have any suggestions for future workshop topics?

Good location and speakers. Thank you for providing this training.

Accelerated concrete pavement situations.

Aggregates.

Recommend possibly splitting into 2 separate presentations or dates. Had a lot of info suited for lab, design, and construction portions. Could go into a little further detail or examples without the single day multiple fields time restrictions.

Loved lunch provided. Overall, enjoyed conference very much!

Workshop Evaluations: Gainesville, Florida - May 9, 2017 - 38 Participants

Rating Category	Rating Average
1. Organization of the program	1.33
2. Speakers knowledgeable	1.33
3. Speakers effective communicators	1.40
4. Usefulness of material presented	1.67
5. Program met expectations	1.63

Ratings were on a scale of 1–5

1=Very Good and 5=Needs Improvement

6. What were the most worthwhile parts of this program?

All good/beneficial! Great job! Learned something in each presentation. Great course. (5)

Information from slides.

Explanation of cementitious components and their reactivity. Excellent!!!

Info concerning grease on dowel bars needs to be eliminated and use the other product.

Very informative PowerPoints. Appreciated the handouts of the slides and reference material. Very organized and informative. (2)

SCMs info was most worthwhile. (2)

Dowel basket anchoring methods and QA program. (2)

Good basic overview.

Info on new testing procedures for concrete properties. (2)

Dowel placements. Was not familiar with at all.

Quality assurance.

Question/answer session.

New ideas, new processes in use; not too much detail but enough to give overview of concrete pavement.

Aggregate optimization.

Very interesting to see the whole picture of my job (testing cement).

Other states' practices w/regard to PCCP.

Learning about concrete durability/pavement.

Optimizing mixes.

Very good, practical, useable info with real world examples.

New technologies and how they apply. Especially liked section on gradations and material related distress.

New test equipment for evaluation of concrete.

Construction elements.

7. What were the least worthwhile parts of this program?

Testing.

Don't just read each slide.

The chemical reaction discussions of supplemental cementitious materials. The discussion moved too quickly to be appreciated. At the speed it was presented it was more confusing than useful.

Freeze thaw.

SCMs.

Dowel anchoring.

Quality assurance section - content was excellent but Florida is very familiar with concepts so nothing new here. (2)

Some of the gradation information.

8. Do you have any suggestions for future workshop topics?

More new technology discussion. More in-depth review of the testing procedures.

More durability aspect of concrete.

Can any hands-on demonstrations be added? SAM, box, etc.?

Videos are always useful - show field demos.

Would like to see info on how the defects of the constructed pavement affect the pavement durability in addition to chemically or environmentally induced distresses.

Handouts of slides are too small. Some text is not readable.

Contractor related distresses - what did contractor do and how did it show up in the pavement?

Workshop Evaluations: Salt Lake City, Utah - May 18, 2017 - 21 Participants

Rating Category	Rating Average
1. Organization of the program	2.00
2. Speakers knowledgeable	2.00
3. Speakers effective communicators	2.00
4. Usefulness of material presented	3.00
5. Program met expectations	2.33

Ratings were on a scale of 1–5

1=Very Good and 5=Needs Improvement

6. What were the most worthwhile parts of this program?

Details on what has been learned recently. Info related to making better performance of durability.

Who is pushing optimized gradations? Recovered ash concerns. What is the relationship between paste content and MRD? Why?

I found the first half of the day to be very informative and the level of expertise to be very advanced.

Gradations and discussion of optimized mixes.

7. What were the least worthwhile parts of this program?

Too much rehashing of basics that have been around awhile (class F fixes, ASR, sulfate is bad, etc.).

It felt as though the dowel placement and quality sections could have used a little more advanced concepts.

Concrete and Materials basic 101 discussions. For the most part the group was advanced and looking for discussions of innovative processes.

8. Do you have any suggestions for future workshop topics?

More focus on recent learning, cutting-edge efforts to improve. If it makes the workshop shorter, that's OK. Maybe consider the morning for basics and the afternoon for more advanced topics.

Although the chemistry was very involved and I could barely follow the concepts, that was the advanced level for which I was looking.

Focus more on the cutting edge technologies. Steps and progress toward PEM goals. How do we get there from here?

Workshop Evaluations: Vicksburg, Mississippi - July 12, 2017 - 24 Participants

Rating Category	Rating Average
1. Organization of the program	1.18
2. Speakers knowledgeable	1.09
3. Speakers effective communicators	1.18
4. Usefulness of material presented	1.36
5. Program met expectations	1.23

Ratings were on a scale of 1–5

1=Very Good and 5=Needs Improvement

6. What were the most worthwhile parts of this program?

Understanding the problems with concrete and why they happen.

Understanding effective and necessary tests for concrete.

I learned a lot of things about concrete that I think will be very helpful for the rest of my internship this summer and later on.

I enjoyed the dowel bar portion the most. Pictures and videos were also very helpful because I'm a visual learner.

Gradation and chemistry of the hydration processes.

Optimized gradation for concrete paving mixtures and supplementary cementitious materials.

Going over the fundamentals for each topic presented. Didn't get too deep in the weeds but covered topics thoroughly.

Insight and opinions from industry/academia experts. Excellent!

Learning about how effective aggregate gradations can be. (2)

The extensive knowledge of the presenters. Very organized and well-presented seminar. (2)

Materials related distress was very informative; contained a lot of Q&A and clarified a lot of.

It is a well-rounded program. I think it was all equally worthwhile and speakers were organized and knowledgeable. (2)

SCMs. (2)

QA/QC and gradation.

Talking about construction since I am not up to speed on the chemistry.

MRDs.

7. What were the least worthwhile parts of this program?

The chemistry was somewhat difficult to understand. Would recommend trying a video to help with flow of what is happening. (3)

It was a little long, but I thought it was very interesting.

None. All worthwhile! (3)

Bar plots.

Dowel anchoring; shorten this presentation. (4)

The amount of detail the presenters went through.

SCMs.

Concrete 101 mainly because I recently attended a fundamentals of concrete class. We did not go into detail about all the different SCMs though.

8. Do you have any suggestions for future workshop topics?

Admixtures in more detail.

High performance concrete, analysis of frequency of failure, comparison with other types of pavements.

Very informative. Keep it as it is! Great job! (3)

Include or invite private concrete and aggregate suppliers.

To focus on the construction operations.

Pavement distresses (load and climate related).

Applications of different types of concrete (maybe not appropriate for paving) but RCC could be mentioned: HSC or UHPC, FRC, SCC, underwater, RCC, etc. Incorporate concrete finishing to dowel bar presentation.