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Best Practices for the Use of RAS in HMA: Instructor Guide

Implementation Report 5-6614-01-P1

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
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Best Practices for the Use of RAS in HMA

Instructor Guide

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Introduction

The asphalt paving industry has always advocated recycling, including reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), tires, etc. The earliest recycling asphalt pavement dates back to 1915. In addition to conserving energy and protecting the environment, the use of RAP/RAS can significantly reduce the cost of hot-mix asphalt (HMA) paving. RAP has been the most extensively recycled material in the history of the asphalt paving industry. With increases in the price of asphalt cement and subsequent price fluctuations, the industry has further amplified its recycling efforts. Most recently, the use of RAS in HMA has become another black gold to the asphalt paving industry since RAS contains a significant amount of asphalt binder (see Table 1). There are two basic types of roofing shingle scraps: 1) post-consumer asphalt shingles or tear-off asphalt shingles (TOAS), and 2) manufacture waste asphalt shingles (MWAS) including roofing shingle tab punch-outs and out-of-spec shingles. MWAS is called prompt roofing shingle scrap in some publications. In February 2009, the Texas Commission on Environmental Quality (TCEQ) issued an Authorization Memo to allow HMA plants to include either MWAS or TOAS under the TCEQ air quality standard permit for permanent HMA plants. Since then, RAS has been used in various pavement constructions.

Table 1. Typical Compositions of New Residential Asphalt Shingles.

Component	**Organic Shingles, % by wt.**	**Fiberglass Shingles, % by wt.**
Asphalt Cement	30–36	19–22
Reinforcing Mat	2–15	2–5
Mineral Granules/aggregate	20–38	20–38
Mineral Filler/stabilizer	8–40	8–40
Adhesives (modified asphalt based)	0.2–2	0.2–2

The main objective of this workshop is to present best practices for RAS collection, processing, screening, and stockpile management of processed shingles and RAS mix design, production, construction, and performance evaluation.

Course Organization

One or two instructors will present this half day course using the curriculum materials, which includes an instructor guide, a student handbook, and a software CD. In addition, the instructors need internet access and projector equipment.

The course is designed to run for two instructional hours, typically from 9:30 a.m. to 11:30 a.m. or from 1:30 p.m. to 3:30 p.m. The instructional time may vary plus or minus 30 minutes depending on the course sponsor.

The complete lesson plan is composed of four modules:

- Module 1: Introduction.

- Module 2: RAS processing and stockpile management.
- Module 3: RAS mix design and performance evaluation.
- Module 4: RAS mix production and construction.

Course Coordination

Usually, a Training Coordinator from the Texas Department of Transportation (TxDOT) will submit a request for the course with requested dates and training sites to the contractor's course scheduler, who in turn, will contact the course contractor. The contractor will then contact the TxDOT Training Coordinator to discuss possible dates for the course. Once a list of potential dates is compiled, the contractor will check on the availability of the instructors. The contractor will confirm the delivery date with the TxDOT Training Coordinator, Course Scheduler, and instructors. Then the course session is formally scheduled for the agreed dates and training site. This also will authorize the contractor to conduct the course. A confirmation is emailed to the instructors.

The contractor will communicate with the host DOT Coordinator to: 1) confirm times of instruction; 2) obtain directions to training facility; and 3) discuss host requirements.

Class Size

The maximum class size permitted is 40 people; however, the smaller the class size, the better, with a minimum of 5. The participant student handbook should be placed at each participant's seat by the TxDOT Training Coordinator prior to the beginning of the class. TxDOT will provide sign-in sheets, pencils, etc. The TxDOT Training Coordinator needs to notify the contractor's Course Scheduler concerning any changes to the number of students.

Host Agency Responsibilities

Host agency is responsible for visual aids for this course, which include the following:

- LCD projector compatible with a notebook computer (e.g., InFocus® or similar make).
- Cable necessary to connect projector to computer, if possible.
- Electronic remote to advance slides in PowerPoint® presentation (if available).
- Projection screen.
- Laser pointer (if available).
- Whiteboard with dry erase pens and eraser.

All equipment should be placed in the room for the instructors to check a half hour prior to the course.

Room Requirements

Instructors will arrange the classroom as they deem most appropriate given the number of participants. All participants should be able to see the screen and instructors. Participants and instructors should be able to move about the room without obstruction.

A preparation table and presentation table should be provided for the instructors. The presentation table will be for the audiovisual equipment, and the preparation table will be for the instructors' materials. The room should be in a quiet area and have a lighting system that permits convenient dimming of the lights, especially where the screen is located.

Training Site

Great care should be taken to select a room that is handicap accessible and will not be overcrowded, too hot or too cold, or subject to outside distractions. The instructors should provide any specific requirements for the training facility so that the training coordinator may:

- Reserve a training room for the duration of the course.
- Check to see if anyone else will be using the room for nighttime functions.
- Determine if books and equipment can be left in the room. Training courses, requiring special equipment or computers, must have after-hours security.

Participants and Instructors

Participants and instructors should be:

- Informed of course starting and ending times.
- Advised on training site address.
- Furnished with maps.
- Advised on parking arrangements.

Final Arrangements

Instructors will be responsible for:

- Reconfirming the training facilities.
- Discussing the seating arrangements and who will set up the room.
- Discussing what time the room is unlocked/locked.
- Checking to make sure a technician is available in case there are problems setting up the room or if something goes wrong during the course.

One day before the course:

- Set-up the Classroom.
- Organize the participant materials.
- Post directional signs.
- Test all equipment.

During the course:

- Instructors will identify whom they should contact if they need assistance.
- Instructors will provide a copy of the student handbook for all course participants.

After the course:

- Instructors will check to make sure students have the course evaluation forms.
- Students will complete evaluations.
- Clean up room and turn off lights and electronic equipment as needed.

Participant Requirements

TxDOT should provide notepads and pens, or instruct participants to bring notepads and pens with them.

Target Audience

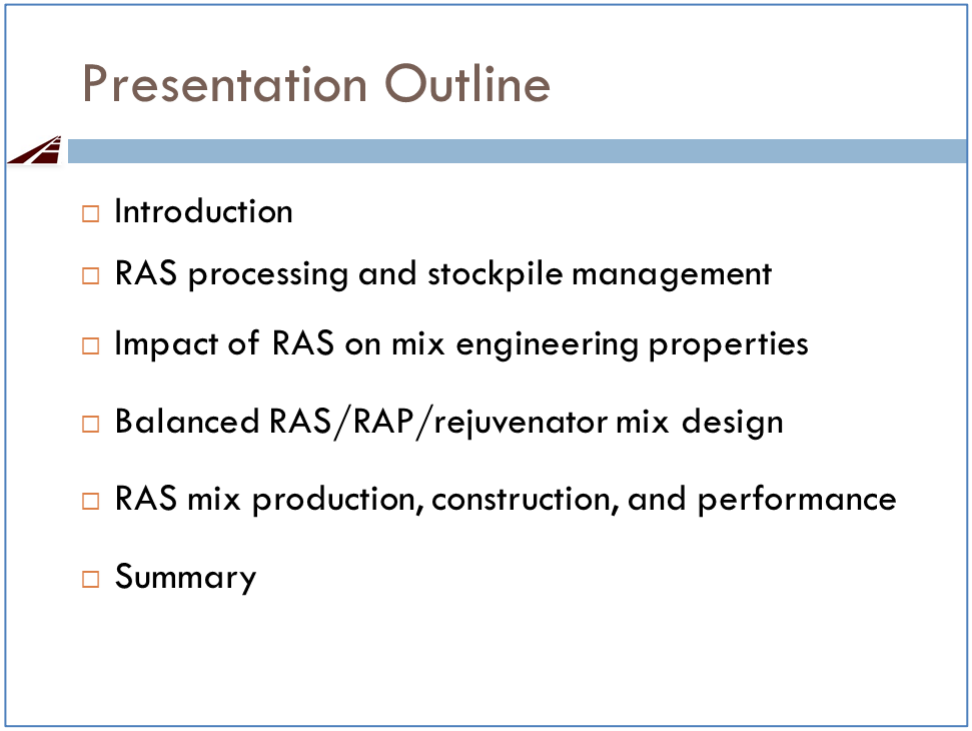
This course is designed for any individuals seeking to best use RAS/RAP in asphalt mixes.

Course Goal

The goal of this course is to present best practices for RAS collection, processing, screening, and stockpile management of processed shingles and RAS mix design, production, construction, and performance evaluation.

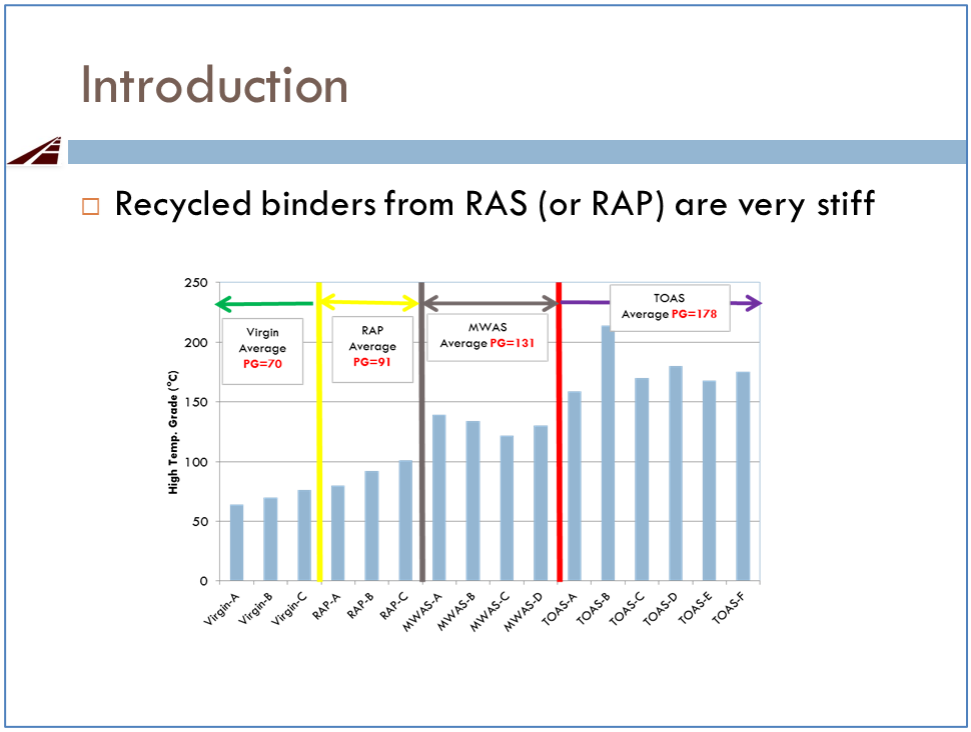
Course Modules

Key Message:	Training title
Interactivity:	**Tell:** In this lesson, we will learn the best practices for the use of RAS in HMA.
Notes:	NA

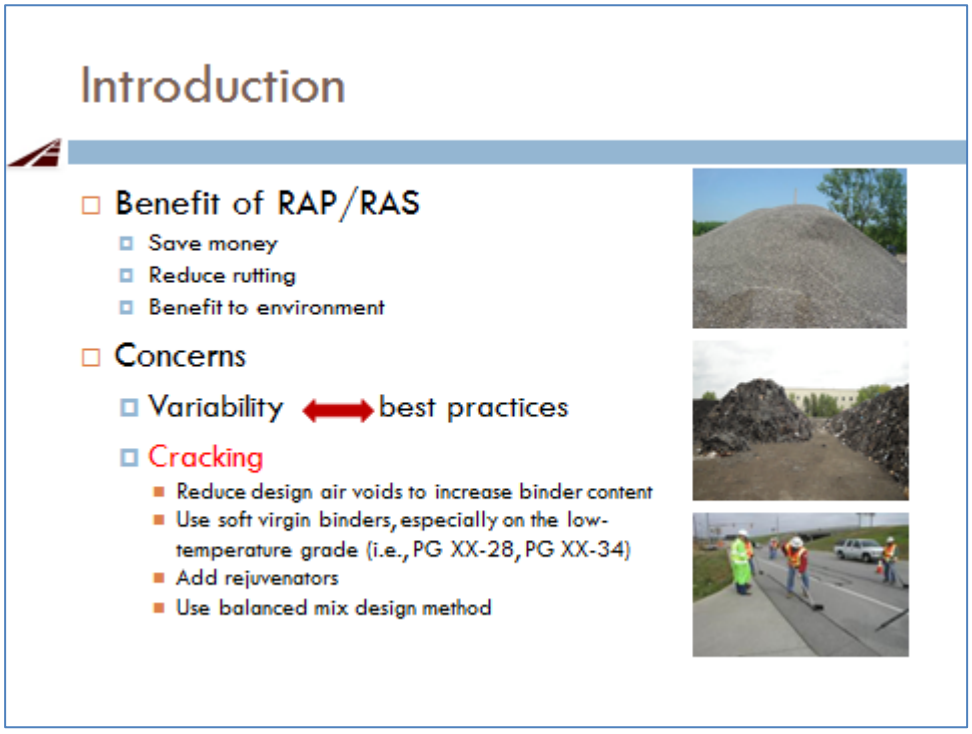


Key Message:	Outline
Interactivity:	**Tell:** This lesson will include six parts: ▪ Introduction. ▪ RAS processing and stockpile management. ▪ Impact of RAS on mix engineering properties. ▪ Balanced RAS/RAP rejuvenator mix design. ▪ RAS mix production, construction, and performance. ▪ Summary.
Notes:	NA

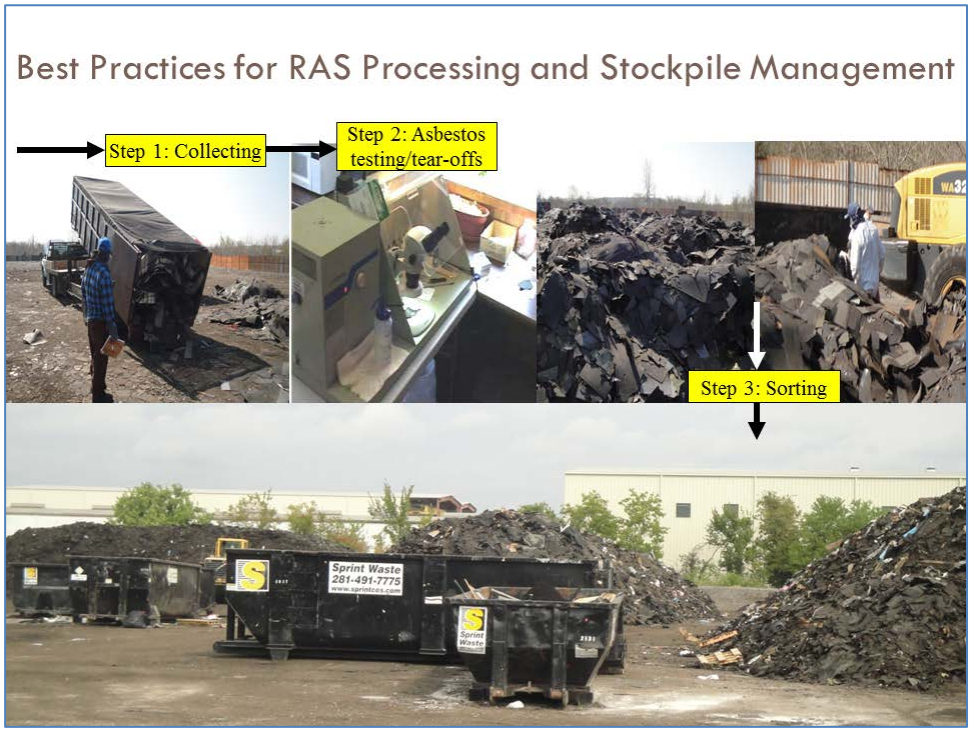
Key Message:	RAS types and characteristics
Interactivity:	**Tell:** Two types of RAS are available: ▪ Manufacture waste asphalt shingles (MWAS). ▪ Tear-off asphalt shingles (TOAS). **Tell:** RAS has very high asphalt content, 20 percent or more.
Notes:	NA



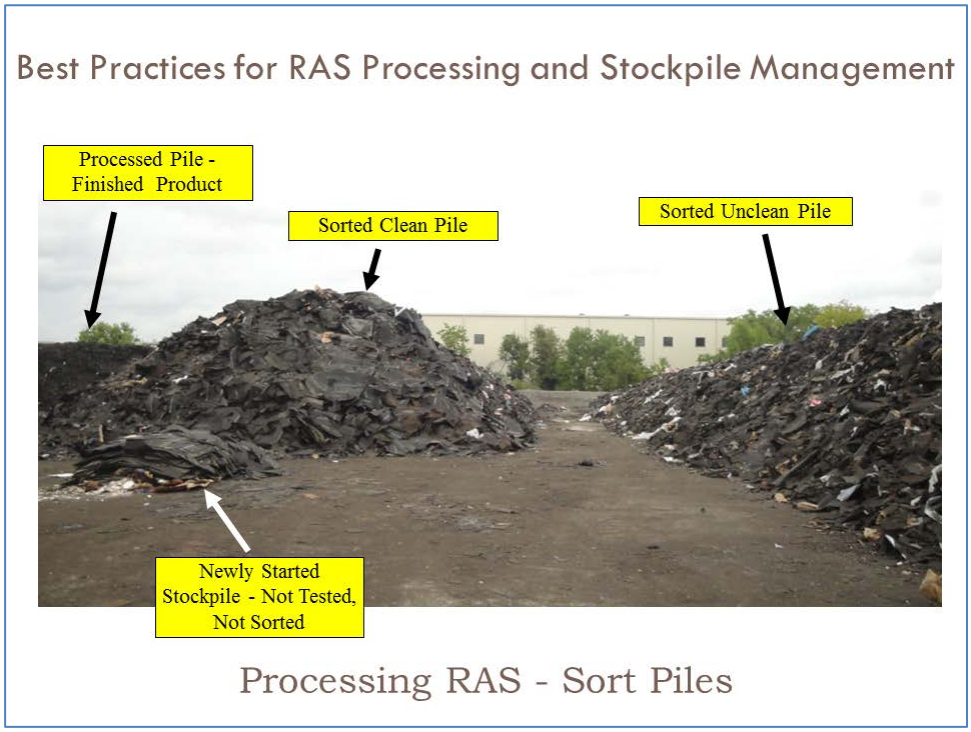
Key Message:	RAS binder characteristics
Interactivity:	**Ask:** Does anyone know how stiff the RAS binder is? **Tell:** Compare the RAS binder with most often used virgin binders in Texas and RAP binders to show that RAS binder is far stiffer than the stiffest virgin binder used in Texas.
Notes:	N/A.



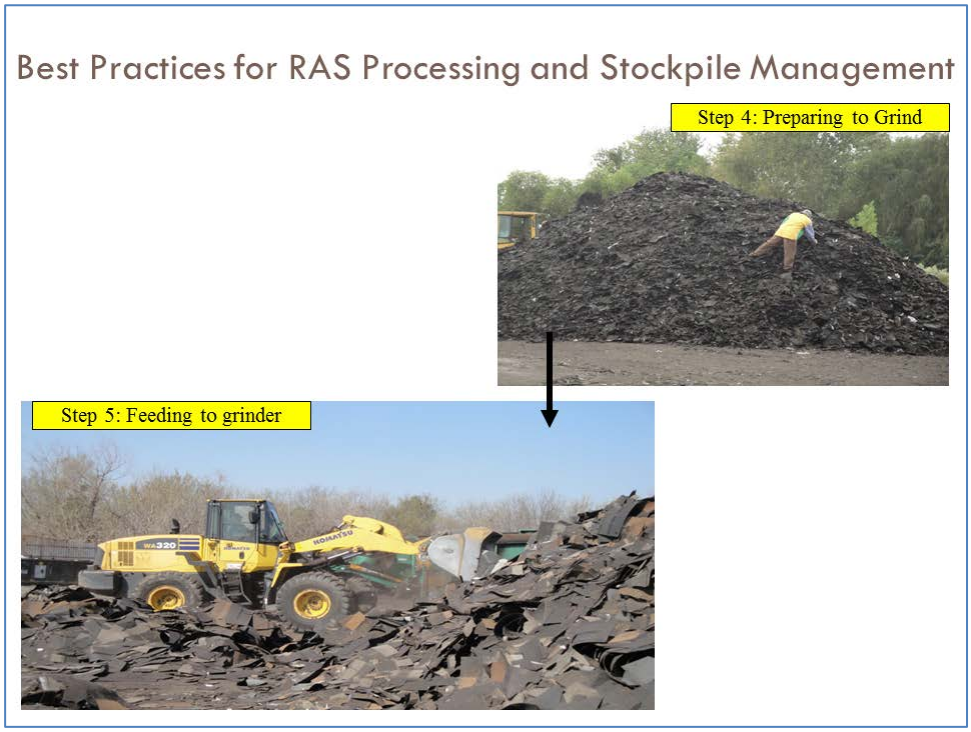
Key Message:	Three benefits and two major concerns on the use of RAS in HMA
Interactivity:	**Tell:** Why do we use RAS? Because of three benefits: 1) save money, 2) reduce rutting, and 3) good to the environment. **Tell:** there are also two major concerns: variability and premature cracking issue. Also the instructor should discuss different ways to address the premature cracking issue: ▪ Reduce design air voids to increase binder content. ▪ Use soft virgin binders, especially on the low-temperature grade (i.e., PG XX-28, PG XX-34). ▪ Add rejuvenators. ▪ Use balanced mix design method.
Notes:	You should be no more than 10 minutes into the lesson at this point.



Key Message:	Best practices for RAS processing and stockpile management
Interactivity:	**Tell:** Best practices for RAS processing and stockpile management include a total of eight steps: ▪ Step 1: RAS collection. ▪ Step 2: Asbestos testing for tear-off asphalt shingles. ▪ Step 3: RAS sorting.
Notes:	NA

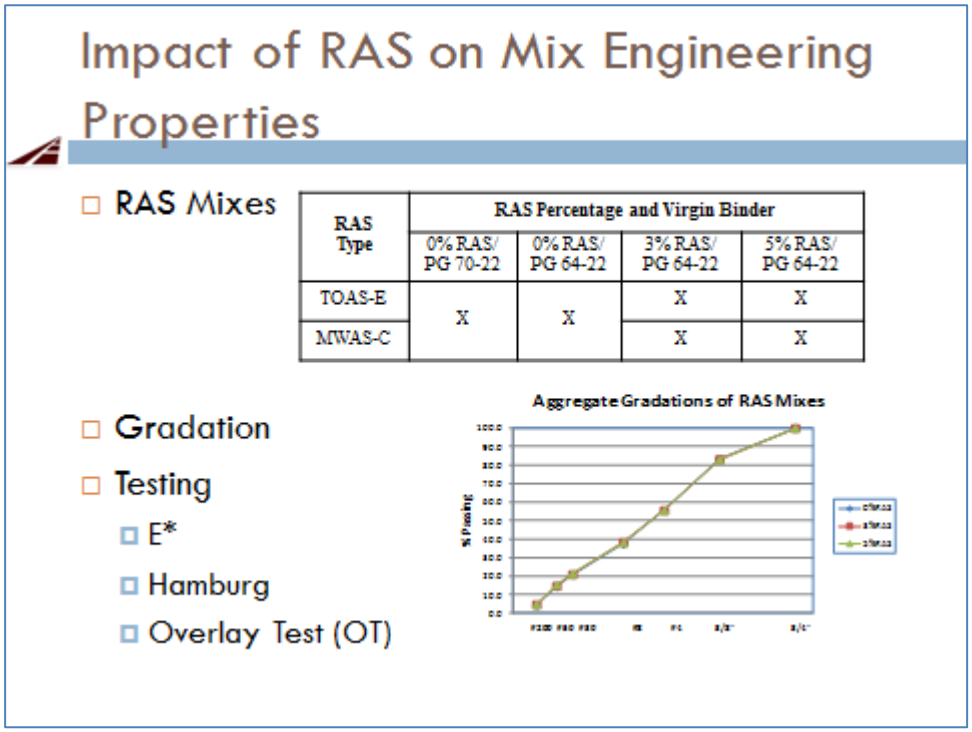


Key Message:	Best practices for RAS processing and stockpile management
Interactivity:	**Tell:** The instructor further describes the RAS sorting process.
Notes:	NA

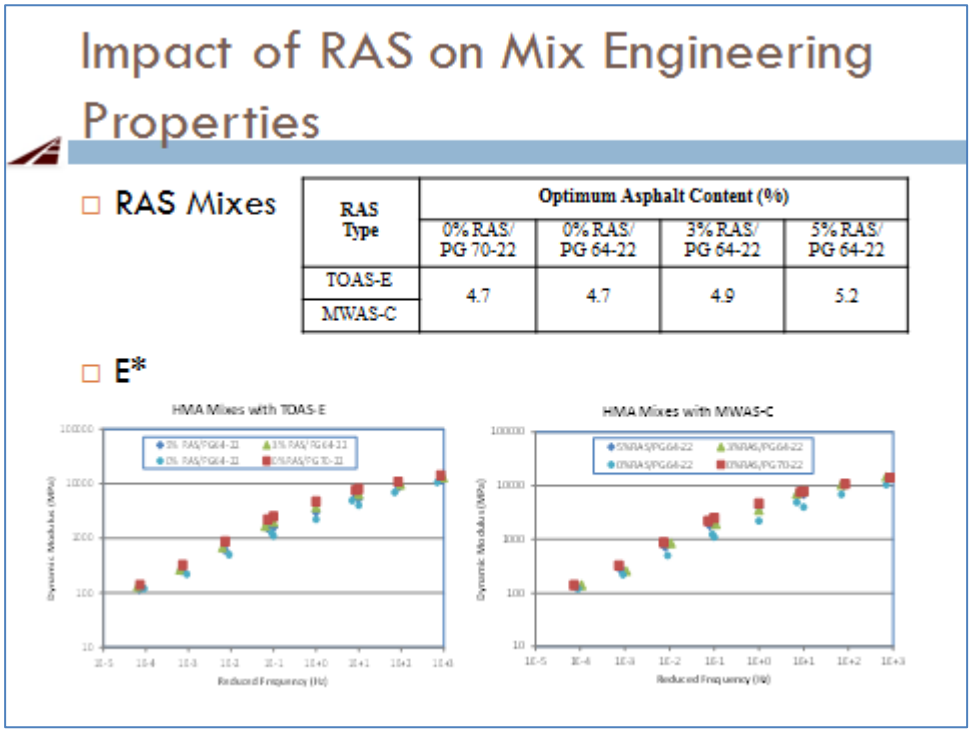


Key Message:	Best practices for RAS processing and stockpile management
Interactivity:	**Tell:** Best practices for RAS processing and stockpile management include a total of eight steps: ▪ Step 4: Preparing to grind RAS. ▪ Step 5: Feeding RAS to grinder.
Notes:	NA

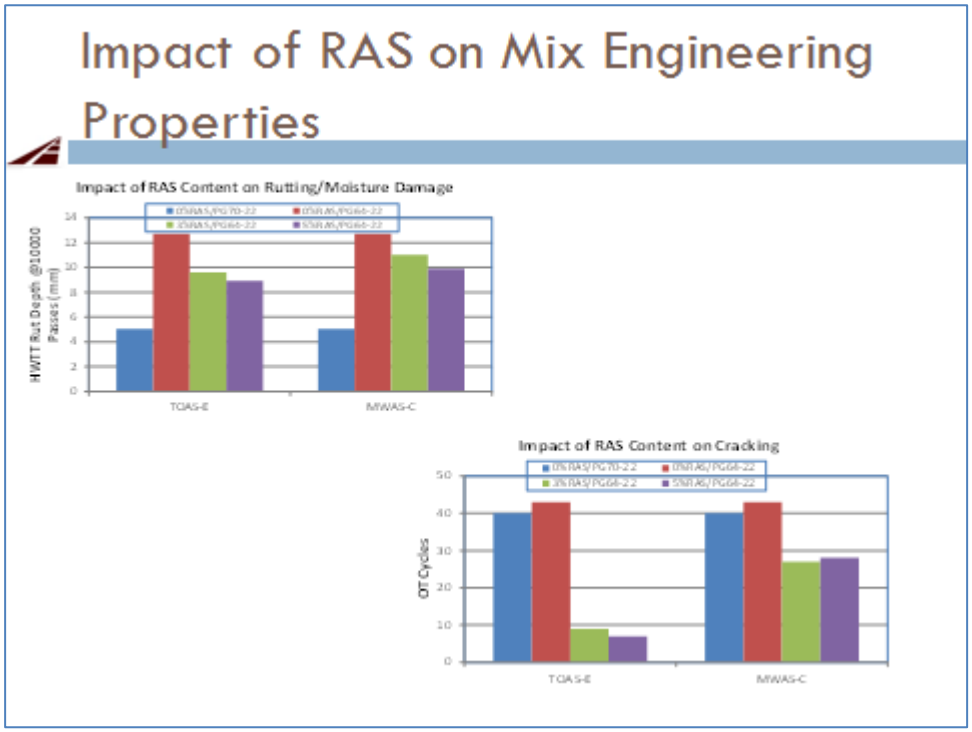
Key Message:	Best practices for RAS processing and stockpile management
Interactivity:	**Tell:** Best practices for RAS processing and stockpile management include a total of eight steps: ▪ Step 6: Grinding RAS. ▪ Step 7: Screening the grinded RAS. ▪ Step 8: Stockpiling RAS in a covered area
Notes:	NA



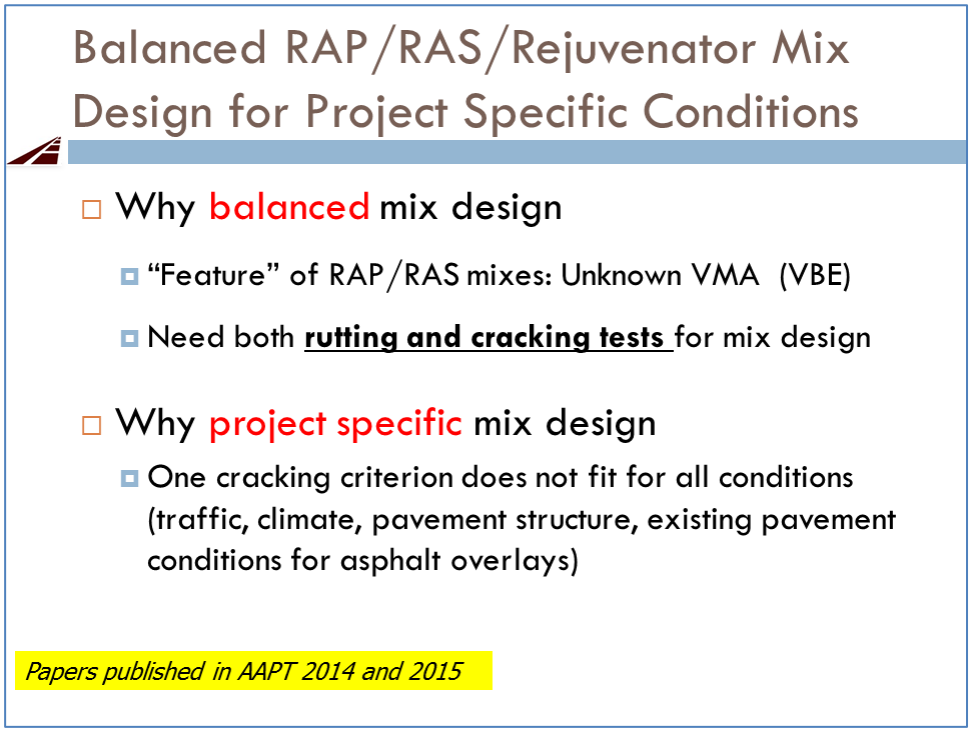
Key Message:	Impact of RAS on mix engineering properties
Interactivity:	**Tell:** On this screen, the instructor will discuss the potential impact of RAS on three mix engineering properties: ▪ Dynamic modulus (E*). ▪ Rutting resistance through Hamburg wheel tracking test. ▪ Cracking resistance through Overlay test (OT). **Tell:** A dense-graded Type C mix is used for this study and three RAS contents are considered: 0, 3, and 5 percent.
Notes:	NA



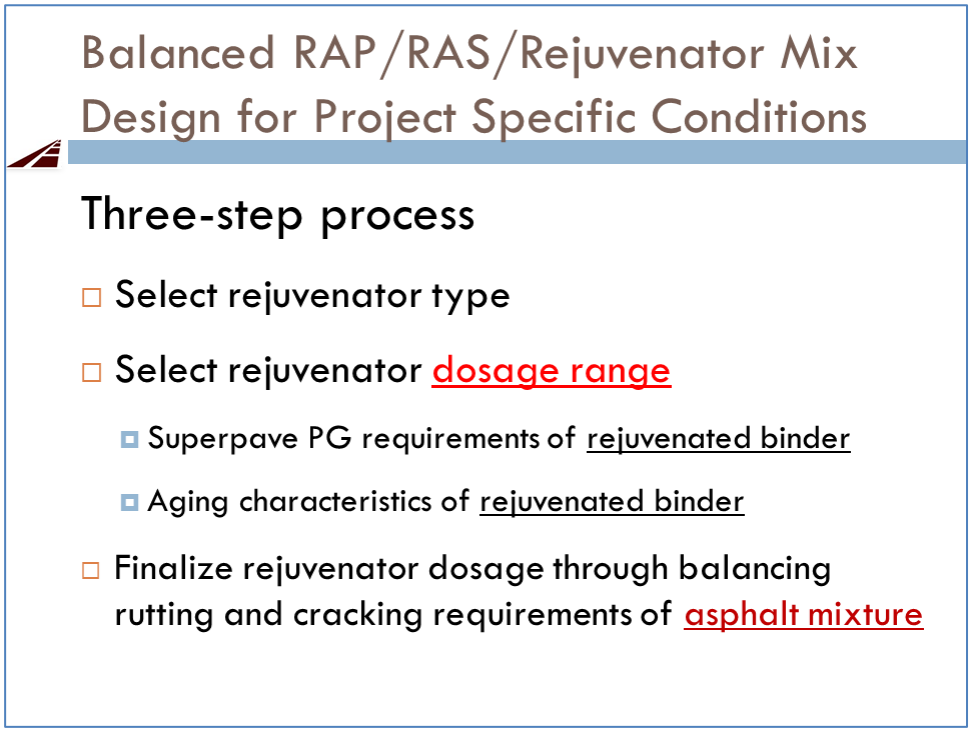
Key Message:	Impact of RAS on dynamic modulus
Interactivity:	**Tell:** The mixes with RAS have higher dynamic modulus than the virgin mix. The addition of RAS makes the mix stiffer.
Notes:	NA



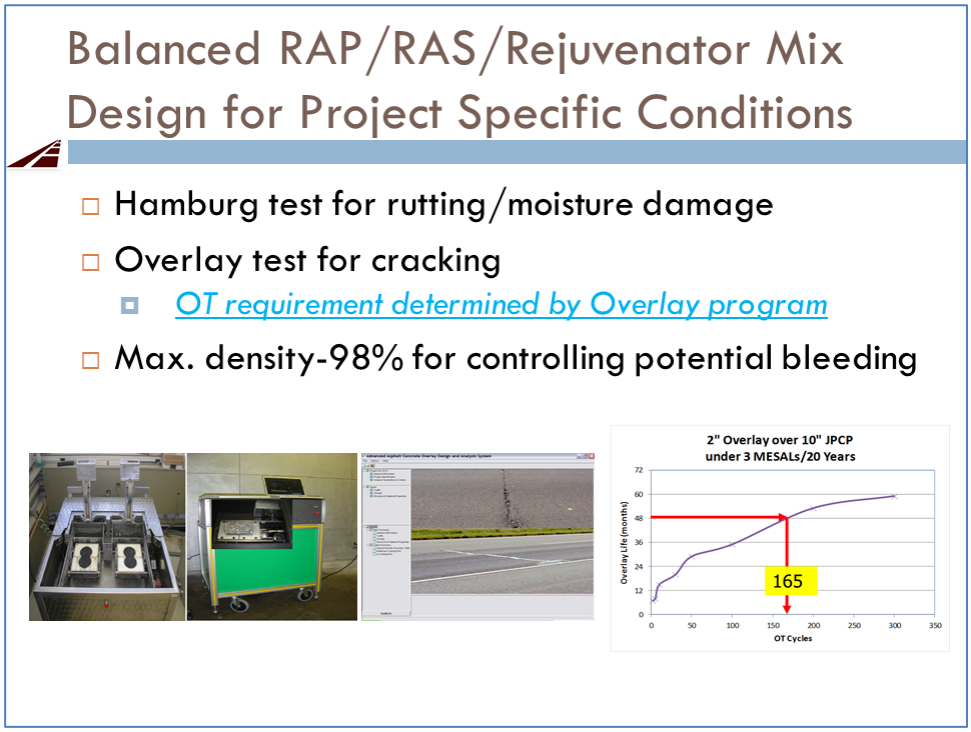
Key Message:	Impact of RAS on rutting and cracking resistance
Interactivity:	**Tell:** The mixes with RAS have better rutting resistance but poorer cracking resistance.
Notes:	NA



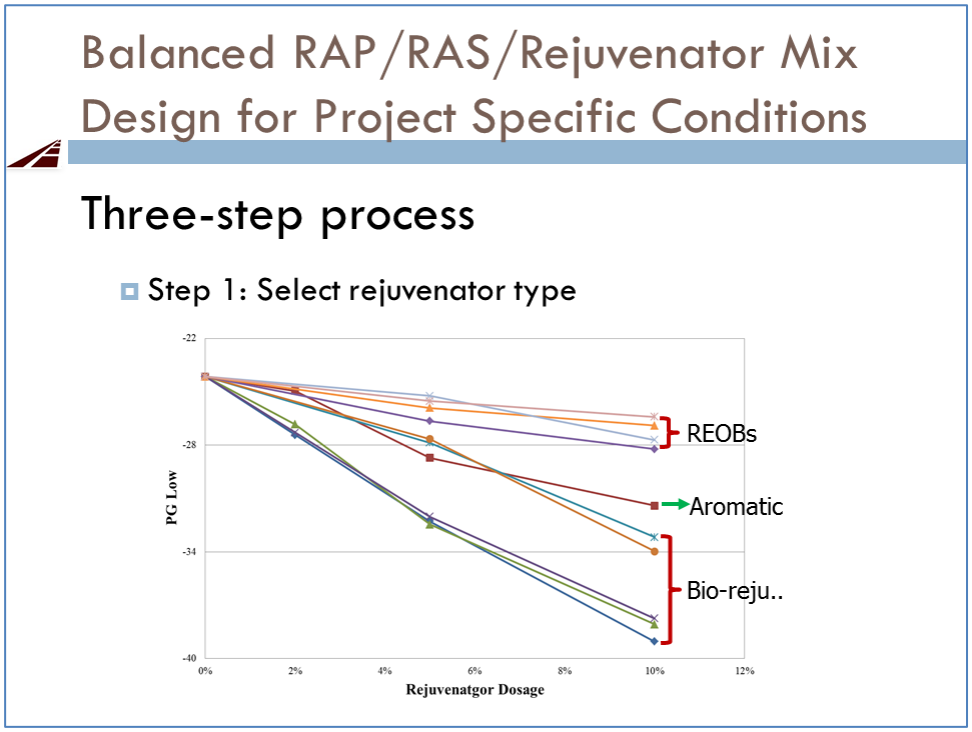
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions
Interactivity:	**Tell:** The slide mainly discusses two things: ▪ Why do we need balanced mix design? ▪ Why do we need to perform the mix design for project specific conditions?
Notes:	NA



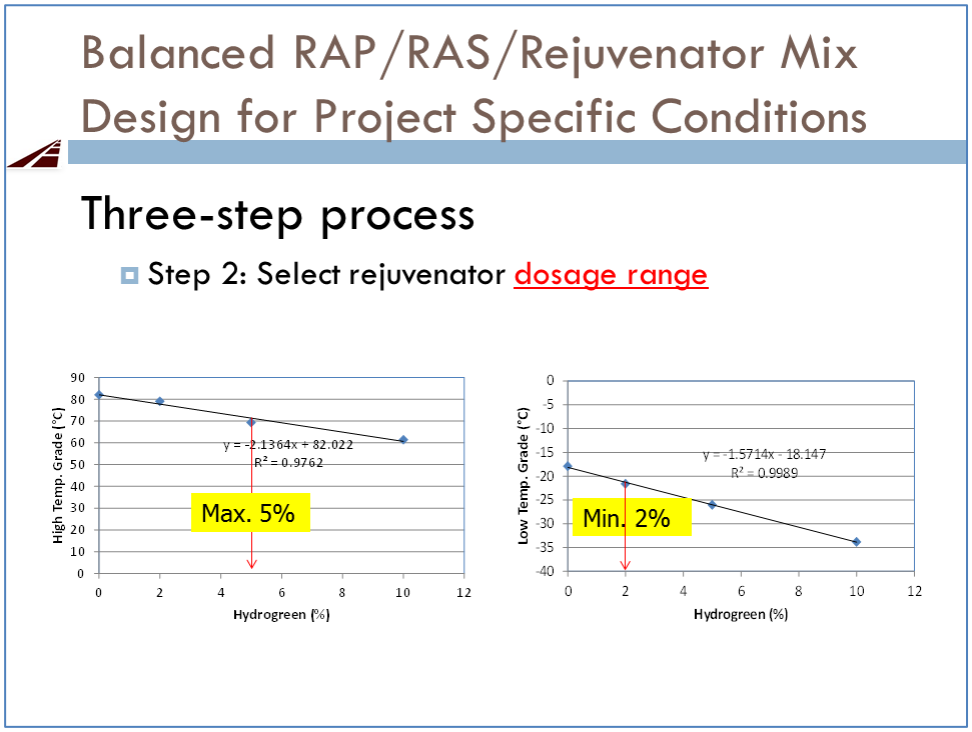
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions
Interactivity:	**Tell:** The balanced RAP/RAS/Rejuvenator mix design for project specific conditions has three steps: ▪ Select rejuvenator type. ▪ Select rejuvenator dosage range. ▪ Finalize rejuvenator dosage through balancing rutting and cracking with a consideration of air voids.
Notes:	N/A



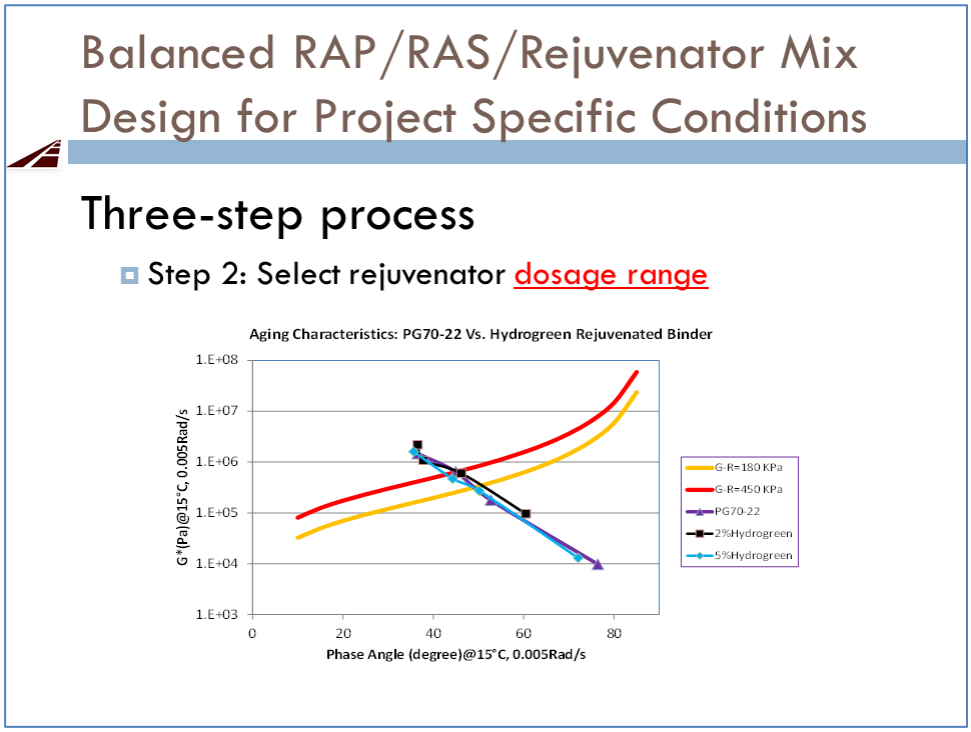
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions
Interactivity:	**Tell:** This slide details rutting, cracking, and density (or air voids) requirements.
Notes:	NA



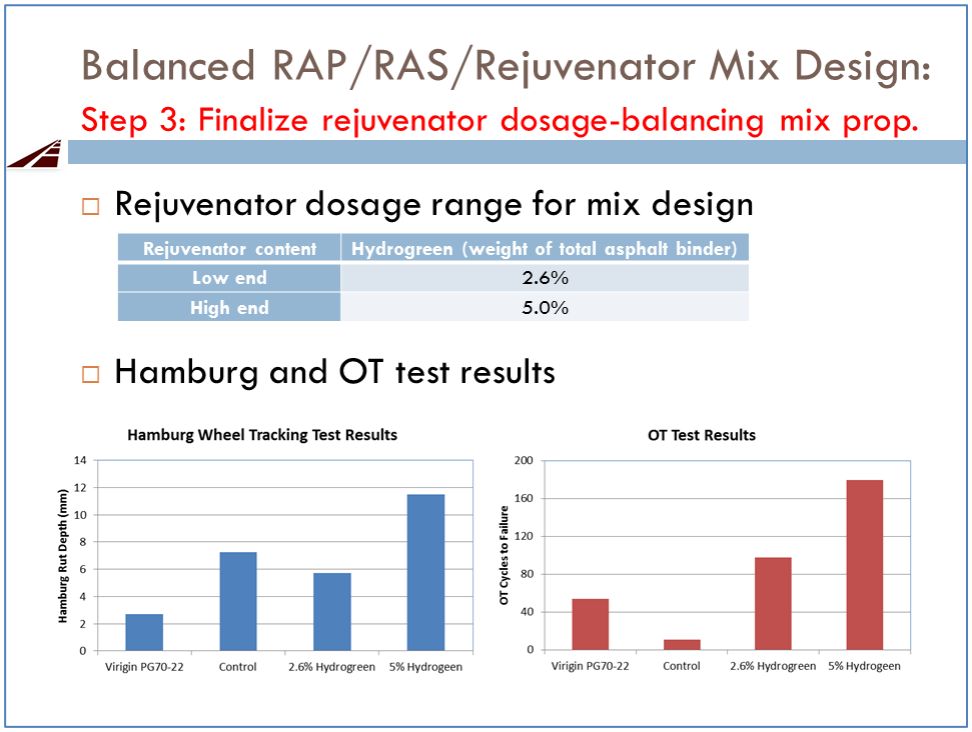
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions: Step 1: select rejuvenator type
Interactivity:	**Tell:** Three types of rejuvenators are available on the market. It seems that bio-based rejuvenators are the most effective ones. However, even within each group, rejuvenators perform differently. Specific blend may be needed for each specific case.
Notes:	NA



Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions: Step 2: select rejuvenator dosage range
Interactivity:	**Tell:** The high temperature PG controls the maximum dosage of rejuvenators and the low temperature PG controls the minimum dosage of rejuvenators.
Notes:	NA



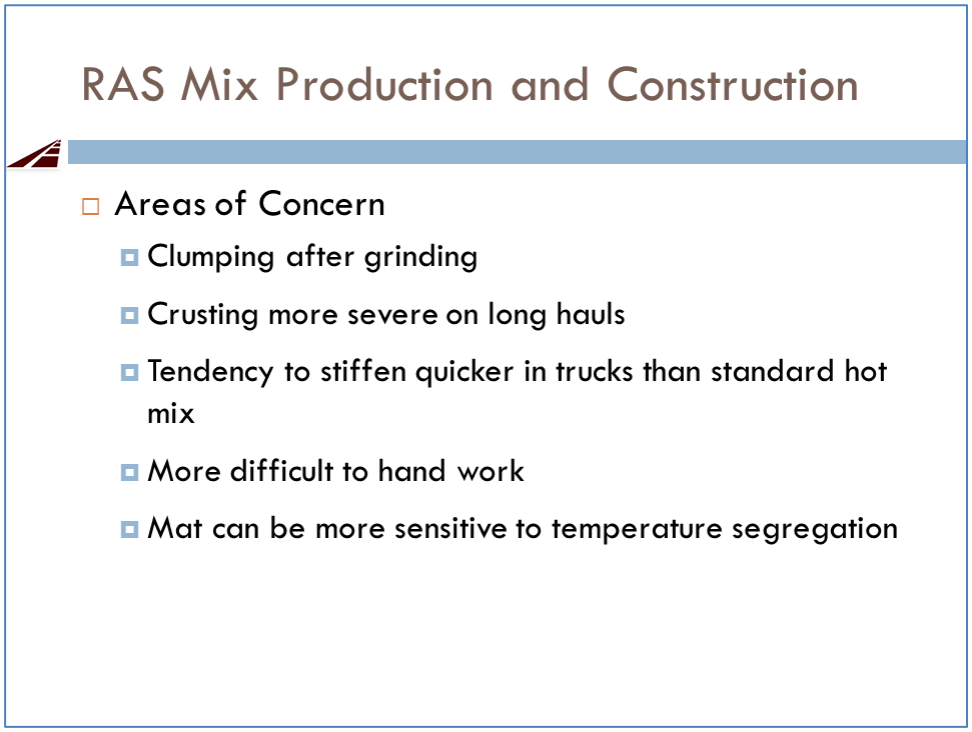
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions: Step 2: select rejuvenator dosage range
Interactivity:	**Tell:** In addition to binder PG requirement, the aging characteristics of the blend should be evaluated through Glower-Rowe parameter. The blend should have similar or even better aging resistance than the virgin binder.
Notes:	NA



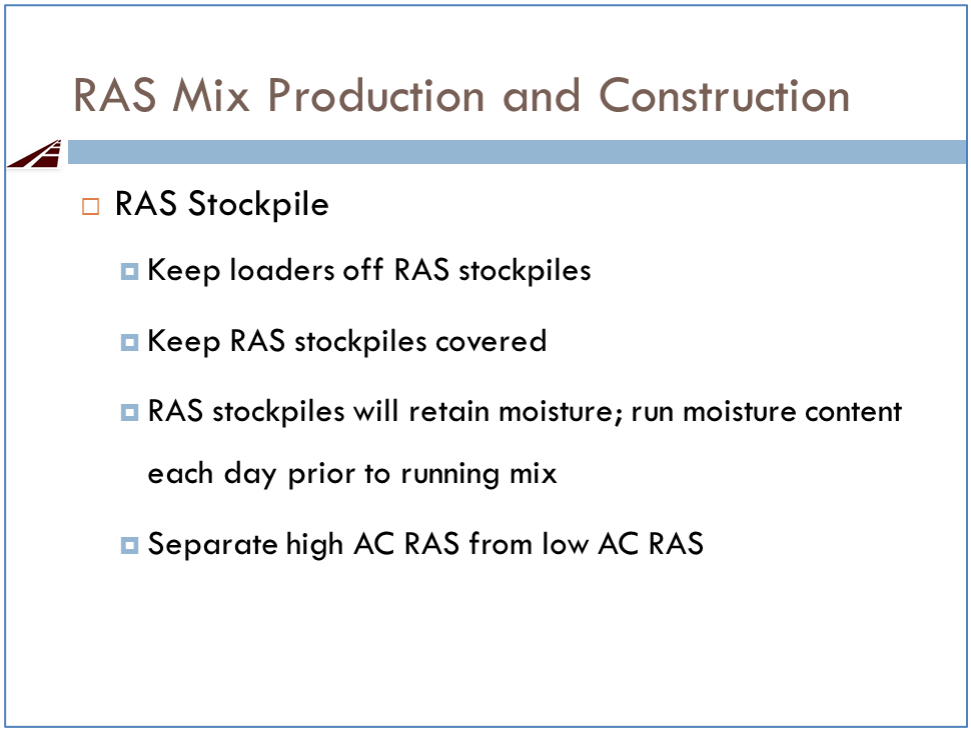
Key Message:	Balanced RAP/RAS/Rejuvenator mix design for project specific conditions: Step 3: Finalize rejuvenator dosage through balancing mix rutting and cracking requirements
Interactivity:	**Tell:** Select the final rejuvenator dosage based on rutting and cracking test results and associated requirements for specific project conditions.
Notes:	N/A

Key Message:	A typical asphalt mix production plant
Interactivity:	**Tell:** A separate RAS bin at this plant.
Notes:	N/A

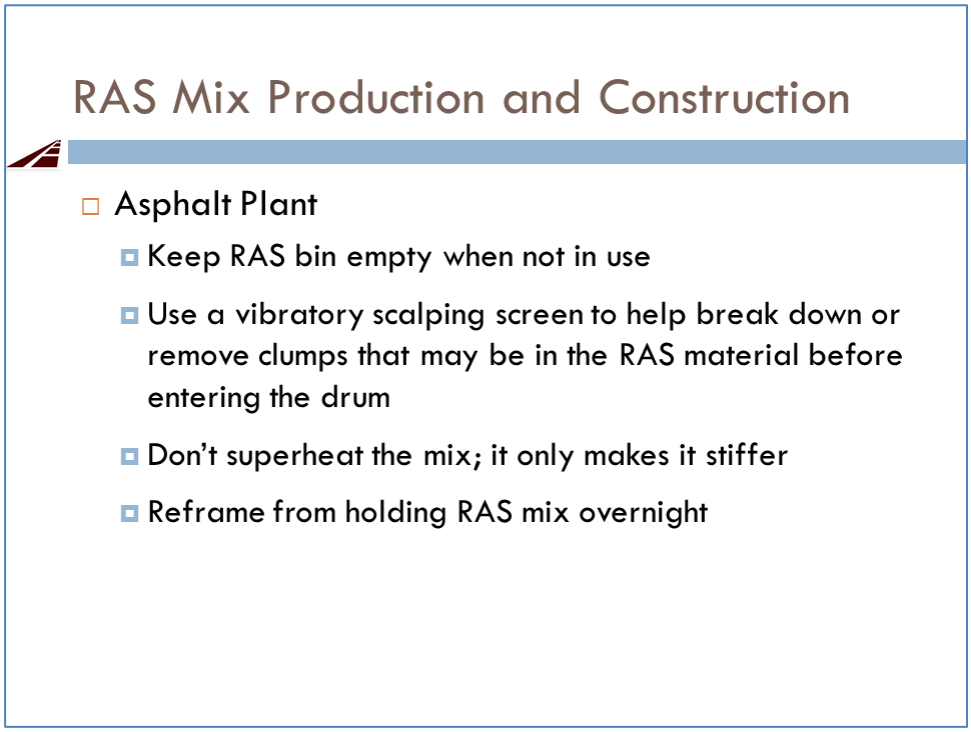
Key Message:	A typical construction site with paver, loading truck, and paving crew
Interactivity:	**Tell:** A good organized on-site construction sequence is very important, especially for the mixes containing RAP/RAS.
Notes:	NA



Key Message:	Potential concerns on RAS mix production and construction
Interactivity:	**Tell:** Overall concerns on RAS mix production and construction as listed in the slide.
Notes:	NA

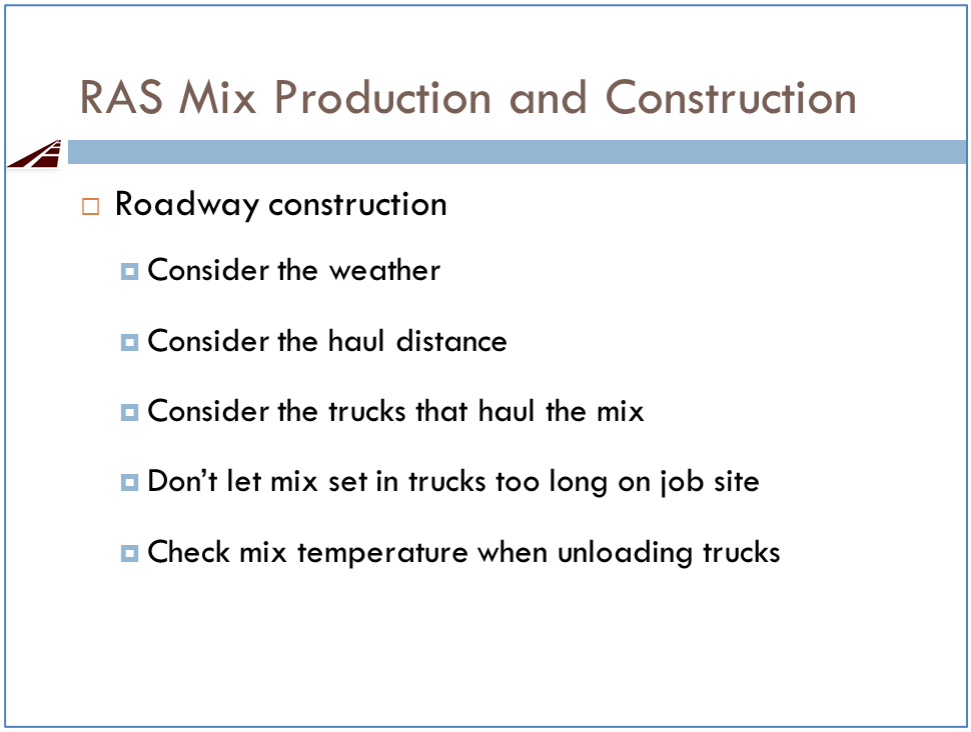


Key Message:	RAS mix production and construction
Interactivity:	**Tell:** The instructor discuss five specific tips for RAS stockpile.
Notes:	**N/A**

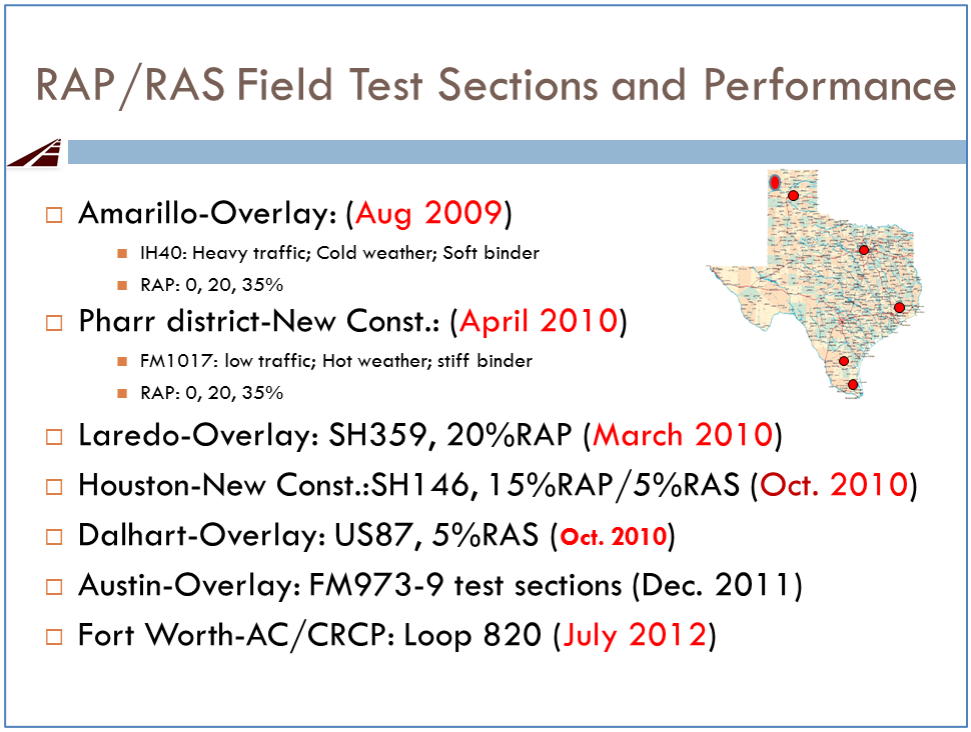


Key Message:	RAS mix production and construction
Interactivity:	**Tell:** This screen shows four specific items worth of paying attention to at the asphalt plant.
Notes:	NA

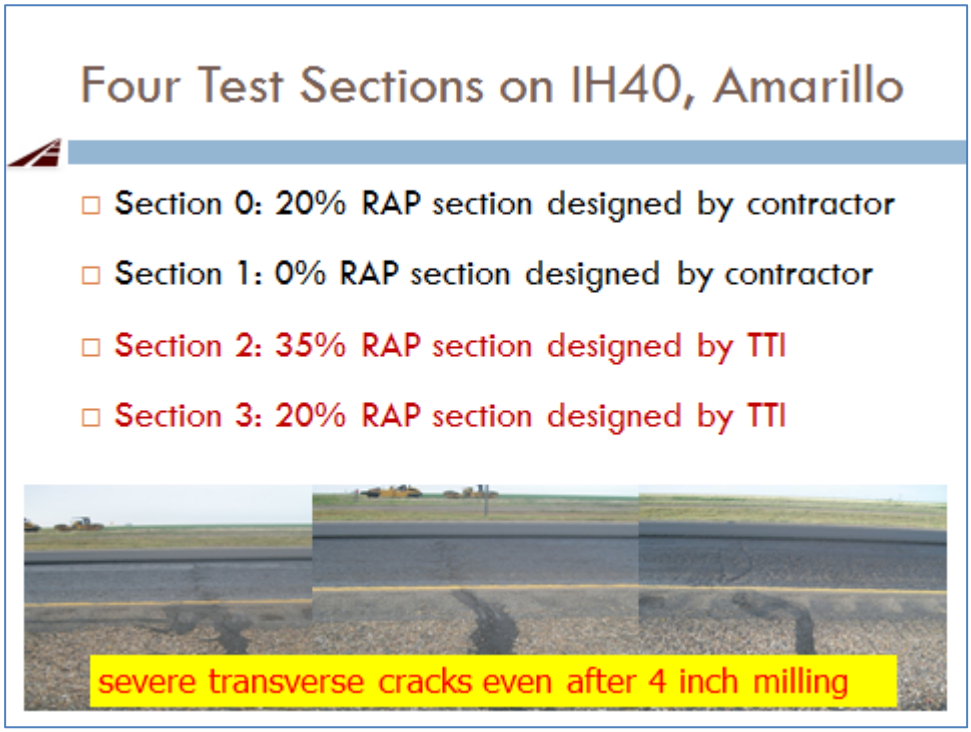
Key Message:	RAS mix production and construction
Interactivity:	**Tell:** The instructor should emphasize the importance of the vibratory scalping screen to loosen the clumped RAS.
Notes:	NA



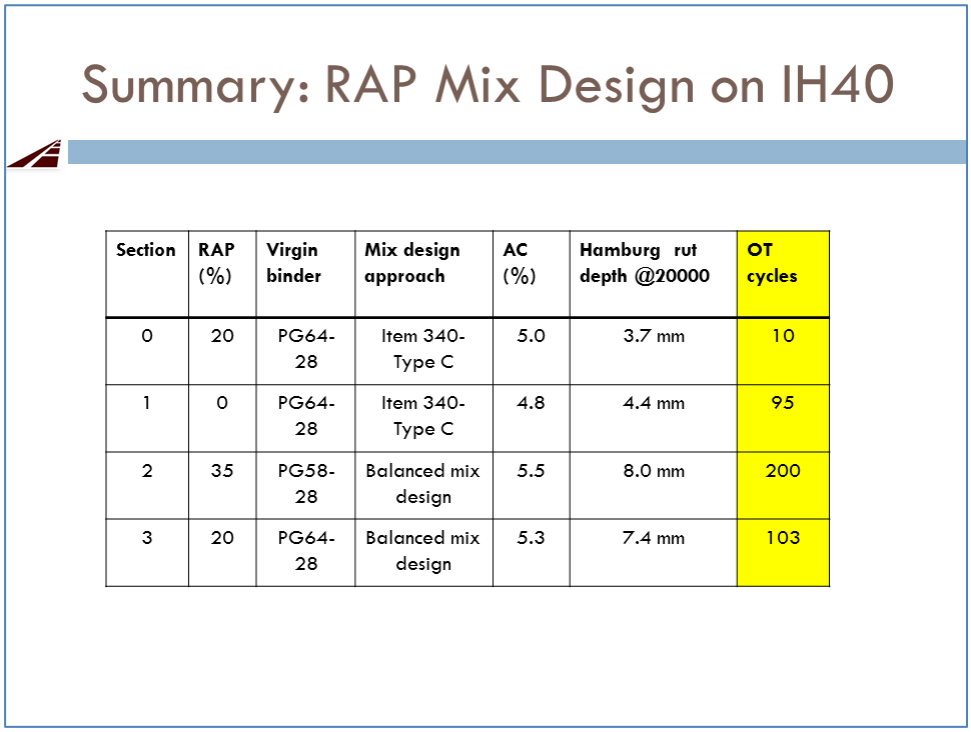
Key Message:	RAS mix production and construction
Interactivity:	**Tell:** This screen lists five key items for roadway construction to ensure good quality construction.
Notes:	N/A



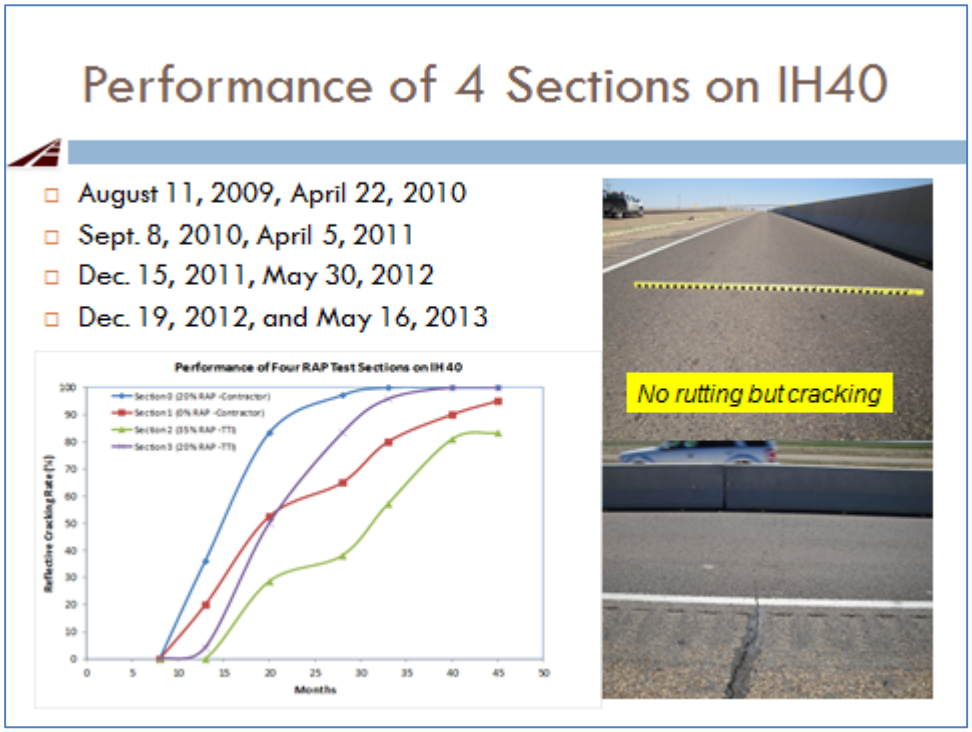
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This screen shows the locations of many field test sections with RAP/RAS being constructed in the past.
Notes:	NA



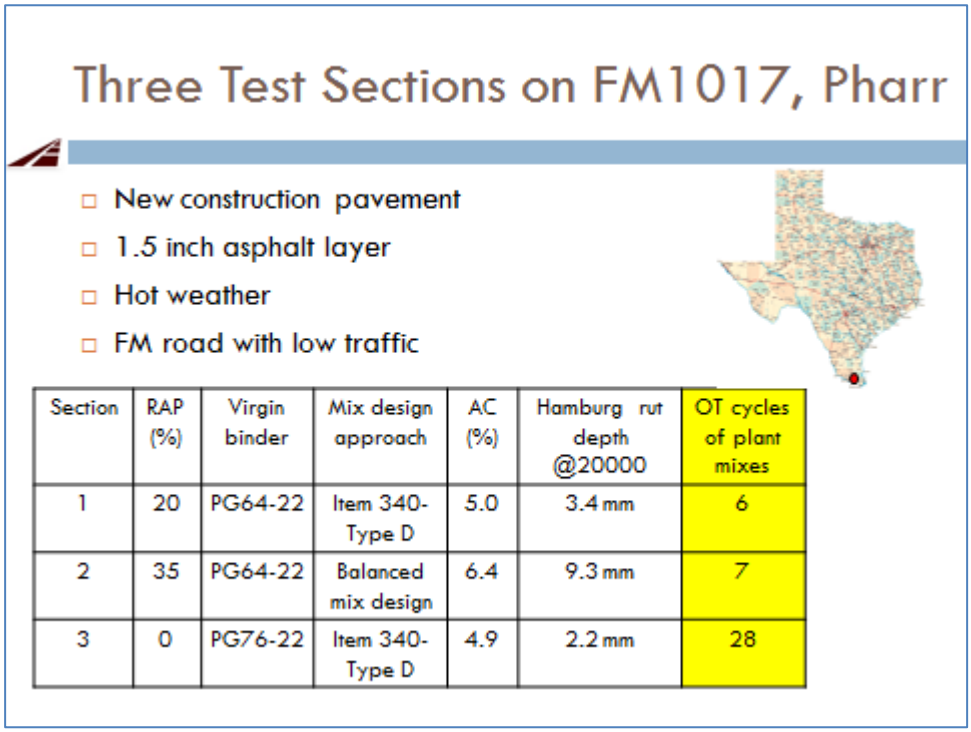
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This slide shows four specific test sections on IH40.
Notes:	NA



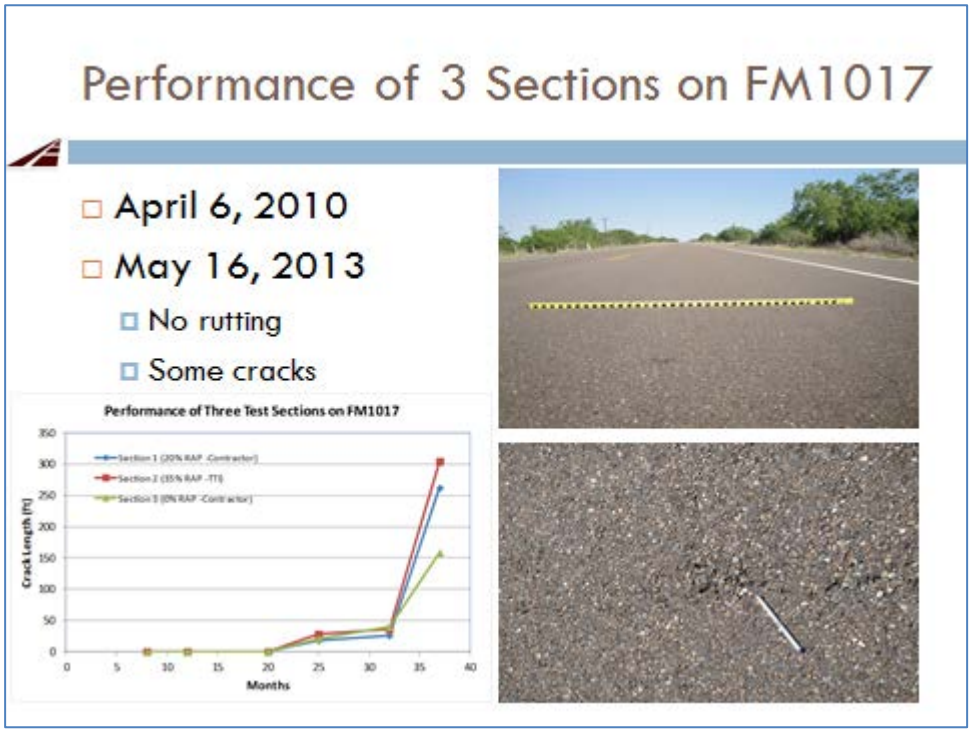
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** The balanced mix design method was used to design the test sections on IH40. The table in this slide details mix design information of each test section including both rutting and cracking test results.
Notes:	N/A



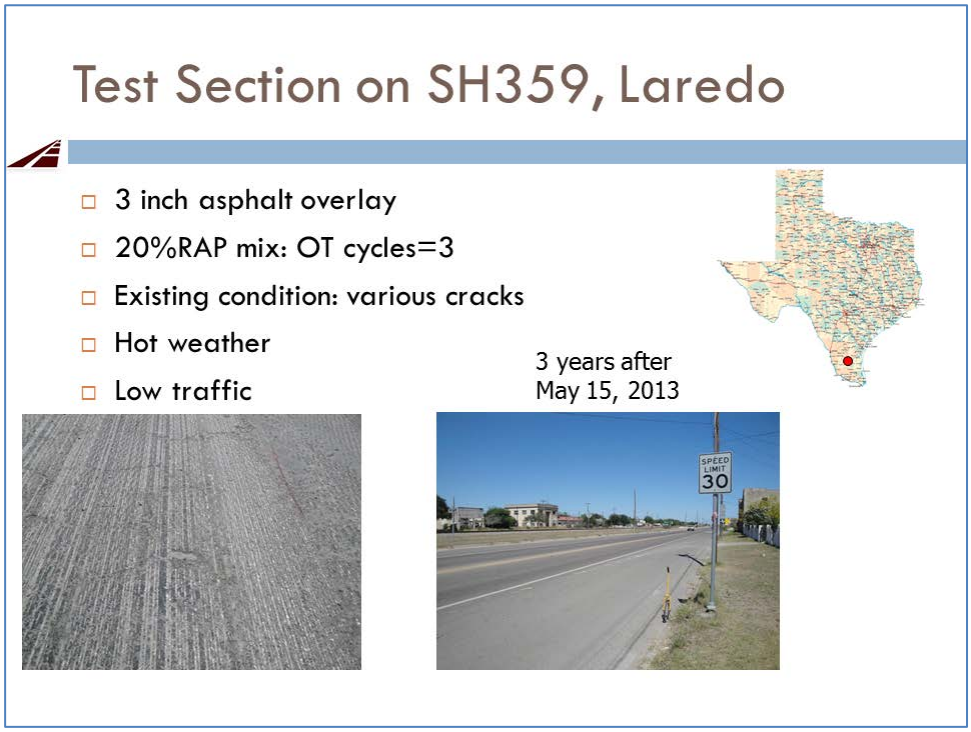
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** In this slide, the performance history of four test sections on IH40 is displayed. Apparently, the 30 percent RAP mixes designed with balancing rutting and cracking requirements performed the best.
Notes:	N/A



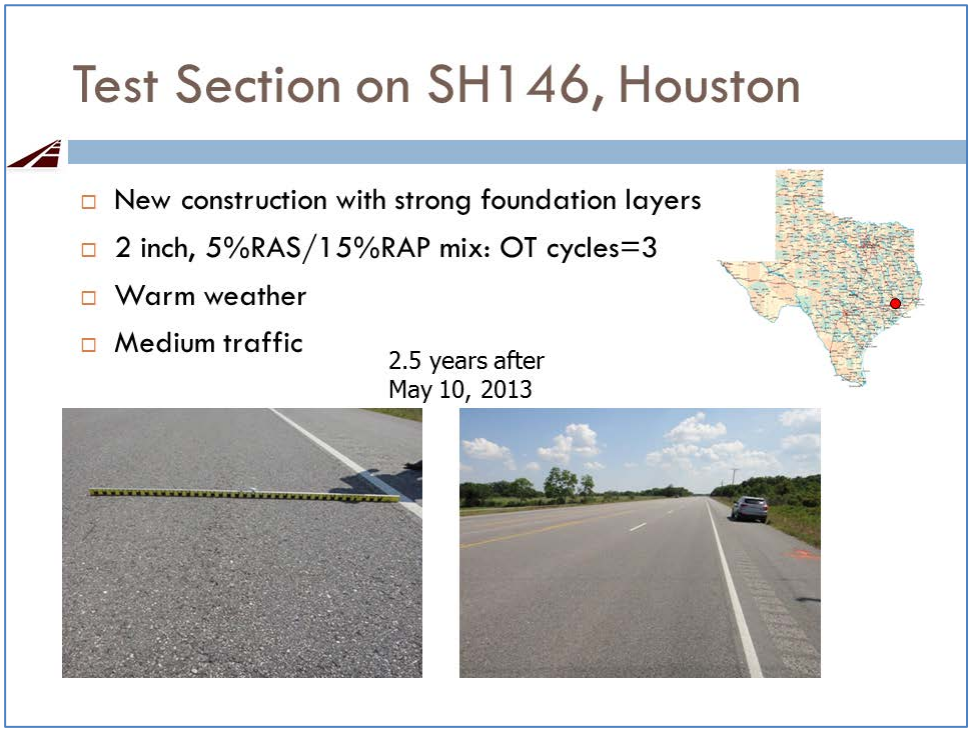
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** On FM1017, three sections with different percentage of RAP were constructed in a hot climatic area. The five features of these test sections are listed below: ▪ New construction pavement. ▪ 1.5 inch asphalt layer. ▪ Hot climate. ▪ Low traffic. ▪ All mixes with relatively poor cracking resistance.
Notes:	N/A



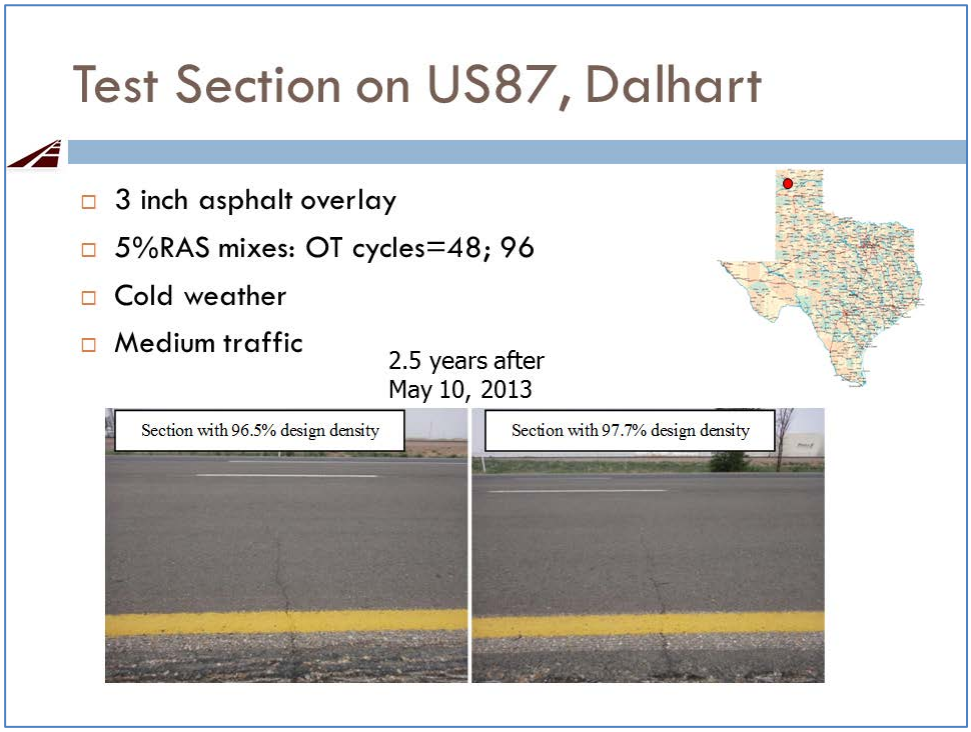
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This slide shows the performance history of these three test sections. It indicated that the performance of these sections is acceptable in the conditions of hot weather, low traffic, and no pre-existing cracks, although the three mixes have relatively poor cracking resistance.
Notes:	N/A



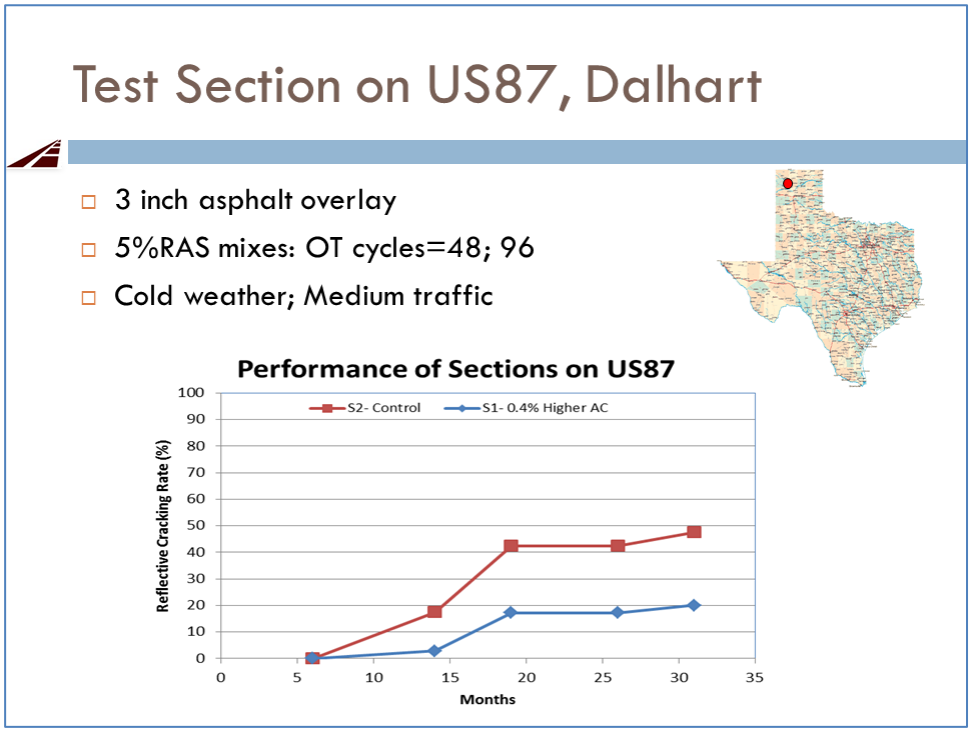
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** Another case for RAP mix with very few OT cycles performed well in the field due to low traffic and hot weather.
Notes:	**N/A**



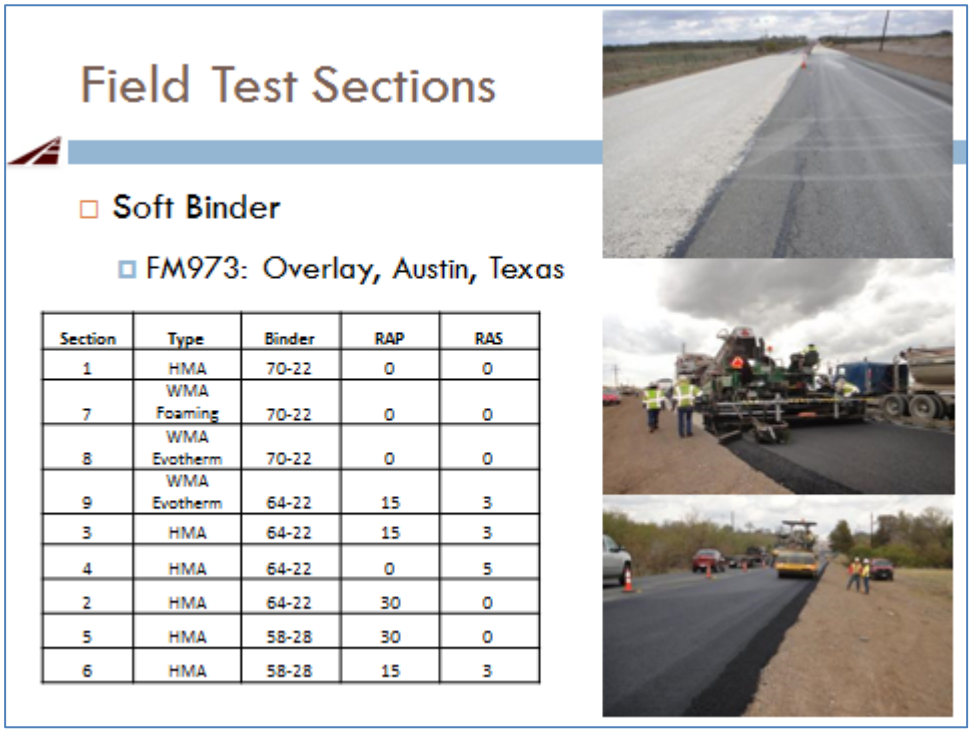
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This slide shows again that RAP/RAS mix has acceptable performance when it is applied in suitable conditions (new construction, strong foundation layers, warm weather, and medium traffic).
Notes:	N/A



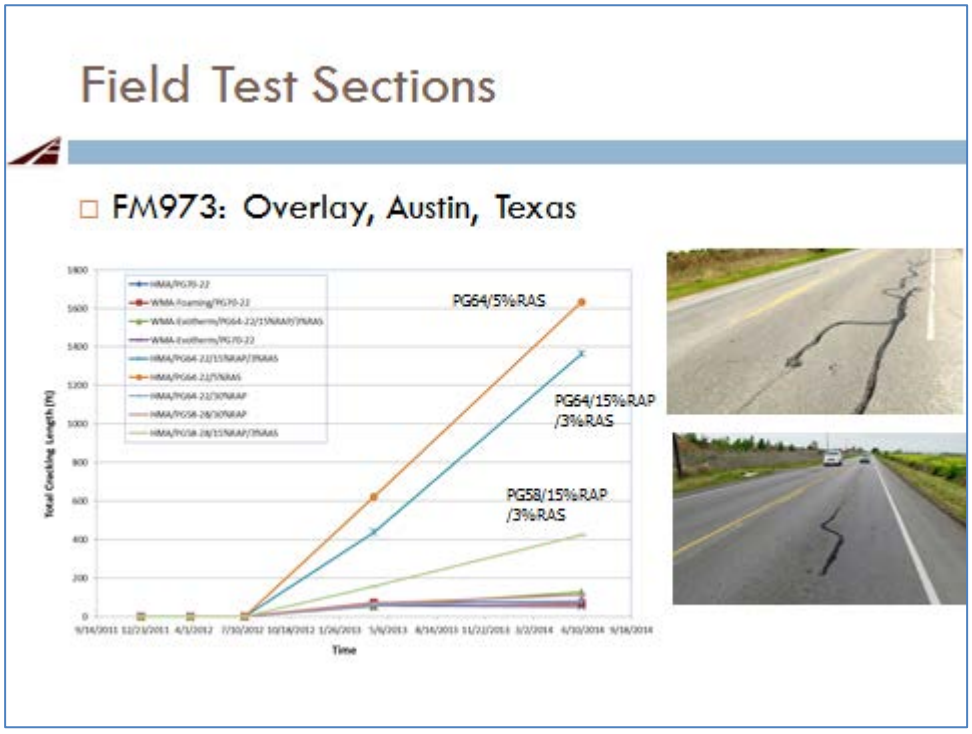
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This case demonstrates the impact of design density and extra 0.3 percent asphalt binder on cracking resistance of RAS mix.
Notes:	N/A



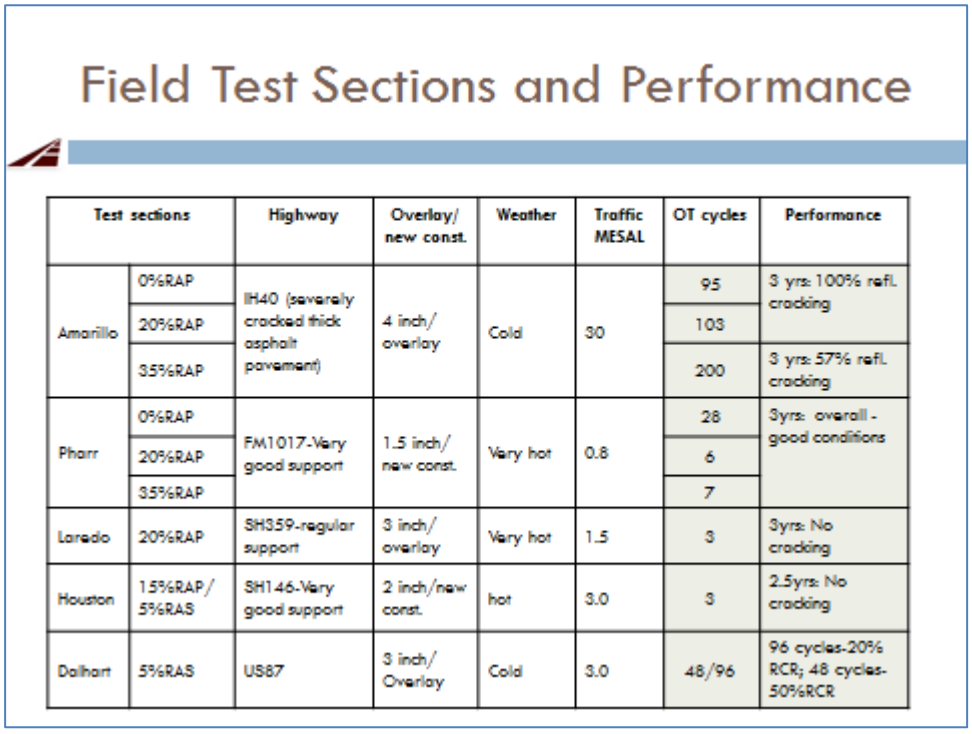
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This case clearly demonstrates the use of higher design density and higher asphalt content can improve cracking resistance of asphalt mixes, even in the coldest climate in Texas.
Notes:	N/A



Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** A total of nine test sections with different RAP/RAS combinations were constructed on FM973, close to Austin, Texas. One of the purposes was to validate the effect of soft binder on improving cracking resistance of RAP/RAS mixes.
Notes:	N/A



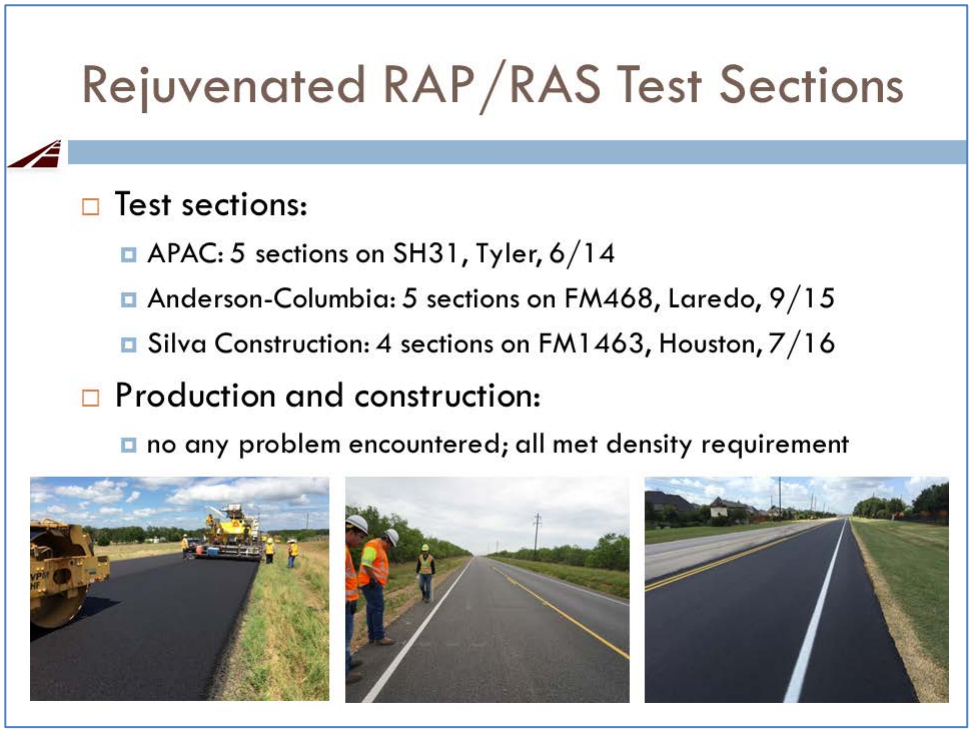
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** The performance of the nine test sections clearly demonstrates that soft binder worked well to improve cracking resistance of RAP/RAS mixes.
Notes:	N/A



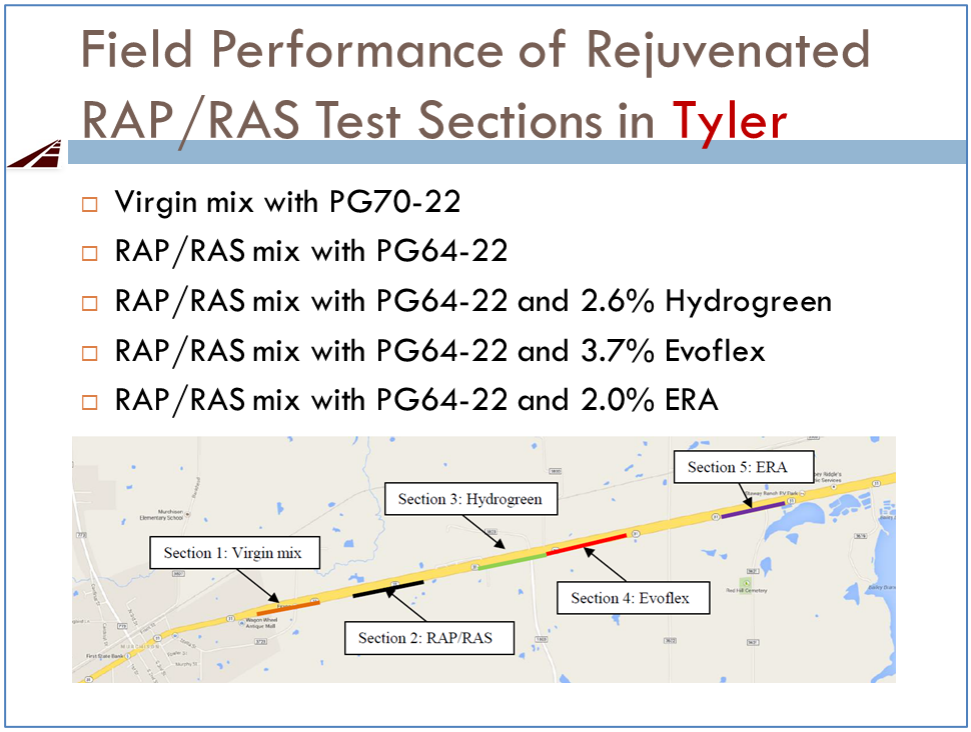
Field Test Sections and Performance

Test sections		Highway	Overlay/ new const.	Weather	Traffic MESAL	OT cycles	Performance
Amarillo	0%RAP	IH40 (severely cracked thick asphalt pavement)	4 inch/ overlay	Cold	30	95	3 yrs: 100% refl. cracking
	20%RAP					103	
	35%RAP					200	3 yrs: 57% refl. cracking
Pharr	0%RAP	FM1017-Very good support	1.5 inch/ new const.	Very hot	0.8	28	3yrs: overall - good conditions
	20%RAP					6	
	35%RAP					7	
Laredo	20%RAP	SH359-regular support	3 inch/ overlay	Very hot	1.5	3	3yrs: No cracking
Houston	15%RAP/ 5%RAS	SH146-Very good support	2 inch/new const.	hot	3.0	3	2.5yrs: No cracking
Dalhart	5%RAS	US87	3 inch/ Overlay	Cold	3.0	48/96	96 cycles-20% RCR_f 48 cycles-50%RCR

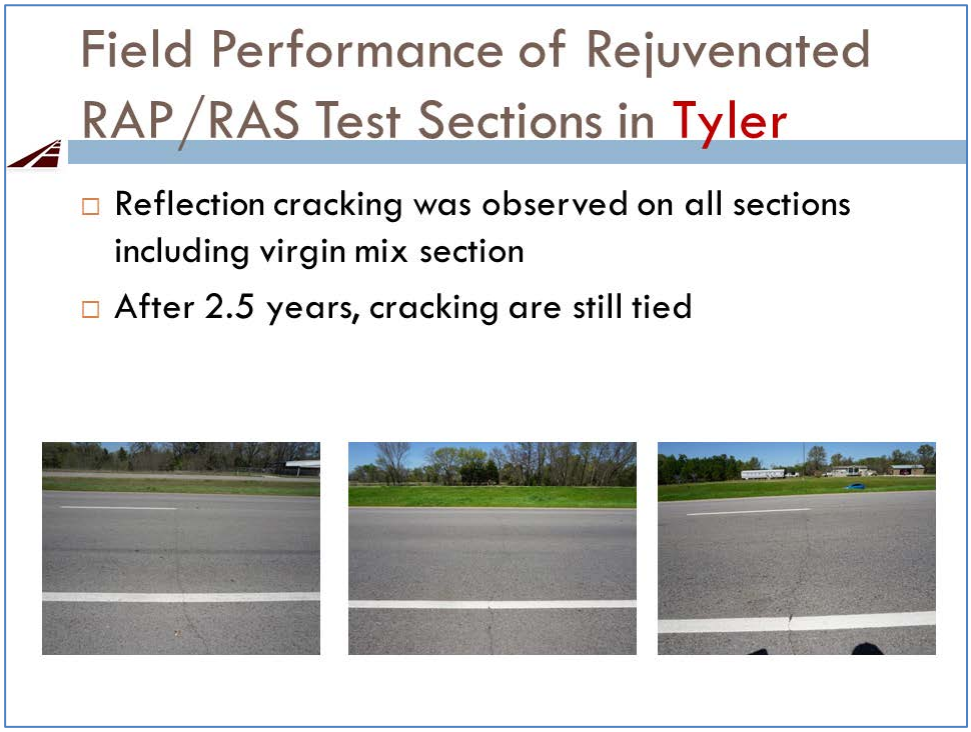
Key Message:	RAP/RAS field test sections and performance
Interactivity:	**Tell:** This slide summarizes the performance of field test sections and compared with OT cycles. It indicates that performance of RAP/RAS mixes depends on pavement structure, climate, traffic, and material engineering properties. They could have similar or even better performance than virgin mixes if designed and used in suitable conditions.
Notes:	N/A



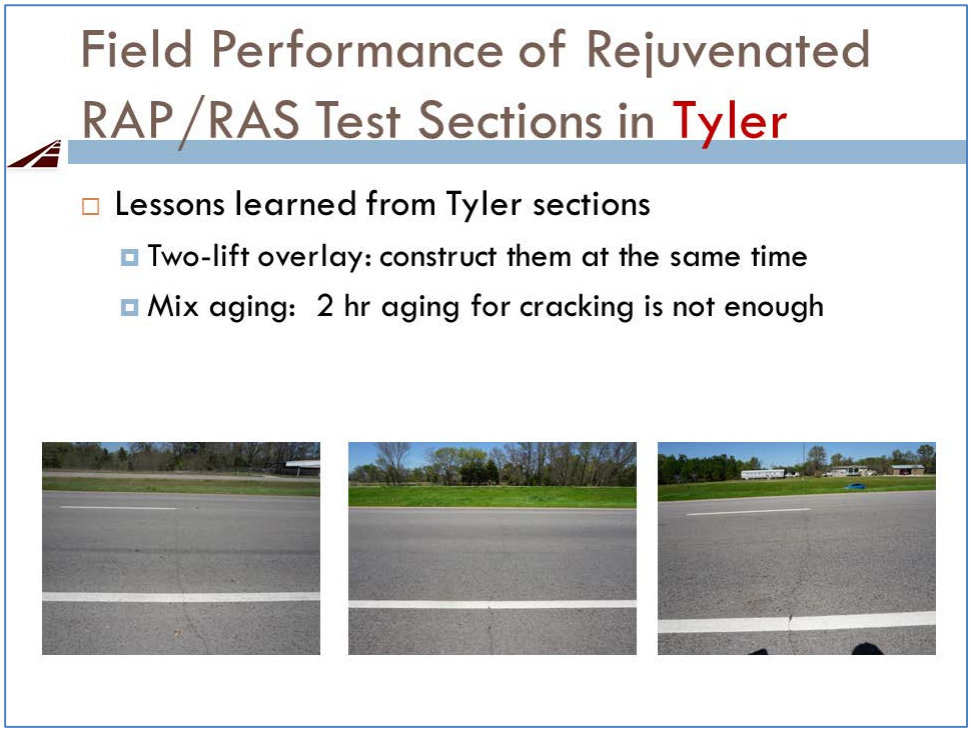
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** This slide describes all rejuvenator test sections constructed in Teaxs.
Notes:	N/A



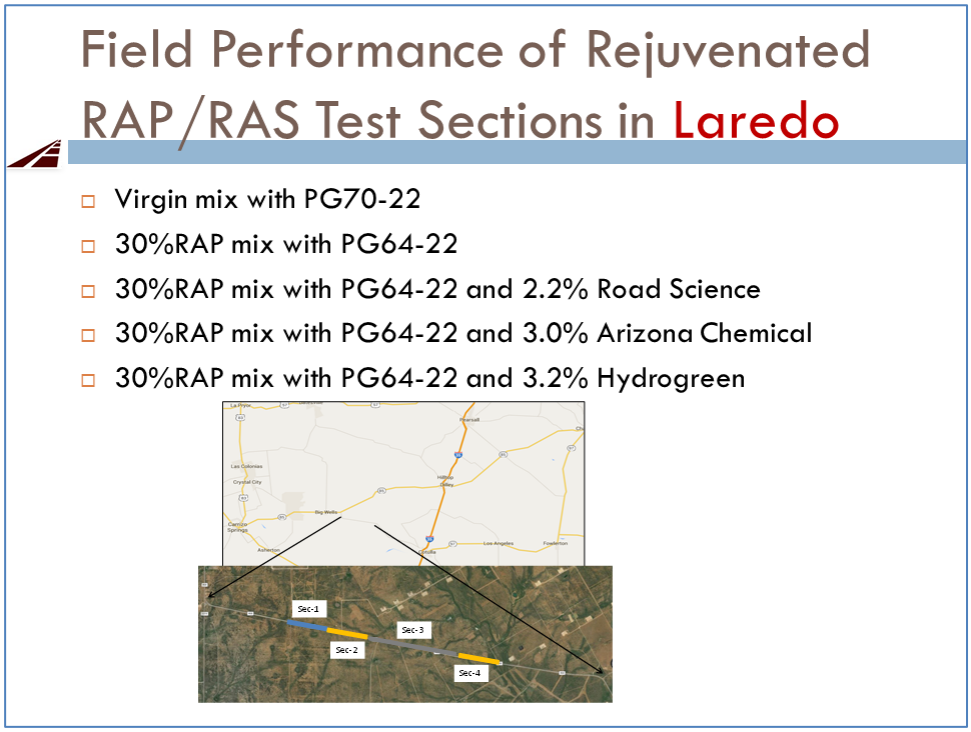
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** This is the first test sections with rejuvenators in Texas. A total of five sections listed in the slide were constructed on SH31 close to Tyler.
Notes:	N/A



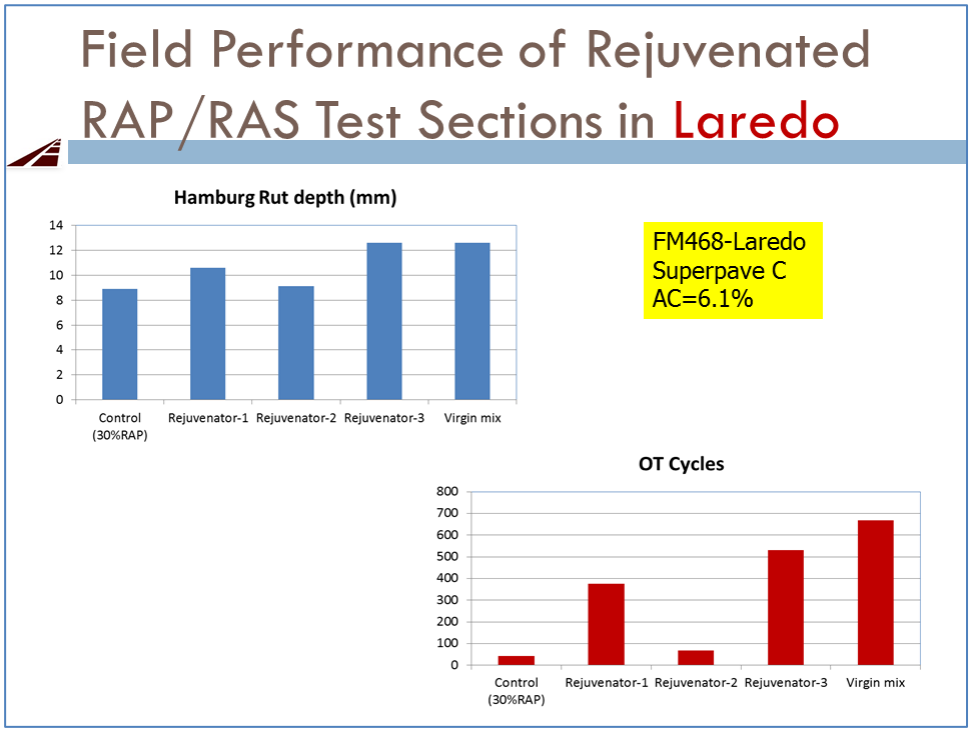
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** The performance of the five test sections is discussed here.
Notes:	N/A



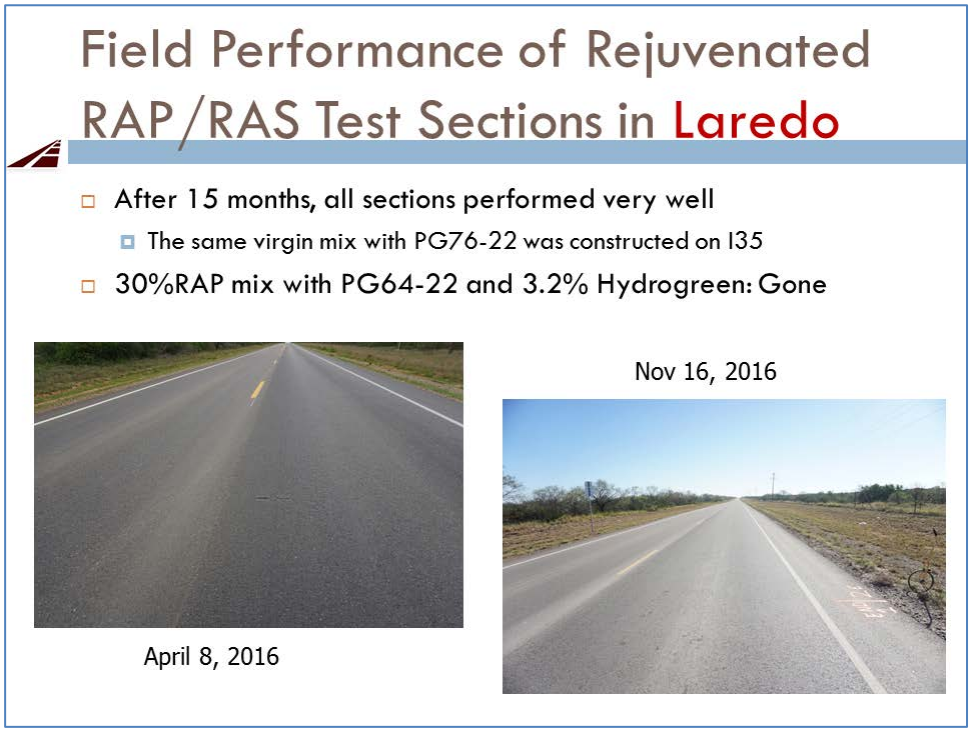
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** This slide discusses two main lessons learned from SH31.
Notes:	N/A



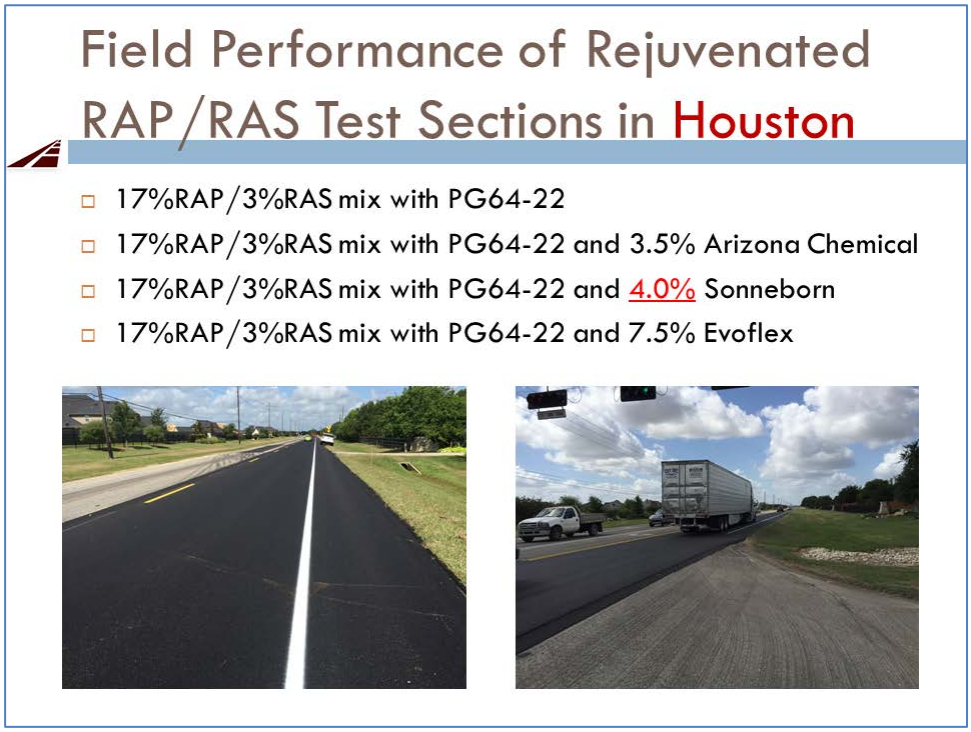
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** Another five test sections were constructed on FM468 in Laredo District.
Notes:	N/A



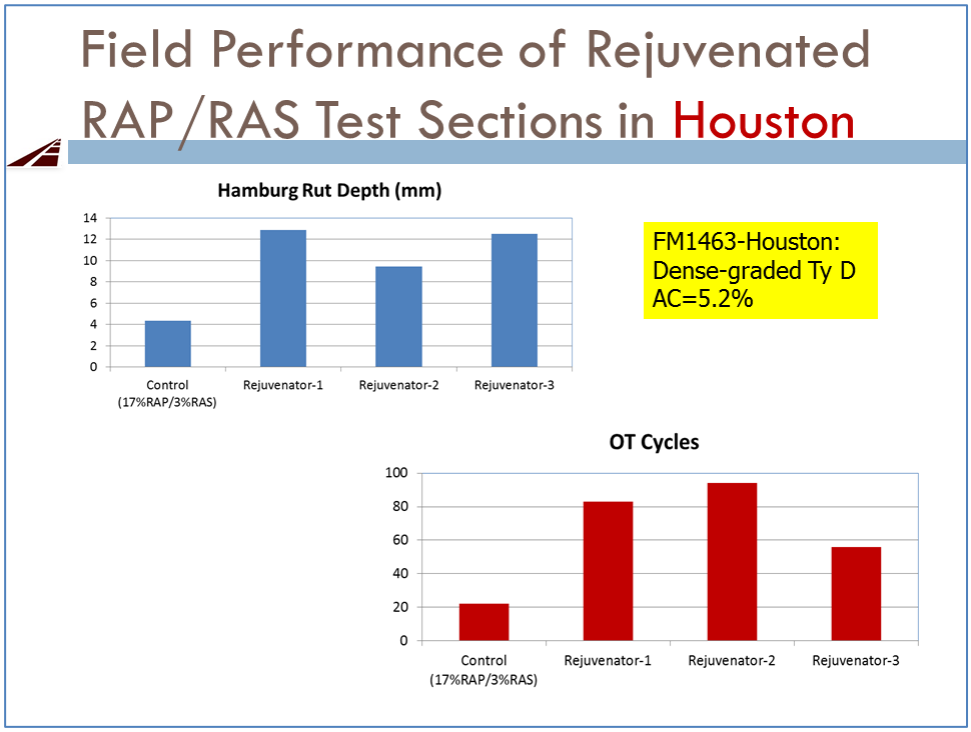
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** Laboratory Hamburg and OT test results of five mixes used in the field are presented in this slide. One lesson learned is that the rejuvenator has better effect when it is directly mixed with virgin binder. The direct spraying rejuvenator on the RAP materials turned out to be not that effective.
Notes:	N/A



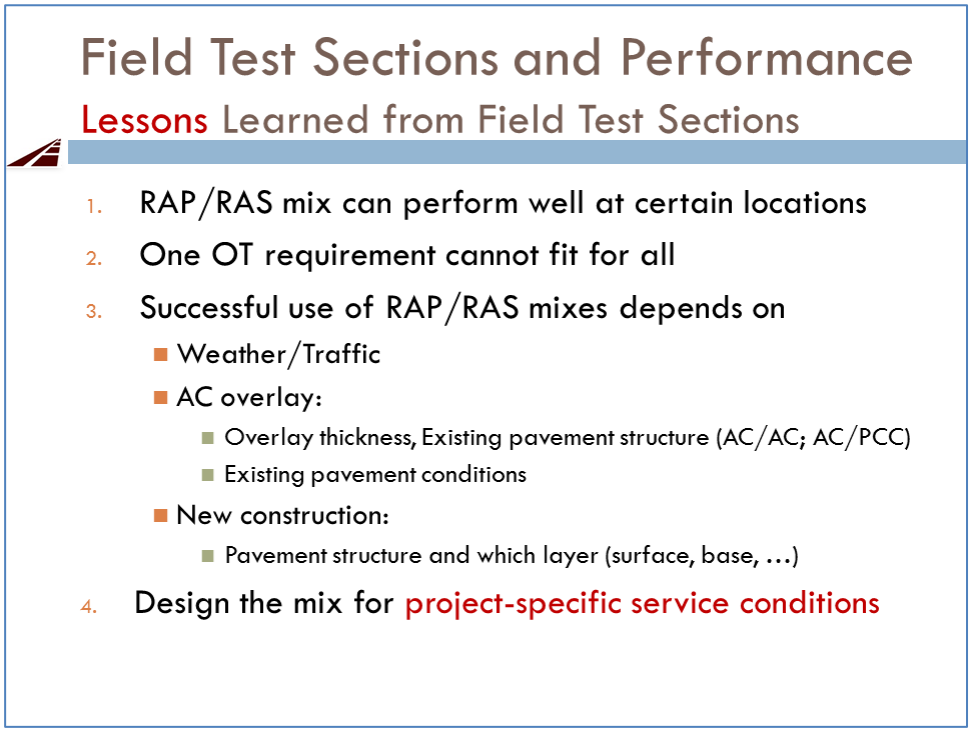
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** This slide shows that all five test sections on FM468 performed well in the first 15 months.
Notes:	N/A



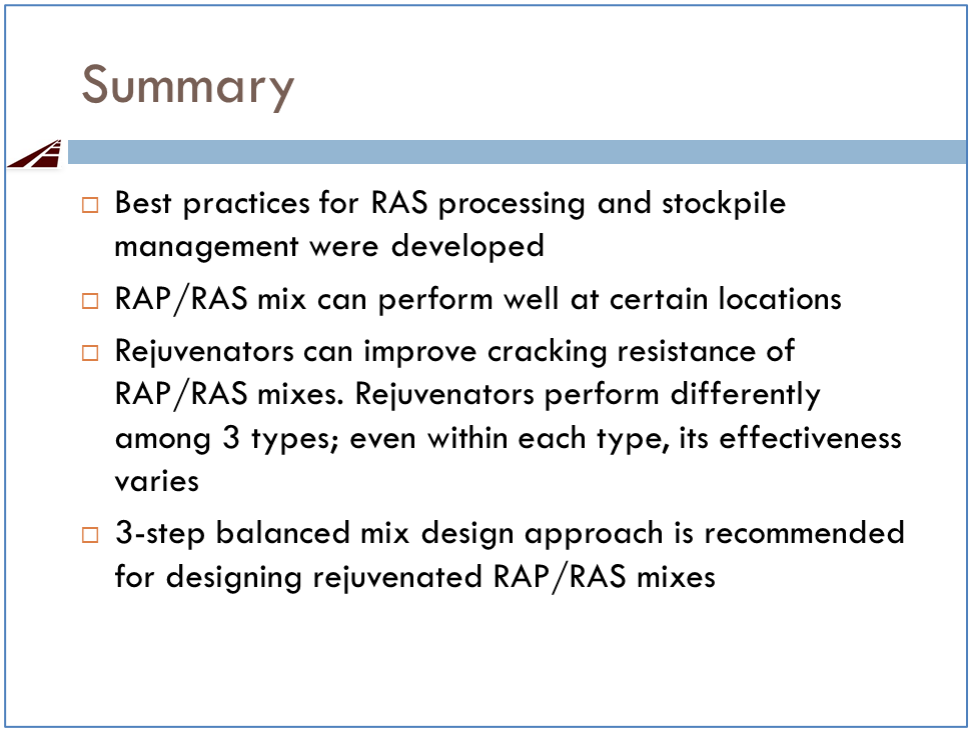
Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** Another four test sections were constructed on FM1463 in Houston District.
Notes:	N/A



Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** Laboratory test results of plant mixes from FM1463 are discussed here.
Notes:	N/A



Key Message:	RAP/RAS/rejuvenator field test sections and performance
Interactivity:	**Tell:** This slide summarizes all the lessons learned from field test sections.
Notes:	N/A



Key Message:	Summary of the workshop
Interactivity:	**Tell:** This slide simply summarizes this workshop.
Notes:	N/A

Key Message:	Q/A time
Interactivity:	**Tell:** It's Q/A time.
Notes:	N/A

Training Evaluation Form

for participants in RAS Best Practices Trainings

Date: _____

Title and location of training:

Trainer:

Instructions: Please indicate your level of agreement with statements listed below in #1–7.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The objectives of the training were clearly defined.	0	0	0	0	0
2. The topics covered were relevant to me.	0	0	0	0	0
3. The materials distributed were helpful.	0	0	0	0	0
4. This training experience will be useful in my work.	0	0	0	0	0
5. The trainer was knowledgeable about the training topics.	0	0	0	0	0
6. The time allotted for the training was sufficient.	0	0	0	0	0
7. The meeting room and facilities were adequate and comfortable.	0	0	0	0	0

8. What did you like most about this training?

9. What aspects of the training could be improved?

10. Please share other comments here:

Thank you for your feedback!