Meeting Overview and Organization

The TPF-5(504) pooled fund hosted its quarterly business meeting on March 27, 2025 from 9 a.m. to 1 p.m. CTS. The meeting was held virtually to maximize attendance.

Meeting Attendees

Timothy Andersen, MnDOT
Kean Ashurst, Kentucky Transportation Center
Hoda Azari, FHWA
Peyman Barghabany, Texas DOT
Dave Barry, Kontur
Gabriel Bazi, Consultant
Chelsea Bennett, MnDOT
Adam Berglund, NDDOT
Colleen Bos, CTC & Associates
Eric Botting, ARRB
Thomas Burnham, MnDOT
Thomas Calhoon, MnDOT
Ruben Carasco, Texas DOT
Manuel Celaya, AID
Marta Charria, Mississippi DOT
Seonghwan Cho, Indiana DOT
Sinan Coban, WisDOT
Melissa Cole, MnDOT
Paul Collins, Kontur
Shongtao Dai, MnDOT
Jerome Daleiden, ARRB
Brian Diefenderfer, Vermont AOT
Brad Frazier, Kentucky DOT
John Garrity, MnDOT
Majeed Hayat, Marquette University
Dwayne Harris, Indiana DOT
Steven Henricks, MnDOT
Katie Johnson, CTC & Associates
Michael Johnson, MnDOT
Gregory Johnson, MnDOT
Monica Jurado, FHWA
Samer Katicha, Virginia Tech
Peter Kemp, WisDOT
Mercedes Kuznia, MnDOT
Sang Ick Lee, Texas DOT
Jenny Li, Texas DOT
Pekka Maijala, Road Scanners
Ken Maser, Infrasense
Kent Martin, Kontur
Alex Middleton, Mississippi DOT
Patrick Miller, Olson Engineering
Soheil Nazarian, UTEP
Paul Nolan, MnDOT
Arlen Norris, NDDOT
Larry Olson, Olson Engineering
Matthew Park, Nebraska DOT
Aaron Perez, NDDOT
Jim Poorbaugh, Mississippi DOT
Avinash Ralla, Caltrans
Ian Rish, Georgia DOT
Ellie Smith, MnDOT
Cindy Smith, Mississippi DOT
Timo Saarenpää, Road Scanners
Jacopo Sala, Kontur
Marcos Sanchez-Pilago, MnDOT
William Stafford, Mississippi DOT
Bruce Tanquist, MnDOT
Curt Turgeon, MnDOT
Guangming Wang, FL DOT
Andrew Wargo, NC DOT
Ben Worel, MnDOT
Eyoab Zegeye, MnDOT
Thomas Zehr, MnDOT

Presentations and Discussions

1. Welcome
    - Eyoab welcomed everyone and provided an overview of the agenda.
    - Pooled Fund Members
        - 11 state members; 6 non-members; MnDOT leads the pooled fund.
        - The non-members are providing data but have not joined the pooled fund.
        - Planning for a combined meeting with TPF-5(518), Implementation of Structural Data from Traffic Speed Deflection Devices pooled fund in September in Virginia,

because there are many overlapping state members. Scheduling poll available at https://forms.office.com/r/haEtdwXK9T

- General overview of activities:
  - Reviewed the MnRoad test section construction, testing, and monitoring:
    - This is also open to use by other studies.
    - Hoping to have TPF-5(518) Implementation of Structural Data from Traffic Speed Deflection Devices pooled fund come in June.
    - Enrolled a graduate student to help process data from test sections.
    - The group has identified road project for Ken Maser to get data from.
    - More states than expected have joined the pooled fund, so the group can add additional tasks to the scope of the pooled fund.
  - Based on interest from last meeting, we are having a training session with Kontur today.
  - Eyoab welcomed NDDOT to the pooled fund.

2. Updates
   - **Development of tools and applications for automated detection of hidden pavement damages – Ken Maser, Infrasense**
     - Ken presented on methodology for implementing data into software that can be helpful for preventing stripping.
     - He started by defining stripping:
       - One practical way to define it is when you have a disintegrating core.
       - Ken noted that in Georgia, they define it based on whether it fails a Hamburg test.
       - In Illinois, they use indirect tensile test to identify stripping.
       - The present study is focused on detecting stripping present in pavement. It will not measure the susceptibility of pavement layers to strip. The stripping must have already occurred to be detected by the NDT technologies
     - Ken reviewed how GPR can indicate stripping. It gives an indication, but it's more suggestive than definitive.
     - Because of that lack of clarity, they want to add other data that might be more helpful in assisting the decision-making process, such as:
       - Deflection data (TSD or FWD)
       - SASW data
       - Surface distress
       - Combining GPR algorithms with supporting data
     - Ken reviewed the project tasks:
       - Data collection
       - Preliminary data analysis
       - Develop specifications for stripping analysis method
       - Develop the prototype analysis system
       - Develop the user-oriented software

    - Training and Documentation
- Data collection is complete and they are heading into preliminary analysis.
- They had two sources of data:
    - From MnRoad test facility.
    - From 10 states, including multiple locations.
- From MnRoad
    - They tested different sections with different layers and different materials. Some sections had stripped areas inserted into the layers.
    - SASW showed consistent correlation with stripped sections.
    - Looked at combined PSPA and FWD data with 3-D GPR.
    - Summary
        - 3DGPR was more sensitive to Level 2 defects (coarse).
        - PSPA appears to be sensitive to all defects.
        - FWD more sensitive to Level 1 (graded) material.
- Discussion:
    - Eyoab: I appreciate definition of stripping. The goal is trying to understand the pavement deterioration. In the beginning, the focus was "stripping" but is now the pooled fund's efforts are meant to include hidden subsurface damage and finding anomalies in pavement under the surface. The goal now is to find subsurface damage of all kinds and get away from just "stripping."
    - Ken: Stripping is a cause. But "damage" may be too broad. In situ stripping is moisture and voiding that can be detected.
    - Eyoab: So we should just be clear that it's "in situ" stripping that we are focused on.
    - Dai – Q: SHRP2 attempted to detect delamination with GPR and they couldn't detect that damage.
    - Eyoab – Happy with the results from PSPA. They are successfully using 3DGPR for project scoping. They recommend critical areas for coring. They have reduced the number of cores used to understand road condition. They may be able to reduce that even further using PSPA.
    - Ken: Yes, coring is hit or miss. PSPA would be much more effective to know where to core.
    - Ian – Q: For states with "classical stripping" he'd like to see a detailed list what types of stripping states identify that is not detectable by non-destructive testing and therefore what kinds of stripping still require destructive testing.
    - Eyoab: Hamburg or lab tests tells you if the pavement is susceptible, but not if it's actually damaged.
    - Ian: If over half of a project fails Hamburg, they know that a deep tilling machine that they are going to use will cause ruts based on Hamburg testing. Basically, construction activity is going to cause damage even if it's not yet damaged. Other states may be looking stripping that occurs

from construction load versus as a result of regular traffic. Destructive testing still required for some circumstances. Just need to state where non-destructive testing doesn't succeed and where destructive testing is still needed.
        - Eyoab: Agree that this would be valuable in the final report
        - Ken: Construction loads are much higher than traffic loads and they induce failures that wouldn't occur due to traffic loads.
        - Jacopo: Related to what Ian is saying, have we simulated those conditions? He assumes not but wanted to be clear. Pavement that is more susceptible to stripping in the future can by identified by Hamburg test? He notes they have NOT simulated that. In case we do get data on something like that, it would be interesting to analyze the signal. More trying to detect properties than specific types of anomalies, but it would be interesting. Perhaps it's a problem that can be solved in the future.
        - Soheil: They was a study on the delamination of interstates in Atlanta, run by ARRA. They were trying to use GPR to detect issues 10 years ago, right Ian?
        - Ian: Right, early 2000's report for ARRA to try to use GPR to detect delamination. GPR showed delamination in particular types of pavements, but others it did not. So, they switched about a decade ago to Hamburg.
        - Soheil: Ian will send report to Eyoab and Ken. Might be some useful data.
    - Now Ken is looking at data and documentation from the ten states:
        - Identified core locations in the GPR data
        - Matched core conditions with GPR data
        - Calculated SCI_12 or SCI_300 from TSD/FWD data
        - Matched core conditions with deflection data
        - Evaluated cracking data at core locations where available
    - They are looking for patterns to see if you can identify deflection in areas that are stripped.
    - Ken identified the next steps for the project and the schedule.
    - <u>Discussion</u>
        - Brian D – Q: Would you expect to always see a reversal in polarity of the GPR data at the stripped locations?
        - Ken: Not necessarily. If moisture is trapped, it could give same polarity as bottom of asphalt whereas air voids give reverse polarity. They are trying to combine data to get a more complete analysis. The challenge of cores is that they are so local.
        - Eyoab: Adam from North Dakota thinks they may have some additional data to send if it's not too late.
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- **Road Doctor Software results from MnRoad stripping test sections – Pekka Maijala**
    - Pekka presented data regarding the MnRoad stripping testing and data that analyzed falling weight.

        - The frequency-based technique is best at identifying anomalies that might correlate to stripping.
        - High frequency includes fractures and delamination that result in signal scattering.
        - Low frequency includes moisture in all layers, deeper layers and fines
        - A strong reflection indicates a sharp change, in moisture, stiffness or a metal object.
        - Measurements are in a time window, not just a single reflection.
    - Pekka also reviewed data from a project in Finland.

    - Discussion
        - Eyoab – Q: We wanted to confirm that GPR can indicate subsurface defects. Is the algorithm you show already available?
        - Pekka: Yes, it's in Road Doctor
        - Eyoab: Next meeting you can show us how this works with real ground truth data and that's available to you.
        - Pekka: Yes, that is perfect. We do not have as much ground truth data from delamination and stripping.
        - Ken: DST data is 50-foot average or 10-meter average. It would be good to have higher resolution. We recently have been getting data at 5cm spacing. It's noisier, but there are filtering methods from DTI and others to clean it up and look at joints and load transfer at joints. He thought about that in terms of stripping, but it's so much data that he's been reluctant to ask anyone to provide it. But if it's important to get more detail, the data is available.
        - Ken – Q: With the frequency analysis, did you do this by processing the 3D radar data in different frequency ranges in Examiner or was it something else.
        - Pekka: It was in Road Doctor. We tried to filter as little as possible and use that as a starting point for frequency analysis

- **IE/SASW results from MnROAD Stripping test section – Pat Miller, Olson Engineering**
    - Pat Miller presented on the sonic surface scanner which provides spectral analysis of surface waves:
        - Limited to a 1 mile per hour rolling speed.
        - Impact Echo (IE) test is a resonance test method.
        - From this data, they develop a dispersion curve.
        - See drops in velocity at the depths of stripping.
        - IE testing best on cold asphalt.
        - Spectral Analysis of Surface Wave (SASW) is applicable for the full range of temperatures.
        - SASW looks at relative changes, which is why it still works.

    - SASW good at identifying stripped pavement layers.
    - Need to improve the automation of the data analysis.
    - At MnRoad, they took 9 lines of data 175-feet long. Almost 7000 test points in an hour.
    - The main limitation is that it requires traffic control due to speed.
    - Reviewed a visual summary of results.
    - They looked at how to combine data into the best format for visual analysis – showing deep versus shallow defects more clearly.
    - Working with Gecko robotics on a miniature version and they have Cantilever software for analysis.
    - Running their data in to Cantilever software to see if it identifies subsurface defects, which it can analyze in about 5 minutes.
    - Preliminary conclusions:
        - IE testing worked well to identify all defects.
        - SASW worked well on the top 6 inches.
        - The SASW Z Score simplifies the SASW analysis/ interpretation.
        - Cantilever software is showing promising results in automating analysis.
- Discussion
    - Jerry D – Q: Pat's Z scaler idea would be interesting concept to apply to 5 cm data. Pavement is complex and variable, but if you normalize it, you can see the outliers and get past the concern of being buried in tons of data.
    - Ken: That's exactly what we do. We remove the background, so the joints stand out more clearly.
    - Eyoab – Q: Very excited about these results. Do you collect thicknesses?
    - Pat: Impact echo calculates thickness based on velocity.
    - Eyoab – Q: Same equipment can give layer thickness and stripping. If you keep all that data from 10 or 20 miles of road, then you can calibrate to depths and see if stripping is really stripping or some other issue. If equipment is ready, he would like to push to have verified data if the equipment is ready. Would you like to see that?
    - Ken: As Pat said, you have to know the module of the velocity to get the thickness. They are relative thicknesses based on assumed velocity. You have to know velocity of wave to get actual thickness.
    - Eyoab: New pavement section is 6 inches, and the old section is 6 inches.
    - Pat: All defects should be in top six inches?
    - Eyoab: Yes
    - Larry O: They will update based on that thickness. With the additional caveat that it works best with cool pavement.
    - Eyoab - Q: Ken is looking at several roads and he is coming up with an algorithm. Would you be able to collect data on those roads to collect and verify data? Could we get a quote for that?

- Larry O: Yes, we certainly can. Cantilever software will help a lot with data analysis
- Eyoab: Timewise how long does the road have to be closed.
- Pat: Test section was done in 1 hour for 7000 data points. They can cover a lot of ground in a day. It depends on what kind of coverage you want.
- Eyoab: Does anyone see value?
- Dai - Q: Yes, he sees the value. We need spot test to verify defect areas. For Z score, do you need to have some threshold for it to show up?
- Pat: Yes, there is a threshold set here. Showing test points over a certain threshold.
- Dai – Q: Different thresholds for different locations?
- Pat: Yes, you can back it off when you see too much noise.
- Dai – Q: What is the sensitivity of the module?
- Pat: When asphalt is warm, the velocity is slower. But the relative change at a defect was about the same. Flag when they are more than a 10 or 20% change of normal for that project.
- Dai – Q: Surface binder is different than the lower lift?
- Pat: Because they are not modeling it, they will see a slight increase in velocity by depth. But they are looking at relative changes to get the Z score. They are taking into account the different layers.
- Eyoab – Q: We will have a closed meeting with members to determine whether the states are interested in including this in the study. Would you find this helpful?
- Ken: Would be useful to look at areas where stripping is identified. It would be nice to have this in addition to core data. Question is where does this best fit in the process? But the idea is useful.

3. Idea solicitations and discussion
    - The discussion above regarding Olson testing at the state sites is something that they will follow up on in a closed meeting with the state members to decide additional topics of interest for the pooled fund study to address.

4. Kontur Examiner training with case studies – Paul Collins

- Paul Collins provided training on the Kontur Examiner software and covered the following:
    - Best practices and guidelines for data collection and data analysis
    - Case studies
    - Q&A after the training
    - Kontur is the manufacturer of the GPR used in this study.
    - He provided an overview of Examiner Specialist:
        - Meant to analyze large areas of data very quickly.
        - Simple navigation via the software interface.
        - Templates for processing and previewing data.

-  QR code for a 3 month Examiner demo key

- Where the data comes from:
    - Multiple antennas attached to the vehicle to gather data horizontally and present it that way, so it's intuitive to interact with.
    - Today presenting data gathered by Roadscanners.
    - Data was collected the day after paving. It was an overlay on an existing road.
        - Dielectric mapping used.
        - Also records radar data.
    - Purpose of the survey is less important than learning about the tools from the data
    - Looking at Examiner, he demonstrated in detail how to be hands on with the software, including:
        - Choosing a template for data process.
        - Navigating Examiner.
        - Finding help resources and understanding the layout of the menu ribbon.
        - How to bring in data and maps.
        - How to import details like marker posts or other reference points.
        - Importing density and dielectric.
        - Exporting dielectric to Veta and other export capabilities.
        - Filtering data, including the underrated gain filter.
        - How to combine data streams to look at the roadway and click into spots.
        - How to customize your view.
        - How to export data as a CSV file.
        - And multiple ways to save your report with logos and generate a PDF.

- <u>Discussion</u>
    - Dai – Q: Since you have dielectric constant, can you use this to determine thickness?
    - Paul: Yes, you can use the dielectric value to apply that to your interface measure.
    - Dai – Q: So you can capture the thickness at each location?
    - Paul – Yes, and it's vehicle mounted so its very stable. For example you don't have to stay on top of a particular line. Positioning is very stable.

    - Ken – My understanding is that dielectric capability is in Mark VI, but not Mark IV
    - Paul: Correct, we built it after the prototyping with MnRoad, so it's in Mark VI.
    - Eyoab: When we collect data for thicknesses and stripping, we use 21 channels. Can this algorithm be applied to this data?
    - Paul: MnRoad has an advantage, because Kyle already knows how to collect the data using dielectric.
    - Eyoab: But this is a different set of data collection. If we are collecting GPR data, I won't be able to apply that.
    - Paul: Not sure if that's possible. It might be, but he needs to check.
    - Eyoab - Q: During the analysis phase, you want to clearly see the target. Are there guidelines or templates you recommend?
    - Paul: Recommendation is start with a template and not make your signal processing chain too large.
    - Eyoab – Q: One question they get a lot, if you have asphalt with aggregate base layer beneath, So, they want to measure the 2 layers. How do you measure base to subgrade?
    - Paul: He recommends the gain filter and he demonstrated how that works.
    - Eyoab – Q: Is it possible to import a CSV?
    - Paul: Yes. But then you still have annotation.
    - Eyoab - Q: Can there be segmentation on depth?
    - Paul: Yes, we'd appreciate that feedback. Can you share an example.
    - Eyoab: I have put some graphs in the chat for you to look at.
    - Eyoab (from chat): "This is segmentation based on Daubechies wavelet as proposed by Adam Zofka. I would really love to see some sort of segmentation to your layer thickness reporting."
    - Paul: Perfect, thank you.

- Wrap Up
    - Everyone expressed appreciation for the software demonstration.
    - Paul indicated that he can refine his presentation to focus on specific topics if needed.
- Questions:
    - Monica: This could be a good topic for the FHWA monthly webinar series. MnDOT and Kontur could present. Sessions are an hour, and they are looking for June and July speakers on the fourth Monday of the month.
    - Eyoab: Yes, we could do that.
    - Eyoab: We are overtime, so we'll plan to hear form Adam next time.