DPS 101 Questions

1. *Another good rule - every 1% enhancement in in-place pavement density equates to a conservative 10% extension to the service life of the pavement, all else being equal.*

   Thank you or the comment. That is consistent with the findings of Linden, et al. (TRB 1217, 1989) which state, "pavement life is reduced 10% for each 1 percent increase in air voids over a base level of 7 percent."

2. *Does vibration of robot/vehicle/gator affect the DPS results?*

   Visually, the sensors start to vibrate when they move faster than 5 in/s across due to the moveable bracket. At this rate, initial tests suggest the vibration does not have a negative affect on DPS results. To date however, we have only tried the Gator and Robot on MnROAD. We need to evaluate both on the full rigor and wear and tear of day-to-day testing on a project. MNDOT will do this evaluation throughout this construction season with the gator moveable bracket and hope to do similar with the robot by the end of this year's construction season.

3. *Have the paving contractors embraced the technology? Are they seeing benefits?*

   Ohio reports that industry is very interested and engaged in the technology. Minnesota reports contractors are excited that they can see results right away, unlike waiting for cores. On a project where echelon paving was used, DPS was able to show differences between placement and rolling patterns that prevented a potential failure point at the longitudinal joint.

4. *Technician certification for requirements for DPS?*

   Task 4 of Pooled fund study addresses technician certification. Fabricio Leiva from NCAT is taking the lead on this. He will update

the pooled fund participants on his workplan and take comments at the pooled fund members on April 6th. Kyle Hoegh from MNDOT will provide a summary of this during the DPS Workshop on April 20th.

5. *What type(s) of mix change(s) require new mix calibration?*

   We are currently evaluating this question as part of the pooled fund study and the more data we gather, the better we'll be able to quantify exactly what requires a new mix calibration. Generally speaking, the following is true from my experience:

   a) The calibration appears vary stable from day to day if no major changes to the mix occur.
   b) The most significant cause for a need for recalibration is a change in aggregate source, which does not happen often in Minnesota. The major example of this was a project last year where the same mix design was used but a limestone restriction on the final lift caused a large shift in the calibration. We will show that example again at the data analysis pooled fund meeting on April 6th. Minor binder content or other changes appear to have less of an effect.
   c) With the puck testing kit 2.0, we will be able to monitor the design void puck for each sample throughout the day in addition to day-to-day, which should provide some additional insight on exactly what changes trigger a need for full re-calibration (design, medium, and high air voids).
   d) What we are requiring now for research purposes is likely much more stringent than what we will eventually be able to specify for deployment after we get a larger database. We are also still validating the puck-based calibration (correlation between dielectric and air voids) with field cores, so that also helps give feedback as to how well the puck-correlation is performing.

6. *Any recommendation on number of passes to collect the data for a given location? Is a single pass enough for a given location?*

   This is a function of what you are trying to accomplish and how much time you have. For a moving traffic control operation and a walk-behind cart, you may only be able to have one pass in some locations along the project. In this case, you may want to prioritize the centerline joint pass and periodically do swerve or straight-line mat passes. The footprint of the measurements are only about a 6 in. radius, so there will be gaps if you do the straight-line passes. There is also the means of collection that comes into play (i.e. collection data with a 3 sensor walk-behind cart would be up to 15 miles of walking per day if you required 3 passes per section, whereas it would be more feasible for a vehicle, robot, or gator-mounted system). We have recommendations for data collection coverage on our pooled fund website, but this is a constantly evolving procedure as we get more data and determine the best ways to use and analyze it. We will continue to update the training documents as the technology changes and can periodically change our recommendations as we get new data or analysis methods. At the end of the pooled fund study, we will convert all the training documents to a draft AASHTO specification to hopefully account for as many of the scenarios and Agency needs as possible. For current recommendations go to the website.

7. *If RDM antennas show a bias higher than the defined criterion, is there any procedure to fix the problem other than repeating calibration process?*

   It is a good idea to check with the vendor if re-calibration does not take care of the issue. For example, we had an internal temperature calibration issue and sagging outside sensors (Ohio DOT and NY DOT had similar issues too). We reported the data from the out-of-spec

calibration and the vendor took care of it for us (new calibration file for the temperature issue, and new mechanical hardware for the sag issue). The key is to conduct the bias or data quality checks so that you get the problem taken care of as soon as possible, so days or weeks of data are not collected without addressing the issue. If you re-calibrate and still have a sensor out of spec, it is a judgement call. For example, you may still want to finish out collection with 2 sensors or still collect with 3 and filter it out during analysis until the vendor can resolve the issue. For full deployment, we will likely have to have spare sensors with a short turnaround time for replacement in cases like this where recalibration does not affect the issue.

8. *3 sensor array vs. 2 w/Gator launched DPS?*

   The gator also has 3 sensors. In one of the videos we had a sensor fixed at the joint with the others moving back and forth. As to which is better, we will have to wait and see how it goes this construction season.

9. *Were additional cores taken in the half mile section to verify the density drop offs?*

   No, although we can be fairly certain based on the DPS data and corresponding ICT data that the drop off is "real." Especially, since the core that was taken in that area matched the DPS measurement well. It may still be worth doing some addition coring to confirm this is the case. It will also be interesting to see if this section fails first! The Contractor did a great job other than that ~0.5 mile section so it likely will fail first.

10. *Will there be any issues when testing pavements with high fraction of RAP using DPS (say up to 50% replacement)?*

AKDOT suggests high fraction RAP mixes are not a problem if the RAP is fractionated into Coarse, Medium, and Fine fractions and the contractor maintains a consistent blend of the fractions such that RAP gradation and asphalt content are consistent as they are fed into the hot plant with the virgin aggregate.

MNDOT has not specifically tested this, so it will be interesting to see. The mixes MNDOT tested were more like 10% RAP. It would be a function of how much dielectric variability there is in the specific RAP material being used. Using the puck testing kit on every design void sample for a project using 50% replacement is easily doable and would be a good way to answer this question.

11. *Any generic guidance on how long to wait after a rainstorm to test pavement with DPS? Is ensuring a dry surface adequate? Is subsurface moisture a concern?*

AKDOT reports that visual inspection for excess water during night paving is difficult. However, the DPS system quickly goes over 100% compaction when there is water in the pavement as water absorbs RADAR wavelengths 80 times better than air and about 16 times better than asphalt mixes. So, the DPS System operator immediately knows the mat has excess moisture. During daytime paving simply tape a one-foot square of clear polyethylene to the pavement with duct tape and wait 10-15 minutes (or less in full sunlight) then pull it off and look for moisture on the plastic surface that was in contact with the pavement.

OH DOT reports that if the pavement looks dry, it is generally okay. Minnesota reports testing right after the final roller as soon as the

pavement appears to be dry. Water lines from the roller do cause spikes in the data. Are looking at the possibility of incorporating moisture measurement sensors.

12. *If the height of pucks changes the correlation of dielectric constant to air voids, do variations in HMA layer thickness affect the DPS readings? Do underlying layers affect the readings?*

Calibration with pucks is done with travel time from direct transmission of the signal through the puck, so thickness is critical. Normal measurement is based on the reflected signal. Similar to a nuclear gauge, the reflected signal is more highly influenced by the upper inch of the surface. Problems could occur with a very thin surface over concrete (like thin bonded wearing course) or with very thick (4- to 5-inch-thick layers). Testing is being done on thick layers at MN Road. Fabricio Leiva will also look at this as part of the pooled fund study. Generally speaking, the lift thickness is not an issue when the asphalt lift is placed on top of asphalt like a typical mill-and-overlay since there is no significant dielectric contrast.