Overlays Webinar 3 – Questions and Answers

The questions submitted during the webinar follow with answers that our speakers have provided. Please note that there are several references to CP Tech Center guides and reports that are available without charge in PDF format through the website: https://cptechcenter.org/concrete-overlays/

1. Why is nonwoven geotextile used rather than woven geotextile?

   The primary reason is transmissivity or drainage. Non-woven geotextiles can provide lateral drainage to help remove water from the pavement structure. There have been overlays built with woven geotextiles, but currently the standard is non-woven. CPTech Center's resources page on Geotextiles provides additional guidance on the use of these as separation layers.

2. Why use PavementDesigner if it is using the same formulas as AASHTO 93?

   PavementDesigner and AASHTO 93 only utilize the same modifying equations for overlays. Both procedures utilize their own design equations for a conventional Jointed Plain Concrete Pavement (JPCP) design and then utilized the modification equations to determine an appropriate thickness for the overlay. These equations can be found in the AASHTO 93 Guide in Part III Sections 5.8 and 5.9 along with an explanation of how they are applied.

3. How are rumble strips for safety installed in concrete shoulders?

   In Colorado & Wyoming, they are installed during the paving process by using a drum attached to the paver that forms the rumble strips into the concrete. Some states require that the rumble strips be milled in hardened concrete rather than constructed as part of the pavement finishing operation.

4. What type of traffic control was used for CO overlay projects?

   A pilot car is used for traffic control on most of the overlay projects on 2-lane highways in Colorado. Maximum delay times are typically specified in the bidding documents, and closure lengths for work areas can be adjusted to maximize production while working within the delay requirements. On divided highways or interstates where traffic levels can accommodate a reduction in lanes, one side is closed for construction, and traffic is run head to head on the other side.

5. Will PavementDesigner be upgraded to allow for input of ESALs for traffic along with a simple calculator rather than just the current traffic categories?

   No. PavementDesigner (along with Pavement ME) has moved to traffic load spectra to more accurately describe the traffic loading. This requires the daily truck traffic along with a spectrum. Currently PavementDesigner allows has 9 default traffic spectrums and Pavement ME has more. Both tools allow users to input their own spectrum as well.

   There are issues with using ESALs as a traffic input as it is not a true traffic measure, but rather a pavement's response to traffic. This is why ESALs are not equivalent between asphalt and concrete, which leads to confusion and errors in pavement design. Additionally, a true ESAL calculation is dependent on the thickness of the pavement, which adds another layer of complexity.

   There has been discussion to include ESALs as an output of PavementDesigner, but that feature is not available at this time. Pavement ME used to provide an ESALs estimation in an output file buried in the file tree structure for a design, but they have removed that feature in the current versions.

6. Is the Bonded concrete overlay on asphalt always a support value always 350,000?

   No. This is only a representative default value in PavementDesigner for the resilient modulus of an asphalt layer as a subbase to a concrete pavement. A typical range would be somewhere between 300,000 and 600,000 psi

7. Is the 1/2 inch difference in design thickness for ME with coefficient calibration an additional 1/2 inch overdesign?

   It depends. National calibration for concrete pavements typically does not change the concrete pavement design by more than a half inch, but it could be +/- that half inch. This was the subject of the research paper referenced below:

   F. Mu, J. W. Mack & R. A. Rodden (2018) Review of national and state-level calibrations of AASHTOWare Pavement ME design for new jointed plain concrete pavement, International Journal of Pavement Engineering, 19:9, 825-831, DOI: 10.1080/10298436.2016.1210804

8. Were all of your overlays joint filled?

   Silicone sealant is used to seal joints on overlay projects in both Colorado & Wyoming.

9. Slide suggests that Bonded Concrete on Concrete only good for 15M ESALs. If underlying pavement is in good enough condition to bond concrete to it, and the new thickness is 3 - 6 inches greater and acting monolithicially, shouldn't expected ESALs be similar to the equivalent new pavement, maybe a lot more than 15M? Maybe up to 100M, like the unbondeds?

    This is a good point. If the quality of the bond is such that the overlay and existing pavement act monolithically, the new pavement structure should be able to achieve well beyond 15M ESALs (assuming that is what it is designed for). There are a number of factors that could impact the bond between the overlay and the existing pavement, and these are primarily covered in Chapter 3 of the Guide to Concrete Overlays.

10. For information I have bonded concrete overlays 1-2" thick (i.e. for flatness and levelness reasons) within 24/7 365 day a year distribution centers that are approaching 30 year life and these overlays continue to perform without any significant maintenance.

    When designed and constructed properly, concrete overlays can certainly last a very long time and exceed the general ranges that were presented. See also question/comment 9.

11. Does the SJPCP module in PavementME give the same answers as BCOA-ME?

    No. The SJPCP module in Pavement ME and the BCOA-ME take different approaches and have a number of different underlying assumptions (primarily on how the bond is handled). However, the designs usually arrive at similar designs. The research paper referenced below goes into detail on the differences between the two design approaches:

    Alland, K., Vandenbossche, J. M., DeSantis, J. W., Snyder, M. B., & Khazanovich, L. (2018). Comparing the Bonded Concrete Overlays of Asphalt-Mechanistic Empirical Design Procedure and the Short Jointed Plain Concrete Pavement Module in the Pavement Mechanistic Empirical Design Procedure. Transportation Research Record, 2672(40), 242–253. https://doi.org/10.1177/0361198118798724

12. For Angela: Do they tie *all* longitudinal joints (including those that occur in the middle of the lane) or just the ones that coincide with lane lines?

    All longitudinal joints are tied on the 6x6x6 projects, whether sawed or construction joints. CDOT has a project special detail labeled D-412-2 Thin Whitetopping Typical Joint Layout that is available on their website: https://www.codot.gov/business/designsupport/2019-and-2012-m-standards/2019-m-standards-plans/2019-project-special-details/2019_m_standards_project_special_details_index

13. 6x6x6 overlays; Do all longitudinal joints need to be tied, or only those in the outer lane? We have seen outermost longitudinal joints open up (when we only tied the longitudinal joints that separated one travel lane from another). As a follow-up, can you comment on using fibers in lieu of tie-bars?

See answer to #11 above.

Colorado has not tested the use of fibers as a replacement for tie bars in sawed joints.

14. Can someone explain the faulting mechanisms for overlays? What is the pumpable layer? How much water can there be beneath the slabs? It seems like it must involve the deterioration of the HMA.

    Faulting of the overlays may occur due to the deterioration and erosion of the asphalt layer. Additionally, if a bonded overlay of asphalt debonds, the overlay panel appear to be "faulting" when it is actually rocking underneath the loading.

15. Does the use of bonded and unbonded concrete overlays include the use of latex modified overlays on bridge decks?

    No. While a consideration for bridge decks, this type of overlay would not be difficult to construct and costly in a pavement application.

16. I wish I could get more information about overlaying a curb/gutter. Thank you.


    This is covered in Chapter 4 of the "Guide to Concrete Overlays"(see page 64). Most of the overlays in Colorado where curb has been overlayed involved an existing vertical curb overlayed by a mountable curb. Ensuring adequate cover (at least 2 inches) over the existing curb is essential to good performance.

17. Has Colorado also tried thicker PCC overlays, say 8"-10"? How did that compare to 6" overlays?

    Yes. Colorado has constructed 6" overlays primarily on urban arterials and rural highways, and thicker overlays (8"-10" and thicker) on interstates and rural highways with heavier truck traffic. All have performed well, and the thicknesses were selected based on traffic levels, existing pavement conditions, and the design approach utilized.

18. How do smoothness requirements differ between concrete overlays and new concrete pavement construction? Are there any modifications needed to address projects that are constructed under traffic?

Colorado's (and many other state's) requirements are the same for both concrete overlays and new construction – the distinctions in smoothness are tied to roadway characteristics as described below:

- **Category I** is for construction that will be affected by curb & gutter, numerous intersections/access points, or utility boxes, and for urban construction, has a speed limit greater than 40 mph.
- **Category II** is for express ways, interstates and any other PCCP that is not affected by curb & gutter, and utility boxes.
- **Category III** is for urban construction that will be affected by curb & gutter, numerous intersections/access points, or utility boxes, and has a speed limit of 40 mph or less.

19. How do the design tools factor for implements of husbandry?

    The major design tools presented only account for conventional over the road trucks that fall into one of FHWA's Vehicle Classifications. If livestock or equipment are being transported via a conventional 18 wheeled truck, the main consideration would be the truck weight. If the vehicle is not a conventional over the road truck, then additional consideration would need to be made.

    This was the subject of a research report from the University of Minnesota and sponsored by Minnesota Department of Transportation. This report may go into more detail on how to handle this situation:

    Lim, Jason; Azary, Andrea; Khazanovich, Lev; Wang, Shiyun; Kim, Sunghwan; Ceylan, Halil; and Gopalakrishnan, Kasthurirangan, "Effects of Implements of Husbandry (Farm Equipment) on Pavement Performance" (2012). InTrans Project Reports. 61.https://lib.dr.iastate.edu/intrans_reports/61

20. How do you overlay curb? What does that process look like?

    See answer to #15 above.

21. How does road salt affect the concrete roads or do you not use road salt?

    AND

    In a northern climate (New England) what parameters for water/cement ratio and air content should be specified? Also has any testing been done on the concrete with the SAM meter? Appropriate Air bubble spacing would appear to be paramount to the durability of the concrete.

    Roadway deicers (especially more modern deicers) can cause damage to concrete if the concrete is not designed well. We recommend following the guidelines of AASHTO PP 84 – i.e. a low w/cm (~ 0.42), and sufficient SCMs and entrained air (SAM <0.2) in the mixture.

Colorado DOT specifications require the use of supplementary cementitious materials (minimum 20% Class F fly ash or 30% slag cement by weight) for all concrete pavement to minimize the impacts of deicing salts.

22. How well does the graded shoulder material stay on the 30 degree safety edge?,

The shoulder material starts out in the correct location when placed against the safety edge during construction, and likely experiences erosion impacts similar to a vertical edge. The difference comes in the vehicle response when coming back onto the pavement.

23. In Ohio, we have a lot of existing brick pavements, or composite pavements with brick. Is there a design process or any experience with concrete overlays on brick pavements?

    This will depend on if the brick is still exposed or if it has been overlaid with asphalt. If there is 3 or more inches of asphalt and it is in good to fair condition, it could possibly be designed as a bonded concrete overlay. If there is only a small amount of asphalt (or if the brick is still exposed), the best approach would be to design it as an unbonded overlay and determine a reasonable resilient modulus for the brick or composite pavement.

24. In practice, how is bonding ensured between PCC and the underlying HMA or PCC?

    Milling the existing asphalt enhances the bond by providing additional surface area. Milling is not always required. The Guide to Concrete Overlays provides additional detail on when milling should be utilized, and the surface preparation required for each type of overlay.

    Better understanding the bond between concrete overlays and the underlying layers (whether they have been milled or note) is the topic of an ongoing NCHRP Study.

25. Is the same criteria used for PPC (Polyester Polymer Concrete) and if so what are the hazards using organic peroxide in epoxy and bonding agent (flashpoint) including

temperature storage, transporting and contractors using for the first time. Bonding agent compound and organic peroxide have a high chance of flashpoint if accidentally combined?

Most concrete overlays are constructed with conventional paving concrete as it is the most economical solution. I am not aware of PPC being used in a paving application like this.

26. Is tie bars required for an Unbonded Concrete Overlay, 6" thick?

See answer to #11 above for Colorado requirements.

27. It appears (from the presentations) that the overlays done, whether thin or thicker are done with conventional pavers. I was curious to know whether any overlays have been done with RCC. With some of the research work out of Louisiana on thinner RCC pavements, it would seem there could be a use for RCC in some cases (i.e., rural routes, parking lots, industrial sites ...).

There have only been a few overlays done with RCC. This is a topic of interest and research. I believe there is a pooled fund study that may include an RCC overlay over asphalt. Additionally, one of the existing RCC overlays was covered in a case study presented at TRB, reference below:

Cervantes, V., Mu, F., Zollinger, C., & Johnston, J. (2018). *Roller-Compacted Concrete Overlay on Asphalt: A U.S. Case Study on Design, Construction, and Performance*. Presented at Transportation Research Board 97th Annual Meeting. Washington, D.C., United states. https://trid.trb.org/view/1495624

28. Just a comment. I worked on the project in Louisville, Ky many years ago. I oversaw and coordinated the paving placement, subcontractors, and suppliers. I was able to get the participation of milling subcontractor to mill the existing asphalt due to severe rutting. I just could not see having so many variable depth panels due to the rutting and asphalt displacement prior to paving. It's amazing to see that small consideration has led to the bonded overlays and designs I saw in this presentation. I was excited then to be involved at what I saw as ground zero for what was to come.

Milling of the existing asphalt is definitely a consideration with these overlays especially when there is excessive rutting. If there is rutting and milling is not used, there are a few extra considerations such as ensuring that the minimum design thickness is maintained for the entire overlay and making sure the joints are all sawed to an appropriate depth. Additionally, excessive rutting and variable depth overlays can lead to some performance issues.

29. Typically design period for all rigid pavements are typically 20 years. Are you saying that unbonded overlay (20-40 years) can be used instead of new pavement design?

Many areas design concrete pavements to last for 30 or 40 years (or more) rather than 20. California at one point was looking at a 100 year design life. Limiting the design life as an input limits options as a designer, especially when looking at concrete pavements where durability and long life are a major consideration. Oftentimes an extra inch of concrete can lead to an extra 10 to 20 years of life for minimal cost (this would really only change the cost of the material as the rest of

the construction process would remain the same). This is an important consideration as there typically aren't enough funds to actually reconstruct when it's truly appropriate. If the life of a pavement can be extended greatly with a little extra material, this should be a consideration. It should be noted that there are many sections of interstate and highway pavement that have long outlived their design lives and then go on to serve as a base for many more years as well.

Overlays themselves should be designed in a similar manner, where the design is evaluated multiple times and design life is treated as an input to evaluate the life cycle cost. Oftentimes these overlays need to act as a new pavement as full reconstruction may be too expensive. These overlays take advantage of the durability and long-life of concrete as well as the stable and stiff existing platform.

Thin concrete overlays (6" or less) in Colorado are designed for 10-20 years (most often 20), and unbonded overlays and new construction are designed for 30 years.

30. Under what circumstances would you ever do a bonded concrete overlay on existing concrete pavement, especially if it is still in good to excellent condition?

    The main reason to perform a BCOC are to eliminate some surface defects such as extensive scaling or surface cracking and/or to improve surface characteristics like friction, noise, and smoothness. Another consideration would be to enhance structural capacity to accommodate increased traffic loads. One example would be if a new trucking or distribution facility was being built and this was not considered in the existing design. An 8" thick pavement may be significantly under-designed if Amazon or UPS decides to build a distribution site where the road is the main link to the highway or interstate.

31. What do you think the reasons are for lower annual maintenance costs on concrete overlays in Colorado? Does the thickness of the overlay matter or is it more a function of materials and existing base/subbase?

    The lower maintenance costs are specific to the thinner overlays and may be attributed to the shorter joint spacing. We would also like to look at concrete overlays in general to understand whether the lower annual maintenance costs extend to thicker overlays with standard joint spacing.

32. What is a common overlay thickness on a local residential street over existing concrete?

    This will depend on the intended design life and the traffic, but typically the only trucks in this type of area would be delivery trucks and garbage trucks, with the occasional emergency vehicle. If that's the case, the design would typically be on the bottom end of the recommended thicknesses (usually around 4 inches for bonded overlays with optimized joint spacings, see the Overlay Guide for details).

33. What material do you use for pavement markings and how often are they refreshed?

    CDOT typically specifies inlaid epoxy pavement markings, and the refresh timelines are dependent on wear – traffic, snowplow, etc.

34. What do you use to have good bond between asphalt and concrete pavement?

    Concrete tends to bond fairly well with older asphalt pavement without much surface preparation. Milling the asphalt will enhance the bond by providing additional surface area for bonding and provides the additional benefit of more closely controlling concrete material quantities. See the Overlay Guide for additional details.

35. Question is within Pavement ME and Designer, how does the program differentiate between the varying levels of performance with fibers - many different types and performance attributes?

    PavementDesigner allows fibers as a design option and requires a residual strength as an extra input. The residual strength is used to adjust the flexural strength of the concrete. This is similar to the CPTech Center's Guidance that was developed in the last few years (see the Center's Overlay web page for more details).

    Pavement ME does not allow for the use of fibers directly in the design program. To design with fibers, a designer would need to use the spreadsheet developed by CPTech Center to make this adjustment.

    BCOA-ME allows designers to select a type of fiber (synthetic structural, structural steel, low modulus synthetic, user defined), and requires a fiber content in lb/yd^3. More guidance can be found in the Practitioner's Info and Technical Docs on the BCOA-ME website and at https://intrans.iastate.edu/app/uploads/2019/03/FRC_for_overlays_TB.pdf.

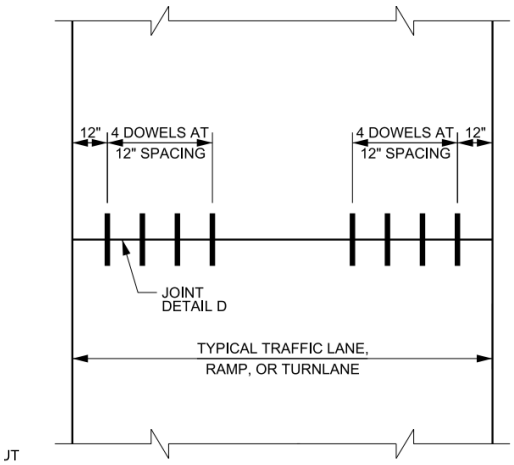
36. Are the 6 foot joints tied with dowel bars?

    The 6' joints are tied with tie bars (deformed bars), and dowel bars are not typically used for load transfer in the transverse joints for thin pavements.

37. Did the Colorado DOT use any fibers in any of the projects in Colorado that were highlighted? Any experience with high volumes of macro synthetic fibers for extending the joint pattern?

    There may have been polypropylene fibers to control shrinkage cracking in some of the earlier overlay projects, and there definitely was in the SH 121 (Wadsworth Blvd) project constructed in 2001. The Colorado DOT has not yet tried macro synthetic fibers on thin overlays but does have a test project on a full-depth application (not related to overlays).

38. Do you have an illustration of wheel path only steel reinforcement bars?



LOAD TRANSFER DOWEL BAR LAYOUT
FOR NEW PAVEMENT

The detail above is from Utah. They have gone to 4 dowels per wheel path in most scenarios. The two pictures are from the Illinois Tollway on I-90 coming into O'Hare International Airport where they used 5 dowels in the wheel paths. This concept of optimizing the number of dowels is something that was done frequently with Dowel Bar Retrofit (DBR) operations.

39. How reliable are the results of PavementDesign.org and BCOA-ME tools? Do the results correlate with field observations?

PavementDesigner.org was previously StreetPave and was simply known as the PCA Method before that. It has been around (and evolving) since the 1960's with good results. Sensitivity plots comparing the JPCP designs from AASHTO 93, PavementDesigner, and Pavement ME were cut out of this presentation for time, but in most cases PavementDesigner provides similar designs to Pavement ME. These will have some variation as Pavement ME allows designers to control many more inputs than PavementDesigner. What is typically seen is that AASHTO 93 will provide overly conservative and thick designs when truck traffic becomes significant and Pavement ME and PavementDesigner will be fairly similar. But remember that AASHTO 93 and PavementDesigner simply use

modifications to their respective JPCP design approaches for overlay design, whereas Pavement ME's is a bit more specific. The JPCP design comparison was the subject of a research study referenced below:

Rodden, R., Voigt, G., and Wathne, L., 2014. Comparison of Roadway Jointed Plain Concrete Pavement (JPCP) Thickness Design Methods Common in the United States (U.S). . 12th International Symposium on Concrete Roads. Prague, Czech Republic.

BCOA-ME correlates very well with field observations and tends to provide similar results to Pavement ME's SJPCP module. The BCOA-ME website provides additional detail as to the calibration effort that was done to create the tool. Additionally there was a study that compared BCOA-ME and the SJPCP approach (see Question/Comment 10 for more detail).

40. Was there any special cyclical maintenance needed for the 6' x 6' joints? Any concerns with water penetration / spall potentials due to the CO and WY weather?

    The maintenance needs for the 6' x 6' joints are similar to those for standard joint spacing. However, joint resealing is often not actually completed on a regular maintenance schedule, especially when funding is tight. Performance engineered mixture (PEM) strategies such as optimized gradations and a corresponding reduction in cementitious contents are being used by concrete paving contractors in Colorado to improve the quality of the concrete and reduce the water/salt penetration and spall potential. CDOT has also added permeability and shrinkage requirements to their specification, and WYDOT is in the process of updating their specifications to incorporate PEM options.

41. What is the minimum thickness for an AC layer for an overlay? And what is the impact of extra thickness?

    The minimum required thickness for an AC layer for a bonded concrete overlay on asphalt is typically between 3 and 4 inches (post-milling). This is an underlying assumption in Pavement ME's SJPCP module and the BCOA-ME design tool. This thickness range is required for the tools to properly model the new pavement system and analyze how the concrete and asphalt will share the load. If the thickness is less than this, a concrete overlay can still be placed, but it would likely be more appropriate to design it as an unbonded overlay on an existing stiff structure (there will likely still be a bond between the two). The absolute minimum thickness allowed by the BCOA-ME tool is 3 inches and for Pavement ME's SJPCP the tool allows down to 2 inches.

    Extra thickness in the asphalt layer tends to be a benefit in terms of required concrete overlay thickness. The reduction in overlay thickness will depend on the other parameters of the design and the design tool being utilized. Additionally, the benefit of additional asphalt thickness tends to max out around 6 inches of existing asphalt. However, it is important to remember that the design tools assume the existing asphalt section is acting monolithically with all of the layers well bonded together without delamination, stripping, or other issues.

42. What condition does the asphalt need to be in to perform a bonded concrete overlay?

    To perform a bonded concrete overlay on asphalt, the existing asphalt should be in good to fair condition. If the asphalt is in poor condition then it would be better to perform an unbonded overlay. The "Guide to Concrete Overlays" provides additional details on both types of overlays as well as guidance on determining the condition of the existing pavement.

43. Comment on interface bond development – while we do not specify the interface bond strength or perform any testing in the field to ensure appropriate level of bonding, we do this using a prescriptive specification to ensure the AC surface is milled and prepared well, kept clean and dry, etc.

    The Overlay Guide provides additional detail on surface preparation for performing bonded concrete overlays. Typically, milling all asphalt surfaces to improve bonding is not required, however current practice for thin bonded overlays does include milling. Some agencies specify a milled surface to help remove surface distortions, reduce high spots, match elevations, or to restore profile.