Design Webinar – Questions and Answers

The questions submitted during the webinar follow with answers that our speakers have provided.

1. Can PavementDesigner.org be used online and not have to download it, which requires IT permission? FL

   PavementDesigner.org is exclusively an online tool and there is nothing to download. Currently Pavement ME is only available as a downloaded software, but an online version is being developed with a release date sometime in 2022.

2. What would be the optimal joint spacing and slab width?, Quebec

   It depends on the trials in the MEPDG. The first trial has to be optimization of the pavement foundation and begin with 18 feet of joint spacing (to reduce the cost of joint cutting and sealing) and a standard 12 feet of width. If the performance prediction shows that your trial design cannot pass because of cracking, you need to reduce the joint spacing to 17 feet and do the trial again, and so on. If you already reach 15 foot joint spacing and still cracking cannot pass, you begin to use widened slab. If still cannot pass the cracking criteria, you have to begin increase the thickness little by little. But most of the time, the IRI is a very sensitive factor that determine the design in non-interstate highways, not the cracking criteria.

3. OptiPave is a really interesting concept. Can we do this same thing to significantly lower slab stresses by cutting slab lengths and widths in half? TX

   Yes. OptiPave allows engineers to design shorter optimized slab dimensions, which can reduce stresses and result in thinner concrete pavements. This is a similar concept to what is used in the design of bonded concrete overlays in the BCOA-ME design tool from the University of Pittsburgh and the SJPCP module in Pavement ME. However, it should be noted that this design process is patented and it has not been widely used in the US for highway, street and roadway design (although it has been evaluated technically at the University of Illinois and has been used fairly extensively for highways in Chile and other places in South America).

4. Has the reduction in predicted cracking (and faulting) with a widened slab been verified, or driven by reduction in edge stresses by moving the wheel loads off the free edge? IL

   Indiana is doing right now. We have a research study to do another local calibration to include the I-465 (10 years old) and I-69 (7 years old) to see the differences. In the previous research study in 2000 the calculation using finite element (by Purdue University) indicated reduction of the edge stress because of moving the wheel wander away from the edge. See ongoing Indiana SPR-4447 Research Study and SPR-2643. Link: https://docs.lib.purdue.edu/jtrp/47/

5. "Why are there only two options for ME regarding sealing (performed and others)? IL

   This is because when the MEPDG models were created, most State DOTs LTPP sections used pre-formed (in only some small portion of pavement) and silicon sealant or hot pour asphalt sealant. Some State DOTs use silicon sealant for transverse joint (because it is more flexible for larger slab opening movement) and hot-pour asphalt sealant for the longitudinal joints (because of smaller slab opening movement). This is to calculate spalling that influences roughness in the joints. Now, there are many state DOTs don't seal their pavement joints. See https://trid.trb.org/view/1263162.

6. If we use CTB and bonded it with PCC layer, would curling stress and cracking reduce especially top down cracking? IL

   Indiana uses only one project so far with CTB, in US-24 in 2010 as an experimental statement. The surface of the CTB had a very thick curing compound to reduce significantly the bonding with the JPCP. The CTB is open graded 1 inch size aggregate and it was a weak concrete, so reflection cracking was not a concern. Based on the FWD testing the curling stress is higher compared to the ATB (asphalt treated base). This is exactly what Prof. Michael Darter predicted in his report on Zero-Maintenance Pavement. See https://trid.trb.org/view/51136

7. Do you recommend bonding between CTB and PCC?" IL

   So far Indiana has constructed only one section for experimental CTB bonded to the JPCP. Just recently during the Summer 2020 we tried unbonded using plastic sheet. Time will tell about the performance.

8. Is the theory that the wider slab that helps the pavement life is that it helps it to have the panels more square? IA

   No, not at all. The purpose is to move the wheel wander away from the edge of the pavement edge. That is why the width of the slab is 14 feet but the delineator line (the white line) is still 12 feet. Since most of the Class 9 trucks have wheel spacing in an axle of about 8 feet, if the trucks travel right in the middle in between the lines, the tandem axle wheels will be about 3 feet from the pavement edge. This will reduce the stresses from the pavement edge that will initiate the fatigue cracks. See https://ops.fhwa.dot.gov/Freight/publications/size_regs_final_rpt/index.htm

9. Can you share the rule of thumb about joint spacing vs thickness again? PA

   The joint spacing-thickness ratio in the 2000 Indiana pavement survey is joint spacing (in feet) divided by thickness (in inches). State DOTs that implemented ratios between 1 to 1.25 in their interstate pavement do not experience issue with mid-slab cracking. See https://docs.lib.purdue.edu/jtrp/47/

10. So the prediction of cracking using MEPDG for the 14 in slab was 0% (for 50% reliability)? If that was the case why not reducing the thickness further to be closer to the cracking threshold by the end of the analysis period? PA

    I actually reduced the pavement thickness in I-465 to 13.5 inches but the Chief Engineer overruled my design due to the unknown risk. This is because the MEPDG software was still in the "trial" software by the NCHRP not as mature as the one today in PavementME. In addition, the I-465 is the first interstate pavement in the nation that was designed with the MEPDG.

11. Is there a max number of tie bars to use in a 14 ft widened slab to prevent longitudinal cracking? OH

    Indiana used the tie bar design from the A Mechanistic-Empirical Tie Bar Design Approach for Concrete Pavements by ACPA, the spacing is 3 feet. Indiana assumed the tie bar is not for load transfer. See https://trid.trb.org/view/905652

12. Can you get longitudinal cracking with a 14 ft widened slab and 7 tie bars into an 8 ft wide shoulder? OH

    With #7 bar, it is not likely, especially with 2 feet tie bars spacing (I believe Ohio is still 2 feet). However, it all depends on the pavement foundation. So far the issue of longitudinal cracking is related to pavement foundation. Research performed in Louisiana, Iowa and Wisconsin suggest that widened slabs, shoulder type, joint spacing and orientation, slab thickness, base type, and traffic volume were among design features that influenced the initiation and severity of longitudinal cracks

    Sources:

    D. Ziao and Zhong Wu. Longitudinal Cracking of Jointed Concrete Pavements in Louisiana: Field Investigation and Numerical Solution, International Journal of Pavement Research and Technology, Volume 11, Issue 5, pg. 417-426, 2018.

    H. Ceylan, Y. Zhang, S. Yang, O. Kaya, K. Gopalakrishnan, and P. Taylor, Prevention of Longitudinal Cracking in Iowa Widened Concrete Pavement, Iowa Highway Research Board Project TR-700, Ames, IA, 2018.

    S. Owusu-Ababio and R. Schmitt, Longitudinal Cracking in Widened Portland Cement Concrete Pavements, Department of Civil Engineering, University of Wisconsin-Platteville, Platteville, WI, 2013.

13. Do you research on bound breaker effects on slab contribution with base layer to reduce curling stress? Also, do you think we can go toward geometry design optimization with stabilized base layer? If yes how we can control reflective cracking? Italy

Our research for CTB (Cement Treated Base) with JPCP was done in 2010. It is actually not fully bonded because we used heavy during compound on the top of the CTB before placing the JPCP. Compared to the ATB (Asphalt Treated Base), the ATB gives significantly less curling stress. Geometry of the slabs can be altered after you maximize the contribution of the foundation to the pavement. In the US "stabilized base layer" is a very weak concrete with open graded gradation. With heavy curing compound and weak CTB, reflective cracking will not occur. It is not LCB (Lean Concrete Base) that is implemented in Germany and many countries in Europe when they bond the LCB with the JPCP. To control the reflective cracking they cut transverse joints in the LCB and line up the joint in the JPCP at the same locations

14. How does integral curb and gutter impact the slab width geometry? IA

    In Indiana pavement design guide, the slab width geometry in the design will not change. If the curb and gutter section has a width of more than 4 feet we treated that as "tied pavement shoulder"

15. Was it a surprise how wider pavements performed with joint faulting? NY

    In MEPDG faulting is influenced by the size of the dowel bar, temperature curling and moisture warping, passing #200 of the subgrade material, erodibility of the base and subbase, and the number of wet days. Since the top 14 inches of subgrade in Indiana is treated with cement 4%, the passing #200 of the subgrade is reduced significantly. The base and subbase are also very erosion resistant (dolomitic limestone). So the excess faulting due to the pavement curling of warping from the widened slab can be countered by the size of the dowel bar (which is very cheap, the difference between 1.25" dowel and 1.5" dowel is only 50 cents). Therefore, the principle of the MEPDG design is to maximize the pavement foundation and make adjustments to the pavement design features later by trials in design.

16. Did the presenter say that a tied PCC shoulder can additionally reduce the mainline pavement thickness similar to the widened slab? Would the thickness of the tied shoulder need to be the same thickness as the mainline PCC? SD

    Yes, tied shoulders will reduce the thickness of the mainline slab. In 2010 when we first implemented the MEPDG, the FHWA had a rule that for travelled/usable pavement shoulder the thickness had to be designed with 10% of the truck traffic in the mainline with a minimum thickness of 9 inches. I designed only one new pavement section using this method, in SR-25 in Indiana (see enclosed Figure 1 for a different thickness of HMA shoulder, but in SR-25 I changed that with 9 inch concrete shoulder and tied the shoulder to the mainline pavement). As a result, the pavement shoulder thickness is not always the same as the thickness of the mainline pavement. The most important thing is to assume the tie bars to tie the pavement and the pavement shoulder with #6 bar with 2 foot tie bar spacing, and therefore the deadload of the pavement shoulder will counter the curling stress. However, we don't

practice that anymore due to the constructability. Contractors have to construct separately the pavement shoulder and the mainline.

Source: See enclosed Figure 1 for the old different shoulder thickness and Figure 2 from the current Indiana design manual.

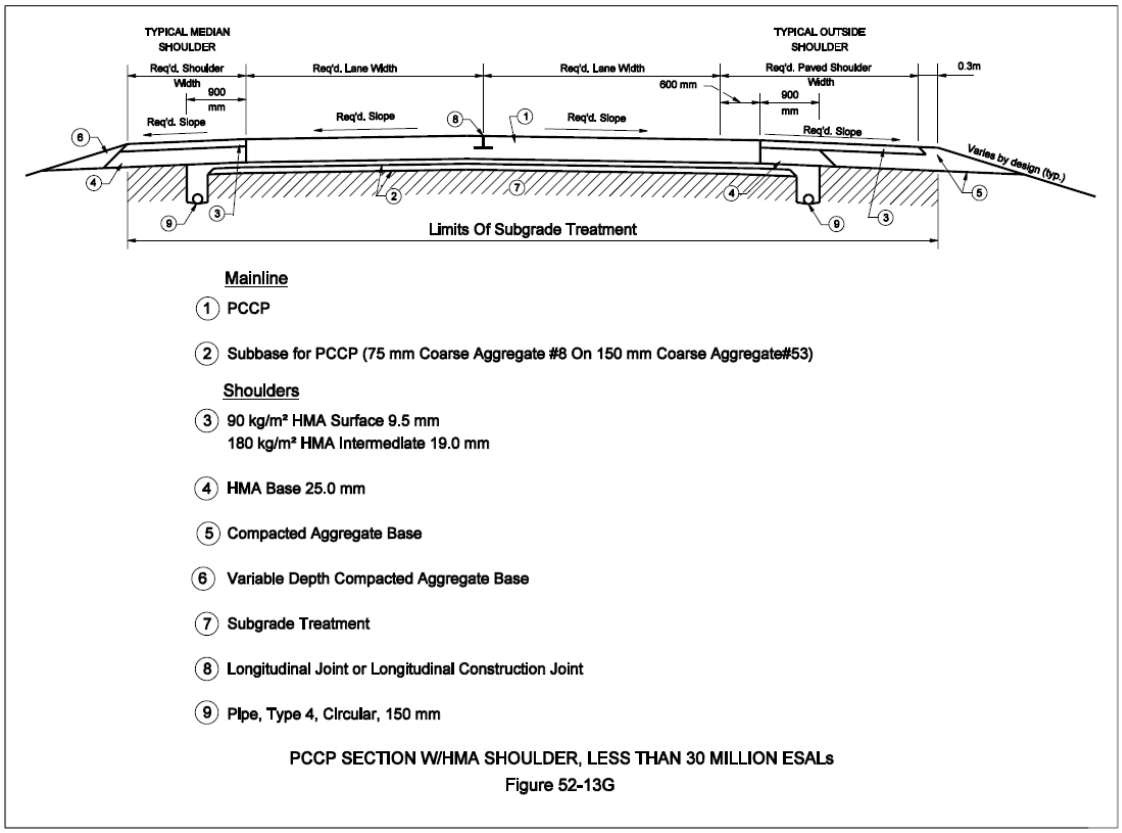
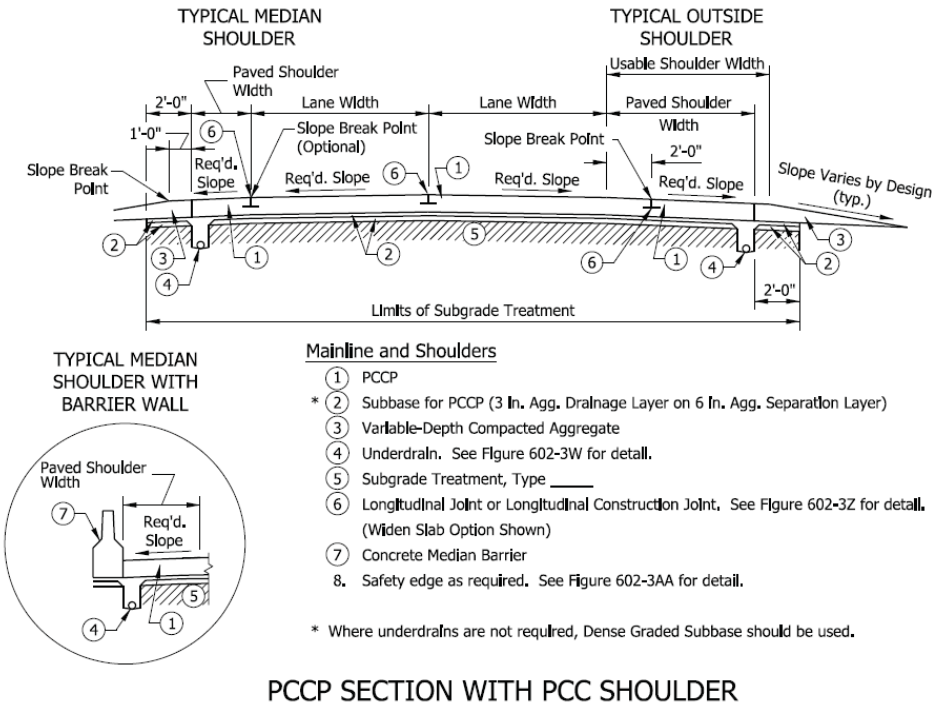


Figure 1



PCCP SECTION WITH PCC SHOULDER

Figure 2