Concrete Pavement Thickness and Slab Geometry – Indiana Experience

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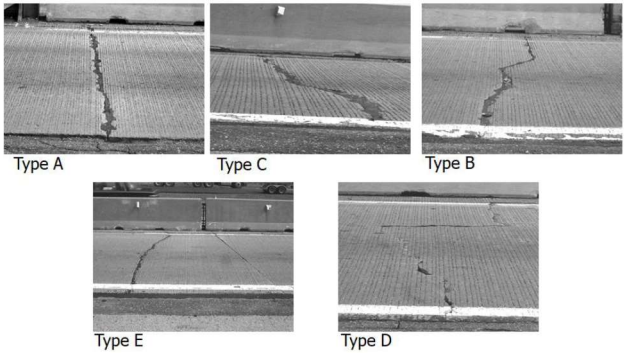
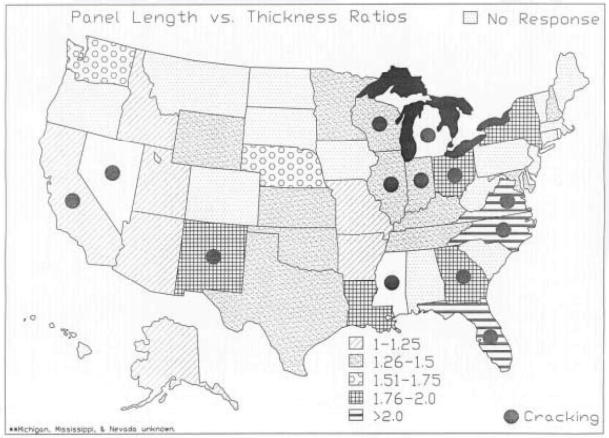
Research Begins in 2000 from Indiana SR-49

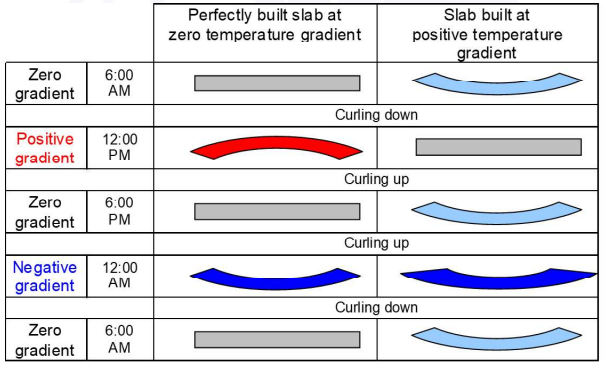


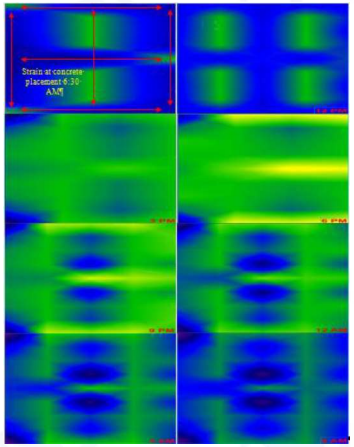
	Crack type						
	No crack	A	B	C	D	E	Total
Number	106	139	19	23	6	7	300
Percent	35	46	6	8	2	2	100

Research Begins in 2000 Survey from Indiana



Concerns Related to Slab Dimensions





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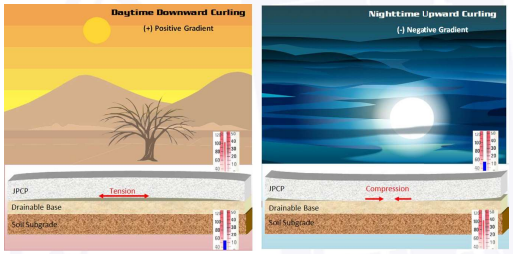
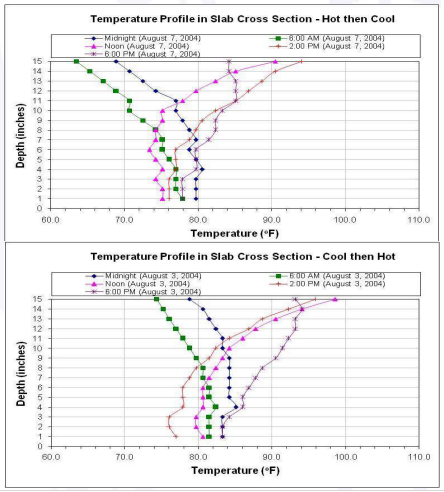
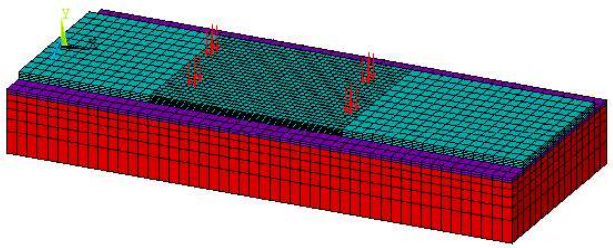


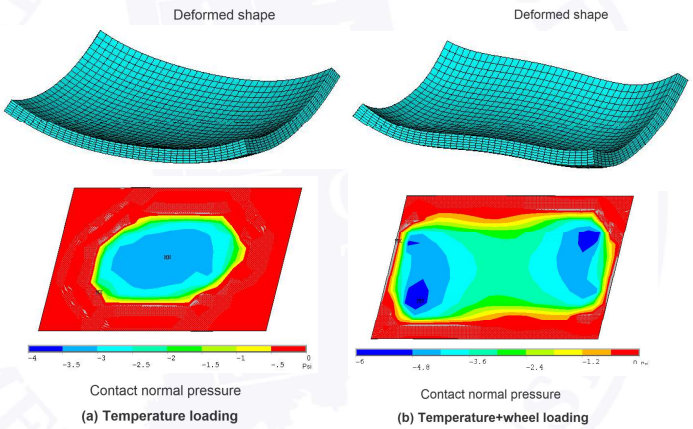


Slab Analysis due to Load

- One axle in each end
- Vertical load = 4 x 17.8 KN
- Pressure = 765 kPa

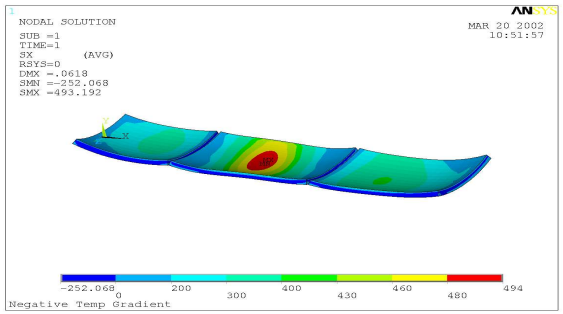


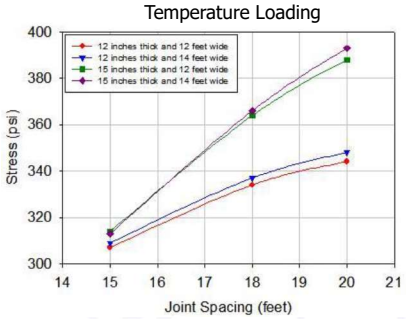
Slab-Subbase Contact Area



Stress Analysis: Loading vs Temperature

- For SR ≥ 0.55 : $\log_{10} N = 11.737 - 12.077\ SR$
- For 0.45 < SR < 0.55 : $N = (\ 4.2577\ /\ (\ SR - 0.4325\ )\ )^{3.268}$
- For SR ≤ 0.45 : N = unlimited

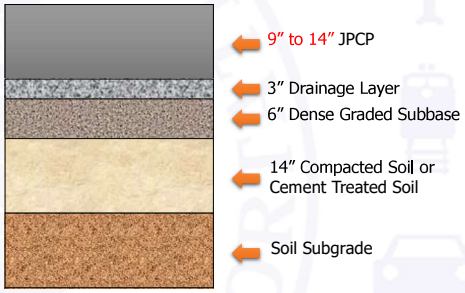




Field Project for Verifications - 2005

Indiana MEPDG Implementation

- Moved from thickness design to performance design
- Maximize the contribution of pavement foundation and pavement underdrain
- Designers have to do trials by varying the slab dimensions to achieve efficient designs with the highest performance



INDOT 2005 MEPDG Sensitivity Analysis

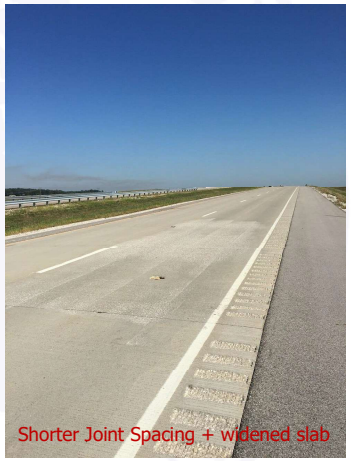
Parameter	Roughness	Faulting	Percent Slabs Cracked
Permanent Curl/Warp Effective Temperature Difference	VS (Very Sensitive)	VS	VS
Joint Spacing	VS	VS	VS
Dowel Bar Diameter	MS (Moderately Sensitive)	MS	NS
Pavement Thickness	S (Sensitive)	MS	VS
Poisson's Ratio	MS	MS	S
Coefficient of Thermal Expansion	VS	VS	VS
Thermal Conductivity	S	MS	VS

Decision for Implementation of Changes in Slab Dimensions

- Reduce the joint spacing to less than 18 feet
- Use tied pavement shoulder or widened slabs with HMA shoulder
- Use widened slab with tied pavement concrete shoulder
- Use of integrated tied pavement inside shoulder with the passing lane
- Use of conservative dowel bar sizes
- Prepare for the adoption of the MEPDG (in 2008)
- Prepare traffic and materials inputs for the MEPDG

Slab Dimensions Options

Thickness is reduced by 1 to 2 inches



Thickness is reduced by 2 to 2.5 inches

Slab Dimensions Options

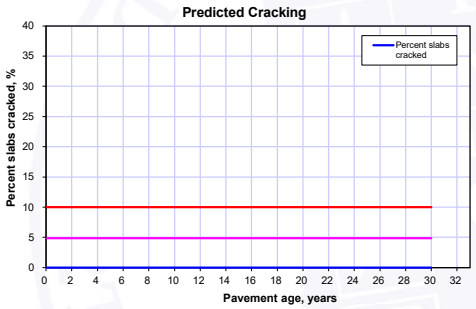
Thickness is reduced by 2 to 3 inches

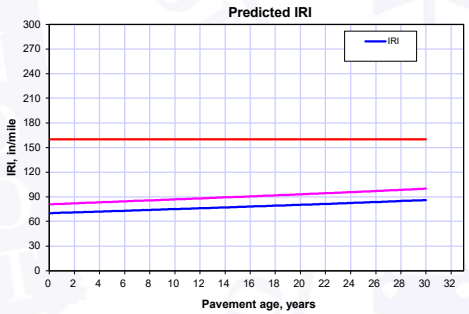
Thickness is reduced by 2 to 2.5 inches

The First MEPDG Interstate Pavement Design I-465

- Designed with AASHTO 1998 Supplemental for 18 foot joint spacing and the thickness was 16 inches
- Designed with MEPDG version 1.0 for 16 foot joint spacing and 14 inches, tied shoulder, not widened slab

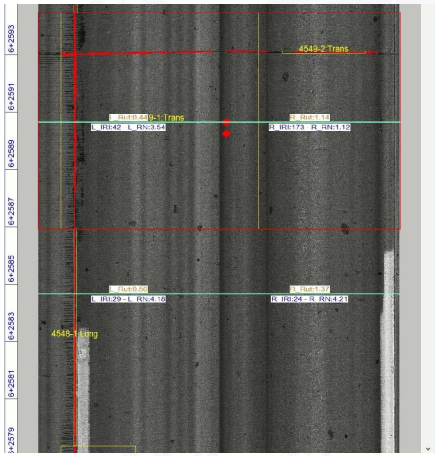
Final I-465 Design – Summer 2010

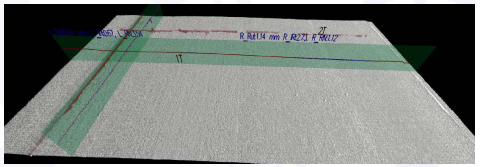




- Designed with MEPDG version 1.0 for 16 foot joint spacing and 14 inches, tied shoulder, not widened slab
- Reduced the joint spacing to maximize performance from a thinner pavement
- Changed order in February 2010
- Constructed in Summer 2010

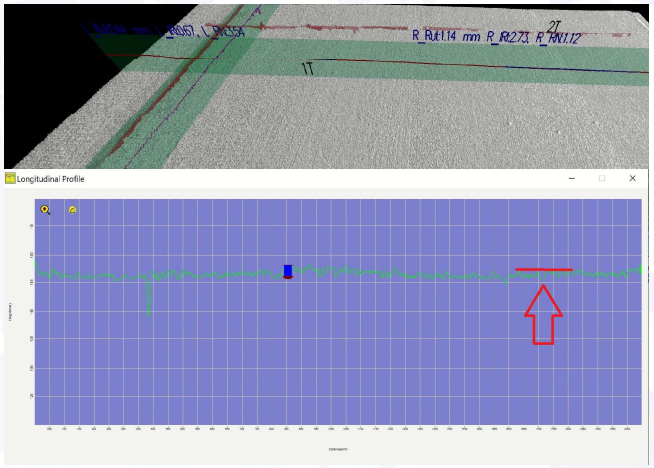
I-465 Performance after 10 years





I-465 Performance after 10 years

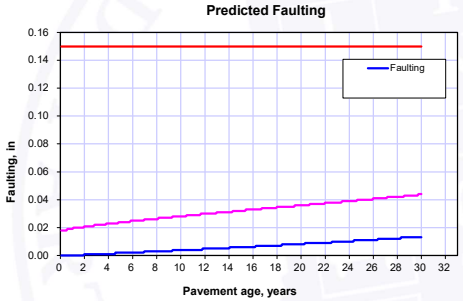
- Zero crack at all lanes, none in the heavy truck lane (3 &4)
- Some cracks in bridge approaches on embankments
- Joint faulting less than 1 millimeter
- Current Lane 4 IRI is 42”/mile
  - Left wheel path 41”/mile
  - Right wheel path 43”/mile
- Current Lane 3 IRI is 45”/mile
  - Left wheel path 43”/mile
  - Right wheel path 48”/mile
- Truck lanes are Lane 3 and 4

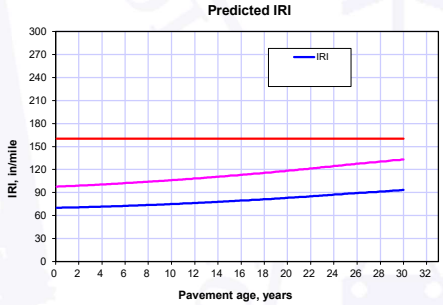


The 2nd MEPDG Interstate Pavement Design I-69

- Designed with AASHTO 1998 Supplemental for 18 foot joint spacing and the thickness was 13 inches
- Designed with MEPDG version 1.0 for 16 foot joint spacing and thickness of 10 inches, HMA shoulder, and widened slab

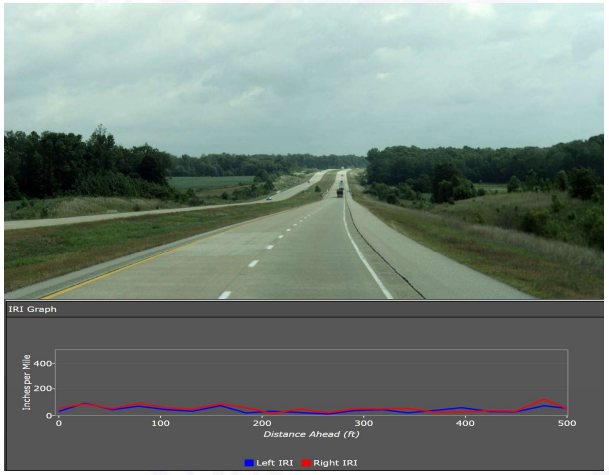
Final I-69 Design – Summer 2012

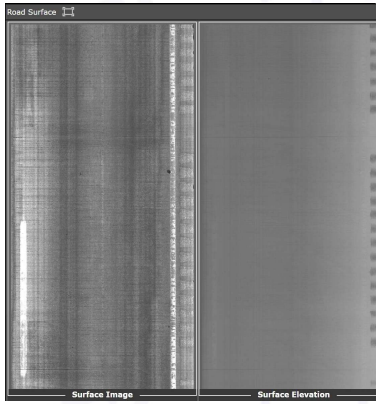




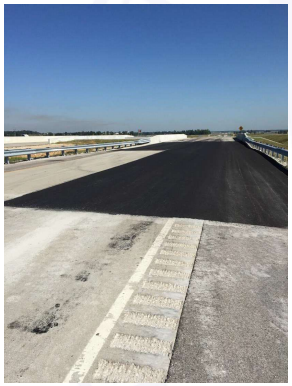
- Designed with MEPDG version 1.0 for 16 foot joint spacing and 10 inches, HMA shoulder, widened slab
- Reduced the joint spacing and implement widened slab to maximize performance from a thinner pavement
- Constructed in Summer 2012

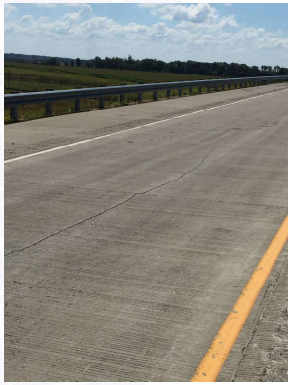
I-69 Performance after 7 years

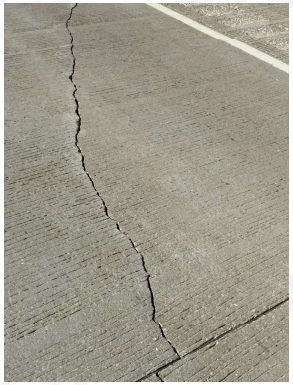




I-69 Issues due to Pavement Soil Settlement

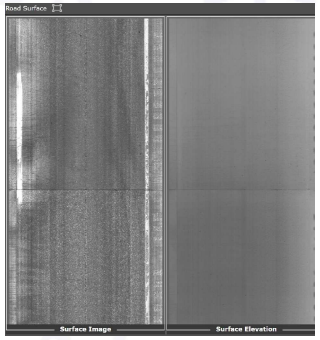


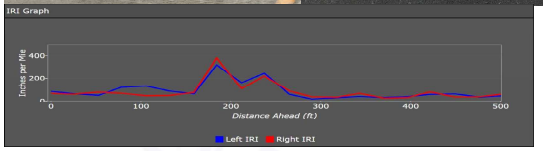




Issues of soil (shale) settlement in embankment fill sections in some areas leading to premature failures

I-69 Issues due to Pavement Soil Settlement





Challenges and Limitations of Slab Dimensions

Base, subbase, and subgrade foundation issue

Soil type, construction, and soil settlement issue in the fill sections

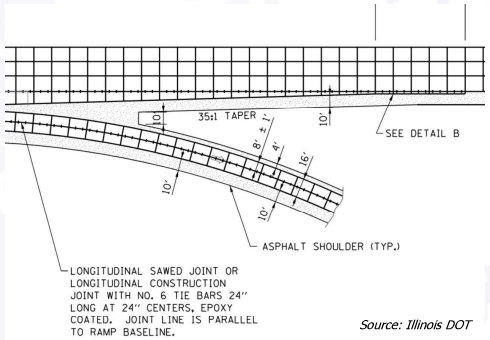
Slab Dimension Limits

1:1 (L:W) ratio with 14 inches thickness tied to moment slab

Slab Dimension Limits

1:1 (L:W) ratio with 14 inches thickness tied to moment slab

Slab dimension Limits and Possible Solution



Conclusions

- Designers have the authority to explore the layers compositions and thicknesses to maximize the contribution of the pavement foundation to approach a better pavement predicted performance.
- The next step is to alter the slab dimensions and thickness and other design features to reduce the thickness of the pavement to still meet the pavement predicted performance.
- Designers have to be very verse and aware of each design features and slab dimensions to achieve efficient designs and have successful projects, there are trade offs.
- So far, the most successful and best performer projects since 2010 MEPDG are either shorter joint spacing, widened slab, or both.