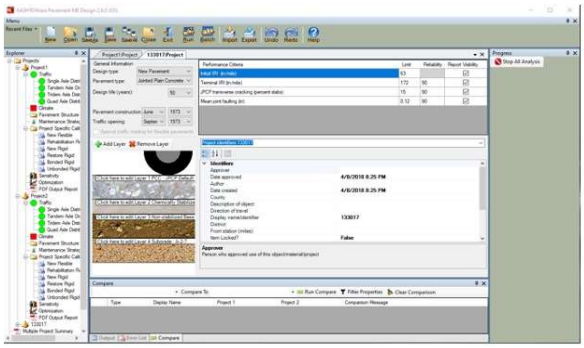
About the Presenter

- **Georgene M. Geary, PhD, PE** is the Principal Engineer and Owner of GGfGA Engineering LLC, a DBE certified consulting firm located near Atlanta, GA.
- Georgene's past experience involved geotechnical, construction, materials, pavements and general transportation research prior to her retirement from Georgia DOT. She is a registered professional engineer in Georgia.
- She holds a BS degree in Civil Engineering from the University of Illinois, Champaign-Urbana and a Masters and PhD from Georgia Tech. Her PhD research involved using high-speed 3D laser technology to analyze and predict concrete pavement life.
- Beyond consulting she also teaches undergraduates at Georgia Tech as an Adjunct to give back to the next generation.

Pavement ME Upgrades

Related to Concrete Pavements

Georgene M Geary, PhD, PE
GGfGA Engineering, LLC
NCC Spring Meeting
April 13, 2021



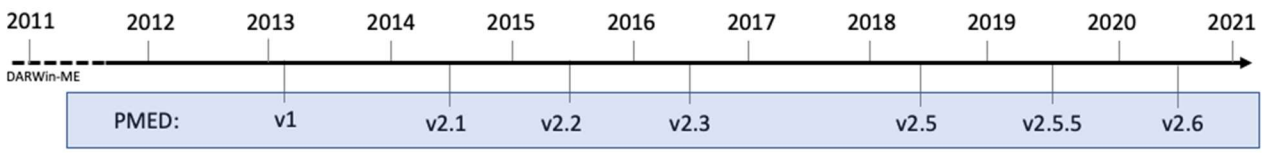
The 2021 Pavement ME v2.6 models related to concrete pavement are ***the same*** *as the 2013 Pavement ME v1.0 -and-* ***the same*** *as the 2004 original MEPDG models*

THE END

Presentation Outline

- Highlights of version changes
- What (else) has not changed
- Inputs (Materials, Climate, Traffic)
- SJPCP
- Local Calibration & MEPDG Users Group
- More change is coming!
- Synthesis Report Outline

PMED Version Timeline –Highlights–



v1

Same as DARWin-ME

v2.2

CTE

NALS

v2.3

NARR

SJPCP

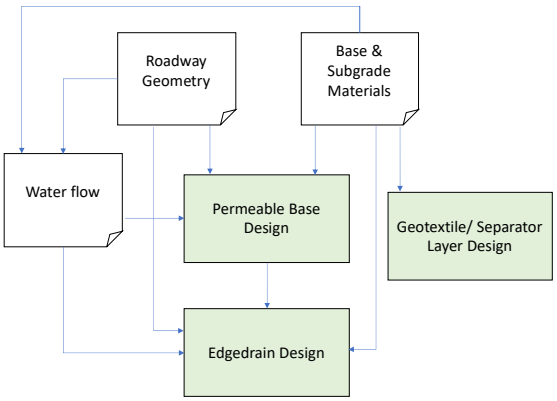
v2.6

Current version

What hasn't changed

- Drainage is a separate Tool – DRIP 2.0
- Sensitivity analysis capabilities
- Concrete models and algorithms for new JPC, CRCP and JPC, CRCP overlays

DRIP 2.0



Basic JPCP model

- Computes incremental damage in the form of cracking and faulting
- Cracking = fatigue failure due to loading, support, environmental conditions

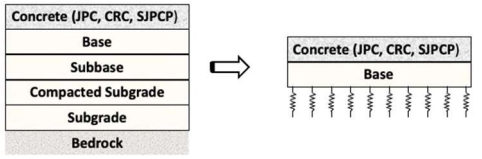


Figure adapted From NCHRP 1-37A

- Faulting = loading, loss of load transfer, erodibility of the support, water

Basic JPCP model - IRI

- IRI = combination of: Initial IRI+ Cracking + Faulting + Spalling + Location
  - Spalling - pavement age, PCC, joint sealant and f-t
  - Location (Site Factor) – age, FI, subgrade fines

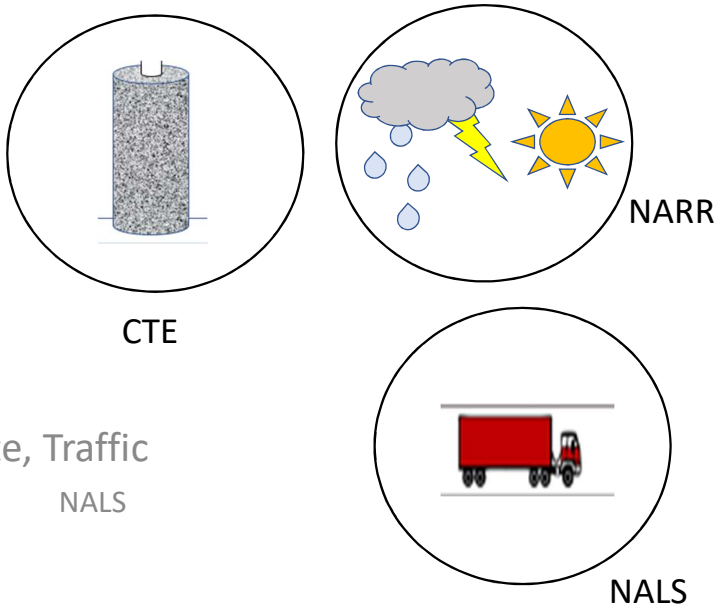
Failure can result from:

✓ **Cracking**
-or-
✓ **Faulting**
-or-
✓ **IRI**

Inputs

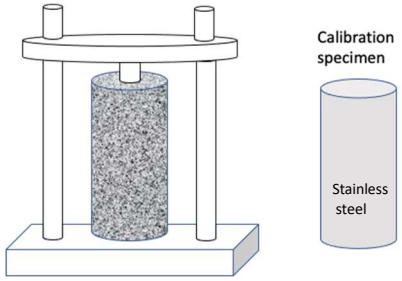
Materials, Climate, Traffic

CTE NARR NALS



Materials -- CTE recalibrated in v2.2

- CTE= coefficient of thermal expansion
- Concrete property related to movement of concrete due to temperature changes
- Tests performed prior to ~2010/2011 commonly used an (incorrect) assumed value for the steel calibration specimen
- Important for design:
  - opening and closing of joints and curling in JPC
  - crack spacing and crack width in CRCP



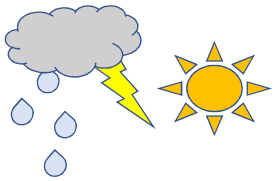
CTE effects on Design

- Missouri found in their latest local calibration the **same** design with:
  - CTE ≤ 5 x 10^{-6}/°F
    - **no** transverse cracking in 30 years
  - CTE ≥ 6 x 10^{-6}/°F
    - >15 percent cracking in just 7.5 years (Titus-Glover et al. 2020)

Climate -- NARR and MERRA (future)

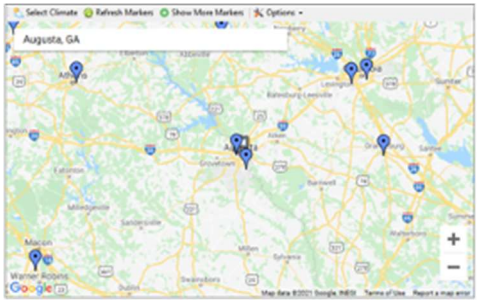
1. original .hcd (NCDC- National Climatic Data Center weather stations)
2. NARR = North American Regional Reanalysis (added in v2.2)
3. MERRA = Modern Era Retrospective Reanalysis for Research Applications

- The Enhanced Integrated Climate Model (EICM) is a combination of 3 different models
- JPCP design uses **hourly** climate data!
- The EICM effects every aspect of JPCP distress prediction
  - Cracking and Faulting are affected by curling and warping
  - IRI uses climate in both the Spalling and Site Factor components

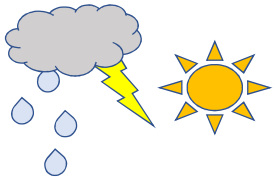


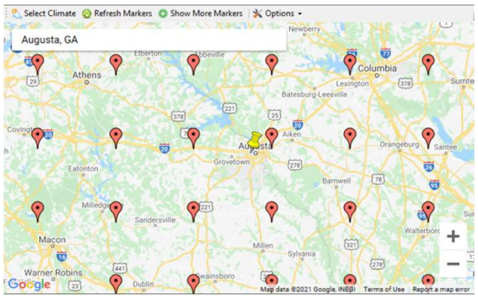
MERRA data will be incorporated in v3.0

NARR and MERRA2 climate stations in PMED



NARR - concrete

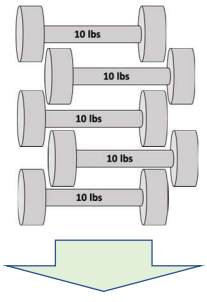




MERRA2 - asphalt

Traffic – NALS

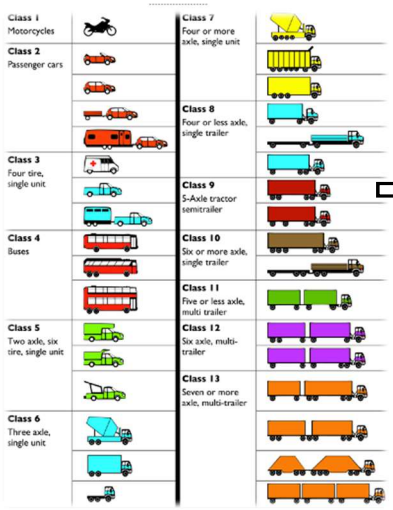
- NALS = Normalized Axle Load Spectra (Loads)
  - Actual loads on the trucks by vehicle class
  - Loads = *f*(vehicle class and axle)
  - NALS added: Global, Heavy, Typical , Light
- TTC = Truck Traffic Classifications (Class)
  - % vehicle by class (i.e. 30% Class 9, 10% Class 10, etc.)
- **Not** Equivalent Single Axle Load (ESAL)



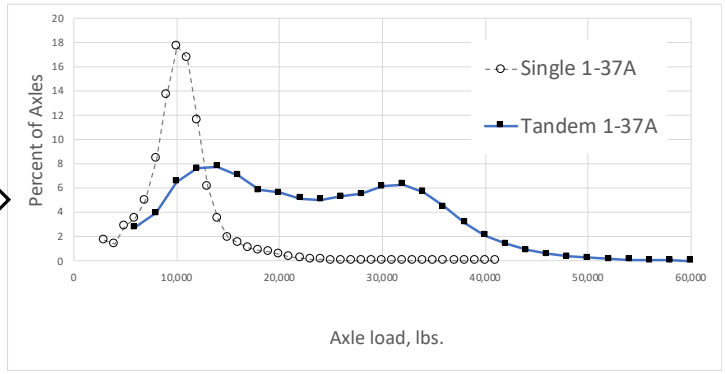
50x heavier!

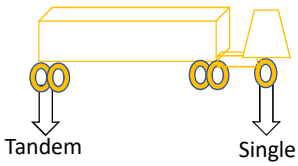
Traffic – NALS – Class 9 vehicle

FHWA Vehicle Classes



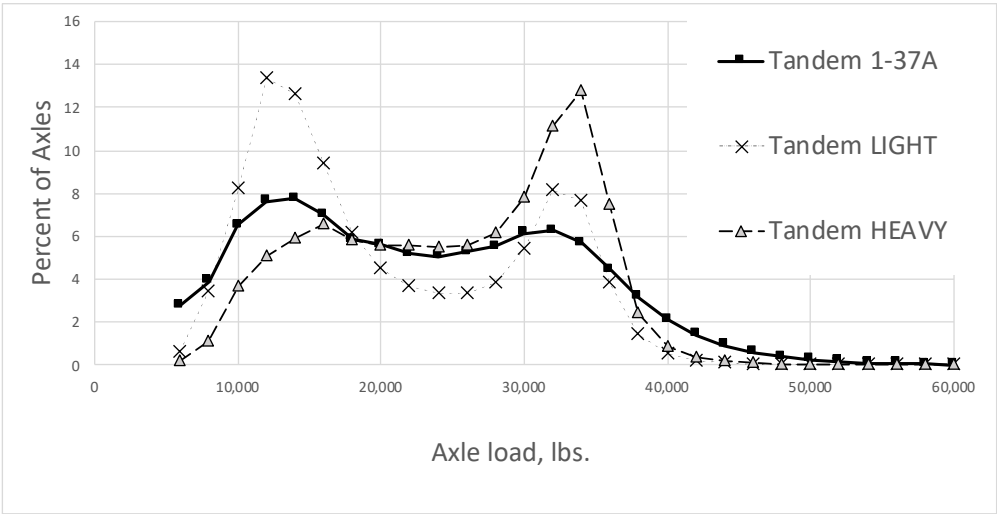
Loads (by axle)

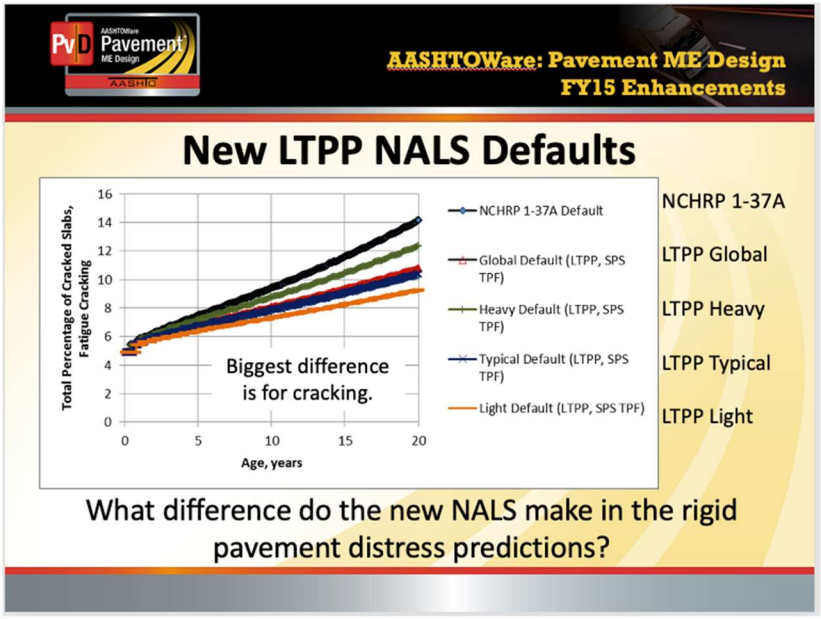




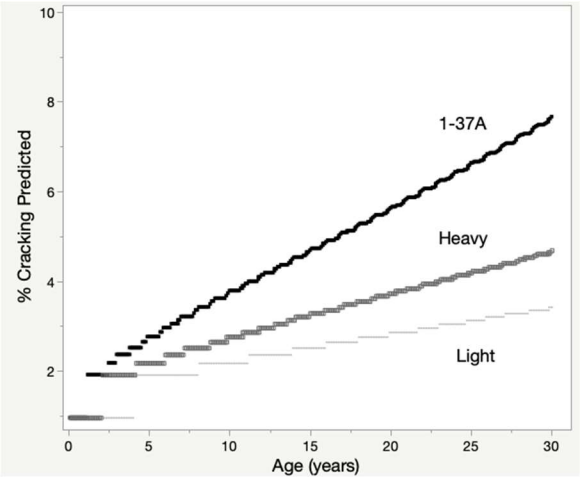
Class 9 vehicle

Traffic – 4 Default NALS added in v2.2

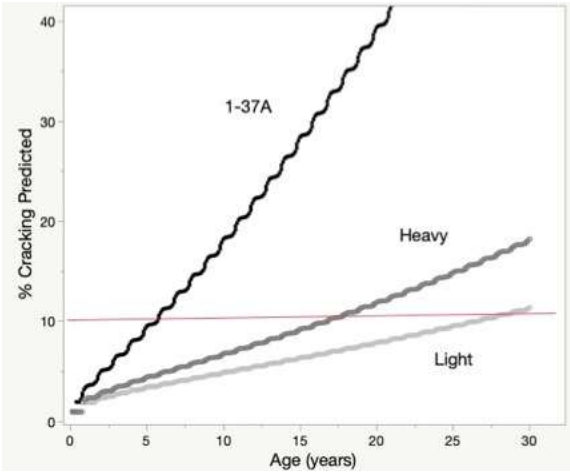




From: PMED webinars on me-design.com



9 inch JPCP

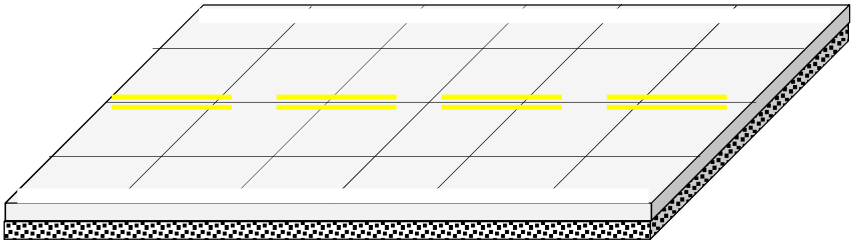


8 inch JPCP

SJPCP – added in v2.3

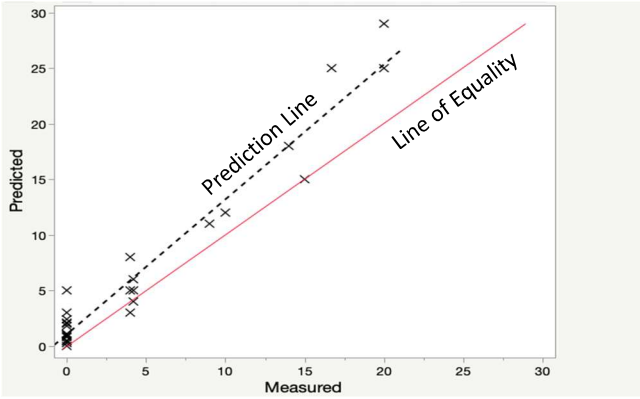
- COA- concrete overlay over asphalt
- SJPCP- short jointed plain concrete pavement = type of COA

Typically 6’ x 6’ panels

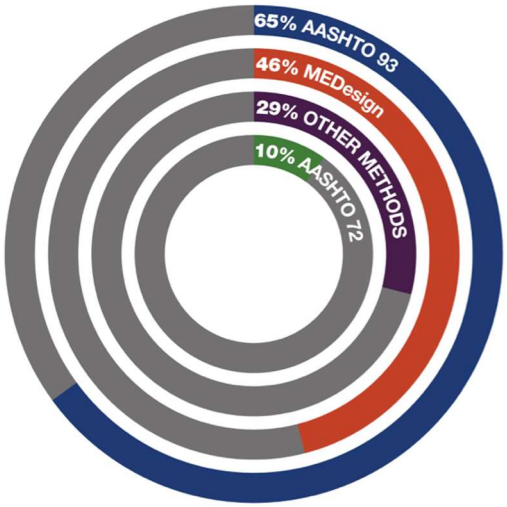


Local Calibration

Why do we get different results?



"WHAT STRUCTURAL PAVEMENT DESIGN METHODOLOGIES ARE AGENCIES CURRENTLY UTILIZING?"

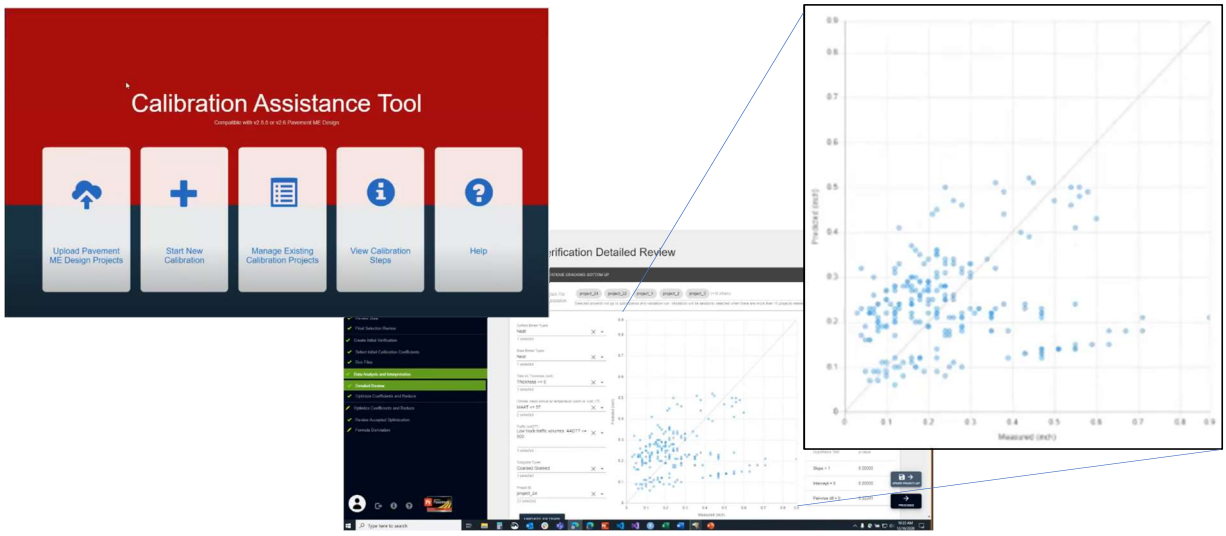


From: FHWA AID-PT 2019/2020 Annual Report, FHWA peer Exchange 2019

Local Calibration issues

- 3 Failure modes for JPC: faulting, cracking and IRI
- Changes in Materials, Climate and Traffic INPUTS
- Complicated program with a multitude of inputs!

Calibration Assistance Tool



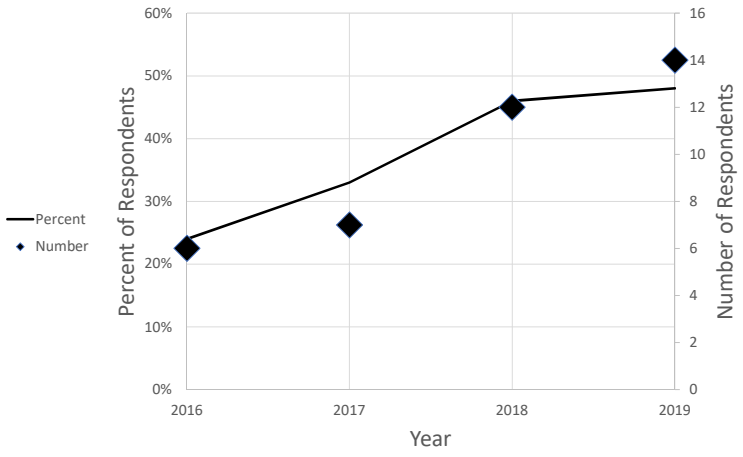
https://me-design.com/MEDesign/Webinars.html

From: MEPDG Users Group Report
APT, 2019

MEPDG Users Group

Users Group Surveys and discussion

Implemented PMED for concrete?



Top Issues

Year/ # of respondents	Top issue (# of respondents choosing)	2nd top issue	3rd top issue
2016/25	Local Calibration (12)	Data inputs (8)	Performance Data availability (7)
2017/21	Local Calibration (10)	Features not in or not calibrated for PMED (5)	Performance Data availability (4) HMA inputs (4)
2018/26	Local Calibration (13)	Features not in or not calibrated for PMED (8)	Data inputs (6)
2019/29	Local Calibration (18)	Data inputs (9)	Features not in or not calibrated for PMED (7) Performance Data availability (7)

Discussion Items

- Widened slabs
- Use of AASHTO 93 to limit min or max thicknesses
- Faulting model – thicker pavement sometimes worse?
- Inputs change sensitivity
- Dowel type not addressed
- Design Catalogs

PMED v3.0

- Web Based
- MERRA (latest climate data) for concrete pavements
- Enhanced slab interface model (NCHRP 1-51)

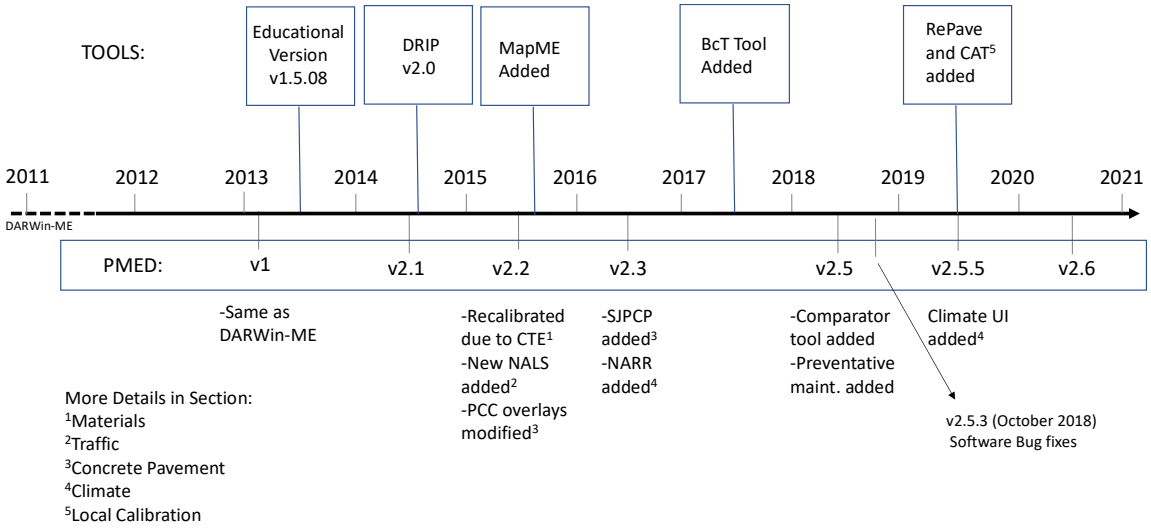
ADDITIONAL NEEDS

- Improved models to represent faulting, foundations and drainage
- Method to measure and incorporate curl and warp (best to not build in stresses in the first place!)
- Model longitudinal cracking in JPCP and transverse cracking and faulting in SJPCP

Synthesis Document Outline

- Introduction
  - Changes related to concrete pavements by software version
  - Tools
  - What (else) has not changed
- Materials
- Climate
- Traffic
- Concrete Pavements (Design)
- Local Calibration
- MEPDG Users Group
- Research in Progress
- Conclusion

PMED Timeline in the Synthesis



www.ggfga.com

Questions?

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THE REAL END