Matching Distress Definitions in Field and in MEPDG for Local Calibration

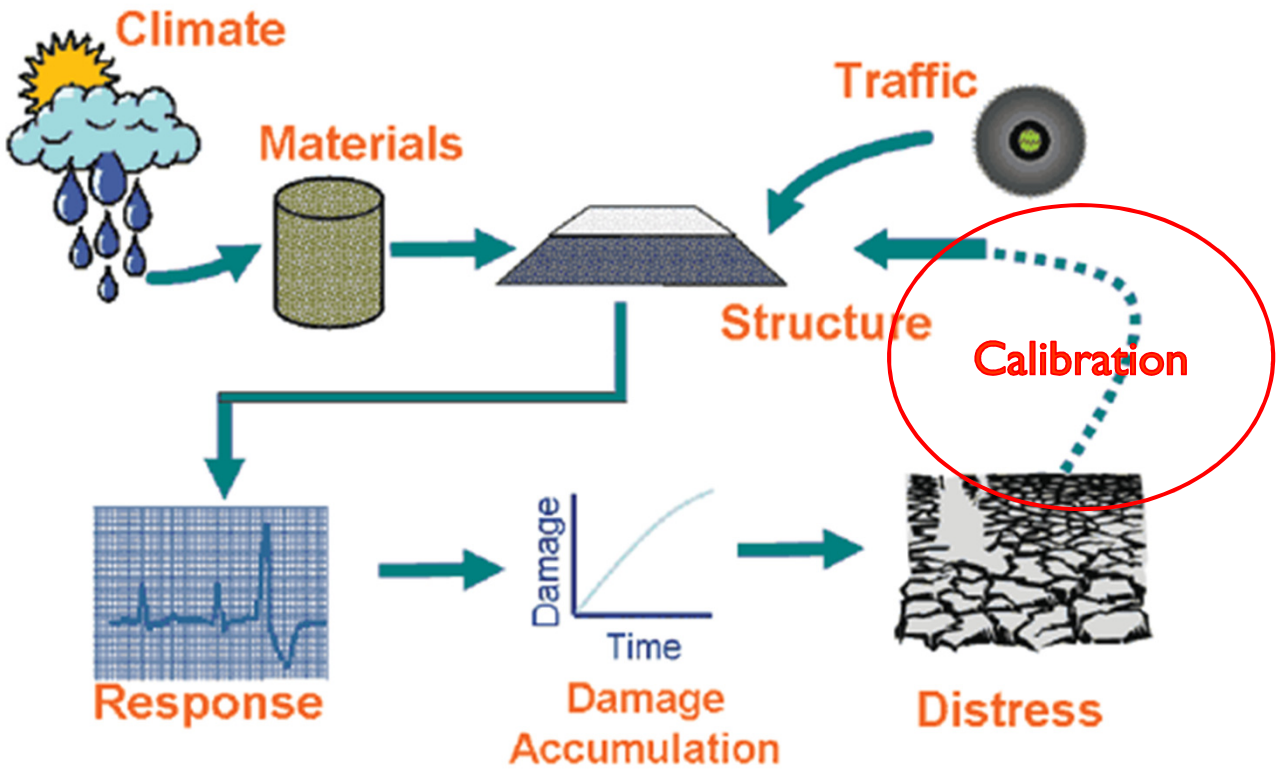
Danny X. Xiao, Kelvin C.P. Wang, Kevin D. Hall

Pavement Evaluation 2010
October 25-27, 2010 ▼ Roanoke, Virginia

UNIVERSITY OF ARKANSAS

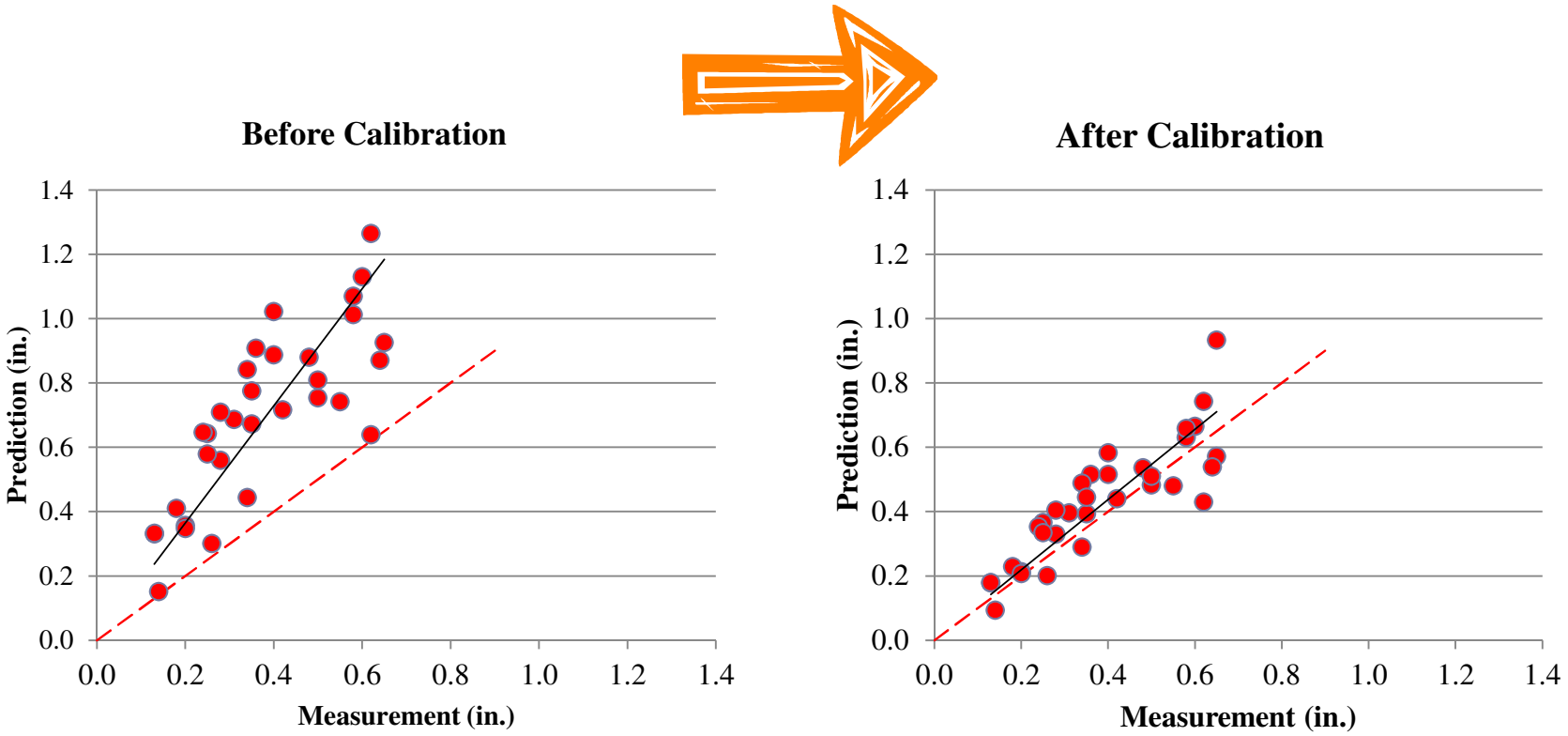
MEPDG

- Mechanistic-Empirical Pavement Design Guide

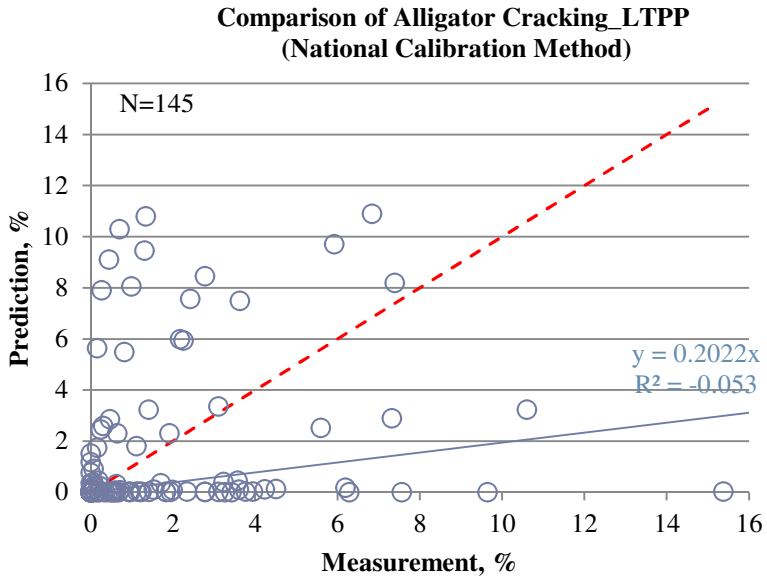


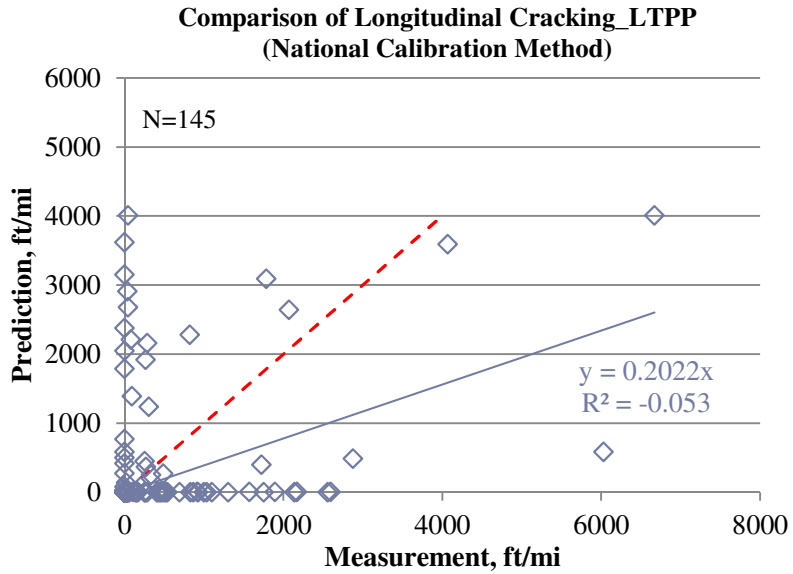
from FHWA

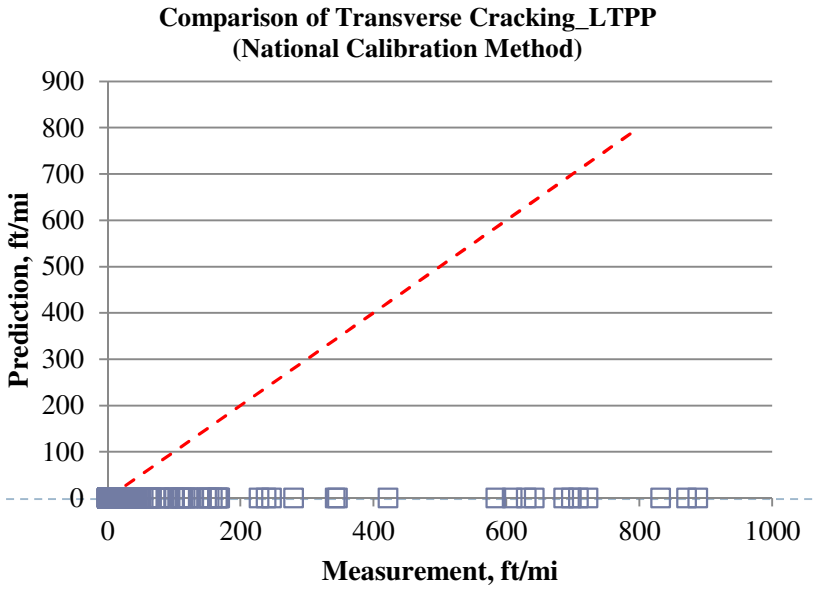
Goal of Calibration



Initial results of MEPDG calibration in Arkansas



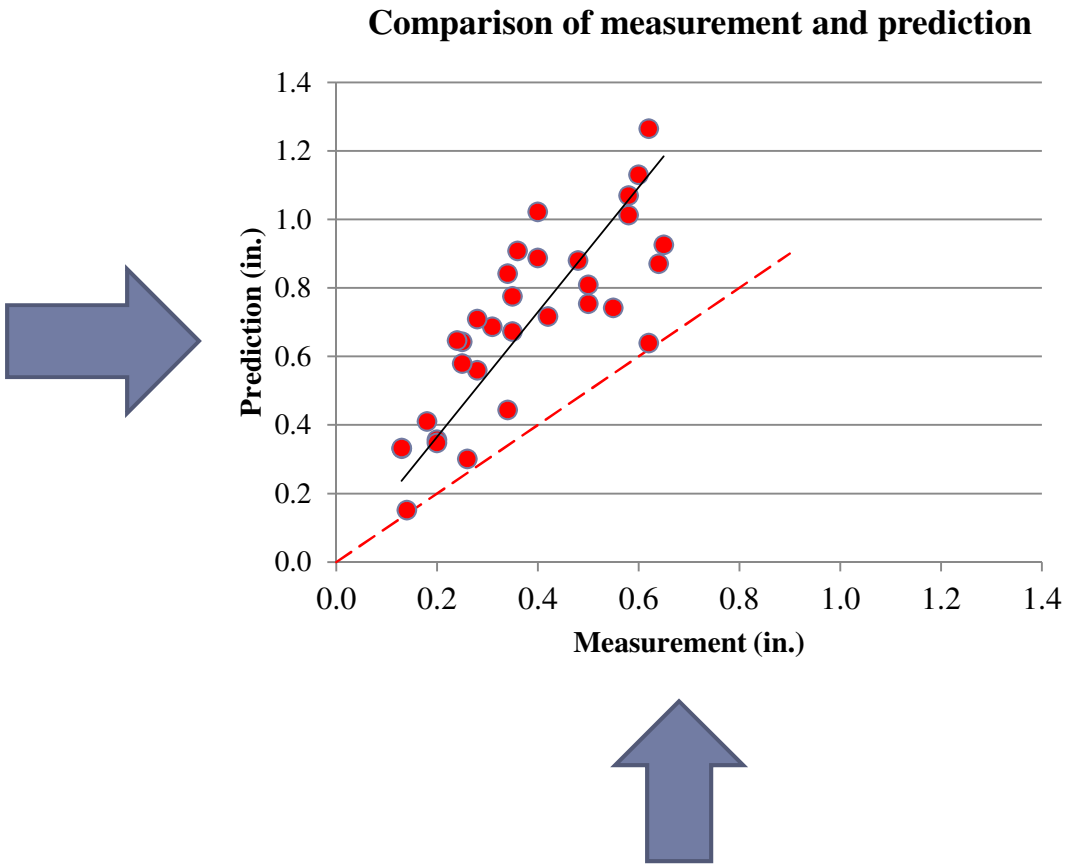




UNIVERSITY OF ARKANSAS

CVEG

Two reasons


Comparison of measurement and prediction
Prediction (in.)
Measurement (in.)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Variability of Measured Distress

- It has been recognized for a long time.

- Rada, G. et al. (1997, 1998), Variability of LTPP distress data
- Goodman, S. (2001), Variability of C-LTPP distress data
- Larson C. (2000), QA/QC of pavement distress data in Virginia
- Schwartz C. (2007), Uncertainty of distress measurement and MEPDG
- Flintsch, G. and McGhee, K. (2009), NCHRP Synthesis 401: Quality management of pavement condition data collection

Problem statement

- Do differences in distress definitions between LTPP and MEPDG affect calibration?
- Is longitudinal cracking in wheelpath alligator cracking?
- Should one use a weighting function to combine low, medium and high severities?

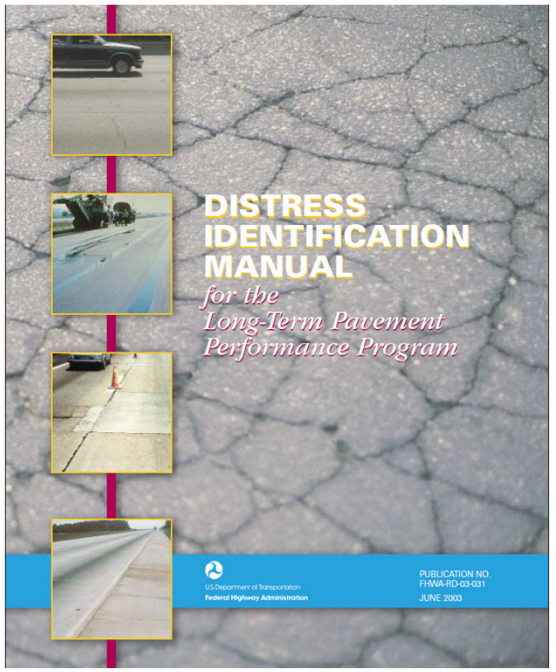
1. Do differences in distress definitions between LTPP and MEPDG affect calibration?

LTPP

- "As a pavement distress dictionary, the manual will improve communications within the pavement community by fostering more uniform and consistent definitions of pavement distress."

(Distress Identification Manual for LTPP, 2003)

Type Severity Amount

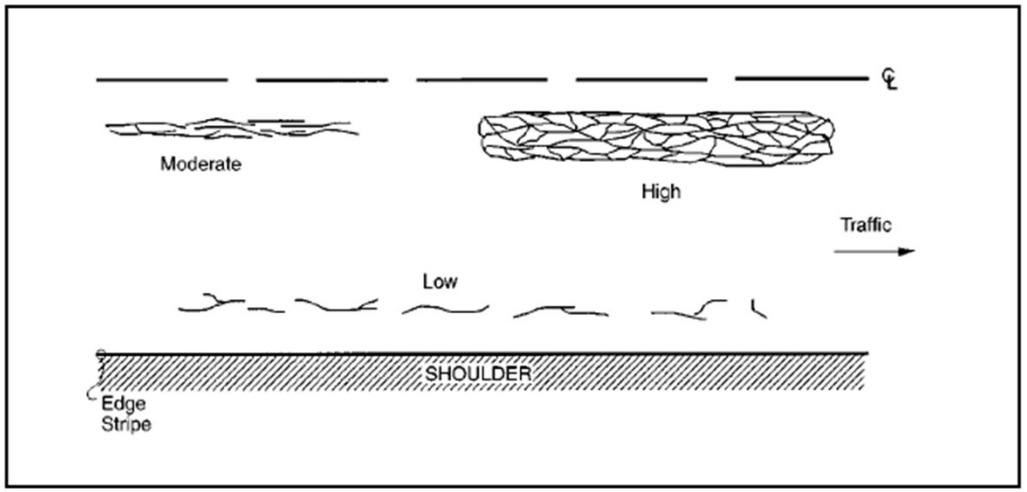


MEPDG

- "Mechanistic–empirical procedures use pavement models based on the mechanics of materials to predict pavement responses (deflections, strains, and stresses) and empirically based transfer functions to estimate distress initiation and development based on these responses."

(NCHRP Synthesis 401, 2009)

Alligator cracking



LTPP

MEPDG

FIGURE 3
Distress Type ACP 1—Fatigue Cracking

(Image from Distress Identification Manual for LTPP, 2003)

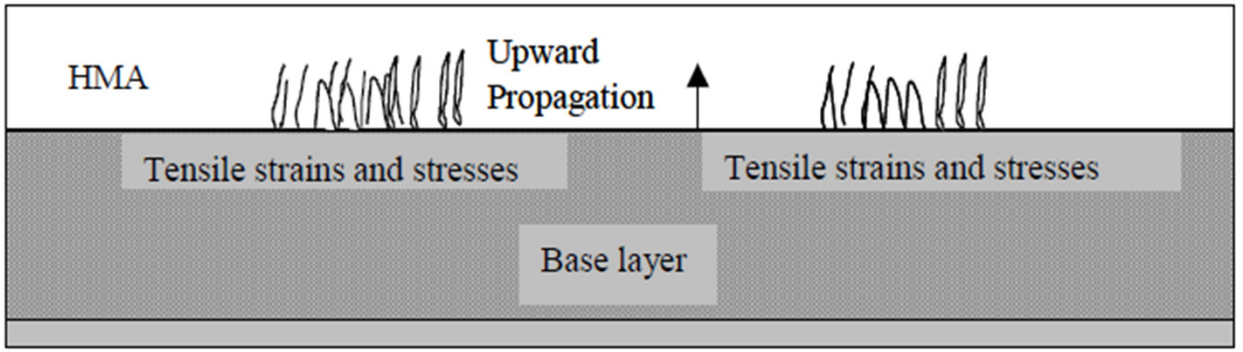


Figure 3.3.3. Bottom-up fatigue cracking.

(Image from NCHRP 1-37A final report, 2004)

Longitudinal cracking

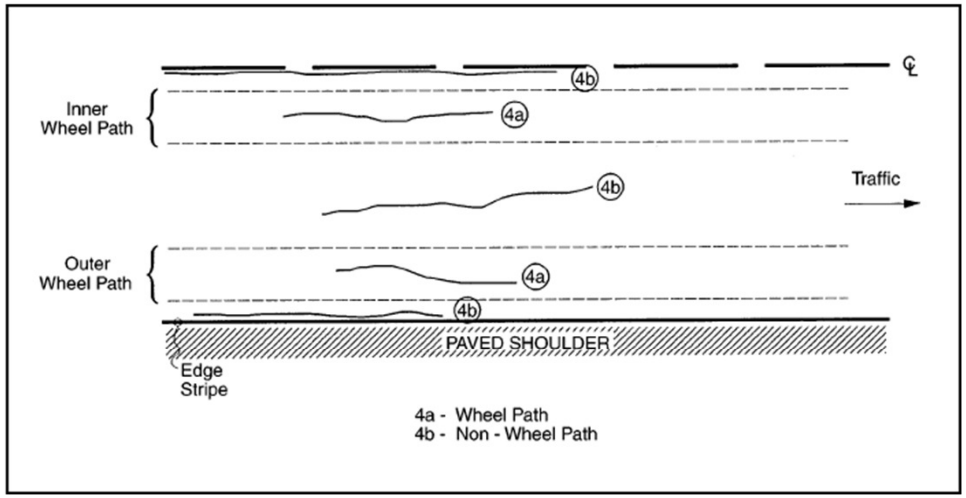


FIGURE 13
Distress Type ACP 4—Longitudinal Cracking

(Image from Distress Identification Manual for LTPP, 2003)

LTPP

MEPDG

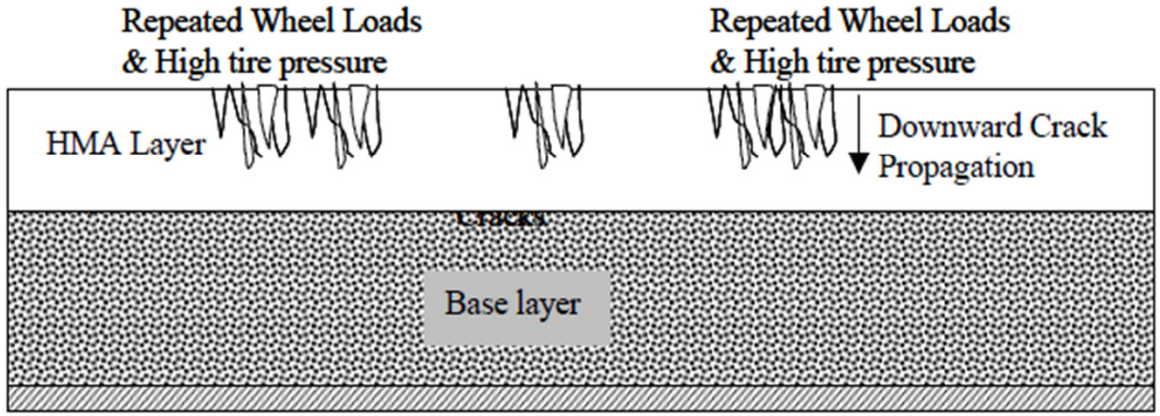


Figure 3.3.4. Top-down fatigue cracking.

(Image from NCHRP 1-37A final report, 2004)

Distress Models in MEPDG

$$N_f = 0.00432C\left(\frac{1}{\varepsilon_t}\right)^{3.291}\left(\frac{1}{E}\right)^{0.854}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

$$\sum_{i=1}^{T} D_i = \frac{n_i}{N_{fi}}$$

Bottom-up(alligator) cracking

$$F.C. = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' * \log10(D*100))}}\right) * \left(\frac{1}{60}\right)$$

Top-down(longitudinal) cracking

$$F.C. = \left(\frac{1000}{1 + e^{(7 - 3.5 * \log10(D*100))}}\right) * 10.56$$

(Equations from NCHRP 1-37A final report, 2004)

Transverse (LTPP) or thermal (MEPDG)?

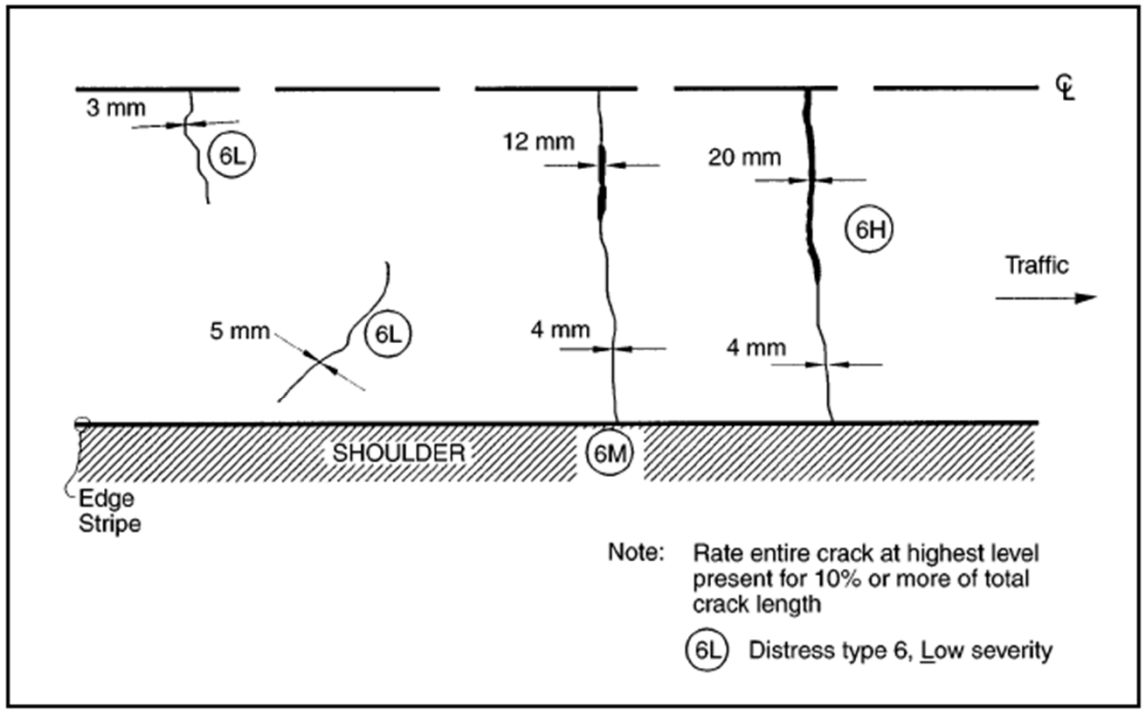
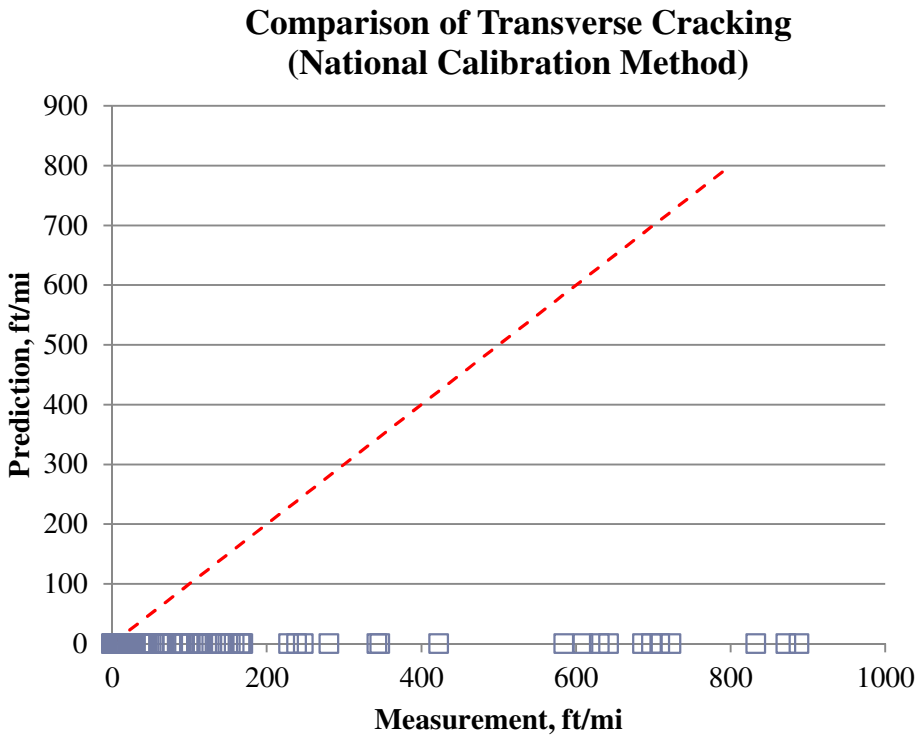


FIGURE 18
Distress Type ACP 6—Transverse Cracking Asphalt Concrete Surfaces

(Image from Distress Identification Manual for LTPP, 2003)

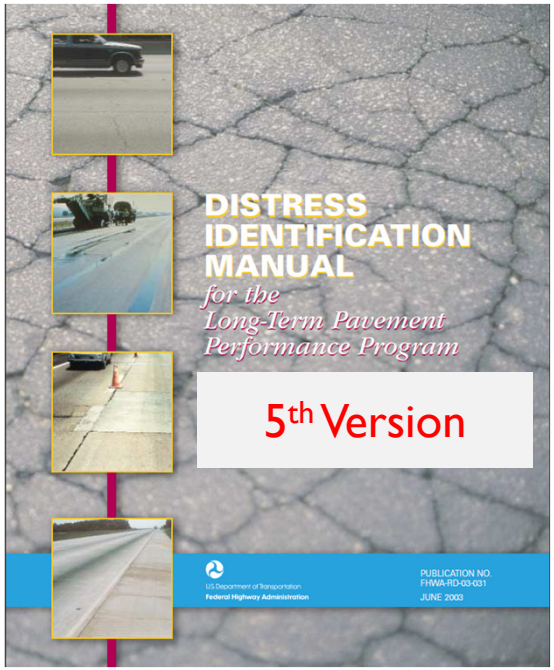
Transverse cracking

- No predicted thermal cracking, but we did see transverse cracking in field.



Recommendation

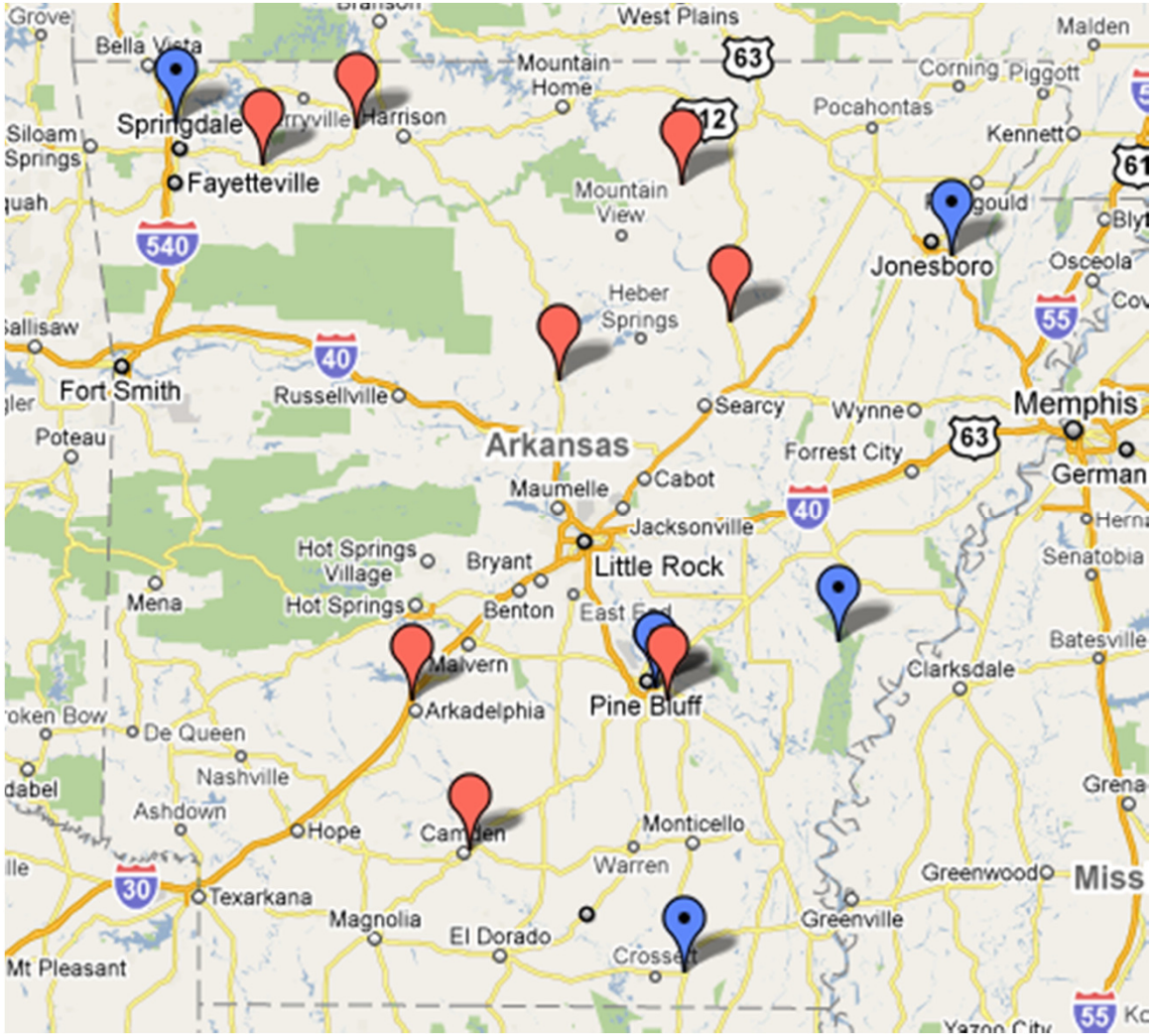
Type Severity Amount Location Mechanism



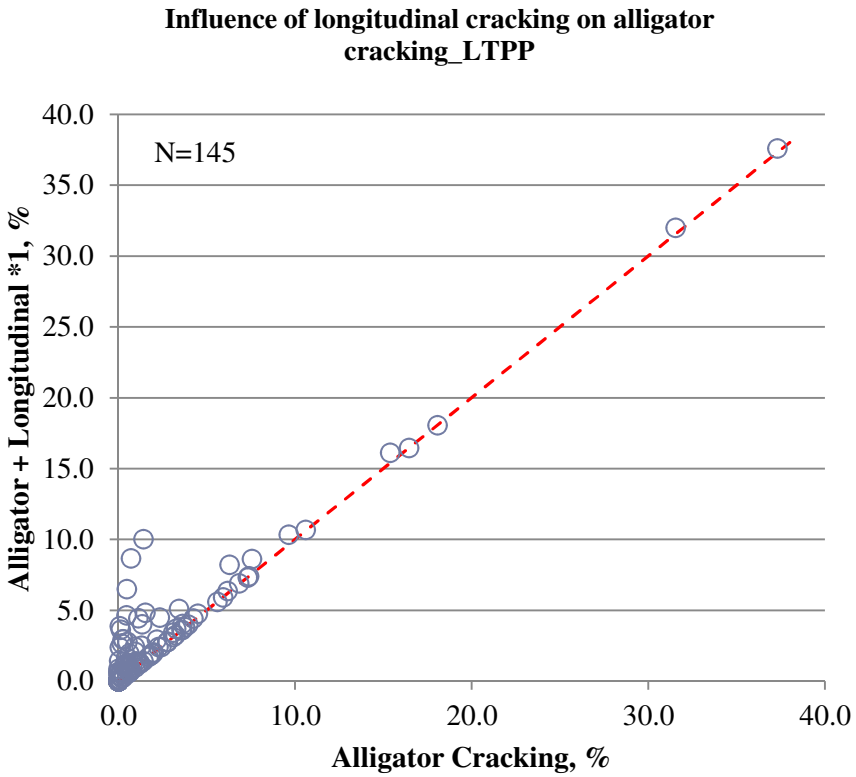
- 2. Is longitudinal cracking in wheelpath alligator cracking?

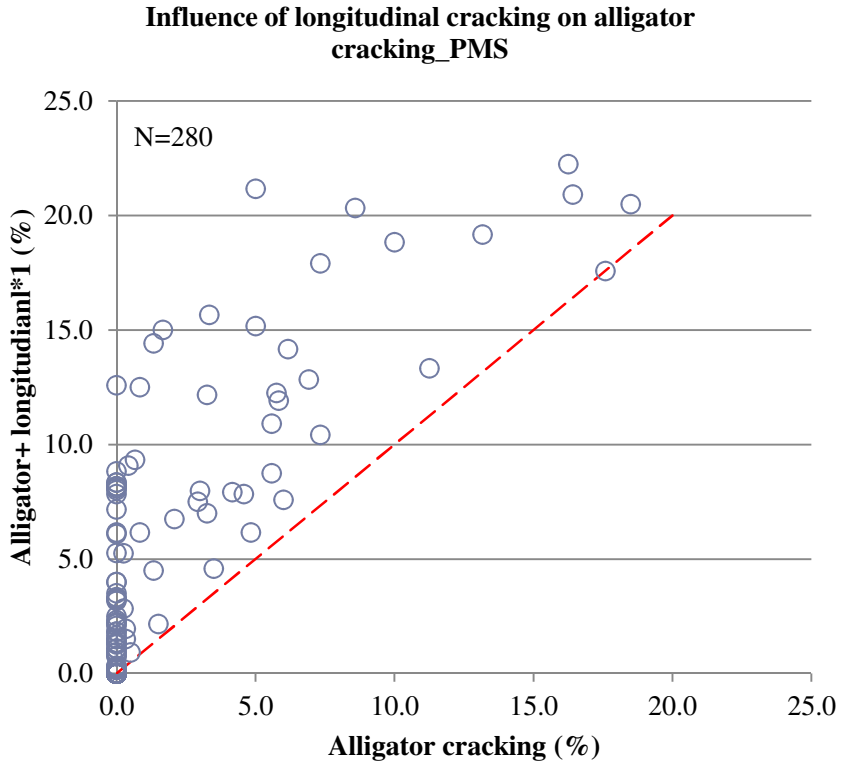
Data source

- 18 sections LTPP
- 8 sections PMS

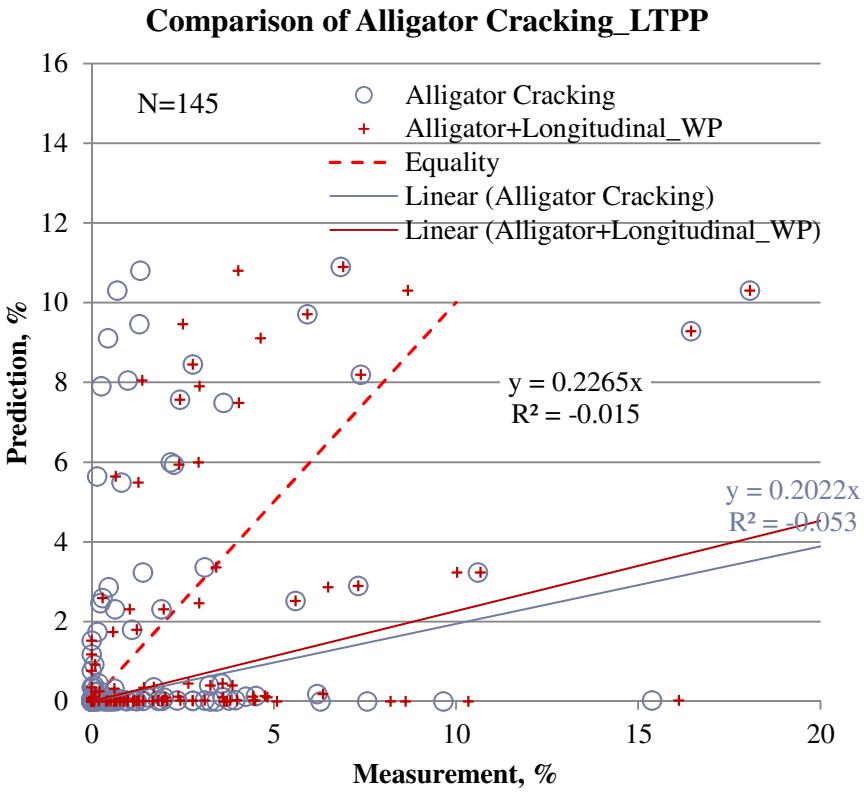


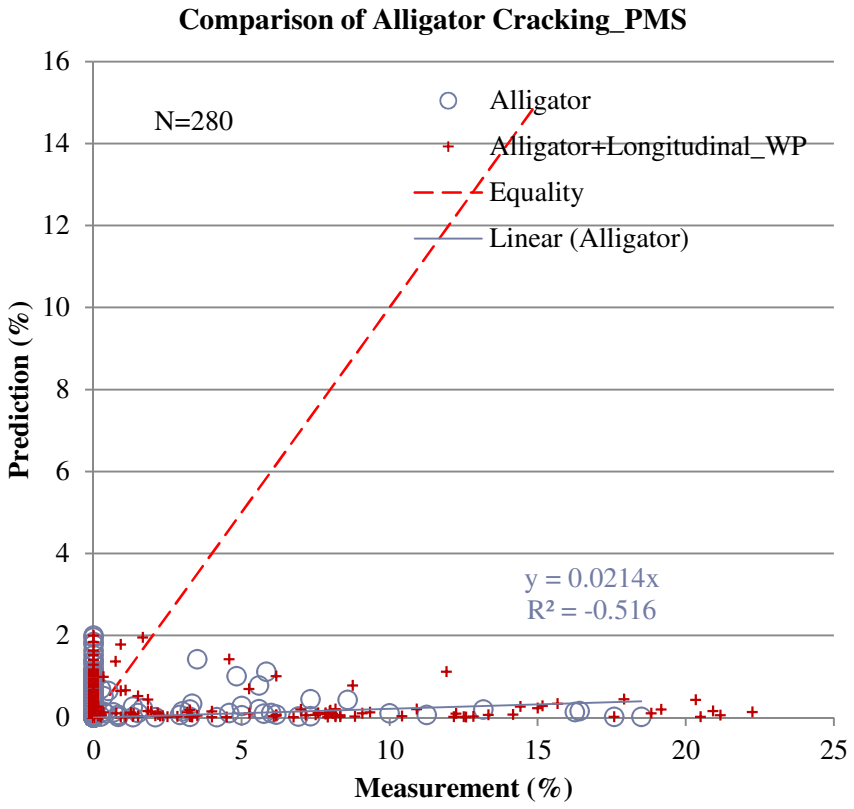
Consider longitudinal_WP as alligator?



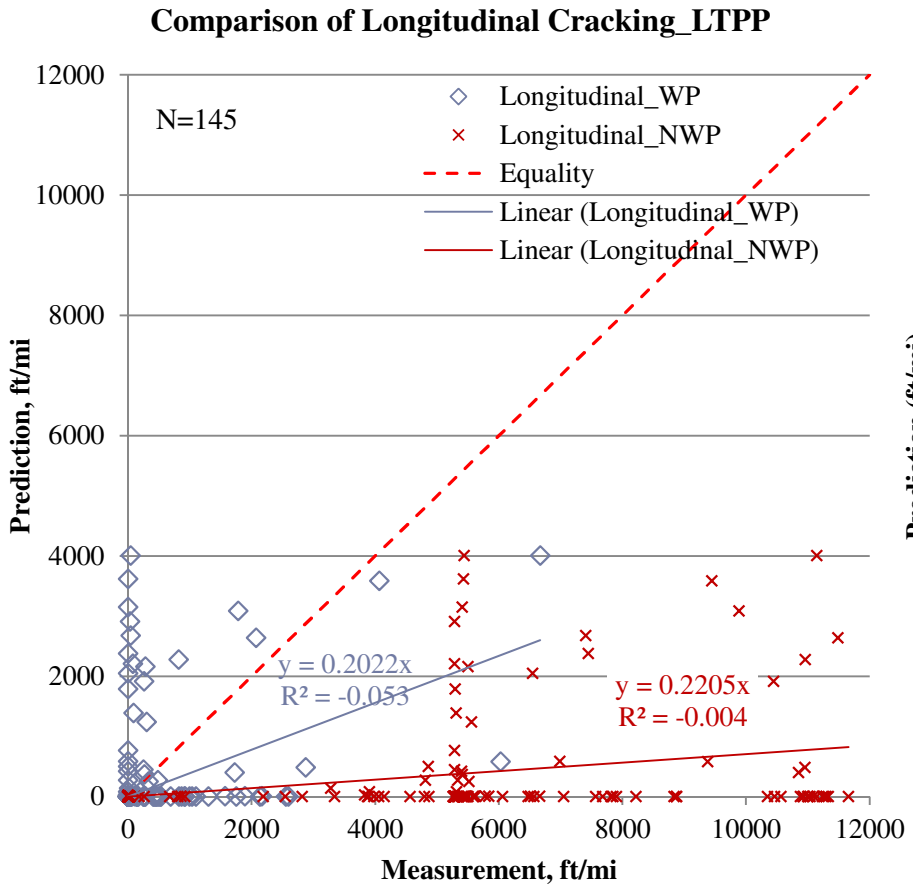


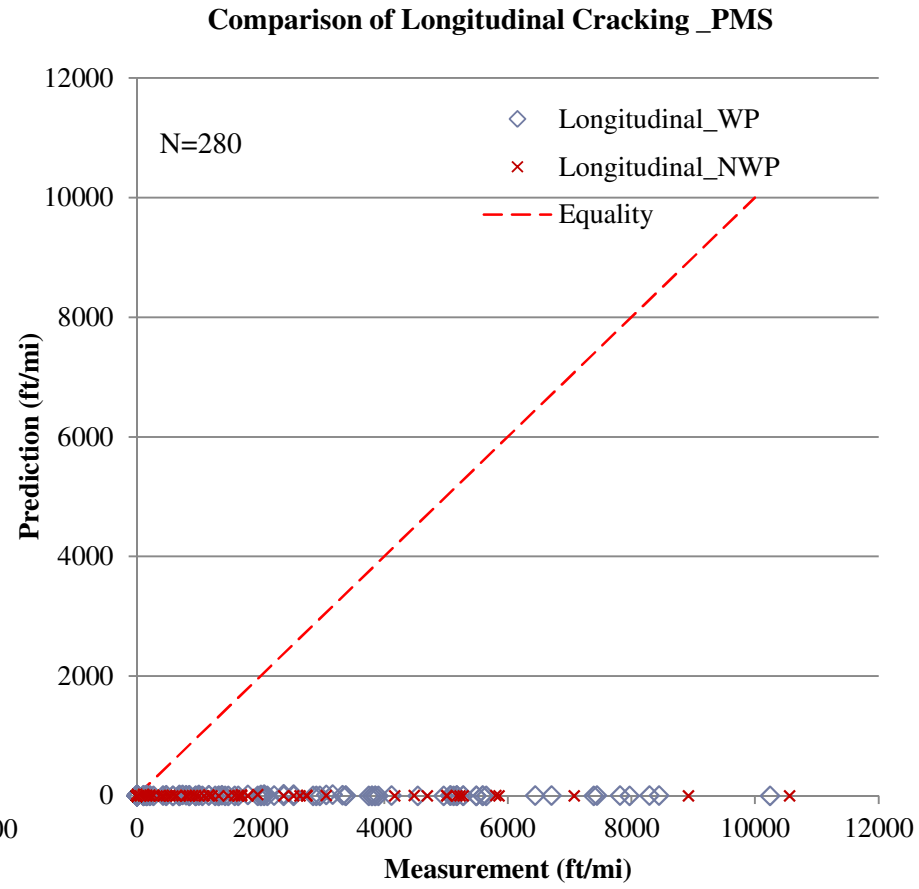
Longitudinal_WP as alligator?





Longitudinal_NWP





An important assumption

Longitudinal cracking in wheelpath is alligator cracking.

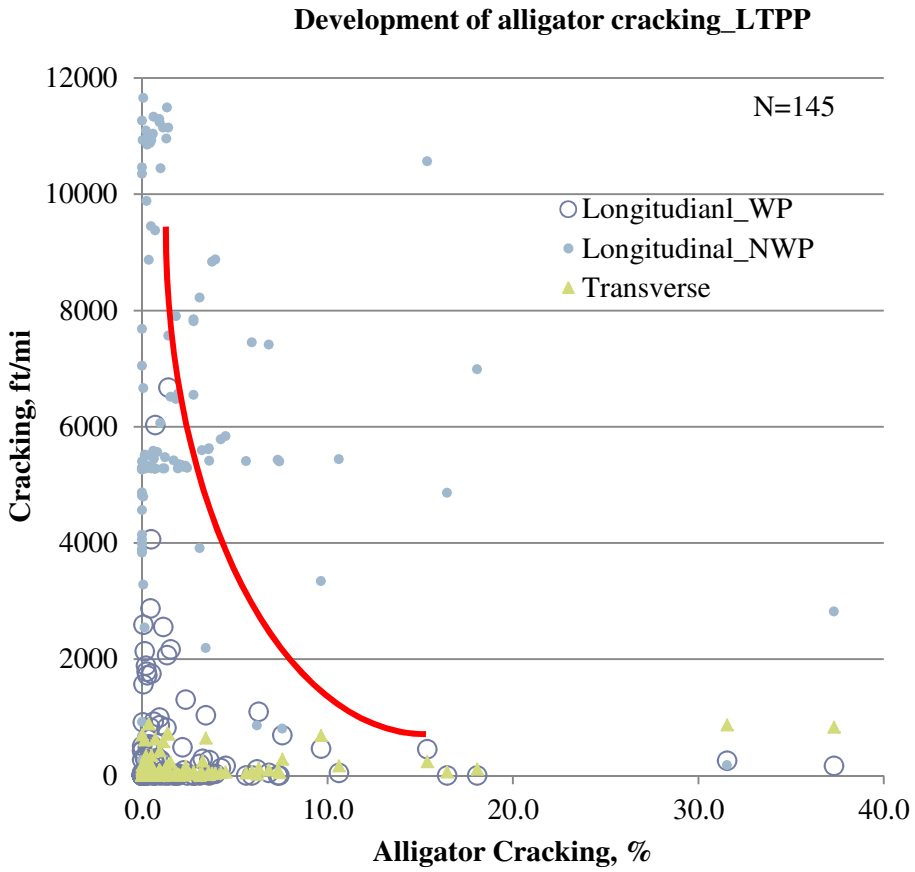
True

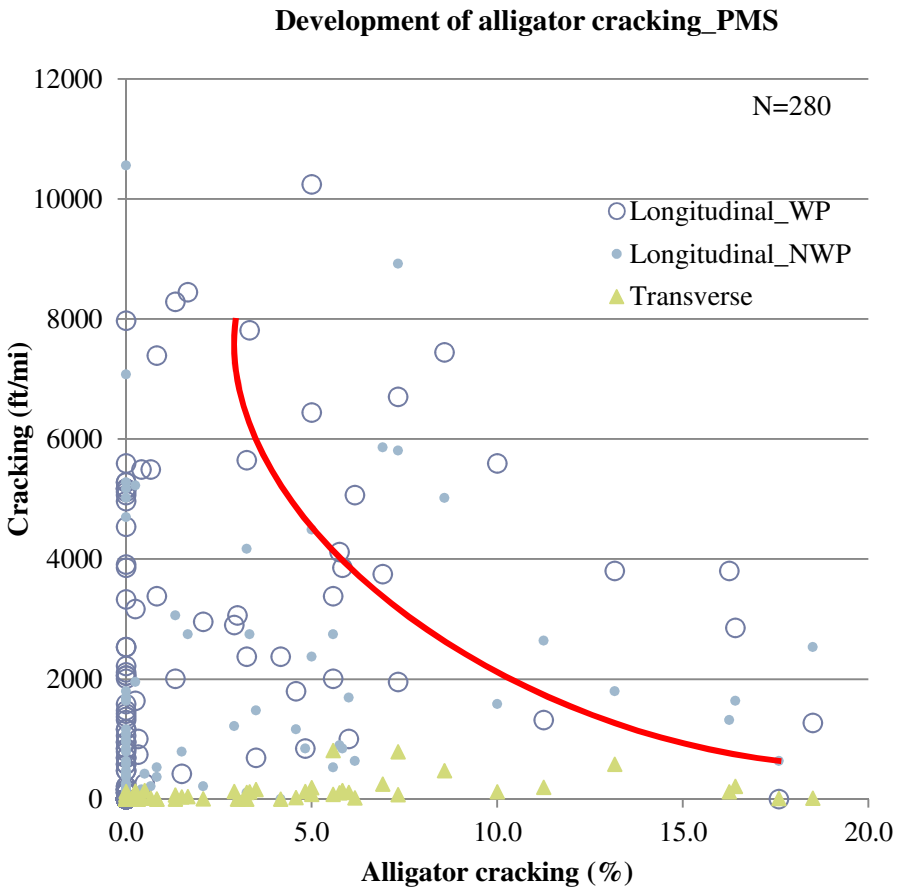
As pavement deteriorates, longitudinal cracking will decrease as alligator cracking increases.

False

As pavement deteriorates, longitudinal cracking will increase as alligator cracking increases.

Development of alligator cracking





- 3. Should one use a weighting function to combine low, medium and high severities?

Combine different severities together

- Pavement Condition Index (PCI), deduct value
- Low: medium : high = 3: 6: 10 (Chou C.,1997)
- MEPDG national calibration

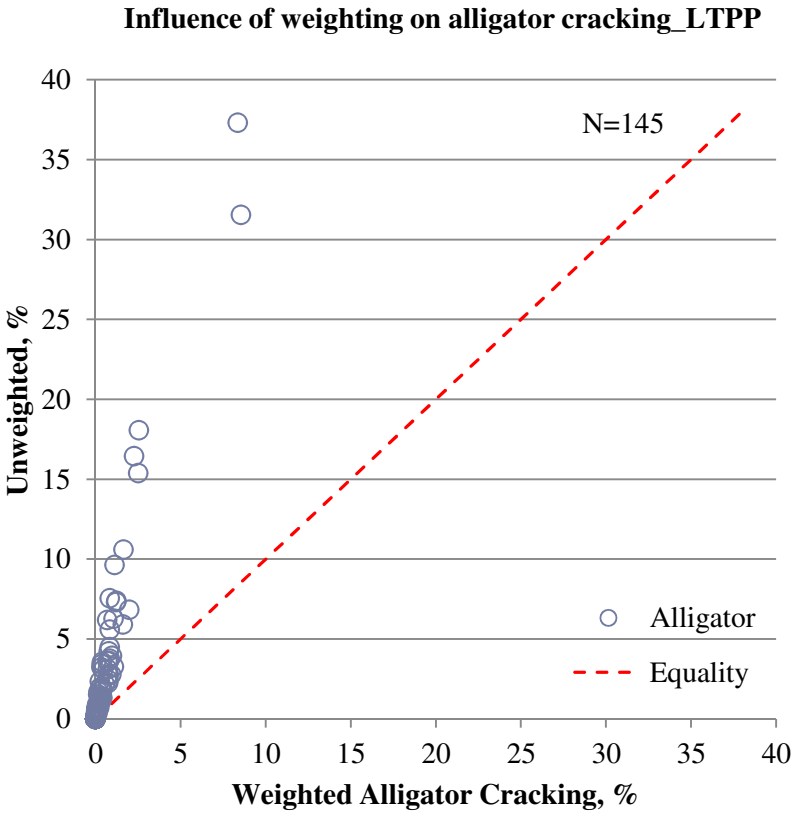
  for transverse cracking:

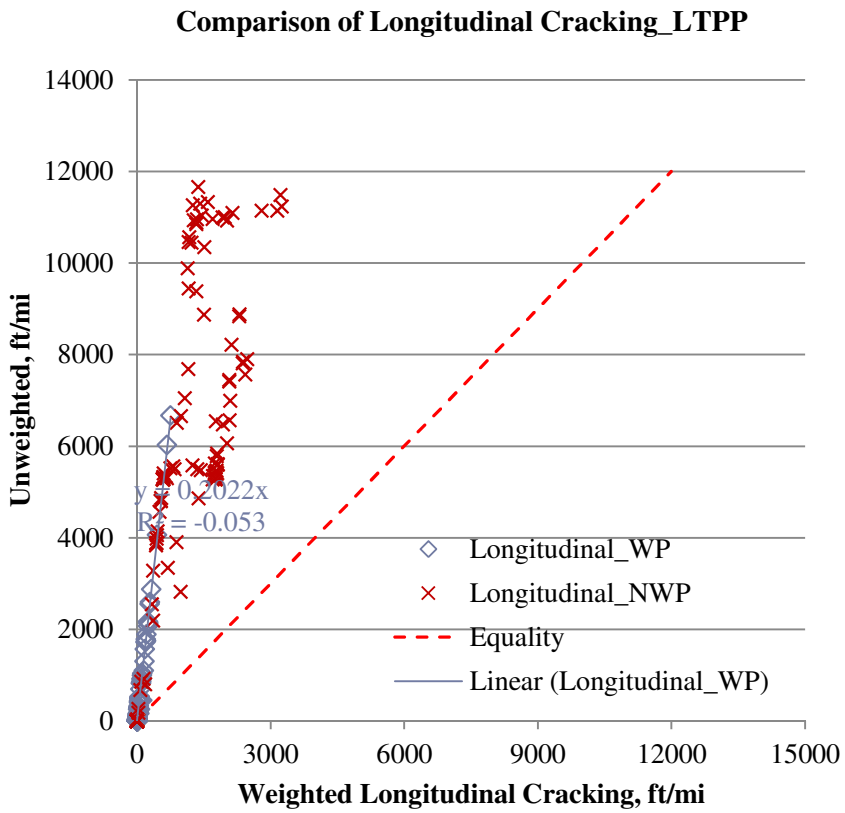
$$Total\ Measured\ Cracking = \frac{Low\_Severity + 3\ Medium\_Severity + 5\ High\_Severity}{9}$$

  for alligator and longitudinal cracking:

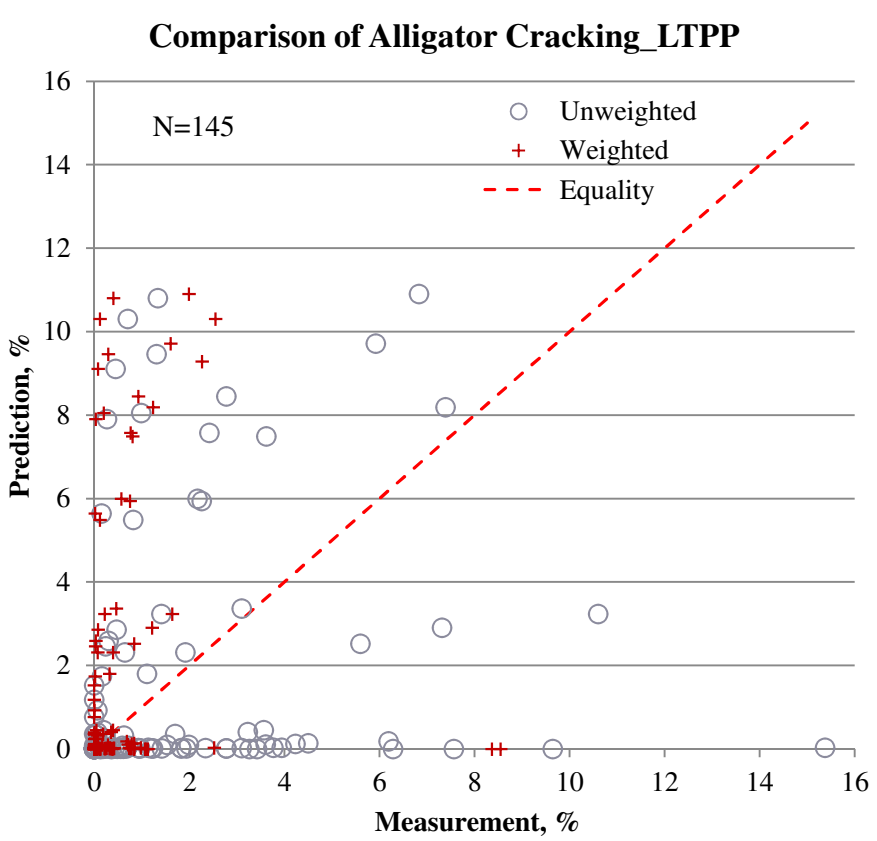
$$Total\ Measured\ cracking = Low\_severity + Medium\ severity + High\_Severity$$

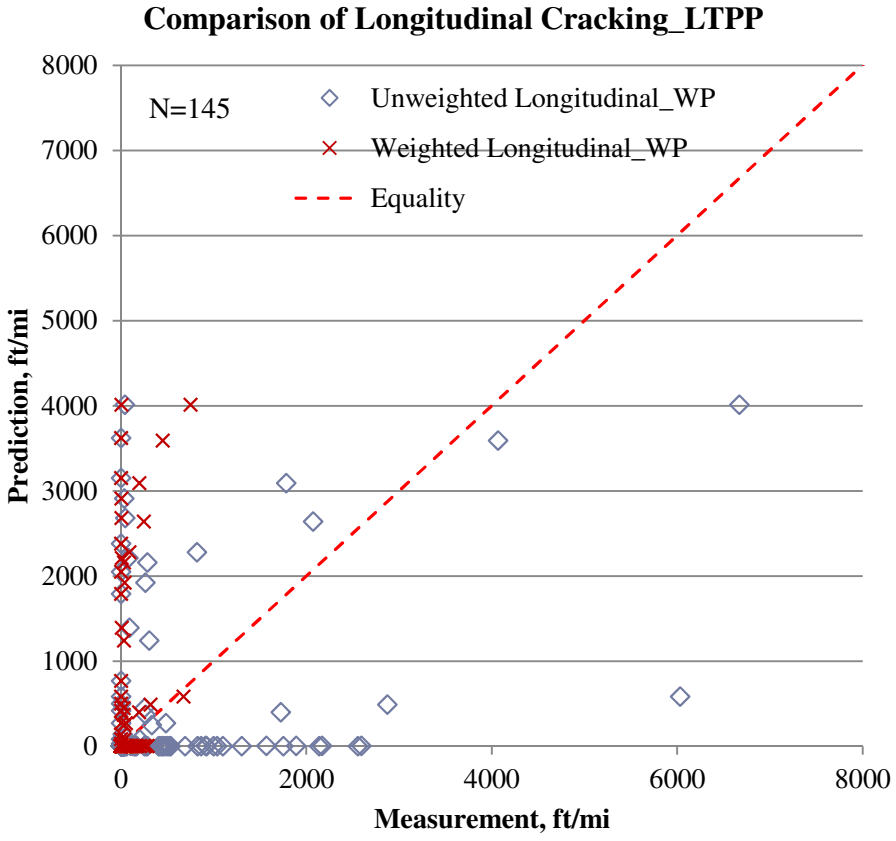
Weighting function: use or not use?



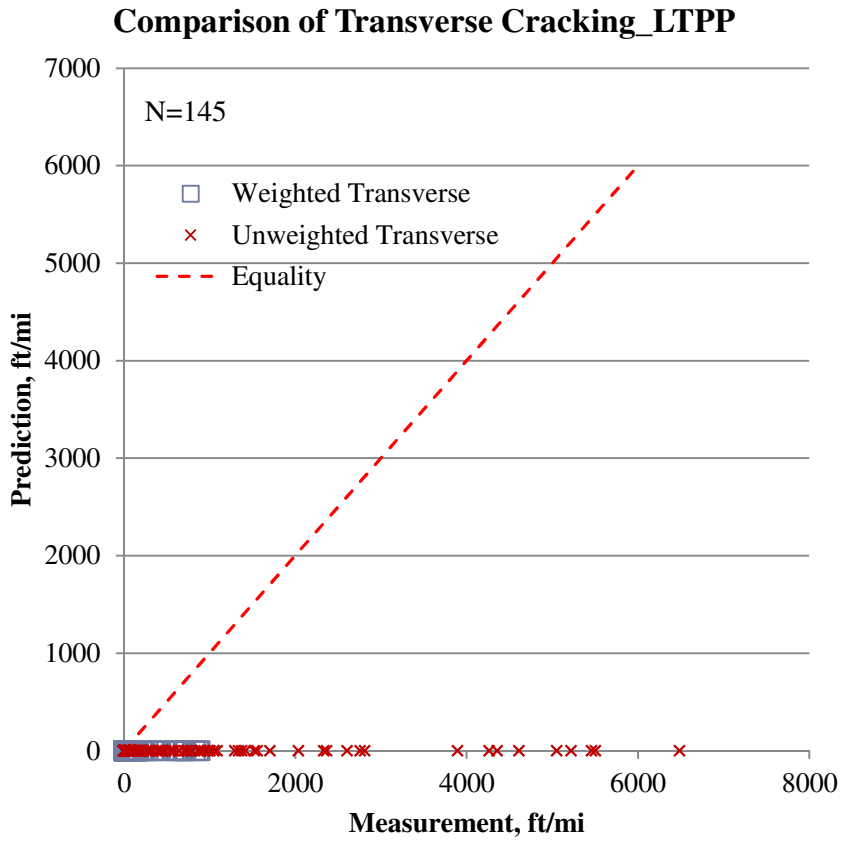


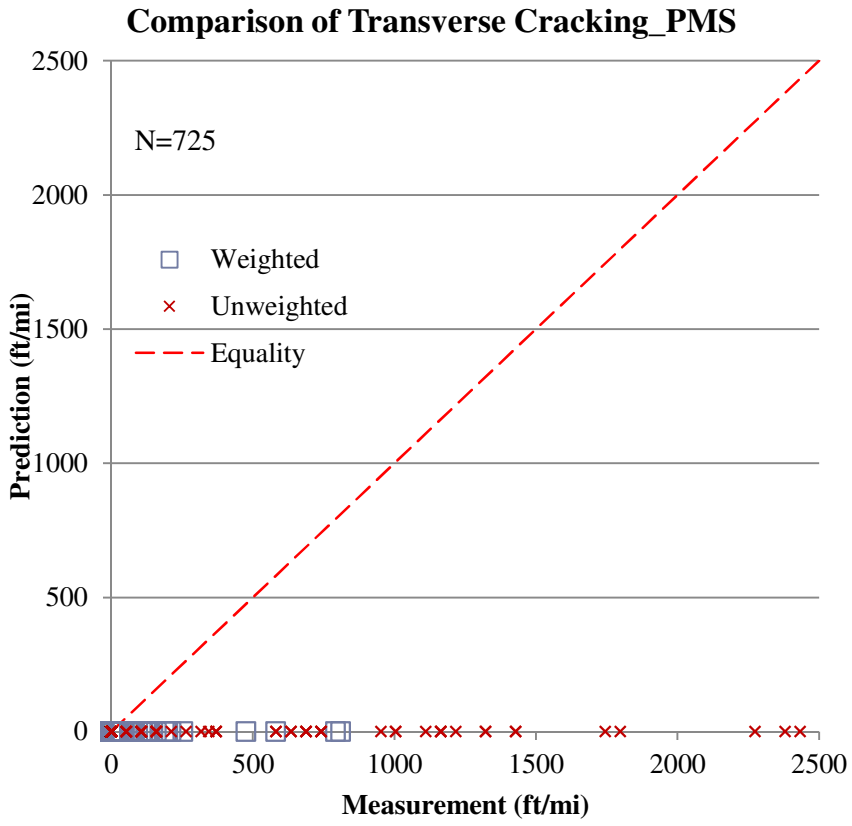
Weighting or not? (cont.)





Weighting or not? (cont.)





Conclusions

- Do differences in distress definitions between LTPP and MEPDG affect calibration?

  ANSWER: Yes, so the gap between LTPP and MEPDG should be considered.

- Is longitudinal cracking in wheelpath alligator cracking?

  ANSWER: Yes, it is recommended.

- Should one use a weighting function to combine low, medium and high severities?

  ANSWER: Based on data shown, cannot support or reject the use of weighting function.

Thank you!

Questions?

Suggestions?

(Fall at the University of Arkansas, by Dr. Nam Tran)