CURLING'S IMPACT ON STRUCTURAL RESPONSE OF JOINTED CONCRETE PAVEMENTS

Dan Ye, Ph.D., P.E.

Fugro Roadware, Inc.

2014 FAA WORLDWIDE AIRPORT TECHNOLOGY TRANSFER CONFERENCE

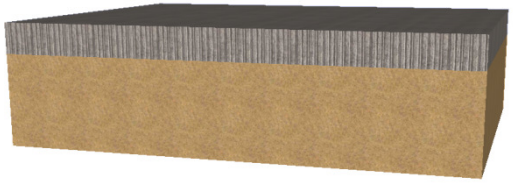
Galloway, New Jersey, USA

August 6, 2014

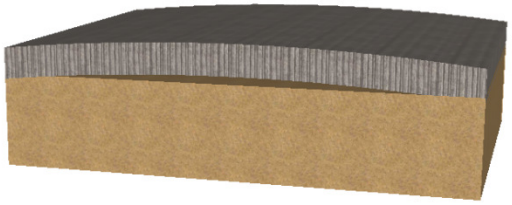
Contents

- Introduction
- Significance
- Corrective Approaches
- Summary

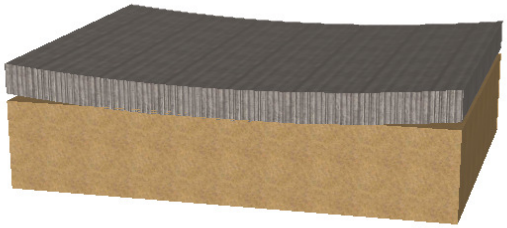
Introduction – Contact Scenarios



(a) Flat slab (typically early in the morning or late in the evening)



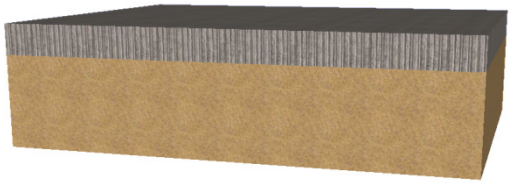
(b)Slab curled downward (typically during daytime)



Slab curled upward (typically during nighttime)

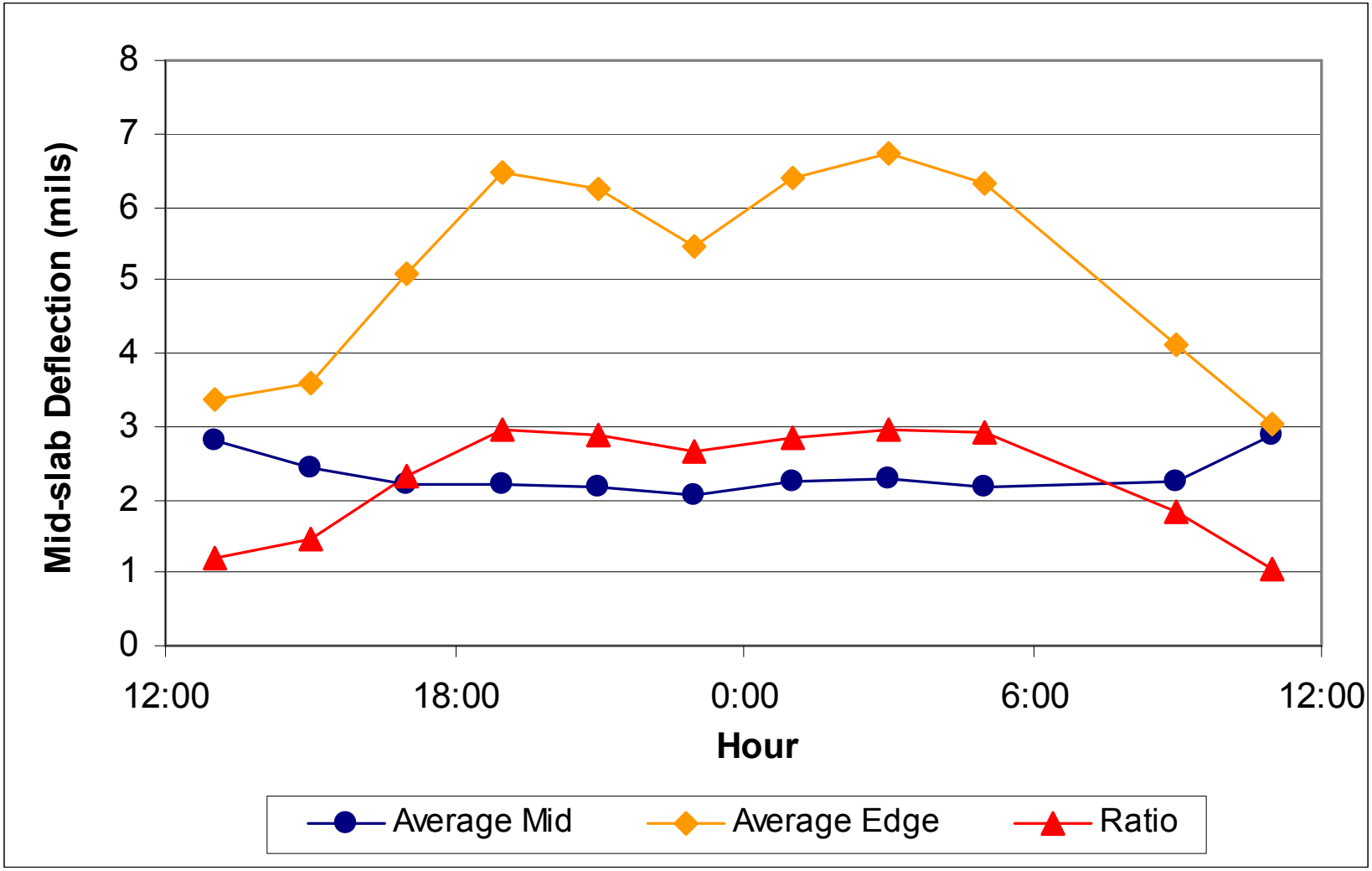
- Temperature gradient
- Moisture gradient
- Built-in temperature gradient
- Drying shrinkage
- Creep
- Confining condition (load transfer efficiency)

Introduction – Conventional Approach



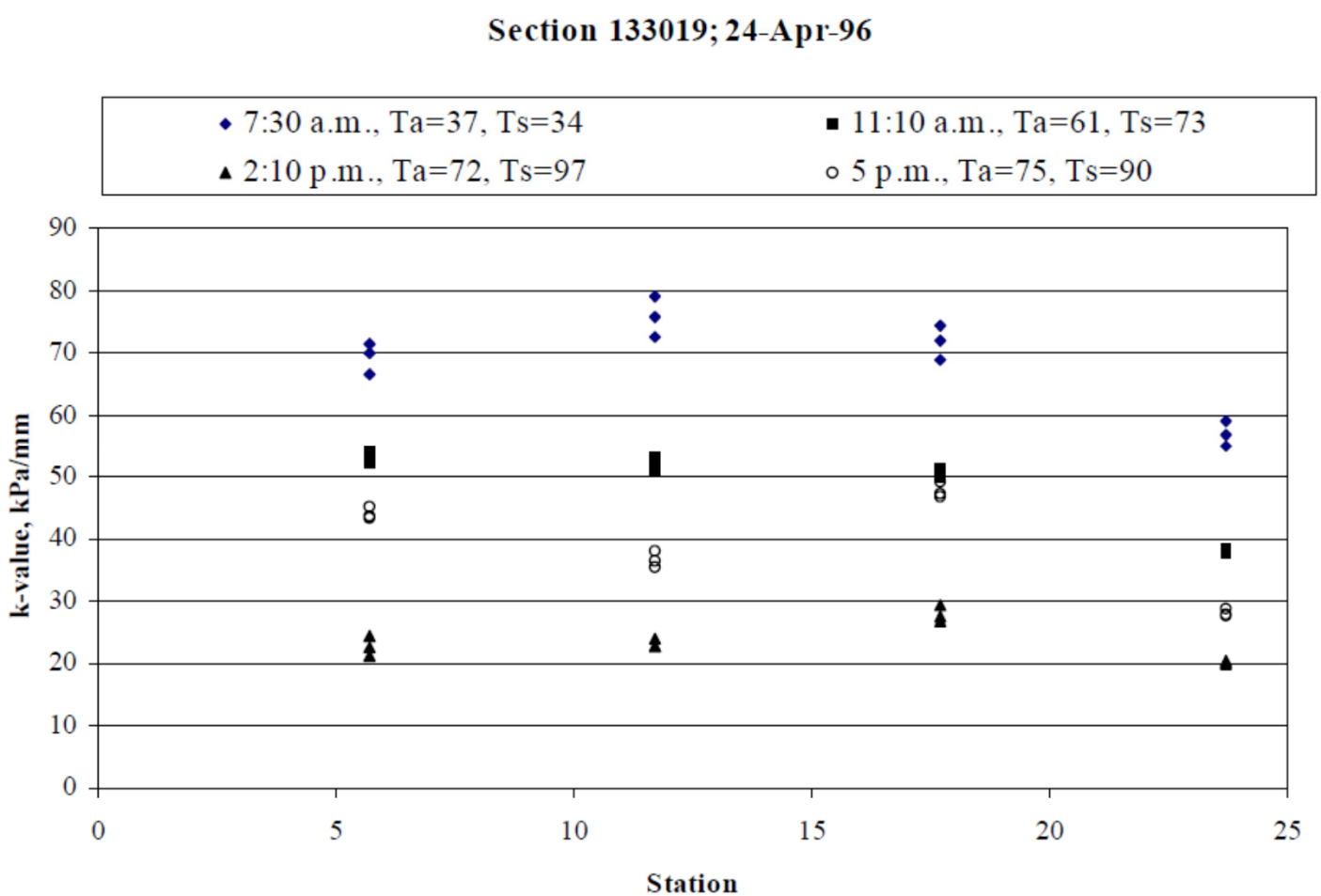
For the most-used conventional backcalculation approach for JCP, it is assumed that the concrete slab is in full contact with the underlying layer.

Significance – Deflection



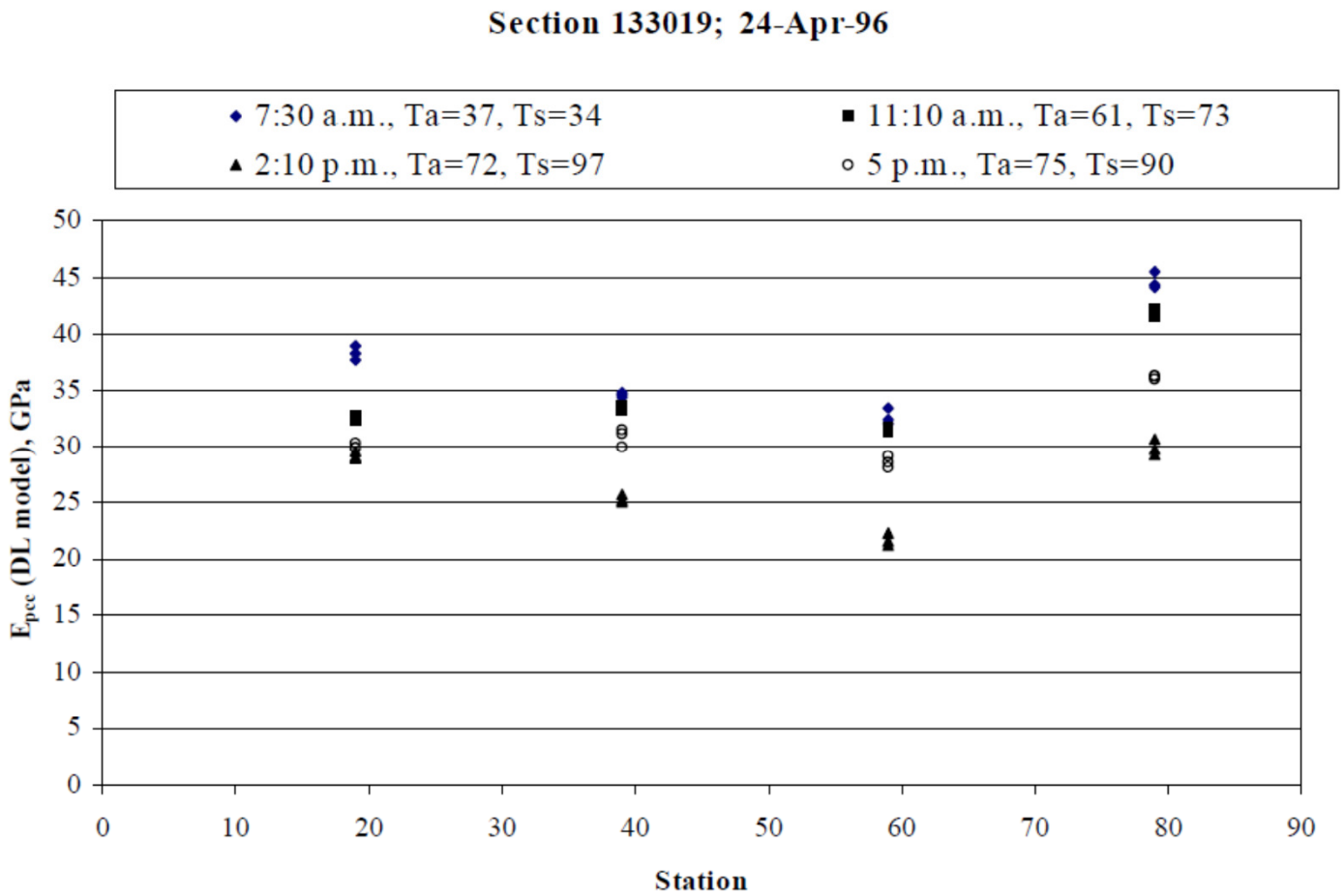
Zaghloul, Sameh, Ivana Marukic, and Nick Vitillo., "Impact of Slab Curling on Backcalculation Analysis." *Eighth International Conference on Concrete Pavements*, Colorado Spring, Colorado, 2005

Significance – SMP-Subgrade



Khazanovich, L., S.D. Tayabji, and M.I. Darter, *Backcalculation of Layer Parameters for Long-Term Pavement Performance (LTPP) Test Sections, Volume I: Slab on Elastic Solid and Slab on Dense-Liquid Foundation Analysis of Rigid Pavements*, Publication No. FHWARD-00-086, Federal Highway Administration, Washington, DC, December 2001.

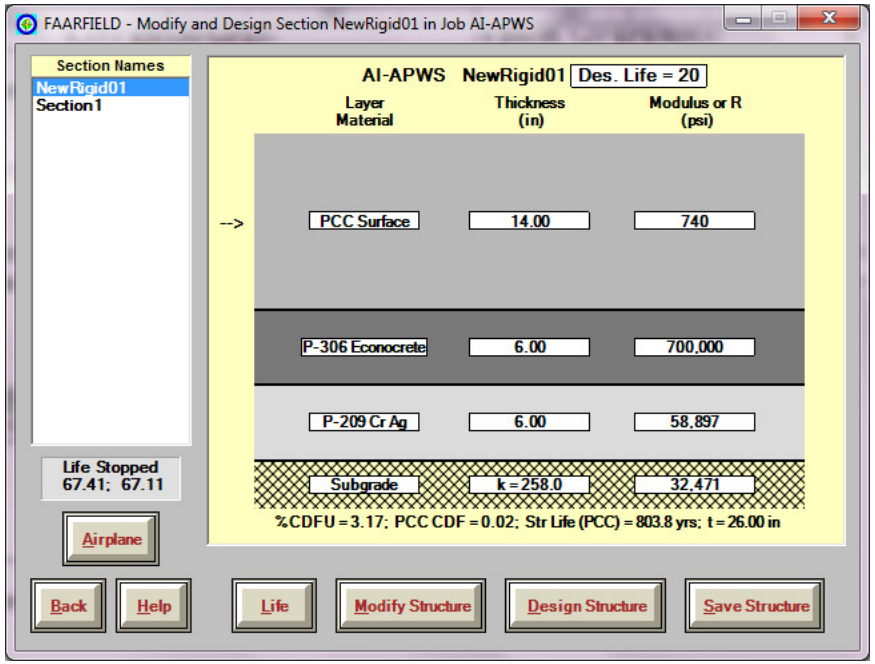
Significance – SMP-PCC



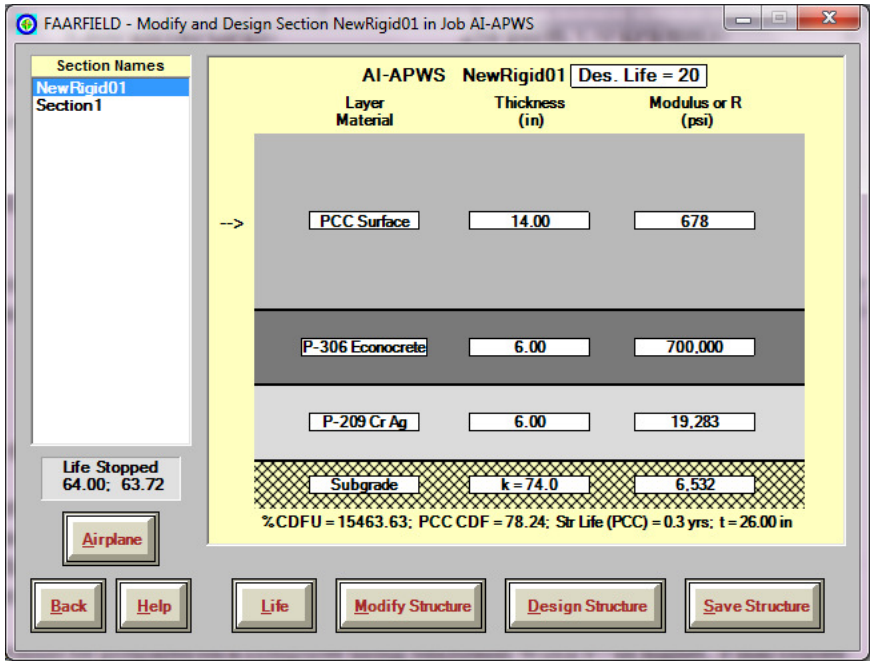
Khazanovich, L., S.D. Tayabji, and M.I. Darter, *Backcalculation of Layer Parameters for Long-Term Pavement Performance (LTPP) Test Sections, Volume I: Slab on Elastic Solid and Slab on Dense-Liquid Foundation Analysis of Rigid Pavements*, Publication No. FHWARD-00-086, Federal Highway Administration, Washington, DC, December 2001.

Significance – Remaining Life

Time	Concrete resilient modulus	Subgrade reaction modulus
7:30 AM	5,800 ksi (40 GPa)	258 psi/in. (70 kPa/mm)
2:10 PM	4,351 ksi (30 GPa)	74 psi/in. (20 kPa/mm)

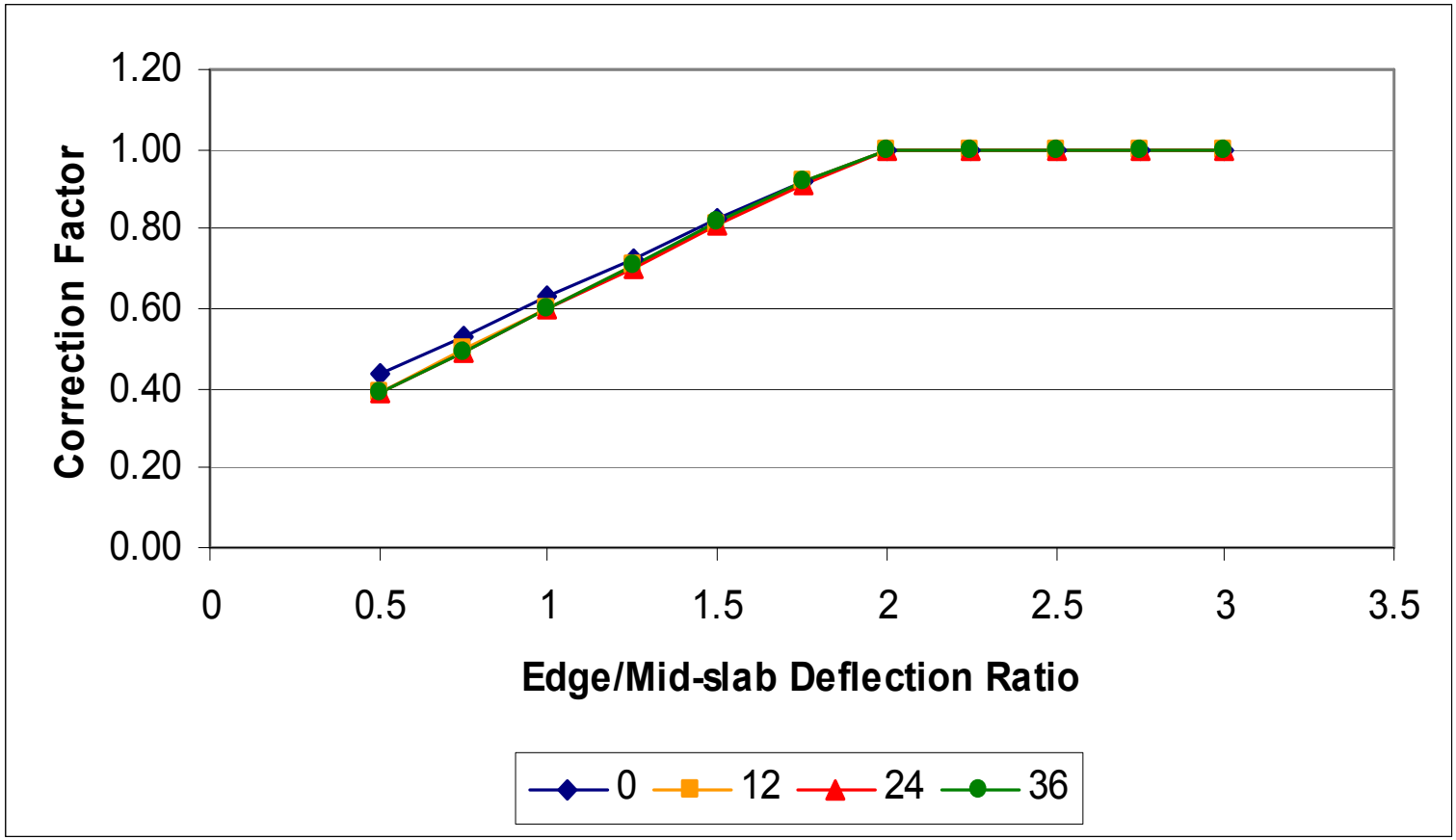


803.8 yrs



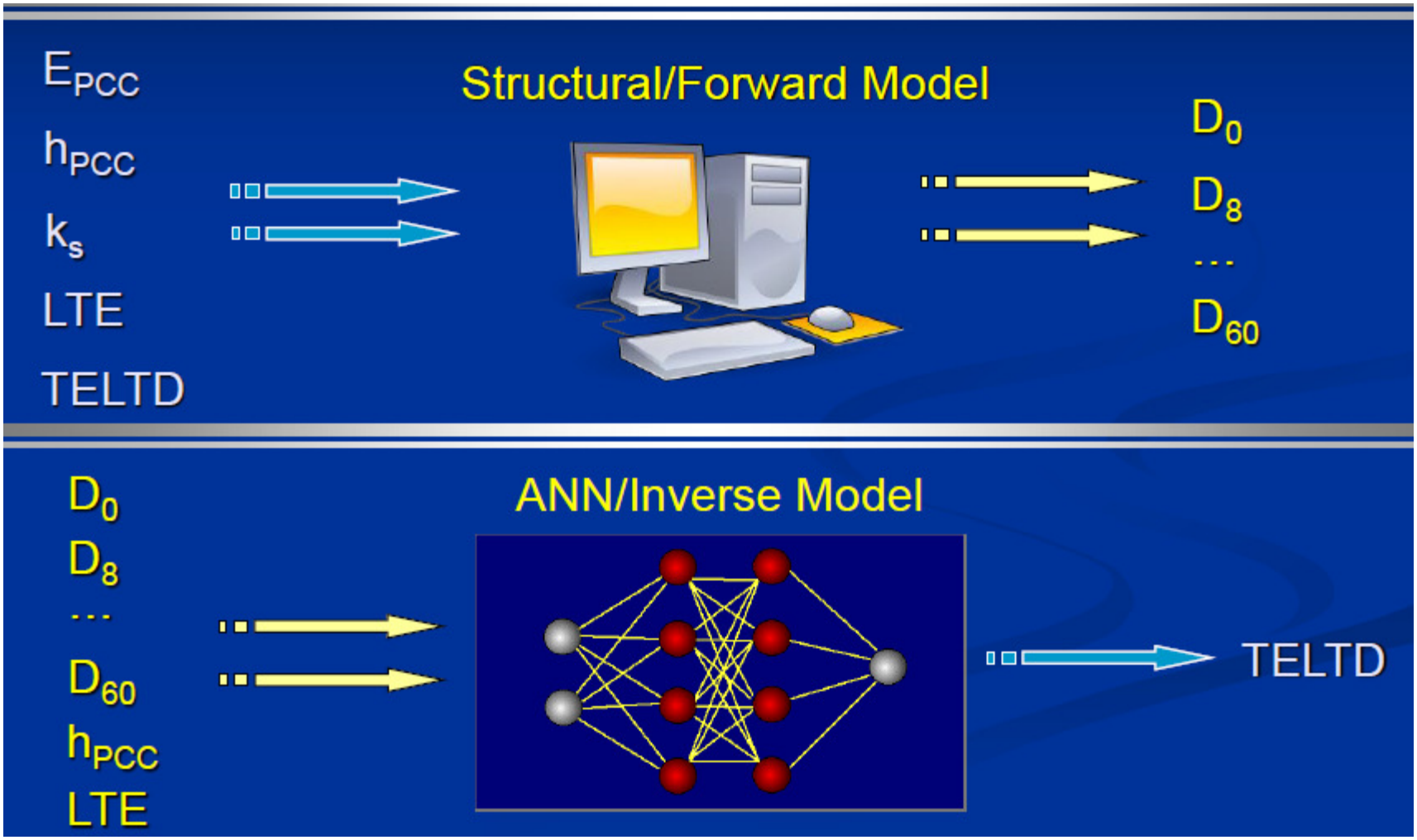
0.3 yrs

Corrective Approaches - Zaghloul



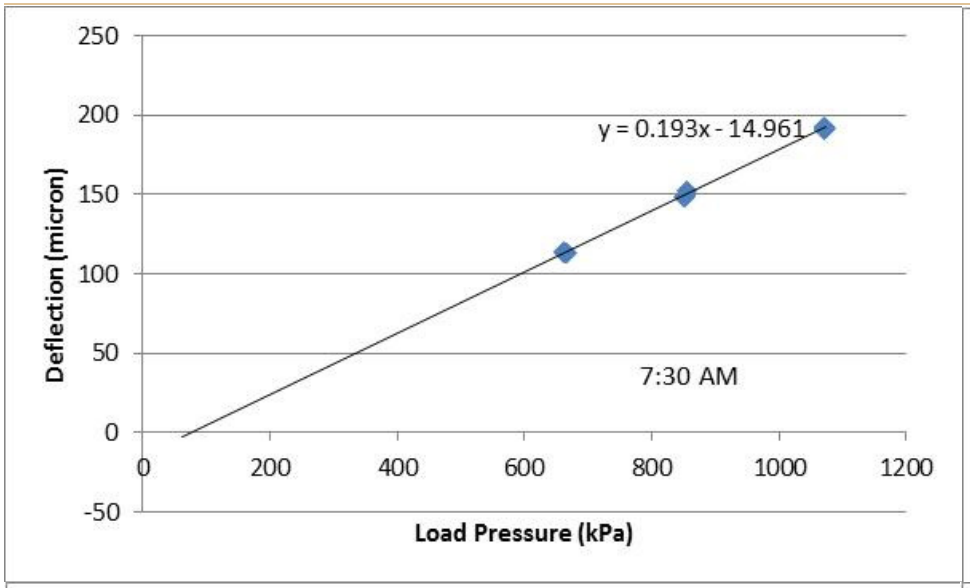
Zaghloul, Sameh, Ivana Marukic, and Nick Vitillo., "Impact of Slab Curling on Backcalculation Analysis." *Eighth International Conference on Concrete Pavements*, Colorado Spring, Colorado, 2005

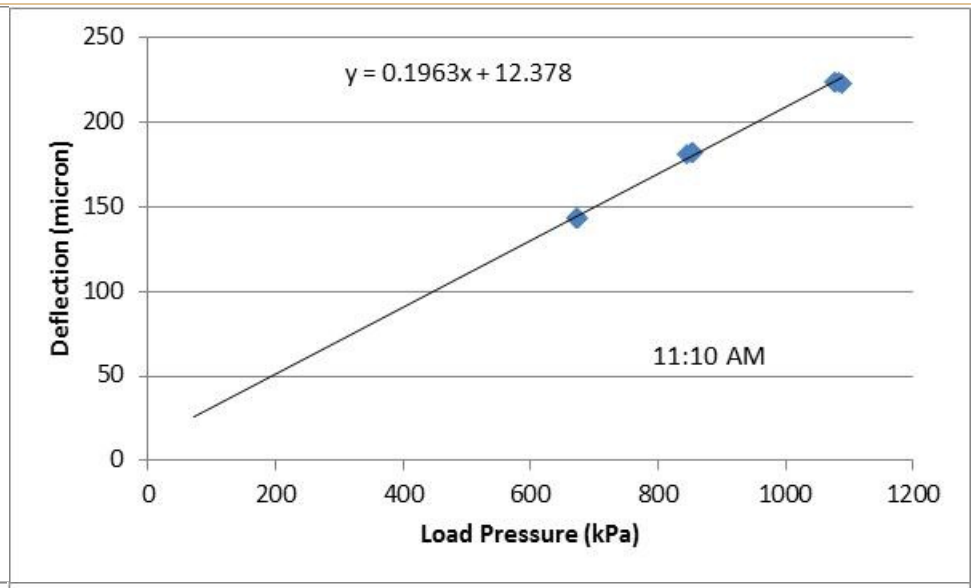
Corrective Approaches - Ceylan

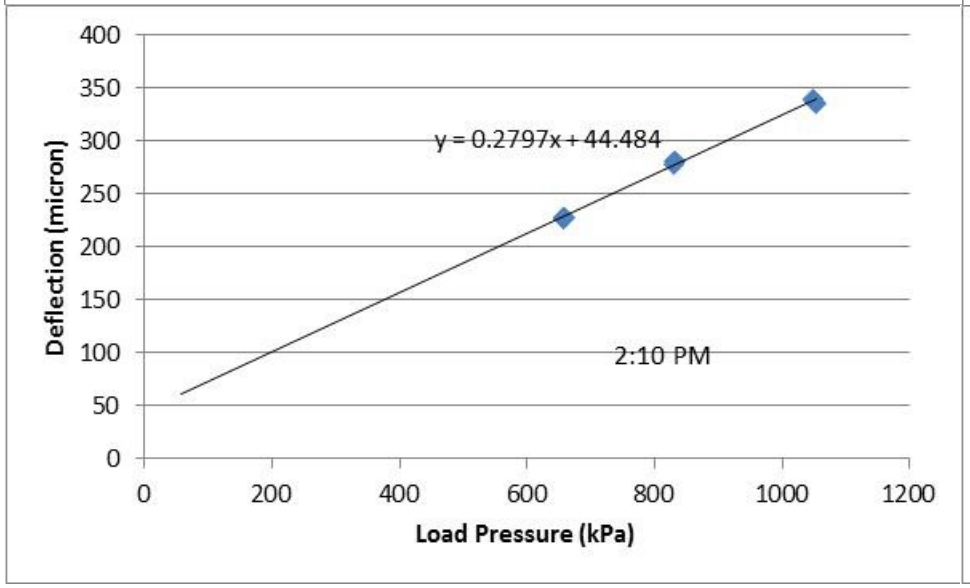


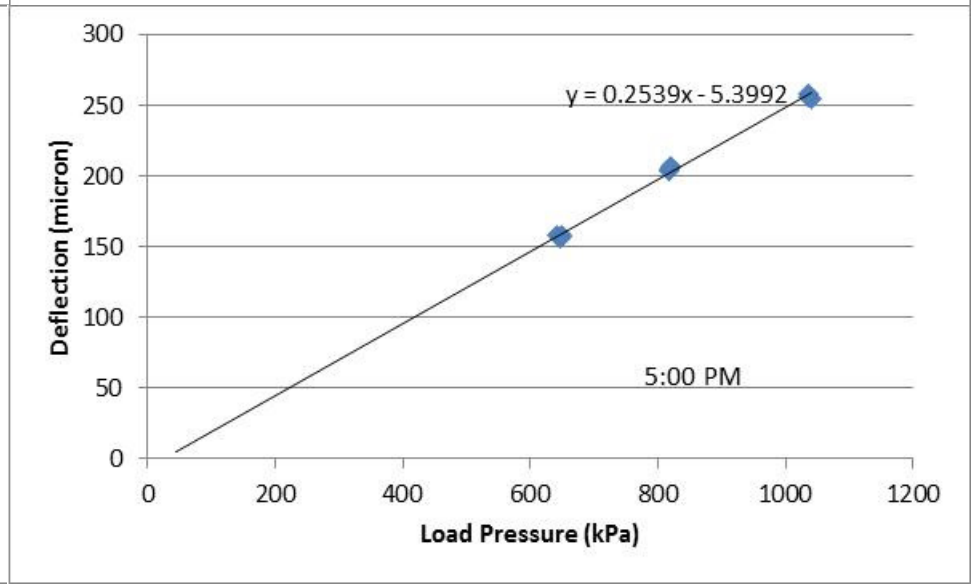
Ceylan, Halil, Mustafa Birkan Bayrak, and Kasthuriangan Gopalakrishnan, “Effect of slab curling and warping on pavement layer backcalculation”, Falling Weight Deflectometer (FWD) User’s Group Conference Des Moines, Iowa, 2007.

Corrective Approaches - Intercept



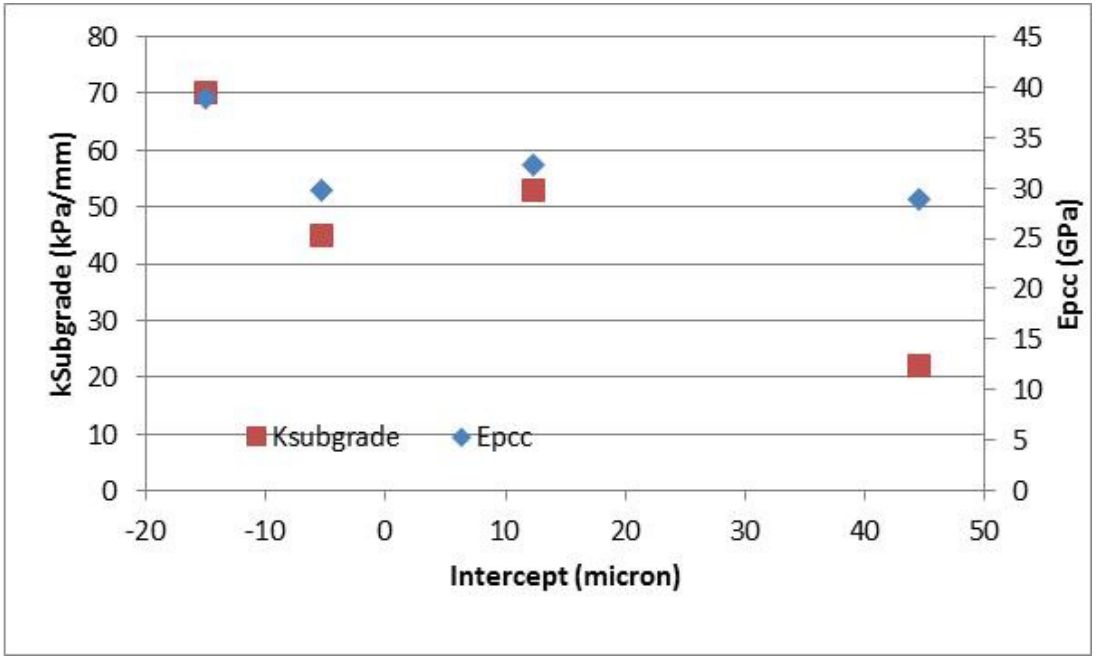




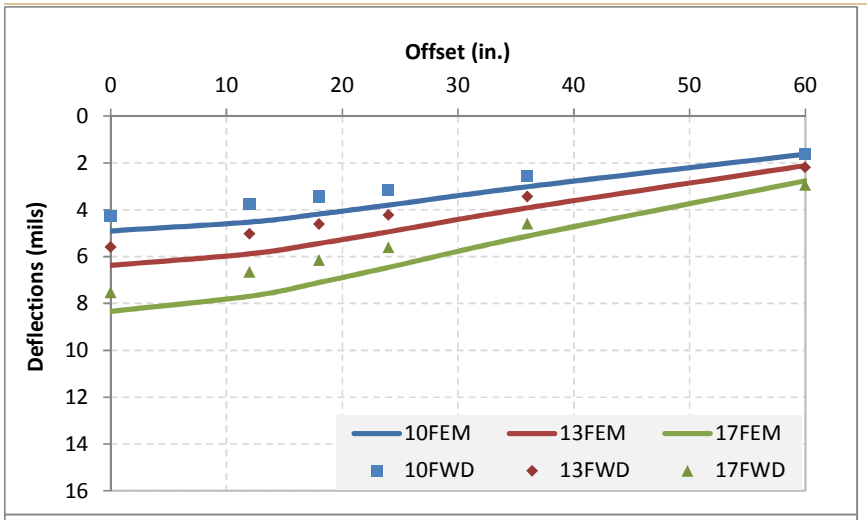


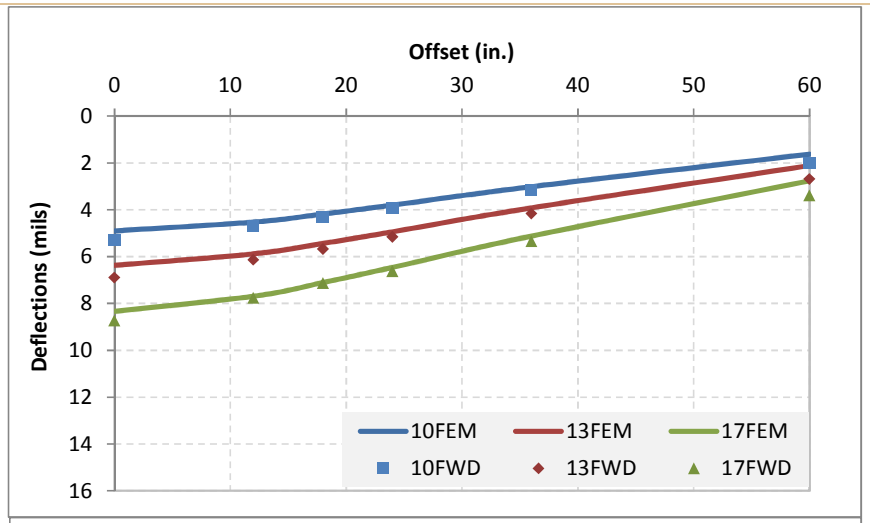
Corrective Approaches – Intercept

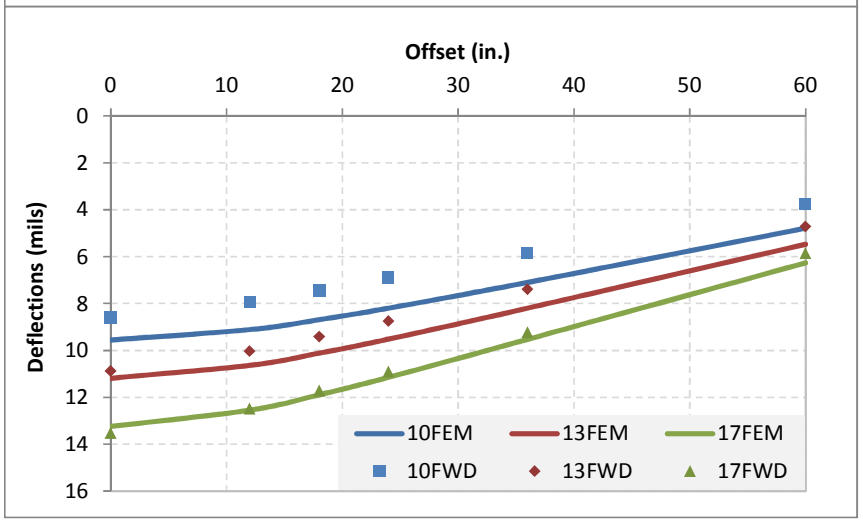
- Intercept seems to be a good indicator if any upward curling is taken place.
- Intercept could possibly be used to adjust backcalculated moduli.

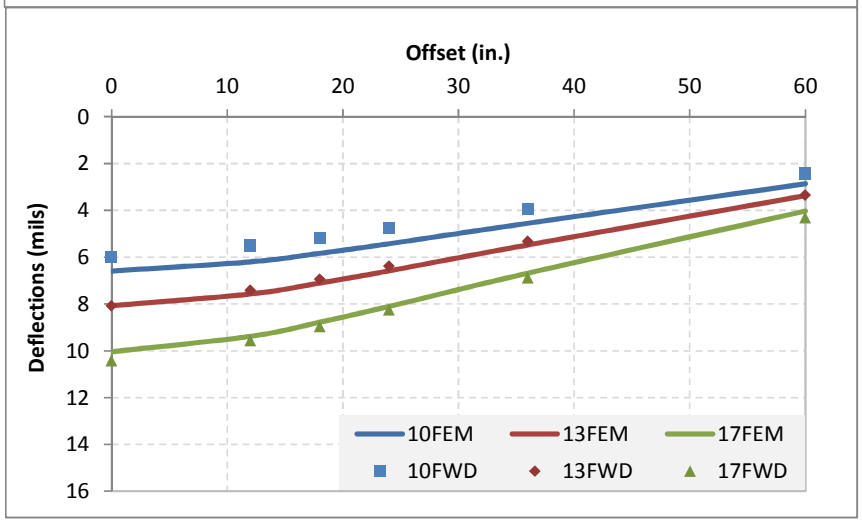


Corrective Approaches - FEM









Epcc, Ksubgrade, Equivalent temperature gradient

Summary

- Curling's effect is significant.
- Backcalculated moduli based on conventional approach could be misleading.
- Corrective approaches are available, but need more research to validate.

Thank You!

Questions?