

# Using FWD Data with M-E Design and Analysis



**Study Update**  
**17<sup>th</sup> Annual FWD User Group Meeting**  
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# Using FWD Data with M-E Design and Analysis



- FHWA contract DTFH61-06-C-00046
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- Prime Contractor: *Applied Pavement Technology*
  - Kurt Smith, P.E. – Principal Investigator
  - Monty Wade, P.E.; Linda Pierce, P.E., and Jim Bruinsma, P.E.
- Subcontractors:
  - Julie Vandebossche, P.E., Ph.D., *University of Pittsburgh*
  - Karim Chatti, P.E., Ph.D., *Michigan State University*
  - Phase I only: Shiraz Tayabji, P.E., Ph.D.; Tom Yu, P.E. (formerly with CTL Group)



# Study Objectives

- Phase I
  - Review of state of the practice and art in *routine* FWD backcalculation and deflection analysis.
  - Review of FWD data analysis within the context of the MEPDG (NCHRP 1-37A).
  - Preliminary case study framework for demonstrating the use of FWD data in the MEPDG.



# Study Objectives

- Phase II
  - Conduct case studies to showcase the use of FWD data to determine input parameters for the MEPDG.
  - Develop practical guidelines for performing *routine* backcalculation and interpreting the results.
  - Recommendations for improvements to FWD data analysis and interpretation for immediate implementation.
  - Final report documenting the research findings, conclusions and recommendations.



# Project Status

- Phase I report submitted.
  - September 2007
- Phase II is on-going.
  - Anticipated final report September 2009

# Phase I – Review of State of the Practice and Art



- Literature search and annotated bibliography prepared:
  - Over 450 records identified (1985-present) – still not likely complete record!!
  - Review of FWD equipment and testing recommendations
  - Review of backcalculation methods
  - Documentation of backcalculation software/tools (characteristics, applicability, availability)

# Phase I – Review of State of the Practice and Art



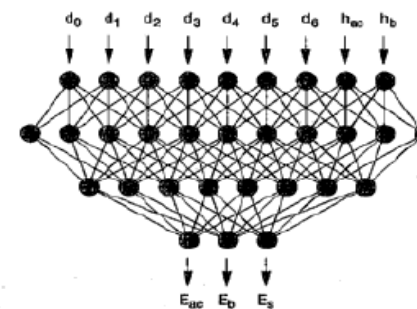
- Review of state of the practice (focus on use for *routine* analysis and interpretation):
  - Static analysis
  - Layer elastic (flexible) and plate element (rigid)
  - Linear materials



# Phase I – Review of State of the Practice and Art



- Review state of the art and applicability to state of the practice:
  - Layer interface conditions: bonding condition, gaps or voids
  - Non-linear materials
  - Dynamic analysis
  - Time domain and frequency domain
  - Finite element
  - Slab curling analysis
  - Artificial neural networks (ANN)



(Meyer and Rix 1994)

# Phase I – Review of FWD Data Use in MEPDG



- Use of FWD associated with Level 1 & 2 design (Level 1 has more rigorous lab inputs)
- Discussion of backcalculation essentially mirrors state of practice:
  - Static analysis
  - Linear materials
  - Layer elastic for flexible backcalculation and best-fit (or AREA) for rigid backcalculation
- Correction of backcalculation results for use in design



# Phase I – Review of FWD Data Use in MEPDG



- Some other points:
  - HMA testing at all locations (including cracked); PCC testing at intact locations.
  - Computation of HMA damage factor: laboratory results (dynamic modulus master curve) are used with backcalculated modulus to determine damage factor for establishing field damaged dynamic modulus master curve.
  - Backcalculated PCC moduli corrected to static value and adjusted based on overall surface condition of pavement.
  - Extensive climate modeling for seasonal variation of layer properties (Enhanced Integrated Climatic Model [EICM]).



# Phase I – Case Study Selection

- Need extensive materials laboratory testing results, climate and traffic data, and FWD data.
- Preliminary sections for case studies:
  - LTPP – SPS sections
  - Mn/Road, NCAT, or State Highway Agencies test sections



# Phase I – Case Study Selection

Case Study/Type	Data Source
1. HMA	LTPP: SPS-1, SPS-5 MnRoad: 17 – 20
2. HMA over Rubblized PCC	LTPP: SPS-6
3. PCC on granular	LTPP: SPS-2 MnRoad: 11 – 13
4. PCC on stabilized	LTPP: SPS-2 MnRoad: 7 – 10
5. PCC (thin, bonded) on HMA	MnRoad: 92, 96, 97 FLDOT
6. Composite (HMA on PCC)	LTPP: SPS-6



# Phase I – Case Study Selection

- Assessment of backcalculation programs for use in Phase II case studies (flexible pavements):
  - Data screening capabilities as well as analysis capabilities
  - Availability to public
  - Batch processing capability
  - User friendliness
  - Data format compatibility



# Phase II – MEPDG Case Studies

- Collection of required design data and backcalculation of FWD data.
- MEPDG design runs: backcalculation-based inputs vs. laboratory testing-based inputs.
- Evaluation of design results with respect to:
  - range of backcalculation-based inputs
  - adjustment of backcalculation results (field-to-laboratory/design)

# Phase II – Guidelines for Routine Analysis of FWD data



- Develop practical guidelines to assist users in setting up and analyzing FWD data and interpreting results:
  - Phase I review of existing guidelines for analyzing FWD data and interpreting results.
  - Results of MEPDG case studies.
  - Solicit volunteers experienced in FWD data analysis to analyze and interpret a set of real world FWD data in context of M-E design.
    - States implementing MEPDG: MN, MT, AZ, SD, others

# Phase II – Advancing the use of FWD data in M-E design



- Develop recommendations for advancing the use of FWD data with MEPDG.
  - Preliminary possibilities:
    - Non-linear materials models in MEPDG and FWD data analysis
    - Load transfer and void analysis for PCC
    - Time domain and frequency domain analyses



# Phase II – Final Report

- Final report documenting the study findings, conclusions and recommendations.
  - Practical guidelines for routine FWD data analysis.
  - Guidelines for using backcalculation results with the MEPDG.
  - Recommendations for advancing the use of FWD data in M-E design and analysis and bridging the gap between state of the practice and art.

# Thank you...

...we would like to have your input!  
You are the ones collecting and analyzing the data,  
your input will help establish meaningful guidelines.

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