Vehicle-Pavement Interaction ARC Year 5 Plan Overview

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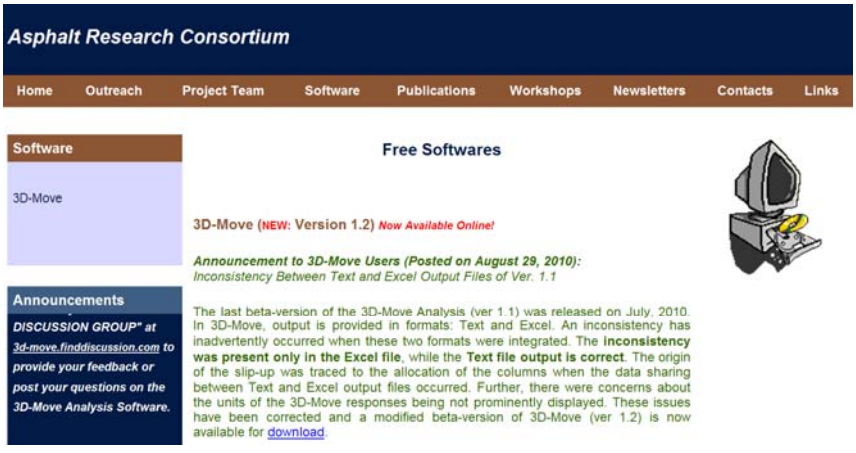
March 14, 2011

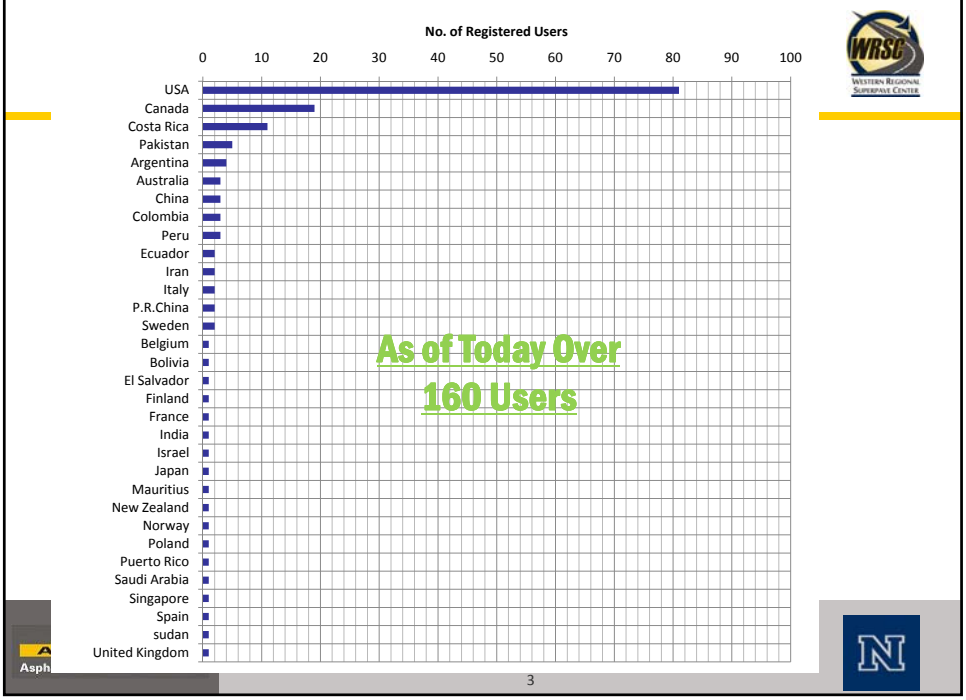
Fundamental Properties and Advanced Models ETG

Phoenix, Arizona

3D-Move:

Freeware Download at: http://www.arc.unr.edu/Software.html





3

ARC Year 5 Plan Overview

- *3D-Move Analysis* Software
  - Visco-elastic material input
  - Performance evaluation
  - Graphical display for measured stress distributions
  - Assess the need for ANN to predict non-uniform contact stress distribution
- Operational, Verification & Validation Plan

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4

New Features in Version 2.0

Viscoelastic Materials Input Options

- Laboratory Data:
  - Symmetrical Sigmoidal Function (MEPDG) – *Completed*
  - Non-Symmetrical Sigmoidal Function – *Completed*
  - Symmetrical Sigmoidal Function (AMPT) – *Completed*
  - Huet-Sayegh Model – *In Progress*
  - User Input (Interpolation) – *Completed*
- Model Equation
  - Witczak Model – *Completed*
  - Huet-Sayegh – *Completed*

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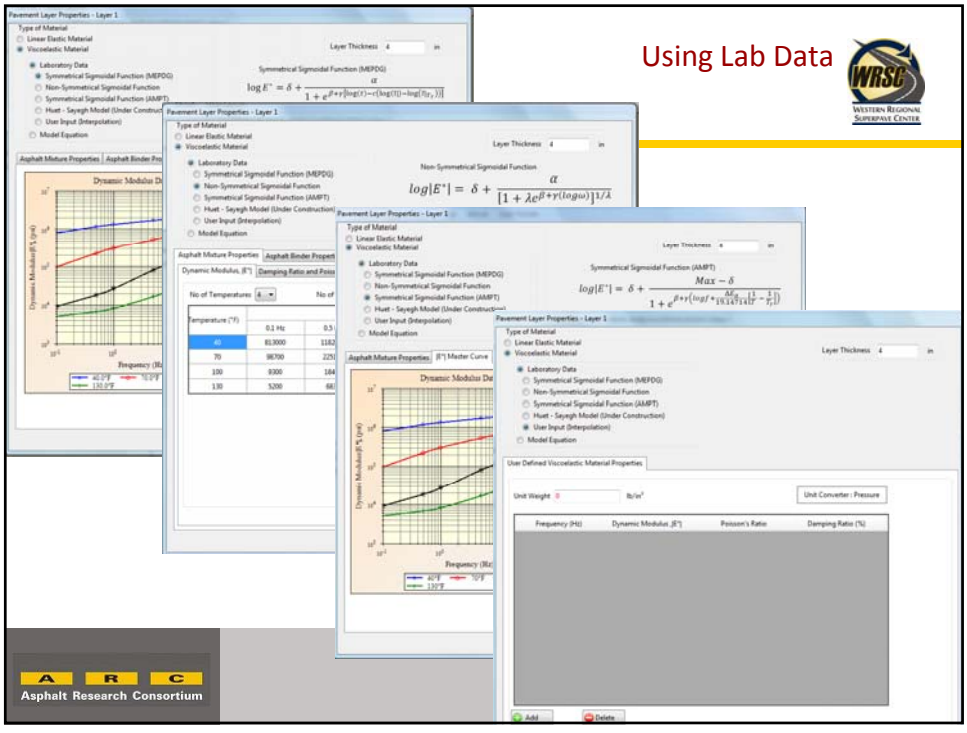
5



Using Lab Data

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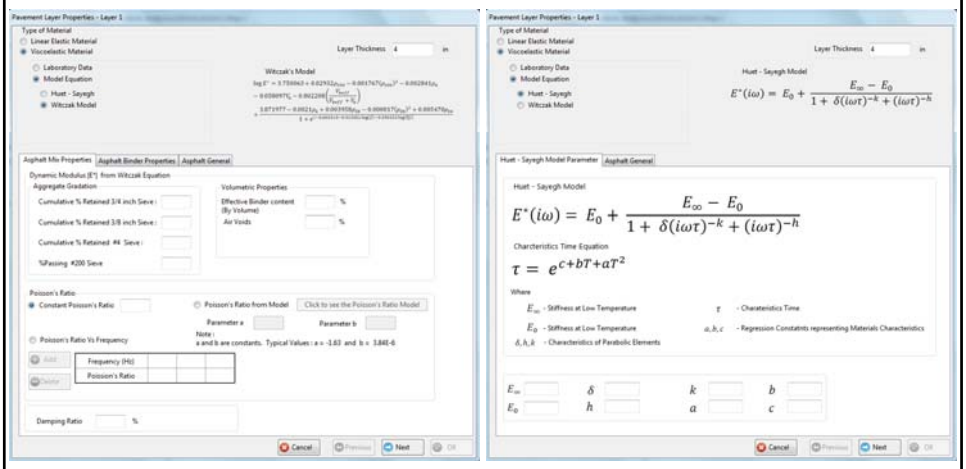
New Features in Version 2.0

Viscoelastic Materials Input Options – Model Equation

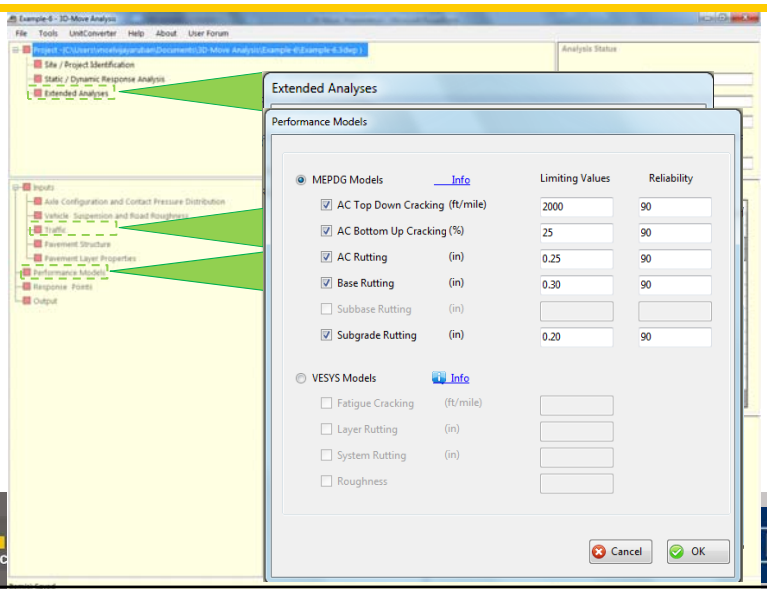


$$E^*(i\omega) = E_0 + \frac{E_\infty - E_0}{1 + \delta(i\omega\tau)^{-k} + (i\omega\tau)^{-h}}$$

$$\tau = e^{c+bT+aT^2}$$

New Features in Version 2.0

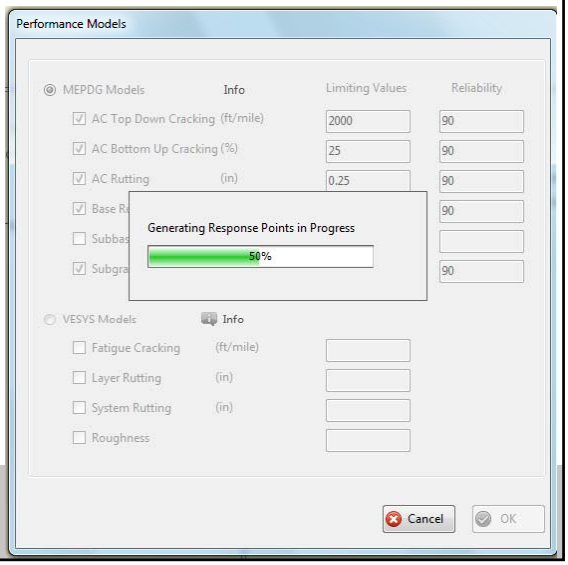
Pavement Performance Models



New Features in Version 2.0

Pavement Performance Models

- Once the "OK" is hit, it does internally produce response points at the pre-defined critical locations.



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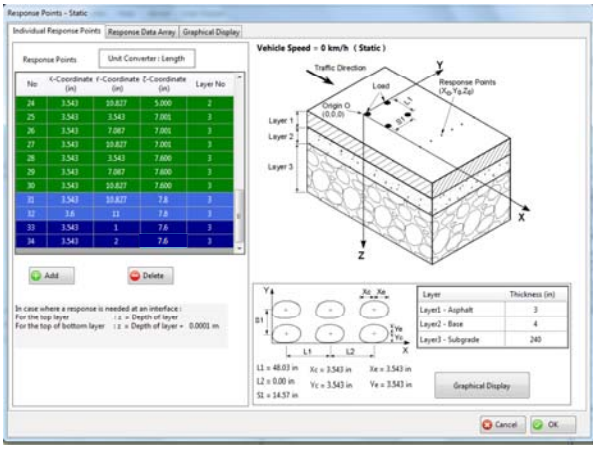
New Features in Version 2.0

Pavement Performance Models



- Recommended Points
- Added Points by User Considered for Performance Analysis
- Added Points by User But Not Considered for Performance Analysis

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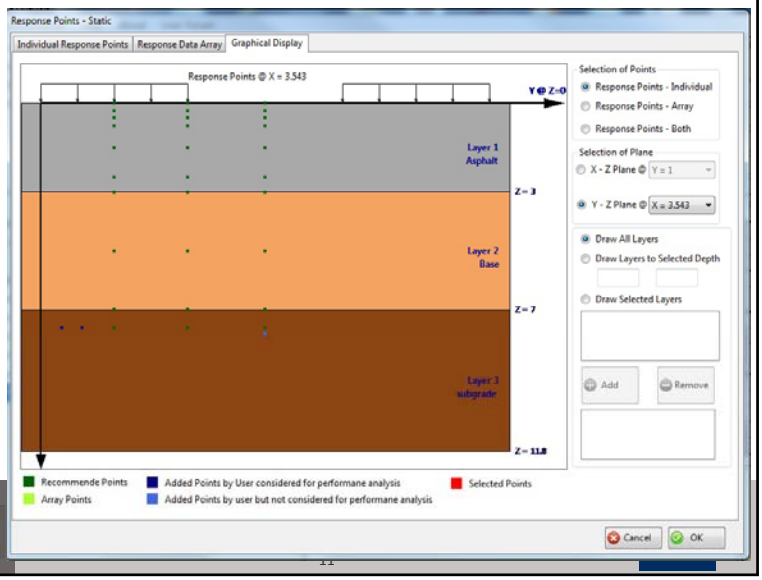
New Features in Version 2.0

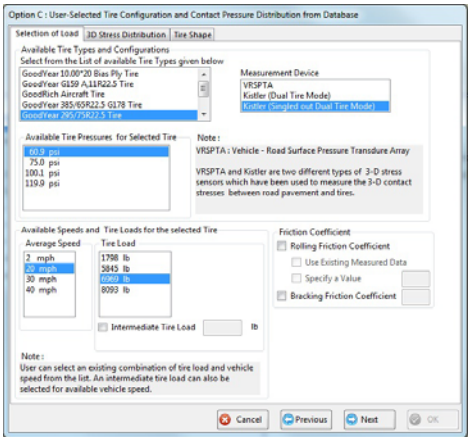
Pavement Performance Models

Graphical display of Response Points Locations



New Features in Version 2.0

Non-Uniform Contact Stress Distribution Graphical Display



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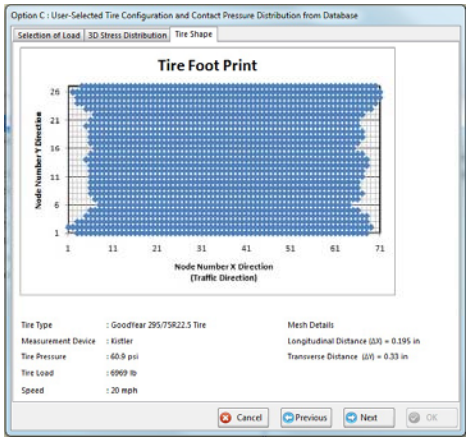


ANN for Non-Uniform Contact Stress Distributions

- Contact stress distribution only available under limited levels of inflation pressure and tire load
- Evaluate the impact of ***linear interpolation*** and ***extrapolation*** of stress distributions from currently available measurements on the response & performance of HMA pavements

ANN for Non-Uniform Contact Stress Distributions

- Pavement responses under:
  - Measured stress distributions under 5, 25, 30 & 36 kN
  - 25 kN *interpolated* from [5 kN; 30 kN]
  - 30 kN *interpolated* from [25 kN; 36 kN]
  - 25 kN *extrapolated* from [30 kN; 36 kN]
- Data under analysis

3D-Move Evaluation, Verification & Validation

- The UNR team will start an Evaluation, Verification and Validation of the *3D-Move Analysis* software in three phases

3D-Move
Evaluation, Verification & Validation

- *Phase I: Operational Evaluation*
  - Plan will help identifying potential errors, bugs, and difficulties involved in using the software for pavement analysis purposes.

3D-Move
Evaluation, Verification & Validation

- *Phase I: Operational Evaluation*
  - Address key questions:
    - Can users successfully generate the assigned examples in the 3D-Move software?
    - Is the software status clear to users at all times?
    - Are the input steps logically organized and grouped for the users?
    - Are the pictures and illustrations used in the various windows helpful to users and do they facilitate the software use/understanding?
    - Was the help menu useful and easy to navigate?
    - Is the output format clear and provide the necessary information for the analysis of the data?
    - What are the main benefits of using the software?
    - In what case studies does the user perceive a great use of the software?
    - Will the agency/user be willing to adopt the software for their pavement analysis?
    - What are the user recommendations for modification or enhancement to make the software more useful and practical?

3D-Move
Evaluation, Verification & Validation

- *Phase I: Operational Evaluation*
  - In the process of preparing three different problem cases
  - In the process of putting together a report form

3D-Move
Evaluation, Verification & Validation

- *Phase I: Operational Evaluation*
  - Potential Participants:

Representatives of public agencies: N. Krishnamenon (Caltrans) Magdy Mikhail (TxDOT) Dr. Charlie Pan (NDOT) Ambi Thurai (Orange County Airport, CA) Dr. Armelle Chabot (IFFSTAR, France) Ken Walsh (OHDOT)	**Representatives of academic/researchers:** Dr. Adrián Ricardo Archilla (Univ. of Hawaii at Manoa) Fujie Zhou (TTI) Dr. Nam Tram (NCAT)
Representatives of private industries: Dr. Zia Zafir (Kleinfelder) Dr Raj Dongre (DLSI), Dr. Guangming (William) Wang (QES) Dr. Shakir Shatnawi (SHATEC) George Way	**Representative of FHWA:** Eric Weaver (FHWA) Nelson Gibson (FHWA)

3D-Move
Evaluation, Verification & Validation

- *Phase II: Verification*
  - Verify selected *3D-Move Analysis* pavement responses with measured field data.
  - Identify datasets that include vehicle dynamics and sufficient laboratory characterization and documentation.

3D-Move
Evaluation, Verification & Validation

- *Phase II: Verification*
  - Potentially Suitable Datasets:
    - VTRC SmartRoad,
    - WesTrack,
    - IFFSTAR,
    - NCAT
    - OHDOT
    - Nottingham data
    - …?

3D-Move
Evaluation, Verification & Validation

- *Phase III: Validation*
  - Validate the findings from Phase II with an independent dataset

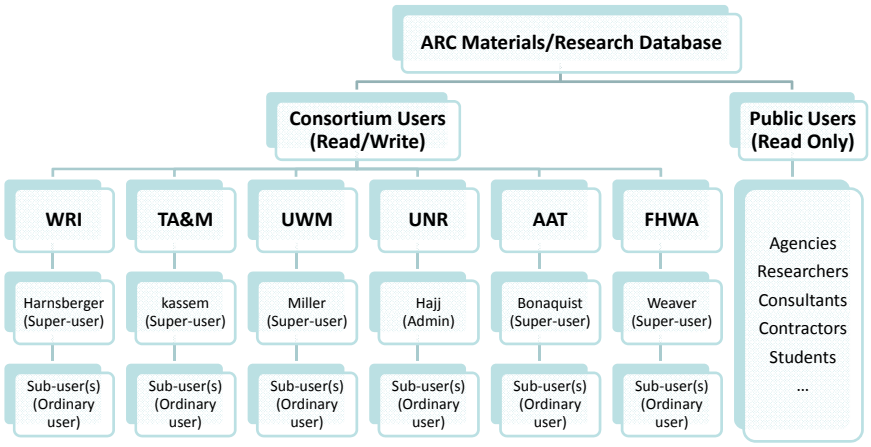
ARC Database

- ***Work element TT1d and TT1e: Development of materials and research database***
  - Store information related to ***sources & properties of materials*** used in various consortium research activities.
  - Includes results update in form of ***reports***, ***white papers*** or ***any other type of documents*** for each research task…

Overall Introduction

- **Challenges:**
  - No software installation – web-base system
  - Flexibility (No hard-coded data)
  - central database
  - Multiple users (role-based infrastructure)
    - Add/Delete/Edit materials information
    - Retrieve information (Public interface)
  - Different users' roles
  - Common materials use
  - Multiple measures for the same material
  - Ability to relate material(s) to validation sections
  - …

Overall Introduction
General Users' Diagram



Getting to the Application

- Using Internet Explorer, visit http://www.business.unr.edu/arc
- Click the **Login** button and enter credentials

Selection and Filtering

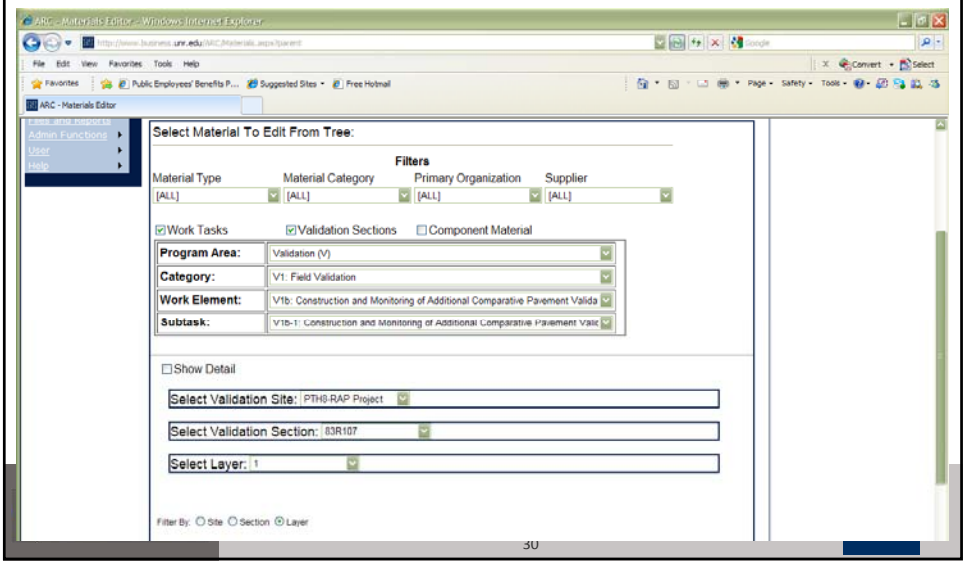
- Materials (and other elements) can be selected and filtered by
  - Material type
  - Material category
  - Organization
  - Supplier
  - Work tasks
  - Validation section
  - Component materials

Support Files (Introduction)

- Support files can include
  - reports,
  - scanned document,
  - picture,
  - just about anything related to the ARC project

- Support files can be filtered by work items (program area, category, work element, subtask)

Selection and Filtering



Final Reports

- Follow FHWA Research Report Format
  http://www.fhwa.dot.gov/publications/research/general/03074/index.cfm
- Compliant with section 508
- Owned by FHWA.
  - With the permission of FHWA final reports can be uploaded to the ARC site otherwise
  - have a link referring to the publication