WORKSHOP ON CALIBRATION OF M-E USING APT

1. Current initiatives related to M-E Design for asphalt, concrete and composite Pavements in terms of:

- Response
- Models
- Performance

Caltrans
- 35 – 40 HVS sections
- CALME used for calibration
- MEPDG doesn't calibrate well with the HVS
- MEPDG used with concrete for ranking the effects on performance of dowels
- Can look at transverse cracking but not longitudinal cracking
- WESTRACK being used at various temperatures
- HVS operates at one temperature

Florida
- Early stage of calibration
- Using the HVS test track for deflection measurements and back-calculation
- Couldn't initiate longitudinal cracking, some transverse cracking (loads: 12 000)

COE-ERDC-Hanover
- Not being used
- Strain measurements available at different depths but not used for local calibration

COE-ERDC-Vicksburg
- Embarking on calibration of CBR design method
- Should be encouraged to characterize materials for M-E design

Gautrans
- Large project (22 sub-projects) being developed by SANRAL to investigate the whole South Africa M-E design procedures for flexible pavements
- Permanent deformation study for HMA in progress. Will be used to calibrate models
- Fatigue calibration will be done at a later stage
- The role of the HVS in calibration will be established through the inception reports due for reporting in June to September 2007
- First update will be ready within 18 months (from November 2007)

Sweden
- Some strain measurements done, relative deflection using E-MU coils

2. What is it we want to calibrate?

- **Asphalt Pavements**

  Response
  - Top-down cracking
    - Strains at the surface (Florida)
    - "Aged" and unaged stiffnesses (Florida)
  - Stiffness

        - Measuring deflections to obtain stiffness (Florida)
        - Using FWD, MDD and back-calculations from RSD, plus laboratory frequency sweep. Also lightweight FWD (Caltrans)
        - Using MDDs to measure stiffnesses and P-SPA (South Africa)
        - Using FWDs before and after (ERDC-Hanover, ERDC-Vicksburg & Sweden?)
    - Rutting
        - Using MDD, profilometer and trenching (Caltrans, South Africa)
        - Use the automated profilometer and occasional trenching (Florida)
        - Use the profilometer and trenching (ERDC-Hanover, Sweden)
        - Use SDD, profilometer and trenching (ERDC-Vicksburg)?
    - Fatigue and reflection cracking
        - Measure change of stiffness (Caltrans)
        - Nothing done with other machines

Models
- Top-down cracking
    - Viscoelastic finite element models (Florida)
    - Strain energy damage law (Florida)
- Rutting
    - Permanent deformation based on repeated shear test and calculated elastic shear stress and strain for asphalt (Caltrans)
    - Vertical strain at the surface of the layers for the unbound layers (Caltrans, South Africa)
    - Dynamic triaxial testing for permanent deformation of unbound layers (South Africa)
- Fatigue and reflection cracking
    - Recursive damage based on tensile strain and laboratory flexural beam damage equation – both for fatigue and reflection cracking for asphalt (Caltrans, South Africa using Miners law instead of recursive)
    - The stiffness of the granular layers changes with the changes of stiffness of the asphalt (Caltrans)

Performance
- Top-down cracking
    - Not sure yet (Florida)
- Rutting
    - Relating HVS rutting to test track rutting (WESTRACK, NCAT, MINROAD) (Caltrans, Florida just NCAT)
    - Relating HVS rutting to LTPP (South Africa)
- Fatigue and reflection cracking
    - Relating damage to cracking for both HVS and test tracks (Caltrans)
    - Comparing damage to cracking for two new pavements and 30 overlays, all field sections (Caltrans)

- **Concrete Pavements (including white topping)**

(CRREL, WES, no concrete pavements)
Sweden not known – to be contacted

Response
- Tensile Stresses
    - Not measured directly (Caltrans, South Africa)
    - Calculated from strains and deflections (Caltrans, South Africa: deflections, Florida: strains)
- Thermal gradient
    - Yes (Caltrans, Florida, South Africa)
- Joint deflections

        - Yes (Caltrans, South Africa)
- Tensile and Thermal Strains
    - Yes (Caltrans)
    - Indirect measurements (South Africa, Florida)
- Joint Opening and Closing
    - Yes (Caltrans, South Africa)
- Mid-slab, edge deflections
    - Yes (Caltrans, South Africa)
- Shrinkage
    - Yes, in association with thermal strains (Caltrans, South Africa)
- Stress in reinforcement
    - No (all)
- Bonding
    - No (all)

Models

- Transverse cracking
    - Location of crack initiation based on calculated stresses (Caltrans, Florida, South Africa)
- Longitudinal cracking
    - Location of crack initiation based on calculated stresses (Caltrans, Florida, South Africa)
- Environmental stresses
    - Location of crack initiation based on calculated stresses (Caltrans, Florida, South Africa)
    - Equivalent temperature differentials (Caltrans)
- Faulting
    - Crack width (South Africa)
    - Load transfer (Caltrans, Florida, South Africa)
- Bonding (friction and separation)
    - Reliance on MEPDG bonding assumptions (Caltrans)
    - Model used (South Africa)
    - Included in finite element model (Caltrans, Florida)
    - Based on assumed level of bonding (Florida)
- Shrinkage
    - Free-shrinkage lab tests (Florida)
    - Built in through equivalent temperature differentials (Caltrans)
    - Model available (South Africa)

Performance

- Transverse cracking
    - Validating MEPDG with 75 field sections and qualitative comparison with HVS test results (Caltrans, Florida: fewer sections)
    - Calibrating CNC PAVE with field sections and qualitative comparison with HVS test results (South Africa)
- Longitudinal cracking
    - Validating Radical 75 field sections and qualitative comparison with HVS test results (Caltrans)
    - Calibrating CNC PAVE with field sections and qualitative comparison with HVS test results (South Africa)
- Environmental stresses
    - Only through transverse and longitudinal cracking (Caltrans)
    - Model for stresses without loading (Florida)
    - Calibrating CNC PAVE with field sections and qualitative comparison with HVS test results (South Africa)
- Faulting

- Validating MEPDG with 50 field sections and qualitative comparison with HVS test results (Caltrans, Florida: fewer sections)
- Load transfer efficiency measured by HVS and related to faulting (Caltrans, South Africa)

- **Composite Pavements**
  Asphalt on concrete

  Response
  - Stiffness
    - Using FWD, MDD and back-calculations, plus laboratory frequency sweep (Caltrans)
  - Rutting
    - Using profilometer and trenching (Caltrans)
  - Reflection cracking
    - Measure JDMD deflection, change of stiffness and trenching (Caltrans)

  Models
  - Rutting
    - Permanent deformation based on repeated shear test and calculated elastic shear stress and strain for asphalt (Caltrans)
  - Reflection cracking
    - Recursive damage based on tensile strain from finite element regression equation and laboratory flexural beam damage equation (Caltrans)

  Performance
  - Rutting
    - None (all)
  - Reflection cracking
    - Comparing damage to cracking for 30 overlays, all field sections (Caltrans)

Actions:

John Harvey to develop a table summarizing the outcomes and circulate to members for additional comment.