New England Transportation Consortium

Field & Laboratory Evaluation of the Portable Falling Weight Deflectometer (PFWD)

NETC Project No. 00-4

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Goals of the Research:

- Use of the PFWD to evaluate thaw weakening of seasonally posted low volume roads.
- Use of the PFWD as an alternative to traditional compaction control devices.

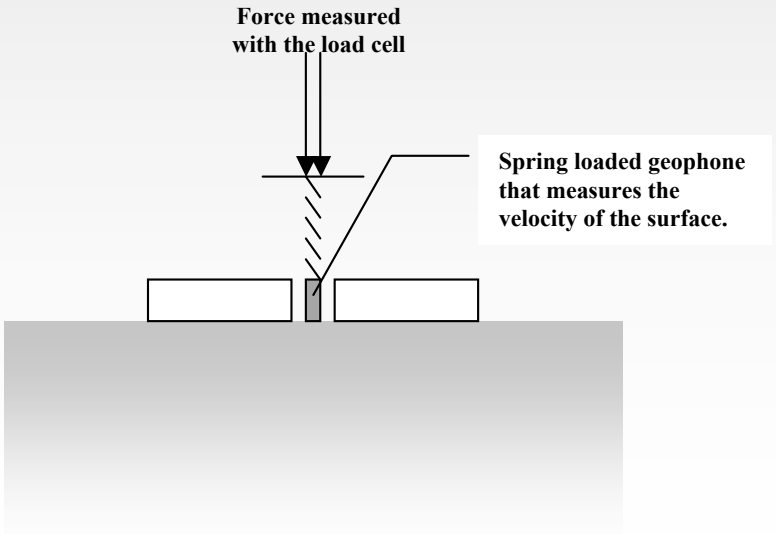
Outline of the presentation:

- What is a PFWD, and how does it work?
- Importance of Research
- Results from Previous Studies
- Spring Thaw Results
- Compaction Control Study
- Summary

What is a PFWD?

- non-destructive, portable device
- determines composite elastic modulus of construction layers (pavement, basecourse, subgrade)

How does the PFWD work?



- Load cell measures the impact force due to the falling weight (10, 15, 20 kg)
- Load transmitted to underlying surface through 100mm, 200mm, or 300 mm diameter load plate.
- Geophone measures the surface velocity (up to 3 may be used).

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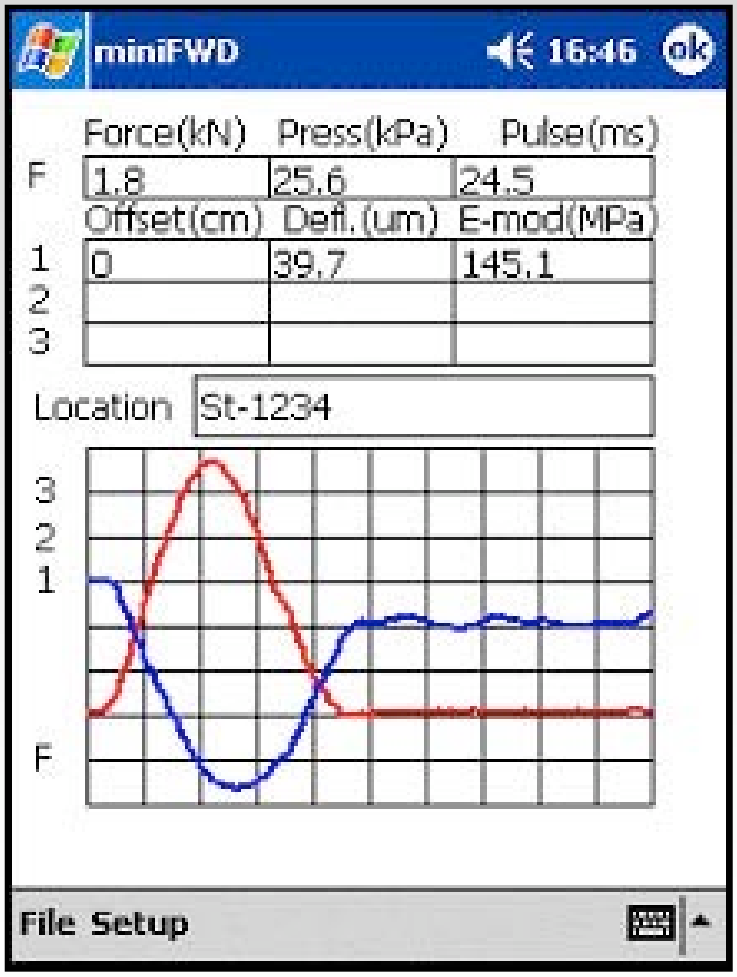

- provides maximum values of force and deflection.
- also provides time history of layer response to applied force.
- used to determine Elastic Modulus (stiffness).

PFWD Demo

Importance of research

- The thawing of ice lenses results in an increase in water, subsequently decreasing the effective stress and shear strength.
- Weight restrictions are used to minimize damage during these damage susceptible periods.

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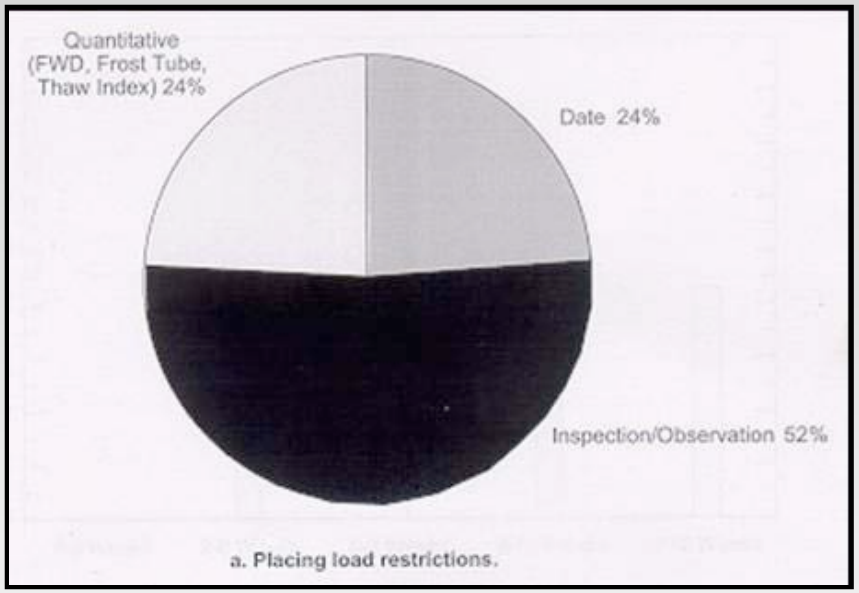
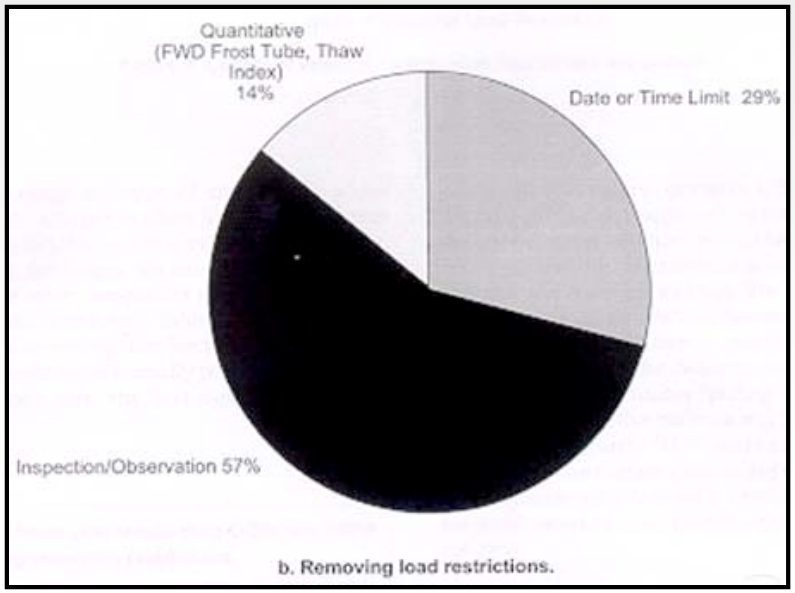


a. Placing load restrictions.



b. Removing load restrictions.

- Study by Kestler et al. (2000) ……
- Over one half of respondents use visual inspection/observation of roads to determine when to place and remove weight restrictions.
- To a lesser degree, date and quantitative methods are used.

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- A Falling Weight Deflectometer (FWD) may be used, however, high costs associated with purchase, operation, and maintenance.
  - $250,000 (FWD) v. $13,000 (PFWD)
  - more units = more roads that may be evaluated

Importance of Research:

- Problems with current compaction control techniques:
  - costly & time consuming
    - sand cone / rubber balloon methods
  - extensive training & safety requirements
    - nuclear moisture density gauge
  - methods report density
    - easy to correlate with engineering properties
    - limited insight into long term performance

Results from Previous Studies:

- Davies (1997)
  - Investigated similarities between PFWD, Benkelman Beam, and FWD.
  - Thin membrane surfaced roads.
  - Underlain by graded/compacted subgrade.
  - 20 test locations

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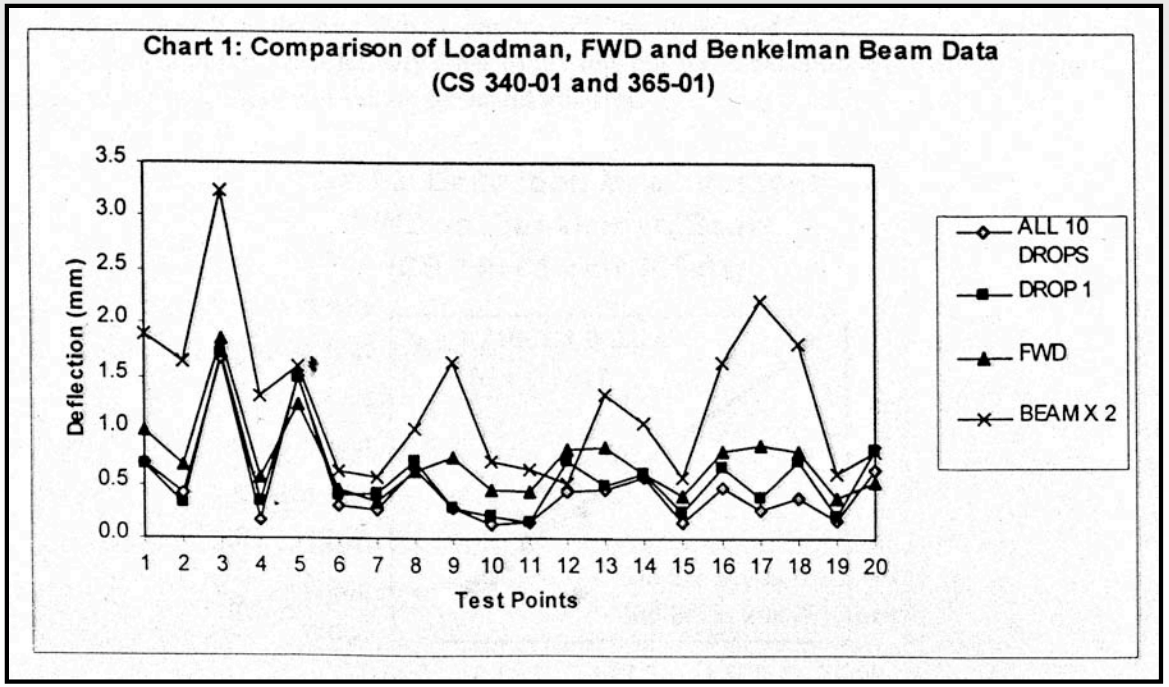
- $R^2 = 0.86$ between the Loadman PFWD and both the FWD and Benkelman Beam
- differences associated with depth of influence of each of the devices



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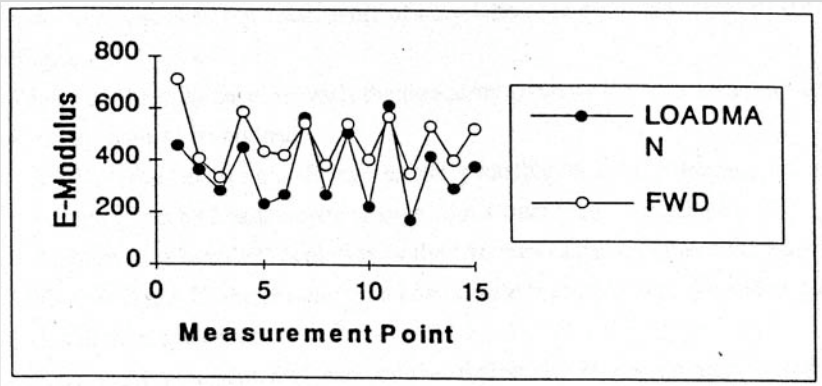

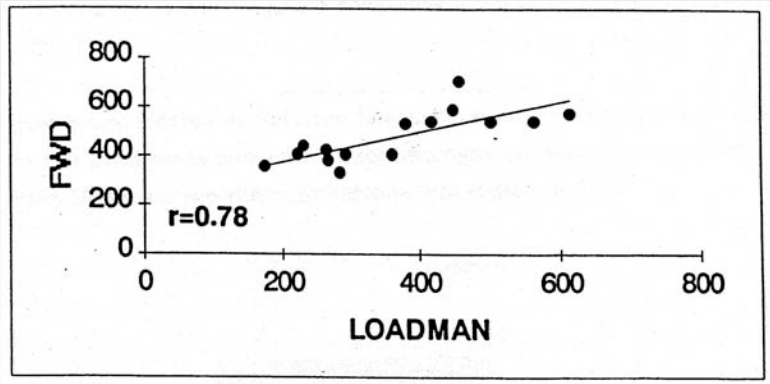

- Gros (1993)
  - measurements with Loadman PFWD and FWD.
  - tests on unbound aggregate containing sand, gravel, and crushed gravel.

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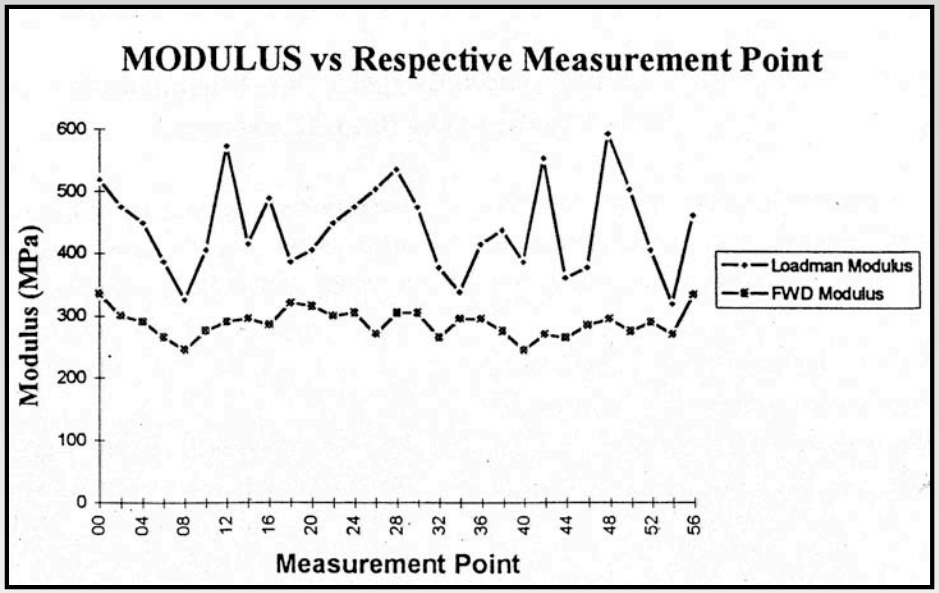

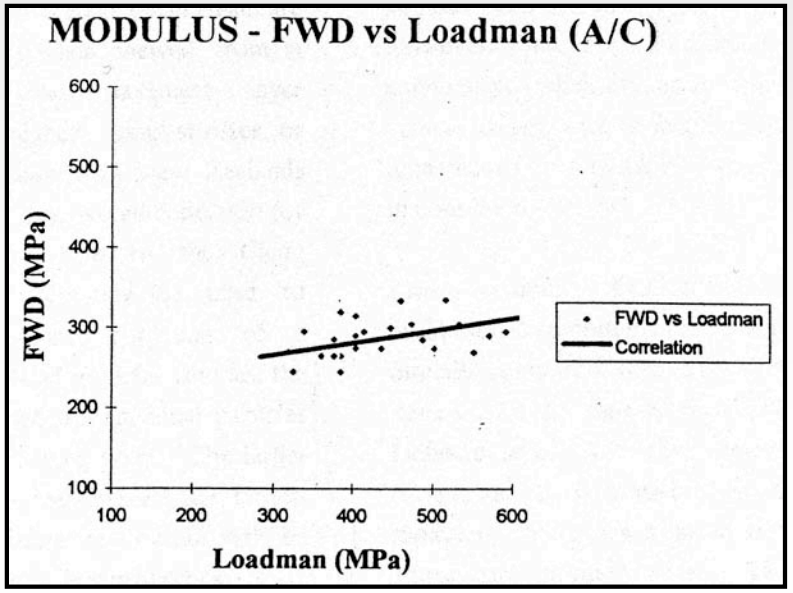

- Whaley (1994)
  - Loadman PFWD and FWD measurements.
  - 80 mm A/C, 200 mm base course, 1220 mm subbase.
  - Loadman yielded higher moduli than backcalculated FWD values.
  - $R^2 = 0.2$

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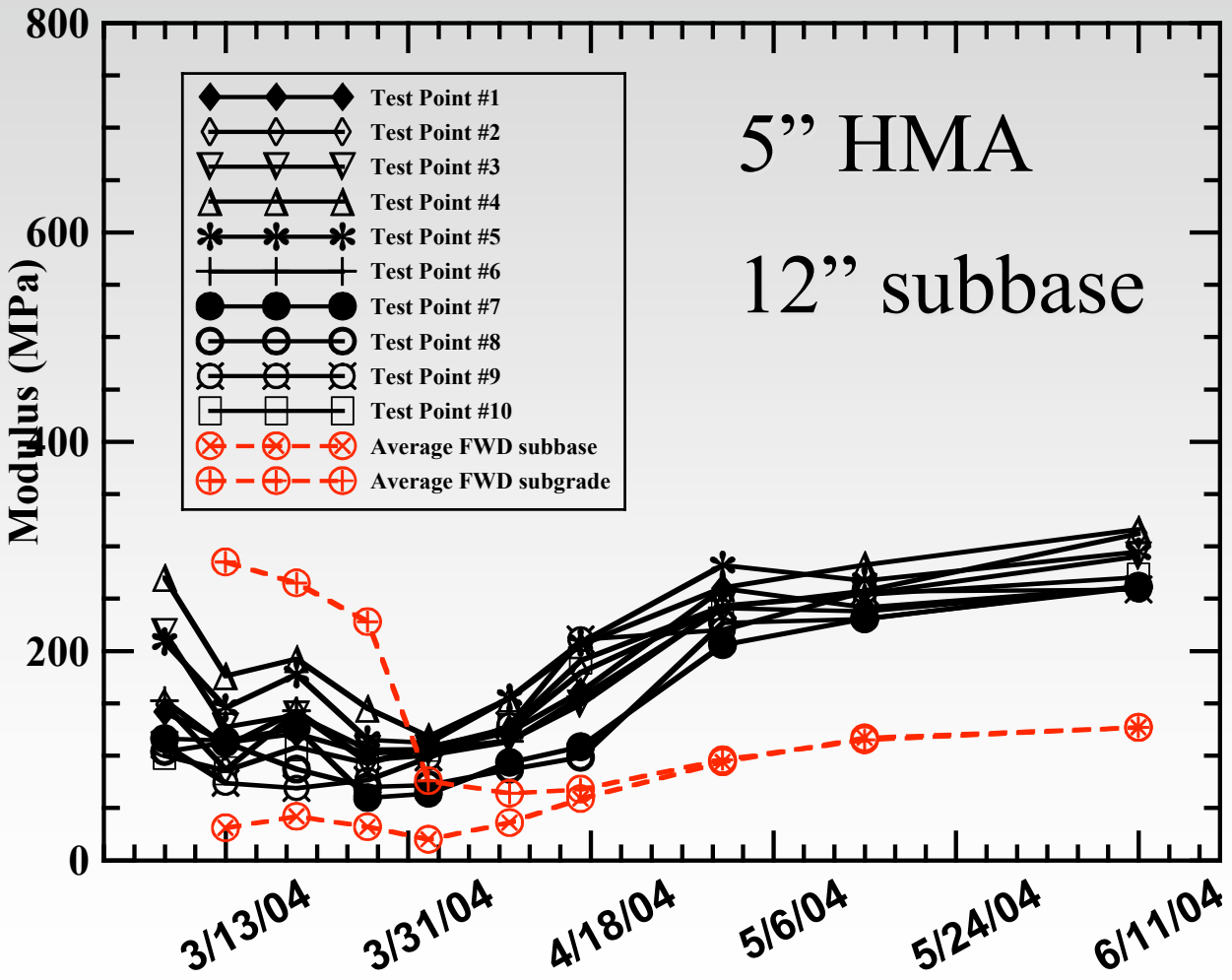
- Summary of Literature Results
  - PFWD compared marginally with other devices when testing on pavement layers.
  - PFWD compared reasonably with other devices when testing on unbound layers.
  - PFWD did adequately follow strength change through spring thaw.

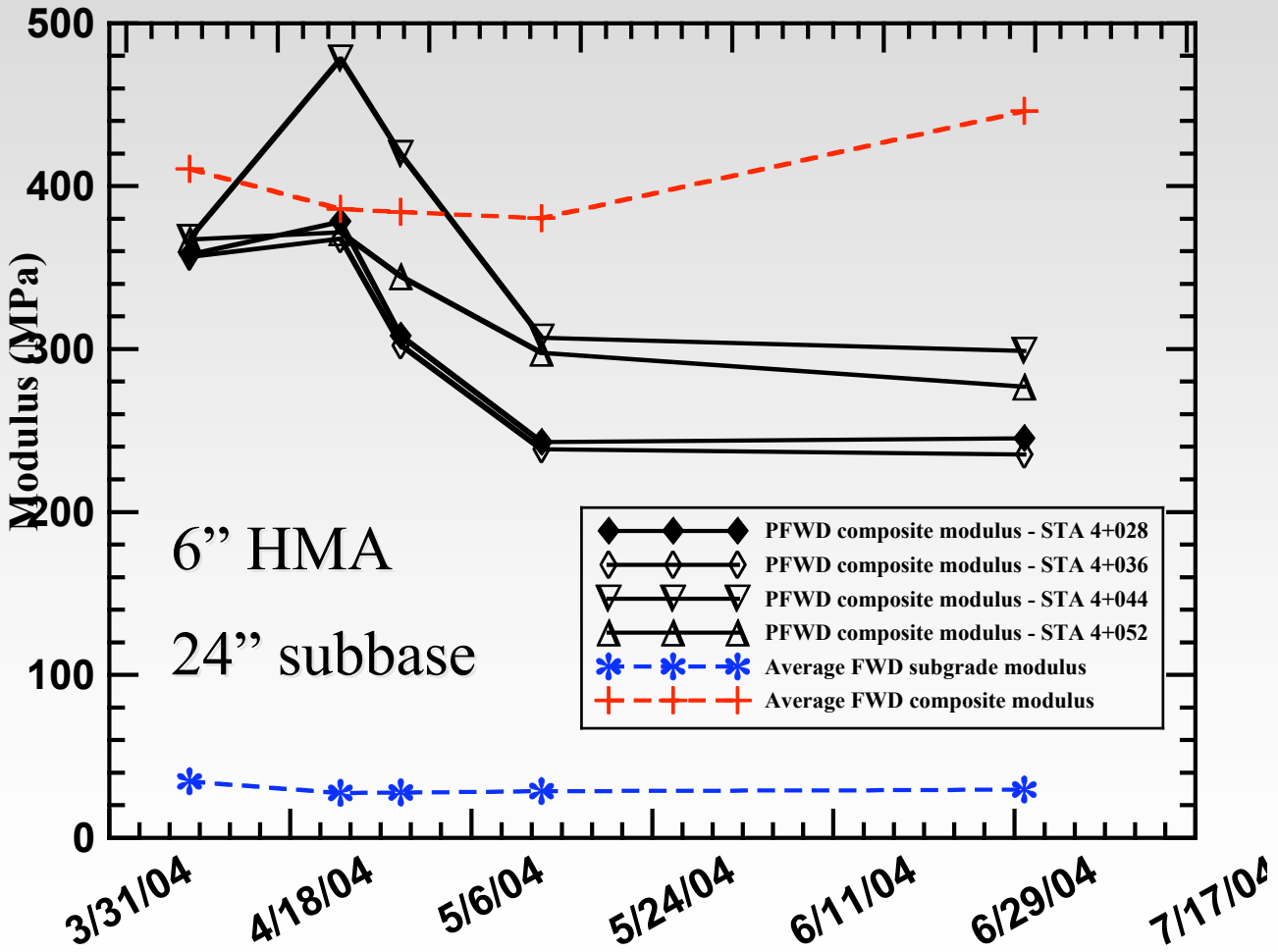
Spring Thaw Study:

- Testing includes PFWD (Prima 100 & Loadman), and FWD.
- Instrumentation to monitor frost depth and porewater pressure
- Seven paved and three unpaved test sites in Maine, New Hampshire, and Vermont

Vermont Parking Lot



Litchfield, Maine



Glenburn – gravel surfaced

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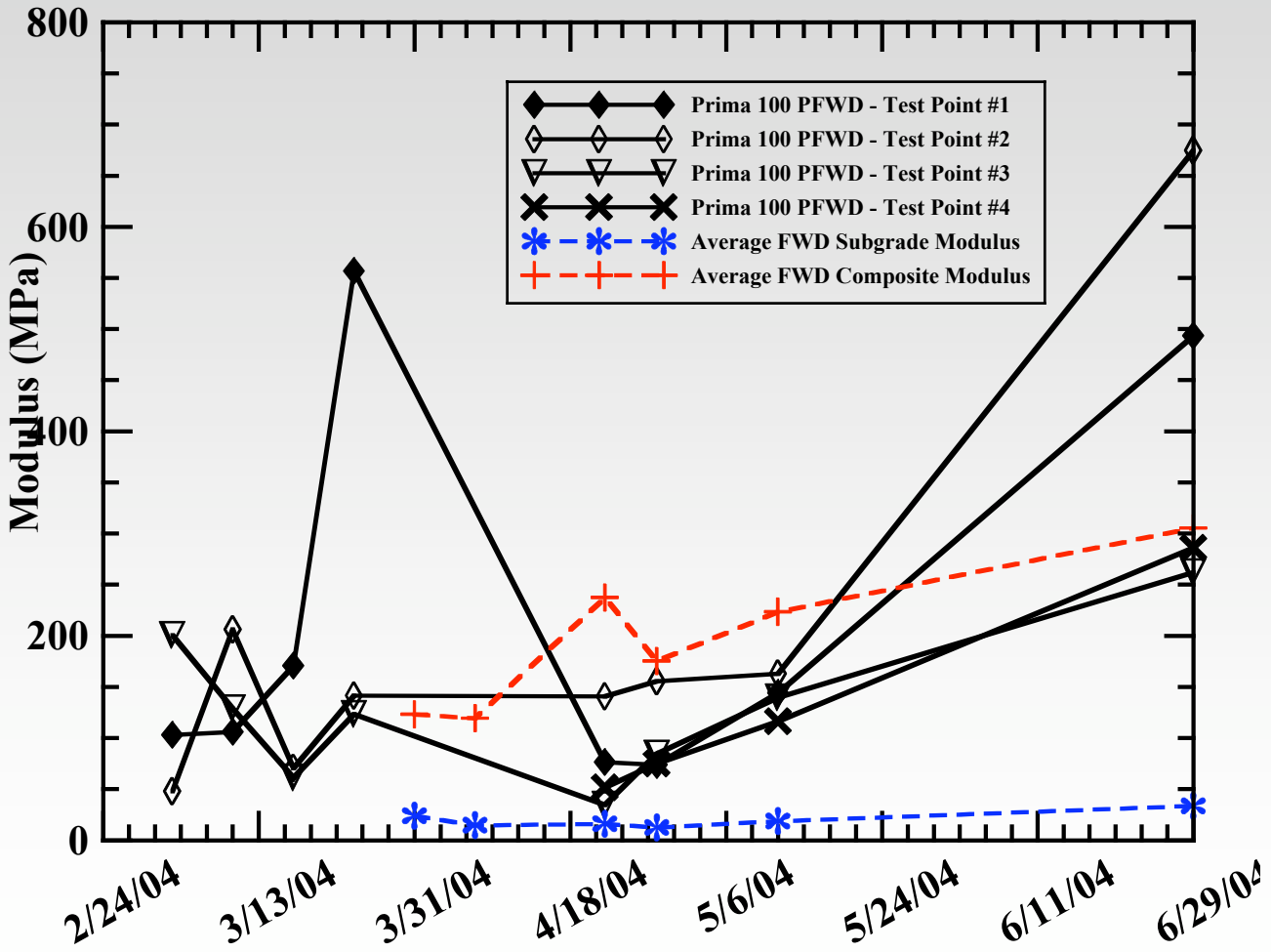
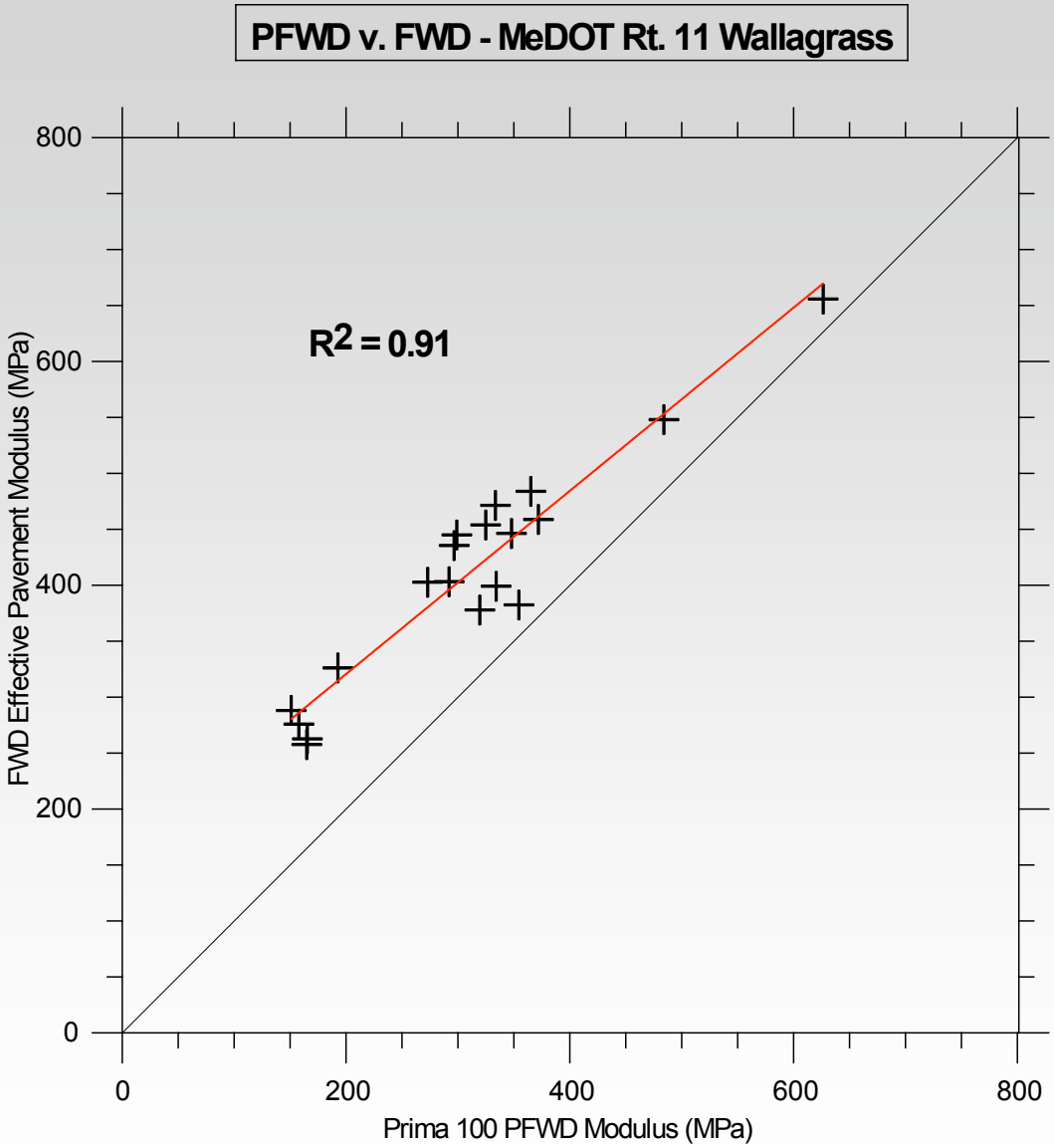
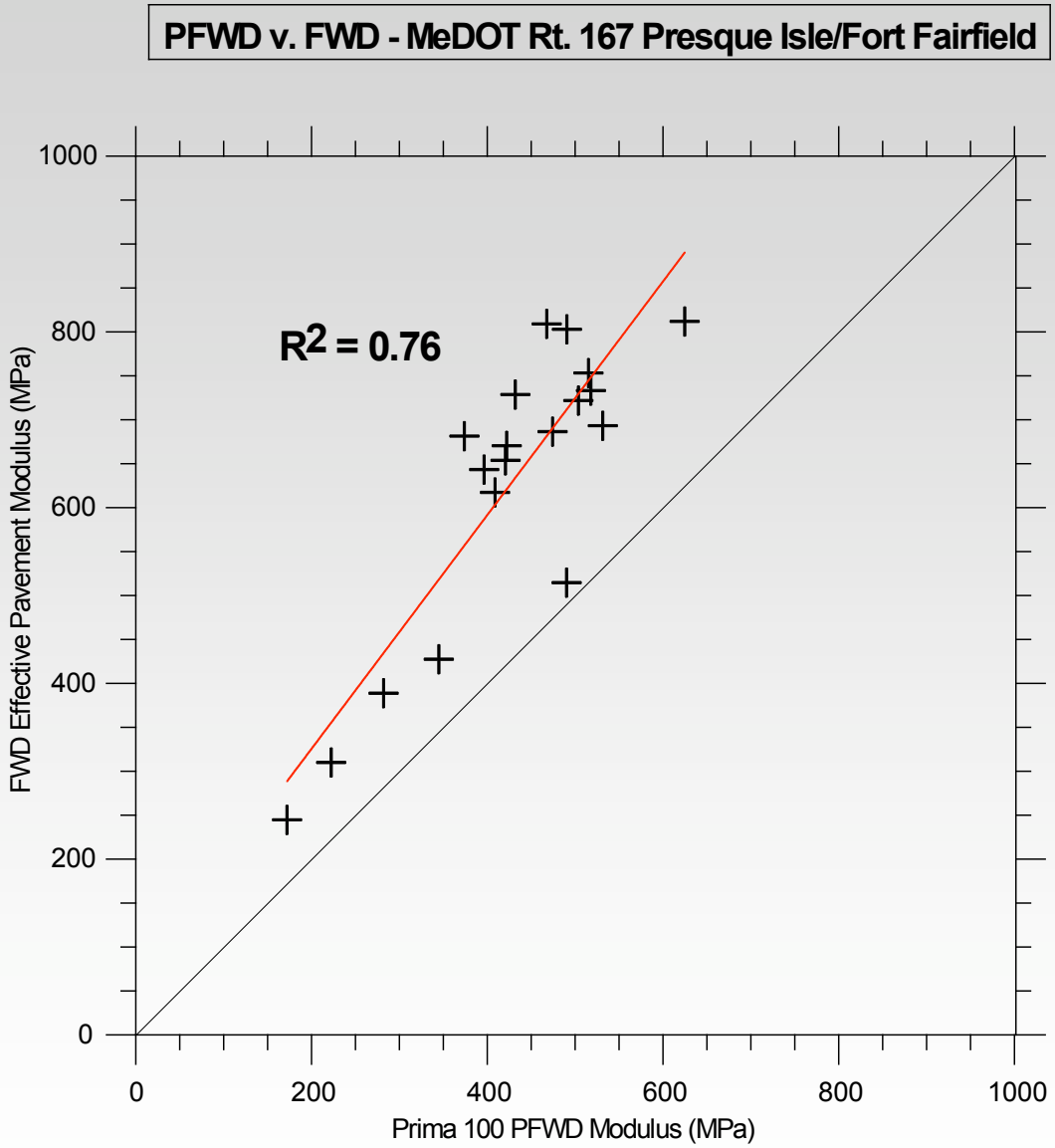


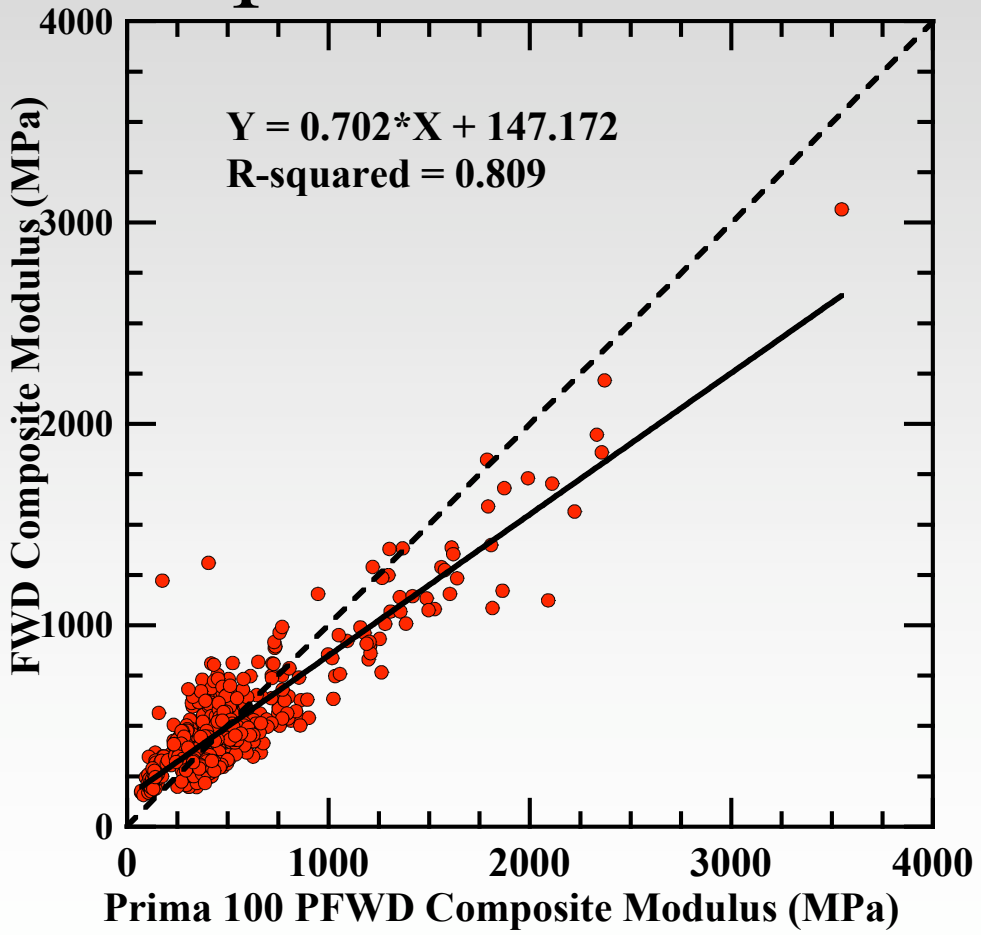
Preliminary PFWD & FWD Comparison

- Route 11 Wallagrass, Maine
  - ~ 14 yrs. old
  - ~120 mm (5 in.) pavement
  - ~ 750 mm (30 in.) subbase
- Route 167 Presque Isle/Fort Fairfield, Maine
  - ~ 13 yrs. old
  - ~120 mm (5 in.) pavement
  - ~750 mm (30 in.) subbase
- 5 test locations @ each site
- PFWD and FWD measurements


PFWD v. FWD - MeDOT Rt. 11 Wallagrass
R2 = 0.91
FWD Effective Pavement Modulus (MPa)
Prima 100 PFWD Modulus (MPa)
0
200
400
600
800


PFWD v. FWD - MeDOT Rt. 167 Presque Isle/Fort Fairfield
R2 = 0.76
FWD Effective Pavement Modulus (MPa)
Prima 100 PFWD Modulus (MPa)
0
200
400
600
800
1000

Spring thaw – FWD vs. PFWD
--- All paved data ---



Field Compaction Control Study:

- Testing at construction sites in CT, NH, and ME
- Materials that have undergone varying degrees of compaction.
- PFWD & NDM at multiple locations.

Southington, CT site

Lab Compaction Study:

- 6’ x 6’ x 3’ test box
- 5 different soil types
- Compact at optimum water content and ± 3% of optimum and 90%, 95%, and 100% of max. dry density.
- PFWD and NDM tests @ 5 locations.


Results Soon!

Summary

- PFWD and FWD have similar effectiveness in monitoring thaw weakening
- PFWD and FWD give similar composite moduli
- Effectiveness as compaction control device TBD