Summary of RAP Research at UNH

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RAP ETG Meeting

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UNIVERSITY of NEW HAMPSHIRE

NHDOT Project
(just completed)

- Testing using millings from known location
- Target same gradation
- Field cores prior to milling (100% RAP condition)
- Volumetrics, Dynamic Modulus, Strength Testing
- Comparison of field vs lab compaction

NHDOT Millings Project

- 4 mixes containing 0-40% millings
  - 0, 15%, 25%, and 40%
- Targeted same gradation
- Volumetrics, dynamic modulus, and strength tests
- Comparison of field and lab compacted specimens

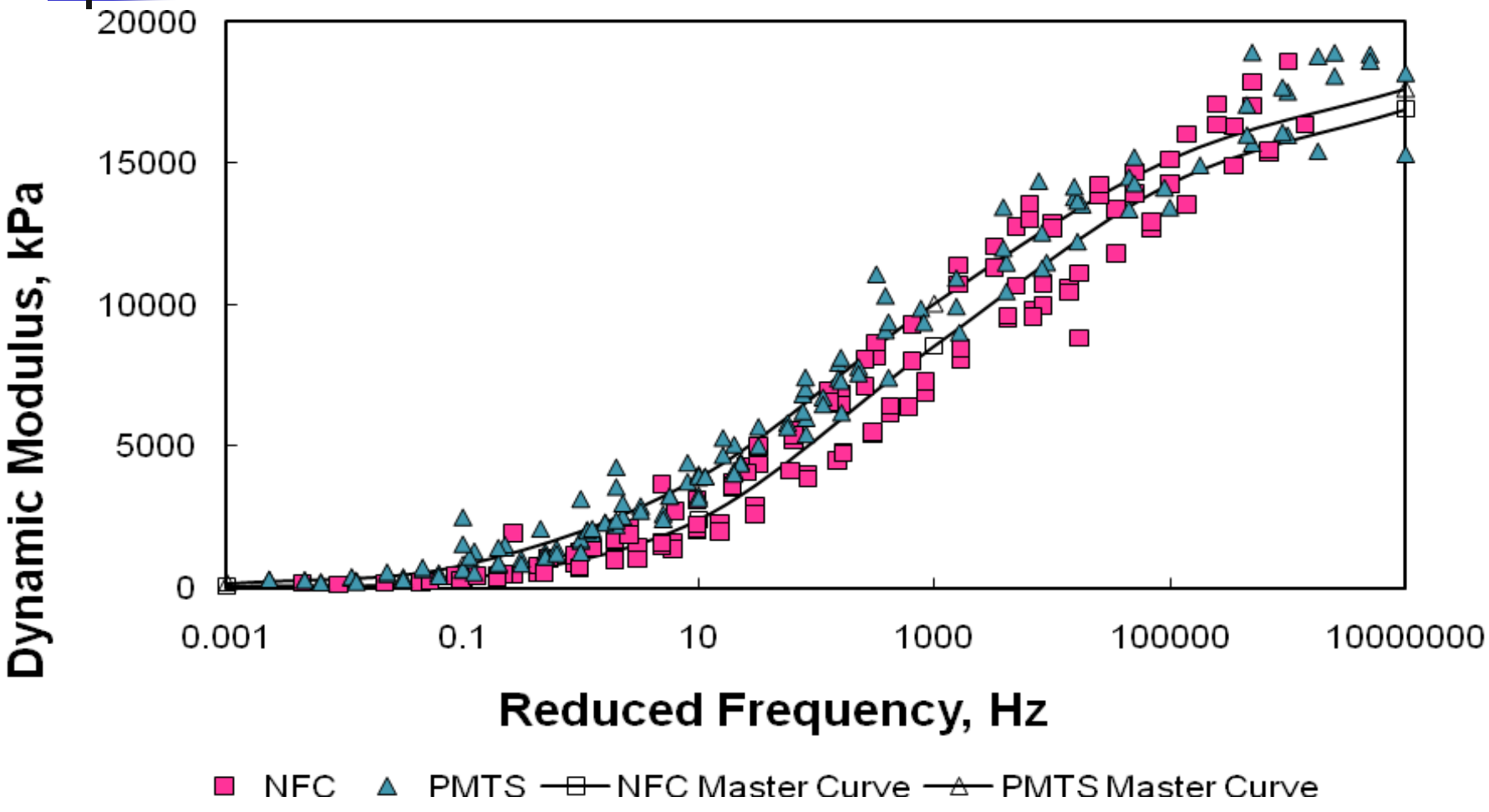
Mix Information

- AC similar for all
- VMA increased with RAP
  - Effective increase of gradation
    - Black rock??

Compaction Comparison

- Compacted plant mix in lab
  - Targeted field air voids
- Compared field compacted mix to lab
- Lab compacted specimens stronger and RAP mixes stronger
  - IDT strength testing
- Field cores (red squares) generally lower |E*| than lab compacted mix (triangles)

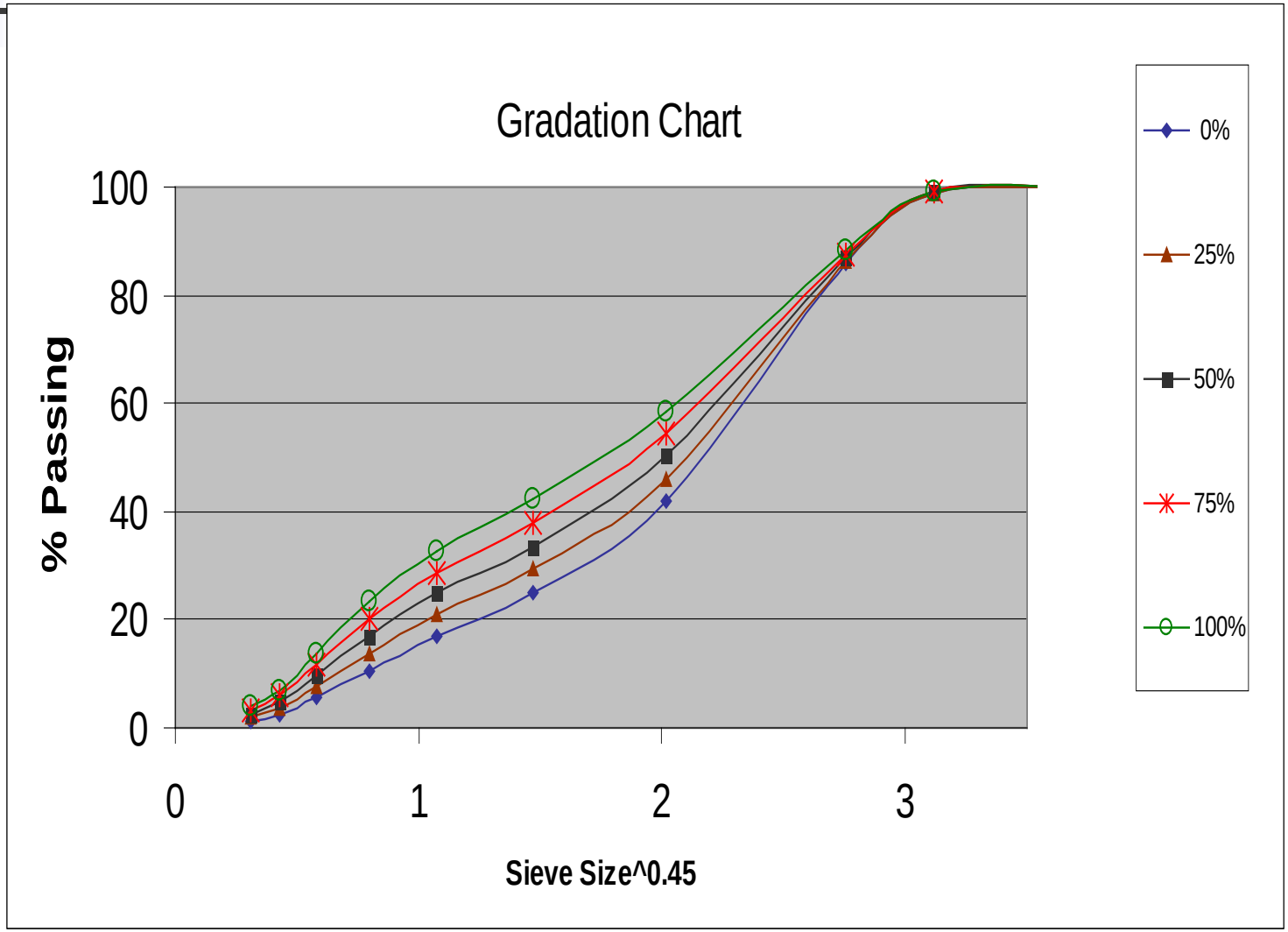
Lab vs. Field compaction



“Black Rock” gradation study

- Know “black rock” and extracted gradation of a single RAP source (NHDOT project)
- Create blended gradations of virgin materials assuming different proportions of black rock and extracted gradations (effectively assuming different amounts of blending between RAP and virgin materials)
- Use 40% RAP case
- Measure volumetrics

“Black Rock” gradation study



Cases Considered

- 0% → no blending
  - 40% RAP black rock + 60% virgin
- 100% → total blending
  - 40% RAP extracted + 60% virgin
- 25%, 50%, and 75% → partial blending
  - 25% gradation represents 60% virgin+30% RAP black rock+10% RAP extracted

Air Void Comparison

- Not much difference with 50-100% blends and these are closest to actual RAP mix values
  - Air voids
- Significant increase with 25% and 0% blending
  - Air voids
- Preliminary conclusion: at least 50% blending happens with this mix.

NETC Project: Determining Effective PG Grade of RAP mixes

- Idea is to use Hirsch model to back binder properties out of measured mix |E*|
- Not as easy as first appears
  - Need to extrapolate on shift factor curve
  - Difficulty in determining phase angle of binder from mix measurements
- Also doing some empirical approaches with measured values
- Will be finishing project this spring/summer

Mix Design summary

	Control	15% RAP	25% RAP	40% RAP
% ac	6.0	5.7	5.3	5.1
VMA	17.4	17.2	17.0	18.0
VFA	77.0	74.0	76.9	70.0

RAP in MEPDG

- Evaluate the sensitivity of predicted performance to assumed PG grade using Levels 1, 2, and 3 analysis;
- Compare the predicted performance of mixtures with different RAP contents and different assumed binder grades
- Version 1.0 software used
- 2008 TRB presentation & preprint

RAP in MEPDG Conclusions

- Level 1 analysis is least conservative for the structure and mixtures examined in this study.
- Level 2 analysis is more conservative for some mixtures and performance criteria, while Level 3 is more conservative for others. The difference between Level 2 and Level 3 results increases as the difference between high and low temperature PG grade increases.
- The number of AC layers impacts the performance prediction, even when the total thickness of the AC layers is the same.
- The assumed PG grade for RAP mixtures affects performance prediction. This effect is not large (may be insignificant for certain structures/distresses) for Level 1 analysis. However, the effect can be quite significant for Level 2 or Level 3 analysis, based on the parameters examined in this study.
- The relative ranking among the mixtures remained constant for the three climactic regions examined for all three levels of analysis.

Stripping Eval using MMLS3