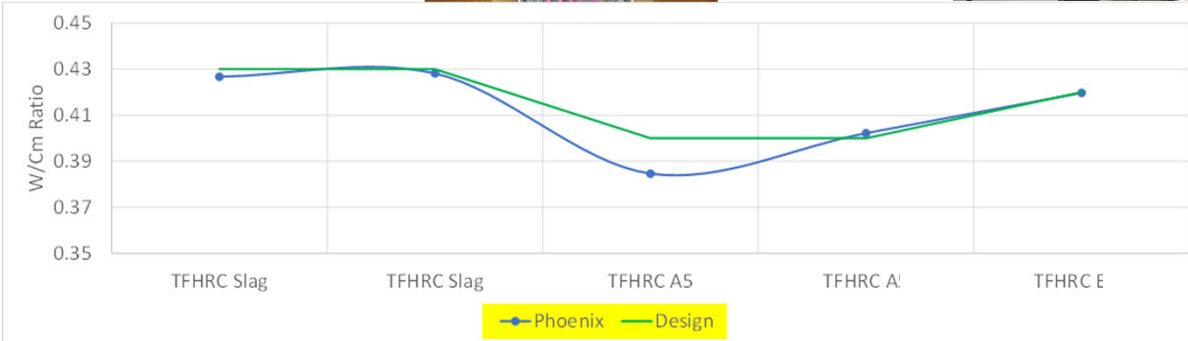
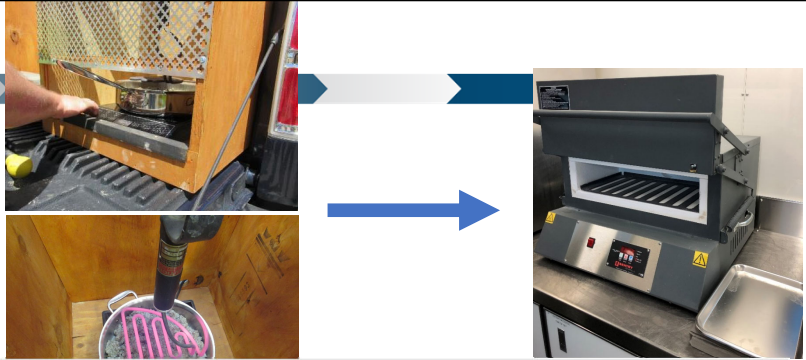


Phoenix Data - MCTC

- Using since 2019
- Equipment Loan



National Concrete Consortium Spring Meeting, 2023

Optimized Gradation and Workability Test Results



U.S. Department of Transportation
Federal Highway Administration

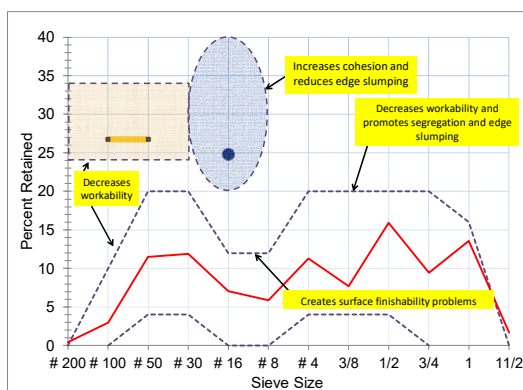
Jagan M Gudimettla, P.E.
Project Manager
Mobile Concrete Technology Center (MCTC)

Disclaimers

- Except for any statutes or regulations cited, the contents of this presentation do not have the force and effect of law and are not meant to bind the public in any way. This presentation is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. However, compliance with any applicable statutes or regulations cited is required.
- FHWA is the source of all images in this presentation unless otherwise noted.



Presentation Topics



Tarantula Curve



Box Test



V-Kelly Test



FHWA Data Collection Efforts

➤ Data from 24 States (30 project mixes)

➤ 2011-2019

➤ Only Mainline Paving projects

➤ Workability Analysis

➤ Combined Aggregate Gradation

➤ Tarantula Curve – 2011

➤ 30 mixtures

➤ Box Test – 2015-2019

➤ 19 mixtures

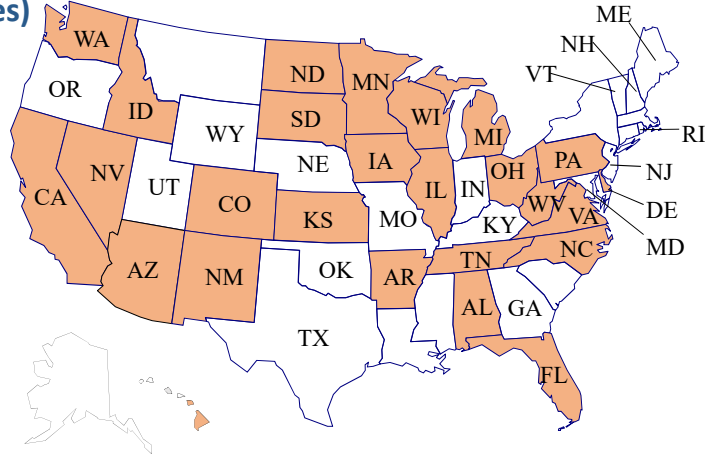
➤ Finish in the Field – 2015 – 2019

➤ 19 mixtures

➤ Objectives

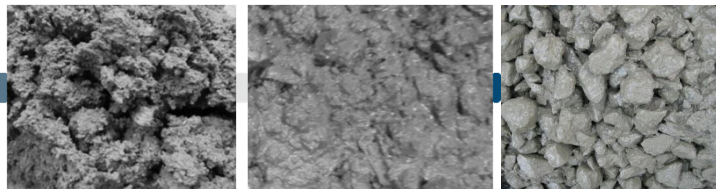
➤ Where do current gradations fall?

➤ Is there a correlation between Tarantula, Box Test and field observations?



Tarantula Curve

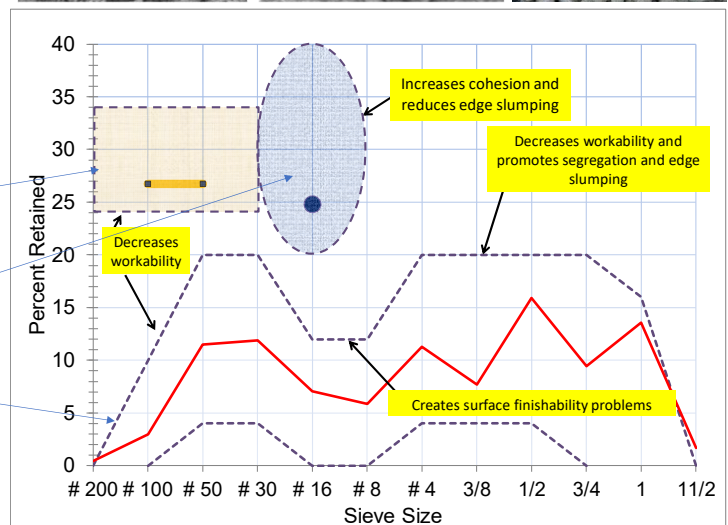
➤ Combined Aggregate Gradation



Criterion 3

Criterion 2

Criterion 1



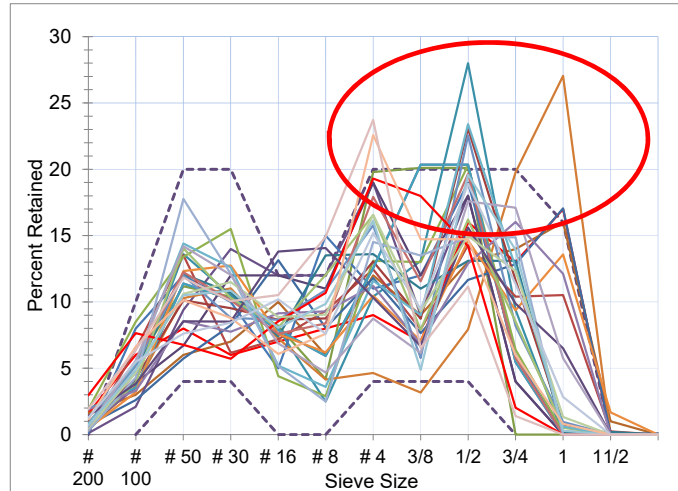
Photos Courtesy: Dr. Tyler Ley, Oklahoma State University

Tarantula Curve

➤ 30 Mixtures

Tarantula Curve	Met	Did not Meet
Criterion 1	21	9

Tarantula Curve: Criterion 1

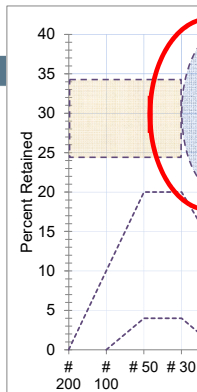


Tarantula Curve

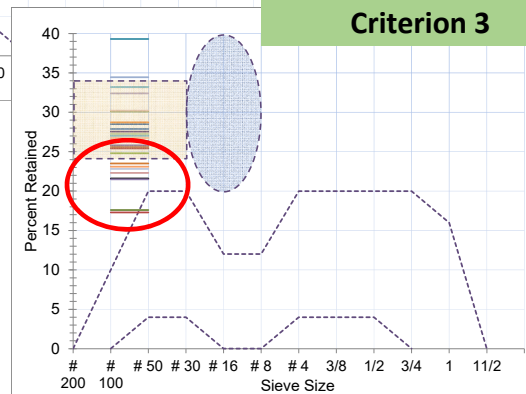
➤ 30 Mixtures

Tarantula Curve	Met	Did not Meet
Criterion 2	29	1
Criterion 3	20	10

Tarantula Curve: Criterion 2



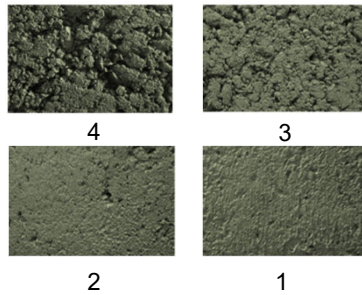
Tarantula Curve: Criterion 3



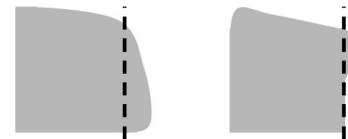
Box Test

➤ Indicators

- Consolidation Ranking
- Edge Slump Potential



Consolidation Issues



Bottom Edge Slumping

Top Edge Slumping

If deflection is more than 1/4" then it fails

Edge Slump Issues

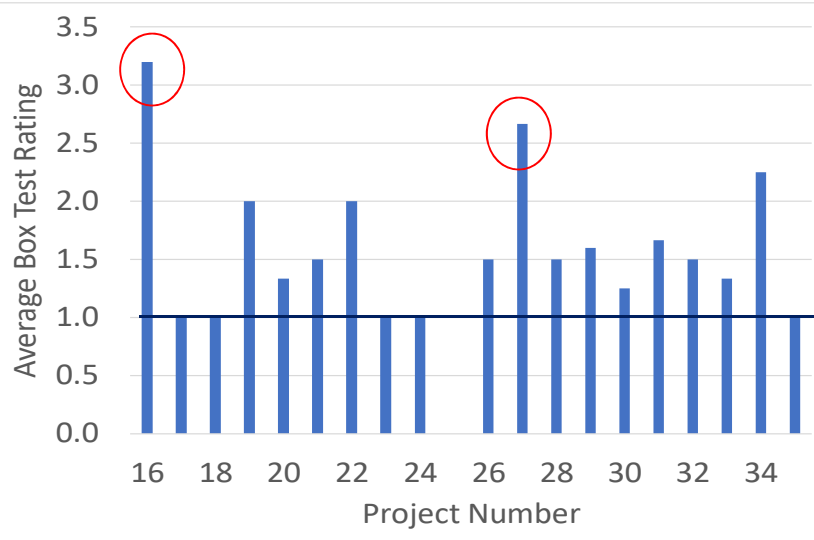


Box Test Results

➤ Consolidation Ranking from Box Test

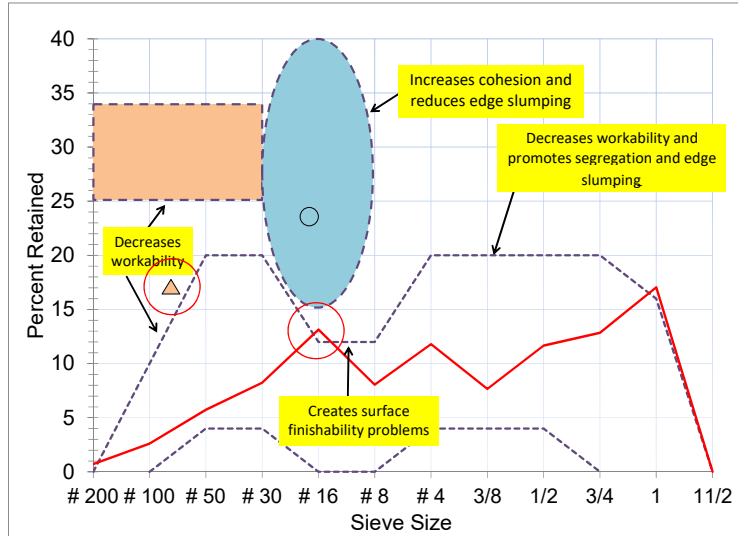
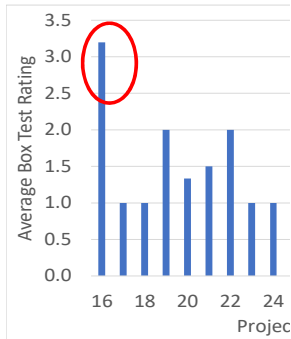
➤ Box Test Ranking from 19 Projects

Box Test Ranking Over 1.5	7 out of 19 projects
---------------------------	----------------------



Tarantula Curve

➤ Project 16



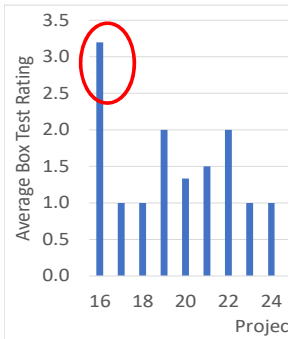
Box Test Results

➤ Project 16



Field Performance

➤ Project 16



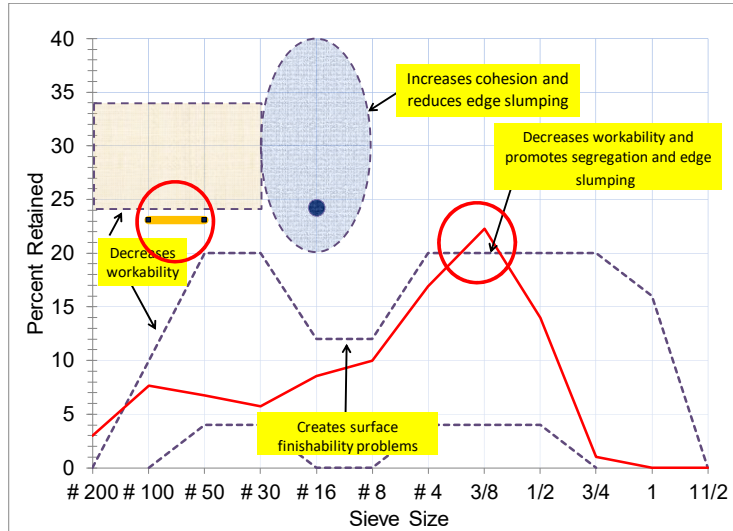
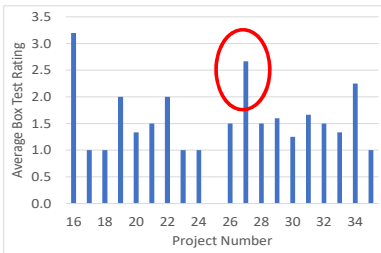
Project 16

- Two Coarse and two fine aggregates
 - Flat and Elongated (Coarse)
 - Coarse Fine Aggregates



Tarantula Curve

➤ Project 27



Box Test Results

➤ Project 27



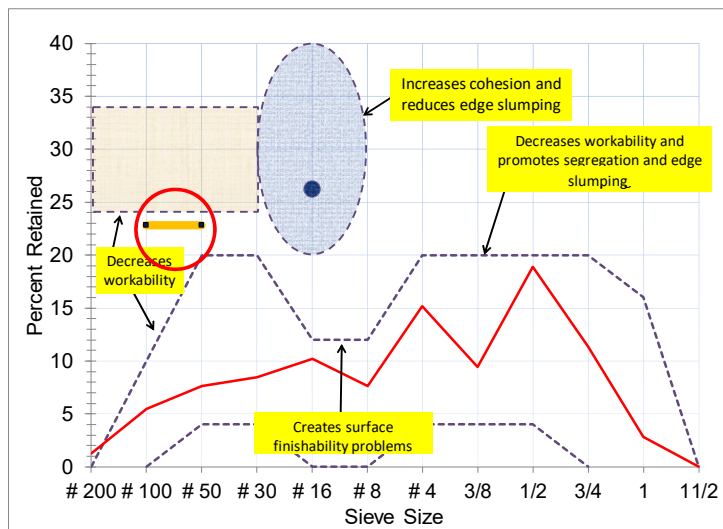
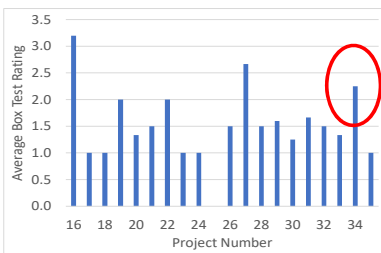
Field Performance

➤ Project 27



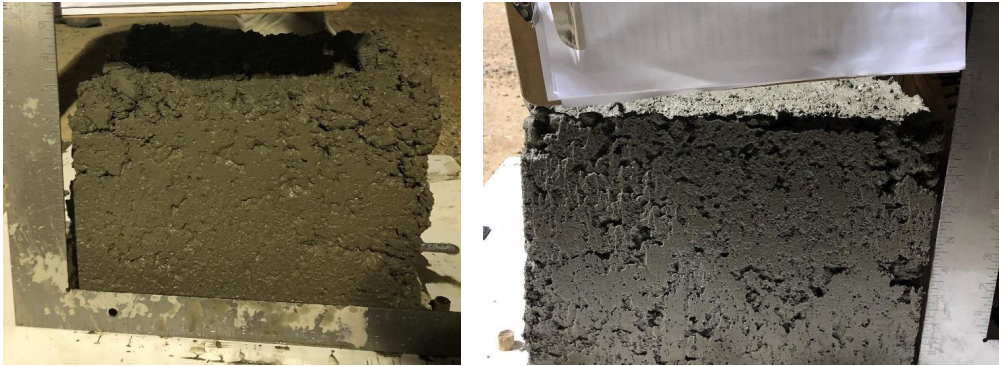
Tarantula Curve

➤ Project 34



Box Test and Field Performance

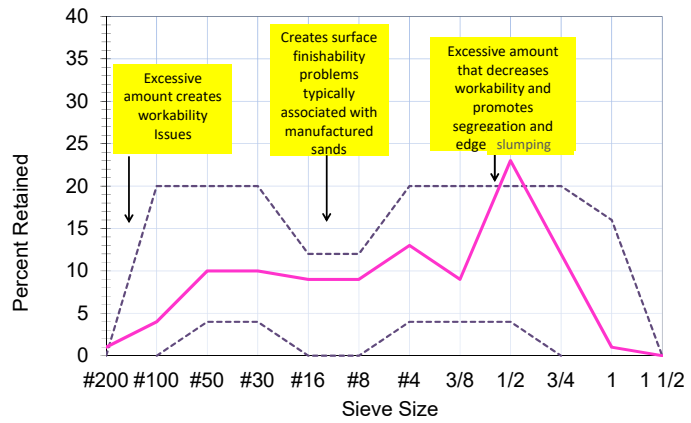
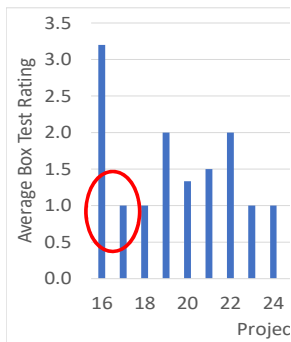
➤ Project 34



Tarantula Curve

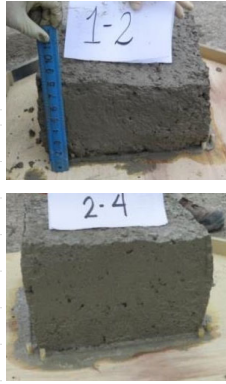
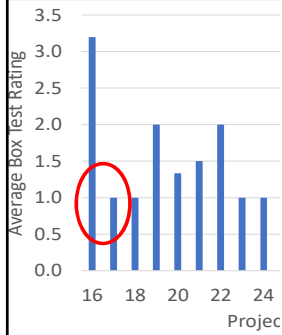
➤ Project 17

➤ Edge Slump Issue



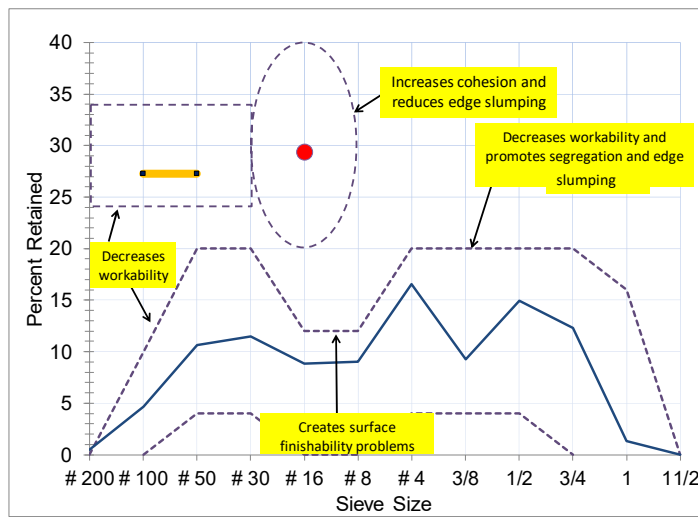
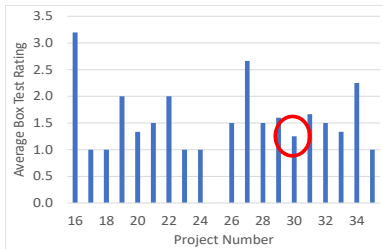
Box Test Results and Field Performance

- Project 17
- Edge Slump



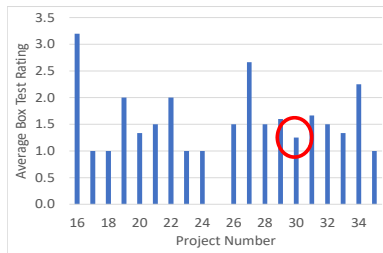
Tarantula Curve

- Project 30
- Iowa



Box Test Results

- Project 30
- Iowa



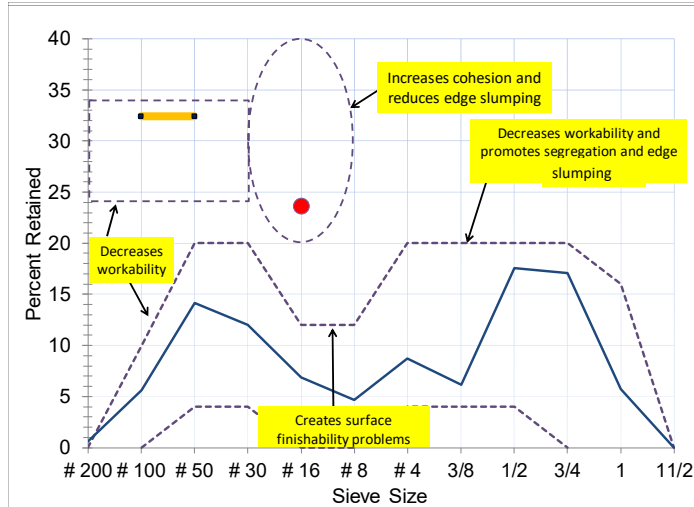
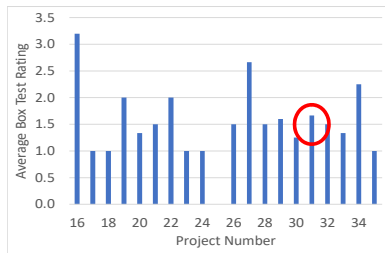
Field Performance

- Project 30
- Iowa



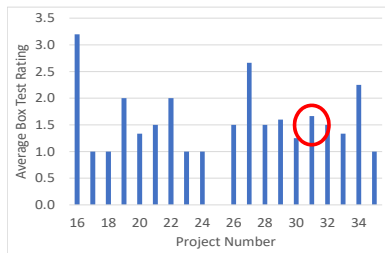
Tarantula Curve

- Project 31
- Minnesota



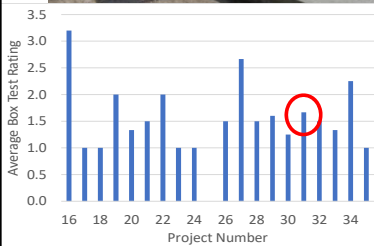
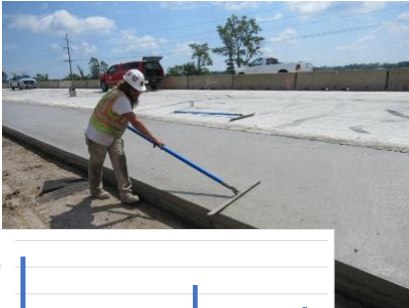
Box Test Results

- Project 31
- Minnesota



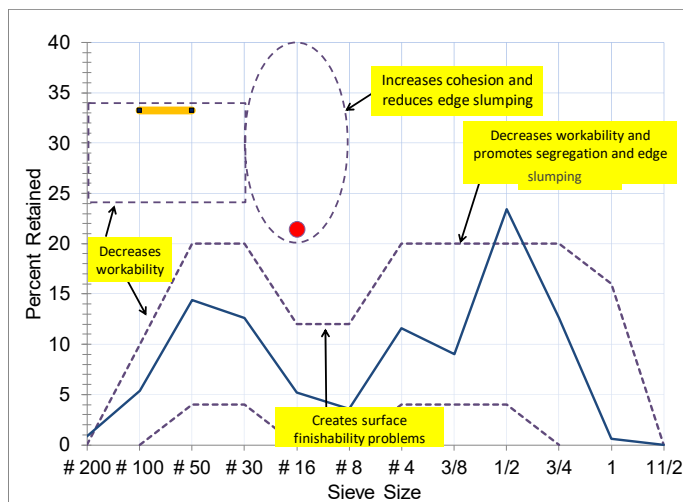
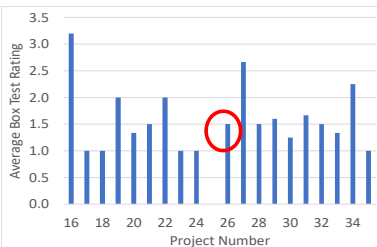
Field Performance

- Project 31
- Minnesota



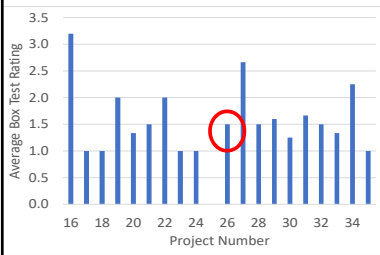
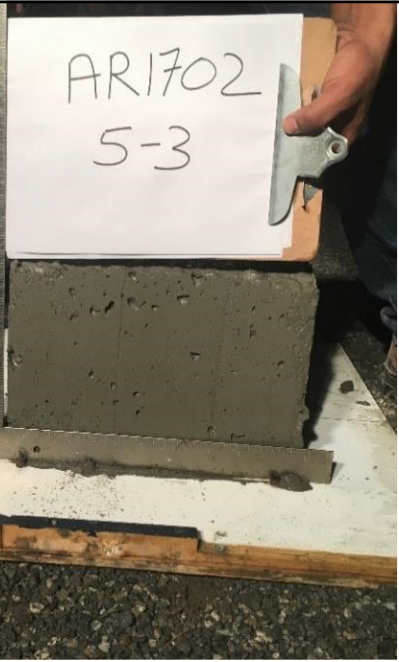
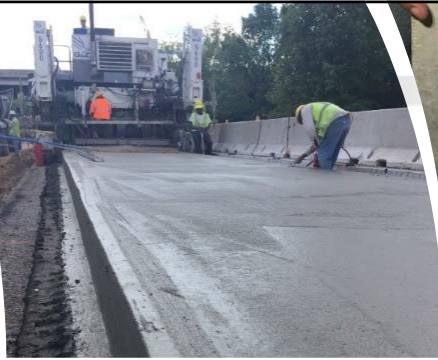
Tarantula Curve

- Project 26
- Arkansas



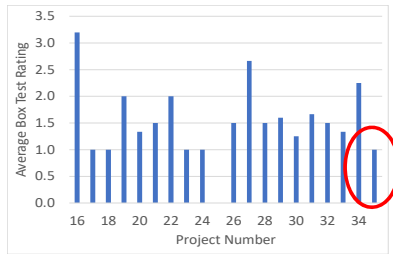
Field Performance

- Project 26
- Arkansas



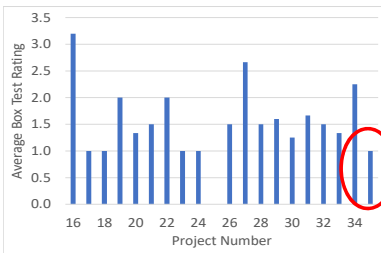
Box Test Results

- Project 35
- Kansas



Field Performance

- Project 35
- Kansas



Assessing Change in Workability with Time

Project A



0 min



15 min



30 min



45 min



60 min

Project B



0 min



15 min



30 min



45 min



60 min



Field Observations



Project A



Project B

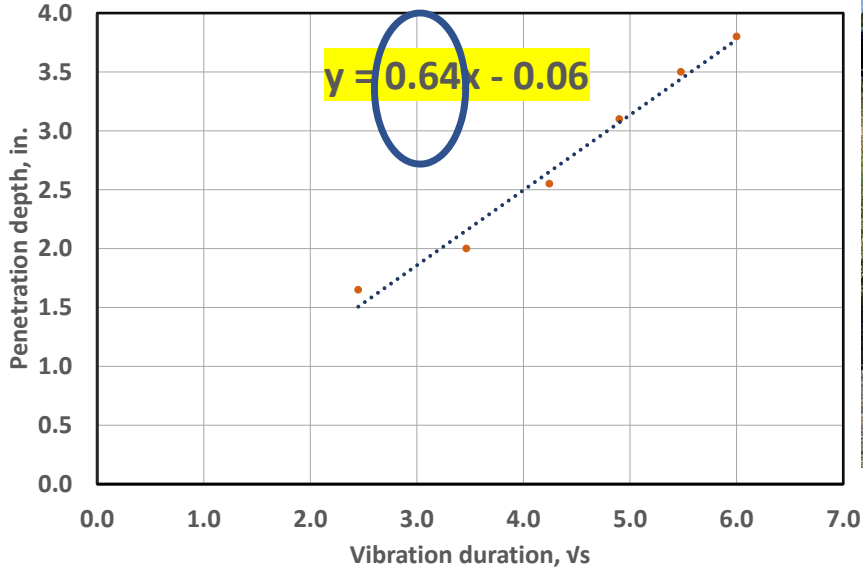


V-Kelly

- **Kelly ball test**
 - Developed in the 1950s in the United States
- **V-Kelly**
 - Add vibrator to a Kelly ball
- **It is a tool**
 - Evaluate workability of a mixture
 - Used to optimize a concrete mixture



V-Kelly



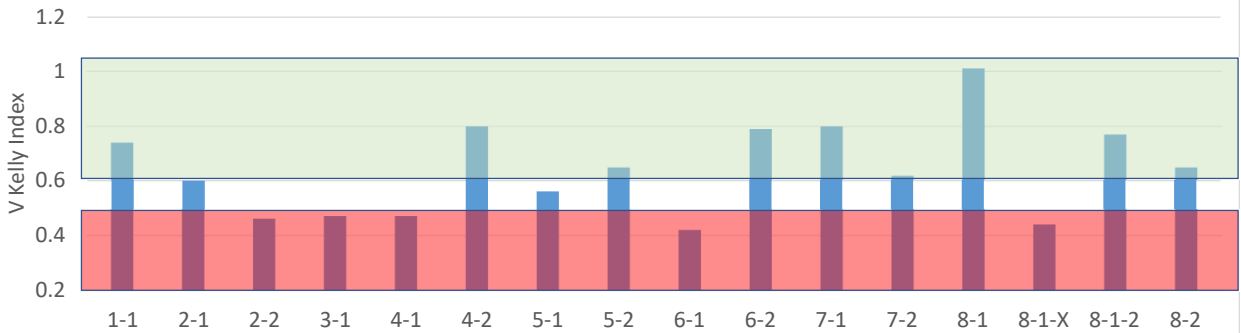
MCTC at MnROAD (2022)



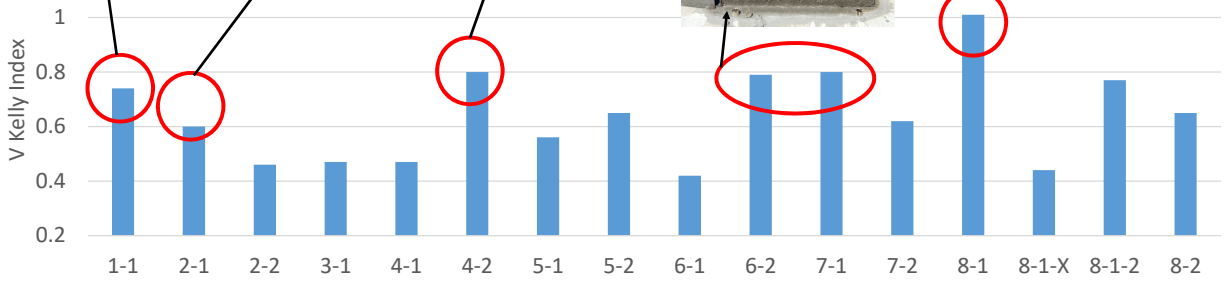
V-Kelly Test Results

➤ Test Cells

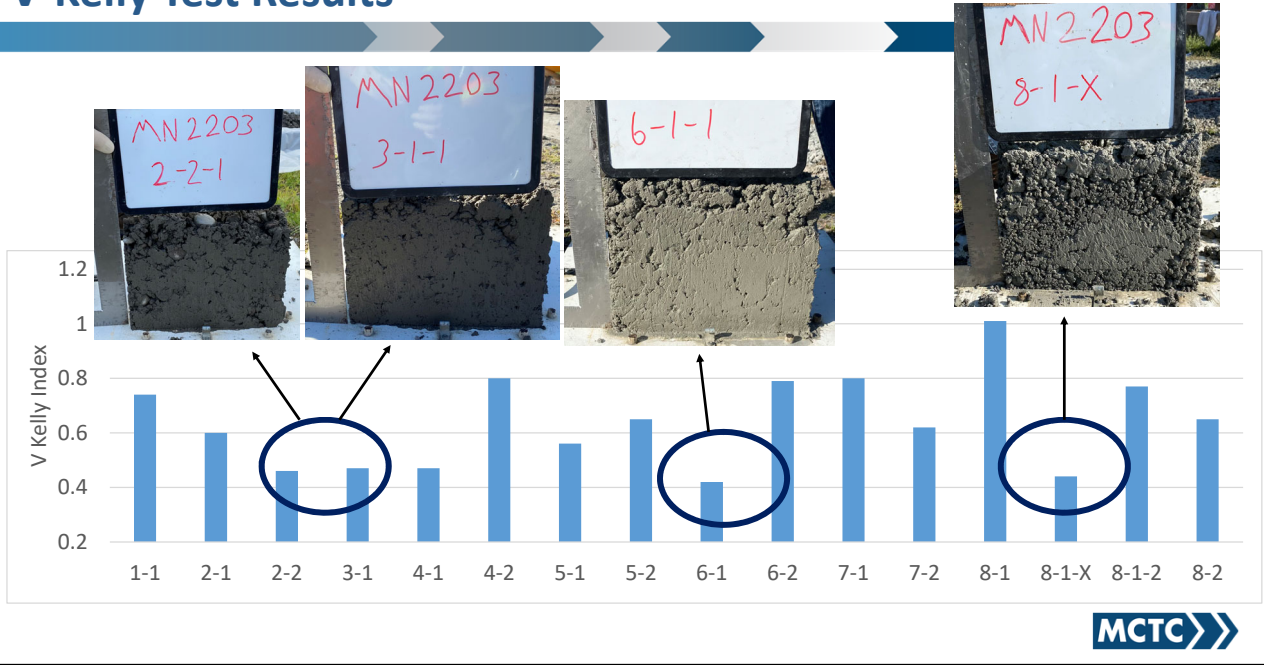
- 3M
- Carbon Upcycling
- Study Control
- Burgess Pigments (three)
- Continental Cement
- Terra CO2
- Carbon Limit
- CP Tech Optimized (two)
- Urban Mining
- Carbon Cure (three)
- Hess Pumice



V-Kelly Test Results



V-Kelly Test Results



Field Validation

Cell 2212



Observations



➤ Tarantula Curve

- **Criterion 1 (individual sizes)**
 - Met most of the time
 - One size aggregate is often off

- **Criterion 2 (Coarse part of the fine aggregate)**
 - Almost always passes

- **Criterion 3 (Fine part of the fine aggregate)**
 - Impacts consolidation and finishability
 - Criterion is not met all the time



Observations



- **The Tarantula Curve, Box Test, and Field Observations correlate in many cases**

- **The Box Test surface finish has correlation to field finish**

- **Assess change in workability over time by running the Box Test at different intervals of time**

- **VKelly appears to be a promising tool in identifying/quantifying workability of paving mixtures**



THANK YOU!



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<https://www.fhwa.dot.gov/mctc>

