National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

NCAT BMD Performance Testing Round Robin

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Outline

- Original NCAT Round Robin
  - Motivation
  - Tests
  - Participation
  - Preliminary Analysis and Observations
- 2021 NCAT Round Robin

Overview and Motivation

- Help collect data on mixture performance tests that are being considered as part of Balanced Mix Design implementation efforts
  - Understanding Test Variability
    - Within Lab
    - Between Lab
- Help test users gain experience and confidence in their ability to perform these tests

Tests Performed

- Cracking
  - Illinois Flexibility Index Test (I-FIT)
    - AASHTO TP124-18
  - IDEAL-CT
    - now ASTM D8225-19
- Rutting
  - Hamburg Wheel-Tracking
    - AASHTO T324-17
  - Asphalt Pavement Analyzer (APA)
    - AASHTO T340-10

Background

- Advertisement sent out in Summer 2018
- 200 Buckets (!) sampled for the Round Robin
  - Mix Sampled from a Stockpile that had been passed through a Material Transfer Vehicle
- Plant Mix sent to participating labs
  - Q1 2019
- Requested an Excel Summary file for each lab per test in addition to the raw data
- Labs provided with detailed fabrication and testing instructions

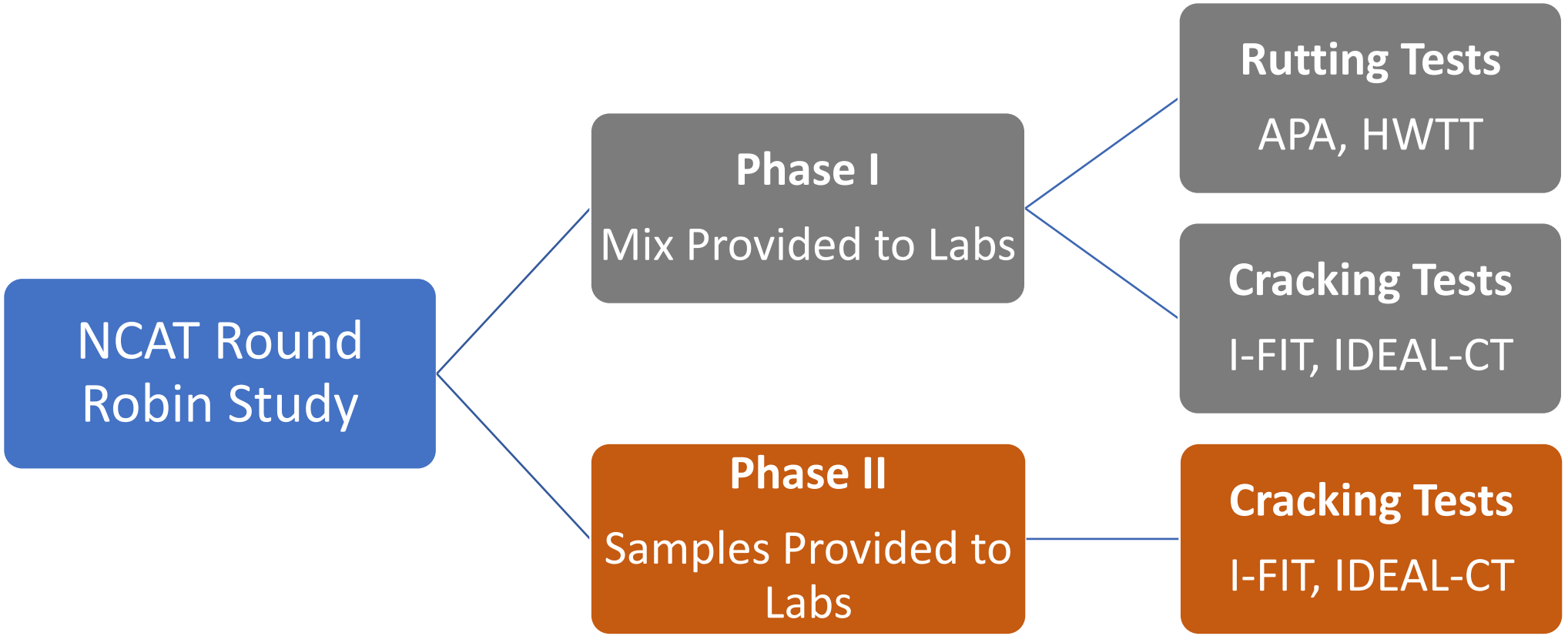
Mixture Information

- 9.5 mm NMAS
- PG 64-22 Base Binder (unmodified)
- 30% RAP
- No RAS or Rejuvenator
- BMD Design

Background

- Phase I
  - All specimen fabrication performed in participating labs
    - Loose Mix Provided
- Phase II
  - Specimens prepared at NCAT and sent to participating labs
- Data summary report sent to participating labs
  - ‘Blind’ for participants
  - Lab 1, Lab 2, etc…

Flow Chart – NCAT Round Robin



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Participation

Test ID	Phase I	Phase II
Hamburg	32	n/a
I-FIT	20	13
IDEAL-CT	15	14*
APA	10	n/a

Example Data Collection Form

1	**NCAT Hamburg Round Robin - Data Summary Sheet**					
2						
3	*General Equipment Information*					
4	Gyratory Compactor Make and Model:					
5	Hamburg Make and Model:					
6	Single or Dual Wheel Tracker?					
7						
8	*General Specimen Info*					
9	Sample ID (only the 4 used for testing)					
10	Date Compacted					
11	Number of Gyrations to achieve 62 mm					
12	Gmb - Dry Mass in Air, g					
13	Gmb - Mass of Specimen underwater, g					
14	Gmb - SSD Mass of Specimen, g					
15	Gmb					
16	Air Voids (%) - Use Provided Gmm of 2.691					
17	*Hamburg Results Summary*****					
18	Sample Location*					
19	Immersion Time**					
20	Max Rut Depth at 2,500 passes (mm)***					
21	Max Rut Depth at 5,000 passes (mm)					
22	Max Rut Depth at 7,500 passes (mm)					
23	Max Rut Depth at 10,000 passes (mm)					
24	Max Rut Depth at 15,000 passes (mm)					
25	Max Rut Depth at 20,000 passes (mm)					
26						
27	* LB = Left Back, LF = Left Front, RB = Right Back, RF = Right Front					
28	** = Time between the specimens being covered with water and the test starting - Includes the required 45 minute conditioning period at 50 degrees C					
29	*** = If your data collection does not have the rut depth at a particular interval, you may interpolate between the two surrounding values					
30	**** = In addition to the results summary below, please send the raw rut depth versus cycles to failure					

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Data Analysis

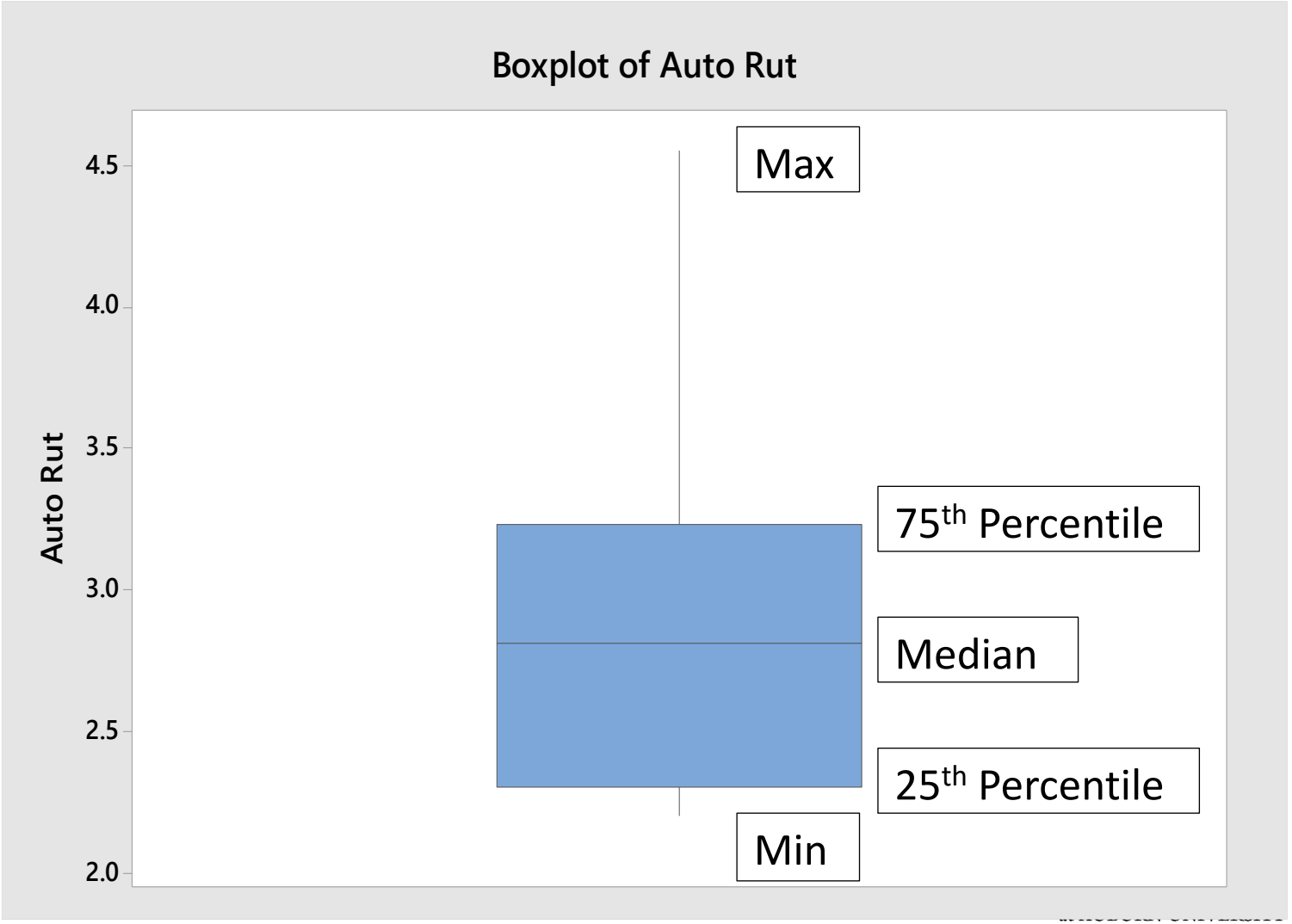
- Populate Database
  - Data quality inspection
  - ASTM E 178-16a – Outlier Evaluation
- Descriptive Statistics
- Boxplot Analysis
- ASTM E691-19 Variability Analysis
  - Repeatability (Within-Lab)
  - Reproducibility (Between-Lab)

APA – Data Analysis

- A full set of replicates requested per lab
  - Either 4 or 6 depending on the model of APA
- Requested both Manual (caliper) and Automated rut depths be reported
  - 9 labs reported Automated, 5 reported Manual
  - Automated data shown

APA – Summary Statistics

- Statistics (mm)
  - N = 9
  - Mean = 2.91
  - St Dev = 0.75
  - Min = 2.20
  - Q1 = 2.30
  - Median = 2.81
  - Q3 = 3.23
  - Max = 4.55



APA – Variability Statistics

- ASTM E691 Repeatability and Reproducibility Coefficient of Variation (CV)
  - Between-lab variation should be higher than within-lab variation

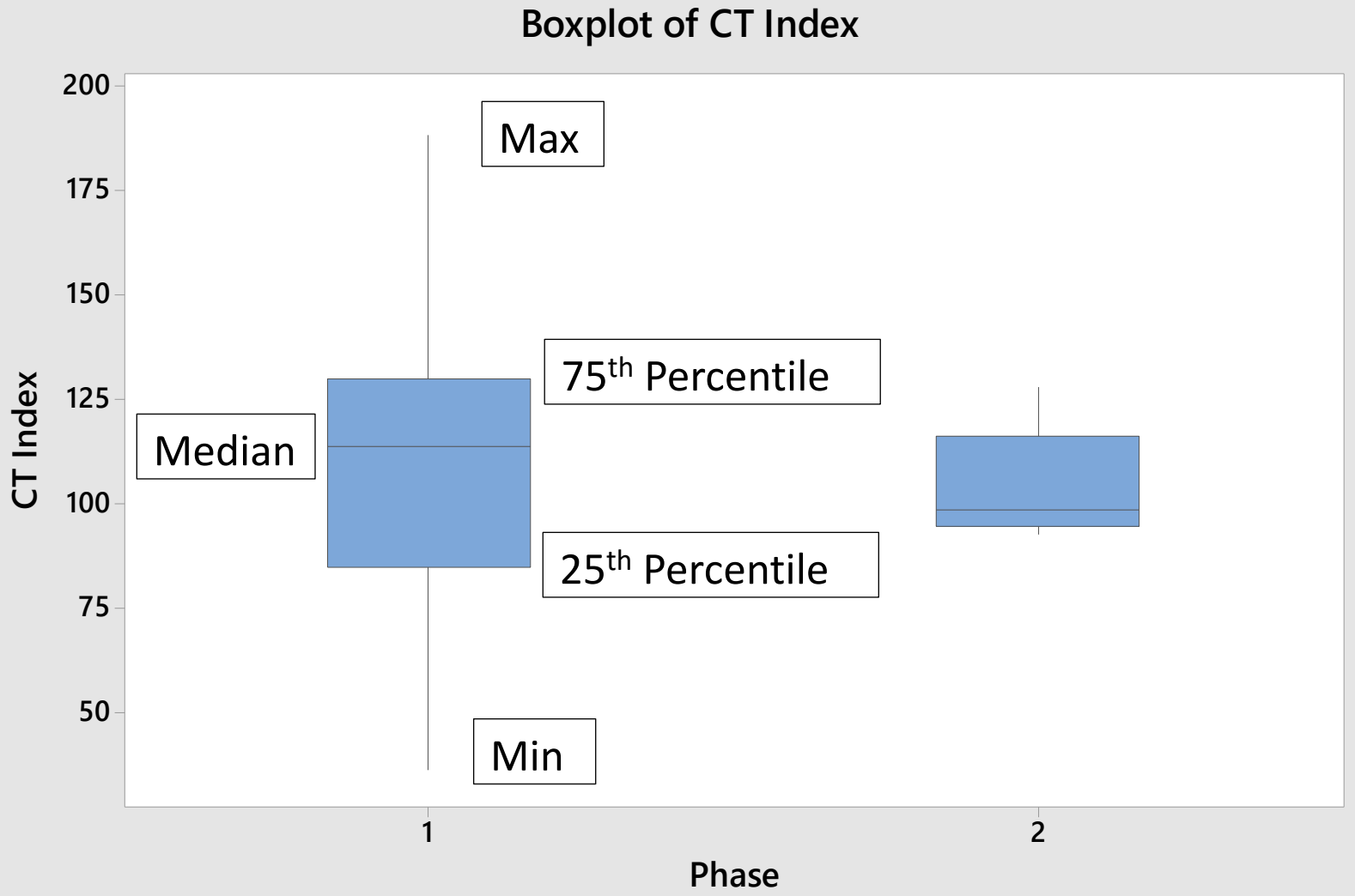
APA Measurement	Mean APA Rut Depth (mm)	Within-Lab CV (%)	Between-Lab CV (%)
Automated Rut Depth (mm)	2.9	18.3	29.6

Specimen Preparation – IDEAL-CT Phase II

- Large volume of specimens made in the NCAT lab
  - Buckets homogenized using a quartermaster
  - Mix split into individual specimens and stored in sealed plastic bags
  - Specimens prepared by the same operator using the same oven and the same gyratory compactor
  - Each lab received a set of specimens with close to the same spread and average of air voids

IDEAL-CT – Data Analysis

- Comparing specimens being fabricated in a single lab versus multiple labs
  - Massive reduction in overall variability



IDEAL-CT – Variability Statistics

- ASTM E691 Repeatability and Reproducibility Coefficient of Variation (CV)
  - Similar within-lab variation
  - Large reduction in between-lab variation for Phase II

Phase	Number of Labs	Mean CT_{Index}	Within-Lab CV (%)	Between-Lab CV (%)
I	15	111.1	19.5	35.3
II	14	103.7	18.8	20.2

Specimen Fabrication – Plant Mix

- Good Practices
  - Blend multiple buckets of same mix when needed/available
  - Heat each bucket once
  - Quarter samples by AASHTO R47
  - Heat mix minimum time required to reach compaction temp

Specimen Fabrication – Plant Mix

- Bad Practices
  - Scoop the mix you need directly out of the bucket
  - Re-heating the bucket multiple times
  - Heating buckets overnight or more than half a day
- Key Point
  - These practices have a much bigger impact on performance testing than volumetric properties

Lessons Learned – Original Study

- Specimen preparation matters!
  - Evident in both the round robin and other studies
  - Training on good specimen preparation practices will be a good time investment for agencies as they move forward with BMD
  - An in-state interlaboratory study would also be a good investment in test implementation to help work through issues
- Collected single-mix data that could be used to help develop or refine precision statements
  - IDEAL-CT data provided to ASTM

2021 NCAT Round Robin

- Mix sampled during 2021 Track Construction
  - 200+ buckets
- Tests offered
  - High-Temperature IDT (HT-IDT) – Rutting
  - IDEAL-RT – Rutting
  - Hamburg Wheel-Tracking – Rutting
  - APA – Rutting
  - IDEAL-CT - Cracking

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2021 NCAT Round Robin

- Finalizing plans and instructions
- Plan to begin shipping mix Q1 2022
- Offers away for labs to benchmark their results against a large population of results
- Collect additional data that may be used to develop test precision statements in the future

Questions?

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