



Non-destructive Testing (NDT) For Asphalt Density Measurement: Evaluation of the PQI-380 Gauge In Louisiana

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Presentation Outline

- Background
- Objective
- Scope of Research
- Results
- Key Takeaways
- Recommendations

Acknowledgement












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BACKGROUND

- Proper compaction of asphalt pavements critical for:
 - Enhanced long-term performance
 - Increased durability
- Benefits of 1% density increase above 93% (Puangchi et al., 1982; Tran et al., 2016) :
 - 10-30% longer service life
 - 8.8% reduced life cycle cost
- Conventional density assessment challenges:
 - Destructive core sampling
 - Time-consuming and costly
 - Disruptive to traffic flow
 - Limited sampling for quality control/assurance

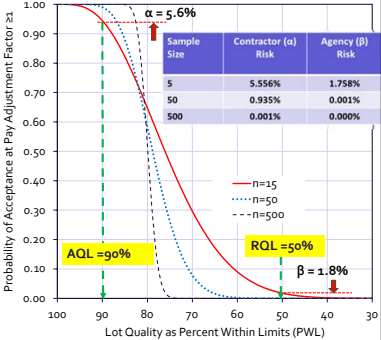


Acknowledgement

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BACKGROUND


- Risks Associated with Limited Sampling:
 - Type I Error (α risk or Contractor's Risk):
 - Good quality work is mistakenly rejected.
 - Type II Error (β risk or Agency's Risk):
 - Poor quality work is mistakenly accepted.




Sample Size	Contractor (α) Risk	Agency (β) Risk
5	5.556%	1.758%
50	0.935%	0.001%
500	0.001%	0.000%

Doctor: "Sir, the surgery has a 50% survival rate, but don't worry, my last 20 patients have all survived"

Normal people


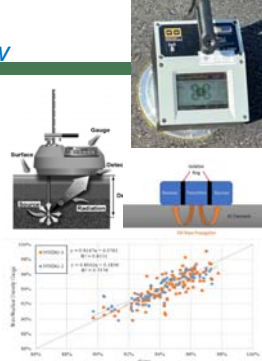


Mathematician



BACKGROUND


State Specifications Overview


BACKGROUND

- Risk Trade-off:
 - Increasing contractor's risk reduces agency's risk and vice versa.
- Balancing Risks:
 - More testing achieves a reasonable balance between both risks.
- Efficient Solution:
 - Non-Destructive Testing (NDT) offers a more efficient approach.

Limited Sample Size



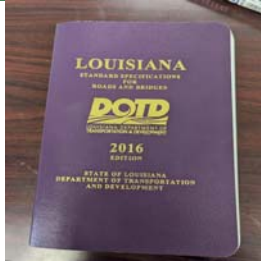
Increased Sample Size



BACKGROUND

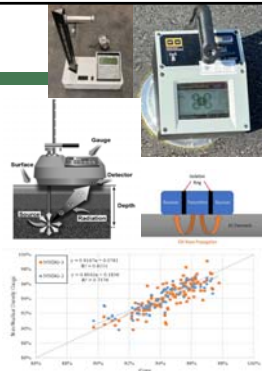
Louisiana DOTD NDT Specification

- Allows NDT for informational purposes.
- NDT Requirements:
 - Must meet AASHTO-T-343 or T-355 standards.
 - Average of 5 readings per location.
 - Daily verification with standard plate.
- Proposed NDT Implementation:
 - Perform device verification using core and NDT data from 10 random locations
 - Combine NDT with limited core sampling.
 - 1 core per lot for offset verification.
 - 5 acceptance and 5 QC NDT readings per lot.
 - ±1.3% tolerance between QC and QA NDT readings.



BACKGROUND

- NDT Techniques:
 - Electromagnetic Density Gauges: Measure dielectric constant
 - Nuclear Density Gauges (NDG): Measure gamma ray attenuation
 - Other NNDGs: Utilize correlations between density and factors like temperature, moisture content, or specific gravity
- Advantages of NDT:
 - Speed, Cost-Effectiveness, Minimal Disruption to traffic, etc.
- Challenges of NDT:
 - Limited accuracy and precision, Calibration techniques, Environmental factors, etc.



OBJECTIVE



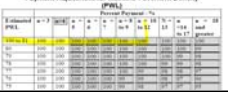
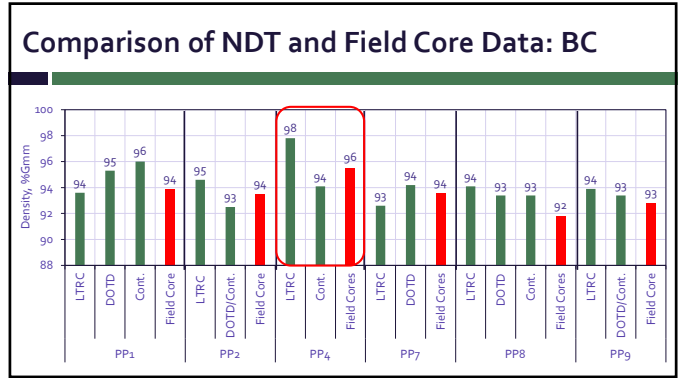
- Collect and analyze data from NDT pilot projects proposed in LTRC project 17-2B for implementation in section 502 of the Louisiana Standard Specifications for Roads and Bridges



SCOPE OF RESEARCH

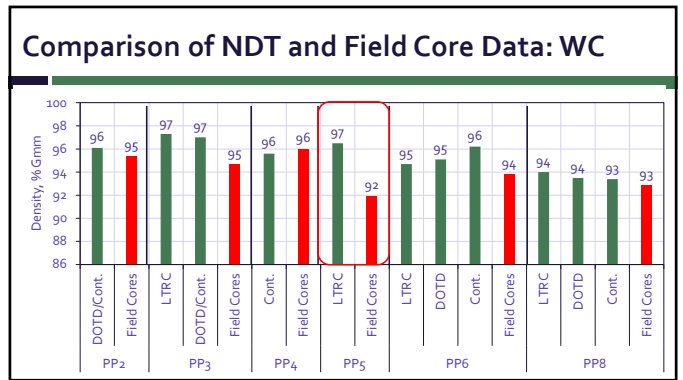
- Project Selection:
 - 10 pilot projects selected
- NDT Testing:
 - PQI-380 used
- Data Comparison:
 - NDT data vs. field core density data
- Operator Bias Analysis:
 - Compare NDT data from LTRC, contractor, and DOTD personnel
- Effectiveness of PQI-380:
 - Evaluate NDT reliability for PWL and PF data

PWL = 100
PF = 100

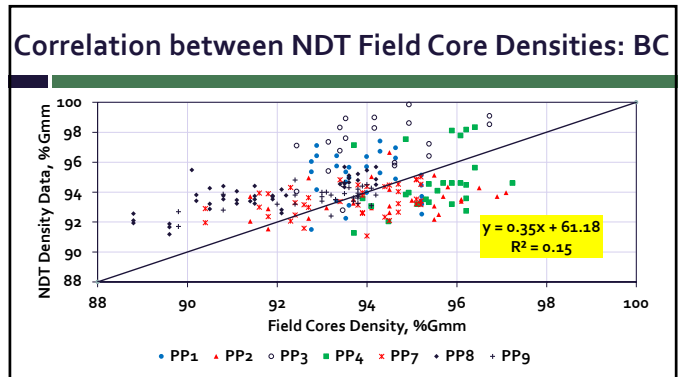





SCOPE OF RESEARCH

Project ID	District	Binder Course				Wearing Course			
		NDT Density Data			Field Core Densities	NDT Density Data			Field Core Densities
		LTRC	DOTD	Contractor		LTRC	DOTD	Contractor	
PP1	61	A	A	A	A	A	NA	NA	NA
PP2	8	A	A*	A*	A	NA	A*	A*	A
PP3	3	A	A	NA	A	A	A	NA	A
PP4	3	A	NA	A	A	NA	NA	A	A
PP5	58	NA				NA	A	A	A
PP6	2	NA				A	A	A	A
PP7	62	A	A	NA	A	NA	A*	A*	NA
PP8	7	A	A	A	A	A	A	A	A
PP9	4	A	A*	A*	A	A	NA	NA	NA
PP10	5	NA							

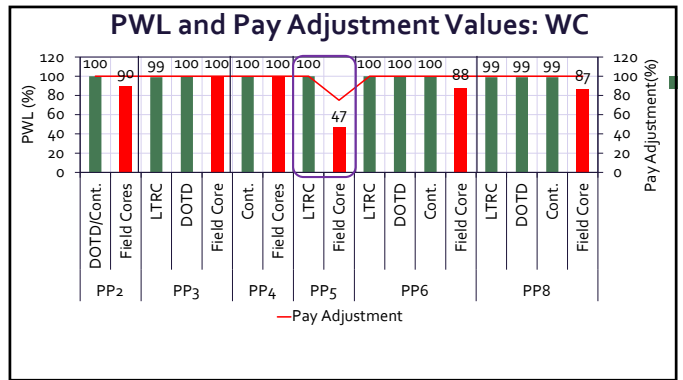
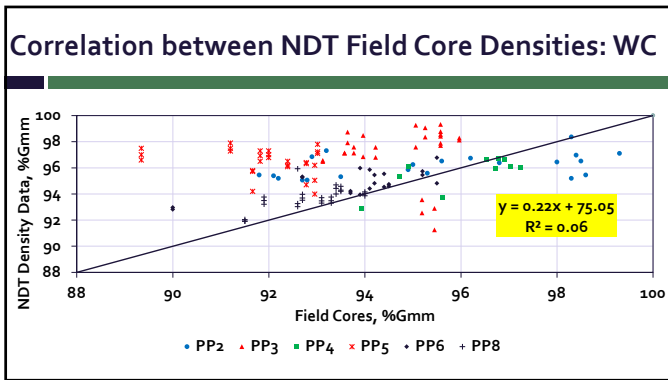
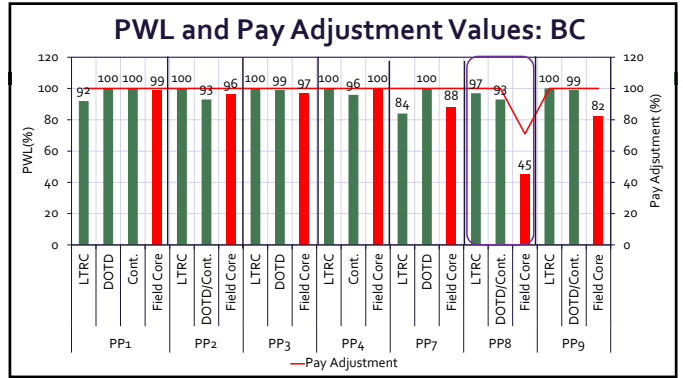


RESULTS



Correlation between NDT Field Core Densities: BC

Project ID	Comparison	R ²	Sig.	Regression Slope
PP1	LTRC versus Field Core	0.23	0.182	0.36
	DOTD versus Field Core	0.22	0.170	-0.34
	Cont. versus Field Core	0.22	0.170	-0.34
PP2	LTRC versus Field Core	0.45	0.001	0.86
	DOTD/Cont. versus Field Core	0.52	<0.001	1.57
PP3	LTRC versus Field Core	0.31	0.340	0.31
	DOTD versus Field Core	0.29	0.106	0.29
PP4	LTRC versus Field Core	0.88	0.006	2.17
	Cont. versus Field Core	0.41	0.002	0.58
PP7	LTRC versus Field Core	0.17	0.059	0.87
	DOTD versus Field Core	0.58	<0.001	1.79
PP8	LTRC versus Field Core	0.63	0.002	1.15
	DOTD/Cont. versus Field Core	0.73	<0.001	1.51
PP9	LTRC versus Field Core	0.16	0.228	0.29
	DOTD versus Field Core	0.51	<0.001	1.17



Correlation between NDT Field Core Densities: WC

Project ID	Comparison	R ²	Sig.	Regression Slope
PP2	DOTD/Cont. versus Field Core	0.22	0.029	1.36
	LTRC versus Field Core	0.00	0.859	-0.02
PP3	DOTD versus Field Core	0.00	0.926	0.01
	Cont. versus Field Core	0.53	0.017	0.65
PP5	LTRC versus Field Core	0.16	0.287	-0.60
	Cont. versus Field Core	0.12	0.371	-0.28
PP6	LTRC versus Field Core	0.55	0.021	1.30
	DOTD versus Field Core	0.56	0.013	1.03
	Cont. versus Field Core	0.67	0.046	1.43
PP8	LTRC versus Field Core	0.20	0.226	0.34
	DOTD versus Field Core	0.61	0.013	0.84
	Cont. versus Field Core	0.74	0.003	1.01

- ### KEY TAKEAWAYS
- The PQI-380 device is effective for monitoring in-place asphalt pavement density.
 - Significant variations were observed in NDT density readings between different operators and between different layers of the pavement.
 - Low correlation between NDT and field core densities concerning
 - 47% of binder course NDT density readings correlated strongly with field core density values
 - 42% of wearing course NDT density readings correlated significantly with field core density values
 - Strength of correlation ranged from moderate to large
 - Overestimations of density, especially in certain scenarios, can lead to potential overpayments.

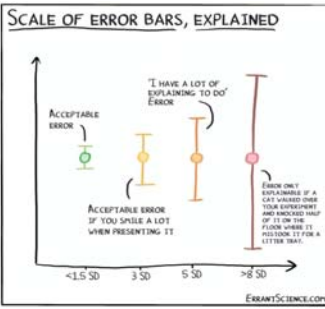
Recommendations

- **Continue Use of PQI-380:** The Louisiana DOTD should continue to allow the use of the PQI-380 device for pavement density monitoring.
- **Optimal Testing Conditions:** Tests to be conducted in accordance with AASHTO T-343 and Louisiana supplemental specification.
- **Minimum R² Value to be established for QC and QA testing:** Contractors should be required to meet a specified minimum R² value between NDT and core density readings during mixture validation.
- **Mixture Validation:** The PQI-380 should be used to measure high and low density locations (include unsupported joints) to assess its sensitivity during mixture validation.
- **Continuous Improvement:** Continue to explore and refine PQI-380 and other NDT methods

PaveScan Rolling Density Meter



What Next?



"I'm Disillusionment. Enlightenment is over there."

Questions



Continuous Evaluation of PQ-380 with other Tools

