


EVALUATION OF NON-DESTRUCTIVE DENSITY DETERMINATION FOR QA/QC ACCEPTANCE TESTING

LTRC/DOTD Research Project 17-2B
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BACKGROUND

- ▶ Measures to Quality Control and Quality Assurance of the pavement.
 - ▶ Density is often considered the most important variable in the construction of durable, longer-lasting asphalt roads.
 - ▶ The QC/QA aim for density on hot-mix asphalt pavement is normally around 92 to 93 percent.
 - ▶ Low density pavement may result in premature pavement distresses. These distresses may be in the form of premature oxidation aging, increased cracking, rutting, structure weakening, raveling or stripping.

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INTRODUCTION

- ▶ For final density acceptance:
 - ▶ Nuclear density gauge for soils
 - ▶ Cores for asphalt



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INTRODUCTION

- ▶ Destructive density methods disadvantages:
 - ▶ Safety concerns
 - ▶ Destructive testing
 - ▶ Long testing times
 - ▶ 24 hours
- Non-destructive density methods advantages:
 - Non-destructive
 - Easy to use
 - Quick results
 - Accurate?
 - Cheaper device and Lower maintenance

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OBJECTIVE

- LTRC objective:
 - Determine if Non-destructive density methods can reduce coring for asphalt density acceptance
 - Provide updated QA/QC procedures if gauges prove to be efficient in providing similar density results as cores.

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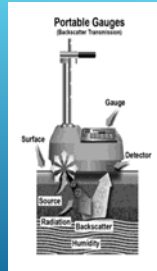
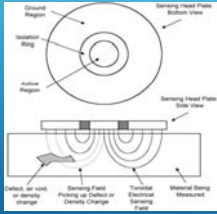
METHODOLOGY

- ▶ Density readings and core obtained from seven asphalt paving sites (nine asphalt mixtures/lifts) in Louisiana. The sites included low and high volume roads for different mat thicknesses and mixture designs to be evaluated.
- ▶ A minimum of five density spots were obtained from each site for density gauge and core comparisons. All cores were trimmed to proper thicknesses.
- ▶ Sand patch testing was implemented to determine the surface texture impact on density readings of gauges.
- ▶ Data collected were analyzed using linear regression and analysis of variation (ANOVA) calculations.



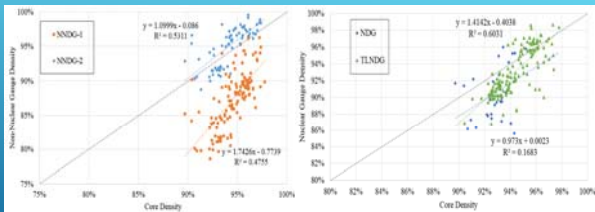
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METHODOLOGY



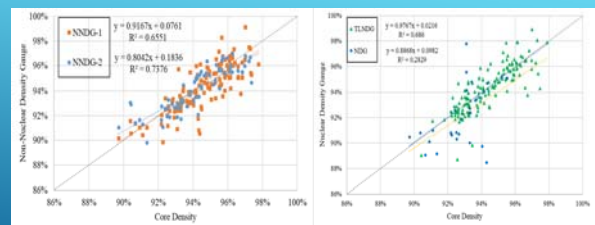
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RESULTS



Density gauges vs Cores (No offset)

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Density gauges vs Cores (with offset through AASHTO T343)

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Percentage of projects with no difference from core

Project	NDG	TLNDG	NNDG-1	NNDG-2
I12BC	1	1	1	1
I20BC	0	x	1	1
I20BC2	x	0	0	x
LA485BC	x	0	1	x
LA98BC	1	1	1	1
ThibBC	1	x	1	1
US190WC	x	1	1	1
US190BC1	x	1	1	1
US190BC2	x	1	1	1
US90BC	1	x	1	1
US90SMA	x	x	1	1
Total	4/5	5/7	10/11	9/9
Percentage of projects with no difference from core	80%	71%	91%	100%

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Density Gauge Cost

	Core Rig	Thin-Layer Nuclear Gauge	Non-Nuclear Gauge
Initial/One Time Costs			
Equipment	\$15,000	\$9,850	\$8,200
RSO training (per person)	\$0	\$290	\$0
Radiation safety & Certification Class (per person)	\$0	\$129	\$0
Annual Costs			
Maintenance (oil change or calibration)	\$500	\$500	\$500
Core drill bits	\$1,000	\$0	\$0
Fuel costs	\$500	\$0	\$0
Nuclear gauge refresher course (per person)	\$0	\$49	\$0
HAZMAT certification (\$49 every 3 years per person)	\$0	\$17	\$0
Cost after 5 years			
Cost after 5 years (1 device and 1 person)	\$25,000	\$13,099	\$10,700
Testing Times			
Time from setup to density reading	24 hours	15 minutes	5 minutes

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CONCLUSION

- ▶ The linear regression analysis showed that the results of the NNDG and TLNDG presented fair to good correlation to roadway cores, while NDG presented fair to poor correlation.
- ▶ ANOVA analysis found that without offset calibration, both NDG and NNDG results were differed from core densities, while with offset they are not significantly different. Based on the P-value, calibrated NNDG results, agreed better with cores comparing to NDG results.
- ▶ Device usage and practicality were observed when taking the readings. Both NNDGs were easy to operate. NDG and TLNDG testing time was typically 10 to 15 minutes while NNDG took 5 minutes from gauge setup to density results.
- ▶ Cost Comparison of each density measuring tool (Core rig, NDG, and NNDG) exhibited that NNDGs would provide the most cost savings. Core rig and NDG cost entail higher maintenance and training costs versus the NNDGs.

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STATUS

- ▶ In the 2018 special provision as an option for contractors to use
 - ▶ the goal is to collect data and make sure the logistics of the specification are working
- ▶ Contractors have not really been using the option
 - ▶ Only a few
 - ▶ Pilot projects for next summer
 - ▶ Both methods will be in the contracts
 - ▶ Collect data and finalize the specification to replace coring for pay

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QUESTIONS?

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SOILS RESULTS

- ▶ 3 Soils Projects

- Cost of each device After 5 years:
 - nuclear gauge – \$45,000
 - low-nuclear – \$21,000
 - 8-10 year service life

	Nuclear Moisture Density Gauge		Economic Model 6750 Density Gauge		Model 6750 Moisture Probe (comes with E-Gauge)	
	Apply	Cost	Apply	Cost	Apply	Cost
Initial Cost	0 (already have)		High (\$21,000)			
Budget	Yes	\$7,800/year	No	\$0	No	\$0
Leak Testing	Yes	\$0	Yes	\$0	No	\$0
License Certification	yes	~\$110K/year	No	\$0	No	\$0
Paperwork	Extensive		Reduced		Reduced	
Safety	Safe when used properly		Safe		Safe	
Training & Ease of Use	User friendly with familiarity		Easy to learn and easy to operate		Easy to learn and easy to operate	

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