

Nuclear Density Testing on Coarse SUPERPAVE Mats

In early 1999, representatives from the State of Mississippi contacted REGIS Engineering Solutions, Inc. (REGIS) in an effort to secure an onsite evaluation of the effectiveness of portable nuclear testing equipment in characterizing the density of modern hot-mix asphalt mats. In March of the same year, data was collected on a Mississippi Department of Transportation (MDOT) project to facilitate the objective comparison of the performance of several popular devices.

Two gauges manufactured by Troxler Electronic Laboratories (4640-B thin layer and 3440 dual purpose) and one gauge manufactured by CPN International (MC-3 dual purpose) were utilized in the study. Representatives from MDOT operated their own Troxler devices and a certified technician from REGIS operated a CPN that was owned by the contractor. The entire data collection process was open to review by all participants and observers so that no single operator would have the opportunity to subjectively manipulate the outcome.

As is typical of many modern mixes, efforts to achieve an aggregate structure resistant to rutting led to a compacted pavement with an open surface texture. Consistent with gauge manufacturers' recommendations, uniform fines were used to fill in large surface voids present in the coarse mat to minimize any potential impact on test data. Baghouse fines being generated at the plant were utilized for this purpose because it was a realistic, readily available material.

Calibration test counts were taken on a designated test section using all three devices, then actual core densities at the same locations were used to compute a different mix correlation for each model gauge. Subsequent corrected test counts were then compared to actual measured core densities to evaluate the corrected performance of each device in a completely objective manner.

Subsequent analyses of test data revealed that the MC-3 generated the most accurate density measurements before correlations were applied. The average uncorrected measurement error for the MC-3 gauge was -1.7 pcf, while the average errors for the 4640-B and the 3440 were -2.9 pcf and -3.0 pcf, respectively. Correlations were then calculated for each device and comparison testing was conducted using corrected gauge readings. Again, the MC-3 generated the most accurate densities. The average corrected measurement error for the MC-3 gauge was -0.2 pcf, while the average errors for the 4640-B and the 3440 were -3.1 pcf and -0.9 pcf, respectively.

In this instance, both uncorrected and corrected MC-3 measurements more accurately characterized the actual density of the compacted coarse SUPERPAVE mat when objectively compared to both a 4640-B and a 3440. In fact, uncorrected MC-3 measurements were more accurate than corrected 4640-B measurements. A research paper describing this work in detail will soon be available through the REGIS web site at "www.geotest.net".



GAUGE CALIBRATION REPORT

RES-129-99

Project Number:	11-0008-02-081-10	Contractor:	Blaine
Gauge Make:	CPN International	Technician:	Darren Russell
Gauge Model:	MC-3	Correlation:	1.7

	Basic Gauge		Actual Cores		Corrected Gauge		Gauge Summary
1	134.9 pcf		Site 1		136.9 pcf		Avg 1
2	133.1 pcf		137.6 pcf		137.9 pcf		137.6 pcf
3	135.1 pcf		94.2 %		137.8 pcf		94.2 %
4	136.5 pcf				137.6 pcf		
5	134.6 pcf		Site 2		134.4 pcf		Avg 2
6	133.3 pcf		135.8 pcf		135.4 pcf		135.1 pcf
7	133.5 pcf		93.0 %		134.1 pcf		92.5 %
8	134.1 pcf				136.3 pcf		
9	135.6 pcf		Site 3		137.2 pcf		Avg 3
10	134.5 pcf		134.0 pcf		135.4 pcf		134.4 pcf
11	134.4 pcf		91.8 %		134.1 pcf		92.1 %
12	136.1 pcf				131.0 pcf		
13	135.2 pcf		Site 4		137.5 pcf		Avg 4
14	136.0 pcf		137.6 pcf		136.4 pcf		137.4 pcf
15	135.6 pcf		94.2 %		137.4 pcf		94.1 %
16	133.6 pcf				138.3 pcf		
17	131.3 pcf		Site 5		132.8 pcf		Avg 5
18	132.1 pcf		134.4 pcf		135.0 pcf		134.2 pcf
19	131.4 pcf		92.1 %		134.7 pcf		91.9 %
20	133.5 pcf				134.1 pcf		
Avg	134.2 pcf	Avg	135.9	Avg	135.7 pcf	Error	-0.2 pcf
COV	1.1%			COV	1.4%		

Notes: Tests conducted on approximately 2 1/4 inches of leveling, consisting of a coarse SUPERPAVE crushed gravel hot-mix asphalt design. N_{dc} was 96 gyrations, producing a PG67-22 asphalt content of 6.2%. G_{mm} =2.340.



GAUGE CALIBRATION REPORT

RES-129-99

Project Number:	11-0008-02-081-10	Contractor:	Blaine
Gauge Make:	Troxler	Technician:	Durwood Foxworth
Gauge Model:	4640-B	Correlation:	2.9

	Basic Gauge		Actual Cores		Corrected Gauge		Gauge Summary
1	135.0 pcf		Site 1		134.4 pcf		Avg 1
2	133.9 pcf		137.6 pcf		137.6 pcf		135.9 pcf
3	134.9 pcf		94.2 %		134.7 pcf		93.1 %
4	133.3 pcf				136.9 pcf		
5	131.5 pcf		Site 2		133.1 pcf		Avg 2
6	132.2 pcf		135.8 pcf		129.2 pcf		132.7 pcf
7	130.2 pcf		93.0 %		135.8 pcf		90.9 %
8	132.1 pcf				132.8 pcf		
9	132.2 pcf		Site 3		128.6 pcf		Avg 3
10	135.2 pcf		134.0 pcf		131.0 pcf		129.5 pcf
11	134.3 pcf		91.8 %		126.4 pcf		88.7 %
12	133.8 pcf				132.0 pcf		
13	135.3 pcf		Site 4		135.3 pcf		Avg 4
14	135.0 pcf		137.6 pcf		137.2 pcf		134.7 pcf
15	134.6 pcf		94.2 %		133.4 pcf		92.2 %
16	134.4 pcf				132.7 pcf		
17	129.1 pcf		Site 5		131.5 pcf		Avg 5
18	131.4 pcf		134.4 pcf		130.1 pcf		131.4 pcf
19	130.1 pcf		92.1 %		132.7 pcf		90.0 %
20	131.0 pcf				131.2 pcf		
Avg	133.0 pcf		Avg 135.9 pcf		Avg 132.8 pcf		Error -3.1 pcf
COV	1.4%				COV 2.2%		

Notes: Tests conducted on approximately 2 1/4 inches of leveling, consisting of a coarse SUPERPAVE crushed gravel hot-mix asphalt design. N_{des} was 96 gyrations, producing a PG67-22 asphalt content of 6.2%. $G_{mm}=2.340$.



GAUGE CALIBRATION REPORT

RES-129-99

Project Number:	11-0008-02-081-10	Contractor:	Blaine
Gauge Make:	Troxler	Technician:	Dwayne Beech
Gauge Model:	3440	Correlation:	3.0

	Basic Gauge		Actual Cores		Corrected Gauge		Gauge Summary
1	133.5 pcf		Site 1		137.5 pcf		Avg 1
2	133.3 pcf		137.6 pcf		135.2 pcf		136.2 pcf
3	133.3 pcf		94.2 %		136.0 pcf		93.3 %
4	134.3 pcf				136.0 pcf		
5	131.0 pcf		Site 2		134.2 pcf		Avg 2
6	131.6 pcf		135.8 pcf		133.4 pcf		134.5 pcf
7	131.0 pcf		93.0 %		134.3 pcf		92.1 %
8	132.3 pcf				136.2 pcf		
9	133.6 pcf		Site 3		133.8 pcf		Avg 3
10	133.5 pcf		134.0 pcf		136.5 pcf		133.6 pcf
11	135.9 pcf		91.8 %		133.2 pcf		91.5 %
12	135.0 pcf				131.0 pcf		
13	131.8 pcf		Site 4		135.9 pcf		Avg 4
14	133.5 pcf		137.6 pcf		135.6 pcf		136.3 pcf
15	132.5 pcf		94.2 %		136.8 pcf		93.3 %
16	134.1 pcf				136.9 pcf		
17	131.4 pcf		Site 5		134.4 pcf		Avg 5
18	132.7 pcf		134.4 pcf		134.9 pcf		134.4 pcf
19	131.6 pcf		92.1 %		133.1 pcf		92.1 %
20	131.8 pcf				135.3 pcf		
Avg	132.9 pcf		Avg 135.9		Avg 135.0 pcf		Error -0.9 pcf
COV	1.0%				COV 1.2%		

Notes: Tests conducted on approximately 2 1/4 inches of leveling, consisting of a coarse SUPERPAVE crushed gravel hot-mix asphalt design. N_{des} was 96 gyrations, producing a PG67-22 asphalt content of 6.2%. $G_{mm}=2.340$.