



**ASPHALT BINDER**

**Section 11 – Correlation of Testing  
Technicians For Core Densities  
WYDOT MTM 423.0**

Section 11 - 1

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**Correlation of Testing Technicians for  
Core Density**

**The actual calculations of the correlation  
will not be on the exam but you would need  
to have an appreciation to the process. In  
addition, you would need to be able to  
answer general questions about the process.**

Section 5 - 2

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**Correlation of Testing Technicians  
for Core Densities**

- **General**
  - ▶ **Compares the hot plant mix pavement  
densities determined by WYDOT field  
laboratory and Contractor's laboratory.**
  - ▶ **The paired t-test is used**
  - ▶ **If difference is significance, then the  
dispute resolution procedure will start**

Section 11 - 3

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### Correlations of Testing Technicians for Core Densities (continued)

- Procedure
  - ▶ Obtain 14 cores
    - ◆ Cores are collected in pairs
    - ◆ Pairs are taken within 2 ft of each other
    - ◆ Each pair is split up
    - ◆ 7 cores for WYDOT and 7 cores for contractor
  - ▶ Test samples
    - ◆ WYDOT MTM 423.0
      - Report densities to the nearest 0.1 pcf

Section 11 - 4

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### Procedure (continued)

- Determine densities to the nearest 0.1 pcf
- Perform the paired t-test
- Calculate the difference between densities
- Determine the S.D. of the differences
- Eliminate up to one outlier based on 2 S.D. (use calculated S.D.)
- S Range= 0.5 to 2.0 pcf
- If  $T < 3.707$ ; No significant difference; for  $n=7$
- If  $T > 4.032$ ; Significant difference
- For  $n=6$

$$T = \frac{\frac{\bar{z}}{S}}{\sqrt{\frac{S^2}{n}}}$$

Section 11 - 5

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### Correlation of Core Densities

Project No(s): \_\_\_\_\_  
 Tester A: \_\_\_\_\_ Organization A: \_\_\_\_\_  
 Tester B: \_\_\_\_\_ Organization B: \_\_\_\_\_  
 Resident Engineer: \_\_\_\_\_ Contractor: \_\_\_\_\_  
 Testing Date: \_\_\_\_\_

Sample Pair ID	Densities, pcf		Differences, pcf	Outlier?	Differences, pcf
	A	B			
1	153.00	151.20	1.80	NO	
2	151.60	153.40	-1.80	NO	
3	148.30	150.30	-2.00	NO	
4	151.40	152.90	-1.50	NO	
5	151.60	150.90	0.70	NO	
6	149.60	150.70	-1.10	NO	
7	155.00	155.50	-0.50	NO	

Average Difference: **-0.629** pcf      Avg Diff: \_\_\_\_\_ pcf  
 Standard Deviation of Difference: **1.409** pcf      SD of Diff: \_\_\_\_\_ pcf  
 Maximum Standard Deviation: **2.00** pcf      Max. SD: \_\_\_\_\_ pcf  
 Minimum Standard Deviation: **0.50** pcf      Min. SD: \_\_\_\_\_ pcf

Avg. Diff + 2\*SD: **-0.629 + 2\*1.409 = 2.190**       $t_{0.05}$ : **3.707**       $t_{0.02}$ : \_\_\_\_\_  
 Avg. Diff. - 2\*SD: **-0.629 - 2\*1.409 = -3.447**       $t$ : **1.18**      **1.18 ≤ 3.707**       $t$ : \_\_\_\_\_

Any Diff. more (+) than + 2.190?      Pass/Fail: **Pass**      Pass / Fail: \_\_\_\_\_  
 Any Diff. more (-) than - 3.447?      Directional Bias: **No**      Directional Bias: \_\_\_\_\_

Comments:  $T = \frac{|Z|}{\sqrt{S^2/n}} = \frac{0.629}{\sqrt{1.409^2/7}} = 1.18$

Section 11 - 6

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**CORRELATION OF CORE DENSITIES**

Tester A: \_\_\_\_\_ Organization of A: \_\_\_\_\_ Project No(s): \_\_\_\_\_  
 Tester B: \_\_\_\_\_ Organization of B: \_\_\_\_\_ QC Supervisor: \_\_\_\_\_  
 Testing Date: \_\_\_\_\_ Contractor: \_\_\_\_\_ Resident Engineer: \_\_\_\_\_

Sample Pair ID	Densities, pcf A	B	Differences pcf	Outlier?	Differences (outlier Removed)
A	144.2	143.9			
B	143.8	144.3			
C	142.3	142.7			
D	143.7	143.5			
E	144.2	144.5			
F	143.9	143.8			
G	145.1	144.8			

Average Difference: \_\_\_\_\_ pcf      Avg. Diff: \_\_\_\_\_ pcf  
 Standard Deviation of Differences: \_\_\_\_\_ pcf      SD of Diff: \_\_\_\_\_ pcf  
 Maximum Standard Deviation: \_\_\_\_\_ pcf      Max. SD \_\_\_\_\_ pcf  
 Minimum Standard Deviation: \_\_\_\_\_ pcf      Min. SD \_\_\_\_\_ pcf

Avg Diff. + 2(SD) \_\_\_\_\_      t<sub>crit</sub>: \_\_\_\_\_  
 Avg Diff. - 2(SD) \_\_\_\_\_      t: \_\_\_\_\_  
 Pass / Fail: \_\_\_\_\_      Pass / Fail: \_\_\_\_\_

Section 11-7

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**Cost Analysis**

➤ Three Questions

- ▶ Mix cost per ton - \$/ton
- ▶ Mix cost per cubic yard - \$/yd<sup>3</sup>
- ▶ Mix cost per square yard - \$/yd<sup>2</sup>

Section 11 - 8

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**Cost Analysis Example**

Material	% of Total Mix	Cost(\$)/Ton	Solution to Mix Cost per Ton (\$/ton)
Aggregate #1	25	4.00	25% x 4.00 or 0.25 x 4.00 = 1.00
Aggregate #2	35	6.00	35% x 6.00 or 0.35 x 6.00 = 2.10
Aggregate #3	35	2.00	35% x 2.00 or 0.35 x 2.00 = 0.70
Asphalt	5	150.00	5% x 150 or 0.05 x 150 = 7.50

**\$11.30/ton**

Density = 156 lb/ft<sup>3</sup> Thickness 4 in.

$$\frac{\$}{yd^3} = \frac{\$11.30}{ton} \times \frac{156 lb}{ft^3} \times \frac{1 ton}{2000 lb} \times \frac{27 ft^3}{yd^3} = \$23.80/yd^3$$

$$\frac{\$}{yd^2} = \frac{\$23.80}{yd^3} \times 4 in \times \frac{1 yd}{36 in} = \$2.64/yd^2$$

Section 11 - 9

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## Homework

Work the following problems tonight:

15-4 Cost Analysis

15-5 Cost Analysis

Change all **pcf** to

*S Range 8 to 32 kg***kg/m<sup>3</sup>** *tric problem*

Section 16 - Problems from material covered earlier today including tank problem and 16-5

Section 11 - 10

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