Practice Problems

Section 15 – Practice Problems

Practice Problems

- Compaction Pay Factors
- Cost Analysis
- Cores vs. Nuclear Testing Correlation
- Density Random Number Selection
- Compaction Pay Factors-SD

Pay Factor Determination (p. 9-45)

- **Density**
  - Determine core densities
    - WYDOT MTM 415.0
    - Round to 0.01%
  - Determine % density

$$\% \text{ Density} = \frac{\text{density}}{\text{max. theor.}} = x$$

  - Determine average ($\overline{x}$)

$$\overline{x} = \frac{\Sigma x}{n}$$

Pay Factor Determination (p. 9-46)

- **Determine standard deviation (s)**

$$s = \sqrt{\left(\frac{1}{n-1}\right)\Sigma\left(x - \bar{x}\right)^2}$$

  - **Calculate the Quality Index (QI)**

$$QI = \frac{\bar{x} - 92.00}{s}$$

  - **If QI < 0.01 Reject**
  - **If QI ≥ 0.01 and $\bar{x}$ ≤ 96.00%**
  - **See Table IV**
  - **IF X> 96.00, PF = lesser of 1.00 or Table 401.5.3-2**

Pat Factor Q Table 401.5.3-2 (p. 9-47)

Quality From	Index To	Pay Factor	Quality From	Index To	Pay Factor	Quality From	Index To	Pay Factor
	≤ 0.00	Reject	0.50	0.53	0.67	1.08	1.11	0.85
0.01	0.01	0.50	0.54	0.56	0.68	1.12	1.14	0.86
0.02	0.04	0.51	0.57	0.59	0.69	1.15	1.18	0.87
0.05	0.07	0.52	0.60	0.62	0.70	1.19	1.21	0.88
0.08	0.10	0.53	0.63	0.65	0.71	1.22	1.25	0.89
0.11	0.13	0.54	0.66	0.69	0.72	1.26	1.28	0.90
0.14	0.16	0.55	0.70	0.72	0.73	1.29	1.31	0.91
0.17	0.19	0.56	0.73	0.75	0.74	1.32	1.34	0.92
0.20	0.22	0.57	0.76	0.78	0.75	1.35	1.37	0.93
0.23	0.25	0.58	0.79	0.82	0.76	1.38	1.40	0.94
0.26	0.28	0.59	0.83	0.85	0.77	1.41	1.43	0.95
0.29	0.31	0.60	0.86	0.88	0.78	1.44	1.46	0.96
0.32	0.34	0.61	0.89	0.91	0.79	1.47	1.49	0.97
0.35	0.37	0.62	0.92	0.95	0.80	1.50	1.52	0.98
0.38	0.40	0.63	0.96	0.98	0.81	1.53	1.55	0.99
0.41	0.43	0.64	0.99	1.01	0.82	1.56	3.57	1.00
0.44	0.46	0.65	1.02	1.04	0.83		≥ 3.58	1.10
0.47	0.49	0.66	1.05	1.07	0.84			

Compaction Pay Factors

1. 94.3% 95.80% 94.70% 95.00% 95.60% 95.2% 94.90%

x = 95.07
s = 0.52

5.90 ≥ 3.58 from Table 401.5.3-2 p. 9-47
PF = 1.10

2. 95.7% 92.90% 92.80% 92.00% 95.40% 93.60% 93.50%

x = 93.70
s = 1.37

1.4 falls between 1.22 & 1.25 from p. 9-47
PF = 0.89

Quality From	Index To	Pay Factor	Quality From	Index To	Pay Factor	Quality From	Index To	Pay Factor
	≤ 0.00	Reject	0.50	0.53	0.67	1.08	1.11	0.85
0.01	0.01	0.50	0.54	0.56	0.68	1.12	1.14	0.86
0.02	0.04	0.51	0.57	0.59	0.69	1.15	1.18	0.87
0.05	0.07	0.52	0.60	0.62	0.70	1.19	1.21	0.88
0.08	0.10	0.53	0.63	0.65	0.71	1.22	1.25	0.89
0.11	0.13	0.54	0.66	0.69	0.72	1.26	1.28	0.90
0.14	0.16	0.55	0.70	0.72	0.73	1.29	1.31	0.91
0.17	0.19	0.56	0.73	0.75	0.74	1.32	1.34	0.92
0.20	0.22	0.57	0.76	0.78	0.75	1.35	1.37	0.93
0.23	0.25	0.58	0.79	0.82	0.76	1.38	1.40	0.94
0.26	0.28	0.59	0.83	0.85	0.77	1.41	1.43	0.95
0.29	0.31	0.60	0.86	0.88	0.78	1.44	1.46	0.96
0.32	0.34	0.61	0.89	0.91	0.79	1.47	1.49	0.97
0.35	0.37	0.62	0.92	0.95	0.80	1.50	1.52	0.98
0.38	0.40	0.63	0.96	0.98	0.81	1.53	1.55	0.99
0.41	0.43	0.64	0.99	1.01	0.82	1.56	3.57	1.00
0.44	0.46	0.65	1.02	1.04	0.83		≥ 3.58	1.10
0.47	0.49	0.66	1.05	1.07	0.84			

% **92.30%** **90.20%**

1.20 falls between 1.1 & 1.21 from 9-47
PF = 0.88 (⚑PF <1.00)

% **91.00%** **90.90%**

) or negative number (see p. 9-46 & 9-47)

Cost Analysis

Example #1

Material	% of Total Mix	Cost/Ton
Aggregate #1	45	$7.50
Aggregate #2	33	$6.65
Aggregate #33	16	$5.50
Asphalt	6	$120

45% x $7.50 or 0.45 x 7.50 = 3.38
33% x $6.65 or 0.33 x 6.65 = 2.19
16% x $5.50 or 0.16 x 5.50 = 0.88
6% x $120 or 0.06 x 120 = 3.38
$13.65 per mix ton

Density = 155 pcf

Pavement Thickness = 4.5 inches

Compute the Following:

1. Mix Cost per Ton
2. Cost per Cubic Yard
3. Cost per Square Yard

$$\frac{\$}{yd^3} = \frac{\$13.65}{ton} \; x \frac{155\ lb}{ft^3} x \frac{1\ ton}{2000\ lb} x \frac{27\ ft3}{yd^3} = \$28.56/yd^3$$

$$\frac{\$}{yd^2} = \frac{\$28.56}{yd^3} \; x\ 4.5\ in\ x \frac{1\ yd}{36\ in} = \$3.57/yd^2$$

Cost Analysis

Example #2

Solution:

Mix Cost per Ton = $25.00

Density = 150 pcf

Pavement Thickness = 5 in

Compute the Following:

1. Cost per Cubic Yard
2. Cost per Square Yard

$$\frac{\$}{yd^3} = \frac{\$25.00}{ton} \; x \frac{150\ lb}{ft^3} x \frac{1\ ton}{2000\ lb} x \frac{27\ ft3}{yd^3} = \$50.63/yd^3$$

$$\frac{\$}{yd^2} = \frac{\$50.63}{yd^3} \; x\ 5.0\ in\ x \frac{1\ yd}{36\ in} = \$7.03/yd^2$$

Table (MTM417.0) (p. 9-33)

Grading (Nominal Max. Size)					
	1”	3/4”	1/2”	3/8”	PMWC
Sieve	Allowable Difference (% Passing)				
1 ¼”	1.5				
1”	2	1.5			
¾”	3	2	1.5		
½”	3.4	3	2	1.5	1.5
3/8”	3.4	3.4	3.4	2	2
No. 4	3.4	3.4	3.4	3.4	3.4
No. 8	3.3	3.3	3.3	3.3	3.3
No. 30	2.9	2.9	2.9	2.9	
No. 200	1.2	1.2	1.2	1.2	1.2

Verification Testing (Aggregate Gradation)

Problem #1

See Section 9-33 Table (MTM417.0)

A Contractor Obtained the Following Gradation for an Aggregate Sample:

Sieve Size	% Passing
1"	100
3/4"	95
1/2"	75
3/8"	68
#4	52
#8	41
#30	27
#200	5.2

For 3/4” size 95% – 94% = **1%** **Ok (1≤ 2)**

For 1/2” size 75% – 72% = **3%** **Ok (3≤ 3)**

For 3/8” size 68% – 65% = **3%** **Ok (3≤ 3.4)**

For #30 size 27% – 23% = **4%** **Fail (4> 2.9)**

The DOT Performed the verification testing on the Corresponding Sample and Obtained the Following Results:

Sieve Size	% Passing
1"	100
3/4"	94
1/2"	72
3/8"	65
#4	50
#8	39
#30	23
#200	4.8

If any fail, see required steps on page 9-32

Grading (Nominal Max. Size)					
	1”	3/4”	1/2”	3/8”	PMWC
Sieve	Allowable Difference (% Passing)				
1 ¼”	1.5				
1”	2	1.5			
¾”	3	2	1.5		
½”	3.4	3	2	1.5	1.5
3/8”	3.4	3.4	3.4	2	2
No. 4	3.4	3.4	3.4	3.4	3.4
No. 8	3.3	3.3	3.3	3.3	3.3
No. 30	2.9	2.9	2.9	2.9	
No. 200	1.2	1.2	1.2	1.2	1.2

Assuming that **PMP ¾”** w … est Results can be used fo …

Verification Testing (Aggregate Gradation)

Problem #2

A Contractor Obtained the Following Gradation for an Aggregate Sample:

Sieve Size	% Passing
1/2"	100
3/8"	96
#4	52
#8	39
#30	17
#200	4.2

Same as above

The DOT Performed the verification testing on the Corresponding Sample and Obtained the Following Results:

Sieve Size	% Passing
1/2"	100
3/8"	93
#4	56
#8	43
#30	21
#200	6.1

Assuming that PMP 3/8” was used, Determine if the contractor’s Test Results can be used for Calculating the Pay Factor.

Verification Testing (Aggregate Gradation)

Problem #3

A Contractor Obtained the Following Gradation for an Aggregate Sample:

Sieve Size	% Passing
3/4"	100
1/2"	96
3/8"	79
#4	61
#8	48
#30	26
#200	4.5

Same as above

The DOT Performed the verification testing on the Corresponding Sample and Obtained the Following Results

Sieve Size	% Passing
3/4"	100
1/2"	94
3/8"	78
#4	59
#8	46
#30	25
#200	4.2

Assuming that PMP ½" was used, Determine if the contractor's Test Results can be used for Calculating the Pay Factor.

Verification Testing (Density)

The Following Densities Were Obtained from Verification Testing. Determine Which Sets Confirm the Contractor's Results.

Contractor's Density	DOT's Density	Difference	Difference Acceptable	Difference Unacceptable
141.2	141.9	0.7 pcf	✖	
142.3	142.1	0.2 pcf	✖	
142.5	141.3	1.2 pcf	✖	
143.5	141.1	2.4 pcf		✖
141.3	144.5	3.2 pcf		✖
143.1	142.9	0.2 pcf	✖	
144.9	143.7	1.2 pcf	✖	
142.3	142.5	0.2 pcf	✖	

From Section 9-34 – Table 2 (TM529) --- Allowable Density

Difference (*between technicians*) 1.50 pcf

If Diff. ≤ 1.50 pcf, then Acceptable

If Diff. > 1.50 pcf, then Unacceptable