DOCUMENTATION WORKBOOK

SPECIFIC TASK TRAINING PROGRAM

Conducted by the

ILLINOIS CENTER FOR TRANSPORTATION (ICT)
AND
IDOT BUREAU OF CONSTRUCTION

FY 2020
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Workbook Page 64-65..................Supplemental Problem: Pavement Patching
Workbook Page 66-67...Supplemental Problem: HMA Surface Adj & Max Pay
DETERMINE DOCUMENTS IN EFFECT AND ORDER OF CONTROL

Answer on Page 26

Project Information: Letting Date: November 9, 2018  Construction Start Date: May 2, 2019

For the above project, rank highest to lowest the documents order of control for those in effect.

___Standard Specifications for Road and Bridge Construction
    Adopted April 1, 2016

___Plans (signed August 2, 2018)

___Supplemental Specifications and Recurring Special Provisions
    Adopted January 1, 2018

___Supplemental Specifications and Recurring Special Provisions
    Adopted January 1, 2019

___Contract Special Provisions

Circle the higher level item according to coordination of contract documents.

Scaled Dimensions VS. Calculated Dimensions

Detail Plans VS. Standard Plans

Standards with Revision Numbers listed in the Index of Sheets
    VS.
Standard Numbers listed elsewhere
MAXIMUM PAYMENT for TONS EXAMPLE

Agg Base Cse TY B

Plan Quantity = 7783 Tons

Revised Plan Quantity = 7850 Tons

7850 x 1.08 = 8478 Tons

Contractor delivered 8496.0 Tons

What is the final payment?
HMA Yield Checks **Binder Course**

width (ft) x length (ft) x (1sy/9sf) x (112lb/sy-in) x (1 ton/2000lb) x thickness (in)  
= theoretical tons

\[
\text{YIELD} = \frac{\text{DELIVERED}}{\text{THEORETICAL}} \times 100 = \% 
\]

For HMA Binder, verify unit weight via District Materials Office, Plans or Special Provisions
HMA BC Theoretical Tons

Daily Yield Check

\[
\text{Yield} = \frac{\text{Delivered}}{\text{Theoretical}} \times 100 = \frac{897.9}{880.3} = 102.0\%
\]

\[
(12 \text{ ft}) (7,860 \text{ ft}) (1 \text{ sy/9sf}) (112 \text{ lbs/sy in}) (1.5 \text{ in})
\]

\[
\frac{2,000 \text{ lbs/ton}}{880.3 \text{ tons}} = 880.3 \text{ tons}
\]
Thick\ness\ Determination Problem

How many depth checks are required for PCC sidewalk that measures 1000 ft in length by 4 ft wide?

Answer on Page 27
Traffic Control Surveillance Problem

Answer on Page 28

The contractor was required to perform traffic control surveillance from Tuesday afternoon until Thursday morning. The contractor worked from 7:00 a.m. to 4:30 p.m. each workday. The contractor performed the inspections and completed the BC 2240’s as required.

What will the total pay be for these days of Surveillance based on the Standard Specifications?
The contractor has excavated for a proposed footing as shown below:

Determine the correct volume of Structure Excavation that will be used as final payment to the contractor at this location.
Trench Backfill Diagram

(looking down from above)

Storm sewer is paid to the inside wall of the structure

Payment for T.B.F. ends 3" from the outside wall of the structure

S.S. length ≠ T.B.F. length

Structure wall

3" T.B.F. included in the cost of the structure

Workbook Page 8
Trench Backfill Example

(for pipe running parallel to the centerline of the road)

Given:
- 42” Circular Concrete Pipe
- Average Depth from subgrade to invert of the pipe = 6.8’
- Trench Length = 75’ from outside face of manhole to outside face of manhole
- Contractor’s Excavated Trench Width = 7’ 4”
- Centerline of Pipe Run is 5’ behind the back of curb

Determine:
- Allowable Pay Quantity for Trench Backfill
Trench Backfill Solution

1. Need to determine if any part of allowable trench width falls within 2 ft of the back of curb.
   Centerline of pipe is given as 5 ft or 60 in from the back of curb.
   \[60'' - 43.5'' = 16.5''\] which is the dimension from the inside of the trench to the back of the curb.

   Since \(16.5'' < 24''\), must use trench backfill.

2. Determine allowable pay length:
   Length given is 75 ft. from outside face of manhole to outside face of manhole.

   According to Article 602.12, 6” greater than the diameter of the structure will be backfilled and incidental to the installation of the structure.

   Therefore 3” on each manhole location is incidental backfill, and allowable pay length is \(75' - 3'' - 3'' = 74.5'\)
3. Check excavated width against allowable trench width.

Allowable trench width →
Since $D = 6.8'$ ( >5.0 ft.),
$\text{Width} = 18'' + \text{Wall} + \text{ID} + \text{Wall} + 18''$
$\text{Width} = 18'' + 4.5'' + 42'' + 4.5'' + 18'' = 87''$

Excavated width = 7’ 4” = 88”
Since excavated width > allowable trench width, we can use backfill tables.
$D = 6.8'$ and ID of pipe = 42”

4. From table, cu. yd./lin ft. x Allowable Pay Length = Trench Backfill
Volume $1.093 \times 74.5' = 81.4 \text{ cu yds.}$
Trench Backfill Problem
(For pipe running perpendicular to the centerline of the road)

Given:
- 24” Circular Concrete Pipe
- Average Depth from subgrade to invert = 3.8’
- Contractor’s Excavated Trench Width = 50”

Determine:
- Allowable Pay Length for the Trench Backfill
- Maximum allowable trench width
- Allowable Pay Quantity for Trench Backfill

Show your calculation on the IDR on Workbook Page 14

Answer on Page 31
Complete the IDR provided on Workbook Page 14

- Today's Date, Contract #96345
- United Construction (Prime)
- Weather is clear, 67 degrees
- Pay item number for Trench Backfill is 20800150
- Location Station 100+00
- Show calculation on the IDR since it is your primary source of Documentation
## Inspector's Daily Report

### General Information
- **Date**: 
- **Contractor or Sub.**: 
- **Weather**: 
- **Inspected by**: 
- **Measured by**: 
- **Calculated by**: 
- **Checked by**: 
- **Initial(s)**: 
- **Date**: 
- **District**: 
- **Contract No.**: 
- **Job No.**: 
- **Project**: 

### Table of Measurements

<table>
<thead>
<tr>
<th>Item Code #</th>
<th>Fund Code (Opt.)</th>
<th>Item</th>
<th>Location</th>
<th>Quantity and Units</th>
<th>Evidence of Material Inspection (Optional)</th>
<th>Posted in Q Book</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

This is: □ an estimated progress measurement (item no.: ____________________________ )

□ a final field measurement (item no.: ____________________________ )

Remarks: (e.g., instruction to Contractor, special problems, sketches with dimensions for final measurements, computations, number of persons working, hours worked) Use reverse side, if needed.

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Answer on Page 31

Workbook Page 14
You are working on a 2 lane milling and bituminous resurfacing project that is 15,000 feet long. The contractor's bid price is $87.00 per ton for the surface mix. As per plan, the contractor mills 1.5 inch of existing surface and then places a 1.5 inch lift of binder and a 1.5 inch lift of surface. Upon the completion of the work you recorded in both lanes a total of 17 surface variations. How much money will be deducted from the contract for the surface variations?
Traffic Control Price Adjustment Problem 1
Art.701.20

Answer on Page 33

Your contractor was performing contract work under Traffic Control Standard 701411. The awarded contract value of this work was $214,305.00. The final value of the completed work under this standard is $248,593.00. The unit price for this pay item is $27,500.00. What is the adjusted unit price for Traffic Control Standard 701411?

Also, what is the pay item number for the additional adjustment?
Traffic Control Price Adjustment Problem 2

Answer on Page 34

Your contractor was performing contract work under Traffic Control Standard 701411. The awarded contract value of this work was $214,305.00. The final value of the completed work under this standard is $180,017.00. The unit price for this pay item is $27,500.00. What is the unit price adjustment for Traffic Control Standard 701411?
Electrical Signal Cable Problem

Answer on Page 35-36

Given the following information, what is the pay length for the electrical signal cable?
## PRIME/TACK COAT EXAMPLE PROBLEM

**Answer on Page 37-38**

### Bill of Lading Information

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Weight</td>
<td>79,550 lbs</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>24,240 lbs</td>
</tr>
<tr>
<td>Net Weight</td>
<td>55,310 lbs</td>
</tr>
<tr>
<td>Residue</td>
<td>60.0 %</td>
</tr>
<tr>
<td>Wt. of Emulsion</td>
<td>35,200 lbs</td>
</tr>
<tr>
<td>Wt. of Added Water</td>
<td>15,080 lbs</td>
</tr>
</tbody>
</table>

### Jobsite Information

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Distributor Weight</td>
<td>33,473 lbs</td>
</tr>
<tr>
<td>Final Distributor Weight</td>
<td>15,020 lbs</td>
</tr>
<tr>
<td>Length of Paving</td>
<td>12,713 ft</td>
</tr>
<tr>
<td>Width of Paving</td>
<td>12 ft</td>
</tr>
<tr>
<td>Required Application Rate</td>
<td>0.05 lbs/sq ft</td>
</tr>
</tbody>
</table>

**Given the data above, determine the following:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Asphalt Applied</td>
<td></td>
</tr>
<tr>
<td>Actual Residual Asphalt Application Rate</td>
<td></td>
</tr>
<tr>
<td>Theoretical Residual Asphalt</td>
<td></td>
</tr>
<tr>
<td>Max Pay Residual Asphalt</td>
<td></td>
</tr>
<tr>
<td>Pay Quantity</td>
<td></td>
</tr>
</tbody>
</table>

(Next page intentionally left blank for problem workspace.)
You are the inspector on a section of two-lane road in Madison County. The contractor is performing pavement patching operations today and the pay items used for the patching are as follows:

- 44200108 Pavement Patching, Type II, 10"
- 44200112 Pavement Patching, Type III, 10"

Yesterday you laid out 3 patches in the northbound lane. The patch at Station 246+52 is 12’ wide by 8.0’ long. The patch at Station 1247+23 is 12.0’ wide by 9.0’ long. The patch at Station 1247+79 is 12’ wide by 11.0’ long.

After the patching operations for these 3 patches are complete, you measure the patches. The in-place dimensions are as follows:

<table>
<thead>
<tr>
<th>Station</th>
<th>Width</th>
<th>Length</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1246+52</td>
<td>12.0’</td>
<td>8.0’</td>
<td>10”</td>
</tr>
<tr>
<td>1247+23</td>
<td>12.0’</td>
<td>10.0’</td>
<td>10.2”</td>
</tr>
<tr>
<td>1247+79</td>
<td>12.0’</td>
<td>11.0’</td>
<td>12”</td>
</tr>
</tbody>
</table>

You have received the required material inspection documentation.

Complete the field book entries on the next page and total the page for these items.
## PAVEMENT PATCHING 10

<table>
<thead>
<tr>
<th>Patch #</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
<th>CALCULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1246+52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1247+23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1247+79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Depth

- **Depth**
  - SB LANE
    - **A = 10.2"**
    - Evidence of Mat'l Insp: Plant Report, Tickets & Test
  - NB LANE
    - **A = 10"**

### Meas. By:

**Answer on Page 39**

---

**Workbook Page 21**
# HMA SC Example (as specified by Engineer)

1. Calculate new theoretical tonnage

<table>
<thead>
<tr>
<th>Plan Quantity = 229 Tons</th>
<th>Measured in field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan Length = 1,022 FT</td>
<td>Length = 1,027.5 FT</td>
</tr>
<tr>
<td>Plan Width = 24 FT</td>
<td>Width = 24 FT</td>
</tr>
<tr>
<td>Plan Thickness = 1.5 inches</td>
<td>Thick = 1.5 inches</td>
</tr>
</tbody>
</table>

\[
\frac{112 \text{ lbs/sy-in} \times 1027.5 \text{ ft} \times 24 \text{ ft} \times 1.5 \text{ in}}{9 \text{ sf/sy (2000 lbs/ton)}} = 230.2 \text{ tons}
\]
2. Calculate the adjustment (Article 406.13)

\[ G_{mb} = 2.37 \quad U = 112 \text{lbs/sy-in} \quad \text{Constant} = 46.8 \]

\[ C = \frac{2.37 \times 46.8}{112} = 0.990 \]

Adjusted Qty: \( 0.990 \times 230.2 = 227.9 \text{ tons} \)

3. Calculate the max pay (Article 406.13)

\[ \text{Max Pay: } 227.9 \times 1.03 = 234.7 \text{ tons} \]
Given:

\( G_{mb} = 2.360 \)
Length = 10,110.0 ft
Width = 24.0 ft
Thickness = 1.5 inch
Delivered = 2310 tons

Is the contractor exceeding the maximum payment quantity?
Drilled Shaft Problem

Answer on Page 42

Calculate the volumes of concrete in the drilled shaft per Art 516

Workbook Page 25
ANSWER TO DOCUMENTS IN EFFECT AND ORDER OF CONTROL, Page 1

Project Information: Letting Date: **November 9, 2018** Construction Start Date: **May 2, 2019**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Document Description</th>
<th>Date Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Standard Specifications for Road and Bridge Construction</td>
<td>April 1, 2016</td>
</tr>
<tr>
<td>2</td>
<td>Plans (signed August 2, 2018)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Supplemental Specifications and Recurring Special Provisions</td>
<td>January 1, 2018</td>
</tr>
<tr>
<td>3</td>
<td>Recurring Special Provisions</td>
<td>January 1, 2019</td>
</tr>
<tr>
<td>1</td>
<td>Contract Special Provisions</td>
<td></td>
</tr>
</tbody>
</table>

For the above project, rank highest to lowest the documents in effect and order of control.

Circle the higher level item according to coordination of contract documents.

- Scaled Dimensions VS. Calculated Dimensions
- Detail Plans VS. Standard Plans
- Standards with Revision Numbers listed in the Index of Sheets VS. Standard Numbers listed elsewhere
Thickness Determination Problem

Answer to Workbook Page 5

How many depth checks are required for PCC sidewalk that measures 1000 ft in length by 4 ft wide?

Refer to Documentation Guide Section "Thickness Determination Schedule" Pages A-16 to A-19

Page A-18 lists PCC Sidewalk Minimum Frequency as 1 per 1,000 sf

Square Feet = 4 ft x 1000 ft = 4,000 sf ~ minimum of 4 checks via before/after elevations by survey or measurements from reference elevation such as stringline, form line or edge of pavement.
Answer to Workbook Page 6

Tues 4:30 p.m. to Wed 7:00 a.m. = 14.5 hours

Wed 4:30 p.m. to Thurs 7:00 a.m. = 14.5 hours

14.5 hours + 14.5 hours = 29 hours

29 hours / 24 hours per day =

1.21 Calendar Days for Traffic Control Surveillance
According to Article 502.12, horizontal dimensions will not extend beyond vertical planes 2’ outside of the edges of footings. Also, if the contractor did not excavate to the 2’ limit, you cannot pay the contractor for work they did not do. Therefore, the pay dimensions are as follows:

Length = 1.0’ + 32.0’ + 2.0’ = 35.0’
Width = 2.0’ + 10.0’ + 2.0’ = 14.0’
Depth = 5.0’ (given)

Volume = (35.0 x 14.0 x 5.0) x 1/27 = 90.7 cubic yards
Trench Backfill Problem Answer – Workbook Page 12

(For pipe running perpendicular to the centerline of the road)

Allowable Pay Length = 2' + 4' + 2' + 2' + 53' + 2' = 65'

Maximum allowable trench width = 9” + OD + 9” = 9” +3” + 24” + 3” + 9” = 48”

Actual trench width exceeds maximum, therefore use Trench Backfill tables.

From Table: 0.323 cy/ft

Trench Backfill = 65’ x 0.323 = 21.0 cubic yards
Allowable Pay Length = 2' + 4' + 2' + 2' + 53' + 2' = 65'

Maximum allowable trench width = 9” + OD + 9” = 9” +3” + 24” + 3” + 9” = 48”

Actual trench width exceeds maximum, therefore use Trench Backfill tables.

From Table: 0.323 cy/ft

Trench Backfill = 65’ x 0.323 = 21.0 cubic yards
Surface Variation Problem
Answer Workbook page 15

Solution: (Per Article 406.11)

1) Since the existing surface was milled, it is considered ‘reprofiled’

2) Per the chart, the cost of 2 tons of mix shall be deducted for each variation

3) Calculation:

\[
($87.00 \text{ per ton} \times 2 \text{ tons per surface variation}) \times 17 \text{ surface variations} = $2,958.00
\]
Traffic Control Price Adjustment Problem 1

See calculation file for Original and Final contract amounts of items under 701411

Original Value: $214,305.00
Final Value: $248,593.00
Unit Price: $27,500.00

\[ X = \frac{(248,593 - 214,305)}{(214,305)} = 0.160 \text{ Increase > 0.10} \]

Adjusted Unit Price = $0.25P + 0.75P \left( 1 + (X - 0.1) \right)

\[ = 0.25 \times (27,500) + 0.75 \times (27,500) \times \left( 1 + (0.16 - 0.1) \right) \]
\[ = 0.25 \times (27,500) + 0.75 \times (27,500) \times (1.06) \]
\[ = 6,875.00 + 21,862.50 = $28,737.50 \]

Unit price difference: $28,737.50 - $27,500 = $1,237.50

Add new pay item # XXX03100 for $1,237.50
See calculation file for Original and Final contract amounts of items under 701411

Original Value: $214,305.00
Final Value: $180,017.00
Unit Price: $27,500.00

\[ X = \frac{(180,017 - 214,305)}{214,305} = -0.160 \text{ Decrease } > 0.10 \]

Adjusted Unit Price: \(0.25P + 0.75P \left(1 + \left(X - 0.1\right)\right)\)

\[ = 0.25 \times 27,500 + 0.75 \times 27,500 \times (1-0.16-0.10) \]
\[ = 0.25 \times 27,500 + 0.75 \times 27,500 \times 0.94 \]
\[ = 6,875.00 + 19,387.50 = 26,262.50 \]

Unit price difference: $26,262.50 - $27,500 = -$1,237.50

Add new pay item # XXX03100 for - $1,237.50
**Electrical Signal Cable Problem**

**Answer Workbook Page 18**

Pay Length = 3.0' + 5.0' + 13.0' + 45.0' + 6.5' + 60.3' + 6.5' + 13.1' + 3.0' + 13.0' = 168.4'
## Electrical Signal Cable Problem

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Horizontal Measure</th>
<th>Slack Pg. 716</th>
<th>Vertical Pg. 717</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>DH-1</td>
<td>5.0’</td>
<td>13.0’</td>
<td>3.0’</td>
</tr>
<tr>
<td>DH-1</td>
<td>H-1</td>
<td>45.0’</td>
<td>6.5’</td>
<td>X</td>
</tr>
<tr>
<td>H-1</td>
<td>H-2</td>
<td>60.3’</td>
<td>6.5’</td>
<td>X</td>
</tr>
<tr>
<td>H-2</td>
<td>P-1</td>
<td>13.1’</td>
<td>X</td>
<td>3.0’</td>
</tr>
<tr>
<td>P-1</td>
<td>Signal</td>
<td>X</td>
<td>X</td>
<td>13.0’</td>
</tr>
</tbody>
</table>

**Pay Total = 123.4’ + 26.0’ + 19.0’ = **168.4’
### Bill of Lading Information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Weight</td>
<td>79,550 lbs</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>24,240 lbs</td>
</tr>
<tr>
<td>Net Weight</td>
<td>55,310 lbs</td>
</tr>
<tr>
<td>Residue</td>
<td>60.0 % A</td>
</tr>
<tr>
<td>Wt. of Emulsion</td>
<td>35,200 lbs E</td>
</tr>
<tr>
<td>Wt. of Added Water</td>
<td>15,080 lbs D</td>
</tr>
</tbody>
</table>

### Jobsite Information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Distributor Weight</td>
<td>33,473 lbs B</td>
</tr>
<tr>
<td>Final Distributor Weight</td>
<td>15,020 lbs C</td>
</tr>
<tr>
<td>Length of Paving</td>
<td>12,713 ft</td>
</tr>
<tr>
<td>Width of Paving</td>
<td>12 ft</td>
</tr>
<tr>
<td>Required Application Rate</td>
<td>0.05 lbs/sq ft</td>
</tr>
</tbody>
</table>

### Given the data above, determine the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Asphalt Applied</td>
<td>7750 lbs</td>
</tr>
<tr>
<td>Actual Residual Asphalt Application Rate</td>
<td>0.0508 lbs/sq ft</td>
</tr>
<tr>
<td>Theoretical Residual Asphalt</td>
<td>7628 lbs</td>
</tr>
<tr>
<td>Max Pay Residual Asphalt</td>
<td>8009 lbs</td>
</tr>
<tr>
<td>Pay Quantity</td>
<td>7750 lbs</td>
</tr>
</tbody>
</table>
New % Residual Asphalt =

\[
\frac{(35,200) \times (0.600)}{E \text{ (Wt. Emulsion)} + A \text{ (% Residue)} + D \text{ (Wt. Added Water)}} = 0.420
\]

Pounds of Residual Asphalt Applied =

\[
B - C \times (\text{New % Residual Asphalt} \times (\text{Initial Wt.} - \text{Final Wt.)})
\]

\[
0.420 \times (33,473 - 15,020) = 7750 \text{ lbs}
\]

1. Application Area = (Length) \times (Width) = 12,713 ft \times 12 ft = 152,556 sq ft
2. Actual Application Rate = (Wt. Residual Asphalt) / (Area) = 7750 lbs / 152,556 sq ft = 0.0508 lbs/sq ft
3. Theo. Wt. Residual Asphalt = (Area) \times (Application Rate) = 152,556 sq ft \times 0.05 \text{ lbs/sq ft} = 7628 lbs
4. Max Pay = (Theoretical) \times 105\% = 7628 lbs \times 1.05 = 8009 lbs
5. Pay Quantity = 7750 lbs
## Answer to Workbook Page 20-21

### PAVEMENT PATCHING 10

<table>
<thead>
<tr>
<th>Patch #</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
<th>CALCULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>10.7</td>
<td></td>
<td>(8.0' x 12.0') / 9 = 10.7 S.Y.</td>
</tr>
<tr>
<td>12</td>
<td>12.0</td>
<td></td>
<td>9.0' x 12.0' x 1 / 9 = 12.0 S.Y. No adjustment</td>
</tr>
<tr>
<td>13</td>
<td>16.9</td>
<td></td>
<td>11.0' x 12.0' x 1 / 9 = 14.7 S.Y. Patch Depth Increase (12&quot; - 10&quot;) / 10&quot; = 20%</td>
</tr>
</tbody>
</table>

15% Increase of S.Y. 
- Increase Qty by 15% 
- Pay = 14.7 x 1.15 = 16.9 S.Y.

<table>
<thead>
<tr>
<th>PAGE TOTALS</th>
<th>39.6</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.Y.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Calculations

- **Payment Calculation**: 14.7 x 1.15 = 16.9 S.Y.

### Diagram

- **SB LANE**: Depicted with dimensions 8.0' x 10.0' (with A = 10"")
- **NB LANE**: Depicted with dimensions 8.0' x 10.0' (with A = 10"")

**Evidence of Mat'l Insp**: Plant Report, Tickets & Test

**Meas. By**: Date: 
**Calc. By**: 
**Chkd. By**: 

**Workbook Page 39**
**Example of DECREASE in Quantity**

### PAVEMENT PATCHING 10

<table>
<thead>
<tr>
<th>Patch #</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
<th>CALCULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>10.7</td>
<td></td>
<td>(8.0' x 12.0') / 9 = 10.7 S.Y.</td>
</tr>
<tr>
<td>12</td>
<td>12.0</td>
<td></td>
<td>9.0' x 12.0' x 1/9 = 12.0 S.Y.</td>
</tr>
<tr>
<td>13</td>
<td>13.2</td>
<td></td>
<td>11.0' x 12.0' x 1/9 = 14.7 S.Y.</td>
</tr>
</tbody>
</table>

- **Depth**
  - SB LANE
  - NB LANE

- **Meas.** 10.0' wide both sides

- **Evidence of Mat'l Insp:** Plant Report, Tickets & Test

- **Meas. By:** Date:
- **Calc. By:**
- **Chkd. By:**

**Pay =** 14.7 x (1 - 0.10) = 13.2 S.Y.

**Depth Decrease**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Meas. 10.0' wide both sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>A</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
</tr>
</tbody>
</table>

**F.B. #3, P 22**

**Workbook Page 40**
Answer to Workbook Page 24 - HMA Surface Max Pay

\[
\text{Adjusted Qty: } 0.986 \times 2264.6 = \boxed{2232.9 \text{ tons}}
\]

\[\frac{112 \text{ lbs/sy-in} \times 10,110 \text{ ft} \times 24 \text{ ft} \times 1.5 \text{ in}}{9 \text{ sf/sy (2000 lbs/ton)}} = \boxed{2264.6 \text{ tons}} \]

\[C = \frac{2.360 \times 46.8}{112} = 0.986\]

\[2232.9 \text{ theoretical tons for the surface area} \]

\[1.03 \times 2232.9 \text{ tons} = \boxed{2299.9 \text{ tons}} \]

Contractor is exceeding the maximum amounts
Drilled Shaft Problem

**Drilled Shaft in soil**

Height of shaft = ELEV A – ELEV B

= 422.5 – 394.40 = 28.1 ft

Diameter of shaft = 7.5 ft

Volume of Shaft in soil = Volume of cylinder

= (π x r^2) x Height of cylinder

= (π x [7.5 ft / 2]^2) x 28.1 ft

= (3.1416 x [3.75 ft]^2) x 28.1 ft = 1241.4 cu ft

1241.4 cu ft / 27 cu ft/Cu Yd = 46.0 Cu Yd

**Drilled Shaft in rock**

Height of shaft = ELEV B – ELEV C

= 394.40 – 362.40 = 32.00 ft

Diameter of shaft = 7.0 ft

Volume of Shaft in rock = Volume of cylinder

= (π x r^2) x Height of cylinder

= (π x [7.0 ft / 2]^2) x 32.00 ft

= (3.1416 x [3.5 ft]^2) x 32.0 ft = 1231.5 cu ft

1231.5 cu ft / 27 cu ft/Cu Yd = 45.6 Cu Yd
Supplemental Information and Practice Problems
BEHIND THE SPECS

**Hot Mix Asphalt Surface Course Adjustment:** The typical unit weight of Hot Mix Asphalt binder mix and surface mix (prior to bulk gravity correction) is 112 pounds per square yard per 1-in of thickness (112 lb/sq yd/in). This unit weight is representative of typical limestone and dolomite aggregate HMA mixes which are most commonly found in Illinois. As a result, most plans show 112 lb/sq yd/in for the unit weight of the HMA. The plans should always be checked to see if this or another value was used to determine plan quantity.

*One Square Yard of HMA One Inch Thick Weighs 112 Pounds for Limestone and Dolomite Mixes*

Article 406.13 provides for the adjustment of plan quantities based upon the properties of the actual HMA surface mix used on the job.

\[
\text{Adjusted Plan Quantity} = C \times \text{quantity shown on the plans or as specified by the Engineer}
\]

Where

\[
C = \text{English: } C = \frac{G_{mb} \times 46.8}{U}
\]

And Where:

- \( G_{mb} \) = average bulk specific gravity from the approved mix design
- \( U \) = unit weight of surface course shown on the plans in lb/sq yd/in.
- 46.8 = English constant*

The goal of Article 406.13 is to add or remove quantities from the project so the resulting cross section will be the thickness shown on the plans. For example, the plan quantity was determined by use of the typical unit weight of 112 lb/sq yd/in to provide a surface course thickness of 2.0 inches. If the mix being supplied uses an air cooled blast furnace slag (lighter than limestone) the resulting mix will be much lighter than the plan quantity and result in a surface thickness greater than 2.0-inches. Some material must be removed or the pavement will be higher than desired. Likewise if a steel slag aggregate (heavier than limestone) is being used in the HMA, the mix will be heavier than plan quantity and result in a thinner pavement surface, so material must be added.

*This constant is derived from the weight of water in one sq yd that is one inch in depth.

The standard weight for one cubic foot of water is 62.4 lbs. A square yard one inch in depth contains 9/12 of a cubic foot or 0.75 cf. The constant is determined as follows:

\[
\frac{0.75 \text{ cf}}{\text{sq yd/in}} \times 62.4 \text{ lbs/cf} = \frac{46.8 \text{ lbs}}{\text{sq yd/in}}
\]

The Factor “C” is unitless and results in the tons needed for surface thickness shown on the plans.
**BEHIND THE SPECS**

**Determination of Gallons:** With the adoption of the 2016 Standard Specifications most gallon pay items were eliminated. However, there may be some active projects under older specifications that would require pay in gallons. Also, most distributors of liquids utilize metering systems that utilize application rates in gallons per square yard. To provide a check on the application rates, the plan quantities and rates may require conversion to gallons or gallons per square yard as checks.

**For Water:**

\[
\text{Gallons} = \frac{\text{weight (lb)}}{8.328 \text{ lb/Gal}}
\]

**For other liquids the specific gravity of the material must be included**

\[
\text{Gallons} = \frac{\text{weight (lb)}}{\text{Specific Gravity } \times 8.328 \text{ lb/Gal}}
\]

\[
\text{Gallons} = \left( \text{Application Rate} \frac{\text{gal}}{\text{area}} \right) \times \text{Area}
\]

\[
TON = \text{Sp Gr} \times 8.328 \frac{\text{lb}}{\text{gal}} \times \text{Gallons} \times \frac{\text{ton}}{2000 \text{ lb}}
\]
Supplemental Problem 1 - Tack Coat Application

The plans call for a tack coat to be applied at a rate of 0.05 lb/sq ft residual asphalt of an SS-1hP emulsion on a milled HMA surface. A review of the plans determined the area to receive the tack coat is 359,472 sq ft., which at a rate of 0.05 lb per sq ft confirms the plan quantity of 17,974 lb residual asphalt.

The contractor requested water to be added by the producer (Urban Asphalt) who provided the resulting material as noted on the bill of lading. The contractor used a small distributor truck to spread the material. The distributor arrived at the job site empty and was filled several times to complete the tack coat work. Once completed, the remaining material was off loaded back into the transport truck. A final weight of 36,960 lb was determined at a local scale for the transport truck.

As an application rate check, a 1 ft x 1 ft piece of cardboard with heavy washers taped to the underside was used to sample the tack coat rate. The weight of the cardboard plus washers was 499 grams. After the distributor covered the cardboard it was dried and found to weigh 522 grams.

Determine the following:

What is the max pay quantity?

What is the pay quantity?

For the material provided, what is the application rate the distributor driver should be applying in gallon/sq yd?

What was the residual application rate indicated by the sample?

What was the average application rate for the job?
Supplemental Problem 1 - Tack Coat Application Answer

What is the max pay quantity?

105% - Per Art. 406.13(b) Ref to Art 1032 or Page A-15 of the Documentation of Contract Quantities Guide.
Plan quantity confirmed to be 17,974 lb = (0.05 lb/sq ft x 359,472 sq ft)

\[ \text{Max Pay} = 1.05 \times 17,974 \text{ lb} = 18,873 \text{ lb} \]

What is the pay quantity?

**Method 1**

1a. \( Wt. \text{ Applied} = (Gross \text{ Wt.}) - (Final \text{ Wt.}) = 78,680 \text{ lb} - 36,960 \text{ lb} = 41,720 \text{ lb} \)

1b. \( \% \text{ Emulsion} = \frac{Wt. \text{ Emulsion}}{Total \text{ Wt.}} = \frac{34,322 \text{ lb}}{45,000 \text{ lb}} = 0.7627 \)

1c. \( Wt. \text{ Emulsion Applied} = (Wt. \text{ Applied}) \times (\% \text{ Emulsion}) = 41,720 \text{ lb} \times 0.7627 = 31,820 \text{ lb} \)

1d. \( Wt. \text{ Residual Asphalt} = (Wt. \text{ Emulsion Applied}) \times (\% \text{ Residue}) = 31,820 \text{ lb} \times 0.590 = 18,774 \text{ lb} \)

**Method 2**

2a. \( Residual \text{ Percent of Blend} = \frac{(Wt. \text{ Emulsion}) \times (\text{Residual Asphalt \%})}{\text{Net \ Weight}} \)

\[ Residual \text{ Percent of Blend} = \frac{34,322 \text{ lb} \times 0.590}{45,000 \text{ lb}} = 0.450 \]

2b. \( Wt. \text{ Residual Asphalt} = (Wt. \text{ Applied}) \times (\text{Residual Percent of Blend}) = 41,720 \text{ lb} \times 0.450 = 18,774 \text{ lb} \)

2c. \( \text{Pay quantity} = 18,774 \text{ lb} - \text{Less than 18,873 lb max pay} \)
For the material provided, what would be the application rate the distributor driver should be applying in gallon/sq yd?

3. **Determine Specific Gravity of blended material.**

4. **Blended Specific Gravity (SG) =**

\[
\text{Blended Specific Gravity (SG)} = \frac{(\text{Wt. Emulsion} \times \text{SG Emulsion}) + (\text{Wt. Water} \times \text{SG Water})}{\text{Net Weight}}
\]

\[
= \frac{(34,322 \text{ lb} \times 1.01) + (10,678 \text{ lb} \times 1.00)}{45,000 \text{ lb}} = 1.008
\]

*Note: SG of water is 1.00*

5. **Residual Asphalt per Gallon of Blended Material =**

\[
8.328 \text{ lb/gal} \times (\text{Combined SG}) \times (\text{Residual Percent of Blended Material} \text{ from Step 2a}) =
\]

Residual Asphalt per Gallon of Blended Material = 8.328 lb/gal x 1.008 x 0.45 = 3.78 lb/gal

6. **Application Rate of Blended Material in Gallons per sq yd =**

\[
= \left( \frac{\text{Residual Rate}}{\text{Residual Asphalt per Gallon of Blended Material}} \right) \times 9 \text{ sq ft} = \left( \frac{0.05 \text{ lb}}{3.78 \text{ gal}} \right) \times 9 \text{ sq ft} = 0.12 \text{ gal/sq yd}
\]

The distributor should apply the blended material at 0.12 gal/sq yd

What was the residual application rate indicated by the sample?

7. **Wt. Residual Asphalt on Sample =**

\[
(\text{Wt. Residual Asphalt, Cardboard and Washers}) - (\text{Wt. Cardboard and Washers}) =
\]

522 g – 499 g = 23 g

Converting to pounds \[
\frac{23 \text{ g}}{453.59 \text{ lb}} = 0.0507 \text{ lb}
\]

8. **Application Rate =**

\[
\frac{\text{Wt. Residual Asphalt on Sample}}{\text{Sample Size}} =
\]

Residual Asphalt Rate Applied = \[
\frac{0.0507 \text{ lb}}{1 \text{ sq ft}} = 0.051 \text{ lb/sq ft}
\]

What was the average application rate for the job?

9. **Average Rate Applied =**

\[
\frac{18,774 \text{ lb}}{359,472 \text{ sq ft}} = 0.052 \text{ lb/sq ft}
\]
Supplemental Problem 2 – Traffic Control Surveillance

The contractor was required to perform traffic control surveillance from the end of the workday on Thursday to start of work the next day. The contractor has established work hours from 7:00 am to 5:00 pm each workday. The contractor performed the inspections providing the completed BC 2240’s as shown.

This was the only period of surveillance for the week. What will the total pay be for the surveillance for these two days based on the Standard Specifications?
Supplemental Problem 2 – Traffic Control Surveillance Answer

Refer to Traffic Control Surveillance Art. 701.20 (g). Time needs to be converted from hours to calendar days.

Thursday 9/13 from 5:00 pm to midnight = 7 hrs.
Friday 9/14 from midnight to 7:00 am = 7 hrs.
Total = 14 hrs.

Converting to calendar day = 14 hrs/24 hrs/day

= 0.58 calendar day.
Supplemental Problem 3 – Surface Treatment

**Bituminous Surface Treatments (Section 403):** Given a project that is 5.2 mi long with a width of 24 ft is to receive an A-1 Seal Coat. The Bituminous Material specified is CRS-2 with a CA-16 Seal Coat Aggregate. Application rates are specified as 0.34 gal/sq yd for CRS-2 and 19 lb/sq yd for CA-16. The plans call for 106 Tons of CRS-2 and 695 Tons of CA-16. The bill of lading for the CRS-2 provided indicated that the gravity (specific gravity) of the CRS-2 is 1.02.

As a check, determine the tons of CRS-2 and CA-16 along with max pay needed to complete the work.
Supplemental Problem 3 – Surface Treatment Answer

1. Determine area of application:

   \[
   Area = \text{Length} \times \text{Width}
   \]

   \[
   Area \ (\text{sq yd}) = \frac{5.2 \text{ mi} \times 5,280 \frac{\text{ft}}{\text{mi}} \times 24 \text{ ft}}{9 \frac{\text{sq ft}}{\text{sq yd}}}
   \]

   \[
   Area = 73,216 \text{ sq yd}
   \]

2. Determine gallons of CRS-2 to be applied:

   \[
   \text{Gallons} = \text{Rate} \left(\frac{\text{gal}}{\text{sq yd}}\right) \times \text{Area} \ (\text{sq yd})
   \]

   \[
   \text{Gallons} = 0.34 \frac{\text{gal}}{\text{sq yd}} \times 73,216 \text{ sq yd} = \text{24,893 gallons}
   \]

3. Convert gallons to tons:

   \[
   \text{TON} = \text{Sp Gr} \times 8.328 \frac{\text{lb}}{\text{gal}} \times \text{Gallons} \times \frac{\text{ton}}{2000 \text{ lb}}
   \]

   \[
   \text{TON} = 1.02 \times 8.328 \frac{\text{lb}}{\text{gal}} \times 24,893 \text{ gal} \times \frac{\text{ton}}{2000 \text{ lb}} = \text{105.73 ton}
   \]

   Max Pay of 105%: 1.05 x 105.88 ton = \text{111.02 ton}

4. Determine tons of CA 16:

   \[
   \text{Tons} = \text{Area} \times \text{Rate}
   \]

   \[
   \text{Tons} = 19 \frac{\text{lb}}{\text{sq yd}} \times \frac{\text{ton}}{2000 \text{ lb}} \times 73,216 \text{ sq yd} = \text{695.5 ton}
   \]

   Max pay of 110%: 1.10 x 695.5 ton = \text{765.2 ton}
Supplemental Problem 4 – Structure Excavation

Field measurements for the excavation the contractor dug for a proposed footing are shown below:

Determine the volume of the Structure Excavation pay item that will be used as final payment to the contractor for this part of the work. (Not to scale)
Supplemental Problem 4 – Structure Excavation Answer

Per Article 502.12 (b): “Horizontal dimensions will not extend beyond vertical planes 2 ft outside of the edges of footings...”

Pay Dimensions =
North: 2.0’ + 8.0’ + 2.0’ = 12.0 ft  
East: 1.0’ + 34.0’ + 2.0’ = 37.0 ft

Note: East end area is in shape of trapezoid. In this case the volume is determined by calculating the end area of the East side (trapezoid) multiplied by the length of the excavation (North side).

Volume:

\[
Volume = \frac{h_1 + h_2}{2} \times width \times length
\]

Where:

h1 = 5.0’, h2 = 2.0’, width = 37.0’ (East pay dimension), and length = 12.0’ (North pay dimension)

\[
Volume = \frac{5 \text{ ft} + 2 \text{ ft}}{2} \times 37 \text{ ft} \times 12.0 \text{ ft}
\]

\[
Volume = 3.5 \text{ ft} \times 37 \text{ ft} \times 12 \text{ ft}
\]

\[
Volume = 1,554.0 \text{ cu ft}
\]

Pay item is in cubic yards, so must convert by dividing by 27 cu ft/ cu yd

\[
Volume = \frac{1,554.0 \text{ cu ft}}{27 \text{ cu ft/cu yd}}
\]

\[
Volume = 57.6 \text{ cu yd}
\]
Supplemental Problem 5 – Maximum Payment

For each Pay Item determine the maximum percent pay, the Standard Specification Reference Article and Documentation Guide Reference source (if available).

Seeding Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NITROGEN FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>PHOSPHORUS FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td></td>
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</tr>
<tr>
<td>POTASSIUM FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Aggregate Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGGREGATE SHOULDERS (TYPE A or B)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGGREGATE WEDGE SHOULDERS (TYPE B)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGGREGATE SURFACE COURSE (TYPE A or B)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGGREGATE BASE COURSE (TYPE A or B)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGGREGATE BASE COURSE REPAIR</td>
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<td>COVER COAT AGGREGATE</td>
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<tr>
<td>SEAL COAT AGGREGATE</td>
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<tr>
<td>GANULAR EMBANKMENT SPECIAL</td>
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<tr>
<td>POROUS GRANULAR EMBANKMENT</td>
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<tr>
<td>SUBBASE GRANULAR MATERIAL (TYPE A, B or C)</td>
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<tr>
<td>AGRICULTURAL GROUND LIMESTONE</td>
<td>TON (M TON)</td>
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</table>
## Supplemental Problem 5 – Maximum Payment (Cont.)

### Bituminous Materials Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BITUMINOUS MATERIALS (PRIME COAT)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BITUMINOUS MATERIALS (COVER AND SEAL COAT)</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BITUMINOUS MATERIALS (PRIME COAT)</td>
<td>POUND* (KILOGRAM) *Residual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BITUMINOUS MATERIALS (TACK COAT)</td>
<td>POUND* (KILOGRAM) *Residual</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hot Mix Asphalt Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIX FOR CRACKS, JOINTS AND FLANGWAYS</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INCIDENTAL HMA SURFACING</td>
<td>TON (M TON)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL BINDER (MACHINE AND HAND)</td>
<td>TON (M TON)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HMA BINDER COURSE</td>
<td>TON (M TON)</td>
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</tr>
<tr>
<td>HMA SURFACE COURSE</td>
<td>TON (M TON)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Supplemental Problem 5 – Maximum Payment Answer

#### Seeding Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NITROGEN FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td>103%</td>
<td>Art. 250.09</td>
<td>A-15</td>
</tr>
<tr>
<td>PHOSPHORUS FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td>103%</td>
<td>Art. 250.09</td>
<td>A-15</td>
</tr>
<tr>
<td>POTASSIUM FERTILIZER NUTRIENT</td>
<td>POUND (KILOGRAM)</td>
<td>103%</td>
<td>Art. 250.09</td>
<td>A-15</td>
</tr>
</tbody>
</table>

#### Aggregate Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGGREGATE SHOULDERS (TYPE A or B)</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art. 481.09</td>
<td>A-15</td>
</tr>
<tr>
<td>AGGREGATE WEDGE SHOULDERS (TYPE B)</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art. 481.09</td>
<td>None</td>
</tr>
<tr>
<td>AGGREGATE SURFACE COURSE (TYPE A or B)</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art. 402.12</td>
<td>A-15</td>
</tr>
<tr>
<td>AGGREGATE BASE COURSE (TYPE A or B)</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art. 351.11</td>
<td>A-15</td>
</tr>
<tr>
<td>AGGREGATE BASE COURSE REPAIR</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art 358.06</td>
<td>A-15</td>
</tr>
<tr>
<td>COVER COAT AGGREGATE</td>
<td>TON (M TON)</td>
<td>110%</td>
<td>Art. 403.15</td>
<td>A-15</td>
</tr>
<tr>
<td>SEAL COAT AGGREGATE</td>
<td>TON (M TON)</td>
<td>110%</td>
<td>Art. 403.15</td>
<td>A-15</td>
</tr>
<tr>
<td>GANULAR EMBANKMENT SPECIAL</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art 206.07</td>
<td>A-15</td>
</tr>
<tr>
<td>POROUS GRANULAR EMBANKMENT</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art 207.04</td>
<td>A-15</td>
</tr>
<tr>
<td>SUBBASE GRANULAR MATERIAL (TYPE A, B or C)</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>311.08</td>
<td>A-15</td>
</tr>
<tr>
<td>AGRICULTURAL GROUND LIMESTONE</td>
<td>TON (M TON)</td>
<td>108%</td>
<td>Art. 250.09</td>
<td>A-15</td>
</tr>
</tbody>
</table>
## Supplemental Problem 5 – Maximum Payment Answer (Cont.)

### Bituminous Materials Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BITUMINOUS MATERIALS (PRIME COAT)</td>
<td>TON (M TON)</td>
<td>105%</td>
<td>Art. 403.15</td>
<td>A-15</td>
</tr>
<tr>
<td>BITUMINOUS MATERIALS (COVER AND SEAL COAT)</td>
<td>TON (M TON)</td>
<td>105%</td>
<td>Art. 403.15</td>
<td>A-15</td>
</tr>
<tr>
<td>BITUMINOUS MATERIALS (PRIME COAT) *Residual</td>
<td>POUND* (KILOGRAM)</td>
<td>105%</td>
<td>Art. 406.13(b)</td>
<td>Ref to Art 1032</td>
</tr>
<tr>
<td>BITUMINOUS MATERIALS (TACK COAT) *Residual</td>
<td>POUND* (KILOGRAM)</td>
<td>105%</td>
<td>Art. 406.13(b)</td>
<td>Ref to Art 1032</td>
</tr>
</tbody>
</table>

### Hot Mix Asphalt Items

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>MAX PERCENT PAY</th>
<th>REF. SOURCE (SPEC)</th>
<th>REF. SOURCE (DOC GUIDE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIX FOR CRACKS, JOINTS AND FLANGWAYS</td>
<td>TON (M TON)</td>
<td>103%</td>
<td>406.13(b)</td>
<td>A-15</td>
</tr>
<tr>
<td>INCIDENTAL HMA SURFACING</td>
<td>TON (M TON)</td>
<td>103%</td>
<td>408.04 Ref to Art 406.13</td>
<td>A-15</td>
</tr>
<tr>
<td>LEVEL BINDER (MACHINE AND HAND)</td>
<td>TON (M TON)</td>
<td>103%</td>
<td>406.13(b)</td>
<td>A-15</td>
</tr>
<tr>
<td>HMA BINDER COURSE</td>
<td>TON (M TON)</td>
<td>103%</td>
<td>406.13(b)</td>
<td>A-15</td>
</tr>
<tr>
<td>HMA SURFACE COURSE</td>
<td>TON (M TON)</td>
<td>103%</td>
<td>406.13(b)</td>
<td>A-15</td>
</tr>
</tbody>
</table>
Supplemental Problem 6 – Trench Backfill

It is 8/24/18 and you have been documenting storm sewer work on IL 78 being installed by Atlas Paving, LLC, who is the prime contractor on the project. You inspected the pipe supplied by County Materials (CMCS mark on pipe) prior to being installed and have the required documentation. The Trench Backfill was supplied by Cullinan – East Peoria. From field notes, fill out the IDR that shows allowable pay Length, maximum allowable trench width and allowable pay Quantity for Trench Backfill from Manhole A to B and B to C. Also show the pay quantity for the storm sewer pipe on the IDR. Include all calculations or a reference to calculations. Include the required evidence of Material Inspection for each item. You are the Inspector and your staff assisted with the work as noted in the Field Book.

Field Book 1

<table>
<thead>
<tr>
<th>MH</th>
<th>SS RCP</th>
<th>Pipe Run</th>
<th>Trench Length</th>
<th>Trench Width</th>
<th>Trench Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CL B T 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>55080410</td>
<td>20800150</td>
<td>62.8'</td>
<td>6.0'</td>
<td>7.8'</td>
</tr>
<tr>
<td>B</td>
<td>24&quot;</td>
<td>64.3'</td>
<td>62.8'</td>
<td>6.0'</td>
<td>7.8'</td>
</tr>
<tr>
<td>C</td>
<td>24&quot;</td>
<td>57.5'</td>
<td>56'</td>
<td>6.0'</td>
<td>7.6'</td>
</tr>
</tbody>
</table>

Note 1 Trench Length is face to face of Man Hole (MH)
Note 2 Trench depth is to pipe invert
8/24/18 - Clear 92F
### Inspector's Daily Report

**Date**

**Contractor or Sub.**

**Weather**

**Inspected by:**

**Measured by:**

**Calculated by:**

**Checked by:**

**Initial(s)**

**Date**

**District**

**Contract No.**

**Job No.**

**Project**

<table>
<thead>
<tr>
<th>Item Code #</th>
<th>Fund Code (Opt.)</th>
<th>Item</th>
<th>Location</th>
<th>Quantity and Units</th>
<th>Evidence of Material Inspection (Optional)</th>
<th>Posted in Q Book</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

This is:  
- [ ] an estimated progress measurement (item no.: ...)
- [ ] a final field measurement (item no.: ...)

**Remarks:**

(e.g., instruction to Contractor, special problems, sketches with dimensions for final measurements, computations, number of persons working, hours worked) Use reverse side, if needed.

---

Printed 9/25/2018  
BC 528 (Rev. 8/04)
**Inspector's Daily Report**

**Date**: 8/24/2018

**Contractor or Sub.**: Atlas Paving, LLC

**Weather**: Clear, 92F

**Inspected by**: [Initial(s)]

**Measured by**: [Initial(s)]

**Calculated by**: [Initial(s)]

**Checked by**: [Initial(s)]

**Item Code#** | **Fund Code (Opt.)** | **Item** | **Location** | **Quantity and Units** | **Evidence of Material Inspection** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20800150</td>
<td></td>
<td>Trench Backfill</td>
<td>MH A to B &amp; MH B to C</td>
<td>131.7 CU YD</td>
<td>LIST and TICK - (Cullinan - East Peoria)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sta 29+77 to 30+33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>550B0410</td>
<td></td>
<td>SS RCP CL B T II 24&quot;</td>
<td>MH A to B &amp; MH B to C</td>
<td>121.8 LN FT</td>
<td>LIST and MARK (CMCS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sta 29+77 to 30+33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is: ☑ a final field measurement (item nos.: 20800150, 550B0410)

Remarks: (e.g., instruction to Contractor, special problems, sketches with dimensions for final measurements, computations, number of persons working, hours worked) Use reverse side, if needed.

See F Book 1 Pg 17 & 18 for Pipe/Trench Measurements and Pipe length Calc's. Allowable trench width for table: 24"+3"+3+18"+18" = 66" - Dug 72" Use Table MH A to B trench parallel and within 2' of sidewalk - Pay for Trench Backfill entire length.

Pay length (A to B)= Dist MH A to MH B less backfill at face of MH A and B (3" each) = 62.8 LF - 2 x (3'/12 in/ft) = 62.3' For 7.8' depth from Table 1.294 CY/LF

Pay Length (B to C) - only pay within 2' of roadway or sidewalk less backfill at face of MH B = 1'+4'+2'- (3'/12 in/ft)+(2'+30'+2') = 40.75'. For 7.6' Depth 1.253 CY/LF

Total Volume Trench Backfill = Pay Length x Volume Factor = (62.3 LF x 1.294 CY/LF) + (40.75 LN FT x 1.253 CY/LF) = 131.7 CU YD

BC 628 (Rev. 8/04)
Supplemental Problem 7 - Traffic Control Price Adjustment

You have been assigned two contracts (A2345 and B6789) on I-55 that are a few miles apart that are very similar in work. The same contractor was the successful bidder on the two projects. Both contracts are utilizing Standard 701411 for traffic control in the ramp areas.

As work progresses, Contract A2345 encounters additional work and time that results in a change order to complete the needed work. In the end, the contractor’s schedule utilizing Standard 701411 increased from the planned 15 working days to 21 working days. The awarded contract value of the work that Standard 701411 was protecting was $178,349.00. The final value of the work completed under the standard was $207,342.00. The unit price for the pay item of the standard was $14,500.00.

Contract B6789 had some changes that resulted in elimination of some work that Standard 791411 was protecting. The contractor schedule for using Standard 701411 was reduced from 15 working days to 14 working days. The awarded contract value of the work that Standard 701411 was protecting was $130,243.00. The elimination of a pay item resulted in cost savings, but roughly the same construction time. The final cost of the work under the standard was $72,018. The unit price for the pay item of the standard was $14,500.00.

Per Article 701.20 what will be the adjusted unit price for Traffic Control Standard 701411 for each of these contracts.
Supplemental Problem 7 - Traffic Control Price Adjustment Answer

Determine if an adjustment is warranted: Change must exceed 10% of the original work cost.

\[ X = \left| \frac{\text{Final} - \text{Original}}{\text{Original}} \right| \]

Note |value| indicates that the resulting value is to be a positive value even if the calculated result is negative. This is termed the “absolute value” of the calculation.

For **Contract A2345**:

\[ X = \left| \frac{\$207,342 - \$178,349}{\$178,349} \right| = 0.163 \]

\( (X - 0.1) = 0.063 \) Greater than 0 – Therefore adjust by increasing the unit price

Adjusted unit price = \( 0.25P + 0.75P \left(1 + (X - 0.1)\right) \)

Note the price will be increased so “+” is used

\[ \text{Adjusted unit price} = 0.25 \times \$14,500 + 0.75 \times \$14,500 \left(1 + (0.163 - 0.1)\right) \]

\[ = \$3,625 + \$10,875(1 + 0.063) \]

\[ = \$3,625 + \$10,875 \times 1.063 = \$15,185.13 \]

Unit price difference is \$15,185.13 - \$14,500 = \$685.13 – This value would be used on new pay item #XXX03100 as an addition
For Contract B6789:

\[
X = \frac{\$72,018 - \$130,243}{\$130,243} = |\text{-}0.447| = 0.447
\]

Note the absolute value of -0.447 is 0.447, a positive value.

\[(X - 0.1) = 0.347\] 
*Greater than 0 – Therefore adjust by decreasing the unit price*

\[
\text{Adjusted unit price} = 0.25P + 0.75P(1 \pm (X - 0.1))
\]

Note the price will be decreased so “-” is used:

\[
\text{Adjusted unit price} = 0.25 \times \$14,500 + 0.75 \times \$14,500 (1 - (0.447 - 0.1))
\]

\[
= \$3,625 + \$10,875(1 - 0.347)
\]

\[
= \$3,625 + \$10,875 \times 0.653 = \$10,726.38
\]

Unit price difference: \$10,726.38 - \$14,500 = -$3,773.62 – This value would be used on new pay item #XXX03100 as a deduction.

**SPECIAL NOTE:** The contractor’s planned and actual time of standard use are not part of the above adjustment. However, good diary records should capture the setup and take down time of traffic control. The changes to the contract resulted in the elimination of a pay item. See Article 104.02. In this case, Traffic control standard 701411 as a percent of the original contract price is:

\[
\text{Adjusted unit price} \times 100 = \text{Percent of Contract unit price}
\]

\[
\frac{\$10,726.38}{\$14,500} \times 100 = 74.0%
\]

Knowing that the work had changed significantly in value with the impacted work changing more than 125% or reduced to under 75% of the original contract value, the impacted items should have their price renegotiated prior to the start of the revised work. The renegotiated prices should have included the work under Traffic Control Standard 701411 which should have been checked prior to start of the work so any needed adjustments could be agreed upon prior to the start of work. In the event that this part of the work was not renegotiated, you have documented the actual usage which would be helpful in the resolution of any contractor claims.

The information gathered would show that the time/work effort required to provide Traffic Control Standard 701411 was within 10% of the original contract proposal (contractor’s schedule vs. actual), thus the contractor likely has a valid claim to the unit price as bid for the standard.
Supplemental Problem 8 – Pavement Patching

You are the inspector on a pavement patching operation by, Fast Patch, LLC. On 6/5/2018, you laid out 3 patches (#’s 34, 35 and 36) in the eastbound lane and recorded your notes in your field book for Class D Pavement Patching Type II, III and IV, 8”. On Patch #35 the contractor elected to increase the patch length 1 ft to avoid sawing through dowel bars. The pavement is 12 ft wide. The weather was sunny and 82F at the time of pour. You measure the final patch dimensions just prior to pouring as follows:

<table>
<thead>
<tr>
<th>Station</th>
<th>Lay Out Width</th>
<th>Lay Out Length</th>
<th>As-Built Length</th>
<th>As-Built Depth, d1, d2, d3, d4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10+47</td>
<td>12.0’</td>
<td>6’</td>
<td>6’</td>
<td>8.2”</td>
</tr>
<tr>
<td>11+86</td>
<td>12.0’</td>
<td>11’</td>
<td>12’</td>
<td>11.2, 12.0, 10.8, 11.5</td>
</tr>
<tr>
<td>13+85</td>
<td>12.0’</td>
<td>30’</td>
<td>30’</td>
<td>8.0”</td>
</tr>
</tbody>
</table>

Fill out your field book as the source document using the information above.
Supplemental Problem 8 –Pavement Patching Answer

Pavement Patching, Class D, 8"

<table>
<thead>
<tr>
<th>Patch #</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>Calc’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sta Start</td>
<td>8.0</td>
<td>11.0</td>
<td>11.0</td>
<td>8.0SY</td>
</tr>
<tr>
<td>34</td>
<td>8.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10+47</td>
<td></td>
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</tr>
<tr>
<td>35</td>
<td>17.6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11+86</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>40.0</td>
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<td></td>
</tr>
<tr>
<td>13+85</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Weather: Sunny, 82F
Contractor: Fast Patch, LLC

Date: 6/5/18

Evidence of Mat’l Insp: Plant Report, Tick & Test
*Length same both sides unless noted

Thickness Adjustment:

\[
\frac{(11.4 - 8.0)}{8.0} \times 100 \% = 42.5 \% > 30 \%
\]

Per Art 442.10 increase quantity

20\% \times 14.7 \text{ SY} = 17.6 \text{ SY Use}

Note Keep as Type II

Calculated By: UBU 6/5/18

Checked By: (by others)
Supplemental Problem 9 –HMA Surface Max Pay Answer

Your project is a short mill and fill HMA resurfacing safety project to construct a high friction pavement surface in front of a recently opened Portillo’s, which has a high frequency of skid accidents. The project is 850 ft in length and includes two 12 ft lanes in each direction and a 12 ft turn lane for a total width of 60 ft. The plans show a surface thickness of 1.5 in using the pay item POLYMERIZED HOT-MIX ASPHALT SURFACE COURSE, MIXTURE F, N 90. The plans indicate the unit weight used in determining quantities was 112 lb/sy/in, which provided a plan quantity of 476 Tons. The contractor submitted a HMA mixture utilizing steel slag in the aggregate blend to meet the Mixture F friction aggregate requirements. As a result, the bulk specific gravity ($G_{mb}$) of the approved HMA mix design is 2.613. The contractor bid the material at $92.45/ton and provided 541 Tons.

Determine the following:

- Check plan quantity of the work.

- Original total bid cost for the surface work.

- Adjusted Plan Quantity for the mix provided.

- Maximum payment Quantity.

- Contractor payment quantity and amount
Supplemental Problem 9 –HMA Surface Max Pay Answer

Check plan quantity of the work.

\[ Tons = \frac{\text{Area(SY)} \times \left( \text{Thickness in Inches} \right) \times \left( \text{Unit Weight of HMA per} \frac{SY}{\text{inch}} \right)}{2000 \text{lb/ton}} \]

\[ \text{Area} = \frac{60 \text{ ft} \times 850 \text{ ft}}{9 \text{ SF/SY}} = \frac{51,000 \text{ SF}}{9 \text{ SF/SY}} = 5,666.7 \text{ SY} \]

\[ Tons = 5,666.7 \text{ SY} \times \left( \frac{1.5 \text{ in}}{2000 \text{ lb/ton}} \right) \left( \frac{112 \text{ (lb/ SY)} / \text{in}}{\text{SY}} \right) = 5,666.7 \text{ SY} \times 0.084 \frac{\text{ton}}{\text{SY}} = 476 \text{ ton} \]

476 tons of HMA matches plan quantity

Original total bid cost for the surface work.

Total bid = Plan Quantity x Unit Price = 476 Ton x $92.45/Ton = $44,006.20

Adjusted Plan Quantity for the mix provided.

The bulk specific gravity \( (G_{mb}) \) of the mix provided in this case is 2.613 (note sometimes this will be referred to as “little d”).

Per 406.13

\[ \text{Adjusted Plan Quantity} = C \times \text{Plan or Engineer’s Specified Quantity} \]

\[ C = \frac{G_{mb} \times 46.8}{U} \]

Where for this project:

\[ G_{mb} = 2.613 \text{ from the approved mix design} \]
\[ U = 112 \text{ lb/sy/in unit weight of surface course shown on plans} \]

\[ C = \frac{2.613 \times 46.8}{112 \text{ lb/sy/in}} = 1.092 \]

\[ \text{Adjusted Plan Quantity} = 1.092 \times 476 \text{ tons} = 520 \text{ tons} \]

Maximum payment Quantity.

Per Article 406.13(b) Max payment is 103%

\[ \text{Max pay} = 1.03 \times \text{Adjusted Plan Quantity} = 1.03 \times 520 \text{ tons} = 536 \text{ tons} \]

Contractor payment quantity and amount.

Contractor provided 541 tons HMA which exceeded maximum payment quantity of 536 tons. Payment to be based on 103% limit of 536 tons.

\[ \text{Payment amount} = 92.45 \times \text{payment quantity} = 92.45 \times 536 \text{ tons} = 49,553.20 \]