Examples of Quantity Calculations Issues

Rectangle with Four Uneven Sides

Area calculated by averaging opposite sides and multiplying the averages. Used mostly for sections of Sidewalks and Bridge Impact Panels.

Figure 1

Area = \((\frac{10 + 14}{2}) \times (\frac{12 + 16}{2})\) = 12' \times 14' = 168 square feet

Not a valid method of calculation.
Acceptable Area Calculations

Figure 1

Measure diagonal distance between two opposite corners to make two triangles.

Use these formulas to calculate each triangle.

\[
\begin{align*}
s &= \frac{(a + b + c)}{2} \\
\text{Area} &= \sqrt{s(s-a)(s-b)(s-c)}
\end{align*}
\]
Example:

Triangle 1: \[ s = \frac{(12 + 14 + 20.5)}{2} = 23.25 \text{ Feet} \]

Area 1 = \[ \sqrt{23.25(23.25 - 12)(23.25 - 14)(23.25 - 20.5)} \]
= \[ \sqrt{23.25(11.25)(9.25)(2.75)} = \sqrt{6,653.50} \]
= 81.6 Square Feet

Triangle 2: \[ s = \frac{(10 + 16 + 20.5)}{2} = 23.25 \text{ feet} \]

Area 2 = \[ \sqrt{23.25(23.25 - 10)(23.25 - 16)(23.25 - 20.5)} \]
= \[ \sqrt{23.25(13.25)(7.25)(2.75)} = \sqrt{6,142.00} \]
= 78.4 Square Feet

Total Area = 81.6 + 78.4 = 160.0 Square Feet

**Note:** Use of the “GNSS Survey Tablets” for measurement of odd shaped surface areas should eliminate problems with calculating these areas in the future.
Calculating Areas with Varying Widths

Areas with varying widths are often calculated by averaging the widths and multiplying by the total length. (Used in measuring area for subgrade stabilization seeding, geotextile fabric, and mulch.)

\[ \text{Area} = \left( \frac{12 + 14 + 11 + 15 + 8 + 13 + 12}{7} \right) \times 525 \]

\[ = 12.1 \times 524 = 6,375.0 \text{ Square Feet} \]

Not a valid method of calculation.

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The distance between each width is different. Each segment has to be calculated individually. (Average each pair of widths and multiply by the individual distance between.)
Correct Area Calculations

Segment A = \((12 + 14) ÷ 2\) x 70 = 13.0 x 70 = 910.0
Segment B = \((14 + 11) ÷ 2\) x 85 = 12.5 x 85 = 1,062.5
Segment C = \((11 + 15) ÷ 2\) x 60 = 13.0 x 60 = 780.0
Segment D = \((15 + 8) ÷ 2\) x 75 = 11.5 x 65 = 747.5
Segment E = \((8 + 13) ÷ 2\) x 125 = 10.5 x 125 = 1,312.5
Segment F = \((13 + 12) ÷ 2\) x 120 = 12.5 x 120 = 1,500.0
Total Area = 910.0 + 1,062.5 + 780.0 + 747.5 + 1,312.5 + 1,500.0 
= 6,312.5 Square Feet

Equal Distance between Width Measurements

If the length between each width measurement is uniformed for each segment, the average of the widths multiplied by the total length is still not valid. The following is a formula for calculating the total area in this case:

\[
\text{Area} = (((a + f) ÷ 2) + b + c + d) \times \text{Segment Length}\*
\]

Area = \(((12 + 13) ÷ 2) + 14 + 11 + 15 + 8\) x 100

= 60.5 x 100 = 6,050 Square Feet

*Formula from 1992 ODOT Field Survey Manual
Asphalt Cement Calculation

During a project the total quantity of asphalt can be miscalculated due several reasons, some are:

- Paynotes from more than one Inspector can cause both Inspectors and CAS to lose track of what’s been paid or not been paid.
- Miscalculating asphalt for small amounts of ACP. This happens more at beginning and end of paving.

Small Quantity & Statspec

Small quantity of asphalt is calculated and paid the first month of paving as small quantity based on the Mix Design’s target value. (Not enough testing to run a Statspec Lot.)

Later, asphalt is calculated for the same Mix Design using Statspec after a minimum of 3 sets of sublot tests have been completed.

There needs to be good communication between the QCCS and the CAS. The asphalt that was paid in the beginning under small quantity needs to be deducted from the Statspec asphalt total.

Double payment of asphalt can add up quickly to a large overpayment.
Small Quantity & Statspec Example

1,500 tons ACP x 5.7% (Asphalt Target Value) = 85.50 tons of asphalt.

At $500.00 per ton, the first month payment is $42,750.00.

If not deducted as part of a new Lot, this amount could be double paid.

The reverse can also happen: ___

Small quantities of asphalt calculated and paid at start of paving. These payments are to remain small quantity for various reasons and not become part of larger Statspec Lot.

A Statspec Lot is later calculated. Small quantities of asphalt calculated earlier are deducted from the Statspec quantity and absorbed into the new Lot.

This becomes an under payment to the Contractor.

RAP & Tank Sticking

Tank sticking cannot be used to calculate asphalt pay quantities when an ACP Mix design contains RAP material.

Tank sticking method does not include the asphalt in the RAP.

Need to use the Ignition Method to determine asphalt content.
Quick Check of Asphalt Pay Quantities

A quick check of the asphalt quantity paid to date:

Total Asphalt paid ÷ Total ACP Paid

If the percent of asphalt calculated is significantly lower or higher than the Mix Design’s target value or test results, a review of the asphalt pay quantities needs to be made.

Statspec & Adjustments to JMF Target Values

When adjustments are made to JMF target values after paving of an ACP Lot has started, test results for modified constituents are entered into Statspec as a ± value of the difference between the original or modified target values and the test result.

Errors are made when the individual entering the ± value differences confuses the positive/negative values and starts entering the opposite sign for each test result.

When this happens, Statspec calculates an incorrect “Mean,” Standard Deviation,” and “Pay Factor” for each constituent. It then calculates an incorrect “Composite Pay Factor” and “Bonus Adjustment” for the entire Lot.

If the Asphalt Content target value is also adjusted, and incorrect ± signs are entered, not only can the “Bonus Adjustment” be affected, but the asphalt pay quantity for the ACP Lot can be incorrect.
Recommendation

To assure the correct ± sign is determined, subtract the Target Value from the Test Result:

- If the Target Value is higher than the Test Result the difference is negative. Target value for #4 aggregate constituent is 50 and Sublot test result is 47, a negative difference of -3 is entered.

- If the Target Value is lower than the Test Result the difference is positive. Target value for #4 aggregate constituent is 50 and Sublot test result is 52, a positive difference of 2 is entered.

- If the Target Value and the Test Result the same value, 0 is entered.
Cold Plane Pavement Removal (Computer-Generated Spreadsheets)

These are common errors found in computer-generated spreadsheets. A spreadsheet can give clean, accurate, and easy to read quantity calculation. Errors can still creep in, a quick visual check of input and calculated information may help find them.

The following are some examples found on spreadsheets for calculation of Cold Plane Pavement Removal.

### Misplaced Decimal Point –
Spreadsheet page shows most grinding width measured between 17.2 and 17.8 feet. One entry listed 176.0 feet. This increased the pay quantity by more than 5 times in the 300 foot sections before and after this entry.
Cold Plane Pavement Removal  
(Computer Generated Spreadsheets)

**Missing Area Formula** – Spreadsheet page shows a calculated area of 0.0 square feet, and 4,620.0 square feet should have been calculated for an average width of 15.4 feet times a length of 300.0 feet. Somehow the Area Formula was removed from the spreadsheet. Because the template for this spreadsheet was used for more grinding calculations, the 0.0 square foot showed up more than once in the paynotes.

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**Spreadsheet Incorrectly Ended** – This issue was found more than once. The final Station 79+30 was entered by mistake into the Length Column and the Area Formula read it as the last section of grinding at 7,930 feet long. This calculated a payment area of 48,373.0 square feet (5,374.8 Square Yards) instead of 0.0.

<table>
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<tr>
<th>Column D Accumulated SqFt</th>
<th>121020.0 SqFt</th>
<th>AREA = Width X Length = SqFt</th>
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<td>123446.7 SqYd</td>
<td>AREA = SqFt9 = SqYd</td>
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Quantities measured in place by Inspector
Gaps and Overlaps in Cold Plane Pavement Removal

On projects with large amounts of grinding, not all work may be performed continuously. Also, other factors may add to the possibility of gaps and overlaps in the calculations and payments:

- Multiple paynotes over several months
- Multiple lanes
- More than one Inspector
- Paynotes turned in just before uploads

On larger projects, it might help to generate a listing of pavement removal by station as work progresses.

- Keep track by lane, if more than one.
- Look for overlaps in grinding, should be no longer than 20 feet between end of grinding one shift and start of the next shift.
- Look for gaps in grinding that should have been completed.

Some of this may not be resolved until end of work after all paynotes have been submitted.
Case of Gaps between Spreadsheets

Five spreadsheets were generated for 12,850 feet of continuous grinding performed during one work shift. Width measurements were taken at 100-foot intervals.

Between each of the five consecutive spreadsheets, where the stationing for one spreadsheet ended, the stationing for the next spreadsheet started 100 feet from the end of the last spreadsheet.

This caused the grinding of 100-foot segments not to be calculated for payment between each consecutive spreadsheet.