Final Estimates Level 1

Course Manual

Florida Department of Transportation

State Construction Office

MODULE 1 – GENERAL

Slide 1 WELCOME

Welcome to the Final Estimates Level 1 course, Module 01 - General, offered through the Construction Training Qualification Program. This Final Estimates training course consists of 8 modules and covers the preparation of final estimates by field personnel. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

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This is a computer-based training course, which means that you are responsible for comprehending the information provided by each module and evaluating your own progress with the help of the intermittent test questions. If you can answer all the questions correctly, you are much more likely to be successful when taking the final exam.

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When you have completed the computer-based training course, check the CTQP website for available Construction Training Qualification's Program (CTQP) Proctors and register to take the Final Estimates Level 1 exam. Only after you have passed the Level 1 exam with a score of 70% or better will you become CTQP qualified in Final Estimates Level 1.

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Let's begin with the first module. In this module, you will become familiar with the Department of Transportation's management of construction projects. Later modules will include more detailed explanations of work methods, calculation explanations, and procedures.

Slide 5 INTRODUCTION

One of the principal functions of the Department of Transportation is to carry out construction and improvement of transportation facilities to ensure adequate service to the public. While most of the transportation projects are accomplished by private contractors, the management of these programs involves specific DOT responsibilities, including:

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Planning and Programming -- studies of improvement needs, determination of priorities, and establishment of construction programs consistent with financial capabilities.

Design -- geometric and structural design of roadways and bridges and preparation of detailed plans and specifications for individual projects.

Contract Administration -- preparation of contract documents, advertisements for bids, evaluation of contractors' proposals, and award of contracts.

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Construction Management -- inspection and testing of construction work as it progresses to ensure that workmanship and materials are in compliance with the plans and specifications.

Contractor Payments -- measurement and payment for work performed through monthly progress estimates and a final estimate upon completion of each project.

Department personnel assigned to the construction phase of a project are usually involved in both construction management and contractor payments. Although this course is limited to guidance of contractor payments, all personnel must also be familiar with responsibilities and procedures for construction management.

Slide 8 KNOWLEDGE CHECK

Now to test your knowledge. You will now be asked review questions based on the information in this CBT. You may choose your answer by selecting the corresponding button or by pressing the corresponding letter on your keyboard.

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1) True or false. A major function of DOT is to carry out the construction and improvement of transportation facilities, so the public is provided with adequate transportation services.
   A. True
   B. False

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2) Multiple choice. For the DOT, the management of Construction projects involves the following specific responsibilities:
   A. Planning, Programming, and Design
   B. Contract Administration
   C. Contractor Payments
   D. Construction Management
   E. All of the above

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3) True or false. Contractors are paid for the work performed through progress and final estimates.

A. True

B. False

Slide 12 CONTRACT DOCUMENTS

To know how to properly pay the Contractor for the work performed, you must read the contract. The purpose of a contract is to guide both the Contractor's and the Department's personnel in the performance of the work and how it should be paid. The contract must be clearly understood because it is important to the preparation of final estimates.

Contracts for road and bridge construction projects consist of several contract documents fulfilling different specific purposes.

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These contract documents include:

- **Contract Plans** (including revisions during construction, plan notes, and estimates quantities)
- **Standard Plans**
- **Standard Specifications**
- **Supplemental Specifications and Developmental Specifications**
- **Special Provisions and Technical Special Provisions**
- **Contract Proposal Form**
- **Supplemental Agreements**
- **Work Orders and**
- **Joint Project Agreements** (JPA)/Locally Funded Agreements (LFA)

You are probably familiar with most, or all these documents, so we will discuss them only briefly now.

Slide 14 CONTRACT PLANS

The Contract Plans provide detailed, pictorial instructions for the road or bridge construction, such as alignment, grades, Intelligent Transportation System (ITS) and lighting, drainage, right-of-way, traffic control, and landscaping. Sometimes special notes are placed on the plan sheets to call attention to a particular construction item or to unusual conditions of measurement and construction of work. Such plan notes govern both the Standard and Supplemental Specifications.

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The plans also include a summary of estimated quantities for each project. These estimated quantities are for individual bid items as determined by the designers and serve as a basis for contractors' competitive bidding.

Slide 16 STANDARD PLANS

The Standard Plans provide guidelines and technical drawings for Design personnel and Construction personnel on how items should be constructed. These standards are developed by the Department and made available for Design, Construction, Maintenance, and Utility operations on the State Highway System.

Slide 17 STANDARD SPECIFICATIONS

The Standard Specifications for Road and Bridge Construction are the directions, provisions, and requirements that the Contractor must follow to perform the work required and are applicable to all Department Contracts. This document is considered an integral part of the "contract package" and describes (1) the general relationships between the Department and Contractors.

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(2) construction details for all the major work items; (3) Specifications and criteria for materials incorporated in the work; and (4) method of measurement and basis of payment for completed work. It is published annually, in July and can be found electronically under the Program Management Office's Website.

Slide 19 SUPPLEMENTAL SPECIFICATIONS AND DEVELOPMENTAL SPECIFICATIONS

Sometimes certain sections of the Standard Specifications need to be revised. Supplemental Specifications identify and describe approved additions or deletions to the Standard Specifications, applicable to all Contracts. These are published as-needed and included within the workbook of the Standard Specifications it is replacing.

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For example, if a change is needed to Section 3-5 of the July 2023 Standard Specification, the Supplemental Specification 3-5 will be published within the July 2023 workbook. In case of discrepancies, the Supplemental Specifications always govern the Standard Specifications.

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Developmental Specifications are created around a new process, procedure, or material and are used on several contracts to monitor their performance before being considered for incorporation in the Standard or Supplemental Specifications.

Slide 22 SPECIAL PROVISIONS AND TECHNICAL SPECIAL PROVISIONS

Special Provisions often are included with the contract documents for individual projects. These may describe a situation unique to a particular project, or they may modify a requirement set forth in the Standard or Supplemental Specifications.

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Technical Special Provisions are technical in nature, prepared, signed, and sealed by an Engineer registered in the State of Florida, other than the State Specifications Engineer, and are applicable to specialty items of work.

Slide 24 COORDINATION OF CONTRACT DOCUMENTS

In case of discrepancies among the previously mentioned contract documents regarding measurement and payment for work, the order of precedence shown below should apply. This is also listed in the Standard Specifications.

1. SPECIAL PROVISIONS
2. TECHNICAL SPECIAL PROVISIONS
3. CONTRACT PLANS
4. STANDARD PLANS
5. DEVELOPMENTAL SPECIFICATIONS
6. SUPPLEMENTAL SPECIFICATIONS
7. STANDARD SPECIFICATIONS

Slide 25 CONTRACT PROPOSAL FORM

The Contract Proposal form is the method which Contractor's submit their bids. It is the official form or the electronically generated bid item sheets on which the Department requires formal bids to be prepared and submitted for the work proposed.

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The information contained within the proposal form will vary depending on the type of contract that is being bid. For example, conventional projects will contain all the pay items within the project with corresponding quantities. The Contractor will provide the prices.

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However, Design-Build contracts are unique because they allow Contractors and Designers to work together to both design and construct a project. The exact pay items and corresponding quantities are not known, but enough information concerning the scope of work has been provided by the Department to provide a bid. The total quantity for this proposal will be 1 lump sum.

Slide 28 SUPPLEMENTAL AGREEMENTS (SA)

Supplemental Agreements are modifications to the original contract used to authorize work different from that shown in the original plans and contract, clarify the Specifications, or to pay for unforeseen work. They may also be used for payment to settle contract claims or settlements of dispute.

Slide 29 WORK ORDERS (WOs)

Work Orders are like Supplemental Agreements but can't be used in all instances. They are typically used to include additional unforeseen work or minor changes into the original contract.

Slide 30 LOCALLY FUNDED AGREEMENTS (LFA)

Locally Funded Agreements are a type of contract included within a project between the Department and another government or private entity. The work could include a utility agreement to relocate or install utility infrastructure. It could also include grant funded projects for other municipalities. For more information on other types of LFAs and definitions, see ***Procedure 350-020-300***, ***Procedure 350-020-301,*** or the ***Construction Project Administration Manual (CPAM), Section 8.12***.

Slide 31 KNOWLEDGE CHECK

Now let's test your knowledge of Contract Documents.

1) Multiple choice. Which of the following is NOT officially considered to be a "Contract Document"?
   - **A.** Supplemental Agreements and Work Orders
   - **B.** Field Records
   - **C.** Standard Specifications
   - **D.** Construction Project Administration Manual (CPAM)
   - **E. Answers B & D**

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2) Multiple choice. Between the scheduled publishing of the Standard Specifications, what does the Department issue to identify and describe changes in the Standard Specifications?
   - **A.** Construction Project Administration Manual (CPAM)
   - **B.** Supplemental Specifications
   - **C.** Work Orders
   - **D.** Supplemental Agreements

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3) Multiple choice. Select the correct sequence of documents in order of precedence, with the document highest in authority listed first.
   - **A.** Contract Plans, Development Specifications, Standard Specifications, Special Provisions, Technical Special Provisions, Supplemental Specifications, Standard Plans.
   - **B.** Standard Plans, Special Provisions, Technical Special Provisions, Supplemental Specifications, Contract Plans, development Specifications, Standard Specifications.
   - **C. Special Provisions, Technical Special Provisions, Contract Plans, Standard Plans, Development Specifications, Supplemental Specifications, Standard Specifications.**
   - **D.** Supplemental Specifications, Special Provisions, Contract Plans, Development Specifications, Standard Specifications, Technical Special Provisions, Standard Plans.
   - **E.** None of the above.

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4) True or false. Special provisions are contract documents that may describe a situation unique to a specific project or modify a requirement set forth in the Specifications.
   - **A. True**
   - **B.** False

Slide 35 WHAT IS FINAL ESTIMATES?

So, now that we have reviewed the documents that have authority within a project, let's discuss final estimates. What is final estimates? Contrary to the name, it encompasses far more than just the final or last payment to the Contractor. Final estimates is the entire payment process to the Contractor. But let's think about this.

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To properly pay the Contractor on the last payment, all the payments before it must be approved, well documented, and tracked. So Final Estimates begins prior to construction of the project and continues throughout the duration of the project. Throughout this training we will discuss the proper methods for measuring and documenting quantities used in the estimate process. Let's discuss the two different types of payments.

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Payments to contractors are normally based on measured units of work accomplished for each bid item and the established unit price for each item. The specifications provide for two types of payments to Contractors; they are progress estimates and a final estimate.

Slide 38 PROGRESS ESTIMATES
Progress estimates are regularly scheduled payments made to contractors on a monthly basis. Procedures for preparing progress estimates are not included in this training course since they are covered in the Department's Construction Project Administration Manual or otherwise referred to as CPAM. This procedure is discussed more thoroughly in Final Estimates, Level 2 Training.

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The CPAM outlines the responsibilities of construction personnel and procedures for supervising construction projects. It provides detailed instructions for tasks like inspecting various work items, sampling and testing materials, as well as preparing documentation of quantities for Final Estimates.

Slide 40 FINAL ESTIMATE
When all work has been completed by the contractor and the final inspection and acceptance has been made by the Engineer, a progress estimate needs to be processed to pay all monies owed to the Contractor prior to the offer of final payment. This estimate is processed at the Resident's Office. Submittal of the final estimate documentation to the District Final Estimates Office (DFEO) is within 30 days after final acceptance. Review of the final estimates documentation will be done by the District Final Estimates Office.

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The CPAM sets forth methods and procedures for preparing and submitting final estimates documentation to the District Final Estimates Office (DFEO). Much of the content of this Final Estimates Level I course is based on this manual. You should keep CPAM available as a reference for procedures but always check the special provisions and specifications for legal requirements on any project.

Slide 42 KNOWLEDGE CHECK

Now let's test what you have learned about estimates.

1) Multiple choice. Which of the following documents sets forth the Department's methods and procedures for preparing and submitting a final estimate?
   A. Construction Inspection Mathematics
   B. Project Engineer Manual
   C. Construction Project Administration Manual
   D. The Review & Administration Manual

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2) True or False. Progress payments are made to contractors on a monthly basis.
   A. True
   B. False

Slide 44 CONCLUSION

This concludes the Final Estimates Level 1 course, Module 01 – General.
Please proceed to the next module. Thank you for your time and attention.

MODULE 2 - DOCUMENTATION

Slide 1 WELCOME

Welcome to the Florida Department of Transportation's computer-based training series on Final Estimates, Level 1 Training. This is Module 2, Documentation. You will become familiar with the various types of final estimates documentation and how they are used. We also look at detailed examples of documentation. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

Perhaps the most important part of preparing final estimates is the documentation of all measurements and computations. Careful documentation reduces errors and makes verifying computations easier. It is important when preparing these site source records to provide enough detail for someone who is not familiar with the project to understand what has been documented. These records may be required as evidence in any arbitration or lawsuit. Therefore, the information within them should be clear and concise.

Slide 3

Final estimates site source records include, but are not limited to:

- Field Books
- Site Source Forms
- Computer Input and Output
- Final As-Built Plans
- Daily Work Report

Slide 4 KNOWLEDGE CHECK

Now let's test your knowledge about documentation.

1) Multiple Choice. Which of the following is not a site source record?
   A. Daily Work Report
   B. Field Book
   C. Supplemental Agreement
   D. Final As-Built Plans

Slide 5 COMPUTATIONS

In order to standardize calculations and ensure uniform results, criteria have been established for precision in final quantities and the rounding of decimal numbers. The criteria are described in Chapter 2 of the Basis of Estimates (BOE) Manual and includes a listing of units of measure and the specified precision the Department requires.

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For example, unit precision is shown in the table which was derived from the Basis of Estimates manual. Tonnage contains a precision to the tenth place whereas square yard measured items will be rounded to the nearest whole number.

Abbreviation	Unit of Measure	Precision
AC	Acre	0.01
AS	Assembly*	1
CF	Cubic Foot	0.1
CY	Cubic Yard	0.1
DA	Day	1
EA	Each	1
ED	Each Day	1
GA	Gallon	1
GM	Gross Mile	0.001
HR	Hour	1
LB	Pound	1
LF	Linear Foot	1
LO	Location	1
LS	Lump Sum	1
LU	Luminaire*	1
MB	Board Measure/ Thousand Feet	0.1
MH	Man-hour**	1
MI	Mile	1
PI	Per Intersection*	1
PS	Per Set*	1
SF	Square Foot	1
SY	Square Yard	1
TN	Ton	0.1
YD	Yard	1

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Basic rules for rounding decimal numbers during manual calculations are described in the Construction Math Course. However, when using calculators or computers use the full decimal capabilities of the machines. In other words, do not round off intermediate results on multiple-entry calculations.

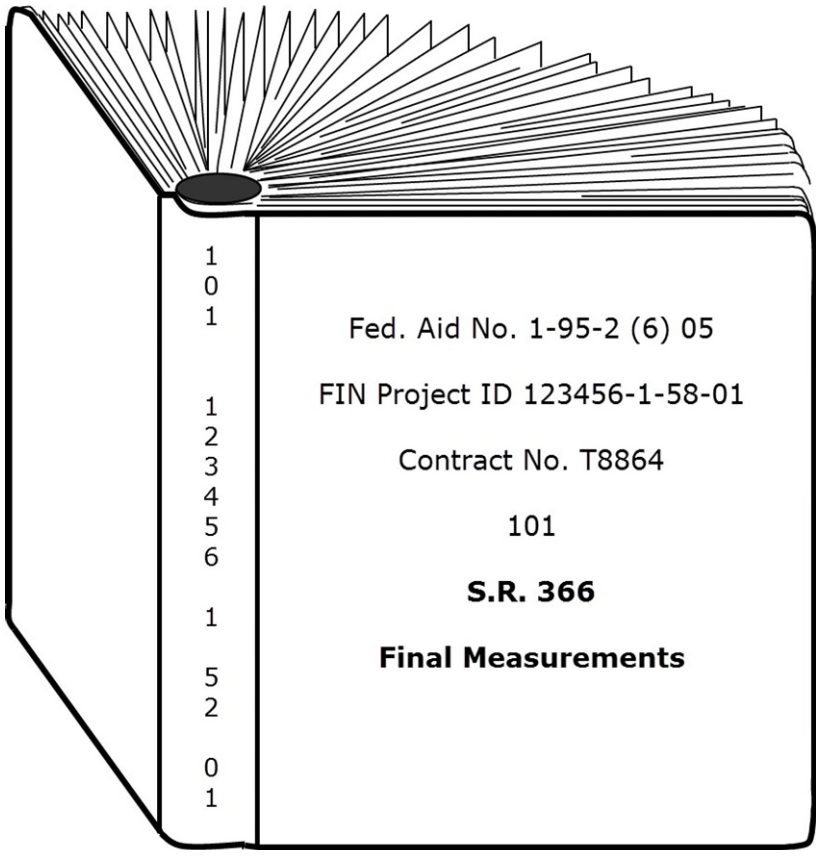
Slide 8 KNOWLEDGE CHECK

Let's test your knowledge about computations.

1) Multiple choice. When using calculators or computers, you should use the:
   A. Rules of rounding described in Construction Math Course
   B. Full decimal capabilities of the machine
   C. Construction Project Administration Manual as a guide to rounding
   D. Machine only as a backup to your manual computations
   E. None of the above

Slide 9 FIELD BOOKS

Let's discuss each of the types of final estimates source documentation.
The first type is Field Books. Field books are hard bound source documents used primarily for sketches or renderings of items in the field. However, they can also be used to document field measurements and calculations for establishing pay quantities.



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The Department has implemented a paperless initiative called e-construction and is encouraging the use of automated forms, specifically utilizing Form 700-050-61, Final Measurement Miscellaneous in place of Field Books, to save time and money and promote electronic documentation; therefore, field books are being used less.

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However, should a project need a field book, these general instructions should be followed:

1. Because field books are a source document, all information should be recorded accurately and uniformly. Field books are to be scanned into Electronic Document Management System (or EDMS).

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2. Each book is assigned a permanent reference number -- “field book number”. This number is displayed on the front cover and spine. Identify the front cover of each field book with bold letters to show the Federal Aid Project Number, Financial Project ID Number, Contract Number, Field Book Number, State Road Number, and the general contents of that book. Place the field book number and the Financial Project ID Number on the binding or spine of each field book.

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3. Clearly index each field book with a complete list of the content beginning on the first lined page, which is to be numbered Page One. Sequentially number all the following pages used to record notes in the upper right corner of each right-hand page.

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4. Record the date, weather conditions, and the names of the field party on the field book page at the beginning of each day's notes. Well documented field records are indispensable in the event of litigation.

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5. Never erase a field book record. Strikethrough the incorrect data and insert the correct data close to it. All such corrections should be initialed and dated by the person making the correction.

Slide 16

6. Do not remove pages from any field book. If an entire page is found in error, mark the original page **VOID**, and show a note referring to the page where that item of work was corrected. The voided sheet should be initialed and dated by the person making the correction.

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7. Enter field notes directly into the field books at the time and place the work is originally done. Keeping notes on loose-leaf or scratch pads and transferring them to the field books is prohibited.

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8. Create legible field records with sufficient sketches and explanatory notes to convey the intent to a person who is not familiar with the job. Include pay item numbers, original and final cross-sections, and relevant information. Good sketches are most important when recording final measurements. The details of the sketches do not need to be elaborate but should be sufficient to clearly show the extent of the work as well as any exceptions.

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9. Use standard symbols and abbreviations. Keep the notes simple and avoid making ambiguous statements.

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10. Show all pertinent measurements and observations. Use the correct precision based on the unit of measure. If there is any doubt about the need for data, record it. Review the data for accuracy and completeness before leaving the field.

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11. Create a complete summary for each item at the end of its field notes. This item summary total will then be checked and entered on the Summary of Quantity Sheets. Those persons preparing and approving the final estimate will properly cross-reference the summary and field records.

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12. Keep the calculations and measurements for Federal Aid participating and non-participating items separated in the field books. This also applies to Joint Participation Agreement items and Locally Funded Agreement items.

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13. When more than one project (State or Federal) is constructed under the same contract, keep separate field books for each project, to separate measurements and other data.

Slide 24

14. Do not record field records for projects let under separate contracts in the same field book. Field books should only contain records related to a single contract and project.

Slide 25

15. When documenting any data on grid sheets, neatness and legibility give credence to the accuracy of field notes and the calculations which they support.

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16. It is necessary for field records to contain all the necessary information for horizontal control for new construction projects and major widening projects. Submit alignment data with the final estimates documentation.

Slide 27 KNOWLEDGE CHECK

Now let's test your knowledge about field books.

1) Multiple Choice. Which of the following are NOT types of final estimates documentation?
   A. Site Source Forms
   B. Final As-Built Plans
   C. Field Books
   D. Basis of Estimates Manual
   E. None of the above.

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2) Multiple Choice. What is the proper identification for the spine of the field book?
   A. Federal Aid No. & Contract No.
   B. Contract No. & Financial Project ID No.
   C. Field Book Number & Financial Project ID No.
   D. Financial Project ID No. & Description of Contents
   E. All of the above

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3) Multiple Choice. If a field book entry is in error, how should the correction be made?
   A. Correction cannot be made
   B. Strike through and enter the correct data
   C. Strike through, enter correct data, initial, and date.
   D. Circle incorrect data and initial, but do not enter correct data.
   E. None of the above.

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4) True or false. A detailed Index of contents should begin on the first lined page (page 1) of a field book.
   A. True
   B. False

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5) Multiple Choice. If an entire page of a field book is full of errors, what should you do to remedy the situation?
   A. Carefully remove the page and start on a new page.
   B. Write the correct data on a new page.
   C. Write the correct data on a new page and mark the incorrect page void.
   D. Write the correct data on a new page, mark the incorrect page void and note where the correct information is shown. Initial and date the voided page.
   E. None of the above.

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6) True or false. You should keep notes on scratch pads and copy them in the field books at a later date so that your entries will be neater.
   A. True
   B. False

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7) True or false. Even though three financial project ID's are included in the same contract, you should combine information from all three jobs in the same Field Book.
   A. True
   B. False

Slide 34 SITE SOURCE FORMS

In addition to field books, the Department has created various forms for documenting measurements, quantities, and other important final estimate information. These forms are commonly referred to as site source forms. For some pay items, tabulation forms or delivery tickets are used as documentation for final estimate quantities. These forms are briefly described here, and some examples are shown.

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There are six main types of forms used for tracking quantities and payment:

1. Final Measurement Site Source Record, *Form 700-050-53*
2. Daily Report of Truck Measured Material, *Form 700-050-54*
3. Daily Log Sheet Miscellaneous Tabulation Form, *Form 700-050-56*
4. Final Measurement Miscellaneous, *Form 700-050-61*
5. Asphalt Roadway – Daily Report of Quality Control, *Form 675-030-20A*
6. Asphalt Roadway Verification Report, *Form 675-030-21*

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Each form is to be completed on a per-day and per item basis.
All tabulation forms should be dated for the day the work was performed.
Begin a new tabulation form for each day's run. Keep these points in mind.

- When more than one form is used, show both the page number and the total pages in the series for each day's operation, so that reviewers can verify that all forms are accounted for.
- Write the total Quantity represented and summarize each day's operation. Identify any non-pay quantities (waste or off project) on the forms.
- Cross check inspector records with contractor's records on a regular basis and reconcile any differences.
- Summarize the forms, electronically, for easy reference to back up documentation.

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1. **FINAL MEASUREMENT SITE SOURCE RECORD, *FORM 700-050-53***

This form was designed for recording field measurement, using the Latitude and Departure measuring method for various pay items. It is used to record area calculations, including odd shapes.

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2. **DAILY REPORT OF TRUCK MEASURED MATERIAL, *FORM 700-050-54***

This form is used to record the quantity for each truck as materials are delivered to the project. An example of this would be borrow excavation where it is measured by the cubic yard based on the volume per truck and the number of trucks.

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For recording volume measurements, each truck is assigned a number. All truck bodies will have a manufacturer's certification or permanent decal showing the truck capacity rounded to the nearest tenth of a cubic yard placed on both sides of the truck. This information should be inserted on the form and used to calculate the total volume hauled to the project.

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3. **MISCELLANEOUS TABULATION, *FORM 700-050-56A/56B***

This form contains 2 versions and is used for two different types of measurements: weight and bag count. Form 700-050-56A, also known as the Weight Site Source Record, can be used to record the tonnage of stone placed on a project. Form 700-050-56B, also known as the Bag Count Site Source Record, is used to record the number of sand-cement rubble bags in a location.

Let’s look at each of these forms in greater detail.

Slide 41 Bulk-Weight Pay Records

The Miscellaneous Tabulation Form (Weight Site Source Record) is used to record the gross, tare, and net weight of each pay item. Example pay items are Rip Rap Rubble and Bedding Stone which is paid by weight in tons. Additional useful information that is recorded is the truck identification number, date, and time.

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For items to be paid for by weight, supporting documentation must be submitted in addition to this form. Weight measurements will be accompanied by certified weight tickets. Certain bulk weight shipments are acceptable as necessary supporting documentation. The following criteria must be followed.

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- There are three methods for weighing material: rail, truck, or barge. Truck weights are the most common and must be done on state certified scales. The ticket indicates the gross, tare, and net weight.
- The State of Florida will recognize any scale that has been certified by a state agency outside Florida using traceable standards. All 50 states have adopted and use the same laws as Florida ***(National Institute of Standards and Technology (NIST) Handbook-44).***

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- Project personnel will record each truck number and time of loading on the ***Miscellaneous Tabulation Form, Form 700-050-56A.***
- Hauling will be done in covered trucks to minimize loss of material.
- If rail cars are used, they must be visually inspected to ensure that all material has been unloaded.
- If material is remaining in cars after the job is completed, it must be hauled by truck to state certified scales to determine the gross, tare, and net weights of the remaining material to make appropriate deductions from the car weights.

Slide 45 Bag Count Pay Records

The Miscellaneous Tabulation Form (Bag Count Site Source Record) is used to record the number of sand-cement bags at a specific location. However, the Rip Rap (Sand-Cement) pay item is paid in cubic yards. This form is designed to calculate the volume by taking the number of bags inputted on the form and multiplying it by the unit weight of one bag and then converting the quantity to cubic yards, which can then be paid.

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Like the Weight Site Source Record, the quantities in this form must be supported. In this case, if the bags were pre-made and delivered to the jobsite, the justification will be delivery tickets with corresponding quantities. If each sand-cement rubble was made on-site, the size of the bags and mixture proportions must be manually documented.

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4. **FINAL MEASUREMENT MISCELLANEOUS, *FORM 700-050-61***

The Final Measurement Miscellaneous Form was designed to replace hard bound Field Books and record the same type of field information including sketches, quantity calculations, survey information, or any needed field notes. The use of the Final Measurement Miscellaneous form is encouraged to promote the paperless e-construction initiative and save the Department money. Since this form can be completed electronically, it is not necessary to print and bind these forms together. Instead, combine forms by pay item in a PDF or PDF package and upload into EDMS for easy reference.

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Here are some examples of what can be recorded on the Final Measurement Miscellaneous Form.

Check Level / Bench Loop Notes
Many field measurements are made and documented in terms of elevations -- depth of cut, height of fill, ditch flow line elevation, etc. Roadway design features are based on a series of Benchmark (BM) elevations established along the highway at the time of the original location survey.

Since considerable time may pass between the original survey and the start of construction, these BM elevations must be checked to verify accuracy and to re-establish any that have been disturbed. All temporary BMs (TBMs) will be tied to the Project BMs unless elevations are assumed.

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"Check levels" must be run at the start of a construction project to assure that (1) construction will be done to design elevations and (2) final measurements for payment will be from the same base elevations as the original survey. Final measurement from inaccurate benchmarks could result in considerable overpayment or underpayment to contractors.

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Detailed instructions for establishing and checking benchmarks are included in the Department's Survey Handbook.

Slide 51 Cross Section Notes

The volume of most earthwork is measured by cross sections -- original ground line cross sections before construction and final cross sections on completion of the work. Cross section notes are recorded on field records.

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Procedures for preconstruction cross sections are described in both the Construction Project Administration Manual (CPAM) and the Survey Manual.

Slide 53 Final Measurements

Field records generally are used for recording measurements in the field as work is completed. These notes are used to prepare progress estimates and are summarized as the basis for final estimates when a project is completed.

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Various types of measurements are recorded – such areas, volumes, lengths, and individual construction items, which are paid for as "per each." There is no fixed format for these notes. However, it is important that they are neat, legible, and accompanied by good sketches, when needed, so they can be clearly understood.

Slide 55 KNOWLEDGE CHECK

Let's test your knowledge about the Site Source Forms and what they can be used for.

1) Multiple Choice. "Check Levels" must be run at the start of a construction project to assure that:
   A. Liquid Bituminous Material in Asphalt distributors is measured accurately.
   B. Construction will be done to Contractor's elevation.
   C. Final measurements for payment will be from the same base elevations as the original survey and the construction will be done to design elevations.
   D. Paver screeds are calibrated to lay down pavement of uniform thickness.
   E. None of the above.

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2) Multiple Choice. In which Manual(s) are the procedures for running check levels and cross sections described?
   A. Review and Administration Manual
   B. Basis of Estimates Manual
   C. Survey Handbook
   D. Construction Project Administration Manual
   E. Both C and D

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3) True or false. Information within Final Measurement Miscellaneous forms should never be discarded.
   A. True
   B. False

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4) Multiple Choice. What should be included with final measurements and calculations, so that non-standard measurements may be interpreted accurately?
   A. Sketches.
   B. Plan Sheets.
   C. Tabulation Forms.
   D. Computer Outputs.
   E. None of the above.

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5. ASPHALT ROADWAY – DAILY REPORT OF QUALITY CONTROL (QCRR), FORM 675-030-20A

The purpose of this form is to record the daily asphalt paving operations. Information collected on this form will include the date, type of material, lot, sublot, the location of the material placed, widths, lanes, lift number, tonnage, spread rates and other relevant information. The Contractor's Quality Control Technician is responsible for filling out the Quality Control forms; however, it must be approved by the Department's Project Administrator prior to payment. The Contractor and Department personnel should coordinate on asphalt quantities frequently to confirm there is consensus in the quantities prior to payment.

Slide 60

The QCRR is also used to determine the adjusted plan quantity and pay quantity limit (105% or 110%) for final payment.

Delivery Tickets

Since asphaltic concrete is a final measure item which is paid by tonnage, printed or electronic delivery tickets are used as documentation for Final Estimate quantities. They are used in conjunction with the QCRR as verification for the tonnage paid. Asphaltic Concrete delivery tickets are used to record the weight and distribution of all material produced at the Asphalt Plant.

Slide 61

All Asphalt Plants are to be equipped with Electronic Weigh Systems with Automatic Ticket Printout or real-time Electronic Ticketing (e-Ticketing) Software. Ensure the following information, at a minimum, is provided on the delivery ticket or the e-ticketing monthly report.

a) Sequential load number
b) Financial project ID Number
c) Date
d) Name and location of plant
e) Type of mix
f) Place for hand recording mix temperature
g) Truck number
h) Gross, tare, and net weights (as applicable)
i) Daily total tonnage of mix

Slide 62

Each printed Asphaltic Concrete delivery ticket consists of an original and at least one legible copy.

1. The original “white” ticket is retained by the Plant Verification Technician, then scanned into PDF format to become part of the Lot Submittal Package.
2. One copy is retained by the Roadway Verification Technician.

Slide 63 KNOWLEDGE CHECK

Let’s test your knowledge about asphalt documentation.

1) True or false. All asphaltic delivery tickets are used as documentation for Final Estimates quantities.
   A. True
   B. False

Slide 64

2) True or false. Cross check inspector records with the Contractor’s records on a regular basis and reconcile any differences.
   A. True
   B. False

Slide 65

3) Multiple Choice. What is the name of the report used by the Contractor's Quality Control Technician?
   A. Asphalt Plant Worksheet
   B. Record of Bituminous Materials
   C. Asphalt Roadway – Daily Report of Quality Control (QCRR)
   D. Roadway Density Worksheet
   E. None of the above

Slide 66

6. **ASPHALT ROADWAY VERIFICATION REPORT, *FORM 675-030-21***

The Department's Verification Technician is responsible for filling out the Asphalt Roadway Verification (VT) Report. This form is used by the Department's personnel to verify spread rates of asphalt, adequate temperatures and record the volumes of bituminous materials such as tack, prime, surface treatment, etc.

Slide 67

To measure bituminous materials, such as tack, the liquid must be measured prior to distribution and again after distribution. The difference is the quantity delivered. Depth measurements are taken from the top of the dome to the top of the material and are recorded to the nearest whole 16th of an inch. Conversion charts can be used to convert the inch measurements to gallons. All distributors must be calibrated and assigned a DOT tank number. Materials will not be accepted from a distributor, which has not been previously calibrated.

Slide 68

The volume of liquid bituminous material varies considerably with changes in temperature. The specifications require that measurements of pay gallons be corrected to a standard temperature of 60 degrees Fahrenheit. Because the depth measurements reflect volumes of bituminous material, adjustments must be made with temperature correction factors selected from tables furnished by the Department or calculated by the formula in the Standard Specifications book.

Slide 69

In the event of a discrepancy between the QCRR and the VT Report, resolution testing must be done. A resolution report will be provided by an independent laboratory.

Slide 70 KNOWLEDGE CHECK

Let's test your knowledge of the asphalt verification testing.

1) True or false. The depth of material in a tank can be converted to gallons with a Tank Calibration Chart.
   A. True
   B. False

Slide 71

2) Multiple Choice. What is the name of the report used by the Department's Verification Technician?
   A. Asphalt Plant Worksheet
   B. Asphalt Roadway Verification (VT) Report
   C. Asphalt Roadway – Daily Report of Quality Control
   D. Roadway Density Worksheet
   E. None of the above

Slide 72

3) True or false. Measurement of tack coat will be measured from the bottom of the dome to the top of the material in the tanker.
   A. True
   B. False

Slide 73 COMPUTER INPUT / OUTPUT

Computer Input / Output sheets are typically used to show the computations of pay item quantities. Information is input into a software program which automatically calculates the quantity, typically an area, volume, or weight. An example of this is the volumetric calculations for subsoil earthwork quantities.

Slide 74

Typically, a computer program, such as Trimble Business Center, is used to compare multiple surveyed surfaces and calculate an earthwork quantity. This is far quicker and more accurate than manual calculations. Computer Input / Output sheets must be uploaded in EDMS for justifying payment of the calculated quantity.

Slide 75 FINAL AS-BUILT PLANS

The Final As-Built Plans are an electronic set of plans which document the original plans with all changes made during construction and shows the "as-built" conditions. The original set of plans are signed and sealed by the Engineer of Record. However, the Final As-Built plans will be signed and sealed by the Responsible Engineer. The contents of the Final As-Built Plans can vary from project to project but should always contain the sheets necessary to show all the work performed. They should include all design and construction changes and shop drawings with adequate sketches, dimensions, and notes. Guidance on how to properly document the changes can be found in Section 5.12 of the Construction Project Administration Manual.

Slide 76

All changes made by the Resident Office will be made in red font by striking through the original information and inserting the changes. The location of any backup documentation to support the changes will be referenced.

Procedures for updatingin the Final As-Built Plans are described as follows:

Slide 77

Receiving the Contract Plans and Creating the Final As-Built Plans

1. The District Construction office will forward a signed and sealed electronic set of Contract Plans to the Resident Office for use during construction.
2. The Resident Office will save this signed and sealed electronic set of Contract Plans into the collaboration site under the Original Plans folder.

Slide 78

3. The plans will then be extracted to the Final As-Built Plans folder (within the collaboration site) by component so any changes during construction can be recorded. All changes made to the project will be electronically reflected on these plans. Do not discard pages from this set.

   The Final As-Built Plans will be submitted as part of the Final Estimates Documentation at the conclusion of the project for review by the District Final Estimates Office (DFEO).

4. Shop drawings for bridges and other structures will be processed according to Structures Design Guidelines.

Slide 79
Updating the Final As-Built Plans

Update the Final As-Built Plans submitted with the Final Estimates Documentation as the project progresses. All additions, deletions, and revisions are to be clearly delineated to reflect the actual conditions of the completed project. All changes will be noted electronically in red by the Resident Office. If an entire plan sheet is revised, imprint "VOID" on the original plan sheet using red text, and insert the new plan sheet after the original (old) sheet in the Final As-Built Plans set. One exception is revised Key Sheets(s), which should be placed in front of the voided Key Sheet.

Slide 80

All revised sheets will be defined on the Signature Sheet of the appropriate component and must be signed and sealed by the responsible Professional Engineer or Resident Engineer. All changes made by the Resident Engineer (in red) will be detailed on the As-Built Signature sheet for each component, and the Responsible Engineer will add the appropriate statement of disclaimer prior to signing and sealing the Final As-Built Plans.

Slide 81
Signing and sealing means sheets will be digitally signed, dated, and the Professional Engineer license number will be noted. The image of the Professional Engineer license seal is no longer required when signing and sealing the Final As-Built plans. If the plans are electronically signed and sealed, then Florida Administrative Code 61G15-23.02 must be followed. No pages are to be discarded from this set.

Slide 82

Now let’s discuss the main components of the Final As-Built Plans. This includes the:

- Key Sheet
- Signature Sheet

- Typical Sections
- Summary of Quantities, if applicable
- Plan Sheets
- Summary of Drainage Structures,
- Optional Materials Tabulations and Drainage Structure Sheets
- Cross Sections

Slide 83

Key Sheet

The Key Sheet of the Final As-Built Plans will show the following data.

a) Prominently redline “Final As-Built Plans” across the top of the sheet in place of or above the "Contract Plans" preprinted line.
Line through or completely delete the words "Contract Plans".

Slide 84

b) On the right side and near the lower corner of the Key Sheet, display the following information in red font:

- Name of Prime Contractor
- Name of the Prime Consultant Construction Engineering Inspection firm (if it is an In-House project, state so)
- Name of District Secretary, Resident Engineer, and Project Manager
- Project Administrator
- Date the work started
- Date the work was final accepted or completed

Slide 85

c) List a complete Index of the related documents on the left side of the Key Sheet, not to exclude the following:
    - A complete list of permanent field books and a general description of their contents.
    - Additional plans such as shop drawings.
    - Other As-Built Plans or Drawings, such as Jack & Bore, Boring Path Reports, Bore Logs, Plowing or Signalization.

Slide 86

d) Correct all project date descriptions, Financial Project ID Numbers, length, etc., shown on the Key Sheet, to agree with the actual construction before the Final As-Built Plans are submitted.

Slide 87
Signature Sheets

The Final As-Built Signature Sheet is the Construction version of the Signature Sheet required for Designers in the Original Contract Plans. The Final As-Built Signature sheet must be signed and sealed by the Responsible Engineer and include a disclaimer stating changes were made or were not made to the Original Contract Plans. There are two scenarios to the Statement of Disclaimer:

Slide 88

- "The above-named professional engineer shall be responsible for the following changes, indicated in redline revision, in accordance with Rule 61G15-23.004, F.A.C. This project was constructed in substantial compliance with these plans as provided by the Engineer of Record."
- "This project was constructed in substantial compliance with these plans as provided by the Engineer of Record. These plans reflect "as-built" conditions and no changes were made to the plan sheets."

Slide 89

All additions, deletions, and revisions to the Final As-Built Plans during construction are to be shown on the Final As-Built Signature Sheet(s) for each component to include:

- Sheet number on which the change is shown in the plans
- A brief description of the revision

Slide 90

Each person applying markups or changes and all reviewers must fill out the table in the bottom right-hand corner of the As-Built Signature Sheet. It is important to identify all personnel who update and review the Final As-Built Plans in case of litigation or claims.

Slide 91
Typical Section Sheets

Authorized revisions to the typical section are to be marked on these sheets. Documentation for such revisions shall be included as a part of the final estimates documentation. Some typical examples include:

a) An increase or decrease in thickness
b) A change in type of material
c) Substitution of pay items
d) Change in limits of work
e) Addition/Deletion of items of work
f) Other Geometric designs (such as varied cross slope)

Slide 92
Summary of Quantities and Estimated Quantities Report

The designer's plan quantities and the final constructed quantities are summarized on the Summary of Quantities Sheets in the Plan Summary Boxes within the Final As-Built Plans. Projects with NexGen plans will have a standalone Estimated Quantities Report (EQR) with a series of summary tables which combine the designer's plan quantities and the final constructed quantities.

For Conventional Projects, projects that contain pay items, the plans will include Summary of Quantities Sheets with Plan Summary Boxes or a standalone Estimated Quantities Report (EQR). The Designer provides the pay item number with the corresponding quantity in the Plan Summary Boxes or EQR for each pay item shown in the plans.

Quantity changes must be substantiated by documentation. Record final quantities and reference supporting documentation on the Summary of Quantities Sheets, when applicable. Verify quantities and reference all backup documentation on the Pay Item Summary and Certification form.

Slide 93

On Lump Sum & Design Build Projects, there are no pay item numbers. Instead, there are pay item descriptions such as Superpave Asphaltic Concrete or Optional Base. The Designer will breakout the estimated quantities into the appropriate Summary of Quantity Boxes by displaying the pay item description and not the pay item number. Only the pay item description will be shown with an estimated quantity used by the Contractor during the bidding process.

Slide 94
Plan Sheets

The Plan Sheet details for all the major groups of plans become the permanent historical record of the construction project. All changes in construction that would constitute a conflict in this record must be clearly delineated on the Final Plan Sheets. Insert revisions and cross out all incorrect data.

Slide 95

The following revisions must be noted:

a) Revisions to the horizontal and vertical alignments as shown on the original plans.
b) Stations or equations that have been introduced or revised during construction.
c) Intersection and crossover details that have been modified or relocated.

Slide 96

d) Inlets, manholes, box culverts and end walls that were added, relocated, revised, or deleted.
e) All sidewalk that was modified, thickness or otherwise and all curb and gutter and shoulder gutter that was added, revised, or deleted.
f) All driveways that were not shown on the original plans, or were shown but are no longer in existence, or were modified in thickness or otherwise.
g) All ditch locations and grades that were adjusted during construction.
h) Changes in fencing items including gate locations.

Slide 97

i) Sign locations that were changed and pavement markings that were modified.
j) All signal details that changed during construction.
k) All Bridge, Approach Slab and Lighting details that differ from the actual construction.
l) Benchmarks set during construction and their descriptions added to the profile portion of the plan sheets.
m) All Utility relocates and/or conflicts reflected on the Utility Adjustment Sheets

Slide 98

Summary of Drainage Structures, Optional Materials Tabulations and Drainage Structure Sheets

The **Summary of Drainage Structures, Optional Materials Tabulations and Drainage Structure Sheets** are used to document all information about drainage structures. The drainage quantities are recorded on the Summary of Drainage Structures sheets rather than the Summary of Quantities sheet**.** Any significant changes during construction such as stationing, additions and/or deletions, are recorded in these sheets as construction progresses. This allows final pay **quantities to be easily tabulated and verified from the summary.**

Slide 99

Ensure revisions made on the Final As-Built Plans set reflect:

a) Actual construction length only when an authorized field change is made, or a plan error is noted.
b) Changes in flow line elevations on the ***Plan and Profile Sheets***.
c) Changes in stations or offset dimensions.
d) Changes in size of structures.

Slide 100

e) Added/Deleted structures.
f) Type of pipe material and thickness used at each structure on the ***Drainage Structures Sheets*** and the ***Optional Materials Tabulation Sheets***. Check the as-built column to indicate what type of pipe material and thickness was used at each structure.
g) Types of inlets and manholes constructed .
h) Plan errors distinguished from field revisions due to different tolerances, when the method of measurement is plan quantity for cross drain and storm sewer pipes, .
i) All significant adjustments in horizontal alignment flow line grade is on the ***Plan and Profile Sheets***. Adjust the cross section to reflect the revision if a pay quantity adjustment is required.

Slide 101
Cross Section Sheets

The disposition of the ***Cross Section Sheets*** with regard to a set of Final As-Built-Plans depends on the method of payment set up for the earthwork items.

(a) **Excavation Borrow Pits, Excavation Subsoil,** and **Excavation Channel on Cubic Yard Basis**: Final cross section sheets and volumetric computations are to be prepared and included in the Final As-Built Plans. They are required to reflect the actual work accomplished and are the basis of final pay quantities. The original plan cross sections remain a part of the Final As-Built Plans.

Slide 102

(b) **Embankment, Regular Excavation,** and **Lateral Ditch Excavation on Cubic Yard Plan Quantity Basis**: The original design cross sections are used as the basis for both plan and final pay quantities and to control grading operations. They are to be retained as part of the Final As-Built Plans. Additional cross sections to correct plan errors and/or to reflect field revisions are prepared and added to the Final As-Built Plans. Detailed instructions pertaining to earthwork are included in ***Section 5.16*** of the ***Construction Project Administration Manual***.

Slide 103 KNOWLEDGE CHECK
Now let's test your knowledge about Final As-Built plans:

1) Multiple Choice. The changes to the Final As-Built Plans:
   A. Should be signed and sealed by the Responsible Engineer
   B. Should be done electronically in red.
   C. Should be made by voiding the original information and recording the corrections.
   D. All of the above
   E. None of the above

Slide 104

2) True or False. On the left side of the Key Sheets a complete Index of the documents related to the Final As-Built Plans should be shown.
   A. True
   B. False

Slide 105

3) True or False. Excavation Borrow Pits, Excavation Subsoil, and Channel Excavation are to be final measured. Final cross section sheets and volumetric computations are to be prepared and included in the Final As-Built Plans.
   A. True
   B. False

Slide 106

4) Multiple Choice. Which of the following is the purpose of Plan Summary Boxes?
   A. To show the Designer's original plan quantity
   B. To show the final quantity as the project progresses
   C. To allow a central place to reference all supporting documentation for final quantities
   D. All of the above
   E. None of the above

Slide 107

5) True or False. Additional plan sheets to correct plan errors and/or to reflect field revisions may be needed and will be added to the Final As-Built Plans.
   A. True
   B. False

Slide 108

ROADWAY AND BRIDGE DAILY WORK REPORT

The project's Daily Work Report is a recorded collection of events for a single day of contract time. It will include site conditions (including weather and temperature), contract time summary, personnel and equipment on the job site, any accidents or situations, and estimated work performed each day during a construction project. Data is collected on every phase of work performed by the Prime Contractor, Subcontractor or Utility Company. Recorded information must be clear, detailed, accurate and objective. Anyone reading the project's Daily Work Report should be able to comprehend the project status and determine work performed.

Slide 109

It is important to understand that the daily work report records only estimated quantities and is not to be used for final payment purposes. Quantities that appear on this document are not recorded with appropriate computations and exact measurements at the site. Therefore, actual measurements, computations and quantities for final payment purposes shall be recorded on the appropriate site source records. The site source record should then be referenced on the daily work report as the source of final payment. This will avoid any confusion with the contractor or others who may review the daily work report later.

Slide 110

Now let's test your knowledge.

1) Multiple choice. Please match the appropriate documentation name with the correct description below:

   A. [Final As-Built Plans]: For reviewing contract time charges, occurrences, instructions, and work performed each day: [Computer Printout]: Document pertinent changes during construction and show the "as-built" condition; [Field Books]: Contains alignment notes and cross section notes, etc.

   B. [Daily Work Report]: For reviewing contract time charges, occurrences, instructions, and work performed each day; [Final As-Built Plans]: Documents pertinent changes during construction and shows the "as-built' conditions; [Field Books]: Contains sketches, alignment notes, cross section notes, etc.

   C. [Final As-Built Plans]: For reviewing contract time charges, occurrences, instructions, and work performed each day; [Tabulation Forms]: Document pertinent changes during construction and show the "as-built' conditions; [Field Books]: Contains alignment notes and cross section notes, etc.

   D. [Final As-Built Plans]: For reviewing contract time charges, occurrences, instructions, and work performed each day; [Daily Work Report]: Document pertinent changes during construction and show the "as-built" conditions; [Field Books]: Contains alignment notes and cross section notes, etc.

   E. None of the above

Slide 111

This is the end of Module 2. Thank you for your time and attention.

MODULE 3 - AREA MEASUREMENTS

Slide 1 WELCOME

Welcome to the Final Estimates Level 1 course, Module 3 – Area Measurements, offered through the Construction Training Qualification Program. This Final Estimates training course consists of 8 modules and covers the preparation of final estimates by field personnel. This training contains interactive elements. An alternate transcript version is available. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

Many pay items are computed based on area measurements. These items can include roadway base, sidewalks, ditch pavement, slope pavement, and performance turf. This module will describe methods for performing these calculations and provide example problems to illustrate documentation for final estimates.

Slide 3

Chapter Eight of the Construction Math CBT training course is entirely devoted to basic information on area measurements and area calculations. If you have trouble with the information covered in this module, review Chapter Eight of the Construction Math course again.

Slide 4 METHODS FOR COMPUTING AREAS

Three methods for computing areas are described in this module:

- geometric formulas (including applications of trigonometry)
- latitudes and departures
- computer programs

We will study all three methods, but first let's review a few basic points about units of measurement.

Slide 5 UNITS OF MEASUREMENT

Areas are usually measured in terms of square feet (SF), square yards (SY), or acres (AC). Sometimes the field measurements and the computations are in units different from those specified for the pay items, and it is necessary to convert answers from one unit to another. For example, since most field measurements are recorded in linear feet, it is convenient to calculate areas in square feet. But a conversion must be made when the pay item is in acres or square yards.

Just keep in mind these relationships:

1 AC = 43,560 SF
144 $in.^2$ = 1 SF
9 SF = 1 SY

Slide 6

Another thing to keep in mind is if you don't get the same answer the difference is probably due to rounding. In practical applications, answers are computed by using the full capacity of a calculator. In this course, however, we will use the following rules of rounding:

Item	No. Of Decimal Places
Pi (π) will be rounded to	3.1416
Converted inches to feet will be rounded to	4 decimal places
Radians will be rounded to	7 decimal places
And Trigonometric Functions	4 decimal places

Now let's get into the area computation methods, beginning with geometric formulas.

Slide 7 GEOMETRIC FORMULAS

Nearly all areas - even irregular shapes - can be computed by a mathematical formula or a combination of several formulas. This method is not always the easiest way to determine areas - but if we understand this first, it will help us to understand other methods.

Slide 8

In studying geometric formulas, we will divide our discussion into:

- rectangles, parallelograms, trapezoids
- triangles (including trigonometric relationships)
- circles (including radians)
- combinations of shapes

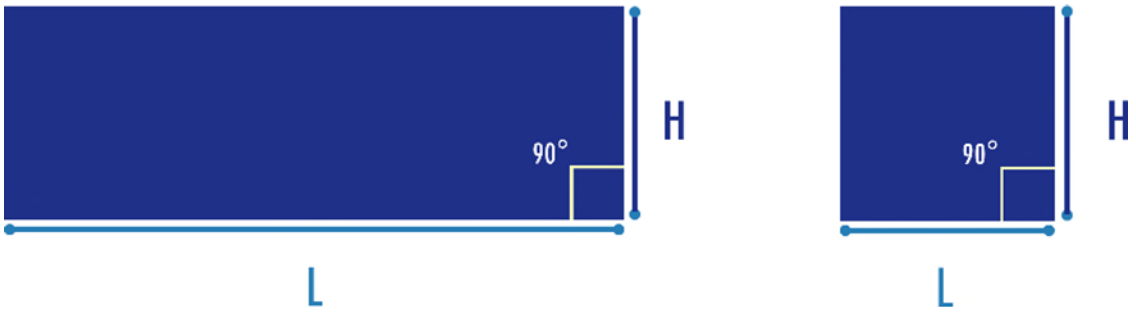
Slide 9 Rectangles, Parallelograms, Trapezoids

These are the simplest area computations and are applicable to many highway features. The basic formula is:

Area = Length x Height (A = L x H)

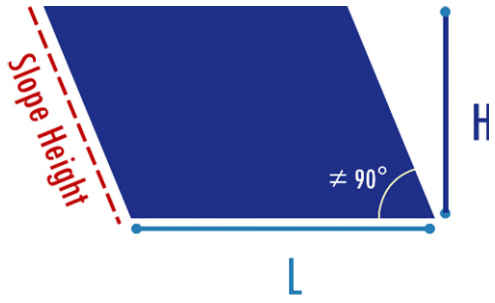
… but there are a few special points toremember.

Rectangles are four-sided figures with opposite sides parallel and four 90° angles. A square is a special type of rectangle with all sides of equal length.



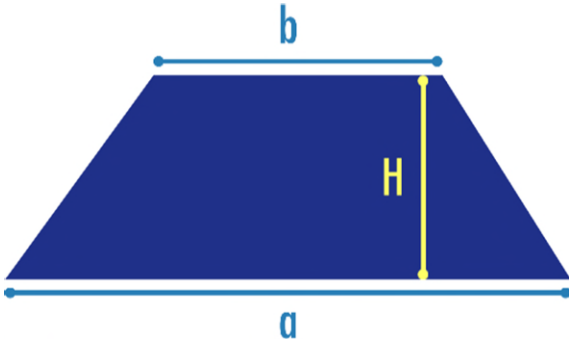
Slide 10

Parallelograms also have parallel opposite sides, but the angles are larger or smaller than 90°.For these figures, the height (H) is always measured perpendicular to the base side. Do not use the slope height for computations.



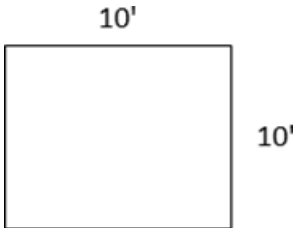
Slide 11

Trapezoids have only two parallel sides. The length used for computation of areas is the average of the lengths of the parallel sides.



Slide 12 Square Area Example

Calculate the area for the square shown.
Each side equals 10 ft.
Answer to the nearest Square Foot.



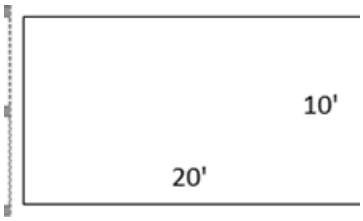
Slide 13

Solution: Area for a square equals length x height, which in this example equals 10 feet times 10 feet. This makes the area of this square 100 square feet.

$$\text{Area} = \text{Length} \times \text{Height} = 10 \text{ ft.} \times 10 \text{ ft.} = 100 \text{ SF}$$

Slide 14 Rectangle Area Example

Calculate the area of the rectangle shown.
Answer to the nearest Square Yard.



Slide 15

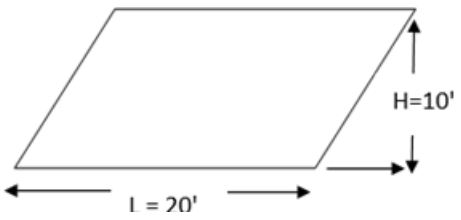
Solution: Area for a rectangle equals length x height, which in this example equals 20 feet x 10 feet. This makes the area of this rectangle 200 square feet. However, the problem asks for the solution to be given in square yards. Remember that the way to convert square feet to square yards is to divide by 9. 200 divided by 9 equals 22.22. The problem also asks that we give our answer in the nearest square yard. We should round our answer, which gives a final answer as 22 square yards.

$$\text{Area} = \text{L} \times \text{H} = 20 \text{ ft.} \times 10 \text{ ft.} = 200 \text{ SF}$$

$$\frac{200}{9\frac{\text{SF}}{\text{SY}}} = 22.22 \text{ SY} = 22 \text{ SY}$$

Slide 16 Parallelogram Area Example

Calculate the area of the Parallelogram shown.
Answer to the nearest Square Foot.



Slide 17

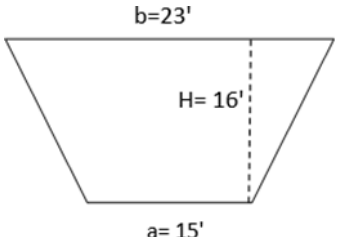
Solution: Area for a parallelogram equals length x height. In the case of a parallelogram, we need to remember to determine the height based on the perpendicular measurement to the base side. In this example, the area would be 20 feet x 10 feet, making the area 200 square feet.

$$\text{Area} = \text{L} \times \text{H} = 20 \text{ ft.} \times 10 \text{ ft.} = 200 \text{ SF}$$

Slide 18 Trapezoid Area Example

Calculate the area of the Trapezoid shown.
Answer to the nearest Square Yard.

$$\text{Area} = \left[\frac{a+b}{2}\right] H$$



Slide 19

Solution: Area for a trapezoid is the average of the two parallel sides or bases, times the height. The height is determined in the same way for a trapezoid as a parallelogram – perpendicular to the base. In this example, add the two bases 15 ft. and 23 ft. which equals 38. Divide 38 by 2 to get 19 - the average of the two bases. Then multiple by the height or 16 ft. 19 times 16 equals 304 square feet.

Remember the problem asked for the answer in square yards. Divide 304 by 9 to get 33.78 square yards. Round to the nearest square yard, which gives us a final answer of 34 square yards.

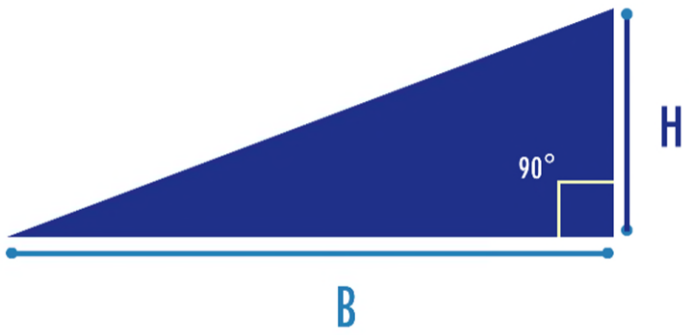
$$\text{Area} = \left(\frac{a+b}{2}\right) H = \left(\frac{15 \text{ ft.} + 23 \text{ ft.}}{2}\right) 16 \text{ ft.} = \left(\frac{38 \text{ ft.}}{2}\right) 16 \text{ ft.} = (19) 16 \text{ ft.} = 304 \text{ SF}$$

$$\text{Area} = \left(\frac{304 \text{ SF}}{9 \,{}^{\text{SF}}/_{\text{SY}}}\right) = 33.78 \text{ SY} = 34 \text{ SY}$$

Slide 20 Triangles

Any triangle can be treated as one-half of a rectangle or parallelogram. The area, then, is one-half of the product of the base (B) times the height (H).

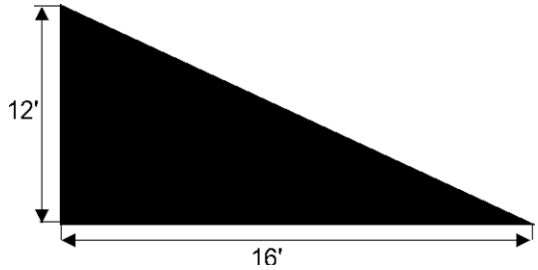
$$A = \frac{BH}{2}$$



Remember, H is measured perpendicular to the base of the triangle not along the slope.

Slide 21

Let's find the area of the triangle shown. We will answer to the nearest square foot. Height = 12 inches and Base = 16 inches. Because H is perpendicular to the base B, we can use the equation **A= BH/2.**



Slide 22

So, the area would be 16 inches (base) times 12 inches (height), divided by 2. This equals 96 square inches.

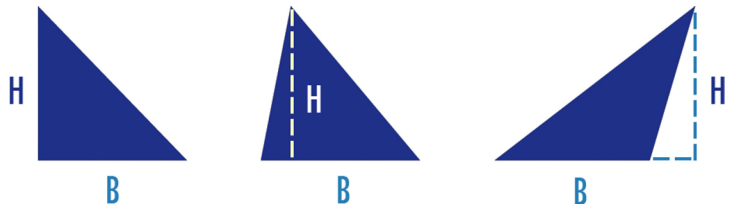
$$A= \frac{16 \text{ in x } 12 \text{ in}}{2} = 96 \text{ in.}^2$$

Slide 23

However, the answer needs to be to the nearest Square Foot. Remember that you can find square feet by dividing any value of square inches by 144. 96 divided by 144 equals 0.667 square feet. The problem asks for an answer in the nearest square foot, so we will round our answer to 1 square foot.

$$A= \frac{96 \text{ in.}^2}{144 \frac{\text{SF}}{\text{in}^2}} = 0.667 \text{ SF} = 1 \text{ SF}$$

Slide 24Here are three examples of triangles that would include the height.



To use the Area = Base times Height divided by 2 formula, you must know the height.

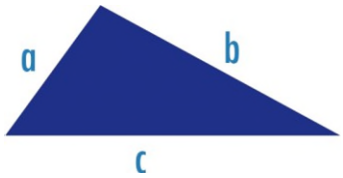
But what if we don't know the height? Well, if we know the lengths of all three sides, we can compute the area using this formula:

$$\text{Area} = \sqrt{s\,(s - a)\,(s - b)\,(s - c)}$$

$$S = 0.5\,(a + b + c)$$

Slide 25

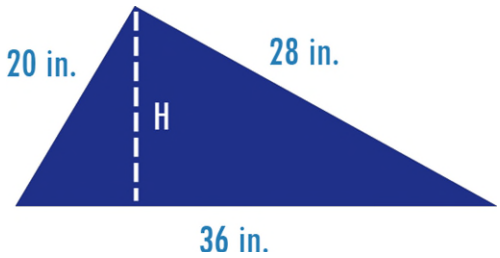
The square root of S times S minus A times S minus B times S minus C, where S equals half of the total sum of all three sides. Simply put, one half times a+b+c, where a, b, and c represent the length of the sides of the triangle.



Slide 26

Here is an example of a triangle where height is unknown and where the length of all sides is known:

The values for this triangle are a=20 inches, b=28 inches, and c=36 inches. Let's find the area to the nearest square foot.



Slide 27

First, we need to calculate the variable for "s". Because we know all three sides, we can add these values and multiply by 0.5. The sum of a, b and c or 20 + 28 + 36 equals 84. One-half of 84 equals 42. Now we have a value for s; s equals 42.

$$S = 0.5(a + b + c) = 0.5(20\text{ in.} + 28\text{ in.} + 36\text{ in.}) = 0.5(84\text{ in.}) = 42\text{ in.}$$

Slide 28

Based on our equation, we now plug in the values for s, a, b, and c. Next, we will use order of operations to solve the equation. According to the order of operations, we must first address the items in parentheses, subtracting each side from s. 42 minus 20 equals 22. 42 minus 28 equals 14. 42 minus 36 equals 6. This leaves us with the square root of 42 times 22 times 14 times 6.

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

$$\text{Area} = \sqrt{42\text{ in }(42\text{ in} - 20\text{ in})(42\text{ in} - 28\text{ in})(42\text{ in} - 36\text{ in})}$$

$$\text{Area} = \sqrt{42\text{ in }(22\text{ in }})(14\text{ in})(6\text{ in})}$$

Slide 29

Again, the order of operations dictates that we must perform our multiplication before we can use the square root. So, we will multiply these 4 values to arrive at 77,616. The square root of 77,616 rounded to the second decimal place is 278.60 square inches. The problem asks us to provide our answer in square feet. Using our conversion table, we know to divide square inches by 144 to calculate square feet. The area of the triangle is 1.93 square feet. The problem also asked that we round to the nearest foot. Our final answer is 2 square feet.

$$\text{Area} = \sqrt{77{,}616\ \text{in}^4}$$

$$\text{Area} = 278.60\ \text{in}^2$$

$$\text{Area} = \frac{278.60\ \text{in}^2}{144\ \frac{\text{in}^2}{\text{SF}}}$$

$$\text{Area} = 1.93\ \text{SF} = 2\ \text{SF}$$

Slide 30 KNOWLEDGE CHECK

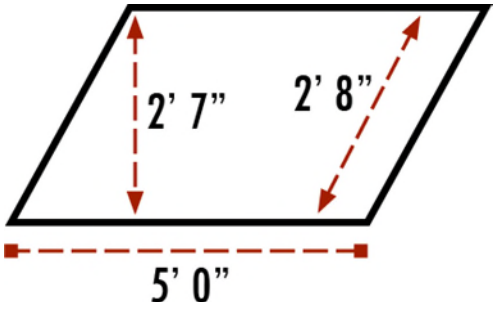
Now let's test your knowledge of calculating areas of various shapes.

1) The unit of measurement for Pay Item No. 285-7 – Optional Base is Square Yards. Which of the following is the area of a 25-foot-wide base, constructed between Station 234+20 and Station 295+31, to the nearest square yard?
   A. 16,975 SY
   B. 152,775 SY
   C. 16,974.55 SY
   D. 152,774.90 SY

Slide 31

2) The area of the parallelogram shown is 21.55 square feet.

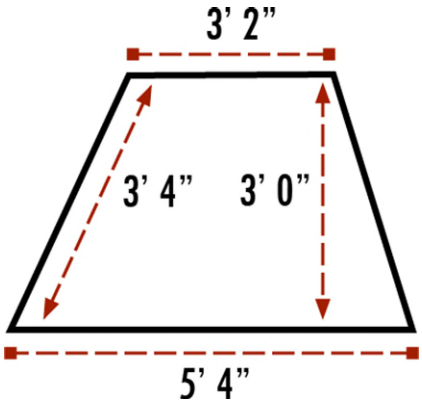
   A. True
   B. False



Slide 32

3) The area of the Trapezoid shown is 12.75 square feet.

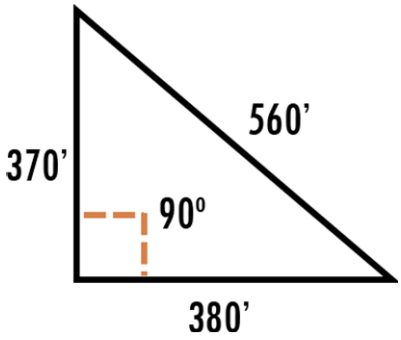
A. True
B. False



Slide 33

4) The area of the Triangle shown is 70,300 square feet.

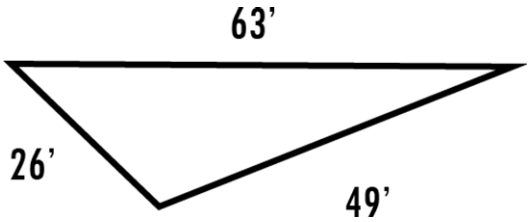
A. True
B. False



Slide 34

5) The area of the Triangle shown is 492.1 square feet.

A. True
B. False



Slide 35

6) If an acre has 43,560 square feet, how many square feet are in 2 and two-tenths acres?

A. 65,322 SF
B. 95,832 SF
C. 19, 800 SF
D. 91,476 SF

Slide 36 Trigonometric Relationships

Sometimes it is necessary to use trigonometric relationships to calculate dimensions when all sides aren't known. Let's review a few of the relationships that can be helpful.

In the case of a right triangle (where one angle is 90°) we can find the length of any side if we know the length of the other two sides. The known relationship is that the square of the hypotenuse (side opposite the 90° angle) is always equal to the sum of the squares of the other two sides ("adjacent" and "opposite" sides). This is known as the Pythagorean Theorem.

For example:

If we know the length of sides a and b, then:

$c = \sqrt{a^2 + b^2}$

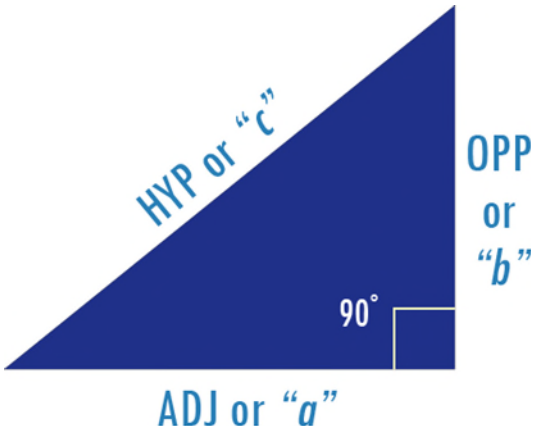
If we know a and c, then:

$b = \sqrt{c^2 - a^2}$

$b = \sqrt{c^2 - a^2}$

If we know b and c, then:

$a = \sqrt{c^2 - b^2}$

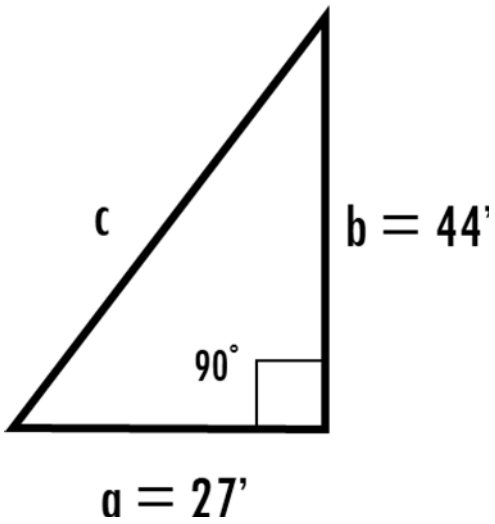


Slide 37 KNOWLEDGE CHECK

Now let's test your knowledge of calculating triangular lengths and areas.

1) Calculate the length of side c in the triangle below to the nearest foot.

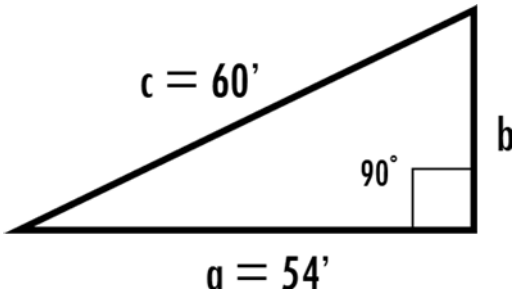
A. 51 ft.
B. 71 ft.
C. 52 ft.
D. 75 ft.



Slide 38

2) Determine which of the following is the length of side b (to the hundredths of a Foot) and the area (to the nearest Square Foot) of the triangle shown.

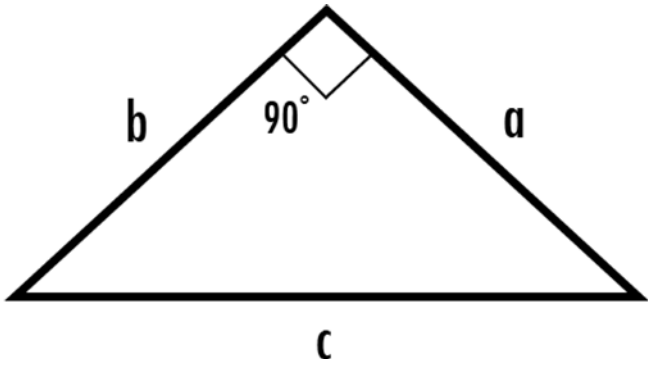
A. Length b = 28.83 ft. and Area = 778 SF
B. Length b = 26.15 ft. and Area = 706 SF
C. Length b = 27.46 ft. and Area = 741 SF
D. Length b = 30.27 ft. and Area = 817 SF
E. None of the above.



Slide 39

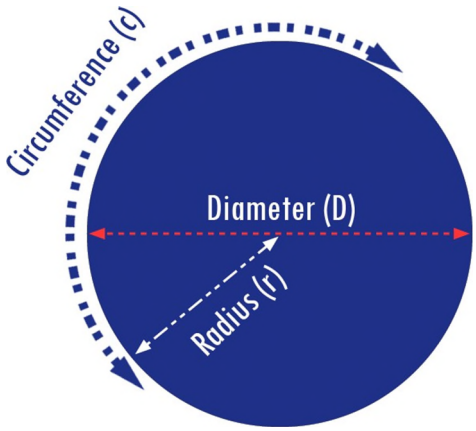
3) Determine which of the following is the length of side c (to the nearest Square Foot) and the area (to the nearest square foot) of the triangle shown Note: a = b = 17 ft.

A. c = 24 ft.; Area = 145 SF
B. c = 21 ft.; Area = 355 SF
C. c = 22 ft.; Area = 560 SF
D. c = 29 ft.; Area = 155 SF



Slide 40 ***Circles***

Circles are entirely symmetrical in shape. Each circle contains a circumference, diameter, and a single radius. Because the radius of a circle starts at the center, it is always half of the diameter. Therefore, the diameter is 2 times the radius.



Diameter(D) = 2 x Radius(r)

Slide 41

The circumference is the length around the perimeter of the circle and can be calculated as Pi times the Diameter of the circle. Remember π (Pi) equals 3.1416 (for this course).

$$\text{Circumference}(c) = \pi \times \text{Diameter}(D)$$

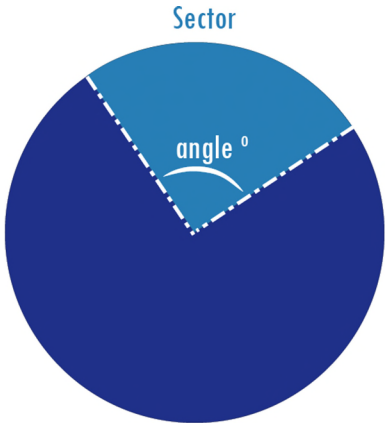
Slide 42

The area of a circle can be described by the formula: (Pi) times the radius squared.

$$\text{Circle Area} = \pi \times r^2$$

Slide 43

To find the area of any sector of a circle, multiply the area of an entire circle by the ratio of the intersected area. This equation will be Pi multiplied by the radius squared multiplied by the angle divided by 360 degrees.



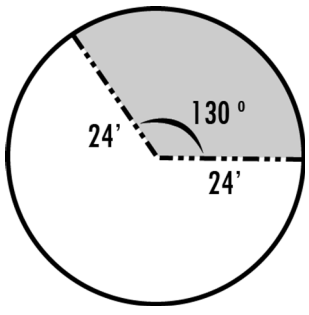
$$\text{Area of Sector} = \pi r^2 \times \frac{\text{angle}^\circ}{360^\circ}$$

Slide 44 KNOWLEDGE CHECK

Now let's calculate the area of a sector.

1) Which of the following is the area of the sector in the circle shown to the nearest tenth of a square foot? Remember to use the rounded value for Pi as 3.1416.

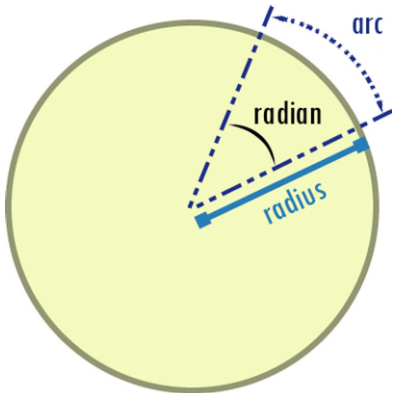
A. 653.5 SF
B. 65.3 SF
C. 208.0 SF
D. 27.2 SF



Slide 45 Curvature Lengths and Areas

Usually, a central angle formed between two radii is measured in degrees. However, radians are another way to describe angles, instead of degrees.

What is a radian? It's simply the ratio of the length of an arc of a circle to the length of the radius, and it serves as the measurement of the central angle between the two radii.



$$\text{Radians} = \frac{\text{Arc}}{\text{Radius}}$$

This means that if the arc of a sector is equal to the radius, that angle has a measurement of one radian.

Slide 46

How many radians are there in a circle? Remember that a radian is the length of the arc divided by the length of radius; and for an entire circle the length of the arc would be equal to the circumference. Once this equation is simplified, we discover there are 2π radians in a circle. This is also equal to 6.2832 radians.

$$\text{Radians in an Entire Circle} = \frac{\text{Arc}}{\text{Radius}} = \frac{\text{Circumference}}{\text{Radius}}$$

$$\frac{(2\pi)(\text{Radius})}{\text{Radius}} = 2\pi = 6.2832 \text{ radians}$$

Slide 47

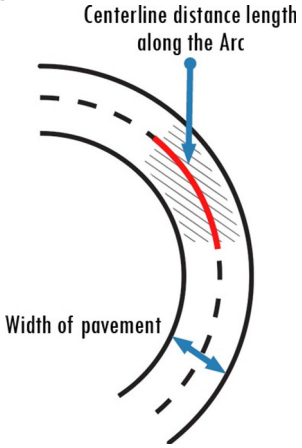
Why is this information important? It can be useful in calculating lengths and areas within construction projects. For example, an engineer can calculate the length of striping on a curve using the following formula. This relationship can be converted to the following formula to be used to calculate centerline lengths.

$$\text{Centerline Length} = \frac{(\text{Sector Angle}^\circ)(\pi)(r)}{180^\circ}$$

Slide 48

For example, to find the striped surface area in the figure at the right, the area will be the centerline distance along the arc times the width of pavement. First, let's calculate the centerline length along the arc. This can be found using the equation:

$$\text{Centerline Length} = \frac{(\text{Sector Angle}^\circ)(\pi)(r)}{180^\circ}$$

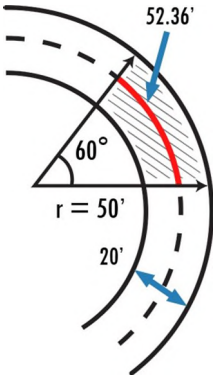


Slide 49

From the illustration, we learn the angle of sector is 60° and the radius is 50'. When these quantities are input in the equation, we calculate a centerline length of 52.36 feet.

$$\text{Centerline Length} = \frac{(60^\circ)(3.1416)(50\text{ ft})}{180^\circ}$$

Centerline Length = 52.36 ft



Slide 50

Now, to calculate the area shaded we must use the centerline length and multiply by the width of the road which is 20 feet.

Area = Centerline Length x Width

= 52.36 ft. x 20 ft.

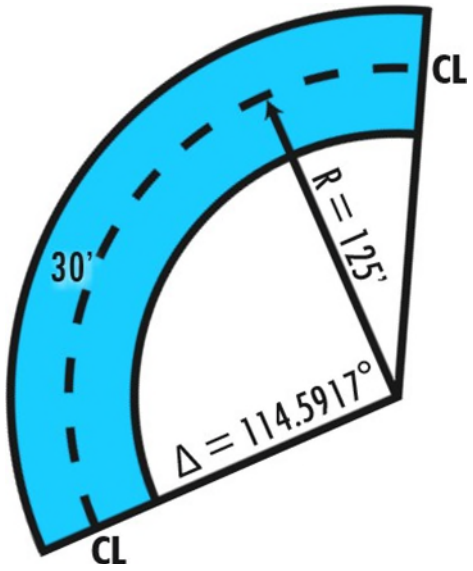
= 1,047.2 SF

Our area is 1,047.2 SF.

Slide 51 KNOWLEDGE CHECK

Now let's test your knowledge of calculating centerline lengths and areas.

1) In constructing a circular curve for a driveway as outlined, the center line radius is 125 ft., the delta of the curve is 114.5917 degrees, and the roadway width is 30 ft. With these dimensions, which of the following is the length of the center line to the nearest foot?



A. 2,000 feet
B. 250 feet
C. 289 feet
D. 350 feet

Slide 52

2) In constructing a circular curve for a driveway as outlined, the center line radius is 125 ft., the delta of the curve is 114.5917 degrees, and the roadway width is 30 ft. With these dimensions, what is the area of the pavement's surface to the nearest square yard?

A. 242 SY
B. 7500 SY
C. 416 SY
D. 833 SY

Slide 53

3) In constructing a circular curve for a driveway as outlined below, the center line radius is 125 ft. and the delta of the curve is 114.5917 degrees. If the roadway width was only 24 ft, the pavement's surface area is 667 Square yards. (To the nearest square yard).

A. True
B. False

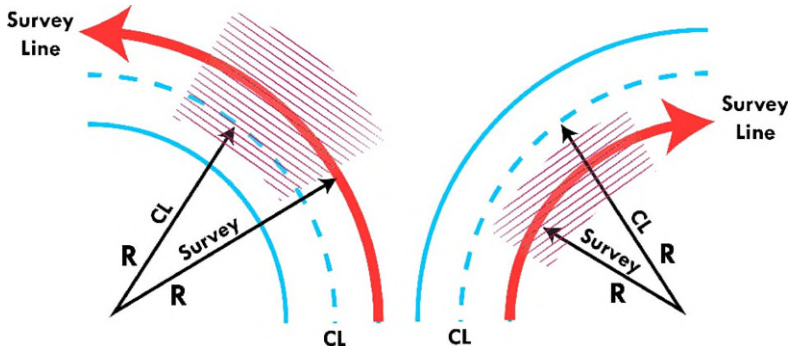
Slide 54 Curvature Corrections

In the previous examples, we solved for roadway areas using centerline lengths. However, if the survey information is not along the centerline, a curvature correction must be made. Corrections for curvature must be made when:

- measurements are determined from a surveyed baseline,
- that base line is not the centerline of the area to be measured, and
- the surveyed base line follows a curve.

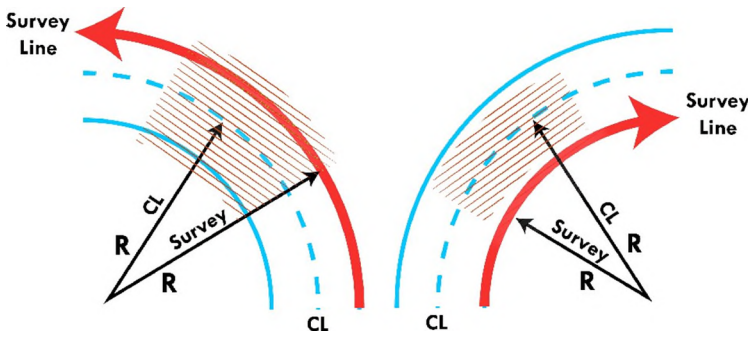
Slide 55

For example, when computing the area of a two-lane pavement surface, no correction factor is needed when the survey line is the center of the highway. The area is found simply by multiplying the stationing length by the surface width. This works on both tangents (straight) and curved sections. But what happens if the survey line is along the shoulder or the curb line? On tangent sections it makes no difference -- but on a curve the stationing length no longer serves as an accurate basis for computing areas. To get the area at the roadway centerline, the area calculated will need to be adjusted appropriately for the differing radii. We illustrate this here.



Slide 56

In the case of the right curve below, the computed area will be <u>less</u> than the actual area if the survey line is used for length measurement. But when the left curve is considered, the computed area will be greater than the actual area.



Slide 57

In other words, when the base line or survey line is on the outside of the area with respect to the center of the curve, the computed area will be greater than the actual area. When the base line is on the inside, the computed area will be less than the actual area.

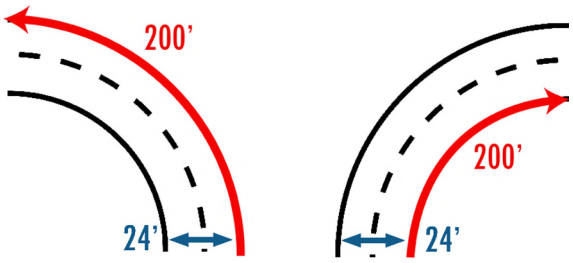
Slide 58

So, what do we do? We introduce a correction factor based on the relationships between the two radii to adjust the calculated area proportionately:

$$\text{Correction Factor} = \frac{\text{Centerline Radius}}{\text{Survey Line Radius}}$$

Slide 59

The correction factor should be rounded to the nearest thousandth. Let's solve the correction factors for an example. Suppose that both curves shown have centerline survey radii of 200 feet, and that the roadway has a 24-foot width. First determine the two radii:



Inside Curve Radius = 200' – ½ (24') = 188 ft.

Outside Curve Radius = 200' + ½ (24') = 212 ft.

Slide 60

Next, determine the curve correction factors:

$$\text{Inside curve correction factor} = \frac{188 \text{ ft}}{200 \text{ ft}} = 0.94$$

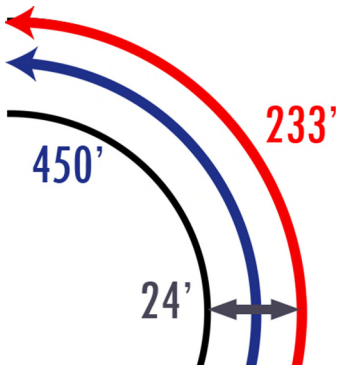
$$\text{Outside curve correction factor} = \frac{212 \text{ ft}}{200 \text{ ft}} = 1.06$$

The computed area between the beginning and end of each curve -- based on survey stationing -- would be multiplied by the appropriate correction factor to determine actual surface area.

Slide 61

Let's look at another example. Suppose that the outside edge of pavement of a left curve had survey line radii of 233 feet, the roadway length is 450 feet, and the width is 24 feet. What is the actual surface area of the curve?

First, to find the centerline radii, subtract 12 ft from the survey radii of the outside edge of pavement.



233' – 12' = 221'

Slide 62

To find the curve correction factor, divide the centerline radii by the outside curve radii.

$$\text{Correction Factor} = \frac{221 \text{ ft}}{233 \text{ ft}} = 0.95$$

Slide 63

Determine the area by multiplying the roadway length by the roadway width by the curve correction factor:

Area = (Roadway Length) x (Width) x (Curve Correction Factor)

= 450 ft. x 24 ft. x 0.95

= 10,260 SF

The area of this curve is 10,260 square feet. Now, let's assume the same length for the curve of the inside edge of pavement and determine the area.

Slide 64

First, find the inside curve radii by subtracting 24 ft from the outside curve survey radii

233' – 24' = 209'

Then, find the curve correction factor by dividing the centerline radii by the radii of the inside curve

$$\text{Inside Curve Correction Factor} = \frac{221 \text{ ft}}{209 \text{ ft}} = 1.06$$

Slide 65

Determine the area by multiplying the roadway length by the roadway width by the curve correction factor:

Area = (Roadway Length) x (Width) x (Curve Correction Factor)

= 450 ft. x 24 ft. x 1.06

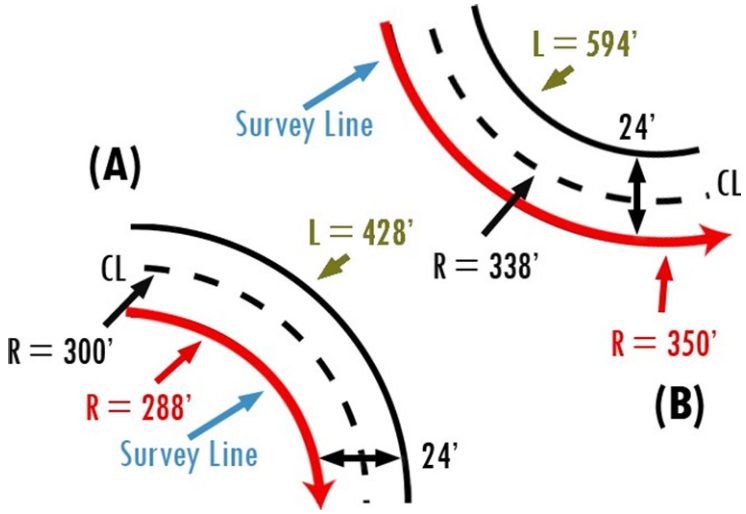
= 11,448 sq. ft.

The area of this curve is 11,448 square feet. Now let's test your knowledge.

Slide 66 KNOWLEDGE CHECK

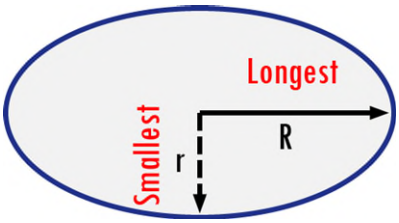
1) The areas of the curved sections of roadway (A) and (B) are [1,187 Square yards] and [1,530 Square Yards] respectively to the nearest square yards.

A. True
B. False



Slide 67 Ellipses

Ellipses are similar to circles but are oblong – or egg shaped. A slightly different formula is used to compute the area:



$A = \pi(R)(r)$

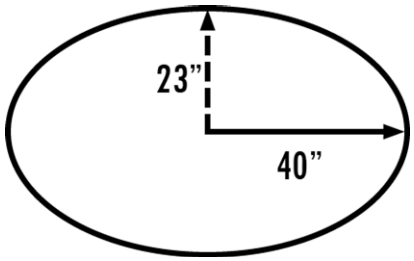
Area of an ellipse is equal to Pi times the two radii of the ellipse. Pi equals 3.1416 for this course. Unlike a circle, the line from the center of an ellipse to the edge is not always the same depending on which end you use. Notice the diagram lists a capital R which is the longest radius. The lower-case r represents the smallest radius.

Slide 68 KNOWLEDGE CHECK

Now let's demonstrate your understanding on how to calculate the area of an ellipse.

1) The area of the ellipse shown is 2,890 Square Inches to the nearest Square Inch.

A. True
B. False

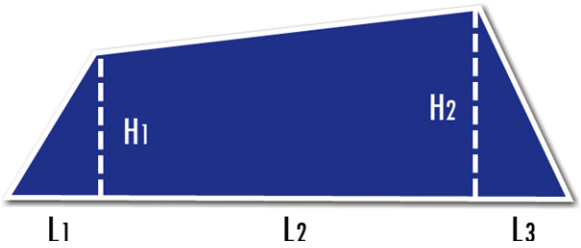


Slide 69 Combinations of Shapes

Many irregular areas can be measured readily by breaking the shapes into several component areas, each of which can be computed by a formula. The total area is then found by adding the individual areas -- or sometimes by subtracting one area from another.

Slide 70

For example, the area of a four-sided figure with no sides parallel can be determined by dividing the shape into two triangles and a trapezoid, as shown:



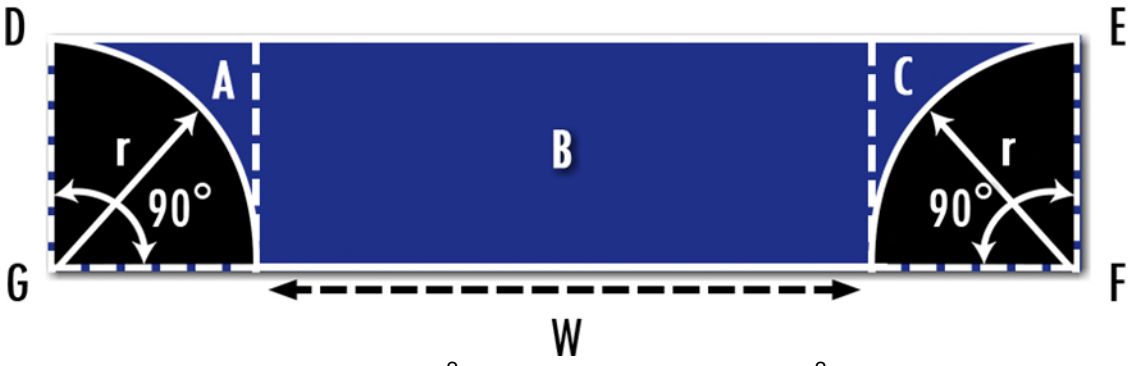
$$A = \left(\frac{L_1 \times H_1}{2}\right) + \left(\frac{H_1 + H_2}{2}\right) L2 + \frac{L_3 \times H_2}{2}$$

Using the formulas for triangles and trapezoids, the total area is:

Area equals L1 times H1 divided by 2 plus H1 plus H2 divided by 2 times L2 plus L3 times H2 divided by 2.

Slide 71

Let's look at another sample scenario. The area of a driveway entrance can be calculated by summing A, B and C, where:



$$A = r^2 = \frac{\pi r^2}{4} \qquad B = Wr \qquad C = r^2 - \frac{\pi r^2}{4}$$

Slide 72

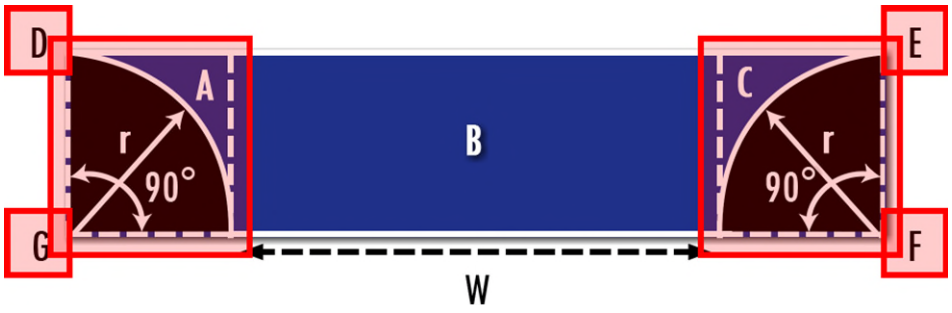
The area of A equals radius squared minus Pi radius squared divided by four. B equals W times radius. And C equals radius squared minus Pi radius squared divided by four or simplified to be:

$$W \times r + 2\left[\frac{\pi r^2}{4}\right]$$

Taking the area of B, which is W times r, and adding 2 times Pi radius squared divided by four.

Slide 73

Another approach would be to consider the driveway entrance one rectangle (DEFG) from which the areas of the two quarter-circles (one semi-circle) must be subtracted, which simplifies to be:



$$(L \times H) - 2\left(\pi \frac{r^2}{4}\right)$$

Taking the area of a rectangle as Length x Height and subtracting 2 times Pi radius squared divided by four.

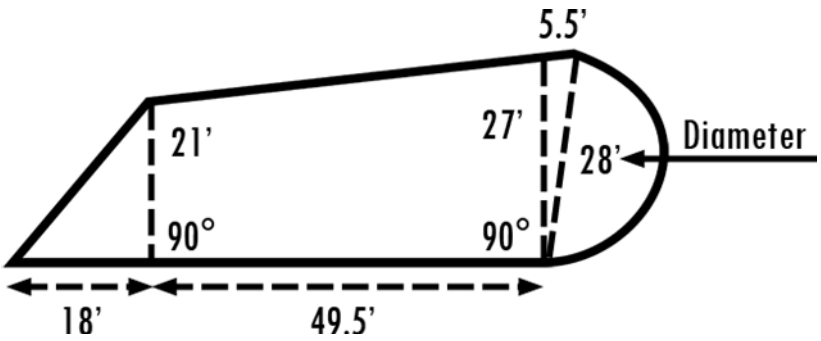
Slide 74 KNOWLEDGE CHECK

Now let's test your knowledge using an irregular shape.

1) By using the combination-of-shapes method, the total area of the irregular shape shown is 1,759.0 Square Foot (calculate to the tenth of a square foot).

   (Note: Add up all the following: Area of ½ Circle, Area of Triangle, Area of Trapezoid and Area of Triangle).

A. True
B. False



Slide 75 COMPUTER PROGRAMS

Many area computations are relatively simple and can be calculated easily with a calculator. However, if field revisions or plan errors are significant throughout the project, we should consider using a computer program. Sometimes manual computations can become difficult because of complexity or numerous calculations. For these situations, the FDOT Quantity Programs are available from the Department to assist with computing and documenting Final Estimate quantities. These programs are located on the FDOT Construction Website. Spreadsheets can also be developed and used to document quantity calculations.

Slide 76 LATITUDES AND DEPARTURES

Latitude and Departure is a method of measurement utilizing offset points to calculate areas. These offset points are referenced to a surveyed baseline or centerline of construction. If the area is on a curve, then the baseline follows the curve. This method averages the widths of each station multiplied by the length between stations to calculate the area. Calculations can be performed manually or by the FDOT Quantity Programs. All Latitude and Departure measurements are required to be recorded on the Department's "Final Measurements" Site Source Record (Form 700-050-53) or on the Final Measurement "Miscellaneous" (Form 700-050-61).

Slide 77

Latitude and Departure measurements are to be taken in the direction of the stationing. The first measurement is taken at the lowest station and the following measurements are taken with the stationing in ascending order. For example, measurements may begin at Station 10+00 and continue to 10+50, 11+00 and 11+50.

Slide 78

This does not mean that measurements must be recalculated when areas are skipped over during different phases of construction and then returned to at a later date for completion. If an area is skipped, the measurements from a later date would be recorded after the last entry from the previous phase. These new measurements would be made on the form starting with the lowest station and proceeding forward to the end of that area.

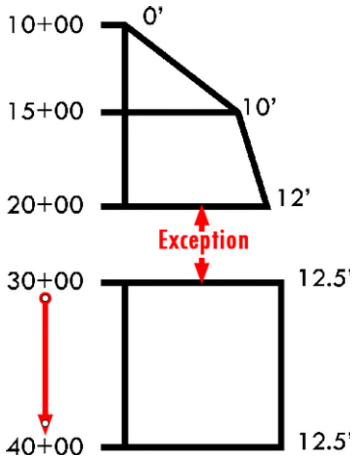
Slide 79

A width measurement must be taken every time the width changes. When widths vary, as with a roadway taper or in curves, more frequent measurements should be taken for accuracy. Be aware of exceptions and station equations. If not noted properly, the area will not be calculated accurately. Sketches are helpful in documenting measurements of atypical or odd shapes.

Slide 80

The following examples will show you how to record measurements on the Latitude and Departure forms.

In this example, there is a plan error in the Performance Turf pay item quantity. The designer overlooked an area when calculating quantities during design and now construction personnel must calculate the affected area.



The measurements will begin at Station 10+00 and stop at Station 20+00. An exception exists from Station 20+00 to Station 30+00. No measurements are taken within the limits of an exception; therefore, no measurement is taken until the end of the exception at Station 30+00 where measurements will resume and continue forward.

Slide 81

This is how this example would be recorded on the Final Measurement form.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FINAL MEASUREMENTS
SITE SOURCE RECORD

700-050-53
CONSTRUCTION
06/17

CONTRACT #: T1234
FINANCIAL PROJECT ID: 123456-1-52-01
PAY ITEM #: 570-1
PAY ITEM DESCRIPTION: Performance Turf (Sod)

NAME OF PERSON(S) TAKING MEASUREMENT: J.M. Bill
DATE: 07/31/2018

STATIONS BKE AND AHD EQUATIONS	BKE / AHD	OFFSET	REMARKS
10+00	0.0 / 0.0		Begin Performance Turf (Sod)
15+00	10.0 / 10.0		[(0+10.0)/2] 500 = 2,500.0 SF
20+00	12.0 / 0.0		[(10+12)/2] 500 = 5,500.0 SF
Exception	/		Exception Sta.20+00 to Sta. 30+00
30+00	0.0 / 12.5		(12.5 x 1,000) = 12,500.0 sf
40+00	12.5 / 0.0		
	/		End Performance Turf (Sod)
	/		Total = 20,500/9 = 2,277.78 = 2,278 SY
	/		

Measurements entered into the FDOT Quantity Programs do not require calculations in the remarks column. The remarks column should be used to make notations of beginning and ending measurements, intersecting streets, other exceptions or obstructions, and any other pertinent information concerning the measurements.

Slide 82

Area 1 and Area 2 are calculated from Station 10+00 to 20+00. However, Area 3 is calculated from Station 30+00 to 40+00. It is very important to be sure to calculate these properly, otherwise a substantial error could be made. Always stop the stationing

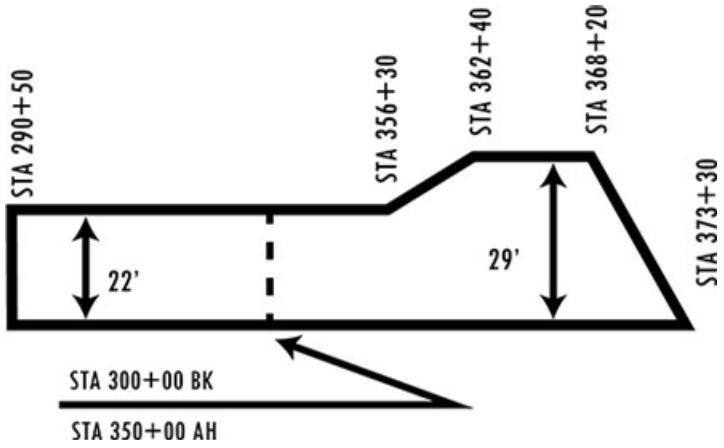
at the back station and restart with the ahead station.

Slide 83 KNOWLEDGE CHECK

Now let's test your knowledge.

1) In the next example, there is another plan error in the Performance Turf pay item quantity and construction personnel must calculate the affected area. Which of the following is the area of the Performance Turf to the nearest square yard, using the latitude and departure method?

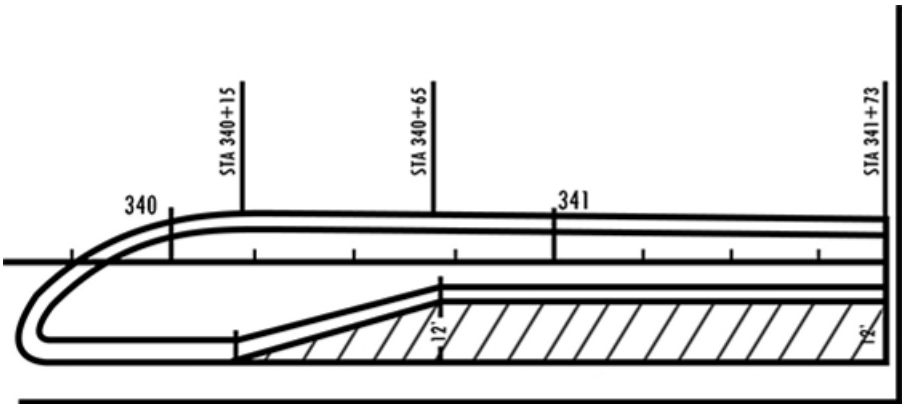
A. 8,350 SY
B. 9,345 SY
C. 7,344 SY
D. 8,279 SY



Slide 84

2) Using the Latitude and Departure method, the hashed area shows 3.5 inches of milling that was left out of the plans. What is the measurement of the hashed area to the nearest square yard?

A. 210.7 SY
B. 177 SY
C. 177.3 SY
D. 211 SY



Slide 85

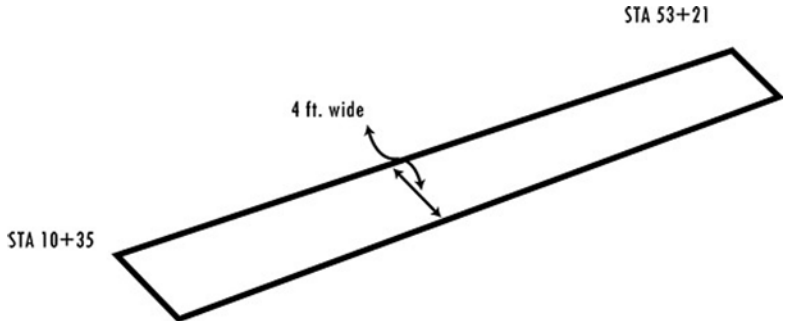
3) Field revisions or plan errors on a Performance Turf (Sod) pay item are often measured by latitude and departures.

A. True
B. False

Slide 86

4) A plan error was noted on a project. The 4-foot sidewalk was not calculated by the designer. Field personnel measured the sidewalk as shown below. Calculate the area from station 10+35 to station 53+21. Rounding your answer to the nearest square yard, which of the following is the missing area?

A. 4,286 SY
B. 1,905 SY
C. 4,300 SY
D. 480 SY



Slide 87 SUMMARY

Let's review a few of the things you learned about area computations:

- All field measurements should be clearly recorded (odd areas with sketches) on site source records (such as Department Forms).
- If any area changes in the field can be determined from simple area calculations, site source records are sufficient documentation.

Slide 88

- When area computations are more complex, measurements should be documented on site source records, calculations should be performed by computer programs, and quantities should be summarized on the Plan Summary Boxes/Tabulation Sheets in the Final As-Built Plans, when applicable, pertaining to the appropriate pay item. Verify quantities and reference back up documentation on the Pay Item Summary and Certification form.
- Some irregular areas can be computed by breaking them into several geometric shapes, each of which can be calculated with established geometric formulas.
- The method of latitude and departure can be used to compute the areas of irregular shapes.

Slide 89

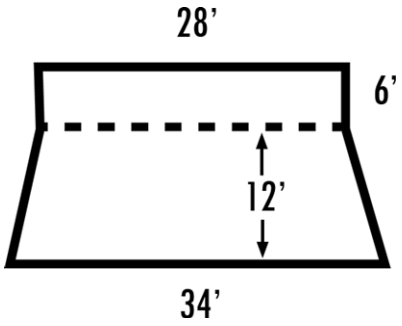
- Available computer programs can help reduce the amount of routine manual calculations, improve accuracy, and provide reliable documentation of final quantities.

- Remember, before final payments can be made, all computations must be checked regardless of which technique is used. Final As-Built Plans and backup documentation must give a complete picture of how the quantities were determined. Some of the back-up documentation may refer you to certain Site Source Records, such as Final Measurement Forms, for further calculations and documentation.

Slide 90

1) The area of the driveway shown is 60 Square Yards.

A. True
B. False



Slide 91

2) The area of irregular shapes can be computed by the method of Latitude and departure.
A. True
B. False

Slide 92

3) All field measurements for odd areas should be clearly recorded:

A. In the Miscellaneous Construction Programs Manual.
B. With sketches on a piece of paper
C. With sketches in the field records and back up referenced in Final Estimates Documentation.
D. All the above.
E. None of the above.

Slide 93 Conclusion

This is the end of Module 3. Thank you for your time and attention.

MODULE 4 - VOLUME MEASUREMENTS

Slide 1 WELCOME

Welcome to the Florida Department of Transportation's computer-based training series on Final Estimates, Level 1 Training. This is Module 4, Volume Measurements. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

Volume measurements are needed for two categories of pay items:

- Earthwork: items such as borrow excavation and subsoil excavation
- Concrete: the various classes of concrete used in bridges and other structures

Each category is calculated differently in the field.

Slide 3 UNITS OF MEASUREMENTS

The pay item unit of measurement for volume is usually by the cubic yard (CY). It is important to keep certain relationships in mind when calculating volumes. From the previous module, we remember that 12 inches equals 1 foot and Pi is equal to 3.1416. We now must remember that one cubic yard is equal to 27 cubic feet.

Slide 4 METHODS FOR COMPUTING VOLUMES

There are various methods used to compute volumes of earthwork and concrete pay items. These include:

1. Cross Sections
2. Truck Measurements
3. Geometric Shapes

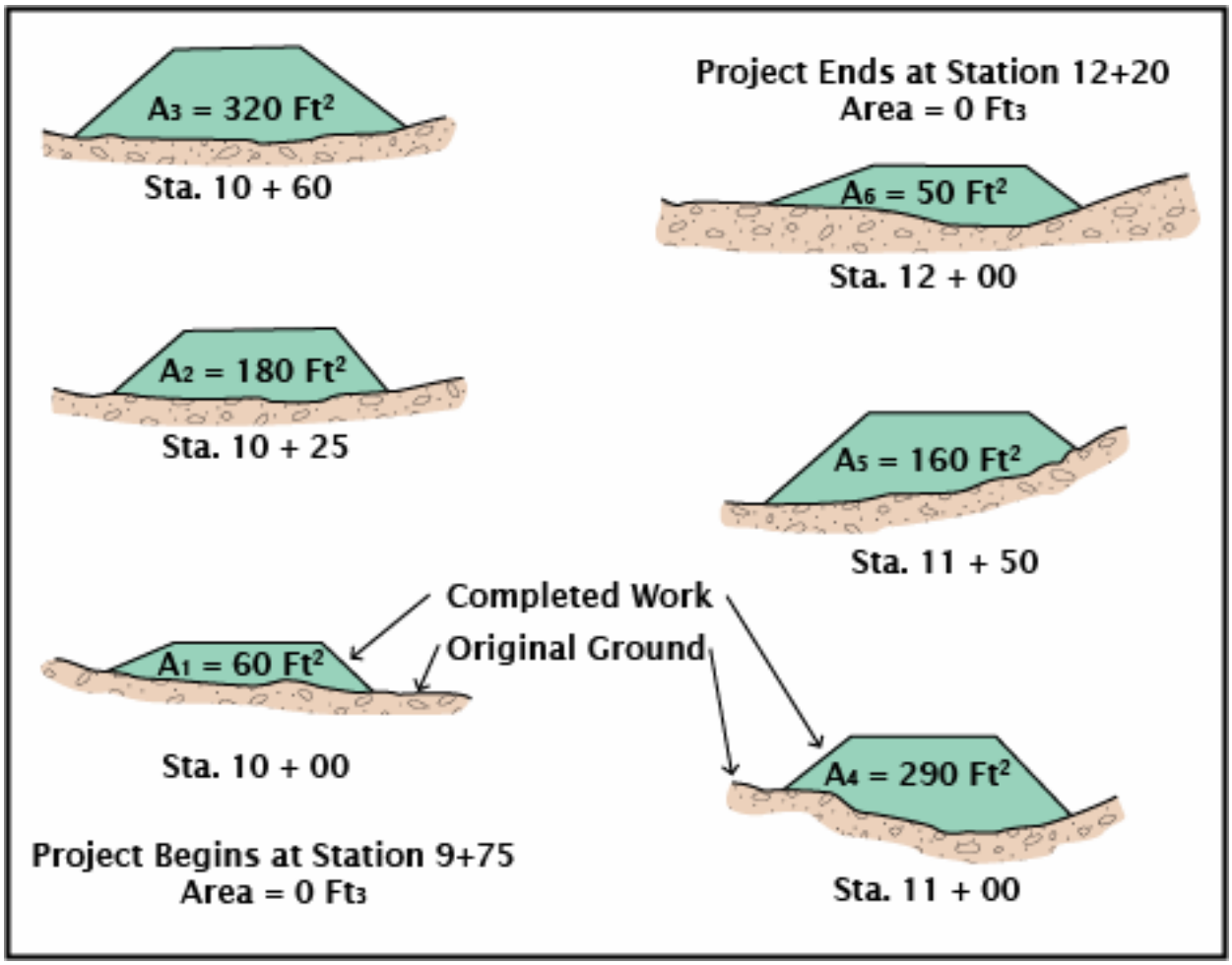
Slide 5

Earthwork can utilize two different methods: the use of cross sections and the use of truck measurements. For example, the Subsoil Excavation pay item compares areas surveyed before and after excavation to calculate the volume of earthwork removed. Whereas the Borrow Excavation pay item is paid by truck quantity.
The method used to calculate the volume of concrete in structures is geometric shapes. Concrete structures such as columns and bridge decks can closely resemble geometric shapes such as cylinders and rectangular solids.

These volumes are fairly simple to calculate and can easily be related to the volume within the concrete structure.

Slide 6 CROSS SECTIONS

In Module 2, we talked about cross section notes and how they are recorded in field books. In this module, we will learn how to use cross sections for measuring volumes of earthwork. The figure shown illustrates typical earthwork cross sections.



Slide 7

A common method of determining volumes from cross sections is using the average end area. It assumes the volume between successive cross sections is the average of their end areas multiplied by the distance between them. This is expressed in the formula:

$$\text{Volume (CF)} = \frac{\text{Area 1 (SF)} + \text{Area 2 (SF)}}{2} \times \text{Length (ft.)}$$

In which Area 1 and Area 2 are the end areas in square feet of successive cross sections and L is the length in feet between the sections.

Slide 8

It should be noted that the average end area method is only approximate in calculating volumes due to the lack of survey between stations; however, it is generally accepted as sufficient for computing earthwork volumes. The average end area method can be calculated manually, using less survey information. There are other methods of calculating earthwork volumes more precisely.

Slide 9

Survey technology, such as LIDAR and photogrammetry, has advanced rapidly over the past years and is becoming more widely used. It is a more accurate means of calculating volumes since it obtains more survey information, but it requires computer software to calculate volumes using surface to surface comparison. Cross section and average end areas are being discussed in this course since they can be used in the field to quickly estimate volume quantities without computer software.

Slide 10

Using the examples of cross sections shown, let's see if we can compute the volume of earthwork by applying the formula shown.

First, we must compute the volume between each pair of cross sections. Once these are calculated we can then calculate a total summation for the entire project.

Our final answer should be in cubic yards, so we will divide by 27.

$$\text{Volume (SY)} = \left(\frac{\text{Area 1 (SF)} + \text{Area 2 (SF)}}{2}\right) \times \text{Length (ft)} \times \frac{1\ \text{SY}}{27\ \text{SF}}$$

Slide 11

The formula will now be:

$$\text{Volume (CY)} = \left(\frac{\text{Area 1 (SF)} + \text{Area 2 (SF)}}{54\ \frac{\text{CF}}{\text{CY}}}\right) \text{x Length (ft)}$$

Volume equals the average of Area 1 and Area 2 multiplied by the length. The simplified formula equals sum of Area 1 and Area 2 divided by 54 multiplied by the length. If this is repeated for each interval between the cross sections, the following volumes shown in the table will be obtained.

Limits	Area ($ft.^2$)	Volume ($ft.^3$)
Station 9+75 – 10+00	Station 9+75 Area = 0 Station 10+00 Area = 60	$\left[\frac{0\ SF + 60\ SF}{54}\right] \times 25 = 27.78\ CY$
Station 10+00 – 10+25	Station 10+00 Area = 60 Station 10+25 Area = 180	$\left[\frac{60\ SF + 180\ SF}{54}\right] \times 25 = 111.11\ CY$
Station 10+25 – 10+60	Station 10+25 Area = 180 Station 10+60 Area = 320	$\left[\frac{180\ SF + 320\ SF}{54}\right] \times 35 = 324.07\ CY$
Station 10+60 – 11+00	Station 10+60 Area = 320 Station 11+00 Area = 290	$\left[\frac{320\ SF + 290\ SF}{54}\right] \times 40 = 451.85\ CY$
Station 11+00 – 11+50	Station 11+00 Area = 290 Station 11+50 Area = 160	$\left[\frac{290\ SF + 160\ SF}{54}\right] \times 50 = 416.67\ CY$
Station 11+50 – 12+00	Station 11+50 Area = 160 Station 12+00 Area = 50	$\left[\frac{160\ SF + 50\ SF}{54}\right] \times 50 = 194.44\ CY$
Station 12+00 – 12+20	Station 12+00 Area = 50 Station 12+20 Area = 0	$\left[\frac{50\ SF + 0\ SF}{54}\right] \times 20 = 18.52\ CY$
	TOTAL =	1,544.44 CY **1,544 CY (Rounded Accurately)**

Slide 12 KNOWLEDGE CHECK

Now let's test your knowledge.

1) Volume measurements are needed for which different categories of pay items?
   A. Subsoil and Borrow Excavation
   B. Columns and Bridge Decks
   C. Fencing and Slope Pavement
   D. Both A and B
   E. None of the above

Slide 13

2) Based on the areas determined for the Stations shown, what is the total volume of earthwork between Station 71+25 and 72+75, to the nearest cubic yard?

A. 1,406 CY
B. 2,828 CY
C. 1,916 CY
D. 1,666 CY

Station	Area	Volume
71+25	308.0 Ft^2	
71+48	287.0 Ft^2	
71+81	291.5 Ft^2	
72+23	304.0 Ft^2	
72+75	315.3 Ft^2	
	Total	_____

Slide 14

3) The table shows the end areas determined for the indicated cross sections. Which of the following is the total volume of earthwork between stations 408+00 and 410+10, to the nearest cubic yard?

A. 2,925 CY
B. 2,332 CY
C. 1,927 CY
D. 1,513 CY

Station	Area (S.F.)	Volume (CY)
408+00	244	
408+62	263	
409+25	212	
409+81	259	
410+10	303	
	Total =	

Slide 15 TRUCK MEASUREMENTS

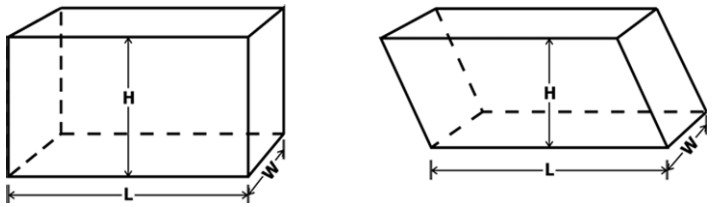
The secondary method for calculating earthwork includes measuring truck quantities. The Borrow Excavation pay item is calculated using this method. Each truck contains a manufacturer's certification or permanent decal showing the truck's capacity. This will need to be recorded on a department issued form and spot checked. The Department's field personnel will confirm the manufacturer's information matches the truck measurements.

Slide 16

Once confirmed, the field technicians can simply count the number of loads delivered and multiply by the capacity of each truck to obtain the total volume hauled on-site. It is important to note that only certain pay items can be measured in this manner. The Standard Specifications will detail how an earthwork item can be measured and paid.

Slide 17 GEOMETRIC SHAPES

Cross sections do not work well for computing the volumes of some pay items such as reinforced concrete. For these items, it is much better to measure the dimensions of the construction and use conventional formulas to compute geometric shapes. The Construction Mathematics self-study training course provides a good background in the use of formulas for calculating volumes. Let's take a quick look at some of the formulas we will be using. The simplest geometric shape is the rectangular solid with opposite sides parallel. Two examples are shown.



Volume = Length x Width x Height

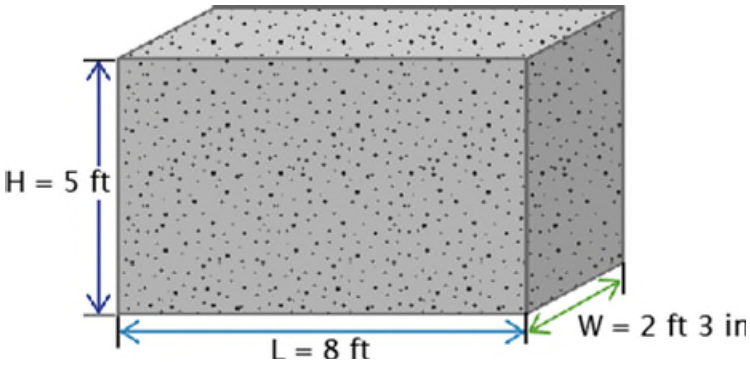
Slide 18

In both cases, Volume equals Length times Width times Height.

Let's work a problem. We will find the volume of the concrete block shown, to the nearest cubic yard.

First, we must make sure all the measurements have the same units of measurement. The height and length are measured in feet. The width is measured in feet and inches. We will convert the inches into feet. 3 inches divided by 12 equals 0.25 feet.

So, our width now equals 2.25 feet.

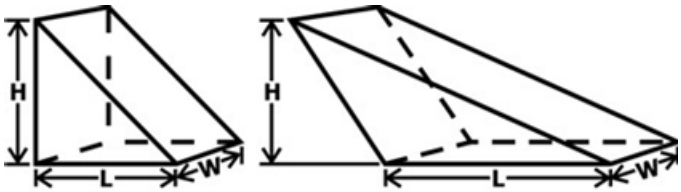


Slide 19

Volume equals length times width times height. Our equation will be 8 times 2.25 times 5, which equals 90 cubic feet. To find the answer in cubic yards, use the cubic feet to cubic yard relationship mentioned earlier and divide by 27, so the volume equals 3.33 cubic yards. Rounding to the nearest cubic yard, we have a final answer of 3 cubic yards.

Slide 20

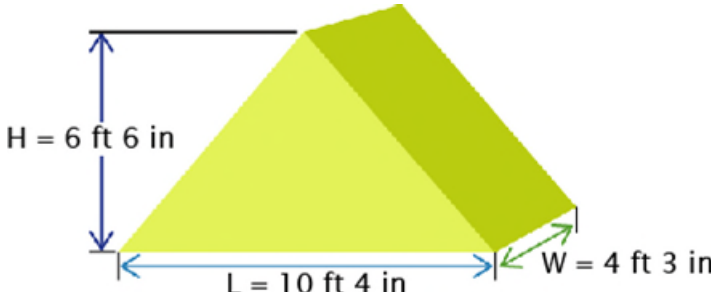
Now that we've learned how to calculate volumes for rectangular and parallelogram shapes, let's discuss triangular shapes. Since a triangle is half of a rectangle, this same concept will apply to volumes as well.



In both cases, $V = \frac{LWH}{2}$

Slide 21

Let's calculate the volume of the triangle shown to the nearest cubic yard.



H = 6' 6" and $\frac{6\text{in.}}{12\ ^{\text{in}}/_{\text{ft}}} = 0.5$ ft → H = 6.5 ft

L = 10' 4" and $\frac{4\text{ in.}}{12\ ^{\text{in}}/_{\text{ft}}} = 0.33$ ft → H = 10.33 ft

W = 4' 3" and $\frac{3\text{ in.}}{12\ ^{\text{in}}/_{\text{ft}}} = 0.25$ ft → H = 4.25 ft

First, we must convert inches into feet to make sure all our measurements have the same units of measurement. Height equals 6 feet and 6 inches. We take the 6 inches and divide by 12 to arrive at 0.5 feet. Height now equals 6.5 feet.

Length equals 10 feet and 4 inches. We take the 4 inches and divide by 12 to arrive at 0.33 feet. Length now equals 10.33 feet. Width equals 4 feet and 3 inches. We take the 3 inches and divide by 12 to arrive at 0.25 feet. Width now equals 4.25 feet.

Slide 22

V = ½ x (Length x Width x Height)

= ½ x (6.5” x 10.33” x 4.25”)

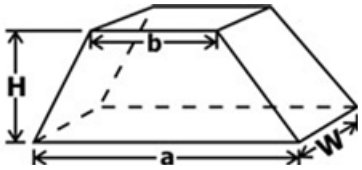
$V=\frac{142.68}{27^{CF}/_{CY}}=5.28=5CY = 142.68\ CF$

The volume of our shape will equal 10.33 times 6.5 times 4.25 divided by 2. This gives us an answer of 142.68 cubic feet. However, we are looking for cubic yards. We will divide 142.68 by 27, which is 5.28 cubic yards. Our example said to calculate to the nearest cubic yard so our final answer will be 5 cubic yards.

Slide 23

Now how about trapezoidal solids?

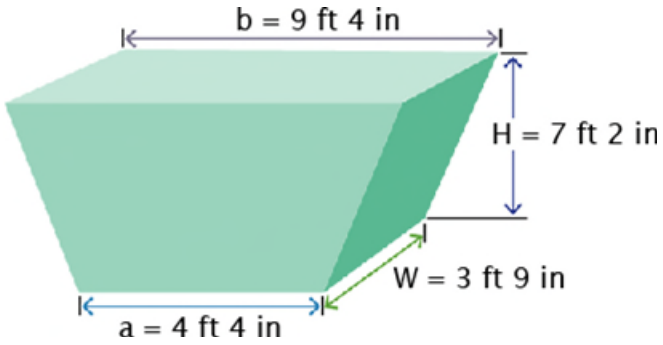
$$V = \frac{a + b}{2} \times HW$$



Do these formulas look familiar? When you stop to think about it, we are really computing an end area and then multiplying by a third dimension to find the volume.

Slide 24

Let's calculate the volume of the trapezoid shown, to the nearest cubic foot.



First be sure that all units of measurement match. We will convert each to feet.

Length A equals 4 feet and 4 inches. We take the 4 inches and divide by 12 to arrive at 0.33 feet. Length A now equals 4.33 feet.

Length B equals 9 feet and 4 inches. We take the 4 inches and divide by 12 to arrive at 0.33 feet. Length B now equals 9.33 feet.

Slide 25

Height equals 7 feet and 2 inches. We take the 2 inches and divide by 12 to arrive at 0.17 feet. Height now equals 7.17 feet.

Width equals 3 feet and 9 inches. We take the 9 inches and divide by 12 to arrive at .75 feet. Width now equals 3.75 feet.

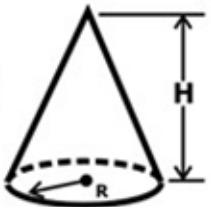
Volume then equals a plus b divided by 2 times the height times the width, we take 4.33 plus 9.33 which equals 13.66 and divide by 2 which equals 6.83.

Multiply 6.83 by 7.17 by 3.75 to arrive at 183.64. Rounded our final answer is 184 cubic feet.

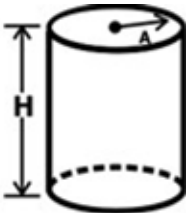
Slide 26

Let's try it with a cylindrical solid and a cone:

$$V = \frac{\pi R^2 \times H}{3}$$

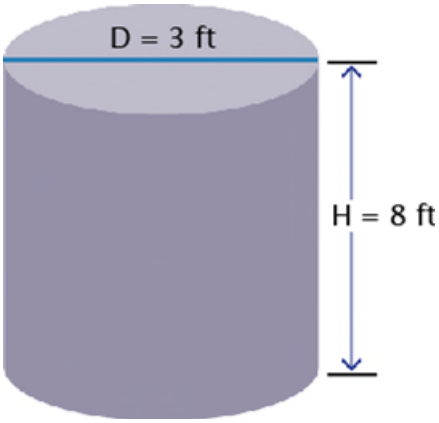


$$V = \pi R^2 \times H$$



Slide 27

Using the equations given, let's solve some examples together.



$V = \pi R^2 x\ H$

$R = {}^{1}/_{2}\,(\text{Diameter}) = {}^{1}/_{2}\,(3') = 1.5'$

$V = \pi R^2 x\ H$

$= 3.1416 \times (1.5')^2 \times 8'$

$$= \frac{56.5\ CF}{27\ {}^{CF}/_{CY}}$$

$= 2.1 = 2\ CY$

Calculate the volume of this cylinder to the nearest cubic yard. The formula for the volume of a cylinder states that volume is equal to Pi times the radius squared times height. We must remember that Pi is equal to 3.1416. Knowing that the diameter is 3 feet, we can divide this by 2 to find the radius.

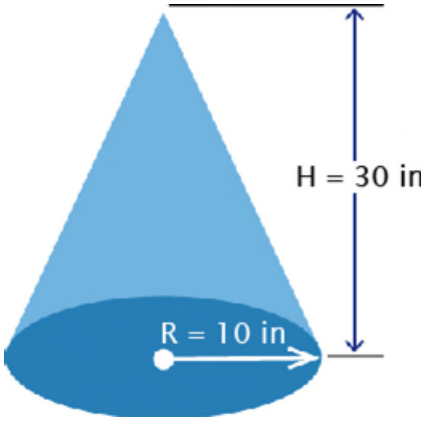
Next, we multiply 3.1416 by 1.5 squared by 8 (the height). This is equal to 56.5 cubic feet. Our problem asks for the answer in cubic yards. We will divide 56.5 by 27 to arrive at 2.1 cubic yards.

Lastly, we will round to the nearest cubic yard making the final answer 2 cubic yards.

Slide 28

Now let's calculate the volume of this cone to the nearest cubic foot. The cone formula states that Volume equals Pi times Radius squared times height divided by 3 . Do you recognize this formula? You should; it is the formula for calculating volume of a

cylinder divided by 3. This tells us that a cone is exactly one-third the volume of a cylinder.



$$V = \frac{\pi R^2 \times H}{3} \qquad H = \frac{30\ \text{in}}{12\ \frac{\text{in}}{\text{ft}}} = 2.5\ \text{ft} \qquad R = \frac{10\ \text{in}}{12\ \frac{\text{in}}{\text{ft}}} = 0.83\ \text{ft}$$

$$V = \frac{\pi R^2 \times H}{3} = \frac{[3.1416 \times (0.83)^2] \times 2.5}{3} = 1.8\ \text{CF} = 2\ \text{CF}$$

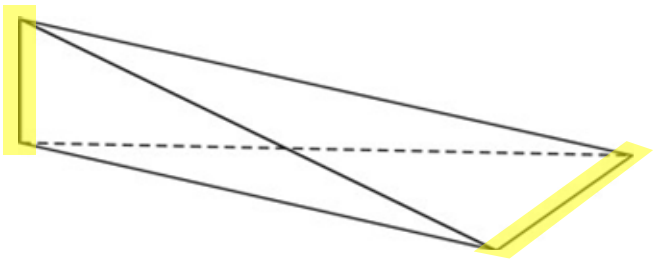
Slide 29

To solve this problem, we will first need to convert the measurements from inches to feet. 30 divided by 12 equals 2.5 feet. 10 divided by 12 equals 0.83 feet. Remember that for this course we will use 3.1416 as Pi, though in practice you should use the fullest capability of your machine to calculate values of Pi. So, 3.1416 times 0.83 squared times 2.5 divided by 3 equals 1.8. Round to the nearest cubic foot and our final answer is 2 cubic feet.

Slide 30

What if we have an odd irregular shaped object? For these instances, the prismoidal formula can be used.

When the side planes of an object taper in or out in relationship to one another, the average-end-area method is not accurate. For instance, in the shape shown, both end areas are zero, and yet the figure does have volume.

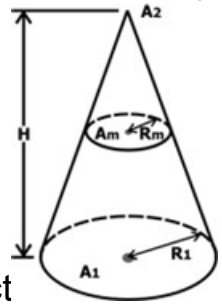


Slide 31

By using the prismoidal formula, the figure's volume can be computed accurately using the following formula:

$$V = \frac{(A1 + A2 + 4Am)}{6} H$$

A1 and A2 correspond to the end areas of the object. However, A_m (or the mean area) corresponds to the cross sectional area located in the middle of the object

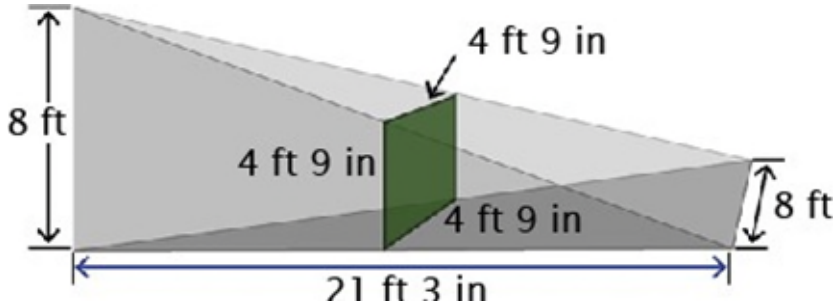


Slide 32

You will see many applications of prismoidal formulas in your work, especially in retaining wall, truck body, and concrete structure calculations. The prismoidal formula should always be used for concrete volume computations when the average of the end areas does not equal the area located in the center of the object.

Slide 33

Let’s go through an example of an odd-shaped concrete block with an average area:



Calculate the volume for the odd shape concrete using the prismoidal formula. Round the answer to the nearest cubic yard.

Volume equals A1 plus A2 plus 4 Am multiplied by the height divided by 6 . A1 equals zero. A2 also equals zero.

The middle area equals the area of the square in the center. 4 feet 9 inches equals 4.75 feet, which makes the middle area equal 22.56 feet.

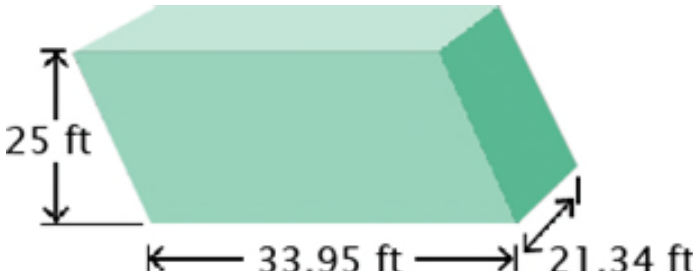
The Height (H) equals 21 feet and 3 inches, or 21.25 feet.

Total Volume equals 4 times 22.56 all divided by six, times 21.25 which equals 319.64 cubic feet. Divide that by 27 gives you 11.83, rounded to the nearest cubic yard is 12 cubic yards.

Slide 34 KNOWLEDGE CHECK

1) Which of the following is the volume of the shape shown to the nearest cubic yard?

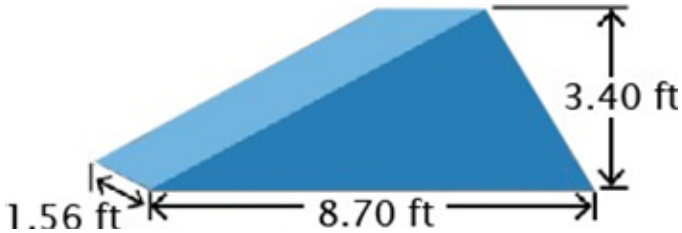
A. 671 CY
B. 8,754 CY
C. 11,784 CY
D. 18,112 CY
E. None of the above



Slide 35

2) Which of the following is the volume of the shape shown to the nearest 10th of a cubic yard?

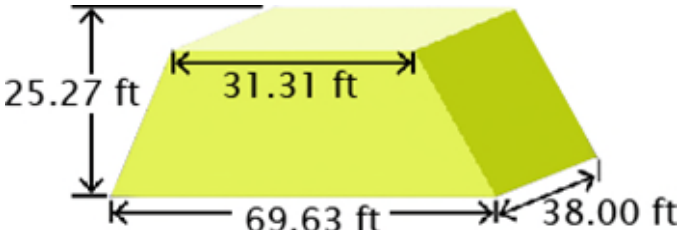
A. 0.86 CY
B. 0.9 CY
C. 1.3 CY
D. 2.8 CY
E. None of the above



Slide 36

3) Which of the following is the volume of the shape shown to the nearest cubic yard?

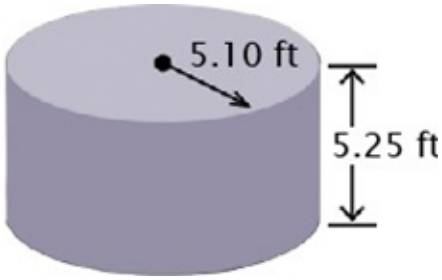
A. 1,795 CY
B. 1,884 CY
C. 1,978 CY
D. 2,077 CY
E. None of the above



Slide 37

4) Which of the following is the volume of the shape shown to the nearest tenth of a cubic yard?

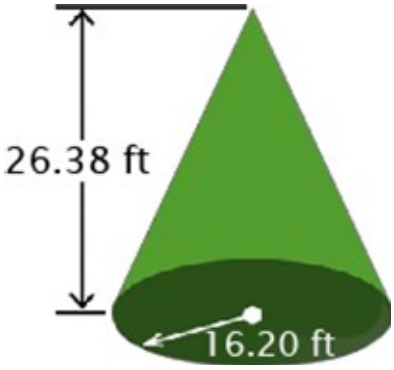
A. 19.3 CY
B. 17.5 CY
C. 18.4 CY
D. 15.9 CY
E. None of the above



Slide 38

5) Which of the following is the volume of the shape shown to the nearest tenth of a cubic yard?

A. 282.0 CY
B. 296.8 CY
C. 268.5 CY
D. 326.4 CY
E. None of the above



Slide 39

6) The prismoidal formula should always be used for concrete volume computations when the mean area:

A. Is less than 50 square feet
B. Is equal to the average end areas.
C. Is not the average of the two end areas
D. Is greater than 50 square feet.
E. None of the above

Slide 40

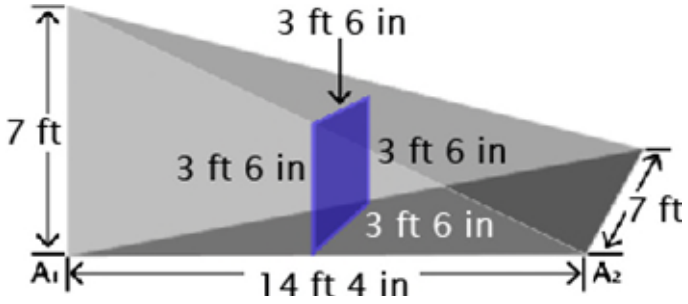
7) True or False. The prismoidal formula is: $V = \frac{(A1 + A2 + 4Am)}{6} H$

A. True
B. False

Slide 41

8) Which of the following is the volume of the figure shown to the nearest cubic foot?

A. 129 Cubic Feet
B. 117 Cubic Feet
C. 136 Cubic Feet
D. 157 Cubic Feet
E. None of the above



Slide 42 CONCLUSION

This is the end of Module 4. Thank you for your time and attention.

MODULE 5 - LINEAR MEASUREMENTS

Slide 1 WELCOME

Welcome to the Florida Department of Transportation's computer-based training series on Final Estimates, Level 1 Training. This is Module 5, Linear Measurements. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

Many pay items are measured based on linear measurements - items such as guardrail, pipe culvert, curb and gutter, fencing, striping, etc. These measurements are usually not as complex as area or volume measurements, but there are some things you should know about properly performing and recording linear measurements.

Slide 3 UNITS OF MEASUREMENT

Most linear measurement pay items are measured in linear feet. Fortunately, most field surveys (both vertical and horizontal) are in the same measurement units. When there is need to convert units, the following relationships should be noted:

1 foot = 12 inches
1 station = 100 feet
1 mile = 5,280 feet

Slide 4 METHODS FOR COMPUTING LENGTHS

There are several methods for making linear measurements.

1. Stationing - When the pay item is constructed parallel to the base survey line, such as curb and gutter and the beginning and end of the construction is identified with right angle ties to the stationing of the survey line, the difference in stationing is an acceptable basis for linear measurement.
2. Taping or Chaining - Some items which cannot be measured by stationing may be measured directly by tape or chain.
3. Level Notes - Elevation measurements made with a survey level are a convenient way of measuring the lengths of piling in place.

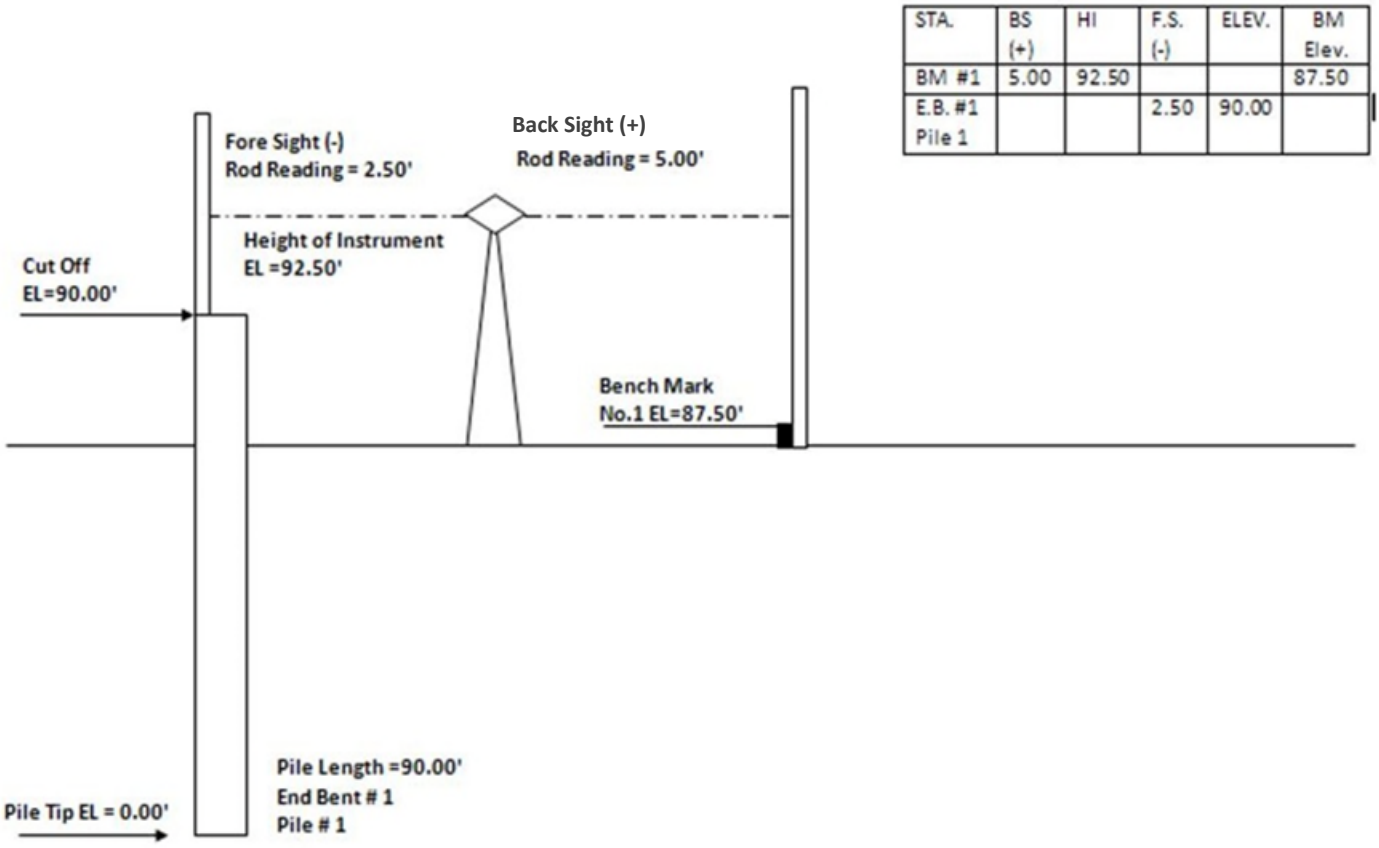
Slide 5

Each of these methods has advantages for particular situations. In fact, some measurements may involve a combination of methods.

For example, fencing is a plan quantity pay item paid by linear feet. However, sometimes changes are authorized or errors in the plans are discovered, and new measurements are required. Seldom are these changes measured by stationing alone unless they are parallel to the centerline. Usually there are irregular breaks in fencing, which require field measurements by a tape or chain as well.

Slide 6

Another example of a linear measurement is piling. Structural Piling is paid on a linear foot basis. Most piling measurements are done using a survey level. Here is an example of how level notes are used for determining lengths.



STA.	BS (+)	HI	F.S. (-)	ELEV.	BM Elev.
BM #1	5.00	92.50			87.50
E.B. #1 Pile 1			2.50	90.00	

Slide 7

To determine the length of piling to be paid, the top of the pile must be surveyed to obtain the elevation. In this case, the survey level will be set so both the benchmark and pile cut off elevation can be seen. Based on the rod readings, the height of instrument can be calculated and used to determine the cut off elevation.
This elevation will quantify the amount of piling to be paid.

Slide 8

Now let's test your knowledge.

1) Fencing can always be measured by stationing.
   A. True
   B. False

Slide 9

2) Most linear measurement pay items are measured in:
   A. Linear Yards.
   B. Cubic Yards.
   C. Linear Feet.
   D. Linear Inches.
   E. None of the above.

Slide 10

3) The methods for making linear measurements are:
   A. Stationing, Chaining, and Cubic Yard Measurements
   B. Stationing, Chaining, and Square Yard Measurements
   C. Stationing, Chaining, and Level Notes
   D. All of the above
   E. None of the above

Slide 11

4) If you have pile cut off elevation at 50.00 ft and a tip elevation (bottom of the piling elevation) of 10.00 ft, which of the following would be your pile length?
   A. 10 ft.
   B. 60 ft.
   C. 40 ft.
   D. 50 ft.
   E. None of the above

Slide 12 CONCLUSION

This is the end of Module 5. Thank you for your time and attention.

MODULE 6 - WEIGHT MEASUREMENTS

Slide 1 WELCOME

Welcome to the Florida Department of Transportation’s computer-based training series on Final Estimates, Level 1 Training. This is Module 6, Weight Measurements. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2

Numerous road and bridge construction pay items are measured by weight, usually tons or pounds. Several different techniques can be used for weight measurement. Let's look at some of these methods.

Slide 3 CERTIFIED SCALES

Scales are the most obvious method of determining weights of pay items. This method is straightforward and can be obtained by simply weighing the material on a scale. But there are a few things to remember to measure weights correctly.

Slide 4

First, scales must meet the requirements for accuracy and condition established by the Bureau of Weights and Measures of the Florida Department of Agriculture. These scales must be recertified every six months by either the Bureau of Weights and Measures or by a registered scale technician.

Slide 5

In addition to the certification of the scales, periodic checks are also required. The contractor must weigh a loaded truck on their scales, and then weigh it on another set of certified truck scales which is not owned by the Contractor. When the difference in weight exceeds 8 pounds per ton of load, a recheck on a second set of certified scales must be done. If both the check and recheck indicate that the printed weight is out of tolerance, the scales must be adjusted and recertified. This check must be done once asphalt production has begun and at least every 30 days during production.

Slide 6

Although tabulation forms are typically used to record the weight of each load weighed on a certified scale; they are not required for a plant equipped with an automatic printer system which records the total weight of the batches contained in each truckload.

Certain shipments by rail, such as bulk cement, may be weighed on state-certified scales and documented with certified weight tickets.

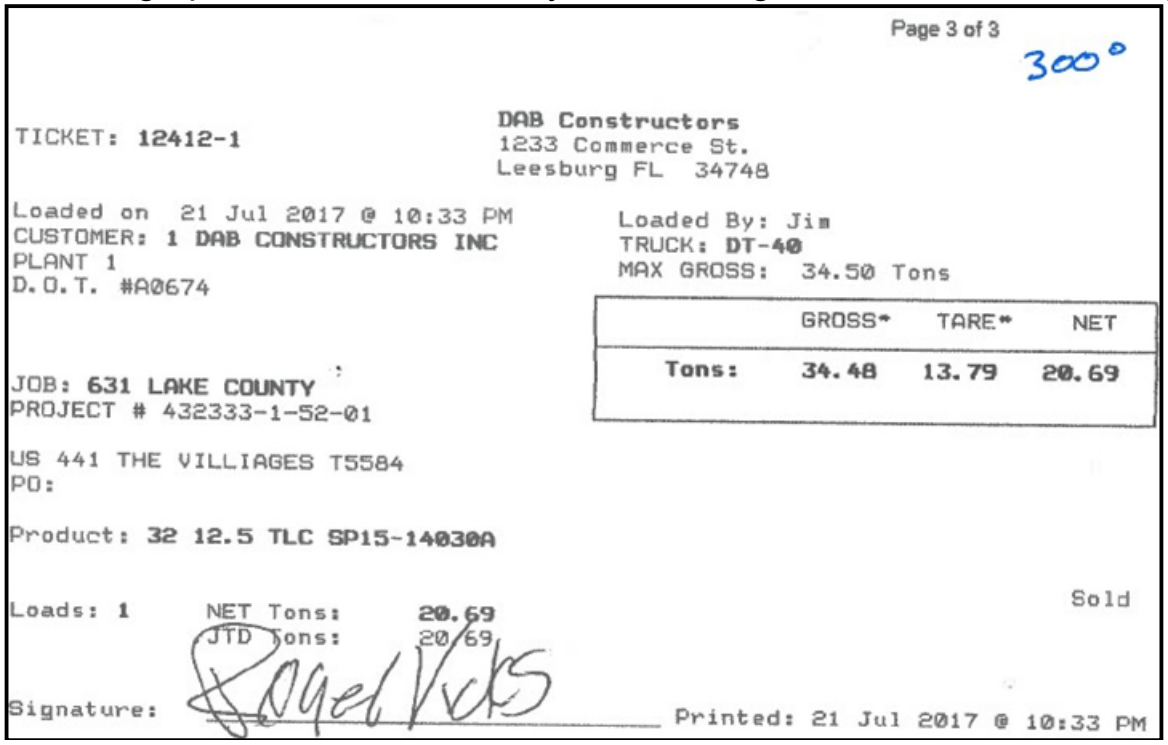
Slide 7

Another example is asphaltic concrete pavement which is paid for by the ton. Asphalt plants have fully automatic setups in which batch scales are equipped with an automatic recording system. When the asphaltic concrete is weighed on conventional truck scales prior to leaving the plant site, the delivery tickets are printed for the project personnel. Delivery tickets from such an approved system are acceptable as documentation.

Slide 8

Let's go through the procedures for this situation.

1. Verify that the batch scales and automatic printer have been certified within the past six months.
2. Before accepting the first load, check the accuracy of the scales and printer by weighing the load on both the plant scales and a certified truck scale.
3. Delivery tickets provided by the plant should include a minimum of the load number, project number, date, name & location of the plant, mix design number, gross, tare, and net tonnage per truck, and the daily total tonnage of mix for the mix design.



Page 3 of 3

300°

TICKET: **12412-1**

DAB Constructors
1233 Commerce St.
Leesburg FL 34748

Loaded on 21 Jul 2017 @ 10:33 PM
CUSTOMER: **1 DAB CONSTRUCTORS INC**
PLANT 1
D.O.T. #A0674

Loaded By: Jim
TRUCK: **DT-40**
MAX GROSS: 34.50 Tons

	GROSS*	TARE*	NET
Tons:	**34.48**	**13.79**	**20.69**

JOB: **631 LAKE COUNTY**
PROJECT # 432333-1-52-01

US 441 THE VILLIAGES T5584
PO:

Product: **32 12.5 TLC SP15-14030A**

Loads: 1 NET Tons: **20.69**
JTD Tons: 20.69

Sold

Signature: Roger Vicks

Printed: 21 Jul 2017 @ 10:33 PM

Slide 9

4. Original delivery tickets are retained by the Plant Verification Technician and uploaded into EDMS as part of the LOT submittal package. One copy is kept by the Roadway Verification Technician.
5. As tickets are collected, they should be saved as a PDF format separately by date. Tickets should be uploaded separately for materials of different Design Mix types.

Slide 10 KNOWLEDGE CHECK

Now let's test your knowledge.

1) Which of the following statements about scales is true?
   A. Scales must meet accuracy and condition requirements established by the Bureau of Weights and Measures.
   B. Scales must be recertified every eight to ten months.
   C. Certified on Florida, Alabama, and Georgia scales only.
   D. Scales must indicate the volume of each loaded truck.
   E. None of the above.

Slide 11

2) Which of the following statements about automatic system scales is true?
   A. Scales must have a degree of error no greater than 40 pounds per thousand pounds.
   B. Scales must be checked for accuracy at the beginning, at the mid, and end of production.
   C. Scales must be checked for accuracy at least once a year during production for the Department.
   D. Automatic printer system batch scales must be certified for accuracy every six months.

Slide 12

3) Each asphalt plant technician should verify that:
   A. The scales are being checked once a year.
   B. A supplementary numbering system has been established.
   C. The original delivery tickets are retained for the LOT submittal package.
   D. All the above.
   E. None of the above.

Slide 13

4) When should you check the accuracy of the scales and printer on a set of commercial truck scales?
   A. Before accepting the first load.
   B. At least every 30 days during production.
   C. Each morning and afternoon.
   D. Every three months.
   E. Both A and B.

Slide 14

5) Tickets should be collected for:
   A. Each week's run.
   B. Materials of different Design Mix type.
   C. Each day's production of material.
   D. Both B and C.
   E. All of the above.

Slide 15 STANDARD WEIGHT TABLES

Another method of determining weight is standard weight tables. Reinforcing steel and structural steel items are usually paid for based on computed weights. The weights of rolled shapes, bars, plates, and pipe railings are computed based on nominal weights provided by the manufacturer and the dimensions shown on the plans.

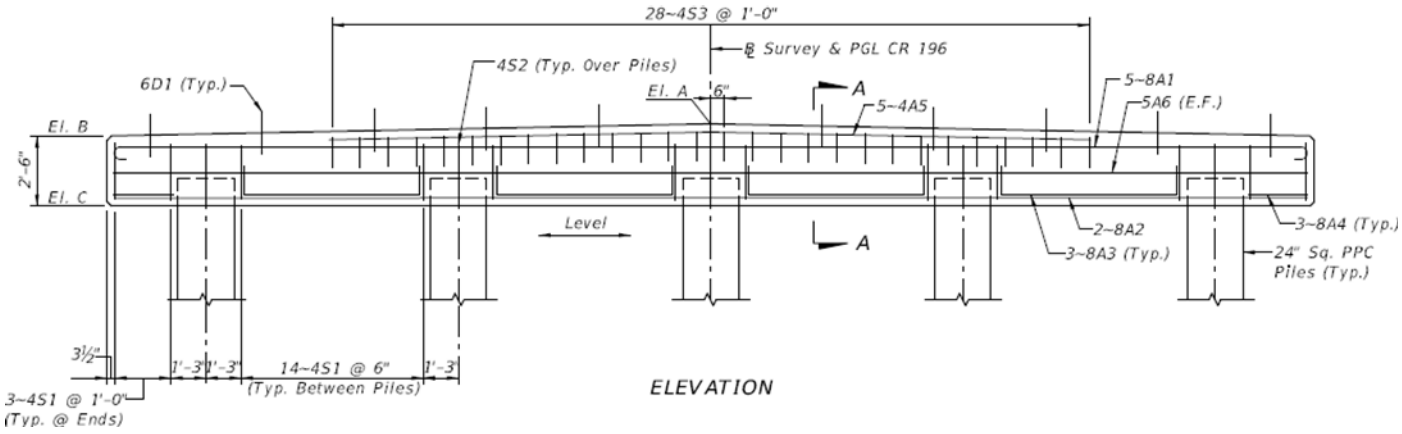
Slide 16

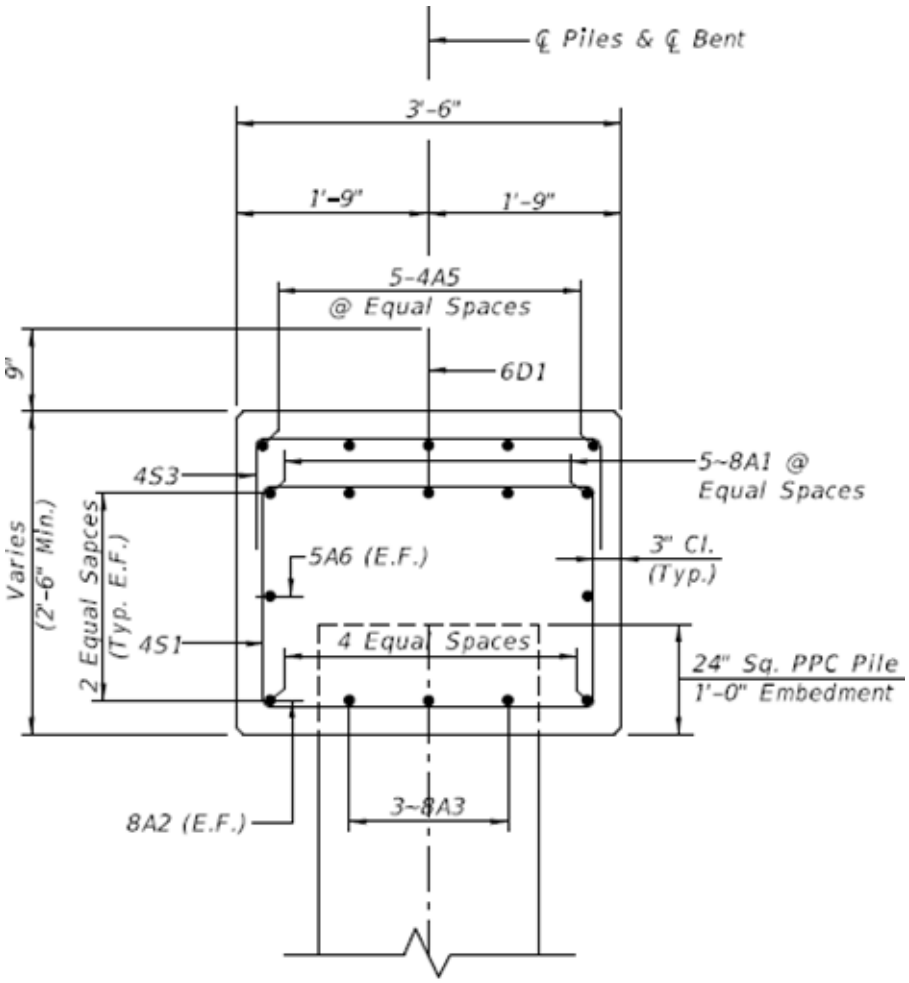
Reinforcing steel, which is commonly called rebar, contains a unit weight in pounds per feet for each size of reinforcing steel. These unit weights are issued by the Concrete Reinforcing Steel Institute Manual of Standard Practice. The weight for sizes #3 through #9 rebar is shown in the table. Using the length of rebar used and the unit weights we can easily calculate the total weight. Note that the bar size number indicates the diameter of the bars in eighths of an inch through bar size B. Notice in the table that the diameter of the bar is the same as bar number divided by 8. For example, a number 4 bar has a diameter of ½ inches, which is 4/8.

Rebar Size and Weights		
Industry Size	*Diameter (inches)*	*Weight (lbs/ft)*
3	3/8	0.376
4	1/2	0.668
8	5/8	1.043
6	3/4	1.502
7	7/8	2.044
8	1	2.670
9	1 1/8	3.400

Slide 17

To do this, we must use the plan sheets to obtain the elevations and details used to calculate the steel lengths.





SECTION A-A

Slide 18

Another place that reinforcing steel is documented is in the Reinforcing Steel tables located in the plans. In this table, the rebar size, length, spacing and quantity is documented by the Engineer.

MARK		LENGTH	NO	TYP	STYLE		B	C	D	E	F	H	J	K	N	O
SIZE	DES	FT IN	BARS	BAR	A	G	FT IN	FT IN	FT IN	FT IN	FT IN	FT IN	FT IN	FT IN	NO	ANG
LOCATION: END BENT 1 OR 6											NO. REQUIRED = 2					
8	A1	45 - 10	5	18	1	1	44 - 0									
8	A2	44 - 0	2	1			44 - 0									
8	A3	9 - 2	12	11			6 - 6	1 - 4	1 - 4							
8	A4	2 - 9	6	1			2 - 9									
4	A5	27 - 2	5	1			27 - 2									
5	A6	44 - 0	2	1			44 - 0									
6	D1	1 - 6	11	1			1 - 6									
4	S1	10 -7	68	4	4	4	1 - 11	3 - 0								
4	S2	7 - 4	5	5			1 - 11	3 - 0	0 - 3	0 - 3						
4	S3	5 - 0	28	11			3 - 0	1 - 0	1 - 0							
5	W1	4 - 6	12	1			4 - 6									
5	W2	3 - 5	12	1			3 - 5									

Slide 19

For example, using the Reinforcing Steel tables located in the plans for End Bent 1 & 6, we can see that there are 4 different designations for the #8 rebar. This includes the A1, A2, A3 and A4 designations and each has a different length. If we multiply the length of each of these designations by their respective number of bars, we can calculate the total length for the following designations.

MARK		LENGTH	NO	TYP	STYLE		B
SIZE	DES	FT IN	BARS	BAR	A	G	FT IN
LOCATION: END BENT 1 OR 6							
8	A1	45 - 10	5	18	1	1	44 - 0
8	A2	44 - 0	2	1			44 - 0
8	A3	9 - 2	12	11			6 - 6
8	A4	2 - 9	6	1			2 - 9
4	A5	27 - 2	5	1			27 - 2
5	A6	44 - 0	2	1			44 - 0
6	D1	1 - 6	11	1			1 - 6
4	S1	10 -7	68	4	4	4	1 - 11
4	S2	7 - 4	5	5			1 - 11
4	S3	5 - 0	28	11			3 - 0
5	W1	4 - 6	12	1			4 - 6
5	W2	3 - 5	12	1			3 - 5

Slide 20

For A1, we see that the length of this designation is 45 feet - 10 inches and there are 5 of these bars. This gives us a total length of 225 feet – 50 inches or in decimal form, this is 229.17 feet. This same calculation can be repeated for A2, A3 and A4.

Designation	***Length (ft. – in.)***	***No. of Bars***	***Total Length (ft.)***
A1	45’ – 10”	5	225’ – 50” or 229.17’
A2	44’ – 0”	2	88.00’
A3	9’ – 2”	12	110.00’
A4	2’ – 9”	6	16.50’

Slide 21

Once the length of each size of rebar or reinforcing steel is determined, the lengths can then be summed together and multiplied by the corresponding unit weight. This will give us the total weight of reinforcing steel similar to what is shown in the plan summary boxes.

SUMMARY OF STRUCTURE QUANTITIES - BRIDGE 484259

SECTION	PAY ITEM NO.	PAY ITEM DESCRIPTION	LOCATION	UNIT	QUANTITY P	QUANTITY F	TOTAL P	TOTAL F	D
LUMP SUM ITEMS	0110-3	REMOVAL OF EXISTING STRUCTURE		LS/SF	1		1		295
	0455-34-5	PRESTRESSED CONCRETE PILING, 24" SQ.	END BENT 1	LF	120				4 R
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]
	0530-[illegible]4	BEDD[illegible]G STONE	BEGIN BRIDGE ABUTMEN[illegible]	[illegible]	[illegible]		311.7		
			END BRIDGE ABUTMENT		147.8				
SUBSTRUCTURE	0400-4-5	CONCRETE CLASS IV, SUBSTRUCTURE	END BENT 1	CY	15.5		89.0		
			INT BENT 2		14.5				
			INT BENT 3		14.5				
			INT BENT 4		14.5				
			INT BENT 5		14.5				
			END BENT 6		15.5				
	0415-1-5	REINFORCING STEEL - SUBSTRUCTURE	END BENT 1	LB	2090		11,844		
			INT BENT 2		1916				
			INT BENT 3		1916				
			INT BENT 4		1916				
			INT BENT 5		1916				
			END BENT 6		2090				

Slide 22

Let’s look at an example. Reinforcing Steel is measured and paid for by the pound, but we don't have to weigh the bars. The specifications accept the Concrete Reinforcing Steel Institute’s standard weights per linear foot for the various sizes of bars. Let's go through some typical calculations.

The following table shows the required reinforcing steel on a project.

Bar Mark	Bar Size	No. Required	Length (ft. & in.)	Length (feet)
W 401	4	66	4’-2”	
W 402	4	10	32’-6”	
W 403	5	6	6’-10”	
W 404	6	19	1’-6”	
W 405	8	5	13’-8”	
W 406	9	2	10’-8”	

Slide 23

Remember how to convert inches to decimals of a foot? To calculate the weight of reinforcing bars, you must first convert the bar lengths from feet and inches to feet and decimals of a foot. You may accomplish this using your calculator.

Slide 24

Once you've made these conversions, the calculations look like the following. Note that the sum of the rebar is rounded to the pound. It is important to round at the end of the calculation, so accuracy is retained.

Bar Size & Mark	Unit Weight (lbs./ft.)	No. Required	Length (ft. & in.)	Length (ft.)	Calculated Weight (lb.)
(#4) W 401	0.668	66	4'-2"	4.1667	183.7
(#4) W 402	0.668	10	32'-6"	32.50	217.1
(#5) W 403	1.043	6	6'-10"	6.8333	42.8
(#6) W 404	1.502	19	1'-6"	1.50	42.8
(#8) W 405	2.670	5	13'-8"	13.6667	182.4
(#9) W 406	3.400	2	10'-8"	10.6667	72.5
				Total (Rounded)	741.3 **741 lbs.**

Slide 25

Reinforcing steel quantities normally are summarized separately for the various components of structures (each end bent, pier, median wall, etc.). These same breakdowns of pay quantities should be recorded in the Summary of Quantities sheets within the Final As-Built Plans or Estimated Quantity Report (EQR) along with the total pounds of reinforcing steel for the project.

SUMMARY OF STRUCTURE QUANTITIES - BRIDGE 484259

SECTION	PAY ITEM NO.	PAY ITEM DESCRIPTION	LOCATION	UNIT	QUANTITY P	QUANTITY F	TOTAL P	TOTAL F	D
LUMP SUM ITEMS	0110-3	REMOVAL OF EXISTING STRUCTURE		LS/SF	1		1		295
	0455-34-5	PRESTRESSED CONCRETE PILING, 24" SQ.	END BENT 1	LF	120				4 R
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]
	0530-[illegible]4	BEDD[illegible]G STONE	[illegible]	[illegible]	[illegible]		311.7		
			END BRIDGE ABUTMENT		147.8				
SUBSTRUCTURE	0400-4-5	CONCRETE CLASS IV, SUBSTRUCTURE	END BENT 1	CY	15.5		89.0		
			INT BENT 2		14.5				
			INT BENT 3		14.5				
			INT BENT 4		14.5				
			INT BENT 5		14.5				
			END BENT 6		15.5				
	0415-1-5	REINFORCING STEEL - SUBSTRUCTURE	END BENT 1	LB	2090		11,844		
			INT BENT 2		1916				
			INT BENT 3		1916				
			INT BENT 4		1916				
			INT BENT 5		1916				
			END BENT 6		2090				

Slide 26 KNOWLEDGE CHECK

Now let's test your knowledge.

1) Which of the following is the pay quantity for the reinforcing steel shown in the Table below?

Bar Mark	Bar Size	Unit Weight (lb./ft.)	No. Required	Length (ft. & in.)	Weight (lbs.)
W 901	9	3	1	15'-8"	
W 902	9	3	1	14'-5"	
W 801	8	2.670	13	41'-11"	
W 802	8	2.670	5	15'-8"	
W 803	8	2.670	6	13'-6"	
W 804	8	2.670	1	12'-5"	
W 601	6	1.502	15	1'-6"	
W 401	4	0.668	24	9'-8"	
W 402	4	0.668	2	7'-4"	
W 403	4	0.668	38	11'-4"	
W 404	4	0.668	10	8'-2"	
			Total		

A. 2,819 lbs.
B. 2,545 lbs.
C. 2,560 lbs.
D. 3,426 lbs.
E. None of the above.

Slide 27

2) The reinforcing steel quantities for the individual end bents and piers of a bridge should be summarized separately in the Plan Summary Boxes within the Final As-Built Plans or EQR and not just entered as a total weight of the reinforcing steel for the project.

A. True
B. False

Slide 28 STANDARD WEIGHT TABLES

Another pay item which uses the standard weight tables is the High Strength Fastener Assemblies (including nuts and washers). These items are to be computed in accordance with the table found in the Standard Specifications, Section 460-8.5, Table 460-9 shown below.

Diameter of High-Strength Fastener, inch	*3/4 in.*	*7/8 in.*	*1 in.*	*1-1/8 in.*	*1-¼ in.*
Weight per 100 bolts	52 lbs.	100 lbs.	135 lbs.	182 lbs.	238 lbs.

For example, the weight of 300 3/4-inch bolts (with nuts and washers) would be 300 bolts times 52 pounds divided by 100 bolts which is equal to 156 pounds.

$$\text{Weight (lbs.)} = 300 \text{ bolts} \times \frac{52 \text{ lbs}}{100 \text{ bolts}} = 156 \text{ lbs.}$$

Weight (in pounds) equals 300 bolts times 52 pounds divided by 100 bolts, which is equal to 156 pounds.

Slide 29 KNOWLEDGE CHECK

Now let's test your knowledge.

1) According to the Standard Weight Table, what is the total weight for the following quantities of High Strength Fasteners? 450 pieces of ¾" bolts, 290 pieces of 7/8" nuts and 638 pieces of 1" nuts.

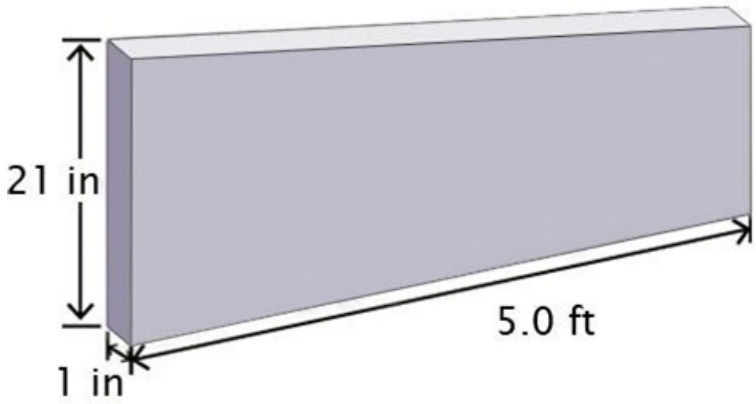
Diameter of High-Strength Fastener, inch	*3/4 in.*	*7/8 in.*	*1 in.*
Quantity of Bolts	450	290	638
Weight per 100 bolts	52 lbs.	100 lbs.	135 lbs.

A. 1,385 lbs.
B. 1,545 lbs.
C. 1,704 lbs.
D. 1,789 lbs.
E. None of the above.

Slide 30

2) Determine the weight of the structural steel shape shown. Note Structural Steel = 490 lbs. per cubic foot (as an example). Convert inches to feet when calculating answer. Calculate answer to the nearest pound.

A. 375 lbs.
B. 413 lbs.
C. 357 lbs.
D. 434 lbs.
E. None of the above.



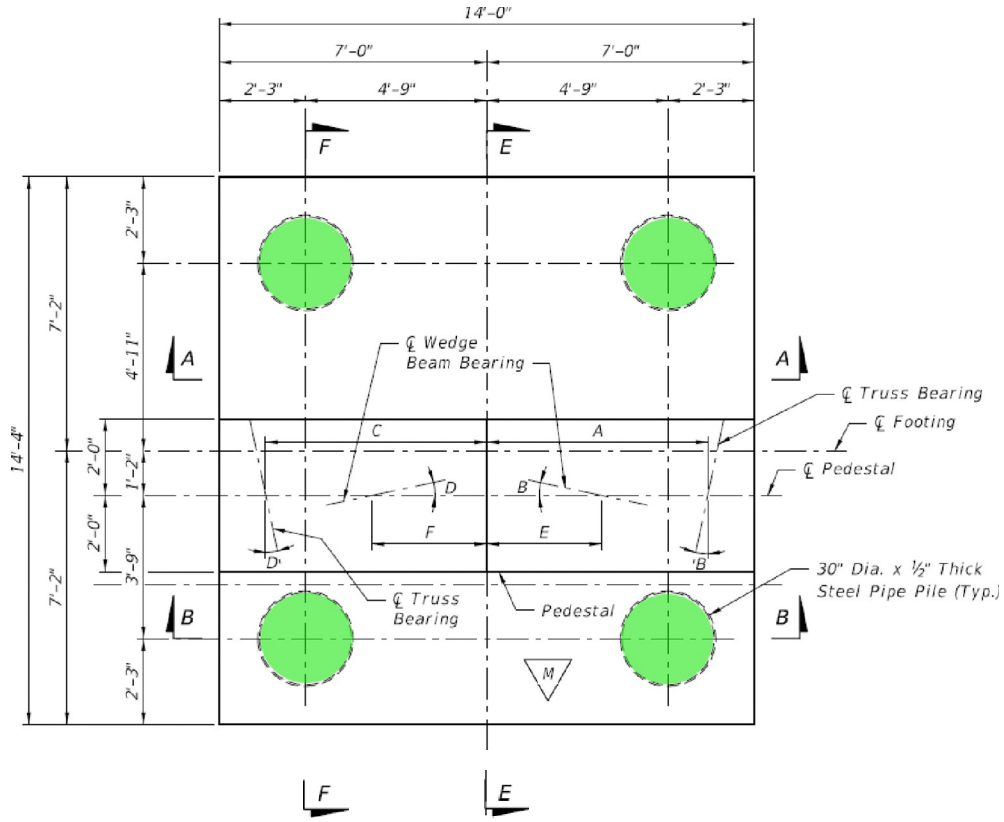
Slide 31 STRUCTURAL STEEL DEDUCTS

Now let's discuss another way to use the standard weight tables. To determine the pay quantities of concrete in certain structures, the volumes of the structural steel embedded in the concrete must be deducted to obtain a net pay volume. Usually, the weight of the steel is determined first and then converted to cubic feet. It is important to note that according to the Standard Specifications, all materials embedded in concrete such as structural steel or pile heads must be deducted when computing the volume of concrete volume to be paid for. Reinforcing bars or welded wire mesh are not deducted from concrete volumes since the area they occupy in concrete structures is minimal.

Slide 32

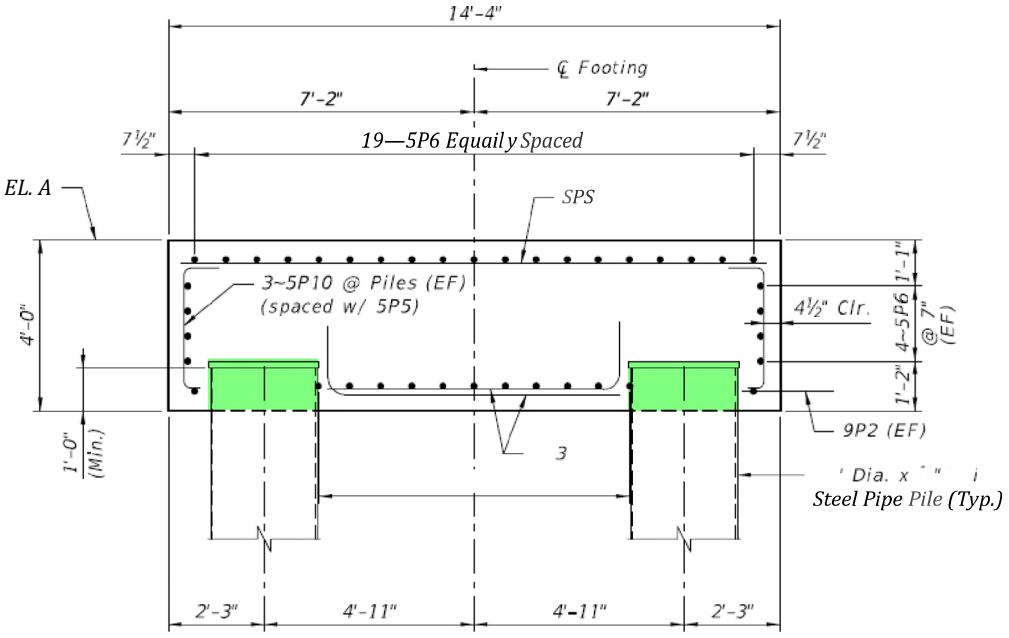
Let's go through a typical procedure for deducting the volume of steel within the end bent of a concrete bridge.

Step 1: Determine the total length of steel in feet embedded in the end bent.
In this example, there are four 30" diameter steel pipe piles that intrude in the end bent. Each of the piles have a wall thickness of ½ inch and extend in the bent a minimum of 1 foot. Therefore, since there are 4 piles extended 1 foot in the bent, the total length of steel is 4 feet.



Pier & Footing

PLAN Pier 3 Right Footing
(For Pier 3 Left Footing see Typical Plan)



SECTION F - F
(Pedestals not shown)

Slide 33

Step 2: Multiply the total length of structural steel shown in the plans by the unit weight per foot for each steel pipe pile.

From the manufacturer's data sheet, we know that 30" diameter steel piles, with ½" thick walls, weigh 157.68 pounds per foot. It is important to note that most manufacturers of structural steel shapes create data sheets that contain both the dimensions and weight so it does not need to be re-calculated by Engineers or contractors.

Since the unit weight is 157.68 pounds per foot, when this is multiplied by the total length 4 feet, we calculate a weight of 630.72 lbs.

4 feet x 157.68 lbs./ft. = 630.72 lbs.

Slide 34

Step 3: Convert the total weight to volume.

Divide the weight obtained in Step 2 by the unit weight for structural steel which is 490 pounds per cubic foot.

$$= \frac{630.72 \text{ lbs}}{490^{\text{lbs}/\text{CF}}} = 1.29 \text{ CF}$$

630.72 pounds divided by 490 pounds per cubic foot equals 1.29 cubic feet.

(This is the amount of deduct from the total footing.)

Slide 35

Step 4: Refer to the plan dimensions of the end bent and determine its volume in cubic feet. Subtract the steel volume from the footing volume to determine the pay quantity of concrete for the footing.

Although the preceding method is generally the simplest and most preferred method, there is an alternative way of determining structural steel deducts from concrete volumes. Instead of computing the total weight of the embedded steel and then converting the weight to a volume, you sometimes can determine the volume of steel directly.

Slide 36

To compute the cubic feet of deduct, multiply the distance the steel protrudes into the concrete (in inches) by the cross-sectional area of the steel shapes by the number of steel members involved.

Volume = (Length into Concrete Member) x (Cross Sectional Area) x (No. of Steel Members)

Using our example problem from the other method, we would have:

$$\text{Volume=Length into Concrete Member x } \left(\frac{\pi(r1^2)}{4} - \frac{\pi(r2^2)}{4}\right) \text{ x No. of Steel Member}$$

Where r1 represents the Outer Diameter and r2 represents the Inner Diameter:

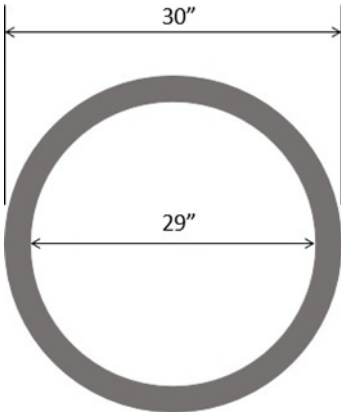
$$\text{Volume} = 12'' \text{ x } \left(\frac{\pi\left({}^{30''}/_{12''}\right)^2}{4} - \frac{\pi\left({}^{29''}/_{12''}\right)^2}{4}\right) \text{ x } 4$$

$$\text{Volume} = 1.29 \text{ cubic feet}$$

Slide 37

So, the piles protrude 12 inches into the end bent times the area of the outer diameter minus the area of the inner diameter all multiplied by 4 since there are four piles in the bent. This equals 1.29 cubic feet which is the same answer we calculated using the other method.

Note: The cross-sectional areas for various steel shapes can be found in the tables shown in the Steel Construction Manual by the American Institute of Steel Construction.



Slide 38 KNOWLEDGE CHECK

Now let's test your knowledge.

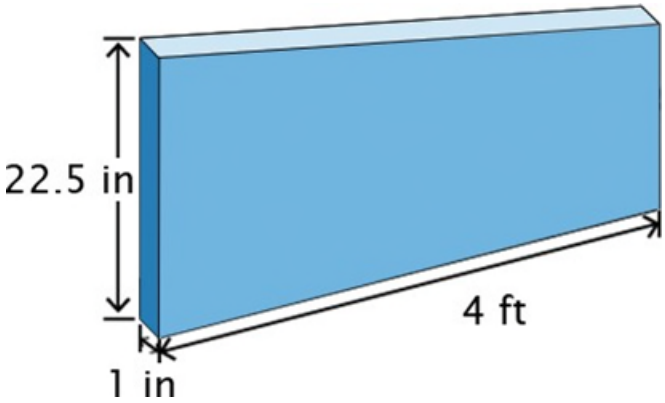
1) The footing for one pier of a bridge has 24 steel "H" piles 12BP53 that extend 1 foot into the footing. The unit weight for one pile is 53 pounds per foot. The weight of Structural Steel is 490 lbs. per cubic foot. Which of the following is the amount of "Deduct" from the total footing volume to the nearest cubic foot?

A. 3.0 Cubic Feet
B. 3.3 Cubic Feet
C. 3.6 Cubic Feet
D. 3.7 Cubic Feet
E. None of the above.

Slide 39

3) Which of the following is the weight of the structural steel shape? Note: Structural steel = 490 lbs. per cubic foot. Convert inches to feet.

A. 278 lbs.
B. **306 lbs.**
C. 2,658 lbs.
D. 3,675 lbs.



Slide 40 CONCLUSION

This is the end of Module 6. Thank you for your time and attention.

MODULE 7 - OTHER MEASUREMENTS

Slide 1 WELCOME

Welcome to the Florida Department of Transportation's computer-based training series on Final Estimates, Level 1 Training. This is Module 7, Other Measurements. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

Most construction items are measured and paid for by one of the techniques described in the previous modules. However, some items do not fall into any of these categories and are measured and paid for by other criteria such as:

- number of units (per each),
- a lump sum for completion of a described item,
- payment based on planned quantities, or
- payment based on the Contractor's certified quantities

In this module we will talk about the criteria and procedures for these other types of measurement and payment.

Slide 3 PER EACH ITEMS

Some of the items commonly measured and paid for on a "per each" basis include:

- inlets
- manholes
- junction boxes
- prestressed concrete poles
- test loads
- delineators
- steel mast arm assemblies
- mailboxes, and
- guardrail end treatments

Slide 4

Measurement of these "per each" items is simply a matter of counting the number of units of a particular item, completed, and accepted. Documentation of the constructed items must be prepared in an organized manner so that the number of items can be checked and verified. It is recommended to document "per each" items on the Final Measurement "Miscellaneous" form and reference within the Final Estimates Documentation.

Slide 5 LUMP SUM ITEM

Some construction work items can be quite clearly defined and is not usually subject to significant changes during construction. These work items are paid for as a lump sum for satisfactory completion of the prescribed work.

Slide 6

Items paid for on a lump sum basis include:

- maintenance of traffic,
- removal of buildings,
- clearing and grubbing,
- removal of existing structures,
- special detours,
- buildings,
- toll plazas, etc.

Slide 7

Ordinarily, there is no measurement involved. The only question is whether the work item was completed in accordance with the plans, specifications, and any special provisions that may be applicable. Satisfactory completion is indicated by a one-line entry on the summary sheet for Lump Sum Quantities as shown. In this example, the clearing and grubbing limits were decreased from the original bid quantity of 1 lump sum. The final quantity is now 0.836 which is less than 1.

SUMMARY OF LUMP SUM ITEMS

PAY ITEM NUMBER	*DESCRIPTION*	*QUANTITY*		*DESIGN NOTES*	*CONSTRUCTION REMARKS*
		P	*F*		
0110-1	Clearing & Grubbing Sta. 410+20 to 412+60 =240' x 310.91 = 1.713 AC Sta. 437+55 to 442+35 = 480' x 300.02' = 3.306 AC Sta. 463+80 to 471+45 = 765' x 217.46 = 3.819 AC Total Acres = 8.838	1 LS	*0.836 LS*		*Trees left standing in median between Sta. 464+00 to 467+20, at the Direction of the Engineer. Area reduced by 1.450 Acres below estimate. Total Acres =7.388 Acres*

Slide 8

But, it is not always that easy. If the scope of work included in the lump sum item is increased or decreased significantly during construction, the amount of the lump sum payment must be adjusted. For example, clearing and grubbing on a project is paid as a lump sum item. The designer computes the estimated acres and records the information on the Summary of Quantity sheets in the plans. The contractor bids a lump sum amount to complete the prescribed clearing and grubbing without quoting a unit cost per acre.

Slide 9

If the Project Engineer calls for additional clearing and grubbing not identified in the plans, or eliminates some planned clearing and grubbing, there is need to adjust the lump sum payment.

Slide 10

The Figure above shows a summary sheet with Designer's quantity of 1 LS. The description column details the locations for the lump sum area in secondary units of acres. However, during Construction, with the approval of the Engineer, 1.450 acres did not need clearing and grubbing, therefore the final quantity was reduced from 1 LS to 0.836 of a LS.

Slide 11

This is calculated by first subtracting the acres not cleared from the original quantity to determine the final quantity.

$$\text{Final Quantity} = \text{Original Quantity} - \text{AC Not Cleared}$$

$$\text{Final Quantity} = 8.838\ \text{AC} - 1.450\ \text{AC} = 7.388\ \text{AC}$$

Then divide the final quantity by the original quantity to determine what percentage was actually cleared and grubbed.

$$\frac{\text{Final Quantity}}{\text{Original Quantity}} = \frac{7.388\ \text{AC}}{8.838\ \text{AC}} = 0.836$$

Slide 12

Note: If the plans do not show an estimated plan quantity this item cannot be adjusted without a supplemental agreement as per ***Section 9-3.3.2 of the Specifications***.

Normally, when a lump sum item is completed in accordance with the plans and specifications, final payment is made based on the bid amount - without measurement or adjustment.

Slide 13 PLAN QUANTITIES

Certain items will be paid for based on plan quantity. The overall effect is much the same as for a lump sum item. If the scope of work for the item remains as planned, the Contractor is paid for the quantity shown in the plans without detailed measurement of final quantities.

Slide 14

If there is a significant difference between the original estimate and the work actually performed, an adjustment is needed. However only the plan error or the field change will need to be measured and documented. More information on how to adjust plan quantity can be found in Section 9-3 of the Standard Specifications.

Slide 18 CONTRACTOR'S CERTIFICATION OF QUANTITIES

Sometimes, pay items are paid based on the Contractor providing certification of the quantity. Certified quantities are those that the Contractor keeps track of and submits for payment each month. The Resident Office will spot check these quantities; however, they will not expend time verifying each pay item's quantity.

Slide 19

There are a few reasons for placing the responsibility of tracking the quantities on the Contractor rather than Department personnel. First, safety is the utmost importance in any project and tracking some of the quantities puts field personnel in harm's way. An example of this are certified Maintenance of Traffic items such as signs, barrier, temporary guardrail, and pavement markings. Most of these items are located immediately adjacent to the flow of traffic which poses a safety risk for additional personnel performing count of quantities. Rather allow the Contractor to certify these quantities.

Slide 20

Another factor is time. The time it takes to count these individual items each day can be time consuming. Typically, certified quantities are not worth the resources to count them daily. Instead, field personnel can perform spot check counts to verify the quantities are reasonable.

Slide 21

Now let's test your knowledge.

1) Multiple Choice. Documentation of "Per Each" item usually is in the form of a tabulation by:

    A. Date and Cost.
    B. Location.
    C. Contractor or Subcontractor.
    D. None of the above.
    E. All the above.

Slide 22

2) True or False. Documenting "per each" items should be done in Field Books, Forms or on the Pay Item Summary Sheets in the Final As-Built Plans.

    A. True
    B. False

Slide 23

3) Multiple Choice. Examples of "per each" items are:

    A. Embankment, and Subsoil Excavation
    B. Inlets, manholes, and signs (permanent)
    C. Optional Base, and Superpave Base
    D. Borrow Excavation and Fill
    E. None of the above

Slide 24

4) True or false. If a plan error for a plan quantity item is found on a project, the total original quantity of the pay item must be measured again plus the area of error.

A. True

B. False

Slide 25

5) True or false. Ordinarily it is necessary to measure a Lump Sum Item for Final Payment.

A. True

B. False

Slide 26

6) The Summary of Quantities sheet of a plan quantity pay item would refer to the designer's original quantities and…

A. The final quantity will be final measured and paid at the contract bid price.
B. The final quantity will be Lump Sum and paid at the contract bid price.
C. The final quantity will be plan quantity subject to any changes in the field and/or any plan errors on the project as per Section 9-3 of the Specifications.
D. None of the above.

Slide 27 CONCLUSION

This is the end of Module 7. Thank you for your time and attention.

MODULE 8 – FINAL ESTIMATES OVERVIEW

Slide 1 WELCOME

Welcome to the Florida Department of Transportation's computer-based training series on Final Estimates, Level 1 Training. This is Module 8, Submittals. This CBT contains audio and interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Slide 2 INTRODUCTION

This module will cover the necessary resources used to assist in the preparation and submitting the Final Estimate. We will also discuss the items within the Final Estimates Documentation Submittal.

Slide 3 GUIDANCE RESOURCES FOR PREPARING THE FINAL ESTIMATE

Before we begin discussing what is needed to submit a Final Estimate, we must mention some of the valuable resources available for Construction personnel to assist in the preparation, checking and payment of the Final Estimate. FDOT developed these documents to establish consistency in how the Department does business, but also to ensure all proper documentation is obtained for future audits. There are two primary resources.

Slide 4 FINAL ESTIMATES GUIDELIST

1. ***Final Estimates Guidelist***

This document is a good resource to help the Final Estimates personnel prepare the Final Estimate documentation. If this is followed, it will help us to ensure we include all needed information. The Guidelist is divided into 3 sections based on the different phases of a contract.

Slide 5 FINAL ESTIMATES GUIDELIST PHASES

Phase I: Before Construction

This typically begins with a kick-off meeting to discuss what is to be expected with the project personnel. At these meetings, the District Final Estimates Office will go over all the documents that personnel need to know such as the Specifications, Special Provisions, manuals, etc. This kick-off meeting should not be confused with the pre-construction meeting typically held with the Contractor. This section covers the tasks to complete during the pre-construction phase that will set a project up for success.

Slide 6

Phase II: During Construction

The Guidelist will discuss the proper documentation of items during the construction phase. This will include documentation of pay items completed throughout the contract, considerations for adjustments with careful detail for fuel and bituminous adjustments, documenting contract time, differentiating between the alternative contract types and accurately recording information in the Final As-built Plans.

Slide 7

The major points of this section are:

- Plan Summary Boxes
- Final Measure Pay Items
- Plan Quantity Pay Items
- Lump Sum Pay Items
- Earthwork Pay Items
- Asphalt Pay Items
- Concrete Pay Items
- Structural Pay Items
- Fuel & Bituminous Adjustments
- Contract Time
- Alternative Contracts: Lump Sum, Design-Build, No Excuse Bonus, etc.
- Final As-Built Plans

Slide 8

Phase III: After Construction

This section encompasses how the final estimate documentation should be prepared and submitted to the District Final Estimates Office. It also includes an overview of the DFEO Review and close out phase.

Slide 9 CONSTRUCTION PROJECT ADMINISTRATION MANUAL (CPAM)

2. Construction Project Administration Manual (CPAM)

While the Guidelist provides a quick overview of the items that should be checked and closely resembles a checklist, the Construction Project Administration Manual, commonly referred to as CPAM, provides a more in depth look at how items should be prepared and documented. The CPAM is for use by all construction personnel, including Final Estimates.

Slide 10

The sections within CPAM that are dedicated to Final Estimates process include:

- Section 2.2: Final Estimates Pre-Planning
- Section 3.5: Quality Control/Quality Assurance Reviews for Final Estimates
- Section 5.11: Final Estimates Documents
- Section 5.12: Final As-Built Plans Process
- Section 5.13: Plan Summary Boxes
- Section 5.14: Field Records and Contractor's Certifications
- Section 5.15: Final Measurements
- Section 5.16: Earthwork Notes & Documentation
- Section 6.2: Alternative Contracts
- Sections 11.1 thru 11.9: Asphalt

Slide 11

These two resources are vital to Construction personnel in preparing a project for Final Estimates.

Slide 12 KNOWLEDGE CHECK

Now let's test your knowledge.

1) Which of the following is a resource to help you make sure that all needed work has been done on the Final As-Built Plans?
   A. The Final Estimates Guidelist
   B. The Summary of Contract Plans
   C. The Final Plan Reminder Checklist
   D. All of the above

Slide 13

2) Which one of the items listed below is NOT listed and detailed on the Final Estimates Guidelist?
   A. Pre-Construction Phase
   B. Construction Phase
   C. DFEO Final Review & Closeout Phase
   D. Maintenance and Warranty Phase

Slide 14

3) True or false. The Construction Project Administration Manual is dedicated for all construction personnel and Final Estimates.
   A. True
   B. False

Slide 15 SUBMITTING THE FINAL ESTIMATE

As construction projects are underway, numerous measurements and computations are made and many documents are prepared to record work accomplishments and pay quantities. In Module 2, we stressed that planning for the final estimate should start before beginning a project. The submission of the final estimate is when that planning pays off. If records have been prepared and maintained in an orderly manner throughout the project, it is much easier to compile the information for the final estimate documentation and submit it to the District Office.

Slide 16

It is important to remember that someone in each district will review the estimate and verify the quantities before final payment is made to the Contractor. Unless the reviewer can easily locate the backup data and verify the calculations, the whole process will be slowed down. So, keep it neat and organized, and make sure all the necessary information is included.

Slide 17 THE FINAL ESTIMATES DOCUMENTATION

There are many documents that are included within the Final Estimate Documentation. Section 5.11 of CPAM discusses these documents thoroughly; however, we will mention a few of them. They are:

- Time Correspondence. This is all the documentation needed to substantiate contract time, including the Notice to Proceed, Notice of Beginning Work, and Final Acceptance Letter. This will also contain all weather letters, holiday extensions, any references to Supplemental Agreements with time extensions, etc.

Slide 18

- Daily Work Report (DWR). This is the report of the work done each day, and corresponding equipment used, for the entire life of the project. It is stored in PrC and should be uploaded daily by the field personnel.

Slide 19

- The Estimates Office Record of Final Plans and Documents (Form 700-050-28) provides important contract time information, such as critical dates & time extensions. It also provides contract amounts, general contract information, and other relevant information about the project.

Slide 20

- Contract Change Documentation. Contract changes can be made through the following documents:
    - Supplemental Agreements
    - Unilateral Directed Extra Work
    - Contractor's Claim
    - Contingency Supplemental Agreement
    - Work Order for unforeseen Additional Work
    - Cost Savings Initiative Proposal (CSIP)

Slide 21

- Final As-Built Plans. This will include the original design plans with all changes shown in red and signed by the Responsible Engineer. This also can include the Contractor supplied as-builts drawings and shop drawings. It is crucial that the Final As-built Plans are accurate since they will be used by both Maintenance and in future designs.

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- Offer Letter & Final Estimate. Within 30 days after Final Acceptance, a final estimate will be generated for all final quantities. This estimate will also include all adjustments (such as Fuel and Bituminous adjustments, Composite Pay Factor adjustments, etc.) and deductions (concrete failures, asphalt straightedge, etc.). Once these items have been generated; the Offer Letter can be submitted to the Contractor along with the final close-out estimate.

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- Back-up documentation. This should be stored in the Electronic Document Management System (or EDMS) to support any quantity changes.

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- Final Plans and Estimates Transmittal (Form 700-050-20). The main purpose of the transmittal is to list all items included in the final estimate documentation submitted to the District. It provides a final check by the people who prepare the documentation together in the field. The District Final Estimates Office uses the transmittal to verify that all listed items are received.

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Other documents may be listed on this form such as:

- Pending Supplemental Agreements
  Sometimes a pending supplemental agreement may not have been submitted to the District Office. If this is the case, the final estimate documentation should include information on the scope, approximate cost and additional contract time involved.
- Unresolved Claims
  Any unresolved claims of the contractor that might affect final payments should be identified and clearly described at the time the final estimate is submitted.

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- Defective Materials
  If the inspection and testing procedures have disclosed some defective materials on the project, and the matter has not yet been resolved, the status of these materials must be described in the final estimate documentation.
- Correspondence File
  All correspondence related to final estimates on each project must be included.

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- Explanation of Overruns and Underruns

  This item is a summary of the explanations of all variations between the original estimated quantities and the final quantities of $10,000 or greater. The Project Administrator generates this report from AdHoc and exports the file to an Excel document where the reasons for changes can be documented.

- Pile Records, Shop Drawings, etc.

All documents pertaining to the Contract will be available electronically on the Department's collaboration site.

Slide 28 KNOWLEDGE CHECK
Now let's test your knowledge.

1) Which item is not listed on the Final Plans & Estimates Transmittal:
   A. Contractor's Certified Payroll Summary
   B. Pending Supplemental Agreements
   C. Overruns & Underruns
   D. Unresolved Claims

Slide 29 CONTRACTOR REQUIREMENTS

After completing all work provided under the contract and after the engineer has made final acceptance, the contractor must meet the following requirements:

- Agree in writing to accept the balance due or refund any overpayment
- Has properly maintained the project
- Provide a sworn affidavit that they have paid all bills and no lawsuits are pending
- Provided the surety affidavit
- Complied and settled all wage-rate provisions
- Furnished all required mill tests and analysis reports
- Furnished the final Construction Compliance with Specifications and Plans Certification
- The Contractor has submitted and the Department has accepted all as-built drawings and certified surveys
- Provided all manufacturer warranties

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If the Contractor fails to furnish all required Contract Documents within 90 days of the Department's offer of final payment or request for refund of overpayment, the Department may suspend the Contractor's Certificate of Qualification under the provisions of Florida Administrative Code 14-22.

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KNOWLEDGE CHECK

Now let's test your knowledge.

1) How should correspondence documents related to Final Estimates on each project be submitted?
   A. Through Fed-Ex
   B. Packed in a box as hard copies
   C. They are kept with the Project Administrator's office for reference
   D. They are available electronically on the Department's collaboration site.
   E. None of the above

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2) The document used to account for all variations of $10,000.00 or greater between the Original and the Final Quantities is called the Variation Schedule.
   A. True
   B. False

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3) Which of the following are some of the requirements that the Contractor must meet prior to receiving Final Payment?
   A. Furnish the final Construction Compliance with Specifications and Plans Certification
   B. Notification of Contractor's Performance Grade
   C. Furnish the Surety Affidavit
   D. All of the above
   E. A & C

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4) Any unresolved claims of the contractor that might affect final payment:
   A. Should not be identified until after the project has closed
   B. Should be identified and clearly described at the time the final estimate is submitted
   C. Should be identified and described during the pre-construction conference
   D. Should be identified and clearly described at the job site
   E. None of the above

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CONCLUSION

This is the end of Module 8. To receive your certificate, please select the Print Certificate button or press Shift+P on your keyboard. Thank you for your time and attention.