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Chapter 12: Earthwork Calculations and Grading Summary

Introduction

There are several methods and tools for developing grading summaries using GEOPAK. This chapter outlines the methods required by CFLHD. GEOPAK is only used to calculate cross section areas and unadjusted volumes. The volumes for each cross section are then imported to an Excel spreadsheet and then Excel is used to adjust the data, develop the grading summary, and generate the mass haul diagram. Working with a spreadsheet provides designers more control and flexibility while compiling final earthwork quantities.

The examples provided in this document are for a simple project improving an existing paved road with minor geometry changes and balanced earthwork. Refer to the CFLHD Guidelines for [Earthwork Representation: Grading Summaries & Mass Haul Diagrams](#) for additional design guidance regarding items that are not common to all road projects, such as retaining walls, subexcavation, waste, and borrow.

GEOPAK Earthwork Calculations

Two key items are needed to produce Geopak earthwork quantities; these are finalized cross sections and an earthwork input file. This section describes the files and process in detail.

GEOPAK Cross Sections

The figure below depicts a proposed cross section ready for earthwork calculations. The edge of the existing road is delineated along with line work for the bottom of existing topsoil and bottom of existing pavement. The existing pavement delineation is necessary for calculating the amount of topsoil that can be conserved. Excavation limits are also shown.



Fig. 12-1: Typical Cross Section ready for earthwork



Earthwork Input File

An earthwork input file lists identifies project specific information, and specific elements in a cross section file by symbology. Additionally, what information and how the output is generated are also determined within an input file.

Workflow 1 describes calculating earthwork quantities using the CFLHD standard earthwork input file. The input file creates two text files. The first text file is the earthwork log file created by GEOPAK while processing the cross sections. The second text file is an ASCII text file that separates out quantities for each cross section into a column format that can be imported into an Excel spreadsheet.

Workflow 1: Using the GEOPAK Earthwork Input File

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.1_v8i.pdf

Working with the Earthwork Excel Spreadsheet

CFLHD's grading summary spreadsheet has been set up to be as user friendly as possible, but a basic understanding of how the spreadsheet works is very important. Cross section quantity data from GEOPAK is imported into a worksheet called "from_GEOPAK". The data is linked to another worksheet called "XSData". This cross section data (XSData) worksheet is where all the earthwork data is stored. The "yellow" columns are locations where the user inputs data, including hand calculations.



The term "hand calculation" used in this document refers to any data that is manually input into the spreadsheet, whether it was calculated by hand or any other program.

Workflow 2: Importing to the "From GEOPAK" Worksheet

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.2_v8i.pdf

Workflow 3: Checking the Imported Data from GEOPAK

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.3_v8i.pdf

The Manual Inputs Worksheet

The manual inputs worksheet is where the user enters project-specific information about the earthwork material. The information required on this worksheet is usually provided by the Geotechnical and Materials Engineers. Information entered on this worksheet is linked to the cross section data (XSData) worksheet and will be reflected in the Grading Summary.



Workflow 4: Manual Inputs

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.4_v8i.pdf

The Cross Section Data Worksheet

The cross section data worksheet (XSData) is where all the earthwork data is calculated. This sheet is organized in the same column order as the grading summary. The imported data from GEOPAK is linked to this sheet and all hand input data can be placed either here or linked to from other worksheets.

Hand Calculation Data

Hand calculated data includes quantities from items like approach roads, obliteration, and subexcavation. Additional worksheets for calculating these quantities have been provided in the base spreadsheet, but they are not linked to the data or summary worksheets.

Workflow 5: Approach Road Data Input

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.5_v8i.pdf

Workflow 6: Roadway Obliteration Data Input

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.6_v8i.pdf

Workflow 7: Subexcavation Data Input

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.7_v8i.pdf

The Calculation Worksheets

The Calculation Worksheet (calc wrksht) is a short summary of earthwork volume totals. This sheet can be used for a quick check during design iterations and as a quality control tool. There are two calculation worksheets: one using the roadway excavation pay item and one using the embankment construction pay item. All of the information shown on this worksheet is linked to other sources. No user input is required on this worksheet.

The Grading Summary Worksheets

The Grading Summary Worksheet has the table that is included in the plan set. This worksheet summarizes the earthwork volumes by station range. These station ranges are dictated by plan sheet station ranges, changes in material type, bridge locations, or construction phasing. There are two Grading Summary worksheets: one for projects using the roadway excavation pay item and one using the embankment construction pay item. Workflow 8 will describe the process for creating this worksheet.



Workflow 8: Formatting the Grading Summary Worksheet

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.8_v8i.pdf

The Mass Haul Diagram Sheet

The Mass Haul diagram is created using the data from the “XSData” worksheet. The benefits of using the spreadsheet for developing the Mass Haul diagram are that the data is directly tied to the summary, hand calculated quantities are easily included in the diagram, and the diagram updates automatically between design iterations as long as the total number of project cross sections does not change.

Workflow 9: Formatting the Mass Haul Diagram Sheet

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.9_v8i.pdf

Design Iterations

All the time spent setting up the grading summary spreadsheet pays off during design revisions. To import new earthwork information, follow the following workflow:

Workflow 10: Updating Earthwork Calculations

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.10_v8i.pdf

Developing Miscellaneous Summaries

The Grading Summary shows all earthwork-related quantities grouped into categories. Individual miscellaneous summary tables, such as the Topsoil Summary, MSE Wall Summary, and Rockery Summary, show the earthwork-related quantities broken out in more detail.

The Topsoil Summary shows quantities by station range of topsoil stripped and placed.

Workflow 11: Topsoil Summary

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.11_v8i.pdf

Workflow 12: MSE Wall Summary

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.12_v8i.pdf

Workflow 13: Rockery Summary

To access this workflow, follow this link:

http://flh.fhwa.dot.gov/resources/cadd/cfl/documents/Workflow_12.13_v8i.pdf