Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 91 (2014) 328 – 333

Procedia Engineering

www.elsevier.com/locate/procedia

XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP) (TFoCE 2014)

The Comparison of the Calculation of the Volume of the Foundation Pit

Jaroslav Šíma[a], Anna Seidlová[a] *

[a] *Department of Geodesy, University of Zilina, FCE, Univerzitná 1, 01026 Žilina*

Abstract

The realization of the earthwork represents a large part of the cost of construction works. Therefore, it is very important to determine the volume of the earthwork as accurately as possible. There are many ways how to determine its value. However, comparing the reasons of different methods we have discovered that results of quantification are often varying. In this paper, we will discuss the results of calculation of the volume by different methods. We will compare the conventional methods of the calculation with the differential exact calculation of using the digital terrain model derived by geodetic and photogrammetric methods.

Peer-review under responsibility of organizing committee of the XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP)

Keywords: Geodesy; engineering geodesy; digital photogrammetry; digital terrain model;

1. Introduction

In the construction, there are cases which require determining the cubic content of the earthworks as precisely as possible. There are many ways in which we can determine the volume of earthworks. However, comparing the reasons of different methods we have discovered that results of quantification are often varying. The cubic content is exactly calculated from a differential digital models obtained by geodetic and photogrammetric methods. This is the case, when we are using a digital model of the flat or slope terrain.

There is often a situation in practice [1,2] that one of the models is formed by construction pit with vertical walls and in that case, the automatic calculation of volumes generally fails. In principle, following methods are currently used to obtain the cubic capacity:

- calculation of the volume from profiles,
- calculation of the volume using DTM.

These methods differ mainly in elaborateness and processing time. Results obtained from graphical documents are often disputed by suppliers.

* Corresponding author. Tel.: +421 41 5135569; fax: +421 41 513 5510
E-mail address: anna.seidlova@fstav.uniza.sk

Peer-review under responsibility of organizing committee of the XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP)
doi:10.1016/j.proeng.2014.12.069

2. Object of the experiment

The foundation pit was excavated during 2012 – 2013 with continual removal using individual trays of soil and slope ensuring with soil nails and shotcrete. After finalization, the vertical walls can allow for other construction activity at foundation pit, Fig.1.

Fig. 1 View of the wall excavation.

The main problem of calculations of the volume *of the earthwork* is often the lack of information concerning the original terrain. In this case, the quality base map of y. 2010 was available, which we prepared for the transhipment utilities (in graphical and numerical version).

For mapping and staking out works was stabilized control minor. We used method combination of GNSS (static method) and terrestrial measurements, with the Leica Viva GNSS apparatus and ET LEICA TC 06. Using the results of measurements we prepared two specific maps of the area, together with a list of coordinates and heights of the original and modified terrain. For mapping of places very difficult to access, we used a prism system of electronic tachymeter.

3. Digital Terrain Model

Under the definition of digital terrain model (DTM) we understand the representation of the terrain or the model with coordinates of points. The coordinates are transmitting the quantities for digital terrain model. DTM is arranged set of numerical information (coordinates *y, x, H*) of the terrain relief stored in computer memory, by the relevant software for its use, [3]. The relief is the Earth's surface created by natural forces or artificially, without objects and features that are situated on it. Landscape area cannot be directly defined mathematically, it must be generalized. We eliminate the unimportant details and we neglect its roughness. The substitution of the terrain, which arose after generalization, is called the topographic surface, this area can be mathematically expressed as a function of two variables in the form $H = z = f(y,x)$. Each point is recorded in the form of $\{i, y, x, z, k\}$, where i is the number of points, y, x, z are the coordinates of the point and k is code, [4].

3.1 Calculation of the cubic content of the earthworks from DTM

Program of the input data, which are the coordinates *Y, X* and *Z*, creates a digital surface which is defined by a TIN network. It is a triangular network containing all points of entry. Area created this way serves as the representation of the actual terrain.

The place where the slope of the terrain is changing rapidly, for example a pit or an excavation, it is necessary to