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Assessment of Volume of Errors in Determining Volumes of Warehouses of Various Dimensions

The surveying service of the mining enterprises carries out the duties according to the instruction for production of surveying works. At the moment there are instructions for realization of surveying works on sheeted coal, ore fields and open-cast mines. Surveying instructions were created in the 50-70th of the 20th century and after were repeatedly processed taking into account new requirements and opportunities of the mining enterprises. At the same time some sections of the instruction for production of surveying works for the last decades did not change to take into account modernization of technologies of shootings. It concerns accuracy of calculating the dimensions of a mineral warehouse, methods of its surveying and calculation.

At present, the method of tacheometric survey using optical and electronic devices is mainly used to determine the dimensions of a warehouse. For calculation of the area and volume of a warehouse, ways of a volume palette, horizontal sections, vertical profiles and prime geometrical figures are used. The way of a volume palette, whose accuracy is defined by the section of its square, is most widespread in systems of automation of surveying works.

Accuracy of volume determination depends on the following factors:
• measurement errors during tacheometric survey of the warehouse surface;
• relevance of a surface of a warehouse floor and accuracy of its determination;
• frequency of surveying points on a surface of a warehouse and its relief variability;
    • accuracies of calculation of volume one way or another.

The purpose of the presented research is the analysis of possible errors in calculating the volume of mineral in warehouses at the expense of errors of measurements of warehouse surface and calculations of its volume. For the analysis the software product for automation of surveying works Samara is used.

The major factors influencing accuracy of calculating the volume of a warehouse are its area, volume, variability of a relief, distances between surveying points and a step of a volume palette.

For the analysis of influence of a step of a volume palette on calculation of volume in the Microsoft Excel editor, the massif of points with incidentally changing elevation marks, which was the improvised warehouse model, was generated. Distances between points are accepted according to the instruction as equaling 20 m. The volume of a warehouse and variability of a surface of a relief were modeled by a random function:

$$H = a + b * Random\ number,$$

where H – an absolute elevation mark of a point; a – the index determining warehouse volume; b – index of variability of a relief; $Random\ number$ – function which incidentally generates number ranging from 0 to 1.

Such model allows changing quickly initial parameters for calculation: volume and variability of a relief of a surface. The area of a warehouse can be changed by decreasing or increasing the quantity of points. The external contour of a warehouse has a constant high-rise mark equal to zero. The floor of a warehouse is level with a zero mark.

At the first stage, dependence of volume change of the warehouse model calculated with the size of a step of a palette equaling 1, 2, 5, 10 and 20 m is studied. Warehouse models with volume of 7, 45, 100, 400, 550, 670, 950, 1200 and 1600 thousand m3. For the true volume the value calculated with a step of a palette of 1 m. The difference in volumes at a step of a palette of 5 and 10 m did not exceed 0.08% for all cases.

The greatest values ΔV are observed at the volume of warehouses up to 100 thousand m3 and reach 4%. Determination of values ΔV at large volumes is explained by higher rate of b, characterizing variability of a relief of a surface of a warehouse. Therefore, this index also affects on a scoping error. It is confirmed by the study of dependence between b and ΔV.

As a result of the analysis of the maximum value of ΔV using an electronic tachymeter was 0.9%, optical theodolite of technical accuracy - 2.2%. It should be noted that the value of ΔV depends not so much on volume, as on the area of a warehouse. For example, with the big area of a warehouse and quantity of surveying points, but small height, the error ΔV increases, and vice versa.

In further research the task of establishment of the value ΔV for various areas is set at the identical size of volume of a warehouse. The complete complex of research will allow defining:
• optimum distance between surveying points at various area and volume of a warehouse;
• necessary accuracy of measurements for various volumes of a warehouse and variability of its relief of a surface;
    • an optimum step of a volume palette at calculation of volume.

The presented research is urgent not only when determining volumes of warehouses, but also for volumes of land works in construction.