

QUANTITATIVE ANALYSIS OF STOCKPILES IN MINING USING SURPAC SOFTWARE – A CASE STUDY

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Abstract - In many of the surface mining operations, ore or other valuable mineral material need to be stacked and stored temporarily in finite time period at dump yard. Every mining industry have an option for measure the stockpile volume and tonnage before shipment or processing. The quantity of ore or mineral stored at dump yard depends on industrial need and demand. This study involves the quantity estimation on stockpiles. Various software technologies are used to aid in stockpile quantity estimation. For the purpose of this study, Total Station survey data were collected for measuring stockpile quantity. Bulk density determination was done to estimate the tonnage of stockpiles at dump yard. In this study, the Surpac software programmed to estimate volume and tonnage of each selected stockpile at study area and then compared with Auto Cad Civil 3D software. The area calculated results of selected stockpiles using Surpac software provided correct results than compare to Auto Cad Civil 3D Software. The results were compared with the actual tonnage of each selected stockpile at study area which was determined from weighbridges. These results suggest that the estimated quantity from Surpac programmed results are more accurate. Additionally, it was concluded that the Surpac is about 2 times faster than the Auto Cad Civil 3D. Surpac software should be used in stockpile area calculation for correct results than compare to Auto CAD Civil 3D software.

Key Words: Total Station, Stockpile, Surpac software, Auto Cad Civil 3D software

1.INTRODUCTION

Generally, every mining industry has to maintain stock yards for temporary storage of mined or excavated material in the form of stockpiles. It is essential that the engineer must be able to make correct estimates of quantity of stockpiles. Generally, three methods are followed for calculating quantities of stockpiles are (1) by coordinates or spot heights, (2) by cross-sections and (3) by contours. The large volumes of data acquisition are possible and also more accuracy than conventional methods (Hamzah *et al*, 2011). The survey field work carried out by GPS, Total Station, GNSS, UAV, LST etc. The field survey accuracy gives accurate volume results (Morales *et al*, 2015). The estimation of bulk density of ore at different locations as a stockpiles at study, which is used to tonnage calculation of ore (Kumar and Ramesh, 2015).

The volume of stockpile of the materials is very important in order to estimate the quantity of deposited material (Ekun *et al*, 2016). The results of total station showed 0.2 mm accuracy for both vertical and horizontal coordinates, then the Total Station and TLS showed different results (Keawaram and Dumrongchai, 2017). The old conventional methods of calculations have taken lots of time and more efforts for obtaining the quantity results of stockpiles and also human errors occurred more which may effect on the results.

The modern technologies developed to overcome this problems, and made it easy for the mining engineers and surveyors to calculate the volumes and tonnages material excavated from the mine. Now a day many software packages available, which can be helpful for measurement of volume calculations. The correct volumes can be achieved using modern survey instruments during field work and also measurement of volumes obtained by using software's i.e. Surpac, Auto CAD, Arc GIS, LIS CAD, Auto Plotter etc. Total Station has been used to collect field data of few stockpiles of study area and then total volume of stockpiles computed using Surpac software and it is compared with the results obtained using Auto Cad Civil 3d software. The results analysis of both software's is evaluated on the basis of tonnage difference and percentage of difference with actual value, also represents as a line graphs (Mantey and Aduah, 2020).

1.1 Modern Techniques of Volume Calculations

The modern techniques provide a correct volume of mineral. The correct volumes can be achieved using modern survey instruments during field work. The following computer software's commonly used for volumetric calculations of excavated material.

- Surpac
- Auto CAD
- Arc GIS
- Auto Plotter
- Lis CAD etc.

The above all software packages require input data in terms of Easting, Northing, Elevation (RL) and Point ID of survey points. This data collected from the field using Total Station, Laser scanning technology, GPS etc.

The collected data downloaded to the computer by using some data conversion software's provided by the manufacturer of the instrument which can be in proper format. Fartherly this format used to import data into the volume calculation software.

1.2 Surpac Software

The Geovia Surpac software is one of the best universal geological modelling and mine planning software for computer program. It's application has been followed at all stages of mine life cycle for resource estimation, planning and operations. It can be used for improving the information from Surveyors, Geologists and Mining engineers. The Multi-disciplinary approach and use of a constant data structure makes the software simpler to use. It is more accurate in terms of volume calculation than conventional methods. The survey data acquisition is carried out with Total Station. After that collection of this acquitted data downloaded into the computer by using conversion software which can be in proper format (Excel file). This Excel file format saved as a CSV (M S DOS), then import this csv file in to the Surpac software. After that edit csv file as type file name .str, which may finally data stored in a string file. The order of file format is follows as a String no, Northing (x), Easting (y), Elevation or RL (z), Code and Point no.

The all survey points collected in some order i.e. bottom elevation, top elevation and spot elevation in the field and their 3D coordinates are measured with Total Station. This collected coordinate data representing the original ground surface level in Numerically by 3D coordinates. These coordinates are saved in string file which may representing bottom boundary and top boundary surfaces. After this process create two DTM's which are saved as a first DTM and boundary DTM. These two DTM's and boundary string file used for volume computation by cut and fill method. Finally, volume of the material is downloaded in pdf format and alternative downloading format also possible by using Surpac software.

2. METHODOLOGY

The methodology has been divided into three categories as a fieldwork, laboratory work and performance analysis. The first step of this research planned towards a goal and starts with knowing everything about it. This was progressed by field investigation & collection of Stockpiles survey data from the study area. The survey data required for measurement on available volume or tonnage of stockpiles at study area and also collection of bentonite ore samples from selected stockpiles locations and laboratory investigation for bulk density to optimize the tonnage of stockpiles at study area. The field study is conducted at the Parameshwari minerals, Narsapur, Telangana (state). The laboratory and performance work at Maharana Pratap University of Agriculture and Technology(MPUAT).

2.1 Acquisition of Surface Survey Data from Stockpile Locations using Sokkia (530R/330R) Total Station

The survey data acquisition carried out by using total station for measuring the coordinates (north, east and elevation) of an unknown point and also representing those coordinates as (x, y, z). Before setup the total station instrument on selected point, should know reference coordinate directions, which is achieved by the process of orientation. There are number of methods for orienting a total station, here we use back sight coordinate method. Figure 2.1 shows survey data collection using Sokkia Total Station.

2.1.1 Procedure of survey data collection

Initially set up the total station on a selected station point and do the temporary adjustments, then next follow as below procedure.



Fig.2.1 Survey data collection using Sokkia (530R/330R) Total Station

2.1.1.1 Orientation

After setting up the instrument on a selected station point, then instrument on and go to new page, then select 'Coordinate measurement' mode. Select station 'Orientation', also edit instrument height and target height. Enter the Northing (N): 20000, Easting (E): 10000 and Elevation (Z): 100 of the occupied point and also enter a name for the station point. Next select 'back sight Coordinate' (NEZ) option and enter the coordinates of known station point as a N: 20000, E: 10000+Horizontal distance, Z: 100 and press OK. To sight the known point through the telescope and bisect the crosshairs accurately, then press 'Ok'. Now the total station is oriented perfectly.

2.1.1.2 Coordinate point shifting

Once oriented, now select the 'Observation' option and check the ordinary (If the error is less than 5 mm then continue the work), then measure the boundaries as like area survey. Place a prism on the shifting point keeping the staff vertically erect as possible. Next target the prism then presses on 'Observation' after that coordinates of shifting point is displayed, then note down and record. If the number of cases are more then (CP: CP₁, CP₂.....CP_n) and press 'Ok'. Continue the above procedure till last boundary coordinates. The above procedure was followed for four selected stockpile locations named as stockpile-1, stockpile-2, stockpile-3 and stockpile -4.

2.2 Measurement of Stockpiles Volume and Tonnage Based on Survey Data using Geovia Surpac Software.

The stockpile volume and tonnage measured using Surpac software based on survey data is described as below:

2.2.1 Measurement of stockpile volume and tonnage

The survey data acquitted from 4 Selected stockpiles at Parameshwari Minerals area were transformed to MS. Excel (Save as csv file) file extension and then import the same data into surpac software. It is the input data for volume and tonnage estimation of Surpac software. The system understands in terms of N, E and Z or (X, Y & Z) i.e. Northing, Easting and Elevation. The estimation results from Surpac software were analyzed the volume and tonnage with the estimation results of cut and fill between DTM's method. It was carried out for selected stockpile-1, 2, 3 & 4 at study area and the volume and tonnage results of all selected stockpile locations are obtained as a resultant and shown in Fig. 2.2.

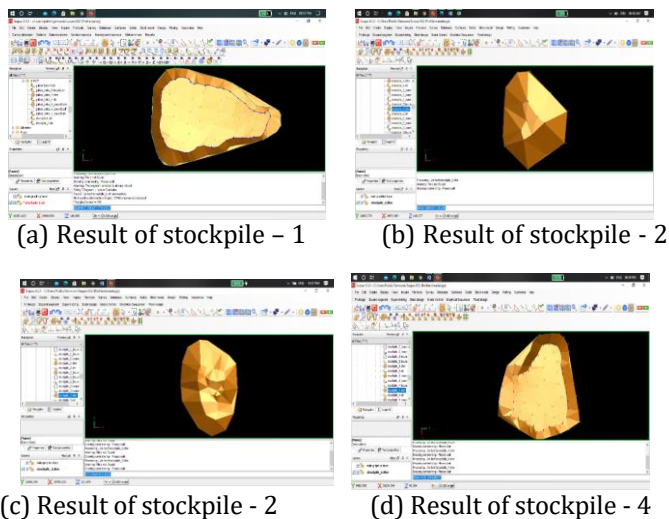


Fig. 2.2 Results (volume & tonnage) of stockpiles

2.2.2 Time study on Surpac software while measurement of volume of 4 stockpiles

The time study conducted on Surpac software during measurement of volumes and tonnages of each selected stockpile, and is given in Table 2.1. The table below represents that how much time taken for processing and computing the field data in various stages to calculate the volumes of each stockpile. The total time taken to measurement of quantity of stockpiles 1, 2, 3 & 4 using Surpac software is 6 minute, 4 minute, 5 minute and 6 minutes respectively.

Table 2.1 Time study on Surpac software

Surpac Software	Stock pile1	Stock pile 2	Stock pile 3	Stock pile 4
Time taken to making format	2 min	1 min	1 min	2 min
Time taken to	1 min	1 min	1 min	1 min

importing data				
Time to volume computation	3 min	2 min	3 min	3 min
Total time	6 min	4 min	5 min	6 min

2.3 Measurement of Stockpiles Volume and Tonnage Based on Survey Data using Auto Cad Civil 3D Software.

The stockpile volume and tonnage measured using Auto Cad Civil 3D software based on survey data is described as below:

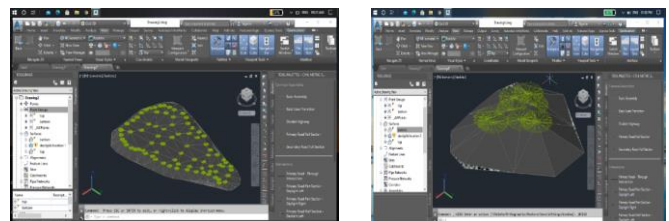
2.3. Auto Cad Civil 3D software:

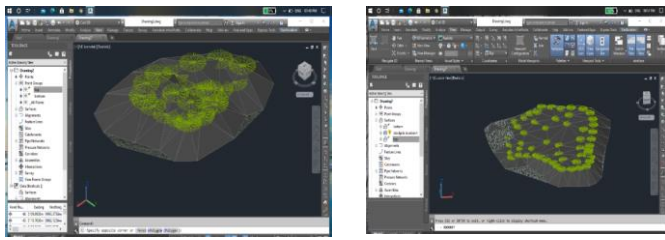
The Auto Cad Civil 3D software is powerful tool for plotting and showing the technical graphs. It is one of the important commercial software for many engineering applications. Also, used to calculate volumes of excavated material from the mine, which is need some survey data collection by using Total Station. Now days, many Auto Cad software's are available worldwide. The Auto Cad Civil 3D creation is not only for normal drawing, but also logically connected with data, which can be placed on the allocated layers or grouped in compound objects. These may consider all of them as a whole entity. The Auto Cad Civil 3D represents the position & size of the constructed objects. Also, writes down this data in an internal database for their subsequent search, analysis, and processing in computer. The Auto Cad Civil 3D software can able to functioning with wide range performance personal computers, suitable graphic workstations under control of various operating systems etc.

2.3.2 Measurement of volume & tonnage of stockpiles

The survey data acquitted from same 4 Selected stockpiles at Parameshwari Minerals area were transformed to MS. Excel (Save as csv comma delimited) file extension and then import the same into Auto Cad Civil 3D 2019 software. It is the input data for volume estimation in Auto Cad Civil 3D 2019 software. The system understands in terms of N, E and Z or (X, Y and Z) i.e. Northing, Easting and Elevation. The estimation results by this Auto Cad Civil 3D 2019 software were analyzed the volume. The procedure was carried out for selected stockpile-1, 2, 3 and 4 at study area and the volume results of all selected stockpile locations are obtained and shown in figure 2.3 (a, b, c and d).

(a) Result of stockpile - 1 (b) Result of stockpile - 2





(c) Result of stockpile - 2 (d) Result of stockpile - 4

Fig. 2.3 Results (volume & tonnage) of stockpiles

2.3.3 Time study on Auto Cad Civil 3D software while measurement of volume of 4 stockpiles

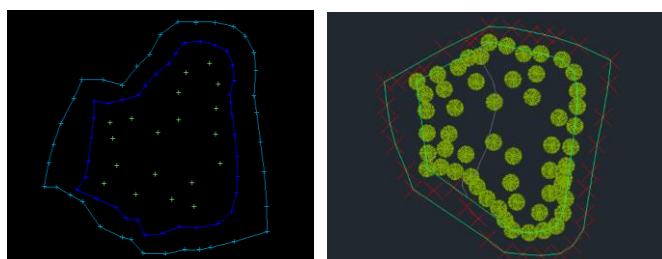
The time study conducted on Auto Cad Civil 3D software during measurement of volumes and tonnages of each selected stockpile, and given in Table 2.2. The following table below describes how much time taken for processing and computing the field data in various stages to calculate the volumes of each stockpile. The total time taken to measurement of quantity of stockpiles 1, 2, 3 & 4 using Auto Cad Civil 3D software is 19 minute, 15minute, 17 minute and 18 minutes respectively.

Table 2.2 Time study on Auto Cad Civil 3D

Auto Cad Civil 3D Software	Stock pile1	Stock pile2	Stock pile3	Stock pile 4
Time taken to making format	6 min	4 min	5 min	6 min
Time taken to importing data	4 min	4 min	4 min	4 min
Time to volume computation	9 min	7 min	8 min	8 min
Total time	19 min	15 min	17 min	18 min

3. RESULTS AND DISCUSSION

3.1 Comparison on Area Results of 4 Stockpiles at Study Area using Surpac Software & Auto Cad Civil 3D Software



(a) Str. file using Surpac (b) Str. file using Auto Cad

Fig. 2.4 Results (area) of stockpile-4

The string file (Fig. 2.4) representing, top and bottom boundary elevated lines of selected stockpiles at study area. For the Area results, must be need at least one boundary string that should be in closed path. String contains a sequence in 3-D coordinates of points delineating a physical

feature and all the string files have an extension of .str and an ID number. The correct value of area depends on a line joining through boundary coordinate points of the string. Surpac resultant string perfectly joined all 3D coordinate points forming a closed path, but Auto Cad Civil 3D resultant string was imperfectly joined through all 3D coordinate points. Few points left inside the traced boundary lines. Resultant area value using Auto Cad Civil 3D is higher than the original area, however the 3D resultant string image displayed as a mirror image of that original position. Then the Area results of selected stockpiles using Surpac software gives correct results in comparison to Auto Cad Civil 3D software (Table 3.1).

Table 3.1 Area results of 4 stockpiles at study area using Surpac and Auto Cad civil 3D

SL No	Location	Total Area in m ²		Area difference in m ²
		Surpac	Auto Cad Civil 3D	
1	Stockpile- 1	3717.00	3837.63	120.63
2	Stockpile- 2	143.00	145.57	2.57
3	Stockpile- 3	292.00	303.69	11.69
4	Stockpile- 4	1534.000	1613.59	79.59

3.2 Comparative analysis on time study for performance between Surpac and Auto Cad Civil 3D software.

The time study was conducted on both Surpac software and Auto Cad Civil 3D during measurement of volumes and tonnages of each selected stockpile, and is given in Table 3.2. The table describes how much time taken for processing and computing the field data in various stages to calculate the volumes of each stockpile. The total time taken to measurement of quantity for stockpile 1, 2, 3 & 4 using Surpac software is 6 minute, 4 minute, 5 minute and 6 minutes respectively. The time study was conducted on Auto Cad Civil 3D software during measurement of volumes and tonnages for stockpile 1, 2, 3 & 4 and total time taken is 19 minute, 15minute, 17 minute and 18 minutes respectively. The total time difference between both software's for quantity estimation for stockpile 1, 2, 3 & 4 is 13 minutes, 11 minutes, 12 minutes, 12 minutes respectively.

3.3 Comparison among Surpac, Auto CAD & Real value of total tonnage on selected stockpiles at study area

The results were compared with the actual tonnage of each selected stockpile at study area which was determined from weighbridges and is given in table 3.3. Comparing the results of the Surpac software with the actual tonnage of stockpiles 1,2,3 & 4. It was found that there were 0.02%, 0.30%, 0.19% and 0.05% differences, while the volumes and tonnages computed from the Auto Cad Civil 3D compared and it was 0.02%, 0.45%, 0.17% and 0.06% differences respectively, to the actual tonnage.

Table 3.3 Comparison of tonnage results among Actual tonnage and computed from Surpac & Auto Cad Civil 3D

Location	Actual tonnage	Surpac tonnage	Auto Cad tonnage
Stockpile 1	9785.800	9783.84	9783.462
Stockpile 2	163.500	163.000	162.757
Stockpile 3	374.700	374.000	374.077
Stockpile 4	2927.500	2926.00	2925.760

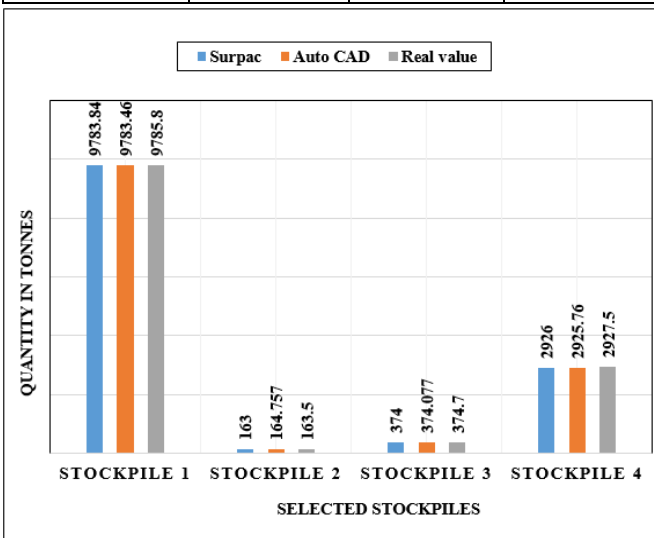


Fig. 3.3 Quantitative Results among Surpac, Auto CAD & Real value of selected stockpiles

The Quantitative results among Surpac, Auto Cad Civil 3D and Actual tonnage of each selected stockpile is closely related and shown in Fig 3.3.

4. CONCLUSION

This study demonstrates the use of a Surpac software for stockpile volume and tonnage estimation. In this study, the Surpac programmed to estimate volume and tonnage of each selected stockpile at study area and then compared conventional method with Auto Cad Civil 3D software. Based on field study and research work carried out the area calculation of stockpiles using Surpac software provides correct result in comparison to Auto Cad Civil 3D software. Quantity of stockpiles calculated using Surpac software given more accurate result in comparison to Auto Cad Civil 3D. The results of the tonnage estimated using Surpac software with the actual tonnage of stockpiles 1,2,3 & 4, it was found that there were 0.02%, 0.30%, 0.19% and 0.05% differences, while from the Auto Cad Civil 3D software, it was 0.02%, 0.45%, 0.17% and 0.06% differences respectively.

4.1 Recommendations

- This study recommends that Surpac software should be used in stockpile area calculation for correct results than compare to Auto CAD Civil 3D software.

- This analysis recommends that Surpac software should be used in stockpile Quantity estimation for better and faster results.

REFERENCES

- [1] Ekun, M.O., Irughe, R.E. and Okonofua, E.S. 2016. Determination of area and volume from dredged geo data set. Nigerian Journal of Technology. Vol. 35, No. 4, pp. 707 – 712.
- [2] Hamzah, H.B. and Said, S.M. 2011. Measuring volume of stockpile using imaging station. Geo information Science Journal, Vol. 11, No. 1: 15-32.
- [3] Keawaram, B. and Dumrongchai, P. 2017. Comparisons of Surveying with Terrestrial Laser Scanner and Total Station for Volume Determination of Overburden and Coal Excavations in Large Open-Pit Mine. International Journal of Geological and Environmental Engineering. Vol. 11, No:12: 964-72.
- [4] Mantey, S. and Aduah, M. S., (2021), "Comparative Analysis of Stockpile Volume Estimation using UAV and GPS Techniques", Ghana Mining Journal, Vol. 21, No. 1, pp. 1-10.
- [5] Morales, C.A. and Arango, C. 2015. Comparison between multicopter UAV and Total Station for estimating stockpile volumes. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XL-1/W4, In: International Conference on Unmanned Aerial Vehicles in Geomatics, Toronto and Canada. pp: 131-135.
- [6] Ramesh, V. & Kumar K.P. 2015. Estimation of Bulk Density, Recovery Tests and Mineralogical Analysis of Iron Ore Mine at Obulapuram Village, Anantapur District, Andhra Pradesh. Procedia Earth and Planetary Science. 11, pp: 84 – 88.

BIOGRAPHIES



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