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# Using Modern Survey Techniques and 3D Software for Establishing and Correcting Control Points in Area West of Al-Qurna City

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**Abstract.** Usually, all correction operations or methods that are used to correct the coordinates or the closing error are based on ready-made data or imported by one of the online sites, but in this study it took in the city of Basra, specifically in the West Qurna 1, exactly in the sixth oil production station (the outer part From the station or the complementary project of the station) the formation of connecting traverses was carried out for the construction of this complementary project, which consists of steel structure, oil pipes and gas-burning flares. This instrument, which was purchased, is a Leica TS10 type, with an accuracy of only one second. This instrument has the ability to withstand high temperatures, in addition to its speed of performance, and it contains a smart screen that facilitates the user's work. Initially, it was relied on points monitored by GPS and previously corrected and relied upon in the construction of the interior of the station, two points were pulled by the Total Station and the occupied station's card, then, as it is known, furthermore, all the traverse points were monitored, which means measuring distances and angles (subtracting two directions) As is also common, two readings were taken for each observation, once in the right direction and once in the left direction. This data was brought to the Civil 3D software and was corrected by the method of least squares, and from the following we will present in the body of this study all the details and steps that have been taken.

This paper offering the general summary for a least squares adjustment of a traverse networks by Variation of Coordinates. A method of constraining bearings, distances and angles in the traverse network is delineated and necessary matrix equations developed for solution. Equations are also have been developed which qualify precisions of adjusted bearings and distances to be estimated.

**Keywords:** Leica ts10, establishing, correct coordinates, closed traverse, least squar error.

## INTRODUCTION

Before we get into the process of creating and correcting traverses, we must identify the errors that may occur during monitoring operations, what are their types, causes, and how to get rid of them or remove their effect only on the accuracy of the measurements so that we can know the method of correction for each calculation or observational operations.

A traverse is the fundamental component of many surveys and consists of a series of sides or lines whose bearings and distances have been determined from Total Station measurements [18]; Which is one of the most important purposes of this study. We will be assumed to be horizontal directions  $\alpha$  and horizontal distances (d). Traverse direction (Azimuth)  $\theta$  are horizontal directions measured clockwise from north ( $0^\circ$  to  $360^\circ$ ) [19]. In the other hand, there is another type of direction, which is called the quarter-circular direction or (bearing). Traverse angles  $\beta$  are differences between directions (Azimuth or bearing), and a traverse line has east and north components (Departure or Latitude) which equal  $\Delta E = d \cdot \sin \theta$ ,  $\Delta N = d \cdot \cos \theta$  respectively [20]. A closed traverse starts and finishes at the same point and an open traverse starts and finishes at different points. A closed traverse is a traverse of n sides whose internal angles sum to  $((n - 2) \times 180)$  and this rule may be used to determine the angular misclose which is mean the difference between the rule (computed) and the sum of the measured angles [21].

Therefore, surveying depends primarily on observations (measurements), which, no matter how accurate they are, will not give absolutely correct results, but will have an error no matter how small it is. For example, if a very experienced observer, using an accurate Total Station, measures an angle a number of times, the angle value will not be the same in all of these measurements [22]. Therefore, it is necessary for the aspirants and students of surveying to be familiar with the sources and types of errors and how to overcome them (if possible) or how to deal with them mathematically in order to reach a value closer to correctness (distance, angle, ratio difference .. etc) that is made measured.

Closed traverses, or as it is called close loop traverses, is one of the types of traversing operations, which is a field and arithmetic monitoring process [23]. The distances and angles between stations and a instrument to correct the

horizontal coordinates of the closed connecting traverses. This work is considered as a basic work in surveying and is useful in engineering and civil works.

It is worth noting that all the methods of correction for traverses can lead to very accurate results and are close to each other [24], especially if the connecting traverses have small sides, and the instruments used are instruments with an accuracy of not more than 1 second, and this is what was used in this study, but in a way of least squares. It is possible to give the same results for the compass rule or the shadows method, but the most accurate among them is the method of least squares that was used in this study [14]. This paper presents some relatively simple techniques that can be employed to give reliable estimations of the precision of traverse stations that allows a simple assessment of the quality of a traverse .

## STUDY AREA

The study area was chosen in the province of Basra, which is the sixth station for the separation of crude oil and gas, which is located west of the district of Qurna - 1 in the north of the province of Basra. The client company is responsible for collecting data on satellite images that will be used later to display the study area and the points taken as vertices for traversal, we will discuss in the body of this research all the details related to the shape taken for it in terms of fixing it with metal disks and placing it as a very small inference mark for Precision.

Fig. 1. shows an image taken by google map for the study area, which represents the sixth station for separating gases from crude oil in West Qurna 1. It is the study area in which a new project has been passed for the development of a new project aimed at replacing all the old pipes, lifting them from the ground and placing them on a steel structure to avoid collision or exposure to any mechanism or vehicle that causes damage, all electrical cables and firefighting issues will be extended in addition to increasing oil production.



FIGURE 1. Study area

## FIELD SURVEYING

The field surveying is a practice that surveyors are viewing for requisite locations to study and create data about their elevations, coordinates, and satellite image etc. The field survey. Also, it may be insensitive or non-insensitive, reliant on the requirements of the survey teams and may also be insensitive, depending on the type of study requisite. In this paper, the process of gathering of information is the preparation of adaptable the terrestrial or 3D-location of points, azimuth directions, lengths, and angles between them. These points are typically on the surface of the Earth. Also, they are often utilized to establish boundaries and maps for locations, ownership such as building corners or the surface position of sub-surface features, or other reasons requisite by government or civil law, such as property sales.

Field surveying can be described as a purpose of the general position of points on the surface of the Earth [15]. Also, its process of determining vertical and horizontal distance between locations, measuring the slopes between two

lines, and governing the directions of lines. Also, along with the real surveys measurement is the geometric calculations. Field surveying is showed realistically by the manufacturing of map, cross section, profile, and chart. In this study, diverse brands of devices and procedures have been employed for gathering of data which include lengths, directions, and coordinates etc.

### Devices Employed in This Study

Total station (T.S) and level have been applied in this study. Type of T.S was Lieca TS -10 with accuracy  $\pm 1''$ . This instrument can be directly working with the other softwares such as Geographic Information System or Civil 3D. Also, it is can be kept in various formats such as pdf, xps, txt, dwg, xml etc. The T.S employed in this study can be showed in the Fig. 2.



**FIGURE 2.** Total Station type leica 10

Level device is the other practice in the study. It is able to calculate the elevations of points which is used in survey works, civil works etc [15].

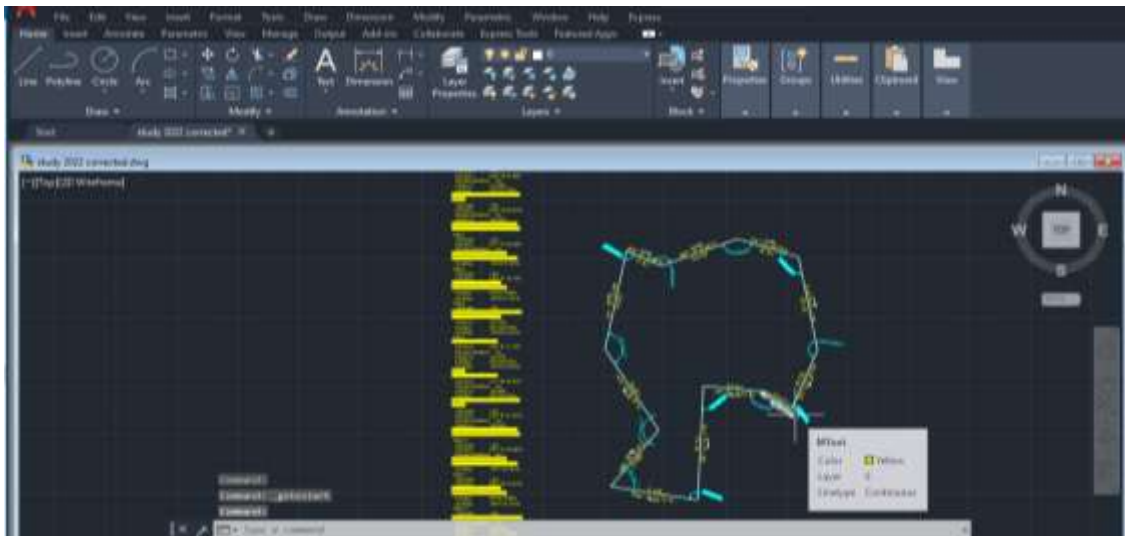
### Softwares Utilized in this Study

Sas.Planet and Civil 3D software have been used in this study . The aim of using the Sas.Planet software is the downloading of satellite image for the (DS-6) station. This software is one of the most significant software which is designed for viewing and taking the high resolve satellite image and traditional maps complied by such services as Google Map, Yahoo Map, Open Street Map, Genshtab map, Navitel map, Yandex Map, Virtual Earth, Bings Maps etc [9]. Satellite images can be taken for any area on the earthby logging into its interface as shown in Fig. 3.



**FIGURE 3.** Main window of the Sas.Planet software

Civil 3D is the other software have been used in this study. This software allows to construe and analyse all collected data to thhe layers, blocks etc [15]. In addition, this data can be imported to civil 3D by Add data and add the type of data by caple or USP. Main window of civil 3D with the our traverse can be illustrated in Fig. 4.



**FIGURE 4.** Shape of traverse which used in this study (Civil 3d software)

### Methodology of this Study

Clear stations were chosen at the beginning, after studying the step of the site to be created for the traverse (early ground control points that exist and are corrected to be relied upon), and through that, we tried to get a clear vision so that we can see all three points with each other from the same manual installation of the instrument. This required a long time to get that clear vision. Then we asked the executing company to put concrete castings containing a solid iron disc whose centre is determined by precise machines and arranged so that it is considered the centre of the ground set point or sometimes it is called (Bench Mark). More than one point was identified for the same oil station, and the

first two known points of coordinates were relied upon to find the lengths and directions between the new ground control points.. After making sure of the correctness and accuracy of the ground control point, we began to work by determining the positions of the new ground control points, which will later be the corners of the large traverse or the small traverses, which we will work on internally correcting, or as the common name is called (Internal).

All these points have been identified and their centres are fixed to be the main points that will be corrected afterwards. It is worth noting, that all these observed points that were not subject to correction at the moment were relied upon through two points that were considered as the baseline (as corrected points), which was relied upon in determining or raising these points... As for the shape of the observed traverse, It can be illustrated in the Fig. 5., in which we adopted the marking of points on the satellite image of the observed traverse within the DS6 station (study area).



**FIGURE 5.** Satellite image of the traverse of the study

Created points that were adopted in this study can be illustrated in table 1.

**TABLE 1.** Illustrates control points of DS6 (incorrected)

BM. No.	East (m)	North (m)	Elv. (m)	Length (m)	Direction
CAL BM 01	722527.389	3405971.258	2.818	dis.12 98.309	Az.12 226° 30' 45"
CAL BM 02	722456.063	3405903.602	3.088	dis.23 135.151	Az.23 121° 13' 26"
CAL BM 03	722571.637	3405833.542	3.087	dis.34 80.871	Az.34 176° 06' 24"
CAL BM 04	722577.128	3405752.858	2.932	dis.45 133.664	Az.45 249° 48' 26"
CAL BM 05	722451.679	3405706.720	2.994	dis.56 105.193	Az.56 345° 30' 53"
CAL BM 06	722425.367	3405808.569	3.211	dis.61 192.032	Az.61 32° 05' 30"

## RESULTS AND DISCUSSION

- a. After the process of observation the directions and distances between the points of the closed traverse, the first step we took was the process of opening the Civil 3D window and drawing these points after fetching them from the Total Station and converting their format to one of the DXF or DWG formats so that the software can recognize them.

- b. We showed the coordinates and levels of each of the ground control points, and we also called the code or what is known as the description to show the details of each of these points. Fig. 6. shows how the ribbing works for the control points of the sixth station (the study area).

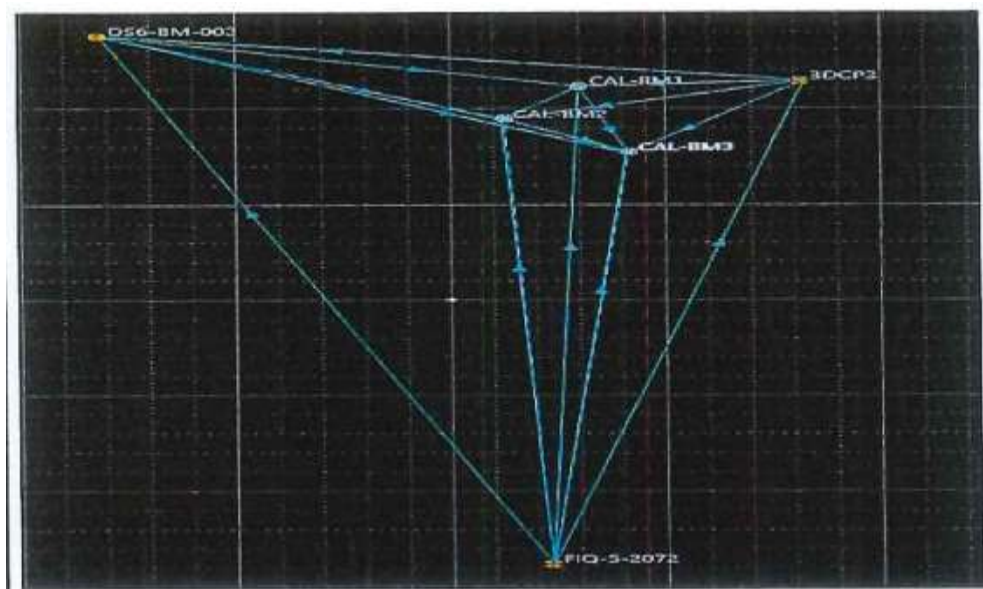


FIGURE 6. LSE crosses

- c. By the command bar of the civil3D window, all the values of angles and deviations that were monitored in the right direction and the available direction were extracted, and we installed them on each of the ground control points.
- d. We showed the distance or distance measured once with the timed monitoring and again with the available monitoring, and we showed the rate taken from both readings only.
- e. After the process of installing the data collected by field monitoring, we connected all the points of the traverse with each other so that it looked like an integrated traverse in terms of points, description, and code.
- f. We also divided this traverse into small traverses that looked like triangles to perform the process of horizontal correction of the coordinates, which includes closing the traverse with its small parts before the large ones to get rid of all the random errors that this traverse was exposed to.
- g. After fixing and correcting the points, it was found through the least squares correction method that the least deviation obtained when correcting in this way is 0.033 m. This indicates the possibility and high ability to correct by the least squares method.
- h. The traverse was tightly closed after correcting all its angles and the forward and reverse directions, as well as correcting the distance monitored by both the instantaneous and available observations, with it worth mentioning that we can correct the average distance or distance between the two points only after showing it on the sides of the closed traverse.
- i. The following table shows all the details of the monitored and corrected points and mentions the coordinates, description, angular error, absolute error, error direction, parameter, and area of traverse.

**TABLE 2.** Illustrates angular error, absolute error, error direction, parameter, and area of traverse

Exastract Information	Closure at other Traverse Points ----- Possible distance error in leg : 9 - 10	
	Angular error (if any) most probable at point 5	
Angular error = 0-00-46	Attention is called to maxima-minima separations	
Angular error/set = 0-00-07 Under	Point	Separation Distance
Error North : -0.0520	1	0.0312
Error East : -0.0238	2	0.0721
Absolute error : 0.0464	3	0.0811
Error Direction : 00-00-38	4	0.0657
Perimeter : 745.220 m	5	0.0543
Precision : 1 in 11527.5096	6	0.0761
area 19502.995 M Square	Number of sides : 6	

The first six points that have been corrected to be relied upon later can be showed in table 3.

**TABLE 3.** illustrates control points of DS6 (corrected)

BM. No.	East (m)	North (m)	Elv. (m)	Length (m)	Direction
<b>CAL BM 01</b>	722527.381	3405971.264	2.814	dis.12 98.289	Az.12 226° 30' 23"
<b>CAL BM 02</b>	722456.077	3405903.614	3.090	dis.23 135.147	Az.23 121° 14' 11"
<b>CAL BM 03</b>	722571.632	3405833.531	3.084	dis.34 80.856	Az.34 176° 05' 41"
<b>CAL BM 04</b>	722577.139	3405752.863	2.927	dis.45 133.682	Az.45 249° 48' 30"
<b>CAL BM 05</b>	722451.673	3405706.721	2.990	dis.56 105.200	Az.56 345° 30' 48"
<b>CAL BM 06</b>	722425.357	3405808.576	3.204	dis.61 192.032	Az.61 32° 05' 33"

## CONCLUSION

1. The use of the least squares method to correct the coordinates for closed connecting traverses gives very accurate results, as it gave a relative error of (1/2400) on the smallest side of the observed traverse.
2. When correcting the coordinates of the observed closed link traverse using all the previous methods (compass, crossing and the method of least squares), the difference in the measured length and the corrected lengths was very small, as it was found that the largest deviation was confined to the shortest measured length (0.033 m), and from it, we conclude:  
Relative Error in the distance ( ST ) = 0.033m / 115.275m = 1 / 3500  
Relative Error in direction of ( ST ) = 5.99 / 49 06 48 = 1 / 30000. It is a good and effective result, especially in sites that require high accuracy.
3. The more accurate the field observation of the traverse, the more the differences in the values of the horizontal and vertical components converge, which indicates the accuracy of the monitoring, and in turn, the obtained results will be of very high accuracy, and vice versa.
4. This method was applied and tested on other traverses monitored for other regions in Baghdad and the rest of the provinces, and it was found to prove the true extent of the accuracy of the results of using the method of least squares in correcting the connecting traverses.
5. The addition of any new field in the traverse correction table increases the possibility of making an error, so care and accuracy must be exercised in conducting the calculations with the success of this method when there is a lock error in the observed traverse.



## RECOMMENDATIONS

Through the experience in this research and many previous experiments, we can recommend the following:

- a) It is preferable to use the method of least squares in correcting the coordinates of closed connecting traverses of all kinds, and when the observer has a very high accuracy in measuring the lengths of the monitored traverses to obtain accurate results.
- b) The observer has the right to use it even if he does not achieve high accuracy in measuring the lengths in traverses, so he gets good and accurate results like other methods.
- c) Caution must be taken when taking the readings, because the instrument may have moved due to air or a simple movement of the surveyor, assistant, or any person who may be present at the work site, which negatively affects the accuracy of the results expected to be obtained.
- d) It is preferable to conduct field observations at low or medium temperatures as much as possible so that high temperatures do not affect the accuracy of measurements or monitoring angles.
- e) It is preferable to rely on field monitoring instruments that have very high accuracy, as we used in this research a total station of the type Leica TS 010, which contains a meteorological accuracy of 1" .
- f) It is preferable that the correction process for any closed link traverse be carried out with the latest available office softwares or the latest versions of Autodesk software.

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