ESTABLISHMENT OF GEODETIC BASELINE

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ABSTRACT: *Geodetic baseline is a set of pillars, ranging from few to more than ten, at distance varying from ten of meters to one kilometer. The geodetic baseline (national or international) is the reference line for conducting surveys, for the triangulation network of countries and for calibration of Electronic Distance Measuring (EDM) Instruments. Hence the calibration of the instrument is for detecting the errors, performance and the correction of the instruments. The design of the baseline enables the determination of all instrument errors to an appropriate level of precision. The measurement for the calibration over short distances supports in the determination of the additive constant whereas the longer distance helps in determination of scale error.This research paper elaborates the establishment procedure and use of geodetic base line in Lahore, Pakistan. It is of vital importance to establish a baseline that can calibrate the instruments and enhance its accuracy. The two baselines established earlier are not functional now, one is in Tarbela and the other in UET. The Baseline at UET comprises of only four pillars but the baseline that would be established in Punjab University will consists of 5 concrete pillars with forced centering arrangements. The points are placed on 0m, 30.5, 86.5, 158, and the last point placed on 195m from the initial point. To ensure the authenticity of the points proper coordinates are acquired so that the points are not displaced.*
After development of baseline 3 different instruments were calibrated on three different dates, ensuring similar metrological conditions, to have precise distance measurements. The results obtained from the calibration shows that the reading these instruments acquire were accurate approximately containing error of 0.55 millimeters.

Keywords*: EDM, geodetic baseline, calibration, triangulation, scale*

INTRODUCTION

The geodetic baseline is the starting line or position for the purpose of measurement [1]. It also serves as reference line for conducting surveys [2]. The formation of geodetic baseline will aid in correction and standardization of Electronic Distance Measuring (EDM) Instruments [3]. The EDMs once calibrated on baseline determines its errors. The design of the baseline enables the determination of all instrument errors to an appropriate level of precision[4].The points on base pillars placed at 0m, 30.5, 86.5, 158, and 195m from the initial point [5]. At present there have been two base lines in Punjab, one in University of Engineering and Technology (UET) Lahore and the second in Tarbela but both are non-functional. With the development of surveying, mapping and development of GIS databases in each public sector organization, establishment of a functional baseline is immensely important.

The major objective of this research was establishment of a functional baseline and a mechanism for calibration of modern ground surveying equipment. It was planned to establish the proposed 5 pillars baseline in premises of Punjab University College of Information Technology (PUCIT) Lahore because of availability of open land which is easily reachable and non-obstructed. Moreover it will be a constant learning resource for researchers working with various surveying equipment and techniques.

METHODOLOGY

For the establishment of the geodetic baseline the first important step was site selection and its clearance all the wild bushes and scrubs so that the site can be easily accessible. After the site is being cleared up, the location where the base pillars would be formed is selected with the help of surveying by total station and special prism reflector. For this purpose,

Figure 1: Location of Geodetic baseline, Punjab University College of Information Technology

the instrument is set up at a particular point which is known as the first point and considered to be as '0m' point [6]. For the selection of the points firstly instrument is placed on the initial point i.e. point of survey. Then the rest of the points are acquired through this initial point. Total five points are acquired. The points are placed on 0m, 30.5, 86.5, 158, and the last point placed on 195m from the initial point. To ensure the authenticity of the points taken with back and forth readings are acquired [7].After the selection of the site the construction process takes place. It is a requisite to dig up the 2 by 2 feet hole. Once the hole is dug then the second stage is to place the steel rods into the exact position of the points observed at the earlier stage. There are two different length of the steel rods attained on is 1 m long and the other is 2m long. In the beginning the 1m long is positioned exactly

where the point was placed which was then verified by the total station. After verifying the location then the 2 m long rod is tied up in such a way that the combined length of the rods is 4.5 feet above the ground. Once it ensured that the steel rods are placed on a right place then the crushed brick are grinded by pressing and squeezing in the base to make the foundation of the pillars[8].

After the foundation was prepared, smoothened and levelled, the cement pipe is placed carefully on the location before the concrete filling gets dry and confirming that the steel plates are not displaced. Subsequently the concrete is filled after placing the cement pipe so that pipe is fixed into the location. The pillars were constructed keeping in view the standard height i.e. 4.5 feet but to make available the use of pillars for every height, the 6 inches base is constructed so that the height of the pillar become 4 feet above the ground instead of 4.5 feet.

When the process of placement and filling of the cement pipe is done then came the very important phase of the baseline establishment, which is the placement of the fabricated steel plates. Fabricated steel plates are the plates with forced centering arrangement in order to set up instrument easily [9]. Steel plates are placed very carefully and to confirm that these plates are placed on the right place. The prism reflector is placed onto it and then the reading are acquired. After the verification that the steel plate is placed on the accurate position, the leveling of the plate is done.

After establishment of geodetic baseline next important stage was its utility to calibrate modern surveying instruments and minimize their error rate. There main sources of error in EDMs are as followed [10].

1.Scale error/proportional error: This type of error originated due to ageing or atmospheric drifts. The first source of this error is bending of the measuring beam, produces a negligible effect. And second source of error is variability of temperature which results in variability of the refractive index (pressure and temperature).

2.Index error/constant error: This type of error is identified as the residual left after meteorological correction.

3.Cyclic Error: it comes periodically as its name specify, it is the residual left after meteorological correction.

The modern instruments function properly and usually does not display cyclic errors but due to the ageing of the instrument malfunctioning can be generated. However the errors are measured by the experimental measurements [16, 13].

The calibration procedure i.e. acquiring readings by placing the instrument on the base pillars [11]. The verification procedure of the established baseline transpire by mounting the instrument on the base pillar and record the reading by placing the reflector prism on the other base pillars. For all the five pillars the reading process take place by taking one station as base station where instrument is placed whereas the other station act as forward sight and back sight [12].

Considering the station B, the back sight is station A and the forward sight is C, D, and E. For C the back sight stations are A and B whereas the forward sight is D and E. If taking D as base station then back sight is A, B and C and forward sight is E [13]. But for the station A and E the case is different. In the case of station A there is no back sight, all the four stations act as forward sight. And for the station E there is no forward sight, the four remaining stations act as back sight[14]. Before the process of acquiring the readings get started the temperature is noted down. This factor is added or set in the instrument before the reading are acquired[15]. The temperature is measured by using the hand held thermometer [16].

The process of calibration by the method cited earlier is done three times. After that the mean of all the reading is computed to generate the results. The instruments calibrated were SOKKIA 530R3, SOKKIA 630R, and NIKON GTM322 in three different rounds on 26th March 2015, 28th March 2015 and 1st April 2015. It was assured that in all three rounds temperature average temperature was same. The results obtain from the calibration shows that the reading these instruments acquire were accurate containing error of approximately 0.6 millimeters.

The readings once acquired are then analyzed [17]. It is necessary to reject those reading that are different or in other words are outliers of the set of readings acquired in order to avoid errors or discrepancies [11]. Hence it is essential to refine the readings for the better results [19].

Considering the distance from A to B the method used for rejection was that first of all the mean of values are taken and then this mean value is subtracted from the individual distance value which computes 'R' [5]. Then after that the highest value is detected and eliminated from the dataset. The method is repeated until the desired results are obtained. The formula for computing R is as followed:

$$R = | X_i - X_{mean} |$$

After analyzing the readings and rejecting the uncertain values the final accepted measurements for all the stations i.e. from A – B, A – C, A – D, A – E, B – C, B – D, B – E, C – D, C – E and D – E are shown in Table 1. the distance for each station is both ways for example if taking into account the distance from A to B then it's also from B-A (similarly for all the stations).

Final Accepted Measurement		
Sr. No	**Station "__" To Station "__"**	**Distance**
1	A - B	30.5201
2	A - C	86.5271
3	A - D	158.017
4	A - E	195.025
5	B - C	56.0094
6	B - D	127.503
7	B - E	164.513
8	C - D	71.4951
9	C - E	108.508
10	D - E	37.0186

Table 1: Final accepted distance (for all stations)

The calibration procedure is done only through the electronic distance measurement instruments, therefore it is recommended that the calibration procedures should also be done through the calibrated steel tapes. Another set of measurements are recommended using calibrated Invar Steel Wire or Tape at some future date [20].

CONCLUSION

The main purpose of this projects was to establish an accurately measured geodetic baseline which has been achieved in the form of 5 base station established in Punjab University College if Information Technology (New Campus). This would be an asset for the university as it will initiate all the surveying required for construction as well as it will act as the fully functional baseline for the calibration of the EDMs. This baseline will also provide improvements in surveying and for calibrating the EDMs [4].

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