

**ESTABLISHMENT OF SECOND ORDER CONTROLS FROM
OLORUNSOGO COMMUNITY IN AWE TOWN TO IDI-MANGORO
VILLAGE ALONG OYO-IWO ROAD, AFIJIO LOCAL GOVERNMENT
AREA, OYO STATE OF NIGERIA**

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ABSTRACT

The study established Second Order Controls from Olorunsogo Community in Awe town to Idi- Mangoro village along Oyo-Iwo Road, Afijio local government area of Oyo State. The study extended the already established Second Order Controls from Olorunsogo community Awe town to Idi-Mangoro village along Oyo/Iwo road with approximate distance of 5Km. The study is necessary due to development activities; and also the problem of insufficient controls within the area. These factors necessitated the need to establish Second Order Control so as to provide the relevant controls in which subsequent lower order jobs can be tied around the area and also for proper mapping of the area. The study was carried out by adopting the specifications for Second Order Control extension using GPS. The field data were downloaded from Trimble R6 GPS instrument into computer system using Trimble data transfer software. The data from reference and the rover were downloaded. After downloading, Hi-Target Geomatic Office software was used for processing of downloaded data. The results were obtained and sorting out for data transformation from Geodetic Coordinates to Universal Traverse Mercator (UTM). The

downloaded data were converted to Rinex Format such that it can be handled by Hi-Target Geomatic Office for further processing. The result of data obtained from the adjusted data was analyzed and the result proved reliable as the unit variance and standard error values fall within allowable limits. Back computation was done from the final adjusted coordinates in order to obtain corrected bearings and distances in-between successive controls. The results obtained from the Excel program and HI-Target Geomatics Office software were compared and the discrepancies were negligible. With the various results generated in the course of the study, it is an indication that the linear accuracy was reliable.

KEYWORDS: Second Order, Controls, Satellites, Geodetic, Traversing, HI target.

1.0 INTRODUCTION

Surveying has been in existence from the beginning of human race. It is generally known that surveying is the bedrock of every meaningful development on or above the earth's surface. Robillard, Wilson and Brown (2006) believed Surveying has to do with the determination of the relative spatial location of points on or near the surface of the earth. They buttressed the above definition by saying that it is the art of measuring horizontal and vertical distances between objects, measuring angles between lines, determining the direction of lines, and establishing points by predetermined angular and linear measurements. Generally, Controls are used for orientation in any survey operation and must be of high degree of accuracy. Control serves as a basis for orienting or checking subordinate survey work regardless of its order of accuracy.

Punmia (2009) defined control points as identifiable positions on the surface of the earth whose coordinates are determined with respect to a defined reference system with a national, state or local origin. Subsequently, control itself is a system of relatively precise measurements by triangulation, traversing and leveling to determine distances, directions and difference in elevation between points on the earth's surface. Controls can be horizontal or vertical. Other types of controls are ground controls, photo controls etc. The provision of such control points depends on the surveying method employed and the equipment used. Geodetic networks basically involve two types of controls; the horizontal and vertical controls, each having its own set of monument points and method of establishment. Generally, controls are also classified according to their degree of accuracy. They are:

- i. First order controls (Primary)
- ii. Second order controls (Secondary)

iii. Third order controls (Tertiary).

However, the advent of digital surveying equipment and satellite positioning system has brought a convenient of methods that facilitates and simplifies the observational methods in today's surveying. The classical method embraces the traditional methods of obtaining planimetric information of control points using Traversing, Triangulation and Trilateration. With the advent of the new technology in surveying, the planimetric and height information of control points can be obtained through the use of Global Positioning System (GPS).

Global Positioning System (GPS) are satellites that were primarily designed for use by US military in the early 60's, with a secondary role of civilian navigation as found in the works of Awange & Aduol, (1999); Awange *et al.*, (2010). Two carrier signals in the L band denoted by L1 and L2 are generated by integer multiplication of the fundamental frequency f_0 . These carriers are modulated by codes to provide satellite clock readings measured by GPS receivers. Two types of codes; the coarse acquisition C/A and precise acquisition P/A are emitted. This study was carried out using Global Positioning System (GPS) equipment. GPS is based on accurate ephemeris data for the real-time location of each satellite and on precisely kept time. It uses satellite signals, accurate time and sophisticated algorithms to generate distances to ground receivers and thus provide "resection" positions anywhere on earth.

A minimum of four satellites must be tracked according to Awange *et al.*, (2010) to solve the positioning intersection equations dealing with position (x, y and z coordinates) which later can be translated to easting, northing and elevation and with clock differences between the satellites and ground receivers. In reality, five or more satellites are tracked to introduce additional redundancies and to strengthen the geometry of the satellite array. Additional satellites (more than the required minimum) can provide more accurate positioning and can also reduce the receiver occupation time at each survey station. The establishment of the second order control is significant because they can be used as a reliable platform for the extension of third order jobs; they will equally assist in township mapping and for public and private uses; also can be used in the production of accurate maps and geographic features; the controls established can be used for any job that requires second order controls; they can serve as bedrock for precise engineering jobs; can also help in assuring the unambiguous location of all parcel of land control area of occupancy and also provides for the subsequent lower order jobs to be tied.

The aim of the study is to establish Second Order controls from Olorunsogo Community in Awe town to Idi-Mangoro village along Oyo-Iwo Road, Afijio Local Government area of OyoState, so as to assist in township mapping and for public and private uses. The study is necessary due to development activities like private, commercial and industrial along the route in the study area and to solve the problem of insufficient controls within the area. These factors necessitated the need to establish Second Order control from Olorunsogo community in Awe town to Idi- Mangoro village along Oyo-Iwo road, Oyo state so as to provide the relevant controls in which subsequent lower order jobs can be tied around the area and also for proper mapping of the area. The study extended the already established Second Order controls from Olorunsogo community in Awe town to Idi-Mangoro village along Oyo/Iwo road, Afijio local Government Area of Oyo State with approximate distance of 5Km. The study area site is geographically situated from latitudes $07^{\circ} 46' 38.92''\text{N}$ to $07^{\circ} 48' 29.60''\text{N}$ and longitudes $03^{\circ} 58' 56.76''\text{E}$ to $04^{\circ} 00' 35.51''\text{E}$. The study area is shown in Figure 1.

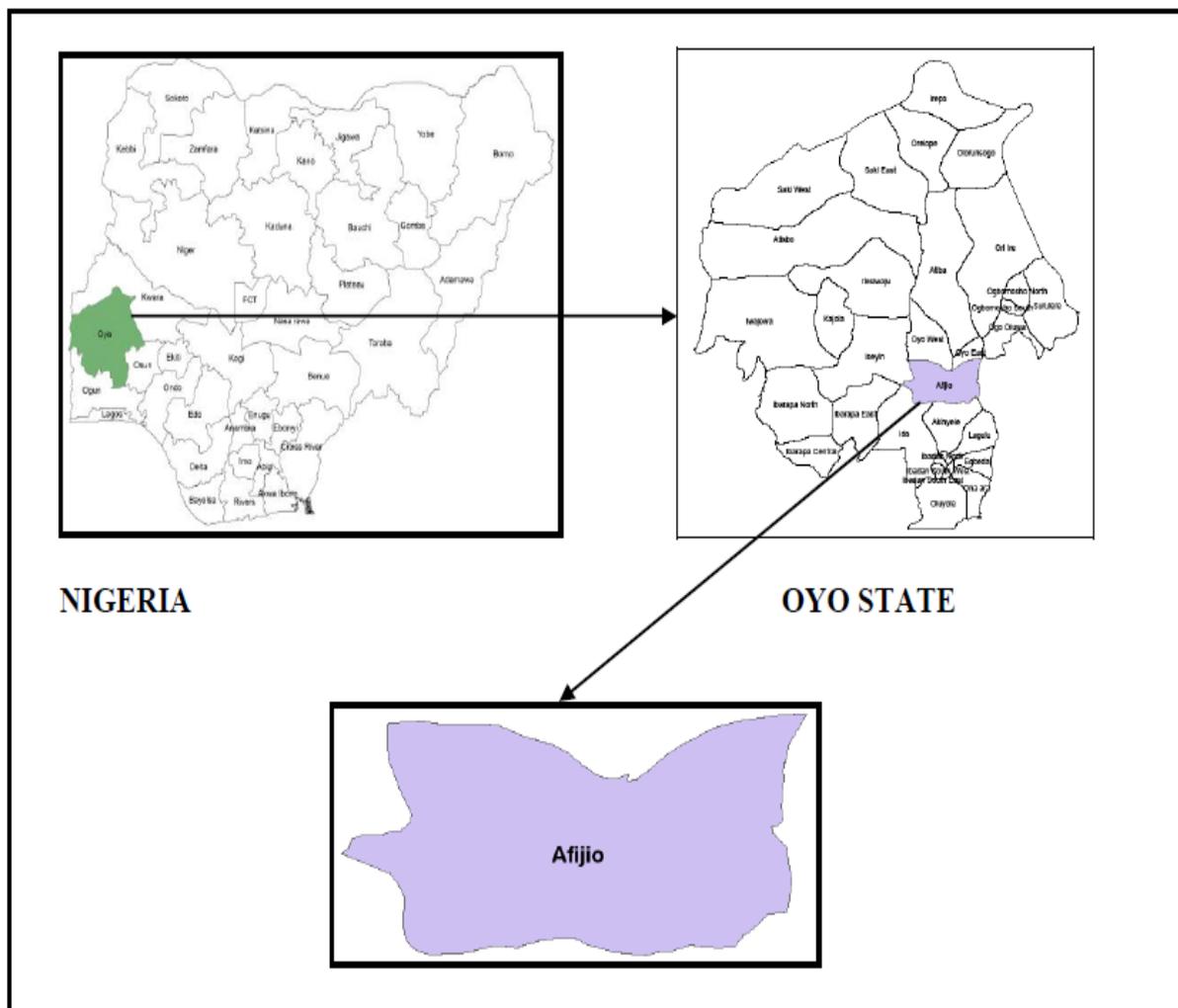


Figure 1: Location diagram of the Study Area.

2.0 METHODOLOGY

The specifications for the study were referenced to the Specifications for Second Order control extension using GPS which was sourced from the Surveyors Council of Nigeria (SURCON) pamphlet on specification for Geodetic Survey in Nigeria. The specifications include the following:-

- i. Dual frequency GPS receivers – Compulsory;
- ii. Minimum of two (2) GPS receivers required for two simultaneous observations for baseline solution;
- iii. Minimum number of Datum control required – Two (2);
- iv. Spacing between any adjacent station should not be shorter than 0.2Km and survey beacons should be of dimensions 40cm x 40cm x 110cm (L x B x H) respectively;
- v. The concrete of beacons should be mixed in ratio 3:2:1 of sharp sand, gravel and cement;
- vi. The beacons should be in-situ and reinforced with iron pipes, each consisting of prefix and pillar number;
- vii. Geometric Dilution of Precision (GDOP) at the beginning and the end of the observation should be within 0 and 8;
- viii. Period of observation with visibility to minimum of four (4) satellites – 90minutes;
- ix. Data sampling rate (Epoch) – maximum time interval between observations – 30 seconds, with cut off angle of 15°;
- x. Poor baseline vector should be discarded from participating in further adjustment; and
- xi. Independent plumb line centering with maximum centering error of 3mm is required.

The methodology adopted in order to acquire a reliable and accurate data needed for computing and plotting the information to have a plan of the study is the principle of working from whole to part. The first thing that was done is the Office Planning which required acquisition of instrument to be used. This also involves the acquisition of the area to be surveyed from existing map i.e. topographical map of the area in order to determine where the study area falls. At this stage, the available data for the study were examined i.e. the data of the existing controls on which the study was tied. The reconnaissance survey of the study area was done to see the general overview of the study area and to plan adequately for the acquisition and processing of the data. The ground control coordinates (primary) were obtained from SIWES and Practical Unit of Federal School of Surveying, Oyo, Oyo State (Table 1).

Table 1: Coordinates of Primary Controls.

PILLAR PREFIX	NORTHING(m)	EASTING(m)	HEIGHT(m)
XSN07	866879.146	604755.785	309.972
FSS1/28/96(YZN)	869917.170	603299.247	275.183
FSS1/17	863523.698	601051.694	312.957

The next step taken was to consider the locations where the stations were to be established in the course of carrying out the study. The following factors were considered.

- i. Intervisibility between two points;
- ii. Good horizon for GPS observation; and also
- iii. Points to be located where they will not be disturbed.

Equipment used in the execution of the study included but not limited to the following:

- i. One (1) Trimble differential GPS and its accessories (GNSS/R6/58000);
- ii. One (1) Tripod stand;
- iii. Three (3) Ranging poles;
- iv. One (1) 50m Steel tape;
- v. One (1) 5m pocket tape;
- vi. One (1) Hand held GPS;
- vii. One (1) Carrier & Tribrach;
- viii. One (1) Circular web;
- ix. One (1) Prismatic Compass;
- x. Mobile phones for effective communication;
- xi. Others include Digger, Hand trowel, Crowbar Shovel, Cutlass, Head pan, Iron rod, Mould, Gravel, Sand, Water and Cement.

2.1 Data Downloading/Transformation

The acquired data from the field were downloaded from Trimble R6 GPS receivers into the Computer System using Trimble Data Transfer Extension of Trimble Business Centre (TBC-5). The download was done for both reference and rover receivers while the downloaded base line vector map was displayed by the Trimble Business Centre software as shown in Figure 2.

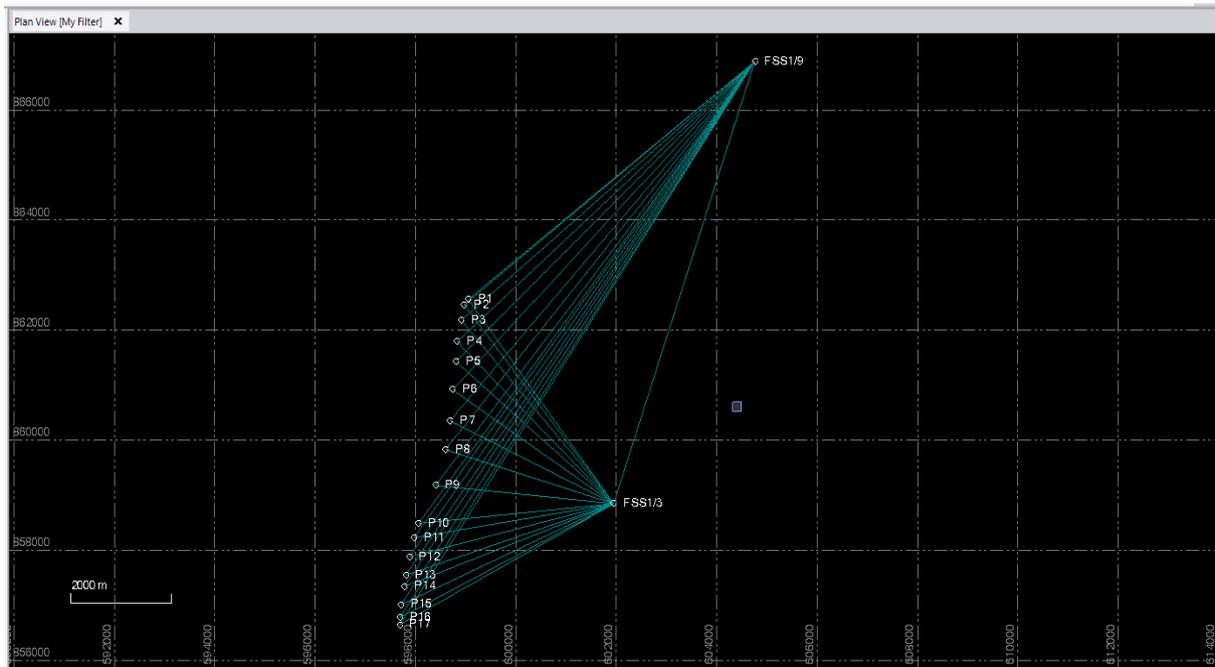


Figure 2: Downloaded Base Line Vector Map of Controls Established.

Also, the processed data were well sorted out for further processing using Hi-Target Geomatics Office software (See Table 2).

Table 2: Results obtained from the processed data in WGS84.

Station Name	NORTHING(M)	EASTING(M)	HEIGHT(M)
FSS2/HND/2016/001	6304463.032	438734.0292	860965.3028
FSS2/HND/2016/002	6304486.699	439032.1862	860639.4351
FSS2/HND/2016/003	6304491.661	439187.9027	860448.7009
FSS2/HND/2016/004	6304494.823	439261.2514	860382.1904
FSS2/HND/2016/005	6304522.38	439443.6591	860165.0873
FSS2/HND/2016/006	6304551.68	439947.1992	859618.1631
FSS2/HND/2016/007	6304557.855	440068.1167	859465.0338
FSS2/HND/2016/008	6304556.322	440176.6585	859367.2618
FSS2/HND/2016/009	6304564.514	440242.0038	859274.5386
FSS2/HND/2016/010	6304577.83	440452.0616	859061.8035
FSS2/HND/2016/011	6304589.398	440642.5468	858831.5763
FSS2/HND/2016/012	6304600.18	440813.812	858659.8523
FSS2/HND/2016/013	6304619.281	440970.8209	858470.5029
FSS2/HND/2016/014	6304627.847	441170.4185	858265.2433
FSS2/HND/2016/015	6304638.582	441344.1411	858059.4284
FSS2/HND/2016/016	6304642.422	441458.9902	857952.7831
FSS2/HND/2016/017	6304658.455	441609.5524	857766.4669
FSS2/HND/2016/018	6304671.969	441782.8123	857591.5312
FSS2/HND/2016/01	6304462.951	438734.0472	860965.2749
FSS2/HND/2016/03	6304491.698	439187.874	860448.6941
FSS2/HND/2016/04	6304494.859	439261.2447	860382.1997
FSS2/HND/2016/05	6304522.49	439443.653	860165.0996
FSS2/HND/2016/07	6304557.865	440068.1278	859465.0304
FSS1/HND/2106/09	6304564.514	440242.0038	859274.5386
FSS2/HND/2016/11	6304589.473	440642.5794	858831.5742
FSS2/HND/2016/12	6304600.22	440813.8212	858659.8254
FSS2/HND/2016/13	6304619.303	440970.8483	858470.4708
FSS2/HND/2016/14	6304627.91	441170.4233	858265.2553
FSS2/HND/2016/15	6304638.586	441344.1562	858059.4244
FSS2/HND/2016/16	6304642.281	441459.8186	857952.7192
FSS2/HND/2016/17	6304648.547	441608.8332	857766.1097
FSS2/HND/2016/18	6304671.899	441782.7915	857591.5212
FSS2/HND/2016/6	6304551.68	439947.1992	859618.1631
FSS2/HND/2016/8	6304556.322	440176.6585	859367.2619
YCY 0249	6304480.745	438915.7503	860746.4481
YCY 0252	6304530.31	439593.9062	860018.7552
YCY 0253	6304546.783	439822.204	859734.8755
YCY 249	6304480.751	438915.744	860746.4475
YCY 252	6304530.326	439593.9116	860018.7519
YCY253	6304546.802	439822.1962	859734.8665

For the basis of this study, the processed results obtained were well sorted out and transformed from geodetic coordinate system with reference Ellipsoid WGS84 into UTM with reference ellipsoid of Clarke 1880 using Hi-Target Coordinate Tool Converter as shown in Table 3.

Table 3: Results showing processed data in MINNA Datum (Clarke 1880).

Station Name	NORTHING(M)	EASTING(M)	HEIGHT(M)
FSS2/HND/2016/001	863261.445	608229.8345	312.9995
FSS2/HND/2016/002	862933.3676	608526.3032	312.6385
FSS2/HND/2016/003	862742.6788	608681.6972	302.3602
FSS2/HND/2016/004	862675.8544	608754.7831	301.5056
FSS2/HND/2016/005	862455.7955	608935.2942	311.8319
FSS2/HND/2016/006	861906.5495	609436.7141	301.2852
FSS2/HND/2016/007	861753.1866	609557.2332	294.9585
FSS2/HND/2016/008	861655.7844	609665.8154	287.6727
FSS2/HND/2016/009	861562.3724	609730.6323	287.7044
FSS2/HND/2016/010	861348.3717	609939.6949	286.5239
FSS2/HND/2016/011	861117.4205	610129.4001	279.9058
FSS2/HND/2016/012	860944.6577	610299.8552	279.1249
FSS2/HND/2016/013	860753.4127	610455.5564	283.2011
FSS2/HND/2016/014	860547.5319	610654.4998	277.6651
FSS2/HND/2016/015	860340.9903	610827.4892	272.4211
FSS2/HND/2016/016	860234.0254	610942.0109	269.724
FSS2/HND/2016/017	860047.235	611091.4864	270.9055
FSS2/HND/2016/018	859869.9159	611263.751	272.4471
FSS2/HND/2016/01	863261.4283	608229.8582	312.916
FSS2/HND/2016/03	862742.6672	608681.666	302.3943
FSS2/HND/2016/04	862675.8588	608754.7738	301.5422
FSS2/HND/2016/05	862455.7928	608935.2804	311.9423
FSS2/HND/2016/07	861753.1818	609557.2435	294.9684
FSS2/HND/2016/8	861655.7845	609665.8154	287.6727
FSS2/HND/2016/11	861117.4081	610129.4275	279.9818
FSS2/HND/2016/12	860944.6256	610299.8617	279.1615
FSS2/HND/2016/13	860753.3778	610455.5823	283.2199
FSS2/HND/2016/14	860547.5351	610654.5002	277.7296
FSS2/HND/2016/15	860340.9857	610827.504	272.4254
FSS2/HND/2016/16	860233.9753	610942.847	269.6332
FSS2/HND/2016/17	860047.2351	611091.4614	260.879
FSS2/HND/2016/18	859869.9157	611263.7352	272.3746
FSS2/HND/2016/6	861906.5495	609436.7141	301.2852
YCY 0249	863040.9915	608410.3461	313.2753
YCY 0252	862308.72	609084.9256	310.1614
YCY 0253	862023.6986	609312.1248	303.6579
YCY 249	863040.99	608410.3394	313.2808
YCY 252	862308.7146	609084.9299	310.1768
YCY253	862023.6871	609312.1157	303.6754

The adjusted results as processed by Hi-Target software were tabulated against the input observed data as shown in Table 4. Also, a customized observation equation Least Squares program written in Excel was used for the Least Square Adjustment solution. The results of the two adjusted programs (Excel and Hi-Target) were compared and displayed as in Table 5.

Table 4: Adjusted coordinates of the newly established points.

OBSERVED DATA				ADJUSTED DATA			DISCREPANCY		
STATION	NORTHING (M)	EASTING (M)	HEIGHT (M)	NORTHING (M)	EASTING (M)	HEIGHT (M)	NORTHING (M)	EASTING (M)	HEIGHT (M)
FSS2/HND/2016/001	863261.445	608229.8345	312.9995	863261.4367	608229.8548	312.9182	0.00835	-0.0203	0.08132
YCY 249	863040.99	608410.3394	312.6808	863040.9915	608410.3461	312.6263	-0.0015	-0.0067	0.0545
FSS2/HND/2016/002	862933.3676	608526.3032	313.2392	862933.3576	608526.3021	313.2721	0.01	0.0011	-0.03285
FSS2/HND/2016/003	862742.6788	608681.6972	302.3602	862742.6747	608681.6782	302.3855	0.00415	0.01905	-0.0253
FSS2/HND/2016/004	862675.8544	608754.7831	301.5056	862675.8578	608754.7782	301.5266	-0.00335	0.00495	-0.021
FSS2/HND/2016/005	862455.7955	608935.2942	311.8319	862455.793	608935.2866	311.8919	0.00255	0.00765	-0.05995
YCY 252	862308.7146	609084.9299	310.1768	862308.7175	609084.9304	310.1793	-0.0029	-0.0005	-0.0025
YCY253	862023.6871	609312.1157	303.6754	862023.6924	609312.1178	303.6582	-0.0053	-0.00205	0.01725
FSS2/HND/2016/006	861906.5495	609436.7141	301.2852	861906.5568	609436.7508	301.286	-0.0073	-0.0367	-0.0008
FSS2/HND/2016/007	861753.1866	609557.2332	294.9585	861753.1824	609557.2407	294.9606	0.00425	-0.00745	-0.0021
FSS2/HND/2016/008	861655.7844	609665.8154	287.6727	861655.7671	609665.8228	287.7165	0.0173	-0.0074	-0.0438
FSS2/HND/2016/009	861562.3724	609730.6323	287.7044	861562.4013	609730.6783	287.7032	-0.0289	-0.046	0.0012
FSS2/HND/2016/010	861348.3717	609939.6949	286.5239	861348.3834	609939.6851	286.5337	-0.01165	0.00985	-0.00975
FSS2/HND/2016/011	861117.4205	610129.4001	279.9058	861117.4225	610129.4137	280.0069	-0.002	-0.01355	-0.1011
FSS2/HND/2016/012	860944.6577	610299.8552	279.1249	860944.6395	610299.8549	279.149	0.01825	0.00035	-0.02405
FSS2/HND/2016/013	860753.4127	610455.5564	283.2011	860753.3611	610455.1347	283.2145	0.0516	0.42175	-0.0134
FSS2/HND/2016/014	860547.5319	610654.4998	277.6651	860547.5286	610654.4982	277.6914	0.00335	0.0016	-0.02625
FSS2/HND/2016/015	860340.9903	610827.4892	272.4211	860340.9916	610827.498	272.4318	-0.0013	-0.00875	-0.01065
FSS2/HND/2016/016	860234.0254	610942.0109	269.724	860234.0028	610942.8137	269.5686	0.0226	-0.80275	0.1554
FSS2/HND/2016/017	860047.235	611091.4864	270.9055	860047.2333	611091.4715	270.8956	0.0017	0.0149	0.00995
FSS2/HND/2016/018	859869.9159	611263.751	272.4471	859869.9317	611263.7072	272.5231	-0.0158	0.0438	-0.07595

Back computation was done from the final adjusted coordinates in order to obtain corrected bearings and distances in-between successive controls. The result obtained is given in Table 5.

Table 5: Back computation of established stations.

FROM STN	D(o)	M(')	S(")	DISTANCE	ΔN(m)	ΔE(m)	NORTHING	EASTING	TO STN
							866879.146	604755.800	XSN 07
XSN 07	136	30	58.2	5015.663	3617.709	3474.055	863261.437	608229.855	FSS2/HND/2016/01
FSS2/HND/2016/01	140	41	29.6	284.904	-220.443	180.485	863040.993	608410.340	YCY 0249
YCY 0249	132	52	2.8	158.200	-107.624	115.950	862933.369	608526.290	FSS2/HND/2016/02
FSS2/HND/2016/02	140	49	29.6	245.988	-190.694	155.389	862742.675	608681.678	FSS2/HND/2016/03
FSS2/HND/2016/03	132	25	43.7	99.036	-66.817	73.100	862675.858	608754.778	FSS2/HND/2016/04
FSS2/HND/2016/04	140	38	22.7	284.626	-220.065	180.508	862455.793	608935.287	FSS2/HND/2016/05
FSS2/HND/2016/05	134	30	14.6	209.820	-147.075	149.644	862308.718	609084.930	YCY 0252
YCY 0252	141	26	32.7	364.491	-285.025	227.187	862023.692	609312.118	YCY 0253
YCY 0253	133	13	25.6	171.038	-117.136	124.633	861906.557	609436.751	FSS2/HND/2016/06
FSS2/HND/2016/06	141	50	49.5	195.042	-153.374	120.490	861753.182	609557.241	FSS2/HND/2016/07
FSS2/HND/2016/07	131	53	49.5	145.876	-97.415	108.582	861655.767	609665.823	FSS2/HND/2016/08
FSS2/HND/2016/08	145	12	52.8	113.681	-93.366	64.856	861562.401	609730.678	FSS2/HND/2016/09
FSS2/HND/2016/09	135	40	43.3	299.145	-214.018	209.007	861348.383	609939.685	FSS2/HND/2016/10
FSS2/HND/2016/10	140	35	51.9	298.898	-230.961	189.729	861117.423	610129.414	FSS2/HND/2016/011
FSS2/HND/2016/011	135	23	27.3	242.702	-172.783	170.441	860944.639	610299.855	FSS2/HND/2016/012
FSS2/HND/2016/012	140	55	49.1	246.372	-191.278	155.280	860753.361	610455.135	FSS2/HND/2016/013
FSS2/HND/2016/013	135	54	52.8	286.553	-205.833	199.364	860547.529	610654.498	FSS2/HND/2016/014
FSS2/HND/2016/014	140	2	59.1	269.419	-206.537	173.000	860340.992	610827.498	FSS2/HND/2016/015
FSS2/HND/2016/015	132	51	17.5	157.303	-106.989	115.316	860234.003	610942.814	FSS2/HND/2016/016
FSS2/HND/2016/016	141	28	56.0	238.709	-186.770	148.658	860047.233	611091.472	FSS2/HND/2016/017
FSS2/HND/2016/017	135	49	49.2	247.186	-177.302	172.236	859869.932	611263.707	FSS2/HND/2016/018

Comparative Analysis of adjusted data from Excel program and HI-Target Geomatics Office software is shown in Table 6. The discrepancies of -0.0158 to 0.0516 were observed on the Northings, -0.00995 to 0.24585 on the Eastings and the heights by -0.6545 to 0.64905. The discrepancies were negligible and within the allowable distances.

Table 6: Comparative Analysis of adjusted data from Excel program and HI-Target GeomaticsOffice software.

STATION ID	ADJUSTED DATA USING HI-TARGET			ADJUSTED DATA USING EXCEL			DESCREPANCY		
	NORTHING (m)	EASTING (m)	HEIGHT (m)	NORTHING (m)	EASTING (m)	HEIGHT (m)	NORTHING (m)	EASTING (m)	HEIGHT (m)
FSS2/HND/2016/01	863261.44	608229.85	312.91818	863261.43	608229.86	312.916	0.00835	-0.0034	0.002175
YCY 249	863040.99	608410.35	312.6263	863040.99	608410.34	313.2808	0.0015	0.0067	-0.6545
FSS2/HND/2016/02	862933.36	608526.30	313.27205	862933.37	608526.29	312.623	-0.0112	0.0121	0.64905
FSS2/HND/2016/03	862742.67	608681.68	302.3855	862742.68	608681.68	302.3828	-0.00075	-0.00415	0.0027
FSS2/HND/2016/04	862675.86	608754.78	301.5266	862675.86	608754.78	301.5277	-0.00045	0.00075	-0.0011
FSS2/HND/2016/05	862455.79	608935.29	311.89185	862455.79	608935.28	311.9111	0.00135	0.00565	-0.01925
YCY 0252	862308.72	609084.93	310.1793	862308.72	609084.93	310.1614	-0.0025	0.0048	0.0179
YCY 0253	862023.69	609312.12	303.65815	862023.70	609312.12	303.6579	-0.0062	-0.00705	0.00025
FSS2/HND/2016/06	861906.56	609436.75	301.286	861906.55	609436.71	301.2852	0.0073	0.0367	0.0008
FSS2/HND/2016/07	861753.18	609557.24	294.9606	871753.18	609557.24	294.9623	-0.00115	-0.00065	-0.0017
FSS2/HND/2016/08	861655.77	609665.82	287.7165	861655.78	609665.82	287.6727	-0.0174	0.0074	0.0438
FSS2/HND/2016/09	861562.40	609730.68	287.7032	861562.37	609730.63	287.7044	0.0289	0.046	-0.0012
FSS2/HND/2016/10	861348.38	609939.69	286.53365	861348.37	609939.70	286.5163	0.01485	-0.00995	0.01735
FSS2/HND/2016/11	861117.42	610128.41	280.0069	861117.41	610129.41	279.988	0.0084	0.00265	0.0189
FSS2/HND/2016/12	860944.64	610299.85	279.14895	860944.64	610299.85	279.1374	-0.00515	0.00465	0.01155
FSS2/HND/2016/13	860753.36	610455.13	283.2145	860753.53	610454.89	281.9667	-0.1675	0.24585	1.2478
FSS2/HND/2016/14	860547.53	610654.50	277.69135	860547.54	610654.50	277.7156	-0.01425	0.0016	-0.02425
FSS2/HND/2016/15	860340.99	610827.50	272.43175	860340.99	610827.5	272.4262	0.0047	-0.00495	0.00555
FSS2/HND/2016/16	860234.00	610942.81	269.5686	860233.99	610942.79	269.6274	0.0118	0.02575	-0.0588
FSS2/HND/2016/17	860047.23	611091.47	270.89555	860046.82	611091.29	270.6438	0.4155	0.1829	0.25175
FSS2/HND/2016/18	859869.93	611263.71	272.52305	859869.96	611263.72	272.3866	-0.0241	-0.014	0.13645

The linear accuracy of the products was calculated and the result is presented in Table 7. With the results, it is an indication that the linear accuracy was reliable. Figure 3 shows the interface of AutoCAD Software showing the plan as the final draft for the study.

Table 7: Linear Accuracy.

POINT ID	NORTHING	EASTING	MISCL. IN NORTHIG	MISCL. IN EASTING	TOTAL DIST. FRM. XSN 07	TOTAL DIST. FRM. FSS1/17	LINEAR ACCURACY FRM. XSN 07	LINEAR ACCURACY FRM. FSS1/17	MEAN
FSS2/HND/2016/1	863261.4284	608229.858							
	863261.4449	608229.851	-0.017	0.007	5015.68	7182.95	1/281049	1/402490	1/341769
FSS2/HND/2016/2	862933.3667	608526.281							
	862933.3712	608526.298	-0.005	-0.02	5457.64	442.169	1/300429	1/412738	1/356583
FSS2/HND/2016/3	862742.6671	608681.666							
	862742.6822	608681.69	-0.015	-0.02	5702.89	7497.88	1/199336	1/262077	1/230707
FSS2/HND/2016/4	862675.8588	608754.774							
	862675.8567	608754.782	0.0021	-0.01	5801.68	7669.86	1/662628	1/875998	1/769313
FSS2/HND/2016/5	862455.7928	608935.281							
	862455.7931	608935.293	-3E-04	-0.01	6085.58	7749.61	1/502786	1/640267	1/571526
FSS2/HND/2016/6	861906.5668	609436.746							
	861906.5468	609436.756	0.02	-0.01	6829.2	7955.6	1/305411	1/355785	1/330598
FSS2/HND/2016/7	861753.1817	609557.244							
	861753.183	609557.238	-0.001	0.006	7023.5	8539.58	1/162538	1/1413481	1/1288010
FSS2/HND/2016/8	861655.7821	609665.82							
	861655.7521	609665.826	0.03	-0.01	7168.82	8687.86	1/287447	1/283972	1/285710
FSS2/HND/2016/9	861562.4072	609730.706							
	861562.3954	609730.651	0.0118	0.054	7281.31	113.656	1/130806	1/159845	1/145236
FSS2/HND/2016/10	861348.3981	609939.675							
	861348.3686	609939.695	0.0295	-0.02	7580.36	8897.81	1/213024	1/250047	1/231535
FSS2/HND/2016/11	861117.4082	610129.428							
	861117.4368	610129.4	-0.029	0.028	7878.68	9150.33	1/197191	1/229018	1/213105
FSS2/HND/2016/12	860944.6256	610299.862							
	860944.6533	610299.848	-0.028	0.014	8121.29	9391.21	1/262801	1/303896	1/283349
FSS2/HND/2016/13	860753.3779	610455.582							
	860753.3443	610454.687	0.0336	0.895	8367.36	9601.03	1/9339	1/10716	1/10028
FSS2/HND/2016/14	860547.5352	610654.5							
	860547.5219	610654.496	0.0133	0.004	8653.56	9802.61	1/620443	1/702827	1/661635
FSS2/HND/2016/15	860340.9858	610827.504							
	860340.9974	610827.492	-0.012	0.012	8922.63	10053.4	1/527745	1/594628	1/561186
FSS2/HND/2016/16	860233.9754	610942.847							
	860234.0302	610942.78	-0.055	0.067	9079.54	10280.8	1/104991	1/118882	1/111937
FSS2/HND/2016/17	860047.2351	611091.462							
	860047.2315	611091.482	0.0036	-0.02	9317.5	10423.8	1/458506	1/512946	1/485726
FSS2/HND/2016/18	859869.9157	611263.735							
	859869.9477	611263.679	-0.032	0.056	9564.66	10624.6	1/148294	1/164728	1/156511
YCY 249	863040.9901	608410.341							
	863040.9967	608410.339	-0.007	0.001	5299.74	10845.9	1/785513	1/1607557	1/1196535
YCY 252	862308.7145	609084.93							
	862308.7205	609084.931	-0.006	-0	6295.26	7374.46	1/1034935	1/1212354	1/1123644
YCY 253	862023.6893	609312.114							
	862023.6955	609312.121	-0.006	-0.01	6658.5	8124.6	1/695217	1/848293	1/771755

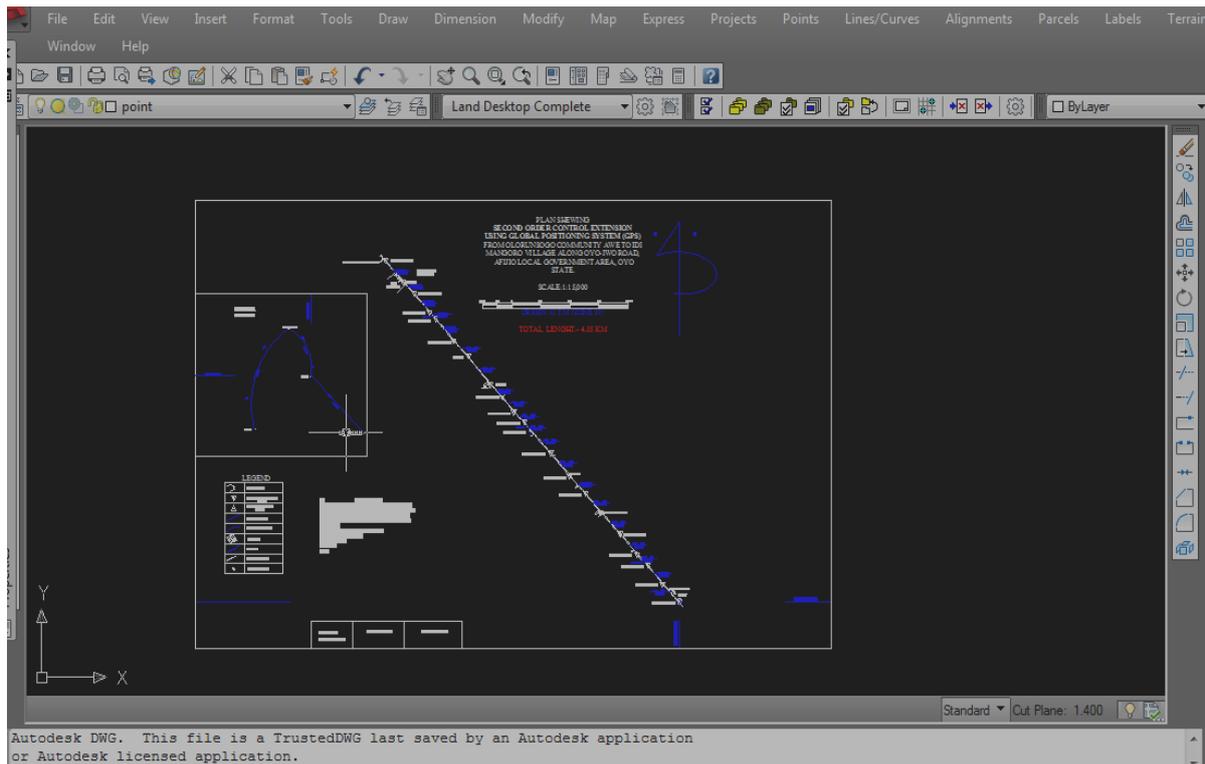


Figure 3: Interface of AutoCAD Software showing the plan.

4.0 DISCUSSION OF RESULTS

The various results obtained from one step to the other were tabulated in the Tables shown in the last section. The data from the field was downloaded into the computer system using the Trimble data transfer software. The data from the reference and rover receivers were downloaded. The downloaded data needed to be converted to Rinex Format such that it can be handled by Hi-Target Geomatic office for further processing. The data were processed via Hi-Target Geomatics Office software and the result was shown in Table 2. Observation equation method was employed in adjusting the acquired data. The adjusted data was converted from space coordinate to UTM using Hi-Target coordinate tool converter. This is shown in Table 3.

The result of data obtained from the adjusted data was analyzed and the result proved reliable as the unit variance and standard error values fall within allowable limits. The results are as shown in Table 4. Back computation was done from the final adjusted coordinates in order to obtain corrected bearings and distances in-between successive controls. The result obtained is given in Table 5. The results obtained from the Excel program and HI-Target Geomatics Office software were compared and shown in Table 6. The discrepancies were negligible. The linear accuracy of the products was calculated and the result presented as

shown in Table 7. With the results, it is an indication that the linear accuracy was reliable. It is also important to state that the various results generated are in order and can be used for a Second Order control establishments when further extension of controls are required in the study area.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Having completed the study successfully and the aim and objectives of control establishment were achieved, it is therefore concluded that the establishment of controls from Awe Town to Idi-Mangoro village along Oyo-Iwo Road, Afijio Local Government Area of Oyo state was a huge success. This will assist in township mapping and also serve the public and private organisations when carrying out surveying works along and around the route. The whole study was carried out in accordance with specifications of surveying profession.

5.2 Recommendations

It is recommended at the end of the study that Government and the bodies concerned should try as much as possible to establish more controls with higher orders along the route and if such were already on ground, they should be marked and the information should be made available on public domain.

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