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The Effect of Dynamic Environment on the Stability of Survey Monuments A Case Study of Idah, Nigeria.

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Abstract
Survey monuments are the primary and lasting evidence that a surveyor has worked on a piece of land. They are the linkage between the plan produced by the surveyor and the land bounded by these monuments. These monuments should not be disturbed, shifted, mispositioned or displaced after emplacement otherwise the survey operation based on them are of no significance. However, some survey monuments may be established on grounds that are prone to dynamic movements. This may cause shifts to the emplaced monuments. This paper discusses the checks that should be conducted on the emplaced monuments to ascertain that they have not experienced any appreciable movements since their emplacements. Furthermore, a case study of a monument placed in a suspected dynamic environment along Idah-Ajaka road in Kogi State, Nigeria was undertaken and its results analyzed. It was observed that after the coordinates were recomputed there was no significant change in coordinates. Hence, the need to construct monuments on built rocks and deep soils to enable survey monuments have sustainable anchorage.

Keywords: Monuments, Dynamic, Mispositioned, Bedrock, Emplacements, Coordinate.

Introduction

Survey monuments are those permanent marks established in the field (the earth's surface) by the surveyor on which field observations could be conducted.
Their accurate horizontal and vertical positions from defined datum are well determined through a proper analysis of the surveyor's field data. These data which are the measurements and observations conducted in the field undergo proper computation and analysis. This enables the surveyor assign coordinates to the monuments. These coordinates should always be the same at different epochs of time.
These computed coordinates are always stored for further use during other survey works. They may also be used to prepare plans which will determine the size, location and configuration of the area covered by the survey monuments. The positions of these monuments are well defined on the plan. Hence, the monuments serve as a linkage between the plan and the areas bounded by the monuments. Therefore the relevance of any plan and the records depend on the existence and reliability of the surveyors monuments. Hence, wherever these monuments are disturbed, shifted,

mispositioned or destroyed, the whole survey operations based on them are of no significance. Fresh surveys must be conducted to re-established new reliable monuments.
The unmovelibity of the monuments ensures that no errors are introduced unto the coordinates assigned to other monuments established by connection to them. Any shifts in the position of any of the monuments within the covered area would create distortion and disorientation to any coordinates assigned unto other monuments connected to the shifted one.
In most surveys these monuments are built or emplaced on the grounds without any geotechnical work on the ground or soil investigation on such grounds to determine the stability of the particular ground as a foundation soil for the monuments. This paper discusses the checks that should be conducted on the emplaced monuments to ascertain that they have not experienced any movement since their emplacement. Furthermore, a case study of a monument placed in a suspected dynamic environment along Idah-Ajaka road in Kogi State, Nigeria was undertaken and its results analyzed to draw a conclusion.

Dynamic Environment
The dynamic environment here refers to those grounds that seem to be unstable and unsuitable for the establishment of structures on them. In such grounds the foundation soil on which the structures may anchor appears to have weak strength, suffer excess seepage, excess compressibility and expansively. Whenever structures are established on these types of grounds, they generally create dynamic situation which may result in the settlement of the soil owing to the imposed weight of the structure.
Some bedrocks on which structure are emplaced at times become destabilized particularly when underground water movement affects the stability. Partial settlement of rocks on which structures are constructed leads to weak stability thereby creating dynamic situation. [1] explained further that dynamic situation also arises owing to soil movement caused by seasonal changes in local water table, surface run off, vibrations created by heavy haulage, excessive traffic along a road nearby and heavy duty machines and equipments within vicinity.

Survey Monuments
Survey monuments can be classified into two broad categories namely boundary and control survey monuments. Boundary monuments define and demarcate the limits of specified rights and interest over portions of land areas. Some control survey monuments are emplaced for scientific studies. According to [2] such control survey monuments serve as basis for scientific studies. Therefore are emplaced on specially selected environment to meet the purpose of their studies and are never placed on any ground suspected to create dynamic situation so that no error would be introduce in their studies. But on the other hand boundary survey monuments are placed in accordance with survey regulations.

Emplacement of Survey Monument
Certain regulations govern the emplacement of survey monuments. These regulations are found in cap 194, survey Coordinates Act (as amended) and even in the land use Act of 1978. These regulations are enacted by the Federal Government which at times are modified for use by the appropriate survey bodies empowered by law to do so. Such bodies as Federal Survey Office, Nigeria Institution of Surveyors (NIS) and the Surveyors Council of Nigeria (SURCON).
For instance, the survey regulations require that a beacon (survey monument) be placed at each corner of a plot being demarcated. More so, beacons (survey monument) must be placed where boundary lines intersect important roads and streams. Further more for long survey boundary lines, it is required that the beacons (survey monuments) should be placed not more than 400 metres apart. Therefore to ensure that such survey regulations are maintained in the course of

survey work some beacons (survey monuments) may inevitably fall into dynamic environment as earlier explained.

Types of Survey Monuments

Two types of survey monuments are advocated to be emplaced in any environment suspected to be dynamic. These are the bedrock monuments and the deep surface monuments. The bedrock monuments are anchored to the bedrock which is expected to be below the dynamic soil. It reflects the stability of the layer of rock to which it is anchored. Deep surface monuments are not anchored to the bedrock but are sufficiently deep to eliminate the effects of changes to local water table or disturbances from the environment [3].

Checks on Survey Monument Emplaced

As dynamic situations may occur in the course of time in different environments, it is pertinent to check all monuments established on any soil before they could be used again for other surveys. Therefore it is extremely necessary to check and verify the stability of any monuments emplaced on suspected dynamic environment before they could be used for other works.

Verification of Controls.

This involves the angular and linear measurements of at least three control points on the field and comparing these with the calculated distances and angles as calculated from the coordinates of the control points, the differences between the two should be within the allowable limits of third order job.

Methodology

The Case Study of Survey Monument CPT 015 Along Idah – Ajaka Road in Kogi State Nigeria.

A third order cadastral control extension was carried out along Idah – Ajaka road in Kogi State, Nigeria in July 2010. This project created sixteen third order cadastral stations that spanned through 6.3 km. It started with station XSP47 at Ogbogbo junction along Idah/ Ajaka road (see Fig. 1 Recce diagram). It was a closed traverse survey using sokkia SET 310 total stations to observe the horizontal angles and distances. By this instrument the coordinates of each point was determined directly as a check. The coordinate of all the stations established in the project are as shown in Table 1.

Monitoring Of Station CTP015

After about a year, it was suspected that station CTP 015 may have been emplaced in a dynamic environment. The runoff water during the rainy season passes very close to the station. The station is about 10 metres from the road (Idah-Ajaka road) which experiences heavy haulage and excessive traffic. Furthermore the station is beside the College of Health and Applied Sciences Idah compound, therefore student have create foot path near it causing the vicinity to experience sand wash off and soil breakages. Owing to these it became imperative that this station should be monitored to ascertain whether the station is experiencing shifts.

To ascertain the stability or otherwise of station CTP 015, the horizontal angles at station CTP 016 and CTP 015 were re-observed at different epochs of time. The distance between stations CTP 016 and CTP 015 were re-measured also at each epoch. The data acquired are tabulated in Table 2. The horizontal angles re-observed at CTP 016 and the distances between CTP 016 and CTP 015, the coordinates of CTP 015 at each epoch were recalculated and tabulated in Table 3.

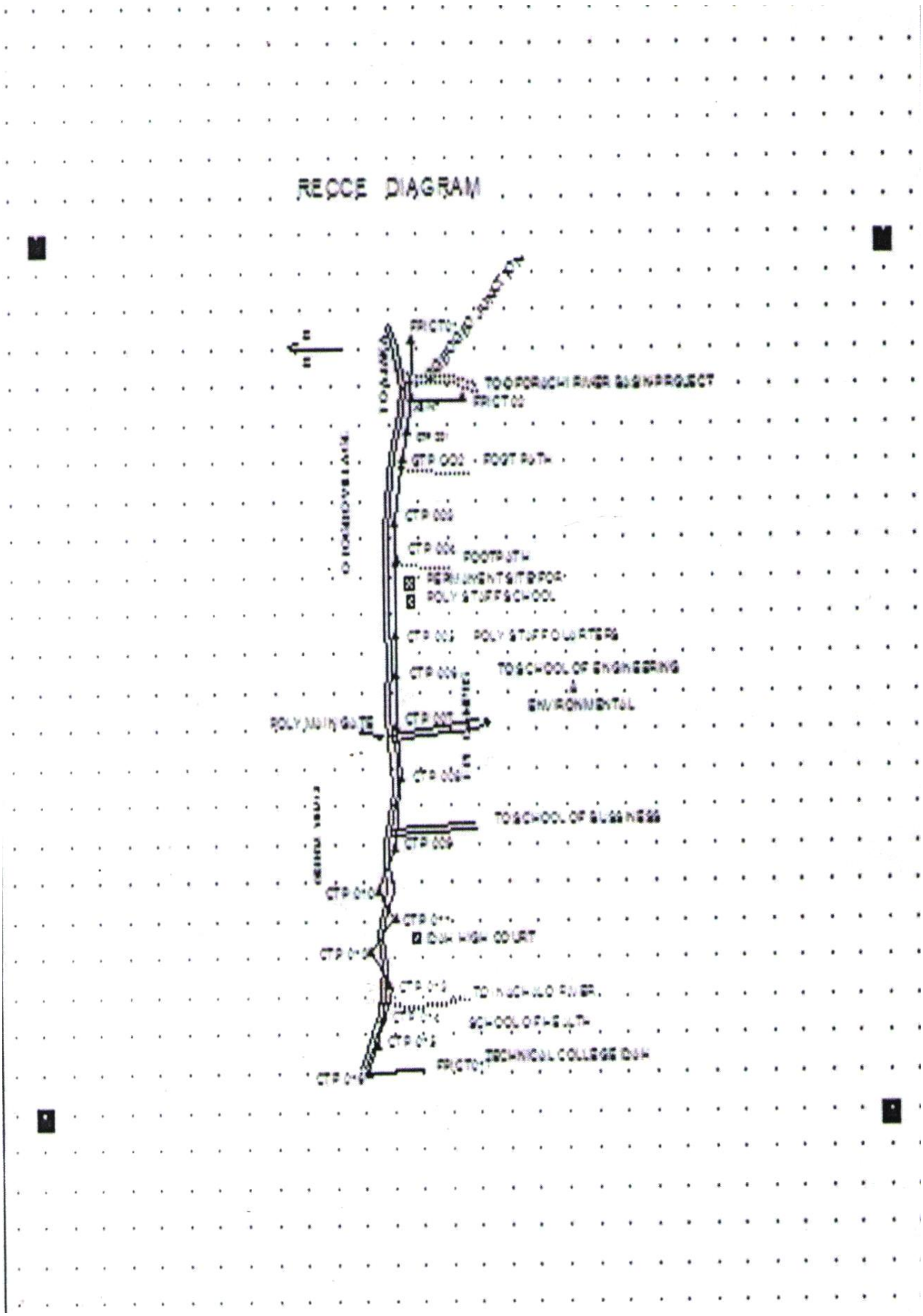
RECCE DIAGRAM

Fig. 1: Reconnaissance Survey Diagram of Road under Study.

Results and Discussion

TABLE 1: Coordinates Of Established Stations

Station	Eastings(Em) coordinate	Northings(Nm) coordinate
XSP 47	23916.199	19729.730
CTP 001	23772.959	19664.236
CTP 002	23647.621	19582.850
CTP 003	23089.694	19300.104
CTP 004	22818.922	19170.735
CTP 005	22447.227	18972.706
CTP 006	22099.296	18800.809
CTP 007	21702.809	18630.694
CTP 008	21167.633	18425.471
CTP 009	20579.923	18219.058
CTP 010	20197.282	18099.247
CTP 011	19912.940	17984.432
CTP 012	19725.140	17922.637
CTP 013	19613.296	17760.719
CTP 014	19286.151	17476.917
CTP 015	18799.140	17353.822
CTP 016	18195.199	17299.731
CTP 017	18191.210	17099.731

Coordinates from field data in July 2010.

TABLE 2: Data Acquired in the Field

Period	Mean horizontal angle observed		Distance (m)
	CTP 016	CTP 015	
July 2010	263^0 44’	170^0 56’ 00”	606.358

	22”		
Feb 2012	263^0 44’ 23"	170^0 55’ 49”	606.375
June 2012	263^0 44’ 23"	170^0 55’ 50”	606.367
Sep 2012	263^0 44’ 23"	170^0 55’ 54”	606.367
Dec 2012	263^0 44’ 23"	170^0 55’ 57”	606.365
Mar 2013	263^0 44’ 22"	170^0 55’ 57”	606.365
June 2013	263^0 44’ 22"	170^0 55’ 57”	606.365

TABLE 3: Re-calculated Coordinates of CTP 015

			Coordinates	
Period	**Bearing**	**Distance (m)**	**Eastings (Em)**	**Northings (Nm)**
June 2010	84^0 52’ 55”	606.358	18799.140	17353.822
Feb 2012	84^0 52’ 56”	606.375	18799.157	17353.801
June 2012	84^0 52’ 56”	606.367	18799.149	17353.821
Sep 2012	84^0 52’ 56”	606.367	18799.149	17353.821
Dec 2012	84^0 52’ 56”	606.365	18799.147	17353.821
Mar 2013	84^0 52’ 55”	606.365	18799.147	17353.821
June 2013	84^0 52’ 55”	606.365	18799.147	17353.821

TABLE 4: The Observed Horizontal Angle at CTP 015 was Analyzed as Follows

Period (epoch)	**The mean value of the observed angleat period (epoch)**	**Deviation E at period (in seconds of degree)**
February 2010	170^0 55' 49"	+11"
June 2012	170^0 55' 50"	+10"
September 2012	170^0 55' 54"	+6"
December 2012	170^0 55' 57"	+3"
March 2013	170^0 55' 57"	+3"
June 2013	170^0 55' 57"	+3"

TABLE 5: Recalculated coordinates of station CTP 015

There are deviations as shown in this analysis but for these deviations to be appreciable an epoch deviation should be more than 30" [4].
The recalculated coordinates of station CTP 015 were also analysed as shown Table 5.
For each deviation EX or Ey to be appreciable, its value should be more that §X or §Y [5]. But as §x and §x are each equal to 10mm, for any of the deviations to be appreciable it should be more than 30mm. Therefore comparing the deviations in the re-observed angle and the recalculated coordinates, the maximum noticeable variations occurred during the re-observation in February 2008. But even at this they were not sufficient to discards the station. Other subsequent values tend to make the station converge to its original position.

Period (epoch)	Recalculated easting coordinates at period	Deviation of recalculated Easting Coordinate Ex (m)	Recalculated northing coordinates at period (epoch)	Deviation of the recalculated Northing coordinate at period ex (mm)
Feb 2012	18799.157	+7	17353.801	-1
June 2012	18799.149	+9	17353.821	-1
Sept 2012	18799.149	+9	17353.821	-1
Dec 2012	18799.147	+7	17353.821	-1
March 2013	18799.147	+7	17353.821	-1
June 2013	18799.147	+7	17353.821	-1

CONCLUSION

The relevance of the stability of survey monuments to the practice of surveying, other professional practices and land developments cannot be over emphasized. Therefore proper construction and accurate positioning of survey monument are of vital importance in all types of surveying and geodetic networks. The monument should therefore be constructed so that there maintain stability over the years. They ought not to be prone to shifts owing to any movement in the soil of their emplacements. Hence they should be emplaced on built rocks and deep soils to enable them have sustainable anchorage.

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