DESIGN AND CONSTRUCTION ISSUES OF THE MILKEN HILL:- ENUGU

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Abstract

This paper is a review of some of the various issues involved in carrying out design or construction work on the Milken hill region of Enugu, a dangerous and subsequently abandoned part of the Enugu escarpment and the adjoining Udi plateau. A data synthesis approach is adopted in this work with a view to identifying the basic elements and their ramification in the problems of the area. It is the opinion of the author that the issues involved are varied and complex but are neither exceptionally unique nor insurmountable. It could actually be suggested that the issues are a unique opportunity that should be carefully studied and exploited to their fullest benefits.

Introduction

The Milken hill is a very wild region within the Udi plateau near Enugu, surrounding this capital city in a half circle, from the North through the West to the South. It has a most difficult topography and geology and environment had been further degraded and the substructure left more of less hollow by coal mining activities within the area in consequence of these, the area is relatively unstable and no land-use characterization could be adopted for the area since 1909 when it was first penetrated. Hence the development of the City of Enugu had been restricted to the alternate sides of Enugu. The area had remained abandoned ever since.

This paper seeks to draw attention of all experts that are or may be involved in design and construction works in this area of the complexities of the problems of this area. It is necessary for these problems to be fully appraised and act as the general design conditions for all planning works within the area. A master scheme which will consider all the problems in all their ramifications should be drawn up to serve as a general standard and guideline within which every unit design must conform.

Location

A few miles South East of the Niger and Benue river confluence at Lokoja, the land rises to form an elongated West-East highland which divides the old Igala division in two unequal lowland areas. In the relief map of Nigeria, this highland appears as a diminutive Eastern counterparts of the Afemai and Western Kabba, and developed exclusively on rocks of the basement complex, while the uplands East of lower Niger is underlain by cretaceous sandstone.

East of the lower Niger valley, the highlands occur as a surface and the escarpment constitute 2 of the main morphological units of the scarp-land of South Eastern Nigeria. Other morphological units of this composite region exists, but we shall limit ourselves to the areas within the Anambra State where the main upland is identified with the well known Udi hill and the scarp surface with the Enugu escarpment.

The Milken hill which is about 2500 hectares in size consist of the scarp surfaces of the Enugu escarpment and the adjoining highlands, extending to Ngwo town on the Western side of Enugu. For its size this area named after the first expatriate engineer who penetrated it for the purpose of constructing a road, provides one of the most varied landscape and science beauties in Nigeria. The area encircles Enugu in a half circle, running from the North Western part of the town through the West to the Southern part of the town. Thus, the area comes directly in the way of accesses into Enugu from the West and Northern parts o the country.

Previous Investigations

The foremost investigation of Milken hill was conducted by the mineral survey of Nigeria which started in 1909, and led to the discovery of sub-bituminous coal near the area. Further, investigations continued till 1914 and its results led to the opening of colliery in Enugu in 1915. In 1922 the geological survey started mapping in South Eastern Nigeria. Bain (1928) investigated the geology of the escarpment West of Enugu (the Milken hill), and Wilson (1926) mapped **a** strip of country along the railway from Port Ilarcourt to Enugu. The Shell D'Arcy exploration parties (later called Shell B.P.) started geological and geophysical surveys of Southern Nigeria in 1938, these were later followed by drilling which was suspended in 1941, and continued on a larger scale in 1946, the result of the Shell B.P. investigations have been of great importance and have clarified the geology and structure of South Eastern Nigeria (Kogbe, 1975).

In 1951 the Nigerian Coal Corporation continued drilling which was done on its behalf by the "Balakhany Black Sea Oil Company Limited", to ascertain the extent and quality of coal seams within the area. Simpson (1954) discovered the occurrence of coal seams at several levels. Reyment (1965) studied the geo-morphology of the area while Short and Stauble (1967) produced the paleographic map of the area and also the morphological feature and sedimentary environment of Southern Nigeria map. More recent works include the lithology of the formations of South Eastern Nigeria (Kogbe, 1974) and a study of the structural units and faults within the Milken hill by Nnoli (1974). Udo (1971) studied the drainage and land **form** characteristics of the area.

The evolution of the drainage in South Eastern Nigeria started in then late tertiary times. The present topography has reached a sub-mature stage and the adjustment to structure is well advanced. The main physiographic units can be recognized in the Benue and Cross River plains, Enugu escarpment and Udi and Igala plateaux, Awka-Orlu uplands and the Anambra lowlands to the West.

Landform

A close relationship exists between the geological formation and the morphological units in the region. The surface bedded sandstone while the middle and lower slopes of the North and East facing escarpments bordering this plateau are associated with rocks of lower coal measure (Fig. 4). The main highland area which is by far the most prominent morphological unit is shaped like an inverted L with a general height of about 300m above sea level. The hills and ridges are surmounted by cappings of hard concretional ironstone about 15m tick. It is suggested that the dome-topped hills follow successful removal of the lalcrilic cappings which preserve the flat tops (Table 1). The plateau is heavily dissected by headstreams and plateau surface carried numerous fiat bottomed dry valleys. The almost non-existent surface drainage is accounted for by the great depth (over 300m on the crest of the escarpment) of highly porous and permeable false-bedded sandstone which underlie the plateau surface. The face of the scarp is cut by gullies which occur mainly on higher slopes of the escarpment. These gullies are mostly deep with a spring issuing at the foot of the vertical back wall. The gully beds are generally semi-circular and the walls which arc almost vertical exhibit a most fascinating artistic variety of design cut by water most which are dry except after a heavy rain storm.

Geological Setting

The Enugu area is underlain by 3 sedimentary formations deposited during the campanian and Maestrichein times of the upper cretaceous era. These are:-

1. The Enugu SHALE.
2. The lower Coal measure.
3. The Ajali sandstone.

- **Enugu Shale:-** This is the oldest of the 3 and consists of finely laminated dark grey (carbonaceous) shale with thin layer of fine grained sandstone. The formation is commonly exposed along deeply incised river valleys on the Milken hill.
- **Lower Coal Measure:-** The Enugu shale is overlain by the coal bearing Mamu formation or the lower coal measure. The coal seams are intcrstratified with sandstones and shale in fairly rhythmic succession and marked by the occurrence of 5 coal scams.
- **Ajali Sandstone:-** The lower coal measure is in turn overlain by the Ajali sandstone which is strongly cross-bedded and loosely consolidated. The friable nature of the sandstone has given rise to extensive gullying and mass wastage characteristics of the area. The sands are generally very thick, especially in the less eroded areas in the vicinity of Ngwo. Information from borehole show the sand to be sometimes as thick as 30-40m thick (Table 2).

Mining Activities in the Area

Enugu become famous for her richness in coal discovered by geological survey of 1909 conducted in the area. Following the opening of a colliery in Enugu in 1915, mining activities have been going on in the region till date. Several mines including the existing ones were opened primarily to tap the No. coal seam. Apart from this seam, 4 others are generally recognized within the Mamu formation (lower coal measure) which are numbered 1-5 in ascending order of sequence varying in thickness from about 5cm to a little over 2.5m.

The mining system used was the partial extraction method of 'pillar and shall' (Fig. 1). In this system, coal is mined by shafts and horizontal adits (a tunnel driven in by the hill side at such a level as to draw off water from the workings). This method is usually adopted for shallow seams of coal, and pillars of the coal are left to support the over-burden. A system of headings or roadways is driven into the seam usually at right angle to each other. The width of headings is such that the intermediate roof would not readily collapse and the pillars are of sufficient dimension to support the overlying surface. Ideally, on reaching the mine boundary, pillars should be extracted on the retreat to the shaft allowing the roof fall into the stall. This is not the case on Milken hill, instead large timber frames are installed the hold up the overburden.

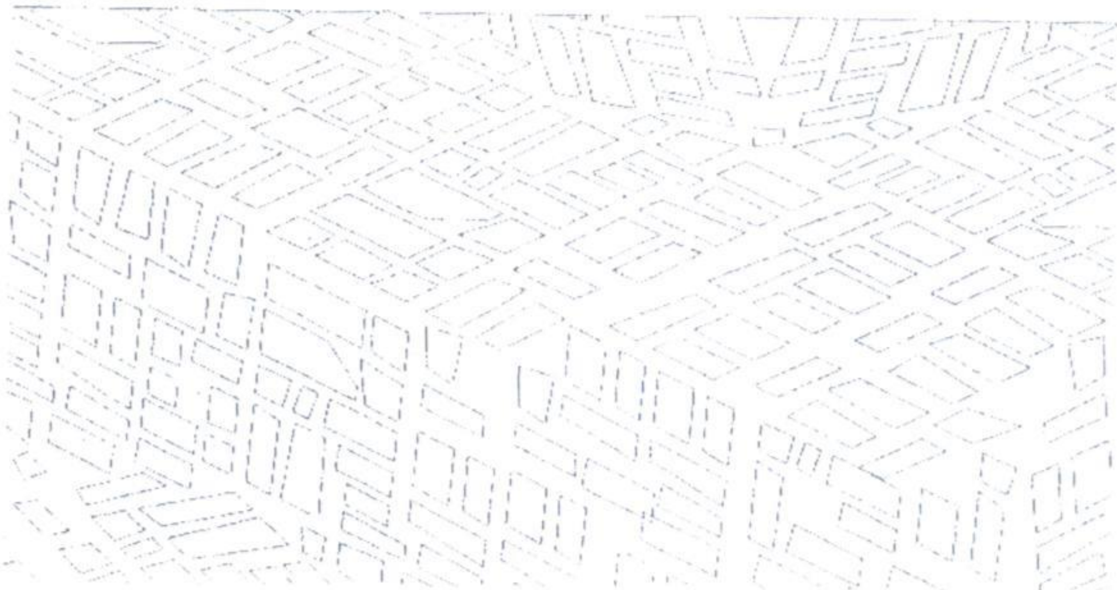

Fig 1. Stall and Pillar Working of Coal Seam

The deterioration of roof strategy may cause a collapse of the surface, but only after a great number of years, little can be done to determine the effect on the surface of surface structure. However, drilling programme will prove the extent of working and the associated pillars and on close examination would disclose their condition and thus their load bearing capacity.

To minimize mining hazards and increase productivity a mechanization plan was initiated in 1977. The 3 existing mines are fully mechanized. It is however, unfortunate that apart from the existing geological aspects of the area was carried out. Hence there is still the problem of hindered operation resulting from lack of information and block movement to a lesser extent. This is further aggravated by extensive blasting during mining operation which weakens the strength of the block within the shatter zone of fault area.

The net effect of the above explanation on the Milken which had been mined since 1938, is that is has a fairly hollow interior which makes construction in this region a very risky or in the least a very expensive proposition. In fact, the Nigerian Coal Corporation advises against any big schemes over the mine areas, including present express road from 9th mile corner to Enugu.

Problem Synopsis

From the foregoing review of some of the physical properties of the Milken hill, it is apparent that we face a very different problem with construction of any kind within this area. The delicacy of the problems would probably require that very expensive methods of construction be used. This may be so much so that the economic viability of the venture vis-a-vis the expected gains may be called to question.

The geology shows a very structurally weak soil of false-bedded (unconsolidated), sandstone up to 40m thick in some areas (Table 2). The soil is highly porous and the whole substructure unstable. As a consequence therefore, most construction in the area would require special foundations as Piles and Raft or Floatation foundations. These very expensive foundation types are usually recommended where weak soils constitute a set back to construction. But in the Milken hill with a hollow substructure this would even prove inadequate, showing the delicacy of the problem at hand. Also a consequence of the geology of the area is the generally highly credibility of the soil in the area. This phenomenon coupled with intense leaching of the soils due to its high porosity has rendered the place absolutely useless for all agricultural purposes. These problems are further encouraged by the very high rugged and steep nature of the terrain and sometimes result in subsidence. Any minor tampering of the natural drainage pattern of the removal of the hard concretional cap or vegetable that cover some parts of the area triggers off serious gullying.

Furthermore, it is very difficult to gain access into the area due to the very high elevation about 300 metres above Enugu general elevation and the scarp faces are almost vertical and consequently very difficult for the construction of accesses into the areas. The net effect of all these is that no land-use characterization could be adopted for the area. Human activities have not ventured into the area since it was first penetrated in 1909, hence the place has overgrown with forest which harbour many dangerous animals especially at the abandoned mine pits. This situation has currently constituted threat to lives of many people in some parts of the town.

Ecology and Designs

With the environmental problems man has had to face, he has attained a point where he is capable of manipulating and bending the natural environment to his will. The natural environment is not an abstract concern nor is it simply a matter of aesthetics or personal taste. Our very survival is directly related and is affected by the environment we live in. It depends on the continued healthy functioning of the natural system of earth.

Environmental deterioration is not a new phenomenon, but its rate and critical impact has risen sharply since the World War II. Rapid economic growth, scientific triumphs, increased urbanization, while all have brought benefits they have not been accompanied by sufficiently foresighted efforts to guide its development hence we very often find ourselves at variance with our natural environment.

Ecology deals with the intricate web of relationship between living organisms and their non-living surroundings. These (2) two interdependent parts make up the ecosystem. Changes in the system occur continuously as myriads of interactions lake place at every minute of the day as plants and animals respond to their surroundings and to each other. Evolution has produced for each species living and non-living, a genetic composition that limits how far each species can keep adjusting to sudden changes. But within these limits the thousand of species in an ecosystem continuously adjust to stimuli. Since the interactions are so numerous they form chains of reactions, small changes in one part is felt and eventually compensated for throughout the system. Disregard for this sensitivity of our natural environment can often have grave consequences.

Examples exist where a man has changed the course of nature and extinguished whole species. The Sahara desert was once the sile of the prosperous ancient African towns of Gao, Timbuktu, etc. with enviable life styles and nourishing trade. It was dis-used to its present slate and forestation programmes have been instituted to stop desert encroachment. Prehistoric animals like the dinosaur suffered the same fate. Also vividly evident is the well intentioned but poorly thought out construction of the Aswan dam in Egypt, built to generate electric power. It generated electricity but also reduced the fish population of the Mediterranean sea, markedly lowered the fertility of the Nile valley and introduced "Bilharzia", diseases that attacks potency in man (Stan Kawka, 1974).

The lesson here is not that activities be halted, but that the consequences of construction must be carefully studied in advance of construction. Planners and managers must begin to understand the enormous inter-related complexities of the environmental systems; weigh the trade offs of benefits of construction against potential environmental harm, look at the alternatives and incorporate safeguards into the basic design of new developments, which may be in the form of more elaborate scheme.

Summary

It is to the imminent future of the Milken Hill that this paper is directed against. What the actual problems are and what the elements that make up these problems will determine what the design solutions should be. It is however, often vague as to what constitute the essential elements, but a grasp of the problem scale and complexity should help eliminate some of these uncertainties and give inputs that may be used in future as design criteria within the area.

A comprehensive scheme which shall summarize the problems of the area in their entire ramification is called for lo serve as a design standard and guideline within which every work in this area should conform. This shall constitute the basis of all design concepts within the area. As a first step, control of the area must be secured and a coordinated programme of study instituted. An appropriate land-use characterization for the area should be adopted, based on the limitations of the area. A land-use characterization that will in the face of all the attendant problems highlighted, exploit the fullest potentials of the area without impairing the ecological equilibrium drastically. We will then evolve a design concept that shall be in direct response to the challenges of the area.

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Table 1: Nigerian Coal Coi poration Borehole Record Aniaiisiodo Project

Borehole No. Awha Ndiagu 1 (Ogbe) Location:
Drilled by: Nigerian coal cor poration Drilled for: NCC
Driller: S. Oji Logged by: Soremekun/lke

Date Commenced: 1-78 date completed 2-10-78

Date	**Core from**	**Core to**	**Recov. %**	**Core description**	**Remarks core diameter**
	0m	**3 m**	**-**	Brown laleritic soils	
	3	5	**-**	Yellowish brown laleritic soil	
	6	10	**70**	Black carbonaceous shale	
	10	13	t »	Black carbonaceous shale	
	13	16	c•>	Black carbonaceous shale	
	16	20	« *i*	Black carbonaceous shale	
	20	23	80	Black carbonaceous shale	
	23	**26**	80	Black carbonaceous shale gradually becoming coaly	
	26	26.2	85	Coal thin band 2m thick sub-bituminous	
	26.2	30	70	Carbonaceous shale poorly indurated	
	30	3-3	70	Carbonaceous shale	
	33	36	80	Carbonaceous shale	
	36	37	75	Coal l/2m thick sub-bit shale	
	37	**40**	60	Shale under coal gradually padding into fine gr. sst.	
	40	43		Alternation of sst. & carb. Shale	
	43.3	**46**		Carb. Sh. Grading into alternating sst & sh	
	46	50	Sludges Recovered Sludges Recovered	and sst. White fn. Gr. sst. Passing down into medium and cause gr.sst. grains are Subrounded-fairly well sorted Med. Gr. Subrounded white sst.	
	56	63		Med. Gr. Subrounded white sst.	
	63	66		While sst, ang. Coarse.	

Table 2: Borehole No. 1002-Bk 2 Loc. Col. Coord. N 380150 E.I., 818,336 Height above 134 ft Drilled November 1950-January 1951 by the Balakhany Black Sea Oil Co. for the Nigerian Coal Corporation Logged by O.P. Casey Open-Holding to 442ft, NX Coring 442-5ft, 7in, BX Coring 571ft,7in-632ft6in

	Thickn ft.	Thickn in.	Depth ft.	Depth in.
Sand,red	60	0	60	0
Gravel, fine	5	6	65	6
Sand, white	61	6	127	0
Sand, white	134	0	261	0
Clay, blue-grey	12	0	273	0
Sand, white, with shale chips and ironstone fragments	99	0	372	0
Sand, brown to white, with shale chips	70	0	442	0
Sandstone, brown to while, with grey and dark shale bands	20	2	426	2
Sandstone, with shaly and carbonaceous bands	30	0	490	2
Sandstone, white, hard with a few shale bands	16	10	509	0
Shale	1	0	510	0
Coal, shaly, No. 5 seam	22	0	512	0
Sandstone, white with shale bands	9	2	521	2
Shale	3	0	524	2
Sandstone, brown to white thin shale bands	18	6	542	8
Shale	4	0	546	8
Coal, No. 4 seam	2	6	549	2
Shale	1	9	550	11
Sandstone, with thin shaly and carbonaceous bands	20	10	571	9
Shale, partly sandy	5	1	576	10
Coal, No. 3 seam. Poor recovery, dirt band ground away	5	2	582	0
Shale	3	1	585	1
Sandstone, with thin carbonaceous streaks	33	5	618	6
Sandstone, white with carbonaceous streaks near base	14	0	632	6