COST ANALYSIS OF A PROPOSED FILL DAM IN MOUAU: COMPARISON OF THREE NEARBY LATERITIC DEPOSITS

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Abstract

The research work involves the comparative cost analysis of having construction soil from three different nearby lateritic deposits namely Amaoba, Isiala Ngwa North and Isiala Oboro represented as site A, B and C respectively in the study. This involves a moisture content and specific gravity test that necessitated the calculation of the void ratio for the three different sites. Furthermore, the in site swell factors were obtained as well as the transportation cost at required parameters, the real cost for each of the site were computed, it is discovered that site A is the most economical for the construction of the proposed dam at Michael Okpara University of Agriculture, Umudike (MOUAU) requiring one cubic metre of soil compacted to the void ratio of 0.8. The cost of hauling from site A is ₦869,560,289.80 giving a difference of ₦430,232,200.20 representing 49% cost difference with site B and a difference of ₦170,725,810.20 representing 20% difference with site C.

1.0 Introduction

Dams are among the oldest structures built by humans for collective use. A dam is a barrier constructed across a river or stream so as to hold back or impound water for public supply for drinking or irrigation, to control flooding, and to generate power. The main kinds of dams are earth fill, rock fill, concrete gravity, concrete arch, and arch gravity. The last three types are all made of concrete, reinforced concrete, or masonry. (Havelin, 2012).

Fill embankments are usually less expensive to construct than concrete dams. Soil or rock present at the site may be used as a construction material. The construction techniques, though complex, are also less costly than concrete dams. For the reasons of available materials, low cost, and stability with mass, fill dams are often built across broad water courses. They are more flexible than concrete structures and can deform without necessarily failing if foundation materials under the dam compress with the weight of the dam and the water (Arinze & Agunwaba, 2011).

This research work studied the cost analysis of earth material required for a proposed earth dam that requires one million cubic meters of soil compacted to a void ratio of 0.8. In this work, three lateritic deposits were considered, that is, Amaoba, Isiala Ngwa North and Isiala Oboro lateritic deposits having been confirmed by Arinze and Ibe (2015) as being a suitable material for fill dams.

2.0 Materials and Methods

The disturbed soil samples for the work were collected at the three lateritic deposits and labeled A, B, C for Amaoba, Isiala Ngwa North and Isiala Oboro respectively. The following tests required directly or indirectly for the cost determination were conducted.

a. **Specific Gravity Test:** The test was carried out in accordance with BS 1377 (1990) as governed by the relation.

$$\text{Specific gravity} = \frac{\text{Density of Soil Particles}}{\text{Density of water}} \quad - \quad - \quad - \quad (2.1)$$

b. **Moisture Content:** The test was carried out in accordance with BS 1377 (1990) as governed by the relation.

$$\text{Moisture Content (\%)} = \frac{W_w}{W_d} \times 100\%$$

Where,

Ww = Weight of water

Wd = Weight of dry soil

c. **Void Ratio (e):** defined as the ratio of the volume of voids to the volume of solids or

$$e = \frac{V_v}{V_s} \quad \text{(Das, 2005)}$$

In this case the dry unit weight (γ_d) is first calculated using the relation

$$\gamma_d = \frac{W_s}{V}$$

Ws = dry weight soil

V = total volume of soil

Then the void ratio is calculated using the equation

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1 \quad - \quad - \quad - \quad - \quad - \quad - \quad (2.5)$$

Where,
Gs is the specific gravity obtained from specific gravity test stated in section 2 (a)
γ_w unit weight of water (9.81KN/m^3)
γ_d is the dry unit weight of soil obtained from equation 2.4 (Budhu, 2011).

d. **Swell Factors (SF):** is the ratio of excavated material to the volume of in situ material:

$$SF = \frac{\text{Volume of excavated material}}{\text{Volume of in situ material}} \times 100 \quad - \quad - \quad - \quad (2.6)$$

e. **Cost per metre cube:** The costs of transporting laterite from each deposit were determined after thorough investigation with various transporting companies.

3.0 Results, Computation and Discussion

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Table 1 shows the summary of the test results. The values represent the average for the replicates of each sample tested.

Borrow Pit	Void ratio	Swell factor	Transportation Cost (₦/m^3)
A	0.55	1.03	₦ 980.40
B	0.57	1.14	₦ 1307.20
C	0.53	1.07	₦ 1143.80

Where ₦ is the Nigerian currency. Currently, $1 = ₦ 199.05.

Let V_o, e_o be the specific volume and void ratio of the compacted soil in the dam and V_i, e_i be the specific volume and void ratio of the soil from the borrow pits where

i = A, B, C. Now,

ViVo = 1+ei1+ eo - - - - - - - - (3.1)

Vi= Vo(1+ei1+ e0)= 1 x 1061+0.8(1+ ei) - - - - (3.2)

To determine the volume of soil from each borrow pit. Substitute the void ratio from table 1 into equation 3.1 and multiplying by the swell factor (Budhu, 2011).

VA= 1 x 1061+0.8(1+0.55) x 1.03=886,944.4m3

VB= 1 x 1061+0.8(1+0.57) x 1.14=994,333.3m3

VC= 1 x 1061+0.8(1+0.53) x 1.07=909,500.0m3

Therefore, the transportation cost for each site.

VA (₦) = 886,944.4 x 980.40 = ₦ 869,560,289.8

VB (₦) = 994,333.3 x 1307.2 = ₦ 1,299,792,490.0

VC (₦) = 886,944.4 x 980.40 = ₦ 1,040,286,100.0

The cost obtained shows that it would be economical to haul laterite from site A, followed by Site C, implying that it would be most expensive to haul from site B.

4.0 Conclusion

The derivation and the calculations shows that the void ratio and swell factor affect the final volume after compaction and therefore must be checked before cost analysis for dams as well as highways are done.

For the proposed one million cubic meters dam compacted to void ratio of 0.8, Amaoba lateritic deposit is the most economical to use.

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