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Analysis of the Method of Erosion Control on Highway Construction in Sapele Road, Benin City, Edo State, Nigeria, using Pearson Product Moment Correlation Coefficient

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Abstract

This study is on Analysis of the method of erosion control on highway construction. The Pearson product moment correlation coefficient (Pearson r) was used to analysis the results. A total of twenty-two (22) question were carefully and scientifically developed from the method of erosion control on highway construction. A total of one hundred questionnaires were distributed to staffs in the Ministry of Infrastructure, Benin City (Sapele road) and surrounding residents. reliability tests of the experiment was done from the data gotten from questionnaires distributed to staffs (X) and residents (y). From the results and data analysed the Erosion level measure shows that the erosion existing in Benin City is very high, there is exists a strong correlation between the responses from employers and those residential quarter form the questionnaire analysed, the valve of r= 1.5 from the pearson correlation coefficient showing a strong correlation between the respondents. from the results of the study from the pearson product moment correlation value (r = 1.5),confirming that exist a strong correction between the response of the employees and residents. The findings of the research showed that erosion causes a lot of damage to highway construction, also long duration of rainfall was also an issue, recommendation was drawn, there should be government regulations to employ the cleaning of drainage by enforcing a series of rules and laws to govern it. Lastly proper supervision of highway and drainage construction to reduce collapse of pavement.

1. Introduction

Highway construction and maintenance can be significantly impacted by the natural process of erosion. Effective erosion controls and procedures should be taken into account for highway construction projects since erosion can really harm drainage systems, road surfaces, and other infrastructure, necessitating expensive repairs and delays. [1]. Erosion is a natural process; however, human activity has caused it to occur at a rate that is 10 to 40 times faster than it used to. Excessive (or fast) erosion causes issues both "on-site" and "off-site". The loss of the higher soil layers that are rich in nutrients can have immediate impacts such as decreased agricultural productivity and, in natural settings, ecological collapse. [2].

soil erosion is the process through which a lower soil layer becomes exposed and is carried by agents of denudation, leaving a topographic roughness on the ensuing terrain. [3].

Islam study was conducted on the effects of vetiver grass on eighteen coastal polders spanning eighty-seven kilometres of Bangladesh's earthen coastal embankment between September 2000 and October 2001. Islam noted that water-borne erosion from wave action, surface runoff, or both is the primary issue in maintaining those earthen embankments. Vegetable grass performance is also impacted by human and animal intervention, seasonal variations in soil moisture content, and characteristics of the shore, such as shifting sea levels, salinity, danger of being washed away by cyclones or tidal surges, etc. For improved performance, he gave certain application guidelines for vetiver. In situations where initial protection and watering could be guaranteed, he was successful. [4]. A strategy was employed using ground modification to improve the soil in order to reduce erosion caused by submerging water. Polyhedral Oligomeric Silsesquioxanes (POSS) and vetiver plant were employed as ground modifiers in this experiment, and the results demonstrated the efficacy of both POSS and vetiver in decreasing erosion. However, vetiver demonstrated a greater resistance to erosion caused by submerging water, although it took longer for a well-established root/stem system to form. [5].

Rahman et al, conducted an experiment with vetiver grass in Bangladesh. The survey gathers data on the morphological variation, ecological distribution, and applications of vetiver grass. By using DNA fingerprinting and microscopical study of flowering material, they were able to identify only one species of vetiver, Vetiveria zizanioides, out of the vetiver grass they collected from several regions in Bangladesh.Rahman et al, discovered that it could propagate through seeds and could withstand submersion for three to four months each year during the monsoon. They also discovered that salty environments are inhospitable to vetiver grass. They demonstrated the diverse socio-economic, cultural, and other applications of vetiver grass in Bangladesh, including its usage as a soil stabilizer, fuel for firewood, thatch and roofing materials, fodder, and raw materials for cottage industries. It was proposed that vetiver grass be utilized to stabilize waste land, protect roadways, irrigation channels, and water dams, as well as be a component of manufactured goods like paper and perfume.[6].

2. Methodology

2.1 Area of Study

The Benin City roadways and surrounding region, which are under the jurisdiction of the Ministry of Infrastructure in Sapele Road Benin City and the Environments are the subject of this research study. The capital of Edo State is Benin City. The Benin River is roughly 40 kilometres (25 mi) north of it. The city, which has a total land area of 1,204 km² (2,500/sq mi), is rapidly developing. Oredo's local government region was the main emphasis, below is the map showing various location or streets

Figure 1: Showing the map of Benin City (Sapele Road) (source: Goggle Earth)

2.2 Sampling and Sampling Techniques

The sampling which comprises of one hundred respondent that are government workers and those close to the area. One hundred respondents of people living the area of the study were derived from the populations. In orders to get this population different work place and people close to those area chosen at random and given questionnaires to respond to the research question raised. The samples was also considered an adequately sourced which highlighted below.[7].

Table 1 Showing the breakdown of respondents

NUMBER OF RESPONDENTS	QUESTIONNAIRES	PERCENTAGE
GOVERNMENT WORKER	60	60%
Residents	40	40%
TOTAL	100	100

2.3 Data collection

2.3.1. The Use of Questionnaires

The research was a quasi-experimental descriptive survey, aimed at eliciting opinions of government people and people that are involved in the area of study in its environs within the Sapele Road, Benin City. The design was used to obtained relevant information on the research work.

2.3.2 Population of the Study

The population comprised of 100 (one hundred) people in the study area. 60 (sixty) people which were government workers was used for the study while the other 40 (fourty) people are peoples that lives in the environment/area within the state.

2.3.3 Instrument of the Study

Two sets of questionnaires formed the movement of the study. One of the questionnaires, which collected data from the government workers, had thirty (30) items focused on collecting data on the 10 (Ten) research questions. The other questionnaires which collected data from people that lives in the area of study, had thirty (30) items focus on collecting Ten (10) research questions as well. Items in the questionnaires have a structure response pattern of **:**

i. Strongly agree (SA)
ii. Agree (A)
iii. Undecided (U)
iv. Disagree (D)
v. Strongly Disagree (SD)

2.3.4 Method of Data Analysis

In analysis the data, the researchers will made use of mean scores to answer the research question that guided the study. In doing this a cut-off mean score of 3 and above will be regarded as constituting a problem while a mean score of less than 3 will be regarded as not being a problem will be given the following value by the researchers.

i.	Strongly Agree	(SA)	5 values
ii.	Agree	(A)	4 values
iii.	Undecided	(U)	3 values
iv.	Disagree	(D)	2 values
v.	Strongly Disagree	(SD)	1 value

With the formula $\bar{x} = \frac{Efx}{N}$ the mean was calculated

Where $\bar{x}$ = mean
E = frequency of observation
X = individual occurrence
N = Sample number

Decision Rule: The cut-off point was established by the mean score, which was 3.0. Any responsible mean that was equal to or higher than 3.0 was acknowledged as agreed upon, while responses below 3.0 were considered disagreed.
A total of one hundred questionnaire were distributed. In order to determine the Pearson product moment correlation coefficient (Pearson r), the questionnaires were gathered, and the means of each of the twenty-two (22) questions were meticulously computed and entered into a table.

X = X-Y = deviation from the mean of X and Y scores
Y = Y-X
Thus, $\frac{\sum x}{n}$ n = number of variables
Y = $\frac{\sum x}{n}$

After the tables have seen formulated the Pearson r co-efficient is calculated using,

$$r = \frac{\sum x}{\sqrt{(\sum x^2)(\sum y^2)}} \quad \text{---------- (1)}$$

If X and Y require decimals or fractions on average, then X and Y will also involve fractions. The raw score or machine formula approach is used to avoid the complications and early approximations associated with multiplying decimals by decimals.

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)\ (n\sum y^2 - (\sum y)^2)}} \quad \text{----------(2)}$$

2.3.5 Computation of correlation coefficients

The Pearson product moment correlation coefficient, or Pearson r, was employed in this study. To determine whether or not the study questions reflect a problem for more investigation, the Pearson r coefficient was required. When the distribution is bivariate, continuous, and normal (or nearly so), but the scores of the individuals involved in each variable are ranked in order magnitude, Pearson (r) is used.

It is employed to ascertain whether there is a positive or negative relationship between the variables. Its values span from perfect negative to perfect positive correlation, or -1 to +1. Positive association if r > 0.R < 0 indicates a bad relationship r = 0: no connection

Table 2: Correlation values ranges. [8]

Ranges	Strength of relationship
-1 to -0.5 or 1.5 to 0.5	Strong
-0.5 to -0.3 or 0.3 to 0.5	Moderate
-0.3 to -0.1 or 0.3 to 0.1	Weak
-0.1 to 0.1	None or very weak

As a result, the computations make use of the generated ranks.
From the problems, a total of twenty-two (22) questions were thoughtfully and scientifically generated. The questionnaires that were issued in the southern Nigerian state of Edo were based on this question (Ministry of Infrastructure). One hundred surveys in all were given out to the citizens, Edo state, and Ministry of Infrastructure. Two groups were created from the questionnaires.

i. Worker-marked erosion crisis questionnaires (X)
ii. Resident-marked erosion crisis questionnaires (Y)

3. Results and Discussion

3.1 Test of Reliability of the Experiment

The reliability coefficient of the experiment is determined using Pearson product moment correlation(r)

Table 3: where X represent workers and Y represent resident

S/N	Description of Questions	X	Y	XY	X^2	Y^2
1	Does Erosion have effect on highway construction	5	4	20	25	16
2	Are there ways to control Erosion on highway construction	4	3	12	16	9
3	Are there damages causes by Erosion on highway construction	5	4	20	25	16
4	Long duration of rainfall causes flood and erosion	4	4	16	16	16
5	Construction of storm drainage suitable to control erosion	5	3	15	25	9
6	Proper urban planning suitable to control erosion	5	4	20	25	16
7	Planting of grass along the shoulder suitable to control erosion	3	3	9	9	9
8	Planting of tress suitable to control erosion on the highway	3	4	12	9	16
9	Reduction in Population growth/urbanization can control erosion	4	3	12	16	9
10	Government policies control erosion	4	4	16	16	16
11	Construction of flood diversion Dams control erosion	5	4	20	25	16
12	The kind of damage erosion has on highway construction, is structural	4	4	16	16	16
13	Regulating cleaning of drainage control erosion	4	3	12	16	9
14	Mode of construction of drainage can lead to control of erosion.	4	4	16	16	16
15	Close supervision of construction works can control erosion	4	3	12	16	16
16	Proper construction, monitoring and maintenance of drainages can control erosion	4	4	16	16	16
17	Adequate project plaining and design can control erosion	4	4	16	16	16
18	Prevention of free flow of surface water can cause erosion	4	3	12	16	9
19	Installing energy dissipater can control erosion	3	4	12	9	16
20	Adequate funding by government	3	3	9	9	9
21	Reforestation	3	4	12	9	16
22	Stabilization of slope	4	4	16	`16	16
Total		88	80	337	362	303

$$\sum x = 88 \sum y = 80 \sum xy = 337 \sum x^2 = 362 \sum y^2 = 303 \quad n = 22$$

Thus, mean = X = $\frac{\sum x}{n} = \frac{88}{22} = 4.0$

Y = $\frac{\sum y}{n} = \frac{80}{22} = 3.6$

Since X and Y in the example above used fractions on average, X and Y will also involve fractions. The raw score or machine formula technique is used in order to do away with the strictness of multiplying decimals and early approximation.

Raw Score or Machine Formula

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)\ (n\sum y^2 - (\sum y)^2)}}$$

$$r = \frac{22X\ 337 - (88\ X\ 80)}{\sqrt{(22X\ 362 - 88^2)\ (22X\ 303 - \ 80^2}}$$

$$r = \frac{7414 - 7040}{\sqrt{(7964 - 7744)\ (6666 - 6400)}}$$

$$r = \frac{374}{\sqrt{(220\ X\ 266)}}$$

$$r = \frac{374}{\sqrt{58520}}$$

$$r = \frac{374}{241.909} = 1.5$$

$$r = 1.5$$

From the Pearson product moment correlation value (r = 1.5), confirming that there exists a strong correction between the response of the employees and residents

4.0 Conclusion

From the results of this study the researcher concluded that, Erosion level measure shows that the erosion existing in Benin City is very high because of the strong and positive correlation valve. People are also over exposed to erosion crisis in their various occupation at works place. There exists a strong correlation between the responses employers and those residential quarter form the questionnaire analyzed. A strong connection between the respondents was indicated by the Pearson moment correlation (r) analysis of the questionnaire data, which came out at r =1.5. From the results obtained above people are over exposed to erosion crisis in their various occupation work space, erosion in the study was caused by high rainfall, lack of proper urban planning, lack of drainage facilities, lack of regulating laws in cleaning drainage which has contributed greatly during constructions.

4.1 Recommendation

Also from the above data gotten from the questionnaire, recommendation were drawn which are: there should proper construction of storm drainage, proper urban plaining, planting of grass along the shoulder of the highway, reduction in population growth and urbanization, construction of dams, Government should regulate the cleaning of drainage system, proper, monitor and maintenance of drainage, adequate funding by government in the construction works.

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Appendix

A questionnaire titled **"Analysis of the method of erosion control on highway construction in Benin City (Sapele Road)"**

Instruction: Please check (√) the appropriate boxes in the spaces below.

Agree (A), Strongly Disagree (SD), Disagree (D), Undecided (U), and Strongly Agree (SA)

SECTION A

Male ( ), Female ( ) Marital

Marital Status: Married ( ), single ( )

Age Status: 18-25 ( ), 26 – 33 ( ), 34 – 41 ( ), 42-49 ( ), 50-57( )

Educational background: Phd ( ), Msc ( ), Bsc ( ), HND ( ), OND ( ), Others ( )

Status: Engineer ( ), Assistant Engineer ( ), Technologist ( ), Technician ( ), Craftsmen ( ), Others ( )

SECTION B

S/N	Questions	SA	A	U	D	SD
1	Erosion have effect on highway construction					
2	Are there ways to control Erosion on highway construction					
3	Are there damages causes by Erosion on highway construction					
4	Long duration of rainfall causes flood and erosion					
5	Construction of storm drainage suitable to control erosion					
6	Proper urban planning suitable to control erosion					
7	Planting of grass along the shoulder suitable to control erosion					
8	Planting of tress suitable to control erosion on the highway					
9	Reduction in Population growth/urbanization can control erosion					
10	Government policies control erosion					
11	Construction of flood diversion Dams control erosion					
12	The kind of damage erosion has on highway construction, is structural					
13	Regulating cleaning of drainage control erosion					
14	Mode of construction of drainage can lead to control of erosion.					
15	Close supervision of construction works					
16	Proper construction, monitoring and maintenance					
17	Adequate project plaining and design					
18	Prevention of free flow of surface water					
19	Installing energy dissipater					
20	Adequate funding by government					
21	Reforestation					
22	Stabilization of slope					