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STABILIZATION OF EXPANSIVE SOIL USING WATER HYACINTH ASH

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Abstract - *Strength of soil is an important criterion while constructing a structure over it. Expansive soils are soils that have low strength and bearing capacity. This project focuses on stabilizing the expansive soil in Kuttanad region. Weakness of soil in this region is hazardous to both the agricultural and domestic life of people residing there. In this project the stabilization is done using an easily available and cost-effective material, water hyacinth ash. Water hyacinth, being a threat to the water bodies, is made to ash and used to treat the soil to increase its stability. The soil will be treated using WHA (0.25%,0.5%,0.75%,1%,1.25% & 1.5%). Optimum percentage of WHA will be determined by comparing the result of UCC test. To determine the effect of curing on the material tests will be conducted on soil treated with optimum percentage of WHA after curing it for 3&7 days.*

Key Words: Water Hyacinth Ash, stabilization, economic material, Kuttanad, Optimum moisture content

1.INTRODUCTION

Construction is a necessary activity in today's world, but suitable land for construction is limited. Soil plays a crucial role in determining the feasibility of building structures in a particular area. Some natural soil deposits are suitable for construction, while others require treatment due to their problematic nature. Soil stabilization is the process of improving soil properties to make it capable of sustaining the loads imposed by structures. This field has seen continuous development and changes over time, with a growing emphasis on environmental sustainability.

To achieve sustainable soil stabilization, recycled materials have been introduced. Construction and demolition waste, as well as broken brick powder, are being reused for stabilization purposes. Additionally, plastic waste, which poses significant environmental challenges, can be recycled and employed for soil stabilization, benefiting both soil properties and reducing plastic waste problems. Water hyacinth, an invasive weed causing transportation difficulties and disrupting aquatic ecosystems, can be converted into ash and utilized for stabilization, representing a new sustainable approach in soil stabilization

1.1 SOIL IN KUTTANADU

Expansive soils can shrink, swell, and change in volume due to moisture variations. They contain clay minerals like smectite or vermiculite that absorb water and expand when wet, leading to structural heaving. Conversely, when they dry out, they contract, causing differential settlement. These soils are weak and have significant engineering drawbacks, necessitating soil treatment prior to construction. In the Kuttanad region, the main issue caused by expansive soil is bund breaching, resulting in agricultural losses and flooding.

1.2 Soil stabilization

Soil stabilization transforms soil properties for long-term strength gains. It involves increasing shear strength and bearing capacity, forming a solid monolith that reduces permeability, shrink/swell potential, and freeze/thaw damage. Expansive soils can expand by up to 10%, causing significant structural harm. Stabilization eliminates the need for costly removal and replacement by improving soil in situ. Chemical methods, such as lime or Portland cement, form permanent bonds between soil particles. Pre-project testing ensures sufficient material for permanent floor stabilization. Various materials are used for soil stabilization.

2. METHODOLOGY

2.1 General

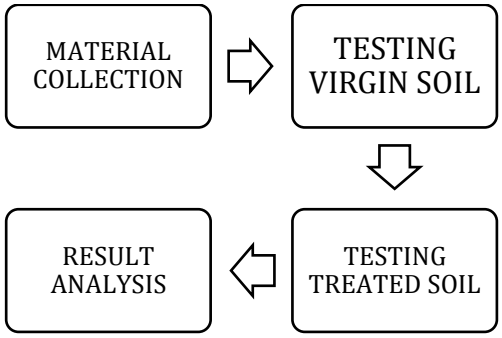

Fig 1: Flowchart illustrating methodology of the project

The purpose of this study is to put forward a stabilization method for soil in kuttanad region. Here stabilization will

be done by treating the soil with water hyacinth ash. By doing so,the pollution caused by water hyacinth, which is an unwanted weed in water bodies can be reduced First the basic properties of the soil collected will be determined using some tests. Thus, the characteristics of the soil in that region can be determined. Then ucc tets will be used to determine the effect of WHA on the strength of soil. Effect of curing on the material will also be studied. The tests that will be conducted are:

- Hydrometer Analysis - IS-3104:1965
- Specific Gravity test – IS 2720(Part III)-1980
- Atterberg Limit test – IS 2720 (Part V)-1985
- Standard proctor test – IS 2720 (Part VII)- 1974
- Unconfined Compressive Strength test – IS 2720 (Part II)-1973
- California Bearing Ratio test – IS:2720 (Part XVI):1987

2.2 Materials used

2.2.1 Water hyacinth ash

Water hyacinth is a weed which grows in water bodies. It is now invading almost all water bodies in Kerala. It is very harmful for aquatic life and is also causing transportation problems in water bodies. It can be dried and burnt to ashes. These ashes contain main compounds which are beneficial for stabilization of soil. From various studies conducted it turned out to be water Hyacinth ash contains calcite, quartz, Zeolite etc. These materials have a good binding property. So, it is good to use it for stabilizing the weak expansive soil.

Fig 2 : Water hyacinth ash

2.2.2 Expansive soil

The clayey soil was collected from Kuttanad taluk, Alappuzha district, Kerala. The soil founded is expansive soil, that is it will show high shrinkage and swelling. this soil has very low strength, and all the engineering properties required for construction is very low. Instability of this soil is the main reason for bund breaching in the agricultural fields of Kuttanad**.**

Fig 3: Collected soil

2.3 Preparation of testing soil

Soil sample collected will be mixed with water hyacinth ash. Water hyacinth ash is made by burning the sun-dried water hyacinth plant collected from nearby water bodies. Percentages of WHA that will be added to the soil are 0.25%, 0.5%,0.75%, 1%, 1.25%& 1.5%

3. BASIC PROPERTIES OF VIRGIN SOIL

- Hydrometer Analysis

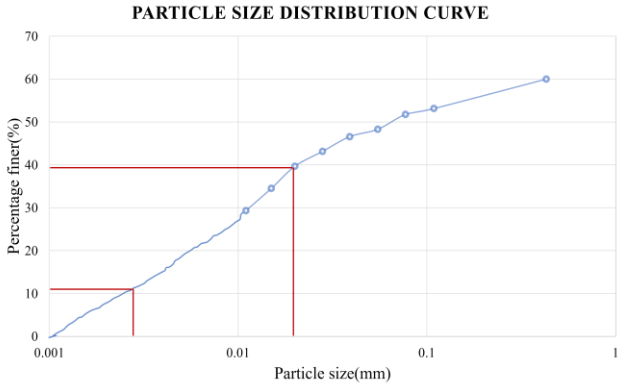

Chart 1: Particle distribution curve

- Liquid limit

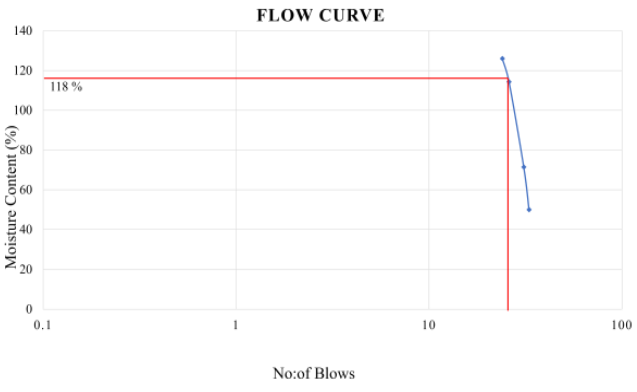

Chart 2: Flow Curve

- Standard proctor test

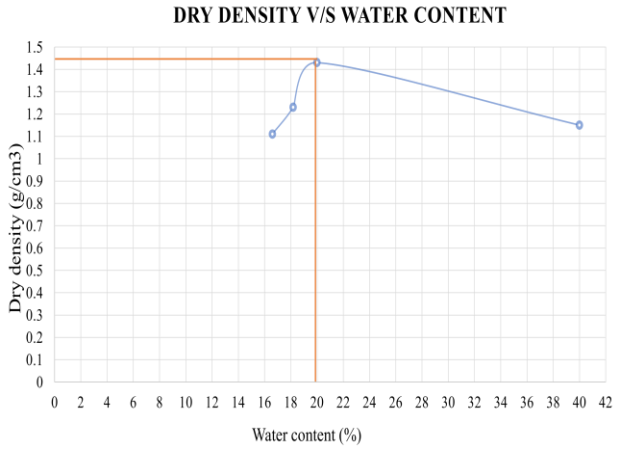

Chart 3: Dry density V/S Water content

- California Bearing Ratio test

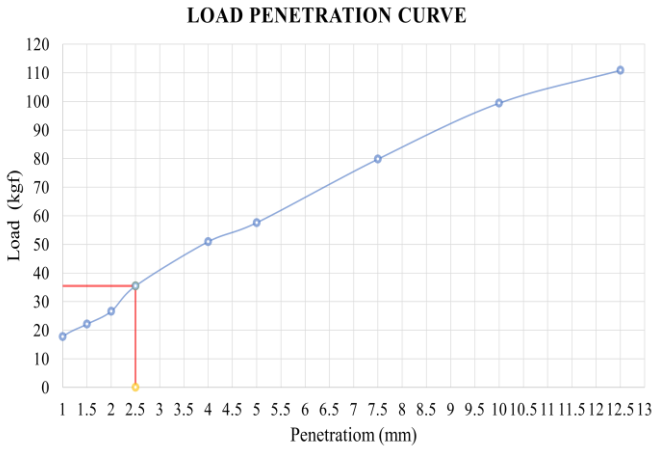

Chart 4: Load penetration curve

Table 1: Basic properties of virgin soil

PROPERTIES	RESULT
Percentage of silt Particles	39.5%
Percentage of clay Particles	12%
Specific gravity	1.3
Liquid limit	118%
Plastic limit	39.9%
Optimum moisture content	1.43g/cc
Max dry density	20%
CBR value	2.8

4. TESTS ON TREATED SOIL

Soil treated with different percentages of WHA and their corresponding unconfined compressive strength value is given below

Table 2: Tests on treated soil

WHA (%)	Unconfined compressive strength (KPa)
0.25	3.6
0.5	4
0.75	4.5
1	5.4
1.25	5
1.5	4.1

Thus the optimum percentage of water hyacinth ash obtained is 1%

5. EFFECT OF CURING

The max value of OMC was obtained when cured for 3 days, the max value of compressive strength was obtained for uncured soil, the max CBR value was obtained for soil cured for 3 days

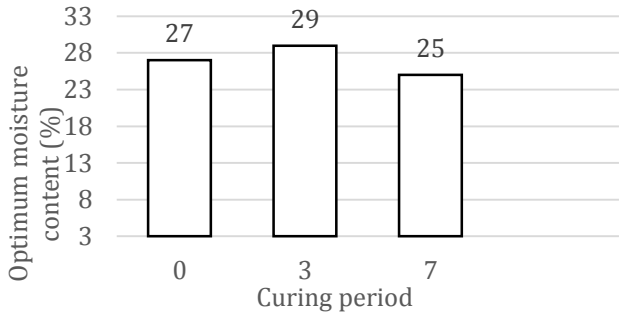

Chart 5: Efeect of curing on optimum moisture content

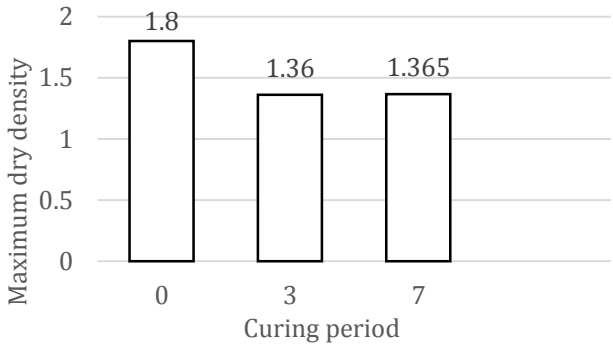

Chart 6: Effect of curing on maximum dry density

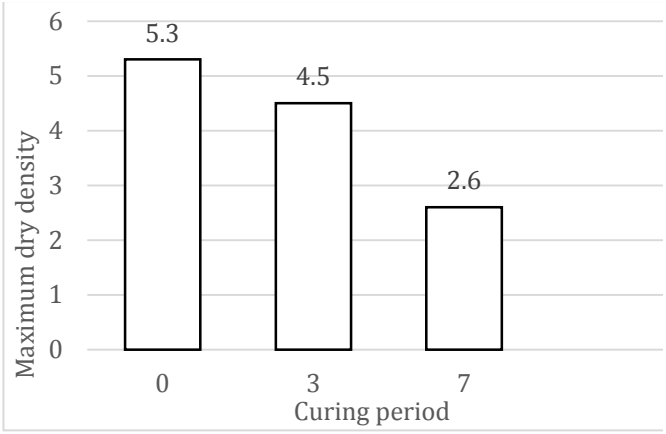

Chart 3: Effect of curing on unconfined compressive strength

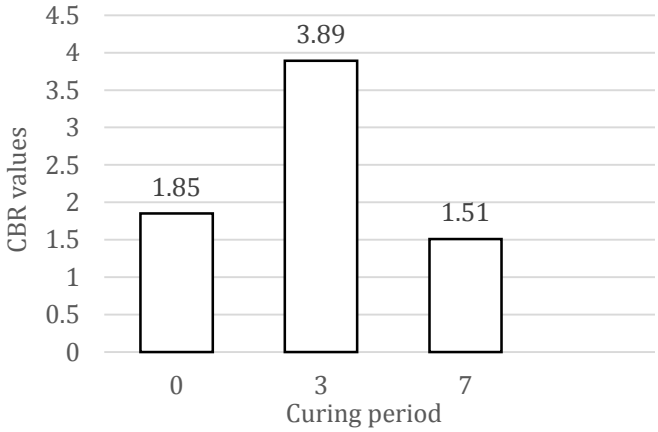

Chart 7: Effect of curing on California bearing ratio

6. CONCLUSION

- Kuttanad region consists of clayey soil which has very low strength.
- Stabilization of Kuttanad soil is necessary before using it for any kind of construction purpose.
- Study focuses on stabilizing the Kuttanad soil using water hyacinth ash.
- The maximum compressive strength was obtained as 1.8 KPa when 1% of water hyacinth ash was added.
- The percentage increase in compressive strength for 1% water hyacinth ash was found out to be 50%

The results of certain tests also indicated that soil qualities are affected by curing.

- The max value of OMC was obtained when cured for 3 days.
- The max value of dry density was obtained for uncured soil.
- The maximum compressive strength was obtained for uncured soil which implies curing is not favored in great strength applications.
- Max CBR value is obtained for 3 day cured soil, which suggests that 3 days of curing is required for strong subsoil strength.

Thus, it is clear that strength of clayey soils like Kuttanadan soil can be increased by treating it with pozzolanic materials like water hyacinth ash. Water hyacinth ash is only an example of one such material. But curing of this treated soil can only be proposed as per the requirement. If the requirement needs good sub soil strength like road construction, then curing is preferred. But in case of application which need good compressive strength like bund construction then uncured soil is preferred

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