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Research Article

STABILISATION OF SOIL BY NAOH AND SISAL FIBRE: AN EXPERIMENTAL STUDY

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ABSTRACT:
Stabilisation is a process that is often used to enhance the engineering features that soft soils (clay soils or cohesive soils) typically display. These attributes include low strength, swelling and shrinkage characteristics, etc., and the most frequent way that these properties are improved is by stabilisation. In this study, an effort was made to determine whether or not soft soil that had been mixed with an alkaline solution was efficient in stabilising soil. It not only offers a solution for the correct utilisation of alkaline solution but also offers a substance that makes an excellent subgrade for the building of pavement.The use of natural fibre in civil engineering to improve the qualities of the soil is favourable since natural fibres are inexpensive, readily accessible in the area, and kind to the environment. Shear strength, load bearing capacity, and other engineering features of the soil all see considerable improvements as a result of the natural fibre reinforcement. The usage of naturally occurring, artificially created, and synthetically produced fibre in a random distribution has seen a significant rise during the last ten years. With this in mind, an experimental investigation was carried out using the soil that was readily accessible in the area, which had Sisal fibre added to it. In this particular investigation, the soil samples were produced in the CBR mould at their maximum dry density, which corresponded to their optimal moisture content. The mould was either reinforced or left unreinforced. It was determined that the ideal level of sisal fibre content in the soil included 0.2 percent, 0.4 percent, 0.6 percent, 0.8 percent, 1.0 percent, 1.2 percent, 1.4 percent, 1.6 percent, 1.8 percent, 2.0 percent, 3.0 percent, 4.5 percent, and 7 percent respectively. In the current investigation, the length of the fibre was determined to be 30 millimetres. The results of the testing helped inform the decision to go with this length. The laboratory CBR values of soil that had been reinforced with sisal fibre and a chemical compound at various percentages were measured, and the effects of the proportion of fibre and chemical on the CBR value, UCC value, and shear value of the soil were also explored. Sisal fibre is a substance that may be broken down by natural processes. Therefore, in order to increase its longevity, it is required to apply an agent such as turpentine oil or linseed oil. Both of these oils have similar effects.In conclusion, this study provides a notation on the optimal percentage of fibre and Chemical compound to achieve the good results. It also provides a comparison between normal soil, reinforced soil, chemically stabilised soil, and chemically stabilised and reinforced soil. Additionally, it provides a brief information of the behaviour of stress in soil both before and after the addition of the chemical and fibre.

1.INTRODUCTION

1.1.1 SOIL STABILIZATION:

In the broadest faculty it refers to the procedures active with a appearance to altering one or added backdrop of a clay so as to advance its engineering performance.

Soil Stabilization is alone one of several techniques accessible to the geotechnical architect and its best for any bearings should be fabricated alone afterwards a allegory with added techniques indicates it to be the best band-aid to the problem. It is a able-bodied accepted actuality that, every anatomy accept to blow aloft clay or be fabricated of soil. It would be ideal to acquisition a clay at a accurate website to be satisfactory for the advised use as it exists in nature, but unfortunately, such a affair is of attenuate occurrence. The alternatives accessible to a geotechnical engineer, if an unsatisfactory clay is met with, are (i) to bypass the bad clay (e.g., use of piles), (ii) to abolish bad clay and adapt with acceptable one (e.g., abatement of peat at a website and backup with called material), (iii) redesign the anatomy (e.g., amphibian foundation on a compressible layer), and (iv) to amusement the clay to advance its properties. The endure another is termed clay stabilization. Although assertive techniques of stabilization are of a about contempt origin, the art itself is actual old. The aboriginal cold of clay stabilization was, as the name implies, to access the backbone or adherence of soil. However, techniques accept now been developed to adapt about every engineering acreage of soil. The primary aim may be to adapt the backbone and/or to abate its acuteness to damp changes. The lot of accepted appliance of clay stabilization is the deepening of the clay componentsof artery and aerodrome pavements.

Classification of the methods of stabilization

A absolutely constant allocation of clay stabilization techniques is difficult. Classifications may be based on the analysis accustomed to soil, on additives used, or on the action involved. Broadly speaking, clay stabilization procedures may be brought beneath the afterward two heads:

I. Stabilization after additives

II. Stabilization with additives

Stabilization after additives may be 'mechanical'—rearrangement of particles through compaction or accession or abatement of clay particles.

It may be by 'drainage'—drainage may be accomplished by the accession of alien load, by pumping, by electro—osmosis, or by appliance of a thermal gradient—heating or cooling.

Stabilization with additives may be adhesive stabilization (that is, clay cement), bitumen stabilization, or actinic stabilization (with fly ash, lime, calcium or sodium chloride, sodium silicate, dispersants, physic-chemical about-face involving ion-exchange in clay-minerals or bang stabilization by grouting with soil, adhesive or chemicals). The adapted adjustment for a accustomed bearings accept to be called by the geotechnical architect based on his acquaintance and knowledge. Comparative class tests followed by bound acreage tests, should be acclimated to baldest the lot of economical adjustment that will serve the accurate botheration on hand. Field-performance abstracts may advice in analytic agnate problems which appear in future.It accept to be remembered, however, that clay stabilization is not consistently the best band-aid to a problem

Stabilization without additives

Some kind of treatment is given to the soil in this approach; no additives are used. The treatment may involve a mechanical process like compaction and a change of gradation by addition or removal of soil particles or processes for drainage of soil.

I. Stabilization with additives

Stabilization of adobe with some affectionate of accretion is actual common. The approach and amount of alternation all-important depend on the attributes of the adobe and its deficiencies. If added backbone is appropriate in the case of cohesion less soil, a cementing or a bounden abettor may be added and if the adobe is cohesive, the backbone can be added by authoritative it moisture-resistant, altering the captivated baptize films, accretion accord with a adhesive abettor and abacus centralized friction. Compressibility of a adobe adobe can be bargain by cementing the grains with a adamant actual or by altering the armament of the adsorbed baptize films on the adobe minerals. Swelling and abbreviating may aswell be bargain by cementing, altering the baptize adsorbing accommodation of the adobe mineral and by authoritative it moisture-resistant. Permeability of a cohesion less adobe may be bargain by bushing the voids with an impervious actual or by preventing flocculation by altering the anatomy of the adsorbed baptize on the adobe mineral; it may be added by removing the fines or modifying the anatomy to an aggregated one.

A satisfactory accretion for adobe stabilization accept to accommodate the adapted qualities and, in addition, accept to accommodated the afterward requirements: Compact ability with the adobe material, permanency, simple administration and processing, and low cost.

Many additives accept been active but with capricious degrees of success. No actual has been beginto accommodated all the requirements, and a lot of the abstracts are expensive.

The various additives used fall under the following categories:

(i) Cementing materials: Increase in strength of the soil is achieved by the cementing action of the additive. Portland cement, line, fly-ash and sodium silicate are examples of such additives.

(ii) Water-proofers: Bituminous materials prevent absorption of moisture. These may be used if the natural moisture content of the soil is adequate for providing the necessary strength. Some resins also fall in this category, but are very expensive.

(iii) Water-retainers: Calcium chloride and sodium chloride are examples of this category.

(iv) Water-repellents or retarders: Certain organic compounds such as stearates and silicones tend to get absorbed by the clay particles in preference to water. Thus, they tend to keep off water from the soil.

(v) Modifiers and other miscellaneous agents: Certain additives tend to decrease the plasticity index and modify the plasticity characteristics. Lignin and lignin-derivatives are used as dispersing agents for clays.

(vi) Chemical Stabilization:

Chemical Stabilization refers to that in which the primary additive is a chemical. The use of chemicals as secondary additives to increase the effectiveness of soil i.e. Cement, Asphalt, Lime and Salt may widelyused in the field as a secondary additives . Some chemicals are used for stabilizing the moisture in the soil and some for cementation of particles.

Here in this project NaOHused as a soil stabilizer and Flyash used as a cementing material.

1.2 SOIL REINFORCEMENT

1.2.1. Reinforced earth

Majorly Soil reinforcement may done by using Metallic mesh or Geosynthetics. The idea of retaining earth behind a metallic facing element connected to anchor or tieback elements, which may be thin metal strips, or strips of wire mesh, is of relatively recent origin. The resulting structure is known as ‘‘reinforced earth’’. The facing element is restrained by the mobilization of friction and or cohesion to ‘grip’ the anchor or tieback; the latter are extended into the backfill zone. A layer of these strips is placed at one elevation and backfilling is carried out; the entire process is repeated to the next higher elevation until the desired height is obtained. Typical spacings between the reinforcing ties are 0.3 to 1.0 m in the vertical direction and 0.60 to 1.50 m in the horizontal direction. Metal strips of 5 to 12 m width and 1.5 mm thickness may be used. If welded wire mesh is used it can be 1 cm diameter in grids of 15 cm × 60 cm. Strips as well as mesh must be galvanized to prevent corrosion. In highly corrosive environments like marine areas, even this may not ensure durability for the anticipated lifetime of the structure. Backfill soils of free-draining type such as sands and gravels are preferred; of course, 5 to 10% of material passing No. 75-μ IS sieve will be helpful for achieving good compaction.

1.2.2 Geo synthetics

‘‘Geotextile’’ means a textile used in geotechnical practice and is of relatively recent origin. Abrief treatment of the evolution, functions, and applications of Geosynthetics in Civil Engineeringpractice.Geosynthetics are classified into the following:

(a) Geotextiles
(b) Geogrids
(c) Geomembrances
(d) Geocomposites

1.2.3 Fiber Reinforcement

The standard fiber-reinforced soil is defined as a soil mass that contains randomly distributed, discrete elements, i.e. fibers, which provide an improvement in the mechanical behavior of the soil composite . Fiber reinforced soil behaves as a composite material in which fibers of relatively high tensile strength are embedded in a matrix of soil. Shear stresses in the soil mobilize tensile resistance in the fibers, which in turn imparts greater strength to the soil . Mainly, the use of random discrete flexible fibers mimics the behavior of plant roots and contributes to the stability of soil mass by adding strength to the near-surface soils in which the effective stress is low .

In this way,some laboratory test results have led to encouraging conclusions proving the potential use of fibers for the reinforcement of soil mass providing an artificial replication of the effects of vegetation.

But due to this the cost of construction may increase and along with that it is not an ecofriendly task hence to attain good results by considering nature using natural reinforcing materials like Coir, Sisal, Jute may give good results as like artificial materials besides that those are all eco friendly materials. But the main problem is durability that can attain by applying materials like Turpentine oil or linseed oil to Fiber.

1.3 SCOPE AND OBJECTIVE

In this way both Chemical/Admixture stabilization and clay accretion are avant-garde treatments to access the ability of soil. In this activity the both words were adopted to attain actual acceptable results. Where in this activity NaOH affected as a actinic stabilizer, Fly ash affected as cementing actual and Sisal Cilia affected as reinforcing material.

In the present study, an attack is fabricated to abstraction how NaOH, Fly ash and Sisal fibers may be finer activated in aggregate with locally accessible clay to get an bigger superior of blended actual which may be acclimated in assorted Sub grades and Embankments. The clay acclimated in analysis was acquired from Musunuru apple abreast to Kavali in Nellore commune of A.P. NaOHPellets from Simhapuri chemicals, Nellore(A.P), Flyash from locally accessible bazaar and Sisal cilia aswell from locally accessible market. This analysis aims at analysis of assorted abstruse backdrop like CBR, Stress ache behavior and compaction adapted of clay . The cold of present plan is to abstraction the a lot of adapted aggregate of soil, Actinic admixture i.e. NaOH with an optimum % of flyash and optimum % of Sisal cilia at the optimum damp agreeable and best dry density.

Merits

1. Effective method of stabilization.
2. Gives much more good results.
3. Fast process of stabilization.
4. Ecofriendly process may not pollute environment.
5. Easiest process of stabilization.
6. Shear strength of soil will increase.
7. Cohesion values will get reduce.
8. Due to presence of less cohesiveness a good bond will form between soil particles and also with fiber.
9. Corrosion can avoid in the soil reinforcement.
10. Decaying / corrosion of fiber can reduce by applying retarders.

Demerits

1. Initial cost is more.
2. More amount of effort require when there is no mechanical energy presence.
3. Care has to take while adding chemical to soil.
4. Excess concentration of chemical may leads to effect the strength of soil.

3. EXPERIMENTAL INVESTIGATION

It deals with the study of various properties of materials used in the preparation of or stabilization of soft subgrade and embankment soil by using NaOH , fly ash and reinforcing with Sisal fiber.

Behavior of Soft subgrade soil, particularly this type of soil depends on many parameters like materials used, sequence of mixing the materials, mixing procedure, dosage of chemical, flyash and sisal fiber etc. It is essential to have a reliable data base, so that the field engineers or researchers can work towards the further developments. It has already been said that most of the soil reinforcement with sisal fiber have no information with regard to either the behaviour of sisal in soil matrix. The main objective of the present investigation is, thus to obtain specific experimental data, which helps to understand the matrix behaviour in the presence of natural fiber (sisal fiber) after attaining the stabilization .

The present investigations carried out are mainly directed towards obtaining specific information regarding the CBR value, MDD and OMC , Shear behaviour with natural fiber apart from their behaviour in soil matrix. The natural fiber considered here is Sisal fiber.

Introduction:

Several investigations were reported the use of fibers in soil. As a part of the present investigation, all the ingredients used in the project for making the stabilized soil matrix are tested for suitability in the light of relevant requirements of specifications of Bureau of Indian Standards.

3.1.STUDIES ON MATERIALS:

3.1.1 SOIL

The clay soil (Expansive / Soft soil) available in the Musunuru village had used in this project . the soil used here in the project contain no any other organic matter and it is free from other industrial chemicals. The soil was tested for physical requirements in accordance withIS 1498-1972 and IS: 2720 all parts.

3.1.2 ALKALINE SOLUTION

Strong Base solution has selected here the whole preparation of Solution have done based on the chemical mixing guide lines that is the solution had prepared based on normality and its considerations on the other hand 40gms of NaOH pellets added for 1liter of Distilled water to prepare 1N NaOH solution.

3.1.3 FLYASH

The flyash using in the stabilization process should consist a good values of Ca composition and that is used as a filler material. Class F flyash used here as a filler agent because of presence of good value of Calcium percentage.

3.1.4 SISAL FIBER

SCIENTIFIC CLASSIFICATION

Kingdom : Plantae
Order : Asparagales
Family : Asparagaceae
Subfamily : Agavoideae
Genus : Agave
Species : A. Sisal fiberana
Binomial name: Agave sisal fiberana

FigNo:3.1.4(a)

Sisal fiber(Agave sisal fiberana) is an agave that yields a stiff fiber traditionally used in making twine rope and also dartboards . The term may refer either to the plant or the fiber , depending on context. It is sometimes incorrectly referred to as sisal fiber hemp because hemp was for centuries a major source for fiber, so other fibers were sometimes named after it.

Fig No: 3.14(b) Sisal Plant.

The plant's origin is uncertain; while traditionally it was deemed to be a native of Yucatan, there are no records of botanical collections from there. Gentry hypothesized a Chiapas origin, on the strength of traditional local usage. In the 19th century, sisal fiber cultivation spread to Florida, the Caribbean islands and Brazil, as well as to countries in Africa, notably Tanzania and Kenya, and Asia. The first commercial plantings in Brazil were made in the late 1930s and the first sisal fiber exports from there were made in 1948. It was not until the 1960s that Brazilian production accelerated and the first of many spinning mills was established. Today Brazil is the major world producer of sisal fiber. There are both positive and negative environmental impacts from sisal fiber growing. Traditionally used for rope and twine, sisal fiber has many uses, including paper, cloth, wall coverings and carpets and here for get a good values of flexural strength for concrete.

The Sisal fiber plants consist of a rosette of sword-shaped leaves about 1.5 to 2 meters tall. Young leaves may have a few minute teeth along their margins, but lose them as they mature. The sisal fiber plant has a 7–10 year life-span and typically produces 200–250 commercially usable leaves. Each leaf contains an average of around 1000 fibers. The fibers account for only about 4% of the plant by weight. Sisal fiber is considered a plant of the tropics and subtropics, since production benefits from temperatures above 25 degrees Celsius and sunshine.

3.1.4.1 Fiber extraction

Fiber is extracted by a process known as Decortication, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibers remain. In India, where production is typically on large estates, the leaves are transported to a central decortication plant, where water is used to wash away the waste parts of the leaf. The fiber is then dried, brushed and baled for export. Superior quality sisal fiber is found in East Africa. Proper drying is important as fiber quality depends largely on moisture content. Artificial drying has been found to result in generally better grades of fiber than sun drying.

FigNo:3.1.4.1Fiber,extraction.

3.1.5TURPENTINE OIL

A product which is useful to minimize the decay of wood and wood resigns. Here also this turpentine oil used to minimize the natural decay of fiber in soil matrix. Turpentine oil bought from the local market. Sisal fiber initially dipped in the oil and later seasoning has done to it. This may reduce the decay of fiber in soil.

Fig No: 3.1.5(a)Turpentine oil

Fig No: 3.1.5(b) Fiber seasoning

4.MATERIALS USED AND THEIR PROPERTIES

4.0 Genaral

This is Deals with the physical and chemical properties of various materials used in the stabilization of the soft subgrade soil/Embankment soil by using Alkaline solution, Flyash and reinforcing with Sisal fiber.

4.1 SOIL

4.1.1 FREE SWELL INDEX TEST:

Initially Free Swell Index test conducted to the soil sample, based on this selling index value the value of optimum chemical value can find easily. IS: 2720 Part(40) - 1970

Formulas to be used

Free swell index = [Vd - Vk] / Vk x 100%

Where, Vd = Volume of soil specimen read from the graduated cylinder containing distilled water.

Vk = Volume of soil specimen read from the graduated cylinder containing kerosene.

Result (for Normal soil)

Vd = Volume of soil specimen read from the graduated cylinder containing distilled water = 22.1

Vk = Volume of soil specimen read from the graduated cylinder containing kerosene = 11.0

Free Swell Index value = {(22.1-11.0)/11.0}X100 = 100.91%

Therefore, FSI value for Normal soil = 100.91%

(Since, From Table 1 - Degree of severity is high)

FigNo:4.1.1(Conduction of Free Swell Index Test).

4.1.2. ATTERBERG'S LIMITS

All the tests are conducted based on IS: 2720 Part(V) -1965.

4.1.2.1. LIQUID LIMIT TEST:

Results

S.NO	Weight of soil taken (gms)	Water added(%)	No. of blows
1	120	30	55
2	120	35	48
3	120	40	41
4	120	45	34
5	120	50	31
6	120	55	22

Table 4.1.2.1: Liquid limit test results for normal.

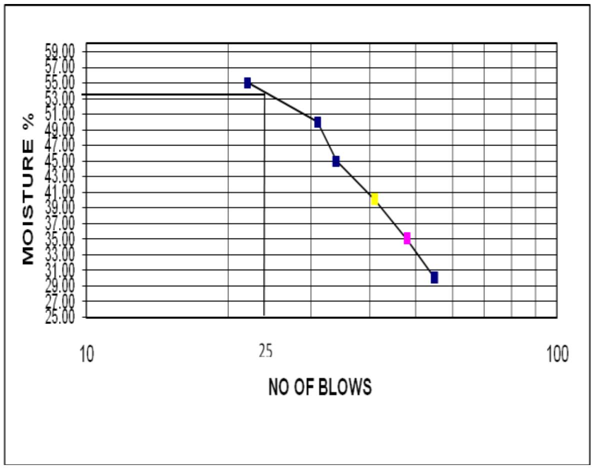


Fig 4.1.2.1: Water content Vs Number of blows.

From the graph we can get the liquid limit value as 53.8% .

Hence, WL = 53.8%.

But, as per Indian Standards, IS 1498-1972 the soil sample contains High degree of severity

4.1.2.2. PLASTICLIMIT:

FORMULAS TO BE USED:

Plastic Limit Wp= Mw/Ms

Where Mw= Mass of water added

Ms= Mass of dry soil

Plastic limit for normal soil

* Weight of empty container(W1)= 15 gms

* Weight of empty container + wet soil(W2)= 61gms

* Weight of empty container + dry soil(W3)=50 gms

* Water content = (W2- W3)/(W3- W1) * 100

* = (61-50)/ (50-15) * 100

= 31.43 %

* Plastic limit WP = 31.43 %

Plasticity Index

* I.P = L.L - P.L = 53.8 – 31.43

* Plasticity Index WP = 22.37%

As per Indian Standards,IS 1498-1972 the soil sample contains Medium degree of severity

4.1.3STANDARD PROCTOR TEST

Test is conducted based on IS: 2720 Part (IX) - 1971

FORMULAS TO BE USED

Bulk density ρ= M/V

Where M= Mass of soil V= Volume of soil

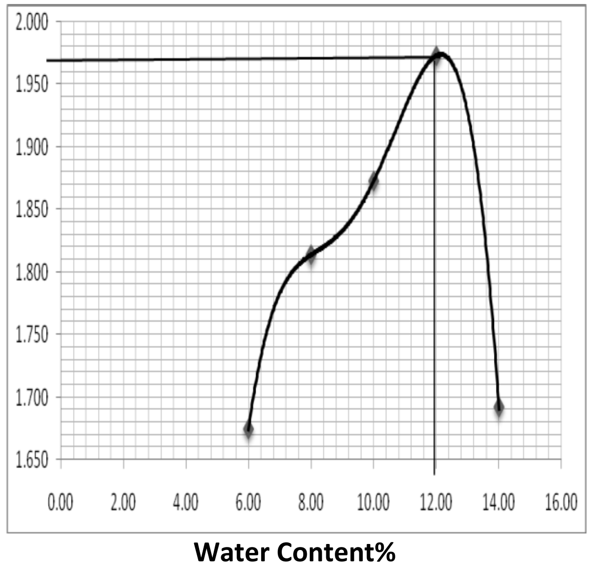
Dry density ρd= ρ/(1+W)

Where W= Water content added.

RESULTS

.No	Water content (%)	Mass of empty mould (gms)	Mass of mould with compacted soil (gms)	Mass of compacted soil (gms)	3Bulk density (gms/cc)	Dry density (gms/cc)
	6	4480	6256	1776	1.776	1.675
	8	4480	6441	1961	1.96	1.814
	10	4480	6541	2061	2.06	1.873
	12	4480	6691	2211	2.21	1.973
	14	4480	6409	1929	1.929	1.692

Table 4.1.3: Proctor test results for normal soil.



Graph 4.1.3 of Standard Proctor Result

From Graph

Maximum Dry Density = 1.973gm/cc

Optimum Moisture Content= 12.0%.

Fig 4.1.3: Conduction of Standard Proctor Test.

4.1.4 CALIFORNIA BEARING RATIO TEST:

Test is conducted based on IS: 2720 Part(XVI) -1965

FORMULAS TO BE USED

Bulk density $\rho = M/V$

Where M = Mass of soil

V = Volume of soil

Dry density $\rho d = \rho/(1+w)$

Where w = Water content added

CBR at 2.5mm & 5.0mm penetration = (Test value / Standard value) X 100

Where, Test value = From the graph between load & penetration

Standard value = From standard values table.

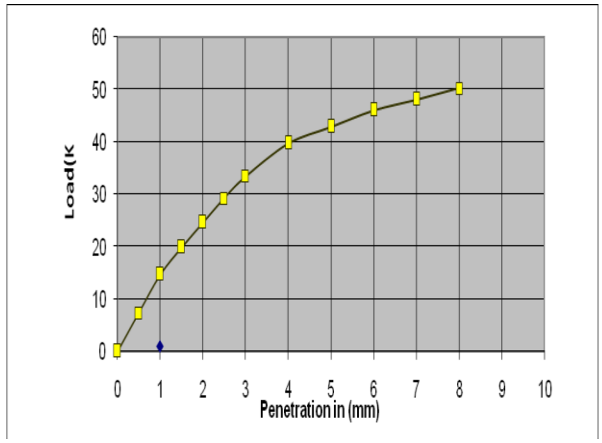
Penetration of plunger(mm)	2.5	5.0	7.5	10.0	12.5
Standard load(kg)	1370	2055	2630	3180	3600

Table 4: CBR standard load

RESULTS

S.No	Penetration dial gauge		Load dial gauge	
	Dial gauge reading	Penetration = reading x L.C (0.01)	Load proving reading	Load (kN) = proving reading x 10 x L.C (1.045)
1	0	0	0	0
2	25	0.25	0.16	1.5675
3	50	0.5	0.8	7.315
4	75	0.75	1.3	12.54
5	100	1	1.5	14.63
6	125	1.25	1.8	17.765
7	150	1.5	1.9	19.855
8	175	1.75	2.1	20.9
9	200	2	2.4	24.557
10	225	2.25	2.7	27.17
11	250	2.5	2.82	29.26
12	275	2.75	3.1	31.35
13	300	3	3.3	33.44
14	350	3.5	3.6	36.575
15	400	4	3.9	39.71
16	450	4.5	4.0	41.8
17	500	5	4.2	42.84
18	550	5.5	4.3	43.89
19	600	6	4.4	45.98
20	700	7	4.7	48.07
21	800	8	4.9	50.16

Table 4.1.4: CBR test results



Graph of CBR Test Results.

From Graph CBR value

@ 2.5mm Penetration = 2.14

@ 5.0mm Penetration = 2.08

Fig No 4.1.4 Taking Values at Different penetration Values during CBR Test

CBR value of the Soil is taken as 2.136.

Table 6:IRC considerations for Subgrade soil

S.No	CBR value	Nature
1	1-3	Poor
2	3-5	Good
3	5-8	Very good
4	>8	Strong (as like rocky strata)

As per IRC considerations the CBR value is less than 3, hence it contain very poor properties as subgrade layer.

*Hence it won't prefer as Subgrade layer.

5.OPTIMUM CONTENT OF NaOH ANDFIBER TO STABILIZE SOFT SOIL

General

This is Deals with the optimum dosages of NaOH solution, Flyash and Sisal fiber. The optimum dosage of fly ash here is fixed as 20% by weight of soil. Here in this session the optimum content of fly ash , Sisal fiber was find separately.

5.1 CALCULATION OF OPTIMUM CONTENT OF NaOH(for 20% of Fly ashby weight of soil)

1. Here the optimum content of flyash is a fixed value and this was a founded value.
2. Now the optimum content of Chemical has to found.
3. Since it is very difficult to find the optimum content of chemical for the soil sample byconducting all the soil tests. Hence wastage of chemical may increase.
4. By considering above difficulties one of the best solution is finding the Free swelling index value of the soil sample.
5. For this the normality of the liquid was adopted from 3N to 15N such as 3N, 6N, 9N, 12N, 15N and the percentage of solution also varied from 3% to 15% such as 3% , 6% ,9%, 12%, 15%.
6. The procedure for preparation of soil is clearly mentioned below

5.1.1 PREPARATION OF SOIL TO FIND THE SWELLING INDEX

Apparatus required

a. 425µ IS Sieve
b. Balance
c. Measuring jars
d. Sodium Hydroxide pellets
e. Distilled water
f. Pipette

Fig 5.1(a)

Mixing procedure

i) Soil has to sieve from 425µ IS sieve and for the preparation of 1N Alkaline NaOH solution it is necessary to add 40gms of NaOH pellets to distilled water. Based on this the pellets will add to water for the required Normality.

ii) Take 50gms of soil in a bowl and add 12.5gms of Flyash(since 20% of Soil i.e. by weight) to the soil, mix the complex thoroughly.

iii) Add the chemical to the soil matrix presented in bowl and here the chemical content have to vary from 3% to 15% as discussed above.

iv) After mixing the soil sample allow the soil for maturity , that can done by packing the soil in a water tight polythene cover and keeping in desicator for atleast 2 weeks.

v) After one week remove the soil packets from Desicator and conduct swelling test for the soil which is presented in polythene covers

vi) The overall optimum content of chemical can find by the following calculations

5.1.2 CALCULATION OF SWELLING INDEX VALUE FOR SOIL SAMPLE

For 3N solution

i) 3N/3%

Volume change in kerosene = 11.95
Volume change in Water = 21.5
Free Swelling index value (FSI) = 80%

Fig 5.1(b): Keeping soil in Desiccator for maturity

ii) 3N/6%

Volume change in kerosene = 12.3
Volume change in Water = 21.2
Free Swelling index value (FSI) = 72.4%

iii) 3N/9%

Volume change in kerosene = 12
Volume change in Water =20
Free Swelling index value (FSI) = 66.67%

iv) 3N/12%

Volume change in kerosene = 13.76
Volume change in Water =19.6
Free Swelling index value (FSI) = 42.4%

v) 3N/15%

Volume change in kerosene = 11.8
Volume change in Water = 19.6
Free Swelling index value (FSI) = 66.1%

Similarly based on above calculation the swelling index values for all the remaining percentages and

Normalities are tabulated below

S.No	Normality	Percentage of chemical added to Soil				
		3%	6%	9%	12%	15%
1	3	80	72.4	66.67	42.4	66.1
2	6	52.23	42.44	42.44	40.23	52
3	9	41.43	40.26	42.1	52	50
4	**12**	7.4	7.6	**6.6**	12.5	12.5
5	15	14	10	11.4	12.4	6.3

Table 5.1.2 : FSI for NaOH mixed soil at different Normality and Percentage

6. EXPERIMENTAL RESULTS AND DISCUSSION

This session gives about the experimental results of both chemically stabilized soil and Sisal fiber reinforced soil individually and also it gives the results oh Final soil sample that is both chemically stabilized and Fiber reinforced soil.

6.1 SOIL MIXED WITH NaOH

For 12N, 9% of Chemical content and 20% of Flyash percent added to soil to form the good and stabilized results. After mixing the soil with both chemical and Flyash it is required to kept the soil for maturity atleast a period of one week. After maturity soil testswill conduct to find the properties.The results are shown in below articles.

Soil mixing images

Fig6.1 (a) After soil mixing it should be required to allow for maturity that is shown below.

Soil Maturity

Fig6.1 (b) After getting maturity (oneweek) soil has allowed for testing. Those results are listed below

7.DISCUSSION

7.1 FREE SWELL INDEX

1. Initially Free Swell Index value found for the normal soil, the founded value of FSI for normal soil is 100.91% Sand Degree of Severity is Critical As PerIS 1498-1972 , IS 2720-40 (1977).
2. After finding the value of FSI for normal soil, NaOH solution added to the soil along with having 20% of Flyash as filler material.
3. This added NaOH contains different Normality and different percentage values.
4. Initially soil mixed with 3N/3% along with flyash and later continued till 15%, finally the mixing values ended with 15N/15% , after mixing with NaOH soil allowed for maturity.
5. After one week FSI value calculated for the stabilized soil, based on the results (shown in Table: 5.1.2) the optimum value of NaOH is 12N/9%, because the FSI value here is too much less and efficient i.e. FSI at 12N/9% is 6.6%, Degree of Severity is Non-Critical as per IS 1498-1972.

7.2 ATTERBERG LIMITS

7.2.1 LIQUID LIMIT

1. Initially liquid limit value found to the normal soil, the value obtained here is 53.8%, but as perIS 1498-1972Degree of Severity is Critical.
2. Later soil mixed with 12N/9% NaOH and allowed for maturity.
3. After one week soil tested and the result obtained is 27%, Degree of Severity is Non-Critical as per IS 1498-1972.

7.2.2 PLASTICITY INDEX

1. Initially Plasticity value found to the normal soil, the value obtained here is 22.37%, but as perIS 1498-1972Degree of Severity is Critical.

2. Later soil mixed with 12N/9% NaOH and allowed for maturity.
3. After one week soil tested and the result obtained is 10.3%, Degree of Severity is Non-Critical as per IS 1498-1972.
4. In this way Plasticity values are reduced, simultaneously Plastic limit values are also decreased.

7.3OPTIMUM MOISTURE CONTENT AND MAXIMUM DRY DENSITY

1. Initially OMC and MDD values found for normal soil that are 12.0% and 1.973gm/cc respectively.
2. After stabilized with NaOH solution the values are changed to 9.7% and 2.08gm/cc.
3. This is because oftheend product in the reaction i.e.due to Calcium Silicate Hydrate (CaH2O4Si) , the expansion nature has decreased. That's why the OMC value decreased and simultaneously MDD value increased.

7.4 CBR

1. Due to the stabilization CBR value has increased from 2.14 to 6.17.
2. In fact we know that 2.14 is a very poor CBR value for subgrade and it won't preferable as a subgrade layer, but this overcame by the stabilization that CBR value has increased to 6.17 after stabilization. As we know that 6.17 is an exceptionally very good value for the pavement construction.
3. Hence we can consider 12N , 9% value of NaOHconcentration as an optimum content.
4. To increase the CBR value of soil matrix reinforcement is a good technique.
5. Sisal fiber is used here as the Reinforcing agent, 1.2% fiber content required to get CBR value of 6.17.
6. But after stabilization, that percentage value decreased to 0.2%.

8.CONCLUSION

1. By using NaOH as an admixture we can stabilize the soft soil. It gives strength to the soil.
2. Engineering & Index properties of soft soil will improved while usingNaOH as an admixture at 12N, 9% for the subgrade construction purposes.
3. As a civil engineer it is our duty to convert the useless construction materials in to useful materials and we have to choose the better ways based on the economic considerations also.
4. We have to control the environmental pollution using the pollution creating agents as the admixtures for the stabilization of materials or to increase strength of the building materials that's why Flyash here used as a filler material. Infact there are so many filler materials in the nature. But fly ash used here because of it is a great pollutant.
5. Improvement of engineering properties is the main criteria for the civil engineers for an economic purpose in the site. 20-30% by weight of fly ash is suited for the little stabilization of soft soil. That is why 20% assumed as a filler material content.
6. After mixing the soil with NaOH and Fly ash , the CBR value increased to 6.17 (After Maturity) from 2.14
7. Also Atterberg limits also get good values that is WL changed from 53.8% to 27% and IP changed from 22.37% to 10.3% .
8. OMC value also changed from 12.0% to 9.7%. Simultaneously MDD value also increased from 1.973gm/cc to 2.08gm/cc.
9. In this way the soil can stabilize effectively at a minimum cost.

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