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Improvement in the Properties of Soil using Fly Ash and Coir Fibre

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ABSTRACT- The reliability and strength of the ground assume a very important role in the field of development advancement. Different changing procedures can be adopted for the floor which needs enough firmness. The change can increase the shear strength of the soil and control the increase in soil properties, thus improving the load limit of the subgrade pile to help asphalts and installations. There is a gigantic variety of change techniques. The convergence point of this report is to focus on the common sense of settling the soil through the use of rubble and coir, thus reusing waste materials and providing a productive and ecological procedure for soil change or adjustment.

KEYWORDS- Fly ash, Coir fibre, Optimum moisture

I. INTRODUCTION

Maintainability is a generally recognized thought in the current advancement circumstance. Notwithstanding the way that the advancement business is changing in a critical manner to the extent that machines and merchandise are used. The advancement cost had emerged close by the unfavorable impact on the environment [1]. That understood get-together of a substantially more offset approach with the earth as its functional center point to make a superior world than they live in. This has provoked the assurance of a trademark fiber as Coir fiber for the quality improvement of soil and cement. Coir fiber is open in bounty, which makes coir fiber outstandingly reasonable as a help material in soil and cement [2]. Also, coir fiber fills in as one more wellspring of pay for the coconut producer who gets the potential gains of the new solicitation made by the progression business[3]. Likewise, it is a decent method for the exchange of coir resting cushion wastage that lessens the interest in extra wastage trade systems and decreases the store on existing landfills and incinerators [4]. The issue of the enormous pace of dampness maintenance in fiber might be reduced by covering the strands with coatings of oil [5]. Additionally, coir strands' being conventional at their beginning stage is organically viable and may diminish the general carbon impression actually. This examination was to separate the assortment in nature of coconut fiber (oil-covered rough and oil-covered arranged fiber fibers) sustained concrete at various fiber substances and to balance it with that of common concrete[6]. The different quality viewpoints assessed incorporate flexural, compressive, and versatility of coir sustained cement at various rates (4%, 5%, and 6% by wt. of cement) of fiber[7]. Impact of state of fiber on quality is also assessed by analyzing on coir fiber organizations of proposed estimations. The ideal degree of arranged fiber fibers and unrefined fiber networks were surveyed by the primer and ideal degree of super plasticizer required for the proper Workability was moreover assessed. Coir is a characteristic fiber got from coconut husk and utilized as a material, as floor mats, sheets, brushes and sheets. Different employments of earthy colored fibers (acquired from ready coconut) are in cushioning, stuffing, cultivation and improvement. White coir, assembled from crude/green coconuts, utilized in planning brushes, strings, string, and nets. Coir-a stringy component encased between solid, internal case and the external layer of a coconut[8]. The singular fiber cells are tight and void, having unbending dividers made out of cellulose. These strands when youthful are dull and a while later wind up established and yellowed because of the presence of lignin stored on dividers. Every cell is around 0.1 cm long and 0.00102 cm to 0.00203 cm in width. Fibers are regularly 100 mm to 300 mm long. Two kinds of coconut are earthy colored shaded (dim) and white. Dull hued procured when completely created coconuts is thick, hard also having a lot of assurance to scratch[9]. This is generally used for making rugs, brushes and firing. Completely age dim shaded fibers comprise of higher lignin and little cellulose than strands, for example, flax and cotton, so are more grounded at this point less flexible. White shaded fibers assembled from coconuts when these are youthful are white or pale dim hued and are better and predominant, yet likewise sensitive. These are by and large turned to make yarn used for making covers or strings[10]. The coir fiber is modestly impervious to water and is among one of a small bunch of normal strands that are impervious to being wounded by saltwater. Simultaneously, saline water and new water are both utilized for getting white-shaded coir fiber. It should not be confused with coir substance, or previously, cockpeats, which is the fine material emerging true to form in view of the treatment in acquiring coir fiber. Coconut fiber is additionally called "copra" in a couple of countries, expanding the confusion. Youthful coconuts, procured around[11]. They comprise of pliant light fibers and last half to a year. Coconut fiber is adequately adaptable to bend yet doesn't split or break and hold a bend similarly forever. Bowing is essentially finished by

framing a string through the moving of strands and winding it physically or using gear[12]. The more extended fiber is cleaned in water and, a short period of time later, dried prior to being consolidated with packs or hanks. From that point onward, it very well might be cleaned and moulded with steel brushes to alter the fibers and empty more limited strands. Likewise, coconut fiber can be hued and concealed to get hanks of different colours[13]. Red fiber is used as a piece of floor coverings, dozing pads, brushes, resting cushions, and firing. A little aggregate is similarly made into yarn[14]. The heaps of turned dim shaded fiber, delivered by a hardware system that tangles the strands close by, are shaped, cut, and loaded up with resting pads, which in crumbling, control over stream inclinations and slants[15]. An imperative degree of the dim shaded fiber pads are showered by versatile plastic that ties the fibers together (rubberised coir), and is used for delicate padding for the vehicle business in far off nations[16]. It is likewise used in security and packaging. The critical use of white strands is that they are for the most part utilized in rope making. Floor coverings of interlinked fiber are created utilizing better assessments of fiber and white fiber, using manual or weaving machines[17]. Coir fiber, in like manner, is it is used in making nets because of its strong protection from saltwater[18].

II. MATERIAL USED

- Coir Fibre
- Soil
- Fly Ash

A. Coconut Fibre

Coconut fibre with an elasticity of 21.5 Mpa is the hardest among every single regular fibre (Munawar et al., 2003). Coir fibres are fit for holding strains four to six times more than different filaments (Munawar et.al, 2003). Despite the fact this is modest and effective noteworthy obstruction in relation to its large scope utilize is large moisture retention, that may be decreased by finishing it with some lubricants. Some merits of coir fiber are: less price, attainable particular quality, low thickness, , low weight, simplicity of accessibility, ability to be reused in a carbon neutralizing manner, protection from micro-organisms, brilliant protection to sound, fire and dampness, durability, strength, flexibility and twisting. Coir word originates from kayar, means line in Malayalam. Strings and ropes are produced using coir fiber for a very long time. Navigators of our country crossed the oceans to various countries hundreds of years back utilized these fibers for propping their ships. Figure 1 shows the Coir fiber and Figure 2 shows Coir fiber mixed with soil.

Figure 1: Coir fiber

Figure 2: Coir fiber mixed with soil

B. Soil

A sustainable remarkable typical renewable resource is a major component for living. Water portability, its embodiment, arrival utilization, and vegetation proficiency all have a relationship with soil. It presents numerous essential soil ideas consisting of improving, grouping, functions, protection, and security. A general comprehension of soil ideas and these intertwined connections is fundamental for settling on sound land administration choices. Soils are made out of four fundamental parts:

- Mineral fragments of various ranges.
- Biological and other essential products (remaining of flora and dead fauna).
- Water.
- Air.

Utilization and capacity of a soil relies upon the measure of every part. Like, great soil in developing vegetation has around forty five percent minerals, five percent natural issue, twenty five percent air, and twenty five percent water. Flora present in marine lands need much water and little air. Soils utilized as crude products for blocks should be totally free of natural issues. Soil assumes an indispensable part in managing life on the planet. Almost the greater part of the food that people consume, aside from what is reaped out of aquatic situations, is developed in the Earth's soils. Different evident capacities which soils give people incorporate fiber to paper and costume, fuel wood generation, and establishments for buildings and structures. More subtle capacities which soils deliver are giving way to weaken poisons and abundance water, underground water energize, supplement recovery, and living space for flora and fauna. This additionally has numerous auxiliary uses, for example, fixings in confectionaries, bug sprays, polishing, cosmetics, and pharmaceuticals; employments of soils extend from penetrating mud’s, ceramics, and craftsmanship, to giving polished coatings on different paper items. It is a basic part of almost every biological community, however is frequently underestimated. Soils are assumed to be the biological community establishment, as soil profitability figures out how an environment will appear as far as the

flora and fauna life it can withstand. For instance, in woodland biological communities, soils can decide species organization, timber efficiency, and untamed life living space, lavishness, and decent variety. The part soil plays in woods is likewise basic in keeping up water quality and long term site efficiency. In developed areas, soil quality has a noteworthy part in yield efficiency as soil supplements and its properties can straightforwardly affect efficiencies. In urbanized regions, soil assumes an essential part in lessening overflow through invasion and supplement constriction. The estimation of soil is not entirely obvious until soil quality ends up corrupted and the basic administrations the soil once provided are decreased. Soil physical properties profoundly affect how soils impact soil quality and efficiency. Generally for the most part it is soil physical properties that decide supplement and dampness content in soils that make impact on quality and efficiency of soil. The physical properties of soil incorporate its surface, mass thickness, moisture capacity limit, natural issue content, soil structure, soil color, and soil efficiency. Figure 3 shows Unreinforced soil and Figure 4 shows Soil with fly ash.

Figure 3: Unreinforced soil

Figure 4: Soil with fly ash

C. Fly Ash

Fly ash is the completely separated mineral deposit coming about after combustion of coal in electric creating plants. It comprises of inorganic, incombustible products present in the coal that has been fused during burning into a glassy, amorphous structure. Fly ash particles are for the most part round fit as a fiddle and ranges from 2 μm to 10 μm. Fly ash consists for the most part of silicon dioxide (SiO_2), aluminium oxide (Al_2O_3) and ferrous oxide (Fe_2O_3). Fly fiery debris like soil contains trace concentrations of heavy substantial metals: nickel, vanadium, cadmium, barium, chromium, copper, molybdenum, zinc and lead. During burning, mineral polluting influences in the coal combine in suspension and exit through ignition apartment along foul gasses. When combined products appear, it cools and hardens into round glossy products known as fly ash. It is gathered from the fumes gasses with the help of electrostatic precipitators or pack channels from fumes gasses. Fly ash particles resemble cement bonds yet also artificially unique. It artificially combines with the by-product Ca (OH) 2 discharged by the combination between cement and water to shape extra bonding items which enhance numerous attractive qualities of cement. Cementitious properties shown by fly powder to varying degrees relying upon the properties of both the fly powder and cement. Contrasted cement and water, the substance response of fly ash remains and Ca (OH) 2 commonly is sluggish bringing about later concrete solidifying. Sluggish concrete solidifying combined to the changeability of fly ash qualities could make huge difficulties to the concrete maker and producer while putting steel-towelled floors. As of now, over half of the concrete put in the U.S. contains fly ash. Dose rates change relying upon the kind of fly fiery remains. Regularly, Class F fly fiery is utilized at dosage of fifteen to twenty five percent by mass of cementitious material and Class C fly cinder at fifteen to forty percent. In any case, fly ash has not been utilized as a part of interior, steel-trowelled sections on account of the inherent issues or difficulties related with fly ash changeability and postponed concrete solidifying. Rate and consistency of concrete solidifying are basic needs in building up the window-of-finish ability and can impact straightforwardly the nature of quality of conclusive wrap up. Postponed or non uniform concrete solidifying fundamentally expands the danger of untimely or inappropriate process bringing about low quality steel-towelled finishes. As of recently, building proprietors, solid providers, and finishers have been hesitant to supplant cement with fly ash in steel-towelled surfaces due to the expanded dangers related with the fly ash. Such dangers incorporate surface stickiness, deferred cement solidifying, and quick mass shrinkage breaking because by later solidifying. Figure 5 shows the Fly ash without and with soil.

Figure 5: Fly ash without and with soil

III. NEEDS AND ADVANTAGES OF SOIL STABILIZATION

Soil properties vary from place to place depending upon the climatic and geographical conditions of that area[19]. They are not suitable for construction always and need to be modified so that they do not cause any damage to the structure built on them. The main need of stabilizing the soil is to improve the bearing capacity so that they are able to withstand the load applied on them[20].

A. Advantages

- If during the construction phase weak soil strata are encountered, the usual practice followed is replacing the weak soil with some other good quality soil. With the application of soil stabilization technique, the properties of the locally available soil (soil available at the site) can be enhanced and can be used effectively as the subgrade material without replacing it.
- The cost of preparing the subgrade by replacing the weak soil with a good quality soil is higher than that of preparing the subgrade by stabilizing the locally available soil using different stabilization techniques.
- The strength giving parameters of the soil can be effectively increased to a required amount by stabilization.
- It improves the strength of the soil, thus, increasing the soil bearing capacity.
- It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation.
- It is also used to provide more stability to the soil in slopes or other such places.
- Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather.
- Stabilization is also done for soil water-proofing; this prevents water from entering into the soil and hence helps the soil from losing its strength.
- It helps in reducing the soil volume change due to change in temperature or moisture content.

IV. OBJECTIVES

- To study the coconut fibre
- To find the Results on use of coconut fibre for soil reinforcement.
- To compare the results with together use of fibres and separate use.
- To study the stress - strain relationship properly which has not been properly done yet.
- To study the shear strength of soil due to use of various percentages of coconut fibre.

V. METHODOLOGY

- Identification of suitable site.
- Collection of soil samples.
- Evaluation of Liquid limit, Plastic Limit, SPT value of soil.
- Reinforcement of other soil samples using various proportions of fibre as well as ash powder.
- Determination of CBR value of fibre reinforced soil.
- Comparison of the CBR values of the reinforced and unreinforced soils.

VI. TESTS CONDUCTED

- Sieve Analysis
- Specific Gravity
- Liquid Limit
- Plastic Limit
- Standard Proctor Test
- CBR
- Direct Shear Test

A. Sieve Analysis

A sieve investigation (or gradation test) is a process utilized (ordinarily utilized as a part of structural designing) to overview the particle estimate dispersion (also called degree) of a coarse grained substance by enabling the substance to experience a progression of screens of dynamically small screen dimensions and measuring the quantity of substance which is ceased through every strainer as a small amount of entire quantity. Sifter analysis is frequently of basic significance to the manner in which the substance functions being used. Sifter investigation could be executed on natural or non natural coarse grained substances like fine aggregates, broken stone, loam, ash, and dust, an extensive variety of produced crumb, grain and seeds, underneath a base area relying on correct technique. Analysis test were used with IS sifters- 4.75 mm, 2.36 mm, 1.18 mm, 0.600 mm, 0.300 mm, 0.150mm, 0.75mm, pan and weighing apparatus. Being such a basic and straightforward evaluation of molecule estimating, this is likely the best well-known.

B. Specific Gravity

Specific gravity is the ratio of the weight in air of a given volume of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature. Specific Gravity is denoted by the symbol G.

C. Liquid Limit

At the point of adding water to dry soil, it transforms its condition of flexibility from hard to delicate. On the off chance that we add water to a fine grained soil, then it will transform its condition from hard to semi hard. On the off chance that if we keep on adding water then soil will further transform its condition from semi hard to plastic at long last accomplish a fluid consistency stage. At the point when the sample achieves fluid condition, it loses its quality to hold its configuration due to its self weight. It will start to disfigure its configuration. So the moisture quantity that is accountable for that condition is called liquid limit. At the end of the day liquid limit may be characterized as “the minimum moisture where the specimen is just in the liquid condition; however having little shearing strength against flow”. On the basis of tests it may be characterized as: the least moisture amount where a part of soil cut by a groove of standard dimension will flow together for a distance of 12 mm (1/2 inch) under an impact of 25 blows in the device.”

D. Plastic Limit

It is used for evaluating the plasticity of soil as per IS: 2720 (Part 5) – 1985.It is the moisture amount of the soil under that it stops to be plastic. It starts disintegrate when curled in strings of 0.3cm dia.

E. Standard Proctor Test

This method includes the determination of the relationship between optimum moisture content and dry density of the soil sample compacted in a mould of a given size with a 2.5kg rammer dropped from a height of 30 cm. The sample is firstly oven-dried approximately 5kg in a pan. The weight of empty mould and soil sample is calculated respectively. The water content to be added to the soil starts from 5% with an increment of 3% to the soil samples. The test is repeated up to the point at which the Optimum Moisture Content and the Maximum Dry Density of the soil is obtained.

Table 1: shows data for the tests

CONTAINER NO.	I
Mass of empty pycnometer (M1)	0.631
Mass of pycnometer + mass of dry soil (M2)	0.832
Mass of pycnometer + soil + distilled water (M3)	1.58
Mass of pycnometer + fill with water only (M4)	1.428
Specific gravity Gs = M2 = M3/(M2-M1)-(M3-M4)	2.66

F. California Bearing Ratio Test

The CBR test shows the bearing limit or obstruction of soil. Subsequent to ascertaining the OMC the perfect water content is blended in oven dried soil. The soil is compacted in 5-layers with 56 blows on each layer. The sample is kept in water for 96 hours for most noticeably worst dampness condition. The sample is then tried on CBR machine in which load and penetration are recorded. The loads relating to 2.5mm and 5mm penetration is taken and CBR values are accessed.

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of sub grade soil for design of flexible pavement. Tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the sub grade soil. California Bearing Ratio (CBR) tests a method of classifying and evaluating soil sub grade. The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions.

G. Direct Shear Test

The direct shear test is a laboratory testing methods used to determine the shear strength parameters of soil. The test can be carried out at different moisture contents; however, it is common to saturate the sample before running the test. The test is carried out on either undisturbed samples or remoulded samples. To facilitate the remoulding purpose, a soil sample may be compacted at optimum moisture content in a compaction mould. Then specimen for the direct shear test could be obtained using the correct cutter provided. Alternatively, sand sample can be placed in a dry state at a required density, in the assembled shear box. A normal load is applied to the specimen and the specimen is sheared across the pre-determined horizontal plane between the two halves of the shear box. Measurements of shear load, shear displacement and normal displacement are recorded. The test is repeated for two or more identical specimens under different normal loads. From the results, the shear strength parameters can be determined.

The strength of a soil depends of its resistance to shearing stresses. It is made up of basically the components;

- Frictional – due to friction between individual particles.
- Cohesive – due to adhesion between the soil particles.

VII. RESULTS

Specific Gravity Test

Table 2: showing the values of various tests

S. No	Dry Density(Kg/m3)	Water content (%)
1	1540	5
2	1556	8
3	1570	11
4	1545	13
5	1520	15

Table2 shows Standard Proctor Test, table 3 shows SPT Test Data of reinforced soil sample (20mm Coconut Fibre) and table 4 California Bearing Test

Table 3: Standard Proctor Test

S. No	Parameter	Range/Value
1	Liquid limit	44.40%
2	Plastic limit	30.76%
3	OMC	11%
4	Plasticity Index	14.36%

Table 3: SPT Test Data of reinforced soil sample (20mm Coconut Fibre)

S No	Fibre content	Dry density	Water Content (%)	OMC (%)
1	0%+0%	1741.50	5	
		1817.23	8	
		1873.84	11	11
		1797.20	14	

		1667.25	17	
2	0.3%+4%	1715.90	5	
		1759.04	8	
		1801.70	11	
		1876.81	14	
		1996.53	17	17
3	0.7%+9%	1920.13	11	
		1943.45	13	
		2266.2	15	20
		2163.0	17	
		1986.2	20	
4	0.9%+11%	2106.2	14	
		2224.3	17	
		2256.8	19	
		2482.6	23	23
		2208.1	25	

Table 4: California Bearing Test

Penetration (mm)	Load (kg)	Load (kg)	Load (kg)	Load (kg)	Load (kg)
	0% Fibre	0.5% Fibre	0.80 % Fibre	1.1% Fibre	1.4% Fibre
0	0	0	0	0	0
0.5	5	10.4	14.6	17.8	19.5
1	10	18.6	17.2	22.40	22
1.5	14	19.4	22.4	30.4	26.3
2	18	18.4	27.2	40.0	35
2.5	20	28.4	32.4	56.2	43
3	23	36.0	42.4	64.8	59
4	28	40.4	57.6	70.6	67.3
5	31	47.0	60.6	76.6	78
7.5	38	54.6	68.0	83.0	85
10	45	58.2	74.4	89.8	92
12.5	50	65.2	88.8	95	96

VIII. CONCLUSION

From the above experimental study it has been revealed that the soil samples reached the highest values of all the parameters when the percentages of coconut fibre reached to1.4%. The OMC and Dry Density of the soil got increased from 11% to 21% and 1570 mg/cm3 to 1752 mg/cm3 respectively with increase in the coconut fibre content percentage.CBR values has also been increased from 1.96% to 4.48% for CBR at 2.5mm penetration and 1.68% to 4.16% for CBR at 5mm penetration with increase in the coconut fibre content.

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