EXPERMENTAL INVESTIGATION ON STRENGTH OF KAOLIN CLAY USING QUARRY DUST AND COIR FIBRE

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Abstract

For growth of country along with the technological advancements, development in infrastructure field is also required and with the rapid rate of urbanization in our country it is becoming difficult to find the proper quality of soil for engineering applications. Hence, it is a challenging task for a geotechnical engineer to come up with the ideas which would allow us to work on the even poor quality of soil with any risk of failure of the structure. With a diversification of many types of soil in our country a major category of soil which is of many problems to engineers is expansive soil which creates a lot of problems to structure formed on them. This study focusses on the expansive soils and how various geotechnical parameters can be enhanced by the use of coir fibre.

Keywords: - kaolin clay, quarry dust, coir fiber.

I. INTRODUCTION

Amongst civil engineering structures, roads are the only ones subjected to vagaries of nature as well as its users. On the other hand, some basic engineering concepts are unfortunately misunderstood by many road engineers. Road subgrade is one of such concepts prevailing its design gets reflected in premature failure and poor pavement performance.

Clayey soils are usually categorized as expansive soils. Other names of these soils are soft soils or fine-grained soils. These types of soils are known lead to critical damage to structures resting on them. Normally in construction industries, the structures that constructed on clay soils are tend to trigger the soil when exposed to additional load as well as external impact. This deformation could potentially cause significant failure to foundation and structures. Besides, the construction of roadway on the soft soils also encountered the same problem. This is because the soils do not have enough physical properties for construction application. It is very risky if the construction is still continuing on these types of soils without any remediation or improvement on the soils. As a general knowledge, the common approach when facing this difficulty is to remove all the soils and replace it with stronger soils or material like crushed rocks.

Kaolin or china clay is the soil rich in clay mineral kaolinite. Kaolinite is a part of the group of industrial elements with the chemical composition Al2Si2O5 (OH)4 . It is the soft white clay produced by the chemical weathering of aluminum silicate like feldspar with low shrink- swell capacity and low cation exchange capacity. Kaolin clay possesses very low bearing strength. So in order to use kaolin clay as subgrade or base course, its bearing strength must have to be improved. The advantage of improving its strength is that many parts of our country are rich with kaolin clay. Addition of any amount of quarry dust to clayey soils (highly plastic) showed considerable increase in shear strength. Considering economy, it is better to improve bearing strength of kaolin clay rather than transporting other type sugrade soils.

II. EXPERIMENTAL INVESTIGATIONS

Utility of quarry dust and coir fiber as a substitute for sand for the improvement of the soil in road construction was studied. A series of Proctor compaction tests were carried out.

2.1 Material used

The variation in properties of kaolinite clay, collected from a site at pappinaseri, near kannur, Kerala, with the addition of coir fiber waste and quarry dust was studied and compared. Tests were conducted using quarry dust passing 2.36mm sieve and discrete coir fibers of length 2 to 2.5 cm. and quarry dust.

2.2 Objectives

- To determine properties of only kaolin clay soil.
- To determine properties of only kaolin clay soil with partial replacement of coir fiber.
- To determine properties of kaolin clay soil with partial replacement of quarry dust.
- To determine properties of kaolin clay soil with partial replacement of quarry dust and coir fiber.
- To find out optimum % of coir fiber, quarry dust and both quarry dust and coir fiber based on dry density.

III METHODOLOGY

PLASTIC LIMIT
SPECIFIC GRAVITY
MODIFIED PROCTOR TEST

COMBINATIONS OR LISTOF EXPERIMENT

Table no.	Combinations
1	100% kaolin clay
2	15% quarry dust + 85% kaolin clay
3	30% quarry dust + 70% kaolin clay
4	45% quarry dust + 55% kaolin clay
5	60% quarry dust + 40% kaolin clay
6	15% quarry dust + 84% kaolin clay + 1% coir fiber
7	15% quarry dust + 83.5% kaolin clay + 1.5% coir fiber
8	15% quarry dust + 83% kaolin clay + 2% coir fiber
9	15% quarry dust + 82.5% kaolin clay + 2.5% coir fiber
10	30% quarry dust + 69% kaolin clay + 1% coir fiber
11	30% quarry dust + 68.5% kaolin clay + 1.5% coir fiber
12	30% quarry dust + 68% kaolin clay + 2% coir fiber
13	30% quarry dust + 67.5% kaolin clay + 2.5% coir fiber
14	45% quarry dust + 54% kaolin clay + 1% coir fiber

15	45% quarry dust + 53.5% kaolin clay + 1.5% coir fiber
16	45% quarry dust + 53% kaolin clay + 2% coir fiber
17	45% quarry dust + 52.5% kaolin clay + 2.5% coir fiber
18	60% quarry dust + 39% kaolin clay + 1% coir fiber
19	60% quarry dust + 38.5% kaolin clay + 1.5% coir fiber
20	60% quarry dust + 38% kaolin clay + 2%coir fiber
21	60% quarry dust + 37.5% kaolin clay + 2.5% coir fiber

IV RESULTS AND DISCUSSIONS

1 SPECIFIC GRAVITY TEST ON KAOLIN CLAY.

Determination	Trial 1	Trial 2	Trial 3
Weight of container, w1(g)	28	26	27
Weight of container + dry soil, w2(g)	35	32	35
Weight of container + dry soil + water, w3(g)	86	80	85
Weight of container + water, w4(g)	81	76	80
Specific gravity =(w2-w1)/(w4-w1)-(w3-w2)	3.5	3	2.7
Average	3.0		

The specific gravity of the kaolin clay sample is 3.

2 PLASTIC LIMIT TEST ON KAOLIN CLAY

Determination	Trial 1	Trial 2	Trial 3
Weight of container with lid, w1(g)	34	36	32
Weight of container with lid + wet soil, w2(g)	55	58	56
Weight of container with lid + dry soil, w3(g)	48	51	49
Plastic limit = ((w2-w3)/(w3-w1))*100%	50	46.6	41.17
Average	45.92%		

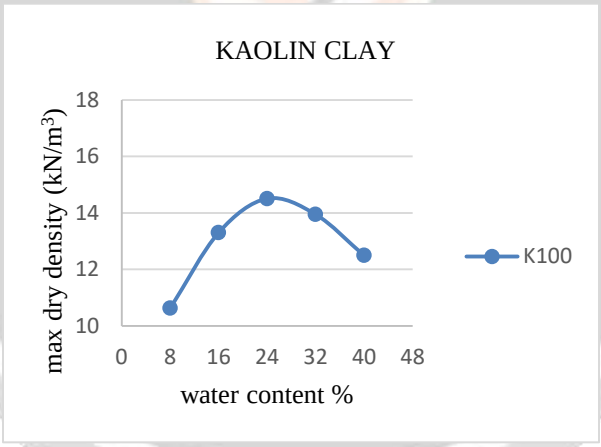
The plastic limit of given sample is 45.92%.

3. MODIFIED PROCTOR TEST

3.1 100% KAOLIN CLAY

PERCENTAGE OF WATER	8%	16%	24%	32%	40%
WEIGHT OF SOIL (gms)	2592	3552	4086	4189	3899
BULK DENSITY (gm/cc)	1.155	1.582	1.822	1.866	1.737
WATER CONTENT (%)	0.067	0.167	0.230	0.312	0.363
DRY DENSITY (kN/m^3)	10.622	13.301	14.506	13.947	12.49

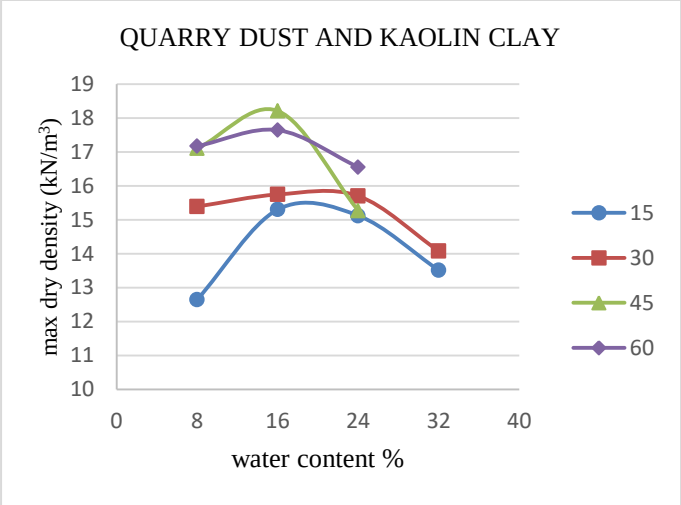
The sample contained only kaolin clay. As per the graph the maximum dry density 14.506 kN/m^3 was obtained by adding 24% of water.



compaction curve for kaolin clay

3.2 QUARRY DUST AND 85% KAOLIN CLAY

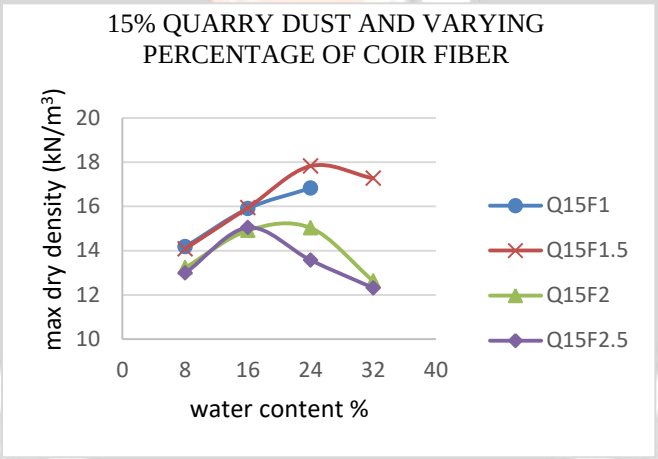
The fig shows the test results of kaolin clay with varying percent of quarry dust in which 45% of quarry dust with 55% of kaolin clay is having the maximum dry density 18.206kN/m^3 at 16%of water content.



compaction curve for kaolin clay and varying percent of quarry dust

3.31 15% QUARRY DUST, KAOLIN CLAY AND COIR FIBER

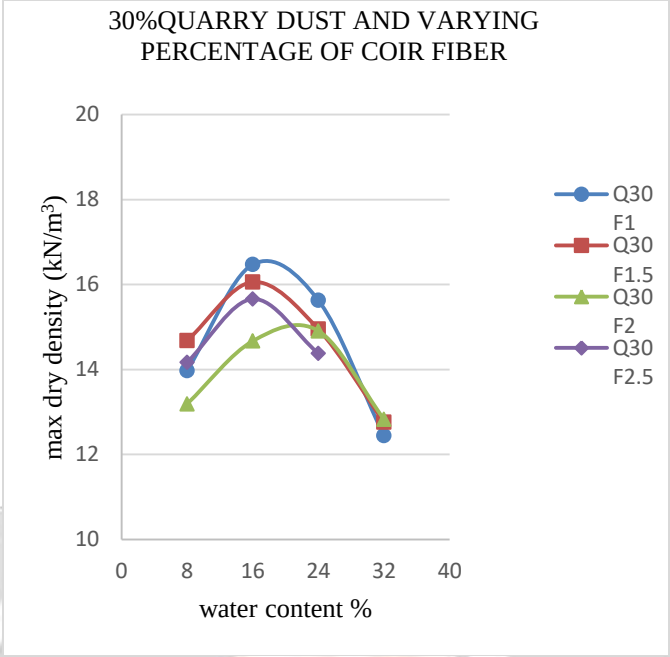
The fig shows the test results of kaolin clay with varying percent of quarry dust and coir fiber in which 15% of quarry dust with 83.5% of kaolin clay and 1.5% of coir fiber is having the maximum dry density 17.83kN/m^3 at 24%of water content.



compaction curve for 15% quarry dust and varying percent of coir fiber

3.32 30% QUARRY DUST, KAOLIN CLAY AND COIR FIBER

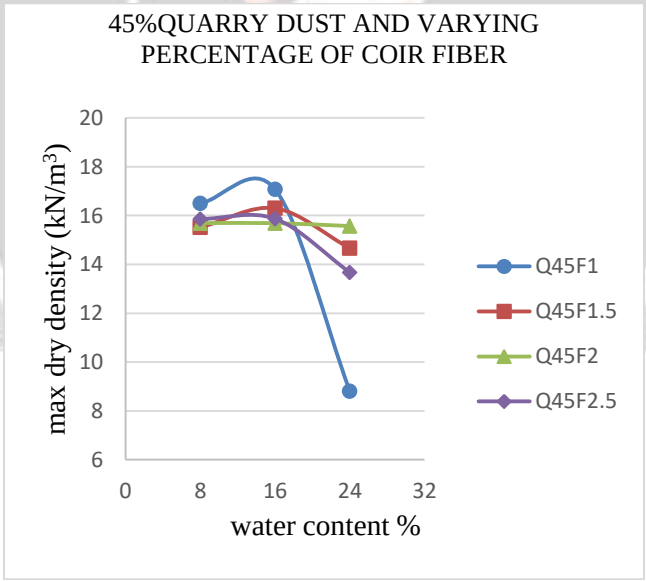
The below fig shows the test results of kaolin clay with varying percent of quarry dust and coir fiber in which 30% of quarry dust with 59% of kaolin clay and 1% of coir fiber is having the maximum dry density 16.473kN/m^3 at 16%of water content.



Compaction curve for 30% quarry dust and varying percent of coir fiber

3.33 45% QUARRY DUST, KAOLIN CLAY AND COIR FIBER

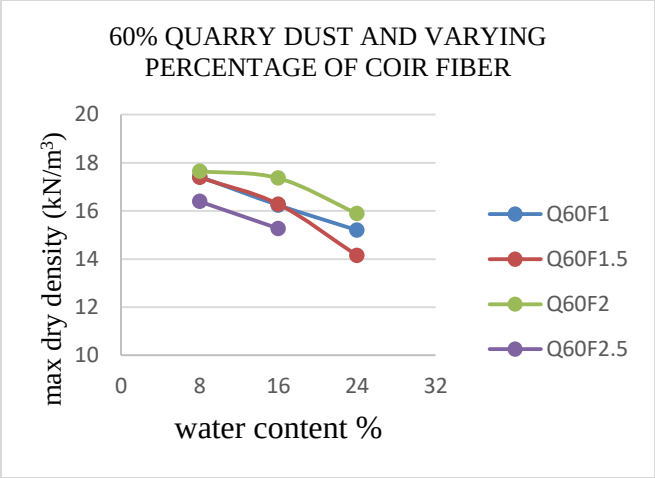
The below fig shows the test results of kaolin clay with varying percent of quarry dust and coir fiber in which 45% of quarry dust with 54% of kaolin clay and 1% of coir fiber is having the maximum dry density 17.07kN/m^3 at 16%of water content



compaction curve for 45% quarry dust and varying percent of coir fiber

3.34 60% QUARRY DUST, KAOLIN CLAY AND COIR FIBER

The above fig shows the test results of kaolin clay with varying percent of quarry dust and coir fiber in which 60% of quarry dust with 38% of kaolin clay and 2% of coir fiber is having the maximum dry density 17.658kN/m^3 at 8%of water content.



Compaction curve for 60% quarry dust and varying percent of coir fiber

CONCLUSION

- The 15%, 30%, 45% and 60% replacement of Quarry dust by kaolin clay increases the dry density by 5.5%, 8.6%, 25.56% and 21.66% respectively, hence we can conclude 45% replacement of Quarry dust by kaolin clay is the optimum percentage of replacement.
- With 15% replacement of quarry dust by kaolin clay, and 1% and 1.5% replacement of coir fibre by kaolin clay increases the dry density by 16.02% and 22.91% respectively. After that increase in coir fibre decreases the dry density. Hence we can conclude 1.5% coir fibre with 15% of quarry dust is the optimum percentage of replacement with kaolin clay.
- With 30% replacement of quarry dust by kaolin clay and 1% replacement of coir fibre with kaolin clay increases the dry density by 13.56% after that increase in the coir fibre decreases the dry density in comparison with 1% coir fibre. Hence we can take 1% coir fibre is the optimum percentage we we working with 30% quarry dust
- With 45% and 60% replacement of quarry dust by kaolin clay increases the dry density by 25.56% and 21.66% but the replacement of coir fibre with kaolin clay will not have any contribution in increasing the maximum dry density.
- Overall it can be concluded that, 15% replacement of quarry dust by kaolin clay and 1.5% replacement of coir fibre by kaolin clay is the optimum % of quarry dust and coir fibre.

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