Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

Strength Enhancement of Kaolinite Clay Using Coir and Polypropylene Fiber Reinforcement

Krishnendu M S
Student, M. Tech Structural Engineering:
Department of Civil Engineering
Rajadhani Institute of Engineering and Technology
Kerala, India

Abstract **- Soil stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties. Ground improvement is a rapidly developing field because good sites for construction are becoming limited day by day. The cost-effective, sustainable, and environmentally friendly approaches are required to strengthen the ground. Kaolinite clay is a soft white clay which has a low shrink-swell capacity and a low cation-exchange capacity. Many structural damages occur when construction is done on kaolinite clay. So, it is necessary to improve the strength and other properties of this clay.**

The usage of coir fiber and polypropylene has found to be a solution for this problem. Coconut coir fiber is a natural fiber and is obtained from the husk of coconut. Polypropylene is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles. In this project, the effect of coir and polypropylene fiber on the properties of clay such as Atterberg limits, compaction characteristics, U.C.C and CBR are focused. Test specimens were prepared with 1%, 2% & 3% of coir and polypropylene fiber. From this study, it was observed that coir and polypropylene fibers could be an effective method to improve the physical and mechanical properties of soil.

Keywords - Kaolinite clay; Soil stabilization; Coir fiber; Polypropylene fiber; Fiber reinforcement; UCS; CBR

1. INTRODUCTION

When the geotechnical engineering projects have to be built on soft and low shear strength weak soils, problems related to bearing capacity and settlement arise. Depending on the nature of project the design solution may involve the expensive option of removal, replacement and stabilization of the compressible clays. There placement option typically entails use of crushed rock, gravel or light weight aggregates which implies higher cost. Other design options involve using ground improvement alternatives such as stone columns, grouting, wick drains, chemical stabilization, adoption of reinforced earth technique etc.

Stabilization of soil is an economical and lasting method to achieve the desired geotechnical properties. Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two. Stabilization of soft soils by addition of fibers involves increase in strength and stiffness through binding. The additives are normally added as fibers. In practice, reducing the water content is difficult and time consuming hence, fibers are preferred. Addition of fibers reduces both the water content and binds the soil particles, which results in an increase in strength and stiffness. The selection of the type and the determination of the percentage of the additive fibers to be used are dependent upon the soil classification and the degree of improvement in the soil quality desired. In general, smaller amounts of additive fibers are required when it is simply desired to modify soil properties such as gradation, workability and plasticity. When it is desired to improve the strength and durability significantly, larger quantities of additive are used.

1.1 MECHANISM OF STABILIZATION

The stabilization mechanism may vary widely from the formation of new compounds binding the finer soil particles to coating particle surfaces by the additive to limit the moisture sensitivity. Therefore, a basic understanding of the stabilization mechanisms involved with each additive is required before selecting an effective stabilizer suited for a specific application. Chemical stabilization involves mixing or injecting the soil with chemically active compounds such as Portland cement, lime, fly ash, calcium or sodium chloride or with viscoelastic materials such as bitumen. Chemical stabilizers can be broadly divided in to three groups: Traditional stabilizers such as hydrated lime, Portland cement and Fly ash; Non-traditional stabilizers comprised of sulfonated oils, ammonium chloride, enzymes, polymers, and potassium compounds; and By-product stabilizers which include cement kiln dust, lime kiln dust etc. Among these, the most widely used chemical additives are lime, may be more economical when compared to the other two, the composition of fly ash can be highly variable. The mechanism of stabilization of the chemical stabilizers are:

- Traditional Stabilizers
- By-product stabilization
- Nontraditional stabilizers

1.2 SOIL STABILIZATION METHODS

Soil stabilization is a method of improving soil properties by blending and mixing other materials. Following are the various soil stabilization methods:

- In-situ Stabilization
- Deep Mixing Method

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

- Wet Mixing
- Dry Mixing
- Chemical stabilization of soil
- Electrical stabilization of clayey soils
- Soil stabilization by grouting

2. OBJECTIVES

The aim of this project is to investigate the strength characteristics of the kaolinite clay, reinforced with coir and polypropylene fiber. By carrying out this study, the following objectives can be achieved,

- To determine the geotechnical properties of the soil.
- To determine the optimum dosage of coir fiber and polypropylene fiber in kaolinite clay.
- To compare the strength between reinforced and non-reinforced soil.
- To determine the CBR value of clay by adding various percentages of coir fiber and polypropylene fiber.

3. MATERIALS

The materials used for the study are kaolinite clay from Thonnakkal, coir fiber and polypropylene fiber.

3.1 KAOLINITE CLAY

Kaolinite has a low shrink-swell capacity and a low cation-exchange capacity. It is a soft, earthy, usually white mineral, produced by the chemical weathering of aluminum silicate minerals like feldspar. In many parts of the world, it is colored pink-orange-red by iron oxide, giving it a distinct rust hue. Lighter concentrations yield white, yellow or light orange colors. Commercial grades of kaolin are supplied and transported as dry powder, semi-dry noodle or liquid slurry. Various tests like hydrometer analysis, specific gravity test, Atterberg test etc.

Fig 1: Kaolinite clay

Table 1: Properties of kaolinite clay

Property	Value
Color	White
Specific gravity	2.4
Liquid limit (%)	33
Plastic limit (%)	20.5
Plasticity index (%)	12.5
OMC (%)	16.12
MDD (g/cc)	1.78
Sand (%)	29
Silt (%)	41
Clay (%)	30
UCC	202.02
CBR for 2.5mm penetration (Kg)	8.32
CBR for 5mm penetration (Kg)	10.26
IS classification	CL

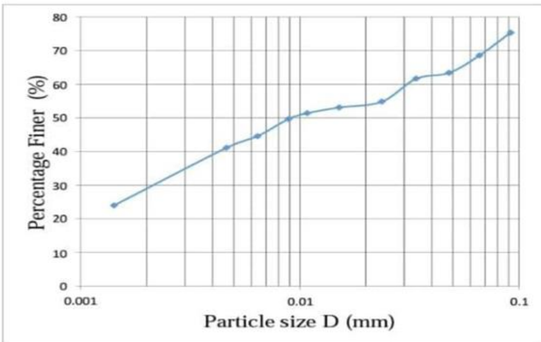

Fig 2: Particle size distribution curve

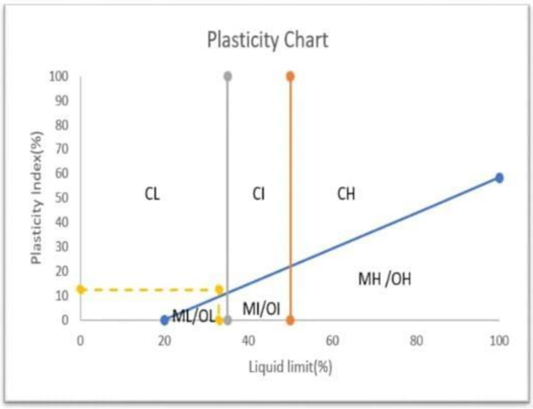

Fig 3: Plasticity chart

3.2 COIR

Coir is a versatile natural fiber extracted from mesocarp tissue, or husk of the coconut fruit. The husk contains 20% to 30% fiber of varying length. After grinding the husk, the long fibers are removed and used for various industrial purposes, such as rope and mat making. The remaining material, composed of short and medium-length fibers as well as pith tissue, is commonly referred to as waste-grade coir. The waste grade coir may be screened to remove some or all of the fiber, and the remaining product is referred to as coir pith.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

Advantages of Coir

- Resistant to fungi and rot.
- Provides excellent insulation against temperature and sound
- Unaffected by moisture and dampness
- Tough and durable

Fig 4: Coir fiber

Table 2: Properties of coir fiber

Property	Value
Length (mm)	30
Diameter (mm)	0.5
Specific gravity	1.3

3.3 POLYPROPYLENE

Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g. ropes, thermal underwear and carpets) stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids. Most commercial polypropylene is isotactic and has an intermediate level of crystallinity between that of low-density polyethylene (LDPE) and high-density polyethylene (HDPE). Polypropylene is normally tough and flexible, especially when copolymerized with ethylene. Polypropylene is reasonably economical, and can be made translucent when uncolored but is not as readily made transparent as polystyrene, acrylic, or certain other plastics. It is often opaque or colored using pigments. Polypropylene has good resistance to fatigue.

Fig 5: Polypropylene fiber

Table 3: Properties of Polypropylene fiber

Property	Value
Length (mm)	12
Diameter (mm)	0.032
Tensile Strength (MPa)	600-700
Modulus of elasticity (MPa)	3000-3500
Melt Point	160
Ignition point	365

4. METHODOLOGY

The clay samples were prepared by adding 1 to 3 percentages of coir fiber and 1 to 3 percentages of polypropylene fiber. The engineering properties of clay samples such as optimum moisture content, maximum dry density, unconfined compressive strength and CBR value is determined. The tests to be carried out are as follows:

4.1 COMPACTION TEST

Compaction test is done as per IS 2720 part 7-1980. It has been done to get the optimum moisture content (OMC) and maximum dry density (MDD) of the clay. The test is first carried out in 3000 grams of clay sample without adding coir fiber and polypropylene fiber and the values are noted. Then it is mixed with 1%, 2% & 3% of coir fiber 1%, 2% & 3% of poly propylene fiber. The length of the coir fiber is taken as 30mm and polypropylene is taken as 12mm. Compaction is a mechanical process of densification of soil mass by the input of some comp active energy. The soil and compaction process, there exist an optimum value of moisture content which will give a maximum value for dry density. Compaction is the process by which the bulk density of an aggregate of matter is increased by driving out of air. For any soil, for a given amount of compactive effort the density obtained depends on the moisture content. At very high moisture content, the maximum dry density is achieved when the soil is compacted to nearly saturation, where all the air driven out. At low moisture content, the soil particle interferes with each other, addition of some moisture will allow greater bulk densities, with a peak density where this effect begins to be counteracted by the saturation of the soil.

To perform a compaction test, clean the mould and fix it to the base. Take the empty weight of the mould with base and measure the internal dimensions. Take about 3Kg of soil sample which has been previously passed through 4.75 mm sieve. Add enough water to the soil to bring its moisture content. Fill the mould with mixed soil on 3 equal layers, with each layer being compacted by 25 blows of a hammer weighing 2.6 kg falling on the soil the blows should be uniformly distributed over the surface of each layer. After compaction, the top of the third layer should not be projecting more than 5mm to the collar. Remove the extension collar and level the top with straight edges. Clean the mould from outside and weigh it. Eject out the soil from the mould, cut it in the middle and keep a representative soil specimen for water content determination. In this test take 3kg of soil sample which has been passed through 4.75mm sieve. Add 1% coir ppf and add enough water to the soil to bring its moisture

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

content and complete the test as same in normal soil. As same as normal clay procedure add ppf at 2%,3% and complete the test. And also, compaction test conducted on the kaolinite clay by adding coir at 1%,2%,3%. By this we determine the optimum moisture content and maximum dry density.

Figure 6: Compaction mould

4.2 UNCONFINED COMPRESSION TEST

Unconfined compression test is done as per IS 2720 part 10-1973. In this test the soil specimens with and without reinforcement (fibers) were prepared in standard mould at the corresponding max dry density. The unconfined compression test is by far the most popular method of soil shear strength testing because it is one of the fastest and cheapest method of measuring shear strength. The method is used primarily for saturated, cohesive soil recovered from thin-walled sampling moulds. The unconfined compression test is inappropriate for dry sands or crumbly clays because the material would fall apart without some land of lateral confinement. The cylindrical shaped test specimens were obtained from the mould by driving sample extruder and specimens were ejected out and trimmed off so that the finished dimensions of the specimen being 3.8cm in diameter and 8.7cm in length. These specimens were tested in unconfined compression testing machine. The samples were tested till the failure surfaces were well developed or till the stress strain curve is well past its peak or until an axial strain of 20% is reached. The mix proportions used in unconfined compressive test is same as that of the compaction test.

To perform an unconfined compression test, the sample is extruded from the sample mould. A sample of soil is trimmed such that the end is reasonably smooth and the length to diameter ratio is on the order of two. The soil sample is placed in a loading frame on a metal plate; by turning a crank, the operator raises the level of the bottom plate. The top of the soil sample is restrained by the top plate, which is attached to a calibrated proving ring. As the bottom plate is raised an axial load is applied to the sample. The operator turns the crank at a specified rate so that there is a constant strain rate. The load gradually increases to shear the sample, and reading are taken periodically of the force applied to the sample and resulting deformation. The measured data are used to determine the strength of the soil specimen and the stress- strain characteristics. The maximum load per unit area is defined as the unconfined compression strength. UCC test also conduct on adding the coir and ppf. The soil is taken and add 1% of ppf and mix it after mould it then the sample is placed in a loaded frame and axial load is applied to the sample and same process done as done in normal clay. As same as normal clay procedure add 2%,3% of ppf and complete the test. And also, UCC test conducted on the kaolinite clay by adding coir at 1%,2%,3%. By this determine the shear strength.

Figure 7: UCC apparatus

Figure 8: UCC testing machine

4.3 CALIFORNIA BEARING RATIO TEST

California bearing ratio test is done as per IS 2720 part 16-1979. In this test the soil specimens with and without reinforcement (fibers) were prepared at the corresponding max dry density. The California bearing ratio is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture condition. The test procedure should be strictly adhered if high degree of reproducibility is desired. The CBR may be conducted in remolded or undisturbed specimens in the laboratory. The test has been extensively investigated for field correlation of flexible pavement thickness requirement. It is then filled in five layers, in the mould and each layer is compacted 56 times

using a hammer of weight 4.89 kg. Mould containing specimen is placed on the testing machine and a cylindrical plunger is allowed to penetrate on the specimen. The load for 2.5 mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain CBR value.
To perform an compaction test, clean the mould and fix it to the base. Take the empty weight of the mould with base and measure the internal dimensions. Take about 5kg of soil sample which has been passed through 20mm sieve. Add water to the soil in the quantity such that the moisture content of the specimen is either equal to the field moisture content. Mix together the soil and water uniformly, Then clamp the mould along with the extention collar to the base plate. Then place the coarse filter paper on the top of the spacer disc. After the mixing fill the mould with 5 equal layers, with each layer being compacted with 56 blows of hammer weighting 4.89 kg dropped. Remove the extension collar and trim the excess soil by a straight edge. Remove the base plate, spacer disc and the filter paper and note down the weight of mould and compacted specimen. Invert the mould containing compacted soil and clamp it to the base plate and plced in the testing apparatus. CBR test evaluate the strength of sub grade soil.

Figure 9 : CBR testing machine

5. RESULTS AND DISCUSSION

Various tests were carried out in order to determine the compaction characteristics, unconfined compressive strength and CBR value of clay with different percentages of coir. The test results are as follows.

5.1 POLYPROPYLENE FIBER

5.1.1 Compaction Test Results

The compaction characteristics of coir fiber reinforced clay is obtained. The test has been conducted to know the MDD and OMC of clay soil. To examined MDD value standard protector test has been performed. The analyzed values obtained after adding the ppf in different dosages of 1%, 2%, 3%. The values of maximum dry density and optimum moisture content of ppf fiber reinforced clay is given in the table.

Table 4: Maximum dry density and optimum moisture content of ppf reinforced clay

Coir Fiber Content (%)	MDD (g/cc)	OMC(%)
0	1.79	16.12
1	1.77	21.4
2	1.69	22.2
3	1.62	23.2

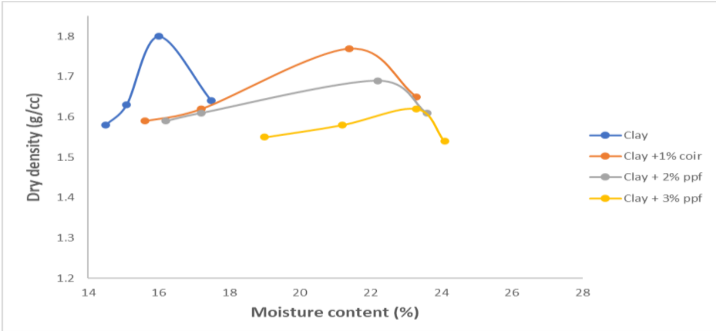

Figure 10: Compaction curve of ppf reinforced with kaolinite clay

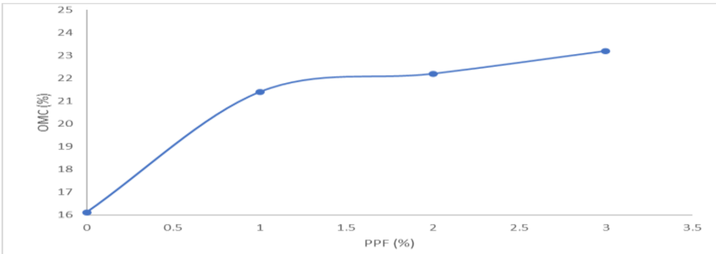

Figure 11: Variation of OMC with ppf content

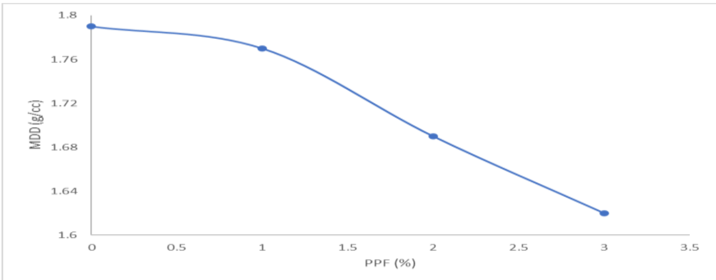

Figure 12: Variation of MDD with ppf content

It is observed that with the increase in ppf content the optimum moisture content increases and maximum dry density decreases. The decrease in weight may be due to the reduction of average unit weight of the solids in the mixture as ppf is lighter than soil. The increase in optimum moisture content may be due to the water absorption of polypropylene fiber.
Soundara B et al (2015), "Effects of fibers on properties of clay" in international journal of engineering, May (2015). conducted Standard Proctor test and CBR test on cohesive soil with low percentage of reinforcement (0-1.5% by weight of oven dried soil). The Maximum Dry Density (MDD) of fiber stabilized soil goes on decreasing and Optimum Moisture Content (OMC) goes on increasing with increase in percentage addition of coir and polypropylene fiber, irrespective of the percentage of addition of fiber. CBR test results reveal that the inclusion of randomly distributed fibers in soil increases the CBR values of the soil by two times.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

Hence, the proportion of 1% fiber with soil may be economically.

5.1.2 Unconfined Compressive Strenght Test Result

The Unconfined Compressive Strength is the maximum axial stress value withheld by the cylindrical specimen before collapsing. The unconfined compressive strength of clay samples with different percentages of polypropylene fibers were calculated from the loads at failure and is shown in Table.

Table 5: Unconfined compressive strength of ppf reinforced clay

Description	UCC (KN/m^2)
Clay	202.02
Clay + 1% ppf	211.34
Clay + 2% ppf	223.77
Clay + 3% ppf	215.488

It is observed that UCC value increased with increase in fiber content. The UCC value of kaolinite clay is 202.02 KN/m^2. There is a considerable improvement in compressive strength in case of all the soil on account of treatment with ppf. The range of UCC of soil varies from 202.02 KN/m^2 to 223.77 KN/m^2. It is noted that the compressive strength of soil increases when treated with ppf up to 2%. The increase may be due to the increase in shear parameters. At 2% of ppf content the value increases with respect to virgin clay. When the strain higher for fiber reinforced soil when compared to stabilized soil. Higher strain value indicates that behavior of the clay changed from brittle to ductile on the addition of ppf. The UCC value was maximum at 2%. The decrease in the UCC value after 2% if fiber may be due to the lesser soil-fiber interaction as fiber-fiber interaction will be more pronounced. The addition of 3% of ppf on the clay decreases the strength of the soil, The maximum strength provided while we adding 2% of ppf to the clay.
(Malekzadeh M et al, "Effect of polypropylene fiber on mechanical behavior of expensive soil "on Article in Electronic journal of Geotechnical Engineering January (2012). The study of the polypropylene fiber on maximum dry density and optimum moisture content with different fiber inclusions. compaction tests have been conducted on soil sample with 0%, 0.5%, 0.75%, and 1% additions and samples have been prepared with same dry density statically. UCC tensile and one-dimensional swell behavior of the unreinforced and reinforced soil sample. The second phase of experimental program focuses on U.C.C, tensile and one-dimensional Swell behavior of the unreinforced and reinforced soil samples. It concludes that mitigation of expansive soil using subsoils on which roads and light buildings are constructed.

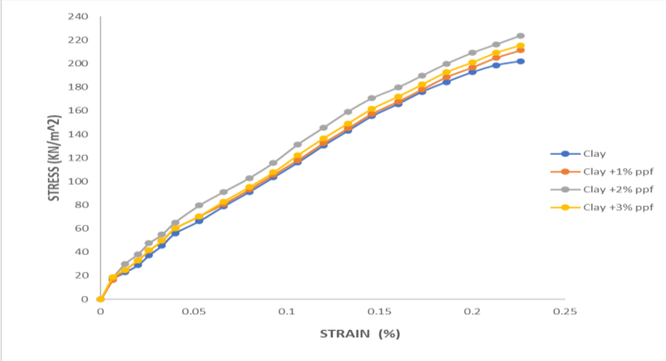

Figure 13: Stress-strain curve of UCC for ppf reinforced kaolinite clay

5.1.3 California Bearing Ratio Test

The bearing capacity of the soil was measured indirectly by conducting the CBR test. The CBR is only tested in this study because it is only test that stimulates the actual site condition. Also, the study was focused in investigating the effect of water on clay CBR value. Analyzed values obtained after adding the ppf on dosage 1%, 2%, 3%. The load penetration curve has shown that there is an improvement in the CBR value.

Table 6: CBR values of clay with ppf

Description	CBR Value for penetration of 2.5mm	CBR Value for penetration of 5.0mm
Clay	8.32	10.26
Clay + 1% ppf	12.8	14.12
Clay + 2% ppf	15.3	16.3
Clay + 3% ppf	14.14	15.5

It is observed that for 2.5 mm penetration of CBR plunger for virgin soil is 8.32 and for 5mm penetration is 10.26. When we add 1% and 2% of ppf is reinforced with the clay the load was increases as 12.8,15.3 on the 2.5mm penetration and 14.12, 16.3 on the 5mm penetration. When we add 3% of ppf with clay, there is a decrease value obtained as for 2.5 mm is 14.14 and for 5mm is 15.5. Here the load values of are increasing while we adding the ppf with virgin soil. So, in clay reinforced with 2% ppf gives the more value. This is due to the reason that randomly distributed fiber incorporated into soil mass improves its load deformation behavior by interacting with the soil particles mechanically through surface friction. Addition of ppf makes the clay a composite material whose strength and stiffness is greater than that of unreinforced soil. The strength of stiffness of reinforced soil increased with the increase in fiber content.
Malekzadeh M et al, "Effect of polypropylene fiber on mechanical behavior of expensive soil "on Article in Electronic journal of Geotechnical Engineering January (2012). The study of the polypropylene fiber on maximum dry density and optimum moisture content with different fiber inclusions. compaction tests have been conducted on soil sample with 0%, 0.5%, 0.75 and 1% PPF additions and samples have been prepared with same dry density statically. CBR value are increasing with addition of ppf. It concludes

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

that mitigation of expansive soil using subsoils on which roads and light buildings are constructed

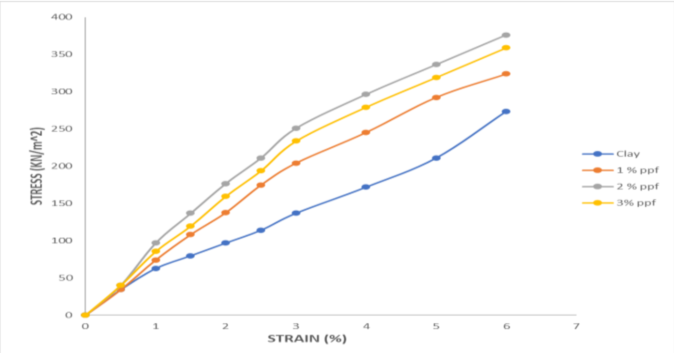

Figure 14: CBR curve for ppf reinforced kaolinite clay

5.2 COIR FIBER

Various tests were carried out in order to determine the compaction characteristics, unconfined compression strength and CBR value of clay with percentages of coir fiber reinforced with clay is given in the table.

5.2.1 Compaction Test Results

The compaction characteristics of ppf reinforced clay is obtained. The test has been conducted to know the MDD and OMC of clay. To examined MDD value standard protector test has been performed. The analyzed values obtained after adding the coir in different dosages 1%, 2%, 3%. The values of maximum dry density and optimum moisture content of coir reinforced clay is given in table.

Table 7: Maximum dry density and optimum moisture content of coir fiber Reinforced kaolinite clay

PPF CONTENT (%)	MDD (g/cc)	OMC (%)
0	1.79	16.12
1	1.74	17.23
2	1.68	17.82
3	1.66	18.23

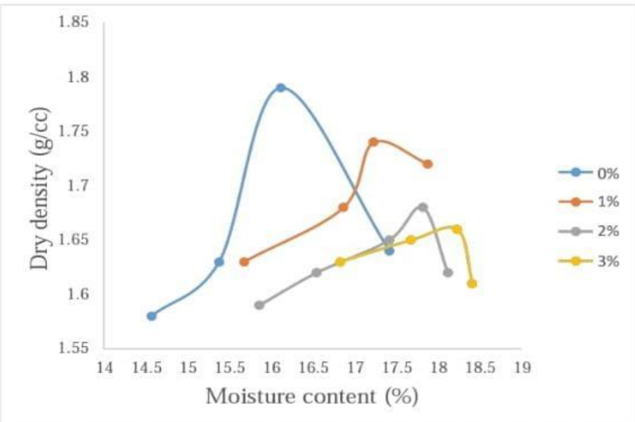

Figure 15: Compaction curve of coir fiber reinforced kaolinite clay

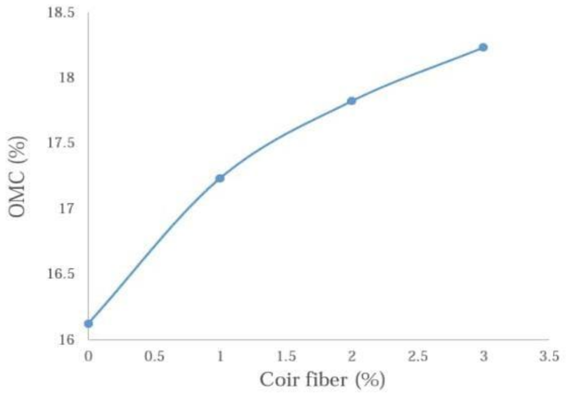

Figure 16: Variation of OMC with coir content

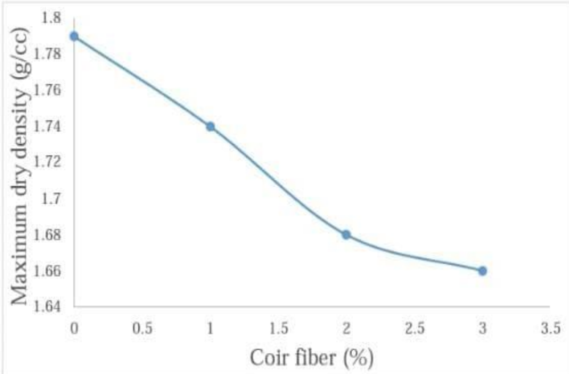

Figure 17: Variation of MDD with coir content

It is observed that with the increase in coir content the optimum moisture content increases and maximum dry density decreases. The decrease in weight may be due to the reduction of average unit weight of the solids in the mixture as coir is lighter than soil. The increase in optimum moisture content may be due to the water absorption of coir fiber
Mahima D et al, "Effects of coir fiber and sawdust ash on the strength characteristics of kaolinite clay "International journal of engineering research and technology, (2019) It is observed that the MDD decreased for increasing in percentage of coir. The OMC value is constantly increasing upon increasing percentage of coir. In UCC value increased in fiber content. At 0.75 % fiber content value increased by 10% of the kaolinite clay. The decrease in the UCC value after 0.75 % if fiber may be due to lesser soil fiber interaction. The Maximum Dry Density (MDD) of fiber stabilized soil goes on decreasing and Optimum Moisture Content (OMC) goes on increasing with increase in percentage addition of coir and polypropylene fiber, irrespective of the percentage of addition of fiber. CBR test results reveal that the inclusion of randomly distributed fibers in soil increases the CBR values of the soil by two times. Hence, the proportion of 1% fiber with soil may be economically.

5.2.2 Unconfined Compressive Strength Test Results

The Unconfined Compressive strength is the maximum axial stress value withheld by the cylindrical specimen before collapsing. The unconfined compressive strength of soil samples with different percentages of fiber were calculated from the load failure and is shown in table.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

Table 8: Unconfined compressive strength of coir reinforced clay

Description	UCC (KN/m^2)
Clay	202.02
Clay + 1% coir	209.2
Clay + 2% coir	219.63
Clay + 3% coir	213.416

It is observed that UCC value increased with increase in fiber content. The UCC value of kaolinite clay is 202.02 KN/m^2. There is a considerable improvement in compressive strength in case of all the soil on account of treatment with coir fiber. The range of UCC of soil varies from 202.02 KN/m^2 to 219.63 KN/m^2. It is noted that the compressive strength of soil increases when treated with coir fiber up to 2%. The increase may be due to the increase in shear parameters. At 2% of coir content the value increases with respect to virgin clay. When the strain higher for fiber reinforced soil when compared to stabilized soil. Higher strain value indicates that behavior of the clay changed from brittle to ductile on the addition of coir fiber. The UCC value was maximum at 2%. The decrease in the UCC value after 2% if fiber may be due to the lesser soil-fiber interaction as fiber-fiber interaction will be more pronounced. The addition of 3% of coir fiber on the clay decreases the strength of the soil, The maximum strength provided while we adding 2% of coir fiber to the clay.

Mahima D et al, “Effects of coir fiber and sawdust ash on the strength characteristics of kaolinite clay “International journal of engineering research and technology, (2019). In UCC value increased in fiber content. At 0.75 % fiber content value increased by 10% of the kaolinite clay. The decrease in the UCC value after 0.75 % if fiber may be due to lesser soil fiber interaction. UCC tensile and one-dimensional swell behavior of the unreinforced and reinforced soil sample. The second phase of experimental program focuses on U.C.C, tensile and one-dimensional Swell behavior of the unreinforced and reinforced soil samples. It concludes that mitigation of expansive soil using subsoils on which roads and light buildings are constructed.

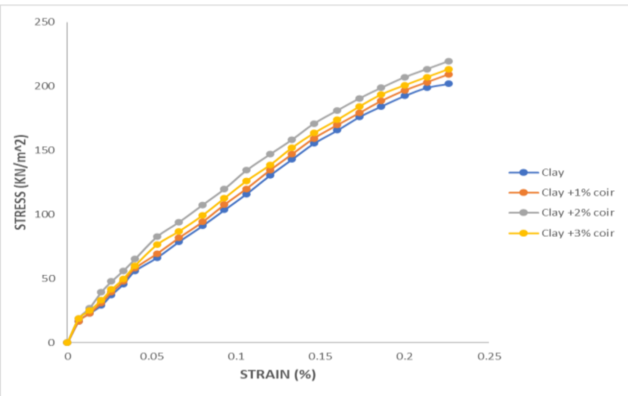

Figure 18: Stress - strain curve of UCC for coir reinforced kaolinite clay

5.2.3 California Bearing Ratio Test Results

The bearing capacity of the soil was measured indirectly by conducting the CBR test. The CBR is only tested in this study because it is only test that stimulates the actual site condition. Also, the study was focused in investigating the effect of water on clay CBR value. Analysed values obtained after adding the coir on dosage 1%, 2%, 3%. The load penetration curve has shown that there is an improvement in the CBR values.

Table 9: CBR values of clay with polypropylene fiber

Description	CBR values for penetration of 2.5 mm	CBR values for penetration of 5mm
Clay	8.32	10.26
Clay + 1% coir fiber	11.6	13.03
Clay + 2% coir fiber	12.48	14.7
Clay + 3% coir fiber	12.02	14.14

It is observed that for 2.5 mm penetration of CBR plunger for virgin clay is 8.32 and for 5mm penetration is 10.26. When we add 1% and 2% of coir is reinforced with the clay the load was increases as 11.6,12.48 for 2.5 mm penetration and 13.03,14.7 for 5mm penetration. When we add 3% coir with the clay, there is a decrease value obtained as for 2.5 mm is 12.02 and for 5mm is 14.14. Here the load value is increasing while we adding the coir with virgin clay. So, in clay reinforced with 2% coir gives the more value. This is due to the reason that randomly distributed fiber incorporated into soil mass improves its load deformation behavior by interacting with the soil particles mechanically through surface friction. Addition of coir fiber makes the clay a composite material whose strength and stiffness is greater than that of unreinforced soil. The strength of stiffness of reinforced soil increased with the increase in fiber content.

R.R Singh, E.R. Shelly Mittal (2014) conducted an experimental study on locally available i.e. clayey soil mixed with varying percentage of coir fiber. Soil samples for unconfined compression strength (UCS) and California bearing ratio (CBR) tests are prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould without and with coir fiber. The percentage of coir fiber by dry weight of soil is taken as 0.25%, 0.50%, 0.75% and 1% and corresponding to each coir fiber content unsoaked and soaked CBR and UCS tests are conducted in the laboratory. Tests result indicates that both unsoaked and soaked CBR value of soil increases with the increase in fiber content.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

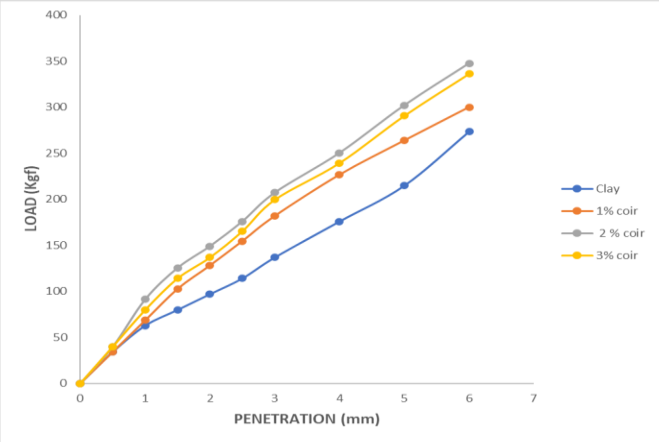

Figure 19: CBR curve for coir reinforced kaolinite clay

5.3. ANALYSING OF RESULTS

5.3.1 California Bearing Test-Polypropylene fiber

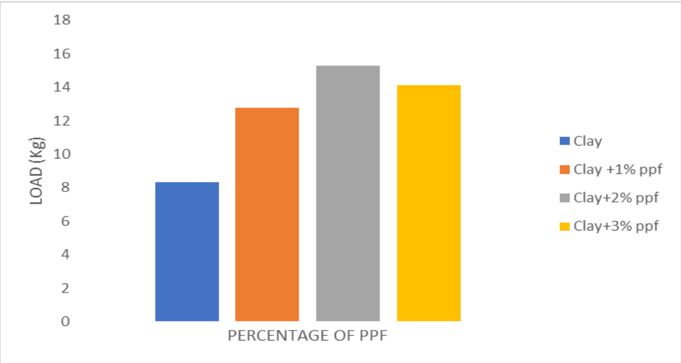

Figure 20: Load for 2.5mm with percentage of ppf

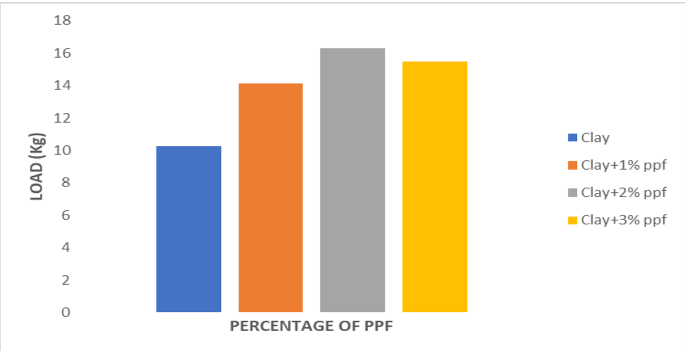

Figure 21: Load for 5mm with percentage of ppf

5.3.2 California Bearing Test – Coir

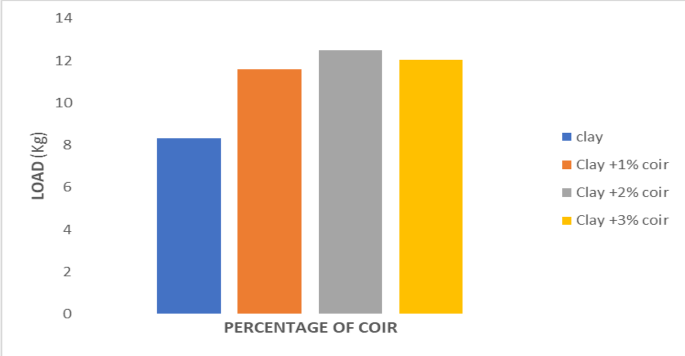

Figure 22: Load for 2.5mm with percentage of coir

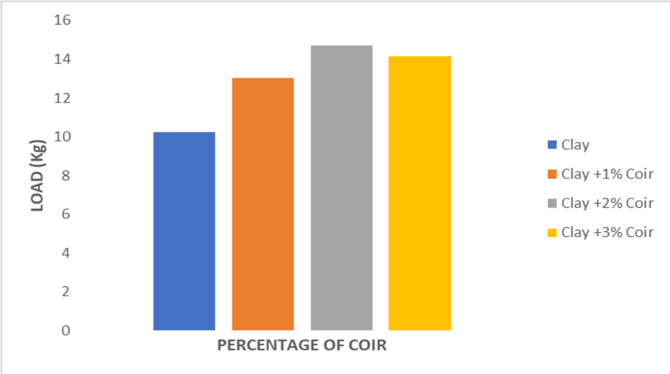

Figure 23: Load for 5mm with percentage of coir

5.3.3 Unconfined Compressive Strength Test

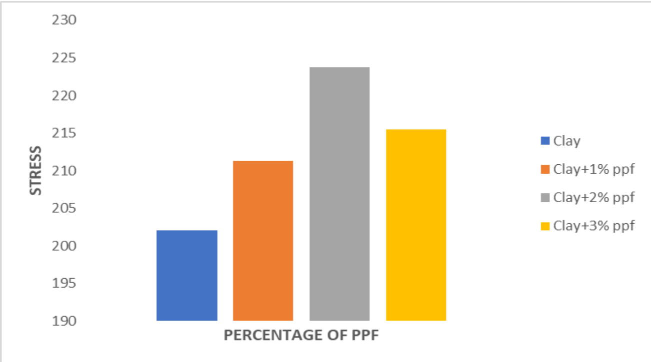

Figure 24: Stress with percentage of ppf

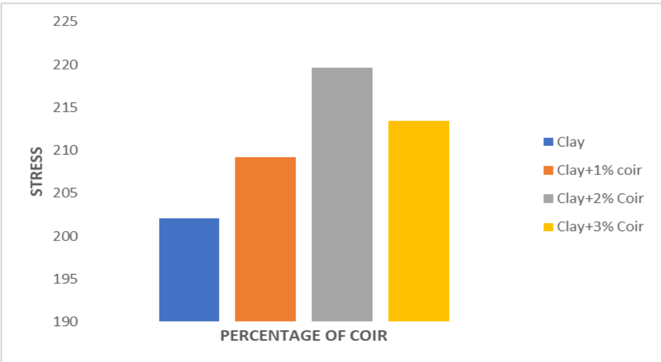

Figure 25: Stress with percentage of coir

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

6. CONCLUSION

The effect of coir fiber and polypropylene fiber on the strength of kaolinite clay have been studied. Following conclusions were obtained:

6.1 COIR FIBRE

- Soil properties are improved by the addition of coir fiber in kaolinite clay.
- OMC increases with increase in addition of coir fiber.
- MDD of clay decreases with increase in addition of coir fiber.
- The strength of soil increases with increase in percentage of coir fiber.
- CBR value increases with increase in the addition of coir fiber.
- Coir fiber is a waste material which could be utilized for stabilizing clay for pavement, embankment construction, etc.

6.2 POLYPROPYLENE FIBER

- Soil properties are improved by the addition of polypropylene fiber in kaolinite clay.
- OMC increases with increase in addition of percentage of ppf.
- MDD of clay decreases with increase in addition of ppf.
- The strength of soil increases with increase in percentage of ppf.
- CBR value increases with increase in the addition of ppf.
- The CBR values of the reinforced soil are greater than the normal, so the proportion of fiber with soil may be economically used in road pavement and embankment construction.

FUTURE STUDY

Consider the results, this experimental study can be taken to the next level by stabilization of kaolinite clay by adding the additives such as polypropylene fiber and coir fiber together. Adding the ppf and coir together and conducting these tests for determine the improvement of strength of the soil.

REFERENCE

1. Mahima D and Sini T (2019), “Effect of sawdust ash and coir fibre on strength characteristics of kaolinite clay”, IJERT, Volume 8, Issue 06, Pg. 12564-1272.
2. Sarah A H and Haita Ali” (2019) Stabilization of expansive soil using polypropylene fibre, Civil Engineering journal, Volume 5, No 3, Pg. 624-635.
3. Langade S, Dahale P and Mehta A (2019), “Effect of polypropylene on cement stabilized soil”, IJCIET, volume 5, Issue: 07, Pg. 180-182.
4. Prasanna R,Robin Varghese and Kumar S (2018), “Stabilization of lithomargic soil using polypropylene fiber”, IJRT, Volume 05, Issue: 07, Pg. 180-182.
5. Pooja Upadhyaya and Yatindra S (2017), “Soil Stabilization using natural fiber coir”, IRJET, Volume 04 Issue: 12, Pg. 1808-1812.
6. Shreyas K (2017), “Stabilization of clayey soil by lime and coir”, ISARSE, Volume 6, Issue 11, Pg. 420-441.
7. Jeena M and Karthika Romison (2016), “Comparative study on effect of soft soil stabilization using coir fibers and polypropylene”, ICETEM, CISSN:2278-1684, P-ISSN:2320-3347, Page no. 61-68.
8. T. Subramani and D. Udayakumar” (2016), “Experimental study on stabilization of clay soil using coir fibre”, IJAISEM, Volume 5, Issue5, Pg. 192-204.
9. Jesna Varghese, Remya U R and Snigdha. V (2016) “The effect of polypropylene on the behaviour of soil mass with reference to the strength parameter”, IJERT, Volume5, Pg. 781-784.
10. Soundara. B and Senthil Kumar K.P (2015), “Effect of fibre on properties of clay”, IJEAS, Volume 2, Issue 5. Pg. 123-128.
11. Shakla Devdatt, Shikha R, Saxena A K and Jha A K (2015), “Soil stabilization using coconut coir fiber”, IJRASET, Volume 3 Issue 9, Pg. 305-309.