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Study On Laterite Soil Stabilization Using Pond Ash And Polypropylene Fiber

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Abstract: Stabilization or Rectification of soil is the most common method for the engineers. Stabilization of soil using the pond ash is one of the influential methods for stabilizing the soil. Stabilization by the fiber is also one of the tact for improving its properties. The aim of the work is to evaluate the strength properties of the soil using coal wastes and polypropylene fiber. In this study mainly inquisition on the different percentage of pond ash (6, 12, 18 and 24 %) and fiber content (0.25, 0.5, 0.75 and 1%) were used to determine the optimum for both additives. Experimental test conducted mainly California Bearing Ratio (CBR) and Unconfined compression strength (UCS) tests. Pond ash and polypropylene fiber is the good stabilizer for the laterite soil. From the investigation it was observed that the pond ash has the pozollonic material to improve the strength properties of the soil and polypropylene fiber has the good non absorbing material it can also bind the soil properly and it increase the soil strength. Industrial coal waste and synthetic waste material used contribute the soil stabilization to improve the properties of soil.

***Index Terms* -** Laterite soil, Pond ash, Polypropylene fiber, OMC, MDD, UCS, CBR.

I. Introduction

Soil stabilization is a making hardening of soil by addition or replacement of additives by to increase the shear capacity of the soil. Soil stabilization is used mainly in construction of earth dams, embankments, sub-grade, sub base, base, runways, pavements, etc. Pavement is a structure formed by natural or borrowed soil, on which other gradual layers such as sub- grade, sub-base, base, asphaltic concrete or cement concrete are laid

Laterite soil in india

Laterite soil formed due to intensive and long-lasting weathering of the underlying parent-rock. Laterization or weathering is a continued process, formed due to chemical and environmental variations effect. Laterite soil commonly occurs in Kerala, western parts of Karnataka, Chhattisgarh and hilly areas of Assam and Orissa or in general hot and wet tropical areas. These are generally porous and spongy structures with deep brown, red or yellowish-red in color because of rich aluminium and iron oxide content in it. In India laterite soil can be used as building materials during construction of structures. Most of laterite gravels and gravely soils give high laboratory and field compaction densities but their performances were found to be very poor under adverse traffic and moisture conditions. The major problems associated with most of the laterite soil are (Ravishankar, 2008)

- It doesn’t achieve conventional specifications for road construction materials especially for road base.
- It undergoes property changes during construction.

Pond-ash

Thermal power plants are the major source to produce electric power required for the industrial development and rail transport. Unlike thermal power plants produces more waste such as fly-ash and bottom ash in vast quantities. This has effect surrounding environment due to dust and others chemical present in ashes. The unutilized fly ash and bottom ash are stored in ash pond and termed as pond ash. Micron-sized pond ash elements consist primarily of silica, alumina and iron. The large quantity disposal into ash ponds is liable for leaching heavy metals from pond ash into ground water and feasible transmissions of trace metals into food chain, through as whole pond ash in not included in the hazardous waste group. The developing countries like China and India together produce over 300 million tons of fly ash per year with less than half of it is in use. In India there are 83 thermal power stations use bituminous and sub bituminous coal producing about 180Mt (Metric ton) of fly ash per year (Sarat, 2015).

Polypropylene fiber (pf)

Stabilization of soil using PF is one of the advanced techniques to improve the strength properties of soil. PF is the world second most widely produced synthetic plastic after the polyethylene. Among polymer fibers polypropylene is the most widely used fiber in researches because of its low cost, outstanding toughness and enhanced shrinkage cracking resistance in the soil reinforcement. One more quality of PF is their efficiency. The efficiency depends on the fiber matrix, fiber volume inclusion, geometry of fiber, types of fibers and orientation of fiber in soil mixture. The PF has a white in color and less weight than the water so it is floated in water. It has the flexibility nature, now days recent used for manufacture of the high compressed stabilized earth block using PF.

Objective of the study

- To determine the geotechnical properties of laterite soil
- To evaluate the strength parameters using Pond ash and polypropylene fiber.
- To determine the change in CBR associated with strength and UCS values with addition of different percentages of PF and pond ash

2.Liturature Review

Ravi Shankar and Suresh (2008) : Studied on the characterization of laterite soil modified with pond ash and cement. Pond ash varying the percentages of 5, 10, 15 and 20%. The pond ash used for the soil MDD decreased and OMC increased due to the pond ash less weight than the soil particles. Hence for proper bonding, cement is replaced with constant 4% maintained. When cement is used the MDD increases and OMC also increases. Addition of the 20% of the pond ash and 4% cement to the soil get the optimum moisture content and maximum dry density. UCS value increases from the 153 KN/m^2 to 235 KN/m^2. CBR test result for the soil un-soaked condition to be 13.2 to 46.2% increased and soaked condition to be 5.6 to 19.6 % increased. Addition of 20% pond ash and 4% of cement improved the strength properties of the soil so this is the peak value.

Pradeep et al (2011) : Investigate on the randomly oriented fiber and fly ash on the strength behavior of locally available course grained soil and fine grained soil. The soil measurement is taken as 100% soil with fly ash, 50% soil with 50% fly ash and soil with 100% fly ash, for these soil and fly ash proportion the PF content varies from 0, 0.5, 1 and 1.5%. Laboratory test are compaction and UCS tests were conducted. When 100% soil with 0% fly ash and to that 1% of PF used, MDD varies from 15.70 to 15.00 KN/m^3, OMC varies from 24.69% to 26.10 %. UCS value increased to 65.86 to 655.57 KN/m^2.

When 50% soil with 50% of FA and with 1% of PF the MDD decreased from 15.70 to 14.73 KN/m^3. OMC varies from 24.69 to 28.63%, UCS value increased from 65.86 to 472.98 KN/m^2.

When 0% soil with 50% of FA and with 1% of PF the MDD value decreased from 15.70 to 13.20 KN/m^3, OMC value increased from 24.69 to 29.30%, UCS value decreased from 65.86 to 24.98 KN/m^2 value is decreased because of fly ash is light weight material than soil. Here studied the different proportion of fly ash mixed with soil, and cheek the strength of fly ash without any addition of soil they conclude that soil mixed with 50% of FA and 1% of PF gives the strength to the soil.

Patil et al. (2013) : Investigated on the properties of sub grade of clay soil using PA. In this study pond ash varies from 0, 10, 20, and 30%. Investigate study on compaction test, UCS and CBR tests are to be carried out. Optimum value obtained at 20% of the pond ash used on the clayed soil. Maximum dry density value increased from 1.43 to 1.48 g/cc. Optimum moisture content decreases from 25 to 20%. California bearing ration value increased from 2.6 to 6.03%. They conclude that soil stabilization optimum dosage of pond ash is 20%.

Vaidya et al. (2014) : Determined the engineering properties of fly ash with a mixture of cement and fiber. The fly ash was replaced by cement at 0, 5, 10, and 20% and fiber variation with 0, 0.5, 1 and 1.5% at an increment of 0.5% weight of fly ash. The results showed that MDD increases up to addition of 1% reinforced FA and cement mixture and further it decreases. MDD value increased from 1.5 to 2.0 g/cc. UCS value increased from 160 to 280 KN/m^2.

Karthik et al. (2014) : Investigated on stabilization of soil using FA. The percentage of FA varies 0, 5, 10, and 15% to the locally available red soil. Test conducted on the Liquid limit, plastic limit, plasticity index, Compaction test, UCS and CBR tests were conducted and the results shows that there is decrease in the liquid limit of the soil. Specific gravity increases at 10% addition of fly ash beyond 10% addition of the fly ash on to the soil value decreases. At the 10% addition of fly ash to the soil get the optimum value. Liquid limit of the test of soil the value decreased from 32 to 23%. plastic limit value decreased from 23.37 to 14. OMC content of the soil increased from 8 to 10%. MDD of the soil increased from 2.1 to 2.4 g/cc. CBR value increased from 2 to 3.6 %. UCS value increased 3.88 to 4.88 kPa.

Changizil et al. (2014) : Investigate on the effect of adding recycled polyester fiber on the properties of clayed soil. Especially shear strength, compaction test, atternberg's limits were conducted. Polyester fiber was mixed with soil in the deferent percentages of 0.1, 0.3, 0.5 and 0.8%. Increase in the fiber content plastic limit of soil increases. Optimum dosage obtained at 0.5% of PF added to the soil. OMC content of the soil decreased from 15 to 12%, MDD of soil increased from 17.68 to 18.8 KN/m^3. Unconfined compressive strength value increases from 150 to 300 kPa. California bearing ratio value increased from 5 to 8.5%.

Agopitusamadi et al. (2015) : Investigate on the laterite soil stabilized with FA as suitable structural material for flexible pavement construction. Conducting test are atternberg's limits, compaction test, UCS and CBR test.fly ash content varies from 0, 5, 10, 15, and 20%. By using fly ash up to 10% get the optimum value. OMC increases from 11.8 to 13%. MDD increases from 1.7 to 2.2 g/cc UCS value increased from 500 to 1200 KN/m^2. California bearing ration value increased from 4 to 30%.

Deepak and Arvind (2017) : Studied on soil stabilized with pond ash and Rise husk ash (RHA) and keeping cement percentage as constant. Modified proctor test were performed in order to investigate compaction behavior of soil, CBR, UCS tests were conducted. Soil was replaced with PA and RHA. Percentage of pond ash varies from 0%, 10%, 20%, 30%, 40% and 50%, rise husk ash varies from 0, 5, 10 15 and 20%. The OMC and MDD for the PA and RHA were calculated separately. For RHA blend with soil, OMC content varies from 16 to 20%, MDD varies from 1.60 to 1.70 g/cc. when PA blend with soil OMC varies from 16.5 to 22% the MDD value decreased from 1.8 to 1.60 g/cc. Finding the optimum values from both admixture, get optimum values for PA at 30% used and for RHA at 15% used. For that percentage varies the cement content 4% UCS and CBR tests.

CBR value increasing from 3.2 to 16.76 % when addition of 10 % RHA, 4% of cement. CBR value also increases 3.2 to 14.6% when soil blend with 30 % of PA and 4% of cement.

Deepak and Aravinda (2015) : Investigated on characteristics of clay soil using pond ash and Polypropylene fiber. PA varies from 0, 10, 20, 30, 40 and 50%. PF varies from 0, 1, 2, 3, 4, and 5% respectively by the weight of soil. Cement content varies from 0, 1, 2, 3, and 4%. Test carried out on the compaction, UCS, CBR tests were conducted from this study. UCS value increased from 110 to 152 kPa, CBR value increased from 2.5 to 30 %. When blend with 5 % of PF and 4% of cement. When pond ash mixed with soil 40% of pond ash and 4% of cement unconfined compression test value increased from 166 to 209 Kpa. Then CBR value increased from 2.5 to 7%. The value increases because due to fly ash contains the silica and alumina these acts as cementaceas bonding with soil.

Sathya et.al. (2016) : Examined on behavior of PF for soil reinforcement at 0, 0.5, 1 and 1.5%.Laboratory test conducted to know soil parameter such as compaction test, unconfined compression test. When PF fiber is added to the soil dry mix of the soil is to done properly and compaction is done with varying the percentage of water content, contributing to the dry density. OMC of the soil increases with increase in the fiber content at higher stabilizer content and reduce after the addition of 1% of stabilizer. It is observed that the MDD value at 1% fiber content is 1.48g/cc. The maximum value of UCS was obtained 4.73 KN/m^2 at 1% PF.

Lathe and Dipin (2016) : Investigated on improving the soil by using the pond ash and coir fiber for laterite soil. During this work series of work test such as, CBR, compaction and UCS test were carried out. Pond ash varies from 10%, 20%, 30%, and 40% and coir fiber varies from 0.5%, 0.75%, 1% and 1.5%. Pond ash up to 30% added to get the optimum results and above 30% pond ash used strength decreases. Addition of 1% of fiber, the UCS of soil increases to 39.2kN/m^2 from 23.95kN/m^2.There is a 15 % increase in UCS of the untreated soil by the combined effect of pond ash and coir fiber.

Ramakrishna et al. (2016) : Investigated on the stabilization of soil using waste fiber material. By conducting experiments on liquid limit, shrinkage limits and unconfined compressive strength. The amount PF used for the study is 0, 0.05, 0.15, and 0.25%. Average diameter of the PF has 0.034mm and average length is 12mm used for the stabilization of soil. Addition of 0.15% of PF to soil optimum value is obtained. Liquid limit value increased from 41.33 to 44.89%, plastic limit value decreased from 29.68 to 23.35%, shrinkage limit value increased from 4 to 6.65%, unconfined compression test value increased from 370 to 430 kPa.

Ravi et al. (2017) : Investigated study of clay soil using the PF and lime. From the study only varying the PF to the soil and fixing the lime content at 4%. Addition of the PF varies to the weight of soil 0.25, 0.5, 0.75 and 1%. Laboratory test conducted on the compaction test and CBR test were formed. When PF replace with clay soil the OMC is decreased and increase the dry density 1.41 to 1.81 g/cc. this obtained at 0.75% of PF used. Optimum result will obtained by using the 0.75% of PF. CBR value increases from 1.72% to 4.56% by keeping 4% of lime constant and 0.75% of PF.

Pallavi et.al. (2016) : Studied on lateritic soil behavior addition of fly ash (FA) and coir fiber(CF). FA content varies from 5, 10, 15%, and CF varies from 0.25, 0.5, and 1%. These additives are mixed with soil at different proportion. They conduct the laboratory experiments such as liquid limit, plastic limit, compaction, and UCS test. When fly and coir fiber added with to the soil the plastic limit and liquid limit was continuously goes on decreasing due to FA has light weight material and it was less specific gravity and hence the plastic limit and liquid limit goes on decreases. Peak value obtained at soil was mixed with 5% FA and 0.5% of fiber. OMC increased from 19.73 to 21.98% and MDD decreased from 1.3 to 1.25 g/cc. UCS value increased from 61.66 to 72 KN/m2.

Jeenamenson (2017) : Investigated on stabilization of soil using fibers such as polyethylene Terephthalate (PET) bottle fibers and polypropylene sack fibers to improve the strength of laterite soil. In this study laboratory test are including compaction test, unconfined compression test are to be conducting by varying the percentage of polyethylene Terephthalate and PF. The Terephthalate fibers and PFs are varying the percentage of 0.05, 0.1, 0.15, 0.2, and 0.25%. For both the PET and PF, OMC doesn't vary much with addition of fibers. The value decreases with increase in the fiber content. For bottle fiber and PF the optimum moisture content varies from 24.02 to 22.5% and 24.02 to 21.0%. MDD increases at 0.1% of fiber is used get optimum. For bottle fiber MDD value increases from 1.55to 1.7 g/cc and for PF MDD increases from 1.55 to 1.6 g/cc. For bottle fiber UCS value increased from 0.24 to 0.56 kg/cm^2. For PF the UCS value increased from 0.24 to 0.6 kg/cm^2.

George (2014) : Studied on the effect of stabilizing agents such as fly ash, cement and lime mixed with laterite soil. Laboratory test such as compaction and UCS tests were conducted. The lime, fly ash and cement are varies in the range of 0, 2, 4, 6, 8, 10 and 12% respectively. In cement stabilization believed to be results of chemical reaction of cement with siliceous content present in the soil during the hydration. Cement stabilized with laterite soil the UCS value increased from 25 to 30 kg /cm^3 when 8% of cement used in soil, beyond 8% the UCS value decreases because due to free lime liberated in the hydration process.

Lime is stabilized with soil variation on the plastic limit and liquid limit of soil. The plastic limit value increased to 18.4 to 28%, liquid limit value increased from 35.7 to 50 %, UCS value increased from 17.5 to 30 kg/cm^2. The fly ash mixed with soil the UCS value increased from 17.5 to 31 Kg/cm^2.

All the materials utilized in the experimental study were locally available region. The materials used in the experimental research consists laterite soil and PA and PF. Experimental inquest geotechnical properties of the soil stabilized with PA and PF and know the suitability for mixed ratio get optimum results using stabilizing agents for laterite soil.

3. MATERIAL USED

In this study, stabilization process is done to progress the strength and bearing capacity of laterite soil using PA and PF separately. The material is collected locally and their properties were studied.

The materials used are

- Laterite soil
- Pond ash.
- Polypropylene fiber.

Laterite soil

Laterite soil sample of 2m depth soil strata was collected from the nearby quarry site. Field density was determined. Laterite soil occurs in coastal Karnataka region. These occur in dry and cold condition region. Figure 3.1 shows the collection of the laterite soil from the sub grade of soil strata. Laterite soil has to be collected before the monsoon season occurs because its properties changes during the rainy season.

Figure 3.1: Collection of soil sample from the quarry

Pond ash

The pond ash was collected from the Udupi power corporation private limited (ADANI ADATLE GROUP). Pond ash is a mixture of coal ash, fly ash and some bottom ash content poured in large areas and mixed with water to avoid dust. This pond ash is used as one of the modifiers with environmental consideration. Figure 3.1 depicted collection of pond ash from Udupi coal factory.

Figure: 3.2 Collection of pond ash from the Udupi power corporation private limited.

Pond ash is a waste material containing the fly ash content and some bottom ash content obtained by burning a coal. Pond ash is a light weight material; precaution should be taken during collection of the samples because when touches without safety instruments burning sensation will takes please to the skin. Pond ash is used to improve the strength and other properties of the soil by partial replacement. The chemical properties of the pond ash are shown in the table 3.2.

Table no: 3.1 Chemical properties of pond ash

Silica (SiO_2)	67.40
Alumina (Al_2O_3)	19.44
Iron Oxide (Fe_2O_3)	8.5
Calcium Oxide (CaO)	3.7
Magnesium Oxide (MgO)	0.45
Sulphur (SO_3)	0.30
Loss of Ignition	3.46

Source: www.properties of coal ashes

3.2 Polypropylene fiber

PF is one of the synthetic waste plastic materials produced in India in larger quantity. The particle size varies in millimeter like 6, 12, 18, and 24 mm etc., in the present study, fiber of 12mm length was considered. It can be used in concrete and recently as soil improving material. These fibers are light in weight and white in color as described in figure 3.3. PF occurs in two types they are monofilament fiber and film fiber. Monofilament fiber manufactures from extrusion process though orifices in a spinneret and then cut in proper length. The tensile strength of the fiber high and due to its light weight and shrinkage

Figure: 3.3 Polypropylene fibers

Table 3.2 Properties of PF

Source: cameo.mfa.org/wiki/ Polypropylene fiber

Fiber type	pure polypropylene
Density (kg/cm^2)	900
Unit weight (g/cm^3)	0.91
Average diameter	0.034 mm
Average length	12 mm
Breaking tensile strength	350 mm
Modules of elasticity(KN/m^2)	35-50
Burning point (C^0)	590
Acidic and alkali resistance	Very good
Specific gravity	0.90

3.3 METHODOLOGY

- Laterite soil samples were collected from the site, and checked for its basic parameter as per IS standards.
- From the results of the basic tests, the optimum percentage of the PA and PF to be added for stabilizing soil are fixed.
- Then the PA is blended by varied proportion i.e. 6, 12, 18 and 24% then PF at 0.25%, 0.5%, 0.75% and 1% determine the OMC and MDD of the soil.
- UCS and CBR tests were conducted for soil samples stabilised with different percentage of PA and PF separately at the end of 7, 14, and 28 days of curing time period. Curing was done by covering the samples in polythene sheet to avoid evaporation of water.

3.4 Test Conducted On The Natural Soil

The collected soil sample were tested based on the IS recommendations. The basic test are performed on the natural soil are, specific gravity grain size distribution, classification of soil, compaction (standard proctor test and modified proctor test), UCS and CBR tests were conducted. The basic test was conducted to know the initial properties of the soil, initial strength of the soil and results tabulated in table 3.3. The basic properties of the pond ash and the polypropylene fiber shown in the table 3.3.

TABLE 3.3 BASIC TEST RESULTS

Sl. No	Basic tests	Results	IS Recommendations
1	Specific Gravity	2.63	IS:2720 (Part 3)-1980
2	Grain size Distribution (%) Gravel Sand Silt and Clay	 23 68 09	IS:2720 (Part 4)-1985
3	Consistency limits (%) Liquid Limit Plastic Limit Plasticity Index	 35 21 14	IS:2720 (Part 5)-1985
4	IS Soil Classification	SP (poorly graded sands)	IS :2720-1498
5	Standard proctor test OMC (%) MDD (g/cc)	 16 1.8	IS:2720 (Part 8)-1980

Pond ash	Basic properties
Specific gravity	2.0
Grain size distribution (%) Gravel Sand Silt and clay	 0 46 54
CBR soaked	5
Compaction test OMC MDD	 14 1.8

6	Modified proctor test OMC (%) MDD (g/cc)	 14 1.9	IS:2720 (Part 8)-1980
7	Soaked CBR Value (%) SPT MPT	 3 5.6	IS: 2720 (Part l6)-1979
8	UCS (KN/m^2)	198	IS:2720 (Part 10)-1991

TABLE 3.4 : BASIC PROPERTIES OF THE POND ASH

4.0 Result and discussion

4.1 Atterberg's limit

Table 4.1: Atterberg's limits of Soil with pond ash

% of PA	0	6	12	18	24
Liquid limit (%)	35	30	25	18	14
Plastic limit (%)	20	18	15	10	8
Plasticity index	15	12	10	8	6

Table 4.2:Atterberg'slimits of Soil with PF

% of PF	0	0.25	0.5	0.75	1
Liquid limit	35	28	23	17	14
Plastic limit	20	17	14	12	9
Plasticity index	15	11	9	6	5

When PA foists with soil liquid limit of laterite soil decreased from 35 to 14, by varying a percentage of PA from 6 to 24% the reduction in plastic limit was due to non- plastic material. Similarly plastic limit was decreased from 20 to 8% when PA foist with soil. The plasticity index was denoting to constant of 6 % when PA was added. The reduction in liquid and plastic limit was due to incorporation of non-plastic material (Latheef, 2016). When PF mixed with laterite soil liquid limit of the soil decreased from 35 to 14%. Plastic limit of the soil decreased from 20 to 9% then plasticity index is also reduced to the 15 to 5. The values are decreased when PF mixed with soil the values are shown in the table 4.2. The values decreased because due to plastic material of synthetic fiber to due to its plastic nature it doesn't absorb the water so much.

4.2Compaction test

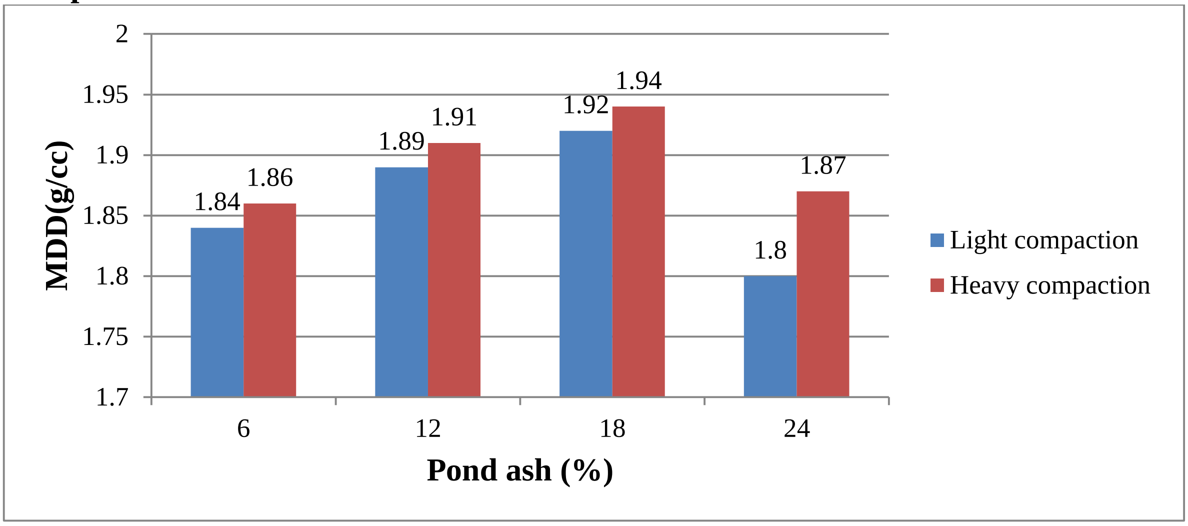

Figure 4.1: MDD values of SPT and MPT

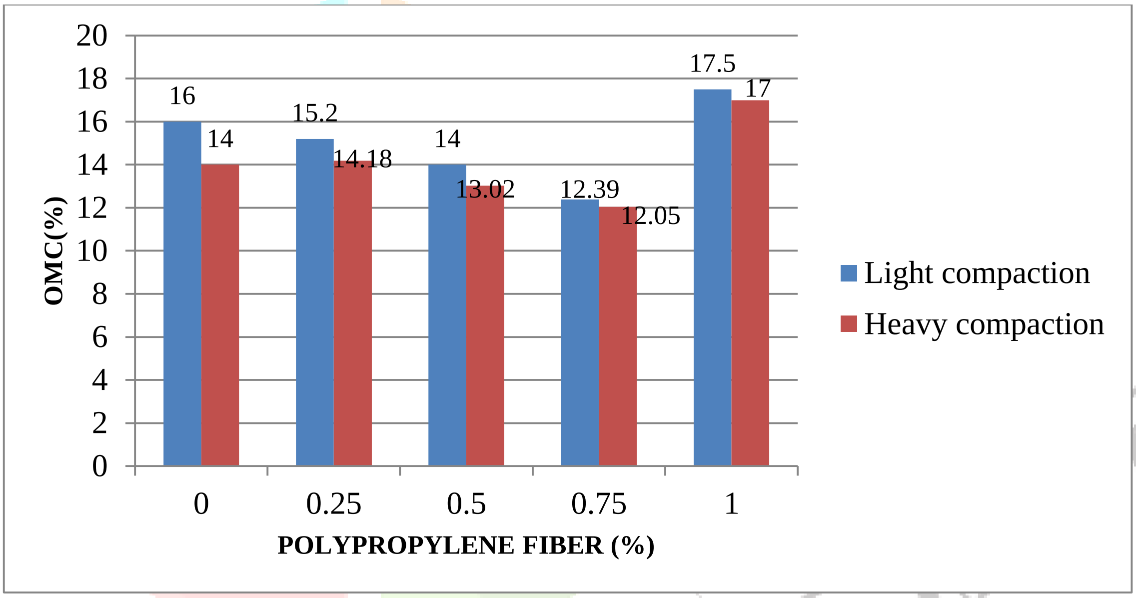

Figure4.2: OMC values of SPT and MPT

OMC and MDD obtained by compaction test by replaced with pond ash. From figure 4.1 shows the result of OMC both light and heavy compaction test. It observed that maximum dry strength of the soil decreased from 2 to 1.6 g/cc for the light compaction. MDD increased from 1.86 to 1.92 g/cc for the heavy compaction. These values increased when 18% of PA replaced with soil. Beyond the 18% of PA replacement the strength of the soil decreases.

Percentage of PA increased the dry density of soil because due to some silica material to give strength to soil and due compaction voids are removed and density of soil increases. Dry density increased because PA is a coal ash it contain the medium finer particle and fill the void of soil and due to compaction air of the void in soil removed out thus increase the density of the soil.

From the figure 4.2 denote that PA is replaced with laterite soil decreases moisture content and become optimum at the of 18% this is due to because Pond is a coal ash containing medium fined particle and fill the voids in the soil. After 18% of PA replaced increase in OMC, because due to it has been attributed to the increase the rate of pozzolanic reaction between pond ashes and soil hence water content more required beyond 18% replaced with laterite soil.

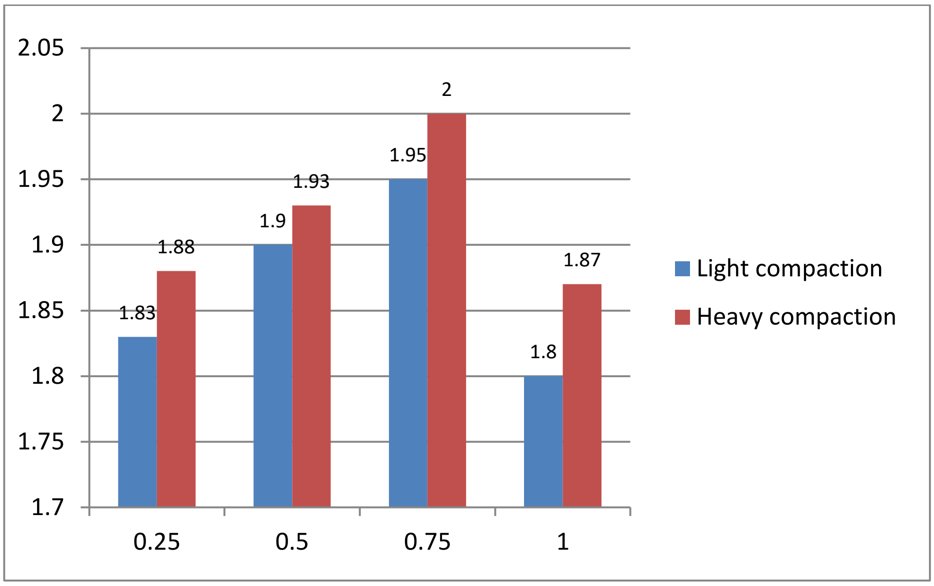

Figure4.3: MDD values of SPT and MPT

Figure 4.3 shows the results obtained when laterite soil replaced with PF. During replacement the contents are dry mixed properly and the added with measured quantity of water. Compaction is done with both light and heavy compaction. PF is light in weight and flexible in nature. During compaction soil particle are arrange properly and bond with fiber. From figure 4.3 noted that the moisture content of soil decreased and dry density of the soil increased due to their synthetic property it absorbs less water content and one most flexibility of fiber they most properly bonding with soil due to compaction and dry density increased. Dry density increases from the 1.83 to 1.95 g/cc for light compaction. From heavy compaction test the dry density increases from 1.88 to 2.0 g/cc. From the figure 4.4 noted that, varying percentage of PF the OMC of soil decreases up to 0.75%. Beyond 0.75% PF used moisture content increases. Moisture content decreases initially up to certain limit because fiber is nonabsorbent material and foist with soil it has synthetic behavior property bond with soil up to a certain limit by varying the fiber. Proper bonding takes place between the soil and fiber with suitable amount of water content. Soil absorbs the water by increasing water content hence the OMC of the soil decrease up to certain limit and then increased. Fiber is replaced with soil in more content the amount of water is to be absorbed by the soil than the fiber, during mixing stage may get expelled under the compaction effect (sathya priya, 2016)

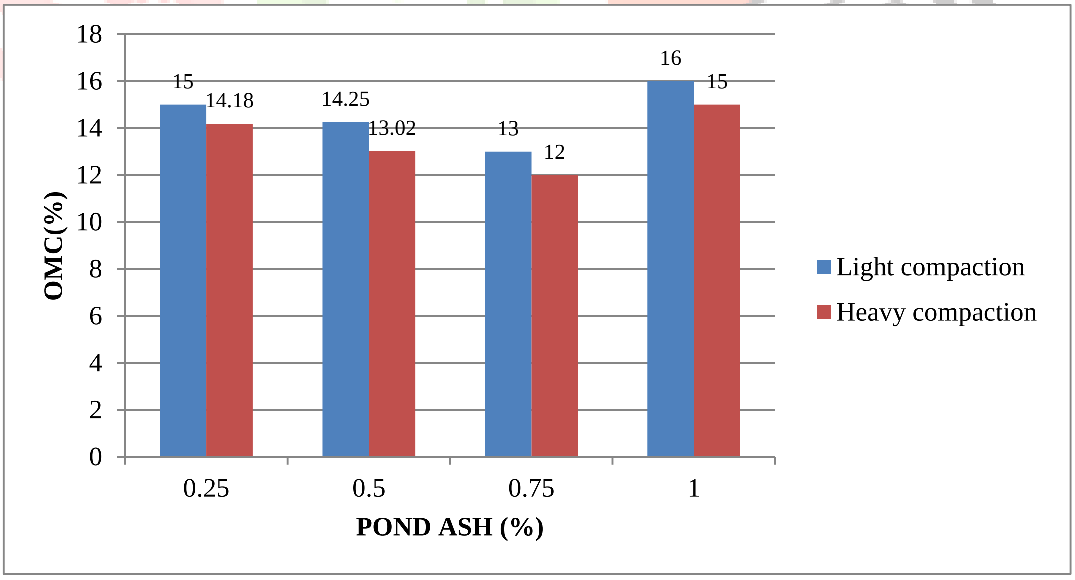

Figure: 4.4: OMC values of SPT and MPT

Figure: 4.5 Compaction of the PF

4.3 UCS Test

In UCS specimens equip on the basis of the OMC which was obtained in compaction tests. The area of mould and weight of soil required for the specimen are to be calculated. Care to be taken during preparing the specimens. The Specimen is placed by covering polyethylene covers in the fresh state due to prevention of moisture evaporation from specimen is as shown in the figure 4.6. Specimens were cured 7, 14, and 28 days respectively. Strength of the specimen increases as the days of curing periods of specimen increased.

Effect due to light compaction (SPT)

Figure 4.7 demonstrate increases the UCS strength from 135 KN/m2 to 300 KN/m2 for 18% replacement of pond ash. PA has coal ash material it contains of some amount of pozzolanic properties and to increase the strength of soil by replaced some of soil with pond ash. So strength of specimen increases with replaced with PA and increased days of curing, strength of specimens also increase.

Strength of soil specimen decreases because replaced with 24%. This is due to because after 18% replacement the PA behaved as low strength filler, and reduction in strength. Weakening the soil pond mixture leads to reduction in UCS strength.

Figure 4.6: UCC molds samples

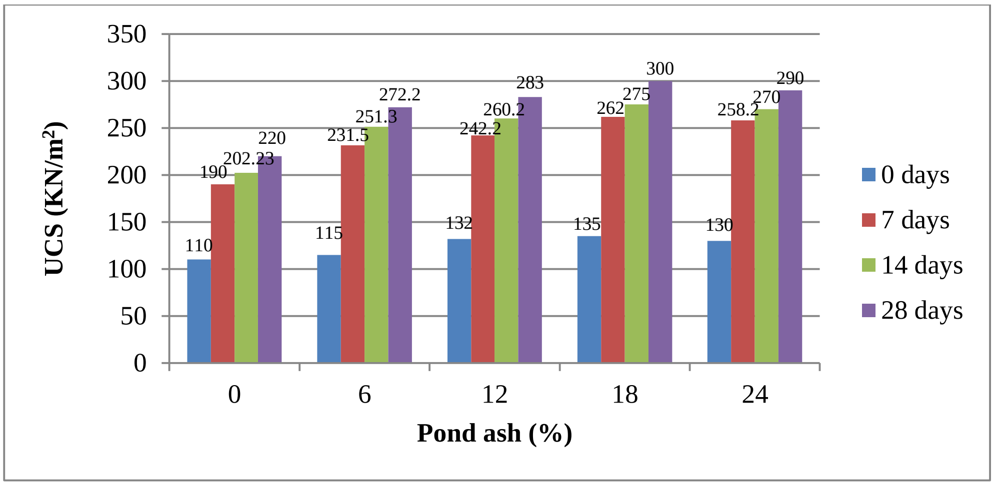

Figure 4.7: UCS values with pond ash for SPT

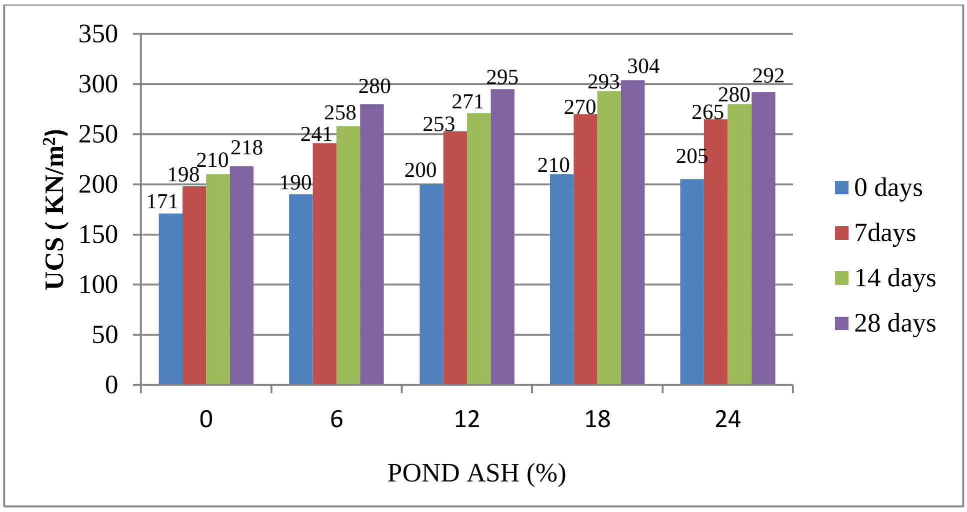

Figure 4.8: UCS values with pond ash for MPT

From the figure noted that strength of UCS increases up-to 18% replacement of PA and then decreases the UCS results. Increase in UCS increases due to some pozzolonic and lime content in PA and improving the stamina due to compaction. Beyond 18% UCS value reduced it may cause due to flocculation of PA particle.

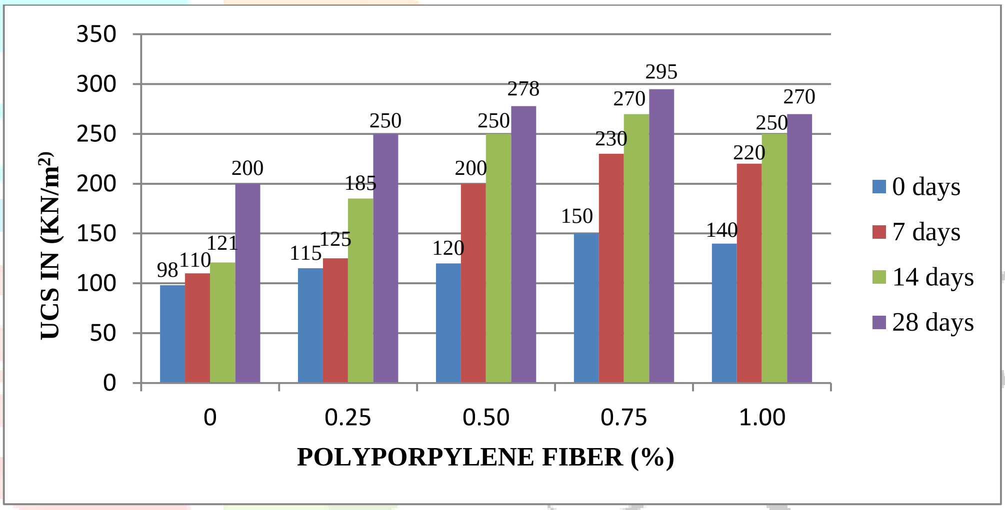

Figure 4.9: UCS results of light compaction

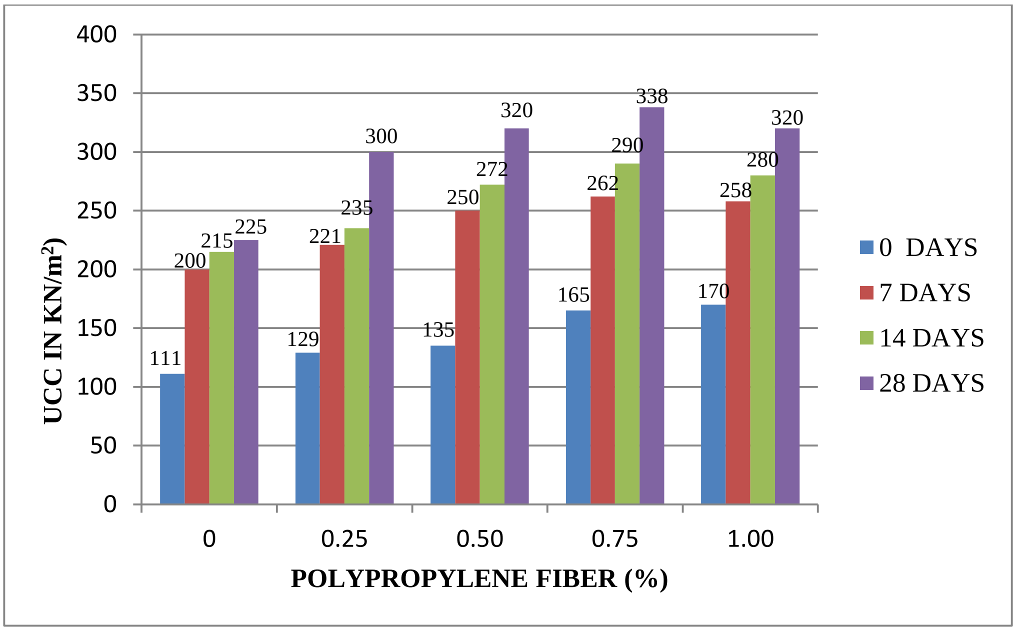

Figure4.10: UCC results of heavy compaction

When PF is replaced with soil and dry mixed properly with suitable instrument materials and OMC and ODD are obtained from the standard proctor test. OMC unite with soil, mixed properly without any lumps and compacted by layer by layer in UCC moulds and specimen in taken, carefully covered with polyethylene covers and curing for the 7, 14 and 28 days respectively. Corresponding day's strength is noted down in conducting test. And suitable results are noted is demonstrated in the figure 4.9.
From graph observed that UCS strength values increases because due to PF has flexible nature and compacted with soil the air voids remove out and strength of soil increases.
OMC and ODD values are obtained from the heavy compaction at different percentages of PF. UCS moulds are prepared for different percentage of PF. UCS value strength increases from 165 to 330 KN/m^2 at 0.75% of PF. Beyond 0.75% the PF strength of soil decreases. UCC values increases due to fiber inclusion in the soil interaction between fiber surface and hydration product is important. The strength of compaction increases because of interlocking bond is carried out due to compaction fiber has a property to crack reduction in soil through bridging action of fiber hence increases the properties of soil

4.4 CBR Test

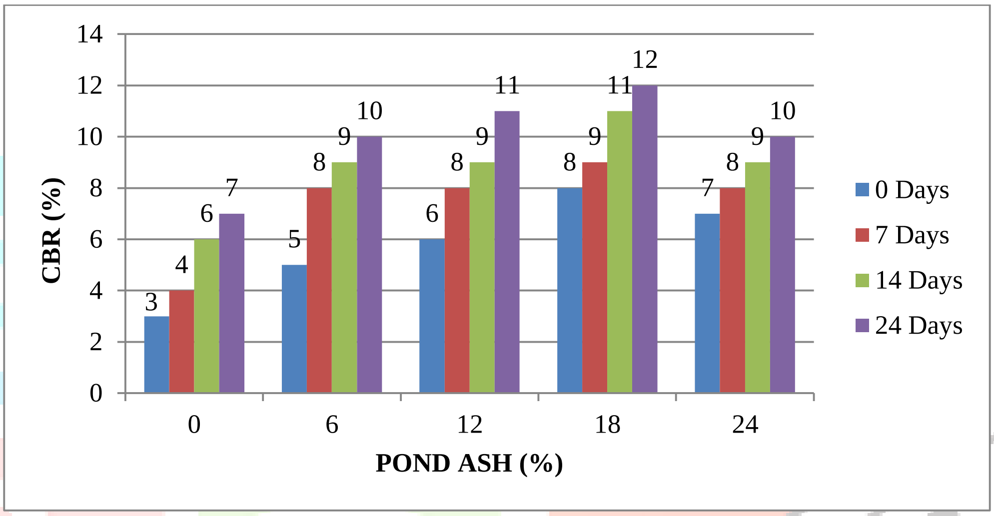

Figure 4.11: CBR values from light compaction

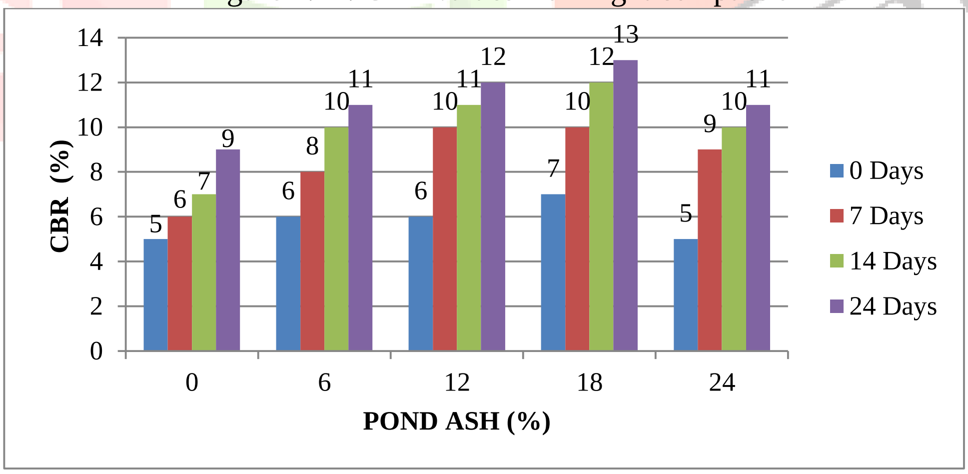

Figure 4.12: CBR values from the heavy compaction

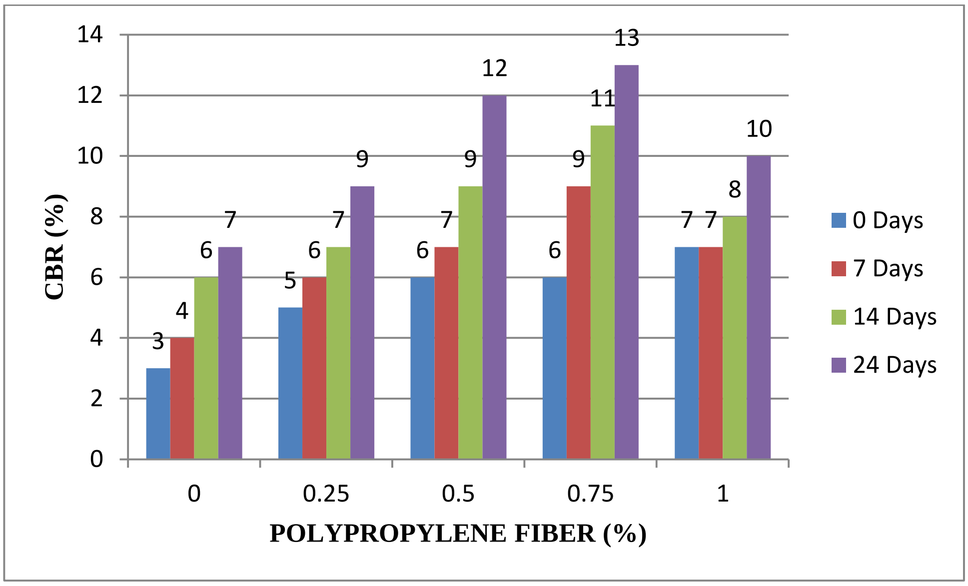

Figure 4.13: CBR values from the heavy compaction

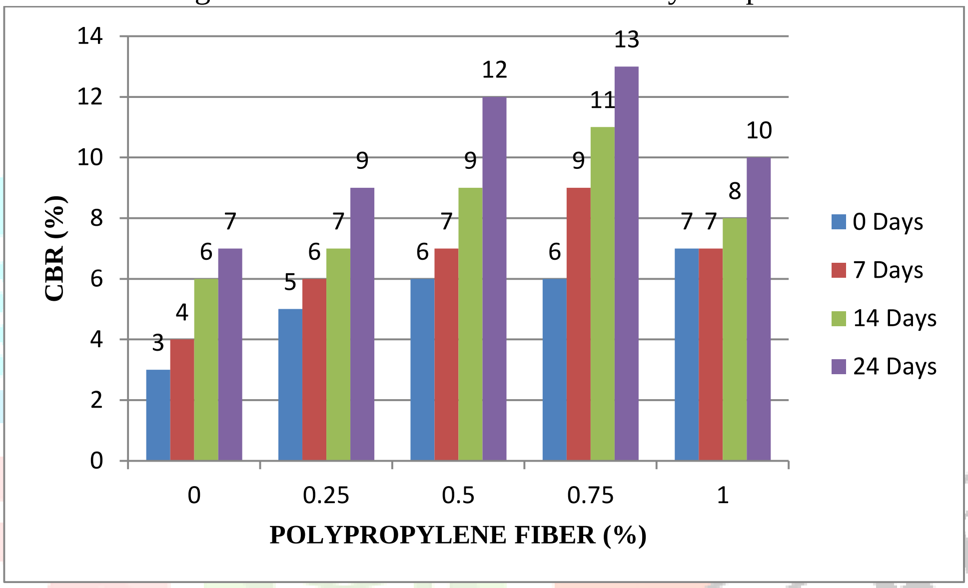

Figure 4.14: Effect of PF on CBR value (SPT)

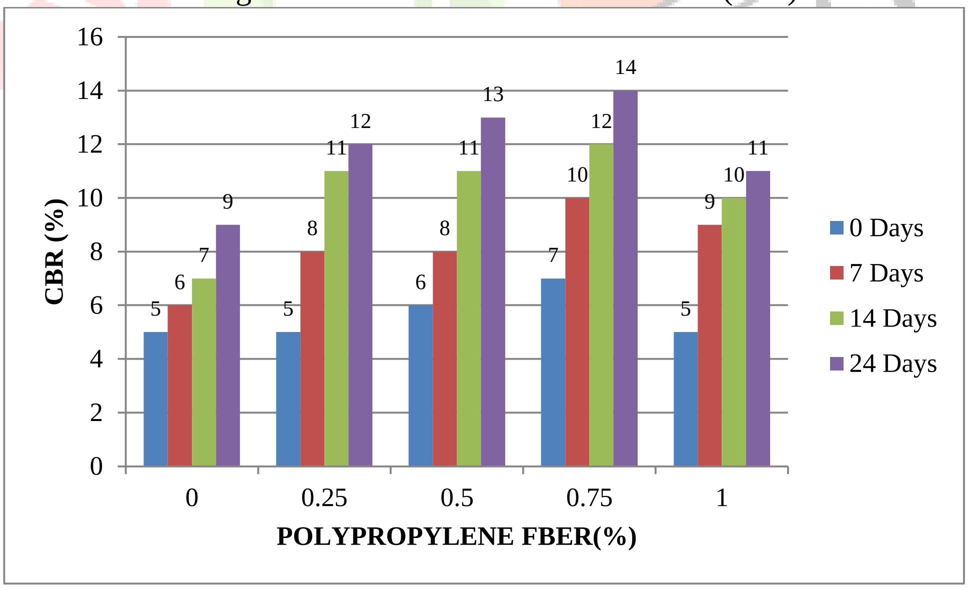

Figure 4.15: Effect of PF on CBR value (MPT)

The CBR test conducted on obtained OMC by compaction test. Replace the soil with different percentage of additives dry mixing was done perfectly. OMC and MDD are taken from the light compaction test figure 4.12 shows the variation of CBR values replacement of pond ash. Soil loses stamina presence of water in it. Hence it is know the capability of soil under worst situation CBR test was carried in soaked condition. The difference in the CBR by varying percentage of PA for curing periods of 7, 14 and 28 days were find out. CBR value

increased because PA mixed with soil due to pozzolonic reaction cementing bond gel formation due to reaction of amorphous silica, calcium and alumina content (Deepak and arvind2017)
From above graph observed that the CBR value increased at 18% of PA replaced with soil, and then result going on increase from 8.0 to 12 % this is due to PA acting as a cementing agent hence the value increased. PA containing some silica alumina and some lime content (calcium aluminates) when water is added to the soil the reaction will be taken place between the soil and pond ash, due to pozzollonic reaction the CBR value increased.
In this the OMC and ODD of soil is taken from the heavy compaction test. And suitable replacement with PA was foisting with soil. The soil was compacted by hammer of each layer of 75 blows; the moulds are curing for 7, 14 and 28 days respectively. Then the CBR results will increased from the 7 to 13% at 18% replacement of PA is as shown in figure 4.14. The strength of soil increased due to the pozzolonic and cementing properties of the PA increase the strength of soil. Pond ashes as mixture of fly ash some bottom ash content so it's have the properties to improve the soil stamina.
The effect of PF is inclusion with soil the CBR value increased. From the figure 4.15 the untreated CBR value is 3 and treated PF CBR value is 11%. So value is increased up to a 0.75 percentage of the PF replaced with laterite soil. Beyond the 0.75% of PF the value will be decreased. Value of CBR increased because the PF has the cracking resistance material, it has a property like high tensile strength and due to compaction the proper reinforcement bond formed between soil and fiber. The CBR value decreased because due to agglomerating means the reducing the interfacial contact area beyond the 0.75% of polypropylene replaced. So reducing the interfacial contact area between the fiber and soil then the CBR value decreased

5.0 Conclusions

In this study different test like standard proctor test, Modified proctor test, UCS and CBR tests was done to evaluate the properties of behavior soil mixed with PA and PF, the conclusion are presented below.

1. It is found that PA has pozzolonic behavior and PF enhanced shrinkage cracking resistance material, so both material can be used partial replacement material for the soil.
2. Pond ash replaced with 18% to the soil , MDD value increased from 1.8 to 1.92 and OMC value decreased from 16 to 13% for SPT. From the MPT, MDD value increased from 19 to 1.94 g/cc OMC value reduced to the 14 to 12%.
3. PF has give the strength of soil up to 0.75% replaced with soil after the 0.75% of replacement the value of OMC increases and MDD decreases.
4. UCS values with pond for SPT the value increased from 135 to 300 KN/m2, for MPT value increased from 210 to 310 KN/m2. UCS values with polypropylene for SPT the value increased from 150 to 322 KN/m2, for MPT value increased from 165 to 338 KN/m2.
5. CBR value increased from 3 to 12% from the SPT and 5 to 13% from the MPT when pond ash replace with 18%.
6. CBR value increased from the 3 to 13% from the SPT and 5 to 14% from the MPT when PF replaced with 0.75%.

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