STUDY OF WASTE MATERIALS IN SOFT SUBGRADE

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Abstract - *Increase in population increases the generation of waste materials. Improper management of industrial wastes causes adverse effects on the ecology. Utilization of industrial waste materials in the improvement of problematic clayey soils is a cost efficient and environmental friendly method. Study focuses on the use of industrial wastes like pond ash, copper slag and coir fiber in the engineering properties of clayey soil . To study the influence of these industrial wastes in the soil, modified compaction test , Tri axial test and CBR test were conducted. From the test results a mix of 20\% pond ash, 1.5\% of fiber and 40\% copper slag was found to be optimum mix. The CBR value for the optimum mix as 4.6%.The strength property of the mix was increased with respect to the parent soil.*

Key Words: **CBR test, Compaction test, Coir fibre, Copper slag, Tri axial test, Pond ash**

1. INTRODUCTION

India is the one of the fastest growing and developing country in the world. As a result of increase in population the generation of waste materials from the industries also increases. Improper management of industrial wastes causes adverse effects on the ecology. Utilization of industrial waste materials in the improvement of problematic clayey soils is a cost efficient and environmental friendly method.

In this project the study focuses on the use and effect of these waste materials in the weak clay soil. To know the influence of the waste material on poor clay soil a series of laboratory tests were conducted. From the test results the optimum mix of the material addition were obtained

1.1 Materials

Clay was collected from kuttanad region. Pond ash and Copper slag were collected from Vintech India Corporation and Blast line India Pvt Ltd. Natural coir fiber was collected from Alapuzha. The properties of clay and pond ash are given in Table 1 and Table 2.

Table -1: Properties of Clay

Test	Value
Specific gravity	2.27
Particle size distribution Hydrometer test	Sand-20% Silt-15% Clay-65%
Liquid limit Plastic limit Plasticity index	172% 69.6% 102%
MDD OMC	1.29g/cm^3 28%
CBR	1.4%
Cohesion intercept Angle of internal friction	15.86kN/m^2 5°
Differential free swell index	45%
Natural moisture content	110%

Table -2: Properties of Pond ash

Test	Value
Specific gravity	2.20
Coefficient of uniformity	3.53
Coefficient of curvature	0.613
Coarse sand size	8.94
Medium sand size	26.71
Fine sand size	51.93%
LL and PL	Non plastic

2. EXPERIMENTAL PROGRAM

The experimental program is carried out in two parts. First compaction characteristics and Tri axial test of different percentages of pond ash-coir fiber-copper slag-clay mixes are investigated and optimum mix is determined. Next CBR test is carried out on optimum mix

The optimum percentage of pond ash to be mixed with the clay soil has been determined on the basis of maximum shear strength. Pond ash at varying percentage 10%, 20% ,30% and 40% were used to mix with clay.OMC and MDD values were obtained for the different percentages of pond ash mixed with soil and triaxial tests were conducted. The mix of 20% pond ash and clay soil shows the maximum strength . This mix percentage has been used for the further studies .

Fig -1: Mix of pond ash, coir fiber, copper slag and clay

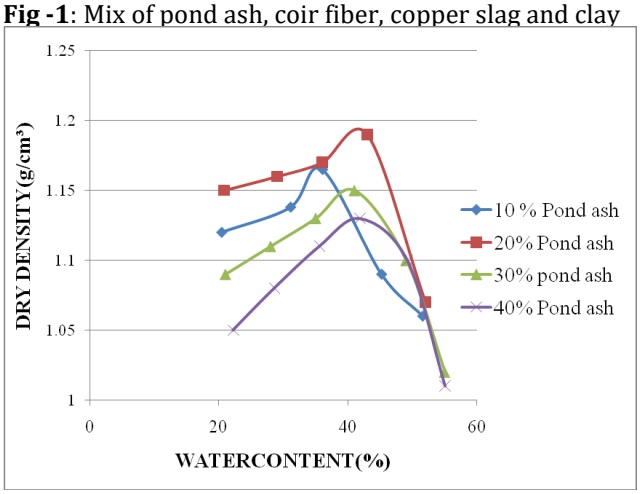

Chart -1: Comparison of compaction curves

Table -3: Tri axial value of pond ash –clay mix

Pond ash content(%)	Cohesion(kN/m²)	Angle of internal friction(°)
10%	62.29	9
20%	60.14	15
30%	53	11
40%	52	10

Four different percentages of untreated coir fibre at 0.5%, 1%, 1.5% and 2% were used in the optimum mix of pond ash and clay to study the triaxial tests. From the test results the optimum fibre proportion in the pond ash soil mix were calculated. At a combination of 20% pond ash , 1.5% coir fibre and clay soil the maximum strength was obtained

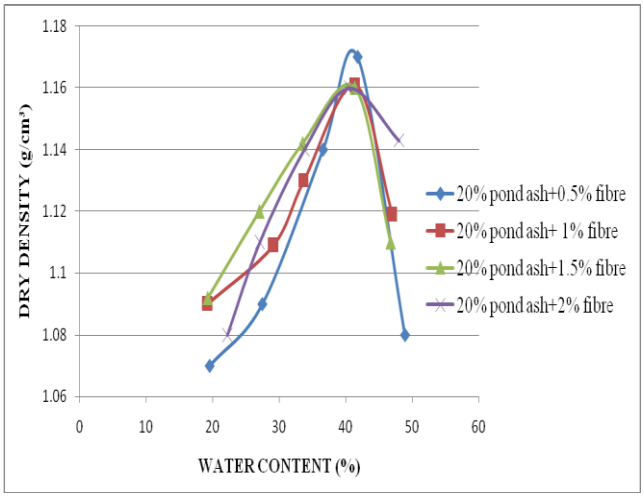

Chart -2: Comparison of compaction curves

Table -4: Tri axial value of coir fibre-clay mix

Coir fibre content(%)	Cohesion(kN/m²)	Angle of internal friction(°)
0.5%	49.5	18
1%	62.13	19
1.5%	76	23
2%	60	22

Copper slag was added in four varying proportions say 10%,20%,30% and 40% to the optimum mix of pond ash,

coir fibre and clay soil. OMC and MDD values of the each mix were determined and triaxial tests were conducted to find the optimum mix proportion

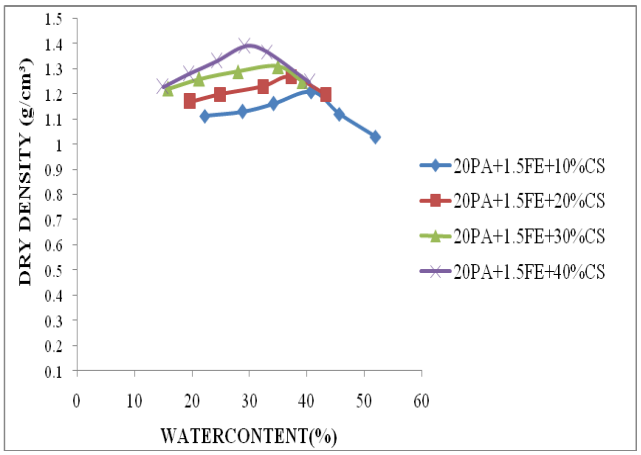

Chart -3: Comparison of compaction curves

Table -5: Tri axial value of copper slag-clay mix

Copper slag content(%)	Cohesion(kN/m²)	Angle of internal friction(°)
10%	43.9	24
20%	42.75	25
30%	40.6	26
40%	34.9	28

A combination of 20% pond ash-1.5% coir fibre-40% copper slag-clay is found to be optimum mix .CBR test is done on the Optimum mix .The sample were soaked for 96 hours and test are conducted as per standard procedure.

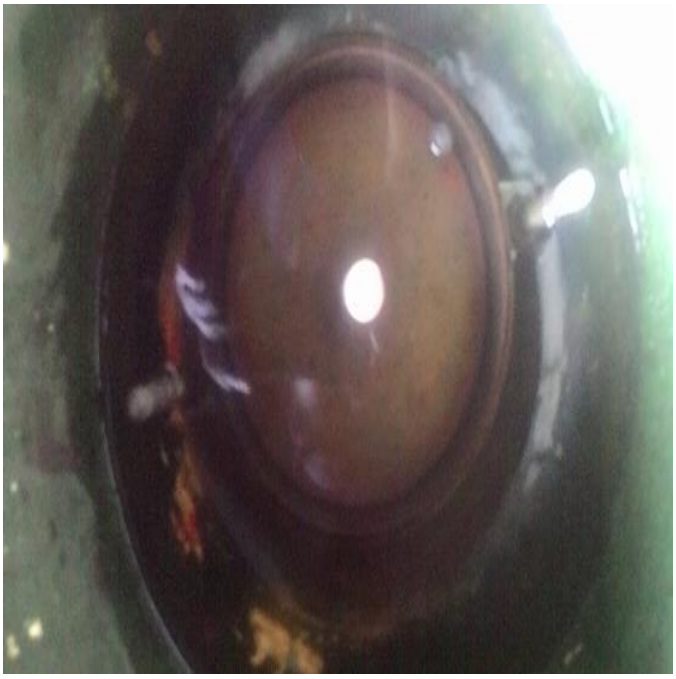

Fig -2: Sample soaked for 96 hours

Fig -3: CBR test

3. RESULT AND DISCUSSION

Effect of pond ash content on MDD and OMC were shown in the chart 4 and 5.

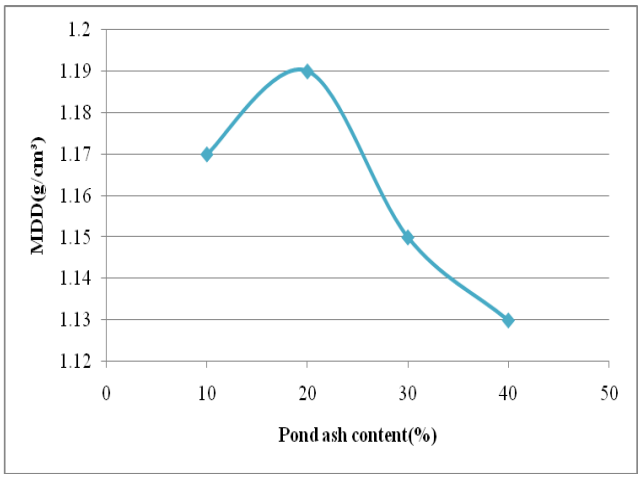

Chart -4: MDD versus pond ash content curve

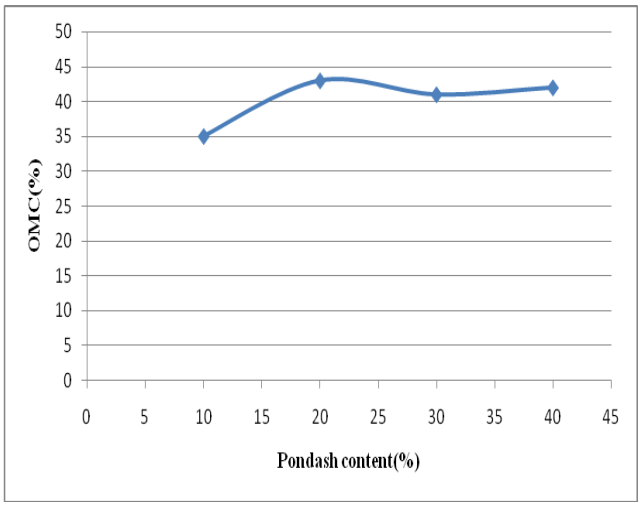

Chart -5: OMC versus pond ash content curve

A decrease in MDD and increase in OMC with addition of pond ash content has obtained. The MDD and OMC value at 20\% pond ash , clay soil mix is 1.19g/cm^3 and is 43\%and they are higher value when compared to other percentages.

The specific gravity of pond ash is much less than that of clay soil. An increase in pond ash content causes reduction in weight and thus the MDD of the mix decreases. The increase in pond ash content the fineness of the mix increases, which in turn, increase the water holding capacity of the mix, resulting in increase in the OMC

Chart 6 and 7 shows the plots of strength parameters versus pond ash content curve. From the chart it is found that with increase in pond ash content on soil, the values of C and Ø decreases.

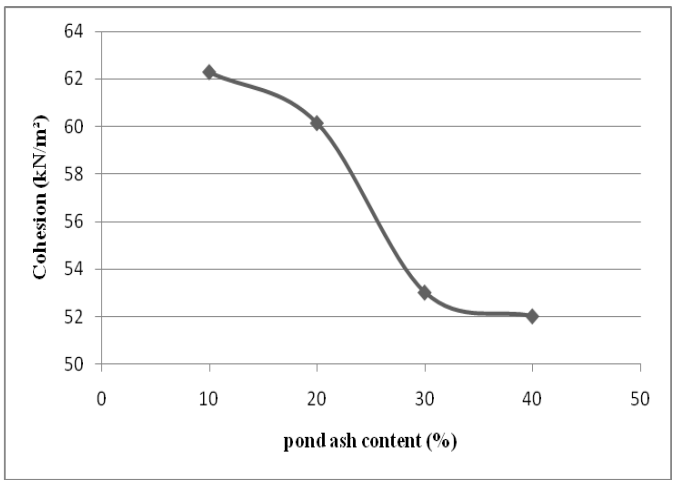

Chart -6: Cohesion versus pond ash content curve

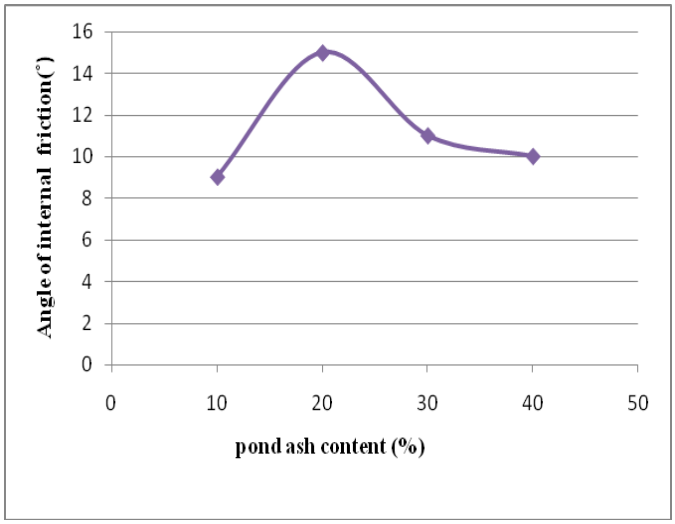

Chart -7: Angle of internal friction versus pond ash content curve

Chart 8 and 9 shows the influence of coir fibre content on the MDD and OMC. For 0.5% fibre MDD and OMC value is 1.17g/cm^3 and 42% then it decrease with increase in coir fibre content.

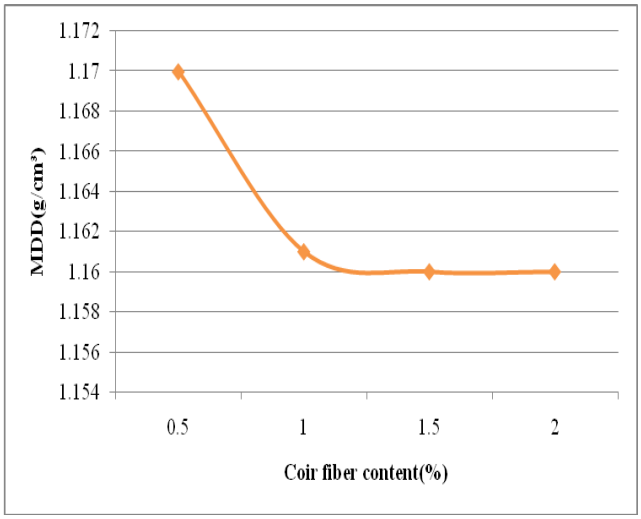

Chart -8: MDD versus coir fiber content

From the chart 8 it is observed that the maximum dry density decreases for increasing percentage of coir. This is mainly due to the lower value of specific gravity of coir fiber as compared to the higher value of specific gravity of clay.

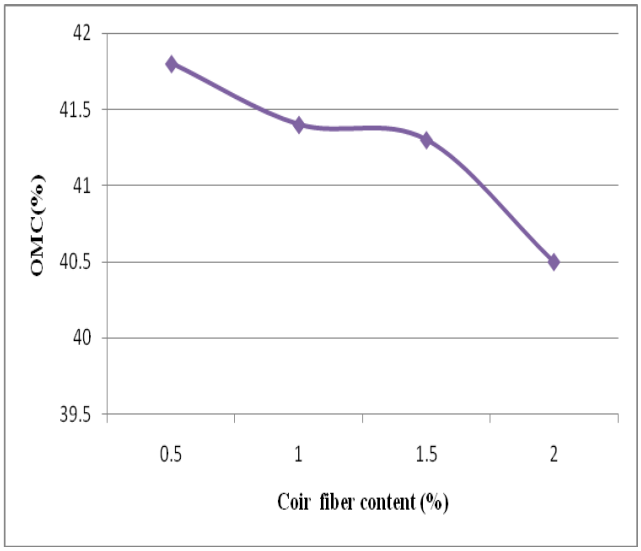

Chart -9: OMC versus coir fiber content

From the chart 9 it shows that the optimum moisture content does not show a significant change by addition of coir fibre , This is may be due to the less water absorption of coir fibre

Chart 10 and 11 shows the plots of strength parameters versus fibre content curve.The strength parameters of the mix increases with the increase in fibre content. Up to 1.5% fibre content, there is a considerable increase in the C and Ø value of mix and above 1.5% there is slight decrease in C and Ø value.The reason might be because of the rough texture of fibre which increases the friction between the particles and holds the soil particles together. Thus it increases the resistance to sliding and deformation of sample

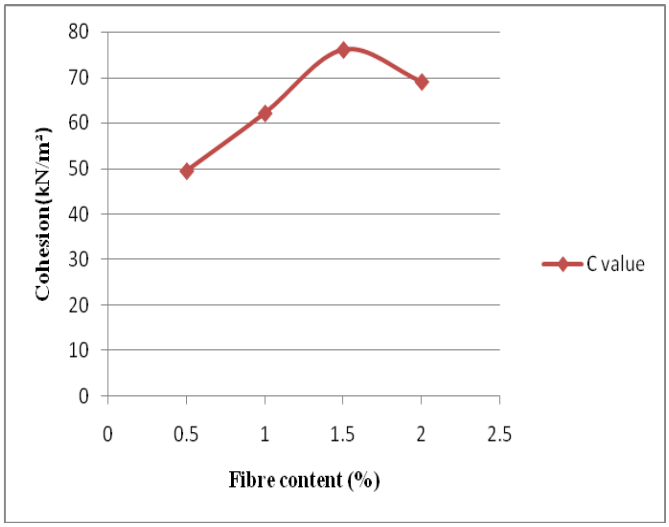

Chart -10: Cohesion versus fiber content curve

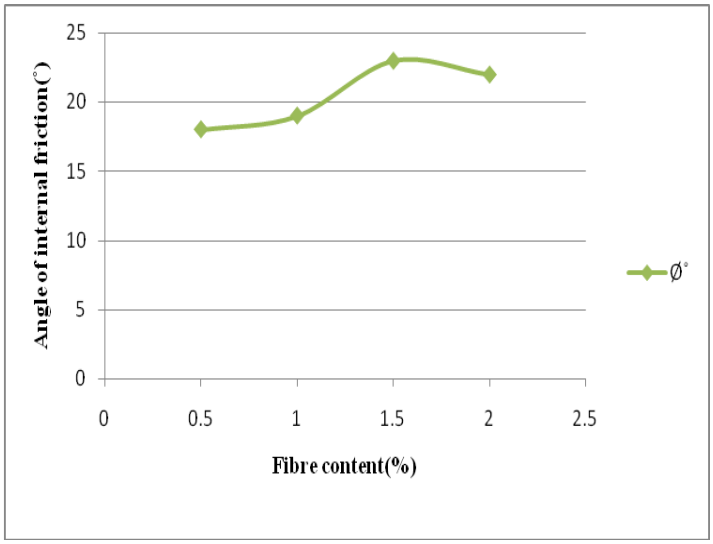

Chart -11: Angle of internal friction versus fibre content curve

The sample shows small reduction in development of strength at 2 % fibre content, which might be due to the excessive addition of coir fibre. It reduces the optimum density of the soil and hence causes the reduction in shear strength of the soil.

Chart 12 and 13 shows the variation of MDD and OMC with addition of copper slag content. The maximum dry density varied in range of 1.21g/cm^3 to 1.39g/cm^3 and optimum moisture content varied in range of 40.8-29.%

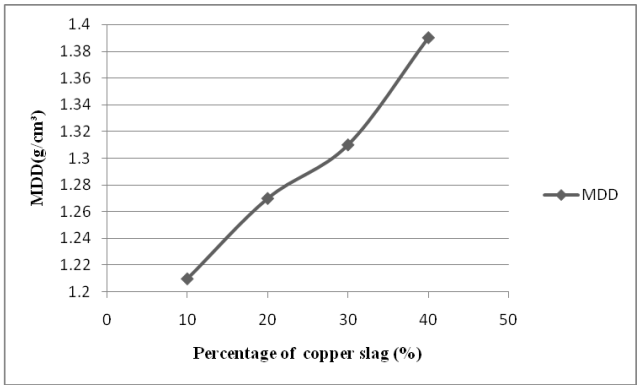

Chart -12: MDD versus copper slag content

Increasing the percentage Copper Slag increases the MDD. The high dry density of copper slag mix is due to high specific gravity of slag particles.

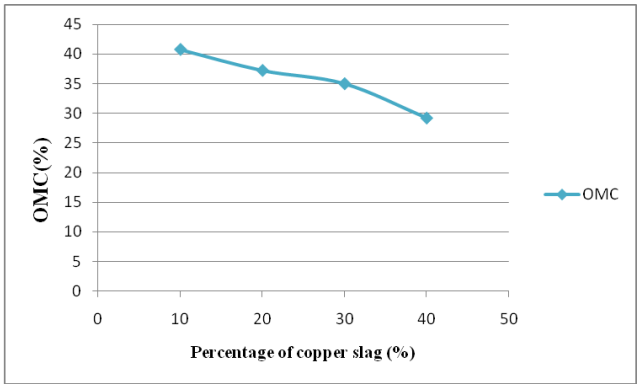

Chart -13: OMC versus copper slag content

From the results of triaxial test the increase in copper slag content decreases cohesion and increases angle of internal friction were observed The absolute maximum value of Ø and absolute minimum value of 'C' are 28° and 34.9kN\cm^2.

Chart 14 and 15 shows that as the copper slag content increase, the cohesion intercept decreases and angle of internal friction increases. The increase in internal friction and decrease in cohesion intercept with increase in content of copper slag is due to the grains of slag are rough and angular .And they provides frictional nature

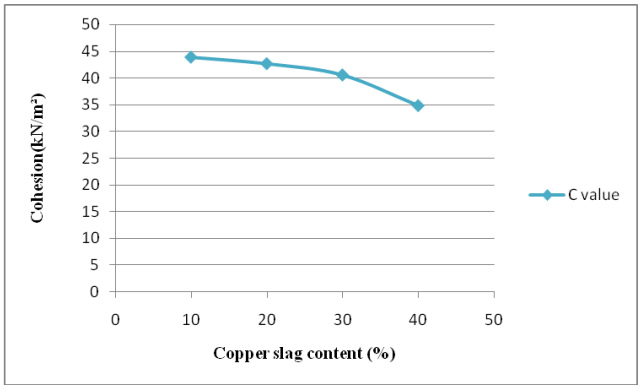

Chart -14: Cohesion versus copper slag content curve

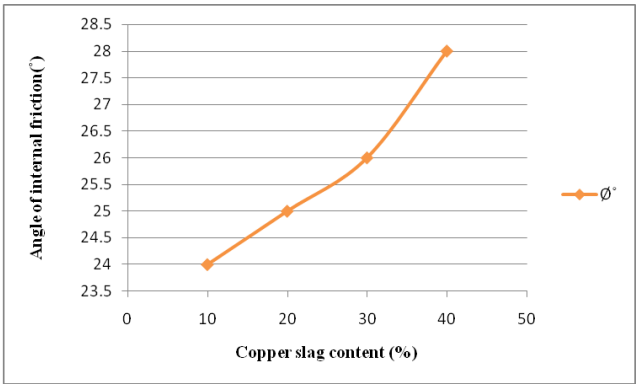

Chart -15: Angle of internal friction versus copper slag content curve

It is observed that the CBR value in soaked condition for soil with virgin clay and modified clay is about 1.4\% and 4.6\%.Hence there is about 3 times increase in CBR value upon addition of waste materials. Hence the percentage of waste materials increase the strength of poor soil.

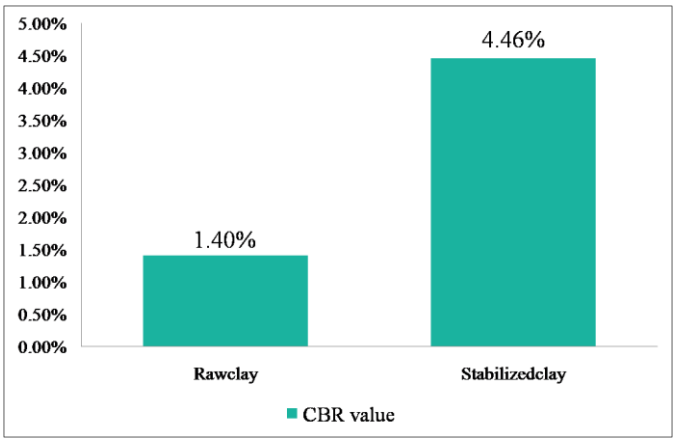

Chart -16: Comparison of CBR value

4. CONCLUSIONS

Based on investigations made in the study it is concluded that increase in pond ash content decreases the MDD and increases the OMC. The strength parameters decreases with increase in pond ash content .From various percentages of pond ash 20\% of pond ash clay mix is adopted as the optimum mix. The increase in fibre content on the mix decreases the compaction characteristics. Fibre content of 1.5\% by weight of soil pond ash is found to be the optimum coir fibre content for the increment in strength of the optimum mix. With addition of copper slag on the optimum mix shows an increase in MDD and decrease in OMC. The increase in internal friction and decrease in cohesion intercept with increase in content of copper slag is observed from the triaxial test. From all the test results, it is concluded that for a mix of 20\% of pond ash, 1.5\%coir fibre,40\%copper slag and clay shows the maximum strength .The CBR test conducted on the optimum mix shows a value of 4.46\% ,which is 3 times than that of parent soil.

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