Improvement in Properties of Clay Soil by Using Calcium Carbide Residue and Fly-ash

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Abstract : The investigation study was done to improve the soil properties by using waste material, which is responsible for poisonous environment. In the study, waste products like Calcium Carbide Residue (CCR) a by-product of acetylene gas factories and Fly Ash produced from thermal plant were added in a weak soil sample in varying ratios. CBR and UCS values increased with increase in dose of Fly Ash up to 20% and afterward it decreased. Therefore, optimum dose of FA was taken as 20%. CBR and UCS values were further improved by blending CCR in a mix of soil and 20% FA. The CBR and UCS value increased by adding 20% Fly Ash and 7% Calcium Carbide Residue (CCR) by weight of soil and was defined as an optimum dose.

IndexTerms **- Calcium Carbide Residue (CCR), Fly Ash (FA), Modified Proctor Test, California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS).**

I. INTRODUCTION

Soil Stabilization is a general term for any chemical, physical, biological, or combined method of changing a natural soil to meet an engineering purpose. Improvement in the behavior of soil by adding Calcium Carbide Residue and Fly Ash is the new method as these waste materials give rise to ecological hazards. The week soil may be utilized along with these materials as due to pozollanic action, the strength of week soil is improved up to desirable load. Every type of soil has its own properties and show different behaviour when subjected to load, some soils are feasible for construction while some are not, due to their poor behaviour, when subjected to load. The thought of stabilization is to enhance the properties of clayey soil like low shear strength, volumetric shrinkage and high moisture susceptibility. Improvement in the behaviour of soil by adding Calcium Carbide Residue and Fly Ash is the new method for sustainable development.

Vichan & Rachan (2010) presented "Improvements in the unconfined compressive strength "of soft Bangkok clay due to the combination of Calcium Carbide Residue and Biomass Ash that highly depended on some factors like (CCR:BA), the soil water content, the binder content and curing time. With initial soil moisture content kept at 1.2 OMC, the use of a 5% binder to stabilize soft Bangkok clay, with a blended binder proportion of CCR: BA = 60:40 gave the highest strength after 14 days of curing.

II.MATERIALS USED:

2.1 Clay soil

It is one of the most important types of soil. These are finely grained particles of size less than 0.002 mm. These are cohesion plastic soils. Clayey soils are very important in geotechnical engineering because of their complex behavior. They generally have high plastic Index (PI>30%), Liquid limit (LL>50%). The source of clayey soil used in the project is village Pamaal, district Ludhiana.

2.2 Fly-ash

By burning of powdered coal, the ash is produced which consists of fine particles that rise with the fuel gases. The chimneys of thermal power plants are used to capture the fly ash. Fly ash (FA) consists of SiO2 and Al2O3and is pozollanic in nature. Production of Fly ash in India is approximately 100 million ton per year and pollutes river water and put human being's life in a dangerous situation by causing problems like lung damage. The pH value is in between 10 and 12. Fly ash is of two types and is defined as Class F fly ash and Class C fly ash. The dissimilarity in classes is due to alumina, iron& silica content in the ash.

Class F

fiery older and harder coal normally produces class F fly ash and it is a cementing agent and pozollanic, it includes less than 10% lime (CaO). Class C fiery of younger lignite coal produces class C fly ash and has cementing properties and is pozollanic in nature. *Class C* fly ash must be well hardened in presence of water and include more than20% lime (CaO). . The Fly ash for the study was collected from Ultra Tech Cement Limited, Unit Ultra Tech Concrete, B-58, Phase 07, Focal Point, Ludhiana.

2.3 Calcium Carbide Residue

It is the by-product of Acetylene Gas Production Process, and is in slurry form that mostly has Calcium Hydroxide (Ca (OH) 2) along with CaCO3, SiO2, and other metal oxides. Acetylene gas factories and PVC Chemical Plants produce CCR in huge quantities and cause hazards to the environment due to their alkalinity. It has high calcium content. With the increase in CCR content, the Maximum Dry Density decreases and Optimum Moisture Content increases.

III. RESULTS AND DISCUSSION

Table 1: Specific Gravity and Atterberg's Llimits of Virgin Soil

Soil	G	LL	PL	PI
Clay	2.56	38.0	21.87	16.13

Table 2: Physical Properties of Virgin Soil

Soil	IS	UCS (kN/m2	OMC (%)	MDD(g/cc)	CBR (%)
Clay	CI	112.53	12	19.6	2.67

Table 3: Water Content (Wc) (%) V/S Dry Density (γd) (kN/m3) for Virgin Soil

Wc %	6	9	12	15	18
γd kN/m^3	18.6	19.2	19.6	18.9	18.0

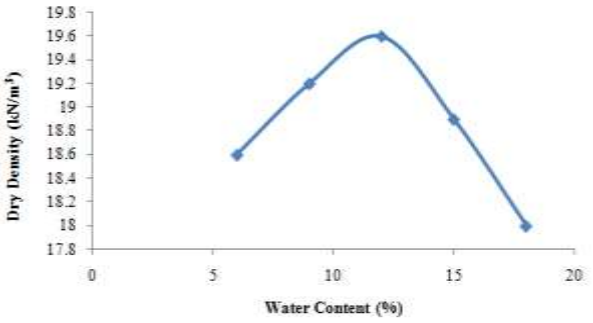


Fig 1: Compaction test results for virgin soil

3.1 Standard proctor test for clayey soil

A series of modified Proctor test at clayey soil was done to find out the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) at different percentages of fly ash. After taking an optimum dose of fly ash, the calcium carbide residue was taken in different percentages. The modified proctor test was conducted on virgin soil. The clay was dried in oven at 110 °C for 24 hours and pulverized. 6% water was added and dry density was calculated. Again 9%, 12%, 15% and 18% water added to dry clay and dry densities were calculated. In the result OMC was found to be 12% and MDD 19.6 KN/m3.

Table 4: Wc (%) v/s γ_d(kN/m3) for Soil: FA (85:15)

Wc %	8	11	14	17	20
γd kN/m^3	18.3	19.0	19.8	18.7	17.7

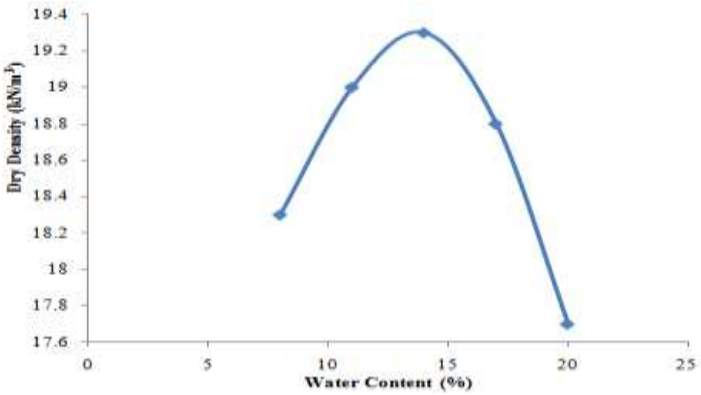


Fig 2: Compaction test results for soil mix with fly ash

Compaction test results for (Soil: FA) at different proportions

Table 5: Compaction test results for (Soil: FA) at different proportions

Soil: FA	100:0	85:15	80:20	75:25
MDD (kN/m³)	19.6	19.3	19.1	18.8
OMC(%)	12	14	15	16

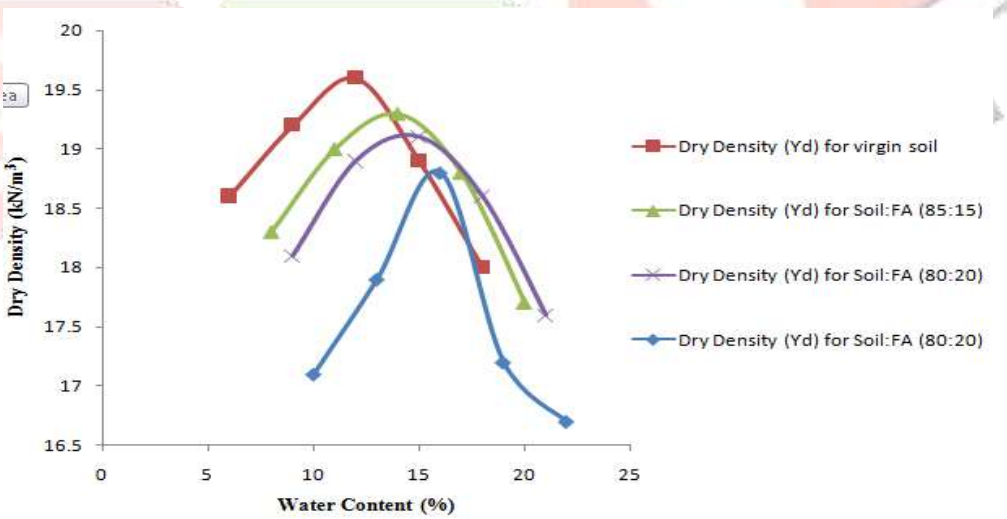


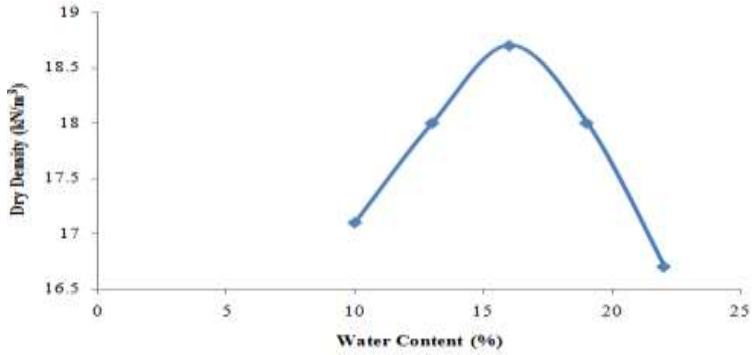
Fig 3: Compaction test results for (Soil: FA) at different proportions

COMPACTION TEST RESULTS FOR SOIL MIX WITH FLY ASH AND CCR

Table 1: Wc (%) v/s γ_d(kN/m3) for Soil: FA: CCR (79:20:1)

Wc %	10	13	16	19	22

γd kN/m^3	17.1	18.0	18.7	18.0	16.7



Wc (%) v/s γ_d(kN/m3) for Soil: FA: CCR (79:20:1)

Compaction test results by varying percentage of CCR

Table2: Effect of CCR on MDD and OMC of Soil

Soil: FA	79:20:1	77:20:3	75:20:5	73:20:7	71:20:9
MDD (kN/m^3)	18.7	18.4	18.0	17.7	17.4
OMC(%)	16	18	21	23	24

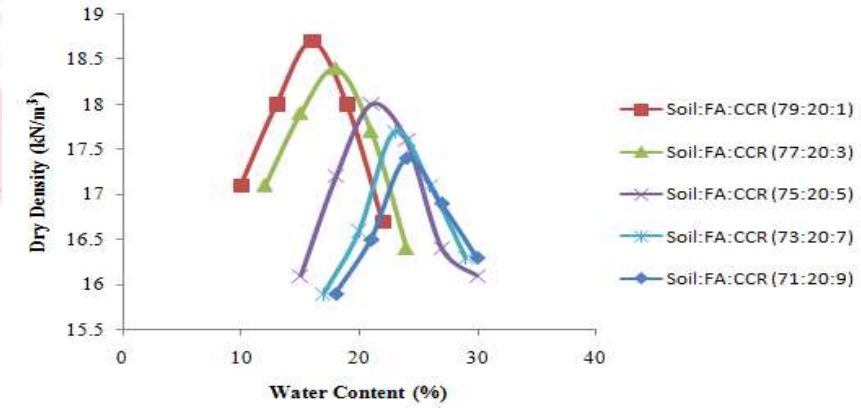


Fig 4: Effect of CCR on MDD and OMC of Soil

3.2 California bearing ratio test

California bearing ratio is the ratio of force per unit area required to penetrate into a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm / min. The CBR tests (soaked & unsoaked) were performed on soil stabilized with fly ash and calcium carbide residue and results are shown below in the form of graphs and readings for various samples**.**

CBR TEST RESULTS FOR SOIL MIX WITH FLY ASH (UNSOAKED)

Table 8: effect of Fly ash on CBR value

Soil:FA	100:0	85:15	80:20	75:25
CBR (Unsoaked)	2.67	4.38	5.93	3.40

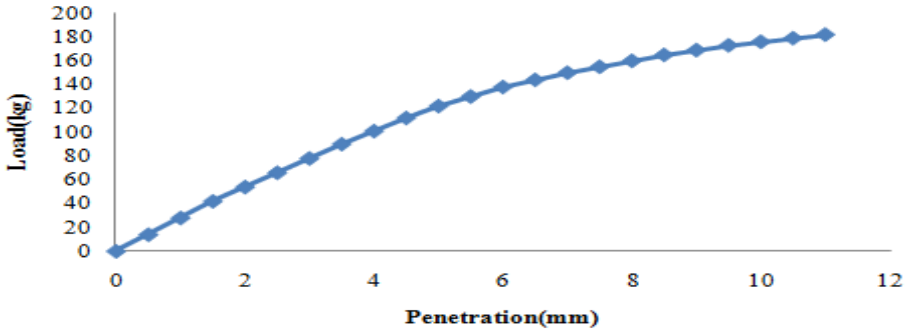


Fig 5: Load vs settlement

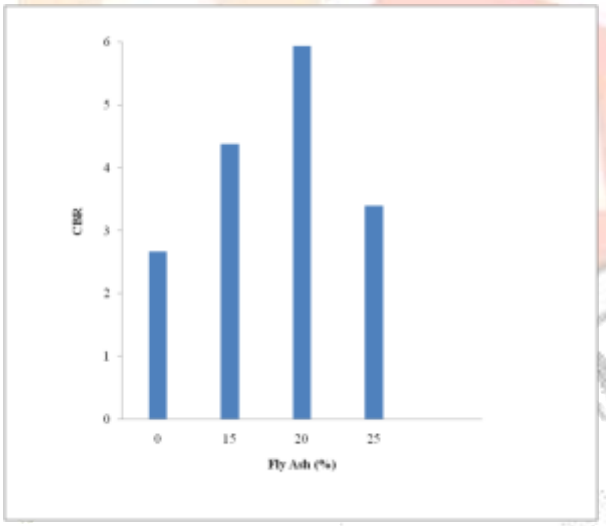


Fig 6: Effect of Fly Ash on CBR Value of Soil (Unsoaked)

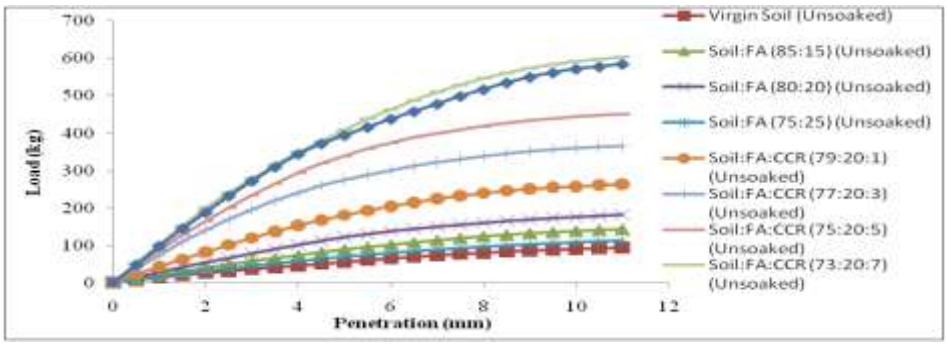


Fig 7: Load–Settlement Response of Soil with Different % of FA & CCR (Unsoaked)

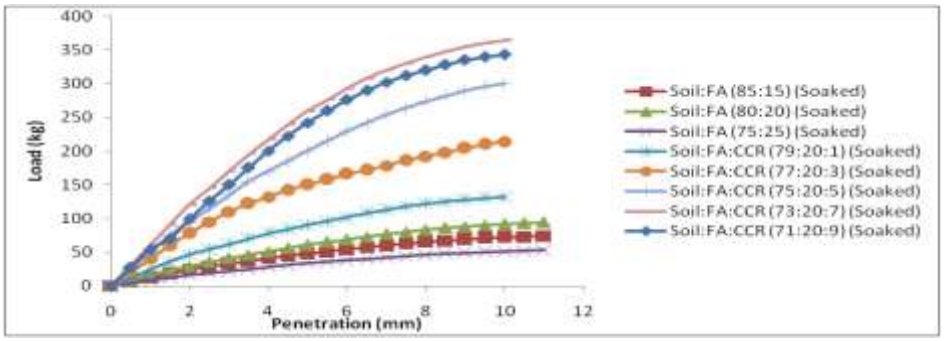


Fig 8: Load-Settlement Response of Soil with different % of FA and CCR (Soaked)

3.3 UCS TEST RESULTS ON SOIL MIX WITH FLY ASH AND CCR (7 DAYS CURING)

Stresses and strains are plotted in vertical and horizontal direction respectively. It shows the behavior of material when the load is applied.The UCS value on virgin soil is 112.53 kN/m^2 and it increases by 147.72% when soil is mixed with 20% FA and 1% CCR, increases by 267.46% when Soil is mixed with 20% FA and 3% CCR, increases by 347.29%when Soil is mixed with 20% FA and 5% CCR and further increased by 401.10 % when Soil is mixed with 20% FA and 7% CCR and then increased 382.24% when soil is mixed with 20% FA and 9% CCR. So, the optimum ratio is Soil: FA: CCR (73:20:7).

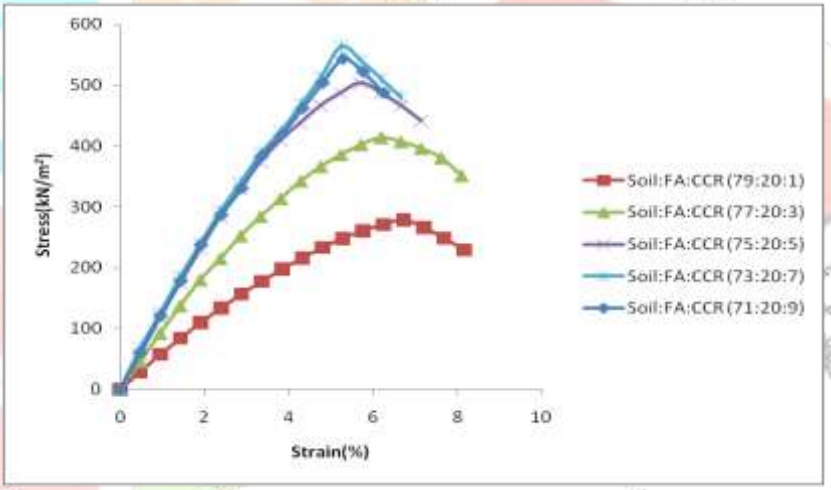


Fig 9:Stress Strain Relation

4.Conclusion:

By adding 20% Fly Ash, the (OMC) becomes 15% and (MDD) comes to 19.1 KN/m3 and the optimized value of FA used forthedifferent percentage of CCR was 20%. by adding of 7% CCR in soil mix of 20% FA, the (OMC) increased to 23% and (MDD) decreased to 17.7 KN/m3 and this seems the best ratio. CBR (Unsoaked)increases to 122% with anincrease in dose of FA upto 20% and further increases to 645% by addition of 7% CCR in soil mix of 20% FA. CBR (Soaked)increases to 104% by addition of 20% Fly Ash and increases to 768% by addition of 7% CCR in soil mix of 20% FA. By adding 20% of FA, the Unconfined Compressive Strength increases by 63% and strain is 7.140 and by adding 25% FA, the stress decreases, so take Soil: FA (80:20) as an optimum value and byaddition of 7% CCR & 20% fly ash the Unconfined Compressive Strength increases by 401% and strain (%) is 5.238 and beyond this ratio the increase in stress is marginal, so take Soil: FA: CCR (73:20:7) as an optimize value. The curing time also has a significant impact on strength of soil. With 7 days curing UCS increases by 401%.

REFERENCES

[1] Bandyopadhyay et al. (2016), "*Stabilization of soil using GGBS and Calcium Carbide Residue",* International Journal of Innovative Research in Science, Engineering and Technology, pp. 17023-17030.

[2] Horpibulsuk et al. (2012)., "*Strength development in silty clay stabilized with Calcium Carbide Residue And fly ash*", The Japanese Geotechnical Society, pp. 477-486.

[3] Isah. And Sharmila S. (2015), "*Soil Stabilization Using Calcium Carbide Residue and Coconut Shell Ash*", Basic and Applied Engineering Research, pp. 1039-1044.

[4] Jaturapitakkul and Roongreung. (2003)., "*Soil Stabilization Using Calcium Carbide Residue and Coconut Shell Ash*" Basic and Applied Engineering Research, pp: 1039-1044.

[5] Krishnan K. and Reddy P.S. (2016), "*Stabilization of week soil with Calcium Carbide Residue*", International Conference on Engineering Innovations and Solutions, pp. 86-89.

[6] Kumpala et al. (2013), "*Strength development in silty clay stabilized with Calcium Carbide Residue and fly ash*", The Japanese Geotechnical Society, pp. 477-486.

[7] Sabat A.K. and Nayak R. (2015), "*Evaluation of Fly Ash- Calcium Carbide Residue Stabilized Expansive Soil as a Liner Material in Engineered Landfill*", Electronic Journal of Geotechnical Engineering, pp. 6703-6712
Uchariya et al. (2016), "*Influence of fly ash and wood ash in soil compaction characteristics and CBR*", International journal for scientific research and development.

[8] Vichan. And Rachan. (2012), "*Chemical stabilization of soft Bangkok clay using Calcium Carbide Residue And biomass ash*", The Japanese Geotechnical Society, pp. 272-281.