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Effect of cement and corn cob ash on UCS and direct shear test of clayey soil

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Abstract
Soil present in nature may have no. of strength deficiencies. Thus needs to be stabilized and its properties needs to be modified in appropriate way to gain high strength characteristics. Large scale agricultural commodities producing nations are facing problems due to agricultural wastage produced like rice husk, corn cob etc. As corn cobs does not decompose easily results in causing numerous problems to surroundings as well as environment. Corn cob ash produced by burning corn cobs. Corn cob ash rich source of silica and thus having large tendency to behave like pozzolana make it suitable for using as cementious material. Objective and motive of study investigation is to investigate Soil: Cement: Corn Cob Ash mixture strength improvement by seeing its strength through UCS, DIRECT SHEAR TEST of stabilized soils. Corn cob ash added in varying amount alongside optimized cement value. For optimum mixture cement 2% and corn cob ash 6% compressive strength enlarged by 310% and 402% equated to virgin soil strength for 7 and 14 days curing spell respectively. Shear strength for optimum mixture increased by 64% equated to virgin soil strength for 14 days curing spell. Consequently Strength parameters were found showing a sufficient improvement in strength features of soil.

Keywords: cement, corn cob ash, clayey soil, soil stabilization

1. Introduction

Soil plays a primitive and vital role in almost every type of construction work. Soil is generally formed by regular deformation and disintegration of rocks due to various ongoing changes in atmospheric conditions around the rocks. It is one of easily available construction material present in abondous amount at construction site. But, Clayey soil present in its natural state at construction site sometimes may not have the suitable strength. It may have very poor and low bearing capacity, higher nature of compressibility, negligible amount of permeability etc. For imparting high amount of strength and stability soil thus needs to be stabilized. There are lots of methods and techniques developed for this purpose. Clayey soil can be effectively stabilized using cement alongside no. of admixtures. Amu O.O. *et al*. (2005) [2] and Singh B. (2011) [11] used cement alongside fly ash, Ashango A.A. *et al*. (2014) [3] and Roy A. (2014) [10] used cement alongside rice husk ash, Ramteke N.B. *et al*. (2014) [9] used cement and sand, Patel N.A. and Mishra C.B. (2014) [8] used cement, Mousavi S. and Wang L.S. (2015) [5] used cement alongside peat ash, silica sand and also alongside kaolin for improving strength of clayey soil respectively, Jimoh Y.A. (2014) [4] and Akinwumi I.I. and Aidomojie O.I.(2015) [1] used cement and corn cob ash for improving strength of literatic soil. and Micheal T. *et al*. (2016) [5] reviewed the literature work done using agricultural wastes. Cement can be used alongside corn cob ash for improving strength of clayey soil it will be environment friendly as well as it will be an economic process.

2. Materials used in the present study

2.1 Soil

Soil was obtained locally from Ludhiana. Roughly 200 kg of nearby existing clayey soil (CL) was poised by removing upper layers of soil and air dried. The unwanted materials were hand sorted. Lumps existing in soil wrecked with service of wooden mallet and sieved through 4.75mm sieve soil tester was oven-dried for 24 hours at 100 °C in advance it was varied with cement using it for experimentations. The belongings of soil used resolute by laboratory tests are arranged underneath in table.

Table 1: Properties of Soil determined

Properties	Corresponding Results
Liquid limit (%)	30
Plastic limit(%)Plasticity	18
Plasticity index (%)	12
Optimum Moisture content (%)	15
Maximum dry density (kN/m^3)	18.3
Specific gravity	2.6
Unconfined Compressive strength (kN/m^2)	83
Cohesion (kN/m^2)	21
Angle of internal friction(^{0})	27

2.2 Cement

The Ordinary Portland Cement is obatined from local shop. Cement of Ambuja Cement Company with Grade 43 is used. The cement hardnes the soil material and structural strength is primarily obtained from the cementing action rather than from friction, cohesion etc.

2.3 Corn cob ash

Corn cobs are obtained from fields at P.A.U. Ludhiana. Cobs air desiccated first and then burnt uninterruptedly in open air. Consequential ashes passed through .075mm is sieve.

Table 2: Chemical composition of corn cob-ash (Yinusa A. Jimoh, O. Ahmed Apampa, 2014) [4]

Constituents	Percantage (%)
SiO_2	63.6
Al_2O_3	5.8
Fe_2O_3	2.9
CaO	3.5
MgO	2.1
SO_3	1.1
K_2O	8.4

3. Methodology Implemented

Liquid limit, Plastic limit, Specific gravity, Standard compactor, Unconfined compression and Direct shear test were performed during the study investigation with varying cement (%) and corn cob ash (%).

Unconfined compression test was performed with 7 and 14 days curing respectively. Direct shear test was performed with 14 days curing.

4. Results observations and discussions

4.1 Representation of attained results

4.1.1 Compaction outcomes (Standard Proctor Test)

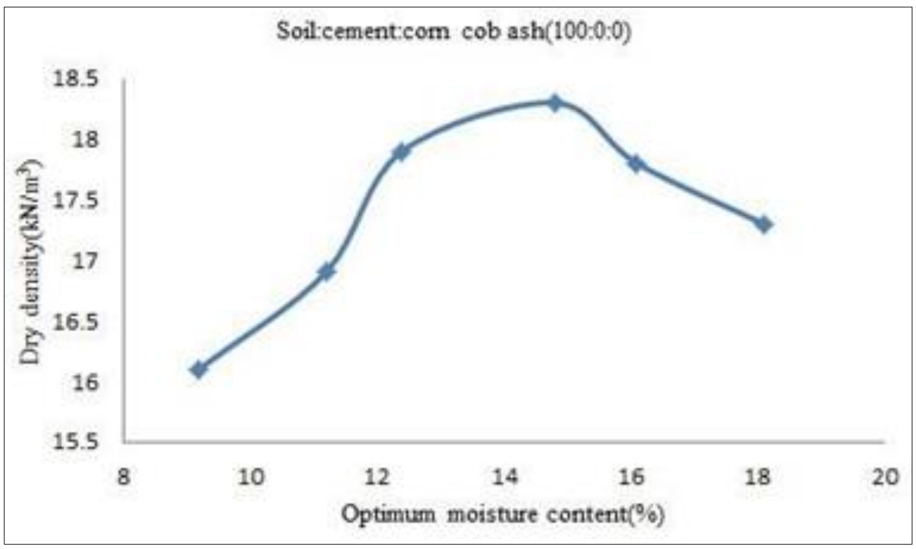

Fig 1: dry density vs optimum mositure content variation

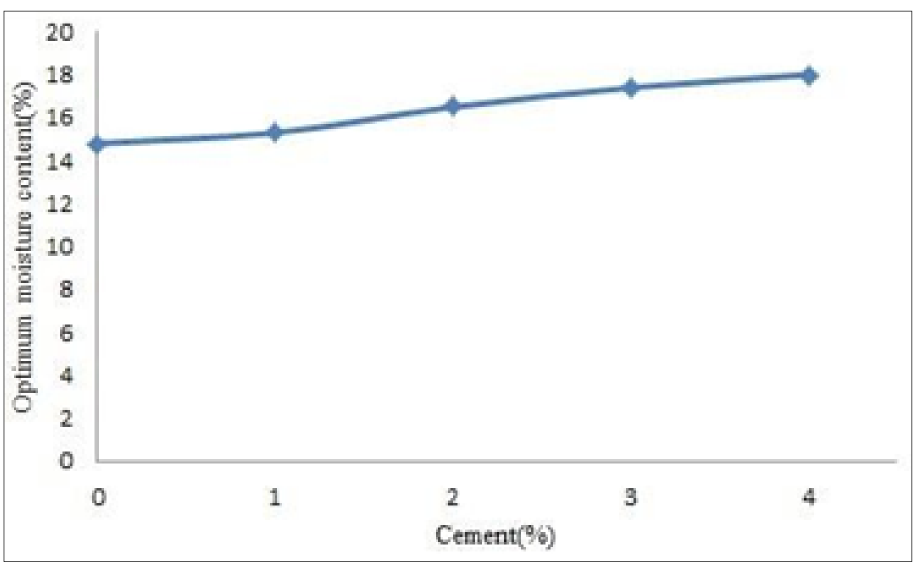

Fig 2: optimum moisture content variation with cement

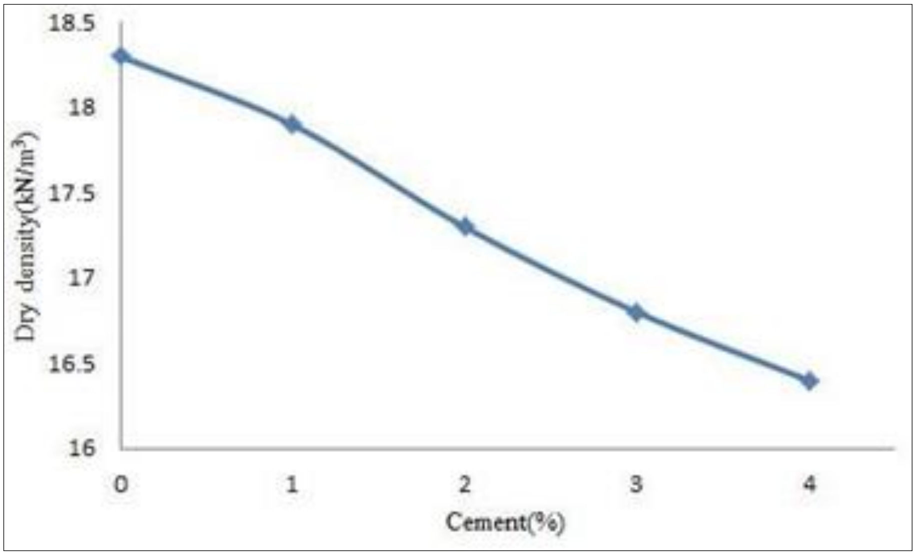

Fig 3: max dry density variation with cement

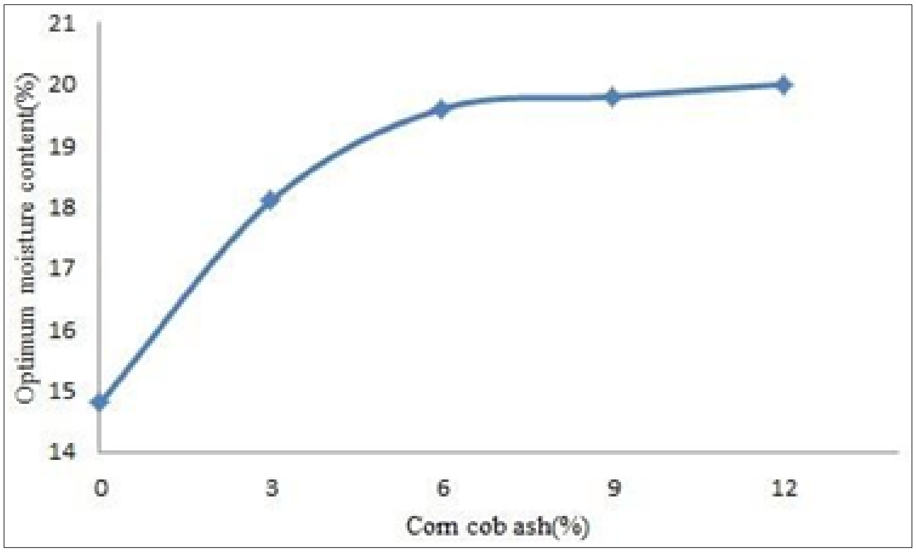

Fig 4: O.M.C. variation soil: cement (2%):corn cob ash (%)

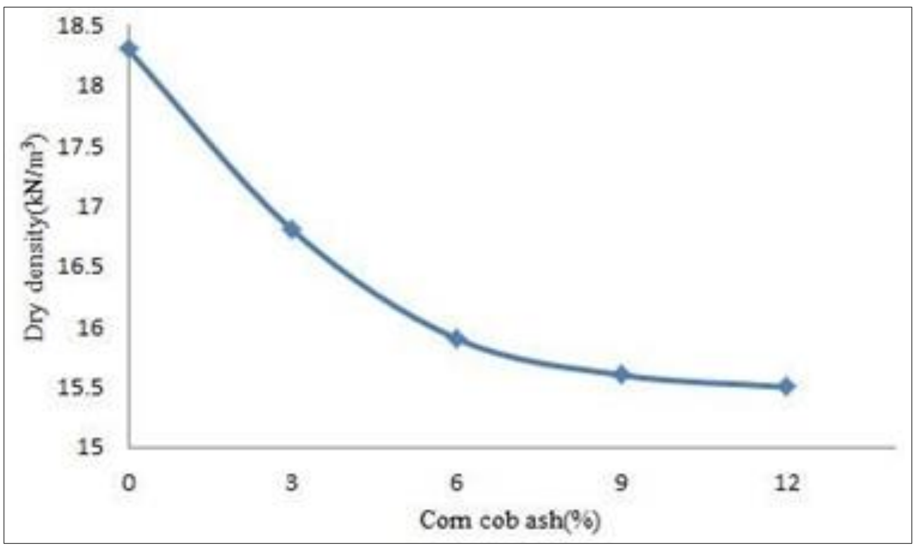

Fig 5: M.D.D. with soil: cement (2%):corn cob ash (%)

4.1.2 Compressive strength outcomes (U.C.S.)

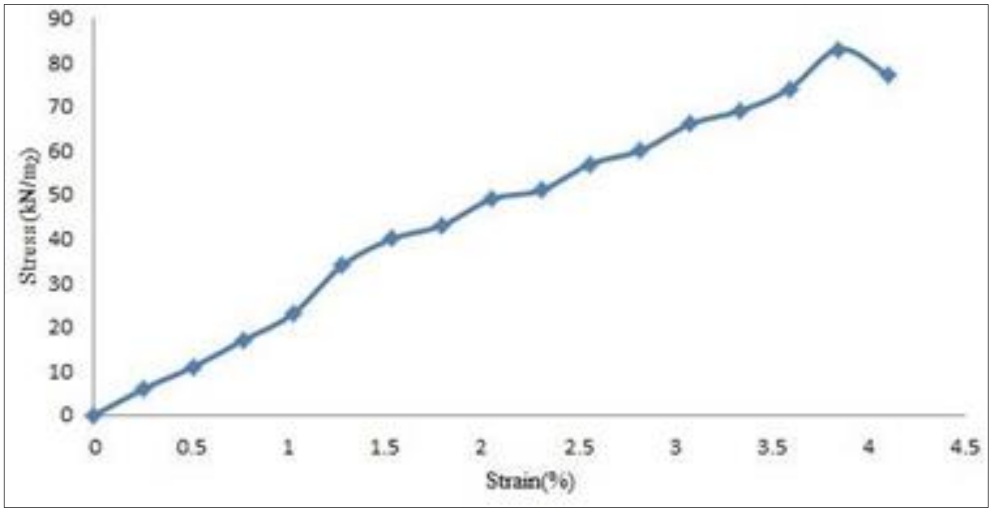

Fig 6: stress vs strain curve for soil

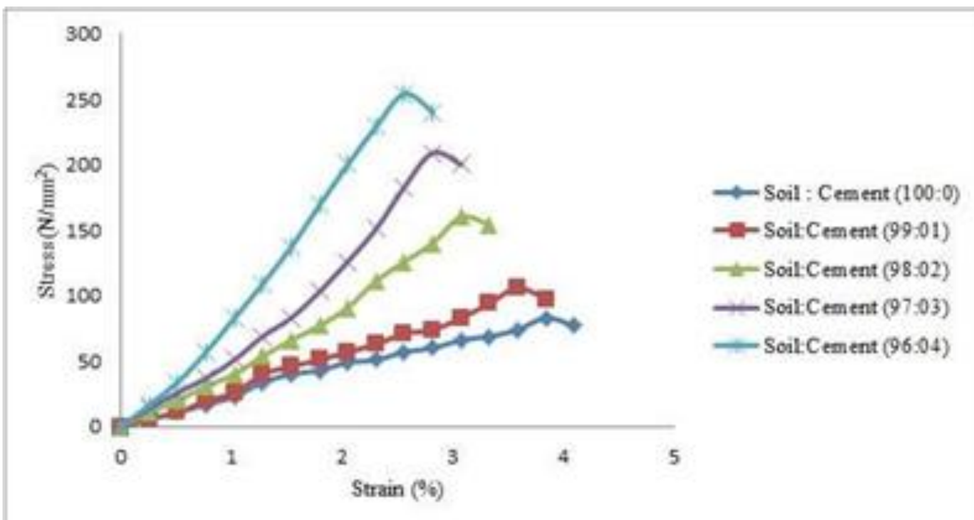

Fig 7: stress vs strain curve soil: cement (7days curing)

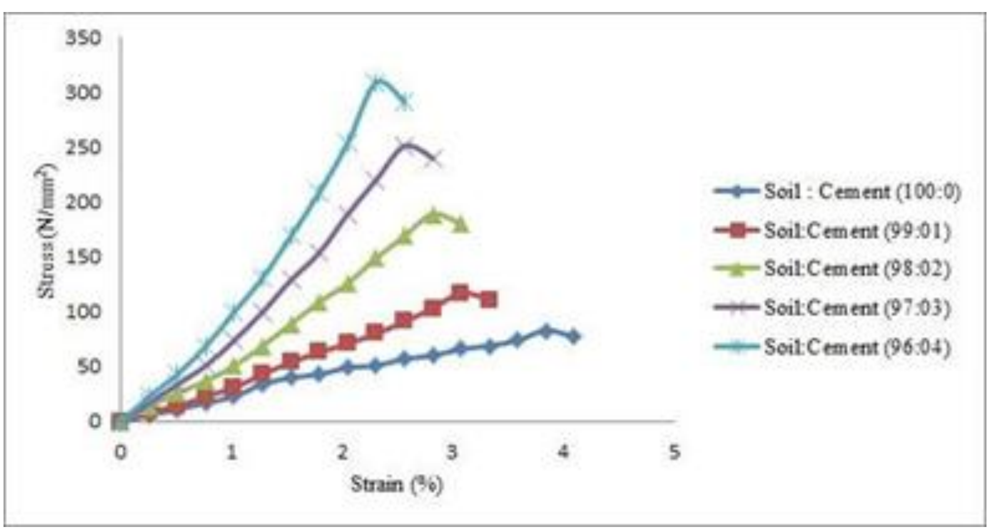

Fig 8: stress vs strain curve soil: cement (14days curing)

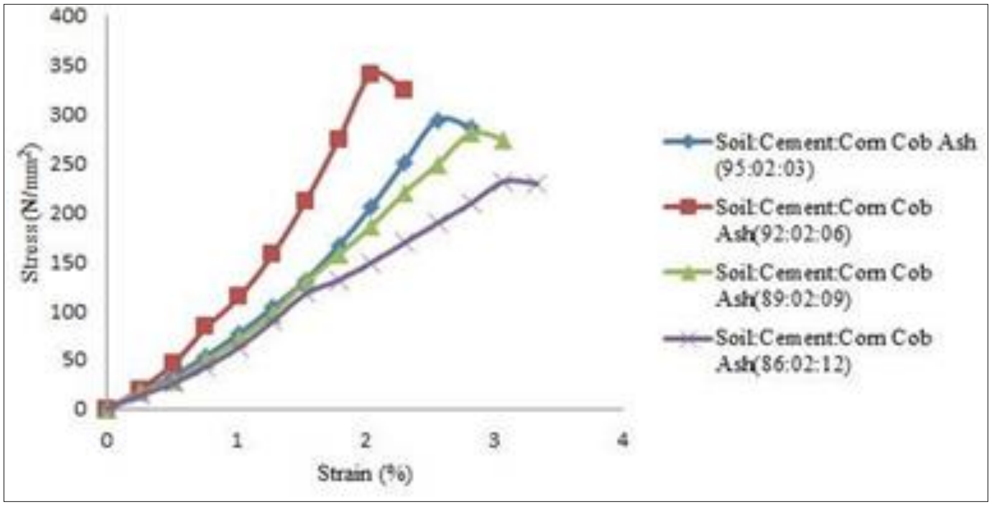

Fig 9: stress vs strain curve soil: cement: corn cob ash (7 days curing)

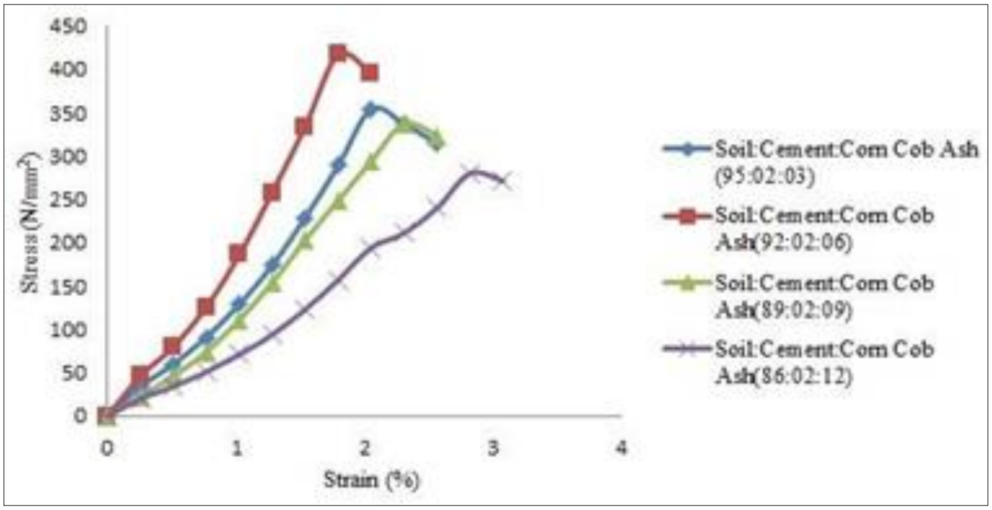

Fig 10: stress vs strain curve soil: cement: corn cob ash (14 days curing)

4.1.3 Shear strength outcomes (Direct Shear Test)

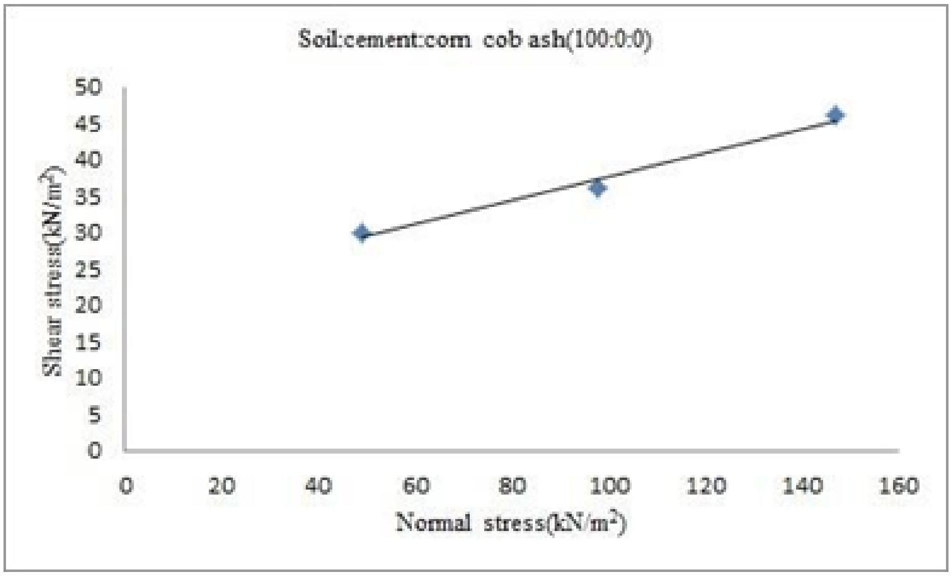

Fig 11: Mohr-Coulomb failure envelope (14 days curing)

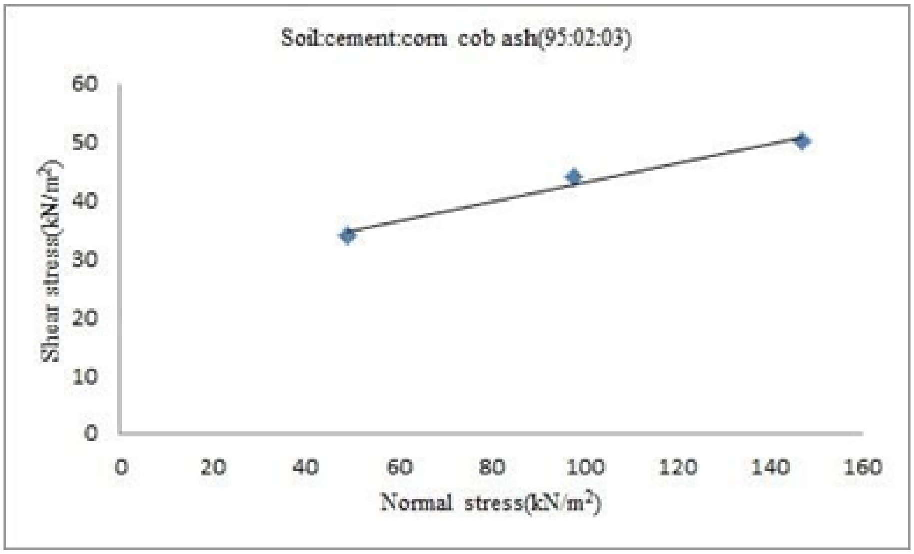

Fig 12: Mohr-Coulomb failure envelope (14 days curing)

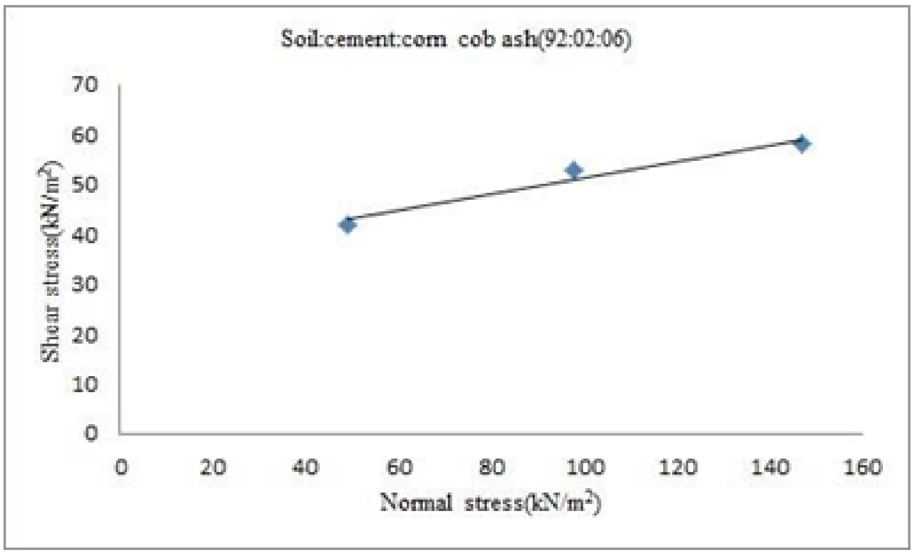

Fig 13: Mohr-Coulomb failure envelope (14 days curing)

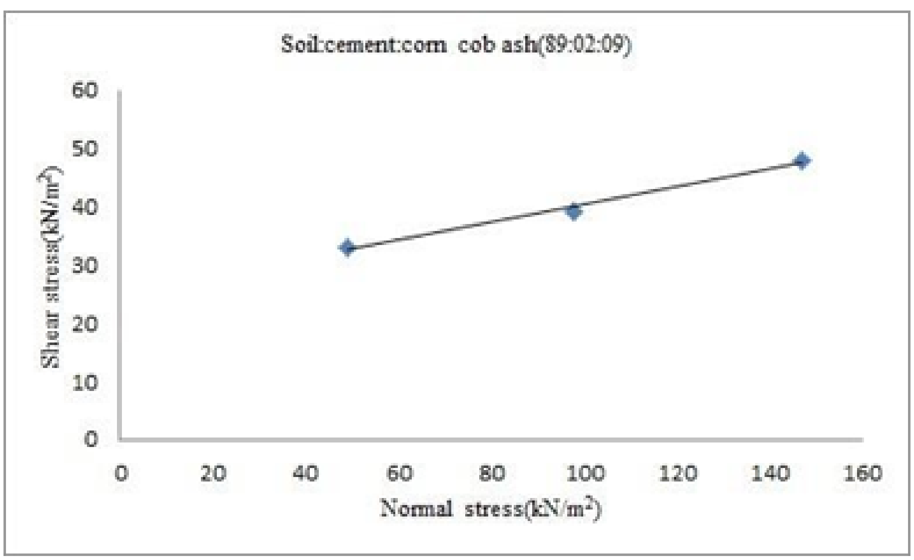

Fig 14: Mohr-Coulomb failure envelope (14 days curing)

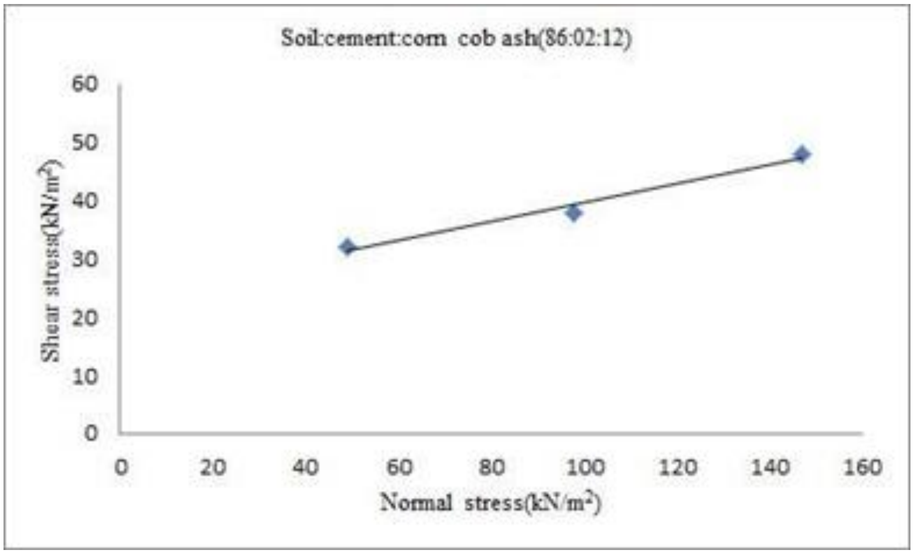

Fig 15: Mohr-Coulomb failure envelope (14 days curing)

4.2 Discussions

4.2.1 Compaction features

O.M.C. of virgin clay is 14.8% and M.D.D. of virgin clay is 18.30 kN/m3.O.M.C. augmented with escalation in cement content and M.D.D. dwindled with escalation in cement content. OMC upturns to 18% and MDD shrinkages to 16.40 after 4% addition of cement. For optimized cement value O.M.C. and M.D.D. obtained is 16.55% and 17.30 respectively. There is escalation at a very wilder rate in O.M.C. value with addition of corn cob-ash (3%, 6%) alongside optimized cement %. These leanings of increase in O.M.C. and lessening in M.D.D. may be accounted for element size of clayey soil and added stabilizing ingredients.

4.2.2 Compressive strength features

Unconfined compressive strength for virgin clay is 83kN/m2. Cement (%) is optimized by relative increase graph. UCS augmented upto 160kN/m 2(92.77%) for optimized cement (2%) with 7 days curing spell and further upsurges upto 189kN/m2 (127.71%) for 14 days curing spell. There is auxiliary increase in UCS with addition of 3%, 6% corn cob-ash alongside optimized cement (2%). There after UCS decline with addition of 9%, 12% corn cob-ash. Optimum mixture Soil: Cement: Corn cob-ash(92:02:06) gives UCS 340kN/m2 which is 310% greater than virgin clayey soil with 7 days curing spell and gives UCS 417kN/m2 which is 402% greater than the virgin clayey soil with 14 days curing spell. UCS increased on account of pozzolanic reaction and decreased with further addition of corn cob- ash due to weaker bond formation.

4.2.3 Shear strength features

Virgin clayey soil Cohesion value is 21.57 kN/m2 and angle of internal friction is 26.70. Cohesion value augmented to 35.30 kN/m2 which is 64% greater than virgin clayey soil and angle of internal friction declines to 17.60 for optimum Soil: Cement: Corn cob-ash mixture (92:02:06) with 14 days curing spell. Increase in Cohesion value occurs due to increase in fine particles and also due to pozzolanic reaction and decrease in angle of internal friction due to decrease in coarse size particles.

5. Conclusions

Following conclusions are thus can be listed on account of performed various test results observed for Soil: Cement: Corn cob ash mixture.

1. With accumulation of cement content (O.MC.) of the virgin clay increases and (M.D.D.) decreases. This leaning goes on in a parallel way with accumulation of corn cob-ash upto 6% in conjunction with optimized cement content.
2. UCS value for optimum mixture Soil: Cement: Corn cob-ash (92:02:06) increases by 310% for 7 days curing spell with respect to the virgin clayey soil value and increases by 402% for 14 days curing spell.
3. Cohesion value for optimum mixture Soil: Cement: Corn cob-ash (92:02:06) increases by 64% for 14 days curing spell with respect to the virgin clayey soil value.
4. UCS and shear strength diminutions with tallying of corn cob ash beyond 6% but both still are grander than virgin clay. It indicates that corn cob-ash adding imparts great strength to the strength features of clayey soil.
5. Corn cob-ash is when used with cement for upgrading strength properties of clayey soil results in a cheaper practice which is less inflated than using only cement.

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