International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)

Impact Factor: 5.858 (SJIF-2019), e-ISSN: 2455-2585

Volume 6 , Issue 7 , July -2020

USE OF CEMENT KILN DUST AND RECRON 3S FIBRE TO IMPROVE THE STRENGTH PARAMETERS OF CLAYEY SOIL

Isha koundal*[1], Anoop Sharma[2]

[1]M Tech Student, Sri Sai College of Engg. & Technology, PTU, Jalandhar, India.

[2]Assistant Professor, Sri Sai College of Engg. & Technology, PTU, Jalandhar, India.

Abstract*— Soil is a natural material on the earth surface and all depends on the nature. As a civil engineer soil is very important part in any construction work, so firstly we need to check soil behaviour, its strength and bearing capacity of soil, that how much strength or capability to bear the structure load in the soil which is under construction. There are many types of soil and having different strengths and load bearing capacity. In this research we focused on to improve the strength parameters of clay soil by adding CKD and Recron-3s Fibre. We performed various tests on the soil to know its strength parameters such as Cement Kiln Dust as a stabilized material in soil with varying percentages 5%, 10%, 15%. Use of cement kiln dust for improving soil property is advantageous because they are cheap, locally available and eco-friendly. Soil samples for California Unconfined Compressive Strength (UCS) tests are prepared at its Maximum Dry Density (MDD) corresponding to its Optimum Moisture Content (OMC) in the UCS sampler without and with recron-3s fibre. The percentage of recron-3s fibre by dry weight of soil is taken as 0.75%, 1.0% and 1.5% and corresponding to each recron-3s fibre content soaked UCS tests are conducted in the laboratory. Adding of recron-3s fibre and Cement kiln dust results in less thickness of pavement due to increase in mix and reduce the cost of construction and hence economy of the construction of highway will be achieved.

Keywords— Clayey soil, Cement Kiln Dust, Recron-3s Fibre, Stabilization and Standard Proctor Test

1. INTRODUCTION

Soil is a significant component in the construction scenario. The longevity of a structure is directly dependent on the soil upon which it rests, therefore, it is necessary to ensure that the soil over which any structure is constructed, is firm or stable enough. Various stabilization techniques prevail in the construction field utilizing diverse materials of varying properties. The basic construction material of the geotechnical engineer's design foundation is the soil.

In many set of circumstances, road service layers, foundation layers and construction material cannot utilize the soil directly. The rising cost of the land and huge demand for high rise buildings makes the improvement of soil at a site unavoidable. Therefore, it is required to revamp the quality of the soil. Soil is used in construction work such as dam construction, highways construction, building construction. When soil kept in untreated state then it lack strength and dimensional stability that leads to unsuitability and partially to the requirements of final constructions. The properties of soil include compressibility and strength so as to fulfil the required design criteria. The expansive soil used in this research also known as clay soil. This soil is taken as it contains particles of montmorillonite, which absorbs water easily and thus, attains contraction and shrinking property.

This study, particularly aims at testing the viability of utilizing waste materials such as cement kiln dust and Recron-3s Fibre which are eco-friendly as well as economical, for soil stabilization. Fibre is such a reinforcing material. Fibres are small pieces of reinforcing material possessing certain characteristic and properties. Fibre is considered as construction material to enhance the flexural and tensile strength. The Recron-3s fibre is made from polymerization of pure Terephthalic acid and Mono Ethylene Glycol using a catalyst. It is a polypropylene fibre which is a stabilizer to improve values. Recron-3s fibres are mixed in soil uniformly to get appropriate strength. As the name implies, Cement kiln dust is fine powder-like by-product of Portland cement production. They are collected from the stacks of high-temperature rotary kilns by the federally mandated dust collection systems (e.g., cyclones, electrostatic precipitators, and/or bag houses). Large quantities of cement kiln dust are produced during the manufacture of cement clinker by the dry process. The properties of CKD effect in many factors because of plant operations such as type of operation, dust collections etc.

2. LITERATURE REVIEW

Siyyagalla Subbarayudu et al. (2017) studied the soil stabilization by using recron-3s fibre, fly ash & lime. In this study, the stabilization of the soil by using RECRON-3S, FLYASH, LIME is done .In this study recron-3S as (1%,2%,) lime(2%,3%,4%) and cement kiln dust at (10%,12%,15%,20%) are used. With different proportion of soil with additive materials California bearing ratio value will be more compare to conventional materials. And from that thickness of pavement can be minimized to the certain extent.

Z.L.Belal et al. (2016) the improvement of engineering properties of two disturbed soils by using CKD in different percentages (5%, 10% and 20 %) was discussed in this paper. The results indicated that CKD additives increased the pH values and decreased the plasticity index in both types of soils under investigation. The (MDD) decreased and (OMC) increased with increasing the percentage of CKD in soil A. In soil B the MDD and OMC decreased.

Al-hassani et al. (2015) investigate the feasibility of utilization the cement kiln dust for the soil stabilization. The characteristics of two types of cohesive soils of different clay content treated by cement kiln dust were studied. The direct shear test /unconfined compression tests, the coefficient of permeability, and durability tests freezing-thawing and wetting-drying were reported. Several tests were carried out to investigate the effect of curing age on the unconfined compression and coefficient of permeability.

Upma et al. (2015) carried out the study of engineering properties of expansive soil using CKD and chemical additive RBI grade 81Road Building International grade 81 at various percentages and for different curing periods. RBI grade 81 is an odourless beige powder that is composed of number of naturally occurring compounds. It works by hydration reaction and it is insoluble in water, non UV degradable, inert and chemically stable. Atterberg's limit, Compaction, California Bearing Ratio C.B.R., Unconfined Compressive Strength U.C.S. tests were carried out on the samples of soil and soil with stabilizers. Reduction in the PI is 67.80%. Addition of the chemical additive RBI grade 81 and CKD contributes the strength development to the soil. From the UCS test, it was found that the UCS value of soil is improved by approximately 450%.

Salahudeen et al. (2014) showed that the index properties of the soil improved with CKD treatment. Peak unconfined compressive strength of 357.07 kN/m^2 and California bearing ratio CBR of 7 % as well as resistance to loss in strength of 44 % were recorded at 10 % CKD treatment. Reduction in the particle sizes with curing period was observed when samples were viewed through the scanning electron microscope. The study showed that CKD can be beneficially used to improve the subgrade of lightly trafficked roads and as admixture in lime stabilization during construction of flexible pavements over expansive soil.

Y. Keerthi et al. (2013) established that the chemical compounds found in soil; quartz, feldspar, dolomite, calcite, montmorillonite, kaolinite etc. react with the chemical constituents found in different identified chemical stabilizers. The purpose of using CKD, and the other additives, is to improve the texture, increase the strength and reduce the swell characteristics of the various soils. This paper represents the stabilization of clayey soil using cement kiln waste. The soil taken from Ravendrapadu in Andhra Pradesh containing different properties in various percentages is mixed with CKD in different proportions and parameters like dry density and moisture content were found out. By examining the values obtained ideal values were obtained at 50% proportional mix of CKD in total percentage.

Kumar et al. (2013) investigated shear strength characteristics as well as mechanical strength of Kaolinite clay soil treated with 5, 10, 15, 20 and 25 % by weight of cement kiln dust. It was observed that up to 20 % mixing of admixture, unconfined compressive strength and undrained shear strength increase significantly then decrease with further increase in percentage of stabilizer. However, when the same samples were tested for mechanical strength by performing CBR tests, it was observed that the CBR values increases with increase in percentage of CKD. Overall, it was observed that the cement kiln dust effectively increases strength and hence make clays suitable for building pavements over it.

P.V.KOTESWARA RAO et al (2012) studied the performance of recron-3s fibre with cement kiln dust in expansive soils. In the present work, an attempt is made to study the influence of polymer fibres on the properties of locally available Black cotton soil with and without admixture modification. This study revealed that the fibre reinforcement improves the soil properties in terms of improved stress-strain patterns and progressive failure in place of quick post peak failure of plain samples. The unconfined compressive strength of Clay soil is increased by 7 times with admixture stabilization and 9 times for admixture with fibre modification with respect to plain samples. The shear strength parameters of clay soil are also significantly increased upon admixture stabilization and admixture with fibre treatment. The CBR value also increased significantly even for soaked CBR tests. By addition of CKD the Liquid limit of the mixture is decreased 23 %, whereas plastic limit is increased by 41%. Plasticity Index of the mix is decreased by 57%.

3. MATERIALS AND METHEODOLOGY

3.1 Clayey Soil

The clayey soil used in this investigation was collected from Chakki Pathankot. The soil was brought to lab in bags and soil was dried in oven for one day followed by pulverization. Soil was pulverized to pass the soil through 4.75 mm size sieve and stored in such way that, there is a very minor chance of absorption of moisture by soil. Sieve analysis tests were conducted on soil to find out the soil classification and according to the soil results soil can be classified as CI (intermediate compressible clayey soil).

Fig.1: Clayey Soil

3.2 Recron-3s Fibre

Recron-3s, name of a geo-fibre used in present study was bought from the Chandigarh shown in figure2. The fibre used in this study of length 12 mm.Recron-3s is also available in different sizes as 6 mm, 12 mm and 24 mm. But here 12 mm is used, as in previous studies 12 mm was found successful. The Recron-3s fibre is made from polymerization of pure Terephthalic acid and Mono Ethylene Glycol using a catalyst. It is a polypropylene fibre which is a stabilizer to improve values. Recron-3s fibres are mixed in soil uniformly to get appropriate strength.

Fig.2: Recron-3s Fibre

3.3 Cement Kiln Dust

Cement kiln dust is fine grained, solid, highly alkaline waste removed from cement kiln exhaust gas by air pollution control devices. CKD are for stabilization of contaminates soils and sludge as filler in asphalts, as a partial additive to produce blended cements for concrete construction. It may be noted that so far, most of the work performed has been limited to freshly generated cement kiln dust while issue or reusing already landfilled material, available in significantly greater quantities has been mostly unexplored. Large quantities of cement kiln dust are produced during the manufacture of cement clinker by the dry process. Several factors influence the chemical and physical properties of CKD, because plant operations differ considerably with respect to raw feed, type of operation, dust collection facility, and type of fuel used. The dust from each plant can vary markedly in chemical, mineralogical and physical composition.

Fig.3: Cement Kiln Dust

3.4 Test Involved

Following tests are to be conducted on virgin soil as well as soil containing different proportion of Recron-3s Fibre and Cement Kiln Dust to determine the various parameters proposed in the objectives;

1) Determination of soil index properties.

- Liquid Limit Test
- Plastic Limit Test
- Plasticity Index

2) Determination of maximum dry density (MDD) and corresponding optimum moisture content (OMC) of soil by Standard Proctor Compaction test.

3) Determination of strength parameters i.e. Unconfined Compressive Strength (UCS).

4. RESULTS AND DISCUSSION

4.1 Mix Proportion Used

In this experimental study, the ratio used for Recron-3s Fibre is 0.75%, 1% and 1.5% while for Cement Kiln Dust it is 5%, 10% and 15%.

Table 1: Various mix proportion of the present study

Sr. No.	Designation(CS:CKD:R.F)
1.	100:0:0
2.	99.25:0:0.75
3	99:0:1
4.	98.5:0:1.5
5.	95:5:0
6.	90:10:0
7.	85:15:0
8.	89.5:10:1.5
9.	89.25:10:0.75
10.	89:10:1.0

4.2 Standard Proctor Test

Clay- Recron-3s Fibre –Cement Kiln Dust

Table 2: SPT Results of Clayey Soil with Recron-3s Fibre and Cement Kiln Dust

CS: Cement Kiln Dust: R.F	M.D.D (g/cc)	O.M.C %
89.5:10:0.5	18.10	14.4
89.25:10:0.75	17.80	14.70
89:10:1.0	18.40	13.90

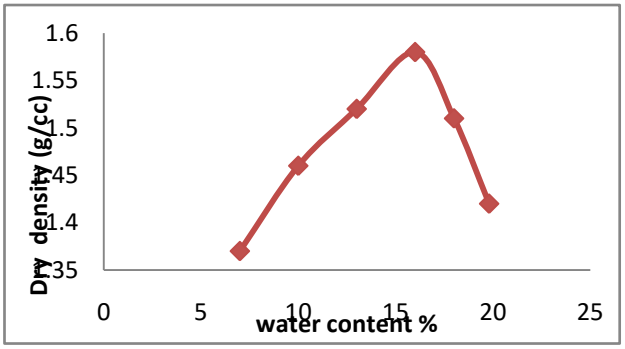

Fig. 4: M.D.D and O.M.C of CS 89.5%: CKD 10%: R.F0.5%

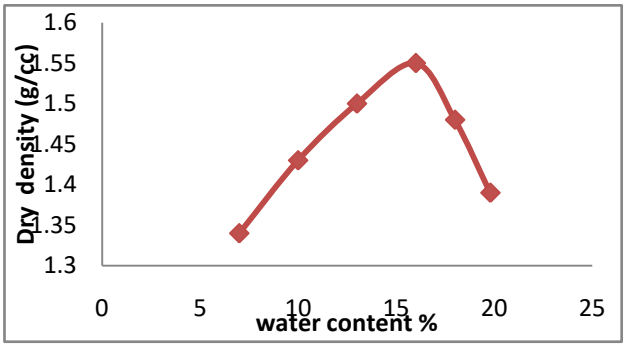

Fig. 5: M.D.D and O.M.C of CS 89.25%: CKD 10%: R.F0.75%

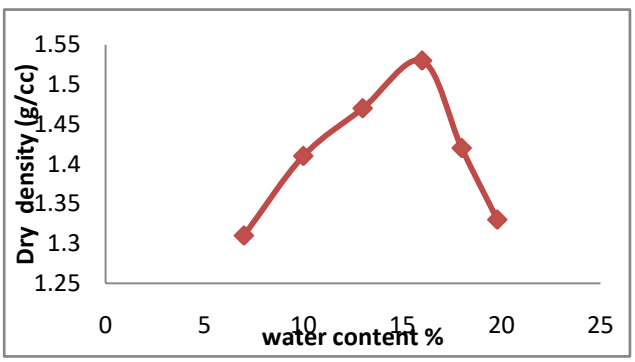

Fig. 6: M.D.D and O.M.C of C.S 89%: CKD 10%: R.F 1.0%

4.3 Unconfined Compression Test

Table 3: Results of UCS Test of virgin soil

Clayey Soil	Curing Period (Days)	UCS (kpa)
100 : 00	7	87.53

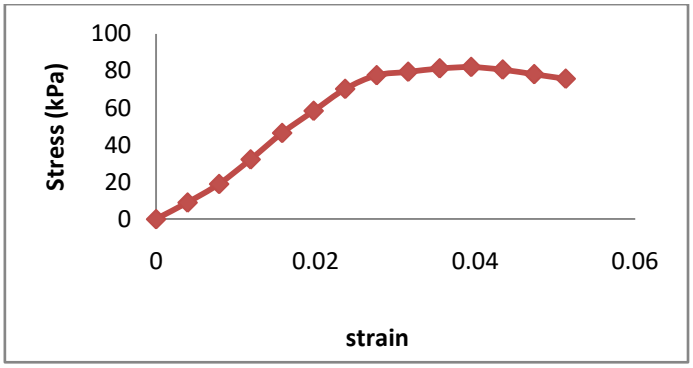

Fig. 7: UCS of virgin soil sample, it is known that U.C.S value of virgin soil = 87.53kpa

Clayey soil, Recron-3s Fibre and Cement Kiln Dust

Table 4: UCS Results of Clayey Soil with Different Proportion of Recron-3s Fibre & Cement Kiln Dust

CS: Cement Kiln Dust: R.F	Curing (Days)	UCS (kPa)
89.5:10:0.5	7	82.6
89.25:10:0.75	7	170.56
89:10:1.0	7	205.81

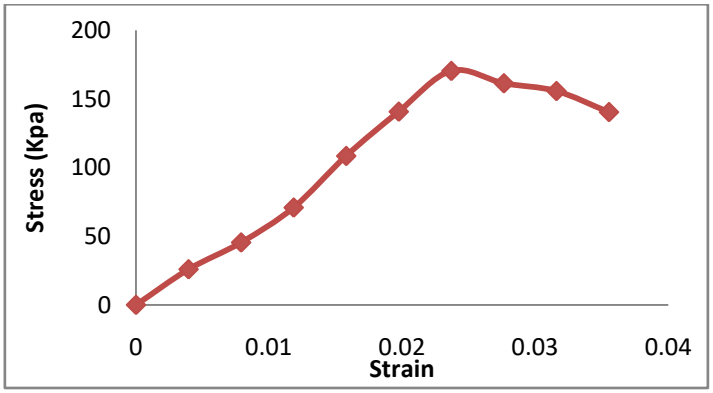

Fig. 8: UCS of Clayey soil stabilized with R.F (0.5%) & Cement Kiln Dust (10%), it gives UCS=170.56 kpa

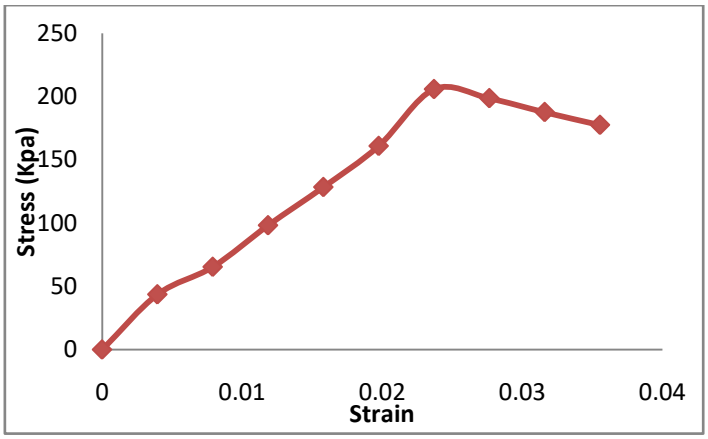

Fig. 9: UCS of Clayey soil stabilized with R.F (0.75%): Cement Kiln Dust (10%), it gives UCS=205.81 kpa

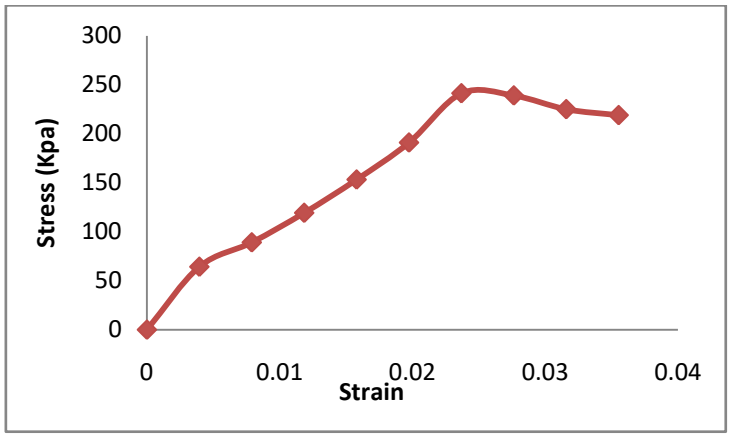

Fig. 10: UCS of Clayey Soil stabilized with R.F (1%): CKD (10%), it gives UCS=241.2 kpa

5. CONCLUSION AND SCOPE OF WORK

On the basis of experimentations, the following conclusions have been drawn:

1. From this study it is concluded that Cement Kiln Dust and Recron-3s Fibre are waste products from industries that can be used as stabilizers to clay soil and this would help to solve the conventional problem of disposal of them.
2. When percentage cement kiln dust increases in soil there is an increase in O.M.C. and decrease in M.D.D. with the increases of quantity of Recron-3s Fibre O.M.C. increases and M.D.D. decreases regularly.
3. The optimum value of Cement Kiln Dust is used for this work was 20% because of the optimum value of UCS is found at 20% of Cement Kiln Dust when added to soil.
4. Unconfined Compressive Strength increases with increase of quantity of Recron-3s Fibre and with fixed quantity of Cement Kiln Dust. The value of Unconfined Compressive Strength is increased 2.92 times from the untreated soil.
5. Addition of Cement Kiln Dust and Recron-3s Fibre stabilizer makes the soil mixes durable, low cost and effective for soil improvement. If these two materials are easily available near to the site.

REFERENCES

Sivyagalla Subbarayudu, "STUDY OF SOIL STABILIZATION BY USING RECRON -3S, FLY ASH & LIME", International Journal For Technological Research In Engineering Volume 4, Issue 9, May-2017.

Kolla Aswani Chandh, "A Study on Effect of Fibre on Non Swelling Sub Grade Layer" International Journal of Engineering Science and Computing, September 2016, Volume 6 Issue No. 9.

R.V.Giridhar, "An structured teaching program on geotechnical application and soil treated", Scientific Journal of India, ISSN: 2456-5644 (Online) ,Vol. 01

P.Sowmya Ratna, "Performance of Recron-3s Fiber with Lime in Expansive Soil Stabilization" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684

P.V.Koteswara Rao, K.Satish Kumar, T.Blessingstone, "Performace of Recron-3s Fiber with Cement Kiln Dust in Expansive Soils", International Journal of Engineering Science and Technology (IJEST), ISSN: 0975-5462 Vol. 4 No.04 April 2012.

Prof. R.K Sharma, "Sub grade Characteristics of Locally Available Soil Mixed with Fly Ash and Randomly Distributed Fibres", International Conference on Chemical, Ecology and Environmental Sciences (ICEES'2012) March 17-18, 2012 Bangkok.

S. Bhuvaneshwari, R. G. Robinson, S. R. Gandhi (2005), "Stabilization of Expansive Soils Using Fly ash", Cement kiln dust India, New Delhi.

Y. Keerthi, P. Divya Kanthi, N. Shyam Chamberlin, B. Satyanarayana (April 2013), Stabilization of Clayey Soil using Cement Kiln Waste, International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 02, No. 02.

IS 2720 (Part V) (1985) ―Determination of Liquid & Plastic Limits.

IS 2720 (Part III) (1980) ―Determination of specific gravity