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EXPERIMENTAL STUDY OF CLAYEY SOIL STABLISED WITH FLY ASH AND RECRON-3S

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Abstract-*The soil is omnipresent material naturally in the universe and is the cheapest available construction material. As clay shows unfavorable behavior as high shrinkage, swell characteristics and low bearing capacity, there is need to improve the strength characteristics. The aim of this research is to study the characteristics of soil when processed with fly ash and recron-3s. The method used in the research is randomly distributed fibre reinforcement soil also termed as RDFS. The objective of the study is to be increase the strength of clayey soil using recron-3s fibre and fly ash. The research was focused on to improve the strength of soil and to obtain an optimum amount of soil-fly ash-recron-3s mix. The proportions used of fly ash were 10, 15, 20, 30, 40 and 50% and recron-3s was in 0.2, 0.4, 0.6, 0.8 and 1.0% in amount by weight. In this study number of proctor test, unconfined compressive strength test were performed. From Proctor test, it was determined that O.M.C increases and M.D.D decreases with increase in fly ash and recron-3s.The fly ash was optimized at 15% and was used for further work. U.C.S value for virgin soil was 214.76 kN/m², by adding fly ash it was increased to 458.13 KN/m² at 15% fly ash. On addition of recron-3s strength was increased and the maximum was at 0.8% i.e. 685.24 KN/m² for 1-week curing and 791.05 KN/m² for 2-week curing period. From the experimental results, it was concluded that recron-3s work as reinforcing the material and provides strength to the soil as well as fly ash worked as cementing material. The preeminent proportion obtained was 84.2% soil – 15% fly ash – 0.8% recron-3s fibre.*

Key Words: **Soil, recron-3S, fly ash, lime, Optimum Moisture Content, Maximum dry density, unconfined compressive test (UCS)**

1. INTRODUCTION

Soil a word which implies earth's upper layer, which might be wrinkled or burrowed; primarily the different face material of the earth where plants and natural issue creates as indicated by the Webster's lexicon. This word "soil" is gotten from Sodium, a Latin word. Soil is inescapable material normally in the universe. The least expensive accessible development material is additionally soil, on a similar hand it is extremely unpredictable material as well. Investigation of soil mechanics is unpredictable thing too in itself. The high fluctuation in attributes and structure makes soil an unpredictable material. The conduct of soil shifts from place to put and furthermore with the adjustment in the normally happening conditions changes the conduct of the dirt. The plain first obligation of geotechnical build is to check whether the designing property of soil matches to the outline prerequisites of a building structure or not.

This is extremely regular issue for a development design that the dirt accessible at a specific site is unsatisfactory for the development work. Quality, dependability, penetrability and solidness are the primary designing properties of soil with which the dirt designer is concerned.

Lacking quality (distortion opposition) is a dirt issue in numerous structures development structures, burrows and other exhuming, streets, landing strips and so on this issue can prompt financial misfortune, and in additionally may prompt loss of human lives as well.

The investigation of designing qualities of soil is worried about the soundness of holding structures, stable establishments, and solidness of inclines, earthen dams and underground structures, asphalt development. As a result of the mind boggling conduct of the dirt as for the designing properties the dirt has rendered it to following impediments.

- Theory of elasticity cannot be applied due to the non-linear stress strain relationship.
- Strength and behavior of soil depends on drainage, pressure, environment and many other factors, because of this same soil shows different strength under dissimilar conditions.
- Soil at different locations is different in characteristics' and composition so the results of soil at one place are different from other place.
- Interpretation of the results of test results is not possible.
- Wide-ranging behavior of soil compels to change the methods of construction at different sites.
- Soil being a particulate material the properties of soil changes as the particles shifts the positions.

2. EXPERIMENTAL STUDY

2.1 Materials

Following are the materials which are used for stabilization of Clay soil:

a) Clay soil: In order to study the behavior of clayey soil with fly ash and recron-3s, a sample of soil is collected from village- Babyal, (District-Ambala), State Haryana as shown in figure 1. The soil shows expansive properties when came in contact with water. The clayey soil is light brown in colour. According to IS soil classification system, the soil was classified as Plastic clay(CI).The index properties of soil are determined as per Indian standard test procedure and tabulated in Table 1.

Fig.1: Soil sample

Table 1: Properties of soil used in study

Sr. No.	Characteristics	Value
1	Specific gravity	2.54
2	Atterbergs limits: a) Liquid limit (%) b) Plastic limit (%) c) Plasticity index (%)	 35.0 20.5 14.5
3	Colour	Light brown
4	IS classification	CI
5	Standard Proctor compaction test result:- Optimum moisture content (%) Maximum dry density(KN/m^3)	 17 17.50
6	Unconfined compressive strength(KN/m^2)	214.76

b) Fly ash: Fly ash used here in this study was collected from Deen bandhu Chhotu Ram Thermal Power Station, Yamuna Nagar (Haryana) as shown in figure 2. The samples were made to dry in oven at temperature of 100˚C to 110˚C. The fly ash brought was then passed through the sieve to remove the solid heavy particles. The dried and sieved fly ash was packed in polythene air tight bags for further usage to protect from the moisture. The physical and chemical properties of fly ash are mentioned in Table 2 and Table 3.

Fig. 2: Fly ash Sample

Table 2: Physical properties of fly ash

Sr.no.	Properties	Value
1	Colour	Dark Grey
2	Standard proctor compaction test::- a) Optimum moisture content (%) b) Maximum dry density(KN/m^3)	33.5 13.3
3	Specific gravity	1.98

Table 3: Chemical composition of fly ash

Sr.no	Constituents	%age
1	Sio_2	58.48
2	Al_2o_3	29.68
3	Fe_2o_3	6.98
4	CaO	1.69
5	MgO	1.36
6	Na_2o	0.27
7	K_2O	1.21
8	P_2O_5	0.31

c) Recron-3s fibre: Recron-3s, name of a geo-fibre used in present study was bought from the Chandigarh shown in figure 3. 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 Terapthalic acid and Mono Ethylene Glycol using a catalyst. It is a polypropylene fiber which is a stabilizer to improve CBR values. Recron-3S fibers are mixed in soil uniformly to get appropriate strength. The physical properties of recron-3s shown in table 4.

Fig. 3: Recron-3s fibre

Table 4: Physical properties of recron-3s fibre

Sr.no.	Properties	Value
1	Colour	White
2	Cut length	12mm
3	Denier(D)	1.5
4	Tensile strength(mpa)	600
5	Melting point(^{0}c)	>250
6	Specific gravity	1.334
7	Equivalent dia (μm)	32-55
8	Water absorption (%)	85.22
9	Acid resistance	Excellent
10	Alkali Resistance	Good

2.2 Experimental Investigation

The following were tests performed for the present study in laboratory:-

1. Atterberg limits.
2. Standard Proctor Test for determination of O.M.C and MDD.
3. Unconfined Compression Test.

The test results on the soil, for the properties of the virgin soil i.e. liquid limit, plastic limit, plasticity index, specific gravity, unconfined compressive strength. After obtaining the properties of virgin soil the tests were done on soil and fly ash mixes, from here the amount of fly ash was optimized by unconfined compressive strength test. The optimized value of fly ash and soil was mixed with different proportions of recron-3s fibre. Then the soil, fly ash, recron-3s samples of different ratios were tested under the Standard proctor test, unconfined compressive strength after 7 day and 14 day curing period.

2.2.1 Standard Proctor Test:-The standard proctor commonly known as SPT in a field test usually conducted for sampling cohesion less soil. This test is extremely useful for determining the optimum moisture content at which a given soil type will become most dense and achieve its maximum density.

2.2.1.1 Proportions of Materials with Clay Soil:

I) SPT test conducted on soil by different mix proportion of fly-ash:

1. Soil (90%) +fly ash (10%)
2. Soil (85%) +fly ash (15%)
3. Soil (80%) +fly ash (20%)
4. Soil (70%) +fly ash (30%)
5. Soil (60%) +fly ash (40%)
6. Soil (50%) +fly ash (50%)

From the above proportion result of MDD (Maximum dry density) & OMC (Optimum moisture content) is calculated:

Table 5: Result of SPT test (Soil-Fly ash)

Sample no.	Proportions Of soil-fly ash	MDD (KN/m^3)	OMC (%)
1	90-10	20.18	18
2	85-15	19.01	18.5
3	80-20	16.07	19
4	70-30	15.09	21
5	60-40	14.01	24
6	50-50	13.13	26

Chart-1 & 2 showing the variation of curves MDD and OMC with %age of fly ash obtained from the result of SPT test.

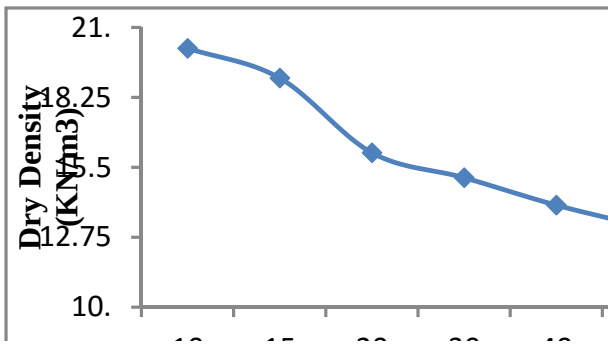

Chart-1: Variation of MDD with % of fly ash

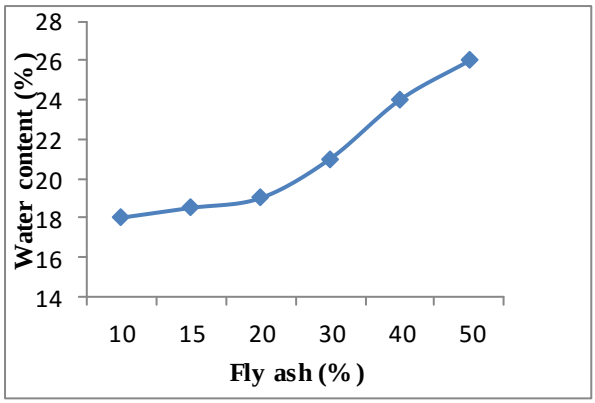

Chart-2: Variation of OMC with % of fly ash

From the result of SPT test best proportions are selected from their MDD & OMC (soil 85% +Fly ash 15%). Now Standard proctor test and unconfined compressive strength for (1 week & 2 week) curing period is performed on best proportion of soil.

II) SPT test conducted on soil by different mix proportion of fly-ash and recron-3s:

1). Soil (84.8%) +Fly ash (15%) +recron-3s (0.2%)

2). Soil (84.6%) +Fly ash (15%) +recron-3s (0.4%)

3). Soil (84.4%) + Fly ash (15%) + recron-3s (0.6%)

4). Soil (84.2%) +Fly ash (15%) +recron-3s (0.8%)

5). Soil (84%) +Fly ash (15%) + recron-3s (1%)

From the above proportions result of MDD (Maximum dry density) & OMC (Optimum moisture content) is calculated:

Table 6: Result of SPT test (Soil-Fly ash-Recron-3s)

Sample no.	Proportions Of soil-fly ash-recron-3s	MDD (KN/m^3)	OMC (%)
1	84.8-15-0.2	16.04	18
2	84.6-15-0.4	15.95	19
3	84.4-15-0.6	15.77	20
4	84.2-15-0.8	15.5	22
5	84-15-1	15.4	23

Chart-3 & 4 showing the variation of curve MDD and OMC with the %age of fly ash and recron-3s obtained from the SPT test:

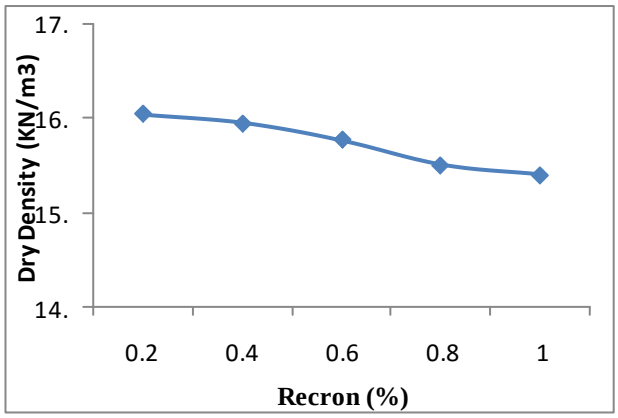

Chart-3: Variation of MDD with % of recron-3s & 15% fly ash

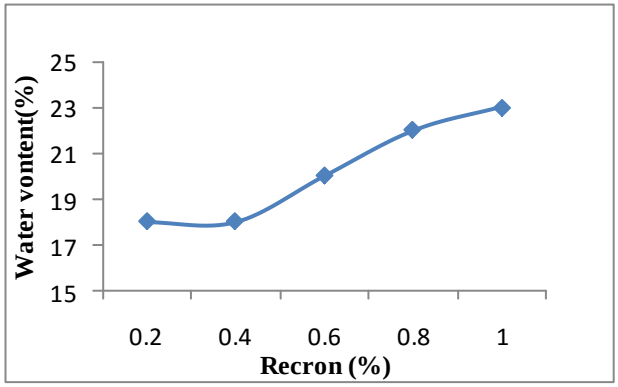

Chart-4: Vibration of OMC with % of recron-3S& 15% fly ash

2.2.2 Unconfined Compressive Strength: - The unconfined compressive strength is defined as the maximum unit stress obtained within the first 20% strain. The objective of UCS test is to determine shear parameters of cohesive soil .It is not always possible to conduct the bearing capacity test in the field. Sometimes it is cheaper to take the undisturbed soil sample and test its strength in the laboratory.

2.2.2.1 Proportions of Materials with Clay Soil:

I) UCS test conducted on soil by different mix proportion of fly-ash:

1. Soil (90%) +fly ash (10%)

2. Soil (85%) +fly ash (15%)

3. Soil (80%) +fly ash (20%)

4. Soil (70%) +fly ash (30%)

5. Soil (60%) +fly ash (40%)

6. Soil (50%) +fly ash (50%)

From the above proportion result of UCS (unconfined compressive strength) is obtained for soil and fly-ash:

Table 7: Result of UCS test (Soil-Fly ash)

Sample no.	Proportions Of soil-fly ash	UCS (kn/m³)
1	90-10	409.10
2	85-15	458.13
3	80-20	378.70
4	70-30	345.26
5	60-40	242.01
6	50-50	234.06

Chart-5 showing the variation of curve with % of fly ash obtained from the result of UCS test.

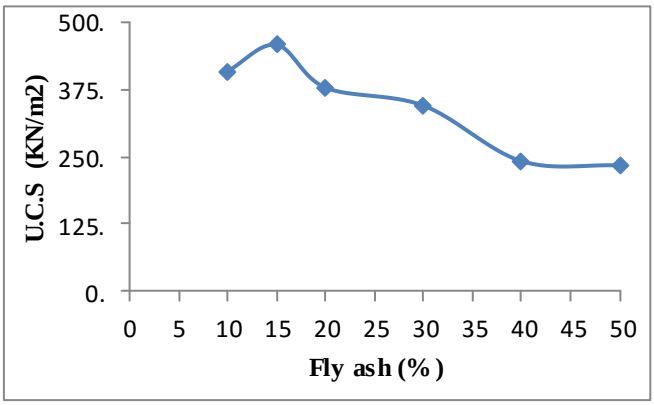

Chart-5: Variation of UCS with % fly ash

VI) UCS test conducted on soil by different mix proportion of fly-ash and recron-3s for 1 week curing period:-

1).Soil (84.8%) +Fly ash (15%) +recron-3s (0.2%)

2).Soil (84.6%) +Fly ash (15%) +recron-3s (0.4%)

3).Soil (84.4%) + Fly ash (15%) + recron-3s (0.6%)

4).Soil (84.2%) +Fly ash (15%) +recron-3s (0.8%)

5).Soil (84%) +Fly ash (15%) + recron-3s (1%)

From the above proportion result of UCS (unconfined compressive strength) is obtained for soil, fly-ash and recron-3s for (1 week) curing period:

Table 8: Result of UCS test (Soil-Fly ash-recron-3s)

Sample no.	Proportions Of soil-fly ash	Curing period (week)	UCS (KN/m³)
1	84.8-15-0.2	1	512.46
2	84.6-15-0.4	1	566.49
3	84.4-15-0.6	1	625.23
4	84.2-15-0.8	1	685.24
5	84-15-1	1	654.35

Chart-6 showing the variation of curve with % of soil-fly ash-recron-3s for (1 week curing period)

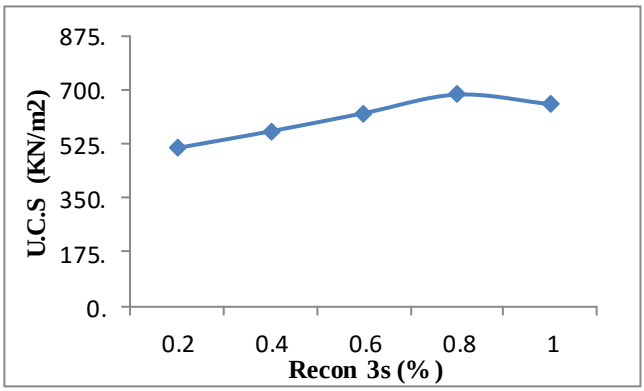

Chart-6: Variation of UCS with% of recron-3s & 15% fly ash

V) UCS test conducted on soil by the different mix proportion of fly-ash and recron-3s for (2 week) curing period:-

1).Soil (84.8%) +Fly ash (15%) +recron-3s (0.2%)

2).Soil (84.6%) +Fly ash (15%) +recron-3s (0.4%)

3).Soil (84.4%) + Fly ash (15%) + recron-3s (0.6%)

4).Soil (84.2%) +Fly ash (15%) +recron-3s (0.8%)

5).Soil (84%) +Fly ash (15%) + recron-3s (1%)

From the above proportion result of UCS (unconfined compressive strength) is obtained for soil, fly-ash and recron-3s for 2 week curing period:

Table 9: Result of UCS test (Soil-Fly ash-recron-3s)

Sample no.	Proportions Of soil-fly ash	Curing period (week)	UCS (kn/m³)
1	84.8-15-0.2	2	614.05
2	84.6-15-0.4	2	678.98
3	84.4-15-0.6	2	744.37
4	84.2-15-0.8	2	791.05
5	84-15-1	2	760.94

Chart-6 showing the variation of curve of U.C.S test with % in soil-fly ash-recron-3s for (2 week curing period)

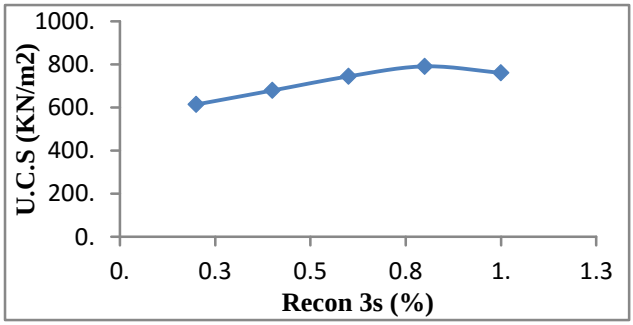

Chart-7: Variation of UCS with % of recron-3s &15% fly ash

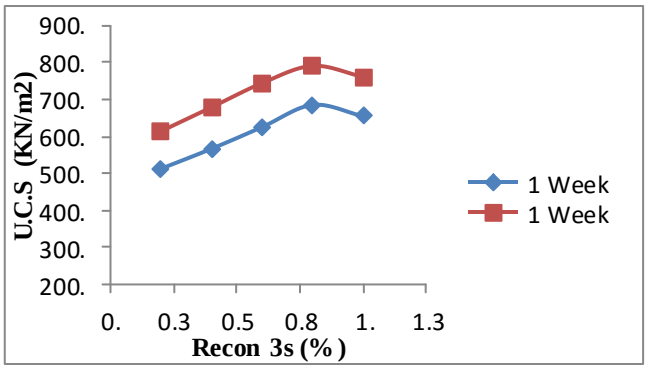

Chart-8: Variation of UCS with % of recron-3s& 15% fly ash for (1 & 2 week) period

3. CONCLUSIONS

On the basis of investigation, the following conclusions have been made:

- With the increase in quantity of fly ash O.M.C value increases and M.D.D decreases.
- When the recron-3s fibre quantity increases the O.M.C values increase and M.D.D decreases.
- 15% fly ash was optimized for the further work.
- The best value obtained from results of U.C.S for 1week and 2 week curing period is 685.24KN/m^2 and 791.05KN/m^2 respectively.
- The best ratio obtained was 84.2% soil: 15% fly ash: 0.8% recron-3s.

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