Study of the Strength Characteristics of Soil Processed with Fly Ash and Recron 3s

Umair Imtiyaz[1], and Ashish Kumar[2]

[1]Scholar, Department of Civil Engineering, RIMT University Punjab,
[2]Assistant Professor Department of Civil Engineering, RIMT University Punjab

Correspondence should be addressed to Umair Imtiyaz; umairimtiyaz87@gmail.com

ABSTRACT- The main focus of this research was to enhance the strength of soil & to get an optimum amount of soil- fly-ash –Recon 3s mix. The target of study was to extend the strength of clayey soil using ash &Recron3s. As we all know ash act as a cement material & Recon 3s act as a reinforcing material. As clay shows high shrinkage, swell characteristics & low bearing capacity. There is a necessity to enhance the strength characteristics. Therefore the main focus of this research was to extend the strength characteristics of soil. The tests performed in laboratory was Pyconometer test for relative density casagrande's test for liquid limit, plastic limit test, Standard proctor test for determination of OMC & MDD, unconfined compression test & Direct shear test. Proportional of the recon 3s used was 0.2, 0.4, 0.6, 0.8 & 1.0 try to proportional of ash was 10, 15,20,30,40 & 50%. The ash was optimized at 15% & UCS value for virgin soil was 215.6KN/m2& by adding ash in numerous proportions i.e., 10, 15, 20,30,40,50. The UCS values were 409.10, 460.1, 378.7, 345.2, 242.01 & 234.06 in KN/m2 that the maximum was at 15% fly ash. After adding Recron3s in several proportions i.e., 0.2, 0.4, 0.6, 0.8 & 1.0 %. The UCS values were 512.46, 566.49, 625.23, 672.1 & 654.35 in KN/m2 for 1 week curing. Therefore, the maximum was at 0.8% & for two weeks curing UCS values was 587.085, 625.23, 676.81, 710.2 & 672 in KN/m2 & again was maximum for 0.8%. The results of direct shear test for virgin soil was - cohesion intercept 24.6 KN/m2 & angle of shearing resistance 19.20 & was increased by adding ash & Recron3s at 15% ash & 0.8% Recron3s it had been 62.2 KN/m2 & 29.10.From this study it absolutely was concluded ash works as a cementing material & Recron3s as a reinforcing material & provides strength to the soil in addition as fly ash .the most effective proportion obtained was; 84.2% soil – 15% ash – 0.8% recon 3s. Also, the tactic utilized in this research was randomly distributed fiber reinforcement soil also turned as RDFS. Also, from Proctor test it had been found that OMC increases & MDD decreases with increase in fly ash & recon 3s.

KEYWORDS- Soil, Recron-3S, Fly Ash, Stabilization, Fiber.

I. INTRODUCTION

The word soil comes from sodium a Latin word. Soil could be a material naturally available in universe. The most cost-effective available construction material is additionally soil, on the identical hand it's very complex material too. Study of soil procedure is complex thing [1] . The high variability in characteristics and composition makes soil a posh material. The behavior of soil varies from place to position and also with the change within the present conditions changes the behavior of the soil [2].Planning requirements of an engineering structure or not. This is quite common problem for a construction engineer that the soil available at a selected site is unsuitable for the development work [3]. Strength, durability, stability and permeability are the most engineering properties of soil with which the soil engineer is worried. Insufficient strength may be a soil issue in many forms construction buildings, tunnels and other excavation, roads, air fields etc. this issue can cause economic loss, and in also may result in loss of human lives too [4]. The study of engineering characteristics of soil is anxious with the

steadiness of retaining structures, stable foundations, stability of slopes, earthen dams and underground structures, pavement construction. Because of complex behavior of the soil with relevancy the engineering properties the soil has rendered it to following limitations [5]. Theory of elasticity can't be applied because of the non-linear stress strain relationship. Strength and behavior of soil depends on drainage, pressure, environment and plenty of other factors, due to this same soil show different strength and dissimilar conditions. Soil at different locations is different in characteristics and composition therefore the results of soil at one place are different from other place [6-7]. Interpretation of the results of tests impossible. Soil being a specific material the properties of soil changes because the particles shift the positions.

A. Review Stage

Various studied had already been carried out on fly ash and Recon 3s Fiber materials differently fly ash is used in major projects in India use of Recon 3s is not common in India but proves economical in US Numerous studied have been completed in which the engineering properties and physical & chemical characteristics of fly ash and Recon 3s where determined in laboratory [8-9].

B. Scope of Work

- Here in this study following tests were performed compaction test, UCS test, Direct shear test are performed for further work CBR value , Triaxial test , permeability durability test should be performed
- Other proportions should be tested for better use of fly ash and recon 3s
- Ucs test is performed here for 1 or 2 weeks curing time should be increased
- Direct test should be performed with curing period
- Recon 3s – fly ash proportion should be also performed

II. MATERIALS USED

In the present experimental study, the soil's properties are improved by the addition of fly-ash and Recron-3S fiber.fly ash are used as stabilizing agent to enhance some properties and also the Recron-3S are going to be acting because the reinforcement's material. Both fly-ash and Recron-3S fiber worked well to boost the properties of soil which are unconfined compressive strength Soil samples were taken from Balder nagar Ambala Fly ash was taken from national fertilizers situated near Nangal Punjab. Recron-3S was taken from the market & is manufactured by Reliance Industries. Simple water [tape water] was used for laboratory [10-11].

A. Source of Soil

The soil used in the study was taken from the Baldev Nagar it's village near Ambala city. The soil has shows some expansive properties when came in the contact with water. The shade of clayey soil is light brown The possession of clay.

B. source of Fly Ash

Fly used in this study was acquired from the thermal power plant of National Fertilizers Limited, Nangal. The samples stay dry in oven at temperature of 100C.The fly ash brought from the site was then passed through the sieve to remove the

solid heavy unfamiliar particles. The dried and sieved fly ash was packed in polythene air tight bags for further usage also it could be protecting from the moisture. Properties and composition of fly ash were provided by the manufacturer unit i.e., NFL Nangal (Punjab).
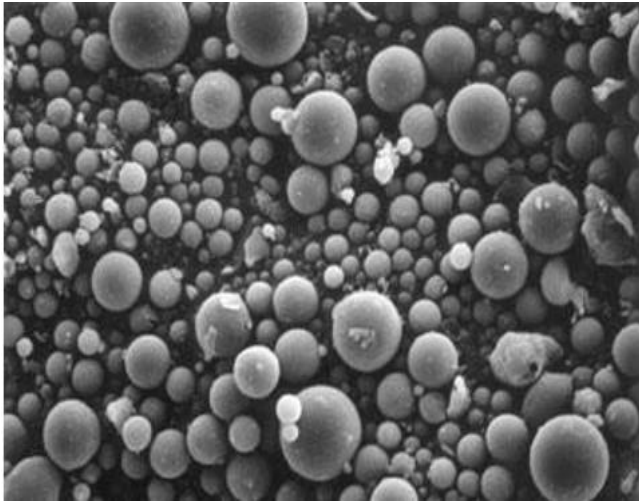

Figure 1: 2000x magnifications of fly ash articles (source: internet)

The engineering properties of fly ash are shown in Table1

Table 1: Engineering properties of fly ash

S no	Properties of fly ash	Values
1	Color of fly ash	Dark Grey color
2	Standard proctor compaction test results	32.3
	Optimum moisture content (%) result	13.6
	Maximum dry density(kn/m3) result	
3	Specific gravity result	1.93

C. Recon 3s

Fiber Source of Recron-3S, name of geo-fiber employed in present here was bought from market. The fabric was packed in a very thin pack of 125 gm. The fiber utilized in this study of length 12mm. 12mm is employed as in previous studies 12mm was found very successful [12]. The Recron-3S fiber is formed from polymerization of pure Terapthalic acid And Monoethanediol employing a catalyst. These fibers are found to be used widely in concrete technology. The fiber contains a special triangular cross section. The equivalently diameter of fiber was about 32- 55µm. The special triangular cross section is for the anchoring and also the interaction with soil ash mix. The physical properties of the Recron-3S, as provided by the manufacturer are as shown in Table no.2

Table 2: Physical properties of Recron3s

Property	Values
Color	White
Cut length	12mm
Denier	1.5
Tensile strength	600
Melting point	≥ 250
Specific gravity	1.334
Equivalent diameter	32-55
Water absorption	85.22
Acid resistance	Excellent
Alkali resistance	Good

Note: Denier is a unit of measurement of the linear mass density of the fibers. It is defined as the mass in grams per

9000m

III. OBJECTIVE OF STUDY

- To study the effect of fly ash & recon 3s fiber on compaction characteristics of soil for different mix proportions (soil: fly ash : recon 3s)
- To study the effect of fly ash and recon 3s fiber on unconfined compressive strength of soil for different mix proportions (soil: fly ash : recon 3s)
- To study the effect of fly ash and recon 3s fiber on shear strength parameters of soil for different mix proportions (soil: fly ash: recon 3s)

IV. PROCESSING OF MATERIALS

The soil samples were collected form Baldevnagar Ambala City. The soil was crushed to break lumps with the help of wooden hammer and dried in air under covered area. The crushed soil was sieved through 2.36mm IS sieve and mixed carefully. The sieved soil was stored in bags. For each test the required amount of soil was taken out and was dried in oven at 105oC for hours. Then dried soil was allowed to cool down at room temperature.

Fly ash brought from National Fertilizers Limited, Nangal (Punjab) & was dried in oven at 1000 C and then allowed to cool down before the test.

V. EXPERIMENTAL INVESTIGATION

This section covers the experimental process for the current investigation, including material processing, fly ash optimization, and the proportions of mix to be used for subsequent testing on soil fly ash recron -3s mix. Here are the results of tests on the selected soil's properties, as well as soil testing results.

Unconfined compressive strength test, standard proctor test

A. Tests Performed in Laboratory

- Pyconometer test for specific gravity
- Casagrande's test for liquid limit.
- Plastic limit test.
- SPT Test [standard proctor test]
- Unconfined compression Test.
- Direct Shear Test

B. Experimental Results

This segment contains the test results on the soil, for properties of the virgin soil i.e. liquid limit, plastic limit, plasticity index, specific gravity, unconfined compressive strength and the direct shear test results. After obtain the property of virgin soil the tests be done on soil and fly ash mixes, from here the sum of fly ash was optimized by UCS test. The optimized value of fly ash and soil was varied with dissimilar proportions of recon 3s fiber. Then the soil, fly ash and recon 3s sample of different ratios were experienced under the unconfined compressive strength and direct shear tests after 7 days & 14 days of curing period. , unconfined compressive strength and direct shear tests were performed on soil, fly ash, and recon 3s samples of various ratios .Shown in graph are standard proctor test curves for a soil fly ash mix produced from a conventional Procter test.

C. Standard Proctored Test (SPT) Test of unconfined compression Shear Test Direct

Experimental Outcomes: This section contains soil test results for liquid limit, plastic limit, plasticity index, specific gravity, unconfined compressive strength, and direct shear test results for virgin soil. After collecting the parameters of virgin soil, tests were done on soil and fly ash blends, and the total amount of fly ash was then optimized using the UCS test. Optimization of soil value with fly ash. The recon 3s fiber was utilized in various amounts. After that, after 7 days and 28 days of curing, unconfined compressive strength and direct shear tests were performed on soil, fly ash, and recon 3s samples of various ratios.

Shown in graph are standard proctor test curves for a soil fly ashmix produced from a conventional procter test.
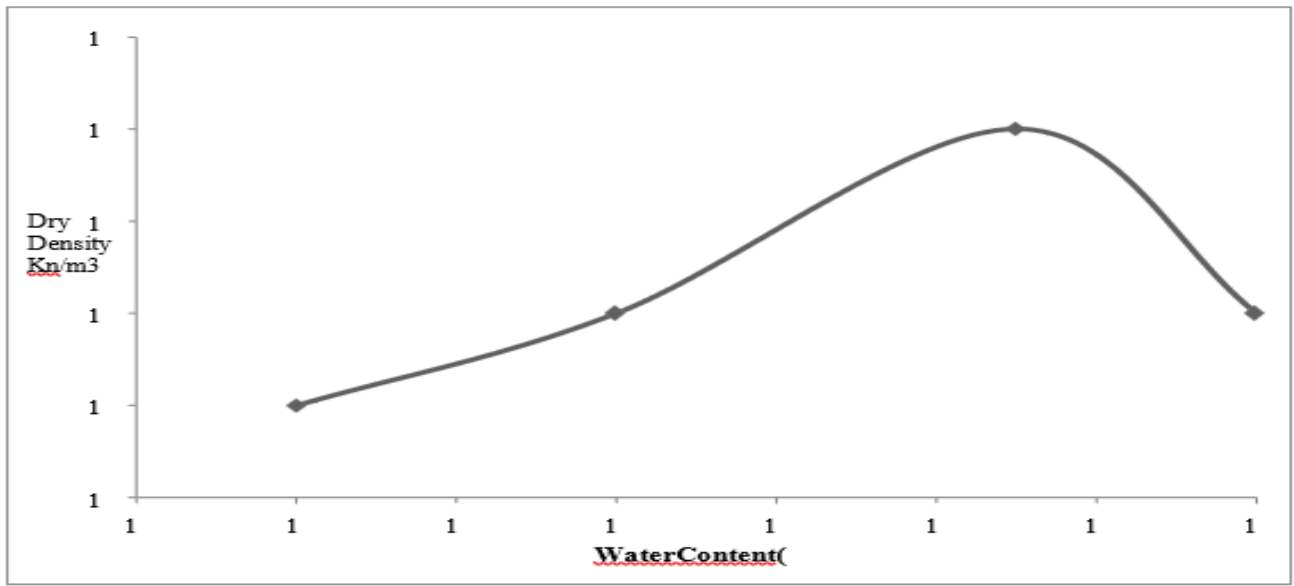
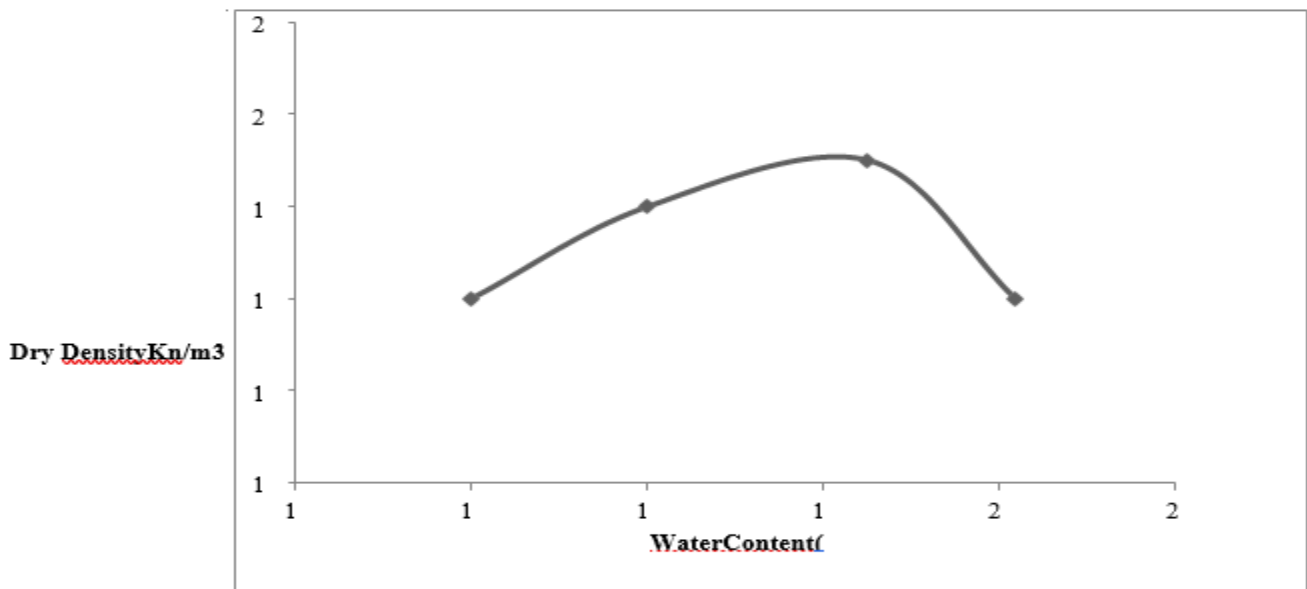Figure 2: Maximum dry density and optimum moisture content for virgin soil

Figure 3: Maximum Dry Density and Optimum Moisture Content for fly ash

D. Direct Shear Test

Results of direct shear test shows increase of cohesion intercept of virgin soil from 24.6 KN/m2 to41.77 KN/m2 at 0.2% Recron-3S and 15% fly ash also increase in angle of shearing resistance was changed from 19.2 to 24.370. The same increase was shown for 0.4, 0.6, 0.8 and 1%. The result showed the decrease in cohesion intercept as well as angle of shearing resistance. The results for cohesion intercept and angle of shearing resistance for 0.4, 0.6, 0.8 and 1% are 51.97, 57.46, 62.2, 60.79 KN/m2.
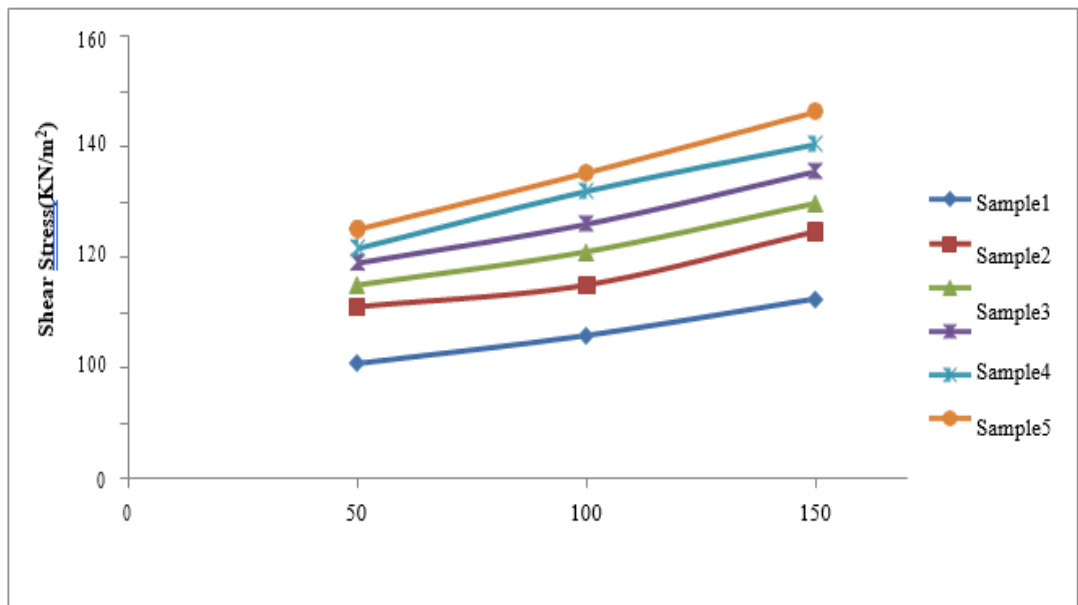

Figure 4: Graph showing results of direct shear test obtained for soil- fly ash – Recron-3S
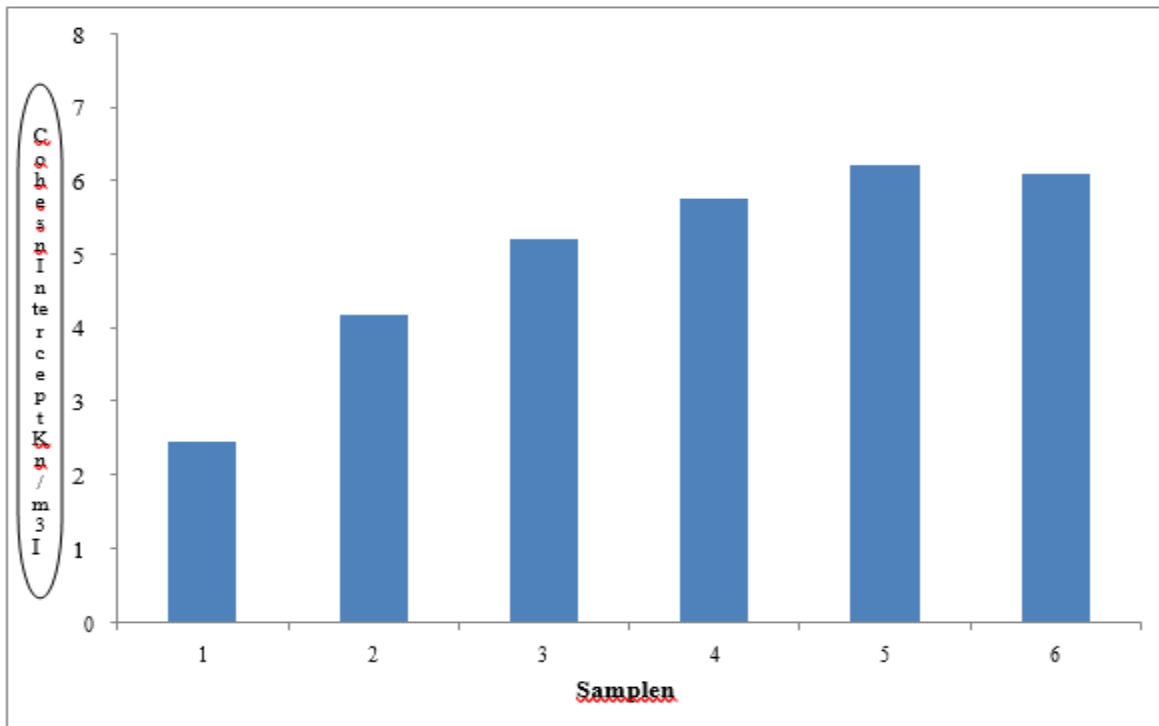
Figure. 5: Results of direct shear test obtain for soil-fly ash–Recron-3S

Table 3: Direct shear test results with increase in Recron-3S at fly ash 15%

Mix proportions	Cohesion intercept (kN/m²)	Angle of shearing resistance (Degree)
100 – 0 – 0	24.6	19.2
84.8 – 15 – 0.2	41.77	24.37
84.6 – 15 – 0.4	51.97	25.64
84.4 – 15- 0.6	57.46	26.86
84.2 – 15- 0.8	62.2	29.1

VI. INTERPRETATION OF THE DATA

A. Maximum Dry Density

The results were obtained were obtained from standard proctor test on different proportions prepared, it is observed from the results that:

- When the soil was mixed with different fly ash content i.e., 10, 15, 20, 30, 40 & 50%. The M.D.D obtained was 20.18, 19.01, 16.07, 15.09, 14.01, and 13.13 KN/m^3 respectively shown in table no. 1 and figure no. 2 to 5. This shows a decrease in the value of M.D.D with the increase in the percentage of fly ash in soil.
- When the fly ash was kept constant at 15% as the optimum amount to be used further, the Recron-3S was introduced at amount of 0.2, 0.4, 0.6, 0.8 and 1.0% and the results of M.D.D were 16.04, 15.95, 15.77, 15.50 and 15.40 KN/m^3 respectively shown in table no 2. This shows a decrease in value of M.D.D with the increase in Recron-3S in fly ash – soil mix.

B. Unconfinecompressive Strength Test

The outcome obtained from U.C.S test increase in strength of virgin soil by addition of fly ash in the start when added 10% but as this sum was increased to 20, 30, 40 & 50 % the strength decreases. Then after a value between 10% & 20% that was 15% was chosen and tested under SPT and U.C.S. At 15% the maximum strength was achieved and was found appropriate to be used for further work. The U.C.S test for soil – fly ash mix was performed on 7 days cured samples 4 samples were made for each proportion for best results. The

strength of virgin soil   was increased from 213.67KN/m2 to 409.10KN/m2 with 10% growth of fly ash and also with 15%, 20%, 30%, 40% & 50%.   The strengths achieved were 460.1, 378.70, 345.26, 242.01 and 234.06 KN/m2 respectively shown in 4.3. After optimizing 15% fly ash the Recron-3S was introduced in amount of 0.2, 0.4, 0.6, 0.8 and 1% and the results after 1 week curing were 512.46, 566.49, 625.23, 686.1 and 654.35 KN/m2 respectively and the results for 2 week curing were 587.085, 625.023, 676.81, 710.2, 678.08 KN/m2 . This 1 week and 2 week curing results showed that the best proportion obtained is 84.2soil: 15 fly ash: 0.8 Recron-3S as it gained maximum U.C.S for 1 week as well as 2 week period.

C. Direct Shear Test

Results of direct shear test shows increase of cohesion intercept of virgin soil from 24.6 KN/m2 to41.77 KN/m2 at 0.2% Recron-3S and 15% fly ash also increase in angle of shearing resistance was changed from 19.2 to 24.370. The same increase was shown for 0.4, 0.6, 0.8 and 1%. The result showed the decrease in cohesion intercept as well as angle of shearing resistance. The results for cohesion intercept and angle of shearing resistance for 0.4, 0.6, 0.8 and 1% are 51.97, 57.46, 62.2, 60.79 KN/m.2

D. Optimum Moisture Content

The results were obtained from standard proctor test on different proportions prepared, it is observed from the results that: And 25.64, 26.86, 29.1, 27.470 respectively as shown in table no 4.5. There was increase in strength in due to the pozzolanic reaction of fly ash. With the increase in Recron-3S fibre the results were increasing but after 0.8% a sudden decrease in both cohesion and angle of shearing resistance, due to use of too much fiber in mix, it can reduce the efficiency of the improvement in the strength.

VII. CONCLUSIONS

On the premise of the investigation the subsequent conclusions are made:

- With the rise in quantity of Fly-ash OMC value increases MDD decreases.
- 15% Fly ash was optimized for the further work.
- The best value obtained from results of UCS for 1week & couple of weeks curing period is 672.1KN/m2 and 710.2 KN/m2.
- The best ratio obtained was 84.2% soil: 15% fly ash: 0.8% Recron-3S.

- With the rise of Recron-3S in soil fly-ash mixes the cohesion intercept and angle of shearing resistance increases.
- The good value of cohesion intercept and angle of shearing resistance are 62.2KN/m2 and 29.10 correspondingly.
- With the increase in the % of recon 3s the % of OMC Increases while as MDD decreases.

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