International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 13 Issue 12, December-2024, Impact Factor: 8.375

An Analysis to find Out How Cement and Coir Fiber Effect their Engineering Properties

Akash Lathwal[1], Dr. R. S. Kesharwani[2]

[1]Research Scholar, Department of Civil Engineering, Baba Mastnath University, Rohtak , Haryana
[2]Supervisor Professor, Department of Civil Engineering, Baba Mastnath University, Rohtak , Haryana

ABSTRACT

This study aims to dissect clayey soils to find out how cement and coir fibres affect their engineering properties. After you find the sweet spot for the different fibre percentages, you may add two more percent of cement. We will be testing the new specimen in clayey soil with three different quantities of cement: 3%, 6%, and no cement at all. Inquiry into clayey soil products is necessary for the achievement of the objectives.

INTRODUCTION

This investigation made use of two laboratory methodologies: the conventional compaction test along with California bearing ratio test.

First Step: We found the sweet spot for the clayey plain soil's moisture content along withits maximum dry density. The standard compaction test as per I.S. code was used for this purpose.

Second Step: Various cement and fibre combinations were tested for their dry densities. We achieved this by conducting a standard compaction test with thoroughly moistened samples, ensuring that the moisture level was at least equal to, if not greater than, the optimal moisture content for clayey soil.

Third Step: Once dry densities of all samples have been determined, California bearing ratio may be tested. After that, the samples were mixed and compressed until they reached a density that was within 95% of their dry weight.

Forth Step: Similar to the third phase, the samples were once again compressed to within ninety-five percent of their dry densities. Samples were then tested in both dry along withwet conditions. It took these samples four days to cure in the damp environment.

Processing Material

A substantial amount of dirt has to be first gathered. The earth was broken up into smaller pieces by using a wood hammer to crush it. To continue with the air drying process, the dirt was placed under the cover. The dirt was then blended extensively after being sieved via an IS 4.75 mm sieve. The plastic bags contained the well-mixed dirt. We removed the necessary amount of dirt from bag along withdried it in an oven set at 105º C for 24 hours for each test. The dirt was then let to cool to ambient temperature prior to the test. The dirt was appropriately combined with coir fibre and cement according to the specified ratios after they were removed from their original packaging.

Mixing Proportion

For a consistent composition, combine clayey soil, coir fibre, and cement. Table 4 shows the intended proportions.

Table -4 Different mix proportion of Coir fiber and cement in the soil

S No.	Name of proportion (%)	Soil (%)	Fiber (%)	Cement (%)
1.	Soil: Fiber: Cement (100:0:0):0sj)	100	0	0
2.	Soil: Fiber: Cement (96.75:0.25:3)	96.75	0.25	3
3.	Soil: Fiber: Cement (96.50:0.50:3)	96.50	0.50	3
4.	Soil: Fiber: Cement (96.25:0.75:3)	96.25	0.75	3
5.	Soil: Fiber: Cement (93.75:0.25:6)	93.75	0.25	6
6.	Soil: Fiber: Cement (93.50:0.50:6)	93.50	0.50	6
7.	Soil: Fiber: Cement (93.25:0.75:6)	93.25	0.75	6

EXPERIMENTAL PROCEDURE

Unsoaked C.B.R test: -To determine how much soil was used for CBR, moisture content along with dry density were utilised. Each soil sample was evaluated for subgrade strength of soil, cement, and fibres using CBR equipment. The samples were not wet before testing. A 15 cm diameter and 17.5 cm high mould was used to compress the sample after it was created at MDD and OMC.

For the purpose of the penetration test, the whole setup with the additional load was retained. We measured the loads at various penetration levels. We found the unsoaked CBR value at 2.5 along with5 mm penetration. For samples with different fibre contents and light compaction densities, a comparable test was performed.

Soaked C.B.R test:-Soil CBR samples should be soaked for at least four days, or 96 hours, according to AASHTO and ASTM (Bowles, 1978). In this investigation, a set of soaked CBR specimens was prepared with varying amounts of cement and Coir fibres (3%, 6%, and 0.25%, 0.50%, and 0.75 of Coir fibres) and then immersed in soil with its natural water content for 96 hours.

The specimens were weighed at regular intervals to account for any weight increases that may have occurred during the curing process. No additional rise in weight was seen when the specimen was acquired at a fixed weight. We predicted that the specimen would cure and become fully saturated..

RESULTS & DISCUSSIONS

General

This section presents the research's findings and visual representations in the form of graphs.Specifically, the specific gravity, liquid limit, along withplastic limit of index property along withengineering properties (compaction test, CBR test drenched along withunsoaked) are ascertained in this section.

Index Properties

1. **Specific Gravity:** In clayey soil, the specific gravity was determined to be 2.69 after being measured.
2. **Liquid Limit:** Casagrande's test yielded the figure, which was determined to be 51% overall.
3. **Plastic Limit:** After the dirt was broken up into particles measuring 3 millimetres in diameter, the value was determined to be 26.37%, and their Plasticity Index was discovered to be 24.63.

ENGINEERING PROPERTIES

1. Compaction Test

This study programme served as the first experimental effort. First, the following soil proportions were subjected to standard compaction test, along withthe appropriate dry density along withoptimal moisture content values were determined.

Sample no.	Composition of soil (by the weight), cement and fiber (%)
1	Virgin soil
2	3% cement
3	6% cement
4	0.25% CF
5	0.50% CF
6	0.75% CF
7	0.25%CF & 3% Cement
8	0.50%CF & 3% Cement
9	0.75%CF & 3% Cement
10	0.25%CF & 6% Cement
11	0.50%CF & 6% Cement

Unreinforced soil has an optimal moisture content of 21.64% and a maximum dry density of 17.28 kN/m³, as seen in figure 1.

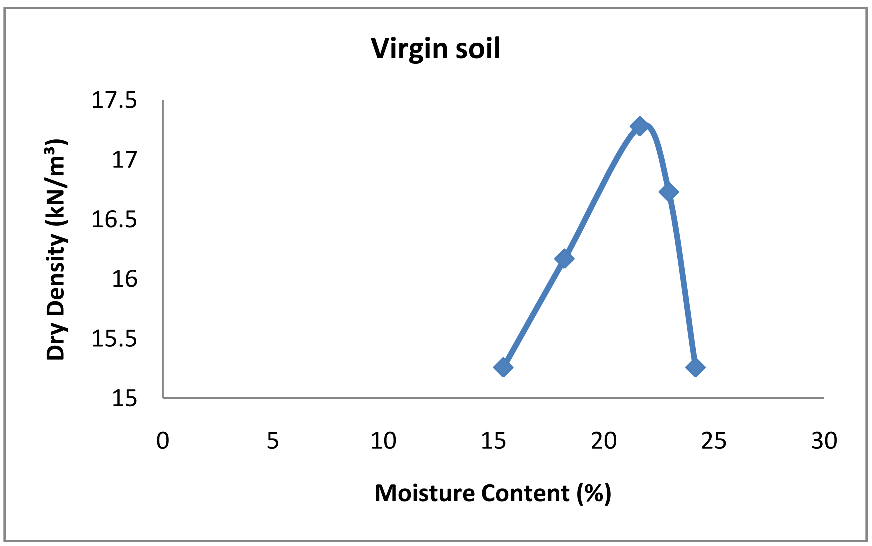


Fig: 1: Maximum dry density with moisture content for virgin soil

Figure 2 shows that reinforced soil with 3% cement has an optimal moisture content of 20.22% and a maximum dry density of 17.98 kN/m³.

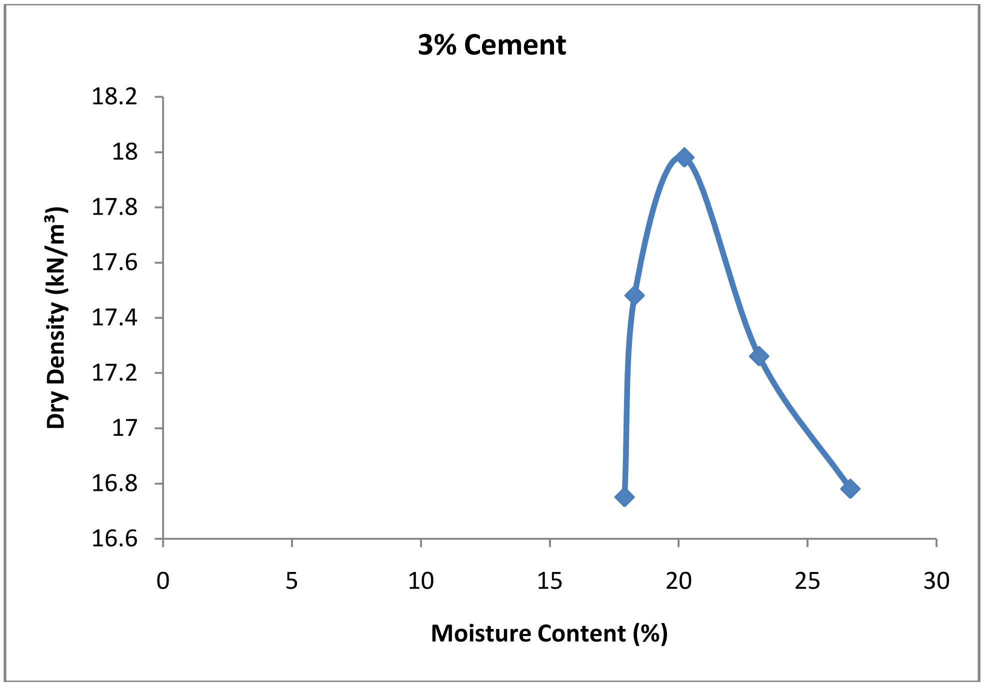


Fig: 2: Maximum dry density with moisture content for reinforced soil with 3% cement

Reinforced soil with 6% cement has an optimal moisture content of 19.05% along with a maximum dry density of 18.1 kN/m³, as seen in figure 3.

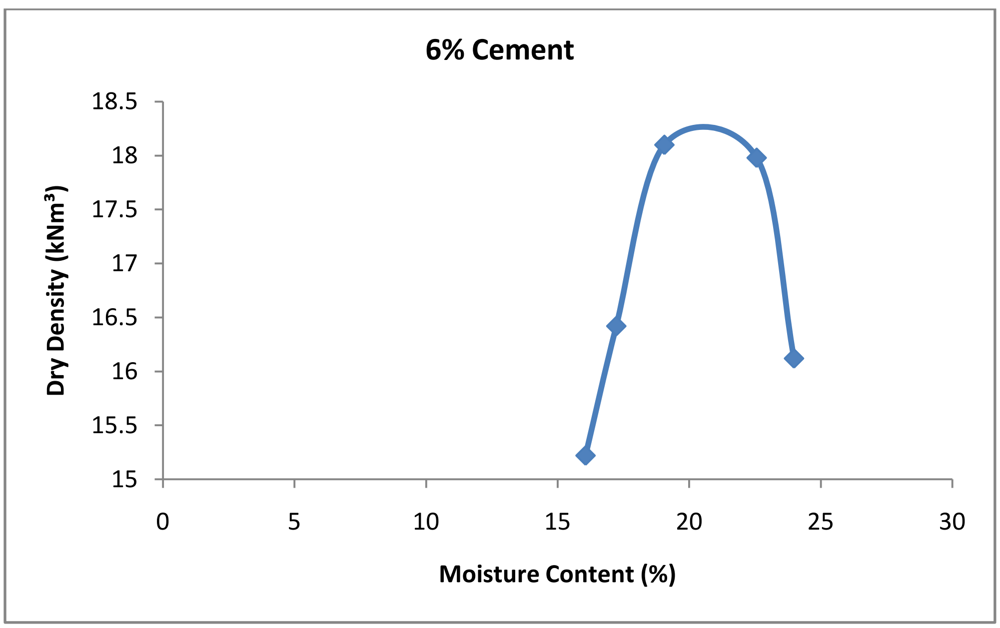


Fig: 3: Maximum dry density with moisture content for reinforced soil with 6% cement

Reinforced soil with 0.25 coir fibre has an optimal moisture content of 19.17% along witha maximum dry density of 16.90 kN/m³, as seen in figure 4.

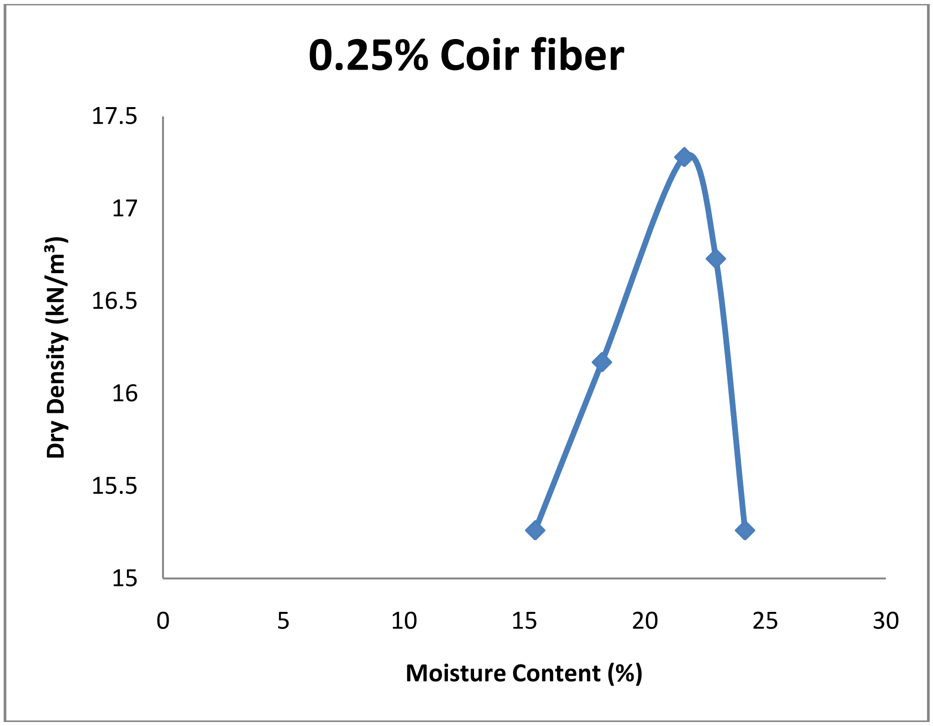


Fig: 4: Maximum dry density with moisture content for reinforced soil with 0.25% Coir fiber

Reinforced soil with 0.50 coir fibre has an optimal moisture content of 20.33 and a maximum dry density of 16.70 kN/m³, as seen in figure 5.

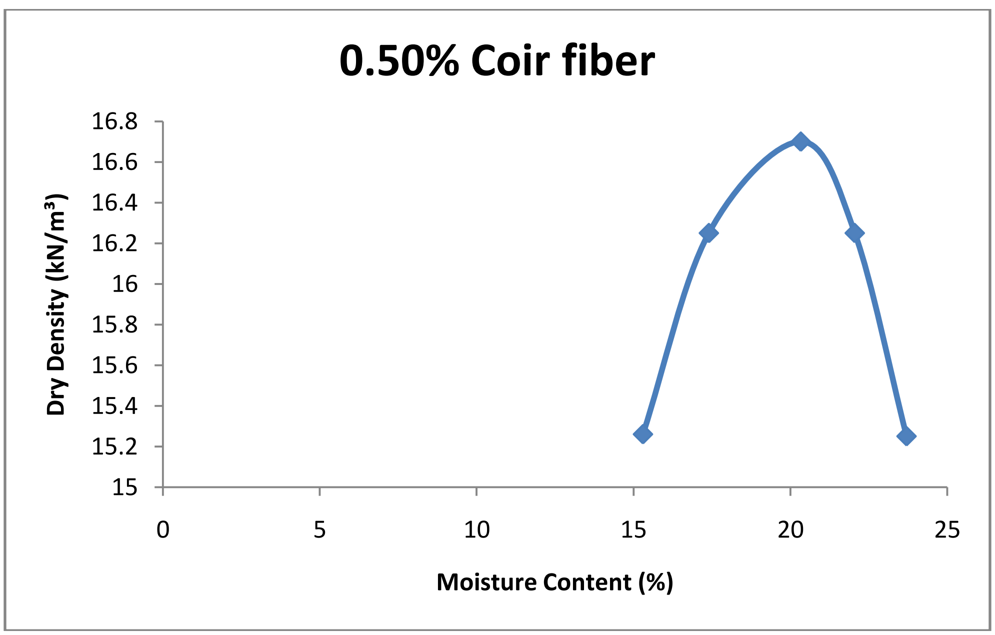


Fig: 5: Maximum dry density with moisture content for reinforced soil with 0.50% Coir fiber

Figure 6 shows that reinforced soil 0.75% coir fibre has an optimal moisture content of 20.53% and a maximum dry density of 16.67 kN/m³.

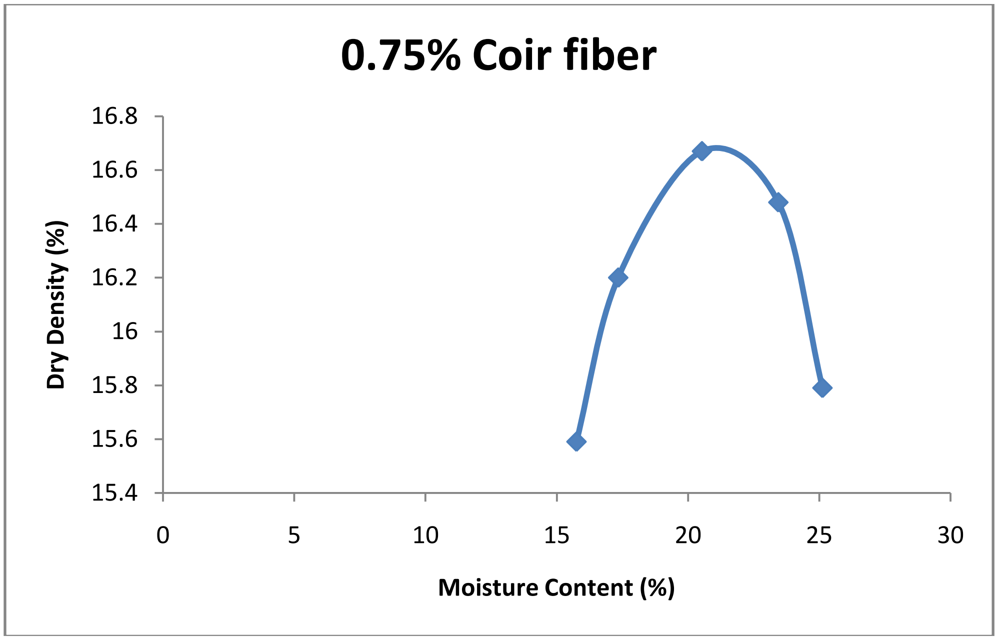


Fig: 6: Maximum dry density with moisture content for reinforced soil with 0.75% Coir fiber

Reinforced soil with 0.25% CF and 3% cement has an optimal moisture content of 24.6% and a maximum dry density of 17.22 kN/m³, as seen in figure 7.

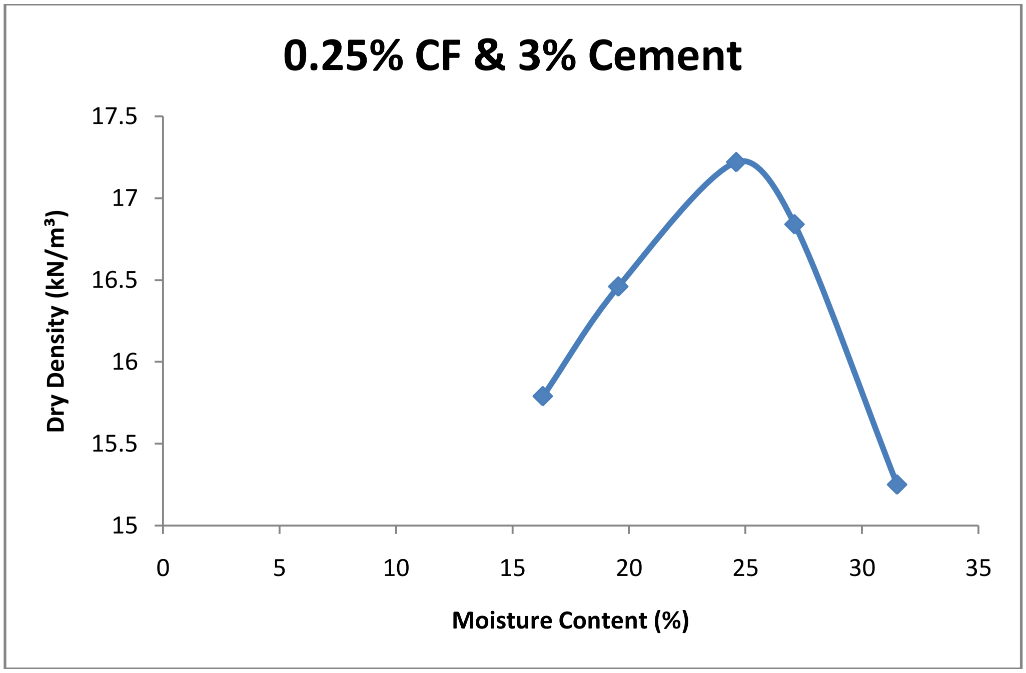


Fig: 7: Maximum dry density with moisture content for reinforced soil with 0.25%CF & 3% Cement

As seen in figure 8, the ideal moisture content for reinforced soil with 0.50% CF and 3% Cement is 24.68% and the maximum dry density is 17.19 kN/m³.

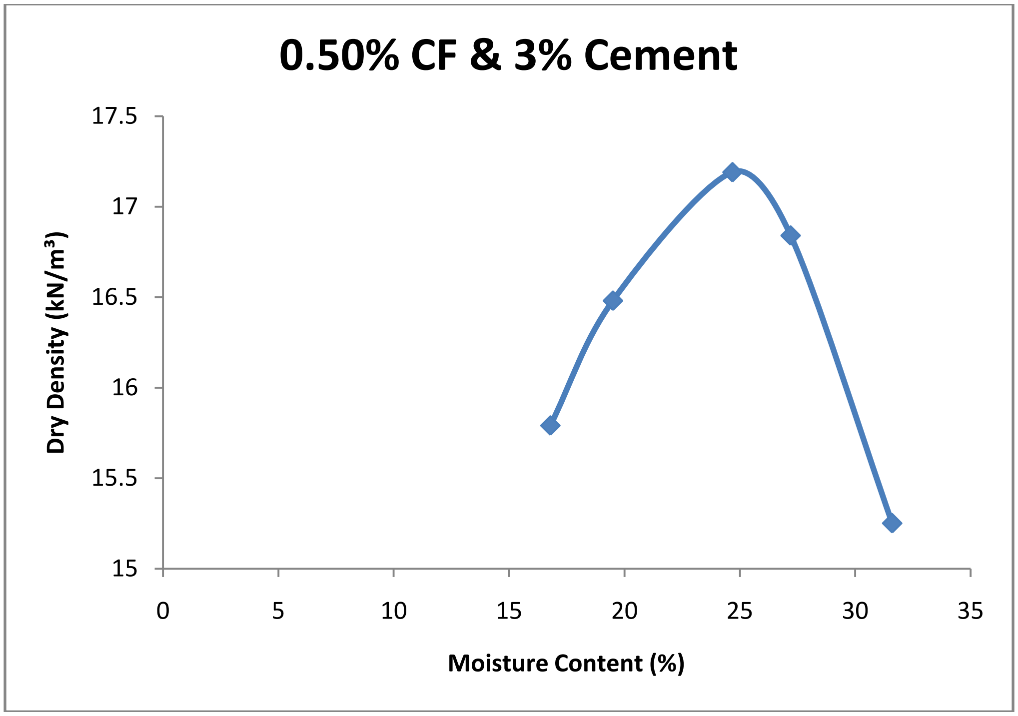


Fig: 8: Maximum dry density with moisture content for reinforced soil with0.50% CF & 3% Cement

The ideal moisture content in case of reinforced soil with 0.75% CF and 3% cement is 24.72% and the maximum dry density is 17.20 kN/m³, as seen in figure 9.

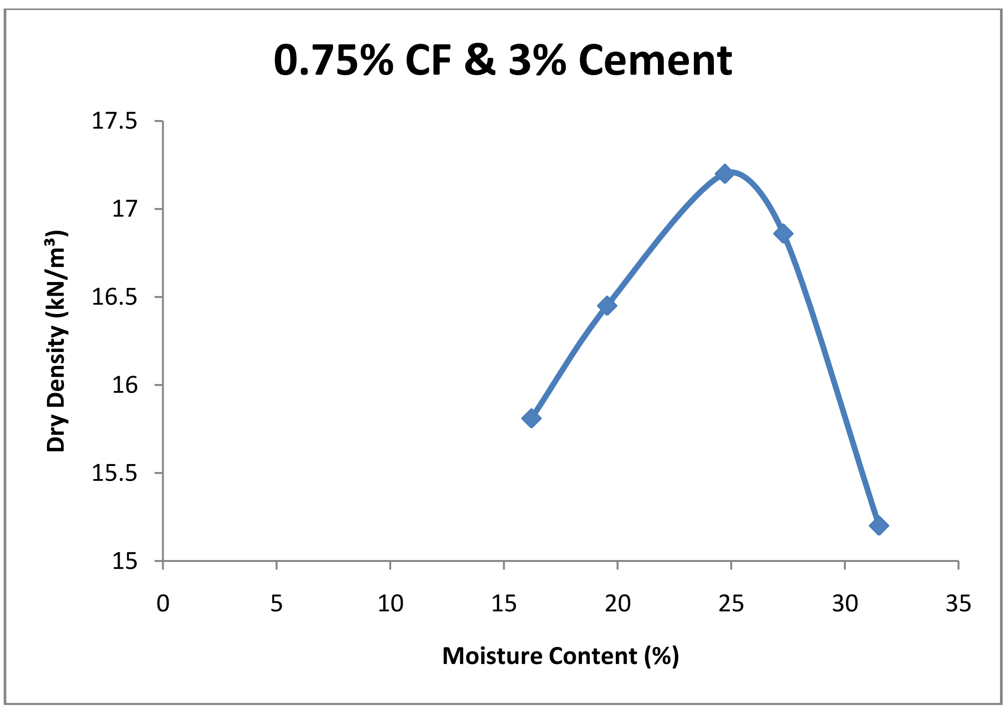


Fig: 9: Maximum dry density with moisture content for reinforced soil with 0.75% CF & 3% Cement

As seen in figure 10, the ideal moisture content in the case reinforced soil with 0.25% CF and 6% cement is 24.80% and the maximum dry density is 17.36 kN/m³.

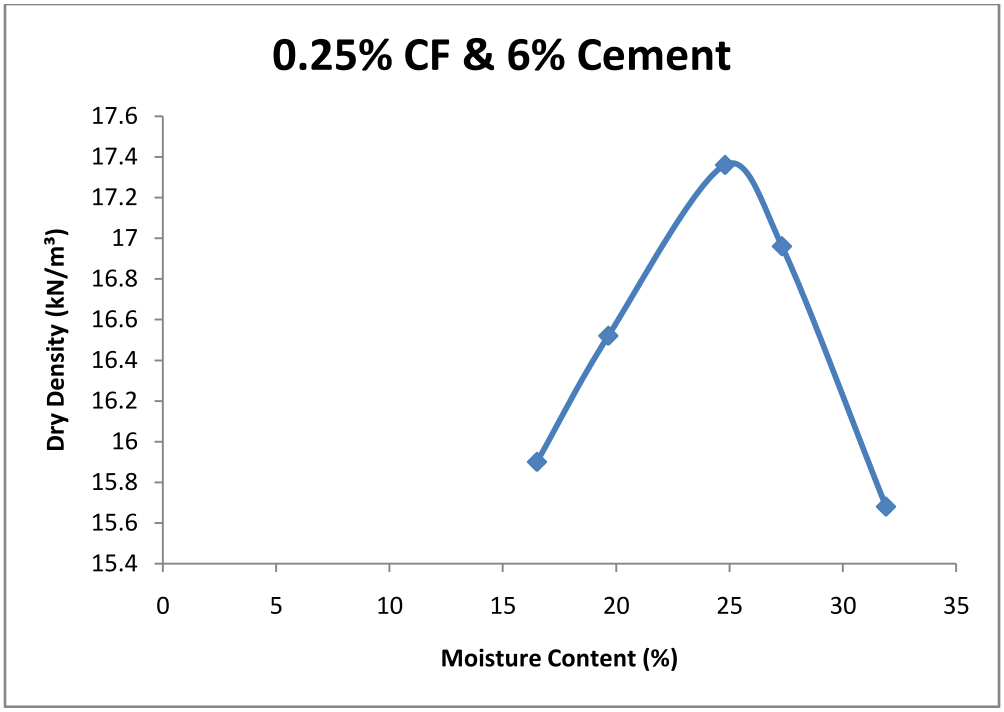


Fig: 10: Maximum dry density with moisture content for reinforced soil with 0.25% CF & 6% Cement

The maximum dry density along withoptimum moisture content in case of reinforced soil with 0.50%CF & 6% Cement is 17.33kN/m³ and 24.9% respectively as shown in fig.11.

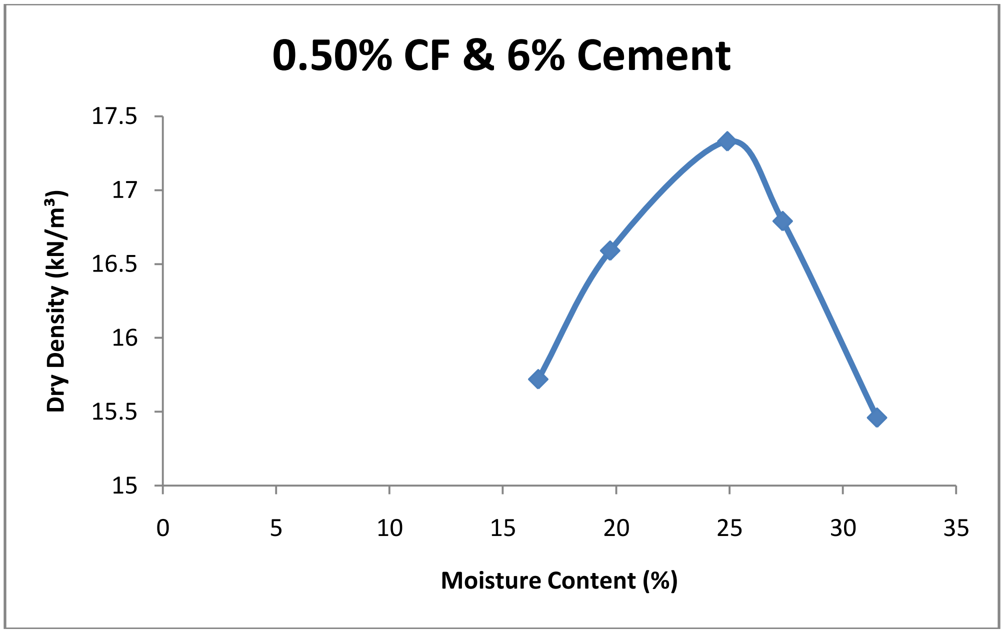


Fig: 11: Maximum dry density with moisture content for reinforced soil with 0.50% CF & 6% Cement

And maximum dry density along withoptimum moisture content in case of reinforced soil with 0.75 CF & 6% Cement is 17.26kN/m³ along with25.0% respectively as shown in fig.12.

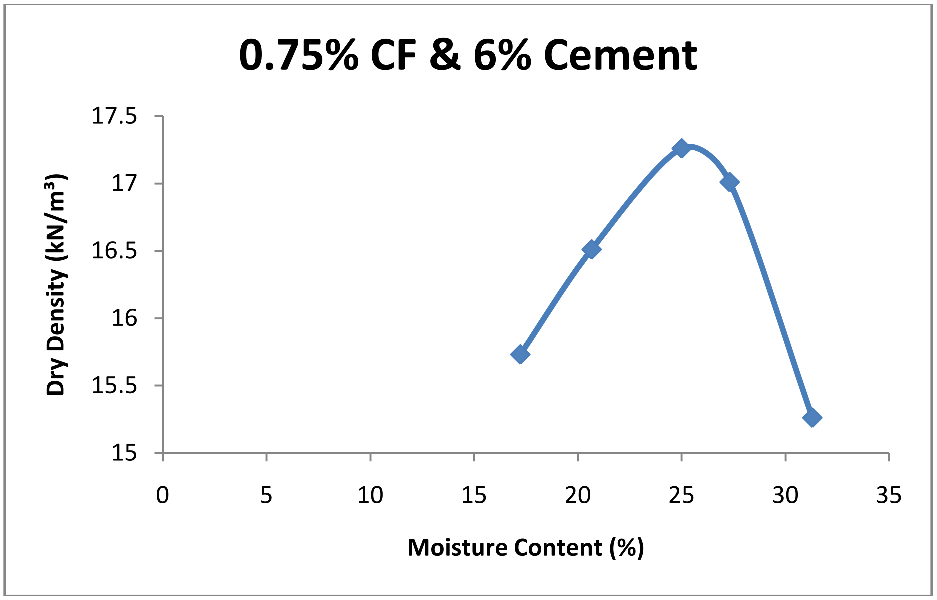


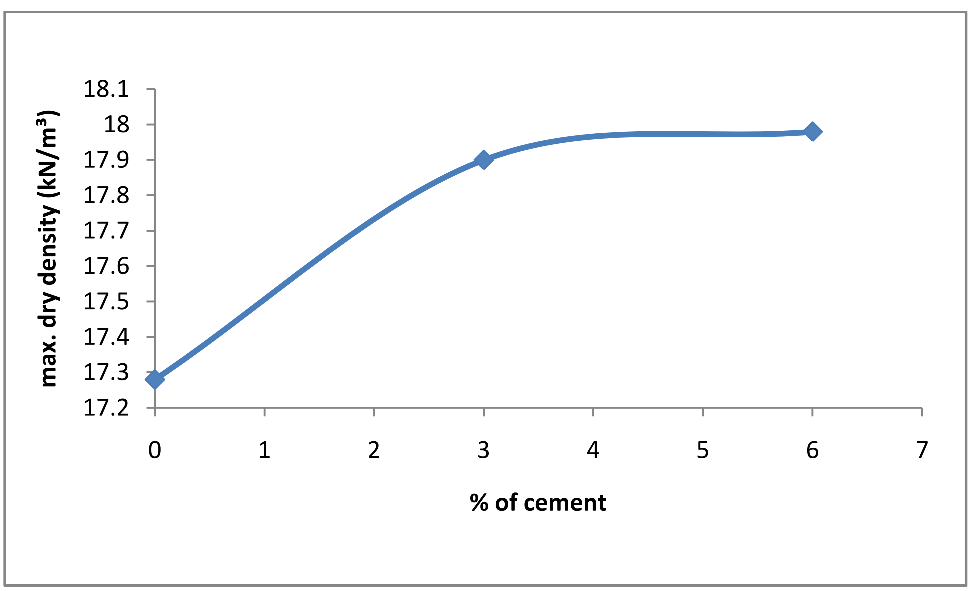
Fig: 12: Maximum dry density with moisture content for reinforced soil with 0.75% CF & 6% Cement

RESULTS OF STANDARD PROCTOR TEST

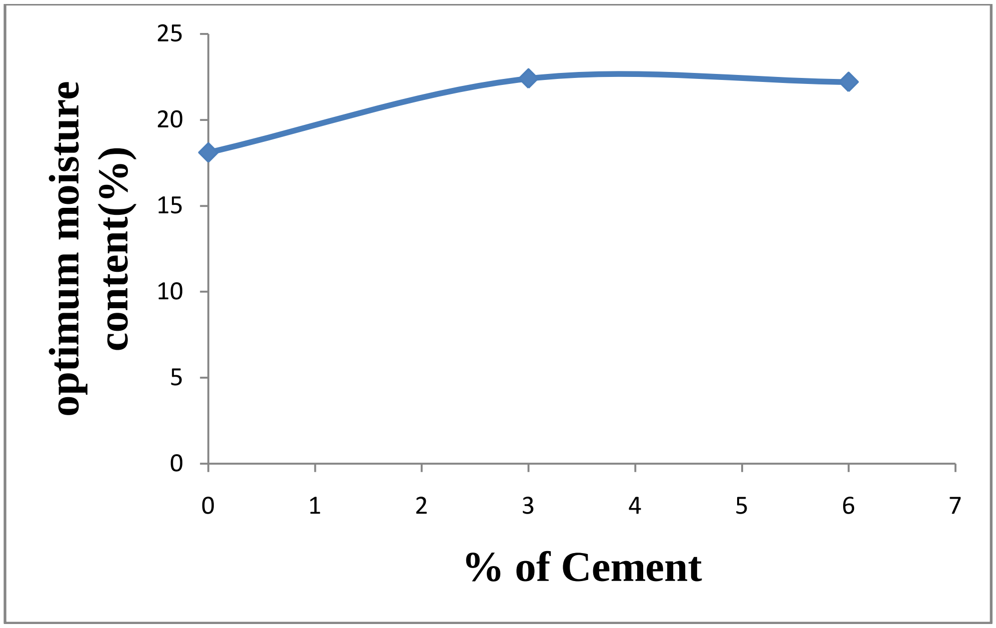
Readings of proctor test on soil & cement

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil (100)	17.28	21.64
2.	Soil : Cement (97: 3)	17.98	20.22
3.	Soil : Cement (94 : 6)	18.1	19.05

1. **Graph showing decrease in (MDD) of soil different proportions of Cement**



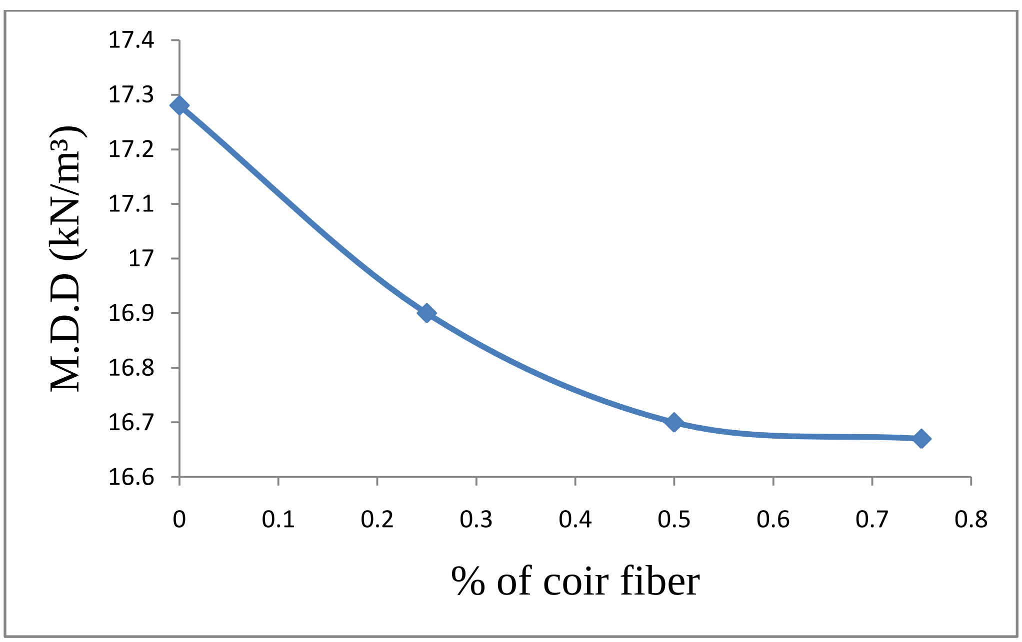
2. **Soil organic matter content (OMC) increase as a function of CEMENT percentage**



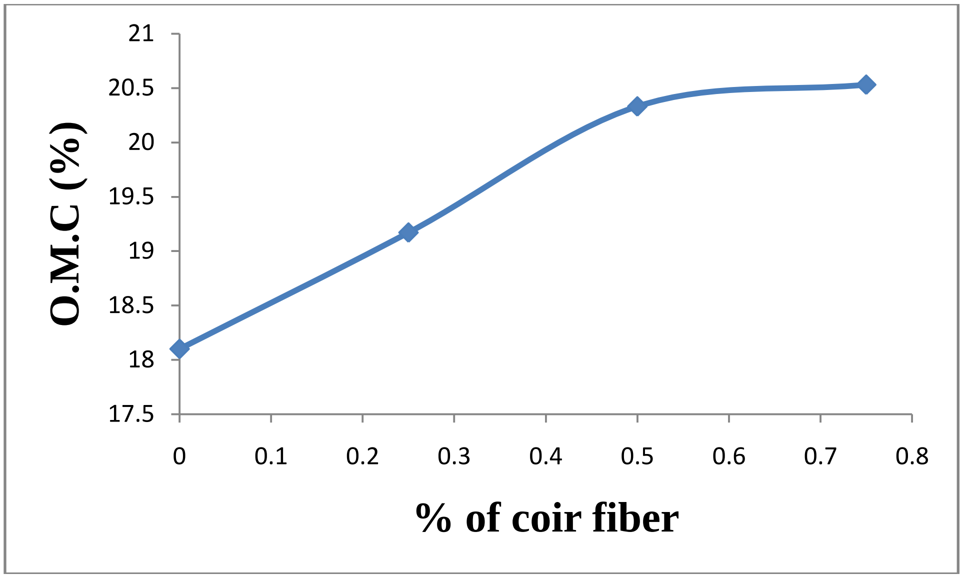
- **Readings of Proctor test on Soil & Coir fiber**

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	S Soil : CF (99.75 : 0.25)	16.90	19.17
2.	Soil : CF (99.50 : 0.50)	16.70	20.33
3.	Soil : CF (99.25 : 0.75)	16.67	20.53

3. Graph showing decrease in (MDD) of soil different proportions of Cement



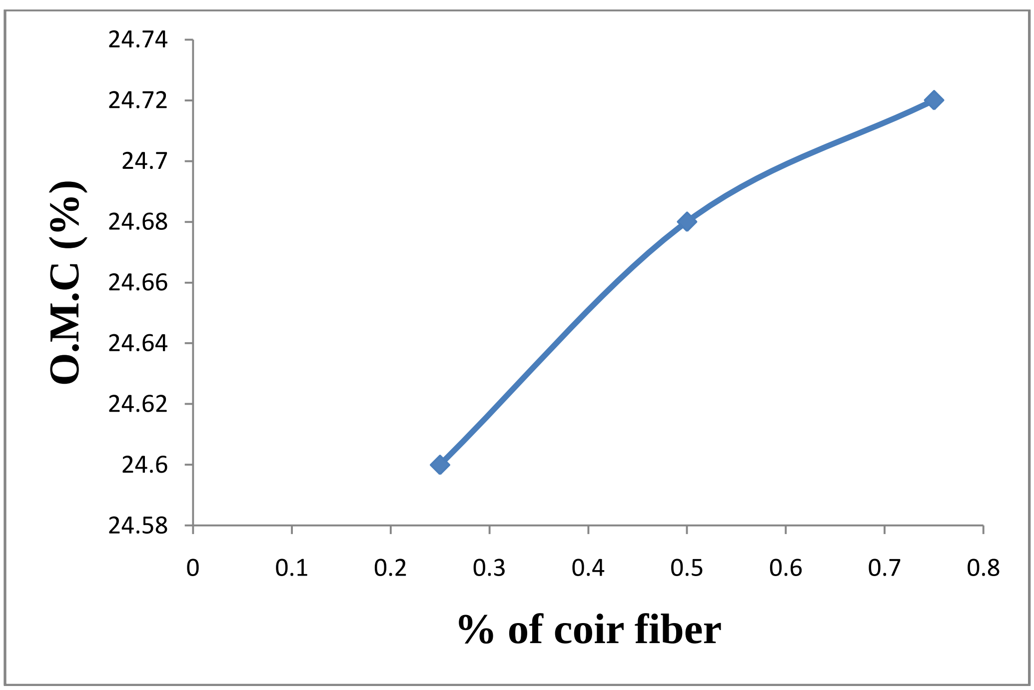
4. Graph showing increase in (OMC) of soil different proportions of CEMENT



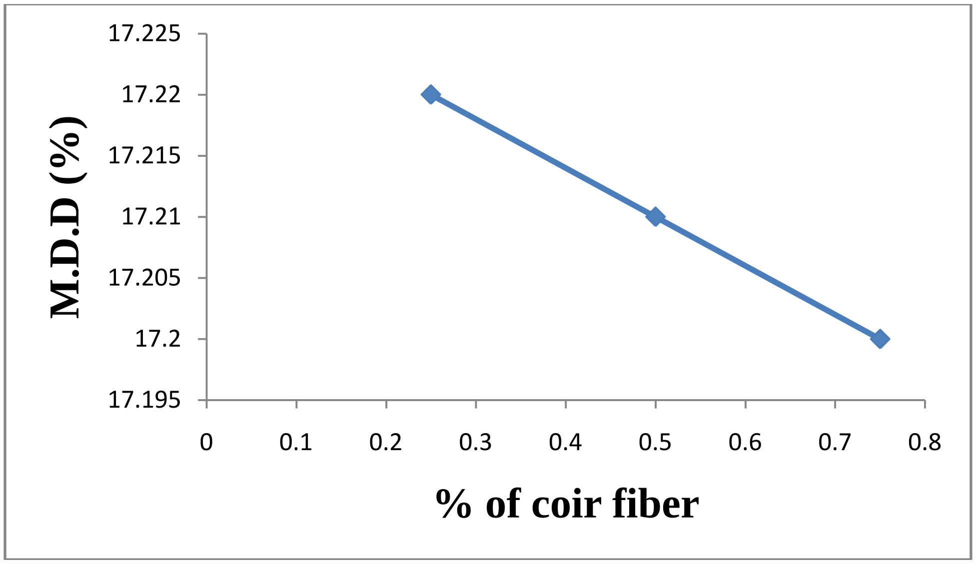
- **Readings of standard proctor test of soil, 3% cement & different proportion of Coir fiber**

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil : CF: Cement (96.75 : 0.25 : 3)	17.22	24.60
2.	Soil : CF: Cement (96.50 : 0.50 : 3)	17.21	24.68
3.	Soil : CF: Cement (96.25 : 0.75 : 3)	17.20	24.72

5. Soil (OMC) is shown graphically as it increases with varying quantities of coir fibre and 3% cement.



6. Soil-MDD-decrease graph displaying varying coir fibre fractions with 3% CEMENT



Test results

By averaging UCS of the 3 samples tested for a given combination of factors, we were able to determine the unconfined compressive strength (UCS). Nevertheless, samples whose UCS values did not fall within 10% of the average were eliminated and the remaining values were used to recalculate the average UCS. What follows is a list of the outcomes.

- Tables 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, and 36 indicate the impact of density along withmoulding water content on the UCS of unstabilized fly ash.
- Chart 4,6,8,10,12,14,16,18,20,22,24,26 shows the effect of density alog withmoulding water content on UCS of laboratory cured, cement, along with crumbed rubber stabilised fly ash.
- You can see how different curing methods affect UCS of cement stabilised fly ash in Tables 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, and 37.
- Tables 10, 11, 12, and 13 illustrate the time-dependent variation of UCS as influenced by lime and cement in case of samples that were cured in a controlled environment.
- Tables 38, 39, and 40 indicate the effects of the various stabiliser combinations on the UCS of samples that have been cured in a laboratory.

DISCUSSION OF RESULTS

Impact of stabilized fly ash's density and moisture content on its UCS

According to Tables 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, there is very little change in UCS due to variations in water content at the MDD stage. In response to a 3% shift in OMC on dry side, UCS automatically changes by 4.5% and by 1.7% on the wet side.

On the other hand, density changes have a more noticeable impact. If density is reduced from 95% MDD to MDD at OMC, UCS drops by 16.4%. Greatest drop in UCS is caused by a combination of a rise in water content and a fall in density.

Impact of stabilized fly ash's density and moisture content on its UCS

In cement stabilisation, like in the case of unsterilized samples, samples with a higher density exhibit greater strength than samples with a lower density throughout the whole curing process.

Nevertheless, the impact of the water content is negligible. After 120 days of cure, UCS of samples with 95% MDD but 6% different water contents are almost identical.

Combination of variables, including fly ash particles for the pozzolanic reaction with the stabiliser, the creation of a dense structure with reduced vacant spaces, and the increased amount of stabiliser, results in a greater UCS of the sample in the MDD stage.

CONCLUSION

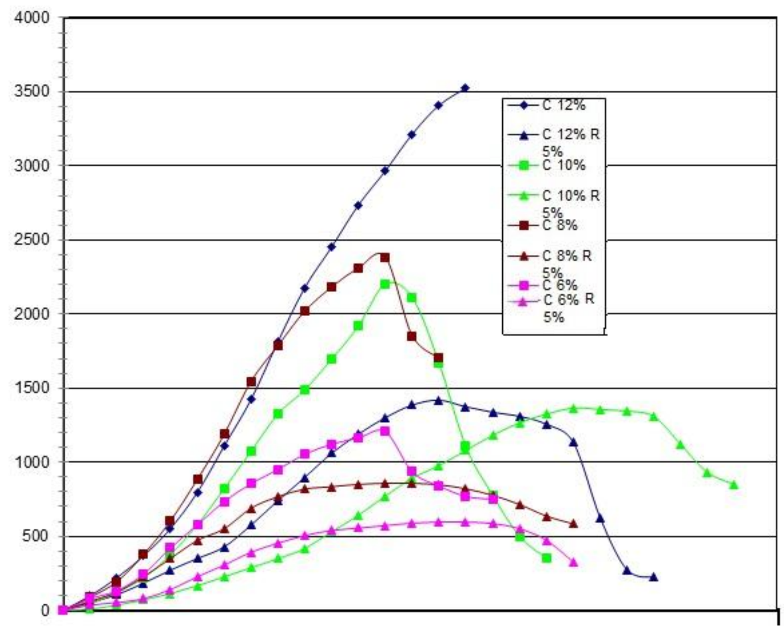


Chart 35: Conclusion of the Experiments

Unstabilized fly ash

- UCS increases with density but decreases with water content, according to the literature.

Stabilized Fly Ash

- Samples stabilised with lime or cement had a higher UCS at the MDD and OMC states compared to samples with lower density.
- The water content of the mould has an impact on UCS samples evaluated after immersion, however it does not have a substantial effect on laboratory cured fly ash.
- Laboratory-cured, cement-stabilized fly ash has a much lower UCS when samples are immersed in water prior to testing.
- When comparing samples at 95% MDD and OMC +3%, the effect of immersion on UCS is more apparent. However, when comparing samples at 95% MDD and OMC -3%, there is no significant affect.
- Environmental influences and immersion had a less impact on the UCS of samples at MDD compared to those at 95% MDD.
- Cement alone increases UCS more than a mixture of two stabilisers (cement and crumbed rubber).
- Both stabilised fly ash samples show an increase in UCS as cure time rises.

Scope for future research work
To further comprehend the strength behaviour of fly ash, which recommended that following investigations be conducted.

1. Research on the pozzolanicity of fly ash
2. Fly ash, both stabilised and unstabilized, morphology and mineralogy study.
3. How the UCS is affected by different stabilisers when used in different amounts and combinations.
4. Fourth, how stabilisers impact the UCS of fly ash-soil mixes.
5. Fifthly, how fibre addition affects strength behaviour of stabilised fly ash-soil combinations.
6. What happens to the strength of stabilised fly ash-soil mixes when the water content and density change? 6.
7. How the UCS of stabilised fly ash-soil mixes changes as a function of the deformation rate.
8. How the curing technique affects the UCS of stabilised fly ash-soil mixes.

REFERNCES

[1]. Kani, G. N. J (1966), "Basic facts concerning shear failure", ACI Journal, CF.675-692.

[2]. Kani, G. N. J (1967), "How safe are our large reinforced concrete beams", ACI Journal, vol. 64, CF.128-141.
[3]. Bazant, Z.P and Kim J.K (1984), "The Size effect in shear Failure of longitudinally reinforced Beams", ACI Structural Journal, vol.81, 5, CF.456-468.
[4]. Elzanty, A.H., Nilson, Slate, F. O. (1986), "Shear capacity of reinforced concrete beams using high strength concrete", ACI Journal, vol. 83, CF.290-296.
[5]. Kim, J.K. and Park, Y.D (1996), "Prediction of shear strength of reinforced concrete beams without web reinforcement", ACI Materials Journal, vol. 93, 3, CF. 675-692.
[6]. Zararis, P.D. and Papadakis, G.C. (2001), "Diagonal shear failure and size effect in RC beams without web reinforcement", J. Struct. Eng., vol. 127, CF. 733-742.
[7]. Kotsovos, M.N. and Pavlovic, M.N. (2004), "Size effects in beams with small shear span-to-depth ratios", Computers and Structures, vol. 82, CF. 143–156.
[8]. Hassan, A.A.A, Hossain, K.M.A, Lachemi, M. (2008), "Behavior of full-scale self-consolidating concrete beams in shear", Cement & Concrete Composites, vol. 30, CF. 588–596.
[9]. Kuo, W.W., Cheng, T.J., Hwang, S.J. (2010), "Force transfer mechanism and shear strength of reinforced concrete beams", Engineering Structures, vol. 32, CF. 1537-1546.
[10]. Stramandinoli, R.S.B, Rovere, H.L. (2012), "FE model for nonlinear analysis of reinforced concrete beams considering shear deformation", Engineering Structures, vol. 35, CF. 244–253.
[11]. Sharma, A. and Ozbolt, J. (2014), "Influence of high loading rates on behavior of reinforced concrete beams with different aspect ratios – A numerical study", Engineering Structures, vol. 79, CF. 297–308.
[12]. Craeye, B., Itterbeeck, P.V, Desnerck, P., Boel, V. and Schutta, G.D. (2014), "Modulus of elasticity and tensile strength of self-compacting concrete: Survey of experimental data and structural design codes", Cement & Concrete Composites, vol. 54, CF. 53–61.
[13]. Aslani, M. and Nejadi, S. (2012), "Mechanical properties of conventional and self-compacting concrete: An analytical study", Construction and Building Materials, Vol. 36, CF. 330–347.
[14]. Domone, P.L. (2007), "A review of the hardened mechanical properties ofself-compacting concrete", Cement & Concrete Composites, vol. 29, CF. 1–12.
[15]. Taylor, H. P. J, "The fundamental behavior of reinforced concrete beams under shear", ACI, vol. 42, CF. 43-77.
[16]. Birgisson, S.R. (2011), "Shear Resistance of Concrete Beams without Stirrups", Thesis in Civil Engineering, Reykjavik University, Dec. 2011.
[17]. Shah, A. (2009), " Evaluation of Shear Strength of High Strength Concrete Beams", Department of Civil Engineering, University of Engineering and Technology, Taxila, Pakistan, June 2009.