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EXPERIMENTAL INVESTIGATION ON STABILZATION OF SILTY SAND

Mr Mohan.N[1], Mr Dilip.N[2], Mr Kiran.K.M[3], Mr Chethan Krishna[4]

1. Asst. professor, Dept of Civil engineering, SJC Institute of Technology, Chickballapur-562101, India.
2. Asst. professor, Dept of Civil engineering, Bangalore Institute of Technology, Bangalore-560004, India.
3. Asst. professor, Dept of Civil engineering, SJC Institute of Technology, Chickballapur-562101, India.
4. Asst. professor, Dept of Civil engineering, NCET, Bangalore -562110, India.

ABSTRACT

In the present work additives such as fly ash, cement and lime are used for stabilization with Silty sand. Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Geotechnical properties of fly ash and its interaction behavior with soils can lead to viable solution for its large scale utilization and disposal. The effect of fly ash on geotechnical properties of silty sand stabilized with optimum percentage of fly ash has been reported. The fly ash in the rate of 5- 20 % was added, at an increment of 5% and the change in the soil properties were studied. Atterberg's limits (silty sand is non-plastic), compaction, California bearing ratio and unconfined compressive strength tests were conducted on these soil fly ash mixtures, and also unconfined compressive strength were conducted on cement and lime mixtures. The effect of 7, 14 and 28 days of unconfined compressive strength were studied for fly ash, cement and lime mixtures. The results indicate that, the maximum dry density increases up to 10% fly ash content, and then dry density decreases gradually with increase in optimum moisture content. The unconfined compression strength is maximum for 15% fly ash content. The California bearing ratio value of the Silty-sand increases gradually with the addition of fly ash up to 15%, beyond, where further increase in fly ash percentage is observed to cause a decreasing trend. The improvement in the California bearing ratio value of the Silty sand upon the addition of fly ash suggests that, it can be effectively used as subgrade stabilizer, for the road Construction works. Cement and Lime are also effective in the stabilization of Silty- sand.

Keywords- Silty Sand, Fly ash, Compaction, Unconfined compression Strength

I . INTRODUCTION

Stabilization is the process of blending and mixing materials with soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity and act as a binder for cementation of the soil.

The soil is heterogeneous mixture consisting of different percentage of coarse and fine grained fractions. There is a wide variation in the behavior owing to the complex geological process during the formation. In geotechnical engineering application, the mechanical behavior of soil namely strength and compressibility plays major role. Fine grained soils containing large amount of silt and clay under high moisture content show low strength and high compressibility and are generally problematic in nature. One such problematic Silty-sand locally called suddha soil is present in southern parts of Karnataka and is chosen for the present investigation. Silty-sand is wide spread below a depth of 1.5m from the ground level and extends to depth greater than 10m. It possesses good strength in dry condition and upon increase in moisture content it loses strength. Many failures have been observed along canal slopes, road bases, and foundation sites where Silty-sand is present. This soil is considered as a problematic soil in view of wide spread damage under saturated conditions.

It is necessary to improve the strength of Silty-sand. Conventional stabilization techniques are not effective when the water content is high. Therefore, different additives such as cement, lime and fly ash may be used. It is necessary to have a basic understanding of the mechanical behavior of soil, in particular during the development of strength and durability aspects in the laboratory due to the effect of additives. In the present work, laboratory investigations are carried out to find the effectiveness of fly ash stabilization to improve the mechanical behavior of Silty-sand for pavement applications.

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II. MATERIALS AND METHODS

The materials used in the experiment are

Silty sand

Silty-sand locally called suddha soil is present in southern parts of Karnataka and is chosen for the present investigation. The geotechnical properties of Silty sand are: Gravel - 3%, Sand - 77%, Silt -20%, Specific Gravity-2.65, Liquid Limit(w_L)-38% Plastic Limit(w_P)-NP, Plasticity Index(IP)-NP, Shrinkage Limit(w_S)-24%, Optimum moisture content (OMC)- 15%, Maximum dry density (MDD) -1.96(g/cc),UCS-38kPa, Unsoaked CBR – 4.39%, Soaked CBR - 2.18%, IS Classification –SM.

Fly ash

Fly ash has been used as an admixture for stabilization of soils. Different test like compaction, unconfined compression strength and California bearing ratio were conducted on this soil-fly ash mixes as per relevant Indian standard codes. To find optimum percentage of fly ash, it was added to Silty sand up to 20% by an increment of 5%. Unconfined compressive strength tests were conducted on these samples at 7, 14 and 28 days.

Cement

Cement has been used as an admixture for stabilization of soils. The unconfined compression strength was conducted on this soil-cement mixes (1% & 3%) as per relevant Indian standard codes. Unconfined compressive strength tests were conducted on these samples at 7, 14 and 28 days.

Lime

Lime has been used as an admixture for stabilization of soils. The unconfined compression strength was conducted on this soil-lime mixes (2% & 4%) as per relevant Indian standard codes. Unconfined compressive strength tests were conducted on these samples at 7, 14 and 28 days.

III. RESULTS AND DISCUSSIONS

The results obtained from the above laboratory tests are presented as follows:

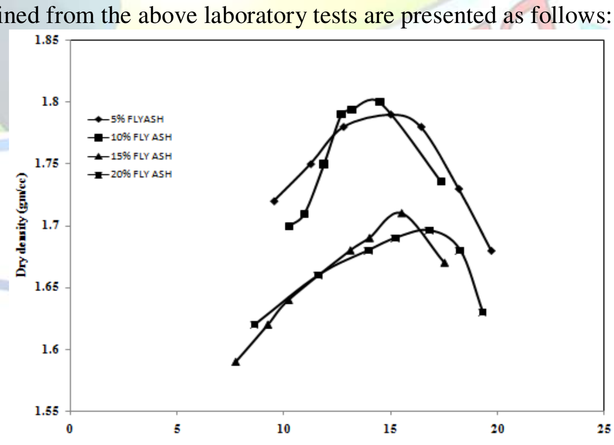

Figure 1: Compaction curve of Silty sand treated with fly ash

Fig 1 shows the variation of dry density-moisture content relationship for Silty-sand with various percentages of Fly ash. It is seen that the density-moisture content relation is affected by addition of fly ash and it varies upon the percentage of fly ash. It is observed from the Fig. that, increase in MDD with increasing in percentage of fly ash, reaches maximum dry density of 1.805 (gm/cc) at 10% fly ash content and is also observed that with further increase in the fly ash percentage, there is a decrease in MDD and increase in OMC.

Figure 2 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under unsoaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 42 kPa to 73 kPa, with 10% fly ash unconfined compressive strength increases from 46 kPa to 94 kPa, with 15% fly ash unconfined compressive strength increases from 109 kPa to 135 kPa and with 20% fly ash unconfined compressive strength increases from 61 kPa to 79 kPa with a curing period of 0 to 28 days. Maximum UCS

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strength is achieved at 15% fly ash content and the optimum fly ash content for strength attainment is 15%. The strength increases with increase in curing period.

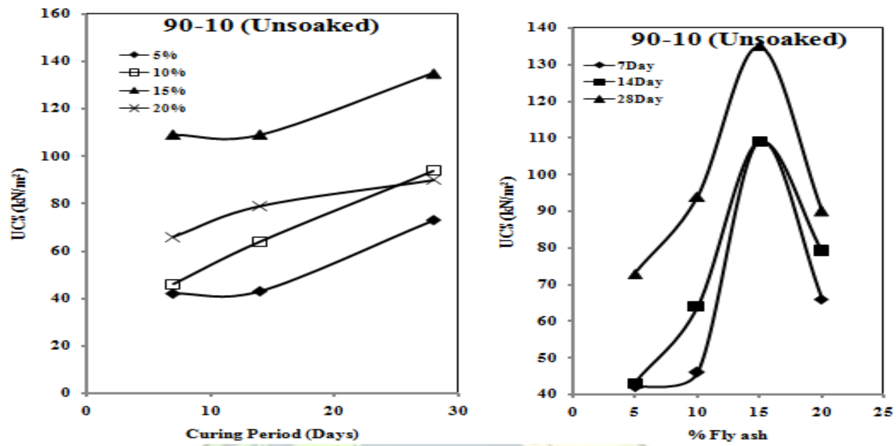

Figure 2: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (90-10) mixture under unsoaked condition

Figure 3 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under soaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 28 kPa to 62 kPa, with 10% fly ash unconfined compressive strength increases from 35 kPa to 69 kPa, with 15% fly ash unconfined compressive strength increases from 72 kPa to 89 kPa and with 20% fly ash unconfined compressive strength increases from 84 kPa to 87 kPa with a curing period of 0 to 28 days. In this case also, the optimum fly ash content is 15%, in general strength reduction due to soaking is 50% and strength increases with increase in curing period.

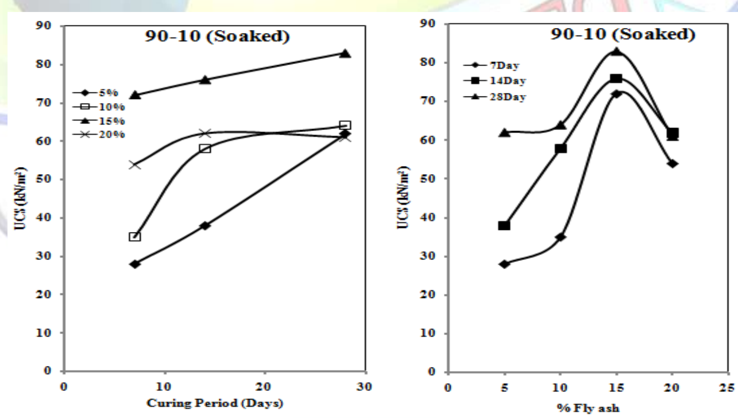

Figure 3: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (90-10) mixture under soaked condition

Figure 4 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under unsoaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 46 kPa to 106 kPa, with 10% fly ash unconfined compressive strength increases from 59 kPa to 123 kPa, with 15% fly ash unconfined compressive strength increases from 111 kPa to 152 kPa and with 20% fly ash unconfined compressive strength increases from 89 kPa to 122 kPa with a curing period of 0 to 28 days. The optimum fly ash content is 15%. The strength increases with increase in curing period.

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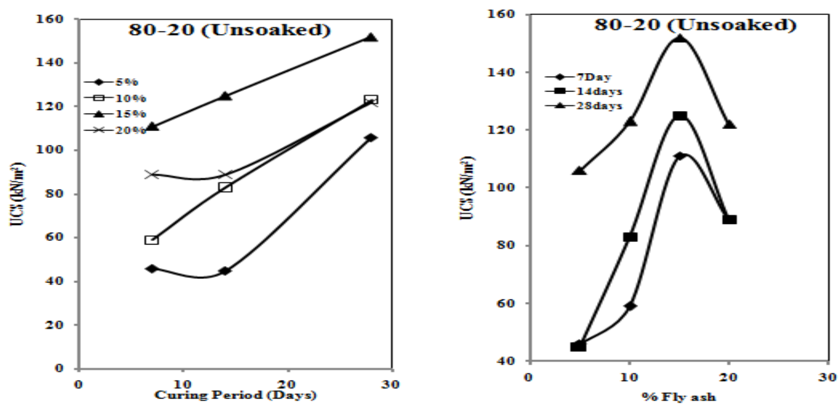

Figure 4: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (80-20) mixture under unsoaked condition

Figure 5 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under soaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 27 kPa to 46 kPa, with 10% fly ash unconfined compressive strength increases from 29 kPa to 59 kPa, with 15% fly ash unconfined compressive strength increases from 48 kPa to 62 kPa and with 20% fly ash unconfined compressive strength increases from 46 kPa to 57 kPa with a curing period of 0 to 28 days. The optimum fly ash content is 15%. The strength increases with increase in curing period.

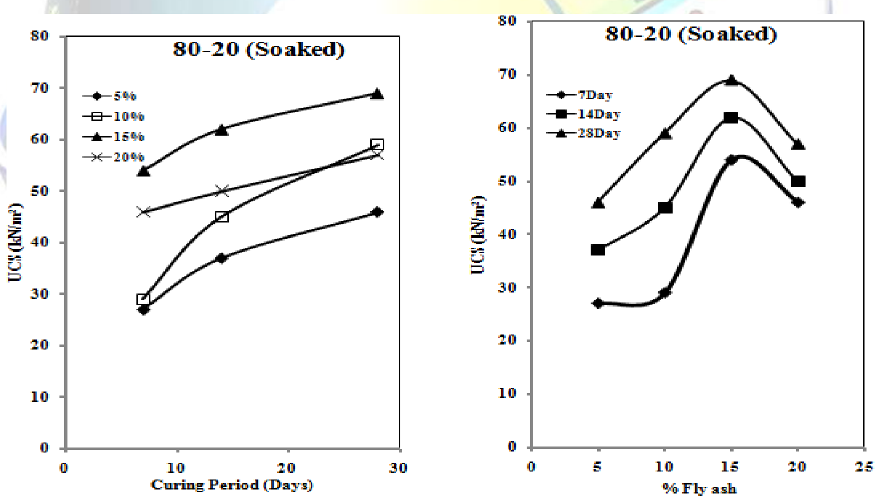

Figure 5: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (80-20) mixture under soaked condition

Figure 6 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under unsoaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 69 kPa to 144 kPa, with 10% fly ash unconfined compressive strength increases from 84 kPa to 164 kPa, with 15% fly ash unconfined compressive strength increases from 87 kPa to 186 kPa and with 20% fly ash unconfined compressive strength increases from 72 kPa to 169 kPa with a curing period of 0 to 28 days. The optimum fly ash content is 15%. The strength increases with increase in curing period.

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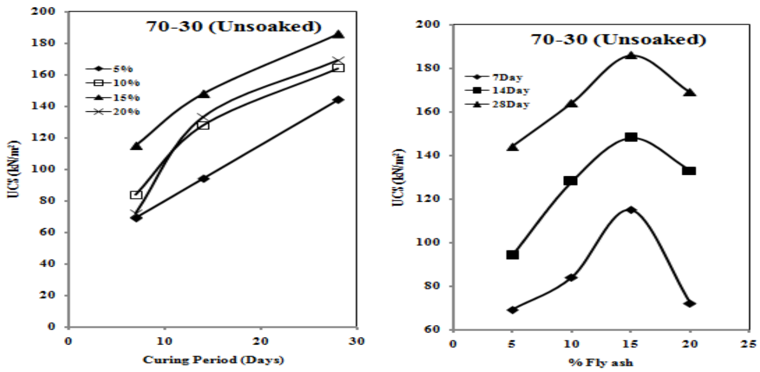

Figure 6: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (70-30) mixture under unsoaked condition

Figure 7 shows the variation of unconfined compressive strength with the curing period and fly ash content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 5%, 10%, 15% and 20% of fly ash compacted to proctor conditions under soaked condition. With the addition of 5% fly ash unconfined compressive strength increases from 23 kPa to 43 kPa, with 10% fly ash unconfined compressive strength increases from 29 kPa to 48 kPa, with 15% fly ash unconfined compressive strength increases from 46 kPa to 54 kPa and with 20% fly ash unconfined compressive strength increases from 43 kPa to 54 kPa with a curing period of 0 to 28 days. The optimum fly ash content is 15%. The strength increases with increase in curing period.

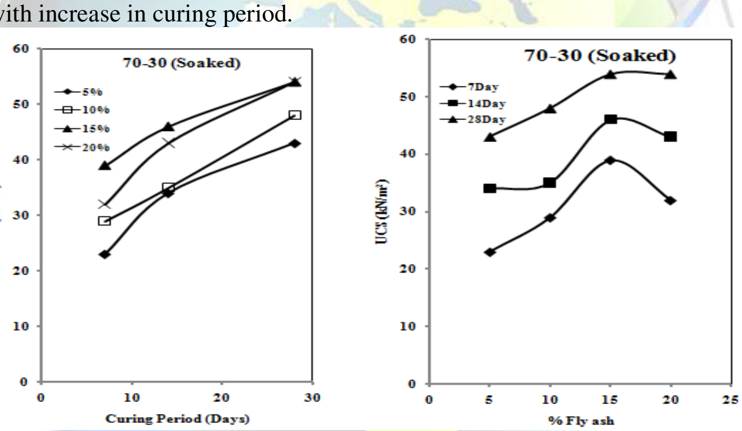

Figure 7: Effect of curing period and fly ash content on Unconfined compressive strength of sand-silt (70-30) mixture under soaked condition

Table Shows CBR values of Unsoaked & Soaked conditions using different percentages of Fly ash

Fly ash%	Unsoaked (CBR)	Soaked (CBR)
0	4.39	2.18
5	4.56	2.9
10	4.70	3.5
15	4.85	3.6
20	4.40	3.2

The California bearing ratio value of the Silty-sand increases gradually with the addition of fly ash up to a 15 percentage, beyond, Thus, further increase in fly ash percentage is observed to cause a decreasing trend in the California bearing ratio values. The improvement in the California bearing ratio value of the Silty sand upon the addition of fly ash suggests that, it can be effectively used as subgrade stabilizer for the road Construction works.

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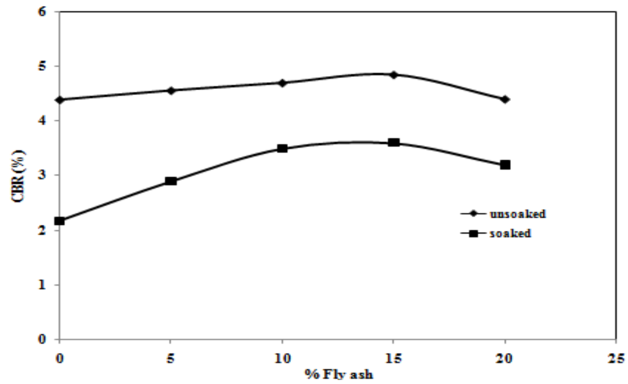

Figure 8: Variation of CBR (%) of Silty-Sand treated with fly ash

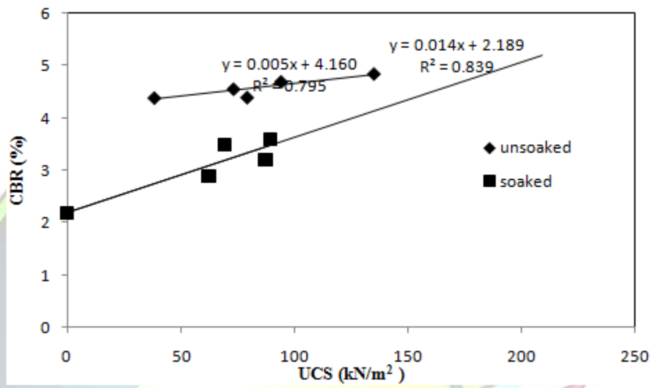

Figure 9: Relationship between UCS and CBR

Figure 10 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 1% and 3% of cement compacted to proctor conditions under unsoaked condition. With the addition of 1% cement unconfined compressive strength increases from 115 kPa to 153 kPa and with 3% cement unconfined compressive strength increases from 141 kPa to 178 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

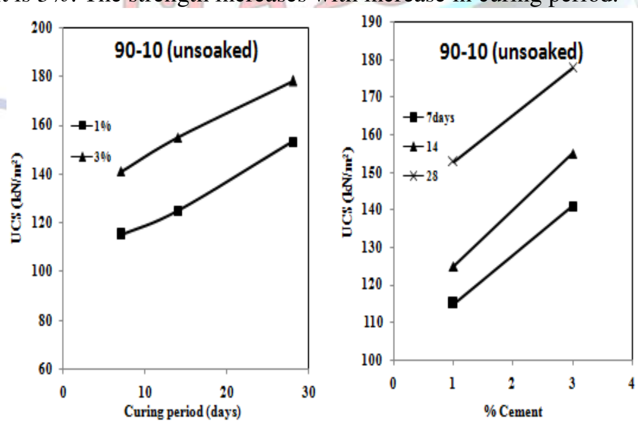

Figure 10: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (90-10) under unsoaked condition.

Figure 11 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 1% and 3% of cement compacted to proctor conditions under unsoaked condition. With the addition of 1% cement unconfined compressive strength increases from 60 kPa to 98 kPa and with 3% cement unconfined compressive strength increases from 116 kPa to 141 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

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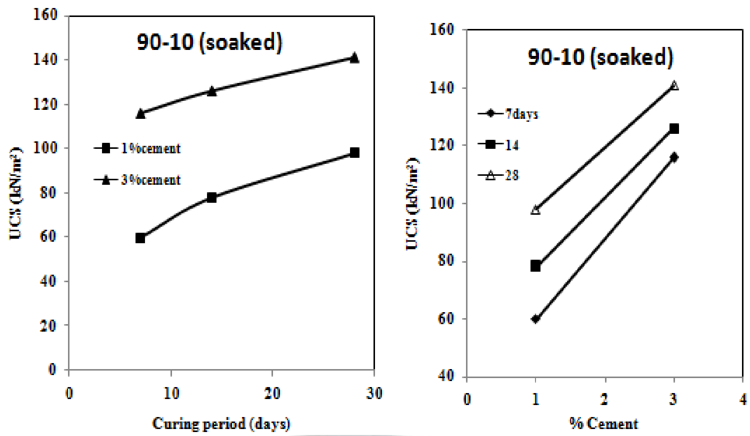

Figure 11: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (90-10) under soaked condition

Figure 12 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 1% and 3% of cement compacted to proctor conditions under unsoaked condition. With the addition of 1% cement unconfined compressive strength increases from 121 kPa to 161 kPa and with 3% cement unconfined compressive strength increases from 153 kPa to 192 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

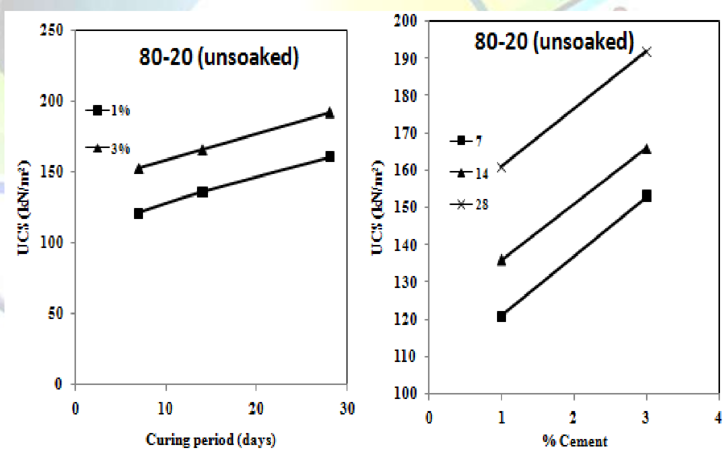

Figure 12: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (80-20) under unsoaked condition

Figure 13 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 1% and 3% of cement compacted to proctor conditions under soaked condition. With the addition of 1% cement unconfined compressive strength increases from 77 kPa to 112 kPa and with 3% cement unconfined compressive strength increases from 129 kPa to 155 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

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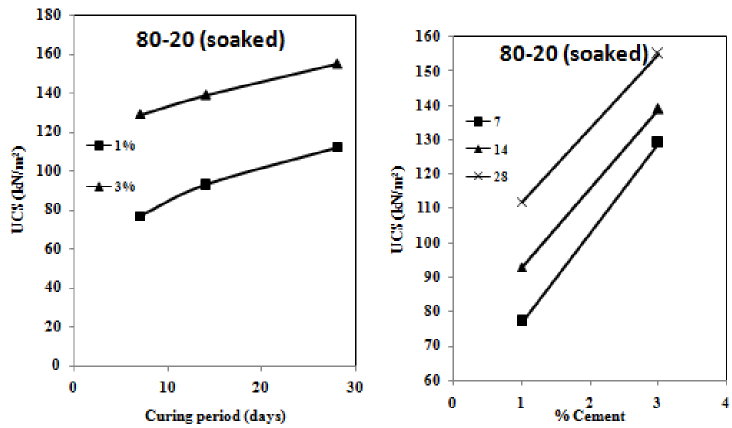

Figure 13: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (80-20) under soaked condition

Figure 14 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 1% and 3% of cement compacted to proctor conditions under unsoaked condition. With the addition of 1% cement unconfined compressive strength increases from 127 kPa to 188 kPa and with 3% cement unconfined compressive strength increases from 179 kPa to 217 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

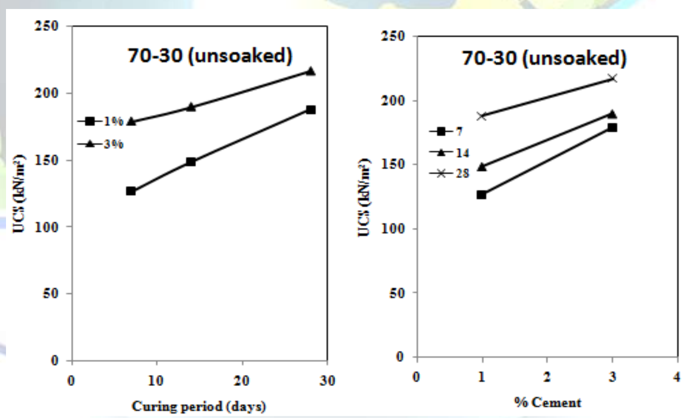

Figure 14: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (70-30) under unsoaked condition

Figure 15 shows the variation of unconfined compressive strength with the curing period and cement content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 1% and 3% of cement compacted to proctor conditions under soaked condition. With the addition of 1% cement unconfined compressive strength increases from 101 kPa to 126 kPa and with 3% cement unconfined compressive strength increases from 157 kPa to 176 kPa with a curing period of 0 to 28 days. The optimum cement content is 3%. The strength increases with increase in curing period.

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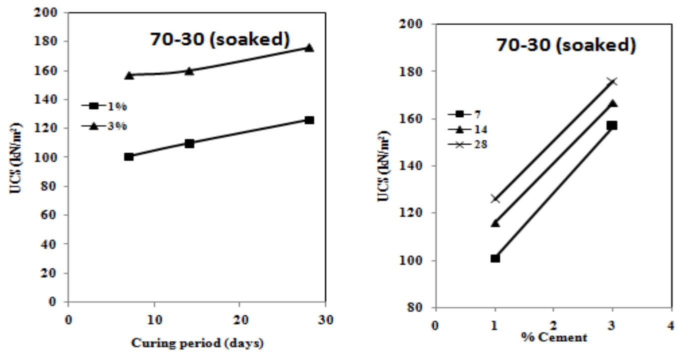

Figure 15: Effect of curing period and cement content on Unconfined compressive strength of sand-silt mixture (70-30) under soaked condition

Figure 16 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 2% and 4% of lime compacted to proctor conditions under unsoaked condition. With the addition of 2% cement unconfined compressive strength increases from 111 kPa to 141 kPa and with 4% cement unconfined compressive strength increases from 116 kPa to 157 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

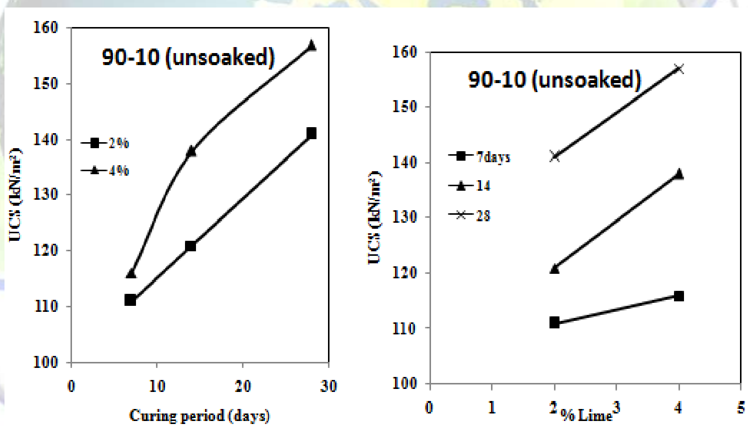

Figure 16: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (90-10) under unsoaked condition

Figure 17 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (90-10) stabilized with 2% and 4% of lime compacted to proctor conditions under soaked condition. With the addition of 2% cement unconfined compressive strength increases from 59 kPa to 92 kPa and with 4% cement unconfined compressive strength increases from 68 kPa to 136 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

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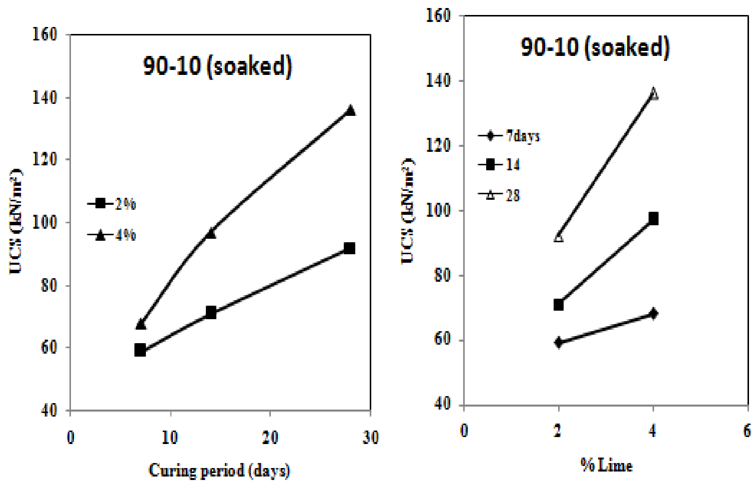

Figure 17: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (90-10) under soaked condition

Figure 18 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 2% and 4% of lime compacted to proctor conditions under unsoaked condition. With the addition of 2% cement unconfined compressive strength increases from 117 kPa to 156 kPa and with 4% cement unconfined compressive strength increases from 127 kPa to 183 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

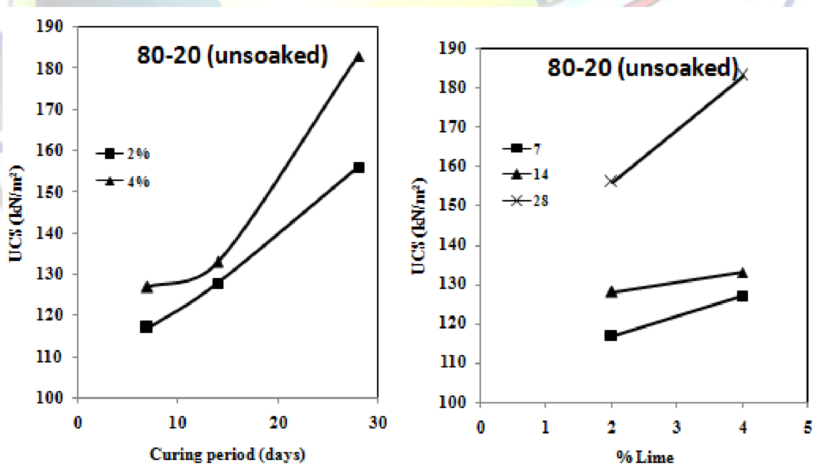

Figure 18: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (80-20) under unsoaked condition

Figure 19 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (80-20) stabilized with 2% and 4% of lime compacted to proctor conditions under soaked condition. With the addition of 2% cement unconfined compressive strength increases from 62 kPa to 108 kPa and with 4% cement unconfined compressive strength increases from 79 kPa to 143 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

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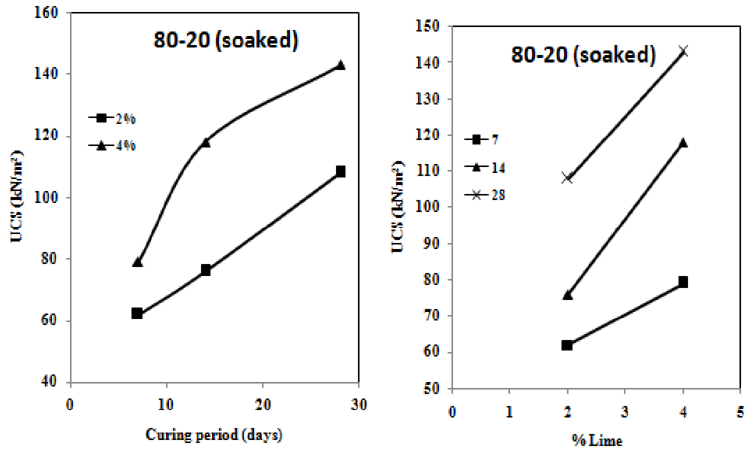

Figure 19: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (80-20) under soaked condition

Figure 20 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 2% and 4% of lime compacted to proctor conditions under unsoaked condition. With the addition of 2% cement unconfined compressive strength increases from 125 kPa to 177 kPa and with 4% cement unconfined compressive strength increases from 132 kPa to 204 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

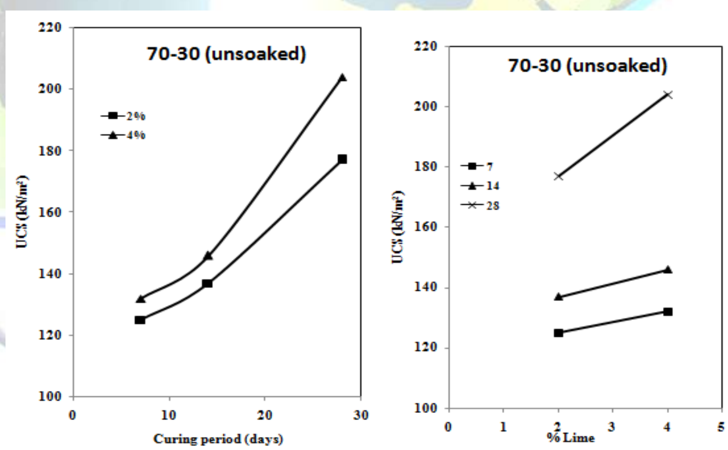

Figure 20: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (70-30) under unsoaked condition

Figure 21 shows the variation of unconfined compressive strength with the curing period and lime content obtained from unconfined compressive strength tests on 7, 14 and 28 days cured sand-silt mixtures (70-30) stabilized with 2% and 4% of lime compacted to proctor conditions under soaked condition. With the addition of 2% cement unconfined compressive strength increases from 98 kPa to 119 kPa and with 4% cement unconfined compressive strength increases from 109 kPa to 158 kPa with a curing period of 0 to 28 days. The optimum lime content is 4%. The strength increases with increase in curing period.

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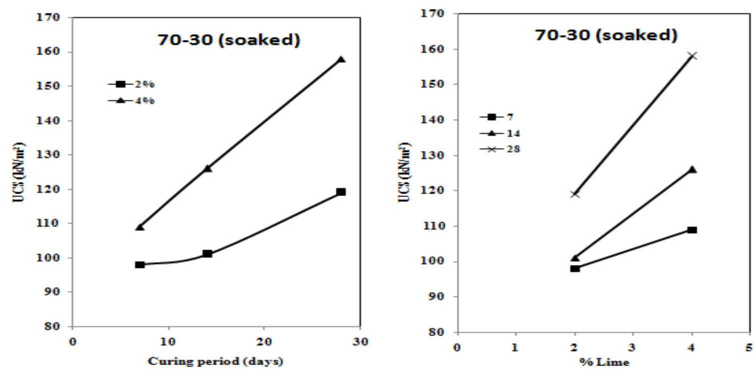

Figure 21: Effect of curing period and lime content on Unconfined compressive strength of sand-silt mixture (70-30) under soaked condition

SUMMARY

Based on the results it can be observed that the strength generally increases with the curing period under both unsoaked and soaked condition for all the fly ash content. The strength development at 5% fly ash is low when compared to 10%, 15% and 20% fly ash. At 5%, 10%, 15% and 20% fly ash soaked strength is less than the unsoaked strength. In general, soaked strength is less than the unsoaked strength. The rate of strength is rapid up to 7 days and gradual beyond 14 days for 5%, 10%, 15% and 20% fly ash. In general the rate of strength development is very similar for all four percentage of fly ash content. From the data 15% additive is optimum from the point of rate of strength development. Based on the results it can be observed that the strength generally increases with the curing period under both Unsoaked and soaked condition for all the cement content. The strength development at 1% cement is low when compared to 3% cement. At 1% and 3% cement soaked strength is less than the Unsoaked strength. In general, soaked strength is less than the unsoaked strength. The rate of strength is rapid up to 7 days and gradual beyond 14 days for 1% and 3% cement. In general the rate of strength development is very similar for all two percentage of cement content. From the data 3% additive is optimum from the point of rate of strength development. Based on the results it can be observed that the strength generally increases with the curing period under both Unsoaked and soaked condition for all the lime content. The strength development at 2% lime is low when compared to 4% lime. At 2% and 4% lime soaked strength is less than the unsoaked strength. In general, soaked strength is less than the unsoaked strength. The rate of strength is rapid up to 7 days and gradual beyond 14 days for 2% and 4% lime. In general the rate of strength development is very similar for all two percentage of lime content. From the data 4% additive is optimum from the point of rate of strength development.

CONCLUSIONS

1. The optimum fly ash content from moisture content dry density relation is 10%.
2. UCS of the Silty-sand (Unsoaked & soaked condition) increases with the addition of fly ash content, and 15% fly ash content is optimum.
3. The strength increases with increase in curing period. The rate of strength gain between 14 to 28 days is significant for all the additives.
4. In general, the strength reduces by 50% under soaked condition for stabilized soils for all the additives.
5. The CBR values of Silty-sand fly ash mixtures are maximum at 15% fly ash content for both unsoaked and soaked condition.
6. UCS of the Silty-sand (Unsoaked & soaked condition) increases with the addition of cement content (1% & 3%). The strength increases with increase in curing period.
7. UCS of the Silty-sand (Unsoaked & soaked condition) increases with the addition of lime content (2% & 4%). The strength increases with increase in curing period.
8. For a soaked CBR of 4% the unconfined compression strength shall be 130kPa. The optimum additive contents are
   1) Fly ash 15% OMC with 28 days curing period
   2) Cement 3% OMC with 14 days curing period
   3) Lime 4% OMC with 14 days curing period.

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REFERENCES

1] **Masoud Karimi & Ali Ghorbani** (University of Guilan Iran) has carried out the studies on "Stabilization of silty sand soils with lime & microsilica".

[2] **Sayed abolhassan naeini, et.al** (Imam Khomeini international university, Iran) have carried out studies Effect of wet and dry condition on strength of silty sand soils stabilized with epoxy resin polymer.

[3] **B.K.Sahu** (University of Botswana) has carried out the studies for "Improvement of California bearing ratio (CBR) of Silty-sand soils in Botswana by using fly ash".

[4] **Chew et al (2004)** conducted studies on the physiochemical and engineering behavior of cement treated clays, and examined the relationship between the microstructure and engineering properties of cement treated soft marine clay.

[5] **Dr. Robert (2009)** has carried out the studies on "Soil stabilization with fly ash and rice husk ash".

[6] **Phanikumar and Sharma (2004)** have carried out the studies on "The effect of fly ash on engineering properties of expansive soil".

[7] **Qubain et al. (2000)** incorporated the benefits of sub-grade lime stabilization, for the first time into the design of a major interstate highway pavement in Pennsylvania.

[8] **Udayashankar et al (2012)** have conducted experimental work for "Stabilization of Black Cotton Soil Using Dandeli Fly Ash".

[9] **Narasimha rao et al. (1994) and Rajasekaran et al (1997, 2000, 2002)** conducted studies on the lime stabilization of soft marine clay in a test tank.

[10] **Balasubramaniam et al. (1989),** have adopted quicklime for the stabilization of soft Bangkok clays.

[11] **Horpibulsuk et al(2003, 2005)** have conducted studies on strength development in cement admixed high water content clays by using Abram's law and clay water cement ratio.