VARIATION OF PRE-CONSOLIDATION BEHAVIOUR OF LIME STABILIZED SOIL REINFORCED WITH COIR FIBERS

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Abstract: Analyzing the consolidation behavior of fine grained soils has been of interest to geotechnical engineers from practical point of view. In several considerations lime stabilization is less effective in importing consolidation behavior of fine grained soil, due to its brittle behavior. Whereas fine grain soil reinforced with fibers increases ductile behaviour, but its consolidation behaviour is marginal due to ductile behaviour. An attempt has been made in this study by using coir fiber waste to mitigate the brittleness in lime stabilized fine grained soil without compromising improvement in pre-consolidation behaviour of the matrix. The results revealed that reinforcing 0.5% (by weight of soil) discreet coir fiber to optimum line stabilized fine grained soil improves both ductility as well as pre-consolidation behaviour of soil-lime-coir matrix.

Keywords: Pre-consolidation, Matrix, Ductility

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1 Introduction

The consolidation tests are conducted on lime treated expansive and non-expansive soils reinforced with coir fiber and the results were analyzed and presented. Expansive Black cotton soil occurring above water table undergo volumetric changes with change in moisture content, similar observations were seen by kulkarni(1973), Yong (1975), Nadgoud and Hedge(2010) says Increase in water content causes the swelling of the soil and loss of strength and decrease in moisture content brings about soil shrinkage.Vishnuda consolidation tests were conducted on expansive Black cotton soil and non-expansive Red earth stabilized with lime treatment alone and lime treated expansive and non-expansive soils reinforced with coir fiber were made to study the change in void ratio, variation of swelling pressure. For the experimental study optimum lime percentage of 4% for Black cotton soil and 3% for Red earth and 1.0% of 5 mm length of and 0.5% random length of coir fiber for both the soils were considered and the results are analyzed. Vishnuda (2000) says that vegetable cover using coir fiber will improves the matrix.

The hydrated lime reacts with the clay particles and permanently transforms them into a strong cementitious matrix. Studies by Nadgouda and Hegde, (2010) and Nisha and Illumpurthi (2008) says that lime stabilization change the properties of soil, same observations were also seen in our research work that, black cotton soil showed that the swelling pressure of the untreated soil was 106 kPa. With the addition of 2% of lime to black cotton soil, the swelling pressure dropped to 42 kPa. Kaniraj and Vasanth (2001), Kaniraj and Gayathir (2003). The swelling pressure decreases with increase in lime content up to 3.5% after which it goes on increasing. The optimum lime content is observed at about 3.5% where the swelling pressure was calculated as 22 kPa

2. Materials Methodology followed

Materials used: The soil used in the investigation were volumetric change expansive black cotton soil**,** which is collected from Davenegere about 250 kms from Bangalore, Karnataka(s), India. Non-volumetric change soil is selected as locally available kaolinitic red earth. Both the soil were collected at a depth of 2 meters from natural ground level. Lime used in this investigation is hydrated lime $Ca(OH)_2$ obtained from Fishers chemical Pvt.Ltd., Kochi, Kerala(S),India and Discreet (Random length of coir fiber) coir fiber is selected from coir board, Tanjor, Tamil Nadu(s), India. The properties of materials used in investigation is highlighted in Table.1.

Table 1 Properties of material used

Material Description		**Black cotton soil**	**Red Earth**
Color		Black	Brick Red
Gs		2.72	2.64
WL (%)		83	45
WIp (%)		50	21
Ws (%)		8.3	14.49
Grain Size Distribution	Gravel(%)	0	0
	Sand (%)	15	45
	Silt (%)	30	20
	Clay (%)	55	35
FSI (%)		110	7.69
MDD(kN/m^3)		14.40	16.83
OMC(%)		28.50	19.67
UCS(kN/m^2)		313	147

Note: Except sieve analysis, soil used for above test is passing 425µ IS sieve
Coir fiber is having Gs=1.21 and density of 12.06 kN/m^3

Methodology adopted:

The soil used in the research work was the soil passing 425µ IS sieve. All compaction test were conducted using mini compaction apparatus.(Sridharan and Sivapulliah, 2005). Beyond 2.5% discreet fiber mixing of soil-fiber forms lumps, hence experiments restricted up to 2.5% only.

The samples were tested in a fixed – ring consolidometer using brass rings of 76 mm diameter and 25 mm height as per IS: 2720 (Part 15) (1986). The required quantity of the mixture was taken and was mixed with required amount of

water carefully. The samples were prepared at their respective maximum dry density and optimum moisture contents. The sides of the consolidation rings were properly greased to avoid any side friction. Then, the properly mixed samples were filled in the ring with much care to see that no air gap was left inside. Finally the samples were compacted statically the consolidation ring. Height of the sample after compaction was about 25 mm.

Testing procedure

The prepared ring with sample was then introduced into the consolidation test assembly with porous stones on either side. The porous stones used were saturated initially by boiling in distilled water for about 30 minutes. Filter papers were placed between the porous stone and the specimen to prevent the mix from being entering into the pores of the porous stones. The pressure pad was positioned centrally on the top of the porous stone. The consolidation assembly was then mounted on the loading frame and centered such that the load applied is axial. The sample was then loaded with a seating pressure of 6.25 kPa and was inundated with water.

The load increment ratio was kept as two. Each load was kept for a period of 24 hours for complete dissipation of pore water pressure and for reaching equilibrium void ratio. The dial gauge readings were noted at the time intervals specified in the IS: 2720 (Part 15) (1986). For the routine tests, a loading sequence of 6.25, 12.5,25,50,100,200,400 and 800 kPa was adopted.

3.Result and Discussions

Pressure-Void ratio Relationship of Lime Treated Expansive and Non- Expansive Soils

Lime treated Black cotton soil reduces the final void ratio by 23% and lime treated Red earth reduces the final void ratio by 10% compared with soil alone. This indicates that lime stabilization is more advantageous to Black cotton soil compared with Red earth as shown in Table.2 as well as Figures 1 and Figure 2. The swelling pressure of Black cotton soil is 400 kPa under a seating pressure of 6.25 kPa in saturation condition. This may be due to presence of montmorollonatic clay mineral, which inhibits swell shrink behaviour.Banarji et al (2002) Lime stabilization makes the swelling pressure to zero as shown in Table 2. However, for Red earth alone or lime treated Red earth the swelling pressure is zero under the seating pressure of 6.25 kPa.This may be due to kaolonatic non expansive clay mineral.

Table 2 Swelling Pressure of Lime Treated BC Soil and Red EarthReinforced with Coir Fiber

Mixture	Swelling Pressure kPa	
	BC Soil	Red Earth
Soil alone	400	0
Soil+1%(5 mm L) CF	300	8
Soil+0.5% RLCF	175	9
Soil+ Opt % of Lime	0	0
Soil+ Opt % of Lime+ 1% (5 mm L) CF	0	0
Soil +opt % of Lime+ 0.5% RLCF	0	0

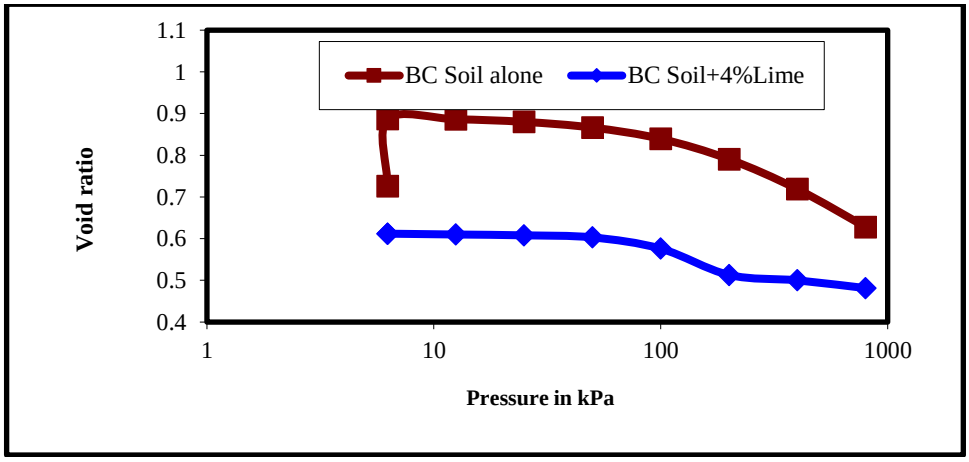

Fig 1: Pressure-Void ratio Relationship of Lime Treated BC Soil

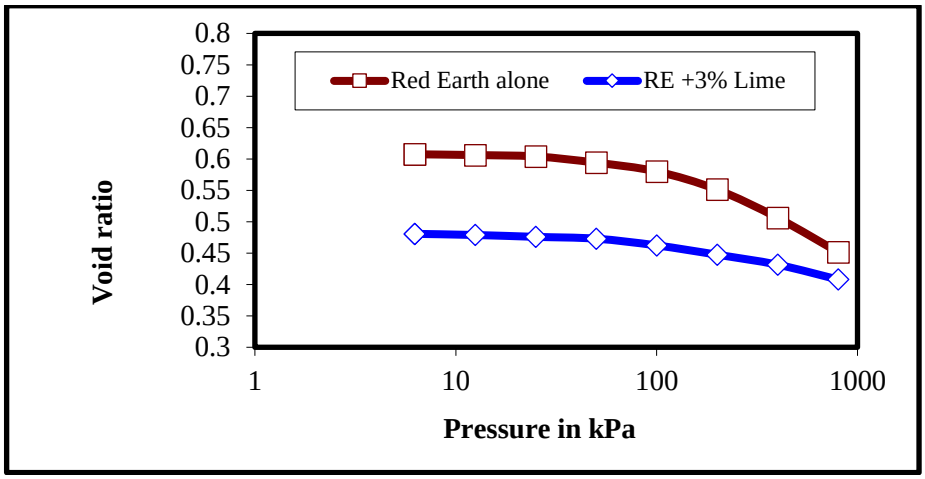

Fig 2: Pressure-Void ratio Relationship of Lime Treated Red Earth

Pressure-Void ratio Relationship of Expansive and Non-Expansive Soils Reinforced with Coir Fiber

Black cotton soil reinforced with 1.0% of 5 mm length of coir fiber reduces the void ratio by 46% and swelling pressure to 300 kPa and Black cotton soil reinforced with 0.5% of random length of coir fiber reduces the void ratio by 25% and swelling pressure to 175 kPa when compared with Black cotton soil alone as shown in Table 2 and Fig. 3 However, Red earth reinforced with 1.0% of 5 mm length of coir fiber or 0.5% of random length of coir fiber decreases the void ratio by 4% and increases the swelling pressure by 8 kPa when compared with Red earth alone as shown in Table 2 and Fig.4.

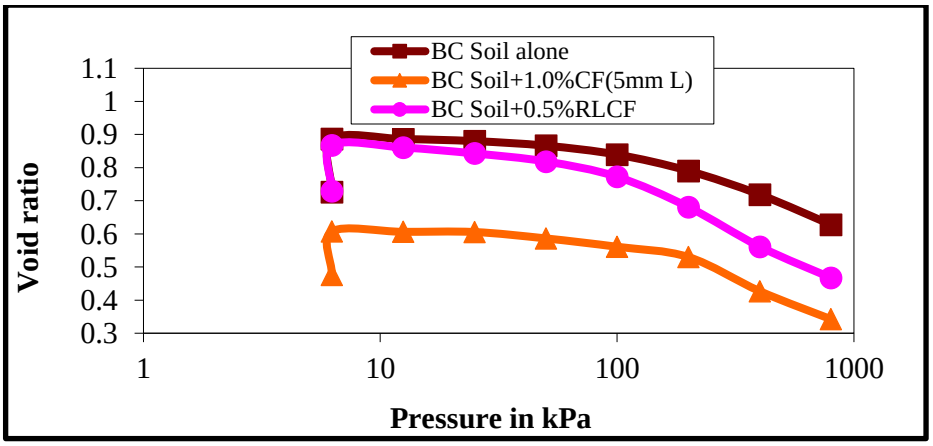

Fig.3 Pressure-Void ratio Relationship of BC Soil Reinforced with Coir Fiber

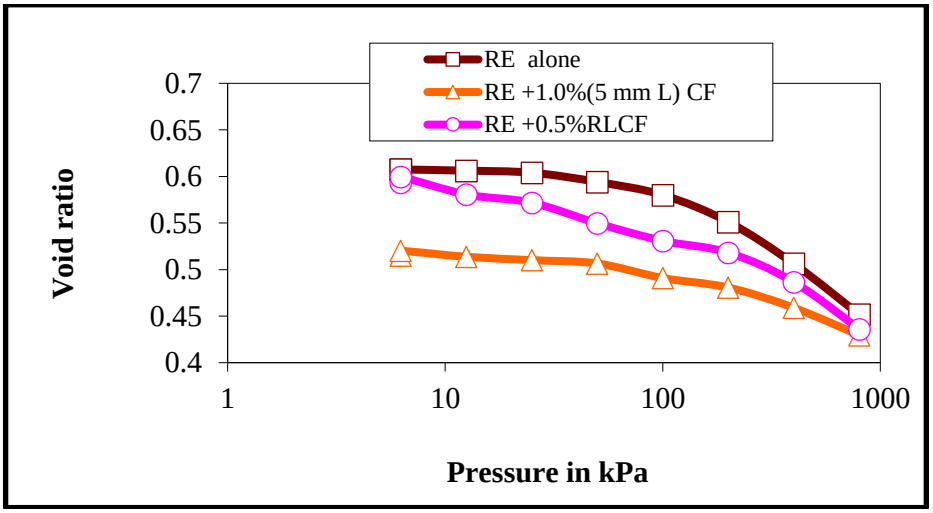

Fig.4 Pressure-Void ratio Relationship of RE Reinforced with Coir Fiber

Pressure-Void ratio Relationship of Lime Treated Expansive and Non-Expansive Soils Reinforced with Coir Fiber

Lime treated Black cotton soil reinforced with 1.0% of 5 mm length of coir fiber reduces void ratio by 30% and 0.5% of random length of coir fiber reduces the void ratio by 25% when compared with lime treated Black cotton soil as shown in Fig.5. This indicates that lime stabilized Black cotton soil reinforced with coir fiber is more beneficial. However, lime treated Red earth reinforced with 1.0% of 5 mm length of coir fiber or 0.5% of random length of coir fiber increases the void ratio by 6% more when compared to lime treated Red earth as show in Fig. 6 Venkatappa Rao (2004) says that addition of fiber in soil act as reinforcing member.

The lime treated Black cotton soil or lime treated Red earth reinforced with coir fiber, swelling pressure reduces to zero as shown in Table 2.(Balue.1995)

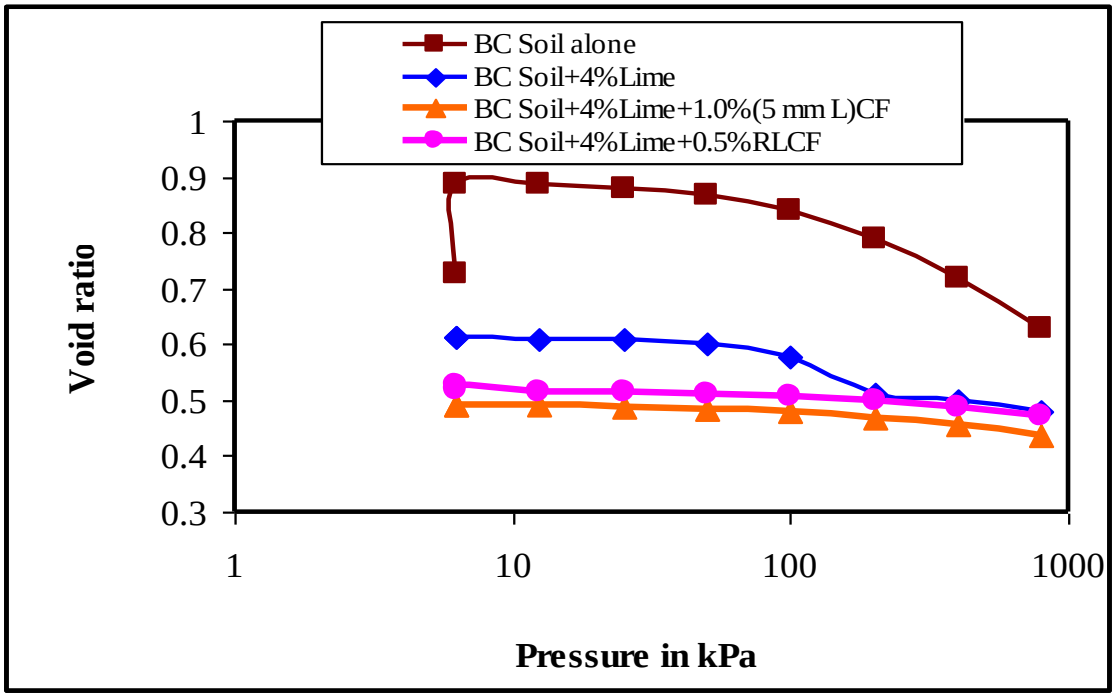

Fig.5 Pressure-Void ratio Relationship of Lime Treated BC Soil Reinforced with Coir Fiber

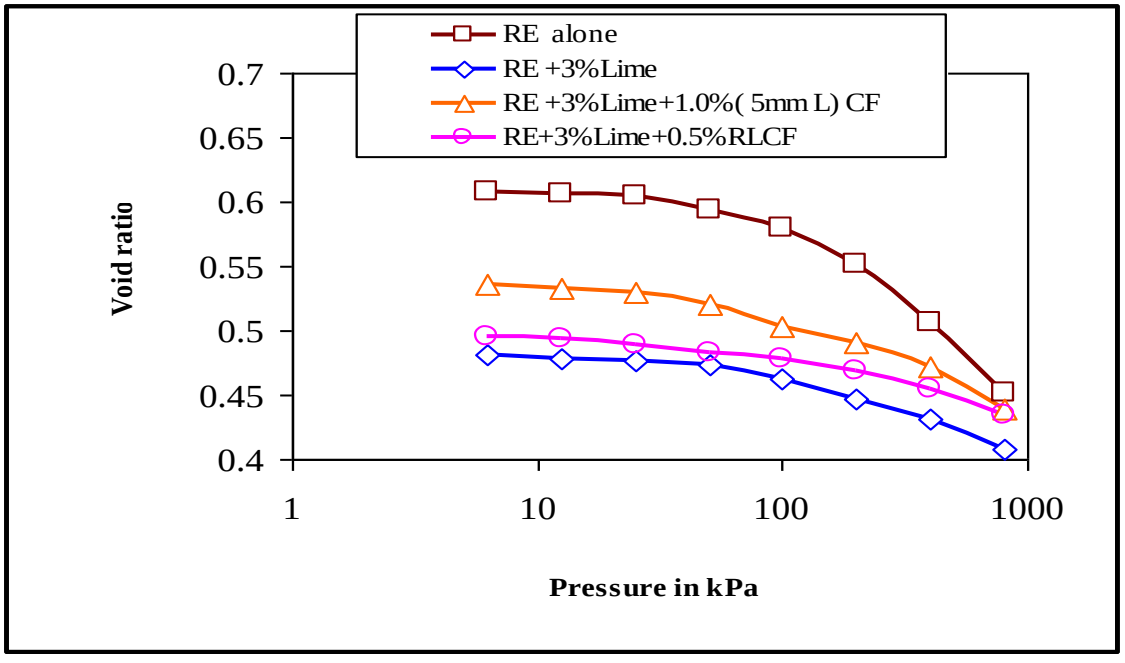

Fig.6 Pressure-Void ratio Relationship of Lime Treated RE Reinforced with Coir Fiber

Conclusions

From the experimental results , it has been found that, compressibility characteristics of expansive and non-expansive soils reinforced with coir fiber. Lime stabilized expansive and non-expansive soils or expansive soil and non-expansive soils reinforced with coir fiber reduces void ratio, compression index compared with untreated and optimum percentage of lime treated Black cotton soil and Red earth. However, lime treated Black cotton soil reinforced with coir fiber decreases void ratio significantly than lime treated Red earth reinforced with coir fiber. Black cotton soil reinforced with coir fiber decreases the swelling pressure compared with Black cotton soil alone. The void ratio of Black cotton soil and Red earth reduces with the addition of lime. For the Black cotton soil and Red earth reinforced with coir fiber void ratio is found to reduce further. The reduction in void ratio is significant for Black cotton soil when compared to Red earth.

The swelling pressure of lime treated Black cotton soil reduces considerably and becomes zero such with the reinforcement of coir fiber. However, with the Red earth no changes was observed.

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