Effect of Granite Dust on Engineering Properties of Lime Stabilized Black Cotton Soil

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Abstract.

This paper presents the effect of granite dust on the engineering characteristics of BC soil stabilised with 5% lime. A laboratory study was undertaken to evaluate the effect of granite dust as a soil stabilizer. Soil sample containing 5% lime and 0%, 10%, 20% and 30% of granite dust were prepared and compaction characteristic and California bearing ratio test were conducted as per relevant IS code of practise.

The test results revealed that the compaction parameters and CBR values of the soil are improved substantially with the addition of the granite dust.

It is also found that the swelling of the BC soil is almost controlled. The result showed the CBR value increased from 1.7% to 7.15%, the optimum moisture content have been reduced from 22% to 14.3% and the maximum dry density have been increased from 1.58 g/cc to 1.88 g/cc.

The conclusion drawn from this experimental work is that the expansive clay like black cotton soil can be stabilized by the combination of lime and stone dust to control its swelling nature and increase the stability.

Keyword. Black cotton soil, granite dust, California bearing ratio, compaction characteristics.

Introduction.

Black cotton soil is an expansive soil found in many parts of India. It contains montmonrollite minerals due to this these soil has a tendency swell and shrink excessively with the change inmoisture content.

To achieve the economy and proper performance founded on such soils it is necessary to check the expansive behaviour and improve the strength characteristic of such weak soils.

The Granite dust is a waste product produced in granite industry while cutting huge granite rocks to the desired shapes. About 3000 metric ton of granite dust/slurry is produced per day as a by-product during manufacturing of granite tiles and slabs from the raw blocks. The marble and granite cutting industries are dumping these wastes in nearby pits or open lands. This leads to serious environmental pollution and occupation of vast area of land especially after the slurry dries up.

This study envisages the effect of granite dust on compaction characteristics (OMC & MDD), California bearing ratio (CBR) and swelling characteristics (DFS) of black cotton soil mixed with % % Lime and 0%, 10%, 20% and 30% granite dust by weight of dry soil.

Literature Review.

Number of studies has been conducted by various researchers on the use of industrial waste materials to improve the performance of weak soils.Cokca (2001) studied the effect of Fly ash on the expansive soil. He found that the plasticity index, activity and swelling potential of the samples decreased with increasing percent stabilizer and curing time and the optimum content of fly ash in decreasing the swell potential was found to be 20%. Also concluded that both high calcium and low calcium class C fly ashes can be recommended as effective stabilizing agents for improvement expansive soils.

Kumar S, et al. (2012) studied the effect of silica and calcium extracted from rice husk ash on geotechnical properties of expansive soils. They concluded that the characteristics of such soils are improved remarkably.

Ali M.S. et al. (2011) presented the effect of stone dust and fly ash on characteristics of fly ash. They concluded that there is a marked improvement in the properties of expansive soil if stone dust and fly ash is mixed in equal proportions. There is a significant control in the swelling behaviour of the expansive clay.

Similarly many researchersKamon et al.(1994),Yorimichi, K. et al. (1999),Rezende,L.R. et al. (2003), Phanikumar et al. (2004), Qian Guoping et al. (2011), Kumar Sabat. (2012), Osman Sivrikaya (2013)have investigated the use of industrial wastes like fly ash, granite mill tailings, marble dusts, other stone wastes to improve the properties of weak/ expansive soils. They concluded that these industrial wastes can increase the strength and decrease the swelling behaviour of expansive soils if mixed in optimum proportions.

Experimental Programme.

The Black Cotton Soil used in the present investigation was collected from Bilheri area of Jabalpur town of Madhya Pradesh state. The properties of Black Cotton Soil are shown in table 1.

Table 1. Engineering Properties of black cotton soil.

S NO.	PARTICULARS	TEST RESULTS
1	Soil Classification	CH
2	Specific Gravity	2.58
3	Liquid Limit, (%)	57
4	Plastic Limit, (%)	19.85
5	Plasticity Index, (%)	37.28
6	Shrinkage Limit, (%)	8.10
7	Grain Size Distribution: Sand (%) Silt + Clay (%)	 10 90
8	Compaction Characteristics Optimum Moisture Content (%) Maximum Dry Density (kN/m³)	 22 1.58
9	California Bearing Ratio	1.7
10	Swelling Characteristics Differential Free Swell (%)	56.6

The granite dust was collected from the plant located near the granite quarry near Chhatarpur district of Madhya Pradesh. The grain size distribution of the dust is presented in Table 2. The specific gravity of granite dust was found to be 2.69.

Table 2. Particle size distribution of granite dust

Sieve Size	Percentage passing
4.75mm	99.98
2.00mm	99.48
1.00mm	96.55
600 micron	88.78
425 micron	64.85
300 micron	53.63
212 micron	36.15
150 micron	23.17
75 micron	4.71

Results and Discussion.

Results of various tests are summarized in table 3.

Table 3. Results of Various Tests

S No	Particulars	Observation and Results				
		CL0G0	CL5G0	CL5G10	CL5G20	CL0G30
1	**Compaction Characteristics**					
a)	Optimum Moisture Content (%)	22	16.5	15.4	15.1	14.3
b)	Maximum Dry Density (g/cc)	1.58	1.64	1.72	1.81	1.88
2.	**California Bearing Ratio**	1.7	3.95	4.92	5.74	7.15
3.	**Swelling Characteristics**					
a)	Differential Free Swell (%)	56.6	20	11.10	5.26	4.1

Where,
CL0G0 = BC Soil + 0% Lime +0 % Granite Dust
CL5G0 = BC Soil + 5% Lime + 0% Granite Dust
CL5G10 = BC Soil + 5% Lime + 10% Granite Dust
CL5G20 = BC Soil + 5% Lime + 20% Granite Dust
CL5G30 = BC Soil + 5% Lime + 30% Granite Dust

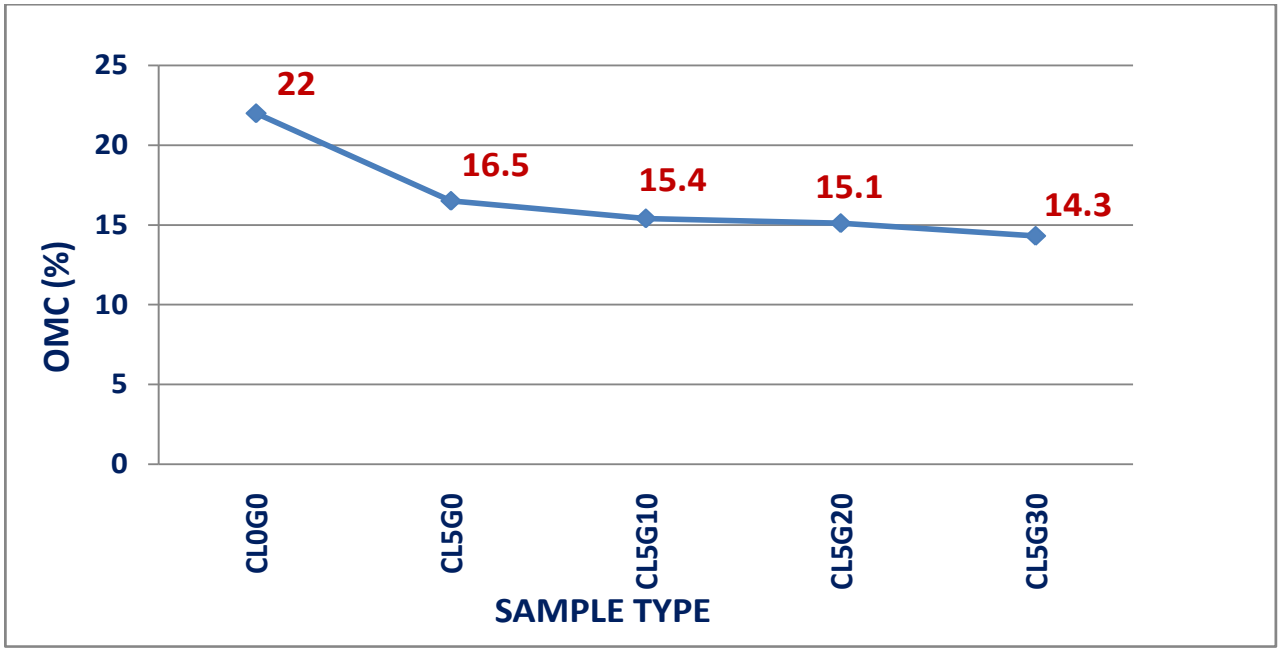

Fig 1. Effect of Granite dust on Optimum Moisture Content

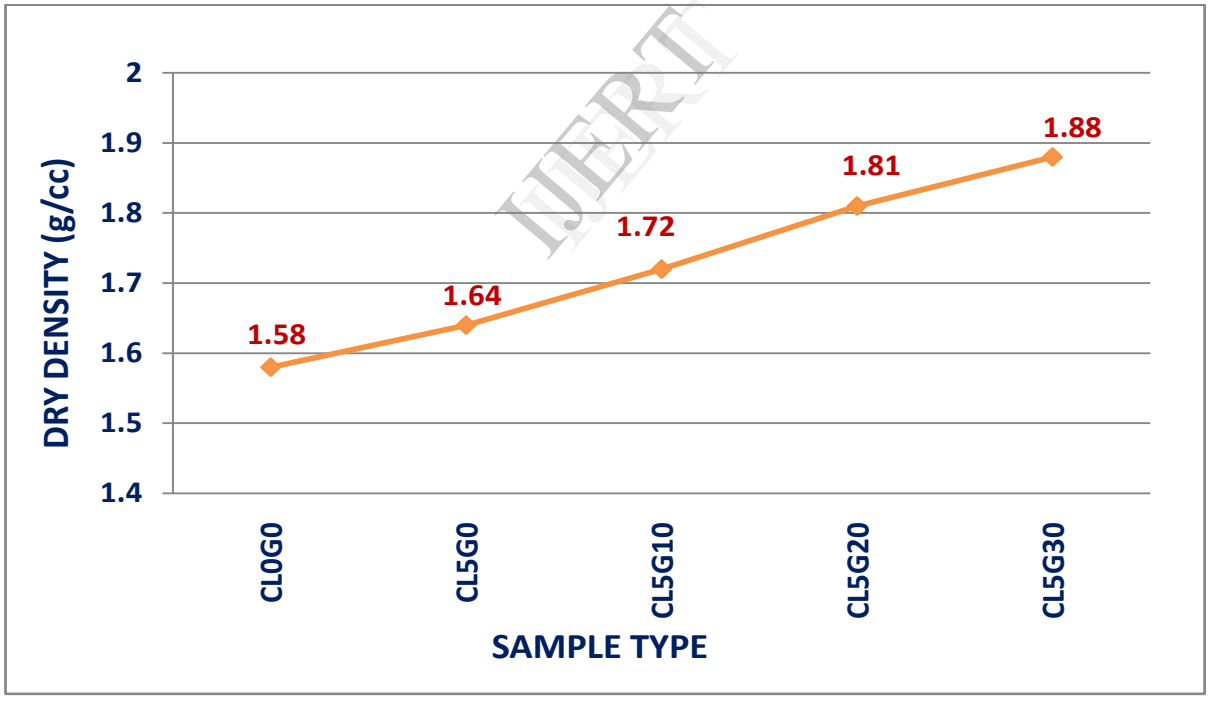

Fig 2. Effect of Granite dust on Maximum Dry Density

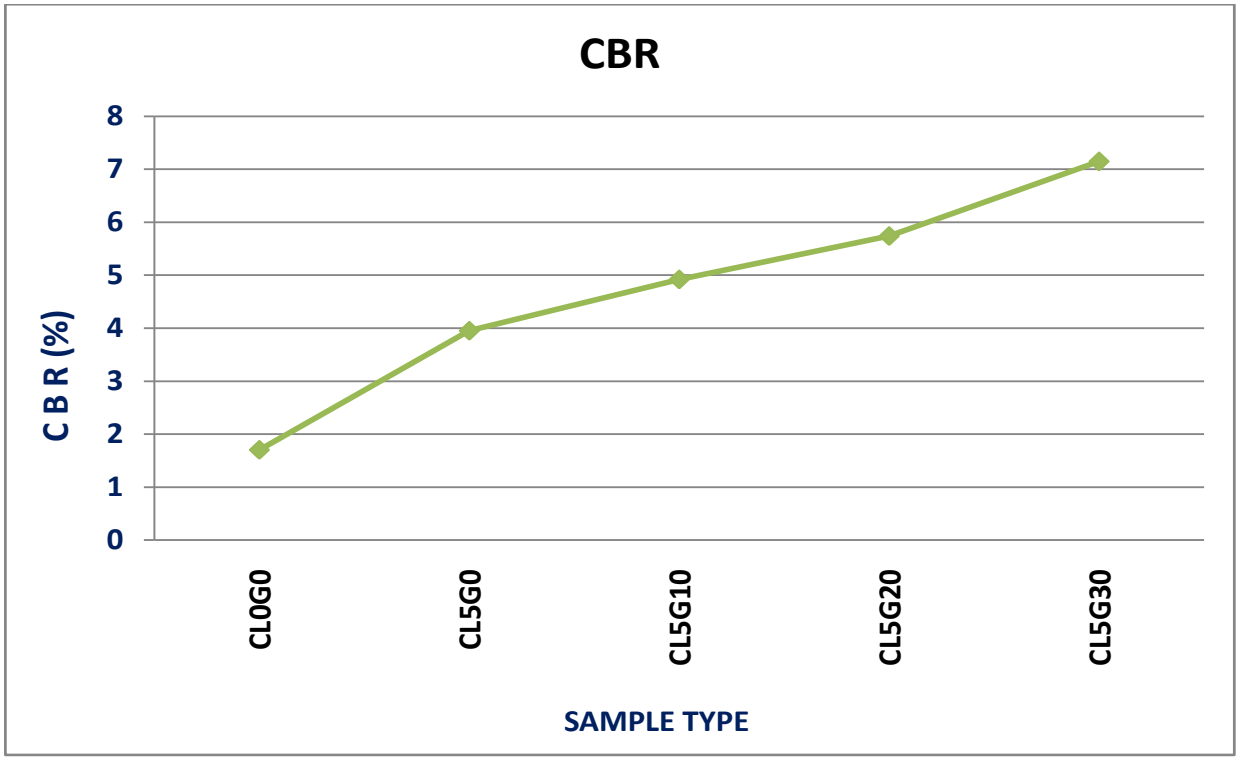

Fig 3. Effect of Granite dust on California Bearing Ratio

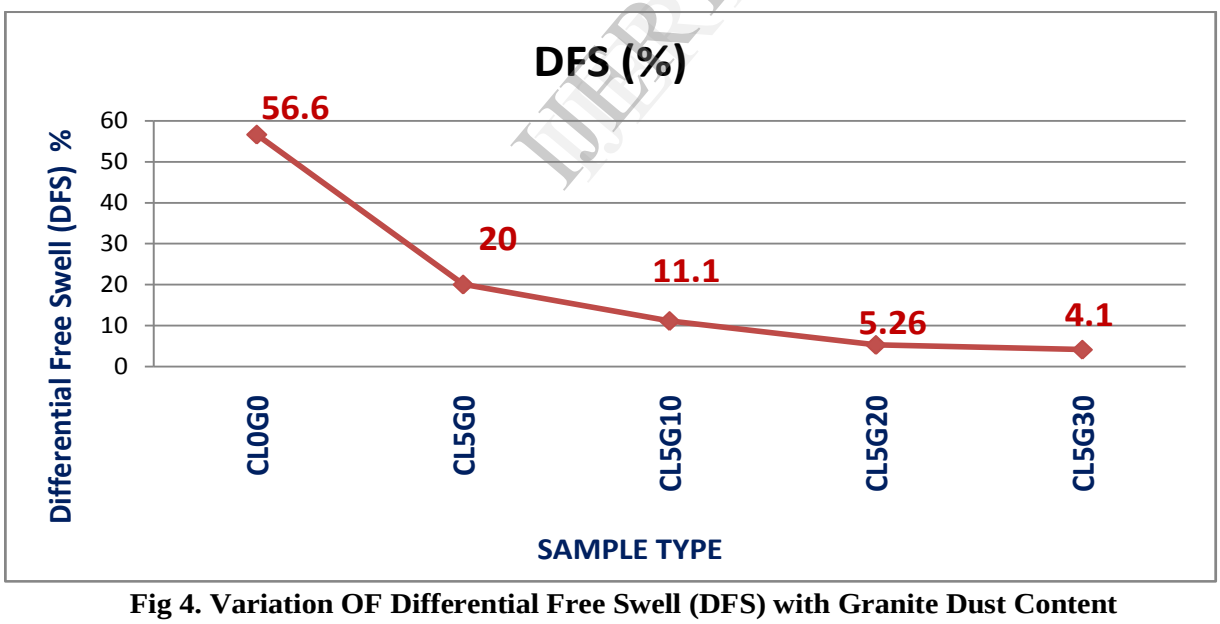

Fig 4. Variation OF Differential Free Swell (DFS) with Granite Dust Content

Conclusions.

The following conclusions can be drawn on the basis of test results obtained from the experimental work conducted on soil samples containing lime stabilised BC soil and granite dust in different proportions.

1. There is a marked reduction in the expansive behaviour of the BC soil mixed with Lime and Granite dust. The differential free swell (DFS) reduces from 56.6% to 4.1%.
2. The lime stabilised B C Soil mixed with different percentage of granite dust has changed the Proctor Compaction parameters. The optimum moisture content has decreased from22% to 14.3% and the maximum dry density has increased from 1.58g/cc to 1.88g/cc with the increase in granite dust content.
3. The addition of granite dust to the lime stabilised BC soil improved the soaked CBR considerably. The addition of 5% lime and 30% granite dustincrease the CBR 1.7% to 7.15%.

From this laboratory investigation it can be concluded that the soft clay like BC soil can be effectively stabilised with the addition of lime and granite dust to check it swelling behaviour and increase the strength and stability characteristics.

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