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UNCONFINED COMPRESSIVE STRENGTH OF STONE DUST TREATED ORGANIC CLAYS

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ABSTRACT: *The paper presents the unconfined compression test results of organic clays from Langol area of Imphal Dist. Manipur, India. The aim of the study is to determine the optimum percentages of stone dust admixture and organic clays by considering the parameters like unconfined compressive strength (q_u) and stiffness or initial modulus of elasticity of soil. The samples were prepared by treating organic clays with different percentages of stone dust from 0 to 25% by dry weight of soil. It is observed that the unconfined compressive strength and initial modulus of elasticity are improved considerably with the addition of stone dust upto 15% by dry weight of soil. Further addition of stone dust beyond 15% shows reduction in strength and initial modulus of elasticity of organic clays. Hence, an optimum proportion of 15% stone dust + 85% organic clays is obtained at which the strength and stiffness of the stabilized organic soil is maximum.*

Keywords: *Organic clays, unconfined compressive strength, stone dust, initial modulus of elasticity.*

INTRODUCTION – I

Organic clays generally consist of organic matters like decomposed leaves, grasses, trunk etc. Since the main component is organic matter, organic clays or peat is very spongy, highly compressible and combustible in characteristics (Roy, 2004). It has been reported that peat or organic soil show unique geotechnical properties in comparison to those of inorganic soils such as clay and sand which are made up of only soil particles (Hashim and Islam, 2008). The physical properties of organic clays are dependent on the four major components which make up the organic soil system; the organic material, the mineral material, water and air. Higher the moisture content and decomposition, the lower is the shear strength; in addition, the higher mineral content causes higher shear strength (Munro, 2005).

Organic soils vary in properties from one deposit to another and from point to point in the same deposit (Huat 2006). Due to the presence of organic matter, the water holding capacity and compressibility of the soil is found to be high whereas the shear strength is low. Hence, such type of soil is not suitable for the construction of load bearing structures. The soil strata in most parts of Imphal invariably have one or more layers of organic clay of different heights at different depths. In Lamphelpat and Langol region, organic clays or peat form the major strata upto 6 to 7 m depth below the ground surface. Rapid infrastructure development in these areas have necessitated to address the high compressibility and low strength issues of these soils and find out suitable improvement and stabilization techniques.

Stone dust is generated a by–product in stone crusher unit in an abundant quantity all over India. Soosan et al. (2001) identified that crusher dust/stone dust exhibits high shear strength and is beneficial as a geotechnical material.

Some of the construction options in organic clay involve excavation–displacement or replacement method, ground reinforcement using pre-loading technique, stone column, piles, thermal pre-compression and pre-load piers (Edil, T.B, 2003). However, those techniques require huge investment cost and efforts. The idea of stabilizing the soil using stone dust is one of the economical methods of ground improvement. The index properties as well as engineering properties of expansive soil such as shear strength parameters (c – Ø) can be improved significantly by adding stone dust (Sabat 2012).

In this paper, an experimental study is made to find the effect of different percentages of stone dust on the unconfined compressive strength of organic clay.

EXPERIMENTAL PROGRAM – II

2.1. MATERIALS USED AND METHOD

2.1.1 Organic Clays:

The organic clay used in the tests was collected from Langol region of Imphal West District, Manipur, India. The organic content of the soil was found by loss on ignition method (ASTM D7348-13). The soils were air dried for few days and pulverized for further laboratory investigations. The properties were determined as per certain relevant code as it is shown in Table 2.1.

Table 2.1 Properties of Organic clays

Sl. No	Property	Value	Remarks
1	Organic content (%)	35.42	ASTM D7348 – 13
2	**Atterberg's Limits**		IS 2720 PART -5 - 1985
	Liquid Limit (LL) %	83.33	
	Plastic Limit (PL) %	70	
	Plasticity Index (PI) %	13.33	
3	**Modified Proctor Test**		IS 2720 PART - 5
	Optimum Moisture Content (OMC) %	35.92	
	Max. Dry Density (MDD) kN/m^3	11.28	
4	Specific Gravity	1.909	IS 2720 PART –3 -1980

2.1.2. Stone Dust admixture:

For the present study, stone dusts were collected from Waithou Stone Crusher, Thoubal District, Manipur. The properties were determined in the laboratory as per relevant codal procedures as shown in the Table 2.2

Table 2.2 Properties of Stone Dust

Sl. No	Property	Value	Remarks
1	**Grain Size Distribution**		IS 2386 Part I – 1963 & IS 383 - 1970
	Coefficient of Uniformity (C_u)	8.33	
	Coefficient of Curvature (C_c)	0.453	
	Fineness modulus	4	
2	Specific Gravity	2.57	IS 2386 Part 3

2.2. PREPARATION OF SAMPLE

The samples were prepared by first dry mixing the soil with the adopted percentages of stone dust (0%, 5%, 10%, 15%, 20%& 25%) by dry weight of soil. Table 2.3 shows the mix of the organic clay and stone dust used in the experiments.

Table 2.3 Work Program

SL No.	Proportion of		Sample
	Organic clay (%)	Stone dust (%)	
1	100	0	SD0
2	95	5	SD5
3	90	10	SD10
4	85	15	SD15
5	80	20	SD20
6	75	25	SD25

The mixture was thoroughly mixed with water equal to 1.25 times the liquid limit in order to ensure complete saturation. This mixture was then poured into a mould of 3.8cm diameter and 12 cm height where it was kept under a consolidation pressure of 88 kPa for 2 days so as to obtain a sample suitable for unconfined compression test as shown in Fig. 2.1(a). The samples were extruded from the mould and trimmed to obtain a sample of dimension 3.8 cm diameter and 7.6 cm height (Fig.2.1 (b)). These samples were subjected to unconfined compression test for carrying out comparative study (Fig. 2.1 (c)).

(a) (b) (c)

Fig. 2.1(a) Sample preparation (b) Extruded sample from the mould (c) Sample subjected to unconfined compression test

Fig. 2.2 Shear Failure of soil sample

2.3 DISCUSSION ON TEST RESULT:

The unconfined compressive strength test were performed on prepared samples as per IS 2720 Part 10.

From Fig. 2.3, it is seen that bulk density (γ) and dry density (γ_d) increases to its maximum value on adding stone dust upto 15% by dry weight of soil. Further addition of stone dust beyond 15% shows decrease in the density. This shows reduction in the inter-particle force of attraction between organic clays and stone dust. Fig.2.4 shows the moisture content of the organic clay with different percentages of stone dust. It can be observed from this figure that the water content decreases from the maximum value for samples without any stone dust upto that with 15 % stone dust. Thereafter the water content increases for samples with stone dust 20% and 25%.The increase in moisture content beyond 15% stone dust indicating the increasing of water holding capacity.

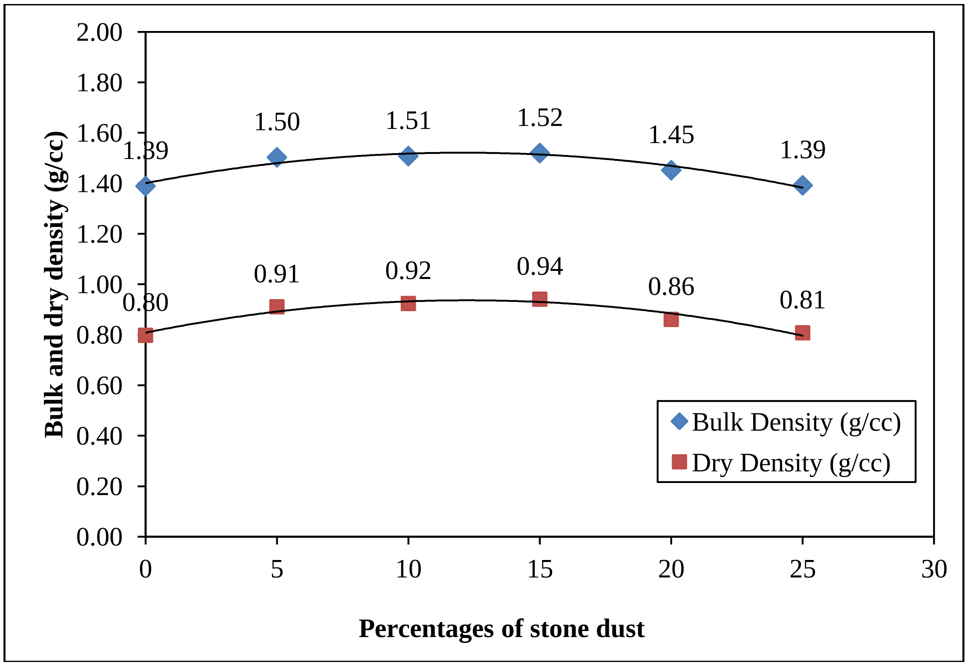

Fig. 2.3 Variation of Bulk density (γ) and Dry density (γ_d) on adding different percentages of stone dust

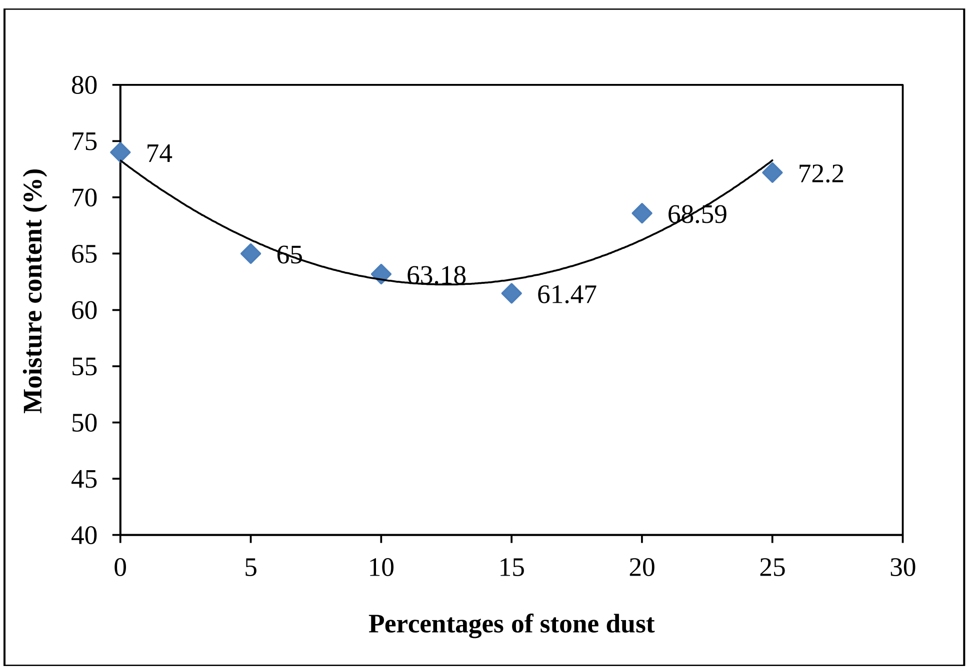

Fig.2.4 Variation of initial moisture content on adding different percentages of stone dust

The stress – strain behaviour of organic clays treated with different percentages of stone dust by dry weight of soil is shown in Fig. 2.5. It is clear from the figure that addition of stone dust in organic clays resulted in a significant increase in unconfined compressive strength (q_u). The unconfined compressive strength increase with addition of different percentages of stone dust follows a similar trend as that followed by the density. The maximum strength is obtained for sample with stone dust percentage of 15%. An increase in initial stiffness can be observed with the addition of stone dust to the organic clay. Fig. 2.7 shows the initial modulus of elasticity of organic clay mixed with different percentages of stone dust. Here too it is observed that the stiffness decreases as the percentage of stone dust increases beyond 15%. The increase n water holding capacity of organic clay and stone dust beyond 15% may be the one of the reasons that the undrained compressive strength (q_u) and stiffness or initial modulus of elasticity decreases.

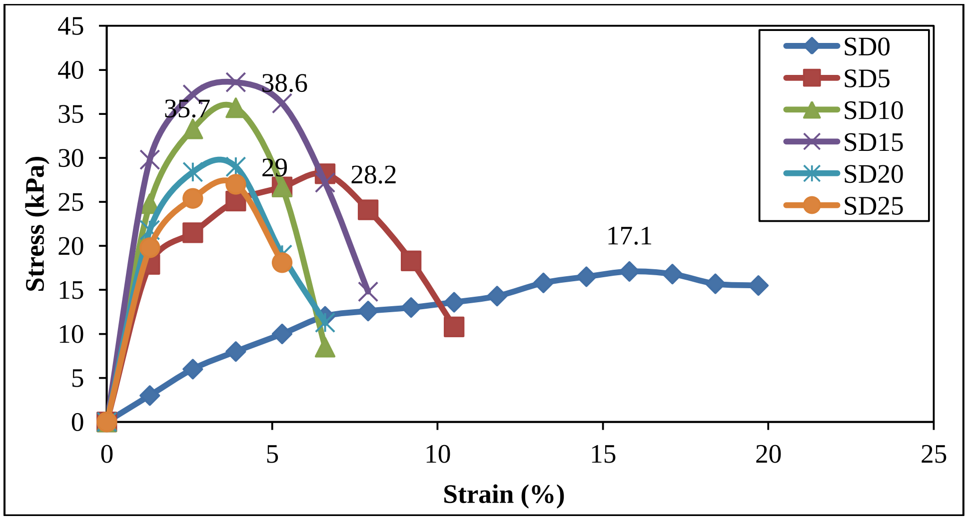

Fig. 2.5 Stress – strain behaviours of organic clays treated with different percentages of stone dust

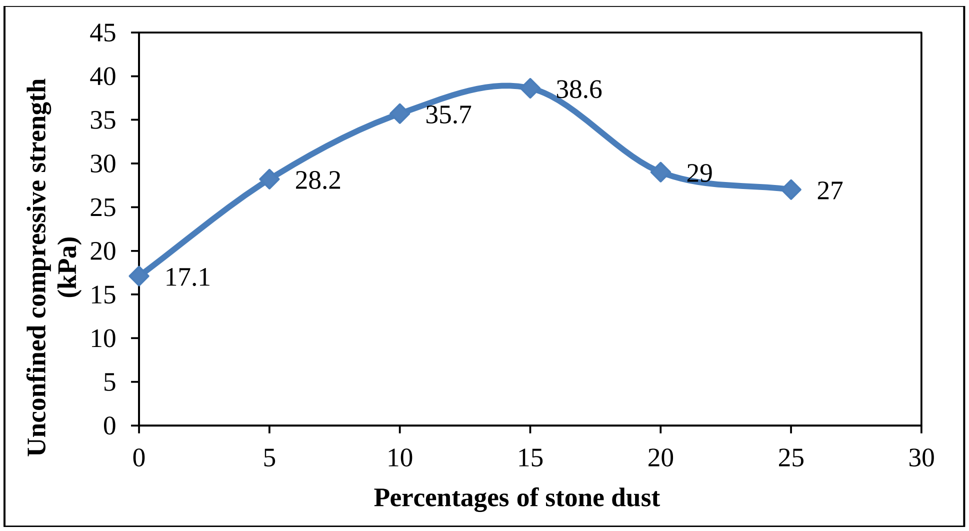

Fig. 2.6 Variation of unconfined compressive strength (q_u) with different percentages of stone dust in organic clay

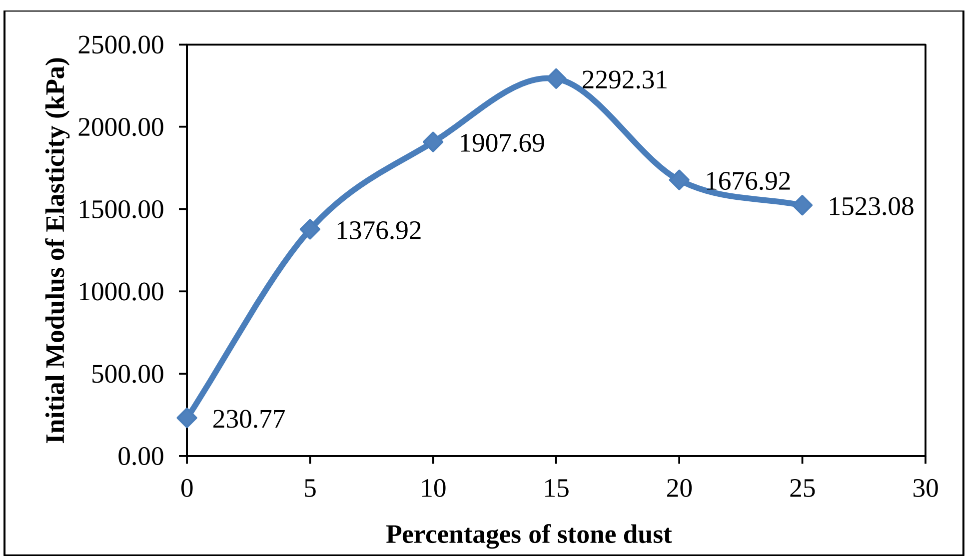

Fig. 2.7 Variation of initial modulus of elasticity with different percentages of stone dust in organic clay

CONCLUSIONS - III

The comparative study on unconfined compressive strength (q_u) of organic clays treated with different percentages of stone dust ranging from 0 – 25% by dry weight of soil were carried out. Based on the test results, the following conclusions can be drawn:

1. The bulk density (γ) and dry density (γ_d) of the soil increases on adding stone dust upto 15% by dry weight of soil. Further addition of stone dust beyond 15% resulted in decrease in the density of organic clays.
2. The moisture content of the sample decreases with the addition of stone dust. However, the moisture content increases on the addition of stone dust percentage beyond 15%.
3. The unconfined compressive strength (q_u) and initial modulus of elasticity (or stiffness) increases significantly on adding stone dust upto 15% by dry weight of soil. Further addition of stone dust beyond 15% by dry weight of soil resulted in decreasing stiffness and q_u. Therefore, an optimum proportion of 85% organic clay + 15% stone dust is found to be effective in the present research work.

Hence, the industrial waste admixture like stone dust which is generated as by-product in stone crusher unit can be utilized effectively in ground improvement techniques.

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