EFFECT OF STRAIN-RATE ON STRENGTH PARAMETERS OF DREDGED MATERIAL FROM DAL LAKE SRINAGAR.

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Abstract:

The shear strength of soil is of special relevance amongst various geotechnical soil properties since it is one of the most essential entities for analyzing and solving different stability problems such as evaluation of earth pressure, bearing capacity of footings and foundations, and slope stability or stability of embankments and earth dams. Shear strength of soil describes the maximum shear stress that a soil can sustain in its incipient failure condition. Strain rate has been found to be one of the prominent factors influencing the shear strength parameters of soil. In the practical world, the soils supporting various structures are subjected to varying strain rates which may be low, intermediate and high .The objective of the current investigation was to study the impact of strain-rate on shear strength parameters (c and ϕ) of dredged soil. Dredged soil is a solid waste generated due to dredging of Dal Lake. The Dal Lake has been the centre of Kashmir civilization and is among the most beautiful National heritages. This lake with its multifaceted eco-system and grandeur has been inviting the attention of national and international tourists. Dredging of the Dal Lake generates the dredged soil in large quantity posing serious disposal and environmental problems all-around the Dal Lake. Concern over environmental effects of dredging, disposal of dredged soil, and the increasing unavailability of suitable disposal sites, has put pressure for characterization of this soil as a resource for various beneficial uses/engineering applications. Hence, using dredged soil has a two-fold advantage. First, to avoid the tremendous environmental problems caused by large scale dumping of dredged soil and second, to help in sustainable development of the world famous lake in the capital City Srinagar. In the current study shear parameters (c and ϕ)were obtained by performing UU triaxial compression tests on three different specimen sizes at three varying strain rates and three confining pressure. It was observed from the test results that shear strength parameters (c and ϕ) increase with an increase in strain rate. It was also observed that the value of shear strength parameters (c and ϕ) is higher for smaller specimen size.

Keywords: **Dredged material, Strain-Rate, Specimen size, Optimum Moisture Content (OMC), C and Φ, Monotonic Triaxial Compression Test.**

1. INTRODUCTION

Soil presents itself to be one of the most ambiguous, uncertain and dubious materials owing to widespread variation of its properties which changes in both spatial and temporal contexts. For design and analysis of any structure supported by soil, the shear strength parameters of the soil are vital and they should be obtained from laboratory and in-situ tests. Since the shear strength parameters are not intrinsic properties of soil, there are a number of factors which affect the estimates obtained from tests, out of which rate of loading or strain rate has been found to be one of the prominent factors influencing the obtained shear strength parameter. The shear strength of soil is of special relevance amongst various geotechnical soil properties and it is one of the most essential entities for analyzing and solving different stability problems such as evaluation of earth pressure, bearing capacity of footings and foundations, earth quick analysis of structures and slope stability or stability of embankments and earth dams. Shear strength of soil describes the maximum shear stress that a soil can sustain in its incipient failure condition. The soil is the weakest of all civil engineering materials and often plays a critical role in the failure of the structures under catastrophic events. Hence, in order for sustainable design of civil engineering facilities against anticipated and rapidly acting unanticipated loads, it is essential that soils subjected to high strain rates are properly characterized and modeled.

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2. MATERIALS

The soil selected for purpose of this study was collected from the Dal basin viz Shalimar area of Jammu and Kashmir. The soil was a dredged material from "Dal'' which is a lake in Srinagar, the summer capital of Jammu and Kashmir. The urban lake, which is the second largest in the state, is integral to tourism and recreation in Kashmir and is named as "jewel in the crown of Kashmir" or "Srinagar's Jewel''. The movement of large volumes of sediment into Dal lake generates dredged material in bulk from various basins. This material can be a valuable resource for many practical purposes. Depending on the type of environment, the excavated material may comprise of gravel, sand , silt or soft clays. On the basis of its characterization, it may be put to various uses such as foundation material, subgrade construction, reclamation, landscaping, agriculture,covers for landfills and constructing wetlands for water quality improvement , bank stabilization , and creation of islands, wildlife habitat wetlands and amongst others.

3. METHODOLOGY

Two series of tests were carried out in this work. The first series of tests aimed at evaluating the physical, index and engineering properties of dredged soil. In the second test series triaxial compression tests under unconsolidated undrained conditions were carried out to evaluate the impact of strain rate on various strength parameters of test soil.Triaxial compression test (UU) performed at confining pressures of 150 kPa, 250kPa and 350kPa at three different strain rates on three different specimen sizes.The triaxial compression test or simply triaxial test, is used for determination of shear characteristics of all types of soils under different drainage conditions. The main principle behind a triaxial shear test is that the stress applied in the vertical direction (axial pressure equivalent to major principal stress) can be different from the stress applied in the horizontal directions (lateral pressure equivalent to minor principal stress). This produces a stress state, which induce shear stress. The shear strength of the material is obtained using a Mohr-Coulomb failure criterion represented by the following mathematical relationship:

$$\tau = c + \sigma_{n\ (\tan\phi\ ).}$$

Where,

τ = shear strength
c = cohesion
σ_n = normal stress acting on failure plane ϕ
= angle of internal friction

4. EXPERIMENTAL RESULTS AND INTERPRETATION

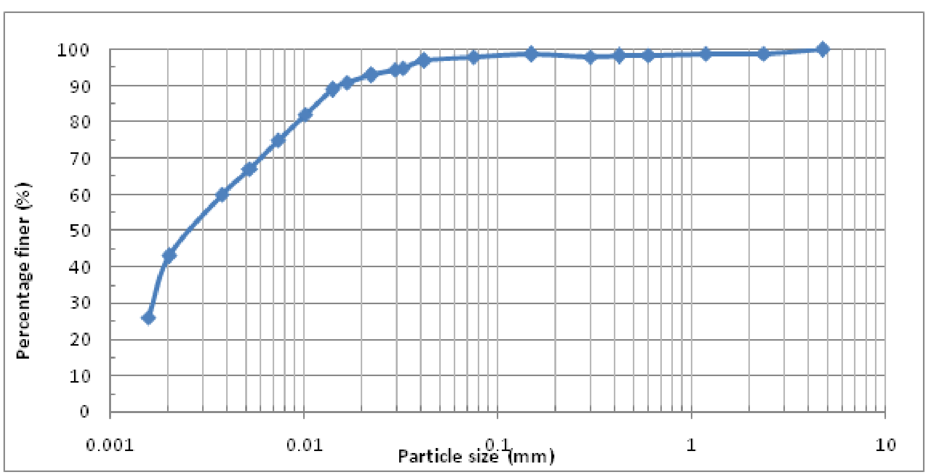

Fig 1 – Particle size distribution curve of the test soil

Table 1- Basic test results of soil sample

Property	Results
Gravel size %	0
Sand size %	2
Silt fraction %	55
Clay fraction %	43
Specific gravity	2.23
Liquid limit (%)	41
Plastic limit (%)	26
Plasticity index (%)	15
Plasticity index A line (%)	15.33
Classification	MI
Color	Grayish brown
OMC (%)	19%
MDD (KN/m^3)	13.92

Influence of strain- rate and specimen size on shear strength parameters

Shear strength of soil is characterized by cohesion (c) and angle of friction (ϕ). The parameters mentioned primarily, define the soil maximum ability to resist shear stress under defined load. The cohesion mobilizes more at high strain rate (6mm/min, in this case) and less at low strain rate (0.24mm/min). In this analysis it is observed that cohesion obtained is higher for smaller specimen (38mm dia) and with increase in specimen size the cohesion decreases. The variation of cohesion is presented in tabular form (Table 2).Figure 2, 3 and 4 shows the variation of shear parameters with strain rate at different specimen sizes 75mm, 50mm and 38mm respectively at OMC respectively.

Table 2: Variation of cohesion (c) with strain –rate and specimen size at optimum moisture content

Strain Rate (mm/min)	Dia of specimen		
	38mm	50 mm	75 mm
	C (kPa)	C (kPa)	C (kPa)
6	45.54	43.27	41.22
1.2	44.24	42.81	39.21
0.24	43.22	38.39	35.35

The influence of strain rate and sample size (diameter) on the friction angle (ϕ) of soil is presented in tabular form (Table 3). It is observed from the table that friction angle (ϕ) increases as the strain rate increases. The friction angle (ϕ) is observed more at high strain rate (6 mm/min, in this case) and less at low strain rate (0.24 mm/min).Again it is observed from the table that friction angle (ϕ) obtained is higher for smaller specimen (38mm dia) and with an increase in specimen size the ϕ decreases.

Table 3: Variation of friction (Φ) with strain –rate and specimen size at optimum moisture content

Strain Rate (mm/min)	Dia of specimen		
	38mm	50 mm	75 mm
	Φ(degree)	Φ(degree)	Φ(degree)
6	22.12	21.43	20.17
1.2	20.76	17.54	16.15
0.24	18.16	15.16	13.28

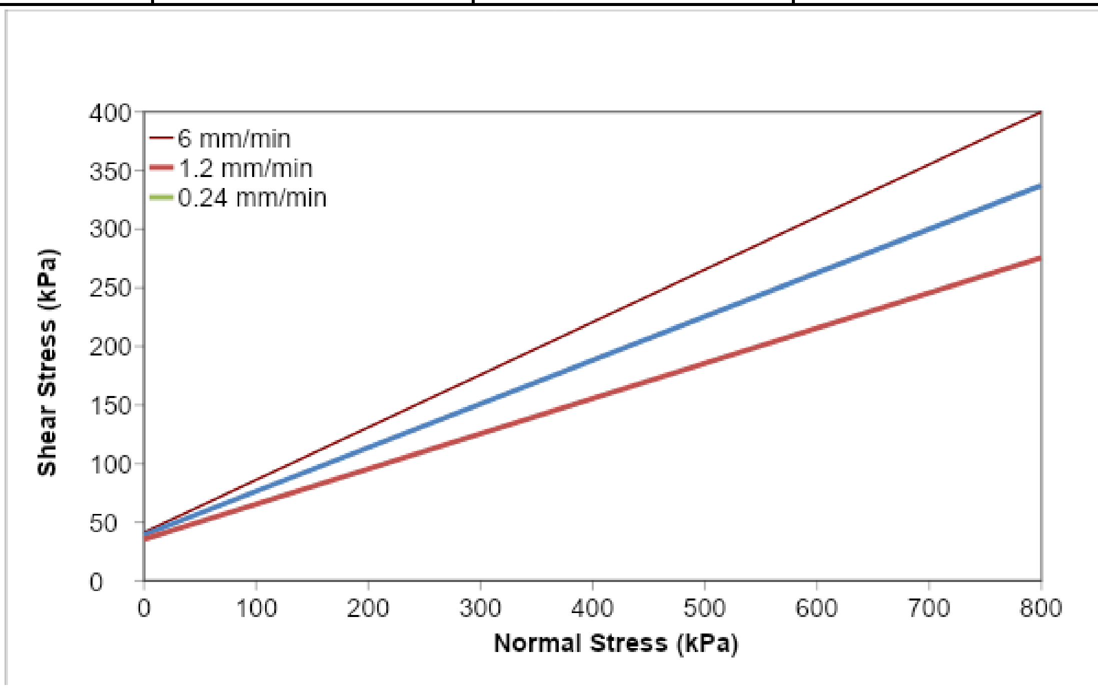

Figure 2: Variation of shear parameters(c & Φ) with strain rate for specimen size 75mm at OMC

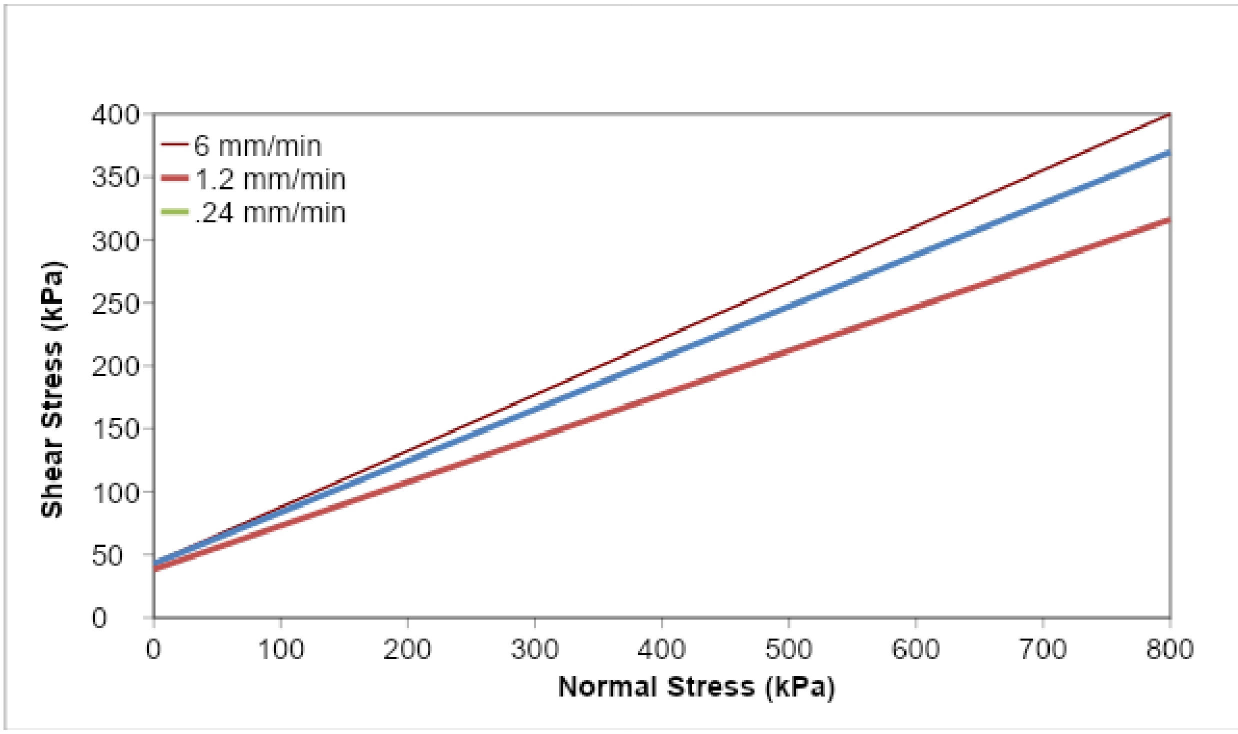

Figure 3 : Variation of shear parameters(c & Φ) with strain rate for specimen size 50mm at OMC

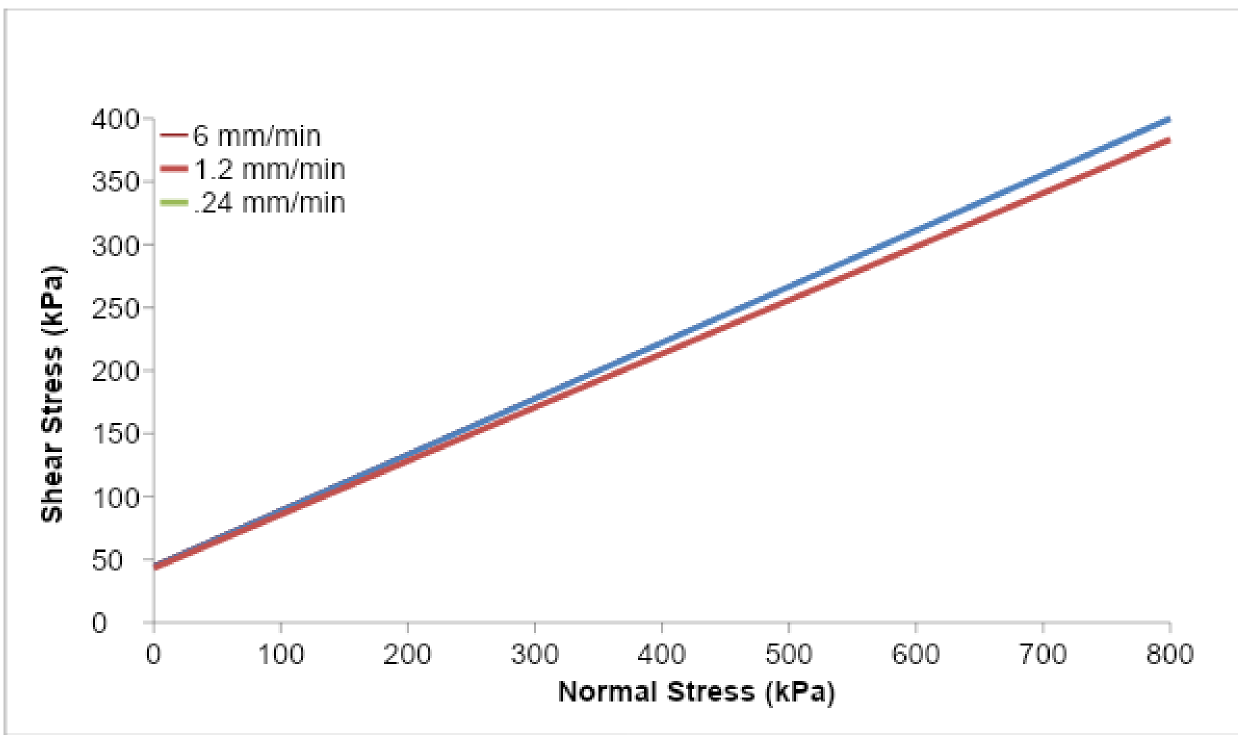

Figure 4: Variation of shear parameters(c & Φ) with strain rate for specimen size 38mm at OMC

5. CONCLUSION

The following conclusions can be drawn from the experimental results:

- On the basis of these tests, it must be concluded that to obtain significant increase in strength it takes a rate of strain equivalent to a fast transient test.

- The cohesion mobilizes more at high strain rate and less at low strain rate.
- Friction angle is observed more at high strain rate.
- Cohesion and friction angle obtained is higher for smaller samples.

REFERENCES

1. Casagrande, A. and Shannon, W.L. (1948). "*Research on Stress-Deformation and Strength Characteristics of soils and Soft Rocks under Transient Loading*". Publ. Graduate School of Engg. Harvard Univ., Soil Mechanics. Series, No. 31.
2. Delon Hempton, Mun, Mc Carty (1958) "*Effect of strain rate on the shear strength of remolded soils*"
3. J.V.Stafford and D.W.Tanner; "*Effect of rate on soil shear strength and soil metal friction".* Proceedings, American society for testing materials, Vol. 36, Part 2, 1936, p. 380-392.
4. Lee, E.L. and C.M. Tarver (1980). "*Phenomenological model of shock initiation heterogeneous explosives*". Physics of fluids 23:2362.
5. Seed, H.B., and Lundgren, R (1954). *"Investigation of the effect of transient loadings on the strength and deformation characteristics of saturated sands".*
6. Whitman, R.V., and Healy, K.A. (1962). "*Shear strength of sands during rapid loading. Journal of the soil mechanics and foundation division",* Proceedings of the American Society of Civil Engineers, 88(SM2), 99-132.
7. Yamamuro, J.A., Abrantes, A.E., Lade, P.V. (2011). "*Effect of strain rate on stress strain behavior of sand".* American society of civil engineering.
8. Ngo., Mendis, P., Gupta, A. and Ramsey, J (2007). "*Blast loading and blast effects on structures"* – an overview. Electronic Journal of Structural Engineering Special Issue: Loading on Structures, 79-91.
9. New Gatun Locks Black Muck Slope Design, Special Engineering Division, The Panama Canal, October 1942.
10. Fillipo, J. M., Hefiner, R.E and Weber, JA: "*Dynamic soil parameters from unconfined compression rate".*
11. Arindem dey ,Yamaramu, Ramagopala. "*Effect of strain rate on the shear parameters of soil".* Importance of free ends in triaxial testing. ASCE journal of the soil mechanics and foundations and Performance of soft deposits, 147-152