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**A Dissertation report
On**

**EFFECT OF GRADING AND PROPORTIONING OF
SAND ON THE COMPACTION PROPERTIES AND
SHEAR STRENGTH OF SAND-CLAY MIXTURES**

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BY

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ABSTRACT

In contrast to the clean sands the behaviour of sand with fines has complexities that have made it difficult for researchers to reach a general framework for their evaluation and this problem exists even today for researchers. The shear strength of soils is an important aspect in many foundation engineering problems such as the bearing capacity of shallow foundations and piles, the stability of the slopes of dams and embankments, and lateral earth pressure on retaining walls. Geotechnical parameters required for design of structures on soil have been developed for ideal soils such as pure sands or pure clays which are rarely found in nature. Natural soils do contain a mixture of clay and sand in different proportions and also of different gradation; hence attempts are being made by various researchers to study the properties of clay-sand mixtures for understanding their behavior, so as to apply them for practical applications. However, in a sand-clay mixture, it is quite difficult to establish the characteristics of the soil, since it possesses both the properties of sand and clay. Not only the proportion of sand, but also the gradation of sand will influence the behavior of clay-sand mixtures. This aspect of gradation of sand has not been attempted in a comprehensive manner in any of the past studies.

It is also well reported in the literature that clay mineralogy also affects the shear strength of soils. Onshore natural soils do contain two types of principal clay minerals, namely kaolinite and montmorillonite, and their presence in soils would have quite different shear strength behavior because it is reportedly found to have diverse engineering behavior.

The main objective of this study is to determine the effect of grading and proportion of sand on the compaction properties and shear strength of the sand-clay mixtures and also to understand the role of clay mineralogy influencing the behavior of sand-clay mixtures. In this study, the effect of gradation of sand used (fine sand / medium sand / coarse sand) in the clay-sand mixtures has been investigated for various index properties, compaction characteristic (Maximum dry density and Optimum moisture content) and stress-strain behavior. This was done with an intention of having a practical application, which would make it easier for engineers to design better earthen levees, embankment dams, and containment barrier systems that utilize these mixtures in their construction and have relatively better performing and stable

material. The test results that are presented herein also provide useful insight into the fundamental principles of soil behavior that affect the mechanical behavior of clay-sand mixtures.

To understand the above effect, two extreme commercially available clay minerals namely kaolinite and montmorillonite were selected. Sieved river sand of three series namely, Coarse sand, Medium sand and Fine sand was mixed separately to kaolinite and bentonite in a controlled way by varying its proportion from 10 to 80% by weight, in increments of 10%, and both the physical properties & engineering properties (Compaction and Shear strength) are evaluated. The same set of experiments was repeated to Red earth and Black cotton in order to understand the role of clay mineralogy, the influence of sand gradation on clay and interaction of sand in clay matrix.

Results from this study indicates that, in clay-sand mixtures of given clay composition, strength increases with increasing coarseness of sand mixed with clay. For a given percentage of sand with increase in gradation of sand, the optimum moisture content reduces and maximum dry density increases. The compaction characteristics of clay-sand mixtures show a better correlation with plastic limit rather than liquid limit or plasticity index. This observation with sand-clay mixtures is in similar line of observation as well reported in the literature by Nagaraj (2000) and Sridharan and Nagaraj (2004) for natural fine-grained soils. Addition of sand with montmorillonitic type of clay would prove to be beneficial to improve the undrained strength of the clay to be suitable for practical applications. Selection of grade of sand can be done based on the level of improvement in strength that is desired. Higher is the desired improvement of strength of soil, coarser the grade of sand should be used. However when similar type of addition of sand to kaolinitic type clay is to be done to find improvement in the strength, then one has to be cautious in using the intermediate grade. The improvement in peak strength at reduced strain level by addition of sand with clay would have beneficial application like increasing the load carrying capacity of sub-grade soils and improved stability of embankments.