Chapter 1

INTRODUCTION

1.1 GENERAL

In most of the construction activities taking place on this earth, the superimposed loads, static or dynamic, finally get transferred to the geological formations beneath them, soil being one of the two widely encountered geological formations. As a consequence of this load transference, the soil beneath will experience densification. This densification may be achieved through many ways such as compaction and consolidation.

The compaction is a mechanical process in which the densification is achieved through the expulsion of air voids at almost constant water content of the soil mass. However, densification through consolidation is primarily attributed to the gradual expulsion of pore water from the voids of the soil mass undergoing consolidation and to the increase in the effective stress on the soil mass. While the compaction is relatively an instantaneous process, consolidation is a time dependent process. Soils in the field exist in different states varying from very soft to stiff. It can be in a normally consolidated state or over consolidated state or in an under consolidated state. The study of consolidation behaviour of soils is a fascinating topic in the field of geotechnical engineering research. Even though consolidation appears to be a simple process of transference of the excess pore water pressure induced due to external loading on the soil mass effectively to the soil solids, it is not so in reality. It is a highly complex process, which can be attributed to the very complex nature of soils, particularly of fine-grained soils.

Fine-grained soils predominately comprise of sands, silts and clay size fractions. The fine fractions of soils are normally composed of clay minerals, which form the active components of fine-grained soils. While the kaolinite is the least active clay mineral, montmorillonite is the most active clay mineral. The behaviour of other clay minerals occupy the intermediate positions. Natural fine-grained soils are mixtures of these clay minerals along with the non-clay minerals as well.
The behaviour of any field soil under the influence of an external input is a function of the clay mineralogical composition of the soil and also of the response of these clay minerals to the external input to the soil mass.

Studies on liquid limit behaviour of fine-grained soils (Sridharan and Venkatappa Rao, 1975; Sridharan et al., 1986a; Sridharan et al., 1988), free swell behaviour of fine-grained soils (Sridharan et al., 1985; Sridharan et al., 1986b), volume change behaviour of fine-grained soils (Sridharan and Venkatappa Rao, 1973; Rao and Sridharan, 1985; Sathyanarayananamurthy, 1986), settling behaviour of fine-grained soils (Sridharan and Prakash, 1999a), undrained shear strength behaviour of fine-grained soils (Sridharan and Prakash, 1999b) clearly demonstrate the contradictory behaviour of kaolinitic and montmorillonitic soils under a given set of testing condition. The quite opposite behaviour of two soils having these extreme clay mineralogical composition can be attributed to altogether different controlling mechanisms (Sridharan, 1991; Sridharan and Prakash, 2000).

All construction activities, which involve loading the subsoil, require the subsoil to be in a compacted state for better performance of the structures founded on soils. Activities such as construction of embankments, pavements – highway, railway and airfield pavements, earthen dams, preparation of the subsoil to receive the superimposed structural loads, reclamation of waste and marginal lands and the like involve compaction of soils. These studies must take into account the effect of clay mineralogical composition also to meet the reality.

From the above discussion, it may be inferred that it is of practical significance to study the consolidation behaviour of compacted fine-grained soils, with particular reference to the effect of soil clay mineralogy on consolidation properties of soils.

1.2 ORGANISATION OF THE PRESENTATION

The present experimental investigation and its outcome are presented in the following format.

The detailed review of the literature regarding the compaction process & the controlling mechanisms, various consolidation characteristics, which are of practical significance & their determination procedures and the effect of different
placement conditions on the consolidation characteristics of compacted soils is presented in the second chapter. The scope of the present experimental work, which has been arrived at as a consequence of this literature review, has also been defined in the same chapter.

Third Chapter presents, in detail, the experimental programme envisaged. This includes the description of various types of soils used in this work – both natural soils & commercial clays and preparation of such soils for the experimental work. The details of a properly planned and executed experimental programme are also discussed in the same chapter.

Fourth chapter presents the results obtained in the present experimental investigation on the compaction characteristics of swelling and non-swelling soils.

Fifth chapter presents the results obtained from the present experimental investigation on the consolidation behaviour of compacted swelling and non-swelling soils, and a detailed discussion on compressibility / consolidation characteristics such as preconsolidation stress, compression index and coefficient of consolidation.

The permeability characteristics of compacted swelling and non-swelling soils are presented in the sixth chapter. This chapter also discusses the validity of Darcy’s law as applied to the compacted soils.

In essence, the thesis deals with compaction, consolidation / compressibility and permeability behaviour of compacted fine-grained swelling and non-swelling soils.

The summary of various observations and discussions made during the present experimental work and the concluding remarks form the seventh chapter.