# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

The surface of the earth is covered by soil, which is derived from rocks by the process of weathering. Soils thus derived, never possess unique properties because rocks are composed of different minerals. The variation in the composition of minerals, rock type and the environment that prevailed during weathering (physical, chemical and biological action) impart variation in physical and chemical properties of the soils. Some soil deposits contain organic matter because a major part of their formation is derived from plants and animals. Determination of the index properties of soils and identification of organic soils are very much important for engineering practice for deriving suitable foundation for various engineering structures. This thesis is concerned with the study of the index properties of soils using hyperspectral radiometry.

## 1.2 DEFINITION OF THE PROBLEM

In geotechnical engineering, the index properties (soil texture, water content, density and Atterberg limits), organic matter content and mineralogy play a major role in understanding the behaviour of the soils. The strength properties of soil are governed by these index properties. The index properties of soils can be determined by simple laboratory experiments. The conventional methods of determining soil index properties have a few limitations, such as difficulty in extraction of representative samples,

availability of limited number of samples, difficulty in preservation of samples, etc. Further, the conventional methods require more time and in practice only a few soil samples can be collected when analysing large areas. In addition, certain soil properties such as moisture content, organic matter content etc. will change from season to season.

## 1.3 NEED FOR THE STUDY

Engineering projects require geotechnical properties of soil (stresses, compressibility, and permeability) deposits of the project area to understand its behaviour and to analyse its suitability. Those properties are influenced by index properties. In engineering projects, cost, time and other few constraints restrict the determination of full site (soil properties) information. When the conventional methods give the soil properties, we can opt for a new technology like remote sensing. Remote sensing may give information about the soils indirectly. It involves less time and it can give information on certain soil index properties precisely. Hyperspectral radiometry is a tool that can be more effective to extract information of soil index properties. Hence, there is a need to develop an approach that uses hyperspectral radiometry for soil studies.

## 1.4 HYPERSPECTRAL REMOTE SENSING

The science of spectral remote sensing is based on taking a portion of the electromagnetic spectrum and breaking it into pieces for the purpose of analytical computations. Emissivity and reflectivity are two of the fundamental physics principles that govern hyperspectral remote sensing (Borengasser et al 2008). In this study, a spectro-radiometer was used and the spectral signatures of various soils were obtained. The spectral curves (spectra) are governed by soil index properties. The analysis of hyperspectral signature curves gives information on certain soil index properties with good

accuracy. Hyperspectral remote sensing gives more accurate reflection results than the multispectral remote sensing (George Joseph 2004). The reflection or absorption of the electromagnetic radiation (EMR) from a material of interest depends on the nature of the material and wavelength of the EM radiation. While multispectral remote sensing is used to identify the material, hyperspectral remote sensing is used to quantify the abundance of the material. Hence, hyperspectral remote sensing may be used to quantify the soil properties.

## 1.5 AIM

To evaluate the potential of hyperspectral radiometry in estimating the index properties (texture, water content, density, liquid limit, mineralogy and organic content) of soils.

## 1.6 OBJECTIVES

The objectives of the study are:

1. To understand the concept of hyperspectral radiometry and the reflectance properties of soils.
2. To examine the possibility of estimating some of the index properties of soils from their hyperspectral signatures.
3. To examine the relationship between certain index properties and the hyperspectral signatures.

## 1.7 OUTLINE OF THE THESIS

This study involves the hyperspectral study for determining soil properties. The spectrometer used here under laboratory condition. The reflection from soil with respect to wavelength is spectral signature / spectra.

This spectra depends on soil properties such as colour, texture, moisture, minerals present in the soil and organic matter. The spectral curve analysis by identifying suitable parameters from the curves gives the effective results.

Chapter 1 of the thesis describes the basic properties of soils, fundamentals of hyperspectral remote sensing and the need for hyperspectral radiometry to study the index properties of soils. The objectives of the study are also listed in the introduction chapter.

Chapter 2 deals with the determination of soil properties using the conventional methods, remote sensing applications to soil studies, application of hyperspectral remote sensing for estimation of certain soil properties, laboratory based spectral studies on soils and its current status with the support of existing literature.

In chapter 3, the methodology adopted and a description on the experimental set up are included. Standardization of the instrument, sample preparation, the procedure of obtaining spectra, spectral curve analysis and modelling are also presented in this chapter. The design of the experimental setup and the other aspects related to field and laboratory are also described in this chapter. Though the chapter provides only an outline of the methodology, the sections corresponding to the experiments contain an elaborate account of the methodology.

Chapter 4 presents and discusses the spectra obtained for each distinct property of the soils tested. The procedure of quantification (soil texture, water content, organic matter, minerals, clay content, soil colour and density) is based on the analysis of the spectral curves. Finally variation in the spectra due to more soil properties is illustrated from the analysis. The analytical and modelling part is also discussed.

The last chapter (chapter 5) discusses the results of the chapter 4. This chapter gives the suitable wavelength regions, spectral parameters for determining each soil property and the spectral regions which are highly governed by soil properties and it lists the conclusions of the thesis.