Chapter 5. Laboratory Measurements

5.1 Bulk Density

Undisturbed core samples of 73 mm diameter and 64 mm height were weighed and oven dried for 48 hours at 105°C temperature. Dry bulk density is the mass of unit volume of oven-dry soil.

5.2 Antecedent Water Content

Gravimetric antecedent water content was determined from the wet and oven-dry weights of undisturbed core samples of 73 mm diameter and 64 mm height. Volumetric water content was determined by multiplying gravimetric water content with bulk density.

5.3 Soil Water Retention Characteristic

Undisturbed core samples (73 mm diameter x 64 mm height; and 73 mm diameter x 31 mm height) were taken from both Horizons A and B1 at each sampling location for measurement of soil water retention characteristics in the laboratory. The soil water contents at 0, 10, 60 and 1500 kPa soil matric suction were measured to determine the soil water capacities of all soil samples. On some soils, water contents were measured at 0, 1, 5, 8, 10, 60, 80, 200 and 1500 kPa matric suctions to determine the detailed water release curve of drying soil.

Photo 5.1 Saturation of Soil Core by Capillary Flow

Soil water that is in equilibrium with free water is by definition at zero soil matric suction or saturation. Soil cores were placed on a sand bath for six weeks to reach saturation water content slowly by capillary flow from the bottom of cores (Photo 5.1). Soil cores were weighed when they achieved saturation.

Ceramic suction plates were used to measure water content at soil matric suction in the range of 10 kPa to 80 kPa. A bubble tower apparatus was used for adjusting water suction (Photo 5.2). Attainment of equilibrium with applied suction was judged by regularly measuring the outflow of water until outflow ceased or became minimal. Soil cores were weighed after attaining equilibrium with applied soil matric suction of 10 kPa, placed back on the ceramic plate and allowed to equilibrate with next desired soil suction. Soil samples were weighed and gravimetric water content was determined.

Photo 5.2 Bubble Tower Apparatus

A pressure plate extractor was used for a soil matric suction range of 200 kPa to 1500 kPa. The pressure extractor accommodated several soil samples which were in contact with a porous ceramic plate. Once the extractor was sealed, an air pressure was applied to the air space above the samples, and water moved downward from the samples through the plate for collection in a measuring bottle. Attainment of equilibrium was judged when outflow of water ceased or became minimal, which generally took 6 weeks. The samples were then removed, and water content was determined gravimetrically.

Photo 5.3 Pressure Plate Extractor Apparatus

5.4 Soil Texture

(1) Particle Size Distribution

Particle size analysis was carried out using a hydrometer method (Gee & Bauder, 1986), which allows for non-destructive sampling of suspensions undergoing settling. By taking multiple measurements of suspension density, detailed particle size distributions can be obtained. An ASTM 152H hydrometer with Bouyoucos scale in g/L was used for particle size analysis. The hydrometer readings (R) were taken at 0.5, 1, 3, 10, 30, 60, 90, 120, and 1440 minutes. A Hydrometer reading (R_L) in a blank solution was used to correct hydrometer readings ($C=R-R_L$). Summation percentage (P) for a given time interval is C/C_o x 100, where C_o is the oven-dried weight of the soil sample. Mean particle size (X) in μm at these times (t) is determined using the following equations.

Photo 5.4 Hydrometer Measurement for Texture Analysis

$X = \theta\, t^{-1/2}$

where sediment parameter θ is expressed as

$\theta = 1000\,(B\,h)^{1/2}$

where $B = 30\,\eta / [g\,(\rho_s - \rho_l)]$, and $h = -\,0.164\,R + 16.3$ and with each term expressed in the following units.

θ= sedimentation parameter, μm min ^{½}
h = effective hydrometer depth, cm,
η = fluid viscosity,g $cm^{-1}\ s^{-1}$,
g = gravitational constant, cm/s^2,
ρ_s = soil particle density, g/cm^3,
ρ_l = solution density, g/cm^3.

A summation percentage curve (P vs log X) was plotted for the hydrometer reading taken over time from 0.5 to 1440 minutes.

(2) Soil Texture Classification

Sand, silt and clay percentage were determined from this curve according to the USDA and ISSS /Australian soil textural classifications (Minasny et al., 2001), which is presented in Table 5.1.

Table 5.1 Soil Textural Classification

	Particle Size Limits	
	USDA/FAO	Australian/ISSS
Clay	< 2 µm	< 2 µm
Silt	2 - 50 µm	2-20 µm
Sand	50-2000 µm	20-2000 µm

Similarly, there are two soil texture triangles available for soil texture classification, USDA Texture Triangle and the ISSS/Australian Texture Triangle. These triangles were used to determine the soil texture based on percentage of clay and sand and are shown in Figure 5.1 and 5.2.

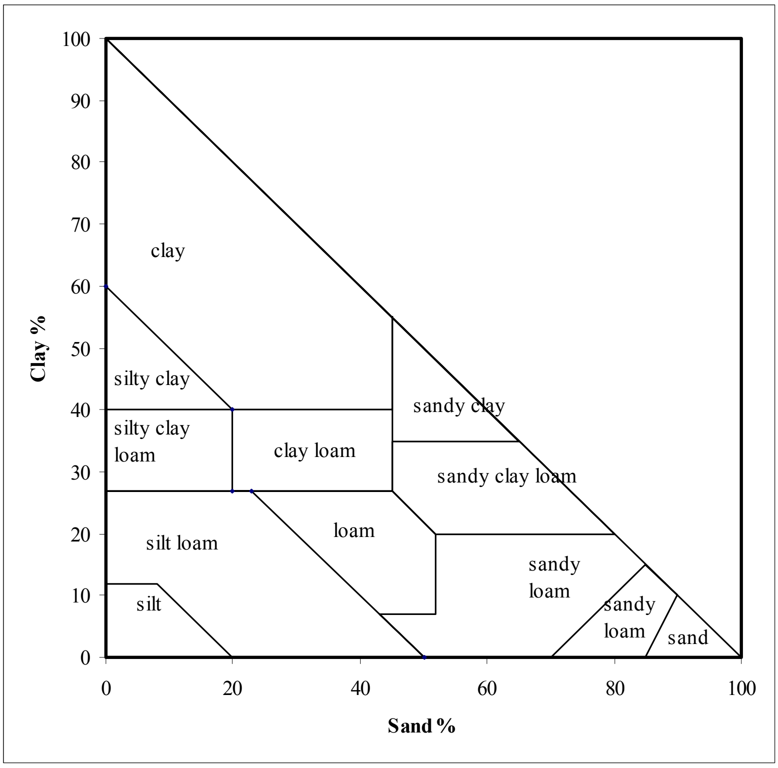

Figure 5.1 USDA Soil Texture Classification Triangle

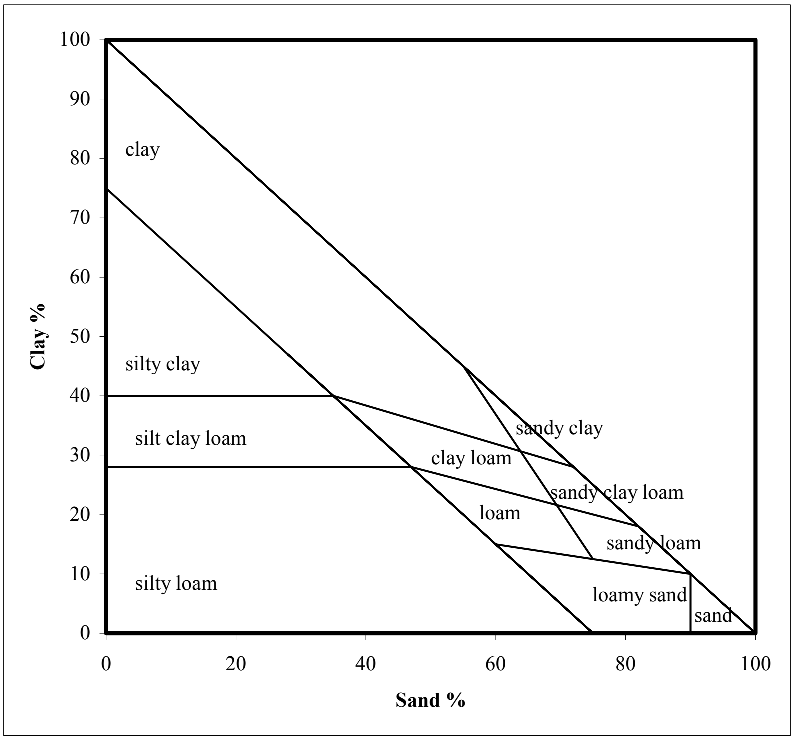

Figure 5.2 Australian Soil Texture Classification Triangle

5.5 Soil Chemical Properties

Bulk soil samples were air dried for several days, then crushed and sifted through a 2 mm sieve. The sifted soil samples were sent to DPI Werribee Centre for chemical analysis. The soil samples were analysed for exchangeable cations Ca, Mg, Na, K, organic matter, soil EC and soil pH. Soil EC and pH were determined first in a 1:5 soil water suspension and based on these results, the appropriate method for determination of exchangeable cations was selected.

5.6 Data Analysis

Statistical parameters such as mean, standard deviation (Std.), and 25, 50 and 75 percentile values of measured data were calculated for each soil group. These parameters were also determined for those soil types which had four or more measured data. Statistical software GenStat version 6 was used for the statistical analysis of measured data sets. Linear interpolation was used to determine percentile values of a soil parameter (X) having a few measured data, after sorting the Xs from smallest to largest.