6.3 Core Cutter Method

6.3.1 Introduction. This method is only used on fine-grained cohesive soils which do not contain stones. It is, therefore, very useful for control of earthworks and subgrade materials but is not suitable for coarse grained pavement materials. The test involves jacking or hammering a steel cylinder of known mass and volume into the soil, excavating it and finding the mass of soil contained in the cylinder.

6.3.2 Apparatus. The following apparatus is required for the test :

a) *Cylindrical steel core cutter.* 130 mm long and of 100±2 mm internal diameter, with a wall thickness of 3mm beveled at one end, of the type illustrated in Figure 6.3.1. The cutter shall be kept lightly greased.

Note. If the average density over a smaller depth is required, then the appropriate length of cutter should be used.

b) *Steel dolly*, 25 mm high and of 100 mm internal diameter, with a wall thickness of 5mm, fitted with a lip to enable it to be located on top of the core cutter (see figure 6.3.1).
c) *Steel rammer.*
d) *Balance*, readable to 1 g.
e) *Palette knife*, a convenient size is one having a blade approximately 200 mm long and 30 mm wide.
f) *Steel rule*, graduated to 0.5 mm.
g) *Short-handled hoe*, or spade, and pickaxe.
h) *Straightedge*, e.g. a steel strip about 300 mm long 25 mm wide and 3 mm thick, with one beveled edge.
i) *Apparatus for moisture content determination*.
j) *Apparatus for extracting samples from the cutter (optional)*.

6.3.2 Care and preparation of apparatus

6.3.2.1 Care of apparatus. The condition of the cutting edge should be frequently checked as any damage will lead to inaccuracy in the test. A badly damaged edge may be re-formed on a lathe taking care to cut the new edge square to the long axis of the mould. Any repair to the cutting edge will require the mould factor to be re-determined.

6.3.3.2 Preparation of apparatus

a) Calculate the internal volume of the core cutter in cubic centimetres from its dimensions which shall be measured to the nearest 0.5 mm (V_c).
b) Weigh the cutter to the nearest 1 g (m_c).
c) Mould factor, To assist in the calculation of the bulk density of the soil it can be useful to calculate a mould factor for each cutter, and to stamp or paint the value on the mould. For the size of core cutter detailed above, the mould factor ratio $\frac{F}{H}$ calculates as 0.979. This value would be used as a multiplier for the mass of wet soil in the core cutter (in g).

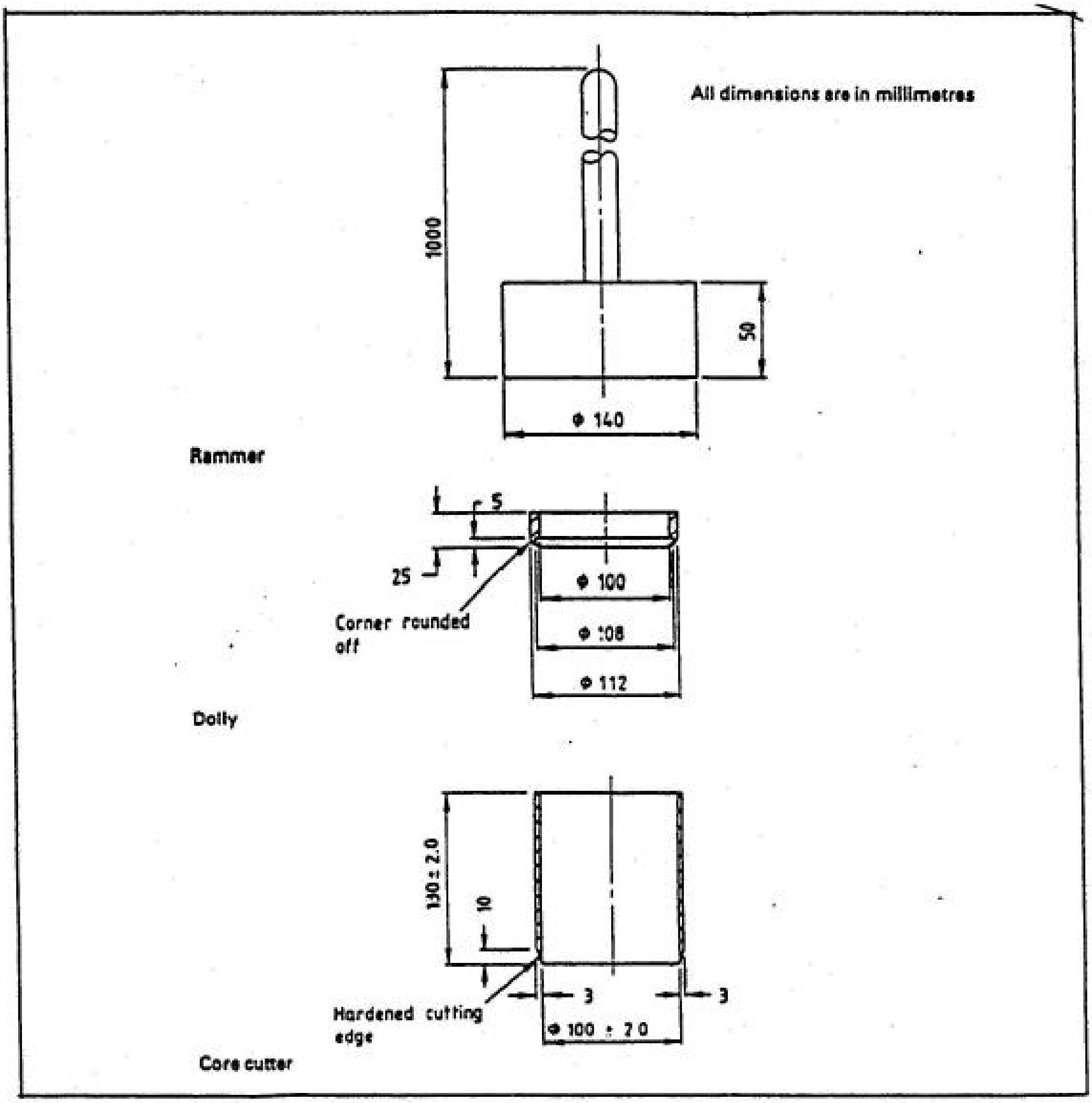

Figure 6.3.1 Core cutter apparatus for soil density determination

Alternatively, a mould factor can be calculated as :

Mould Factor $$F = \frac{p}{4} \text{ x } \frac{D^2 \text{ x } H}{(1000)^3} \text{ x } (1000)$$

$$F = 0.7854 \text{ x } \frac{D^2 \text{ x } H}{(1000)^2}$$

Where,
D is the diameter of the mould in mm.
H is the height of the mould in mm.

The value obtained from this calculation is used as a divisor to the mass of wet soil in the core cutter (in g).

6.3.4 Test procedure

6.3.4.1 The area to be tested is first leveled and all loose material removed. The lightly greased mould with driving dolly fixed is placed in position with the cutting edge on the prepared surface.

6.3.4.2 The mould is then slowly driven into the soil by use of a jack or with a suitable rammer (see Figure 6.3.1). Take care not to rock the mould and drive the cutter until only about 10 mm of the dolly remains above the surface of the soil.

The use of a jack is to be preferred as this causes least disturbance to the soil. However, some form of reaction weight such as a vehicle is required. To use a jack, a block of wood is first placed on the top of the dolly and a hydraulic or screw jack is then placed between the wood block and the underside or the reaction weight (normally a jeep). The jack is then extended so that the mould is driven squarely into the ground until only about 10mm of dolly is remaining above the surface. If driving is continued until the soil completely fills the mould and dolly, there is a danger of compressing the soil in the mould, thus giving incorrect results.

6.3.4.3 The mould, dolly and soil are then dug out of the ground using a spade. The soil in the mould should not be disturbed during this operation.

6.3.4.4 The driving dolly should then be removed from the mould and the soil protruding from each end of the mould trimmed off using a straight edge. The mould and soil are weighed, m_s.

6.3.4.5 The soil in the mould is then removed, crumbled and representative samples taken for moisture content.

6.3.5 **Calculation and expression of results.** In principle, the bulk density of the soil. $r\ (\text{in Mg/m}^3)$, is calculated from the equation :

$$r = \frac{m_s - m_c}{V_c}$$

where,
m_s is the mass of soil and core cutter (in g);
m_c is the mass of core cutter (in g);
V_c is the internal volume of core cutter (in mL).

Alternatively, using the mould factor ratio (see Chapter 4), the bulk density of the soil, $r\ (\text{in Kg/m}^3)$, can be calculated from the equation :

$$r = m_s - m_c \ x \ \frac{F}{H}$$

As a second alternative, using the mould factor F, the bulk density of the soil, $r\ (\text{in kg/m}^3)$ can be calculated from the equation :

$$r = \frac{m_s - m_c}{F}$$

Value in kg/m^3 are converted to Mg/m^3 by dividing by 1000.

Calculate the dry density, ρ_d (Mg/m^3) from equation :

$$\rho_d = \frac{100\rho}{100 + w}$$

where, w is the moisture content of the soil (in %).

The in-situ bulk and dry densities of the soil (Mg/m^3), are expressed to the nearest 0.01 Mg/m^3.

An example of a completed test calculation is given in Form 6.3.1 at the end of this document.

6.3.6 Report. The test report shall contain the following information :

a) the method of the test used;
b) the in-situ bulk and dry densities of the soil in Mg/m^3) to the nearest 0.01 Mg/m^3 ;
c) the moisture content, (in %), to two significant figures;
d) all other details required by the test form regarding sample origin and description etc;
e) the operator should sign and date the test form.

Form 6.3.1

BANGLADESH ROAD RESEARCH LABORATORY

IN-SITU DENSITY TEST
(Core Cutter Method)

Contract : *Dhaka-Aricha Road*

Origin of sample : *Mile 36 + 900' C.L.*

Description of soil : *Moist firm brown laminated silty CLAY*

Date of test : *20/05/2000*

Refers to Sample No. *183*

Date of Sample *19/05/2000*

Compaction test sheet no. *56*

MDD *1.69* Mg/m^3

OMC *16* %

Core cutter number	1	2	3		
Core cutter factor (F) (Volume m^3 x 10^3)	1.021	1.019	1.023		

Test number		1	2	3		
Position of test		10' LHS	15' RHS	20' LHS		
Core cutter number		1	3	6		
Mass of soil + core cutter (m_s)	g	2834	2793	2904		
Mass of core cutter (m_c)	g	995	983	1002		
Weight of Soil, $W_s = (M_s - M_c)$	g	1839	1810	1902		
Bulk density of soil $\rho = \frac{m_s - m_c}{(F \times 1000)}$	Mg/m^3	1.8	1.78	1.86		

MOSITURE CONTENT DETERMINATIONS

Container number		58	61	67	81	77	63				
Mass of wet soil + container (m_1)		142.27	146.59	151.62	146.48	154.79	155.60				
Mass of dried soil + container (m_2)	g	127.38	130.61	136.03	132.17	137.87	137.41				
Mass of moisture ($m_3 = m_1 - m_2$)	g	14.89	15.98	15.59	14.31	16.92	18.19				
Mass of container (m_4)	g	37.66	38.24	39.81	41.02	40.61	39.63				
Mass of dry soil ($m_5 = m_2 - m_4$)	g	89.72	92.37	96.22	91.15	97.26	97.78				
Moisture content $m_3/m_5 \times 100\%$		16.6	17.3	16.2	15.7	17.4	18.6				
Average moisture content, w	%	17		16		18					
Dry density $\rho = \frac{100\rho}{100 + w}$	Mg/m^3	1.54		1.53		1.58					
Maximum dry density	Mg/m^3	1.69		1.69		1.69					
Relative compaction	%	91.0		90.8		93.3					

Remarks ______________________

Name and Designation		
Operator	Checked	Approved
F.R. Khan ARO		