CHAPTER III

EXPERIMENTAL STUDY

1. Bangkok subsoil profile

For engineering purpose, the soil profile in Bangkok can generally be divided into four layers (MOH, NELSON and BRAND, 1969):

1. A weathered crust of 2±1 m, usually composed of dark grey clay having cracks due to alternate cycles of wetting and drying. In some areas, miscellaneous fill, generally clayey, is encountered. The water table is at EL. 1.0 to 1.5 m. (Refer to mean sea level).

2. Very soft to medium dark grey clay, referred to as the soft Bangkok clay, that usually extends to EL. -12±2m.

3. Stiff to hard light grey and yellow-brown clay of variable thickness.

4. Dense sand and gravel layers, with some sandy clay, that occur alternately to a depth of at least 300 m. (MUKTABHANT, et al, 1967).

The soil profiles of the soft Bangkok clay (soft to very soft dark grey clay layers) were shown (from MUKTABHANT, et al, 1967) in Fig. 3.1, 3.2 and 3.3.

Some typical index properties of soft Bangkok clay were summarized in Table 3.1 (MOH, NELSON AND BRAND, 1969).

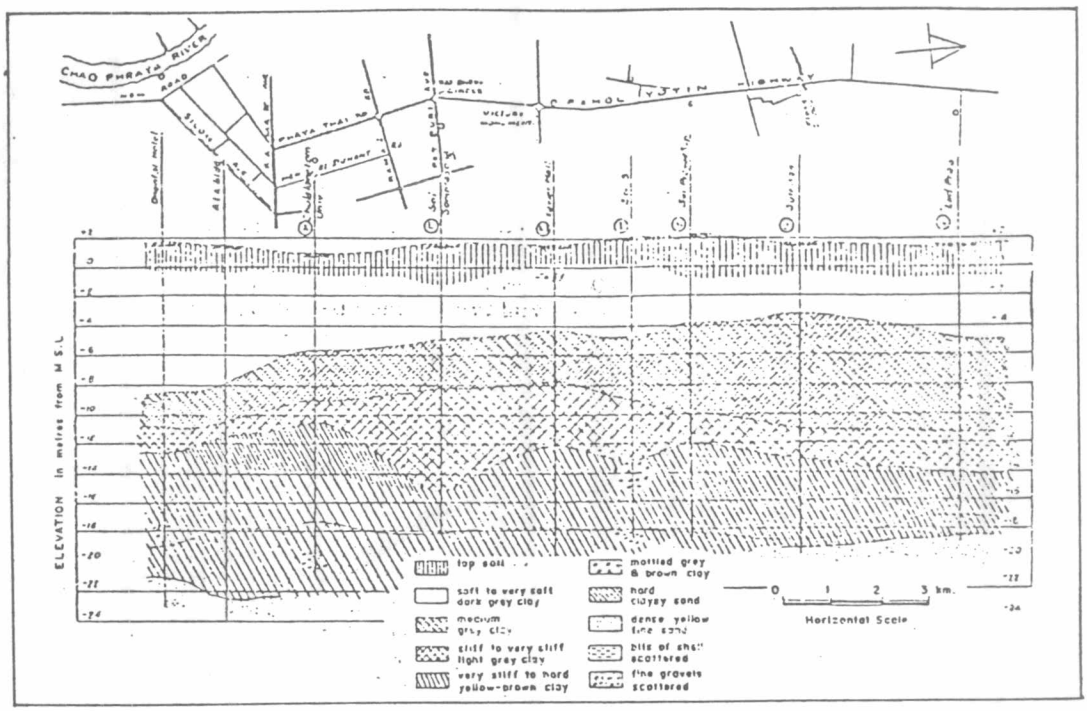

FIG 3.1 Profile of Subsoils along the alignment of Pahol Yotin Highway.

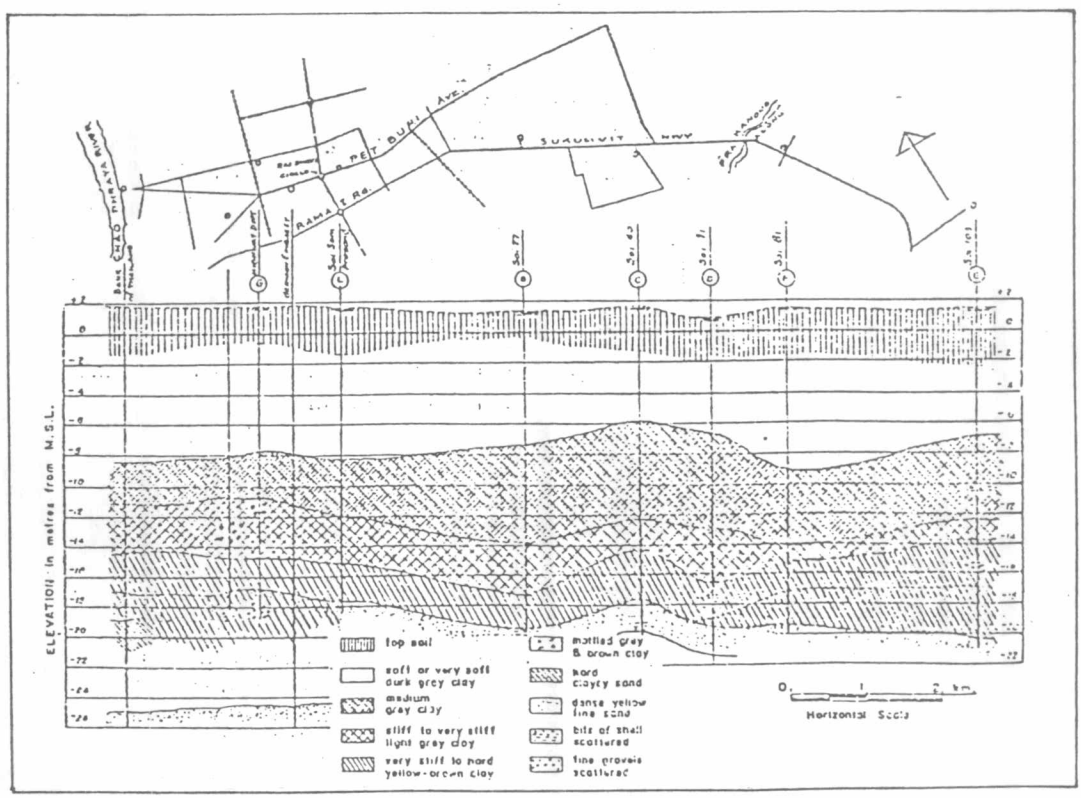

FIG 3.2 Profile of Subsoils along the alignment of Sukumvit Highway.

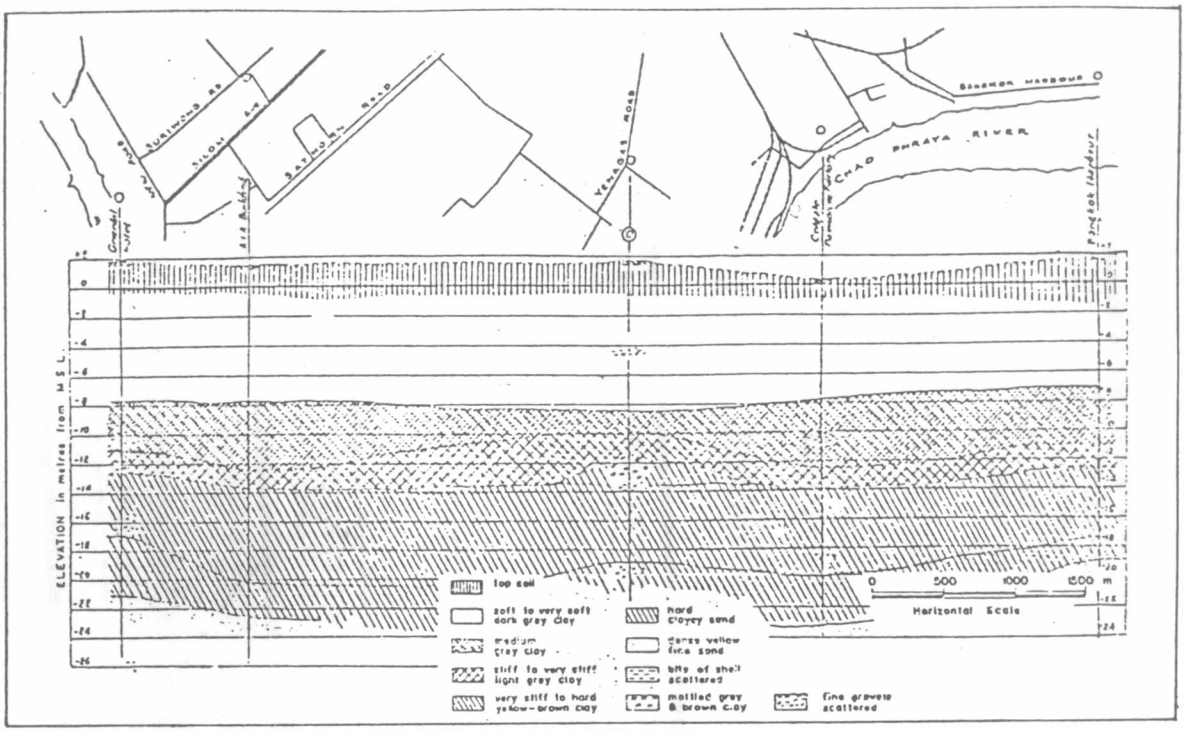

FIG 3.3 Profile of Subsoils along the alignment of Oriental Hotel and Bangkok Harbor.

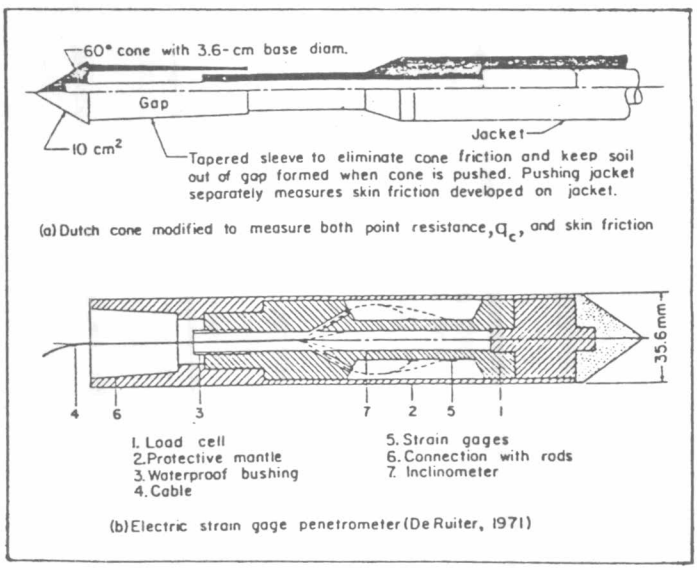

FIG 3.4 (a) and (b)

Dutch Cone

TABLE 3.1 Index Properties Of Bangkok Clay

Properties	Representative Value	Typical Range
Natural Water Content (%)	60-70	50-78
Liquid Limit (%)	75	55-95
Plastic Limit (%)	28	23-33
Plasticity Index (%)	47	20-60
Liquidity Index (%)	0.85	0.7-1.0
Activity	0.8±0.1	0.6±1.1
Specific Gravity	2.70	2.65-2.75
Total Unit Weight (t/m^2)		
above 2±1 m. depth	1.70	1.65-1.80
below 2±1 m.	1.65	1.45-1.75

2. The Dutch cone penetrometer

The Dutch cone penetration test has a history of development in Europe, particulary in Netherland and Sweden for 40 years. SCHMERTMANN (1966) has explored soil in various places in United States and found that the Dutch cone penetration test is an excellent method and it deserves serious consideration by soil engineers. The instrument is light and sturdy, making transportation fairly easy, and it is simple enough to be manufactured locally. In developing countries these are important advantage.

The most common cone configuration was shown in Fig. 3.4. The equipment for a Dutch cone penetration test can be truck-mounted with a hole made in the truck bed for pushing the cone and drill rods via use of a hydraulic ram system and using the truck with or without additional anchorage for reaction. Alternatively a system of anchor piles or screw anchors can provide the reaction. Reactions generally do not exceed 10,000 kg. with most on the order of 3,000 to 5,000 kg.

Fig. 3.5 shows a Dutch cone penetrometer, mounted with the anchorage to provide the reaction, available for 2,000 kg. capacity and can be penetrated to a layer of sand or stiff clay with bearing capacity not exceeding 200 t/m^2.

A Dutch cone penetrometer consists of

(1) Cone point.

It is made of hardened steel with 30^o or 60^o apex angle (only the 60^o apex angle will be considered) and end area of 10 cm^2. (3.6 cm. base diameter).

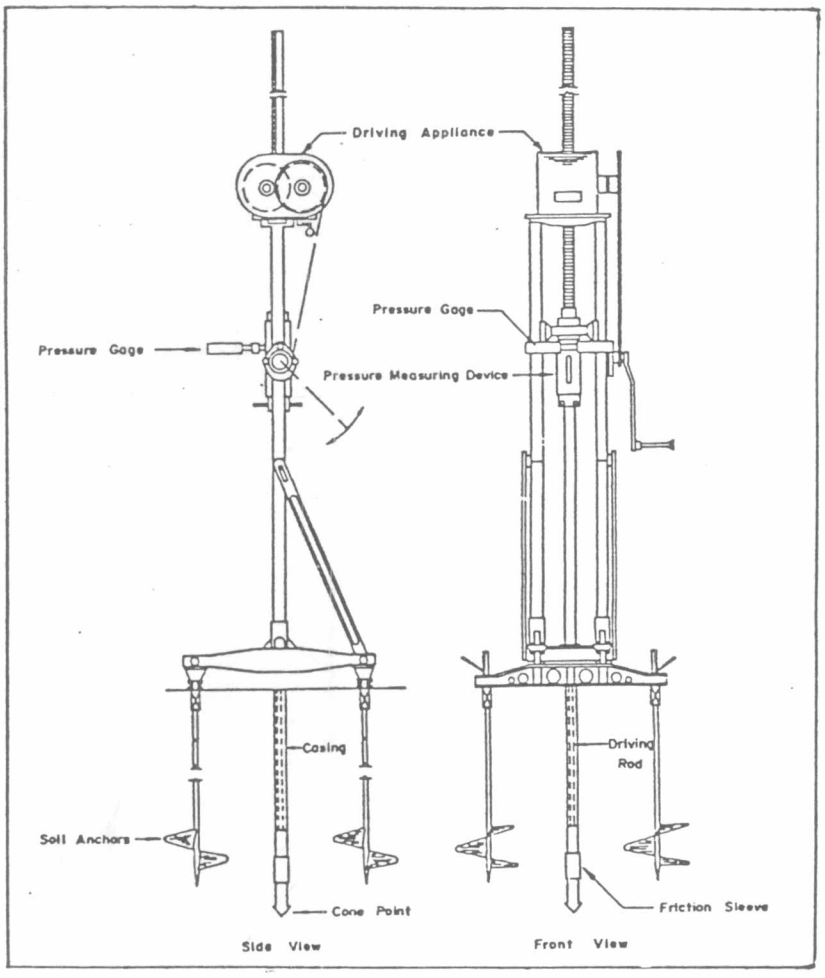

FIG 3.5 DUTCH CONE PENETROMETER

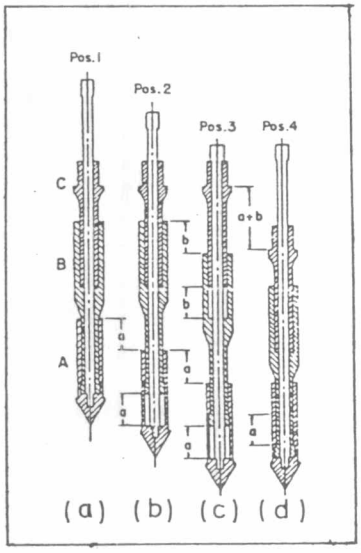

FIG 3.6 Pushing Sequence of C.P.T

The cone point is only advanced for bearing capacity or cone resistance (q_c).

(2) Jacket sleeve

It is made of hollow hardened steel with surface area of 150 cm^2. By pushing jacket separately it can measure skin friction (f_s),

(3) Pressure rod (driving rod)

The pressure rod with a diameter of 1.5 cm. and 1.0 m. long is made of hardened steel and used to transmit external force to the cone point.

(4) Casing

The casing with inner diameter of 2.0 cm. and 1.0 m. long provides structural strength and bulking. It can be attached to another casing.

(5) Pressure gauge (Bourdon gauge)

The thrust is measured by a hydraulic load cell connected to a Bourden gauge.

(6) Driving applicance

(7) Anchorage

On operation, a cone is pushed into the soil stratum of interest and the corresponding cone resistance is measured. The cone resistance may be of the cone alone or a cone resistance and the skin friction. The cone resistance is related to the undrained shear strength.

Fig. 3.6 illustrates the pushing sequence for the cone penetration test.

The cone is forced into the ground at a rate varying from 1 to 2 cm./sec. to the distance "a" in Fig. 3.6 (a) and the cone resistance (q_c) is measured. If the cone is continued to be forced with the friction jacket to the additional distance "b" both cone resistance and skin friction is measured. The skin friction is obtained by substracting the cone resistance from the total thrust.

After the cone is pushed to the distance "a+b" (about 6 cm.). The casing must be forced to move down as shown in Fig. 3.6 (d). Such measurements are made at every 20 cm. or 10 cm. if more detail is desired.

3. The Dutch cone penetration test (CPT) results

The CPT results from several sites, where soft clay layers are fairly uniform, have been used to estimate the undrained shear strength. Locations of CPT were shown in Fig. 3.7.

At each site CPT results were carried out and a representative value of the cone resistance, q_c, was determined. The average CPT results were shown in Fig. 3.8.

DONMUANG site (site A)

At this site the CPT were run along the center, left and right edge of new runway by Krungthep Engineering Consultant (1979). The depth of penetration is about 15 m. below ground surface. To a depth of 12 m. the subsoil is basically very soft to soft clay. The natural water contents (w) are generally high and close to the liquid limit (LL).

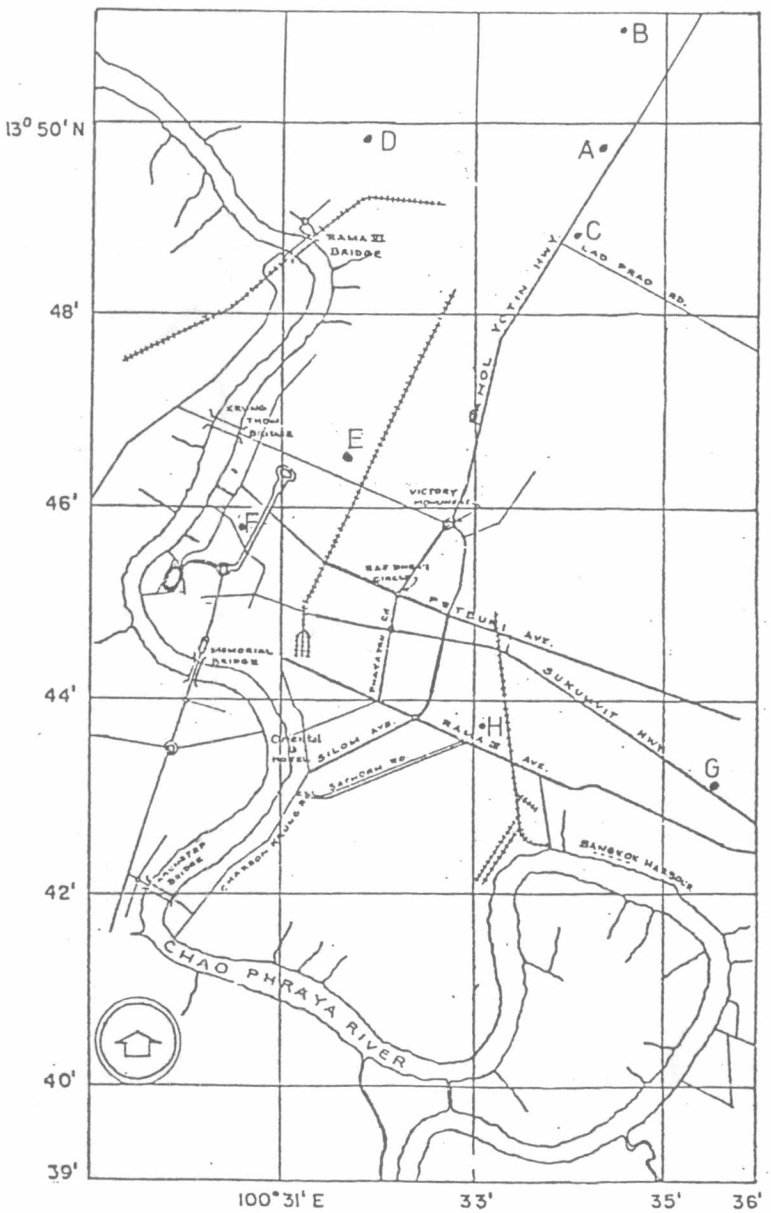

FIG 3.7 Location of C P T (•)

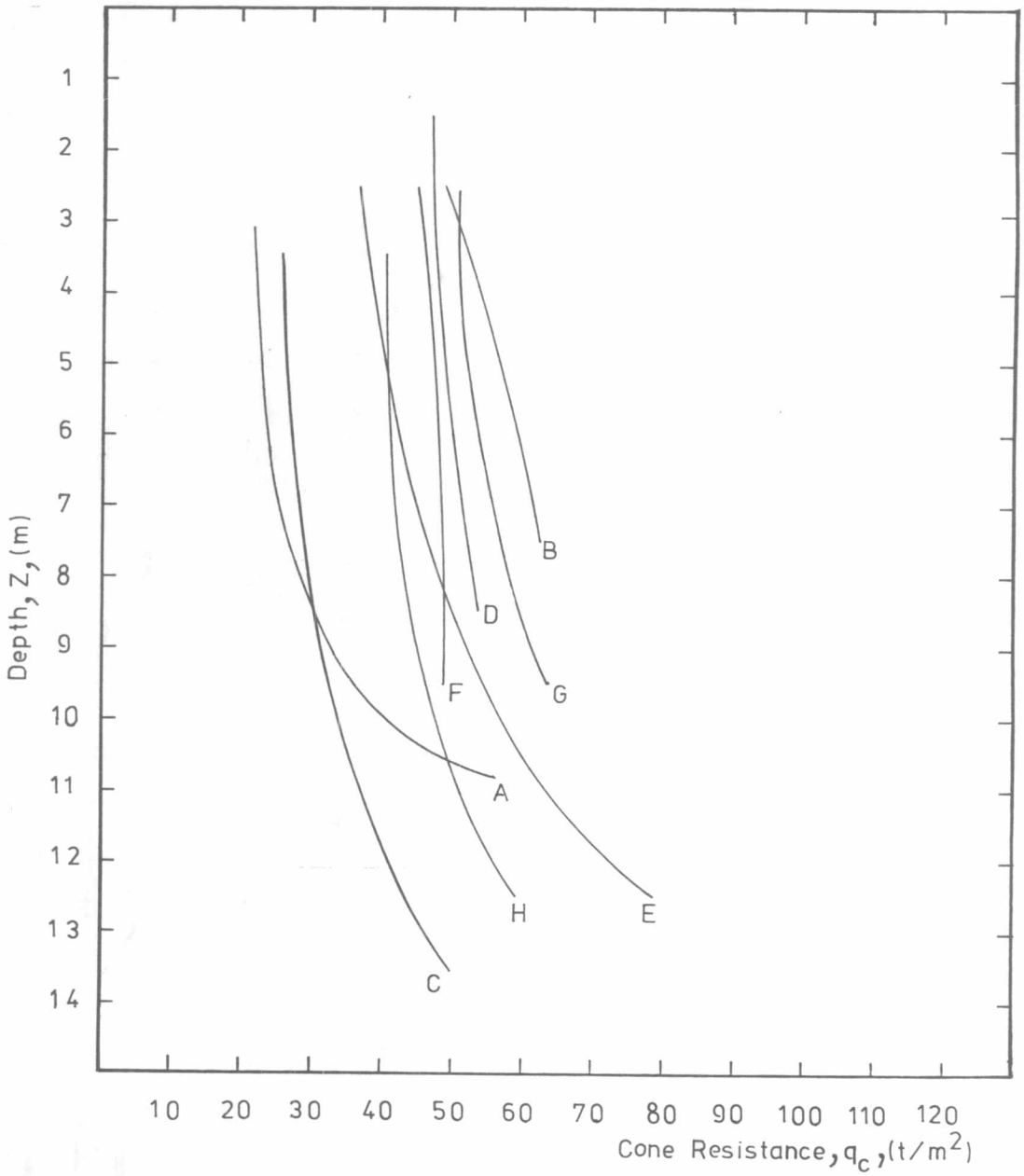

FIG 3.8 Average CPT Results For Bangkok Area

A- DONMUANG Site
B- AIT Site
C- LADPRAO Site
D- NAVANAKORN Site
E- SAMSEN Site
F- BANGKUNPROM Site
G- SUKUMVIT Site
H- LUMPINI Site

A.I.T. site (site B)

The CPT were performed at the Asian Institute of Technology (Rangsit) by SOM-ART (1976). The depth of penetration is about 8 m. The very soft and soft clay layers extend from the depth of 2 to 6 m. It is underlain by medium silty clay with sand loam.

LADPRAO site (site C)

APICHAI (1972) has explored subsoil at the head office of the Gammon Co., Ltd. Ladprao to the depth of 25 m. The very soft and soft clay layers extend from the depth of 2 m. to 14 m.

NAVANAKORN site (site D)

The CPT results were obtained from the depth of 18 m. The soft clay layer extends from the depth of 1.5 m. to 6.5 m.

SAMSEN site (site E)

The CPT results were obtained from the Metropolitan Water Works Authority. The depth of penetration is 30 m. The soft and very soft clay layers extend from the depth of 2 m. to 12 m.

BANGKUNPROM site (site F)

Data were obtained by PHAM TIEM NAM (1972) at the head office of Bank of Thailand. The very soft clay layer extends from the depth of 2 m. to 8 m.

SUMUMVIT site (site G)

Data were also obtained by PHAM TIEM NAM (1972) at the Science Museum building. The very soft and soft clay layers extend from the depth of 2 m. to 13 m.

LUMPINI site (site H)

Data were obtained from the Metropolitan Water Works Authority. The soft clay layer extends from the depth of 3 m. to 13 m.