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THE SETTLEMENT OF A HIGH RISE TOWER ON PILES AT ZAMALEK, CAIRO

BY

Dr. MOHAMED M. BAHLOUL

ABSTRACT:

This article gives the result of the settlement observations for a high rise tower at Zamalek, Cairo, Egypt. Maximum settlement of 80.38 mm and minimum 28.43 mm were recorded and cracks of some bricks walls were observed. The behaviour of tower was analysed based on Bahloul, Vesic, Berezantsev and Skempton, and important conclusions were drawn.

INTRODUCTION:

A high rise tower consisted of three levels was constructed at Zamalek, Cairo. The levels were the central part of 34 floors, the intermediat part of 17 floors and the outer part of 5 floors. The whole parts were connected together without joints of any kind and constructed in the same time. A bored piled foundation of temporary casing was used, diameters of piles were 65 cm, and 85 cm, resting on the medium sandy layer at 13 to 15 m below surface. Figs. (1,2) show the building, foundations and the general profile of soil.

Literature Review:

A thorough review of settlement of pile groups in sand is given else where (1). There is at present (1983) no closed form rational theory of settlement of pile groups in sand, it is recommended in the calculation of the settlement of pile groups in sand to use the methods proposed by Skempton (1953), Berezantsev (1961), Vesic (1975) and Bahloul (1983).

Settlement Calculations:

The predicted settlement of different pile groups of the tower was calculated from the results of the load tests on pile nr. 1 and pile nr. 40 using the 4 recommended methods (Skempton, Berezantsev, Vesic and Bahloul).

Calculations are enclosed at the appendix.

Predicted max. settlement under 34 f. part 89.9 mm.
Predicted min. settlement under 5 f. part 15.46mm.
Predicted intermediate " " 17 f. part 33.73mm.

Settlement Observations:

A program of settlement recording was done and included 28 points, on the columns at garga under all the structure.

The first reading was at April 4, 1980 and then every 2 weeks. Due to constructions process the nr. of correct points became 10 points only at DEC, 1983. Some readings are shown in Fig.(3).

Results of Settlement Observations at Dec. 1983:

The meximum settlement was under the part 34 f. and reached 80,38 mm at col. 50 f., the mean settlement under the part 34 f. was 78.24 mm. The minimum settlement was under the small part of 5 f. part and reached 28.43 mm.

The intermedicate settlement was under the 17 f. part and was 51.95 mm. Maximum differential settlement was between the 34 f. and 5 f. and when it reached 50.46 mm at April 1981 caused craking and then crushing of some bricks walls.

CONCLUSIONS:

Good corrolations between the predicted and the measured values of settlement of Zamalek tower were obtained. The comparison of the settlement of Zamalek tower with other results from literature is given in Fig.(4) and indicate that the amount of settlement is normal according to the group size. It is recommended to use settlement joints between different parts of different loads in the same building and to construct the heaviest first, then the medium, and at last the lighter part. Otherwise to use about the same pile group size under columns.

REFERENCES:

1. Bahloul M.(1983). Settlement of pile groups in sand. Bul. Fac. of Enrg. Mansoura.

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3. Berezantsev, Khristoforov and Golubkov (1961). Load bearing capacity and deformation of piled foundation 5th I.C.S.M.F.E. Paris 1961, Vol. 2. pp. II.15.

4. Vesic, A.S. (1975). Principles of pile foundation design duke University series N. 38.

5. Bahloul (1982). Settlement of Zamalek tower. Contract report.

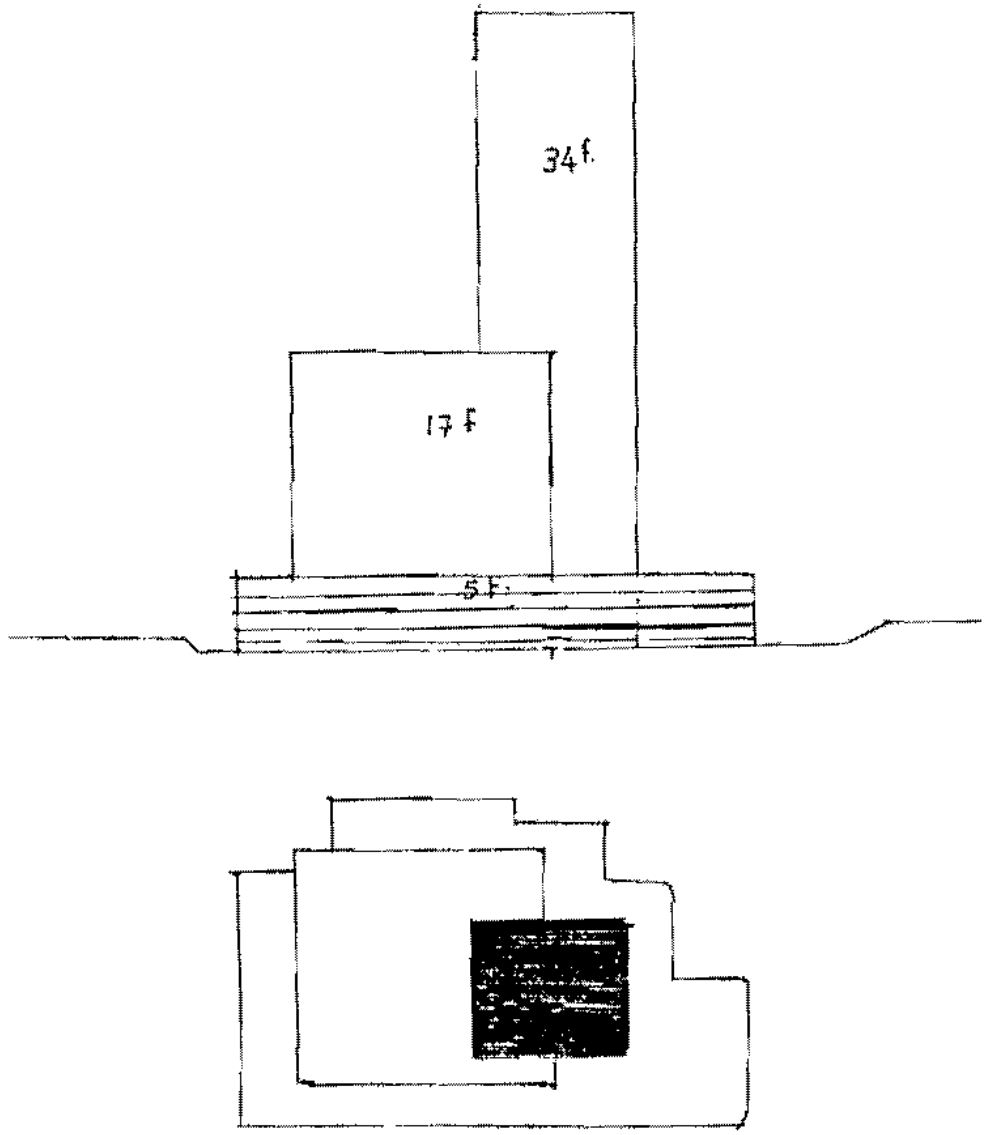


Fig. (1-a)

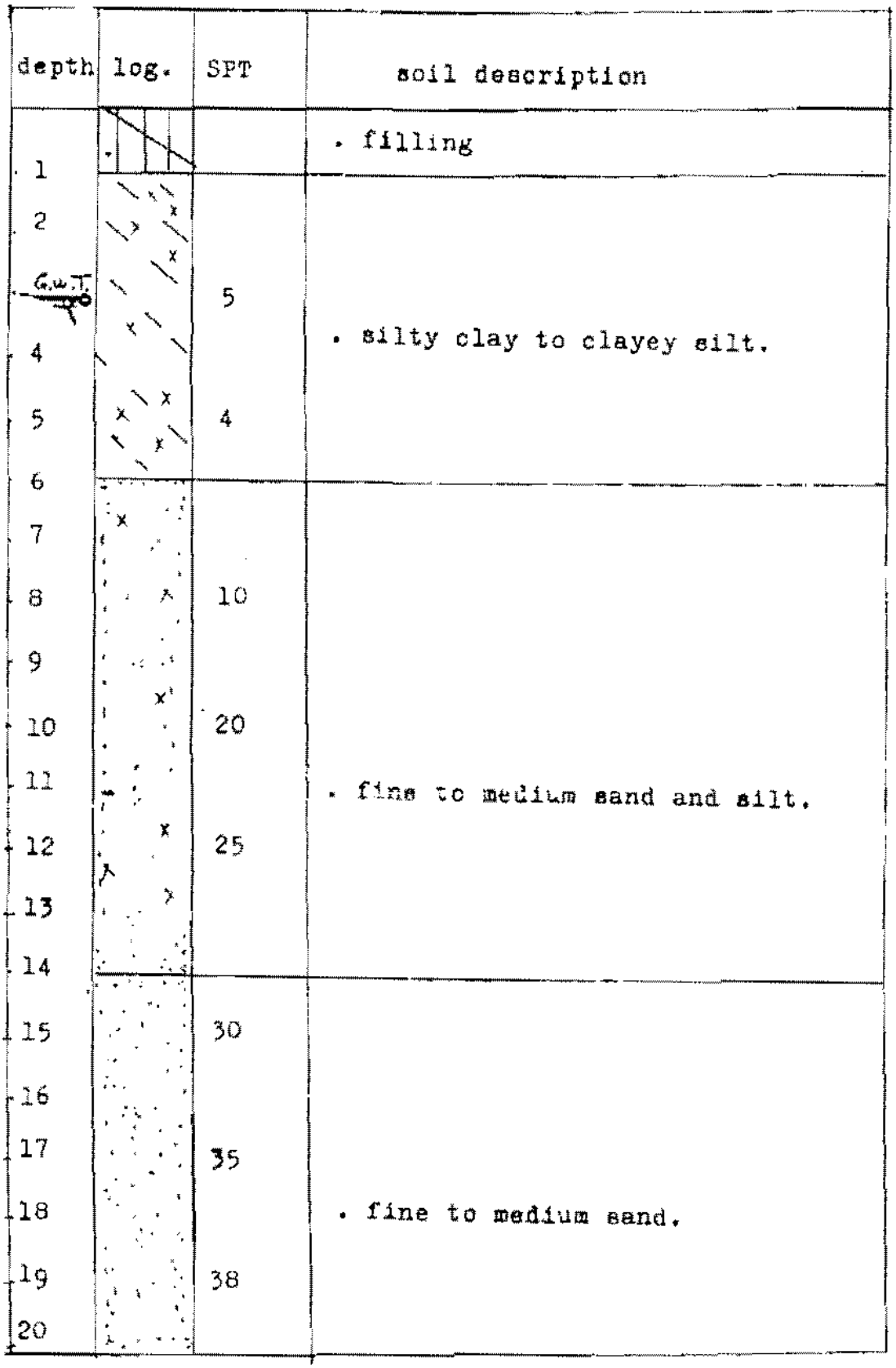


Fig.(1-b): General soil profile.

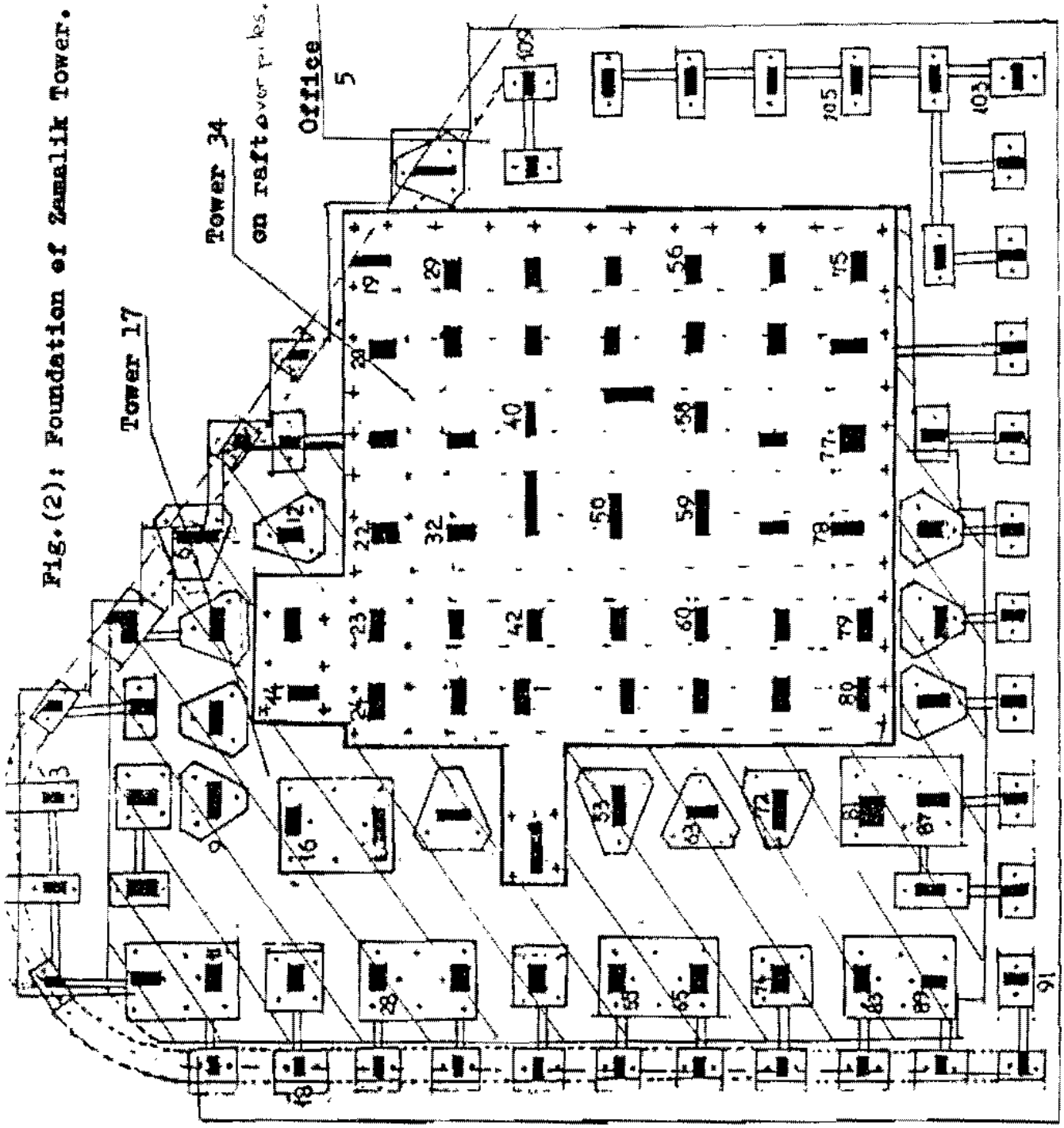


Fig.(2): Foundation of Zamalik Tower.

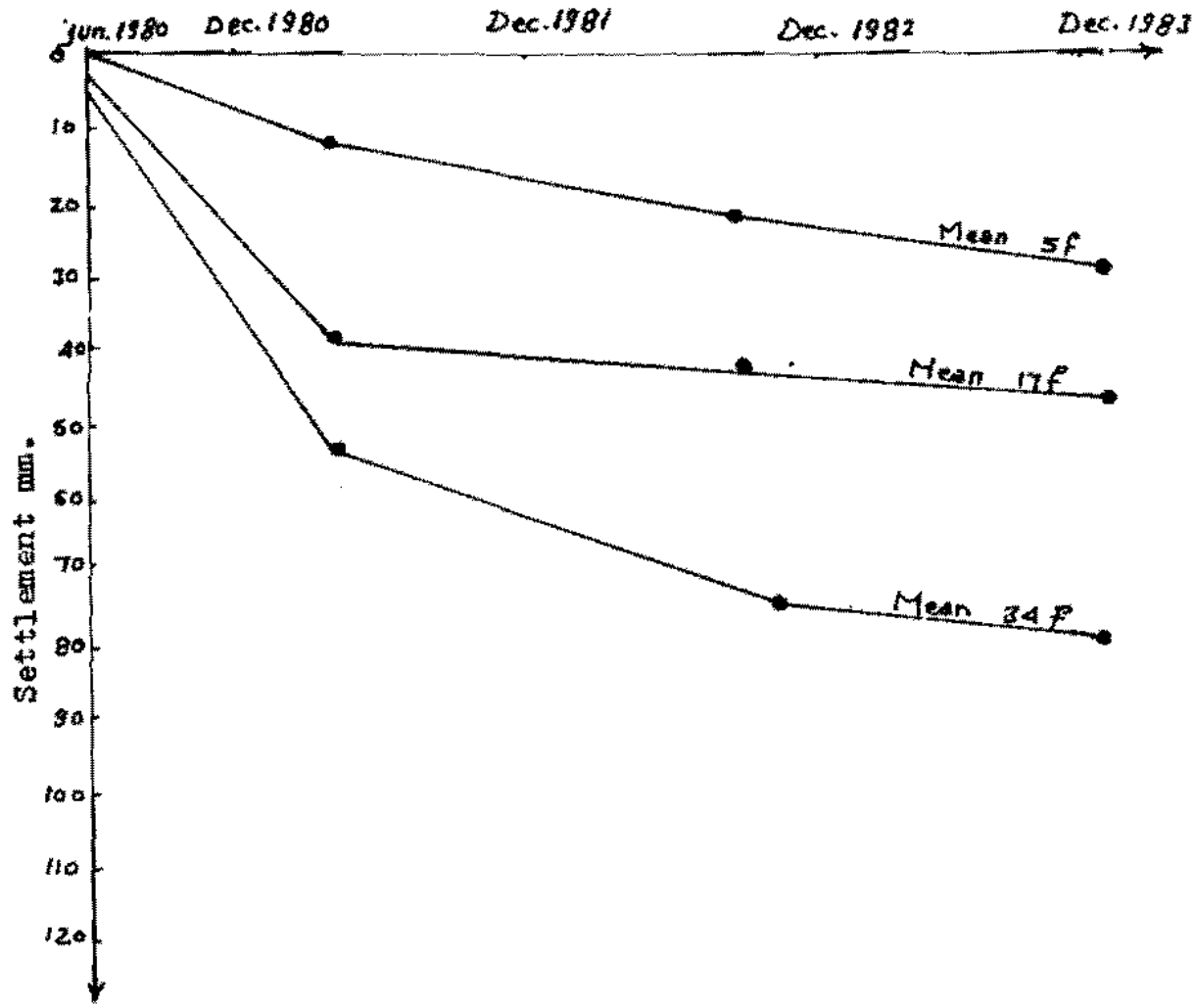


Fig.(3): Observed Sett./tim.

Comparisson of predicted and observed settlement for Zemalik tower.

Part	Predicted mm.	Observed mm.	Obs. to Pred. ration
Tower 34	89.9	78.24	0.87
Tower 17	33.73	45.78	1.35
Office 5	24.47	28.43	1.16

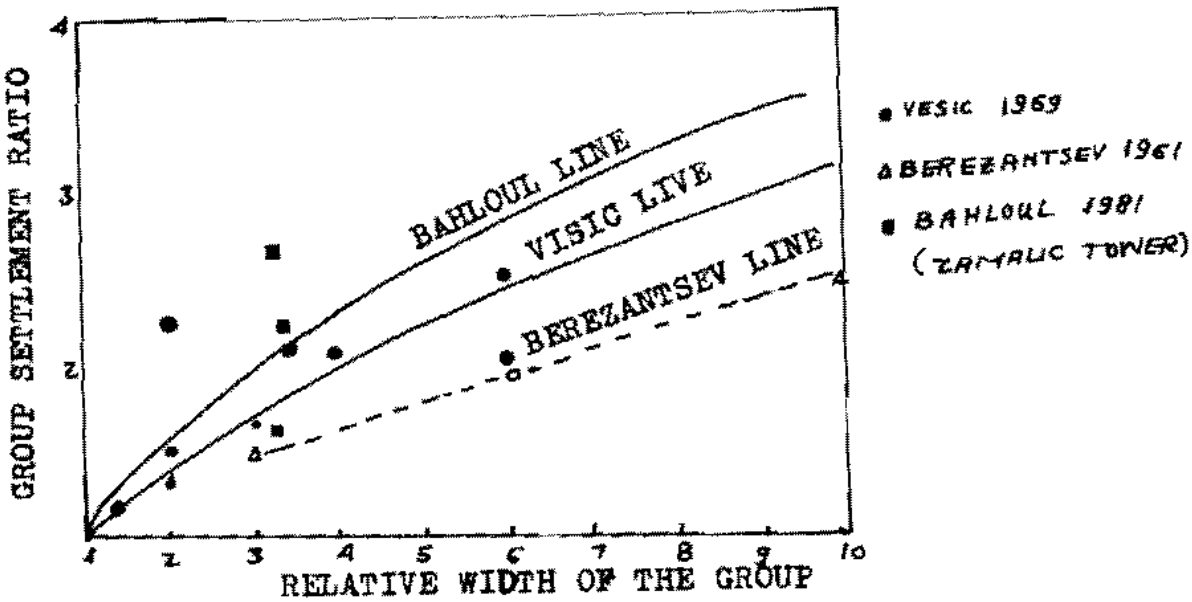


Fig.(4-a): COMPARISON OF ALL DATA ON GROUP SETTLEMENTS ZAMALIK TOWER.

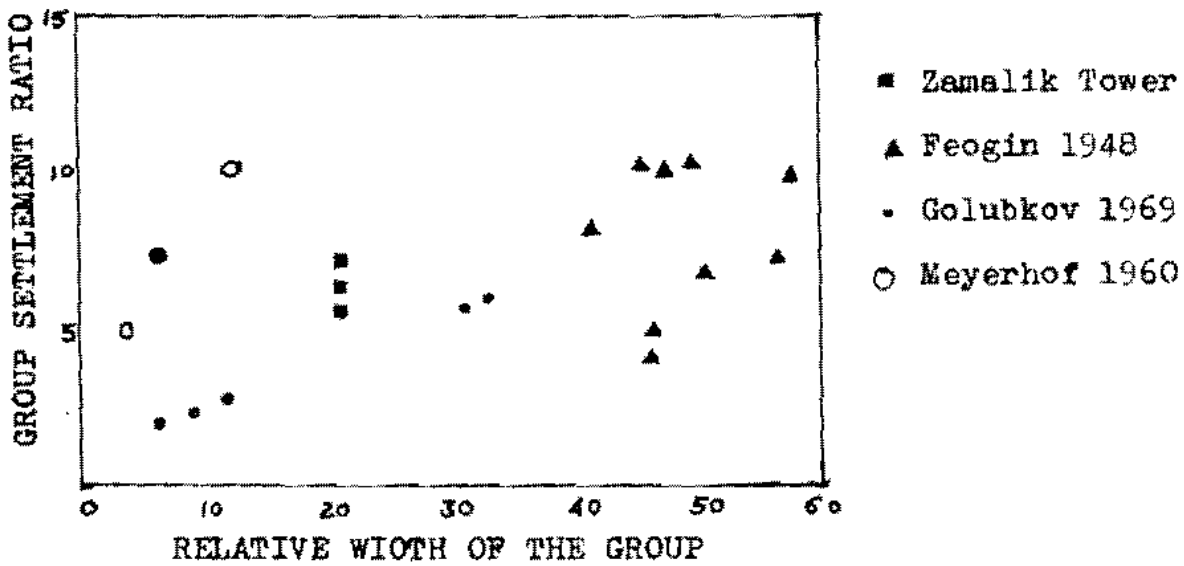
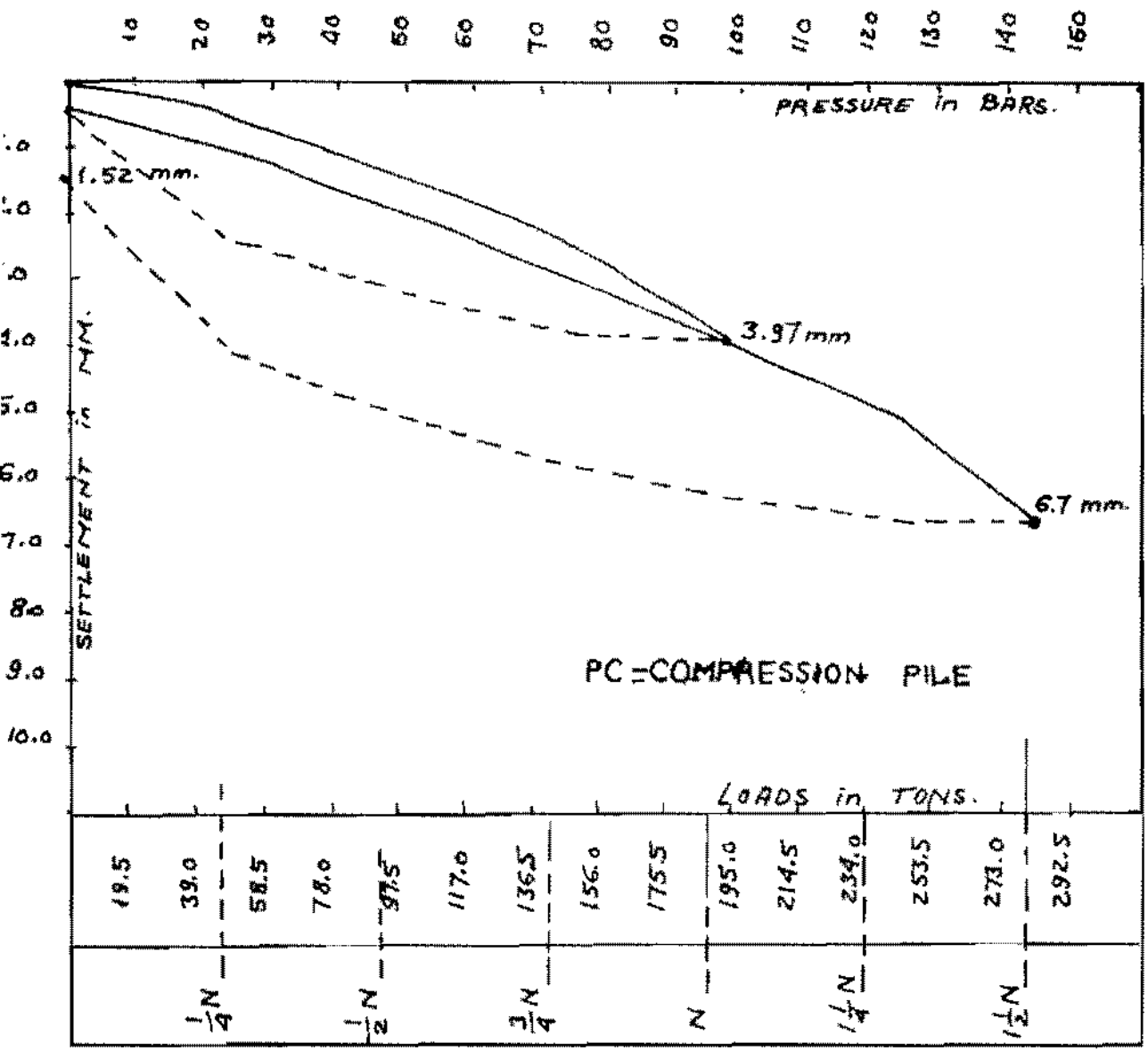


Fig.(4-b): COMPARISON OF ALL DATA ON GROUP SETTLEMENTS*ZAMALIK TOWER.



ABICON PILING CO
ZAMALEK BUILDING
10th OF RAMADAN

PILELOAD TEST No. 1

BENOTO BORED PILE

820 mm DIAMETER

WORKING LOAD 185 TONS

TEST LOAD 1.5 x 185 = 277.5 TONS

PILE TOE LEVEL - 17.5

METHOD OF TEST HYDRAULIC JACK WITH TWO TENSION PILES ø 820 mm.

= P + E = 6.689 mm.

E = ELASTIC SETTLEMENT FOR SOIL + PILE.

E = 6,689 - 1,524 = 5,165 mm.

P = PERMENANT SETTLEMENT=1.524 mm.

Fig. 5.a.

C. & M. M. RAHLOUL

OWNER - COOPERATIVE - 10th OF RAMADAN

PILING COMPANY - ABICON

LOCATION - Tower No. 1

PILE No. 40

PILE DIAMETER = 82 CM

STARTING DATE TEST No. -2-

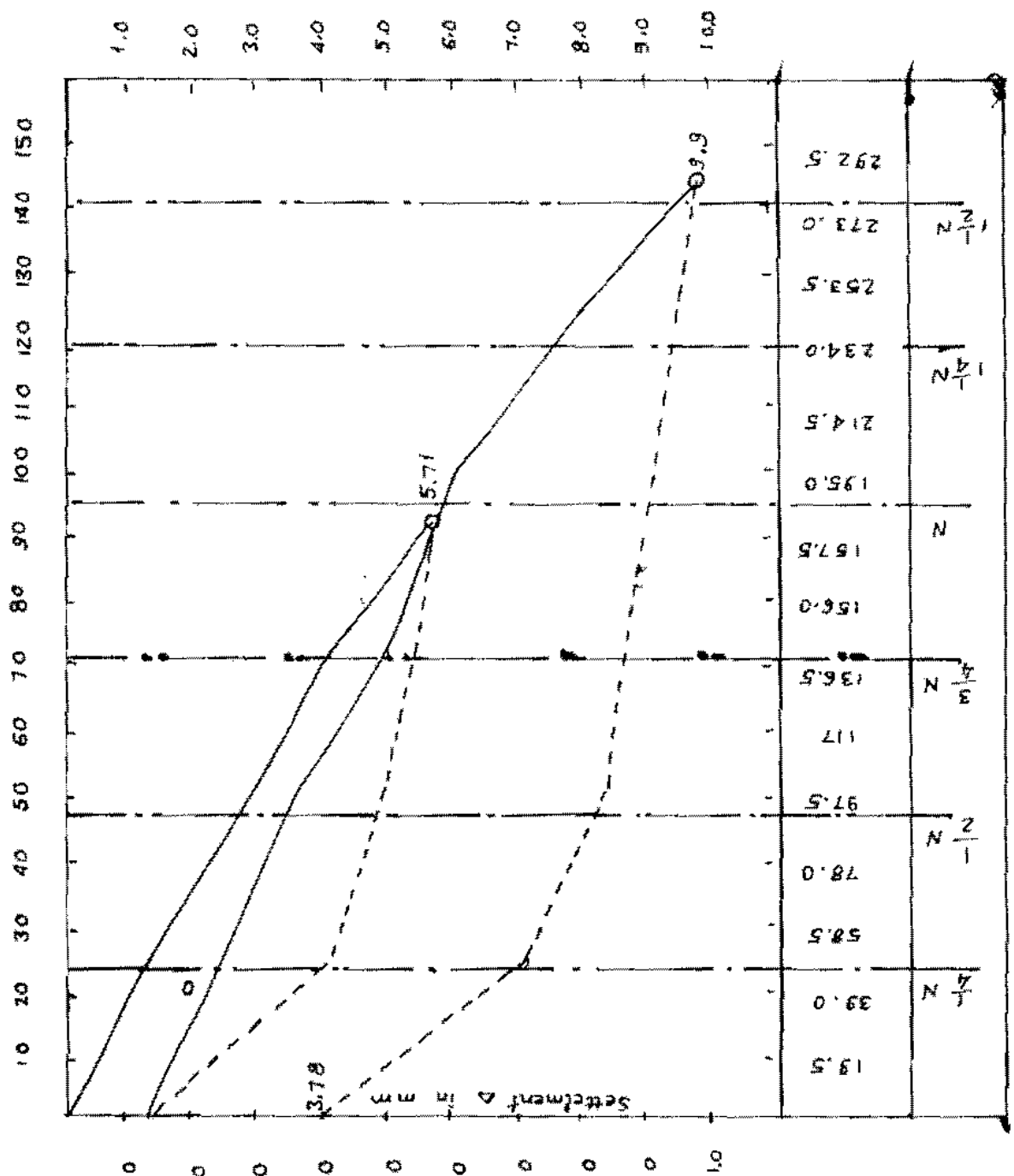
END OF TEST

WORKING LOAD - 185.0 TONS

TEST LOAD - 185.0 x 1½

= 277.5 TONS.

Fig 5.b.



Commission File NO 40

APPENDIX

Calculations

Study of behavior of 820 mm piles and load 200 t

length H = 15 m, D = 0,82 m, P = 200 t

Bearing capacity analysis

$$Qp = \frac{1/3 \text{ Kg/cm N Apcm}^2}{1000} = t = 1/3x4x25x82{,}82 \frac{}{9} = 175 \text{ t}$$

$$Qs = \frac{1/3\ 0.2x12x\ \ x82x1500}{1000} = 30 \text{ t}$$

total load = 175 + 30 = 205 O.K

q_o = 0,8 x 15 x 300 3600 t/m^2 (Meyerhof 1953).

Settlement analysis:

1. $$Ws = (170000 + 0{,}5 \times 30000) \frac{1500}{\frac{\times 82 \times 82}{4} 200000} \times 10 \text{ mm} = 2{,}63 \text{mm}$$

2. $$Wpp = \frac{0.14 \times 170}{0.82 \times 3600} \times 1000 = 8.06 \text{ mm.}$$

3. $$Wps = \frac{2{,}25 \times 30}{15 \times 3600} \times 1000 = 1.25 \text{ mm.}$$

Total settlement = 11,94 mm.

Study of behavior of 820 mm pile, P 185 t.

Length H = 13,5 m D = 82 cm Load = 185 t.

Bearing capacity analysis:

Qp 1/3 x 4 x N x Ap = 155 t.

Qs 1/3 0002 Ns As = 27 t.

Q total = 182 t ...o.k.

q_o = 0.8 x 13 x 300 = 3120 t/m^2 ...(Meyerhof 1953).

Settlement analysis:

1. $$Ws = \frac{(150000 + 0.5 \times 35000)\ 1300}{77 \times \frac{82 \times 82}{4} \times 200000} = 2.13 \text{ mm.}$$

2. $$Wpp = \frac{0.14 \times 155}{0.82 \times 3120} = 8.47 \text{ mm.}$$

3. $Wps = \frac{2.25 \times 27}{1.35 \times 3120} = 1.44$ mm.

Total settlement = 12.04 mm.

Study of behavior of 620 mm pile, P 110 t, H 13 m.

1. Bearing capacity analysis:

Qp = 88 t

Qs = 25 t

Q total = 113 t....O.K.

q_o = 3120 t/m^2

2. Settlement analysis:

Ws = 2.16 mm.

Wpp = 6.37 mm.

Wps = 1.33 mm.

Total = 9.86 mm.

Predicted settlement of piles under the 5 stories office:

Max. settlement under the caps of 2,3 piles as follows:

Width of 2,3 piles 1x2 = 2 m.

Predicted settlement Vesic = $9.86 \quad \frac{2}{.62} = 17,71$ mm.

Bahloul = $9.86 \quad \frac{2}{.62} \quad \frac{1}{7} = 25,3$ mm.

Skempton= 9.86 x 4 = 39,44 mm

Berezantsev = $9.86 \frac{3.83}{2.44} = 15.46$

mean values of predicted settlement under the office part in order of 24.47 mm.

Predicted settlement under the 17 tower:

A) Max. settlement under the cap of 8 piles as follows:

width of 3 pile rows 2 x 2 = 4 m

Predicted settlement according to Vesic = $12.04 \quad \frac{4}{.82} = 26.59$mm.

" " " " Bahloul= $\frac{12.04}{0.7} \quad \frac{4}{.82} = 37.99$mm.

" " " " Skempton 72.24 mm.

" " " " Berezantsev 20.6 mm.

Max. mean value = 39.35 mm.

B) Settlement under the caps of 3 piles as follows:

Predicted Veisc = 18.80 mm
" Bahloul = 26.86 mm
" Skempton= 48.16 mm
" Berezantsev= 18.64 mm

Min. mean value 28.11 mm.

Mean value of All Tower 17 = 33.73 mm.

Predicted settlement of pile groups

Under the raft of 34 tower:

Width of 12 piles rows gives B = 2 x 11 = 22 m

Predicted settlement according to Vesic = $\frac{22}{.82}$ x 11.94=62.36 mm

" " " " Bahloul = $\frac{22}{.82} \times \frac{11.94}{0.7}$ = 89 mm

" " " " Skemton = 144 mm.

" " " " Berezantsev = $\frac{26.21}{4.91}$ = 64.27mm

The mean value of predicted settlement 89.9 mm.

Predicted differential settlement under the structure:

The max. differential settlement will be between the tower 34 and the office part and will be 89.9 - 24.47 = 65.43 mm.

The min. differential settlement will be between the tower 17 and the office part and will be in order of 33.73-24.47=9.26 mm.

The intermediat differential settlement will be between the tower 34 and tower 17 and will be in order of 56.17 mm.