CHAPTER IV

MODEL DESIGN

4.1 Basis of Model Design

Model design has been based on geometric similitude;

1) For geometrical similarity the prototype and the model, it is necessary that all linear dimensions of the model be scaled down from the corresponding dimensions of the prototype by a constant ratio. For this study, the geometrical scale factor is made equal to three.

Model design has been based on stress similitude;

1) Keeping the ratio of the design column load on pile cap, P, to the design shear strength contributed by the concrete, V, constant between the prototype and the model.

2) Keeping the ratio of the calculated flexural strength, M, to the design column , P, constant between the prototype and the model.

4.2 Model Design Analysis

4.2.1 Three-Pile Cap

1) Punching Shear:

prototype;

a) Dimension b=142 cm., c=45 cm., d=75 cm., L=105 cm.

b) Material

Concrete f'_c = 250 ksc.

Reinforcement f_y = 3400 ksc.

f_s = 1700 ksc.

c) Analysis

$$v = 0.53\sqrt{f'_c} = 0.53\sqrt{250} = 8.38 \text{ ksc.}$$

$$V = vb_od = 8.38x4(45+75)75 = 301,681 \text{ ksc.}$$

$$P = 50x3x1000 = 150,000 \text{ kg.}$$

$$\frac{P}{V} = \frac{150,000}{301,681} = 0.497$$

model;

a) Geometrical scale factor = 3

b) Design analysis

$$\frac{P}{V}\text{ model} = \frac{P}{V}\text{ prototype} = 0.497$$

$$P_{model} = V_{model}x0.497 = 0.53\sqrt{f'_c}(\frac{b}{3}_o)(\frac{d}{3})(0.497)$$

$$= \frac{150,000}{9} = 16,667 \text{ kg.}$$

Force scale factor = 9

2) <u>Flexural Analysis of Model</u>: (Working Stress Design)

a) Beam analogy

$$A_s = \frac{M}{f_sjd} = \frac{16667x12.73}{3x1700x0.876x25} = 1.90 \text{ cm}^2.$$

Use 3-Ø9 mm. (A_s = 1.909 cm^2.)

b) Truss analogy

$$T = \frac{P(2L^2-c^2)}{18Ld}$$

$$= \frac{16667(2x35^2-15^2)}{18x35x25} = 2355 \text{ kg.}$$

$$A_s = \frac{T}{f_s} = \frac{2355}{1700} = 1.39 \text{ cm.}^2$$

Use 3-Ø9 mm. (A_s = 1.909 cm.^{2})

4.2.2 Four-Pile Cap

1) Punching Shear:

prototype;

a) Dimension b=170 cm., c=45 cm., d=75 cm., L=105 cm.

b) Material

Concrete	f'_c	=	250	ksc.
Reinforcement	f_y	=	3400	ksc.
	f_s	=	1700	ksc.

c) Analysis

$$v = 0.53\sqrt{f'_c} = 0.53\sqrt{250} = 0.497$$

$$V = vb_o d = 0.497\text{x}4(45+75)75 = 301,681 \text{ kg.}$$

$$P = 50\text{x}4\text{x}1000 = 200,000 \text{ kg.}$$

$$\frac{P}{V} = \frac{200,000}{301,681} = 0.663$$

model;

a) Geometrical scale factor = 3

b) Design analysis

$$\frac{P}{V}_{model} = \frac{P}{V}_{prototype} = 0.663$$

$$P_{model} = V_{model}\text{x}0.663$$

$$= 0.53\sqrt{f'_c}\left(\frac{b_o}{3}\right)\left(\frac{d}{3}\right)(0.663)$$

$$= \frac{200,000}{9} = 22,222 \text{ kg.}$$

Force scale factor = 9

2) Flexural Analysis of Model; (Working Stress Design)

a) Beam Analogy

$$A_s = \frac{M}{f_s jd} = \frac{22222x10}{2x1700x0.876x25} = 2.98 \ cm.^2$$

Use 6-Ø9mm. (A_s = 3.817 $cm.^2$)

b) Truss Analogy

$$T = (P/24Ld)(3L^2-c^2)$$

$$= \frac{22222(3x35^2-15^2)}{24x35x25} = 3651 \ kg.$$

$$A_s = \frac{T}{f_s} = \frac{3651}{1700} = 2.15 \ cm.^2/edge$$

$$= 2x2.15 = 4.30 \ cm.^2/each\ way$$

Use 6-Ø9mm. (A_s = 3.817 $cm.^2$)