CHAPTER 6

DESIGN AND CONSTRUCTION OF MODELS

6.1 Representation of Models

The S- and Z-beams exploited in the design examples in Chapter 4, reduced to models on half-scale, serve to incorporate into the experimental investigation. The reduction process abides by known principles of structural model analysis[1]. Linear proportionality applies to the beam's dimensions and loads whereas cross-sectional areas, concrete and steel alike, diminish by the square of the adopted scale. The width b and thickness t of the cross-section decrease in half to $\frac{b}{2}$ and $\frac{t}{2}$ respectively, resulting in a lessened sectional area of $\frac{1}{4}$ bt which is automatically equal to the prototype's sectional area divided by the square of the scale index. This square of scale index holds for longitudinal reinforcement transformation but does not remain valid in respect of binders.

Tables 6.1 and 6.2 register variation of minimum reinforcement requirement belonging respectively to the S-beam and Z-beam models. Figures 6.1 and 6.2 in turn represent the structural details of the S-beam and Z-beam models.

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1 Heinz Hossdorf, "English Version by C. Van Amerongen", Model Analysis of Structures (New York: Van Nostrand Reinhold Co., 1974).

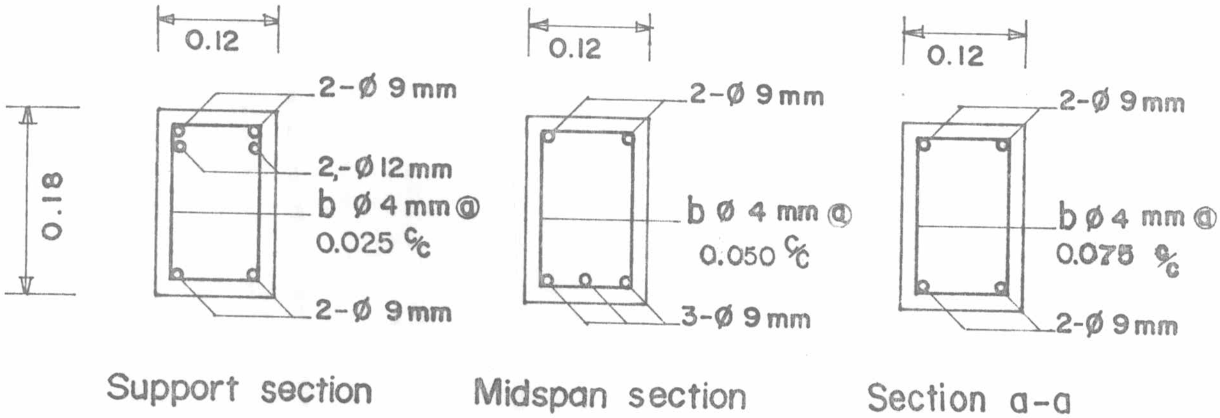
Table 6.1 - Variation in Reinforcement Requirement for S-beam Model

θ deg	Minimum Required Area of Reinforcement cm^2		
	Longitudinal		Binding
	Top	Bottom	
0	0.633	1.688	0.051S
10	0.830	1.843	0.023S
20	0.668	1.403	0.013S
30	0.078	0.763	0.013S
35	0.763	0.144	0.013S
40	0.763	0.019	0.013S
50	1.700	0.398	0.032S
60	3.340	0.750	0.095S

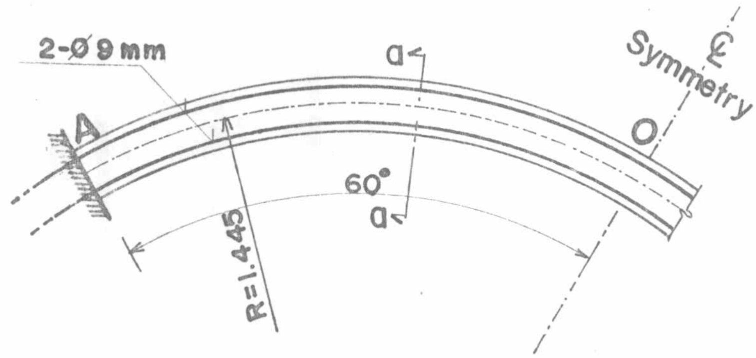
Table 6.2 - Variation in Reinforcement Requirement for Z-beam Model

Longitudinal Part			
Distance m	Minimum Required Area of Reinforcement cm^2		
	Longitudinal		Binding
	Top	Bottom	
x = 0.80	4.205	1.075	0.086S
0.55	2.481	0.582	0.079S
0.30	1.214	0.569	0.073S
0	0.555	0.962	0.065S
Transverse Part			
y = 1.00	1.009	0.645	0.073S
0.75	0.636	0.930	0.066S
0.50	0.628	1.415	0.060S
0.25	0.624	1.726	0.055S
0	0.644	1.854	0.049S

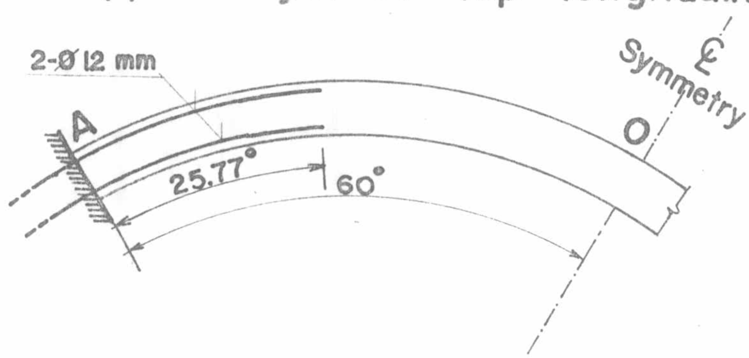
FIGURE 6.1 S-beam Model Details



(a) Detail sections

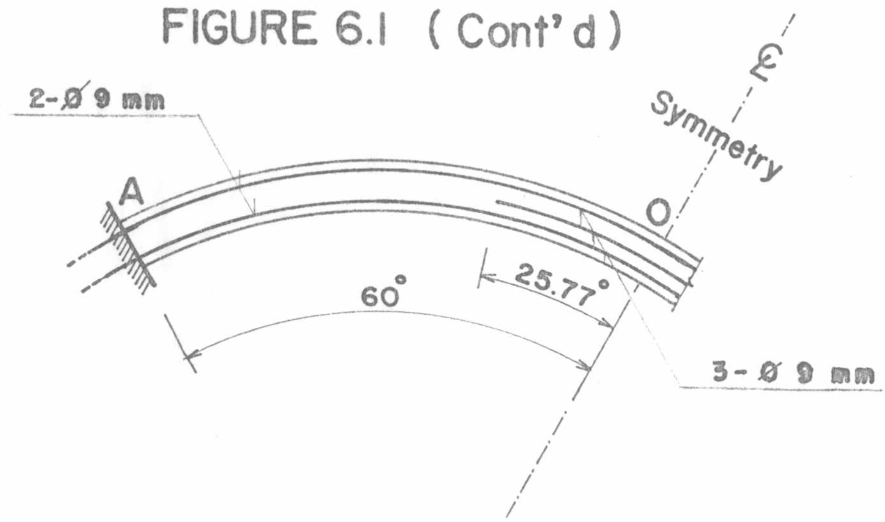


(b) Plan of upper layer of top longitudinal bars

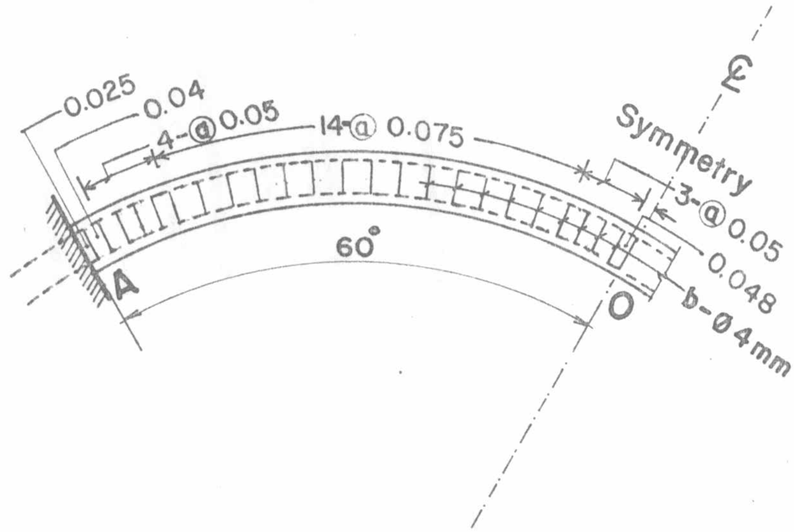


(c) Plan of lower layer of top longitudinal bars

FIGURE 6.1 (Cont'd)

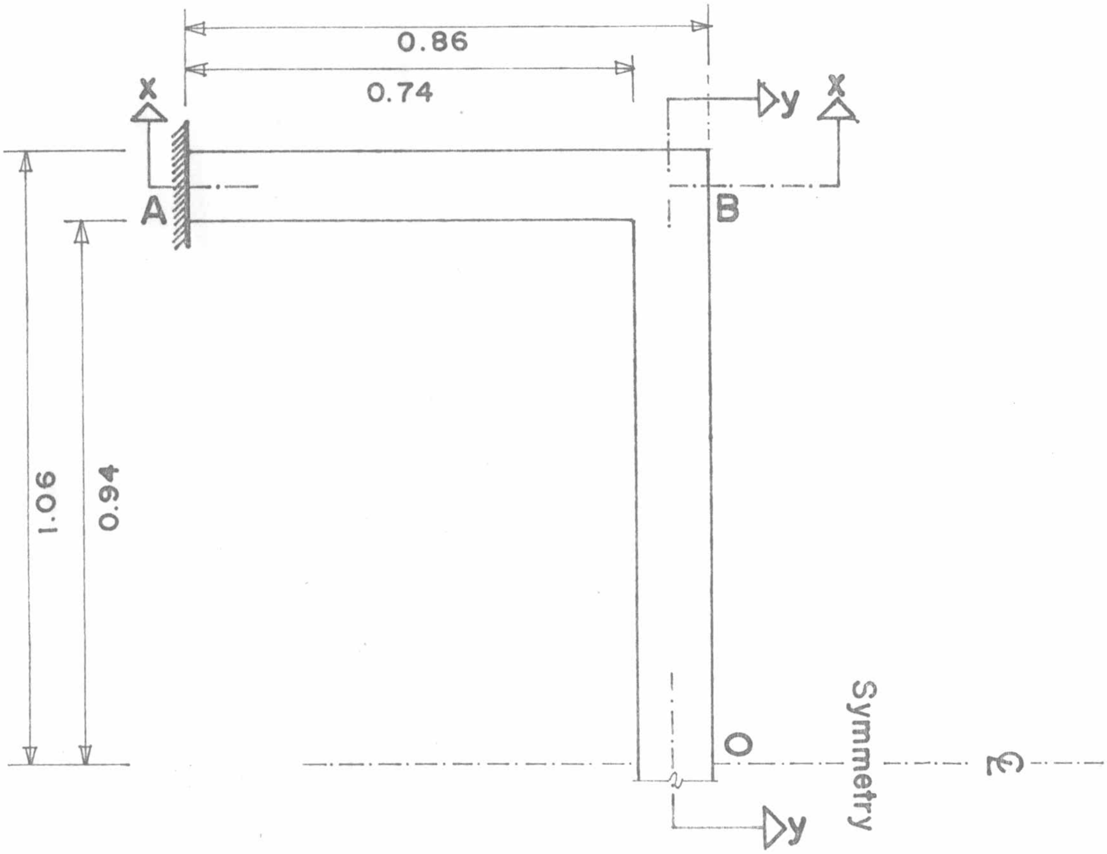


(d) Plan of bottom longitudinal bars

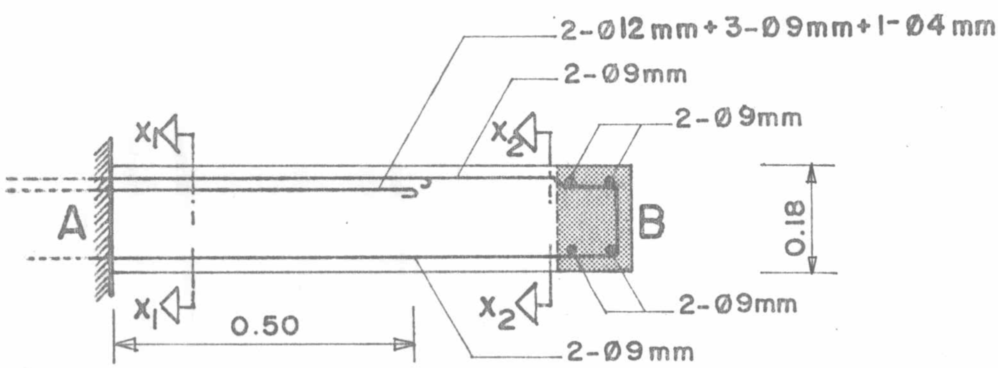


(e) Arrangement of binders

FIGURE 6.2 Z- beam Model Details

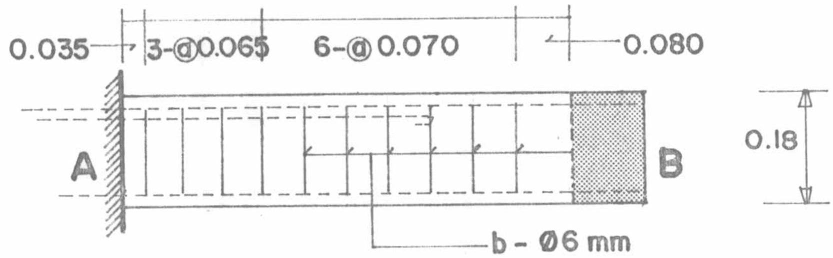


(a) Half-plan of the Z-beam model

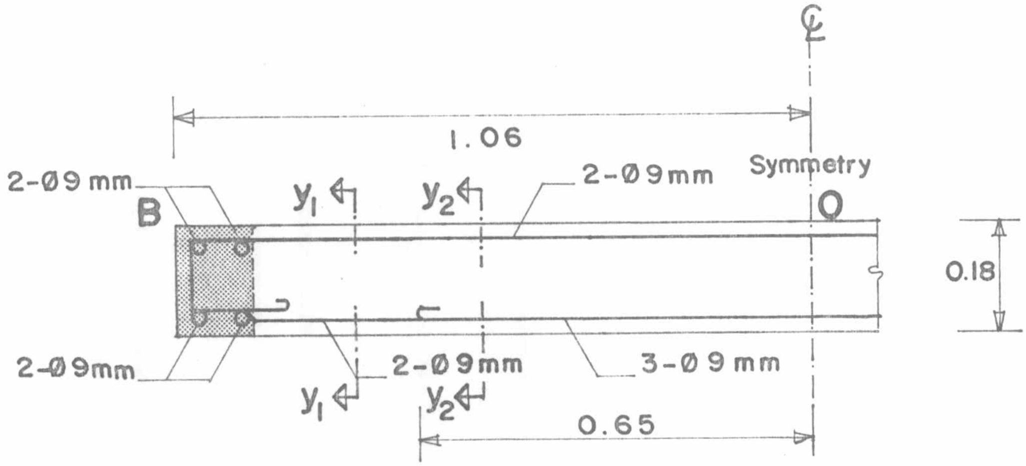


(b) Section x-x shows longitudinal reinforcement

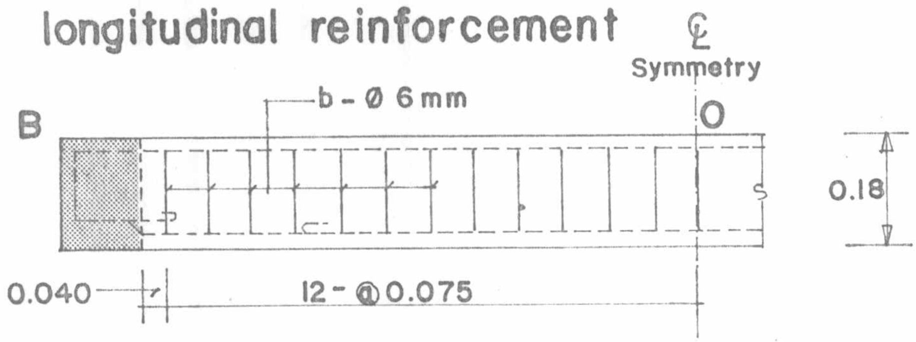
FIGURE 6.2 (Cont'd)



(c) Section x-x ; Arrangement of binders

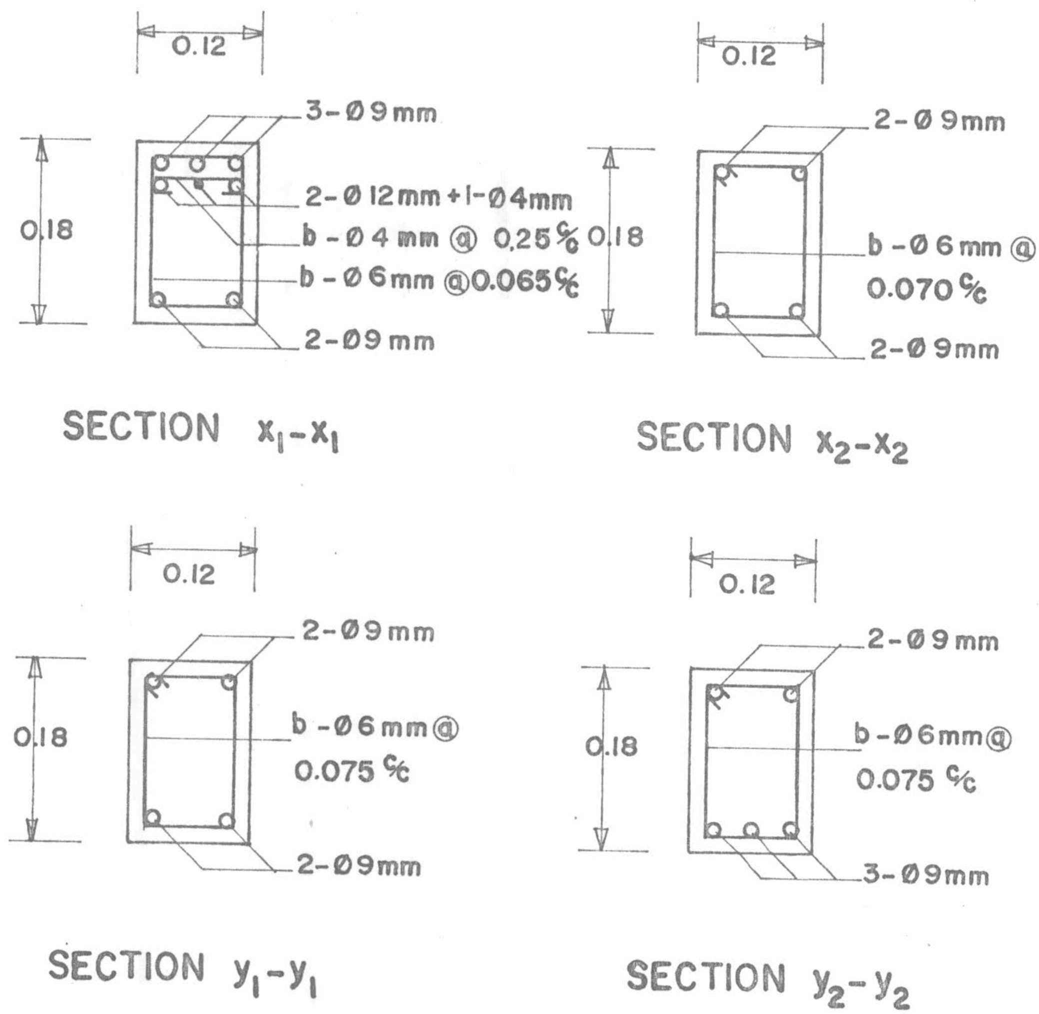


(d) Section y-y illustrates longitudinal reinforcement



(e) Section y-y ; Arrangement of binders

FIGURE 6.2 (Cont' d)



(f) Detail sections

6.2 Construction of the Models

An alfresco ground integrated into the Royal Irrigation Department's laboratory compound in Nontaburi rendered services to the construction and testing of the models. The construction commenced with driving of timber piles, each with 15 centimetres in diameter and 6 metres in length, bearing concrete footings each 2.00 by 2.00 by 0.60 metres in size. A concrete column 80 by 80 centimetres in cross-section and 1.15 metres in height rested on each footing, totalling four in number. Each pair of columns functioned as the model's fixed support. The model proper, the columns, and the footings were erected as integral parts of one another to form a space frame of some sort. The columns and footings were heavily reinforced so as to limit their deformation to a minimum. Beam forms of structural grade timber were lined on the inside with plywood. Placement of reinforcement underwent immense care to ensure positioning integrity appropriate to first-rate research.

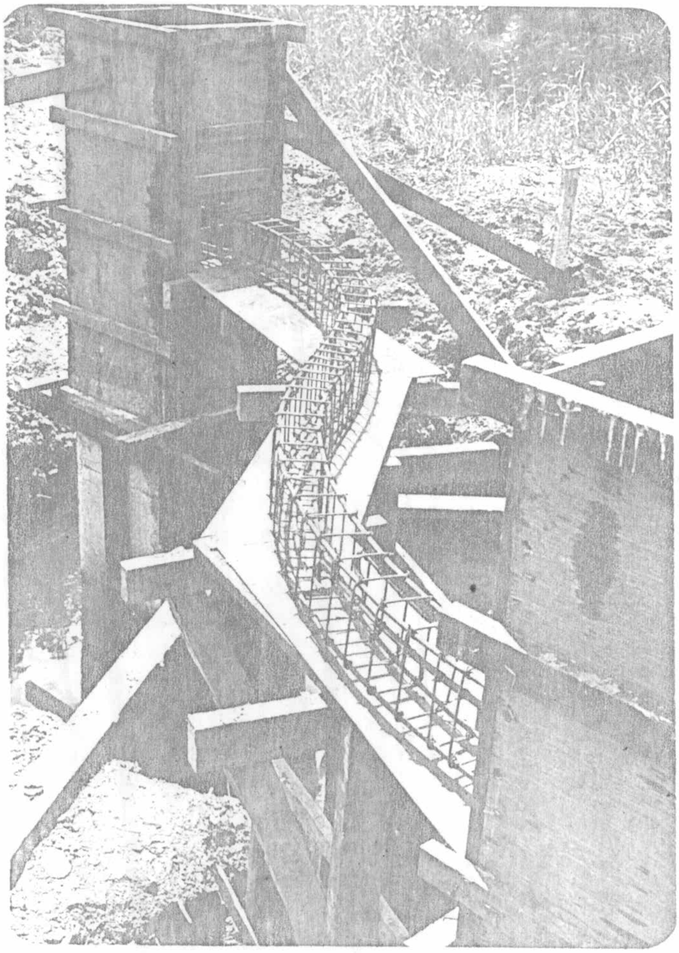
One cubic metre of the model-forming concrete proportioned to exhibit a cylinder strength of 210 kilogrammes per square centimetres at 28 days'age features the following constituents:

ordinary Portland cement (Elephant brand; Type III)	368 kg,
river sand	1,054 kg,
crushed limestone	615 kg, and
water	232 kg

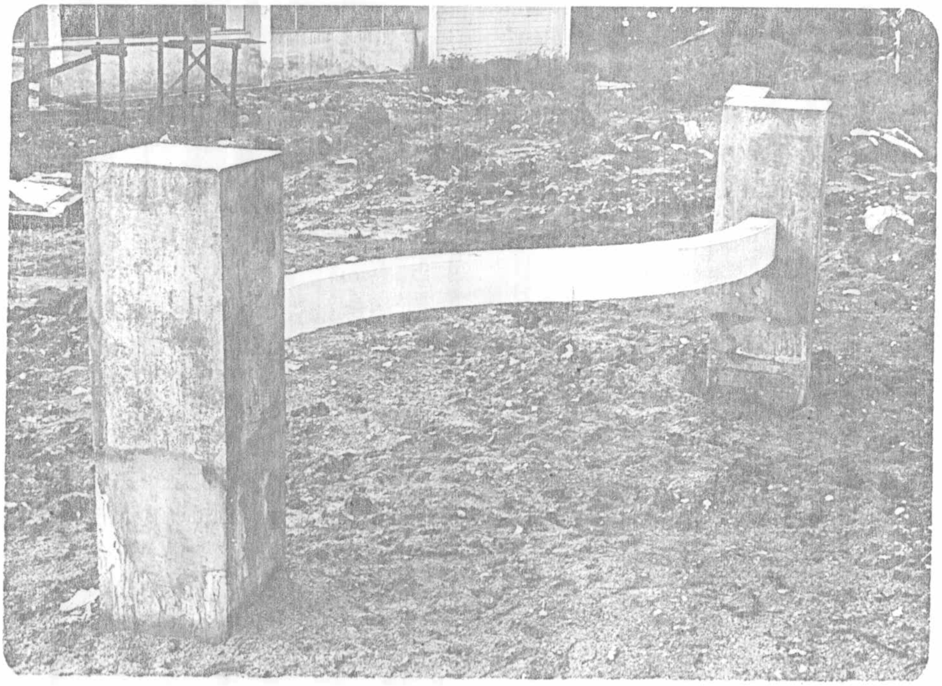
The sand possessed a specific gravity of 2.62 and a fineness modulus of 3.13. The crushed limestone with a maximum size of 1 centimetre bore a specific gravity of 2.73, a dry unit weight of 1,481.40 kilogrammes per cubic metre, and a fineness modulus of 3.39. The concrete mix particularised in the foregoing corresponds to a mix proportion of 1:2.86:1.67 by weight with a water-cement ratio of 0.63. Standard cylinders were so cast and stored as to generate a highly accurate representation of the models' concrete. These cylinders revealed, at the date of testing of the models, an average compressive strength of 210.4 kilogrammes per square centimetre. Details regarding properties of the concrete materials and representative cylinders emerge in Appendix D.

The reinforcing steel employed falls into the structural-grade classification. Round bars with diameters of 4, 6, 9, and 12 millimetres were undertaken to reinforce the beam proper. Information on the strength properties of these bars has been included in Appendix D.

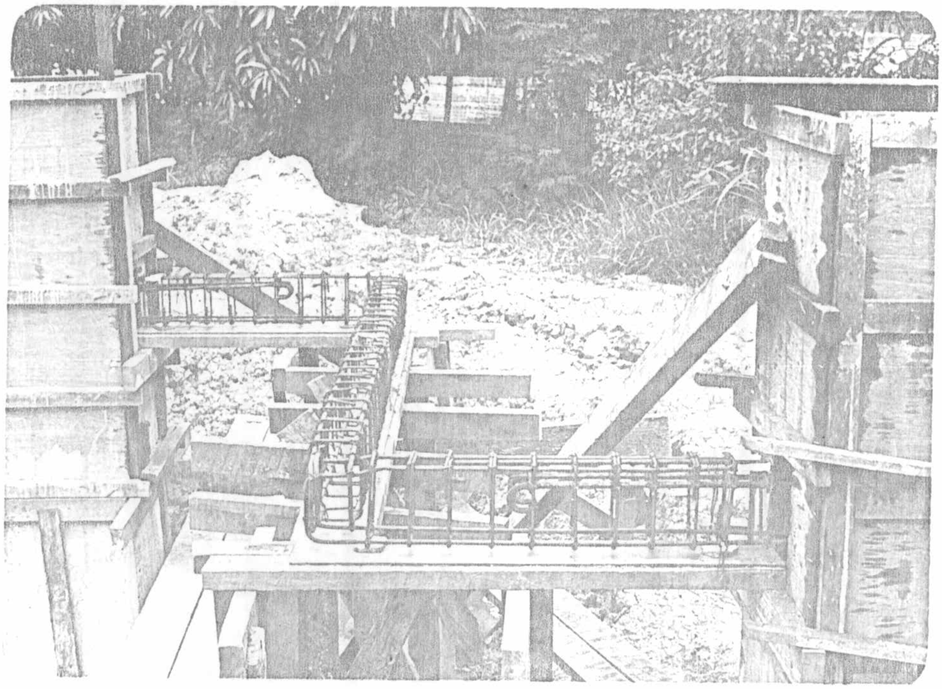
The entire construction consumed a three months' time from June to September 1980. Removal of forms took place after the models had attained 15 days' age. 25 days' continual curing with the aid of soaked gunny bags was administered to the models. Photographs 6.1, 6.2, 6.3, and 6.4 register a few among the many recording the progress and completion of the construction.



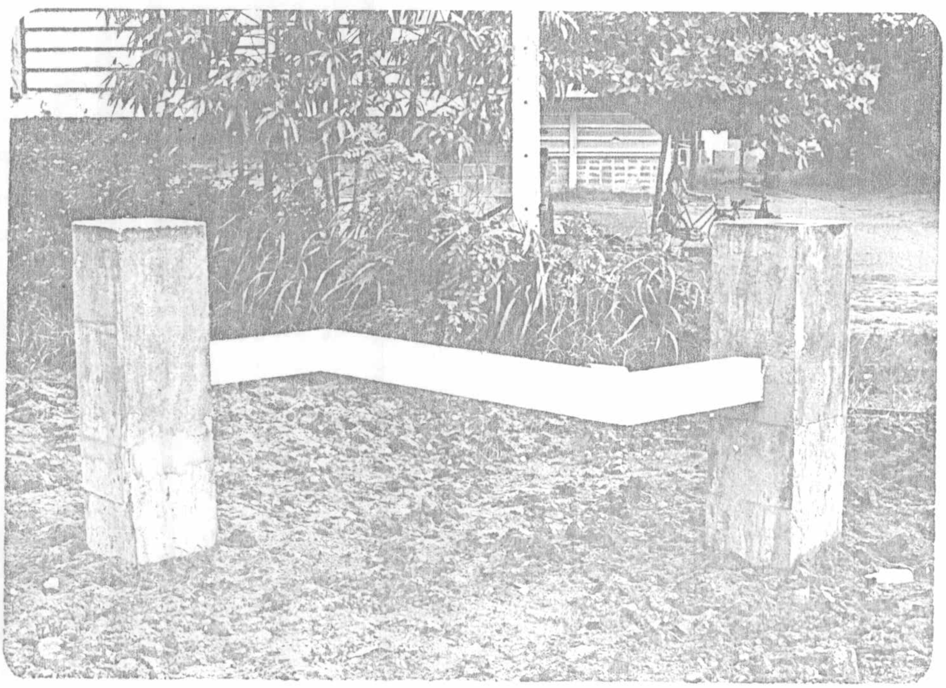
Photograph 6.1 Installation of Reinforcement for S-beam Model.



Photograph 6.2 S-beam Model after Completion of Construction.



Photograph 6.3 Installation of Reinforcement for Z-beam Model.



Photograph 6.4 Z-beam Model after Completion of Construction.