CHAPTER 6

EXPERIMENTAL WORK

6.1 General

To verify the analytical theory developed and to obtain experimental data, experimental work was planned and executed. The details and the experimental data are presented in this chapter.

6.2 Scope of Experimental Work

Static tests are performed on 24 beam column specimens. Each specimen has cross-sectional dimensions of 15 cm x 20 cm. The length of member is fixed as 100 cm between the loading faces. Of the total of twenty four beam column test specimens, twelve number provided a basis for experimental observation of the mode of failure for a variation of steel contents in the range of 1 to 3 percent at a constant ratio of the tension reinforcement to the compression reinforcement as equal to one.

These twelve specimens were divided into three categories. Each of the four beam columns in the first category had tension reinforcement of 2 numbers

of 12 mm diameter bars. Each of the four beam columns in the second category had tension reinforcement of 3 numbers of 12 mm diameter bars, while the rest of the beam columns in the third category were reinforced by 8 numbers of 12 mm diameter bars distributed uniformly on the section. Sectional dimensions and the reinforcement details are shown in Figs. 6.1 and 6.2.

Testing programme provided a basis for the study of beam column behaviour for four different eccentricity ratios in each category.

The other twelve specimens were tested to study the effect of variation of the ratio of tension reinforcement and the compression reinforcement on the mode of failure. Three such ratios of 1, 1.5 and 2 were established in the testing specimens. The tension reinforcement consisted of 2 numbers of 10 mm diameter bars for each of the 12 specimens.

The loading was applied at four different eccentricity ratios.

The testing programme, thus provided a basis for study of beam column behaviour for different eccentricity ratios for 2 distinct aspects of sectional properties.

Analytical predictions of ultimate load capacity of the sections were compared with the experimental data.

6.3 Material Strengths

Three concrete cubes of 15 cm x 15 cm x 15 cm and six concrete prisms of 7.5 cm x 7.5 cm x 15 cm were cast for each batch of concrete. The crushing strength of cubes and prisms and the stress strain diagrams for the prisms were recorded.

Mild steel bar specimens from each set were tested. Stress strain curve, yield point, ultimate load and percent elongations were recorded. An average yield stress of 3000 kg/cm^2 was observed for mild steel specimens.

E_s for mild steel was obtained as 2.1×10^6 kg/cm^2. Modular ratio m was calculated by the relation E_s / E_o where E_o for concrete was obtained from stress strain relationship of concrete prism specimens. Results of cube and prism testing are recorded in Tables 6.1 and 6.2.

6.4 Testing Equipment

The beam column specimens were tested on compression testing machine of 200 T. capacity in

structural engineering laboratory. The beam columns had two ends hinged while testing. Hinge loading device with the specimen is shown in Fig.6.3. Beam column specimen is first aligned at bottom to marking lines M with the seat resting against concrete. The assembly is then drawn to the testing machine. The alignment at the top of the specimen is then done to marking lines M at the top. The testing machine is set for initial load at this operation. The specimen is guarded by ropes to avoid accident. The steel balls of 25 mm diameter shown in the figure help to achieve a hinge loading on the specimen. The device worked satisfactorily.

Dial gauges to measure lateral deflections in two major directions at the mid height were used. Strains on concre faces were measured by Demac Strain Gauge at 20 cm gauge lengths.

TABLE 6.1

CONCRETE CUBE STRENGTH

Specimen No. and mark	Date of Casting	Date of Testing	Average cube Strength in kg/cm^2
1 MUP 1/5	1-5-78	31-5-78	
2 MUP 1/5	1-5-78	1-6-78	251.43
3 MUP 28/4	28-4-78	2-6-78	
4 MUP 28/4	28-4-78	2-6-78	
5 MUP 2/5	2-5-78	31-5-78	
6 MUP 2/5	2-5-78	31-5-78	220.15
7 MUP 4/5	4-5-78	1-6-78	
8 MUP 4/5	4-5-78	2-6-78	
9 MUP 3/5	3-5-78	1-6-78	
10 MUP 3/5	3-5-78	1-6-78	241.58
11 MUP 3/5	3-5-78	31-5-78	
12 MUP 3/5	3-5-78	1-6-78	
13 S1 7/5	7-5-78	7-6-78	
14 S1 4/5	4-5-78	8-6-78	233.33
15 S1 4/5	4-5-78	8-6-78	
16 S1 7/5	7-5-78	8-6-78	
17 S2 5/5	5-5-78	9-6-78	
18 S2 5/5	5-5-78	9-6-78	224.88
19 S2 5/5	5-5-78	9-6-78	
20 S2 5/5	5-5-78	9-6-78	
21 S3 6/5	6-5-78	10-6-78	
22 S3 6/5	6-5-78	10-6-78	273.78
23 S3 6/5	6-5-78	9-6-78	
24 S3 6/5	6-5-78	9-6-78	

TABLE 6.2

CONCRETE PRISM STRENGTH

Specimen No.	Average Prism Strength in Kg/cm^2	E_o Kg/cm^2
1 2 3 4	236.99	3.4×10^5
5 6 7 8	190.72	3.64×10^5
9 10 11 12	189.38	1.89×10^5
13 14 15 16	227.80	2.02×10^5
17 18 19 20	239.20	2.05×10^5
21 22 23 24	219.00	2.49×10^5

Note : Specimen mark, date of casting and date of testing shall be as in Table 6.1

TABLE 6.3

BEAM-COLUMN SPECIMEN DATA

Specimen No. *	e_x cm	e_y cm	D'_x	D'_y	mp @	Z	N
1	3.81	10.16	- 0.25	0			
2	3.81	15.24	- 0.25	0.30	0.05	1.0	2.05
3	3.81	20.32	- 0.25	0.58			
4	0.00	20.32	- 0.50	0.58			
5	3.81	10.16	- 0.25	0			
6	3.81	15.24	- 0.25	0.30	0.07	1.0	2.73
7	3.81	20.32	- 0.25	0.58			
8	0.00	20.32	- 0.50	0.58			
9	1.30	5.08	- 0.37	- 0.25			
10	2.60	10.16	- 0.33	0	0.19	1.0	1.43
11	3.81	20.32	- 0.25	0.58			
12	0.00	20.32	- 0.50	0.58			
13	4.00	20.00	- 0.20	0.57			
14	0.00	20.00	- 0.50	0.57	0.06	1.0	1.36
15	4.00	15.00	- 0.20	0.29			
16	4.00	10.00	- 0.20	0			
17	4.00	25.00	- 0.20	0.86			
18	4.00	20.00	- 0.20	0.57	0.06	1.5	1.36
19	0.00	20.00	- 0.50	0.57			
20	4.00	15.00	- 0.20	0.29			
21	4.00	25.00	- 0.20	0.86			
22	4.00	20.00	- 0.20	0.57	0.06	2.0	1.36
23	0.00	20.00	- 0.50	0.57			
24	4.00	15.00	- 0.20	0.29			

* For specimen dimension, see Fig.6.1

@ For reinforced details, see Fig.6.2

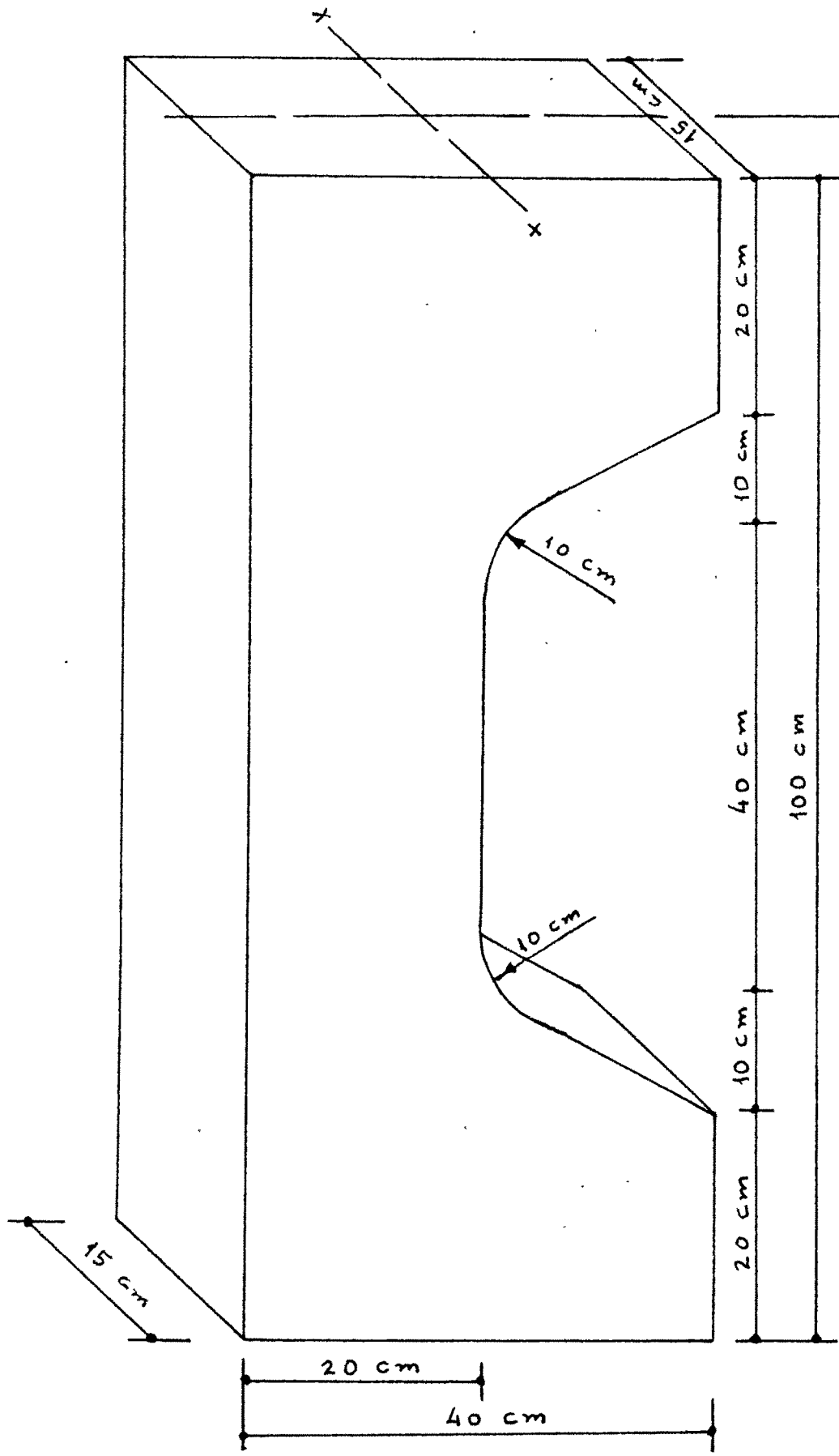
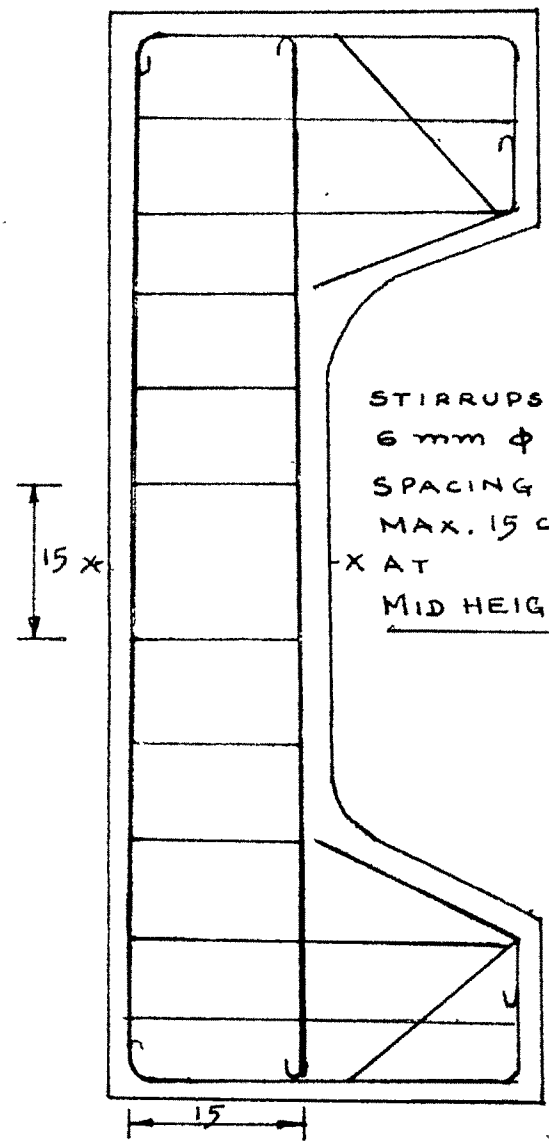
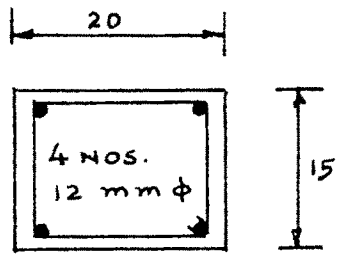


FIGURE 6.1 BEAM-COLUMN DIMENSIONS

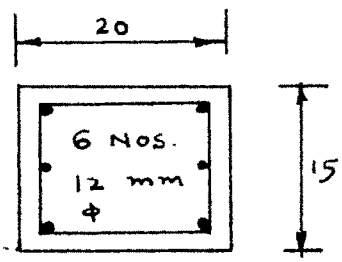


TYPICAL DISPOSITION OF REINFORCEMENT

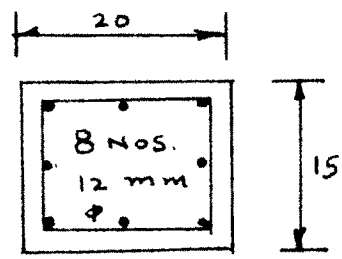
SECTION AT X-X



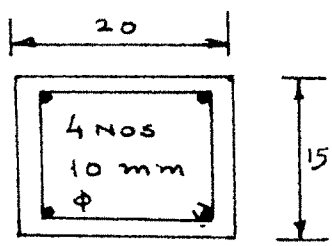
BEAM - COLUMN
1, 2, 3, 4



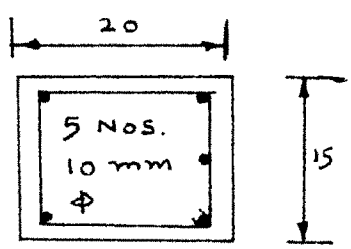
BEAM - COLUMN
5, 6, 7, 8



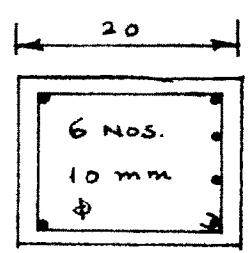
BEAM - COLUMN
9, 10, 11, 12



BEAM-COLUMN
13, 14, 15, 16



BEAM-COLUME
17, 18, 19, 20



BEAM-COLUMN
21, 22, 23, 24

FIGURE 6-2

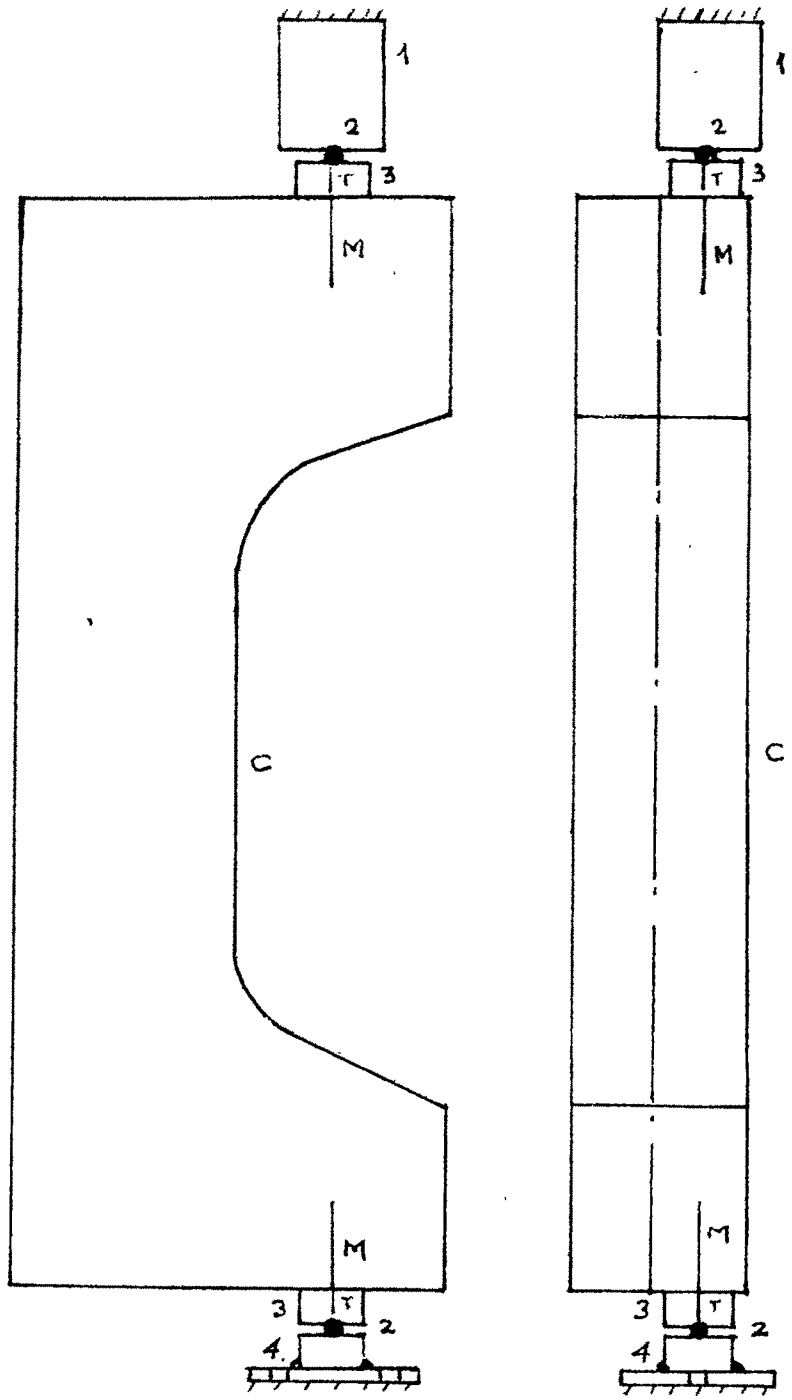
ARRANGEMENT OF REINFORCEMENT AND SECTION DETAILS

1. Attachment to Testing Machine
2. 25 m.m DIA. STEEL BALL
3. Seat to Rest Against Concrete
   6 cm. Dia
   3 cm. Ht.
4. Bottom Seat welded with Plate

M Marking On Specimen

T Marking On 3

C beam-column Specimen



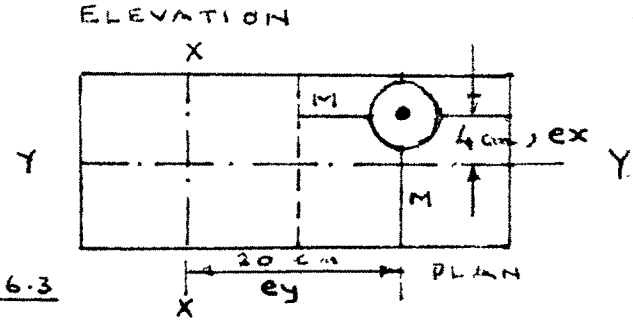


FIGURE 6.3

HINGE DEVICE IN POSITION WITH SPECIMEN LOADING AT $e_x = 4$ cm, $e_y = 20$ cm