CHAPTER 7

TEST

7.1 Instrumental and Operational Preparation

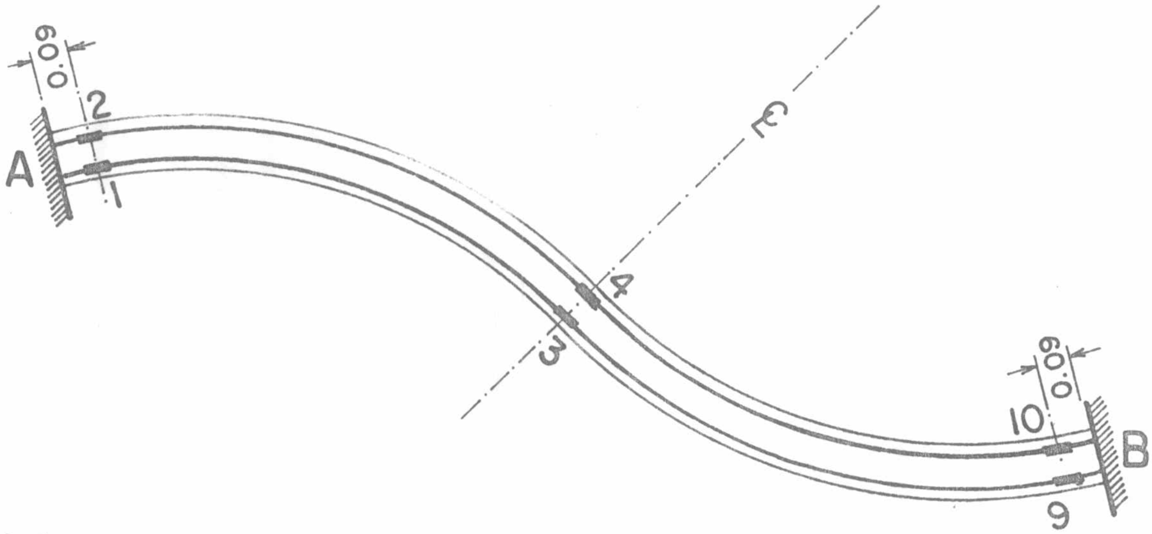
Electrical resistance strain gauges each with a resistance of 120 ohms were employed for detecting strains at diversified locations on each model. These gauges classify into two groups: (a) water-proof type with a gauge length of 5 millimetres and a gauge factor of 2.08; and (b) ordinary type with a gauge length of 3 centimetres and a gauge factor of 2.10. Water-proof gauges were mounted on reinforcement and ordinary ones on beam sides. Figures 7.1 and 7.2 give detail as to the positions of the mounted gauges. A Tinsley's Type 4907 strain indicator in conjunction with a reflecting galvanometer and a multi-point switch was called upon to record resistance changes in the gauges.

An extensometer was furnished at the centre-span of the beam to register the vertical deflection. In an effort to minimise displacement of the supporting columns, thereby to attain a condition closely impersonating the theoretical fixity of the beam's ends, the heads of the columns were tied to heavy road-construction equipment via steel cables. Each cable equipped with a turnbuckle bears a horizontal direction commensurate with the resultant plane analytically dictated by magnitudes of the end bending and torsional moments. Extensometers were installed along two orthogonal faces of each column to sense its movement and to enable corrective operation on the turnbuckle.

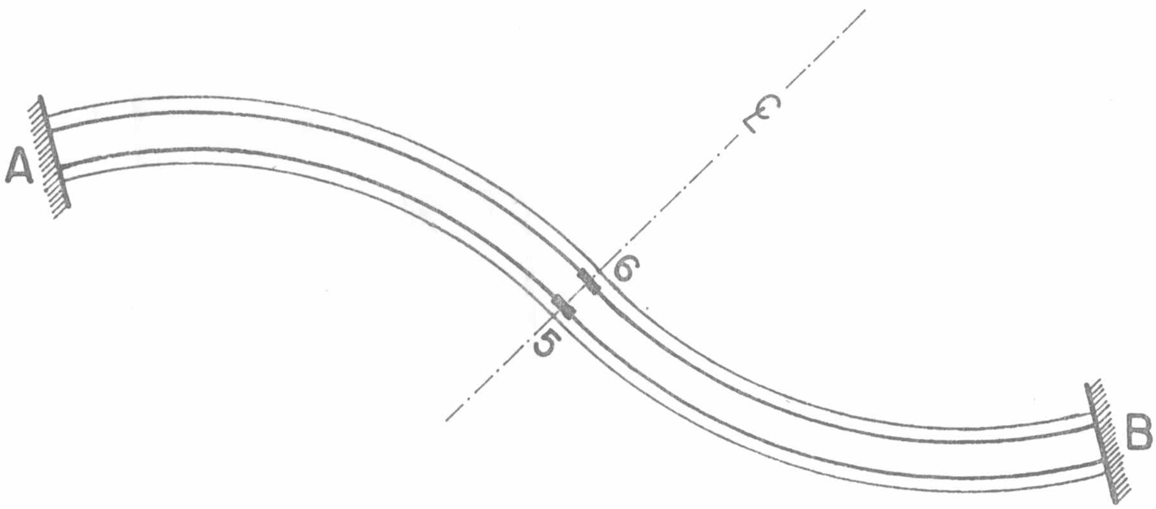
Sand bags each weighing 25 kilogrammes formed the means for loading the model. A load increment of 400 kilogrammes was imposed by juxtaposing the bags into a single layer over the beam. 21 men were commissioned to set the test in motion: two for photographic work; two for detection of cracks; four for arrest of support displacement; two for registration of extensometer readings; three for detection of electrical resistance changes; and eight for placement of sand bags on the beam.

Photographs 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, and 7.8 record attachment of electrical gauges and arrangement prior to testing.

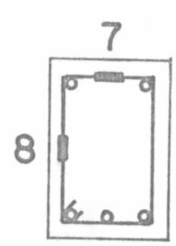
FIGURE 7.1 Locations of Strain Gauges Appropriate to S-beam Model



(a) On top bars in upper layer

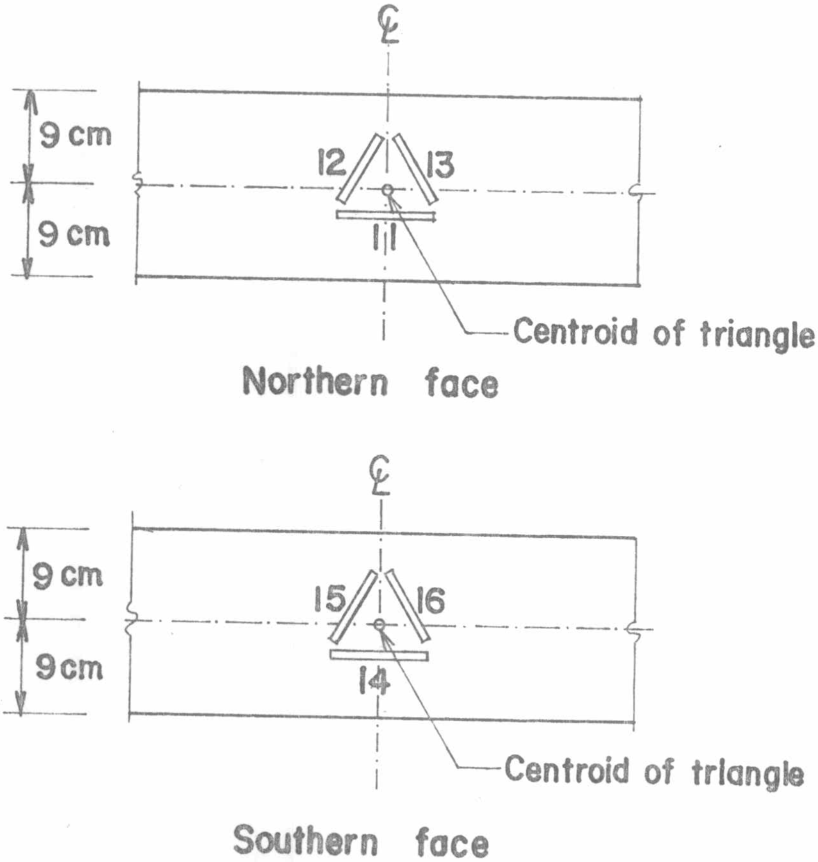


(b) On bottom bars



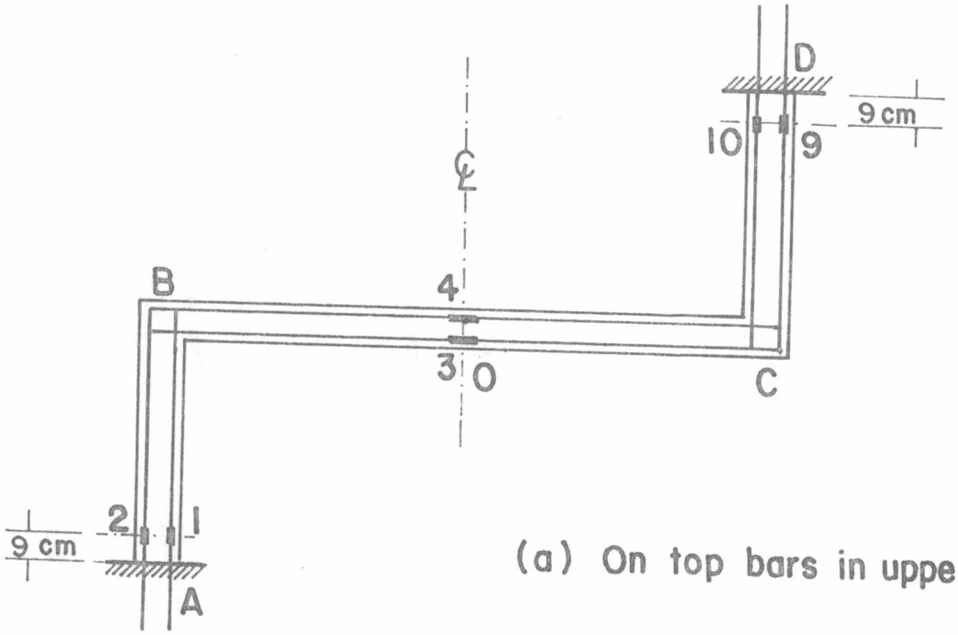
(c) On central binder

FIGURE 7.1 (Cont' d)

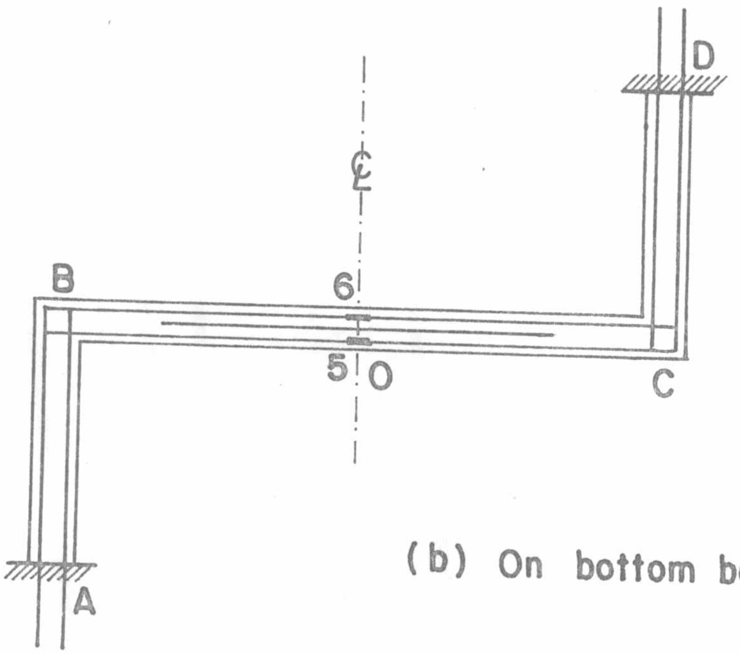


(d) On beam's sides

FIGURE 7.2 Locations of Strain Gauges Appropriate to Z-beam Model

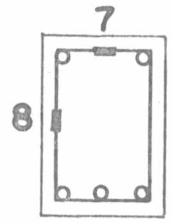


(a) On top bars in upper layer

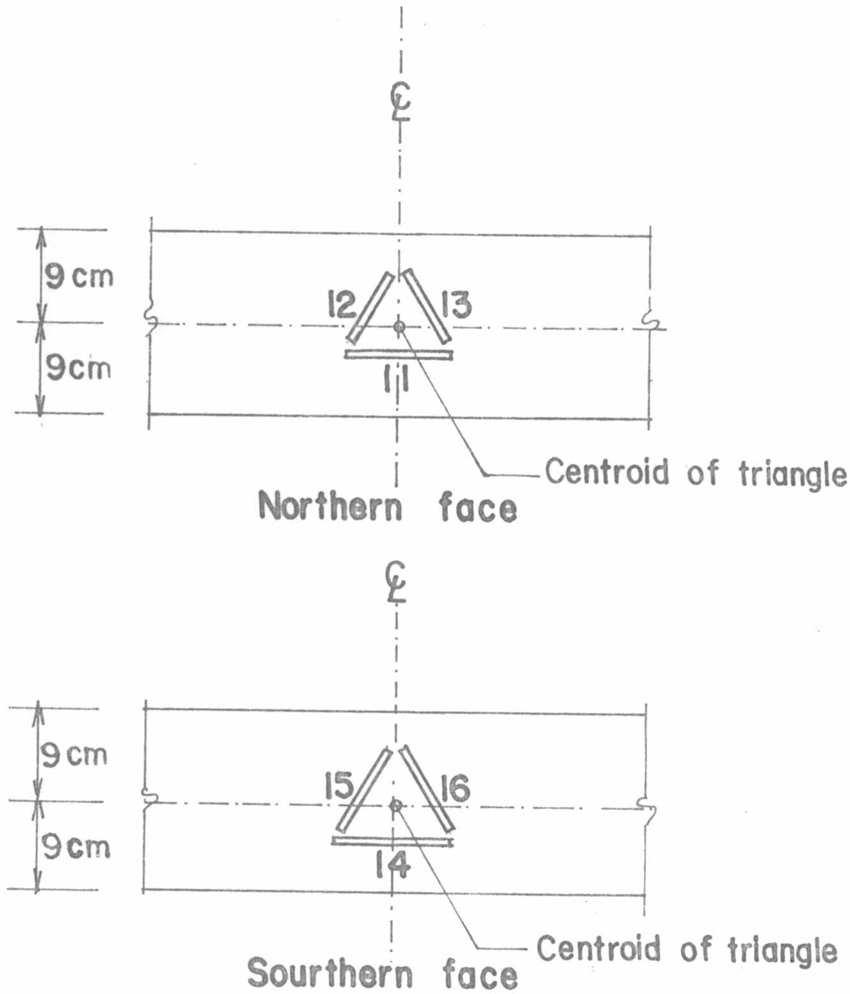


(b) On bottom bars

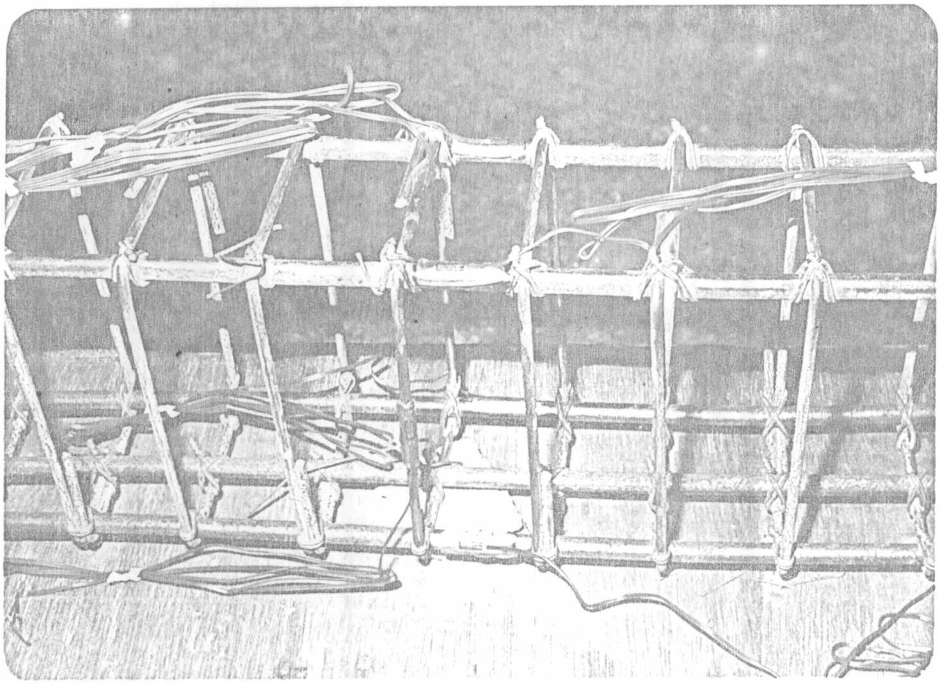
FIGURE 7.2 (Cont' d)



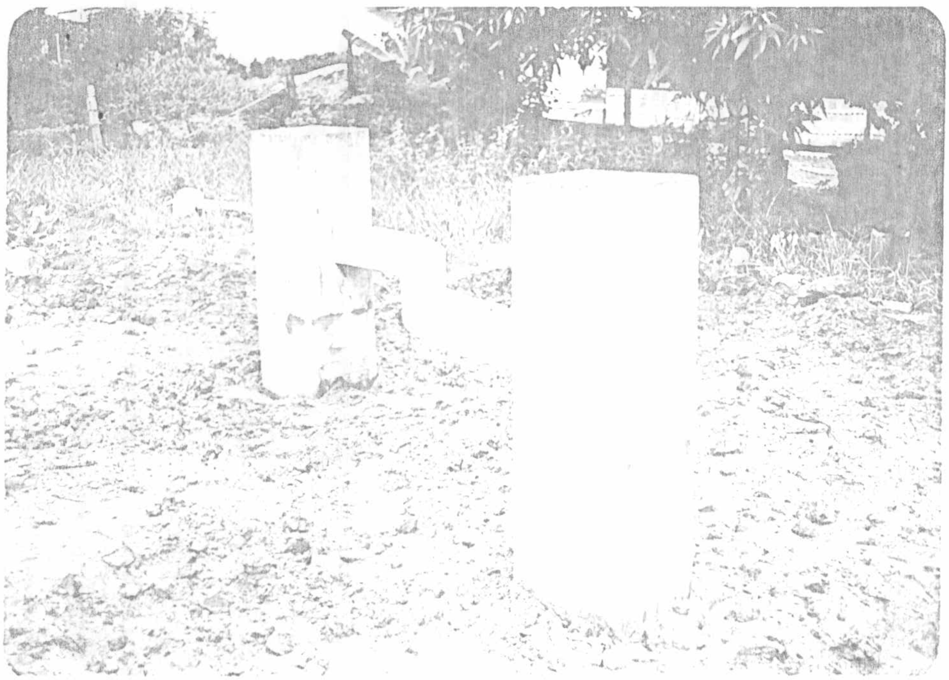
(c) On central binder



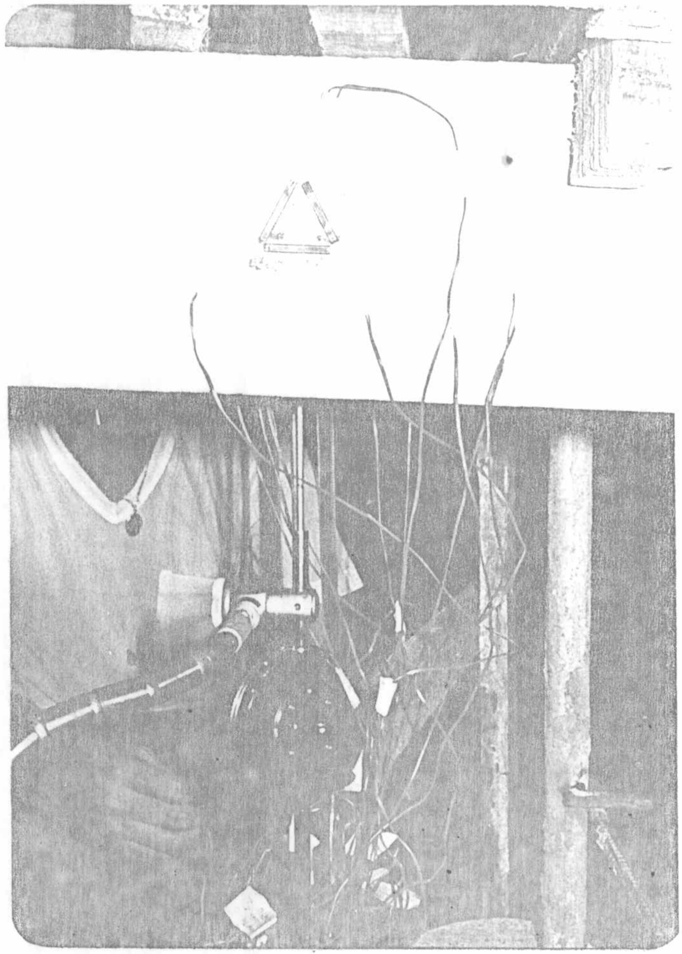
(d) On beam's sides



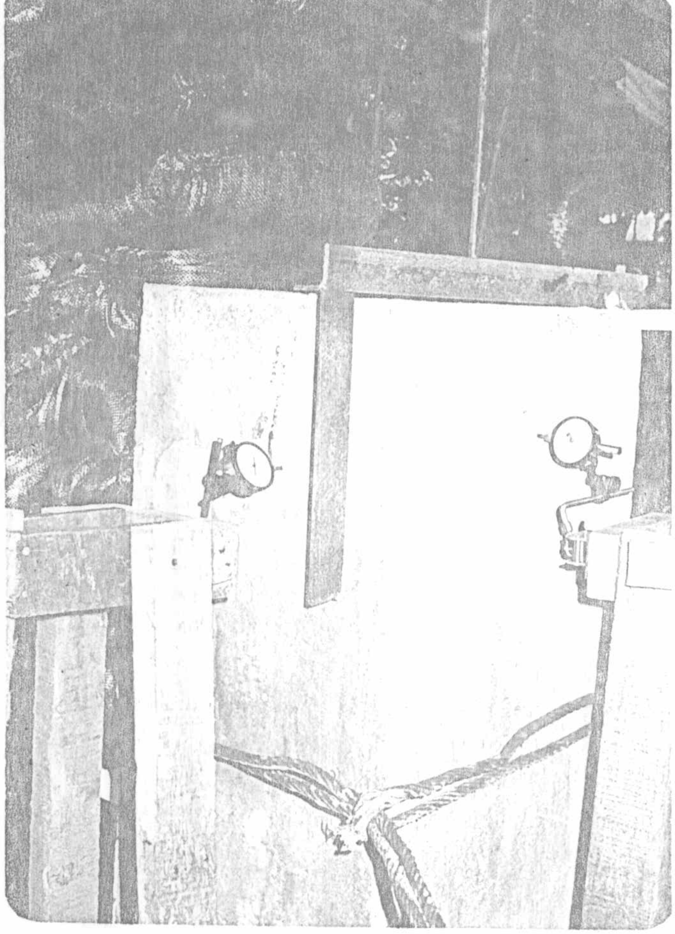
Photograph 7.1 A View of Attachment of Gauge to Reinforcement.



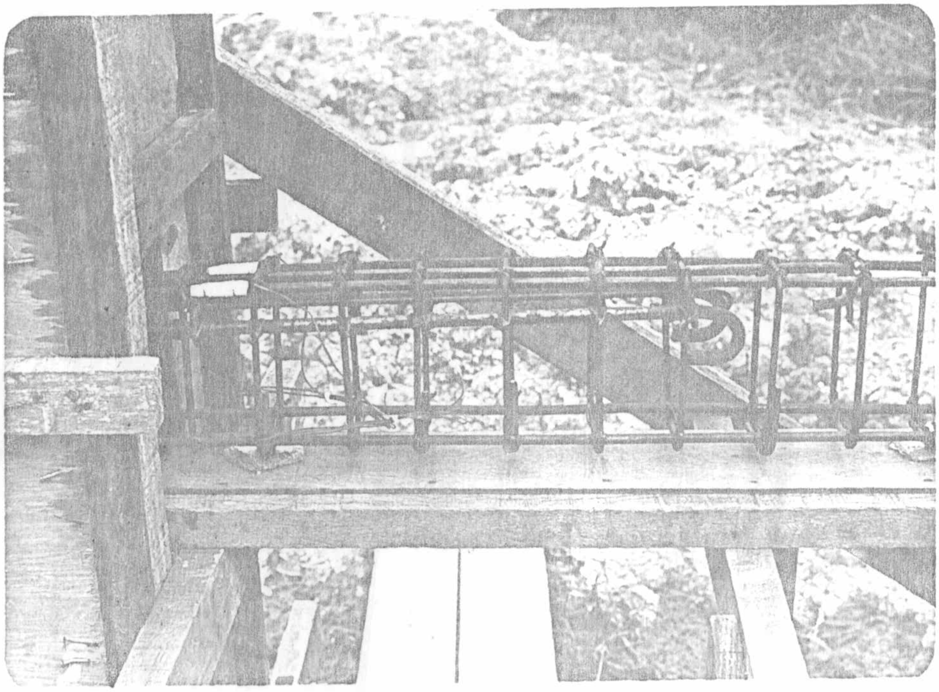
Photograph 7.2 S-beam Model Prior to Test; Wires for Resistance Change Detection Ply with Beam.



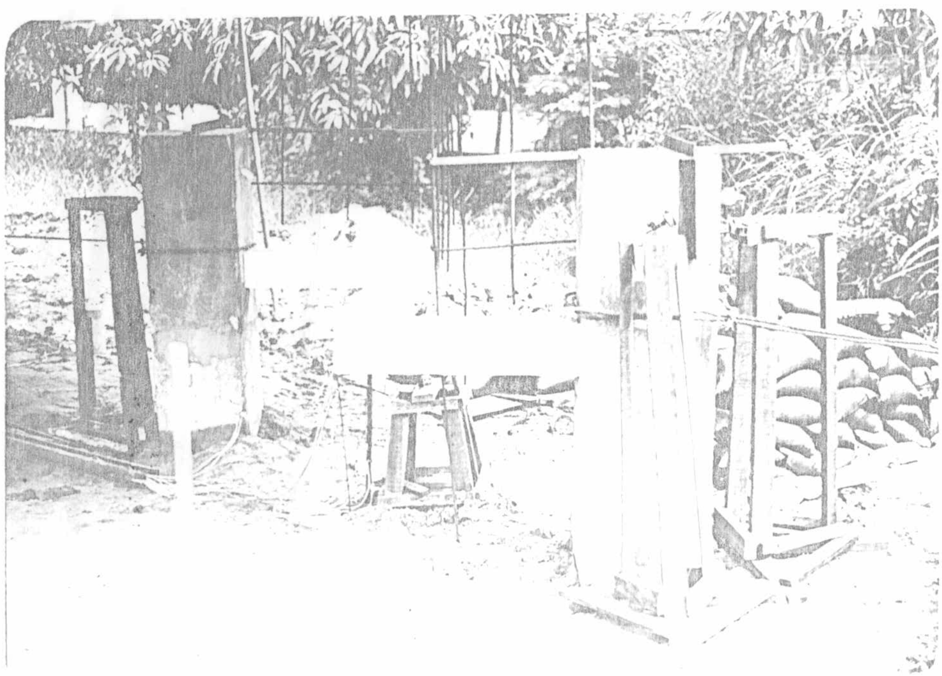
Phtograph 7.3 S-beam Model; Gauges Positioned at Centre-span to Form Rosette.



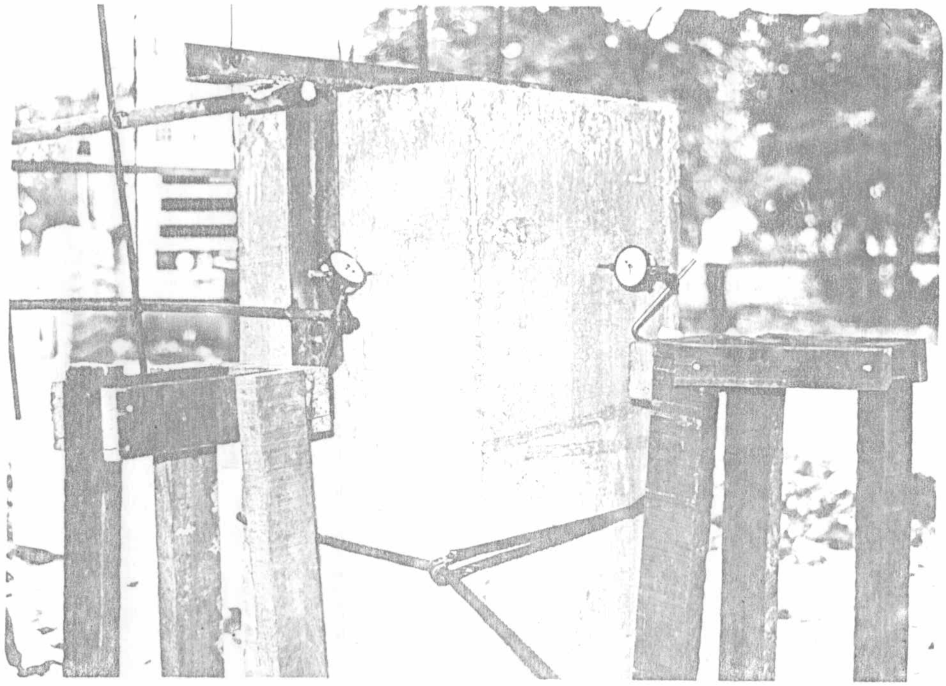
Photograph 7.4 S-beam Model; Arrangement for Arresting Displacement of Supporting Column.



Photograph 7.5 Z-beam Model; A View Showing Arrangement for Embedment of Electrical Strain Gauge in Beam.



Photograph 7.6 Z-beam Model Prior to Test.



Photograph 7.7 S-beam Model; Arrangement for Arresting Displacement of Supporting Column.

Photograph 7.8 Electrical Devices and Their Interconnection for Detecting Resistance Changes in Gauges.

7.2 Testing

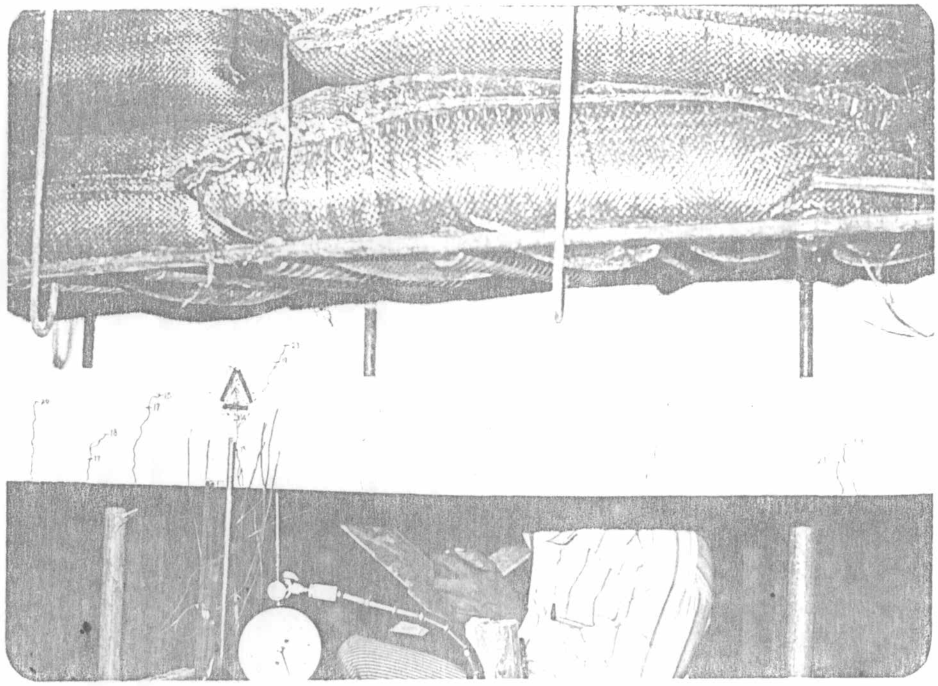
The test manoeuvred on September 11, 1980 conferred chronological priority on the S-beam model. The beam's concrete attained an age of 28 days at the test date. Imposition of each load increment corresponding to a uniform load intensity of 132 kilogrammes per lineal metre was immediately succeeded by registration of extensometer readings and resistance changes in gauges. Following application of an imposed load of 3,775 kilogrammes, equivalent to an intensity of 1,248 kilogrammes per metre, an incipient crack formed on an upper corner at a location bordering on each support. The corner referred to is incorporated into the intrados of each half-arc. Further application of load increments resulted in extension of this pioneering crack. The extended mark on the upper face of the beam made somewhat a right angle to the beam's longitudinal axis whereas the prolonged trace on the intrados showed a diagonal pattern. This diagonal formation well accords with the foreseeable sense of warping due to combined influence of critical torsion and shear. The fraternal crack emerging on the extrados at a further stage of loading somewhat pursued a vertical mode of development. This vertical formation emits predominance of bending in recognition of contradictory influences of torsion and shear.

The first crack in proximity to the centre-span on the beam's soffit came to pass at an imposed load of 1,380 kilogrammes per metre. Extension of this crack on each side of the beam assumed a diagonal pattern consistent with the sense of influencing twist. At a load of 2,545 kilogrammes per metre the test was called off seeing that the centre-span extensometer's pointer had been rotating at speed. Photographs 7.9, 7.10, 7.11, 7.12, 7.13, 7.14, and 7.15 represent proceedings of the test as well as depict modes of cracks.

Loading of the Z-beam model ensued in like manner. The following milestones were chronicled: load corresponding to formation of incipient crack at support, 1,215 kilogrammes per metre; load identifying with development of first crack at centre-span, 1,326 kilogrammes per metre; and load at termination of test, 2,115 kilogrammes per metre. Vital cracks exhibited similarity to ones on the S-beam model in respect of both location and pattern. Photographs 7.16, 7.17, 7.18, 7.19, 7.20, and 7.21 give a pictorial account of the test and its aftermath.

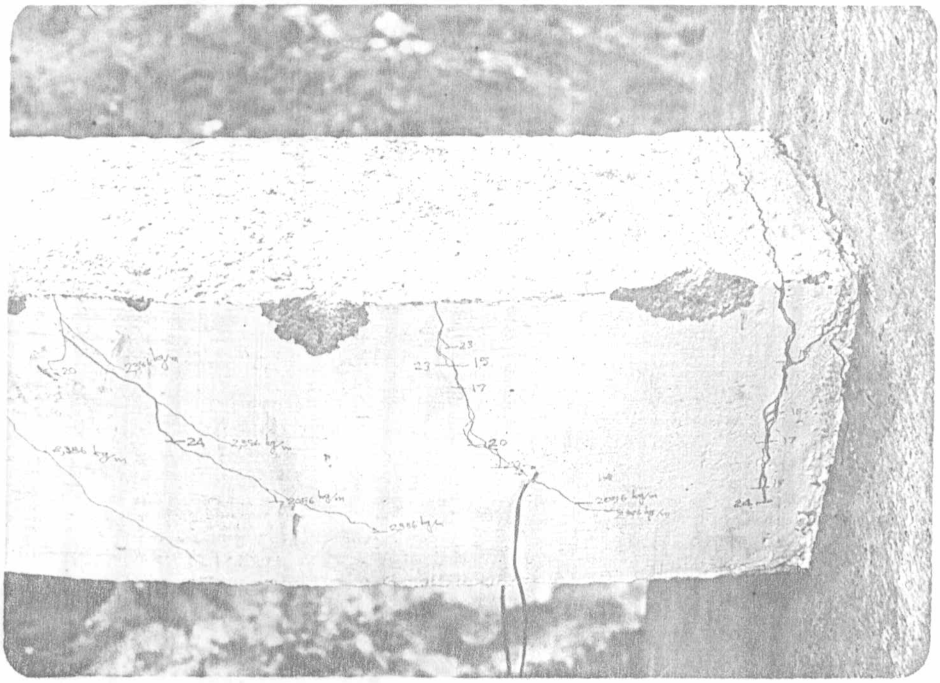
Photograph 7.9 S-beam Model at an Early Stage of Loading.

Photograph 7.10 S-beam Model at an Intermediate Stage of Loading.



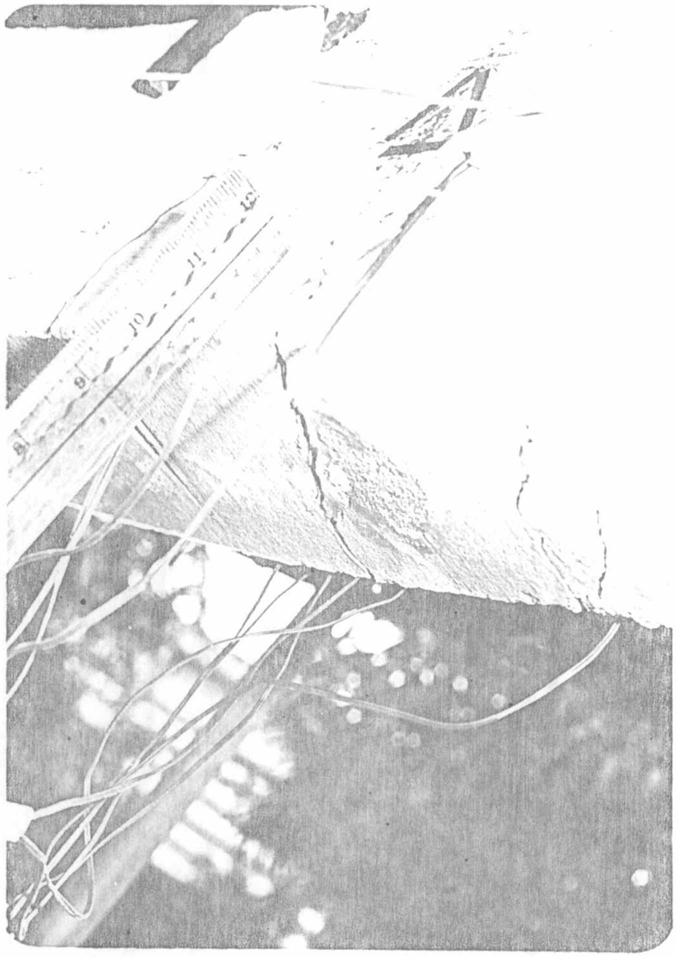
Photograph 7.11 S-beam Model; Registration of Crack Paths and Extensometer Readings.

Photograph 7.12 S-beam Model; Cracks on Intrados and Upper Face, in Proximity to Support.

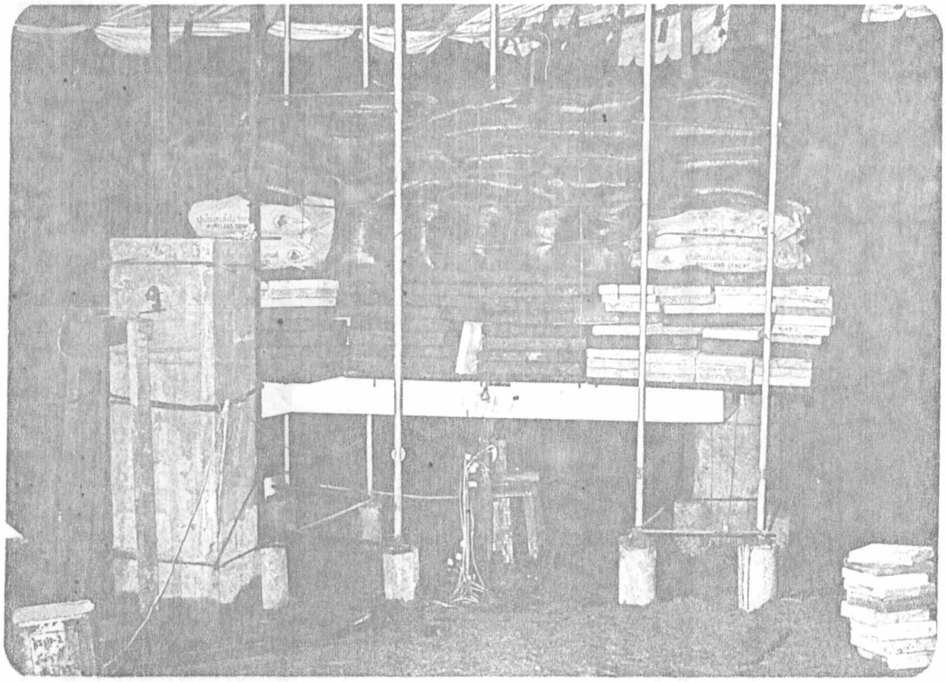


Photograph 7.13 S-beam Model; Cracks on Extrados and Upper Face in Proximity to Support.

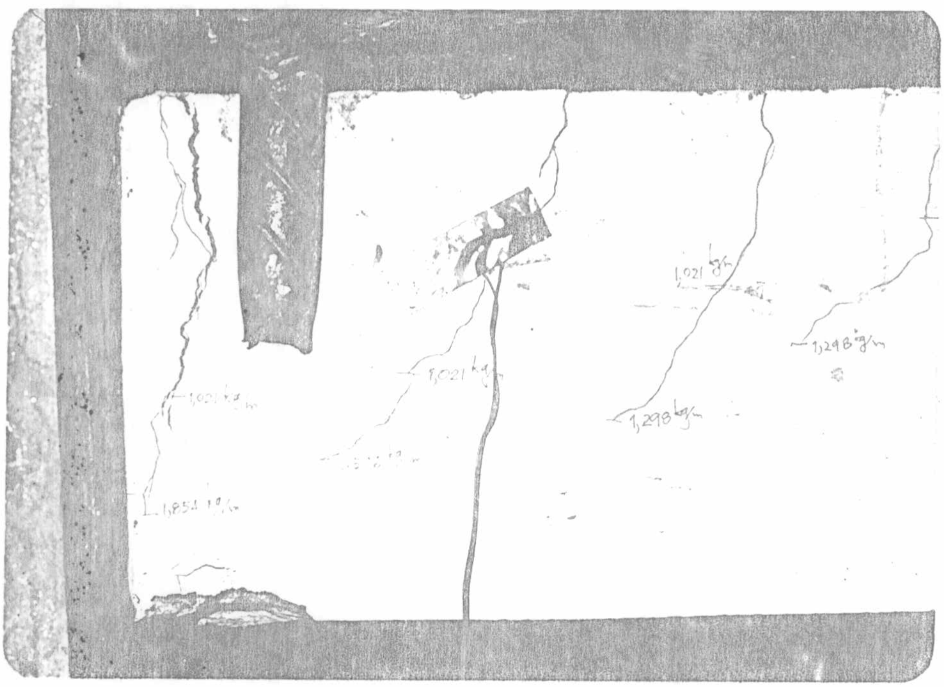
Photograph 7.14 S-beam Model; Crack at Centre-span.



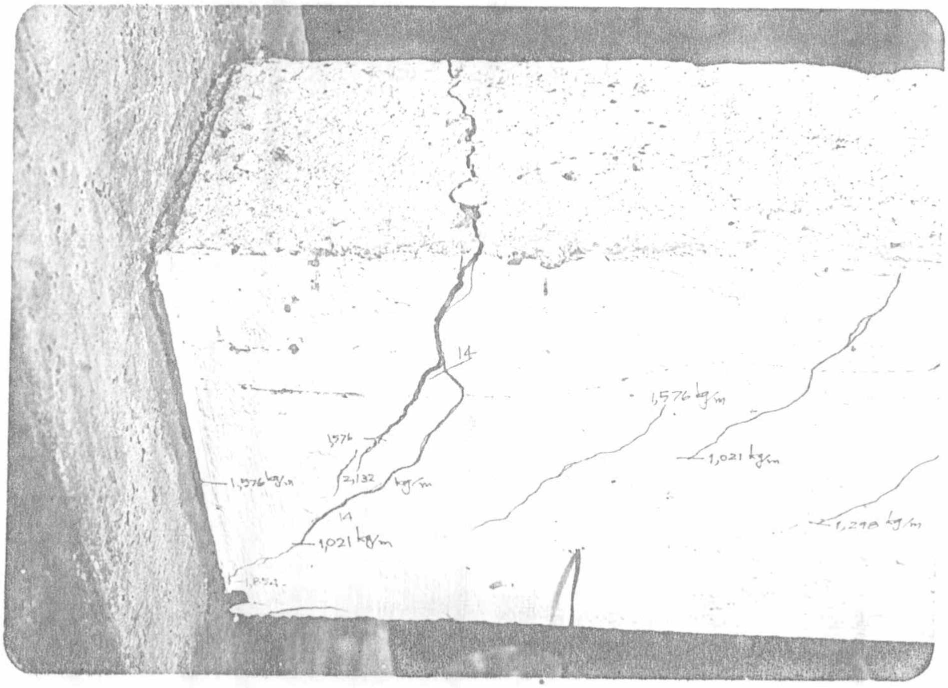
Photograph 7.15 S-beam Model; A View of Crack-riddled Soffit at Centre-span.



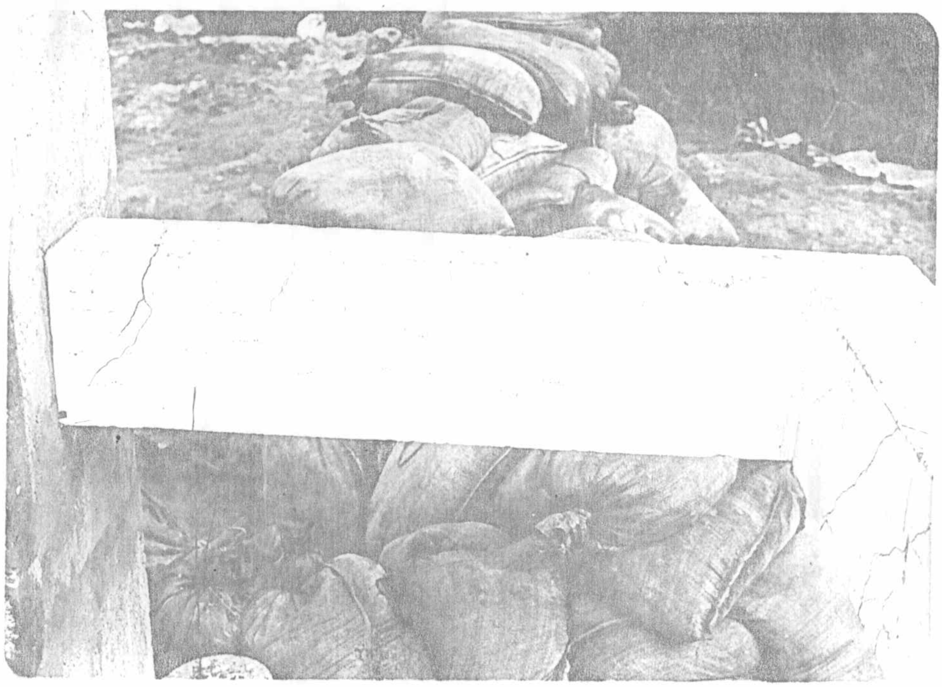
Photograph 7.16 Z-beam Model at an Early Stage of Loading.



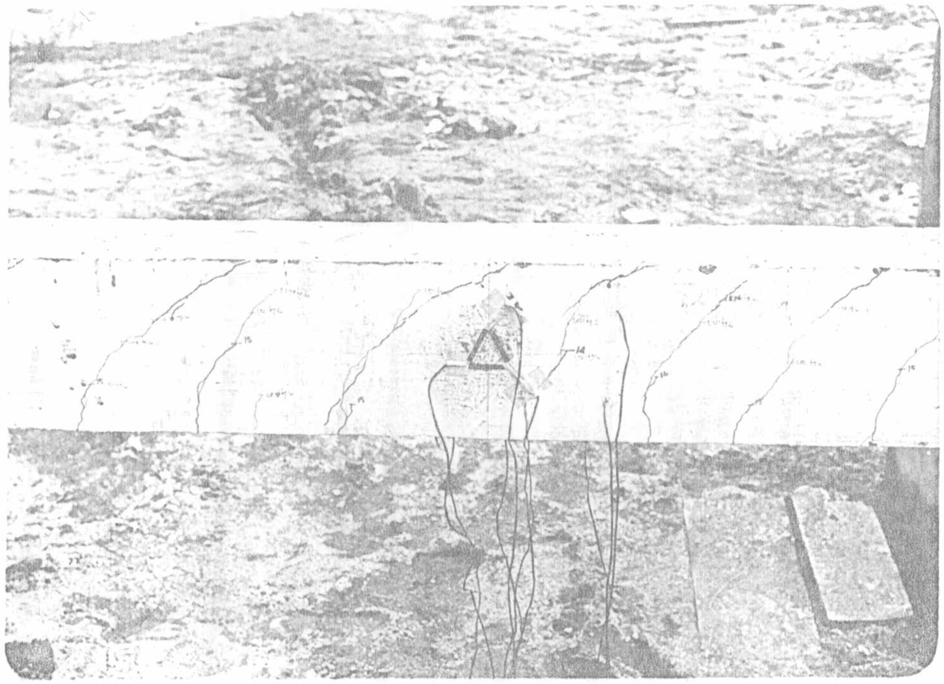
Photograph 7.17 Z-beam Model; Crack Paths at Support, on Stronger Side of Beam.



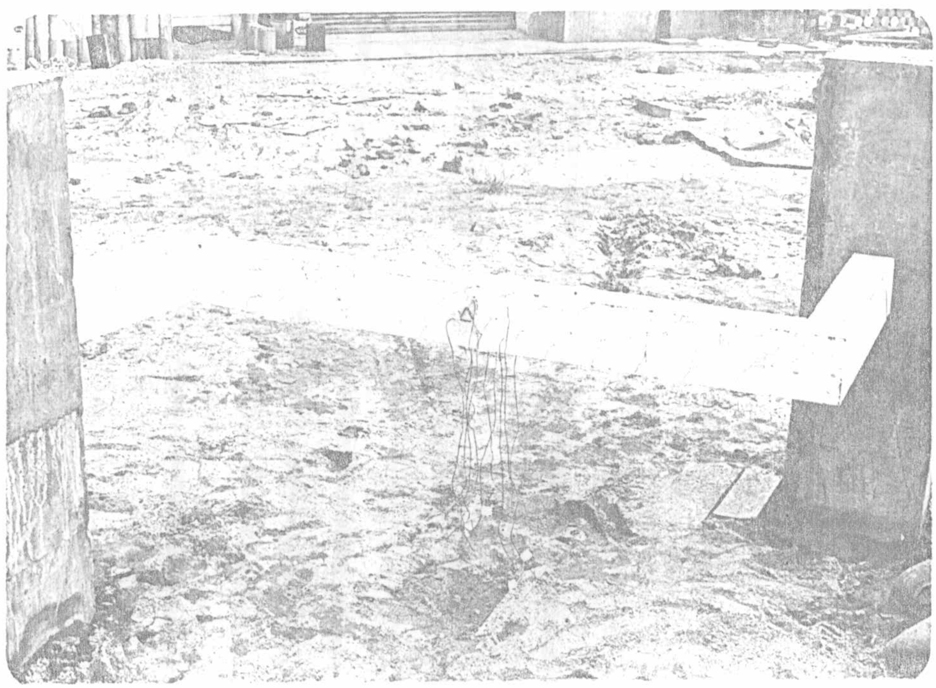
Phtograph 7.18 Z-beam Model; A View of Incipient Crack and Its Extension on Weaker Side of Beam, at Support.



Photograph 7.19 Z-beam Model; Another View of Crack Modes.



Photograph 7.20 Z-beam Model; A View of Inclined Centre-span Cracks.



Photograph 7.21 Z-beam Model; Crack Paths on Side of Transverse Member.