V-150 CONFINEMENT EFFECTIVENESS OF LATERAL TIES IN A RC COLUMN

Manojya Pallewatta[1], Juneid Qureshi[2]

1. Introduction: The axial capacity of reinforced concrete columns can be enhanced by lateral confinement of concrete, generally achieved by lateral reinforcement in the form of ties. It has been indicated that lateral reinforcement improves the capacity of a column especially beyond its maximum load by providing improved ductility. The improvement of the capacity and ductility of columns is dependent on the ability of the lateral reinforcement to effectively confine the concrete contained in the core. This can be accounted by considering the ratio of lateral reinforcement to concrete area and their spacing. The above parameters are considered in existing analytical procedures, but the reinforcement is considered as an one dimensional element subject only to pure axial loads. This assumption may be justified for lower diameter bars, but as the diameter increases the effects of bending induced by lateral volumetric expansion of core concrete may become significant and as a result the axial load carrying capacity of lateral tie has to be reduced. It is the objective of this study to ascertain whether the above effect results in significant deviations in constructing the analytical method eg. FEM.

2. Experimental work: Two short columns of 200x200x365mm were cast with 9mm and 16mm diameter ties placed at 75mm spacing and negligible longitudinal reinforcement respectively. These ties were specially fabricated by electric arc welding, to be continuous so as to overcome any discrepancies due to slipping at free end anchorages. The tie placed at the center of the column was provided with strain gauges to measure inner and outer fiber strains along the four legs.

Casting was done perpendicular to the axis of the column to minimize the effects of bleeding. The concrete used was High Performance Concrete (HPC) which has high strength. The columns were tested on a universal testing machine to ultimate failure. Configuration of the tie, location of strain gauges, detailing of the column and testing setup are shown in Fig.1.

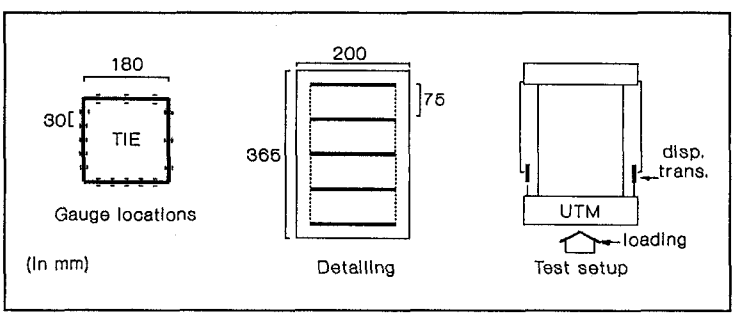

Figure 1 Experimental Details

3. Reduced lateral confinement by steel: In the columns tested, residual load bearing capacity was evident after the maximum load through a considerable deformation indicating considerable ductility. From strain gauge readings on link arms the significance of flexural effect was evident, which is indicated by Fig.2 and Fig.3 giving mean stress vs. mean strain at a position of a tie arm as indicated in the figures of the two columns depicting the reduction in

1,2. Graduate Students, Department of Civil Engineering, University of Tokyo

axial stiffness. It is of interest to note that there was no evidence of tie steel yielding up to the maximum load for the column with lesser diameter tie, whereas with the bigger diameter tie several positions yielded before the maximum column load was reached which is also depicted by mean strains at max. column loads in the above diagrams. Fig.4 shows the curvature diagrams for a tie arm for two sizes of ties and the mean stress distribution along a tie arm at maximum load of respective columns. The induced lateral stress is uniform, but the curvature is distributed. This implies that the section in which maximum curvature is induced is the critical section to govern the lateral confinement effectiveness. The mode of failure was concrete compression in the middle half of the column. There was no evidance of concrete failure in between lateral ties.

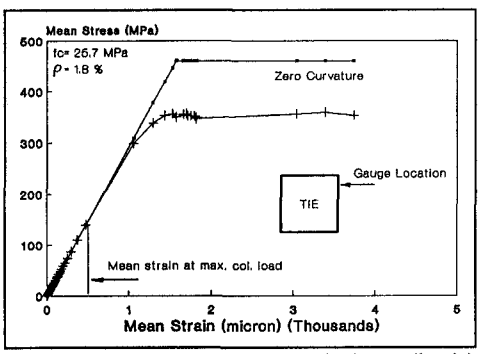

Figure 2. Mean stress vs. mean strain (9mm dia. tie)

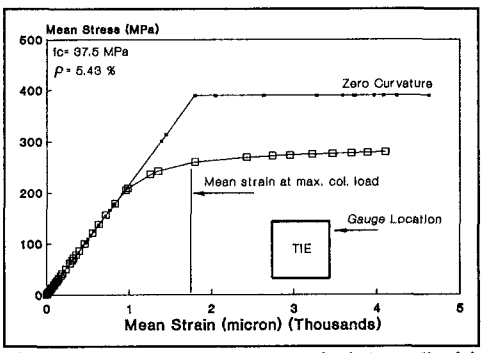

Figure 3 Mean stress vs. mean strain (16mm dia tie)

4. Conclusions: From the above discussion two conclusions can be derived. Firstly there is a reduction in the residual load carrying capacity resulting from local yielding of confining ties, after the peak load of a column, which should be considered in analytical estimations of residual capacity and ductility. Secondly, a significant deviation of the peak load of a column was not observed though larger diameter tie yielded before the peak load.

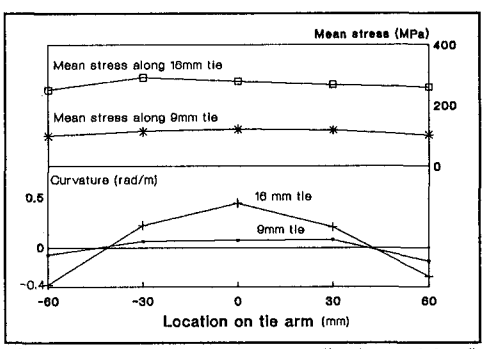

Figure 4 Curvature & mean stress dist (at peak load)

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