CHAPTER 5

CONCLUSIONS

5.1 GENERAL

As per seismic design philosophy it is desirable to have a strong column weak beam system so that the structure survives though the beams may plastify. To achieve this type of behaviour, normally, additional strength is built into the column compared to the load level at which the beams plastify. Unfortunately, the normal design procedure assumes only beams and column to exist and the contribution of the slab to lateral load is neglected. This thesis examined in detail the problems associated with this practice and has come up with certain recommendations which, it is felt, will be useful for design of multistorey buildings. The findings reported herein is based on the parametric study to find the influence of slab in a plane frame idealisation, model tests conducted on beam-slab sub assemblages to verify the effect of slab on the stiffness and strength and extensive carefully instrumented 3D storey height 1/4 scale model tests, one with the slab and the other without the slab.

5.2 SUMMARY AND CONCLUSIONS

i. Parametric study

The parameter studied was span to storey height ratio (L/H). The other parameters such as breadth of column to depth of column ratio (bc/dc), Breadth of flange to breadth of web ratio (B/bw), Breadth of flange to depth of flange ratio (B/df) and breadth of web to depth of beam ratio (bw/D) were suitably considered and changed within the practical limitations.
ii. Element Tests

Based on tests conducted on 10 specimens subjected to simulated cyclic loading the following conclusions are made.

(a) It is important to consider the slab's influence for stiffness and strength.

(b) The flexural rigidity of the beam element becomes significantly less during cyclic loading. In fact the available flexural rigidity is only of the order of 10% of the gross EI of a rectangular section.

(c) The flexural rigidity varies along the span, because of non uniform cracking.

(d) The contribution of slab to the stiffness is more, when the slab is subjected to tension than when it is subjected to compression as reported in literature.

(e) For the purpose of lateral load analysis a simple stepped variation of stiffness has been suggested (Figure 3.22). This variation is found to give acceptable results (with an error of about 15 percent) when compared with measured deflections.

iii. Beam-column-transverse beam floor system

Based on two quarter scale model tests, the following conclusions are made.

(a) Both cracking load and ultimate load are influenced by the presence of the slab. The observed ultimate load and predicted load for the specimens with the slab co-relate well (10 percent). Thus it is
possible to consider the slab in the analyses and get a realistic ultimate load. This is recommended for designs.

(b) Neglecting the slab will lead to an under estimation of ultimate load (2.4 times). Thus it is imperative to consider the slab.

(c) The presence of flange increases the stiffness by about two times compared to a beam without flange.

(d) Energy absorption of a flanged beam confined by transverse beams is two times that of a rectangular beam when subjected to lateral loads.

(e) In the precracking and working load stages, the strength and stiffness of a flanged beam-column-transverse beam system are nearly twice and even in the final stages the presence of slab is felt as it gives 25 percent more stiffness than a rectangular beam-column-transverse beam system.

(f) The presence of slab in a flanged system changes the torsional behaviour of transverse beams from uniform torsion to non uniform torsion.

(g) The capacity of the column has to be larger than the flexural capacity of the flanged beams and the torsional capacity of torsional beams.

(h) In the tests conducted the capacity of column was kept by 1.18 times more than the capacity of the flanged beam and the collapse load was arrived. However premature collapse of column was witnessed at 90 percent of the predicted collapse load. This is due to significantly different failure mechanism.
(i) The mechanism of failure is significantly altered by the presence of the slab. A new type of combined torsion - flexure failure mechanism has been identified. This type of failure mechanism leads to premature collapse to occur bypassing the full formation of the column hinges.

(j) It is necessary to strengthen the column as per the suggestions of Durrani and Zerbe (1987). This will prevent a column failure but may lead to a combined flexural-torsional failure of the floor system. This should be accounted for.

5.3 SUGGESTIONS FOR FUTURE WORK

1. As the effective width of flange is controlled by so many variables such as span of beam, width of the flange, span of transverse beam, aspect ratio of slab, breadth of web, thickness of slab, magnitude of moments, intensity of gravity loading, number of cycles etc. it is desirable that a number of tests are conducted by varying the parameters to arrive at a flexural rigidity of the flanged beam.

2. In the tests conducted on 3D models it was noticed that the slab was effective up to the centre of span of the transverse beam on both sides of the main beam. However this has to be examined in detail by keeping a ratio of spans of main beam to transverse beam up to 1:2.5. By keeping the span of main beam as 1 and increasing the span of transverse beam up to 2.5 times the span of main beam, tests are to be conducted to arrive at a conclusion regarding the effectiveness of the slab in various cases.

3. The 3D models tested in this work is of a single bay frame subjected to lateral cyclic loading. To study the stiffness and capacity variation
in a confined flanged system the study may be extended to more bays.

4. In the tests conducted only the lateral loads were considered. It is desirable to conduct further tests with realistic live loads in addition to lateral loads.

5. Tests on two bay 5 or 7 storeyed frame with a slab with transverse beams may be conducted to study the sequence of formation of hinges, ductility of R.C.C frames and their behaviour.

6. Postulation of failure mechanism for different beam/column/transverse beam/slabs strength have to be made for important parameters such as $L/H$, $L/L^*$, $EI$ of longitudinal beams/$EI$ of transverse beams, $EI$ beams/$EI$ columns.