CHAPTER 8
CONCLUSIONS

8.1. Conclusion

The following section summarizes the results and findings of the previous chapters. A section is also devoted to the discussion of further study and proposed experiments.

8.1.1. Horizontal Shear

The following are the conclusions with regard to horizontal shear:

- Initial de-lamination occurs at approximately 40% of the ultimate load. Horizontal shear stresses of 0.2 to 0.5 MPa are calculated based on a simplified model.
- Ultimate horizontal shear failure when total de-lamination takes place occurs at levels between 1.0 MPa and 2.5 MPa, indicating that these levels are 5 to 6 times higher than those encountered during the initial onset of slip.
- The empirical method for determining the transverse shear bond strength of the composite beam as developed by Schuster relies on experimental data and is thus not readily available for the design office. The method is however been adopted by the Eurocode for the design of composite slabs.
- The level of horizontal stress failure is a function of the level of reinforcing; the concrete strength; and the stiffness ratio of the shear length of the beam (inverse of slenderness ratio). An exact way to benchmark how these parameters affect the final horizontal shear strength could not readily be determined from the test data.
- In composite beams where the level of reinforcing was relatively high, the horizontal shear stresses required to ensure that the beam fails in flexure and not horizontal shear exceeded 2.0 MPa. In these cases some form of shear enhancement (shear connectors) would be required. Base on calculations it was determined that very low levels of shear connectors were required to ensure this condition.
8.1.2 Vertical Shear

The following are the conclusions with regard to vertical shear:

- The A.C.I. homogenous equation for vertical shear prediction in reinforced concrete beams without shear reinforcement is used to determine the vertical shear strength of the composite beams.
- The equation gives reasonable predictions for composite beams of low shear stiffness ratio (high slenderness ratio) but is very conservative for beams of intermediate to high stiffness ratio.
- The shear failure is again a function of the level of reinforcement of the composite beam; the concrete strength; and the shear stiffness ratio of the beam. The beams of high reinforcing levels and high stiffness ratios seem to have reserve strength in the channel after web shear cracking has taken place.

8.1.3. Flexure

The following are the conclusions with regard to flexure:

- The A.C.I. equation as developed for the nominal flexural strength of reinforced concrete beams is used.
- The equation gives reasonable results for beams of low reinforcing ratios and low shear stiffness ratios. Beams with intermediate to high shear stiffness ratios underperform with regard to the equation. This seems to tie in with the results as obtained from the horizontal shear results, which indicates that beams with premature horizontal shear failure do not reach their full flexural capacity. It is also the reason why these specific beams require some form of shear enhancement.

8.1.4 Deflections

The following are the conclusions with regard to deflections:

- The A.C.I. I-effective method for predicting the deflection behaviour of reinforced concrete beams is used.
• The equation accurately predicts the deflections during the pre-cracking range before the onset of initial horizontal slip.
• After shear bond failure occurs the properties of the composite beam are changed and the equation becomes inaccurate.

8.1.5. General

The following general statement can be made with regard to the above conclusions;
• When intermediate levels of reinforcing are encountered in composite beams using lipped channel sections the levels of horizontal shear stresses required for the beam to reach its full capacity exceed the allowable between the concrete and the steel channel to prohibit de-bonding.
• The designer is to take cognizance of this and must design for some form of shear connector or design the beam with a reduced flexural capacity.

8.2. Further Study

The following are proposals with regard to further study:

8.2.1. Materials

• Tests to determine the push out strength of a concrete core inside a channel. The tests can vary the concrete strength, channel size and thickness.
• Similar tests to the above but the influence of embossments is determined on the pull out test.

8.2.2. Composite Beams

• Experiments to determine the influence of shear enhancements on the ultimate capacity of the channel. Shear enhancers could include welded shear reinforcement; plate strips between the channel lips; or merely by increasing the depth of embedment of the channel lip.
• Experiments to determine the influence of the channel configuration on the ultimate capacity of the composite beam. Varying factors such as size, thickness and steel strength must be included.
• Experiments to determine the long-term deflection criteria of the composite beam.