CHAPTER 10

SUMMARY AND CONCLUSIONS

10.1 GENERAL

After the SCC specimens were casted, cured and tested, the test results were investigated. Based on the results of the experimental investigations, the conclusions arrived are presented in this chapter.

10.2 CONCLUSIONS

Based on the experimental investigations, the following conclusions were arrived.

WORKABILITY

- The test results of fresh concrete are within the limits of SCC i.e., flowability, passing ability and resistance against segregation. Moderate bleeding without segregation was noticed for SCC mixes with 80% to 100% copper slag. Addition of steel fibre reduced the flowability and passing ability but satisfying the suggested limits for SCC.

- The workability of SCC mixes increased substantially with the addition of copper slag content. This may be attributed to the low water absorption and glassy surface of copper slag. Copper slag has water absorption 0.28% and fine aggregate has water absorption 1.05%. Hence when the percentage of copper slag increases, the free water content in SCC mix increases, resulting an increase in the
workability of the concrete. The increase in free water content in the SCC mix could be the reason for the moderate bleeding noticed for SCC mixes with 80% to 100% of copper slag.

HARDENED PROPERTIES

- With the increase in copper slag percentage, the density of SCC increases. Copper slag has a specific gravity of 3.68, higher than that of OPC (3.09), fine aggregate (2.78) and the replacement of FA with copper slag leads to the production of SCC with higher density.

- Without the addition of steel fibres, copper slag up to 30% replacement as fine aggregate in SCC mixes showed an increase in compressive strength of about 6–10%, flexural strength of about 5-8% and a splitting tensile strength of 3–5%.

- With the addition of steel fibres to the above SCC mixes, the use of copper slag as fine aggregate resulted in a 28-day compressive strength increase of about 5–8%, flexural strength of about 4-6% and a splitting tensile strength increase of 3–5%.

- Further additions of copper slag showed a decrease in the above strengths. When the percentage of copper slag increases, the free water content in SCC mix increases. This leads to reduction in strength.

- From the present investigation, for SCC mixes with 100% sand and 0% copper slag, the relationship between compressive strength and flexural strength is given by $f_b = 0.897 (f_{ck})^{0.4522}$ and with the addition of steel fibres, the relationship between compressive strength and flexural strength is given by $f_{fb} = 0.868 (f_{ck})^{0.4554}$.
From the present investigation, for SCC mixes with 100% sand and 0% copper slag, the relationship between compressive strength and split tensile strength is $f_{ct} = 0.751 \ (f_{ck})^{0.455}$ and with the addition of steel fibres, the relationship between compressive strength and split tensile strength is $f_{ct} = 0.790 \ (f_{ck})^{0.4371}$.

For SCC mixes without copper slag and without steel fibres, the relationship between static modulus of elasticity and the compressive strength is given by $E = 3594.6f_{ck}^{0.5743}$ and with the addition of steel fibres, the relationship between static modulus of elasticity and the compressive strength is given by $E=4275.7f_{ck}^{0.4781}$.

**DURABILITY**

When exposed to sulphuric acid, compressive strength for SCC mixes without steel fibres and with 100% sand and 0% copper slag reduces by 18% to 19%, with 0% sand and 100% copper slag reduces by 22% to 24%. Whereas steel fibres are added, for SCC mixes with 100% sand and 0% copper slag reduces by 19% to 21%, with 0% sand and 100% copper slag reduces by 22% to 25%.

When exposed to hydrochloric acid, compressive strength for SCC mixes without steel fibres and with 100% sand and 0% copper slag reduces by 20% to 22%, with 0% sand and 100% copper slag reduces by 24% to 26%. Whereas steel fibres are added, for SCC mixes with 100% sand and 0% copper slag reduces by 21% to 23%, with 0% sand and 100% copper slag reduces by 28% to 30%.
Hence it can be concluded from the results of this study that using copper slag as fine aggregate in SCC is technically possible and useful.

The compressive, flexural and split tensile strengths of SCC increases, up to 30% addition of copper slag when compared with that of the control mix and further additions of copper slag showed a reduction in the above strengths. Hence 30% replacement of fine aggregate with copper slag may be considered as the optimum proportion for fine aggregate replacement.