

THE USE OF ADMIXTURES IN CONCRETE

Project report submitted by

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## SUMMARY

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The main objectives of this project are:

1. To carry out a comprehensive literature survey on the types, uses and advantages of the various admixtures in concrete.
2. To carry out a survey on the applications of the main types of admixtures in concrete.

### REFERENCES

1. Chemical Admixtures for Concrete ✓  
by M. R. Rixon and N. P. Mailvaganam
2. Concrete Admixtures Handbook ✓  
by V. S. Raamachandram
3. Concrete Admixtures  
by Peter Russell
4. British Standards:  
Part 1 : 1982  
Part 2 : 1982  
Part 3 : 1985

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