ABSTRACT

When designing structures, engineers have to consider not only strength and serviceability of the structures but also the construction cost. Material cost is one of the major costs in steel structures and cost of construction in RCC structures includes cost of materials and cost of formwork. Design that uses a smaller amount of material is therefore preferable, given that the construction methods do not become too expensive or impracticable. To achieve this goal, optimization techniques have been employed in structural design. There are many conventional optimization algorithms based on linear and non linear methods. Theses methods require substantial gradient information and usually seek to improve the solution in the neighbourhood of starting point resulting in an optimum solution which may not necessarily be global optimum solution. To select appropriate optimization method for structural design, it is therefore necessary to understand characteristics of optimization problem.

Optimization of structural components can be classified in to size, configuration and topology optimization subject to varieties of constraints. Moreover in structural design, design variables are discrete in general and continuous in particular. Further in design optimization problems material constants, loading and structure geometry considered usually do not correspond to actual ones. There may be difference between nominal and real geometry, material may behave in a different way then the assumed one, constant loading actually vary during the structure life span. All of this is accounted by safety factors, which amplify load magnitude or reduce material strength, leading in general to over-conservative structures. These characteristics suggest that **Soft-Computing (SC)** rather than **Hard computing (HC)** methodologies may be more beneficial in dealing with such cases.

Genetic Algorithms (GAs) are global optimization search algorithms inspired by darwin's survival of the fittest principle. GAs start their search from many points simultaneously which makes it suitable to get global optimum. It does not require any gradient information and the method can successfully deal with discrete and continuous design variables and design constraints. The problem of conservative designs can be overcome by describing the design variables or material behaviour in uncertain (i.e. fuzzy) form and thus using concept of **Fuzzy Logic (FL)**, one may get better results in terms of optimal design. **Artificial Neural**

Networks (ANNs) are motivated by biological nervous systems. Modern computers and algorithmic computation are good at well-defined tasks. Biological brain, on the other hand, easily solves speech and vision problems and the problems where available data are insufficient or noisy. This has prompted researcher to study biological nervous systems in an attempt to design computation systems with brain-like capabilities. Structural design problems to some extent come under this category.

In the present study software is developed in Visual Basic for optimization of size, shape and topology of various structural components, based on soft computing techniques such as Genetic Algorithms, Fuzzy Logic and Artificial Neural Networks. Some of the problems have also been tried by employing **Hybrid methodologies** to improve the results obtained through individual technique. Optimum concrete mix design problem is also undertaken using combination of all three soft-computing tools with the reason that cost effective concrete ingredient proportion will reduce ultimately the over all cost of the RCC structures. Comparison of results, wherever possible, is made to see the suitability of particular algorithm to solve given problem.

To cover various aspects of different soft computing methods, their implementation to various optimization problems and comparison thereof the thesis has been divided into the following chapters narrated briefly.

The scope and objectives of the present work are given in **Chapter 1.** An overview of engineering optimization is the subject matter of **Chapter 2.** The reported work related to the present study has been described in **Chapter 3.** Concepts related to GA, FL and ANN are covered in **Chapter 4, 5 and 6** respectively. **Chapter 7** deals with hybridization of soft computing methodologies. **Chapter 8** is devoted to the structural optimization problems handled with GA based optimization module of the software. Fuzzy logic based optimization problems are covered in **Chapter 9** with the description of fuzzy logic based program segment. The working of BPNN software module is demonstrated in **Chapter 10** whereas **Chapter 11** illustrates the use of hybrid methods to solve the optimization problems. Finally, the concluding remarks about this work and possibility of future extension are highlighted in **Chapter 12.**