CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Reinforced concrete is one of the most versatile and widely used construction materials, Modern day concrete application include dams, bridges, swimming pools, homes, streets, basements, balustrades, plain cement tiles, pavement blocks and lamp-posts.

Concrete has a number of performance characteristics such as: Durability, workability, Fire resistance, environmentally safe and compressive strength. The compressive strength of concrete is a major and important mechanical property. The quality of concrete is judged largely on the strength of that concrete. Strength is usually the basis for acceptance or rejection of the concrete would be used in the construction process.

Increasing construction challenges in combination with new innovations in materials and construction techniques have strengthened the position of concrete as a construction material and led to more rapid development in field of concrete technology. Production of concrete having higher strength represents an important part of this development. High strength concrete (HSC) can be defined as a concrete that has higher strength and durability as compared to the conventional one.

Basic ingredients of High Strength Concrete (HSC) and Normal Strength Concrete (NSC) are always the same (i.e. cement, fine aggregate, coarse

aggregate, water), although higher quality materials may be needed in HSC.

Also, additional special materials may be used in High Strength Concrete (HSC) such as: High Range Water Reducing Admixtures (HRWR) and supplementary cementitious materials. It would be difficult to produce High Strength Concrete mixtures without using the above mentioned special materials.

The main drawback of High Strength Concrete (HSC), it is more “Brittle” than conventional concrete, and hence the failure may be occurs suddenly. This is probably because cracks in High Strength Concrete (HSC) pass through aggregates and not around it as in the case of Normal Strength Concrete (NSC). Also, the unit cost of production of High Strength Concrete (HSC) may be higher than conventional concrete. This may be due to the use of additional special materials and extra high quality control procedures, but actually the strength per unit cost will be increased.

Addition of the mineral and chemical admixture makes the HSC become a highly complex material resulting in a difficultly to model its behaviour. The compressive strength of concrete is obtained by measuring concrete specimens after a standard curing of 28 days. Conventional methods of predicting 28-day compressive strength of concrete are basically based upon statistical analysis by which many linear and nonlinear regression equations have been constructed to model such a prediction problem (Hakim, 2006). Obviously, obtaining test values (after 28-day) of the strength of concrete takes time. Furthermore, choosing a suitable regression equation involves technique and experience and is not a simple

task. Such traditional prediction models have been developed with a fixed equation form based on a limited number of data and parameters. If the new data is quite different from the original data, then the model should be updated to include its coefficients and also its equation form.

Artificial neural networks (ANNs) have been investigated to deal with problems involving incomplete or imprecise information (Noorzaei, 2007).Several authors have used ANNs in structural engineering. For example, (Cheng et al, 1998) applies the NN for predicting properties of conventional concrete and high performance concretes. (Ann, 2003) developed neural network models that provide effective predictive capability with respect to the workability of concrete incorporating metakaolin (MK) and fly ash (FA). (Guang and Zong, 2000) proposed a method to predict 28-day compressive strength of concrete by using multilayer feed forward neural networks. (Dias and Pooliyadda, 2001) used back propagation neural networks to predict the strength and slump of ready mixed concrete and High strength concrete, in which chemical admixtures and mineral additives were used.

Artificial neural networks (ANNs) are data processing systems consisting of a large number of simple highly interconnected processing elements (artificial neurons) in an architecture inspired by the structure of the central cortex of the brain. They have the ability to learn from experience in order to improve their performance and to adapt themselves to changes in the environment (Mansour, 2004). ANNs can provide meaningful answers even when the data to be processed include errors or are in complete and can process information extremely rapidly when applied to solve real world problem.

1.2 Research Problem

Obtaining test values (after 28-day) of the strength of concrete takes time and high cost, for these reasons Artificial Neural Networks (ANN_s) were used to predict compressive strength of High Strength Concrete (HSC).

1.3 Objectives of the Research

This research deals with the prediction of compressive strength of High Strength Concrete using Artificial Neural Networks (ANN_S) modeling technique. To achieve the target of the research, the following specific objectives are proposed:

1- To have sound understanding about the basic characteristics of Normal Strength Concrete (NSC) materials with special consideration to the factors affecting concrete strength.

2- To have an adequate knowledge about High Strength Concrete (HSC) special materials, their mechanism of work and properties of High Strength Concrete (HSC).

3- To have a prime background about Artificial Neural Networks (ANNs); the main characteristics, the capabilities and the applications as a modeling technique for complex systems.

4- To use the information and the background in 2 and 3 to develop an Artificial Neural Networks (ANN_S) model for predicting compressive strength of High Strength Concrete.

5- To use the developed Artificial Neural Networks (ANN_S) prediction model in 4 to carry out a parametric study to determine the influence and

role of each parameter affecting the compressive strength of High Strength Concrete (HSC).

1.4 Methodology

Actual and reliable data as many as possible were carefully collected from previous studies. These data were studied and divided into two sets; training set and testing set.

Microsoft Excel Solver is used in developing computational technique and assists in evaluation of experimental and field data.

The steps below show the building process for a neural networks forecasting model:

- A computer program is designed to predict compressive strength of High Strength Concrete (HSC).
- Train the networks using training data.
- Test the network and check its efficiency.

1.5 Organization of the Research

This research has been organized as follow:

1- General introduction, in chapter one.

2- The basic characteristics of Normal strength concrete (NSC) materials, properties of concrete, and the factors affecting strength of concrete, in chapter two.

3- High Strength Concrete basic component materials, HSC special materials and their mechanism of work, HSC special production

techniques, properties of HSC and its mix design procedures and proportions, in chapter three.

4-The main characteristics of the Artificial Neural Networks (ANNs), the capabilities and the applications as a modeling technique for complex systems are studied, in chapter four.

5- An ANN model for predicting compressive strength of HSC is constructed and evaluated. Moreover a parametric study to determine the influence and role of each parameter affecting the compressive strength of HSC is discussed, in chapter five.

6- The research summary and conclusion with recommendations for future studies are presented, in chapter six.