Chapter 1

Introduction

1.1 Introduction

The main focus of this research is on the investigation and assessment of innovative structural wall bearing element of durable materials that are suitable for building in the harsh climates such as the desert environment. The proposed system should provide the desired properties such as thermal insulation, crack resistance, and environment friendly as well as the ease of construction. Ferrocement sandwich panel system with light weight infill was studied in previous researches a suitable structural system for heat insulation. Ferrocement sandwich panel system with core of AAC (Autoclaved Aerated Concrete) blocks are proposed in this research to act as a wall bearing structural system instead of the conventional reinforced concrete elements. The physical, mechanical, and thermal properties for the proposed structural system are investigated and the advantages and limitations are highlighted.

According to ACI definition of Ferrocement as a construction technique, "Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh and/or small diameter rods completely infiltrated with, or encapsulated in, mortar. The most common type of reinforcement is steel mesh. Other materials such as selected organic, natural or synthetic fibers may be combined with metallic mesh."(ACI 318M-89, 1990). The first application of ferrocement was known in 1852 in France as "Ferciment", and it was used as boat building material (A.M. Waliuddin et al, 1995). Actually, application of ferrocement technology was limited such as garden benches, boats, and water tanks. Yet, because of the recent conducted researches on ferrocement as load bearing applications, ferrocement technology nowadays has variety of applications like precast ferrocement elements, different roofing systems, and repair works (R. N. Swamy and M. l. Abboud, 1988).

Hassan Gaafar made a comparison between Ferrocement (FC) and the conventional Reinforced Concrete (RC), and it was found that the load bearing characteristics for FC is similar to RC (E.H. Fahmy et al, 2005). However, the main difference is that crack

development process is delayed by the dispersion of the reinforcement in line form through the mortar (www.advanceferrocement.com). In addition, FC is lighter than RC by up to 75%, and saving could be up to 40% in large construction and between 20-25% in small constructions when using FC instead of RC, and FC has thermal conductivity 7% less than RC, its strength to weight ratio 3-6 times higher than RC (www.memberes.tripod.com). Thus, FC has many advantages compared to RC elements.

1.2 Ferrocement Sandwich Panels

One of the most developed applications of ferrocement technology is the ferrocement sandwich panel. Ferrocement sandwich panel system has been proposed to act as a wall bearing structural system, and it consists of two thin skin layers of relatively high strength separated by a thick layer of AAC blocks as a core as shown in Figure 1.1. Because of the high strength of the two thin layers at the two faces, the sandwich panel could be used as wall bearing elements with high performance in resisting vertical and horizontal loads and resisting impacts (R. N. Swamy and M. l. Abboud, 1988).

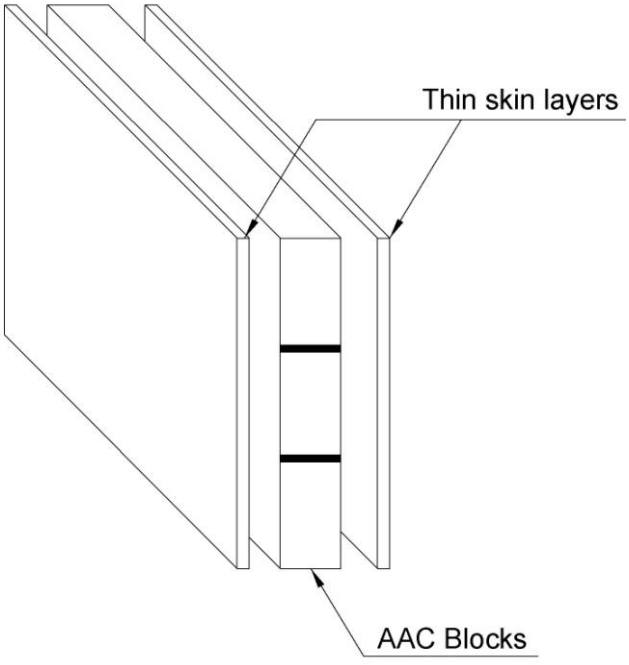

Figure 1.1: Ferrocement sandwich panel composed of two skin layers and AAC blocks

AAC has been produced for more than 70 years. Based on manufacturers' belief, AAC blocks attain various benefits which include, but not limited to: environmental friendliness, insect resistance, fire resistance and thermal ratings. It is easy to use due to its light weight, though some masons have complained about using both hands to handle a piece due to the lack of cells in the block. Initial construction costs may range from 1% to 5% more than traditional construction, yet significant savings may be achieved due to the low energy consumption, maintenance, pest control and insurance premium costs. Hence, it offers advantages over other cementitious construction materials such as (www.aac-pacific.com):

- AAC's improved thermal efficiency reduces the heating and cooling load in buildings.
- AAC's workability allows accurate cutting, which minimizes the generation of solid waste during use.
- AAC's resource efficiency gives it lower environmental impact in all phases of its life cycle, from processing of raw materials to the disposal of AAC waste.
- AAC's light weight also saves cost and energy in transportation.
- AAC's light weight reduces labour cost.

1.3 Scope and Objectives of the work

The main objective of this research is to investigate the use of AAC bricks; which have superior thermal insulation, in producing elements acting as wall bearing elements using the concept of ferrocement. In order to achieve this objective, the effects of some parameters on the behavior of ferrocement sandwich wall system are investigated. The main investigated parameters in this research are:

- AAC bricks thickness.
- Mortar strength.
- Different type and distribution of shear connectors between the AAC masonry wall and

the outer ferrocement layers.

The research aims at improving the characteristics of the proposed ferrocement sandwich panel system, which are compressive and flexural strength and the maximum lateral loading capacity. Thus, the comparison between different designations in this research is based on these characteristics. The proposed system is lighter and more economical than the conventional reinforced concrete structural system, so if this innovative wall system replaces the ordinary reinforced concrete structural system in the low height buildings, the total cost of constructing would be reduced. In order to simulate the compressive and flexural behavior of ferrocement sandwich wall bearing panel, a finite element numerical model has been developed using ANSYS software program. This analytical model is validated using the experimental results. Thus, after validation, the analytical model can be used in predicting the performance for different geometries and dimensions of various ferrocement sandwich wall panels.

1.4 Thesis Organization

This Thesis is composed of eight chapters, and it is organized as follows:

Chapter 1: A general description of the research topic is presented in this chapter. Scope and objectives of the work and the thesis organization are also presented.

Chapter 2: The recent literature on ferrocement technique and AAC bricks are presented in this chapter. The parameters effecting on the strength of the AAC bricks and its mechanical characteristics are discussed.

Chapter 3: The experimental program is detailed in this chapter. The mechanical and thermal characteristics of the material used in producing the specimens are discussed. The different designations and tests of the experimental program are illustrated in details. Furthermore, specimen setup and experimental setup is presented.

Chapter 4: The axial compressive loading test results are discussed. Mode of failure of the specimens and the effects of the test parameters on the behavior of the test specimens are presented with relevant graphs and figures. Comparison between the experimental results and the theoretical analysis has been conducted.

Chapter 5: The flexure loading test results are discussed. Mode of failure of the specimens and the effects of the test parameters on the behavior of the test specimens are presented with relevant graphs and figures. Comparison between the experimental results and the theoretical analysis has been conducted.

Chapter 6: The lateral loading test results are discussed. Mode of failure of the specimens and the effects of the test parameters on the behavior of the test specimens are presented with relevant graphs and figures.

Chapter 7: It includes the numerical model for calculating the lateral loading of the different designations using ANSYS software program.

Chapter 8: It contains a brief summary of this research and highlights on the main conclusions of this investigation. In addition, recommendations for future further researches in related topics are suggested.