Chapter 8

Summary and Conclusions

8.1 Summary

Ferrocement sandwich panel system with core of AAC blocks has been proposed to act as a wall bearing structural system instead of the conventional reinforced concrete elements. An experimental program was conducted to investigate the physical, mechanical, and thermal properties for the proposed wall bearing structural system. Several parameters were considered in this research such as: wall thickness, mortar strength, type and distribution of shear connectors, and wall openings. The experimental program is divided into three different types of testing in this research, the first and the second tests aimed at determining the mechanical properties of the ferrocement walls, namely axial compression loading testing, flexural loading testing. The third testing is in-plane lateral loading testing conducted to simulate seismic and wind load effect on structural walls. A total of twenty three specimens were tested under axial compression loading, and five specimens were tested under bending as simply supported flexural elements, while ten full scale wall specimens were tested under lateral in-plane loading. The load was applied incrementally, and the strain, the displacement, and the failure load were recorded at each load increment. The obtained results represent an indication of the viability of using the developed structural system as wall bearing elements.

The experimental results of the axial compression test have shown that the ferrocement wall provides relatively higher ultimate axial compressive load and ductility ratio than the control wall and better crack resistance. A theoretical model was developed and used to predict the axial ultimate load by using the Egyptian code (Egyptian Code for Design and Construction of Concrete Structures, 2001).The comparison between the experimental and the theoretical has exhibited that the theoretical model reasonably predicts the ultimate compressive strength.

The experimental results of the out-of-plane bending test have shown that the ferrocement wall with nails shear connectors exhibited relatively high ultimate bending loads. A theoretical model was developed to predict the flexural failure load. The theoretical ultimate load of each specimen was calculated based on its dimensions and its material properties. The comparison between the experimental and the theoretical results has shown that the theoretical model agreed well with the experimental results.

The experimental results of the lateral loading test have shown that the ferrocement wall provides relatively higher ultimate lateral load and ductility ratio than the control wall and better crack resistance. A numerical model was developed by using the finite elements method to predict the lateral failure load and to simulate the behavior of the masonry wall specimens under lateral loading testing. The ANSYS commercial finite element program was used in developing the numerical model. The comparison between the results of the model and the experimental verify the validity of finite elements model for predicting the ultimate lateral load of the ferrocement masonry wall.

8.2 Conclusions

The effects of different parameters on the behavior of the ferrocement masonry wall were studied experimentally and analytically in this thesis, and based on this study the following observations and conclusions could be drawn:

- The ferrocement masonry wall specimens under axial compression loading exhibit superior ultimate loads compared to those exhibited by the control specimens.
- Using welded wire mesh as shear connectors results in a significant increase in the ultimate load. For ferrocement AAC masonry specimens with block thick. 150mm, using welded wire mesh as shear connectors instead of nails resulted in increasing the average compressive strength by about 200%, and for ferrocement AAC masonry specimens with block thick. 250mm the average compressive strength increased by about 175%. The use of welded wire mesh connector provides better tying of the ferrocement layer to the wall, and it provides better ductility and preserves the integrity of the failed prism.
- For the ferrocement masonry wall specimens, increasing the thickness of the AAC blocks from 150 mm to 250 mm resulted in decreasing the axial compressive strength by about 10%.
- For the control wall specimens, increasing the thickness of the AAC blocks from 150 mm

to 250 mm resulted in decreasing the axial compressive strength by about 20%.

- The simplified equation provided by the Egyptian Code for Design and Construction of Concrete Structures for the design of solid reinforced concrete walls could be applied to predict reasonably the axial compression strength of the ferrocement masonry wall.

- Using different shear connectors does not have much effect on the ultimate load of the flexural loading. However, In case of using nails as shear connectors with condense distribution instead of WM shear connectors or cross steel shear connectors results in slightly increase in the ultimate flexural load.

- The theoretical model, which developed by EL-Halfawy, could be applied to predict the ultimate flexural load and mode of failure for the ferrocement masonry wall.

- The ferrocement masonry wall specimens under lateral loading exhibit significant superior ultimate lateral loads compared to those exhibited by the control specimens.

- For the ferrocement masonry wall specimens, increasing the thickness of the AAC blocks from 150 mm to 250 mm resulted in increasing the ultimate lateral load by about 115%.

- For the control wall specimens, increasing the thickness of the AAC blocks from 150 mm to 250 mm resulted in decreasing the ultimate lateral load by about 16%.

- For the ferrocement masonry wall specimens, the existence of window wall opening or door wall opening results in lower wall stiffness and lower ultimate lateral load.

- For the control wall specimens, the existence of window wall opening or door wall opening results in lower wall stiffness and lower ultimate lateral load.

- The finite element model of the ferrocement masonry wall under lateral loading gives a good agreement with the experimental results.

- The finite element model is validated using the experimental results, thus it could be used to perform more parametric studies.

8.3 Recommendations for future work

The following recommendations are suggested for future research work:

- Investigating the behavior of the ferrocement masonry wall under different and various parameters with different aspect ratios.
- Conducting an experimental program with a large number of specimens for applying appropriate statistical patterns of data.
- Studying the behavior of the ferrocement masonry wall under axial eccentric compression.
- Developing a theoretical model to predict the ultimate lateral load and mode of failure for the ferrocement masonry wall.
- The dynamic effect of the ferrocement masonry wall could be studied.
- The impact loading effect of the ferrocement masonry wall could be studied.
- Investigating the behavior of the ferrocement masonry wall under high temperature and fire resistance.
- Investigating the behavior of the ferrocement masonry wall under salt attack and aggressive environment.
- Experiment the durability of the ferrocement masonry wall.
- The finite element model could be used for more future parametric studies.