CHAPTER – 6

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

A combined experimental and numerical investigation was conducted to investigate the in-plane shear behaviour of unreinforced and reinforced clay brick masonry wall panels in the ratio of 1:6 cement mortar with partial replacement of fine aggregate with fly ash (0%, 10% and 20%) and with fly ash brick masonry wall panels in the ratio of 1:6 cement mortar with partial replacement of fine aggregate with fly ash (0%, 10% and 20%). The work involved: characterizing the brick assemblage material and the shear bond strength between the clay brick masonry in the ratio of 1:6 cement mortar with partial replacement of fine aggregate with fly ash and with fly ash brick masonry in the ratio of 1:6 cement mortar with partial replacement of fine aggregate with fly ash.

6.1 CONCLUSIONS

i. The mechanical properties were found to be enhanced in fly ash bricks than the clay bricks. Compressive strength and flexural strength of fly ash brick was 54.21% and 56% higher than the clay bricks and 8.58% lighter in weight than the clay bricks.

ii. Costs of fly ash brick is 40% less than the clay brick.

iii. Fly ash bricks are energy-efficient and environment friendly and it is recommended for the construction in seismic zones.

iv. Equation for determining the masonry strength has been arrived using the brick strength and the mortar strength.

v. Based on the triplet bond shear test, the presence of fly ash had a strong influence on brick-mortar joint. The bond strength of unreinforced clay brick masonry in 1:6 cement mortar with 20% replacement of fine aggregate with fly ash, CBM20 was about 1.5 times higher than the unreinforced clay brick masonry in 1:6 cement mortar, CBM.

vi. The bond strength of unreinforced fly ash brick masonry in 1:6 cement mortar with 10% replacement of fine aggregate with fly ash, FBM10 was twice the unreinforced fly ash brick masonry in the ratio of 1:6 cement mortar, FBM based on the triplet shear test. Incorporation of fly ash resulted in the reaction of pozzolanas with the calcium hydrate which produced strong calcium silicate hydrates, thus enhancing the bond strength of the masonry by modifying the microstructure of the mortar-brick unit interface.

vii. Elastic modulus of masonry ($E_{pm}$) was determined with the prism strength ($f_{pm}$).
viii. The equivalent homogeneous elastic modulus of the brick masonry was arrived for the unreinforced and the reinforced brick masonry (both clay brick masonry and fly ash brick masonry) with the elastic modulus of brick, mortar and mesh and with thickness of brick and the mortar bed joint.

ix. Depending on the quality of masonry brick units and mortar in unreinforced brick masonry wall, diagonally oriented cracks were formed (either followed the bed and head-joints or passed through the bricks or partly followed the joints and partly passed through the bricks).

x. Based on the in-plane shear test, the in-plane shear strength of clay brick masonry wall increased by 15% to 18% when reinforced with hexagonal woven wire mesh in alternate bed course of the masonry wall.

xi. Based on the in-plane shear test, the in-plane shear strength of the fly ash brick masonry wall increased by 50% when reinforced with hexagonal woven wire mesh in the alternate bed course of the masonry wall.

xii. The in-plane loads corresponding to the reinforced masonry wall panels are higher than that of the unreinforced masonry wall panels. The gain in strength is 14.28% for the CBPR, 20% for CBP10R and 16.66% for the CBP20R when compared with the unreinforced clay brick masonry wall panel.

xiii. The experimental results on the in-plane diagonal compression test, the in-plane shear capacity of the reinforced clay brick masonry wall panel had an average increase of 20% than the unreinforced clay brick masonry wall panel.

xiv. The in-plane shear capacity of the masonry wall can be determined as the sum of the contribution by both masonry and the reinforcement.

xv. Deformation capabilities of the reinforced walls are enhanced by the presence of woven wire mesh which indicated the ductility.

xvi. The reinforced clay brick masonry walls attained 20% higher shear strengths and 12% higher deformation resistance than those of the unreinforced masonry walls. Thus the seismic behavior can be enhanced.

xvii. The cost of the fly ash brick masonry construction was reduced by 35% than the clay brick masonry construction. The cost of the construction of masonry wall structure with reinforcement increased only upto a maximum of 5%.
The comparison of experimental values with the results obtained from ANSYS indicated that the compressive strength of brick masonry by experimental method was 52% higher. Therefore, to get the actual compressive strength of brick masonry, the finite element analysis results should be enhanced by a factor of 1.52.

Fly ash brick masonry wall reinforced with woven wire mesh are recommended for the construction of masonry structure in seismic zone 4 and zone 5.

Clay brick masonry walls reinforced with woven wire mesh is recommended for the construction of masonry structure in the seismic zone 2, zone 3 and zone 4.

Based on the values arrived on the in-plane shear capacity of the masonry wall to retain in-plane shear force, fly ash brick masonry walls reinforced with woven wire mesh in the alternate bed course are recommended for soft, medium and hard soil and in all seismic zones in India.

6.2 SUGGESTIONS FOR FURTHER RESEARCH

(i) As most of the existing walls require strengthening against earthquake loads, research needs to be extended to include cyclic loading.

(ii) The study can be extended for the,
   a) Out-of-plane behaviour of brick masonry
   b) Effect of providing woven wire mesh externally
   c) Role of in-fills in a concrete frame
   d) Strengthened walls with various fiber reinforced polymers