CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

7.1 GENERAL CONCLUSIONS

The general conclusions that states the main objective of this work carried out was given below

- Selection of material and its character are the essential parameters to achieve self compacting mortar for ferrocement work.
- Study on cement and admixture compatibility is required to give better performance for self compacting mortar.
- Use of chemical admixtures can impart high performance self compacting mortar with respect to strength and durability.
- The effect on the volume fraction of reinforcement is directly proportional to the load carrying capacity under flexure.
- Irrespective of the percentage of reinforcement for higher spans, the resisting capacity increases with slightly lesser deflection compared to the shorter spans.
- Shear span to depth ratio has major role in controlling the deflection and load carrying capacity. Hence it’s an important parameter to be considered for flexural members.
• In general, as the shear span to depth ratio increases the flexural strength decreases. But it is also influenced by the chemical admixtures which contribute increase in compressive strength.

• Ferrocement –RC composite flexural members always have higher capacity, delayed first crack and more ductility compared to the conventional RC beams.

• There is a substantial increase in the flexural strength with the use of shear connector in ferrocement RC composite beams. The deflection has reduced to a minimum of one forth compared to controlled beam.

• The composite action was achieved by using chemical bonding medium compared to the other types of mechanical shear connectors. The application of bonding chemical to the composite sections is very simple technique compare to the mechanical shear connector which requires complication in the fabrication and welding.

• The ultimate failure moment is always higher for ferrocement composite beams when compared with regular RC beams.

• The ferrocement placed only at the soffit of the beam, the flexural strength has improved twice that of the RC beam and delayed the first crack.

• The finite element technique reduces the cost and time taken for the experimental work. The FE tools like ANSYS can be used in case of complex system of loading and complicated configuration of the experimental profiles. The results obtained from ANSYS shows slight variation compared to the experimental result.
7.2 SPECIFIC CONCLUSIONS

7.2.1 Effect of Admixtures on the characteristic of self compacting mortar

- Though the flowability of self compacting mortar among the admixtures were having slight variation, Conplast SP337 (water reducer) and SIKAMENT FF (T) (super plasticizer) was selected based on the compressive strength results at 28 days to cast the ferrocement channel sections.
- The influence on compressive strength of self compacting mortar follows the same trend on increasing the flexural strength of ferrocement channel and ferrocement RC composite sections.

7.2.1.1 Performance of using SCM in Ferrocement Technology

- To enhance the quality of Ferrocement elements the use of Self compacting mortar gives good workability to produce well finish surface to the members. Since ferrocement is a very thin member with 2-3mm cover thickness corrosion problems can be eliminated.
- Incorporating the ferrocement technology in the regular RC system helps in improving the overall ductility of the structure.
- The permanent formwork systems using ferrocement will help not only to reducing the time taken for the construction but also gives resistance to earth quake forces as well.
7.2.2 Effect of Shear Span to Depth Ratio (a/h) and Volume of Reinforcement of Ferrocement Channel Section under Flexural Loading

7.2.2.1 SCM with super plasticizing admixtures

- In both 1m and 1.5m length beams, irrespective of the percentage of reinforcement, the load carrying capacity is high for the shear span to depth ratio using SCM with super plastizing admixture. The beams having a/h ratio 2.5 was having least load carrying capacity and maximum deflection.
- Even for the increase in span there is no much difference in the value of increase in deflection in “S” type beams.

7.2.2.2 SCM with water reducing admixtures

- But the trend was different in case of ferrocement channel sections casted using SCM with water reducing admixtures. The increase in a/h ratio reduces the load carrying capacity of the beam irrespective of the layers of weld mesh used for both 1m and 1.5m length beams.
- The same conclusions were draw by Ahmad et al (1995) using conventional mortar for ferrocement channel sections. The use of SCM has increased the load carrying capacity of the member compared to the conventional mortar of the same proportion.
- But in the beams casted using water reducing admixture, the maximum flexural strength is for the a/h ratio 1.5 and the deflection also follows the same.
- The flexural strength of beams using super plasticizer was 14.28 % high and the deflection is reduced to 20.21% as compared to the beams using water reducer. This strength increase is an indication
on the influence of mortar strength ie mortar strength is directly proportional to flexural strength, (Mansur 1987; Fahmy 2005) which has been proved from the above result.

- The crack and flexural strength of ferrocement channel section increases for the shear span to depth ratio 2.
- Thought the volume or percentage of reinforcement increases, if the a/h ratio increases the flexural strength decreases and deflection increases in all the cases.
- From the load deflection curve it was identified and proved that the ferrocement sections were having ductile behavior.

7.2.2.3 Flexural strength of ferrocement in-filled RC composite beams

The flexural strength of ferrocement in-filled RC composite beams were having high strength compared to conventional RC beam. The load deflection curve indicates the ductile behavior of composite section which will have better resistance for the earthquake forces. During earthquake, major losses are due to sudden collapse of structures. Since the ferrocement composite beams have more ductile property than RC, it can be recommended for the earthquake resistance construction. There is no significant improvement in the flexural strength after the percentage of reinforcement in the ferrocement reaches an optimum level. The strength of members depends upon the shear span to depth ratio.

7.2.3 Effect on flexural strength with the use of shear connector for Ferrocement in-filled RC beams

- Ferrocement composite beams possess high ultimate failure moment when compared with regular RC beams. This means, the area of steel
and concrete can produce higher ultimate moment carrying capacity for beams.

- The energy absorbed before failure is always higher in composite beams. (Area covered by stress strain diagram), this indicate, Ferrocement RC composite beams were having better ductility and hence good earthquake resistance.
- The moment curvature graph reveals that composite beams will have better load deflection behaviors than regular RC beams.
- Amongst the four different types of shear connections, the chemicals bonding type exhibits favorable performance in terms of ductile behavior and also ultimate load carrying capacity. This is evident from the comparison graph for moment-curvature.
- The usage of shear bolts as shear connectors also exhibits better performance than the TMT rods type shear connectors.

### 7.2.4 Effect under flexural loading of Beam with Ferrocement at the Tension Zone

- The investigation reported on the ferrocement placed at tension zone improves the flexural and substantially delayed the first crack. Hence ferrocement can successfully used in RC members.
- Mid span deflection was reduced nearly two times that of controlled RC beam.
- The beams overall ultimate capacity, stiffness and crack resistance and ductility has improved using ferrocement at the flexural zone.
- Further the flexural capacity can be increased by adding two or three layers of weld mesh at the soffit of the beam.
7.2.5 Experimental verification of results with FEM tool ANSYS

The specific conclusion can be drawn from the experimental and ANSYS result that Finite element Techniques can be used for the complicated models to reduce the cost and time taken for the research work. When the properties of the materials used in the experiment were included in the ANSYS the result from FE technique gives closely related value of experiment results.

7.3 RECOMMENDATIONS FOR FUTURE RESEARCH

This research study on the flexural behavior of the members in various aspects reveals the following worth noted points for the further research work:

- Permanent formwork systems can be extended for the compression members to improve ductility and earth quake resistance characteristics.
- Precast wall panels can be fabricated with simple bolt connection details for fixing it in position to reduce the construction time. This prefabricated wall panels can be used effectively in construct cavity wall construction.
- Connection details for the permanent form works such as beams, columns and wall panels can be designed and checked for shear and flexural strength.
- Formwork for the reinforced concrete arch construction is too high compared to the material cost due to its complication in the shape to fabricate it. But it is easy to construct an arch, domes using ferrocement
technology without heavy formwork. Even precast arch segments can be fabricated and assembled at the site.

- Precast concrete stairs are particularly suitable for the construction in high traffic area and it is ideal for industry to residential buildings. The disadvantage of precast concrete is its weight. This can be replaced by precast ferrocement stairs which is of less weight compare to the concrete stairs. Ferrocement technology can be utilized for the fabrication of stairs for heavy loaded industrial structures with the steel frame works.

- The ferrocement technology can be further extended with folded shapes or any other non geometrical shapes. This shape gives provisions for the installation of electrical items to give aesthetic appearance to the rooms.

- To save the cost and time for experimental work, finite element software can be used for modeling and analysis.