CHAPTER 1

INTRODUCTION

This chapter emphasizes the history, significance and characteristics of ferrocement technology. It also describes the application of ferrocement in various fields, advantage and disadvantage of using ferrocement.

1.1 GENERAL

The present day scenario of the rapid development of building infrastructures in India, lays emphasis on cost effective systems in terms of the speed in construction and structural soundness. The revised earthquake zones map of India has restricted most of the building infrastructure to have ductile robustness. While many fast –track constructions are done using precast and composite technologies, there are considerable amount of constructions, which are being done using conventional methods such as RC frame and masonry infills. The modern fast track technologies are being considered more economically viable only for large scale and high-rise structures. The present development in infrastructure gives major importance to the affordable housing projects, which are necessarily low rise structures. For such projects, usage of appropriate construction technologies for achieving economic and technical feasibility and fast track completion of the projects become very vital. The usage of ferrocement as building elements in India has been
restricted to either low cost applications or structural non-participating building elements. The use of ferrocement as permanent formworks for regular RC elements will help to build the required ductile robustness in the structures and as well as to aid fast track constructions. The permanent ferrocement formworks will also have structural participations and partial to complete interactions with the regular RC members and hence will improve their efficiency in terms of earthquake resistance and serviceability.

1.2 FERROCEMENT

Ferrocement is a thin wall reinforced concrete consisting of welded wire fabrics continuously running in both the direction and embedded in rich cement mortar to form a new material with characteristics superior to either of its constituents. As per ACI 549R, 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. Uniform distribution of reinforcement in the ferrocement composites provide better performance such as high tensile strength, crack resistance, better ductility and impact resistance. These better properties are achieved within a very small thickness of about 15-40mm. The elements can be cast into many forms without the requirement of much skilled labour.

1.2.1 Historical Review

Joseph-Louis Lambot of France is the first person to make several constructions like rowing boats, plant pots, seats etc with steel and cement mortar in early 1848 and he called it as “ferciment”. Later, in the early 1940s, Professor Pier Luigi Nervi of Italy established some preliminary characteristics of ferrocement through a series of tests. He soon used this
material to construct several roofs and small tonnage vessels and in 1943 ferrocement was accepted by the Italian Navy. There was very little application of true ferrocement construction between 1888 & 1942 when Pier Luigi Nervi began a series of experiments on ferrocement. He observed that reinforcing concrete with layers of wire mesh produced a material possessing the mechanical characteristics of an approximately homogeneous material capable of resisting high impact. After the Second World War, Nervi demonstrated the utility of ferrocement as a boat building material. Ferrocement was finally accepted in 1960’s for boat building in the United Kingdom, New Zealand, Canada and Australia. In 1972, US national Academy of Science formed a panel to report on the application of ferrocement and the recommendation of the panel was established to collect the information on ferrocement. Subsequently, in 1975 the International Ferrocement Information Center and American Concrete Institute formed a Committee 549 in a state –of- the –art report on ferrocement, to establish and to disseminate the information on ferrocement. In 1978, an elevated metro station with continuous ferrocement roofing was erected in Leningrad. In 1979, RILEM (International Union of Laboratories & experts in construction system and Structures) established a Committee (48-FC) to evaluate testing methods for ferrocement. In 1984, ferrocement was used in the construction of a shaking table of large scale earthquake simulation facility at the state university of New York at Buffalo. In 1991, the international Ferrocement Society was established with headquarters at Asian Institute of Technology in Bangkok. The International Ferrocement Society (IFS) formed a Committee (IFS-10-01), the recommendations of which were published as “Ferrocement Model Code” (FMC) in January 2001. The description in the above model code reflects the advances in ferrocement and past experiences too.
1.2.2 Characteristics of Ferrocement

Various research works on Ferrocement carried throughout the world so far reveal that Ferrocement possesses the following characteristics:

- Ease of construction
- Improved tensile properties
- High resilience
- Ability to take large deflection before collapse
- High Ductility due to ductile nature of the weld mesh, which provides an added degree of protection against sudden collapse
- Improvement in toughness, fatigue, resistance, impermeability, stiffness increased with an increase in the reinforcement but the increase is to an optimum level.
- High resistance to cracking, because of the distribution of small diameter wire mesh reinforcement over the entire surface and high volume of matrix. This is identified from the pattern of failure which exhibits closely spaced cracks.
- It can be fabricated into very thin sections. Hence Ferrocement is ideal for shell construction.
- Ferrocement has substantial potential for supporting vibratory loads.
- Light weight as compared with similar structures made of reinforced or pre-stressed concrete.
- Ferrocement is more economical than most of the materials that it replaces.
1.2.3 Application

Laminated cementitious composite Ferrocement can be used in numerous application as construction material namely in the affordable housing constructions. Researchers have been conducted to use ferrocement as major or secondary component in the roofs, floors, walls etc. Some of the applications are listed below:

Ferrocement housing construction in Bangladesh, Indonesia includes the utilization of local materials like wood, bamboo. Precast ferrocement elements are widely used in various countries due to its less weight as formworks, secondary roofing systems. Corrugated roof sheets are used as roofing material for low cost housing in Singapore, India, Peru. It also used as composite material in the repair and rehabilitation of reinforced concrete columns and beams.

First ferrocement technology has become popular when it was used in the marine applications. It is adopted as fishing boats, prawn brood stock, buoys floating systems in China, India, Thailand, Philippines. Ferrocement canal lining is vastly adopted in many countries as it prevents the seepage loss. It has been used for grain storage bins in Thailand, India and Bangladesh to reduce losses from attack by birds, insects and rodents.

Biogas and solar energy are two alternate sources of energy for the rural areas in which ferrocement can be of use in their production. In Thailand and India, biogas digesters and biogas holders have been constructed with ferrocement which lead to a considerable cost reduction. Ferrocement can be effectively used for various water supply structures like well casings for shallow wells, water tanks, sedimentation tanks, slow sand filters and for sanitation facilities like septic tanks.
Other than this construction application it is also accepted to be used for Pressure pipes, Pavement Slabs, Shuttering for concrete construction, manhole cover, curved benches for parks, which is especially evident in countries like China, New Zealand, U.S.S.R and Southeast Asia.

1.2.4 Advantage

The following are the advantages for the selection of Ferrocement for various applications:

- It possess high material properties such as toughness, impact resistance, ductility, durability, strength and also crack resistance
- It has high degree of flexibility in choice of shape
- Skill needed for the construction can be easily acquired
- Due to its less weight compare to the other material, heavy plant and machinery are not required for erection
- Large, internally unsupported domes and curved roofs have been built that could not have been constructed with other materials without elaborated ribs, trusses, and tie rods.

1.2.5 Disadvantage

The following are the disadvantages of ferrocement construction:

- The large amount of labour required for ferrocement construction is a disadvantage in countries where the cost of unskilled or semi-skilled labour is high.
- Especially tying the rods and mesh together is tedious and time consuming and requires precision
1.3 OBJECTIVE OF THE PROJECT

The present investigation is focused on the behavior of ferrocement RC composite members under flexure. The objectives of the research work are listed below:

- To develop self compacting mortar for the ferrocement work and to study the performance of mortar using chemical admixtures.
- To study the flexural behavior of ferrocement channel section which is intended to be used as formwork, by varying the depth and volume of weld mesh.
- To select the ferrocement channel section which exhibits higher moment carrying capacity to in-fill the conventional Reinforced concrete to act as composite beam.
- To analyze the performance of ferrocement in-filled with RC using various shear connectors under flexure.
- To study the behavior of composite beam when the ferrocement is placed only at the tension zone.
- To validate the experimental results with the finite element software ANSYS 14.5 for each critical type of beams.