Ferrocement An Effective Alternative for Construction Industry

Kavita V. Desai
M.E. Student, Department of Civil Engineering
Dr. D.Y.Patil Institute of Engineering And Technology, Pimpri, Pune, Maharastra, India

Dr. Deepa A. Joshi
Associate Professor, Department of Civil Engineering
Dr. D.Y.Patil Institute of Engineering And Technology, Pimpri, Pune,Maharastra, India

Abstract- Construction industry is developing rapidly all over the world. Concrete and steel are the basic construction materials which are being used with different concepts for construction such as RCC, Prestressed and Ferrocement. Ferrocement is an innovative technology and has several advantages. In this paper, a review of research work carried out on ferrocement has been presented. Million cubic meter concrete is being consumed for constructing building, roads, dams, bridges, etc. Lot of steel and cement consumed for that construction. Production of steel and cement emits huge amount of CO2 and harms the environment. There is need to replace of that material and save the earth. Ferrocement can be replace all conventional construction materials like RCC, bricks, timber, steel etc. and construction become ecofriendly. Historical development, advantages of ferrocement and the research work has been discussed in detail. After studying the available literature, it has been found that the research work on ferrocrete in context of CO_2 emission is required to be carried out.

Keywords – Ferrocement, CO_2 Emission, Construction, RCC

I. INTRODUCTION

Conventional reinforced concrete is combination of steel bars and concrete. Shuttering and scaffolding are quite essential. Ferrocement is a composition of weld mesh, mild steel angles or bars, chicken mesh and mortar. This mixture becomes a homogenous material and can be built in conditions and in any shape. Ferrocement is a very thin material that's why it becomes light in weight nature but its ductility is very high as compared to conventional RCC. Ferrocemnent is defined as 'Cement mortar strongly bonded and encased in layers of fine wire meshes making it a homogeneous and ductile composite'. [1] According to Naval Ship R&D Center, 'Ferrocement consist of several layers of wire mesh reinforcing mortar of sand and Portland cement'.[2] All conventional material can be replaced by Ferrocement and material like steel, cement, timber, wood, clay, etc. can be saved to some extent. Production of steel and cement emits huge amount of green house gases (GHGs) and harms the environment. That emission measured in terms of CO_2. Carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tone of carbon dioxide or mass of another greenhouse gas with a carbon dioxide equivalent to one tone of carbon dioxide [3]. Carbon credits are measured in units of certified emission reductions (CERs).

II. HISTORY OF FERROCEMENT

It has been reported in literature that Ferrocement was introduced around 17 decades ago[2]. The name of ferrocement was "Ferci-ment". A rowing boat was constructed in 1849 in France. Then in 1887 a boat was constructed in Holland also. After 1940 the process was revived in Itely and small crafts were constructed. Same time in New Zealand & England research on ferrocement was going on. Around 1965 in United Sates & Canada ferrocement was introduced and was constructed a barges & small craft in the same material. At that time ferrocement was well popular for constructing crafts in England, New Zealand, Australia, Russia, China, Thailand, Vietnam, Iran, South Africa, Span, France, Korea, etc. [2] Since early 1970, National University of Singapore was proved multiple applications of ferrocement like sunscreens, secondary roofing slab, repairing material of partial completion building, water tanks. [4] During World War II, due to shortage of steel plates ferrocement was used for construction of ships, buildings and warehouses [1].

III. APPLICATIONS OF FERROCEMENT

Sakthivel & Jagannarthan (2011) have presented a review on ferrocement construction & its applications. A

review showed ferrocement are very thin, light weight, water tight, easily maintained as well as repaired, can be construct any shape, ductable & crack resistance material. Ferrocement partially or fully eliminate the formwork as well as less material required for scaffolding. Ferrocement construction consumes less material due to its light weight nature as well as less scaffolding and shuttering, so storing space for materials is less. Therefore ferrocement could be used for earth retaining structure, swimming pool, underground & overhead water tank, as a water proofing material, domes, corrugated roof, curtail wall, elements for facade work, sunscreens, any architectural works, boats, rehabitation of ancient buildings, sewer line, column-beam jacketing, etc. For construction of ferrocement highly skilled labor as well as heavy machinery for lifting material is not required.

Paramasivam (2001) has discussed in detail a case studies of ferrocement applications. In Singapore , 11 story 3 building casted without constructing sunscreens in west facing. The design of reinforced concrete sunscreens was too bulky & heavy for long spans more than 3 m & also cumbersome connection details for the precast construction. For that tedious situation ferrocement were more suitable, considering the ease of handling & erection, architectural requirements, durability & overall cost. An inverted L-shape sunscreen module of length 2.7m were proposed with bolted connections. Similarly same case was in other partially completed apartments. The span of sunscreen was 3 to 5 meter & were successfully installed.Ferrocement precasted sheets were successfully applied as secondary roofing slab as a heat insulator on top of roof. Very successful application of construction water tank in rural areas where water scarcity was main problem. More than 5000 water tanks of capacity 5cum to 16 cum were supplied to Philippines. In urban areas, base of water tank in cast-in-situ & rest of all was precasted & were installed on top of roof. Another successful application was an enclosure for a geotechnical centrifuge at National University, Singapore.

IV. COST EFFECTIVENESS OF FERROCEMENT CONSTRUCTION

UNHCR (2006) presented total construction period and mandays for water tank resting on ground. Water tank capacity was 45cum, 75cum, 90cum & was required three to four weeks for construction of each tank with 60-75 man-days of skilled labor.

Saleem and Ashraf (2008) has presented cost analysis of small house which was in ferrocement. They have done the study on earthquake in Oct. 2005 and they understood that most of houses were collapsed only due to improper construction of RCC, mud houses and rubble masonry. That type of houses were constructed only due to poor economic condition. Housing in ferrocement is very economical and researchers presented that not more than Rs.30000 /-per panel of 10'6" including labor cost & that material is very safe in earthquake regions.

Rifaie et al. (2014) has present an experimental work on ferrocement house which not only meet the structural requirements but also is a good thermal insulator. Ferrocement system is a new innovative method for eco housing.

V. PARAMETERS OF CO_2 EMISSION FOR FERROCEMENT CONSTRUCTION

Construction produces 7% of the GHGs emissions, of which 76% originates from engines [5]. Today's mission of the world is reduction of GHGs emission.

Rifaie et al. (2014) have presented the conclusion on energy consumption is reduced for heating and cooling system is more than 50% and reduction in emission of CO2 while construction was greater than 50%.

Ahn et al. (2013) have presented a framework model for estimating, benchmarking and monitoring pollutant emission for construction operations. From previous case studies, emission factors can be defined and then estimation can be done for proposed construction operations. Monitoring can be done further.

Marshall et al. (2012) have presented methodology to estimate emissions due to construction activities. According to methodology list of equipment's associated with various action was prepared and corresponding horsepower rating for each equipment was determined. On the basis of horsepower, the emission factors were decided. Also activity emission were calculated considering from different data sets related to type of action. Finally considering the all activities and equipment used in the construction, the total project emission were arrived at. It have been found that the site construction action given the largest emission in entire project. The bulk excavation activity gives huge value emissions.

Melanta et al. (2013) have been introducing an emission estimation tool for estimation of greenhouse gas emissions such as carbon footprint estimation tool (CFET). CFET has been divided the construction activities in to four stages such as site-preparation, equipment usage, material production & environmental impact mitigation component. On the basis of above four stages CFET was successfully used for road work in Maryland and found out

total net emission 1,79,055MT CO_2 during period Nov. 2007 to Jan. 2010.

VI.CONCLUSION

Ferrocement is an alternative to conventional RCC construction. Ferrocement technology is getting more attention because of its advantages such as light weight, water tightness, ductile, ease in construction and maintenance. Ferrocement application started with boats and now, various structures such as building, retaining wall, swimming pools, water tanks, domes, corrugated roof, etc. are being built with it.

Ferrocement has another important advantage of reduction in CO_2 emission. For sustainable development and prevention of environment, this feature of ferrocement, makes it more suitable for construction. However very less research work is done in this context and hence carried out research work for estimation of CO_2 emission of ferrocement structure.

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