

Ferrocement: A Modern Technology with its Application in Water Resource Department (WRD)

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Abstract- Maharashtra recently faced the draught situation in many districts. The groundwater level is reducing every year. Small dams on small natural nallas can recharge the groundwater thereby elevating the water table. Such crash program is being implemented by Government of Maharashtra and the success is seen now. Ferrocement Technology is looked upon as an alternative to traditional and most conventional concrete structures and is studied in detail in the present study. It's methodology along with its versatile application in Water Resources Department for the construction of Bandharas is the subject matter and is explained in the following study. There are numerous benefits of Ferrocement technology over the conventional methods of construction due to inherent properties of Ferrocement like thin wall construction, adaptability to any shape, ease in giving any shape etc. Based on this detailed review, further study involves detailing out the cost and timelines associated with the conventional method of constructing of bandharas and construction of similar structure at different location using Ferrocement Technology, exhibiting the benefits associated with Ferrocement.

Keywords- Ferrocement, groundwater.

1. Introduction

Ferrocement has a history of more than 150 years. It remained in background up to 1940. It has boomed as a construction material in the last two to three decades. Originally in 1940, Nervi in Italy has named this composite of Ferro (iron) and cement (cement mortar) as "Ferrocement". All over the world it is known as "Ferrocement". The matrix of this composite is not plain cement but cement mortar in the form of micro concrete. Hence, it is also named as Ferrocete and both these words, i.e. Ferrocement and Ferrocete are used interchangeably. Closely spaced and thoroughly distributed continues fine wire mesh reinforcement in brittle matrix of cement mortar forms Ferrocete. The ingredients of Ferrocete remains strongly bonded together up to yield of steel wires and hence behave more like a homogenous and ductile material. Ferro-cement is cement based composite material which has proved to be an ideal construction material for thin walled structure of various sizes and shapes (even complicated geometries), Water Storage Tanks (cylindrical, spherical and even cubical in shapes), Grain Storage Bins, Septic Tanks, Bio Gas Plant Digesters, Garbage Bins, Roofing and Welling Units, Irrigation/ Drainage

Units, Precast Culvert Sections for Rural roads, non-pressure pipes, Check dams for heights up to 1.5m, Rural kiosk etc. Performance of Ferro-cement items has been impressive, dependable and durable. These are economical when compared to steel, wood, plastic and even R.C.C. structures. Ferro-cement structures are easy to make, maintain and repair. Ferrocement is a highly versatile form of reinforced concrete made up of wire mesh, sand, water and cement which possesses unique qualities of strength and serviceability. It can be constructed with a minimum of skilled labor and utilizes readily available materials. There are several applications of Ferro cement which include building industry, irrigation sector, and water supply and sanitation areas. Studies proved that it is an excellent composite in the case of seismic resistant structures.

1.1 Initial Work on Ferrocement

Ferrocement in form of Mesh reinforcement cement mortar was used in Europe by Mr. J.L. Lambot in France. He constructed a Ferrocement rowing boat in 1848, in which reinforcement was in form of flexible woven wire mat and small size bars. He had patented this process. In the early

1940, Nervi of Italy used Ferrocement for ship building to overcome the shortage of steel plates in Second World War. He also applied Ferrocement techniques in building and warehouses. Ferrocement has been used in construction of domes, roofs of stadiums, opera houses and restaurants in Europe. Inspire of Nervi's demonstration of successful use of the material, no systematic studies were made till 1960, when its use as a boat building material was made in Australia, UK and South East Asian countries.

1.2 Recent Studies

In 1972, National Academy of Science, USA, established an ad-hoc panel to study the use of Ferrocement in developing countries. Its report on 'Ferrocement applications in developing countries', was published in 1973. It gave impetus to systematic study of Ferrocement in United States. This was followed by American Concrete Institute, establishing committee 549 on Ferrocement in 1974. From then, considerable effort has been made by many individuals and institutions all over the world to develop Ferrocement as a construction material.

At Bangkok, in Thailand "International Ferrocement Information Centre" was established and a "Journal of Ferrocement" is regularly published by it. A.C.I. committee 549 has studied all aspects of Ferrocement and in 1988 has published their reports 'State of Art Report on Ferrocement – ACI 549 – R – 88' and 'Guide for the design, construction and repair of Ferrocement – ACI 549 – 1R – 88'. These reports have established Ferrocement as a reliable standardized building material.

2. Typical Features of Ferrocement

The feature of a well-built Ferrocement construction are the low weight, maintenance costs and long lifetime in comparison with purely steel constructions, however, meticulous building precision is considered crucial here. When a Ferrocement sheet is mechanically overloaded, it will tend to fold instead of break or crumble like stone or pottery. Therefore, it is not brittle. As a container, it may fall and leak but possibly hold together. Another feature of Ferrocement structures is that they are stronger and more durable than some traditional building methods. Depending on the quality of construction and the climate of its location,

houses may pay for themselves with almost zero maintenance and lower insurance requirements. Water tanks could pay for themselves by not needing periodic replacement, if properly constructed of reinforced concrete. Ferrocement structures can be built quickly, which can have economic advantages. In extreme weather conditions, the ability to quickly erect and enclose the building allows workers to shelter within and continue interior finishing. Ferrocement is used often because the constructions made from it are more resistant to earthquakes. Earthquake resistance is dependent on good construction technique and additional reinforcement of the concrete.

3. Constituents of Ferrocement

Following are the Constituents of Ferrocement.

3.1 Cement: The cement should be fresh, of uniform consistency and free from lumps and foreign matter. It should be stored under dry conditions and for as short duration as possible. Cement percentage is normally higher in Ferrocement than in reinforced concrete.

3.2 Sand: Normally wet sand is the most commonly used in Ferrocement. It should be free from silt and clay. Sand should be inert with respect to other materials used and of suitable type with respect to strength, density, durability and shrinkage of the mortar made with it. Grading of sand is to be such that a mortar of specified proportions is produced with a uniform distribution of the aggregate, which will have a high density and good workability and which will work into position without segregation and without use of high water content.

3.3 Water: Water to be used in mixing and curing should be potable i.e. fresh and free from any organic and harmful solution which will lead to deterioration in the properties of the mortar. Saline water is not acceptable but chlorinated water can be used.

3.4 Reinforcing Mesh: One of the essential components of Ferrocement is wire mesh. Different types of wire meshes are available. These generally consist of thin wires, either woven or welded into a mesh, but the main requirement is that it must be easily handled and, if necessary, flexible enough to be bent around sharp corners. The function of the wire mesh and reinforcing rod in the first instance is to provide the form and to support the mortar. In the hardened state its function is to absorb the ten-

sile stresses on the structure which the mortar, on its own would not be able to withstand.

3.4.1 Types of Meshes in Ferrocement

There are many types of meshes used in Ferrocement, some of them are:

i) Hexagonal and Welded Mesh

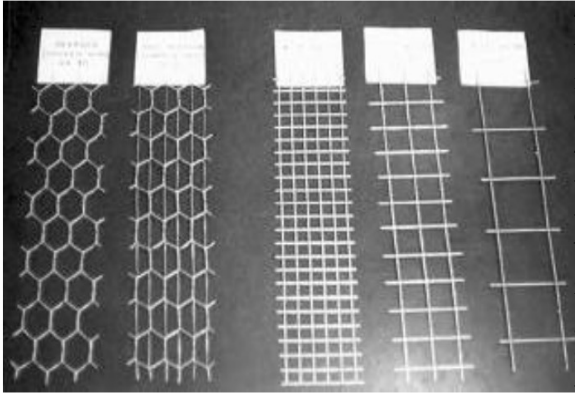


Fig 1: Hexagonal and Welded Mesh

ii) Woven Wire Mesh

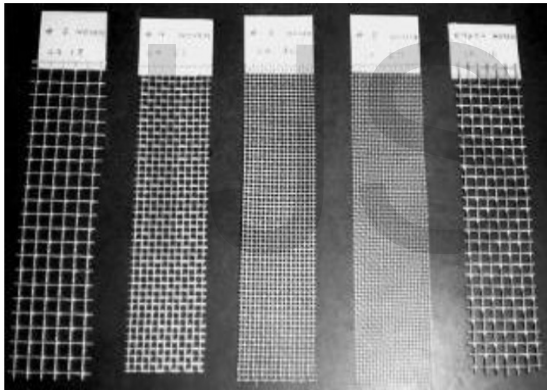


Fig 2: Woven Wire Mesh

4. Applications of Ferrocement

There is not a single branch of Civil Engineering where Ferrocement is not used. Its applications are enumerated below:

4.1 Liquid retaining structure

4.1.1 Water tanks: rectangular, circular, spherical, small and large size, open, covered, loft tanks, ground service reservoirs, underground and elevated, hopper and shell bottom.

4.1.2 Effluent treatment plants: septic tanks, clarifiers, settling tanks, digesters, humus tanks, sludge – drying beds. All the units in water purification plants, gobar gas plant:- KVIC type, Janata model, rain water harvesting tanks, petal tanks, small dams, bandharas, K.T. Weirs and needles required for them. Gutters and canals of parabolic section, water proofing treatment to leaking dams on their

upstream faces, cut off trenches in earthen dams.

4.2 Soil retaining structure

Soil retaining walls, counter fort walls, grain silos, face wall panel and anchor plates for reinforced - earth techniques.

4.3 Building Components

4.3.1 Foundations – parabolic shape, multi-bulbed under-reamed piles, RCC column encased in Ferrocement, double walling for compound walls on expensive soils.

4.3.2 Walling – single wall, partition wall, double wall with cavity, thermal insulated, soundproof walls, wall resisting rain penetration. Single wall box like structure, garages, police chowky, site office, stores, way side shops, latrines, service units, go-downs, watchman cabin, animal shades, bus shelters, telephone booths, cycle stand etc. Double walled construction with inbuilt columns and beams, pre-case stiffened plates for cavity walls and hollow floors in construction of multi-storey buildings, earthquake resisting structure.

4.3.3 Roofing:- flat roof with channel section, sloping roofs, shaped roofs like folded plates, cylindrical shells, domes, pagoda, vaults, umbrella, conical, thermally insulated, hollow floors with grid beams hidden inside, forming box sectional floors.

4.3.4 Precast box sectional large size hollow floors to replace large size prestressed core slabs.

4.3.5 Waterproofing: for slabs, roofs, water tanks etc.

4.4 Large size space structures

Large size conduits for stream diversion and egg-shaped storm water drains, outfall sewers. Precast canal sections in parabolic shapes, large size petal tanks with pull-back counterforts, spun pressure pipes, penstocks, Egg shaped digesters, chimneys etc.

4.5 Precast Ferrocement products

All types of small size units, in water retaining structures, building components and soil retaining structures.

4.6 Special products

Earthquake resisting structures, Polymerised Ferrocement railway sleepers, Hollow dams, boats, cold storage structures, Ferrocement solar flat plate collectors, portable bunkers, retrofitting of damaged buildings, box girders for bridges.

5. Construction of Ferrocement Structures

A Ferrocement structure is formed by first fabricating the mesh reinforcement to the shape and size of

structure. It is then mortared and cured. The steps in constructing Ferrocement structures are

- a) Planning
- b) Fabricating
- c) Tying
- d) Mortaring
- e) Curing
- f) Handling and Erecting

6. Proposed construction of Bandhara using Ferrocement technology

Bandhara types of structures have very large scope in Maharashtra, recently state government, and released huge amount of funds for Bandhara to overcome from the recent drought situation. If we use such type of cost effective, easy to do structures, it's very easy to eradicate drought from roots in very less time period. Because all these structures are very easy to construct as well as require less time compared to other structures. Once such Bandhara is proposed to build using Ferrocement Technology.

6.1 General Note on the Proposed Bandhara

The proposed bandhara is situated in the eastern part of Pune district. It receives moderate to low intensity of rainfall. The average annual rainfall is less than 600mm (23.42 inches). The monsoon rainfall in 2 years is irrelevant and insufficient; this caused lowering the ground water table which has lead to huge scarcity of water.

In the light of above, Hon. Collector of Pune gave the direction to construct the series of cement concrete Bandharas across the Nalla to check the water flow and thereby increase in the water table. The proposed construction of bandharas using Ferrocement Technology will be helpful to reduce the overall cost by 30–40% as compared to tradition cement concrete bandhara.

7. CONCLUSION

The Ferrocement Technology seems to be far more superior on all the dimensions like socially, economically and environmentally, such as time required constructing, cost benefit ratio, per liter cost of structure, design according to site conditions etc. Inherent of Ferrocement like crack control and water tightness, make it the "King of Water kingdom". Any construction concerned with water can be

safely made in Ferrocement. There are number for qualities, which make Ferrocement a good water retaining material. Mainly water tightness is due to crack control due to high specific surface, high strength in tension and compression, high first crack stress and through disbursements of fine wire reinforcements throughout the body of Ferrocement.

All this benefits sets the tone for the Construction of Bandhara Using Ferrocement Technology which will be completed in the coming months and a detailed comparison can be obtained over the conventional methods of Bandhara construction.

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