

FERROCEMENT TECHNOLOGY:

APPLICATIONS IN WATER RESOURCES AND PUBLIC WORKS DEPARTMENTS

By

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- **Synopsis**

Ferrocement technology is not new to us. It is as old as Reinforced Cement Concrete. Though Ferrocement material can not directly replace the RCC, it can economically be used at appropriate locations as well as for the specific purposes.

Ferrocement can go a step ahead of RCC, because of the durability that can be achieved in high performance ferrocement. It has mouldability (with out any moulds, in some cases), ease of pre-casting and handling, and can be executed without help of any sophisticated machinery.

Highlighting some special features of the Ferrocement, a general comparison with conventional reinforced concrete is discussed, just to know the versatility of this unique construction material.

With this, the author has listed various possible applications of Ferrocement in Public sector where its use can be made on mass scale, particularly in rural areas.

Government departments like Water resources, Rural Development, Agriculture, Water Supply as well as Public works Department shall come forward to make use of this technology through their various projects, which shall reduce costs and enhance water retaining properties as well. Many intricate and novel designs or shapes can easily be constructed using Ferrocement.

There are many more applications of Ferrocement as a construction material than listed below. By learning this technique, the horizon of Applications can be expanded. Sky is the limit!

- **Introduction of Ferrocement as a construction material**

Ferrocement is a type of thin walled reinforced concrete, commonly constructed of hydraulic cement mortar (without coarse aggregate) reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials.

Ferrocement has a very high tensile strength-to-weight ratio and superior cracking behavior in comparison to conventional reinforced concrete. This means that thin ferrocement structures can be made, relatively light and more watertight. Hence,

ferrocement is an attractive material for the construction of prefabricated housing units, boats, barges, and other portable structures.

- **Properties and Parameters governing design**

- Since the reinforcement pattern is changed (different than RCC), it changes the structural properties also. The construction material becomes more homogenous, when compared with RCC which is heterogeneous.
- As bond area increases, the tensile strength increases.
- Due to better distribution of steel through out the body of the structure, the surface becomes almost crack resistant. Thus, it enhances the weathering properties and water tightness.
- The cement consumption in Ferrocement ranges from 500 - 750 kg/ cum, while in case of RCC, it is 100 – 300 kg / cum. Use of fly ash is advantageous in Ferrocement.
- Steel reinforcement used is basically wire mesh, 0.5 – 2.5 mm, with the consumption of 350 – 500 kg/cum. While in case of RCC, the steel dia is 6 – 40 mm, with the consumption of 90 – 160 kg/cum.
- Cover to the reinforcement is 2.5 to 5 mm, while in case RCC, it is 12 to 40 mm.
- No coarse aggregate is used. This reduces the dead weight of the structure to large extent. Dead weight of Ferrocement frame structure is 175 kg to 275 kg per M³, while the av. weight of RCC framed structure is 300 to 600 kg/cum.
- It is possible to keep min. dimension upto mere 10 mm to max. 60 mm. The minimum dimension for RCC is 75 mm and above.
- Simple design techniques and methods, similar to RCC.

- **Special features of Ferrocement**

Ferrocement is basically a thin walled construction. The required strength is achieved through the shape of the structure. Welding the steel skeleton in fabrication shops provides complete control over the shape and size of the member. The thin-walled Ferrocement members are shaped as shells, domes, pyramids, folded plates, ribbed plates, box sections and conduits. Strength through shape property is advantageously used in constructing retaining walls and folded plate roofings etc. Lightweight property is used for the low bearing capacity soils or constructing floors over existing floors etc.

- Ferrocement materials are high in cement content with less water-cement-ratio. If a lean and fluid mortar mix is used, it cannot be held by the mesh. Thus, Ferrocement is a self quality-conscious construction material.
- Due to equal and uniform distribution of steel through out the body of the structure, there is equal strength in both the directions.
- No formwork or centering is required while casting in Ferrocement. . The mesh acts as reinforcement as well as a formwork to hold the mortar.

Formwork less construction property is useful for large size domes, pyramids, shells etc.

- Big and costly machinery is also not required, since it is more a manual operation. The elements are formed by press-filling stiff and rich cement mortar in tightly stretched and tied layers of mesh reinforcement.
- Due to its inherent qualities of high strength-to-weight ratio, we get better crack resistance and thin-walled construction. Thus, there is economical use of materials. Water tightness property is useful for constructing large size water tanks, swimming pools and reservoirs.
- Ferrocement can be cast-in-situ, precast or can be used in composite construction.
- Ferrocement thus offers liberty to the Architects in imagining beautifully shaped structures, which can be easily designed by the Designers with simple design parameters and constructed by the Engineers due to simple techniques of casting.

- **Applications in public sector**

- A. Water resources Department**

Huge and massive structures are planned and constructed by Water Resources Department of the state government. Most of them are water retaining structures. The structures like dams, barrages, weirs, aqueducts, canals, cross drainage works are being built by the department, which require complicated designs, big machineries, huge centering works as well as good quality control during execution so as to have leak proof structures.

In case of irrigation projects, long water distribution network is created through the canal system to divert water to each field in the command area. There is about 20 to 30 % water loss during transit. The major canals and distributaries are lined by cement concrete to reduce these seepage losses and also to reduce the roughness (coefficient of rugosity) of the canal surface to enhance its discharging capacity. Even after lining of canals by cement concrete, the water loss does not come to zero, as water seeps through construction and expansion joints provided during the execution of lining work.

Leakage through the body of the masonry dams is a big problem. Rectification work by any means is more difficult after impounding of the reservoir behind the dams.

Ornamental, attractive and aesthetic shapes of some parts of the dam viz. spillway piers, entrance gates, and various cabins on dam top, statues and fountains in the gardens and many such permanent structures are difficult to cast in RCC.

Massive designs of Kolhapur type weirs, RCC retaining walls, small bandharas, field storage tanks and such structures are becoming uneconomical during construction. They require high maintenance costs in the long run. Constructing small field channels, storm water gutters, drains etc. with lining and having lengths in kilometers is a time consuming work.

To find solutions - may be in parts - to such problems, one can think of alternative designs utilizing Ferrocement material, wherever possible. The areas where this Ferrocement Technology can be useful shall be thought of. It can be either designed / used during original construction or as a rectification treatment also.

Some possible applications of Ferrocement in the Water Resources Department are as below.

- **Leakages through dams:** As a water proofing treatment to the upstream surface of the dam, thin layer of Ferrocement material can be provided to obtain a crack free and water resistant surface. This layer shall also have good bond with existing masonry wall of the dam or with a concrete seprum provided to the upstream face. Even patch working by this material, after pinpointing the leakage spots can also help reducing the leakages through body of the dam to the great extent.
- **Canal lining:** Many trials have been taken in case of PCC or RCC canal lining works. To achieve smooth surface manually to the PCC is difficult job. No. of construction & expansion joints and min. thickness of 80 mm for PCC does not stop seepage and the work becomes costly. Even by mechanized lining using paver machines, providing expansion joints at proper place is difficult task. Ferrocement cast-in-situ or pre-cast panels, having thickness 10 to 25 mm may be more useful to avoid these problems. Ferrocement lining can be done over the well compacted earth surface, as well as for rectification work of existing damaged PCC lining. Using this material, a smooth and impermeable crack free surface can be achieved, with little load on the earth sections.
- **KT weir needles:** Normally, fabricated steel needles of 2 m length and 0.5 m high are used for KT weirs to block the flow of water after monsoon. But, to remove and replace these needles once in every year is cumbersome task. Many needles, being heavy, gets buckled or damaged in the process, some get stolen. Removing needles before start of monsoon need heavy cranes or similar machinery to be brought on remote site, having no easy approach. Rusting of plates of the needles is another problem. Simple, light weight, 10 mm thin walled needle of same shape in Ferrocement can solve all above problems.
- **Small precast structures:** Using Ferrocement as construction material, small structures scattered over the command area of an Irrigation project can be made in pre-fabrication units and transported to site for fixing. Pre-casting helps in achieving better quality control, economy due to mass production. Designs can be standardized and casting be done at different places. Few examples are - portable measuring devices, turn outs, blocks, outlet gates, precast c-shaped channel sections as lining to small field channels, watchman cabins, control cabins, gauges, road pavement blocks, storm water gutters, guard stones, chainage stones, name boards, sign boards, portable curing tanks etc.
- **Canal structures:** Cross drainage works of canals can be built in ferrocement, cast-in-situ. Structures like falls, chutes, village road bridges,

cart tracks, long span foot bridges, and cattle bridges, pipe line crossings etc. can be built with slender and elegant designs with speedy construction.

- **Big structures** like Earth retaining walls for deep cuts, water storage tanks (elevated or underground) can also be designed in ferrocement to achieve economy and durability.
- **Boats:** After impounding a reservoir, many existing roads get cut which connect the villages in the upstream area of a dam. The people living their need to go to other big towns for marketing, or to their farms. Water transport through boats is their only option. But many accidents have occurred on regular run boats due to overloading or tilting during storms. A twin hull stable boat made of Ferrocement material is having light weight still stable, rust or leakage proof designed to the required load. It can be run manually or with engine and has very low maintenance cost.
- **Retrofitting:** Repairs to damaged structures or any part there of is a big challenge. Some structures built in masonry or concrete are beyond repairs and need to dismantle. Such structures or their components can be strengthened by jacketing, covering them with Ferrocement, which gives that member added strength and prevent it from further collapses. Old / damaged canal structures like slab culverts, bridge piers, cart track slabs etc. can be retrofitted utilizing Ferrocement instead of dismantling and rebuilding them. Repairs to existing PCC lining for damaged patches can also be done with Ferrocement.

B. Public Works Department

Many government buildings, bridges and flyovers, roads, highways etc. are constructed by this department on mass scale. An application utilizing ferrocement material to any small part of these structures may result in multifold savings in cost and time. Moreover good seismic resistant, eco-friendly, crack proof, leak proof and simple structures using precast Ferrocement products can be produced which shall also speed up the construction.

The technology can very well be used for retrofitting of the old or damaged structures, components like columns, beams, and chajjas. Water proofing to the existing slabs, lavatories is major problem found everywhere. Ferrocement is an excellent impervious material for such waterproofing work, to be done even in patches. It is economical and durable than the conventional methods of water proofing by brickbat coba, or injections using epoxy materials.

Possible applications of Ferrocement technology in the Public Works department are listed below.

- Low cost housing, eco-friendly housing
- Seismic resistant houses in earthquake prone area
- Mass housing, colonies using prefabricated units in Ferrocement

- Small components of a building viz. lintels, chajjas, wall units, roofs, domes, entrance gates, cabins, compound walls, gutters, man holes, covers, flower beds, home interior units, kitchen shelves, lofts, toilet units, parapets, folded or curved stair cases, toilet blocks, water fountains
- Foot paths, road pavement blocks, sign boards, kilometer stones, dividers, toll plazas, bus stops, fins, sun louvers, swimming pools, temples having any complicated shapes, cable ducts
- Rural applications like cattle farms, drinking water spouts, single or common toilets, low cost hutments, farm houses, storage godowns, small industrial sheds, septic tanks, gobar gas plants, sewerage pipes.
- Sloping roofs: The conventional RCC for sloping roofs poses problems of casting to slope, waterproofing and consequently durability. The roofing system consists of precast ferrocement troughs, about one meter width, placed adjacent to each other. These form a formwork for the in-situ concrete and also form a part of the stiff structural roofing element.
- Thatched walls using mud mortar are common in rural huts. The same principle is used in Ferrocement, which is more durable and sustainable.
- Business entrepreneurship to rural youths, alternative to service. Requires small capital amounts, no heavy machinery, work is done manually by skilled workers. Ferrocement technology is easy to learn and like do-it-yourself type.
- Retrofitting or repairs of old / damaged structures, waterproofing of slabs, toilets.

- **Provision in the Schedule of Rates**

The item wise rate analysis and brief specifications have already been incorporated in the regional schedule of rates by Water Resources Department, Pune Region. This schedule is also available on website: www.kukadiprojects.com for further detailing of designs and detailed specifications required for the execution of work, and also for incorporating these in the bid documents, the members and experts in Ferrocement Society, Pune are ready to help.

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