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# Use of Ferrocement in Construction of Irrigation Works

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**ABSTRACT:** Ferrocement is a thin construction element with thickness in the order of 10-25 mm (3/8-1 in.) and uses rich cement mortar; no coarse aggregate is used; and the reinforcement consists of one or more layers of continuous/ small diameter steel wire/ weld mesh netting. It requires no skilled labour for casting, and employs only little or no formwork. In ferrocement, cement matrix does not crack since cracking forces are taken over by wire mesh reinforcement immediately below the surface. Husain Doshi Gufa, an underground ferrocement shell structure which was built in 1993 at Ahmadabad, India has not only withstood the 2001 earthquake but also has remained crack-free till date. Such a structure involving complex curvatures can be constructed in a reliable manner using ferrocement technology, giving free reign to architectural expression.

Ferrocement has come into widespread use in the last two decades. Sufficient design information is available and adequate field experience has been acquired to enable safe design and construction of many types of Ferrocement structures. The standard methods of ferrocement construction and effect of shape due to which novel forms are generated have to be researched upon and benefits brought out. Considering the unique features, ferrocement will no doubt be one of the most important structural alternatives for RCC and a repair material in the future and thus has a great potential for developing and developed countries.

**KEYWORDS:** Ferrocement, Reinforcement, architectural

## I. INTRODUCTION

The task of a Civil Engineer is most difficult. He has to build lifelong structures out of various non-standardised natural resources, with the help of whatever skills and labour are available at site, and in the most unfavourable conditions at worksite. The Civil Engineer has to build his structures on uncertain foundations; the structures may be exposed to hazardous environments or vagaries of nature like earthquakes or cyclones. The structure he builds should cater for all the sections of society and are critically reviewed by anybody. It is also expected that the structure should stand minimum for fifty years.

The material of the millennium, "Ferrocement" has come to the help of Civil engineers. Ferrocement 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 upto 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.

## II. LITERATURE REVIEW

Ferrocement is now well established as a construction material. To establish it as a structural material, its design which is directly applicable in field is essential.

Presently, ferrocement is treated as an extended form of R.C.C and all the designs are made as a two material composite with steel and mortar taking load separately. It is treated as a thin layered system with thickness not exceeding 50mm. All the designs are based on laboratory investigation and are of no use in field.

Ferrocement is homogenous and ductile composite with strong and perfect bond between steel meshes and mortar upto to the yield of steel. Bond between the two ingredients makes all the difference, increasing the tensile strength crack resistance substantially. Both steel and mortar share load together as if it is one material. It is quite a different material and applying principles of RCC designs though it is absurd and irrational.

A limited number of Conferences on Ferrocement happens in India. The literature review for present study majorly focuses on Ferrocement India Society and the work carried out by them.

"Ferrocete Technology - A Construction Manual" By Dr. B.N. Divekar has been referred which summarizes applications of Ferrocement in Civil Engineering along with basics of Ferrocement and all the aspects related to it. Ferrocete performance is quite different than conventional concretes. In many aspects Ferrocete is superior to reinforced concrete, prestressed concrete, fibre reinforced concrete and polymer concrete. Minimum number of easily available raw materials, no high technical skills, simple design principles and no heavy site machinery are added advantages of ferrocete. The construction manual gives information about Raw materials in Ferrocete Technology. It needs only 3 raw materials, only 3 steps of construction, only 3 types of skills and no special machinery for fabrication and casting. Design of Ferrocete structures involves analysis with the assumption that the dimensions of the structural members and the properties of material of which the structure is composed are known. Behaviour of the structure in the form of stresses, strains and deflection etc. under given loadings is studied by analysis. Method of constructing ferrocete structure with the development made by the author in construction techniques is refereed. Practical hints and the lesson learned in using this technology will definitely provide to any new consumer in the field.

"Construction and Repair Techniques for Ferrocement Application" by P.C. Sharma, Retd. Head-Material Science Division, Structural Engineering Research Centre (G) & Chief Editor, New building material and Construction World, New Delhi, Former Chairman, Indian Concrete Institute Western UP, Ghaziabad centre talks about Special Construction Techniques such as Ferrocement Core Units for composite structures - check dams. Ferrocement precast core units can be cast over masonry and composite structures can be assembled using these units. Using these techniques SERC (G) has developed precast ferrocement mini check dams for heights upto 1.5m. The system developed use precast ferrocement units for assembling of check dams at sites. Steps of the construction are (1) a ferrocement core of U shape is cast over low cost masonry moulds. The core has projected reinforcement at top and at both ends (2) the core is removed from the mould (3) the R.C.C. base is added in the bottom of the U shape unit (4) the core and base jointed unit is transported to the site (5) the foundation trench is excavated and the precast unit is placed on compacted and levelled ground (6) units are aligned, levelled and adjusted (7) the reinforcement projected at the end is lapped and tied to the reinforcement of the adjoining units (8) mortar is packed in the joints (9) the core is filled with soil, sand, gravel etc. (10) the top mesh projections and bars are bent to cover the top of F.C. core (11) the top is sealed with M-20 grade cement sand mortar.

Though the cost of such check dams may be higher than earth or boulder bunds but considering frequent breaching of earth / boulder bunds resulting in loss of water and expenditure in repairs, F.C. check dams may prove to be economical in long run.

"Ferrocement: An Innovative Advent to Sustainability and Versatility" by Er. P.C. Sharma, Retd. Head-Material Science Division, Structural Engineering Research Centre (G) & Chief Editor, New building material and Construction World, New Delhi, Sayandhar, Vasu Krishna, Vikash Kumar B.Tech. (Civil), SRM University. This papers prime focus highlights the recent developments and application of ferrocement while considering its sustainability. Ferrocement covers all the dimensions of sustainability. It is an environmentally sound technology. According to United Nations Conference on Environment & Development in Rio De Janeiro (1992), environmentally sound technologies (EST) protect the environment, are less polluting, use all the resources in a more sustainable manner, recycle more of their wastes and products in a more acceptable manner. Since Ferrocement does not contain aggregate, tremendous amount of energy, GHG's emission can be saved. The durability of Ferrocement also contributes to the sustainable development. An application of Ferrocement includes Housing application, Water Tanks, Canal Lining and has some special applications like Precast Sandwich walls. Ferrocement water filters, Ferrocement segmented shells.

"Ferrocement : Ideal Technology for the mass scale use in public works by Government Departments" by Rajendra Pawar, CE, V.M.Kulkarni, Sub.Divisional Engineer, Hydrology Project, Nashik. This paper highlights the importance and advantages of this technology for the wide use in Govt, departments, as it is very easy & simple for construction for departmental Civil Engineers. If used on mass scale, the ferrocement material becomes certainly cost effective. The uses for lining to canals, precast gutters, pipes, precast and portable flow measuring devices, small building components (precast), road pavements, underground sewers, water tanks, boats etc. are some of the areas where this technology can be very effectively implemented by Government Departments. Its usefulness, cost effectiveness and durability has already been proven.

"Lokmanagal Bandhara" by Sonali Bharat Patil, Govt, of Maharashtra and Vijaykumar N. Honmote, Z.P.Solapur is a good reference of comparison of conventional type of cement concrete bandharas with different types of ferrocement bandharas. Comparison in all dimensions socially, economically and environmentally, such as time required to construct, cost benefit ratio, per litre cost of structure, designs according to site conditions, material and man power required, aesthetic view etc. and how sustainable it is over conventional type of cement concrete bandharas. This literature gives a complete idea that good amount of money is wasted per year on water retaining and storage structures. If Ferrocement technology is used considerable saving in time and money can be achieved and it is more sustainable for water conservation structures.

"Analysis and Design of Ferrocement Panels an Experimental Study" by Nagesh M.kulkarni, D.G.Gaidhankar, research paper of International Journal of Inventive Engineering and Sciences (IJIES) ISSN : 23199598, Volume - 1, Issue -5, April 2013 is a good reference to understand durability of Ferrocement for different application of area like ferrocement floor and roof system for building, flexural behavior of flat and folded ferrocement panel, structure behavior of ferrocement system for roofing etc. "State-of-the-Art Report on Ferrocement" reported by ACI Committee 549 provide technical information on the mechanical properties, performance, and applications of ferrocement. The intent of this report is to promote the more effective use of ferrocement as a construction material for terrestrial structures in contrast to marine structures where it has been so far most widely used.

Public Works Department - District scheduled rate and City scheduled rates of the year 2015-2016 has been referred for the item rates to arrive at an estimated cost of the entire project.

A case study on actual work by the Government of Maharashtra Water Conservation Department is studied in detail that is focussed on Construction of Cement concrete Bandhara at Kalas (Patil Mala), Tal - Indapur, District - Pune, State - Maharashtra. Complete design details is studied in detail with all the cost proposition and advantages and disadvantages to understand the direct comparison with Ferrocement Construction for similar type of structure.

### **III. MATERIAL, METHODS & METHODOLOGY**

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

#### **a. Planning the work**

In Ferrocement construction, the work is executed in 2 stages, fabrication and tying mesh in factory and mortaring and curing at work site. Depending upon the magnitude of the work, this 2 stages are to be monitored in such a way that they function simultaneously and concurrently to save the construction time.

Mortaring of meshes is a continuous operation and proper co-ordination should be sort in mixing, supplying the mortar to the number of masons working at a time at the site.

**b. Fabricating skeleton of the structure**

The skeleton of the Ferrocete structure is its bone structure on which the body is built. It should be self-standing, rigid and stable. The skeleton is formed by bending the weldmesh to the shape and then by inserting steel bars in it (SERC method) or by "bending steel bars to the shape and then tying weldmesh over it.

**b.1 Forming skeleton by bending weldmesh:**

These bend weldmesh elements are assembled and tied together to form the tank skeleton. Chickenmesh or squaremesh are tied over it. The steel rods are inserted in the layers of mesh reinforcement.

This system yields to deshaped tanks with a tendency of walls to bulge out due to the loose framework. Also there are limitations to the shape and size of the structures which can be constructed.

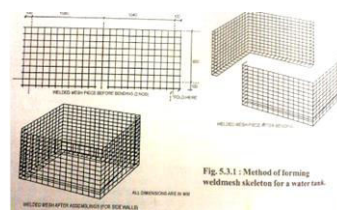


Fig. 1: Method of forming weldmesh skeleton for a water tank

**b.2 Welding bar skeleton:**

The skeleton of the structure is formed by welding steel bars to the exact shape and size of the finished structure. Mesh reinforcement is tied over it later. Welding imparts to the skeleton rigidity, correct shape and size, strength and continuity of joints. When bars are welded, overlaps need not be provided, which results in an indirect saving of steel.

**c. Tying Mesh**

Tying tightly the weldmesh and fine wire mesh on the welded bar skeleton is the key to the construction of uniform, strong, and elegant Ferrocete structures. Minimum two layers of fine wire mesh are required to contain the mortar in between them for forming Ferrocete elements.

In addition to reinforcing effect and contribution to the tensile strength of Ferrocete, weldmesh provides a smaller grid of wires on which chickenmesh can be tied tightly. Sewing of chickenmesh at closer intervals is possible due to it.



Fig. 2: Weld mesh and Chicken wire mesh

The mortar is applied under pressure into the layers of mesh in such a way as to impregnate and encase them completely.

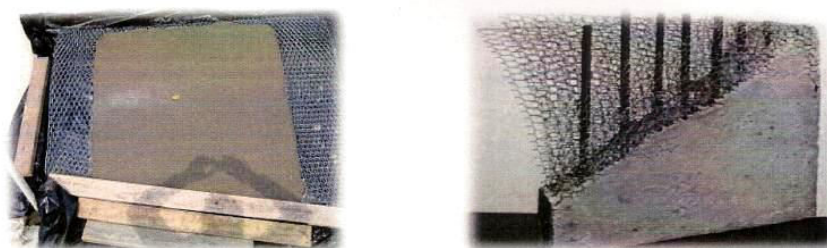


Fig. 3: Mortar application and typical cross section

Mortar is made from a good grade of Portland cement, well-graded sharp sand, clean water and, optionally, small amounts of additives to achieve an earlier setting strength or for plasticizing. A rich mortar is used in Ferro cement construction. The ratio of cement to sand should be 1:2 or 1:3. The sand used in the mortar should be clean, dry, and sharp; 10% to 15% should pass through mesh sieve (opening 0.150 mm). Only fresh water should be used for mixing. Although salt water does not affect the ultimate strength, it should be avoided, because it causes rust in the reinforcing. Up to 15% of the cement may be replaced by plasticizing and air-entraining agents, for example, pozzolana, diatomaceous earth, or fly ash. The ratio of water to cement should be 0.4 to 0.45. If the sand is perfectly dry; otherwise it should be 0.4. In some circumstances the use of a high-early strength Portland cement is advantageous, for example in production-line work, where it is desirable to remove the structures from the forms as soon as possible, or in cold climates to reduce the period needed for protection against low temperatures. Portland cement, which is used primarily for mass production by commercial Ferro cement builders, fulfills these requirements. However, its alkaline (salt-water) resistance is low. Portland cement, although slower setting than, is preferred for Ferro cement construction because of its high resistance to sulfate and to alkaline solutions. The chemical reaction between the cement and water (called hydration) in the mortar mix makes the mortar set hard. The hardening (and strengthening) of the mortar is rapid at first. It reaches near-maximum strength by the time curing is complete, usually up to 30 days. The mortar must be kept moist during application and curing.

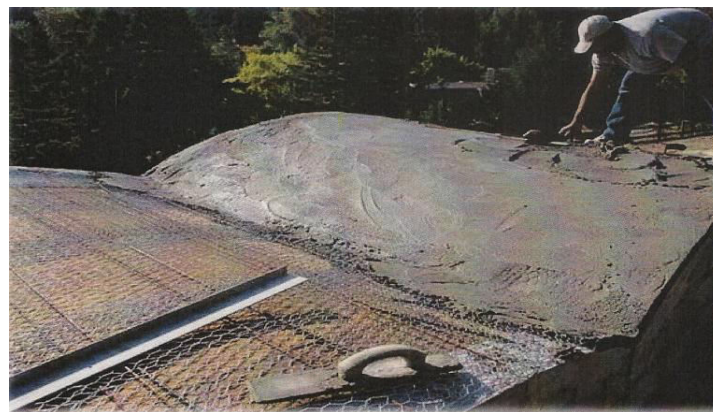


Fig.4: Applying Mortar

The temperature during application and curing influences the ultimate strength of the structure. At freezing temperatures ( $0^{\circ}\text{C}$ ) or below, increasing ice crystals will destroy the bond between sand and cement, causing the structure to fail. Near the boiling point, the early hardening will occur too fast. The hydration process also produces some heat. However, in thin-walled Ferro cement structures the heating effect is negligible. The mortar will generally achieve compression strength of 4,400 pounds

It was stated earlier that for most Ferro cement construction a water-cement ratio of 0.40:1 should be used for a workable mix and high strength. This ratio assumes that the sand in the mix is completely dry before water is added. As this is hardly ever the case, allowance should be made for the water already contained in the sand; the volume or weight of the water to be added should then be adjusted. This can be done by taking two identical samples of the sand, weighing one sample on site, and drying the other one in an oven. The weight difference between the two samples shows the amount of water already in the sample. That weight should be subtracted from the amount of water to be added to the same volume of cement-sand mix as used in the sample. The best test of a mortar mixture is to try it on a model section of the structure that is to be built. Use the same rods and mesh arrangement with the mortar that will be used in the structure. Another, less accurate, method is the widely-used "slump test". A sheet metal cone about 450 mm (18 inches) high is filled with several layers of mortar and rods. The last layer or mortar is towelled flat and the cone is set base down on a flat, horizontal surface. Then the cone is carefully lifted, leaving the contents behind. The difference between the height of the metal cone and the height of the wet contents is called the slump; it measures the relative water content of the mortar. A good dry mix, as used for Ferro cement, should show not more than 65 mm (2-1/2 inches) of slump. More would indicate excessive wetness and could result in shrinkage and cracks. Compromises are sometimes necessary in the composition of Ferro cement mortars. A high cement-to-sand ratio makes a strong, rich mortar, which is more workable, produces a better finish, and is far less permeable to water than a weaker mortar with a

lower cement-to-sand ratio. However, a rich mixture shrinks more than a weaker mortar, causing hair cracks and sometimes large cracks as well.

For important projects, test panels should be made and, after curing, can be laboratory tested to determine crushing, compression, tensile, shear, and flexing strengths, as well as impact resistance. In general, a mortar made with a cement-to-sand ratio of approximately 1:2 to 1:3 and a water-to-cement ratio of 0.4 to 0.45 will produce the least amount of shrinkage and a workable mix.

For large structures and where the distance from the mixing site to the construction site is considerable, it may be advantageous to pump the mortar to the construction area. A special plasterer's pump is used to transport the mortar through pipes to the work site. For better flow through the pipes, the water to cement ratio should be slightly higher than normal, with a slump of 75 mm or more. A disadvantage of this method is that incomplete mixing or separation of the cement and sand during travel can clog the pipes. They must then be taken apart, cleaned out, and reassembled, resulting in a substantial loss of time and labour. The available mortar guns have not been successfully used because the heavier parts of the cement-sand mix tend to separate at the pipe nozzles. After checking the reinforcing for smoothness (and pounding out flat spots, retying loose mesh, etc.), the structure is ready for mortar. All loose rust should be wire-brushed off; oily and dirty surfaces should be sprayed with a hydrochloric acid (HCl; danger: protect skin and eyes) solution and, after cleaning, neutralized with fresh water. All the mortar should be applied at one time at an even temperature; it should be shaded from direct sunlight and winds, and protected from frost. A few simple tools are needed: buckets or shallow containers to carry the mortar; steel and wooden floats; soft brooms for erasing float marks; and long flexible boards for finishing long, curved surfaces. The stiff mortar is pushed with hand pressure through the reinforcing. As this is done, great care must be taken to avoid leaving air pockets, which can occur in back of the rods or the expanded metal. In places where penetration is very difficult, a pencil vibrator or an orbital sander with a metal plate substituted for the sandpaper pad can be used to ensure complete covering of the reinforcing by the mortar. Localized vibration can also be created by using a piece of wood with a handle attached. Air pockets can be located after curing by tapping the structure with a hammer.

These places should be drilled out and filled with cement and water grout, or an epoxy compound. Workers on one side of the structure push the mortar through the mesh and rods until it appears on the other side, where the other workers finish it off smoothly with approximately 2 mm of mortar protruding beyond the mesh. The same finishing is then done on the opposite side. It is of the at most importance that none of the work that has been completed be allowed to dry out while the workers are completing another part of the structure. In direct sunlight or during hot weather, moistened gunny sacks or other coarsely woven cloth should cover completed areas. If the work cannot be finished in one operation, the finished work should be kept moist, and a bond of thick cement grout or epoxy compound should be put on between the old and the new work. Several polyvinyl acetate bonding products are also available. If a concrete mixer is available, a paddle-wheel type is greatly preferred over the conventional tilting-drum mixer, because of the stiffness of the mortar used for Ferro cement construction.

#### d. Curing

Curing plays a very important role in Ferrocrete construction as the structures are very thin walled and likely to get dry very quickly particularly in summer season of the tropical countries. In curing structure lie water like or containment vessels, they are filled in completely with water and cured for 21 days. For the first 8 to 10 days the mortar is seen wet and saturated with water. As it gets hardened with time, outer surface of the tank becomes bond dry and indicates that the tank is getting cured properly.

The tank should not be filled in fully immediately after casting. Everyday about 30 to 40cm of height of tank should be filled till it is full.

Curing of other Ferrocrete structure done under wet gunny bags. For pre-cast Ferrocrete items, sprinklers or steam curing techniques may be used.

#### e. Finishing and Painting

After curing, the surface is rubbed down with abrasive (carbide) stone to achieve a smooth finish, and then rinsed thoroughly with fresh water. Because well-made Ferro cement is impermeable (waterproof), there should be no need for painting. However, if painting is desired, the structure should first be scrubbed with a 5% to 10% solution of hydrochloric acid (HCl; protect eyes and skin), flushed with clean, fresh water, and scrubbed again with a weak

solution of caustic soda (NaOH; protect eyes and skin), after which it must be rinsed again. The Ferro cement can then be sealed with a coat of epoxy resin, and one or more coats of epoxy paint applied as a finish. After sealing one side of the Ferro cement slab it is best to wait as long as possible before sealing the other side. Due to continuous hydration and curing, the untreated surfaces will show a white powder for a long time. Even after careful removal of this powder and rinsing, it will take years before paint will form a good bond with the untreated surface.



Fig.5 Painting of Structure

For storage of diesel fuel in Ferro cement tanks (not recommended because of the adverse effect of the alkaline action of the Ferro cement upon the diesel fuel), the insides of the tanks should be sprayed with a polysulfide compound. Several kinds of epoxy resins and compounds are also available for the protection of bare metal, bonding cement to any other material, filling in voids, etc. Ferro cement tanks intended for water storage should be given a cement wash inside and stored with a little water inside them. Underground Ferro cement grain silos in Ethiopia are waterproofed with bitumen. After curing, the surface is cleaned with a wire brush, and a coat of bitumen emulsion (diluted 1 volume of emulsion to 1 volume of water) is scrubbed into the surface. After it dries, a cement-emulsion mixture (1 volume of water to 1 volume of cement to 10 volumes of emulsion) is brushed on.

#### IV. RESULTS AND DISCUSSIONS

##### Comparison between Cement Concrete and Ferrocete

As ferrocete is basically composed of reinforcement and mortar, one is naturally tempted to compare it with reinforced concrete.

The word 'concrete' itself implies something which is solid, heavy and substantial in size. The idea of thin, slender and lightweight ferrocete structures is not assimilated easily by majority of structural designers and site engineers. Main points of comparison between reinforced concrete and ferrocete are as follows: RCC is a heterogeneous concrete. After first crack, steel and concrete share the load separately and the design is based on concrete taking the compression and the steel taking tension.

In ferrocete due to strong bond between wire meshes and mortar, even after first crack steel and mortar act together as a homogenous material. Upto to the yield of steel wires, strains in steel and mortar are same. After the first crack, in the zone of multiple cracking, crack width remains same and the number of cracks goes on increasing. This shows ductile behavior of Ferrocete. Hence Ferrocete is miles away from RCC.

Specifically, in case of Bandharas, Chain Bandharas (small Dams) are to be built across the streams to store, as much water as is possible, along the stream itself. The chain of Bandharas is arranged in such a way that upper bandhara is built at the tail water level of the lower bandhara. Conventionally they are built in solid concrete which is costly, time taking and cumbersome to build.

Dams built across the streams are designed as watertight structures which will not tilt or slide. In concrete dams these properties are achieved by providing sufficient thickness to the wall, increasing the weight of the structure and by providing sufficient base width. Hence the concrete dams are very bulky and heavy. Heavy formwork is required for casting them, along with the length of the dam when supports are provided in form of buttresses or counterforts, the thickness of the wall cannot be reduced. The wall portion supported between the buttresses is designed as a flexural member. Base width is controlled by the middle third rule.



Ferrocete wall is used as bandhara which is watertight and can be cast in any shape and needs no formwork for casting. The straight wall in conventional dam is replaced by an arch with its convexity towards water. Arch being a compression member transferring water load to the buttresses through membrane compressive stresses, very thin section of wall, even 50 to 75mm thick, is more than sufficient to take the load of 3m of water. The buttresses transfer the load through cantilever action to the base slab of the dam. Width of the base slab is decided by using middle third rule. Dead weight of the dam is provided by arranging heaps of stones on both the faces of the dam.

There is another alternative for comparison with constructing concrete bandharas. This is termed as Ferrocete Box shaped bandharas. In this, Ferrocete boxes, open at top, are cast as water tanks. Number of such boxes placed side by side and joined together form the wall of the dam. Water tightness to the dam will be provided by ferrocete. Base width of the box is designed by using middle third rule. The dead weight to the dam is provided by filling stones in the boxes. These boxes will provide confinement to the stones dumped in them. After completion the top of boxes will be covered with concrete and will provide a pathway over the dam to cross the stream.

Table No1:- Comparison of Reinforced Cement Concrete & Ferrocete

Sr. No.	Description	Reinforced Cement Concrete	Ferrocete
a.	Thickness	Minimum 75mm	Thin walled, 25 to 30mm
b.	Matrix	Cement Concrete (even plum concrete)	Micro-concrete (rich cement mortar)
c.	Reinforcement	Steel bars > 6mm dia. Spaced distance apart	Continuous fine wire mesh dispersed throughout the body of the structure
d.	Strength	Weak in tension, bond and shear	High tensile strength, superior bond and shear strength
e.	Strength to weight ratio	In tension and compression very low	Very high
f.	For casting	Formwork and shuttering are quiet essential. Due to forms honeycombing is very likely	Tightly tied wire meshes act as forms for mortar casting. Filling is dense and compact.
h.	Composite	Heterogeneous	Nearly homogenous
i.	Design	Complicated	Simple
J-	Strength through	Size, weight and reinforcement	Shape
k.	Structural behavior	Rigid	Ductile
l.	Economic	Cost Reduction not possible	Cost effective, overall cost reduction, time saving
m.	Environmental	Cannot reduce the amount of material, aggregate are used	The 10-15% amount of material is saved; local material can be used
n.	Social	Number of people required are less	Number of people required are more because no use of machinery, people participation, women participation

## V. CONCLUSION

The Ferrocement Technology seems to be far more superior on all the dimensions like socially, economically and environmentally, such as time required to construct, cost benefit ratio, per liter cost of structure, design according to site conditions etc.

Inherent of Ferrocete 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 ferrocete 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.

The current comparison of Ferrocement bandhara with cement concrete bandhara shows a visible benefit in cost saving and time. 30% reduction in cost is observed as compared to cement concrete bandhara. Cumulative effect of such saving in cost is significant and helpful to lower the cost of the entire project at the same time getting the quality output.

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