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Recent Ferrocement Construction Technology in Sustainable Construction

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Abstract – It is a composite structural material comprising thin sections consisting of cement mortar reinforced by a number of closely spaced layers of steel wire mesh. Application of Ferrocement in construction industry is large due to the low self-weight, No need of more skilled labor, no need of formwork. Ferrocement is generally used repairing, strengthening and retrofitting of the structures. Ferrocement was firstly developed and used by Italian architecture, P. L. Nervi in 1940.

Different type of meshes is used in Ferrocement such as, Hexagonal wire mesh, Welded wire mesh, Woven wire mesh, expanded metal mesh, and three dimensional meshes. The desired shape may be built from a multi-layered construction of chicken wire, and if needed reinforced with steel wire or steel bars. Over this finished framework, an appropriate mixture of cement, sand and water is spread out. During hardening, the Ferrocement is kept moist, to ensure the cement is able to set and harden. Quantity requirement of Ferrocement in building construction is much less as compared to R.C.C. Therefore dead load of Ferro-cement building is reduced by at least 50%. Consequently the foundation cost gets reduced. Ferro-cement is sustainable construction material. The comparison of Cost-time for material used in construction industry in each material showed that the material which includes Construction method, new techniques, installation process is the most suitable alternative to the existing traditional method like reinforced cement concrete.

Keywords— Ferrocement, Metallic mesh, Lightweight structure, Sustainable construction material, Construction Cost and Time

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I. INTRODUCTION

Ferrocement is a thin composite made of a fully mortar matrix based on cement, reinforced with thoroughly spaced wire-mesh layers of small diameter. The mesh can be produced from steel or various appropriate materials to generate parts of little thickness, resilience and excessive robustness, and rigidity and high strength will be accomplished once correctly shaped. Ferrocement is believed to be one of the distinctive techniques of construction that are now used throughout the globe. It is the cement material made of tightly spaced mesh layers in which the reinforcement is provided evenly throughout the material of Ferrocement making it ductile from fragile. Ferrocement has a high strength and serviceability that acts as a building material for several purposes. Compared to RCC, it functions as a homogeneous material having comparable characteristics in all directions. The mesh surface area in Ferro-cement is very large, which enables the mortar to properly bond with it, resulting in lesser cracks, exhibiting greater durability because of the same. It also has a much greater tensile strength and rupture module that helps to avoid cracks.

Similar skinny building material offers characteristics that do not match Ferrocement's characteristics such as strength, toughness, water tightening, lightness, and durability. The bending behaviour of Ferro-cement and concrete reinforced cement yields practically similar results. Ferro concrete is however regarded a hybrid material lies between reinforced concrete and stainless steel.

Ferro-cement can be considered a type of thin reinforced concrete construction in which large amounts of small-diameter wire meshes are used uniformly throughout the cross section instead of discretely placed reinforcing bars and in which Portland cement mortar is used instead of concrete. Metallic mesh is the most common type of reinforcement. Meshes made of alkali-resistant glass fibers, and woven fabric made of vegetable

fibers such as jute-burlap and bamboo, have also been tried as reinforcement.

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. Ferrrocement 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 greenhouse gases (GHGs) and harms the environment. That emission measured in terms of CO2. 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).

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 CO2 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 CO2 emission of ferrocement structure.

From the early history of ferrocement and through its subsequent evolution, the definition of ferrocement has been changing. Ferrocement can be defined as a type of reinforced concrete (RC) characterized by the small size of the reinforcement, which is wire mesh, and the aggregate, which is sand. The basic definition of ferrocement is given by ACI committee [1], however before and after this committee report, ferrocement has been defined with different researcher and committee [2–8].

However, there was insufficient application and research on ferrocement contraction between 1888 and 1942. An Italian engineer, Pier Luigi Nervi, carried out a series of experiments on ferrocement after that period. Based on the tests, it is observed that reinforcing concrete with layers of wire mesh produces a material possessing the mechanical characteristics of an approximately homogeneous material which is capable of resisting high impact load. Nervi also applied the ferrocement concept to civil engineering structures and used the idea of corrugation for the roofs of several significant structures including a roof system spanning 98 m for the Turin Exhibition Hall.

Ferrocement is now considered as a versatile, low-cost construction material with large potentials in many other areas, including housing applications. In many aspects, ferrocement is deemed to be an extension of RC, and it has relatively better mechanical properties and durability than conventional RC. Within certain loading limits, it behaves as a homogeneous elastic material, and its elastic behavior is better than normal RC. The uniform distribution and high surface area to volume ratio of its reinforcement results in a better crack arrest mechanism and higher first crack load; moreover, ferrocement has better fire and heat resistance compared to RC [9–23]. The use of ferrocement technology seems to be an alternative to the current conventional systems. Ferrocement wall panels, precast ferrocement roofing elements, and ferrocement permanent formwork are few examples of ferrocement structural components being used in construction sector today.

Ferrocement use in the precast slab and composite precast slab applications. The utilizing of ferrocement in precast technology is highlighted regarding the mechanical and in-service properties. The advantages of ferrocement can be realized from its potential in precast and precast composite application. The flexibility of ferrocement provides for the design of panels that are thin, durable and have a high first crack load, which results in reduced construction time and total cost of the precast elements. Despite its thin structural form, ferrocement shows ductile behavior resulting in flexible transportation and erection options for the precast structures. Research conducted over the past decades demonstrates the advantages of ferrocement composite precast panels and suggests that new designs have the potential to overcome most of the precast and the precast composite structures' shortcomings. The use of ferrocement as a permanent formwork, concrete cover, precast slab, precast half slab and precast composite slab have proved its advantageous characteristics. Based on this review of research on ferrocement, it is evident that usage of the ferrocement should continue to be an important research focus for precast composite slab applications.

Constituents of Ferrocement

The wall panel of ferrocement includes the thick cement mortar which is planned as per the standard mix design procedures for mortar and concrete which includes cement, sand, wire mesh. Water and admixtures

Cement: The cement to use is usually ordinary Portland. However, rapid hardening Portland cement may be used in cold climates. Sometimes a sulphate resistant Portland cement is used, either wholly or in part mixed with ordinary Portland against sulphate attack. If the cement is used with admixtures, care should be exercised in compatibility.

Water: Water should be potable, clean, and free from harmful salts or foreign materials which may impair the strength and resistance of the mortar.

Fine Aggregates: The importance of good, clean, well graded sand cannot be over emphasized if one is to make the high grade impervious mortar required. Skeleton steel: It is provided to supports the steel wire mesh. The size of Skeleton steel is normally 6 to 8 mm of Fe 250 bars were used.

Wire mesh: Consists of galvanized steel wires of diameter 0.5 to 1.5 mm, spaced at 5 to 20 mm centre to centre Welded wire mesh has hexagonal or rectangular openings

Admixtures: admixtures are may be used in ferrocement for improvement in impermeability, water reduction, air entrainment, which increases resistance to thawing and freezing.

Durability of Ferrocement

According to the ACI Committee, 'durability' is defined as 'ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration', that is, durable concrete will retain its original form, quality and serviceability, when exposed to its environment. The various measures required ensuring 'durability' in conventional reinforced concrete is also applicable to ferrocement, since, ferrocement has almost the same type of ingredients/constituents, except, coarse aggregates and the use of smaller fine aggregates, than conventional concrete and a thin cross section. However, other unique factors, which affect durability, especially, the susceptibility to corrosion of ferrocement are:

- Very small cover to the mesh reinforcement.
- Very low cross sectional area of the mesh reinforcement wires. 3. Because of small wires being used the surface area of the reinforcement is high.
- To prevent corrosion, Mesh reinforcement are galvanized, but the zinc coating can cause and produce hydrogen gas bubbles during hydration.

1.1 Related Work

“Ferro cement is a type of thin wall reinforced concrete construction where usually hydraulic cement is reinforced with layers of continuous and relatively small diameter mesh”.

Joseph Aspdin introduced to the world Portland cement and patented it during 1824.Subsequent developments in material, higher burning temperature, continuous process rotary kiln etc., drastically improved the material and reduced the cost. A spate of buildings erected from 1835 onwards was of concrete but the concept of reinforcing the material was hardly around this period (John E Morgan 1998).

To overcome the low tensile strength of concrete, attempts were made to reinforce it using bronze rods and strips. But the higher rate of thermal expansion of bronze caused cracking." A note on the history of reinforced concrete in buildings" by Hamilton.S.B. describes the early use of armatures of embedded iron in masonry and to reinforce brick work. Within a short period, use of reinforced concrete was put under use. Joseph Monier built large garden tubs (1849); Francois Coiquet (1852) cast concrete around an ion skeleton within timber shuttering; William Wilkinson a New castle builder took out a patent in 1854 for embedding in floors or beams of concrete a network of flat iron bars (John E Morgan 1998).

In the same period Joseph Louis Lambot and horticulturist living on his estate at Miraval near Bringnoles in Var experimented with plant pots, seats and tubs made of meshes and plastered with sand and cement mortar replaced his rotting rowing boat. He called this material as „Ferciment" in a patent, which he took in 1852. Lambot"s row boats still now available in Brignoles museum in France.

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

In 1945,Nervi built the 165 ton Motor Yatch “Prune” on a supporting frame of 6.35mm diameter rods spaced 106mm apart with 4 layers of wire mesh on each side of rods with total thickness of 35mm.It

weighed 5% less than a comparable wooden hull &cost 40% less at that time.

In 1947, Nervi built first terrestrial ferrocement structure was due to the corrugations of the wall &the roof which were 44.45mm thick.

Sr.No	Title	Author & Year of Publication	Description
1	Review on Ferro-cement an effective alternative for construction industry	Kavita V. Desai, Dr. Deepa A. Joshi , International journal of innovation in engineering and technology (IJIET) Volume 6 Issue 2, December 2015	Ferro-cement 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. Ferro-cement has another important advantage of reduction in CO2 emission. For sustainable development and prevention of environment, this feature of Ferro-cement, makes it more suitable for construction
2	Review on Study on performance of prefabricated Ferro- and technology	Lakhan Murari, Elson John, (IJERST), Special Issue, Vol. 3, No. 1, April 2016	it can be concluded that the prefabricated Ferro-cement columns and wall panels may be used for the construction of low rise buildings and it is also cheaper compared to RCC elements of similar size.
3	Study and Cost Analysis of Ferro-cement Panel for Affordable Housing	Ganesh A. Choughule, N. N. Morey, Journal of Basic and Applied Engineering Research, Volume 3, Issue 10; July-September, 2016	The cost of Ferro-cement panel construction is approximately half than cost of construction of conventional brickwork. result shows that panels with more no of layers having higher flexural strength and less deflection compared with panels having less no of layers of mesh and construction of Ferro-cement structure is rapid and economical as compared with conventional material for affordable housing.

Sr.No	Title	Author & Year of Publication	Description
4	Ferro-cement Construction Technology and its Applications	A.S. Burakale, P.M.Attarde, Mayuri D.Patil (IRJET), Volume: 07, Issue: 07, July 2020	This is only a review study and experimental research on new building materials for use in Ferro-cement construction or combinations of meshes and fibers are needed. The standard methods of Ferro-cement construction and effect of shape due to which novel forms are generated have to be researched upon and benefits brought out. This study recommends Ferro-cement as the best alternative material to RCC and also a construction material of the future due to its properties/ advantages. And also recommended that Ferro-cement also use for repair work
5	Development of Ferro-cement technology for low-cost farm structures,	A.S.M. Abdul Awal, M. Siddikur Rahman and M. Bellal Hossain, 2014	The cost of construction of Ferro-cement structures has also been estimated on the basis of present cost of materials and labour. It is hoped that the observations made in this study will bring new idea in achieving wide acceptance of this technology for the construction of low-cost structures for farm uses.
6	Alternate and low cost construction material and techniques",	Satish Deshmukh, Mittal C. Mohite, (IJSTE), Volume 5, July 2018	.In this study they studied different alternate construction material and the potential of these materials to be used as alternate building material. They concluded that Depending on the availability of the materials in a particular region, these materials can be selected as transportation consists of approximately 30% of total construction budget.

In 1948 Nervi used ferrocement in first public structure, the Tutrin Exhibition building, the central hall of the building which spans 91.4m, was built of prefabricated elements connected by reinforced concrete arches at the top &bottom of the undulations. In 1958, the first ferrocement structure a vaulted roof over shopping centre was built in Leningrad in Soviet Union. In 1971 a ferrocement trowler named “Rosy in I was built in HongKong. It had an overall length of 26m &is claimed to be the world’s longest ferrocement fishing boat.

In 1972, the National Academy of Sciences of the United States of America set up an Adhoc Panel on the utilization of ferrocement in developing countries under the chairmanship of In 1974, the American Concrete Institute formed committee 549 on ferrocement. ACI Committee 549 first codified the definition of ferrocement in 1980, which was subsequently revised in 1988, 1993 and 1997(Naaman A.E, 2000).

In 1975, two ferrocement aqueducts were designed &built for rural irrigation in china.

In 1976, the International Ferrocement Information Centre (IFIC) was founded at Asian Institute of Technology, Bangkok, Thailand. The centre is financed by the United States Agency for International development, Government of New Zealand, International Development Research Centre of Canada.

In 1978, an elevated metro station of 43.5mx1.6m in size with continuous ferrocement roofing was erected in Leningrad.

In 1979, RILEM (International Union of Testing &research Laboratories of materials &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. The International Ferrocement Society (IFS) formed a Committee (IFS-10-01),the recommendations of which were published as “Ferrocement Model Code”(FMC) in January2001.The definition in the above model code reflects the advances in ferrocement and past experiences too.

1.2 Problem Definition

It has been seen that a significant amount of research has already been done in perspective of structure. The use of Ferro-cement and their factors affecting the construction sector in india not so much data available for study.

This study attempted to determine how much profit and efficiency of construction projects could be increased using Ferro-cement. This study also explored and evaluated differences between constructions in India, by analysing the traditional material like RCC over Ferro-cement. We reduce the cost and get more benefits using Ferro-cement.

1.3 Aims and Objectives

- To find the differences in cost by analyzing construction project cost between RCC structure and Ferrocement structure
- To find How much time need to complete one project using Reinforced concrete and Ferrocement material and to study Environmental Assessment Factors on ferrocement material
- To minimize energy costs / waste without affecting production & quality and to minimize environmental effects and to identify the source of wastes for specifically chosen activities at a construction site and

relate them to the waste generate in construction industry using both material.

- To study Effect on total project cost and benefits using Ferrocement material and advance construction techniques.

II. RESEARCH METHODOLOGY

Research Methodology will be designing a questionnaire survey by which we can find out the factor affecting the construction cost which directly related with material use in construction projects.

2.1 Formation of questionnaire

For this particular project, a questionnaire survey approach has been adopted to find the impact of various factors affecting the cost of project. The design philosophy of the questionnaire was based on the fact that it had to be simple, clear and understandable for the respondents and at the same time it should be interpreted well by the researcher.

2.2 Through literature survey

It has been seen that a significant amount of research has already been done in perspective of structure. The use of Ferro-cement and their factors affecting the construction sector in india not so much data available for study. And hence, a preliminary research through various literatures throughout the globe led to the formation of a preliminary list consisting of factors affecting the project cost and time.

2.3 Through preliminary survey of the sites

After recognizing the basic factors through the literature survey, preliminary survey of various sites led to the understanding the nature and relative importance of those factors in the Indian working conditions. The survey co-related the effectiveness of global factors with respect to the Indian sites and also gave us and practical insight adding a few more factors, though they are area specific.

2.4 By talking to local experts

Due to varying environmental, social and economic changes, the effectiveness of the factors may also vary over the period of time, and due to the time constraint of the project, it's not feasible to cover all the aspects. And hence by talking to local experts, who are equipped with the practical knowledge of the situation, information required to verify the importance of a particular factor with respect to Indian working conditions can be achieved.

And hence, the factors affecting the construction cost and time were identified through the literature based on previous research, site survey and with input, revision and modifications by local experts.

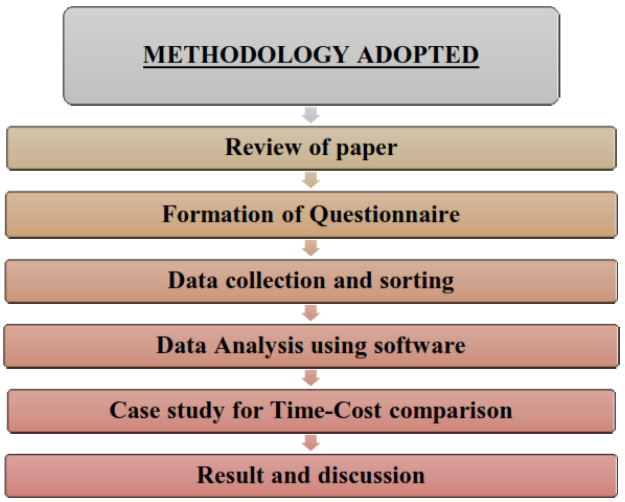


Figure1.1: Methodology chart

FERROCEMENT CONSTRUCTION PROCESS

As thin structural elements, ferrocement has been used in numerous applications ranging from engineered structures to architectural applications such as sheets, boards, shells, hulls, and also sandwich type construction using thin skins, and constructions where the reduction of self-weight, improved water permeability and development of very fine crack widths are essential.

Structural Applications

Ferrocement can be used in various structural members subjected to different type of stresses. As a compression member, hollow columns with horizontal stiffeners can be cast in ferrocement. Columns or walls in concrete, RCC, stone or brickwork can be encased in ferrocement to increase their strength due to confinement. Members subjected to membrane stresses like shells, domes, pyramids can be cast in ferrocement very easily; and being a homogenous material, full section of member is utilized in resisting the membrane stresses. A ferrocement hyperbolic paraboloid shell structure was constructed by the student chapter of the American Society of Civil Engineers at Funded by the International Development Research Centre of Canada, two prototype cylindrical water tanks for the collection of rainwater were designed, constructed, and tested for use in the rural areas of the Philippines. A greater use could be made of ferrocement in water-retaining constructions and other similar constructions where crack width is a design criterion. Because of its very small crack widths under service load and it superior extensibility, ferrocement provides excellent leakage characteristics for applications in water tanks; moreover, should pressure increase, ferrocement

stretches to allow higher leakage and acts as a safety valve, thus, it does not fail

Roofing Applications

Ferrocement appears to be an economic alternative material for roofing; and flat or corrugated roofing system is quite popular Ferrocement roofing materials can be factory mass-produced in prefabricated form, a process best suited to the concentrated demands of the urban area, or it also can be fabricated in-situ in villages. Construction of hundreds of ferrocement roofs for poorer areas of Mexico has been well documented; and large ferrocement roofs have also been constructed in Italy spanning with a thickness of 30 mm. The use of ferrocement as roofing for large span structures with internal ribs has been successful in many European and South American countries. Domes have been constructed in Jordan using thick ferrocement with internal ribs.

Need for Repair of RCC Structures

Some major reasons for the deterioration of RCC structures are cracking (due to incorrectly made construction joints, poor compaction, segregation, poor curing and high water content) and spalling (due to corrosion in the reinforcement bars accelerated by a lack of adequate cover). The cracks in the concrete may be developed due to wrong design of structure or due to poor quality of materials used, and this will facilitate internal corrosion of steel reinforcement used in RCC elements; the cracks in course of time deepens up due to increase in corrosion and subsequently, peeling of concrete cover or spalling of concrete takes place. Use of proper repairing materials and methods of damaged or deteriorated RCC structures is a necessity not only to serve the intended service life but also assure the safety of buildings value: Ferrocement Repair Techniques A good repair improves the function and performance of structures, restore and increase its strength and stiffness, enhances the appearance of the concrete surface, provides water tightness and prevents ingress of the aggressive species to the steel surface durability. Ferrocement repairs and rehabilitation can be done in RCC structures to increase the strength of columns, beams and slabs up to 30% as well as contribute towards prevention of crack formation. Ferrocement which can be made from non-formwork construction processes is an advantage over other types of repair and strengthening techniques; enhanced crack resistance combined with high toughness, its rapid constructions with no heavy machinery involved, small additional weight it imposes, and considering an economical aspect of rehabilitation, this material proves to be a cost effective solution for rehabilitation and general applications. The ferrocement material is a waterproof system and does not allow the penetration of water and atmospheric gases. It can totally replace deteriorated/ damaged RCC with reduction in dead load.

Ferrocement Repair Methodology It is generally noticed that corrosion of RCC structures most commonly takes place in the main reinforcement in slabs, beams and columns and the stirrups, where proper cover is not maintained and where reinforcement is exposed in the cover area. Patchwork repair can be done using ferrocement to the damaged concrete surfaces in slabs, beams and columns to restore the original strength of the RCC. Ferrocement patch repair method can be carried out in columns, bottom and middle portions of beams, soffit of slabs, etc. and following are the repairing steps recommended in the previous studies

Step 1: Breaking open the damaged spalled cover or the affected zone or the cover of RCC elements (such as beams or columns) with the help of a chisel and hammer.

Step 2: Exposing the original reinforcing bars and scraping of corrosive layers of reinforcement and applying anticorrosive paints (if any) or cutting and replacing the corroded reinforcement.

Step 3: Roughening the concrete surface, and placing chicken and/or galvanized wire/ weld mesh in position and the mesh should get fixed/ embedded to original slab/beam/column reinforcement. Use skeletal reinforcement, if required. Step 4: Applying cement mortar on the reinforcing wire-mesh by hand or through spraying (similar to guniting/shotcreting methods)

Step 5: Provide necessary curing for 28 days. Alternatively, ferrocement membrane protective layer can be carried out. In this, layers of closely spaced wires can be used on to the RCC surfaces to prevent crack widening. The cement matrix is in proportion of about 1:2 and has admixtures which reduce shrinkage and develop early high strength. The matrix is vibrated locally using light vibrating tools. Finish of the membrance is just like plaster.

Ferrocement Confinement

Ferrocement confinement is done around defective circular or square/rectangular RCC columns in order to enhance the strength, ductility and energy absorption capacity of existing concrete columns. A jacketing layer of 30 mm is created alround the RCC columns with ferrocement is done in order to increase its load carrying capacity.

This confinement work also protects the existing reinforcement, provides water tightness and prevents ingress of the aggressive species to the surface of original concrete or steel surface. Ferrocement not only increases the performance/ function of structures but also enhances the appearance of the existing RCC structure. The

repair in the structural elements using ferrocement can withstand for long years without cracking provided the mortar used is of proper proportion using good quality materials, and the wire mesh is of anti-corrosive coating type

Properties of Ferrocement

Ferro Cement Is A Type Of A Reinforced Concrete Haring Large Amount Of Smaller Diameter Wire Meshes Are Needed, These Wires Are Metal Wire And Sometimes Other Type Of Suitable Material Can Be Used Sand, Cement, Mortar Mix And Quantity Of Reinforcing Material Decide The Strength Of Ferro Cement.

III. MATERIALS:

The Following Materials Are Used In This Work:

1) Ordinary Portland Cement (43 Grade)

2) Fine Aggregate

3) Chicken Meshes-Hexagonal Opening

4) Water

5) Steel According to the Design

6) Binding Wire

7) Admixtures

Cement: Some Of The Properties Of The Cement Are:

Specific Gravity = 3.15, Standard Consistency =34%, Initial Setting Time = 40mins Compressive Strength = 52.16 N/Mm2

Fine Aggregate: Fine Aggregate Used Are Passing Through 4.75 Mm Is Sieve With A Specific Gravity Of 2.62

Chiken Mesh: Galvanized Chicken Wire Mesh With A Hexagonal Opening Of Size 12mm And A Wire Thickness Of1.29mm Is Generally Used.

Water: Potable Drinking Water Was Used For Mixing And As Well As For Curing Other Constituent Elements Are As Follows:

Steel – Generally The Diameter Of Steel Used Is From 3 Mm To 10 Mm But Generally 6 Mm Diameter Steel Is Most Commonly Used.

Binding Wire – Binding Wire Of 18 To 24 Gauges Is Used.

Admixtures – For Increasing The Workability, Minimizing Water Use And Reducing The Setting Time Of Cement Admixtures Are Added.

Equipment Required For Ferrocement Construction

- ► Nails
- ► Hammer
- ► Plumb Bob
- ► M. S. Plane
- ► Steel Cutter
- ► Chisel
- ► Wire Brush
- ► Spade
- ► Showel
- ► Sieve
- ► Wheel Barrow

Ferrocement as Sustainable Construction Materials:

The low material cost, labor intensity and semi-skilled labor requirements make ferrocement is the most promising alternative materials for housing. The constituent materials of ferrocement are easily available and are quite inexpensive. The fabrication technique of ferrocement is quite easy and common people could be trained in a short time to learn the skill. Advantages of ferrocement as a construction material may be summarized as follow:

1. Very high quality control.
2. Pre-Fabricated products.
3. Easy production and installation.
4. Shading devices to provide shading and day lighting to the building (use light weight and low cost environmental element). 5. Fast construction.
6. Manpower can be easily trained at site.
7. Improved structural performance.
8. Cost reduction, 15-50% cheaper than conventional techniques.
9. Less maintenance.

10. Reduction in dead weight, 50-75% lighter than conventional techniques

CASE STUDY

Structure Type: Residential Building Construction

Construction Type: Ferrocement house

Name of the project: Meerai, Nigdi, Pimpri chinchwad

Location: Nigdi, Pimpri chinchwad

Completion period: 8 Months

Construction Type: Ferracement panel

No. of Floor: Ground only

Contractor Name: Mr. Tilekar

Authority Engineer: Mr. Purandar

Local Authority: Pimpri chinchwad Municipal Corporation, Pune

QUESTIONNNAIRE SURVEY

1. Have you heard about New Construction material management?
2. Are you aware of waste material management in your area?
3. Do you ever noticed Construction waste in the road, public area and Land and should try to reuse material adding some admixtures or other?
4. In India, Do you thing Construction waste management is good?
5. Do you know India recycle just one per cent of its construction and demolition?
6. Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?
7. Will you know construction industry rule is mention from ministry of environment?
8. Have you ever heard about the importance of recycling in construction industry?
9. Do you use Ferrocement material on your construction site?
10. Have you use any method or techniques to reduce wastes or Recycling material which is cost effective?
11. Does it effect on quality using recycled material?
12. Does cost-benefit analysis affect the project cost?
13. Do you think there is enough information about the environmental impact due to Construction waste?
14. Do you think Construction and demolishing of old materials replace new construction material is an more cost effective that the other and which impact on sustainable development?
15. Can you say that to increase project productivity by reducing the time & cost?
16. Do you think by decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?
17. Do you think using recycle material benefit the total project cost?
18. Have construction waste management have effect on project cost?
19. Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?
20. Do you think Cost benefits analysis should be done before starting construction?
21. Do you think by using automation technique wastages of material is decreased?
22. Do you use new technology for construction of building?
23. Is that affect in reducing cost of building and time consuming?
24. By giving proper training to mason increase the productivity of work and decreases the wastages of material and additional new

construction material which is good & Re-useable?

25. Not following construction step induced rework and that also increase construction waste?

26. Does electrical and plumbing work increase the rework?

27. By proper storage of material on site and use the new construction material more which saves the cost and time and increase the productivity and Quality?

28. Do you think main reason of steel waste is because of irresponsible beam reinforcement and fabrication cutting?

29. Do you think using RMC over traditional method decreased the waste of material?

30. Now, do you use Construction waste management system on your site to increase the productivity and decreasing the cost of project?

Formula: ∑W= 3 x n3 + 2 x n2 + 1 x n1

SURVEY REPORT

N	O	P	Q	R	S	T	U	V	W
Does cost-benefit analysis affect the project cost?	Do you think there is enough information about the environmental impact due to Construction waste?	Do you think Construction and demolishing of old materials replace new construction material is an more cost effective	Can you say that to increase project productivity by reducing the time & cost?	Do you think by decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?	Do you think using recycle material benefit the total project cost?	Have construction waste management have effect on project cost?	Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?	1. Do you Cost benefits analysis should be done before starting construction?	Do you think by using automation technique wastages of material is decreased?
1	3	1	1	1	1	2	1	1	1
1	2	1	1	1	1	1	1	1	1
1	2	1	2	1	1	1	1	2	1
1	1	3	1	1	1	1	2	2	2
1	2	1	1	1	1	2	1	2	1
1	2	1	1	1	3	1	1	1	2
1	2	1	3	1	1	1	1	3	3
1	2	1	1	3	1	3	1	1	1
1	1	1	1	1	1	1	1	1	1
1	2	3	2	1	1	1	2	2	1
1	2	1	1	1	1	1	1	2	1

Sr.No.	Have you heard about New Construction material management?	Are you aware of waste material management in your area?	Do you ever noticed Construction waste in the road, public area and Land and should try to reuse material adding some admixtures or other?	In India, Do you think Construction waste management is good?	Do you know India recycle just one per cent of its construction and demolition?	I. Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?	Will you know construction industry rule mention from ministry of environment?	Have you ever heard about the importance of recycling in construction industry?	Do you use Ferrocement material on your construction site?	Have you use any method or techniques to reduce wastes or Recycling material which is cost effective?	Does effect on project cost?	Do you think there is enough information about the environmental impact due to Construction waste?	Do you think Construction and demolishing of old materials replace new construction material is an more cost effective that the other and which impact on sustainable development?	Can you say that to increase project productivity by reducing the time & cost?	Do you think By decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?	Do you think Cost benefit analysis affect the project cost?	Do you think using recycle material benefit the total project cost?	Do you think Have construction waste management have effect on project cost?	Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?	Do you think Cost benefits analysis should be done before starting construction?	Do you think by using automation technique wastages of material is decreased?	Not By giving proper training to masons increase the productivity of work and decreases the wastages of material and additional new construction material which is good & Re-usable?	Not following construction step induced rework and that also increase construction waste?	Does electrical and plumbing work increase the rework?
1	Pushkar	1	1	1	2	1	1	2	1	2	2	2	1	3	1	1	1	1	2	1	1	1	1	1	1	1
2	Rishita	1	1	1	2	2	1	1	2	2	1	2	1	2	1	1	1	1	1	1	1	2	1	1	1	1
3	Tejas	1	2	1	1	2	1	1	1	1	3	2	1	1	2	1	2	1	1	1	2	1	3	1	2	1
4	Shubhi	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	2	2	2	1	2	1	2	1
5	Sagar	1	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1	1	1	2	1	2	1	2	1	2
6	Ratan	1	2	1	1	1	1	2	2	1	1	1	1	2	1	1	1	3	1	1	1	2	1	1	1	1
7	Vivek	2	2	1	2	2	1	1	2	2	2	1	1	1	2	1	3	1	1	1	1	3	3	2	1	1	3	2
8	Rishabh	1	1	1	1	1	1	1	1	1	2	2	1	2	1	1	3	1	1	1	1	1	1	1	3	1	1	1
9	Ankur	1	1	1	1	1	1	3	2	3	1	3	1	1	1	1	1	1	1	1	1	1	2	2	1	1	3	
10	Sachin	1	1	1	2	2	1	1	1	2	2	2	1	2	3	2	1	1	1	2	2	1	2	1	1	1	1	
11	Manisha	1	3	1	2	1	1	1	2	2	2	1	2	1	2	1	1	1	1	1	2	1	1	1	2	1	1	
12	Radhika	1	1	1	2	1	1	1	3	2	2	1	2	1	2	1	1	2	3	1	1	2	1	1	1	1	2	1
13	Ram	1	1	1	1	1	1	1	1	1	2	2	1	1	3	1	1	1	1	2	1	1	2	2	1	2	3	1
14	Rahul	1	1	1	2	2	1	3	2	1	1	2	2	1	1	1	3	1	1	1	1	3	1	2	2	1	1	2
15	Raj	1	2	1	1	1	1	2	1	2	1	2	1	2	1	1	1	1	1	1	2	2	1	1	3	1		
16	Prabhkar	2	2	1	2	1	1	2	2	1	1	2	1	2	3	1	1	1	3	2	1	3	1	1	3	1	2	
17	Akshay	1	1	1	1	1	1	2	2	1	2	2	1	3	1	2	1	1	1	1	2	1	1	1	1	1	1	
18	Abhishek	2	3	1	2	1	1	1	3	2	2	2	1	2	1	1	1	3	2	1	2	1	2	1	1	1	3	
19	Bhagyashree	1	1	1	2	2	1	1	3	2	2	1	1	1	3	2	1	1	1	3	2	1	2	2	2	1	1	
20	Vishant	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	3	1	1	3	1	1	1	1	1	2	1	
21	Prakash	1	1	1	2	1	3	2	3	1	1	3	3	2	1	1	1	1	2	1	3	1	1	2	3	1		

RELATIVE INDEX METHOD RESULTS

Sr. No.	Questions	YES(1)	No(2)	CANT SAY(3)	Total
1	Have you heard about New Construction material management?	80	20	0	100
2	Are you aware of waste material management in your area?	70	25	5	100
3	Do you ever noticed Construction waste in the road, public area and Land and should try to reuse material adding some admixtures or oth	97.5	0	2.5	100
4	In India, Do you thing Construction waste management is good?	42.5	42.5	15	100
5	Do you know India recycle just one per cent of its construction and demolition?	60	40	0	100
6	I. Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?	90	0	10	100
7	Will you know construction industry rule is mention from ministry of environment?	25	67.5	7.5	100
8	Have you ever heard about the importance of recycling in construction industry?	40	47.5	12.5	100
9	Do you use Ferrocement material on your construction site?	35	52.5	12.5	100
10	Have you use any method or techniques to reduce wastes or Recycling material which is cost effective?	60	32.5	7.5	100
11	Does it effect on quality using recycled material?	40	55	5	100
12	Does cost-benefit analysis affect the project cost?	92.5	5	2.5	100
13	Do you think there is enough information about the environmental impact due to Construction waste?	20	70	10	100
14	Do you think Construction and demolishing of old materials replace new construction material is an more cost effective that the other ar	87.5	0	12.5	100
15	Can you say that to increase project productivity by reducing the time & cost?	82.5	12.5	5	100
16	Do you think By decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?	82.5	10	7.5	100
17	Do you think using recycle material benefit the total project cost?	85	0	15	100
18	Have construction waste management have effect on project cost?	65	22.5	12.5	100
19	Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?	80	15	5	100
20	I. Do you think Cost benefits analysis should be done before starting construction?	42.5	45	12.5	100
21	Do you think by using automation technique wastages of material is decreased?	67.5	22.5	10	100
22	Do you use new technology for construction of building?	42.5	55	2.5	100
23	Is that effect in reducing cost of building and time consuming?	80	20	0	100
24	By giving proper training to masons increase the productivity of work and decreases the wastages of material and additional new construction material which	62.5	25	12.5	100
25	Not following construction step induced rework and that also increase construction waste?	62.5	12.5	25	100
26	Does electrical and plumbing work increase the rework?	67.5	20	12.5	100
27	By proper storage of material on site and use the new construction material more which saves the cost and time and increase the productivity and Quality?	80	10	10	100
28	Do you think main reason of steel waste is because of irresponsible beam reinforcement and fabrication cutting?	72.5	10	17.5	100
29	Do you think using RMC over traditional method decreased the waste of material?	80	27.5	12.5	100
30	Now, do you use Construction waste management system on your site to increase the productivity and decreasing the cost of project?	100	0	0	100

Sr. No.	Questions	YES(1)	No(2)	Other(3)	Total	Total Number(N)	A=N	RII	Ranks	YEAR	Std Deviation	Variance
1	Have you heard about New Construction material management?	80	40	0	120	100	300	0.4	4	1.2	0.405	0.164
2	Are you aware of waste material management in your area?	70	50	15	135	100	300	0.45	8	1.4	0.590	0.336
3	Do you ever noticed Construction waste in the road, public area and Land and should try to reuse material adding some admixtures or	97.5	0	7.5	105	100	300	0.35	2	1.1	0.316	0.100
4	In India, Do you thing Construction waste management is good?	42.5	85	45	172.5	100	300	0.58	16	1.7	0.776	0.512
5	Do you know India recycle just one per cent of its construction and demolition?	60	80	0	140	100	300	0.47	5	1.4	0.496	0.246
6	I. Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?	90	0	30	120	100	300	0.4	4	1.2	0.808	0.363
7	Will you know construction industry rule is mention from ministry of environment?	25	135	22.5	182.5	100	300	0.61	20	1.8	0.549	0.302
8	Have you ever heard about the importance of recycling in construction industry?	40	95	37.5	172.5	100	300	0.58	16	1.7	0.679	0.461
9	Do you use Ferrocement material on your construction site?	35	105	37.5	177.5	100	300	0.59	19	1.8	0.660	0.435
10	Have you use any method or techniques to reduce wastes or Recycling material which is cost effective?	60	65	22.5	147.5	100	300	0.49	11	1.5	0.640	0.410
11	Does it effect on quality using recycled material?	40	110	15	165	100	300	0.55	15	1.7	0.591	0.338
12	Does cost-benefit analysis affect the project cost?	92.5	10	7.5	110	100	300	0.37	3	1.1	0.379	0.144
13	Do you think there is enough information about the environmental impact due to Construction waste?	20	140	30	190	100	300	0.63	21	1.9	0.545	0.297
14	Do you think Construction and demolishing of old materials replace new construction material is an more cost effective that the other and which impact on sustainable development?	87.5	0	37.5	125	100	300	0.42	6	1.3	0.670	0.449
15	Can you say that to increase project productivity by reducing the time & cost?	82.5	25	15	122.5	100	300	0.41	5	1.2	0.530	0.281
16	Do you think By decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?	82.5	20	22.5	125	100	300	0.42	6	1.3	0.588	0.346
17	Do you think using recycle material benefit the total project cost?	85	0	45	130	100	300	0.43	7	1.3	0.723	0.523
18	Have construction waste management have effect on project cost?	65	45	37.5	147.5	100	300	0.49	11	1.5	0.716	0.512
19	Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?	80	30	15	125	100	300	0.42	6	1.3	0.543	0.295
20	I. Do you think Cost benefits analysis should be done before starting construction?	42.5	90	37.5	170	100	300	0.57	17	1.7	0.697	0.472
21	Do you think by using automation technique wastages of material is decreased?	67.5	45	30	142.5	100	300	0.48	10	1.4	0.675	0.456
22	Do you use new technology for construction of building?	42.5	110	7.5	160	100	300	0.53	14	1.6	0.545	0.297
23	Is that effect in reducing cost of building and time consuming?	80	40	0	120	100	300	0.4	4	1.2	0.405	0.164
24	By giving proper training to masons increase the productivity of work and decreases the wastages of material and additional new construction material which is good & Re-usable?	62.5	50	37.5	150	100	300	0.5	12	1.5	0.716	0.513
25	Not following construction step induced rework and that also increase construction waste?	62.5	25	75	162.5	100	300	0.54	15	1.6	0.868	0.753
26	Does electrical and plumbing work increase the rework?	67.5	40	37.5	145	100	300	0.48	10	1.5	0.714	0.510
27	By proper storage of material on site and use the new construction material more which saves the cost and time and increase the productivity and Quality?	80	20	30	130	100	300	0.43	7	1.3	0.648	0.421
28	Do you think main reason of steel waste is because of irresponsible beam reinforcement and fabrication cutting?	72.5	20	52.5	145	100	300	0.48	10	1.5	0.783	0.613
29	Do you think using RMC over traditional method decreased the waste of material?	80	55	37.5	152.5	100	300	0.51	13	1.5	0.716	0.512
30	Now, do you use Construction waste management system on your site to increase the productivity and decreasing the cost of project?	100	0	0	100	100	300	0.33	1	1.0	0.000	0.000

Sr. No.	Questions	N	Min	Max	Mean	Standard deviation	Variance
1	Have you heard about New Construction material management?	40	1	2	1.2	0.405	0.164
2	Are you aware of waste material management in your area?	40	1	3	1.4	0.590	0.336
3	Do you ever noticed Construction waste in the road, public area and Land and should try to reuse material adding some admixtures or	40	1	3	1.1	0.316	0.1
4	In India, Do you thing Construction waste management is good?	40	1	3	1.7	0.776	0.512
5	Do you know India recycle just one per cent of its construction and demolition?	40	1	2	1.4	0.496	0.246
6	I. Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?	40	1	3	1.2	0.808	0.363
7	Will you know construction industry rule is mention from ministry of environment?	40	1	3	1.8	0.549	0.302
8	Have you ever heard about the importance of recycling in construction industry?	40	1	3	1.7	0.679	0.461
9	Do you use Ferrocement material on your construction site?	40	1	3	1.8	0.660	0.435
10	Have you use any method or techniques to reduce wastes or Recycling material which is cost effective?	40	1	3	1.5	0.640	0.41
11	Does it effect on quality using recycled material?	40	1	3	1.7	0.580	0.336
12	Does cost-benefit analysis affect the project cost?	40	1	3	1.1	0.379	0.144
13	Do you think there is enough information about the environmental impact due to Construction waste?	40	1	3	1.9	0.545	0.297
14	Do you think Construction and demolishing of old materials replace new construction material is an more cost effective that the other and which impact on sustainable development?	40	1	3	1.3	0.670	0.449
15	Can you say that to increase project productivity by reducing the time & cost?	40	1	3	1.2	0.530	0.281
16	Do you think By decreasing waste we can decrease the project cost & using of new construction material which is increase the life of building?	40	1	3	1.3	0.588	0.346
17	Do you think using recycle material benefit the total project cost?	40	1	3	1.3	0.723	0.523
18	Have construction waste management have effect on project cost?	40	1	3	1.5	0.716	0.512
19	Do you think most environmental issues in India could be minimized if Construction Waste is managed properly?	40	1	3	1.3	0.543	0.295
20	I. Do you think Cost benefits analysis should be done before starting construction?	40	1	3	1.7	0.697	0.472
21	Do you think by using automation technique wastages of material is decreased?	40	1	3	1.4	0.675	0.456
22	Do you use new technology for construction of building?	40	1	3	1.6	0.545	0.297
23	Is that effect in reducing cost of building and time consuming?	40	1	2	1.2	0.405	0.164
24	By giving proper training to masons increase the productivity of work and decreases the wastages of material and additional new construction material which is good & Re-usable?	40	1	3	1.5	0.716	0.513
25	Not following construction step induced rework and that also increase construction waste?	40	1	3	1.6	0.868	0.753
26	Does electrical and plumbing work increase the rework?	40	1	3	1.5	0.714	0.51
27	By proper storage of material on site and use the new construction material more which saves the cost and time and increase the productivity and Quality?	40	1	3	1.3	0.648	0.421
28	Do you think main reason of steel waste is because of irresponsible beam reinforcement and fabrication cutting?	40	1	3	1.5	0.783	0.613
29	Do you think using RMC over traditional method decreased the waste of material?	40	1	3	1.5	0.716	0.512
30	Now, do you use Construction waste management system on your site to increase the productivity and decreasing the cost of project?	40	1	1	1.0	0.000	0

SPSS RESULTS

Have you heard about New Construction material management

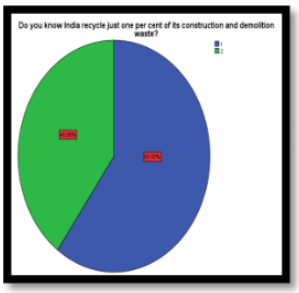
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	32	80.0	80.0	80.0
	2	8	20.0	20.0	100.0
	Total	40	100.0	100.0	

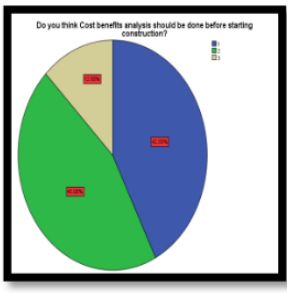
Are you aware of waste management in your area?

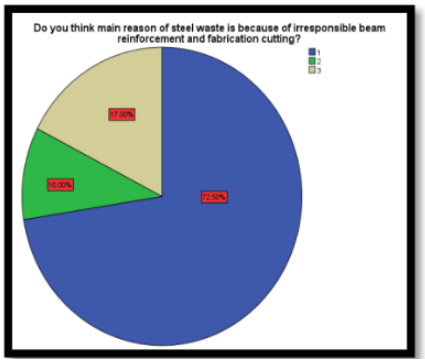
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	28	70.0	70.0	70.0
	2	10	25.0	25.0	95.0
	3	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Do you thing adding of new material Construction industry as per the cost effectives and timeless is necessary?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	36	90.0	90.0	90.0
	3	4	10.0	10.0	100.0
	Total	40	100.0	100.0	







SITE PHOTOS

Footing Reinforcement and Casting:

Plinth Beam:

Plinth filling

Steel Framing:

Finishing stage

Cost Analysis 1500Sq.Ft.

Cost estimation

We need following data before starting preparation of the estimate of a ferrocement structure.

A. Detailed drawings

B. Quantity statement

C. Sanctioned schedule of rates (Either CSR or DSR)

D. Various leads sanctioned by the competent authority for that site.

E. Specifications.

Factors governing the cost of structure

a. Specifications and units of measurements.

b. Materials-quality and their market rates.

c. Labour-skilled, unskilled. Their turnover and wages per day

d. Contingencies like water, transport, electricity and unforeseen items.

e. Overheads.

f. Profits expected.

Drawings: Drawings of the structure to be constructed are based on the designs. The dimensions of all components and the details of the meshes, bars etc shall be clearly shown in the drawings. Schedules showing the meshes shall be shown.

Components of estimate

A. **Materials**: Quantity and Rates From the drawings, the quantities of the materials like steel, mesh, sand and cement can be calculated. For the skeletal steel, from the bar diameters and their spacing in two directions, the weight per unit area can be obtained. From the type and size of mesh and their number of layers, the area of mesh reinforcement can be calculated. From the thickness of the Ferrocrete item, we can get volume of wet mortar in liters. When the mix proportion of the mortar is known, volumes of cement and sand for the dry mix can be calculated. The quantity of water and the additives can be obtained from the proportions prescribed in the specifications.

B. **Labour required:** The man-hours per unit of construction of ferrocrete items based on our experience. The wages of the skilled and unskilled labour will be as per the rates payable in that area. Labour component of ferrocrete items is on higher side, may go up to 20 % sometime.

C. **Contingencies** Generally the ferrocrete items are fabricated and tied in factory, and then taken to the site for mortaring. Hence the cost of handling, transporting, hoisting and erecting of the cage at site, octroi, water charges etc are considered under contingencies. They vary from 5 to 8 %.

D. **Overheads** The key to the best ferrocrete construction lies in its strict supervision. A full time supervisor at site is a must. His charges will have to be considered in addition to office and other expenses, while working out the overheads. Overheads may be taken up to 8 to 10 %.

E. **Profits** Ferrocrete construction is a specialized job and profit margins expected in it are higher if the design is complicated.

Cost analysis for single ferrocement channel

Item	Qty.	Rate	Amount (Rs.)
Steel	3.55 kg	46/kg	164
Chicken mesh	36 sq. ft.	5.5/sq. ft	198
Cement	0.5 bag	300/bag	150
sand	0.035 cu. m	4500/brass	56
Labour (skill)	1	125/3hr.	125
(semi-skill)	2	80/3hr.	160
	Total		853
	Contingencies, Tools and plants charges (Add 2% in total)		**900**

Therefore cost for 3m ferrocement roofing channel

Roofing = 900 Rs.

Consider Room size: 10ft. × 10ft.

No. of ferrocement channel required = 8

Cost of channels required =8×900 =7200 Rs.

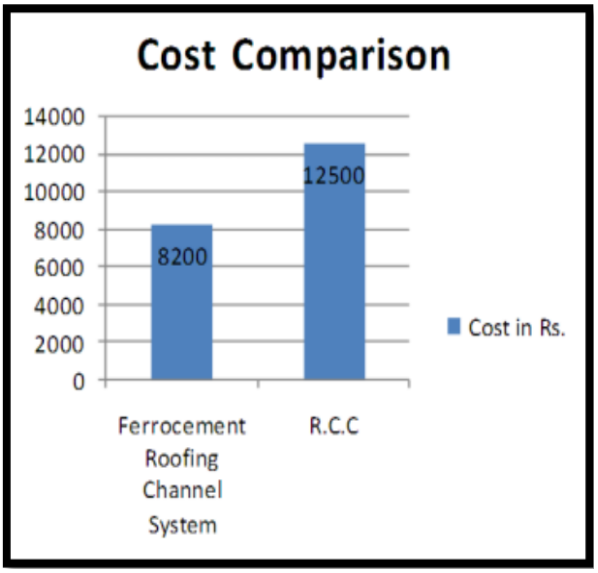
Cost of gap filling between channels and installation=1000Rs.

Total cost required for 100sq. ft. =8200 Rs.

Therefore Total cost using ferrocement channel roofing system = 82 Rs. /sq. ft

Total cost using conventional (R.C.C) roofing system = 125 Rs. /sq. ft

Therefore % saving = 35%



Total Cost analysis:

A) Ferrocement Structure's cost analysis: Approximate costs were made by referring to Chandra Mohan Hangekar's Do-It-Yourself Build Your Home Yourself Book from Ferrocement Society India before construction of the Ferrocement Structure. Before construction, the total approximate cost amounted to 1,46,8,620 Rs and after construction the total approximate cost was 1,38,4,300 Rs. As a result of the use of reused and locally available materials and reduced further charges, costs were reduced.

B) Load-bearing structure with the same base area cost analysis: The Plinth area method was used to cost the load bearing structure using the Plinth area rate from CPWD 2020. The cost of the load bearing structure was approximately 1,77,4,765 Rs.

C) Cost analysis of RCC structure of same plinth area: Approximate costing of RCC structure was done using Plinth Area Method by considering Plinth area rates from CPWD 2020.Total approximate cost for RCC structure came to be 1,90,8,505 Rs.

Time analysis:

Time analysis was done by using Gantt Chart method.

A) Time required for Ferrocement farmhouse came to be 125 Days.

B) Time required for Load bearing structure was calculated by previous industry experience which came to be 180 Days.

C) Time required for RCC structure was calculated by previous industry experience which came to be 250 Days.

Advantages of Ferro cement

- Required materials are readily available.
- It can be used for large construction work.
- Minimum skilled labors are required.
- Light weight members due to smaller thickness.
- Most suited for high levels of prefabrication.
- Highly versatile material hence can be fabricated in any desired shape.
- It is having high tensile strength and flexural strength.
- It is highly durable, crack resistant and water resistant.
- Due to its ductile behaviour it can be used in earthquake resistance.
- Have good impact resistance and toughness.
- Construction with this is easy, less weight and lasts long.
- It requires low maintenance

Disadvantages of Ferrocement

- It fails in compression due to absence of mass concrete.
- Liable to corrosion due to bad compaction.
- Because of distinctive shapes trouble in construction.
- Frequently suffers from intense spalling of matrix cover.
- Delamination of extreme tensile layer.
- Labour demanding therefore excessive labour cost.

CONCLUSION

Ferrocement panel, which is a thin and lightweight component, being an emerging technology in the construction field, has many advantages when compared to that of conventional methods of reinforcements

This review has summarized that ferrocement is a versatile but unharnessed material. The ease of construction with mere materials makes it suitable for low cost light construction especially in developing countries. The applications of ferrocement in both cast in situ as well as precast construction have been explored in all areas of civil engineering but there is a dearth of enough research and a coded rationale for design. The standardization of procedures and applications as load bearing and non-load bearing elements is lacking. The regulatory authorities need to publish the codes as for reinforced concrete structures. The performance of ferrocement elements greatly depends on the number and characteristics of the reinforcing mesh, fillers, and mortar mix. Optimum ranges for these parameters need to be specified. The light weight sandwich panels offer a good potential towards good energy efficiency and disaster resilience. This review study emphasizes more experimental research with sustainable

building materials, combinations of meshes, fibers and fillers. Considering the economics, simplicity and versatility, ferrocement can prove to be a potential alternative to RCC in elemental light construction.

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