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FERROCEMENT CONCRETE: A STUDY ON AESTHETICS AND TEXTURES IN FERROCEMENT CONCRETE.

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Abstract - Ferrocement is a thin, versatile material comprised of wire mesh, cement mortar and steel rods of small diameters that provides good strength and durability. Originated by Jospeh Monier in 19th century, which later evolved into a structural and aesthetic material. Its unique properties makes it easily mouldable and helps in achieving different forms. The research focuses on Aesthetics and textures that can be derived truly out of the ferrocement concrete. The performance of the material in indoors and outdoors without compromising on their properties. Acts as a sustainable material, that needs to be considered for the future.

Introduction

Ferrocement concrete is a thin, lightweight and versatile concrete that comprises of rich cement mortar, with wire mesh and steel rods with small diameters. Unlike normal reinforced concrete, ferrocement doesn't contain coarse aggregates, increasing the workability and capability of moulding in various shapes and forms. These characteristics not only helps in retrofitting in columns and in other structural strengthening, it can also help in developing creative architecture features. The material is known for its durability, ductility, tensile strength and crack resistance.

Fig.1-Ferrocement concrete with reinforcement

Source- https://www.istockphoto.com/search/2/image-film?phrase=cement

The origin of ferrocement started in mid of 19th century, by a French Gardener Joseph Monier. The Frenchmen initially experimented the material with garden pots and tubs, and this was achieved with the help of cement and iron mesh. Joseph Monier used Plain cement concrete for the same garden pots and tubs, which couldn't handle the tensile strength in an effective way and cracked easily. This marked the beginning of ferrocement concrete, which in current days is used in water tanks, shells, roofs, domes, vaults and many architectural structures.

The redefining factor in ferrocement concrete when compared to that of reinforced concrete is its strength and flexibility. To achieve desirable strength and flexibility, materials like cement mortar that helps in binding all the components together and provides good compressive strength, fine sand is used for easily penetrating the wire mesh and provide uniform finish layer, Water is added to create a workable consistency in the concrete, wire mesh that is generally made up of stainless steel, to prevent corrosion, acts as a main reinforcement, these meshes provides a better tensile and flexural strength to the concrete, small diameter bars are added to provide stiffness and shape to the structure. The fine mesh and mortar when they come together, they help the material to distribute stresses evenly and reduces the quantum of cracks at the time of tension, and this makes ferrocement suitable for thin-walled structures and other prefabricated elements.

Various students and researches were done over the years to understand the material and also to improve the performance of ferrocement. Early set of researches were based on structural behaviour, like how ferrocement jackets would enhance the load carrying capacity of columns and beams, where these researches led to a solution of retrofitting and strengthening the existing load carrying structures. Further studies involved studying on stress- strain graph of ferrocement

panels, the shear strength, durability of ferrocement under marine conditions. The results from these researches had demonstrated that ferrocement has the capability of maintaining stability under various environmental conditions, can withstand high stress and provides good resistance to corrosion and cracks.

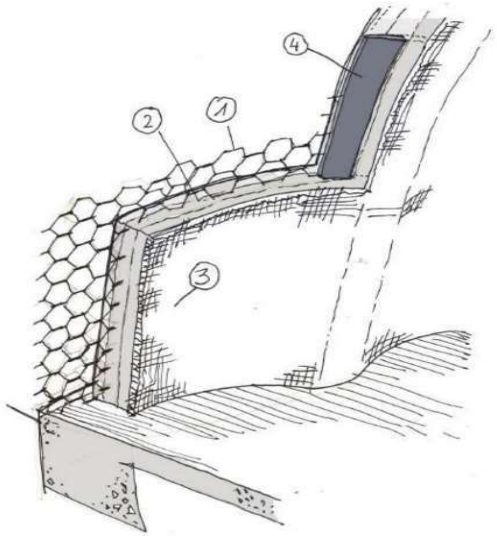
In recent years, the research has involved usage of ferrocement for strengthening of concrete columns, jacketing or covering the existing concrete column with ferrocement increases the load carrying capacity of the column, so that the structure can hold larger deformations before it faces failure. In addition to these researches, because ferrocement uses less amount of cement and steel rods when compared to that of Reinforced concrete, it is said to be an economical material, as well as a sustainable material for architecture. Followed by its lightweight nature, and low maintenance requirement it is considered to be suitable for modern day practices.

In an architectural view, ferrocement offers greater potential to its flexibility through form and texture. Its character helps the designers to create complex shapes, roofs, domes and folded plates, it can also be used in interior partition walls, facades and other aesthetic features. This ability to create a fluid and a flowy surface adds value to the architectural appeal and structural strength ensures safety

Ferrocement's availability and adaptability for both structural and aesthetics makes it an important scope for study in modern architecture. Since the trends move towards eco- friendly materials, ferrocement is considered to be a good response to the current trend.

1. MATERIALS AND PROPERTIES

Materials play a crucial role in providing characteristic to ferrocement. The performance provided by ferrocement largely depends on quality and other materials. Cement, considered to be a primary material used in the ferrocement, plays a crucial role in binding the ingredients. Its properties like fineness, soundness, heat of hydration etc. provides strength to the material. Chemical constituents like Magnesia, Alkalis and Iron oxide helps in providing strength, appreciable setting time and pigmentation respectively, followed by silica fumes that provides compressive strength to the material. Sand provides stability by forming a matrix. The sand has to clean and free from chloride salts, with size ranging from 0.06mm to 2.5mm to ensure uniform bonding. Water is an important component, which helps in maintaining the strength and durability for the mix. The proportion of cement and water has to be ensured very carefully, to achieve the required workability, reduce cracks and shrinks. Admixture plays the role of a catalyst, where introducing the admixture improves the workability, durability and other desired properties. Admixtures- plasticizers, super plasticizers, accelerators etc. The mesh reinforcement helps in providing tensile strength, resists cracking, and the framed rods plays the role of providing structural stability, shape and rigidity. Meshes and rods are tied together by lacing wires, that helps in maintaining proper alignment in the material. In few cases welding rods are used to ensure stability and a strong framework. When unique properties of the above components come together it contributes to the formation of ferrocement.



1.Wire mesh, 2.Cement mortar, 3.Inner plaster, 4.Formwork to support the mesh.(Fig.2).

Fig.2- 3 Dimensional section of ferrocement concrete.

Sourcehttps://issuu.com/deenadhayalan3165/docs/deenadhayalan_41840002_material_specificatio n_qual

METHODOLOGY Ferrocement structures are formed by different layers of meshes above a framework made up of steel. The meshes and rods are tied securely using lacing wires or welding. The steel used in the process has to be galvanised, to resist rusting of the material. Once the framework is done, cement mortar is applied over it. The cement mortar has to be poured in such a way it completely fills the gap in between meshes. This process helps to helps to eliminate the trapped air bubbles, as these bubbles has the capability to create empty spaces that holds water, which can lead to rusting of the material. The structure must hold moist at the time of curing, preventing cracks and improving strength.

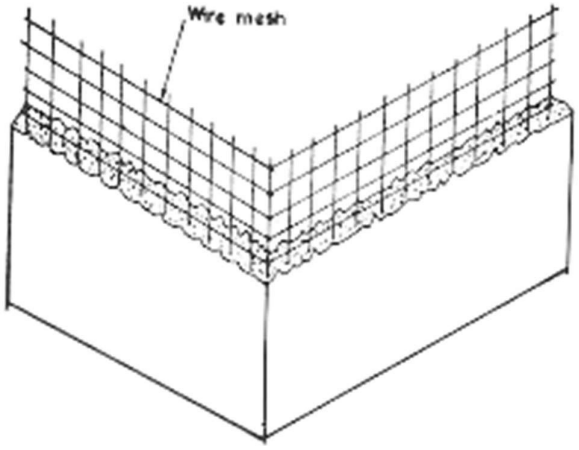


Fig.3- Isometric section of ferrocement concrete, with wire mesh.

Source- https://www.slideserve.com/houstonlarry/5-ferrocement-powerpoint-ppt-presentation

These processes and ideology had been evolved through various trial and errors, which helped the engineers to make the material better. Some of the new advancements in the material include acrylic liquid as an admixture, helps in reducing the quantum of moisture absorption and improves shock resistance. These upgradations over the years make the material more suitable for architecture and structures.

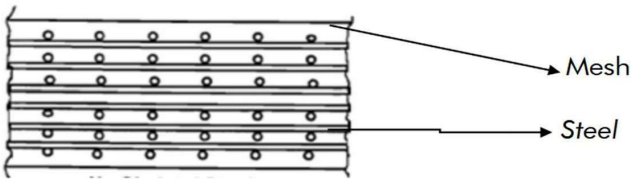


Fig.4- Section of a ferrocement concrete.

Source-https://www.slideserve.com/houstonlarry/5-ferrocement-powerpoint-ppt-presentation

4. A STUDY ON AESTHETICS AND TEXTURES IN FERROCEMENT CONCRETE

Ferrocement is a versatile material known for its durability and strength, with no much of construction cost involved. Unlike normal concrete, ferrocement is comparatively lighter and thinner, which parallelly provides durability and crack resistance. Their unique properties not only respond positively to structural applications, but also enhances the textural and aesthetic qualities while designing.

The objective is to explore, how ferrocement can contribute to sensory experience and aesthetics in a building, alongside maintaining its functional and structural properties. The material can be moulded, shaped, and curved easily when compared to the normal concrete (before it sets). This allows the designer to explore and experiment various surface finishes and patterns, which supports the design both aesthetically and functionally.

Aesthetics in the field of architecture are not just limited to tactile and visual appearance, they also play a crucial role in providing form, colour, texture and the response of material to other aspects like light, wind etc. Ferrocement can easily adapt and respond to aesthetic architecture due to its mouldable quality. The cement mortar can mould to any shape before it sets, which gives the designer the scope to define shape- rigid, curved or free flowing, which directly leads to various finish typologies such as rough finish, polished finish, smooth finish etc.

Generally, concrete has the ability to hold colours, as a result of which ferrocement are tinted with pigments, finished with paints and oxides, which helps in enhancing the structure. In surface activate structures like plates, domes, folded plates, shells and vaults, ferrocement can express lightness and flow of form alongside maintaining structural stability. As the materials get slender or thin, the section provides delicate detailing, allowing all the aspects like light, shadow and wind to interact across the surfaces.

The textures of ferrocement can be modified in various ways, like fine mortar mixes helps in smooth finishing of the surface, similarly by stamping or sand texturing, coarse or patterned textures are achieved. On technology advancement, new methods like shotcrete, cement spraying helps to achieve even and clean finish to the surface. Admixture like acrylic polymer has improved the textural quality of the material, which alongside enhances the workability, resists cracks, makes the surface smooth and resists absorption of water ensuring durability.

Ferrocement acts as a bridge between traditional architecture and modern architecture. It embodies sustainability along with aesthetic durability, which helps in retaining the natural charm in the structure. Ferrocement depicts a form that shows out material honesty and explicit expressions in structures. The texture and the respective finish shows, how the material is handled and moulded, this allows merge of art and engineering, how form, texture, light can shape a space.

2. RESULTS AND DISCUSSION

Ferrocement concrete emphasizes the material's potential to bridge between structural and aesthetical expression. As emphasized by Naaman A E(2000)- Ferrocement and laminated cementitious property and Paramasivam P(1998)- Thin- walled reinforced concrete for construction,

though the wall is thin, its wire mesh reinforcement and adaptable framework provides opportunities in vast amounts in both architecture and structural fields. Works by Mansur M A & Ong K C G(2006)- Ferrocement in structural applications. Cement in concrete composites and Ramaswamy A(2014) Ferrocement technology and applications, depicted the material's lightweight nature, flexible forms and crack resistive properties, that conventional concrete isn't easily capable of. Shannag M J(2000)- High performance ferrocement laminates for architecture use, and Kiran R(2017) Exploration of surface finishes and textures in ferrocement and architectural aesthetics, had worked on surface treatments, imprints and moulded texturing techniques creating tactile richness, enhancing the experience of the space. Paul S C, Panda B, Garg A(2020)- Material characterization of sustainable ferrocement composites and their architectural potential, emphasizes the integration of sustainability and design in ferrocement, increasing their scope in structures and architecture.

CONCLUSION

Ferrocement concrete is material that has the capability to gel strength, flexibility and aesthetics. Its ability to form, lightweight, thin and free form structures makes it stand alone for architecture. The ability to form intricate detailing and in textures and finishes enhances and adds value to the space. Admixtures and finishes have improved tactile and visual appeal of the structure, acts as material to create organic forms, expressive facades for the designers. The material helped in bridging the gap between traditional artistry and modern architecture. It stands as a material under timeless architecture uniting functionality, creativity and unity. The material also helps in sustainability projects which would be the future consideration in the upcoming days and years.

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