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An Investigation On The Effects Of Ferrocement On Brick Masonry Walls

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Abstract: In order to prevent failure and collapse in the event of a severe earthquake or the addition of more weight on buildings, masonry walls need to be reinforced before either scenario may occur. It is probable that the strength of the masonry walls of the structure will need to be strengthened in order for the restoration procedure to be completed successfully. Masonry walls that are not reinforced have a high compressive strength, but these walls are brittle and extremely weak when exposed to the action of lateral loads, which causes tension in the walls. Masonry walls may be reinforced using steel or concrete ties. When tensional forces are put on a masonry wall, there is an increased risk that the wall may crack. Masonry walls are susceptible to cracking for a number of reasons, including the base moving, the shaking from earthquakes, and lateral stresses being applied to the structure. After that, in order to make the beams more robust, additional layers of cast-in-place wire mesh and precast ferrocement laminates were added to them. The experimental findings, which were measured in terms of stiffness, have been compared both within and between the groups in order to evaluate the impact of varying the development length and the number of wire-mesh layers. This was done so that we could determine how the length of development affects the stiffness of the material. time required to build a brick masonry beam without using plaster in the construction process.

Index Terms **- Brick Masonary, Ferrocement, Stresses in Masonry, Masonry Walls Strengthening**

I. Introduction

The loads from the building are transferred via the walls of buildings composed of load-bearing masonry. The failure or collapse of such load-bearing masonry walls might result in the collapse of the whole building. Even if loads are transferred via the columns of reinforced concrete framed structures, it is more probable for these walls to fracture and collapse in the event of an earthquake. This is the case even though the loads are being transferred. Masonry walls that have a thickness of one-half of a brick are often utilised as separators within the interior of RC-framed constructions. These half-brick masonry walls will become unstable and unsafe in the case of an earthquake because lateral forces will be applied to them. Out-of-plane wall reinforcement may be used with lateral building reinforcement to produce a structure that is more resistant if reinforced concrete jackets are applied to the partitions [1]. This creates a more secure environment for occupants. Masonry walls made of reinforced brick are highly suggested for usage in newly constructed buildings. Masonry walls will be less likely to crumble as a result of this measure, which will be helpful in the event of an earthquake. Another technique for reinforcing an existing masonry wall involves attaching concrete jackets reinforced with steel to either one or both sides of the wall. Brick construction offers for more flexibility in terms of the building's architecture, and it does not need an incredibly big initial expenditure on the part of the builder. Building with masonry is one of the most important duties for a civil engineer because of the longevity of masonry buildings, the ease of the processes involved, the often beautiful outlines created, and the ease with which materials can be obtained [2]. Masonry is expected to become more important in the construction industry in the not-too-distant future owing to the scarcity of other structural materials, particularly steel and wood, as well as the almost infinite variety of masonry's fundamental building blocks. In light of the fact that masonry building makes use of raw components, it is quite probable that this is the case. Brick masonry consists of burned clay bricks as well as mortar that is produced by combining cement and sand in whatever proportion that is deemed appropriate. Masonry takes on the attributes of the bricks and mortar that it is formed of because of the method that it is normally built, which causes it to take on those traits. These fundamental components come together to create a composite while retaining their own identities and the characteristics that set them apart from one another.

Masonry is one of the sorts of building materials that is among the least well-known in the world. This misperception has, over the course of the years, led to a significant misuse of the material by means of design processes that are inadequate or even non-existent, as well as construction procedures that are inferior [3]. This is despite the fact that, in recent years, sound design methodologies as well as significantly improved building practises have emerged. These methodologies and practises all make the best use of the potential of the material because of the abundance of data and information that is accessible today. Inside of a building, there are many different kinds of masonry structural components that may be found. Two examples of these components are beams and walls. In the construction of masonry buildings that are not very high in height, brick masonry beams are often employed. They may be reinforced or unreinforced, and the cross-section is often either square or rectangular, but it may also be circular on occasion. However, the most common shapes are square and rectangular.

II. Brick Masonary

Brick is often utilised to create low-rise constructions' load bearing walls. Brick masonry has been used in the construction of more than 35 percent of the structures in India. Columns constructed of brick masonry are often seen in low rise structures. Brick has a greater potential to withstand fire than concrete or masonry does. In contrast to masonry, brickwork is very simple in terms of the construction of apertures and connections. A ferrocement shell surrounds a brick core in a novel construction type called ferrocement-brick composite. With or without microscopic steel bars of different diameters, ferrocement may be made of cement-sand mortar strengthened with steel wire meshes. Brick masonry constructions that have been encased with ferrocement have the potential to significantly boost both their load-bearing capacity and their resistance to moment loads [4]. The concentric axial load is applied to the brick masonry columns, and the ultimate compressive strength of the brick masonry column with surface treatment by ferrocement is given. The results of the control specimen, which did not include any ferrocement, are compared with those of brick masonry that had the additive. During the course of the study, it was found that there was a lot of consensus [5]. Ferrocement is being utilised more often in various building projects because of the numerous advantages it offers over traditional reinforced concrete construction (RCC). Casting metal into any difficult shape without the need for expensive formwork is one of the most significant benefits it offers. In India, the majority of buildings are constructed using masonry techniques, namely brickwork [5]. The term "masonry structure" refers to buildings that are constructed from stone or materials that have a similar appearance to stone. Masonry is made from stones, clay bricks, concrete blocks, lime mortar blocks, etc. When it comes to the construction of buildings, there are many distinct kinds of masonry walls.

- ✓ Load bearing masonry walls
- ✓ Reinforced masonry walls
- ✓ Hallow masonry walls
- ✓ Composite masonry walls.

III. Ferrocement

Strength and impact resistance are rather high in the ferro concrete. Traditional materials like wood, adobe, and stone masonry are not as resistant to fires, earthquakes, and corrosion when utilised in home building in poor nations. In industrialized nations, boat construction has been popular because the skill can be mastered rapidly, enabling individuals to save money by providing their own work.

A building and sculpting approach for novelty architecture was popular in the United States from the 1930s through the 1950s, creating "dinosaurs in the desert." This composite material comprises a brittle filler ingredient called matrix that is reinforced with fibres to improve structural performance. As a composite material in general, ferro-cement is created from cement mortar and a thin layer of wire mesh or another small diameter steel mesh, which is then sandwiched between the layers to create a rigid structural shape [6]. In terms of performance, strength, and application, this reinforced concrete material must be categorised as a new kind of material since it behaves in ways that are fundamentally different from those of ordinary reinforced concrete.

Ferrocement, a kind of reinforced concrete, offers greater mechanical qualities and durability than regular reinforced concrete. It functions as a homogenous elastic material within specified loading limits, and these limitations are wider than typical concrete's. The material's strong tensile strength is a consequence of its reinforcement's homogeneous distribution and high surface area to volume ratio, which prevents the spread of cracks.

Due to the increased likelihood of damage to such ageing and damaged masonry walls, especially in situations where they are not reinforced, the masonry structure has been the focus of a broad variety of current study. The process of determining the means by which the load-carrying capacity of these structures may be increased or enhanced is now a highly active field of research. The load-carrying capacity of brick masonry may often be repaired or improved using these techniques, which are very successful in the majority of situations. Ferro cement is a composite material that is very adaptable and may be made up of reinforcing wire mesh in either a single layer or a layer that is closely packed, either with or without reinforcing rods in cement mortar. This makes it an excellent material for retrofitting. Tests were conducted on a full-scale masonry wall that had been restored using ferro cement for the purpose of this investigation [7]. The purpose of this research is to get a deeper comprehension of the behaviour of masonry walls when subjected to gravity loading and to explore the efficacy of ferro cement as a material for use in rehabilitation.

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IV. Masonry Walls Strengthening

The following are some of the ways that may be used to reinforce masonry walls: 1. Installing reinforced concrete jackets on either one or both of the walls of the structure. 2. The use of FRP Structural Repointing for the purpose of fortifying masonry walls

V. Stresses In Masonry

In addition to compressive stresses, masonry may be exposed to tensile and shear stresses, bend and torsional stress. An item is under compression stress if the forces exerted on it are attempting to compress it. To have a tensile stress, the material must be pulled taut. Material on each side of a plane is being pulled apart by the pressures exerted on it (negative compressive stress). Shifting layers or pieces in opposing directions are caused by shearing tension [10]. The force vector component parallel to the cross section generates shear stress. However, when a member is subjected to normal stress, which happens when the load on the structure is delivered across the centre of gravity of its cross-section, this stress is known as normal stress. Out of plane loads and compressive pressures are the primary stresses imposed on masonry walls [11]. If the fundamental compressive strength is known, empirical formulae may be used to determine additional stresses.

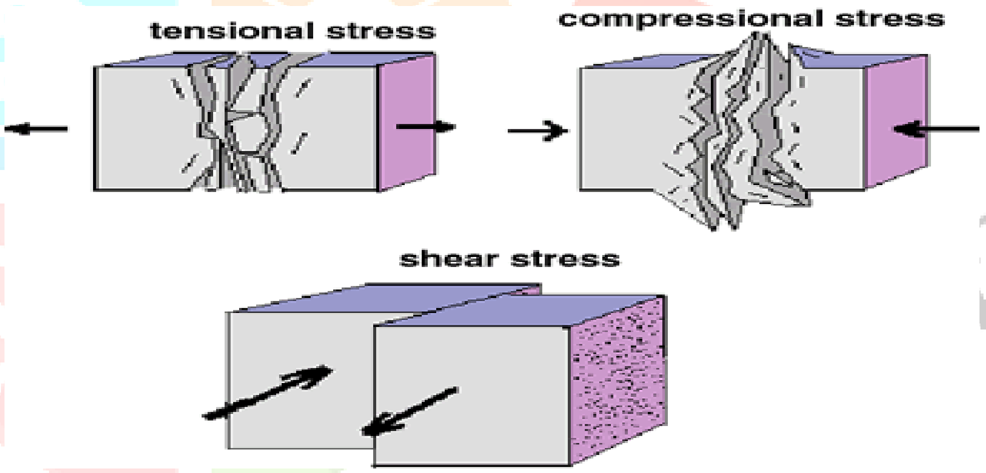

Figure 1.1 Diagrammatic representation of Stresses in Masonry

VI. Experimental Investigation of Beam

Ferrocement-coated brick masonry beams have a stress-strain relationship, failure mechanism, and strength that are considerably different from typical brick masonry beams. Research on composite beam behaviour has only included a tiny number of lab experiments up to this point. There is a literature review of experimental and theoretical investigations in the following study's.

6.1 Ferrocement Encased Masonry Beam

Brick masonry beams clad in ferrocement were tested in this research. Ferrocement coating of the beam significantly increases its ability to withstand compressive stress and moment.

Masonry beams may be retrofitted using ferrocement [9]. In all, there were nine brick masonry beams built. A total of nine examples were tested, three of which had ferrocement overlays, three of which had plaster overlays, and three of which were unreinforced masonry beams, each with a varied spacing of reinforcing wires.

VII. Details of experimental study of masonry walls after encasement with Ferro cement.

Test specimen

The specimens which were damaged earlier were used for encasing with Ferro cement of 12 mm thick. The 4/20 gauge wire mesh was used, with a cement sand proportion of 1:2, water cement ratio of 0.55. According to the minimum volume fraction formula $\sigma_{mt} \times A_m = f_y \times A_{mesh}$ where σ_{mt} = Tensile strength

of mortar, A_m = Area of mortar, f_y = proof stress of mesh, A_{mesh} = Area of mesh = As the number of layers of wire mesh was calculated and found to be two. The wire mesh was fixed to the walls in two ways as described below

- By driving nails at scattered intervals as shown in plate 1.
- By placing 6 mm dia M.S. rod dowels through the holes drilled at regular intervals as shown in plate 2.

The cement mortar was forced manually so as to see that it fills in the gap between the wall and the mesh. Cement mortar was then leveled with a float. The walls were cured with water for 28 days by covering it with gunny bags. The surface strains both vertically and horizontally were measured at the same point as before. The details of walls are given in table 1.1

Table 1.1

Type of wall	Dimensions			Thickness of Ferro Cement	Method of fixing wire mesh
	(L)	(H)	(T)		
SWEB	1824 mm	1812 mm	249 mm	12 mm	Using nails only
SWFB	1824 mm	1812 mm	249 mm	12 mm	Using M.S. Rod Dowels & nails.

SWEB - straight wall English bond SWFB - straight wall Flemish bond

Test setup and loading system It was same as before


Plate 1 Fixing of wire mesh to wall With nails only.

Plate 2 Fixing of wire mesh with M.S.rods and nails.

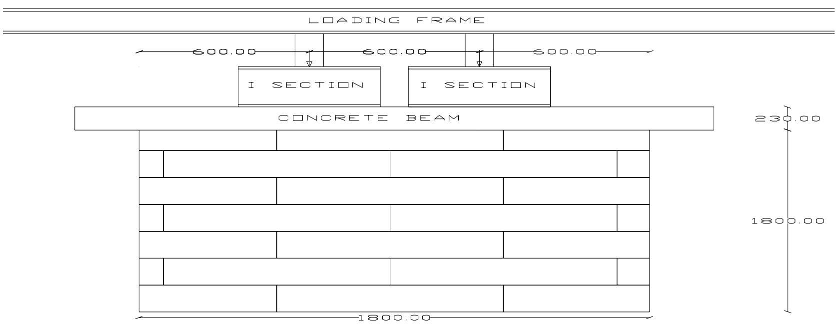

Fig 1.2 Loading system

Plate 3. Typical crack pattern of Walls before encasing.

Plate 4. Typical crack pattern of wall after encasement.

VIII. Conclusion

The current study examined the impact of ferrocement overlay on a brick masonry beam under compression and flexure. Only load has been taken into account in this research. Additional study might be done to examine the influence of other variables on the water-to-cement ratio and temperature on the behaviour of ferrocement overlay. The following areas may be the subject of further investigation, study, and experimentation: To accurately calculate the confinement effect, the load carried by the grout must be determined. With the addition of the ferrocement overlay, the masonry beam performs better. Variable loads are expected. Wire mesh, the cement-sand ratio, and the water-cement ratio utilised in precast ferrocement jackets must be examined. To examine the effects of a variety of different forms of time-varying loads. Unplastered brick masonry beams benefit from the use of ferrocement overlay, although the increase in strength isn't as significant as it is for beams with plaster overlay. When a plastered or unplastered masonry beam collapses, the fracture breadth rapidly grows, resulting in brittle failure of the system as a consequence. A ferrocement overlay on a beam, on the other hand, slows down the disintegration process. exhibiting a great degree of flexibility. Ferrocement overlayed beams are more robust than brick masonry beams with plaster and brick masonry beams that have not been plastered in terms of their structural integrity. In comparison to unplastered and plastered masonry beams, the flexure strength of ferrocement-coated masonry beams is higher. Beams with ferrocement jackets will take two weeks longer to build than brick masonry beams without plaster because of the additional labour required.

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