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A Study on Strengthening of Brick Masonry Walls & Beam using Ferrocement

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Abstract: Brick masonry structures are the most common type of structures built India. Significant increase in load carrying capacity of brick masonry beams is possible through encasement by ferrocement overlay. This study investigates the possibility of using ferrocement for brick masonry beam. A total of twenty four numbers of brick masonry segmenttested in this investigation. The brick masonry segment were divided into three sets. The first set of segment were completely unreinforced, the second set of beams had covered with mortar plaster and remaining have ferrocement overlay around it.

Keywords: Brick, masonry, Composite Material, ferrocement

1. Introduction:

Because it is one of the oldest forms of construction material still in use today, 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. 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. 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. 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. Masonry mortar may be made with any combination of cement and sand (with or without additives). They were among the oldest sorts of buildings that were constructed by man in their most basic form. Masonry is a load bearing material that has been used for ages. Civil engineers have just begun building buildings using steel and concrete in the last one hundred years. Up until around the middle of the 19th century, the most common construction material for buildings as well as engineering works was masonry made of brick and stone.

2. Related Work

Pitreetal [1995] suggests that the use of waste materials in building construction, such as fly ash, kiln ash, surkhi, cinder, and crushed stone, coupled with lime and cement, presented a feasible option. It was studied whether or if these waste materials, along with lime, might be used to produce alternatives for cement in the walls. Fly ash and un-slaked lime walls were stronger than slaked lime walls, but surkhi and slaked lime walls gained more than un-slaked lime alone. Lime walls reinforced with kiln ash are stronger than any other sort, making them a viable alternative to cement sand walls. Lime walls reinforced with surkhi and fly ash have enough compressive strength for building usage. [16] Dr. D. B. Raijiwala 3- An experiment on coal ash's influence on concrete and wall compressive strength.

According to the findings, the compressive strength of concrete containing coal ash is noticeably greater when compared to concrete made without coal ash. It has been shown that coal ash may successfully substitute cement up to a maximum of ten percent of the time. However, the results demonstrate that the maximal strength of concrete might be accomplished with just 5% of the cement being replaced with coal ash and no extra plasticizer at all. After that, there was a correlation between the amount of coal ash in concrete and a decrease in the strength of the concrete. [17]

Deodhar [2000] Brick masonry prisms' compressive strength is influenced by the thickness of Walls material and brick material, according to the study. A brick masonry structure's strength increases with the thickness of the brick material used in comparison to the wall's thickness. Metric bricks and conventional bricks perform best when the joint thickness is 5mm to 10mm, and brick masonry loses a significant amount of strength when the joint thickness is more than 10mm. Brick masonry has a stress-strain curve that is quite similar to concrete's. Brick strength has no effect on the total strain of brickwork equivalent to maximum stress, which was always greater. [18]

Moinul Islam and Saiful Islam [2010] Six percent (10 percent, 20, 25, 30, 30, 40%, and 50%) of the cement weight was substituted with fly ash in the research. Six fly ash walls with 40% cement substitution had 14% stronger compressive strength and 8% greater tensile strength than typical portland cement walls. Fly ash Walls specimens became weaker than conventional Portland cement specimens. Fly-ash walls are stronger than Portland cement walls. Fly ash may replace cement in any construction project, reducing environmental impact and maximising resources (energy conservation, use of by-product). Fly ash reduces Walls mix cement and hydration heat. Fly ash concrete is environmentally friendly and cost-effective. [19]

Mandal and Majumdar [2009] The compressive strength of Walls was tested at ages of 3, 7, and 28 days using a variety of parameters, including fluid-to-fly ash ratios, alkali activator concentrations, curing temperatures, and curing durations. For the current alkali activated fly ash Walls, a 48-hour curing period at 60-70oC seemed ideal. It was found that the ratio of fluid to fly ash and activator fluid concentration had a significant impact on compressive strength, thus he made this conclusion. The Walls' compressive strength increased as the curing temperature rose from 25oC to 90oC, whereas the Walls' tensile strength increased as the fluid-to-fly ash ratio decreased. [20]

Miranda et al [2005] Research has shown that activated fly ash walls are just as effective as Portland cement walls in inactivating reinforcing steel. Cl- adds about a 100-fold increase in corrosion rate when added to the binder. Due to the increased binder/sand ratio in fly ash walls, the icorr values were somewhat higher in these Walls s, which had a higher chloride content. [21]

AravindGalagali [2004] An IS regulation stated that rich walls (CM 1:6) were permitted in the masonry. However, brick masonry did not need such ornate walls. It was determined that'masonry Walls' might be used, which were constructed by substituting cement with fly ash up to 30%. This unwittingly resulted in a reduction in the project's overall cost. [22]

3. Methodology:

The research involves the conduct of experimental evaluations of the resistance of brick masonry when subjected to certain situations. In order to accomplish this goal, a total of nine samples of brick wall segments were built. The bricks were laid in a pattern known as the English course. Under normal circumstances, the masonry walls were built with a mix percentage of 1:3. (cement: sand). The ratio of water to cement was maintained at 0.52.

The height, width, and depth of the walls were 900, 19, and 230 centimetres, respectively (Length x Height x Width).

A total of nine walls were built, three of which did not have any ferrocement applied to them, three had plaster applied to the outside surface, and the other three had a coating of wire mesh ferrocement applied to them. After being exposed to the open air for 28 days, the beams went through the curing process. There will be two different kinds of tests carried out, namely the prism test and the flexural strength test.

In order to conduct the prism test, a total of fifteen different specimens were cast and put through a compression test for each case. These cases included an unplastered masonry prism, a prism that had been retrofitted with ferrocement, and five different specimens that were equally distributed for each case. We have successfully cast a total of ten prisms, each measuring 230 millimetres by 110 millimetres by 420 millimetres (Length x width x height)

3.1. Prism Test:

Before construction, compressive strength testing should be done on mock-up prisms made from the same materials and with the same bonding arrangement as the real structure. Moisture content, mortar consistency, and mortar joint thickness must match perfectly for prisms to operate effectively. This specimen must be at least 40 cm tall with a height-to-depth ratio of 2 to 5.

Using a testing equipment with a force equally distributed throughout the specimen's whole top and bottom surfaces, the prism test must be performed after 28 days between sheets of nominal 4mm plywood.

Specimens

A minimum of three prisms should be made, using the same materials and workmanship as the original. Mortar bedding, joint thickness, tooling for joints, arrangement of adhesives and grouting patterns are all included.

Metal wall ties, if employed, may be included even if structural reinforcement is not. Grouting prisms isn't necessary unless the whole structure is going to be grouted.

The thickness of the prism should match the overall thickness of the structure. The length of the prism should be equal to or larger than the thickness of the prism. It is recommended that the prism's height should be at least twice the thickness of the prism, or at least 400 mm in height.

TESTING

Load the specimen at a rate of 350 KN/m to 700 KN/m and place it in the test equipment. When the failure occurred, compare it.

The fmt Strength of prisms is used to gauge the masonry's sturdiness. When the h/t ratio of the prisms tested is less than 5 and more than 2, the compressive strength values indicated by the tests should be corrected in brickwork by multiplying by the correction factor provided. When it comes to the basic compressive strength of masonry, 0.25fmt is the figure that comes from the prism test for masonry.

During the testing of prisms, cracks of various kinds and locations will form, each indicating a different type of failure. Based on the nature of the failure and the location of the cracks that are formed, it is possible to determine the type of failure that was produced during the prism testing process. This allows us to determine how the specimen failed and under what circumstances. Shapes is shown in fig. 1.

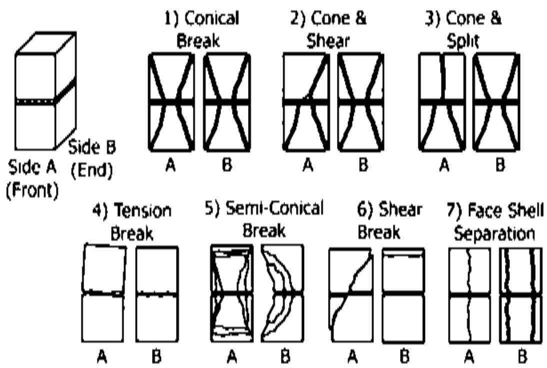

Fig. 1. Cracks Shape

3.2. Flexural Strength Test

Flexural beams may be tested in two ways using this test. Method A makes advantage of intense loads at three-quarters of the arc's length to achieve its results. Concrete cubes are used in Method B to provide a consistent load throughout the whole span.

Testing

Although the orientation of the specimens is not specified by ASTM E 518, Both Method A and Method B specimens should have their tooled joints facing down. As a result, loads should be applied to the unfinished material's face.

The test results for any specimen that fails outside of the centre third of the specimen should be thrown away if Method A is utilised. Results may now be compared more accurately thanks to this more standardised testing method. As a consequence, the test's findings should be discarded.

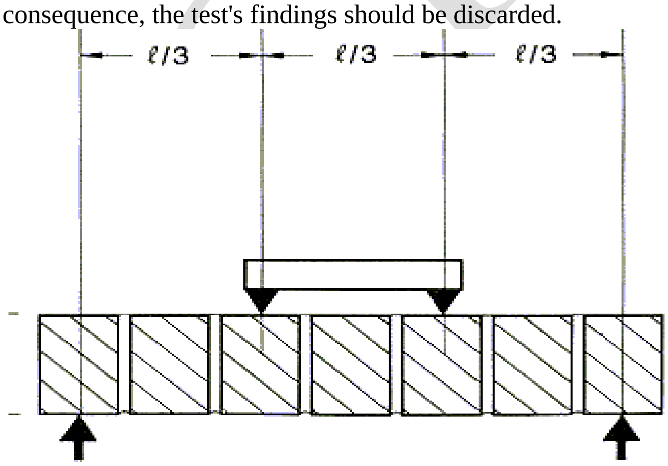

Fig. 2. Method A setup

4. Result and Discussion:

Test Performed For Cement And Their Result:

Compressive Strength Test

3 days strength 20.31 Mpa
7 days strength 27.43Mpa
28 days strength 48.06 Mpa

Fineness Test

Fineness= 3.16%

Consistency

Consistency = 29%

Initial and Final Setting time

Initial setting time 148 minute
Final setting time 252 minute

Test Performed For Fine Aggregate And Their Result:

Abrassion Value Test

Abrassion value 24%

Specific Gravity and Water Absorption

Specific gravity 2.6
Water absorption 1.5

Silt Content

Silt content= 0.8%

Fineness Modulus

F.M. =2.24

Test performed for brick and their result:

Compressive Strength Test

Compressive strength 10.5Mpa

Water Absorption Test

Water Absorption 12.67%

Fig. 3. Setup of specimen during testing

Fig. 4. Loading of specimen

5. Conclusion:

This inquiry compares 24 beam test findings. Brick masonry beams, beams with 20 mm cement-sand plaster, and beams with 20 mm ferrocement overlay were studied.

From the test results of the beams the following conclusions may be drawn.

1. Beams with ferrocement overlay have a higher cracking load and ultimate load than brick and plaster beams.
2. When compared to both unplastered and plastered masonry beams, the load-bearing capacity of a masonry beam that has a prism of ferrocement enclosed in it is greater.
3. It was discovered that applying rich mortar plaster over an unplastered brick masonry column raised the nominal stress at cracking and failure by just a tiny amount.

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