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EFFECT OF OPENING OF MESHES AND DIFFERENT PLATE SIZES WITH SINGLE LAYERON MECHANICAL PROPERTIES OF FERROCEMENT ELEMENTS

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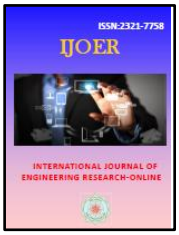


ABSTRACT

The concept of use of fibers to reinforced brittle materials dates back to ancient constructions built in India. Using mud walls reinforced with Woven. Bamboo mates and reeds. In the present form ferrocements may be considered as a type of thin reinforced concrete constructions why cement mortar matrix is reinforced with many layers of continuous and relatively small diameter wire meshes. While the mortar provides mass, the wire mesh imparts tensile strength and ductility to the material.

Ferro cement is a relatively new material consisting of wire meshes and cement mortar. An. Italian architect and engineer named P.L. Nervy in 1940 developed this material. It consists of closely spaced wire meshes which are impregnated with rich commit mortar mix, the wire mesh is usually of .5 lo 1.0 mm spacing and cement mortar is of cement sand ratio of l: 2 or 1:3 with water cement ratio of .4 to 45. The ferrocement elements are usually of the order of 2 to 3ems in thickness with 2 to 3 mm external cover 10 the reinforcement. The steel content varies between 300 kg to 500kg per cubic meter or mortar. The basic idea behind this material is that concrete can undergo large strains in the neighbourhood of the reinforcement and the magnitude of strains depends on the distribution and subdivision of reinforcement throughout of the mass of concrete.

1. INTRODUCTION

The constituent materials of ferrocement are cement, sand, water, steel reinforcement, Hybrid fibers and coating. Ferrocement has found applications in several diverse areas like building of storage tanks, shell structures, boats, wall elements, canal linings. Since wire meshes do not add significantly to the compressive strength of the mortar, ferrocernent is ideally suited to situations where the primary forces are tensile, such as in storage tanks, tension zones of flexural roofing elements or elements etc. Analysis of ferrocement structures is based on same principles as used for structure of other materials. Expect that possibilities of bucking may have to be investigated because of the thinness of the sections. For design, the behavior of ferrocernent composite differs from that of reinforced concrete in the following aspects: Since matrix i.e. mortar does not contain any coarse aggregates, the ferrocernent composite is homogeneous, and as such, shrinkage cracks which appear at coarse aggregate paste interfaces in concrete, do not develop. Since these shrinkage cracks are the initiators of further cracking, the first cracking in ferrocement is at comparatively higher loads and the elastic range is longer that for R.C.Since the wire mesh is usually fine (0.56mm to 1.5-mm in dia) and wires closely Spaced (1mm to 12mm apart), the cracking in ferrocement is finer and closely spaced as compared to concrete.

An important development that has recently occurred is the recognition of ferrocement as a material suitable for construction in India. In the last 10 to 15 years ferrocement has been used for a

number of structures both. at laboratory/experimental level and prototype/field applications

2. SCOPE AND OBJECTIVE OF THE PROJECT

The study is also carried on the experimental and analytical investigations of the ultimate moment capacity and the ultimate shear capacity of the plates with sizes of 500x150x30mm, 600x180x30mm and 700x210x30mm. The mode of failures and the crack patterns were also observed. Variables chosen for the investigation were the single layer of mesh with different openings and shearspan to depth (a/d) ratio with different types of plates and meshes of single layer of specimens. For ultimate moment capacity shear intensity, bending and cracking stress analysis by trial and error methods based on the principles of equilibrium and strain compatibility were used. Both methods have produced satisfactory results.

The variation of shear force with a/d ratio along with different fiber percentages of single layer with two opening of mesh is examined. The experimental ultimate shear is compared with different code values (viz., AC1, BS, AC, and lS). The variation of ultimate moment of resistance and experimental shear is also examined with respect to volume fraction to and a/d. ratios. The variation of ultimate shear to the shear strength v_{cr} is observed with reference to volume fraction and different types of steel meshes are used. Those are Square mesh with 1,2mm and Hexagonal mesh with 4, 6mm and Diamond mesh with 8, 12mm opening meshes are used in this present project.

3. MATERIALS

Ordinary Portland cement giving a 28days mortar (1:3) compressive strength of 53MPa and fine aggregate confirming to the requirements of ASTM-C-33 was used in the entire investigation. Steel square mesh, Hexagonal and Diamond mesh was used as reinforcement to the Ferro cement rectangular elements. The diameter of wire was found to be 0.56mm, 1.0mm and 1.5mm. The openings in the mesh are 1mm x 1mm, 2x2mm for square mesh and 4x4mm & 6x6mm for Hexagonal mesh and 8x8mm & 12x12mm opening for Diamond mesh.The ultimately highest yield strength was observed in hexagonal wires of the mesh was found to be 370Mpa, A cement Sand ratio of 0.50 and a water cement ratio 0.45 were used for casting the units. Ferro cement control specimens of rectangular plate sizes 500x150x30mm, 600x180x30mm and 700x210x30mm with 1, 2 and 3-layers as reinforcement for shear and flexure test of specimens for flexural test were also cast along with the test units. The compressive strength of the mortar found to be 35Mpa.The constituent materials of Ferro cement are rectangular plates, cement, sand, water, steel meshes as reinforcement.

4. OUTLINE OF EXPERIMENTAL PROGRAME

The experimental investigation consists of casting and testing three series of rectangular plates ('A" , B and "C"). The " A "series represents the 500x150x30mm, 600x180x30mm and 700x210x30mm plate specimens with reinforcing as square mesh with single layer like 1,2 and 3-layers of two mesh openings and each mesh opening we are casted one specimen in their cross section .The " B" series represents the 500x150x30mm, 600x180x30mm and 700x210x30mm plate specimens with reinforcing as square mesh 1, 2 and 3-layers of two mesh openings and each mesh opening we are casted one specimens. The " C" series represents the 500x150x30mm, 600x180x30mm and 700x210x30mm plate specimens with reinforcing as square mesh 1-layer of two mesh openings and each mesh opening we are casted one specimen. And finally elements are tested for after 28 days curing for the test of shear and flexure from this tests we can determined first crack load, first crack moment, ultimate load, cracking stress, shear strength, volume fraction first crack stress and ultimate moment and their corresponding deflection. Here, volume fraction and shear strength can be determined some theoretical equations. By observing in this study shear and bending values should be depends upon mesh type, thickness of mesh, size of the plate, mesh size and opening it varied. But in this project we got the best results for Hexagonal mesh of 6mm opening with thickness of 1mm. And if volume fraction increase automatically increases shear strength of the plate. But some situations it will decrease because of to increase the thickness of mesh and opening of the mesh. At the same time parameters also reduced like shear and bending. Finally we draw the

optimum values of plates we can drawn the load-deflection curves.

5. CALCULATION OF VOLUME FRACTION AND CRACKING SHEAR STRENGTH

Hence, it is worth mentioning that Hexagonal mesh improves the shear capacity over than that of diamond and square meshes because of it having a higher straight length. So, diagonal cracks increases strength as compare to other cracks. From these results it is observed that depend on volume fraction. So, the main purpose is to determine V_f of plate and cracking shear strength $V_{cr.}$ The volume fraction of all mesh type is calculated by using some theoretical equations for square, diamond and hexagonal mesh the volume fraction is analyzed. Here, one calculation carried to determine volume fraction of steel meshes. Hence for example hexagonal mesh.

$V_f = N/4*\pi*dw^2/h*(1/D_L+1/D_t) \rightarrow 1$

Where, N = No.of mesh layers = 3

Dw = dia. of mesh = 1mm, $\pi = 3.14$

D_L = Distance center to center between longitudinal wires

D_t = Distance center to center b/w transverse wires

$D_L = D_t = 4$mm & 6 mm

h = Thickness of Ferro cement plate is 30mm

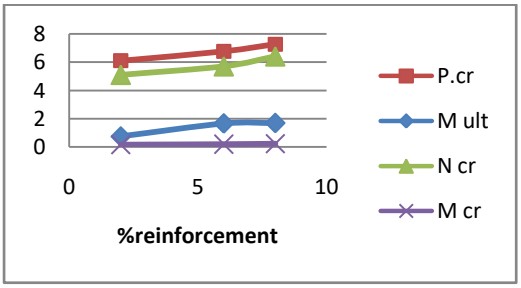
6. REPRESENTATION OVERALL GRAPHICAL

Finally, based on the results of Ferro cement plates single-layer plates got the best results of shear and flexural parameters with the variation of mesh openings and mesh types as reinforcement.

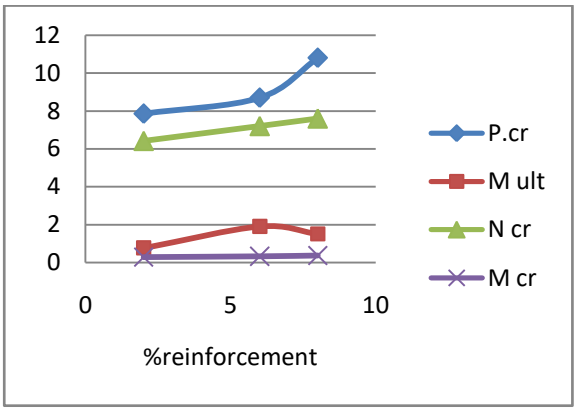
A. Effect of Percentage of reinforcement.

B. Effect of mesh opening

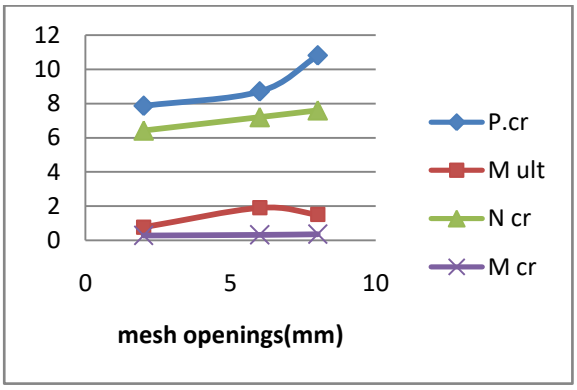
GROUP-A: By the effect of percentage of reinforcement three mesh types varies the shear and flexural parameters like N_{cr}, M_{ult}, P_{cr} and M_{cr}. But Hexagonal mesh 6mm opening specimens gives the best results shown in below



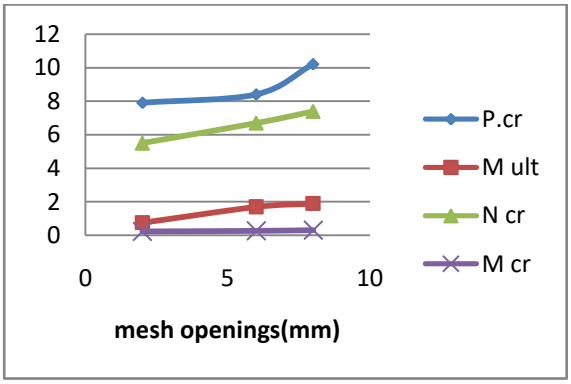
SQUARE MESH WITH 2mm OPENING OF 700*210*30 SPECIMEN(SINGLE LAYER)



HEXAGONAL MESH WITH 6mm OPENING OF 700*210*30mm SPECIMEN (SINGLE LAYER)



DIAMAND MESH OF 700*210830mm PLATE OF SINGLE LAYER SPECIMEN



SQUARE MESH OF 700*210*30mm PLATE SINGLE LAYER SPECIMEN

Finally, from the above all graphs shows the first crack moment, ultimate moment, cracking stress and cracking load with effect of percentage of reinforcement and mesh openings. In this hexagonal 6mm mesh of 3-layer specimens are the best results obtained.

7. DISCUSSIONS AND RESULTS

EFFECT OF SHEAR AND BENDING: Finally, from the bending and shear results we observed following issues discussed below:

EFFECT OF 500X150X30mm SIZE OF PLATE ON FERROCEMENT MATRIX

- In this project we observed the results of ferrocement plain plate(conventional) having the very low moment, load and Zero deflection when compared to the reinforced plates.
- From the results ferrocement plate with square mesh with opening of 2mm specimen A1H13 is 5% increase the all the parameters from bending and shear when compared to A1H11 specimen.
- From the results ferrocement plate with square mesh with opening of 2mm specimen A2H13 is 8% increase the all the parameters from bending and shear when compared to A2H11 specimen.
- By increasing the mesh opening and thickness of the reinforcing mesh that is by using hexagonal mesh the optimum values are having the plate B2H23(6mm opening). Almost it increases the 30% of bending and shear parameters compared to square mesh plates.
- To increasing the mesh opening and thickness of the reinforcing mesh that is by using diamond mesh the optimum values are having the plate C2H23(12mm opening). Almost it decreases the 5% of bending and shear parameters compared to hexagonal mesh plates.
- Finally, Plate size effect is on the ferrocement matrix from the results size of the plate 500x150x30mmwith hexagonal mesh 6mm opening of 3-layer specimen having the best results compared to the conventional plate results.

8. CONCLUSION

Based on the results and observations of the experimental, the analytical study presented in this thesis and considering the relatively high variability and the statistical pattern of data. The main purpose of the present work, to check the suitability of cracking stress, ultimate moment, shear strength, first crack load, ultimate load, volume fraction and corresponding deflection of the ferrocement rectangular plate elements.

From the results of number of Ferrocement specimens tested and some conclusions can be drawn as follow:

1. Using three different types of meshes as reinforcing did not significantly increases the bearing capacity due to lack of confining mortar. Although the reinforcement ratio was double, the increase in the bearing capacity was less than the improved associated with a smaller increase in the reinforcement ratio in the specimen reinforced with on side from bottom of plate.
2. The cracking loads slightly increased as the reinforcement volume fraction increased and the cracking loads were dependent on the mesh layers and opening of the mesh.
3. Flexural first crack stress, first crack moment and ultimate moment increased with the increase of number of mesh layers for three types of meshes.
4. The shear and flexural capacity of plates should be increased with increases the number of mesh layers present study we used 1-layer, 2-layer & 3-layer specimens .
5. The rate of increase of both the cracking stress and ultimate bending moment are maximum for ferrocement contains Hexagonal mesh and are the least for the square mesh.
6. One of the main advantage of ferrocement plates is that it can constructed with low cast housing compared to R.C.C structures. And it decreases the self weight up to 20-40%. so, ferrocement structures can be used in minor structures.
7. From Load-Deflection response of ferrocement plates, it is clear that till the cracking stage the curve behaves as linear and after that it is non-linear.
8. Using different types of plates 500x150x30mm, 600x180x30mm and 700x210x30mm in this plates 700x210x30mm plate with 3-layer hexagonal 6mm opening of mesh gives the best results.
9. The proposed equations for the first crack stress, first crack moment and ultimate

moment of the flexural ferrocement elements are simple but provide reasonably accurate results as compared to relatively more complicated equations involving many parameters.

10. Flexural first crack stress, first crack moment and ultimate moment increased with the increase in percent effective reinforcement for any type of meshes.
11. For the ferrocement plates with light weight mortar under flexural loading, increasing the number of openings leads to an increase in the ultimate load, cracking stress, cracking moment and corresponding deflection.
12. From the results ultimate values for hexagonal mesh of 6mm opening mesh with 700X210X30mmsize of the plate of 3-layer specimens when compared to conventional ferrocement rectangular plate.
13. With this results we conclude that if volume fraction increases the shear intensity of plate also increases and it depends upon the opening, thickness of mesh and size of the plate.
14. If increase the opening of the mesh a cracking stress, cracking and ultimate moment and ultimate load-deflection increases with increase of size of the ferrocement rectangular plate.
15. Finally, we increase the effective % reinforcement with size of the plate and opening of the mesh to increases the first crack stress, first crack moment, ultimate moment, first crack load and shear strength. But in this project we got the ultimate results for hexagonal mesh 6mm(A2H23) opening of mesh with 700x210x30mm size of rectangular ferrocement plate element.
16. From this results we conclude that the ferrocement structures are cost effective and light weight structures when compared to R.C.C structures. Because, in this ferro cement plates mortar matrix was used there is no coarse aggregate content. So, it is in light weight and also it should be satisfy approximately the strength parameters of concrete.

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