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"Response Of Ferrocement Confinement OnBehavior Of Concrete Short Column"

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ABSTRACT : *In recent years, the repair of unstrengthened and damaged reinforced concrete member by external bonding such as ferrrocement laminate is increasing which demands need of investigations on behavior of ferrocement confinements. Significant amount of work has been carried out on confinement of column with ferrocement laminates considering change in parameter such as types of meshes with different sizes, concrete grade, height of column, etc. In this study, use of ferrocement as an external confinement to concrete specimen is investigated with reference to layers of confinement and orientation of meshes. The effectiveness of confinement is achieved by comparing the behavior of confined specimen with that of unconfined specimen.*

The experimental program consists of testing 30 specimens under uniaxial compression. Cylindrical specimen of 120mm dia. and 600 mm height were used. Results show that the confinement of cylindrical specimen can improve the ultimate strength with single and double layer of mesh compared to unconfined specimen. Ultimate compressive strength increases with the change in orientation of square mesh from 90º to 45 º. ***Keywords:*** *Confinement, compressive strength, ferrocement, column.*

1. INTRODUCTION

Ferrocement is a type of thin reinforced concrete laminates commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh [1]. The conventional construction materials such as steel and concrete have exhibited signs of deterioration over the years in their long-term performance which can be attributed to either the inherent nature of the materials or the weak resistance offered by these materials to adverse environmental conditions and natural disasters such as fires and earth quakes. There are a lot of confinement materials that are used for strengthening the concrete structures. Ferrocement, glass fiber, aramid fiber, carbon fiber, etc. are some of the few materials that are used in the confinement of concrete columns. The use of ferrocement as an external confinement to concrete column is investigated in this study. Ferrocement is a special form of reinforced concrete, which exhibits a behavior differing much from conventional reinforced concrete in strength performance and potential application.

In developing countries, the raw materials for ferrocement construction are easily available, and also it could be constructed in any complicated shape. The skill required is of low level and it has superior strength properties as compared to conventional reinforced concrete. These are the reasons for which the ferrocement is considered to be an appropriate confinement material in developing countries such as India. The development of innovative rehabilitation and strengthening technique is required to extend the life expectancy of many concrete structures. The above mentioned factors have contributed to motivate researchers to unleash the potential of using composite materials to retrofit and strengthen the structures. Procedures that are technically sound and economically feasible are needed to upgrade the deficient structures .One such strengthening technique currently being studied is the confinement of concrete columns [2-8].

2. EXPERIMENTAL INVESTIGATIONS

Experimental investigation has to investigate the influence of no .of layers and orientation of meshes on compressive strength of ferrocement confined column. Experimental program has been carried out and result have been discussed achieving following objectives..

2.1. Objectives:

Major parameter affecting behaviour of concrete column confined externally with ferrocement are considered as no. of layers, orientation of mesh, concrete grade. For this experimental program effect of orientation of meshes varying from 90°, 80°, 70°,60°, 45°, and no. of meshes is studied with reference to compressive strength of ferrocement confined column.

2.2. Materials

2.2.1 Cement

Portland cement (OPC) 43 grade conforming to IS 8112: 1989 for the M25 grade of concrete.

2.2.2 Sand

Locally available natural river sand owing to its rounded shape was used in this work, as it ensures better packing characteristics than the crushed sand.

2.2.3 Coarse aggregate

Crushed graded aggregate of quartzite origin having a maximum size of 20 mm was used as coarse aggregate. Coarse aggregate had negligible water absorption.

2.3. Mix proportion

In this investigation, concrete mix had been chosen of grades of concrete, namely M25. The mix design for M25 is according to IS 10262-1982. The mix proportions of the concrete used in this investigation are M25 1: 1.42: 2.56 and water cement ratio 0.43.

2.4. Casting

For this investigation, plain cement cylindrical specimens of size 120mm dia. and 600 mm in length were casted. A total no. of cylindrical specimens was casted 30 and three unconfined specimens also casted. The test specimens were casted in a steel mould, and oil was applied on the inner side of the mould for easy removal of the specimens. The concrete was mixed by using concrete mixer. First, cement and fine aggregate were mixed in a dry form until uniformity was achieved and lastly coarse aggregate was added. Then, water was sprinkled and mixed thoroughly until a uniform mix was obtained. The concrete was then placed as suitable layers of equal thickness, and each layer was compacted by hand compaction. The specimens were demoulded after 24 h, and the specimens were kept for curing in a water tank till the age of the testing (28 days).

2.5. Confinement of plain cement concrete

For the preparation of confined specimens, the plain cement concrete specimens were wrapped with ferrocement laminates. The specimens were taken out after curing (28 d), and then the surface of the specimen was roughened. A rich mortar of 1:1 was applied on the roughened surface of the specimens, and then welded wire mesh (WWM) of a single layer mesh or double layer mesh as per the requirement was wrapped around the specimen. Finally, the specimens were plastered with 1:2 mix mortars with water: cement ratio of 0.43 with a confinement thickness of 20 mm. Thus, the diameters of the confined specimens were 160 mm, i.e. the diameter of plain concrete, 120 mm, plus
ferrocement confinement thickness equal to 20 mm around the specimen. The dimensional detail of the confined concrete specimen is shown in Fig.1.

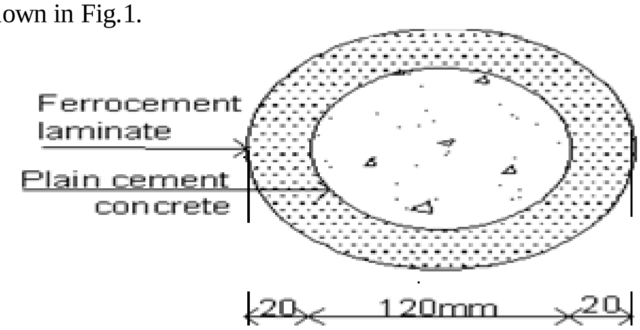

Fig. I Dimensions of confined concrete specimen

2.6 Testing

Specimens were loaded under UTM up to failure. The load was applied gradually up to failure. LVDT are used for measuring the displacements in longitudinal and lateral direction. The loads were applied in small increment under displacement control. Vertical deformation and lateral movement also measured. Visual observation was made throughout the test. Single specimen took 45-55 minute on an average.

3. RESULTS AND DISSCUSSION

The results of test for unconfined concrete specimen are tabulated in table 1. Results of confined specimen for single layer are tabulated in table 2. Results of confined specimen for single layer are tabulated in table 3. It is observed that during test the initial cracks formed at 20 to 35 percentage of ultimate load for single and double layer of mesh confinement. It is observed that load carrying capacity of confined specimen was increased in a range of 17, 25, 36, 40, 47 percentage as compared to controlled specimens in single layer and in double layer this increase is found to be 50, 52, 54, 54, 56 percentage research for orientation 90°,80°,70°,60°,45°. This increase in load carrying capacity is due to the improvement of dimensional stability as well as integrity of this composite material was caused by the presence of a large volume fraction of mesh which was provided as confinement to the core concrete, also due to the change in orientation from 90° to 45°.

TABLE 1 Results of unconfined specimen

Sr. No.	Specimen	c/sArea (mm²)	Axial load (kN)	Average (kN)	Compressive Strength N/mm^2
1	Uc1	20106	191	174	10
2	Uc2	20106	160		8
3	Uc3	20106	172		8.6

TABLE 2 Results of Confined specimen for single layer

Orientation	Specimen	Axial load (kN)	Compressive Strength N/mm2
90˚	90D	347	17
80˚	80D	363	18
70˚	70D	380	18.89
60˚	60D	384	19
45˚	45D	397	19.75

Large confinement pressure is also exerted on the core contents and the redistribution of crack propagation resulted in less lateral expansion of the core. Thus, the load carrying capacity increased in the confined specimens as compared to the controlled specimens. Due to the confinement effect, the deformations first initiated on the ferrocement laminates. Only after the failure of the laminates, the core failure took place.

TABLE 3 Results of Confined specimen for double layer

Orientation	Specimen	Axial load (kN)	Compressive Strength N/mm^2
90˚	90S	210	10
80˚	80S	231	11.5
70˚	70S	274	13.86
60˚	60S	285	14
45˚	45S	329	16.4

Fig. 2. Failure of unconfined specimens.

Fig. 3. Failure of confined specimens.

The crack pattern is similar in all the concrete specimen but initiation of cracks is somewhat late in concrete specimens with double layer specimen as compared to single layer concrete specimens. Experimental results satisfy the equation given by Walliudin and Raffeeqi i.e. [13].

$F_{ct} = f_{cu} + K\ fy$ (1)

where F_{ct} = theoretical compressive strength of concrete , f_{cu} = unconfined compressive strength of concrete , K = $K_m K_g K_p$, K_m = coefficient to account for the method of confinement, K_g = is coefficient to account for the grade of concrete, kp = $35pk_r$, p= volume fraction of wire mesh reinforcement, k_r = is ratio of cross-sectional and surface area of shell, f_y = the yield strength of wire.

4. CONCLUSION

On the basis experimental results following conclusions are drawn.

i) Ferrocement laminates can be used as good strengthing material, or it can be used for retrofitting technique as confined specimen gives more strength than the unconfined specimen

ii) Double layer WWM gives nearly double strength than the single layer of WWM.

iii) There is increase in strength with change in orientation of mesh from 90º to 45º.

iv) Effect of orientation of mesh is more in single layer, this is found to be about 36% as compared with double layer.

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