MAT JOURNALS

Journal of Structural and Transportation Studies
Volume 2 Issue 3

Strengthening of R.C.Column for Retrofitting and Rehabilitation by Using Ferrocement and Wiremesh

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Abstract
The corrosion of concrete structures might be due to elderly, poor safeguarding, corrosion due to poor eco-friendly conditions and accidental situations like quakes. The need to upgrading the unsuccessful civil Engineering infrastructure greatly enhances with the ever growing demands. Therefore rehabilitating and retrofitting civil engineering infrastructure has been identified as important issue to be addressed. Ferrocement is a new material consisting of closely spaced wire meshes and cement mortar which is very effective in strengthening work. The simple idea is that it undergoes large strains in the neighborhood of the strengthening and the magnitude of straining depends on the distribution and sector of reinforcement throughout of concrete. In this paper the strengthening of reinforced concrete columns using ferrocement laminates are studied. In this study, the use of ferrocement as an outside detention to concrete samples is investigated. The usefulness of detention is achieved by comparing the behavior of retrofitted samples with that of conventional samples. The test results showed that the confined concrete specimens can enhance the ultimate concrete compressive strengths and failure strains. The strengthened columns have performed better in cracking behavior, reduction in deflection and increased in the ultimate load. In this book the parameters, which critically influence the moment carrying capacity of the ferrocement laminates is also identified and discussed.

Keywords*- Deterioration, ferrocement, laminates, retrofitting*

INTRODUCTION

General

"Fer-ciment" (or) "Ferro cement" was invented by a Frenchman, Joseph Louis Lambot, in 1848. The rapid development of reinforced concrete stifled the development of ferrocement until the first half of the 21st century.

Deterioration of a RC structure is regularly caused by a combination of various factors. It can result from physical destruction, chemical attack, and from material ruin on exposure to severe atmosphere. Physical destruction to RC can arise from a number of causes like fire damage, explosive damage, impact (handling, construction, vehicular etc.,) and damage from natural calamities such as floods, cyclones and earthquakes. The main Chemical causes of concrete deterioration are namely alkali - silica reaction, alkali-carbonate reaction, carbonation, sulphates attack and steel corrosion. The other factors contributing to concrete degradation include high structural stress, thermal stresses, shrinkage and poor quality of materials.

Applications of ferrocement

Ferrocement can be used with more advantages. Some of the applications of ferrocement are the following: Tanks, Containers and Silos, Floors and Roofs, Heavy duty floors tiles, Waterproofing, ferrocement buildings, Ferrocement ducts, Rehabilitation of structures etc.

Advantages based on the repair works
Better cracking behaviour, Capability of improving some of the mechanical properties of the treated structures. Ability to withstand thermal changes very efficiently. Ability of achieving water proofing property without providing any surface treatment.

Literature Review

B.Kondraivendhan, Bulu Pradhan (2009) In this study, the use of ferrocement as an external confinement to concrete specimens is investigated. The effectiveness of confinement is achieved by comparing the behavior of retrofitted specimens with that of conventional specimens. The primary test variable considered in this study is the concrete compressive strength. All the other parameters, such as size, shape, number of layers of wire mesh, and L/d ratio of the specimens, were kept constant. The sections chosen are circular cylinders with a size of 150 mm x 300 mm and L/d ratio of 6:1. The test results showed that the confined concrete specimens can enhance the ultimate concrete compressive strengths and failure strains.

Fahmy E.H., et al (1999) In this investigation twenty four reinforced concrete column models were tested under concentric compression load. Each specimen was first loaded till failure or up to either 67% or 85% of the ultimate load of the control specimens. After unloading, the damaged column specimens were repaired by a complete jacket form of 10mm thick ferrocement around the four sides of the specimen.

Experimental Investigation

General

The main aim of this project is to study the compressive strength of concrete columns rehabilitated and retrofitted with ferrocement laminates. The experimental programme consists of casting and testing of eight RCC columns of size 150mm ×150mm× 1000mm.

The aim of this project was done by the following tasks,
Control beam-2 nos.
Retrofitting of beams-2 nos.
Rehabilitation of beams-4 nos.
The loading variations for the rehabilitated columns are,
0.67 P_u- 2 nos.
0.75 P_u- 2 nos.

Then evaluate ultimate strength of beams in flexure, load deflection behaviour, stiffness and energy absorption of beams.

Testing of materials

Properties of materials used for this investigation are arrived by testing of cement, fine aggregate, coarse aggregate, reinforcement and the details of the test results are given below.

Table 1. *Properties of materials*

Content	Water	Cement	Fine Aggregate	Coarse Aggregate
Size/ Grade	Ordinary potable water free from impurities.	OPC 53	Passing through 4.75mm and retaining on 0.75 micron	Passing through 20mm and retaining on 10mm sieve
Specific Gravity		3.05	2.56	2.74
Mix design	The mix proportion of 1: 1.74: 3.47 at 0.44 water cement ratio was used.			

Test results of concrete cubes

The concrete mix proportion designed by IS method to achieve the strength of 25 N/mm^2.Three cube specimens were cast and tested at the time of column test (at the age of 28 days) to determine the compressive strength of concrete. The average compressive strength of the concrete was 35.11 N/mm^2.

Reinforcement details Mesh used

Longitudinal reinforcement: 8 nos. of 12mm dia. HYSD bars. No. of layer: 1 layer

Shear reinforcement: 6mm dia. at 150mm c/c. Weld meshes size: 15mx 15mm, 2mm dia.

Woven mesh : t=0.8mm, gauge=20.

Fig.1 *Rebar reinforcement used*

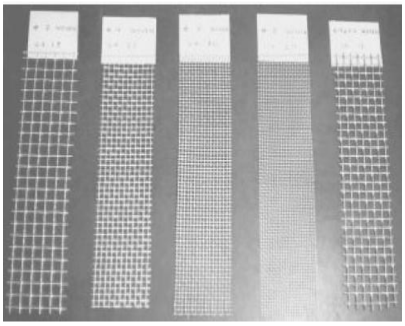


Fig.2 *Woven mesh*

Preparation of test specimen

All the ingredients were first mixed in dry condition. To the dry mix calculated quantity of water was added and thoroughly mixed to get a uniform mix. Oil was applied on the inner surface of the mould and the reinforcement cage was placed in position. Concrete was poured in two layers and each layer was compacted. The specimen were stored under polythene sheet for one day, demoulded next day and cured for a period of 28 days using gunny bags.

Rehabilitation and retrofitting of RCC columns

The following figures shows that the step by step procedure of casting of specimens

Fig.3 *Roughening the column*

Fig.4 *Layed Wire Mesh*

Fig.5 *Applying Mortar on Wire Mesh Surface*

Testing procedure

All the columns were tested under compression in a loading frame of 100 tonnes. And all the columns were tested for a simply supported condition. The loading was applied on all columns by means of 600 KN capacity of hydraulic jack. The jack was operated manually.

Three deflection meters were placed at the center of the column on all four sides. The deflections at a load increment of every 2 tonnes were recorded.

Specimen details and load-deflection curves

The numbering details, the column designation and load applied in first stage for the test specimens are mentioned in the table below:

Table 2. *Details of Specimen*

S. No	Column designation	Load applied in initial stage (Tonnes)
1	Control CS1	40
2	Control CS2	40
3	CSA1	28
4	CSA2	28
5	CSB1	30
6	CSB2	30
7	CSC1	-
8	CSC2	-

Note: P_u: ultimate load, A1 and A2: 67% of ultimate load ($0.67P_u$), B1and B2: 75% of ultimate load ($0.75P_u$),C1 and C2 : Retrofitting columns.

Results and Discussion

The compressive test results for the conventional columns, rehabilitated and retrofitting columns and their comparisons are given in this chapter.

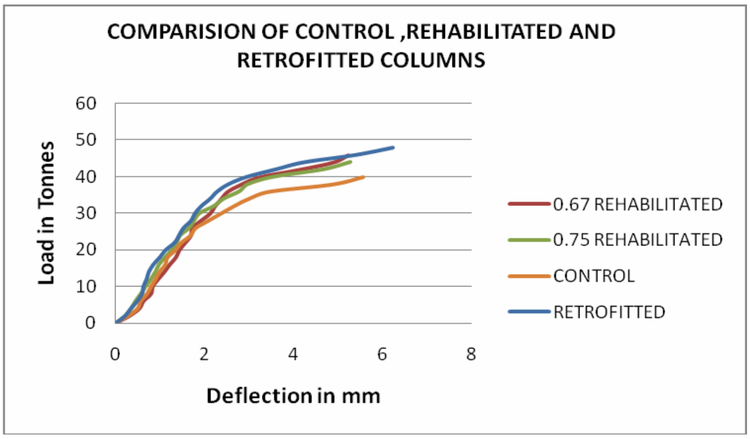
Table 3. *Ultimate load of specimens*

S.No	Column designation	Ultimate Load Tonnes	Load at First Crack Tonnes
1	Control CS1	40	22
2	Control CS2	40	22
3	Rehabilitated CSA1	46	24
4	Rehabilitated CSA2	44	25
5	Rehabilitated CSB1	42	24
6	Rehabilitated CSB2	44	24
7	Retrofitted CSC1	48	26
8	Retrofitted CSC2	48	25

Test results of all columns

The following are the test results of all rehabilitated and retrofitted columns. The performance of the columns were assessed in terms of the first crack load, the crack width, average crack ultimate loads.

Graph 1 Load vs. Deflection curve for control, retrofitted and rehabilitated columns



Failure of Ferro cement laminates
The following figure shows the failure of laminates.

Fig.6 *Failure of laminates*

Table 4. *Load deflection readings for all specimens*

Load	Control column	ehabilitated column	ehabilitated column	Retrofitted column
0	0	0	0	0
2	0.28	0.31	0.21	0.21
4	0.49	0.53	0.34	0.34
6	0.56	0.62	0.44	0.48
8	0.7	0.79	0.56	0.59
10	0.79	0.83	0.67	0.62
12	0.89	0.95	0.79	0.69
14	0.98	1.09	0.89	0.74
16	1.11	1.21	0.97	0.84
18	1.16	1.35	1.11	0.99
20	1.34	1.43	1.26	1.12
22	1.47	1.56	1.37	1.32
24	1.68	1.69	1.45	1.42
26	1.79	1.72	1.65	1.52
28	2.07	1.91	1.76	1.69
30	2.36	2.12	1.88	1.78
32	2.65	2.23	2.21	1.92
34	2.98	2.37	2.43	2.12
36	3.45	2.52	2.78	2.28
38	4.87	2.83	2.98	2.53
40	5.56	3.25	3.56	2.94
42		4.13	4.67	3.58
44		4.89	5.28	4.23
46		5.23		5.39
48				6.23

CONCLUSION
In this project it is clearly noticed that the use of ferrocement laminates appears to be a useful rehabilitative measure for the existing member at distress. It is a viable alternative material for the repair and strengthening of reinforced concrete elements. The load carrying capacity and ductility of RCC member is improved by ferrocement.

In this experimental program, eight reinforced concrete columns were casted and tested up to failure. Two RC columns are to be tested to find ultimate load. Out of the remaining six columns, two columns were tested for retrofitting. The rehabilitation columns were loaded up to different load variations of ultimate load to distress them. Then the columns were rehabilitated with ferrocement laminates with one layer with shear connector. Retrofitted columns were retrofitted with ferrocement laminates with one layer with shear connector. The rehabilitated columns and the retrofitted columns were tested up to failure. Then the behaviors of the tested columns were studied.

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