IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

STUDY OF COLUMN STRUCTURE BEHAVIOUR WITH FIBER AND FERRO CEMENT CONFINEMENT UNDER COMPRESSION

[1]SYED JAWID HUSSAIN, [2] Dr. SIVA KUMAR RAMAMOORTHY
[1]PhD Scholar, [2]Professor
[1]Department of Civil Engineering,
[1] Shri Jagdish Prasad Jhabarmal Tibrewala University, Vidyanagari, Jhunjhunu, Rajasthan-333001

Abstract : Retrofitting older buildings has grown to represent a significant component of construction activity. Any construction that relies only on columns to convey the weight to the base has a strong sense of authority. The columns' load bearing capability is heavily influenced by the slenderness ratio. In general, the load-bearing capability of concrete columns diminishes as the slenderness ratio increases. It is thus required to reinforce defective columns to enhance the load bearing capacity, flexibility and energy absorbing capabilities which may be accomplished through exterior confinement of column. Materials like ferrocement, fibre-reinforced polymers (FRP), and steel jacketing may all be used for external confinement.

Reinforcing degraded and weak columns using ferrocement confinement is a time-tested, practical, and inexpensive method. Wire mesh with higher strength mortar are used to create ferrocement, a kind of reinforced concrete used for thin walls. The larger specific surface of small-diameter reinforcing wires results in a more homogeneous ferrocement. Greater ductile response as well as energy absorbing capacity may be achieved by using wires that are more closely spaced. Ferrocement-bound structures deform above the elastic point, unlike typical concrete structures, which deform brittle when they reach their limit of deformation. Taking all of this into account, the current research concentrated upon behavior of R.C.C columns having varying slenderness proportions upon ferrocement confined columns and unconfined columns.

An count of 27 column specimen having 3 distinct slenderness ratios were cast in the experimental section of this thesis. 3 slenderness ratio had been deliberated (i) $\lambda=3$; (ii) $\lambda=7$; & (iii) $\lambda=15$. Those samples had then subdivided into three distinct groups. There were three groups: one with 3 unconfined control columns from every group size, second with 3 curbed by ferrocement and utilising a single wiremesh layer, as well as a 3rd group with 3 confined by ferrocement and utilizing 2 layer of wiremesh. Every column was subjected to monotonic uniaxial compression stress. Ferrocement confinement improved the column's load-carrying stability and capacity by reducing column's lateral displacement. Ferrocement confinement lost strength as its slenderness ratio increased. Its even shown as wiremesh is much effectual in the ferrocement till 1 or 2 layer.

Index Terms **– Ferrocement, Slenderness ratio, GI wire mesh, Compressive strength, Split tensile strength, Flexural Strength.**

I. Introduction

Ferrocement-a Composite Material

Ferrocement is form of thinner reinforcing wall that is generally made of hydraulic cementmortar and reinforced having close spacing continous layers as well as comparatively tiny wiremesh size (ACI Committee 549-R97, 1997). For the insitu cast of ferro-cement constructions, admixtures such as silica fume and super plasticizers, as well as non-metallic fibers, are used in combination having higher cement ratio and a lower W/C proportion of 0.4 or less. Because of this, ferro cement buildings have a high strength-to-weight ratio. As a result, ferrocement structures have a far lower self-weight than RCC. When used as a thinly reinforced concrete composition and in the building of newly built constructions & the repairing/rehabilitating of pre-existing buildings, ferrocement has found several uses. Since it's reinforced into 2 dimensions, ferrocement have homogeneous, isotropic characteristics into both ways, unlike typical reinforced concrete, Because of these qualities, ferro cement has higher tensile strength with higher modulus of rupturing. Waterproofing, cracking-resistantance, also energy-absorbtion are just a few of the characteristics of ferrocement. There is less damage and destruction to ferrocement structures during earthquakes because the stresses at nodal points are reduced. Beams and columns that are restricted with ferrocement generate their first fracture when the force applied is sufficiently high relative to the elastic point. The increased binding forces that form with the matrix due to ferrocement reinforcement's higher specific surface than of reinforced concrete yields smaller fractures and lower crack widths than traditional reinforced concrete on average. Additionally, ferrocement's cheap maintenance and repair costs make it a standout among other building materials. Ferrocement may be efficiently used for reinforcing or retrofitting such items like storage tanks, ships, house panelling, roofing, form work, and so on because of its many benefits.

II. Literature Review

Abdullah and Takiguchi (2003) square column were tested concurrently with compression and cyclic loads utilizing both square and circular ferrocement. There were three sorts of columns investigated in the research : It was decided to build 6 similar reference RC columns using a 1:3–1:8 scale. Using circular ferrocement jacket having 6 layers of wiremesh as reinforcement, 3 columns—defined as C.J-A.L15-6.L, C.J-A.L10-6.L, & C.J-AL.20-6.L—had been put through their paces under a variety of axial stresses. Strengthening RC columns by using ferrocement has been tested on specimen C.JAL15-6/3L, which has a decreased number of wiremesh layers in its center section. S.J-A.L15-4.L and S.J-A.L15-6.L reference columns was reinforced by wire mesh squared ferrocement jackets before being tested to see whether various forms of jacketing affected lateral loaddisplacementresponse to lateral loads. Twelve distorted D-6 bars were dispersed uniformly over the column cross-section in each of the reference columns. We utilized smoothR-2 (diameter 142mm) bars placed 50 mm apart as transverse reinforcement.

Kondraivendhan and Pradhan(2009) concrete's behavior was researched as a result of the effects of concrete confinement. All other variables were held constant while examining the effects of various grades of concrete encased in ferrocement. A broad variety of concrete grades have been utilised into our research, including M.25, M.30, ., M.40, M.45, M.50, & M55. The compressive strengths of M.25, M.30, M.35, M.40, M.45, M.50, and M55 are 25.N/mm^2, 30.N/mm^2, 35.N/mm^2, 40.N/mm^2, 45.N/mm^2, 50.N/mm^2, and 55.N/mm^2, correspondingly. To test various concrete grades, 42 cylindrical specimens, three of each of which were made in triplicate, were to be cast (21 for controlled specimens and the rest for confined ones). Columns of 150mm x 900mm plain cement concrete examples were cast and subsequently restricted with ferrocement, as seen in the figure. It has been discovered as when compressive strength of concrete amplified, it greatly improved in lesser concrete grades like M25, which showed a 78% rise, as contrasted to higher concrete grade M55, resulting into a 45.3% increase.

Xiong et. al. (2011) Engineers investigated how circular concrete columns with steel bars (FS) may be utilised for boosting compressive strength of concrete & ductility of structure. Ferro-cemented reinforced columns was put to test under uniaxial compression with comparison to barmat-mortar (B.S) and fiber reinforced polymer (F.R.P), wrapped column. Measurements of cretecylindrical columns was 105mm (dia)x450mm and 150mm(dia)x450mm. Later of 24 hours of wet curing, sample were moved to a curing chamber where they were left for 27 days. There were examples of 105 millimeters in diameter (FS or BS) and 150 millimeters (FRP). There's 30% increasing in compressive strength of FS columns as compared to BS columns, according to the comparative studies. Using ferrocement caging coupled by steel bars, samples demonstrated greater flexibility, energy absorption and compressive strength volume as F.R.P or B.S reinforced circular column.

Mourad and Shannag (2012) stress specimen confined using ferrocement and welded wiremesh even as restraining medium for ultimate load capacity of column specimens. The findings revealed that confinement enhanced the load bearing capacity by 33% for pre-stressed specimens. The specimens' ductility also improved. The confinement increased ultimate load capacity by 28 percent and 15 percent for samples that had been strained to 60% and 80% of their ultimate loading capacity, correspondingly.. Contained column specimens exhibited ductile failure, whereas control specimens exhibited brittle failure.

K.Mounika (et al 2015)

Researchers are studying the impact of adding coconut and jute fibers to fiber-reinforced concrete on mechanical qualities. Compressive, split, and flexural strength are among the characteristics. For example, mass of cement may be used to investigate coconut and jute fiber content percentages of 0, 1, and 1.5 percent. There were a total of 7 batches of concrete mix.

The findings are compared to normal M-30 grade concrete. As more fibers are included, the workability of FRC decreases. The maximum compressive strength, or 11.27 percent greater than normal concrete, is observed in the 0.5 percent JFRC. CFRC with a maximum flexural strength of 0.5 percent outperforms ordinary concrete by a factor of 60.36. A 22.6 percent increase in regular concrete's tensile strength was discovered for said split tensile strength for 0.5 percent CFRC.

KSHITIJA NADGOUDA(2014)

Increasing the structural strength of concrete necessitates its reinforcing. Because they are easily accessible in large quantities, coconut fibers were used in the experiment. Based on laboratory testing, the study compares the characteristics of coconut fiber-reinforced concrete to ordinary concrete. Better waste fiber management is another benefit of using coconut fibers. Concrete's flexural strength was boosted by around 13% when coconut fibers were used, and the concrete was also better adhered to the coconut fibers. According to a research, the maximum fiber level is 3%. (by weight of cement). The ideal range of fibre content for fiber-reinforced concrete must be determined via further study.

III. OBJECTIVES

Wire mesh confinement within columns with insufficient strength is subject of current study, which aims to determine its usefulness. Ferrocement-confined columns were compared to their unconfined, reinforced counterparts to arrive at this conclusion. The following research goals are established in this study:

1) For investigating influence of column slenderness on load-carrying capability.
2) To examine first crackload as well as cause of failure
3) To examine the impact of varying percentages of wire mesh on the ferrocement confinement.

IV. MATERIALS AND ITS PROPERTIES

Materials

Columns are cast using cement, coarse aggregates, fine aggregates and reinforcing steel bars. Cement mortar is utilised to apply GI wire mesh to column surface.details of materials may be found in following sections:

Cement

Portland- Concrete mix and mortar made using Pozzolana Cement were tested and approved. Table 3.1 summarizes results of numerous testing on product's physical attributes. IS1489(Part 1): 1991 specifies protocol for conducting all tests in lab.

Fine aggregate

Concrete and cement mortar both utilized local sand as a fine aggregate. Table4.2 and Table4.3 exhibit physical parameters and sieve analysis findings of sand, respectively.

Coarse aggregate

Concrete was made using crushed stone aggregate of 10mm, 20mm in a 1:1 ratio. Table 4.4, 4.5, 4.6 feature physical parameters and sieve analysis findings for coarse aggregate.

Table4.1 Cement's Physical Properties

S.No.	Property	Value found Experimentally	Value as per IS:1489-1991
1	Standard Consistency	34	-
2	Fineness of cement as retained on 90 micron sieve'in %'	0.5	Min0.1
3	Setting Time(in minutes) Initial Setting time Final setting time	 130 460	 Min30 minutes Max 600 minutes
4	Specific gravity	3.0	
5	Compressive strength (N/mm^2) 7days 28days	 24.19 35.89	 Min22 Min33

Table4.2 Fine Aggregate's Physical Properties

S.No.	Property	Value found Experimentally
1	Specific gravity	2.67
2	Bulk density loose (kg/lt)	1.50
3	Fineness modulus	2.65
4	Water absorption	1.8%
5	Grading zone(based on percentage passing 0.6 mm)	ZoneII

Table 4.3 Fine Aggregate Sieve Analysis

Total weight taken=1000 gm

S.No.	Sieve size	Mass retained(gm)	Percentage retained	Cumulative percentage retained	Percentage passing
1	4.75mm	15.5	1m.55	1.55	98.45
2	2.36mm	101.5	10.15	11.7	88.30
3	1.18mm	249.5	24.95	36.65	63.35
4	600µm	139	13.90	50.55	49.45
5	300µm	221	22.10	72.65	27.35
6	150µm	202	20.20	92.85	7.15
				∑=265	

Fine aggregate's F.M of =265/ 100=2.65

Table4.4 Coarse Aggregate Sieve Analysis (20mm)

Total weight taken=10000 gm

S.no.	Sieve size(mm)	Mass retained(gm)	Percentage retained	Cumulative percentage retained	Percentage passing
1	40	0	0	0	100
2	20	0	0	0	100
3	10	4846	48.46	48.46	51.54
4	4.75	3879	38.79	87.25	12.75
5	Pan	1275	12.75		
				∑=135.71	

20mm coarse aggregate fineness modulus =(135.71+500)/ 100=6.35

Table4.5 Coarse Aggregate Sieve Analysis (10mm)

Total weight taken=10000 gm

S.No.	Sieve size	Mass retained(gm)	Percentage retained	Cumulative percentage retained	Percentage passing
1	40mm	0	0	0	100
2	20mm	0	0	0	100
3	10mm	985	9.85	9.85	51.54
4	4.75mm	8345	83.45	93.3	12.75
5	Pan	670	6.7		
				∑=103.15	

10mm aggregate Fineness modulus = (103.15+500)/100 =6.03

Table4.6 Coarse Aggregate's Physical Properties

Total mass =10000gm

S.No.	Features	20mm	10mm
1	Kind	Crushed	Crushed
2	Specific gravity	2.60	2.68
3	Total water absorption(%age)	3.62	1.58
4	Fineness modulus	6.35	6.03

GI wire mesh

For ferrocement confinement, a GI steel wire mesh of 0.45mm-diameter wires was utilized. Mesh had a grid of 6mm × 6mm squares. Fig. 3.1 shows a steel mesh. GI wire mesh is described in Table3.7.

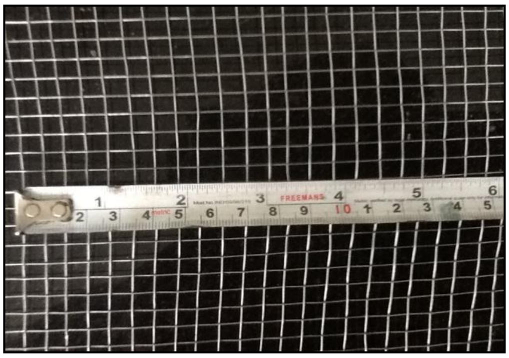


Fig.4.1GI Wire Mesh

Table 4.7 GI Wire Mesh features

Wire's diameter	0.44mm-0.46mm
Ultimate Tensile Strength of wirekg/mm^2	88
Mesh opening dimension	6mmx6mm square mesh

Concrete Mix

Proportions of concrete design mix were 1:1.61:1.475:1.475 (cement: sand: 10mm coarse aggregate: 20mm aggregate) by weight, as detailed in Table 3.1 through Table 3.6. When casting 150mmx150mmx150mm cement concrete cubes, water cement ratio was maintained at 0.5. Compressive strength later 28 days was 29.71 N/mm2.

Mortar Mix

Cement sand mortar with a 1:3 ratio is utilized in ferrocement applications. In this case, water-cement ratio was set at 0.4.

V. RESULTS AND DISCUSSION

5.1 Introduction

This sector focuses on findings from testing of specimens. For each of three different types of ferrocement specimen (RFCS1, RFSC1, and RFLC1, each of which had one layer of wire mesh), three different unconfined control concrete specimens were prepared, as were graphs showing the average load-deflection for each of the three ferrocement specimen types (RFCS1, RFSC1, and RFLC1, each of which had 1 sheet of wiremesh with λ =3, 7, 15 respectively). All specimens were subjected to a concentrated manner of loading throughout testing procedure. Values of loadvs.deflection, first crack load, fracture form, final load capability are all noted down.

5.2 Outcomes of Control and Ferrocement Confined Columns(λ=3)

Because of their modest height, these columns are known as Pedestals. In order to gain strength, pedestals make use of their whole height. Load-carrying capability of confined columns substantially doubled after confinement relative to unconfined control columns, according to results. In following sections, we'll go into further depth about each column we examined.

5.2.1 Control column (CS, λ =3)

Some low-level cracking noises were detected when loading began, which may have been caused by concrete micro-cracking. S pecimen deflected as loading proceededSome cracking and spalling of concrete's surface was seen towards bottom and in center of slab's breadth when it was loaded to 115 kN. Initially, two fractures were seen at 272 kN, one in upper left corner spreading diagonally to mid height , the other on right to half width covering diagonally to top and bottom in equal height. These cracks appeared simultaneously Suddenly, column collapsed when weight hit 274 kN and a tremendous boom could be heard from top of structure. Mid-height deflection was as high as 3.81 millimeters. In Fig. 5.1 and Fig. 5.2, graph of load vs. mid-height deflection shows column at several periods of loading.

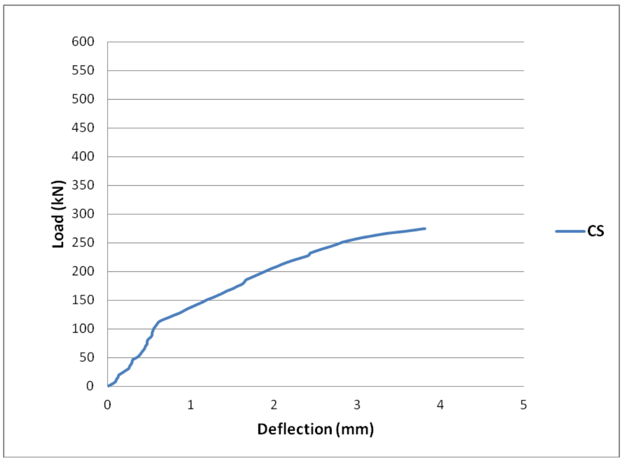


Fig.5.1 Load vs. Mid Height Deflection of Control Column(CS,λ=3)

(a)

(b)

(c)

(d)

Fig.5.2 Altered Stages of Control Column (CS,λ=3)

(a)Before Loading (b) First Crack (c) While Failure (d) After Failure

5.2.2 Ferro cement confined column with one sheet of wiremesh (RFCS1,λ=3)

Lateral distortion decreased as a result of confinement. It was at this point when first fracture was discovered. W ire mesh layer separated from mortar layer by vertical cracksAt a load of 527 kN, core concrete of column finally gave way under weight of wire mesh keeping it in place. Figures clearly show delamination of mortar layer. Core concrete ruptured when longitudinal reinforcing twisted outward.

When compared to control column CS, confinement enhanced maximum load capacity by about two fold. 2.25mm was greatest deflection. At different levels of loading, you can see load vs. deflection graph and column in Fig.5.3 and Fig.5.4 correspondingly.

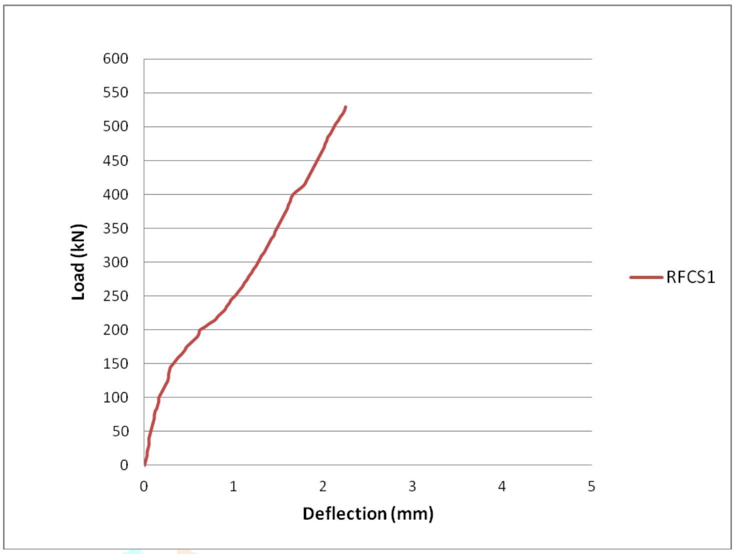


Fig. 5.3 Load vs. Mid Height Deflection of Restricted Column With 1 Sheet of WireMesh (RFCS1, λ=3)

(a) (b)

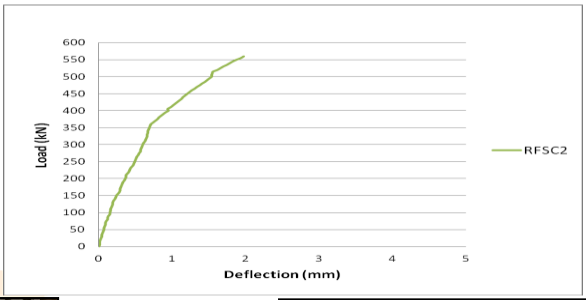
(c) (d)

Fig5.4 Unlike Phases of Ferrocement Confined Column with 1 Layer of Wire Mesh(R.F.C.S.1,λ=3)(a)Before Load(b)First Crack(c)While Failure(d)After Failure

5.2.3 Ferro cement confined column with 2 layers of wiremesh(R.F.C.S.2,λ=3)

Specimen's response was consistent with that of earlier samples as soon as loading began.At a load of 548 kN, a fracture was initially seen upon right side of column in a vertical direction, and as load rose, it became wider.An ultimate load of 554 k.N was cause of collapseAt one-fourth of specimen's height from top, it failed in compression. In comparison to control specimen CS, highest deflection measured was 1.98 mmIn addition, confinement enhanced overall capacity of vehicle. Findings show that confinement with 2 layers of wire mesh has a smaller effect on ultimate loading capability than confinement with a single layer of wiremesh. It is seen in Fig5.5 that load vs. mid-height deflection graph is presented in Fig5.6.

Fig5.5 Load vs. Mid Height Deflection of Ferrocement Confined Column having 2 Sheets of WireMesh (R.F.C.S.2, **λ**=3)



(a)

(b)

(c)

(d)

Fig5.6 Dissimilar Stages of Ferrocement Confined Column having 2 Layers of WireMesh(R.F.C.S.2,λ=3)(a)Before Loading(b)First Crack(c)While Failure(d)After Failure

5.2.4 Contrast of CS,R.F.C.S.1 and R.F.C.S.2(λ=3)

In comparison to a control column, test findings demonstrate that after ferro cement confinement to columns, ultimate load capacity, first fracture load, and deflection have all increased significantly. L/d ratio for column specimens is 3 (short column or Pedestal). Contained columns RFSC1 and RFSC2 have an ultimate load value almost double that of control column.

One-fourth of height was found to be in compression mode, with failures occurring either at top or bottom. Concrete in failure zone broke, exposing longitudinal reinforcement and rupturing core concrete as collapse occurred. Failure. Delamination of mortar layer from wire mesh was same in confined specimens, resulting in a comparable fracture pattern.

During testing of restricted columns, sound of micro cracking of concrete was not audible. This shows that confinement also minimizes micro cracking. 3 column samples C.S, R.F.C.S.1 and R.F.C.S.2 are shown in Fig5.7, where load and mid-height deflection values are compared.

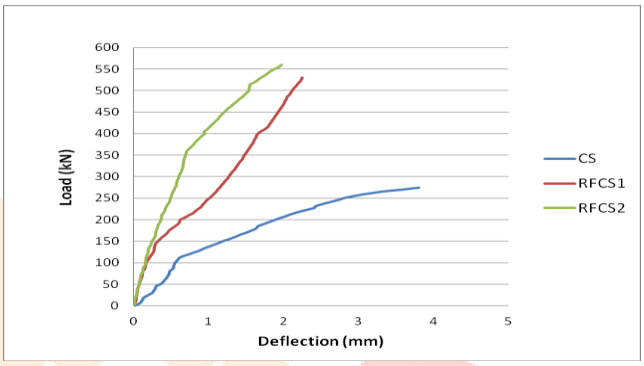


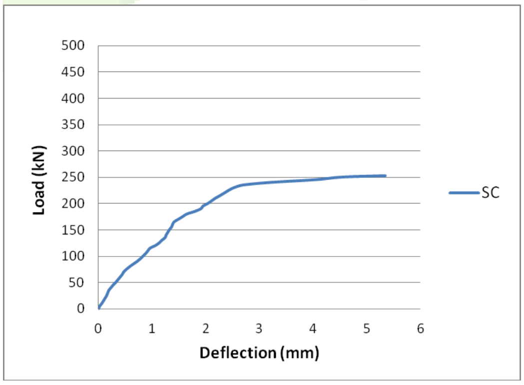
Fig5.7 Contrast of Load vs. Mid Height Deflection of Control & Confined Column(C.S, R.F.C.S.1 & R.F.C.S.2, λ=3)

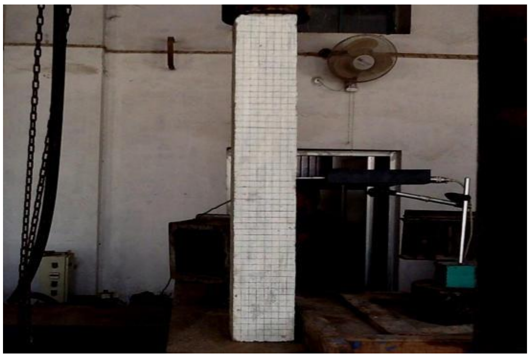
5.3 Outcomes of Control and Ferrocement Confined Columns(λ=7)

5.3.1 Control column (S.C,λ=7)

When load has been applied, sample's deflection remained unchanged. At a load of 250 kN, first fracture was discovered around 1/4th height through bottommost diagonally extended upside, by left to the right of seen face. An ultimate load of 252 kN caused brittle breakdown. Failure mode was discovered to be compression. As illustrated in image, concrete spalling was seen fully from rupturing zone, that caused bend in longitudinal reinforcment,Figures 5.8 and 5.9 show load vs.mid-height deflection graph, crack pattern, column before, during, and after loading.

Fig5.8 Load vs. Mid Height Deflection of Control Column(S.C,λ=7)





(a)

(b)

(c)

(d)

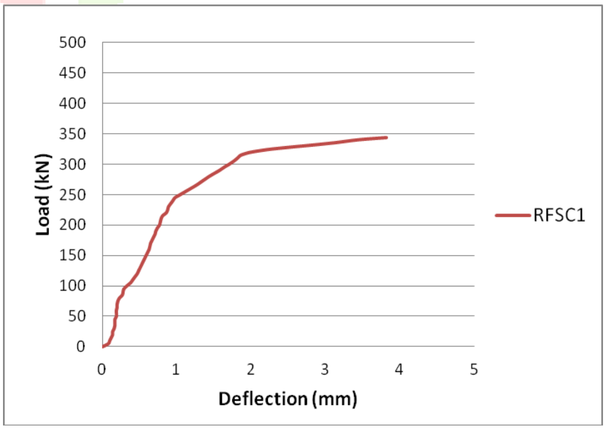
Fig5.9 Dissimilar Stages of Control Column(S.C,λ=7)

(a)Before Loading(b)First Crack(c)While Failure(d)After Failure

5.3.2 Ferro cement confined column having 1 layer of wire mesh (RFSC1,λ=7)

Even after applying a weight of 335 kN, column showed no signs of breaking. F irst break appeared in mortar layer with a cracking sound when load neared 337 kN.During compression collapse of column, ferrocement mortar layer was removed by wiremesh. 343kN was load at which beam failed. Largest reported lateral displacement was 3.82 millimeters. Fig5.10 shows load vs. mid height deflection graph, whereas Fig. 5.11 displays detailing of column before, during, & after loading as well as crack pattern.

Fig5.10 Load vs. Mid Height Deflection of Ferrocement Confined Column having 1 Sheet of WireMesh (R.F.S.C.1, λ=7)



(a)

(b)

(c)

(d)

Fig5.11 Different Stages of Ferrocement Confined Column with 1 Layer of WireMesh(R.F.S.C.1,λ=7)(a)Before Loading(b)First Crack(c)While Failure(d)After Failure

5.3.3 Ferro cement confined column having 2 sheets of wiremesh(R.F.S.C.2,λ=7)

A weight of 346 kN on bottom of column at middle breadth caused column to split. F racture ran from bottom up to one-quarter of column's height in a diagonal pattern. This point was deflected by 2.78mm. After additional loading, column deflected till maximum of 2.97 mm before failing at 353 kN, around one-fourth of way up column's height. In compression mode, column also failed. Particulars of column before, during, after loading is presented into Figure 5.12, while loadvs.mid height deflection chart is depicted into Figure 5.12.

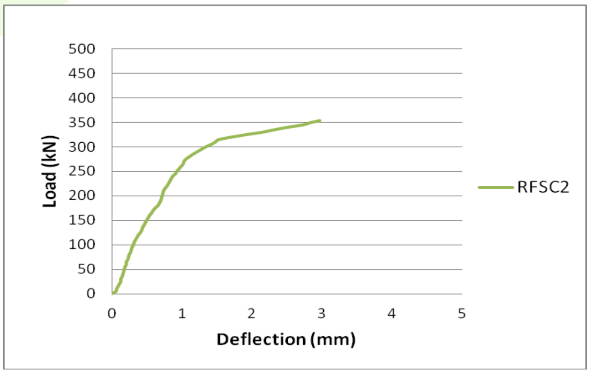


Fig5.12 Loadvs.Mid Height Deflection of Ferrocement Confined Column withTwo Sheet of WireMesh (R.F.S.C.2, λ=7)

(a)

(b)

(c)

(d)

Fig5.13 Dissimilar Stages of Ferrocement Confined Column having 2 Sheets of WireMesh(R.F.S.C.2,λ=7)(a)Before Loading(b)First Crack(c)While Failure (d)After Failure

5.3.4 Contrast of S.C,R.F.S.C.1 and R.F.S.C.2(λ=7)

Curve in Fig5.14 shows as ferrocement restricted samples could tolerate greater loading value & have a minimal deflecting behavoiur. As seen in Figs. 5.9, 5.11, and 5.13, all specimens failed due to in compressio Comparison also shows that ulltimate loading capability till 1 layer of wiremesh is significantly improved with confinement of ferrocement. Final load capacity is less impacted, but deflection is reduced noticeably, when using two or more layers of wire mesh. Slenderness ratio has also been shown to have an influence. Increasing slenderness ratio reduces the load-carrying capability.

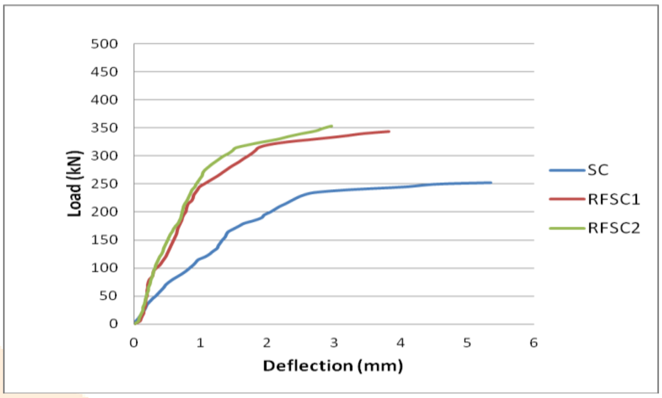


Fig. 5.14 Contrast of Loadvs.Mid Height Deflection of Control & Ferrocement Confined column (S.C,R.F.S.C.1 & R.F.S.C.2, λ=7)

5.4 Results of Control & Ferrocement Confined Columns(λ=15)

5.4.1 Control column (L.C,λ=15)

At a lesser load of 20-25 kN, column's slenderness (λ=15) caused it to deflect more. As weight of system rose, so did deflection. Microcracks in concrete made some noise. With a load of 150 kN, deflection increased. Increases in deflection were more pronounced with load at 190 kilograms (kN). At a load of 201 kN, first fracture was found slightly over one-fourth of column's height. At load of 203 k.N, column failed. Load and deflection graphs are shown in Fig. 5.15; column is depicted into Fig5.16.

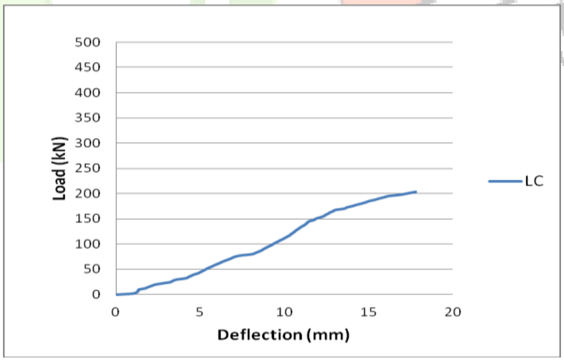


Fig.5.15 Loadvs.Mid Height Deflection of Control Column(LC,λ=15)

(a)

(b)

(c)

(d)

Fig5.16 Dissimilar Stages of Control Column(L.C,λ=15)

(a)BeforeLoading (b) First Crack (c)While Failure (d)After Failure

5.4.2 Ferrocement confined column by one sheet of wiremesh(R.F.L.C.1,λ=15)

Column LC exhibited less deflection as loading progressed because of smaller diameter of column. After first fracture emerged, column failed with a load of 280 kN, resulting in loss of whole structure.. One-quarter of way up from floor, fissures could be seen. Due to bursting of concrete and ferrocement layers as well as bending longitudinal reinforcement, column fell without additional deflection without further deformation. As compared to control column LC, confinement decreased deflection to 12.31 mm. Figure 5.17 depicts column's load vs. deflection graph, whereas Figure 5.18 depicts the specifics of loading process at various stages.

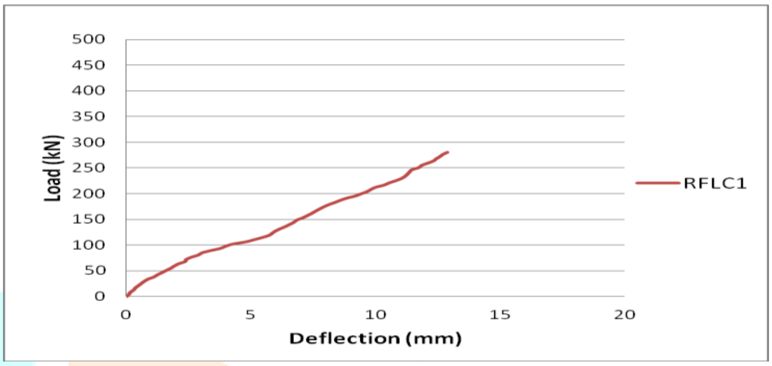


Fig5.17 Loadvs.Mid Height Deflection of Ferrocement Confined Column having 1 Sheet of WireMesh (R.F.L.C.1, λ=15)


(a) (b)


(c) (d)

Fig5.18 Dissimilar stages of ferrocement confined column with one sheet of wiremesh(R.F.L.C.1,λ=15)(a) Before Loading(b)First Crack(c)While Failure(d)After Failure

5.4.3 Ferrocement confined column by two sheets of wire mesh(R.F.L.C.2,λ=15)

Similar to column RFLC1, this one even lead to failure to load. There was a 283 kN fracture in bottom corner that extended up to one-third of column's height. Fracture began to widen as strain grew. When load reached 286 kN, mortar layer began to delaminate. Near bottom, compression was most common mechanism of failure.

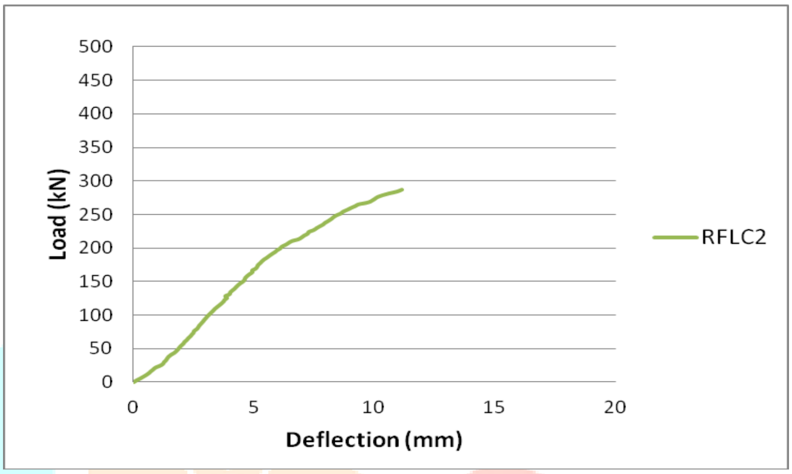


Fig5.19 Loadvs.Mid Height Deflection of Ferrocement Confined Column having 2 Sheets of WireMesh (R.F.L.C.2,λ=15)

(b)

(b)

(c) (d) (e)

5.20 Dissimilar Stages of Ferrocement Confined Column having One Sheet of Wire Mesh(R.F.L.C.1,λ=15)(a)Before Loading(b)First Crack(c)While Failure(d)&(e)After Failure

5.4.4 Contrast of LC,R.F.L.C.1 and R.F.L.C.2(λ=15)

Under load-deflection requirements, both of confined RFLC1andRFLC2 ferrocements behave linearly as per unconfined control column L.C.In case of RFLC1, confinement greatly decreased deflection, while small deflection has been controlled as per RFLC 2.

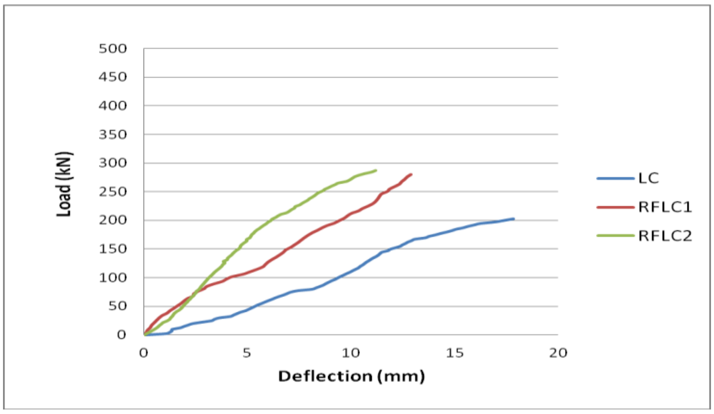


Fig5.21 Contrast of Load vs. Mid Height Deflection of Control & Ferrocement Confined Columns (L.C,R.F.L.C.1 & R.F.L.C.2,λ=15)

Overall Comparison of Test Results of Columns

Table 5.1 provides a comparison of various slenderness ratios and wire mesh layers in ferrocement restricted columns and control columns. It is shown in Figure 5.22 that the slenderness ratio and ferrocement confinement affect column's load-carrying capability.

Table5.1Test Results of Control and Ferrocement Confined Columns

Specimen	Slenderness ratio	Number of Specimen	Avg. Ultimate load(kN)	% Increment in ultimate load	Avg.ultimate lateral deflection(mm)	First crack load(kN)
CS	3	3	274	-	3.81	272
RFCS1	3	3	527	92	2.25	524
RFCS2	3	3	554	102	1.98	548
SC	7	3	252	-	5.35	250
RFSC1	7	3	343	36	3.82	337
RFSC2	7	3	353	40	2.97	346
LC	15	3	203	-	17.81	201
RFLC1	15	3	280	38	12.31	274
RFLC2	15	3	286	41	11.16	283

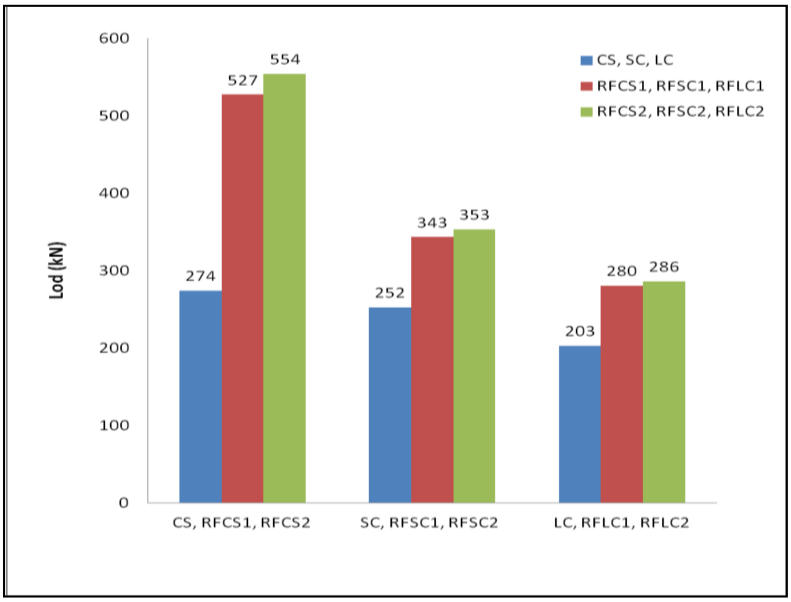


Fig. 5.22 Comparison of Influence of Slenderness Ratio & Ferrocement Confinement upon Ultimate Load Capacity

5.5.1 Effects of ratio of slenderness and ferrocement confinement on maximum capacity for load

Contained columns RFCS1 and RFCS2 have a higher ultimate load bearing capability than control column CS. Control columns S.C(λ=7) and L.C(λ=3) both have lower ultimate load capacity as control column C.S(λ =3), that depicts influence of slenderness ratio. By 1 layer of wiremesh (RFCS1, λ =3) with 2 layers of mesh (R.F.C.S.2, λ =3), load-carrying capability of limited columns was not significantly improved. For comparing to control columns of same narrowness ratio, percentage increase in R.F.C.S.1 (λ =3), R.F.S.C.1 (λ =7), and R.F.L.C.1(λ =15) with one layer of wire mesh is 92%, 36%, and 38%, respectively.

5.5.2 Slenderness ratio & ferrocement confinement have an impact upon lateral deflection.

With ferrocement confinement, lateral deflection while compression also got minimized. In comparison to control column CS, deflection is decreased to 2.25mm (R.F.C.S.1) & 1.98mm (R.F.C.S.2) for short columns with a slenderness ratio (=3). Different slenderness ratio columns were found to have same pattern. When compared to control column SC, which had a lateral deflection of 5.35mm, short column with a slenderness ratio of 7 demonstrated reduced lateral deflections of 3.82mm (R.F.S.C.1) & 2.97mm (RFSC2). When linked to a control column LC, which had a lateral deflection of 5.35mm, a similarly length column with a slenderness ratio of =15 showed a reduced lateral deflection of 3.82mm (R.F.L.C.1) and 2.97mm (RFLC2). L ateral deflection decreases with ferrocement confinement in all of column groups. Test findings demonstrate that lateral deflection rises as slenderness ratio increases.

5.5.3 First Crack Load and Crack Pattern as a Result of Concrete Confinement

Prior to ultimate load, first crack load value was recorded when compression failure occurred in short columns. This is due to fact that whole height is damaged in columns with a modest slenderness ratio.One-fourth of column's height was seen from top or bottom to be zone of rupture in short columnsCracks often begin at corner of an unconfined control column, and then spread diagonally toward the centre of column's breadth.For initial cracking load, column reacted into same way like control column, with ferrocement confinement.

Before final breakdown, it happened at a greater altitude the load's value.After initial fracture formed at corner, it spread vertically, detaching mortar layer from wire mesh and causing core concrete to collapse.

As of lengthy control column, fail zone has been found as more than $1/4^{th}$ height, rather than midheight, as previously thought. After horizontal fracture appeared, a rupture occurred. After confinement, column revealed its initial fracture at bottom corner, which widened as weight increased. Ferrocement layer was delaminated up to mid-height after fracture progressed vertically towards corners. It illustrates that confinement is better in middle of the breadth and weaker towards corners.

VI. CONCLUSIONS

RCC columns with varying slenderness ratios and the confinement of ferrocement are studied in this experimental investigation. Following conclusions might be observed from test data:

1.Ultimate load bearing capability of columns was enhanced because of the use of ferrocement confinement.

2. The strength given by ferrocement confinement reduces as the column's slenderness ratio increases.

The strength rose by 92 percent in the short column (λ=3) as compared to the long column (λ=15), where only a 36 percent rise was seen.

3.While lateral deflections are greatly reduced when ferrocement confinement is used up to the first layer of wire mesh, a modest reduction occurs with the second layer.

4. The control sample's ultimate load capacity was enhanced by 92 percent with a single layer and by 102 percent with two layers, which is marginal.

5.As a building material, ferro-cement is a highly homogenous, ductile, and energy-absorbing substance. It's a man-made wood that's perfect for areas prone to earthquakes.

6.The ideal way to build buildings is to use ferrocement cavity walls and hollow floors inside a prefabricated framework, which automatically forms stiffened shear walls and floors. A precast or cast-in-situ technique of construction may be employed with this technology. The only other option is a Forretrofitting structure damaged by stress loading ferrocement.

7.Consequently, usage of ferrocement like an building material and technology is excellent for earthquake-prone locations.

8.When fibers are included into concrete or mortar, the compressive strength increases. Fibers help to decrease mortar spalling, which is a common problem. Fiber reinforced concrete specimens performed better under stress and strain when enclosed in a Ferro cement shell than plain concrete specimens. Improved peak stress and strain may be seen when fibers are more tightly packed in columns. With a greater specific surface factor and fibers added to the mortar, the improvement in strain has become more obvious. A higher quantity of confining steel in fiber and nonfiber columns boosted the strength and ductility of columns, while fiber columns showed a somewhat greater improvement in these properties.

9.Construction using ferro-concrete Strength, stiffness, ductility, and the ability to dissipate energy are all improved. In terms of fire, earthquake, and corrosion protection, externally ferrocement-coated columns are superior. With low residual stress concentrations, cracking may be reduced and the structural durability can be enhanced with use of restricted ferrocements. Strengthening and retrofitting using FRP provides a number of benefits over other materials. Because of its thinness, its application doesn't add any weight to the structure already in place. It aids in the preservation of historic buildings' cultural significance. It will not rust. The corner radius as well as number of F.R.P layer are most important characteristics that have a considerable impact on specimen behavior. If equated with ferrocement jackets, F.R.P jacket boost final axial compressive strength of post-heated reinforced concrete column more, yet they dont help restore rigorousness of the post-heated reinforced concrete column.

10.For jacketed specimens, the ultimate load capacity and flexural strength will be greater. It is possible to apply the ferrocement jacketing technology efficiently if the suitable jacketing scheme is adopted/introduced This method is better suited for tiny specimens, as seen by the fracture pattern. Strengthening ferrocement mortars is essential to producing stronger strength, more deformability, better energy dissipation, and greater stiffness, and this increase is most noticeable in small-size jacketed specimens. The strength-to-weight ratio of the little jacketed specimen is greater. We can therefore conclude that this method is efficient and cost-effective for small storage tanks, some types of roof shell construction, ships and boats, architectural monuments and sculptures, and wherever the ease of forming complex shapes and the lighter weight of ferrocement can be easily exploited. One layererd mesh ferrocement jacket could not offer considerable exterior incarceration, according to stress–strain behavior and failing of pattern. It is possible, however, to improve the behavior of restricted concrete by using a two layer mesh ferrocement jacket.

11.The experimental technique used in this work was designed to examining behaviour of ferrocement-coated reinforced concrete columns through various shapes under axial compression stresses. Here are the most important conclusions from this study: Slenderness of concrete columns below axial compression stresses was the most important factor in determining their behavior. Increasing the slenderness ratio reduced the column's ability to bear weight. When compared to the outcomes attained for reference samples, the load bearing capability values of column specimens having wire mesh have improved significantly. Loading capacity of square column was greater as of circular column for both reference and modified samples. This is due to the larger surface area of square samples and their greater ability to withstand lateral expansions. Both lateral and vertical displacements appear to raise as upsurge in the slenderness ratio, which is consistent with the observed behavior. For each column tested, the modulus of elasticity may be approximated by multiplying 260 by the compressive strength. Depending on ductility of tested column, failure modes often begin at upper or lower end of trial and progress to a specific zone. Axial loads seem to cause all of the examined materials to become brittle. For reinforced concrete columns, this scenario provided a comprehensive review of potential strengthening and repair options. With these procedures, reinforced concrete infrastructure may be improved without the need for rebuilding or replacement, making it more sustainable. Detailed descriptions of each approach are provided, along with its benefits and drawbacks. Injured columns can be repaired. However, it's also very hard to recover column's previous stiffness. According to a review of various research, this conclusion may be formed. Hybrid jacketing techniques, that incorporate benefits of new materials and reinforcing methods could be most efficient since they are fairly quick to install and can significantly improve strength, ductility and drift as well as preserve aesthetic appeal of initial geometry/configuration of a building's geometrical form, according to some researchers. Research needs in this study include exploring efficiency of strengthening and repair procedures for high-strength RC columns, as well as analyzing usefulness of these approaches under actual bi-directional loading protocols, since most studies presently concentrate on the seismic performance of reinforced columns in uni-directional lateral loading situations. In contrast to past research that concentrated on ductility levels that could be used in force-based design, retrofitted columns may now be used directly for displacement-based design.

VII. FUTURE SCOPE

Ferrocement panel systems have previously been studied for their flexural behavior when mixed with various additives and wire meshes, but data on the low-velocity impact behavior of ferrocement panel fibers is rare. The new study is aimed at filling in the gaps in previous studies. A fibrous ferrocement panel with enlarged wire mesh has been used in this pilot study to overcome the aforementioned shortcomings, and the flexural and impact performance has been evaluated. It was determined that ferrocement panels could be made by adding hooked steel fibers to 1, 2, and 3 layers of expanded wiremesh. An investigation into formulation and execution of fibrous ferrocement panels exposed to low-velocity impact is likely to provide important information.

REFERENCES

1. ACI Committee 549-R97: State-of-the-Art Report on Ferrocement, ACI 549-R97, in Manualof Concrete Practice, American Concrete Institute, Farmington Hills, Michigan, 1997, 26pages.
2. AbdullahandTakiguchi,K.(2003),"Aninvestigationintothebehaviorandstrengthofreinforcedconcretecolumnsstrengthenedwithferrocementjackets".Cement&ConcreteComposites, vol.25: pp233–242.
3. Desai, J.A. (2011), "Corrosion and Ferrocement, Proceedings of the National Conference onFerrocement".FS 2011,13-14 May2011, Pune,India, pp 45-52.
4. Divekar,B.N.(2011),"Cost effectiveConstructionusingPrecastFerrocementPanels,Proceedings of the National Conference on Ferrocement". FS 2011, 13-14 May 2011, Pune,India,pp129-134.
5. Kaish, A.B.M.A., Alam, M.R., Jamil, M., Zain, M.F.M., Wahed, M.A. (2012), "Improvedferrocement jacketing for restrengthening of square RC short column". Construction andBuildingMaterials, vol.36:pp 228–237.
6. Kondraivendhan, B., Pradhan B. (2009), "Effect of ferrocement confinement on behavior ofconcrete".Constr BuildMater, vol. 23(3): pp 1218–22.
7. Moita,G.F.,deLasCasas.E.B.,MantillaCarrasco,E.V.,Bonif_acio,S.N.(2003),"Experimental and numerical analysis of large ferrocement water tanks". Cement & ConcreteComposites,vol. 25: pp243–251.
8. Mourad,S.M.,Shannag,M.J.(2012),"Repairandstrengtheningofreinforcedconcretesquarecolumnsusingferrocementjackets". Cement&ConcreteComposites,vol.34:pp 288–294

9. Naaman, A.E. (2000), "Ferrocement & Laminated Cementitious Composites". Techno Press3000,Ann Arbor, Michigan,USA, 2000.
10. Nassif,H.H.andNajm,H.,(2004),"Experimentalandanalyticalinvestigationofferrocement-concrete composite beams". Cement &Concrete Composites,vol.26: pp 787-796.
11. Xiong, GJ., Wu, XY., Li, FF., and Yan, Z., (2011), "Load carrying capacity and ductility ofcircular concrete columns confined by ferrocement including steel bars". Construction andBuildingMaterials, vol.25: 2263–2268.
12. Abdullah; Takiguchi, K. An investigation into the behavior and strength of reinforced concrete columns strengthened with ferrocement jackets. Cem. Concr. Compos. 2003, 25, 233–242.