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Study of column structure behaviour with fiber and ferrocement confinement under compression

Syed Jawid Hussain[1], Dr. Siva Kumar Ramamoorthy[2]

[1] Phd-Research Scholar, Shri Jagdish Prasad Jhabarmal Tibrewala University, Vidyanagari, Jhunjhunu, Rajasthan

[2] Professor, Shri Jagdish Prasad Jhabarmal Tibrewala University, Vidyanagari, Jhunjhunu, Rajasthan

Abstract: Concrete is that the most generally used structural material round the world, due to its higher compressive strength, low cost and might be easily manufactured with the locally available materials. Mould ability to any shape resulting in architectural finishes, high resistance and weathering action, and Aesthetic appearance. Therefore, it's widely utilized in construction. A concrete with reinforcement when subjected to earthquake and nuclear blast etc, fails suddenly because of low durability,Poor ductility,More brittleness.
This problem is avoided if the critical section are ready to undergo large plastic deformations and be in an exceedingly position to soak up large amounts of strain energy. The structures which are designed for seismic resistant demands high ductility. Therefore, the ductility of concrete is being improved by confining it in steel binders, as ties in compression members and as stirrups in beams nowadays. within the structures which are statically indeterminate the critical section, at which first hinge forms are incidentally also the section having maximum shear force. The stirrup reinforcement, which is provided must be sure of shear at that section and simultaneously provide confinement. Moreover, use of sophisticated arrangement of closely spaced stirrups in confinement columns not only creates plane of weakness between core and also the concrete and interrupts the continuity but also adds the matter of steel congestion.
Therefore it should not be possible to sufficiently confine the structure by providing the laterals ties alone but it'd be useful if a supplementary or indirect confinement, additionally to laterals, is provided at the critical sections or a decent alternative for the confinement is devised several investigations have revailed that incorporation of discontinuous, discrete and uniformly spread fibres in concrete increases durability ductility, impact, toughness, flexural strength and fatigue resistance. Hence reinforcement of concrete is confined with ferro-fibre.

Keywords: fibre, ferrocement , confinement , compression, etc

1. INTRODUCTION

Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh and or small diameter rods completely infiltrated with, or encapsulated in, mortar”. The most common type of reinforcement is steel mesh. Ferrocement is a thin cement mortar laid over wire mesh, which acts as a reinforcement. It is relatively cheap, strong and durable, and the basic-technique which is easily acquired. Ferrocement is also known as ferrociment, ferrocemento, ferocimento and ferrozement.
Test on ferro-cement beams were carried out to study the moment capacity and cracking behavior of ferro cement in flexure. A design method was proposed to predict the ultimate strength based on ultimate strength theory used for conventionally reinforced concrete beams. With the knowledge of maximum steel stresses and specific surface of the reinforcement they developed equation to predict maximum cracks width and cracks spacing.

Ferrocement Constituents :
Ferrocement is made up of cement, sand, drinkable water, and reinforcing mesh, among other things.

1.1 Cement:

Cement must be fresh, have a consistent consistency, and be rid of lumps and foreign substances. It should be kept as dry as possible and for as minimum period as feasible. In ferrocement, the cement percentage is usually larger than in reinforced concrete.

1.2 Sand:

Sand The most common type of sand used in ferrocement is wet sand. Silt and clay should not be present. It should be inert to other materials and of a suitable kind in terms of strength, density, shrinkage, and durability of the mortar it is used to make. Sand must be graded in such a way that a mortar of specific proportions is generated with a uniform distribution of the ingredients.

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1.3 Wire mesh:
Wire mesh is one of the important constituents of ferrocement. This generally consists of thin wires. The mechanical properties of ferrocement depend on the type, quantity and properties of the mesh reinforcement. The wire mesh used in this project is of square pattern. strength The different types of wire mesh are square mesh, Hexagonal wire mesh, expanded metal, rectangular wire mesh etc.

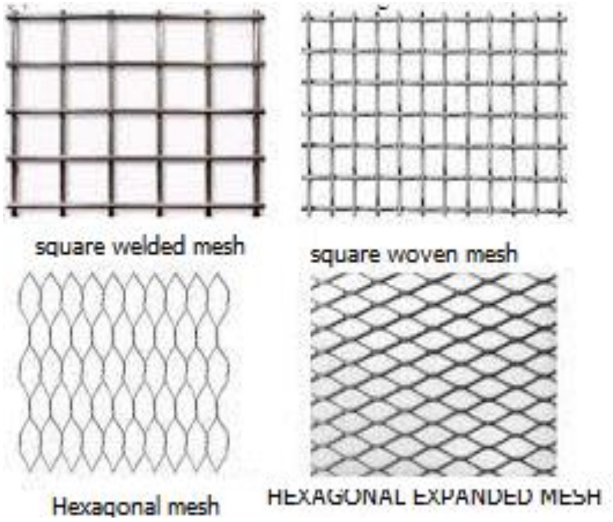

Fig 1: Different shape of wire mesh

1.4 **Advantages of Ferrocement:**
1. Structural elements will be thin and light weight.
2. They can be easily recast.
3. Considerable saving in form works.
4. The basic raw materials are easily available.
5. It can be fabricated in any shapes.
6. It is durable than most woods and cheaper than imported steel.

2 FIBRE

History of fibre: Early steel fibers used as concrete reinforcement were round and smooth. They were obtained by cutting or chopping wire. Today, smooth, straight fibers have largely been replaced by fibers that have either rough surfaces, hooked ends, or are crimped or undulated throughout their length. These characteristics improve a fiber's resistance to pullout from a cement-based matrix. Brittle materials have been reinforced with fibre since ancient times. Fibre is a small piece of reinforcing material possessing certain characteristic properties.
Historically fibre has been used to reinforce the brittle materials. The horse hairs were used to reinforce plaster and straws were used to reinforce sun-based brick. Fibres considerably increase the resistance of concrete to crack. Propagation Patent has been granted since the turn of century for various methods of incorporating wire segment or metal chips into concrete. The problems of low tensile strength and brittle characteristics of concrete have been overcome by providing reinforcing rod in the tensile zone of the concrete since the middle of 19th century.

2.1 Advantages of Fibres
1. Fibres considerably increase the resistance of concrete to crack propagation.
2. Tensile and flexural strength, impact and toughness of FRC will increase.
3. Fibre have a negligible effect on the load at which crack initiate in the, matrix.
4. The performance of fibres can be substantially improved by increasing bond strength.
5. The post cracking resistance provided by fibres is influenced by aspect ratio and orientation.
6. The reinforcing action of fibres can be predicted by using a composite material approach based on knowledge of properties of individual component.

2.2 Types of fibres
There are many types of fibres used in concrete mix they are:
- Steel fibres

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- Glass fibres
- Asbestos fibres
- Polypropylene fibres
- Plastic fibre
- Cotton fibre
- Wood fibre
- Carbon fibre

Each fibre has its own limitations and properties

LITERATURE REVIEW

ANKIT SINGH PARMAR (et al 2019)

though concrete is robust once compressed, it becomes fragile once placed below stress.As soon as concrete is poured, cracks begin to develop. normal concrete couldn't be used in pavement constructions because of problems with plasticity, failure, and structure. These faults in concrete could also be corrected by adding reinforcing fibers to the combination.Synthetic organic compound chemical compound polythene has plasticity, strength and shrinkage qualities.Concrete homes have polythene fibers plain-woven inside them. 1.5 p.c of the time was spent utilizing concrete grade M30, M35, and M40 to chop polythene and tyre fiber int30mm x 6mm dimensions.
It was set to use IRC 44:2008 to line down concrete mixes.

KSHITIJA NADGOUDA (2014)

Increasing the structural strength of concrete necessitates its reinforcing. as a result of they're simply accessible in giant quantities, coconut fibers were employed in the experiment. Supported laboratory testing, the study compares the characteristics of coconut fiber-reinforced concrete to normal concrete. higher waste fiber management is another advantage of mistreatment coconut fibers. Concrete's flexural strength was boosted by around thirteen once coconut fibers were used, and therefore the the} concrete was also higher adhered to the coconut fibers. per a pursuit, the most fiber level is three-d. (by weight of cement). the perfect vary of fibre content for fiber-reinforced concrete should be determined via more study

MOURAD AND SHANNAG (2012)

stress specimen confined mistreatment ferrocement and welded wire mesh at the same time as restraining medium for final load capability of column specimens. The findings discovered that confinement increased the load bearing capability by 33 for pre-stressed specimens. The specimens' plasticity additionally improved. The confinement enlarged final load capability by twenty eight percent and fifteen percent for samples that had been strained to hour and eightieth of their final loading capability, correspondingly. Contained column specimens exhibited ductile failure, whereas management specimens exhibited brittle failure.

1. Experimental Methods or Methodology

In this experimental program two types of specimens as steel and G.I wire for laterial and longitudinal reinforcement were casted. To check their behaviour under axial loading in Digital Compression testing machine of 3000kN with sensitivity of 5kN/s. For this casting material used is as follows;

1.Steel bar:

Steel bar of size 6mm dia was used as a longitudinal reinforcement and lateral ties for Column.

2.Galvonised Iron Wire:

GI- wire is used as a longitudinal reinforcement and lateral ties. The dia of GI-wire is 4mm.

3.Fabric wire:

The mechanical properties of ferrocement depend on the type, quantity and properties of the mesh used in reinforcement. In this experimental study expanded square Galvonised woven wire mesh was used. The Diameter of meshed wire is 0.43mm, opening of wire mesh is 0.36cm.

1. Concrete:
   M25 grade concrete was used.
2. Cement:

Cement used in this project is an Ordinary Portland Cement of 53 grade confirming to IS 12269 – 1987.

3. Coarse aggregate:

Coarse aggregate is the strongest and least porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of moisture. In this experimental study, locally available crushed basalt stone aggregates of maximum size 12 mm down is used and tests are carried out.

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4.Fine aggregate:
River sand available locally was used for concrete and for the mortar, fine aggregate (passing through 800µ and retained on 600 µ sieve was used for Ferrocement).
5.Mortar:
Cement mortar with 1:2 ratio and with water-cement ratio of 0.5 was used.
6.Concrete fibre:
The shakti man steel fibres by volume fraction 1% of fibres are used in this experimental study investigation. The fibres used are 'Shakti man round crimped steel fibber's of diameter 0.45 mm and length 36 mm (aspect ratio 80) are used. The steel fibres are uniformly dispersed inside the entire mass of concrete.

7. Motar fibre:
The "Recron 3s" synthetic Polypropylene fibre, manufactured by Apollo fibres limited and marketed by Reliance industries, was used in mortar. The standard dosage rate for this fibre in mortar is 125gms per 50kg bag of cement, in cement sand ratio Optimized as per application.
The quality of construction is improved due to considerable reduction in cracks during plastic and hardening stage of concrete. Applications of "Recron 3s" fibre are:
- Tanks, manhole cover tiles
- RCC & PCC like Lintel, beam, column, flooring and wall plastering
- Plastering.

Advantages:
- Considerable reduction in cracks during plastic and hardening stage
- Improves abrasion resistance by over 40%. Marginal increase in flexural, compressive strength

Table no – 1;
Furnished the details of Columns Casted.

Sl No	Designation	Dia of Bar/GI in mm	No of Specimen	No of Mesh Layers	Conc fibre %	Mortar fibre %
1	P60	6	3	0	0	0
2	CF60	6	3	0	1	0
3	P61	6	3	1	0	0
4	CF61	6	3	1	1	0
5	P62	6	3	2	0	0
6	CF62	6	3	2	1	0
7	P40	4	3	0	0	0
8	CF40	4	3	0	1	0
9	MF40	4	3	0	0	0.25
10	MCF40	4	3	0	1	0.25
11	P41	4	3	1	0	0
12	CF41	4	3	1	1	0
13	MF41	4	3	1	0	0.25
14	MCF41	4	3	1	1	0.25
15	P42	4	3	2	0	0
16	CF42	4	3	2	1	0
17	MF42	4	3	2	0	0.25
18	MCF42	4	3	2	1	0.25

Where: C stands for CONCRETE, P for PLAIN, M for MORTAR and F for FIBRE
Experimental procedure:
This Experimental program was designed to study the behavior of circular short columns of size 150 mm in diameters and 300mm in height, by Axial loading under a Digital Compression testing machine of 3000kN with sensitivity of 5kN/s. This experimental program consisted of casting and testing of 54 columns which were arranged in 18 set. Each set consist of three columns accordingly. The average value of three columns is taken to represent the behavior of one set. Out of 18 set, first 6 set of columns was made up of 6mm dia steel reinforcement with increasing the mesh layers as zero, one and two. Here (1, 3, 5th) set of specimens was made up of plain concrete and (2, 4, 6th) set of specimens was made by adding

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concrete fibre in the core of the specimen.

Remaining sets of specimen was made up of 4mm GI wire as reinforcement with increasing the mesh layers as zero, one and two. Here, set no (7, 11, 15th) specimen was made up of plain concrete, set no (8, 12, 16th) specimen was made by adding of concrete fibre in the core of the specimen, set no (9, 13, 17th) was made by adding of mortar fibre, and last 3 set i.e. (10, 14, 18th) of specimen was made by adding of mortar fibre in outer surface of the core and concrete fibre in the core of the specimen.

The below table explains the experimental program in detail showing the percentage of concrete crimped "steel fibre" and mortar "Recron3s" synthetic Polypropylene fibre. used in the specimen with proper designation.

Testing procedure:

The Longitudinal and Lateral dial gauge were attached to moveable cross head of the compressometer and correctly centered to see the Longitudinal as well as Lateral strains simultaneously. Before applying the load, the dial gauge attached to the compressometer is adjusted to zero and the test specimen were capped with iron plate for smooth loading surface. The readings of the dial gauge were noted at each 10 sec time interval. The load goes on increases and attains the peak value and then starts decreasing up to 75% of the maximum load. From this readings the stress-strain graphs are plotted also the nature of failure, spalling of mortar was noted. This whole arrangement is kept in compression testing machine vertically and at centered so that the load applied axially at the top of specimen.

concrete cubes

CURING PROCESS

CYLINDER TESTING

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CUBE TESTING CYLINDER TESTING

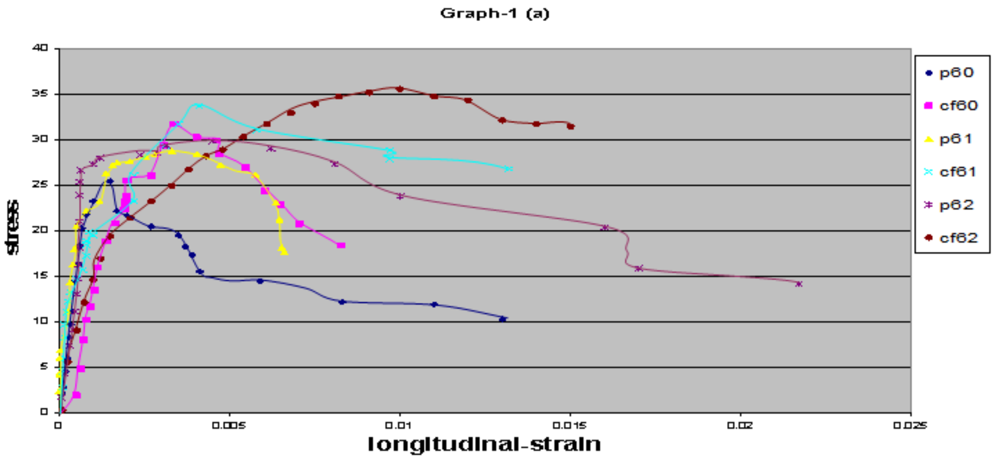
Figure 3 : Compressive test on specimen

TEST RESULTS

DICUSSION OF TEST RESULTS:

Steel reinforcement specimen.

The below graph–1(a) and graph–1(b) explains the behaviour of all steel reinforcement specimens, Graph of stress-strain are drawn.



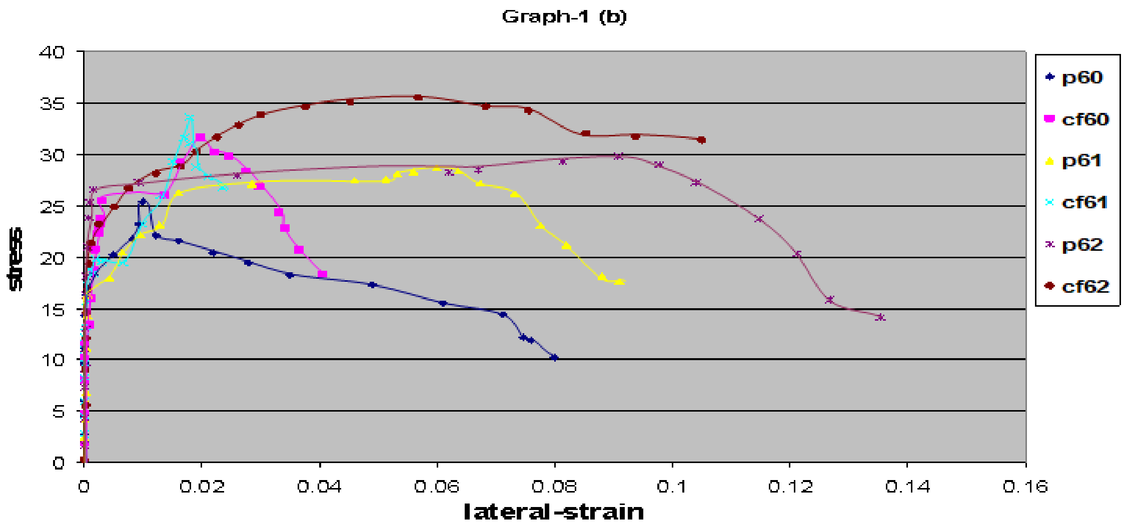


Figure : Stress - strain curve

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Study of Behaviour for Confined Ferro Fibre Reinforced Concrete with Behaviour of Plain Reinforced Concrete Specimens:

The above graph no 1a and 1b shows the behaviour of stress-strain curve for the steel reinforcement specimen, here we observed that initially the behaviour of all the specimen were similar to each other even though there was a variation in each set, after a certain level of stress the behaviour differ this is due to the implement in plain concrete, here we can see the variation between P60 (plain concrete, 6mm dia, zero mesh) specimens and CF62 (concrete-fibre, 6mm dia, double mesh) specimens. The variables in the study are specific surface factor (Sf) which controls the behaviour of ferrocement. Specific surface factor is the product of specific surface ratio and yield stress of mesh wires in the direction of force divided by strength of plain mortar; specific surface ratio is the ratio of total surface area of contact of reinforcement wires present per unit length of specimen in the direction of application of load in a given width and thickness of ferrocement shell to the volume of mortar

Now considering to each set we can see that as increase in ferrocement confinement meshes such as (P60, P61, P62) or (CF60, CF61, CF62) the behaviour of specimens increases. And also we see that the fibre concrete specimen shows comparatively good behaviour and strength as compared with the specimen of without fibre.

CONCLUSION

1. The design becomes most suitable for the structure which is subjected to earthquake and nuclear power plant etc.
2. The spalling of mortar is considerable reduce by the addition of "Recron 3s" synthetic Polypropylene fibre in mortar.
3. With the increase in the specific surface factor the improvement in strain is more pronounced. The strength achieved by steel reinforcement specimen is high as compared to that specimen with G.I reinforcement.
4. With the increase in SSR there is improvement in the stress-strain behaviour of the specimen, showing improving more ductility.
5. Addition of fibre in plain concrete has improved the Compressive strength up to 22.5% as compared with plain concrete
6. The stress-strain behaviour of confinement ferrocement shell with fibres is better as compared to plain concrete.
7. The peak stress-strain value improves with the increase in confinement of ferro-fibre reinforcement in concrete.
8. The structures which are designed for seismic resistant demands high Ductility. Therefore, the ductility of concrete can be improve by addition of "Steel fibre" to the concrete core of column specimen.

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