Analysis of Ferrocement Jacketing on Retrofitted Beams

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ABSTRACT

Almost all the structures whether or not or not industrial, business or housing area unit fabricated from RCC. There structure fare nicely to a lower place ancient circumstances, but among the event of maximum earthquakes, giant load imposition etc. The permanent injury may takes place in structure. It poses a more durable scenario for a structural engineer than constructing a replacement building. This could be as a result of form of restraints associate already created building offers like non designed construction, wear & tear etc. instead of torning apart the structure one can strengthen the deficient structural elements of the structure. As a result of the advancement in technology with the help of non-destructive testing one can merely verify such deficient elements. Once known the only reply is to retrofit such elements. Retrofitting is completely different from repair or rehabilitation. It's primarily a way of strengthening Associate in Nursing sweetening of the performance of deficient structural elements in an extremely structure or as complete structure. In deficient buildings retrofitting could also be done by increasing the strength, stiffness and/or malleability of its specific constituent elements or of the whole building. For any building, relying upon the need, a mixture of the on prime of could also be elite. Retrofitting of individual members or elements is remarked as native retrofitting. Someone is not once it involves spoilt for alternatives retrofitting, he possesses to detain mind form of selections before embarking on the work of retrofitting. The alternatives on the market embrace fiber bolstered Plastic or GFRP, Carbon Fibre bolstered Plastic or CFRP or Ferrocement. He has to keep up a balance between handiness, aesthetic, significantly economy & simple operational. Ferrocement jacketing though lacks among the esthetic 0.5 but it wins by leaps & bounds altogether different problems. The reason for this could be its readily on the market, is easy to work with and is not even ¼ as costly as GFRP or CFRP.

The endeavour of our gift study is to observe the impact of varied share of tensile reinforcements on the behavior of beams retrofit with ferrocement jacketing. The impact of share increase in tensile reinforcement vice-versa the share increase in final load carrying capability is calculated. Combined deflections of retrofitted and non retrofitted beams area unit compared at altogether completely different stress levels. The results shows an increase in load carrying capability of retrofit beams though the increase varies with share of tensile reinforcements. The share increase in load carrying capability is most simply just in case of two bars of eight metric linear unit us intelligence as tensile reinforcement. The deflections conjointly diminished considerably with the increase in share of tensile reinforcement.

1. INTRODUCTION
1.1. GENERAL

Most of the structures we have a tendency to lay our eyes on area unit invariably product of bolstered Cement Concrete or RCC because it is often known as albeit it's a beautiful construction material, however once set it's terribly tough to extend its strength or alter its shear or flexure strength. Another major disadvantage with RCC is that at the most places it's for the most part factory-made by unskilled staff, and if ostensibly minor however small print, if not unbroken in mind results in RCC of reduced strength. a number of these points area unit increase in water cement quantitative relation, improper solidification etc. Strengthening the concrete might become necessary for variety of reasons, like substandard particularization of the steel reinforcement and deterioration of the concrete beneath severe environmental conditions. Alternative desires for strengthening arise as a result of either the look codes have modified that create these structures substandard or larger hundreds area unit permissible on the parts of the infrastructure wherever intensive retrofitting is needed. [Rochette & Labossiere 2000]. The transformation of non-engineered construction into associate built one thus must be specified it can be sustained. Once talking of RCC buildings they'll be created to endure 3 totally different **R**'s particularly repair, rehabilitation & retrofitting. Repair is partial improvement of the degraded strength of a building once associate earthquake. In effect, it's solely a cosmetic sweetening. Rehabilitation could be a useful improvement, whereby the aim is to realize the first strength of a building once associate

earthquake. Retrofitting suggests that structural strengthening and sweetening of performance of deficient structural components of a building to a pre- outlined performance level, whether or not or not associate earthquake has occurred. The unstable performance of a retrofitted building is aimed above that of the first building.

Surveys of existing residential buildings reveal that several buildings aren't adequately designed to resist earthquakes. Within the recent revision of the Indian earthquake code [IS 1893:2002], several regions of the country were placed in higher unstable zones. As a result several buildings designed before the revision of code might fail to perform adequately as per new code. It's thus counseled that the prevailing buildings be retrofitted to enhance their performance within the event of associate earthquake and to avoid massive scale injury to life and property.

The methodology adopted for these ought to be straightforward in execution, provide higher performance even once handled by less knowledgeable staff, should involve materials that area unit promptly obtainable, and however sturdy, sturdy and economical. Ferrocement is one such material that might afford to supply answer to such a scenario. Ferrocement could be a form of skinny wall concrete unremarkably made of cement mortar bolstered with closely spaced layers of continuous and comparatively little size wire mesh. In its role as a skinny concrete product and as laminated cement based mostly composite, ferrocement has found itself in various applications each in new structures and repair, rehabilitation & retrofitting of existing structures. Compared with the traditional concrete, ferrocement is bolstered in 2 directions; thus, it's homogenous-isotopic properties in 2 directions. Taking advantage of its typically high reinforcement quantitative relation, ferrocement usually includes a high lastingness and a high modulus of rupture. Additionally, as a result of the precise surface of reinforcement of ferrocement is one to two orders of magnitude above that of concrete, larger bond forces develop with the matrix leading to average crack spacing and dimension over one order of magnitude smaller than in typical concrete [Shah and. Naaman 1971.]. As a laminated composite, ferrocement usually suffers from severe spalling of matrix cowl and delamination of maximum tensile layer at high reinforcement quantitative relation, leading to premature failure. Therefore, serviceableness thought instead of strength limit governs the look. [Jamal & Ziyyad 2006] Adding discontinuous short fiber to building material matrix, that might bring vital improvement in plasticity and shear capability furthermore as moderate increase in lastingness, turns to be a logical answer to resolve or alleviate these issues. Ferrocement primarily differs from typical bolstered or pre-stressed concrete by the way within which the reinforcing components area unit spread and organized.

1.2. FERROCEMENT
Ferrocement is additionally written as ferrociment, ferrocemento, ferrocimento, and ferrozement.. Virtually that means abundant steel instead of abundant concrete. Ferrocement is typically said as thin-shell concrete.

In some cases, it's additional fascinating to possess only 1 sturdy direction. This sort of ferrocement, that has associate orthotropic behavior, is achieved by victimisation swollen

steel meshes. Slitting steel sheets and increasing them during a direction perpendicular to the slits type swollen steel sheets. Swollen steel sheets have a diamond-shaped mesh pattern. Rolling might flatten these sheets and enhances their performance as reinforcement in concrete or mortar. [Khaloo & Morshed 2000]. This sort of ferrocement is stronger and comparatively stiffer within the long diagonal direction of diamonds and has lower strength and stiffness within the perpendicular direction [Naaman 2000]. Ferrocement could be a material consisting of wealthy cement mortar matrix uniformly bolstered with one or additional layers of terribly skinny wire mesh with or while not supporting skeletal steel. Its properties vis-à-vis RCC area unit given here in **Table 1.1**

Ferrocement once employed in retrofitting needs primarily observing the purpose of application, then the meshing or reinforcement is applied at the specified purpose. This may be finished the employment of studs, fasteners and covering it with cement plaster. The event of ferrocement evolved from the basic conception behind concrete i.e. concrete will stand up to massive strains within the neighborhood of the reinforcement & magnitude of the strains depends on the distribution & subdivision of the reinforcement throughout the mass of concrete. Ferrocement behaves as a composite as a result of the properties of its brittle mortar matrix area unit improved owing to the presence of ductile wire mesh reinforcement. Its nearer spacing of wire meshes (distribution) within the wealthy cement sand mortar & the smaller spacing of wires within the mesh (subdivision) impart plasticity & higher crack arrest mechanism to the fabric.

Over the last twenty years, several researchers initiated studies to see the mechanical properties of ferrocement furthermore as its potential use in construction applications.

It has been showed that the traditional ways used for concrete analysis area unit valid to predict load–deflection relationship of ferrocement. Studies on the tensile properties of ferrocement indicated that the final work load of the material was adequate the load carrying capability of the reinforcement within the loading direction which the pure mathematics of the mesh influenced the behavior of ferrocement. [Naaman & sovereign 1971]. The properties of wire mesh & skeletal steel ordinarily employed in ferrocement area unit given in **Table 1.2**

1.2.1. Historical Background
The credit of victimisation ferrocement within the gift day goes to Joseph Joseph Louis Barrow Lambot UN agency in 1848 made many athletics boats, plant pots, seats & alternative things from a cloth he known as ferciment. Lambot's construction consisted of a mesh or grid reinforcement product of 2 layers of little diameter on bars at right angle & plastered with cement mortar with a skinny cowl to reinforcement Lambot's rowboats were 3.66 m long, 1.22 m wide & twenty five metric linear unit to thirty eight metric linear unit thick. These were bolstered with grid & wire netting. One amongst the boat build by him, still in remarkably fitness, is on show within the depository at Brignoles, France.

There was little application of true ferrocement construction between 1888 & 1942 once Pier Luigi Pier Luigi Nervi began

a series of experiments on ferrocement. He discovered that reinforcing concrete with layers of wire mesh made a cloth possessing the mechanical characteristics of associate more or less homogenised material capable of resisting high impact. Once the Second World war, Pier Luigi Nervi incontestable the utility of ferrocement as a ship artifact.

In 1945, Pier Luigi Nervi designed the a hundred sixty five ton Motor Yatch "Prune" on a supporting frame of 6.35 metric linear unit Defense Intelligence Agency rods spaced 106 metric linear unit apart with four layers of wire mesh on all sides of rods with total thickness of thirty five metric linear unit. It weighed five-hitter but a comparable picket hull & price four-hundredth less at that point.

In 1947, Pier Luigi Nervi designed initial terrestrial ferrocement structure, a entre pot of concerning 10.7 m x 21.3 m .size. The strength of the structure was owing to the corrugations of the wall & the roof that were forty 44.45 metric linear unit thick.

In 1948 Pier Luigi Nervi used ferrocement in initial public structure, the Tutrin Exhibition building. The central hall of the building that spans 91.4 m, was designed of ready-made components Connected by concrete arches at the highest & bottom of the undulations.

In 1958, the primary ferrocement structure - a rounded roof over center was inbuilt Peterburg in Union of Soviet Socialist Republics.

In 1970, a image ready-made ferrocement home was made in U.S.A. The house was found abundant lighter in weight & higher in resistance to dynamic load than the conventionally designed brick or block house. In 1971 a ferrocement trawler named "Rosy in I" was inbuilt urban center. It had associate overall length of 26 m & is claimed to be the world's longest ferrocement watercraft.

In 1972, the U.S.A. National Academy of sciences through its board on sciences & technology for international Development established associate adhoc panel on the employment of ferrocement in developing countries.

In 1974, the yankee Concrete Institute shaped committee 549 on ferrocement. In 1975, 2 ferrocement aqueducts were designed & designed for rural irrigation in China.

In 1976, the International Ferrocement data Centre (IFIC) was supported at Asian institute of Technology, Bangkok, Thailand. The centre is supported by the us Agency for International development, the govt of latest island & the International Development analysis Centre of North American country.

In 1978 associate elevated railroad station of 43.5 m x 1.6 m in size with continuous ferrocement roofing was erected in Peterburg.

In 1979 RILEM (International Union of Testing & analysis Laboratries of materials & structures) established a Committee (48-FC) to guage testing ways for ferrocement.

In 1984, ferrocement was employed in the development of a shaking table of enormous scale earthquake simulation facility at the state university of latest royal house at Buffalo.

Recently, it's been rumored that the Chinese are building ferrocement boats even before war second. It's calculable that they need designed 2000 boats. Most of those boats area unit twelve meter to fifteen meter long & area unit in the main employed in carrying product.

1.2.2. Constituent Materials
The constituent materials of ferrocement area unit mentioned within the succeeding sub sections.

A. Reinforcing Mesh
One of the essential parts of ferrocement is wire mesh. Differing types of wire meshes area unit shown in **Figure 1.1** and these area unit obtainable virtually every place, they typically include skinny wires, either woven or welded into the mesh however main demand is that it should be simply handled and if necessary, versatile enough to be bent around sharp corners. The perform of wire mesh and reinforcing rod is to produce the shape and to support the mortar in its inexperienced state. Within the hardened state, its perform is to soak up the tensile stresses on the structure that the mortar on its own wouldn't be ready to stand up to. The specifications and properties of wire mesh & skeletal steel area unit mentioned in **Table 1.2.**

B. Cement
The cement used ought to notify IS specifications. There are a unit many sorts of cements that area unit obtainable commercially within the market of that normal hydraulic cement, Portland Pozzulona cement area unit the 2 most ordinarily used.

C. Aggregates
The most common combination employed in ferrocement is sand .Sand ought to accommodates IS commonplace fine combination. Combination is that the term given to the inert material & it occupies sixty to eighty take advantage of the amount of mortar. Aggregates to be used for the assembly of prime quality mortar for ferrocement structure should be sturdy enough, water-resistant & capable of manufacturing a sufficiently possible combine with minimum water / cement quantitative relation to realize correct penetration of wire mesh. The sand cement quantitative relation is unbroken from two to four.

D. Water
The quality of blending water for mortar features a visual impact on the ensuing hardened ferrocement. Impurities in water might interfere with setting of cement & can adversely impact the strength of cause staining of its surface & can also result in its corrosion of ferrocement.

Typically water that's piped from the general public provides is thought to be satisfactory. The water cement magnitude relation is mostly unbroken from 0.3 to 0.5.

E. Admixtures
Admixtures area unit wont to alter or improve one or additional properties of cement mortar or concrete. Most of the admixtures area unit wont to improve the workability, to lesson water demand & to prolong mortar setting. Admixtures may be classified into teams consistent with the impact they're expected to realize.

He unremarkably used admixtures
1. Accelerating admixtures
2. Retarding admixtures
3. Water reducing admixtures
4. Air entraining admixtures.

A new category of water reducing admixtures has emerged throughout last 20 years, referred to as "super plasticizer". There are a unit the high vary water reducers.

F. Coatings
To increase the sturdiness of ferrrocement, it's going to be protected by surface coatings, like as acrylic, latex, polyester & cement based mostly paints.

1.2.3. Applications of Ferrocement
Ferrocement has found wide unfold applications in housing notably in roofs, floors, slabs, & walls. Some researchers were additionally created on the employment of ferrocement in beams & columns. Ferrocement roofs investigated enclosed shell roofs, pleated plates & the channel formed roofs, box girders & secondary roofing.

[Kaushik et al 1987] investigated the behaviour of ferrocement cylindrical shell units as roofing components and located that they'll be used as roofing components for low value housing & satisfy Indian needs of loading, deflections & crack dimension with economy. Ferrocement may be effectively used for roofing for brief spans. Ferrocement technology package for roofing uses state of-the-art style principles to manufacture bolstered shells. Unremarkably referred to as channels they're created on specially designed vibratory tables and profiled moulds. The assembly system is unambiguously tailored to supply special finish details, consistent form and thickness; all crucial for prime performance. They need a really high density, area unit run proof to penetration of water and supply high structural strength. Ferrocement roofing technology offers a viable various to traditional flat roofing systems like bolstered cement concrete, bolstered brick cement, sand stone, etc. in each rural and concrete areas of the country.

Ferrocement roofing channels area unit factory-ade mistreatment designed mixture of cement, sand and water to

convey high strength mortar that's bolstered with a layer of galvanised iron network mesh of twenty-two gauge and tor steel bars of 8-12 millimeter diameter provided within the bottom nibs of the channel. Ferrocement roofing channels may be safely transported for the appliance once a solidifying amount of fourteen days.

A. Benefits of Ferrocement channels
➢ Fast construction – prefab channels modify to construct a roof in barely three days.
➢ No shuttering needed, in contrast to in-slab block casting.
➢ 30% value saving over RCC roofing.
➢ Less loading on the walls.
➢ High strength to weight magnitude relation.
➢ Appealing aesthetics - elegant profile and uniform size.

1.3. OBJECTIVES OF PRESENT WORK
Even though in depth work is finished on the employment of ferrocement laminates in retrofitting however specially its behaviour in flexure with regard to totally different tensile reinforcements have to be compelled to be studied. Keeping this in mind, this study was undertaken to check the behaviour of RCC beams having totally different tensile reinforcements and strong with ferrocement jacketing.

1.4. DEFINE OF THE THESIS
The thesis has been organized within the following 5 chapters:

Chapter 1 : This chapter presents the final introduction, historical background and properties of ferrocement.

Chapter 2 : This chapter deals with the review of literature highlight and also the would like for this study.

Chapter 3 : Herein, the small print of experiment established area unit given and also the properties of constituent materials are mentioned.

Chapter 4 : This chapter deals with the results and their discussion in light-weight of the objectives.

Chapter 5 : It details the conclusions of the work administrated.

TABLE 1.1: PROPERTIES OF FERROCEMENT & RCC

S. No.	Ferrocement	Reinforced cement concrete
1	It is a steel mortar composite material	It is a mix of coarse aggregate, fine aggregate, cement & steel
2	Its reinforcement consists of closely spaced, multiple layer of steel mesh Completely impregnated with cement Mortar	Reinforcement is at tensile & compressive faces with shear stirrups
3	It can be formed into sections about 20-40 mm thick	Minimum section thickness varies from 100 mm for thin shells to 1200 mm in large beams
4	Only a fraction of an inch or 25 mm of cover over the outermost mesh layer	Minimum cover to reinforcement is one inch or 25 mm
5	Ferrocement reinforcing can be assembled over a light or no framework into the final desired shape and mortared directly in place, even upside down, with a thick mortar paste	Heavy framework required to support massive weight of concrete
6	Thin panels of ferrocement can be designed to levels of strain or deformation, with complete structural integrity and water tightness	Very thick panels of concrete required for water tight section due to relatively high permeability of concrete
7	Ease of fabrication makes it possible to form compound shapes	Compound shapes require difficult & cumbersome framework

8	The uniform distribution and high surface area to volume ratio of its Reinforcement	Percentage of reinforcement varies from 1-4%
9	A high degree of toughness, ductility, durability, strength & crack resistance	Relatively low degree of toughness, ductility, durability, trength & crack resistance
10	Self weight of ferrocement elements per unit area is quite small	About 5-10 times heavier

TABLE 1.2 PROPERTIES OF WIRE-MESH & SKELETAL STEEL

A) Wire mesh		
1	Wire diameter	0.5 mm to 3 mm
2	Size of mesh openings	6 mm to 25 mm
3	Volume fraction of reinforcement	Upto 8% in both directions corresponding to up to 630kg/m as steel per cubic meter of mortar.
4	Specific surface of reinforcement	Upto 4cm2/cm3 in both directions.
B) Intermediate skeletal reinforcement (if used) consists of wire, wire fabrics, rods & strands		
1	Diameter	3mm to 10mm
2	Grid size	5 cm
3	Portland cement	Any type depending on application
4	Sand to cement ratio	1 to 3 by weight
5	Water to cement ratio	0.4-0.5
6	Sand	Fine sand passing I.S sieve No 8 & having 5% by weight passing No 100 with a continuous grading curve in between
7	Thickness	6 to 50 mm
8	Steel cover	1.5 to 5.0 mm
9	Ultimate tensile strength	34.5 N/mm^2
10	Compressive strength	27.6 to 68.9 N/mm^2
11	Allowable tensile strength	10.3 N/mm^2
12	Modulus of rupture	55.1 N/mm^2
13	Cube strength of mortar	29.9 N/mm^2
14	Young modulus of wire mesh	2 × 105 N/mm^2 for welded wire mesh
		1.38 × 105 N/mm^2 for woven mesh.
15	Yield strength of wire mesh	410 N/mm^2 for welded wire mesh.
		385 N/mm^2 for woven mesh.

BAR   SQUARE   EXPANDED   HEXAGONAL
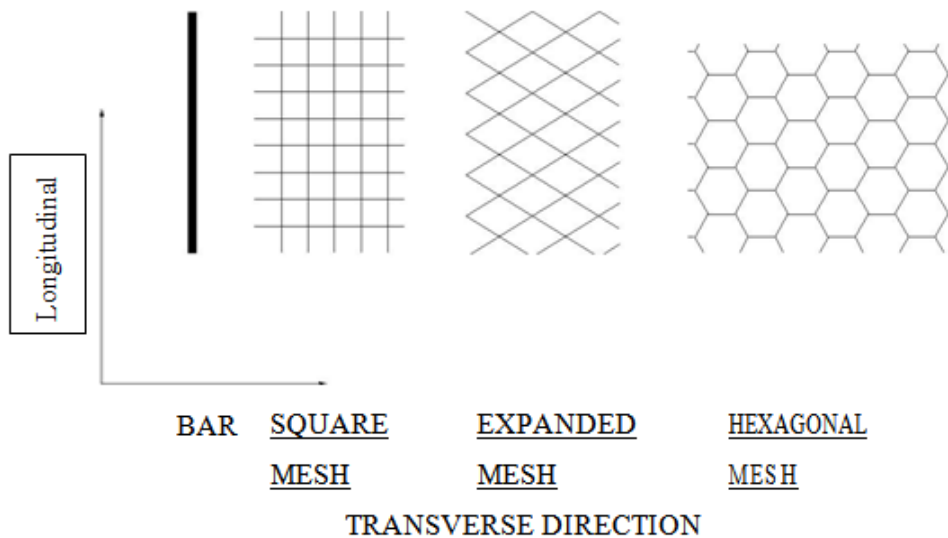
MESH   MESH   MESH

TRANSVERSE DIRECTION

FIGURE 1.1: DIFFERENT TYPES OF WIRE MESHES

1.5. SUMMARY

A RCC beautiful construction material, however once set it's terribly tough to extend its strength or alter its shear or flexure strength. T o endure 3 totally different **R**'s particularly repair, rehabilitation & retrofitting. Repair is partial improvement of the degraded strength of a building once associate earthquake. In effect, it's solely a cosmetic sweetening. Rehabilitation could be a useful improvement, whereby the aim is to realize the first strength of a building once associate earthquake. Retrofitting suggests that structural strengthening and sweetening of performance of deficient structural components of a building to a pre-outlined performance level, whether or not or not associate earthquake has occurred. Ferrocement is typically said as thin-shell concrete. Objective of this work is study to check the behaviour of RCC beams having totally different tensile reinforcements and strong with ferrocement jacketing.

2. REVIEW OF LITERATURE
2.1. PRELIMINARY REMARKS

Earthquakes area unit the most important nemesis of all the buildings. Whereas analysing and assessing the injury caused by the earthquakes it absolutely was inferred that a building mustn't suffer collapse total i.e. once a devastating earthquake it mustn't suffer such irreparable injury which might need tearing down and reconstruction and just in case it sustain such injury it may be repaired quickly and simply to bring it to its usual functioning [ISET, 1981].

In this state of affairs ferrocement involves our rescue owing to its ease in use and its flexibility. It's employed in retro-fitting thus on strengthen the broken structural members [Singh and Kaushik et al, 1998].

Ductility needs area unit the most feature of associate degree economical earthquake restraint style method, and Ferrocement being extremely ductile material have junction rectifier to its application in rehabilitation of homes broken by earthquake and also the effectiveness of its use has been reported by several researchers [Desia, 1999, Wasti and Erberik et al, 1998]. Ferroconcrete components area unit designed to fail during a ductile manner by action on the description need sowing to the brittle nature of concrete [IS 1893:2000].

Shear failure {are also|also area unit|are} classified as brittle and shear zones are thus bolstered by provision of stirrups for transformation to ductile failure, however, a limit is obligatory on the supply to avoid brittle shear-compression failure. Within the event of associate degree earthquake, however, the shear masses will exceed shear capacities, and injury in shear zones could result in harmful failure of such members.

Many experimental studies are conducted in recent years to strengthen flexure members by mistreatment numerous materials. [Andrew associate degreed Sharma 1998] in an experimental study compared the flexural performance of ferroconcrete beams repaired with typical technique and Ferrocement. They finished that beams repaired with Ferrocement showed superior performance each at service and supreme load. The flexural strength and malleability of beams repaired by Ferrocement was reported to be larger than the corresponding original beams and also the beams repaired by typical technique. [Al-Farabi et al 1993] whereas work the effectiveness of covering material guaranteed plates for capability sweetening, reported hyperbolic strength and reduced malleability. Premature failure by plate separation was additionally known as a possible downside at the plate curtailment place. Steel plates guaranteed by epoxy were wont to repair shear cracked beams utilizing numerous styles of plate bonding by [Basunbul et al 1993]. The experimental investigation clearly incontestible that the effectiveness of the repair primarily depends on however effectively the diagonal tension cracks within the shear-damaged beams were cornered. Flexural mode of failure was discovered surpassing shear capability for less than those specimens wherever full enclosing of the shear zone was carried.

2.2. PROPERTIES

Lots of analysis has gone into ascertaining the properties of ferrocement, its behavior in flexure & shear, benefits & disadvantages of various kinds of mesh etc. The pioneer work done by few researchers is mentioned here.

[Yuzugullu 1991] reported that mistreatment expanded mesh reinforcement will increase the load carrying capability of ferrocement components.

[Desayi and EI- Kholy 1992] studied the deflection and cracking of light- weight fiber bolstered ferrocement in bending proposing a additive equation for predicting the deflection within the portion of load-deflection curve.

[G. J. Al-Sulamani et al 1992] studied the behavior of Ferrocement beneath direct shear by conducting compression tests on Z-shaped specimens bolstered with wire mesh manufacturing pure shear on shear plane. Tests results indicate that Ferrocement beneath direct shear exhibits 2 stages of behavior (cracked and uncracked) whereas beneath flexure it exhibits a 3rd stage i.e. plastic stage additionally. The cracking and supreme shear stresses increase with increasing mortar strength and wire mesh reinforcement. Empirical equations are developed here mistreatment regression on analysis to predict the cracking and supreme shear stresses in terms of the mortar lastingness f_t and V_f. It indicates that the shear stiffness within the uncracked stage isn't considerably suffering from the quantity of wire mesh; it's principally suffering from the mortar strength. The shear stiffness within the cracked stage is suffering from each quantity of wire mesh and mortar strength. Malleability of ferrocement material beneath direct shear will increase with increasing wire mesh reinforcement and reduces with higher mortar strength. The behavior of ferrocement in flexure has received adequate attention by several researchers and it's been discovered to be kind of like the ferroconcrete members. The behavior of ferrocement material beneath direct shear was investigated by conducting axial load tests on direct shear specimen. The direct shear specimen employed in this study has Z-shape. It's dimension of three hundred millimeter; one hundred mm thickness height p_f 600mm. There's a triangular notch within the middle of every aspect of the specimen to force failure on the shear plane that has dimensions of 30mm×220mm. The wire mesh Layers area unit placed to cross the shear plane. Regular reinforcing bars area unit placed prime and bottom blocks of the specimens to avoid any premature failure of those finish blocks. Ferrocement once subjected to flexure, exhibits 3 stages of behavior; uncracked, cracked and yield or final stage. The third stage is a sign of the malleability that ferrocement possesses beneath flexure.

[Xiong and Singh 1992] investigated a qualitative mechanistic model to indicate the flexural fatigue of ferrocement, they showed that the oblong stress distribution assumption is best for estimating steel stress once coming up with weld mesh ferrocement against fatigue.

[Martinelli, Hanai, Schiel 1991] showed a collection of application that was that were developed by the Sao Ilich Ramirez Sanchez cluster. In those applications, skinny walled long span structural components were created with bolstered mortar, by mistreatment giant gap meshes of the order of fifty millimeter the steel content in bolstered mortar had been varied from two hundred kg/m^3 to values as low as that of RCC.

[Kobayashi et. Al 1992] reported the properties of impact injury obtained from lateral impact take a look at of ferrocement.

[Kahn et al 1975] to check the composite behavior of ferrocement, they tested forty composite beams made from 0.25 in. thick steel plates and 1 in. thick plates made from either ferroconcrete(RCC) or ferrocement. They finished the need of mistreatment sand-blasted plates to boost the composite action between layers.

[Ong et. al. 1992] provided extra information on the performance of ferroconcrete beams strengthen and repair with ferrocement laminate. The study centered on Shear association mistreatment Ramset nails at numerous spacing, epoxy glue adhesive and Hilti bolts. The consequences of volume fraction of the ferrocement laminate {and the|and therefore the|and additionally the} level of injury of the beam were also studied. The performances of the strong beams were compared to the management beams with regard to cracking, deflection and supreme strength. The results showed that everyone the strong beams exhibited higher final flexural capability and larger stiffness.

[Mohd. Warid Hussin 1991] bestowed in depth information on the cracking and strength behavior of skinny ferrocement sheets of 10mm thickness in flexure. Cement replacement by five hundredth to seventieth ash & inclusion of super softener will manufacture mixes of wonderful flow characteristics and adequate early strength that may additional ease the development Method and modify incorporation of short distinct fibers while not difficulties of fabrication. The inclusion of fibers will increase stiffness, decrease deflection and shows giant malleability at failure.

Little gap meshes exercise higher cracking management than giant gap meshes. However, incorporation of fibers within the combine modifies this pattern as giant lead to substantial reduction in crack spacing and crack widths compared with typical ferrocement. For structural applications of ferrocement, deflection could be a major style limitation. Fiber ferrocement beside layers of mesh will increase stiffness of the composite and reduces deflection in the least stages of loading. The measured crack spacing and crack dimension may be satisfactorily foreseen by the tactic planned during this work.

[Hani H. Nassif, Husam Najam 2004] had performed associate degree experimental study to look at a shear transfer between composite layers. They need finished that so as to supply full composite action between each the layers a minimum of 5 studs area unit required. They additionally finished that beams having shear studs with hooks exhibited higher pre-cracking stiffness moreover as cracking strength than those with L- formed studs and additionally beams specimens with sq. mesh exhibited higher cracking capability than the management beams moreover as beams with hexangular mesh.

[Mohammad Taghi Kazemi et al 2005] had performed a study to judge a retrofit technique for strengthening shear deficient short concrete columns. Ferrocement jacket bolstered with expanded steel mesh is employed for retrofitting during this study. That they had finished that expanded meshes were more practical ties in shear strengthening of concrete columns and additionally specimens strong with expanded meshes showed distributed fine shear cracking even at giant amounts of displacement malleability capability.

[Abdullah A, Katuski Tskiguchi 2003] had strong ferroconcrete columns with ferrocement jackets. That they had used circular and sq. ferrocement jackets strengthening sq. ferroconcrete columns with inadequate shear resistance. That they had finished that by providing external confinement over entire length RCC columns, the malleability is increased hugely. That they had additionally finished that ferrocement jacket may be wont to strengthen RC column with inadequate shear strength to boost its malleability and additionally variety of layers of wire mesh inside center position of the circular ferrocement jacket may be adopted in strengthening shear failure kind RCC column.

[Ohama and Shirai 1992] compared the sturdiness of polymer-ferrocement with typical ferrocement. The polymer-ferrocement, mistreatment styrene hydrocarbon rubber latex, is ready with numerous polymer-cement ratios, and tested for accelerated pervasion, chloride particle penetration and accelerated corrosion. It's finished that the pervasion and chloride particle penetration depth of polymer-ferrocement decreases markedly with a rise in polymer-cement magnitude relation not withstanding exposure and immersion periods, and area unit powerfully suffering from polymer-cement magnitude relation and water and water cement magnitude relation. The corrosion inhibiting property of polymer-ferrocement is remarkably improved with a rise in polymer-cement magnitude relation. As within the case of typical ferroconcrete, the mechanical properties of ferrocement rely to an outsized extent on the properties of the building material matrix and also the reinforcing steel. The apparent tensile properties of ferrocement represent a big departure from that of normal ferroconcrete therein the spread reinforcement changes the discovered cracking pattern. At a microscopic level the building material matrix is responding within the same approach, however at the macroscopical level the primary tension cracks typically seem at stress levels above for unreinforced mortar. The setting of Portland cement is that the basic reaction within the fabrication of ferrocement. This setting method is a dead ringer for that of hardening typical concrete, however special precautions should be taken if high levels of performance area unit expected. To supply associate degree rubberized skinny shell, for instance, the mortar should have a coffee water-to-cement magnitude relation. Correct moist-cure amount is additionally imperative. Each of those ideals area unit without delay appreciated by engineers and designers, however it's

going to take special attention to realize them within the field. **Curve 2.1** shows a typical stress-strain curve for ferrocement. In stage I the fabric behaves during a linearly elastic manner with each the reinforcement and also the matrix deforming elastically. Then, because the load will increase, the building material matrix cracks, and stage II begins wherever there's a modification of slope within the stress-strain curve. It's been shown that the strain at the primary crack may be hyperbolic by increasing the extent of the steel exposed to the cement, by decreasing the diameter of the wire, by increasing the quantity of reinforcement. These cracks area unit terribly fine and may be seen solely by special lighting effects or microscopic investigation. For many functions, the materials area unit unchanged by loading into this region, that constitutes ferrocement's sensible operating limit. Finally, stage III corresponds to the latter stages of deformation wherever the total load is being carried by the reinforcement. The strain limit of stage III may be foreseen by considering the utmost load-carrying capability of the steel reinforcement alone. To place the mechanical properties into perspective, it's necessary to stay in mind that there's a transition from the characteristic behavior of ferrocement to it of typical ferroconcrete which abundant of the employment of ferrocement in developing countries most likely can fall on or close to this transition. One in every of the necessary objectives within the future development of ferrocement are going to be a rational style system to hide the response of the structure to traditional conditions, moreover because the final behavior of the structure. Engineering analysis is required during this space. The influence of the water-cement magnitude relation on body incorporates a nice impact on the shrinkage, strength, and porosity of the ultimate product. However, the sensible higher limit of water-cement magnitude relation for ferrocement depends on the appropriate price of porosity, since it's clear from **Curve 2.2** that ferrocement made up of mortar with a water-cement magnitude relation of over regarding 0.6 incorporates a terribly high porosity. The first demand for creating waterproof mortar is tight management of the water/cement magnitude relation, with the workability obtained by the gradation and amount of sand moreover as by the optional use of sure admixtures.

2.3. FERROCEMENT FOR BUILDINGS
Ferrocement, as already satiated, could be a boon for the development trade notably the retrofitting trade. It's additionally employed in the pre-fabricated trade owing to its light-weight weight. Typically ferrocement roofing units area unit created in factories or fictitious on website. It provides savings within the use of materials and labor for change of integrity the smaller units.

The result's a structure that's additional stable, sturdy and needs very little maintenance. Some researchers were additionally created on the employment of ferrocement in beams and columns. Analytical and experimental investigation of hollow ferrocement units were studied by [Mathews et, al 1998] the system consists of prime and bottom flanges connected by webs, there by going hollow areas in between. The hollow section is chosen principally the passage of warmth from outside. Supported the investigation the load deflection of the developed section is sort of kind of like that of a typical ferrocement element. There seems to be sensible potential for the employment of those components for roof/floor in residential buildings for span up to 3.5m [Kaushik, et.al. 1997] investigated the behavior of eight merely supported concrete steel and concrete ferrocement composite slabs of span 1.5m and 3.0 the results show that the ferrocement and furrowed iron composite slabs may be safely used for roofing and flooring functions. The ferrocement composites exhibit higher performance as compare to CGI composite in terms of load carrying capability, energy absorption capability, malleability and recovery in unloaded .

The behavior and performance of composite ferrocement brick bolstered block while not ferrocement panels particularly to be formed into straight forward geometric forms was administrated by [Mattone 1992]. The benefits afforded by this building technique area unit numerous: fabrication ensures product quality by optimizing mixture grain, the water cement magnitude relation binder and habit-forming quantities and should entail a discount in value, whereas the simplicity of the operation to be performed to get a structural part from the semi-finished product create the method ideally appropriate for assist activities, sanctionative even unskilled employees to participate within the construction of their homes.

2.4. TRAITS OF FERROCEMENT
The traits to be unbroken in mind once mistreatment ferrocement area unit mentioned below.

2.4.1. Easy Placement
Performance of ferrocement jacketing is very increased because it may be simply placed with minimal or no kind work. Cement suspension, the widely used bonding agent is extremely low-cost & quite effective. Even if the mortar used has terribly less water-cement magnitude relation still it may be worked onto the inverted beams.

2.4.2. Acquisition
The application of ferrocement jacketing doesn't need masterful labour. Even masons well versed with the art of cement coating will do that job satisfactorily. Solely minimal oversight can serve the duty in hand.

2.4.3. Sturdiness
Durability is that the main question regarding performance of ferrocement and bolstered mortar components. Bolstered corrosion notably looks as a primary downside to be solved to convey a safe margin of quality assurance to thin-walled constructions. Ferrocement or bolstered mortar members area generally engineered with three millimetre to eight millimeter reinforcement cowl thickness.

Despite comparatively low water/cement magnitude relation counseled for the mortar combine 0.35-0.50. This is often not itself enough to make sure reinforcement protection against corrosion, not withstanding it's in orderly aggressive environments. Direct approaches to ferrocement sturdiness issues aren't given during a sample variety.

2.4.4. Cost

Ferrocement uses steel wire meshes that area unit regarding a pair of to five times costlier by weight than normal steel bars. The assemblage of these meshes needed medium level or non-skilled labour, That is a plus in developing countries wherever the price of labor is comparatively low. However, this work typically takes abundant time and also the productivity goes down. In fabrication plants this lack of productivity will raise the price then ferrocement or bolstered mortar could become non competitive against alternative industrial merchandise. The tendencies area unit normally cut back |to scale back |to cut back} the mesh content or to substitute them for alternative appropriate meshes and fibers which will reduce the assembly value. There area unit samples of production rationalization, by mistreatment long beds and stretching the meshes, or by mistreatment prestressing. Application of short fibers in conjunction with continuous wires additionally has been verified to be economical in several things. The appliance of pre-stressing techniques to ferrocement (or typically to skinny walled bolstered mortar or "fine grain concrete") incorporates a nice potential within the light-weight weight fabrication and a few of the pre-cast concrete production techniques may be custom-made to ferrocement. This additionally ought to cut back the price, as a result of mesh content and wiring labor may be reduced.

Quality control is another necessary facet in fabrication, not solely as a result of a decent quality of the weather should be reached, however additionally as a result of internal control will cut back the price.

2.4.5. A Flexible Ferrocement

The structural analysis ought to take the subsequent aspects as references:

A. Ultimate limit strength should be verified for the general structure and its internal components. Continuous reinforcing components (meshes, wires and tendons) typically area unit the suitable ones to assure the structural safely.

B. The use of adequate structural form dimensions of the sections, strength and modulus of snap of the mortar or small concrete, reinforcement lastingness and bond strength, cracking configuration, etc, can permit the right stiffness.

C. Cracking management ought to be done by using pre-stressing, by choosing the sort and properties of the meshes, wires and tendons, and by mistreatment fiber as secondary reinforcement. Additionally malleability and impact strength are going to be determined by those parameters.

D. When high performance ferrocement is important, it'll result the requirement of high reinforcement content, high specific surface of the reinforcement, a high performance mortar, and a little cowl thickness. Moreover, special protection, ensures against corrosion are going to be necessary.

E. In the foremost engineering applications, competitive ferrocement has got to be applied as do able with lower content of meshes, however still employing a high, a minimum of medium performance, mortar or micro-concrete. A canopy thickness abundant larger than this ones that are applied in ferrocement ought to be necessary to stop corrosion of the reinforcement and to avoid an excessive amount of costly protection measures. In broadest that means, we are able to say that ferrocement (or bolstered mortar, or fine grain ferroconcrete, or bolstered small concrete) could be a special variety of ferroconcrete to be applied in thin-walled constructions and components. This material results from the association of a little sized mixture concrete with continuous reinforcing components which will embody distinct fiber as complimentary reinforcement

2.4.6. Continuous and Discontinuous Reinforcing components

Thin-walled building material merchandise are created either with totally different and fiber bolstered cement or cement mortar. What differentiates ferrocement merchandise from fiber bolstered cement product is that ones uses a distributed reinforcement created with continuous reinforcing components (meshes) and also the alternative uses distributed reinforcement created with discontinuous components (short fibers) Continuous reinforcing components area unit higher to soak up impact high and focused tensile masses, as a result of the bonding strength is developed on an outsized strength. Thus, preference ought to incline to continuous reinforcement for the final word strength limit, otherwise, short fibers cab absorb impact load stresses and secondary tensile stresses with a comparatively low fiber volume, they'll be simply placed in some circumstances. During this approach a hybrid composite ought to be attention-grabbing to cut back the quantity of meshes in ferrocement, to form easier the execution, to boost the corrosion resistances and to cut back the price of the merchandise.
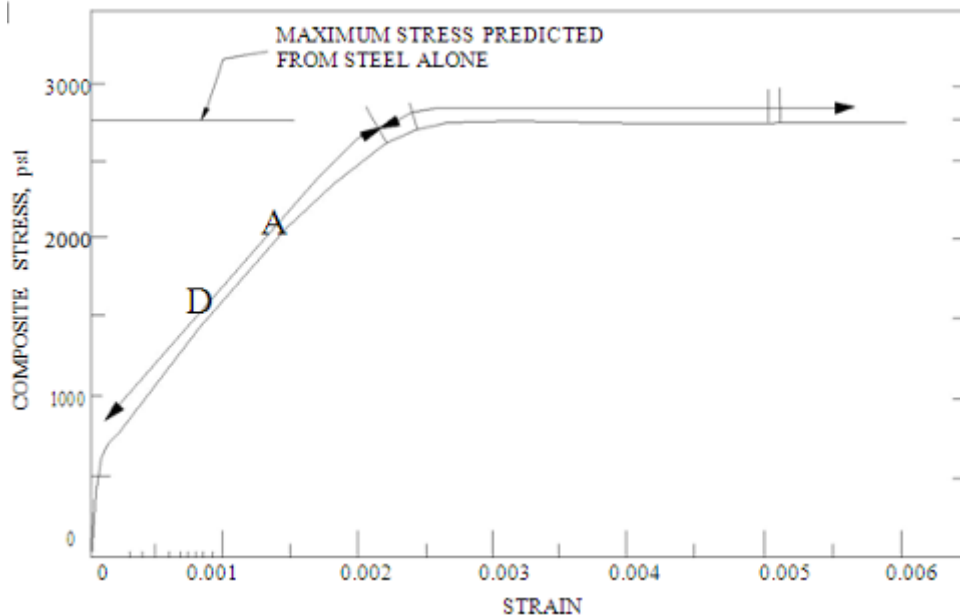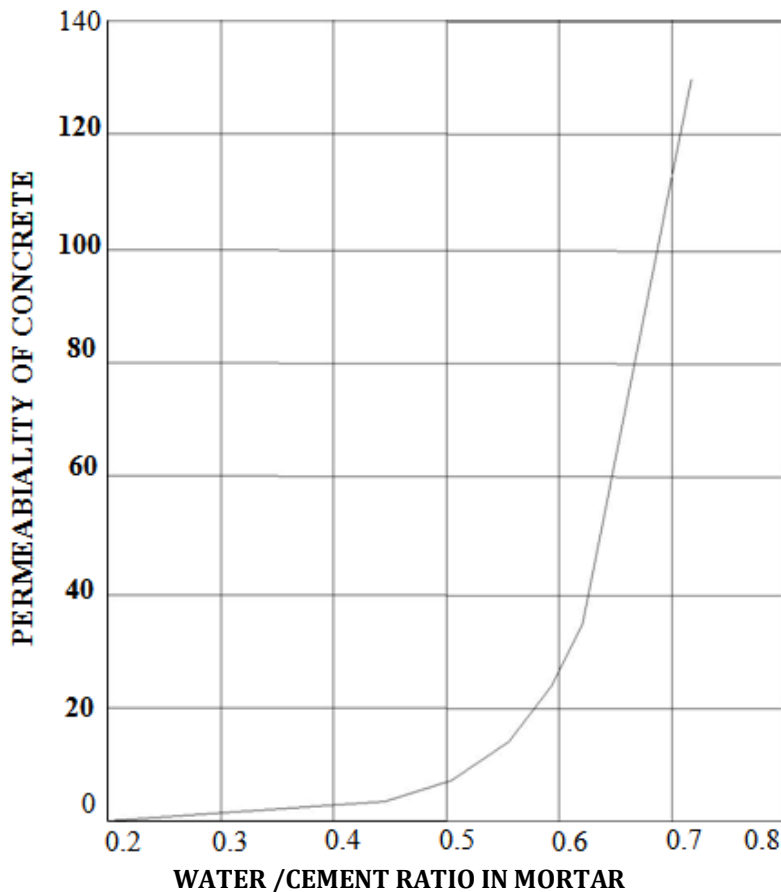
FIG2.1. GRAPH SHOWING STRESS AND STRAIN RELATION IN FERROCEMENT

CURVE 2.2: RELATION BETWEEN PERMEABILITY AND WATER TO CEMENT RATIO (WEIGHT BASIS) FOR MATURE PORTLAND CEMENT PASTE (CEMENT HYDERATED 93%). (R.B WILLIAMSON)

2.5. SUMMARY
Lots of analysis has gone into ascertaining the properties of ferrocement, its behavior in flexure & shear, benefits & disadvantages of various kinds of mesh etc. The result's a structure that's additional stable, sturdy and needs very little maintenance. Some researchers were additionally created on the employment of ferrocement in beams and columns. Analytical and experimental investigation of hollow ferrocement units were studied. The alternative uses distributed reinforcement created with discontinuous components (short fibers) Continuous reinforcing components area unit higher to soak up impact high and focused tensile masses, as a result of the bonding strength is developed on an outsized strength.

3. EXPERIMENTAL PROGRAMME
3.1. INTRODUCTION
Very little data is offered in literature concerning RCC beams retrofitted with ferrocement jacketing strengthened with totally different share of tensile reinforcements and tested in flexure to failure. Thus, the most objective of this thesis is to review the

behaviour of beneath ferroconcrete beams retrofitted with ferrocement jacketing, strengthened with totally different share of tensile reinforcements. To hold out the investigation twelve example beams, were cast, out of those six beams area unit taken as management beams and tested to failure to search out the load carrying capability of the beams. Alternative six area unit then stressed to fifty percent of the last word load of the management beam then retrofitted with ferrocement jacketing. The strength behavior, their failure masses, final deflection etc. area unit discovered and analyzed within the ulterior chapter.

3.2. TAKE A LOOK AT PROGRAMME

The aim of the experiment was to first of all verify the properties of constituent materials particularly cement, sand, coarse aggregates and steel bars as per relevant Indian normal specifications. Primarily, but it's envisaged the result of retrofitting with ferrocement jacketing at totally different share of tensile reinforcements, flexural behaviour of the beams with totally different share of tensile reinforcements. The rise in flexure strength if any, the decrease in deflection of management & retrofitted beam at same load and therefore the value edges vis-à-vis the strength edges area unit studied.

Twelve example beams (127× 227 x 4100mm) were forged exploitation M 20 grade concrete. the combination proportion of fabric comes intent on be 1:1.19:1.57:1.57 (cement: sand: ten millimeter coarse aggregate: twenty millimeter coarse aggregate) by weight. Four of the beams having 2 bars of eight millimeter Defense Intelligence Agency as tensile reinforcement, alternative four having 2 bars of ten millimeter Defense Intelligence Agency as tensile reinforcement & last four having 2 bars of twelve millimeter Defense Intelligence Agency as tensile reinforcement, with the compressive reinforcement fastened as 2 bars of eight millimeter Defense Intelligence Agency. All told beams vi millimeter Defense Intelligence Agency bars of soft-cast steel @ 150 millimeter c/c area unit provided as shear stirrups in order that the beam doesn't fail in shear. The stress and compression reinforcement was of metal five hundred grade, the clear cowl to prime & bottom bars was unbroken at twenty five millimeter.

Out of the twelve beams, 2 beams having 2 bars of eight millimeter as tensile reinforcement and 2 beams having 2 bars of ten millimeter as tensile reinforcement & last 2 having 2 bars of twelve millimeter as tensile reinforcement totaling to 6 beams area unit termed as management beams. These beams area unit loaded to failure to understand the last work load. Currently the remaining six beams area unit stressed to fifty maximize the last work load then retrofitted with ferrocement jacketing exploitation cement suspension as bonding agent. The take a look at came upon, jack & information acquisition system for taking readings area unit shown in **3.1, 3.2 & 3.3**. For the convenience of presentation the beams area unit labeled as shown in **Table 3.1**

3.3. MATERIALS

Cement, fine aggregates, coarse aggregates, reinforcing bars area unit utilized in casting of beams and GI wire mesh, cement mortar is employed for retrofitting of those beams. The specifications and properties of those materials area unit as under:

3.3.1. Cement

Potland Pozzolona Cement from one ton was used for the study. The physical properties of cement as obtained from numerous tests area unit listed in **Table 3.2.** All the tests area unit dole out in accordance with procedure ordered down in IS 1489 (Part 1):1991.

3.3.2. Fine Aggregates

Locally offered sand was used as fine mixture within the cement mortar and concrete combine. The physical properties and sieve analysis results of sand area unit shown in **Table 3.3 & Table 3.4.**

3.3.3. Coarse Aggregates

Crushed stone aggregates (locally available) of 20mm and 10mm within the magnitude relation of 1:1 were used throughout the experimental study. The physical properties and sieve analysis of coarse mixture area unit given in **Table 3.5, Table 3.6 and Table 3.7**

3.3.4. Water

Fresh and clean water is employed for casting the specimens within the gift study. The water is comparatively free from organic matter, silt, oil, sugar, chloride and acidic material as per Indian normal.

3.3.5. Reinforcing Steel

HYSD steel of grade Fe-500 of 8mm 10mm & 12 millimeter diameters were used as longitudinal steel. 6mm diameter MS bars area unit used as shear stirrups. The properties of those bars area unit shown in **Table 3.11.** The reinforcement steel is shown in **Figure 3.7**

3.3.6. Steel Mesh

GI steel wire mesh of two.4 millimeter diameter with rectangular grids was utilized in ferrocement jacket. The grid size of mesh was forty 5 × 12 millimeter. The salient properties of mesh wire used area unit given in **Table 3.8**. Steel mesh is shown in **Figure 3.8, 3.9 & 3.10**.

3.3.7. Concrete combine

M20 grade concrete combine styled |is meant |is intended} as per IS code design procedure exploitation the properties of materials as mentioned higher than i.e. **Table 3.1 to Table 3.7**. The water cement magnitude relation utilized in the planning is

0.48. The combination proportion of fabric comes intent on be 1:1.19:1.57:1.57 (cement: sand: ten millimeter coarse aggregate: twenty millimeter coarse aggregate) by weight and compressive strength of materials when seven days and twenty eight days is 21 and 27 N/mm^2 severally.

3.3.8. Mortar combine
The vary of combine proportion suggested for common Ferrocement applications area unit cement: sand magnitude relation by weight, 1:1.5 to 1:25, however not bigger than 1:3 and water cement magnitude relation by weight, 0.35 to 0.5. The upper the sand contents the upper the specified water contents to take care of same workability. Fineness modulus of the sand, water cement magnitude relation contents to take care of magnitude relation ought to be determined from path batches to make sure a combination that may infiltrate the mesh and develop a robust and dense matrix. The proportion of cement sand mortar used for the ferrocement sheets was 1:2 (cement: sand) by weight. The water-cement magnitude relation for mortar was 0.40 for given consistency of cement.

3.4. TESTING PROCEDURE
3.4.1. RCC Beam style
When exploitation 2 bars of 8mm Defense Intelligence Agency (A$_{SC}$=100.53 mm^2) as compression steel & 2 bars of twelve mm Defense Intelligence Agency (A$_{st}$=226.28 mm^2) bars as tension steel and for M20 grade of concrete, & taking the dimensions of the beam as 127 millimeter deep & 227 millimeter wide the section comes intent on be under-reinforced. Because the steel offered in market is 12 m long, that the length of beam was unbroken at four metre to economize the total study. The beam is intended for given steel i.e. two bars of 8mm at compression face and a pair of bars of 10mm at tension face. The stirrups used were of 6 millimeter diameter at a spacing of a hundred and fifty millimeter c/c. In step with style the dimension of the beam comes intent on 127 × 227 millimeter. Longitudinal section and crosswise of beam is shown **Figure 3.1, 3.2, 3.3**.

3.4.2. Casting of Beams
The casting of beams was wiped out single stage. The beams were forged in moulds of size 127 × 227 × 4000 m. initial of the whole beam mould is oiled. will be} done in order that the set RCC beam can be simply far away from the mould when twenty four hours. Currently the bottom/ tensile reinforcement steel, top/hanger bars & the stirrups area unit sure along with the assistance of binding wires. The steel is then placed within the oiled moulds. Cowl blocks of size 25mm area unit placed inside and stuck at sides to supply uniform cowl to the reinforcement. Coarse aggregates, fine aggregates, cement & water area unit combined during a mechanical mixer as per the proportion of style mix. The concrete is then poured within the mould and vibrations area unit given with the assistance of needle vibrator, in order that that the combination gets compacted. The vibration is finished till the mould is totally stuffed and there's no gap left. The beams area unit then far away from the mould when 24 hours. When demoulding the beams area unit cured for twenty eight days exploitation jute baggage.

3.4.3. Testing of beams
All the twelve beams were tested beneath merely supported finish conditions. Two points loading is adopted for testing. The rational for adopting 2 purpose loading is that as we would like to check the beams in flexure i.e a pure bending case. The testing of beams is finished with the assistance of hydraulic operated jack connected to load cell. The load is applied to the beam with the assistance of load cell and worth is recorded from the information acquisition system. That is hooked up with the load cell. 3 dial gauges area unit placed one at centre of the span of the beam and alternative 2 at middle points of support & load. The worth of deflection is obtained from these dial gauges. The experimental came upon is shown in **Fig. 3.11** and a scientific line diagram shown in **Fig 3.1, 3.2 & 3.3**. Out of twelve beams, 2 beams every of same tensile reinforcement and with 3 totally different tensile reinforcements totaling six beams area unit management beams, that area unit tested when twenty eight days of natural action to search out the last work load and deflection. Remainder of six beams is stressed upto fifty percent of the last work load obtained from the testing done on the management beams. **Fig 3.12** shows failure of beams.

3.4.4. Method of Retrofitting
The remaining six beams that were stressed to fifty maximize the last work load area unit currently prepared for retrofit. Firstly, the surface of beam is clean. Then cement & water area unit mixed within the magnitude relation of 1:20 to arrange cement suspension. This suspension is applied on bottom & 2 sides of the beam for ensuring a correct bond of cement mortar with RCC beam. The wire mesh that is already in U form is wrapped round the beam from 3 sides and its 2 open ends tied with every other with the assistance of steel wire. Currently cement suspension that consists of cement & water is applied as bonding agent to the surface of beam. When the applying of bonding agent retrofitting of beam is finished by applying 20mm thick cement mortar on the 3 faces as ferrocement laminates on all the remaining six beams with 3 totally different tensile reinforcements. The beams area unit cured with jute baggage for seven days before testing. They're then tested with identical procedure as adopted throughout the testing of management beams to calculate ultimate load and corresponding deflections.

3.5. ANALYSIS OF BEAMS
For the loading shown in **Curve 3.3.** the Moment of Resistance (MOR) of the beams having three totally different tensile reinforcements area unit calculated, equally the deflections at a load interval of one kN also are calculated. The subsequent assumptions area unit used once conniving the design strength of ferrocement members for flexure.

A. Strain in reinforcement & concrete ought to be assumed directly proportional to the space from the neutral axis.

B. Maximum strain at extreme concrete compression fibre ought to be assumed capable 0.003.

C. Stress in reinforcement below fixed yield strength ought to be taken as Effective modulus 'Er' times the steel strain wherever Er for enlarged steel mesh that we have a tendency to used includes a worth of 138000 MPa in longitudinal direction & 69000 Mpa in crosswise direction. For strains bigger than that love yield strength of mesh reinforcement, stress in reinforcement shall be thought-about freelance of strain and capable yield strength of mesh reinforcement.

D. Tensile strength of concrete is neglected.

E. Stress-Strain distribution of concrete could also be thought-about glad by the utilization of equivalent rectangular concrete stress distribution.
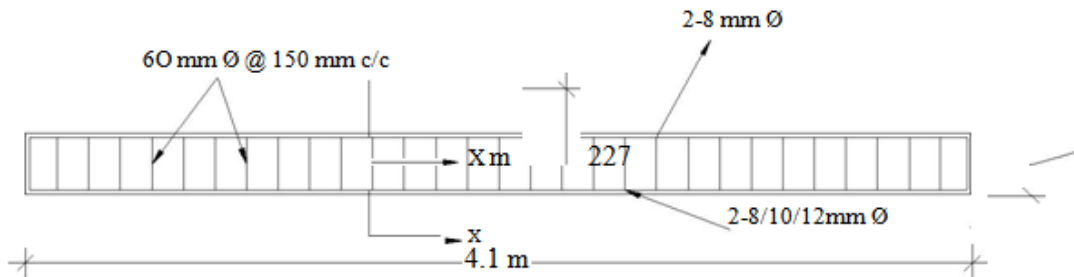
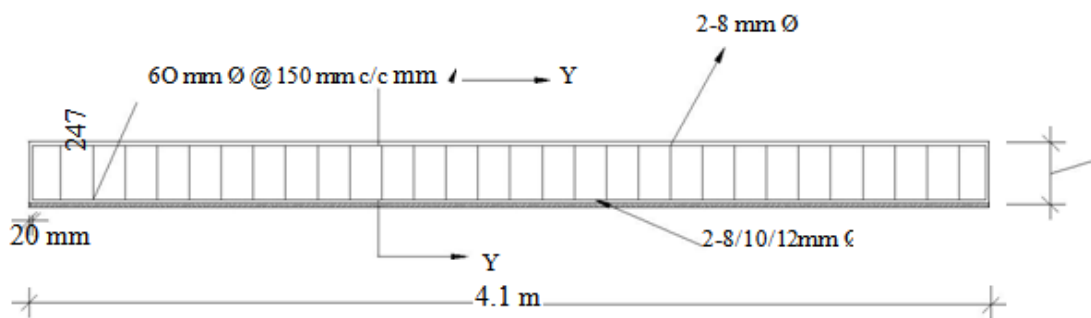**Figure 3.1: Longitudinal Cross- Section of Unretrofitted Beam**

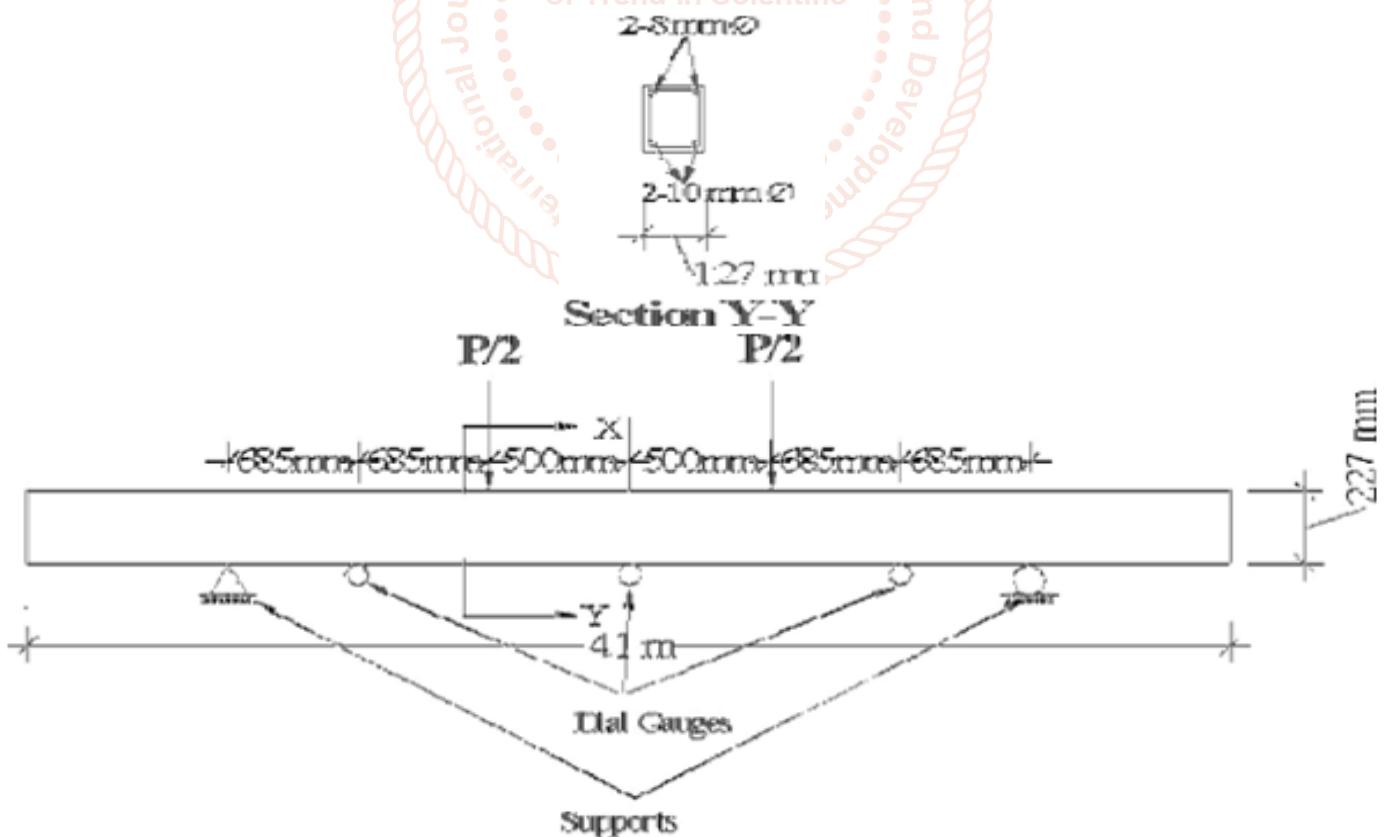**Figure 3.2: Longitudinal Cross- Section of Retrofitted Beam**

Section Y-Y

Figure 3.2: Testing System of Beam

TABLE 3.1: THE DETAILS OF TAGGING OF BEAMS

S. No.	Description of beams	Tag
1	Two beams having two bars of 8 mm as tensile reinforcement and tested to failure. A_{st}=100.53 mm²	C1
2	Two beams having two bars of 10 mm as tensile reinforcement and tested to failure. A_{st}=157.07 mm²	C2
3	Two beams having two bars of 12 mm as tensile reinforcement and tested to failure. A_{st}=226.19 mm²	C3
4	Two beams having two bars of 8 mm as tensile reinforcement and stressed to 50 % of ultimate load & retrofitted with ferrocement jacketing. A_{st}=100.53 mm²	R1
5	Two beams having two bars of 10 mm as tensile reinforcement and stressed to 50 % of ultimate load & retrofitted with ferrocementjacketing. A_{st}=157.07 mm²	R2
6	Two beams having two bars of 12 mm as tensile reinforcement and stressed to 50 % of ultimate load & retrofitted with ferrocement jacketing. A_{st}=226.19 mm²	R3

TABLE 3.2: PHYSICAL PROPERTIES OF CEMENT

Sr. No.	Characteristics	Value obtained Experimentally	Value specified by IS: 1489-1991
1.	Standard consistency	34	-
2.	Fineness of cement as retained on 90 micron sieve 'in %'	0.4	Min 0.1
3.	Setting time		
	1.Initial	90 mins.	Min 30 mins
	2.Final	420 mins	Max 600 mins
4.	Specific gravity	3.15	-
5.	Compressive Strength(N/mm²)		
	1. 7 days	28.00	Min 22
	2. 28 days	36.00	Min 33

TABLE 3.3: PHYSICAL PROPERTIES OF FINE AGGREGATES

S. No.	Characteristics	Value
1.	Specific gravity	2.50
2.	Bulk density loose (kg/lt)	1.50
3.	Fineness modulus	2.466
4.	Water Absorption	1.98 %
5.	Grading Zone (Based on percentage passing 0.60 mm)	Zone II

TABLE 3.4: SIEVE ANALYSIS OF FINE AGGREGATES

Total weight taken = 1000gm

Sr. No.	Sieve Size	Mass Retained (gm)	Percentage retained	Cumulative Percentage Retained	Percent Passing	Permissible limits in % age
1.	4.75 mm	0	0	0	100.00	90-100
2.	2.36 mm	0	0	0	100.00	75-100
3.	1.18 mm	204	20.4	20.4	79.60	55-90
4.	600 mm	321	32.1	52.5	47.50	35-59
5.	300 mm	295	29.5	82.0	18.00	8-30
6.	150 mm	97	9.7	91.7	08.30	0-10
				Σ=246.6		

$$\text{FM OF SAND} = \frac{246.6}{100} = 2.466$$

TABLE 3.5: SIEVE ANALYSIS OF COARSE AGGREGATES (20 mm)

Total weight taken = 3 kg.

S. No.	Sieve Size	Mass Retained (gm)	Percentage Retained	Cumulative Percentage Retained	Percentage Passing
1.	40 mm	0.00	0.00	0.00	0.00
2.	20 mm	136.00	4.54	4.54	95.46
3.	10 mm	2480.00	82.67	87.21	12.79
4.	4.75 mm	274.00	9.14	96.35	3.65
5	Pan	110	3.67	Σ=188.10	

$$\text{FM of 20 mm Coarse aggregate} = \frac{188.10 + 500}{100} = 6.881$$

TABLE 3.6: SIEVE ANALYSIS OF COURSE AGGREGATES (10 MM)

Total weight taken = 3 kg.

S. No.	Sieve Size	Mass Retained (gm)	Percentage Retained	Cumulative Percentage Retained	Percentage Passing
1.	40 mm	0.00	0	0.00	100.00
2.	20 mm	0.00	0	0.00	100.00
3.	10 mm	298.00	9.94	9.94	90.06
4.	4.75 mm	2506.00	83.54	93.48	6.52
5	Pan	196.00	6.54	Σ=103.42	

FM of 20 mm Coarse aggregate= $\dfrac{103.42+500}{100} = 6.034$

TABLE 3.7: PHYSICAL PROPERTIES OF COARSE AGGREGATES

S. No.	Characteristics	Value	
		20 mm	10 mm
1.	Type	Crushed	Crushed
2.	Specific gravity	2.66	2.70
3.	Total water absorption	3.645	1.643
4.	Fineness modulus	6.881	6.034

TABLE 3.8: PHYSICAL PROPERTIES OF STEEL BARS AND STEEL MESH WIRE

Sr. No.	Diameter of bars / mesh wire	Yield strength (N/mm^2)	Ultimate strength	Percentage Elongation (%)
1.	12 mm	550.00	610.0	16.2
2.	10 mm	445.55	509.2	15.5
3.	8 mm	559.5	634.13	20.3
4.	6 mm	442.42	612.7	32.9
5.	2.4 mm	400	511.36	2.52

FIGURE 3.4: TESTING JACK SHOWING FULL TRAVEL OF THE JACK

FIGURE 3.5: DATA ACQUISTION SYSTEM CONNECTING WITH LOAD CELL

FIGURE 3.6: TESTING JACK WITH SYSTEM FOR CONVERTING CONC. LOAD TO TWO POINT LOAD

FIGURE 3.7: TENSILE REINFORCEMENT STEEL, WITH HANGER BARS & STIRRUPS

FIGURE 3.8: STEEL MESH BEND IN SHAPE TO ENCAPSULATE THE BEAM

FIGURE 3.9: STEEL MESH SHOWING LONGITUDINAL DIMENSIONS

FIGURE 3.10: STEEL MESH SHOWING TRANSVERSE DIMENSION

FIGUR 3.11: EXPERIMENTAL SET UP SHOWING POSITION OF DIAL GAUGES

FIGURE 3.12: FAILURE OF BEAMS

3.6. SUMMARY

The aim of the experiment was to first of all verify the properties of constituent materials particularly cement, sand, coarse aggregates and steel bars as per relevant Indian normal specifications. Cement, fine aggregates, coarse aggregates, reinforcing bars area unit utilized in casting of beams and GI wire mesh, cement mortar is employed for retrofitting of those beams. In testing procedures RCC Beam style, Casting of Beams, Testing of beams, Method of Retrofitting, are done. For the loading the Moment of Resistance (MOR) of the beams having three totally different tensile reinforcements area unit calculated, equally the deflections at a load interval of one kN also are calculated.

4. RESULTS AND DISCUSSION
4.1. INTRODUCTION

In the gift work it's envisaged to review the impact of various proportion of tensile reinforcements on the strength of the retrofitted beams. Twelve beams are forged victimization M20 grade of concrete having 3 totally different percentages of tensile reinforcements labeled as C1, C2 & C3 for management beams & R1, R2 & R3 for retrofitted beams. The compressive reinforcement was unbroken mounted at a pair of bars of eight millimeter military intelligence TMT steel bars at high and 2-

three-legged stirrups of half dozen millimetre diameter steel bars at a centre-centre distance of a hundred and fifty millimetre was unbroken as shear reinforcement. Once testing the management beams to failure the flexural & serviceableness properties are discovered. The remaining beams are then stressed to fifty maximize the final word load & later retrofitted as per the procedure careful in Chapter 3. These beams are once more tested to failure & variations in strength & serviceableness properties are once more discovered. The following section presents an in depth discussion of those discovered values.

4.2. MANAGEMENT BEAMS

Out of a complete of twelve beams forged, six management beams are tested for final load & most deflection. Their failure load & deflections are shown in **Table 4.1**. From the table it's discovered that in beam C2 there's a rise of 83.33 have the benefit of 12 KN to 22 KN & in beam C3 there's a 133.33 to extend of from 12 KN to 28 KN final load as compared to beam C1, equally there's a rise within the values of safe masses & energy absorptions. The proportion increase in these values is shown in **Table 4.2**. These will increase in final masses, safe masses & energy absorption values are because of the rise in proportion of tensile reinforcements.

The load deflection curve for various percentages of tensile reinforcements is shown in **Fig 4.1, 4.2 & 4.3**.

From the curves it's deduced that because the load will increase the deflection at the start will increase linearly, then will increase at a lot of higher rate. This can be attributed to the yielding of reinforcement.

Fig 4.4 shows the load-deflection behaviour vis-à-vis one another for the management beams, wherever within the load-deflection curves C1, C2 & C3 are shown at a same time enabling North American country to touch upon their various curves higher.

The 3 curves conjointly emphasize the observation created earlier that there's a rise in final load carrying capability and deflection strength of beams as we tend to proceed from curves C1 towards C3. From these graphs the final work load of all the 3 differing kinds of reinforcement is thought that is shown in **Table 4.2**.

The nature of beams whether or not they are beneath bolstered or over bolstered is calculated and conferred in **Table 4.3**

4.3. STRESSING OF BEAMS

Now the remaining six beams viz. 2 every of R1, R2 & R3 are stressed to fifty percent of the final word load values given in **Table 4.2**. The deflections like a uniformly increasing load obtained are shown in **Table 4.4**.

These load-deflections curves follow a pattern the same as that for management beams as shown in **Table 4.1** and are described diagrammatically in **Fig 4.5**.

The curves having same reinforcement i.e. C1 & R1, C2 & R2, C3 & R3 path one another. This shows that once stressed to fifty maximize the final word load the beams retain their physical property as they follow identical path.

4.4. BEAMS ONCE RETROFITTING

The six beams stressed to fifty maximize final load are currently retrofitted victimization ferrocement jacketing. These are tested to failure & their load-deflection in conjunction with that of non-retrofitted counterparts is conferred in **Table 4.5** & shown diagrammatically in **Fig 4.6, 4.7, 4.8 & 4.9**

4.4.1. Behaviour of retrofitted beams

The retrofitted beams R1 & R2 follow the curves of their various management beams C1 & C2 specifically for initial loading, and then the curves of R1 & R2 run parallel & higher than the curves of C1 & C2. This shows a rise within the load carrying capability of the retrofitted beam. However, the curves of retrofitted and management beams, R3 & C3 virtually coincide until seventy five maximize the final work load, once that they follow identical pattern as R1 & R2. Load-deflection curves of all the beams C1, C2, C3 & R1, R2 & R3 are premeditated in **Fig 4.9**.

Also for beams having same proportion of reinforcements the retrofitted beams have a far smaller deflection as compared to manage beams, this can be because of accumulated stiffness of the retrofitted beams.

4.4.2. Impact of proportion of reinforcement on final load

The absolute values of final masses, final deflections & energy absorptions are shown in **Table 4.6**. conjointly shown are the sharp age increase of the values of retrofitted beams w.r.t. management beams i.e. increase in price of final deflection of beam R1 compared to the worth of C1 & therefore on. It's discovered that with the retrofitting of beams there's a rise in final load price of ready of beams. This will increase with increase in proportion of reinforcement for R1 to R2 however as we've got discovered in **Table 4.3**. For beam R3 in over bolstered therefore the increase in final load is a smaller amount than that of R3. This could be attributed to the beam R3 being over bolstered as compared to others.

4.4.3. Impact of proportion of reinforcement on energy absorption

The values of energy absorption conjointly follow the same pattern because the values of final deflection. The retrofitted beam R1 and R2 follow the curves of C1 and C2 specifically until tiny masses then the curves of R1 and R2 run parallel and higher

than the curves of C1 and C2. This shows a rise within the load carrying capability of the retrofitted beam. The curves of R3 and C3 virtually coincides until seventy fifth of final load once that this follow identical pattern as R1 and R2.

Comparing the proportion increase in energy absorption price of C1-R1,C2-R2 and C3 -R3, we tend to observe that the vary of this can be increase is between 5%-10%. Hence there's not a considerable increase in energy absorption capacities of the beams once retrofitting .This is because of the actual fact that we tend to had retrofit the beams once prestressing it to fifty maximize final load.

Load – deflection curves of all beams C1,C2,C3, and R1,R2,R3 are premeditated in **Fig 4.9.**

Also the beams having same proportion of reinforcements the retrofitted beams have a far smaller   deflection as compared to manage beams, this is because of accumulated stiffness of the retrofitted beams.

4.5. COST ANALYSIS

Finally analysis is finished in **Table 4.7, 4.8 & 4.9**. Here {the proportion |the share |the proportion} increase in price & percentage increase in strength once retrofitting of beams with ferrocement jacketing is calculated. The magnitude relation of the 2 is termed as strength/cost magnitude relation. From the tables it's discovered that the strength-cost magnitude relation of R2 beam is far over that of R1 & R3. The strength-cost ratio's of R1 & R3 are virtually equal indicating the impact of beneath reinforcement and over bolstered severally.

TABLE 4.1: LOAD & DEFLECTION VALUES OF DIFFERENT PERCENTAGE OF TENSILE REINFORCEMENTS

LOAD 'kN'	DEFLECTION 'mm'		
	C1	C2	C3
0	0	0	0
2	2.2	2.0	2.37
4	5.1	4.3	4.6
6	8.5	6.7	6.72
8	12.3	9.6	8.25
10	16.2	12.4	10.4
12	23.1	15.2	13.15
14	50.0	18.3	16.2
16		21.0	19.9
18		23.5	20.5
20		27.0	24
22		29.4	26.6
24		38.0	27.7
26			29
28			35
30			53

TABLE 4.2: CHANGE OF ULTIMATE LOAD, SAFE LOAD & ENERGY ABSORPTION VALUES WITH INCREASE IN TENSILE REINFORCEMENTS

S. No.	Beams	% age reinforcement '%"	Ultimate load 'kN'	% increase in Ultimate load '%'	Safe load 'kN'	% increase in safe load '%'	Energy Absorption 'kNmm'	% increase in Energy Absorption '%'
1	C1	0.35	12	-	9.5	-	367.28	-
2	C2	0.55	22	83.33	12.0	26.32	590.14	60.67
3	C3	0.78	28	133.3	13.1	37.90	663.23	80.57

TABLE 4.3: CALCULATE DEPTH OF NEUTRAL AXIS & CHECK IF THE BEAM IF UNDER OR OVER REINFORCED

Sr. No.	Description	C1	C2	C3	R1	R2	R3
1	Breath of beam 'b' mm	127.00	127.00	127.00	167.00	167.00	167.00
2	Effective depth of beam 'd' mm	198.00	197.00	196.00	218.00	217.00	216.00
3	Depth of beam 'D' mm	227.00	227.00	227.00	247.00	247.00	247.00
4	Area of tensile reinforcement 'A_{st1}' mm^2	100.50	157.10	226.20	100.50	157.10	226.20
5	Area of wire mesh 'A_{st2}'mm^2	0.00	0.00	0.00	73.64	73.64	73.64
6	Area of tensile reinforcement 'A_{sc}' mm^2	100.50	100.50	100.50	100.50	100.50	100.50
7	Characteristics Strength of concrete 'f_{ck}' N/mm^2	20.00	20.00	20.00	20.00	20.00	20.00
8	Strength of Steel 'f_y' N/mm^2	500.00	500.00	500.00	500.00	500.00	500.00
9	Depth of neutral axis 'n_a' mm	48.74	58.79	68.21	59.43	66.81	74.28
10	Solving by taking the areas	0.00	0.00	0.00	0.00	0.00	0.00
11	Depth of critical neutral axis 'n_c' mm	68.30	68.30	68.30	68.30	68.30	68.30
12	Section under reinforced if $n_a<n_c$ & over vreinfroced if $n_a>n_c$	under	under	under	under	under	over

In Table 4.1 & 4.2 deflection value is Found out for C1, C2 &C3.

In Table 4.3 depth of neutral axis is found out and check whether the beam is under reinforced or over reinforced.

TABLE 4.4: LOAD & DEFLECTION OF DIFFERENT TENSILE REINFORCEMENTS WHEN STRESSED TO 50 % OF ULTIMATE LOAD

LOAD 'kN'	Deflection 'mm'		
	R1	R2	R3
0			
1	1.11	1.16	0.82
2	2.18	2.50	1.72
3	3.60	3.92	2.84
4	5.03	4.85	3.82
5	7.05	6.22	4.72
6	8.70	7.05	6.10
7		8.50	6.70
8		9.40	7.70
9		10.75	8.48
10		12.05	9.50
11		13.45	10.72
12			11.59
13			12.70
14			14.20

In Table 4.4 Load & Deflection of different tensile reinforcements varies from 0 to 14 KN when stressed to 50% of ultimate Load. Deflection values of R1, R2 & R3 are found out in mm.

TABLE 4.5: LOAD VS DEFLECTION DATA FOR CONTROL BEAMS & RETROFITTED BEAMS

LOAD	DEFLECTION					
	C1	R1	C2	R2	C3	R3
0	0.00	0.00	0.00	0.00	0.00	0.00
2	2.18	2.60	2.00	2.10	2.37	1.20
4	5.12	5.80	4.25	4.60	4.60	3.60
6	8.50	8.05	6.72	7.10	6.72	5.50
8	12.30	11.35	9.60	9.05	8.25	7.40
10	16.20	14.05	12.40	12.00	10.40	10.00
12	23.10	17.30	15.20	13.75	13.15	12.80
14	50.00	21.70	18.30	16.00	16.20	16.00
16		55.00	21.00	17.85	19.90	18.45
18			23.50	19.90	20.50	20.02
20			27.00	22.20	24.00	23.05
22			29.40	24.00	26.60	25.92
24			38.00	26.30	27.70	27.65
26				30.40	29.00	29.40
28				57.00	35.00	33.60
30					53.00	39.00
32						42.00
34						57.00

In Table 4.5 collective data of load & deflection for controlled beam C1,C2 & C3 and retrofitted beams R1, R2 & R3. On the basis of these value curve 4.5 is ploted.

TABLE 4.6: VALUES OF ULTIMATE LOAD, DEFLECTIONS AND ENERGY ABSORPTION OF THE CONTROL & RETROFITTED BEAMS

Sr. No.	Beam type	Ultimate load 'kN'	% increase in ultimate load '%' w.r.t to control beam	Ultimate deflection 'mm'	% increase in ultimate deflection	Energy absorption 'kN-mm'	% increase in Energy absorption
1	C1	14.00	-	38.00		367.28	
2	C2	16.00		50.00		590.14	
3	C3	24.00		50.00		663.23	
4	R1	28.00	14.29	55.00	100.00	406.45	10.67
5	R2	30.00	16.67	53.00	87.50	626.79	6.21
6	R3	34.00	13.33	57.00	41.67	697.09	5.10

In Table 4.6 values of ultimate Load in KN, Deflections and Energy absorption of the controlled & Retrofitted beams in terms of percentage increase. The variation is shown through curve 4.6,4.7,4.8 &4.9.

TABLE 4.7: COST ANALYSIS OF BEAM WITH 8 mm STEEL AS TENSILE REINFORCEMENT

S. No.	Material	Unit	Qty '/beam'	Rate 'Rs/unit'	Amount 'Rs'
A	RCC Beam only				
1	Cement	kg	48.76	5.00	243.79
2	Steel '8 mm'	kg	3.20	45.00	143.91
3	Steel '8 mm'	kg	3.20	45.00	143.91
4	Steel '6 mm'	kg	3.08	40.00	123.20
5	Binding wire	kg	0.95	50.00	47.38
6	Coarse Aggregate	cum	0.106	700.00	74.47
7	Fine Aggregate	cum	0.053	600.00	31.91
8	Form work	sqm	2.38	500.00	1191.05
9	Labour	L.S.	1	500.00	500.00
	Total	Rs			2499.61
B	Retrofitting of Beam				
1	Cement	kg	47.64	5.00	238.21
2	Fine Aggregate	cum	0.071	600.00	42.88
3	Expanded wire mesh	sqm	2.86	150.00	428.78
4	Labour	L.S.	1	250.00	250.00
	Total	Rs		959.87	
Increase in cost '%'					38.40
Increase in strength '%'					15.00
Strength/Cost Ratio					0 .39

In Table 4.7 analysis of beam with 8 mm steel as tensile reinforcement in RCC Beam and cost retrofitted beams is compared. The increase in cost % is about 38.40 % and increase in strength % is 15%.Then ratio of strength by cost is found out and it is about 0.39.

TABLE 4.8: COST ANALYSIS OF BEAM WITH 10 mm STEEL AS TENSILE REINFORCEMENT

S. no.	Material	Unit	Qty '/beam'	Rate 'Rs/unit'	Amount 'Rs'
A	RCC Beam only				
1	Cement	kg	48.76	5.00	243.79
2	Steel '10 mm'	kg	5.08	45.00	228.78
3	Steel '8 mm'	kg	3.20	45.00	143.91
4	Steel '6 mm'	kg	3.08	40.00	123.20
5	Binding wire	kg	1.14	50.00	56.81
6	Coarse Aggregate	cum	0.106	700.00	74.47
7	Fine Aggregate	cum	0.053	600.00	31.91
8	Form work	sqm	2.38	500.00	1191.05
9	Labour	L.S.	1	500.00	500.00
	Total	Rs			2593.91
B	Retrofitting of Beam				
1	Cement	kg	47.64	5.00	238.21
2	Fine Aggregate	cum	0.071	600.00	42.88
3	Expanded wire mesh	sqm	2.86	150.00	428.78
4	Labour	L.S.	1	250.00	250.00
	Total	Rs			959.87
Increase in cost '%'					37.00
Increase in strength '%'					17.00
Strength/Cost Ratio					0.45

In Table 4.8 cost analysis of beam with 10 mm steel as tensile reinforcement in RCC Beam and retrofitted beams is compared. The increase in cost % is about 37 % and increase in strength % is 17 %.Then ratio of strength by cost is found out and it is about 0.45.

**TABLE 4.9: COST ANALYSIS OF BEAM WITH 12 mm STEEL AS TENSILE REINFORCEMENT**

S. no.	Material	Unit	Qty '/beam'	Rate 'Rs/unit'	Amount 'Rs'
A	**RCC Beam only**				
1	Cement	kg	48.76	5.00	243.79
2	Steel '12 mm'	kg	7.30	45.00	328.41
3	Steel '8 mm'	kg	3.20	45.00	143.91
4	Steel '6 mm'	kg	3.08	40.00	123.20
5	Binding wire	kg	1.36	50.00	67.88
6	Coarse Aggregate	cum	0.106	700.00	74.47
7	Fine Aggregate	cum	0.053	600.00	31.91
8	Form work	sqm	2.38	500.00	1191.05
9	Labour	L.S.	1	500.00	500.00
	Total	**Rs**			**2704.61**
B	**Retrofitting of Beam**				
1	Cement	kg	47.64	5.00	238.21
2	Fine Aggregate	cum	0.071	600.00	42.88
3	Expanded wire mesh	sqm	2.86	150.00	428.78
4	Labour	L.S.	1	250.00	250.00
	Total	**Rs**		959.87	
	Increase in cost '%'				35.49
	Increase in strength '%'				13.00
	Strength/Cost Ratio				0.37

In Table 4.9 cost analysis of beam with 12 mm steel as tensile reinforcement in RCC Beam and retrofitted beams is compared. The increase in cost % is about 35.49 % and increase in strength % is 13%.Then ratio of strength by cost is found out and it is about 0.37.
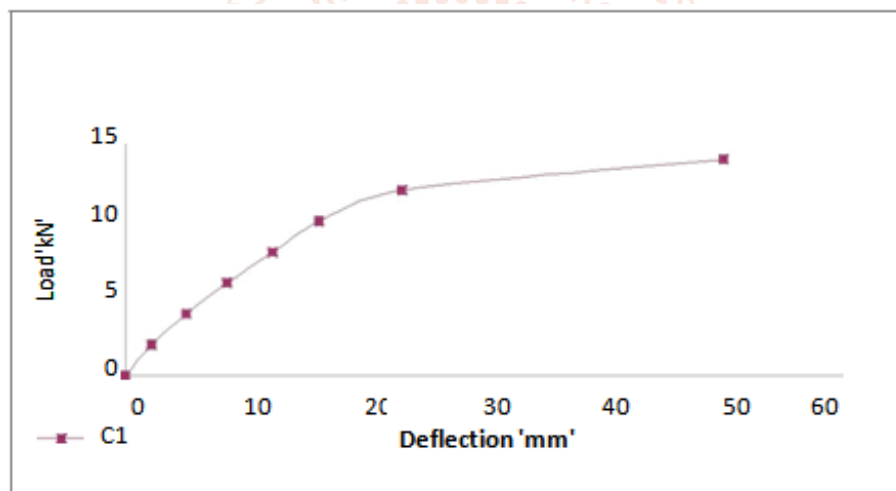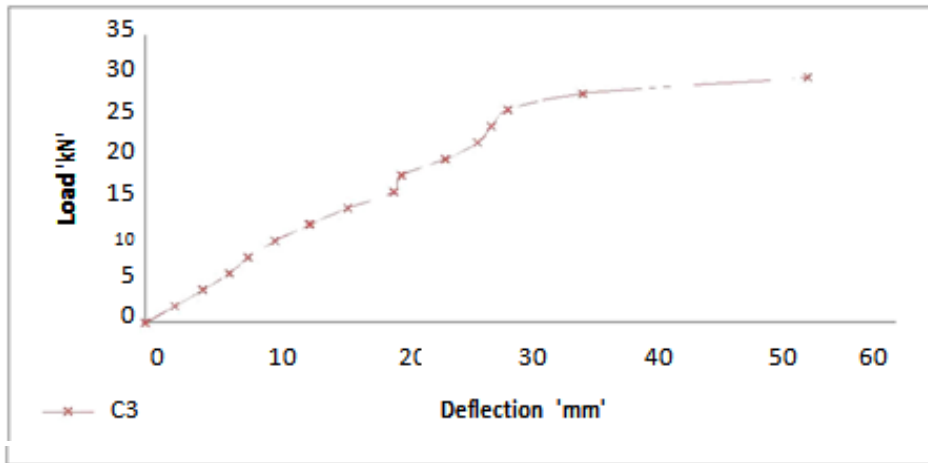

Curve 4.1: Load vs deflection curve for beam C1

In Curve 4.1 the variation between load and deflection is shown in which the deflection first increases and then constant upto certain limit then increases.
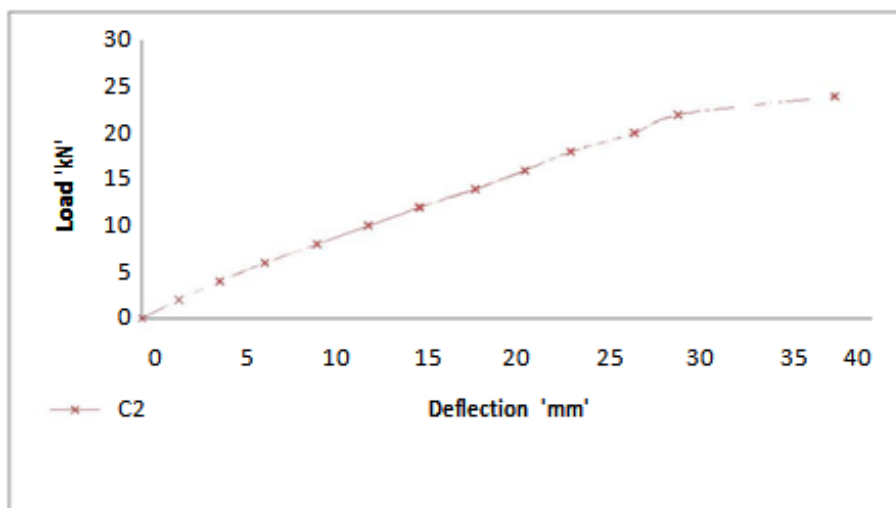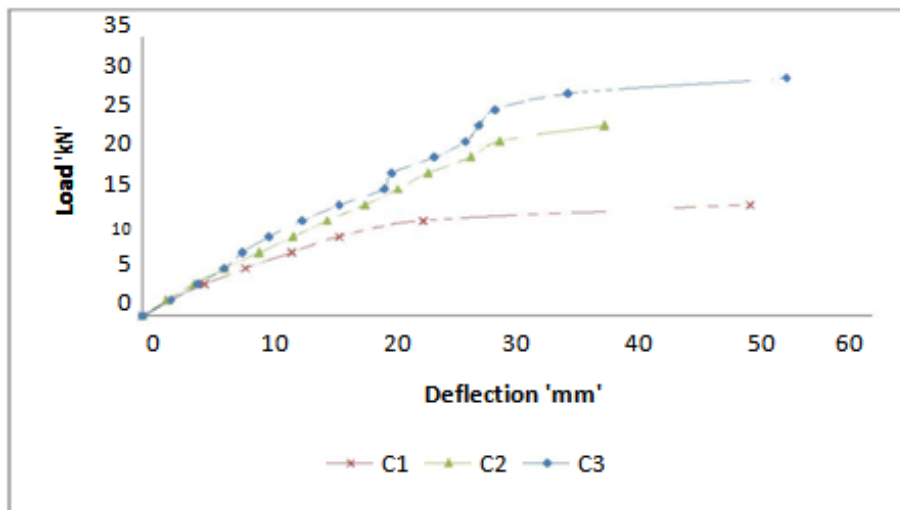

Curve 4.2: Load vs deflection curve for beam C2

In Curve 4.2 deflection increases then becomes constant for C2 Beam with change in load.

Curve 4.3: Load vs deflection curve for beam C3

In Curve 4.3 deflection increases then decreases after certain load it increases suddenly for C3 Beam with change in load.
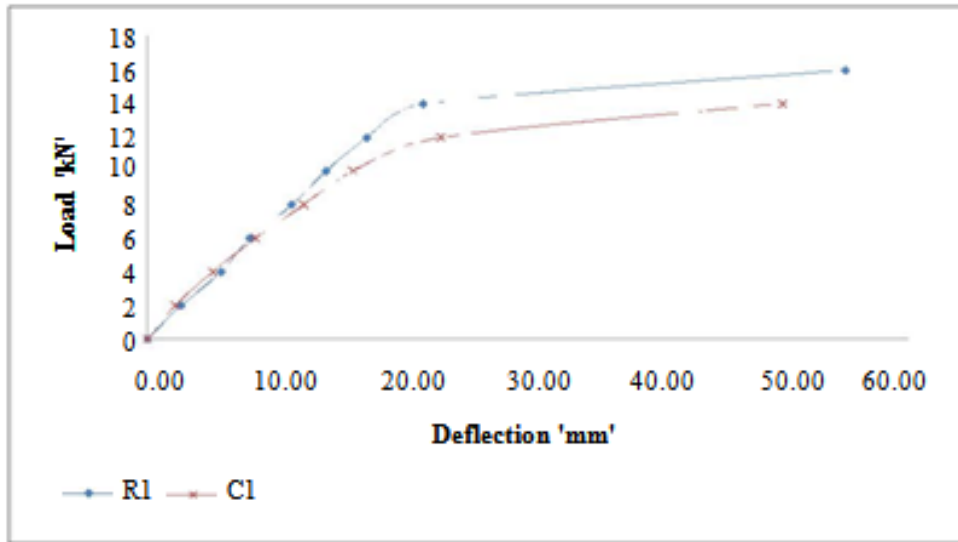

Curve 4.4: Load vs deflection curve for beams C1, C2 & C3

In curve 4.4 the combined effect of C1, C2 & C3 is shown. Red line represent C1 beam and green shows C2 beam & blue represent C3 respectively.
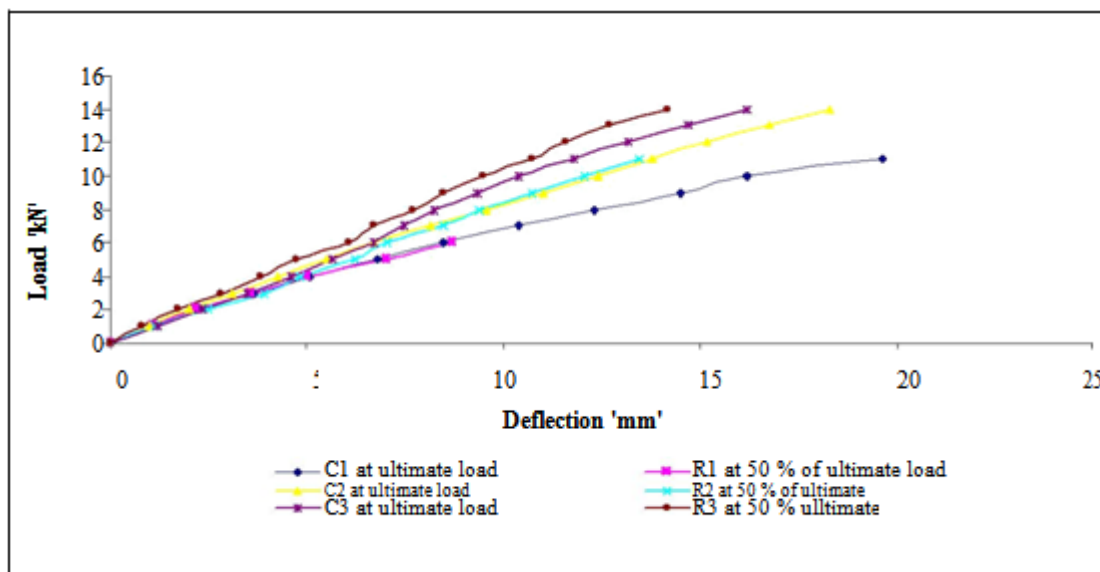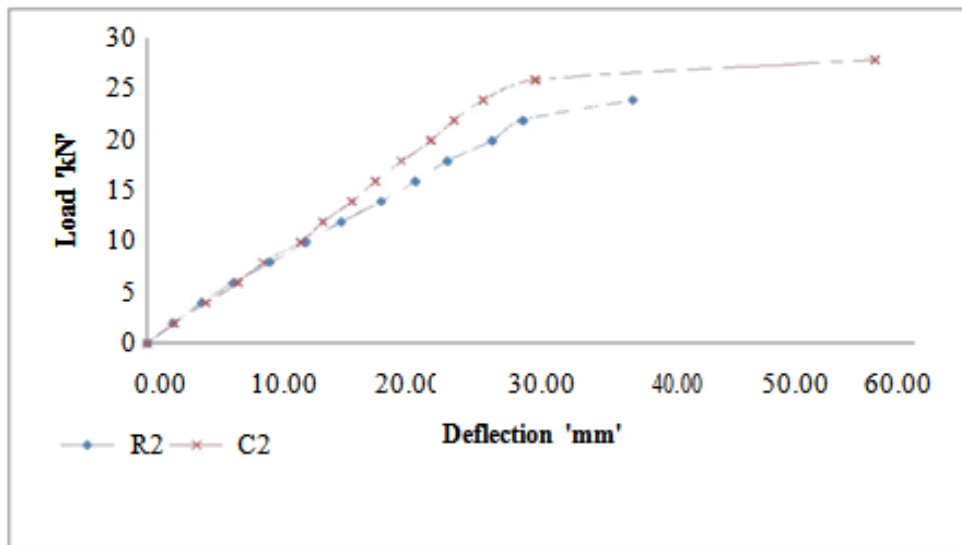

Curve 4.5: Load vs deflection curves for beams C1, C2 & C3 & R1, R2 & R3 with R1, R2 & R3 stressed to 50 % of ultimate load of C1, C2 & C3
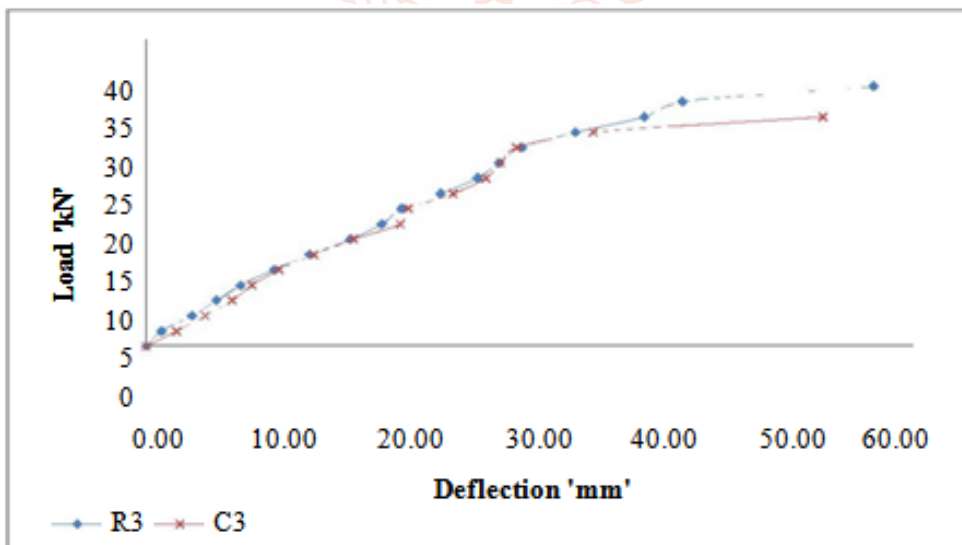
Curve 4.6: Load vs deflection curves for beams C1 & R1

In Curve 4.6 the variation of concrete beam C1 &R1 are shown in which deflection increases first then constant.
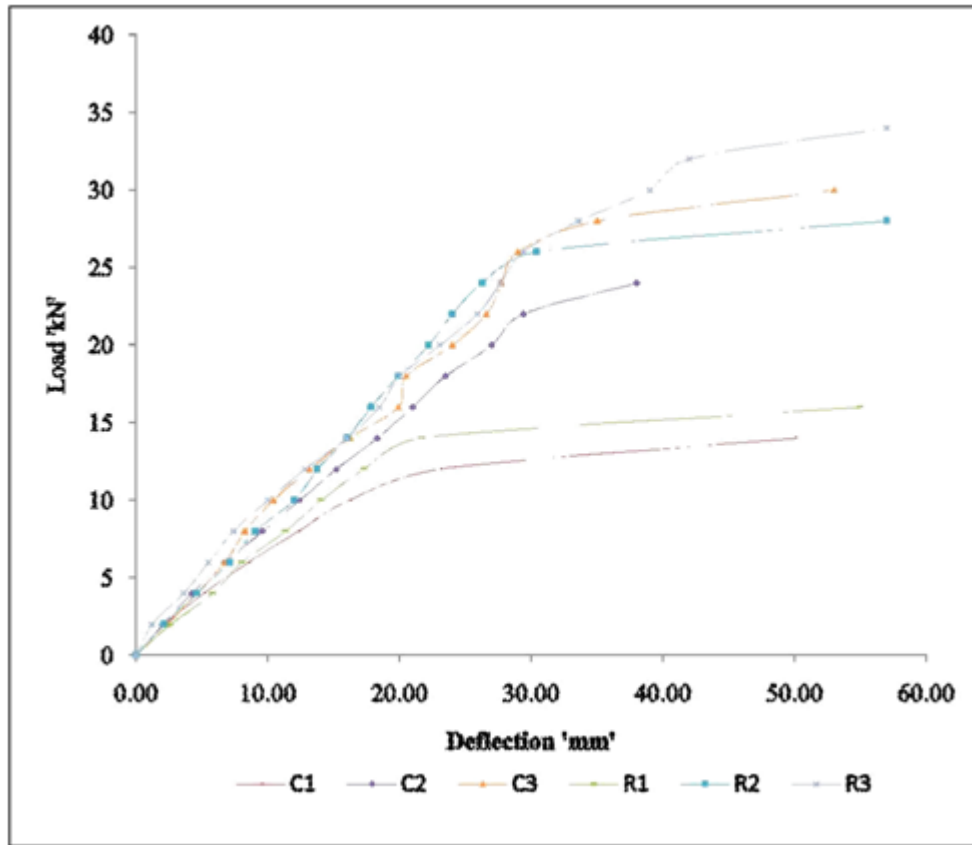

Curve 4.7: Load vs deflection curves for beams C2 & R2

In Curve 4.7 the variation of concrete beam C2 &R2 are shown in which deflection increases first then constant.

Curve 4.8: Load vs deflection curves for beams C3 & R3

In Curve 4.8 the variation of concrete beam C3 & R3 are shown in which deflection increases first then decreases and after certain limit it increase.

Curve 4.9: Load vs deflection curves for beams C1, C2 & C3 & R1, R2 & R3

In Curve 4.9 the combined effect of beams Load vs deflection curves for C1, C2 & C3 and R1, R2 & R3 is represent by different colour.

5. CONCLUSIONS
5.1. GENERAL
The study is dispensed to analyse the impact of ferrocement jacketing on strength and repair ability parameters of strong RCC beams varied proportion of tension steel.

Supported the work dispensed:
A. The final load, the energy absorption values & safe load will increase with the rise in proportion of tensile reinforcement beam.
B. Retrofitting victimization ferrocement jackets is effective for all beams stressed to 50% of their final load for all beneath bolstered beam.
C. Retrofitting of beams with ferrocement jacketing considerably decrease the deflection of the beam indicating a better degree of stiffness of beam.
D. Retrofitting provides higher energy absorption capability for all beneath bolstered beams however become constant with increase in proportion of tension reinforcement.

5.2. Scope for more work
The present work has been dispensed solely retrofitting on beams having for strengthening of tension steel solely. This work may be more extended to parameter additionally.
Effect of following parameters additionally
A. Effect on doubly bolstered beams.
B. Effect of variation of member of ferrocement bolstered beams.
C. Variation in compression reinforcement sole

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