EXPERIMENTAL INVESTIGATION OF R.C. COLUMN BY USING FERROCEMENT JACKETING

K.Uday[1], V.R. Raji[2], M.Ponraj[3], J.Sandhiya[4]

[1] *PG Student, Civil Engineering, Jaya Engineering College, India*
[2] *Assistant Professor, Civil Engineering, Jaya Engineering College, India*
3 Assistant Professor, Civil Engineering, Jaya Engineering College, India
4 Assistant Professor, Civil Engineering, Jaya Engineering College, India

ABSTRACT

The project is to strengthen the concrete by externally applying the ferro cement jacket on the concrete. In the areas where earthquake occurs frequently, the building gets damaged and the life of it becomes less. Hence as a Civil Engineer it is our responsibility to find an alternative for this. Also the need of the construction industry look for a reliable and cheaper strengthening component for reinforced concrete structure as led to the usage of ferro cement which proves to be a promising solution.The concrete specimens are externally wounded by chicken mesh and suitable test was made to find out its strength.

Keyword: - *Permeable Concrete, Polymer Admixture, Compressive Strength, Flexural Strength, Split Tension Test, and Concrete Pavement etc….*

1.INTRODUCTION
1.1 GENERAL

The term Ferro cement is most commonly applied to a mixture of Portland cement and sand applied over layers of woven or expanded steel mesh and closely spaced small-diameter steel rods rebar. It can be used to form relatively thin, compound curved sheets to make hulls for boats, shell roofs, water tanks, etc. It has been used in a wide range of other applications including sculpture and prefabricated building components. The term has been applied by extension to other composite materials including some containing no cement and no ferrous material. These are better referred to by terms describing their actual contents.

Ferrocement is a composite material comprising rich cement which is highly reinforced with continuous and small diameter steel rods and wires. It may be defined as sophistically designed well-proportioned cement based compound in which optimum quantity of suitably sized steel sections are evenly dispersed for achieving remarkable homogeneity, ideal monolithic properties, excellent strength and absolute impermeability. Its engineering properties, not only in compression but also in tension, bending and fatigue are far superior.

Ferrocement has a great potential to be used as strengthening jacket material for substandard reinforced column. Substantial progress has been made over the past decades in the use of composites in the construction industries, which includes the use of confinement likeferrocement , and meshes etc.It also reduce the problems associated with deterioration of the infrastructures. The confinement should be adequate to develop the flexural hinges and to provide sufficient ductility.

Applying ferrocement is a very effective method or remedy deficiencies such as inadequate shear strength and inadequate splices of longitudinal bars architectural locations, stiffness sheets were found The addition of ferrocement is a simple and rapid to apply, does increase the column sectional dimensions significantly and can be applied while the structure is in use. The jackets is effective in passive confinement, that is latterly confining stress is induced in the concrete as it expands laterally. A circular jacket can be considered equivalent to continuous hoop reinforcement. The strengthening of the structural components using external wrapping overcome the design in the adequacies, poor construction practices, increase in loads and seismic conditions etc.

Portland cement concrete, like most granular materials, exhibits an increase in compressive strength when subjected to confinement. This characteristics is advantageously used in the design of reinforced concrete columns, for instance, in which the load capacity is considerably increases when the columns is properly confined with stirrups or spiral reinforcement. Concrete filled ferrocement have been reconsidered in construction industry, especially in seismic regions. Their benefits include high stiffness and strength large energy absorption, and enhanced ductility and stability. But outdoor use of ferrocement in corrosive environment may prove costly.

1.2 Ferro Cement

Ferrocement is a composite material comprising rich cement which is highly reinforced with continuous and small diameter steel rods and wires. It may be defined as sophistically designed well-proportioned cement based compound in which optimum quantity of suitably sized steel sections are evenly dispersed for achieving remarkable homogeneity, ideal monolithic properties, excellent strength and absolute impermeability. Its engineering properties, not only in compression but also in tension, bending and fatigue are far superior.

Fig.1 ferrocement panels

Unlike RCC, its panels are quite thin. Its thickness is generally between 10mm to 40mm. It is light in weight and can be constructed to any shape of cross section. Hence, widely suited for precast products.

1.2.1 Construction

Ferrocement construction is a high precision work. As the structure is normally around 25mm thick, there lies no scope for error in workmanship.

Fig 2 **Ferrocement construction**

The construction process can be divided into 4 distinct phases:

1. Designing the structure: The basic steel structure has to be properly designed. Precision of design may make or mar the final outcome.

2. Fixing the steel frame: The correct quantity of steel has to be arrived at based on the use of the structure. Steel structure has to be properly fixed and then wrapped with adequate layers of chicken wire.

3. Mortar application: Cement - Sand mortar of correct ratio has to be applied on both sides of the structure. This is a very meticulous job. The application has to be good enough so that the finishing is smooth.

4. Curing: Recommended Curing is for 14 days

1.2.2 Features

Fig.3 Features of Ferrocement Construction

Ferrocement is a low weight building system with high structural strength. It has lower maintenance costs over its lifetime and is more durable than its traditional counterparts. However, skill of the designer as well as the applicator is of paramount importance, as this is a high precision building system with zero margin of error.In Ferro-cement while mortar provides the mass, the steel and wire mesh imparts tensile strength and ductility to the material.

In terms of structural behavior it exhibits very high tensile strength-to-weight ratio and superior crack resistant performance. The distribution of small diameter wires over the entire surfaces enveloped with chicken mesh, provides very high resistance against cracking. Moreover many other engineering properties, such as toughness, fatigue resistance, impermeability are considerably improved.

Ferrocement construction eliminates/minimises use of formwork resulting in reduced construction costs. It also reduces maintenance cost as damages (if any) are localised and easily repairable.

Fig.4 ferrocement formworrk

1.2.3 Advantages

Immense Structural Strength : Due to perfect homogeneity and monolithic body
Light Weight: Being thin and much lighter than RCC, hence portable and easy to handle and erect.
Completely waterproof: No leakage or sippage. Even there is no sweating or dampness. So ideal for water retaining and moisture proof structures.
Endearing Insulation: Very less conductive than steel and RCC. Hence cool in summer, warm in winter. Minimum condensation.
Long durability: goes on gaining strength especially in contact with water/ moisture. Almost permanent life.
Joint less structure: Being single bodied monolithic construction, there are no joints. Hence no chance of opening out.
Excellent fire and explosion resistance: Almost complete fire resistant. Even temperatures up to 170 degrees C have not shown any effect.
Zero maintenance: No recurring expense or botheration. Construct-Erect-Forget!!
Easy reparability: Damage, if any, are always localized. Hence can be repaired quickly and easily.

Mold ability to any shape: During construction it can be molded to any decorative shape. Hence tailor made attractive designs possible.
Resistance to environmental deterioration: Almost immune to biological growths and atmospheric effects.
Good vibration and sound absorbance
Easily painted for decoration.
Environment friendly construction: Construction blends with the environment, ambience & surrounding.
Green Construction: uses locally available resources, green material and is labor intensive.

1.2.4 Utility of Ferro cement

Fig.5 Precast Building Components

Ferro cement applications are free-form and can be limited only by one's imagination. It provides easy mold ability and can take any form. It can be used for manufacturing precast building components that can be easily transported. Some popular uses are for making Septic Tanks, Water Tanks and Designer Roofing systems. Other specialized applications include silos, bins, boats, biogas holders, milk kiosks etc.

2.REVIEW OF LITERATURE

M.A. Mansur, P. Paramasivam(1985) The results of an experimental investigation conducted of three ferrocement sections under combined bending and axial loads are reported in this paper. Each section has identical dimensions, but contained different volume fraction of reinforcement. Based on the conventional reinforced concrete analysis, a method is presented for predicting the ultimate load capacity, and hence the interaction behaviour of a ferrocement section. The experimental data are in good agreement with the theoretical predictions.

B.R. Walkus(1988) The behaviour of ferrocement elements subjected to uniaxial long term tension is presented. Based on the results of experiments, deformations of ferrocement under short term and long term load are compared. It is shown that in ferrocement during long term loading the number of micro-cracks of crack width 20 to 100 µm is constant.

M. Rahman, M.A. Mansur(1990) The feasibility of using ferrocement as a replacement material for cast iron in the fabrication of supporting legs (columns) for a centre lathe has been investigated in this project. These machine tool structures were designed with the aid of a finite element package so as to have static stiffness at least equal to those of the corresponding cast iron legs. Tests were carried out to evaluate the performance of the ferrocement legs with reference to the traditional cast iron legs.

The highly improved dynamic performance as exhibited by the ferrocement legs indicates that this new construction materials has a great potential in the machine tool industry.

M. Rahman, M.A. Mansur, K.H. Chua(1993) In an earlier study, the feasibility of using ferrocement as a replacement to cast iron in the manufacture of machine tool structures was investigated by fabricating a prototype ferrocement bed for a centre lathe and testing the bed alone. Improved performance exhibited by the ferrocement bed in comparison with the parent cast iron bed under both static and dynamic loadings has inspired the authors to pursue the work and assess the bed in terms of the performance of the machine as a whole.A centre lathe was chosen for this purpose. The traditional cast iron bed in the machine was replaced by a ferrocement bed, designed and fabricated for accommodating all the necessary parts and attachments. The method of fabrication and installation of the bed are described in this paper. Identical vibration and cutting tests were performed in the original as well as the modified machines. Test results indicate that the machine with ferrocement bed provides significantly higher damping and natural frequencies, specially the torsional frequency, and results in an approximately 40% deeper cut than the original lathe before the onset of chatter.

B.P. Hughes, N.F.O. Evbuomwan(1993) This paper reports on some of the results of on-going research in the development of a reinforced repair mortar to be used in enhancing the strength of downgraded reinforced concrete beams. Following the encouraging progress made in the formulation and evaluation of the plain repair mortar, preliminary tests were carried out involving the application of the reinforced repair material to the soffit of model reinforced concrete beams of 1 m length. The results of six beams are presented from a particular series of tests. The application of the polymer-modified ferrocement to the beams was found to lead to increased ultimate flexural strength and ductility, without any occurence of bond failures.

S.F. Ahmad, Sarosh H. Lodi, Juneid Qureshi(1995) The shear behavior of ferrocement channel beams have been studied by conducting tests under transverse loads for 15 beam specimens. Influence of variations of the dominant parameters were studied through systematic tests. Test results indicate that cracking and ultimate shear strength increases with the increase in the volume of wire mesh and mortar strength, and decreases with the increase of shear span to depth ratio. A computational model based on cracking criteria related to combined stresses and ferrocement tensile strength profile distribution across beam depth has been proposed to predict the cracking strength. Also an empirical expression has been developed for the same for ease in direct design application.

Essam Eltehawy(1998) This paper presents an experimental investigation performed on reinforced concrete slabs, where plain cement mortar reinforced with welded steel mesh, known as Ferro cement is applied. The paper provides comparison between the performance of using the new technique, as a strengthening material of reinforced concrete slabs and the existing reinforced concrete slabs.

P. Paramasivam, C.T.E. Lim, K.C.G. Ong(1998) In this paper methods of repair and strengthening of reinforced concrete beams using ferrocement laminates attached onto the surface of the beams are reviewed. Investigation into the transfer of forces across the concrete/ferrocement interface, the effects of the level of damage sustained by the original beams prior to repair, and the results of repeated loading on the performance of the strengthened beams are discussed. The results show that ferrocement is a viable alternative strengthening component for the rehabilitation of reinforced concrete structures.

P.Rathish Kumar, T.oshima, S.Mikami and T.Yamazaki(2003) Plastic hinge formations associated with lateral displacement excursions is favored in beams and girders rather than in columns to ensure that the overall structural integrity is not compromised. Plastic hinges can occur in columns, however, particularly at the base of multistory frames and bridges where incurred, damage acts to dampen seismic forces considerably. Ductile behaviour is hence essential at these crucial sites to prevent complete structural collapse under sustained loading.

The structural response during earthquakes have indicated that the majority of the column failures was caused by high shear stresses ,insufficient transverse reinforcement rendering those members ineffective at dissipating seismic energy and inadequate ductility rapidly leading to failure. The present objective is to complement the earlier work of the authors3 ,4, 5, on the use of ferrocement jackets for seismic retrofit of non-ductile reinforced concrete columns with inadequate shear strength. The response of R.C and ferrocement retrofitted columns to seismic loading was examined under three different axial load ratios.

Abdullah, Katsuki Takiguchi(2003) This study presents behavior and strength of reinforced concrete (RC) columns strengthened with ferrocement jackets. A total of six identical reference columns were prepared and tested after being strengthened with circular or square ferrocement jackets. Other than the ratio of axial load, parameters studied include the jacketing schemes, and the number of layers of wire mesh. Unless failure occurred at an earlier stage of loading, the columns were tested under cyclic lateral forces and constant axial load. Test results show that by providing external confinement over the entire length of the RC columns, the ductility is enhanced tremendously. Also, test results of this investigation revealed that the design method, proposed earlier by the authors, is very effective.

Mohammad Taghi Kazemi, Reza Morshed(2005) This paper presents results of an experimental study to evaluate a retrofit technique for strengthening shear deficient short concrete columns. In this technique a ferrocement jacket reinforced with expanded steel meshes is used for retrofitting. Six short concrete columns, including four strengthened specimens, were tested.

Specimens were under a constant compressive axial force of 15% of column axial load capacity based on original concrete gross, Ag, and the concrete compressive strength, . Main variables were the spacing of ties in original specimens and the volume fraction of expanded metal in jackets. Original specimens failed before reaching their nominal calculated flexural strength, Mn, and had very poor ductility. Strengthened specimens reached nominal flexural strength and had a ductility capacity factor of up to 5.5. Based on the test results, it can be concluded that ferrocement jackets reinforced with expanded steel meshes can be used effectively to strengthen shear deficient concrete columns.

Prem Pal Bansal, Maneek Kumar, S.K.Kaushik(2006) Various retrofitting techniques are used in field and out of all plate bonding technique is considered as the best. In this technique, the plates of different materials viz CFRP, GFRP, ferrocement etc are bonded to the surface of structural member to increase its strength. Ferrocement sheets are most commonly used as retrofitting material these days due to their easy availability, economy, durability, and their property of being cast to any shape without needing significant formwork. In the present work, effect of wire mesh orientation on the strength of stressed beams retrofitted with ferrocement jackets has been studied. The beams are stressed up to 75 percent of safe load and then retrofitted with ferrocement jackets with wire mesh at different orientations. The results show that the percent increase in load carrying capacity for beam retrofitted with ferrocement jackets with wire mesh at 0, 45,60 degree angle with longitudinal axis of beam, varies from 45.87 to 52.29percent. Also a considerable increase in energy absorption is observed for all orientations. However, orientation at 45 degree shows higher percentage increase in energy absorption followed by 60 and 0 degree respectively.

M.A.Saleem and M.Ashraf(2007) The greatest humanitarian challenge faced even today after one year of Kashmir Hazara earthquake is that of providing shelter. Currently on the globe one in seven people live in a slum or refugee camp**.** The earthquake of October 2005 resulted in a great loss of life and property. This research work is mainly focused on developing a design of small size, low cost and earthquake resistant house. Ferrocement panels are recommended as the main structural elements with lightweight truss roofing system. Earthquake resistance is ensured by analyzing the structure on ETABS for a seismic activity of zone 4. The behavior of structure is found satisfactory under the earthquake loading. An estimate of cost is also presented which shows that it is an economical solution.

Noor Ahmed Memon, Salihuddin Radin Sumadi, Mahyuddin Ramli(2007) The performance of high workability mortar mix, applicable for the casting of thin ferrocement elements by using slag as cement replacement and superplasticizer as water reducing agent is investigated. Cement mortars (1:2. 1:2.5 and 1:3) incorporating various percentages of slag and superplasticizer were designed to have high workability (136±3% flow). Performance of the mortars is studied in terms of compressive strength, unit weight, strength development and water absorption. Effect of three different curing regimes on strength and strength development of the mortars is also the part of this study. The results showed that the high workability slag cement mortars of reasonably high strength, low water absorption and exhibiting early age strength comparable to that of the OPC mortars can be designed in order to cast thin ferrocement elements by the method of pouring.

Boshra Aboul-Anen, Ahmed El-Shafey and Mostafa El-Shami(2008) This paper addresses the composite action between the ferrocement slabs and steel sheeting. This is an important issue that could impact the performance and strength of space trusses. The current paper presents the experimental models of ferrocement slabs with and without steel sheeting and their numerical models using the finite element method. Finite element models were developed to simulate the behavior of the slab through nonlinear response and up to failure, using the ANSYS Package. Additionally, the comparison between the theoretical and experimental models is presented and discussed.

M.A. Mansur, K.L. Tan, A.E. Naaman(2010) In continuation of an experimental investigation reported earlier by the authors on bolted moment joints in ferrocement construction, this study regards (1) further testing of ten such joints to broaden the range of the principal parameters – thickness of the connected ribs and location of bolts and (2) simple analytical modeling for design. Test results, as presented and discussed in this paper, indicate that the mode of failure of a joint depends on whether the applied moment is in the opening or closing mode. Under the closing mode, failure always occurs by shear punching of the bearing plates through the connected ribs. In contrast, failure in the opening mode occurs by bending failure of either the connected or the longitudinal rib. Based on observed failure modes, expressions have been derived for predicting the strength of such a joint. A comparison of theoretical predictions with present test results and those reported earlier shows good agreement.

Bong.J.H.L and Ahmed.E(2010) The need of the construction industry look for a reliable and cheaper strengthening component for reinforced concrete structure as led to the usage of ferrocement which proves to be a promising solution. This paper describes the structural short term behaviour of a beam strengthened with ferrocement laminate and identifies its advantages. Beam which is strengthened with ferrocement laminate is compare to a control beam for the analysis of advantages of using ferrocement. From the experiment carried out, beam strengthened with ferrocement proves to have higher cracking load, ultimate load as well as having a lower deflection in comparison to a normalbeam.

Hassan M.H. Ibrahim(2011) An experimental study on 18 simply supported ferrocement plates having a span/depth ratio of 2.0 was conducted. Various wire mesh types were used as web reinforcement. Flexural steel was designed to preclude failure in modes other than flexure. Two groups, A and B, were tested under central uniform loads covering 10% and 67.5% of the clear span respectively. It was observed that, the percentage increase of shear capacity over the reference specimen is remarkable for group A and nearly equal to 40%. Moreover, a hexagonal mesh, of 0.15%, improves the shear capacity than those of diamond and square meshes of 0.25% and 0.38% volume fraction respectively. Specimens of group B demonstrate a slight increase of the ultimate shear capacity than those of group A despite that the web reinforcement is less effective as pointed out by comparing the results of each group with its associated reference specimen. A good agreement between the classical shear equations prediction and the experimental values is obtained for group A specimens whereas the ultimate shear capacity for group B is underestimated. It is also indicated that the strut and tie model is an inappropriate technique for the ferrocement plate design compared to the classical shear equations of deep beams.

S.M. Mourad, M.J. Shannag(2012)A series of 10 one-third scale square reinforced concrete column specimens were cast; preloaded under axial compression up to various fractions (0%, 60%, 80%, and 100%) of its ultimate load; repaired using ferrocement jackets containing two layers of Welded Wire Mesh (WWM) encapsulated in high strength mortar; and then retested to failure. The overall response of the specimens was investigated in terms of load carrying capacity, axial displacement, axial stress and strain, lateral displacement, and ductility. The test results indicated that jacketing reinforced concrete square columns with this form of ferrocement provided about 33% and 26% increases in axial load capacity and axial stiffness, respectively, compared to the control columns. The test results also indicated that repairing similar reinforced concrete columns (after preloading them to failure) with the same ferrocement jacket almost restored their original load capacity and stiffness. Furthermore, the repaired columns failed in a ductile manner compared to the brittle failure exhibited by the control columns.

Mahyuddin Ramli, Amin Akhavan Tabassi(2012) This paper, based on laboratory programs, evaluated the load-deflection characteristics, first crack strength, crack width and crack spacing of three commercial polymer-modified ferrocements namely styrene-butadiene rubber (SBR), polyacrylic ester (PAE), and vinyl acetate–ethylene (VAE), and unmodified ferrocement elements cured in air and saltwater exposure conditions. The results indicated that continuous saltwater exposure significantly improved the behaviour of polymer modified ferrocements in flexure by exhibiting higher experimental values of the first crack load and ultimate strength of all the specimens. Irrespective of the exposure conditions, polymer modified ferrocements showed lower average crack width than that of the unmodified ferrocement.

A.B.M.A. Kaish, M.R. Alam, M. Jamil, M.F.M. Zain, M.A. Wahed(2012) Conventional square ferrocement jacketing (square jacketing with single or multiple layers wire mesh) cannot provide lateral confinement effectively in restrengthening of square RC column due to stresses concentration at the column corners. Therefore, improvement of conventional square ferrocement jacketing technique is focused in this study. Three new square ferrocement jacketing techniques such as square jacketing with single layer wire mesh and rounded column corners (RSL); square jacketing using single layer wire mesh with shear keys at the center of each face of column (SKSL) and square jacketing with single layer wire mesh and two extra layers mesh at each corner (SLTL) are considered for this purpose. Entire study was carried out experimentally. A total number of 41 scaled down non-jacketed and ferrocement jacketed column specimens were tested under both concentric and eccentric modes of loading. Test results and the crack patterns of tested specimens show that all three improved square ferrocement jacketing techniques are effective to overcome the stress concentration problem of conventional square ferrocement jacketing. Among all jacketing techniques considered in this study SLTL type jacketing shows the best performance in carrying concentric loading, however, in case of eccentric loading, best performance is found in RSL type ferrocement jacketing.

Bo Li, Eddie Siu-shu Lam, Bo Wu, Ya-yong Wang(2013) In this study, a method for rehabilitating reinforced concrete interior beam–column joints using ferrocement jackets with embedded diagonal reinforcements is proposed. It improves seismic performance of substandard beam–column joints and repairs deteriorated concrete cover without increasing the dimensions of the joints. Ferrocement, comprising mortar and wire mesh, was applied to replace concrete cover to enhance shear strength of the joints. Diagonal reinforcements were installed to reduce the forces transferred to the joint core. Four 2/3 scale interior beam–column joints, including one control specimen and three strengthened specimens, were prepared and tested under quasi-static cyclic loading. Three types of mortars were considered for each strengthened specimen. Test results have indicated that the proposed rehabilitation method can improve seismic performance of interior beam–column joints using ferrocement with high strength mortar. Strength of mortar is the vital factor affecting the performance of strengthened specimens. Anchor bolts installed at the interface between ferrocement and concrete substrate improve bonding and overall performance. Finally, a method for predicting the shear strength of joints rehabilitated by ferrocement jackets with embedded diagonal reinforcements is proposed.

A.B.M. Amrul Kaish, M.R. Alam, M. Jamil, M.A. Wahed(2013) This study focuses on the improvement of square jacketing technique in effective restrengthening of existing RC building column. Square jacketing technique can't effectively provide lateral confinement due to stress concentration and subsequent cracking at the corners. In order to overcome this problem, two different approaches are taken into account; i.e. (a) strengthen all the corners, and (b) reducing stress concentrations at corners. Three types of square jacketing techniques under these two approaches are considered in this study. Test results and crack pattern shows that, both approaches are effective to overcome the stress concentration problem of square jacketing. However, the first approach is practically more suitable than the second one.

M. Yaqub, C.G. Bailey, P. Nedwell, Q.U.Z. Khan, I. Javed(2013) This paper presents the results of an experimental study carried out to compare the effectiveness of ferrocement and fibre reinforced polymers (FRPs) jackets for the repair of post-heated square and circular reinforced concrete columns. The suite of test specimens comprised (a) non-heated and non-repaired; (b) post-heated and non-repaired and (c) post-heated and repaired, columns. Glass fiber reinforced polymer (GFRP), carbon fibre reinforced polymer (CFRP) and ferrocement jackets were used to repair the heated columns. All the columns were tested under axial compression. The test results covering the axial compressive strength, stiffness (secant stiffness), ductility, deformation and energy dissipation for the non-heated and non-repaired, and post-heated and non-repaired columns, were explored and compared with those of the post-heated columns repaired with FRP and ferrocement jackets. The test results showed that the FRP jackets increased the compressive strength, ductility, deformation ability and energy dissipation capacity of post-heated columns but did not increase the stiffness. However, the ferrocement jackets enhanced both the strength and stiffness of the post-heated columns. It is concluded that a possible combination of ferrocement and FRP jackets is the optimum solution to restore the required strength, stiffness and ductility following structural damage from a fire.

Lila M. Abdel-Hafez, A.E.Y. Abouelezz, Faseal F. Elzefeary(2013) Experimental tests have been carried out to study the behavior of different single story frames infilled with brick masonry under the in-plane lateral load influence. Three phases of frames were tested. The first phase was conducted on individual reinforced concrete bare frame used as control frame. The second phase was conducted on two model frames representing individual reinforced frame infilled with masonry panels constructed between two columns, then constructed the top beam, and the other one constructed as bare frame and then infilled with masonry. The third phase was strengthened with different methods to improve its behavior. Glass fiber reinforced polymer (GFRP) sheets, steel rebar impeded in frame, plastering and ferrocement meshes were used.The drift, toughness, ductility and failure load were improved by using such masonry wall due to like-shear wall effect which also increased frame capacity to resist lateral load. The ferrocement strengthening method was recommended to improve the ductility and ultimate failure loads of the existed frames. Also casting concrete of frame over the masonry “Balady” method; increases the ultimate load capacity of frame by 145% of bare frame ultimate failure load. Also it increases its ductility and toughness by 33% and 195%, respectively. The ductility of infilled frame strengthened with ferrocement was the best of all strengthened frames, while strengthening with GFRP increases its ultimate load carrying capacity but reduces its ductility.

3. Materials Used

3.1 Cement

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. Cement and water form a paste that binds the other materials together as the concrete hardens. Portland Pozzolana cement (PPC) is manufactured by the inter-grinding of OPC clinker with 10 to 25 per cent of pozzolanic material. The pozzolanic materials generally used for manufacture of PPC are calcined clay or fly ash. PPC produces less heat of hydration and offers greater resistance to the attack of aggressive waters than Ordinary Portland Cement.

The reaction of cement when mixed with water is called hydration. Both C_3s and C_2s make up nearly 75% of cement. The hydration of these compounds is responsible for the setting and hardening of cement. In the presence of water, the silicates and aluminates form produces of hydration which result in a hard mass over a period of time. This hard mass is known as hydrated cement paste. The hydration surface reaction commences immediately once cement comes in contact with water.

3.2 Fine aggregate

Sand used for the experimental program was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through BIS 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. Fine aggregate was tested as per IS 2386-1963.

Fine aggregate is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic materials. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds. Much of the earth’s surface is sandy, and these sands are usually quartz and other siliceous materials. The most useful commercially are silica sands, often above 98% pure. Beach sands usually have smooth, spherical to ovaloid particles from the abrasive action ofwaves and tides and are free of organic matter. The white beach sands are largely silica but may also be of zircon, monazite, garnet, and other minerals, and are used for extracting various elements.

Sand is used for making mortar and concrete and for polishing and sand blasting. Sands containing a little clay are used for making molds in foundries. Clear sands are employed for filtering water. Sand is sold by the cubic yard (0.76 m3) or ton (0.91 metricton) but is always shipped by weight. The weight varies from 1,538 to 1,842 kg/m3,depending on the composition and size of grain. Construction sand is not shipped great distances, and the quality of sands used for this purpose varies according to local supply.Standard sand is a silica sand used in making concrete and cement tests. The fine aggregate obtained from river bed of Koel, clear from all sorts of organic impurities was used in this experimental program.

3.3 Coarse Aggregate

The material which was retained on test sieve 4.75mm was termed as coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in the work. The aggregate was washed to remove dust and dirt and was dried to surface dry condition. The aggregate was tested as per Indian Standard Specifications IS: 2386-1963. Coarse aggregate are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone used is granite, limestone,and trap rock. The last is a term used to designate basalt, gabbro, diorite, and other dark-colored, fine-grained igneous rocks. Graded crushed stone usually consists of only one kind of rock and is broken with sharp edges. The sizes are from 0.25 to 2.5 in (0.64 to 6.35 cm), although larger sizes may be used for massive concrete aggregate. Machine crushed granitebroken stone angular in shape was used as coarse aggregate.

Coarse aggregates are usually those particles which are retained on I.S. 4.75mm sieve. The aggregates should be absolutely clean, free from organic matter and other impurities. The aggregate should be capable to resist weather. The grading of concrete is very important for getting good quality concrete. Good grading of aggregate implies that the quantity of aggregate used should contain all standard fractions of aggregate in required proportions such that the sample contains minimum voids

3.4 Water

The water is required for preparation of mortar, mixing of cement concrete and for curing work etc during construction work. The quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work. Quality of Water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6.

3.5 Reinforcement

The longitudinal reinforcements are high-yield strength deformed bars of designed diameter. The stirrups are made from high-yield strength deformed bars of designed diameter.

3.6 Chicken mesh

The materials used are mesh wire (Chicken mesh) and tie bars for winding process and the materials used for plastering are OPC 53 grade, sand and water as per calculated mix ratio

Fig 6.chicken mesh

4. METHODOLOGY

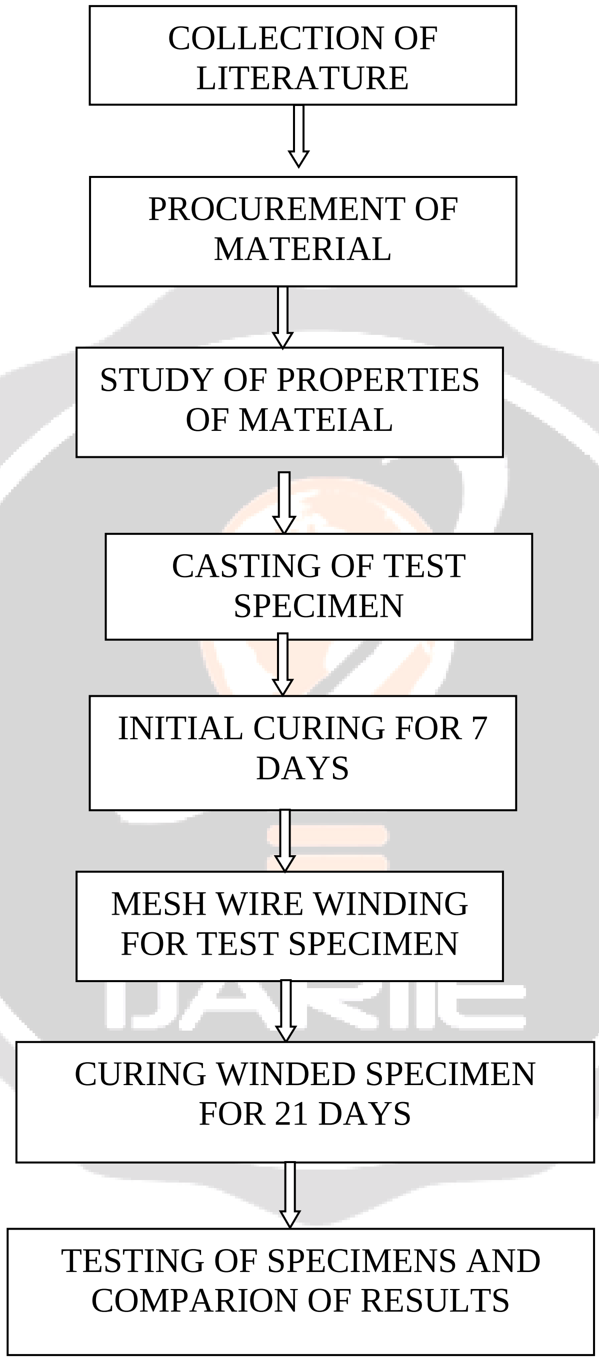

Fig 7 Methodology

5. CONCLUSION

The general objective of the research is to evaluate the load carrying capacity for the specimen by using ferrocement for strengthening.

The scope of the study, need for the study and the formulated objectives are described in detail. Initially literature survey has been made. The materials to be used in this project are collected and material testing is carried out and a physical property of the materials is also determined. The work has been carried out as per methodology arrived.

The following works will be carried out such as the mix design for m25 concrete grade will be made as per material tests results. The specimens are casted and the strength characteristics of the specimen such as compressive test, load carrying capacity and flexural behavior of reinforced cement concrete beam shall be tested. The results are finally concluded.

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