Study on flexural strengthening of RC beams using ferrocement laminates with Recron-3S fibre – A Review

N.Karunya[1], R.T.Anitha Ranee[2], K.Eswaran[3], Dr.J.Sridhar[4]

[1] PG student, Department of Civil Engineering, K.S.Rangasamy college of technology, Tamilnadu, India
[2] Assistant Professor, Department of Civil Engineering, K.S.Rangasamy college of technology, Tamilnadu, India
[3] PG student, Department of Civil Engineering, K.S.Rangasamy college of technology, Tamilnadu, India
[4] Professor, Department of Civil Engineering, K.S.Rangasamy college of technology, Tamilnadu, India

---***---

Abstract - ***Worldwide a great deal of research is currently being focused on the use of effective material for repair and strengthening of existing reinforced concrete structure and the research is also concern about the effective utilization of fiber in construction industries. This paper reviews seventeen articles of strengthening the reinforced concrete elements with ferrocement laminate. This review paper is mainly concern about the types of meshes, number of layers of meshes, mortar mix ratio, and fibers usage in laminates that are used in the research works to strengthen the reinforced concrete elements.***

Key Words: *ferrocement laminate, Recron-3S, 3 layers of mesh.*

1. INTRODUCTION

Natural disasters such as earthquakes, tornadoes and tsunami threaten the integrity of civil infrastructures and safety of their uses. A large number of existing reinforced concrete buildings and other structures typically have not sufficient capacity to resist the forces during such catastrophes. In order to guarantee the safety of the people, the older structures need to be repaired and strengthened to prevent their collapse. Efficient methods are needed to be developed for structures repair and strengthening. The ageing of the nation's infrastructure in a tight economic environment has necessitated the search for innovative and cost effective solutions. In recent years, the use of ferrocement laminate has become a subject of great interest in structural community. Several studies had been focused on the use of externally bonded ferrocement laminates to reinforce existing structures in need of strengthening. In general ferrocement is considered as a highly versatile form of composite material made of cement mortar and layers of wire mesh or similar small diameter steel mesh closely bound together to create a stiff structural form. This material, which is a special form of reinforced concrete, exhibits behaviour so different from conventional reinforced concrete in performance, strength and potential application it must be classed as a separate material. In rationally designed ferrocement structures, the reinforcement consists of small diameter wire mesh in which the proportion and distribution of the reinforcement are made uniform by spreading out the wire mesh throughout the thickness of the element. This distribution of achieving improvements in many of the engineering properties of the material such as fracture, tensile and flexural strength, toughness, fatigue resistance and impact resistance but also provide advantages and novelty of the concept have stimulated what is now considered a worldwide interest in the use of ferrocement. For achieving higher values of specific surface, Number of layers of meshes needs to be increased. Many a time, it becomes difficult to force mortar in this layer. The fine diameter wires, with smaller openings pose more problems. This is over come by using different types of fibres to improve the specific surface of the reinforcement. As the fibre take care of cracking of mortar, bigger diameter wire meshes with larger opening can be used and which simplify the penetration of mortar in the meshes. This results in a high strength material for which flexural properties can be designed and predicted with much accuracy. It also offers higher energy absorption capacity and impact resistance to ferrocrete. Behaviour of such fibre in ferrocement laminates on reinforced beam will be studied in this project which includes flexural test.

1.1 Definition of ferrocement (act 549)

Ferrocement is a thin walled concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small wire mesh. The mesh may be of metallic or other suitable materials.

2. Literature survey

The present investigation deals with studies on utilisation of fibre in ferrocement laminates and its application in flexural strengthening of RC beams, an attempt has been made to review briefly the available literature on the following topics.

1. Strengthening of RC beams
2. Effect of fibres

Ganapathy and Sakthieswaran (2015)[4] studied the flexural behaviour of reinforced cement concrete beam by using fibrous ferrocement laminates. The Properties of fibrous Ferrocement laminates and Load - Deflection behaviour for control specimen was compared with Polymer modified fibrous Ferro cement composite beams. Wire meshes were used for ferrocement laminates with mortar mix of 1:2 and water- cement ratio of 0.4. Six beams were casted and tested under two point loading. All beams were tested to ascertain the load deflection behaviour and maximum ultimate load. Five beams were cracked under overloading by applying 70% ultimate load, and one beam was used for control beam. Then the cracked beams were strengthened by polymer modified fibrous ferrocement composites with two different volume fractions (4.94%, 7.41%). Comparing the flexure strength of control beam with respect to the beam rehabilitated with modified fibrous Ferro cement laminate. The reinforced cement concrete beam using fibrous Ferro cement laminate increased the flexural strength of the beam.

Ezz-Eldeen (2015)[3] experimentally studied the strengthening and retrofitting of reinforced concrete beams that was completely damaged due to flexural failure. The strengthening technique consists of steel wire mesh with and without additional longitudinal steel angles. The specimens were casted and tested under monotonic load upto failure with two point loading condition. The cracks were grouted with mortar. Then the beams were strengthened using two and three external plies of expanded galvanized steel wire mesh having square grids in the form of U-jacket. From the experimental results it was concluded that increasing numbers of steel wire mesh plies fixed with 2, 4 and 6 vertical clamps without external steel angles increased the beam carrying capacity from 26.59% to 49.55%. The deformation of retrofitted beams decreased by increasing the wire mesh plies.

Sridhar et al. (2014)[7] investigated the flexural behaviour of reinforced concrete beams strengthened with ferrocement laminates using steel slag as a partial replacement material for fine aggregate. The parameter varied in the study was the volume fraction of mesh reinforcement (1.88% and 2.35%) and the replacement percentage of steel slag (0% and 30%) with fine aggregate in ferrocement laminate. Galvanized square weld mesh with mortar mix ratio of 1:2 and water-cement ratio of 0.4 was used for ferrocement laminate. Four beams were strengthened with ferrocement laminates using the epoxy resin as bonding agent. One control specimen and four strengthened beams were subjected to flexural test under two-point loading. The midspan deflection, first crack and ultimate load and mid span deflection were studied. From the experimental result, it was concluded that the beams strengthened with ferrocement laminate with the volume fraction of 2.35% and 30% of steel slag increased the load carrying capacity under flexural load. The other mechanical properties such as ductility and energy absorption capacity was found to be increased for specimens with 2.35% of volume fraction of mesh reinforcement and 30% of steel slag replacement.

Rahman et al. (2014)[8] studied the effect of wire mesh on the strength of RC beams repaired using ferrocement layers. Three set of RC beams of the same dimension (width 4″, thickness 6″ and span 5.5′) are tested up to ultimate load by one point loading system as a simply supported beam. After testing of beams three beams were repaired by 0.5 inch ferrocement layer on three sides. Three Beams were subjected to two layers of ferrocement on the bottom of thickness 1 inch and one layer in other two sides. And another set of three beams were surrounded by total 1 inch ferrocement layer on three sides. Then the beams were tested again and comparison was made on cracking load, ultimate load and deflection between the normal beams and repaired beams. The study represents the performance of beams according to their different layers. From this test results, it was concluded that the beams with bottom two layers of ferrocement overlay (repairing) gave comparatively good performance.

Khan et al. (2013)[5] investigated the serviceability performance of reinforced concrete beams strengthened through two ferrocement strengthening techniques, cast in situ and precast ferrocement laminates. Eight RC beams was tested under two-point loading up to service load. Then, those beams were strengthened by cast in situ wire-mesh layers and by precast ferrocement laminates. Wire-mesh was anchored to the soffit of the beam through nails. The laminate connectors were placed over the exposed stirrups and mortar was used to fix the laminate connectors with stirrup. After hardening of mortar, precast laminate was attached by passing bolts through the holes and nuts were used to tighten the laminates. The experimental results in terms of stiffness were compared within and across the groups to assess the effect of variation of development length and number of wire-mesh layers. Performance of RC beams strengthened by three layers of wire-mesh using both techniques has been found better in terms of maximum increase in stiffness.

Ayub et al. (2013)[6] experimentally investigated and made an assessment on the effectiveness of ferrocement strengthening techniques i.e., cast in situ Ferro-mesh layers and precast ferrocement Laminate. Totally ten reinforced concrete beams including one control beam was intentionally designed and detailed to fail in flexure. Prior to strengthening, beams were tested under two-point loading till service limit. Beams were strengthened in the flexural dominant region and tested to failure under the same loading arrangement. The parameters for structural behaviour was limited to stiffness, load carrying capacity, failure mode and ductility of the beams by varying number of wire mesh layers, development length and technique of application, i.e. cast in situ ferro-mesh layers and precast ferrocement laminate. It was concluded that strengthening through cast in situ Ferro-mesh layer is the most efficient technique, whereas strengthening of the beams by using precast Ferrocement Laminate is not only easy to implement at household level, but is also promising in terms of enhancing load carrying capacity, stiffness and ductility.

Bashandy (2013)[1] evaluated the efficiency of strengthening reinforced concrete beams using three valid strengthening materials and techniques. The first is based on using concrete layer while the second is based on using mesh reinforced concrete layer and the third is based on using steel plates. Samples are divided in to three groups, a group strengthened using 2cm thickness concrete layer only (two types), another group is strengthened using 2cm thickness concrete layer reinforced with meshes (steel and plastic) and a group of beam is strengthened using steel plates. The initial cracking load, ultimate load and crack pattern of tested beams are illustrated. Economically, steel meshes costs less compared to steel plates by about 60 %.

Shaheen et al. (2013)[17] studied the structural behaviour of ferrocement concrete composite channels reinforced with various types of reinforcing materials. The thickness of the two webs and base were kept constant as 25 mm. The test specimens were loaded under four point loadings until failure. Determined the mechanical properties of the used steel and wire meshes and the ultimate load, flexural behaviour, ductility ratio, energy absorption and mode of failure at collapse of the control beams which were reinforced with steel and the results were compared with the conventionally reinforced ferrocement beams reinforced with expanded metal mesh, welded metal mesh and glass fibre mesh. Employing polypropylene fibres in mortar mix increase in the first crack load, serviceability load, ultimate load, and energy absorption, higher stiffness However, it resulted in a decrease in the ductility ratio, less deflection at the corresponding load levels. Increasing the number of the steel mesh layers in the ferrocement forms increases the first crack load, service load, ultimate load, and energy absorption decreases.

Vidivelli et al. (2012)[15] revealed the work associated with the behaviour of strengthening the predamaged reinforced concrete beams by using ferrocement plates. The study elaborated the mechanical properties of ferrocement with three different volume fractions of reinforcements. Ferrocement laminates are introduced to enhance the overall performance of reinforced concrete beams. Eight beams were cast and tested for flexure. Out of eight beams two beams were treated as control beams and the remaining six beams were loaded to a predetermined damage level, and strengthened by fastening ferrocement laminates. Fastening of ferrocement laminates onto the surface of the predamaged beam was done by using epoxy resin adhesive. The strengthened beams were again tested for ultimate load carrying capacity by conducting flexural test. A comparative study was made between the control beams and the predamaged beams strengthened by ferrocement laminates. The test results have shown that ferrocement can be used as an alternative strengthening material for the reinforced concrete beams damaged due to overloading.

Patil et al. (2012)[13] studied the performance of chicken mesh on strengthening of beams retrofitted using ferrocement jackets. RC beams initially stressed to a prefixed percentage of the safe load are retrofitted using ferrocement to increase the strength of beam in both shear and flexure, the chicken mesh was placed along the longitudinal axis of the beam. To carry out the investigation, six prototype beams were cast using the proportioned mix. Out of the six beams, two were used as control beams are tested to failure to find out the safe load carrying capacity. The other four beams were stressed to 60 and 80 percent of the safe load obtained from the testing of the control beams and were then retrofitted with 15 mm thick ferrocement jackets made with 1:2 cement sand mortar and w/c ratio 0.40. The jacket was reinforced with doubled layer of 10mm x 10mm hexagonal chicken mesh. From the study it is seen that the safe load carrying capacity of rectangular RC elements retrofitted by ferrocement laminates is significantly increased with chicken mesh used for retrofitting.

Veera and Maheshwar (2011)[16] studied the behaviour of RC beams deficient in shear, strengthened using ferrocement jacketing with maintaining the original cross sectional dimensions. The experimental programme consists, casting of 24 simply supported shear deficient RC beams of size 120mm x 200mm in cross section and 1500mm in length. The preloading levels adopted in this investigation were 70%, 90% and ultimate load. Ferrocement jacketing with 2,4,6 and 8 layers of woven wire mesh were used. The improvement in the load carrying capacity for the ultimate loaded beams and then jacketed with 2 layers is 2.30%, with 4 layers is 5.96%, 6 layers is 7.79% and with 8 layers is 9.52%. The shear failure is averted in the strengthened beams and the mode of failure has transformed from shear failure to flexure failure.

Kumar et al. (2010)[10] studied the mechanical properties of mortar containing Acrylic Latex in ferrocement, with three different volume fractions of mesh reinforcement. Experimental investigations consist of the preparation of acrylic rubber latex based modified ferrocement elements with different volume fractions of steel mesh reinforcements. Tests were carried out involving the application of the reinforced repair material to the soffit of the reinforced concrete beams of 3 m length. The levels of damage of the original beams prior to repair did not affect the ultimate load of the strengthened beams tested. The performance of the strengthened beams was compared to the control beams with respect to cracking, deflection and ultimate strength which confirm preeminent results. The flexural and compressive strength of polymer modified mortars are improved over unmodified mortar by adding 15% of acrylic rubber latex through 5% volume fraction of mesh reinforcement in the polymer ferrocement specimens.

Kumar et al. (2010)[11] investigated the mechanical properties of mortar through difference in polymer content and also by ferrocement with three different volume fractions of mesh reinforcement incorporated by styrene butadiene rubber latex. A preliminary test program was set up to investigate the mechanical properties of ferrocement by methods of attachment of mesh reinforcement with volume fraction 3.55%, 5% and 6.43% with influence of polymer modification on the properties of cement mortar. Different parameters were taken into account regards to the polymer cement ratio and volume fraction of reinforcement. To understand the characteristics of polymer ferrocement composites eight beams were cast and tested under static condition with two points loading. Out of eight beams two control beams were tested to attain the ultimate load. The remaining six beams were retrofitted with polymer modified ferrocement laminates with the same volume fraction of mesh reinforcement as adopted during the preliminary study. Result from the test program shows that by incorporation of polymers, the mesh reinforcement with volume fraction 5% appropriate for compressive as well as flexural members and 6.43% precise for tensile members.

Effect of fibres in ferrocement laminate

Shoaib et al. (2014)[14] studied the behaviour of hybrid ferro fibre reinforced concrete under tension. In this investigation polypropylene and steel undulated fibres have been used in ferrocement. The cement mortar mixed with 1% fibre and single layer and double layer weld mesh was used for the study. Loading was applied gradually through a hydraulic system and mid span displacements were recorded. The loading was continued till the failure of specimen occurred. The initial and final crack width is recorded. The behaviour of other combination has been studied for tensile strength and ultimate load at failure. It was observed that specimen with steel fibre takes more tensile load than the specimen with the polypropylene fibre, but in crack control for the polypropylene fibre reinforced specimen is good then steel fibre and specimens without fibre.

Badagha et al. (2013)[2] studied the effects of polyester fibres on the behavior of cement composites in terms of compressive strength and split tensile strength, tests were carried out on specimens with polyester fibres and without polyester fibres. The variable percentages of fibre content, chosen for this investigation were 0.3, 0.4, 0.5, 0.6, 0.8 and 1.0%. From test results, for polyester fibre mortar, the maximum compressive strength increased at 7 days 17.68 % without any chemical agents or any other additives. The maximum split tensile strength increased by 32.58 % at 7 days and 70.37 % at 28 days respectively. The optimum level of fibre was found to be 0.6%.

Sakthivel et al. (2012)[12] investigated the impact strength of fibre reinforced ferrocement slab elements using a combination of PVC coated weld mesh and a new type of synthetic fibre material, bar-chip-54 polyolefin fibres in proportions of 0.5%-2.5% of volume of specimens, three, four and five layer of mesh were used. From the experimental results it was concluded that addition of bar chip polyolefin fibres in cementitious matrix has shown substantial increase in the compressive, split tensile and mortar flexural strength, when compared to plain cement mortar. Both PVC-coated weld mesh and synthetic bar-chip polyolefin fibres can be effectively used as non-corrosive reinforcing materials in ferrocement.

Naaman et al. (2004)[9] made an attention to reduce number of layers and add discontinuous fibres (expanded steel meshes, Kevlar fibre reinforced polymer mesh and synthetic fibres) into the mortar in ferrocement .The specimens were subjected to four point loading .The results were compared with the specimen using plain mortar ,the presence of fibre results in substantial increase in modulus of rupture, significant reduction in crack spacing and in turn crack width, prevention of cover spalling even at large deflection , and considerable improvement in shear capacity and delays the inter laminar shear failure.

Table -1 : Materials, type of testing and experimental results

AUTHOR	SPECIMEN (mm)	FERROCEMENT LAMINATE	ADHESIVE	TYPE OF LOAD	TYPE OF TESTING	RESULT
Ganapathy.L (2015)	RC BEAM Size:1000x 150x150 Grade of concrete: M20	Mesh : wire mesh Mortar mix : 1:2, w/c : 0.4 No. of layers :3,4	Epoxy resin	Static load Two point loading condition	Flexural test	The strength of beam using fibrous Ferro cement laminated was increased.
Ezz-Eldeen (2015)	RC BEAM Size:1250 x 160 x 100 Grade of concrete: M20	Mesh : galvanized steel wire mesh	Epoxy resin	Static load Two point loading condition	Flexural test	The deformation of retrofitted beams decreases by increasing the wire mesh piles
R. Malathy (2014)	RC BEAM Size:1220 x 100 x 150 Grade of concrete: M20	Mesh : galvanized steel wire mesh Mortar mix : 1:2, w/c : 0.4 FA : 30% steel slag No. of layers : 1,2	Epoxy resin	Static load Two point loading condition	Flexural test	Overall performance of RC beam strengthened with Vf of mesh reinforcement 2.35 % and replacement of fine aggregate with steel slag by 30% are found to be high
S.U.Khan (2013)	RC BEAM Size:1800 x 150 x 200 Grade of concrete: M20	Mesh : woven square wire mesh Mortar mix : 1:2, w/c : 0.5 Cast in situ and precast laminates No. of layers : 2,3	Epoxy resin	Static load Two point loading condition	Flexural test	Performance of RC beams strengthened by three layer of Wire mesh using both technique was found to be better in terms of maximum increase in stiffness.
Yousry B.I.Shaheen (2013)	CHANNEL BEAM Size:2000 x 100 x 100 Thickness of web : 25 Grade of concrete: M20	Mesh : expanded metal mesh, welded metal mesh, fibre glass mesh Mortar mix : 1:2, w/c : 0.4 Fibre: polypropylene fibre (0.9 kg/m³)	Epoxy resin	Static load Four point loading condition	Flexural test	Employing weld wire mesh and polypropylene fibre in mortar mix increases the first crack load, serviceability load, and

		No. of layers : 1,2,4				ultimate load, and energy absorption, higher stiffness.
A.E.Naaman (2004)	-	FERROCEMENT PLATES Size: 304.8 x 76.2 x 12.7 Mesh : expanded metal mesh, Kevlar FRP mesh Fibre: PE spectra 900 fibre , PVA fibre No. of layers : 2	-	Four point bending	Frame system	The addition of fibers to the matrix was very effective in preventing the spalling of mortar cover at ultimate load.
Damyanti G Badagha (2013)	CUBES (cement mortar) Size : 70.6 x 70.6 x 70.6 Fibre : Recron-3S fibre (0.3,0.4,0.5.0.6,0.8, 1.0 % by weight of cement)	-	-	-	Compression test Split tensile strength	At 0.6% of fibre gave maximum split tensile strength.

3. CONCLUSIONS

This paper reviewed the earlier works of ferrocement laminates, Recron-3S fibre and strengthening of RC beams reveals the following

- In the earlier work, attempts have been made by different authors to investigate the flexural, shear and tensile behaviour of ferrocement laminates with different parameters.
- Also most of the investigation are focused on the behavior of ferrocement laminates cast with cement and sand mortar with different parameter such as volume fraction, water cement ratio, type of wire mesh etc.,
- Further, no more information is available in the literature about the effect of recron-3s fibre in ferrocement laminate on the strength and other properties like ductility factor, energy absorption, load deflection behavior etc.,
- Hence there is a lot of scope for studying the effect of recron-3s fiber in ferrocement laminates and its application in strengthening of RC beams in flexure.

REFERENCES

[1] Alaa A.Bashandy, "Experiments on flexural strengthening of reinforced concrete beams using valid strengthening techniques", Acta Technica Napocesis: civil Engineering and Architecture, Vol.56, No.1, Pp.36-50, 2013.

[2] Damyanti G Badagha and C.D.Modhera, "Studies on harden properties of mortar using polyester fibre", International Journal of Advances in Engineering and Technology, Vol.6, No.3, Pp.1154-1159, 2013.

[3] H.A.Ezz-Eldeen,"An experimental study on strengthening and retrofitting of damaged reinforced concrete beams using steel wire mesh and steel angles", International Journal of Engineering Research and Technology , Vol.4, No. 5, Pp.164-173,2015.

[4] L.Ganapathy and N.Sakthieswaran, "Strengthening of reinforced cement concrete beam using fibrous ferrocement laminates", International Journal of Science and Engineering Research, vol.3, No.5,Pp. , 2015.

[5] S.U.Khan, M.F.Nuruddin, T.Ayub and N.Shafiq, "Effects of ferrocement in strengthening the serviceability properties of Reinforced concrete structures", Advanced Material Research,Vol.690,Pp.686-690,2013.

[6] S.U.Khan,S.F.A.Rafeeqi and T.Ayub, "Strengthening of RC beam in flexure using ferrocement", IJST, Transactions of Civil Engineering, Vol. 37, No. C+, Pp 353-365, 2013.

[7] R.Malathy, J.Sridhar and R.K.Sangeetha,"Flexural strengthening of reinforced concrete beams using ferrocement laminates with partial replacement of

fine aggregate by steel slag", Journal of Engineering and Technology, Vol.4, No.2, Pp.123-126,2014.

[8] Md.Motiur Rahman,Tahmina Tasnim Nahar and Anish kumer saha, "Effect of wire mesh on the strength of R.C.C beams repaired using ferrocement layers", International Journal for Research and Development in Technology ,Vol.1,No.1,Pp.13-18,2014.

[9] A.E.Naaman and Victor C.Li, "Bending response of hybrid ferrocement plates with meshes and fibers", Journal of Ferrocement, vol.34, No.1, pp.275-288, 2004.

[10] D.Raj kumar and B.Vidivelli, "Acrylic rubber latex in ferrocement for strengthening reinforced concrete beams", American Journal of Engineering and Applied sciences, Vol.3.No.2, Pp.277-285, 2010.

[11] D.Raj Kumar and B.Vidivelli, "Performance of SBR latex modified ferrocement for repairing reinforced concrete beams", Australian Journal of Basic and Applied Sciences, Vol.4, No.3, Pp.520-531, 2010.

[12] P.B.Sakthivel and A.Jagannathan, "Fibrous ferrocement composite with PVC-coated weld mesh and bar-chip polyolefin fibers", International Journal of Geomate, Vol.3, No. 2, Pp.381-388, 2012.

[13] Sandesh S Patil, R.A.Ogale and Arun Kr. Dwivedi, "Performance of chicken mesh on strength of beams retrofitted using ferrocement jackets", IOSR Journal of Engineering, Vol.2, No.7, Pp.1-10, 2012.

[14] Sayyed Shoaib, Swayambhu Bhalsing and Pankaj Autade, "Behaviour of hybrid ferro fibre reinforced concrete under tension", International Journal of Innovative Research in Science, Engineering and Technology, Vol.3, No.4, Pp.508-513, 2014.

[15] B.Sivagurunathan and B.Vidivelli, "Strengthening of Predamaged reinforced concrete beams by ferrocement plates", International Journal of Current Engineering and Technology, Vol.2, No.4, Pp.340-344, 2012.

[16] M.Veera Reddy and E.Maheshwar Reddy, "Rehabilitation of shear deficient RC beams", International Journal of Earth Sciences and Engineering, Vol.4, No.6, Pp.1125-1128, 2011.

[17] Yousry B.I. Shaheen, Noha M. Soliman and Ashwaq M. Hafiz, "Structural behaviour of ferrocement channels beams", Concrete Research Letters, Vol.4, No.3, Pp.621-638, 2013.

BIOGRAPHIES

Ms. N.Karunya has completed B.E in Civil Engineering from Bharathiyar institute of Engineering for women and doing M.E (Structural Engineering) degree course from K.S.Rangasamy College of Technology, India.

Mrs. R.T.Anitharanee obtained her B.E and M.E degree courses in Civil and Structural Engineering from Kumaraguru College of Technology and PSG College of Technology, India repectively. Has a teaching experience of two and a half years and currently working as Assistant Professor, Department of Civil Engineering, K.S.Ranagasamy College of Technology, Tiruchengode, India.

Mr. K.Eswaran has completed B.E in Civil Engineering and doing M.E (structural Engineering) degree course from K.S.Rangasamy College of Technology, India.

Dr. J. Sridhar obtained PhD from Sona College of Technology, India. He has a teaching experience of eight years and currently working as Professor, Department of Civil Engineering, K.S.Ranagasamy College of Technology, Tiruchengode, India.