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Flexural Behavior of Ferrocement Composite Slab

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Abstract: This project presents a Flexural behaviour of composite ferrocement slabs to investigate the effect of impact and ultimate flexural load on ferrocement slabs of size 600mmx400mmx15mm (thickness) reinforced with PVC coated steel weld mesh, and compare the results with slabs made of GI-coated steel weld mesh. PVC-coated weld mesh is used as non-corrosive reinforcement in ferrocement slab. The ferrocement slab was cast using Ordinary Portland Cement, locally available river sand and portable water with cement mortar ratio of 1:3 and water cement ratio of 0.5. The aim of this study is to observe the influence of PVC coated weld mesh ferrocement slab using ferrocement in enhancement of the mechanical properties of slabs subjected to impact and flexural load. The flexural load, maximum deflection, crack- pattern and crack-width of ferrocement slabs reinforced with PVC and GI coated weld mesh were analysed. Finally, the analytical results were compared with experimental results to predict the effectiveness of ferrocement techniques in structural applications.
Keywords: Cement, Fine Aggregate, Coarse Aggregate, Water, Ferrocement, PVC, GI, Deflection, Non-corrosive coating, weld-mesh.

I. INTRODUCTION

With an increased demand for the building infrastructure at economical cost, it has led to use the available materials in an efficient way. The basic idea is utilization of the material strength possessed in it. Today's structures are situated in more aggressive environment. These leads to the development of Ferrocement structures.

Ferrocement is a type of thin-wall reinforcement concrete commonly constructed of hydraulic cement mortar, reinforced with closely spaced layers of continuous and relatively small diameter mesh. But in general, Ferrocement can be defined as "A Composite material consisting of a matrix and a reinforcement in a finely distributed manner which act together to form a new material with characteristics superior to either of its constituents.

According to American Bureau of shipping it can be defined as "A thin, highly reinforced shell of concrete in which the steel reinforcement is distributed widely throughout the concrete, so that the material under stress acts approximately as a homogeneous material. The strength properties of the material are to be determined by testing a significant number of samples".

Ferrocement is considered to be an extension of reinforced concrete technology. It is the uniform distribution of the reinforcement in the resulting composite and its different material performance, strength behaviour and potential applications which create a distinction from conventional reinforced concrete, that it must be classified as a separate material.

Ferrocement possesses a degree of toughness, ductility, strength and crack resistance that it is considerably greater than that found in other forms of concrete construction. These properties are achieved in structures with a thickness that is generally less than 25mm, a dimension that is nearly unthinkable in other forms of concrete construction, and a clear improvement over Conventional reinforced concrete. Surprisingly, good performance can be achieved in Ferrocement with almost primitive field conditions and it does not necessarily require highly skilled practitioners. One can call it a high technology material, yet its production in terms of required labours skills and lack of sophistication of its constituent parts could be viewed as a low technology. The combination of ferrocement slab with concrete slab, when the two are so connected that they act as a single unit in resisting flexure is called as composite slab. The vast literature shows that Ferrocement is a versatile construction material and that it has already attained worldwide popularity in almost all kind of applications.

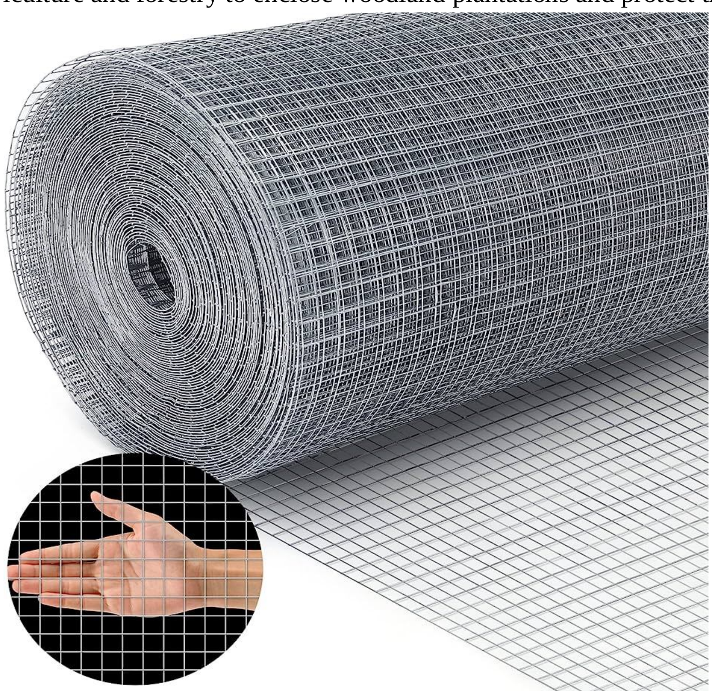
II. FERROCEMENT SLAB

The most extensively used building medium in the world today is concrete and steel combined to make reinforced concrete; familiar uses are in high-rise buildings, highway bridges, and roadways. Yet, the first known example of reinforced concrete was a fibre cement boat. Reinforced concrete developed as the material familiar today in fairly massive structures for which formwork to hold the fresh concrete in the wide gaps between reinforcing rods and a fairly thick cover over the rods nearest the surface are required, he observed that reinforcing concrete with layers of wire mesh produced a material possessing the mechanical characteristics of an approximately homogenous material and capable of resisting high impact. Thin slabs of concrete reinforced in this manner proved to be flexible, elastic, and exceptionally strong.

Ferrocement

A. Wire Mesh

Mild steel welded wire mesh layers of 2mm diameter and 25mm spacing of wire mesh. Square mesh is used in this experiment. Steel meshes for Ferro cement includes square woven or square welded mesh and chicken wire mesh of hexagonal shape and expanded metal mesh. Some mesh filaments are galvanized. Properties of the resulting Ferro cement product can be expected to be affected by mesh size, ductility, manufacture and treatment. Wire mesh is commonly used in industrial applications when separation or filtration is needed; it is also popular for use in commercial applications, like insect screening or animal fencing. Wire nettings include the so-called wire netting fences. Examples are the rectangular nettings which are often used to enclose properties. Hexagonal nettings are used in agriculture and forestry to enclose woodland plantations and protect them against animals.



Wire Mesh

B. PVC Mesh Of Ferrocement Composites

Concrete has been widely used in construction due to its high compressive strength, excellent workability and easily moulded into any shape. However, several problems attached to ordinary concrete, i.e., possesses low tensile strength, low ductility, and low resistance to cracking, which could lead to failure of concrete. Therefore, there are needs to improve the performance and durability of concrete, as well as reducing the defects in concrete. One of the effective methods is by adding pieces of short fibers to the concrete mixing process. reported that the use of fiber in concrete can improve its resistance to pull out or stress to rupture found that some properties of fiber control the dry and plastic shrinkage cracking, thus reduces bleeding of water.

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PVC Coated Wire Mesh

C. Properties Of Ferrocement

The essential properties of Ferro cement are:

1) The ability to construct thin shells at any shape.
2) The possibility of elimination of shrinkage and temperature cracking due to inherent material properties.
3) An improvement in effective tensile strength compared with plain or ordinary reinforcement concrete.

D. Characteristics Of Ferrocement

1) Ease of construction
2) Improved tensile properties
3) High resilience
4) Ability to take large deflection before collapse
5) Vibration resistance: Ferrocement has substantial potential for supporting vibratory loads.
6) Light weight as compared with similar structures made of reinforced or prestressed concrete.

E. Advantages Of Ferrocement

1) It can be fabricated into almost any shape
2) It can be fabricated into almost any shape
3) Heavy plant and machinery are not required
4) Easy to repair
5) On the material side:
6) Toughness
7) Ductility
8) Durability
9) Strength
10) Cracking resistance

III. MIX PROPORTIONS

Table – 1 Mix Proportions

CEMENT Kg/m3	FINE AGGREGATE Kg/m3	COARSE AGGREGATE Kg/m3	WATER Kg/m3
350	684	1210	197
1	1.95	3.45	0.5

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Table – 2 Quantity Calculation of Slab

Different Mixes	Water kg	Cement (Kg) (Slab)	FA required in kg (Slab)	CA required in kg (Slab)	Mesh required in kg (Slab)
M0	0.71	0.84	2.46	4.36	0.211
M1	0.71	0.84	2.46	4.36	0.097

IV. EXPERIMENTAL INVESTIGATION

As per derived mix design ratio, Specimen to be casted are listed below as follows as

1) Cube mould (150 x 150x 150 mm)
2) Cylinder mould (150 x 300 mm)
3) Slab mould (600 x 400 x 150 mm)

Cube Specimen

Cylindrical Specimen

Beam Specimen

V. TESTING OF SPECIMEN

A. Hardened Concrete Test

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. One of the main purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. Following are the static tests to be carried out on the fresh concrete in order to study the properties and behaviour of a fresh concrete that determines the mechanical behaviour of the concrete. Hardened concrete is a type of concrete that is strong and have the capacity to bear the structural as well as service loads that are applied to it. Hardened concrete is one of the strongest and durable construction materials. Hardened concrete is concrete that is completely set and able to take the loads.

Compression Test on Cube

Flexural Strength Test on Beam

Split Tensile Strength Test

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VI. TEST RESULTS

Table – 3 Compressive Strength of Mortar Cubes

Mortar Cube	7 Days N/mm2	28 Days N/mm2
1	20.9	32.23
2	21.03	33.33
3	21.8	34.8
Average value	21.24	33.25

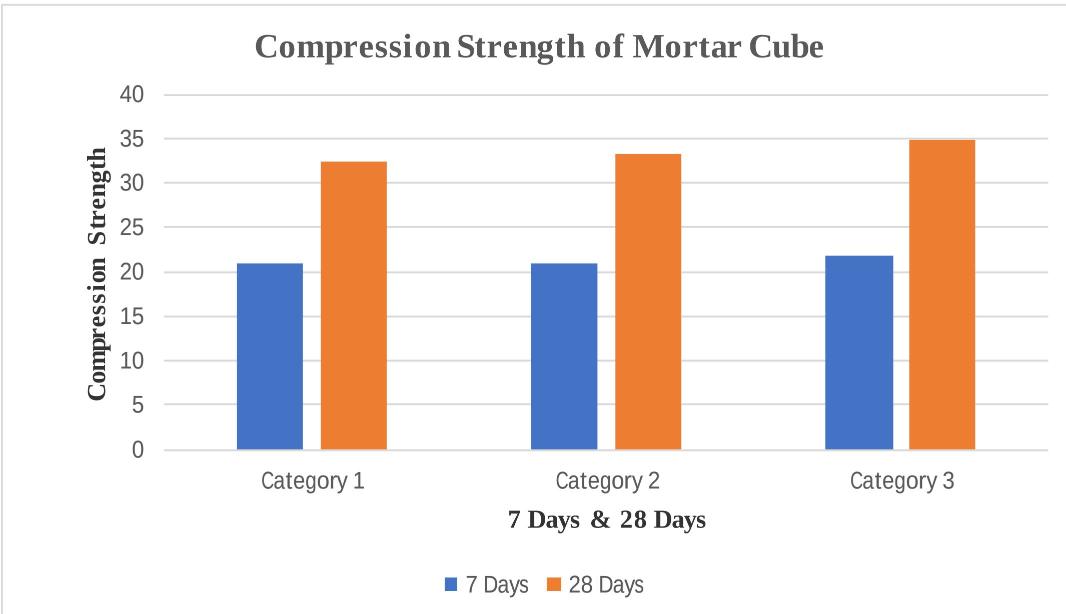

Table – 4 Compressive Strength of Concrete Cubes

Concrete Cube	7 Days N/mm2	28 Days N/mm2
1	13.9	22.23
2	13.03	21.06
3	14.5	23.8
Average value	13.81	22.12

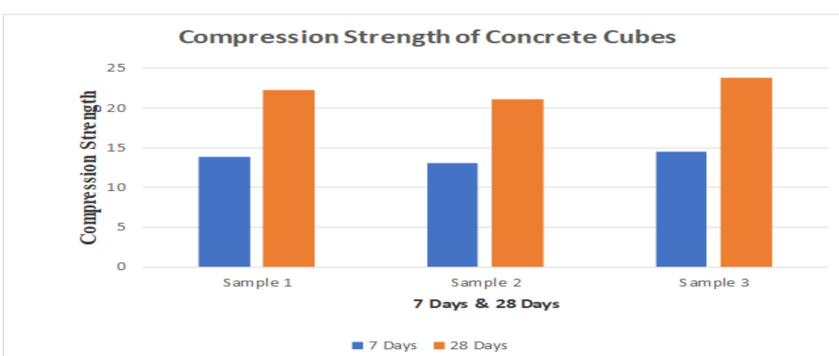

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Table – 5 Split Tensile Strength of Cylinder

Concrete Cylinder	7 Days N/mm2	28 Days N/mm2
1	2.26	3.82
2	2.12	3.23
3	2.30	3.56
Average value	2.22	3.54

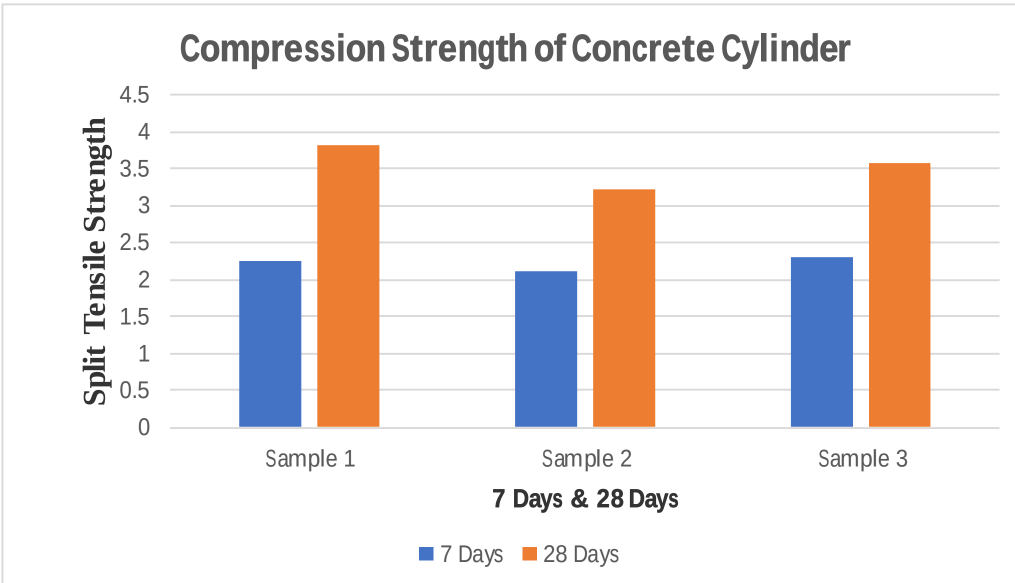


Table – 6 Flexural Strength of GI Mesh Slab

Types of Loading	Load Carrying Capacity IN (N)	Flexural Strength (N/mm2)
Two-Point loading	3900	8.62
Centre point loading	2900	6.59

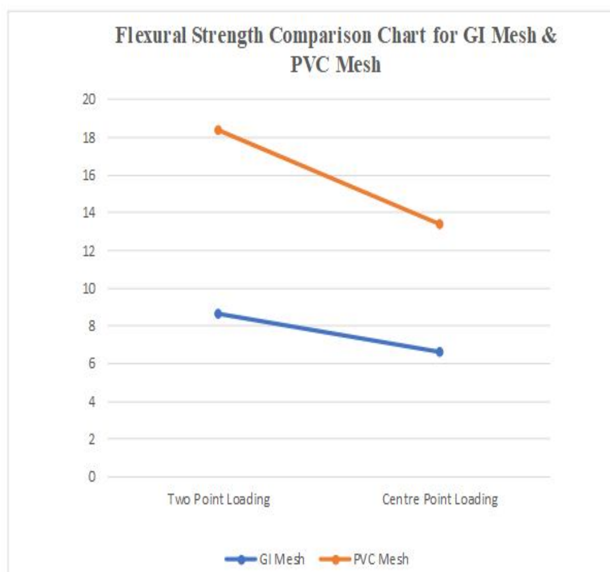
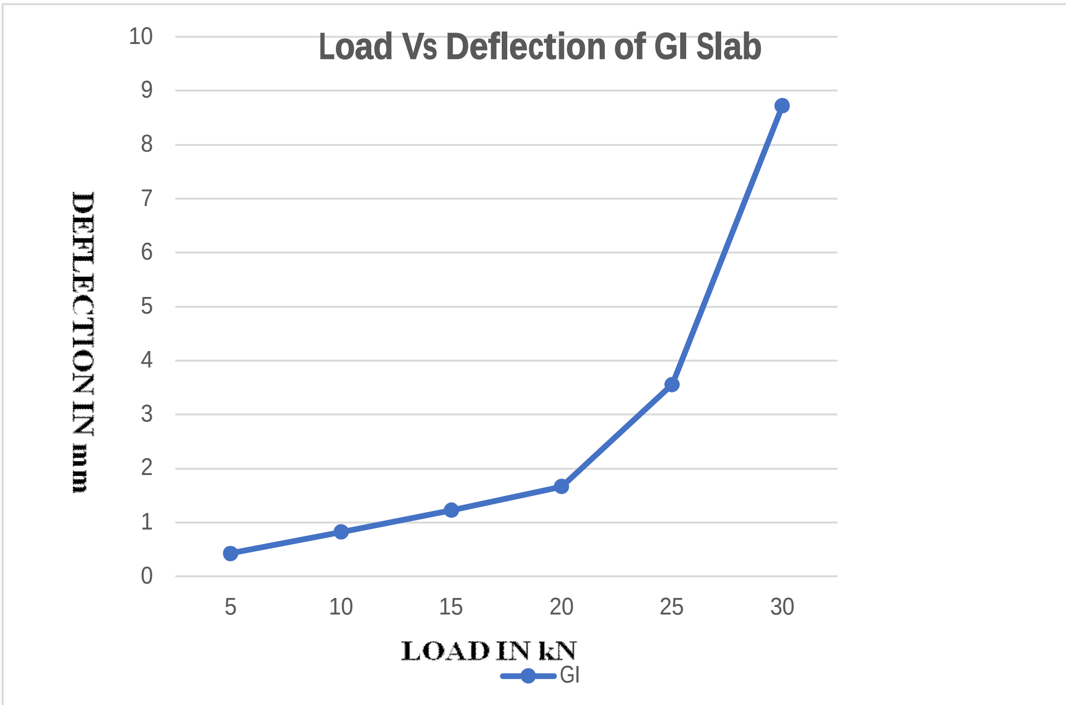


Table – 7 Flexural Strength of PVC Mesh Slab

Types of Loading	Load Carrying Capacity IN (N)	Flexural Strength (N/mm2)
Two-Point loading	4150	9.75
Centre point loading	2950	6.24

Table – 8 Flexural Strength of RCC Slab

Load in KN	0	5	10	15	20	25	30
Deflection of slab1 in mm	0	0.43	0.83	1.23	1.67	3.56	8.72
Deflection of slab2 in mm	0	1.45	2.34	3.45	4.23	6.45	9.45



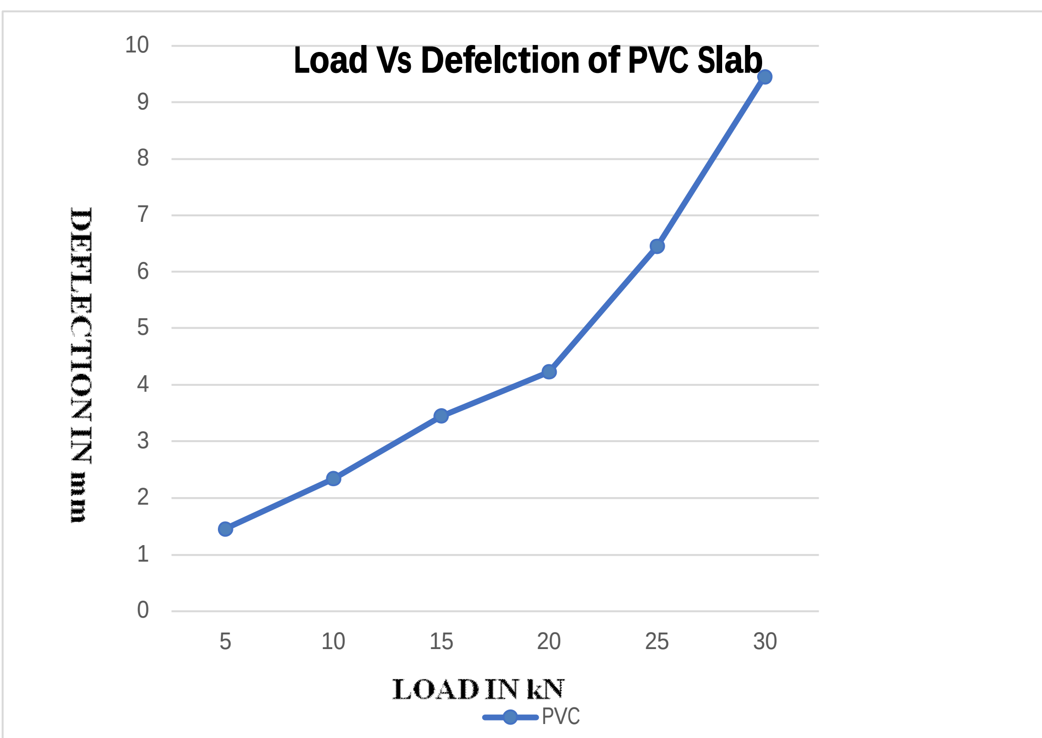


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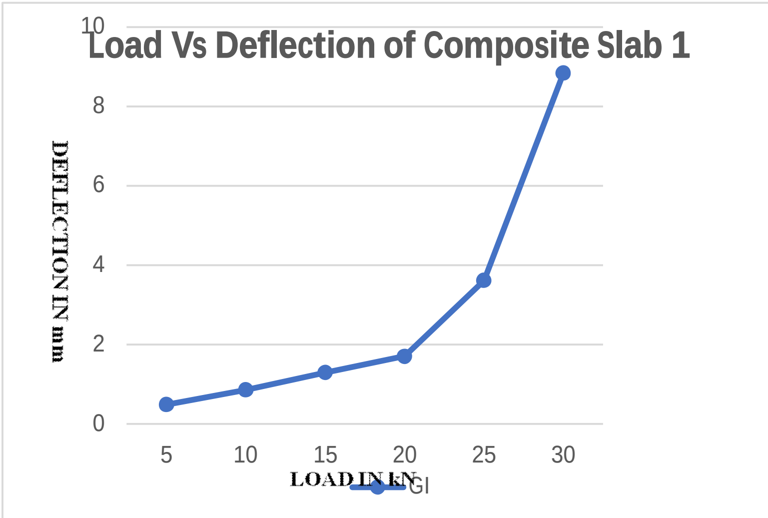
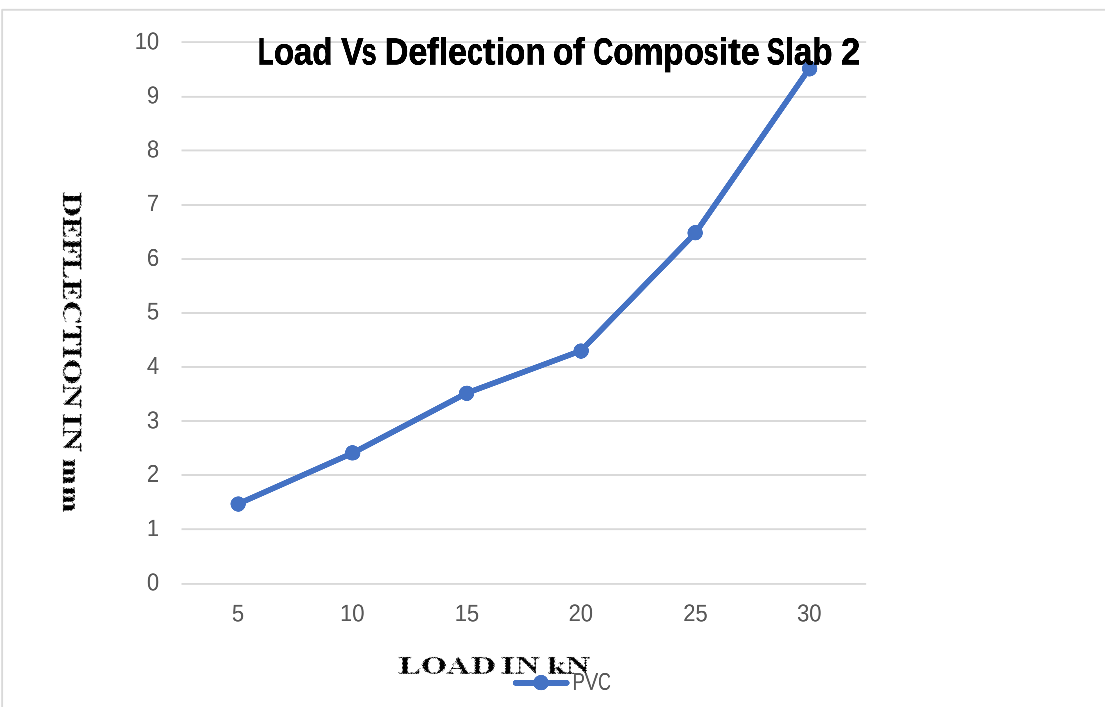
Table – 9 Flexural Strength of Composite Slab

Load in KN	0	5	10	15	20	25	30
Deflection of slab1 in mm	0	0.49	0.86	1.30	1.71	3.62	8.83
Deflection of slab2 in mm	0	1.47	2.41	3.52	4.30	6.48	9.52





VII. CONCLUSION

This paper proves that reinforced concrete slabs with Ferro cement tension zone cover is superior in crack control, stiffness and first crack moment to similar slabs with normal concrete cover. Construction costs with Ferro cement cover will, of course, be higher. However, this could be greatly offset by sparing millions of pounds spent on repairing damaged structures caused by cracked or spelled normal concrete covers. Moreover, it allows existing conventional concrete materials and practices to be used. Further research work will be required to investigate the use of Ferro cement cover for other applications, especially the use of deep covers, usually advocated in corrosive conditions, without giving rise to wide surface cracks. Within the range of the variables covered by the present study, the following conclusions may be drawn:

1) The longer the fiber and its interlocking length tends to improve the compressive strength of fiber reinforced concrete. However, the use of the PVC coated material as fiber, with its smooth and slippery surface characteristics, fails to increase the tensile strength of fiber reinforced concrete.
2) There is a good correlation between slump and compressive strength, and between unit weight and elastic modulus, of fiber reinforced concrete. It is indicated that the higher the PVC coated welded wire mesh fraction and the longer the fiber length or the interlocking length tends to lower the elastic modulus of fiber reinforced concrete.
3) The fibrocement components used in this study have a simple cross-section and can be easily fabricated using simple formwork.
4) Increasing the number of steel fabric plies from 1 to 3 resulted in a significant increase in flexural strength and energy absorption to failure.
5) The preliminary research conducted in this study indicates that ferrocement capping can be successfully used for reinforced concrete slabs.
6) The crack width of the tested reinforced concrete slabs was significantly reduced by the use of ferrocement. Specimens with ferrocement cover exhibited higher stiffness and cracking moment than those with normal concrete cover. Deflection near the service load was significantly reduced in the specimens with ferrocement cover.
7) A slight improvement in the flexural strength of the test specimens with ferrocement coating was observed
8) Full composite action can be achieved by shear connectors, which are used to connect between the shear-loaded plates of the ferrocement slab and improve the shear behaviour.

VIII. ACKNOWLEDGEMENT

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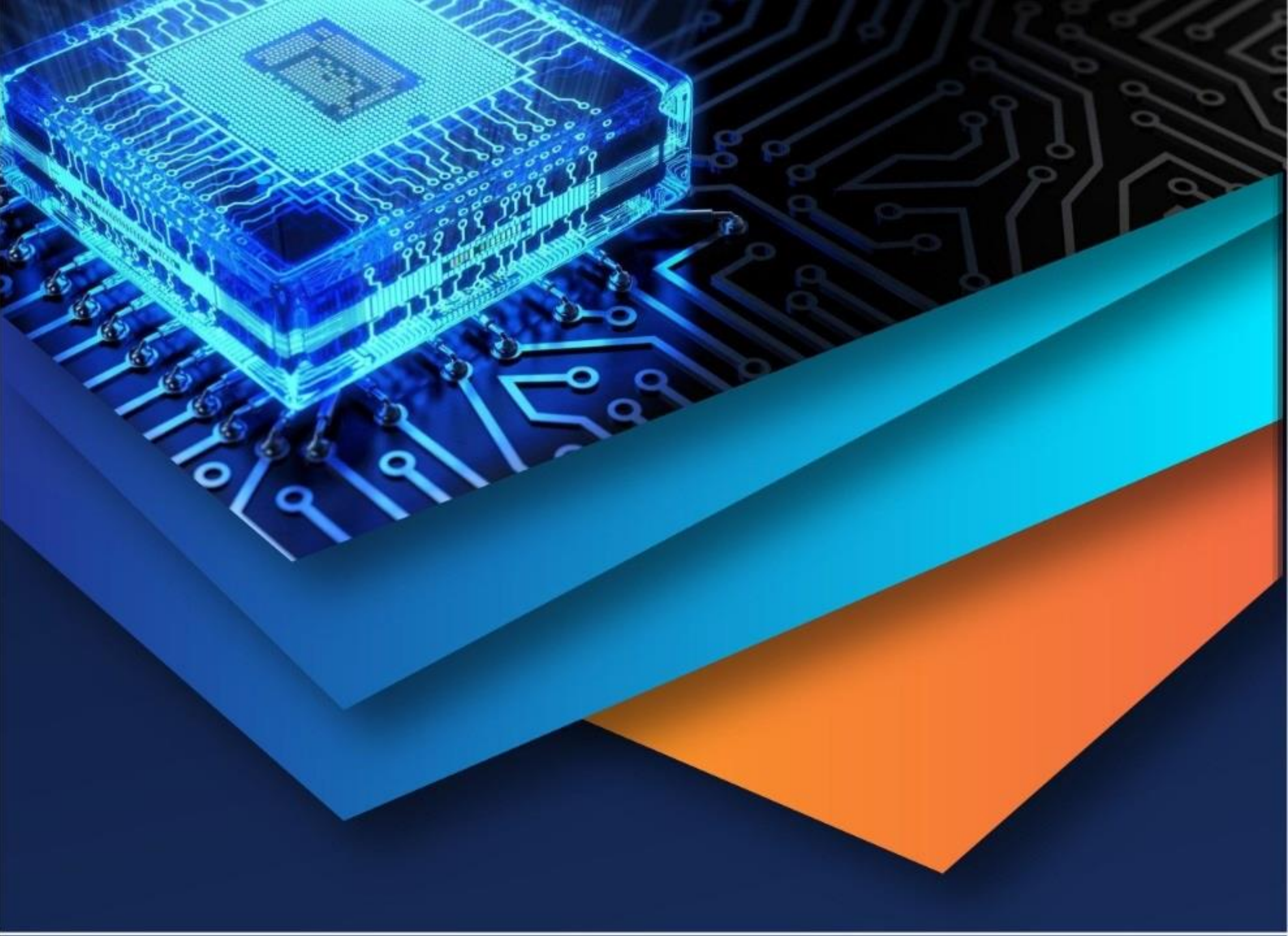

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