# FLEXURAL BEHAVIOUR OF FERROCEMENT SLABS LONGITUDINAL STEEL WINDED PALM FIBER

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## ABSTRACT

*Ferro cement slab panels are a thin composite material composed of a mortar matrix based on cement and strengthened with a layer of tiny diameter wire mesh positioned near together. Recently it is observed that Ferro cement has increased attention as a potential building material in developing countries like India, especially for construction of slabs and roof. Prefabricated slab panels of thickness 50mm to 150mm are now used where speedy construction is required. These panels are becoming much popular because of its ease in construction, speed and economy. The main advantage of Ferro cement panel of its reduced thickness and self-weight. This project examines the use of palm fiber in Ferro cement. In this present study the physical properties of cement, fine aggregate, water and palm fiber are tested and the values evaluated. The compressive strength of Ferro cement slab made with 1%, 2%, 3%, 4% and 5% of palm fiber additionally added by weight of cement are found and the panels of size 600mm x 450mm x 50mm are casted and cured. The slab panels load carrying capacity analysis is done by using loading frame equipment. One to three percentage of palm fiber added Ferro cement slab loading carrying capacity is 9% to 30% increased. The optimum utilization of palm fiber percentage is 3%.*

Keywords : *ferrocement slab, palm fiber, mortar, slabs.*

## 1 INTRODUCTION

Hungarian architect Áron Losonczi created translucent concrete, a novel building material, at the Technical University of Budapest in 2001. It comes in precast blocks of different sizes and is also referred to as light-transmitting concrete. This cutting-edge polymer lets light through by incorporating optical fiber strands into its structure. The fibers allow light,

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either artificial or natural, to pass through translucent panels, which makes it appropriate for a variety of architectural and interior design uses, such as partitions and cladding. Optical fibers, positioned in the matrix of the concrete component parallel to one another, allow for the inter-communication of the two sides of the concrete component with relative ease. Due to the lung capacity of the optical fibers, this claim operates optimally without wastage. Unlike the ordinary concrete, the composition for making translucent concrete consists entirely of fine aggregates without including coarse ones. This unique feature design ensures a relatively uniform and smooth texture conducive to embedding optical fibers. Some structural flexibility allows the use of optical fibers in the concrete to enhance the visual aspect of the design. Translucent concrete not only provides energy-efficient solutions for interior design by reducing the reliance on artificial lighting, but also allows for abundant natural light, creating a multitude of design opportunities. This material serves as an excellent way to integrate architectural structures with contemporary aesthetics for added interior focal points.

The ferrocement is another building material that is very useful and easy to handle. It is a composite reinforced in a mortar matrix made with cement that contains small-diameter rods and approximately spaced wire mesh that is thin in cross-section. Ferrocement is a type of concrete that has reinforcement placed in layers of mesh and tiny rods that fully embedded in mortar in accordance with the American Concrete Institute (ACI) code of practice 549-1988. Ferrocement was invented by the Italian engineer Pier Luigi Nervi in the year 1940, since then it has been popular due to its strength and ability to sustain itself through any building application. The method for making ferrocement is easy and cheap, it only requires materials that can be found most of the time, such as water, cement and sand. In most third world countries, these materials are because they are cheap. The reinforcing materials, for example, expanded metal parts, wire mesh, streel rods, or even chicken wire are affordable and easy to manage for most people. Ferrocement building can be done without the need for complex equipment or complicated formwork and therefore, can easily be done by unskilled labor. Due to its simplicity, ferrocement can be of great help in areas where resources are scarce. It is applied to light frameworks as very thin coats usually not exceeding 2.5 cm in thickness. The ferrocement is essentially very light-weight but possesses a high density and is extremely long-lasting. It is watertight, worm and borer resistant, rot, and rodent resistant. Further, ferrocement can be manufactured in aesthetically beautiful shapes so the requirement of extensive formwork for traditional reinforced concrete is not the same in case of ferrocement. In developing countries, ferrocement is often less expensive than other common construction materials, including steel, timber, or fiberglass reinforced plastic (FRP). On the whole steel and FRP are expensive and wood is becoming scarce due to ecological reasons. Ferrocement is an ideal material for many construction purposes for its structural strength, long life and low cost. Ferrocement can beused in local irrigation, water supply and sanitation constructions, and construction industry., Ferrocement usage includes making of load carrying wall panels because of the material's lighter weight. Ferrocement lends itself to sculpted forms and can be utilized in making decorative items, architectural elements, and functional structures such as tanks and even boats. In this work, ferrocement slabs developed by casting layers of hexagonal wire mesh were evaluated for their strength and durability. With special consideration to the use of the interfacing layer of palm fibers, the study focused on the loaded panels under flexural loads. The benefits of palm fibers, which are environmentally friendly, were seen to enhance the mechanical properties of the ferrocement panels. The results indicated how the use of palm fibers can enhance the strength and flexibility of the ferrocement structures, therefore making the structures ideal for tough construction applications. On the whole, ferrocement and translucent concrete could be regarded as building materials of the future on economy, aesthetics and functionality. While the translucent properties of concrete can be used to produce aesthetic designs, ferro cement is a cost effective alternative that can be used for a variety of structural and non-structural applications. These materials emphasize how important innovation is in addressing the evolving needs of the construction industry especially in resource constrained settings.

## 2 MATERIALS AND METHODS

53 grade cement conforming to IS: 122629 is used for the preparation of the panel. There are no lumps or extraneous objects in the freshly mixed cement, which has an even consistency. The fineness of cement is 6% and it consistency 36%. The initial and final setting time of cement obtained from laboratory is 35mins and 540mins. The river sand passing through IS 4.75mm sieve is used the aggregate is comparatively devoid of silt and clay, fresh, powerful, hard, and free of harmful organic contaminants. The river sand specific gravity is 2.65. Chicken wire mesh of 10mm mesh opening and 0.5mm wire diameter are used for this work. Has anyone ever thought of using date palm fiber to make high-quality yarn? Using date palm leftovers such as fronds, leaves, leaflets, rachis, and more, Egyptian researchers at the Consortium have created high-performance sustainable textile fibers for the first time in history. This study's objectives were to identify the physiochemical, morphological, and

mechanical characteristics of date palm byproducts and extract high-performance fiber utilizing a combined alkaline-mechanical technique.

### *2.1 Physical and Mechanical Properties of Date Palm Fiber*

Deforestation or a food crisis won't cause any issues, even though this fiber is made from date palm waste. This specific fiber, like flax and sisal, has five times the structural tensile strength of steel, is 100% biodegradable and compostable, and has better thermal insulating qualities than carbon fiber. For a variety of industrial applications and natural fiber composites, the physical characteristics of the natural fibers are essential in assessing their quality. Many essential factors, including structure, micro-fibrillar angle, chemical composition, cell diameters, and flaws, have a significant impact on and define the mechanical properties of natural fibers.

### *2.2 Sources of Date Palm Fiber*

The Middle East and North Africa are home to around 140 million date palms. Presently, Egypt leads the world in date production, followed by Saudi Arabia, Iran, the United Arab Emirates, Pakistan, and Sudan. When date palms are pruned for agricultural purposes, almost 48.8 million tons of trash are produced annually. As a result, date palm fiber production is booming right now. All of these nations use date palm byproducts, including fronds, leaves, leaflets, rachis, fruit branches, etc., to make sustainable textile fibers.The mechanical characteristics of date palm fibers are determined by their primary cell wall and various secondary walls, which are made up of a number of helically wrapped cellular micro-fibrils made of long-chain cellulose molecules. The three primary components of all cell walls are cellulose, hemicelluloses, and lignin. The essential structural elements of the majority of natural fibers are cellulose and lignin. Cellulose is somewhat degradable when exposed to chemical treatments, despite its resistance to hydrolysis, strong alkali, and oxidizing chemicals. Conversely, lignin is a complex hydrocarbon polymer that often gives plants their stiffness and helps move water.

**Table 1. Properties of Palm fiber**

| Length | Density | Diameter | Specific Modulus | Thermal conductivity | Tensile strength | Elongation at Break |
|---|---|---|---|---|---|---|
| 20-250mm | 0.9 to 1.2g/cm$^3$ | 100 to 1000μm | 7 | 0.083 W/mK | 58 to 203 MPa | 5 to 10% |

**Table 2. Chemical Composition(%) of Date Palm Fibers**

| Constituents | Cellulose | Hemicelluloses | Lignin | Ash | Extractive |
|---|---|---|---|---|---|
| Leaflet | 40.21 | 12.80 | 32.2 | 10.54 | 4.25 |
| Leaf | 54.75 | 20.00 | 15.30 | 1.75 | 8.20 |
| Rachis | 38.26 | 28.17 | 22.53 | 5.96 | 5.08 |

**Figure 1. Date palm tree and fiber**

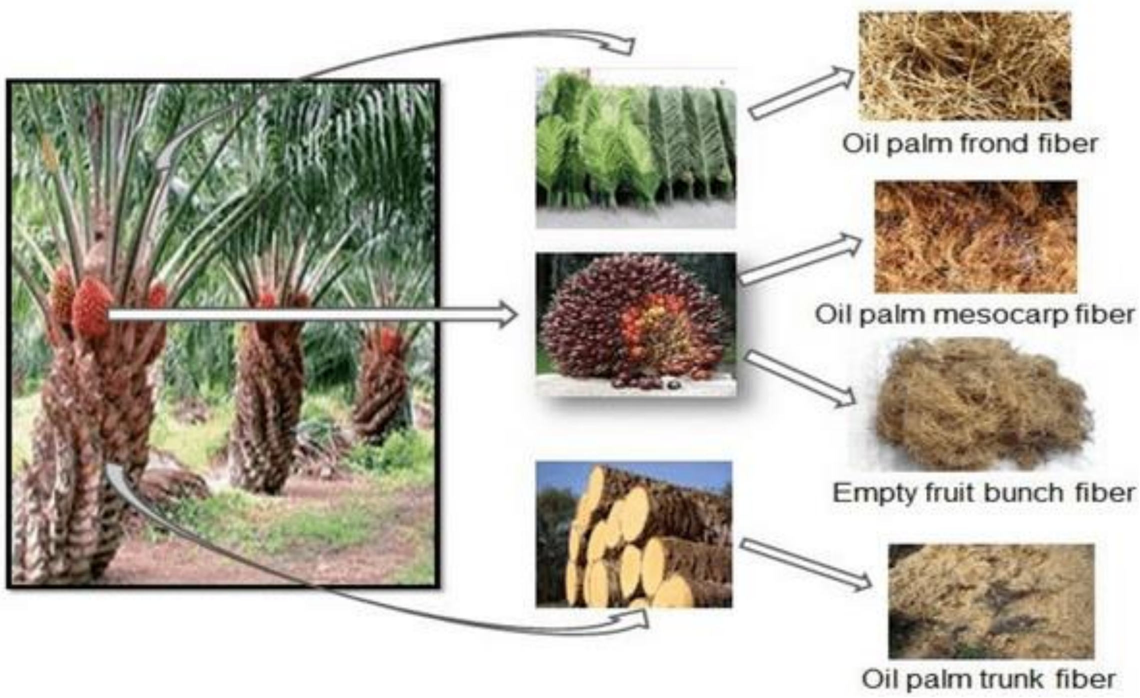


**Figure 2. Sources of Date Palm Fiber**

## 3 EXPERIMENTAL METHOD

**Table 3. Details of material quantity of one cubic**

| Materials | Std.panel | Palm fiber | | | | |
|---|---|---|---|---|---|---|
| | | 1% | 2% | 3% | 4% | 5% |
| Cement | 270g | 270g | 270g | 270g | 270g | 270g |
| Sand | 540g | 540g | 540g | 540g | 540g | 540g |
| Palm fiber | - | 2.7g | 5.4g | 8.10g | 10.8g | 13.5g |
| Water | 135g | 135g | 135g | 135g | 135g | 135g |

**Figure 3 Casting ferrocement slabs**

The purpose of the experimental program was to examine how ferrocement panels performed in axial compressive loading. For this purpose a total of 18 ferrocement slab panels are casted of size 600mm x 450mm x 50mm with Chicken wire mesh of 10mm mesh opening and 0.5mm wire diameter are used for this work. The panels are of the following types in total numbers.

- Standard panel without addition of palm fiber - 3
- 1% palm fiber added slab panel - 3

- 2% palm fiber added slab panel - 3
- 3% palm fiber added slab panel - 3
- 4% palm fiber added slab panel - 3
- 5% palm fiber added slab panel - 3

After 28 days of curing and 48 hrs drying each panel was moved and placed under the test frame. The test set up is the loading frame equipment to apply compressive load and the panels are placed in such a way that it is uniformly supported. For this a channel section is provided below the test specimen and load is applied at top of the panel through 32mm diameter steel rod of the same length as that of the panel to distribute the load equally. The test up is as shown in figure 4. The applications of the load is continued till the failure occurs. The load at which first crack and the ultimate load capacity is noted down.

**Figure 4. Testing of slab panels**

**4 RESULT AND DISCUSSION**

Eighteen numbers slab panels cast, cured and tested by using loading frame equipment. The first crack load and ultimate loads are represented in table 4 and graphically shown in figure 5. 1 to 3% palm fiber added Ferro cement slab load carrying capacity increased compare to the standard slab panel. 3% palm fiber Ferro cement slab load bearing capacity 30% increased compare to standard slab panel. The 4% and 5% palm fiber added Ferro cement slab load bearing capacity slightly reduced compare to 3% palm fiber slab panel. The 4% and 5% palm fiber added Ferro cement slab present air voids due to grouping of fiber so this reason load bearing capacity reduced. The optimum utilization of palm fiber is 3%.

**Table 4. First crack and ultimate load for Ferro cement slab panels**

| Ferrocement slab panel | First crack load(kN) | Ultimate load (kN) |
|---|---|---|
| Std slab panel | 96.50 | 139.33 |
| 1% palm fiber slab panel | 105.96 | 152.99 |
| 2% palm fiber slab panel | 116.34 | 167.98 |
| 3% palm fiber slab panel | 127.74 | 184.44 |
| 4% palm fiber slab panel | 120.52 | 174.02 |
| 5% palm fiber slab panel | 113.72 | 164.19 |

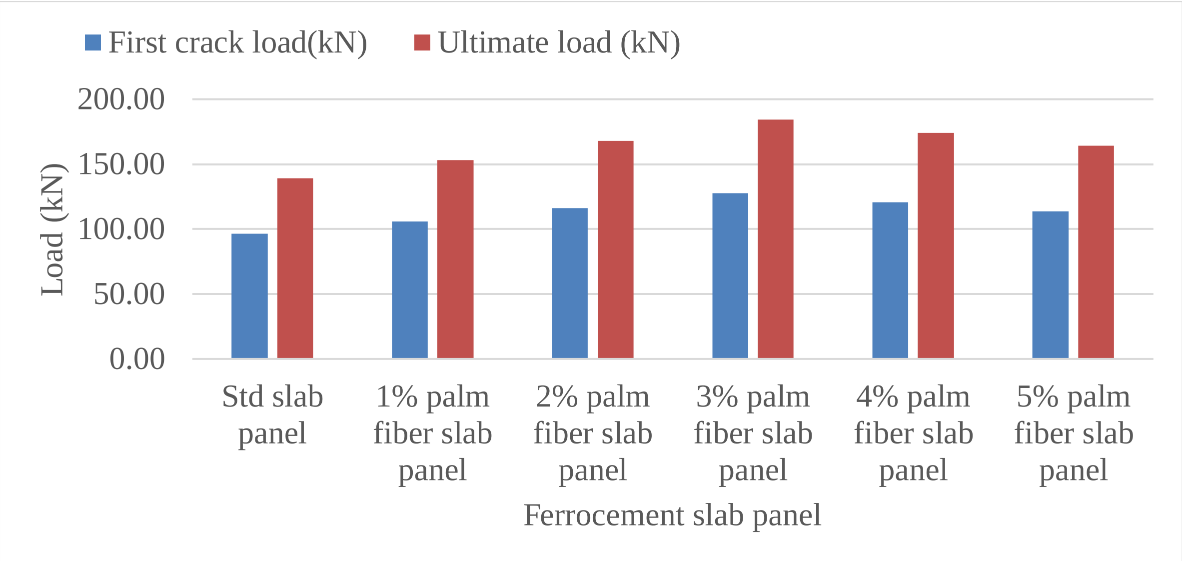


**Figure 5. First crack and ultimate load for Ferro cement slab panels**

## 5 CONCLUSION

The ferro cement slab panels load carrying capacity is checked by loading frame equipment and its result conclusion are given below One to three percentage of palm fiber added Ferro cement slab loading carrying capacity is 9% to 30% increased. The optimum utilization of fiber percentage is 3%. 4% and 5% palm fiber added Ferro cement slab load bearing capacity slightly reduced compare to 3% palm fiber slab panel. 4% and 5% of palm fiber added ferro cement slab present some internal air voids and fiber grouping so this above reason the strength of slab is reduced.

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