

## INVESTIGATION ON ABACA FIBRE CONCRETE WITH METEKAOLIN AND SILICA FUME AS PARTIAL REPLACEMENT OF CEMENT

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### ABSTRACT

The most popular building material is concrete. Concrete is a composite product made of fine and coarse aggregate that is joined by fluid cement (cement paste) that eventually becomes hard. As a partial replacement for cement, metakaolin and silica fume are used in this study's tiny trial to modify the investigation on abaca fibre concrete. Abaca fibre is a novel natural material that might potentially trap more atmospheric CO<sub>2</sub> clouds and is extracted by us. Mechanical approach. Metakaolin and silica fume, along with the addition of 0%,0.25%, replace 0%,5%,10%,15%,20%,25% of the cement. Concrete containing 50mm long Abaca fibre at 0%,0.25%,0.5%,0.75%. Concrete test results for compressive strength, split tensile strength, and upv must be determined after 7 and 28 days.

### 1. INTRODUCTION

Concrete is a long-lasting building material made up of a certain ratio of water, sand, aggregates, and cement. The strength and durability of concrete are influenced by a variety of elements, and by choosing an appropriate replacement material for the original materials used in concrete, the strength attributes of the concrete will be improved. This particular type of concrete falls within the unique concrete unit. A dehydroxylated variety of the clay mineral kaolinite is known as metakaolin. Metakaolin is frequently used to make ceramics, but it's also utilised in concrete as a cement substitute. Comparing metakaolin to portland cement, which has smaller particles (1-2 m) and a higher surface area, but larger particles than SF. A by-product of the smelting process, which involves burning coal and high-purity quartz in electric furnaces to create silicon and ferrosilicon alloys, is silica fume (SF). Additionally, it is gathered as a waste product in the manufacturing of various silicon alloys such calcium silicon, ferromanganese, ferromagnesium, and ferrochromium (ACI 226-3R-87). Micro silica, commonly referred to as silica fume, is an amorphous (non-crystalline) form of the mineral silica. It is an ultrafine powder with spherical particles and an average particle diameter of 150 nm that is gathered as a waste product from the manufacturing of silicon and ferrosilicon alloys. The primary use is as a pozzolanic component in high performance concrete. The stalks of the plant's leaves are used to harvest the abaca fibre. Manila hemp is another name for abaca. Although it resembles a banana plant in appearance, it is quite distinct in terms of its traits and applications. It is a member of the Musasea family and is a native of Asia. Humid locations, such as the Philippines and East of Indonesia, have been planted with it. It is also known as sustainable and biodegradable fibre.

### 2. OBJECTIVES

1. To optimize the usage of Metakaolin and Silicafume in partial replacement of cement.
2. To determine the compressive and split tensile strength in abacafibre concrete.

### 3. MATERIALS

**3.1 Cement:** The materials are ground, mixed in specific ratios based on their purity and composition, and then burned in a kiln at a temperature of roughly 1300 to 1500 °C. At this temperature, the material sinters and partially fuses to form Moulder-shaped clinker.

**3.2 Fine Aggregate:** The locally available river sand, passing through 4.75 mm was used in this Experimental work. Sand passing through 1.18mm size sieve should be used & Natural River sand conforming to Zone-II.

**3.3 Coarse Aggregate:** The properties were established in accordance with IS 2386-1999. As coarse aggregate, crushed gravel stones made from hard stones like granite or marble are employed. Aggregates are often only allowed to be a maximum size of 20 mm. The aggregates act as reinforcement to make the composition overall stiffer.

**3.4 Metakaolin:** Unpurified natural pozzolanic substance is metakaolin. It is made kaolinite clay and thermally activated common clay. The temperature of the mineral is raised to between 600°C and 800°C. Typically, metakaolin is utilised as a substitute to silica fume. The strength of the concrete can be increased by replacing some of the cement with metakaolin.

**3.5 Silicafume:** Silica fume can be utilised as an additive in concrete due to its pozzolanic qualities. Silica fume is a fine, sphere-shaped substance that is airborne. It is a very small particle, smaller than one micron.

**3.6 Abacafibre:** The abaca plant, a native of the Philippine Islands, is used to make baca fibres, which are natural fibres of vegetable origin.

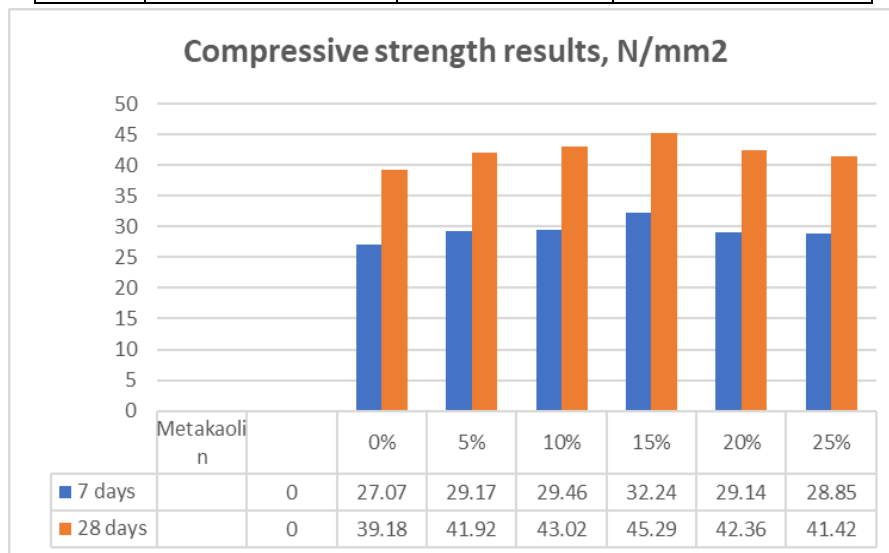
**3.7 Water:** This is done to make sure that the water is essentially free of contaminants including dissolved salts, organic debris, and suspended particulates that could harm the concrete's setting, hardening, strength, and durability.

#### 4. COMPRESSIVE STRENGTH

The ability of a material or structure to support loads on its surface without cracking or deflecting is known as compressive strength. When a material is compressed, its size tends to decrease, and when it is stretched, its size elongates.

**Table 1:** Compressive strength of concrete with metakaolin as partial replacement of cement.

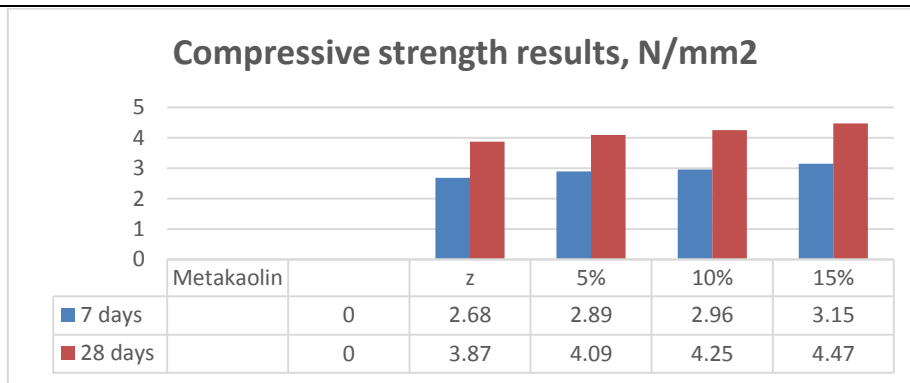
| S.No | Metakaolin | Compressive strength results, N/mm <sup>2</sup> |         |
|------|------------|-------------------------------------------------|---------|
|      |            | 7 days                                          | 28 days |
| 1    | 0%         | 27.07                                           | 39.18   |
| 2    | 5%         | 29.17                                           | 41.92   |
| 3    | 10%        | 29.46                                           | 43.02   |
| 4    | 15%        | 32.24                                           | 45.29   |
| 5    | 20%        | 29.14                                           | 42.36   |
| 6    | 25%        | 28.85                                           | 41.42   |



**Graph 1:** Compressive strength of concrete with metakaolin as partial replacement of cement.

**Table 2:** Compressive strength of concrete with Silica fume as partial replacement of cement.

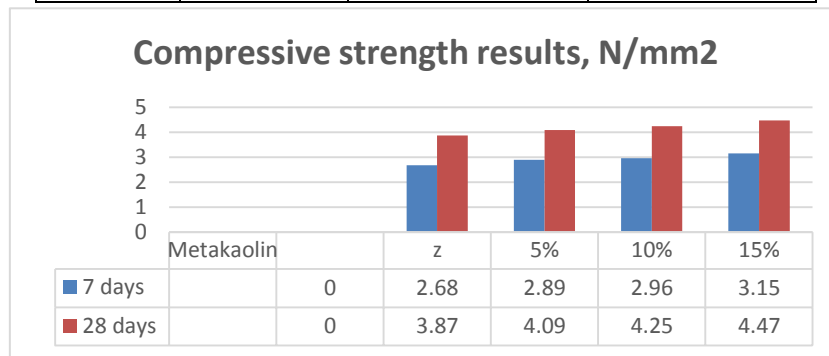
| S.No | Silica fume | Compressive strength results, N/mm <sup>2</sup> |         |
|------|-------------|-------------------------------------------------|---------|
|      |             | 7 days                                          | 28 days |
| 1    | 0%          | 27.07                                           | 39.18   |
| 2    | 5%          | 29.34                                           | 42.15   |
| 3    | 7.5%        | 31.39                                           | 45.25   |
| 4    | 10%         | 28.27                                           | 40.92   |



**Graphs 2:** Compressive strength of concrete with Silica fume as partial replacement of cement.

**Table 3:** Compressive strength of Abacafibre in concrete.

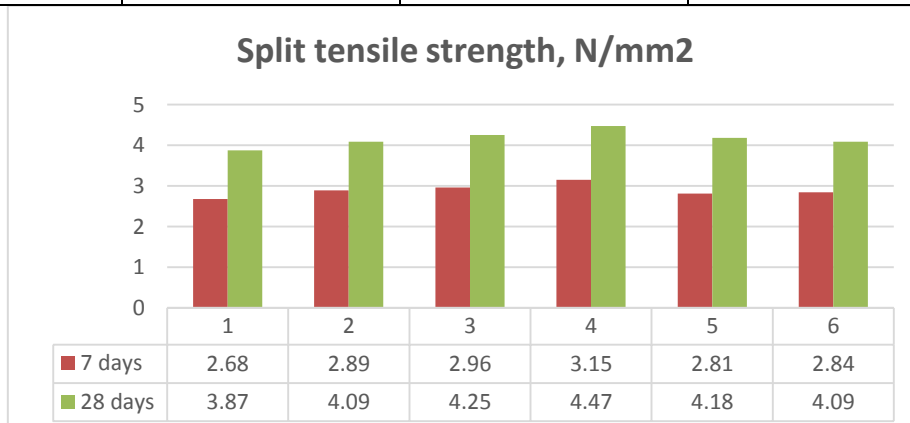
| S.No | Abaca fiber | Compressive strength results,N/mm <sup>2</sup> |         |
|------|-------------|------------------------------------------------|---------|
|      |             | 7 days                                         | 28 days |
| 1    | 0%          | 27.07                                          | 39.18   |
| 2    | 0.25%       | 30.58                                          | 43.75   |
| 3    | 0.5%        | 31.99                                          | 46.27   |
| 4    | 0.75%       | 28.79                                          | 41.85   |



**Graph 3:** Compressive strength of Abacafibre in concrete.

**Table 4:** Compressive strength of combined replacement of concrete by 15%Metakaolin+7.8% silicafume+0.5% Abacafibre in concrete.

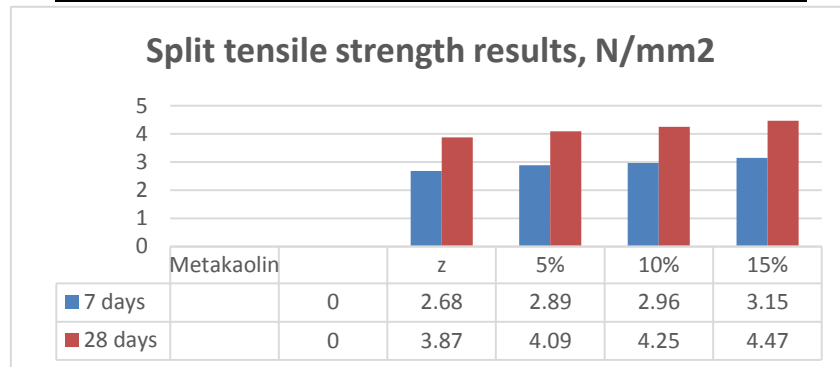
| S.No | MK+SF+AF             | Combined compressive strength,N/mm <sup>2</sup> |        |
|------|----------------------|-------------------------------------------------|--------|
|      |                      | 7days                                           | 28days |
| 1    | 0%                   | 27.07                                           | 39.18  |
| 2    | 15%MK+7.5%SF+0.5 %AF | 36.62                                           | 52.37  |



**Graph 4 :** Split tensile strength of concrete with metakaolin as partial replacement of cement.

**Table 5 :** Split tensile strength of concrete with metakaolin as partial replacement of cement.

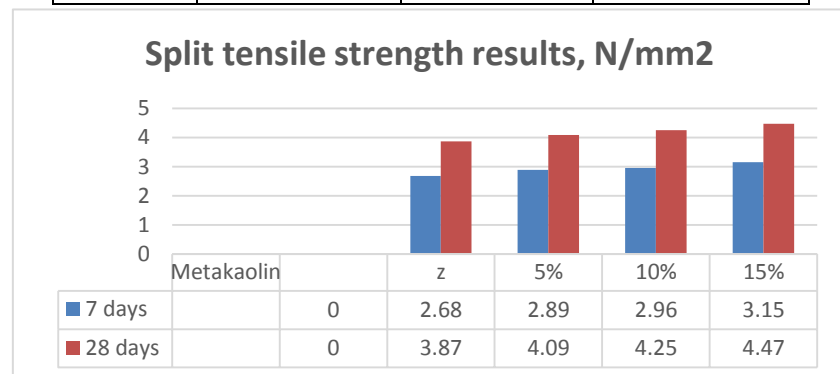
| S.No | Metekaolin | Split tensile strength,N/mm <sup>2</sup> |         |
|------|------------|------------------------------------------|---------|
|      |            | 7 days                                   | 28 days |
| 1    | 0%         | 2.68                                     | 3.87    |
| 2    | 5%         | 2.89                                     | 4.09    |
| 3    | 10%        | 2.96                                     | 4.25    |
| 4    | 15%        | 3.15                                     | 4.47    |
| 5    | 20%        | 2.81                                     | 4.18    |
| 6    | 25%        | 2.84                                     | 4.09    |



**Graph 5:** Split tensile strength of concrete with Silica fume as partial replacement of cement.

**Table 6:** Split tensile strength of concrete with Silica fume as partial replacement of cement.

| S.No | Silica fume | Split tensile strength,N/mm <sup>2</sup> |         |
|------|-------------|------------------------------------------|---------|
|      |             | 7 days                                   | 28 days |
| 1    | 0%          | 2.68                                     | 3.87    |
| 2    | 5%          | 2.92                                     | 4.16    |
| 3    | 7.5%        | 3.08                                     | 4.48    |
| 4    | 10%         | 2.81                                     | 4.07    |



**Graph 6:** Split tensile strength of Abacafibre in concrete.

**Table 7:** Split tensile strength of Abacafibre in concrete.

| Sl.no | Abaca fiber | Split tensile strength,N/mm <sup>2</sup> |         |
|-------|-------------|------------------------------------------|---------|
|       |             | 7 days                                   | 28 days |
| 1     | 0%          | 2.68                                     | 3.87    |
| 2     | 0.25%       | 3.01                                     | 4.31    |
| 3     | 0.5%        | 3.16                                     | 4.58    |
| 4     | 0.75%       | 2.86                                     | 4.17    |

**Table 8:** Split tensile strength of combined replacement of concrete by 15%Metakaolin+7.8% silicafume+0.5% Abaca fibre in concrete.

| S.No | MK+SF+AF            | Combined split tensile strength,N/mm <sup>2</sup> |        |
|------|---------------------|---------------------------------------------------|--------|
|      |                     | 7days                                             | 28days |
| 1    | 0%                  | 2.68                                              | 3.87   |
| 2    | 15%MK+0.75%SF+0.5AF | 3.62                                              | 5.18   |

## 5. CONCLUSION

- At normal concrete the achieved compressive strength of concrete is  $27.07\text{N/mm}^2$  for 7 days and  $39.18\text{N/mm}^2$ .
- At normal concrete the achieved split tensile strength of concrete is  $2.68\text{N/mm}^2$  for 7 days and  $3.87\text{N/mm}^2$  for 28 days.
- At 15% replacement of metakaolin the achieved compressive strength of concrete is  $32.24\text{N/mm}^2$  for 7 days and  $45.29\text{N/mm}^2$  for 28 days.
- At 7.5% replacement of silica fume the achieved compressive strength of concrete is  $31.39\text{N/mm}^2$  for 7 days and  $45.25\text{N/mm}^2$  for 28 days.
- At 0.5% abaca fibre in concrete the achieved compressive strength is  $31.99\text{N/mm}^2$  for 7 days and  $46.27\text{N/mm}^2$  for 28 days.
- At 15% replacement of metakaolin the achieved split tensile strength of concrete is  $3.15\text{N/mm}^2$  for 7 days and  $4.47\text{N/mm}^2$  for 28 days.
- At 7.5% replacement of silica fume the achieved split tensile strength of concrete is  $3.08\text{N/mm}^2$  for 7 days and  $4.48\text{N/mm}^2$  for 28 days.
- At 0.5% abaca fibre in concrete the achieved split tensile strength is  $3.16\text{N/mm}^2$  for 7 days and  $4.58\text{N/mm}^2$  for 28 days.
- The combined replacement of compressive strength of concrete with 15% of metakaolin + 7.5% of silica fume + 0.5% of abaca fiber at 7 and 28 days are 36.62 and  $52.37\text{N/mm}^2$ .
- The combined replacement of split tensile strength of concrete with 15% of metakaolin + 7.5% of silica fume + 0.5% of abaca fiber at 7 and 28 days are 3.62 and  $5.18\text{N/mm}^2$ .

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