# A STUDY ON STRENGTH OF LIGHTWEIGHT FOAMED CONCRETE BY USING OF POLYPROPYLENE FIBRE

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## ABSTRACT

Lightweight foamed concrete (LFC) is typically made from blending stable froth to bond glue or mortar. LFC is light however its quality is diminishing because of the decrease of thickness. This paper portrays the examination of mechanical properties of LFC with the incorporation of polypropylene fiber, for example, compressive quality and flexural quality. The bond to sand proportion utilized in this investigation was 3:1. Every one of the examples was tried utilizing the focused on thickness of 1500 kg/m3. Polypropylene fiber with 0.25% and 0.40% volume part were added to LFC plan blends. The foamed concrete was intended to accomplish the consequence of impact from volume part of polypropylene fiber utilized with various relieving age of 7, 28 and 60 days. The examination was setup to look at its mechanical properties with agreement to ASTM standard strategy for testing. From the outcome broke down, the consideration of polypropylene fiber into the lightweight foamed concrete examples has more commitment in flexural quality when contrasted with control test without the fiber. The 0.25% and 0.40% level of polypropylene fibers added is demonstrated to have contributed more on flexural of LFC. Notwithstanding, 0.25% is an ideal volume of fibers that ought to be incorporated to contribute the greatest flexural quality of the lightweight foamed concrete.

## 1.0. INTRODUCTION

The advantages of lightweight concrete has been an element in the development business for a considerable length of time, however like other material there are elevated standards of the execution raised and now development industry requesting a steady, dependable material and unsurprising attributes. It was first presented by the Romans in the second century where 'The Pantheon' has been developed utilizing pumice, the most widely recognized kind of total utilized in that specific year. From that point on, the utilization of lightweight concrete has been generally spread crosswise over different nations, for example, USA, United Kingdom and Sweden. Lightweight foamed concrete can be known as a kind of concrete that incorporated an extending operator in it to expand the volume of the blend however on a similar time, it gives extra characteristics, for example, decreased the dead weight. Auxiliary lightweight concrete has a set up thickness (unit weight) on the request of 300 kg/m3 up to 1840 kg/m3; 87 to 23% lighter contrasted with typical Weight concrete with a thickness in the scope of 2240 kg/m3 to 2400 kg/m³.Lightweight foamed concrete is ordinarily being made from blending stable froth to bond glue or mortar. This activity creates little encased air rises inside the mortar along these lines making it lighter and having extraordinary properties, for example, low warm conductivity and high imperviousness to fire. It has been expressed that foamed concrete is named having an air substance of over 25%. Foamed concrete may have densities running from as low as 300kg/m3 to as high as 1800kg/m3. Froth concrete need least amount of total or in some cases no totals was utilized; consequently it is lightweight and high stream capacity. To blend a steady froth concrete, it relies upon numerous variables, for example, strategy for froth readiness, choice of frothing specialist, expansion for uniform air-voids conveyance, material review and blend structure proportion.

Figure 1: Normal concrete

Figure 2: Foam concrete

Fibers consideration in concrete is outstanding to have commitment towards properties of concrete. A few examinations have demonstrated the viability of including fibers into concrete blends where a portion of the investigations brought about mechanical and sturdiness properties upgrade of concrete. There are two kinds of fibers typically incorporated into concrete which are the manufactured and normal sort of fiber and they have their very own favorable circumstances in the concrete grid proportioning of bond composites. Manufactured fibers known as a man-made fiber from looks into and advancements of material businesses and it was first answered to be a segment of development materials in 1965.

The usage of manufactured fiber strengthened concrete is by and by exists worldwide because of its promising normal for advancing the mechanical properties of concrete. In examination of engineered fibers, characteristic fibers are known to be increasingly ecological well disposed. That is the reason they are as of now getting a great deal of consideration for supplanting manufactured fiber. It has been accounted for that common fibers have numerous points of interest, for example, low thickness, recyclable and biodegradable contrasted with the manufactured fiber. Other than that, common fiber display numerous points of interest properties and offer significant decrease on the expense and advantage related with preparing contrasted with manufactured fiber.

### 1.1 LIGHT WEIGHT CONCRETE

LFC is light yet its quality is diminishing because of the lessened thickness. Be that as it may, the nearness of fiber in concrete grid can characteristic the enhancement of the mechanical properties of the lightweight concrete. Accordingly, the incorporation of polypropylene fiber is required to enhance or alter the mechanical properties of foam concrete.

Figure 3: Polypropylene fiber

To accomplish this point, the examination was done dependent on the accompanying goals:

i. To deliver lightweight foamed concrete utilizing bond sand proportion (3:1) with 1500 kg/m3 thickness.

ii.To acquire ideal w/c proportions for different level of Polypropylene Fiber in Lightweight Foamed Concrete.

iii.To ponder the impacts of Polypropylene fiber on mechanical properties of lightweight foamed concrete.

There are 3 classifications of foam concrete blends arranged in this examination included 0%, 0.25% and 0.40% of polypropylene fiber utilizing bond to sand proportion 3:1. The thickness for all examples was controlled to 1500 kg/m3 ± 100 kg/m3.

## 2. EXPERIMENTAL PROGRAM

The generation of LWC in this investigation essentially isolated into two phases;

Preliminary blends utilizing water to bond proportion 0.30 to 0.40 to get ideal blends

Flexural test utilizing ideal water to concrete proportion in blend extent. The materials utilized were as equivalent to for the two phases.

## 2.1 MATERIALS

The production of lightweight foamed concrete with cement-sand ratio (3:1) made from six types of raw material which are Ordinary Portland Cement (OPC), sand, water and foam.

- ***Cement:*** Ordinary Portland Cement (OPC) was used throughout the study with specific gravity 3.12
- ***Sand:*** Sand is brought from quarry having specific gravity 2.54. Only fine sand was used throughout the production process of lightweight foamed concrete. The sand was dried in an oven at the temperature of 105 °C ± 5 °C for at least 24 hours to remove the moisture in it.
- ***Foam agent:*** Foam is a form of stable bubbles, produced by mixing foaming agent and water in foam generator. The purpose of the foam is to control the density of lightweight foamed concrete by incorporating dry preformed stable foam into fresh lightweight foamed concrete. For this study, the ratio of foaming agent to water is 0.1 kg: 3 kg (1:30) by volume. *Polypropylene Fiber*. Chopped cylindrical Polypropylene Fiber (PP) with 19 mm of length, 22 µm of diameter width crossing was used in this investigation. Characteristic of tensile strength of fiber is 400 $N/mm^2$ with 0.9 $kg/dm^3$ density. In this investigation, dosage 0.25 % and 0.40 % of PP was added into each sample of foamed concrete with density of 1500 $kg/m^3$.

### 2.2 TRIAL MIX PROPORTION

The mix proportion with cement-sand quantitative relation (3:1) of the light-weight foamed concrete was used throughout the study. Trial mixes with numerous water-cement quantitative relation that is zero.3, 0.32, 0.34, 0.36, 0.38, and 0.40 were administrated. The optimum combine proportion made up our minds supported density and strength of light-weight foamed concrete.

The trial mixes consisted of 3 varieties of trial mixes that are foamed concrete with 1/3, 0.25% and 0.40% of plastic Fiber. The samples for every combine proportions were cured in storage tank for seven days before undergoing compressive strength check.

### 2.3 FRESH CONCRETE PROPERTIES TEST

*Flow Table Test:* Flow table check was conducted by employing a flow table and mold. The flow table was fastidiously cleaned and dry, and also the flow mould was placed at the middle of the flow table. A layer of mortar was placed concerning two metric linear unit (1 in.) in thickness within the mould and being tamped twenty times with the tamper. The tamping pressure ought to be simply adequate to ensured uniform filling of the mould. Then the method was perennial for the second layer of mortar.

### 2.4HARDENED CONCRETE TESTING

***2.4.1Compression Test:*** The maximum load carried and compressive strength by the specimen was recorded and calculated using formula as shown in Equation below.

$$f_c^{'} = \frac{P}{A},$$

Where;
f'c = Compressive strength, MPa
P = Maximum load carried by the specimen, N
A = Surface area of specimen that carried load, $mm^2$

= width (mm) × thickness (mm)

Figure 4: Setup for compression test

***2.4.2 Flexural Strength Test:*** when getting optimum water-cement quantitative relation throughout trial mixes, it's used into the assembly of prism samples for all classes. The flexural strength check was performed on rectangular specimens with dimensions of height (h) and dimension (w) forty metric linear unit and length (l) a hundred and sixty metric linear unit. Specimens were water cured for seven, twenty eight and ninety days before undergoing the check session. the consequences of plastic Fiber into light-weight foamed concrete on its engineering properties in terms of flexural strength were mentioned at the tip of the chapter.

Table 1: Design Mix Proportions for mechanical properties

| Mix details | Cement-Sand Ratio | Water-Cement Ratio | Number of samples | Volume of Polypropylene Fiber (g) |
|---|---|---|---|---|
| LFC-CS[1] | 3:1 | 0.34 | 3 | 0 |
| LFC-0.25PF[2] | 3:1 | 0.32 | 3 | 5.18 |
| LFC-0.40PF[3] | 3:1 | 0.32 | 3 | 8.29 |

Note:

-CS= LFC with 0% of polypropylene fiber added

[2]LFC-0.25PF = LFC with 0.25% of polypropylene fiber added

[3]LFC-0.40PF = LFC with 0.40% of polypropylene fiber added

*Flexural Strength Test.* The maximum loaded carried by the specimen was recorded and flexural strength was calculated by using formula in Equation 2 below.

$$r = \frac{3PL}{\frac{1}{3}bd^{\frac{1}{3}}}$$

Where;

*R* = Flexural strength, MPa

*P* = Maximum applied load indicated by the testing machine, N *L* = Span length, mm


Figure 5: Setup for flexural test

## 3 RESULT AND DISCUSSION

### 3.1 FLOW TABLE AND INVERTED SLUMP TEST

Table 2: Design Mix Proportions for mechanical properties

| Water to Cement Ratio | Average Flow Table Test Value (cm) | | |
|---|---|---|---|
| | 0 % PP | 0.25 % PP | 0.40 % PP |
| 0.30 | 19.9 | 19.9 | 18 |
| 0.32 | 21.1 | 20.4 | 18.5 |
| 0.34 | 24 | 23.5 | 22.3 |
| 0.36 | >25 | 25 | 24.5 |
| 0.38 | >25 | >25 | 25 |
| 0.40 | >25 | >25 | >25 |

Table 1 and 2 shows the result of flow table and inverted slump spread measurement of the fresh concrete. Mostly flow table spread for water to cement ratio 0.36 to 0.40 displayed values of 25 cm above. This result shows that they have exceed the limit of spread which means the fresh concrete was too slurry caused by the excessive water content. This kind of result will lead into the segregation to the samples where the foam and cement are separated as the foam moves upward and the mortar settled at the bottom part.

Table 1 and 2 the results of flow table and inverted slump unfold activity of the contemporary concrete. Principally flow table unfold for water to cement quantitative relation zero.36 to 0.40 displayed prices of twenty five cm on top of. This result shows that they need exceed the limit of unfold which implies the contemporary concrete was too suspension caused by the excessive water content. This sort of result can lead into the

segregation to the samples wherever the froth and cement ar separated because the foam moves upward and also the mortar settled at all-time low half.

### 3.2 TRIAL MIXES (COMPRESSIVE STRENGTH TEST)

Figures 4 to 6 show the info of compressive strength in numerous share of plastic fiber inclusion. There's associate improvement of strength victimisation water to cement quantitative relation beginning zero.30 before it decreases at zero.36 for management LFC and zero.34 for LFC with content zero.25% and 0.4% fraction of plastic fiber. Concerning the graph below, water to cement quantitative relation zero.38 and 0.40 for all LFC samples is greatly beyond the remainder of the water-cement quantitative relation as a result of the specimens suffered segregation ensuing mortar concrete rather than foamed concrete.

Table 3: Compressive strength of concrete for 28 days

| Water to Cement Ratio | Compressive Strength of Concrete | | |
|---|---|---|---|
| | LFC-CS | LFC-0.25PF | LFC-0.40PF |
| 0.30 | 17.5 | 18.31 | 18.43 |
| 0.32 | 18.11 | 18.98 | 19.14 |
| 0.34 | 19.34 | 19.79 | 19.81 |
| 0.36 | 20.17 | 21.18 | 20.98 |
| 0.38 | 21.32 | 21.43 | 21.42 |
| 0.40 | 22.34 | 23.52 | 24.14 |

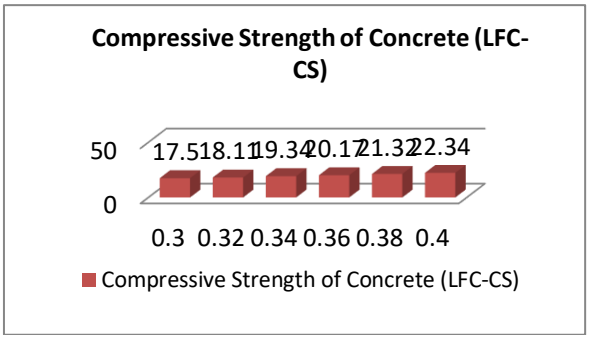


Figure 6: Compressive Strength of LFC-CS

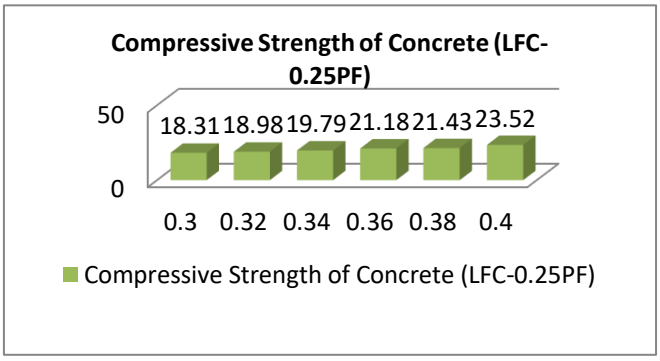


Figure 7: Compressive Strength of LFC-0.25PF

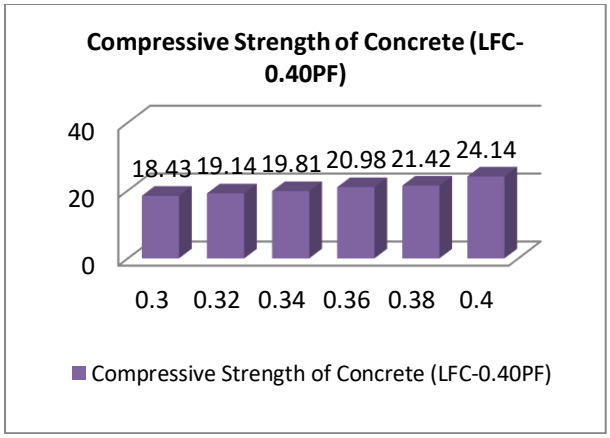


Figure 8: Compressive Strength of LFC-0.40PF

By not considering the quarantined samples as light-weight foamed concrete, for LFC-CS, the best compressive strength was achieved by 0.40 water-cement quantitative relation combine proportion that is 22.34 MPa. For LFC-0.25PF, the best compressive strength was achieved by zero.32 water-cement quantitative relation with eighteen.824 MPa. For LFC-0.40PF, water-cement quantitative relation 0.32 combine proportion was achieved the best compressive strength that is 18.45 MPa. It's famed that the inclusion of fibres slightly decreases the common compressive strength of concrete. From the info on top of, its well-tried the addition of plastic fiber in light-weight foamed concrete decreases the utmost of compressive strength.

### 3.3 FLEXURAL STRENGTH TEST

Figures 9 below shows the info of flexural strength in numerous share of plastic fiber inclusion and natural action age days. The flexural strength for all samples is increase because the natural action age days increase. From the graph below, it shows that zero.25% and 0.4% fraction of plastic fiber inclusion improved the flexural strength compare to the management light-weight foamed concrete at each natural action age days. {This will this will this could this may} be tested that the fiber inclusion can enhance the flexural strength of LFC. the best price of flexural strength is achieved by zero.25% fraction of plastic fiber at age ninety days was recorded, whereas very cheap reading of flexural strength is recorded by management samples of light-weight foamed concrete with 1/3 fraction of plastic fiber volume on seven days. Visually furthermore, the distinction strength of flexural in higher and lower share of plastic fiber inclusion of light-weight foamed concrete are often seen at 7days, 28days and sixty days. The 0.25% fraction of plastic fiber has higher flexural strength than the zero.40% of plastic fiber supplemental in LFC.

Table 4: Flexural strength of Concrete for WC ratio 0.4

| Duration | Flexural Strength of Concrete | | |
|---|---|---|---|
| | LFC-CS | LFC-0.25PF | LFC-0.40PF |
| 7 days | 2.48 | 3.12 | 2.98 |
| 28 days | 2.96 | 3.86 | 3.84 |
| 90 days | 3.14 | 4.43 | 4.39 |

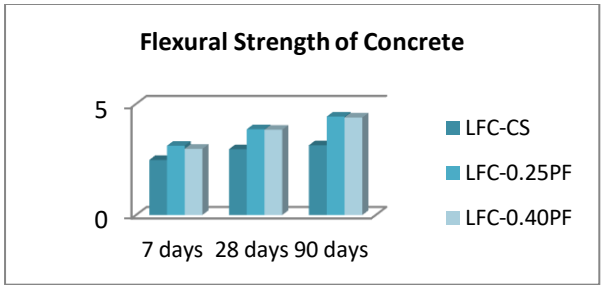


Figure 9: Flexural strength development up to 90 days of Age for LFC-CS, LFC-0.25PF and LFC-0.40PF

Based on the flexural check conducted, the flexural strength will increase because the natural action age days increased for all samples. From the results, it's ascertained that the addition of plastic fiber within the concrete combine includes a positive result on the flexural strengths of concrete. Addition of plastic in low percentages, about 0.25%, will increase the flexural strength. However, the flexural strength decreases once 0.40% of plastic fibers are supplemental. The fast decrease in flexural strength is probably because of the non-uniform fiber distribution within the specimen. It's safe to mention that the rise in strength is because of extra load absorbed by the fibers gift within the concrete matrix. Moreover, the specimen with the addition of plastic fiber failed to cracks into 2 elements and holds the partner along as a result of the indiscriminately homeward fibers crossing the cracked section resisted the cracks from spreading and avoid the section from bending.

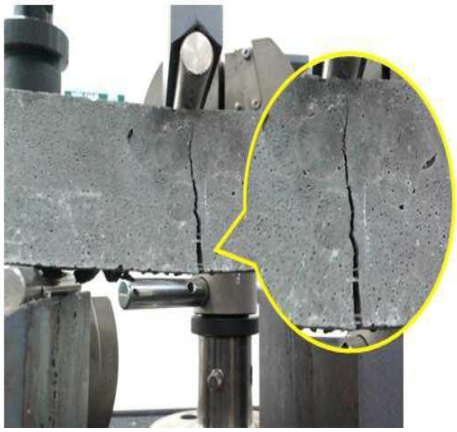

Figure 10: Progress of bending test of specimen with fiber inclusion


Figure 11: Cross section of samples with fiber after test

## 4 CONCLUSIONS

This experiment was conducted to see the result of plastic fiber inclusion to the properties of light-weight foamed concrete. There are many vital conclusions are obtained from the experimental result:

1. The production of light-weight foamed concrete victimization cement-sand quantitative relation (3:1) with 1500 kg/m3 density with success achieved by ready 3 varieties of light-weight foamed concrete as well as LFC-CS, LFC-0.25PF and LFC-0.40PF with controlled density 1500 kg/m3 one hundred kg/m3 starting from 1400 kg/m3 to 1600 kg/m3 as mentioned within the initial objective.
2. Following the primary objective, this study is conducted to get optimum water-cement ratios for numerous share of plastic Fiber (PP) in light-weight Foamed Concrete. This was achieved by ready the sample with zero nothing, 0.25 % and 0.40 you look after plastic fiber through trial mixes. The optimum water to cement quantitative relation for LFC-CS, LFC-0.25PF and LFC-0.40PF are 0.34, 0.32 and 0.32 severally.
3. The mechanical properties coated during this study were flexural strength solely. Supported the result, it are often over that the inclusion of PP fiber into the LFC will improved in flexural strength of LFC. However, there's associate optimum volume of fibers that ought to be enclosed to contribute the utmost flexural strength of the light-weight foamed concrete.
4. The highest flexural strength was achieved by zero.25% PP fiber at ninety natural action days with four.96 MPa. The flexural strength conjointly increased because the natural action age increased.

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