ISSN: 2278-0181
NCNTCE-2015 Conference Proceedings

# Fibre Reinforced Lightweight Concrete using Pumice Stone

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***Abstract*** **- Lightweight aggregate concretes are widely incorporated in construction and development. This study, presents an experimental investigation on the properties of volcanic pumice lightweight concretes. Fibre reinforced lightweight concrete (F R L W C) is a composite material developed to reduce the brittleness of concrete and dramatically increases its flexural strength. Fibre reinforced lightweight concrete (FRLWC) is used reinforced column of structural member. Increasing utilization of lightweight materials in structural applications is making pumice stone a very popular raw material. More than the target means strength of Grade concrete is achieved with 20 & 40 per cent replacement of natural coarse aggregate by pumice aggregate and with 0.5, 1 & 1.5 per cent of polypropylene and glass fibre. Target mean strength of concrete is to be achieved. The compressive strength of Light weight concrete is to be studied with various percentage replacements of pumice stones and also to increasing the characters of concrete various percentage of using Glass Fibres and polypropylene.**

## I. INTRODUCTION

Structural lightweight aggregate concrete is defined as concrete which has a compressive strength in excess of (17.2 MPa) at 28 days of age and has an equilibrium weight not exceeding (1842 kg/m$^3$). The low density lead to reduce dead load obtained by use of lightweight concrete and that reducing not only result in a decrease in cross section of columns, beams, walls and foundations, but also decrease the induced seismic loads and reduce the risk of earthquake damages to structures since, the earthquake loads influencing the structures and buildings are proportional to the mass of those structures and buildings. Structural lightweight concrete mixtures can be designed to achieve similar strengths as normal weight concrete. The same is true for other mechanical and durability performance requirements.

## II. PUMICE AGGREGATES

The name “Pumice” is a generic term for a range of porous vesicular materials produced during explosive volcanic eruptions. Pumice is essentially composed of solidified frothy lava which is generally rhyolite in composition, but can also be produced in a less acidic form. Aggregate strength ranges from very weak and porous, to stronger and less porous. The principal requirements for pumice to be considered a desirable aggregate for use in structural lightweight concrete are a low density and relatively high strength.

### *A, PROPERTIES*

Pumice is composed of highly micro vesicular glass pyroclastic with very thin, translucent bubble walls of extrusive igneous rock. It is commonly, but not exclusively of silicic or felsic to intermediate in composition but basaltic and other compositions are known.

Scoria differs from pumice in being denser. With larger vesicles and thicker vesicle walls, it sinks rapidly. The difference is the result of the lower viscosity of the magma that forms scoria. When larger amounts of gas are present, the result is a finer-grained variety of pumice known as pumices.

FIGURE-1
A 15 centimetre (6 inches) piece of pumice its very low density.

## III. PUMICE CONCRETE PRODUCTS AND APPLICATIONS

Lightweight pumice concretes are ideally suited in applications where 3500 psi or less is acceptable and where thermal and lightweight properties are desired.
commercial buildings—especially those located in extreme temperature locations—benefit from the inherent insulates properties (4x R-value; reduced or eliminated moisture condensation) and resistance to freeze/thaw cycles afforded by pumice aggregate concrete.

## IV. GLASS FIBERS

This is the most versatile industrial materials known today. .All glass fibres described in this article are derived from compositions containing silica. They exhibit useful bulk properties such as hardness, transparency, resistance to chemical attack, stability, and inertness, as well as desirable fibre properties such as strength, flexibility, and stiffness.

## V. POLYPROPYLENE FIBER

High performance short (12mm) polypropylene fibre was used in this investigation. This fibre shows a micro reinforcement manufactured form (100%) polypropylene. It was brought form Fosroc Company for construction chemicals. It was stored under cover away from heat sources.

## VI. TEST RESULTS OF MATERIALS:

### *A. CEMENT*

Table-1

| Cement Test | Actual Result |
|---|---|
| Fineness of Cement | 4.50% |
| Initial & Final Setting Time | Initial-30 min Final-600min |

### *B.FINE AGGREGATE*

Table-2

| Fine Aggregate Test | Actual Result |
|---|---|
| Specific Gravity | 1.48 |
| Water Absorption | 0.33% |

### C.COARSE AGGREGATE

Table-3

| Coarse Aggregate Test | Actual Result |
|---|---|
| Specific Gravity | 2.62 |
| Water Absorption | 1.62% |
| Impact Test | 43.60% |

### D.COARSE AGGREGATE (PUMICE)

Table-4

| Coarse Aggregate Test(Pumice) | Actual Result |
|---|---|
| Specific Gravity | 0.79 |
| Water Absorption | 4.6% |
| Impact Test | 43% |
| Bulk Density | 0.372 kg/litre |

## VII. M40 MIX DESIGN

Table-5

| CEMENT | FA | CA | W/C |
|---|---|---|---|
| 1 | 1.584 | 2.02 | 0.40 |
| 492.5 | 780 | 992.76 | 197 |

## VIII. COMPRESSIVESTRENGTH

Values of compressive strength for all mixes are shown in Table (8) and Figure (1) at 7 and 28 days, results demonstrated that in general, all concrete specimens exhibited an increase in compressive strength with increase the per cent of steel fibres. The per cent of increasing in compressive strength at 7 days about (27.18%, 30.32%, and 22.6%) for (0%, 0.5%, and 1%) polypropylene respectively. While in 28 days, adding (0%, 0.5%, and 1%) polypropylene lead to increasing in compressive strength by about (30.33%,33.79%, and 0%) respectively. It can be seen that the increase in compressive strength of light weight polypropylene concrete at 28 days was greater than their corresponding compressive strength.

Table-6
Compressive Strength-Polypropylene:

| | Compressive Strength | | |
|---|---|---|---|
| Polypropylene | 7 Days (N/mm2) | 14 Days (N/mm2) | 28 Days (N/Mm2) |
| 0.5 | 31.2 | 35.5 | 47.4 |
| 1 | 31.4 | 35.7 | 47.4 |
| 1.5 | 30.1 | 34.1 | 45.5 |

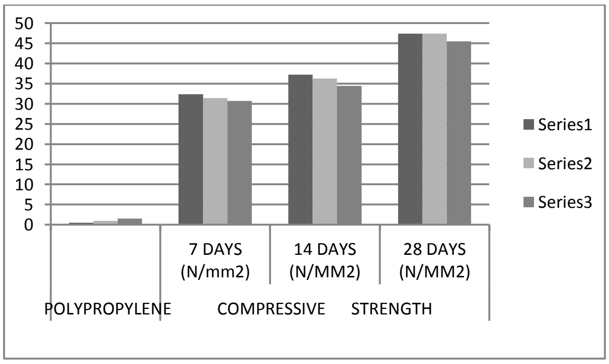


Table-7
Compressive Strength-Glass Fibre:

| Glass Fibre | Compressive Strength | | |
|---|---|---|---|
| | 7 Days (N/mm2) | 14 Days (N/mm2) | 28days (N/mm2) |
| 0.5 | 30.1 | 34.2 | 45.7 |
| 1 | 29.5 | 33.6 | 44.8 |
| 1.5 | 28.3 | 32.1 | 42.9 |

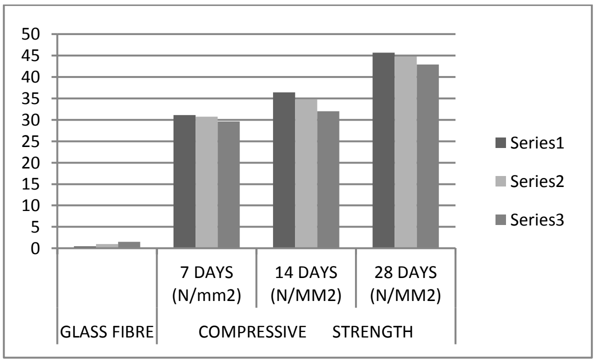



Table-8
Compressive Strength-Polypropylene With 20% Pumice:

| 20% Pumice Aggregate & Polypropylene | Compressive Strength | | |
|---|---|---|---|
| | 7 Days (N/mm2) | 14 Days (N/mm2) | 28 Days (N/mm2) |
| 0 | 28 | 27.2 | 36.3 |
| 0.5 | 24 | 26.7 | 35.7 |
| 1 | 25.5 | 25.4 | 33.9 |
| 1.5 | 22.3 | 24.9 | 33.2 |

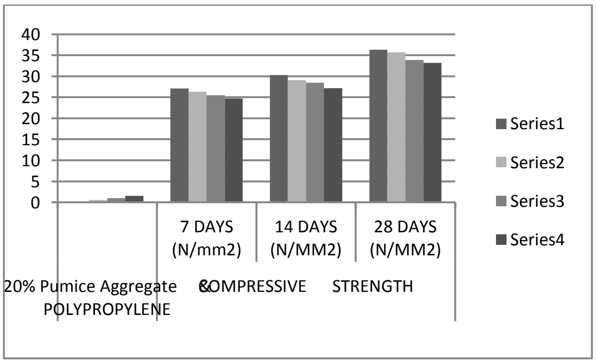



Table-9
Compressive Strength-Glass Fibre With 20% Pumice:

| 20% Pumice Aggregate & Glass Fibre | Compressive Strength | | |
|---|---|---|---|
| | 7 Days (N/mm2) | 14 Days (N/mm2) | 28 Days (N/mm2) |
| 0 | 22.6 | 25.7 | 34.3 |
| 0.5 | 22.2 | 25.2 | 33.7 |
| 1 | 21 | 24.9 | 31.9 |
| 1.5 | 20.5 | 24.7 | 31.2 |

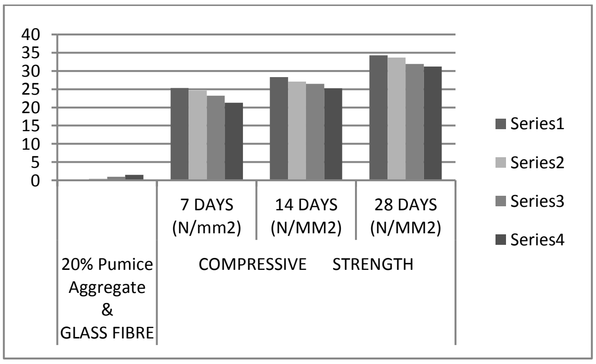



Table-10
Compressive Strength-Polypropylene With 40% Pumice:

| 40% Pumice Aggregate & Polypropylene | Compressive Strength | | |
|---|---|---|---|
| | 7 Days (N/mm2) | 14 Days (N/mm2) | 28 Days (N/mm2) |
| 0 | 20.6 | 23.4 | 31.3 |
| 0.5 | 19.54 | 22.2 | 29.6 |
| 1 | 18.5 | 21 | 28.1 |
| 1.5 | 20.7 | 21.47 | 28.6 |

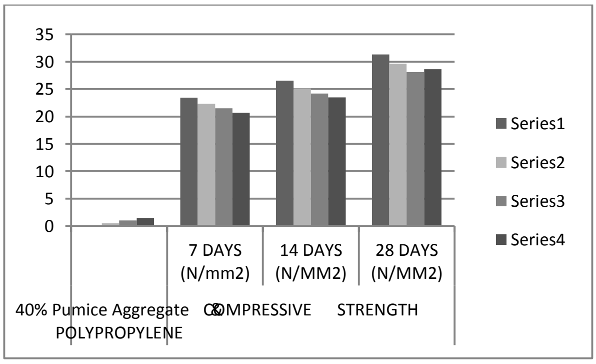
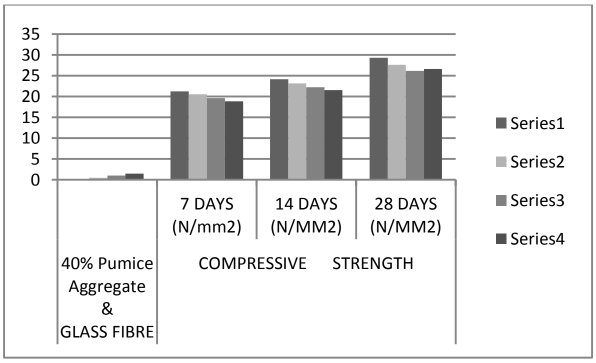


Table-11
Compressive Strength-Glass Fibre With 40% Pumice:

| 40% Pumice Aggregate & Glass Fibre | Compressive Strength | | |
|---|---|---|---|
| | 7 Days (N/mm2) | 14 Days (N/mm2) | 28 Days (N/mm2) |
| 0 | 19.3 | 21.9 | 29.3 |
| 0.5 | 19 | 21.5 | 27.6 |
| 1 | 18.8 | 21 | 26.1 |
| 1.5 | 19 | 20.7 | 26.6 |




## IX. SPLITTING TENSILESTRENGTH

The test results of the flexural strength are reported. The results indicated that in general, all types of concrete specimens exhibited continued increase in flexural strength with increasing in polypropylenes. The increase in flexural strength for light weight concrete with steel fibre relative to reference concrete mix were 29.25%, and 54.24%for light weight concrete with 0%, 0.5%, and 1%steel fibre by volume of concrete respectively. This behaviour is mainly attributed to the role of steel fibre in releasing fracture energy around crack tips which is required to extent crack growing by transferring stress from one side to another side. Also this behaviour is due to the increase in crack resistance of the composite and the ability of fibres to resist forces after the concrete matrix has cracked.

Table-12
Split Tensile-Polypropylene:

| Polypropylene | SPLIT TENSILE | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0.5 | 3.2 | 5.1 | 6.8 |
| 1 | 3.5 | 4.6 | 6.4 |
| 1.5 | 3.8 | 4.4 | 5.8 |

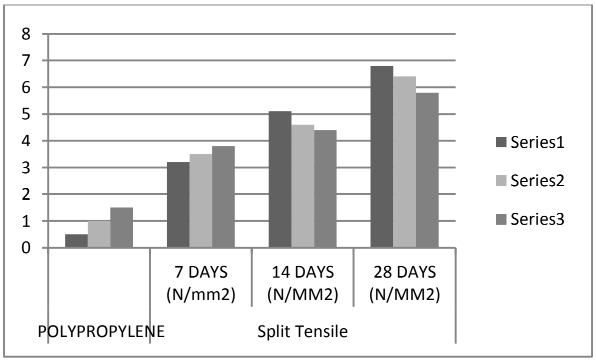



Table-13
Split Tensile-Glass Fibre:

| Glass Fibre | Split Tensile | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0.5 | 2.8 | 3.7 | 5.7 |
| 1 | 3 | 3.9 | 6.1 |
| 1.5 | 3.4 | 4.3 | 6.5 |

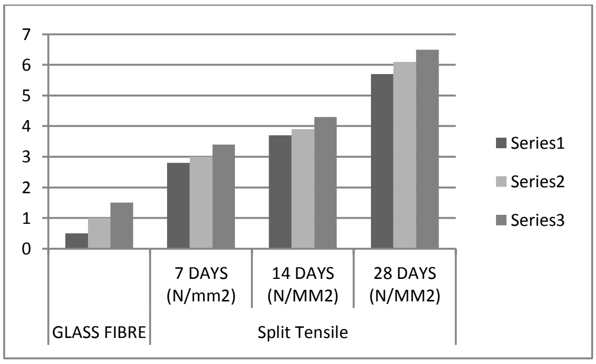



Table-14
Compressive Strength-Polypropylene With 20% PUMICE:

| 20% Pumice Aggregate & Polypropylene | SPLIT TENSILE | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0 | 2.6 | 4.3 | 4.9 |
| 0.5 | 3.1 | 4.6 | 5.7 |
| 1 | 3.5 | 5 | 6.1 |
| 1.5 | 3.9 | 5.4 | 6.7 |

ISSN: 2278-0181

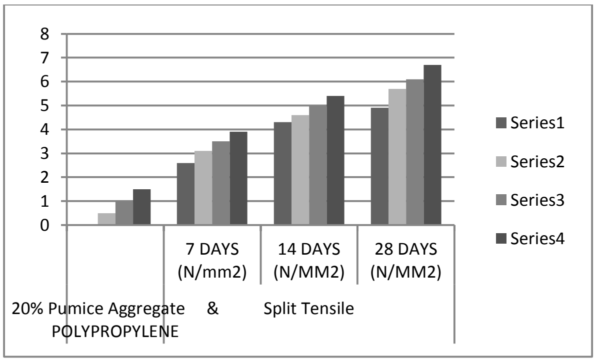




Table-15

Compressive Strength-Glass Fibre With 20% Pumice:

| 20% Pumice Aggregate & Glass Fibre | SPLIT TENSILE | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0 | 2.2 | 3.6 | 4.6 |
| 0.5 | 2.7 | 4 | 5.2 |
| 1 | 3 | 4.2 | 6.1 |
| 1.5 | 3.7 | 5.1 | 7 |

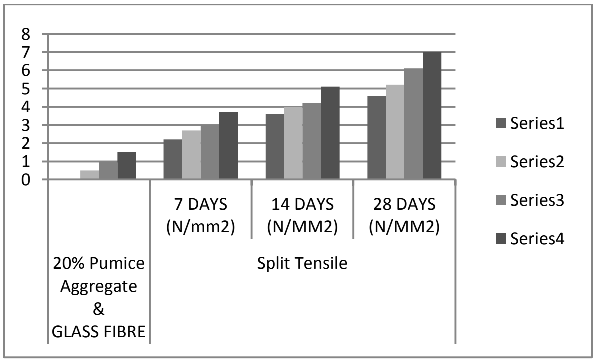



Table-16

Compressive Strength-Polypropylene With 40% PUMICE:

| 40% Pumice Aggregate & Polypropylene | Split Tensile | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0 | 3.4 | 4.2 | 5.6 |
| 0.5 | 3.6 | 4.9 | 6.3 |
| 1 | 4.3 | 5.5 | 6.9 |
| 1.5 | 4.4 | 6 | 7.2 |

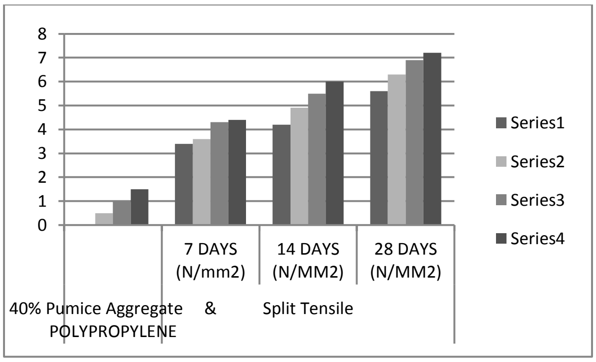
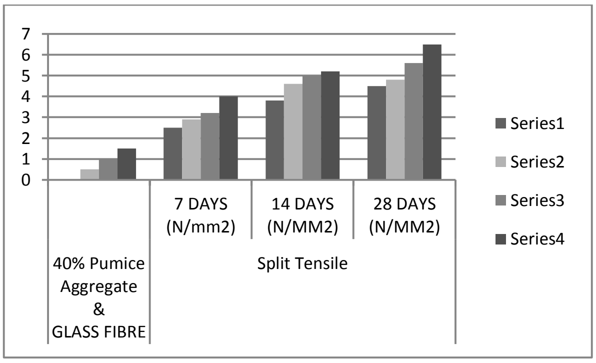



Table-17

Compressive Strength-Glass Fibre With 40% Pumice:

| 40% Pumice Aggregate & Glass Fibre | Split Tensile | | |
|---|---|---|---|
| | 7 DAYS (N/mm2) | 14 DAYS (N/mm2) | 28 DAYS (N/mm2) |
| 0 | 2.5 | 3.8 | 4.5 |
| 0.5 | 2.9 | 4.6 | 4.8 |
| 1 | 3.2 | 5 | 5.6 |
| 1.5 | 4 | 5.2 | 6.5 |




## X. CONCLUSION:

From the literature review, we can conclude the pumice stones can be successively replaced for light weight concrete main fact using pumice stones has good compressive strength like as ordinary aggregate, when replaced in particular percentage while fibres like glass fibre and polypropylene is added with the light weight concrete its improve the characters of the concrete. The workability of light weight concrete is similar to ordinate mix concrete. Concrete cube, cylinders have to be made for the various replacement of coarse aggregate by using pumice stones. The replacement percentage should be 20 and 40%. Additionally the concrete is to be strengthening by glass fibre and polypropylene. The fibres will be added 0.5, 1, 1.5% for 20 & 40% aggregate replacement. Further test results of compressive strength, split tensile and flexural strength of the various percentage of pumice stones. Result has to be discussed.

## XI. REFERANCES:

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