# Mix proportioning of M25 grade concrete by replacing normal aggregate with light weight aggregate (Pumice)

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**Abstract.** Day to day a large development in construction activities are happening. All constructions require huge quantity of concrete. All we know that conventional concrete has density 2400 kg/m$^3$.This type of concrete is not at all required in all aspects. So that new era concretes are developed to solve more problems. In general Components of buildings have concrete density 2400 kg/m$^3$. In high rise buildings the components are large in size. Thus, by making the components lighter, a concrete needs to have a lesser density while still retaining its adequate compressive capacity. Lightweight aggregate are employed when making the bulk of lightweight concrete. The objective of the current study is to develop lightweight concrete by replacement of pumice stone for natural aggregate for M25 grade, with pumice stone ranging proportion from 0-27.5% at 5% intervals.

**Key words**: Light weight aggregate concrete, Pumice stone.

## 1 Introduction

Concrete is a robust material. In many nations, due to the growing cost of raw materials and the non-stop discount of natural sources, the use of waste materials is a capability alternative within the production enterprise. Recycled materials can use after processor to required quantity, these materials proven to be effective as production substances and with no trouble meet up the design requirements. The aggregates used in structural light-weight concrete may be a combination of fractions of each lightweight coarse and quality substances and lightweight coarse fabric with the ideal, herbal great aggregate. Any combination that is adequate for replacement as lightweight has a dry free bulk density of less than 1200 kg/m$^3$ or a particle density of less than 2000 kg/m$^3$.

## 2 Literature review

A. Dattatreya Kumar et al.[1] assessed with experimental results that water absorption capacity concrete is higher as compare to normal aggregate with light weight aggregate (pumice) are

33.0 and 46.23 24-hours. Shahd Hesham Mohamed et al.[2] stated that the SLWHSSCC produces density approximately 20-25% lower than HSSCC. The author concluded use LWA pumice aggregate for manufacture of SLWHSSCC. R.B. Karthika et al.[3] Stated that as % of pumice quantity increases the unit weight of concrete decreases which results to form light weight concrete. Shafiq M.S et al.[4]explained that after 100% substitution of pumice stone, the split tensile strength falls about 3.36% after 28 days curing. Hayder Kadhem Adai Al-farttoosi et al.[5] said that the splitting tensile strength of concrete with pumice ranges from 5% to 10% of its compressive strength. Manoj V et al.[6] accomplished that 20% replacement of pumice stone given higher workability performance and compressive strength (87.36 MPa) with 2% nano silica substitution in cement. Abraham, A.L. and Mohan, R.P.[7] said that mechanical strength properties are increases with accumulation of polypropylene fibres to the LWC (pumice).the author recommends the optimum content of polypropylene fibres as 1.5%.N. Sivalinga Rao et al.[8] concluded that the compressive strength of light weight concrete drops abnormally. The author recommends mixing of fibres for improvement of compressive strength. GVV Satyanarayana and Mahesh[9] experimentally proved that the mechanical properties improved when fibres are added to foam concrete. Alaa M.rashad [10] concluded that the pumice aggregate increases the thermal insulation of the matrix. So that the fire resistance of matrix is increases with increase in % of pumice stone.

## 3 Materials and methodology

### 3.1 Cement

Cement as shown in Figure 1, is a binder constituent is used to bind sand and gravel together. Its chemical constituents interacts with water to produce extensive compounds that alters the parameters of concrete.

**Figure 1. 53 grade of cement (OPC)**

### 3.2 Fine Aggregate and Coarse Aggregate

Construction aggregate are class of coarser to medium referenced by IS:383, Aggregates are the substances on the whole used in the construction. Occupies larger volume in concrete.

### 3.3 Light Weight Aggregate Pumice

Pumice is made up of incredibly tiny, transparent bubble partitions of extrusive igneous rock and extremely microvesicular glass pyroclastic. When volcanic gases separate from viscous magma, several types of bubbles are formed that remain inside the viscous magma as it cools to glass. Explosive eruptions (plinian and ignimbrite-forming) frequently produce pumice as presented in Figure 2.

**Figure 2. Light weight aggregate (pumice stone)**

### 3.4 Water

Potable water used for mixing and curing.

### 3.5 Super Plasticizer

Super plasticizers (SPs), additionally acknowledged as excessive vary water reducers components used in producing excessive energy concrete.

### 3.6 Methodology

Properties of materials were assessed accordance of specified codes to make a mix of M25 referenced by IS:10262.

## 4 Experimental investigation

Basic physical tests are done on materials like cement (IS:12269-2013), coarse aggregate (IS:383-2016), pumice aggregate (IS:2386 (PartIII)-196) and fine aggregate (IS:383-2016). Based on the previous studies target mean strength is fixed and the mix proportions are calculated as per the IS10262:2019 for desired strength with replacement of pumice as 15%, 20%, 25% and 27.5%.

Table 1: Physical properties of materials

| S. No | Material | Properties | Results |
|---|---|---|---|
| 1. | Cement (OPC 53 Grade) | Specific gravity | 3.16 |
| | | Normal consistency | 31% |
| 2. | Fine aggregate | Specific gravity | 2.46 |
| | | Fineness modulus | 2.79 |
| 3. | Coarse aggregate | Specific gravity | 2.73 |
| | | Sieve analysis | 4.68 |
| | | Water absorption | 0.67% |
| | | Bulk density | 1.54 g/cm$^3$ |
| | | Impact test | 25.16% |
| | | Crushing strength | 24.75% |
| 4. | Light weight aggregate (Pumice) | Specific gravity | 0.969 |
| | | Water absorption | 24.24% |
| | | Bulk density | 0.969 g/cm$^3$ |
| | | Impact test | 21.05% |

## Mix design as per IS 10262:2019 guidelines

Target mean strength $f`_{ck}= f_{ck} +1.65S$ or $f_{ck}+X$ (whichever is high)

Concrete volume =1 m$^3$

Volume of materials were calculated accordancxde of their respected specific gravities.

**Mix proportions for conventional concrete of M25 grade**

| | |
|---|---|
| Target mean strength | 31.60 kN/m$^2$ |
| Water cement ratio | 0.45 |
| Water content | 176.38 kg |
| Cement quantity | 352.70 kg/m$^3$ |
| Coarse aggregate | 960.68 kg/m$^3$ |
| Fine aggregate | 831.73 kg/m$^3$ |

**Table 2:** Mix proportions of M25 grade (kg/m$^3$)

| S. no | % of replacement | Cement | CA | FA | LA | Unit weight |
|---|---|---|---|---|---|---|
| 1. | 0 | 352.70 | 960.68 | 831.73 | - | 2400 |
| 2. | 15 | 352.70 | 816.58 | 831.73 | 144.10 | 2180 |
| 3. | 20 | 352.70 | 768.54 | 831.73 | 192.14 | 2100 |
| 4. | 25 | 352.70 | 720.51 | 831.73 | 240.17 | 1900 |
| 5. | 27.5 | 352.70 | 696.49 | 831.73 | 264.19 | 1863 |

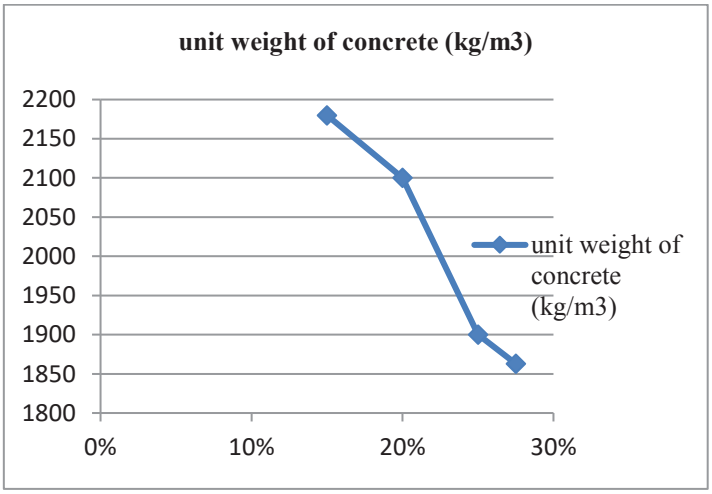


**Figure 3. Density variation chart**

## 5 Conclusions

From the above study it was concluded that,

- The unit weight of concrete is decreased with raise in content of pumice and shown table 2.
- The target density achieved when 27.5% of normal coarse aggregate replaced with pumice.
- The trends of light weight concrete density decrease linearly as shown Figure 3.

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