# Use of vermiculite for light weight floating concrete

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***Abstract:*** **The research paper deals with the study of vermiculite as a replacement of conventional aggregate and its use as a light weight concrete.The tests were conducted as per Bureau of Indian Standards (BIS) specification codes to evaluate the suitability of the vermiculite for structural and non-structural application by partial replacement of up to 25% of cement. The cement-vermiculite samples failed to meet the required strength for structural applications. The strength and other properties met the Bureau of Indian Standards for non-structural materials such as flooring tiles, solid and pavement blocks, and bricks. Detailed leachability and economic feasibility studies need to be carried out as the next step of research.**

***Key Words: Vermiculite,*** **Sodium Silicate, Lime Reactivity, Compressive Strength.**

## 1. INTRODUCTION

The objectives of the project are as follows:

1) To study the experimental material vermiculite.

2) To carry out chemical analysis of the experimental material.

3) To study the compatibility of vermiculite with different building materials.

4) To introduce a light weight concrete.

5) To check floating characteristic of the light weight concrete made from vermiculite.

## 2. MATERIALS USED

### 2.1 Cement

The OPC 53 Grade cement has been used as after conducting necessary testing according to IS specifications.

### 2.2 Lime

Pure Lime (CaO), generally called quick lime, is a white oxide of calcium. Much of commercial quick lime, however, contains more or less magnesium oxide, which gives the product a brownish or grayish tinge. Quick lime is the lime obtained after the calcinations of limestone. It is also called caustic lime. It is capable of slaking with water and has no affinity for carbonic acid. The specific gravity of pure lime is about 3.40

### 2.3 Sodium Silicate

Also known as water glass or liquid glass, available in aqueous solution and in solid form, soluble in water, producing an alkaline solution. There are various states of this compound; all are glassy, colorless, and soluble in water. Sodium silicate is stable in neutral and alkaline solutions. In acidic solutions, the silicate ion reacts with hydrogen ions to form silica acid, which when heated and roasted forms silica gel, a hard, glassy substance.

### 2.4 Flt Ash

Fly ash or Pulverized Fuel Ash (PFA) is the residue from the combustion of pulverized coal collected by mechanical separators obtained from Dahanu Thermal power plant.

### 2.5 Grit

The Grit was primarily used for the purpose of providing bulk to the mixture.

### 2.6 Vermiculite

Vermiculite is a hydrous phyllosilicate mineral. It undergoes significant expansion when heated. Exfoliation occurs when the mineral is heated sufficiently, and the effect is routinely produced in commercial furnaces.

## 3 CHEMICAL & PHYSICAL TESTS ON VERMICULITE

### 3.1 Chemical Analysis Report

By Inorganic qualitative analysis the following results are obtained.

1) Sulphates of $SO_4^{-2}$ present

2) Chlorides as $Cl^-$ present

3) $Fe_3^+$ and $Fe_2^+$ present

4) $NO_3^-$ present

5) $Ca_2^+$ present in negligible amount

6) $Mn_+^2$ present

### 3.2 Physical Tests

**Lime reactivity Test (IS:1727-1967)**

TABLE 1. LIME REACTIVITY TEST RESULTS

| Proving Ring Used=10 KN | | | | | |
|---|---|---|---|---|---|
| Cube No. | Dials | Constant | Load (N) | Strength(MPa) | Strength ($Kg/Cm^2$) |
| 1 | 24 | 15.526 | 372.61 | 0.076 | 0.76 |
| 2 | 32 | 15.526 | 496.83 | 0.10 | 1.013 |
| 3 | 28 | 15.526 | 434.73 | 0.089 | 0.89 |
| 4 | 29 | 15.526 | 450.25 | 0.091 | 0.91 |
| 5 | 26 | 15.526 | 403.68 | 0.082 | 0.82 |
| 6 | 24 | 15.526 | 372.67 | 0.076 | 0.76 |

## 4 EXPERIMENTAL PLAN

From the chemical analysis that was available, it was found that the vermiculite contains significant quantities of aluminium and sulphate ($SO_4^{-2}$). With this composition it was impart that lime (CaO) may have better binding characteristics as compared to cement. In such combination sodium silicate was known to have a positive effect on the binding material composition. With this in background following experimental programme was devised.

### 4.1 Proportions Adopted

Cement: - 1 Part
vermiculite: - 2 Part
Fly Ash: - 2 Part
Grit: - 3 Part
Water: - As Per Desired Workability

TABLE 2. PROPORTIONS OF MATERIAL IN MIXTURE

| Sr. No. | Material | % by weight | Weight (Kg) |
|---|---|---|---|
| 1 | Binding Material | 12.5 | 2.125 |
| 2 | Vermiculite | 25 | 4.25 |
| 3 | Fly Ash | 25 | 4.25 |
| 4 | Grit | 37.5 | 6.375 |

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### 4.2 Experimental Trials

The binding material used consist of following constituents in varying proportions

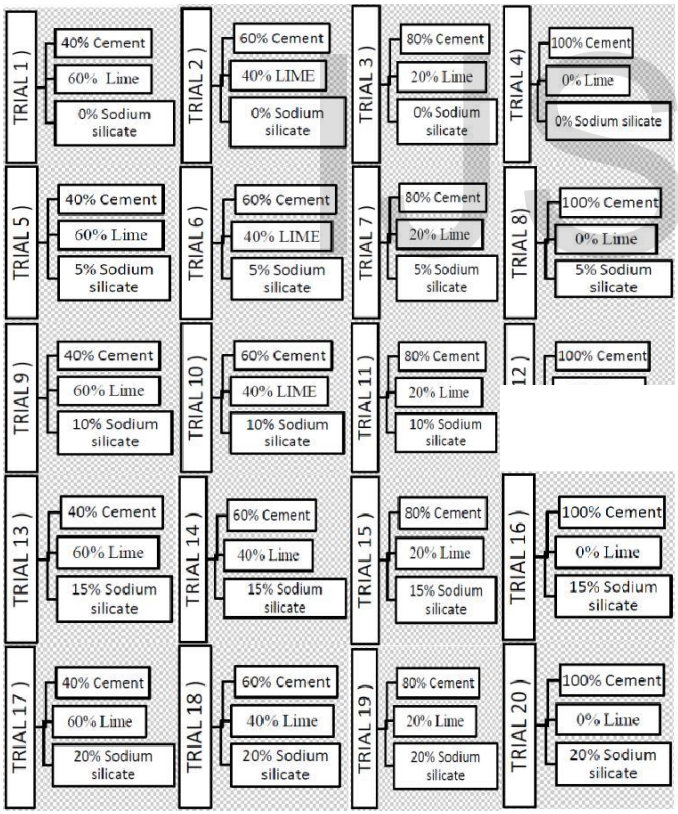


Figure-1 Mixing Proportions

### 4.3 Casting Methodology:

a) Moulds of dimensions 100mm*100mm*100mm were used for casting of cubes.

b) The Weigh Batching was done. Quantity for each mould was 2.5 Kg and for each trial was 17 Kg.

c) Mixing by hand followed by pan mixing was done to get intimate mixture.

d) Gunny bag and air setting curing was adopted.

e) Compression testing was done with the help of proving rings.

f) Compressive strength were found out and tabulated.

Image- 2. Compression Testing

## 5 EXPERIMENTAL RESULTS

The compressive strength is tabulated on the basis of the percentage of sodium silicate.

**TABLE 4. 0 % SODIUM SILICATE**

| SR NO. | PROPORTION | WATER CONTENT AMOUNT (ml) | WATER CONTENT W/B.M | STRENGTH (Mpa) 7 DAYS | STRENGTH (Mpa) 28 DAYS |
|---|---|---|---|---|---|
| 1 | 100% CEMENT + 0% LIME | 1500 | 0.78 | 0.06 | 0.23 |
| 2 | 80% CEMENT + 20% LIME | 1500 | 0.78 | 0.08 | 0.2 |
| 3 | 60%CEMENT + 40% LIME | 1500 | 0.78 | 0.11 | 0.29 |
| 4 | 40% CEMENT +60% LIME | 1500 | 0.78 | 0.182 | 0.55 |

**TABLE 5. 5 % SODIUM SILICATE**

| SR NO. | PROPORTION | WATER CONTENT AMOUNT (ml) | WATER CONTENT W/B.M | STRENGTH (Mpa) 7 DAYS | STRENGTH (Mpa) 28 DAYS |
|---|---|---|---|---|---|
| 1 | 100% CEMENT + 0% LIME | 1400 | 0.73 | 0.038 | 0.247 |
| 2 | 80% CEMENT + 20% LIME | 1300 | 0.67 | 0.073 | 0.318 |
| 3 | 60%CEMENT + 40% LIME | 1300 | 0.67 | 0.41 | 0.904 |
| 4 | 40% CEMENT +60% LIME | 1300 | 0.67 | 0.468 | 1.026 |

**TABLE6. 10 % SODIUM SILICATE**

| SR NO. | PROPORTION | WATER CONTENT | WATER CONTENT | STRENGTH (Mpa) | STRENGTH (Mpa) |
|---|---|---|---|---|---|
| | | AMOUNT (ml) | W/B.M | 7 DAYS | 28 DAYS |
| 1 | 100% CEMENT + 0% LIME | 1200 | 0.625 | 0.105 | 0.43 |
| 2 | 80% CEMENT + 20% LIME | 1200 | 0.625 | 0.289 | 0.55 |
| 3 | 60%CEMENT + 40% LIME | 1300 | 0.67 | 0.500 | 1.067 |
| 4 | 40% CEMENT +60% LIME | 1400 | 0.73 | 0.47 | 1.148 |

**TABLE 7. 15 % SODIUM SILICATE**

| SR NO. | PROPORTION | WATER CONTENT | WATER CONTENT | STRENGTH (Mpa) | STRENGTH (Mpa) |
|---|---|---|---|---|---|
| | | AMOUNT (ml) | W/B.M | 7 DAYS | 28 DAYS |
| 1 | 100% CEMENT + 0% LIME | 1300 | 0.67 | 0.23 | 0.55 |
| 2 | 80% CEMENT + 20% LIME | 1200 | 0.625 | 0.48 | 1.114 |
| 3 | 60%CEMENT + 40% LIME | 1200 | 0.625 | 0.537 | 1.146 |
| 4 | 40% CEMENT +60% LIME | 1400 | 0.73 | 0.627 | 1.42 |

**TABLE 8. 20 % SODIUM SILICATE**

| SR NO. | PROPORTION | WATER CONTENT | WATER CONTENT | STRENGTH (Mpa) | STRENGTH (Mpa) |
|---|---|---|---|---|---|
| | | AMOUNT (ml) | W/B.M | 7 DAYS | 28 DAYS |
| 1 | 100% CEMENT + 0% LIME | 1400 | 0.73 | 0.12 | 0.585 |
| 2 | 80% CEMENT + 20% LIME | 1300 | 0.67 | 0.147 | 0.421 |
| 3 | 60%CEMENT + 40% LIME | 1700 | 0.88 | 0.2 | 0.705 |
| 4 | 40% CEMENT +60% LIME | 1600 | 0.83 | 0.304 | 0.79 |

## 6 CONCLUSION

- The experimental results indicate that in general there is an increase in strength with decreasing in cement content and increasing lime content.
- In the present experimental programs, the maximum percentage lime content was 60% of the total binders.
- This indicates that the vermiculite is more suitable for lime as a binder as compare to that of cement.
- The addition of Sodium Silicate as a co-binder has favorable effect up to 15% of the total binder weight. Beyond this it leads to a fall in 28 days strength. This indicates that 15% Sodium Silicate as a co-binder is the optimum % for 28 days Strength.
- The results show that the experimental material (vermiculite) is more compatible with LIME than with CEMENT. It gives appreciative strength with 15% of Sodium Silicate by weight of bonding materials.
- The maximum strength was obtained with 60% replacement of Cement with Lime and addition of 15% of Sodium Silicate.
- In most of the present day construction, the partition wall an external wall is meant only as a physical separator to prevent passage of light and sound. Therefore the wall adds to the dead load on the building, framework including RCC beams, columns and foundation.
- This block made with vermiculite is lighter in weight, at least by 30% as compare to brick work. This will lead more economical frame structure. In addition this material appears to have higher thermal and acoustic insulation properties. However this needs to be proved by additional laboratory test. Higher thermal insulation of the walls will lead to cooler and better living conditions without artificial facilities like air conditioner. This could be viewed as a significant contribution from the point of eco-friendly building technology.
- A non-load bearing wall has to resist only the compressive stress due to self weight of the wall itself and no other load.
- Self weight, stress on the wall is work out to only 0.48 N/mm$^2$. With the recommended mix proportion the strength work out to 1.42 N/mm$^2$. Hence from a Structural point of view this is suitable as non-loading partition wall.

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