

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

## Strength of Magnesium Oxide Blended with Mineral Admixtures

Sk. Ummisalma<sup>1</sup>, S.Reddemma<sup>2</sup>

P.G. Student, Dept. of Civil Engineering, Universal College of Engineering, Guntur, Andhra Pradesh, India<sup>1</sup>

Asst. Professor, Dept. of Civil Engineering, Universal College of Engineering, Guntur, Andhra Pradesh, India<sup>2</sup>

**ABSTRACT:** Roof is an important part of a structure and so the roofing material. In ancient periods, bamboo, straw poles are used as roofing material and at present GI sheets are used as roofing material. Magnesite based roofing sheets appear to be more prospering and suitable in many respects. Magnesite cement materials are called Sorel Cements. Sorel discovered it from the combination of magnesium oxide and Magnesium Chloride Solution. Sorel discovered it from the combination of magnesium oxide and Magnesium Chloride Solution. Magnesium corrugated sheets have many advantages, over asbestos and GI sheets, and is strong, durable, water resistant, fire resistant, easy to fix. Major ingredient in Magnesium corrugated sheets is MgO. Since MgO is costly, and hence in the present thesis studies are carried out in replacing magnesium oxide by Fly ash, Stone Dust and Modulus of rupture is obtained from the above mixes. Experiments includes normal consistency, modulus of rupture for MgO with the replacements depends on the proportions of replacement materials. Observed properties of replacements for modulus of rupture are as follows for 40% Flyash, 25% stone dust and 40% Flyash +25% Stone dust replacements of MgO. When compared to above three combinations the maximum modulus of rupture observed at 40% Flyash + 25% Stone dust replacements of MgO.

**KEYWORDS:** magnesia cement, fly ash, stone dust, modulus of rupture etc.,

### I. INTRODUCTION

Based on the specific climatic conditions, environmental, living standards etc. revolutionary changes have been taking place regarding building materials especially roofing materials. In olden days people used bamboo or straw poles, as a roofing material. At present this is considered as traditional roofing system and prevalent only in rural areas in general. After the advent of industrial revolution, GI sheets or asbestos sheets are used as roofing material. An asbestos cement sheet consists of Portland cement reinforced with Asbestos fibres. Asbestos usage in the building industry stemmed from its inexpensive processing and its special physical and chemical properties, which make it virtually indestructible. Asbestos is a fibrous silicate mineral that maintains chemical resistance especially to alkalis, fire resistance, mechanical strength due to the fibres high length to diameter ratio, flexibility and good friction and wear characteristics. All forms of Asbestos affect human health and causes lung cancer and diseases like Asbestosis. Its ill effects are far-reaching and affects everyone from the person involved mining to the ultimate consumer. Various roofing materials evolved in due course of time namely clay concrete roof planks, sisal fibre- cement corrugated roofing sheets, corrugated sheets from coir Portland cement, Ferro cement roofing sheet, Ferro cement folded plate roofing sheets, Ferro segmental shell roof, Magnesite cement roofing sheets etc. Several alternatives are being constantly explored and in this aspect Magnesite based roofing sheets appear to be more prospering and suitable in many respects. Magnesite cement materials are called Sorel cements and they are being used for the past two centuries onwards. Sorel discovered it from the combination of magnesium oxide and magnesium chloride solution. This combination has many superior properties than Portland cement. Various Magnesium cements are available at present. Mainly Magnesium Oxychloride (MOCI) binds very well to a variety of inorganic and organic aggregates such as saw dust, sand and gravel giving a cement that has high early strength. The reactivity of MgO has significant effect on magnesia cement properties. Hence MgO should conform to certain specifications of physical and chemical properties. Otherwise MgO can affect the development strength of cement thus formed. Since MgO is costly, and hence in the present thesis, studies are carried out in replacing magnesia oxide by flyash, stone dust.

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## II. MATERIALS USED

The following materials are used in preparation of test specimens for the experimental investigation.

- 1) Magnesium oxide      2) fly ash      3) stone dust

### MAGNESIUM OXIDE:

Magnesium oxide used in the present investigation is supplied by kami magnesite products pvt. ltd., hyderabad. Magnesium oxide is produced commercially by heating magnesite to 600-8000c, which drives off most of the co<sub>2</sub>. it has good thermal conductivity and electrical resistivity at elevated temperatures MgO is available in almost all forms like single crystals. pieces and powder sizes as fine as nanometres. magnesite is a mineral composed of mgco<sub>3</sub> is 47.8% of MgO and 52.2% of co<sub>2</sub>.

| Physical properties of MgO        |                     |
|-----------------------------------|---------------------|
| Density (g/cm <sup>3</sup> )      | 3.58                |
| Melting point                     | 2800 <sup>0</sup> C |
| Boiling point                     | 3600 <sup>0</sup> C |
| Specific gravity                  | 3.53-3.58           |
| Surface area (cm <sup>2</sup> /g) | 28-35               |

### Flyash:

Flyash used in the present investigation is supplied by Nellore thermal power plant. Flyash is a finely divided residue of pulverized coal or lignite combustion in thermal power station. It is generally grey in colour, abrasive m refractory in nature. Flyash is a by-product from the power stations and is available in the form of fine residue.

Table1: Physical properties of flyash

| Physical properties of fly ash |               |
|--------------------------------|---------------|
| Density (g/cm <sup>3</sup> )   | 3.58          |
| Melting point                  | 28000C        |
| Dielectric constant            | 9.65 at 1 MHz |
| Young's modulus                | 249 Gpa       |
| Shear modulus                  | 155 Gpa       |
| Bulk modulus                   | 155 Gpa       |
| Poisson's ratio                | 0.18          |

Table2: Chemical Properties of flyash

| Chemical Properties of flyash |                            |
|-------------------------------|----------------------------|
| Solubility                    | 0.00062 g/ 100 gr of water |
| Molecular weight              | 40.32                      |
| Class/structure               | Cubic FCC, NaCl            |

### Chemical Composition:

The major constituents of ash are silica alumina and iron oxide with traces of calcium, magnesium and sulphur.

| Constituents     | Percentage (%) |
|------------------|----------------|
| Silica           | 49-67          |
| Alumina          | 16-29          |
| Iron oxide       | 4-10           |
| Calcium oxide    | 1-4            |
| Magnesium oxide  | 0.2-2          |
| Sulphur          | 0.1-2          |
| Loss of ignition | 0.4-0.6        |

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## Stone dust:

Stone dust used in the present investigation is supplied by Dinesh Stone Crusher, Ramachandra Puram near Tirupati.

## III. EXPERIMENTAL PROCEDURE

### Consistency:

About 300 g of MgO was initially mixed with 27 percent of water and mixed well to form paste. The paste was filled into mould of Vicat's apparatus and care was taken such that the MgO paste was not pressed forcibly in to mould and the surface of the filled past was smoothed and levelled. A square needle of size 1 mm x 1 mm attached to the plunger is then lowered gently on to surface of the MgO paste and is released quickly. The plunger pierces the MgO paste and the reading on the attached scale was recorded. The experiment was performed carefully away from vibrations and other mechanical disturbances. The same test procedure was repeated by increasing the percentage of mixing water at 0.5% increment until the penetration reading was 5 to 7 mm from the bottom of the mould. When this condition is fulfilled the amount of water added was taken as the correct percentage of water for normal consistency. The entire test was completion of the experiment exceeds 5 minutes, the sample has to be rejected and fresh sample has to take and the operation has to be reported again. Fresh MgO has to be taken for each repetition of the experiment. The plunger shall be cleaned each repetition of the experiment.

### Preparation of beams:

The beams were prepared by mixing of MgO to standard consistency. The beam mould was 100X25X25mm in size.

The mixture is filled into the metal moulds after applying grease of petroleum jelly. The metallic mould was placed horizontally on a non-absorbent plate and filled with mixture and consolidated the same with finger pressure only. The surface of the test pieces was smoothed with knife.

18 beams were prepared as mentioned above and kept at  $27 \pm 2^{\circ}\text{C}$ , 90% relative humidity. They were kept undisturbed for 24 hours. The beams were gauged and removed from the moulds and immediately placed them in a tray covered with not less than 25 mm depth of dry sand.

The beam was rested on one side of the two parallel metal rollers of 12.5 mm in diameter and placed apart at 75 mm centres as per IS:(10132-1982). The load was applied to the opposite side at a uniform rate of 25 kg per minute through a third similar roller placed midway between other two. 6 beams were taken to determine the braking load at 3 days, 7 days and 28 days. The breaking load for 3 days, 7 days and 28 days was obtained.

$$\text{Modulus of rupture } R = 0.72 W$$

$$W = \text{Breaking load in Kg}$$

### Details of test programme:

The details of the different gauged materials used in the present experimental work are presented in table 4.1, a total of 57 samples were used in Vicat apparatus and 342 samples were tested for modulus of rupture. First 18 specimens were prepared with 100% MgO and then MgO is replaced with different percentages of flyash and for each percent 18 specimens were prepared, next to that MgO is replaced with different percentages of stone dust and for each percent 18 specimens were prepared and also the MgO is replaced with both Flyash and stone dust with varying percentages. The No of specimens prepared were shown in the below table.

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### Test Programme

| SI NO | Description of materials | Percentage replacement of MgO | No of specimens for modulus of rupture | No of trials for consistency |
|-------|--------------------------|-------------------------------|----------------------------------------|------------------------------|
| 1     | MgO                      | -                             | 18                                     | 03                           |
| 2     | Flyash                   | 15                            | 18                                     | 03                           |
|       |                          | 20                            | 18                                     | 03                           |
|       |                          | 25                            | 18                                     | 03                           |
|       |                          | 30                            | 18                                     | 03                           |
|       |                          | 35                            | 18                                     | 03                           |
|       |                          | 40                            | 18                                     | 03                           |
|       |                          | 50                            | 18                                     | 03                           |
|       |                          | 60                            | 18                                     | 03                           |
|       |                          | 3                             | Stone dust                             | 15                           |
| 20    | 18                       |                               |                                        | 03                           |
| 25    | 18                       |                               |                                        | 03                           |
| 30    | 18                       |                               |                                        | 03                           |
| 35    | 18                       |                               |                                        | 03                           |
| 40    | 18                       |                               |                                        | 03                           |
| 4     | Flyash + stone dust      | 25 + 10                       | 18                                     | 03                           |
|       |                          | 30 + 15                       | 18                                     | 03                           |
|       |                          | 35 + 20                       | 18                                     | 03                           |
|       |                          | 40 + 25                       | 18                                     | 03                           |
| Total |                          |                               | <b>342</b>                             | <b>57</b>                    |

### IV.RESULTS AND DISCUSSION

The results of the present investigation are presented in graphical forms. The average modulus of rupture of six test samples is compared with that of six reference samples. Test samples were made with replacing Magnesium oxide(MgO) with Flyash or Stone dust, Flyash and Stone dust in different proportions. Reference samples were made with Magnesium Oxide (MgO).

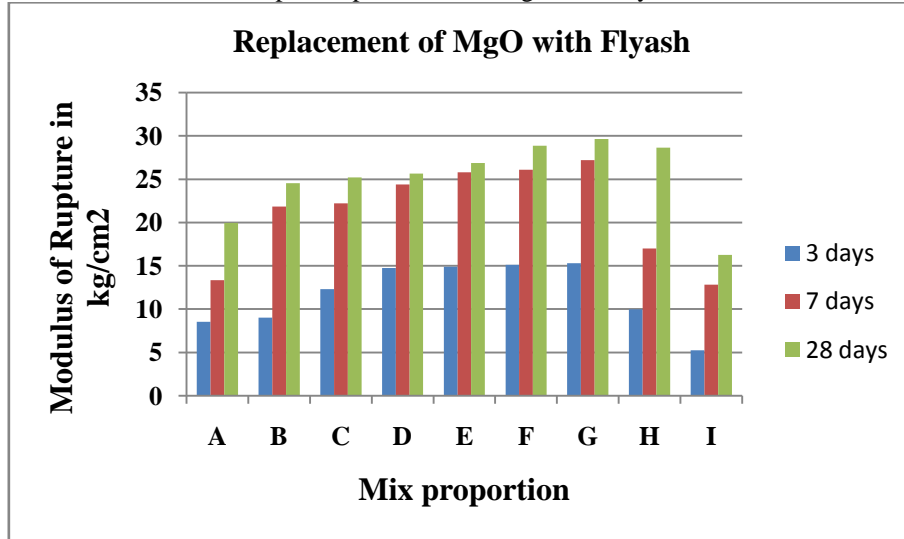
Modulus of rupture at different ages of the test samples and reference samples, also the percent changes in the modulus of rupture of typical test samples and reference samples are shown below.

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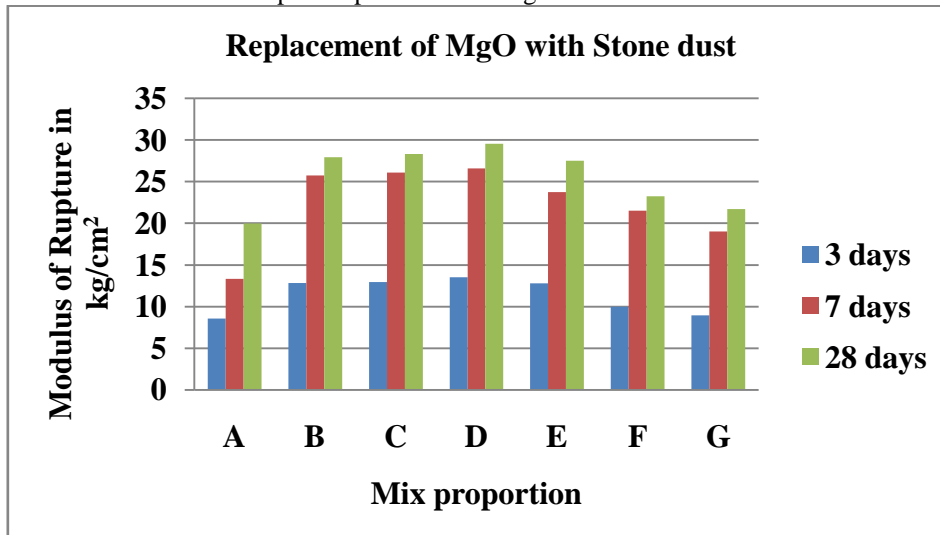
Graph1: Replacement of MgO with Flyash



- |                         |                         |
|-------------------------|-------------------------|
| A: MgO                  | F: 65% MgO + 35% Flyash |
| B: 85% MgO + 15% Flyash | G: 60% MgO + 40% Flyash |
| C: 80% MgO + 20% Flyash | H: 50% MgO + 50% Flyash |
| D: 75% MgO + 25% Flyash | I: 40% MgO + 60% Flyash |
| E: 70% MgO + 30% Flyash |                         |

The above graph shows the modulus of rupture for different replacements of MgO with Flyash for 3 days, 7 days, 28 days. The results show that at all the ages significant increase in modulus of rupture is observed in test samples i.e., 85% MgO + 15% Flyash, 80% MgO + 20% Flyash, 75% MgO + 25% Flyash and 70% MgO + 30% Flyash, 65% MgO + 35% Flyash, 60% MgO + 40% Flyash there after decrease in modulus of rupture is observed in 50% MgO + 50% Flyash and 40% MgO + 60% Flyash.

Graph2: Replacement of MgO with Stonedust



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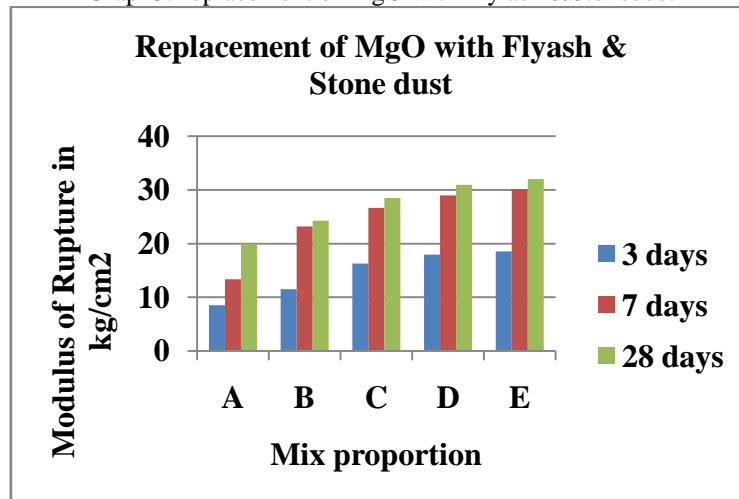
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- |                            |                            |
|----------------------------|----------------------------|
| A: MgO                     | D: 75% MgO + 25% stonedust |
| B: 85% MgO + 15% stonedust | F: 65% MgO + 35% stonedust |
| C: 80% MgO + 20% stonedust | G: 60% MgO + 40% stonedust |

The above graph shows the modulus of rupture for different replacements of MgO with Flyash for 3days, 7days, and 28days. The results show that at all the ages the change in modulus of rupture due to use of the stone dust. Significant increase in modulus of rupture is observed in test samples i.e, 85%MgO + 15% stone dust, 80%MgO + 20% stone dust, 75%MgO + 25% stone dust, there after decrease in modulus of rupture is observed in 70%MgO + 30% Stone dust, 65% MgO + 35% Stone dust and 60%MgO + 40% stone dust.

Graph3: Replacement of MgO with Fly ash & Stonedust



A: MgO

- B: 65% MgO + 25% Flyash + 10% Stone dust
- C: 55% MgO + 30% Flyash + 15% Stone dust
- D: 45% MgO + 35% Flyash + 20% Stone dust
- E: 35% MgO + 40% Flyash + 25% Stone dust

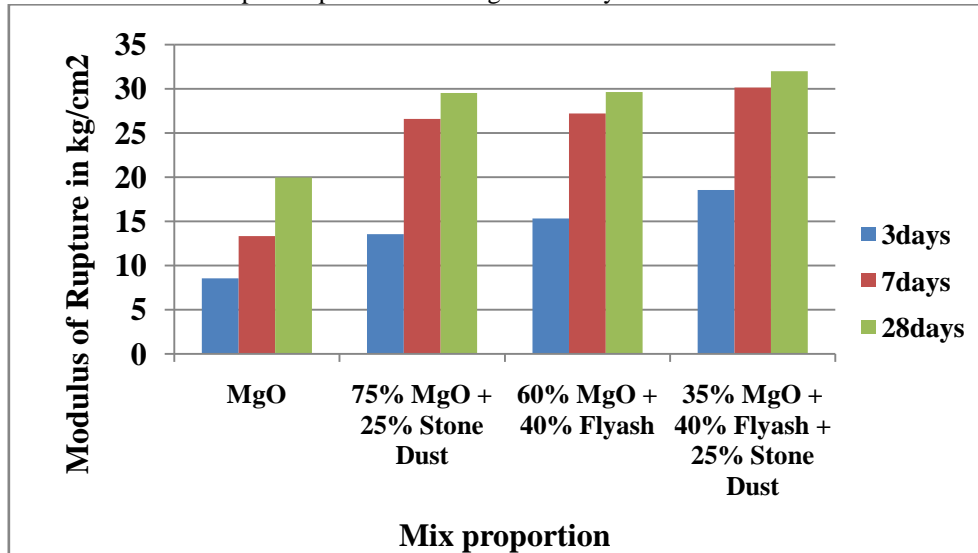
In the above, graph3 both the fly ash and stone dust was replaced with MgO at different percentages. Significant increase in modulus of rupture is observed in test samples at all the ages i.e., 25% Flyash + 10% Stone dust, 30% Flyash + 15% Stone dust, 35% Flyash + 20% Stone dust and 40% flyash + 25% stone dust.

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Graph4: Replacement of MgO with Fly ash & Stone dust



The above graph shows the difference in modulus of rupture of MgO, MgO replaced with 25% stone dust, MgO replaced with 40% Fly ash and MgO replaced with 40% Flyash and 25% stone dust at the age of 3 days, 7 days, and 28 days. The highest strength gained was shown in MgO replaced with 40% Flyash and 25% stone dust.

### V. CONCLUSIONS

1. As fly ash replacement increase up to 40% in magnesium oxide (MgO), Modulus of rupture increased about 48.54% at 28 days
2. As fly ash replacement increase more than 40% in magnesium oxide (MgO), Modulus of rupture decreased
3. As stone dust replacement increase up to 25% in magnesium oxide (MgO), Modulus of rupture increased about 48% at 28 days.
4. As fly stone dust replacement increase more than 25% in magnesium oxide (MgO), Modulus of rupture decreased
5. Fly ash 40% and Stone dust 25% replacement in magnesium oxide (MgO), Modulus of rupture increased about 60.32% at 28 days
6. As fly ash decrease and stone dust increase replacement in magnesium oxide (MgO), modulus of rupture decreased.

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