A STUDY ON PARTIAL REPLACEMENT OF METAKAOLIN AND MARBLE DUST WITH CEMENT

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ABSTRACT

unprecedented amounts of cement have been poured into urban construction over the last decade. Since research is still scarce on the factors un- derlying the cement consumption, the motivation of this paper is to provide insight into cement-based socioeconomic metabolism and to improve understanding of the linkage between human activities and cement consumption. Partial replacement of Metakaolin and Marble dust shows very positive results on compressive strength of concrete at early as well as on later stage. It is very effective in reducing the bleeding and segregation from fresh concrete. The higher percentage replacement (15% and above) reduce the workability and makes difficult to work with concrete which results poor productivity at site. Finer grain size of Metakaolin and Marble dust produces dense and compact concrete which is one of the basic requirements of a good concrete

1. INTRODUCTION

1.1 General

In construction Industry, consumption of cement is increasing day by day as well as cost is also increasing so to reduce the consumption of cement, partial replacement with Metakaolin and Marble powder was done in this study. Metakaolin is a calcinied clay0 and easily available in Gujarat, Maharashtra & Bombay etc. It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain i.e. ceramic material. The particle size of Metakaolin is smaller than cement particles. Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Some of industries used to wash out this marble powder with water in natural streams which cause water pollution and is harmful for our environment. So, it is advisory to use marble dust as partial replacement with cement as it has properties similar to cement and one of good pozzolanas. Similarly use of Metakaolin leads to Green concrete, because during production of Metakaolin concrete there is no emission of carbon dioxide Since there is large emission of carbon dioxide in manufacturing of cement and clinker, results in 3-5% increase in greenhouse gasses and global warming.

The growing concern of resource depletion and global pollution has challenged many researchers to seek and develop new materials relying on renewable resources. These include the use of by-products and waste materials for building construction. The high cost of conventional building materials is a major factor affecting construction in India. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used for various purposes in construction industry. This will have double the advantages, reduction in the cost of construction material and also as a means of disposal of wastes. Thus the approach is logical, worthy and attributable. Therefore an attempt has been made in this study to utilize the metakaoline and waste marble powder is used as a partial replacement of cement in the development of low cost concrete. So a study on various strength and durability properties of these

materials is carried out. Also suitable measures have to be adopted for attaining the target strength.

1.2 Construction Waste

Environmental Protection Agency (EPA) defines construction and demolition (C&D) waste as waste materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain materials that include: concrete, asphalt, wood, metals, gypsum, plastics and salvaged building components. It is a challenging task to handle C&D waste because it is bulky, heavy and inert and also mixture of various materials of different characteristics. It is also difficult to choose any suitable disposal method, for example, it cannot be incinerated due to its high density and inertness.

1.2.1 Metakaoline

Metakaoline is a pozzolanic probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC.

Figure-1: Metakaoline powder

1.2.2 Marble dust

It is an essential component of igneous and metamorphic rocks. The size varies from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. The crushed marble powder used in the experiments is in a form of white powdered, which replaces fine aggregate from the conventional concrete. The particle size used ranges from 10 to 45µm

Figure-2: Marble dust waste from construction Industry.

1.3 Scope of the Work

`The aim of the present study is to use naturally available and low cost metakaoline and marble dust as a partial replacement to cement in concrete and to recycle the Construction waste materials so that to reduce environmental pollution.

1.4 Objectives of the Research

Objectives of the study as follows:

To study mechanical properties such as compressive strength at the end of 7, 14 and 28 days of curing by partially replacing cement with metakaoline and marble powder under normal curing.

To reduce environmental Pollution

To study the properties of fresh pollution by utilizing waste material in concrete.

To make Eco-friendly concrete

concrete this is cast by using metakaolin and marble dust

To study the properties of fresh concrete this is cast by using metakaoline and marble dust.

2. LITERATURE REVIEW

Abdullah Anwar et.al (2014) : In this paper the authors represented that Marble Dust Powder has replaced the (OPC&PPC) cement of 0%, 5%, 10%, 15% 20%, & 25% by weight

& M-20 grade concrete was used. Concrete is M30. mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyze the behavior of concrete while replacing the Marble Dust Powder with Different proportions in concrete. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of cement with marble dust powder is about 10% for (PPC) and (OPC). This will post less on the production of carbon dioxide and solving the environmental pollution by cement production there by enhances the urban surroundings.

Sanjay N. Patil et,al (2014) : The paper deals with the use of Metakaolin which is having good pozzolanic activity and is a good material for the production of high strength concrete. Use of MK is getting popularity because of its positive effect on various properties of concrete. Literature Review shows that optimal performance is achieved by replacing 7% to 15% of the cement with Metakaolin and when use of MK is less than 10% , then the benefits are not fully realized so at least 10% Metakaolin should be used. Values of compressive strength of concrete with Metakaolin after 28 days can be higher by 20%. Dosage of 15% of Metakaolin causes decrease of workability. So increasing amount of perceptual proportion of Metakaolin in concrete mix seems to require higher dosage of super plasticizer to ensure longer period of workability.

J.M. Khatib et.al(2012) : In the paper author studied the compressive strength, density and ultrasonic pulse velocity of mortar containing high volume of Metakaolin (MK) as partial substitution of cement. In this paper up to 50% of MK was used to replace cement in increment of 10. After De-molding, specimens were cured in water at 20°C for a total period of 28 days. The density seems to reduce with the increase of MK content especially at MK content

above 30%.The strength increases as the MK content increases up to about 40% MK with a maximum strength occurring at 20% where the strength is 47% higher. At 50% the strength start reducing, 10% and the 30% MK mixes exhibit an increase in strength of around 37%.

Prof. P.A. Shirule et.al (2012) : The paper described the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. The Compressive strength of Cubes & Split Tensile strength of Cylinders are increased with addition of waste marble powder up to 10% replaced by weight and it was also observed that 10% replacement gave optimum percentage of strength

B.B.Sabir et.al (2001) : The paper described the partial replacement of cement with the Metakaolin in concrete and mortar, which causes great improvement in the pore structure and hence resistance of concrete to harmful solutions. The paper also demonstrated clearly that MK is very effective pozzolanas and result enhanced early strength with no detriment to, and some improvement in the long term strength. Mortar and concrete were observed as great improvement in resistance to the transportation of water and diffusion ions which lead to degradation of matrix.

3. TESTS ON MATERIALS

3.1. Materials

3.1.1. Cement: cement is a binding material invented by Joseph Aspdin in 1824. It is manufactured from calcareous materials, such as limestone or chalk, and argillaceous material such as shale and clay.

3.1.2. Coarse Aggregate: I f

the size of aggregate is bigger than 4. 75 mm, then the aggregate is considered as coarse aggre gate.

Eg: Stone, ballast, gravel, brick ballast.

3.1.3. Fine Aggregate: According to IS 383, most of the aggregate which will pass through 4. 75 mm IS sieve and entirely retained on 75 µ sieve is considered as fine aggregate.

Eg: Sand crushed stone, ash or cinder and surkhi.

3.1.4. Water: water is the main ingredient used to mix all t he contents. Potable water is used as usage of any other water may contain salts and cause decrease in strength of concrete.

3.1.5 Metakaolin

Metakaoline is a pozzolanic probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC.

Figure 3.1: Metakaoline powder

3.1.6 Marble dust powder: It is an essential component of igneous and metamorphic rocks. The size varies from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. The crushed marble powder used in the experiments is in a form of white powdered marble flour, which replaces fine aggregate from the conventional concrete. The particle size used ranges from 10 to 45µm One of the major wastes produced in the stone industry during cutting, shaping, and polishing of marbles is the MDP. During this process, about 20-25% of the process marble is turn into the powder form. India being the third (about 10%) top most exporter of marble in the world, every year million tons of marble waste form processing plants are released. Due to the availability of large quantity of waste produced in the marble factory, this project has been planned and preceded.

Figure 3.2: marble dust powder

3.2 Tests on Cement

3.2.1 Specific Gravity of Cement

Specific gravity of the cement is calculated by using density bottle method. Cement specific gravity: 3.12
The following is the procedure to find specific gravity of cement.

Aim: To determine the specific gravity of cement

Required Materials & Apparatus:

- Ordinary Portland Cement
- Kerosene
- Specific Gravity Bottle (100 ml)
- Weighing balance with 0.1 gm

accurate

Procedure:

1. The Flask should be free from the moisture that means it should be fully dry. Weigh the empty flask(W1)

2. Fill the bottle up to half of the flask (about 50gm) with cement and weigh with its stopper (W2)

3. Add Kerosene to the cement mix well to remove the air bubbles in it. Weigh the flask with cement and kerosene (W3)

4. Empty the flask and fill the bottle with kerosene up to the top and weigh the flask (W4)

Tabulation:

1. Weigh of the empty flask(W1) = 243.30

2. Weigh of the flask with cement (W2) = 293.30

3. Weigh of the flask with cement and kerosene (W3) = 365.35

5. Weigh of the flask with full of kerosene up to top (W4) = 322.30

CONCLUSIONS

The present experimental investigation was aimed to design a high grade concrete with partial replacement of Metakaolin and Marble dust to cement analysing the same on various parameters to obtain replacement percentage of metakaolin in production of concrete. Some of the broad conclusions
The following conclusions may be drawn based on the experimentations conducted on the behavior of concrete with partial replacement of cement by Metakaolin and Marble dust The addition of Metakaolin along with cement has increased the compressive strength of the concrete when compared to the conventional concrete.

- From the Test results we find that metakaoline and marble dust can be use for partial replacement in concrete.
- The compressive strength of concrete is more at 10%+10% replacement of metakaoline and marble dust. Has give maximum strength is 41.28 KN/M2
- The Split tensile strength of concrete Cylinder strength of concrete is more at 10%+10% replacement of metakaoline and marble dust. Has give maximum strength is 4.73 KN/M2
- Flexural strength of concrete replaced with Metakaoline and Marble dust 10% + 10

% has given Maximum strength which is 4.73 KN/M2

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