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ORIGINAL ARTICLE **OPEN ACCESS**

Effect of Marble Slurry as a Filler on Setting Time of Magnesia Cement

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ABSTRACT
Marble slurry is generated by marble processing which causes serious impact on the environment. . Study of the reuse of marble waste material can be considered as an eco-friendly step. The effect of marble slurry as filler in different amount on setting characteristics of Magnesia cement has been carried out. For this function, three different type of dry mixture composition (1:0, 1:1 and 1:2) of magnesia cement and marble slurry were gauged with two different type of concentration 24°Be and 30°Be of magnesium chloride gauging solution. The initial and final setting time were observed to be increases as ratio of marble slurry increased in cementing composition.
Keywords: Marble Slurry, Magnesia Cement, Hydraulic cement

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INTRODUCTION

There are two types of cement used in the construction industry: hydraulic and non-hydraulic. Hydraulic cement set and hardens extremely fast in presence of water (The chemical action between cement and water known as hydration) and result in water resistance product which is stable. Portland cement is the most important and widely used hydraulic cement [5-7]. Any non-hydraulic cements is derived from calcinations of gypsum or limestone because its products of hydration are not resistant to water.

In 1853, a French chemist, S.T. Sorel discovered that zinc chloride solution, formed very hard cement when mixed with zinc oxide. In 1867, he found that a paste of cement having similar features is obtained by the interaction of magnesia with the aqueous solution of its salts, particularly halides and sulphates [14-15]. Later it was found that various other metallic oxides & chlorides did the same, an oxy-chloride being formed in each case. It is also known as magnesia cement, plastic magnesia or magnesia oxychloride cement. The author would be used "Magnesia cement" name in his Ph.D. work. Some work on this composition has been performed at the Central Building and Research Institution Roorkee and CRRI, New Delhi [11]. Magnesia cement Association in Washington has also released some work connected to technical problems and application of this cement under the auspices of American Standards for testing of the Material (A.S.T.M.). Sorel`s cement specification and standard for the raw materials have also been developed by various standard[6-8].The lightweight Sorel`s cement composites doped with coal fly ash, due to their specific and unique properties can find use in flooring systems, building envelopes, in the insulation boards with high fire resistance, repair applications, walling blocks, etc[3-4-12].Magnesia cement has superior qualities over other inorganic cements but some associated problems of reduction in strength with time, dimensional instability, cracking and sweating etc. are also common. These are impeding problems on which the attention of the scientists is required to be focused urgently.

During cutting and polishing processes, marble industry units generate huge quantities of marble sludge [2-10].

Marble slurry is an industrial waste produced from cutting of marble stone. The result is that the mass of marble waste materials to the environment directly can cause environmental problem. This waste marble slurry is dumped in open spaces and water bodies, posing major ecological issues. When the slurry dries, its fine particles causes air pollution which has got adverse impacts on human health. One way to

overcome this issue is by incorporating marble slurry and recycled aggregates in concrete[9]. Study of the reuse of marble waste material can be considered as an eco-friendly step because it gives a feasible solution for the great amount of marble sludge waste in the world [1]. Author has used marble slurry as a filler in magnesia cement and find out the effect on setting time of this cement in this paper [13].

MATERIAL AND METHODS

The raw material used in the study were calcined magnesite, magnesium chloride and marble slurry dumping site in Makrana, Rajasthan.

Calcined Magnesite

Magnesia used in this study was of Salem, Chennai (Tamil Nadu) origin with following characteristics: (1) min. magnesium oxide 90 % (2) Bulk density 0.85 kg /I (3) 95 % passing through 75-micron (200 IS sieve) (4) CaO < 1.5 % (5) Ignition loss at 100 °C~ 2.5 ± 0.5 %.

Magnesium Chloride (MgCl2.6H2O)

The magnesium chloride utilised in this study was of Indian Standard Grade 3 and has the following characteristics: (1) Easily dissolved in water. (2) Crystalline solid, colourless, hygroscopic crystals. (3) Magnesium chloride hexahydrate ≥ 95 % (4) Magnesium sulphate, calcium sulphate and alkali chlorides (NaCl) contents must be less than 4%, according to Indian Standard: 1973-IS-254.

Marble Slurry (As Filler)

Marble slurry was procured from Makrana dumping site, Rajasthan. It had following characteristics: (1) Loss of Ignition (LOI) – 35-43.2% % (2) Silica – 1.70 % (3) Iron Oxide – 0.10-0.28 % (4) Lime – 49-55% (5) Magnesia – 0.8-1.8 %

(7) Bulk Density (gm/cc) – 1.2-1.5 (8) Specific Gravity – 2.82-2.86

(9) 100% passing through 200μm size particles Indian Standard sieve (2) 50% retained by 125-micron IS sieve.

Formation of magnesium chloride solution:

In water, Magnesium chloride solution was prepared. Firstly magnesium chloride flakes were transferred into plastic containers then potable water was added to prepare a solution that is highiy concentrated. The insoluble impurities settle at the bottom, throughout night the solution was allowed to stand. In other plastic containers, the supernatant concentrated solution was taken out and after each dilution it was well stirred before determining the specific gravity - Indian Standard Institution, 1982. The specific gravity on the Baume scale (°Be) is used to express the concentration of the solution.

Preparation of dry-mix compositions

Lightly calcined magnesite (magnesia) and marble slurry (as filler) were combined to create dry mixes in the following weight ratios- 1:0; 1:1and 1:2.

Determination of standard consistency, initial and final setting times of cement pastes

Wet mixes were prepared by gauging dry mix compositions (in the ratio 1:0, 1:1, 1:2) with 24°Be and 30°Be magnesium chloride gauging solution. The standard consistency, initial and final setting times were investigated as per IS 10132-1982 using Vicat apparatus [16-17]. The observed results are disclosed in table-1 and table- 2.

Effect of marble slurry as filler on setting time of magnesia cement:

Table-1 : Concentration of gauging solution- 24 °Be Humidity: 85 ± 5

Dry-mix Composition	Setting Time	M_1	M_2	M_3	AST
1:0	IST (min)	145	145	148	146
	FST (min)	295	303	308	302
1:1	IST (min)	303	302	307	304
	FST (min)	406	407	411	408
1:2	IST (min)	314	315	319	316
	FST (min)	450	453	456	453

AST (Average Setting Time); IST (Initial Setting Time); FST (Final Setting Time); M (Mould)
Dry-mix Composition: Ratio by weight of magnesia and marble slurry

Table-2 : Concentration of gauging solution- 30 °Be Humidity: 85 ± 5

Dry-mix Composition	Setting Time	M_1	M_2	M_3	AST
1:0	IST (min)	224	227	227	226
	FST (min)	366	371	367	368
1:1	IST (min)	360	362	364	362
	FST (min)	447	449	451	449
1:2	IST (min)	370	373	373	372
	FST (min)	459	460	461	460

AST (Average Setting Time); IST (Initial Setting Time); FST (Final Setting Time); M(Mould)
Dry-mix Composition: Ratio by weight of magnesia and marble slurry

RESULT AND DISCUSSIONS

The effect of marble slurry on the setting characteristics of magnesia cement for dry mix composition (1:0; 1:1 and 1:2) at different concentration of gauging solution (24 °Be and 30 °Be) has been revealed in Table -1 and 2. As in the ratio 1:0; 1:1 and 1:2 dry-mixes composition initial and final setting time increases respectively. As the proportion of filler increases (1:0; 1:1 and 1:2) it has been seen that the setting time increases simultaneously. Therefore as the proportion of fillers increases, the setting time increases because the heat is absorbed by the filler during the reaction between MgO and $MgCl_2$ evolves.

$$\mathbf{MgO + MgCl_2.6H_2O \longrightarrow 5Mg(OH)_2.MgCl_2.8H_2O / 3Mg(OH)_2.MgCl_2.8H_2O + Exothermic}$$

It was well-established that the initial setting time and the final setting time both increases when the percentage composition of marble slurry as filler increases. The most probable explanation of this result is the fact that the amount of residual active lime and un-reacted magnesia content in the matrix also increases when ratio of filler increases in dry mix composition. It means that positive volume changes are quite possible under humid conditions.

$$\mathbf{Ca/MgCO_3 \longrightarrow CaO + MgO + CO_2} \quad \mathbf{...(1)}$$

$$\mathbf{CaO / MgO + H_2O \longrightarrow Ca(OH)_2 / Mg(OH)_2} \quad \mathbf{...(2)}$$

CONCLUSIONS

Following important conclusions have been drawn from the results of the effect of marble slurry as filler on initial and final setting time of magnesia cement.

1. Setting time of magnesia cement increases as ratio of marble slurry increased in cementing composition.
2. It was also noted that more setting time increases 30 °Be density of gauging solution in comparison of 24 °Be.

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