Eco. Env. & Cons. 28 (October Suppl. Issue) : 2022; pp. (S467-S470)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i06s.077

Effect of marble slurry as filler on soundness and compressive strength of magnesia cement

R. N. Yadav and Rajendra Sharma

Department of Chemistry, Govt. RR (PG) College, Alwar 301 001, Rajasthan, India

(Received 8 June, 2022; Accepted 10 August, 2022)

ABSTRACT

Investigation, the effect of different amounts of marble slurry as filler on soundness and compressive strength of magnesia cement has been carried out in this paper. For this purpose, three different dry mix compositions (1:0; 1:1 and 1:2) of magnesia and marble slurry were prepared. The dry mixes were then gauged with 30°Be concentration of magnesium chloride gauging solution. It was observed soundness as well as compressive strength decrease with increasing amount of marble slurry in dry mix composition.

Key words: *Magnesia cement, Marble slurry, Gauging solution, Soundness*

Introduction

Magnesia cement is an inorganic mineral binder which was introduced by a French chemist by Sorel (1867). It is prepared by exothermic reaction between reactive MgO powder and concentrated $MgCl_2$. At room temperature phase-3 or [3Mg $(OH)_2$. $MgCl_2.8H_2O$] and phase-5 or [5Mg$(OH)_2$.$MgCl_2.8H_2O$] are the two chief hydrated phases that impart mechanical strength to the cement by intergrowth and interlocking tendencies of their needle like crystals by Sorrel and Armstrong (1976); Mathur (1986). Many researchers reported some very unique and diverse cementing properties of magnesia cement in comparison of Portland cement, Beaudoin and Ramachandran (1975); Chandrawat, *et al.* (2011). Such as low specific gravity (~2.4), resilient and light in weight, tough and fire proof compound which is extensively used for both light and heavy floorings. Magnesia cement is characterized by rapid setting and high early strength. Magnesia cement possesses enormous load bearing capacity and can easily resist vibrations arising from heavy cast iron wheels, without displaying any cracks or fissures, Mathur (1986). It shows better resistance towards oil, grease and paints and remains unaltered by the attack of acids or alkalis by Sglavo, De Genua, Conci, Ceccato and Cavallini (2011). The manufacturing process of MOC binders is free from any carbon dioxide gas emissions. These binders actually act as "sinks" for atmospheric carbon dioxide by Power, *et al.,* (2017). The ability of MOC cements to incorporate wood ller was exploited to produce "woodstone" panels and re-resistant, Prymelski (1979); Verth and Prymelski (1974). Closely related are "magnesium oxide boards", which are often MOC blended with perlite and are used to replace plaster boards by Magnaliner Fire Resistant Board, Euroform Products (2015); Feigin and Choi (2011). Several patents exploit this characteristic to produce reinforced cement boards by Biefeid, *et al.* (1955); Lin (2011). The industrial applications of MOC cement has been limited because of the associated problems of poor water resistance, volume instability, cracking and sweating etc.

Marble slurry is a suspension of marble fine particles in water, generated during processing and pol-

ishing of marble. It is shaping to major threat of the Environment by mining and processing activities. Some bad effects of the marble slurry are contamination of top fertile soil cover, contamination of the rivers and contamination of air.

In this study is to evaluate reuse ofmarble slurry as a filler in magnesia cement with the concept of sustainable development.

Materials and Methods

The raw materials used in the study were: **A.** Calcined magnesite **B.** Magnesium chloride **C.** Marble slurry.

A. Calcined Magnesite

Magnesia used in this study was of Salem, origin from Chennai with following characteristics: MgO ≥ 90%, Bulk density = 0.85 kg /I , 95 % passing through 75-micron (200 IS sieve), CaO <1.5 % and Loss of Ignition at 100 °C~ 2.5 ± 0.5 %.

B. Magnesium Chloride ($MgCl_2.6H_2O$)

The magnesium chloride utilised in this study was of Indian Standard Grade 3 and has the following characteristics: (1) Highly soluble in water. (2) Crystalline solid, colourless, hygroscopic crystals. (3) Minimum 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.

C. Marble Slurry (As Filler)

Marble slurry was procured from Makrana dumping site, Rajasthan. It had following characteristics: (1) Lime – 48-50% (2) Magnesia – 3.5-4.0 %

(3) Bulk Density (gm/cc) – 1.42 (4) Specific Gravity – 2.82-2.86

(5) 100% passing through 200µm size particles Indian Standard sieve.

D. Preparation of magnesium chloride solution in water

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.

E. Preparation of dry-mix compositions: Dry-mix compositions of lightly calcined magnesite (magnesia) and marble slurry (as filler) were mixed ratio of 1:0; 1:1 and 1:2 by weight respectively and gauged with 30°Be gauging solution.

F. Determination of soundness: The soundness test was carried out by the Le-chatelier's apparatus**, Indian Standard (1989); Indian Standard (1962).** The inner surfaces of the mould was oiled and placed the mould on a glass sheet and filled it with cement paste, covered the mould with another piece of glass sheet and peace a small standard weight on this covering glass sheet and allowed to set for a week. Measure the distance (x) between pointed ends of indicating arms. Immerse the mould in a beaker of boiling water for two hours. Cool and again measure the distance (y) between the pointed ends. The difference (y-x) measures unsoundness or expansion of the product, **Chandrawat (1976); Gupta (1976).** This experiment was repeated three times for different dry-mix compositions. Results of soundness are given in the Table: 1, 2 and 3.

G. Determination of compressive strength: Effect of marble slurry on compressive strength of Magnesia cement was determined by using cubes (molds) of size 70.6 × 70.6 × 70.6 mm^3 as per standard procedure by Methods of Test for Materials for Use in the Preparation of Magnesium Oxychloride Flooring Composition, *Indian Standard Institution*, (1982); Mathur (1986); Yadav (1989). The dry mix compositions 1:0; 1:1 and 1:2 (magnesia : marble slurry) were gauged with 30 °Be gauging solution. Three cubes were filled by each composition ratio. All cubes were air dried at room temperature under lab conditions (85 ± 5 % relative humidity, 30 ± 2 °C temperature) and were tested for compressive strength after 30 days. The results obtained are recorded in Table 4**.**

Results and Discussion

The effects of marble slurry as a filler on soundness and compressive strength of magnesia cement having different dry mix compositions are given in Table 1, 2, 3 and 4.

Dry-mix compositions having marble slurry as filler the trends were found more than 1:0 dry-mixes composition due to increasing chance of remaining active lime and unreacted magnesium oxide content in the matrix. Expansion in the volume of trial blocks is expected on increasing chance of remaining active lime and unreacted magnesia in the matrix as ratio of inert filler marble slurry increase 1:1 to 1:2 in dry-mix compositions. These unused con-

Table 1. Effect of marble slurry as a filler on soundness of magnesia cement.

Concentration of gauging solution- **30°Be**	**Dry-mix -1:0***	Humidity: 85 ± 5%			
S.No.	Observations	M_1	M_2	M_3	Av
1.	Weight of cement composition (g)	38	38	38	38
(i)	Magnesia	38	38	38	38
(ii)	Marble slurry	-	-	-	-
2.	Amount of $MgCl_2$ solution (in ml)	17.5	17.5	17.5	17.5
3.	Distance between two pointers before starting (in mm)	18.3	16	20	18.1
4.	Distance between two pointers after 7 days before boiling (in mm)	24	21.2	25.8	23.7
5.	Distance between two pointers after boiling (in mm)	24.1	21.3	26	23.8
6.	Expansion of cement (in mm)	0.1	0.1	0.2	0.1

* One part by weight of magnesia and no part by weight of marble slurry.
M(Mould), Av(Average values related to soundness test)

Table 2. Effect of marble slurry as a filler on soundness of magnesia cement.
Concentration of gauging solution- **30°Be** **Dry-mix -1:1*** Humidity: 85 ± 5%

S.No.	Observations	M_1	M_2	M_3	Av
1.	Weight of cement composition (g)	38	38	38	38
(i)	Magnesia	19	19	19	19
(ii)	Marble slurry	19	19	19	19
2.	Amount of $MgCl_2$ solution (in ml)	12.8	12.8	12.8	12.8
3.	Distance between two pointers before starting (in mm)	17	16	15	16
4.	Distance between two pointers after 7 days before boiling (in mm)	24	22	22	22.7
5.	Distance between two pointers after boiling (in mm)	25	22.5	22.4	23.3
6.	Expansion of cement (in mm)	1	0.5	0.4	0.6

* One part by weight of magnesia and one part by weight of marble slurry.
M(Mould), Av(Average values related to soundness test)

Table 3. Effect of marble slurry as a filler on soundness of magnesia cement.
Concentration of gauging solution- **30°Be** **Dry-mix -1:2*** Humidity: 85 ± 5%

S.No. Observations	M1	M2	M3	Av
1. Weight of cement composition (g)	39	39	39	39
(i) Magnesia	13	13	13	13
(ii) Marble slurry	26	26	26	26
2. Amount of MgCl2 solution (in ml)	11.9	11.9	11.9	11.9
3. Distance between two pointers before starting (in mm)	15	19	17	17
4. Distance between two pointers after 7 days before boiling (in mm)	22	25.5	23	23.5
5. Distance between two pointers after boiling (in mm)	26.8	30	27.5	28.1
6. Expansion of cement (in mm)	4.8	4.5	4.5	4.6

* One part by weight of magnesia and two parts by weight of marble slurry.
M(Mould), Av(Average values related to soundness test)

tents get hydrated during soundness test and form their hydroxide. Thus under humid conditions positive volume changed are quite expected. On boiling the trial blocks active lime and magnesia changes in their hydroxide form. Accordingly, significant volume changes are noticed more in 1:2 dry-mix composition.

$$Ca/MgCO_3 \longrightarrow CaO / MgO + CO_2$$

$$MgO/CaO + H_2O \longrightarrow Mg(OH)_2/Ca(OH)_2$$

It was noticed that compressive strength decreases as amount of marble slurry increases in dry-mix. This is due to fact that only magnesia is present in the dry-mix composition (1:0) to react with gauging solution which forms the strength giving composition ($MgO.MgCl_2.8H_2O$). But in case of other com-

Table 4. Effect of marble slurry on compressive strength of MOC
Concentration of gauging solution -**30°Be** Humidity-85±5%

Compressive Strength (MPa) Dry-mix composition	M_1	M_2	M_3	ACS
1:0	78.71	76.74	74.77	76.74
1:1	43.29	45.26	47.22	45.26
1:2	25.58	23.61	27.55	25.58

M(Mould), ACS(Average Compressive Strength)

positions (1:1 and 1:2), amount of magnesia content is reduced and calcium content is increased in dry-mix composition ratio respectively. During the preparation of wet-mix composition, calcium carbonate decomposes in lime and released CO_2. Thus, compressive strength of product is reduced as filler ratio increases in the dry-mixes of MOC accordingly.

Conclusion

Soundness of dry-mix composition decreases with increasing amount of marble slurry in dry-mix. Soundness characteristics for 1:0 and 1:1 dry-mixes results are obtained which is good for a construction material.

Compressive strength of cement decreased with increasing ratio of marble slurry.

Acknowledgment

The authors are thankful to Dr. Hukam Singh, principal R. R. College, Alwar (Raj.) for providing lab facilities in college. The authors are alsothankful to Shri Kushal Jain of PWD, Alwar (Raj.) for providing facilities for compressive strength measurements.

References

Beaudoin, J. J., and Ramachandran, V. S., 1975 "Strength development in magnesium oxychloride and other cements." *Cement and Concrete Research*, 5(6), 617-630.

Biefeld, L. P.; Armstrong, M. C.; Shannon, R. F. (1955), *Bonded glass ber product and method of making same. U.S. Patent* 2,717,841.

Chandrawat, M.P.S., (1976). "*Technical Problems in oxychloride Mill Stone, Industries in India, their solution and specifications for good quality products*". (Ph.D Thesis), Jaipur, Rajasthan, University of Rajasthan.

Chandrawat, M. P. S., Yadav, R. N., Gupta, P. and Dagur, N., 2011, "Impact of sodium silicate as an additive on the properties of MOC cement." *Int. J. Chem. Sci.*, 9 (2), 581-588.

Feigin, M. E.; Choi, T. S. 2011, Magnesium oxide-based construction board. *U.S. Patent* 7,998,547.

Gupta B.L., (1976). "*Concrete Technology*" (New Delhi: Standard Publisher), pp 18.

Indian Standard: (1962) 712.

Indian Standard: (1963) 12.

Indian Standard: (1989) Specification for 33 grade ordinary portland cement, IS: 269.

Lin, Q.h.,2011, Process for producing GM-siding with wood grain. *U.S. Patent* 8,025,755.

Magnaliner Fire Resistant Board. Euroform Products, Warrington, U.K., (accessed Apr 8, 2015).http://www.euroform.co.uk/MagnalinerMagnesium-Oxide-Board.shtml.

Mathur, R. 1986. "*Effect of temperature of calcination of magnesite and proportion of inert fillers on the bonding characteristics of magnesium oxychloride cement*." (Ph.D. thesis), University of Rajasthan, Jaipur, India.

Methods of Test for Materials for Use in the Preparation of Magnesium Oxychloride Flooring Composition, (1982), *Indian Standard Institution*.

Power, I. M., Dipple, G. M., and Francis P. S., 2017 "Assessing the carbon sequestration potential of MOC cement building materials." *Cement Concrete Comp.*, 78, 2017, 97-107. (Doi 10.1016/j. cemconcomp.01.003)

Prymelski, F., 1979, Building materials in the form of woodstone panels or sheets and processes for their production. *U.S. Patent* 4,150,185.

Sglavo, V. M., De Genua, F., Conci, A., Ceccato, R., and Cavallini, R., 2011, "Influence of curing temperature on the evolution of magnesium oxychloride cement." *J. Mater. Sci.*, 46, 6726-6733. (DOI 10.1007/s10853-011-5628-z0).

Sorel,S. T. 1867 "A New Magnesium Cement." *Comp Rend*, 65, 102-104.

Sorrel, C. A. and Armstrong, C. R. (1976) "Reactions and equilibria in magnesium oxychloride cements." *I. Am. Ceram. Soc.*, 59, 5154.

Verth, J. Z.; Prymelski, F., 1974, Xylolith building boards and sheets. *U.S. Patent* 3,788,870.

Yadav, R. N. 1989 "*Effect of some additives on setting, strength and moisture resistance of oxychloride cement*." (Ph.D. Thesis), University of Rajasthan, Jaipur, India.