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TALC AS AN ADDITIVE IN MAGNESIA CEMENT

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INTRODUCTION

Magnesium oxychloride cement (magnesia cement), popularly known as Sorel's cement, is one of the strongest binders. Organic binders are normally known as adhesive while inorganic binders are often regarded as cements. It is obtained by reaction of magnesia with an aqueous solution of its salts, particularly halides and sulphates. A complex compound of definite composition $3MgO.MgCI_2.11H_2O$ is said to be formed with higher densities of gauging solution i.e., 20°Be or more, which is responsible for its setting and cementing action. This complex has been modified slightly as a mixture of $3Mg(OH)_2.MgCl_2.8H_2O$ and $5Mg(OH)_2.MgCl_2.8H_2O$.

Sorel's cement is a quick setting, high strength cement. It requires no humid curing. It is commonly used as a flooring material in Railway coaches and heavy-duty purposes due to its high early strength and low specific gravity. Magnesia cement may find varied applications and give better results than Portland cement in making sound quality terrazzo tiles, toys, statues, artificial marble/ ivory etc., calcined magnesite and partially calcined dolomite (from Rajasthan quarries) below 750° C have both been found good for these purposes. Various standards for the raw materials have been evolved and revised from time to time to meet the requirements of the users. The present investigations were undertaken as a trial to check the undesirable effects of active lime and other basic acids in Sorel's cement by addition of silicious talc. Being a pollutant and industrial waste, its utilization proposes a cost-effective breakthrough to the remedial measures against the pollution.

MATERIALSUSED

a. Commercially available lightly calcined magnesite of the following composition was used.
MgO: 90% (minimum)
CaO: 15% (maximum)
Ignition loss at 110 °C: 2.5±0.5% Bulk density: 0.85 Kg/lit.
Minimum 95% passing through 75 microns (200 IS sieve)
It was procured from M/S Shri, Hari Udyog Bharti, Alwar (Raj.)
b. Magnesium chloride used in the study was of IS grade III with following characteristics
Colourless, crystalline, hygroscopic crystals
$MgCl_2$: 95% (minimum)
$MgSO_4$, $CaSO_4$, and alkali chloride contents were less than 4%

c. Dolomite: It is a readily available inert filler. Locally available dolomite powder conforming to following grade was used.
MgO: 20.8% Ca0: 28.7% 100% passing through 150 micron IS sieve
50% retained on 75 micron IS sieve (minimum).

EXPERIMENTAL

To evaluate talc as an additive in magnesia cement following investigations were carried outafter incorporating it in different proportions in the 1:2 dry-mix (one part of magnesia: two parts of inert filler dolomite dust of above information).

(i) ***Setting Investigations:*** The effect of ash powder on setting characteristics of the magnesia cement was studied by admixing the ash in dry mixes (by weight of magnesia) in varying amounts (0%, 5%. 10%, 15%, 20%). Wet mixes having different quantities of the additive were prepared by gauging 1:2 dry. mixes (by weight of magnesia and dolomite) with 23°Be solution of magnesium chloride to get the plastic mass of IS consistency. Setting periods of wet mixes were determined as per IS specifications with the help of Vicat Apparatus [22]. Experimentalresults are recorded in the Table1.

Room Temperature: 28±1°C   Strength of g.s: 23°Be
Relative humidity:above 90%   Composition of dry-mix: 1:2(MgO:Dolomite)
Quantity of dry-mix: 225 gm.

Table 1: Effect of Talc on Setting Characteristics of Magnesia Cement

S.No.	%Additive	Vol of g.s. (ml)	Setting time (min)	
			Initial	Final
1	0	54	140	225
2	5	60	150	225
3	10	63	195	230
4	15	64	208	288
5	20	64	198	285

g.s.= gauging solution

(ii) ***Weathering Investigations:*** After studying setting characteristics of the blocks prepared were cured under identical conditions of temperature and relative humidity: They were weighed at different intervals (24 hrs., 7 days and 30 days). Trends in change of weights of these blocks with time. reflect the weathering effects. Observed results are summarized in the Table 2.

Room Temperature: 28±1°C   Strength of g.s: 23°Be
Relative humidity:above 90%   Composition of dry-mix: 1:2(MgO:Dolomite)
Quantity of dry-mix: 225 gm

Table 2: Effect of Talc on Weathering Characteristics of Magnesia Cement.

S.No.	%Additive	Weight of blocks (gm) after		
		24 hrs	7 days	30 days
1	0	256.52	252.20	249.70
2	5	256.72	250.80	250.50
3	10	265.83	259.34	257.91
4	15	254.90	248.18	244.75
5	20	251.70	244.02	241.30

(iii) Moisture Ingress Investigations: Test blocks prepared for setting time investigations with different proportions of the additive (0%, 5%, 10%, 15%, 20 %) were exposed to boiling water in a steam bath after curing for one month under identical conditions. Relative water vapour transmission (moisture ingress) so caused is expressed as a function of time. (hrs) required for development of cracks in the trial blocks. Observed findings are reflected in the Table 3.

Room Temperature: 28±1°C Strength of g.s: 23°Be
Relative humidity:above 90% Composition of dry-mix: 1:2 (MgO:Dolomite)
Quantity of dry-mix: 225 gm

Table 3: Effect of Talc on Moisture Ingress Characteristics of Magnesia Cement.

S.No.	%Additive	Trial blocks kept in boiling water (in hrs)					
		0-5	5-10	10-15	15-20	20-25	25-30
1	0	NE	NE	NE	NE	C	-
2	5	NE	NE	NE	NE	C	-
3	10	NE	NE	NE	NE	NE	NE
4	15	NE	NE	NE	NE	NE	NE
5	20	NE	NE	NE	NE	NE	NE

NE= no effect; C=Cracked

(iv) Compressive Strength Investigations: The effects of talc on compressive strength of magnesia cement were studied by preparing wet-mixes having varying quantities of the additive (0%, 5%, 10%, 15%, 20%) as above. The dry-mixes were then gauged with 23° Be solution of magnesium chloride to get a wet-mix of IS consistency. These wet-mixes were than filled into standard size moulds (70.6 mm x 70.6 mm x 70.6 mm). After curing for one month under identical conditions the compressive strength of these blocks were determined as per IS specifications with the help of compressive strength testing machine. The results are recorded in the Table 4.

Room Temperature: 28±1°C Strength of g.s: 23°Be
Relative humidity:above 90% Composition of dry-mix: 1:2 (MgO:Dolomite)
Quantity of dry-mix: 600 gm

Table 4: Effect of Talc on CompressiveStrength of nesia Cement.

S.No.	%Additive	Compressive Strength (Kg/Cm^2)
1	0	500
2	5	510
3	10	520
4	15	540
5	20	530

(v) Linear Change Investigations: To study the effect of talc on linear change of magnesiacement, it was added in different proportions in the 1:2 dry-mix by weight of magnesia. Wet-mixes were prepared by gauging these dry-mixes with magnesium chloride solution of 23° Be to get the plastic mass of IS consistencyy. Wet-mixes were than filled into standard size moulds (200mm x 25mm x 25mm). Linear changes in the beams so formed were determined as per IS specification. Findings are summarized in the Table: 5.

Room Temperature: 28±1°C
Strength of g.s: 23°Be
Relative humidity:above 90%
Composition of dry-mix: 1:2 (MgO:Dolomite)
Quantity of dry-mix: 225 gm

Table 5: Effect of Talc on Linear Change Characteristics of Magnesia Cement.

S.No.	%Additive	Change in length (mm)	Length of beams (mm)	
			Initial	Final
1	0	0.29	200.00	200.29
2	5	1.38	200.00	201.38
3	10	1.41	200.00	201.41
4	15	1.42	200.00	201.42
5	20	1.60	200.00	201.60

DISCUSSIONS

Effect of talc on setting characteristics of magnesia cement are summarized in the table 21. Under identical conditions of the investigation, it is found that volume of the gauging solution increases slightly with increasing proportions of talc. This is attributed to the hydrophobic characteristics of the additive which hinders efficient hydration of the gauging solution. Such a situation results in the internal friction posed by less or little wet magnesia and dolomite powders. This is apparent from initial and final setting time data also. Accordingly with increasing proportions of the additive setting periods increase gradually up to a certain limit, when almost constant setting periods are noted (beyond 15%). It appears that slippery structure of the additive and partial tendency of cross linking makes the wet-mix too slippery. Hence, additional time to gain extra strength as required by the setting period is expected. Obviously, this can be possible only with lapse of the time. As a lot of moisture is retained in the trial blocks even after final setting time, the trial blocks exhibit losses in weights with time. This is evident from the table22, which depicts effects on talc on weathering characteristics of magnesia cement. Moisture resistance characteristics of the trial blocks is quite encouraging. This is an accordance with hydrophobic structure of the additive. The table 23 reveals the effect of moisture- ingress characteristics of magnesia cement. As expected, the hydrophobic nature of the talc is reflected in these observations. Partial tendency of talc to exchange cation and formation of cross-linkages at suitable sites of the adjacent strength giving magnesium oxychloride compositions contribute positively to the ultimate strength of the product. Accordingly, it is noted that incorporation of the additive causes slight increase in the strength. This is apparent from the table 24, revealing effects of talc on compressive strength of magnesia cement. However, the slippery or sliding structural characteristics of the talc are retained even in the set blocks. Thus, it is found in the table. 25 that volume/length of the trial beams increase slightly with lapse of time and with increasing proportions of the additive.

The above discussions can be explained based on the following chemical transformations:

$MgO + H_2O \rightarrow Mg(OH)_2$

$CaO + H_2O \rightarrow Ca(OH)_2$

$5\ Mg(OH)_2 + MgCl_2 + 8\ H_2O \rightarrow$ Magnesium oxychloride cement

$x\ MgO + y\ MgCl_2 + 2\ H_2O \xrightarrow{talc}$ Oxychloride cement

(Layer structure of talc)

CONCLUSIONS

(i) In a small amount it is a good additive
(ii) Talc be an excellent additive for hydraulic cements havingremarkable shrinkage defects.
(iii) Incorporation of talc contribute to watertightness ofmagnesia cement.
(iv) It increases workability of the wet-mix.

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