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PROPERTIES OF GYPSUM PLASTER PRODUCED IN THE MECHANISED PAN SYSTEM

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Gypsum plaster produced in the mechanised pan system had been evaluated for its quality and examined for chemical and physical properties. The results indicate that a gypsum plaster of good quality conforming to relevant Indian Standards can be produced. The plaster can be used for the manufacture of fibrous plaster boards.

INTRODUCTION

Gypsum plaster ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) called calcined gypsum or plaster of Paris, is produced by heating the ground mineral/by product gypsum at 130-190°C in a suitable calcining plant when it loses about one and half molecule of water of crystallization in the form of steam. Gypsum is in fact, one of the oldest building material in the world⁽¹⁾.

Gypsum plaster when ground with small quantities of other substances such as accelerators, retarders, fillers and binders has varied and extensive applications. The principle uses of gypsum plaster include: plaster of Paris; building, moulding and casting plasters of many kinds; dental and surgical plasters; plaster for bedding plate-glass while grinding and polishing pottery-mould plaster, etc. Huge quantities of plaster are required in the manufacture of plaster board; partition blocks and tiles; light weight gypsum blocks; asbestos and other insulating boards; as reinforced gypsum concrete slabs.

To make gypsum plaster of uniform quality, a mechanised pan system has been developed at this Institute⁽²⁾. Three samples of mineral gypsum procured from Rishikesh and Rajasthan were calcined in this pan system. The plaster produced was evaluated for its quality and examined for chemical and physical properties. The results obtained are described and discussed in the paper.

EXPERIMENTAL

1. Chemical Analysis of Gypsum

The gypsum samples were analysed for chemical composition as per IS:1288-1973, specification of test for mineral gypsum and gypsum products.

2. Evaluation of Gypsum Plaster

The quality of gypsum plaster produced in the pan system was examined by determining its chemically combined water, hemi hydrate ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) and anhydrite (soluble α - CaSO_4), and insoluble (β - CaSO_4) contents following the method of Holdridge⁽³⁾. The differential thermal analysis of gypsum plaster was carried out as per Mackenzie's⁽⁴⁾ technique.

3. Testing of Gypsum Plaster

The gypsum plaster samples were examined for their chemical composition as per IS:1288-1973, specification of test for mineral gypsum and gypsum products and for physical properties as per IS:2542 (Part 1) - 1978, specification of gypsum plaster concrete and products, Part-1, plaster and concrete and IS:8272-1976, specification for gypsum plaster for use in the manufacture of fibrous plaster board respectively.

RESULTS AND DISCUSSION

Chemical Analysis of Gypsum

The chemical composition of gypsum samples is reported in table 1. Table 1 indicates that sample 3 has

highest SO_3 content and thereby the highest purity among three samples.

Chemically Combined Water, Hemihydrate and Anhydrite Contents of Gypsum Plaster.

The amount of chemically combined water, hemihydrate, soluble and insoluble anhydrite contents determined in the gypsum samples is reported in table 2.

As seen from table 2 the chemically combined water of gypsum plaster is below 6.2% normally found in the plaster produced from the pure grade of gypsum⁽⁵⁾. This signifies that plaster produced in the pan system is well calcined. It can be further seen that hemihydrate content

TABLE - I
Chemical Composition of Gypsum

Constituents	Gypsum soluble		
	Sample-1 (Rishikesh)	Sample-2 (Rajasthan)	Sample-3 (Rishikesh)
SiO_2 + insoluble in HCl, %	2.70	8.80	7.20
HCl, %			
Al_2O_3 + Fe_2O_3 , %	0.84	0.66	00.50
CaO, %	30.25	31.74	31.50
MgO, %	0.15	0.10	0.10
SO_3 , %	37.15	39.60	41.50
L.O.I., %	18.66	19.06	19.20
$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, %	80.62	85.14	89.22

TABLE - 2
Chemically Combined Water, Hemihydrate and Anhydrite Contents

Gypsum plaster Designation	Combined Water (%)	Hemi-hydrate (%)	Soluble (α - CaSO_4) (%)	Insoluble (β - CaSO_4) (%)
1	6.03	95.00	3.50	1.50
2	6.10	95.20	3.80	1.00
3	6.12	95.20	4.00	0.80

of gypsum plaster lies between 95 to 95.20% indicating perfect calcination of gypsum. Data also shows that the magnitude of anhydrite formation does not exceed 5.0% in each case. However, the formation of soluble anhydrite

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TABLE — 3 Chemical Requirements*

Property Studied	Gypsum Plaster Samples			IS:2547-1976 limits for Retarded Hemihydrate Plaster
	Sample-1 (Rishikesh)*	Sample-2 (Rajasthan)*	Sample-3 (Rishikesh)*	
1. SO ₃ , % by mass, Min.	44.5	47.0	49.5	35.0
2. CaO, % by mass, Min.	33.20	35.80	36.20	2/3 of SO ₃ content
3. Soluble magnesium salts expressed as, % of MgO, Max.	0.28	0.30	0.20	0.3
4. Soluble sodium salts expressed as, % of Na ₂ O, Max.	0.16	0.10	0.10	0.3
5. Loss on ignition, % by mass.	7.06	6.84	6.44	Not greater than 9 and not less than 4
6. Free lime, Min. %	0.54	0.52	0.52	3

* Determined as per IS:1288-1973. Specification of test for mineral gypsum and gypsum products. The names of states mentioned in the parenthesis are the source of gypsum.

TABLE — 4 Physical Requirements*

Property Studied	Gypsum Plaster Samples			IS:2547-1976 (Part-I) limits for Retarded Hemihydrate Plaster.
	Sample-1 (Rishikesh)*	Sample-2 (Rajasthan)	Sample-3 (Rishikesh)	
1. Setting time, minutes				
a) Plaster-sand (FM 1.25) mixture (retarded)	140	152	156	120-900
b) Neat plaster (retarded)	80	84	85	60-180
2. Transverse strength, Kg./cm ² , Min.	20	24	29.5	14.0
3. Soundness	Passes	Passes	Passes	Set plaster pats should not show any sign of disintegration, popping and pitting. Diameter of the indentation shall not be less than 3 mm & not more than 4.5 mm.
4. Mechanical resistance of set plaster, Min.	4.0	3.8	3.7	1.0
5. Residue on 1.18mm IS sieve %, Max.	1.00	0.8	0.8	0.2 at 24 hours.
6. Expansion on setting %, Max.	0.02	0.02	0.018	

* Tested as per IS:2542 (Part-I) 1978. Specification for methods of test for gypsum plaster, concrete and products, Part-I, Plaster and Concrete.

TABLE — 5 Properties of Gypsum Plaster for Use in Fibrous Plaster Board

Particulars	Gypsum Plaster Samples			IS:8272-1976* Limits
	Sample-1 (Rishikesh)	Sample-2 ((Rajasthan)	Sample-3 (Rishikesh)	
1. Chemical composition SO ₃ %, by weight, Min.	44.5	47.0	49.5	42.0
2. Fineness, % weight retained on IS:600 micron IS sieve.	0.5	0.8	0.5	1.0
3. Setting time, minutes				
a) Unretarded	6.0	6.0	7.0	25±5
b) Retarded	24.0	26.0	26.0	
4. Compressive strength, Kg/cm ² , Min.				
a) Unretarded	110.0	118.0	128.0	76.0
b) Retarded	95.0	105.0	110.0	

* Specification for Gypsum plaster for use in the manufacture of fibrous plaster board.

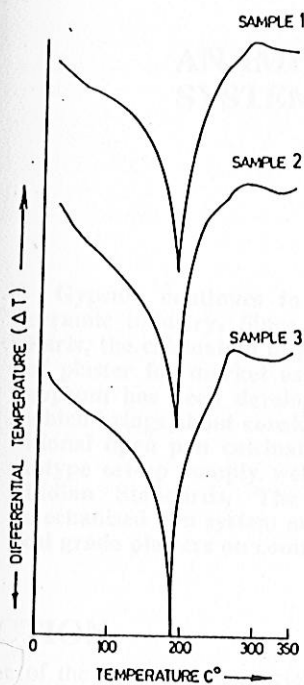


Fig.1. Differential Thermal Analysis Of Gypsum Plaster Samples.

(γ - CaSO_4) is more than the insoluble anhydrite (β - CaSO_4) indicating a negligible content of overburnt plaster. Moreover, as suggested by Riddle⁶, the formation of high amount of soluble anhydrite improves the working qualities, adding to the length of gypsum plaster setting.

Differential Thermal Analysis (D.T.A.)

The extent of formation of hemihydrate was checked by d.t.a. of gypsum plaster samples. The results are plotted in FIG. 1. Data does not represent any endothermic

peak below 190°C, indicating the absence of uncalcined material. Also the long endotherm obtained at 190°C indicates the inversion of $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ into γ - CaSO_4 .

Chemical and Physical Properties of Gypsum Plaster

The results of chemical and physical properties of gypsum plaster are shown in tables 3, 4 & 5 respectively.

These tables indicate that the chemical and physical properties of gypsum plaster comply with all the requirements laid down in IS:2547-1976, specification for retarded hemihydrate gypsum plaster.

Table 5 data shows that gypsum plaster complies with all the chemical and physical requirements given in IS:8272-1976, specification for gypsum plaster for use in the manufacture of fibrous plaster board.

CONCLUSIONS

1. Gypsum plaster of good quality can be produced in the mechanised pan system designed and installed at the Institute.
2. The plaster conforms to all the requirements given in IS:2547-1976.
3. The plaster complies with the properties laid down in IS:8272-1976 indicating the suitability of plaster for use in the manufacture of fibrous plaster board.

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NOTE:

Readers kindly note that the following articles published in our April issue, CEW XX No. 4, April 1985, were the papers presented at the CHEMTECH + ORT '85, 5th International HighTech Exhibition & Conference held in Bombay from January 8-14, 1985.

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