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Industrial Feasibility Studies of Azad Kashmir Gypsum

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Gypsum occurs at four localities around Muzaffarabad i.e. Balak Bhanna, Sherwan, Shawai and Thangar areas between 2-4 kilometers northwest of Muzaffarabad, Azad Kashmir along the west bank of river Neelum and Katha Shawai. This gypsum is fine-grained and massive and belongs to Hazara formation. The reserves are enough to be used in different industires. Samples were taken from these four deposits and studied for their commerical and industrial suitability for the production of gypsum plaster. The physical studies proved that "Plaster of Paris" produced from these samples conform to the standard specifications for gypsum plasters.

Key words : Azad Kashmir, Gypsum, Plaster of Paris.

Introduction

The term gypsum is both a mineral name and a rock name. Gypsum, hyhdrous calcium sulphate ($CaSO_4$ $2H_2O$) is a member of the rock family known as evaporites because they were precipitated by the partial or complete evaporation of marine brines. The other members of the family include anhydrite, rock salt, primary dolomite, and potassium and magnesium salts. Gypsum is a secondary product formed by the hydration of anhydrite. The sedimentary basins of Pakistan are endowed with vast deposits of gypsum, comparable in quality to the best in the world (Zubair *et al.* 1984).

The proportion of gypsum used in a crude state is very small. Gypsum is mixed (3-5%) in Portland cement as a retarder to control the setting time of the cement. Pulverized gypsum, and to some extent gypsite and anhydrite, are applied to the soil as conditioner and fertilizer, "land plaster". It is also used as a disinfectant, as a flux in glass and porcelain manufacture, and in fertilizer industry. The massive fine-grained variety is used for statuary and decorative purpose . Gypsum is also used as casting / molding plaster, in paints, pharmaceuticals and in the paper industry. Gypsum can also be used for manufacture of sulphuric acid (Ellison and Makasi, 1990).

Geology. There are about 2.4 million tons good quality gypsum around Muzaffarabad town and most of these deposits are easily approachable (Fig.1). Gypsum occurs within Hazara formation in four localities around Muzaffarabad-i.e. Balak Bhanna, Sherwan, Shawai and Thangar area 2-4 kilometers north west of Muzaffarabad, along the west bank of river Neelum and and Katha Shawai.

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Balak Bhana deposit is very close to the Neelum Valley road about one kilometer northwest of Muzaffarabad. The general trend of the bed is northwest and the exposed length of the outcrop is about 160 feet. Sherwan deposit is about 500 is exposed in the Sherwan Nala, about 2-3 Km northwest of Muzzafarabad. The deposit feet above the road. The general trend of the bed is northwest-southeast with a steep dip towards the southwest. Shawai deposit is thick bedded gypsum interbedded with shale and limestone. Six distinct beds of gypsum up to an average length of about 800 feet with a total thickness of 160 feet are easily traceable. Thanger deposit is located at about 3-4 kilometers northwest of Muzaffarabad and it is also interbedded with limestone and shale. This deposit is 350 feet long and 35 feet thick.

Megascopic analysis of these gypsum samples shows that almost all the samples from four of the localities are white in colour, only the Sherwan gypsum is yellowish white at places. Mostly these gypsum occur in massive form with sub vitreous to earthy luster, however, some crystalline forms are also found in Sherwan area. The Balak Bhanna deposits are very near to the Nellum Valley road and contain up to 10% of impurities.

Experimental

Chemical Tests. Chemical analysis of 26 gypsum samples, 5 from Balak Bhanna, 11 from Sherwan, 6 from Shawai and 4 from Thanger were carried out using standard methods (ASTM, C 471-76, 1987). The samples were analysed to determine lime content CaO, MgO, Fe_2O_3, Al_2O_3, SO_3, SiO_2, combined waster, insoluble matter and loss on ignition. An-

hydrous gypsum was also determined as calcium sulphate. The average results are presented in Table-1.

Preparation of Plaster of Paris. 26 samples of gypsum were ground to 50 mesh. Each sample of gypsum powder was heated up to 165°C for three hours to make calcined gypsum ($CaSO_4$ 0.5 H_2O) commonly known as Plaster of Paris. This material was further ground to 100 mesh in accordance with the standard method (ASTM C28-86, 1987 and Brit Std. 1951).

Setting Time. The initial and final setting time of each sample of gypsum powder was determined on vicat appearatus (ASTM C 472-84, 1987). The initial and final setting time of Plaster of Paris is 12 and 18 respectively according to ASTM designation. It is a short time duration so in order to increase the working time some organic chemicals such as sodium citrate was used as a retarder which is the best chemical to give more setting time with

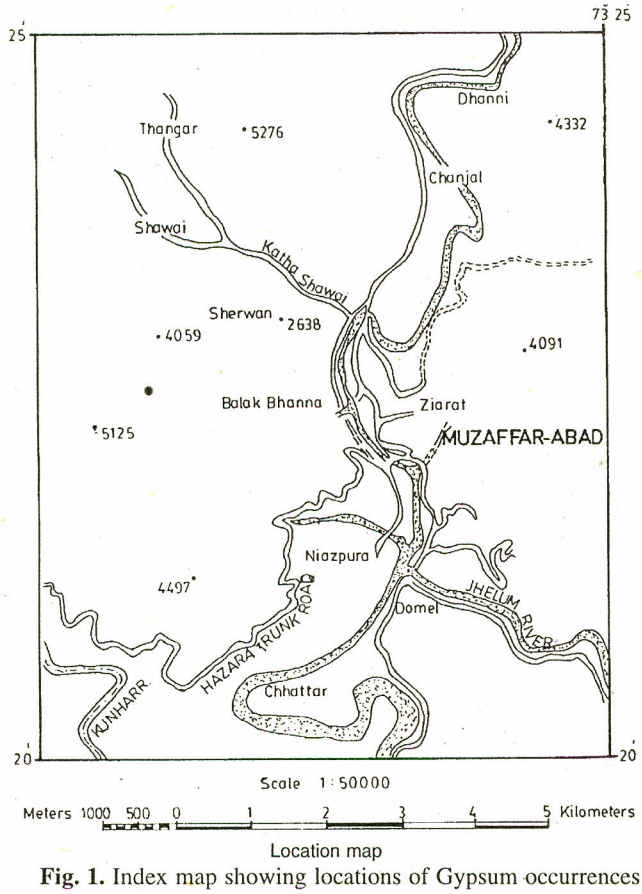

Fig. 1. Index map showing locations of Gypsum occurrences near Muzaffarabad.

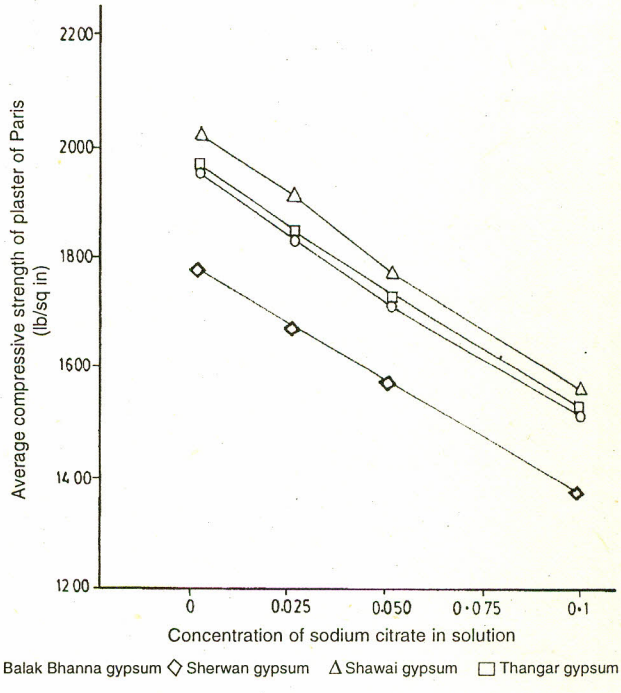

Fig. 2. Effect of admixture of sodium citrate solution on compressive strength of plaster of Paris (average).

Table 1

Average chemical analysis of gypsum samples

Oxides	Balak Bhanna Ares (%)	Sherwan Area (%)	Shawai Area (%)	Thangar Ares (%)
L.O.I.	40.034	4.470	3.640	5.740
Si	02.010	3.330	2.330	2.850
R_2O_3	0.842	1.290	1.580	0.900
CaO	32.510	31.410	31.300	31.820
MgO	0.190	0.470	0.630	0.420
SO_3	38.370	37.720	42.562	41.260
Free H_2O	0.044	0.0230	0.007	0.019
Comb H_2O	17.690	17.160	17.950	16.360
Total	95.690	96.143	99.999	99.369
$CaSO_4$	72.600	70.310	72.340	70.140

Table 2

Effect of different concentrations of sodium citrate solution on setting time and compressive strength of gypsum samples

S.No.	Sample No.	Initial and Final Setting time (min)				Compressive Strength (Psi)			
		A	B	C	D	A	B	C	D
		(Balak Bhana Gypsum) -I							
1	BB-1	18-25	25-35	38-50	50-62	1950	1825	1710	1500
2	BB-2	18-25	25-35	40-52	52-64	2010	1900	1735	1525
3	BB-3	12-18	25-28	27-35	50-55	1800	1720	1650	1475
4	BB-4	12-18	22-28	24-32	60-75	2120	1950	1740	1550
5	BB-5	18-24	25-35	32-40	46-56	1900	1825	1700	1530
	Average	16-22	24-32	32-42	49.8-63	1950	1830	1710	1516
		(Sherwan Gypsum)-II							
6	SH-1	18-24	24-30	33-40	45-50	1750	1625	1550	1320
7	SH-2	18-24	22-30	28-35	42-50	1850	1750	1640	1460
8	SH-3	16-24	24-30	25-35	52-60	1750	1625	1535	1320
9	SH-4	12-18	18-25	22-26	42-52	1850	1725	1625	1450
10	SH-5	18-24	24-30	35-42	58-65	1800	1730	1600	1420
11	SH-6	18-24	22-30	35-42	52-60	1750	1675	1550	1375
12	SH-7	12-20	22-30	33-38	50-60	1860	1780	1660	1480
13	SH-8	18-24	20-26	35-40	55-65	1660	1580	1510	1315
14	SH-9	12-20	21-30	24-32	45-55	1850	1565	1500	1200
15	SH-10	18-24	20-26	25-35	43-61	1750	1680	1545	1320
16	SH-11	16-24	22-29	30-36	42-50	1700	1620	1520	1300
	Average	16-22.5	18-28.5	28-36.3	48.55.6	1760	1665	1567	1360
		(Shawai Gypsum) - III							
17	SW-1	18-24	25-30	32-38	52-58	1975	1900	1675	1525
18	SW-2	16-22	24-29	30-36	50-57	1960	1880	1670	1520
19	SW-3	12-18	20-26	30-40	45-54	2050	1940	1800	1600
20	SW-4	12-18	20-27	32-42	45-55	2040	1930	1800	1600
21	SW-5	18-26	22-28	35-42	48-52	2150	1970	1840	1630
22	SW-6	18-25	25-30	33-38	50-58	1950	1850	1685	1500
	Average	16-22.5	23.29.5	32-39	48-57	2021	1913	1770	1562
		(Thangar Gypsum)-IV							
23	TH-1	12-18	16-22	25-30	32-40	2025	1910	1825	1590
24	TH-2	18-22	24-28	35-42	52-60	1825	1750	1625	1505
25	TH-3	15-20	18-24	28-33	50-58	1800	1725	1600	1475
26	TH-4	12-18	16-22	24-30	48-60	2150	1935	1850	1650
	Average	14-18.5	18.5-25	27-34	43-54.5	1960	1840	1725	1555

*Standard compressive strength of the gypsum samples should not be less than 1800 psi (ASTM C 59-83, 1987)

A-Original Samples B-with 0.02% sodium citrate sol.

C-with 0.05% sodium citrate sol. D-with 0.1% sodium citrate sol.

less effect on compressive strength. Besides, it is a cheap material also and is thus economical to use. The effect of sodium citrate solution, in different strengths as admixture on setting time and compressive strength was studied (Ahmad and Ahmad 1989) and is shown in Table-2. Ligosulphate may be used as retarder (Khater *et al* 1987 and Can. Patt. 1965).

Compressive Strength. To determine the compressive strength of gypsum of powder (ASTM C 471-76, 1987) cubes specimen of 2 inch were prepared of each sample. The cubes were positioned in the testing machine such that the load may be applied on surfaces formed by face of the molds, not on the top and bottom. The load was applied continuously without shock, at a constant rate within the range of 15-40 psi (103-276 kPa)/s. A higher rate of loading was permitted for the first half of the maximum load. The average compressive strength being the compressive strength of the specimen (ASTM C472-84, 1987). The results are presented in Table 2.

Results and Discussion

The plaster of Paris samples prepared from gypsum collected from different locations of Azad Kashmir were studied for their physical properties mainly density, setting time and compressive stgrength. Sodium citrate solutions of different concentrations were used as retarder..

When the samples from Balak Bhanna gypsum deposits were treated with sodium citrate solution of different concentrations (i.e. 025% and 0.1%), the results showed (Table-2-I), that the setting time incrused with the increase in concentration but the compressive strength of the samples decreased. These results indicated that the compressive strength of all the samples was more than the specified standards, while the setting time was in conformity with the standard specifications.

Similarly, samples of plaster of Paris from Sherwan area were treated with different concentration of sodium cirtrate solution (Table-2-II). When solution of 0.025% concentration was used, the setting time of all the samples increased and the compressive strength decreased by 4-7%, but, generally it remained within permissible limits. The results were similar to that of samples of Balak Bahana.

The average values of compressive strengtth and setting time of gypsum samples of the four localities are plotted against the concentration of sodium citrate solution (Fig 2 & 3) respectively. These results show that gypsum samples of Shawai, Thanger and Balak Bhanna areas are the best for making plaster of Paris. The results of gypsum samples from

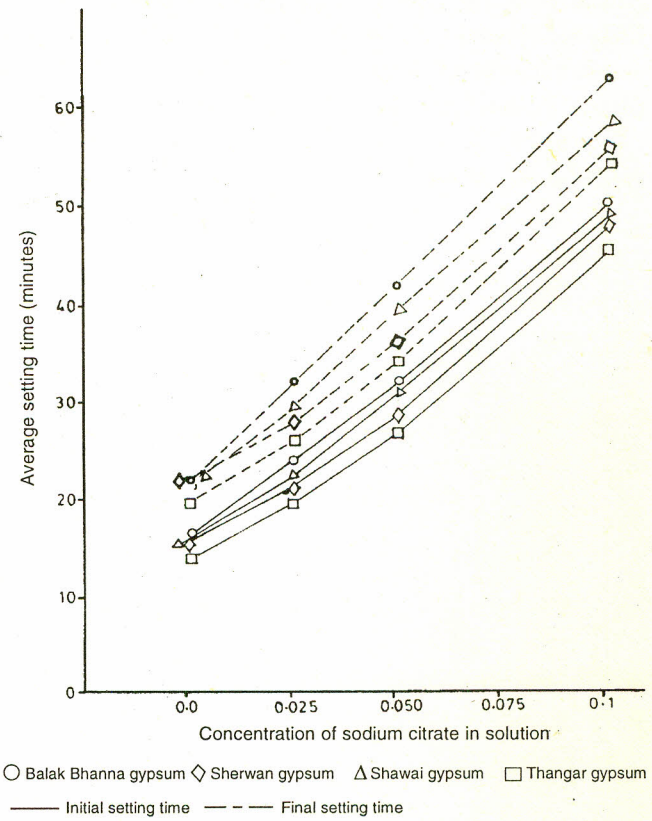

Fig 3. Effect of admixture of sodium citrate solution on setting time of plaster of Paris (average).

Sherwan deposits are encouraging.

The studies reveal that gypsum from all the four localities are suitable for making plaster of Paris, casing and molding. It may also be concluded that sodium citrate is a good retarder because its effects on the compressive strength are also less.

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