

UTILIZATION OF RED MUD FOR PREPARATION OF SPECIAL CEMENTS

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AIM OF THE PROJECT

Aim of the project was to investigate the possibility of producing three varieties of special cements, namely :
1. Aluminoferrite (C₄AF) - belite (β-C₂S) using lime + red mud + fly ash;
2. Aluminoferrite (C₄AF) - ferrite (C₂F) - aluminates (C₃A & C₁₂A₇) utilizing lime + red mud + bauxite; and
3. Sulfoaluminoferrite (C₄(A,F)S̄) - aluminoferrite - ferrite using lime + red mud + bauxite + gypsum.

MATERIALS AND METHODS

As received uncausticised red mud and bauxite (in form of lumps) from M/s HINDALCO Industries Ltd., Renukoot, India fly ash from its captive power plant (Renusagar Power Company) and locally available hydrated lime and gypsum of commercial grade were used in these investigations. The materials were ground and /or sieved to -150 μm size.

To prepare each sample, 100 g of the raw materials in predetermined proportions were taken and ball milled for 45 min. for homogenization. The resultant blend was made into a thick paste using an appropriate quantity of water and moulded into cube (5 cm size) shapes, dried overnight in a hot air oven at 100 °C and then fired (clinkered) in an electric muffle furnace. A heating rate of approximately 200 °C/h was employed and the firing temperature kept at a predetermined level (1150-1350 °C) up to 2 h. The clinkered products were cooled in the furnace up to 700 °C and then overnight to room temperature. The clinkers so produced were ground in an agate mortar and pestle and sieved through 150 μm mesh.

TABLE 1 : Chemical analyses of the raw materials (wt. %)

	Lime	Gypsum	Red mud	Bauxite	Fly ash
Fe ₂ O ₃	0.65	0.13	33.1	16.5	3.70
Al ₂ O ₃	0.65	0.07	18.2	48.0	37.80
SiO ₂	1.00	0.89	8.8	3.0	45.60
CaO	67.13	37.41	2.7	0.5	5.35
TiO ₂	-	-	19.6	8.5	-
Na ₂ O	-	0.27	5.8	-	-
SO ₃	-	53.35	-	-	-

TABLE 2 : Compositions (wt. %) of different raw mixes fired at 1250 °C for 2h.

	Lime	Gypsum	Red mud	Bauxite	Fly ash
Series A	65.0	-	0-35.0	-	35.0
Series B	50.0	-	5.0-50.0	45.0-0	-
Series C	47.5	7.5	0-45.0	45.0-0	-
Series D	50.0	25.0	0-25.0	-	25.0
Series E	35.0	10.0	5.0-30.0	45.0-20.0	5.0

TABLE 3 : Compositions (wt. %) of representative samples of raw mixes fired at different temperatures (for 2h) and for varying duration (at 1250 °C).

	Lime	Gypsum	Red mud	Bauxite	Fly ash
A3	65.0	-	10.0	-	25.0
A6	65.0	-	25.0	-	10.0
B3	50.0	-	15.0	35.0	-
B7	50.0	-	35.0	15.0	-
C4	47.5	7.5	15.0	30.0	-
C7	47.5	7.5	30.0	15.0	-

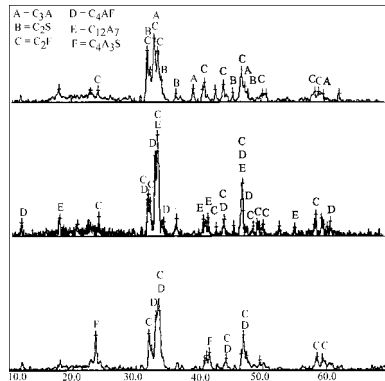


FIGURE 1: X-Ray diffraction patterns of A6, B7 and C7 cement samples made by firing at 1250 °C for 2h.

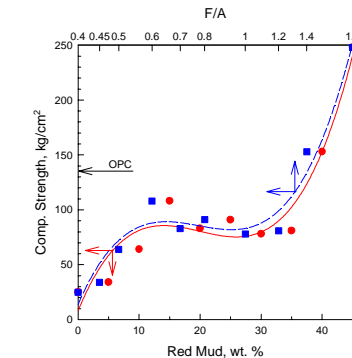
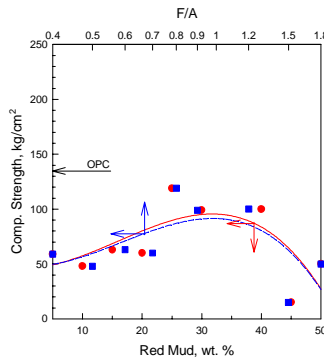


FIGURE 3: Effect of quantity of red mud on the 28-days strength of cements of Series C.

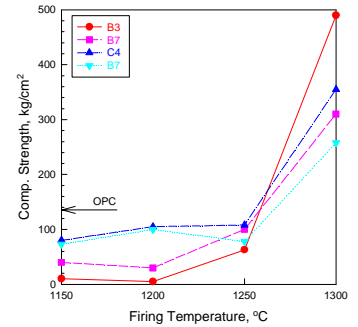


FIGURE 4 : Effect of firing temperature on the 28-days strength of cements of Series B and C.

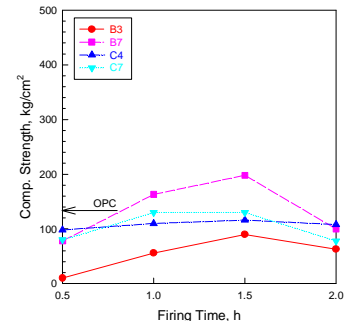


FIGURE 5 : Effect of firing time on the 28-days strengths of cements of Series B and C.

CONCLUSIONS

The following conclusions emerge from the investigation on the preparation of special cements utilizing HINDALCO's red mud, fly ash and bauxite :

1. It is possible to prepare cements having 28-days strength comparable to that of OPC using raw mixes containing lime + red mud + bauxite or lime + gypsum + red mud + bauxite.
2. It is not feasible to produce cements having strength as good as that of OPC from any raw mix containing fly ash. Even partial replacement of bauxite by fly ash results in a deterioration in the quality of cements.
3. The strengths of the cement samples made from lime + red mud + bauxite or lime + gypsum + red mud + bauxite increase with temperature. Unusually high strengths (compared to OPC) can be obtained by firing at 1300 °C.
4. An iron oxide to alumina (F/A) ratio of 0.8-1.2 in the raw mixes and a firing temperature of 1250 °C for 1.0-1.5 h give the best results for preparing the special cements.
5. The strength development may be attributed to the formation of C₄AF, C₃A and C₁₂A₇ phases in the case of cements made from lime + red mud + bauxite and C₄AF, C₄(A,F)S̄ and C₃A in the lime + gypsum + red mud + bauxite cements.