

# “Composite cement manufacturing using wet fly ash: Case Study”

Bankim A. Jethwa

Chief Manager-Mechanical  
ACC Jamul, ACC Limited

---

## ABSTRACT

Manufacturing composite cement using wet fly ash is a unique idea, successfully implemented at Jamul first time in (Lafarge Holcim) LH India. This project shows how the team could innovatively changeover of product portfolio within short span of time, that too without any major revamping. Team together churn out the idea how to use wet fly ash in full scale for (Portland pozzolona cement) PPC/Composite cement manufacturing to improve the overall performance of the plant in terms of quality, cost, efficiencies etc. Huge price escalation in raw material slag price from Rs.900 ((From January to March month) Q1'18) to Rs. 1385 ((April to May month) Q2'18). Hence overall higher production cost of cement. Reduction in major air pollutant — 30% in suspended particulate matter (SPM), 78.6% in Sulphur oxide (SO<sub>x</sub>), and 65.5% Sulphur oxide (NO<sub>x</sub>), were observed. Yearly cost saving after preparation of composite cement through wet fly ash is 60.42 crore in Jamul Cement Works.

**Keywords:** Air pollution, composite cement, low cost, and Portland pozzolona cement.

## HOW TO CITE THIS ARTICLE

Bankim A. Jethwa, “Composite cement manufacturing using wet fly ash: Case Study”, International Journal of Enhanced Research in Science, Technology & Engineering, ISSN: 2319-7463, Vol. 7 Issue 10, October-2018.

## 1. INTRODUCTION

Air Pollution is a growing problem in both developing and developed countries. Constantly increasing urbanization and industrialization have led to enormous emissions of an array of pollutant e.g. Sulphur oxide (SO<sub>x</sub>), Sulphur oxide (NO<sub>x</sub>), suspended particulate matter (SPM) etc. into the atmosphere. The adverse-effects of these pollutants are well known [1].

In addition to their adverse effects on human health and vegetation, they cause the acidification of the environment and also play a key role in global warming [2]. Cement manufacturing plants are the third largest industrial source of air pollution, according to Environmental Protection Agency. Cement industries are emitting more than 500,000 tons per year of SO<sub>2</sub>, NO<sub>2</sub> and CO. The pollution can contribute to respiratory illness, heart disease; formation of acid rain reduces visibility, which can be transported over long distances before falling on land and water. The sources of air pollutants are both natural and anthropogenic. Natural sources consist of those substances which would be present even in the absence of human activities.

These are forest fires, volcanoes, dust storms, sea-salt spray, pollen and spores released by plants and biological activities in the soil, while anthropogenic sources, the pollutants are emitted due to the human activities. It consists of gases and waste smoke formed by thermal power plants, cement kiln, house-holds, automobiles, rocket combustion processes etc. However the emissions from natural sources are comparatively higher in amount than the anthropogenic emissions globally. But the latter does more dangerous because the emissions are released into the atmosphere in a particular region in higher concentration [3]. The objectives of the present study were to minimise cost of production by composite cement and reduction in major air pollutant SPM, SO<sub>x</sub> and NO<sub>x</sub> by process modification.

## 2. MATERIALS AND METHODS

ACC cement plant is situated in Jamul village, Bhilai, Chhattisgarh 490024. Cement production capacity is 2.59 million tons per annum.

Ambient Air quality around the cement industry - Ambient air concentration around the industry was determined by the cooperation with pollution control board Raipur, following Indian Standard Methods for Measurement of Air Pollution (1974).

Sampling station - Air quality was determined during the study period September 2018 around the study site in the radius of 1km.

Determination of concentration of particulate matter in ambient air Determination of concentration of particulate matter in ambient air was done by Indian standard method for particulate concentration measurement by the formula given by [4] Watson (1998) following pollution control board Raipur.

Suspended particulate matter (SPM) and gaseous concentration collected with the help of respirable dust sampler (RDS) sampler (Envirotech, Model APM 460) provided by pollution control board Raipur. Suspended particulates were trapped on a glass fibre filter paper attached to the hopper of RDS. The particulates deposited on filter papers were computed as the net mass divided by the volume of sampled air. Two sets of RDS sampler were used in the interval of three days for multiple sampling in each site. The samplers were operated at the height of five meters for 24 hours sampling with average flow rate 1.0 L/min. Total five to six samples in each direction in each month were collected during the overall sampling period.

Sample preparation and mass measurement - All particulate samples were collected in glass microfiber filter sheets (size 8"x10", Whatman), because of low resistance to air flow, a low affinity for moisture and maximum collection efficiency. The filters were attached with a respirable dust sampler. Pre and post sampling treatment of filter papers was carried out in moisture-free desiccators followed by drying in an oven for 24 hours. All pre and post-sampling treated filters were weighed using a 5-digit balance (Sartorius Model R 200D). Meteorological parameters during the sampling period were collected from a local meteorological station.

Calculation of concentration of ambient particulate matter (PM)  $RSPM = (W_2 - W_1) \times 10^6 / V$ .

$W_1$  = initial weight of filter paper,  $W_2$  = final weight of filter paper  $SPM = RSPM + \text{weight of collector}$

Determination of Sulphur dioxide (SO<sub>2</sub>) – determination of SO<sub>2</sub> was done by following, West and Gaeke method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide) 26. Sulphur dioxide from air was absorbed in a solution of potassium tetrachloromercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, was formed, the complex was made to react with para-rosaniline and formaldehyde to form the intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution was measured by spectrophotometer at 560nm.

Sampling - 30 ml of absorbing solution, potassium tetrachloro-mercurate (TCM) placed in an impinger and sampled for 24 hours at the flow rate of 1 L/min. After sampling the volume of sample were measured and transferred to a sample storage bottle. Analysis - Distilled water was added up to the calibration mark on the absorber to replace water lost by evaporation during sampling and was mixed thoroughly. 10 ml of the collected sample was pipette out into a 25 ml volumetric flask. 1 ml 0.6% sulphamic acid was added and allowed reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. 2 ml of 0.2% formaldehyde solution and 2 ml para-rosaniline solution were added and diluted to 25 ml with distilled water. A blank was prepared in the same manner using 10 ml of unexposed absorbing reagent and allowed to stand for 30 min to colour development and absorbance of samples and blank was taken at 560 nm. The SO<sub>2</sub> concentration was calculated by the formula described by the West and Gaeke (1966). Formula -  $C (SO_2 \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t$  Where,  $C (SO_2)$  = Concentration of Sulphur dioxide,  $\mu g/m^3$   $A_s$  = Absorbance of sample,  $A_b$  = Absorbance of blank,  $CF$  = Calibration factor,  $V_a$  = Volume of air sampled in  $m^3$ ,  $V_s$  = Volume of sample,  $V_t$  = Volume of aliquot,

Determination of nitrogen dioxide (NO<sub>2</sub>) Determination of nitrogen dioxide was done by Modified Jacobs & Hochheiser Method [5]. Ambient nitrogen dioxide (NO<sub>2</sub>) was collected by bubbling air through a solution of sodium hydroxide and sodium arsenate. The concentration of nitrite ion (NO<sub>2</sub>) produced during sampling was determined colorimetric ally by reacting the nitrite ion with phosphoric acid, Sulfanil-amide and N-(1-naphthyl)- ethylene-diamine-di-hydrochloride (NEDA) and measuring the absorbance of the highly colored azo-dye at 540 nm. Analysis - Distilled water was added up to the calibration mark on the absorber to replace water lost by evaporation during sampling and was mixed thoroughly. 10 ml of the collected sample was pipette out into a 50ml volumetric flask and 1ml of hydrogen peroxide solution, 10ml of sulphanilamide solution, and 1.4ml of NEDA (N-(1-naphthyl) – ethylene – di-amine – di - hydrochloride) solution, were added with thorough mixing after the addition of each reagent and volume was made to



## B. Challenges

- Flow ability of wet fly ash from existing phosfogypsum hopper.
- We had constraint of adding extra load on silo, hence designed low weight structure and distributed maximum load on existing structure.
- Using of the existing weigh feeder which was 40TPH was not possible with the wet fly ash.
- Using existing circuit for wet fly ash which is design for slag of moisture 12%.
- Very congested space, narrow pass for air slide.
- Erection at +63m height was challenging including materials/equipments shifting.
- Availability of appropriate material/ equipment as due to time constraint we arranged in-house available material.
- Re-location of existing blower without affecting the dispatch and production.
- Transportation of the wet fly ash through the slag recalimer to the weigh feeder.

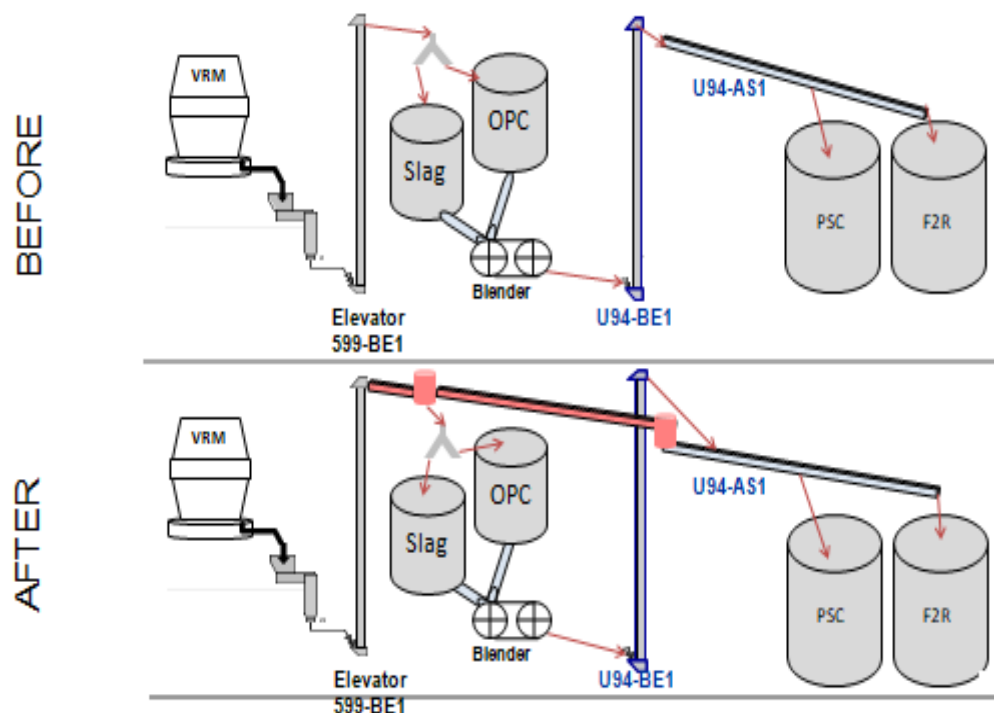


Figure 3: Layout before and after modification in air slide

Reduction in pollutant during June month is shown in “Fig. 4”.

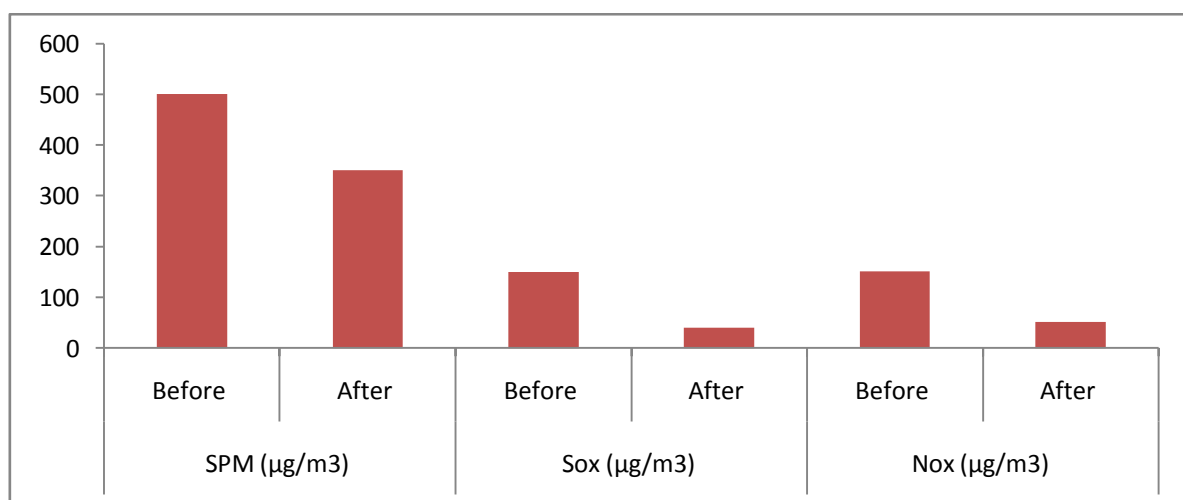


Figure 4: Before and after SPM, SO<sub>x</sub>, and No<sub>x</sub> reduction

Overall cost saving data for composite cement in comparison with PPC and PSC is shown in “Table 1”.

**Table 1: Cost comparison after modification**

|   |                  |              |
|---|------------------|--------------|
| <b>A. Saving on account of Composite Cement</b>             |                  |              |
| Variable Cost of PSC from VRM as per original Plan          | Rs/T             | 1683         |
| Variable Cost of Composite from VRM in Jun18                | Rs/T             | 1300         |
| Saving in Cost per ton                                      | Rs/T             | 383          |
| Composite production in Jun18                               | Ton              | 46,747       |
| Say Monthly Avg Production of Composite Cement              | Ton              | 40,000       |
| Yearly Saving After Composite Cement                        | Rs. Crore        | <b>18.38</b> |
| <b>B. Saving on account of PPC</b>                          |                  |              |
| Variable Cost of PSC from VRM as per original Plan          | Rs/T             | 1683         |
| Variable Cost of PPC from VRM in Jun18                      | Rs/T             | 1275         |
| Saving in Cost per ton                                      | Rs/T             | 408          |
| Say Avg Saving Cost Per Ton                                 | Rs/T             | 400          |
| PPC production in Jun18                                     | Ton              | 70,570       |
| Say Monthly Avg Production of PPC                           | Ton              | 70,000       |
| Yearly Saving After Composite Cement                        | Rs. Crore        | <b>33.60</b> |
| <b>C. Saving on account cancellation of High Price Slag</b> |                  |              |
| Slag Price of bided & allotted Lot                          | Rs/T             | 1385         |
| Normal Avg Price of allotted lot of slag                    | Rs/T             | 900          |
| Quantity of High Price slag (Rs.1385/Ton)                   | Ton              | 200000       |
| Saving on cancellation of high price slag                   | Rs.              | 97000000     |
| Penalty Charges against Cancellation                        | Rs.              | -12,600,000  |
| Yearly Saving on account of high price slag                 | Rs. Crore        | <b>8.44</b>  |
| <b>Total Saving (A+B+C)</b>                                 | <b>Rs. Crore</b> | <b>60.42</b> |

From table 1 yearly cost saving after preparation of composite cement through wet fly ash is 60.42 crore in Jamul Cement Works.

The rate of reaction for thermal NO<sub>2</sub> increases with temperature; therefore, hard-to-burn mixes which require hotter burning zones will tend to generate more thermal NO<sub>2</sub> than kilns with easier-burning mixes. SO<sub>2</sub> emissions from cement plants are primarily determined by the content of the volatile sulphur in the raw materials. Kilns that use raw materials with little or no volatile sulphur have little problems with SO<sub>2</sub> emissions. In the scientific literature, it is largely stated that the concentrations of particulate matter are higher at colder temperatures in ambient air of some industrial sites probably because of the effect of additional emission sources, such as heating [6; 7].

### CONCLUSION

The study elucidates that air pollution emitted from cement industries adversely affecting the ambient air. Emissions of NO<sub>x</sub> from cement plant can mainly be attributed to large quantity of excess air exceeding the optimum values; however, raw materials from another source of NO<sub>x</sub>. Sulphur dioxide emissions are largely attributed to the raw materials adsorbed by the cold feed in the pre-heater and the remainder is released with the fuel gases in presence of large quantities of excess air. The dream/ thought of using 100% wet (pond) fly ash for manufacturing of PPC/Composite cement. and enabling process to meet required quality, reliability and sustained operation.

## **REFERENCES**

- [1]. Levy, J. I. and Steven, R.: "Spatial and temporal variability in urban fine particulate matter concentrations", Environmental Pollution, vol. 159, pp. 2009- 2015, [2011].
- [2]. Hansen, M.; Kristine, A.; Krogh, E.B.; Bent, H. S.: "Environmental risk assessment of ionospheres" Trends in Analytical Chemistry, vol. 28, (5) pp. 534-542, [2009].
- [3]. Henderson-Sellers, A. and Gornitz, V.: "Possible climatic impacts of land cover transformations, with particular emphasis on tropical deforestation", Climatic Change, vol. 6, pp. 231-257, [1984].
- [4]. Watson, J.G.; Chow, J.C.; Willeke, K.; Baron, P.: "Aerosol measurement: Principles, techniques and applications", New York, Van Nostrand Reinhold, Air pollution measurement committee, (1998) pp. 622-39.
- [5]. Jacob, M.B.; Hochheiser, S.: "Continuous sampling and ultra-micro determination of nitrogen dioxide in air," (IS 5182 Part 6 methods for measurement of air pollution: Oxides of nitrogen), Analytical Chemistry, 32 (1958) 426.
- [6]. Mari, M.; Nadal, M.; Schuhmacher, M; Domingo, J.L.: "Monitoring PCDD/Fs, PCBs and metals in the ambient air of an industrial area of Catalonia", Spain, Chemosphere, 73 (2008) pp. 990-98.
- [7]. Venier, M.; Ferrario, J; Hites, R.A.: "Polychlorinated dibenzop-dioxins and dibenzofurans in the atmosphere around the great lakes", Environ. Science and Technology, 43 pp.1036-1041, [2009].