Analysis of Fly Ash & Water Treatment Plant Sludge in Brick Manufacturing

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Abstract— Sludge received from a water treatment plant is generated in huge quantity, which is mostly, disposed and launched directly in the water bodies, resulting a negative effect in the environment. Also, ash is produced due to burning of coal and is the industrial solid waste most generated roughly around six million tons/year. An efficient disposal of ash is always problem attributable to its large volume and harmful risks to the environment. The specific purpose of this analysis was to judge the technical potentialities of ash and sludge from a waste water treatment plant within the production of ecological bricks. The wastes water were analyzed for physico-chemical, mineralogical and morphological properties. Numerous mixtures were made ready by incorporating these industrial wastes in brick production. The results of wastes incorporation on physical properties like compressive strength and water absorption were determined. The simplest result, in terms of compression strength and water absorption, was reached by the series of bricks made with 50% soil, 20 % cement, 15 % fly ash and 15 % sludge by weight. The results showed that sludge and ash can be used as waste additives within the making of soil-cement bricks.

Key words: Soil-Cement Bricks, Ecological Bricks, Thermal Power Plant, Coal Ash, Water Treatment Plant Sludge

I. Introduction

Domestic waste water treatment plants produce huge quantities of sludge as a result of treatment processes of raw water such as coagulation, flocculation and filtration [1, 2]. The by-product from the purification process is a huge amount of waste in the form of sludge called water treatment residual or water Treatment sludge, which after drying is considered to be a non-biodegradable waste material.

The sludge composition in water treatment plants is mainly determined by the geology, hydrology of the river basin, human activities in catchments and chemicals used in a purification process. Consequently sludge produced from water purification processes may contain high concentrations of those chemical removed by the purification processes.

Aluminium sulphate is the most widely used coagulant in drinking water treatment. Some researchers have linked aluminum's contributory influence to occurrence of Alzheimer, children mental retardation, and the common effects of heavy metals accumulation [3,4].

The common practice by most water treatment plants is the disposal of sludge to the nearest watercourse around the treatment plant without prior treatment. However, the laws in India are demanding a change in this behavior, and thus proper management of the sludge becomes inevitable.

The mineralogical composition of sludge from a water treatment plant is clay, silt, and sand [5]. This means that the waterworks waste has the potential to be used as a possible new additive to clay-based products [5,6]. The reuse of waterworks waste for obtaining soil-cement bricks has also been recently suggested [7,8].

Similarly, the disposal of the large amount of fly ash generated from combustion of coal is also a major concern as it possesses health hazards and severe implications for the environment. The main drawback of Thermal power plants in India is the high production of ash. Fly ash represents about 65-85 % of coal-ash produced by thermal power plants, while bottom ash accounts for 15-35 % [9].

The fly ash is a fine-grained, powdery particulate material that is carried off in the flue gas and usually collected from the flue gas by means of electrostatic precipitators, bag houses, or mechanical collection devices such as cyclones [10].

Fly ash from a bag house filter produced in the Indian power plant is mostly recycled as a cement raw material to be used in civil engineering materials. However, cyclone ash does not find at present time a commercial application; rather, it is usually stored in an abandoned surface mine or dumped in landfills in the vicinity of the power plant.

The utilization of fly ash in construction, as a low-cost adsorbent for the removal of organic compounds, flue gas and metals, light weight aggregate, mine back fill, road sub-base, and zeolite synthesis has been widely examined. However, there is a perpetual request for new applications of fly ash since the amount of this coal waste released by thermal power plants has been increasing throughout the world.

The purpose of this study was to investigate the characteristics and possible utilization of water treatment plant sludge and thermal power plant fly ash in the Manufacturing of bricks. The suitable conditions of using dried sludge and coal fly ash in producing bricks under the criteria of Indian Standards (IS) were investigated. The influence of wastes proportion in the raw materials in relation to the brick was also examined.

II. Experimental analysis

A. Material used

All the reagents used for experimental studies were of analytical grade. The samples of coal fly ash from a cyclone filter were obtained from a thermal power plant located at Korba in Chhattisgarh. The used sludge from a water treatment plant used was collected from a waterworks located in Indore, Madhya Pradesh. Pozzolana Portland cement (PPC) 43 Grade and soil were used.

B. Production of Bricks

Most appropriate proportion of fly ash, sludge from a water treatment plant, soil, cement or lime were identified for the manufacture of bricks.

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Fly ash, sludge, soil, cement or lime mixtures with different mass ratios were prepared, besides a bricks series without addition of wastes and lime (the control pattern) are presented in Table 1. The dimensions of the bricks were 190 X 90 X 900 mm. All technical evaluation of the bricks was performed according to Indian Standard. Compressive strength as well as absorption tests were performed on the bricks according the standard after the curing time of 28 day . From each series, tests were done to determine the compression resistance and water absorption tests on 5 bricks.

Group	Proportion of materials (mass %)				
	Soil	Cement	Fly Ash	Sludge	Lime
G-0	85	15	-	-	-
G-1	-	-	10	90	-
G-2	45	5	4	46	-
G-3	55	10	8	27	-
G-4	50	20	15	15	-
G-5	55	-	16	18	11
G-6	60	-	7	18	15

Table 1: Materials used in the Preparation of Bricks

III. RESULTS & DISCUSSION

A. Cost Estimation of Modified Brick (For 10% Sludge)

Total weight of one brick = 2.330kg
For % proportion of SLUDGE: FLYASH: SAND: SOIL = 10:12:26:52
Weight of Sludge = 0.223kg or 10% of weight of conventional brick
Weight of Flyash = 0.270kg or 12% of weight of conventional brick
Weight of Sand (murrum) =0.60kg or 26% of weight of conventional brick
Weight of soil (Colluvial or Tallus soil) = 1.212kg% of weight of conventional brick

– Cost of Sludge (Including Transportation cost)
= Rs 0 per Brick
(According to Indian Government Provision, It is mandatory for authorities of STP to dispose of Sludge free of cost at the required places)

– Cost of Fly ash (Including Transportation cost)
= Rs 500 per tonne or RS 0.5 per kg
Then
Amount of Fly ash = 0.5 * weight of fly ash
Amount of Fly ash = 0.5*0.27
Amount of Fly ash = RS 0.13 Per Brick

– Cost of labour
= RS300 per 1000 Bricks
RS .3 per brick

– Cost of sand
RS 90per 50kg or 1.8 RS per kg
Amount of sand = 1.8*weight of sand
Amount of sand =1.8*0.60
Amount of sand = Rs 1.08 per Brick

– Cost of Soil
Rs 60per 50kg or 1.2 per kg
Amount of soil = 1.2 *weight of soil
Amount of soil= 1.2*1.2
Amount of soil= RS 1.44 Per Brick

Total cost of Brick = cost of (Sludge + Fly ash+ labour + sand +soil)
= (0+0.13+0.3+1.08+1.44)
= Rs 2.95 or Rs 3 per Brick

B. Cost Estimation of Modified Brick (For 20% Sludge) –

Total weight of one brick = 2.330kg
For % proportion of SLUDGE: FLYASH: SAND: SOIL = 20:12:23:45
Weight of Sludge = 0.467kg or 20% of weight of conventional brick
Weight of Flyash = 0.279kg or 12% of weight of conventional brick
Weight of Sand (murrum) =0.54kg or 23% of weight of conventional brick
Weight of soil (Colluvial or Tallus soil) = 1.05kg or 45% of weight of conventional brick

– Cost of Sludge (Including Transportation cost)
= Rs 0 per Brick
(According to Indian Government Provision, It is mandatory for authorities of STP to dispose off Sludge free of cost at the required places)

– Cost of Fly ash (Including Transportation cost)
= Rs 500 per tonne or RS 0.5 per kg
Then
Amount of Fly ash = 0.5 * weight of fly ash
Amount of Fly ash = 0.5*0.27
Amount of Fly ash = RS 0.13 Per Brick

– Cost of labour
= RS300 per 1000 Bricks
RS 0.3 per brick

– Cost of sand
RS 90per 50kg or 1.8 RS per kg
Amount of sand = 1.8*weight of sand
Amount of sand =1.8*0.54
Amount of sand = Rs 0.972 per Brick

– Cost of Soil
Rs 60per 50kg or 1.2 per kg
Amount of soil = 1.2 *weight of soil
Amount of soil= 1.2*1.05
Amount of soil= RS 1.26 per Brick

Total cost of Brick = cost of (Sludge + Fly ash+ labour + sand +soil)
= (0+0.13+0.3+0.90+1.26)
= Rs 2.59 or Rs 2.60 per Brick

C. Cost Estimation of Modified Brick (For 30% sludge)

Total weight of one brick = 2.330kg
For % proportion of SLUDGE: FLYASH: SAND: SOIL = 30:12:20:38
Weight of Sludge = 0.699kg or 30% of weight of conventional brick
Weight of Flyash = 0.270kg or 12% of weight of conventional brick
Weight of Sand (murrum) =0.0.466kg or 20% of weight of conventional brick
Weight of soil (Colluvial or Tallus soil) = 0.88kg or 38% of weight of conventional brick

– Cost of Sludge (Including Transportation cost)
= Rs 0 per Brick

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(According to Indian Government Provision, It is mandatory for authorities of STP to dispose off Sludge free of cost at the required places)

– Cost of Fly ash (Including Transportation cost)

= Rs 500 per tonne or RS 0.5 per kg
Then
Amount of Fly ash = 0.5 * weight of fly ash
Amount of Fly ash = 0.5*0.27
Amount of Fly ash = RS 0.13 Per Brick

– Cost of labour

= RS300 per 1000 Bricks
RS .3 per brick

– Cost of sand

RS 90per 50kg or 1.8 RS per kg
Amount of sand = 1.8*weight of sand
Amount of sand =1.8*0.466
Amount of sand = Rs 0.83 per Brick

– Cost of Soil

Rs 60per 50kg or 1.2 per kg
Amount of soil = 1.2 *weight of soil
Amount of soil= 1.2*0.88
Amount of soil= RS 1.06Per Brick
Total cost of Brick = cost of (Sludge + Fly ash+ labour + sand +soil)
= (0+0.13+0.3+0.83+1.06)
= Rs 2.32 or Rs 2.40 per Brick

D. *Benefit Cost Ratio Analysis*

Manufacturing cost per Brick = Rs 2.95
Lets Selling price per Brick = Rs 3.00
Benefit cost ratio = selling cost/manufacturing cost
= 3/2.95
=1.027
Benefit cost ratio > 1
Hence it is very profitable.

E. *Feasibility Analysis*

1) *Economic Feasibility*

It utilizes waste material such as sludge ajnd fly ash whose management leads to expenditure of millions of fund by the Indian government.
Since BCR =1.027 >1
Hence Economically Feasible

2) *Environmental Feasibility*

Sludge and Fly ash both are harm the environment in number of ways. Such as fly ash causes pulmonary diseases and sludge cause sewage sickness of land. Since this project utilizes use of both wastes in making of Brick which is not harmful in nature.
Hence environmentally is feasible.

3) *Technical Feasibility*

Sludge bricks can be made just like Clay Bricks
I.e. no additional technology is required.
Hence technically feasibility.

Fig. 1: The Appearance of the Brick Specimens after Curing at 28 days

IV. CONCLUSION

The results of this work have demonstrated that sludge-fly ash-soil-cement brick can be successfully produced using water treatment plant sludge and cyclone fly ash under the conditions and manufacturing methods used in this study. The proportion of sludge and fly ash in the mixture soil-cement and soil-lime was the two key factors affecting the quality of brick. The massive brick built with the composition of 55 % soil, 15 % cement, 12 % coal fly ash and 18 % water treatment

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plant sludge showed satisfactory results regarding to the mechanical and physical requirements (resistance to compression and absorption of water) stipulated by the Indian standards. This study showed that water treatment plant sludge and coal fly ash could be used as brick material for economic and environmental sustainability. The incorporation of these wastes into brick production is a suitable alternative to their current disposal paths.

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