

Techno-Economic Feasibility of Partial Replacement of Soil by Fly Ash in Clay Brick

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ABSTRACT: It is evident that during the stage of development a balance needs to be maintaining between development and degradation of environment. India is a country that has a traditional practice of 'recycling of wastes'. However, of these days under the pretext of globalization, emerging theories of 'use and throw', India is losing its traditional practice by giving way to adopting the changing western ideologies and life style. The cheap source of energy is electricity generated by hydro-power and thermal power in India. The thermal power generation has by-product as fly ash which needs to be disposed off environment safely through dumping and re-use. The present paper deals with the problem and possible solutions of fly ash which is a waste generated by thermal power plants. The use of fly ash for partial substitution of soil for brick manufacturing emphasized

KEYWORDS: Environment, Recycling, Fly ash, waste, brick manufacturing.

I. INTRODUCTION

Since India is a developing country, the foremost requirement is enough, assured, and cheap energy. This energy is important because India needs to secure "food for all" and industrial built up. The cheap source of energy is electricity generated by hydro-power and thermal power in India. The thermal power generation has by-product as fly ash which needs to be disposed of environment safely through dumping and re-use. The present paper deals with the problem and possible solutions of fly ash which is a waste generated by thermal power plants. Fly ash has several negative environmental effects and the generation is in substantial quantity.

The objective of present work is to propose a suitable method for its reuse especially in construction industry. The case study is done using fly ash generated by Deepnagar Thermal Power Plant, Bhusawal, Maharashtra. Laboratory scale studies are done to investigate: Techno-economic feasibility of partial replacement of soil by fly ash in clay brick manufacturing. The electricity demand all over the world is increasing tremendously. In order to meet ever rising demand for electricity, all over the world major power projects are being installed. Till date thermal power is the major source of electricity generation in India that provides 60% of its electricity. In blooming of construction industry blended cement are uses with supplementary material like fly ash because of its considerable cost and effectively sustainable (Mahajan et al. 2016). Thermal power plants burn coal and produce fly ash as a by-product. In 1998 the fly ash generation rate in India stood at 100 Million Metric Tonnes (Pachauri et al. 1998) which reached to about 180 million tonnes in 2014-15 and it is reliable to meet future demand (Mahajan et al. 2016). It has estimated that with new power plants, fly ash production of the country will reach a high of 225 million tonnes per annum by 2016. Fly ash particles are very fine (< 0.2 micron size) hence, they spread very rapidly. Figure 1(a) shows fly ash spread on approach road from dumping sites.



1(a)

Ash also gets mixed with soil and water bodies as well as disperse in the atmosphere with large retention time. The pathways of pollutant movement. Soil is a basic raw material for brick manufacturing. Now the time has come when its use must be minimized because it is more important to preserve the soil for agricultural applications (Sinha et al. 2000). The use of fly ash for partial substitution of soil for brick manufacturing is emphasized (Sinha et al. 2000). It is reported that in USA 80% of fly ash is re-utilized, while in India it is merely 3% .

II. EFFECT OF FLY ASH

A. Effect of fly ash on soil

Depending upon the source of coal, fly ash may contain heavy metals including nickel, vanadium, arsenic, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, lead, selenium, radium (Deshmukh et al. 2000). If fly ash is disposed on land, plants will absorb it. Thus heavy metals may join the food chain, will reach human body, and can cause long-term toxicity and disorders (Sims et al. 1994). The iron and magnesium content of fly ash may change the physico-chemical properties of soil. Excess of fly ash can increase soil pH and electrical conductivity and affect the soil environment (Elsewi et al. 1980; Deshmukh et al. 2000; Patil et al. 2003).

B. EFFECT OF FLY ASH ON WATER

Fly ash disposed on land is likely to join nearby surface water by getting washed through rain water or forming a thin film on water surface due to settling down. Areas near the fly ash generation may show settled layers of ash on open stored water in houses for drinking and other purposes also. Transportation of fly ash for dumping also allows it to be dispersed due to wind blowing. Thereby heavy metals present in the fly ash become a part of water and air (Wikipedia). Fly ash may contain heavy metals, which may enter the ground water regime too.

C. EFFECT OF FLY ASH ON HUMAN HEALTH

Around 81 million people live in areas that fail to meet national air quality standards for particulate matter. When humans or animals inhale this fly ash, it causes several diseases and allergies like silicosis, flurosis, as reported due to skin contact of fly ash. Fly ash also causes respiratory allergies, asthma, bronchitis (Pachauri et al. 1998). When ingested, fly ash imparts heavy metals to the body (Rao, 1981). The heavy metals can get accumulated in heart, lungs, liver, kidney and slowly start damaging their functions. They can even disturb the functioning of central nervous system (Metcalf et al. 2002).

III. REUSE OF FLY ASH IN BRICKS

Malhotra (2005) has deliberated on different ways of effectively utilizing fly ash besides cement-concrete in building components such as bricks and block, roads and embankments, hydraulic structures, reclamation of low lying areas, agriculture, mine fields, simultaneous manufacture of alumina and cement clinkers. Larson and Turbo Ltd., has

shown that use of fly ash in road construction has following benefits: Reduced heat of hydration, improved workability and ease of pumping, superior microstructure leading to lower permeability, higher long term strength, better performance in aggressive environment and higher electrical resistivity leading to lesser chances of reinforcement corrosion. Due to these reasons the use of fly ash in Indian road construction industry has increased from 3% in 1994 to 38% in 2005; while the fly ash generation itself has increased by three folds (Mohan Raj, 2010).

The present study described briefly as follows:

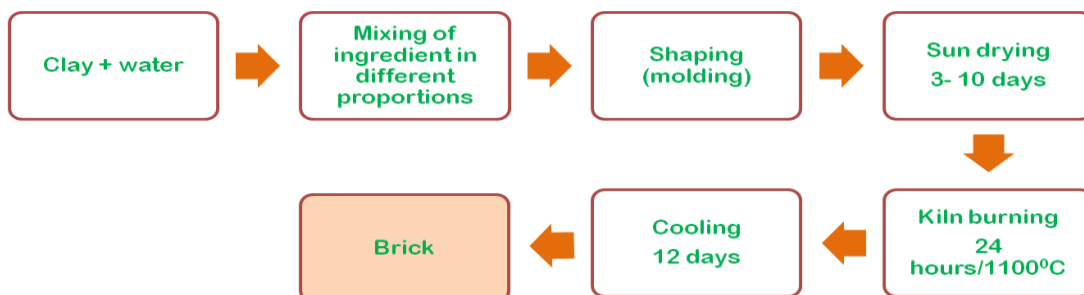
Local clay used for brick manufacturing was used for this study. The clay was mix with various proportions of fly ash ranging from 0% to 50% by weight of soil, in the step of 5%. The bricks were manufactured by traditional methods. They are tested in the laboratory for their important engineering properties. The cost of fly ash blended brick are compared with the same of plain clay bricks. It is found that addition of fly ash in optimum proportions not only enhances the engineering properties of the brick but also reduces their total cost. Over and above this it provides a safe and environmentally consistent method of fly ash disposal which otherwise is a grave concern. It must be noted that clay itself is a precious natural resource which is depleting rapidly. Use of fly ash saves the natural clay. This earns again environmental benefits.

In India, the natural resource is depleting at a steady state with the development, industrialization and urbanization. One such very important resource is soil which cannot be synthesized nor can it be manufactured in industries. With increasing inflow of migrants to cities, the need to have houses becomes impertinent. The construction industry has grown at a fast pace. India being a developing country it has seen many ongoing infrastructural projects being carried out like road development, housing schemes. Increasing housing and industrial development require more of raw material like bricks, cement and sand. Fly ash has been already used successfully for partial replacement of cement and lime in concrete (BIS 4139- 1989). However, use of fly ash in conventional clay bricks is not quite popular. Few have successfully used local fly ash of their region in the clay brick manufacturing and have found it to be suitable even for high proportion in bricks production (Minocha et al. 2009). During the present work it was observed that local brick manufactures (in and around Jalgaon District) are making use of fly ash. However, sparse data is available related to its benefits (or detrimental) and economy. The optimum proportion of fly ash that can be used is not well established. The present work aims to investigate the engineering properties of bricks due to addition of fly ash and suggest optimum proportion of fly ash that can be used in manufacturing clay brick.

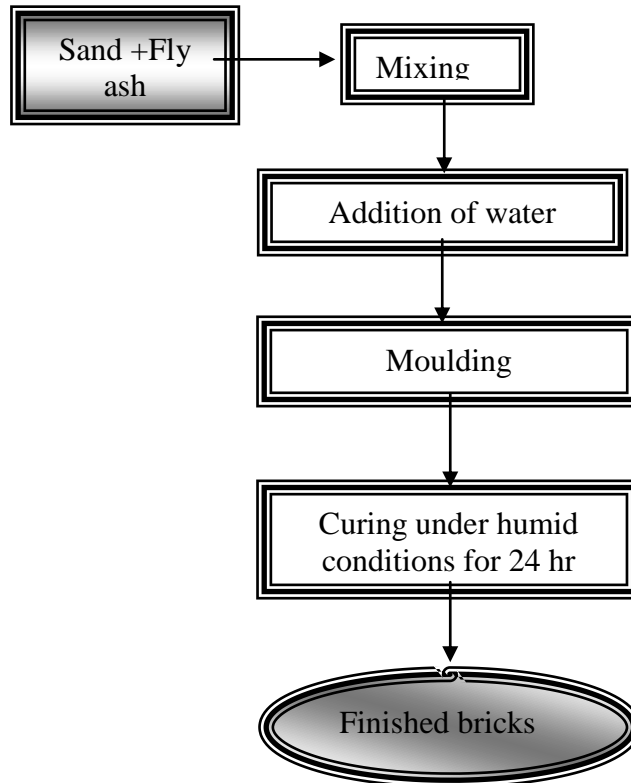
IV. METHODOLOGY

The experimental studies were carried out. Addition of fly ash in clay with varying proportions ranging from 5 to 50%, The bricks are casted as per traditional practice as per IS code (size 19 x 9 x 9 cm) and are tested in the laboratory in accordance with IS code 1077 -1970 and 3595 - 1974. Characterization of raw material used is the basic requirement in any research work.

The conventional brick manufacturing process is schematically explained by block diagram as below fig.2a. and fig 2(b) shows fly ash



2(a)



2(b)

The ingredients i.e. clay and water along with fly ash are mixed and filled in the mould for shaping. The natural sun drying of moulded bricks takes at least 3 to 10 days depending upon weather condition. The burning takes place at 11000C for 24 hours and followed by cooling for 12 days. This forms the final brick (Rangwala, 2006). For the present study, blends of clay-fly ash are used. Moulds and kilns were used. The weight of clay, fly ash for various blends is determined as follows. One moulded fresh brick was taken. It is oven dried. Weight of dry brick is determined, which is equivalent of the soil/clay required to prepare one brick. Then various proportions of fly ash and soil were prepared by weight replacement of soil. . Figs.3 (a) shows the moulded fly ash bricks kept for sun drying with various fly ash proportion and Fig.3 (b) is the image obtained at compressive testing of brick in the laboratory.



3(a)



3(b)

V. EXPERIMENTAL RESULTS

A. LABORATORY TESTING OF BRICKS

The testing is done in accordance to relevant IS codes of practices (IS 3495-1992; Standard Specifications on brick testing 1976 1-9-2). The bricks are tested for dry and wet compressive strengths, water absorption, efflorescence, and finishing. Table.1 shows the dry as well as compressive strength of clay-fly ash bricks.

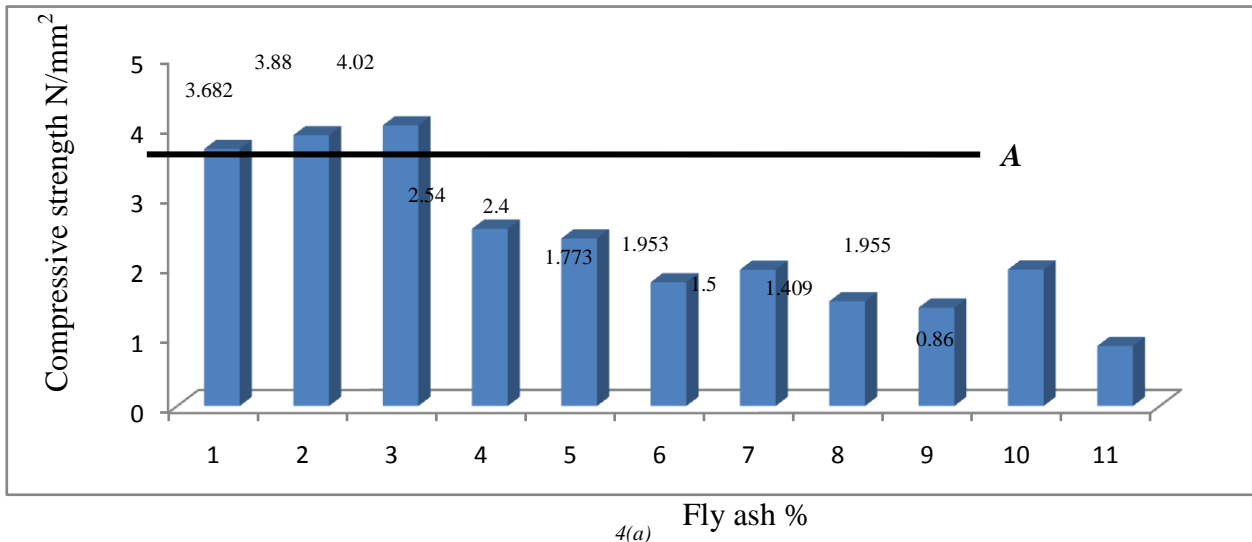
It is observed that there is increase in the compressive strength of clay bricks with addition of fly ash from 0% to 10%. There after the values shows somewhat decreasing trend. Therefore, it is clear that fly ash addition up to 10% by weight of clay taken as optimum proportion to enhance the dry compressive strength of brick. Addition of more fly ash has detrimental effect on the strength. This is attributed to the fact that small proportion of fly ash fills the void in clay matrix; but at higher proportions it reduces the strength since ash acts as a non-reactive component in the matrix.

Table 1: Dry and Wet Compressive strength of clay-fly ash bricks

Brick Sample No.	Fly ash proportion %	Dry Compressive strength in N/mm ²	Wet Compressive strength in N/mm ²
1	0	3.682	2.589
2	5	3.880	3.214
3	10	4.020	3.750
4	15	2.540	2.679
5	20	2.400	2.232
6	25	1.773	2.500
7	30	1.953	2.455
8	35	1.500	1.697
9	40	1.409	1.385
10	45	1.955	1.000
11	50	0.860	0.894

Figure.4 (a) represents pictorially depict the results Dry compressive strengths of bricks of various clay-fly ash blends;

Line A-A denotes Minimum limit as per IS specifications (3.5 N/mm²).



It has seen that fly ash addition up to 10% in clay-fly ash bricks has resulted into slight reduction in water absorption. This has attributed to the better filling of pore openings due to fly ash. However higher proportions of fly ash has increased the water absorption obviously due to poor binding.

VI. CONCLUSION

It observed that addition of fly ash up to certain proportion (10%) enhances the dry compressive strength of bricks. Further addition leads to the reduction in strength. The wet compressive strength of fly ash-clay bricks is found to be increasing up to 10% of fly ash and later on it reduces.

This suggests a suitable method of fly ash disposal and thereby protecting the environment.

REFERENCES

- [1] Chang, A. C., Lund, L. J., Page, A. L. and warneke (1977) Physical properties of fly ash amended soils. Journal of Environmental Quality, v. 6(3), pp. 267-270.
 - [2] MahajanLomesh S., Bhagat S.R. and Pore S.M.(2016) Strength appraisal of blended concrete. International Journal of science, spirituality, business and technology, vol.5, No.1, pp. 47-51.
 - [3] MahajanLomesh S., Pawar A.S.,and Bhagat S.R.(2016)Comparative analysis of suitability of flyash and coconut husk for removal of turbidity and color from paper mill waste water.International journal of innovative research in science and engineering, Vol.2, Issue 3,pp. 450-459.
 - [4] Elsewi, A. A., Bingham, F. T. and Page, A. L. (1980) Chemical characteristics of fly ash to plants. Journal of Environmental Quality, v. 7(1), pp.69-72.
 - [5] Rangwala, S.C. (2006) Engineering Materials, Khanna Publications, New Delhi.
 - [6] Rao, M.N. and Rao, H.V.N. (1981) Air Pollution, Tata McGraw Hill Publications, New Delhi.
 - [7] Pachauri, R. K., and Shridharan, R. V. (1998) Looking back to Think ahead, TERI Publication, New Delhi.
 - [8] Mohan Raj, E. (2010) Modern trends in road construction industry, Presentation by Senior Project Manager of L & T, available on L & T website.
 - [9] Metcalf and Eddy Inc. (2002) Wastewater treatment, disposal and reuse, Tata McGraw Hill Publications, New Delhi.
 - [10] Deshmukh Anjali, Mate, D. B. and BhartiBhaisare (2000) Soil properties as influenced by fly ash application. Journal of Soils and Crops, v. 10(1), pp. 69-71.
 - [11] Patil, Ravindra (2003) Micro Nutrient Availability and Uptake by Groundnut under different levels of fly ash applications, Ph D Thesis, Dr. PanjabraoKrushiVidyapeeth, Akola.
 - [12] Mr. Rajesh H. Davdal, Mr. Noor Mohammed, " Text Detection, Removal and Region Filling Using Image Inpainting", International Journal of Futuristic Science Engineering and Technology, vol. 1 Issue 2, ISSN 2320 – 4486, 2013
 - [13] UdayModha, Preeti Dave, " Image Inpainting-Automatic Detection and Removal of Text From Images", International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622 Vol. 2, Issue 2, 2012
- Muthukumar S, Dr.Krishnan .N, Pasupathi.P, Deepa. S, "Analysis of Image Inpainting Techniques with Exemplar, Poisson, Successive Elimination and 8 Pixel Neighborhood Methods", International Journal of Computer Applications (0975 – 8887), Volume 9, No.11, 2010.