

# Case study of fly ash brick manufacturing units at Kota in Rajasthan

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**Abstract.** Kota Super Thermal Power Station of 1240 MW is located at Kota in Rajasthan, India. The quantity of fly ash generated by it is about 1.64 to 2.03 million tonnes per year. This fly ash is being utilized for making bricks, tiles, portland pozzolana cement, construction of highways, and other purposes. 1.79 million tonnes of fly ash was utilized for different applications in one year duration from April 01st, 2015 to March 31st, 2016. Out of this total utilization, 0.6439 million tonnes (36.06 %) of fly ash was used for making bricks, blocks, and tiles. In this paper, a case study of two fly ash brick manufacturing units using fly ash produced from Kota Super Thermal Power Station is described. These units produce about 15,000 and 20,000 bricks respectively by employing 10 and 16 workers each and are making a profit of about Rs. 6,000 and Rs. 8,000 per day in one shift.

## 1. Introduction

Thermal power stations use coal as a fuel for production of electricity. Fly ash is obtained as a waste product when coal is burnt in power plants. This ash is usually collected and stored in an ash pond near the thermal power plant. Coal burnt in Indian thermal power plants is of low quality and thus the quantity of ash produced is about 30% to 45% of the amount of coal burnt [1]. Ash storage not only requires lot of land, but the fly ash storage also leads to environmental problems related to air and water pollution. The environment ministry of Government of India (MEFCC) in an attempt to reduce environmental degradation due to fly ash, issued notifications in years 1999, 2003, and 2009 respectively. These notifications proposed a strategy, so that the fly ash of thermal power plants can be fully used for various activities in a time bound phased manner.

The latest notification was issued by MEFCC on January 25th, 2016, according to which the thermal power plants in India should achieve the 100% utilization of fly ash that is produced by them before December 31st, 2017. It is also notified that every construction agency situated in the radius of 300 km from a thermal power plant should only use bricks, cements, tiles, and other building materials that are made by using fly ash from December 31st, 2017 onwards. It is also suggested that the state authorities should modify building bye laws of cities having population more than 10 lakhs and make provisions for mandatory use of fly ash based bricks in building constructions [2]. These provisions will provide a huge impetus to the products made from fly ash and their manufacturing units.

In the light of new regulations proposed by MEFCC, it is a high time to evaluate and assess the prospects of fly ash based brick manufacturing units near a coal based thermal power plant. Various researchers in the world have reviewed the characteristics of fly ash, its application in producing bricks, and performance of fly ash based bricks [3]–[7]. This paper is an attempt in a direction towards accessing the profitability of fly ash based small scale manufacturing units in Rajasthan, India.

The first part of this paper describes the amount of fly ash utilization in India with a focus on Kota Super Thermal Power Station (KSTPS) at Kota, and its fly ash utilization percentage. Second part



presents the results of case studies and surveys conducted at two fly ash based brick manufacturing units that are utilizing the fly ash generated by KSTPS. Last part of the paper presents the conclusions of this study.

## 2. Fly ash generation and utilization in KSTPS

Central Electricity Authority (CEA) every year publishes the status report on Indian thermal power plants fly ash generation and utilization. Based on the last five years data available in those reports from April 01st, 2011 to March 31st, 2016, it can be concluded that the fly ash utilization is remaining almost stable in the range from 56% to 61% in India [1], [8]–[10]. More mandatory changes in the rules for fly ash utilizations are needed for achieving 100% utilization of fly ash. It seems that due to this fact, MEFCC has amended the rules in January 2016.

The operation and management of Kota Super Thermal Power Station at Kota is controlled by Rajasthan Rajya Vidyut Utpadan Nigam Limited (RVUNL), a power generation company of Rajasthan Government. KSTPS has seven power generating units amounting to total installed capacity of 1240 MW. Figure 1 shows the satellite image of KSTPS and its seven units [11]. It produces 5,000 tonnes of fly ash everyday as a waste product. Figure 2 shows a satellite image of KSTPS, in which the plant area of 204 ha and ash dump area of 423 ha can be prominently seen [11]. Table 1 presents the fly ash generation and utilization status of KSTPS [1], [8]–[10]. KSTPS is successful in utilizing more than 100% of the fly ash. It means that the ash, which was dumped in ash pond in the past, is also being used, other than the dry fly ash from silos. It is also to be noted that out of the total utilization of 108.72% from April 2015 to March 2016, 36.06% of the fly ash was utilized for producing bricks, tiles and blocks.

The fly ash from ash pond is presently being provided free of cost to brick manufacturers. 20% of the fly ash from electro static precipitator (ESP) is also presently being provided free of cost to brick manufacturers as per MEFCC notification. The remaining fly ash of unit one to unit six is sold by KSTPS to cement manufacturing companies as a rate of Rs. 250/tonne. KSTPS is free to sell unit seventh fly ash, at a rate of Rs. 484/tonne. There are 15 silos at KSTPS as shown in table 2 [12].



**Figure 1.** Satellite image of KSTPS at Kota, Rajasthan.



**Figure 2.** Satellite image showing plant area and ash dump area of KSTPS.

**Table 1.** Utilization of fly ash generated by 1240 MW KSTPS during past five years [1], [8]–[10].

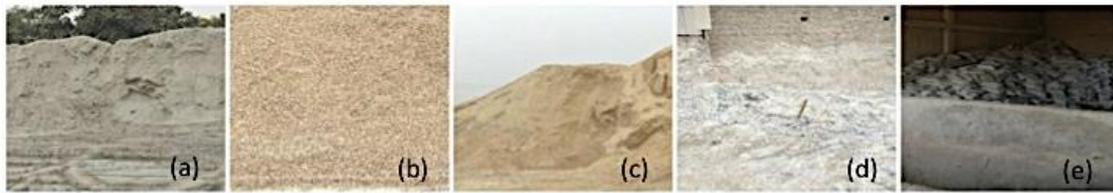
| Description  | April-2011       | April-2012       | April-2013       | April-2014       | April-2015       |
|--|------------------|------------------|------------------|------------------|------------------|
|  | to<br>March-2012 | to<br>March-2013 | to<br>March-2014 | to<br>March-2015 | to<br>March-2016 |
| Fly ash generated (million tonnes)                           | 2.0284           | 1.8504           | 1.9799           | 1.7330           | 1.6422           |
| Fly ash utilized (million tonnes)                            | 2.1061           | 2.2891           | 1.9741           | 1.7345           | 1.7854           |
| Percentage utilization (%)                                   | 103.87           | 123.71           | 99.71            | 100.09           | 108.72           |
| Use for bricks & tiles production<br>(million tonnes)        | 0.1882           | 0.4219           | 0.6204           | 0.4043           | 0.6439           |
| Percentage utilization for producing<br>bricks and tiles (%) | 8.93             | 18.43            | 31.43            | 23.31            | 36.06            |

**Table 2.** Fly ash collecting silos at KSTPS [12].

| Installed capacity of units<br>in KSTPS (MW) | Number of fly ash<br>silos | Silos storage<br>capacity (tonnes) |
|--|----------------------------|------------------------------------|
| Unit 1: 110 MW and Unit 2: 110 MW            | 3                          | 650                                |
| Unit 3: 210 MW                               | 2                          | 600                                |
| Unit 4: 210 MW and Unit 5: 210 MW            | 4                          | 1600                               |
| Unit 6: 195 MW                               | 4                          | 1600                               |
| Unit 7: 195 MW                               | 2                          | 750                                |
| <b>Total</b>                                 | <b>15</b>                  | <b>5200</b>                        |

### 3. Study of fly ash brick manufacturing units

To study and understand various aspects of fly ash utilization for making bricks, a survey was conducted at two fly ash brick manufacturing units situated in Kota city of Rajasthan at Kunhari area near KSTPS. Fly ash bricks are made by using fly ash, 6 mm aggregate, stone dust, lime, and Plaster of Paris (POP) in various proportions. Figure 3 shows various ingredients required for fly ash bricks.



**Figure 3.** Ingredients used for production of fly ash based brick: (a) Fly ash; (b) 6 mm aggregate; (c) Stone dust; (d) Lime; and (e) POP.



**Figure 4.** Steps for fly ash bricks construction in a manufacturing unit.

Fly ash is obtained from KSTPS, 6 mm aggregate and crusher dust are obtained from stone crusher plants at Kota, lime is brought from Borunda in Jodhpur (Rajasthan), and POP is brought from Nagaur (Rajasthan). The manufacturing process involves mixing the above-mentioned ingredients in requisite proportions.

The mixture is then carried to the fly ash brick-making machine. In the machine, it is pressed and molded into the standard brick size. The bricks are then sun dried with requisite amount of water curing. The manufacturing steps being performed in a fly ash brick unit are shown in figure 4.

Table 3 shows a comparative analysis of composition of materials used in two different fly ash brick-manufacturing units. It also presents a financial analysis and profitability of small scale fly ash brick manufacturing industry at Kota. There is a profit margin of Rs. 0.40/brick for the brick manufacturer. These industries are not only providing employment to workers but are also providing bricks for building construction in Kota.

This also has reduced the consumption of fired clay bricks. Fired clay bricks were not only causing air pollution but were also responsible for excavation of top soil. Hence in one way, the fly ash bricks can be called as green building construction materials.

**Table 3.** Data analysis of two fly ash brick manufacturing units located at Kota, Rajasthan.

| Description          | Unit 1  | Unit 2   |
|----------------------|---|--|
| Number of workers    | 10  | 16   |
| Composition (%)      | Fly ash (60%),<br>6 mm aggregate (15%),<br>crusher dust (10%), lime (10%), POP (5%) | Fly ash (50%),<br>crusher dust and 6 mm aggregate (30%),<br>lime (15%), POP (5%) |
| Size of brick        | 22.86 cm×10.16 cm×7.62 cm   | 22.86 cm×10.16 cm×7.62 cm  |
| Weight of brick (kg) | 3 kg  | 3 kg   |
| Price (Rs./brick)    | Rs. 2.5/brick   | Rs. 2.5/brick  |
| Technology           | Hydraulic jack compression machine  | Hydraulic jack compression machine   |
| Manufacturing speed  | About 15,000 bricks/day   | About 20,000 bricks/day  |
| Profit (Rs./day)     | Rs. 6,000/day   | Rs. 8,000/day  |

#### 4. Conclusions

Ministry of Environment of Government of India is moving in right direction by making rules for the utilization of fly ash based products. It was observed that the fly ash utilization in India during April 2015 to March 2016 was only 61% of the fly ash generated in that year. However Kota Super Thermal Power Station was successful in utilizing more than 100% of the fly ash. It is also to be noted that out of the total utilization of 108.72% fly ash from April 2015 to March 2016, 36.06% was utilized for producing bricks, tiles, and blocks. Fly ash brick costs Rs. 2.5/brick to the consumers whereas the cost of fired clay brick (conventional brick) is Rs. 3.5/brick. Also there is a profit of Rs. 0.40/brick to the manufacturing unit, thus earning a profit of Rs. 6,000/day and Rs. 8,000/day for unit one and unit two respectively.

#### References

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