“Fly Ash Utilization”

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Introduction

- Industrialization/urbanization/major infrastructure/economic development >>> electrical energy demand.

- At present about 65% of the electricity consumed in India is generated by thermal power plants accounts two-thirds of the power which includes gas, liquid fuel and coal.

- Coal is the only natural resource and fossil fuel available in abundance, used widely as fuel for thermal power plants producing electricity.

- Current installed base of coal based thermal power: 96,743.38 MW which comes to 54.66% of total installed capacity.
Power utilities in India based on Coal Thermal Power Station (2010-2012)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed capacity</td>
<td>80458 MW</td>
</tr>
<tr>
<td>Coal consumed</td>
<td>407.61 million-tonne</td>
</tr>
<tr>
<td>Average ash content</td>
<td>32.16%</td>
</tr>
<tr>
<td>Total ash generated</td>
<td>131.09 million-tonne</td>
</tr>
<tr>
<td>Total ash utilized</td>
<td>73.13 million-tonne</td>
</tr>
<tr>
<td>Percentage utilization</td>
<td>55.79%</td>
</tr>
</tbody>
</table>
Coal combustion for generation of electricity results in to 30-35% fly ash as a waste product.

Present generation of fly ash from coal based thermal power plants in India is 131 MT/year and it is expected to increase to 300-400 MT/year by 2016-17.

Coal based thermal power plants generate huge amount of fly ash that is a major problem of disposal of fly ash in India.

The current utilization of fly ash is only about 55%, mainly in the areas of cement as well as concrete manufacturing and building products and to some extent in earth fills.
## FLY ASH SCENARIO

Indian Scenario Fly Ash Generation and Utilization......

PROJECTIONS......

<table>
<thead>
<tr>
<th>Year</th>
<th>Fly ash produced in million tonnes</th>
<th>Fly ash used n million tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-07</td>
<td>116</td>
<td>24.8</td>
</tr>
<tr>
<td>2007-08</td>
<td>123</td>
<td>27.1</td>
</tr>
<tr>
<td>2008-09</td>
<td>130</td>
<td>29.7</td>
</tr>
<tr>
<td>2009-10</td>
<td>138</td>
<td>32.2</td>
</tr>
<tr>
<td>2010-11</td>
<td>145</td>
<td>34.7</td>
</tr>
<tr>
<td>2011-12</td>
<td>154</td>
<td>38.0</td>
</tr>
<tr>
<td>2012-13</td>
<td>163</td>
<td>42.5</td>
</tr>
<tr>
<td>Projected</td>
<td>Fly ash production</td>
<td>Fly ash utilisation</td>
</tr>
<tr>
<td>2013-14</td>
<td>173</td>
<td>48.0</td>
</tr>
</tbody>
</table>
UTILIZATION AREAS

<table>
<thead>
<tr>
<th>Utilization Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cement manufacturing</td>
<td>47%</td>
</tr>
<tr>
<td>2 Cement substitution</td>
<td>12%</td>
</tr>
<tr>
<td>3 Road embankments</td>
<td>10%</td>
</tr>
<tr>
<td>4 Low lying area filling</td>
<td>9%</td>
</tr>
<tr>
<td>5 Ash bund raising</td>
<td>9%</td>
</tr>
<tr>
<td>6 Mine fill</td>
<td>7%</td>
</tr>
<tr>
<td>7 Brick manufacturing</td>
<td>5%</td>
</tr>
</tbody>
</table>
| 8 Agriculture & others           | 1%         

% use of flyash

TECHNOLOGIES DEVELOPED

UTILISATION

- Roads & Embankments
- Building Components
- Hydraulic Structures
- Agriculture Related Studies & Applications
- Mine fills

SAFE MANAGEMENT

- Ash Pond Management
- Reclamation of Abandoned Ash Ponds

FACILITATION

- Characterization of Fly Ash
- Handling and Transportation
- Research & Development
Different modes of Fly Ash Utilization

- Building materials
- Mine filling
- Road and pavement construction
- Cement blending
- Agriculture/soil amendment
- Concrete and mortar
- Light weight aggregate
- Manufacture of asbestos products
- Embankment/ Land development
- Floor and wall tiles
- Refractory bricks/tiles
- Paint Industry
- Domestic scouring powder, etc.
Fly Ash in Concrete:

- Fly ash could be an expensive replacement for Portland cement in concrete and using it, improves strength, segregation and ease of pumping concrete.

- The rate of substitution typically specified is a minimum of 1 to 1 ½ pounds of fly ash to 1 pound of cement.

- Fly Ash particles provide a greater workability of the powder portion of the concrete mixture which results in greater workability of the concrete and a lowering of water requirement for the same concrete consistency.
### Chemical Composition:

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>PORTLAND CEMENT%</th>
<th>FLY ASH%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>21.82</td>
<td>53.39</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>6.49</td>
<td>16.07</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>1.93</td>
<td>13.05</td>
</tr>
<tr>
<td>CaO</td>
<td>60.74</td>
<td>6.33</td>
</tr>
<tr>
<td>MgO</td>
<td>1.08</td>
<td>5.48</td>
</tr>
<tr>
<td>SO₃</td>
<td>2.62</td>
<td>1.06</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.14</td>
<td>1.59</td>
</tr>
<tr>
<td>Free Cao</td>
<td>0.84</td>
<td>0.11</td>
</tr>
</tbody>
</table>

1. Fly ash are amorphous (glassy) due to rapid cooling; those of cement are crystalline, formed by slower cooling.

2. Portland cement is rich in lime (CaO) while fly ash is low. Fly ash is high in reactive silicates while Portland cement has smaller amounts.
Fly Ash in Bricks

Raw Materials for Fly Ash based bricks

  Or
- Fly Ash, Sand, Lime and Gypsum.
- Consumption of Fly Ash to produce a single fly ash based brick is 1.250gm.
Fly Ash Based Brick Manufacturing Process:

After sundry at least for 7 days, product will ready for delivery.

Curing of stacked Cement based fly ash bricks by water spraying for 21 days.

Air dry under covered shed for 24 hours from basic stacking.

Machine room

Mixing zone of composite mortar

Raw materials stacking yard (Fly ash, Cement, Sand)
# Basic Technical Details of Fly Ash Bases Bricks in Comparison with Clay Burnt Bricks

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items</th>
<th>Conventional clay burnt bricks</th>
<th>Fly Ash based bricks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dimension in mm(LXWXH)</td>
<td>250mmX125mm X75mm</td>
<td>190mmX90mm X90mm</td>
</tr>
<tr>
<td>2.</td>
<td>Colour</td>
<td>Red</td>
<td>Grey</td>
</tr>
<tr>
<td>3.</td>
<td>Basic Ingredient</td>
<td>earth or clay</td>
<td>fly ash</td>
</tr>
<tr>
<td>4.</td>
<td>Density (gm/cc)</td>
<td>1.60-1.70</td>
<td>1.80-1.90</td>
</tr>
<tr>
<td>5.</td>
<td>Dry weight(in kgs)</td>
<td>3.75-4.00</td>
<td>2.80-2.90</td>
</tr>
<tr>
<td>6.</td>
<td>Common building bricks compressive strength (kg/cm2)</td>
<td>50-65</td>
<td>70-90</td>
</tr>
<tr>
<td>8.</td>
<td>Breakage</td>
<td>5-7 1/2 percent</td>
<td>Less than 1%</td>
</tr>
<tr>
<td></td>
<td>Efflorescence</td>
<td>present</td>
<td>negligible</td>
</tr>
<tr>
<td>---</td>
<td>---------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>9.</td>
<td>Eco-friendly</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>10.</td>
<td>Mortar saving:</td>
<td>N.A.</td>
<td>10-15%</td>
</tr>
<tr>
<td></td>
<td>During laying</td>
<td>N.A.</td>
<td>25-30%</td>
</tr>
<tr>
<td></td>
<td>During plastering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Carpet area savings per %</td>
<td>N.A.</td>
<td>6.8m²</td>
</tr>
<tr>
<td></td>
<td>rmt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Brick requirement per %</td>
<td>4951 Nos</td>
<td>5065 Nos</td>
</tr>
<tr>
<td></td>
<td>sqm</td>
<td>38,900 Nos</td>
<td>50,000 Nos</td>
</tr>
<tr>
<td></td>
<td>Per % cum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Labour Cost</td>
<td>20 – 30%</td>
<td>15 – 20%</td>
</tr>
<tr>
<td>14.</td>
<td>Quality Control</td>
<td>Less possible</td>
<td>100%</td>
</tr>
<tr>
<td>15.</td>
<td>Outside plastering</td>
<td>must</td>
<td>May be avoided, ruled pointing may be applied</td>
</tr>
<tr>
<td>16.</td>
<td>Water treatment: Dipping in water before use prior brick work</td>
<td>Labour cost involved(24 hours must)</td>
<td>Labour cost nil</td>
</tr>
<tr>
<td>17.</td>
<td>Whether qualifies for CMD in terms of Kyoto Protocol</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>
• Maximum Fly Ash is used in cement industries.

• In all over India, only 6.51% of Fly Ash is used in Brick making.

• All most all the Thermal Power Stations are involved in sending Fly Ash to different Fly Ash based brick industries, a eco friendly construction material.
Fly Ash in Portland Cement:

- Fly ash, being primarily pozzolanic, can actually replace a percentage of the Portland cement, to produce an even stronger, more durable and more environment friendly concrete.

- The initial compressive strength is low but as days pass, fly ash concrete gains more strength and eventually has a lot more strength as compared to normal Portland cement.

- Significantly reduces the release of CO₂ into the atmosphere.

- Can be used for construction of structures on/under water.
Fly Ash in Soil Stabilization and Modification:

- Soil stabilization is the alteration of soil properties to improve the engineering performance of soils.
- Modification of soil properties is the temporary enhancement of sub-grade stability to speedup construction.
- Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load-bearing capacity of a sub-grade to support pavements and foundations.
- Stabilization can be used to treat a wide range of sub-grade materials from expansive clays to granular materials.
Fly Ash in Embankment:

- Fly ash can be used for construction of road and embankment. This utilization has many advantages over conventional methods.

- Saves top soil which otherwise is conventionally used.

- Avoids creation of low lying areas (by excavation of soil to be used for construction of embankments).

- Avoids recurring expenditure on excavation of soil from one place for construction and filling up of low lying areas thus created.
Fly Ash in Agriculture

- Improve permeability status of soil.
- Improve fertility status of soil/agriculture yield.
- Improve soil textural properties and soil aeration.
- Reduces soil bulk density and crust and compact formation.
- Improves water-holding capacity/porosity.
- Provides several micronutrients such as Mo, B, Fe, Zn, Cu. Etc.
- Alternative for gypsum for reclamation of sodic soils and lime for reclamation of acidic soils.
- Improves soil microbial activities in combination with other organic amendments.
Fly Ash Risk in Agriculture

- Uptake and accumulation of toxic heavy metals by crop plants.
- Fetal effects on humans and cattle due to consumption of heavy metal contaminated crops.
- Ground water pollution due to heavy metal percolation down to earth.
- Higher doses of FA in agriculture field may causes soil infertility.
- The radiochemical pollution present in FA
More recently, fly ash has been used as a component in Geopolymers, where the reactivity of the fly ash glasses generates a binder comparable to a hydrated Portland Cement in appearance and properties, but with possibly reduced CO₂ emissions.
Fly Ash as a Catalyst:

- Fly ash, mainly class C, may be used in the stabilization/solidification process of hazardous wastes and contaminated soils. For example, the Rhenipal process uses fly ash as an admixture to stabilize sewage sludge and other toxic sludge.
**Fly Ash in Waste Treatment:**

- Fly ash, in view of its alkalinity and water absorption capacity, may be used in combination with other alkaline materials to transform sewage sludge into organic fertilizer or biofuel.
Fly Ash as a Wood Substitute Material:

USE:

A very good wood substitute for doors, windows, ceiling, partitions, furniture, etc.

RAW MATERIALS:
Fly ash polymer, Additive, Woven jute mats.
Salient Features:

- Environment friendly technology.
- Fruitful utilization of industrial wastes such as fly ash.
- Energy efficient production technology.
- Products stronger than woods.
- Weather resistant and durable.
- Termite, Fungus, rot and rodent resistant.
- Fire resistant.
- Cheaper than natural wood.
- Less maintenance cost.
As seen above, there are a large number of sectors where fly ash can be put into use. There are many reasons for the same like:

A. In terms of usability in Concrete and Cement:
   - Higher Ultimate Strength
   - Increased Durability
   - Improved Workability
   - Reduced Bleeding
   - Increased Resistance to Sulfate Attack
   - Reduced Shrinkage
   - Almost zero emission of greenhouse gases.
B. In terms of usage as fly ash bricks:

- Reduces excavation of clay.
- Low cost of brick as compared to clay brick of same quality.
- Number of bricks required per unit volume of construction is less as dimensional accuracy is maintained.
- Lesser consumption of mortar.
- Better resistance to water damage.

C. Other benefits of using fly ash:

- Reduces soil erosion by replacing top soil as ingredients for most construction mixes.
- Reduces pollution measure by re-use of wastes.
- Reduces the amount of greenhouse gases being added to the atmosphere.
- Hydrophobic nature helps in proper draining off of water from roads and structures.
- Production of crude oil from polyethylene.
- Also used in sewage treatment and generation of biofuel as an alternate source of energy resource.
Fly Ash has been proved to be a useful material for many applications. Policy framework and national strategy can make it possible to utilize all fly ashes in gainful manner.

It would mitigate the environmental threat, generate employment and industrial wealth, conserve mineral resources, provide sustainable construction and agriculture including forestry and cleaner environment.

It’s products including agriculture produce grown on fly ash with in safe limits.

Thus, these may be used on large scale with no consequential impact on human health as well as the environment.
Save nature save yourself...

Thank You........