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Research Article

Enablers and barriers for utilization of fly-ash in Indian cement industry

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Abstract

In last four decades, an evolution changes have brought in cement concrete technologies and apart from the strength consideration, durability and economy have become core factors for deciding the quality of the cement concrete. Presently cement concrete has four essential ingredients - cement, aggregates (coarse & fine), water and fly ash in place of traditionally three ingredients cement, aggregates and water. In India, though various Indian Standards published by Bureau of Indian Standard (BIS), specifies use of fly ash as part replacement of cement in concrete, in actual practice it is in nascent stage (NTPC, 2006).In utilization of flyash in Indian cement industry has different scenario, the supportive view are vast space occupied by wet flyash ponds alarm government to support cement industry, the carbon dioxide reduction advantage, water contamination due to open storage of flyash etc., these enables its more and more utilization by cement firms but on other view limitations also occurs, like lack of required information to actual uses of flyash by state/central government construction department, builders and developers etc. In this paper fly-ash utilization in different sectors is presented a special focus on cement sector utilization and its enablers – barriers about replacement of cement in concrete by fly-ash is discussed.

Keywords: cement, fly-ash, million tons, utilization

1. Introduction

The most consumed substance on earth is concrete which is second only to water, with nearly one ton of the material used annually for each person on the planet. In concrete the most critical ingredient is cement, locking together the sand and gravel constituents in an inert matrix, it is the glue which holds together much of modern society's infrastructure.

Indian cement is a global commodity, manufactured at thousands of local plants, it is its weight is the reason; land transportation of cement supply is expensive, and generally limited to an area within 300 Km of any one plant site. The cement industry is consolidating globally, but large, international firms account for only 30 percent of the worldwide market. In many developed countries, market growth is slow or nil whereas in developing markets growth rates are more rapid as per country like India on other hand china is the fastest growing market today, the reason behind it is both local and global. The cement industry faces a unique set of issues, which attract attention from communities near the plant, at a national and an international level (Singh, 2013). A well known concept of higher cement content means greater strength and thus durability has not proved in true sense for the structures exposed to different climatic conditions. In order to make cement concrete strong and durable at lower cost, use of other supplementary cementations material i.e. fly ash started in practice and is today proven technology world over. What amount of flyash, which quality of flyash and flyash utilization in cement has various barriers and enablers are presented in this paper in detailed.

2. Objective

The following research is undertaken for understanding utilization of flyash in Indian cement industry its barriers – enablers in this utilization is in details. The primary issues are

(i) What is the structure of Indian cement industry?
(ii) Taking research papers and conducting literature review for understanding the different sectors of utilization of flyash in India focusing in cement industry.
(iii) Taking in comprehensive knowledge of utilization of flyash, to understand the trends in the utilization of flyash in cement industry, improvement in the current utilization and the development of the methods to increase the utilization and thus to know the factors affecting the usage: past and current.
(iv) Taking in detailed the barriers and enablers in the utilization of flyash in Indian cement industry.

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3. Literature review

A literature review is a body of text that aims to review the critical points of current knowledge and or methodological approaches on a particular topic. Literature reviews are secondary sources, most often associated with academic - oriented literature, such as theses, journals and research reports, a literature review usually precedes a research proposal and results section. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area.

A well-structured literature review is characterized by a logical flow of ideas; current and relevant references with consistent, appropriate referencing style; proper use of terminology; and an unbiased and comprehensive view of the previous research on the topic.In this research paper, literature review is undertaken for selected research paper and research reports which were distil from a total of 100.

4.Materials and methodology

The methodology adopted is the combination of literature surveys, interaction with experts and discussion with various academician and visit to various ash generation and consumption units. This constitutes

- The detail literature review on issues of flyash utilization in India and abroad.
- Data source from central electricity authority, Indian energy book, report ministry of coal and report department of industrial policy and promotion has been analyzed to understand the current generation and utilization of flyash in India.
- Detailed discussion with experts, some stakeholders from power sector, cement sector and brick manufacturers in the context of the study, the discussion aimed at strengthening the finding of the literature review, understanding the ground realities in terms of associated costs and benefits accruing to the users of flyash.
- Inputs received based on consultations from the experts and stakeholders a cost benefit analysis was conducted for the sectors of cement to distil the perceived and real barriers to gainful utilization of flyash.

5. Cement industry in India.

Cement is one of the core industries which plays a vital role in the growth and development of a nation. The industry occupies an important place in the Indian economy. Keeping in line with the technological world, the Indian cement industry has transited itself into a more advanced one. At present, the Indian cement industry is positioned second globally (DIPP, 2011) and accounting for about 7-8% of the total global production. It had a total capacity of about 330 m tons (MT) as of financial year ended 2011-12. Cement is a cyclical commodity with a high correlation with GDP, growing at around 1.2 x of GDP growth rate. The housing sector is the biggest demand driver of cement, accounting for about 64% of the total consumption. The other major consumers of cement include infrastructure (17%), commercial & institutional (13%) and industrial segment (6%) (Master, 2012).
This has offered advantages to the industry.

With the ever increasing industrial activities, real estate, construction and infrastructure, in addition to the onset of various Special Economic Zones (SEZs) being developed across the country, there is a huge demand for cement. The industry is not only meeting the requirements arising within the domestic market but also fulfilling the burgeoning demands of the international arena. India is also exporting good amount of cement clinker and by products of cement.

6. Energy efficiency – Indian cement industry

China remains the top producer in the world after china Indian cement industry is the second largest producer of cement in the world (DIPP 2011). In 2011, it was 244.4 Million Tons (Mt) installed capacity of Indian cement industry, while cement production was 174.29 Mt. In 2007, the final energy consumed by the Indian cement industry was 607 Peta Joules (Pj) (CSTEP, 2012).This account for 9 percent of the total energy consumed by the Indian industrial sector. In cement manufacturing energy is consumed in various processes, the sub processes are – raw meal grinding, preheating, precalcining, clinkerization and grinding. 80-90 percentage is thermal energy, while the remaining is electrical energy i.e. portion of the energy consumed is thermal energy (80-90%) and the rest is electrical. The cement grinding mills consumes the highest electrical energy while the clinkerization sub process consumes the largest share of thermal energy.

7. Indian flyash generation scenario

Fly-ash is the major solid waste produced in thermal power stations. The quantity of fly-ash produced annually by the 88 thermal power plants in the country is estimated to be 131 million tons. (CEA, 2010). In the absence of a well-planned strategy in India for the disposal of this fly-ash, it is posing serious health and ecological hazards (Kanojia et al. 2001).

Further, the table given below shows the generation and utilization of fly-ash for the year 2010 and 2011 in India which aware us the contemporary consumption rate.

Table 1 - Generation and utilization of fly-ash in India, 2010 and 2011.(Source central electricity authority report 2010-11, 2011-12)

	2010-11	2011-12
No. of coal/Lignite based thermal power station (India)	88	90
Installed Capacity	80548 Mega Watt	83797 Mega

		Watt
Total Ash generated	131.09 Million Tons	66.49 Million Tons
Total Ash utilized	73.13Million Tons	36.26 Million Tons
Percentage Utilization	55.79%	54.33%

8. Utilization of flyash sector wise

In the financial year 2016-17 it is expected to increase the production of fly-ash around 300-400 MT/year. The large amount of fly-ash produced if not utilized in right quantity will be hazardous to environment.

Table 2 - Fly-ash utilization during the year (2010).
(Source central electricity authorityl report 2010-2011)

S.No.	Mode of Fly-ash Utilization	Utilization in (Million Tons per annum)	Percentage Utilization
1.	Cement	35.47	48.50
2.	Reclamation of low lying area	9.31	12.73
3.	Roads and Embankments	8.52	11.65
4.	Mine Filling	6.04	8.26
5.	Bricks & Tiles	4.61	6.30
6.	Agriculture	1.27	1.74
7.	Others	7.91	10.82
	Total	73.13	100

Table 3 - Fly-ash utilization during the year (2011). (Source central electricity authority annual report 2011-2012)

S.No.	Mode of Fly-ash Utilization	Utilization in (Million Tons per annum)	Percentage Utilization
1.	Cement	17.45	48.13
2.	Reclamation of low lying area	3.16	8.72
3.	Roads and Embankments	4.72	13.02
4.	Mine Filling	2.45	6.76
5.	Bricks & Tiles	2.36	6.51
6.	Agriculture	0.37	1.02
7.	Others	5.74	15.83
	Total	36.26	100

In the cement sector the utilization is approximately same with figure of 48.50 percent and 48.13 percentage in 2010 and 2011; in roads and embankment sectors has increase in percentage utilization from 11.65 percentages to 13.02 percentages. Otherwise other sector has decrease in percentage of utilization of fly-ash which decreases the overall percentage utilization in financial year 2011-12.

9. Utilization of fly-ash in Indian cement industry

India is the second largest cement producer in the world (DIPP, 2011) but still has per capita consumption about 150 as compared to world average of about 400 - A huge potential. (Bajaj, 2010), manufacturing of cement is the most important sector it take a lion share in fly-ash utilization in India. Owing to its pozzolanic properties fly-ash is used as a replacement for some of the Portland cement content of concrete. Use of fly-ash as a partial replacement for Portland cement is generally limited to class F fly-ash as this fly-ash is pozzolanic in nature, and contains less than 20% lime Cao. The current utilization of fly-ash in cement industry is 48.13% in 2011-12 (CEA, 2011).The cement industry of India is expected to add 30-40 million tons per annum (MTPA) of capacity in 2013. The industry has a current capacity of 324 MTPA and operates at 75-80 per cent utilization.

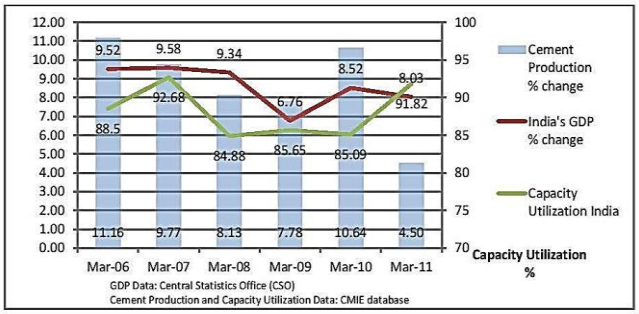

Figure 1: Cement production and capacity utilization and India GDP data
(Source Central Statistics office and CMIE India)

Table 4- Expected Fly-ash absorption in cement (million tons per annum)
(Source: WBCSD/CSI/LOW Carbon technology road map for Indian cement industry)

Serial No.	Year	Expected Fly-ash absorption in Indian Cement Industry (million tons per annum)
1	2015	52.65
2	2020	73.01
3	2025	94.63
4	2030	120.50
5	2035	143.72
6	2040	158.02
7	2045	167.74
8	2050	177.45

It is anticipated that the cement industry players will continue to increase their annual cement output in coming years and the country's cement production will grow at a compound annual growth rate (CAGR) of around 12 per cent during 2011-12 - 2013-14 to reach 303 MMT, (RNCOS,2012). India's cement producing capability is

expected to touch about 400 Mn. tons per annum over the next 5 years (Bajaj 2010).

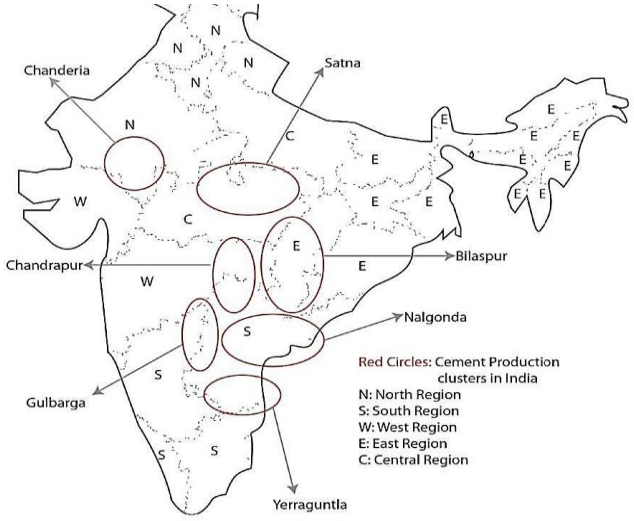

Figure 2: The division of cement production & market on the map of India (Source cementing growth, industry report, Ernst & Young, page 18-19)

10. Results and discussion

Cement industry would continue to remain the top user of flyash in the future, the cement industry comprised of 171 large cement plants with an installed capacity of 293.04 million tons and more than 350 mini cement plants (DIPP, 2011), with an estimated capacity of 11.10 million tons per annum for a total installed capacity of 304.14 million tons as on 30/11/2011(DIPP, 2011). Over 350 small cement plants and 171 large cement plants including some owned by central and state governments also with currently 42 players in industry. Cement production during the year 2011-12 was 144.94 million tons registering growth of 4.13% over the previous year 2010-11(DIPP, 2011). This study estimates the benefit of cement plants in tons also the major driving forces for increased utilization of flyash by this sector would remain to be the economics of flyash procurement and the resultant margins of profit. This utilization can be encouraged further by certain steps being taken by the power plants like grading of ash, taking appropriate initiatives reducing the unburned carbon content in flyash etc.

11.Barriers in utilization of flyash in Indian cement industry

(i) In India, utilization of fly ash in cement concrete is limited mainly due to lack of required information to actual users like State / Central Govt. construction departments, builders, developers etc. (NTPC, 2012).

(ii) Mandate free flyash supply, the mandatory requirement of power plant to provide free flyash though users preferred it but it acts as barrier from power plant perspective, a market determination of price of flyash would provide an incentive for the power producers to invest, improve and make available the right quality of ash to its users.

(iii) Transportation cost of ash is one of the most important financial barriers , these cost have restricted the use of flyash in spite of policy reforms of free flyash supply from power plants,

(iv) Investment costs for ash handling and storage, these involves the proper handling, storage and mixing of flyash pose a hindrance as expressed by many cement manufacturers.

(v) For utilization of flyash it is mandatory to look the quality of ash from power producer that is in terms of fineness (measured in terms of mesh and blain) and presence of unburned carbon particles. To deliver required quality of flyash to user it needs investment which is not observed?

(vi) Lack of awareness/confidence amongst consumers of PPC.

(vii) Lack of implementation / monitoring by government committee on utilization of flyash.

12. Conclusion and enablers in utilzation of flyash in Indian cement industry

(i) Substitution of fast depleting limited natural resources of limestone (example cement grade limestone) and total cement grade limestone reserves are estimated at 110,907 million tons (Bajaj, 2010).

(ii) Approx 25-30% conservation of fossil fuel like coal, oil and gas etc. can be achieved due to the substitution of clinker with fly-ash.

(iii) Approx 15-20% electrical energy savings which will reduce further conserve fossil fuels due to avoidance of electricity generation.

(iv) Carbon dioxide reduction (indirect): 1KwH in specific power consumption reduces Carbon dioxide emissions by 1Kg hence; reduction in Carbon dioxide emissions is expected to be 13-17kg/t PPC 9 for cement with 27-35% by mass fly-ash).

(v) Possibility of realizing vast space occupied by wet flyash ponds subject to government support to cement industry.

(vi) Avoidance of ground water contamination due to open storage of fly-ash.

(vii) Environment friendly disposal of fly-ash and creating economic value while conserving the fast depleting natural resources (coal, limestone)

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