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CRI TECHNOLOGY DIGEST

MANUFACTURE OF PORTLAND POZZOLANA CEMENT FROM FLYASH—A WAY TO CONSERVE ENERGY, RAW MATERIALS AND CAPITAL

CEMENT RESEARCH INSTITUTE OF INDIA

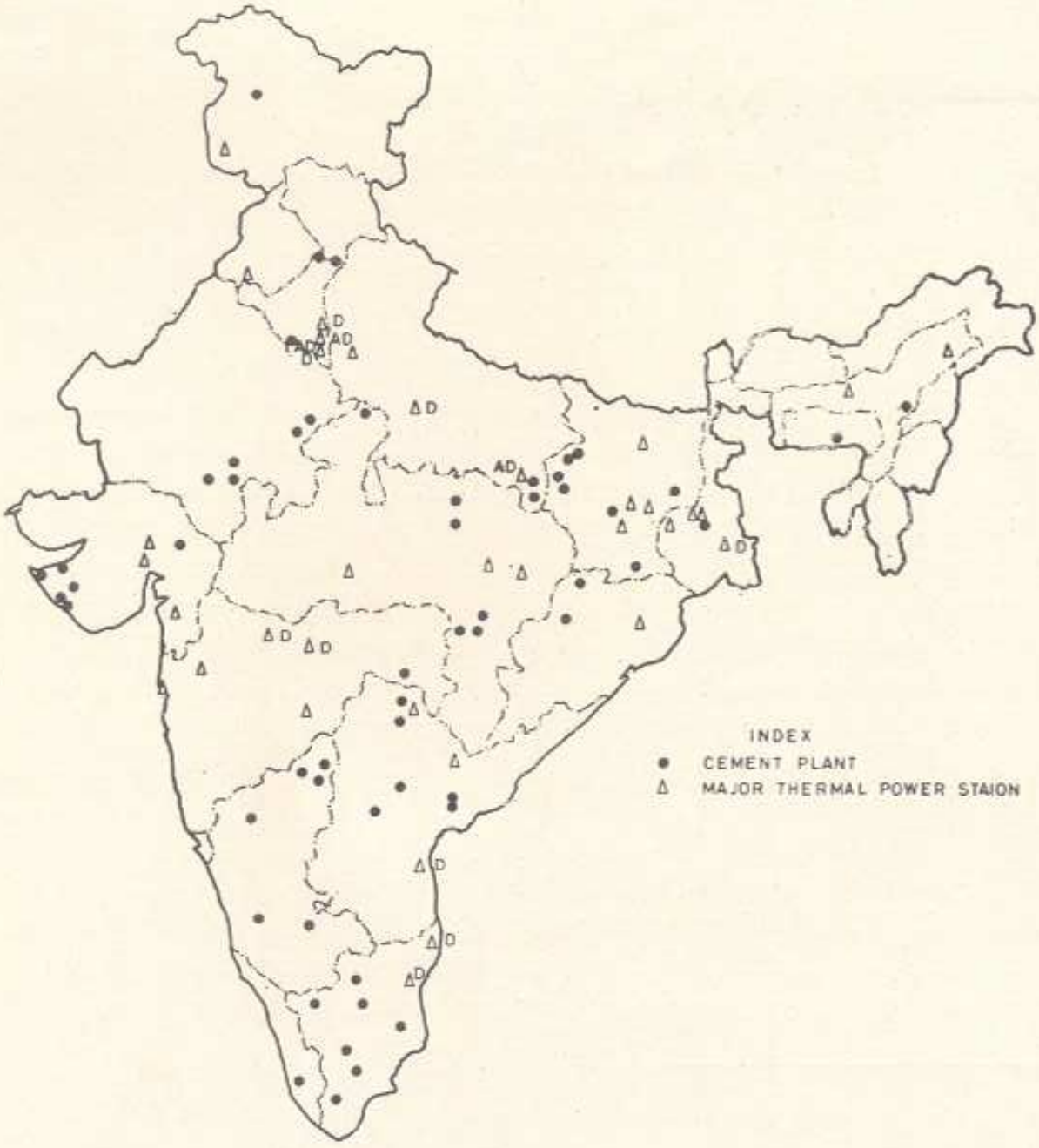
MANUFACTURE OF PORTLAND POZZOLANA CEMENT FROM FLYASH—A WAY TO CONSERVE ENERGY, RAW MATERIALS AND CAPITAL

USE of flyash, a waste from coal fired thermal power stations, either as raw material or as additive to Ordinary Portland Cement to obtain Portland Pozzolana Cement, is an established solution for augmenting the cement availability in the country. While the manufacture of PPC has reached a high level, i e, 6·6 MT in 1979-80, the contribution of flyash has not been significant. In view of energy saving potential including availability of large quantities of flyash from super power thermal stations and continued shortage of cement in the country, the need to take steps to increase the use of flyash in PPC has become more imperative.

In view of the latest R&D work done in the country, there should be no apprehension with regard to use of flyash for manufacture of PPC and concrete. This Technology Digest aims at focussing attention at some of the vital issues involved with the use of flyash in particular for the manufacture of portland pozzolana cement (PPC), thus opening new vistas in the development and scope of manufacture of blended cement.

About 8 millon tonnes of flyash are produced in the country every year, though only 0·41 million tonnes are available in usable dry state. Although the production of PPC has increased manifold, the same obtained from flyash has not increased over the years. The sites of major thermal power stations in India and Cement plants as shown in the map indicate the scope and potentials of utilization of flyash in PPC manufacture.

Variation in the quality, handling and transportation problems, lack of complete data on Indian flyashes and economics of producing flyash cement from them seem to have inhibited the use of flyash in India. In order to solve some of these problems, CRI had undertaken a comprehensive study on Indian flyashes and also coordinated at national level the inter laboratory investigations on Indian flyashes including preparation of specific techno-economic feasibility reports. The split location concept for setting up flyash



Cement Plants and Major Thermal Power Stations in India

cement units close to the thermal power stations situated near big consumption centres was also worked out in detail for specific locations.

As a result of these investigations, sufficient data and expertise have been generated at CRI to guide the use of flyash in cement manufacture through comprehensive evaluation programme and to solve problems faced in the manufacture of PPC based on flyash.

Technical and Techno-Economical Considerations in the Utilization of Flyash

Intrinsic potential of flyash needs to be examined in terms of its chemical, mineralogical and physical state vis-a-vis those of OPC to which the flyash has to be added as a constituent. In this context the following technological and design parameters have been examined and arrived at through laboratory/pilot plant investigations: (a) overall quality of flyash and variation there in; (b) physical state like fineness and granulometry; (c) clinker composition, compatability and ratio of components; (d) choice of manufacturing technique; (e) gypsum content; and (f) energy and cost analysis.

Collection and Sampling of Flyash

A standard collection and sampling procedure has been evolved and systematic scheme for evaluation of flyash for use in PPC manufacture has been formulated. According to the scheme about 30 samples of flyash need to be collected daily and evaluated for various selected properties for obtaining reliable data on a particular flyash for exercising quality controls, through use of statistical control charts.

Characteristics of Indian Flyashes and Quality Variation

Apart from satisfying the specified requirements on its own properties (IS: 3812), a flyash has to conform to the indirect requirements in specifications for properties of end product, i e, PPC (IS : 1489-1976). The chemical composition of flyashes is known to vary from source to source due to change in coal source and operating conditions. Indian flyashes generally consist of SiO_2 55-65%, Al_2O_3 15-25%, Fe_2O_3 4-9% besides unburnt carbon and

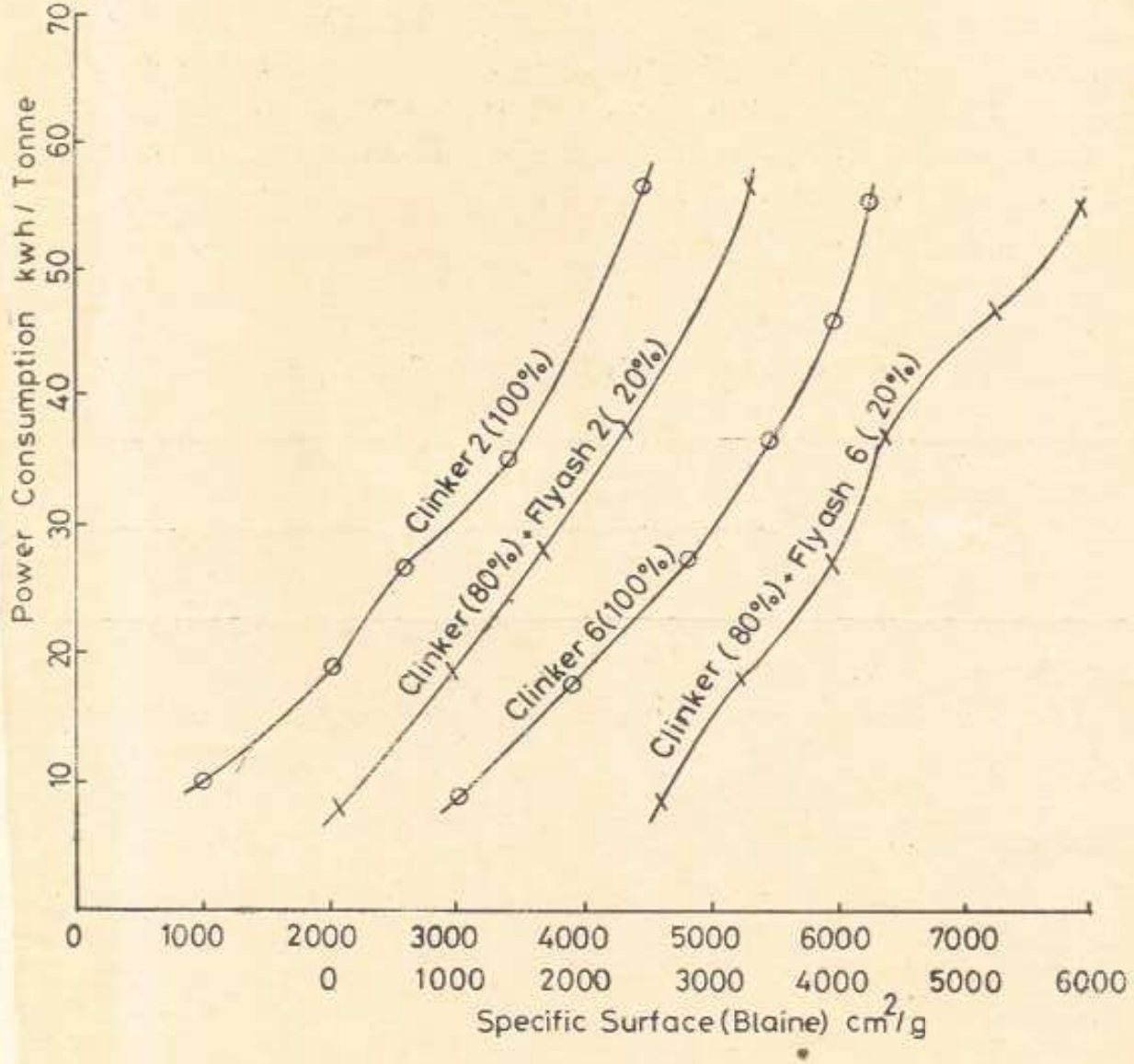
small amounts of alkalies and sulphates. The lignite flyashes contain significant amount of CaO (5-15%) and are also slightly different. The mineral content of Indian flyashes are mullite, α-quartz, hematite and only small quantity of glass (20-25%). While in general the Indian flyashes conform to IS : 3812 requirements in isolated cases the value of unburnt carbon crosses the limit of 12% and in certain cases the fineness is lower than the desired 3200 cm^2/g level. Extensive investigations at CRI show that the fineness of Indian flyashes varies between 3000-6000 cm^2/g and lime reactivity between 37-62 kg/cm^2. While the variation in the quality is considered large with overall standard deviation for fineness being 580 cm^2/g and coefficient of variations between 9-16%, the practical implication of this variation has been evaluated through study of PPC made with various flyashes and it is observed that through proper controls on parameters, the influence of these parameters is not reflected on the PPC properties. In fact PPC of acceptable quality (IS : 1489-1976) can be made without large in-plant variation (4-7%) in strength of PPC at 7 and 28 days age. It is suggested that the use of standard deviation be made for controlling the consignments of flyash and flyash cements.

PHYSICAL CHARACTERISTICS OF FLYASHES

Characteristic	Station						
	1	2	3	4	5	6	7
Specific Surface (Blaine) cm^2/g	2628	4720	4624	4016	3000	4430	4579
LOI %	0·52	4·86	7·4	4·1	7·0	0·79	5·88
Residue on 90 μ Sieve %	5·6	13·8	10·8	10·4	15·2	5·7	14·2
Lime Reactivity kg/cm^2	53·2	48	68	48·2	—	54	54
Compressive Strength of Mortars at 28 days as percent of control	84·5	86	82·1	87	85	89	85

Choice of Clinker and Compatibility

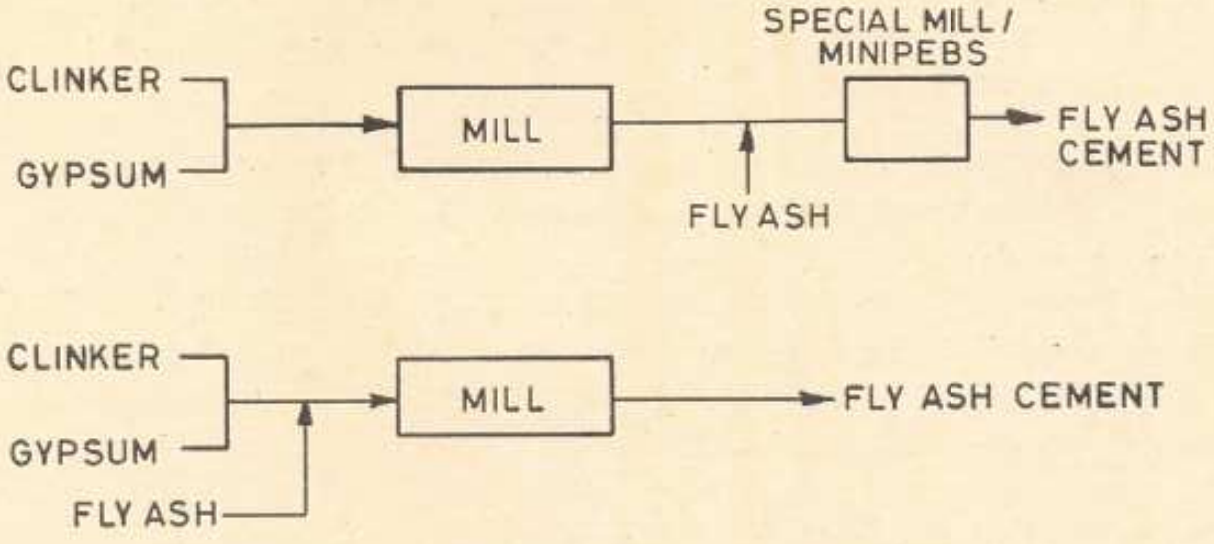
The choice of cement/clinker for making portland pozzolana cement is guided by the intrinsic worth of cement/clinker. Although there is no unanimity with regard to the type of clinker which is most appropriate for use with flyashes clinkers with relatively high C/S ratio are generally prefered in order to get early strength at par with parent OPC. Results of investigations at CRI on this aspect show that besides the clinker composition, the compatability of the two components in their overall quality is very significant. Average Indian clinkers with C_3S, $\approx$ 35-40% could be used with proper control on various parameters.



Comparative Grindability of Clinker and Clinker (80%) Flyash (20%)

Choice of Manufacturing Technique

Problems facing the technology of manufacture of flyash cements are rather complex due to wide differences in the properties such as fineness, specific gravity and grindability of the two major components, i e, clinker and flyash. Optimisation of parameters to obtain, a uniform product with desired characteristics is thus most important, both for technological and economic consideration. Although both the techniques such as intergrinding and blending can be adopted, a comprehensive review of various system studied at CRI has shown that among the various possible modes for manufacture of flyash cements, a process combining the two, ie, partial intergrinding (involving first grinding of clinker to a predetermined fineness level followed by intergrinding of flyash and clinker) is most suitable, alternatively intergrinding is observed to be more appropriate. These technologies also takes care of variation in quality of components and also the differences in their grindability characteristics. Schematic diagram of these techniques is shown below.



Economics of Producing Flyash Cement and Split Location Plants for PPC

Flyash cements can be made both at the cement works or at split location near thermal power plants situated close to big consumption centres. While the practice so far has been to move the flyash to cement works, movement of clinker to grinding unit near

power station in particular where these are in rational direction is considered advantageous from the point of handling, transportation and distribution of cement. In split location units the choice of manufacturing technique can also be exercised better. While there is no doubt that the economy of production of PPC will be better at cement works which already have extra infrastructural facilities, the detailed techno-economic reports prepared by CRI with respect to various locations show that the split location units are also techno-economically viable for 300 TPD and higher capacities. The split location concept also enables the supply of cement through bulk supply system and thus reduce the packaging costs.

Saving in Energy

When flyash is used as an additive to obtain flyash cement, there is saving in fuel cost to the extent flyash is introduced directly. The electrical energy savings are however, not so direct as these are related to choice of manufacturing technique and component characteristics. The analysis done at CRI indicates the 20 percent saving in fuel consumption and about 15 kWh/tonne reduction in power consumption are achievable at a 20 percent flyash replacement level. However, overall savings from these may get slightly reduced in some cases when stripping of form work is to be done at early ages.

Assistance by CRI

Based on the data collected and experience gained with the use of flyash, CRI is ready to assist plants, entrepreneurs planning to set up unit to manufacture flyash cement through systematic evaluation of components, process and economics of the specific proposal.

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