CEMENT RESEARCH INSTITUTE OF INDIA

CRI TECHNOLOGY DIGEST

CRI RICE HUSK ASH MASONRY BINDER — RHAM

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The technology for the manufacture of Rice Husk Ash Masonry (RHAM) binder developed by CRI aims at the utilisation of huge quantities of paddy waste available from hulling of rice either in the fields or at the mills for simultaneously producing a rural binder material. RHAM binder is essentially a lime pozzolana mix with the difference that the pozzolana, which in this case is rice husk ash, is far more active than most of the other known pozzolanas and in this context RHAM binder offers an attractive alternative to ordinary portland cement for masonry purposes. RHAM binder can fulfil the requirement of binder material for most of the constructional purposes (excepting RCC) in rural sector particularly and also, to a considerable extent in semi-urban areas, augmenting the short supply of portland cement. This Technology Digest deals with the essential features of utilization of rice husk for making binder including various available technologies in India and abroad and their influence on the activity of the ash produced, used and the scientific approach for developing appropriate technology by CRI for producing highly active and easily grindable ash for manufacturing rice husk ash binder and the special place of rice husk ash amongst manufactured pozzolanas both from the point of view of high pozzolanic activity and disposal of an agro-industrial waste, rice husk, which otherwise presents ecological problems.

Rice Husk as a Potential source for Pozzolana

Rice Husk contains upto 30 percent inorganic mineral matter most of which is silica. The technology of RHA based binders utilizes this silica present in rice husk mostly in amorphous state. The husk on incineration yields rice husk ash (RHA) which has varying degree of pozzolanicity depending upon the conditions under which it is produced. Considerable effort has therefore gone into investigations aiming at producing highly active ash from rice husk for utilization and to exploit its pozzolanic activity in making binder material. R&D efforts in this field were first discussed in international forums like International

Conference on rice by products utilization, Valensia 1974 which evinced lot of interest in practically all the rice producing countries and even has drawn the attention of UNIDO who have organised workshops on industrial utilization of agro wastes for making cement at Peshawar (1979) and Alor Setar (1979).

It is in this context that rice husk ash based binder materials and the development of technology related thereto was considered important and of direct relevance to a country like India which is major rice producing country of the world accounting for nearly one fourth of global paddy production. What makes development of such a technology more relevant is the renewable nature of this source of energy and binder materials.

Technological Developments

The technology developed abroad particularly in USA is quite sophisticated, consisting of an integrated plant for incinerating the hulls to produce rice husk ash for producing high priced special cement and simultaneously recovering thermal energy to do useful work. However, the capital investment of the plant based on this technology is very high and as such is not considered appropriate to the Indian situation.

In India efforts in the past have been mainly directed towards producing clinker and lime based binders utilizing pozzolanic activity of rice husk ash. In this regard following technologies have been reported :

i) Intergrinding of boiler ash from rice husk fired boilers with lime.

ii) Firing of lime-rice husk-clay mixture and fine grinding of the calcined product.

Rice husk ash available from boilers as tested for pozzolanicity and lime reactivity indicates low pozzolanic activity and it has to be

ground very fine for increasing its reactivity for use in producing rice husk ash binder under technology (i). It is obvious that the grinding energy requirement is very high. On the other hand although the grinding energy and costs thereof for the technology under (ii) are lower than the former but then the activity is also lower and so is the strength development in the binder produced from it.

R&D Work at CRI

In view of the above R&D activities at CRI towards utilization of rice husk for making binder were therefore mainly directed towards the following objectives:

i) Optimization of conditions of incineration of rice to produce highly active ash, instead of using byproduct ash from boilers using husk as fuel.

ii) Studies relating to variability in composition of the ash and reactivity obtained by incinerating different strains of rice cultivated under varying agricultural practices.

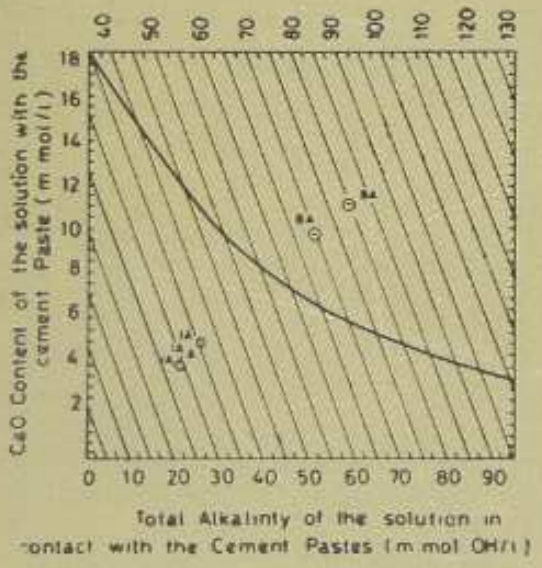
iii) Design and development of a low cost incinerator for producing highly active ash.

iv) Comparative evaluation of ash obtained from husk fired boilers vis-a-vis laboratory incinerated ash for reactivity and grindability.

v) Formulation of RHA based binders.

Highlights of the R&D efforts are summarized as follows :

i) According to investigations at CRI rice husk ash obtained both under controlled and uncontrolled burning have indicated that



BA—Boiler Ash
IA—Incinerator Ash

Fig 1 Pozzolanicity Diagram—Solubility of $Ca(OH)_2$ in the Presence of Alkalies at 40 °C

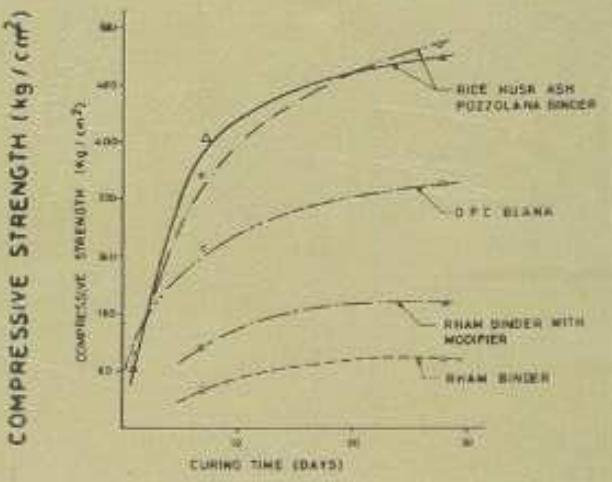


Fig 2 Compressive Strengths of Rice Husk Ash Binder Samples

the reactivity of ash is a function of state and form in which silica exists and it has been established from morphological studies that while the rice husk obtained under uncontrolled burning as in open firing or in boilers contain mainly cryslobalite and ∝-quartz (plate 2) the ash obtained under controlled incineration delineated by CRI contains silica distributed predominantly in amorphous state (plates 1&3) and this explains the differences in their relative activities. These observations have been further confirmed by lime reactivity and pozzolanicity tests, while RHA obtained under controlled incineration is highly pozzolanic (Fig 1) with a lime reactivity of ≃90 kg/cm,^{2} the ash obtained under uncontrolled burning is non-pozzolanic with a lime reactivity of ≃ 20 kg/cm.^{2}

Further, grindability studies have indicated that grindability of rice husk ash is a function of thermal treatment given to the husk. Uncontrolled burning yields ash which is hard to grind while ash obtained under controlled incineration is easily grindable. The energy

SEM (outerface) of Rice husk 320 × Plate 1

SEM hard burnt Rice husk 1250 × Plate 2

SEM (Innerface) of Soft burnt Rice husk 320 × Plate 3

consumption ratio for grinding to a specific fineness of ash from boilers and from controlled incineration is approximately 3:1.

ii) Optimisation of various parameters like temperature, time and air requirements during incineration of rice husk and mode of cooling of rice husk ash for producing highly active ash.

iii) Design of two types of incinerators and standardization of operational parameters for producing 0·5 tonnes of active ash per day.

iv) Formulation of clinker and lime based binders based on active ash obtained from incinerators with typical performance characteristics as indicated in Fig 2.

Rice Husk Ash Masonry Binder—RHAM

RHAM binder is essentially a lime pozzolona binder.

Factory made lime pozzolana mixtures conforming to IS : 4098-1967 have been classified and are recommended for following applications:

Type	*Applications*
LP 40	Masonry mortars and plasters of 30—50 kg/cm^2 grade and foundations concrete
LP 20	Masonry mortars and plasters of 15-30 kg/cm^2 grade and foundations concrete
LP 7	Masonry mortars and plasters of 7-15 kg/cm^2 grade

Performance characteristics of RHAM binder produced with CRI technology are superior to LP 40 grade lime pozzolana mixtures and as

such can be used for most of the construction activities (excepting RCC) with advantages of improved workability, bond strength and higher load carrying capacity.

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