Review Paper on Application of Ceramic Furnace Lining waste in Construction Industry

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Abstract: Wastes from various industries have found their importance in the construction industry. This paper talks about a different kind of waste called the ceramic furnace lining waste. Here, review of various papers consisting of research in the said area is presented and possible application if the ceramic furnace lining waste is proposed. The paper reviews current knowledge on the various application of various refractories available from the ceramic and metallurgy industries. Mostly the refractories are silica rich and hence are either used as a partial replacement to cement or aggregate. Also new technologies like alkali-activation makes them use as a binder due to amorphous silica present. The paper intends to study how refractories are currently used and propose the possible use of ceramic furnace lining waste in the construction industry.

Keywords—Ceramic furnace lining waste, construction industry, silica, alkali-activation, cement.

I.Introduction

Ceramic industry uses a wide range of refractories. This paper discusses about a specific type of refractory bricks. These are the IS-8 bricks used in the furnaces of ceramic industry which have a temperature of the range of 1200°C. Morbi, Gujarat, India being a cluster of ceramic industries, the ceramic furnace lining waste is obtained in abundance and is an issue for the industries to dispose it off. It is found that the CFLW is rich in silica and alumina. There can be various application to the material in the construction industry.

II.Literature review

1) *Mohamed Zeghad, Jozef Mitterpach, Brahim Safi, Belaid Amrane, Mohammed Saidi et al (2015) [1]* study the reuse of refractory brick wastes (RWB) as a supplementary cementitious materials (by a total replacement of silica fume) to produce a new concretes; namely a high performance fiber-reinforced concrete (HPFRC). This work presents an experimental study on the formulation and physico-mechanical characterization of high performance fiber reinforced concretes based on three types of refractory brick wastes. These were recovered from the float glass industry (Mediterranean Float Glass) after their use in the oven basin (i.e. d. they are considered waste unit). Three compositions of concrete (HPFRC) were established based on three types of refractory brick wastes (finely crushed), with the dosage of each type of bricks is kept constant and similar that dosage of silica fume used for the control concrete. While all the other components and the water/binder ratio are maintained constant with the same quantity of the superplasticizer. The performance of HPFRC, were evaluated by determining the essential characteristics of fresh and hardened concrete. The results obtained showed that refractory bricks finely ground have the potential to be used as cementitious materials.

2) *H. M. Khater, Abdeen M. El Nagar, M. Ezzat et al(2016)[2]* Geopolymer bricks prepared by partial binder substitution of ceramic by clay brick wastes in the ratio from 0 up to 100 %, while the used fine sand was in the ratio of 15% from the total weight, also sodium hydroxide activator was used in the ratio of 8% of the total weight. The properties of the produced geopolymer bricks have been studied through measurement of compressive strength, water absorption, FTIR, XRD and SEM imaging. Results demonstrate the possibility of using alkali activated ceramic and grog materials in producing heavy duty building with compressive strength values more than 35 MPa up to 20% grog increase, however further increase results in lowering strength values as a result of increase of crystalline content and sufficiency of the used activator to dissolve all the crystalline fractures.

3) *C. M. F. Vieira and L. F. Amaral (2000) [3]* work investigates the recycling in the proper heavy clay ceramic processing. The characterization of the grog was performed by XRD, XRF, sieving and sedimentation method to determine its particle size distribution, DTA/TG and SEM. Grog originated from bricks produced at 500-600ºC, was added up to 20 wt % into the clayey body. Rectangular test specimens were prepared extrusion, dried until constant weight and then fired in an industrial furnace at 970ºC. Body samples were initially tested for plasticity. After firing, samples were then tested for linear shrinkage, water absorption and mechanical strength. The results have shown that grog addition improves the workability/plasticity of the investigated clay. With respect to the physical and mechanical

properties, it was observed that the grog decreased the linear shrinkage and practically did not change the water absorption and the mechanical strength of the fired ceramic. These results indicate the possibility of recycling fired brick waste into the own ceramic processing.

4) *Taner Kavas, Bekir Karasu, Ozlem Arslan et al(2006) [4]* The refractory bricks of a rotary cement furnace containing of alumina and magnesium chromite were studied in order to determine whether they could be used in the concrete production as aggregates. Three mortars were prepared by mixing 1 part cement, 3 part aggregate materials, 0.5 part water by weight and mechanical, chemical, thermomechanical and microstructural characteristics were evaluated. The compressive and bending strength of samples were determined after 2 and 28 days curing. Resistance to chemicals were established by calculating the weight gain of mortars stored in 2 % HCl solution for 1 h and 24 h. Thermomechanical characteristics were determined by measuring the compressive strength of heat treated specimens at temperatures of 400 °C, 600 °C and 800 °C. Consequently, magnesium chromite containing waste brick aggregates have given the best results.

5)*Shivaji S. Bidwe and Ajay A. Hamane (2015) [5]* This paper contains the experimental study of strength of geopolymer concrete for different molarities of sodium hydroxide solution. This paper also contains results of the laboratory tests conducted to find out the effect of sodium hydroxide concentration on the strength of the geopolymer concrete. In these days the world is facing a major problem i.e. the environmental pollution. We can use fly ash instead of cement in the construction in order to reduce environmental pollution. The Concrete made by using Fly ash and alkaline liquid mixture as a binder is known as geopolymer concrete. In this study for the polymerization process alkaline liquids used are Sodium Hydroxide (NaOH) and Sodium Silicate (Na2SiO3). Different molarities of sodium hydroxide solution i.e. 8M, 10M and 12M are taken to prepare different mixes and the compressive strength is calculated for each of the mix. The size of the cube specimens taken are 150mm X 150mm X 150mm. Curing of these cubes is done in an oven for 3 days and 28 days. The Compressive strength of these geopolymer concrete specimens is tested at 3 days and 28 days. The results show that there is increase in comp. strength of geopolymer concrete with increase in molarity of Sodium Hydroxide Solution. Ordinary Concrete Specimens are also manufactured with cement as binder. It is found that the Compressive strength of Geopolymer Concrete specimens is higher than the Compressive strength of Ordinary Concrete Specimens.

6) *Hilal El-Hassan, Ehab Shehab, Abdelrahman Al-Sallamin et al (2018) [6]* investigates the performance and microstructure of alkali-activated slag concrete (AASC) subjected to different 28-day curing regimes: air, intermittent water curing (7 days in water followed by 21 days in air), and continuous water curing. Three concrete mixes were prepared with fixed contents of slag, desert dune sand, and aggregate and activated by an alkaline solution consisting of sodium silicate and sodium hydroxide. The ratio of alkaline activator solution (AAS) to slag was varied between 0.45 and 0.55. Samples were tested to assess transport and mechanical properties. Test results showed that an AAS:slag ratio of 0.50 provided optimal performance. Intermittent water curing was found to be the most effective curing regime, resulting in a reduction in porosity and sorptivity, and an increase in bulk electrical resistivity, modulus of elasticity, and compressive strength. Differential scanning calorimetry, Fourier transform infrared spectroscopy, and scanning electron microscopy were used to characterize the microstructure. Calcium alumino-silicate hydrate gel was highlighted as the main reaction product, while sodium alumino-silicate hydrate gel was only detected in air cured counterparts.

7) *CK Yip & JSJ van Deventer et al(2002)[7]* involves the role of calcium in improving cement durability. It is suggested that calcium provides a crucial link between the chemistries of geopolymerisation and the hydration of cement. In essence, this investigation explores how the different calcium sources affect the process of geopolymerisation. Four different calcium sources were used in this investigation using various sodium hydroxide concentrations to provide the alkaline environment required. They are: granulated blast furnace slag, ordinary Portland cement, wollastonite and calcite. Compressive strength testing and x-ray diffraction were the main techniques used. For the calcium sources investigated, it was found that the difference in CaO content in the source material had little impact on the resultant compressive strength. However, the mineralogy of the calcium sources used and the alkaline conditions present were found to have a significant influence on the resultant product. Using lower hydroxide concentrations, samples prepared with calcium sources which were predominantly amorphous gave a better compressive strength than their crystalline counterparts did. However, when higher hydroxide concentrations were used, samples containing crystalline sources of calcium gave a compressive strength that was at least as good as the amorphous ones.

III.SUMMARY OF FINDINGS

From review of above papers, following findings are observed:

- Refractories can be used as replacement of cement or sand. Means they can be used as binders and fillers both.
- IS-8 bricks used as refractories have a high alumina and silica content and hence can be used for alkali-activation.
- Crushing of these refractories is easier as compared to foundry bricks as no sludge is attached to the surface of the bricks.
- Refractories can also be effectively used in producing self-compacting concrete.
- Calcium sources also affect the durability of cement.
- This material can also be used to prepare HPFRC.

IV.References

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