Use of Brick Kiln Dust as Partial Replacement of Cement in Concrete: Review

Hardeep Singh[1] Er Avani Chopra[2]
[2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Chandigarh University, Gharuan (Punjab), India

Abstract— Today construction work is going on a very large scale so requirement of cement concrete plays an important role. As India is developing country the demand of cement consumption and production increase day by day. India is the second world largest country which produces cement, more consumption of cement also affect our environment so now a day's green concrete constructions are more widely using and it is capable for sustainable development characterized by application of industrial waste quarry dust, wood ash, brick dust etc. to reduce consumption of cement and also reduce the emission of CO_2 by cement. It would be very cost effective in construction industries and there will be reduction in pollution and utilize agriculture waste by these new innovations in cement.

Key words: Cement, Concrete, Brick Dust, Industrial Waste, Quarry Dust, Wood Ash

I. INTRODUCTION

Cement is second largest thing used in world after water. Concrete is prepared by the mixture of cement, fine sand, coarse aggregate and water in the fixed proportion which is used in buildings, dam, bridge, highways, foundations etc. In which Cement is act as binding material and it bind the aggregate into solid when it's become set and hard and it also gives the strength on setting and hardening (Abdelghani and Hamina, 2009). Fine aggregate are those aggregate which pass through the sieve of 4.75 mm sieve. Sand is very common fine aggregate used in concrete. Natural and artificial sands are used to prepare concrete. Sand helps to reduce the cracking of concrete. Sand helps the cement in hardening and setting process by allowing the water into its pores.

Coarse Aggregate is those aggregate which retained on 4.75 mm sieve. Most commonly 20 to 25 mm size of coarse aggregate is used in concrete. Crushed stone, crushed granite, gravel and broken bricks are most common coarse aggregate are used in concrete. It helps to increase the crushing strength of concrete. It occupies large volume of concrete.

Water is most important ingredient in concrete. The strength of the concrete is depends upon the quantity and quality of water is used in concrete mix. It acts as lubricant in concrete.

Green concrete is a term given to a concrete that has had innovative steps taken in a mix design and placements to ensure a sustainable structure and a long life cycle with a low maintenance surface. With the increasing interest of the public, industry and government in sustainable development, environmental assessment in construction is becoming more important. Society and the social changes that have occurred in the world have placed insatiable demands on the construction industry in terms of the world's material and energy resources.

The construction industry must address certain consequential issues in the process of achieving sustainable development as it consumes considerable resources and has a significant impact on the environment.

India has taken a major step on developing the infrastructures such as express highways, bridges, power projects and industrial construction, etc, to meet the requirements of globalization, in the construction of buildings and other structures concrete plays an important and rightful role and a large quantum of concrete is being utilized.

Green concrete" is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 by Dr.WG. Green concrete is not in green color. It is concept of thinking environment into concrete considering every aspect from raw materials manufacture over the design to structural design, construction and service life. Green concrete is very often also cheap to produce. Waste can be used to produce new product or can be used as an admixture so that natural sources are used more efficiency and the environment is protected from waste deposits. Dumping of brick dust and other waste brick particles, flakes etc., not only occupy land but also create environmental problems. The problems could be reduced to a large extent by using these waste materials in cement concrete. The reasons for using brick dust include economical gain and beneficial modification of certain properties of fresh and hardened concrete elements (GeZhi et al., 2010). This study gives an overview of the physical and chemical properties of brick dust as a mineral admixture (BDMA), which is dumped as waste from brick and tile factories in Bangladesh. Various properties of brick dust have been studied. Experimental results indicate that brick dust could be used for partial replacement of cement in concrete. Concrete cubes prepared with 20% cement replaced by brick dust (BDMA) shows compressive strength comparable to concrete cubes prepared with Portland cement only (Kamal, 2004). Concrete prepared with 20% cement replaced by BDMA also shows good resistance to chemical attack, specially the sulfate attack. They also show better pore refinement after long period. Chemical composition and lime reactivity strength of brick dusts have been found to be within the range given for good pozzolanic material. The pore refinement and relatively low heat of hydration in the presence of BDMA show that certain properties of concrete could be improved by using brick dust in combination with Portland cement (Ilhami et al., 2009).

A. Brick Dust (BD)

One of the oldest construction materials is brick, which was first used in Southern Turkey and around Jerico dating 7000 Bc(Brick Directory 2015). According to literature, there are

two major ingredients from which building bricks are made, one is clay and other is sand. Brick dust is a waste product obtained from different brick kilns and tile factories. There are numerous brick kiln which have grown over the decades in an unplanned way in different part of the country (Kumar et al., 2014). Tons of waste products like brick dust or broken pieces or flakes of bricks (brickbat) come out from these kilns and factories. So far, such materials have been used just for filling low lying areas or are dumped as waste material.

Fig. : Brick Dust

Brick dust is the waste product which comes from the field where bricks are made and from the demolition waste of the building. As Brick is composed of clay which contains sufficient amount of soluble silica and alumina finely grounded brick dust when combined with lime shows pozzolanic reaction (Rogers, 2011). As earliest said that Brick is the oldest and majorly used construction material so large amount of Brick dust is generated during manufacturing of Bricks and demolition of the constructional structure so it is a major problem to dispose such a large amount of Brick Dust.

If Brick dust is used as a replacement for a percentage of cement then is will not only reduce the problem of disposing this waste, it will also reduce the environmental impact which is caused by the CO2 emission from the manufacturing of the cement.

II. LITERATURE

Brick kiln dust is the waste product which is generated in from the brick industry. India is the second largest producer of bricks. Large amount of bricks are manufactured so large amount of waste is also generated and that waste is the mixture of some other ashes like coal ash, wood ash soil and dust particles which is dumped in the environment. Brick kiln dust has pozzolanic properties. The clay from which brick is made contain silica and alumina and when these are react with lime shows pozzolanic reaction.

(Hemraj R. Kumavat, 2013) Investigated brick waste for its use as a replacement of cement and sand in cement mortar as it behaves as a pozzoloana. It may make an important contribution towards decreasing the adverse effect of the production, disposal and the dumping of brick waste on the environment. His findings show that richer mixes gives lower value of bulk density and higher values of compressive strength for sand replacement with brick waste up to 40%. It also presents useful data for the brick manufacturing industry, builders and mortar manufacturing companies in terms of minimizing the impact of brick waste and using eco-efficient materials.

(B.Rogers, 2011) Investigated an optimal methodology for determining whether a given brick dust will produce a pozzolanic reaction when combined with lime. This property will be referred to as pozzolanicity. The research required a review of the properties of pozzolanic materials, the nature of the pozzolanic reaction, and a review of existing methods for determining pozzolanicity. A testing program performed at the Architectural Conservation Laboratory at the University of Pennsylvania was designed and executed to evaluate methods for testing pozzolanicity of brick dust to determine their efficacy. His findings of the tests was the final result of the research, along with recommendations for ways in which this immensely valuable resource can be tested and utilized economically and sustainably for conservation work in the future.

(Sharda Sharma, 2014) Investigated on concrete block pavements (CBPs) which have appearance of solid block with interlocking properties with each others for laying on the surface of road or pedestrian. As per requirement and use there are various sizes, shapes, patterns and designs of the CBPs are available now a days. In this paper we have considered the experimental study for construction of paver blocks with partial replacement of cement with brick kiln dust at concrete mix (CM) 0 %, 5 %, 10 %, 15 %, 20 %, 25 % and 30 % with adding superplasticizer admixture is maximum 2 % of superplasticizer by weight of cement. His findings considered the compressive strength and water absorption of paver block at 7, 14 and 28 days.

(Ravi and Dubey, 2014)Investigated on pozzolanic properties including particle size, specific surface, chemical and mineral composition, amorphousness and water demand, affect their reactivity as well as the strength of lime–pozzolan pastes. Reactivity was evaluated with chemical, mechanical and mineralogical methods. A number of artificial pozzolans were investigated including Ground Granulated Blastfurnace Slag (GGBS); Leca; Pulverised Fuel Ash (PFA); Calcined Clay (Metastar); Microsilica (MS); Rice Husk Ash (RHA); Red Brick Dust (RBD); Tile and Yellow Brick Dust (YBD). His findings concludes that the pozzolan‘s specific surface has a much greater influence on the water demand of the paste than its particle size or the lime:pozzolan ratio. It was evidenced that each pozzolan has a particular water demand for a given workability that increased with its specific surface; and that the replacement of lime by pozzolan lowers the water demand of the paste except for Metastar, on account of its greater fineness and specific surface. There is a good correlation between the chemical and physical activity indices and the rate of portlandite consumption. These evidenced that the most amorphous pozzolans (Metastar, GGBS, RHA and MS) are the most active. Finally, it also appears from the results, that the amount of lime combined by reactive crystalline phases in the pozzolans is insignificant when compared to that bound by their amorphous fraction. He also concluded that amorphousness determines pozzolan reactivity to a much greater extent than any other pozzolan property (Ali heideri and hasanpour, 2013). It also concludes that the specific surface area of the pozzolan governs the water demand of the paste, while amorphousness largely

determines the strength of the paste. In contrast, the chemical composition of the pozzolan is not instrumental as a variable affecting neither pozzolan reactivity nor the strength of the paste.

(Hasanpour, 2013)Investigated the feasibility of using waste bricks powder of Gachsaran Company in concrete. Cement is replaced by waste bricks powder in different proportions until 40 percent by weight. pozzolanic properties of bricks powder and compressive strength of concrete were investigated. His findings demonstrated that the bricks powder show pozzolanic properties. Findings also show that concrete with partial cement replacement by waste bricks powder has minor strength loss. The results of the investigation confirmed the potential use of this bricks powder material to produce pozzolanic concrete.

Ms. Monica C. Dhoka (2013) Carried out experimental study on green concrete and described the properties of concrete and its strength with the use of waste materials. She described about green concrete in which we can reduce the pollution in environment by adopting suitable proportion of materials like cement and can improve the durability of concrete under the serve condition.

Bambang Suhendro (2014) Analysed that 8 to 10% of the world's total co2 emissions take place by manufacturing cement and global warming gas is released by crushing lime stone and clays. He described the term green concrete which is the utilisation of waste material by replacing of quantity of cement. He discussed about environment pollution and its effects in this case study. Now a day's everyone is aware from the environmental effects and global warming which is being increased day due to production of these construction materials specially in industries by day so now many countries are utilising waste materials and replacing it of further materials which generally use in making concrete but to observe the proper strength in construction.

Garg Chirag & Jain Aakash (2014) carried out study on green concrete to avoid the pollution and re used the material. He described that green concrete is an excellent substituent of the cement because it uses the waste products and give durability and strength than from normal concrete by adopting standard materials for green concrete construction. He observed that 0.9 tons of co2 produced per tones from cement production so by using green concrete we can reduce co2 emission from atmosphere.

Patel Ankit Nileshchandra & Prof. Jayeshkumar Pitroda (2013) Performed experimental study on green concrete and describe the feasibility of using stone waste dust in concrete production as the partial replacement of cement and for reducing disposal and pollution problems. He replaced OPC and PPC cement by stone waste dust in the range of 0%,10%,20%,30%,40% and 50% by weight for M-25 Grade concrete. HE also evaluated mechanical properties of specimen on split tensile strength test for 28 days. Finally in results he found that split tensile strength increased up to 30% replacing of stone waste in OPC and 20 % replacement of stone waste in PPC.

Then the physical properties of BKD obtained through experiments in the lab. Experiment result has been shown below:

S.No.	Lab Experiments	Result
1	F.M.	3.73
2	Specific gravity	2.35
3	Bulk density (kg/rrr')	1837
4	Maximum Dry Density (MDD)(Mg/m3)	1.5
5	Optimum moisture content (OMC) (%)	17

Table 1: Physical properties of BKD (Adopted from Sharma et al., 2014)

S.No	Chemical	Percentage
1	SiO2	1.4 46.52%
2	Al2O3	5.3 10.62%
3	Fe2O3	3.2 4.29%
4	CaO	61.6 24.48%
5	Na2O	1.02%
6	K2O	1.84%
7	MgO	0.8 8.56%
8	TiO2	0.514%
9	MnO	0.079%
10	P2O5	0.199%
11	SO3	0.895%
12	LOI	0.66%
13	Cl	108 ppm

Table 2: Chemical composition of brick powder (Adopted from Sharma et al., 2014)

III. CONCLUSION

We live in the world full of development and committed for more comfort, opportunity, possibilities and facilities. There is lots of inventions and revolutions in every field, but these invention or revolution has harmful impact on the environment because as the development increase day by day our natural resources get reduce day by day and pollution to different natural sources are occurred. So after studying all these research paper we concluded that if we can reduce or reuse some material in field of concrete production which is at its top now-a-days then it largely impact environment and leads to pollution free and soothing surrounding. Thus as concluded from above literature review we can research further more in direction of partially replacing cement, sand and aggregate up to most optimum level we can by reusing or introducing waste material as its option. From studying all these research paper it is clear that positive and favorable results are obtained if further research work and study is carried out in this field. And by using locally available wastes like brick kiln dust, glass waste, marble dust powder, ceramic waste, quarry dust, GGBS, Fly ash, etc. as partial substitution at place of cement in concrete, it may produce more cost effective concrete than the conventional concrete and also help to damp the industrial waste produce by the industries. Our target is to produce cost effective and eco-friendly concrete with all desired properties and strength which one obtains by regular concrete ingredients. Brick dust can be a better option because the specific gravity of brick powder being higher than the raw materials of concrete, it helps in increasing the density of concrete which results in less pores and high compact concrete. This is an eco-friendly concrete as it subsides the stagnation of demolished brick waste by

consuming it. As much as of the total cost of cement in conventional method can be saved by using brick dust. Cost saving percentage increases with increase in richness of mix design.

REFERENCES

[1] Abdelghani Naceri, Makhloufi Chikouche Hamina,(2009) "Use of waste brick as a partial replacement of cement in mortar", Waste Management, 29,(2009), 2378–2384.
[2] GeZhi, GaoZhili, Sun Renjuan, Zheng Li.(2012)" Mix design of concrete with recycled clay-brick-powder using the orthogonal design method. Construction Building Material 2012;31:289–93
[3] Kamal Uddin M., (2004). Use of brick dust in concrete as mineral admixture and partial replacement of cement, Journal of Civil Engineering (IEB), 32(1): 69-78.
[4] Ilhami Demir, HasbiYaprak, Osman Simsek "Performance of Cement Mortars Replaced By Ground Waste Brick In Different Aggressive Conditions" Department of Civil Engineering, Kirikkale University, Kirkkale, Turkey
[5] Ms. Monica C. Dhoka(2013) "Green Concrete: Using Industrial Waste of Marble Powder, Quarry Dust and Paper Pulp" International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 Volume 2 Issue1 PP.67-70 2013.
[6] Bambang Suhendro(2014), "Toward green concrete for better sustainable environment 2nd International Conference on Sustainable Civil Engineering Structures and Construction Materials (SCESCM 2014) pp. 305-320 2014
[7] Hemraj Ramdas Kumavat, Yogesh Narayan Sonawane,(2013) "Feasibility Study of Partial Replacement of Cement and Sand in Mortar by Brick Waste Material", International Journal of Innovative Technology and Exploring Engineering, Vol.2, No.4, March 2013.
[8] Sharda Sharma, Ritesh Mall , Khalid Raza (2014) "Effect of waste brick kiln dust with partial replacement of cement with adding superplasticizer in construction of Paver Blocks International Journal of Science, Engineering and Technology Research, Volume 3, Issue 9, pp. 2261-2266,
[9] Ali heideri , b hasanpour(2013) "Effects of waste bricks powder of gachsaran company as a pozzolanic material in concrete, Asian Journal of Civil Engineering 14(5):755-763 • January 2013
[10] Shetty M.S., Concrete Technology: Theory and Practice, S.Chand & Company Ltd. New Delhi, 2007
[11] Saurabh Dubey , Ram Ji Porwal (2014) Studies on Effect of Cement Concrete Strength by using Waste Materials Likes Fly Ash and Brick Kiln Dust, International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 6, June – 2014
[12] Rajesh Kumar Bharti and Mr.R.D.Patel(2014), "A Study on Low Performance Concrete using Mineral Admixtures (Brick Kiln Dust and Silica Fume) ". IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 10, 2014 | ISSN (online): 2321-0613

