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Review Paper on Strength Properties of Concrete by Utilizing a Mixture of Bagasse Ash and Stone Dust

Prabha Ahirwar [1], Pushpendra Kumar Kushwaha[2], Mithun Kumar Rana[3]

[1]M. Tech. Research Scholar, Civil Department, RKDF College of Engineering, Bhopal (M. P.), 402026 India
[2]Assistant Professor, Civil Department, RKDF College of Engineering, Bhopal (M. P.), 402026 India
[3]Assistant Professor, Civil Department, RKDF College of Engineering, Bhopal (M. P.), 402026 India

ABTRACT

The infrastructure need of our country is increasing day by day and with concrete as a main constituent of construction material and the safety of systems is to be ensured. Portland cement is the major construction material throughout the world. Today researchers are focusing on utilizing industrial or agricultural waste, as a source of raw materials for industry which results in foreign exchange earnings and environmental pollution. Industrial wastes, such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement materials. The utilization of bagasse ash is more, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. There is a possibility in using sugarcane bagasse ash as cement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, and concrete roof tiles and cement interlocking block. Cement is a prime ingredient for concrete based construction but it’s over usage leads to environmental pollution.

Keywords: Sugarcane bagasse ash, Quarry dust, strength properties of conventional concrete.

1. Introduction

For the development of any structure, Concrete is the main material. The principle fixing to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest hazard to mankind on this planet today.Concrete is the most popular building material in the world and as such by its ecstasy, there is no substitute for concrete with conventional constituents. But sustaining the building activity in the long-term to meet the future demand for buildings by using the currently available energy-intensive materials and building techniques or technologies have become seldom possible. Building industries contribute greenhouse gas (GHG) emissions (22%) to the atmosphere and as the public's concern about climate change is wisely addressed as a result of the growing impact of global warming and increasing sea level; concrete technologists face the task of leading future growth in a manner that maintains the quality of the environment. Of course, the current environmental issues are well-related to technology choices which object to the production of sustainable and environmentally friendly concrete. Primary binder to produce concrete is Ordinary Portland cement (OPC). It has major drawbacks of emission greenhouse gas which effects to global warming, environmental pollution, and depletion. The environmental impacts of the concrete industry by conservation of cement, aggregates, water or additives and admixtures can be reduced through resource productivity by conserving materials and energy for concrete making and by improving the durability of concrete products. Even though the task is most challenging as it results and experiences in the scarcity of resource materials, it can be accomplished if pursued diligently through a possible way without much affecting the basics and requirements of concrete technology and construction techniques so far applied.

2. Literature Review

The environment has been affected by use and discharge of various types of industrial and agricultural wastes since commencement of the industrial age. Several researchers have been carried out to utilize these waste materials in construction works. Apart from getting rid of these waste materials, their use in construction works protects the environment from contamination. These wastes have now been utilized to produce cost effective environmental friendly concrete. Industrial and agricultural wastes are also used for the production of low cost building materials. This chapter presents a comprehensive literatures review related to the application and use of supplementary cementitious materials (SCMs) and industrial waste materials.. Utilization of these wastes such as sugarcane bagasse ash (SGBA) and stone dust (SD) in concrete industry. Detail analysis of pozzolanic activity of sugarcane bagasse ash, physical and chemical properties of bagasse ash and morphological analysis of concrete so produced,requires attention and has been considered well in reviewing the literature. Industrial waste material such as stone dust and its influence on fresh and hardened properties such as durability of concrete is also presented through thorough literature survey. From the comprehensive literature survey, critical observations derived are summarized at the end of the chapter

2.2 SUGARCANE BAGASSE

Sugar cane crop is typically used to produce sugar and ethanol by the various processes as shown in Fig.2.2. The fibrous residual substance known as Bagasse is obtained by extracting the sugar juice from sugarcane which is approximately 50% of the sugar cane quality [Bahurudeen and Santhanam (2013)]. Utilization of the bagasse has substantially increased with the increasing demand for sugar and ethanol production in recent years.

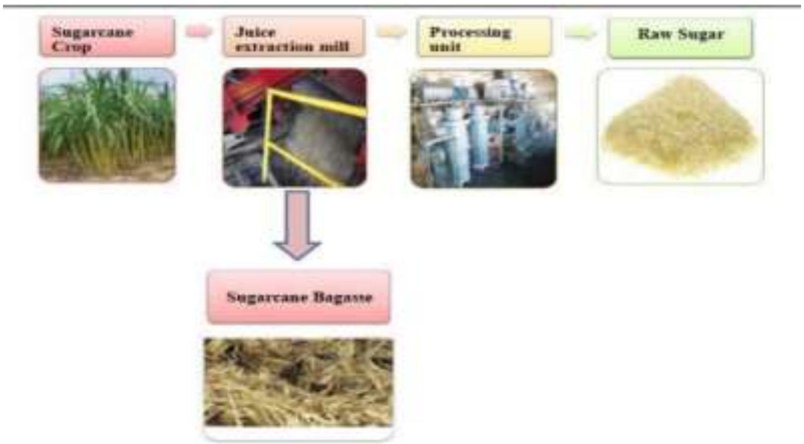

Fig.2.1 Flow diagram for production of raw sugar and sugarcane bagasse

Sugarcane Bagasse is widely used as a fuel in the cogeneration to produce steam and electricity.. Sugar cane bagasse ash (SGBA) is derived from the boilers of Sugar mills as an incineration residual ash as the final waste in the sugar production, is shown in Fig.2.3. Each ton of burnt bagasse may generate 25–40 kg of bagasse ash and, subsequently, a considerable amount of SGBA could be generated [Sales et al. (2010)].

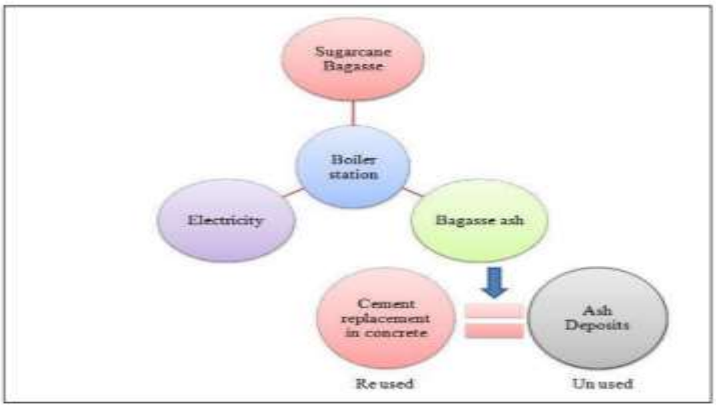

Fig.2.2 Application of Sugarcane Bagasse [Sales et al. (2010)]

Sugarcane bagasse ash Literature reveals that Sugarcane contains 30% bagasse whereas sugar recovered is about 10% and bagasse leaves about 8% bgasse ash depending upon the quality and type of the boiler and type of SGBA as waste [Goyal et al.(2007)]. Production of sugarcane is increased day by day and bagasse ash disposal becomes a serious concern. Though many researchers have suggested that the bagasse ash can be used as partial cement replacement material. Fig.2.4 shows the flow mechanism of the manufacturing of bagasse ash from sugarcane bagasse.

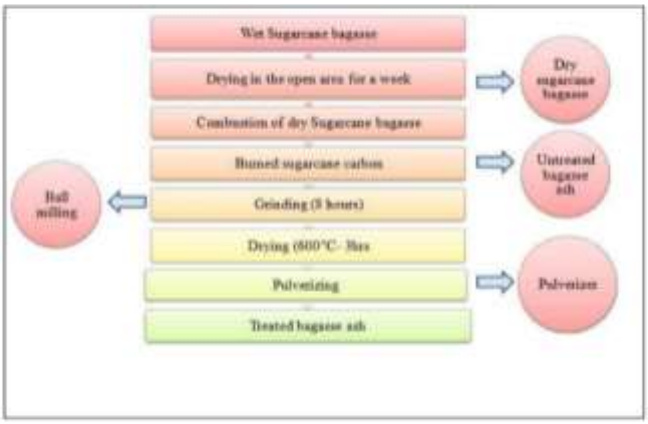

Fig.2.3 Production steps for Sugarcane Bagasse ash [Praveenkumar et al. (2020)]

2.3 PROPERTIES OF SUGARCANE BAGASSE ASH

Sugarcane bagasse ash is used as a pozzolanic material which depends on its physical and chemical properties. Crop species, growing conditions of the crop, grinding conditions, ash collection methods, regions included, combustion temperature and its duration, and cooling duration are the controlling factors for the pozzolanic properties .

2.4 PHYSICAL PROPERTIES OF SGBA

Many researchers have been studied on the various physical properties (PP) of the SGBA such as Blaine fineness (BF), density (DY), pH, pozzolanic index (PI), particle size (PZE), microscopic properties (MP) , surface area (SEA), specific gravity (SPY) and strength activity index(SAI). Many researchers have reported that the sugarcane SGB has been burnt at temperatures range of 600–800 °C in order to obtain the SGBA and also analyzed the formation of spongy particles by sugarcane biomass which may be partially burnt or un-burnt. (Chusilp et al. 2009; Cordeiro et al. 2012; Rattanashotinunt et al.2013). The PZE before and after grinding were found to be 23 mm and 10 mm respectively and SPY of SGBA was observed 2.2 while PZE of cement was found to be 14.6 mm and SPY of cement was found to be 3.14 .From the above observations, it was observed that values of PZE and SPY of SGBA are lower than that of cement. Fineness of SGBA could be improved by using a ball mill (BM) for grinding. Also, Amin (2011) has observed that the SGBA having the PZE of 5.1 mm, lower than that of Portland cement has 21 mm PZE. Table 2.5 shows the various physical properties of SGBA as reported in literature.

Table 2.1 Physical properties of SGBA

Materials	Particle size (µm) d_x	Surface Area	Surface Area test *	Density (Kg/m^3)	Specific Gravity	Process	References
SGBA	5.40 (avg. size)	943m^2/kg	BAP	-	1.85	Grinded until mean particle size is 5.40 µm sieve	Ganesan *et al.*(2007)
SGBA	-	64 m^2/g	BET	-	-	-	Batra *et al.* (2008)
SGBA SGBA1	23.00 (d50) 10.00 (d50)	- -		- -	2.08 2.29	Grinded in Ball Mill until particles retained is less than 5%	Chusilp *et al.*(2009)
SGBA	-	300 m^2/kg	BAP	-	-	Ground and sieved through 90 µm sieve	Morales *et al.*(2009)

2.5 LITERATURE REVIEW ON STONE DUST USED AS REPLACEMENT MATERIALS IN CONCRETE MIX

The usage of stone dust has been dealt almost all over the world, but the structural use of stone dust is still in the research level. Due to over exploitation of river sand and its related harmful consequences, stone dust has been identified as the next potential alternative for river sand. A good quantum of studies was made in the area of quarry dust utilization in structural concrete in India and other countries.

2.5.1 Properties of concrete containing stone waste

Part of studies suggests that stone dust as construction materials can be a sustainable practice. Studies have claimed that waste from stone industry can be effectively recycled into concrete in the recent year and a practice certainly benefiting the stone as well as construction industries.In the conservation of energy and materials, the observation on the utilisation of waste materials for concrete constituents is brought for prime consideration. During 1985-2004, experimental results have documented and data base were developed. The relations between the compressive strength, density, splitting tensile strength, flexural strength, and the elastic modulus were investigated. Stone dust is a problem for the people living nearby quarries and dumping of stone dust is also a serious environmental issue. Exposure to such suspended particulate matter, as pollution experts call it, for long durations can cause serious respiratory problems,in humans.

Problem of river sand and its alternatives Depletion of river sand materials due to the overuse of the river sand material in concrete has led to environmental concerns and hence becoming costlier day by day. The deep pits dig in the river bed effects the ground water level and erode the banks and nearby land. Due to excessive use of river sand, the construction industries may expect a serious shortage of sand in the near future and seeking for alternatives. Ekanayaka et al (2007) have reported that there may be potential alternatives for river sand found near shore marine sand, dune sand, land based sand, offshore sand, quarry dust and manufactured sand. Aggarwal et al (2007) have observed that bottom ash can be recommended as substitute for river sand. It was used for construction in all over the world due to the its easy availability, ease of extraction, environmental impact and cost.

Shanmugavadivu et al. (2008) have reported that concrete mix designs were prepared with stone dust as fine aggregates and various grades of concrete were prepared and tested. Due to use of stone dust, the fine aggregate content was increased and simultaneously the coarse aggregate content was reduced. The water cement ratio and the cost of the concrete were reduced with increased proportions of fine aggregate.

Many researchers have reported that various properties of concrete can be improved by using stone dust along with some additives and admixture. Karthikeyan and Ponni (2007) have observed that the sand was replaced by stone dust and used as filler material in flyash based bricks with lime, and gypsum. Safiuddin et al (2007) also have worked on the partial replacement of sand with quarry dust in concrete containing fly ash/silica fume and the concrete having sand replaced by stone dust by 20% replacement by weight , cement has been replaced by 10% flyash and 10% by silica fume by weight. It was found that stone dust as fine aggregate improved the workability in terms of slump without affecting the quality of concrete. The compressive strength, dynamic modulus of elasticity and also the initial surface absorption were observed marginally increased. Joseph et al (2012) have also investigated the complete replacement of conventional river sand with the various combination of lateritic sand and stone dust in structural characteristics of concrete. Norazila and Kamarulzaman (2010) have found the properties of foam concrete was enhanced by sand replacement with stone dust up to 30% They have further reported that the compressive and flexural strength of foam concrete with stone dust were nearly 40% higher than the control foam concrete.

Binici et al. (2008) Use of limestone fines (upto 7-10%) in manufactured sand lower the abrasive loss due to an increase in compressive strength. However, any higher fines content than 10% reduced the abrasion resistance of concrete.

Al-Akhras et al.(2010) he studies Compressive strengths gain was recorded upto 15% substitution, for moist and auto-clave curing conditions. The reason behind the strength gain was presence of higher lime content of slurry mixes

Silva et al.(2013) define Different proportion of quarry sand on three concretes prepared with granite sand, basalt sand and river sand. Addition of marble sand led to reduction in the strength.

3. Conclusion

In the present work, the main emphasis was given to explore the effect of waste materials such as SGBA and SD on the various properties of concrete when used singly or in combination. Various aspects like materials characterizations through XRF, SEM/EDS studies along with the elemental mapping are described and covered briefly for samples under study

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