A REVIEW PAPER ON THE EXPERIMENTAL INVESTIGATION ON THE USE OF BAGASSE ASH IN THE CONSTRUCTION OF LOW VOLUME TRAFFIC ROADS

Irfan Ahmad Najar[1], Dr. Devinder Sharma[2] Er. Munish Kumar[3]

[1] M-Tech Scholar, Civil Engineering Deptt; SRMIET, Bhurewala, Ambala, Haryana, India.
[2] Director, Civil Engineering Deptt; SRMIET, Bhurewala, Ambala, Haryana, India.
[3]Assistant Professor, Civil Engineering Deptt; SRMIET, Bhurewala, Ambala, Haryana, India.

Abstract - *This paper summarizes the ongoing researches about the experimental investigation on the use of bagasse ash in the construction of low volume traffic roads. The main focus of this research was to improve the transport industry so as to result in greater economy and mobility of goods and services by developing economic roads and also to utilize the various agro-wastes in the construction industry to result in suitable waste management for environmental susceptibility and eco-conservation. in this case sugarcane bagasse ash(an agro-waste) is being utilized for the Construction of low volume traffic roads(village roads, city street roads and other arterial roads).*

***Key Words*: Sugarcane bagasse ash, Coarse and Fine aggregate, cement, Water bound Maccadam and Wet Mix Maccadam.**

1. INTRODUCTION

As we know that the roads are the life-line of every nation. A country's road network should be efficient in order to maximize economic and social benefits. Roads are an integral part of the transport system. They play a significant role in achieving national development and contributing to the overall performance and social functioning of the community. It is acknowledged that roads enhance mobility, taking people out of isolation and therefore poverty. Roads play a very important role in the socio-economic development of the country. The road transport industry is the backbone of strong economies and dynamic societies.

The road transport industry is indeed instrumental in interconnecting all businesses to all major world markets, driving trade, creating employment, ensuring a better distribution of wealth and uniting mankind. It plays a crucial role in the daily economic and social life of industrialized and developing countries alike. An important part of the road transport industry's story is sustainable progress.

Due to the above mentioned advantages, the road transport has become very popular and its share is constantly increasing. It is therefore legitimate and indispensable to safeguard an industry that is vital to economic growth, social development, prosperity and ultimately peace and which plays a crucial role in everyone's life in industrialized and developing countries alike by meeting the demand for the sustainable mobility of both people and goods.

But very less has been achieved in this sector because in the road transport sector energy planning has a special significance as transport is the second largest consumer of energy. As we know that due to limited availability of natural resources and rapid urbanization, there is a shortfall of conventional building construction materials. Thus the funds required for the construction of roads also increase. These financial constraints hamper the development of a developing nation like India. Also energy consumed for the production of conventional building construction materials pollutes the air, water and land. The growth of transport not only leads to pressure on limited availability of non-renewable energy resources but also gives rise to broader environmental issues. Moreover, the various processes for the production and processing of cement, bitumen, fine and coarse aggregate require a lot of energy and production of harmful gaseous and chemical wastes into the environment. As the demand for transport services rise, it leads to increased use of scarce land resources and contributes to the atmospheric pollution in a big way. The massive constructions release enormous amount of pollutants to the atmosphere and studies reveal that the pollutants from the construction industry are more harmful than the pollutants from any other segment. But on the other hand, there is a large production of agricultural wastes such as rice husk ash, wheat straw ash, hazel nutshell, fly ash, cork and sugarcane bagasse ash. Agriculture industry is the largest industry in India as more than 70% of Indian population is dependent on it. It is observed that in India more than 600 MT wastes have been generated from agricultural wastes-(2010).

Sugarcane is largely produced in the states of Punjab, Haryana, Uttar Pradesh and Tamil Nadu. The state of Uttar Pradesh is called the "Sugar Bowl" of India. A large number of sugarcane processing industries are located in these areas. But a large quantity of wastes called as bagasse is produced from these sugarcane processing industries as shown in figure 1.2 (a).

Fig. 1.1(a): Sugarcane bagasse

As production of sugar cane is more than 1500 million tons in the world and in India about 10 million tons of sugarcane bagasse ash is treated as a waste material.

These roads can be constructed in those areas where there is availability of sugarcane bagasse. In Uttar Pradesh and Haryana, there is a large scale cultivation of sugarcane and thus the sugarcane bagasse can be easily procured to be used in the construction of low volume traffic roads.

The fibrous residue (about 40–45%) of sugarcane after crushing and extraction of its juice is known as "bagasse". The bagasse is reused as fuel in boilers for heat generation which leaves behind 8–10% of ash, known as Sugar Cane Bagasse Ash (SCBA) which is treated as waste and unutilized. Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses and 25% of lignin. The use of sugarcane bagasse as bio fuel or burning in open fields has posed a great environmental threat of polluting air, water, etc. Even after strict restrictions by the government of these above said states, there is no end to field fires as people only want to get rid-off these bulky and huge wastes. During rains these wastes begin producing highly offensive gases, thereby again causing nuisance. The smoke produced also causes invisibility. It can therefore be advantageous to use it in the construction of pavements to mitigate the disposal problem as well as to minimize the use of natural aggregate (sand) and binding material (cement, bitumen), so as to construct the low volume economic road pavements.

LITERATURE REVIEW

Various studies have been carried out in the recent past on the use of sugarcane bagasse in the development of modified concrete. These studies reinforce the view of using this vast bulky waste in the construction of pavements. The various findings in this field are as tabulated below:-

Test for Aggregates for concrete, New Delhi: Bureau of Indian Standards; IS: 2386 (Part-III)-(1963) [1] these tests revealed the various properties of fine and coarse aggregates. It described the various properties of aggregates like shape, size, moisture content, permeability and specific gravity etc. On the basis of specific gravity comparison of bagasse ash and Ordinary Portland Cement (OPC), it is found suitable to replace the binding material of normal concrete with bagasse ash partially.

American Society for Testing and Materials, ASTM C33 (1978) [2] discussed the properties of various aggregates and sub base strata. Chemical properties like chloride action, carbon content and other organic constituents of various agro materials were discussed. On comparison of above properties, it was justified that certain proportion of fine aggregate can be substituted in normal concrete with suitable proportion of agro wastes like SCBA.

Mr. Lavanya M.R et al. (1980) [3] studied the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash. The feasibility of using sugarcane bagasse ash in a finely grounded state, as partial replacement for cement in conventional concrete is examined. The tests were conducted as per Bureau of Indian Standard (BIS) codes to evaluate the stability of SCBA for partial replacement up to 30% of cement with varying Water Cement (W/C) ratio. They showed that addition of SCBA results in improvement of strength in all cases and as per the results obtained. It was concluded that bagasse ash can increase the overall strength of concrete when used up to 15% cement replacement level with W/C ratio of 0.35.

Modani, Vyawahare, Mageswari and Vidivelli, Shafana (2013) [4] have conducted the work regarding tensile strength test of agro-waste based concrete in accordance with IS 5816: 1999 (Indian Standard) and observed that bagasse ash increased the tensile strength with an optimum replacement of fine aggregate by bagasse ash by 10%. They found that if the percentage of fine aggregate replacement is increased more than 10%, the strength of the concrete gets reduced.

Shafana T and Venkatasubramani R (2014) [5] studied the various mechanical properties of concrete with partial replacement of fine aggregate with bagasse ash. They found the various characteristics of bagasse ash like specific gravity and fineness modulus and values were satisfying as per the guide-lines of IS 2386 part-3 (Indian Standard, 1963) and part-1 (Indian Standard, 1963b) respectively. Findings revealed that the concrete is having suitable workability by using bagasse ash and therefore no need to use an admixture.

Mr. H.S. Otuoze et al. (2015) [6] had investigated on characterization of Sugar Cane Bagasse Ash (SCBA) and Ordinary Portland Cement (OPC) blends in concrete. The SCBA was obtained by burning Sugar Cane Bagasse (SCB) between 600-700 degrees Celsius. The sum of percentages of SiO_2, Al_2O_3 and Fe_2O_3 is 74.44%.For strength test , mix ratio of 1:2:4 was used and OPC was partially replaced with 0% ,5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% by weight in concrete. Compressive strength values of hardened concrete were obtained at the ages of 7, 14, 21 and 28 days. Based on the tests conducted, it can be concluded that SCBA is a good pozzolanic material for concrete cementation and partial blends of it with OPC could give good strength development and other engineering properties in concrete. An optimum of 10% SCBA blends with OPC could be used for reinforced concrete with dense aggregate. Higher blends of 15% and up to 35% of SCBA with OPC are not acceptable. The values fell short of meeting requirements.

M.Vijaya Sekhar Reddy and I.V.Ramana Reddy (2012) [7] studied the behaviour of High Performance Concrete (HPC) which is being the most used type of concrete in the construction industry. They replaced cement with Supplementary Cementing Materials (SCM) like fly ash, silica fume and SCBA. The mix design adopted was M_{60}, cubes were casted and cured for 90 days in 5% HCl (PH=2), NaOH, $MgSO_4$ and Na_2SO_4 solutions.

They concluded that there was a considerable increase in service life of the concrete structures and reduction in heat of hydration by using the supplementary cementing materials in concrete. They observed that the maximum and minimum percentage of reduction in strength of concrete when concrete was replaced with fly ash were 12.64% and 1.92%.

Rukzon S and Chindaprasirt P (2012) [8] checked the utilization of bagasse ash in high strength and light weight concrete. They found the concrete to be light weight with greater strength at 18% replacement of ordinary Portland cement.

Mr. G. Siva Kumar et al., (2013) [9] had studied the preparation of bio-cement using sugar cane bagasse ash. In this study they had used SCBA as partial replacement in Ordinary Portland Cement (OPC) by 10% weight. Compressive strength tests of the sample were carried out and reported that the cementitious material in sugar cane bagasse ash is responsible for early hydration. The pozzolanic activity of bagasse ash results in formation of more amount of C-S-H.

Objectives and Scope of Study

The main objectives of the proposed experimental study is as discussed below-

- To study the physical properties of SCBA modified concrete.
- To arrive at a mix design review for modified concrete using IS code method.
- To study the workability of a fresh sample of this concrete.
- To study the different strengths of hardened concrete such as compressive strength of concrete samples at 7 and 14 days.
- To compare the workability and various strengths for different percentage substitutions of cement and sand with sugarcane bagasse ash.
- Economical design of low volume traffic road pavement tiles of different shapes and sizes by using SCBA.

CONCLUSION

Following conclusions have been drawn based on the present study:

Sugarcane bagasse ash modified concrete performed better when compared to ordinary concrete up to 20% for cement replacement and 10% of sand replacement in ordinary concrete.

Increase of strength in paver blocks is mainly due to presence of high amount of silica in sugarcane bagasse ash. These pavements are unaffected by the spillage of oil from vehicles and are ideal for bus stops, bus depots and parking areas.

As far as the costs are concerned, it is estimated that the amount required per kilometre length of flexible pavement is Rs.90,10,000 and the cost of interlocking bagasse ash paver blocks road is Rs.68,93,000 per kilometre. The construction of road using bagasse ash paver blocks seems to be more cost effective than the conventional flexible pavement by 23.50%.

Block pavement does not need in-situ curing and so can be opened to traffic soon after completion of construction.

The design life of bagasse ash paver blocks road is high when compared to conventional flexible pavement and also the maintenance of bagasse ash paver blocks road is easy when compared to flexible pavement.

The occurrence of damage is less in bagasse ash paver blocks road and it is easy to remove and rectify the road with less amount. The digging and reinstatement of trenches for repairs to utilities is easier in the case of block pavement. Since the blocks are prepared in the factory, they are of a very high quality, thus avoiding the difficulties encountered in quality control in the field.

Concrete block pavements restrict the speed of vehicles to about 60 km per hour, which is an advantage in city streets and intersections. The block pavements are ideal for intersections where speeds have to be restricted and cornering stresses are high.

Unlike concrete pavements, block pavement does not exhibit very deterioratory effect due to thermal expansion and contraction, and are free from the cracking phenomenon. Use of permeable block pavement in cities and towns can help replenish depleting underground sources of water, filter pollutants before they reach open water sources, help reduce storm water runoff and decrease the quantum of drainage structures.

Apart from these things, bagasse ash is a readily available waste material and is also an eco-friendly material. The design life of bagasse ash paver blocks road is 20 years, whereas design life of flexible pavement is only 10 years. So utilization of the waste material sugarcane bagasse ash is advantageous as a replacement of cement or fine aggregate in the preparation of concrete paver blocks.

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