EXPERIMENTAL INVESTIGATION ON PAVER BLOCKS WITH PARTIAL REPLACEMENT OF CEMENT WITH SUGARCANE BAGASSE ASH

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ABSTRACT: Concrete Paving blocks are ideal materials on footpaths for easy laying, aesthetic look and finish. It was found that rapid deterioration occurred on pavers and blocks became unserviceable within few years of its utility. The application of paver blocks has extended to the traffic areas and due to movement of vehicles, the formation of cracks on the paver blocks. By considering this as a matter of grave concern to the serviceability of paver blocks and with the aim of manufacturing durable as well as serviceable paver blocks. An attempt is made by partially replacing cement with sugarcane bagasse ash in paver blocks. The strength and durability characteristics study is to be carried out in order to analyse the suitability of such paver block in practical.

Keywords: Sugarcane Bagasse Ash, Industrial Waste, Compression Strength

1. INTRODUCTION

1.1 BAGASSE ASH

The fibrous residue of sugarcane after crushing and extraction of its juice, known as 'bagasse', is one of the largest agriculture residues in the world. Literature illustrates the versatility of sugarcane residue usages; through its conversion inclusive but not limited to paper, feed stock and biofuel. The utilization of these waste materials in the manufacture of concrete provides a satisfactory solution to some of the environmental concerns and problems associated with waste management. Agro wastes such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolanic materials for the development of blended cements. Few studies have been reported on the use of bagasse ash as partial cement replacement material in respect of cement mortars. In this project, the effects of bagasse ash as partial replacement of cement on strength and durability properties of hardened concrete paver blocks are studied.

Fig. 1 – BAGASSE ASH

EFFECTS AND ADVANTAGES OF SUGARCANE BAGASSE ASH

Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste as a source of raw materials for construction industry. This waste utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. Therefore, it is possible to use sugarcane bagasse ash as cement replacement material to improve the quality and reduce the cost of construction materials such as mortar, concrete pavers, concrete roof tiles and soil cement interlocking block. There are wide ranges of paving options that can be used. In this project, the major construction material "cement" is being replaced with a readily available and cheaper material from the sugar industry wastes called "bagasse ash". By using this, there is also scope for an effective wastes reduction technique and it also improves the strength property of normal concrete blocks. Also, the surface tends to be more durable and allows a year-round mobility to all types of low volume traffic. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement and the results proved to be beneficial. The tests results indicate that bagasse ash is an effective mineral admixture, with 20% as optimal replacement ratio of cement. Partial replacement of cement by sugarcane bagasse ash increases workability of fresh concrete; therefore, use of super plasticizer is not necessary. The density of concrete decreases with increase in sugarcane bagasse ash content, therefore low weight concrete is produced in the society with waste materials. The rates of blending is reduced and better of-shutter finish is possible without affecting the aesthetics. Improved long term strength and durability performance is observed by replacing cement partially with bagasse ash. The compressive strength tends to be less at the early stage but increases at later stage, meaning that the bagasse ash can be used as an effective replacement material for cement. In this study the attempt is made to study the use of bagasse ash in production of paver block to design the low volume traffic road.

2. BASIC TEST RESULTS:

1	Normal Consistency Of Cement	34%
2	Specific Gravity Of Cement	2.88
3	Initial Setting Time Of Cement	35 Min
4	Specific Gravity Of Bagasse Ash	2.51
5	Specific Gravity Of Course Aggregate	2.60
6	Fineness Modulus Of Course Aggregate	2.89

3. Mix Design for Paver Bocks:

Grade designation = M40

Type of cement = 53

Max. nominal size of aggregate = 10 Max. cement content = 450kg/m^3 Workability = 25mm

Target strength for mix proportioning:

Fck^1 = fck +1.65(S).

= 48.25 N/mm^2. Approximate air content

Nominal max size of aggregate = 10mm Entrapped air (%) = 1.5

Selection of water cement ratio Nominal size = 10mm

IS10262:2019 for 48.25N/mm^2 of 53 grade cement is 0.38

But extreme exposure condition w/c ratio is 0.4 0.38<0.4

Hence OK.

Selection of water content

From Table 4, water content = 208kg.

Water content = 214.24kg.

Calculation of cement content

Water cement ratio = 0.38

Cement Content =564kg/m^3.

564 > 360 kg/m^3 Hence OK.

Proportioning of volume of coarse aggregate and fine aggregate content

Nominal size = 10mm

From Table 5, the proportionate volume of coarse aggregate corresponding to 10mm aggregate and fine aggregate (zone-2) for water cement ratio of 0.50 = 0.50

In present case water cement ratio is 0.38.

Volume of coarse aggregate for the water cement ratio of 0.38 = 0.50+0.024 = 0.524

Volume of fine aggregate content = 0.476 **Mix Calculations**

Total volume = 1m^3.

Volume of cement = (Mass of cement/ Specific gravity of cement) *(1/1000)

= 0.1958m^3.

Volume of water = 0.2142m^3. Volume of all in aggregates = a-(b+c)

= 0.59m^3

Volume of fine aggregates = 748.59kg Therefore,

Cement = 564kg/m^3.

Coarse aggregate = 812.59 kg/m^3. Fine aggregates = 748.59 kg/m^3. Water = 214.24 kg/m^3.

Total ratio = 1:1.32:1.44.

Fig. 2 – Conventional concrete cubes

Fig. 3 – Compressive strength test of conventional concrete cubes.

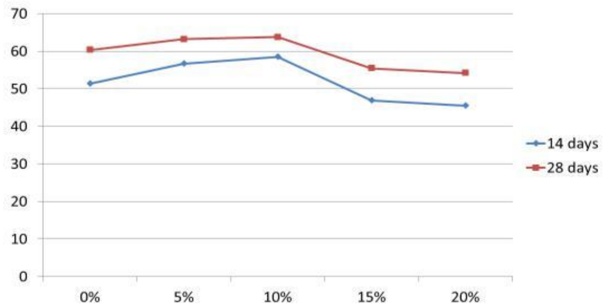
4. Test result On Conventional Concrete:

Sl no	Sample	Weight of cube (kg)	Load (KN)	Compressive Strength (N/mm²)
1	Cube - 01	8.260	610	27.11
2	Cube - 02	8.310	670	29.78
3	Cube - 03	8.375	710	31.56

5. Test result On Paver Blocks:

Sl No	% Replacement	14 Days Result	28 Days Result
1	0%	51.38 N/mm²	60.35 N/mm²
2	5%	56.74 N/mm²	63.21 N/mm²
3	10%	58.55 N/mm²	63.79 N/mm²
4	15%	46.94 N/mm²	55.44 N/mm²
5	20%	45.51 N/mm²	54.21N/mm²

6. RESULTS



Compressive strength v/s percentage of replacement

Fig. 4 – Casting of paver blocks without replacement of sugarcane bagasse ash.

Fig. 5 – Casting of paver blocks with replacement of sugarcane bagasse ash.

x-axis: Compressive strength

y-axis: Replacement of sugarcane bagasse ash in percentage.

As per the result obtained, there is a increase in compressive strength of paver blocks with replacement of sugarcane bagasse ash for 5% and 10% when compared to 0% replacement.

The increase in replacement of sugarcane bagasse ash for 15% and 20% there is a decrease in compressive strength of paver blocks. Therefore, up to 10% of replacement of sugarcane bagasse ash can be used and it is economical to use.

CONCLUSIONS

In addition to the reduction in cost, another advantage of using bagasse ash paver block pavement is the design life. For flexible pavement the design life is only 10 years whereas the design life is 20 years in case of bagasse ash paver block pavement.

The maintenance of bagasse ash paver block pavement shall be far easier when compared to conventional flexible pavement, as only the particular damaged block has to be removed and re-laid with new one. This enormously contributes to the economy factor by reducing the overall investments in pavements in the long run.

The usage of bagasse ash leads to far lesser environmental hazards than conventional concrete, which leads to reduce the pollution and global warming.

Increase of strength in paver blocks is mainly due to presence of high amount of silica in sugarcane bagasse ash.

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

As the blocks are prepared in factory, they are of very high quality, thus avoiding the difficulties encountered in quality control in field.

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