Experimental Study of Manufacturing of Cement Concrete Pavement Tiles by Partial Replacement of Cement with Bagasse Ash

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Abstract— Ordinary Portland cement is recognized as a major construction material throughout the world. A huge shortage is created in most of the construction materials especially cement, resulting in steady increase of price. Moreover cement industry creating environmental problem by emission of CO2 during manufacturing of cement. There are lots of environmental impacts of cement on our ecology. With increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are ecofriendly and contribute towards waste management. The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical, environmental, and technical reasons. One of the agro waste sugar cane bagasse ash (SCBA) which is a fibrous waste product obtained from sugar mills as byproduct. Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapour. On the other side Sugar cane bagasse ash generated in sugar mill creating environment issue as most of the part is used as a land fill. Ordinary Portland cement (OPC) is partially replaced with finely sugarcane bagasse ash. It mainly contains aluminum ion and silica. Sugarcane Bagasse Ash was obtained by burning of Sugarcane at 600 to 800 degree Centigrade and the Bagasse Ash were then ground until the particles passing the 150 micron. This waste, utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control as industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cementing materials (SCMs). In this, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 10%, 15%, 20% and 25% by weight of cement were prepared for M30 grade Concrete pavement tiles. The tests to be conducted on tiles like such as compression strength, water absorption and abrasion.

Keywords: Cement Concrete Pavement Tiles, Cement, Sugar Cane Bagasse Ash

I. INTRODUCTION

Ordinary Portland cement is the most extensively used construction material in the world.

Since the early 1980's, there has been an enormous demand for the mineral admixture and in future this demand is expected to increase even more. Also in this modern age every structure has its own intended purpose and hence to meet this purpose modification in traditional cement concrete has become essential. Cement which is one of the ingredients of concrete plays a great role, but it is most expensive. Therefore requirements for economical and more environmental-friendly cementing materials have extended interest in other cementing material that can be used as a partial replacement of the Ordinary Portland cement.

Portland cement is the conventional building material that actually is responsible for about 5% - 8% of global CO2 emissions. This environmental problem will most likely be increased due to exponential demand of Portland cement. Portland cement industry is investigating alternatives to produce green building materials. This situation has led to the extensive research on concrete resulting in mineral admixture to be partly used as cement replacement to increase workability in most structural application. If some of raw material having similar composition can be replaced by weight of cement in concrete tile then cost could be reduced without affecting its quality. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. Concrete plays a significant role in the construction of structures around the world .According to Construction Materials Concrete is a composite material obtained by mixing cement, sand, gravel and water. A concrete mix can be considered to consist of two main parts, aggregates (sand and gravel) and cement paste (water and cement). Concrete is the key material used in various types of construction, from the flooring a hut to a multi-storied high rise structures form pathway to airport runway, from an underground tunnel and deep sea platform to high-rise chimneys and Towers. Concrete is one of the versatile heterogeneous materials, civil engineering has ever known. With the advent of concrete civil engineering has touched highest peak of technology. Concrete is a material with which any shape can be cast and with equal strength or rather more strength than the conventional building stones. It is the material of choice where strength, permanence, durability, impermeability, fire resistance and abrasion resistance are required. Cement concrete is one of the seemingly simple but actually complex materials. The properties of concrete mainly depend on the constituents used in concrete making. The main important material l used in making concrete is cement, sand, crushed stone and water. Even though the manufacturer guarantees the quality of cement, it is difficult to produce a fault proof concrete. It is because of the fact that the building material is concrete and not cement.8The properties of sand, crushed stone and water, if not used as specified, cause considerable trouble in concrete. Control and methods of placing also plays the leading role on the properties of concrete. Agro wastes are used in construction material. Agro wastes such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolonic materials for the development of concrete.

II. LITERATURE REVIEW

A review of previous research works were done to accomplish the objectives of this project.

Many researchers have studied the compressive strength for the cement replacement with Pozzolonic material. Based from R.C.Valore 1954, the first comprehensive about cellular concrete was presented by Valore in 1954 that was summarizing about the composition, properties and function of cellular concrete. The Romans used a primal mix for their concrete. In there have small gravel and coarse sand that have been mixed with hot lime and water, and sometime also consist of animal blood. To trim down shrinkage, they used horsehair. The historical also have been proven from the states of Assyrians and Babylonians that used clay as the bonding.

III. METHODOLOGY

Cement concrete chequered tiles are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square and round blocks of different dimensions with designs for interlocking of adjacent tile blocks. The raw materials required for manufacture of the product are Portland cement and aggregates which are available locally in every part of the country. Cement concrete tiles and paving blocks find applications in pavements, footpaths, gardens, passenger waiting sheds, bus-stops, industry and other public places. The product is commonly used in urban areas for the above applications. Hence, the unit may be set up in urban and semi-urban areas, near the market. A lot of face-lift is being given to roads, footpaths along the roadside. Concrete paving blocks are ideal materials on the footpaths for easy laying, better look and finish. Whereas the tiles find extensive use outside the large building and houses, lots of these materials are also used in flooring in the open areas of public offices and commercial buildings and residential apartments. Concrete is composed of cement and aggregates combined with water. It is the most widely used construction material has several desirable properties like high compressive strength, stiffness and durability under usual environmental factors. At the same time concrete is brittle and weak in tension. Plain concrete has two deficiencies, low tensile strength and a low strain of fracture. These shortcomings are generally overcome by reinforcing concrete. A strong stone-like mass is formed from a chemical reaction of cement and water. The concrete paste is plastic and can be moulded into any form or to welled to produce a smooth surface. Hardening of concrete starts immediately after mixing, but precautions are taken to avoid rapid loss of moisture. An excess of water, however, produces a concrete that is more porous and weaker. The quality of the paste formed by the cement and water largely determines the character of the concrete. Proportioning of the ingredients of concrete is referred to as designing the mixture, and for most structural work the concrete is designed to give compressive strengths of 15 to 35 MPa. Normally the full hardening period of concrete is at least 7 days. Gradual increase in strength takes place and maximum strength is achieved at 28days.

The raw materials required for the chequered concrete tiles in the present work are:

1) Cement
2) Coarse Aggregate
3) Water
4) Sugarcane Bagasse Ash
5) Chemicals (drying purpose)
6) Pigments (for colour of tile)
7) Birla white (for colour mixing)

– Basic tests on cement:
- Fineness off cement
- Consistency
- Initial and final setting time
- Specific gravity of cement

– Tests on coarse aggregates:
- Specific gravity
- Bulk density
- Fineness modulus

– Tests on sugarcane bagasse ash:
- Specific gravity
- Finenes moduless

IV. EXPERIMENTAL WORK

The following table shows the quantity of cement; fine aggregate, coarse aggregate, water and bagasse ash for 0%, 5%, 10%, 15%, 20% and 25% replacement of cement with bagasse ash. The following shows the representation of mixes:

1) The T0 represents the standard concrete mix consisting of cement, quarry dust, coarse aggregate and water.
2) The T1 represents the concrete mix consisting of cement replaced with 10% of bagasse ash.
3) The T2 represents the concrete mix consisting of cement replaced with 15% of bagasse ash.
4) The T3 represents the concrete mix consisting of cement replaced with 20% of bagasse ash.
5) The T4 represents the concrete mix consisting of cement replaced with 25% of bagasse

1	Standard Consistency (%)	32
2	Initial Setting Time	134 minutes
3	Final Setting Time	292
4	Fineness (by sieving)(%)	2.50
5	Specific Gravity	3.15

Table 1: Properties of Cement

S.NO	PROPERTY	VALUE
1	SPECIFIC GRAVITY	2.74
2	BULK DENSITY (LOOSE)	1379Kg/m3
3	FINENESS MODULUS	8.772

Table 2: Physical Properties of Coarse Aggregate:

FINENESS TEST ON SCBA SIEVE SIZE	PASSING WEIGHT%	RETAINED WEIGHT(gm)	CUMULATIVE WEIGHT
2.36mm	97	30	1000
1.18mm	89	60	970
600µ	80	110	910
300µ	50	300	800
150µ	5	450	500
90 µ	1	40	50
Pan	0	10	10

Table 3: Properties of Bagasse Ash:

V. RESULTS

A. Wet Transverse Strength

S.NO	Tile	Percentage of mix	Wet transverse
1	Tile 1	0	3.12
2	Tile 2	10	3.43
3	Tile 3	15	3.62
4	Tile 4	20	3.68
5	Tile 5	25	2.99

B. Perpendicularity:

S.No	Tile	% of Mix	As Per Is Code	Examined Value in (mm)			
			VALUES	Side 1	side 2	side 3	side 4
1	Tile 1	0%	Not <3mm	2	2	3	2
2	Tile 2	0%	Not <3mm	1	2	2	1
3	Tile 3	0%	Not <3mm	2	2	1	2
1	Tile 1	10%	Not <3mm	2	2	3	2
2	Tile 2	10%	Not <3mm	1	2	2	1
3	Tile 3	10%	Not <3mm	2	2	1	2
1	Tile 1	15%	Not <3mm	1	1	1	2
2	Tile 2	15%	Not <3mm	1	1	2	1
3	Tile 3	15%	Not <3mm	2	1	1	2
1	Tile 1	20%	Not <3mm	1	2	2	1
2	Tile 2	20%	Not <3mm	2	1	2	1
3	Tile 3	20%	Not <3mm	0	1	2	1
1	Tile 1	25%	Not <3mm	1	2	2	1
2	Tile 2	25%	Not <3mm	1	2	1	2
3	Tile 3	25%	Not <3mm	2	1	1	2

C. Straightness:

S.No	Tile	% of mix	As per is code	Examined values in (mm)			
			values	Side 1	side 2	side 3	side 4
1	Tile 1	0%	Not <3mm	2	2	3	2
2	Tile 2	0%	Not <3mm	1	2	2	1
3	Tile 3	0%	Not <3mm	2	2	1	2
1	Tile 1	10 %	Not <3mm	2	2	3	2
2	Tile 2	10 %	Not <3mm	1	2	2	1
3	Tile 3	10 %	Not <3mm	2	2	1	2
4	Tile 1	15 %	Not <3mm	1	1	1	2
5	Tile 2	15 %	Not <3mm	1	1	2	1
6	Tile 3	15 %	Not <3mm	2	1	1	2
7	Tile 1	20 %	Not <3mm	1	2	2	1
8	Tile 2	20 %	Not <3mm	2	1	2	1
9	Tile 3	20 %	Not <3mm	0	1	2	1
10	Tile 1	25 %	Not <3mm	1	2	2	1
11	Tile 2	25 %	Not <3mm	1	2	1	2
12	Tile 3	25 %	Not <3mm	2	1	1	2

D. Water Absorption:

S.no	Tile	% of mix	As per is code	Examined values in (mm)			
			values	Side 1	side 2	side 3	side 4
1	Tile 1	0%	Not <3mm	2	2	3	2
2	Tile 2	0%	Not <3mm	1	2	2	1
3	Tile 3	0%	Not <3mm	2	2	1	2
4	Tile 1	10 %	Not <3mm	2	2	3	2

5	Tile 2	10 %	Not <3mm	1	2	2	1
6	Tile 3	10 %	Not <3mm	2	2	1	2
7	Tile 1	15 %	Not <3mm	1	1	1	2
8	Tile 2	15 %	Not <3mm	1	1	2	1
9	Tile 3	15 %	Not <3mm	2	1	1	2
10	Tile 1	20 %	Not <3mm	1	2	2	1
11	Tile 2	20 %	Not <3mm	2	1	2	1
12	Tile 3	20 %	Not <3mm	0	1	2	1
13	Tile 1	25 %	Not <3mm	1	2	2	1
14	Tile 2	25 %	Not <3mm	1	2	1	2
15	Tile 3	25 %	Not <3mm	2	1	1	2

VI. CONCLUSION

1) The amount of concavity and convexity which is related to the flatness of tile surface did not exceed 1 mm.
2) In the perpendicularity test the longest gap between the arm of the 'square' and the edge of the tiles did not exceed 2 percent of the length of the edge
3) In the straightness test the gap between the thread and the plane of the tile did not exceed 1 percent of the length of the edge.
4) When tested according to the procedure laid down, the average percent of water absorption shall not exceed 10.
5) The percentage of water absorption has been gradually decreased in the tile which the bagasse ash has been replaced with 10%
6) When tested according to the procedure laid, the average wet transverse strength shall not be less than 3 N/mm2.
7) The wet transverse strength has been increased in the tile in which the bagasse ash has been replaced with cement by 20%

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