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Effect on Compressive Strength of Interlocking Tiles Upon Replacing Cement and Aggregate by Bagasse Ash, Lime and Demolished Concrete

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Abstract: ***This research paper describe the effect on compressive strength of interlocking titles, in which cement is a binding material, a substance used in construction that sets and hardens and can bind other materials together. It is widely used in construction with great advantages but cement with its wide range of properties has several disadvantages as well. Manufacturing of cement causes ill effect on environment at all stages of process. These include emissions of airborne pollution in many forms such as dust, gas, noise and vibration. Usually manufacturing of cement causes emission of greenhouse gas carbon dioxide to 5% in cement structures to 8% in case of roads in cement. Cement manufacturing releases CO2 in atmosphere both directly and indirectly. Directly when Calcium Carbonate is heated, producing lime and carbon dioxide and also indirectly through emission of energy. The cement industry produces up to 5% of global manmade CO2 emission. The production of Portland cement is not only costly and energy intensive, but it also produces large amounts of carbon emissions. The production of one ton of Portland cement produces approximately one ton of CO2 in the atmosphere. The productive use of waste material represents a means of alleviating some of the problems of solid ash, lime and demolished concrete.***

Keywords: ***Cement, Greenhouse Gas, Calcium Carbonate, CO2 Emission, Binding Material.***

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. 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. Construction is the major part of everyday life. It requires all the construction material which mainly includes cement and sand. Cement provides the basic strength to the building.

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The manufacturing of cement is a major issue as it involves pollution on a large level as well as cost of construction also increases. This cement can be replaced by a construction material called bagasse ash. Sand provides bulk strength and other properties to the building. Cement is a binding material, a substance used in construction that sets and hardens and can bind other materials together. It is widely used in construction with great advantages but cement with its wide range of properties has several disadvantages as well. Manufacturing of cement causes ill effect on environment at all stages of process.

These include emissions of airborne pollution in many forms such as dust, gas, noise and vibration. Usually manufacturing of cement causes emission of greenhouse gas carbon dioxide to 5% in cement structures to 8% in case of roads in cement. Cement manufacturing releases CO2 in atmosphere both directly and indirectly. Directly when Calcium Carbonate is heated, producing lime and carbon dioxide and also indirectly through emission of energy. The cement industry produces up to 5% of global manmade CO2 emission. The production of Portland cement is not only costly and energy intensive, but it also produces large amounts of carbon emissions. The production of one ton of Portland cement produces approximately one ton of CO2 in the atmosphere. The productive use of waste material represents a means of alleviating some of the problems of solid Waste management. The reuse of wastes is important from different points of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the environment and it also helps to save and recycle energy production processes. Wastes and industrial by-products should be considered as potentially valuable resources merely awaiting appropriate treatment and application. Cement is a binding material, a substance that sets and hardens independently, and can bind other materials together. In ancient civilization, the binding materials were of traditional type such as jaggery, lead, jute, rice husk etc., now in modern civilization cement is main binding matrials. If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. For this reason sugarcane bagasse ash (SCBA) is one of the main byproduct can be used as mineral admixture due to its high content in silica (SiO2).

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. The project focuses on the reuse of industrial wastes as a part of building material to provide economical and strong interlocking tiles. Recent researches have shown that bagasse ash, the waste produced from sugarcane industry is rich in Cementous property. Use of it as a partial replacement of cement saves the cost of cement. Demolished concrete will be used in place of aggregates to provide economical replacement of aggregates. The most important product of the hydration reaction of cement is the Tricalcium silicate which is responsible for the gain of strength of cement. Bagasse as rich in silica combines with marble dust which contains lime combine with each other to form tricalcium silicate hence providing a suitable replacement of cement. Hence comparable results for the compressive strength are obtained with a considerable reduction in the cost of production. In this research paper section I contains the introduction, section II contains the literature review details, section III contains the details about methodology, section IV describe the result section V provide conclusion of this research paper.

II. RELATED WORK

Mrs.U.R.Kawade, 2013, 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 on waste reduction. One of the agro waste sugar cane bagasse ash (SCBA) which is a fibrous waste product obtained from sugar mills as by product. Juice is extracted from sugar cane then ash produced by burning bagasse in uncontrolled condition and at very high temperature. In this paper SCBA has been chemically and physically characterized and partially replaced in the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight of cement in concrete. The properties for fresh concrete are tested like slump cone test and for hardened concrete compressive strength at the age of 7, 28, 56 and 90 days. The test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement. The results show that the SCBA concrete had significantly higher compressive strength compare to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Although, the optimal level of SCBA content was achieved with 15.0% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of super plasticizer is not essential. Prashant O Modania, 2012, Today researches all over the world are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. Sugar-cane bagasse is one such fibrous waste-product of the sugar refining industry, along with ethanol vapor. Bagasse ash mainly contains aluminum ion and silica. In this paper, untreated bagasse ash has been partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength and sorptivity. The result shows that bagasse ash can be a suitable replacement to fine aggregate. On the basis of experimental investigation carried out, the following conclusions can be drawn.

i) The fraction of fine aggregates i.e. 10% to 20% can be effectively replaced with a bagasse ash (untreated) without a considerable loss of workability and strength properties.
ii) The compressive strength results represent that, the strength of the mixes with 10% and 20% bagasse ash increases at later days (28 days) as compared to7 days that may be due to pozzolanic properties of bagasse ash.

The Sorptivity test result shows that the sorptivity coefficient increases with increase in percentage of bagasse ash which indicate more permeable concrete that is due to porous nature of SCBA and the impurities in it. iv) In its purest form the bagasse ash can prove to be a potential ingredient of concrete since it can be an effective replacement to cement and fine aggregate.

R.Srinivasan, 2010, 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. Sugar cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. This waste product (Sugar-cane Bagasse ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminum ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased.

Apurva Kulkarni, 2013, Utilization of industrial and agricultural waste products in the industry has been the focus of research for economic, environmental, and technical reasons. Sugar cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. Huge quantity of ash which is a waste product, available at very negligible rate. It causes the chronic lung condition pulmonary fibrosis more specifically referred to as bagassios. In this paper Bagasse ash can be utilized by replacing it with fly ash and lime in fly ash bricks. Trial bricks of size (230x100x75) mm were tested with different proportions of 0%, 10%, 20%, 30%, 40%, 50% and 60% with replacement of fly ash and 0%, 5%, 10%, 15% and 20% with replacement of lime.

These bricks were tested in Compression test and Water absorption test as per Indian Standards. The aim of this research was to make economical and green bricks to maintain environmental balance, and avoid problem of ash disposal. T. S. ABDULKADIR, 2015, This research evaluates the suitability of SCBA as a partial replacement for cement in concrete productions. Total weight of 34.7kg of sugarcane bagasse (SCB) was obtained and burnt at 7000C. A total of 2.71kg of SCBA was obtained after passing the residual through 45µm sieve, standard size of ordinary portland cement (OPC). Chemical test was conducted on SCBA to evaluate its percentage composition. It was then used to replace OPC by weight in ratio of 0%, 10%, 20% and 30%. Total of 48 pieces of 100mm concrete cubes of design mix ratio 1:1.66:2.77 were prepared. The cubes were tested at 7, 14, 21 and 28days of curing ages for density and compressive strength. The results of chemical test showed that SCBA has pozzolanic properties having met ASTM- 595 (1985) with total sum of silica, alumina and ferric composition of 80.55%. The results showed a decrease in concrete density with increase in % replacement of SCBA. Average compressive strength of 26.8N/mm2 was obtained for control specimens at 28days (i.e. 0% SCBA) while 22.3, 20.1 and 17.3N/mm2 compressive strength at 28days were obtained for 10%, 20% and 30% replacement respectively. Pozzolanic activity index (PAI) of 83.2%, 75% and 64.5% were obtained. This showed that only 10% and 20% replacement of cement by weight of SCBA satisfied ASTM-595(1985) specification for PAI. It was concluded that SCBA is a low weight material and 10% replacement of SCBA has the highest PAI. Also, 10% and 20% replacement of SCBA with compressive strengths of 22.3N/mm2 and 20.1N/mm2 are recommended for reinforced concrete. Ajay Goyal, 2014, With the ever increasing demand and consumption of cement and in the backdrop of waste management scientists and researchers all over the world are always in quest for developing alternate binders that are environment friendly and contribute towards sustainable management. Sugarcane bagasse (SCB) which is a voluminous by-product in the sugar mills when juice is extracted from the cane. It is, however, generally used as a fuel to fire furnaces in the same sugar mill that yields about 8-10% ashes containing high amounts of un-burnt matter, silicon aluminum, iron and calcium oxides. But the ashes obtained directly from the mill are not reactive because of these are burnt under uncontrolled conditions and at very high temperatures. The ash, therefore, becomes an industrial waste and poses disposal problems. For obtaining amorphous and reactive sugarcane bagasse ash (SCBA), several trials were conducted to define optimum burning time and temperatures. SCBA used in this study was obtained by burning SCB at 600o C for 5 hours (James and Rao, 1986) under controlled conditions and its physical, chemical, and mineralogical characterization was done to evaluate the possibility of its use as binder partially replacing cement in the mortar applications.

Prakash Chavan, 2015, Soil is the foundation material which supports loads from the overlying structure. Soil is the most widely used material in a highway system, either in its natural form or in a processed form. Also all pavement structures eventually rest on soil foundation. The construction cost can be considerably decreased by selecting local materials including local soils for the construction of the lower layers of the pavement such as the sub- base course. The formation of undulations corrugations, up heaving and rutting are generally attributed to the poor sub grade conditions. In the present study the soil sampling was done on Kavadimatti village Bagalkote district as per IRC recommendations. This soil was classified as CH as per Indian Standard Classification System (ISCS). Different dosages of blast furnace slag i.e. 3%, 6%, 9% and 12% were used to stabilize the expansive soil. The performance of Bagasse Ash stabilized soil was evaluated using physical and strength performance tests namely; plasticity index, specific gravity, compaction, California bearing ratio (CBR) and Unconfined compressive strength Test (UCS). These tests were conducted in order to evaluate the improvement in strength characteristics of the subgrade soil. Hence use of such advanced materials in road construction can prove efficient in increasing the strength of soil and in turn reduce the project cost. From the results, it was observed that the basic tests carried out proved significant after the addition of Bagasse Ash. Furthermore California bearing ratio (CBR) value improved from 1.16% to 6.8 %. And the unconfined compressive strength of specimens increased from 93KN/m^2 to 429 KN/m^2.

III. METHODOLOGY

3.1 Flow Diagram

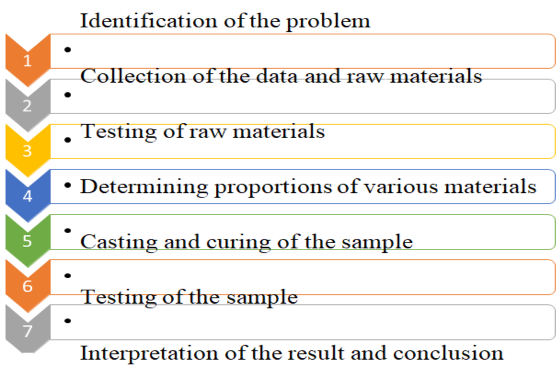

Figure 1. Flow diagram

3.2 Collection and use of Materials

3.2.1 Portland Cement

It is a predetermined and homogeneous mixture of materials principally containing lime (CaO) and silica (SiO_2) with a smaller proportion of Alumina (AL_2O_2) and iron oxide (Fe_2O_3). Ordinary Portland cement (OPC) is by far the most important cement. On the basis of strength of the cement at 28 days when tested as per IS 4031-1988, the Ordinary Portland Cement was categorised into three category, i.e. 53grade, 43grade and 33grade. If the compressive strength of cement after 28 days is more than 33 N/mm^2 it is called 33grade cement, if the compressive strength of cement is more than 43 N/mm^2, it is called 43grade cement and so on. But at the factory the original strength gained by these cements is much greater than the BIS specification.

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Figure 2 Ordinary Portland cement

TABLE 1: Characteristics of Cement Provided By Manufacturer

S no.	CHARACTERISTICS	Obtained Value
1.	Ratio of percentage of alumina to that of iron oxide Min	0.66
2.	Insoluble residue, percent by mass, *Max*	4.0
3.	Magnesia, percent by mass, *Max*	6.0
4.	Total sulphur content calculated as sulphuric anhydride (SO3),percent by mass, Max	3.5
5.	Loss on ignition, percent by mass, Max	5.0
6.	Chloride content, percent by mass, Max	0.1
7.	Alkali content	0.05

3.3 Impact Test

Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure. The impact value of a material can also change with temperature. Generally, at lower temperatures, the impact energy of a material is decreased. The size of the specimen may also affect the value of the Izod impact test because it may allow a different number of imperfections in the material, which can act as stress risers and lower the impact energy.

Figure 3. Impact testing

3.4 Crushing Value Test

Crushing Value Test is important to test to be performed on aggregate. The strength of aggregate parent rock is determined by preparing cylindrical shape specimens of size 25 mm diameter and 25 mm height. This cylinder is subjected to compressive stress. Depending on the type of parent rock gives the different crushing value of aggregate as a compressive strength varying from a minimum of about 45 MPa to a maximum of 545 MPa. It is a fact that parent rock compressive strength does not exactly indicate the strength of aggregate in concrete. For this reason assessment of the strength of the aggregate is made by using a sample of bulk aggregate in a standardized manner. This testing method is known as an aggregate crushing value test.

Figure 4. Crushing value test

3.5 Material Test

3.5.1 Fineness index

- Fineness test is done to check the grained or size of particle for fine construction of a building or any structure by performing sieve test procedure.
- The fineness of sample or sizes of the particle is measured by passing sample through the 90 micron IS sieve. The portion of sample whose grain size is larger than the specified mesh size thus determined.

3.5.2 Consistency Value

- This test is conducted to determine how much water needs to be added to obtain sufficient workability. The consistency value also gives us an idea of the water cement ratio for the mixture.
- Standard consistency of a sample paste is defined as that consistency which will permit a vicat plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 33-35 mm from top of the mould.

3.6 Cubes Testing

Sample from fresh concrete shall be taken as per Indian standard code IS 2911 and sample shall be made, cured and tested at specified number of 7,14 and 28 days in accordance with IS 516. The strength parameters are based to 28 days' strength. Test at other age shall be performed, if specified. For compressive strength test interlocking tiles of size 270mm×100mm×50mm were made. Test was done on the hydraulic testing machine. Compressive strength is defined as resistance of concrete to axial loading. Cubes are placed in the machine and after tightening its wheel start button is pressed as pressure is begin to apply. Reading of meter is note down when cracks are there on cubes. Compressive strength is calculated by following formula:

Compressive Strength = P/A

Where A = area of interlocking tiles P = load

Figure 5 : Compression Testing Machine

IV. RESULTS

4.1 Test results of Cement

The cement used was Ordinary Portland Cement of 53 Grade (OPC-53) by manufacturer Jaypee Cement. The test results are as under:

TABLE 2: Test Results of Cement

S. N	Name of Experiment	Normal Range	Obtained Value			
			Sample 1	Sample 2	Sample 3	average
1	Consistency of Cement	26 to 33%	39%	37%	40%	38%
2	Fineness	Should not exceed 10%	5%	6%	4%	5%
3	Initial setting time	30 min	25min	29 min	27 min	27 min
4	Final setting time	600 min	625min	645min	635 min	635 min

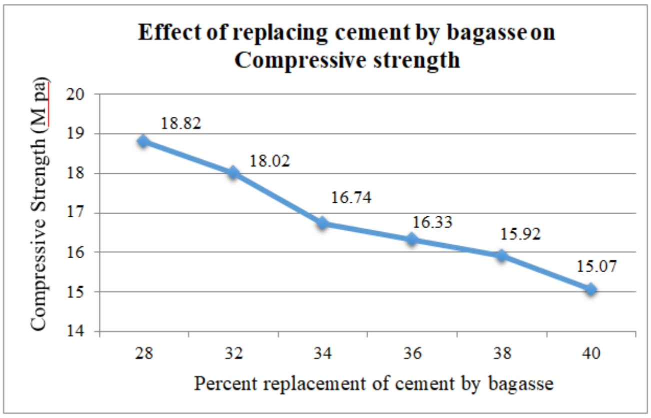

Figure 6 Effect of replacing cement

V. CONCLUSION

- The Manufacturing The strength of the interlocking attained was 72.28 percent of the standard specimen with using only 30 percent of the cement used in standard specimen.
- The cost of best interlocking was Rs. 4.6095 as compared to standard specimen which costs approximately Rs.8.39.
- Hence the cost of interlocking is almost halved and the strength attained is 2.28 percent of standard specimen.

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