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Study of BFRC Concrete Using Partial Replacement of Cement with Oyster Shell Ash (OSA) And Fly Ash

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A B S T R A C T

One of the materials that is most frequently utilized in the building industry is concrete. Sand, cement, water, and aggregate make up the majority of the materials in concrete mix. River sand and regular Portland cement are typically utilized as fine aggregate and cement in concrete mixes. This problem can be solved by using fly ash (FA) and oyster shell ash (OSA) in place of cement. Concrete uses the fibers to solve specific deficiencies. Steel, basalt, glass, polypropylene, and carbon fibers are the most widely used types of fibers. By adding more mineral admixtures, the workability of ternary mixes containing fly ash and oyster shell ash (OSA) increased and surpassed that of concrete that was closely related. The binary mix with a higher % substitution of fly ash and oyster shell ash (OSA) had a lower workability and a higher workability, respectively. Properly constructed blends show

Keywords: concrete. Sand, cement, water, aggregate, fly ash and oyster shell ash (OSA)

1. Introduction

Here Concrete is a product obtained artificially by hardening of the mixture of cement, Sand, gravel and water in predetermined proportions. When these ingredients are mixed, they form a plastic mass which can be poured in suitable moulds, called forms, and so on standing into hard solid mass. The chemical reaction of cement and water, in the mix is relatively slow and require time and favorable temperature for its completion. The time, known as setting time may be divided into three distinct phases. The first phase designated as time of initial set, requires from 30 minutes to about 60 minutes for completion. During this phase, the mixed concrete decreases its plasticity and develops pronounced resistance to flow. The second phase, known as final set, may vary between 5 to 6 hours after the mixing operation. During this phase, concrete appears to be relatively soft solid without Surface hardness. Conventional concrete is modified by random dispersal of short discrete fine fibers of asbestos, steel, sisal, glass, carbon, poly-propylene, nylon, etc. Asbestos cement fibers so far have proved to be commercially successful. Fibers include synthetic fibers and natural fibers each of which lend varying properties to the concrete. The improvement in structural performance depends on the strength characteristics, volume, and spacing. Dispersion and orientation, shape and their aspect ratio (ratio of length to diameter) of fibers. A fiber-reinforced concrete requires a considerably greater amount of fine aggregate than that for conventional concrete for convenient handling. For FRC to be fully effective, each fiber needs to be fully embedded in the matrix, thus the cement paste requirement is more. For FRC the cement paste required ranges between 35 to 45 per cent as against 25 to 35 per cent in conventional concrete the behavior of fiber reinforced concrete (FRC).

2. Literature Review

Sasui Sasui, Gyuyong Kim, Jeongsoo Naa, Arievan Riessen ,Marijana Hadzima-Nyarko June 2021 This study incorporates fine waste glass (GS) as a replacement for natural sand (NS) in fly ash (FA) and/or -(OYSTER SHELL ASH (OSA)) based alkali activated mortar (AAm). Tests were conducted on the AAm to determine the mechanical properties, water absorption, apparent porosity and the durability based on its resistance to Na2SO4 5% and H2SO4 2% concentrated solutions. Whereas the microstructure and chemical composition of AAm was analyzed by SEM-EDX to support results obtained from the experimental tests. The study revealed that the effects of GS depends on the ratio of binders used to synthesize the mortar. For high FA/OYSTER SHELL ASH (OSA) mortar, an increase in strength and reduction of porosity was observed with increasing GS up to 50 wt%. For lower FA/OYSTER SHELL ASH (OSA) mortar, increasing GS up to 100 wt%, increased strength and decreased porosity. The lower porosity attained with the incorporation of GS, improved the resistance of mortar to Na2SO4 solution thus increasing durability.

Anant Kumar, Nupoor Dungan , Anurag Wahane International June 2021 Fly ash and Ground Granulated Burnt Slag (OYSTER SHELL ASH (OSA)) are chosen mainly based on the criteria of cost and their durable qualities. Not only this, Environmental pollution can also be decreased to some extent because the emission of harmful gases like carbon monoxide & carbon dioxide are very limited. This paper presents a laboratory investigation on optimum level of Fly ash and OYSTER SHELL ASH (OSA) as a partial replacement of cement to study the strength characteristics of concrete as compare to conventional concrete (CC) of M25 grade. Portland cement was partially replaced by 10%, 20% & 30% of OYSTER SHELL ASH (OSA) i.e. (GC1, GC2, and GC3) and Fly ash by 10%, 20% & 30% as FC1, FC2 & FC3. It is observed that replacement of cement in any proportion lowers the compressive strength of concrete as well as delays its hardening. This provides an environmentally friendly method of fly ash and OYSTER SHELL ASH (OSA) disposal.

Zhuo Tanga,Wengui Lia Vivian,W.Y.Tamb and Zhiyu Luoa March 2020 By harnessing the benefits from both construction and demolition waste recycling and geopolymer binders, geopolymeric recycled aggregate concrete (GRAC) can contribute to the green and eco-friendly construction material products. In this study, the compressive behavior of GRAC based on fly ash and slag was experimentally investigated under both quasi-static and dynamic loadings. Quasi-static compressive tests were performed by using a high-force servo-hydraulic test system, while dynamic compressive tests were carried out by using a Ø80-mm split Hopkinson pressure bar (SHPB) apparatus. The compressive properties of GRAC under dynamic loading, including stress-strain curves, energy absorption capability, and failure modes were obtained and compared with those under quasi-static loading. The results show that the compressive properties of GRAC exhibit a strong strain rate dependency.

K. Anupama Reddy, Venkata Ramesh Kode, Potharaju Malasani, Srikanth Satish Kumar Darapu October 2019 In recent years, the development of multi blended mix concrete has gained attention due to its multiple advantages and environmental friendliness. This paper has attempted to examine mechanical properties of Multi blended concrete of M30 grade made with micro silica and basalt fibers. To reduce the deleterious effects of the production of cement on the environment, concrete is being developed by substituting admixtures like OYSTER SHELL ASH (OSA) and Fly Ash in place of cement. Multi blended concrete developed with Fly ash and OYSTER SHELL ASH (OSA) showed depletion in the mechanical properties. Micro silica & Basalt fibers were added to this mix additionally to overcome this deficiency. Initially four series of mixes of multi blended concrete were developed with a composition of Fly ash 20% and OYSTER SHELL ASH (OSA) 30%, 40%, 50% & 60% as replacement of cement. For better performance, micro silica at 5% by weight of cement and Basalt fibers at 0.2% by volume of concrete were added. The mechanical properties such as Split tensile & Compressive strengths were studied at the age of 7 & 28 days. The results showed that M30 grade multi blended concrete can be achieved with 30% OYSTER SHELL ASH (OSA), 20% fly ash, 5% micro silica, 0.2% basalt fibers.

Akshay kumar Moogi, Swapnil Cholekar Aug 2018 In this experiment effect of fibers and supplementary materials on the strength of concrete for M30 grade have been studied by keeping the constant percentage of fibers and replacing 30% of the cement content by OYSTER SHELL ASH (OSA) and Flyash in concrete. Basalt Fibers used in this experiment. In this experiment 1.5% of total dosage of fiber content was fixed with Supplementary materials Flyash OYSTER SHELL ASH (OSA) in varying percentages i.e. 0%FA-OYSTER SHELL ASH (OSA), 100%FA-OYSTER SHELL ASH (OSA),25%FA-75%OYSTER SHELL ASH (OSA), 50%FA-50%OYSTER SHELL ASH (OSA) and 75%FA-25%OYSTER SHELL ASH (OSA) of total dosage (i.e.30%) by weight of cement. Cubes and Beams are casted to check the compressive & flexural strength of concrete. In this experiment it is also aimed to study the effect BFRC when subjected to sulphate attack. Here study cited on effect of sulphate on Basalt fiber reinforced concrete. Also checking the strength parameters compare the test results with sulphate and without sulphate attack. Results are taken after 90 days curing and 90 days of sulphate attack. The optimum supplementary material content while studying the strength parameters of all specimens is found 100%FA-0%OYSTER SHELL ASH (OSA).

Poornima M Reddy Dr. Shreenivas Reddy Shahapue Maneeth P D Brijbhushan S August 2017 The paper deals with the effects of addition of various proportions of polypropylene fibers on the properties of concrete. Main objectives of this experimental investigation is to characterize the selected mechanical properties of PPFRC and to study the effect of volume fraction of (PPF). The present dissertation work is carried out with M30 grade concrete with w/c ratio of 0.363. Cement is replaced by 20% of fly ash and 10% of OYSTER SHELL ASH (OSA). Polypropylene fibers are added by 0%, 0.50%, 1.00%, 1.50% & 2.00% of volume fraction. For all mixes compressive, split tensile, flexural tests are carried out and they are compared with conventional concrete.

S. Paulraj,Dr. N. Balasundaram,K. Sates Kumar,M. Dharshna Devi January 2017 Concrete is second most widely used material other than water, its more versatile but modern day engineering structures require more demanding concrete owing to the huge applied load on smaller area and increasing adverse environmental conditions. Many materials were studied as impregnation agents to concrete to enhance its quality, strength and durability, in this work we had tried to utilize Basalt fiber as a strength enhancement agent in Self compacting concrete to obtain higher strength values in tandem with good workability. Promising results were obtained in the self compacting nature by using simple admixtures such as VBA, workability agents etc. Rheological properties obtained suggested that the concrete is not only highly workable but also possess high durability and versatility. The SCC slump value varied from 620 to 760 mm with good compressive strength in the range of 25-32 N/mm2.

J. Guru Jawahar and G. Mounika 2016 The second most consumed product in the world is Cement. It contributes nearly 7% of the global carbon dioxide emission. Geopolymer concrete (GPC) is becoming a special type of more eco-friendly concrete alternative to Ordinary Portland Cement (OPC) concrete. This project mainly aims at the study of effect of class F fly ash (FA) and -(OYSTER SHELL ASH (OSA)) on the mechanical properties of geopolymer concrete (GPC) at different replacement levels (FA50-OYSTER SHELL ASH (OSA)50, FA25-OYSTER SHELL ASH (OSA)75, FA0-OYSTER SHELL ASH (OSA)100) using Sodium silicate (Na2SiO3) and sodium hydroxide (NaOH) solutions as alkaline activator. Specimens were cast and cured for different curing periods at ambient room temperature to determine the GPC mechanical properties viz. compressive, splitting tensile and flexural strength. Test results reveal that increase in OYSTER SHELL ASH (OSA) replacement enhanced the mechanical properties of GPC at all ages at ambient room temperature.

Anil Ronad , V.B.Karikatti, S.S.Dyavanal july 2016 Concrete is most used construction material. Construction industry uses most of the natural resources as it includes production of cement. It is the major contributing factor to the CO2 emission, causing global warming. An alternate to the OPC has been found out known as Geopolymer concrete. It uses industrial waste material such as fly ash and Oyster Shell Ash (OSA) instead of cement thereby decreasing impacts due to cement production. In this study both fly ash and OYSTER SHELL ASH (OSA) are utilized in making Geopolymer concrete. Alkaline solution used is comprises of sodium silicate (103 kg/m3) and Sodium hydroxide in the ratio of 2.5.sodium hydroxide of 10 molarity is used. Plain concrete is weaker in tension. Fibers are added to enhance the strength to the concrete to meet given serviceability requirements. Basalt fiber is considered a promising new material .it has good strength characteristics, resistance to chemical attack, sound insulation properties. It has wide range of applications like soil strengthening, construction of bridges,highways, industrial floors. In present study various proportions of basalt fibers added to the geopolymer concrete and compressive and split tensile strength of the different mixes were compared with the geopolymer concrete without basalt fibers. Fibers are added to the geopolymer concrete in the range of 0.5% to 2.5% at 0.5% increments. Compressive and tensile strength of different mixes compared with reference mix (0% fiber). From the results it is concluded that addition of basalt fibers at an optimum content to the geopolymer concrete can increase both compressive and tensile strength.

A.H.L.Swaroop, K.Venkateswararao, Prof P Kodandaramarao Jul-Aug 2013 Durability of concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of detoriation. It also includes the effects of quality and serviceability of concrete when exposed to sulphate and chloride attacks. Fly ash and Ground Granulated Burnt Slag (OYSTER SHELL ASH (OSA)) are chosen mainly based on the criteria of cost and their durable qualities. Not only this, Environmental pollution can also be decreased to some extent because the emission of harmful gases like carbon monoxide & carbon dioxide are very limited. In this paper our study is mainly

confined to evaluation of changes in both compressive strength and weight reduction in five different mixes of M30 Grade namely conventional aggregate concrete (CAC), concrete made by replacing 20% of cement by Fly Ash (FAC1), concrete made by replacing 40% of cement by Fly Ash (FAC2), concrete made by replacing 20% replacement of cement by OYSTER SHELL ASH (OSA) (GAC1) and concrete made by replacing 40% replacement of cement by OYSTER SHELL ASH (OSA) (GAC2).

Jia, Aruhan and Yan 2012 This paper presents a study of the carbonation process of concrete with different initial curing periods consisting of fly ash and -(OYSTER SHELL ASH (OSA)). Both are exposed in a natural indoor environment for 720 days and at accelerated conditions. The relationship between compressive strength and carbonation depth is analyzed. The factors affecting the carbonation of high-volume mineral admixture concrete in a natural environment and accelerated conditions are discussed using the orthogonal method. The factors include: water–binder ratio, content of mineral admixtures, total amount of cementitious materials and fly ash–slag ratio. The influence of different initial curing periods at early ages on carbonation depth is also reported. The results show that there is not always a linear rule between compressive strength and carbonation depth of high-volume mineral admixture concrete. Adequate curing at an early age can decrease the carbonation resistance of concrete significantly. For insufficiently cured concrete, the early stage before 56 days is the main developing stage of carbonation in a natural environment. An evident decrease of carbonation depth can be observed after exposure for 180 days and this will make the carbonated area turn to a red colour again when sprayed with phenolphthalein. In order to guarantee the excellent anti-carbonation ability of concrete in field structure, it is very important to ensure the initial curing time, except for restricting the water–binder ratio and the content of mineral admixtures.

K. Ganesh Babu, V. Sree Rama Kumar March 2000 The utilization of supplementary cementitious materials is well accepted because of the several improvements possible in the concrete composites and due to the overall economy. The present paper is an effort to quantify the 28-day cementitious efficiency of -(OYSTER SHELL ASH (OSA)) in concrete at the various replacement levels. It was observed that this overall strength efficiency of OYSTER SHELL ASH (OSA) Concretes can also be defined through a procedure adopted earlier for other cementitious materials like fly ash and silica fume. The overall strength efficiency was found to be a combination of general efficiency factor, depending on the age and a percentage efficiency factor, depending upon the percentage of replacement as was the case with a few other cementitious materials like fly ash and silica fume reported earlier. This evaluation makes it possible to design OYSTER SHELL ASH (OSA) concretes for a desired strength at any given percentage of replacement.

3. Problem Statement

1. The most important problems faced in reinforced concrete construction are the decay of reinforcing steel, which considerably affects the durability and life of concrete structures.
2. Normal concrete gives a very low tensile strength, restricted ductility and small amount of resistance to cracking. Internal small cracks lead to brittle failure of concrete. In this new generation civil engineering constructions have their own structural and durability requirements.
3. In this thesis has attempted to examine mechanical properties of M30 grade of concrete of made with basalt fibers. To reduce the deleterious effects of the production of cement on the environment, concrete is being developed by substituting admixtures like OYSTER SHELL ASH (OSA) and Fly Ash in place of cement.
4. Multi blended concrete developed with Fly ash and OYSTER SHELL ASH (OSA) showed depletion in the mechanical properties. Basalt fibers were added to this mix additionally to overcome this deficiency.
5. In this experiment 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash OYSTER SHELL ASH (OSA) in varying percentages i.e. 0% of fly ash and 100% of OYSTER SHELL ASH (OSA), 20% of fly ash and 80% of OYSTER SHELL ASH (OSA), 40% of fly ash and 60% of OYSTER SHELL ASH (OSA),20% of fly ash and 80% of OYSTER SHELL ASH (OSA), 100% of fly ash and 0% of OYSTER SHELL ASH (OSA) of total dosage (i.e.40%) by weight of cement. Results are taken as a Beams and Cubes are casted to check the flexural strength and compressive of concrete at 7 days and 28 days.

4. Materials Used

4.1 Cement

Cement is a well-known building material and has occupied an indispensable place in construction works. There are a variety of cements available in the market and each type is used under certain conditions due to its special properties. A mixture of cement and sand when mixed with water to form a paste is known as cement mortar whereas the composite product obtained by mixing cement, water, and an inert matrix of sand and gravel or crushed stone is called cement concrete. The distinguishing property of concrete is its ability to harden under water. The cement commonly used is Portland cement, and the fine and coarse aggregates used are those that are usually obtainable, from nearby sand, gravel or rock deposits. In order to obtain a strong, durable and economical concrete mix; it is necessary to understand the characteristics and behavior of the ingredients. Portland cement is defined as hydraulic cement, i.e. cement that not only hardens by reacting with water but also forms a water-resistant product. The ingredients of concrete can be classified into two groups, namely active and inactive.

4.2 Fine Aggregate

Sand or fine aggregate includes all particles which will pass through a 10-mm IS sieve. Natural sand is by far the most commonly used fine aggregate, though sometimes fine stone and gravel crushing are used when natural sand is not economically available. Sand may be further classified as fine, medium or coarse in accordance with its fineness modulus (FM) as given below:

1. Fine sand, FM 2.20 to 2.60

2. Medium sand, FM 2.60 to 2.90

3. Coarse sand, FM 2.90 to 3.20.

Grading – Particle size of fine combination is flexural in to four ones.

1. Zone I

2. Zone II

3. Zone III

4. Zone IV

4.3 Coarse Aggregates

Coarse aggregates are those which range from 10-mm size upwards to 80-mm maximum size, namely all material that is retained on a 10-mm IS sieve. Coarse aggregate may consist of natural picked gravel, crushed gravel, crushed stone and the like. Coarse aggregates also have to be graded from 10-mm up to the maximum size used on the job, usually 63-mm. The grading of aggregates varies with the mix desired. Coarse aggregate used should conform as nearly as possible to the grading limits indicated in Table 1.10 for its nominal size as per IS: 383-1970.

The maximum size of aggregate is conventionally designated by the sieve size on which is percent or more particles are retained. In general, larger the maximum aggregate size, the smaller will be the surface area per unit volume which has to be covered by the cement paste of a given water-cement ratio. Therefore, it may be economical to use as large a size of maximum aggregate as possible, provided of coarse, strength, workability and durability properties are satisfied.

4.4 Water

The purpose of water in concrete is three-fold. Water distributes the cement evenly so that every particle of the aggregate is coated with it and brought into intimate contact with other ingredients. It reacts chemically with the ingredients of cement; the reaction called hydration of cement, and brings about the setting and hardening of cement. Water also lubricates the mix and gives it the workability required to place and compact it properly. Cement requires about 25 to 50 percent of water for hydration. Additional water is required for the workability of concrete

This should be restricted since excess water makes the concrete weak. Finally curing of concrete with water pounding is a widely prevalent practice in the country.

Water used to mix concrete should be clean, free from oil, alkalies and acids, salts, sugar, organic material or other substances that may be deleterious to Crete and steel. In general, water that is fit to drink is good for concrete. From the durability point of view, chlorides and sulphates should be within the permissible limits, The permissible limits of chlorides and sulphates in the draft code have been made more stringent from durability considerations. The PH value for water shall not be less than 6.

4.5 Fly ash

The fly ash or pulverized fuel ash (PFA) is the residue from the combustion of pulverized coal collected by the mechanical dust collectors or electronic electrostatic precipitors or separators from the fuel gases of thermal power plants. Its composition varies with the type of fuel burnt, load on the boiler and type of separators, etc. like Portland cement, fly ash contains oxide of calcium, aluminum and silicon, but the amount of calcium oxide is considerably less. The carbon content in fly ash should be as low as possible, where as the silica content should be as high as possible.

Table 1 The chemical composition of fly ash

The principal constituents of fly ash are :	
(i) Silicon dioxide (SiO_2)	30 to 60 per cent
(ii) Aluminium oxide (Al_2O_3)	15 to 30 per cent
(iii) Unburnt fuel (Carbon)	upto 30 per cent
(iv) Calcium oxide (CaO)	1 to 7 per cent
(v) Magnesium oxide (MgO)	small amounts
(vi) Sulphur trioxide (SO_3)	small amounts

4.6 Oyster shell ash

There has been consistent report to recycle wastes including industrial by-products in order to accomplish a sustainable society through resources recycling. Oyster shell is a by-product of oyster farming, constituting approximately 90% of an entire oyster in a mass ratio, and hence generates a significant amount of waste . In coastal regions of oyster producing countries, a great quantity of shells including oyster shell has been being disposed rather than being recycled . In South Korea and other countries, disposal of the oyster shell requires transportation to a designated area since oyster shell is classified as an industrial waste by the waste control act. In this respect, illegal dumping and burying of oyster shell have been frequently observed raising critical social issues. Belated treatment of oyster shell waste results in various environmental concerns such as shortage of disposal area, significant disposal cost, door, disfigurement, and rainwater-induced coastal pollution . Against these backdrops, appropriate recycling of oyster shell waste is necessary to provide ancient and eco-friendly means of treating these wastes.

5. Conclusions

1. This thesis is aimed to study an experimental study on strength of basalt fiber reinforced concrete produced by partially replacing cement with oyster shell ash (osa) and fly ash. Based on the discussions of the experimental results, it can be summarized that.
2. The flexural & compressive strength of fly ash & oyster shell ash (osa) based multi blended concrete with basalt fibers were improved when compared with conventional concrete mix design m30.
3. Compressive strength of fly ash & oyster shell ash (osa) based multi blended concrete with basalt fibers increase in percentage of fly ash & oyster shell ash (osa) at 7 days. It followed the similar trend at 28 days except at 40% of oyster shell ash (osa) and fly ash (i.e.40% by weight of cement) increase in percentage with basalt fibers.
4. The basalt fiber reinforced multi blended concrete almost the same flexural strength as that of conventional concrete at 40% of oyster shell ash (osa) and fly ash (i.e.40% by weight of cement).

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