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Microstructure Analysis Of Cement Mortar On Partial Replacement Of Fine Aggregates By Industrial Wastes

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Abstract: ***The industrial wastes due to their high performance when blended with the building materials generated great interest in the field of structural engineering. Many industries are looking for the effective use of their industrial wastes. The applicability of bottom ash and green sand generated by industries as partial replacement of fine aggregates in cement mortar mix design is researched in this paper. Inorder to evaluate the effects of bottom ash and green sand admixtures on properties of cement mortar, the reference cement mortar without the admixtures is studied as well. The paper is also aimed to determine the optimum dose of the wastes to give a better performance. The influence of the admixtures on the mechanical performance is evaluated by measuring the compressive strength of the specimens. The analysis of the microstructure of the specimens is done by means of several techniques like X-ray diffraction method (XRD), Fourier Transform Infrared spectra analysis (FT-IR), Transmission Electron Microscopic method (TEM) and Acid attack test. The use of bottom ash and green sand as partial aggregate replacement in the composition of cement mortar also represents an alternative to final landfill disposal.***
Keywords: Bottom Ash, Green Sand, Partial Replacement, XRD, FT-IR, TEM, Acid Attack, Microstructure Analysis.

I. INTRODUCTION

The building industry is recognized as the largest consumer of natural resources and significant producer of waste. In order to preserve clean environment, there is a need for improvement of existing production technologies of building materials by transforming them into sustainable and environmentally friendly. The production of building materials has harmful effect on the living environment. Hence several ways are identified for saving the natural sources. The most important way widely applied in civil engineering for long years is to replace natural sources with secondary materials like wastes from other processes. Global growth in the production and manufacturing sectors leads to the accumulation and accelerating the output of industrial waste. It is found from the literature survey that many industrial wastes can be effectively used as the building materials.

In general, the demand of natural sand is quite high in developing countries facing shortage in good quality natural sand. The continuous extraction of the natural sand from the river bed causes several threats to the environment like lose of water retaining sand strata and vegetation, deepening of the river courses, bank slides, destruction of aquatic life and affecting agriculture due to lowering of underground water table. In past decade variable cost of natural sand used as fine aggregate increased the cost of construction. In this situation research began for inexpensive and easily available alternative to natural sand which resulted in the use of bottom ash and green sand as partial replacement of fine aggregate.

The principle purpose of the cement mortar is to adhesively bind together the individual units. It also provides protection against the penetration of air and water through the joints in a masonry assembly. Mortar also bonds the non masonry elements of an assembly such as joint reinforcement and ties. It also compensates for minor dimensional variations.The mortar joints also contribute to the architectural quality of the masonry assembly. The mortar prepared by partial replacement of fine aggregate with bottom ash and green sand showed better results on strength, durability and architectural properties. It also offers technical, economic and environmental advantages which are of great importance in the construction sector.

II. MICROSTRUCTURE ANALYSIS

Microstructure analysis focuses on the art and science of preparing, interpreting and analyzing microstructures in engineered materials to better understand the behaviour of the materials and their performance.

The analysis also examines the mechanical processes taking place in the specimen and the environmental behaviour of the material.

It involves the simple determination of certain parameters such as grain size or coating thickness through porosity and pore structure to full characterization of multi-component systems. It is done to know the performance, response to the environment and the failure mechanisms. It also helps to determine the unknown constituents in the cement mortar.

III. LITERATURE REVIEW

A. General

The following section deals with the comprehensive literature review regarding the papers published on the microstructure analysis of cement mortar by using various industrial wastes like bottom ash, green sand, fly ash, nanomaterials, geopolymers, marble powder and other materials. Several researches have been conducted on the cement mortar incorporated with industrial wastes regarding the load carrying capacity, failure mechanisms and other related parameters. Some of the literature have been reviewed and discussed.

B. Reviews On Literatures

RimvyadasKaminskas(2008),has experimentally made a study on the paper "The Effect of Pozzolano on the Properties of the Finest Fraction of Separated Portland Cement". The finest cement fraction samples were selected from the sleeve filters by grinding the quickly hardening Portland cement. Tripoli and Silica Fume were used as Pozzolanos. The samplesof 4 X 4 X 16 cm were casted with cement sand ratio of 1: 3 and the water cement ratio was maintained as 0.6. The tests like XRD, DTA and FT-IR were performed by using X-ray and DTA patterns and IR spectrum. The finer cement fraction provides the greater strength during the first days of hydration. Later, the compressive strength starts to decrease due to the growth of Ettringite crystals. The 28 days compressive strength of the sample reached over 32.5MPa.

RafatSiddique et al.,(2009),had experimentally made a study on "Effect of used-Foundry Sand on the Mechanical Properties of Concrete". The M30 grade concrete was made with a replacement of 10%, 20% and 30% of fine aggregate by foundry sand. Tests were done to determine the properties of fresh and hardened concrete. The compressive strength, split tensile strength, flexural strength and modulus of elasticity were determined for 28, 56, 91 and 356 days. It was found that the compressive strength, split tensile strength, flexural strength, and modulus of elasticity of concrete specimens increased with the increase in foundry sand contents. The increase in compressive strength varied between 8% and 19% depending upon UFS percentage and testing age, whereas it was between 6.5% and 14.5% for split tensile strength, 7% and 12% for flexural strength, and 5% and 12% for modulus of elasticity. The results of this investigation suggested that used-foundry sand could be very conveniently used as fine aggregate in making good quality mortar, concrete and other construction materials.

SaveriaMonosi et al., (2010), has experimentally studied the paper "Used Foundry sand in Cement Mortars and Concrete Production". The properties of mortars and concretes containing different dosages of used foundry sand (UFS) as partial replacement of sand were investigated. Both mortars and concretes were evaluated with respect to consistency of the fresh mixture and compressive strength of the hardened material. A low (10%) amount of used foundry sand does not change the mortar's performances. In the presence of higher additions a decreasing workability can be outlined, and so a higher dosage of superplasticizer is required in order to keep it constant.

Gurpreet Singh andRafatSiddique(2012),had made an investigation on "Effect of Waste Foundry Sand (WFS) as Partial Replacement of Sand on the Strength, Ultrasonic Pulse Velocity and Permeability of Concrete". Thenatural sand was replaced by 0%, 5%, 10%, 15%, and 20% of WFS by weight. The compression test and split tensile strength test were carried out to evaluate the strength properties of concrete at the age of 7, 28 and 91 days. Modulus of elasticity and ultrasonic pulse velocity test were conducted at the age of 28 and 91 days. Rapid Chloride Permeability test was performed on all five mix proportion at the age of 28 and 91 days. The partial replacement of sand with WFS upto 15% increased the strength properties of concrete. Inclusion of WFS decreased the chloride ion penetration in concrete, which indicates that concrete has become denser and impermeable. Hence WFS can be suitably used in making structural mortar and concrete.

Pavlik Z et al., (2012), has made astudy on "MSWI bottom ash as eco-aggregate in cement mortar design". The experimental results proved the potential applicability of applied Municipal Solid Waste Incineration bottom ash in cement based composites design. The admixture of MSWI bottom ash improved the compressive and bending strength of modified composites in comparison with the reference material. The application of MSWI bottom ash also limited the possible liquid water transport into the studied materials. On the other hand, the elastic mechanical properties decreased with the addition of bottom ash.

Xueying Li et al., (2013), has experimentally studied the paper "Mechanical Properties and Microstructure of Class C Flyash based geopolymer paste and mortar". In this paper, the compressive strength and microstructure for geopolymer pastes and mortars made

of Class C Flyash wereanalyzed. The compressive strength depends on the potential partial reaction of the surfaces of siliceous aggregates with the alkali silicate solution forming additional reaction products surrounding the aggregate particles and a highly dense and uniform binder aggregate interface. In XRD patterns, broad band diffraction peaks around 30 degrees of 2 theta show that gels have been formed in these samples.

Chow P L and SalimBarbhuiya(2014), has made a study on "Hydration and Microstructural properties of cement paste containing Nano and Microsilica". The influence of nano and microsilica addition on OPC pastes has been studied interms of hydration and microstructural properties. The XRD analysis showed that C-S-H and C-H of the control mix continued to increase with the age. Also there was significant decrease in the amount of Ettringite due to the transformation of calcium sulphoaluminate to calcium aluminate hydrate.

Karthikeyan B et al., (2014),has experimentally studied the paper "Microstructure Analysis and Strength Properties of concrete with Nano silica". This study reports part of experimental investigations on using nano sized mineral admixtures in concrete as a partial replacement of cement. The silica fume which is the mineral admixture used in this work was ground for 1 hour with varying quantities using planetary ball mill. On analyzing the results of grinding, it was observed that the grinding was effective in 1 hour and the size of micro-silica has reduced by 75.45% reaching nano size. Physical tests such as specific gravity, microstructure analysis using Scanning Electron Microscope (SEM), chemical composition identification by X-ray Fluoroscent (XRF) and crystalline check for silica using X-ray diffraction (XRD)were performed for samples of both unground and ground micro-silica. From the results, it is understood that cubes cast with 10% replacement of nano-silica for cement by weight are showing better strength performance.

Balg Abdullah Al Muhit et al., (2015), has made a study on "Effect of Microstructure on compressive strength of graphene oxide-cement composites". The mechanical properties of cement paste incorporating graphene oxide were investigated. The compressive strength test showed that high compressive strength was acquired in GOCC 0.55 samples. The heterogeneous nucleation of C-S-H was responsible for high strength of the specimens. The XRD analysis showed that smaller crystalline sizes of C-S-H and Portlandite were responsible for faster and numerous heterogeneous nucleation and higher strength.

Subramani T and Sumathi C (2015), has studied the paper "Experimental Investigation of Partial Replacement of Cement with Flyash and Sand with Bottom Ash and Glass used in concrete". The study was conducted to evaluate the strength characteristics of concrete with bottom ash and glass and flyash in concrete. The concrete mix design was done for M_{30} grade concrete. It is concluded that the compressive strength results at 7 days showed reduction in strength due to the slow action. The strength increases at 40 % flyash, 20% bottom ash and 30% glass. By using bottom ash, the cost of fine aggregate is also reduced.

IV. MOTIVATION STUDY FROM THE REVIEWED LITERATURE

The reviewed literature shows that the performance of the cement mortar specimens produced by introducing the industrial wastes like bottom ash and green sand depends on several factors like specific gravity, density, water absorption, chemical composition, size, porosity, permeability, environmental conditions, etc., Some of the literatures showed that the strength of the waste admixed samples decrease with the increase in bottom ash content. But due to the abundant availability of bottom ash and its increased strength at later ages, it can be used for the partial replacement of fine aggregate. The use of bottom ash of proportion 20% and use of green sand of proportion 15% was found to produce mortar and concrete of high durability and strength.The Super-plasticizer can be used to maintain the constant workability for all the mixes.

V. FURTHER POSSIBILITES

A. Fine aggregate can also be replaced with marble powder, copper slag and manufacturer sand instead of bottom ash and green sand.
B. Cement can be replaced by Metakaolin, Ground Granulated Blast furnace Slag (GGBS), Fly ash and Natural Steatite powder.
C. The Nano materials can also be used for the better performance and durability of the mortar and concrete specimens.
D. The thin sections can also be casted to know the physical properties of the mortar.

VI. RESULTS AND DISCUSSION

After having a detailed literature review, the following work was proposed. It is clear that lot of research work has been done in cement mortar specimens. In future it was to carry out an experimental investigation on mortar specimens in which the fine aggregates are partially replaced by industrial wastes.Totally four mixes are prepared in which a control mix without the inclusion of industrial wastes is also involved. The super-plasticizer is also added to the mix in order to maintain constant workability.

Fifteen specimens are required for each mix. The mix ratio of the mortar is 1:3. The bottom ash and green sand is replaced by varying the proportions of fine aggregate by 0%, 10%, 20% and 30%. The mix is prepared and then it is allowed to stand in the mould for 48 hours. It is then subjected to curing for 28 days. The microstructure analysis is then done on the specimens by using several techniques like XRD, FT-IR, TEM and Acid Attack test. The analysis is undertaken to determine the failure mechanisms and its intrusions.

REFERENCES

[1] Ahmed SoufianeBenosman, Mohamed Mouli, HamedTaibi, Mohamed Belbachir,YassineSenhadji, IliesBahlouli& David Houivet (2013), "Study on Chemical Resistance of PET Mortar Composites : Microstructure and Phase Composition changes", Scientific Research Journal.

[2] Balg Abdullah Al Muhit,Bou Hyun Nam, Lei Zhai and Joseph Zuyus (2015), "Effect of Microstructure on Compressive strength of graphene oxide-cement composites", Nanotechnology in construction.

[3] Chow P L and SalimBarbhuiya (2014), "Hydration and Microstructure properties of Cement paste containing Nano and micro-silica", Sustainable Solutions in Structural Engineering and Construction, ISBN 978-0-9960437-0-0.

[4] Dilip Kumar, Ashish Gupta and Sri Ram (2014), "Uses of Bottom Ash in the Replacement of Fine Aggregate for making Concrete", International Journal of Current Engineering and Technology, E-ISSN: 2277-4106, P-ISSN: 2347-5161.

[5] Dushyant and Bhimani R(2013), "Innovative Ideas for Manufacturing of the Green Concrete by Utilizing the Used Foundry Sand and Pozzocrete", International Journal of Emerging Science and Engineering (IJESE),ISSN: 2278-1684, PP: 46-49.

[6] Eknath P Saloke and Desai D B (2014), "Application of Waste Foundry Sand in Manufacture of Concrete", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), ISSN: 2278-1684, PP: 43-48.

[7] JanardhananTharrini and VenkatasubramaniRamasamy (2015), "Properties of Foundry sand, Ground Granulated Blast furnace Slag, and Bottom Ash based Geopolymers under ambient conditions", PeriodicaPolytechnica Civil Engineering, DOI; 10.3311/PPci.8014.

[8] Kadam M P and Dr. Patil Y D (2013), "Effect of Coal Bottom Ash as Sand Replacement on the Properties of Concrete with different w/c ratio", International Journal of Advanced Technology in Civil Engineering, ISSN: 2231-5721, Volume 2, Issue 1, 2013.

[9] Karthikeyan B, Sumanth, Harshavardhan, Rajasekharareddy A and Dhinakaran G (2014), "Microstructure Analysis and Strength Properties of concrete with Nano silica", International Journal of Chemtech Research, ISSN:0974-4290, Vol.6.No.5.

[10] Morsy M S, Alsayed S H &Aqel M (2010), "Effect of Nano Clay on Mechanical Properties and microstructure of Ordinary Portland Cement Mortar", International Journal of Civil and Environmental Engineering (IJCEE-IJENS), Vol. 10, No. 01.

[11] Nivetha D, Srividhya S, Dharmar S (2016), "Review on Mechanical Properties of Cement Mortar enhanced with Nanoparticles", International Journal of Science and Research, ISSN:2319-7064.

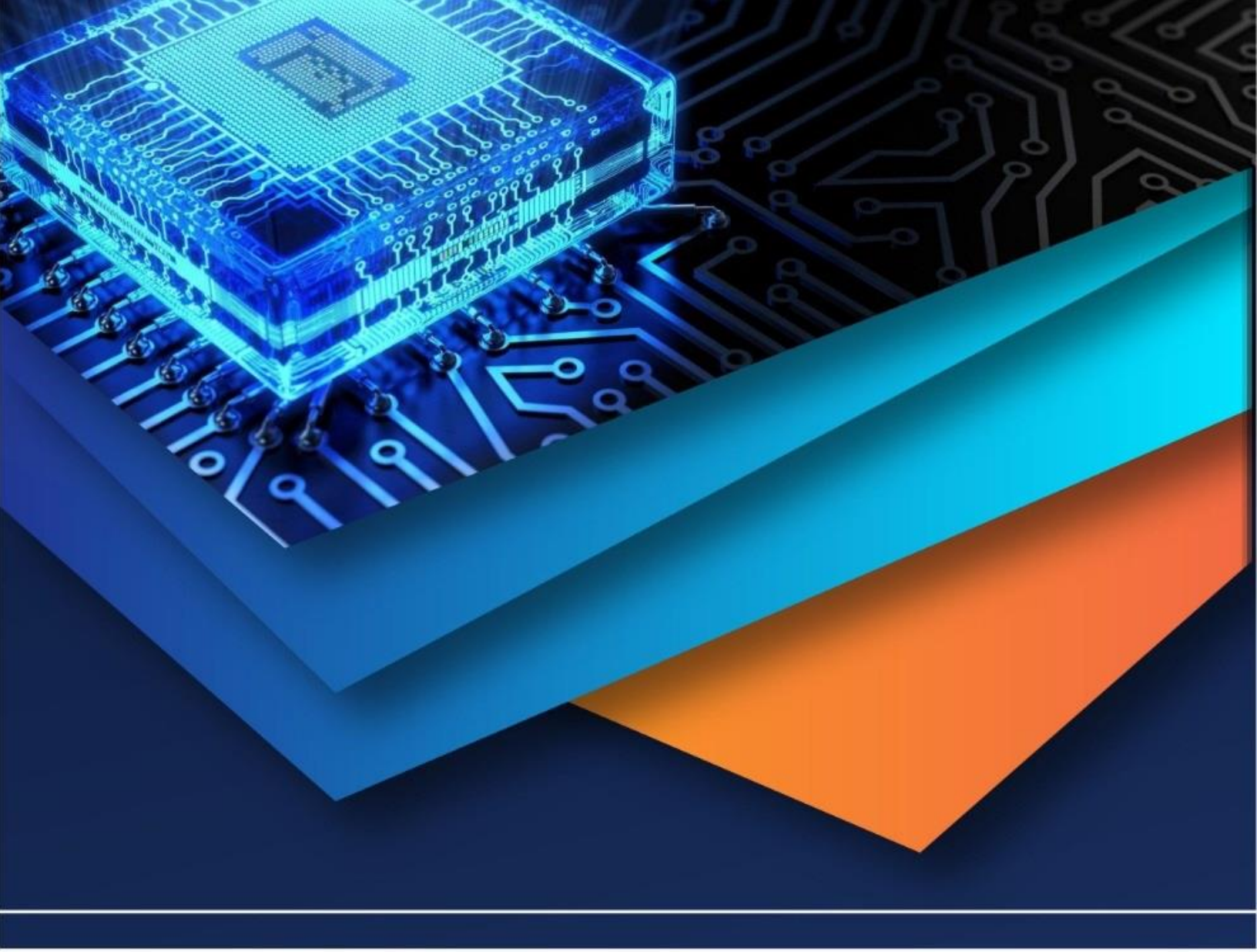
[12] Pavlik Z, Keppert M, Pavilkova M, Fort J, Midhalko O and Corny R (2012), "MSWI Bottom Ash as eco-aggregate in Cement Mortar design", WIT Transactions on Ecology and the environment, Vol.165, ISSN:1743-3541.

[13] Sahana R (2013), "Setting time, Compressive strength and Microstructure of Geopolymer paste", International Journal of Innovative Research in Science, Engineering and Technology, Volume 2, Special Issue 1, ISSN: 2319-8753.

[14] SaveriaMonosi, Daniela Sani and Francesca Tittarelli (2010), "Used Foundry Sand inCement Mortars and Concrete Production", The Open Waste Management Journal, Volume 3, 2010, 3, 18-25,.

[15] Subramani T and Sumathi C (2015), "Experimental Investigation of Partial replacement of Cement with Flyash and Sand with Bottom Ash and Glass used in concrete", International Journal of Application or Innovation in Engineering and Management, Volume 4, Issue 5,ISSN:2319-4847.

[16] Xueying Li, Xinwei Ma, Shoujie Zhang and LnzuZheng (2013), "Mechanical Propertiesnand Microstructure of Class C FLyash based geopolymer paste and mortar", Materials 2013, 6, 1485-1495, doi:10.3390/ma6041485.



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