International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June 2018 www.irjet.net p-ISSN: 2395-0072

Partial Replacement Of Cement With Different Additives In Concrete

Gaurav N. Nagavkar[1], Dr. Sandeep L.Hake[2]

[1]M.E. Civil Structure, Sr. Engineer, Parin Construction, Pune, Maharashtra, India.
[2]Associate Professor, Dr. V. V. P. College of Engineering, Ahmednagar, Maharashtra, India

---

Abstract - *Due to development in construction industries demand & need for cement is increasing day by day, which is main cause of pollution. In the manufacturing process of cement, emission of CO_2 is more but also consumes significant amount of natural resource. Main problem is disposal of waste material as well as industrial by-product like from thermal power plant. As a matter of fact the current tendency in the world is to find new materials at lower cost which can guarantee better performances during their incorporations in the concrete. This study consist the development and properties of concrete by partial replacement of additives, Carbon Black Powder & Calcium* Sulphate*, Rice Ash Husk with Cement. An attempt was made using these materials, as filler, desiccant and which imparts the enhanced properties of concrete by partial replacement of cement with different percentage ratio. Concrete cubes and cylinders are cast depending on percentage ratio and it's effect is studied at different ages by performing tests on concrete specimens. A comparison is made with test results to conventional concrete only to arrive at valid conclusion.*

Key Words: Concrete, Fine Additives, Carbon Black, Gypsum, Sunla Gypsum, Rice Husk Ash.

1. INTRODUCTION

Concrete is a mixture of naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. Cement is occupied second place as most used material in the world after water. The rapid production of cement creates big problems to environment. First environment problem is emission of CO_2 during the production process of the cement. The CO_2 emission is very harmful which creates big changes in environment. According to the estimation, 1 tone of carbon dioxide is released to the atmosphere when 1 tone of ordinary Portland is manufactured. As there is no alternative building material which totally replace the cement. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Substantial energy and cost savings can result when industrial by products are used as a partial replacement of cement. Fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, High Reactive Meta kaolin, silica fume are some of the pozzolanic materials(additives) which can be used in concrete as partial replacement of cement. In this project the PET as a partial replacement of fine aggregate and Carbon Black as a partial replacement of Cement.

After studying different journals it suggest that additives or mineral admixtures may enhance the concrete properties. Further studies establish the behavior of carbon black powder and calcium sulphate particularly effecting the parameters, such as strength, setting time, soundness, consistency, shrinkage, bleeding, heat of hydration etc. with respect to properties of materials used in it like aggregate, sand, cement, water, and other admixtures.

A study is made to minimize the pores present using carbon black powder, a waste from rubber industry as filler and calcium sulphate powder. Due to their extreme small size they can fill the pores thereby it is expected to achieve the benefits by Increasing in density of concrete thereby increase in strength and resistance to atmospheric attack. Also Decrease in permeability of concrete.

To suggest the optimum percentage of addition above additives in concrete number of cubes with different percentage were cast. The strength properties were again studied and its results are compared to conventional concrete.

2. LITERATURE REVIEW

V. Leskeviciene, I. Sarlauskaite, D. Nizeviciene, et. al. [1] While dehydrating gypsum with additives at the temperatures of 800 °C and 900 °C the influence of alkali additives on both the crystalline structure of anhydrite and properties of anhydrite binder was investigated. The industrial and household wastes including other lowcost materials were used as additives. Having heated them with gypsum the anhydrite with alkali activation properties was obtained. The properties of such substances were evaluated using the methods of chemical, diffractive X-ray scanning and scanning electron microscopy (SEM) analyses. Some additives, e.g. 5 % ground glass waste, were found to increase crystal agglomerate formation of anhydrite binder,

accelerate the hydration process of anhydrite and double the compressive strength of hydrated samples compared to samples without additives.

B.Padma priya1,Mrs.K.Pandeeswari [2] The New trends of construction methods sometimes cause harmful effects on environment though they are effective to mankind. Reuse of waste materials acts eco friendly also prevents exploitation of resources. Usage of such materials for construction purpose enhances the traditional methods of construction. In this paper presents an experimental investigation on the effect of PET (Polyethylene Terephthalate) on various strength properties. The strength properties of M40 grade concrete are studied with 0%, 10% and 20% of PET. There is decrease in strength when the ratio of PET to fine aggregate was increased. So that the PET percentage is taken as constant, the Carbon Black as a partial replaced by cement with 0%, 10%, 20%, and 30%. The strength properties were again studied and its results are compared to conventional concrete.

M.Magistri, P.Recchi, P.Forni, et. al. [3] The experimental evidences that were collected during the present research clearly show how dehydration of natural, dihydrate, CaSO4 during the grinding process is indeed able to influence crucial cement quality parameters such as fineness and, even more importantly, compressive strengths. Moreover, the efficacy of grinding aids/performance enhancers seems to be heavily related to the source, as well as sheer amount, of SO3. More in detail, it has been observed how improvers of the early compressive strengths seem to be particularly effective as dihydrated CaSO4 becomes partially dehydrated to the corresponding hemihydrates form, while improvers of the late compressive strengths provide the best results when a complete dehydration of the SO3 source takes place. Applied to an industrial production scenario, these results indicate how a deep understanding of the gypsum dehydration degree that is occurring in each production line appears to be quality-wise necessary.

Md. Jalal Uddin, Md. Quayyum [4] Cement is considered one of the most important building materials around the world. It is mainly used for the production of concrete. Concrete is a mixture of inert mineral aggregates, e.g. sand, gravel, crushed stones, and cement. Cement consumption and production is closely related to construction activity, and therefore to the general economic activity. Cement is one of the most produced materials around the world. Due to the importance of cement as a construction material, and the geographic abundance of the main raw materials, i.e. limestone, cement is produced in virtually all countries. Many cement concretes have been found to be susceptible to deterioration in soils, ground waters, or seawaters that contain high levels of sulphates. Sulphates react with the aluminium-containing phases of portland cement concrete-mortar-paste, causing internal expansion. It has been found that the resistance of a concrete to sulphate attack is related to the C3A content of the cement and to the total amount of aluminate compounds, C3A and C4AF. Sulphate attack is consider one of the major deteriorative problems occurred when the cement based materials, such as concrete, mortars and buildings, are exposed to this environment. Sulphate ions in soil, ground water and sea water may cause deterioration of reinforced concrete structures by provoking expansion and cracking due to factors such as type of cement, sulphate cation type, sulphate concentration and the period of exposure. Many structures affected by sulphate degradation often need to be repaired or, in most severe cases, they need to be reconstructed. In this investigation the work is carried out to examine calcium sulphate particularly effecting the different parameters , such as strength , setting times, soundness, consistency etc. the sand used is ennore sand of three different grades. Calcium sulphate is added in different proportions to cement and its effect is studied at different ages.

Dr. G.Chitra, P.Vetri Selvi, Dr.D.Vijayalakshmi [5] In this experimental investigation an attempt was made to minimize the presence of pores in conventional concrete using carbon black powder, a waste from rubber industry as filler. Carbon black filler material imparts the enhanced performance of concrete. To suggest the optimum percentage of carbon black to be added in concrete totally 18 number of concrete cubes, 12 number of concrete cylinders with carbon black of different percentage (0%, 2%, 5%, 8%, 12%, 15%) were cast. Study on morphology, surface hardness, uniformity, compressive strength, tensile strength and water absorption were carried out on carbon black concrete specimens. A Comparison is made with test results to arrive at valid conclusion. It can be observed that the specimens with 2% and 5% carbon black show good performance with respect to control specimens.

Sami Masadeh [6] The effect of added carbon black to concrete mix on corrosion of steel reinforcement was studied. This was achieved by inserting steel bars in different concrete mixes containing 0.1, 0.2, 0.3, 0.4, and 0.5, carbon black/cement. Samples were cured, immersed in 3.5% chloride solution for 6 months. Chloride

permeability and corrosion rates were measured. Tests showed that corrosion rate and chloride ions penetration decreased with increased carbon black content. This was expressed due to filling effect of very fine particles of carbon black and was in the order less than 250 nm.

M. S. Al-Hwaiti[7] In this study, treatment of phosphogypsum (PG) with lime-water (LWT), sulphuric acid (SAT), a mixture of H2SO4 and HNO3 (AWT), PG-water (ST), and PG-limestone (LT) was attempted to purify PG and improve its quality so that it can be used for manufacture of ordinary Portland Cement (OPC). The treatment of PG removes P2O5, SO3, and MgO impurities into water-leachable phase. Chemical analysis of the treated PG and mechanical properties of OPC mortar after various treatment of PG established improvement of the quality of PG. The purified PG contain less impurities when compared with untreated PG. It was observed that the leachable of P2O5, SO3, and MgO in these samples ranged from 86% to 90%, 69% to 94%, 96% to 99%, respectively, can be achieved using these treatment processes. The major phases Alite (C3S), Belite (C2S), Aluminatetricalcic(C3A), and Tetra-calcium aluminoferrite (C4AF), and control ratios Lime Saturation factor (LSF), Aluminum/Iron ratio (AR), and Silica ratio (SR) were measured. These experimental results showed that the C3S, C3A and C4AF, C2S, LSF, AR, and SR contents fulfilled the requirement of the Jordan Standards and European Standards; hence treated PG can be replaced by natural gypsum. The X-ray diffraction analysis of OPC samples showed that C3S and C2S are major mineral phases, C3A and C4AF represent as minor constituents while the CaO and MgO represent as trace phases. The effect of treated PG on the mechanical properties of OPC mortar was investigated. The OPC produced with purified phosphogypsum were found to have strength properties similar to those produced from mineral gypsum thus fulfilling Jordan Standards and European Standards. The present study indicates that the use of PG in OPC manufacture can solve the waste disposal problem thus cleaning our environment at one hand, on the other hand it can save natural raw materials i.e gypsum.

Sihai Wen, D.D.L. Chung [8] Cement reinforced with discontinuous carbon fiber is known for its piezo resistivity-based strain sensing ability, its electrical conductivity and the consequent multi-functionality. The high cost of carbon fiber is disadvantageous. Both carbon fiber and carbon black (used with silica fume in the amount of 15% by mass of cement) increase the DC conductivity and the EMI shielding effectiveness of cement, but carbon fiber is more effective than carbon black. Partial (50%) replacement of carbon fiber by carbon black lowers the cost, in addition to increasing the workability, while the electrical conductivity and the electromagnetic interference shielding effectiveness are maintained. However, the partial replacement reduces the strain sensing effectiveness. Total replacement of carbon fiber by carbon black diminishes both the conductivity and the shielding effectiveness, further reduces the strain sensing effectiveness, decreases the compressive modulus and increases the compressive strain at failure, while the compressive strength is maintained. The increased workability due to the partial replacement enables a higher total conductive admixture content to be attained. The maximum total conductive admixture content is 3.5% by mass of cement. In contrast to fiber replacement, the addition of carbon fiber to cement with carbon black decreases the compressive strength, strain at failure and density.

Dr. Kiran Kumar B V , Saritha N [9] In this research deals with the effective usage of carbon black powder as a additive in bitumen grade VG-10. For identification of basic properties changes in bitumen after addition of carbon black powder in various percentages like 0.25%, 0.5%, 0.75, 1.0%, 1.25%, 1.5%, 1.75% and 2.0% for all the different percentage addition of carbon black to the bitumen, tests were conducted to identify the basic properties changes and optimum addition of carbon black powder for the Marshall mix design to calculate OBC. Here the changes found related to softening point temperature and the viscosity.

Sudarsana Rao.Hunchate, Vaishali.G.Ghorpode, et.al [10] High Performance Concrete (HPC) now a days used widely in the construction industry worldwide. To produce HPC with normal ingradients we use mineral admixtures like Silica fume, fly ash and metakoline and workable agents Superplasticizers are also used. The usage of mineral admixtures in the concrete not only enhances its strength properties but also durability. The compressive strength are investigating finding the optimum use of mineral admixture (Silica fume of levels 0, 5, 10,15, 20 and 25% at 7 days and 28 days of curing). The present investigation aims to give design mix for HPC by using silica fume and superplasticizers. The following conclusions can be made on the basis of the current experimental results. A mix design procedure for HPC using silica fume and super plasticizer is formulated by ACI method of mix design and

available literature on HPC. As the silica fume content increases the compressive strength increases up to 15% [HPC4] and then decreases. Hence the optimum replacement is 15%. The 7 days and 28 days cube compressive strength ratio of HPC is 0.84 to 0.9. The percentage replacement of cement by silica fume increases, the workability decreases.

Ch. Kusuma Keerthi, K. Rajasekhar [11] High performance Concrete is the concrete meets the performance and requirements that are not to be obtained by conventional material, normal mixing, placing and curing practices. In this study, a brief review on strength and durability on M80 grade of concrete results, a new composite material has been developed and improved cements evolved. Important governing factors for HPC (High Performance Concrete) are strength, long term durability. As per Indian standard code IS: 456-2000 concrete of compressive strength≥60Mpa, concrete of grades M80 and M90 etc are considered as High Performance Concrete(HPC). In this project mineral admixtures namely Fly Ash, Silica Fume, Slag& Metakaolin contributed by various reputed industries are used. The scope of using high performance concrete in our constructional activities lies large, viz., precast, prestressed bridges, multi-storied buildings, bridges and structures on coastal areas and like. To affect this change, we will have to revise the designing to structures by encouraging use of high strength concrete. As soon as micro crack appears, sudden failure is observed in high strength concrete cubes.

N. Bhanumathidas and N. Kalidas [12] Gypsum plays a crucial role in cement.Though it is used in a small quantity, inthe range of 2.5-3.0 percent in terms of SO3, gypsum.s role in cement is significant, more predominantly at early ages. Gypsum renders workability to mortar or concrete by keeping the cement in plastic state at early age of hydration. This is achieved by changing the course of hydration of calcium aluminate that manifests as retardation in cement hydration. This is how gypsum is identified as a set regulator or retarder, as known popularly. Nevertheless, gypsum also contributes for strength acceleration in the early stages of hydration. This dual role of gypsum is discussed in the feature.

Andreea MONCEA, Maria GEORGESCU [13] In the last years, the ternary binders, silicate, aluminate, sulphate had developed a greater interest because of their utilization for dry mortars. The main binders which compose these binders are Portland cement, calcium aluminate or high aluminate calcium cement and calcium sulphate. The last can be used in different forms (gypsum, hemi hydrate or anhydrite), the type and amount of them having an important influence on physical-chemical properties of the mortars. Data concerning the influence of the calcium suphate type, used as hemyhidrate and anhydrite on the physical-mechanical properties of the complex, ternary binders are brought in this paper. The data concerning the chemical processes occurring at the binder's hardening, resulted by X-ray diffraction analyses are also presented.

Ambarish Ghosh and Chillara Subbarao [14] This paper presents the results of a laboratory investigation on tensile strength, bearing ratio, and slake durability characteristics of a class F fly ash stabilized with lime alone or in combination with gypsum. The effects of lime content _4, 6, and 10%_, gypsum content _0.5 and 1.0%_, and curing period _up to 90 days_ on the tensile strength, bearing ratio, and durability characteristics of the stabilized fly ash are highlighted. Unconfined compressive strength test results for the mixes cured up to 90 days are presented to develop relationships between different tensile strengths _Brazilian and flexural_ and unconfined compressive strength. Both soaked and unsoaked bearing ratio tests were also carried out on this stabilized fly ash. The Brazilian tensile strength of the lime and gypsum stabilized fly ash mixes varied between 309 and 1,084 kPa for 45 days curing. The flexural strength of the lime and gypsum stabilized mixes cured for 45 days varied between 665 and 1,459 kPa. Fly ash stabilized with lime and gypsum showed medium durability at 28 days curing and there was enhancement of durability with increase in curing period. Empirical models to estimate tensile strength, bearing ratio, and slake durability indices of stabilized fly ash from unconfined compressive strength test results are also proposed herein. With enhanced tensile strength and durability characteristics, the stabilized fly ash may find potential use in civil engineering construction.

OBILADE, I.O [15] Rice Husk Ash (RHA) when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with RHA by weight at different %. Compacting factor test was carried out on fresh concrete while Compressive Strength test was carried out on hardened 150mm concrete cubes after 7, 14 and 28 days curing in water. The results revealed that the Compacting factor decreased as the percentage replacement of OPC with RHA increased. The compressive strength of the hardened concrete also decreased with increasing OPC replacement with RHA. It is recommended that further studies be carried out to gather more facts about the suitability of partial replacement of OPC with RHA in concrete.

T. S. ABDULKADIR, D. O. OYEJOBI, A. A. LAWAL [16] 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 700 C. 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 ASTM595 (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/mm was obtained for control specimens at 28days (i.e. 0% SCBA) while 22.3, 20.1 and 17.3N/mm 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/mm are recommended for reinforced concrete.

3. CONCLUSION

This research review paper discusses various forms of excess use of cement & its increasing amount of demand in industry. In the manufacturing process of cement, emission of CO_2 is more but also consumes significant amount of natural resource. Main problem is disposal of waste material as well as industrial by-product like from thermal power plant. As a matter of fact the current tendency in the world is to find new materials at lower cost which can guarantee better performances during their incorporations in the concrete. To bare & control it's consequences replacement of cement by other fine additives partially and or fully can minimize the control over use of cement. After studying different literatures scope of this research includes, strength parameters of concrete and any structure gives guarantied results. This experimental study gives wet properties of concrete as well as hardened properties of concrete. Optimum result after tests over concrete gives actual design mix ratio to obtain pure concrete.

ACKNOWLEDGEMENT

I sincerely express my deep sense of gratitude towards my respected guide **Prof. Hake S. L.** for his valuable guidance, profound Technical advice, persistent encouragement and help during the completion of this work. His time to time helpful suggestion boosted me to complete this task successfully. He has helped me in all possible ways right from gathering the materials to report preparation. I express my sincere thanks to **Parin Construction** who has extended support and provided useful guidance. Their co-operation and suggestion are acknowledged with deepest gratitude.

REFERENCES

[1] B. Padma priya, Mrs. K. pandeeswari.- .Experimental investigation on the properties of concrete with Plastic PET Fibre & carbon black.International Journal of AdvancedResearch. (2016).ISSN 2320-5407, Vol 4, issue 4 1082-1088

[2] M.Magistri, P.Recchi, P.Forni - MapeiSpA, Milan, Italy- "Optimization in the use of cement additives: effect of gypsum dehydration on the reactivity of performance enhancers" published on net.

[3] Dr.G.Chitra, P.VetriSelvi & Dr.D.Vijayalakshmi-CarbonBlackasanAdditiveinConventionalConcrete. International Journal of Emerging Technology and Advanced Engineering. IACSIT International Journal of Engineering and Technology, Vol. 6, No. 1,February 2014

[4] S.Venkatasubbaiah,Sri.V.K.Visweswararao- A Study on Replacement of Phosphogypsume in Conventional Cement Concrete.- International Journal of Innovative Research in Science, Engineering and Technology. Vol. 6, Issue 1, January 2017.

[5] OBILADE, I.O.- USE OF RICE HUSK ASH AS PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE- ISSN2305-8269 Sept. 2014. Vol. 5. No. 04

[6] SamiMasadeh- The Effect of Added Carbon Black to Concrete Mix on Corrosion of Steel in

Concrete,Journal of Minerals and Materials Characterization and Engineering,.- International Conference on Recent Trends inengineering & Technology - 2013(ICRTET'2013) Vol.8 No.6

[7] Md. Jalal Uddin, Md. Quayyum- Influence of calcium sulphate on cement mortor& characteristics behaviour of different properties. IJCER vol.-2, Issue-6.

[8] R.B. Thakare, K.G.Hiraskar,O.P. Bhatia- Utilization Of phosphogypsum in cement concrete for strength & economy. Published by CI-PREMIER PTE LTD.

[9] Muhammad Aleem1 , Istehsan-ur-Rahim2 , Umair Anwar Awan2 , Usman Afzal2 , Usman Haseeb2- Incorporation of Rice Husk Ash as Cement Replacement- IOSR Journal of Engineering (IOSRJEN) Vol. 05, Issue 07 (July. 2015), ||V2|| PP 25-30

[10] RishabhKashyap, Manu Chaudhary, Abhishek Sen3- Effect of Partial Replacement of Cement by Rice Husk Ash in Concrete- International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

[11]Sidney Mindess & J. Francis Young (1981): Concrete, Prentice-Hall, Inc., Englewood Cliffs, NJ, pp. 671.

[12]Steve Kosmatka & William Panarese (1988): Design and Control of Concrete Mixes, Portland Cement Association, Skokie, Ill. pp. 205.

[13] Michael Mamlouk & John Zaniewski (1999): Materials for Civil and Construction Engineers, Addison Wesley Longman, Inc.,

[14]IS 1288-1982

[15]IS 1290-1973

[16]IS 3812-2012-PART1

[17]IS 3812-2012-PART2

[18]IS 2547-1976