EFFECT OF COPPER SLAG AND MARBLE POWDER ON PERFORMANCE OF CONCRETE

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ABSTRACT

Many countries are witnessing the rapid growth in construction industry which leads to severe effect on surrounding environment as the use of natural sources is in excess. In order to reduce the dependence on natural resources and to reduce the severe effect on environment, using byproducts like copper slag and marble powder as a replacing agent in determining the strength of concrete. A comprehensive review of studies has been present in this paper for scope of replacement of byproducts in concrete.

Keywords- Byproducts, Concrete Strength, Copper Slag, Marble Powder, Replacement

I. INTRODUCTION

The amount and type of generated waste has grown as the world population increases. Many of the wastes produced today will remain in the environment for a long time. For many years, efforts and practices to minimize disposing wastes to landfills have been minimal. Dumpsites for municipal and hazardous waste attracted little attention and were under few controls. The result of rapid industrialization is the rapid depletion of resources, and environmental impacts due to production of enormous waste exceeding assimilation capacity of the environment. Without any consideration of the wastes and its ill effects on the environment, the people used to throw it without any treatment. And now the time has came that these wastes have become pollutants and have started polluting the surroundings. Therefore a way has been found out that some of these wastes can be used into various industries which will lighten the burden on the environment.

River sand is being used as fine aggregate in concrete for centuries. However, river sand is not a renewable natural resource. In some regions, river sand has been excessively exploited, which has endangered the stability of river banks and the safety of bridges, and creates environmental problems. On the other hand, river sand is expensive due to excessive cost of transportation from natural sources. Seeking for river sand alternatives has become urgent. There have been many alternative materials with similar physical & chemical properties of Sand found (Lime stone waste, marble powder, furnace slag and welding slag, stone dust etc.). Copper slag is a industrial-product obtained during the matte smelting and refining of copper. Hence it is an industrial by-product abundantly available near copper producing industries having similar physical &chemical properties of Sand, considered as an alternative to the river sand. Copper slag possesses physical mechanical and chemical characteristics that qualify the material to be used in concrete as a partial replacement for Portland cement or as

a substitute for fine aggregates. For example, copper slag has a number of favorable mechanical properties for aggregate use such as excellent soundness characteristics, good abrasion resistance and good stability. Copper slag also show pozzolanic properties since it ingredient low CaO Under activation with NaOH, it can show cementitious property , used as partial or full replacement for Portland cement. The usage of copper slag for applications such as Portland cement replacement in concrete, or as raw material has the benefit of lowering the cost of the concrete and help in protecting the environment.

Whereas Marble powder also the byproduct produced from the marble processing plants during the cutting, shaping and polishing. During this process, about 20-25% of the process marble is turn into the powder form. India being the topmost exporter of marble, every year million tons of marble waste form processing plants are released. The disposal of this waste marble on soils causes reduction in permeability and contaminates the over ground water when deposited along catchment area. Thus, utilizing this marble waste in construction industry itself would help to protect the environment from dumpsites of marble.

II. LITERATURE REVIEW

1. **Noha M. Soliman et al., (2013)** - This research aims to study the effect of using marble powder as partially replace of cement on the properties of concrete. The influence of using marble powder on the behavior of reinforced concrete slabs is also investigated. The main variable taken into consideration is the percentage of marble powder as partial replacement of cement content in concrete mixes. The various strength of concrete like compressive, flexural and split tensile were studied.
2. **Tamil Selvi P. et al., (2014)** – In this paper, study on the effect of copper slag as a fine aggregate replacement in concrete is carried out. For this study M40 concrete grade was selected as per IS: 10262-2009 was designed. The various strength of concrete like compressive, flexural and split tensile were studied and non-destructive test such as rebound hammer test and ultrasonic pulse velocity measurement were studied for various replacements of fine aggregate using copper slag that are 0%, 20%, 40%, 60%, 80% and 100%.
3. **Jashandeep Singh et al., (2015)** – In this paper the study on behavior of concrete, having partial replacement of cement with waste marble powder is carried out. For this study M25 concrete grade was selected and IS method was used for mix design. The various strength of concrete like compressive, flexural and split tensile were studied for various replacements of cement using marble powder that are 0%, 4%, 8%, 12%, 16%, 20%.
4. **Binaya Patnaik et al., (2015)** - An experiment was conducted to investigate the strength and durability properties of concrete having copper slag as a partial replacement of sand (fine aggregate). Two different types of Concrete Grade (M20 & M30) were used with different proportions of copper slag replacement (0 to 50%) in the concrete. Strength & Durability properties such as Compressive Strength, Split Tensile Strength, Flexural Strength, Acid Resistivity and Sulphate Resistivity were evaluated for both mixes of concrete. R R Chavan et al., (2013) - This paper focuses on an experimental program to investigate the effect of using copper slag as a replacement of fine aggregate on the strength properties. For this research work, M25 grade concrete was used and compressive strength on cube and flexural strength on beam were conducted for various proportions of copper slag replacement with sand of 0 to 100% in concrete.

5. **Ranjan Kumar et al., (2015)** - In this experimental study, the effect of Marble powder in concrete on strength is presented. Five concrete mixtures containing 0%, 5%, 10%, and 20% Marble powder as cement replacement by weight basis has been prepared. Compressive strength, split tensile strength & flexural strength of the concrete mixtures has been obtained at 7 and 28 days.
6. **M. V. Patil et al., (2016)** - This paper investigates the technical feasibility of using copper slag as a replacement of fine aggregate in concrete. For this research work, m30 grade concrete was used and tests were conducted for various proportions of copper slag replacement with sand of 0 to 100% in concrete.
7. **Zine Kiran Sambhaji et al., (2016)** - In this work, an extensive study using copper slag has been carried out to investigate strength, workability and durability. Copper slag is an industrial byproduct material produced from the process of manufacturing copper. the effect of using copper slag as a fine aggregate on properties of cement mortars and concrete various mortars & concrete mixtures were prepared with different proportions of copper slag ranging from (0CS+100S)%, (10CS+90S)%, (20CS+80S)%, (30CS+70S)%, (40CS+60S)%, (50CS+50S)%, (60CS+40S)%, (70CS+30S)%, (80CS+20S)%, (90CS+10S)%,(100CS+0S)% using M25 grade concrete.
8. **Ramya Raju et al., (2016)** - This paper presents the study of concrete mix design using marble powder. Marble powder of 0%, 5%, 10%, 15%, 20%, and 25% by weight of cement were added to the concrete. The compressive test and tensile strength is carried out along with variation in w/c ratio.

III. MATERIALS AND METHODOLOGY

1. **Noha M. Soliman et al., (2013)** - The fine aggregate used in the experimental program was of natural siliceous sand. Its characteristics satisfy the [(E.C.P. 203/2007) and (E.S.S. 1109/2008)]. It was clean and nearly free from impurities with a specific gravity 2.6 t/m3 and a modulus of fineness 2.7. The coarse aggregate used was of crushed dolomite, which satisfies the Egyptian Standard Specification [(E.S.S. No. 1109\ 2008)]. Its specific gravity is 2.70t/m3 and a modulus of fineness 6.64. The cement used was the Ordinary Portland cement, type (CEM (I) 42.5 N) produced by the Suez cement factory. Its chemical and physical characteristics satisfied the Egyptian Standard Specification [(E.S.S. 4657-1/2009)]. The marble powder used was obtained from the processing plants out of sawing and polishing of marble blocks. Marble powder is brought Egyptian factories of marble company. Super plasticizer used was a high rang water reducer HRWA. It was used to improve the workability of the mix. Mild steel bars (nominal diameters 6 and 8 mm) were used in reinforcing all the concrete slabs. There yield stress was 240 MPa and there tensile strength was 350 MPa. The compressive strength test, split tensile strength test were carried out on hardened concrete.
2. **Tamil Selvi P. et al., (2014)** – In this experimental study, The fine aggregate used was conforming to grading zone II Table 1 of IS 383 . The coarse aggregate used in this study is of angular in shape and the maximum nominal size of coarse aggregate is 20 mm and it is Conforming to Table 2 of IS 383. The cement used in this study is of OPC 53 grade conforming to IS 12269. Copper Slag with sp. gravity 3.45 and fineness modulus 3.84 was used. Slump cone and compaction factor test carried out on fresh concrete. Compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete as per IS 516-1959.

3. **Jashandeep Singh et al., (2015)** - In this experimental study, 20mm size course aggregate having specific gravity of 2.8 and fineness modulus of 6.218 was used. Bulk Density were found to be 1.654. Free surface moisture 2%. River sand (zone 2) having the sp.gravity of 2.88 and fineness modulus 2.029 was used. The Bulk Density is 1.659. Free surface moisture 2%. The cement having specific gravity of 3.15 was used. The compressive strength test, split tensile strength test were carried out on hardened concrete.
4. **Binaya Patnaik et al., (2015)** – In this experimental study, 20mm size angular crushed granite metal having specific gravity of 2.6 and fineness modulus of 7.1 was used. Bulk Density in loose state and compacted state were found to be 1414 kg/m3 and 1550 kg/m3 respectively. The water absorption was 1.1%. River sand having the sp.gravity of 2.6 and fineness modulus 2.4 was used. The Bulk Density in loose state and compacted state were found to be 1597 kg/m3 and1700kg/m3 respectively. The water absorption was 1.20%. 53 Grade OPC having specific gravity of 3.094, fineness modulus of 4.62% and normal consistency of 32% was used. As per IS 4031-1988, various tests were conducted to check the quality of cement and confirmed to specifications of 12269-1987. Copper Slag with sp. gravity 3.47 and fineness modulus 3.3 was used. Mix Design was done as per the code book, IS: 10262 – 1979 and the amount of materials were calculated for M20 & M30 grade of concrete mixes. The compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete.
5. **Ranjan Kumar et al., (2015)** – Portland Slag Cement with conforming to BIS (IS: 455-1989) was used in the entire experimental study. Normal river sand locally available in the market and confirming to Zone II as per BIS (IS 383:1970) and CA were used in this experiment. CA used as 60% by weight of 20 mm size & 40% of 10 mm size of total aggregate may be taken. Marble Powder collected from the nearby source was used for the investigation. Compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete as per IS 516-1959.
6. **M. V. Patil et al., (2016)** - The raw materials used in this research were cement, fine and coarse aggregate, copper slag, plasticizers and water. The cement used was 53 grade Birla super cement. Fine aggregate and coarse aggregate used was available locally. Copper slag was brought from a dealer in Pune. Along with all the raw materials, to improve the workability of concrete, plasticizers were used. And final raw material i.e. water, normal drinking water was used for work. Before starting the various tests on concrete, the physical properties of the raw materials were determined. These properties are fineness modulus, specific gravity; water absorption etc. Sieve analysis was performed to determine the fineness modulus of copper slag, sand and coarse aggregate. The s sand and copper slag having specific gravity 2.67 & 2.75 was used. The water absorption of 20 mm coarse aggregates, sand &copper slag was found to be 0.609, 1.01 and 0.65. The compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete.
7. **Zine Kiran Sambhaji et al., (2016)** - The cement used in this experimental work is "Bhavya Gold Cement."(OPC53). Coarse aggregates (i.e. 20 mm and 10 mm) and fine sand were taken from a nearby crusher. The gradation test conducted on the fine sand and copper slag showed that they met specifications requirements for concrete sand. The compressive strength test, pulse velocity test and modulus of elasticity were carried out on concrete.

8. **Ramya Raju et al., (2016)** – In this experimental study, Compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete as per IS 516-1959 of 7 days and 28 days with the variation in w/c ratio.

IV. CONCLUSION

1. Addition of up to 40% of copper slag as sand replacement gained 32% more strength with that of control concrete. However further addition of copper slag caused reduction in strength. . It was observed that up to 20% replacement of natural sand by copper slag, the split tensile strength of concrete was increased by 70% and flexural strength of concrete was increased by 50%. All percentage replacement of fine aggregate by copper slag the split tensile and flexural strength of concrete was more than normal mix.
2. It is observed that when increasing percentage replacement of fine aggregate by Copper slag the unit weight of concrete is gradually increases. It is observed that when increasing percentage replacement of fine aggregate by Copper slag the unit weight of concrete is gradually increases.
3. Cost of Concrete production reduces when Copper Slag is used as a fine aggregate in concrete. High toughness of Copper Slag attributes to Increased Compressive strength. Use of copper slag helps in waste management and dumping industrial wastes. (Ramya, Jayaraj, & Shaikh, 2016)
4. The replacement of fine aggregate using copper slag in concrete increases the density of concrete thereby increases the self weight of the concrete. The workability of concrete increased with the increase in copper slag content of fine aggregate replacements at same water-cement ratio.
5. Up to 12% replacement of cement with waste marble there is a increase in all mechanical properties. The replacement of 12% of cement with waste marble powder attains maximum compressive and tensile strength.
6. Workability was increased by using small amount of marble powder ratio as a replacement of cement and leads to increase the compaction and the strength of concrete. The increasing of marble powder ratio as a replacement of cement over the optimum dosage leads to the segregation of aggregate and bleeding of cement and aggregates lead to decrease the resistance of concrete.
7. Use of these waste material leads to sustainable development in construction industry. To save the environment, MDP may be used as better partial substitute as a replacement of cement in concrete.
8. Use of super plasticizer with marble powder as a partial replacement of cement in higher grades shall be useful for high rise structure to reduce the economy.

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