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Behaviour of Concrete Using Silica Fume and Copper Slag as Partial Replacement

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ABSTRACT—

When creating a suitable concrete , it's important to take workability, strength, durability, economic considerations, and sustainable development concerns into account. Since it uses less cement, using copper slag as a partial replacement for cement is a good way to reduce pollution and conserve resources. In addition, silica fume and copper slag are combined to strengthen concrete constructions. The major goal of this study was to increase concrete durability by optimising critical concrete mix design variables such cement factor, water-to-binder ratio (w/b), copper slag, and silica fume. To accomplish this, standards-based experimental research was done to optimise modifications in the aforementioned fields. According to the study's findings, mixing copper slag and silica fume together with cement factor and w/b ratio values that are appropriate results in a mix design that is stronger, more lasting, and easier to work with.

Keywords*— *suitable concrete, workability, durability, mix design, modifications,

I. Introduction

Concrete is a most common advancement material on earth. It is made by mixing coarse and fine aggregates, water, bond, and included substances in a particular embraced degree. Concrete has found use in liberal an extensive variety of improvement shape road, channel, linings, platform, and dams to the most exquisite and stylish of structures. With the extension of support to supply required versatility, moves in essential framework, and the usage of pre-pushing and post tensioning, it has transformed into the chief helper material.

Concrete is a most broadly utilized building material for different sorts of structures because of its auxiliary solidness and quality. The way toward choosing appropriate elements of concrete and deciding their relative sum with the goal of delivering a concrete of the required quality solidness and usefulness as monetarily as conceivable is named the concrete blend plan. The compressive quality of solidified concrete is by and large viewed as a list of its different properties relies on numerous variables.

The Ordinary Portland Cement (OPC) is one of the principle fixings utilized for the creation of concrete and has no option in the common development industry. Lamentably, generation of concrete includes emanation of a lot of carbon-dioxide gas into the climate, a noteworthy patron for nursery impact and an Earth-wide temperature boost, thus it is inescapable either to scan for another material or incompletely supplant it by some other material1. Fly fiery debris, Ground Granulated Blast heater Slag, Rice husk powder, High Reactive Met kaolin, silica rage are a portion of the pozzolanic materials which can be utilized in concrete as halfway substitution of bond. Expansion of silica smoke to concrete has numerous points of interest like high quality, sturdiness and decrease in bond generation. Concrete is a composite material, where coarse and fine aggregates are filler material and bond stick is restricting material. Concrete is composite of sand, shake, pummeled shake, or other aggregate held together by a hardened paste of weight driven bond and water. The totally mixed fixings, when suitably proportioned, impact a plastic mass which to can be tossed or framed into a destined size and shape. Perpetual supply of the bond by the water, concrete winds up detectably stone like in quality and hardness and has utility for a few reasons.

II. LITERATURE REVIEW

Vaičiukynienėa et al. (2012) has examined about utilization of by-product waste silica in concrete–based materials. It was discovered that the optimum content of thermally activated technogenic silica gel additive under the conditions explored was up to 10% of the total quantity of the cement. After 28 days of hardening, the strength of hardened cement paste increased 7 MPa when the quantity of the additive was – 10% of the total weight when compared to the strength qualities of the samples with no additives used. After 28 days of hardening, the strength of the hardened cement paste increased 7 MPa (with 10% additive), compared with the control specimen without additives. This quantity of silica gel additive enables to decrease the quantity of used cement.

Roy (2012) learned about that effect of partial replacement of cement by silica fume on hardened concrete. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by SF. Very little or no work has been carried out using silica

fume as a replacement of cement. Moreover, no such attempt has been made in substituting silica fume with cement for low/medium grade concretes (viz. M20, M25). Properties of hardened concrete viz Ultimate Compressive strength, Flexural strength, Splitting Tensile strength has been determined for different mix combinations of materials and these values are compared with the corresponding values of conventional concrete. From the study it has been observed that maximum compressive strength (both cube and cylinder) is noted for 10% replacement of cement with silica fume and the values are higher (by 19.6% and 16.82% respectively) than those of the normal concrete (for cube and cylinder) where as split tensile strength and flexural strength of the SF concrete (3.61N/mm2 and 4.93N/mm2 respectively) are increased by about 38.58% and 21.13% respectively over those (2.6 N/mm2 and 4.07 N/mm2 respectively) of the normal concrete when 10% of cement is replaced by SF.

Raveendran and kumar (2015) learned about the performance of silica fume on strength and durability of concrete. In this study, effects of mineral admixtures on the water permeability and compressive strength of concretes containing silica fume (SF) were experimentally investigated. The main parameter investigated in this study is M20 grade concrete with partial replacement of cement by silica fume.They were incorporated into concrete at the levels of 0%, 5%, 10%, 15% and 20%. This paper presents a detailed experimental study on compressive strength, split tensile strength and flexural strength at an age of 7and28 days. Test results indicate that use of silica fume in concrete has improved the performance of concrete in strength at a particular percentage replacement. Although the highest compressive strengths of concretes observed was 10% silica fume mix for ordinary Portland cement and were reduced as the increase in the replacement ratios.

Patnaik et al. (2015) they studied about the force and toughness functions of concrete having copper waste as a fractional substitution of sand and results have been presented in this paper. Two different kinds of Concrete Grade (M20 & M30) were used with different proportions of copper slag replacement (0 to 20%) 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. test results explains that the strength functions of concrete has better having copper slag as a partial substitute of Sand (up to 40%) in concrete but in terms of stability the concrete found to be low resistant to acid attack and better resistance against sulfate attack.

Raza et al. (2015) the concrete performance by using iron slag as a partial replacement of coarse aggregates in concrete. In this study the coarse aggregate (CA) were partially replaced with iron slag aggregate at different proportions of 0%, 10%, 20%, 30% 40% and 50%. Compressive strength and Flexural strength on M40 grade of concrete with 0.45 water/cement ratio were investigated. In which to determine and check out the compressive strength, Flexural strength, and split tensile strength of concrete with various percentages of iron Slag Aggregate. The result has been found from the various tests which were compared with conventional concrete. Thus the use of iron slag in concrete could enhance the strength in concrete.

Chauhan and Bondre (2015) has clarified about the incomplete replacement of sand by copper slagin concrete. This paper reports the exploratory examination which researched the halfway replacement of sand with quarry dust. At first cement concrete block was contemplated with different extents of cement concrete + copper slag(M 20 and M25). The test comes about demonstrated that the expansion of copper slagfine aggregate proportion of 30%, 40% and half was found to upgrade the compressive properties.

III. EXPERIMENT AND METHODOLOGY

Table-1 Sieve Analysis of Coarse Aggregates (20mm size)

Sieve size	Weight Retained	Cumulative Weight Retained	Cumulative Weight Retained%	%Weight Passing
80 mm	0	0	0	100
40 mm	0	0	0	100
20mm	416	416	20.8	79.2
10 mm	1584	2000	100	0
4.75mm	0	2000	100	0
2.36mm	0	2000	100	0
1.18mm	0	2000	100	0
600µm	0	2000	100	0
300µm	0	2000	100	0
150µm	0	2000	100	0

Sum of cumulative weight retained % = 20.8 Coarse aggregates size =20mm

Aggregates taking for sieving = 2 kg

Table-2 Sieve Analysis of Coarse Aggregates (10mm size)

Sieve size	Weight retained	Cumulative weight retained	Cumulative weight retained %	%weight passing
40mm	-	-	-	-
20mm	0	0	0	100
10mm	1460	1460	73	37
4.75mm	540	2000	100	0
2.36mm	-	2000	100	0
1.18mm	-	2000	100	0
600µm	-	2000	100	0
300µm	-	2000	100	0
150µm	-	2000	100	0

Sum of cumulative weight retained %= 73.0

IV. Conclusions

- All of the concrete containing silica fume and copper slag showed normal consistency equal and higher than the control concrete. Up to 10%, and 20% replacement the normal consistency was mostly constant minor differences, at 30% replacement the normal consistency had shown a slight increment to 35%.
- Slump shows that the workability increases with the increase in the percentages of contain silica fume and copper slag. All investigated containing silica fume and copper slag mixtures has height slump values and acceptable workability.
- Flexural strength is increments when the 0 to 20% of level of the silica fume increment and diminishing from 30% used of silica fume with the age of 28 days.

References

1. **Biao Li, Aoxing Gao, Yang Li, Henglin Xiao, Na Chen, Dongtao Xia, Songbo Wang, Changning Li, Effect of silica fume content on the mechanical strengths, compressive stress–strain behavior and microstructures of geopolymeric recycled aggregate concrete, Construction and Building Materials, Volume 384,2023,131417,ISSN 0950-0618, https://doi.org/10.1016/j.conbuildmat.2023.131417.**
2. **Ch. Venugopal Reddy , Dr. T.L. Ramadasu" effect of silica fume on the compressive strength of cement-silica fume mortars" ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-7, 2017.**
3. **Danute Vaičiukynienėa , Vitoldas Vaitkevičiusa , Aras Kantautasb , Vytautas Sasnauskasa "Utilization of By-Product Waste Silica in Concrete–Based Materials" Materials Research. 2012; 15(4): 561-567.**
4. **Dr.K.Chandramouli, J.Sree Naga Chaitanya (2021) "Mechanical Properties of concrete with Silica Fume and Partial Replacement of Coarse Aggregate by Steel Slag" International Advanced Research Journal in Science, Engineering and Technology ISSN (O) 2393-8021, ISSN (P) 2394-1588.**
5. **I Rohini and V.Arularasi (2016) "Effect Of Fly Ash And Copper slagA Partial Replacement Of Cement And Fine Aggregate In Concrete" International Journal of Latest Research in Engineering and Technology (IJLRET) ISSN: 2454-5031 ,PP. 15-33.**
6. **Jian-Dong Wu, Li-Ping Guo, Xiang-Peng Fei, Bang-Cheng Lyu, Bo Chen,Synergistic effects of silica fume and slag on the microstructure and mechanical behaviors of ultra-high-strength and high-ductility cementitious composites,Construction and Building Materials,Volume 367,2023,130169,ISSN 0950-0618,https://doi.org/10.1016/j.conbuildmat.2022.130169.**
7. **K. Lakshmidevi, A.V. Narasimha Rao (2015) "Effect of Fly Ash and Copper slagon Properties of Concrete" International Journal of Innovative Research in Science, Engineering and Technology ISSN :2319-8753.**
8. **K.G.Raveendran , V. Rameshkumar (2015) "Performance of Silica Fume on Strength and Durability of Concrete" International Journal of Innovative Research in Science, Engineering and Technology ISSN(Online) :2319-8753.**
9. **K.N.R. Thesarajan, L.Subbaraj**,R.Priyavarshiny*, N.ajithaparvathy*(2020)"Experimental Investigation on Partial Replacement of Silica Fume and Copper Slag in Concrete", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 15, (2020) pp. 409-414.**
10. **Khalid Raza , Apoorv Singh , R. D. Patel(2015) Strength Analysis of Concrete by Using Iron Slag as a Partial Replacement of Normal Aggregate (Coarse) in Concrete International Journal of Science and Research (IJSR) ISSN : 2319-7064.**
11. **Latif Miyan , G. R. Krishnamurthy (2017) "Study on Replacement of F.a. by Copper Slag in Concrete (M30)" International Journal of Science and Research (IJSR) ISSN (Online): 2319- 7064.**

12. **Liaqat A. Qureshi, Arslan Janjua, and Usman Muhammad(2018) "Effect of Cement Replacement by Silica Fume on Compressive Strength of Glass Fiber Reinforced Concrete" International Journal of Structural and Civil Engineering Research Vol. 7, No. 3, August 2018.**

13. **Nagarajan Arunachelam D,Jeyaprakash Maheswaran ,Maheswaran Chellapandian ,Gunasekaran Murali 3 and Nikolai Ivanovich Vatin Development of High-Strength Geopolymer Concrete Incorporating High-Volume Copper Slag and Micro Silica(2022) ,Sustainability 2022, 14(13), 7601; https://doi.org/10.3390/su14137601 Received: 18 May 2022 / Revised: 17 June 2022 / Accepted: 18 June 2022 / Published: 22 June 2022.**

14. **Nirmala, R., Praveen kumar, S., Akash Nithish, K.M. (2022). Experimental Investigation on the Copper Slag, Silica Fume and Fly Ash in High-Performance Concrete. In: Naganathan, S., Mustapha, K.N., Palanisamy, T. (eds) Sustainable Practices and Innovations in Civil Engineering. Lecture Notes in Civil Engineering, vol 179. Springer, Singapore. https://doi.org/10.1007/978-981-16-5041-3_24.**

15. **P. Thej Kumar, R. Harshini Reddy and DVS Bhagavanulu "A Study On The Replacement Of Cement In Conrete By Using Cow Dung Ash" International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-9, December 2015 ISSN: 2395-3470.**