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Ternary Effect in Concrete: Jaggery, Alccofine, and Graphene Oxide

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Abstract: ***This study investigates the effects of incorporating jaggery as an additive and Alccofine 1108 and graphene oxide as partial replacements for cement in concrete.***
Jaggery, a traditional natural sweetener, is introduced as an organic additive to enhance the workability and mechanical properties of concrete. Alccofine 1108, a high-performance micro-fine material, and graphene oxide, a carbon-based nanomaterial known for its exceptional strength and durability, are evaluated as partial cement substitutes to improve the sustainability and performance of concrete. To determine the optimal proportions of these materials. Various mixes were prepared by replacing cement with 5%, 10%, and 15% Alccofine 1108 and 0.05%, 0.10%, and 0.15% graphene oxide, 0.05%, 0.10% and 0.155% added to jaggery by weight of cement. The concrete samples were tested for compressive strength, tensile strength, and durability properties, including resistance to chloride ion penetration and sulfate attack.To determine compressive strength result, Split tensile strength result and Ultra Pulse Velocity result.
Keywords: Jaggery, Alccofine 1108, Graphene Oxide, Compressive strength ,Split tensile strength and Ultra Pulse Velocity.

I. INTRODUCTION

With two billion tons used annually, concrete is one of the most widely used building materials in the world. Given that it provides significant strength at a comparatively low cost, it is appealing in a variety of applications. Most ingredients that are readily available locally can be used to make concrete. It can be shaped into a great number of different structural arrangements. Moreover, it requires little upkeep over the course of its service life. The CO2 emissions from the Portland cement sector contribute to the global average by about 7%. In addition to reducing CO2 emissions and energy consumption during cement manufacture, partially substituting one or more additives for Portland cement results in blended cement varieties that offer long-lasting cementitious systems to the building sector.
Jaggery, known for its sticky and granular texture, possesses unique properties that make it a promising candidate for use in concrete. When finely ground and incorporated into concrete mixtures, jaggery can act as a filler material, effectively occupying space between coarse aggregates and cement particles. This substitution not only reduces the demand for natural sand, a finite resource facing depletion in many regions, but also offers several potential benefits to the resulting concrete.
Alccofine 1108 is a finely ground material, typically derived from the pozzolanic reaction of high-purity fly ash, which undergoes controlled processing to enhance its reactivity and fineness. When incorporated into concrete mixtures as a cementitious additive, Alccofine 1108 offers several potential benefits over conventional Portland cement.
In the pursuit of advancing construction materials towards greater sustainability and performance, researchers and engineers have turned their attention to innovative additives that can enhance the properties of concrete. One such material that has gained significant interest is graphene oxide, which holds promise as a partial replacement for cement in concrete mixtures.

II. OBJECTIVES

The following are the study's objectives:
1) To maximise the use of jiggery, Alcofine 1108, Graphene Oxide in cement..
2) To assess results from split tensile and compressive strength testing.

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III. MATERIALS

1) *Cement:* Cement is mostly used as a binder in concrete, which is used in construction and hardens to bond other materials. Ordinary Portland cement (OPC) of grade 53 is used in construction.
2) *Fine Aggregate:* Mostly composed of crushed stone or natural sand, fine aggregate is an essential part of concrete, and the density of the small particles greatly affects the concrete's hardened qualities.
3) *Coarse Aggregate:* Coarse aggregate is defined as the aggregate that is kept above IS Sieve 4.75 mm. Per IS 383:1970, the typical maximum size is gradually 10-30 mm.
4) *Water:* Water is one of the most important materials in construction since it is required for curing work, mixing cement concrete, and making mortar, among other tasks. The quality of the water used during construction directly affects the strength of the motor and cement concrete.
5) *Jaggery:* Using jaggery as a partial replacement for cement in concrete is an unconventional approach, but it has been explored in some experimental studies. Jaggery, which is a traditional non-centrifugal cane sugar, contains sucrose, glucose, and fructose, along with some minerals.
6) *Alccofine 1108:* Alccofine 1108 is a type of microfine material, often referred to as a pozzolan, that is added to concrete mixes as a cement replacement or supplementary material. It reacts chemically with calcium hydroxide in the presence of water to form additional calcium silicate hydrate (C-S-H) gel, which enhances the strength and durability of concrete.
7) *Graphene Oxide:* Graphene oxide (GO) has garnered attention as a potential additive in cement-based materials due to its unique properties and the potential benefits it offers in enhancing the performance of cementitious composites.

IV. RESULTS AND DISCUSSIONS

A. *Compressive Strength Test*

The cube specimens of 150mm x 150mm x150mm were cast and tested in compression testing machine for 7 and 28days of curing period for different proportions of concrete mix.

Table 5.1: Compressive Strength Result on Concrete by Additive of Jaggery for Cement.

S.No	Jaggery	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.56	39.13
2	0.05%	30.24	44.15
3	0.10%	31.51	45.33
4	0.15%	30.29	43.34

Table 5.2: Compressive Strength Result on Concrete by Alcoffine 1108 As Partial Replacement of Cement.

S.No	Alccofine 1108	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.56	39.13
2	5%	29.23	43.06
3	10%	31.11	45.15
4	15%	29.89	42.52

Table 5.3: Compressive Strength Result on Concrete by Graphene Oxide As Partial Replacement of Cement.

S.No	Graphene Oxide	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.56	39.13
2	0.05%	35.83	53.09
3	0.10%	40.14	58.27
4	0.15%	38.17	54.61

Table 5.4: Combined Replacement Compressive Strength Result on Concrete.

S.No	Jag+Af+Go	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.56	39.13
2	0.10% of Jag+10% Af+0.10% of Go	45.02	64.38

B. Split Tensile Strength

At the age of 7 and 28days, the cylindrical specimens (150mm diameter x 300mm height) were tested for evaluating the split tensile strength. The experiment is performed by putting a cylindricalsample horizontally between a compression testing machines.

Table 5.5: Split tensile Strength Result on Concrete by Additive of Jaggery for Cement.

S.No	Jaggery	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.63	3.84
2	0.05%	3.01	4.36
3	0.1%	3.34	4.76
4	0.15%	2.96	4.29

Table 5.6: Split tensile Strength Result on Concrete by Alccofine 1108 As Partial Replacement of Cement.

S.No	Alccofine 1108	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.63	3.84
2	5%	2.87	4.21
3	10%	3.13	4.46
4	15%	2.95	4.19

Table 5.7: Split tensile Strength Result on Concrete by Graphene Oxide as Partial Replacement of Cement.

S.No	Graphene Oxide	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.63	3.84
2	0.05%	3.54	5.17
3	0.10%	4.06	5.76
4	0.15%	3.78	5.42

Table 5.8: Combined Replacement Split tensile Strength Result on Concrete.

S.No	Jag+Af+Go	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.63	3.84
2	0.10% of Jag+10% Af+0.10% of Go	4.48	6.36

V. CONCLUSION

1) The Normal Concrete Compressive Strength Results is 26.56 and 39.13 N/mm^2 for 7 and 28 days.

2) By additive of Jaggery to cement at 0.10% the optimum compressive strength results is 31.51 and 45.33 N/mm^2 for 7 and 28 days.

3) By Partial replacement of cement with Alccofine 1108 the optimum compressive strength results at 10% is 31.11 and 45.15 N/mm^2 for 7 and 28 days.

4) By Partial replacement of cement with Graphene Oxide the optimum compressive strength results at 0.10% is 40.14 and 58.27 N/mm^2 for 7 and 28 days.

5) By combined replacement of 0.10% of Jaggery+10% Alccofine+0.10% Graphene Oxide the compressive strength results is 45.02 and 64.38 N/mm^2 for 7 and 28 days.

6) The Normal Concrete Split tensile Strength Results is 2.63 and 3.84 N/mm^2 for 7 and 28 days.

7) By additive of Jaggery to cement at 0.10% the optimum Split tensile strength results is 3.34 and 4.76 N/mm^2 for 7 and 28 days.

8) By Partial replacement of cement with Alccofine 1108 the optimum Split tensile strength results at 10% is 3.13 and 4.46N/mm^2 for 7 and 28 days.

9) By Partial replacement of cement with Graphene Oxide the optimum Split tensile strength results at 0.10% is 4.06 and 5.76 N/mm^2 for 7 and 28 days.

10) By combined replacement of 0.10% of Jaggery+10% Alccofine+0.10% Graphene Oxide the Split tensile strength results is 4.48 and 6.36 N/mm^2 for 7 and 28 days.

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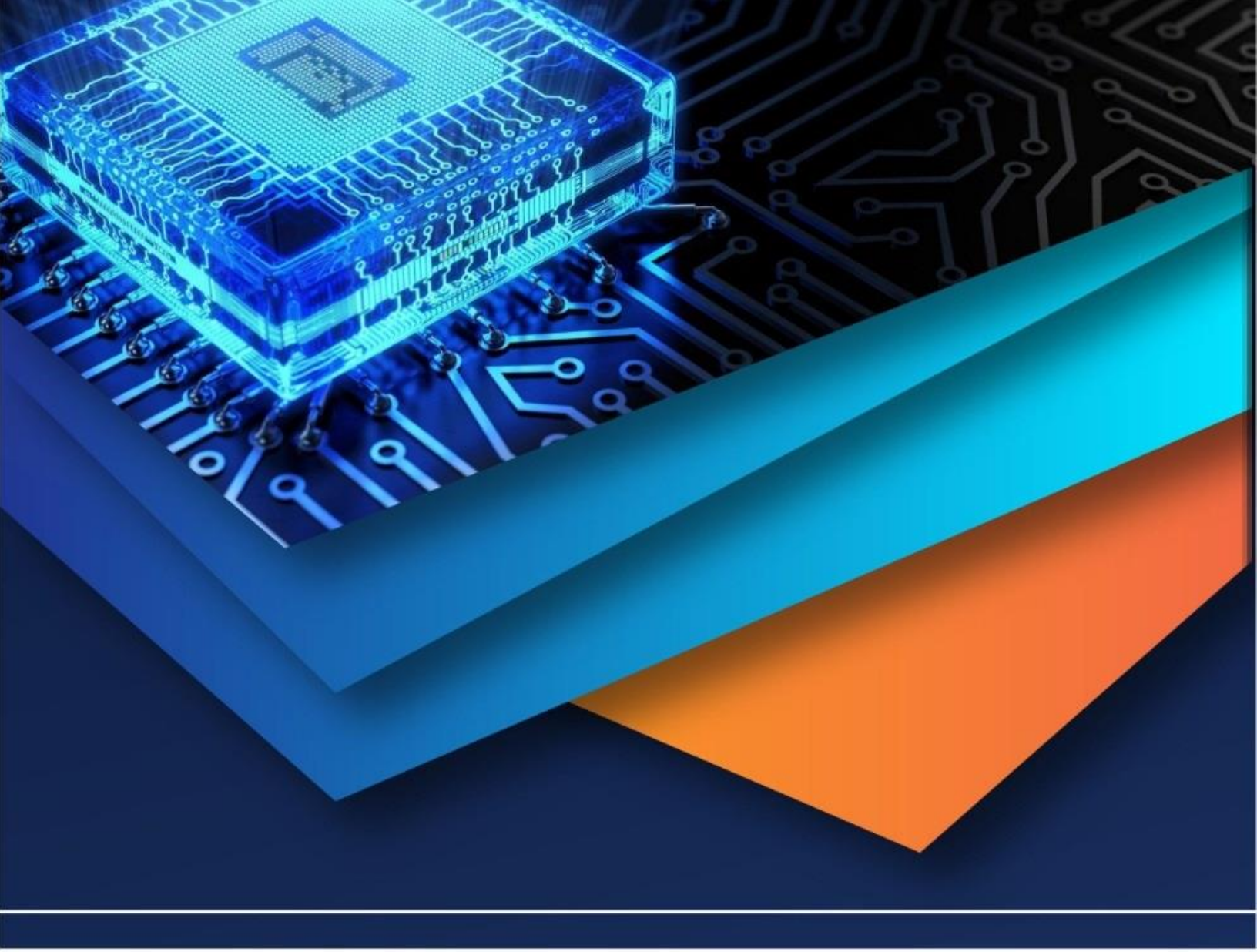

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