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MECHANICAL PROPERTIES OF CONCRETE WITH GRAPHENE OXIDEAND M-SAND

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ABSTRACT

The growing need for environmentally friendly building materials calls for creative ways to improve concrete's qualities while reducing its negative effects on the environment. This study examines the effectiveness of grapheme oxide (GO) nanoparticles as a concrete performance enhancer and manufactured sand (M-sand) as a sustainable substitute for natural sand. Utilizing M-sand, a byproduct of aggregate crushing, which provides a more regular gradation and fewer contaminants, is crucial given the depletion of natural sand deposits and the related environmental problems. At the same time, GO offers a viable way to enhance the macroscopic and microstructure characteristics of cementations composites due to its remarkable mechanical strength, high surface area, and chemical inertness. This study investigates different dosages of GO in the concrete mix as well as varied replacement amounts of natural sand with M-sand.Test for compressive strength and split tensile strength for 28,56 and 90 days.

KEYWORDS: ***M-Sand, Graphene Oxide, cementations, Compressive strength and Split tensile strength***

1. INTRODUCTION

The most widely used building material in the world, concrete is a multipurpose composite that is necessary for contemporary infrastructure. Cement, aggregates (sand and gravel), and water make up the majority of its composition. Cement hydrates these ingredients to form a strong, stone-like material. It is the foundation of roads, bridges, and structures due to its exceptional strength, moldability, and accessibility. The main factors contributing to concrete's widespread use are its long-term performance and affordability. Nonetheless, continuous study is motivated by its substantial environmental impact, especially from cement manufacture. Through creative material additions, efforts are concentrated on improving its sustainability and qualities. In the end, concrete is still essential to world progress and is always changing to satisfy new needs.

In the building business, manufactured sand, or M-sand, has become a vital substitute for the quickly running out of natural river sand. Hard rocks like granite or basalt are crushed into tiny, sand-sized particles to

create it. To get the right particle size distribution and get rid of contaminants, this designed material goes through a multi-stage process that includes crushing, screening, and frequently washing.The need for sustainable alternatives is highlighted by the escalating environmental issues linked to excessive riverbed mining, such as ecological deterioration and altered river flow. By using quarry waste and lowering the need on natural resources, M-sand provides a practical and environmentally responsible option. M-sand is produced under controlled conditions to guarantee consistent quality, in contrast to natural sand, which varies in quality and frequently contains significant quantities of silt and clay.

The oxidation of graphite, a readily available carbon source, produces graphene oxide (GO), an intriguing two-dimensional substance. It is a prospective additive because of its remarkable qualities, which include great mechanical strength and surface area. GO promotes a denser microstructure and improved hydration when added to concrete by acting as a nucleation site and nanofiller. In addition to increasing durability by lowering porosity and crack propagation, this results in notable improvements in mechanical qualities including compressive and tensile strength.

2. OBJECTIVES

1.To assess the effects of varying degrees of natural fine aggregate replacement with Msand on the mechanical prop erties of concrete, both fresh (workability, setting time) and hardened (compressive strength, split tensile strength).2 . To examine how different proportions of graphene oxide (GO) as a partial cement substitute affect the concrete's mechanical characteristics (compressive strength and split tensile strength) at various curing ages.

3. MATERIALS

3.1 Cement:A finely ground powdery substance, cement is typically produced from limestone and clay and functions as a key binding agent. Its chemical reaction with water, known as hydration, transforms it into a hardened paste that effectively binds aggregates within concrete and mortar.

3.2 Fineaggregate:In civil engineering, fine aggregate refers to granular material, such as sand, crushed stone, or crushed slag, with particle sizes ranging from those passing a 4.75 mm sieve down to those retained on a 0.075 mm sieve. Its critical functions in concrete include improving workability, enhancing density, and contributing to the overall strength and smooth surface by effectively filling the spaces between coarse aggregates.

3.3 Coarse aggregate: In construction, **coarse aggregate** refers to materials such as gravel or crushed stone. Its distinguishing characteristic is that its particles are predominantly retained on a 4.75 mm sieve. This type of aggregate is essential for giving concrete and asphalt mixes their bulk, strength, and structural integrity.

3.4 Water: Water has two critical roles in concrete: it undergoes **hydration**with cement to form the hardened binding paste, and it provides **workability** by lubricating the mix, which allows for proper placement and finishing.

3.5M-SAND:M-Sand serves as a sustainable and often superior alternative to natural river sand in various construction applications, including concrete mixes, masonry, and sometimes plastering. Its angular particle shape generally provides better bonding with cement, contributing to higher strength and durability in hardened concrete.

3.6 Graphene Oxide: An oxidized form of graphene, graphene oxide (GO) is a single-atom-thick sheet of carbon with attached hydroxyl, epoxy, and carboxyl groups. It's highly dispersible in polar solvents and is a key intermediate for producing reduced graphene oxide.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength

The compressive strength test measures the maximum load a material, like concrete, can withstand under compression before it fails or deforms. This is typically done by gradually applying force to a standardized specimen cube in a testing machine for 28,56 and 90 days.

Table 1: Compressive strength results of concrete with M-Sand used as a partial replacement of Fine aggregate.

Sl.no	% of M-Sand	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.96	35.85	38.32
2	10%	36.21	39.19	42.14
3	20%	37.06	40.18	43.21
4	30%	37.45	40.89	43.86
5	40%	36.33	39.56	42.48

Table 2: Compressive strength results of concrete with Grapheme oxide used as a partial replacement of Cement

Sl.no	% of Graphene Oxide	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.96	35.85	38.32
2	0.05%	44.52	48.41	51.85
3	0.10%	48.99	53.38	57.19
4	0.15%	45.83	49.41	53.09

Table 3: Ccombined Compressive strength of concrete with 30%M-Sand+0.10%GO

Sl.no	*30%M-Sand+0.10%GO*	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.96	35.85	38.32
2	*30%M-Sand+0.10%GO*	51.28	55.76	59.88

4.2 Split tensile strength

The split tensile strength test offers an indirect way to find the tensile strength of brittle materials like concrete. In this test, a cylindrical specimen is laid horizontally, and a compressive load is applied across its diameter. This action causes the cylinder to split along the loaded line due to the tensile stresses that are generated within it.To cracking in concrete constructions for 28,56 annd 90 days.

Table 4: Split tensile strength results of concrete with M-Sand used as a partial replacement of Fine aggregate.

Sl.no	% of M-Sand	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.47	3.73
2	10%	3.56	3.88	4.14
3	20%	3.66	4.01	4.27
4	30%	3.93	4.28	4.66
5	40%	3.59	3.91	4.19

Table 5: Split tensile strength results of concrete with Graphene oxide used as a partial replacement of Cement

Sl.no	% of Graphene Oxide	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.47	3.73
2	0.05%	4.35	4.76	5.05
3	0.10%	4.84	5.27	5.66
4	0.15%	4.56	4.95	5.32

Table 6: Combined Split tensile strength of concrete with 30%M-Sand+0.10%GO

Sl.no	*30%M-Sand+0.10%GO*	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.47	3.73
2	*30%M-Sand+0.10%GO*	5.07	5.52	5.97

5. CONCLUSION:

1. The normal concrete compressive strength results for 28,56 and 90days is 32.96,35.85 and 38.32 N/mm^2.
2. At 30% partial replacement of fine aggregate with M-Sand which gives compressive strength result for 28,56 and 90days is 37.45,40.89 and 43.86N/mm^2.
3. At 0.10% partial replacement of cement with Graphene Oxide which gives compressive strength result for 28,56 and 90days is 48.99,53.38 and 57.19N/mm^2.
4. Compressive strength result for combined replacement of 30% partial replacement of fine aggregate with M-Sand and 0.10% partial replacement of cement with Graphene Oxide which gives compressive strength result for 28,56 and 90days is 51.28,55.76 and 59.88N/mm^2
5. The normal concrete split tensile strength results for 28,56 and 90days is 3.21,3.47 and 3.73N/mm^2.
6. At 30% partial replacement of fine aggregate with M-Sand which gives split tensile strength result for 28,56 and 90days is 3.93,4.28 and 4.66N/mm^2.
7. At 0.10% partial replacement of cement with Graphene Oxide which gives split tensile strength result for 28,56 and 90days is 4.84,5.27 and 5.66N/mm^2.
8. split tensile strength result for combined replacement of 30% partial replacement of fine aggregate with M-Sand and 0.10% partial replacement of cement with Graphene Oxide which gives compressive strength result for 28,56 and 90days is 5.07,5.52 and 5.97N/mm^2.

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