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Experimental Studies on Graphite Admixture Concrete and its Application

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***Abstract**: Graphite is a type of crystal carbon and a half-metal, with a planar and layered structure. It is a grayish black, opaque substance, lighter than diamond, smooth and slippery to touch, a good conductor of heat and electricity, and a crystalline solid. Graphite is used in various applications, including steelmaking, brake linings, lubricants, foundry facings, and batteries. Graphite atoms are sp2 hybridized and are non-inflammable.*
The study aims to study the properties of graphite admixture concrete and suggest its use in the construction sector. The objectives include assessing mechanical properties, thermal conductivity, durability, workability, cost-benefit analysis, and sustainability. The experimental studies used include the Cement Fineness Test, Consistency Test, Initial Setting Time, and a Cost-Benefit Analysis.

1. INTRODUCTION

Carbon is the sixth element on the periodic table and can be found in abundance in the sun, stars, comets, and atmospheres of most planets Carbon is a Group 14 element (on older periodic tables, Group IVA) along with silicon, germanium, tin, and lead. Carbon is distributed very widely in nature.Graphite is a type of crystal carbon and a half-metal along with being one of the renowned carbon allotropes. This crystal carbon has a structure that is planar and layered. Graphemes is the term used to denote each layer of the same. Every layer has atoms of carbon arranged in a honeycomb-like network with the division of 0.142 nm with 0.335 nm distance between planes. There is a covalent bonding for atoms in the plane with the criteria being met by only three out of four probable bonding sites.

1.1 Properties of Graphite

1. Graphite occurs in the free state but can also be prepared artificially.
2. It is a grayish black, opaque substance.
3. Lighter than diamond, smooth and slippery to touch.
4. It is a good conductor of heat and electricity.
5. Carbon atoms are sp2 hybridized.
6. It is a crystalline solid It melts about 1800K. Non-inflammable.
7. Soft due to weak Vander wall forces.

1.2 Uses of Graphite

1. In modern times, Graphite is usually consumed in steelmaking, brake linings, lubricants, foundry facings, batteries to name a few.

2. One of the important components of graphite viz. grapheme has certain special features and is one of the widely known strong materials. To separate the component from the carbon crystal would require better advances in technology.
3. The uses of the crystal include electrodes and refractoriness used in applications for processing materials at high temperature.

2. AIM AND OBJECTIVES

2.1 AIM: To study the properties of Graphite Admixture concrete and suggest its use in construction sector.

2.2 Objectives

1. Assessing Mechanical Properties: Determine how the inclusion of graphite admixtures affects the compressive strength, flexural strength, and tensile strength of concrete.
2. Thermal Conductivity: Investigate how graphite affects the thermal conductivity of concrete, which is crucial for applications where insulation is required.
3. Durability: Analyze the impact of graphite on the concrete's resistance to environmental factors such as freeze-thaw cycles, chemical exposure, and corrosion of reinforcing materials.
4. Workability: Evaluate the workability of graphite-admixed concrete, including slump flow and setting times.
5. Cost-Benefit Analysis: Conduct a cost-benefit analysis to determine if the use of graphite admixtures is economically viable compared to traditional concrete mixes.
6. Sustainability: Assess the environmental impact of graphite admixtures, considering factors like reduced carbon emissions and resource efficiency.

3. METHODOLOGY

Following is the procedure adopted for Experimental Studies On Graphite Admixture Concrete and its Application below tests are followed:

3.1Cement

- **Fineness Test** *:* from that test we received the fineness of cement that we are used for our project work

Table 3.1: Fineness test of cement

Sample	Wt. Passing Through 90 micron sieve	Wt. Retained on 90 micron sieve
100 gm	5 gm	95 gm

Fineness of Cement = 5/100 ×100 = 5%

- **Consistency Test**: This test is conducted to find the setting times of cement using a standard consistency test apparatus, Vicat's apparatus.

Table 3.2: Consistency test of cement

Sr. Numbers	% Added of Water	Quantity of Water Added	Penetration
1	20	80	36
2	22	88	24

3	24	96	12
4	26	104	4

Consistency of Cement was found to be 26%.

- **Initial Setting Time**: For this test, a needle of 1 mm square size is used. The needle is allowed to penetrate into the paste (a mixture of water and cement as per the consistency test). The time taken to penetrate 33-35 mm depth is recorded as the initial setting time.

Table 3.3: Initial setting time of cement

Sr. Numbers	Setting Time	Penetration (mm)
1	10	33
2	20	25
3	30	12
4	40	4

Initial Setting time of Cement was found to be 40 min.
Finial setting time of Cement was found to be 600 min.

3.2 Sand
Sieve Analysis (SA): the results of the seive analysis

Table 3.4: Sieve Analysis of Sand

Sr. no	Sieve Size	Sieve Weight(gm)	Wt. Retained(gm)	% Retained	Cummulative % Passing
1	4.75 mm	724	0	0	100
2	2.36 mm	498	185	185	18.5
3	1.18 mm	358	197	382	38.2
6	300 micron	365	274	656	65.6
7	150 micron	341	43	699	69.9
8	90 micron	367	3	702	70.2
9	75 micron	383	1	703	70.3
10	pan	284	0	703	70.3

3.3 Specific Gravity Test (SGT): following procedure for Specific gravity test are we as followed:

- Weight of Empty Pycnometer : (W1) = 546 gm.
- Weight of Pycnometer + Sand : (W2) = 1033 gm.
- Weight of Pycnometer + Sand + Water: (W3) = 1816 gm.
- Weight of Pycnometer + Water : (W4) = 1518 gm.
- (SPG) = W2-W1/ (W4-W1)- (W3-W2)
- = 2.58
- For Coarse Aggregate **= 2.96**

3.4 Silt Content Of Sand:

- Water Content = 50ml. silt content = v1/v2 × 100

- Silt Content = 10ml (V1)
- Sand Content = 120ml (V2)
- Silt Content of Sand = 8.33

3.5 Bulk Density Of Fine Aggregate:

- Wt. of empty jar = 174 gm.
- Wt. of jar + Fine Aggregate = 4014 gm.
- The Water capacity of jar 2400ml.
- = 4014 – 174
- = 3840/240 = 1600 Kg/m^3.
- The Bulk Density of Fine aggregate is 1600 kg/m^3.

3.6 Bulk Density Of Coarse Aggregate:

- Wt. of empty jar = 174 gm.
- Wt. of jar + Coarse aggregate = 3654 gm.
- The water capacity of jar 2400ml.
- = 3654 – 174
- = 3480/240 = 1450 Kg/m^3.
- The Bulk Density of Coarse aggregate is 1450 Kg/m^3.

3.7 Impact Test Of Coarse Aggregate:

- Empty mould Wt. = 2.215 kg.
- Empty mould + Coarse aggregate = 2.856 kg.
- Sieved from 2.36mm IS sieve 20
- Wt. retained or passing = 40g.
- Impact value = 40/641 × 100 = 6.24.

3.8 Water Absorption Of Coarse Aggregate:

- Only dry sample = 1000gm.
- Partly fill water + coarse aggregate (A) = 1872gm.
- Empty jar + water (B) = 1214gm.
- Saturated surface dry sample (C) = 1001gm.
- Oven dry sample (D) = 994gm.
- C – D/D × 100 = 1001 – 994/994 × 100 = 0.70%

3.9 Los Angeles Abrasion Value Of Aggregate:

- Sample = 5 kg.
- Revolutions = 500.
- Sieved through = 1.18 mm IS sieve.
- Wt. passing = 263 gm.
- 5000-263/5000×100= 94.74%

3.10Fineness Modulus (FM):

Table 3.5: Fineness Modulus of Fine aggregate

Sr. numbers	Sieve Size	Sieve Weight(gm)	Wt. Retained(gm)	% Retained	Cummulative % Passing
1	4.75 mm	724	0	0	100
2	2.36 mm	498	185	185	18.5
3	1.18 mm	358	197	382	38.2
6	300 micron	365	274	656	65.6
7	150 micron	341	43	699	69.9

8	90 micron	367	3	702	70.2
9	75 micron	383	1	703	70.3
10	pan	284	0	703	70.3

Sr. numbers	Sieve Size	Sieve Weight(gm)	Wt. Retained(gm)	% Retained	Cumulative % Passing
1	40 mm	862	0	0	0
2	31.5 mm	837	0	0	0
3	25 mm	697	528	10.56	89.44
4	20 mm	820	2158	43.16	56.84
5	16 mm	756	1286	25.72	74.28
6	12.5 mm	628	518	10.36	89.64
7	10 mm	771	358	7.16	92.84
8	pan	479	129	2.58	97.42

- 403/100 = 4.03
- 500.46/100 = 5.00

3.11 Slump Test

Table 3.6: Slump test of Concrete

Sr. Number	Proportion					Slump
W/C		Water Content	C	F.A	C.A	
1	0.45	1260	2800	3584	8652	35 mm
2	0.46	1288	2800	3584	8652	41mm
3	0.47	1316	2800	3584	8652	55 mm

- **Mix Design For M35 grade:**

Grade of Concrete M35 Characteristic strength (Fck) = 35 N/mm^2.
Standard Deviction = 5.0
35+1.65 + 5 =43.25N/mm²
• Specific gravity
F.A = 2.60, C.A = 2.89, c = 3.14
• Max. water content = 186 kg
• Max. cement content = 320kg/m³, Free W/C Ratio = 0.45

- **Step-1: Target mean strength.**

Fck = fck + 1.65× 5 = 35 + 1.65 × 5 = 43.25 N/mm². 25

- **Step-2: Selection of W/C ratio.**

As per IS 456: 2000 the free W/C ratio for sever exposure condition is taken as 0.45.

- **Step- 3: Estimation of entrapped air prevent.**

As per IS 10262-2019 entrapped air % For max. Nominal size of aggregate Taking 20mmis 1.0%.

- **Step- 4: From selection of Water and Sand.**

For maximum Nominal size of aggregate 20mm.
Max. water content = 186 kg and sand % of Total aggregate dry Volume = 35% .Required water content = 186 +(186 × 3)/100 = 191.6 liter/m^3.

Sand content = 35 - 3.5 = 31.50%. Step- 5: Determination of Cement Content.
W/C Ratio = 0.45
Water = 191.6 liter/m^3, C = 425.78 kg/m^3.
W/C = 0.45, 191.6/C = 0.45

- **Step- 6: Determination of Fine & Coarse Aggregate.**

Consider vol. of concrete = 1m^3 entrapped air =1% (IS 10262-200).
Absolute volume= 0.99m^3, V = [W + C/Sc + 1/P × F.A/Sf.a] × 1/1000
0.99 = [191.6 + 425.18/3.14 + 1/0.315 × F.A/260] × 1/1000F.A = 542.83kg/m^3.
Similar C.A., V = [W+ C/(Sc) + 1/(1-P) × Ca/Sca] × 1/1000
0.99 = [191.6 + (425.78)/(3.14) + 1/(1 - 0.315) × C.a/(2.89)] ×1/1000C.A =1312.11kg/m^3.

Table 3.7: Mix Design Result

Water	Cement	F.A.	C.A.
191.6	425.78	342.83	1312.11
0.45	1	1.28	3.09

Ratio: - 1: 1.28: 3.09.

4. RESULT AND DISCUSSION

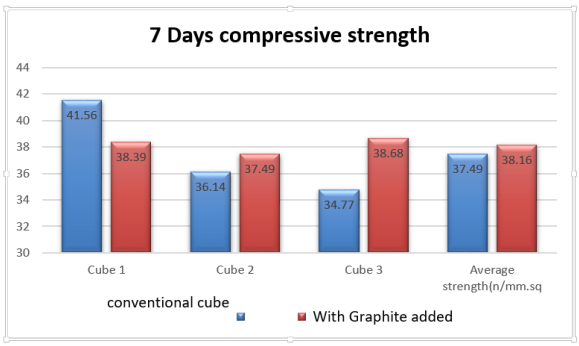
The results show that graphite admixtures can improve the compressive strength, flexural strength, and tensile strength of concrete, as well as its thermal conductivity, durability, workability, cost-benefit analysis, and environmental impact. The study also considers the environmental impact of graphite admixtures, considering factors like reduced carbon emissions and resource efficiency.

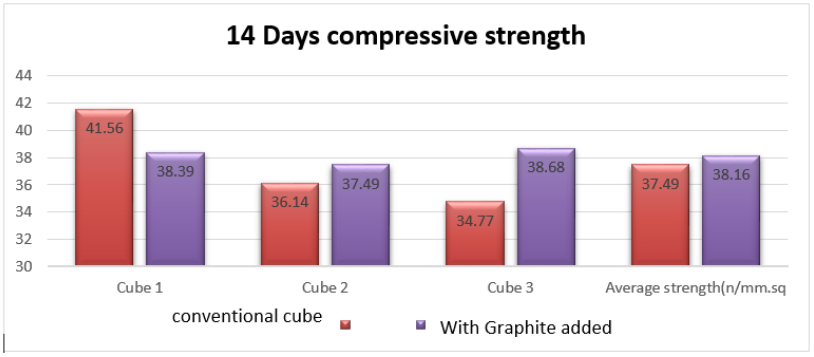
Table 4.1: The result of Conventional

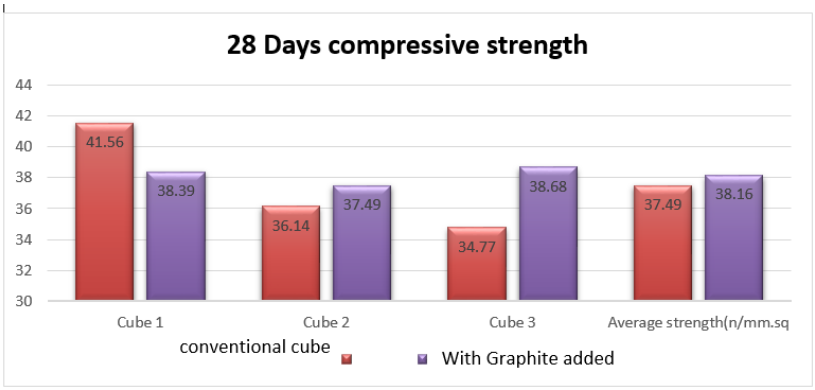
Day	Cube 1	Cube 2	Cube 3	Average strength (n/mm's)
7	22.95	22.96	23.28	23.06
14	31.78	30.32	32.51	31.53
28	41.56	36.14	34.77	37.49

Table 4.2: The result of cubes with graphite Cube Added 2%

Day	Cube 1	Cube 2	Cube 3	Average strength(n/mm's)
7	28.92	24.42	20.54	24.62
14	37.49	36.12	36.45	36.68
28	38.39	37.49	38.68	38.16







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