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Influence of RGO and Fly-ash on Cement Composite at Elevated Temperatures

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Abstract - *The experiment was conducted to do a study on influence of reinforcing RGO and fly ash with Ordinary Portland Cement concrete composite. In this study samples were made with 0.02%, 0.04% and 0.06% of RGO and 20% of fly ash by weight. In this it was found that on introduction of RGO into the cement can increase the compressive strength as well as the tensile strength of the concrete block by more than 40% because of reduction in pores which are being filled by reduced graphene oxide and fly ash. The composites were exposed to elevated temperatures of 200°C, 400°C and 600°C to predict its behavior. Fly ash was used as a filler material for making cement cheap and its properties which help in enhancing strength of concrete. It was also noticed that on introduction of RGO the rate of hydration was enhanced. However, the workability of the RGO-cement reduced. In overall conclusion it was in the impression that RGO & fly ash can be a promising filler for the Ordinary Portland cement.*

Key Words: Reduced graphene Oxide, Fly-ash, Concrete mix, admixtures, Rate of hydration.

1.1. INTRODUCTION

Recently concrete has gained a lot of popularity because of its applications as a resource-efficient, durable and cost effective. Concrete acts as a material which is non-flammable and can be exposed to elevated temperature for use in furnaces, reactors and unexpected fire. However the mechanical properties of concrete are subject to change due to high temperature effects, such as strength, young's modulus, volume deformation, these properties diminish remarkably resulting in poor structural quality of concrete. Fly ash, which is a principle by-product generated from coal combustion and thermal power plants, it can also be extracted from volcanic ashes. It is a spherical powder with a specific gravity range of 2.1–3.0 allowing then to flow and blend freely in mixtures. A concrete mix with fly ash can provide environmental and economic benefits. It was observed that up to 25% fly ash has given good results in fresh and hardened state. Fly Ash when used as admixture in concrete. It enhances the workability, compressive strength, flexural strength and also increases its pumpability, durability and concrete finishing. It also reduces hydration heat and makes the concrete light weight, reduce corrosion, reduces permeability and dense calcium silicate hydrate(C-S-H). Alkali silica reaction, sulphate reaction shrinkage as it decreases its permeability and bleeding in concrete. The disposal of fly ash is a serious environmental problem. In India, 110 million of fly ash is produced and 2-30 percent is used and rest occupies vast tracks of valuable land as a pond. The major composition of fly ash is mainly SiO2, Al2O3 and Fe2O3, however it may contain CaO depending upon the source. As we know that the cement molecules have some free space in them which can be filled with nano-sized materials having high surface area to volume ratio. We know that addition in small proportion of nanomaterials such as reduced graphene Oxide, Nano silica, nano alumina, which can effectively blend with cement matrix, enhancing mechanical and durability properties. Nanomaterials are suggested to be super-sorbents that absorb free water due this the workability reduces. Further, it was noticed according to the reports that the compressive, tensile and flexural strength were increased up to 30%, 78% and 60% respectively. Till date many have done research on 0.03% RGO finding its properties but we have included 20% fly ash and 0.05% of plasticizers in the cement and subjected to elevated temperature to see what are the properties of cement and how the components all together enhance the mechanical properties of the cement.

2.1. METHODOLOGY AND EXPERIMENT.

2.1.1 Cement:

In this experiment we have used Ordinary Portland Cement of grade 43 (Ultra tech Cement) with IS: 8112-1989. The cement was in light grey colour with good chemical and physical characteristics.

Fig: 1 Ordinary Portland cement

The properties and Requirements of cement are as mention in the table below.

SI.No.	Physical Properties of Cement	Requirements as per IS code
1.	Specific Gravity	3.10-3.15
2.	Standard Consistency	30-35
3.	Initial Setting time	30 Min
4.	Final Setting Time	600 Max
5.	Compressive Strength	33 N/mm^2
6.	Compressive strength	43 N/mm^2

Table 1. Physical properties Cement

2.1.2 Reduced Graphene Oxide:

Fig: 2 Reduced Graphene Oxide

Reduced Graphene Oxide is a material which has high surface to volume ratio. The reduced graphene oxide was purchased from United Nano Tech limited. The features of RGO are as given in the table.

Length Average	1-10 micron
Thickness Average	0.8~2nm
Product Purity	>98.8%
Number Of layers	Average 3-6
Lateral dimension	~ 10µm
Surface Area BET	>150 m^2/g
Bulk Density	0.48 g/cm^3

Table 2.Physical Properties of RGO

2.1.3 Fly ash:

Fig: 3 Fly-ash

The fly ash used for the study was of F-class. Class F fly ash is designated in ASTM C618 and originates from anthracite and bituminous coals. The chemical composition of fly ash is given below.

Chemical Composition	ASTM C618 Requirements %
$SiO_2+Al_2O_3+Fe_2O_3$	70
SO_3	5
Moisture Content	3
Loss of ignition	6

Table 3. Chemical Composition of Fly Ash

2.1.4 Super plasticizer:

Fig.4 Masterglenium Sky 8341

The chemical used as a super plasticizer was masterglenium sky 8341. This was provided free from BASF Bengaluru. This was used 0.5% as to increase the workability of the concrete.

Aggregate: As we know that aggregates are the most important constituent of the concrete. The aggregate used should have least voids so that they can bind easily with less paste which means less cement and less water this proportionately makes concrete economical.

2.1.5 Course Aggregate:

Fig.5. Course Aggregate

These are the crushed stones size ranging from 4.5mm to 20mm the aggregates used were as per IS: 383.

2.1.6 Fine Aggregate:

Fig. 6. Fine Aggregate

These aggregates vary from size 150micron to 4.5mm as per IS: 383. This was brought from Cauvery River and screening was done to remove oversize aggregates.

2.2.1Mix Design:

The mix design was based on M30 grade as per IS: 10262 2009 method. The mix was in the proportion 1:1.61:2.74. A total of 168 cubes were made in the set of 12. We have done 7 types of test were made. The water cement ratio used for the study was 0.35. 3 samples were made for each test. The test was carried out on 7th day and 28th day for compressive strength.

2.2.2 Specimen Preparation:

The specimens were made based on three combinations. 1. OPC Concrete Composite. 2. RGO concrete Composite 3. RGO-Fly ash Concrete Composite. In this the fly ash was mixed with RGO and Cement with the help of ball milling process and then mixed with the proportionate quantity of cement. Took course aggregate and fine aggregate in the given proportions and added RGO-Fly ash-cement and dry mixed all of them together then added 0.5% of superplasticizer with 20% reduction in water content as per water cement ratio of 0.35.The specimen size is 70mm × 70mm × 70mm and was cured at a temperature 26° and 85% humidity. All the specimen were test on 7th day and 28th day to find compressive strength.

2.3 Testing of Specimen:

Fig.8 Compressive Strength Testing Machine

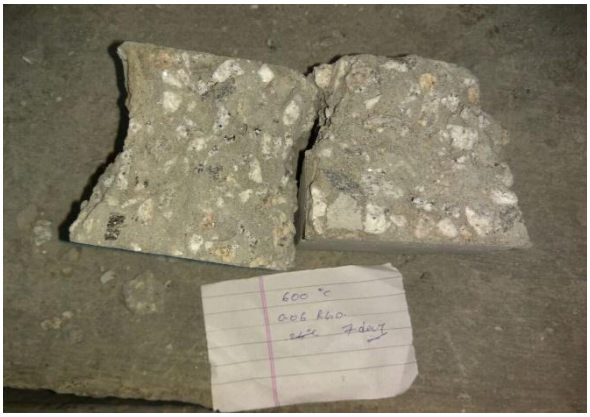
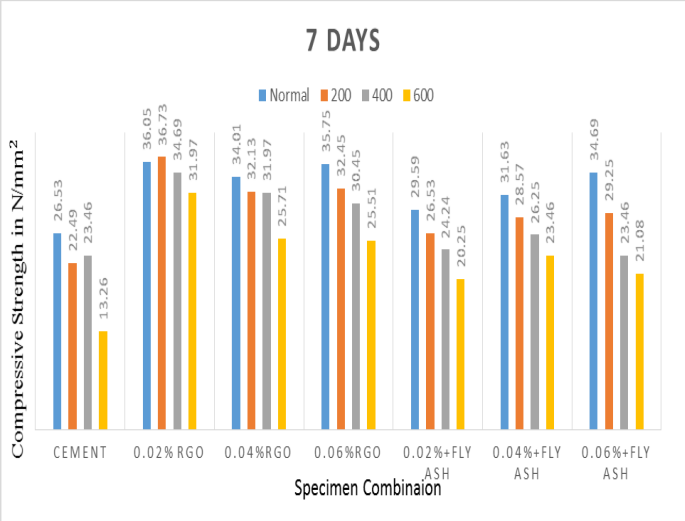


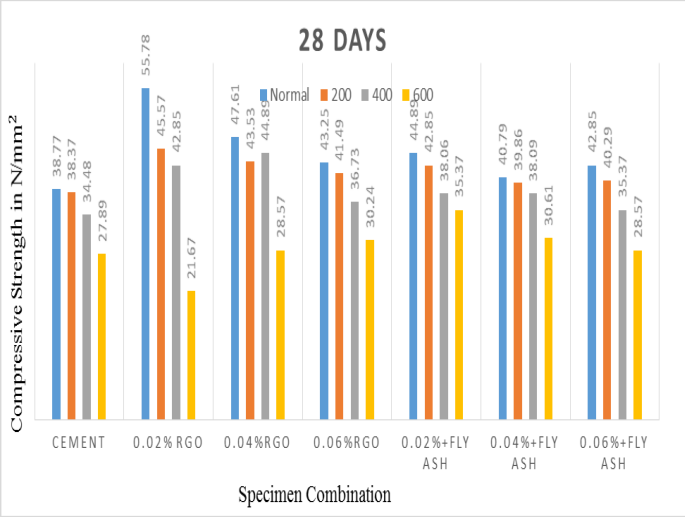
Fig.9 Specimen after failure

The compressive strength of all concrete specimens was determined following Indian Standards procedure. The specimens were removed after 24 hours from the moulds and then immersed in water until their respective testing period. For each test three specimens were tested for the determined the average compressive strength. Test was performed on compressive testing machine having capacity of 1000 MT. the average values of samples has been reported below.

3.RESULT AND DISCUSSION We have successfully done the test and obtained the values. The values obtained are and represented in the graph below.



Graph 1. Overall Result of the experiment performed on 7th Day.



Graph 2. Overall Result of the experiment performed on 28th Day.

4. CONCLUSION:

1. Addition of 0.02% RGO in specimen the heat of hydration is more and the setting time decreases.
2. 0.02% RGO maintains the characteristics at elevated temperature 600°C
3. Increase in RGO reduces the strength but it maintains the properties at elevated temperatures.
4. Increased percentage of RGO in fly ash, cement mix helps increase in strength at normal temperature.

RGO shows its properties on ordinary Portland cement as well as Fly ash mixed cement. That is it increases its strength within 7days of curing.

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