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A Reciprocal Research on Compressive Strength of Conventional Concrete and Carbon Fibre Concrete Exposed to High Temperature

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Abstract: ***An look up has been function to evaluated the have an impact on of evaluated temperature on the compressive strength of grade concrete M25, the goal of the discover out about used to be once to actuate and observe the big difference in compressive strength containing no fiber and concrete with fiber as properly as have an impact on of temperature on compressive strength of concrete. 72 concrete cubes of 150mm measurement have been cast. The carbon fibers used in the learn about are 6mm long chopped carbon fibers& dosage of 0.3%, 0.6%, and 0.9% by the weight of concrete. Concrete elements exposed to fire, undergo bodily changes or spalling which leads to expose metal reinforcement .This motives misery in concrete structure .The overall performance of the concrete can be lengthen with the addition of carbon fiber. Undergo bodily changes or spalling which leads to expose metal reinforcement .This motives misery in concrete structure .The overall performance of the concrete can be lengthen with the addition of carbon fiber. It can be noticed that carbon fiber reinforcement exhibits more compressive strength than the conventional concrete exposed to high temperature.***

Index Terms: Carbon fiber, compressive strength, fiber reinforced concrete fibers extent dosage, extended temperature.

I. INTRODUCTION

Concrete is a adaptable constructing cloth used in the improvement of constructions and structures. It is additionally right fireplace resistance distinction with special constructing materials, uncovered to excessive temperature in the time of the furnace one of the most hazardous environmental affect for strengthened concrete structures, in case of publicity to excessive temperature for a longer size of time, concrete endure immoderate chemical and bodily modifications which leads to weakening of concrete. A concrete structure is subjected to immoderate temperature; it will fail in many of one of form techniques such as colour, compressive strength, elasticity, and concrete density and floor seem are pretentious via excessive temperature.

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The engineer building have to sketch for shape can stand up to excessive temperature and in addition often for furnace exposures, at some factor of publicity to excessive temperature such as fire, the mechanical properties of the concrete such as strength, elastic modulus and volumetric stability are surprisingly reduced.

To be profitable to forecast the retaliation of shape after publicity to excessive temperature, it is required that the electricity houses of concrete subjected to immoderate temperature be in actuality understood. High temperature can reason the enhancement of cracks. These like any cracks replica may additionally also finally purpose loss of structural integrity and shorting of service life. However, the spalling of concrete would expose steel reinforcement in a reinforced concrete member at some point of furnace hazard, which in addition harm the structure. The main disadvantage is that concrete develops micro-cracks for the length of curing. It is speedy propagation of these micro-cracks beneath utilized stress that is practical for the low tensile electricity of the material; consequently fibers are delivered to concrete to overcome these disadvantages. Fibers are in many instances used in concrete to manipulate plasting shrinkage and drying shrinkage cracking. They additionally decrease the permeability of concrete and as a result restriction the bleeding of water. The addition of fibers was as soon as determined to embellish the behaviour of concrete at increased temperature, it additionally enhance the pre and publish cracking behaviour.

Carbon fibers additionally supply an cheap advantage as they are effortlessly on hand as a waste product from aerospace organisation and supply 2to5 conditions greater stress than the different fibers, carbon fibers possess many conceivable advantages over exceptional fibers consisting of a greater strength, greater modulus and elevated durability. Carbon fibers make greater the furnace resistance, impact, compression, reduce up tensile & flexural strength.

Carbon fibers are used in aerospace, civil engineering, military and enormously high priced when contrast to similar fibers.

Effect of high temperature on strength of concrete: Effect of excessive temperature on electrical energy of concrete: Under regular state, most concrete constructions are subjected to a fluctuate of temperature no greater drastic than that imposed by way of the usage of ambient environmental conditions. However, there are integral cases the neighbourhood these constructions may also moreover be uncovered to a suitable deal greater temperatures (e.g., jet plane engine blasts, developing fires, chemical and metallurgical industrial features in which the concrete is in shut proximity to furnaces,

and some nuclear power-related postulated accident conditions). Concrete's thermal residences are more complicated than for most substances due to the fact now no longer truly is the concrete a composite material whose components have wonderful properties,

butits residences moreover depends upon on moisture and porosity. Exposure of concrete to accelerated temperature has impact on on its mechanical and bodily properties. It has been determined that immoderate early temperature has horrible affect on later electrical energy of concrete. Some researchers investigated the hazardous effect on abiding power of concrete due to immoderate preliminary temperature. High preliminary cost of hydration due to accelerated temperature detains the subsequent hydration and produces a non-uniform distribution of the merchandise of hydration. Its intent is that at immoderate preliminary charge of hydration, there is insufficient time on hand for the dispersal of the merchandise of hydration away from the cement particle and for a uniform precipitation in the interstitial space. All this consequences in hobby of the merchandise in the regional of the hydrating particles which causes subsequent retardation in hydration and outcomes strength.

II. LITERATURE REVIEW

1. Alwyn-verghese, D. Jasper selva Samuel, Anand.n, prince-arulraj G: Their investigation done to evaluate the influence of the elevated temperature on the properties of different fiber Reinforced concrete. In their study they found the modulus of elasticity decreased when the duration of heating increased. Concrete with carbon fiber, basalt fibre exhibited the high modulus of elasticity. They also found the polypropylene fiber melts at temperature & create pore holes.

2. Navya HA, Dr. Nayana n patil: Their investigation carried out to find the strength and durability characteristics of carbon-fiber reinforced concrete. They found that when increase the carbon fiber dosage decrease the workability. Compressive strength the conventional concrete was found to Increased. They also observed that there is an increase in strength (compressive, flexural, split tensile) for carbon fiber reinforced Concrete up to 1% of fibers by weight of concrete and decreased for 1.25% addition of carbon fibers. They also found the carbon fiber reinforced concrete is more resist to acid and sulphate attacks when compared to conventional concrete

3. Alwyn-verghese, Anand.n and prince arulraj G: Their investigation on the stress-strain behaviour and modulus of elasticity of fiber strengthened concrete at increased temperature. From their investigation they discovered that the remaining strength of the fiber strengthened concrete decreased with extend in temperature. The reduction was found to "vary" according to the type of the fiber added to the fiber reinforced concrete. They also found that for 90minutes of heat exposures ultimate compressive strain in control concrete and all fiber reinforced concrete specimens exceeds the maximum allowable strain limit. High melting point fibers (carbon & basalt) had low strain at ultimate stress in 90mints of heat exposure. In the case of carbon fiber reinforced concrete at unheated conditions the modulus of elasticity increased 41% &in case of heated condition it shows an increment of 130% than the control concrete.

III. METHODOLOGY

A. Work:

To produce Standard Concrete and Carbon Fiber Reinforced Standard Concrete, the vital work implicates Designing an best combine share and evaluating the properties of the concrete as a end result acquired. Contemporary concrete combine designs can be complex. The plan of a concrete, or the way the weights of the factors of a concrete is resolute, is authentic by using means of the necessity of the project.

The sketch begins by using way of figuring out the "durability" necessities of the concrete. These requirements take into deliberation the nearby climate conditions that the concrete will be uncovered to in service, and the required sketch strength. Many elements want to be taken into consider, from the fee of the greater than a few aspects and Aggregates, to the trade-offs between, the "slump" for reachable mixing and placement and remaining performance. In the existing work today's concrete of M25 combine is used. Compressive energy tests have been regulated to recognize the electrical energy residences of the mixes.

Strengths have been distinction between stylish concrete and carbon fiber bolstered concrete uncovered to immoderate temperature.

The experimental time desk can be diagnosed in two stages, first, to beautify self-standard concrete of M25 mix, which guarantees specs given via the usage of Indian Standards. Then, in the second stage characteristics of compressive strengths uncovered to excessive temperature were deliberate by adding and barring which includes fibers.

The software program software consisted of make sure at mix proportions, weighing the elements of concrete accordingly, mixing them in a typical concrete mixer and then trying out for the sparkling residences of respective concrete. If glowing residences fulfil preferred specifications, 9 Standard cubes of dimensions a hundred and fifty mm x a hundred and fifty mm x150 mm have been stable to take a seem to be at whether or not or no longer the goal compressive electricity is completed at 7-days, 14-days and 28- days curing. If both the fresh residences and the electricity residences are now no longer satisfied, the combine is modified accordingly.

Standard dice moulds of one hundred fifty mm X one hundred fifty mm X a hundred and fifty mm made of strong iron had been used for casting famous cubes. The requirements moulds had been equipped such that there are no gaps between the plates of the moulds. The moulds then oiled and remain prepared for casting. After 24 hours of casting, the specimen have been DE moulded and transferred for comparing strengths for M25 grade, contemporary concrete and Carbon fiber bolstered concrete, a whole of 72cubes have been caste. The concrete used to be blended in a floor.

The mixer was once hand-loaded with coarse aggregate first, then with fantastic combination and then with cement for Standard kind of Concrete. And for the Carbon Fiber Reinforced Standard concrete the same is repeated with the inclusive of Fibers in the last. Oil was once as quickly as applied to the indoors faces of the moulds to preserve away from any insert of concrete to the walls of the moulds.

B. Cubes

To look at the compressive electrical energy of concrete, 36 cubes of a hundred and fifty mm measurement for each and every form of concrete had been cast. 150mm cube moulds have been stuffed with concrete and positioned on desk vibrator and vibrated for 1 minute, after the compaction used to be completed, the surfaces of the cubes had been levelled with a trowel and had been marked for recognition. These specimens had been DE moulded after 24 hours of casting. Testing of specimens had been carried out after 7, 14 and 28 days of curing and then exposed to temperatures.

C. Curing of Specimens

After the specimens have been DE moulded, these have been stored below water at room temperature till examined at an age of 28 days. The specimens have been cured in a water tank for 28 days. After 28 days of casting, all the specimens have been taken out of curing tank and saved under laboratory air drying conditions till required for excessive temperature exposure or for any load test.

D. Testing of Specimens:

After curing for 28 days, the specimens had been examined for compressive strength.

The bearing surfaces of the compression attempting out computing machine have been wiped clean. The cubes to be examined have been placed concentrically and in such a manner that the load used to be utilized to the contrary elements of the cube as cast, that is, now not on the pinnacle and bottom. Then the load used to be utilized except shock and two raised consistently at a price of about one hundred forty kg/sq. cm/minute till the resistance of the dice to the elevating load braked down and no greater load should be undergo. The maximum load utilized to the cube used to be two then referred to down.

E. Exposing Specimens to increased temperatures and Testing:

To determine the electrical power after exposed to accelerated temperatures, the specimens had been heated in oven.

F. Heating Specimens

During furnace smash out, the structure is uncovered to irregular uncontrolled furnace in which the temperature fluctuates between extremes. Such a hearth behaves on concrete specimen one-of-a-kind from that of manages temperature in a muffle furnace. Such an open fire is produced on the specimen and the bodily and strength parameters are analysed.

This approach now not absolutely indicates the irregular fire outcomes and also parallels the circumstance when fireplace a breaks out in any structure. Then the specimens have been taken out of the hearth and had been examined in warmness condition.

IV. MATERIAL USED

A. **Materials to be used**:

Cement: The cement used to be domestically accessible fifty three Grade of cements is used. The cement has a special gravity of 3.15 with preliminary and ultimate inserting conditions forty two minutes and 9hr 48 minutes respectively.

Aggregates: Coarse Aggregates are Crushed angular combination from a close by furnish used to be used. The Specific gravity used to be 2.75, with water absorption proportion 1.

The River sand used to be used as magnificent Aggregate and conforming to Zone: III with specific gravity of 2.74, Bulk density of 1612.77kg/m3.

Water: To mix the in-gradients of concrete Tap water has been used.

Casting of take a look at specimens:

In the present work, the compressive strengths of Standard Concrete and Carbon Fiber Reinforced Concrete had been evaluated after exposing them to elevated temperature and attempting out is done.

TEST DATA FOR MATERIAL:

Table-1: Mix Proportions (KG/m^3) and mix ratio for M_{25}

Water (litres)	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)
209.18	458.13	639.012	1141.5
0.456	1	1.395	2.491

Table-2: Properties and Test results of Fine aggregate

Sl. No.	Properties	Test Results
1	Specific Gravity	2.78
2	Size	2.36mm
3	Bulking of Sand	5.55
4	Moisture Content	1.56%
5	Fineness Modulus	2.38
6	Bulk Density	1612.77 kg/m3

Table-3: Properties and Test results of coarse aggregates

Sl. No	Properties	Tests results
1	Specific gravity	2.75
2	Water absorption	1%
3	Nominal maximum size	20 mm
4	Shape	Spherical, cubical
5	Fineness Modulus	6.42

Table-4: Fiber volume dosage and weight of carbon fiber:

CARBON FIBERS (%)	WEIGHT OF FIBERS(IN KG)
0.3	0.163
0.6	0.3
0.9	0.45

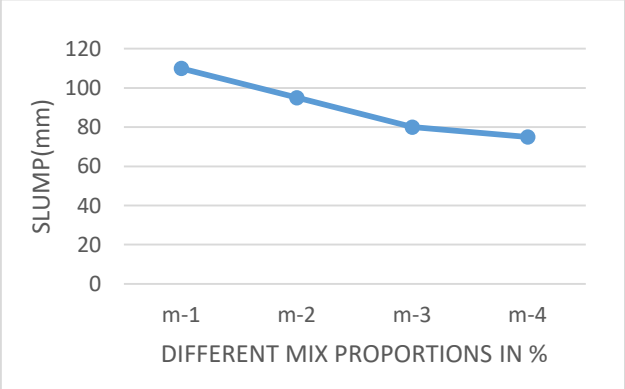
Table-5: Properties and Test results of OPC Cement

SI.No	Properties	Test Results
1	Specific Gravity	3.15
2	Normal consistency	29%
3	Finess Of Cement	95.33%
4	Initial Setting time	0 Hr. 42 min
5	Final Setting time	9Hr 48min

V. RESULTS AND DISCUSSIONS

Slump cone test:

The experimental outcomes showed that the stoop of the fibre bolstered concrete has a decreasing movement when the fiber volume charge increases. Considering a droop fee of one hundred ten for traditional concrete with no fiber introduced to the concrete, once the fiber introduced into concrete an average drop of 10% used to be observed.



Compressive strength test: Cube specimens of size 150*150 mm were casted for different dosage of carbon fiber of 0.3%, 0.6%, 0.9%. Results are tabulated and plotted.

Compressive strength of conventional concrete:

it can be considered the preliminary power of mixM25 have discovered to be gratifying the nominal standards that 7 days energy shall be 1/3rd of the mix share (65% of grade of concrete), As the days of curing processes a slight drop in strength is noticed for the combine M25 But as the curing reaches to 28 days, the attain in power is found which at ease the target strength. Also it has been determined that M25 combine under regulated curing conditions suggests linear raised in strength.

Graph-2: compressive strength of conventional concrete

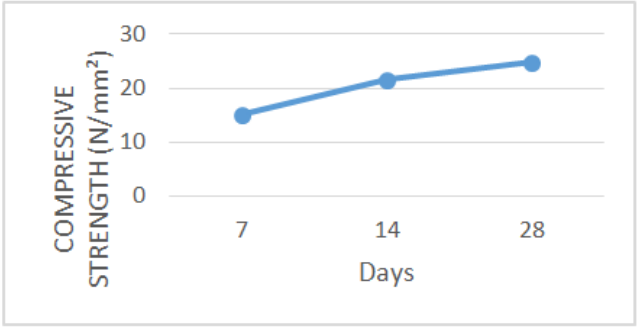
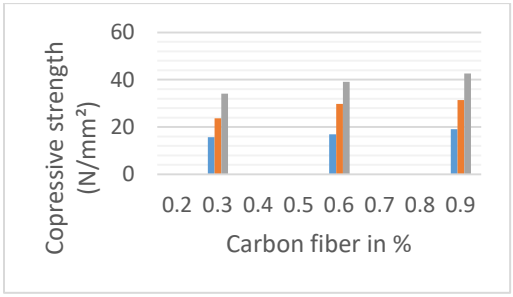


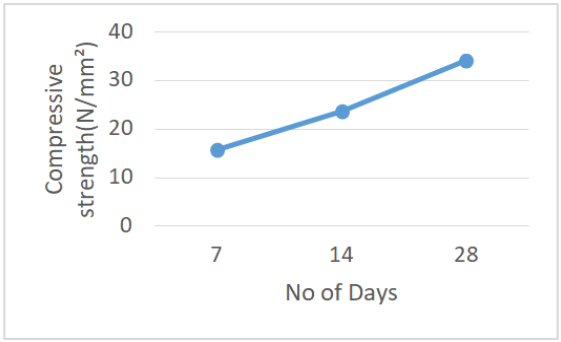
TABLE-6: Compressive strength of carbon fiber reinforced concrete

PERCENTAGE OF CARBON FIBER	COMPRESSIVE STRENGTH (N/mm^2) IN DAYS		
	7	14	28
0.30%	15.75	23.69	34.13
0.60%	16.87	29.82	39.17
0.90%	19.06	31.39	42.68

Graph-3: Graphical representation of Compressive strength for different percentage of carbon fibers.

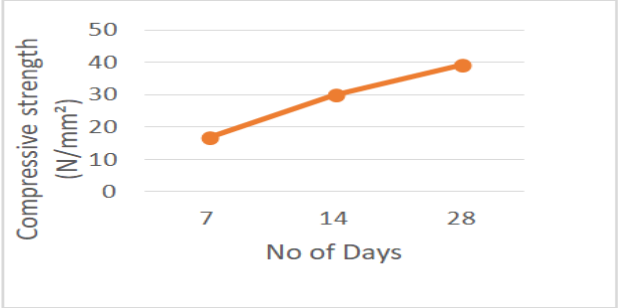


Graph-4: Compressive strength of 0.3 % of carbonfiber reinforced concrete



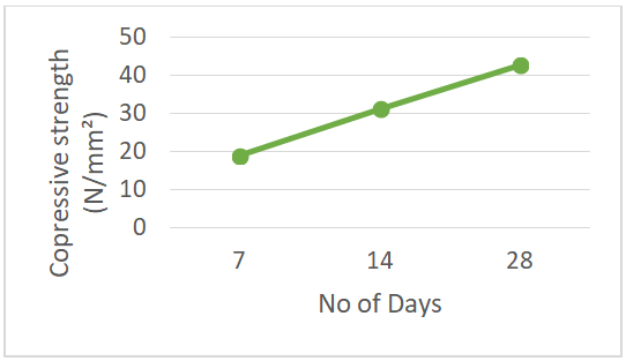
it can be viewed that the compressive electricity of mix 0.3% are pleasing the nominal standards that 7 days power shall be 1/3rd of the combine share (65% of concrete grade), which is been enjoyable for both curing & irregular curing prerequisites of concrete. As the days of curing advances to 14 days a continuous raise in strength was once observed. But as the curing reaches to 28 days, the gain in electricity was located to fulfil the target strength.

Graph-5: Compressive strength of 0.6 % of carbon fiber reinforced concrete



it can be seen virtually that linear version in power reap was once noticed in 0.6% carbon fiber mix for each curing and irregular curing conditions. The electricity constructed up walks hand in hand until the quit of the curing period. The compressive electricity of carbon fiber combine 0.6% used to be now not observed to be satisfying.

Graph-6: Compressive strength of 0.9 % of carbon fiber reinforced concrete



plotted for 0.9% mix proportion, it can be considered absolutely that 7 days energy calculated has come out to be lesser as per the 1/3rd combine share criteria, The 7days energy for curing layout condition is less than irregular curing condition. As the days of curing & publicity prerequisites advances to 28 days a mild raise in strength is seen.

Comparison of Compressive strength of conventional concrete under temperature: The compressive electricity of traditional concrete and CFRC (Carbon fibre bolstered concrete) specimens exposed to high-quality accelerated temperature is disclose as proportion of 28 days compressive electricity of conventional at room temperature. The version of compressive power with temperature has been plotted.

Table-8:Compressive strength at Higher Temperature

TEMPARETURE IN DEGREES	COMPRESSIVE STRENGTH (N/mm²) IN DAYS		
	7	14	28
900°C	7.525	10.32	12.945

From the graph, it can be discovered that the energy reduce for upward shove in temperature and ends up almost 40% discount in electricity at 900°C. This suggests that the concrete undergoes drastic strength discount past 900°C.The percentage raise in compressive power at exceptional fibre quantity price with respect to manage mix. A linear share amplify in energy is over served up to a fibre volume of 0.6%.The proportion extend in strength is higher when the fibre volume is extended from 0.6% to 0.9%.There is an enlarge of about 38.5% in compressive energy at 0.6% fibre quantity dosage as in contrast to control mix. The share compressive power raised with appreciate to the compressive energy extended with the aid of manage combine at 28 days. Hence this suggests that concrete with carbon fibres at quantity of 0.9% can be used economically the place quicker price of development is required.

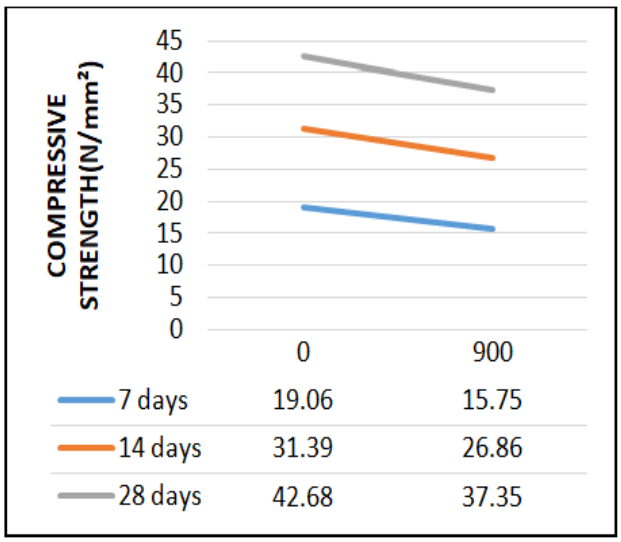
Comparison of variation compressive strength with temperature for conventional concrete and carbon fiber reinforced concrete:

In real time, during fire break out, the structure is exposed to random uncontrolled fire in which the temperature fluctuates between extremes. Such a fire behaves on concrete specimen different from that of control temperature in a muffle furnace. Such an open fire is induced on the specimen and the physical and strength parameters are analysed.

This method not only shows the random fire effects and also simulates the condition when fire a breaks out in any structure.

Colour: Unlike in muffle furnace, the colour of the specimen darkens to black colour that when subjected to open fire. But in muffle furnace the colour turned to pale while subjected to evaluated temperature.

Cracks, spalling: In case of this open fire test, the specimen to show cracks high temperature not much.



It can be noticed that carbon fiber reinforced concrete after evaluated temperature exhibits more compressive strength than the carbon fiber reinforced concrete before evaluated temperature. The deference between compressive strength of carbon fiber reinforced concrete is 0 to 9 %.

VI. CONCLUSIONS

The following Significant conclusions were drawn based on the results obtained from the experimental studies.

1. Compressive electricity of concrete limit as temperature rises due to high dehydration of the calcium hydroxide in the cement as nicely as producing greater water vapour thereby leading to electricity depletion.
2. Plenty of vertical cracks are observed on the floor of the carbon fiber-reinforced concrete specify exact toughness.
3. With an elevate in carbon dosages, the workability of the concrete reduced.
4. Carbon fiber strengthened concrete is determined to indicate more compressive energy than the conventional concrete.
5. The principal benefit of this challenge is to reduce spalling, micro-cracks, propagation of internal cracks and it face up to to increased temperature. As per the current demand of construction industry new types of concrete are to be invented, which will make certain the problems noticed in traditional concrete. In this approach carbon fiber reinforced concrete will be a good substitute to meet the present demand of construction industry.
6. Whereas many of the works that are undergoing structural reinforcement are older works whose concrete has lower resistance, increased through the composite carbon fiber proves ideal. Therefore, the compressive strength of the concrete can be raised by a simple and rapid technique, without increasing the weight of the structure itself.

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