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CRETEX – An Advanced and Futuristic Concrete

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Abstract - *This research paper presents the results of an experimental investigation carried out to evaluate the compressive strength of an advanced and futuristic concrete which is made by the addition of the adhesive known as "Heatx" into the fresh concrete. Thus the title* ***"CRETEX"*** *is given by extracting the word "Crete" from the "Concrete" and "X" from the "Heatx", where heatx is an adhesive product of Pidilite Company.*

The computations of the strength of concrete and improvement in its properties have always been interesting areas of the research. The research paper focuses on the observed improvement in concrete property such as "Compressive Strength" by the addition of heatx into the fresh concrete.

"Compressive Strength" test was conducted on a total of 16 concrete cubes of grade M 20. In this experiment, 8 cubes were cast for 14 days and remaining 8 cubes for 28 days curing period having different proportions of "Heatx" like 0%, 1.25%, 2.5% and 5% of the cement quantity. The complete experimental procedure ran for approximate 2 months. The results are obtained and compared with the results of the ordinary concrete mix and also have been discussed in detail.

***Key Words*: Advanced Concrete, Futuristic Concrete, Compressive Strength, Concrete Cubes, Fevicol Heatx, Adhesive Materials, Concrete Durability, Concrete Compactness.**

1. INTRODUCTION

Concrete is basically a mixture of 4 constituents mainly- cement, water, sand and coarse aggregates and it is widely used as construction material. It is used for various construction works like building construction, dams, highways, bridges etc. The computations of the strength of concrete and improvement in its properties have always been interesting areas of the research. Properties like compressive strength, durability, workability etc of the concrete mainly depend on its constituents and procedure of mixing, placing, curing and compaction during casting.

The compressive strength of the concrete can be modified by the alteration in its constituents during the mixing process. The compressive strength of concrete is measured at several intervals and compressive strength just after 28 days is considered as the standard strength. Various experiments have been performed on the concrete to increase its mechanical properties like workability, compressive strength, durability, tensile strength, compactness, setting time etc. Different materials have already been tested on concrete like silica fumes, steel fibres, fly ash, brick kiln dust, rice husk and many more.

The incorporation of the heatx (Pidilite Company Product) to the fresh concrete is an innovative approach to enhance its compressive strength without any alterations in constituents of the concrete. Failure could occur from the loss of shear and torsion strength, loss of bond strength, loss of compressive strength and spalling of concrete. Now, when the heatx is incorporated into the fresh concrete in specified quantity so it makes a very strong bond due to its adhesive properties with the constituents of the fresh concrete hence as a result, we get an advanced and futuristic high strength concrete with high durability and high stability.

2. MATERIALS

2.1 Cement

It is a material with adhesive and cohesive properties which becomes active when it is mixed with the water and is capable of making the bond with the other material such as sand and coarse aggregates in the fresh concrete.

For this experiment, Ambuja Portland Pozzolana Cement was used. Before conducting the experiment, necessary laboratory tests as per IS 1489 (Part-I): 2015 for the Portland Pozzolana Cement have been performed and obtained results are tabulated below-

Table-1: Cement Tests Results

S.No	NAME OF THE TEST PERFORMED	TEST RESULTS
1.	Fineness	382 m^2/kg
2.	Initial Setting Time	146 Minutes
3.	Final Setting Time	215 Minutes
4.	Soundness	0.5 mm
5.	Specific Gravity	2.90

The above Ambuja Portland Pozzolana Cement complies with the requirements of IS 1489 (Part- I): 2015 for Portland Pozzolana Cement.

2.2 Water

Water is one of the important constituents of the concrete as it actively participates in the chemical reaction with the cement. Since the quality of water affects the strength therefore water used for the experiments was clean, colourless and odour free without any suspended particles in it. It was taken from the tube well having a normal temperature as of the simple room temperature.

2.3 Sand

The sand makes the concrete more compact and denser by filling the minute voids of the concrete. The sand was obtained from the nearby "Kharun River" located nearby Raipur, Chhattisgarh. The obtained river sand had been dried in the laboratory.

Before conducting the experiments, necessary laboratory tests for sand have been performed as per IS 2386 (Part-III): 1963 and sand passing through 4.75 mm sieve conforming to Zone II as per IS 383:1970 was used for the experiment. The obtained results are tabulated below –

Table-2: Sand Tests Results

S.No	NAME OF THE TEST PERFORMED	TEST RESULTS
1.	Fineness Modulus	2.75
2.	Specific Gravity	2.65
3.	Water Absorption	0.80 %
4.	Silt Content	2.604 %
5.	Bulk Density	1560 kg/m^3

2.4 Coarse Aggregates

The coarse aggregates make the concrete movable by its rolling action. Coarse aggregates are capable to bear the high compressive loads and therefore, they are very crucial to impart the high compressive strength.

For the effective compactness and packing of the concrete, two sizes of the coarse aggregates 10 mm and 20 mm respectively were used. They were obtained from the local supplier.

Before conducting the experiments, necessary laboratory tests for coarse aggregates have been performed as per IS 2386 (Part-I): 1963 and IS 383:1970 and the obtained results are tabulated below –

Table-3: Coarse Aggregates Tests Results

S.No	NAME OF THE TEST PERFORMED	TEST RESULTS
1.	Fineness Modulus	7.06
2.	Specific Gravity	2.75
3.	Water Absorption	0.85 %
4.	Aggregate Crushing Value	17.50 %
5.	Aggregate Impact Value	18.65 %

2.5 Fevicol Heatx

The Fevicol Heatx is a product of the "Pidilite" company which is basically a synthetic solvent borne rubber based adhesive made with a special formula for having excellent heat resistance property up-to 170°C temperature. It is an advanced version of the Fevicol SR-998 and it is available in different sizes starting from 100 ml to 5 litres in the markets.

Due to its extraordinary adhesive properties, it gets easily mixed and adhered to the concrete constituents during the mixing process. Because of continuous mixing for 2- 5 minutes, at a certain point of time, mixing becomes very rigorous and concrete becomes very thick as well as very viscous. Every constituent of the concrete gets adhered very strongly to each other hence makes it more closely packed and compacted as compared to the ordinary concrete mix.

Fevicol Heatx fills all voids or pores present in the concrete and covers all constituents completely during the mixing process and this makes a protective layer over the constituents. Therefore, its heat resistance property makes it more durable and long lasting at the regions where high temperature is found. Thus, it imparts an extraordinary strength and long life to the concrete structures.

In this experiment, the heatx is used as 0%, 1.25%, 2.5% and 5% respectively of total cement quantity (by weight) in the concrete and amazing results have been found and recorded which is discussed in further sections.

Fig. 1: Fevicol Heatx

3. EXPERIMENTAL SETUP AND PROCEDURE

3.1 Mix Proportioning

For the entire experimental investigation, M20 Grade of Concrete of nominal mix 1: 1.5: 3 as per IS 456:2000 was used without any change to the quantity of cement, sand, coarse aggregates and water respectively. The w/c ratio was used as 0.45. Fevicol Heatx was added to the concrete as 0%, 1.25%, 2.5% and 5% respectively of the cement quantity (by weight) without replacing any of the constituents of the concrete.

Table-4 Mix Proportions (for 4 concrete cubes)

Mix	Heatx (%)	Cement (kg)	Sand (kg)	C.A (kg)	Water (kg)
Ordinary	0	5.50	8.25	16.50	2.50
Mix-1	1.25	5.50	8.25	16.50	2.50
Mix-2	2.50	5.50	8.25	16.50	2.50
Mix-3	5.00	5.50	8.25	16.50	2.50

3.2 Cube Casting and Curing

For the entire experimental investigation, 16 cube moulds of 150 mm x 150 mm x 150 mm each was used for casting of concrete cubes.

16 concrete cubes were cast in 4 batches. Each batch was having 4 concrete cubes where 2 cubes were for 14 days and remaining 2 were for 28 days curing period. Likewise, 4 batches of concrete cubes (total 16 cubes) were cast with 0%, 1.25%, 2.5% and 5% heatx respectively.

The constituents of the concrete were weighted using electronic balance as per the Table-4 and then mixed properly with the help of spade. The mixing process was done for 2-5 minutes so that all constituents of concrete get properly mixed.

The prepared concrete mix is then poured into the lubricated mould in 3 layers and 25 strokes were given to each layer with the help of the tamping rod for uniform compaction. After that, filled concrete moulds were covered by the wet gunny bags for 24 hours to maintain and provide moisture for sufficient initial strength gain.

Fig. 2: Hardened concrete cubes inside the mould

After 24 hours, hardened concrete cubes were removed from the moulds safely and then, they were placed inside the curing tank having fresh water for 14 days and 28 days period respectively. The water was changed once after every 7 days and the uniform temperature was maintained at 27 +/- 2^0 C.

Fig. 3: Hardened concrete cubes inside the curing tank

3.3 Weight and Area

Before proceeding for the compression test, cubes were taken out from the curing tank and dried for ½ hour. Then, weights of the cubes were measured up to three decimals with the help of the electronic balance. Cubes were weighted after 14 days and 28 days curing period respectively. Dimensions of the cubes were also checked with the help of the scale and cross sectional area of each were calculated. The obtained data is tabulated below-

Table-5 Area and Weight Data

Mix	Cube Number	Age of Cube	C.S.A (mm^2)	Weight (kg)
Ordinary	Cube -1	14	22500	8.450
	Cube -2	14	22500	8.325
	Cube -3	28	22500	8.335
	Cube -4	28	22500	8.403
1.25% Heatx	Cube -5	14	22500	8.400
	Cube -6	14	22500	8.360
	Cube -7	28	22500	8.390
	Cube -8	28	22500	8.345
2.5% Heatx	Cube -9	14	22500	8.460
	Cube -10	14	22500	8.454
	Cube -11	28	22500	8.310
	Cube -12	28	22500	8.421
5% Heatx	Cube -13	14	22500	8.470
	Cube -14	14	22500	8.495
	Cube -15	28	22500	8.140
	Cube -16	28	22500	8.270

Fig. 4: Weighing cubes on electronic balance

3.4 Compression Test

"Compression Test" is a most important and popular test to determine the compressive strength of the hardened concrete cube using compression testing machine (CTM).

Total 16 concrete cubes were tested under the compression testing machine as per IS 516:1959. As per Table-5, concrete cubes with no. - 1, 2, 5, 6, 9, 10, 13 and 14 were tested at the end of 14 days. Similarly, concrete cubes with no. – 3, 4, 7, 8, 11, 12, 15 and 16 were tested at the end of 28 days.

For the determination of compressive strength, compression testing machine with the maximum capacity of 1000 KN was used. All concrete cubes were placed properly and centrally aligned under the compression testing machine so that uniform load shall be applied to the opposite sides of the concrete cube.

Fig. 5: Determination of compressive strength under CTM

The compressive load was uniformly applied on the opposite sides of concrete cubes at the rate of 140 kg/cm²/minute until the failure of the concrete cubes. The load, at which the concrete cube fails under CTM, is called its "Maximum Compressive Load". The value of the maximum compressive load for each concrete cube has been recorded successfully and tabulated below and the formula used for the calculation of compressive strength for each concrete cube is as follows-

$$\underset{(N/mm^2)}{\text{Compressive Strength}} = \frac{\text{Max. Compressive Load (Newton)}}{\text{Cross-sectional area } (mm^2)}$$

Table-6 Compressive Strength of Concrete Cubes

Mix	Cube Number	Age of Cube	Max. Load (N)	Comp. Strength (N/mm^2)	Average Strength (N/mm^2)
Ordinary	Cube -1	14	355000	15.78	17.22
	Cube -2	14	420000	18.67	
	Cube -3	28	454000	20.18	21.35
	Cube -4	28	507000	22.53	
1.25% Heatx	Cube -5	14	452000	20.09	19.93
	Cube -6	14	445000	19.78	
	Cube -7	28	537000	23.87	23.04
	Cube -8	28	500000	22.22	
2.5% Heatx	Cube -9	14	455000	20.22	**21.84**
	Cube-10	14	528000	23.47	
	Cube-11	28	618000	27.47	**26.98**
	Cube-12	28	596000	26.49	
5% Heatx	Cube-13	14	294000	13.07	13.27
	Cube-14	14	303000	13.47	
	Cube-15	28	466000	20.71	19.51
	Cube-16	28	412000	18.31	

Fig. 6: Failed concrete cube samples after compression test

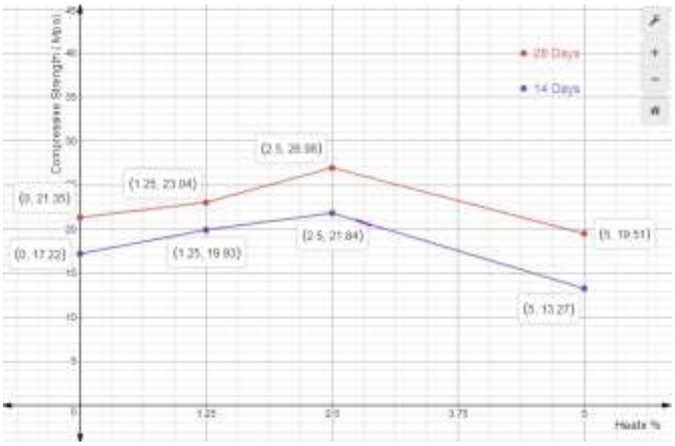
4. RESULTS AND CONCLUSIONS

From the present experimental investigation, a successful study has been carried out and the % increment of compressive strength has been determined for an advanced and futuristic concrete.

It has been found that the compressive strength was gradually increasing when the % of heatx was increased from 0% to 2.5% and on a further increment of heatx from 2.5% to 5%, the compressive strength was reduced gradually.

The maximum average compressive strength of cretex is found to be **21.84 N/mm²** (14 days) and **26.98 N/mm²** (28 days) when **2.5%** of **heatx** was incorporated into the fresh concrete. The 28 days compressive strength of the ordinary concrete mix is increased by **26.37%** after the addition of **2.5%** of heatx into it.

The conclusions of the entire experimental investigation are explained by means of the graph and it is given below-



Graph 1: Average Compressive Strength

For the better results, the heatx should not exceed more than the **2.5%** of the cement quantity (by weight). If the heatx is further increased then the compressive strength of cretex will be reduced and it will be less than the compressive strength of an ordinary concrete mix. Thus, the compressive strength of cretex is found to be **13.27 N/mm²** (14 days) and **19.51 N/mm²** (28 days) when **5%** of **heatx** was incorporated into the fresh concrete and this is less than the compressive strength of an ordinary concrete mix. Here, the 28 days compressive strength of cretex is reduced by **8.61%** in comparison to the ordinary concrete mix.

5. DISCUSSIONS

The entire experimental investigation was solely conducted for study and determination of compressive strength after addition of heatx to an ordinary concrete mix at various proportions. Further investigations and tests can also be conducted like slump cone test, compaction factor test, split tensile strength test, flexural strength test, water penetration test, chloride test etc for the complete information of its behaviour and mechanical properties.

Although, the cretex is less economical as compared to an ordinary concrete because it requires around **10 kg heatx** for **1 m³** of cretex production that means an extra cost of **Rs 3800/m³** will be required for its production.

However, in future, due to its high adhesive nature, compactness, waterproof property, heat resistant property and bond strength of heatx, the cretex may be used for the following purposes-

a. For preventing the cracks, bleeding, segregation in concrete.
b. To prevent steel reinforcement from corrosion and chemical attacks.
c. To increase the setting time in hot climate zones.
d. To resist the high temperature in hot climate zones.
e. To prevent water penetration in heavy rainfall zones.
f. To reduce the dimensions of columns, beams and slabs.
g. To bear and transfer the impact and shock in rigid pavement works.
h. To construct high-rise buildings and long-span bridges for longer life and durability.

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