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To Study Behaviour of Concrete by Partially Replacement of Waste Paper Sludge Ash

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ABSTRACT

Global warming, which is mainly caused by mankind with the emissions of greenhouse gases, is nowadays one of the major topics in the world. The reduction of these greenhouse gas emissions has become a primary focus of the environmental organizations and the government in many countries. Since Portland cement production is accompanied by a significant CO2 emission, which is a principle greenhouse gas, it is useful to look for ecological alternatives of cement. Portland cement is normally replaced with fly ash or blast furnace slag cement, which are both byproducts from other industrial waste. The sources of these byproducts are limited. Therefore, seeking for other alternatives of Portland cement is significant from both economic and environmental point of view. In this research the use of thermally activated paper sludge minerals as partial Portland cement replacement is investigated. The replacement of cement with paper sludge minerals is proposed to reduce the environmental pollution that are associated with the concrete productions and with the disposal of paper waste. By calcination and dehydration of paper sludge, which is a by-product of recycled paper waste, a non-poisonous mineral with a highly pozzolanic activity is formed. Besides the pozzolanic activity this mineral also shows hydraulic potential. Therefore, the production and usage of thermally activated paper sludge minerals has attracted increasing interest due to its environmental advantages and excellent cementitious potential.

The use of Top-Crete as a partial cement replacement is a relatively new research area. The cement paste and mortar mixtures have been composed with TC ranging from 0% to 10%, with water to binder ratio of 0.45.The particle size distribution of TC is slightly finer than that of PC and FA. TC has a specific surface area of 7.2262 m2/g, which is about 27 times higher than PC. The ignition loss of TC is 21%, which mainly arises from the release of carbon dioxide by the thermal decomposition of the large CaCO3 content. Knowledge on these physical properties will increase the ability to explain the influence of TC on various properties of blended cement pastes.

Experiments have been performed on the cement paste and mortar mixtures to gain more insight in the effect of TC on the properties of blended cement pastes and mortars. The properties include workability, setting time and compressive strength. These properties are tested according to the procedure outlined in the Indian standards.

TC hydrates compensate for the chemical shrinkage. It was also observed that the replacement of PC with 10% TC substantially increases the autogenous shrinkage of the blended cement paste compared to that of the control paste. This attributed to the acceleration of the PC hydration, the highly pozzolanic reaction of TC and the refinement of porosity by TC. The first two contribute to the removal of water from the specimen which results in self-desiccation of the specimen. While the refinement of the porosity results in the increase of the capillary tension.

Overall, from this research, it has been found that a certain percentage of TC can act as a replacement of cement without significant loss in strength and with a considerable shorter setting time. Replacing cement with 10 % TC in blended pastes.

Keywords:- Top-Crete**,** Compressive Strength, Workability

I.INTRODUCTION

Concrete is the most commonly used building material in the world. Its huge popularity is a consequence of several advantages, such as general availability, wide applicability and low cost. These advantages are also accompanied by a great environmental burden. The billions of tons of raw materials mined and processed each year leave a mark on the environment. Furthermore, during the production of Portland cement large quantities of CO2 are released into the atmosphere and enormous amounts of energy are required. Portland cement is one of the most important ingredient of concrete. The environmental load of concrete can be reduced by the partial replacement of Portland cement with other cement alternatives or additives. These cement replacing materials could be fillers or waste products. Among of them, activated paper sludge waste has been proposed to be a promising cement replacement. Large amounts of paper sludge waste are generated in highly urbanized cities due to the recycling of tons of paper. The traditional method of the disposal of the paper sludge waste is by land filling or by dumping in the sea. Scarcity of land makes it necessary to find other possibilities to use this waste. Recycling of this paper sludge waste is the best solution and will be beneficial for the environment and interesting for the government, since the environmental impact of new materials and the costs for disposing those waste products will be reduced.

Top-Crete is formed by calcination and dehydration of the minerals in paper sludge, including kaolin clay and calcium carbonate, at a specific temperature and time range. When calcining paper sludge at 700 to 750 degrees after 2 or 5 hours a very reactive metakaolin is created. Metakaolin reacts with CH and creates a dense structure with low porosity, improving the properties of paste, mortar and concrete.

This study focuses on activated paper sludge minerals as partial replacement of cement.

II EXPERIMENTAL INVESTIGATION

In the presence environmental investigation paper ash been used as partial replacement of cement in concrete mixes. On replacing cement with different weights percentage of paper ash the compressive strength of experimental investigations are as follows

Stage I:Laboratory setup and procurement of materials.

Stage II: Mixing of concrete, moulding and curing of concrete specimens.

Stage III: Testing procedure for evaluating the strength parameter of Concrete specimens.

III TESTING PROCEDURE

3.1 INITIAL AND FINIAL SETTING TIME OF CEMENT:

INITIAL SETTING TIME:

Place the test block under the rod bearing the needle.Lower the needle gently in order to make contact with the surface of the cement paste and release quickly, allowing it to penetrate the test block. Repeat the procedure till the needle fails to pierce the test block by 5.0+-0.5 mm measured from the bottom of the mold is the initial setting time

FINAL SETTING TIME

Replace the above needle by one with an annular attachment.

The cement should be considered as finally set, when upon applying the needle on the surface on the test block, the needle makes an impression there in, while the attachment fails to do so. The period elapsing the time period between water is added to the cement and needle makes an impression on the surface of the test block while the attachment fails to do so is the final setting time

S.No	Setting time	Cement	Top Crete	FOR 15% REPLACEMENT
1	Initial setting Time	45 minutes	42 minutes	40 minutes
2	Final setting Time	540 minutes	520 minutes	500 minutes

Table:1 INITIAL AND FINIAL SETTING TIME OF CEMENT:

3.2 Specific gravity of cement

Weigh a clean and dry Pycnometer with its stopper (W_1).Place a sample of cement up to half of the flask and weight with its stopper (W_2). Add kerosene to cement in flask till it is half full. Mix thoroughly with glass rod to remove entrapped air continue stirring and add more kerosene till it is flush with graduated mark. Dry the outside and weigh (W_3). Remove entrapped air by vacuum pump, if available. Empty the flask clean it and refill it with kerosene flush up to graduated mark and weigh it (W_4)

Specific gravity= $(W_2-W_1)/ [(W_2-W_1)-(W_3-W_4)]*0.79$

Table2: Specific gravity of cement

S.No	Cement	Top Crete (10%)	Top Crete(15%)
1	3.142	3.12	3.055

3.3 Soundness of cement

Place the mold on glass sheet and fill it with the cement paste formed by gauging cement with 0.78 times the water required to give a paste of standard consistency

Cover the mold with another piece of glass sheet place a small weight on this covering glass sheet and immediately submerge the whole assembly on water at a temperature of 27^0 c and keep it there for 24 hours

Measure the distance separating he indicator points to the nearest 0.5mm (say d_1)

Submerge the mold again in water which is boiling for 25 – 30 minutes and keep it for three hours

Remove the mold from water and allow it to cool for few minutes and then measure the readings (say d_2)

(d_2-d_1) represents the expansion of cement

Table 3: Soundness of cement

S.No	Cement	Top Crete	For 15% Replacement
1	5mm	3mm	5mm

3.4 Fineness of cement

Take cement and weight is 100 Gms on the electric weight machine

Put the 100 Gms cement in a sieve of 90 microns and hand shake it for 10-15 minutes

Weigh the residue left on the sieve 90 microns and note down the weight

Repeat the procedure thrice and note down the values

Table 4: Fineness of cement

S No	Material	Fineness
1	Cement	96%
2	Top Crete	98.9%

3.5 BULKING OF FINE AGGREGATES:

Take 1 kg of oven dry sand put in the graduated transparent cylinder level up surface of sand and measure the volume v_1

Pour the sand into the metal tray without ant loss add 2% of water by weight and thoroughly mix the sand with water by hand

Pour the wet sand into the graduated cylinder in loose state without any tamping level in the top surface and measure the volume v_2 and calculating the percentage change in the volume

Increase the percentage of water by 2% and repeat the above procedure till decrease in volume is noticed there in words increase the % of water by 4% and repeat the steps 2 and 3 till the change ion volume becomes Zero

Volume v= $(v_2-v_1)/v_1*100$

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S.NO	PERCENTAGE OF WATER ADDED	INITIAL VOLUME OF SAND ADDED(V_1)	VOLUME OF SAND(V_2)	VOLUME= V_2-V_1/V_1*100
1.	0%	670	670	0
2.	2%	670	840	25.37
3.	4%	670	920	37.313
4.	6%	670	870	29.850
5.	8%	670	840	25.37

3.6 SLUMP CONE TEST

Procedure for slump test

1. Dampen the slump test mould and place it on a flat, moist, non-absorbent, rigid surface, like a steel plate.
2. Fill the cone 1/3full and uniformly rod the layer 25 times to its full depth
3. Fill the cone with a second layer until 2/3 full by volume and 25 times uniformly, ensuring that the rod just penetrates into the first layer.
4. Over fill the cone with the third layer and rod uniformly, 25 times, with the rod just penetration into the second layer.
5. Strike off the excess concrete level with the top of the cone by a screening and rolling motion of the tamping rod.
6. Remove any spilled concrete from around the bottom of the cone.
7. Immediately remove the mould from the concrete by raising it carefully in to vertical direction without lateral or torsional motion.
8. Measure the difference between the height of the mould and the height of the specimen at its highest point to the nearest 6.3 mm. the distance will be slump of the concrete.

Fig Slump cone Test

S.No	Material	Slump Test
1	Cement	35 mm slump
2	Top Crete	24 mm slump
3	15% REPLACEMENT	31 mm slump

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3.7 Vee-bee test

1. A Conventional slump test is performed, placing the slump cone inside cylindrical part of the Consistometer.

2. The glass disc attached to the swiver arm is turned and placed on the top of concrete in the pot.

3. The electrical vibrator is switched on and a stop watch is started simultaneously.

4. Vibration is continued fill the conical shape of the concrete disappears and the concrete assumes a cylindrical shape.

5. When the concrete fully assumes a cylindrical shape, the stop watch is switched off immediately the time is noted.

s.no	Material	Vee-bee time
1	Cement	23 seconds
2	Top Crete	15 seconds
3	Topcrete (C15)	20 seconds

Fig Vee –Bee Test

3.8 FABCRICATION OF CUBES:

In this project total 20 specimens are prepared in a mould 100 x 100 x 100mm for compression test and 300 x 150mm diameter mould for tensile test & 150 x 150 x 700mm for flexural tests. The specimens are filled by concrete by 3 layers of moulds each layer tamped by 25 strokes using damping rod. After the specimens are stored in a room temperature for 24 hoursAfter completion of 1day the specimens are taken out from moulds and placed in a curing tub for 3, 7, 21 and 28 days.


Fig

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CURING:

Curing is probably the most important aspect of micro silica concrete as the material undergoes virtually zero bleeding. If the rate of evaporation from the surface is faster than the rate of migration of water from interior to the surface, plastic shrinkage takes place. In the absence of bleeding and slow movement of water from interior to the surface, early curing by way of membrane cuing is essential

Fig Specimens Placed in Curing tub for 3,7,21,28 days

Fig C0,C10,C15 cubes

IV RESULTS

4.1 COMPRESSIVE STRENGTH TEST ON CONCRETE SPECIMENS

Specimens were removed from the moulded after the 24 hours and curing. Cubes specimens of different percentage of SCBA were tested under compression testing machine in according with IS 516 for 3 days, 7 days, and 28 days.

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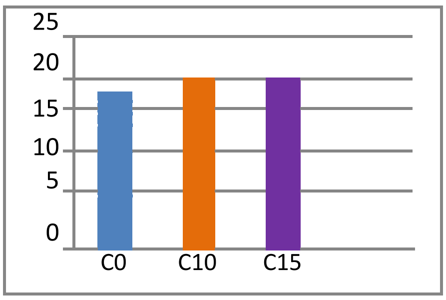
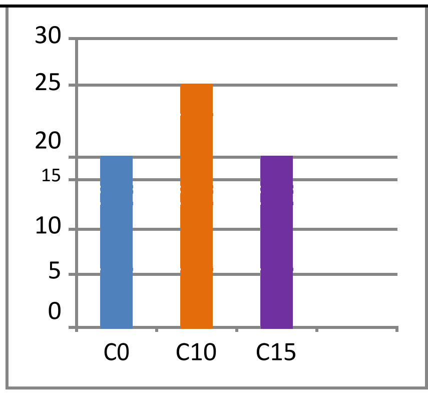
Fig Compressive Strength Test of (3,7,21,28 days) Cubes using CTM

NO.OF DAYS	CONCRETE (N/mm^2)-C0	TOPCRETE(N/mm^2)C-10	For 15% Replacement-C15s
3 days	17.1	21.4	20.5
7 days	20.3	26.4	23.4
14 days	25.7	29.3	25.6
21 days	30.45	31.47	30.25
28 days	32.05	36.86	31.8

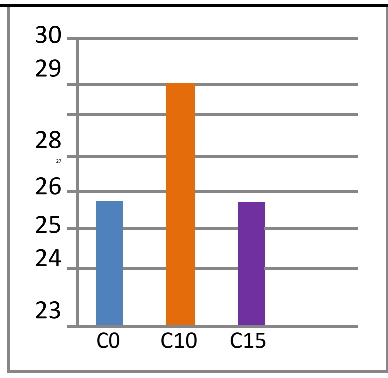
Table: Compressive Testing Results for C0,C10,C15



Compressive Test For 3 Days



Compressive Test For 7 Days



Compressive Test For 14 Days

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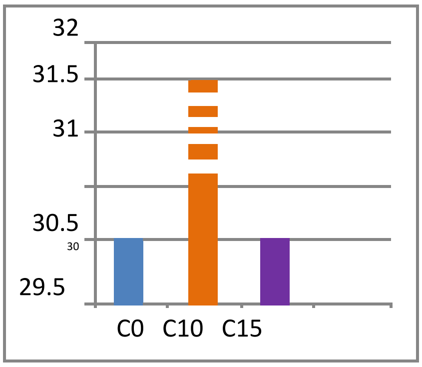
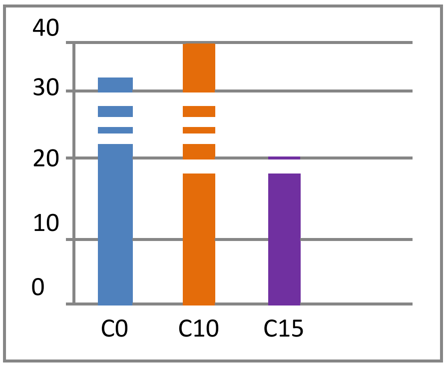
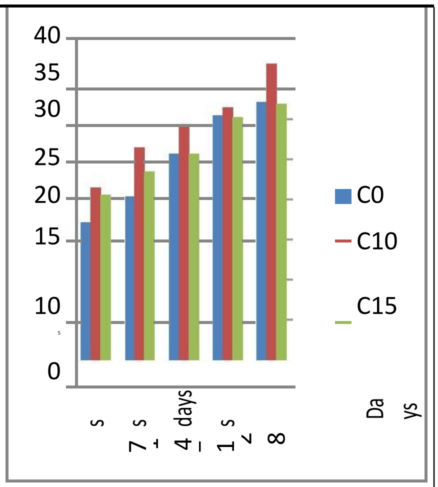


Compressive Test For 21 Days



Compressive Test For 28 Days



COMPRESSIVE STRENGTH COMPARISON

V CONCLUSION

a. The specific surface area of top Crete 27 times greater than cement. The workability of topcrete has decreased in compared with ordinary concrete. It is inferred that reduction in workability is due to large surface area of topcrete.

b. The compressive strength of concrete (with 0%, 10%, 15%, weight replacement of cement with topcrete) cured in water for 3, 7, & 28 days indicates that the compressive strength nearly equal to from the replacement percentage 15% compare with normal concrete.

c. The compressive strength values are increases when compared to 3, 7 & 28 days curing in water.

d. The replacement of cement with 15% of topcrete the cubes act as a brittle material when compared to 5% & 10%.

e. The split tensile strength of concrete with, 10% and 15% weight replacement of cement with topcrete have decreased with normal concrete but the C-10 value is low when compared to C-15.

f. By using the topcrete it acts as an admixtures and changes the properties of workability .As per the literature review the properties of shrinkage and heat of hydration has changed by using topcrete

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