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INVESTIGATION OF PHASE CHANGING MATERIAL IMPLEMENTATION OVER CONSTRUCTION MATERIALS

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Abstract - *The experimental investigation on the phase changing materials, utilized on concrete. This experiment presents the effect of paraffin wax as phase changing material on various proportions in the concrete and partial replacement of phase changing material with concrete. The result of the investigation explain the temperature changes over the time period throughout the day. The other test include water absorption test & workability tests are performed to indicate the characteristics of pconcrete are within codal provision. The various proportions of phase changing material (0%, 10%, 20%, 30%) gives various result for 7thday, 14thday and 28thday of compressive strength test gives test result as compared to conventional concrete*

***Key Words*: Phase changing material, Paraffin wax, thermal comfort, Paraffin incorporated concrete, air cooling, Temperature test, water absorption.**

1. INTRODUCTION

In modern times, concrete forms the major construction material for the last few centuries. In last few decades, Earth is undergoing major risk factor known as Global warming. Global warming leads to the ongoing risk of the earth's climate system, increases surface temperature makes hotter mornings and colder nights of the Earth's environment. Usually Indian temperature varies from 15°c to 40°c.

Phase changing materials are being used for the purpose of increasing thermal storage capacity of building. Phase changing material have the specialized characteristics of storing thermal energy from radiation of solar effect and will be emitted during the colder night. These make phase changing material as a social and economic solution for increasing thermal comfort over construction.

This paper audits that in construction industry is effecting the thermal comfort inside the buildings which are in warmer regions effectively by using the paraffin wax as a partial replacement in concrete and implementation of the concrete surface with mortar of cement &paraffin wax.

2. MATERIALS

2.1 CEMENT

Cement is a binder which binds sand and gravel produces concrete. Cement mixed with fine aggregate to form mortar. Cement used in construction usually inorganic often calcium carbonate or lime based formed by a process known as calcination generate calcium oxide is then grounded with small amount of gypsum to form ordinary Pozzolana Cement (OPC).

2.2 FINE AGGREGATE

These fine aggregates are those natural sand particles passing 4.75 mm sieve and predominantly retained on 75µm sieve. the increased round shape of grains increases the workability. The fine aggregate has the purpose of filling the voids in coarse aggregate and to act as workability agent.

2.3 COARSE AGGREGATE

Coarse aggregate are obtained by crushing natural rock which are retained on 4.75 mm sieve provide strength to the entire structure and enormously increases volume of concrete. It influences durability hardness and other mechanical properties of concrete.

2.4 PARAFFIN WAX

Paraffin wax are also known as petroleum wax obtained from coal, petroleum and shale oil. Paraffin wax are under alkane group with mixture of hydrocarbon molecules with general formula C_nH_{2n+2}

Fig-1: Paraffin wax

Paraffin wax are odorless and bluish white substances which are having specified characteristics of being solid at room temperature and begin to melt above (approximately) 37°c. Such paraffin wax can be used as a partial replacement in the concrete which provides heat energy storage in colder seasons of building.

3. THERMAL COMFORT

Thermal comfort is that condition which explains the satisfaction of the resident with respect to their thermal environment. It is personal experience can be different from one person to other. It can't be expressed in degree (or) some limited temperature ranges.

Thermal comfort of a person is described as that condition of mind that express satisfaction with thermal environment and is assessed by subjective evaluation.

3.1 NEED OF THERMAL COMFORT

The needs of thermal comfort are

- Healthy and safety execution (HSE) of United Kingdom suggests that environment can be reasonable comfort when atleast 80% of its occupants are thermally comfortable.
- Thermal comfort depends on the environmental factors like air temperature and air velocity inside a building.
- The effect of well being on thermal comfort is major focus of the dwellers which adversely affects the mental, physical health of occupants of any building.
- Problems with morale (or) health can affect productivity of occupants on buildings.

4. Mix Designing

Mix designing of concrete is the process of determining absolute properties of cement, sand and aggregate for concrete to achieve required strength in structure where such concrete is being used. Mix design can be stated as concrete mix.

4.1 Design mix of M_{20} grade concrete

Table -1: Materials of concrete and its quantity

Materials	Quantity
Cement	411.85 kg/m^3
Fine Aggregate	622.22 kg/m^3
Coarse Aggregate	1235.56 kg/m^3

Table -2: Materials of concrete and its specific gravity

Materials	Specific Gravity
Cement	3.1
Fine Aggregate	2.55
Coarse Aggregate	2.65

Table -3: Materials of concrete and its proportion

Materials	Proportion
Cement	1
Fine Aggregate	1.5
Coarse Aggregate	3
Water	0.4

4. EXPERIMENTAL INVESTIGATIONS AND RESULTS

Several Investigation are made in the implementation of phase changing materials in building construction material which inferred various results.

Paraffin Wax is the major phase changing material in this experiment which is used in both ways.

- As a plastering material in cement mortar.
- As a partial replacement of fine aggregate.

4.1 WORKABILITY TEST

Concrete Slump Test is a measurement of concrete's workability, or fluidity. It's an indirect measurement of concrete consistency or stiffness. A slump test is a method used to determine the consistency of concrete.

Fig -2: Slump cone test

The pH value should be lies between 6 to 9. The water/ cement ratio normally ranges from 0.25 to 0.5. Here the water/cement ratio is fixed as 0.4. The slump test shows that slump fomed is zero slump. The concrete in the compaction factor test resulted is 0.78.

4.2 Compressive strength test

In M_{20} grade concrete, the paraffin wax (10%, 20% and 30%) is replaced with aggregate weight of fine aggregate. The incorporation of different proportion of paraffin wax showed different results when compared to normal concrete cubes.

Table -4: Percentage of paraffin wax replacement and equivalent aggregate weight of fine aggregate.

SL.NO	PERCENTAGE OF PARAFFIN WAX	AGGREGATE WEIGHT OF PARAFFIN WAX (KG/M³)	AGGREGATE WEIGHT OF FINE AGGREGATE (KG/M³)
1.	0%	0	622.22
2.	10%	62.22	560
3.	20%	124.44	497.78
4.	30%	186.66	435.56

The slump value of freshly prepared PW Concrete was almost same when compared to normal concrete. The compressive strength of hardened concrete is checked on 7th, 14th, 28th days. The results are shown in the table below.

Fig -3: Compressive strength apparatus testing concrete.

Table-4:Compressive strength of PW concrete

Percentage of PCM (%)	7th day (N/mm²)	14th day (N/mm²)	28th day (N/mm²)
0	16.95	22.19	33.21
10	16.78	21.47	31.54
20	16.56	20.84	30.05
30	15.32	19.03	28.52

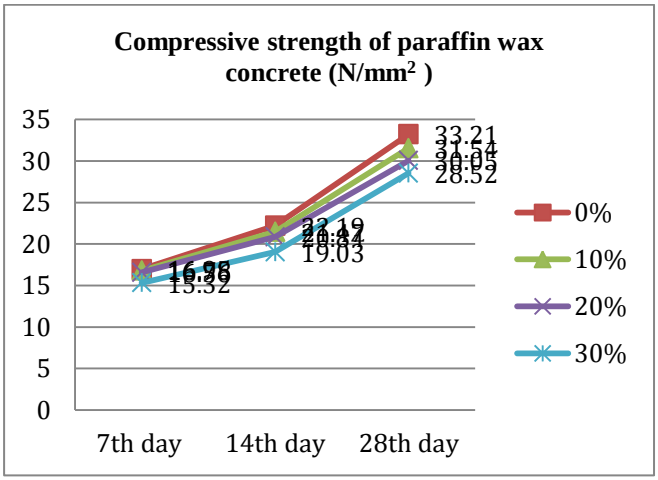

Chart -1: compressive strength of the concrete with different proportion of concrete on 7th day, 14th day, 28th days.

The compressive strength of various PCM concrete showed nearby values of ordinary M_{20} grade concrete

when it is replaced with 10% of aggregate. Above 10% replacement of fine aggregate reduces the strength of the concrete. It shows that increases in paraffin wax in concrete decreases strength.

4.3 TEMPERATURE TEST

There were totally 2 cubes were casted with 10% PCM implemented M_{20} concrete with dimensions of 15cmx15cmx15cm. One of those cubes was plastered with paraffin wax incorporated cement mortar with ratio 1:6. The other cube was plastered with normal cement mortar with ratio of 1:4.

The observation is done on the thermal capacity and heat dissipation inside the casted cubes. The cubes had been placed in open exposure to sunlight. The experimental observation is done from morning 9am to evening 9pm. The thermal measurement was done by the small instrument known as Thermometer.

Table-5: Temperature at Different Time

walls	Temp @ 9am	Temp @ 12pm	Temp @ 3pm	Temp @ 6pm	Temp @ 9pm
Without plastering	30.3°C	34.6°C	36°C	32.1°C	28.0°C
With plastering	31.9°C	32.0°C	34.9°C	32.3°C	31.3°C

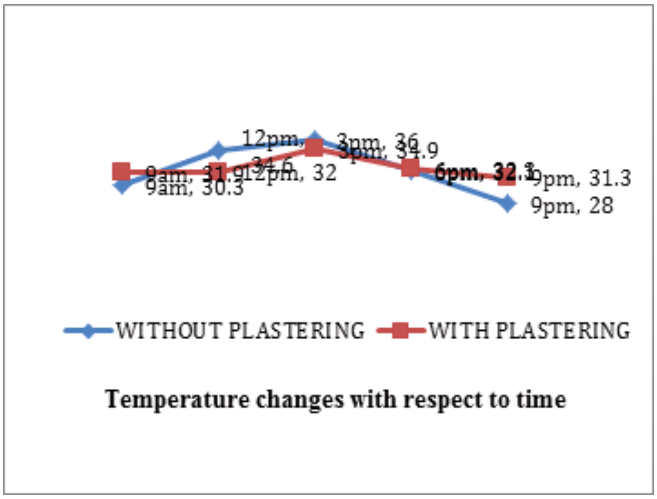

Chart -2: Temperature changes with respect to time

The surface temperature was very low and provide thermal comfort over the other surfaces. Hence the result produced for this was good. It is observed that the constant temperature is maintained over a period of the time.

4.4 WATER ABSORPTION TEST

This test method is used to determine the rate of sorptivity or absorption of water in cement concrete by measuring the increment in the specimen mass resulting from absorption of water as a function of time when surface of the specimen is exposed to water.

In this experiment Concrete cube of size of 150 mm x 150 mm x 150 mm for sample testing is casted .Coarse aggregate, fine aggregate and cement are the ingredients used. This test actually done to determine how much water absorption takes place.

In order to find the value in calculation the water absorption = $\frac{(A-B)}{B} \times 100\%$

Where B is Weight of concrete before the water & A is Weight of concrete after cooling and drying and it is observed that Water absorption takes places is around 1.42%.

5. CONCLUSION

In this project it is concluded that the usage of Phase changing material in the building constructions can give a fine results. When paraffin wax or petroleum wax is incorporated with cement mortar, it gives temperature variation throughout the day. It is observed that in day time, the temperature is reduced and in night time, temperature is increased slightly. The temperature ranging from 2.7^0c to 3.5^0c is increased or decreased accordance to external temperature. When paraffin wax is mixed with concrete, it is observed that the wax accumulates into the voids of concrete during the curing process. The thermal conductivity of paraffin wax are usually 0.21 W/m^0c makes the concreteto swell out of wax at higher temperatures. If the paraffin wax is undergoing polymerization process and gets encapsulated it shows increased thermal conductivity and produces a better result. The surface temperature varies predominantly to lower and higher temperature when compared to normal conventional concrete. Our outcomes of this project are

- The need of external air conditioning or cooling is greatly reduced.
- Having a higher scope of more important tool for improving the thermal comfort in the domestic building.
- It can be utilized also in both residential and commercial buildings.
- To reduce the power supply for external air conditioner and maintain sophistic nature of occupants and buildings.

- It enables the development of sustainable Green buildings.

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