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EXPERIMENTAL AND SIMULATION ON CEMENT COMPOSITES AND PHASE CHANGE MATERIALS

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Abstract **- Energy efficiency in building can be achieved through cutting down both consumption and embodied energy. Embodied energy can be reduced by the use of renewable and locally available materials. Consumption can be reduced through the redesign of appliances such as water heaters and lighting sources. The project focuses on the reduction of room temperature and for saving of the energy in the buildings. The proposed solution consist of adding paraffin wax in the form of liquid with the concrete and placing the mix in the form of encapsulation or cenospheres in the wall panels. The addition of phase change materials like paraffin wax or bees wax and polyethylene glycol (PEG) along with the titanium dioxide powder concrete mix and making the building an energy efficient building. The effect of each thermal behavior modification on the properties of concrete on addition of titanium dioxide powder to the partial replacement of cement the PCM reduces the heat transfer in the structure. This controls the temperature interval and gives the required result during addition of PCM materials. This project literally aims to achieve an efficient green building which reduces the heat transfer from external environment to internal structure. They provide an impact over the hollow blocks and it is found that CenoPCM capsules have great potential to be added into construction materials for reducing energy consumptions in buildings. The construction industry is striving to develop energy efficient buildings and materials, as economic and environmental constraints are bound to increase in the coming years.**

keywords **- pcm , thermal resistance , compression strenght ,energy consumption**

1. INTRODUCTION

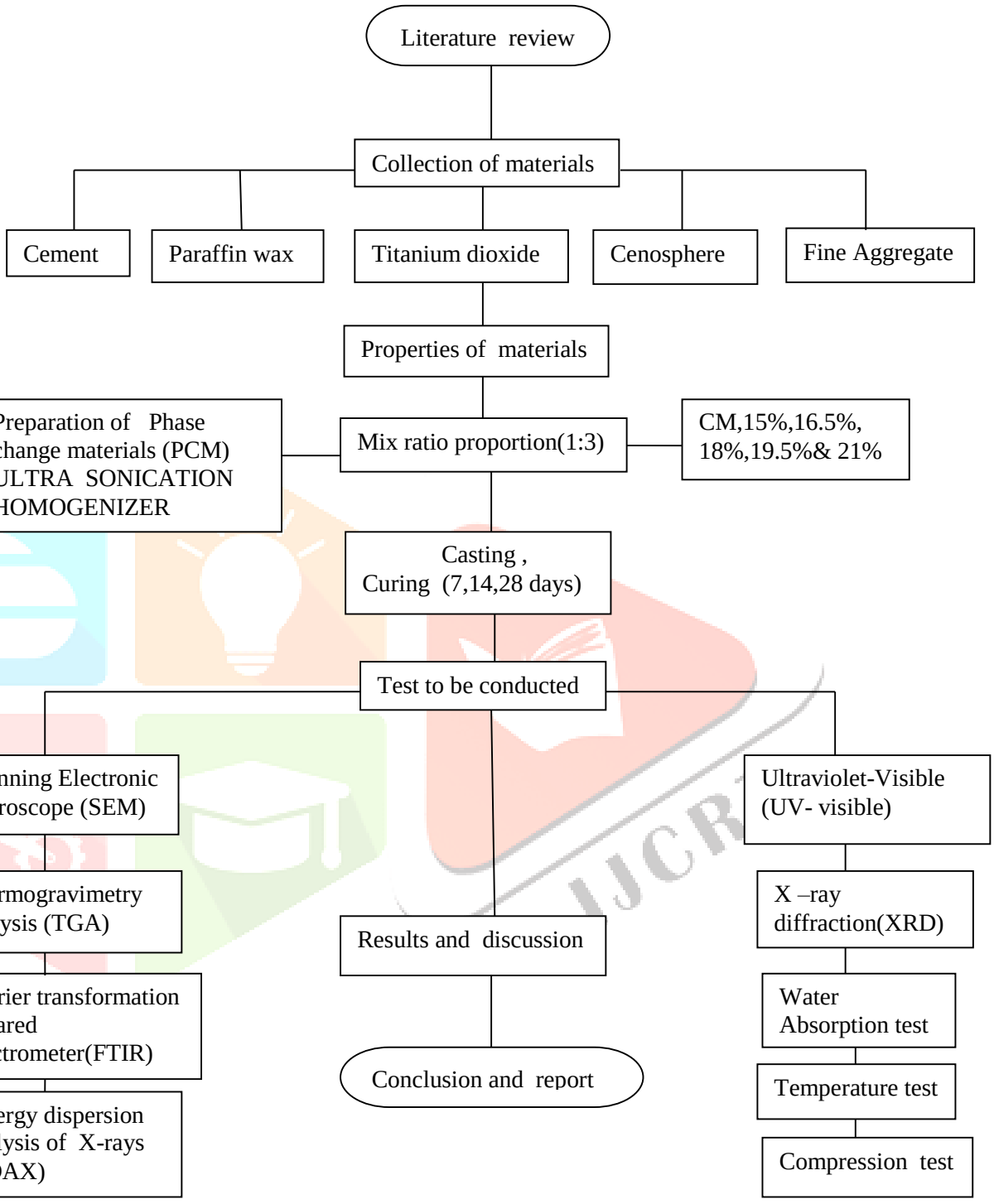
During earlier periods, the buildings were constructed tremendously with no consideration for insulation mainly because of the reason of cheaper cost of energy. But now the condition is different. Buildings with no kind of insulation results in the waste of energy. This concern is now not a factor of economy alone but the need for sustainability. An estimation from the studies conducted proves that the use of insulation in buildings helps to save the building energy costs by 10 to 20%. But the actual cost also depends on the extent of insulation the building possesses initially, how much more is to be added, the number of openings, say doors and windows. The efficiency of insulation also depends on the weather stripping.

2. OBJECTIVE

Energy efficient building design involves constructing or upgrading buildings that are able to get the most work out of the energy that is supplied to them by taking steps to reduce energy loss such as decreasing the loss of heat through the building envelope. Energy efficient homes, whether they are renovated to be more efficient or a built with energy efficiency in mind, pose a significant number of benefits as listed below:

- Synthesization and characterization of composite materials with PCM and TiO_2.
- To apply the composite materials on mortar , concrete & wall panel for thermal studies
- Stimulation of energy studies with the composite materials.

3. METHODOLOGY



4. WORK - In this research study it is aimed at addition the phase change materials along with a particle of fly ash, the cenosphere with paraffin wax material to reduce the effect of heat passing through the structural building. Tests conducted at various stages of the curing process allowed us to study the strengths of the specimens. The mortar samples are prepared by mixing the paraffin wax, and cenosphere particles. Water to cementitious material was maintained 0.20. They were then subjected to different chemical environments.

Following steps are involved in this chapter.

- ❖ Preparation of the PCM
- ❖ Preparation of the specimen
- ❖ Testing of properties of specimen
- ❖ Mixing
- ❖ Casting
- ❖ Curing
- ❖ Temperature test
- ❖ Testing of materials

4.1 PREPARATION OF PCM

The powder particles of cenosphere are collected and measured as per the designed proportion along with the waxes of various grades and they are mixed together in the process of ULTRA SONIC HOMOGENIZER. The process is done with the application of proper measurement of the containments. The ultrasonic homogenizer sonicator uses the dispersion effect of ultrasonic waves in the liquid to cause cavitation of the liquid, thereby breaking the solid particles or cell tissue in the liquid. Ultrasonic homogenizer consists of two parts: ultrasonic generator and transducer. It is generally equipped with soundproof box. When working of this sonicator, the transducer is placed in a soundproof box, which has good sound insulation effect.

4.2 CASTING

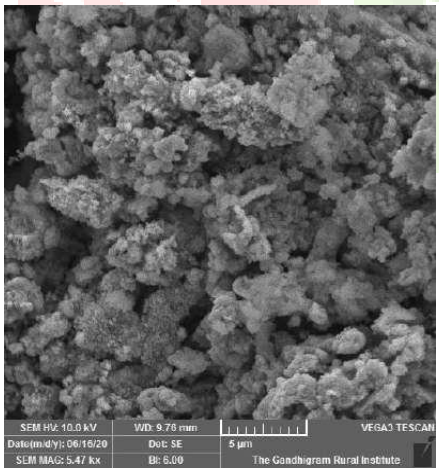
Fresh mortar mixture was cast in cube moulds (70mm x 70 mm x70mm). The moulds were filled in two layers and each layer was compacted by using a tamping rod of standard size, so as to avoid entrapped air inside the mortar cubes and honey combing effect on the sides. During pouring of mortar, it is better to avoid wasting of mortar for effective and economical usage. In order to avoid wastage, small trowels are used to collect the mortar that is coming out the mould.

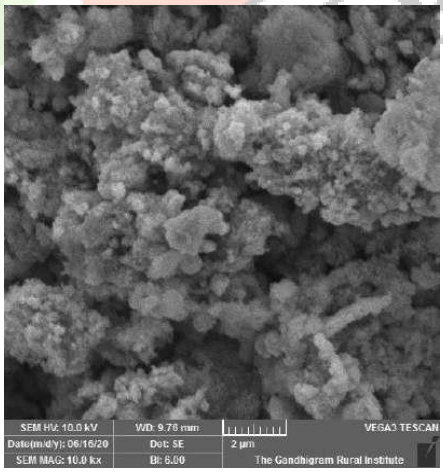
4.3 CURING

The test specimens after compaction they were taken and stored at a room temperature of 23 to 32 ºc (Ambient Curing). Samples were removed from the mould after 24 hours of casting and left again at room temperature. Then they were taken to immerse in distilled water for curing.

4.4 SCANNING ELECTRON MICROSCOPE

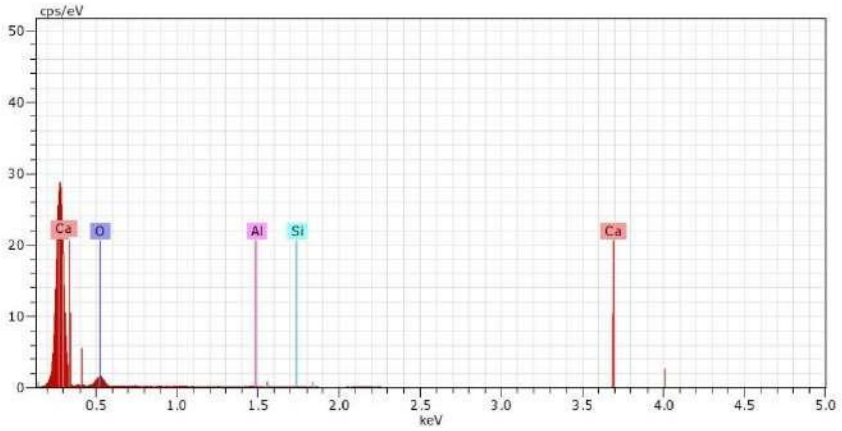
This SEM produces the images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the various signals that contain information about the surface topography and composition of the sample. In this, the components like cenosphere and paraffin waxes(normal and heavy grade) and titanium dioxide are mixed according to the proportions. The images of the component are obtained to study the detailed structure.





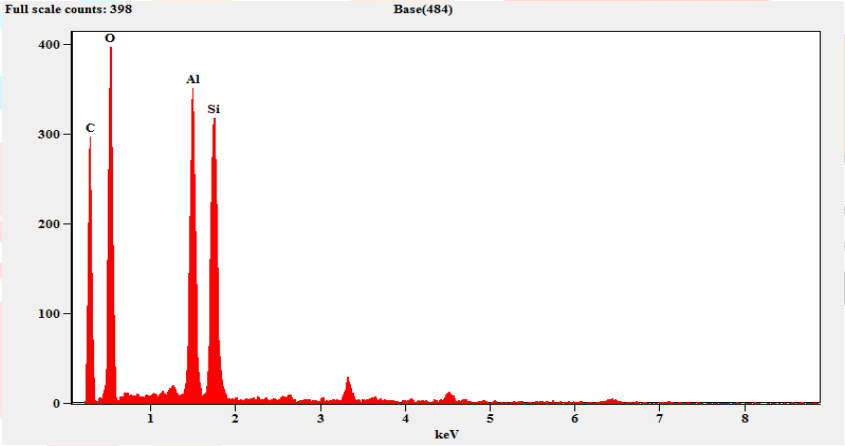
4.5 ENERGY DISPERSIVE X-RAY ANALYSIS (EDAX)

This is an x-ray technique used to identify the elemental composition of materials. The imaging capability of the microscope identifies the specimen of interest. The data generated by EDAX analysis consist of spectra showing peaks corresponding to the elements making up-to the true composition of the sample (cenosphere , paraffin wax and titanium dioxide).



4.6 THERMO-GRAVIMETRICAL ANALYSIS

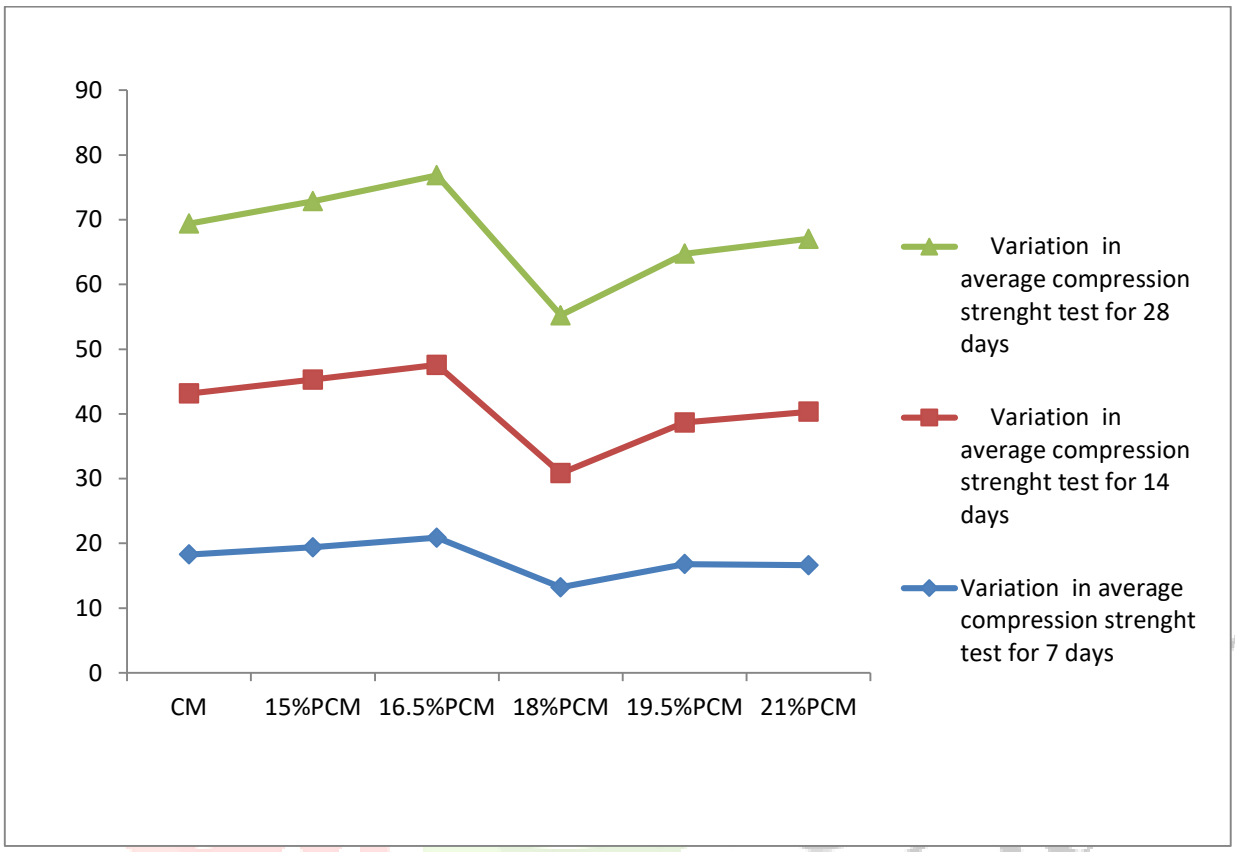
Thermo-gravimetrical analysis (TGA) technique was used to characterize the thermal stability of the samples under study. Analyses were performed on the pure PCMs between 50 °C and 500 °C under N_2 atmosphere with a flow of 80 mL/min at a heating rate of 10 °C/min with a mass of approximately 30 mg.



4.7 COMPRESSIVE STRENGTH TEST

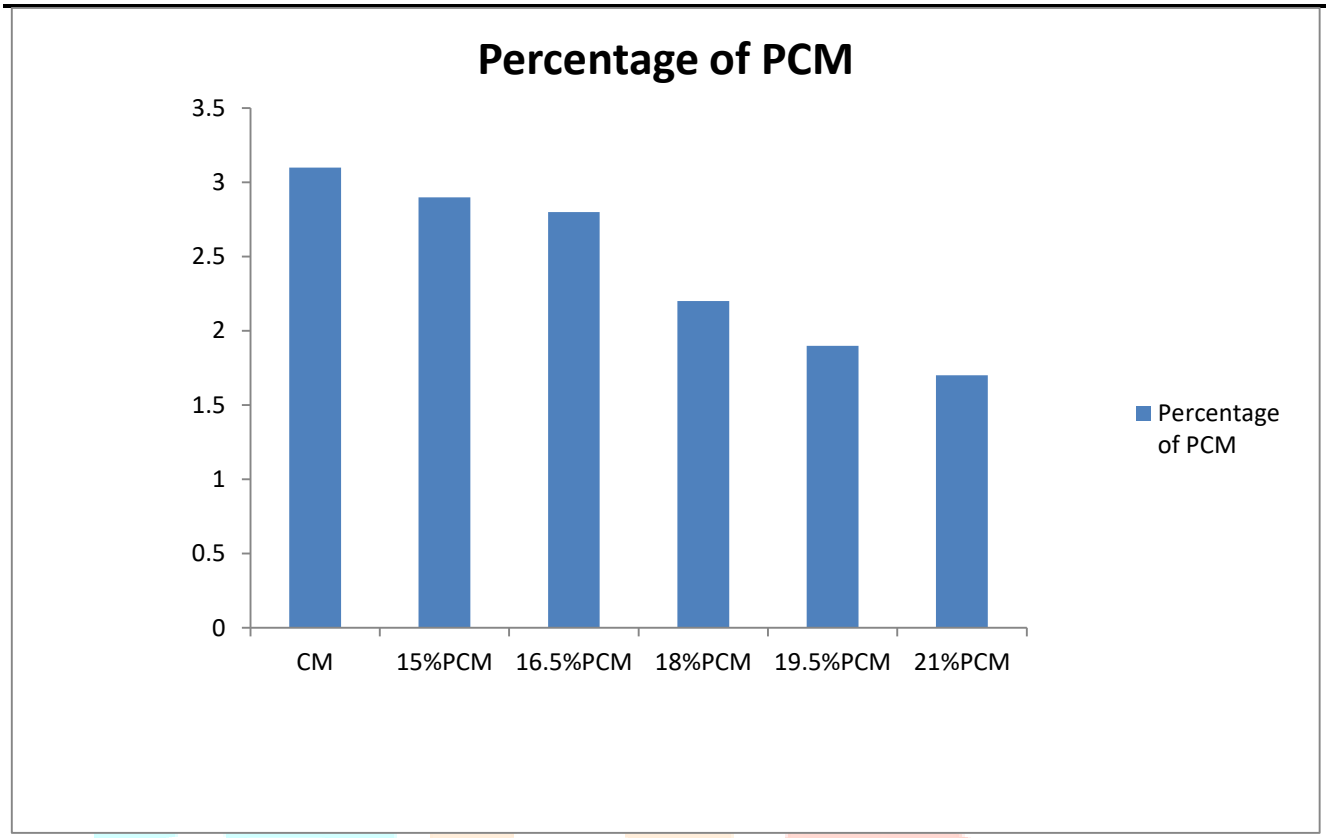
The compressive strength is the ratio of the maximum load to the surface area of mortar cube. Three cubes were tested for each mix ratio and the average of three specimens is taken as the compressive strength it was tested by Compression Testing Machine of Capacity 2000kN. The geopolymer mortars were tested for compressive strength at the age of 7day and 28 day. The specimens were subjected to a compressive force at the rate of 132kN per minute until the specimen failed.

$$\text{Compressive strength} = \text{Load} / \text{Area} \ (\text{N/mm}^2)$$



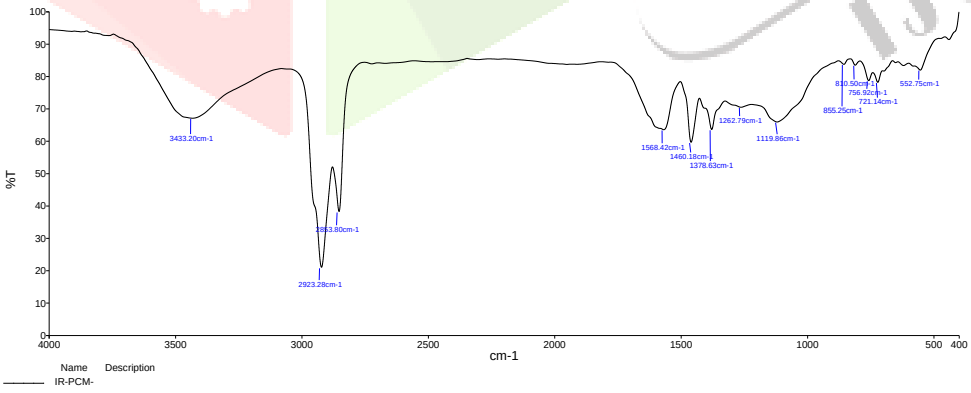
4.8 WATER ABSORPTION TEST

Water absorption was measured using cube specimens of size 70 mm x 70 mm x 70 mm. The weights of the dried specimens were taken. The specimens were immersed in water at room temperature for 24 hours. The specimens were removed from water and the water is allowed to drain for 1 min by placing them on a wire mesh, removing visible surface water with a damp cloth and then the saturated weight was measured. From the difference in weight, the water absorption values were found out. Fig.6.8 shows the specimens immersed in water.



4.9 FTIR

FTIR spectroscopy is an established technique for quality control when evaluating industrially manufactured material, and can often serve as the first step in the material analysis process. A change in the characteristic pattern of absorption bands clearly indicates a change in the composition of the material or the presence of contamination.

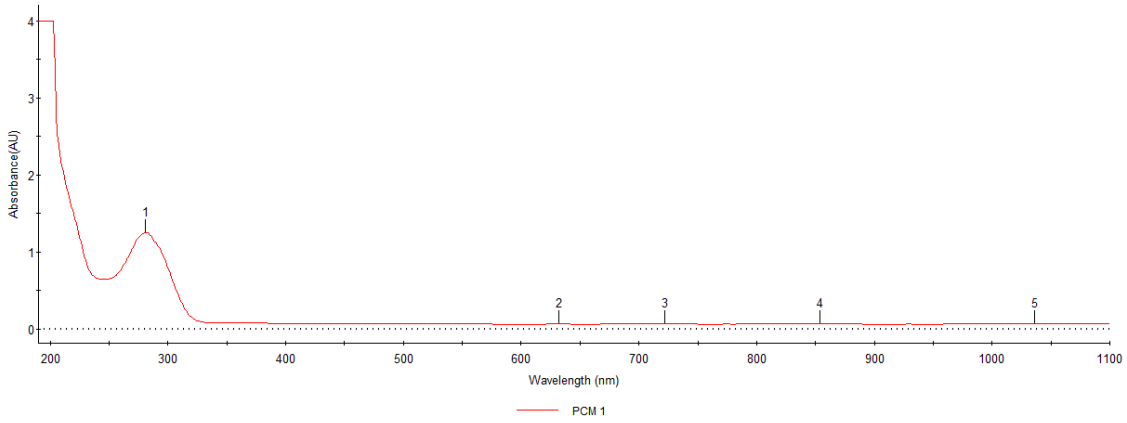


4.10 THERMAL GRAVIMETRIC ANALYSIS

TGA is Thermal Gravimetric Analysis. It is a thermal analysis technique. Here, the change of the mass of a sample is observed and analyzed with the change of the temperature. This can also be measured as a function of time at a constant temperature.

4.11 ULTRAVIOLET–VISIBLE SPECTROSCOPY

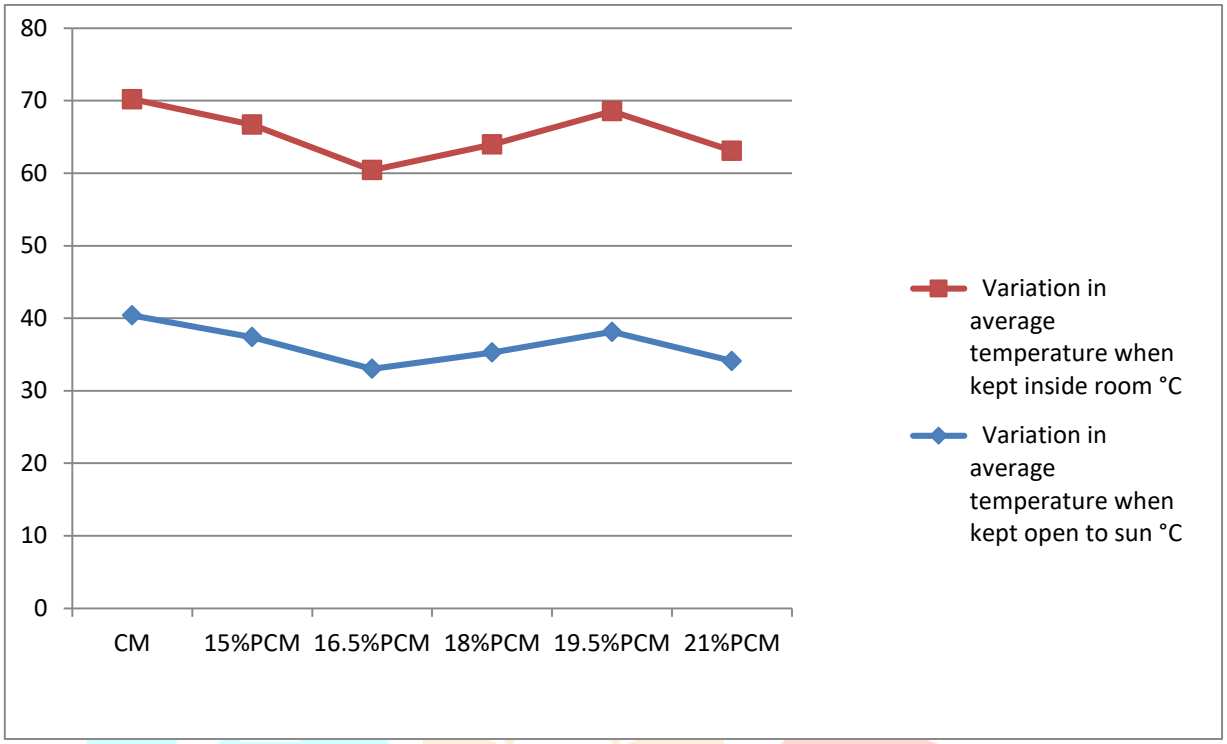
UV/Vis spectroscopy is routinely used in analytical chemistry for the quantitative determination of different analytes, such as transition metal ions, highly conjugated organic compounds, and biological macromolecules.



4.12 TEMPERATURE TESTING

The samples are tested for obtaining the suitable percentage of addition of PCM by determining the temperature of the samples under various surroundings. A temperature sensor is used in this to determine the temperature of the samples. The samples are tested at three different surroundings,

- Placing under direct sun.
- Placing in a controlled room temperature



5. BUDGET:

The approximate budget of this project work is given in below table.

S.No	Details of equipment, consumables	Approxy cost in Rs
1.	Travelling and procuring expenses for material collection	5200
2.	Testing Charges for material characterization	5000
3.	Casting the sample	1000
4.	Report Preparation	3200
5.	Miscellaneous (Helpers, Casting, Field visit(If time permits))	1000
	Total	15400

6. BENEFITS TO SOCIETY

The motivation of energy conservation is correlated to the willingness to use energy more efficiently in the future, to the presence of fiery spirits, to the likelihood of implementing suggested measures, to the size of the organization and electricity consumption, to the degree of total responsibility for a building owner, the operation of the building, the activities in the building and the electricity contract.

7. OUTCOMES

This way the temperature inside a room goes up very fast. In summer walls treated by this matter slow overheating down an ideal material for inner heat insulation of walls in construction, mainly of concrete buildings, thermal bridges, parts of walls behind heating elements, where due to condensation, mould can appear and for all spaces which are inadequately heat insulated and where it is required to increase the temperature in a room by increasing the temperature of walls and where savings of energy is required in combination with controlled thermoregulation of heating systems. Tests which have been carried out but more importantly the experiences of users proved that in relation to the type of properties and to the heating system it is possible to save 25% or more on heating expenses.Thermal insulation material is excellent material for achieving an anti- condensation effect. Occurrence of cold areas on interior walls mainly in corners can cause condensation of room humidity and subsequent occurrence of mould. The idea behind using thermal insulation material is to distinctively decrease dispositions for creating condensation with the existence of microscopical air spaces in painted surfaces and this way decrease the possibility of mould occurrence.

8.CONCLUSION

The test results obtained from normal grade paraffin wax was compared with that of the heavy grade paraffin wax. The results proved that the heavy grade paraffin wax gave more reduction in the temperature difference than the normal grade paraffin wax. The utilization of the heavy grade would provide much greater difference as shown in result obtained.

The compressive strength of the material is not obtained well in the normal grade paraffin mixed PCM than the heavy grade mixed PCM. This result shows that they can also provide higher strength than the normal conventional mortar when applied. The main objective of obtaining the optimum temperature is obtained at 16.5% addition of PHASE CHANGE MATERIAL which is paraffin wax of heavy grade gives the almost reduction in temperature.

The performance of samples under various environments has also proved that the sample made with 16.5% has given a considerable reduction of temperature of about 2°c to 3°c. thus they can be utilized

in further construction progress in case to reduce the temperature and increase the cooling of the building during the construction process.

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