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Study of Phase Change Material and Waste Iron Ore Tailing, for Thermal Energy Storage and Compressive Strength in Concrete.

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ABSTRACT: As we all know that concrete is used everywhere like buildings, roads etc. We design the concrete according to the need of concrete and the properties like compressive strength, durability, fire resistant etc are different for buildings and roads. To enhance the properties of concrete we try to use cheapest material which is easily available nearby the construction sites. There are some reactions (endothermic and exothermic) takes places when the concrete is placed. Temperature is one of that due to this when concrete is introduced in the environment so temperature affect it very badly like cracks occurs in concrete, looses compressive strength, bleeding of concrete etc. When the concrete introduced in the environment due to endothermic reaction like thermal properties means they absorb heat from environment that's why inside the building temperature is high so to control this so many researches are going on.

In this research paper we are going to use the paraffin wax as Phase Change Material (PCM) which is replaced by cement and waste iron ore tailing as replaced with sand, in our experiments and will observe the thermal properties and compressive strength of concrete.

Keywords: Concrete, Paraffin, Waste iron ore tailings, Compressive Strength, Adiabatic Temperature.

INTRODUCTION

Now a day, most countries deal with the problem of building consumption which is the major cause of energy consumption. For a sustainable future, number of methods or techniques has been introduced to reduce the building energy consumption. So introducing Phase Change Material (PCM) in building material becomes helpful to reduce the building energy consumption and is able to improve its thermal heat storage and make it environment friendly. Phase change material absorbs or release some amount of energy in the form of heat at certain temperature ranges during phase change process. Hence, incorporating phase change material in concrete, concern on energy efficiency, by reducing the building energy consumption PCM exist in building material has wide range of applications such as drop ceilings, stud walls and metal roofs etc. which are used to improve thermal heat storage of buildings and make them environment friendly.

PCM used in concrete classified as two types i.e. one is Organic and another one is inorganic both the types have different properties different advantages, different limitations but our main scope is to reduce the energy consumption in buildings. Use of PCM in concrete give the advantage of heat storage, control cracking and also effect its fresh and hardened properties.

1. PHASE CHANGE MATERIAL (PCM)

Phase change material is a material which is used for absorbing and releasing some amount of energy in the form of heat at particular temperature. These materials can be able to change their solid state into liquid and vice-versa by absorbing or releasing certain amount of energy. For example Water, it can absorb or release some amount of energy and able to changes its physical state.

PCM heat exchange mechanism

Physical state of PCM has ability to change its phase when it exposed to heat source. The chemical bonds within the PCM start breaking by absorbing sufficient amount of heat (which is an endothermic process) and changes its solid state into liquid.

As the temperature of the source reached at phase change temperature of phase change material then breaking of bond is complete and the phase gets changed. On the other hand, when temperature of heat is less than temperature required by PCM to change its phase, then molten PCM changes itself from solid to liquid by releasing heat to the environment which is an exothermic process.

Major reason to performance of Phase change material into concrete as it:-

a) Improved thermal heat storage
b) Control cracking
c) Environment friendly
d) Cost effective

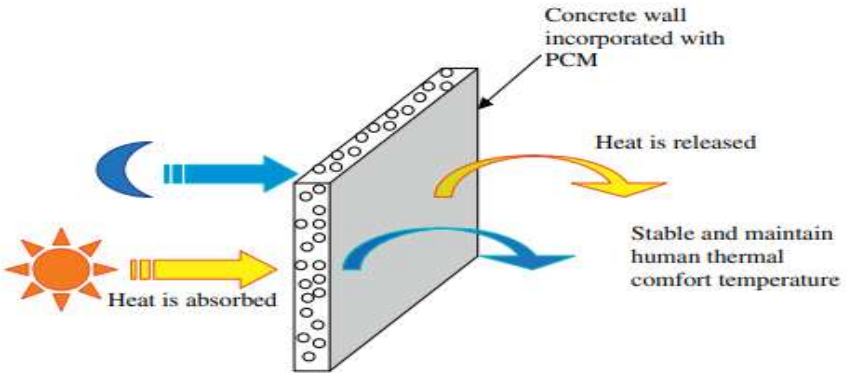

Fig.1. PCM enhancing the human comfort by providing heating and cooling and function to concrete walls.

2. IRON ORE TAILING (IOT)

The solid waste that are originated from iron ore industries are known to be IOT. During the beneficiation process of iron ore concentrate these waste are produced. Out of all other types of solid waste, IOT is one of the most common wastes in the world. Because of high yield and less utilization ratio, there is increase in IOT due to the recent growth of steel and iron industries in India and the biggest iron ore producer in the world. Due to the increase in the production of steel the waste generates which is called as IOT and this waste can cause the harmful effect to the environment. The crystallographic structure of the IOT is determined by the X-Ray Diffraction (XRD) test.

SCOPE

The scope of this paper is to attain the maximum compressive strength as much as possible by the limited substitution of cement and sand with the phase change material i.e. paraffin wax and with the waste iron ore tailing. The phase change materials provides the potential of reducing energy for heating and cooling due to load reduction and for increasing indoor thermal comfort due to reduced indoor temperature fluctuations

LITERATURE REVIEW

[4] In this paper, Iron Ore Tailing is partially replaces with fine aggregates. The objective of this paper is to make the use of industrial waste as the partial substitution for fine aggregate in concrete structure to make it partially attractive. The test was conducted on (0%, 10%, 20% 30% 40%) As a result, the strength of concrete increase up to 30% of replacement level, decreases in strength is observed 30-40% of replacement.

[16] In this paper, fine aggregate are completely replaced by IOT and the cement is partial replaced by GGBS at the different percentages (10%,20%,30,40%). The specimen was prepared and various tests are performed on concrete, as a result it showed increasing in strength when the percentage is also increased, only up to 30% further results in decreasing the strength.

Error! Reference source not found. In this paper, the iron ore tailing is used in concrete as a substitution of the aggregates. A concrete grade of M40 was prepared having the w/c 0.5. Various tests were performed on the concrete. It was noticed that the compressive strength of the concrete is improved with respect to conventional concrete and the tensile strength shows the improvement when the partially substitution of conventional fine aggregate(FA) by 20% with iron ore tailing (IOT).

Error! Reference source not found.In this paper iron ore tailing is identified as an industrial by product, which is used as alternative to sand. In this paper the sand is replaced with iron ore tailing with the replacement percentage of 10%, 20%, 30%40% and 50% for M25 and M40. The result shows that the workability and mechanical properties of concrete increases up to 40% replacement of fine aggregate with iron ore tailing as compared to normal concrete.

0In this paper the author describe about the Phase Change Material and advantages of adding PCM in concrete .Based on the temperature of the environment Phase change materials are the materials that are able to store heat energy in the form of temperature and releasing the energy.

Error! Reference source not found. In this paper, to control the heat energy of concrete Phase change material is used. As a result, when Phase change material is introduced in concrete it slightly reduces the flow ability. There is slight delay in both initial and final setting time of concrete when phase change material in added into concrete.

Error! Reference source not found.The objective of this paper is to give a review of different types of PCMs and the concrete properties that will be affected by the PCMs i.e. fresh and hardened properties. As the result shows that PCM concrete has few useful properties like thermal performance and latent heat storage in the form of temperature.

[4]The aim of this study is to check the IOT impact on environment and by utilizing it for the AAC production. They prepared AAC block by using iron ore tailing in it. 0%, 20%, 40%, 50%, 60%, 80%, 100% of Iron Ore Tailing is investigated with the partial replacement of IOT with silicon sand. As a result, it shows that the increase in the ratio of IOT has adverse effect on the compressive strength of AAC and the better quality of tailings may increase the strength of AAC and it doesn't affect bulk density of AAC.

[15] In this paper, the aim of this to check the compressive strength of the concrete and to find out the effect of partial replacement of sand by IOT. In this paper iron ore tailing is used as partial replace to fine aggregate at 0%,5%10%15% and 20%. The mix was M25. As a result, increase percentage of IOT workability of mix reduces. Replacement of 15% of IOT gives the best result for compressive strength.

[11] In this paper, PCM are used as the latent heat thermal storage materials and as a result latent heat storage materials will provide a solution in developing efficient thermal storage system for building. The thermal mass of the structure can be increases with the PCM.

[1] The objective of this research is to find out the best percentage of the phase change material which is affected by the time in concrete and achieve the high temperature storage performance, and to check out the mechanical properties at the different percentages of PCM concrete add on with as filler GGBS (Ground Granular Blast Slag) is prepared i.e. 0%, 5%, 10%, 15%, 20%. Then the test specimen is put for curing at 7 and 28 days. Concrete achieves the highest thermal energy storage only adding up to 5% paraffin wax thereafter decreasing.

[3] In this paper, the research was done to explore the chances of making concrete including large volumes of industrial or factory by-products and dependent materials like fly ash, demolition waste and steel slag. The fly ash is used as a binder and is replaced by the cement, demolition waste is used as recycled fine aggregate and the steel slag is used as coarse aggregate. The different mixes were prepared and then tested at a different ages for checking the mechanical strength. The result shows that the use of construction or industrial waste increases porosity of the concrete and also decreases the durability and strength of concrete. If mixed with the steel slag then the concrete retrieves its strength and durability loss.

[18] In this paper, the IOT was used as aggregate for the different amount of replacement to the ultra-high-performance concrete (UHPC) and the tailing was specified by the techniques like SEM, and XRD. In this, the UHPC is prepared by the replacement of natural aggregates

with the IOT. The result shows that if the substitution of natural aggregate by IOT is 100%, then compressive strength and workability of the material decrease. If the substitution is not over 40%, after curing of 90 days the compressive strength of tailings is decreased and the flexural strength increases.

CONCLUSIONS

- 0%-15% there is the increase in the compressive strength of concrete.
- At 20% it shows that the compressive strength decreases.
- IOT can effectively be used as FA in concrete.
- As we replace the percentage of replacement then the compressive strength decreases.
- During the study, it was studied that with the increase of industrial waste content in concrete the strength of the concrete seems to be decreasing.
- Thus these waste materials can be used for construction works, like small road pavements, small/minor residential building

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