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Thermal insulation of bricks using cement kiln dust, coconut shell powder ash and waste polystyrene containers

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Abstract: Reusing of solid wastes such as cement kiln dust, coconut shell powder ash and waste polystyrene containers leads to the reduction in quantity of solid waste produced. Reduction in CO2 emission leads to the reduction in air pollution. Our idea is to make bricks by partially replacing soil by cement kiln dust and coconut shell powder ash to make eco-friendly bricks. Reducing the overall cost of Construction by using waste material such as by cement kiln dust and coconut shell powder ash etc. By the replacement of soil by various proportions (5%, 10%, 15%, 20%, 25%, 30%) in which 25 % of replacement of coconut shell powder ash, 2% of cement kiln dust and 0.1% of hollow silica spheres as constant in which provides the strength of second class brick within the limit of water absorption of brick and there is a reduce of thermal conductance of 0.17 W/m2K when compared to the normal brick. Thus concluded that the replacement these waste materials provides good thermal insulation and compressive strength at low cost and environmental friendly.

Key Words: co_2, coconut shell powder, hollow silica spheres etc.

I. Introduction

CKD is having self-cementing characteristics, reacts with soil in a manner similar to Portland cement. Typically, CKD has approximately one-third of the amount of cement oxides (CaO, Al2O3, SiO2, and Fe2O3) present in Portland cement. coconut shell was burnt as a means of solid waste disposal which contributed significantly to CO2 and methane emissions. However, as the cost of fuel oil, natural gas and electricity supply has increased and become erratic, coconut shell has come to be regarded as source of fuel rather than refuse. When polystyrene is sent to the landfill, it is quickly covered and this process deprives it of water and oxygen, which would normally help it to break down. Much of the disposable packaging that we eat from today will therefore still be around in 500 years. If the first settlers in Barbados in 1625 had been able to eat from polystyrene and the containers had been put into a landfill, the same containers would still be around today. The soil is taken from Thalavaipuram and the tests are conducted are grain size distribution, Atterberg's limit, specific gravity tests, etc.

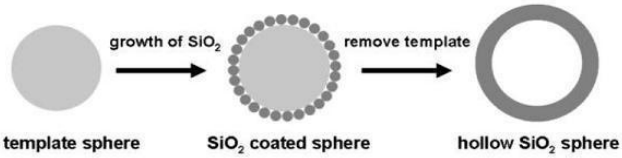
II. Mix Proportion

Table 1: Mix Proportion

MIX	CLAY SOIL%	COCONUT SHELL POWDER ASH %	CEMENT KILN DUST %
CSCK 5	93	5	2
CSCK10	88	10	2
CSCK15	83	15	2
CSCK20	78	20	2
CSCK25	73	25	2
CSCK30	68	30	2

Cement kiln dust is kept constant since the compressive strength value decreases on further addition.

III. Preparation of Hollow Silica Spheres:



Step 1: The waste polystyrene containers are collected.

Step 2: These collected waste styrene containers and dissolved t ethanol, dimethyl form-amide and sodium silicate.

Step 3: The amount of ethanol taken is 20 ml and ratio dimethyl form-amide and sodium silicate taken is 1:6

Step 4: Then the waste polystyrene containers are immersed this liquid and stirred continuously for 24 hrs.

Step 5: Then the solutions are taken out and oven dried at 110˚C

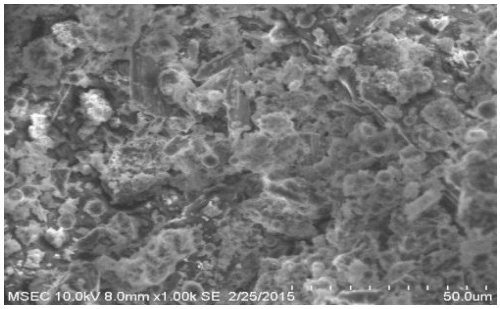


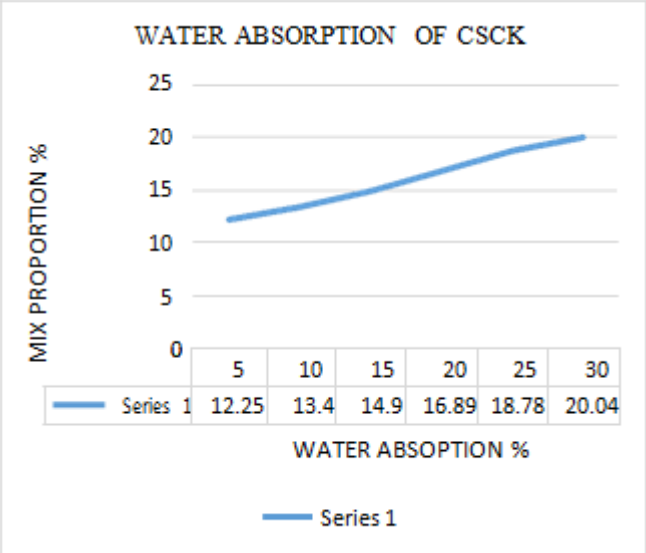
Fig 1: SEM image of hollow silica spheres

IV. Experimental Procedure

1. Water Absorption Test :

1. The dried specimen has to be immersed completely in clean water at a temperature of 27 ± 2ºC for 24 hours.
2. The specimen has been removed from the water and wiped out the traces of water with a damp cloth and weighed as as M2.
3. The weighing of wet brick must be done after 3 minutes of the specimen has been removed from the water.
4. The Water absorption (percent by mass), after 24-hour immersion in cold water is given by the following formula:

W in % = (M2-M1)/M1 * 100%



Graph 1 Water Absorption

2. Testing on Compressive Strength

(IS 3495 Part 1)

[1] The specimen has been placed with flat faces horizontal between two plywood sheets, each of 3mm thickness and carefully centred between the plates of the testing machine.

[2] The load has been applied axially at a uniform rate of 14 N/mm² per minute till the failure occurs and the maximum load at failure has to be noted.

[3] The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

[4] Compressive Strength in N/mm² is given by,
Compressive strength= (Maximum load at failure in N / Average area)

Table 2 Compressive Strength

MIX PROPORTION	LOAD KN	COMPRESSIVE STRENGTH IN N/mm^2
CSCK 5	62.8	2.57
CSCK10	100.9	4.56
CSCK15	116.5	4.86
CSCK20	**136.4**	**5.63**
CSCK25	**120.3**	**5.16**
CSCK30	96.64	4.2

3. Testing On Thermal Insulation:

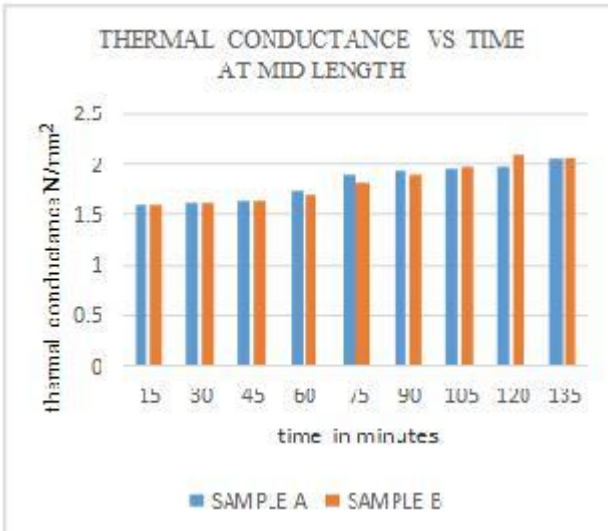
3.1 Thermal Conductance:

As per Fourier's Law of heat conductance, thermal conductance is defined as the ratio of heat flux to temperature difference.

$K = q / (T_h - T_c)$ in W/m²K Where,
Q - Heat flux in W/m²

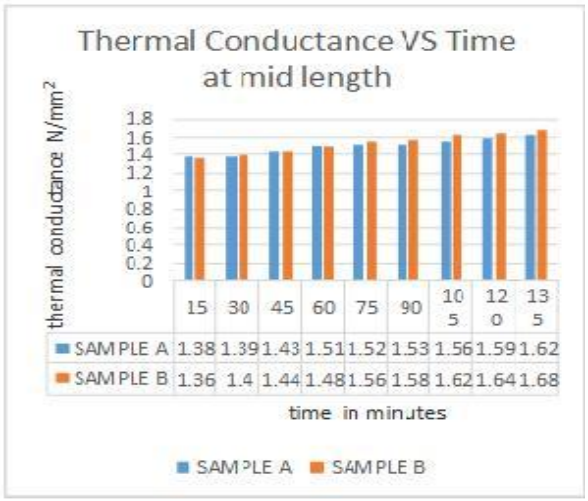
3.3 Observation and Calculation:

Input Temperature = 80°C



GRAPH 1 Thermal conductance Vs Time

Input Temperature = 100ºC



GRAPH 2 Thermal conductance Vs Time

V. Cost Analysis:

TABLE 1 Cost analysis

BRICK TYPE	CHAMBER Rs.	HAND MADE Rs.
6 hrs FIRED BRICK	4.825	3.325
THERMAL INSULATION BRICK	12.85	11.35

VI. Result and Discussion:

1. As the percentage of CSCK increases, the water absorption percentage will also increase. As per IS 1077 :1992, the water absorption % must be less than 20 % by weight.
2. Thus concluded that,
3. bricks with CSCK % from 5 to 25 holds good results in water absorption test**.**
4. Up to 25% of clay soil can be replaced by coconut shell powder ash.
5. When the percentage of CSCK exceeds 25% the compressive strength value becomes less than 5 MPa.
6. Thus concluded that 20% is the optimum percentage for CSCK.
7. The compressive strength obtained for 20% replacement is 5.63MPa.
8. When input temperature is maintained as 80ºC for the period of exposure of 2 hrs, Difference in thermal conductance between control specimen and specimen A&B is 0.05 W/m²K.
9. When input temperature is maintained as 100ºC for the period of exposure of 2 hrs, Difference in thermal conductance between control specimen and specimen A&B is 0.17 W/m²K.

VII. Conclusion:

Thus concluded that, Generally building walls are exposed to sunlight for the period of nearly 8hrs per day. Thus the thermal conductance of the brick can be reduced by approximately **0.17 W/m²K** by incorporating 0.1 % of hollow silica spheres with 20%(A) and 25%(B) of CSCK .

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