Experimental Investigation of Performance of Rockwool Filled Concrete Block

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Abstract- *Recent developments in building energy saving managements have led to considerable improvements in energy savings of building sector. Therefore looking at various optimization strategies to reduce the building energy consumptions. These measures include improving the building materials, energy conversion technologies, control strategies etc. But there is still a strong interest to reduce the energy use of buildings through reduction of heat losses. The largest source of energy Mineral wool (or rock wool) is a non-metallic, inorganic product manufactured using stone/rock. The Rockwool can be placed inside hollow concrete blocks and the insulation assessment of these materials can be examined based on the heat transfer rate. This study aims at the comparative study of Rockwool and Thermocol (Polystyrene) insulation used in concrete blocks. Cement-based composites are among the most widely-used construction materials due to their low cost, high compressive strength, high durability, versatility, and easy-handling. Unfortunately, cement-based composites are intrinsically porous and may deteriorate and be liable to rebar corrosion as a result of exposure to harsh environments or poor construction quality. In general, proper design procedures, adequate concrete cover depth, corrosion-inhibiting admixture, and low-permeability cement-based composites can be selected for corrosion prevention and control. There are three type of concrete blocks used for this analysis. The thermal properties of Rockwool-concrete composite and Thermocol-concrete composite will be analyzed and will be simulated in ANSYS. Thus we determine the effectiveness of insulation provided by the Rockwool material with the hollow concrete block. In hardware part rock wool inserted building block's thermal conductivity is tested by ASTM C518 test method (British standard).This analysis will help us to determine the efficient insulator and will help us reuse the Rockwool and Thermocol wastes generated in industries and commercial sites.*

Keywords — *Rock-wool, ANSYS, polystyrene, mineral wool*

I. INTRODUCTION

Over the last 30 years, the requirements for the thermal insulation of buildings in the Netherlands have been increased. More than 30% of total secondary energy is used by residential and commercial buildings according to the Natural Resources. Therefore looking at various optimization strategies to reduce the building energy consumption is crucial. These measures include improving the building materials, energy conversion technologies, control strategies etc. Developments of near zero energy buildings are becoming quite popular with introduction of renewable resources and energy storage strategies. But there is still a strong interest to reduce the energy use of buildings through reduction of heat losses. The largest source of energy Mineral wool (or rock wool) is a non-metallic, inorganic product manufactured using stone/rock (volcanic rock, typically basalt or dolorite)* together with blast furnace or steel slag's as the main components (typically 97%). The remaining 2-3% organic content in the product as sold is generally a thermosetting resin binder (adhesive) and a little oil.

Rock wool is an organic fibrous substance produced by steam blasting and cooling molten glass. Rock wool is frequently used for acoustic insulation, fire protection, cement reinforcement, pipe insulation and even as synthetic soil for growing plants. There is tons of Rock wool wastes generated annually. This Rock wool being loose and bulky requires large space to be stockpiled or land filled. Traditional landfill and stockpile methods are not environment friendly solutions and these wastes can be reused and recycled to avoid environmental problems resulting from improper solid waste disposal.

Rock wool wastes are usually briquetted and reprocessed. One solution to Industrial Waste Products Management is the use of these products in concrete as a substitute for aggregates or cementitious materials depending on the chemical composition and grain size of the by product. Using these raw materials as substitute for raw materials may help preserve natural resources. The Rockwool can be placed inside hollow concrete blocks and the insulation assessment of these materials can be examined based on the heat transfer rate. Changing the profiles of hollow block alters the rate of heat transfer through the bricks.

Three basic mechanisms affect heat transfer through hollow bricks. These are solid conduction through the materials forming the brick, radiation transfer through the voids and convective transfer in and through the voids. The three interact to affect heat transfer. Because of that, in such a case, an equivalent thermal conductivity (Keqv) is determined for the brick samples. An appropriate selection of masonry products for walls and roof reduce the energy consumption of air-conditioning. To achieve this objective, the thermal properties of these materials have to be known. Hence, the purpose of the present study is to assess the thermal performance of locally manufactured masonry bricks for the local environmental conditions. The assessment includes studying the effects of geometry, type and method of use of thermal insulation, and mortar types on equivalent thermal conductivity (Keqv) and thermal resistance (R) of the bricks. These kinds of data are not widely available and will be useful as a basis for selection of brick types for buildings.

II. DETAILS EXPERIMENTAL

A. *Materials and Procedures*

Mineral wools, including rock and slag wools, are inorganic strands of mineral fiber bonded together using organic binders. Mineral wools are capable of operating at high temperatures and exhibit good fire performance ratings when tested.Rock wool is produced from two minerals: diabase (dolerite) or basalt. Next to virgin materials, also recycled rock wool can be added to the process as well as slag residues from the metal industry. Rock wool is a mineral inorganic fibrous material with excellent and distinguished properties and characteristics. It is efficiently applied in all fields of thermo-acoustic insulation; furthermore it is used in many industries and agricultural activities.

Rock wool is produced by melting mix of basalt, limestone & coke in a special vertical furnace at very high temperature (about 1500 C). Then the molten rock is made into thin fibres through a high speed centrifugal machine. After adding certain amount of binder, dustproof oil, silicon oil and mechanical operations, rock wool fibres are then processed to be the final desired product with specified physical so the rock wool fibre and binder can be tied in perfectly; avoid delaminating which happens often on line, the quality is much more stable and uniform. Rock wools produced by small production line. Our rock wool is produced by automatization production and chemical properties and specifications. The binder is sprayed equably by using new technology.

Table1: Chemical Composition of rock-wool

Chemical composition		
Silica	SiO_2	44.06%
Alumina	Al_2O_3	15.94%
Titania	TiO_2	1.58%
Ferrous Oxide	FeO	11.93%
Lime	CaO	16.36%
Magnesia	MgO	5.68%
ManganeseOxide	MnO	0.17%
Sodium Oxide	Na_2O	3.71%
Potassium Oxide	K_2O	0.57%

Fig.1.Rock-wool sheet

B. *Specimen*

From the proposal topic the first study was focused on how effectively the waste rockwool can be used in insulating the building for more energy efficient economically way. As per this idea the next step was took on effectively using the rock wool insulation in concrete blocks which made to have a software analysis on the concrete block models for which the market available common design of concrete block was designed.

The 3 types of Concrete blocks used in this analysis are: Hollow Block, Solid Block, Styrol Insulated Blocks. The design of these blocks is done through 3D modelling CAD software called SOLIDWORKS .Given below is the screenshot of these designed blocks.

Fig.2.Hollow block

Fig.3.solid block

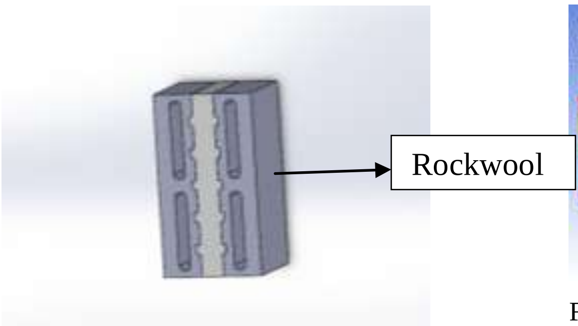

Fig.4. Rockwool/Styrol insulated block

C. ***Test methods***

The SOLIDWORKS CAD model of concrete block for analysis is imported in ANSYS 17.2 and is simulated under Steady State Thermal conditions with necessary boundary conditions to have a comparative study to understand the effectiveness and thermal efficiency on a normal concrete block, normal hollow concrete block, hollow concrete block filled with waste Rockwool insulation styrol concrete block with thermocol and Rockwool insulation materials.

Given are the Ansys analysis of normal concrete block geometry and analysis result when it subject to a constant temperature change.

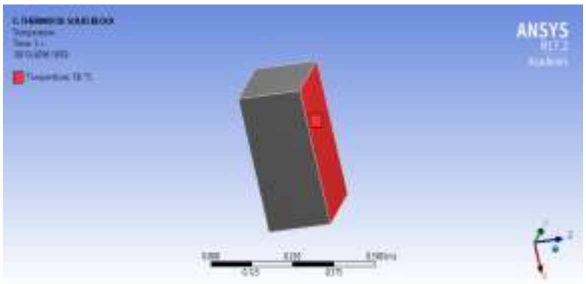

Fig.5.Temperature of one side maintained at 50°c

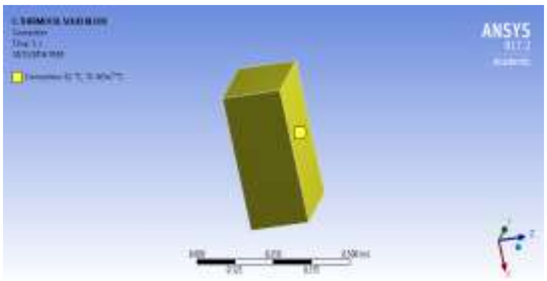

Fig .6.Convection of 12w/m^2°c added to five faces

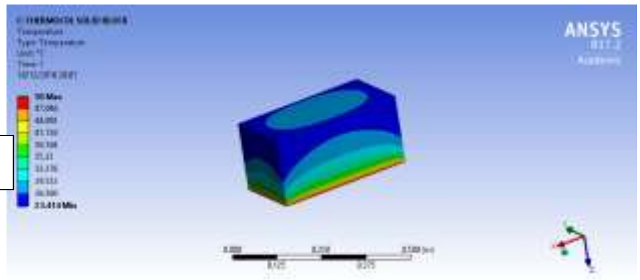

Fig .7.Temperature of the hollow block ranges from 23.414°C to 50°C

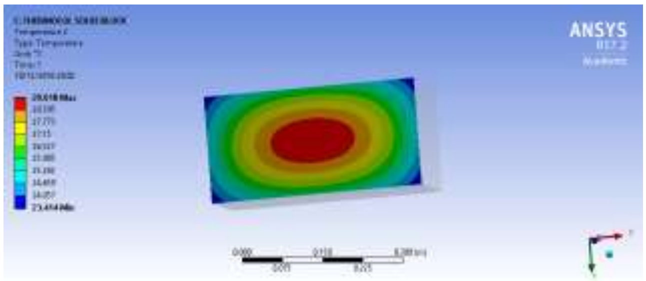

Fig .8.Temperature on desired side is found to range from 23.414°C to 29.018°C

The Initial Conditions kept as like this the concrete block is filled with Rockwool. One side of the block is maintained at a temperature of 50°C Convection of 12W/m^2°C exists between the Air-Concrete Medium.

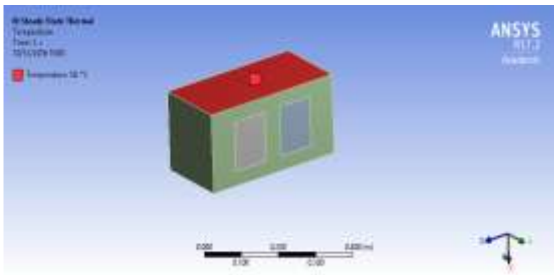

Fig .9.Temperature of one side maintained at 50°c

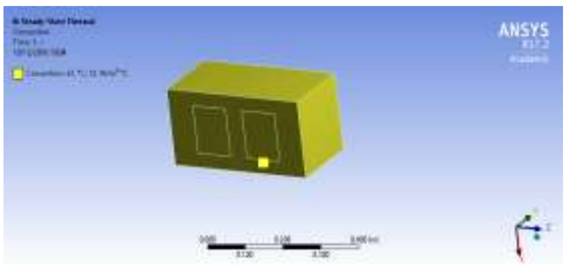

Fig .10.Convection of 12w/m^2°c added to five faces

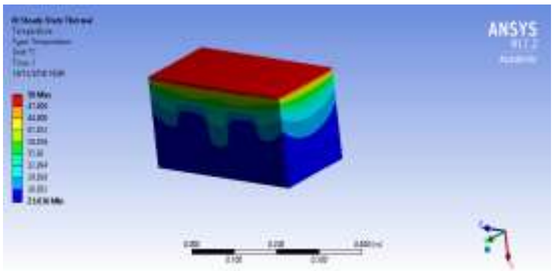

Fig .11.Temperature of the hollow block ranges from 23.036°C to 50°C

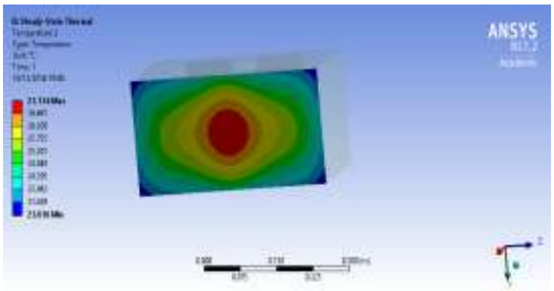

Fig .12.Temperature on desired side is found to range from 23.036°C to 27.114°C

III.RESULT AND DISCUSSION

A . DATA ANALYSIS OF TEMPERATURE IN THE DESIRED REGION

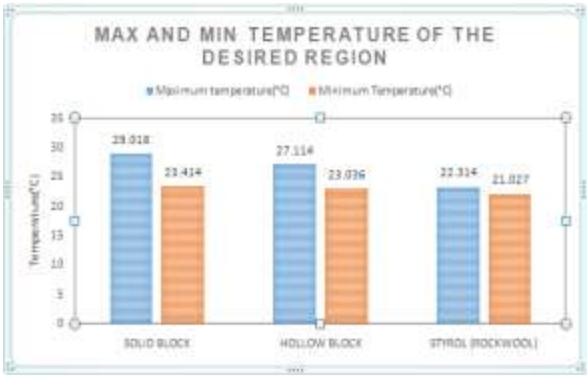

Fig.13.max and min temperature of the desired region

We find that :

- Under hollow block, rockwool insulation has lesser max and min temperatures range than thermocol insulation, thus acting as a better insulator in this case.
- Under Styrol based we find that rockwool is a better insulator because of its lower temperature in the desired region than by using thermocol insulation.
- Overall we find that of the three types of concrete blocks, greater temperature reduction is obtained in the Styrol (rockwool used) concrete block.

B. DATA ANALYSIS OF TEMPERATURE OF THE ENTIRE BLOCK

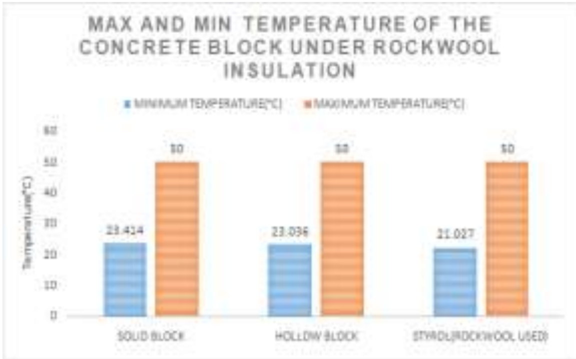

Fig.14.Max and Mix Temperature Of The Concrete Block Under Rockwool Insulation

We find that :

- The temperature range for Solid block is same irrespective of the insulation used.
- Under hollow block, rockwool insulation has lesser max and min temperatures range than Thermocol insulation, thus acting as a better insulator in this case
- Under styrol based we find that rockwool is a better insulator because of its lower temperature in the desired region than by using thermocol insulation.
- Overall we find that of the three types of concrete blocks, greater temperature reduction is obtained in the Styrol (rockwool used) concrete block.

IV.CONCLUSION

Thermal fatigue behavior of plasma sprayed YSZ TBC system on 2024 AA was studied and major conclusions are as follows:

- In all cases, the initial cracks were initiated at the edge/corner of the square specimens.
- The failure of YSZ TBCs systems on 2024AA were observed due to the multiple cracks mode only. The results show four types of cracks formed in TBCs systems on 2024 AA, i.e., vertical cracks, horizontal crack, propagating crack, and penetrating crack [16]. In this article, vertical cracks and propagating cracks (or horizontal crack) emerged in YSZ based TBCs systems for 2024AA. The penetrating vertical cracks started penetrate from top coat to the substrate surface at 600^0C.

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