Design and Product Development Ceramics Using for Making Wall of Energy Conservation Building

Chanon Tunprawat[1]*, Kiattiphong Sijuntheuk[1], Mayuree Reungsombat[1], Yuwadee Porntharaphong[1]
Lecturer of The Faculty of Architecture and Design
Rajamanagala University of Technology Phra Nakhon.

Abstract

This research aims to study and develop ceramics material using in the wall construction which can be used to proof the heat and water, reduce absorbed humidity in the building. The product can save the energy, especially, the building which is set the air conditioning. The experiment found that the proportion of clay body can be developed and the result of thermal conductivity (K- value) was 0.111 W/ m. /K, the permeability was 7 percent, the glaze can be used to proof water. The product was compared to three kinds of construction materials which are brick, concrete masonry unit, and autoclaved aerated concrete found that K- value and permeability were lower. Moreover, it can proof water and save more energy for the air conditioning building.

Keyword. Ceramics,Wall, Energy Conservation.

1. Introduction

Global warming causes concrete effects; therefore, organizations throughout the world immediately corporate to solve the problem and stop any actions caused the crisis seriously. The cause of global warming is greenhouse effect which is the rising of greenhouse effect concentration in the atmosphere rapidly.

Greenhouse effect caused by human activities is to use energy in various purposes by burning of fossil fuels, for example, oil, gas and carbonization.[12] There are many solutions to stop global warming. Because the energy inside the building is spent much to response the human's activities, to reduce and conserve the energy inside is important.

The problem rose in the building is the internal heat. It caused by sunlight and external temperature. The heat straightly effects and leads the uncomfortable feeling to human; therefore, people try to relieve the uncomfortable feeling with air conditioner. [1] If the building is not appropriately designed, the energy will be waste.

There are rules and laws to control the building construction and conserve the energy in the building in Thailand.[2] The rule for the building construction is to use the appropriate and efficient materials to protect the heat, called insulation.[2]At present, there are researches about the materials mentioned.

Construction materials can be divided in many categories, for example, post, shaft, roof, floor, wall and other. Each of them should protect the heat and conserve the energy. Generally, the roof is such a part which is the most absorbable the external heat straightly. The widest area of the construction is the wall, especially in the high building. The wall is the part being the most absorbable the heat by considering its area. In order to protect the external heat, the material to construct the wall should be emphasized.

The building installed air conditioning, the material to construct the wall should be particularly concerned. Some materials are insulation, but they are unqualified to protect external humidity. There are relative researches in material selection to construct the wall that can save the air condition working as well as saving the energy.[3] [7] [8][9] Especially, the temperature and humidity is high all year as in Thailand.[10]

The materials for the wall construction are classified to various types. Ceramics material is the one that use to construct the wall and can be used for long time. Ceramics material is bricks. If it is compared the qualification to other materials, the weakness of brick is to absorb external heat in high level.[10] Nowadays, there are bricks with air holes or parallel holes called structural clay tile or hollow brick. The holes of brick can be used as insulation. Generally, the brick used in building construction is high permeability. The high permeability material will absorb air humidity. If the holes of bricks are used in air condition parts of the building, other materials should be used. According to the construction, the cost for the construction is higher. The researcher realizes in using the materials- brick, to proof humidity and heat, and to construct the wall which is developed and experimented. The purpose of research is divided in 2 categories.1.Experiment and develops the ceramics material to proof the heat and low permeability. 2. Develop the product to proof water in protecting humidity outside the building.

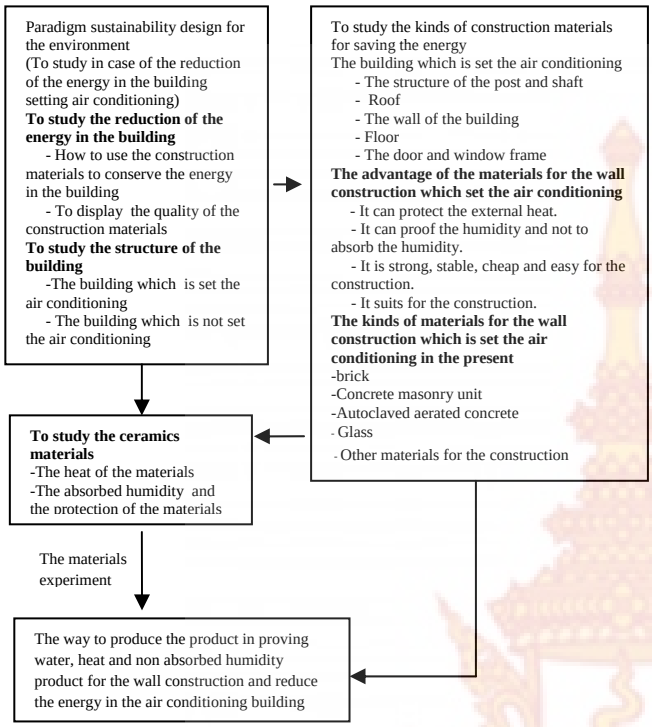
Literature related;

1.Paradigm sustainability design for the environment

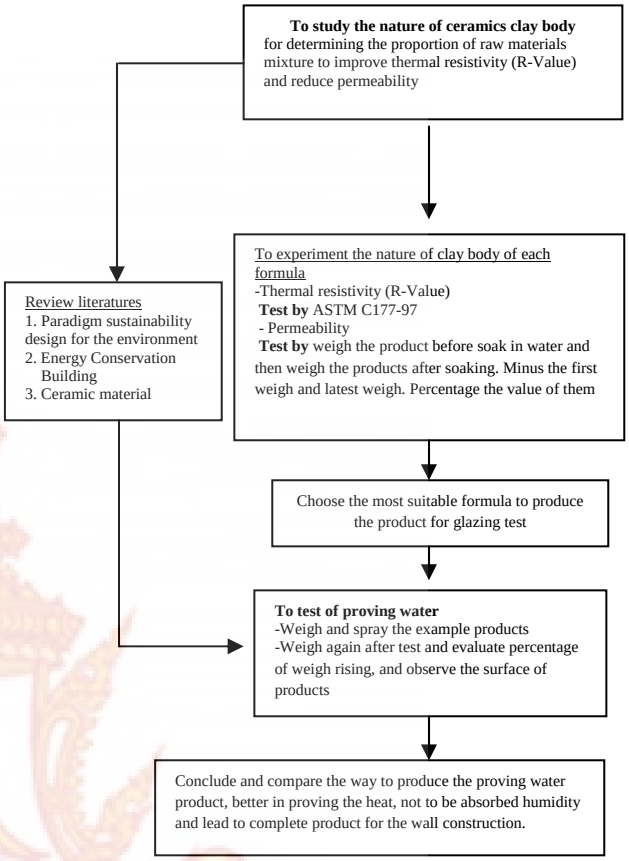
2. Energy Conservation Building

3.Ceramic material

Scope of research



Method of Research



2. Materials and Method

Materials Theory concerned

- Ceramics materials (brick) which porosity, the air holes inside can release the heat and thermal conductivity is low.[6]

- The nature of ceramics is it can resist the fire, strength and it can be the insulation.[5]

- Ceramics materials can be experimented and developed the ability to protect the heat, for example, the insulation and the insistent fire brick.[5]

- The ability in proving humidity of the material can be measure by absorbed water of the material.Generally, Permeability of Stoneware clay is 1-5%.[5]

- Ceramics glaze can proof gas and fluid; [4] [11]therefore, the product can proof the humidity on one face to another. This product cost low, save and beautiful.

2.1 The raw material using in the experiment was kaolin, ball clay, feldspar and quartz. Then, rice husk ash and sawdust were added for the porosity. The raw materials above are not difficult to find because they are sold in Thailand and not expensive.

2.2 The experiments of raw materials mixture were 11 formulas.

Independent variables were kaolin, ball clay, feldspar and quartz, rice husk ash and sawdust

Dependent Variables were thermal conductivity (k-value), thermal resistivity (R-Value) and permeability. The materials mixed were burnt at 1,200 ˚c oxidation firing. The proportions of the raw materials mixture are in table 1.

Table 1 The proportion of components of raw materials

formula	kaolin (%)	Ball clay (%)	feldspar (%)	quartz (%)	Rice husk ash (%)	Saw dust (%)
1	35	30	20	15	-	-
2	35	30	20	15	2.5	-
3	35	30	20	15	5	-
4	35	30	20	15	7.5	-
5	35	30	20	15	10	-
6	35	30	20	15	12.5	-
7	35	30	20	15	-	2.5
8	35	30	20	15	-	5
9	35	30	20	15	-	7.5
10	35	30	20	15	-	10
11	35	30	20	15	-	12.5

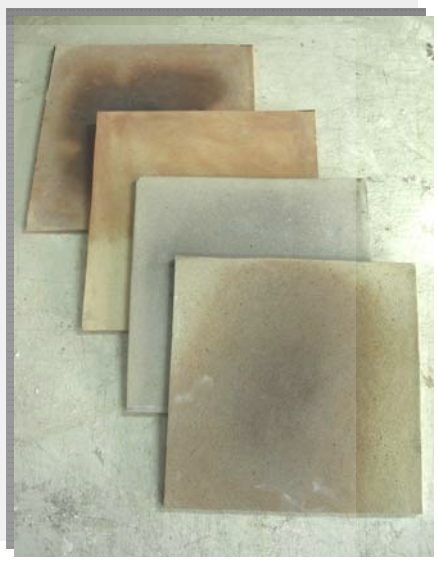


Fig. 1 The tested thermal resistivity (R-Value) and thermal conductivity (k-value) products

2.3 To test the product

2.3.1 To evaluate thermal resistivity (R-Value), the product was test by the Department of Science Service, the Ministry of Science, tested by ASTM C177-97

2.3.2 To evaluate permeability

The procedure of the experiment

2.3.2.1 Heat 3 products approximately 110-150˚c then record the weigh.

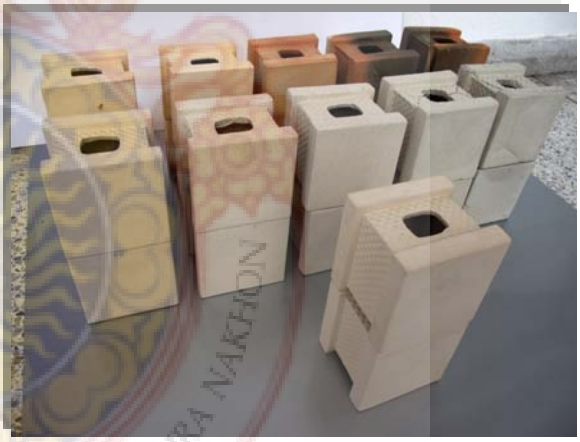


Fig. 2 The tested permeability products

2.3.2.2 Boil the products for 3 hours. Leave 24 hours until it is cold.

2.2.3 Take products from water. Wipe and weigh then evaluate the weight as a rule below;

$$\frac{\text{Wet weight-}_{\text{dried}}\text{ weight}}{\text{Dries weight}} \times 100$$

3.To produce the products to be test glazing. The glaze is used for proving water.

4.The test of proving water

The procedure of the experiment

4.1 Weigh and record the products.
4.2 Spray products with water for 15 minutes.
4.3 Wipe the surface, weigh products and evaluate them. The rule is below;

$$\frac{\text{Wet weight-}_{\text{dried}}\ \text{weight}}{\text{Dries weight}} \times 100$$

4.4 Observe the proving water of the surface

Fig. 3 the proving water of the products

3.Results and discussion

The experiment found that the most suitable of clay body was the 4th formula. Those are kaolin 35%,ball clay 30%, feldspar 20%,quartz 15%, rice husk ash 7.5%. The results are below;

-Thermal conductivity (k-value) 0.111 W/m.K and
-Thermal resistivity (R-Value) 0.072 m^2 K/W.
- Permeability 7 %

To compare with other formula this is the one which are low thermal conductivity (k-value), high thermal resistivity (R-Value). The qualification of the mixture of clay body is in the table 2.

Table 2. The result of clay body tested

formula	permeability %	thermal conductivity (W/m.K)	thermal resistivity (m^2 K/W)
1	6.8	0.117	0.068
2	6.8	0.126	0.063
3	7	0.132	0.061
4	7	0.111	0.072
5	9	0.113	0.071
6	10.5	0.116	0.069
7	8.2	0.115	0.070
8	10	0.110	0.073
9	10.7	0.139	0.058
10	11.0	0.140	0.057
11	11.2	0.120	0.067

The result of the water proof testing found that the product weight is not increased as equal to 0%; moreover, the product does not absorb water during the test. According to the result, the coat of product is able to resist the water.

Thermal conductivity (K value) of designed and developed product is low as equal to 0.11 W/m k. as compared to other 3 materials of wall construction : common brick, concrete masonry unit, and autoclaved aerated concrete. In order to find thermal resistivity (R value) of the wall constructed by each type of material, R value of each layer of each material are required to plus. Permeability rate as equal to 7% is significantly low as compared to common

brick, concrete masonry unit, and autoclaved aerated concrete, so the material does not absorb humidity. Permeability rate is in the table 3.

Refer to the water proof testing, water is not absorbed through the product coat considered as water proof while common brick, concrete masonry unit, and autoclaved aerated concrete require supplementary material caused waste expense and construction period for resisting heat and humidity.

Table 3 Comparison of thermal conductivity, thermal resistivity, and Permeability rate between product in the project, common brick, concrete masonry unit, and autoclaved aerated concrete

Product	thermal Conductivity (W/m.k)	thermal Resistivity (m2 K/W)	Permeability %
Common Brick	0.473	0.15	30-40
Concrete Masonry unit	0.519	0.149	30
Autoclaved Aerated Concrete	0.089 – 0.132	0.58	30
Ceramic block	0.111	.	7

Source: Journal "Alternative for selection material for construction with saving energy" Department of Alternative Energy Development and Efficiency in 2004

4. Conclusions

The result of the test realizes that ceramics is able to be developed to material for the wall construction which saves energy in the building as heat proof and humidity proof from the outer building. Furthermore, there are many advantages from coating the surface of the product, for example, sun heat radiation, strength, low cost, no toxic, beauty, and maintenance etc. The product development is not complicated for ceramic operator who is interested in development construction material.

Fig.4 Sample wall constructed by the prototype of the project

Fig.5 Prototype of the product of the project

5. Acknowledgements

Supported by The Faculty of Architecture and Design Rajamanagala University of Technology Phra Nakhon.

6. References

[1]กรมพัฒนาพลังงานทดแทนและอนุรักษ์พลังงาน.2547. เอกสารเผยแพร่แนวทางการเลือกใช้วัสดุก่อสร้างและอนุรักษ์พลังงาน.พิมพ์ครั้งที่ 1.บริษัท แกรนด์เพรส แอนด์แพคกิ้ง จำกัด.กรุงเทพมหานคร.

[2]คณะกรรมการนโยบายพลังงานแห่งชาติ.2535. พระราชบัญญัติการส่งเสริมการอนุรักษ์พลังงาน พ.ศ. 2535.

[3]จันทร์จิรา เตชะเวชเจริญ. 2545. ความชื้นในอาคาร. วารสารโลกพลังงาน.ปีที่5.ฉบับที่17.หน้า110-121.

[4]ดรุณี วัฒนศิริเวช,สุธี วัฒนศิริเวช.2552.การวิเคราะห์แร่ดิน เคลือบและตำหนิในผลิตภัณฑ์เซรามิก.พิมพ์ครั้งที่ 1 สำนักพิมพ์แห่งจุฬาลงกรณ์มหาวิทยาลัย. กรุงเทพมหานคร.

[5]ไพจิตร อึ่งศิริวัฒน์.2541.เนื้อดินเซรามิก.พิมพ์ครั้งที่1. สำนักพิมพ์โอเดียนสโตร์.กรุงเทพมหานคร.

[6]ภูษิต เลิศวัฒนารักษ์และจตุพร ตั้งศิริกุล.2550.ผลของวัสดุทางธรรมชาติที่มีต่อคุณสมบัติของก้อนอิฐดินดิบสำหรับการก่อสร้างบ้านดิน.วารสารวิจัยและสาระสถาปัตยกรรม/การผังเมือง.คณะสถาปัตยกรรมศาสตร์และการผังเมือง มหาวิทยาลัยธรรมศาสตร์.ปีที่ 5 ฉบับที่ 1.หน้า185-199

[7]รังสิมา กาญจนสมบัติ.2541.ผลกระทบของการดูดซับความร้อนและความชื้นของวัสดุภายในอาคารต่อภาระการทำความเย็นของระบบปรับอากาศ. วิทยานิพนธ์ปริญญามหาบัณฑิตสาขาวิชาเทคโนโลยีที่เหมาะสมเพื่อการพัฒนาทรัพยากร. บัณฑิตวิทยาลัยมหาวิทยาลัยมหิดล.

[8]สถาบันเทคโนโลยีแห่งเอเชีย.2547.คู่มือการออกแบบอาคารที่มีประสิทธิภาพด้านการประหยัดพลังงาน.กรมพัฒนาพลังงานทดแทนและส่งเสริมพลังงาน.กรุงเทพมหานคร.

[9]สุนทร บุญญาธิการ.2542.เทคนิคการออกแบบบ้านประหยัดพลังงานเพื่อคุณภาพชีวิตที่ดีกว่า.พิมพ์ครั้งที่ 1. พร็อพเพอร์ตี้มาร์เก็ต.กรุงเทพมหานคร.

[10]สุนทร บุญญาธิการและอุษณีย์ มิ่งมงคล.2543.การใช้ฉนวน.เอกสารเผยแพร่การอนุรักษ์พลังงาน.กรุงเทพฯ. กรมพัฒนาและส่งเสริมพลังงาน กระทรวงวิทยาศาสตร์และสิ่งแวดล้อม(อัดสำเนา).

[11]สุรศักดิ์ โกสิยพันธ์.2534.น้ำเคลือบเครื่องเคลือบดินเผา. พิมพ์ครั้งที่2.สำนักพิมพ์ไทยวัฒนาพานิช. กรุงเทพมหานคร.

[12]สุวัฒน์ อัสวไชยชาญ. 2551.50 เรื่องต้องรู้อยู่กับโลกร้อน. พิมพ์ครั้งที่1. สำนักพิมพ์สารคดี. กรุงเทพมหานคร.