

## A Preliminary study on the Double Skin Façade using Phase Change Material

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**Abstract.** The objective of this study is to describe the technology of the double skin Façade which is built by installing an additional external wall on the existing insulating external wall in order to reduce energy loss from the surface of the building external skin and which saves energy and copes with the change in the external environment, and to provide the basic data for application of a Phase Change Material to the double skin façade by reviewing Phase Change Materials which are types of thermal storage systems in order to complement the shortcomings of the Double Skin Façade e System for energy saving.

**Keywords:** Passive, Thermal System, Double Skin Façade System, Phase Change Materials

## 1 Introduction

### 1.1 Background and Purpose of Study

In relation to energy consumption and carbon emission, the earth is recently confronted with an environmental problem of so-called global warming caused by greenhouse effect resulting from excessive energy consumption and carbon emission. For this reason, though energy saving buildings which have materialized pleasant indoor environment by minimizing the environmental pollution load through saving of energy and resources when buildings are planned and designed are developing all over the world, modern buildings have problems of increase in the external skin area due to expansion in vertical direction and the energy loss due to the all glass curtain wall. Accordingly, the objective of this study is to describe the technology of the Double Skin Façade which is built by installing an additional external wall on the

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existing insulating external wall in order to reduce energy loss from the surface of the building external skin and which saves energy and copes with the change in the external environment, and to provide the basic data for application of a Phase Change Material which is a type of thermal storage systems to the Double Skin Façade for energy saving.

## **2 Double Skin Façade System**

### **2.1 Concept of the Double Skin Façade System**

Double Skin Façade is the system which minimizes the external environmental load by using natural environmental conditions through utilization of multiple skins built by adding a separate internal skin to the existing external skin. In shape, the Double Skin Façade System is comprised of the outer skin which contacts the outdoor air, the inner skin which contacts the indoor air, apertures at the upper and lower parts of outer skins for ventilation, and cavity which plays the role of thermal buffering layer between outer skins.

### **2.2 Types of Double Skin Façade System<sup>1</sup>**

#### **1) Whole Type**

Many spaces are connected vertically and horizontally into one air space layer and one air space later that surrounds the building is created without any thermal separation.

#### **2) Corridor Type**

Air space layer is vertically divided for each floor and for vertical direction, it is divided to a place that requires sound, fire, or facility technology. It is installed crossly one by one along the each axis in order to prevent floating of air.

#### **3) Box Type**

Controllability of resident on individual space is excellent as it is divided and installed vertically and horizontally, it is not affected by the height of building, and flow of air is relatively convenient.

#### **4) Shaft Type**

It shows outstanding performance in inflow of air and ventilation through chimney effect, and diverse elevation plans are possible.

#### **5) Shaft + Box Type**

It has effects of box type and chimney effect and it is composed of shaft type that climbs numbers of floors. However, insulation function on shaft is required and it can only be applied to low-rise buildings as it hinders view and due to limitation of chimney height.

<sup>1</sup> Ryu Ri, A Study on Double Skin System Design for Green Office Building, Conference on Asia Society of Basic Design and Art in Yulim in 2011

### 2.3 Intermediate Conclusion

In this chapter, the concept of the Double Skin Façade System and the advantages and disadvantages of each type are grasped.

As the box type Double Skin Façade System is presumed to be an efficient system required for buildings in the aspect that it is superior in securing the personal privacy and in the function to block indoor and outdoor noise asked by occupants in diverse domestic residences, we intend to supplement the disadvantage of the box type Double Skin Façade System that is solar heat gain.

## 3 Phase Change Materials

A Phase Change Material (PCM) is a material which can absorb or release heat when it changes from solid to liquid or the phase is changed in the opposite direction at a certain temperature, and is a medium which has a melting point in general and a high thermal storage capacity. As to the flow pattern of PCM energy, its temperature changes accumulating sensible heat<sup>2</sup> in the solid state below the melting point, and accumulates latent<sup>3</sup> energy without having any temperature change until the process of melting and becoming liquid.

### 3.1 Case Analysis of Phase Change Material Applications

At present, the technologies which use a Phase Change Material are widely researched, developed, and utilized all around the world. Phase Change Material is dominating overseas markets due to its superior thermal storage performance as a type of heat accumulating materials, and, in the domestic market, it is used by energy related institutes and research organizations for research purpose and is commercialized by some small/medium companies, that are pursuing entry into the market.

**Table 1.** Examples of Applying a Phase Change Material to Buildings<sup>4</sup>

Type	Features
Concrete Block impregnated with PCM	- The cooling electric power is saved without having any loss in the basic material properties of concrete. The wall which contains a Phase Change Material has shown relatively small indoor temperature deviation in comparison to that of a general wall.
Floor impregnated with PCM	- Application of a PCM as a thermal storage layer has shown the best effect on reduction of indoor cooling load. Reduction in the indoor energy depends on night ventilation and air conditioning conditions.
Glass impregnated with PCM	- It has a good indoor energy reduction performance thanks to direct solar heat gain from outside.

<sup>2</sup> Sensible heat: The heat shown in temperature change without accompanying any change in the state of the material

<sup>3</sup> Latent heat: The heat required for change in the state of the material without involving any change in the temperature

<sup>4</sup> Oh, Jung-gik, Huri Focus : Climate change, the development trend of building materials corresponding regenerative, House and City Research Institute, 2009

Roof which contains PCM	- The high temperature of the air flowing in increases the heat transfer speed and reduces the melting time.
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### 3.2 Intermediate Conclusion

In this chapter, the concept, operation plan, and application examples of Phase Change Material which is a type of thermal storage systems are grasped. In order to supplement the disadvantage of the box type Double Skin Façade System that is solar heat gain discussed earlier, we intend to apply a PCM under the purpose of reducing the indoor energy positively utilizing the external solar heat. PCM is presumed to be one of the alternative thermal storage materials applicable to a Thermal Storage System that discharges chilly air in solid state during the day time process of absorbing the energy from solar heat or the heat source, and reduces the energy load by releasing the energy accumulated during cooling as heat.

## 4 Conclusions

In this paper, the concept of the Double Skin Façade System and the advantages and disadvantages of different types are grasped as the basic data required for application of a Phase Change Material, a part of the thermal storage system, to the Double Skin Façade System, and it is confirmed that the Double Skin Façade System applicable to the diverse domestic forms of residence is the box type Double Skin Façade System through the preceding studies being conducted at present and analysis of design trend. The potential for grafting of a thermal storage system which uses PCM as the heat accumulator is also analyzed as a way to save energy.

Subsequent studies are required to be conducted as, in the future studies, a new design of Double Skin Façade System should be devised in such a context in order to resolve the problem caused by direct contact of the thermal storage material with the indoor air in grafting the thermal storage system that uses a PCM as the thermal storage material.

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