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A Preliminary Study on Thermal Storage Wall applying with Change Material

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Abstract. In this basic study of which the objective was to confirm the applicability of a Phase Change Material to Thermal Storage Wall, the concepts and characteristics of Thermal Storage Walls and Phase Change Materials were looked into through a literature survey and analysis of preceding research data. As a result of the research, it is expected that a Thermal Storage Wall can save heating energy by storing solar energy and releasing it indoors, and application of a Phase Change Material to Thermal Storage Wall will help in enhancing the efficiency as a thermal storage wall thinner than the existing one can store sufficient thermal energy using the latent heat.

Keywords: Passive Solar System, Thermal Storage Wall, Trombe Wall
Phase Change Material

1 Introduction

The weather anomalies caused by global warming such as sea level rise, severe drought, and heavy rain are beyond a serious level and are threatening the survival of all human beings. The main cause for such global warming is greenhouse gas and all countries of the world are making continuous efforts to reduce emission of greenhouse gas. In particular, the major cause for greenhouse gas is carbon dioxide, and, as more than half of the emitted carbon dioxide is emitted in construction field, efforts of construction field are badly required above all things.

Under such circumstances, the objective of this study is to make basic data for a Thermal Storage Wall which can more efficiently save heating energy by looking into the concepts and characteristics of Thermal Storage Walls and Phase Change Materials through a literature survey and analysis of preceding research data and confirming the applicability of a Phase Change Material to Thermal Storage Wall.

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2 Thermal Storage Wall System

2.1 Passive Solar Energy System

A Passive Solar Energy System is a system designed to maximize the utilization efficiency of solar energy by applying the thermodynamic theory. Most of such systems are comprised of a solar energy collector, an energy storage part and an energy utilization part. First, the solar energy collector is built by installing a south-facing window for energy collection on the south side wall, the energy storage part stores solar energy using the structure of the building such as energy storage wall inside the building, energy storage roof and energy storage floor, and the energy utilization part has a structure and system that enable the heat to be naturally transferred from the solar energy collector and the energy storage part to the indoor space. The most important element in a passive solar energy system is the heat accumulator, which has to have sufficient volume and area so that the solar energy obtained during day time can be stored. In particular, such a heat accumulator plays an important role in minimizing the difference in the indoor temperatures between day and night.[1]

2.2 Concept and Characteristics of Thermal Storage Wall

Thermal Storage Wall System, one of the indirect gain types among passive solar energy system, is a system which uses the characteristic wherein the heat absorbed into the Thermal Storage Wall when the solar energy is received through the window installed on the south is discharged indoors by natural circulation. This system is most widely applied as its system efficiency is relatively high among passive solar heat systems, and it can be easily applied to the south side wall.[2]

2.3 Intermediate Conclusion

As a result of examining the concept and characteristics of Thermal Storage Wall which is one of the indirect gain types among passive solar energy system through a literature survey and analysis of preceding studies, it is found to be effective in reducing the heating load in winter. But, as it causes increase in the cooling load in summer through solar radiation, it is presumed that the method to suppress increase in the cooling load due to solar heat gain in summer is required to be also considered.

1 Park Jin-seo, An Efficiency Analysis of the Passive Solar Heating System for Office Building, Master's Thesis of Inha University, 2010

2 Yoon Jong-Ho, Baek Nam-Choon, Shin U-Cheul, Experimental Study on the Thermal Performance of Passive Solar Trombe Wall System, Journal of the Korean Solar Energy Society Vol.28 No.1, 2008

3 Phase Change Material

3.1 Concept and Characteristics of Phase Change Material

A Phase Change Material means a material that melts and absorbs heat when the ambient temperature rises and coagulates and releases heat when the ambient temperature drops showing its thermal storage and release properties repeatedly. When a phase change phenomenon of a certain material takes place, that is to say, when a material changes from solid to liquid (or from liquid to solid) or from liquid to gas (or from gas to liquid), heat is absorbed or released, and such heat is called latent heat. As latent heat is bigger than sensible heat which is the heat absorbed or released as temperature changes in the condition no phase change phenomenon takes place, phase change materials are widely used as energy storage media, and the phase change materials of which the melting point ranges are between 20～30^{o}C are widely used as heat accumulators in particular in the construction field for efficient management of energy.[3]

3.2 Examples of Studies in which a Phase Change Material is applied[4]

The Energy Storage System to which a Phase Change Material is applied has been considered as a thermal storage medium for building because of its advantage that latent energy is stored, and has been developed and tested in order to take into account the peak load transfer and thermal energy saving and to enhance the thermal energy storage capacity of building.

Table 1. Examples of Studies in which a Phase Change Material is applied

PCM Board	It is a finishing material for building interior produced by evenly mixing into gypsum board a latent heat material made by putting a Phase Change Material into micro-capsules. The number of times for the heater to be turned on in a room finished by PCM board is found to be remarkably smaller than that in a room finished by general board, which can enhance the pleasantness of the occupants and the energy saving effect by reducing the frequency of changes in the temperature of the indoor air, and enabling the temperature to be maintained close to the desired temperature for a longer period of time.
PCM Block	It is a block produced by evenly mixing a latent heat material made by putting a Phase Change Material into micro-capsules with cement mortar, which is used as structure. The effect of PCM Block is same as that of PCM Board.
PCM Floor Heating	Though, in the case of the traditional floor heating system, thermal energy is stored using a thick floor base as a unique thermal storage media, when PCM is applied, the thermal energy storage capacity is excellent even when the thickness of the floor surface is reduced. It provides a constant temperature within the floor structure, and plays the role to eliminate the overheating phenomenon on the thermal energy source and the floor surface.

3 Yun Huy-Kwan, Preparation and Characterization of PCM for Energy saving Accumulator, Master's Thesis of Chungbuk National University, 2011

4 Yim Byeong-chan, Plan to apply PCM to buildings and utilize it, Korean Institute of Architectural Sustainable Environment and Building System Vol.4 No.2, 2010

3.3 Intermediate Conclusion

As a result of examining the concept and characteristics of Phase Change Materials through a literature study and analysis of preceding studies, it is expected that application of a Phase Change Material as a construction material has an effect of improving the pleasantness of the occupants and saving thermal energy by storing the heat generated in the building above the temperature range of pleasantness in the material at day time and maintaining the indoor temperature lest it should drop below the temperature range of pleasantness by releasing the heat at night.

4 Conclusion

As a result of examining the concepts and characteristics of Thermal Storage Walls and Phase Change Materials respectively through review of the existing studies and literature, it is presumed that a Thermal Storage Wall can save heating energy by storing solar energy and releasing it indoors, and a Thermal Storage Wall which uses, as the heat accumulator, a Phase Change Material using latent heat reduces the range of change in the indoor temperature and helps in enhancing the efficiency of the Thermal Storage Wall System as sufficient thermal energy can be stored even when the thickness of the wall is reduced from that of the existing thermal storage wall. Also, it is expected to bring daylighting effect differently from the existing opaque concrete or masonry type Thermal Storage Wall, as it blocks direct sunlight and allows the diffused light to come indoors.

References

1. Seong Byeong-Min, Kim Won-Pil, A Study on Problems and Design Improvements according to the Diversion of Balcony Area at Multi-family Housing, Journal of Architectural Institute of Korea Vol.28 No.12, 2010
2. Yim Byeong-chan, Plan to apply PCM to buildings and utilize it, Korean Institute of Architectural Sustainable Environment and Building System Vol.4 No.2, 2010
3. Yoon Jong-Ho, Baek Nam-Choon, Shin U-Cheul, Experimental Study on the Thermal Performance of Passive Solar Trombe Wall System, Journal of the Korean Solar Energy Society Vol.28 No.1, 2008
4. Yun Huy-Kwan, Preparation and Characterization of PCM for Energy saving Accumulator, Master's Thesis of Chungbuk National University, 2011
5. Kim Su-min, Energy saving construction material using PCM, Korea Green Building Council Vol.13 No.1, 2012

