

A study on the proposal for environmental friendly construction components through analyzing CO2 emission and energy emission

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ABSTRACT: The serious environmental problems of the earth such as global warming, resources exhaustion, environment pollution rise as main issue throughout the world. Therefore, there are international agreements to preserve the earth environment and compulsory observance is also required in Korea. With the consequence that domestic industry policy in Korea which focuses on developing should be converted into environmentally sustainable developing policy such as the reservation of energy and resource and reduction of carbon dioxide emission. Although construction industry is an obstruction industry to environment which occupies 40% material consumption, 24% energy consumption, 42% Carbon dioxide emission of all in Korea. It also occurs 30% industry waste and 60% illegal waste of all industries in Korea, a study related to the improvement of environmentally sustainable performance in construction industry is not as much as the other industries. Consequently, in this study, the floor component which has superior environmentally sustainable performance is proposed through the analysis of energy consumption and carbon dioxide emission in floor components.

Keywords: energy consumption, carbon dioxide, wet floor, dry double floor, dry radiant double floor, dry radiant floor

1. INTRODUCTION

1.1 Research Background and Purpose

Global warming is one of the most terrible environmental disasters which the world faces at the present. Several countries including OECD recognize global warming as the most difficult problem that human

beings should solve. Carbon dioxide occupies the most portions of greenhouse gases.

The construction industry which occupies 48% of material consumption and 40% of energy consumption in all industries is the mass consumption industry. It also occupies 42% of all carbon dioxide emission and

generates 20% of all industrial waste and 60% of illegal waste. In terms of resource and environment, as the construction industry fatally affects environment of the earth, environmentally sustainable countermeasure against the problem has to be established as soon as possible. Therefore, the reduction of energy consumption and technology for development of environmentally sustainable materials are required at the stage of producing construction materials. As an effort to realize this, developing and utilizing a variety of construction materials and components based on compatibility of construction materials. However, as for a interior component of buildings, a quantitative study on the amount of energy consumption and the carbon dioxide emissions to know the environmental load in buildings have not been sufficiently performed yet.

Consequently, in this study, a floor component of buildings to be able to reduce energy consumption and carbon dioxide emissions was screened out by comparing carbon dioxide and energy consumption between existing floor component and several types of a dry floor component quantitatively. The results of the research would be utilized as a fundamental data to select the best environmentally sustainable components at the planning stage of architecture.

1.2 Research Method and Procedure

In this paper, the study is performed to reduce the energy consumption and carbon dioxide emissions of floor components through the procedure on figure 1.

Firstly, the method of the study is set up after choosing a building and floor components which become the subjects of the study through previous research. Secondly, the mount of materials is calculated through an on-the-spot survey and data research for the material requirement estimation in each floor component.

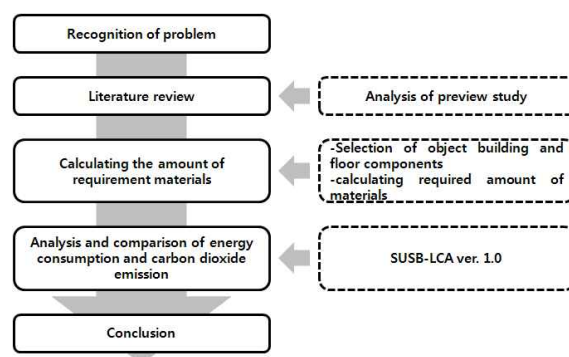


Figure 1: Clear Research Process

2. LITERATURE REVIEW

In this study, to quantitatively and objectively evaluate the energy consumption, we used CO₂ emission in floor components, SUSB-LCA ver. 1.0 and searched for energy consumption and carbon dioxide emissions of building interior component materials. In this study, SUSB-LCA ver. 1.0 which is the program to evaluate environmentally sustainable performance in buildings is used to quantitatively and objectively calculate energy consumption and carbon dioxide emissions of component materials

2.1 Summary of SUSB-LCA ver. 1.0

SUSB-LCA ver. 1.0(Sustainable Building Life Cycle Assessment ver. 1.0) is the useful program that can be used to calculate LCE(Life Cycle Energy), LCCO₂(Life Cycle CO₂), LCC(Life Cycle Cost) and assess environmental performance quantitatively. Moreover, SUSB-LCA ver 1.0 makes it possible to compare relatively environmentally sustainable technology-applied building with existing buildings built in terms of LCE, LCCO₂, LCC, and assess comparatively reduction impact on LCE, LCCO₂, LCC by application of environmentally sustainable architectural technology.

Major function of this program is calculating LCE, LCCO₂, LCC over L.C.C of building, and it is possible for it to compare with the output of each object when environmentally sustainable

technology is applied to objects. Furthermore, the by putting the data such as the amount of materials, energy consumption in operation stage and the amount of waste in removal stage into the program, the LCE, LCCO₂, LCC can be output.

2.2 Assessment Method

The environmental load of building life cycle is evaluated with SUSB-LCA ver 1.0 in 3 stages divided which are construction stage, use and maintenance stage and removal stage.

The construction stage is divided into three stages such as material production stage, material transportation stage and onsite construction stage and the use and maintenance stage is divided into building use stage and maintenance stage. Besides, Removal/Discard stage is divided into Building Removal and Discard of building waste from removal work. The figure 2 below indicates the way to make assessment of environment load by SUSB-LCA ver. 1.0.

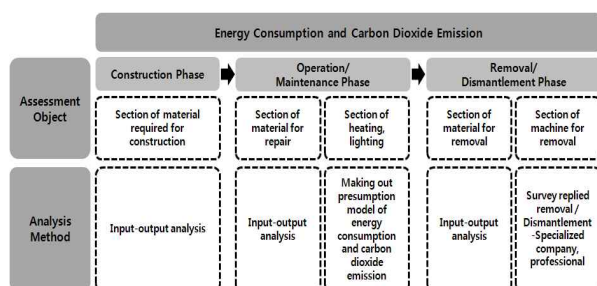


Figure 2: Environmental load assessment of building by SUSB-LCA ver. 1.0

2.3 Calculation Method of Energy Consumption and Carbon Dioxide Emission

In this study, SUSB-LCA ver. 1.0, which is the program to evaluate environmental performance of buildings, is used to calculate energy consumption and carbon dioxide emission of floor components for objective and quantitative evaluation of them. Energy consumption and carbon dioxide emission of components are figured out with SUSB-LCA ver. 1.0 through the procedure in figure 3 below.

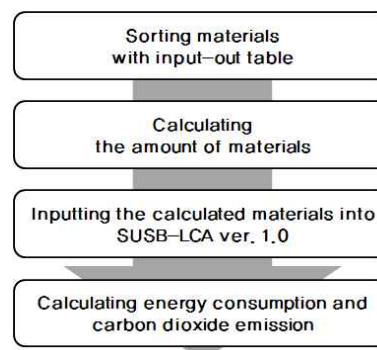


Figure 3: The calculation method energy consumption and carbon dioxide emission with SUSB-LCA ver. 1.0

First of all, the construction materials which floor components consists of should be sorted by each related industry department with input-output table. Next, the calculation of the amount of materials is performed through the individual integration which is generally used since it is pretty hard to calculate them directly. Thirdly, the amount of materials calculated above is inputted into SUSB-LCA ver. 1.0 to calculate energy consumption and carbon dioxide emission.

As mentioned above, there are 3 phases such as construction phase, operation/maintenance phase and demolition phase in SUSB-LCA ver. 1.0. In this study, the purpose is to analyze energy consumption and carbon dioxide emission of materials in floor components. Therefore, the calculated materials is just input into SUSB-LCA ver. 1.0 in construction phase which includes construction material production phase.

This method is more efficiently than existing one in terms of accuracy and time because it just needs the amount of materials for the calculation of energy consumption and carbon dioxide emission. Furthermore, when each floor component is applied to the object building, it is much easier to analyze energy consumption and carbon dioxide emission. Therefore, the environmentally sustainable performance is analyzed more in the concrete.

3. SELECTION OF OBJECT BUILDING AND FLOOR COMPONENTS

3.1 Object Building Selection

The object building is a normal apartment constructed in B district in Korea in 2004. Brief information of RC-structured Building is like table 1 below.

Table 1: Brief information of object Building

Category	Data		Category	Data
zoning district	Central commercial zone, urban planning district		Rate of building volume to lot	355.99%
Lot area	99,744 m ²		Building coverage ratio	59.21%
Total floor area	Aboveground	355,075 m ²	Structure type and scale	RC structure, 35 stories above and 3 stories below the ground
	Underground	82,654 m ²	Building-covered area	59,061 m ²
	Sum	437,729 m ²	Gardening area	29,109 m ²

3.2 Selection of Floor Components

As for choosing the types of floor component as an object, totally, 4 types of floor are chosen, one of them is wet floor, which has been used from the past and is one of general types in housing, and the others are 3 types of a dry floor lately invented and used for construction. The table 2 below is for composing material according to each floor type.

Table 2: Composing materials of floor components

Floor type	Composing Materials
Wet floor	fire insulating material(20mm) + bubbled concrete(60mm) + copper pipe + mortar(40mm)
Dry double floor	protection against dust + base panel(25mm) + floor finishing material(12mm)
Dry radiant double floor	sound insulator(20mm) + protection against dust(350mm) + plywood(12mm) + panel(30mm) + heatproof panel(2mm) + XL pipe + aluminum panel(2mm)
Dry radiant floor	fire insulator(20mm) + panel(30mm) + heatproof panel(2mm) + panel(12mm)

4. ENERGY CONSUMPTION AND CARBON DIOXIDE EMISSION OF FLOOR COMPONENTS

4.1 Output Standard of Required Materials in the Floor Components

The calculation of energy consumption and carbon dioxide emissions is progressed with focus on unit (width:1m, length:1m). And in order to calculate the amount of materials, the materials used for each component are searched through visiting site and data review. In addition, the amount of required materials is calculated at firsthand with integration method. The calculation of required materials is done by two professionals who have more than five years experience. Also, cross check is also performed not to make any omissions.

4.2 Components and Calculation of Energy Consumption and Carbon Dioxide Emission

4.2.1 Energy Consumption

By analyzing energy consumption classified by floor component type, the result is shown in figure 4.

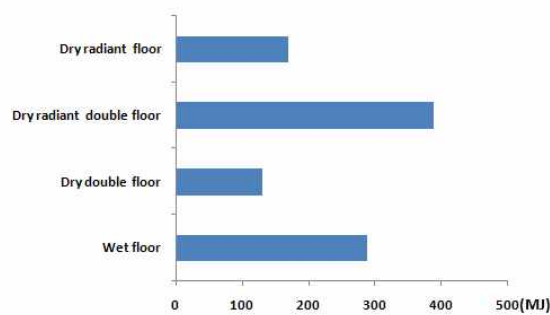


Figure 4: Energy consumption of the floor components

First of all, dry double radiant floor occupy 388.61MJ as the most energy consumption of them. Next, wet floor has 287.64MJ and dry radiant floor has 169.08MJ. Lastly dry double floor has 130.41MJ as the least energy consumption.

As a result of showing percentage comparing three types of dry floor components to existing wet floor, dry radiant double floor is 135.1%, dry radiant floor is 58.8% and dry double floor 45.3%. According to this order, the dry double floor has a superior performance in terms of energy consumption as the least energy consumption.

4.2.1 Energy Consumption

The result of the analysis classified by a floor type is like figure 5.

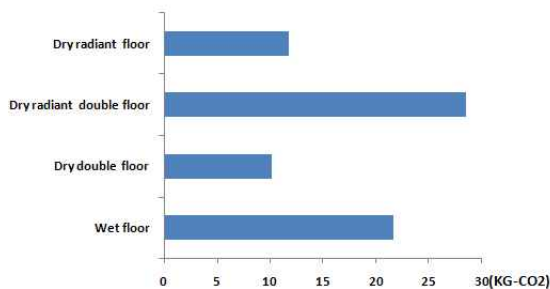


Figure 5: Carbon dioxide emission of the floor components

It shows that Dry radiant double floor has 28.54KG-CO₂ as the most carbon dioxide emission. As for carbon dioxide of the others, the existing wet floor has 21.69KG-

CO₂. Dry radiant floor has 11.74KG-CO₂ and dry double floor has 10.2KG-CO₂ as the least carbon dioxide emission. As the result of showing in percentage, dry radiant double floor has 131.6%. Dry radiant floor is 54.1% and dry double floor is 47.0%. It is proved that carbon dioxide emission of dry double floor is the lowest among them.

4. CONCLUSION

But in case of dry radiant double floor, the energy consumption has the increase of 0.32%. This means that energy consumption and carbon dioxide production of it increase more than existing wet floor. Continuous and comprehensive efforts to realize this are being promoted in building industry. Many components, which is based on development of various building materials and utilization of it, compatibility of building, are being developed. In this study, energy consumption and carbon dioxide emission of wet floor component which is the most general type of the several components is compared with dry double floor, dry radiant double floor, dry radiant floor component in terms of energy consumption and carbon dioxide emission. The result is like these followings.

Firstly, in respect of energy consumption, it is found out that wet floor component is 287.64MJ. Dry double floor component is 130.41MJ and dry radiant double floor component is 388.61MJ. Lastly, dry radiant floor is 169.08MJ. Therefore, the energy consumption of dry radiant double floor was relatively the most, and energy consumption of dry double floor is the least. Secondly, in respect of carbon dioxide emissions, wet floor is 21.69KG-CO₂, dry double floor component is 10.2KG-CO₂, dry radiant double floor component is 28.54KG-CO₂, dry radiant floor is 11.74KG-CO₂. Furthermore, when applying three types of dry floors to the object building which adopts the wet floor, in case of the reduction of energy consumption, dry double floor has the reduction rate of 0.51%. Besides, dry

radiant double floor has the increase of 0.32% and dry radiant floor has the decrease of 0.38. In case of the reduction of carbon dioxide emission, dry double has the reduction rate of 0.41%. dry radiant double floor has the increase of 0.28% and dry radiant floor has the decrease of 0.32%.

The result of this study can be used as a basic data for selection of best alternative component by analyzing and estimating environmental impact in advance at the planning stage. In addition, this would be able to be used as a basic unit to assess environmental load of rebuilding for remodeling. And the order of priority to select alternative technology environmentally demanding materials could be judged. Dry double floor supposed proposed in this study is the component being developed continuously in respect of energy consumption and carbon dioxide emission. Particularly, if variableness, noise, disaster prevention and heating are pieced out by double floor system, it will be expected to increase the efficiency of building work and environmental amenity.

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