Analysis Report of Reducing Cooling Loads by Using the LOW-E Pair Glass

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1. Introduction

Proton Engineering Frontier Project has been developing a 100MeV proton linear accelerator. Accelerator & Beam Application Building, which is the main building in Proton Accelerator Research Center of PEFP, is facilities for Energy Saving Strategy of Korea. Therefore, we re-established architectural, mechanical and electrical design to enhance energy efficiency[1]. In architectural design aspect, we changed design of windows from color pair glass to low-E pair glass to enhance energy saving capabilities.

In this paper, we described energy saving effect of the low-E pair glass for Accelerator & Beam Application Building in PEFP.

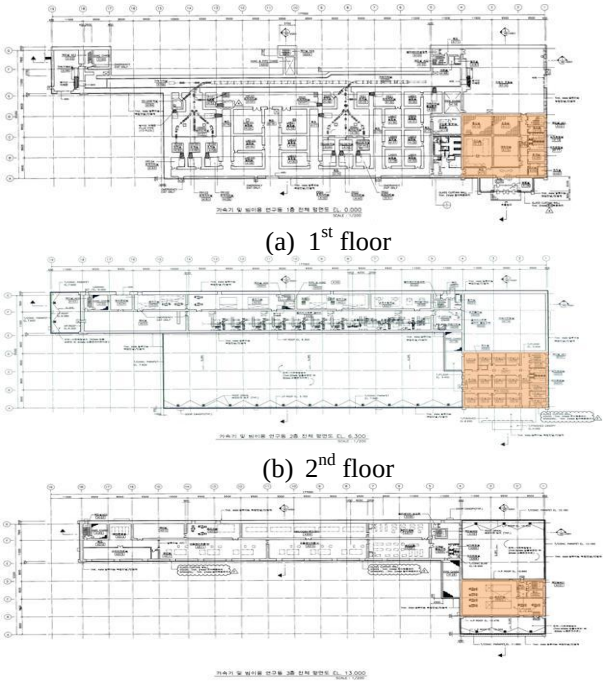
2. Energy Saving by Low-E Pair Glass

To simulate the energy saving effects, we applied EnergyPlus(Product by U.S. DOE) Program to building energy simulation. EnergyPlus program is a whole building energy simulation program for engineers, architects, and researchers to model energy and water usage in buildings. EnergyPlus models energy flows, such as heating, cooling, lighting, ventilation, and water usage.

2.1 Simulation Zone (Accelerator & Beam Experiment Hall)

In this pa\per, we simulate the cooling load amount of the Accelerator & Beam Application Building of PEFP. To simulate the cooling load amount, we analyzed areas for general public in Accelerator & Beam Application Building for each floor (such as research area as described in Fig. 1.

- Target location : Gyeongju
  (Consider Soil Temperature)
- Site : Latittude(35.33), Hardness(129.32)
  Time Zone(+9), Height(35m)
- Set the Temperature of Cooling : 25 Degree
- Internal Heat
  Occupancy Density : 8㎡/person
  (based on 120W/person)
  Lighting Density : 13.5 W/㎡
  Equipment Density : 7.1 W/㎡
  Infiltration : 0.7 ACH
  Ventilation : 0.00236㎥/s・person
  (Occupancy, Lighting, Office equipment density is usually applied in the office building was applied.)
- Dimming control : Not Applicable
- Air-Conditioning unit Operating Hours
  : AM09:00 ~ PM06:00



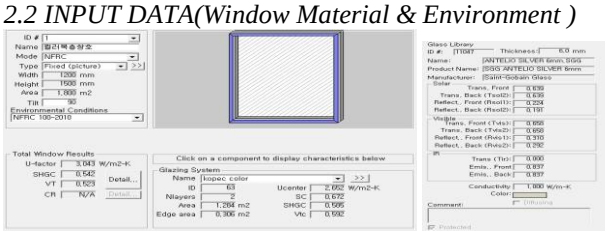
(a) 1st floor

(b) 2nd floor

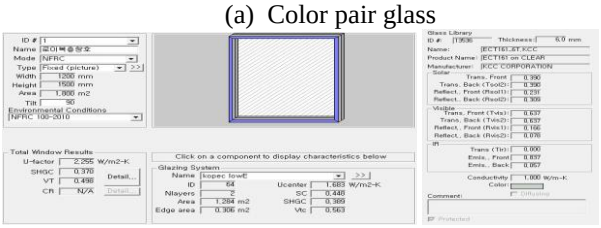
(c) 3rd floor

Fig. 1. General Public Areas of Accelerator & Beam Application Building for Energy Saving

2.2 INPUT DATA(Window Material & Environment)



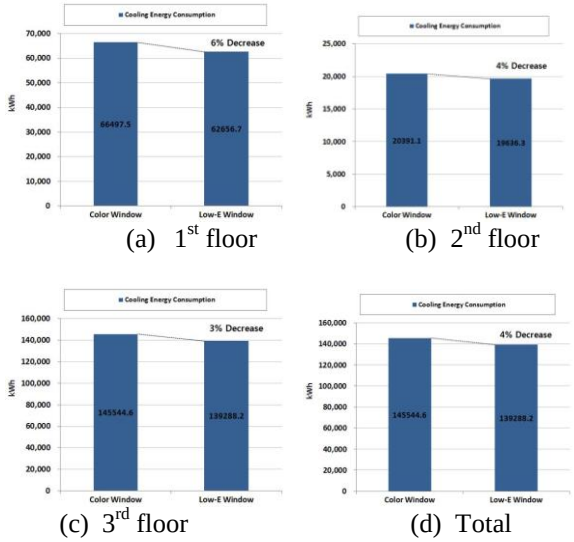
(a) Color pair glass



(b) LOW-E pair glass

Fig. 2. Input Data of Color Pair Glass and Low-E Pair Glass

2.3 Simulation Results of Cooling Load



(a) 1st floor (b) 2nd floor

(c) 3rd floor (d) Total

Fig. 3. Cooling Load Simulation Results for Accelerator & Beam Application Building

In this paper, we simulated cooling load of each floor for Accelerator & Beam Application Building by applying Low-E pair glass. For the 1st floor, simulation result shows that its cooling load decrease is 6%, which maximum among all floors because area of low-E pair glass installation is maximum among all floors. Whereas, cooling load decreases 4% and 3% in 2nd floor and 3rd floor, respectively.

By applying low-E pair glass, cooling load in PEFP is rather low amount compared with general office building.

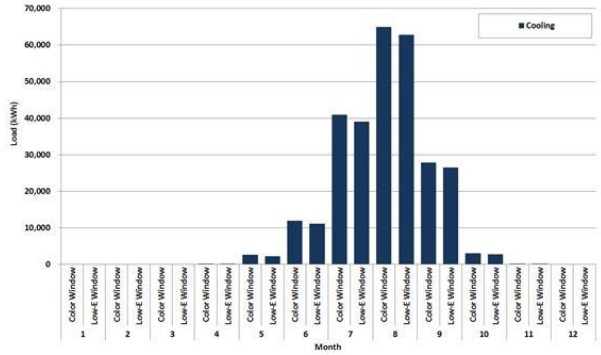


Fig. 4. Monthly Cooling Energy Consumption for Accelerator & Beam Application Building

Another reason of low cooling load of Accelerator & Beam Application Building is that its window sizes are smaller than other buildings. Therefore internal heat by sunshine is rather low and temperature difference between building internal and external is small amount because of heat transmission coefficient of windows. The third reason is that wall thickness of Accelerator & Beam Application Building is thicker than other buildings. For general office building in summer, cooling load in building increases by temperature rise because of wall heating by solar radiation. Whereas, wall thickness of Accelerator & Beam Application Building is rather thicker than general office building, its heat capacity is rather high. Therefore, cooling load variation by solar irradiation is low and air conditioning unit operation hours can be shortened. According to this reason, another insulators are needless to decrease cooling load of Accelerator & Beam Application Research Building.

3. Conclusions

In this paper, we described energy saving effect of low-E pair glass by reducing cooling load. From simulation results, it is verified that additional insulator is not necessary by changing design of windows of Accelerator & Beam Application Building from color pair glass to low-E pair glass. According to the design change, 4% decrease of cooling load occurs by EnergyPlus simulation program.

To save energy in Accelerator & Beam Application Building, we also installed aluminum panel and insulator at building exterior. Therefore, energy saving performance is higher than other general office building.

REFERENCES

[1] Energy Saving Scheme of PEFP, 2010, 08