Study on light environments in LCCM housing and lighting energy reduction effects

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1. Introduction

LCCM housing ("Life Cycle Carbon Minus" housing) has been proposed as "housing that creates a negative ("minus") CO_2 balance throughout its long lifetime, including CO_2 emissions during construction, by striving to reduce CO_2 as much as possible during construction, use and demolition, and by creating renewable energy using solar panels and the like" [1)]. To study this LCCM housing, a joint research organization called "Research on Zero Energy Housing" has been established under an initiative by the Building Research Institute, and the National Institute for Land and Infrastructure Management is taking part in this. The author has compiled a report on light environments in this housing as well as its lighting energy reduction effects, and gives a brief outline of the content here.

2. Study on the light environment of LCCM housing

When studying the light environments of LCCM housing, the author first proposed a concept[2)] based on knowledge of light environments obtained from low energy housing with validated efficiency (a type of energy-saving housing), among others, then enlisted the collaboration of academic and professional experts in simulating daylight lighting and lighting designers for artificial lighting. Bearing in mind that daylighting could conversely cause an increase in lighting consumption, since the introduction of daylight causes glare or the room interior is felt to be dark in contrast to the brightness around the windows, we used the highly precise daylight environment simulation software "Radiance" in our study. We mainly studied the impact of south-opening louvers at different time and seasons, and taking account of the daylighting simulation results, compared the results to the initially drafted plan and incorporated them in later versions of the plan (Fig. 1). As for artificial lighting, the study was based on the rationale of distributed multiple-light arrangement harnessing the characteristics of LEDs, i.e. compactness and long life[2)]. We obtained a working brightness in accordance with specific domestic activity by using distributed light, even if the average luminosity was low, and planned balanced lighting with less contrast and no sense of discomfort.

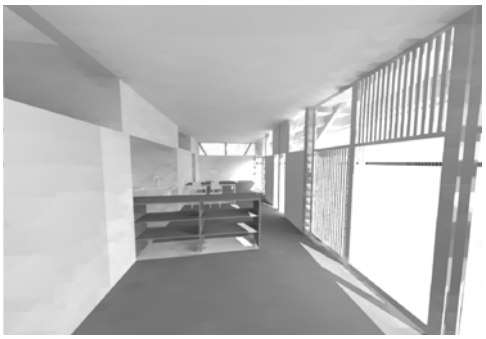

Fig. 1 Daylighting simulation example

3. Study on the lighting energy reduction effect of LCCM housing

The total energy consumption by artificial lighting in LCCM housing was around 480W, and the annual lighting power consumption was around 530kWh (primary energy consumption around 5.1GJ). Bearing in mind that, with LED, CO_2 emissions when in use account for almost the whole of the life cycle, it should be possible to reduce environmental load while adequately forming light environments including lighting effects.

4. Conclusion

A demonstration version of LCCM housing reflecting the results of this study will be built inside the Building Research Institute. It will be completed in February 2011, and after completion, verification trials reproducing the living conditions of residents will be held. In future, we plan to measure artificial lighting consumption volumes and take actual measurements of light environments.

References

1) BRI NEWS Vol. 52, Advanced eco housing for the low-carbon society: LCCM housing
2) Y. Miki, Proposal of distributed multiple-light arrangement using small high efficiency lamps, National Institute for Land and Infrastructure Management, Annual Report (2005), 84-85