BUILD SIMUL
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Coupling simulation system of annual building energy and microclimate

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Abstract

We have developed a simulation system for a year-round assessment of environmental comfort, energy conservation, and CO_2 emissions in buildings and street blocks where active utilization of sunshine, vegetation and solar energy resources is fully considered. An analysis model has been constructed for handling interactions between highly complex street-block wide solar radiation patterns and building air-conditioning load. As a demonstration case of the present system, coupled solar radiation-thermal load analysis for an eleven-story office building has been performed. By comparing the result of a building located in a city block with a reference case of a self-standing building, the proper arrangement of buildings and spaces such as solar reflectance of building surface may be proposed.

Keywords

simulation,
energy savings,
radiosity method,
solar radiation analysis,
annual thermal load

Article History

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1 Introduction

Recently, there has been a growing interest in need for constructing smart cities as a next generation low-carbon energy/social system. In order to achieve them, tasks such as a drastic reduction in building-wise CO_2 emissions and a promotion of actively utilizing renewable energy resources in buildings and street blocks should be properly handled, in addition to design of a smart grid network and heat exchange. Our significant concern is the proper investigating for yearly energy consumed by air-conditioning, since it occupies a large fraction of the entire energy consumption of a building in operation. Energy consumed by air-conditioning and the on-site energy generation by natural energy resources are influenced by the surrounding environment of the building. Of particular importance is local solar radiation, which is generally quite different from those measured at a nearby meteorological station. When such published data are used, environment performance of the building of interest may not be accurately predicted. Some studies worked on the microclimate effects on the building energy (Urano et al. 2001; Sun et al. 2011; Yang et al. 2012), but these simulations do not output annual building energy consumption which is necessary for building performance comparison.

The present authors have developed a system called "low-carbon street block simulator" enabling assessment of environmental comfort, energy conservations, and CO_2 emissions throughout the year in buildings and street blocks in which sunshine, vegetation and solar energy resources are actively used. Simulation would be useful in promoting architectural and urban planning to realize a comfortable and low-carbon society. The present simulation system has been materialized by coupling a computer program for analyzing solar radiation and annual building thermal load to energy balance. Such analyses have been conducted separately and, then, results have been integrated to yield a final solution. This has rendered a comprehensive assessment extremely difficult.

By analyzing temporal variation in solar radiation and reflection, it is possible to estimate the effects of changes in solar reflections to the building walls on air-conditioning load of the building and power generation by solar cells.

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