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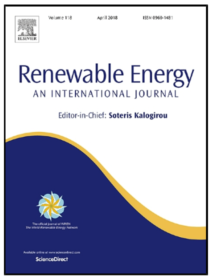

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Application of heliostat in interior sunlight illumination for large buildings

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Abstract

Heliostat daylighting systems, used to transmit sunlight deep into rooms where natural light cannot reach, are increasingly applied in buildings. A roof-mounted heliostat with an area of 22.95 m^2 was developed in this work to verify the feasibility of high flux and long distance daylighting in large building interior. The developed heliostat system consists of a heliostat, a secondary reflector, and glass windows forming the light path within the building. The problem of gravitational deformation of the steel beams base of the heliostat was solved by a rectification algorithm embedded into the computer program, to realize vertical daylighting. The spectrum and chromaticity of the heliostat daylighting system developed was measured, and the results verify the good visual quality of the interior illumination. The light transmission distance is more than 70 m, and the system can provide a level of 20-80 klux daylighting illuminance in the daytime. An economic analysis was carried out, and data indicates a good cost-effectiveness of the heliostat daylighting system developed. It is hoped that this research will be of some reference value to the design of heliostat daylighting systems in large buildings.

Keywords

Daylighting; heliostat; solar tracking; deformation

1. Introduction

Daylight is usually considered to be able to improve human’s visual comfortability and to make a great impact on people's daily life and work. Generally, the electric consumption for artificial lighting can take account of about 30% of the total energy consumed in office buildings[1, 2]. The use of daylighting can contribute to energy savings and the reduction of greenhouse gas emissions[3-5]. Furthermore, daylight is benefit for physiological rhythm and reduces the effects of illnesses [6, 7]. So the design of daylighting systems in buildings is very important.

The traditional way for daylighting is fenestration on the wall or roof of a building, which cannot track sunlight, so called passive daylighting method here. However, windows are hard to solve the problem of interior daylighting for tall multi-story buildings constructed in urban areas[8, 9]. In order to introduce more sunlight and meet the need for deep indoor illumination, a variety of daylighting systems have been developed to realize remote transmission of sunlight. These can be roughly divided into three kinds, including light pipes, optical fiber daylighting system and heliostats daylighting system[10]. Generally, the transmission distance of those daylighting devices are of, respectively, about 0-4 m, 20-50 m and 50-2000 m.

Light pipe systems utilize an inner mirror surface of the pipe to transmit sunlight by multiple reflections. A typical light pipe system consists of an outside collector, a mirror pipe and a luminaire that releases light into the interior[11]. Light pipe systems could be used to enhance interior illumination for buildings, such as schools or industrial buildings[12, 13]. Light pipes for daylighting are easy to install and cost effective. But due to multiple reflections, light loss is serious and the transmission distance is only a few meters[14, 15], what limits its application. In terms of