World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:11, No:05, 2017

Dynamic Building Simulation Based Study to Understand Thermal Behavior of High-Rise Structural Timber Buildings

Authors : Timothy O. Adekunle, Sigridur Bjarnadottir

Abstract : Several studies have investigated thermal behavior of buildings with limited studies focusing on high-rise buildings. Of the limited investigations that have considered thermal performance of high-rise buildings, only a few studies have considered thermal behavior of high-rise structural sustainable buildings. As a result, this study investigates the thermal behavior of a high-rise structural timber building. The study aims to understand the thermal environment of a high-rise structural timber block of apartments located in East London, UK by comparing the indoor environmental conditions at different floors (ground and upper floors) of the building. The environmental variables (temperature and relative humidity) were measured at 15-minute intervals for a few weeks in the summer of 2012 to generate data that was considered for calibration and validation of the simulated results. The study employed mainly dynamic thermal building simulation using DesignBuilder by EnergyPlus and supplemented with environmental monitoring as major techniques for data collection and analysis. The weather file (Test Reference Years- TRYs) for the 2000s from the weather generator carried out by the Prometheus Group was considered for the simulation since the study focuses on investigating thermal behavior of high-rise structural timber buildings in the summertime and not in extreme summertime. In this study, the simulated results (May-September of the 2000s) will be the focus of discussion, but the results will be briefly compared with the environmental monitoring results. The simulated results followed a similar trend with the findings obtained from the short period of the environmental monitoring at the building. The results revealed lower temperatures are often predicted (at least 1.1°C lower) at the ground floor than the predicted temperatures at the upper floors. The simulated results also showed that higher temperatures are predicted in spaces at southeast facing (at least 0.5°C higher) than spaces in other orientations across the floors considered. There is, however, a noticeable difference between the thermal environment of spaces when the results obtained from the environmental monitoring are compared with the simulated results. The field survey revealed higher temperatures were recorded in the living areas (at least 1.0°C higher) while higher temperatures are predicted in bedrooms (at least 0.9°C) than living areas for the simulation. In addition, the simulated results showed spaces on lower floors of high-rise structural timber buildings are predicted to provide more comfortable thermal environment than spaces on upper floors in summer, but this may not be the same in wintertime due to high upward movement of hot air to spaces on upper floors.

Keywords : building simulation, high-rise, structural timber buildings, sustainable, temperatures, thermal behavior
Conference Title : ICCEA 2017 : International Conference on Civil Engineering and Architecture
Conference Location : Montreal, Canada
Conference Dates : May 11-12, 2017