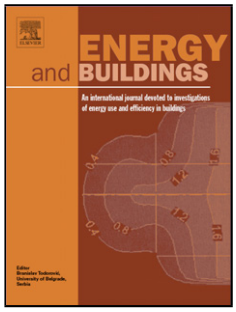

Title: Passive design optimization of newly-built residential buildings in Shanghai for improving indoor thermal comfort while reducing building energy demand

Authors: Shaoqing Gou, Vahid M. Nik, Jean-Louis Scartezzini, Qun Zhao, Zhengrong Li

PII: S0378-7788(17)31210-0
DOI: https://doi.org/10.1016/j.enbuild.2017.09.095
Reference: ENB 8014

To appear in: *ENB*

Received date: 9-4-2017
Revised date: 18-8-2017
Accepted date: 30-9-2017

Please cite this article as: Shaoqing Gou, Vahid M.Nik, Jean-Louis Scartezzini, Qun Zhao, Zhengrong Li, Passive design optimization of newly-built residential buildings in Shanghai for improving indoor thermal comfort while reducing building energy demand, Energy and Buildings https://doi.org/10.1016/j.enbuild.2017.09.095

Title of the manuscript

Passive design optimization of newly-built residential buildings in Shanghai for improving indoor thermal comfort while reducing building energy demand

Shaoqing Gou [a], Vahid M. Nik [b, c], Jean-Louis Scartezzini [d], Qun Zhao [e], Zhengrong Li [a,*]

[a] HVAC and Gas Institute, School of Mechanical Engineering, Tongji University, 200092 Shanghai, China

[b] Division of Building Physics, Department of Building and Environmental Technology, Lund University, Lund, Sweden

[c] Division of Building Technology, Department of Architecture and Civil Engineering, Chalmers University of Technology, Gothenburg, Sweden

[d] Solar Energy and Building Physics Laboratory (LESO-PB), Ecole Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland

[e] College of Architecture and Urban Planning, Tongji University, 200092 Shanghai, China

*Corresponding author. Tel.: +86 13917205110

Email addresses: shaoqing.gou@hotmail.com (Shaoqing Gou), vahid.nik@byggtek.lth.se (Vahid M. Nik), jean-louis.scartezzini@epfl.ch (Jean-Louis Scartezzini), zhaoqun@tongji.edu.cn (Qun Zhao), lizhengrongtongji@126.com (Zhengrong Li).

Abstract

The objective of this paper is to optimize the passive design of newly-built residential buildings in hot summer and cold winter region of China for improving indoor thermal comfort while reducing building energy demand. In this respect, this paper investigates the performance of a representative apartment building in the city of Shanghai and evaluates the optimum solutions by using a developed optimization approach, which includes three major steps of 1) setting the model for multi-objective optimization, 2) sensitivity analysis for reducing the dimension of input variables, and 3) multi-objective optimization by using the Non-dominated Sorting Genetic Algorithm II (NSGA-II) coupled with the Artificial Neural Network (ANN), among which a novel indicator for evaluating the annual indoor thermal comfort of residential buildings of Shanghai named Comfort Time Ratio (CTR) is defined based on the modification of Szokolay's theory in terms of bioclimatic analysis, and the impacts of passive design variables on the indoor thermal comfort and building energy demand in terms of different directions are comprehensively investigated. Results of the multi-objective optimization indicate that the residential buildings of Shanghai have a great potential in comfort-improvement and energy-saving. A series of novel optimal passive design tactics for residential buildings in Shanghai are derived accordingly which could be easily understood and conveniently carried out by the architects in practice.

Keywords: Passive design; Residential buildings; Multi-objective optimization; Artificial neural network; Genetic algorithm; Thermal comfort; Energy demand

1. Introduction

During the past 20 years, with the acceleration of urbanization, the number of newly-built residential buildings has increased enormously in most cities of China. As for the hot summer and cold winter climatic region, the energy demand for providing indoor thermal comfort of residential buildings is significantly higher than the other climatic