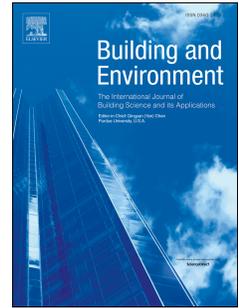


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An integrated school and schoolyard design method for summer thermal comfort and energy efficiency in Northern China

Anxiao Zhang, Regina Bokel, Andy van den Dobbelsteen, Yanchen Sun, Qiong Huang, Qi Zhang



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4 Anxiao Zhang ^a, Regina Bokel ^b, Andy van den Dobbelsteen ^b, Yanchen Sun ^a, Qiong Huang ^{a,*}, Qi
5 Zhang ^a

6 ^a School of Architecture, Tianjin University, Tianjin, China

7 ^b Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands

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10 Abstract

11 A good school design consists of a thermally comfortable school and schoolyard as well as a low
12 energy consumption of the school building. The main contribution of this study is that it develops
13 an integrated design approach to systematically evaluate and optimize school design parameters at
14 different design stages for summer outdoor thermal comfort and building cooling demand. A
15 typical school in northern China was selected to illustrate the simulation-based design framework.
16 The three-dimensional microclimate model ENVI-met was used to calculate outdoor temperatures
17 and the Physiological Equivalent Temperature (PET) index as a measure of the outdoor thermal
18 comfort condition. The ENVI-met results were then used as input for the thermal boundary
19 conditions in the energy simulation software DesignBuilder. DesignBuilder, in turn, was applied to
20 calculate the building cooling demand while taking into account the local outdoor thermal
21 conditions. The integrated design approach proves to be effective for mitigating school heat stress
22 and energy saving. By taking the school case as a reference, the integrated design method resulted
23 in a high-performance design that reduced the outdoor discomfort time by 25% and the building
24 cooling demand by 5%. Planting trees was found to be the most effective considering both the
25 outdoor thermal comfort and building cooling demand. Other implications for planning and
26 designing schools in terms of the school case are also presented in order to help architects in
27 selecting strategies that enhance the thermal performance characteristics of both the school
28 building and the schoolyard.

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31 Keywords:

32 School design, outdoor thermal comfort, building cooling demand, ENVI-met, northern China

33

34 1. Introduction

35 Schools are the premises where children develop into intelligent and responsible adults. Since
36 children spend most of their day at school, it is essential to provide students with a healthy and
37 comfortable learning environment. Focus has been put on the physical, visual, and aural comfort
38 conditions required for learning as well as the energy consumption of school buildings [1] [2] [3].

*Corresponding author. School of Architecture, Tianjin University, No. 92 Weijin Street, Nankai District, Tianjin 300072, P. R. China. Tel.: +86 18602658127.
E-mail address: qhuang@tju.edu.cn (Q. Huang).

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