



# Design optimization of office building envelope configurations for energy conservation



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## HIGHLIGHTS

- Building Envelope Energy Load (ENVLOAD) is essential for green building design.
- Office Building Envelope design Model (OBEM) was developed based on ENVLOAD.
- OBEM provides envelope configurations for architects' reference.
- Tabu search links OBEM to optimize an office building envelope configuration.
- Optimized design reduces construction cost under energy conservation regulations.

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## ABSTRACT

Designing envelope configurations of office building with the low construction cost and energy consumption is a discrete optimization problem. The configuration is currently determined merely on architects' experiences resulting in an inefficient expense or by building energy performance simulation which is time-intensive and involves complex processes. Based on an efficient regression equation to substitute complex energy simulators, this study developed an Office Building envelope Energy performance and configuration Model (OBEM) to provide envelope configurations, including construction material, sunshade type, sunshade length, window number, and window length and width for architects' reference. Also, Tabu search, which is effective in solving discrete optimization problems, was integrated with OBEM into an Optimal OBEM decision support system (OPOBEM). The OPOBEM was applied to a real office building construction for optimizing its envelope configuration at minimum construction budget under the energy conservation regulations of green buildings. The result shows that the optimized installation of sunshade type efficiently reduces solar heat gain according to the high variation of the sunshade coefficient, thus achieves the goal of energy conservation and reduces the envelope costs. Compared with architects' manual estimation, the optimized envelope design realizes nearly 41% budget savings, thus demonstrating the feasibility of the proposed OPOBEM.

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## 1. Introduction

Constructing green buildings with nearly zero-energy is a major objective in energy policies worldwide [1]. Building envelope features considerably affect the energy efficiency of buildings, indoor environmental quality and the thermal comfort for human [2–4]; thus, the effective evaluation of the thermal performance of building envelopes is crucial in the reduction of air-conditioning energy

consumption [5]. Specifically, precise design of building envelope can significantly help improve energy efficiencies of building [6]. Several building envelope energy efficiency standards, such as Overall Thermal Transfer Value (OTTV) equation and Perimeter Annual Load (PLA), were proposed and revised to apply to different buildings in different countries according to climate type, analysis period (such as summer or whole year), or building type [5,7,8]. The OTTV is doubtful to be selected as an effective index in Taiwan, where cooling load predominates [9]. The PLA proposed by Japan government is defined as annual thermal load of perimeter spaces within 5 m of exterior wall [10]. Comprehensive building thermal

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