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Optimizing the Configuration of a Compact Thermal Facade Module for Solar Renovation Concept in Buildings

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Abstract

Solar concepts show potentially an improved cost-performance (energy) ratio when applied as the integrated parts of building renovations. This paper reported a compact solar thermal facade (STF) module with the internally extruded flow channel suiting for solar renovation concept in buildings. A few of impact factors were considered for the parametric study in order to optimize the STF's configuration for various applications through the validated simulation model. The overall research results are expected to be useful for further improvement in the thermal performance of solar renovation measures.

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Keywaords: Solar; Thermal facade; Configuration; Renovation

1. Introduction

Building sector is currently responsible for more than one third total primary energy consumption and the equivalent total carbon emission. As most of the existing buildings have poor energy performance, renovation of existing buildings to achieve the energy-efficiency standards will represent a large proportion of the building construction duties and contribute to the corresponding primary energy saving target. The biggest challenge in building renovation is to increase the cost-performance ratio. To achieve

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this, it is necessary to reduce renovation costs and also to increase energy performance of the renovated components at the same time. Effective solutions thus need to be developed, demonstrated, and replicated.

Integrating of solar thermal module with building facade components represents a promising solution to tackle the above challenge. The solar thermal façade (STF) module is defined as the "multifunctional energy facade" that differs from conventional solar panels or construction materials as it offers a wide range of solutions in the architectural design features (i.e., colour, texture, and shape), exceptional applicability and safety in construction, as well as additional energy production. There are a series of demonstration projects displaying how synergic collaboration between the solar thermal module and the building facade can be within the STF applications [1]. Diverse directions with miscellaneous motives have led to a lot of different STF building integration variations [2-5]. Typical strategies can be assigned to dissimulation into building envelope, special placement, and modular building component design. Furthermore, it can be found that majority of new building project belongs to solar house, passive house or even net zero energy building design, while renovation projects provide a new direction of functional transformation instead of sole repairing. More focuses have been put on threatening resource shortage, comfort living environment, as well as position architectures themselves in the niche market. It is worthy mention that as an innovative choice of multifunctional building envelope, STF has superiority in reducing costs by combined functions of solar absorption and building covering, and improving the energy performance of buildings via reduction in energy load and generation of certain amount of energy simultaneously. It is usually modularized to be adaptable to both individual and mass renovation solutions.

This paper proposes a compact metal STF module featured with simple structure, low cost, high feasibility in building renovation as displayed in Fig.1 (a). The STF module is made up by two stainless steel sheets, one of which is extruded by machinery mould together to formulate arrays of pin-fin corrugations, while the another sheet working as the absorbing surface remains smooth and can be coated into optional colour or texture according to different requests. Such STF can be employed as shading or rainscreen as an advanced building envelop to buffer the overall building energy load and delivery of solar thermal energy. It also has feasible functions in heating/cooling the building, providing hot water, power generation and improving the insulation and overall appearance of building, as illustrated in Fig. 1 (b). In order to optimize the configuration of such a STF, seven impact factors will be considered for the parametric through the validated simulation model. It is expected that the research result could be useful for further design of such STF in various building renovation scenarios.

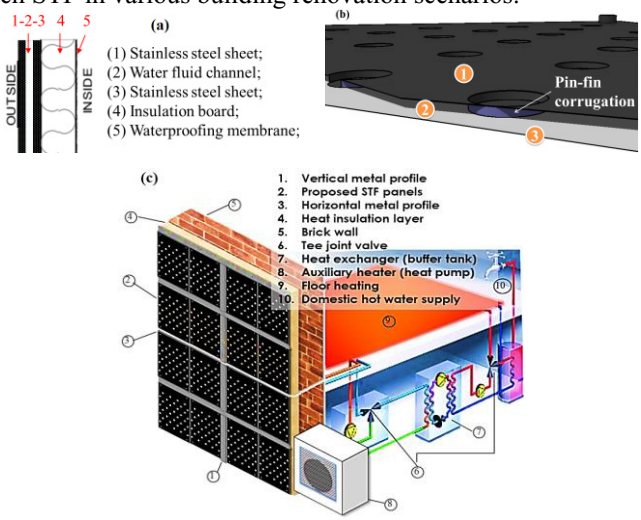

Fig. 1 (a) Schematic design of the proposed STF; (b) flow channel of the STF; (c) conceptual wall renovation with the STF

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