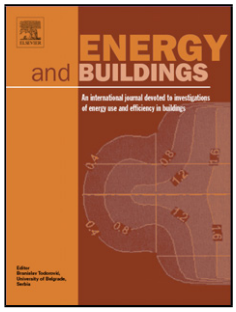

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Regulating top albedo and bottom emissivity of concrete roof tiles for reducing building heat gains

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Research highlights:

- Decreasing the emissivity of concrete roof tile's bottom reduces building heat gains.
- Increasing tile' top albedo and decreasing tile's bottom emissivity should be done simultaneously.
- Concrete tile's bottom emissivity can be decreased using existing techniques.

Abstract: In Southern China concrete tile roof is widely used as double-skin roof to shield sunlight directly on the roof deck. Colony of dust and algae rapidly reduces the albedo of the tile's top after construction, increasing the heat gain of the interior building during summer months. Here we show a simple retrofit strategy by decreasing the tile's bottom emissivity and increasing the tile's top albedo simultaneously. A building cell housed for concrete tiles with different tile's top albedo and with different tile's bottom emissivity is built to monitor the temperatures of the roof at different elevations. The temperatures observed at the roof tile and at the roof deck indicate that both decreasing the tile's bottom emissivity and increasing the tile's top albedo can effectively decrease the roof deck temperature and reduce the heat gain of the building. We speculate that increasing the tile's top albedo and decreasing the tile's bottom emissivity should be done simultaneously to retrofit concrete tile roofs for reducing the heat gains of buildings in summer months.

Keywords: Concrete tile; albedo; emissivity; temperature; radiative heat transfer

1 Introduction

Tropical regions are subject to longer solar insolation and hotter summer. A suite of roofing techniques have been introduced to cut down the heat gain of the building, including green roofs [1-4], reflective cool roofs [5-7], and other roofing techniques [8-10]. Among these techniques, raising the rooftop albedo, increasing the insulation, and the combination of them effectively reduce the heat entering the interior building. Rooftop can be lighted-colored such that it reflects most sunlight off the surface and keeps the roof cooler than conventional dark-colored roofs [11, 12]. In last decades, experiments and simulations have been conducted to advance the correlation between rooftop albedo and building heat gains. Akbari et al [13] monitored one house and two school bungalows in Sacramento, California and found that changing the rooftop albedo from 0.18 to 0.73 saved the cooling energy about -2.2 kWh/d and reduced the peak cooling demand about 0.6 kW. Likewise, Parker *et al* [14]measured the impact on the space cooling of Florida residences and found that increasing the roof solar reflectance reduced the average cooling energy by 19%. Qin *et al* [15] found that the building heat gain from a reflective roof decreases linearly with the increase of rooftop albedo. Similar studies have demonstrated the effectiveness of reflective cool