


Chapter 1

A Review on the Practical Value of Passive Roofs for Rural Housing in Panzhihua, China

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ABSTRACT

The climate of Panzhihua, China, is characterized by dry, hot, and strong solar radiation. However, the existing regulations classify the region as a moderate climate zone at first, ignoring the local climate characteristics, resulting in a lack of effective guidance for housing construction. Due to the growing needs of residents, roofs in the area have adopted many immature climate response strategies. The research objective of this study is to conduct a literature review of existing roofing strategies, identifying and prioritizing the roles and importance of passive roofing in the region. The thermal performance of common passive roofs in this region, including GRs, CRs, VRs, and BRs, is analyzed, and the practical value of these passive roofs in the hot-dry region is demonstrated. This study will effectively guide the construction of residential roofs in the region, which is conducive to building

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1. INTRODUCTION

In hot-dry regions, the building envelope receives a lot of solar radiation, which causes thermal stress and indoor thermal discomfort. Today, however, residents rely on mechanical systems for cooling, resulting in huge energy consumption (Athmani, et al., 2022). According to statistics (Gan, et al., 2019; Gibberd, 2020; Harputlugil & de Wilde, 2021), buildings consume 40% of energy and produce more than a third of global greenhouse gases. These increased gases will trap more heat, leading to a greater “greenhouse effect” and an increase in global temperatures (Gibberd, 2020). In addition, in hot-dry regions, which account for one third of the world's land and 15% of the world's population, about one third of the energy used is used for cooling needs to mitigate indoor overheating risks (Athmani, et al., 2022; Baccega, et al., 2022). Refrigeration is a major basic need in this region for most of the year.

The roof is one of the most critical components of the building envelope (Rawat & Singh, 2022). According to some studies (Athmani, et al., 2022; Dristy, et al., 2020; Saurabh & Madhura, 2023), because roofs are exposed to sunlight throughout the day, especially in low-rise rural houses, they are a major source of thermal stress, and often cause uncomfortable indoor conditions. Panzhihua is located in the hot-dry region in southwest China, with strong solar radiation throughout the year, dry winter, and hot summer, and the roof faces great challenges (Panzhihua Climate, 2023). In Panzhihua area, most rural houses are low, with 1 or 2 floors, and the roof area accounts for a large proportion of the surface area of the enclosure structure, which bears strong solar radiation. Rural housing in China is mostly built by local builders based on their experience (Liu, 2021). Builder and owners pay more attention to economy and safety, and the lack of awareness of building energy efficiency leads to poor thermal performance of the building envelope, which requires more energy consumption to achieve indoor thermal comfort. Especially in hot-dry regions, buildings that lack energy-efficient design and use inefficient cooling systems consume a lot of energy (Rawat & Singh, 2022). As Panzhihua is located in Hengduan Mountain Area and is relatively remote, the builder's construction skills are not mature. In recent years, due to residents' lack of awareness of passive roofs, many of inefficient roof systems have been used in rural houses built in Panzhihua. Finally, rural energy consumption remains high. So, selecting low-energy technology considering the regional characteristics of rural housing in the region has become an urgent problem to be solved (Fu, 2020).

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