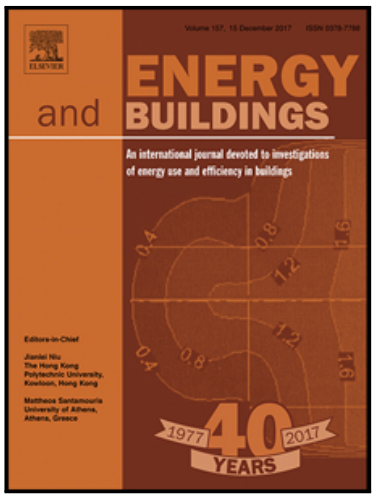

Cooling load calculation methods in spaces with stratified air: a brief review and numerical investigation

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Cooling load calculation methods in spaces with stratified air: a brief review and numerical investigation

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Keywords: Stratified air distribution; cooling load calculation; effective cooling load factors; return grille height; energy saving

Abstract:

Due to vertically thermal stratification in indoor spaces, the cooling load calculation is always a challenge in the design of stratified air distribution systems (STRAD), which in turn is crucial to determine the supply air flow rate and the cooling load to be removed by the air conditioning system. In this paper, several cooling load calculation methods, developed in the past twenty years and focused on STRAD systems, were briefly reviewed. It attempts to clarify these methods in terms of their advantages, limitations and suitable ranges of applications. Furthermore, series of numerical simulations with a total number of 56 cases were conducted, and the applications of a novel cooling load calculation method in STRAD systems were investigated. The reliability of the method was validated for STRAD systems with separated locations of return and exhaust grilles, when adopted in three typical spaces with different building heights, namely a small office、a large terraced classroom and a terminal building. Databases of effective cooling load factors ($ECLF_i$) for different heat sources distributed in the three spaces were obtained and presented, which can be conveniently used to calculate cooling loads. In addition, the influences of return grill height on the occupied zone cooling load as well as the energy saving potentials of STRAD systems were also clarified. The results presented in this paper are helpful for the design and optimization of STRAD systems.

1. Introduction

Stratified air distribution (STRAD) systems have higher ventilation effectiveness and are more energy efficient, in comparison with the conventional mixing ventilation (MV) systems. For the advantages of STRAD systems, they have been achieved considerable acceptance in Europe, South Africa, Japan and North America [1]. A STRAD system is defined as a means of providing supply air directly to the occupants in a space and cooling the lower, occupied zone of a building while leaving the upper zone uncooled [2]. Hence, the STRAD system may include any kind of system which maintains a stratified temperature and contaminant distribution in a space, including displacement ventilation (DV) and under floor air distribution (UFAD) et al. Since the airflow in a STRAD system is much more complicated than that in a MV system, it requires more rigorous analysis of building thermal and airflow characteristics during the design process. As a relatively new technology, STRAD technology is being used widely without fully understanding its