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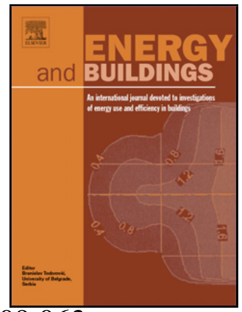

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Author: Christian Kaltreider Moncef Krarti John McCartney

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ACCEPTED MANUSCRIPT

HEAT TRANSFER ANALYSIS OF THERMO-ACTIVE FOUNDATIONS

Christian Kaltreider

Moncef Krarti, PhD, PE, LEED®AP*

John McCartney, PhD

Civil, Environmental, and Architectural Engineering Department

University of Colorado, Boulder

*Correspondent Author: krarti@colorado.edu, (303) 492-3389/7371

Abstract

A transient, three-dimensional finite volume method (FVM) numerical model was developed specifically for the purpose of modeling thermo-active foundations. Validation against a physical experiment was first carried out using measurements obtained from an experimental set-up of a thermo-active foundation. The model was then used to investigate three design parameters as they apply to thermo-active foundations including tube spacing, pier depth, and flow velocity. The model was also used to investigate the thermal interaction between the thermo-active foundation and the building above it using annual simulations based on hourly weather data for Boulder, CO. In particular, it is found that thermo-active foundation can increase a building's ground-coupled slab heat loss for 57% of hours during the heating season when compared to a standard foundation. A decrease in slab heat loss or increase in slab heat gain was seen for 32% of hours during the cooling season.

Keywords: buildings, ground-coupled heat transfer, heating and cooling, heat exchangers, thermo-active foundations

Introduction

As global primary energy resources rapidly decline, the importance of energy conservation is more evident now than ever before. Furthermore, the connection between fossil fuel use and global warming creates even more concern over the world's consumption of fossil-based energy. In the United States, the building sector accounts for 40% of all energy use and is the largest contributor to greenhouse gas emissions [1]. Moreover, most of the primary energy used by US commercial buildings, 27.3%, is used for heating and cooling [1]. Consequently, any technological developments in this area have the potential to have a far reaching effect.

Ground-source heat pumps (GSHP) have demonstrated 30% to 70% energy savings in heating mode and 20% to 50% in cooling mode when compared with air-source heat pumps and traditional air-conditioning systems [2-3]. Residential and commercial installations of GSHP have grown quickly and steadily, with installations growing an average of 10% per year in 30 countries from 1994 to 2004 and

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