

OPTIMAL OPERATION FOR HVAC SYSTEM WITH SEASONAL UNDERGROUND THERMAL STORAGE SYSTEM

Masato Miyata¹, Harunori Yoshida¹, Masanobu Aono²,
Tadakatsu Takegawa², Yoshiyuki Nagura³, Youichi Kobayashi³, Jeongsoo Kim³

¹ Department of Urban and Environmental Engineering, Kyoto University, Kyoto, Japan

² Shikoku Electric Power Co., Inc, Takamatsu, Japan

³ Yonden Consultants Co., Inc, Takamatsu, Japan

⁴ Yasui Architects and Engineers, Inc, Osaka, Japan

ABSTRACT

The present paper proposes an optimal operational strategy of an actual HVAC system with a seasonal underground thermal storage system using simulation. The simulation is a powerful tool for the system because it is difficult to try various operational methods experimentally in the actual system due to the long heat transfer time in the underground. This paper develops the whole system simulation by connecting an underground thermal model, which can simulate the heat exchange between the ground and the pipes buried in the foundation piles, and the models of mechanical components in the air-conditioning system. The optimum operational strategy found using simulation, which is to minimize the energy consumption of the whole system, can save the energy consumption by approximately 30 % and improve system COP from 3.02 to 5.04 compared with the values of the present operational method.

KEYWORDS

Commissioning, Underground Thermal Storage, Optimization, FEM, HVAC System

INTRODUCTION

The present paper proposes a method to optimize the performance of an HVAC system with seasonal thermal storage using simulation. In this system, water cooled by cooling towers is circulated through pipes pre-installed in foundation piles to cool the ground in winter, and in summer the cool water is fed to cooling coils of AHU to perform pre-cooling of supply air. Although the system utilizes natural energy, if operated improperly the system may consume more energy than a common HVAC system with refrigerators, due to using a large amount of energy for water circulation.

This paper discusses the optimal operational method of an actual HVAC system in Japan using whole system simulation. Conducting various case studies using the simulation, the optimum operational strategy is attained.

INFORMATION OF THE ANALYZED BUILDING

The building analyzed in this paper is located in Takamatsu, Japan, and has an HVAC system with underground thermal storage. Figure 1 shows an outline of the HVAC system. The building has no artificial heat source and is air-conditioned by means of cooling water from the underground and heating

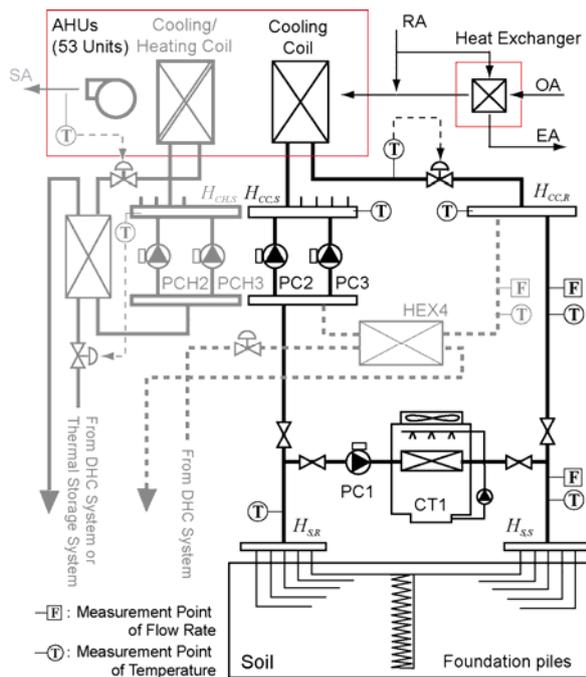


Figure 1 Air-conditioning system.

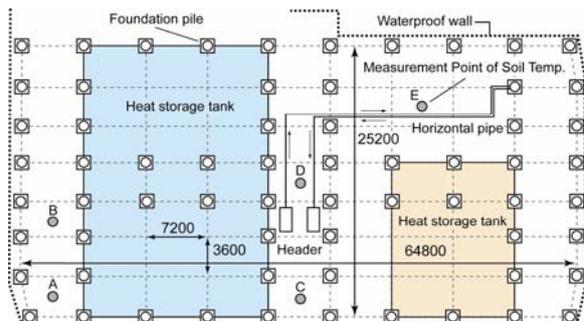


Figure 2 Layout plan of foundation piles.