Commissioning of a Coupled Earth Tube and Natural Ventilation System at the Acceptance Phase

Song Pan
Master
Sanko Air Conditioning Co., Ltd.
Nagoya, Japan

Mingjie Zheng
Dr.
Sanko Air Conditioning Co., Ltd.
Nagoya, Japan

Harunori Yoshida
Pro.
Kyoto University
Kyoto, Japan

ABSTRACT
In this paper, the environment and energy performance of an actual coupled earth tube and natural ventilation system in a gymnasium was measured during the acceptance phase in two operation states: no ventilation and natural ventilation. From the measurement result, the authors found a design fault, which the airflow temperature from floor apertures on the north side was 3 degrees lower than from the floor apertures on the south side. By the use of the CFD (Computational Fluid Dynamics) coupled analysis with natural ventilation method, the natural ventilation air volume and the indoor temperature in three outdoor air conditions have been calculated to perform commissioning. Several findings were obtained and informed to the operator.

KEYWORDS
Earth tube, Natural ventilation, CFD coupled analysis with natural ventilation method

INTRODUCTION
Recently, even though coupled earth tubes and natural ventilation systems are often used in Japan, the amount of basic information based on actual measurements and simulations of such systems is limited. Furthermore, design methods and optimal operation policy have yet to be clarified. When the commissioning of a coupled earth tube and natural ventilation system is performed during the acceptance phase, as part of efforts to verify the design and prevent faults that might occur due to unclear information or lack of experience on the part of the designers during the planning and design phase, and in order to confirm the function and performance of the system under various outdoor air conditions and system utilization states, the following questions must be answered clearly:

What commissioning items must be considered?
What points should be measured for each commissioning item?
What simulation tools should be adopted?
What should be simulated?

The purpose of this paper is to clarify the commissioning method and processes for this type of system.

As part of that effort, the authors reviewed previous research efforts and existing simulation tools used for coupled earth tube and natural ventilation systems and then developed a natural ventilation simulation tool that considers vertical air temperature distribution and coupled the CFD analysis method with this simulation tool (Zheng, 2007; Pan, 2007b). Using this CFD coupled analysis method, the authors performed the commissioning of an actual system at the plan/design phase (Pan, 2007a; Pan, 2007b). The commissioning results of the following four items are reported:

- energy conservation performance
- air temperature of the occupied section
- natural ventilation air volume
- airflow velocity through the floor apertures

In this paper, we report the measurements and simulations of the actual system completed on February, 2008, during which commissioning at the acceptance phase was performed and several findings were obtained.

OUTLINE OF THE COUPLED EARTH TUBE WITH NATURAL VENTILATION SYSTEM
An outline of the building and the coupled earth tube with natural ventilation system is shown in Tables 1 and 2, respectively. The building is the indoor gymnasium of an elementary school. The ventilation system consists of rotary natural ventilation windows near the ceiling of the north and south walls, floor apertures, under-floor pits and the outdoor earth tube. Outside air is obtained from inlets and supplied to the room by means of seven south floor apertures and six north floor apertures, six north floor apertures, as shown in Figure 1, after the air flows through the outdoor earth tube, under-floor pits, indoor vertical shaft and outdoor vertical shaft. Furthermore, forced ventilation is performed by means of two supply fans installed at the inlet of the under-floor pits and the two exhaust fans installed near ceiling of the north outside wall. No-ventilation operation (natural room temperature state) can easily be achieved by closing all the floor apertures.