ABSTRACT

This study presents the efficiency of a method combining the pile foundation and a thermosyphon proposed as a method for ensuring thermal stability of the ground. The prototype of the thermosyphon was placed in the ground at King Sejong Station in permafrost Antarctica and the temperature variations in the ground were monitored. Consequently, the temperature of the ground where the thermosyphon was embedded indicated the sensitivity of that ground to the climatic conditions in winter, compared to the temperature variation in the ground without the thermosyphon. The thermosyphon at King Sejong Station proved to pump out heat efficiently, thereby stabilizing the frozen ground.

KEY WORDS: Thermosyphon, Permafrost, Antarctica, Thawing, Thermal pile, Working fluid, Phase change.

INTRODUCTION

The ground in permafrost regions is vulnerable to settlement, which might be caused by the thermal effect from the superstructure and a disturbance from construction activity or thermal variation. For this reason, a shallow foundation or deep foundation method could possibly cause unexpected damage to the structure. Thus it is necessary to sustain a thermal balance in the ground.

Methods commonly adopted in sustaining thermal stability in permafrost include replacing the ground with a low thermal conductivity material and installing a vent under the structure to prevent the heat from transferring directly into the ground. However, ground replacement is costly and a vent under the structure potentially constrains the usefulness of the structure.

To deal with such problems, the method of using a thermosyphon to effectively pump out the ground heat to stabilize the ground has been increasingly employed to particular structures or to the ground in permafrost (Yarmak and Long, 2007). The thermosyphon is a device designed to transfer heat effectively by circulating a working fluid by taking advantage of the density difference caused by the phase change of the working fluid and gravity. Thermosyphons are used to prevent thaw settlements, sustain the load bearing capacity in frozen ground, and thermally stabilize the ground in winter by discharging the latent heat out of the ground.

The thermosyphon mechanism is based on natural convection. The temperature rises when the fluid absorbs the heat and a buoyant flow is generated by the difference in density between the upper and lower levels of tank. Consequently, convection moves the heated fluid upward.