터널 라이닝 내부에 설치한 열교환기의 현장모니터링 연구

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Study on long-term monitoring of heat exchanger installed in the tunnel lining

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This paper presents an experimental study on a new potential geothermal energy source obtained from tunnel structures. An “energy textile”, which is a textile-type ground heat exchanger, was fabricated between a shotcrete layer and a guided drainage geotextile in the tunnel lining system. To examine the long-term thermal behavior of the energy textile, the difference in temperatures of the inlet and outlet fluid circulating through the heat exchange pipe within the energy textile was monitored using a constant-temperature water bath. Daily heat exchange rate of the energy textile during cooling operation was estimated from the measured temperatures of the inlet and outlet fluid through the energy textile. The air and ground temperature was also continuously monitored. The operation of the energy textile as a ground heat exchanger was simulated using a 3D numerical CFD model (Fluent). The thermal conductivity of shotcrete and concrete lining components and temperature variation of air in the tunnel were incorporated in the model. The numerical analysis shows a good agreement with the long-term monitoring result.

Key words : Heat exchanger(열교환기), Numerical analysis(수치해석), Energy textile(에너지 텍스타일)

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국내 지중열전도도 측정 방법의 한계 및 개선 방향

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Limitations and improvement of the in situ measurements of ground thermal conductivity in Korea

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The borehole heat exchanger of Geothermal Heat Pump (GHP) system should be sustainable and cost effective for long term operation. To guaranty the performance of the system thermal Response Tests (TRTs) with simple recommended procedures have been applied in many countries. Korea government developed a standard TRT procedure in order to control the quality on GHP projects. In the TRT procedure interpretation method has a rule that data set has to be interpreted by the line source model(LSM). The LSM employes some assumptions that surrounding medium is homogeneous and the line source is infinite and constant heat flux, however real ground condition is unisotropic and heterogeneous, and showing regional or local ground water flows in many cases. We need to develope improved evaluation models to estimate accurate ground thermal conductivity with respect to geological and influence of ground water because current TRT standard test procedure has limitations to be applied for every locations and system. This study surveyed the uncertainty of the thermal parameters from the interpretation method considering different evaluation period. The interpretation of 208 TRT data sets represents limitations of LSM application that some obtained ground thermal conductivities are statistically unstable and convergence time of ground thermal conductivity over test period shows trends responding the length of test period. This evaluation study will be helpful to provide some effective procedure for the thermal parameter estimation and to complement current TRT standard procedure.

Key words : geothermal heat pump(지열 열펌프), thermal response test(열응답 실험), ground thermal conductivity(지중열전도도), line source model(선형열원모델), evaluation(평가)

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