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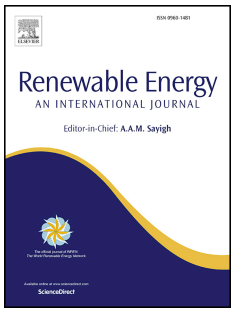

Design optimization for ventilation shafts of naturally-ventilated underground shelters for improvement of ventilation rate and thermal comfort

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Design Optimization for Ventilation Shafts of Naturally-ventilated Underground Shelters for Improvement of Ventilation Rate and Thermal Comfort

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Abstract

A good ventilation system is essential for an underground shelter to provide a comfortable environment with better indoor air quality. Ventilation shafts are widely used for ventilation purpose in an underground shelter. In the current work, the position of the ventilation shaft is optimized by employing the Response Surface Model (RSM). Two RSMs are constructed. The first RSM is constructed by 32 CFD models via Fractional Factorial Design (FFD) and the second model is constructed by 53 CFD models via Central Composite Rotatable Design (CCRD). The first and the second models are subsequently analysed by using the linear and quadratic models, respectively. The result indicates that both models lead to similar predictions on the inputs (factors) that strongly affect the response. Moreover, the response surface values agree well with the CFD values. Based on desirability functions, the optimized design improves the ventilation system by 24.5% as compared to the actual design. Also, the optimized design meets the comfort temperature and design criteria recommended for a naturally-ventilated underground shelter. Overall, this study finds that statistical analysis is a useful tool for the improvements of ventilation rate and thermal comfort.