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Estimation of Effective Thermal Conductivity in Micro Carbon Fiber Reinforced Clay Soil (MCFRS) with Different Fiber Distributions

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ABSTRACT

The effective thermal conductivity of Micro Carbon Fiber Reinforced Soil (MCFRS) is widely used for various applications in geothermal engineering. Due to the filamintic shape of carbon fibers, it is important to understand the effect of fiber distribution in interpreting the thermal conductivity of fiber-reinforced soils. In this study, we evaluate the thermal conductivity of MCFRS using finite element simulation methods in three-dimensional space and discuss the effects of carbon fiber distribution on thermal conductivity. The results show that adding carbon fiber can effectively improve the thermal conductivity of soil. Also, the thermal conductivity of MCFRS is closely related to the distribution of fibers. In the case of parallel distribution, the thermal conductivity is 1.87 and 1.47 times that of purely random distribution and random distribution in the XZ/XY-plane, respectively, if the heat transfer is in the X-axis direction. This study provides evidence for the potential improvement of the thermal conductivity of MCFRS.

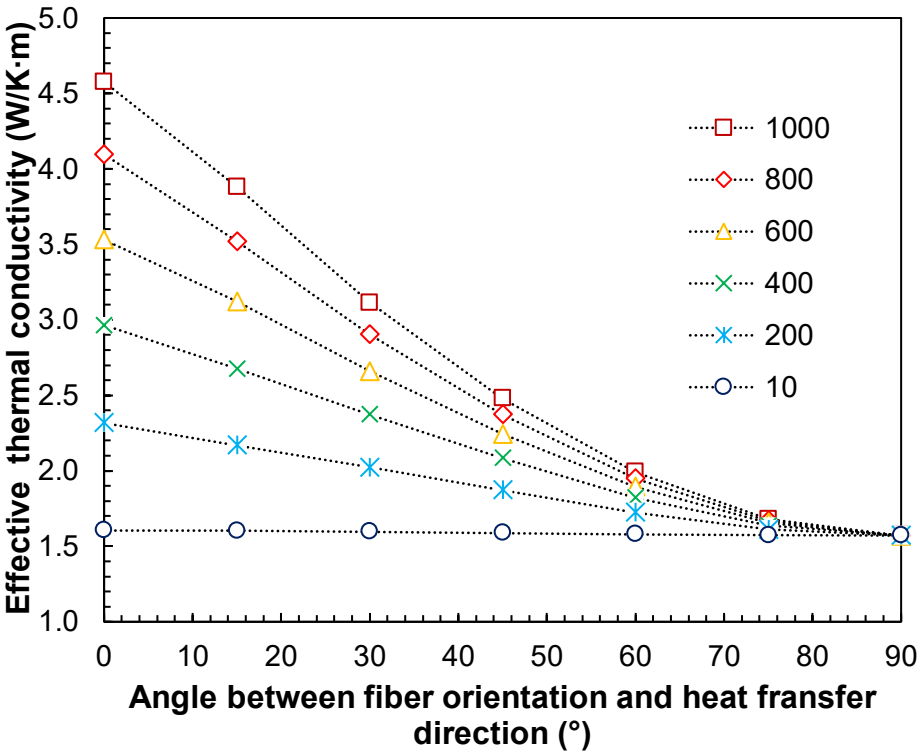
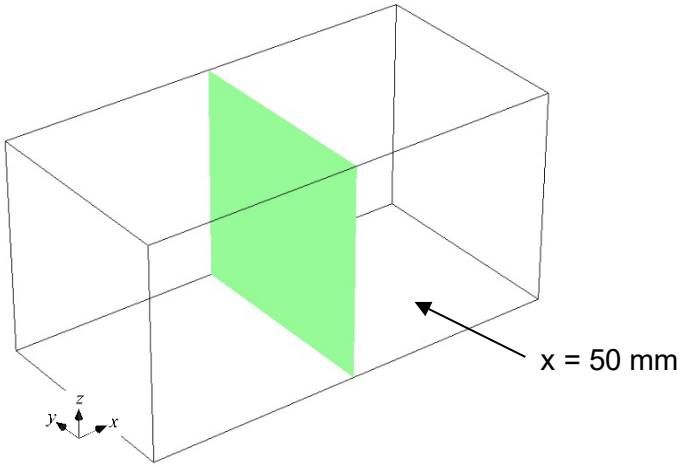


Fig. 1 The changes of the effective thermal conductivity of MCFRS for the various angles between fiber orientation and the direction of heat transport.

(a)



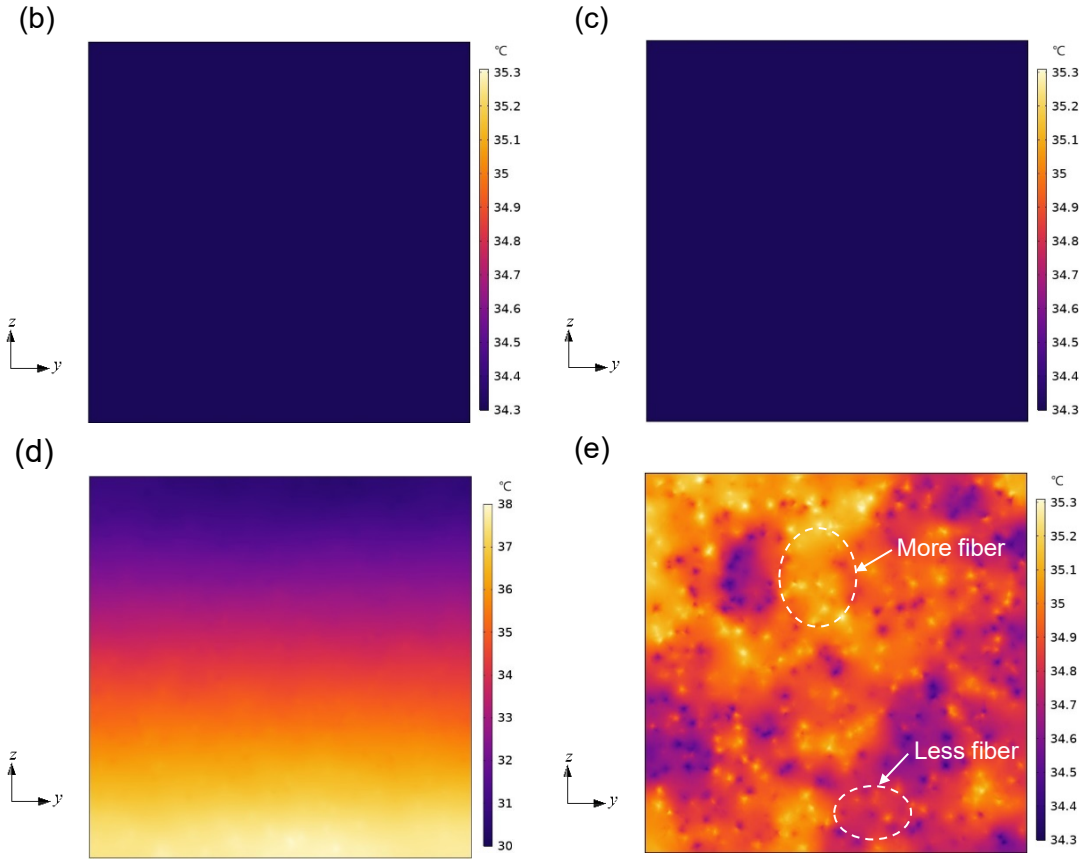


Fig. 2 Temperature contour in cross-section of MCFRS, thermal conductivity of carbon fiber: 1000 W/(K m), at 100 mins. (a) Schematic of the cross-section in YZ-plane at x = 50 mm; (b) without carbon fiber; (c) fiber orientation 90°; (d) fiber orientation 45°; (e) fiber orientation 0°.

REFERENCES

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