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Experimental study of ice lens formation in granular materials

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Ice lens is formed by the migration and accumulation of unfrozen water. Although the mechanism for ice lens formation has been developed by various theoretical model, the comparison with experiments is not well performed.

We performed the unidirectional freezing experiment for ice lens formation using granular materials. In order for understanding the ice lens formation, granular materials that have uniform properties are favorable over natural soils. Our freezing method is step-wise freezing which means the cooling temperatures are constant. We observed the configuration of ice lens with various particle sizes and cooling temperatures. Also we estimated temperature conditions of ice lens in specific conditions. As a result of experiments, we have obtained clear and systematic relationship between the ice lens and particle sizes and cooling temperatures. Ice lens is formed at farther position from cooling plate in lower cooling temperature and at closer position in higher cooling temperature. We indicate that this trend can be explained by critical freezing velocity for particle exclusion. As for the relationship between the thickness of ice lens and particle size, the ice lens is thicker in smaller particle sizes and thinner in larger particle sizes. This trend is consistent with the particle size dependence of unfrozen water.

Keywords: ice lens, granular materials