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Microbially Induced Desaturation and Precipitation (MIDP) via Denitrification during Centrifugal Loading

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Microbially induced desaturation and precipitation (MIDP) via denitrification has the potential to mitigate earthquake-induced liquefaction by two mechanisms: biogenic gas production to desaturate and dampen pore pressure changes in soil and calcium carbonate precipitation to mechanically strengthen soil. Lab-scale tests have demonstrated that both desaturation and precipitation are effective mitigation mechanisms. However, small-scale laboratory column tests at ambient pressure lead to gas pockets and lenses, causing upheaval due to low overburden pressures. Therefore, biogenic gas formation, distribution, and retention need to be evaluated with more realistic over-burden pressures to understand the effectiveness of this treatment mechanism. Centrifuge tests of soil desaturated by MICP treatment are currently being performed to simulate field pressures and stresses. In addition, a numerical model was developed to evaluate the scaling effects on biogenic gas generation between the centrifuge model and prototype scale. The centrifuge tests are conducted within a laminar box on the 1-m radius centrifuge at the University of California, Davis NHERI/CGM centrifuge facility. Desaturation is induced in the laminar box prior to acceleration in the centrifuge by augmenting saturated soil with an enriched culture of denitrifying microorganisms. The models are accelerated to 80 g in stages and measurements of soil moisture content are made over time to see the combined influence of steady-state pore pressure and overburden pressure on the degree of saturation. Upon reaching the final centrifuge acceleration, the models are subjected to strong shaking until either liquefaction is triggered or the capacity of the centrifuge is reached. Test results provide evidence of the capacity for MIDP to mitigate the potential for earthquake-induced soil liquefaction by desaturation. Comparison of modeling results to test data suggest that the numerical model does not consider certain pore-scale influences and the effects of mixing from liquid-gas transfer and transport observed in the centrifuge tests. Thus, future work will add these features to the model.

References

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