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The breach of the Kingstone coal ash pond in December 2008 directed many concerns towards the mechanical stability of coal ash impoundments. The loss of shear strength as additional ash was deposited until the coal ash liquefied was the reason for this catastrophic failure. This failure lead to contamination of watersheds totaling about 300 acres. Poor mechanical performance of coal ash impoundments has prompted the need to investigate mitigation techniques. Microbial induced calcium carbonate precipitation (MICP) is a novel approach to improve the stability of the coal ash sediments by using natural, biological processes to cement the particles together. The tendency to capture some heavy metals remaining after coal combustion through co-precipitation is another advantage of using MICP. The improvement in mechanical properties is evaluated with a series of laboratory tests, and is illustrated through increases in shear stiffness, reduction in compressibility, and increases in undrained shear strength. Traditional incremental load consolidation apparatuses were modified to evaluate the effect MICP on the compressibility and hydraulic conductivity of coal ash sediment. One-dimensional incremental load consolidation tests were performed after treating the specimens to target shear wave velocities, measured using bender elements. After finishing the incremental loading, the treated samples were unloaded and reloaded to evaluate the effect of breaking the calcium carbonate bonds between particles. The effect of treatment and load application on hydraulic conductivity is evaluated by measuring imposed water pressure while injecting deionized water into the samples. The results reveal that the compressibility of the ash material is reduced, and cycling one-dimensional loading indicates that the compressibility remains improved even if the cemented bonds are degraded during the unloading-loading process. Furthermore, the reduction in hydraulic conductivity is reduced by only one order of magnitude. The undrained shear strength of the treated coal ash was assessed using a fall cone apparatus, which showed an improvement in shear strength as a function of level of cementation. The MICP-improved soil properties were used to evaluate the slope stability of a local ash pond. Finally, the immobilization of heavy metals is examined to further assess the long-term stability of ponded coal ash.