Innovative Approach for Addressing Coastal Erosion Protection Using Microbial Induced Carbonate Precipitation

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Considering the global climate change and the ensuing sea level rise, the subsequent acceleration of coastal erosion is evident. Phenomena of coastal erosion, coastal flooding and shoreline retreat are expected to show a significant increase in frequency and intensity, in global level. The effects of coastal erosion are worsened by storms, and the reduction of sediment supply associated with global warming and anthropogenic modification of rivers and coastlines. As a countermeasure to coastal erosion, this work focuses on the development of coastal artificial in-situ rocks. We developed a new method that encompasses microbes and the related mechanism is called “Microbial Induced Carbonate Precipitation” (MICP). We successfully isolated three microorganisms, Micrococcus sp., Pseudoalteromonas sp., and Virgibacillus sp., from the selected area, and investigated their effectiveness in order to make a solidified sand sample. The precipitated bounding material has also been confirmed as calcite by XRD and XRF analysis. We successfully demonstrated that all of these bacterial species are very sensitive with certain environmental parameters, such as temperature, pH, culture type, culture duration, etc. In laboratory scale, we successfully obtained solidified sand by syringe (\(d = 2.3\) cm, \(h = 7.1\) cm) solidification method bearing UCS (Unconfined Compressive Strength) up to 1.8 MPa using 0.5 M CaCl\(_2\) and urea as cementation solution at 30\(^\circ\)C. In addition, we propose a new sustainable approach for field implementation of this method through a combination of geotube and MICP mechanism, which will contribute to coastal erosion protection. The proposed approach is more economic, energy-saving, eco-friendly, and sustainable for bio-mediated soil improvement.