

Biocement: Green Building- and Energy-Saving Material

Chu Jian, Ivanov Volodymyr*, Viktor Stabnikov, He Jia, Li Bing,
Maryam Naemi

School of Civil and Environmental Engineering
Nanyang Technological University, Singapore

*Presenter Dr. Ivanov Volodymyr, email: cvivanov@ntu.edu.sg

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Abstract. Cement and chemical grouts have often been used for soil strengthening. However, high cost, energy consumption, and harm to environment restrict their applications. Biocement could be a new green building- material and energy-saving material. Biocement is a mixture of enzymes or microbial biomass with inorganic chemicals, which can be produced from cheap raw materials. Supply of biocementing solution to the porous soil or mixing of dry biocement with clayey soil initiate biocementation of soil due to specific enzymatic activity. Different microorganisms and enzymes can be used for production of biocement.

References

- [1] J.T. DeJong, M.B. Fritzges, and K. Nusslein "Microbially induced cementation to control sand response to undrained shear." *J. Geotech. Geoenviron. Eng.*, 2006. 132(11), 1381-1392.
- [2] J.T. DeJong, Mortensen, B.M., Martinez, B.C. and Nelson, D.C. "Bio-mediated soil improvement". *Ecol. Eng.*, 2010, 36(2): 197-210.
- [3] W. De Muynck, Verbeken, K., De Belie, N., Verstraete, W. "Influence of urea and calcium dosage on the effectiveness of bacterially induced carbonate precipitation on limestone." *Ecol. Eng.*, 2010, 36(2),99-111.
- [4] W. De Muynck De Belie N, Verstraete W. 2010. Microbial carbonate precipitation in construction materials: a review. *Ecol Eng.*, 2010, 36:118-136.
- [5] S.U. Gerbersdorf, Jancke, T., Westrich, B., Paterson, D.M. "Microbial stabilization of riverine sediments by extracellular polymeric substances". *Geobiology*, 2008, 6:57-69.
- [6] U. Gollapudi, C. Knutson, S. S. Bang, and M. Islam. "A new method for controlling leaching through permeable channels". *Chemosphere*, 1995, 30:695-705.
- [7] M.T. Gonzalez-Munoz, M.T., Rodriguez-Navarro, C., Martinez-Ruiz, F., Arias, H.M., Merroun, M.L. and Rodriguez-Gallego, M. "Bacterial biomineralization: new insights from *Myxococcus*-induced mineral precipitation". *Geological Society, London, Special Publications*, 2010, 336: 31-50.
- [8] M.P. Harkes, van Paassen L.A., Booster J.L., Whiffin V.S., van Loosdrecht M.C.M. "Fixation and distribution of bacterial activity in sand to induce carbonate precipitation for ground reinforcement". *Ecol Eng.*, 2010, 36:112-117.
- [9] V. Ivanov, Stabnikov, V., Zhuang, W.-Q. , Tay, S.T.- L., and Tay J.- H. "Phosphate removal from return liquor of municipal wastewater treatment plant using iron-reducing bacteria". *Journal of Applied Microbiology*, 2005, 98: 1152-1161.
- [10] V. Ivanov, V. and Chu, J. (2008). "Applications of microorganisms to geotechnical engineering for bioclogging and biocementation of soil in situ". *Reviews in Environ. Sci. Biotechnol.*, 7: 139-153.
- [II] V. Ivanov, V., Kuang, S.-L., Guo, C.-H. and Stabnikov, V. "The removal of phosphorus from reject water in a municipal wastewater treatment plant using iron ore". *J. Chem. Technol. Biotechnol.*, 2009, 84: 78-82.
- [12] Ivanov V. *Environmental Microbiology for Engineers*. CRC Press, Taylor &Frensis Group, Boca Raton, 2010. 438 p.
- [13] J.K. Mitchell, and Santamarina, J.C. "Biological considerations in geotechnical engineering". *J. Geotech. Geoenviron. Eng.*, 2005, 131: 1222-1233.
- [14] S.K. Ramachandran, V. Ramakrishnan, and S. S. Bang. "Remediation of concrete using microorganisms". *ACI Materials J.*, 2001, 98: 3-9.

- [15] L.A. van Paassen, Ghose R, van der Linden TJM, van der Star WRL, van Loosdrecht MCM. 2010. "Quantifying biomediated ground improvement by ureolysis: large-scale biogROUT experiment". J Geotech Geoenviron Eng, 2010, 1721-1728.
- [16] L.A. van Paassen, Daza, C.D, Staal, M, Sorokin, D.Y, van der Zon, W., and van Loosdrecht, M.C.M. "Potential soil reinforcement by biological denitrification." Ecol. Eng., 2010, 36(2), 168-175.
- [17] S.K. Ramachandran, Ramkrishnan V, Bang SS. "Remediation of concrete using microorganisms". ACI Mater J , 2001, 98:3-9.
- [18] K.V. Tittelboom, De Belie N, De Muynck W, Verstraete W. "Use of bacteria to repair cracks in concrete." Cement Concrete Res, 2010, 40:157-166.
- [19] V.S. Whiffin, V.S., Van Paassen, L.A., and Harkes, M.P., "Microbial carbonate precipitation as a soil improvement technique". Geomicrobiol. J., 2007, 24 (5), 417-423.
- [20] D.T. Wright, Oren A. "Nonphotosynthetic bacteria and the formation of carbonates and evaporites through time." 2005. Geomicrobiol J 22:27- 53.