Manipulating Mix Design and Surface Texture for Eco-Friendly Concrete Bio-Tiles

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BACKGROUND

Creating the cement used in concrete is a highly energy intensive process, therefore substitute materials can be used to reduce environmental impacts [1]. In addition to this, concrete is generally not recycled when it reaches its end of life, but its life expectancy can be increased through processes such as bio-cementation and reactions with seawater as is the case in traditional Roman concrete [2],[3].

PROJECT OBJECTIVES

- Reduce pollution associated with the production of concrete
- Promote growth of microorganisms on the concrete surface
- Entrain materials that are not easily recycled as aggregates in concrete

METHODS

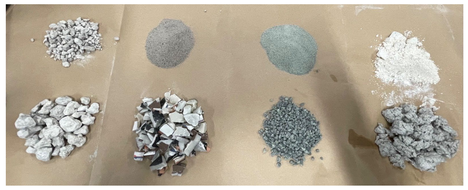

Figure 1: Materials Used in Concrete Mixtures

Mix designs were identified that had the potential to fulfill one objective. Each mix was tested for compressive strength. Afterwards, these mixes were cast into tiles with varying surface textures. This was completed to determine their potential for attracting organisms and promoting biodiversity in the surrounding environment.

Figure 2: Surface Texture Samples of Roman Concrete Tiles

Using volcanic ash and olivine as supplementary materials **cuts CO_2 emissions** and produces concrete viable for use in **eco-friendly coastal infrastructure.**

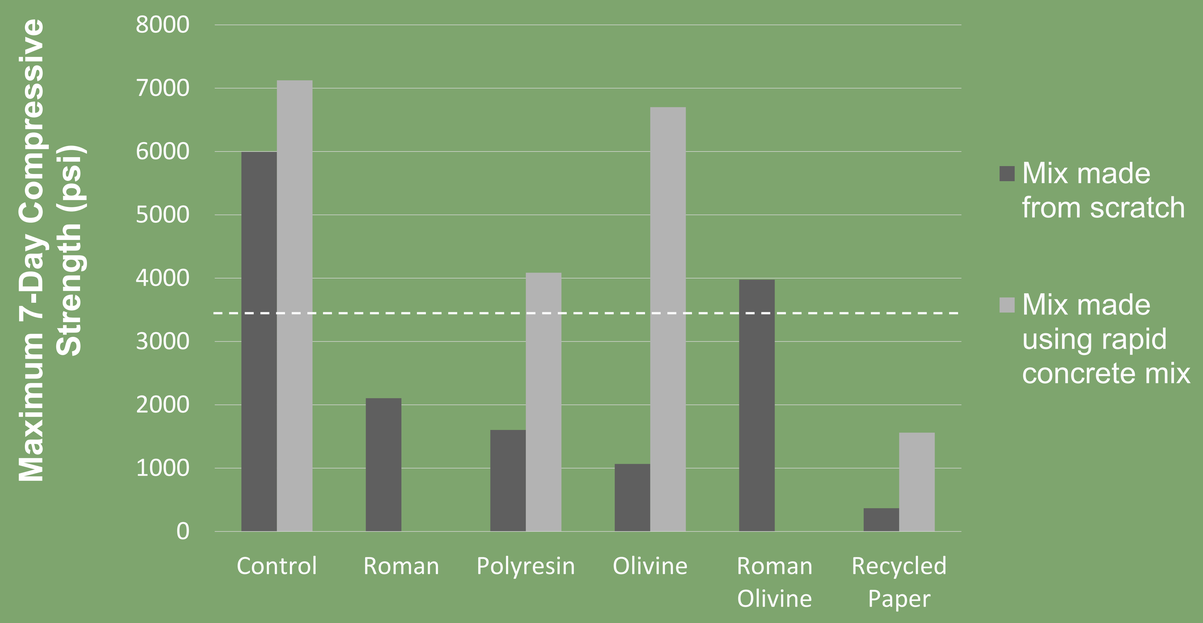

Figure 3: Compressive Strength of Different Mix Designs

Figure 4: Compressive Test Samples

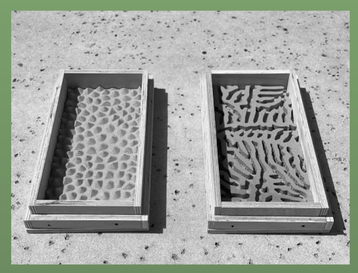

Figure 5: Textured Concrete Molds

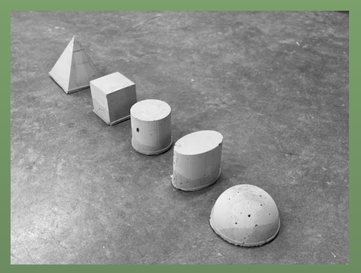

Figure 6: Surface Geometry Samples

FIU Coastal Ecosystems REU Site

RESULTS

It was discovered that while several of the mix designs reached the goal of 3500psi 7-day compressive strength, none of the mixes surpassed the strength of the control group (i.e. Portland cement, sand, gravel). Most notably, the “Roman Olivine” mix reached a 7-day compressive strength of almost 4000psi. This was deemed the optimal mix design as it replaced 17% of the cement content with supplementary cementitious materials. This mix is also favorable because olivine is known to absorb CO_2 from the atmosphere.
The concrete tiles with varying surface texture must be deployed in the field for at least one year before their efficacy at promoting biodiversity can be determined.

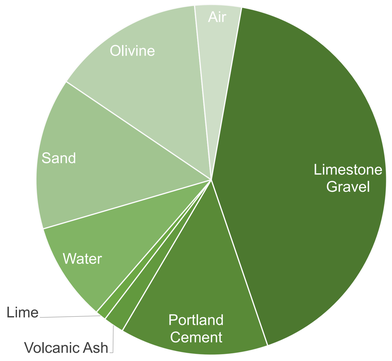

Figure 7: Roman Olivine Concrete Composition (% Volume)

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[1] M. Rubenstein, “Emissions from the cement industry,” *State of the Planet*, 09-May-2012. [Online]. Available: https://news.climate.columbia.edu/2012/05/09/emissions-from-the-cement-industry/. [Accessed: 26-Jul-2021].
[2] D. M. Iqbal, L. S. Wong, and S. Y. Kong, “Bio-Cementation in Construction Materials: A review,” *Materials*, vol. 14, no. 9, p. 2175, 2021.
[3] P. Preuss, “Roman seawater concrete holds the secret to cutting carbon emissions,” *Berkeley Lab*, 04-Jun-2013. [Online]. Available: https://newscenter.lbl.gov/2013/06/04/roman-concrete/. [Accessed: 26-Jul-2021].

ACKNOWLEDGEMENTS:

Sara Pezeshk, Shahin Vassigh
Brad Schonhoff and Katherine Castrillon
Dr. Rita Teutonico and Dr. Todd Crowl
FIU CREST CAChE
UMBC McNair Scholars Program

FIU Institute of Environment

This material is based upon work supported by the National Science Foundation under Grant No. HRD-1852123. This NSF Grant was awarded to Florida International University as part of the Research Experiences for Undergraduates (REU) Site Program. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.