Using volcanic ash and olivine as supplementary materials cuts CO₂ emissions and produces concrete viable for use in eco-friendly coastal infrastructure.

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

METHODS
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.

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 CO₂ 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.

REFERENCES:

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FIGURE LEGEND:
Figure 1: Materials Used in Concrete Mixtures
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Figure 2: Surface Texture Samples of Roman Concrete Tiles

Figure 3: Compressive Strength of Different Mix Designs

Figure 4: Compressive Test Samples

Figure 5: Textured Concrete Molds

Figure 6: Surface Geometry Samples

Figure 7: Roman Olivine Concrete Composition (% Volume)