Beneficial Use Case Study

Erosion Mitigation Units

Coal Combustion Product Type
Fly Ash

Project Name
Erosion Mitigation Units

Project Location
Clifton Springs, Victoria; Kangaroo Island, South Australia

Project Participants
Reef Design Lab, Dezeen Awards, Good Design Australia, Victorian Premier's Design Awards

Project Completion Date
2022

Project Summary
As coastal erosion and habitat degradation intensify due to climate change and historical overfishing practices, Reef Design Lab—based in Melbourne, Australia—developed a novel solution: Erosion Mitigation Units (EMUs). Designed to form a permeable barrier that reduces wave energy and simultaneously fosters native marine ecosystems, the EMUs use a specially developed low-carbon concrete that incorporates 30 percent fly ash as a replacement for portland cement. First installed in 2022 at Clifton Springs, Victoria, and later in 2023 off the coast of Kangaroo Island, these sculpted structures offer an affordable, multifunctional approach to shoreline protection and marine biodiversity restoration.

Project Description
Historically, Port Phillip Bay's shellfish reefs have been decimated by two centuries of dredging and bottom trawling. To address both ecological loss and shoreline vulnerability, Reef Design Lab designed and deployed 46 EMUs—each measuring approximately 6.5 feet in diameter and weighing 1.6 metric tons—60 meters offshore in the shallow waters of Clifton Springs. A second installation of 12 EMUs was later completed near Kingscote on Kangaroo Island.

The EMUs were fabricated using a concrete mix composed of 30 percent fly ash and a recycled shell aggregate in place of traditional rock or gravel. This shell-based aggregate, while inherently weaker, was made workable thanks to the use of fly ash, which lowered the carbon footprint and improved the mix's compatibility with the recycled material. Vibrating the mix during casting allowed the shell particles to rise to the surface, which were then exposed through sandblasting to create a complex, textured substrate ideal for marine colonization.

The units' undulating design promotes water flow and encourages recreational interaction such as swimming and snorkeling, while also attracting oysters, mussels, sea snails, shrimp, crabs, and rays. Installed via a simple barge and crane system anchored to the seabed, the EMUs have already shown early signs of success, with growing seagrass mounds, stable placement, and increased marine activity.

The project was recognized with the 2023 Dezeen Award for Sustainable Design (Building Product of the Year), a Good Design Award for Sustainability, and a commendation from the Victorian Premier's Design Awards. As the EMUs continue to be monitored, their multifunctional benefits are positioning this form of engineered reef as a scalable, sustainable model for future coastal protection initiatives.

Photo - Alex Goad and Reef Design Lab