Title: Nature-Inclusive Solutions for Coastal Erosion Protection

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The PhD project addresses the significant global challenge of coastal erosion, which is predicted to result in the loss of 6,000 to 17,000 sq. km of land during the 21st century, potentially leading to the displacement of 1.6 to 5.3 million people and incurring costs ranging up to 1 trillion USD. Various strategies have been developed to mitigate the risk of coastal erosion. Nature-inclusive solutions for coastline protection, such as reef and vegetation preservation, have gained popularity over traditional hard-engineered structures. Coral reefs act as natural barriers, absorbing wave energy and reducing erosion by stabilising coastlines, protecting against the damaging effects of storms and rising sea levels. However, climate change poses a significant threat to coral reefs worldwide. Hence, there is a growing need to develop artificial reefs using sustainable, bio-compatible materials.

The research questions focus on developing an environmentally safe artificial reef system using bio-compatible coral sand concrete to control coastal erosion, understanding the impact of various concrete properties on coral settlement and growth, and constructing a low-carbon artificial reef system to prevent wave-based erosion of coastal soils. The study also aims to evaluate the environmental impacts of this system, providing a resilient approach to protect coastlines from erosion.

The PhD project will develop a sustainable artificial reef system, introducing an innovative concept of nature-inclusive solution to coastal erosion through a combination of material innovation and physical modelling. Task 1 involves the development of sustainable and low-carbon cement-based materials for artificial reefs. Coral sand aggregate and low-pH cement, replacing traditional reinforced concrete, will be tested for the production of a durable and resilient concrete artificial reef base. Task 2 will focus on more ecologically friendly artificial reef, which will provide a foundation habitat for corals allowing for recruitment and settlement of coral polyps. The bio-compatibility of the artificial reef will be assessed and optimised by planting various corals and monitoring their growth. In Task 3, physical modelling, involving a series of tests carried out in a lab-scale water tank, will be conducted to assess the viability of using a sustainable and low-carbon artificial reef base to mitigate coastal erosion. This pioneering research will eventually develop an environmentally-friendly artificial reef system, offering a sustainable approach to protect coastlines from erosion and supporting biodiverse marine environments.

Training opportunities:

The PhD student will receive interdisciplinary training in Marine Ecology, Civil and Environmental Engineering, and Physical Modelling at the Universities of Surrey and Reading. They will gain hands-on experience in various labs at Surrey, including the Surrey Advanced Geotechnical Engineering Lab. They will also receive training in bio-compatibility assessment at Reading University. A unique

two-month placement at Hong Kong University of Science and Technology is included, where they will work within renowned Department of Civil and Environmental Engineering. This opportunity is open to candidates from diverse backgrounds.