Investigation of Natural Beachrock and Physical–Mechanical

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Typically, the mitigation of coastal erosion is achieved by amending surface conditions using materials such as concrete. The objective of this study is to evaluate the feasibility of constructing artificial beachrocks using natural materials (e.g., microbes, sand, shell, pieces of coral, and seaweed etc.) within a short time, and to propose the method as a novel strategy for coastal protection. Initially, a survey on resistivity and a multichannel analysis of seismic waves (MASW) were conducted along the coastal lines to characterize and elucidate the subsurface structure of existing beachrocks in the Southeast Yogyakarta coastal area, Krakal–Sadranan beach, Indonesia. The field survey on natural beachrocks suggests that both resistivity and shear wave velocity were higher in the deeper deposits compared to the underlying unconsolidated sand layer within a depth of approximately 1.5 m and covering an area of 210.496 m^2 for the α-section and 76.936 m^2 for the β-section of beachrock deposit. The results of the sand solidification test in the laboratory showed that treated sand achieved unconfined compressive strength of up to around 6 MPa, determined after a treatment period of 14 days under optimum conditions.

Keywords: beachrock, resistivity, MASW, physical properties,

The coastal zone comprises a narrow strip of coastal lowlands and a vast area of coastal waters. It has become an important site for extensive and diverse economic activities. The rise in sea level, which is attributed to global warming, has resulted in coastal sand drainage around the world, thus mean sea level will result in the retreat of unprotected coastline [1,2]. One of the common methods of preventing coastal erosion is covering the surface of the sandy beach with concrete. However, this method has a significant impact on the environment and destroys the surrounding landscape.

Beachrock is a sedimentary rock that occurs in the intertidal zone of sandy beaches, mainly in the tropics and subtropics [3]. It is composed of the same material as the surrounding beach, and most of the cement material is carbonated. Most of the research on beachrock is related to its geological or chemical properties, and there is very little literature on the underground structure of beachrock. There have been a few cases of electrical exploration on Thassos Island, Greece [4]. To elucidate the formation process of beachrock, it is important to understand the structure of its underground and surrounding area. Kubo et al. [5] investigated beachrock on Yagaji Island, Okinawa, Japan, using a direct current (DC) electrical survey on a seismic surface and showed the results of the structure around the seashore to a depth of more than 10 m. Insufficient data in the South East Asian country related to recent beachrock sedimentary is a challenge for further study because of the weathering process is extremely rapid, especially is intertropical areas. This study serves as a pilot research study on the beachrock sedimentary processes at intertropical areas and compares the rock properties of the artificial beachrock, which is fabricated using the microbially induced carbonate precipitation (MICP) method, as a solution to coastal erosion as new revetment technology with a self-repair function. Upon receiving successful results following MICP treatment using marine ureolytic bacterium for the desired engineering application, further studies were carried out to (i) examine the underground structure of natural beachrock based on a geophysical survey, (ii) develop a 3D beachrock structure, and (iii) identify the physical and mechanical properties, such as porosity, compressional wave (P-wave) velocity (VP), shear wave (S-wave) velocity (VS), and strength characteristics of artificial beachrock. These properties were relatively comparable with those of natural beachrocks and were significantly determined by the precipitated crystals based on the MICP treatment.
