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COASTAL ENGINEERING

THE CONCEPT OF SEDIMENT TRANSPORT AND HOW IT AFFECTS COASTAL AREAS.

Sediment refers to the conglomerate of materials, organic and inorganic, that can be carried away by water, wind or ice. While the term is often used to indicate soil-based, mineral matter (e.g. clay, silt and sand), decomposing organic substances and inorganic biogenic material are also considered sediment. Most mineral sediment comes from erosion and weathering, while organic sediment is typically detritus and decomposing material such as algae. These particulates are typically small, with clay defined as particles less than 0.00195 mm in diameter, and coarse sand reaching up only to 1.5 mm in diameter 5. However, during a flood or other high flow event, even large rocks can be classified as sediment as they are carried downstream 6. Sediment is a naturally occurring element in many bodies of water, though it can be influenced by anthropogenic factors.

What is Sediment Transport?

Sediment transport is the movement of organic and inorganic particles by water. In general, the greater the flow, the more sediment that will be conveyed. Water flow can be strong enough to suspend particles in the water column as they move downstream, or simply push them along the bottom of a waterway. Transported sediment may include mineral matter, chemicals and pollutants, and organic material.

Another name for sediment transport is sediment load. The total load includes all particles moving as bedload, suspended load, and wash load 11.

HOW IT AFFECTS COASTAL AREAS

In the coastal zone there is an interaction between the hydrodynamic forces and sediment and bathymetric profile of the bottom. The fluid stream due to friction forces, runs the sediment from the bottom and the sediment material is transferred over a certain distance. So, moving water causes the bottom sediment transport, and the spatial variability of sediment transport volume causes changes in morphology of the bottom, which in turn affects the water movement change. The question of what controls the rate and method of sediment transport and the nature of changes in the level of the bottom occupied researchers for over a century. Numerous relations between the level of bottom elevation and the rate of sediment transport and flow parameters, including several empirical and far less theoretical relations have been proposed. Empirical relations generally cannot be applied beyond the limited conditions for which they were formulated, and most theoretical propositions depends on arbitrary assumptions with only a little or no physical credibility (ALLEN 1977). Comprehensive description of such a complex system is very difficult and therefore only by successive approximations and simplify-cations it is possible to describe the phenomena occurring in the coastal zone of the sea. Despite that in recent years there has been a significant progress, still many issues remain unresolved.

Hydrodynamic processes (waving and wave driven currents) are the driving force of the sediment transport and the evolution of seabed. Actual parameters of morphodynamical and lithodynamic processes depend on the kind Szymon Sawczyński, Leszek M. Kaczmarek166Technical Sciences 17(2)2014

of sediment which residues in the seabed and on the supply of these fractions of sediment that are susceptible to the effects of water flow in the bottom layer (transportation in the form of bedload transport and suspended as a result of shear bottom stresses impact). First, the parameters of the litho – and morphodynamic processes depend on the wave climate, the bathymetric bottom arrangement and hydrotechnical facilities in the coastal zone of the sea. In the traditional division (GRADZIŃSKI et al. 1986) adopted in considerations concerning the transport of sediment, the sediments are transported in three layers, starting from the lowest point: bedload, saltation and in the layer of suspended sediments. The bedload layer covers an area below the bottom of the theoretical level of very high concentration of sediment particles set in motion under the influence of the shear stress impacting the bottom surface. Shearing the bottom layer being the result of shear stress causes only a slight increase in the space between the particles of sediment. Surface friction and intermolecular collisions cause energy transfer between individual molecules of the sediment. The thickness of the bedload layer ranges from one to several tens of sediment grain diameters (NIELSEN 1992, O’DONOGHUE,WRIGHT 2003).In saltation layer with a thickness of about few centimetres, the sediment particles are transported and they are raised from the bottom as a result of turbulent pulsations and punching through the falling sediment particles on the small height above the bottom. Due to the short time of the particles staying in suspension, their transport depends on the oscillation velocity of the wave motion (GRADZIŃSKI et al. 1986). Suspension layer with a thickness of about meters covers an area over the saltation layer up to the free surface of the water column. In this layer, sediment particles reside for a period longer than the period of the wave, and their resultant transport is mainly related to the return current which is characteristic for the coastal zone of the sea. To describe the transport of sediment in suspension it is applied the theory of compensating return current (SVENDSEN 1984). Sediment transport may take place in two basic regimes. In the regime in which the bottom is covered with bottom forms, e.g. in the form of ripples or in the regime where the bottom is flat with a mobile “carpet” of sediments or flat– stationary. The ability of occurrence of these sediment movement variants depends primarily on the type of sediments building the sea bottom and on the intensity of the waving impact on the bottom