Flow and sediment transport induced by a plunging solitary wave

Two parallel experiments involving the evolution and runup of plunging solitary waves on a sloping bed were conducted: (1) a rigid-bed experiment, allowing direct (hot film) measurements of bed shear stresses, and (2) a sediment-bed experiment, allowing for the measurement of pore-water pressures, and for observation of the morphological changes. The two experimental conditions were maintained as similar as possible. The experiments showed that the complete sequence of the plunging solitary wave involves the following processes: Shoaling and wave breaking; Runup; Rundown and hydraulic jump; and Trailing wave. The bed shear stress measurements showed that the mean bed shear stress increases tremendously (with respect to that in the approaching wave boundary layer), by as much as a factor of 8, in the runup and rundown stages, and that the r.m.s. value of the fluctuating component of the bed shear stress is also affected, by as much as a factor of 2, in the runup and hydraulic jump stages. The pore-water pressure measurements showed that the sediment at (or near) the surface of the bed experiences upward-directed pressure gradient forces during the downrush phase. The magnitude of this force can reach values as much as approximately 30% of the submerged weight of the sediment. The experiments further showed that the sediment transport occurs in the sheet flow regime for a substantial portion of the beach covering the area where the entire sequence of the wave breaking takes place. The bed morphology is explained qualitatively in terms of the measured bed shear stress and the pressure gradient forces.

General information
State: Published
Organisations: Coastal, Maritime and Structural Engineering, Department of Mechanical Engineering, Meteorology, Wind Energy Division, Risø National Laboratory for Sustainable Energy, Grontmij A/S, Technical University of Denmark
Contributors: Sumer, B. M., Sen, M., Karagali, I., Ceren, B., Fredsøe, J., Sottile, M., Zilioli, L., Fuhrman, D. R.
Pages: C01008
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Geophysical Research
Volume: 116
Issue number: 1
ISSN (Print): 0148-0227
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.19 SJR 2.272 SNIP 1.475
Web of Science (2017): Impact factor 2.752
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.36 SJR 2.369 SNIP 1.558
Web of Science (2016): Impact factor 2.733
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.39 SJR 2.754 SNIP 1.605
Web of Science (2015): Impact factor 3.318
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.27 SJR 2.853 SNIP 1.757
Web of Science (2014): Impact factor 3.426
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.38 SJR 3.088 SNIP 1.809
Web of Science (2013): Impact factor 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.93 SJR 2.917 SNIP 1.522