An Evaluation of Suspended Sediment Concentration Models under Breaking Waves

Gabriel Lim[1], Ravindra Jayaratne[1], Tomoya Shibayama[2]

[1]University of East London, 4-6 University Way, London, UK
[2]Waseda University, 3-4-1 Okubo, Tokyo, Japan

Phone: +44-(0)-208-2232536
E-mail: r.jayartne@uel.ac.uk

Introduction: Sediment suspension in and outside the surf zone predominantly occurs due to the vortices generated by sand ripples, movement of the bottom boundary layer with high bed shear stress (sheet flow) and the turbulence generated by breaking waves (Jayaratne and Shibayama, 2007). However, developing an accurate and reliable concentration model for large-scale breaking waves is a challenging task due to the complex nature of the phenomenon and measurements in field-scale experiments. The present study evaluates existing suspended sediment concentration (SSC) models under breaking wave agitation, including the model of Jayaratne and Shibayama (2007), against published data. The model of Jayaratne and Shibayama (2007) is compared for performance against the model of Shibayama and Rattanapitikon (1993).

Methods: The performances of different models are compared against one another using plots, to see which are most efficient and accurate. Figures 1 and 2 show the comparisons between the proposed model (Jayaratne and Shibayama, 2007) and alternative model (the model of Shibayama and Rattanapitikon, 1993) against the datasets of Ribberink et al. (2014) (plots of other datasets also included in full paper).

Results: It was found using these datasets that the model of Jayaratne and Shibayama (2007) predicted SSC to a high level of accuracy; more accurately than the model of Shibayama and Rattanapitikon (1993), in all regions including the shoaling zone and breaker zone.

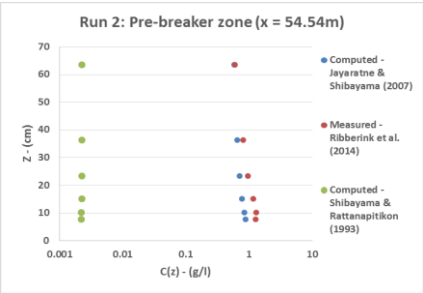

Fig. 1: Comparison of concentration profile plots – Pre-breaker zone: Ribberink et al. (2014, red) vs. proposed model (blue) and alternative model (green)

[*Note: Z = height above bed, C(z) = concentration profile*]

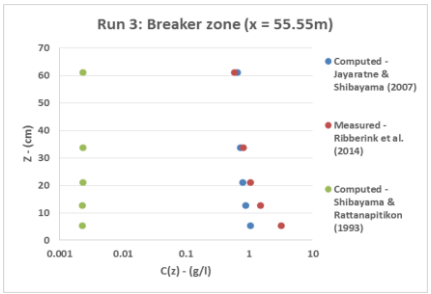

Fig. 2: Comparison of concentration profile plots – Breaker zone: Ribberink et al. (2014, red) vs. proposed model (blue) and alternative model (green)

Discussion: Inconsistencies were found in the degree of accuracy to which the two models predicted SSC. One of the trends identified when calibrating the SSC models with the dataset of Ribberink et al. (2014), was that the proposed model often predicted less accurately lower down in the water column (i.e. near the bed) than at the top of the water column, as shown in Figs. 1 and 2. This trend was found to be more prominent in the breaker zone region (than in other regions) where the turbulence from breaking waves is known to be highest. Of course, no conclusions can be made based on this trend alone, but it could have various implications. One of the implications would be that the model has not accounted for certain processes that occur in (and around) the breaker zone, causing the model to be less effective for predicting SSC in these regions. As mentioned in earlier sections, the wave breaking phenomenon is very complex and is not yet fully understood. Before conclusions can be made regarding the reason(s) for the discrepancies, further investigation is required.

References: [1] Jayaratne and Shibayama (2007) *Suspended sediment concentration on beaches under three different mechanisms.* Coastal Engineering Journal, World Scientific, 49(04), pp.357-392. [2] Ribberink et al. (2014) *Sandt-Pro: Sediment transport measurements under irregular and breaking waves*. Proceedings of International Conference on Coastal Engineering, 1(34). [3] Shibayama and Rattanapitikon (1993) *Vertical distribution of suspended sediment concentration in and outside surf zone*. Coastal Engineering in Japan, JSCE, 36(1).