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Stem breakage of salt marsh vegetation under wave forcing: A field and model study

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1 Stem breakage of salt marsh vegetation under wave forcing:  
2 a field and model study

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10 **Abstract**

11 One of the services provided by coastal ecosystems is wave attenuation by vegetation, and  
12 subsequent reduction of wave loads on flood defense structures. Therefore, stability of veg-  
13 etation under wave forcing is an important factor to consider. This paper presents a model  
14 which determines the wave load that plant stems can withstand before they break or fold.  
15 This occurs when wave-induced bending stresses exceed the flexural strength of stems. Flex-  
16 ural strength was determined by means of three-point-bending tests, which were carried out  
17 for two common salt marsh species: *Spartina anglica* (common cord-grass) and *Scirpus mar-*  
18 *itimus* (sea club-rush), at different stages in the seasonal cycle. Plant stability is expressed  
19 in terms of a critical orbital velocity, which combines factors that contribute to stability:  
20 high flexural strength, large stem diameter, low vegetation height, high flexibility and a low  
21 drag coefficient. In order to include stem breakage in the computation of wave attenua-  
22 tion by vegetation, the stem breakage model was implemented in a wave energy balance.  
23 A model parameter was calibrated so that the predicted stem breakage corresponded with  
24 the wave-induced loss of biomass that occurred in the field. The stability of *Spartina* is  
25 significantly higher than that of *Scirpus*, because of its higher strength, shorter stems, and  
26 greater flexibility. The model is validated by applying wave flume tests of *Elymus athericus*  
27 (sea couch), which produced reasonable results with regards to the threshold of folding and  
28 overall stem breakage percentage, despite the high flexibility of this species. Application of  
29 the stem breakage model will lead to a more realistic assessment of the role of vegetation  
30 for coastal protection.

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