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# A THEORY OF BREAKERS AND BREAKING WAVES

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

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in

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by

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# ABSTRACT

## A THEORY OF BREAKERS AND BREAKING WAVES

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Breakers are ubiquitous on the surface of large water bodies in nature and almost always accompany the flow past bodies immersed in flowing water, such as ships and bridge piers. Despite this fact and their considerable practical importance, they have been not well understood and a variety of questions arises in connection with their occurrence, onset, equilibrium configuration, stability and consequences. From a scientific point of view, the subject is made more difficult by the fact that breakers in nature are often unsteady and involve nonlinear free surface phenomena and turbulent dissipative processes.

A physical and mathematical model for steady spilling breakers is proposed which is shown to be in very good agreement with careful systematic measurements of Duncan , based on breaking waves produced by a towed hydrofoil. The steady breaker is modeled as an almost stagnant eddy riding on the front of an underlying gravity wave. The equilibrium of the breaker is the result of balance between the hydrostatic pressures due to the weight of the eddy and friction at the dividing streamline between the eddy and the underlying flow. The breaker causes a pressure to act on the underlying wave, determining its ultimate shape and leading to its suppression. The analysis tends to explain the appearance of a threshold steepness for breaking in experiments and the existence of a marginal stability zone where both breaking and non-breaking solutions can exist.

This model for steady breakers is extended to include studies of breaker stability and natural modes and a nonlinear theory of non-steady breakers is developed. The unsteady breaker is visualized as turbulent gravity current which rides down the forward slope of the underlying wave and grows due to turbulent entrainment from the flow below. Small oscillations around equilibrium are studied analytically. This analysis allows to assess the stability of the breaker and tends to explain Duncan's observations of natural oscillations in the length of the breaker. A numerical scheme is developed to study the dynamics of the breaker under conditions when the underlying wave is not steady.

Conclusions are drawn on the implications of the model for some engineering applications.