Coastal Engineering Technical Note

ONE-LINE (SHORELINE CHANGE) MODELS

PURPOSE: To indicate the cases in which a simple one-line numerical model of shoreline erosion and accretion can be used for obtaining preliminary design information on the shoreline response to a coastal structure. Shoreline is defined as the intersection of any desired water level and the beach face.

GENERAL: Shoreline evolution near coastal structures can be represented by simple, one-line (shoreline) numerical models that predict the long-term change in shoreline location due to the erosion or accretion that occurs following the construction of a coastal structure such as a groin, jetty, or breakwater. These models make a number of simplifying assumptions.

1. The shoreline slope in a direction normal (perpendicular) to a base-line representing the original shoreline is assumed to remain constant.

2. Littoral transport is considered as a total quantity calculated from an equation such as that found in the Shore Protection Manual (1984), i.e., there is no distribution of motion across the surf zone.

3. Littoral transport is determined from a limited number of input parameters, e.g., breaking wave height, wave period, and breaking wave angle (the angle between the wave crest and the shoreline at the position where the wave breaks).

These models are intended for use as simple models for prediction of changes in the shoreline location only. They compute variations in littoral transport along the shoreline and adjust its position accordingly. They can not be used when more sophisticated analysis of sediment distribution is required.

INPUT REQUIRED: General input to a one-line model is the local wave climate (wave period, height, and direction) and the proposed location of the coastal structure which is under investigation. Information on local bathymetry is

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needed for wave refraction analysis which is required to determine breaking wave height and breaking wave angle. Coastal structures are assumed, in the model, to be impermeable. Input information required on the structure includes the proposed length and orientation, i.e., the end points of the structure. Existing models have been developed for straight structures only (no doglegs in the structure).

MODEL OUTPUT: One-line models predict changes in shoreline location; i.e., when an initial shoreline location is known, the models will predict changes in the initial location as a function of time. Variation of the structure location as input to the model (variation of length and orientation) allows comparison of different design options to find the optimum design considering the effects on the shoreline, the relative size and cost of the structures, and any desired shoreline changes. The predicted shoreline changes for the final selected design can be used to determine beach-fill requirements for the project. The one-line models are intended to provide quick, low-cost predictions.

APPLICATIONS: Primary applications of one-line models have been to single structures, although the models could be developed for groups of structures. Le Méhauté and Soldate (1980) applied a one-line model to predict shoreline evolution near a jetty. This model is for long-term changes to the shoreline; i.e., it does not model the seasonal changes in beach profile due to variations in wave climate from season to season during the year, and it does not model short-term variations caused by individual storms. This model includes a FORTRAN IV program listing and directions on use of the program.

Perlin (1979) applied a one-line model to a shore-parallel detached breakwater. The model simulated the shoreline position of a tombolo formed behind the breakwater. This model is also for long-term changes.

Kraus and Harikai (1983) have applied a one-line model to a combination of structures including a breakwater, a jetty, and shore-parallel breakwaters. This model has been written in BASIC for use on minicomputers, and is used for long-term evolution of the shoreline. It was found that the accuracy of the results increases with the length of time simulated in the model. This is due to a "smoothing out" of short-term seasonal changes.

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LIMITATIONS: One-line numerical models are based on simplified analysis of erosion and accretion of segments of a shoreline. These models cannot be used to predict changes in onshore-offshore slopes, bar formation, or changes in bathymetry other than shoreline location. The models will not predict the seasonal variations in a shoreline resulting from changes in onshore-offshore transport, but they can predict seasonal variations that result from changes in longshore transport. The models may be inaccurate where large onshore-offshore movement of sediment occurs. The models generally deal with impermeable structures.

ADDITIONAL INFORMATION: Information on the Le Méhauté and Soldate model and the present availability of other models can be obtained from Nicholas C. Kraus, Coastal Processes Branch, CERC by calling (601) 634-2018 (FTS 542-2018).

REFERENCES:

Kraus, N. C., and Harikai, S. 1983. "Numerical Model of the Shoreline Change at Oarai Beach," Coastal Engineering, Vol 7, No. 1, pp 1-28.

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Perlin, M. 1979. "Predicting Beach Platforms in the Lee of a Breakwater," Proceedings of Coastal Structures '79, ASCE, pp 792-808.

Shore Protection Manual. 1984. 4th ed., 2 vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, US Government Printing Office, Washington, DC.

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