25. DESIGN OF COASTAL STRUCTURES AGAINST EROSION IN HA TINH PROVINCE – VIETNAM

Nguyen Xuan Doan[1*], Thieu Quang Tuan[2], Tadashi YAMADA[3]

[1]Graduate School of Science and Engineering, Chuo University
(〒112-8551, Japan–Tokyo–Bunkyo–Kasuga 1-13-27)
[2]Faculty of Marine and Coastal Engineering, Vietnam Water Resources University
(175 Tay Son-Dong Da-Hanoi-Vietnam)
[3]Dept. of Civil and Environment Engineering, Chuo University
(〒112-8551 Japan–Tokyo–Bunkyo–Kasuga 1-13-27)
*E-mail: *doannx55@wru.vn*

Cam Nhuong coastal construction is built at location where beach erosion causes serious problems. However, since it has constructed for 2002 after several storms and due to spatial changes in wave climate, tidal currents, sediment composition the dike was partial damaged. Therefore, this research analysis of the shoreline developments in the past and estimated developments in the future, the physical and hydrodynamic processes causing erosion will be properly identified. Finally, the accurate hard coastal construction alternate is given.

Key Words: *Coastal construction, jetty, sea wall, sediment transport, wave overtopping.*

1. INTRODUCTION

Jetties are long, narrow, dam-like structures that are built more or less perpendicular to the coast to prevent the shoaling and migration of inlet channels or navigation (approach) channels and to protect the channel entrance against storm waves.

A seadike is a sand or soil dike (artificial sand or soil dune) protected on both sides by armour layers and filter layers to prevent erosion of sand. in case of strong tidal currents passing the structure (seadike protruding into sea).

Vietnam is located within one of the main basins of tropical storms in the northwest Pacific with an average striking frequency of about six storms per year. To protect the hinterland from the impact of typhoons such as coastal erosion and surge inundation, the sea-dike system in Vietnam is rather long (over 200 km) and was built and rehabilitated over the past many generations. Due to economic constraints most sea-dikes are low-crested (ranging typically from 4,0 to 5,0 m in crest level), irrespective of many rehabilitation efforts. The amount of wave overtopping over the dikes during storms is thus very large, i.e. up to hundreds of litters per second per unit dike width at some locations.

2. RESEARCH SCOPE AND METHODOLOGY

This research scope to typical hydraulic (wave and water level) and dike geometric (geometry of dike slopes, sediment transport.).

Reports of dike failures due to typhoons over the past decades indicate that wave overtopping, which induces erosion of the inner slope, is the major cause of sea-dike failures leading to dike breaching in Vietnam, especially at the northern delta and the northern part of the central coast. Seadike breaching incidents in the past brought about catastrophic consequences in terms of loss of lives and damages to coastal infrastructures.

The following two main research activities are identified:

• Laboratory investigation of the average discharge of wave overtopping on dikes.
• Investigation of the characteristics of the wave overtopping flow on dikes.

The project limits its research scope to typical hydraulic (waves and water level) and dike geometric (geometry of dike slopes and foreshore) conditions of sea-dikes in the northern delta and north of the central coast of Vietnam, where dikes are mostly subjected to severe wave overtopping.

In order to fulfil the above objectives, extensive laboratory experiments of wave overtopping on sea-dikes with soil and grass on the inner slope will be carried out. The test program is a combination matrix constituted by various hydraulic and dike geometric conditions. Measured quantities will be wave parameters at the dike toe, wave overtopping discharge, and instantaneous wave overtopping flow parameters at the dike crest and the inner slope.

3. RESULT

Sediment transport: The Cerc formula

$$Q = \frac{K}{16\sqrt{\gamma_b}} \rho g^{3/2} H_{sb}^{5/2} \sin(2\theta_b) \qquad (1)$$

Q:The submerged total longshore transport rate.
K : Dimensionless coefficient.
γ_b : Breaker index.
ρ : Density of water.
θ_b: Wave angle at breaking.
g : The acceleration due to gravity.
H_{sb} : Significant wave height at breaking.

Theory and calculation of dike height based on wave overtopping criteria.

$$\frac{q}{\sqrt{gH_{m0}^3}} = \frac{0,67}{\sqrt{\tan\alpha}}\gamma_b\xi_0 \exp\left(-4,3\frac{R_c}{H_{m0}}\frac{1}{\xi_0\gamma_b\gamma_f\gamma_\beta\gamma_v}\right) \qquad (2)$$

R_c : free board height.
H_{m0} : Wave height.
ξ_0 : wave breaking parameter.
γ_f : reduction factor due to slope roughness.
γ_β : reduction factor due to oblique waves.
γ_v : reduction factor due to crown wall.
q : average wave overtopping discharge.
α : dike slope angle.

The crest elevation of sea dike.

$$H_{dd} = H_{hws} + R_c + a \qquad (3)$$

H_{dd} : Design dike crest elevation.
H_{hws} : Maximum astronomical tide, 130TCN – 2002.
R_c : Crest freeboard.
a : Safety factor.

EXPERIMENTAL STUDY ON WAVE OVERTOPPING AT SEADIKES.

The Wave Overtopping Simulator is a device that can simulate overtopping wave tongues on a real dike crest, Van der Meer et al (2006, 2007 and 2008).

In the **Fig.1** The deepest point at the dike toe is approximately 0.5m.

The damage at the dike toe after maximum discharge of 70 l/s/m representing a simulated storm in 4 hours in reality.

In the **Picture 1** shows the wave overtopping created by Wave Overtopping Simulator on the inner slope covered with grass during the experiment.

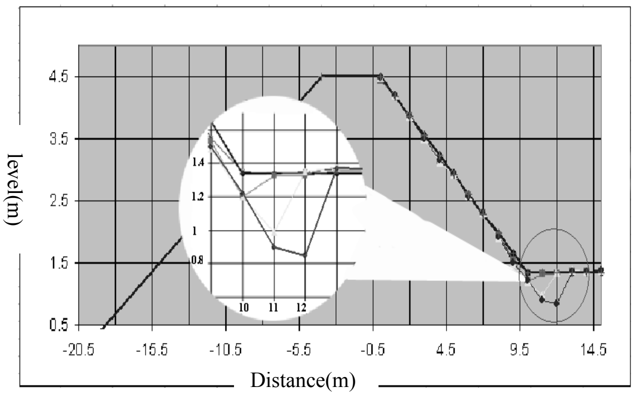
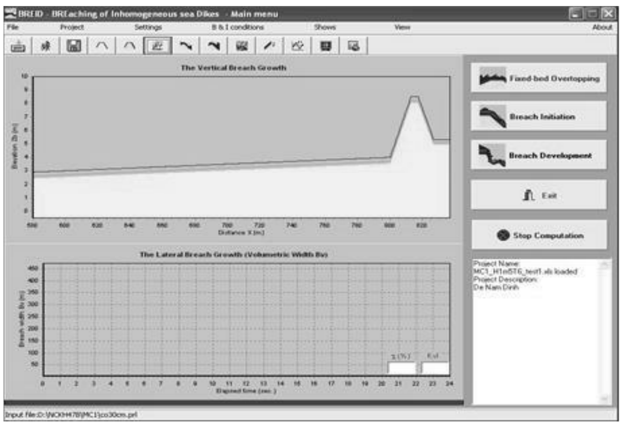


Fig.1 Erosion by wave overtopping.

Picture 1 Actual performance.



Picture 2 BREID software.

Table 1 The calculation parameters.

Δt (s)	Δx (m)	Time (h)	Water level (m)	Overtopping discharge (l/m/s)
0.01	0.2	4	4.0	40.0

In the **Picture 2** Conduct research erosion process on the inner slope covered by Bermula grass with BREID program, with the initial condition and boundary condition: Crest elevation is +4.5 m, slope m = 4, m '= 3, dike without crest wall and berm.

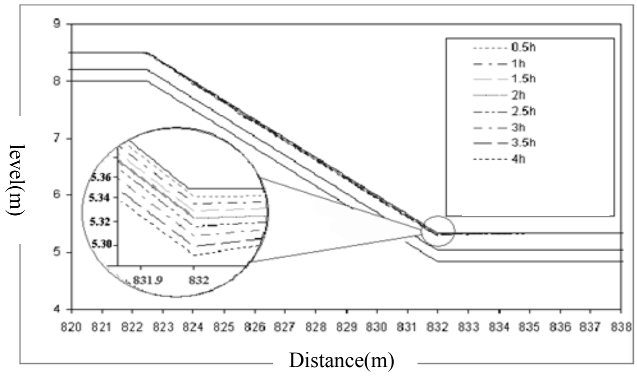


Fig.2 The standard inner slope.

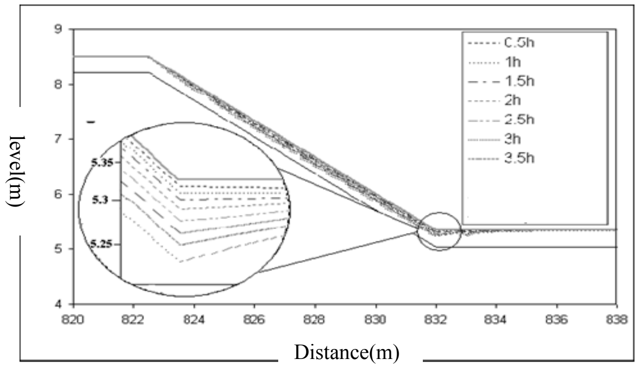


Fig.3 Good Bermuda grass.

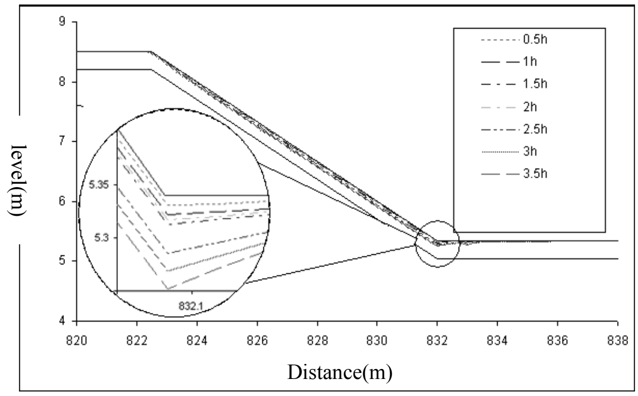


Fig.4 Bermuda grass layer is thin.

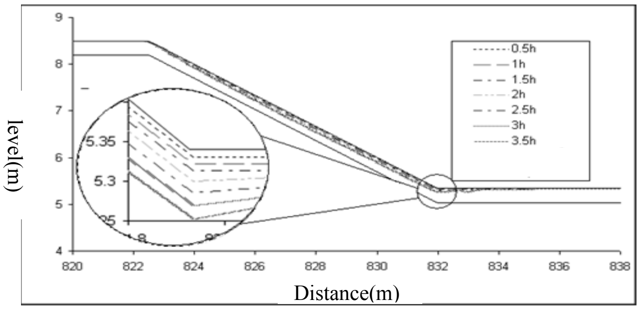


Fig.5 Clay layers.

Assuming wave overtopping discharge is 40 l/s/m with cross-sectional geometry and hydraulic boundary conditions above, running the wave overtopping module to determine the design water level. This work aims to create wave overtopping discharge as the designed. Results are shown in **Table 1.**

In the case of standards inner slope, grass and clay layers, the wave overtopping in 3.5h, 40 l/s/m will make a slope eroded about 14cm (**Fig.2, Fig.3** and **Fig.5**).

In other hand, with the similar wave overtopping parameters as above, good quality grass but exists a kind of initial damaged depth 5cm in the inner slope, then after 4h, the deepest eroded is 20cm (**Fig.4**), erosion area appear grass roots in the clay layer, if the waves continue to spill over in this case, the sea dikes will be destroyed due to serious because the grass roots have reached the limit and the dike's sand core layer has revealed.

5. CONCLUSIONS

These structures are built along a limited section of the shoreline as a last defence line against the waves, when natural beaches and dunes are too small or too low to prevent erosion due to high waves. Erosion of downdrift shores may be accelerated by wave reflection from the structure. Calculation of the crest level of sea dike can be used overtopping or run-up wave.

Different grass slopes were tested with series of increasing values of mean wave overtopping discharge, each lasted for 4 hours representing a simulated stom in reality.

Compared with field experiments with Wave Overtopping Simulator, research methods grass roof in the storm erosion according to numerical models have many outstanding advantages. This method does not require funding and human resources such as field experiments. while not causing damage to buildings at the research site.

With the parameters model have been tested, can be applied to predict the erosion of sea dikes toe. Counselors can also refer to the high computational design and reasonable structure to carry.

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